Environmental Assessment of the Alaskan Continental Shelf

Quarterly Reports of Principal Investigators for October — December 1978

VOLUME II

Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado

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U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Environmental Research Laboratories

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

TRANSPORT

Contents

QUARTERLY REPORT

Contract No.: 03-5-022-67, T.O. #3

Research Unit No.: 91

Reporting Period: 1 October - 31 December 1978

Number of Pages: 11

Current Measurements in Possible Dispersal Regions of the Beaufort Sea

Knut Aagaard

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Seattle, Washington 98195

27 December 1978

A78-29

I. Objectives

The objective of this work has been to obtain long-term Eulerian time series of currents at selected locations on the outer shelf of the Beaufort Sea. Such measurements are necessary to describe and understand the circulation on the outer shelf. It is this circulation which transports and disperses the plankton, substances of biological and geological consequence, and pollutants. The water motion also influences the ice distribution and drift. The current time series must be long enough to define the important temporal scales of motion.

II. Field Activities

These are described in the attached Preliminary Report, Ref.: M78-65.

III. Results, and IV. Preliminary Interpretation of Results

The recent mooring recoveries resulted in the following time series of significant length:

Mooring No.	No. of Long Time Series	Deployed	Recovered
Lonely #4 (sounding: 200 m)	1	12 November 1977	30 October 1978
Lonely #5 (sounding: 100 m)	1	12 March 1978	2 November 1978
Lonely #6 (sounding: 200 m)	2	11 March 1978	11 November 1978

V. Problems Encountered

Two moorings were not recovered, as described in the attached Preliminary Report. In each case this was due to failure of the acoustic release. We have spent considerable time trying to ascertain the cause of the failures, but can obviously not be certain without the releases themselves being in hand. It may be that the problem resulted from leaky batteries of a type since discontinued, which did not provide sufficient voltage to operate the pinger/release functions.

VI. Estimate of Funds Expended to 31 October 1978

Allocation 10/1/78 - 9/30/79		$60,300
1. Salaries, faculty & staff	$2,415	
2. Benefits	368	
3. Indirect Costs	1,256	
4. Supplies & Other Direct Costs	1,614	
5. Equipment	-0-	
6. Travel	1,685	
Total Expenditures	$7,338	
Balance	$52,962	

University of Washington

Department of Oceanography

Seattle, Washington 98195

Preliminary Report

University of Washington Participation in NOAA UH-1H Helicopter Cruise W-31

Current Measurements in Possible Dispersal Regions of the Beaufort Sea

21 October - 13 November 1978

by

Clark Darnall

NOAA Contract 03-5-022-67, TA 3

Approved by:

Knut Aagaard, Research Professor
Principal Investigator

George Anderson, Professor
Associate Chairman for Research

Ref: M78-65

1. *Objective*

To look at the time-dependent circulation and dynamics of the outer continental shelf of the Beaufort Sea, by means of long-term Eulerian time series current studies at selected locations, where the ice cover is not seasonally removed. Cruise W-31 was a recovery phase of the study.

2. *Narrative*

<u>Mooring recovery</u>

Four moorings were to be recovered. They were Lonely #3 and #4 (deployed on Cruise W-28, in October 1977) and Lonely #5 and #6 (deployed on Cruise W-30 in March 1978). We would also try mooring Lonely #2 (which would not release the previous cruise). The recovery procedure would be:

(1) General area relocation (within several kilometers) by use of the helicopters G-NS 500A, VLF navigation equipment.

(2) Precise mooring relocation by ranging and bearing on the mooring's acoustic transponding release. Upon satisfactory relocation (within 500 meters), the mooring would be released, allowing the flotation to lie against the underside of the ice cover.

(3) After further pinpointing of the mooring (within 100 meters), a diving hole would be cut through the ice, and Scuba divers would secure a retrieval line to the mooring. The mooring would then be recovered through the same hole.

A physical description and location of the moorings is in the Appendix.

The report of events is as follows:

<u>21 Oct. 1978</u> S. Harding, G. Petersen and C. Darnall arrived at the Navy Arctic Research Lab., Barrow, AK. We began preparing our diving and recovery equipment.

<u>25 Oct. 1978</u> NOAA UH-1H helicopter N57RF arrived with pilot Lt. Jon Barnhill and mechanic John Glennon.

<u>26 Oct. 1978</u> Minor repairs and inspection were performed on the helicopter in the morning.
Weather; thin high stratus, -17°C, wind 090°T 4kt.
1400 ADST Petersen, Harding and Darnall departed Barrow in N57RF (Barnhill and Glennon) to survey ice conditions and locate moorings Lonely #2, #3, and #4. After refueling at Lonely, we proceeded to site #2. We attempted to call up the transponder, to no avail. Nor was the timed ping command answered. After several attempted commands, the fuse in the AMF301 power amplifier blew. Replacement fuses were also blown. We returned to Barrow to determine the problem.
The ice in the mooring areas was solid, 1-2 ft. thick, with considerable ridging and rafting, and with no new or open leads.

1900 ADST After returning to NARL, we determined that a transformer, power transistor, and a resistor were out in the power amplifier. We began looking for a replacement in either Alaska or Seattle. Day's flight time 2 hr. 50 min.

27 Oct. 1978 There was no AMF command equipment available in Alaska, but we were able to have a unit sent up from Seattle.

28 Oct. 1978 The replacement power amplifier arrived on the 1100 Wien Flight and checked out OK. We planned to fly the following day. We changed from Alaska Daylight Savings Time to Alaska Standard Time this evening.

29 Oct. 1978 Weather; clear, -20°C, wind 090°T at 12 kt.

0755 AST Petersen, Harding, and Darnall departed Barrow in N57RF (Barnhill). After refueling at Lonely, we proceeded to site #3, to attempt that mooring recovery. The acoustic transponder release replied to the first transponder command, but not to a timed pinger command. The initial range was 1.28 km at 293°M. After several moves/re-interrogation (with no response to the timed ping command) we were at a slant range of 140 m. Since the transponder release was at 90 m below the surface, we should have seen a reduction in the slant range to 111 m, when the mooring was released (the transponder release would then be 30 m below the surface).

1123 AST We sent the release command, and received no confirmation of release. The slant range remained the same, 140 m. We tried various output levels, transducer depths, and adjacent received frequencies. We tried sending the release command from several different locations, but to no avail. The mooring wouldn't release, so we decided to return to Lonely for fuel and then try mooring #4.

1505 AST Mooring #4 replied to the first timed ping command (1 pulse/2 sec for 60 sec) and the transponder reply was 400 m at 220°M. As it was too late in the day to attempt a recovery, we returned to Barrow and planned to try again the next day.

1530 AST Sunset.
Day's flight time 4 hr. 32 min.

30 Oct. 1978 Weather; clear, -24°C, wind 030°T at 10 kt.

0818 AST Petersen, Harding and Darnall departed Barrow in N57RF (Barnhill). We refueled at Lonely, and headed for site #4.

1035 AST The first transponder reply was 1.53 km at 063°M. After several moves we were at a slant range of 220 m.

1149 AST We sent release command. The release confirmation (1 pulse/sec for 60 sec) was received and the slant range was now 110 m. We moved the helicopter to the final position and began digging the diving hole. After a considerable amount of trouble with the diving gear (due to the cold), the divers (Harding and Darnall) began the dive. They were out of the water, after attaching the retrieval line, within 15 min. The zipper in one Unisuit had come apart and was leaking badly. We hauled the mooring out and packed up. As we had only enough fuel for the return to Lonely, the pilot had not been able to start and warm the helicopter for several hours (the normal procedure at this temperature is to start and warm the helicopter every 45-50 mins.). The helicopter started OK, but the pilot felt that we were at or a little beyond the safe working range of this aircraft.

We returned to Lonely for fuel and then on to Barrow.

1800 AST After close inspection of the damaged Unisuit zipper, we decided that it was unusable, and could not be repaired in Barrow. We called Seattle and arranged to have another suit sent up the same evening. It should arrive on the 1100 AM Wien flight the next day. We wouldn't be able to fly till the next day. The helicopter mechanic wanted some time to check out the standby D.C. generator, as it had been popping the circuit breaker when placed on line.

1845 AST The recovered current meters were opened. The bottom end plate of the upper meter was gone (unnoticed before) and the meter had been about 85% flooded. Little, if any, tape had been recorded after deployment. The lower meter was dry and battery voltages were okay.

1854 AST The lower meter cycled through. There was approximately 40% of the tape recorded (this was as expected).
Day's flying time 3 hr. 21 min.

<u>31 Oct. 1978</u> We cleaned up our gear, filled tanks and prepared for the next day.

1000 AST It was determined that the problem with the standby D.C. generator was in the voltage regulator, and a replacement was ordered from Ft. Wainwright along with another VHF radio (which had also been giving us trouble). As we couldn't fly without the generator, we would be down until the 2nd of November.

Since we were right at our range limit the previous day, and moorings #5 and #6 are further out, we began looking into getting a second aircraft to support us with fuel and/or heat.

<u>1 Nov. 1978</u> The parts for the helicopter arrived, were installed and checked out OK. We planned to fly the next day. We arranged for the NARL twin otter N127RL to meet us at mooring site #5 with extra fuel and a Herman Nelson heater.

<u>2 Nov. 1978</u> Weather; high thin stratus, -27°C, wind 040°T at 7 kt.

0718 AST Harding, Petersen and Darnall depart Barrow in N57RF (Barnhill).

0944 AST Mooring #5 replied to the first timed ping command transponder command range 920 meters at 184°M. We also checked on mooring #6. It responded satisfactorily (range 1.05 km at 047°M). The ice in this area was drifting quite fast. We made radio contact with N127RL and they would orbit until we located our final hole.

1105 AST We released mooring #5 (release confirmation 1 pulse/sec for 60 sec.). N127RL was able to land nearby and we pulled the Herman Nelson over and started heating the helicopter. The use of the heater to keep our diving gear warm was a great help, and we had no problems with our gear freezing up.

1403 AST The divers (Harding & Darnall) began the recovery dive. The mooring was approximately 35 meters from the hole, and our diving lights were essential in locating the floats. We were out of the water within 15 min. We pulled the mooring out, loaded up and headed for Lonely.

1815 AST We opened the current meters. The upper meter had recorded the entire reel of tape, but the lower meter had recorded little if any after deployment. Both meters were dry, but the battery voltage on the lower one was less than 2VDC.

G. Petersen left for Seattle, as he had other commitments. Jack Glennon, the helicopter mechanic, would assist us on the ice.

Day's flight time 3 hr. 15 min.

<u>3 Nov. 1978</u> Weather; clear, -28°C, wind 085°T at 12 kt. During helicopter warmup the right fuel boost pump went out. We were shut down again. A replacement pump was ordered from Ft. Wainwright; hopefully it would get in the following day. All of the fuel must be emptied out of the tanks, and since there was no fuel suction system available, it would have to be flown off (about 2-1/2 hrs. of circling the field). As there was concern about condensation developing in the empty tank, it would not be emptied until the pump had arrived and was ready for installation.

<u>4 Nov. 1978</u> The boost pump arrived on the afternoon flight. This replacement took the rest of this day and part of the next.

<u>5 Nov. 1978</u> Weather; snowing, -18°C, wind 260°T at 12 kt. The boost pump was installed in the evening and we planned to fly the next day.

<u>6 Nov. 1978</u> Weather; overcast, light snow, -27°C, wind 290°T at 20 kt. We loaded up before breakfast for an early start, but on startup (which gave some difficulty) the linear actuator on the engine governor went out. We were grounded again.

We investigate the possibility of getting the other UH-1H from Deadhorse, but Ted Flesher said this was impossible. An ERA helicopter charter was out due to the VLF navigational equipment requirement. We would just have to wait for N57RF to be repaired. The parts are ordered from Ft. Wainwright.

7 Nov. 1978 The parts did not arrive.

8 Nov. 1978 Weather; freezing rain/snow, -6°C, wind 270°T at 20 kt. The Wien flight did not come in due to weather.

9 Nov. 1978 The linear actuator arrived and was installed. We planned to fly the following day, with the NARL twin otter bringing out fuel and a Herman Nelson.

10 Nov. 1978 Weather; high thin stratus, -2°C, wind 190°T at 20 kt.

0734 AST Harding and Darnall departed Barrow in N57RF (Barnhill and Glennon).

0916 AST We landed at mooring site #6. The first xpdr. reply 1.35 km at 243°M. The relative ice to bottom drift was 1.9 km/hr. After one move, our 110 VAC portable generator stopped, and we were unable to get it started. Either the carburetor froze up or the ignition gave out. The twin otter was unable to land due to rough ice condition, so they para-dropped a drum of JP-4 fuel. After retrieving the drum of fuel, we were still unable to start the generator, we were unable to open the fuel drum (the bung was frozen with corrosion), so we were in need of fuel. We returned to Lonely for fuel and on to Barrow.

1400 AST The mechanics at NARL small engine shop were unable to start (or repair by the next day) our generator, so we rented another 2.0 KW generator from them.
Day's flight time 3 hr. 35 min.

11 Nov. 1978 Weather, low overcast, freezing rain, -10°C, wind 210°T at 14 kt.

0808 AST Harding and Darnall departed Barrow in N57RF (Barnhill and Glennon). At mooring site #6, the first transponder reply was 690 meters at 340°M. It was difficult to get a timed ping response, but finally with low output levels we received a reply.

1121 AST We released mooring #6, and received a release confirmation (1 pulse/sec for 60 sec.).

1230 AST NARL twin was unable to land, but dropped two drums of fuel.

1301 AST Divers began the recovery dive. The upper float and current meter were very close to our hole (approximately 10 meters).

1410 AST We had pulled the mooring, leaded up and pumped the fuel into the helicopter. We returned to Lonely and on to Barrow.

1645 AST We opened the current meters. Both were dry and had recorded almost all of the tape. The battery voltage on the upper meter was low (approximately 5 VDC) and on the lower very low (less than 2 VD).

1648 AST The upper meter cycled through very weakly.

1728 AST This was the time of the last record cycle on the upper meter. Day's flight time 3 hr. 4 min.

12 Nov. 1978 Weather; mix snow and freezing rain, -8°C, wind 020°T at 18 kt. There were reports of aircraft icing and low visibility. There was no flying due to weather.

13 Nov. 1978 Weather; clear, -20°C, wind 032°T at 14 kt.

0800 AST Harding and Darnall departed Barrow in N57RF (Barnhill, Glennon). We would return to moorings #3 and #2 and try again to release them, using the AMF-210 test set to vary the encoding parameters.

0928 AST At mooring site #3 we received a transponder reply (range 1.14 km at 305°M), but there was no response to the timed ping command. For about one hour we tried varying the PRF rate, receiver frequencies, transducer depth, output levels and all combinations of the above with no response. The transponder reply was then range 1.84 km at 280°M. We decided that this mooring wasn't going to release and we moved on to mooring #2.

1033 AST We landed at site #2. We received no reply to either the transponder or the timed ping command. We tried releasing the mooring with no response. Again we tried all combinations of PRF rates, output levels, receiver frequencies, and transducer depths, with no response. We decided that this mooring would not release. On our return to Lonely we searched for floats that had been left during previous recoveries.

The helicopter would start seal hunting operations the next day, and we began packing our gear.
Day's flight time 3 hr. 3 min.

14 Nov. 1978 Harding and Darnall departed Barrow on the Wien flight for Seattle.

3. *Methods*

Mooring description

The current meter moorings were designed and constructed at the Department of Oceanography, University of Washington. The flotation was 28 inch O.R.E. steel spheres distributed along the mooring. The current meters were Aanderaa Model RCM-4. The acoustic transponder/releases were AMF model 322. The mooring line was 1/2 inch dia. Nolaro using parallel polyester fibers. The anchor consisted of lengths of railroad rails (each approximately 70 lbs.), with galvanized chain laced through holes cut in one end.

Recovery equipment

An AMF Model 301 ranging and bearing command system were used for precise relocation of the AMF Model 322 transponder/releases. An AMF 210 test set was used as a back-up coder and to vary the command parameters.

The divers used Unisuits (a variable volume dry suit), double 80 cu. ft. aluminum tanks with independent Poseidon regulators on each tank. Each diver was connected to a common tether line, and used U.S. Navy Diving procedures and line signals.

4. *Personnel*

Stephen Harding	Research aide	Dept. of Oceanography/U. of Wa.
Gary Petersen	Electronics technician	Dept. of Oceanography/U. of Wa.
Clark Darnall	Oceanographer	Dept. of Oceanography/U. of Wa.
Lt. Jon Barnhill	Pilot	NOAA
John Glennon	Mechanic	NOAA

Acknowledgements

Lt. Barnhill's and John Glennon's assistance in completing this project was greatly appreciated. The personnel of the Naval Arctic Research Lab and associated flight operations were very helpful in the accomplishment of our project.

APPENDIX A

Mooring locations:

Lonely #2 (1000 m)	71°40.0'N, 152°10.1'W
Lonely #3 (100 m)	71°21.5'N, 152°29.3'W
Lonely #4 (200 m)	71°31.8'N, 152°15.3'W
Lonely #5 (100 m)	71°17.0'N, 150°44.1'W
Lonely #6 (200 m)	71°17.7'N, 150°37.9'W

Flight time:

NOAA UH-1H helicopter N57RF - 23 hr. 40 min.

QUARTERLY REPORT

Contract R7120847
R7120846

Research Unit #138

Reporting Period: 1 October 1978 - 31 December 1978

Number of Pages: 2

NORTHWEST GULF OF ALASKA STUDY OF MESOSCALE OCEANOGRAPHIC PROCESSES (GAS-MOP)

J. D. Schumacher

R. D. Muench

S. Hayes

Pacific Marine Environmental Laboratory
National Oceanic and Atmospheric Administration
3711 - 15th Avenue N.E.
Seattle, Washington 98105

December 20, 1978

I. Task Objectives

- Eulerian measurements of the velocity field at several positions and levels

- CTD measurements in Lower Cook Inlet, Kodiak, and Western Gulf region

- Measurements of the along- and cross-shelf sea surface slope

- Process study to understand the interrelations among the velocity field, the bottom pressure gradient, and density field, and the wind field in order to determine the dynamics of the circulation on the continental shelf.

II. Field or Laboratory Activities

A. Cruises:

1. DISCOVERER RP-4-D1-78B, Leg IV (Cruise Report appended)

B. Scientific Party: (see Cruise Report)

C. Methods:

Plessey 9040 CTD
Plessey 8400 Digital Data Logger
Aanderaa RCM-4 current meters
TG-2 pressure gauges
AMF releases

D. Sample Localities: (see Cruise Report.)

E. Data Collected or Analyzed: (see Cruise Report.)

III. Results and Preliminary Interpretation

The following publications have been submitted, are in press; or have been presented at scientific meetings:

1. Hayes, S. P. (1979)

Variability of current and bottom pressure across the continental shelf in the Northeast Gulf of Alaska. J. Phys. Oceanogr. Vol. 9

2. Schumacher, J.D., R. K. Reed, M. Grigsby and D. Dreves (1979). Circulation and hydrography near Kodiak Island, September - November 1977. NOAA Tech. Report. (in peer review)

3. Shay, T.J. and R. D. Muench (1978). Shelf break currents in the North Western Gulf of Alaska. Eos, Trans. AGU 59 (12) (abstract of paper presented at Autumn 1978 AGU meeting) (copy of abstract appended).

IV. Problems encountered are discussed in the cruise report.

SHELF BREAK CURRENTS IN THE NORTH WESTERN GULF OF ALASKA

T. J. Shay (Department of Oceanography, WB-10, University of Washington, Seattle, WA 98195)
R. D. Muench (PMEL/NOAA/ERL, 3711 15th Avenue, N. E., Seattle, WA 98105)

Current records from three outer continental shelf moorings located in the western Gulf of Alaska during spring and summer 1976 have been analyzed. The measurements were made in 100-120 m depths near the shelf break shoreward of the Alaska Current, in the westward intensification region of the Pacific subarctic gyre. Vector-averaged speed and direction indicate a general WSW (longshore) flow at both 20 m and 50 m depths at all three moorings. Scalar averaged speeds were 2-10 times greater than vector averaged speeds, indicating a high directional variability. Spectral energy estimates indicate that kinetic energy in spring was generally an order of magnitude higher than in summer. The highest energy, most vertically coherent currents were observed near the terminal end of a bathymetric trough extending southwestward to the shelf break from Shelikof Strait. Broad peaks were found in the rotary spectra at the 3.5-5.5 and 1.5-2.5 day bands in most records during both spring and summer. Significant rotary coherence occurred at 3.5-5.5 days for longshore separations of about 500 km. Current records will be compared with local geostrophic wind stress and wind stress curl and with wind data obtained from two nearby environmental buoys.

From Eos, Trans. AGU 59(12).

CRUISE REPORT
NOAA Ship DISCOVERER
RP4-DI-78B: LEG IV

3 October-24 October

Jim Schumacher, Chief Scientist

OBJECTIVES

Leg IV was the final field operation in support of PMEL's Gulf of Alaska physical oceanographic processess research program. The general objective of this program is to describe and understand circulation in order to characterize advective and diffusive processes and examine their relation to water-borne substances resulting from petroleum development.

The specific objectives for RP4-DI-78B Leg IV are:

1. Recover 21 moorings which included current meters, pressure gages and sediment traps (see TABLE II for details).

2. Occupy selected CTD stations from the PMEL CTD Station Grid (see TABLE 1).

3. Recover 6 surface marker moorings.

4. Deploy drift cards (TABLE IV).

PERSONNEL

Jim Schumacher	NOAA/PMEL	Chief Scientist
Jim Haslett	NOAA/PMEL	Physical Scientist
Bill Parker	NOAA/PMEL	Electronics Tech
Pat Romeiro	USFS/PMEL	Student
Gary Massoth	NOAA/PMEL	Chemical Oceanographer

CHRONOLOGY

Depart Kodiak: 3 October 1978, Operations, recovery of K6B to K13B and C-10 and occupation of all planned CTD stations in the northwest Gulf of Alaska and the south-western end of Shelikof Strait: 3-12 October. Touch-and-go Kodiak, repair the PFR and off-load equipment to make deck space available: 12-13 October. Operations, Lower Cook Inlet including recovery of remaining moorings and many of the remaining CTD stations: 13-20 October. Touch-and-go Homer, off-load sediment samples and scientific party except Chief Scientist: 20 October. Operations, complete scheduled CTD casts: 20-23 October. Return to Kodiak: 24 October 1978.

ACCOMPLISHEMENTS

Although our primary objective was ambitious, given a physical environment with high tidal currents and extensive fishing activities, we were totally successful! All moorings were recovered, with the only equipment loss being a 41" subsurface float and sediment trap on C-11B. This unprecedented success was due to the accurate and expert deployment of the moorings, in conjunction with an excellent mooring recovery technique (see TECHNIQUES) developed by the officers of the DISCOVERER. Four of the six sediment traps deployed in May were recovered after an 85 day collec-period (two traps each at C-1B and C4B). The trap that was deployed at C11B was returned from a commercial fishing vessel in Homer, 20 October. Initial sample processing was conducted aboard ship. Samples were prepared for transfer to PMEL and were off-loaded at Homer, 20 October.

Hydrographic data were collected at 184 stations; including two sections extending from the coastal region to seaward of the Alaska current and several sections in the lower Cook Inlet/Shelikof Strait region. It is noteworthy that CTD operations, including quality control, were conducted in a very professional manner. The CTD listing program provides a nearly real-time view of averaged data in engineering units, the DDL tape dump ensures that the digitizer was recording data and that the CTD system was functioning within specified limits, and further quality assurance, e.g. keeping updated plots of the difference between parameters recorded by the 9040 CTD system and calibration bottle values all result in more reliable data.

Of the six marker buoys deployed in May, only 3 were recovered; two from Middle Albatross Bank and one from lower Cook Inlet. The latter surface marker was not recovered from the site where it was moored and the radar reflectors were missing.

A total of 2000 drift cards were deployed at 20 locations (see TABLE IV) over the continental shelf. Wind speed and direction measurements were collected 17 times in the vicinity of EB46007 for comparisons. (TABLE V).

RECOMMENDATIONS

1. Discontinue use of surface marker buoys. They are of questionable value as deployed, and when drifting free, as has occurred, they are a hazard to navigation.

2. If beacon systems are to be used, the system needs to be redesigned (see TABLE III). However given our ability to recover moorings what circumstances warrent their use?

3. A cradle for the current meters, constructed of wood and easy to break down, would be useful.

4. Close attention should be paid to the corrosion problem encountered on the AMF 395 releases. Apparently the end plate is insulated from the case. Both of the releases which did not respond when interrogated (but did release) were corroded between the end plate and the case.

TECHNIQUES

A 100% rate of mooring recovery is exceptional. This success resulted from three independent operations; mooring design and preparation,* careful deployment with emphasis on location,* and finally recovery, each of which was successfully accomplished. The following "Procedure for Recovering Moored Subsurface Current Meter Arrays" was written by LCDR Emerson Wood to provide an example of the proceedure so successfully used on RP4-DI-78B: Leg IV and are included as page 4.

ACKNOWLEDGEMENTS

Under the leadership of Captain Sidney Miller, the DISCOVERER has become a competant physical oceanographic research ship. Under the direction of Lieutenant Commander Emerson Wood, Operations Officer, CTD operations (in particular quality control) have been brought up to high standards. The entire compliment functions well and has contributed to this extremely successful Leg. Thank you.

Jim Schumacher

Jim Schumacher
Chief Scientist
23 October 1978

* Thanks to MILLER FREEMAN & Jim Haslett

Procedure for Recovering Moored Subsurface Current Meter Arrays

NOAA Ship DISCOVERER Oct, 1978 EW

Navigational control for recovery of moored subsurface arrays aboard the DISCOVERER is provided by Loran-C in all Alaskan waters. Radar and SATNAV are used as back-ups, but the excellent coverage provided by Loran-C in Alaska justifies the use of this system for primary control. Although Loran-C and Radar seldom agree to better than 0.5 to 1.0 nm, the repeatability of Loran-C has proven to be within 0.1 nm (the use of Loran-C for recovery assumes that the Loran-C rates were recorded during deployment).

To facilitate navigating to the precise position of an array, an enlarged Loran-C diagram is first drawn on a maneuvering board (see Figure 1.) sheet (H.O. 2665-10). The position of the array is plotted in the center of the sheet with Loran-C rates drawn to every 0.5 or 1.0 μs; the radius of the plot being 1.0 nm. The crossing angles of the Loran-C rates and the distance between rates are scaled from the largest scale chart of the area. These are then transferred to the maneuvering board sheet, and the enlarged scale greatly facilitates accurate positioning of the ship.

Once the ship is positioned as close to the array as possible, the release mechanism is electronically interrogated and released as soon as possible to avoid drifting away from the position due to wind and/or current. When the buoy is sighted the ship is maneuvered to retrieve the array from the starboard hero platform on E-deck fantail.

The preferred method of retrieval is to lasso the largest subsurface buoy from the hero platform with a wire rope, which is then led aft through the stern A-frame to the stb'd capstan. The array is then retrieved under the A-frame, one section at a time (a chain is suspended from the A-frame and is hooked onto the chain beneath each current meter and/or float while that section is disconnected on deck). Occasionally it is not possible to lasso the subsurface float, in which case a grappling hook is used to secure the viny floats - the rest of the procedure being the same as for the lassoing method.

While maneuvering the ship close to the array when it is at the surface, the stb'd shaft is kept at zero rpm and all maneuvering is done with the bow thruster and the port shaft. This practice decreases the likelihood of any part of the array getting caught in the propellers.. Generally the ship is positioned with the wind on the port beam, so that the ship slowly drifts onto the array (once it is at the surface). In winds greater than about 25 kts., the ship is brought directly into the wind to facilitate maneuverability. Using the above technique, moored subsurface arrays have been recovered routinely in winds of up to 30-35 kts. and seas of 8-12 feet.

7X-12147.20

MANEUVERING BOARD

7Y-31858.57 FIGURE 1

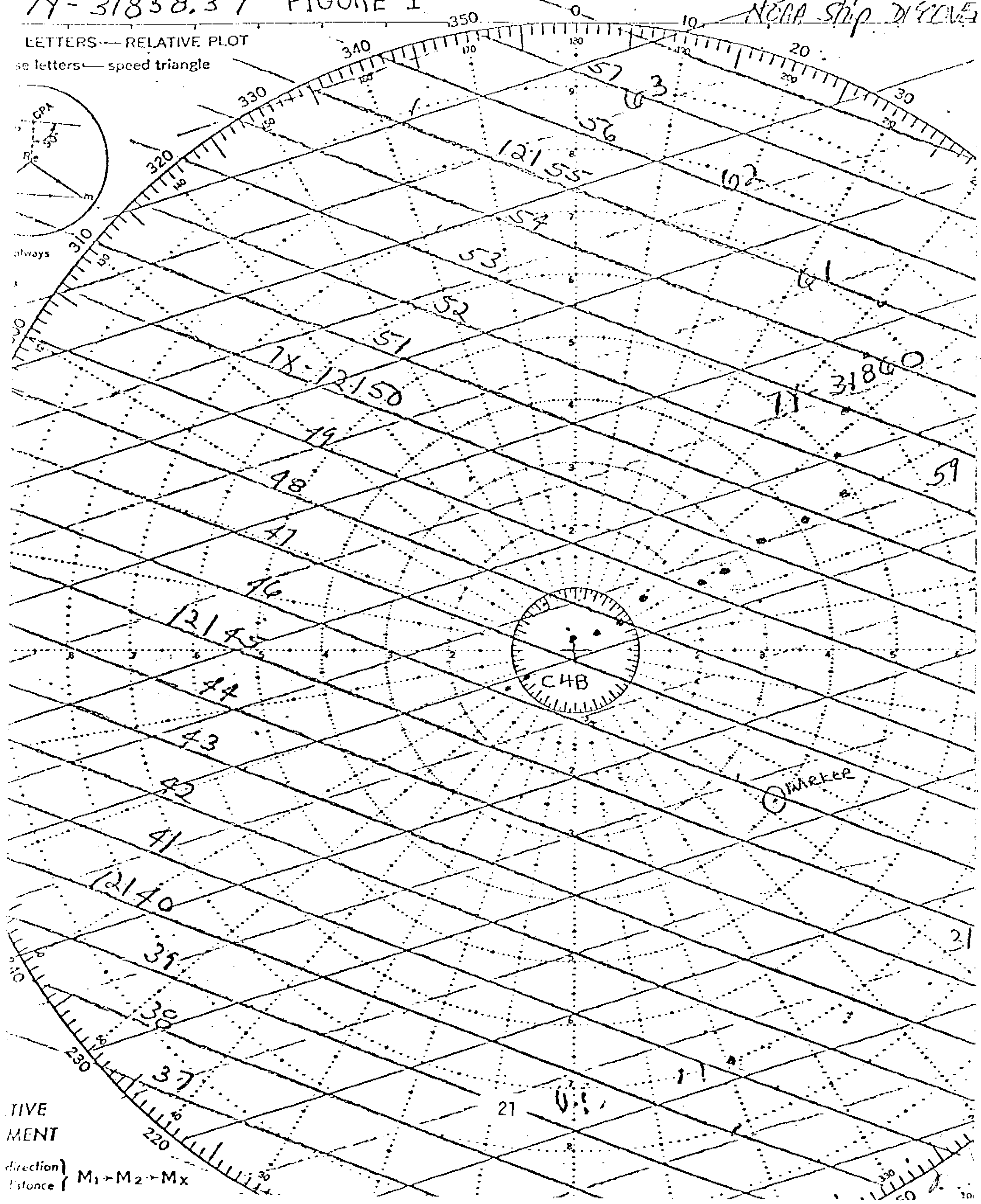

TABLE 1 CTD CAST LOG

CONSEC NO.	STATION NAME	DAY	GMT TIME	LATITUDE	LONGITUDE	CAST DEPTH(m)	WATER DEPTH (m)
001	K7B	276	2345	57°05.9'	152°13.2'	82	84
002	K8B	277	0120	57°06.3'	152°44.5'	145	150
003	667		0414	57°03.8'	152°51.9'	76	80
004	668		0509	57°00.0'	152°42.8'	144	144
005	669		0558	56°55.6'	152°38.6'	145	162
006	670		0649	56°53.3'	152°33.0'	142	152
007	671		0737	56°48.8'	152°28.8'	162	166
008	672		0849	56°41.6'	152°29.0'	171	176
009	673		0934	56°38.4'	152°28.4'	157	162
010	674		1047	56°32.9'	152°29.9'	192	195
011	K10B		2151	56°49.4'	152°24.4'	106	120
012	K9B		2317	56°59.8'	152°33.6'	128	133
013	K6B	278	2204	57°14.1'	152°24.0'	68	75
014	675	279	0256	56°25.9'	152°24.1'	304	311
015	676		0401	56°21.6'	152°20.9'	436	440
016	677		0539	56°18.0'	152°16.2'	1509	1865
017	678		0808	56°12.2'	152°11.5'	1500	3876
018	776		1518	55°13.8'	152°47.6'	1506	4500
019	775		1736	55°18.4'	153°01.9'	1495	5120
020	774		1959	55°28.9'	153°09.4'	1503	5200
021	773		2231	55°37.2'	153°19.2'	1500	4206
022	700	280	0051	55°42.1'	153°27.0'	1500	3218
023	699		0346	55°44.8'	153°34.9'	1197	1232 *
024	698		0532	55°50.2'	153°37.9'	906	950
025	697		0701	55°55.1'	153°41.1'	203	208
026	696		0751	55°59.2'	153°44.8'	89	93
027	695		0921	56°08.5'	153°55.6'	203	214
028	694	280	1027	56°16.9'	154°01.1'	117	124
029	693		1139	56°23.7'	154°15.6'	37	42
030	361		1425	56°13.2'	154°58.9'	24	32
031	360		1522	56°08.4'	155°09.6'	30	36
032	K11B		1612	56°01.1'	155°05.6'	47	56
033	351	281	0150	56°28.4'	157°08.4'	40	45
034	352		0246	56°21.4'	157°01.1'	164	166
035	353		0345	56°15.8'	156°56.4'	91	99
036	354		0708	55°56.8'	156°37.2'	189	200
037	355		0821	55°53.0'	156°27.0'	242	248
038	347		0939	55°51.9	156°21.2'	238	239
039	348		1044	55°53.1'	156°14.4'	214	214
040	349		1142	55°50.9'	156°07.3'	176	177
041	350		1252	55°47.6'	155°56.3'	86	91
042	358		1520	55°58.4'	155°25.8'	21	27
043	359		1624	56°03.9'	155°16.3'	28	34
044	346		1902	56°30.0'	155°12.5'	34	42
045	344		2002	56°34.1'	155°27.6'	75	84
046	342		2126	56°38.2'	155°44.2'	239	243
047	340		2238	56°42.9'	155°54.9'	290	294

* CTD fish changed after this cast

TABLE 1 (continued)

CONSEC NO.	STATION NAME	DAY	GMT TIME	LATITUDE	LONGITUDE	CAST DEPTH(m)	WATER DEPTH (m)
048	338	282	0015	56°46.7'	156°15.4'	182	188
049	336		0109	56°47.2'	156°25.7'	150	157
050	330		0654	57°20.4'	154°55.0'	151	159
051	329		0949	57°23.5'	155°01.9'	225	232
052	328		0844	57°26.1'	155°08.2	230	235
053	327		0941	57°29.3'	155°15.7'	250	254
054	326		1045	57°33.6'	155°21.2'	289	292
055	325		1136	57°36.1'	155°25.5'	198	202
056	C10		2056	58°29.6'	153°13.7'	165	166
057	150		2344	58°34.1'	152°44.0'	41	47
058	149	283	0032	58°36.0'	152°49.2'	184	186
059	526		0837	59°09.0'	151°00.5'	88	91
060	527		0928	59°05.7'	150°59.7'	188	192
061	528		1013	59°02.8'	150°57.2'	154	160
062	529		1059	58°58.1'	150°56.2'	137	140
063	530		1158	58°51.3'	150°52.9'	152	159
064	531		1302	58°44.9'	150°51.6'	165	175
065	532		1403	58°38.6'	150°48.0'	190	199
066	533		1504	58°32.3'	150°44.9'	130	137
067	559		1604	58°24.5'	150°49.0'	72	76
068	560		1715	58°18.9'	150°37.9'	55	64
069	561		ABORTED				
070	561		1919	58°12.0'	150°27.3'	80	87
071	562		2020	58°08.7'	150°19.5'	154	159
072	563		2100	58°06.5'	150°16.6'	222	230
073	564		2210	58°04.3'	150°06.6'	306	320
074	565		2316	57°59.5'	150°00.9'	259	265
075	566	284	0017	57°56.0'	149°53.6'	249	260
076	567		0106	57°53.4'	149°48.0'	233	243
077	568		0220	57°48.2'	149°40.9'	261	276
078	569		0320	57°44.1'	149°36.5'	495	500
079	570		0445	57°40.3'	149°31.5'	816	826
080	574		0616	57°38.1'	149°25.4'	477	1200
081	572		0812	57°33.9'	149°19.5'	1501	1800
082	767		1016	57°30.3'	149°14.3'	1504	2377
083	768		1247	57°22.5'	149°00.8'	1505	3000
084	769		1501	57°16.7'	148°50.0'	1521	3850
085	770		1751	57°08.6'	148°38.3'	1500	4300
086	771		2027	57°01.1'	148°24.2'	1500	4512
087	772		2301	56°52.7'	148°12.5'	1501	4389
088	585	287	0450	58°27.7'	151°54.2'	100	105
089	584		0551	58°32.5'	151°44.2'	175	177
090	583		0634	58°36.7'	151°44.8'	151	155
091	582		0723	58°48.3'	151°46.4'	130	142
092	581		0811	58°46.9'	151°46.9'	173	190
093	580		0918	58°49.5'	151°35.5'	121	126
094	579		1028	58°54.7'	151°46.4'	118	122
095	578		1120	59°00.1'	151°46.4'	123	128

TABLE 1 (continued)

CONSEC NO.	STATION NAME	DAY	GMT TIME	LATITUDE	LONGITUDE	CAST DEPTH(m)	WATER DEPTH (m)
096	576	287	1158	59°03.7'	151°44.5'	170	172
097	038		1359	59°13.4'	152°00.0'	78	89
098	039		1434	59°11.1'	152°03.4'	84	94
099	040		1516	59°08.4'	152°07.2'	135	146
100	041		1552	59°06.1'	152°09.3'	146	150
101	042		1635	59°03.1'	152°12.3'	106	115
102	043		1710	59°01.2'	152°15.6'	87	98
103	044		1941	58°59.5'	152°16.5'	93	96
104	C11B	289	1813	59°33.3'	151°41.2'	75	84
105	C12A		2047	59°32.5'	152°14.0'	52	57
106	C13A		2323	59°28.7'	152°40.4'	61	68
107	008	290	0214	59°46.9'	151°59.3'	20	28
108	007		0245	59°47.5'	152°03.0'	30	34
109	006		0331	59°48.7'	152°09.5'	37	45
110	005		0415	59°49.3'	152°16.0'	72	79
111	004		0458	59°50.0'	152°22.1'	71	76
112	003		0557	59°52.0'	152°27.3'	38	45
113	002		0627	59°53.6'	152°32.1'	29	36
114	C7B		1706	59°16.8'	152°13.8'	58	67
115	033	291	0238	59°23.5'	152°01.9'	50	59
116	032		0344	59°25.9'	152°15.0'	67	73
117	031		0449	59°27.5'	152°28.3'	51	53
118	030		0604	59°27.3'	152°47.2'	58	64
119	029		0649	59°30.2'	152°55.1'	32	40
120	028		0730	59°32.2'	153°02.9'	27	36
121	027		0802	59°34.4'	153°08.7'	22	29
122	C3B		1640	59°24.0'	152°52.9'	51	58
123	C4B		1911	59°16.4'	152°55.6'	72	76
124	C5B		2033	59°09.6'	152°55.7'	124	128
125	C6B		2206	59°19.2'	152°38.1'	70	75
126	C2B	292	0131	59°13.7'	153°07.2'	60	64
127	C1B		0225	59°10.7'	153°18.0'	38	43
128	097		1908	59°18.6'	153°17.5'	29	36
129	098		1951	59°17.2'	153°12.1'	47	53
130	099		2028	59°14.2'	153°07.1'	47	58
131	100		2104	59°11.7'	153°05.0'	65	71
132	101		2140	59°09.5'	158°01.9'	87	92
133	102		2226	59°06.5'	152°54.4'	124	128
134	103		2304	59°04.1'	152°57.0'	133	139
135	104		2345	59°01.7'	152°54.7'	147	152
136	105	293	0023	59°00.1'	152°51.1'	155	160
137	119		0127	58°59.7'	153°04.8'	152	154?
138	118		0158	59°00.2'	153°09.1'	130	143
139	117		0238	59°00.8'	153°14.5'	90	91?
140	116		0332	59°02.7'	153°19.5'	55	64
141	115		0422	59°04.1'	153°25.0'	43	51
142	038		2244	59°13.9'	152°01.9'	63	67
143	039		2327	59°11.8'	152°03.7'	91	97
144	040	294	0007	59°09.3'	152°07.5'	144	148
145	041		0050	59°06.4'	152°09.5'	144	153

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TABLE 1 (continued)

CONSEC NO.	STATION NAME	DAY	GMT TIME	LATITUDE	LONGITUDE	CAST DEPTH(m)	WATER DEPTH (m)
146	042	294	0127	59°04.0'	152°13.4'?	123	126
147	043		0211	59°00.8'	152°16.1'	95	100
148	044		0238	58°59.3'	152°17.0'	90	96
149	045		0416	58°51.2'	152°23.3'	127	133
150	046		0451	58°49.2'	152°21.4'	134	134
151	047		0532	58°46.2'	152°21.5'	120	126
152	048		0605	58°44.1'	152°21.0'	108	117
153	049		0643	58°41.4	152°21.3'	148	151
154	135		0808	58°42.8'	152°33.9'	100	109
155	134		0854	58°45.9'	152°36.4'	196	200
156	133		0942	58°48.1'	152°38.4'	196	201
157	132		1032	58°50.0'	152°45.2'	175	183
158	131		1127	58°50.6'	152°49.9'	158	160
159	130		1224	58°50.0'	152°56.0'	151	155
160	129		1316	58°50.3'	153°00.9'	154	159
161	128		1410	58°51.5'	153°06.5'	169	173
162	127		1453	58°50.5'	153°10.1'?	160	166
163	144		1709	58°42.2'	153°14.5'	131	137
164	145		1748	58°42.4'	153°11.2'	159	163
165	146		1833	58°40.5'	153°05.6'	153	159
166	147		1907	58°39.0'	152°59.3'	149	151
167	148		1957	58°36.9'	152°52.8'	153	157
168	149		2038	58°36.1'	152°48.4'	184?	182
169	150		2127	58°33.9'	152°33.8'	44	49
170	126		2357	58°52.2'	152°38.4'	172	179
171	080	295	0056	58°55.2'	152°39.1'	158	160
172	079		0217	59°00.0'	152°39.3	117	150
173	078		0257	59°03.3'	152°37.9'	123	131
174	077		0335	59°05.9'	152°37.7'	124	141
175	004		1225	59°51.6'	152°21.6'	72	80
176	012		?	59°46.2'	152°22.5'	77	82
177	018		1400	59°40.5'	152°23.1'	64	73
178	024		1457	59°34.9'	152°26.5'	51	58
179	031		1545	59°28.4'	152°28.1'	53	58
180	072		1630	59°23.0'	152°31.2'	61	64
181	073		1719	59°17.9'	152°33.2'	72	76
182	074		1805	59°14.4'	152°33.7'	68	73
183	075		1839	59°11.6'	152°34.7'	83	87
184	076		1917	59°08.6'	152°36.0'	120	125

TABLE II RECOVERED MOORINGS (continued)

Mooring ID Location Depth (meters)	Deployment/ Recovery Date (JD)	Instrument Serial #	Instrument Depth (meters)	Remarks
K13B 56°24':156°49' 115	142 281	CM3178 CM3289 Release (242) #601429	28 111	rotor broken, rod bent during recovery fin broken, fin broken lack of wear on block implies broken during recovery beacon submerged, very clean meters
C1B 59°11':153°19' 40	147 292	CM2504 CM3286 TG205 Sediment Trap Release (242) #601629	18 35 38 30	rotor fouled-heavy drag rotor clean trap, CM, release and TG205 tangled upon recovery
C2B 59°14':153°18' 62	142 292	CM3176 CM2505 Release (395) #605926	18 48	rotor fouled rotor missing
C3B 59°24':152°54' 62	142 291	CM598 CM3180 Release (242) #601229	25 55	rotor free timer apparently failed
C4B 59°17':152°55' 83	148 291	CM3294 CM3290 Sediment Trap TG189 Release (395) #702264	19 64 73 78	rotor fouled rotor free did not respond to interrogation, but released As with the other release failure (K6B) there was corrosion around the end plate
C5B 59°10':152°54' 135	147 291	CM2156 CM3184 Release (242) #151	27 72	rotor not balanced due to growth-does not print correctly rotor free
C6B 59°19':152°38' 77	148 291	CM3173 CM3295 Release (242) #503235	26 71	rod bent on recovery insufficient secondary flotation(6vinys), became intermittantly submerged

TABLE II

RECOVERED MOORINGS

Mooring ID Location Depth (meters)	Deployment/ Recovery Date (JD)	Instrument Serial #	Instrument Depth (meters)	Remarks
K6B 57°14':152°23' 82m	140 278	CM 3296	32	extensive marine growth on rotor
		CM1676	72	no rotor, did not respond to interrogation but fired
		Release (395) #702464		
K7B 57°06':152°13' 84	140 276	CM2513	29	rotor drag due to marine growth
		CM1675	74	no rotor
		Release (395) #606667		
K8B 57°07':152°43' 155	140 277	CM3174	30	rotor drag due to marine growth
		CM1827	75	rotor clean
		TG 232	153	
		Release (395) #606967		
K9B 57°00':152°34' 146	141 278	CM 3172	13	Rotor drag
		CM 3185	58	rotor clean
		CM 2498	142	rotor clean
		TG 107	144	stopped after deployment
		Release (242) #503135		Mooring deployed 12 meters too shallow
K10B 56°50':152°24' 153	141 277	CM2512	24	rotor slightly fouled
		CM2502	69	rotor clean but drags
		CM3287	149	rotor missing
		TG 234	151	#3287 probably fouled by cable during deployment. Functioned OK during checkout
		Release (242) #602229		
K11B 56°03':155°06' 60	141 280	CM2355	25	rotor missing, spindle rod pulled out
		Release (395) #702364		
K12B 56°00':156°20'	142 280	CM3183	24	rotor missing
		CM1671	208	less tape used than other CMs, battery voltage high, suggests intermittant operation
		Release (242) #602029		

TABLE II RECOVERED MOORINGS (continued)

Mooring ID Location Depth (meters)	Deployment/ Recovery Date (JD)	Instrument Serial #	Instrument Depth (meters)	Remarks
C7B	148	CM2249	17	slight marine growth
59°19':152°11'	291			speed reads 6 counts for
68				zero speed for 2249
		CM2500	62	
		Release (242)		
		#601529		
C8B	148	CM 3179	63	slight marine growth
59°02':152°04'	287			but rotor free
190		CM2252	64	
		CM1682	179	
		Release (395)		
		#701964		
C9B	148	CM1973	66	slight marine growth
58°47':152°16'	287	CM2501	67	but both rotors free
124		CM2248	114	
		TG229	122	
		Release (242)		
		#501683		
C10B	148	CM3171	25	marine growth on rotor
58°30':158°12'	282	CM3175	70	rotor free
175		CM1669	165	encoder physically
		Release (242)		jammed during post re-
		#503035		covery check
C11B	149	CM1451	82	rotor fouled, fin broken;
59°33':151°40'	289	Sediment Trap		mooring apparently
		Release (322)		trawled but not moved
		#702714		more than ~ 100m. 41"
				float and trap missing
C12A	148	CM2358	20	marine growth but rotor
59°32':152°14'	289			free
50		CM3291	46	rod bent on recovery
		Release (242)		
		#603361		
C13A	148	CM3293	26	rotor missing
52°28':152°41'	289	CM2356	57	rotor free

45 CM's
6 TG's

TABLE III RECOVERY BEACONS

Mooring	Radio: Detected	Radio: Worked Aboard Ship	Radio: Case Corrosion	Radio: Case Failure	Antenna Type	Light: Visible	Light: Worked Aboard Ship	Light: Case Corrosion	Light: Case Failure
K-6 L-15832 R-3096		x	x		flat	x	x		
K-7 L-1370 R-3049		Inter-mittant on board			low	x	x	x	
K-8 L-1372 R-2387		x	x		whip			x	x
K-9 L-1380 R-2386		x			whip			x	x
K-10 L-1379		x			whip		x	x	Broke Aboard ship
K-11 L-1377 R-3108			x worst of all	x	flat	x	x	x	
K-12 L-1369 R-2388	x	x			whip	x	x		
K-13 L-1382 R-3101			x		flat			x	x

TABLE III RECOVERY BEACONS (continued)

	Radio					Light			
Mooring	Detected	Worked Aboard Ship	Case Corrosion	Case Failure	Antenna Type	Visible	Worked Aboard Ship	Case Corrosion	Case Failure
C-1					Whip				
C-2	x	x			Flat				
C-3 L-1375 R-2391	x	x			Whip	x	x	x	
C-4			x	x	Flat			x	x
C-5 L-2272 R-2385			x	x	Whip	x	x	x	
C-6			x	x	Flat			x Clamp failure	x
C-7 L-1374			x	x at antenna	Whip	x	x	x Slight	
C-8 R-2334 L-	x	x			Whip			x	x
C-9 R- L-1373			x	x	Whip	x	x	x	
C-10 R-2389		x			Flat			x	x Severe

TABLE IV

DRIFT CARD DEPLOYMENTS

Deployment Site	Date (JD)	Drift Card Numbers
K7B	276	4001-4100
K8B	277	4201-4300
K9B	277	4301-4400
K10B	277	4101-4200
K6B	278	4401-4500
359	281	4701-4800
358	281	4801-4900
528	283	5001-5100
529	283	5101-5200
530	283	5201-5300
531	283	5301-5400
532	283	5401-5500
533	283	5501-5600
559	283	5601-5700
560	283	5701-5800
561	283	5801-5900
562	283	5901-6000

TABLE V

WIND OBSERVATIONS NEAR EB 46007 (59°10.8': 152°43.4')

Date	Time	Speed (knots)	Direction (°T)	Ship's Position	
20 October	0600	31	300	59°08.9'	152°51.4'
	0630	30	296	59°10.1'	152°46.6'
	0700	32	298	59°10.6'	152°47.6'
	0730	30	299	59°10.5'	152°48.6'
	0800	31	300	59°11.1'	152°46.5'
	0830	32	299	59°11.4'	152°47.3'
	0900	32	285	59°12.0'	152°48.3'
	0930	24	285	59°15.4'	152°43.5'
22 October	0400	45	285	59°06.1'	152°36.0'
	0430	46	287	59°12.4'	152°40.6'
	0500	36	285	59°14.5'	152°41.2'
	0530	33	285	59°19.4'	152°43.1'
	0800	26	290	59°11.9'	152°34.9'
	0830	35	285	59°09.9'	152°36.3'
	0900	26	270	59°15.8'	152°37.6'
	1830	36	295	59°11.7'	152°34.0'
	1900	32	275	59°09.9'	152°34.7'

QUARTERLY REPORT

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STUDY OF CLIMATIC EFFECTS ON FAST ICE EXTENT AND ITS SEASONAL DECAY ALONG THE BEAUFORT-CHUKCHI COASTS

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31 December 1978

I. TASK OBJECTIVES

Specific objectives of the final stages of this project are to complete studies of some aspects of the synoptic climatology of the area, especially with respect to upper air patterns; to examine the occurrence of polynyi on the Chukchi coast; and to determine summer conditions for available years of record at Barrow, prior to 1921, in relation to the Hunt and Naske data on ice observations from ships' logs.

II. OFFICE ACTIVITIES

a) Personnel

R.G. Barry - Principal Investigator

J.C. Rogers - Graduate Research Assistant (25%)

A. Carleton - Graduate Research Assistant (50% from 1 October)

III. DATA ANALYZED AND RESULTS

1. Synoptic Climatology

The 500 mb height patterns over Alaska have been analyzed for the summer season (May-August) for the period 1947-76. The patterns were classified according to a modified version of the Kirchhofer method, already used for the MSL pressure data. Forty distinct types were produced. Some of the weather characteristics of the types have been analyzed and further analysis is in progress.

The frequency of air masses at Barrow during May-September for the period 1965-76 has been analyzed using mean daily MSL equivalent potential temperature as the air mass identifier, with boundaries determined by partial frequency analysis. The difference in air mass frequencies between mild and severe ice years is currently being completed.

The data on 500 mb pressure pattern types and surface air masses will be combined in order to investigate the role of upper air circulation in summer ice-severity on the North Slope. A detailed discussion of the results will be presented in the final report in April. Some preliminary conclusions are as follows:

(1) Air mass frequency is closely associated with ice conditions. Severe ice years occur in summers with a dominance of Arctic air at Barrow (80% in August), while mild ice years occur in association with infrequent Arctic air (20% in August) and its displacement by warmer Pacific air masses from the south.

(2) August is the key month. There are large significant differences in Arctic air frequency during this month between severe and mild ice years. Differences are also notable in July, but are not as great, and there are no significant differences in May, June, or September. This implies difficulty in long-range prediction of ice severity.

(3) The 500 mb patterns responsible for displacing Arctic air with Pacific air seem to be mostly those with ridging over Alaska and/or Canada, leading to southerly flow over the North Slope. If such ridging is not present during August, it will be a moderate to severe ice summer.

(4) Severe ice years seem to be associated with the formation of a large upper trough over the Alaskan region, effectively blocking Pacific air from reaching the North Slope.

2. Early Climatic Records at Barrow

In earlier reports we established the relationship between climate and Beaufort Sea ice conditions. It was shown that the mean summer temperature and/or maximum accumulated thawing degree days (TDD's) were highly correlated to the open water extent in the Beaufort Sea by late summer. Changes in the summer temperature regime have been examined for the years since 1921 when meteorological data became available regularly at Barrow.

Two factors now allow us to analyze Beaufort Sea climate and ice conditions for certain years prior to 1921. They are:

(1) The availability of temperature data at Barrow for the summers of 1882, 1883, 1902, 1903, 1911, and 1916.

(2) The publication of ships logs and notes from whaling ships by Hunt and Naske (R.U. #261).

Here we describe these early summers in terms of climate and ice conditions and determine whether the ice conditions, described in Hunt and Naske's report, correspond to the conditions one might expect based upon the climatic data and the ice-climate relationships we have previously established. If the climate and ice conditions show some correspondence, then one might feasibly use the Hunt-Naske information to infer ice-climate conditions for other 19th and 20th century summers when climatic data are not available.

Monthly temperatures at Barrow for the summers of 1882 and 1883 are given in the World Weather Records, Vol. 90, but we have been unable to locate the daily records. The monthly values can be used to obtain a mean summer temperature, which can be compared to present day averages, and TDDs can also be reasonably estimated. However, there is a small error in the TDD value compared with that based on daily data. Daily data for the other four summers were supplied by the National Climatic Center.

TDD accumulations (estimated for 1882 and 1883) are shown in Table 1, together with the mean summer (JJA) temperature. Table 1 shows that 5881 TDDs accumulated at Barrow in 1911. This figure is considerably higher than the largest known TDD accumulation for reliable post-1921 data (514 TDDs in 1954), which would make 1911 the warmest known summer in the 20th century at Barrow. The following is a description of the 1911 summer ice conditions taken from Hunt and Naske's final report (9/30/77, p. 13) and based upon the 1 August and 2 August 1911 ship log report of the U.S. Revenue Cutter Bear:

> "...The present season in the Arctic has been one of the most remarkable, so far as ice conditions are concerned, within the memory of the oldest inhabitants. The ice left Pt. Hope the latter part of June and in early July the Arctic was practically free of ice...at Pt. Hope there had been no real Arctic pack during the entire winter."

The reference to "Arctic" probably means the Beaufort Sea as well as the Chukchi Sea to Pt. Hope because the 2 August 1911 position of the Bear was 71.06°N 157.50°W (Hunt and Naske, p. 158). Presumably the summer of 1911 was also the mildest for a period covering much of the later 19th century too, since the "oldest inhabitants" could not remember another as mild.

The summer of 1911 was also remarkable with respect to cloud conditions. Twenty-one clear days were reported during June compared to six cloudy days and three partly cloudy days. In July, 16 clear days occurred, 12 cloudy, and in August nine clear days occurred. During recent Junes and Julys the Barrow meteorological data indicate that approximately 20 or more days are normally cloudy, the remainder partly cloudy or clear. The average July 1 to September 15 cloud cover is 88%. The large number of clear days could account for the higher temperatures due to more insolation, warming of the tundra, and rapid ice decay. During 1954, now evidently the second warmest 20th century summer at Barrow, there were only four clear days in June, and one clear day in both July and August.

The winter of 1910-11 was not particularly different from most other subsequent winters at Barrow in terms of temperature. The reference to "...no real Arctic pack during the entire winter" may be a reference (by an inexperience Arctic ice observer?) to the continuous breaking and movement of the ice which occurs between Pt. Hope and Cape Lisburne. We have observed this breaking of the pack during springtime using Landsat imagery, and the phenomenon may well occur throughout the winter. There is never a stable fast ice in some areas between Pt. Hope and Cape Lisburne because of the sharp dropoffs to great depths of water at the coast. Despite some missing temperature data in April and May 1911, it can be estimated that about 2,592 freezing degree days accumulated during 1910-11, making it a slightly warmer than normal winter by today's normals. It was cold enough that winter to produce the usual quantities of sea ice.

The TDD accumulations for the summers of 1902 and 1903 were 405 and 319 respectively. This suggests that both years tended toward having light-ice summers, similar to but not as extreme as that of 1911. The captain of the C.T. Pederssen reports that "The year 1902 was also an open season along in August and September... N.E. gales again drove the pack far off shore." (Hunt and Naske, p. 16). Reports from the Alexander's log (p. 109-111 of Hunt and Naske) indicate that the Beaufort Sea first cleared of ice after the first week of August and remained clear through most of September. In 1903, however, the Alexander's daily log gives a different story. On August 5 the Alexander was tied to grounded fast ice and could not move northward from Wainwright in the Chukchi Sea (Hunt and Naske, p. 118). By August 10, however, she was off Cape Halkett "working ice" all day and on August 11 was in ice in only two fathoms of water in Harrison Bay. On August 20 they were at Banks Island but still in ice. Further reports suggest that in 1903 the fast ice ultimately cleared but there was little if any pack ice retreat. It appears therefore, that a normal to heavy-ice season occurred in 1903 rather than a normal to light-ice season as would have been suggested by the temperature data.

Only sketchy ice reports are available (Hunt and Naske, p. 168) regarding the summer of 1916. They indicate drifting ice still in the Chukchi Sea on 16 August at $70^{\circ}31'$, $161^{\circ}04'$, a late ice season for this area by today's mean. Climatic data are missing for June and July 1916. The August mean temperature at Barrow was $2.1^{\circ}C$ or $1.2^{\circ}C$ below the 1931-1970 normal, while September's temperature was $-0.9^{\circ}C$, or average. Thus 1916 could be considered a late breakup, somewhat heavy ice summer.

During 1882 the months June through September had temperatures which were respectively $+0.4^{\circ}C$, $+2.2^{\circ}C$, $-0.1^{\circ}C$, and $+0.7^{\circ}C$ from the 1931-1970 means. These data suggest a light-ice summer. Hunt and Naske (p. 46) present log reports containing ice information from the Corwin and Fleetwing. Ice was present eight miles north of $70.42^{\circ}N$, 159.25°W on August 10, and heavy drift ice was found in Harrison Bay on 12 August at 70.45°N, 150.23°W. These records suggest a late breakup with slightly heavier than normal ice conditions, with fast ice breakup not yet completed. A Fleetwing report possibly indicates a pack ice incursion on 27 August 1882: "Got as far as Cape Smyth, plenty of ice coming. Came near going on shore but the ice grounded outside of us." Despite the severe ice conditions described in the logs in Hunt and Naske there is no mention of September ice conditions. We know that breakup was underway and that ice conditions in August were somewhat worse than present day means. This is also suggested by the temperature record, mentioned above, which indicates August was the coldest month (compared to averages) during that summer, which presumably means there were periods of northerly winds. The lack of September ice condition descriptions makes it difficult to see if, overall, the summer was one of heavy ice conditions, contrary to the climatic conditions.

The summer of 1883 was colder than that of 1882 with departures from average of -0.8°C, -1.7°C, and -0.6°C in June, July, and August respectively (no September data). The only useful ice report describes drift ice near Cape Lisburne on July 27, suggestive of, but by no means reliable evidence for, a heavy ice summer.

The results of the comparison of pre-1921 meteorological data with ships log information from Hunt and Naske has yielded mixed results. After analyzing both data sources the results may be tentatively summarized as follows:

1. For the summers of 1902 and 1911 there is very good agreement between the two sources of information, both of which indicate that mild, light-ice summers occurred.

2. For the summers of 1883 and 1916 information from one or both sources of information are too sparse, or missing, to be of any value in comparing the similarities or dissimilarities in the sources.

3. For the summers of 1882 and 1903 there is some element of disagreement between the two sources of information regarding the thermal and sea ice conditions. Data are sufficient for analysis in August but not September 1882.

In June of 1916 the cooperative observer at Barrow, T.L. Richardson, wrote in the Weather Bureau reports "Observations discontinued as thermometer box gathered heat from house and records were false. Material for separate shelter should be sent by mail so proper records can be made in future. Lumber is lacking on this place. Will take observations beginning Aug. 1 as sun will be low enough to not interfere at night." Richardson only began making temperature observations for the Weather Bureau in 1916, but his message raises some questions about temperatures observed in summertime. If observed temperatures in previous (to 1916) summers were too high for similar reasons than one might expect that during the summer of 1903 temperatures may have actually been lower, bringing the climatic conditions more in line with the ice observations. During 1902 and 1911, TDD totals were sufficiently high that, even if temperatures were actually lower, mild summers would still have occurred.

Whether or not there is likely to be good agreement (1 above) or poor agreement (3 above) between the data sources can be checked by analyzing post-1920 data. Temperature data for these summers have been described in our previous reports. Hunt and Naske present some ship's logs information for the summers of 1928-1938, 1948, and in several years in the 1950's and 1960's. Hunt and Naske also present ship's log reports for other pre-1921 summers for which there are no available temperature data. The anlysis presented in this report has shown some of the precautions necessary in interpreting overall summer ice conditions from the ship's logs. In analyzing pre-1921 reports, without the benefit of corresponding temperature data, it will be necessary to pay close attention to details such as time of the summer, ship's location when ice conditions are described, and a working knowledge about what ice conditions are like in recent years at those times and in those locations.

3. Polynyi in the Vicinity of Point Hope

LANDSAT imagery for March-June 1977 have been analyzed to determine the limits of polynyi with open water or thin ice cover. Dates as closely similar in each year as possible were selected. Table 2 lists the areas of open water extent and the monthly rate of change.

Differences between years have been examined in relation to variations in alongshore and onshore/offshore components of the geostrophic wind, computed from MSL pressure data at 6 NMC grid points in the area.

The following results have been obtained:

(1) An analysis of Table 2 indicates that 1974 was a 'maverick' year in terms of polynya extent around Pt. Hope. LANDSAT imagery showed either decreasing or near-static extents from March to May of that year. The other four years (1973, 1975, 1976, 1977) showed increasing extent of the polynyi at varying rates, from March though to June. The rate of increased size was particularly marked in May.

It was decided to compare the prevailing wind regimes in the Pt. Hope region in 1974 with those of the other four years.

(2) Wind vectors for two areas--north of Pt. Hope promontory, and south of Pt. Hope, show that 1974 was clearly anomalous in terms of the dominant wind regimes in these two regions, but especially in the area south of the promontory. It is also apparent that February is the critical month in helping to determine polynya extent and development:

a) February 1974: Prevailing wind from north of north-east at about 7 $msec^{-1}$, which made it offshore in the region south of Pt. Hope and the strongest for all five Februaries. This was confirmed by offshore wind of 5.2 $msec^{-1}$ at two adjacent grid points.

b) February 1973, 1975, 1976, 1977: Winds were of varying strengths (cf. 1976 at 4 $msec^{-1}$ and 1977 12 $msec^{-1}$), yet all from a general easterly rather than north-north-easterly direction. Thus winds in these Februaries were alongshore in the southern section of the promontory, as opposed to the offshore regime in 1974.

c) For the remaining months:

1974 experienced winds with a marked east to north-easterly component and were the strongest of all five years, especially in April (11 $msec^{-1}$). The marked offshore regime thus continued.

1976 experienced generally lightest winds with a marked easterly (alongshore) component.

1973 was similar to 1974 in terms of wind strength, but more easterly (alongshore) direction. Even so, in this year only a gradual increase in polynya extent occurred, probably due to the wind turning more north-easterly (offshore) in April and May. Further, the regime off Point Hope itself shows an offshore wind for this region (as in 1974), but in February this had been onshore. Thus again, February appears to be the critical month.

d) May-June polynya extents:

The relation between alongshore/offshore wind regimes and rates of polynya development appears to continue right up until June in this region.

1974: a marked increase in polynya extent occurred from May to June (+2788 km^2). This was accompanied by a decrease in the wind speed in this region (about 2 $msec^{-1}$ in June) and a direction now slightly south of east; i.e. an alongshore component prevailing.

1975: a slight increase in polynya extent from May-June of the order of +456 km^2. A decreased wind velocity was apparent (2 $msec^{-1}$), but the direction was north of north-east, giving a more offshore component at this time, which appears to inhibit polynya development.

1976: showed a marked increase in polynya size of 913 km^2 which was second to that of 1974. Again, the wind becomes south of south-east in these months (alongshore), at about .2 $msec^{-1}$.

(3) The wind vectors for the region north of the promontory show the same general trends as do those for the southern part of the region:

a) 1974 is again anomalous with a marked northerly component in February. Alongshore winds thus prevail along the western side of the promontory. Strong east-north-easterly winds persist into April, which is similar again to the situation in 1973, however in February of that year winds were lighter east-south-easterlies in this region.

b) 1976, together with 1974, is the only year in which a north-north-easterly wind occurs in February in this region, yet is only of the order of 1 $msec^{-1}$, and becomes more easterly by March. In 1976 only a slight increase in polynya extent occurs from March to April (138 km^2) and this may be related to the trend to stronger northerlies in this region in those two months. The other three years (1973, 1975, 1977) show quite marked increases in polynya size, probably due to the more easterly wind components prevailing.

The following conclusions were reached:

(1) There seems to be a close relationship between polynya extent and rate of change in the vicinity of the Point Hope promontory and the prevailing wind vectors.

(2) In the southern part of the region, where polynyi are consistently best developed, a marked alongshore component from the east to south-east appears to favour continued increase in polynya extent. Offshore wind regimes (as in 1974) appear to inhibit polynya development in the months of February to June. Further investigation of this is in progress.

TABLE 1: Climatic Data for Barrow, Alaska

	Thawing-Degree Days (°C)						
	May	June	July	August	September	TOTAL	Mean Summer Temperature (°C) (JJAS)
1902	7	141	137	108	12	405	2.7
1903	0	74	108	116	22	319	1.9
1911	0	111	229	186	62	588	4.6
1916	0	ND	ND	65	17	-	ND
1882	0*	56	193	101	17	366	2.7
1883	0*	33	105	85	ND	223	2.4(JJA only)

1931-1970 mean summer (JJAS) temp. 1.8°

ND = no data.

* = estimate based on mean monthly temperature.

Table 2. Open-Water Polynya Data

Month	Year	Area (km^2)	Monthly Rate of change
March	1973	125 km^2	
April	1973	625 km^2	+500 km^2
May	1973	1025 km^2	+400 km^2
June	1973	(missing)	
March	1974	1475 km^2	
April	1974	1337 km^2	-138 km^2
May	1974	1275 km^2	- 62 km^2
June	1974	4063 km^2	-2788 km^2
March	1975	(missing)	
April	1975	* 212 km^2	
May	1975	* 1194 km^2	+982 km^2
June	1975	* 1650 km^2	+456 km^2
March	1976	337 km^2	
April	1976	475 km^2	+138 km^2
May	1976	1700 km^2	+1225 km^2
June	1976	2613 km^2	+913 km^2
March	1977	(missing)	
April	1977	663 km^2	
May	1977	2113 km^2	+1450 km^2
June	1977	(missing)	

* Imagery restricted

QUARTERLY REPORT

Contract #03-5-022-55, Task 10
Research Unit #267
Reporting Period: October 1, 1978
to December 31, 1978
Number of Pages: 5

OPERATION OF AN ALASKAN FACILITY

FOR APPLICATIONS OF REMOTE-SENSING DATA TO OCS STUDIES

Albert E. Belon
Geophysical Institute
University of Alaska

December 31, 1978

OPERATION OF AN ALASKAN FACILITY

FOR APPLICATIONS OF REMOTE-SENSING DATA TO OCS STUDIES

Principal Investigator: Albert E. Belon
Affiliation: Geophysical Institute, University of Alaska
Contract: NOAA #03-5-022-55, Task 10
Research Unit: #267
Reporting Period: October 1 to December 31, 1978

I. TASK OBJECTIVES

The primary objective of the project is to assemble available remote-sensing data of the Alaskan Outer Continental Shelf and to assist other OCS investigators in the analysis and interpretation of these data to provide a comprehensive assessment of the development and decay of fast ice, coastal geomorphology, sediment plumes and offshore suspended sediment patterns along the Alaskan coast from Yakutat to Demarcation Bay.

II. LABORATORY ACTIVITIES

A. Operation of the Remote-Sensing Data Library

We continued to search periodically for new Landsat imagery of the Alaskan coastal zone entered into the EROS Data Center (EDC) data base. As a result, 132 Landsat scenes were selected and ordered from EDC at a total cost of $2,214. These data products, which are gradually received from EDC, complete our files of Landsat data from the launch of the first satellite, July 26, 1972. This imagery is ordered in the following formats:

-70mm positive transparency of MSS, spectral band 5

-9 inch print of MSS, spectral band 7

Other formats are ordered on a case-by-case basis and at the request of individual OCS investigators.

We continued to receive and catalog daily copies of NOAA satellite imagery of Alaska in both the visible and infrared spectral bands under a standing order with the NOAA/NESS Fairbanks Satellite Data Acquisition Station. 155 NOAA scenes at a total cost of $2,088 were acquired in 10" positive transparency format during the reporting period.

As mentioned in our last quarterly report, under a State-funded project we are receiving Air Force Weather satellite imagery(DMSP) on a daily near-real-time basis. During this reporting period 64 scenes were received in a variety of data products.

Side-looking airborne radar (SLAR) imagery of the Beaufort coastline from Oliktok Pt. to Brownlow Pt. was obtained on November 28. Copies of this imagery are on file in our library.

B. Operation and maintenance of data processing facilities

Development of a system of computer programs for Landsat digital image processing was completed this quarter. The software, developed with NASA funding, resides on the University of Alaska's Honeywell 66/20 computer. This system makes it possible to perform processing of relatively small areas from raw Landsat data tapes. In addition it is possible to manipulate the results of processing done on other systems to evaluate the results. We are currently testing the programs for OCS related interests (see Section II C).

C. Development of data analysis and interpretation techniques

In November our application specialist traveled to the EROS Data Center in South Dakota, to use their Digital Analysis Laboratory. A Landsat Scene of the Simpson Lagoon, Colville River area was processed using a GE Image 100 and the Interactive Digital Image Manipulation System (IDIMS). The work is aimed at deriving information of shoreline length and the distribution of suspended sediment. Several analysis techniques were attempted. Preliminary products from the analysis were recorded on magnetic tape and will be manipulated in Fairbanks using the new software system (reported in Section II B).

D. Assistance to OCS investigators

Twelve OCS investigators utilized our facilities during this reporting period, many of them repeatedly. Additionally several visitors, though not formal OCSEAP investigators, used our facility for OCSEAP-related activities. Approximately 35 people made extensive use of our services for either OCSEAP or OCSEAP-related projects. Some of these users and their activities are:

George Divoky, RU-196, Pt. Reyes Observatory, visited our facility while in Fairbanks for an OCSEAP meeting and spent several hours browsing through the last year's NOAA and Landsat imagery and ordered several prints.

Joe Truett, RU-467, LGL Ltd., looked at the recent Landsat imagery of Simpson Lagoon to update his record of good imagery for that area.

Brendan Kelly (Shapiro, RU-250) continued working with NOAA imagery to correlate ice data he has obtained to the imagery.

Stu Rawlinson (Cannon, RU-530) asked for assistance in locating historical air photos of the Beaufort coast. Microfiche of USGS mapping photo indices were studied and an order placed for contact prints and enlargements of these photos.

Seelye Martin, RU-87, U. of Washington, called and asked that orbital maps of Landsat coverage for Spring 1978 and 1979 be sent to him. These were sent to him by return mail and also were included in the remote-sensing supplement distributed during this reporting period.

Jay Brueggeman (Braham, RU-69) requested a data search for Landsat imagery in the Norton Sound-Bering Sea area. A list of scenes and their geographic coordinates, cloud cover and dates of acquisition was sent to him along with xerox copies of the scenes.

Don Schell, RU-537, discussed methods of data analysis with our applications specialist. He is interested in salinity and nutrient distribution on the Beaufort coast between Pt. Barrow and Prudhoe Bay. Landsat imagery was ordered for visual photo interpretation on an experimental basis.

Kristina Ahlnas (Royer, RU-289) continues to look through daily NOAA and DMSP imagery and orders enhanced products of certain scenes.

Brian Matthews, RU-526, asked for any satellite imagery that would verify data he had which showed a marked drop in salinity in the Simpson Lagoon on June 8. Enlargements of NOAA imagery for several days preceding that date were made for him which depicted gradual melting and run-off leading to freshwater flooding (see Section III).

Dick Hoopes, National Weather Service, visited the library to become familiar with data available here and asked for copies of any NOAA or DMSP imagery which would be useful for their daily ice forecasts.

Mitchell Taylor, University of Minnesota, called to ask for imagery for a polar bear study he is involved in. We told him that we had already conducted a search for imagery and had furnished NOAA imagery to one of his co-workers, Fred Sorenson. Mr. Taylor was not aware of this and thought that it would be adequate. Recently Mr. Sorenson again contacted us and would now like a search done for Landsat imagery to give more detail to ice conditions for a given date and site in the Chukchi Sea.

Gary Wohl, Oceanographic Services Inc., telephoned to ask for a data search for Landsat imagery in an area in the Bering Sea to aid in his study of sea ice. A complete listing was sent to him and he asked that we order the scenes for him. Since it was an extremely large order it has been partially filled at this time.

Jerry Kreitner, Office of the Pipeline Coordinator, asked for recent aerial photographs of Prudhoe Bay to aid in an environmental impact statement being prepared for a gas conditioning plant. Photos from a 1977 NASA U-2 mission were plotted on a map and sent to him.

Louis Barton, Alaska Department of Fish & Game, Anchorage, asked that we send him sample prints of NOS aerial photography to see if it would be useful in his study of herring along the coast of the Seward Peninsula. Representative copies of CIR and natural color were sent to him and he later returned them with the intention of personally browsing through the photography on file here in the near future.

III. RESULTS

A supplement catalog of remote-sensing data was compiled and distributed by the OCSEAP Arctic Project Office along with Bulletin #22. This supplement covers remote-sensing data acquired for and archived by the remote-sensing library during the last year and should be kept with previously distributed catalogs for a complete file of remote-sensing imagery available here.

Brian Matthews, RU-526, discovered an abrupt decrease in salinity from one of his recording stations in Simpson Lagoon this spring on June 8. This is believed to correspond to the surge of fresh water that builds up from snow melt on the North Slope. To study the event, a data search was performed which yielded NOAA satellite coverage of the entire North Slope on a daily basis and several Landsat scenes at key periods between mid May and early June. Custom enlargements of the NOAA images were produced inhouse and Landsat scenes ordered from EDC. Landsat on June 8 passed west of the study area but imaged a large overflow occurring at the mouth of the Colville River. The images will be used with other data to document the event.

In support of the concentrated efforts concerning the Beaufort Lease sale, we have undertaken a search to identify Landsat imagery covering the area. An image acquired on July 25, 1977 was located that shows the westward movement of sediments from the Sagavanirktok River toward Simpson Lagoon. The Arco causeway, clearly visible in the image, appears to be deflecting the sediment seaward of the lagoon system. A custom enlargement of this image was prepared and taken by Arctic Project Office personnel to a meeting held by the State of Alaska and ARCO where it served as the basis of discussion concerning possible effects of the causeway. We will continue this effort to attempt to locate pre-causeway imagery for comparison.

IV. ESTIMATE OF FUNDS EXPENDED

The estimated expenses of the project during the reporting period were $15,340.69 plus $4,647.30 in outstanding obligations for standing orders for Landsat and NOAA satellite imagery.

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: #289
Task Order: #19
Reporting Period: 10/1/78-12/31/78
Number of Pages: 3

CIRCULATION AND WATER MASSES IN THE GULF OF ALASKA

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December 1978

I. TASK OBJECTIVES

To gather and analyze hydrographic and current meter data in the northern Gulf of Alaska for the purpose of describing possible flow trajectories. To describe the physical environment and to understand its driving mechanisms. To continue to monitor NOAA satellite data for use by this project and other OCSEAP investigators. To organize and lead to synthesis of physical oceanographic data for NEGOA.

II. FIELD ACTIVITIES - None

III. RESULTS

A thesis entitled "A Statistical and spectral analysis of observed surface winds at three stations in the Gulf of Alaska" was completed by David Livingstone. Two manuscripts which evolved from this thesis are being submitted for publication in scientific journals. The paper "On the effect of precipitation and runoff on coastal circulation in the Gulf of Alaska was accepted for publication in the Journal of Physical Oceanography Vol. 9:3. Work continues on several other manuscripts involving seasonal fluctuations in the Alaska Current and the variation of flow across the Seward line.

A preliminary synthesis report was prepared and presented at the fall OCSEAP physical oceanographers meeting. Revisions of this report are expected in the next few months.

IV. PRELIMINARY INTERPRETATION OF RESULTS

Current meter data for Hinchinbrook Entrance and Montague Strait show a general inflow in the former and outflow in the latter. Very high temperatures were measured in mid-September (>12°C) and are well-correlated with high temperatures near Valdez (data from a different project). Anomalous currents accompany the temperatures at both locations. Salinities decreased uniformly from April through September as expected.

Analysis of IMS 9 current meter data indicate responses that would be expected if eddies propagated through the array. These eddies are confirmed by the hydrographic data.

The entrainment hypothesis, used to account for the trayectories of the Lagrangian drifters released by Hansen, has been supported with current meters data from Station 62. The upper level velocities are directed more onshore than the lower layer velocities. It is assumed that the upper meter (20m) is below the offshore moving upper layer.

V. PROBLEMS ENCOUNTERED

Some delays were experienced in getting a suitable work statement completed for next year. The major problem seemed to involve communication between the PI and Juneau office. No serious differences were evident after the discussions.

Reservations are expressed here over the ability of this PI to hold the other PI's to a schedule for the synthesis report. Without their full cooperation a synthesis effort will be unsuccessful.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 19 R.U. NUMBER: 289

PRINCIPAL INVESTIGATOR: Dr. T. C. Royer

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	
Acona #193	7/1/74	7/9/74	submitted	None	None	
Acona #200	10/8/74	10/14/74	submitted	None	None	
Acona #202	11/18/74	11/20/74	submitted	None	None	
Acona #205	2/12/75	2/14/75	submitted	None	None	
Acona #207	3/21/75	3/27/75	submitted	None	None	
Acona #212	6/3/75	6/13/75	submitted			
Oceangrapher #805	2/1/75	2/13/75	submitted	None	None	
Silas Bent #811	8/31/75	9/28/75	Submitted			
Discoverer #812	10/3/75	10/16/75	(a)			
Surveyor #814	10/28/75	11/17/75	submitted			
Discoverer #816	11/23/75	12/2/75	(b)	None	None	
Station 60	7/2/74	8/26/74	None	(c)	None	
Station 64	4/28/75	5/20/75	None	(c)	None	
Station 9A	-	-	-	Lost		
Station 9B	4/20	7/24/76	-	submitted	submitted	
Moana Wave MW 001	2/21/76	3/5/76	submitted			
Moana Wave MW 003/004	4/20/76	5/21/76	submitted			
Moana Wave MW005	7/22/76	8/1/76	submitted			
Moana Wave 006	9/13	9/19/76	submitted			

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	
Surveyor SU 003	9/7/76	9/17/76	submitted			
Surveyor	9/20/76	10/2/76	submitted			
Miller Freeman	11/1/76	11/19/76	submitted			
Moana Wave	10/7/76	11/16/76	submitted			
Miller Freeman	3/9/77	4/2/77	submitted			
Station 9C	7/22/76	11/2/76	submitted			
Acona 248	8/11/77	8/14/77	submitted			
Discoverer	11/8/77	11/16/77	submitted			
Acona 253	11/10/77	11/17/77	10/30/78			
Hinchinbrook	11/10/77	9/19/78	None	Submitted	Submitted	
Montegue	11/10/77	9/19;78	None	Submitted	Submitted	
Station 9D	11/3/76	3/29/77	None	Submitted	Submitted	
Acona	2/16/78	2/25/78	submitted			
Acona 260	4/22/78	5/8/78	submitted			
Acona 264	7/31	8/12/78	1/15/79			
Acona 266	9/17	9/30/78	1/15/79			
Hinchinbrook	9/19/78	Current	None	Scheduled when retrieved		
Monteque	9/19/78	Current	None	Scheduled when retrieved		

Note: [1] Data Management Plan and Data Formats have been approved and are considered contractual.

(a) Parent tapes were coded in PODAS format, tapes were submitted to F. Cava as requested.

(b) Data useless due to malfunction of shipboard data logger.

(c) In edit process. Development of computer editing program has held up data.

Data Batch 1 = STD/CTD
2 = Current meter
3 = Pressure guage

Fiscal Report

Contract: 03-5-022-56

Task Order: #19

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$20,305.80	$315,068.26
Travel	1,742.49	16,927.71
Equipment	-0-	44,434.62
Other	13,525.71	110,697.55
Staff Benefits	3,367.94	52,681.77
Overhead	10,152.90	161,802.89
Total Billed	$49,094.84	$701,612.80
Total Award		809,096.00
Total Unbilled		107,483.20

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

QUARTERLY REPORT

Contract No. R7120848
RU: 367
Reporting Period:
1 October - 31 December 1978
Number pages: 2

COASTAL METEOROLOGY

B. A. Walter
S. A. Macklin
R. M. Reynolds

Pacific Marine Environmental Laboratory

29 December 1978

Task Title: Coastal Meteorology

PI: B. A. Walter, S. A. Macklin, R. M. Reynolds
NOAA/PMEL
3711 15th Avenue N.E.
Seattle, Washington 98105

Reporting period: 1 October - 31 December 1978

I. Task Objectives

To provide an improved understanding of mesoscale features of the surface wind fields in the Kodiak, LCI and NEGOA lease areas by:

A. Providing graphical presentations of surface winds (over-water and over-land) for typical sets of synoptic weather conditions.

B. Determining the relationship between wind observations made over-the-water and over-the-land for various synoptic scale weather patterns.

C. Investigating the behavior of the regional surface wind fields in response to the passage of a typical synoptic disturbance.

D. Creating a Kiliuda Bay meteorological data base.

II. Field and Laboratory Activities

A. Cruises: None

B. Field Experiments:

1. A meteorological station was installed at Pivot Point, Kiliuda Bay, Kodiak Island on 15 October by Mr. Macklin and Mr. Reynolds.

2. On 18-19 October Mr. Reynolds and Mr. Macklin serviced the meteorological stations in Lower Cook Inlet. A defective anemometer was replaced at the Contact Point station. On 28 November a defective anemometer was replaced at the Augustine Island station.

C. Laboratory Activities:

1. Mr. Walter attended an OCSEAP workshop on Physical Oceanography and Meteorology at Rosario Resort Hotel from 16-19 October.

2. Mr. Macklin delivered an address to the Energy Transfer Group, Department of Atmospheric Services, University of Washington on 5 December. The talk was entitled "Mesoscale Winds in Lower Cook Inlet".

3. Mr. Steven Deters, an Analyst with Potomac Research, Inc., has been contracted to provide computer programming services for an eight week period beginning 20 December.

III. Results:

A. Data from the March 1978 Lower Cook Inlet cruise is undergoing further analysis. Work to date has bocused attention on three sites of mesoscale influence: Cape Douglas, Augustine Island and Kachemak Bay. A katabatic flow from the Douglas Peak-Four Peaked Mountain area appears to be especially important with respect to surface wind aberrations.

B. Meteorological measurements from many sources collected over the past year from the Kodiak, LCI and NEGOA regions will soon be integrated into a master meteorological data file in the University of Washington CDC 6400 computer. Completion of this project will greatly enhance our ability to meet the task objectives mentioned above.

Research Unit 435
November 1-December 31, 1978

Quarterly Report

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA

J. J. Leendertse
S. K. Liu

The Rand Corporation
Santa Monica, California 90406

Reference: Three-Dimensional Subgridscale Energy Model of Eastern Bering Sea, Proceedings, Coastal Engineering, American Society of Civil Engineers, 1978

Progress Report

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA (RU 435)

National Oceanic and Atmospheric Administration

November 1, 1978 - December 31, 1978

J. J. Leendertse and S. K. Liu

During the reporting period our effort has been directed toward the preparation of the report (R-2405-NOAA) on the Bristol Bay model development, adjustment, verification and prediction, and the development of the Norton Sound model, including the dynamics of ice cover.

The Bristol Bay report contains a detailed description of the hydrodynamic environment of the system, the model setup procedure, and the manner in which boundary conditions are prescribed during various phases of the study. The report also describes the process of model adjustment, the selection of proper bottom stress coefficients and turbulent closure constants. In the verification prediction run, the predicted tidal level at the model's open boundary is used to drive the adjusted model. The computed current distribution and tidal propagation are then compared against the observed values so that the model's predictability can be evaluated. Preparation of this report is nearing completion.

In the development of the ice-movement model of Norton Sound, the response of the ice cover to driving forces is based upon considerations of the change in momentum in the horizontal plane due to wind stresses at the upper surface, the stress at the ice-water interface, Coriolis force, internal ice stress and the sea surface tilt.

At the beginning of the model development, the dynamic processes of air-ice, ice water interface, momentum transfer, salt rejection during ice formation, the growth of ice pack thickness, initial vertical thermohaline structure, and the generation of turbulent energy due to the differential velocity at the ice-water interface are represented by parametric relationships. These computations are then incorporated into the main simulation algorithm.

Some of the ice-related computation requires extensive programming and debugging effort. During the computational code development, the problems of simulation data processing and graphical representation were also considered.

The preliminary coding process has already started. Testing and debugging will be conducted on a model with a simpler bathymetry.

Research Unit 435
November 1978

A THREE-DIMENSIONAL MODEL FOR ESTUARIES AND COASTAL SEAS: VOLUME VI, BRISTOL BAY SIMULATIONS

S. K. Liu
J. J. Leendertse

The Rand Corporation
Santa Monica, California 90406

This Note is intended only to transmit preliminary research results and views or conclusions expressed herein may be tentative and do not necessarily represent the opinion of the sponsor.

PREFACE

This report presents simulations of the time and wind effects in Bristol Bay, a part of the Bering Sea. The simulations were made in support of an ongoing study of the environment of this region being conducted by the National Oceanic and Atmospheric Administration (NOAA) as part of an environmental assessment of the area in anticipation of possible oil and gas lease sales. The Rand work is directed towards the development of a prediction method for the possible pathways of pollutants discharged accidentally in the lease areas.

This report is the sixth in a series describing the development of a three-dimensional model for estuaries and coastal seas. In the first report [1], a basic framework for computation was designed. In the second report [2], this was extended and different aspects of computation were reported. The third report [3] presented a listing of the program as developed up to that time. In the fourth volume [4], a significant change in the computation method was reported which made the computation more stable, and the computation of subgridscale energy was included. The fifth report [5] presented the listing of the program and replaced the third volume.

ACKNOWLEDGMENTS

This study was supported by the Bureau of Land Management through interagency agreement with the National Oceanic and Atmospheric Administration, under which a multi-year program responding to needs of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office.

The authors would like to express their appreciation to Drs. R. L. Charnell, R. Overstreet, D. Hansen, M. Pelto, J. Galt, H. Mofjeld, R. Muench, C. Pearson, J. Schumacher (all from NOAA), L. K. Coachman, T. Kinder (from the University of Washington), and D. Amstutz (from the Bureau of Land Management) for providing valuable discussions during the course of our investigation. The authors obtained much support from the Technical Project Officer, Mr. M. Pelto, in arranging the field data surveys for the model study and in coordinating our work with the efforts of other study groups.

Thanks also go to our Rand colleagues Mr. A. B. Nelson, Ms. K. Sparr and Ms. J. Douglas for their indispensable efforts in simulation, graphics development and report preparation.

CONTENTS

I. INTRODUCTION

At the start of the modeling study reported here, the investigators had to make a decision as to what type of model should be used. At that time extensive experience had been obtained with a vertically integrated two-dimensional model and it would have been quite logical to use a two-dimensional model, as such models could be considered the established practice.

From the limited field data available at the beginning of the investigation, it was clear, however, that we were dealing with a three-dimensional flow problem, and since a three-dimensional model had been developed recently, it seemed appropriate to use it even though we had only limited experience in using that model.

Considerable difficulties were encountered in its application. It was generally difficult to describe the boundary conditions for the model. The ongoing research effort in the physical oceanography of Bristol Bay, by the National Oceanographic and Atmospheric Administration, was initially not directed toward describing these conditions, even though the effort did provide excellent data as to the main physical process and distributive data which could be used in starting the model. However, as soon as the modeling boundary requirements became clear, an all-out effort was made by this agency to assist us, and the data which was finally used was well suited for the adjustment and verification of the model.

Since we had only limited experience in the use of the model, the first estimates of some of the characteristic parameters of the system were quite far from the values which we later used. The adjustment of these parameters was time-consuming, as many experiments had to be made.

For the adjustment and verification, comparisons of observed and computed data have to be made. We used graphical representation of observed and computed data in the comparisons, rather than comparing numerical outputs, thus plotting programs had to be developed. The major problem here was not preparing the programs for these graphs, but writing the programs for processing the very extensive data sets generated by the simulation. These data are indeed massive, and as a result processing can be expensive if the processing procedures are not well designed.

As the reader will see later, we succeeded in making extensive graphical representations, thanks to many plotting programs available in a two-dimensional simulation system. We adapted these programs and subroutines in a provisional manner, as our budget did not allow for building an extensive simulation system. This approach put high demands on the skills of our colleagues who are supporting us.

Because the prototype data system, the selected model and the modeling investigators are three components in a modeling investigation, an adaptive process takes place involving these three components in an iterative manner. At the beginning, a basic model is selected by the investigators so as to be representative of the basic environmental components of the prototype system according to the available general information about the system at that time.

As the modeling effort proceeds, the investigators have an opportunity to look more closely at the involved dynamic processes through the analytic nature of the numerical model. Field sampling programs can thus be designed more effectively to resolve the finer details of the system. From these data, new insight leads to the further refinement of the model, and so on.

Section II of this report gives a general description of the hydrodynamic environment of the Bristol Bay system. Because of the pronounced vertical nonhomogeneity, a three-dimensional model is required to characterize its response to the tide- and wind-driven forces. Section III describes the model setup procedure and the manner in which boundary conditions are prescribed during various phases of the study.

Section IV describes the process of model adjustment. This adjustment process involves the selection of appropriate bottom stress coefficient and turbulent closure constants until the accuracy of tidal propagation and vertical description between model and prototype system is acceptable.

Section V describes the verification run using the adjusted model. The run involves the prediction of tidal level at the model's open boundary to drive the model. The computed current distributions are then compared against the observed values so that the model's predictability can be evaluated.

II. PHYSICAL PROCESSES IN BRISTOL BAY

Bristol Bay (Fig. 1) is situated on the continental shelf area at the southeastern corner of the Bering Sea, which has one of the largest shelf areas of the world's oceans. Because of this, the water mass movement in Bristol Bay is driven predominantly by wind and tide, whereas waters in the deeper basin to the west are part of the cyclonic Bering Sea slope current system flowing parallel to the continental shelf break. The annual cycles of surface heating and cooling and the duration, strength and phasing of these periods give a distinctive hydrodynamic behavior to the Bristol Bay system. During autumn and winter, local negative buoyancy (vertically unstable) exists due to surface cooling and brine rejection during ice formation. In spring, positive buoyancy is added by fresh water runoff, ice melting and insulation. The hydrographic structure in Bristol Bay is further modified by the seasonal wind, with higher mean speed in autumn and winter.

Generally, most of Bristol Bay is covered with ice until the end of May when ice begins to melt in June, during which time St. George Basin and the shelf slope comprise a region of relatively warmer water, and the shallower shelf shoreward contains colder water. The region north of the Alaska peninsula remains ice-free during winter.

Because the deeper basin is the source of warm, salty water, the salinity decreases from the shelf slope to the shallower coastal zone. In spite of the temperature variation in the area, the density decreases toward the shore due to the fact that density of sea water is more sensitive to salinity change than to temperature variation. The exception is the coastal area near Kuskokwim Bay, where water of high salinity was observed [6].

In the deeper waters of Bristol Bay, the depth of mixed layers ranges from 10 to 30 meters, whereas in the shallower coastal region the water is vertically isothermal with generally cooler water. Similar vertical distributions were found for salinity. Generally, the mixed layer depth does not have persistent geographic trend. It tends to reflect the local wind condition, which causes the deepening of the layer.

In the modeling investigation reported here the physical process involved can essentially be described by a set of partial differential equations associated with the prototype hydrodynamic system. The equations of horizontal motion for an incompressible internally source-free fluid on a rotating earth in Cartesian coordinates with z-axis positive upward are:

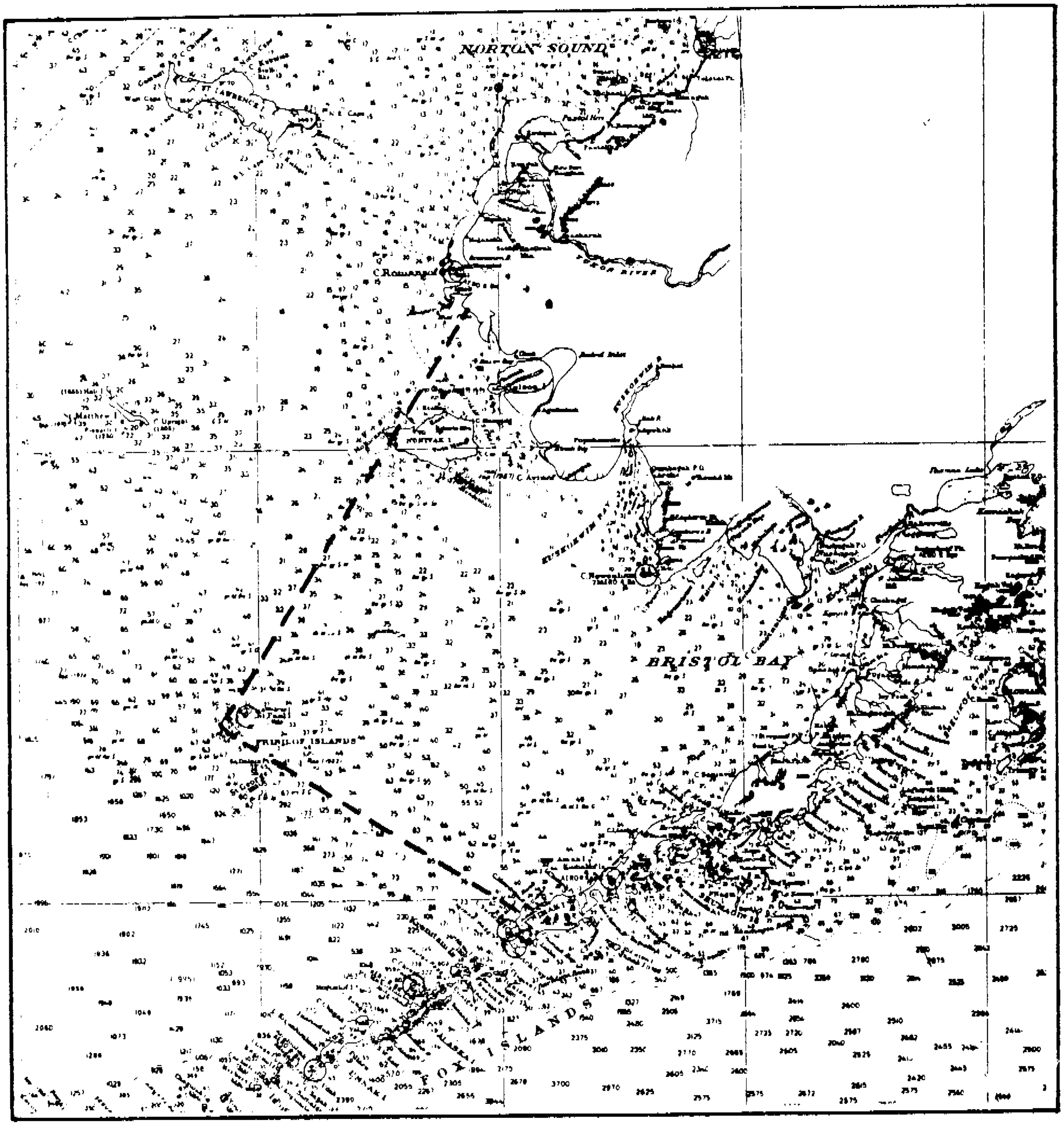


Fig. 1--Location map of Eastern Bering Sea and the approximate boundary of Bristol Bay model

$$\frac{\partial u}{\partial t} + \frac{\partial (uu)}{\partial x} + \frac{\partial (uv)}{\partial y} + \frac{\partial (uw)}{\partial z} - fv + \frac{1}{\rho}\frac{\partial p}{\partial x} - \frac{1}{\rho}\left(\frac{\partial \tau_{xx}}{\partial x} + \frac{\partial \tau_{xy}}{\partial y} + \frac{\partial \tau_{xz}}{\partial z}\right) = 0$$

$$\frac{\partial v}{\partial t} + \frac{\partial (vu)}{\partial x} + \frac{\partial (vv)}{\partial y} + \frac{\partial (vw)}{\partial z} + fu + \frac{1}{\rho}\frac{\partial p}{\partial y} - \frac{1}{\rho}\left(\frac{\partial \tau_{yx}}{\partial x} + \frac{\partial \tau_{yy}}{\partial y} + \frac{\partial \tau_{yz}}{\partial z}\right) = 0$$

where x, y and z are Cartesian coordinates, positive eastward, northward and upward, respectively; u, v and w denote the respective components of velocity; f represents the Coriolis parameter; ρ is the density of water; τ_{xx}, τ_{xy}, τ_{xz}, etc. are components of stress tensor.

The flow in the modeled area, the vertical acceleration of fluid motion associated with the predominant hydrodynamic process (i.e., tide- and wind-induced circulation) is approximately five orders of magnitude smaller in comparison with the gravitational acceleration. Therefore we can neglect the vertical acceleration and advection, and the equation of motion in the vertical direction becomes the hydrostatic equation

$$\partial p/\partial z + \rho g = 0$$

The equation of continuity is

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0$$

The equations of salt and heat balance are:

$$\frac{\partial s}{\partial t} + \frac{\partial (us)}{\partial x} + \frac{\partial (vs)}{\partial y} + \frac{\partial (ws)}{\partial z} - \frac{\partial [D_x(\partial s/\partial x)]}{\partial x} - \frac{\partial [D_y(\partial s/\partial y)]}{\partial y} - \frac{\partial [\kappa(\partial s/\partial z)]}{\partial z} = 0$$

$$\frac{\partial T}{\partial t} + \frac{\partial (uT)}{\partial x} + \frac{\partial (vT)}{\partial y} + \frac{\partial (wT)}{\partial z} - \frac{\partial [D_x(\partial T/\partial x)]}{\partial x} - \frac{\partial [D_y(\partial T/\partial y)]}{\partial y} - \frac{\partial [\kappa'(\partial T/\partial z)]}{\partial z} = 0$$

where s and T represent salinity and temperature; D_x and D_y are horizontal diffusion coefficients; k and k' are vertical exchange coefficients for salt and heat, respectively

The relationship between density, salinity and temperature can be approximated by an equation of state in the form

$$\rho = \bar{\rho} + \rho'(s, T)$$

Similar equations can be written for subgridscale (SGS) turbulent energy densities and dissolved pollutant constituents:

$$\frac{\partial e}{\partial t} + \frac{\partial(ue)}{\partial x} + \frac{\partial(ve)}{\partial y} + \frac{\partial(we)}{\partial z} - \frac{\partial D_x(\partial e/\partial x)}{\partial x} - \frac{\partial[D_y(\partial e/\partial y)]}{\partial y} - \frac{\partial[\kappa(\partial e/\partial z)]}{\partial z} + hD \pm S_e = 0$$

$$\frac{\partial P}{\partial t} + \frac{\partial(uP)}{\partial x} + \frac{\partial(vP)}{\partial y} + \frac{\partial(wP)}{\partial z} - \frac{\partial D_x(\partial P/\partial x)}{\partial x} - \frac{\partial[D_y(\partial P/\partial y)]}{\partial y} - \frac{\partial[\kappa(\partial P/\partial z)]}{\partial z} + hK_P' \pm S_P = 0$$

where e is the subgridscale turbulent energy per unit mass; p denotes any pollutant concentration of concern; D_e is the dissipation rate for turbulent energy; K'_e is the decay rate for the pollutant concentration; and S_e and S_p are the source and sink terms for turbulent energy and pollutant concentration, respectively.

The above set of partial differential equations describes the physical processes only in a limiting sense such that quasi-continuous spatial-temporal representation is required to describe the dynamic features of concern. In the process of finding the numerical solution to the differential equations of the mean flow, certain conceptual descriptions of the fine features of the dynamic behavior are being introduced. The way to describe these fine features becomes the product of the iterative learning process mentioned earlier. The modeler's final formulation embodies not only the specific solution method associated with the PDE, but also the investigator's conceptual description of the prototype behavior that he or she learns through data and intermediate modeling results.

During the course of our model development, changes in formulation took place as a consequence of new insight into the fine dynamic features derived from reviewing the simulation results against updated prototype data.

If we use the standard notation for summing, differencing and shifting as defined by

$$\bar{F}^x = \tfrac{1}{2}\{F[(i+\tfrac{1}{2})\,\Delta x, j\,\Delta y, k\,\Delta z, n\,\Delta t] + F[(i-\tfrac{1}{2})\,\Delta x, j\,\Delta y, k\,\Delta z, n\,\Delta t]\}$$

$$\delta_x F = \frac{1}{\Delta x}\left\{F\left[\left(i+\frac{1}{2}\right)\Delta x, j\,\Delta y, k\,\Delta z, n\,\Delta t\right] - F\left[\left(i-\frac{1}{2}\right)\Delta x, j\,\Delta y, k\,\Delta z, n\,\Delta t\right]\right\}$$

$$F_+ = F[i\,\Delta x, j\,\Delta y, k\,\Delta z, (n+1)\,\Delta t]$$

$$F_- = F[i\,\Delta x, j\,\Delta y, k\,\Delta z, (n-1)\,\Delta t]$$

where i, j, k, n denote the discrete representation in the x, y, z, t domain, the finite difference formulation finally adapted for the computation of Bristol Bay takes the following form:

Equations (1) through (9) for level k with layer-average values, the continuity equation, the mass momentum, and SGS energy balance equations for the interior of the modeled system, and the equation of state are:

$$\overline{\delta_t \zeta}^t = -\sum_k [\delta_x(\bar{h}^x u) + \delta_y(\bar{h}^y v)] \qquad \text{at } i, j, n$$

$$\overline{\delta_t(\bar{h}^x u)}^t = -\delta_x(\overline{\bar{h}^x \bar{u}}^x \bar{u}^x) - \delta_y(\overline{\bar{h}^y v}^x \bar{u}^y) - \bar{h}^x\,\delta_z(\bar{u}^z \bar{w}^x) + f\bar{h}^x \bar{v}^{xy} - \frac{1}{\bar{\rho}^x}\bar{h}^x\,\delta_x p$$

$$+ \frac{1}{\bar{\rho}^x}[h\delta_z E_x \delta_z \bar{u}^{2t} + \delta_x(hA_x\delta_x u)_- + \delta_y\,\overline{\bar{h}^x \bar{A}_y^x}^y \delta_y u)_-]$$

$$\text{at } i+\frac{1}{2}, j, k, n$$

where E_x is the vertical momentum exchange coefficient and A_x, A_y are horizontal exchange coefficients in x and y direction, respectively.

$$\overline{\delta_t(\bar{h}^y v)}^t = -\delta_x(\overline{\bar{h}^x u}^y \bar{v}^x) - \delta_y(\overline{\bar{h}^y u}^y \bar{v}^y) - \bar{h}^y\,\delta_z(\bar{v}^z \bar{w}^y) - f\bar{h}^y \bar{u}^{xy} - \frac{1}{\bar{\rho}^y}\bar{h}^y\,\delta_y p$$

$$+ \frac{1}{\bar{\rho}^y}\left[h\,\delta_z E_y\,\delta_z \bar{v}^{2t} + \delta_x\left(\overline{\bar{h}^y A_x^y}^x\,\delta_x v\right)_- + \delta_y(hA_y\delta_y v)_-\right]$$

$$\text{at } i, j+\frac{1}{2}, k, n$$

$$\overline{\delta_t(hs)}^t = -\delta_x(\bar{h}^x u\bar{s}^x) - \delta_y(\bar{h}^y v\bar{s}^y) - h\,\delta_z(w\bar{s}^z)$$

$$+ \delta_x(\bar{h}^x D_x\,\delta_x s)_- + \delta_y(\bar{h}^y D_y\,\delta_y s)_- - h\,\delta_z(\kappa\,\delta_z \bar{s}^{2t}) \qquad \text{at } i, j, k, n$$

where D_x and D_y are the horizontal diffusion coefficients and k is the vertical mass exchange coefficient. For temperature we have

$$\overline{\delta_t(hT)}^t = -\delta_x(\bar{h}^x u\overline{T}^x) - \delta_y(\bar{h}^y v\overline{T}^y) - h\,\delta_z(w\overline{T}^z) + \delta_x(\bar{h}^x D_x \delta_x T)_- + \delta_y(\bar{h}^y D_y \delta_y T)_- + h\,\delta_z(\kappa'\,\delta_z \overline{T}^{2t}) \quad \text{at } i, j, k, n$$

where k' is the vertical thermodiffusion coefficient. For SGS energy density in the system,

$$\overline{\delta_t(he)}^t = -\delta_x(\bar{h}^x u\bar{e}^x) - \delta_y(\bar{h}^y v\bar{e}^y) - h\,\delta_z(w\bar{e}^z) + \delta_x(\bar{h}^x D_x \delta_x e)_- + \delta_y(\bar{h}^y D_y \delta_y e)_- + h\,\delta_z(E_e\,\delta_z \bar{e}^{2t}) + S - Dh \quad \text{at } i, j, k, n$$

where E_e is the vertical momentum exchange coefficient. For pollutant constituent concentration, we have

$$\overline{\delta_t(hP)}^t = -\delta_x(\bar{h}^x u\bar{P}^x) - \delta_y(\bar{h}^y v\bar{P}^y) - h\,\delta_z(w\bar{P}^z) + \delta_x(\bar{h}^x D_x\,\delta_x P)_- + \delta_y(\bar{h}^y D_y\,\delta_y P)_- + h\,\delta_z(\kappa\,\delta_z \bar{P}^{2t}) + S \quad \text{at } i, j, k, n$$

The equation of state can be approximated by

$$\rho = (5890 + 38T - 0.375T^2 + 3s)/[(1779.5 + 11.25T - 0.0745T^2) - (3.8 + 0.01T)s + 0.698(5890 + 38T - 0.375T^2 + 3s)] \quad \text{at } i, j, k, n+1$$

The continuity equation is used to compute the vertical velocity:

$$\delta_z w = -\delta_x(\bar{h}^x u) - \delta_y(\bar{h}^y v) \qquad \text{at } i, j, k, n+1$$

Similar equations for velocity components u and v can be written for the top and bottom layers, but now the effects of wind and bottom friction must be considered.

$$\overline{\delta_t(\bar h^x u)}^t = -\delta_x(\overline{\bar h^x u}^x \bar u^x) - \delta_y(\overline{\bar h^y v}^x \bar u^y) - \bar h^x \delta_z(\bar u^z \bar w^x) + f \bar h^x \bar v^{xy} - \frac{1}{\bar\rho^x} \bar h^x \delta_x p$$

$$+ \frac{1}{\bar\rho^x} \left[\theta \rho_a w_a^2 \sin\psi - (E_x \delta_z \bar u^{2t})_{k=3/2} + \delta_x(hA_x \delta_x u)_- \right.$$

$$\left. + \delta_y\left(\overline{\bar h^x \bar A_y}^x \delta_y u\right)_- \right] \qquad \text{at } i + \frac{1}{2}, j, 1, n$$

$$\overline{\delta_t(\bar h^y v)}^t = -\delta_x(\overline{\bar h^x u}^y \bar v^x) - \delta_y(\overline{\bar h^y v}^y \bar v^y) - \bar h^y \delta_z(\bar v^z \bar w^y) - f \bar h^y \bar u^{xy} - \frac{1}{\bar\rho^y} \bar h^y \delta_y p$$

$$+ \frac{1}{\bar\rho^y} \left[\theta \rho_a w_a^2 \cos\psi - (E_y \delta_z \bar v^{2t})_{k=3/2} + \delta_x \overline{\bar h^y \bar A_x}^x \delta_x v)_- \right.$$

$$\left. + \delta_y(hA_y \delta_y v)_- \right] \qquad \text{at } i, j + \tfrac{1}{2}, 1, n$$

where ϕ represents the wind-stress coefficient, w_a is wind speed, and ρ_a represents the density of air. At the bottom layer, the momentum equation becomes

$$\overline{\delta_t(\bar h^x u)}^t = -\delta_x(\overline{\bar h^x u}^x \bar u^x) - \delta_y(\overline{\bar h^y v}^x \bar u^y) - \bar h^x \delta_z(\bar u^z \bar w^x) + f \bar h^x \bar v^{xy} - \frac{1}{\bar\rho^x} \bar h^x \delta_x p$$

$$+ \frac{1}{\bar\rho^x} \left[(E_x \delta_z \bar u^{2t})_{k=K-1/2} - \bar\rho^x g u_- (u_-^2 + \bar v_-^{xy})^2)^{1/2} / (\bar C^x)^2 \right.$$

$$\left. + \delta_x(hA_x \delta_x u)_- + \delta_y(\overline{\bar h^x \bar A_y}^x \delta_y u)_- \right] \qquad \text{at } i + \frac{1}{2}, j, K, n$$

$$\overline{\delta_t(\bar h^y v)}^t = -\delta_x(\overline{\bar h^x u}^y \bar v^x) - \delta_y(\overline{\bar h^y v}^y \bar v^y) - \bar h^y \delta_z(\bar v^z \bar w^y) - f \bar h^y \bar u^{xy} - \frac{1}{\bar\rho^y} \bar h^y \delta_y p$$

$$+ \frac{1}{\bar\rho^x} \left[(E_y \delta_z \bar v^{2t})_{k=K-1/2} - \bar\rho^y g v_- ((\bar u_-^{xy})^2 + v_-^2)^{1/2} / (\bar C^y)^2 \right.$$

$$\left. + \delta_x(\overline{\bar h^y \bar A_x}^x \delta_x v)_- + \delta_y(hA_y \delta_y v)_- \right] \qquad \text{at } i, j + \frac{1}{2}, K, n$$

In the modeled area, each vertical motion of water mass has to work against buoyancy forces induced by the density gradient. If the available kinetic energy of the turbulent motion is insufficient to overcome this stabilizing effect, turbulence is inhibited and suppressed. As a consequence, the process of momentum and mass-heat exchange will be lower than the neutral stability condition. The criteria for the onset of this turbulence-suppressing process in the system can be obtained by the local density gradient and turbulent energy level. The exchange coefficient for stratified flow can thus be expressed as

$$E_x = \bar\rho^{xz} \, \overline{\bar L \sqrt{e_-}}^{xz} \exp\left[m \frac{g}{\bar\rho^{xz}} \frac{(\bar L^z)^2 \delta_z(\bar\rho^x)}{e_-^{xz}} \right]$$

$$E_y = \bar\rho^{yz} \, \overline{\bar L \sqrt{e_-}}^{xz} \exp\left[m \frac{g}{\bar\rho^{yz}} \frac{(\bar L^z)^2 \delta_z(\bar\rho^y)}{e_-^{yz}} \right]$$

$$\kappa = a_4 \overline{L\sqrt{e_-}}^z \exp\left[r \frac{g}{\bar{\rho}^z} (\bar{L}^z)^2 \frac{\delta_z \rho}{\bar{e}_-^z}\right]$$

$$E_e = a_1 \overline{L\sqrt{e_-}}^z \exp\left[m \frac{g}{\bar{\rho}^z} (\bar{L}^z) \frac{\delta_z \rho}{\bar{e}_-^z}\right]$$

where L is a length scale which is taken as a function of the distance from the bottom and surface boundaries as follows:

$$L = k' z(1 - z/d)^{1/2}$$

where k' is the von Karman constant, z represents the vertical distance from the bottom to the point considered, and d is the vertical distance from surface to bottom. In the computation, if the computed L is greater than half of the layer thickness, the latter is used as L. In the horizontal direction, the exchange coefficient is computed as a function of the local vorticity gradient.

$$A = \gamma \left|(\delta_x \bar{\omega}^y + \delta_y \bar{\omega}^x)\right| (\Delta l)^3$$

from which we obtain the horizontal exchange coefficient

$$D_x = \bar{A}^x \qquad D_y = \bar{A}^y$$

In the interior, the generation of subgridscale energy is derived from

$$S = a_3 \overline{L\sqrt{e_-}}^z \left[(\delta_z \bar{u}^x)^2 + (\delta_z \bar{v}^y)^2\right]$$

In the bottom layer, energy which is taken out of the mean flow through the bottom stress immediately enters the subgridscale energy system as a source term.

$$R_x = \frac{1}{\bar{\rho}^x} (\tau^{xz})_{k+1/2} = gu[u^2 + (v^{xy})^2]^{1/2}/(\bar{C}^x)^2 \qquad \text{at } i + \frac{1}{2}, j, k, n$$

$$R_y = \frac{1}{\bar{\rho}^y} (\tau^{yz})_{k+1/2} = gv[u^2 + (v^{xy})^2]^{1/2}/(\bar{C}^y)^2 \qquad \text{at } i, j + \frac{1}{2}, k, n$$

$$S = \overline{u_- R_x}^x + \overline{v_- R_y}^y \qquad \text{at } i, j, k, n$$

The rate of turbulent energy dissipation is determined from the concept that the dissipation rate depends on the transfer process from larger eddies to smaller eddies according to

$$D = a_2 e_-^{3/2} / L$$

III. MODEL SETUP AND BOUNDARY SPECIFICATIONS

During the initial phase of this investigation, a model of seven layers in the vertical was set up (Fig. 2). A series of simulations was performed to test the basic hydrodynamic behavior of Bristol Bay in response to tide- and wind-driven forces. Due to the lack of field data at that time, historic tide data of limited extent were used at the model's open boundary for the computation. The preliminary model uses fixed diffusion coefficients for the vertical and horizontal exchange of momentum and constituents transport. In the second phase of our study, analyses made from the field sampling program were available for further refinement of the model. Substantial improvements have also been made in the computational scheme and the vertical resolution. The new computational scheme, developed under the sponsorship of the Department of the Interior, has the advantage that it considers the intensity and transport of the subgridscale (turbulent) energy in a system. In this new scheme the vertical exchange computation is coupled to the local turbulent energy intensities, a length scale and a density gradient in an implicit manner. The most critical stability conditions associated with the earlier computational method were removed by this change. In the horizontal direction, the diffusion coefficient contains two parts. The first part represents the local subgridscale horizontal mixing which cannot be resolved by the computational grid as advective terms. This part is estimated by the well-known four-third power law of the characteristic length scale (grid dimension). The second part is calculated as a function of vorticity gradient, or, in other words, the deformation of the local velocity field. With the new scheme, requirements for field diffusion experiments are minimized. The new computational method also gives an accurate account of the arbitrary bathymetry at each spatial grid location, thus allowing for more precise computation of wave propagation in the model. In the meantime, the accuracy of the calculated currents in the lower layers is improved.

With these improvements in the computational method, the Bristol Bay model has been re-schematized to incorporate the field data collected during this phase of our study. The model realignment also allows us to take full advantage of data obtained previously from the range of pressure gauges and current meter deployments. The new arrangement has better vertical resolution (i.e., increased from 7 to 15 layers) to incorporate the recently obtained field data on the vertical nonuniformity of the current and density system without sacrificing too much horizontal resolution. The new setup also makes the time integration procedure twice as efficient as compared with the previous version. The horizontal and vertical schematization of the new model are illustrated in Figs. 3 through 5. The relative location of the model with respect to the sampling network is shown in Figs. 3 and 6.

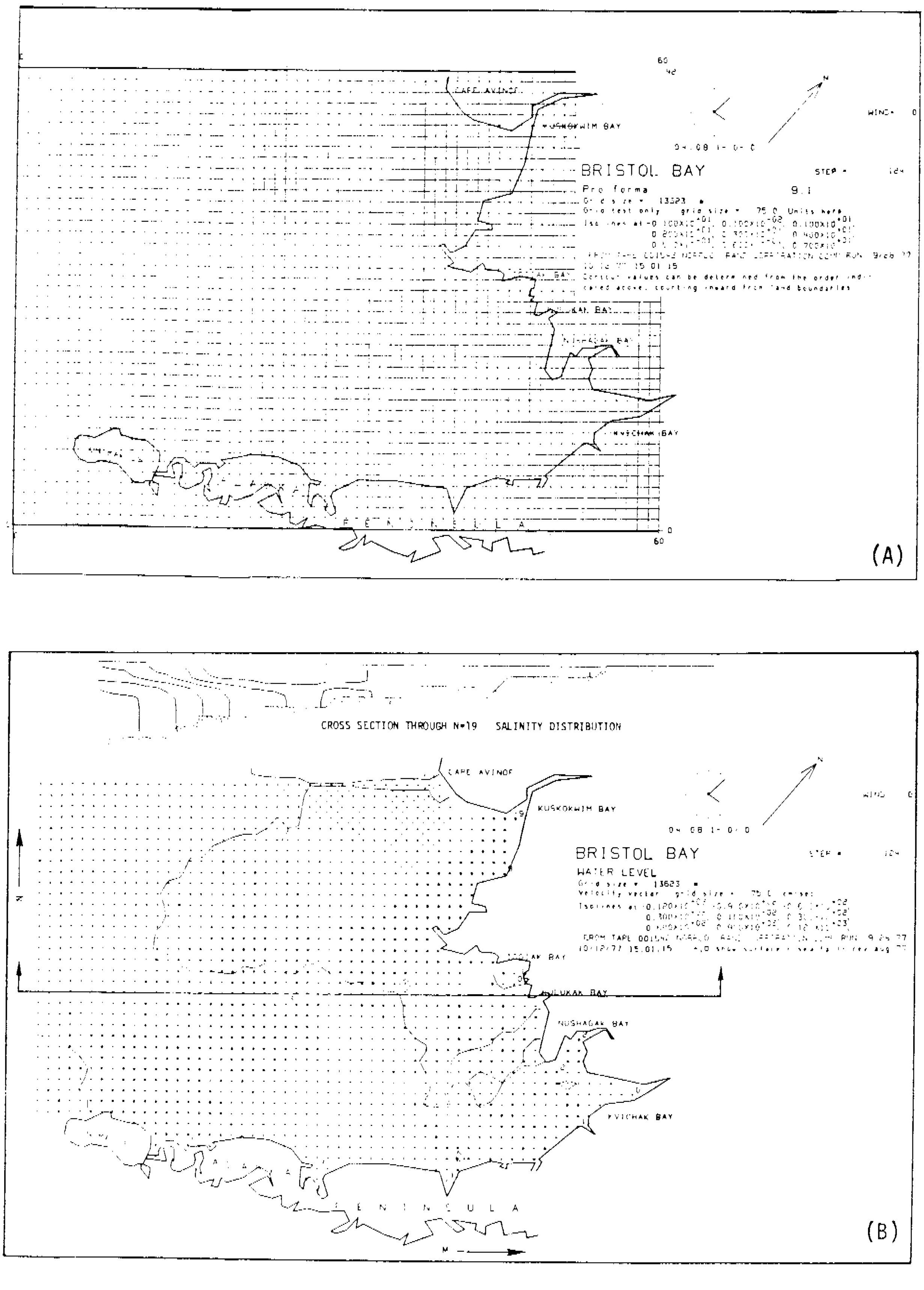


Fig. 2--The original schematization of the Bristol Bay model (A), which has a horizontal grid dimension of 60 x 42 with 7 layers in the vertical (B)

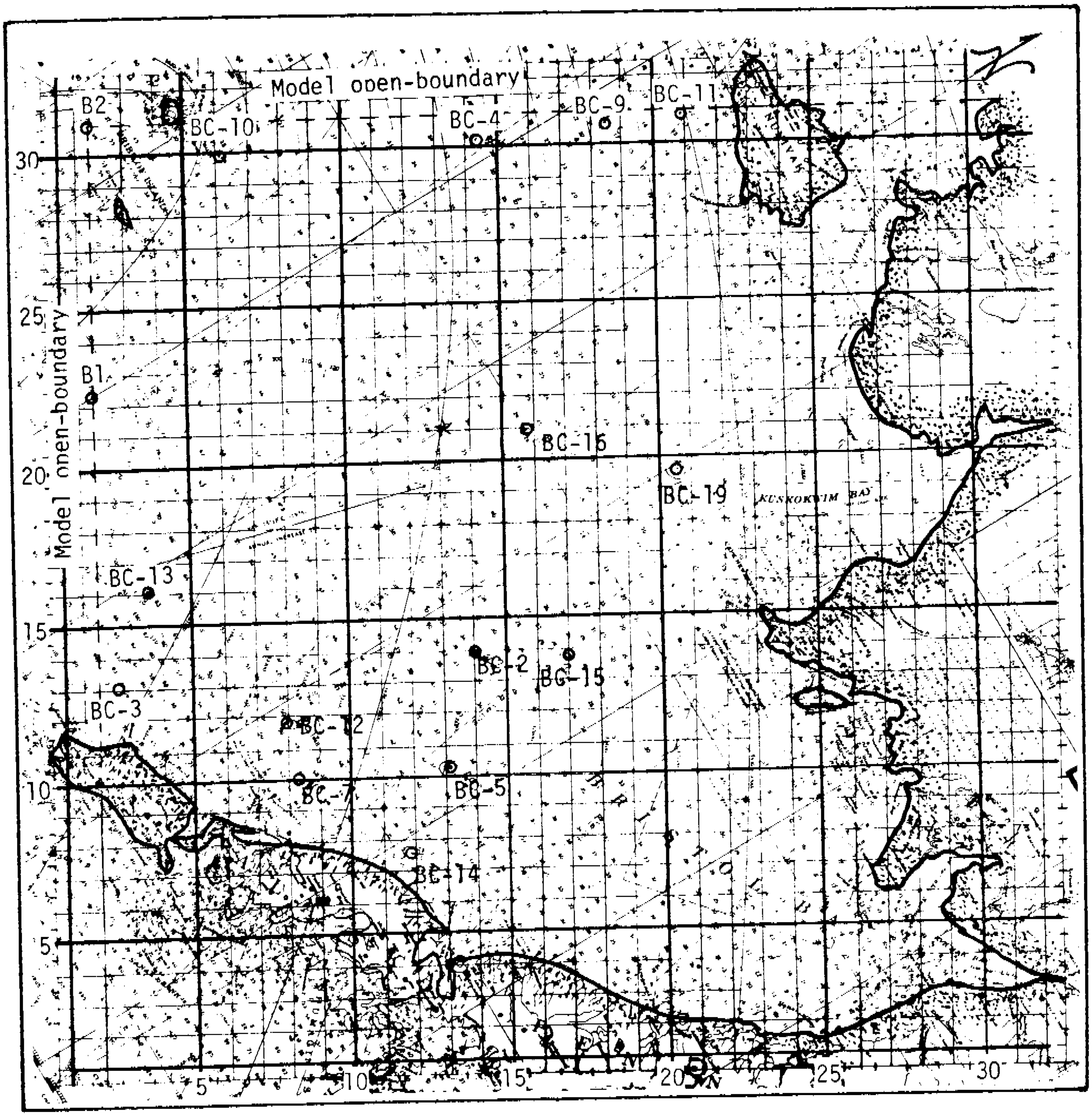
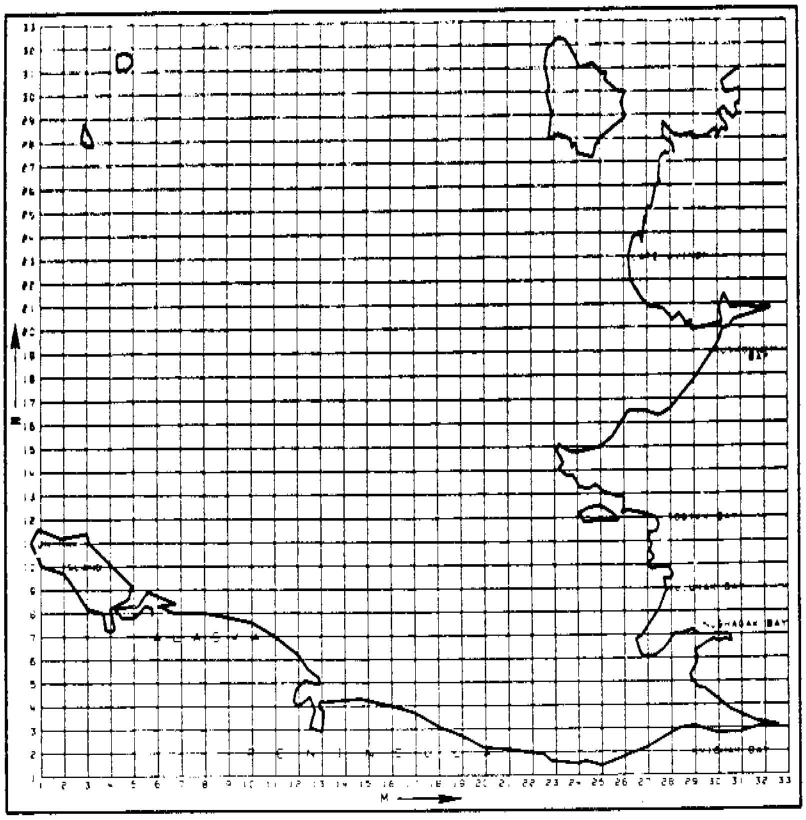
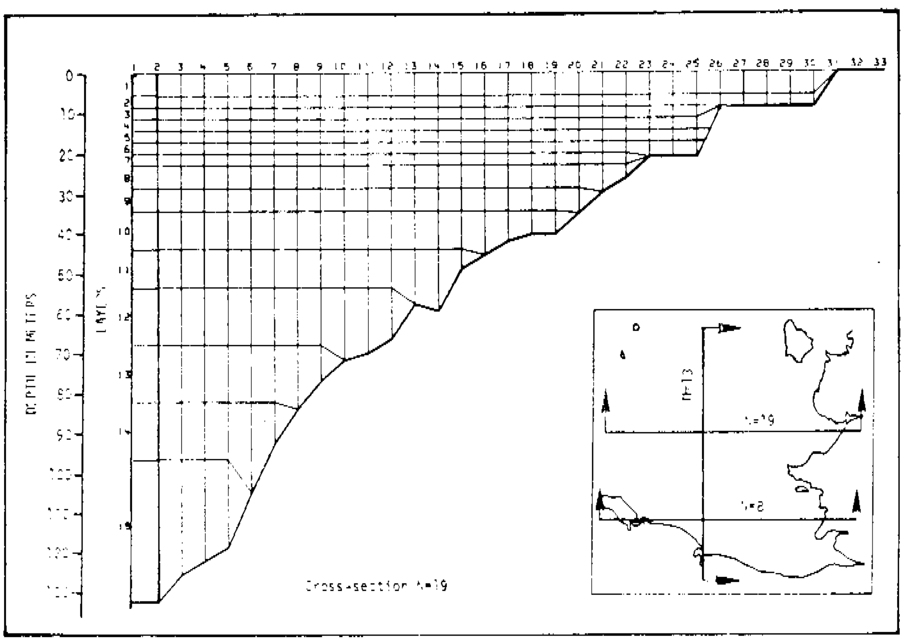


Fig. 3--Realigned three-dimensional model of Bristol Bay, showing horizontal schematization and locations of the model's open boundaries



(A)



(B)

Fig. 4--Horizontal (A) and vertical (B) distribution of grid dimensions, showing the arrangement of layer thickness in the Bristol Bay model

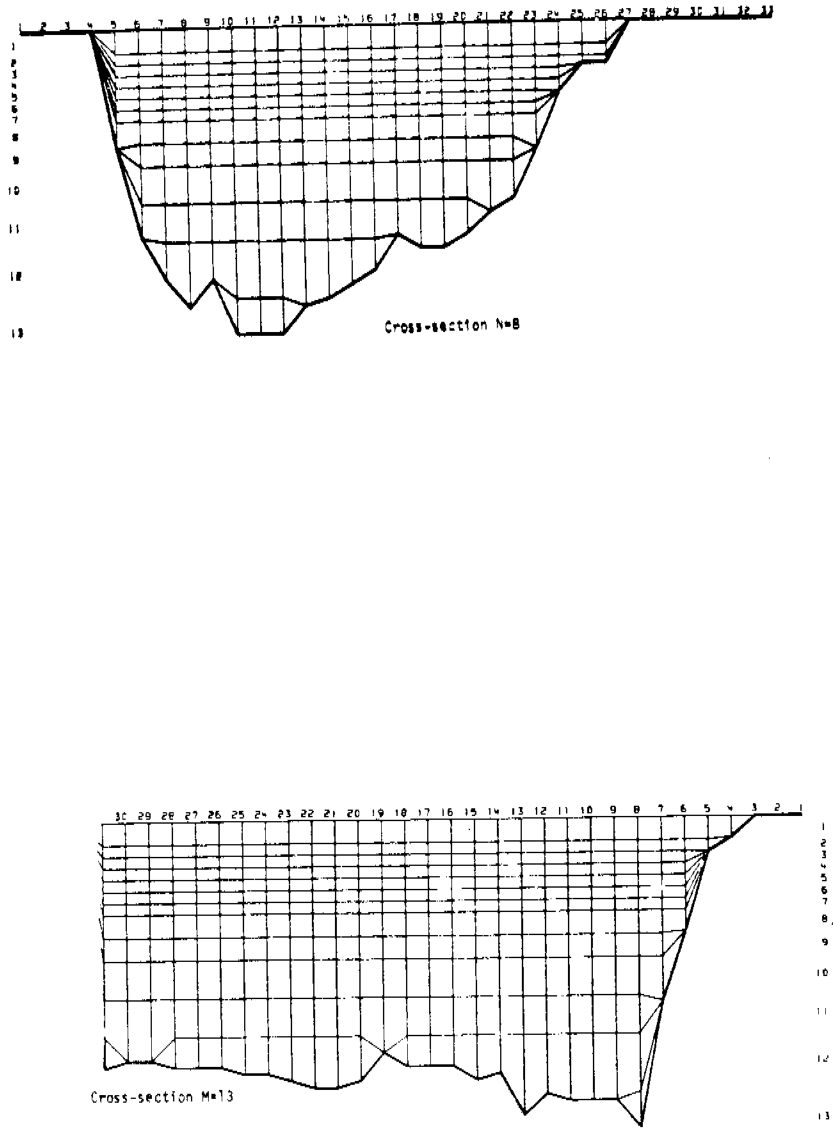


Fig. 5--Vertical schematization of the model is illustrated by two east-west cross-sections

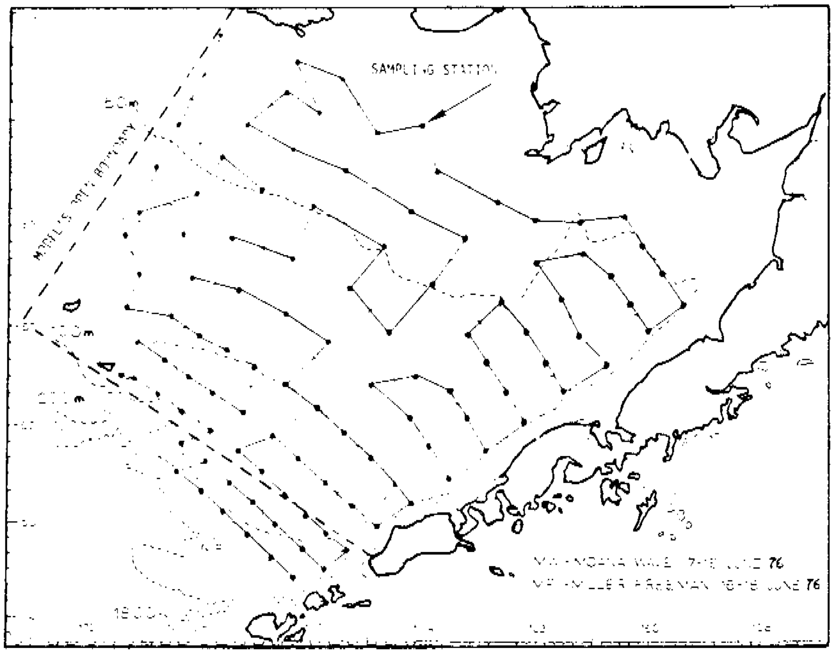


Fig. 6--Network of hydrographic survey stations covered by NOAA research ships Moana Wave and Miller Freeman [Ref. 6]

The initial conditions for model simulation were selected from a quasi-synoptic hydrographic survey conducted during early summer of 1976 [6]. Horizontal and vertical distribution of salinity and temperature from the observation were then schematized as the initial condition for the simulation (Figs. 7 through 10). For the deeper portion of the bay, the mixed layer thickness was selected uniformly at 22m. CTD data in this area indicate some anomaly from this value, depending on the local wind condition. It is our opinion that this value (i.e., 22m) gives a good representative condition for that period. Any anomaly from this mean value induced by a transient wind field would be accounted for during the simulation.

The horizontal grid dimension of the model is 21.82 km, which is equal in both directions. The vertical grid dimension (Fig. 4) was selected as such that it gives good resolution near the areas of density nonhomogeneity and at the same time provides accurate bathymetric representation of the system. The top layer is somewhat larger (6m) to accommodate the anticipated tidal range and wind setup near the coastal areas. The step size used for time integration was 3 min.

One of the most difficult and yet important tasks in the numerical simulation of coastal seas is the specification of open-boundary conditions. During the model's setup stage, only two major tidal components, namely, K1 and M2, were used in a series of test runs. The amplitude and phase of these two components were obtained from a set of two tidal charts compiled by NOAA using updated information up to that time (Fig. 11). In the model's adjustment process, similar boundary conditions were applied, but now the computed amplitudes and phases at model interior points are compared to the reported values in the cotidal charts. During the course of adjustment, bottom stress coefficients were changed until amplitudes and phases of the main tidal components in the model agreed with the tidal charts.

For the model's verification run, the boundary conditions were obtained indirectly from field measurements. At several points along the boundary of the model, water level data were recorded over long periods of time. Unfortunately, the recording periods were not all simultaneous and did not coincide with the period of current observations in other parts of Bristol Bay. To make the most effective use of all data in our studies, we used predicted boundaries and simulated time periods for which current data were available for verification. The tide predictions were based upon tidal analysis by our coworkers at NOAA of pressure recordings at the boundary station. From this information, the tide was predicted at the stations (with locations i,j) which coincide with the field data stations by use of the following formula:

$$\eta_{i,j,n} = \sum_{m=1}^{N} f_m H_{i,j,m} \cos [a_{i,j,m} t + (V_o + u)_m - k]$$

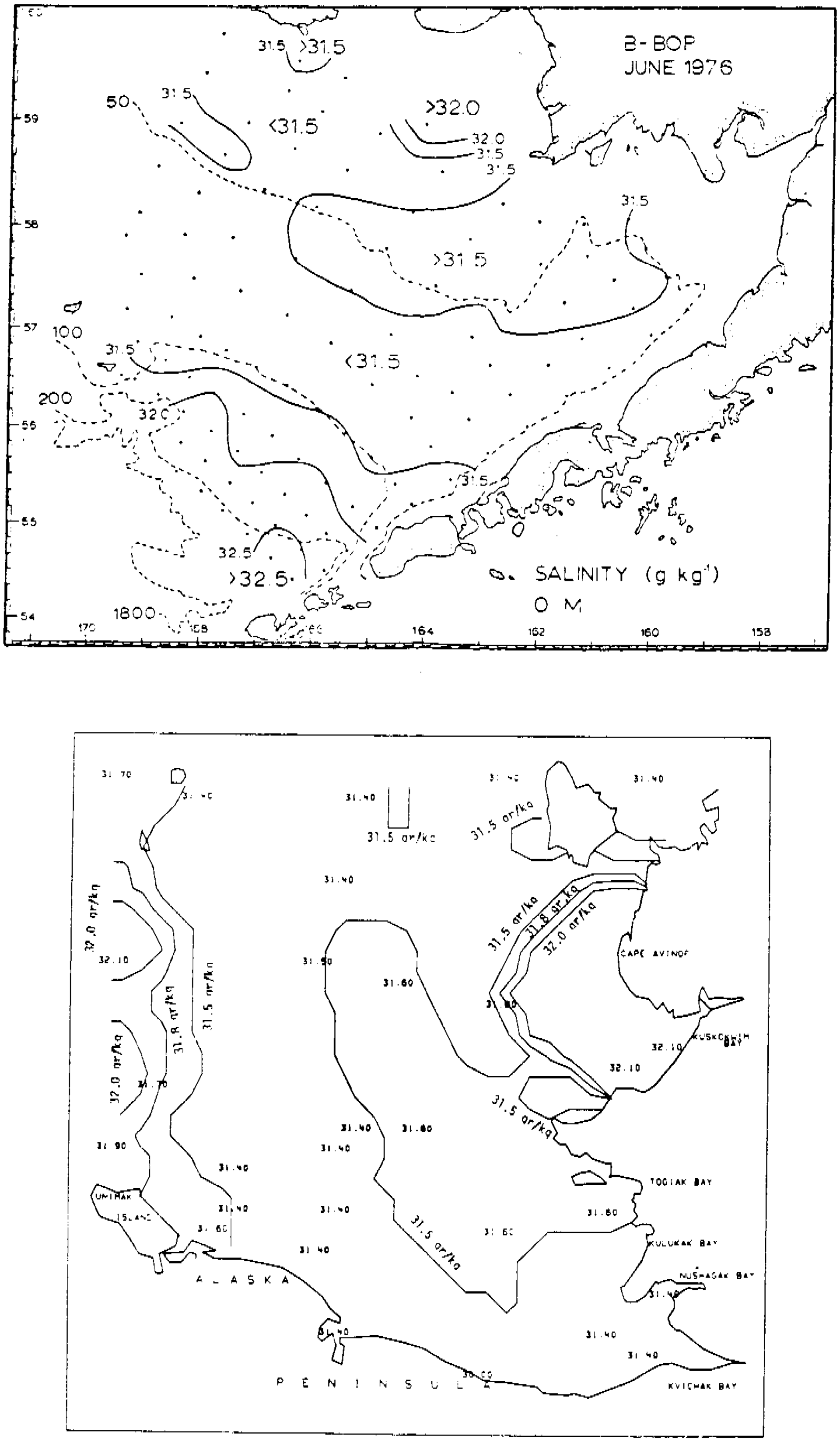
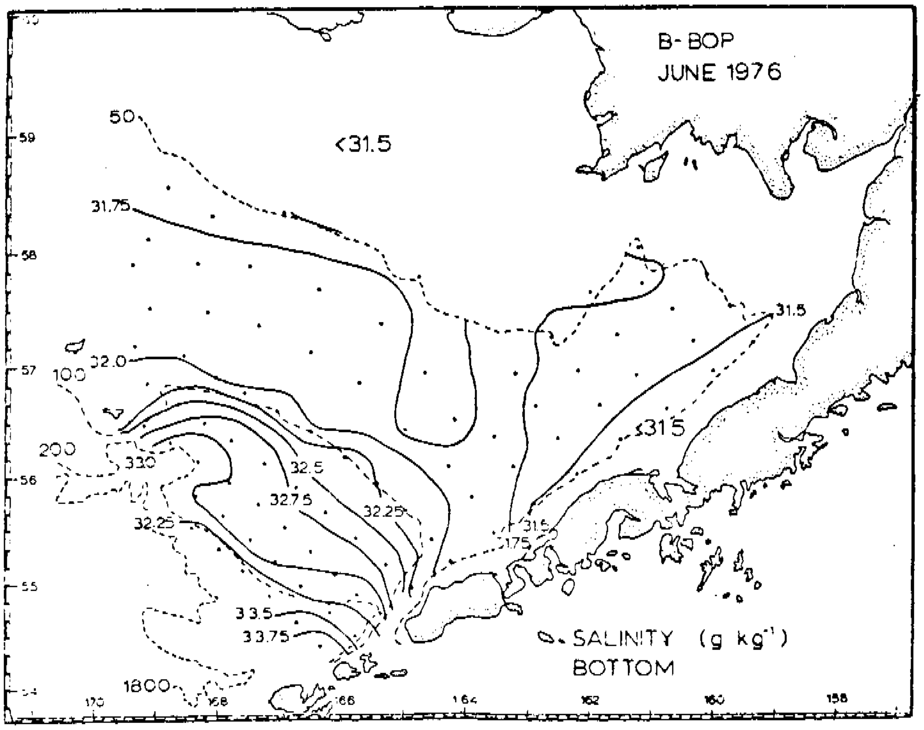


Fig. 7--Observed surface salinity field [Ref. 6] and the schematization in the model



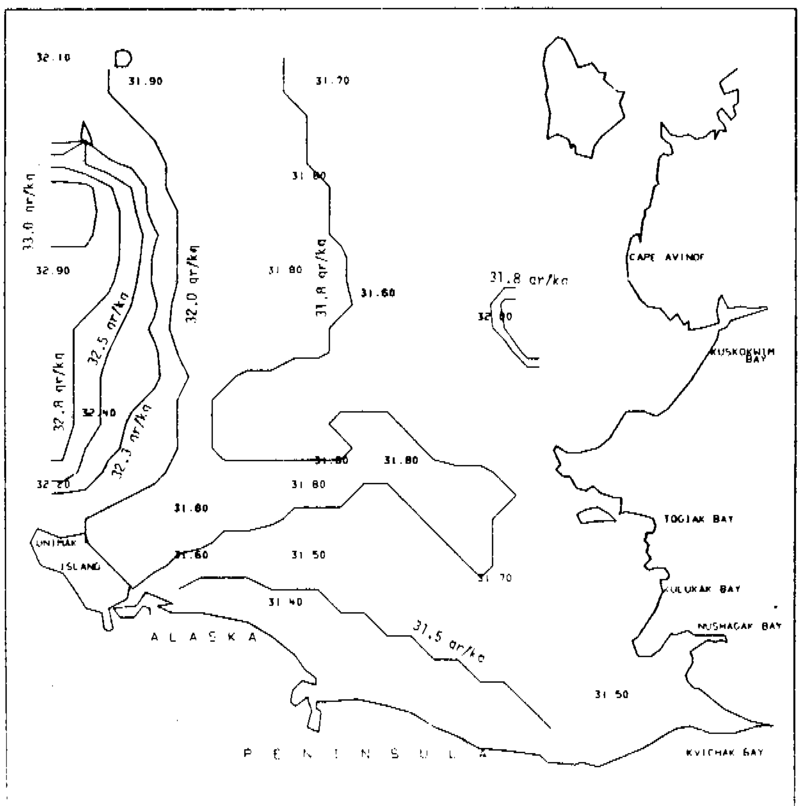


Fig. 8--Observed salinity field at 50m [Ref. 6] and the schematization in the model's 10th layer

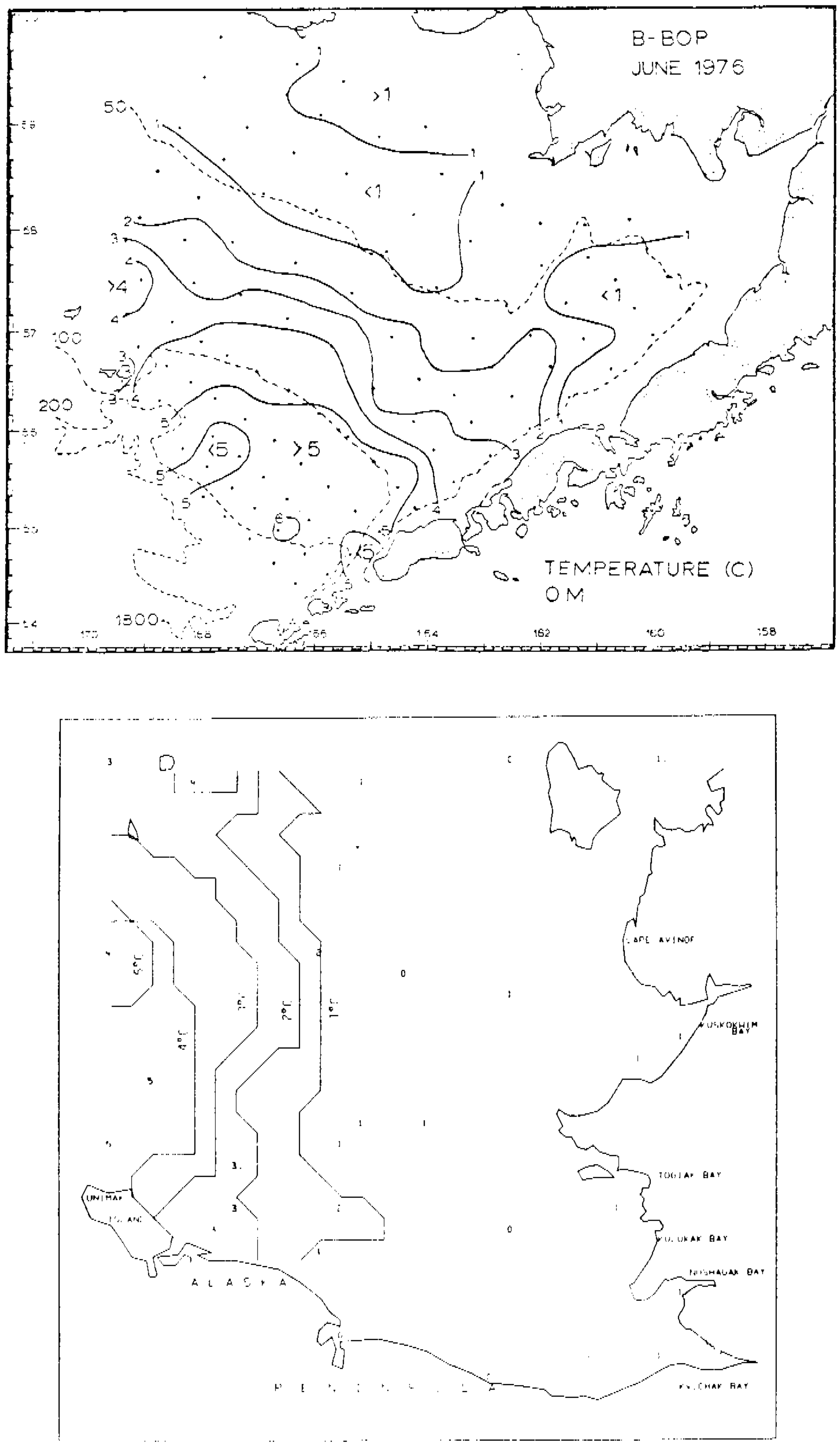


Fig. 9--Observed surface temperature field [Ref. 6] and the schematization in the model

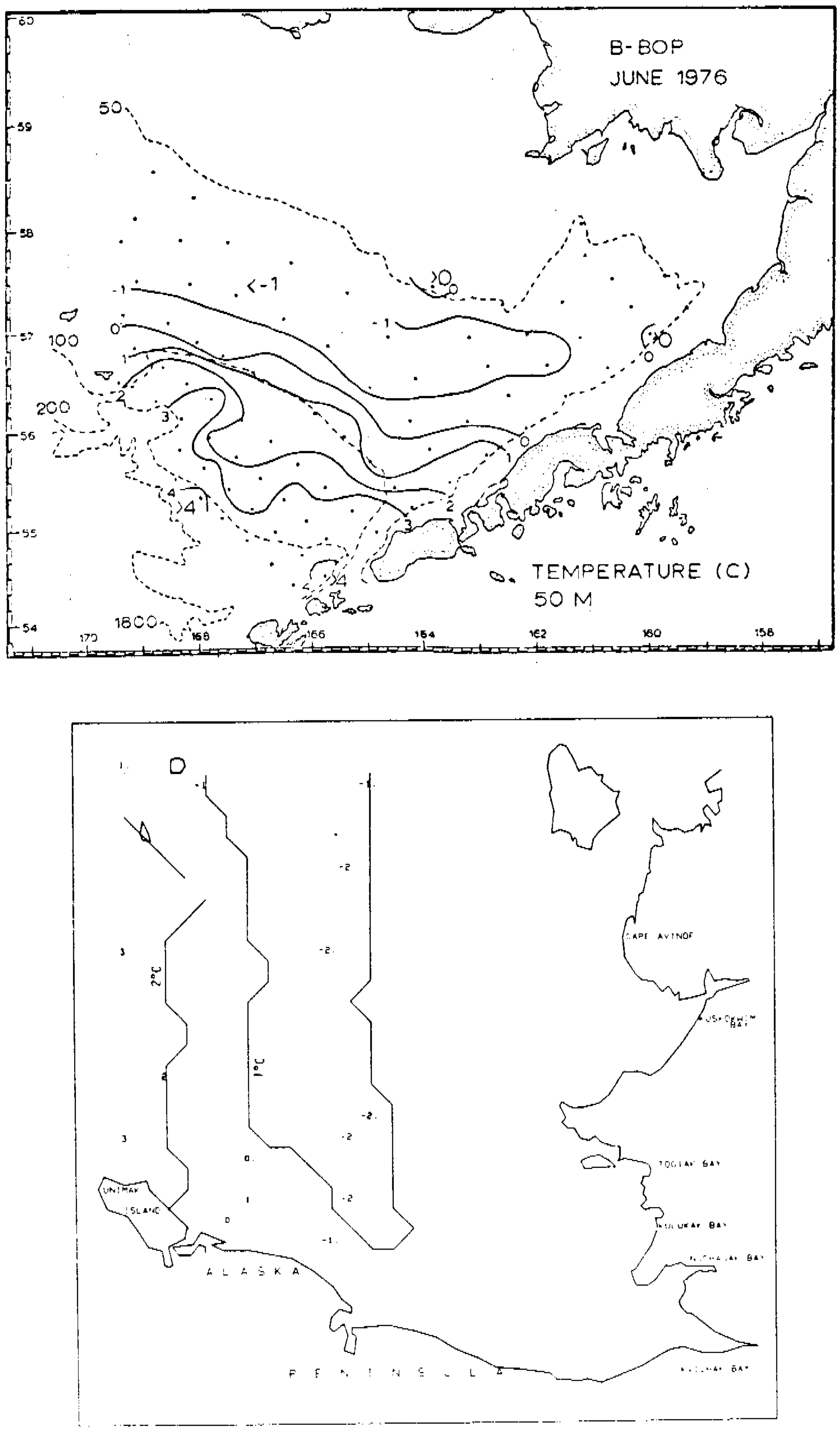
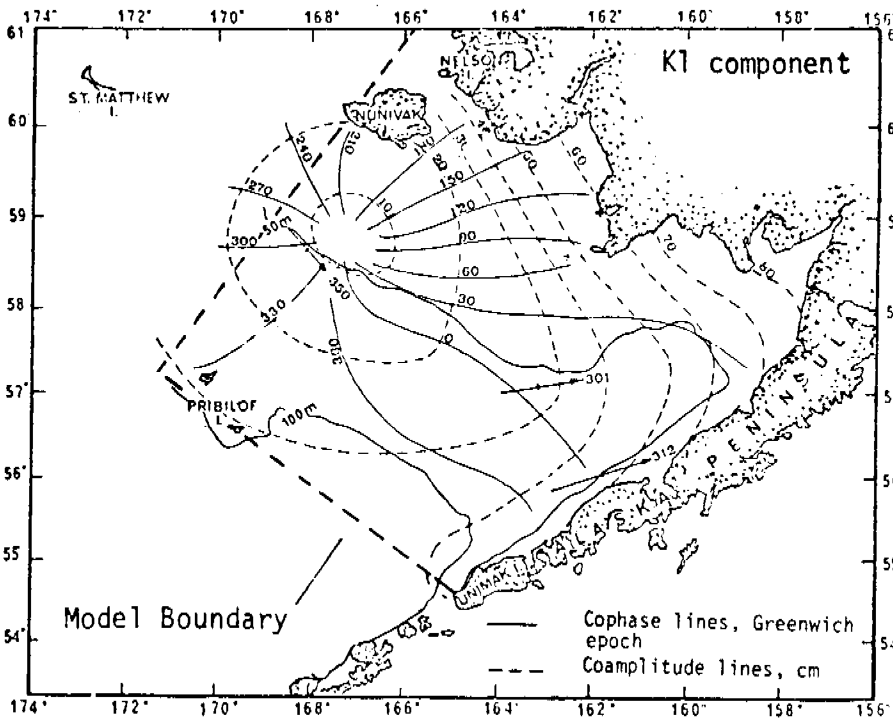


Fig. 10--Observed temperature field at 50m [Ref. 6] and the schematization in the model's 10th layer



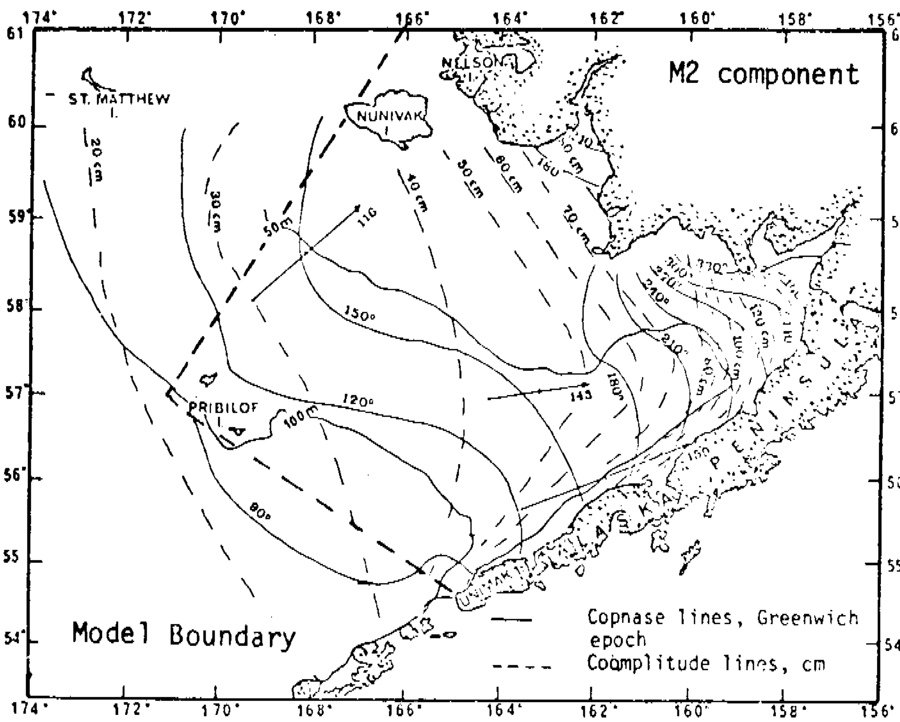


Fig. 11--Co-tidal charts of K1 and M2 components in Bristol Bay, as compiled by NOAA

where $\eta_{i,j,n}$ = predicted water level at boundary location (i,j) for time level n

f = factor for reducing mean amplitude $h_{i,j,m}$ to year of prediction

$a_{i,j,m}$ = speed of tidal constituent m at location (i,j)

t = time reckoned from some initial epoch such as 0000 hour of May 31, 1976 used for prediction

$(V_o + u)$ = value of equilibrium argument of tidal constituent A when t = 0

k = epoch of tidal constituent A

$H_{i,j,m}$ = mean amplitude of tidal constituents at location (i,j)

For the model boundaries between the locations where tide predictions were available, linear interpolation of tidal amplitudes and phases were used for each tidal constituent.

Treatment of constituents across the open boundary is different. Inasmuch as the dissolved properties can be transported in and out of the model's boundary, a special procedure has to be used during the computation. When current is flowing out of the model's boundary, concentration at the open boundary is computed (without diffusive terms) from the information available within the computational domain. However, when the flow returns, the recovery of concentration to a preset level is specified as a sinusoidal function. Because of the small tidal excursions in relation to the grid size, the variations of concentration across the open boundary are small.

IV. MODEL ADJUSTMENTS AND SIMULATIONS

During the initial stage of the study, a series of preliminary test runs were made for the adjustment of the realigned model. During this period, only two tidal constituents were applied at the model's open boundary. As we have mentioned earlier, amplitude and phase of these two tidal components were derived from a set of two tidal charts compiled by NOAA, using updated information during that time.

For each of the simulation runs, the computed field of water level, velocity, temperature, salinity and turbulent energy densities were tabulated and graphed. Time histories of these variables at 25 locations were recorded every 10 time steps, thus at 30-minute intervals. The entire field of computed water levels is also recorded at 30-minute intervals for the later computation of tidal charts by means of two-dimensional Fourier analyses.

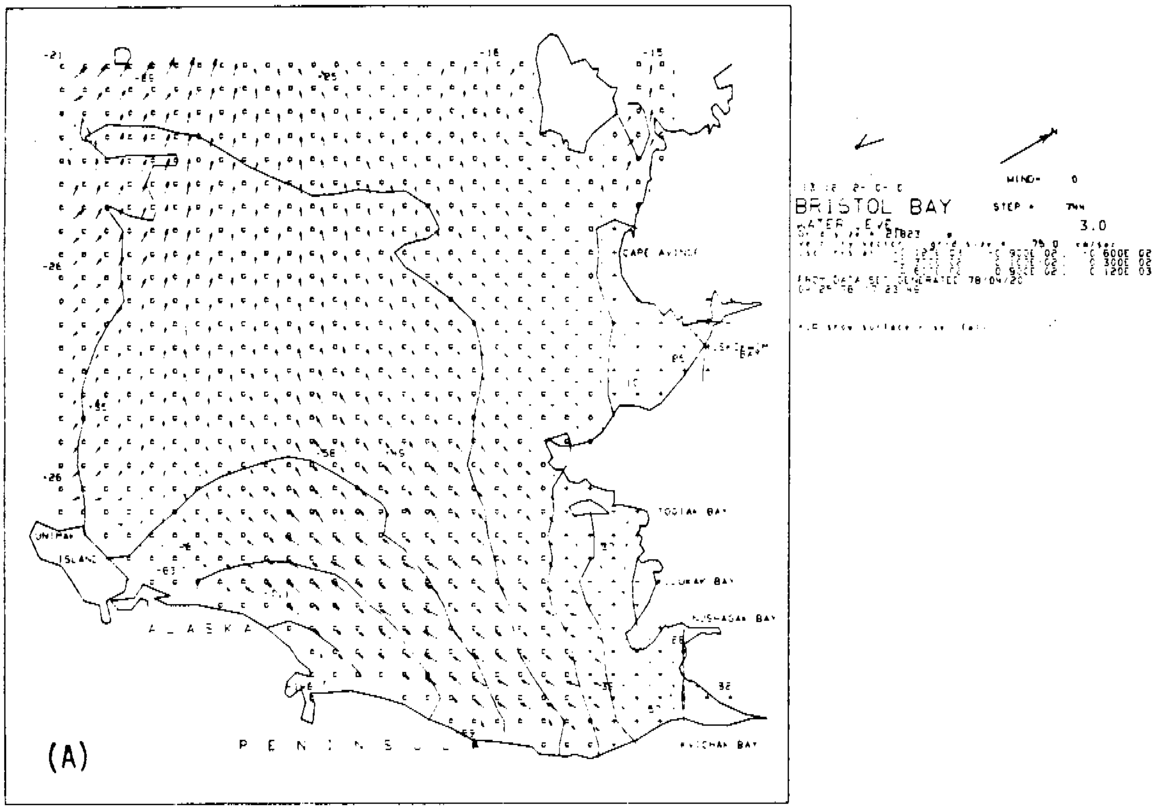
Computed vertical profiles of salinity and temperature were compared against the observed profiles for different constants in the turbulent closure computations. From these experiments, we determined these constants and obtained an impression of the sensitivity of these constants in the model results.

Computed amplification and phase lag of tidal propagation between the model's boundaries and interior points have been used to adjust the bottom stress coefficients. A value of 700 (in cgs units) was found to be appropriate. Because of the relatively low tidal dissipation in the bay system, the dynamic field is not very sensitive to the selection of bottom stress coefficients. On the other hand, the dynamic behavior near the pycnocline is sensitive to the selection of turbulent closure constants relating the vertical density gradient and the transport, generation, and decay of turbulence. After the adjustment process, the same values were used later for the model's verification run.

These turbulent closure constants [4] take the following values:

$$a_1 = 1.0$$
$$a_2 = .08$$
$$a_3 = .08$$
$$a_4 = .001$$

Because of the vast surface area and the vertical density structure of the system, the dynamic response to wind stress is significant. During the preliminary model adjustment stage, a sequence of investigations was carried out to evaluate the influence of wind stress on the behavior of the system. Comparisons were made using identical tidal and initial conditions with and without the presence of the surface wind stress. Typical wind conditions during the summer period (SW wind of 20 knots) were used in these simulations. Figures 12 and 13 show the differences in water level distribution in Bristol Bay during ebb and flood tides with and without wind stress in the second day of a simulation. The presence



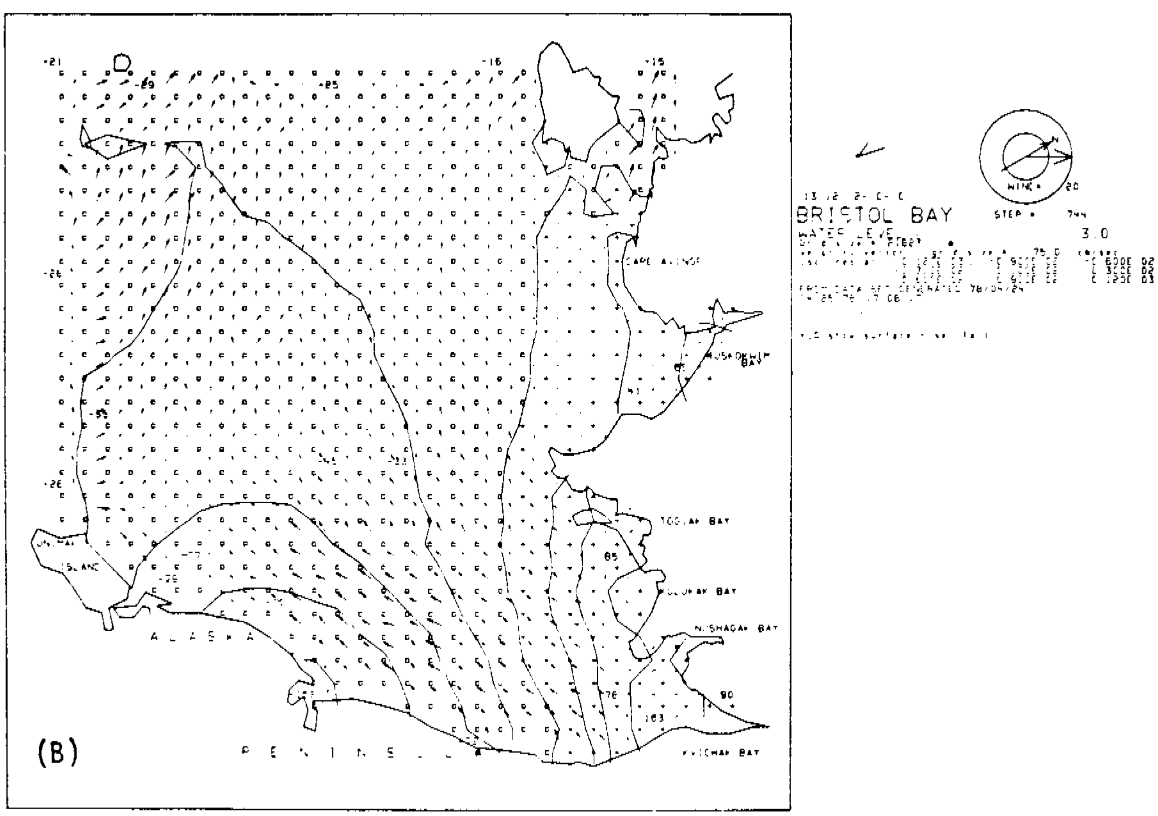
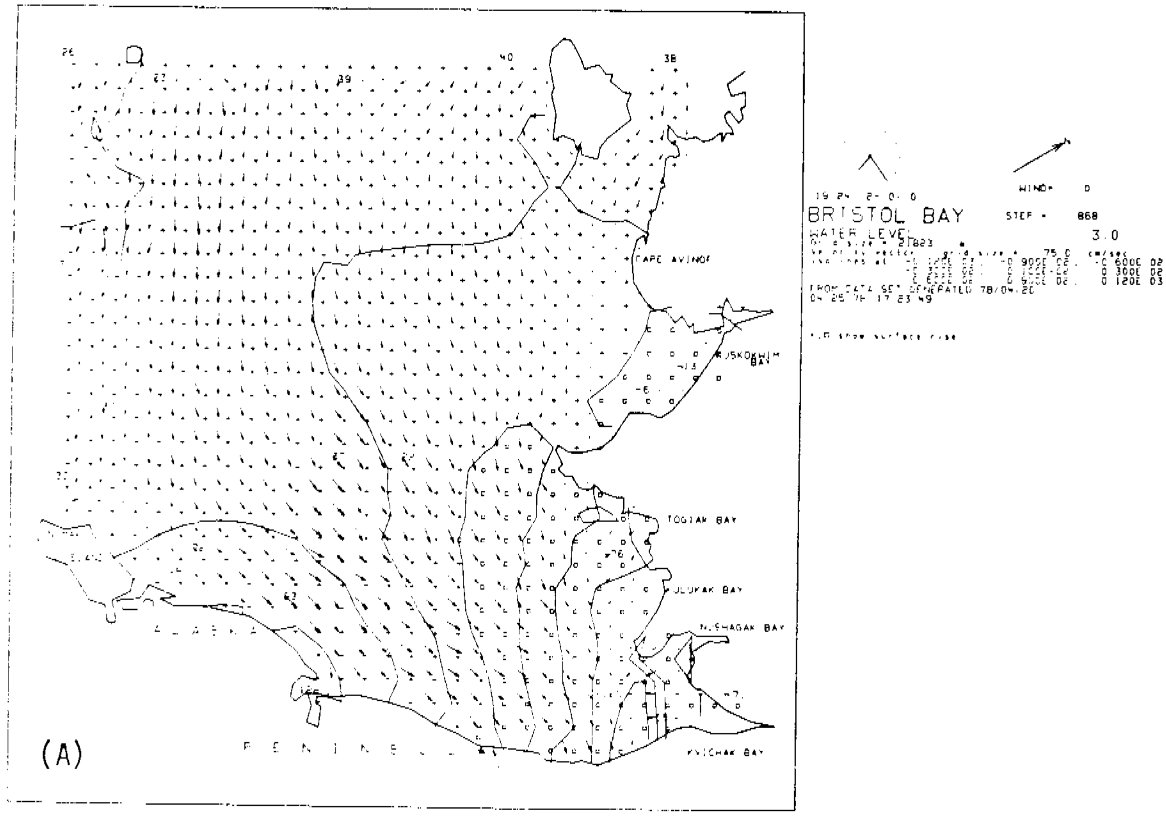


Fig. 12--Comparison of isocontours of water levels, rise and fall of water surface and surface current during ebb tide without (A) and with (B) the effect of a 20-knot SW wind stress



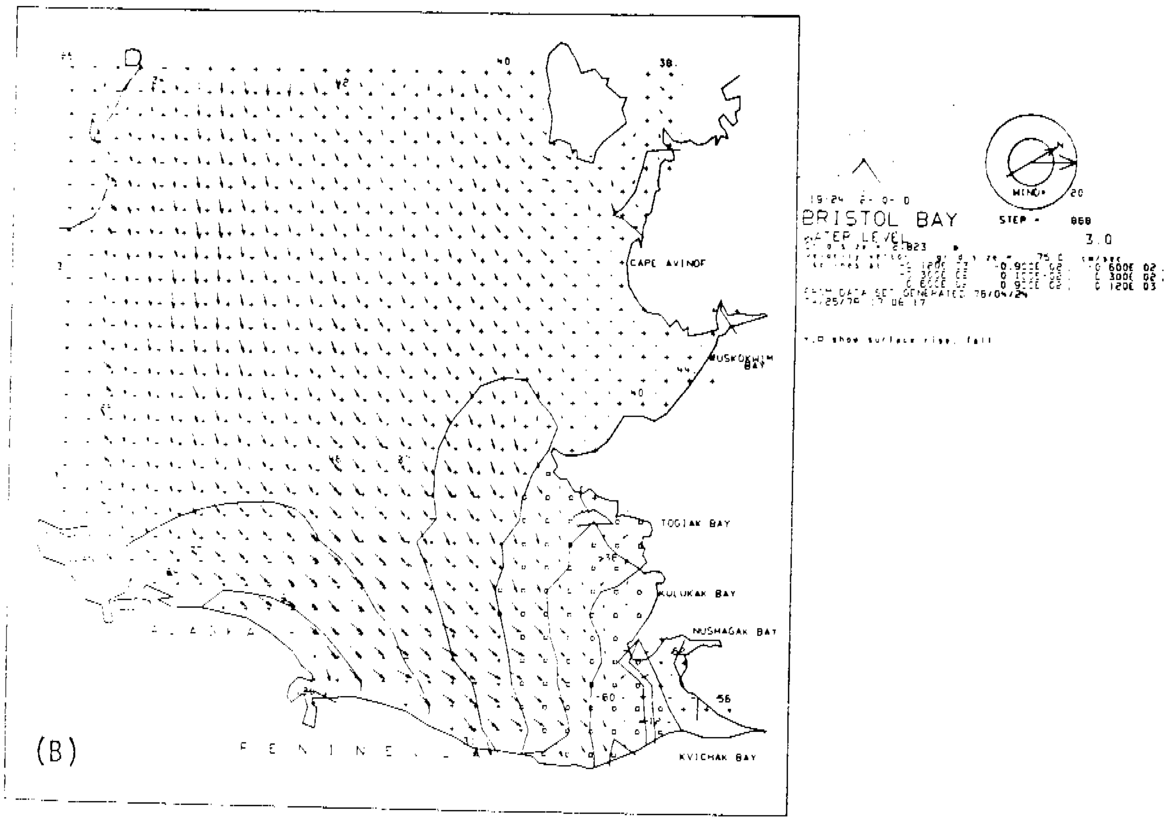


Fig. 13--Comparison of isocontours of water levels, rise and fall of water surface and surface current during flood tide without (A) and with (B) the effect of a 20-knot SW wind stress

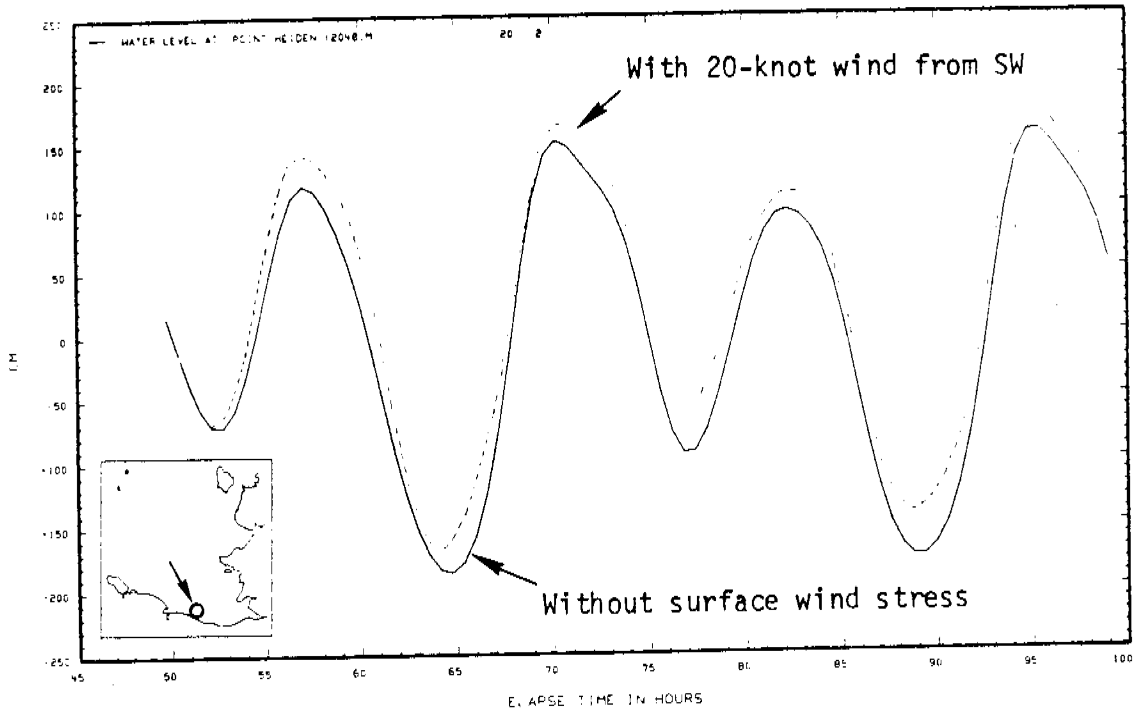


Fig. 14--The effect of a 20-knot SW wind on the variation of water surface elevation near station BC-14

of wind induces not only some phase shifts in the tide (Fig. 14), but also causes down-welling components in the coastal waters of the Alaskan Peninsula.

Changes in the circulation pattern can be seen in Figs. 12 and 13. With the absence of surface energy input, the only source of turbulence in the upper layer is transported through the pycnocline from the bottom layers. The suppression of turbulence due to strong vertical density gradients causes the upward transport of turbulent energy to be very inefficient. As a consequence, the subgridscale energy content in the upper layers is very low. On the other hand, with the presence of wind, the thickness of the mixed layer tends to increase until a quasi-equilibrium condition is established. Figure 15 shows the vertical distribution of salinity, temperature and the turbulent energy densities with and without the presence of 20-knot winds. The slight deepening of the mixed layer thickness is due to the wind effect.

The surface wind stress input, through the vertical shear coupling process, also has certain impacts on the direction of tidal flow in both the upper and lower layers. This effect is illustrated in Fig. 16 and Fig. 17, which show the east-west and north-south velocity components with and without the wind effect. Noticeable differences in the surface layers can be seen if two graphs in the north-south current component are compared.

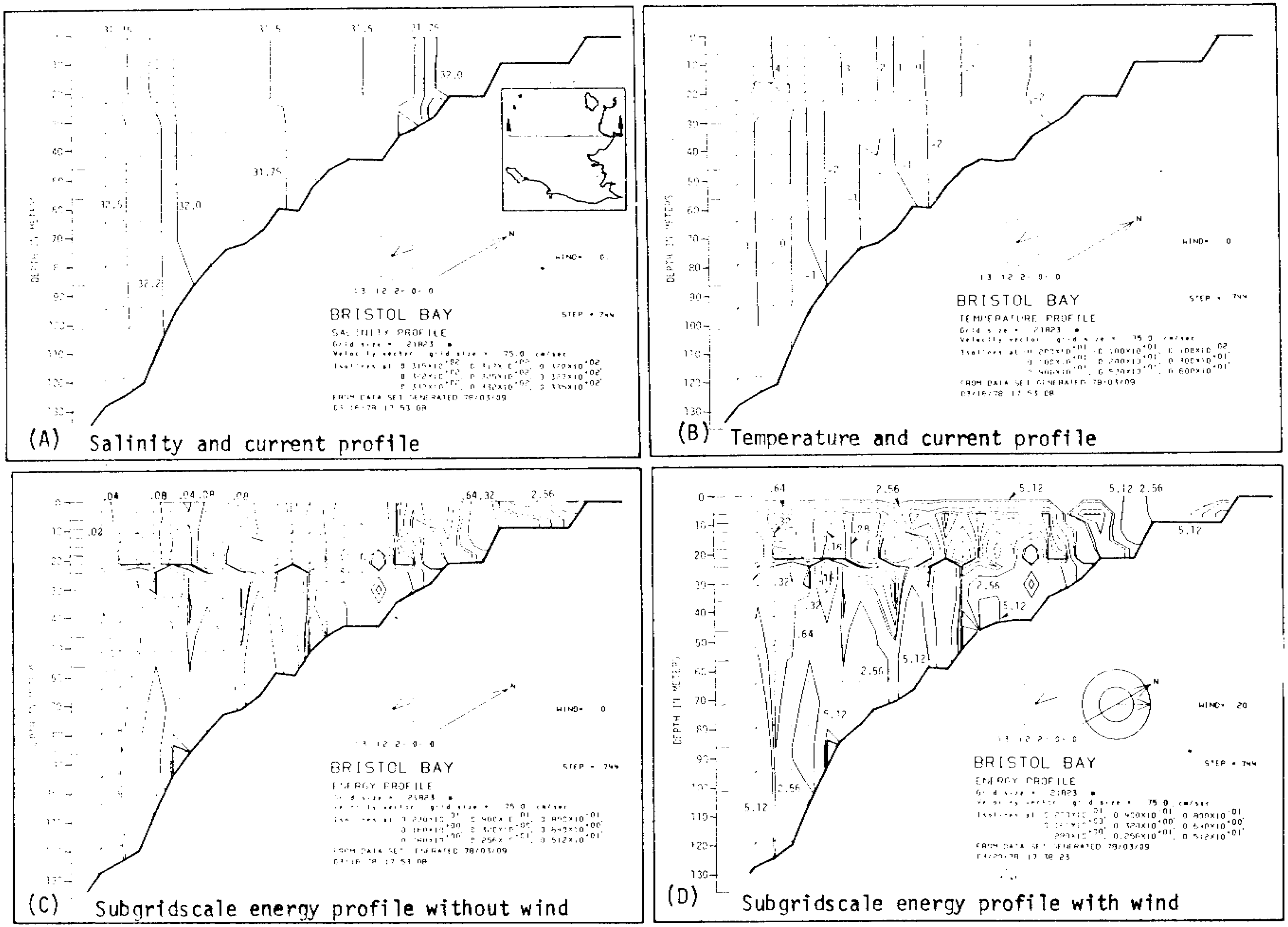
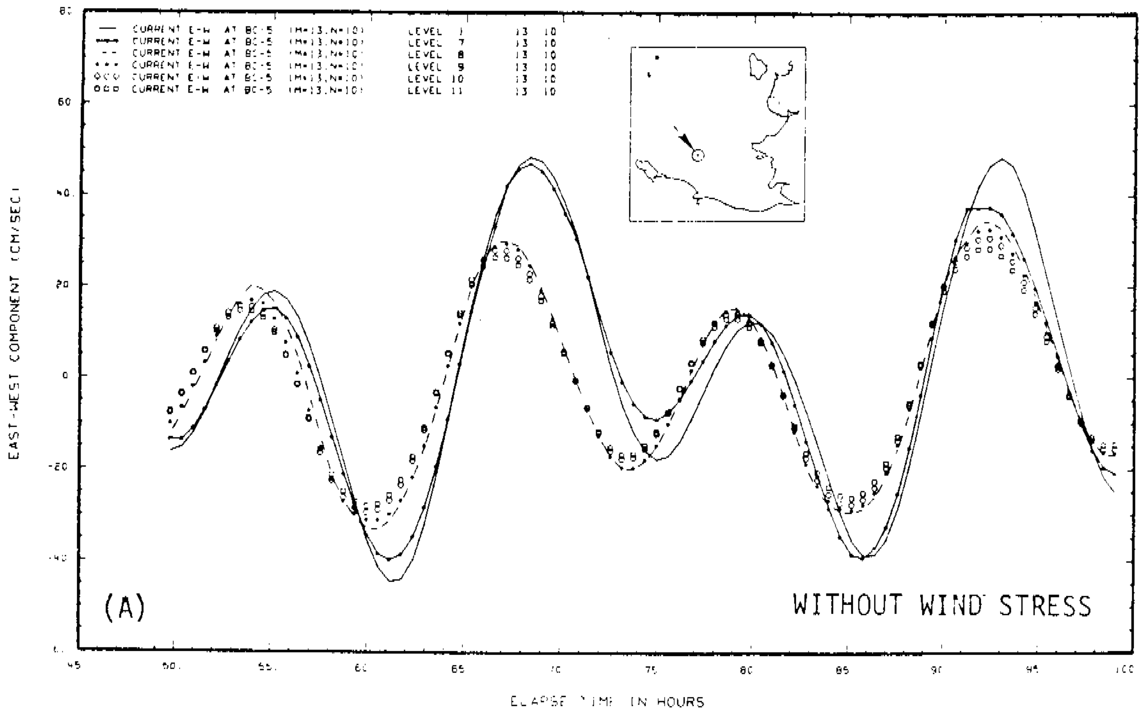


Fig. 15--Vertical distribution of salinity, temperature and the turbulent energy densities with and without the presence of a 20-knot SW wind stress



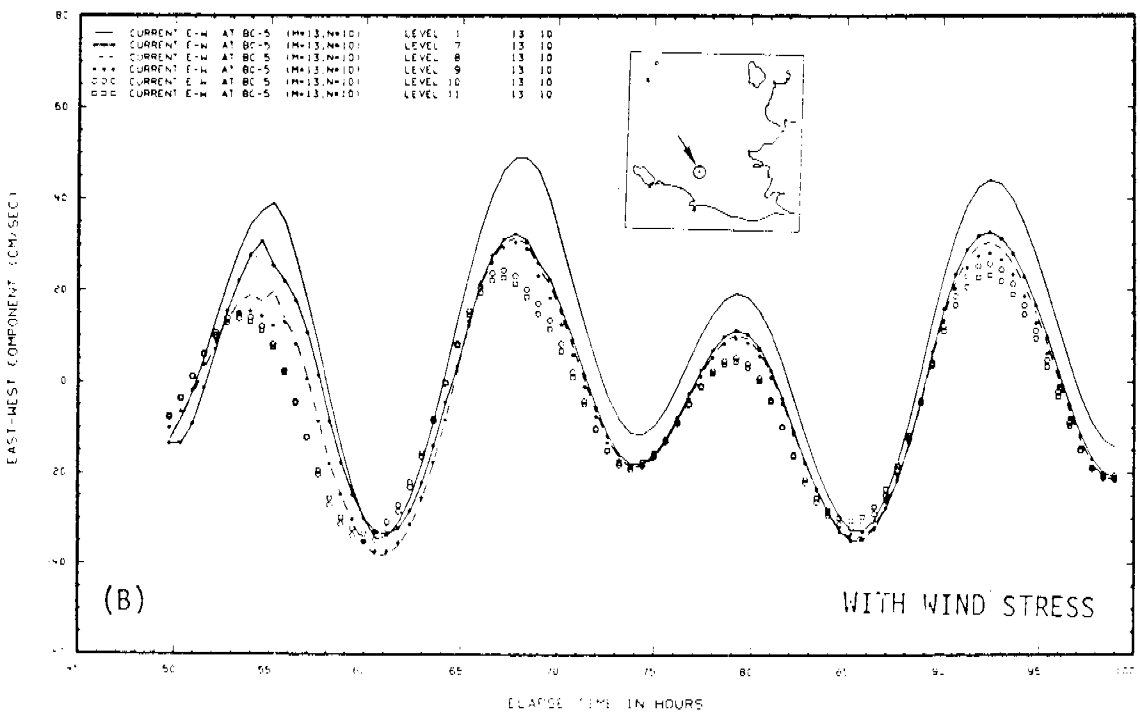
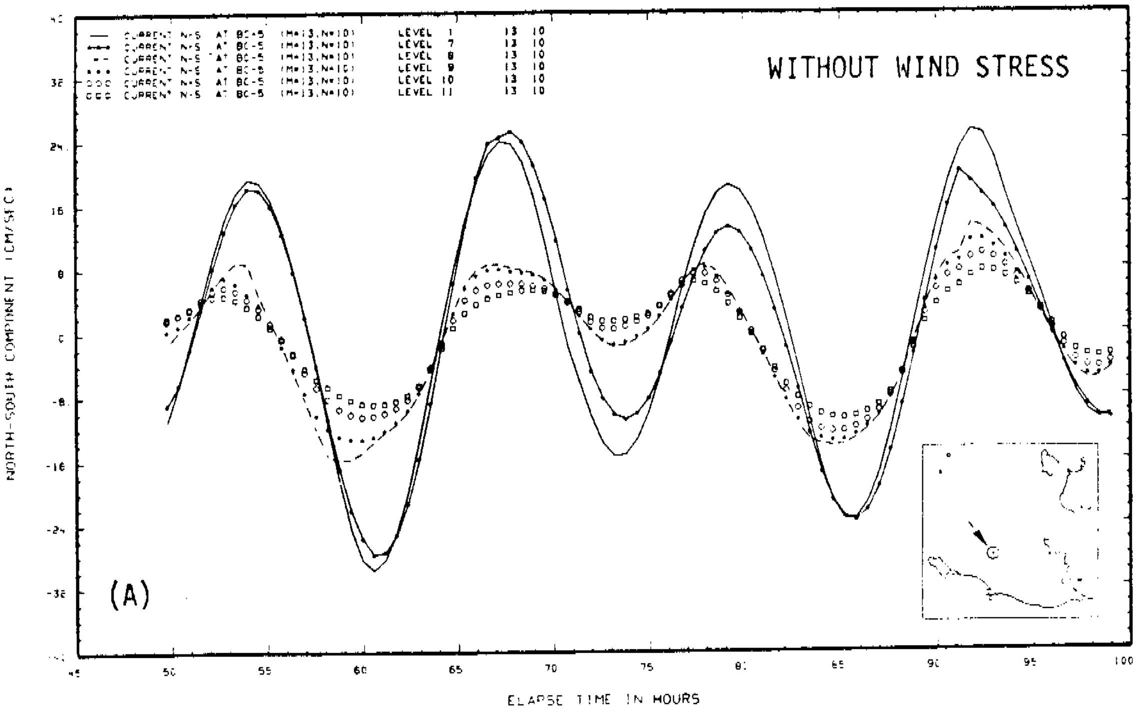


Fig. 16--East-west current velocity components at six selected layers near station BC-5 with and without the wind effect



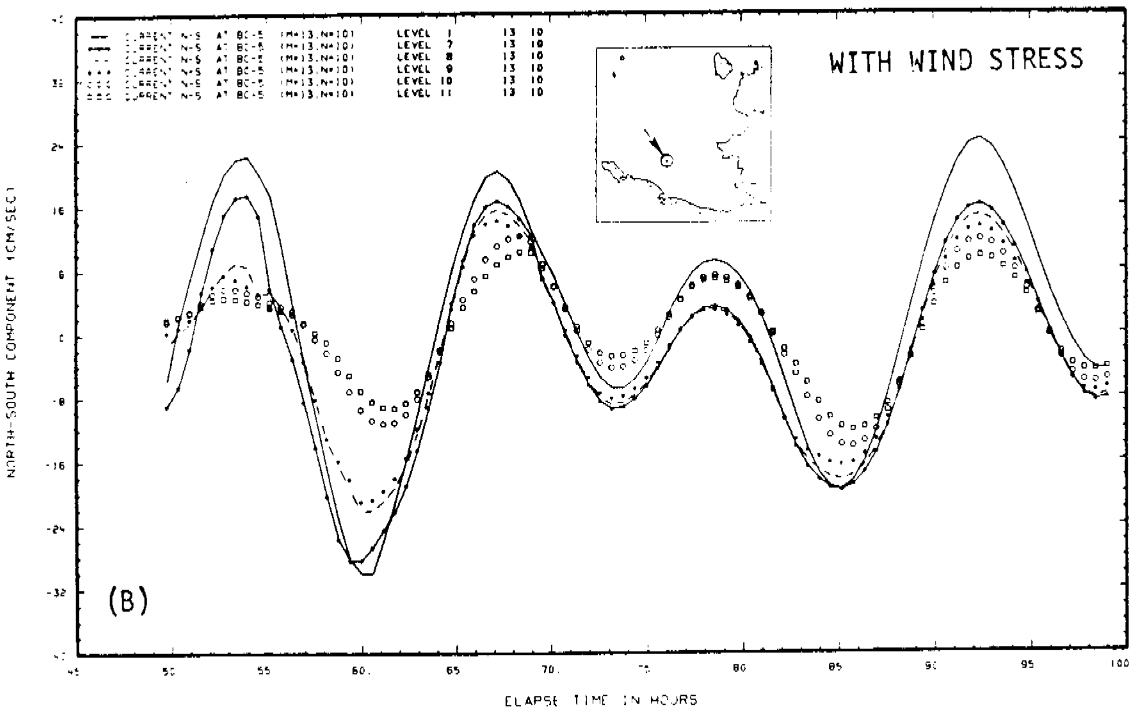


Fig. 17--North-south current velocity components at six selected layers near station BC-5 with and without the wind effect

V. MODEL VERIFICATION AND PREDICTION

After the model's adjustment phase, a particular period in 1976 was selected for verifying the predictability of the model and the establishment of a set of predictive parameters.

The period of beginning from June 16 to June 19, 1976, was selected because during that period vertical pycnic structure was fully developed to represent the spring-summer conditions in Bristol Bay. In other words, once the model is verified, it can thus be considered useful for predictive purposes for the spring-summer period. Therefore, during the verification run, all the simulation parameters such as turbulent closure constants and bottom stress coefficients were kept the same as those used at the final stages of the model adjustment period.

Basic input information used for the verification run were observed average wind condition over the area and the predicted tides at the model's open boundaries. By compiling ship's weather reports, an average SW wind of 15 knots for the verification period was derived. The speed and direction of the wind during that period did not change.

The basic tidal amplitudes and phase at the model's open boundary stations during the verification period are presented in Appendix A. Amplitude and phase for boundary grid points not covered by the field program were linearly interpolated between these points. Some extrapolations were also required for cases when the sampling station was not located exactly on the boundary of the computational grid. Predicted water levels at the model's open boundary were obtained by convoluting 15 tidal constituents. For convenience, clock time used in the simulation is the Greenwich mean time (GMT).

During the run-in period of the simulation, predicted water levels at the open boundaries are multiplied by a factor which varies linearly from 0.0 to 1.0 in six hours. This period coincides approximately with the natural period of oscillation of the bay system if the average depth is considered to be 80 meters. No comparison between the computed currents and the observed currents was made for the first 12 hours of the simulation to avoid any perturbative transient effects.

After this 12-hour initialization period, the verification run was carried out to 62.5 hours. Therefore, data for a period of 51 hours was available for both comparison and for the analyses of tidal propagation. A period of at least 50 hours is necessary for performing two-dimensional Fourier computation in order to resolve the diurnal tidal components.

Observed current data collected by NOAA at four locations within the modeled area were available for comparison. Cumulative effects of surface wind stress outside of the model's area are, of course, unknown unless measured water levels instead of the predicted water levels are used. However, because the model's open boundaries are located approximately halfway between the Kamchatka Peninsula, the USSR and Bristol Bay in the east/west direction, and also located halfway between the Chuktskiy Peninsula, the USSR, and the Alaskan Peninsula in the north/south direction, thus the model's open boundary is located approximately at the midpoint of the water surface due to wind setup for almost all wind directions. Due to this consideration, the predicted water level at open boundary requires no further wind adjustment for the purpose of our computation. At the beginning of the computation, the system is assumed to be barotropic (i.e., isobaric surfaces and isopycnic surfaces coincide with the level or reference surface). This inaccuracy sometimes gives certain minor perturbations in the computed water level and current field. They usually tend to smooth out after a short period, however.

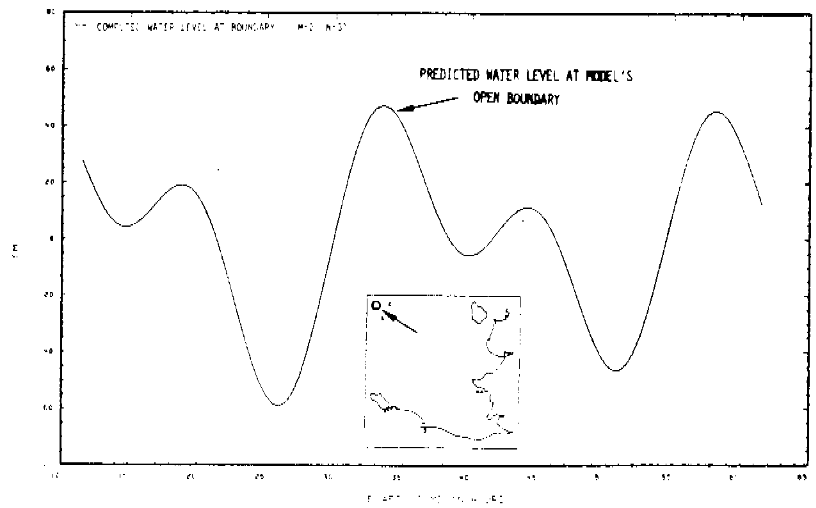
In this section, observed current at four locations are compared to the computed values, located nearest to those current meter deployments. The current meter locations in the field did not coincide with the grid system. Also, the local depth at the current meter locations is not necessarily the same as in the model. Consequently, differences in computed and observed values can be expected for these reasons alone.

Hourly values of observed currents were obtained from PMEL for comparison. These hourly data were processed from 20-minute recordings in the following manner. For each hour, three recorded values (i.e., 00 min., 20 min., and 40 min.) are averaged and reported as the value for the 20th min. of the hour. In effect, the data were filtered with a low pass filter. Observed time series at two stations are reported as east/west and north/south velocity components, while the other two stations are reported in current amplitudes and directions. Relative locations with respect to the model grid can be found in Fig. 3.

In Fig. 18, Graphs A and B show the predicted water level at two locations along the model's western open boundary. Elapsed time in the diagram represents the number of hours from the beginning of the simulation (i.e., the midnight of June 16, 1976). Values for the first 12 hours' run-in period are not plotted in the graphs.

Figures 19 through 22 present the hourly observed current data and the computed current at locations near the current meter. Also presented in these graphs are the computed water level and the vertical velocity components. These graphs are reduced so that they can be grouped for easy comparison. The same graphs on a much larger scale are presented for reference in Appendix B.

Figure 19 contains four graphs. Graph A gives the water level at grid point (14,14) from dynamic computation. Graph B illustrates the computed east/west current components at four depths at this grid location plotted together with the hourly observed east/west current



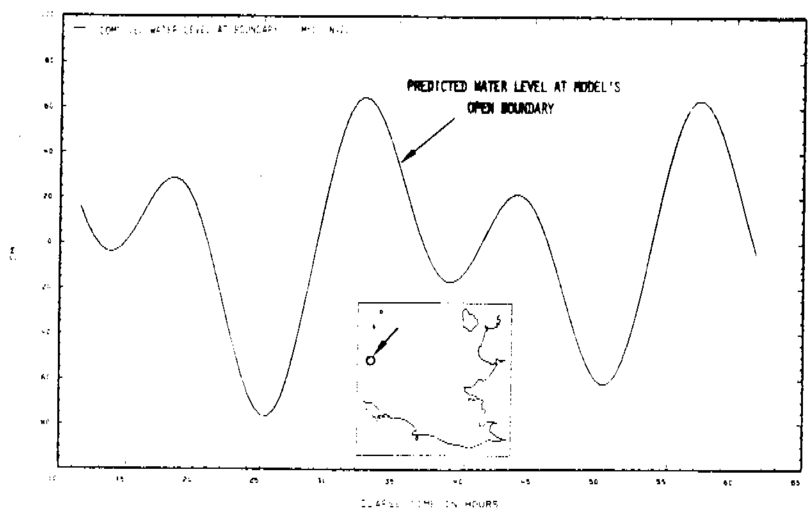


Fig. 18--Predicted tide at model's open boundary for the simulation between 0000 hr 16 June 1976 and 1400 hr 18 June 1976

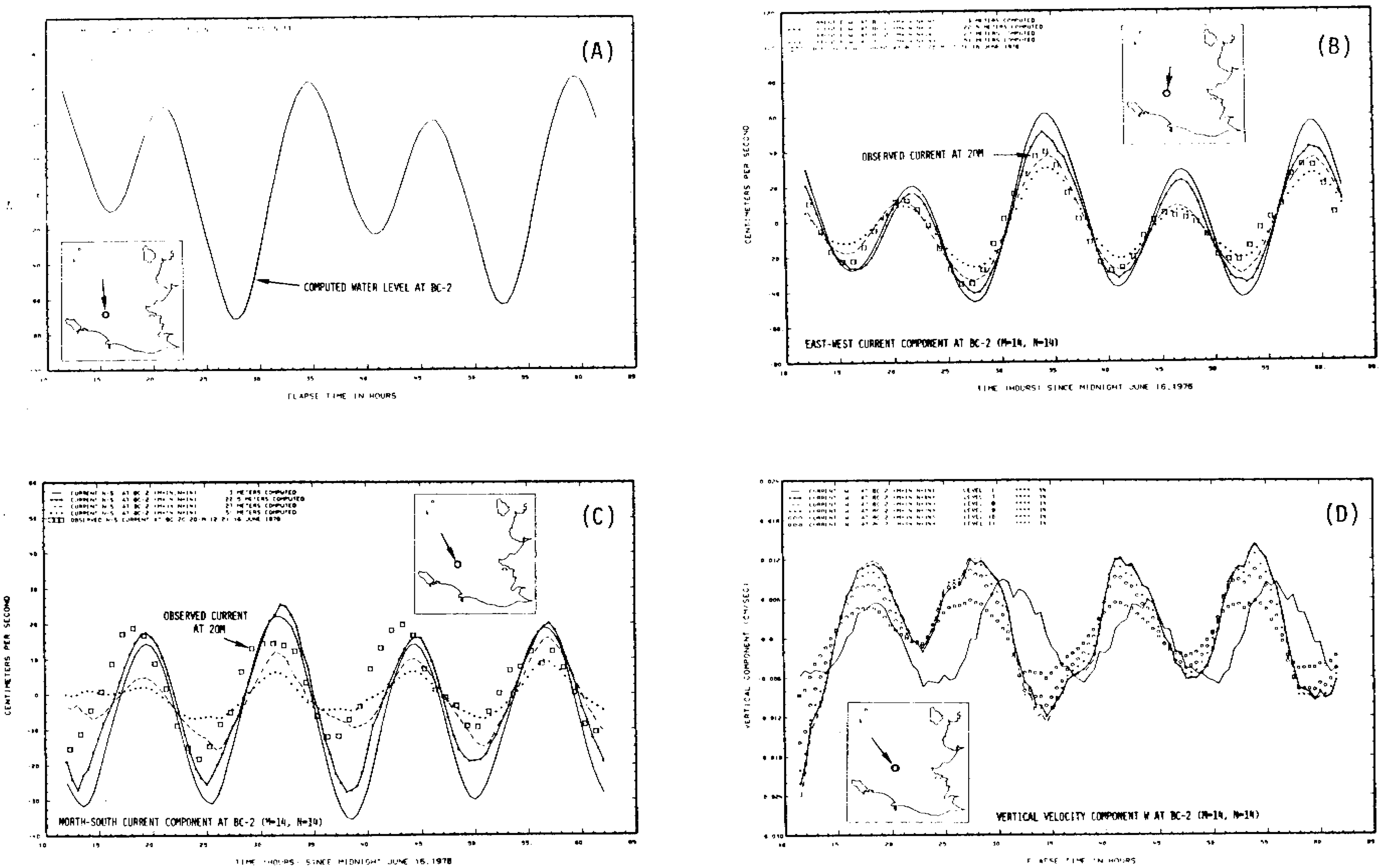


Fig. 19--Comparison between the computed and the observed current component at a given location (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 16 June through 1400 18 June 1976.

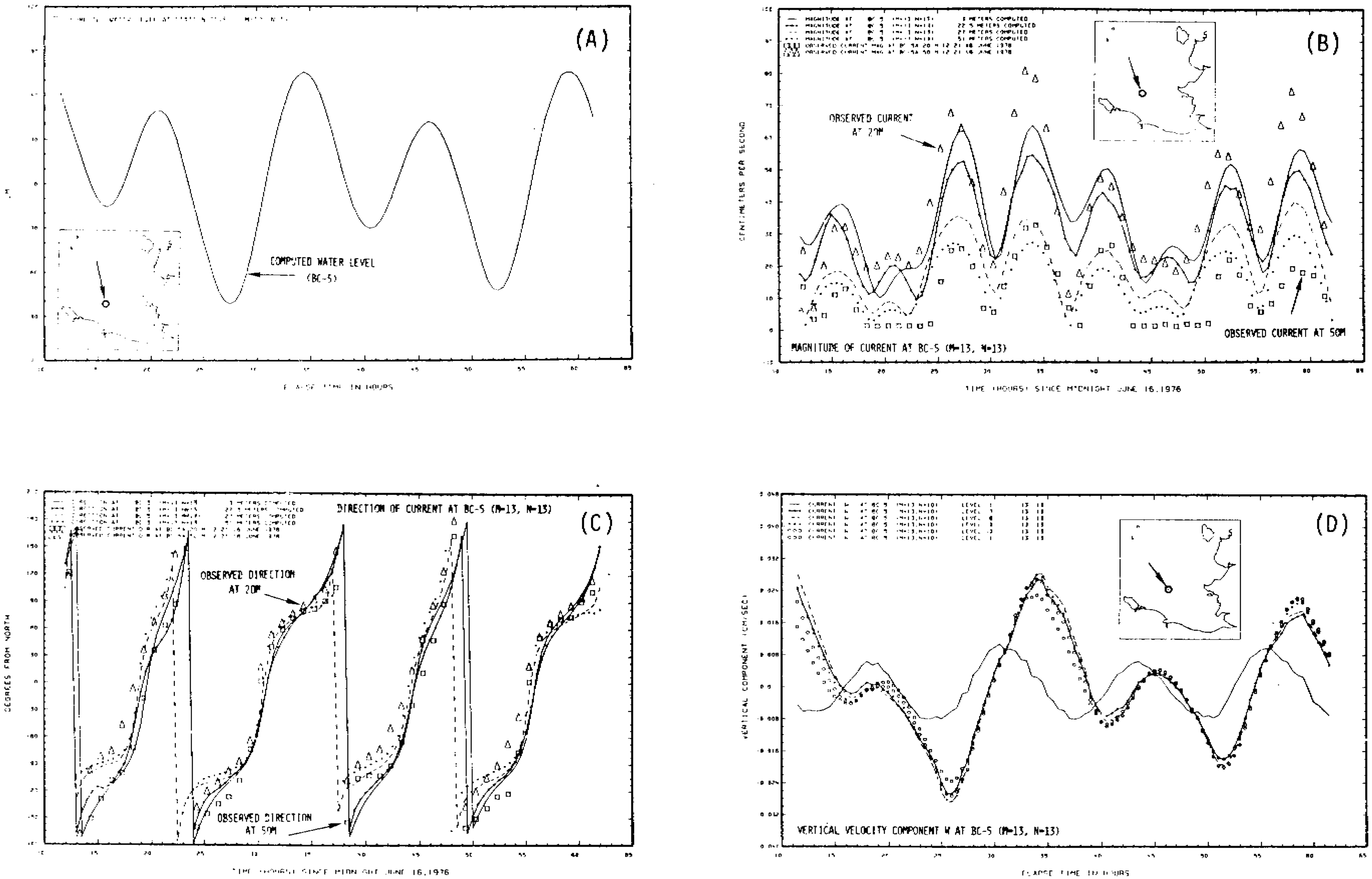


Fig. 20--Comparison between the computed and the observed current speed and direction (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 16 June through 1400 18 June 1976

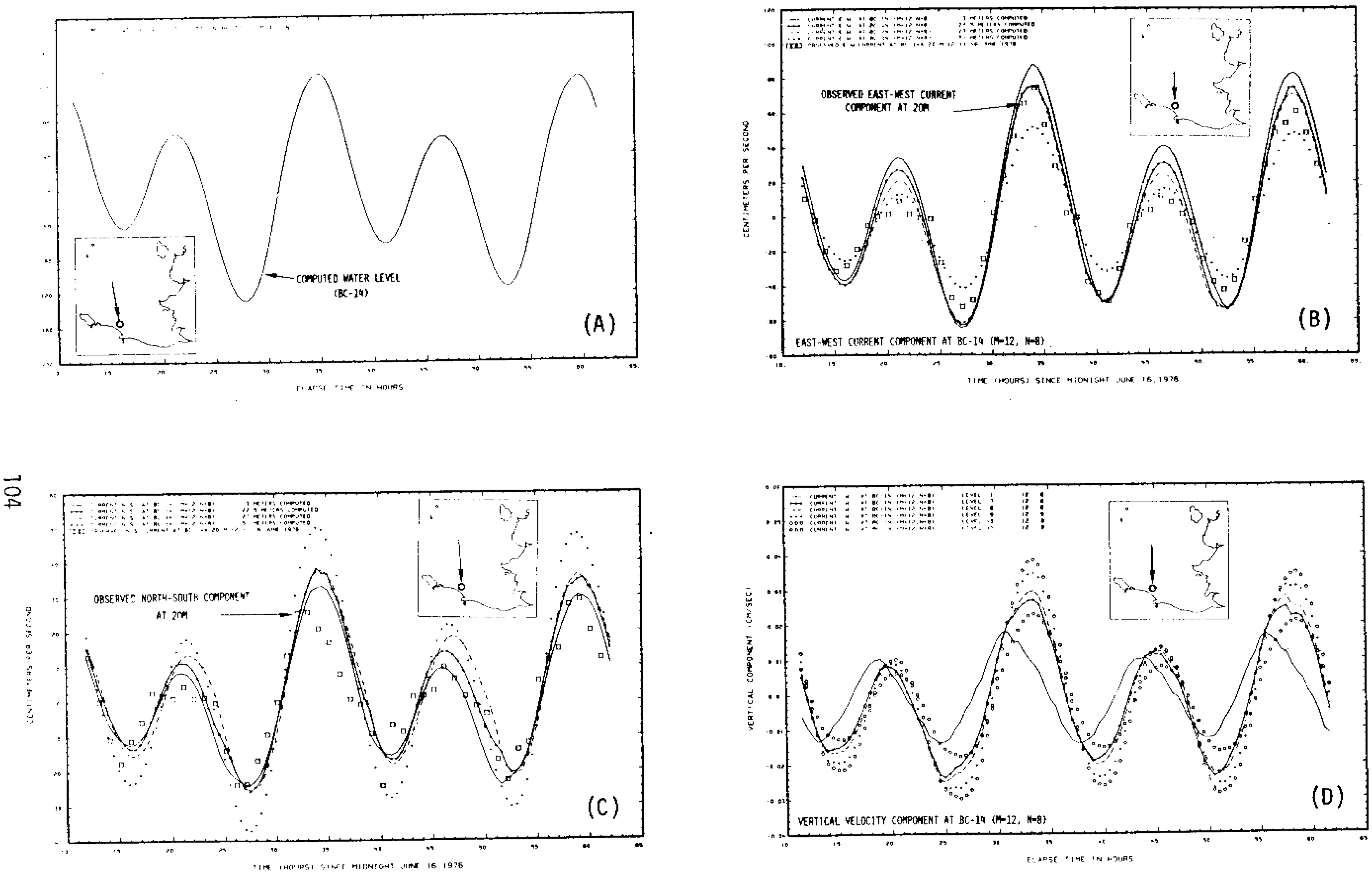


Fig. 21--Comparison between the computed and the observed current components at a given location (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 hr 16 June through 1400 18 June 1976.

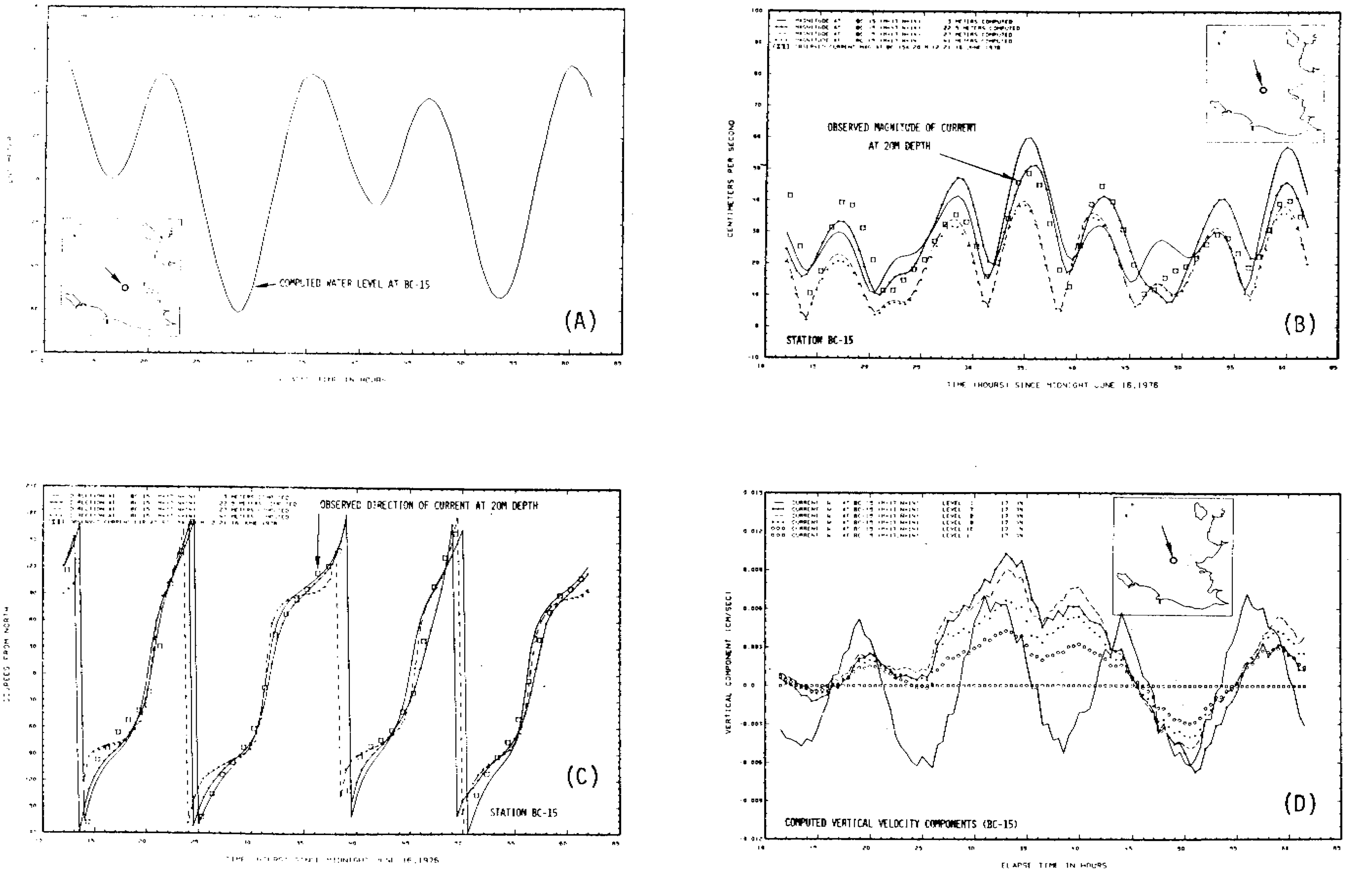


Fig. 22--Comparison between the computed and the observed current speed and direction (B and C) together with the local water level (A) and vertical velocity component at six selected levels (D) during the period 0000 16 June through 1400 18 June 1976.

east/west current component at station BC-2, measured at a 20-meter depth. Graph C gives similar comparisons, but for the north/south velocity components. These computed values agree quite well with the reported average values. Some uncertainties still exist. These uncertainties include the true horizontal location of the station. Depth values in the model are schematized according to the published navigation chart, which may not represent the true local depth. Local depth of the mixed layer may also be slightly different from the modeled value. Finally, the predicted water level at the model's open boundary also contains certain random and systematic errors. Graph D contains six curves representing the computed vertical velocity components at six selected layers. The vertical velocity of these layers not only reveals tide-induced vertical displacements, but also contains instabilities induced by the vertical stratification. The dynamic behavior of each layer is closely related to the local vertical densimetric Froude number and the Brunt-Vaisala frequency. More detailed discussion on the vertical dynamic behavior in Bristol Bay will be given later in this section. Figure 20 gives similar comparison graphs for Station BC-5. In this figure, the currents are plotted as magnitudes and direction. The computed currents in the lower layers agree quite well with the observed values, whereas surface currents are in general higher than the computed magnitudes--particularly at their maximum range. The predicted current directions are excellent (Graph C). Some of the underestimates in the surface currents at this particular location may be traced to the low turbulent energy content. This is indicated by the dichotomic velocity distribution in the vertical (Graph D). Notice the lack of vertical velocity gradients in the bottom layers as compared to the similar graph in Fig. 19.

The next figure (21) represents the comparison at Station BC-14, which is located very close to the Alaskan Peninsula. The computed currents agree extremely well with the observed values, particularly for the east-west component. Due to its closeness to the southern boundary, vertical displacements are very large, resulting in a vertically quasi-homogeneous structure. For the same reason, the surface layers lead the lower layers, showing pronounced tidal influence and lack of vertical instability.

Good agreement is also found at Station BC-15 (Fig. 21). This station is shallower than the previous three stations. Vertical displacements of water columns show pronounced instabilities (Graph D), yet the magnitude is only about one-third of that at Station BC-14.

In the spring-summer period, stable stratifications are usually found in the waters with depth greater than 50 meters in Bristol Bay. This positive density gradient requires additional energy in the vertical turbulent exchange process. As a consequence, not only is upwelling being suppressed, but the bottom layers are also being insulated from the surface wind stress. Unlike the deeper layers where water is nearly neutrally stable, the upper layers tend to oscillate from their equilibrium position. This oscillation can often be characterized by the Brunt-Vaisala frequency which, in the upper layer, can be approximated by

$$N = \left\{ - \frac{g}{\rho_o} \frac{\partial \bar{\rho}}{\partial z} \right\}^{\frac{1}{2}}$$

where N is in radians per second, and ρ_o is the reference density at the free surface.

From the observed data, the period of oscillation (i.e., $2\pi/N$) varies from a fraction of an hour in the thermocline to several hours in the deeper waters, although it is more difficult to measure in the lower layers. In the simulation the computed vertical velocity component also gives a convenient indication of the vertical displacements by means of frequency-domain analyses. To illustrate this dynamic behavior, we analyzed the vertical velocity component W for selected layers at several locations by the spectral method.

In the surface layer at Station BC-2, the computed vertical velocity component contains not only tide-generated vertical displacements, but also oscillations induced by the stratification effect. In its spectrum (Fig. 23A), several peaks located outside tidal bands indicate these oscillations with a primary peak located at a frequency which corresponds to a period of 1.3 hours. Near the pycnocline (layer 7), energy in the higher frequencies increased (Fig. 23B). No predominant peak can be identified, however. Near the bottom, short period oscillations diminished. Major spectral peaks in this region are located near the tidal frequency (Fig. 23C). Since we have a rather sharp density gradient in the vertical, higher modes involve higher rates of shear and thus tend to reduce the vertical scale of the higher modes and accelerate their degradation into subgridscale turbulence.

Similar analyses were made for stations BC-14 and BC-15. The results of the spectral analyses are presented in Appendix C. The vertical instability is somewhat suppressed, due primarily to the well-mixed vertical structure near the coastal region. The spectra of vertical displacements in three layers at station BC-14 are also plotted on log-log scale (Fig. 24). The shapes of these spectra all possess a similar slope; they fall approximately as f^{-2} at the lower frequencies and then flatten out to around f^{-1} above 0.5 cycles per hour. This characteristic shape agrees with the observed spectra of the first mode internal waves [7].

Amplitude and phase correlation between these oscillations in each layer are also analyzed. For example, at station BC-2 the amplitude and phase relationship between the surface layer and a layer immediately below the pycnocline are shown in Figs. 25A and 25B. The bottom layer, which is driven primarily by tide, leads the surface layer by approximately three hours at tidal frequencies, whereas no phase and amplitude differences exist for the density-induced vertical instability toward the higher

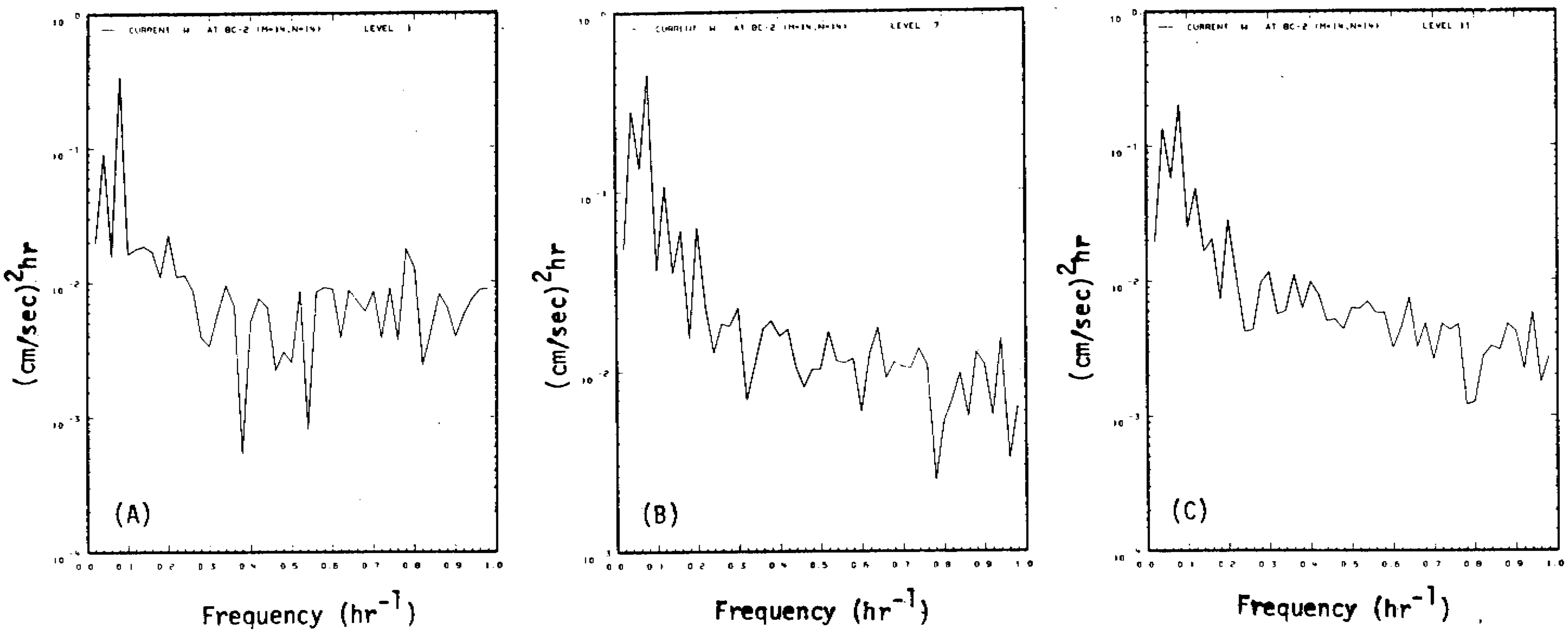


Fig. 23--Line spectra of the computed vertical velocity components near station BC-2. Graphs (A), (B) and (C) are for layers 1, 7 and 11, respectively. Spectral values are computed by fast Fourier transformation.

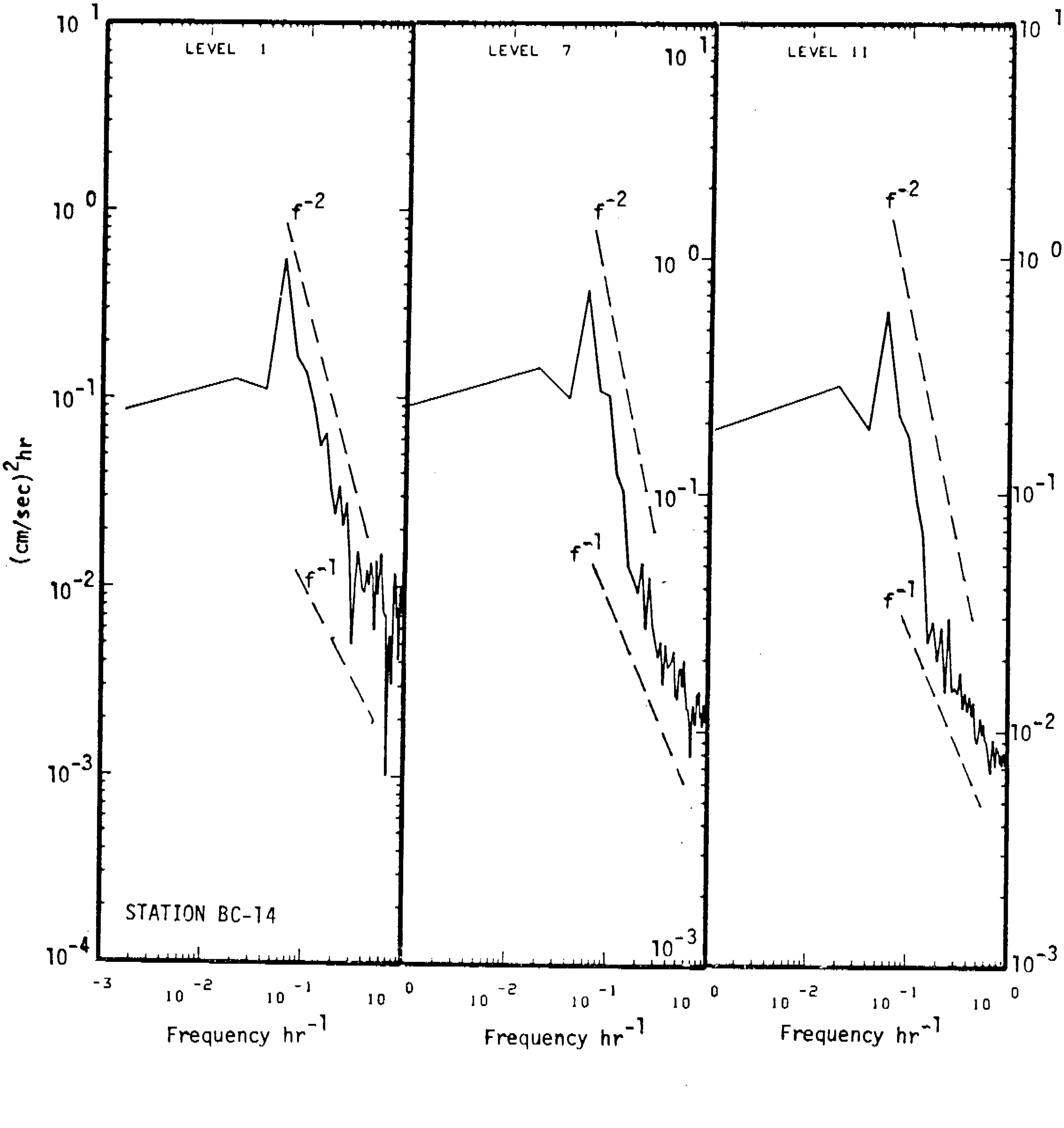


Fig. 24--The spectra of vertical displacements in three layers at station BC-14. The slope falls approximately as f^{-2} at the lower frequencies and then flattens out to f-1.

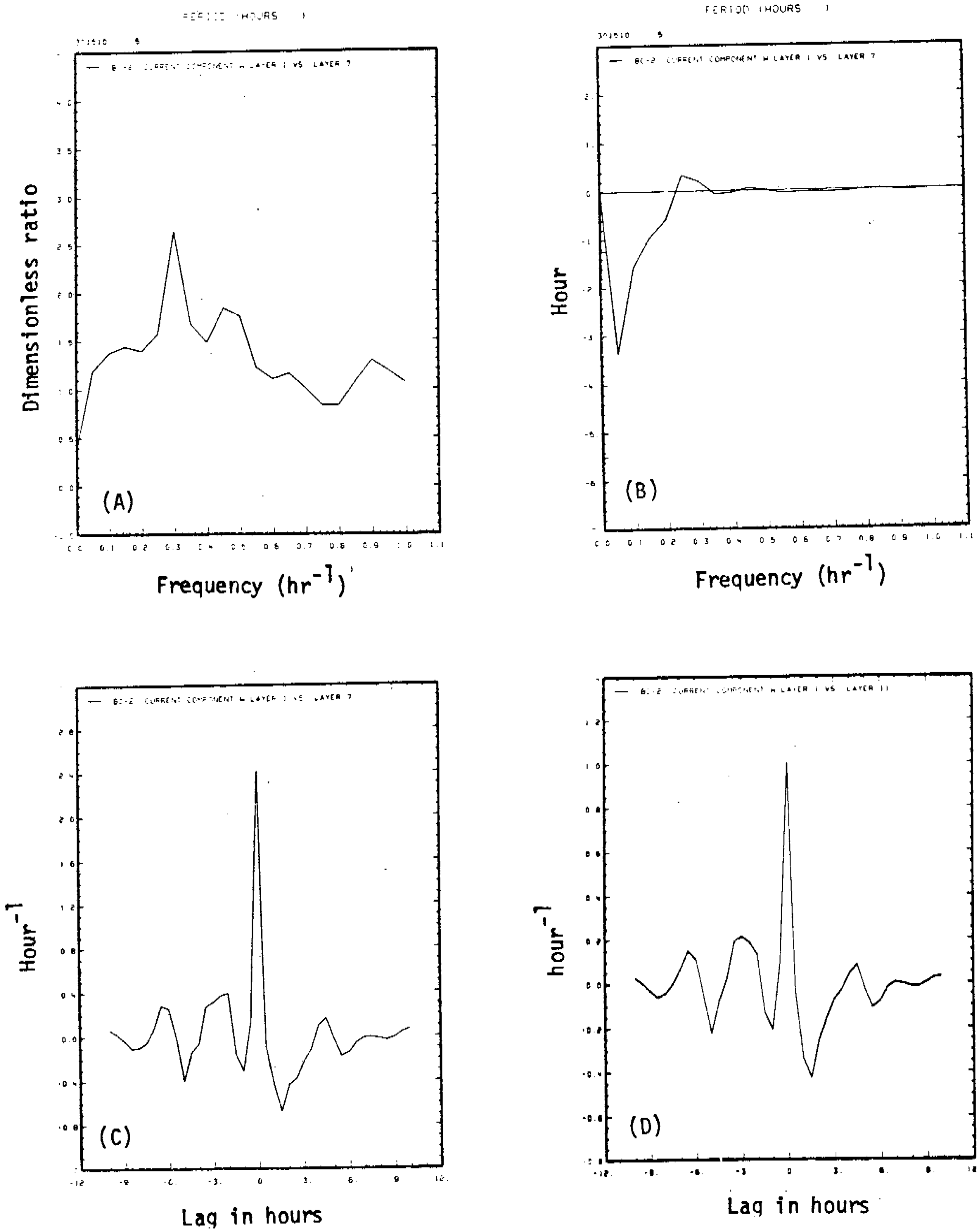


Fig. 25--Amplitude (A) and phase (B) spectra of vertical oscillation between layer 1 and layer 7 near station BC-2. Graphs (C) and (D) are the computed transfer function between layers 1 to 7 and 1 to 11, respectively.

frequencies. With this correlation, it is thus possible to compute the vertical movement in a layer from information derived from another layer through the impulse response function (Figs. 25C and 25D).

These two impulse response functions are derived from the amplitude-phase relationship computed by means of their cross-spectral estimates between the surface layer and layers 7 and 11. The prediction is made using a technique called convolution [8]. The convoluted time series of vertical layer displacements in the 7th and 11th layers from the surface layer information are plotted against those obtained from dynamic computation in Fig. 26. In these graphs dotted curves represent the convoluted values.

The computed coherency spectra are shown in Fig. 27. Higher coherencies are found generally in tidal frequencies. Coherency-associated vertical instabilities are between 0.5 and 0.6. This is in general agreement with the observations of Haurwitz, et al. [9].

It has been a general practice to assess the vertical diffusion coefficients for momentum and constituents according to the local vertical velocity gradient. This approach is far from satisfactory, because the moving fluid has a certain amount of memory of previous events in the mass, momentum and constituents exchange processes, both in the spatial and time domains of reference. Thus, if water moves over a rough bottom area, a high exchange rate will be maintained for awhile, even during slack tide or if the considered water parcel enters an area with a smoother bottom because the turbulent energy has not immediately decreased. For this reason we have now included the subgridscale (turbulent) energy in the computation in the development process of our three-dimensional model. The computed turbulent energy-related diffusion coefficient for station BC-14 is plotted together with the local turbulent energy densities (Fig. 28). Graph 28A illustrates the vertical distribution of SGS energy densities in six selected layers. In one particular instance, energy level within the pycnocline became negative, indicating the existence of a certain local density discontinuity. The values were reset to zero for further computation. Graph 28B presents the vertical distribution of ε defined by

$$\varepsilon = L\sqrt{e}$$

where ε is the energy-related eddy viscosity coefficient, L is the local length scale and e is the local turbulent energy density. Notice that a minimum level of exchange rate is maintained even during slack water.

The effects of vertical density gradients on the vertical exchange rates are expressed by a dimensionless parameter (Fig. 29) which is a function of local vertical density gradient and local energy level. The final value used in the computation for the nonhomogeneous vertical exchange is the product of this parameter and the homogeneous eddy viscosity coefficient. In this figure the value

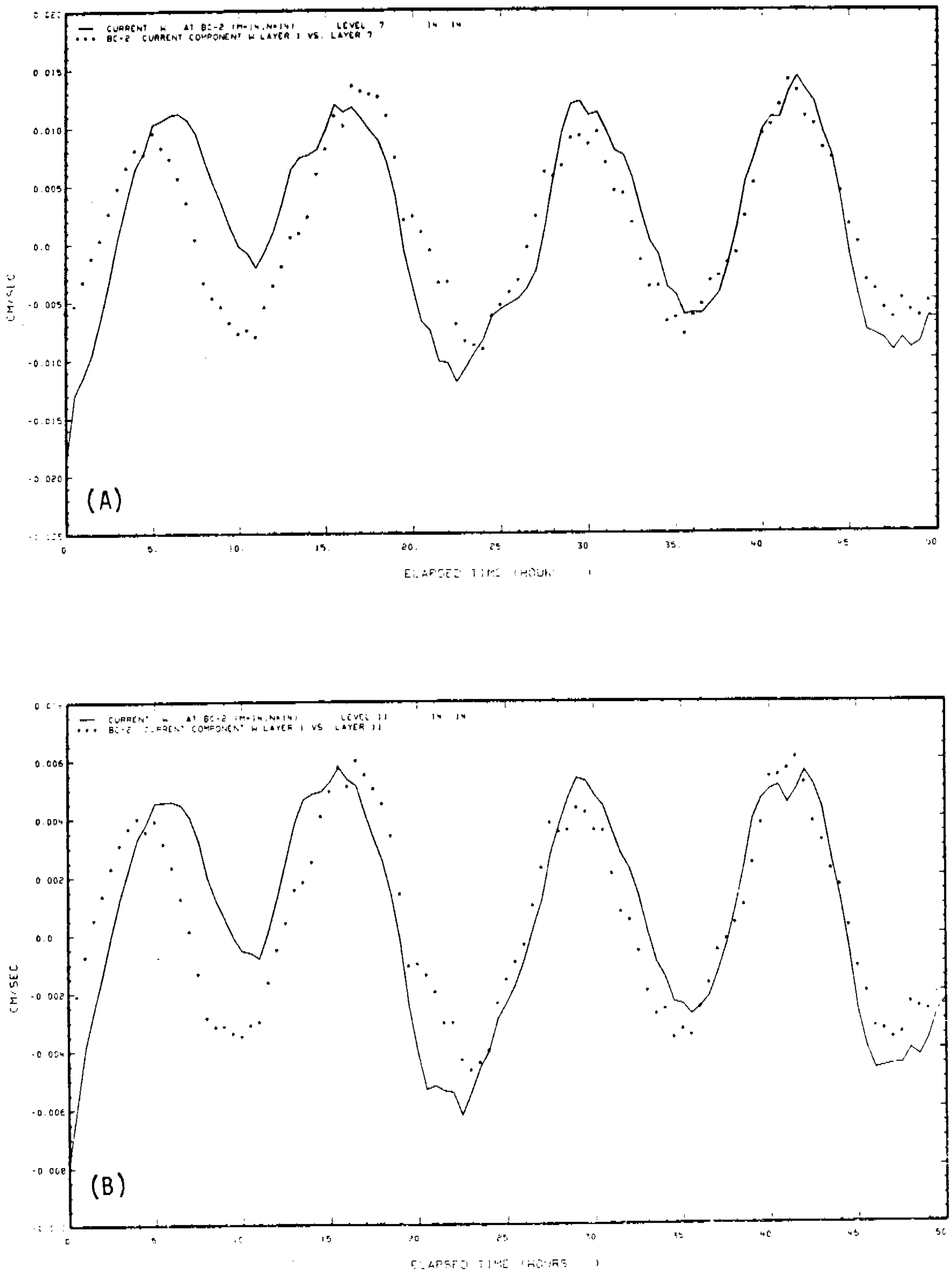


Fig. 26--Estimated vertical oscillation in layers 7 (A) and 11 (B) from the vertical displacement in the surface layer near station BC-2 by the convolution method

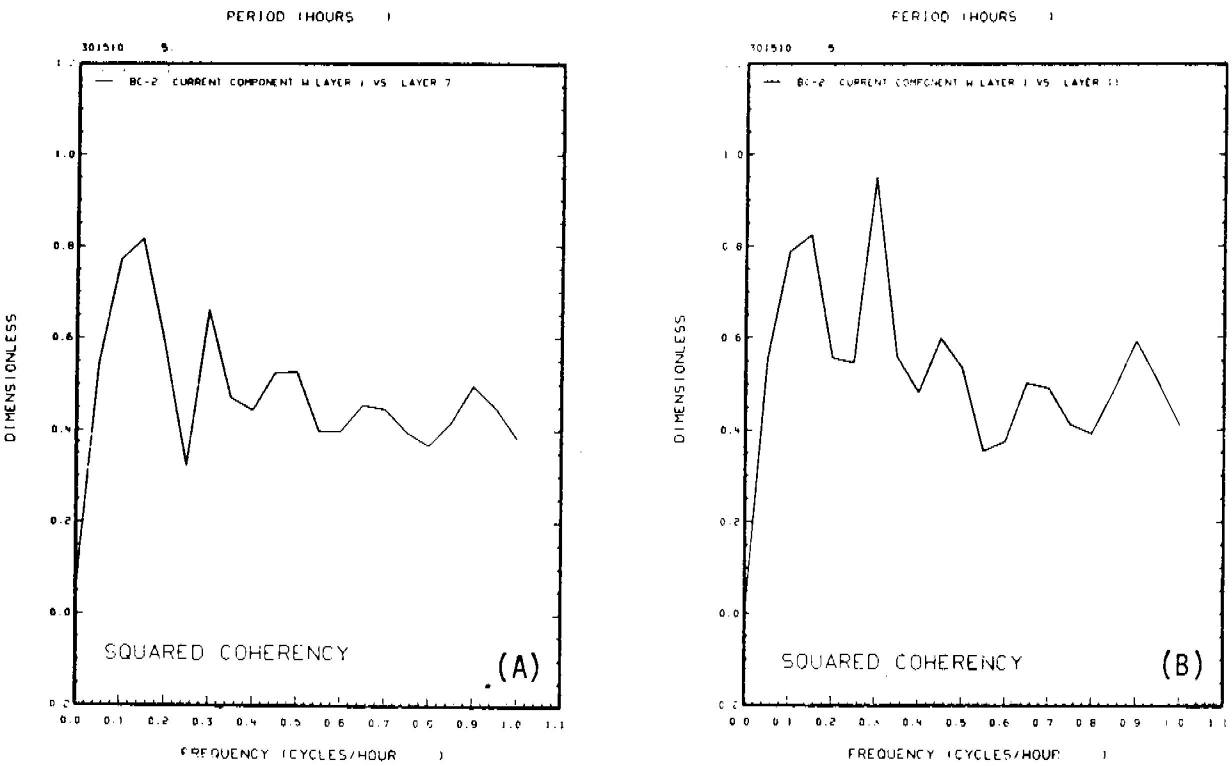
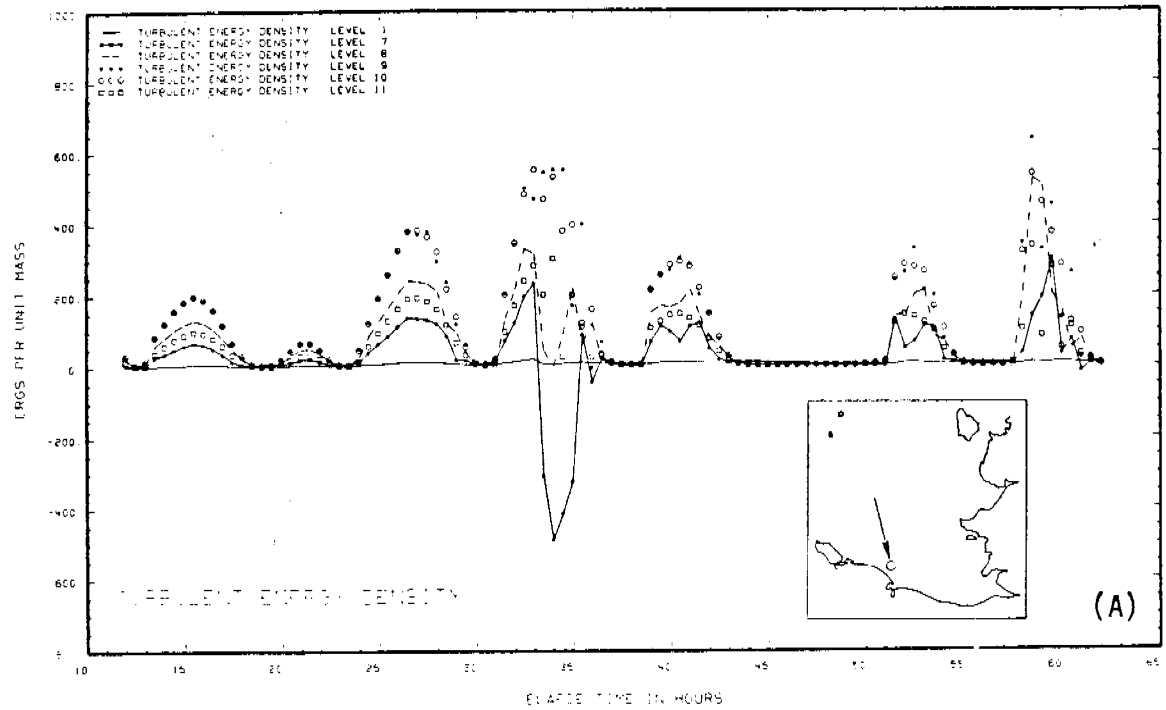


Fig. 27--Computed coherency spectra between the oscillation in the surface layer and layer 7 (A) and between the surface layer and layer 11 (B) near station BC-2



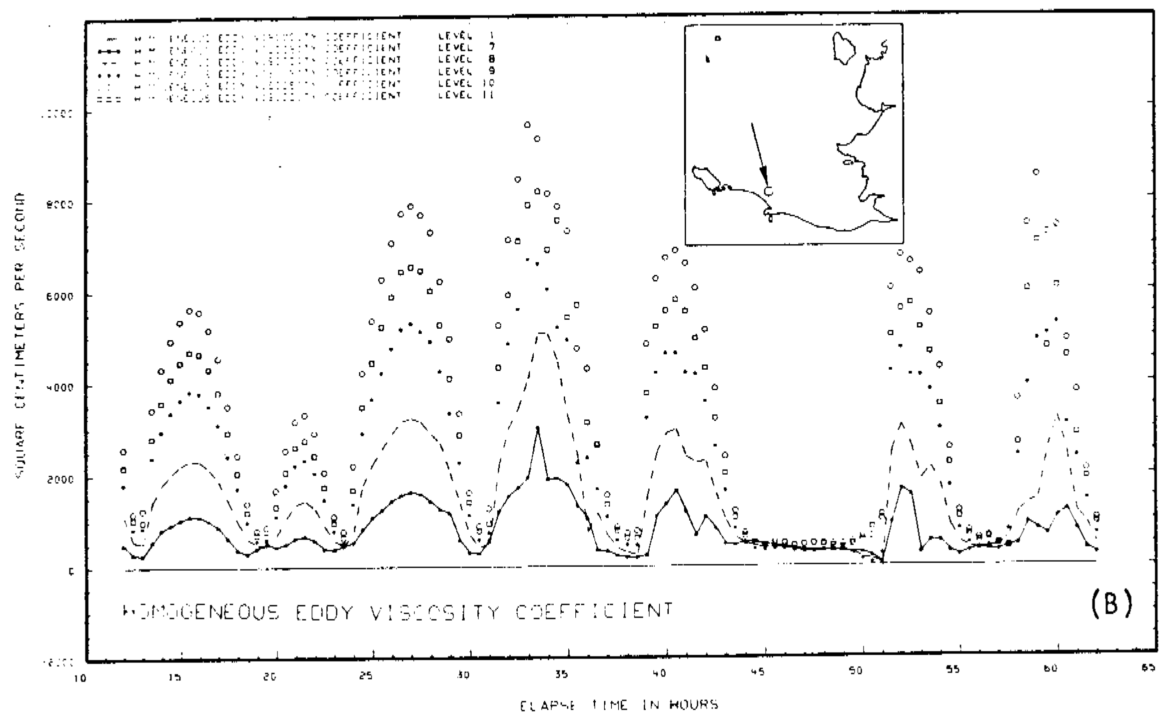


Fig. 28--Computed time histories of SGS turbulent energy densities in six selected layers near station BC-14 during the verification period (A). Temporary occurrence of negative energy in the pycnocline (layer 7) is due to computational effect (see text). The values were reset to zero in the subsequent computational step. Graph (B) shows the computed homogeneous eddy viscosity coefficient derived from the local SGS turbulence level.

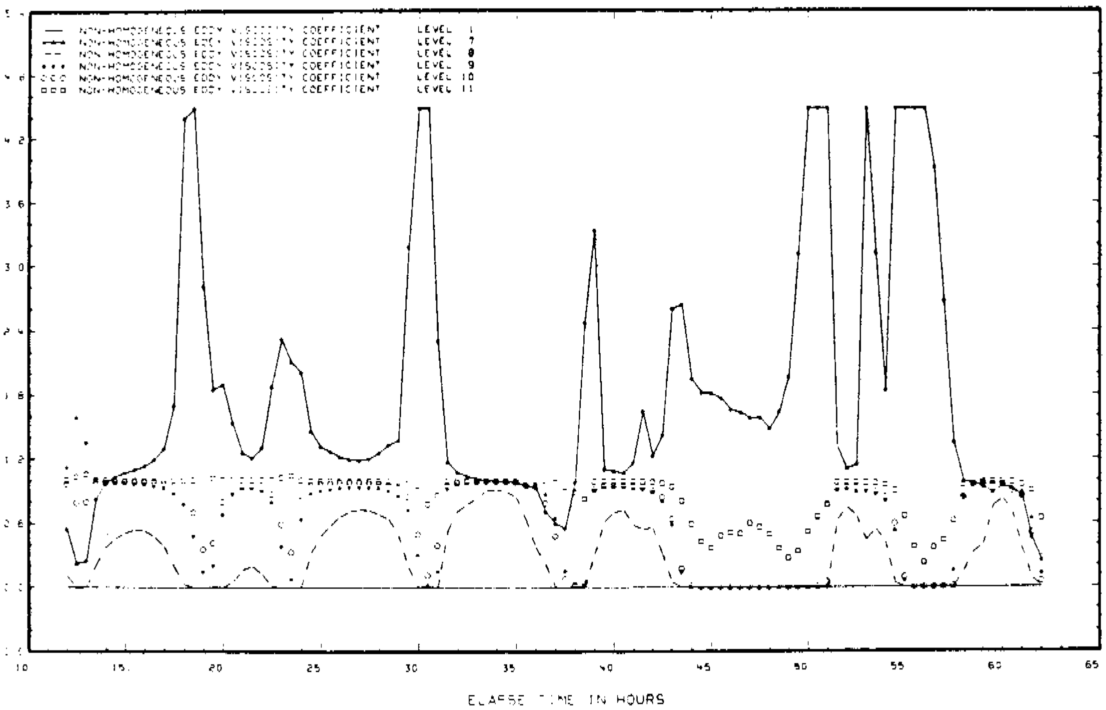


Fig. 29--Computed dimensionless parameter for the suppression and enhancement of vertical exchange rate due to vertical density gradient and SGS turbulence level near station BC-14

of this parameter exceeds unity within the pycnocline, indicating that instantaneous negative density gradients were induced by local oscillation, thus enhancing vertical mixing. This has been confirmed by recent studies [10,11] on the instabilities of shear flow, or Richardson instability. In a zone of large-scale upwelling/downwelling where large vertical shear coexists with large horizontal shear, when the local Richardson number decreases to values below 0.25, shear instability will lead to a sudden large increase in mixing across the thermocline [11]. Because of the spatial resolution associated with the horizontal computational grid, we can only represent this local behavior in a general area. In addition, because of the formulation employed in the computation, this enhanced mixing occurs when the local Richardson number is less than zero instead of 0.25 (see Fig. 30). The discrepancy may explain the scatter of the observed data within this range.

A sequence of predicted results from the computations is presented in Figs. 31 through 35. Figure 31A shows the computed water level, velocity distribution in the surface layer and the rise and fall of the water surface at 1400 pm, June 18, 1976. Computed velocity distribution in the 8th layer (depth = 27m) is presented in Fig. 31B. Figures 32A and 32B show the instantaneous distribution of salinity and temperature in the surface layer at 1400 pm June 18, 1976. At the same point in time, the vertical distribution of salinity, temperature and turbulent energy densities (in ergs per unit mass) through a cross-section are shown in Fig. 33.

In these vertical plots, the plotting scale for the vertical velocity component has been enlarged 727 times so that the upward and downward displacements can be visualized. For instance, the tide-induced upwelling near the coast of the Alaska peninsula is evident in Fig. 34. The rise of the water surface near this region can also be seen near the coastal zone.

One of the interesting phenomena associated with the vertical stratification is the formulation of layers with different densities. A similar feature also exists in the computed distribution of salinity and temperature. As in Fig. 35, a layer of warmer water is temporarily located beneath the cooler water illustrated by the 1-degree isotherm.

Inasmuch as our studies are directed towards the development of a prediction method for the possible pathways of pollutants discharged accidentally in this area. The main thrust of our research has been to obtain the horizontal flow fields.

For the convenience of later reference, two complete sets of the simulation output are presented in Appendix D. The first set gives the horizontal and vertical circulation pattern, water level and constituent distribution for ebb tide condition at 0748 am, June 18, 1976. The second set includes these important parameters for a flood tide condition occurring at 1400 pm, June 18, 1976.

The tidal propagation within Bristol Bay may be illustrated by a set of three-dimensional plots from the results of the hydrodynamic computation (Fig. 36). A period of 12 hours of the verification

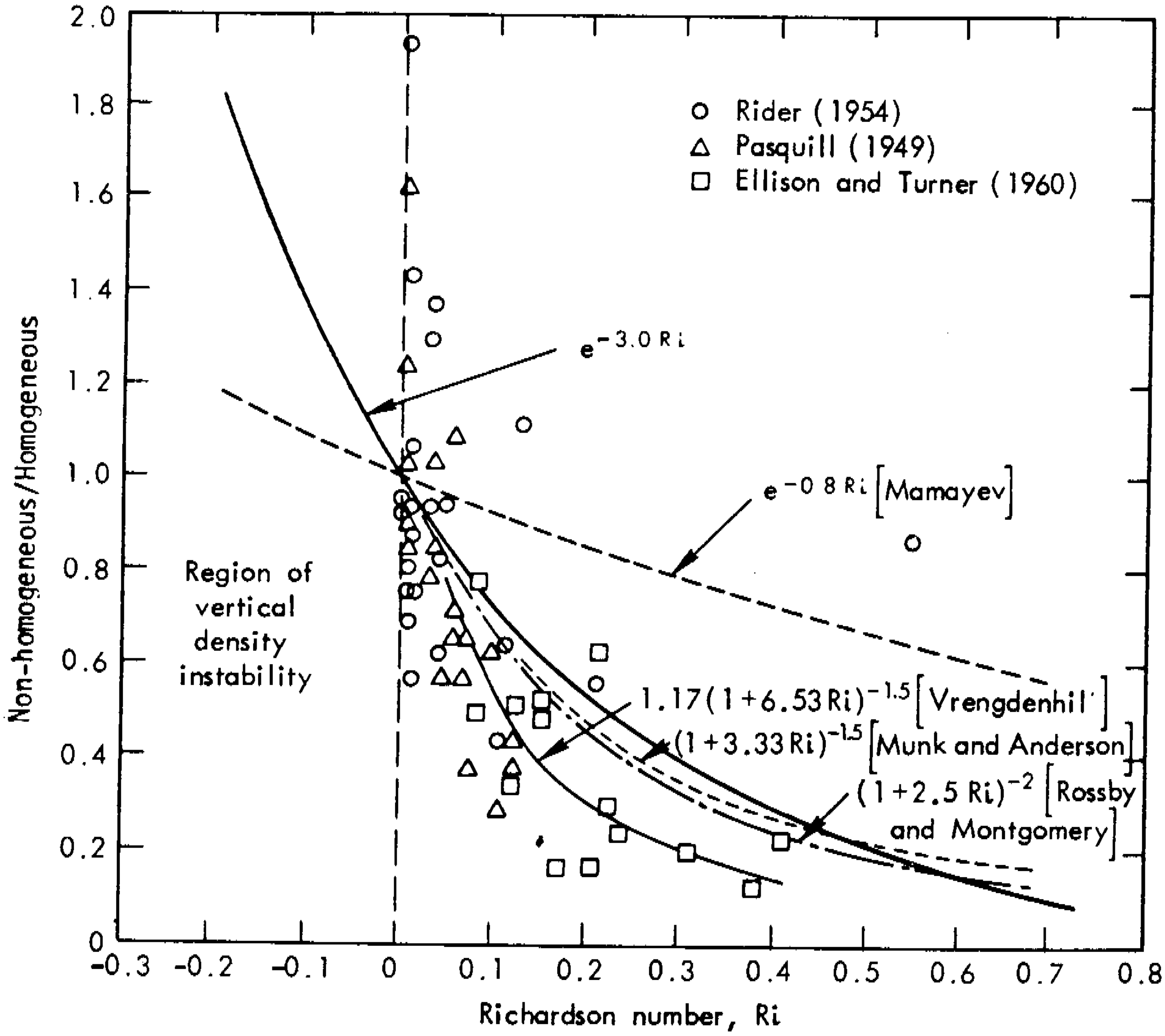
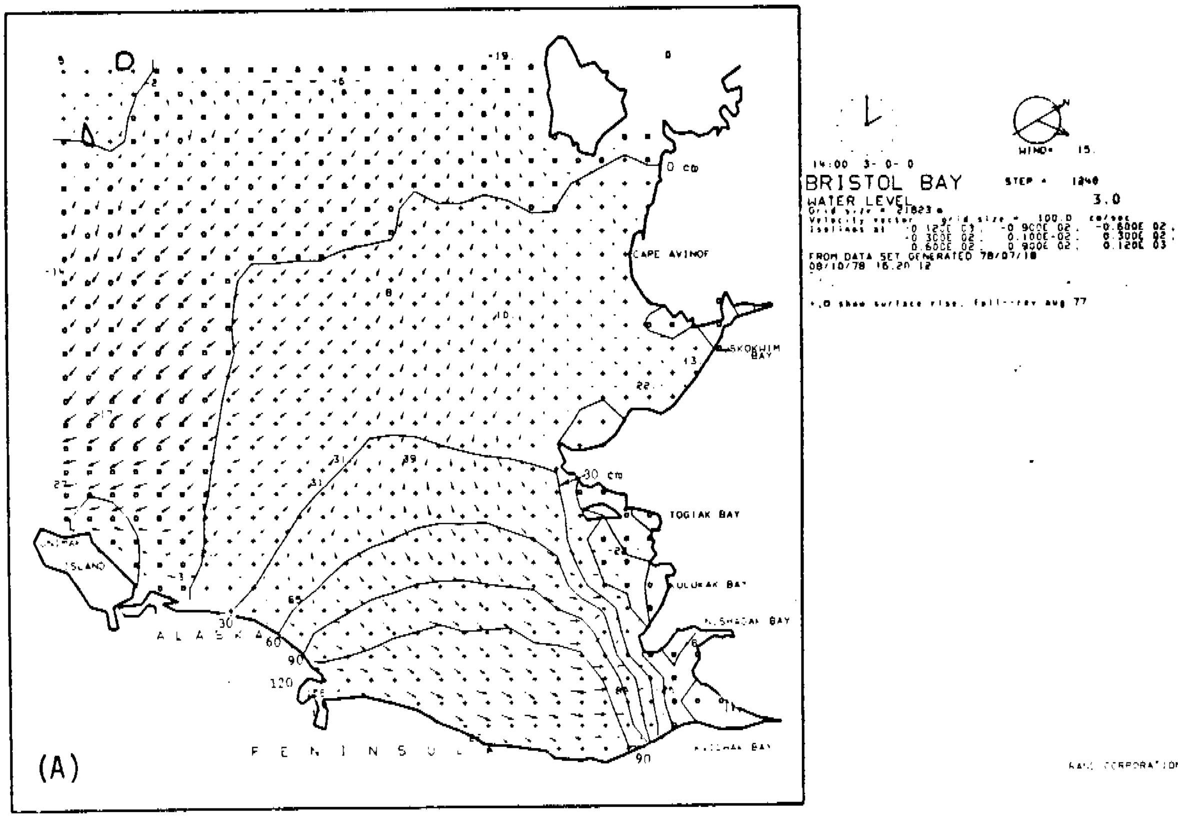


Fig. 30--Ratio of the vertical mass exchange coefficient in stratified flow and the coefficient in flow with isotropic density as a function of the Richardson number



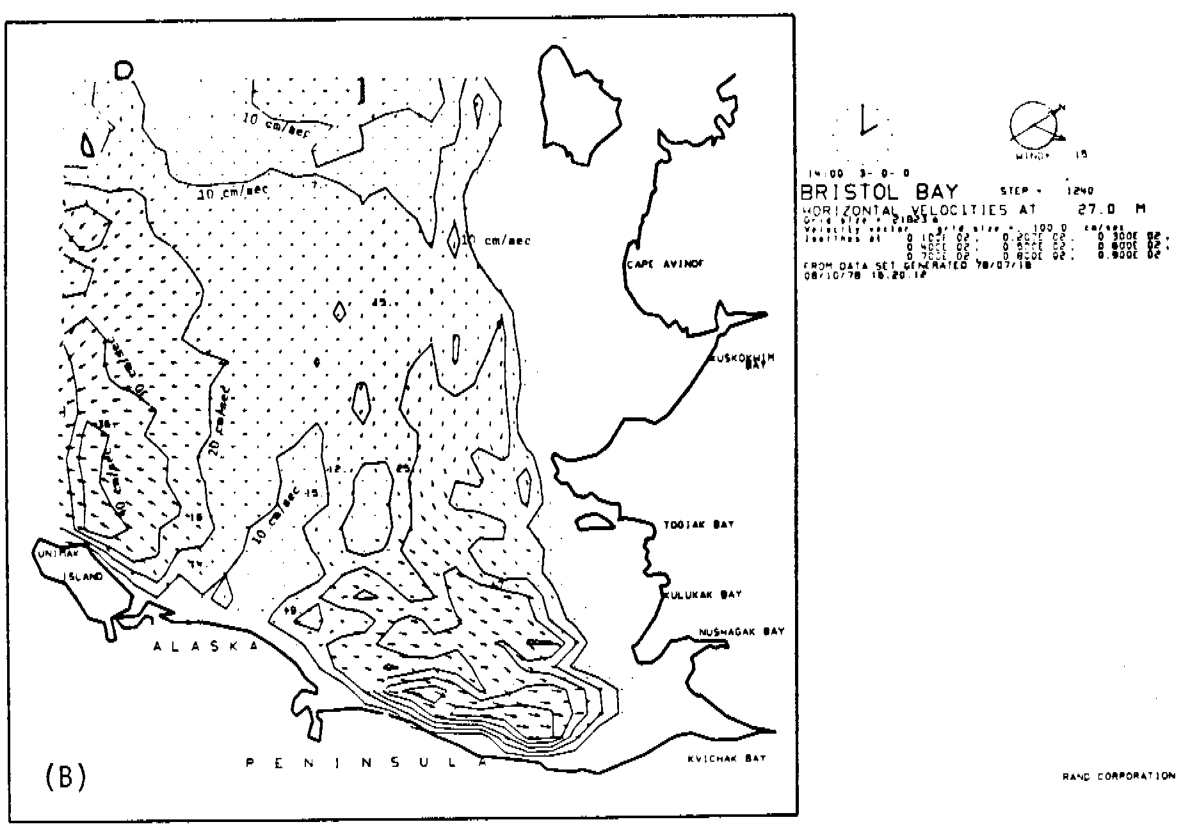


Fig. 31--(A) Computed water level, velocity distribution in the surface layer and the rise and fall of water surface. (B) Computed velocity distribution in the 8th layer (27m) at 1400 pm 18 June 1978.

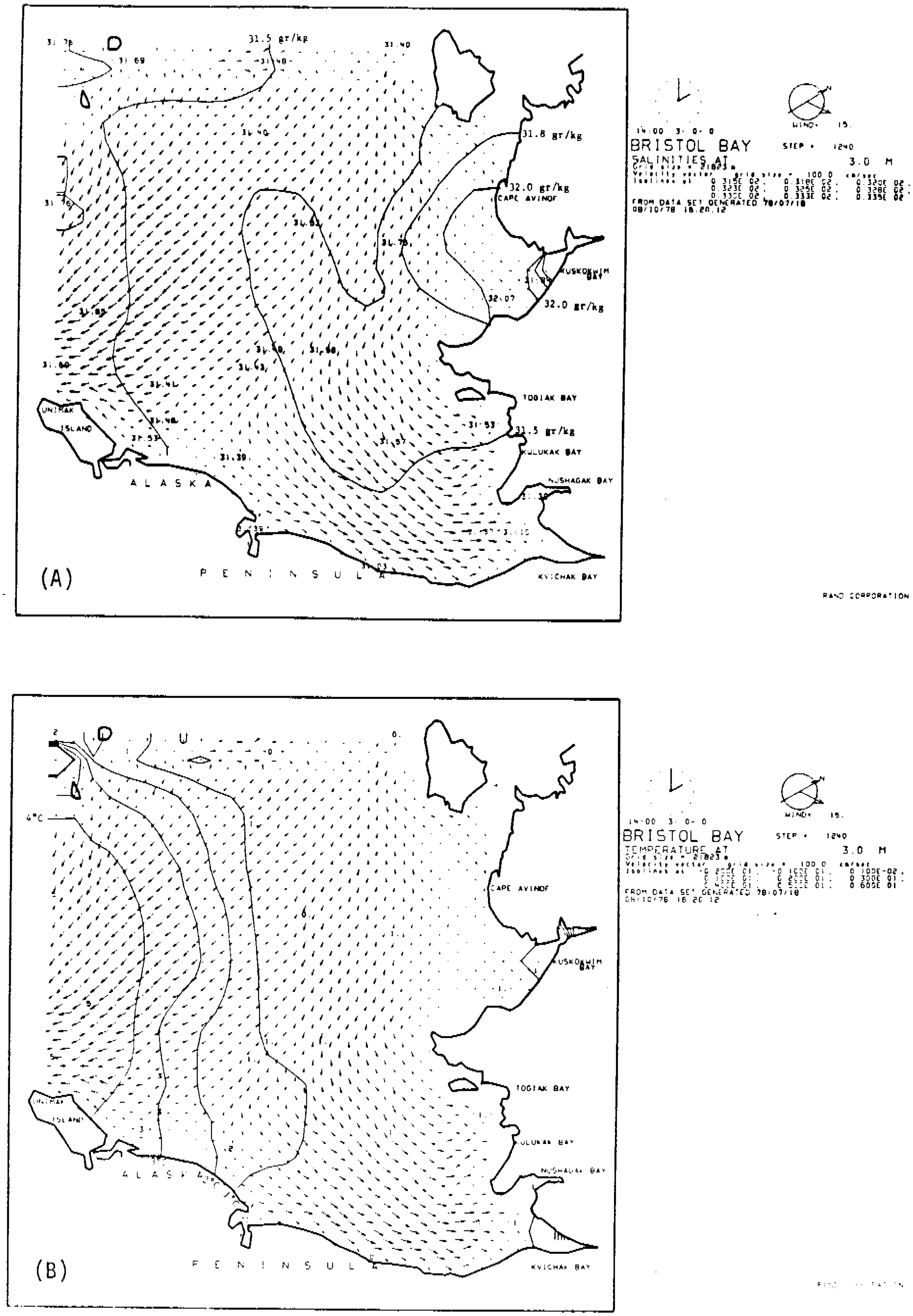


Fig. 32--Computed salinity (A) and temperature (B) distribution in the surface layer at 1400 pm 18 June 1976.

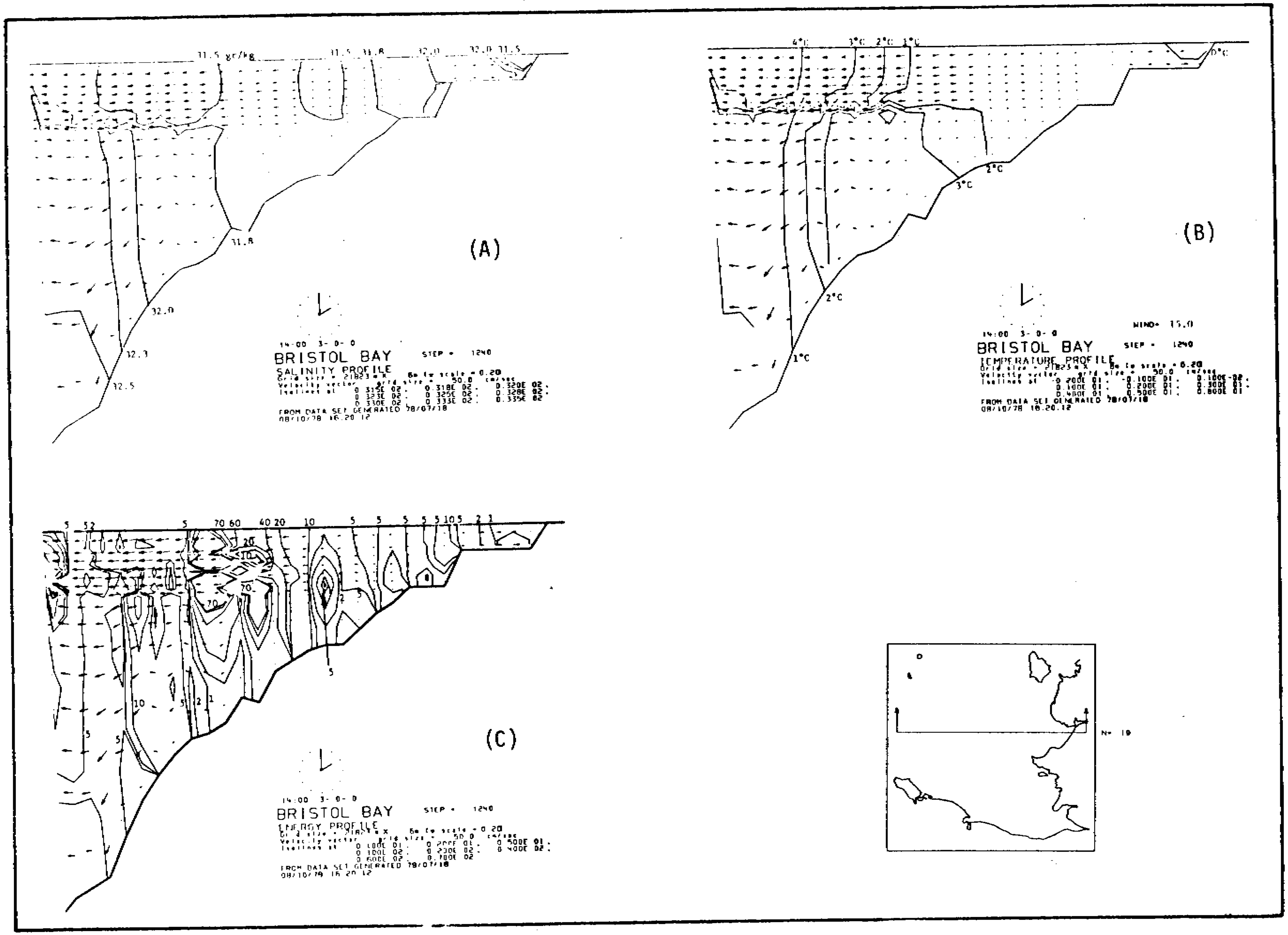


Fig. 33--Computed vertical distribution of salinity (A), temperature (B) and turbulent SGS energy (C) along a profile indicated in inset map at 1400 p.m. June 18, 1976. The vertical plotting scale for the vertical velocity component has been enlarged 727 times.

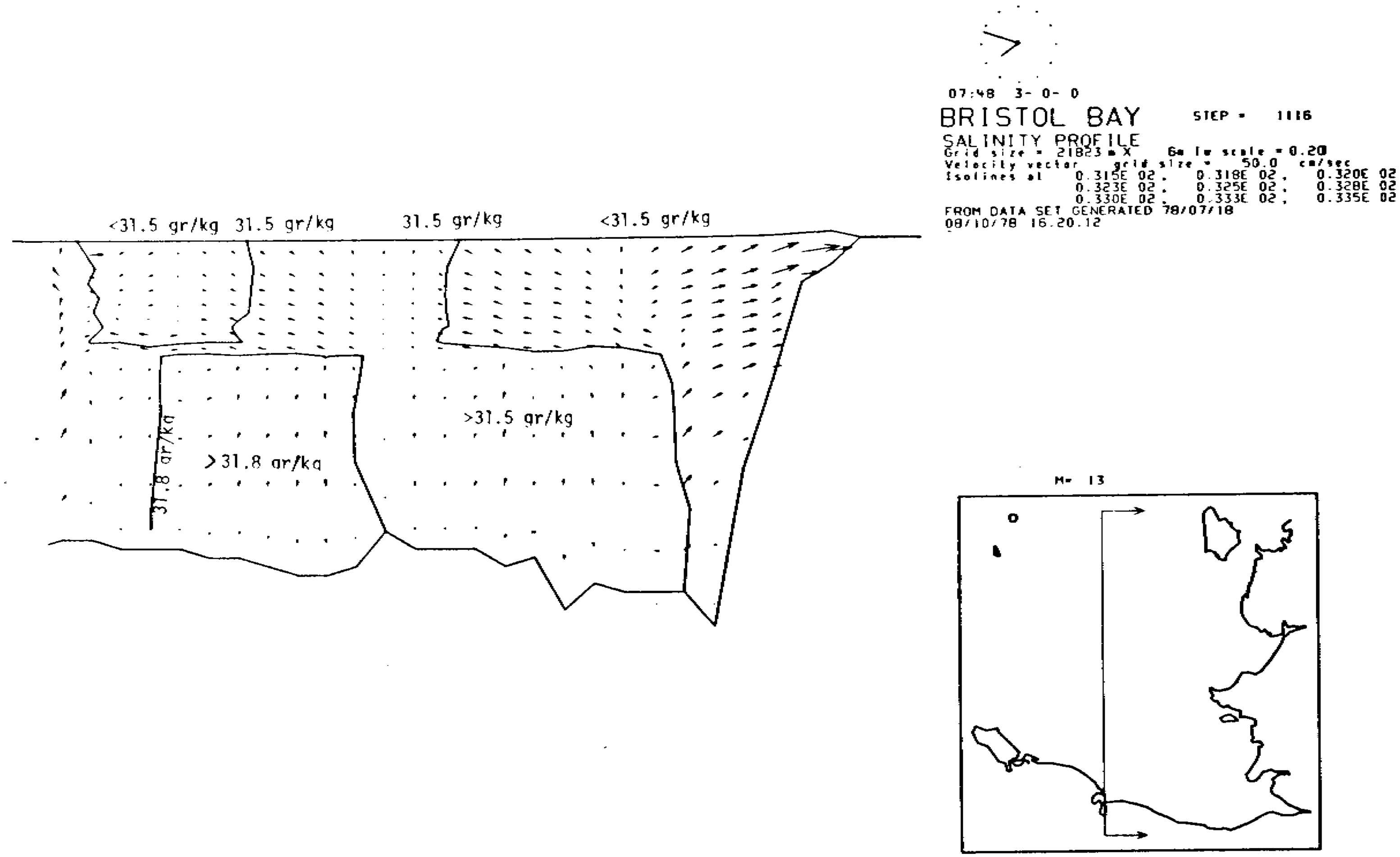


Fig. 34--Vertical distribution of salinity and current through a cross-section at 0748 a.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

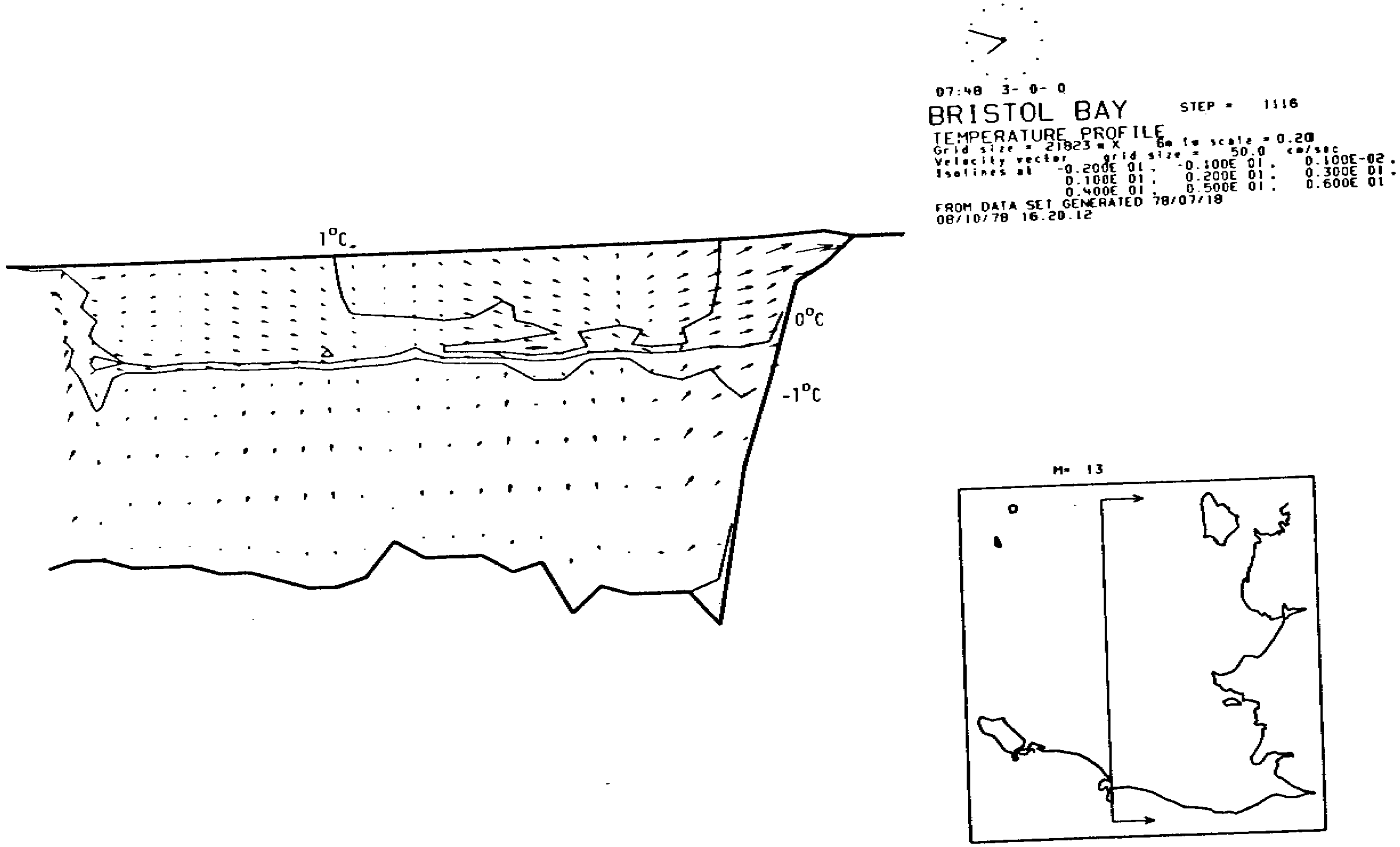


Fig. 35--Vertical distribution of temperature and currents through a cross-section at 0748 a.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

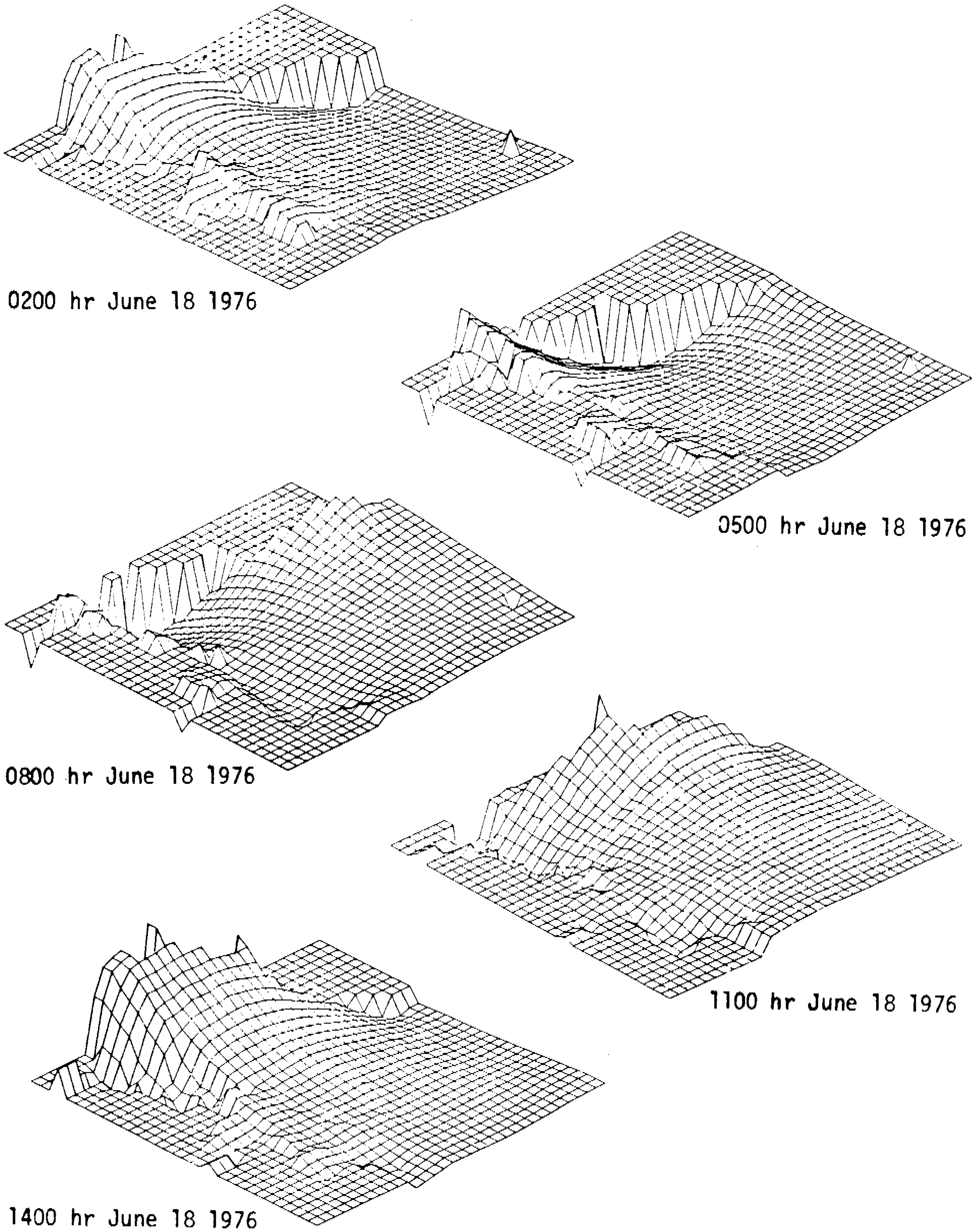


Fig. 36--Three-dimensional plots of the computed water surface movement in the modeled area during a 12-hour period in the verification run. Higher tidal harmonics superimposed on the principal lunar and solar components are evident.

period, from 0200 hour to 1400 hour June 18, 1976, is selected to demonstrate the movement of the water surface in the modeled area. This illustrates the rising and falling of the water surfaces in Bristol Bay at three-hour intervals as they would be seen by a spectator looking from the north toward the Alaska Peninsula. Higher tidal harmonics superimposed on the principal lunar and solar components are also evident. It should be pointed out that the result would be different if the computation were to be carried out assuming a homogeneous density structure. This is due primarily to the different vertical shear structures induced by the vertical density gradient and the modification of the horizontal pressure gradient caused by the variations in the horizontal density distribution.

In these plots the areas bounded by land are assumed to have a water level value of zero in order to illustrate the movement of the water surface. This causes the emergence and exposure of St. Paul Island at the right-hand corner of each graph. In order to reveal the water surface variation at the open boundaries, values at the model's boundary gridpoints were set equal to its interior neighboring points in these plots.

The computed co-tidal charts for the diurnal and semi-tidal components are presented in Figs. 37 and 38. The phase, amplitude, and the location of the amphidromic point agrees well with a similar map compiled from field data (Graph A). Differences are found near the shallower waters where observed data are scarce. The computed chart for the quarter-diurnal component is presented in Fig. 39. Notice that the amplitudes are relatively small, as they are generated by the nonlinear advective mechanism induced primarily by tidal energy. As we did not include the quarter-diurnal components in our inputs, this figure presents only the amplitudes generated by the diurnal and semi-diurnal components. It would not represent the actual quarter-diurnal tide conditions.

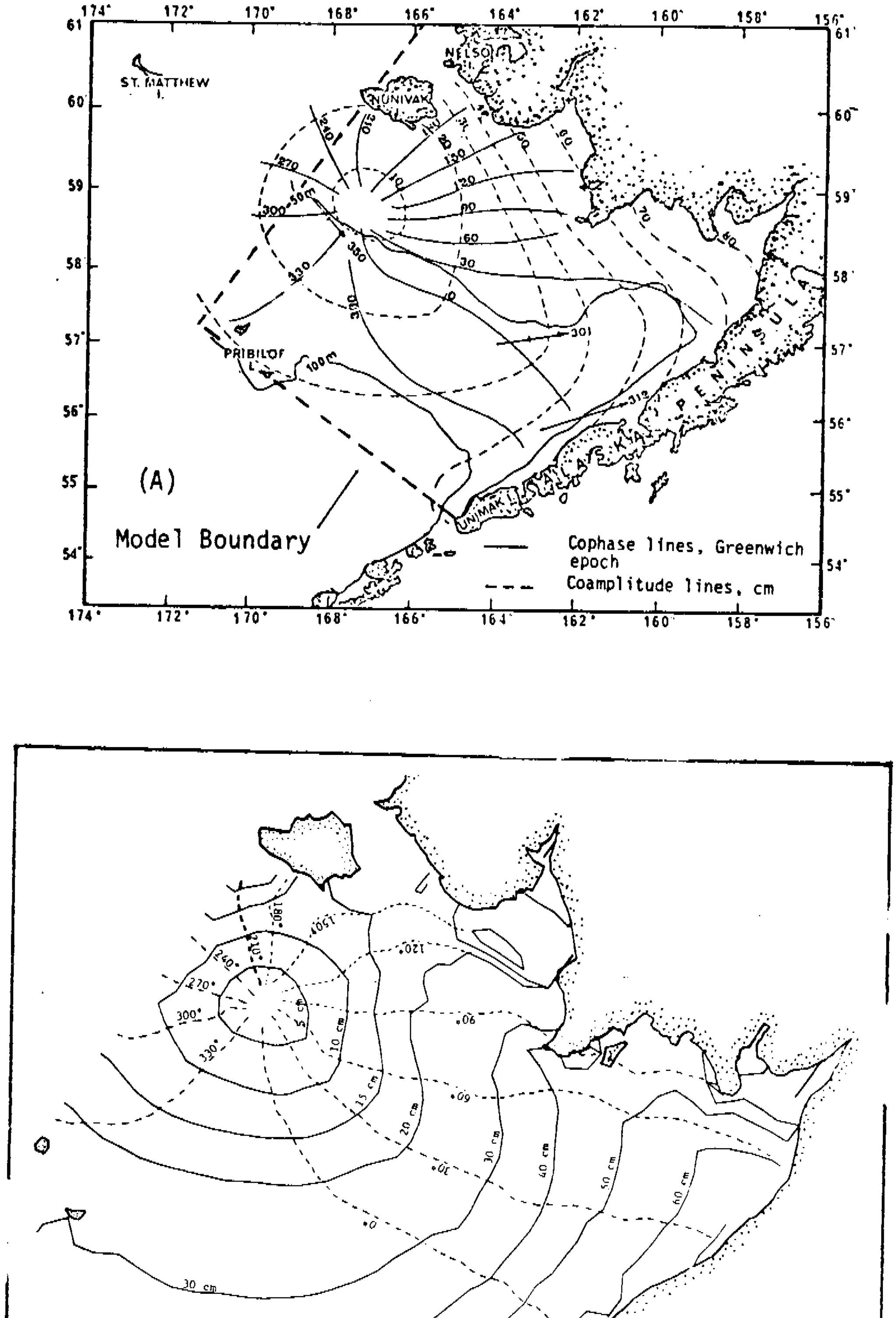
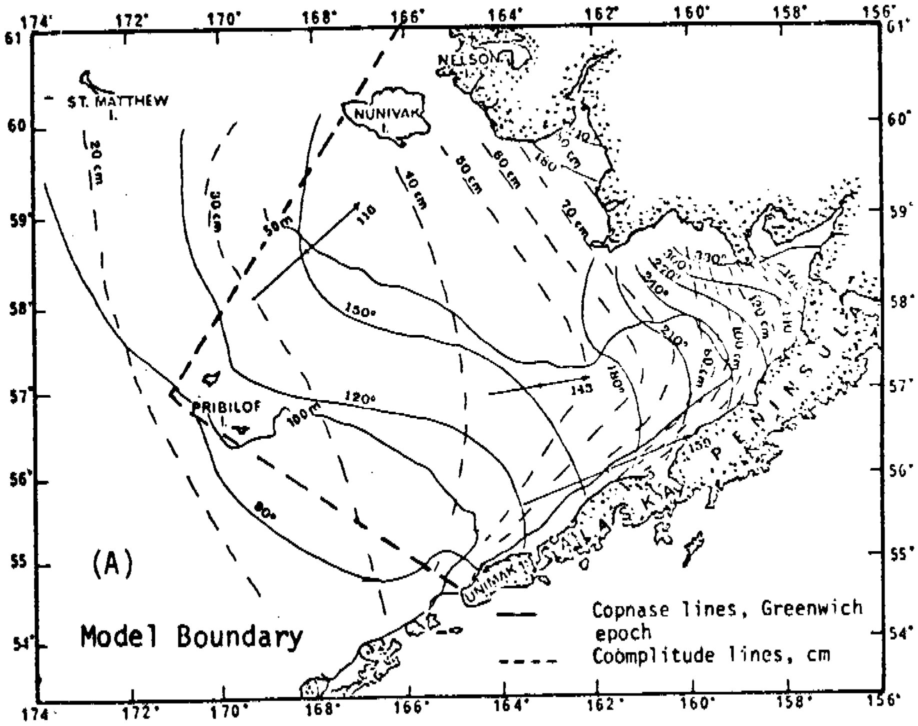


Fig. 37--Comparison between the computed (B) amplitude and phase of the diurnal tide and a similar chart (A) derived from field data as compiled by the Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration



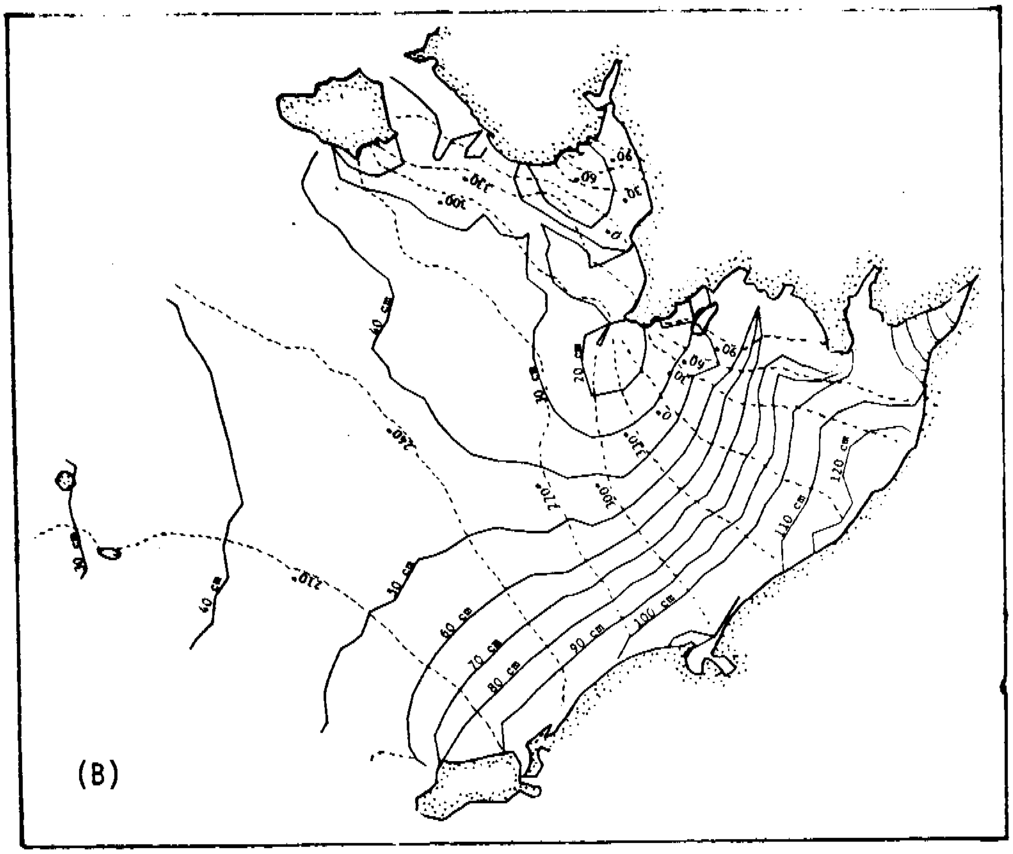


Fig. 38--Comparison between the computed (B) amplitude and phase of the semidiurnal tide and a similar chart (A) derived from field data as compiled by the Pacific Marine Environmental Laboratory, National Oceanic and Atmospheric Administration. The observed chart does not show an amphidromic point at the cape west of Togiak Bay, as no data collection station was available.

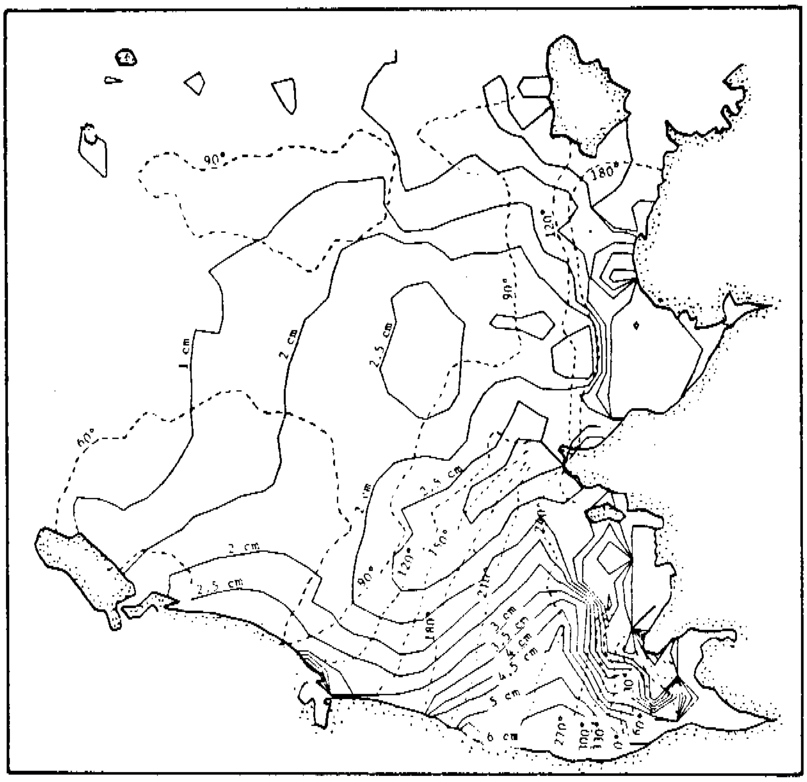


Fig. 39--Computed amplitude and phase of the quarter-diurnal tidal component

VI. CONCLUSIONS

During the course of the investigation the following conclusions have been reached:

1. Bristol Bay is primarily a tide- and wind-driven system with distinctive nonhomogeneous hydrodynamic behavior. Therefore a three-dimensional model is required to characterize its response to these driving forces.

2. Vertical resolution is essential for good representation of the vertical fine structures.

3. The bay system is not very dissipative. Because of the three-dimensional representation, where interlayer stress interacts with local density gradient and turbulence level, the required bottom stress coefficient is much smaller than that required in shallow estuaries.

4. The model's boundary is selected in a location which is not sensitive to the general wind setup in the Bering Sea as a whole. Due to this consideration, the predicted water level at the open boundary which drives the model requires no further wind adjustment for the prediction of current field in the modeled area.

5. To model the nonhomogeneous structure of the bay, the computation of subgridscale turbulent energy is necessary for a good representation of the vertical dynamic behavior. This approach also enables us to reduce from a large number of temporal-spatial varying diffusion coefficients to a few closure constants by which the model is adjusted. Therefore these adjusted closure constants represent a set of efficient predictors of the system's behavior under future conditions.

6. The computed current field from predicted tides at the open boundary agrees very well with the observed values in the modeled area.

7. Because of the sensitive interactions between density gradient, vertical shear structure and the vertical momentum exchange processes, it is very difficult to separate the wind and tide effects on the circulation. As a consequence, accuracy in tidal current prediction is a prerequisite in predicting surface drift and the pathways of pollutant discharges.

8. The model developed in the study forms a good basis for establishing a predicting method for response of the Bristol Bay system.

Appendix A

BASIC TIDAL AMPLITUDE AND PHASE AT MODEL'S OPEN BOUNDARY STATIONS FOR PREDICTION

PARAMETERS USED IN THE TIDAL PREDICTION

Tidal Constituents	Speed (hr^{-1})	f-value	(V_o+u) (deg)	$H_{(2,31)}$ (cm)	$G_{(2,31)}$ (deg)	$H_{(5,31)}$ (cm)	$G_{(5,31)}$ (deg)	$H_{(14,31)}$ (cm)	$G_{(14,31)}$ (deg)	$H_{(18,31)}$ (cm)	$G_{(18,31)}$ (deg)	$H_{(21,31)}$ (cm)	$G_{(21,31)}$ (deg)	$H_{(2,13)}$ (cm)	$G_{(2,13)}$ (deg)
Q1	.0372815	0.0863	242.6	3.7	325.0	3.2	320.0	1.5	307.4	0.1	294.0	1.8	136.7	5.5	296.5
O1	.0387306	0.0863	136.1	20.5	324.0	17.6	320.0	6.3	305.1	2.5	215.5	10.7	164.6	26.4	303.6
M1	.0402693	1.428	278.5	1.8	332.0	1.5	325.0	0.5	301.3	0.3	230.5	1.0	188.4	2.1	312.0
P1	.0415526	1.000	201.4	9.77	341.5	8.67	334.1	3.9	302.3	3.0	251.5	6.0	204.6	13.1	318.4
K1	.0417810	0.916	165.0	29.23	340.7	26.06	335.7	12.3	303.0	9.5	255.6	18.3	207.1	40.7	319.4
J1	.0432930	0.881	61.9	1.4	355.3	1.30	346.8	1.0	309.6	0.7	284.2	1.0	221.1	2.6	324.7
OO1	.044831	0.607	20.7	0.5	27.0	0.5	17.18	0.5	334.6	0.4	322.0	0.2	246.6	1.3	345.3
2N2	.077490	1.029	157.4	1.5	28.9	1.43	24.62	1.1	40.3	1.4	37.3	1.6	27.4	2.5	355.8
μ2	.077690	1.029	247.5	1.77	38.0	1.72	33.7	1.5	50.3	1.8	50.5	2.0	39.4	3.0	2.1
N2	.078999	1.029	50.9	7.6	70.0	8.3	75.3	11.6	98.2	12.5	109.3	11.9	97.9	14.8	35.4
ν2	.079202	1.029	141.0	1.3	76.6	1.45	81.9	2.1	104.9	2.2	116.8	2.1	105.6	2.6	34.1
M2	.080511	1.029	304.4	21.97	124.4	24.09	129.4	33.3	151.3	35.6	164.4	35.6	155.4	42.1	89.3
L2	.082023	0.988	7.6	0.33	195.0	0.31	195.6	0.2	198.6	0.3	202.3	0.4	208.1	0.5	172.7
S2	.083333	1.000	0.0	0.3	356.9	0.3	329.3	0.2	209.2	0.3	252.9	0.3	296.8	0.5	323.8
K2	.0835615	0.804	149.2	0.3	356.7	0.3	327.7	0.3	318.1	0.4	1.1	0.3	43.9	0.6	82.7

Appendix B

COMPUTED AND OBSERVED TIME HISTORIES OF THE VERIFICATION RUN

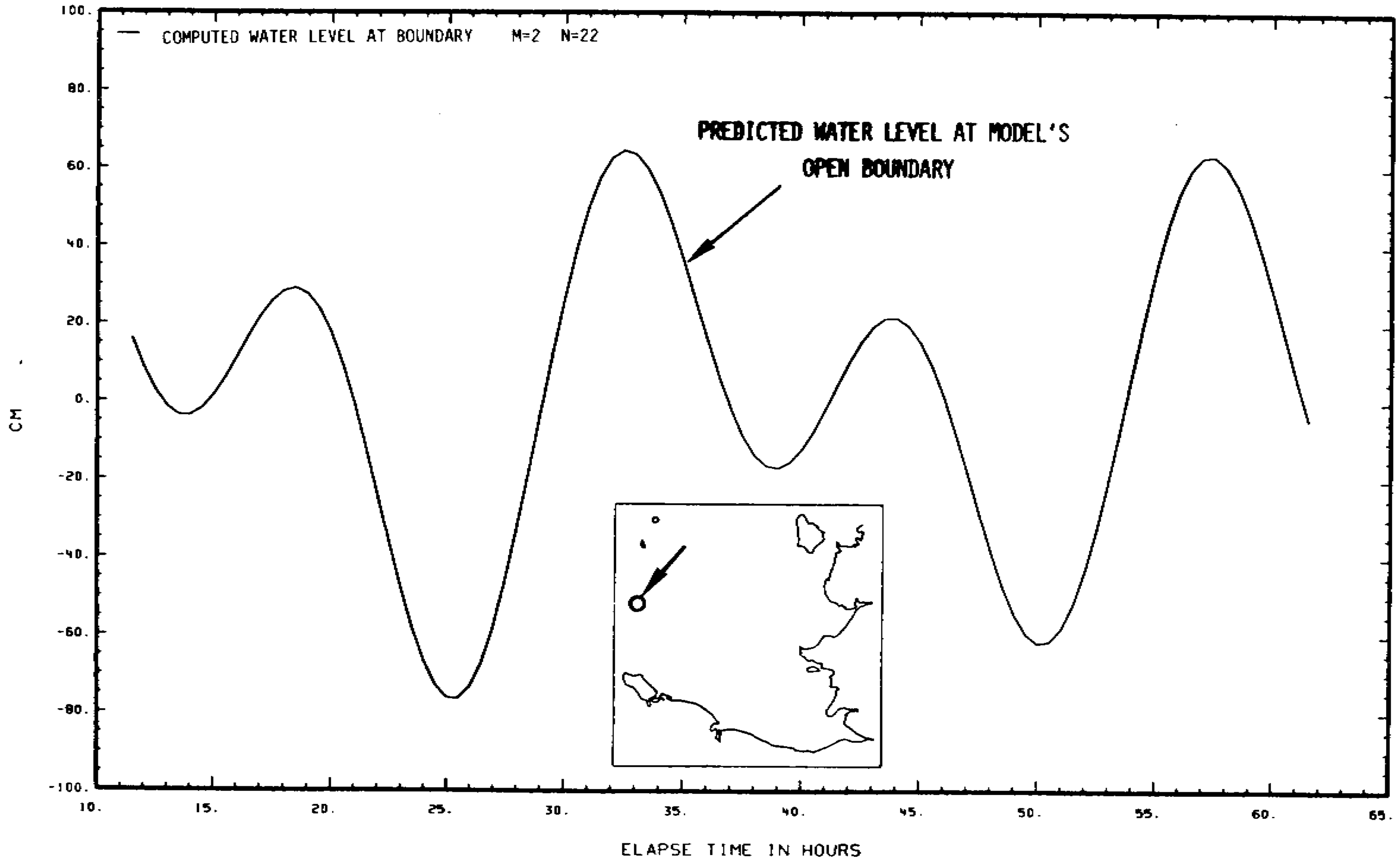


Fig. B-1--Predicted water level at a model's boundary point (M=2, N=2) for the model's verification run

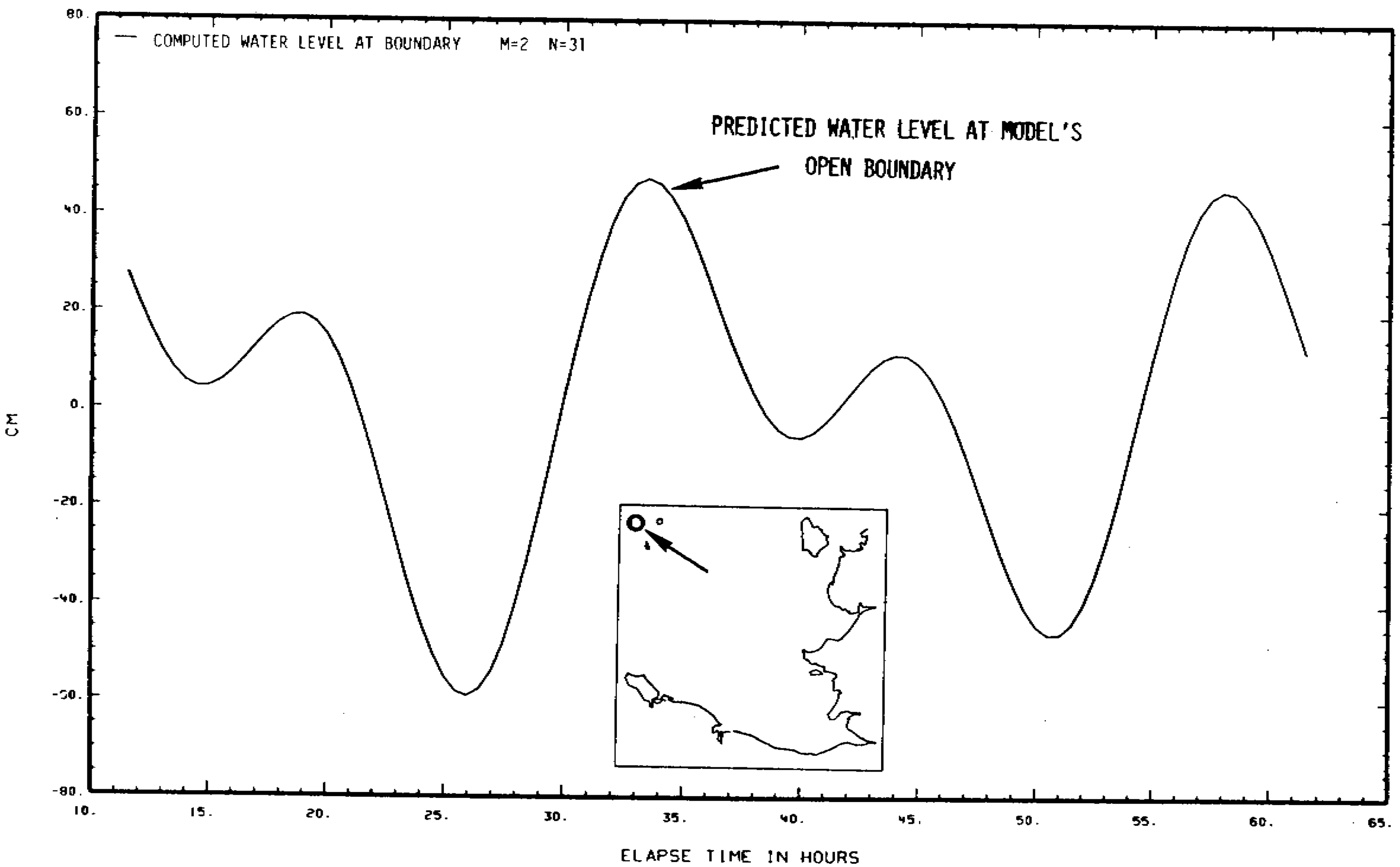


Fig. B-2--Predicted water level at a model's boundary point (M=2, N=31) for the model's verification run

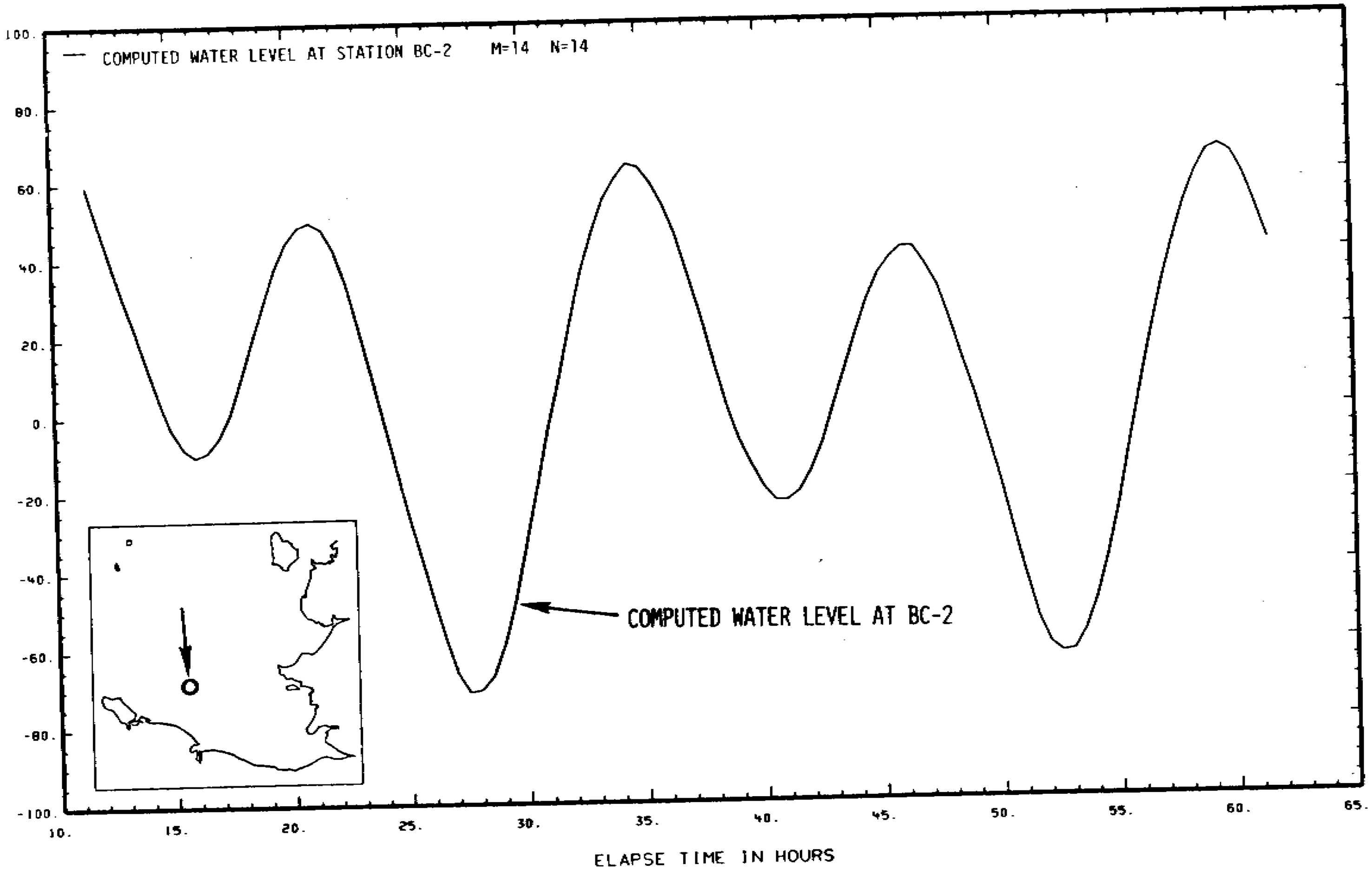


Fig. B-3--Time history of water level from the dynamic computation near station BC-2 (M=14, N=14)

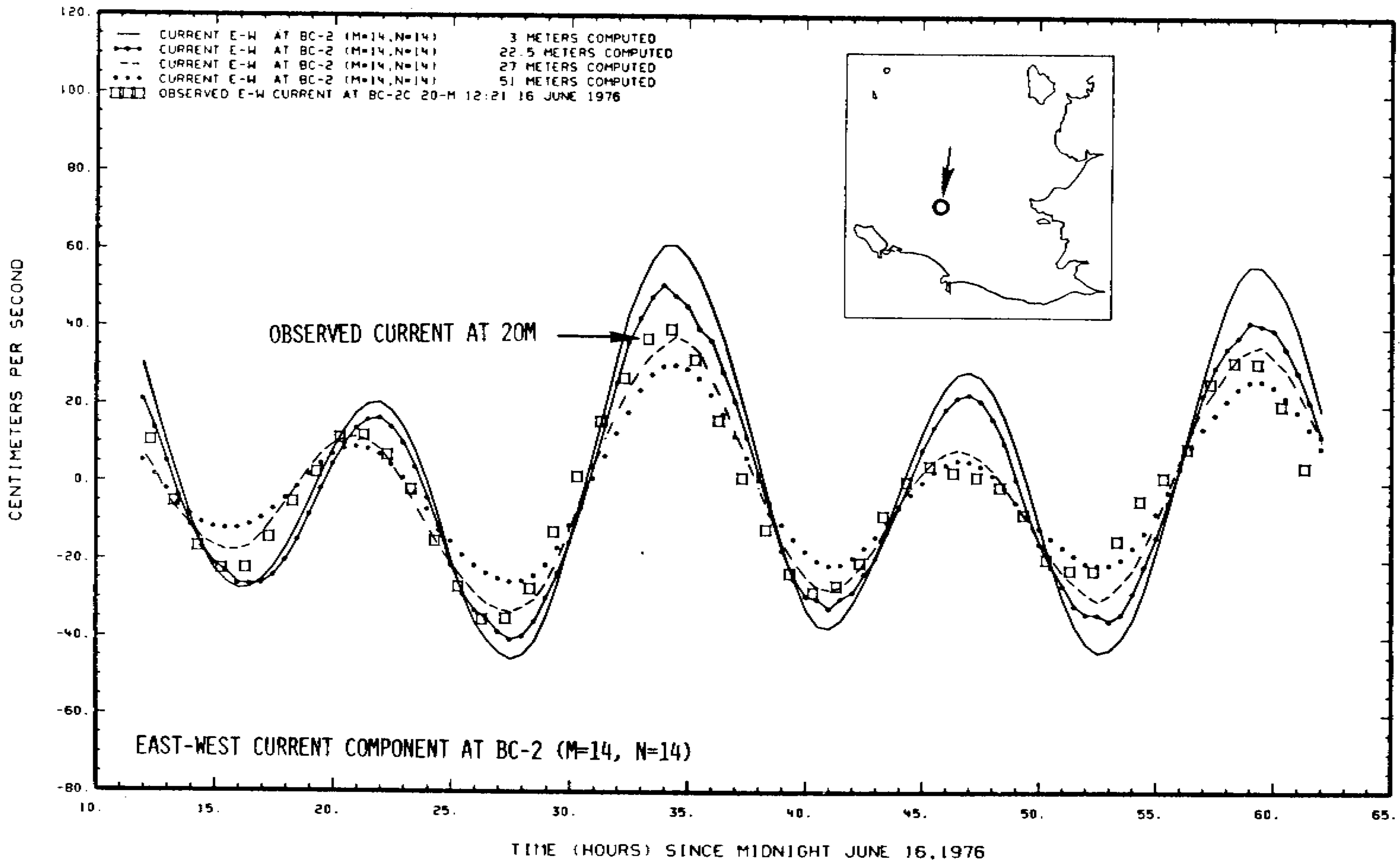


Fig. B-4--Observed east-west current component at station BC-2 and the computed values at a nearby gridpoint

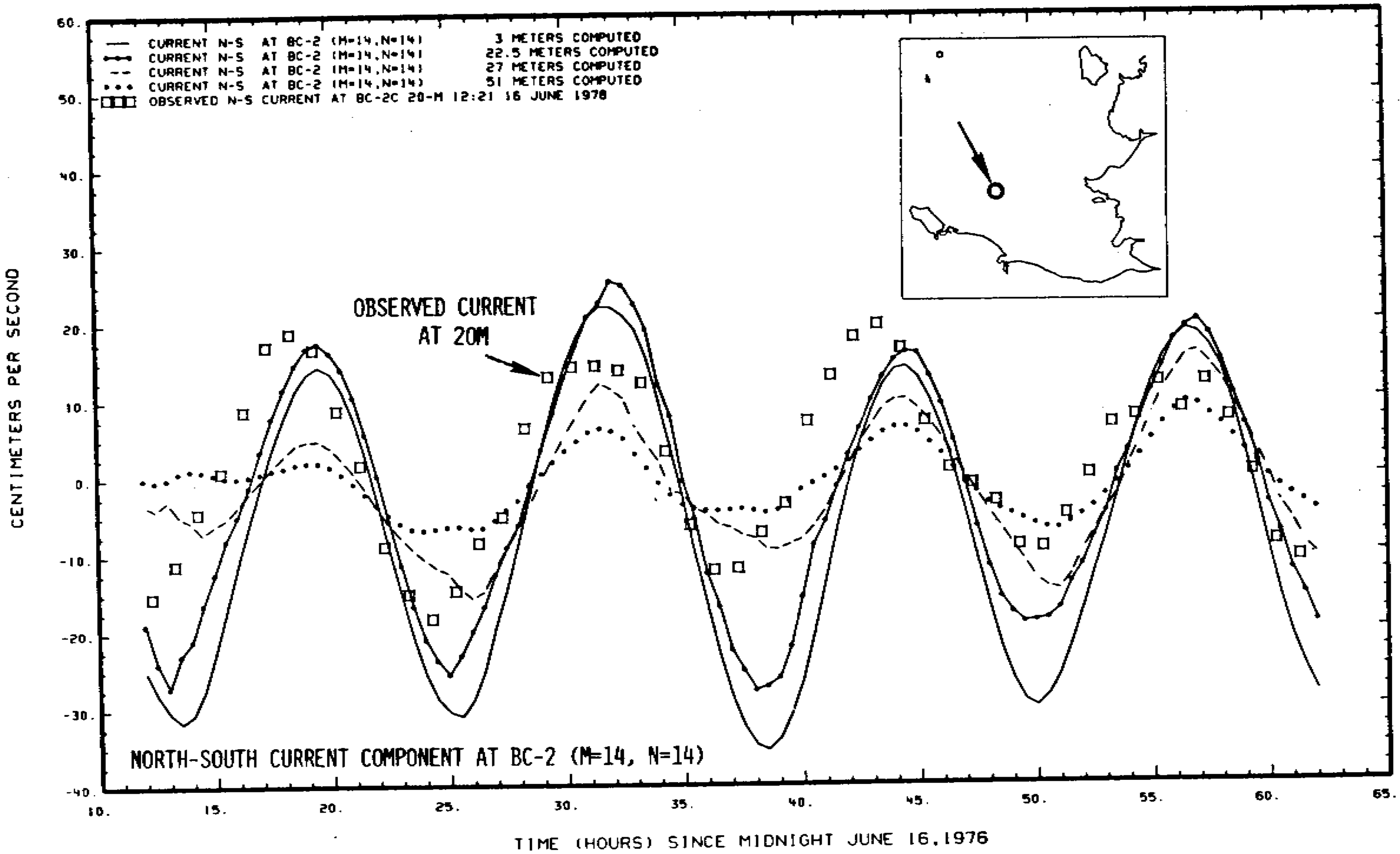


Fig. B-5--Observed north-south current component at station BC-2 and the computed values at the nearby gridpoint

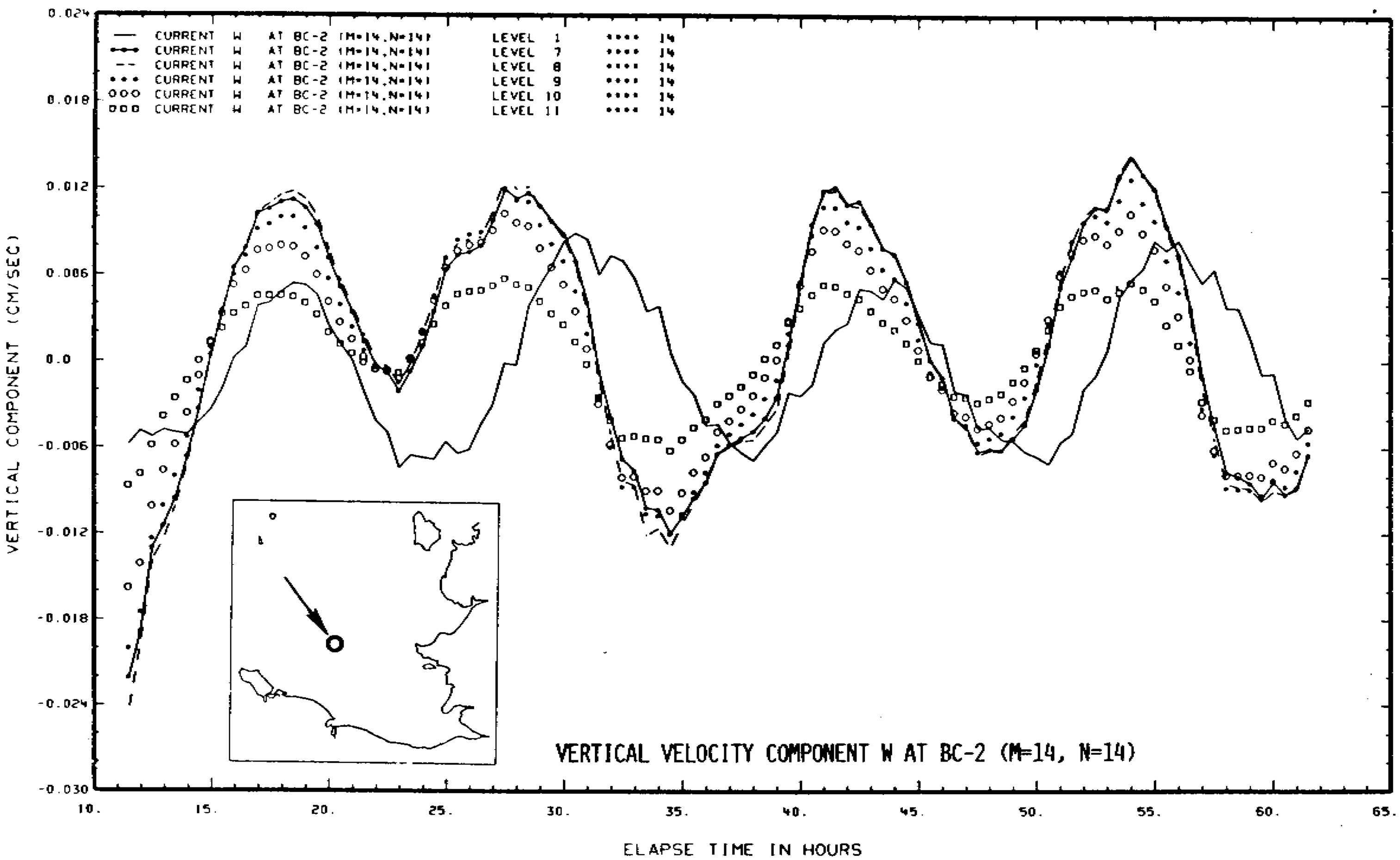


Fig. B-6--Computed time histories of vertical velocity component at the gridpoint nearest to station BC-2

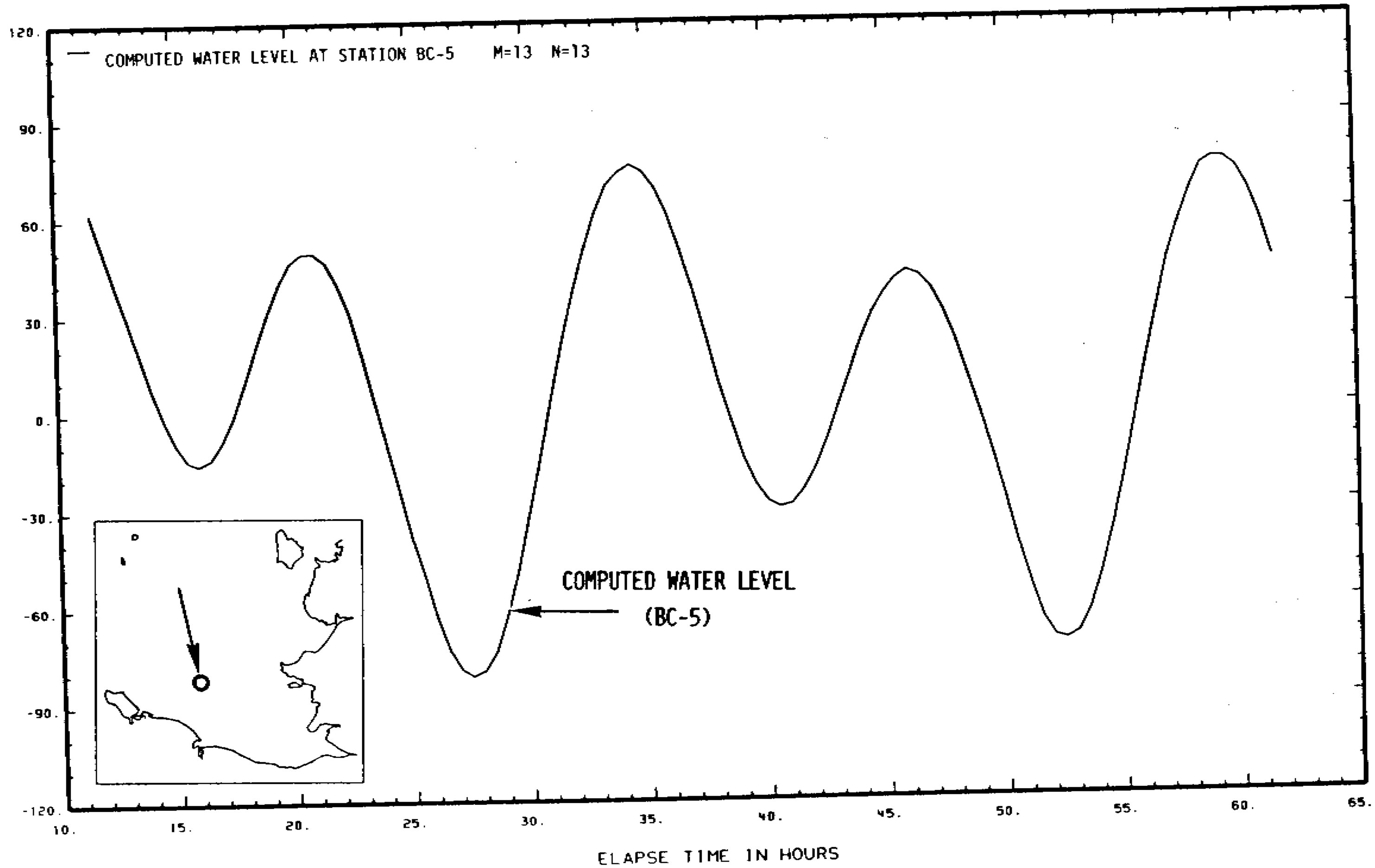


Fig. B-7--Time history of water level from dynamic computation near station BC-5

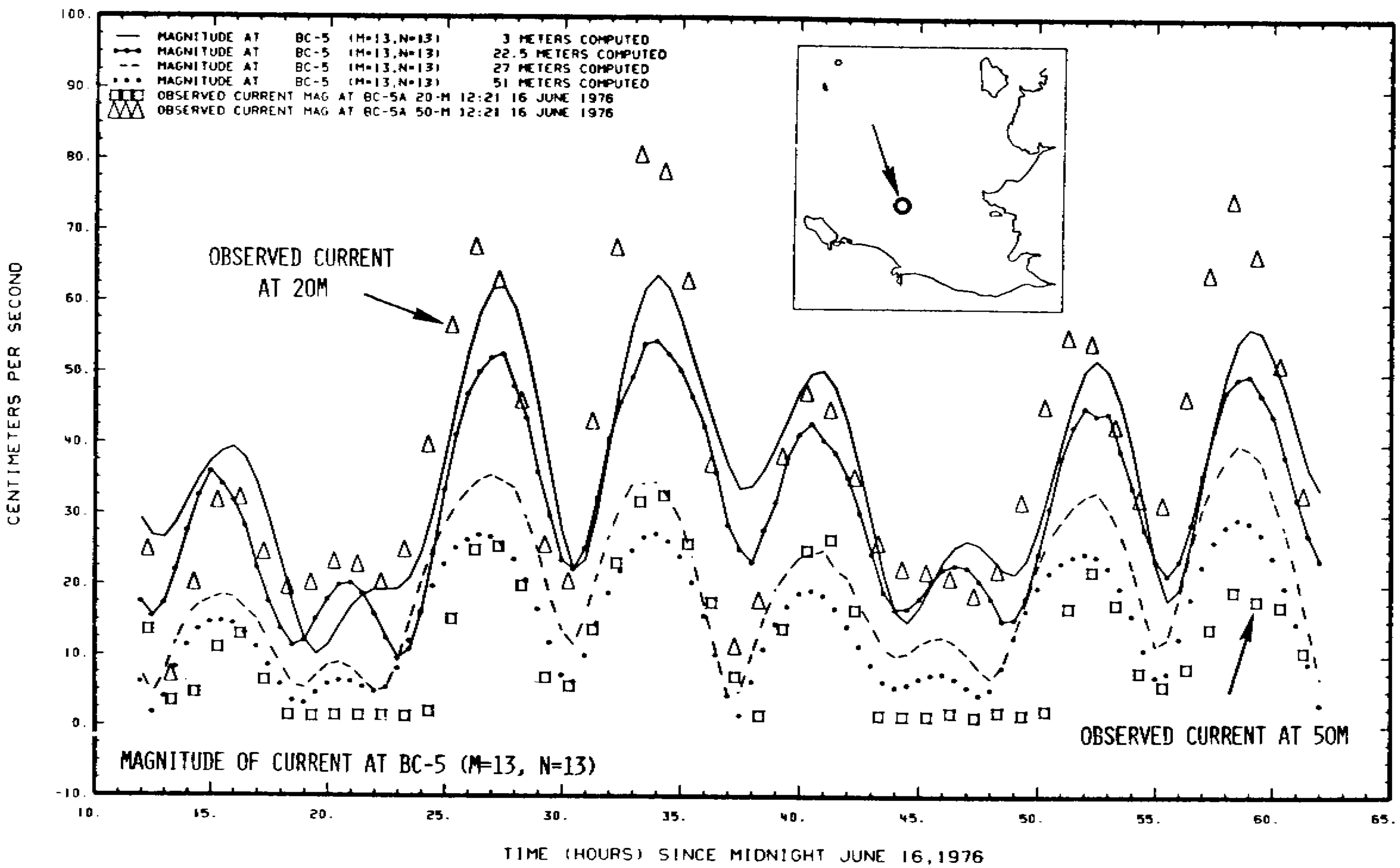


Fig. B-8--Observed magnitudes of current at station BC-5 and the computed values at the nearby gridpoint

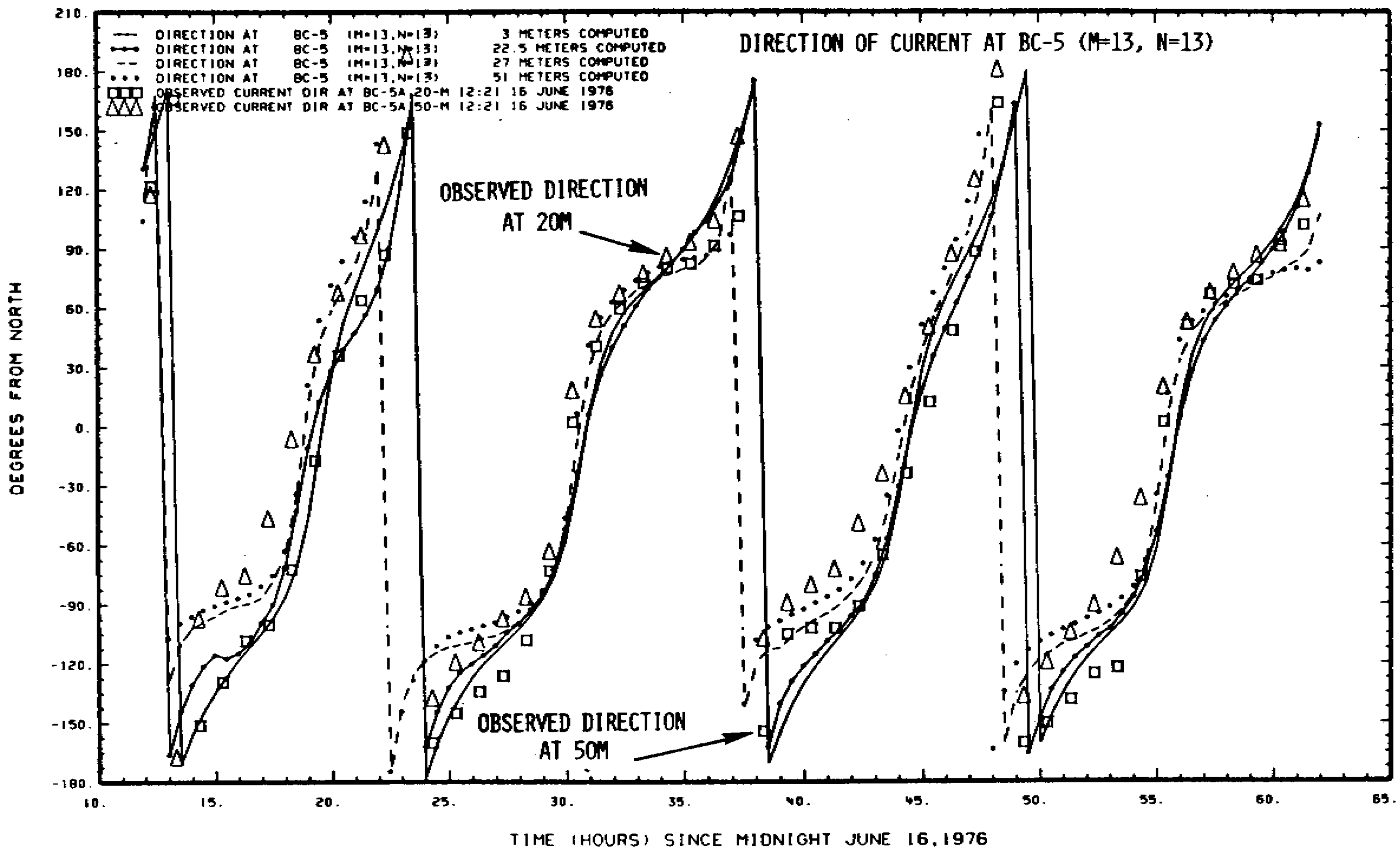


Fig. B-9--Observed direction of current at station BC-5 and the computed values at the nearby gridpoint

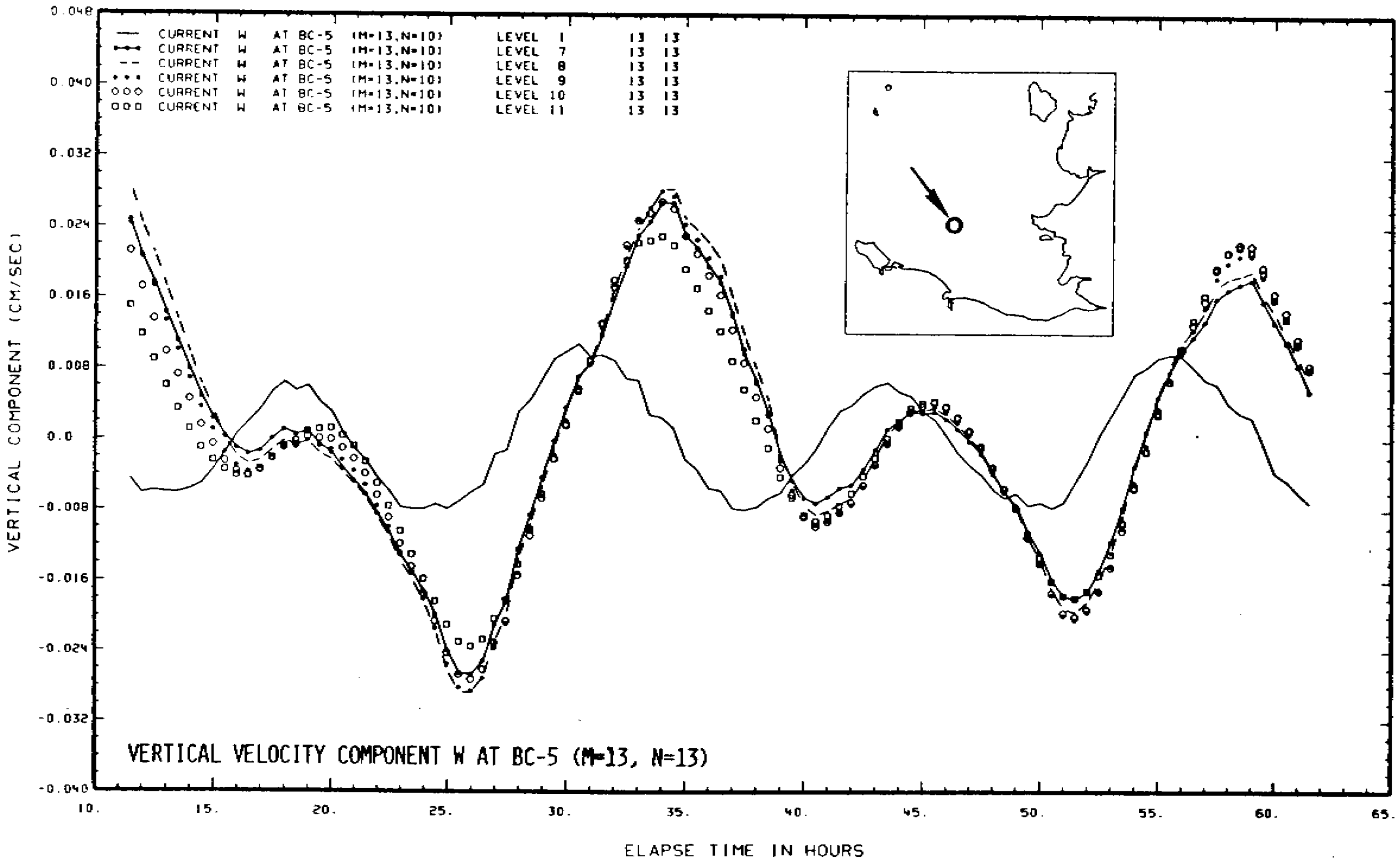


Fig. B-10--Computed time histories of vertical velocity component at the gridpoint nearest to station BC-5

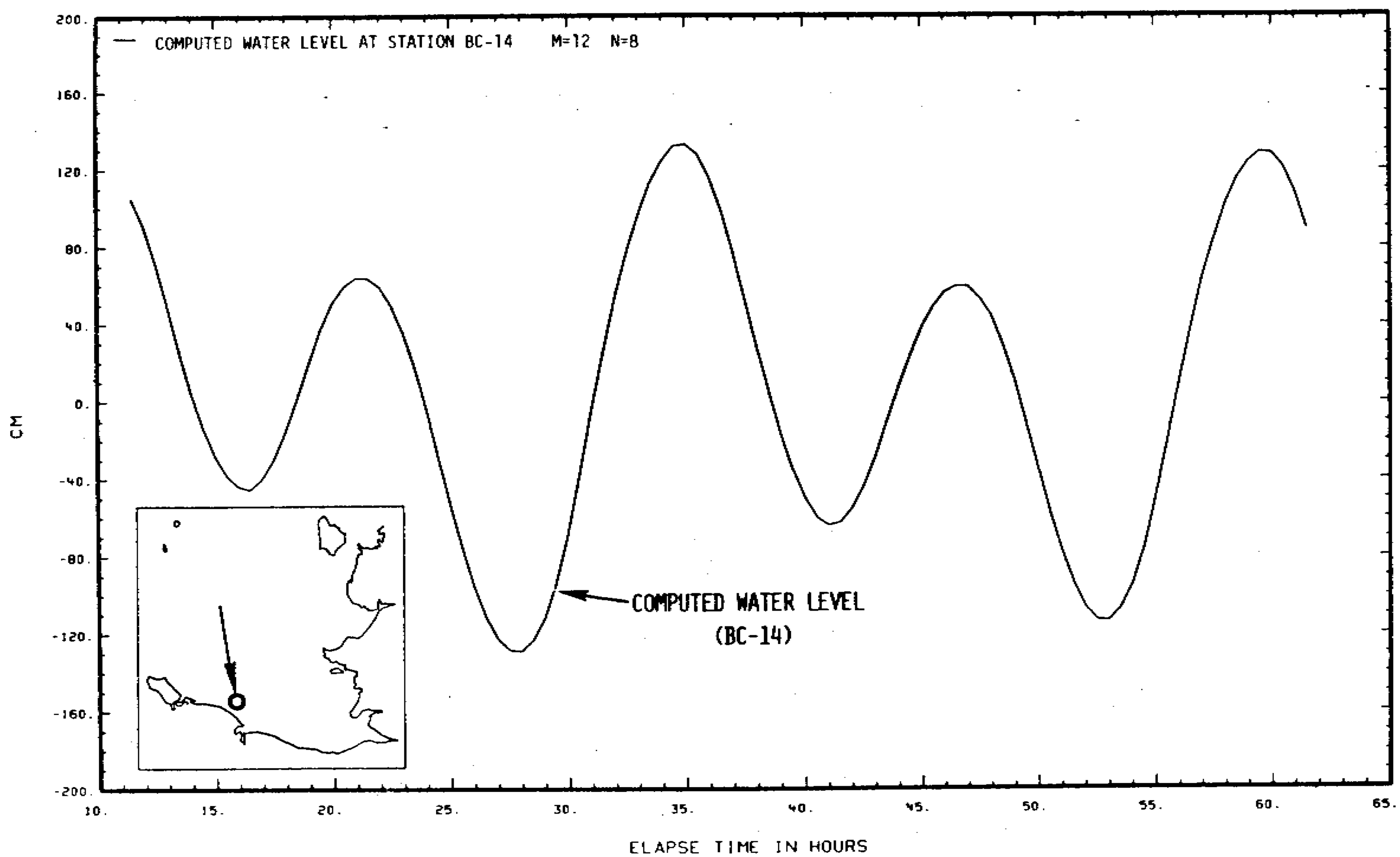


Fig. B-11--Time history of water level from dynamic computation near station BC-14

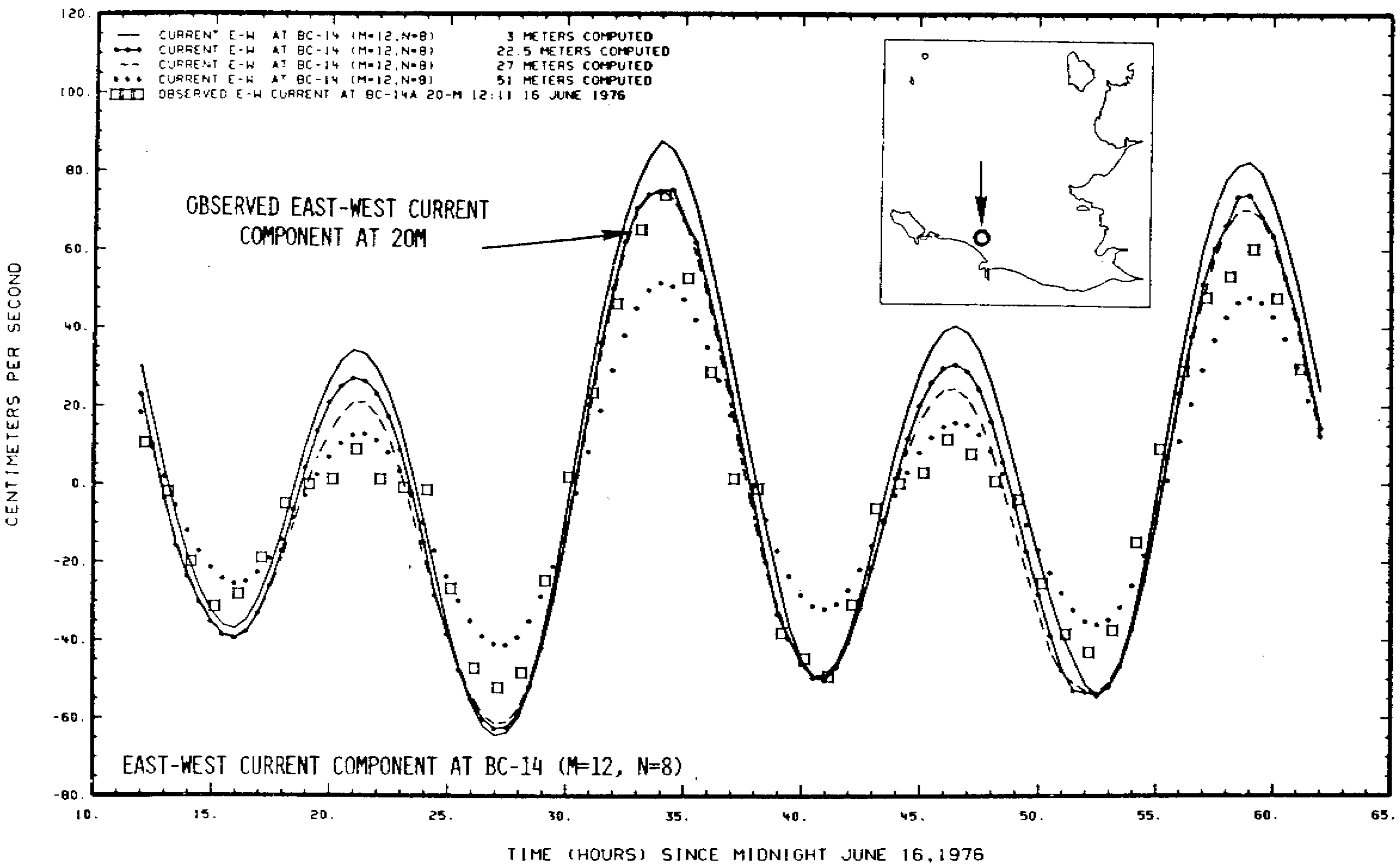


Fig. B-12--Observed east-west current component at station BC-14 and the computed values at the nearby gridpoint

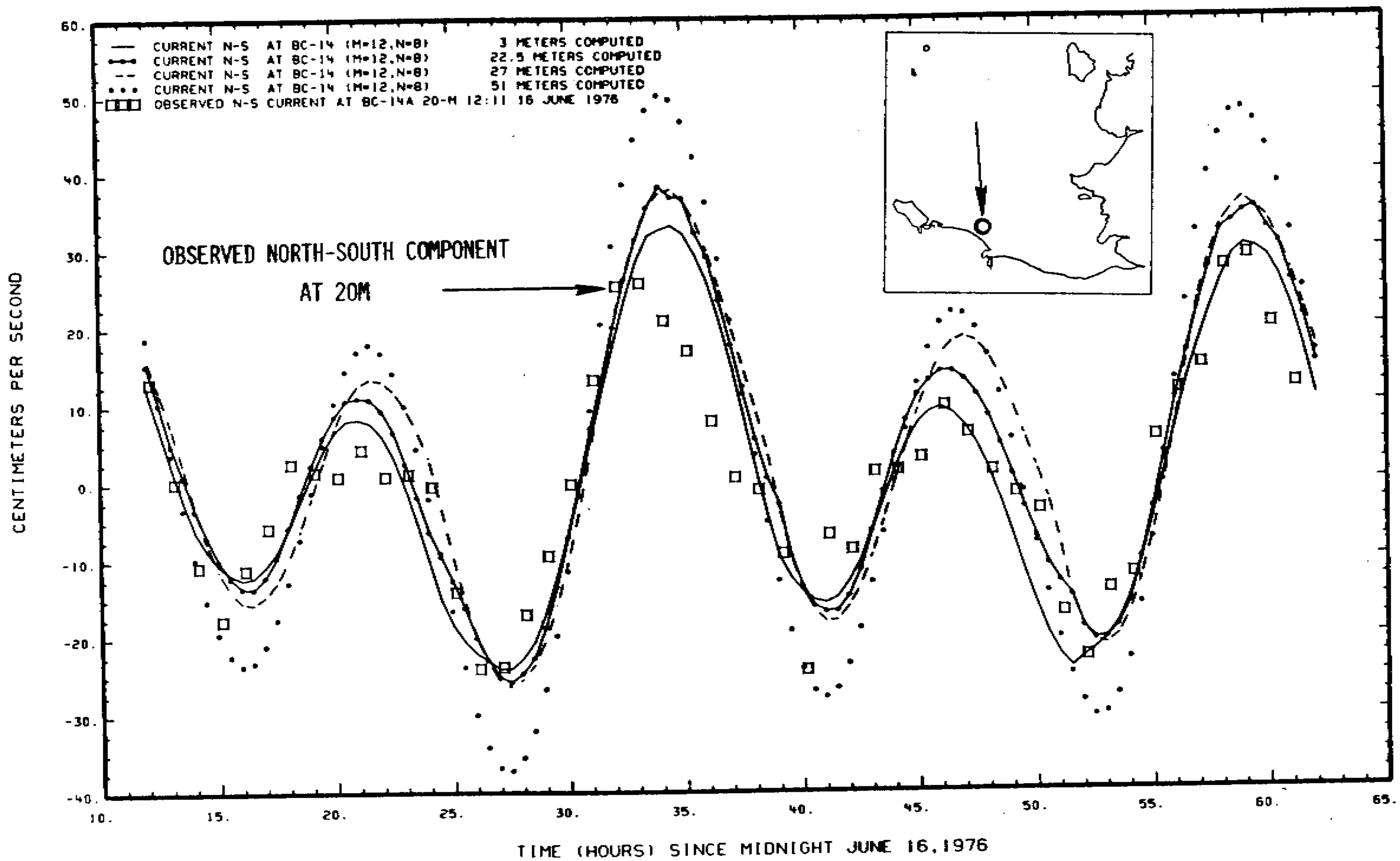


Fig. B-13--Observed north-south current component at station B-14 and the computed values at the nearby gridpoint

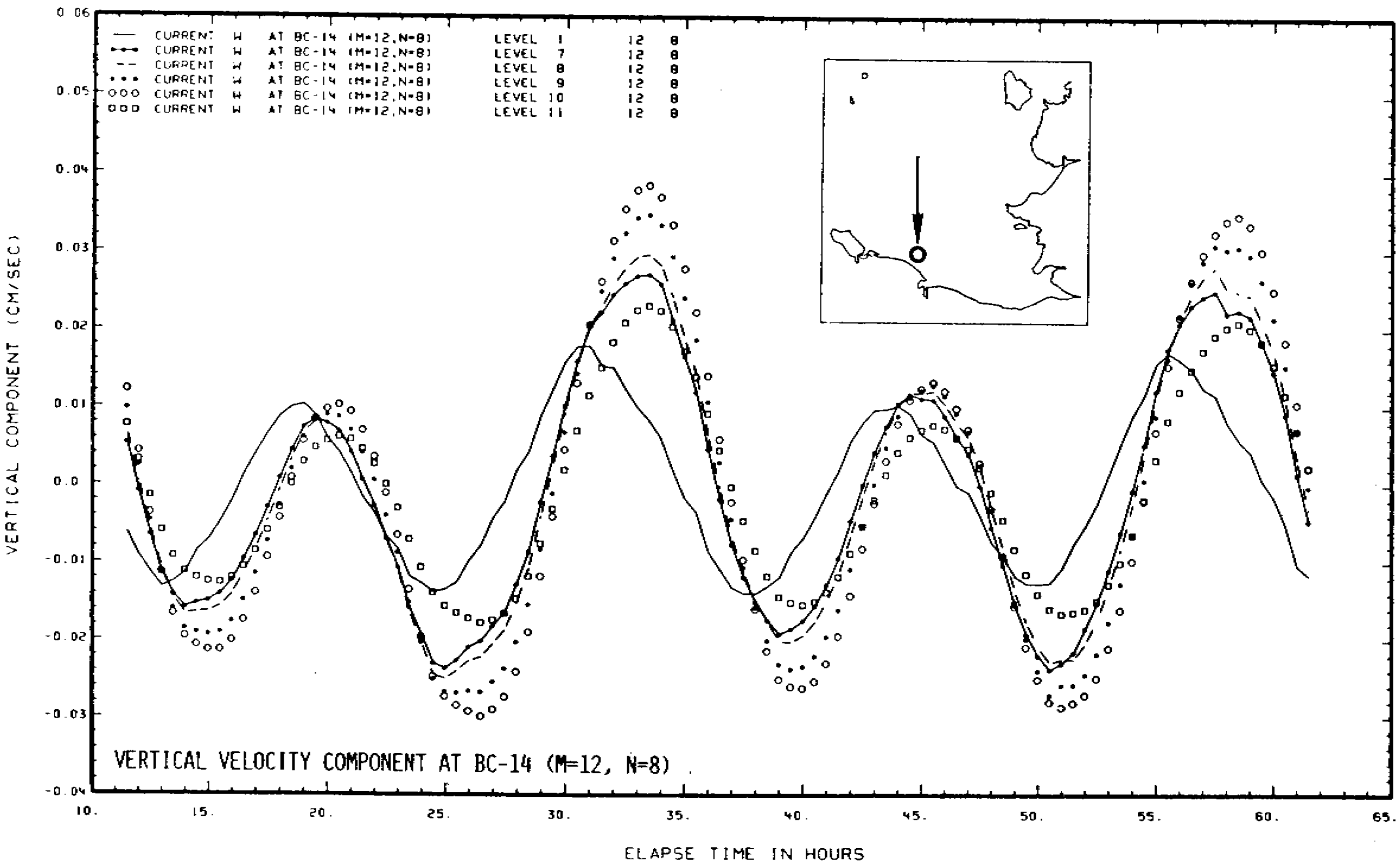


Fig. B-14--Computed time history of vertical velocity component at the gridpoint nearest to station BC-14

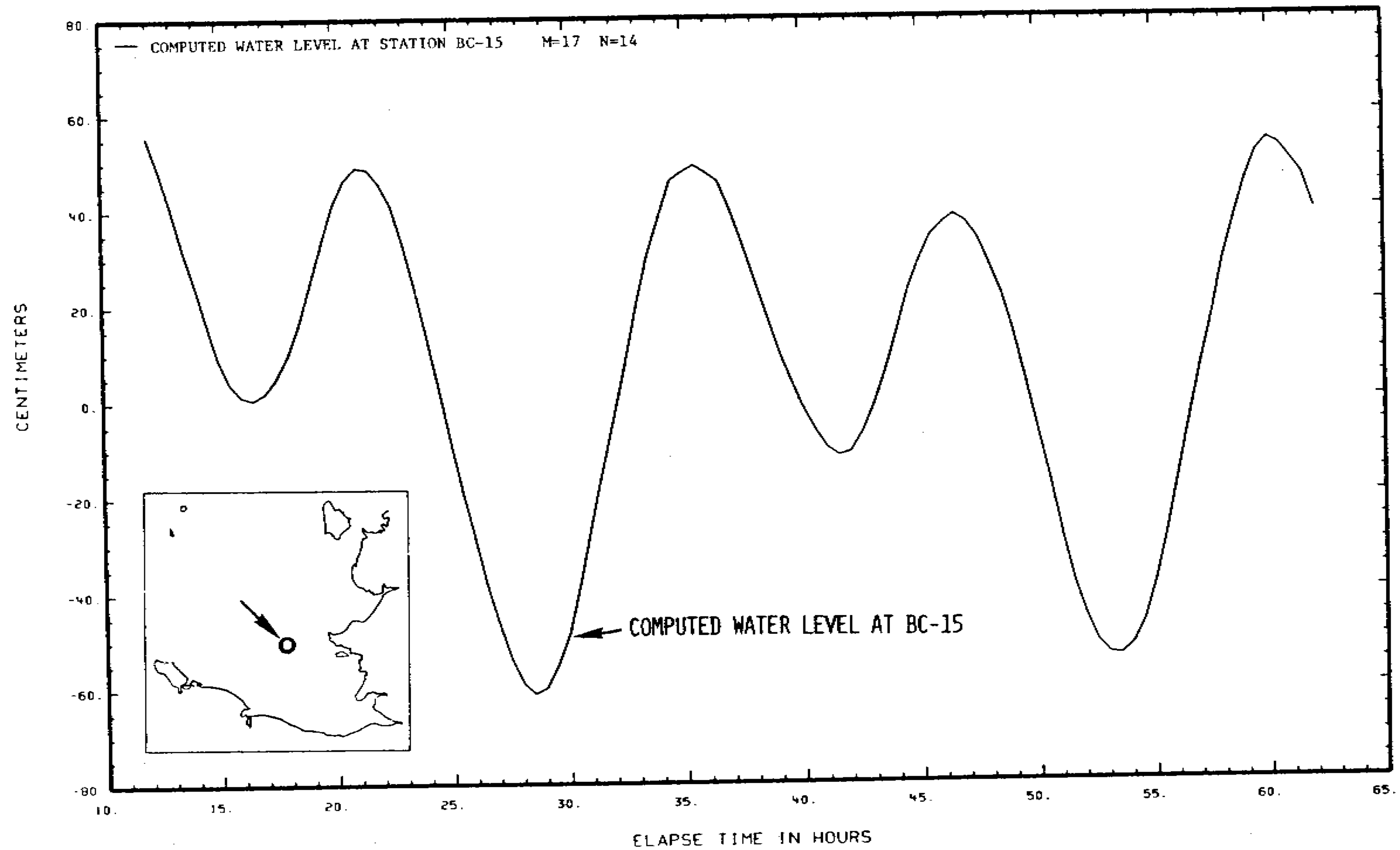


Fig. B-15--Time history of water level from dynamic computation near station BC-15

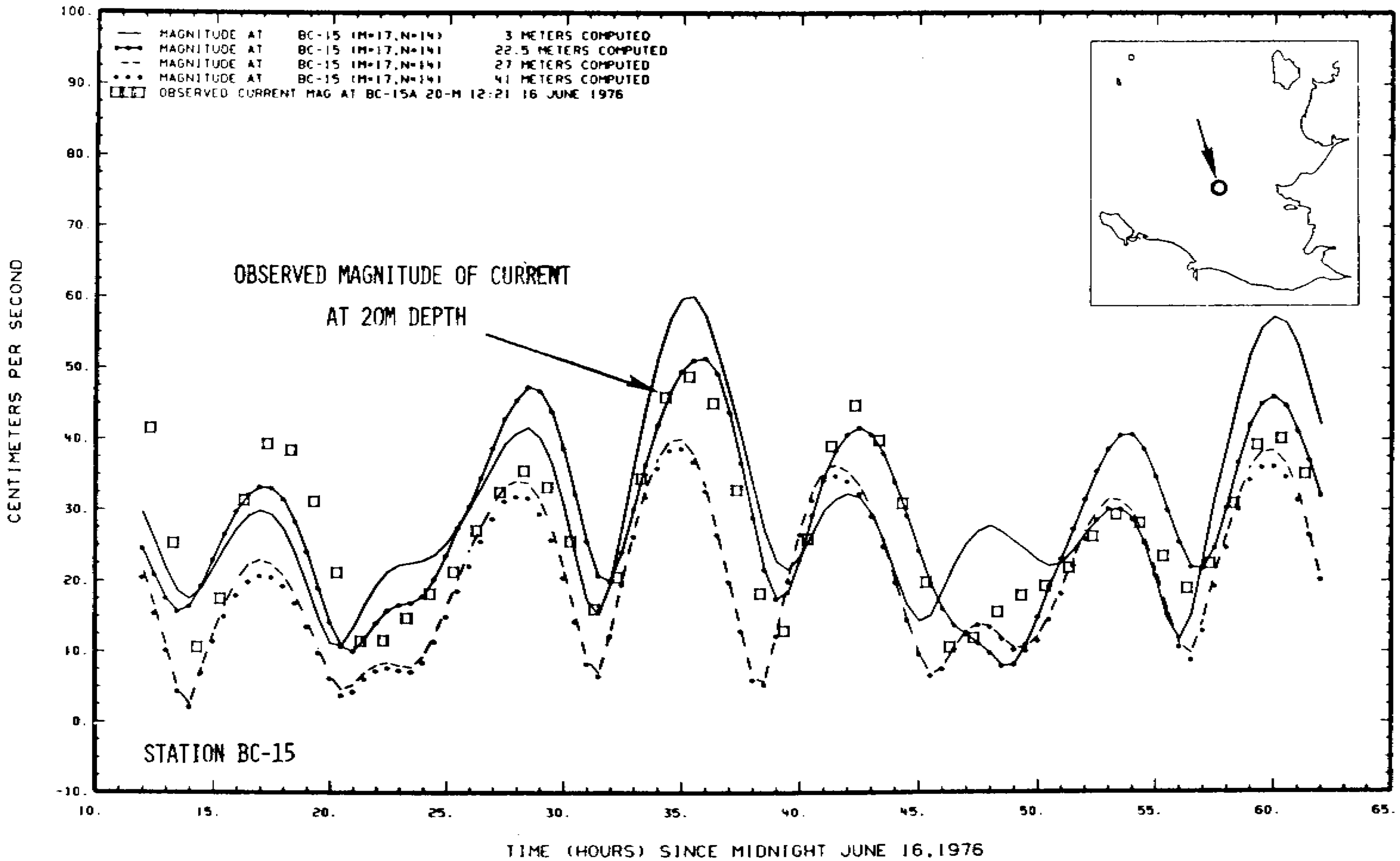


Fig. B-16--Observed magnitude of current at station BC-15 and the computed values at the nearby gridpoint

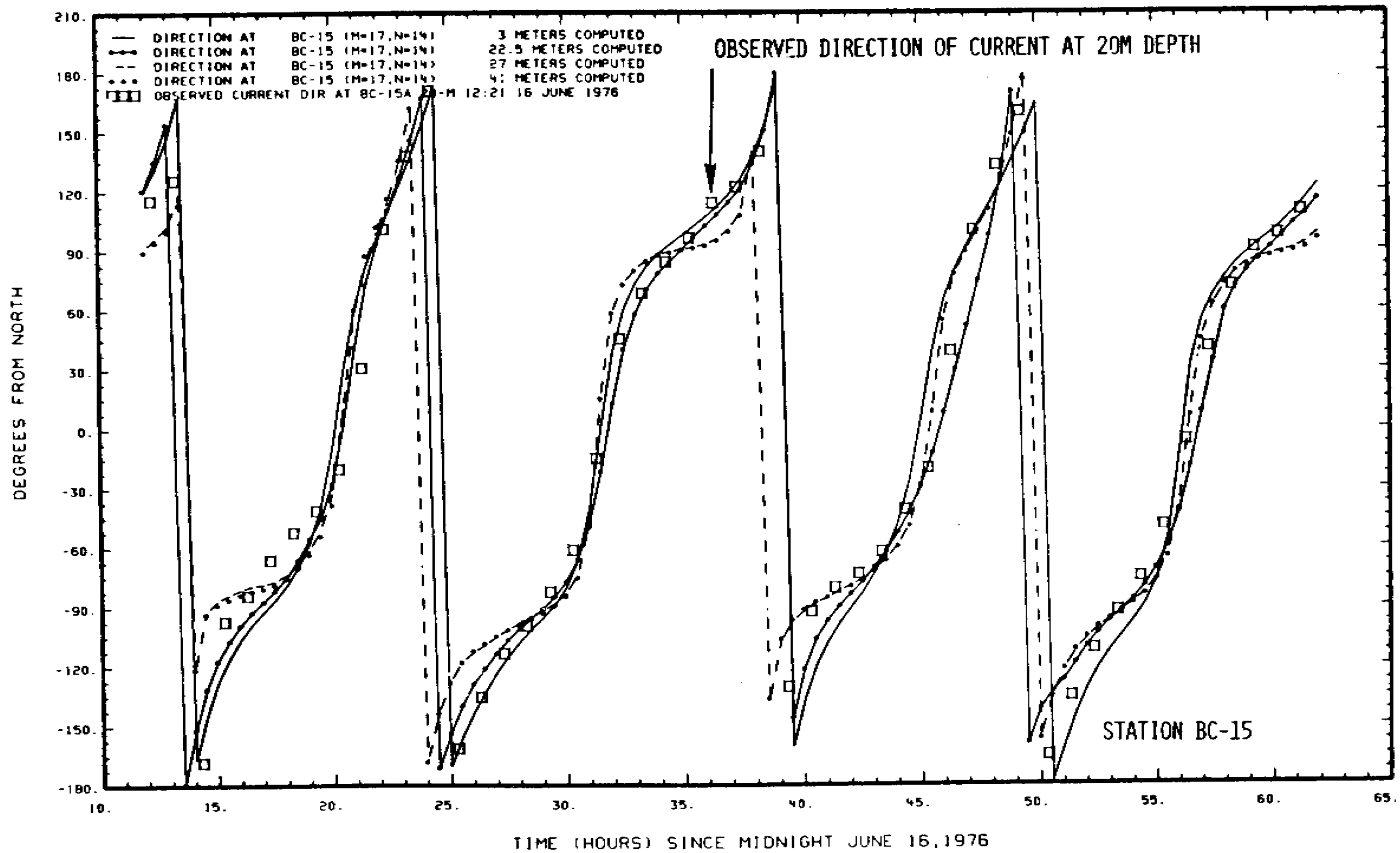


Fig. B-17--Observed direction of current at station BC-15 and the computed values at the nearby gridpoint

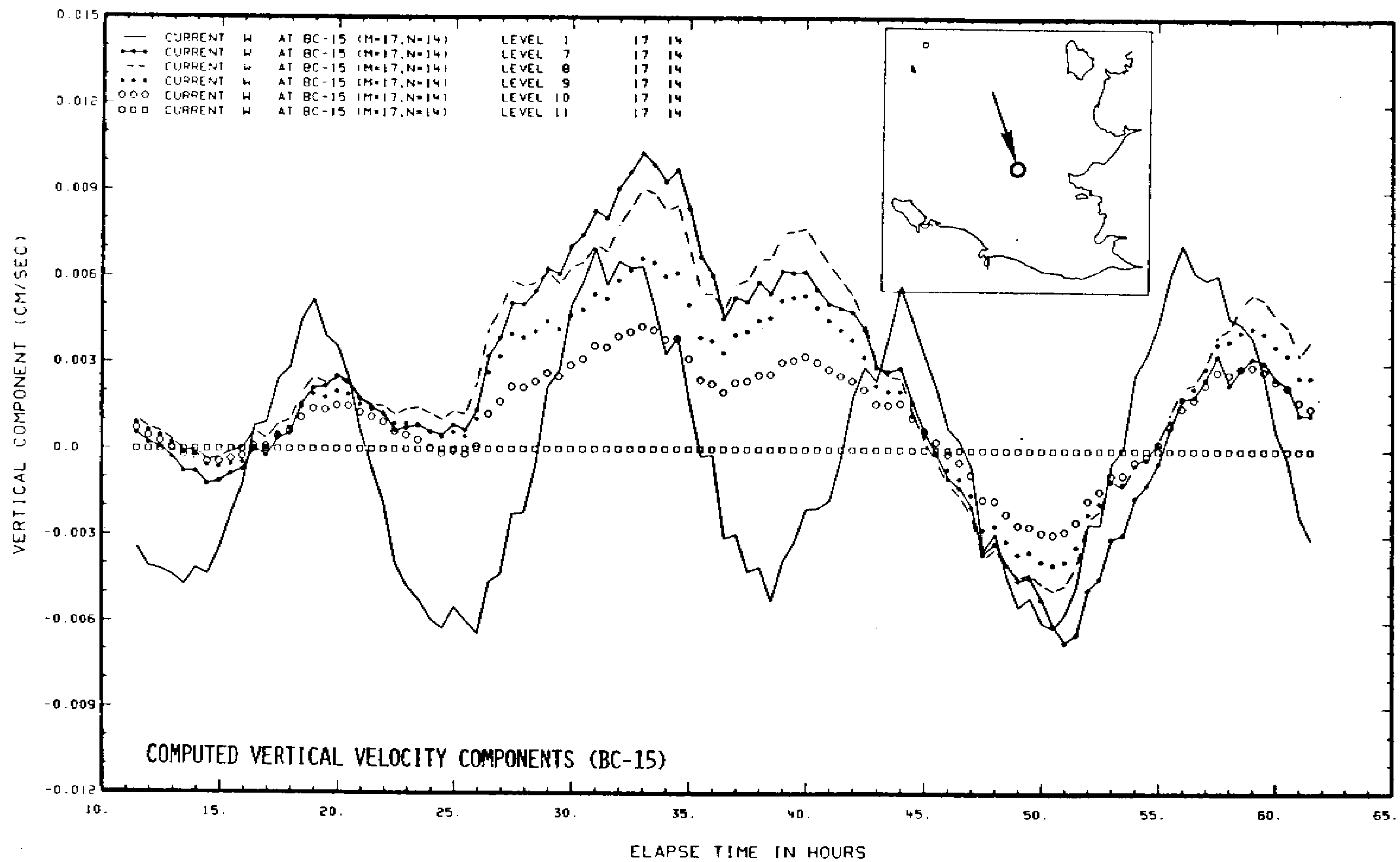


Fig. B-18--Computed time history of vertical velocity component at the gridpoint nearest to station BC-15

Appendix C

SPECTRAL ANALYSIS OF THE COMPUTED VERTICAL VELOCITY COMPONENTS

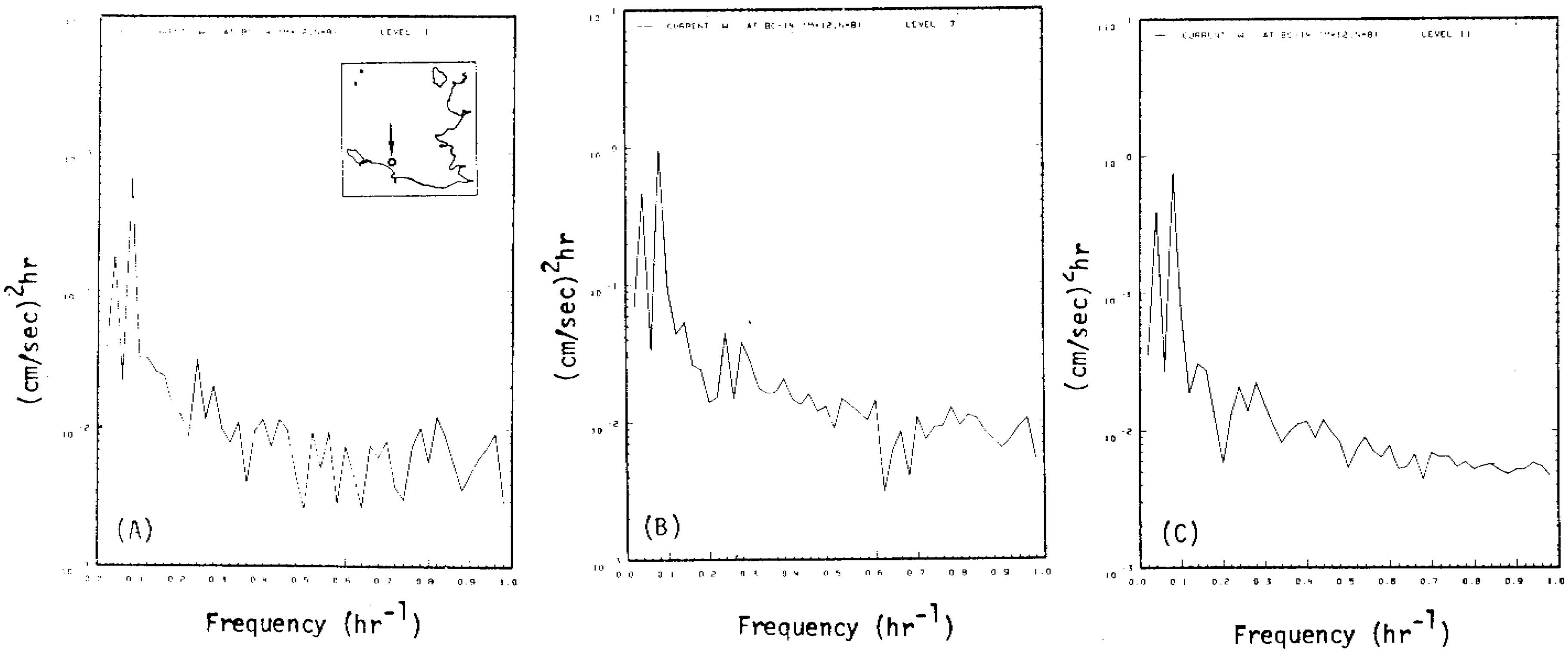


Fig. C-1--Line spectra of the computed vertical velocity components near station BC-14. Graphs (A), (B) and (C) are for layers 1, 7 and 11, respectively. Spectral values are computed by fast Fourier transformation.

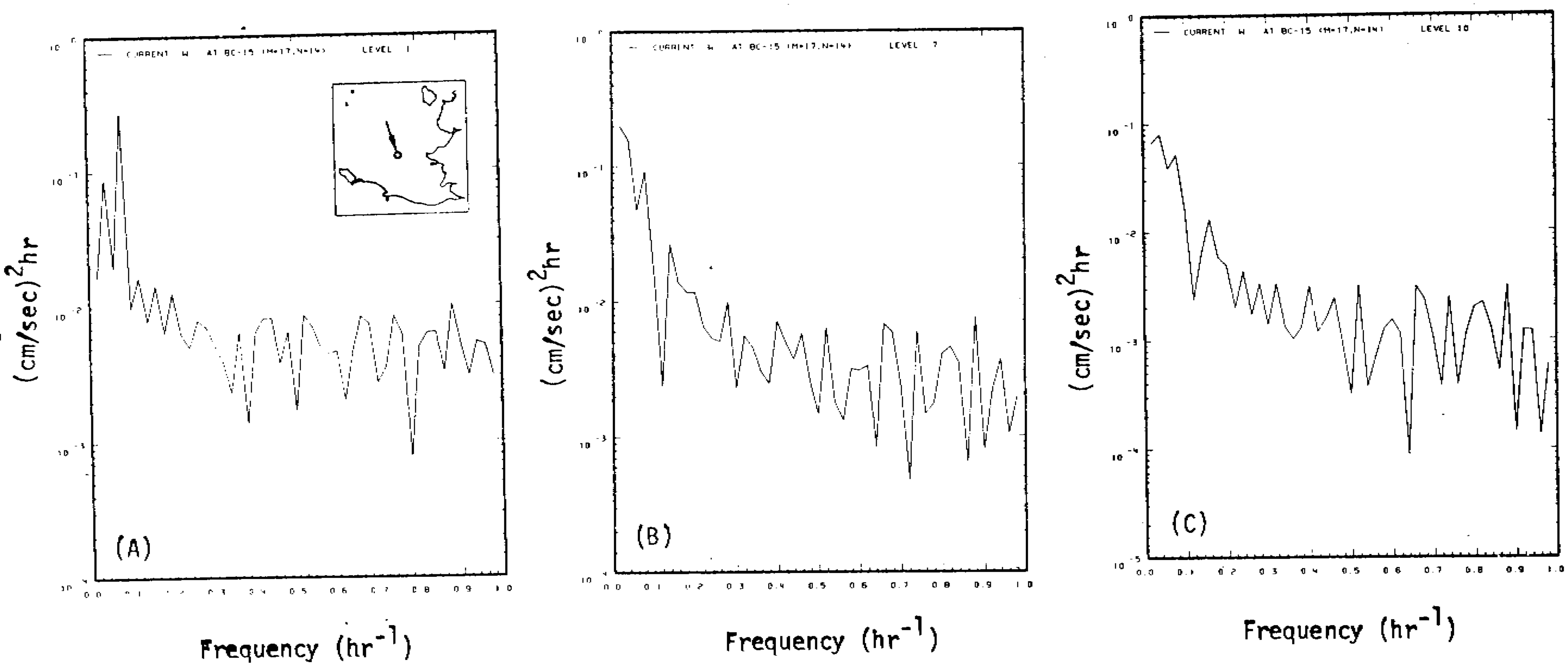


Fig. C-2--Line spectra of the computed vertical velocity components near station BC-15. Graphs (A), (B) and (C) are for layers 1, 7 and 11, respectively. Spectral values are computed by fast Fourier transformation.

Appendix D

COMPUTED SPATIAL DISTRIBUTIONS OF WATER LEVELS, CURRENTS, TEMPERATURES AND SALINITIES AT SELECTED TIME INTERVALS

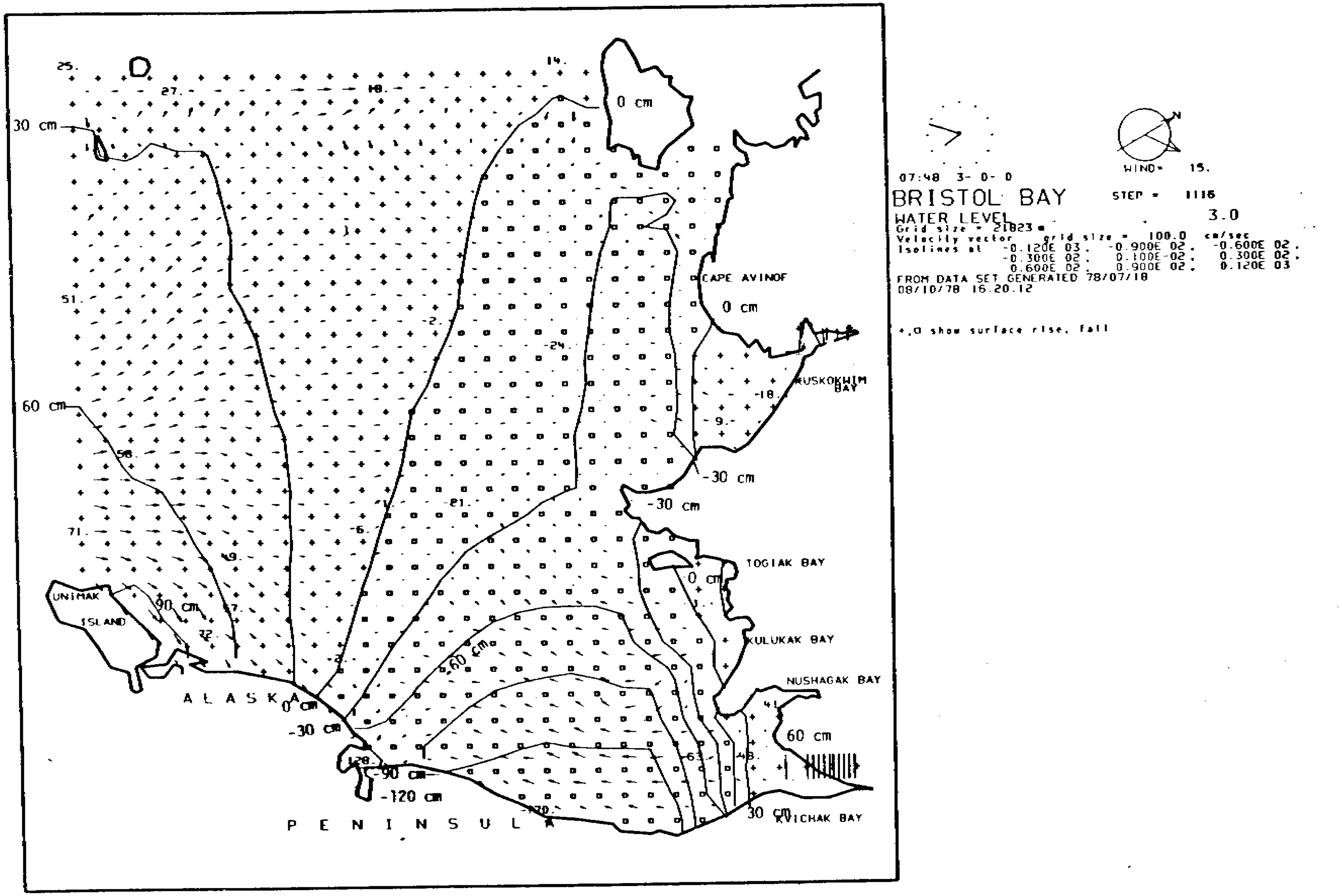


Fig. D-1--Computed contours of water level; the rise (+) and fall (□) of water surface and the distribution of surface current at 0748 a.m. June 18, 1976

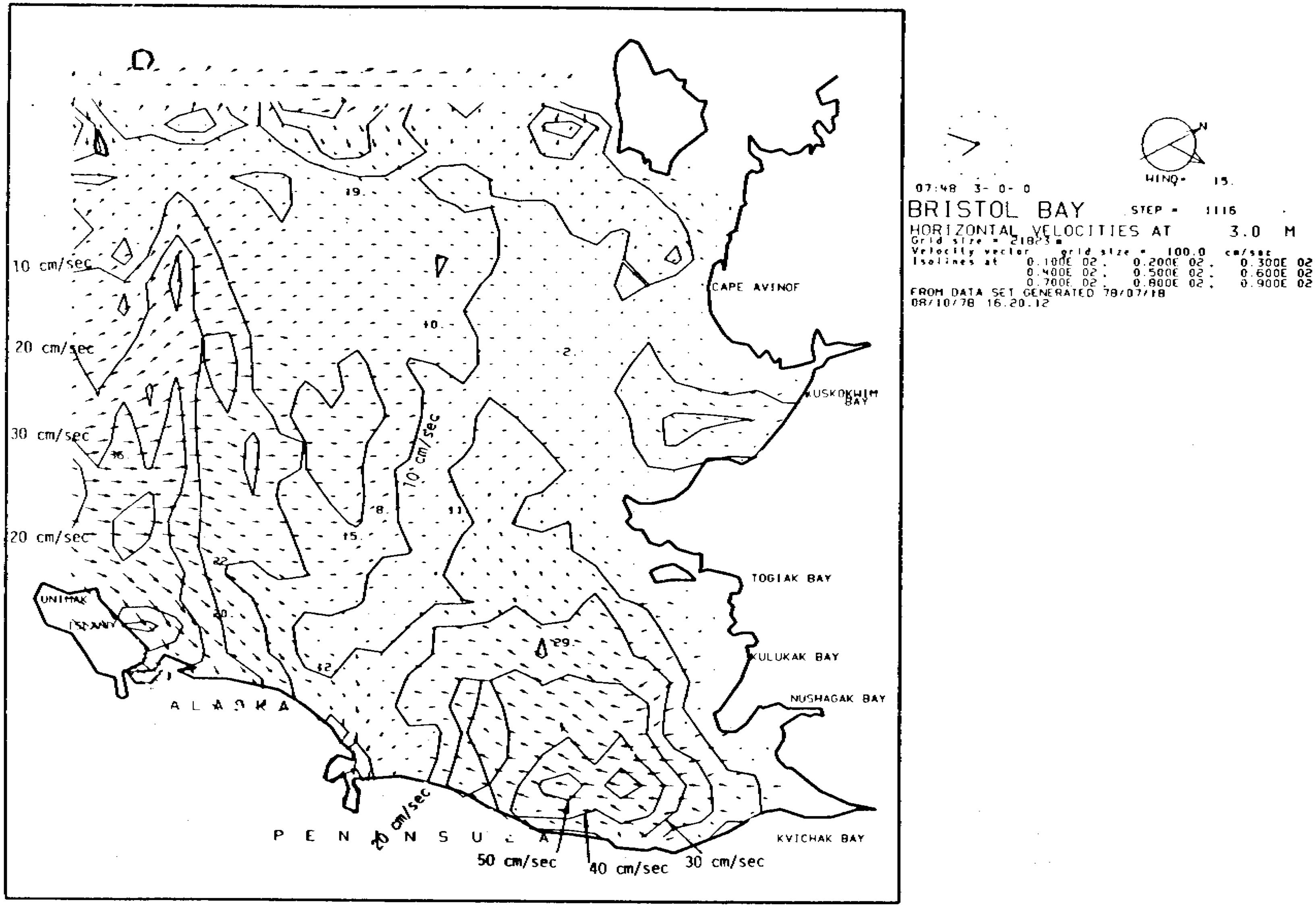


Fig. D-2--Computed current distribution in the surface layer at 0748 a.m. June 18, 1976

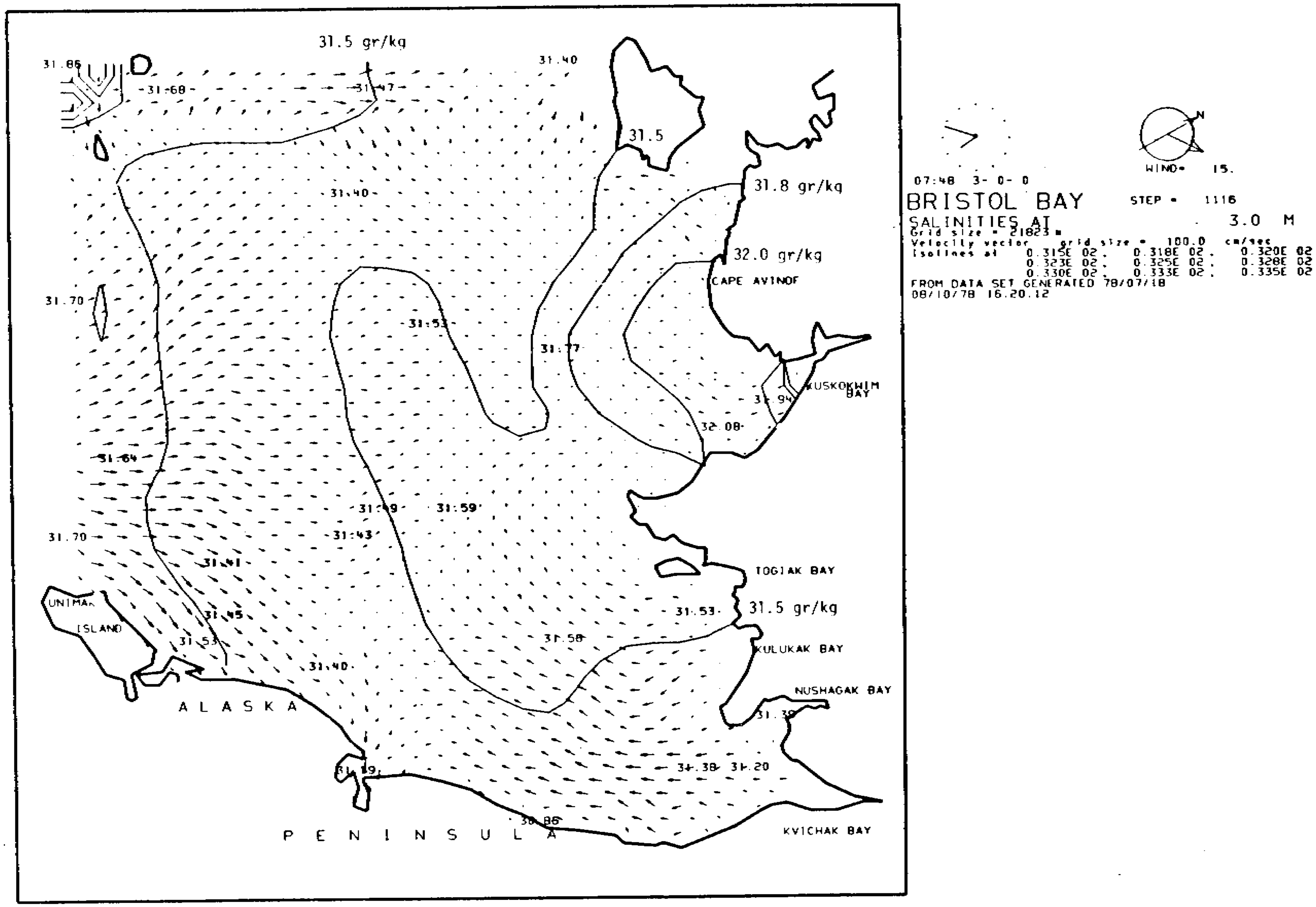


Fig. D-3--Computed salinity distribution in the surface layer at 0748 a.m. June 18, 1976

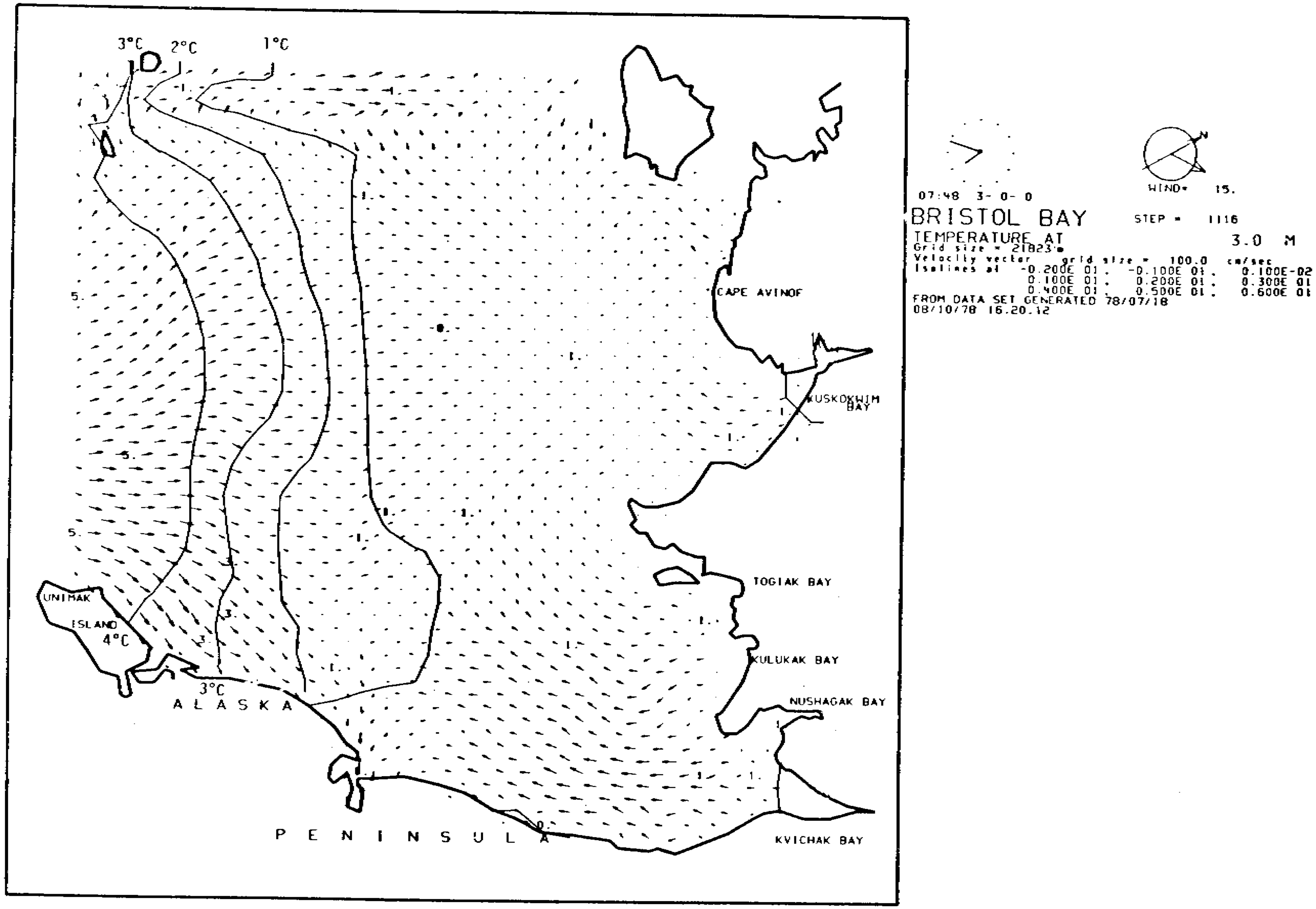


Fig. D-4--Computed temperature distribution in the surface layer at 0748 a.m. June 18, 1976

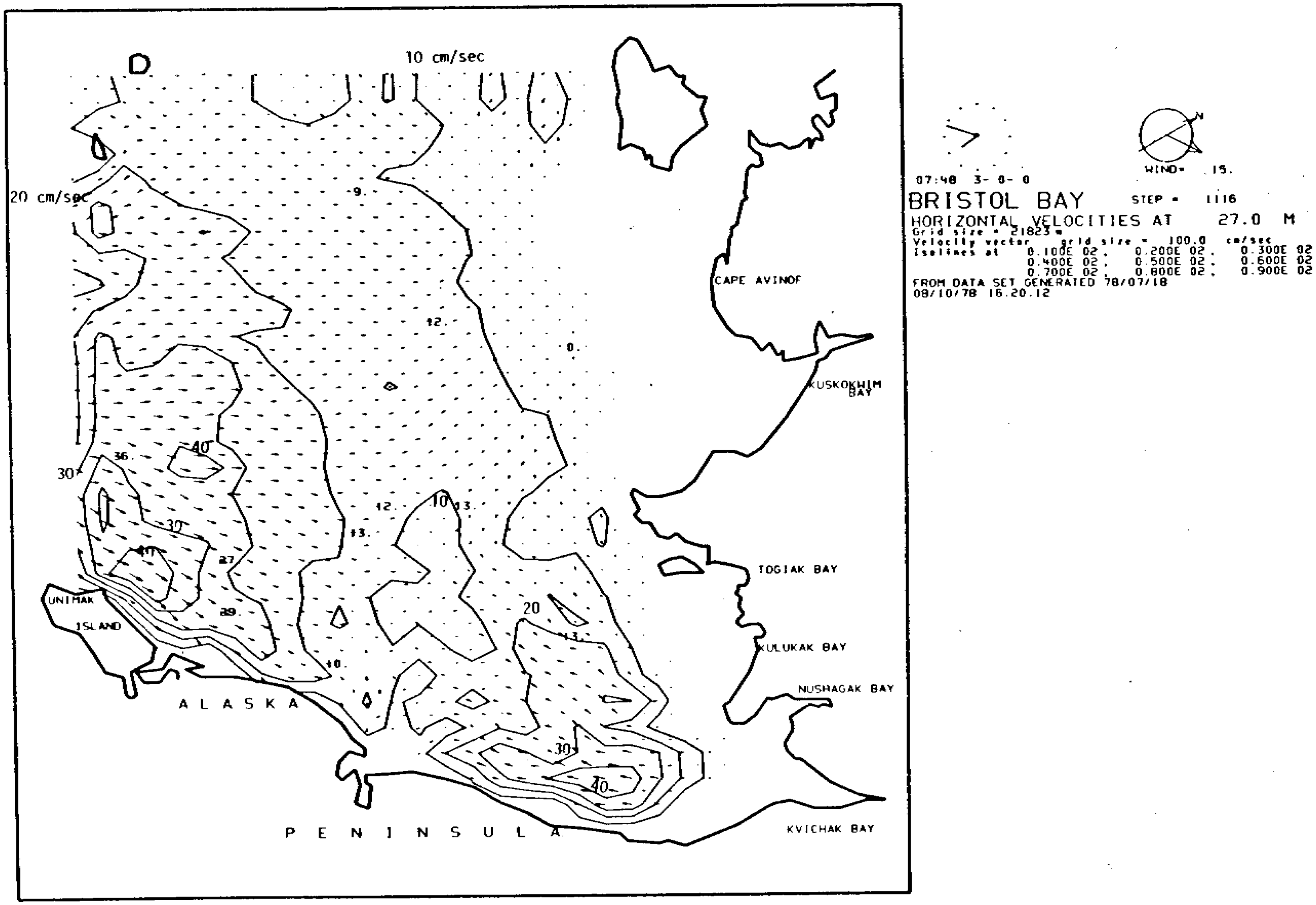


Fig. D-5--Computed current distribution at 27-meter depth at 0748 a.m. June 18, 1976

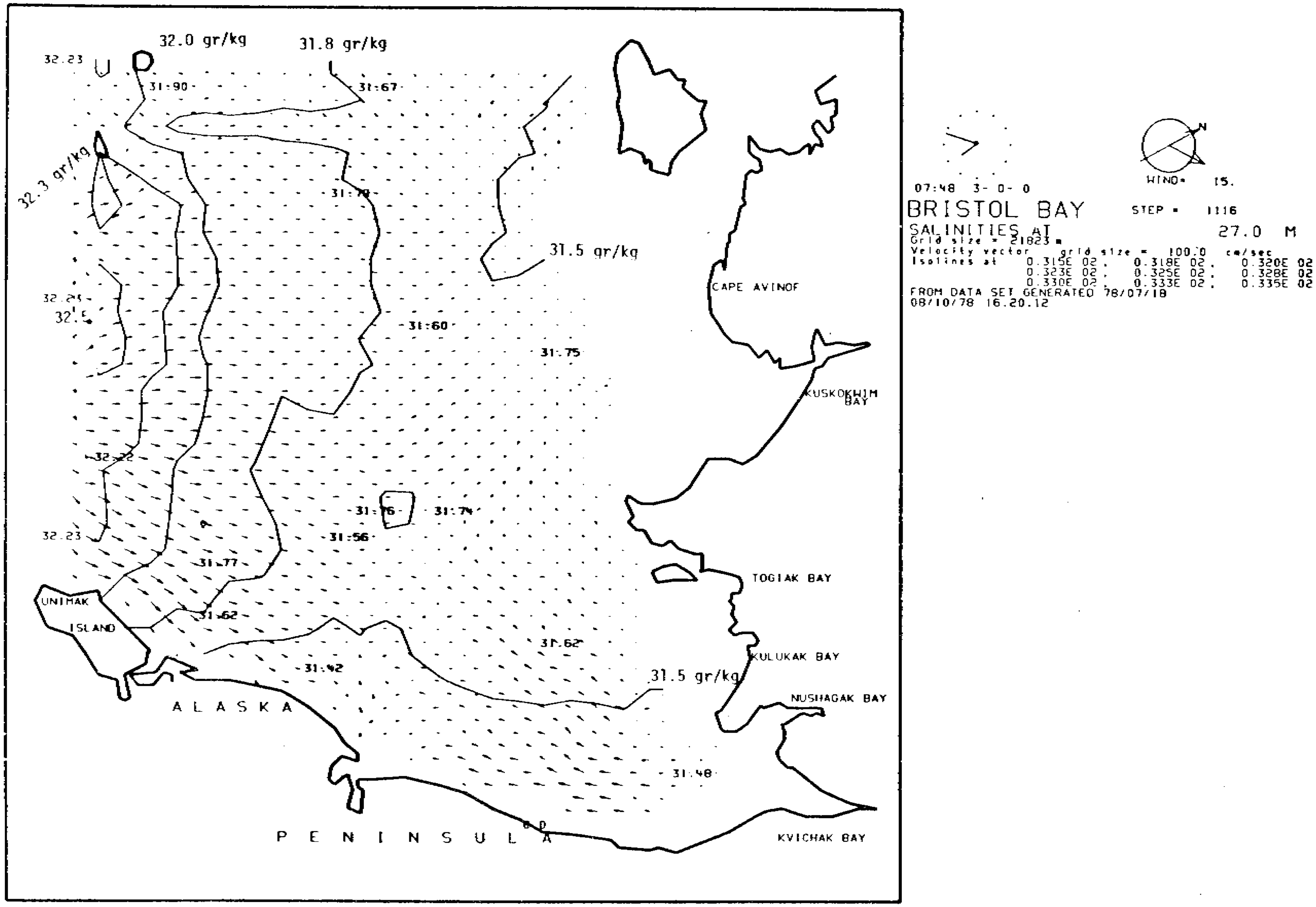


Fig. D-6--Computed salinity distribution at 27-meter depth at 0748 a.m. June 18, 1976

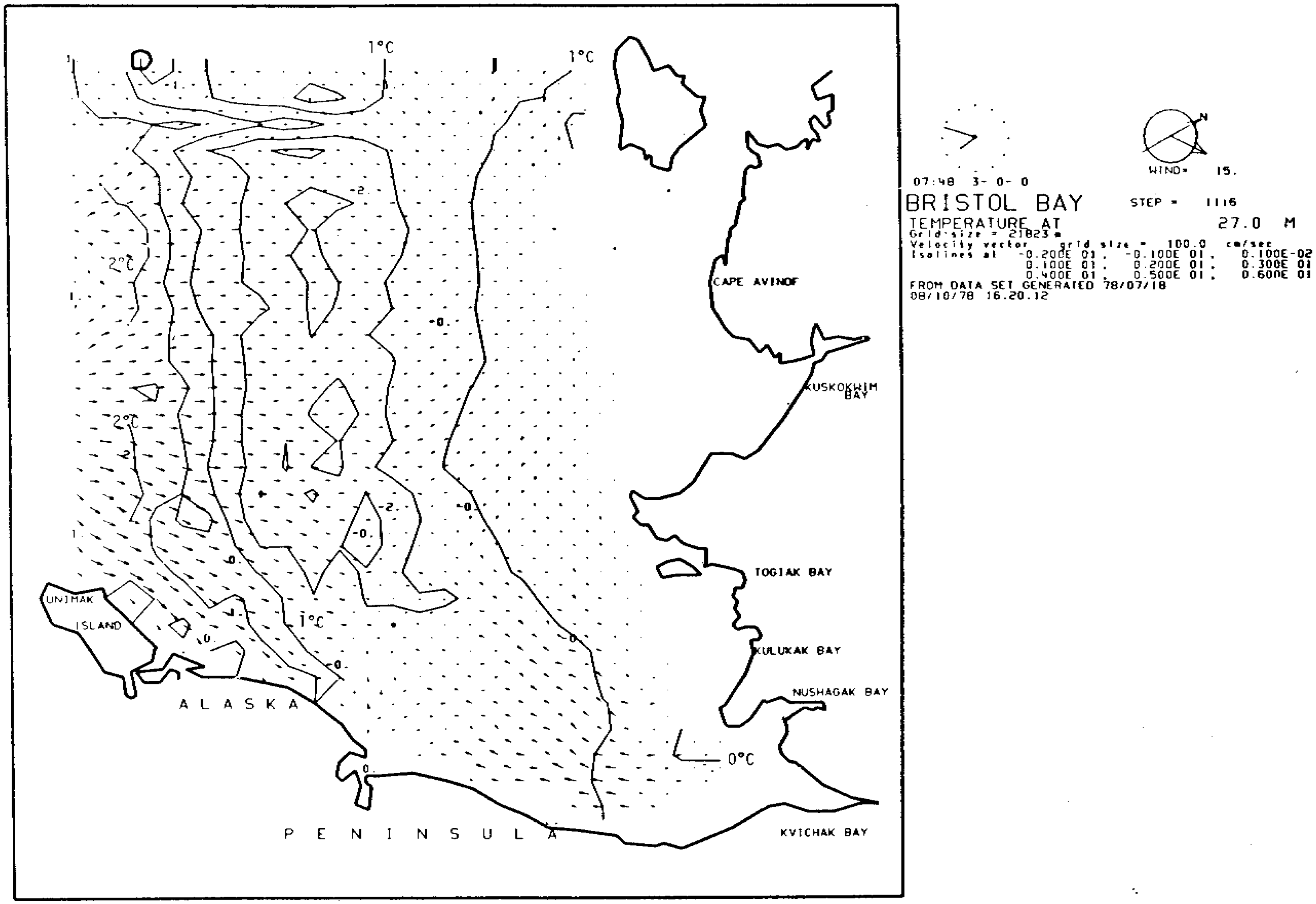


Fig. D-7--Computed temperature distribution at 27-meter depth at 0748 a.m. June 18, 1976

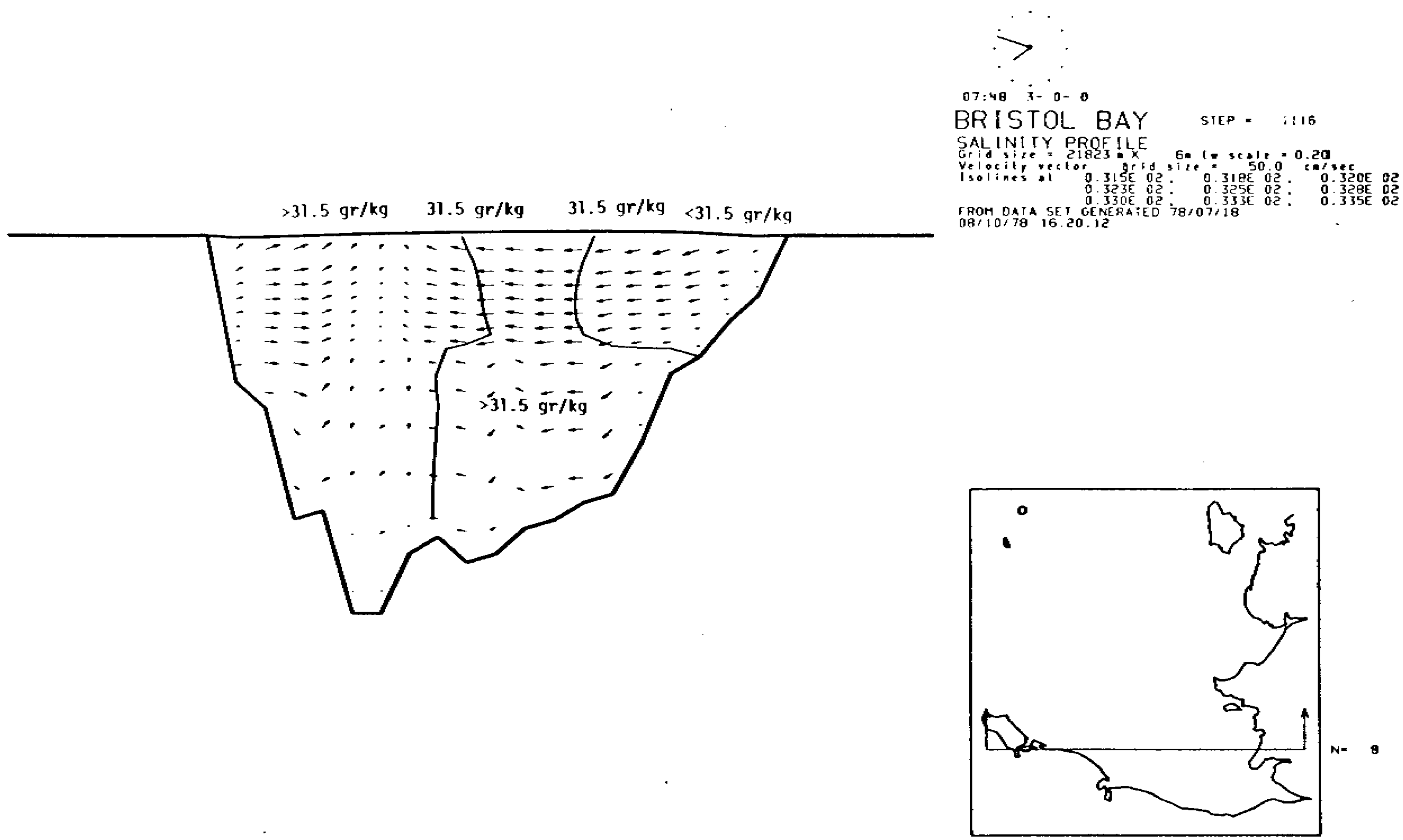


Fig. D-8--Vertical distribution of salinity and currents through a cross-section at 0748 a.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

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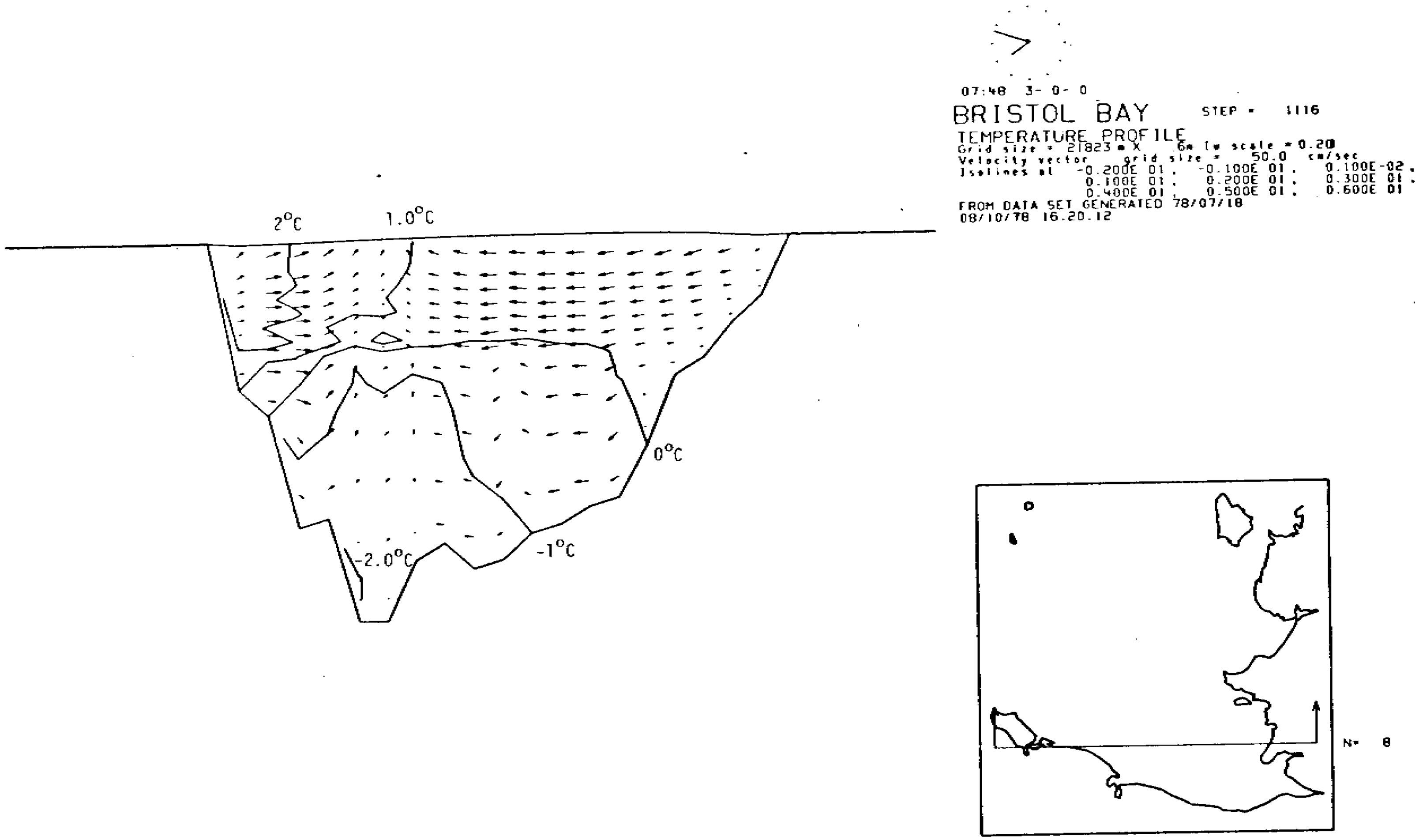

Fig. D-9--Vertical distribution of temperature and currents through a cross-section at 0748 a.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

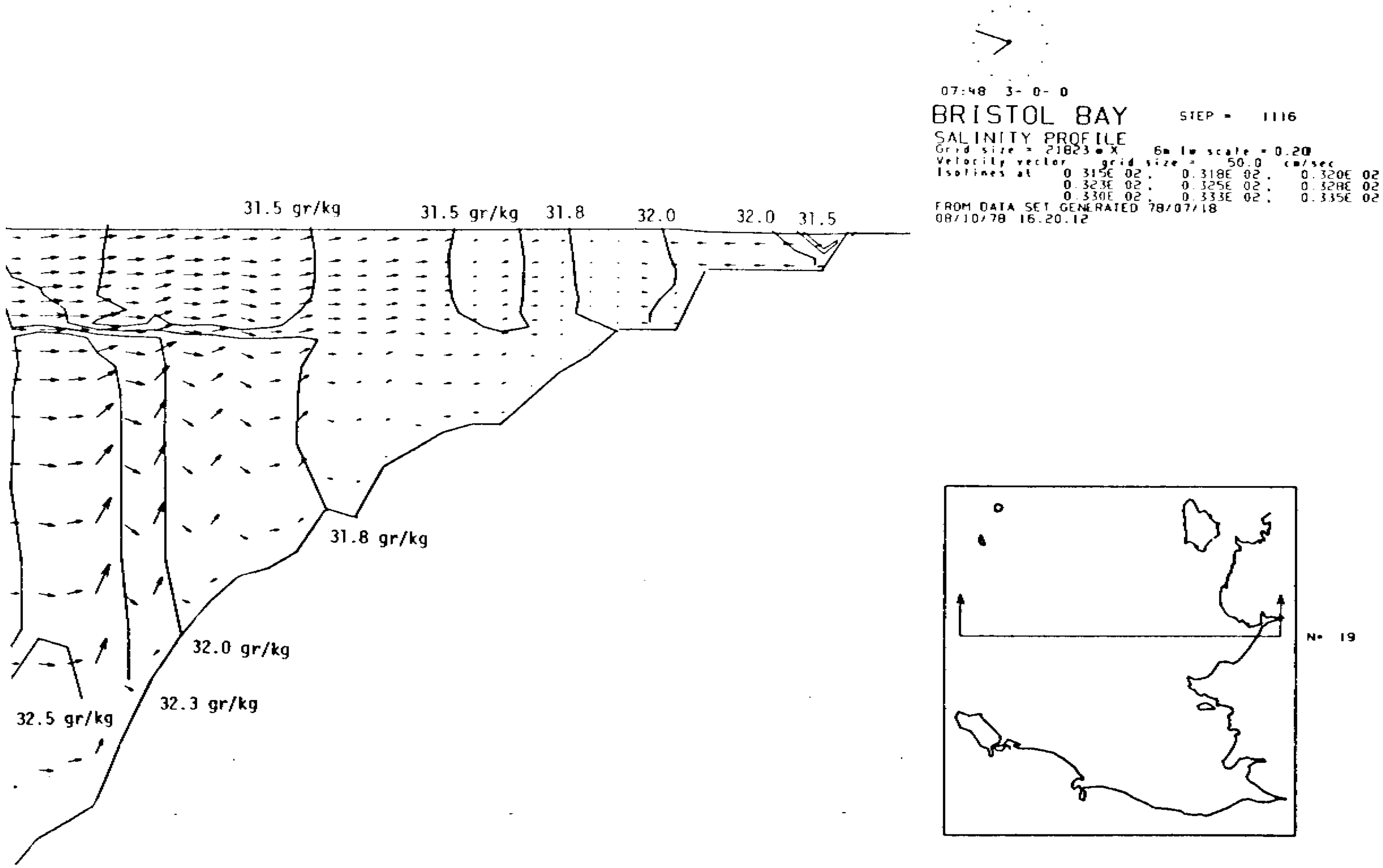

Fig. D-10--Vertical distribution of salinity and currents through a cross-section at 0748 a.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

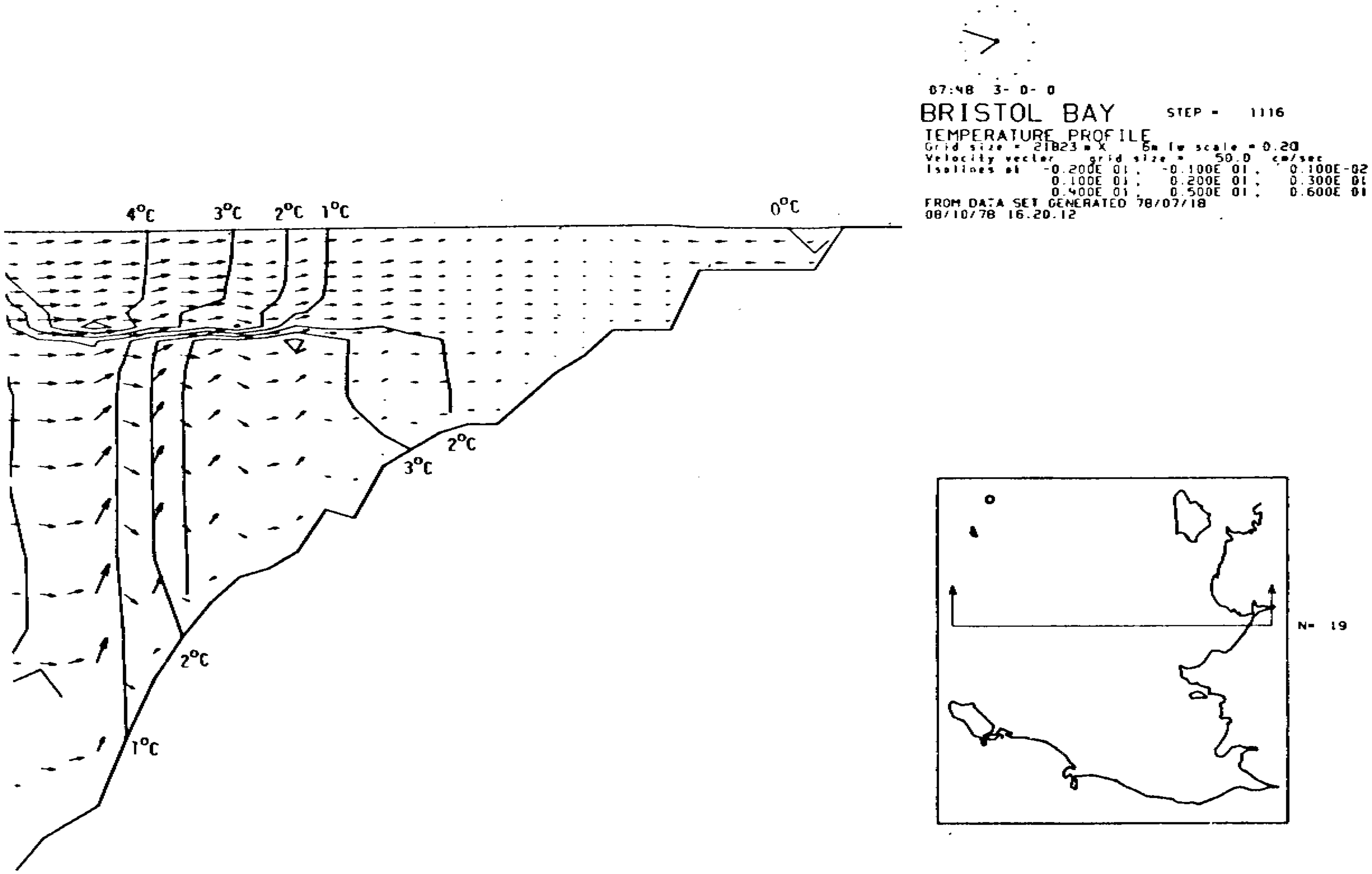

Fig. D-11--Vertical distribution of temperature and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

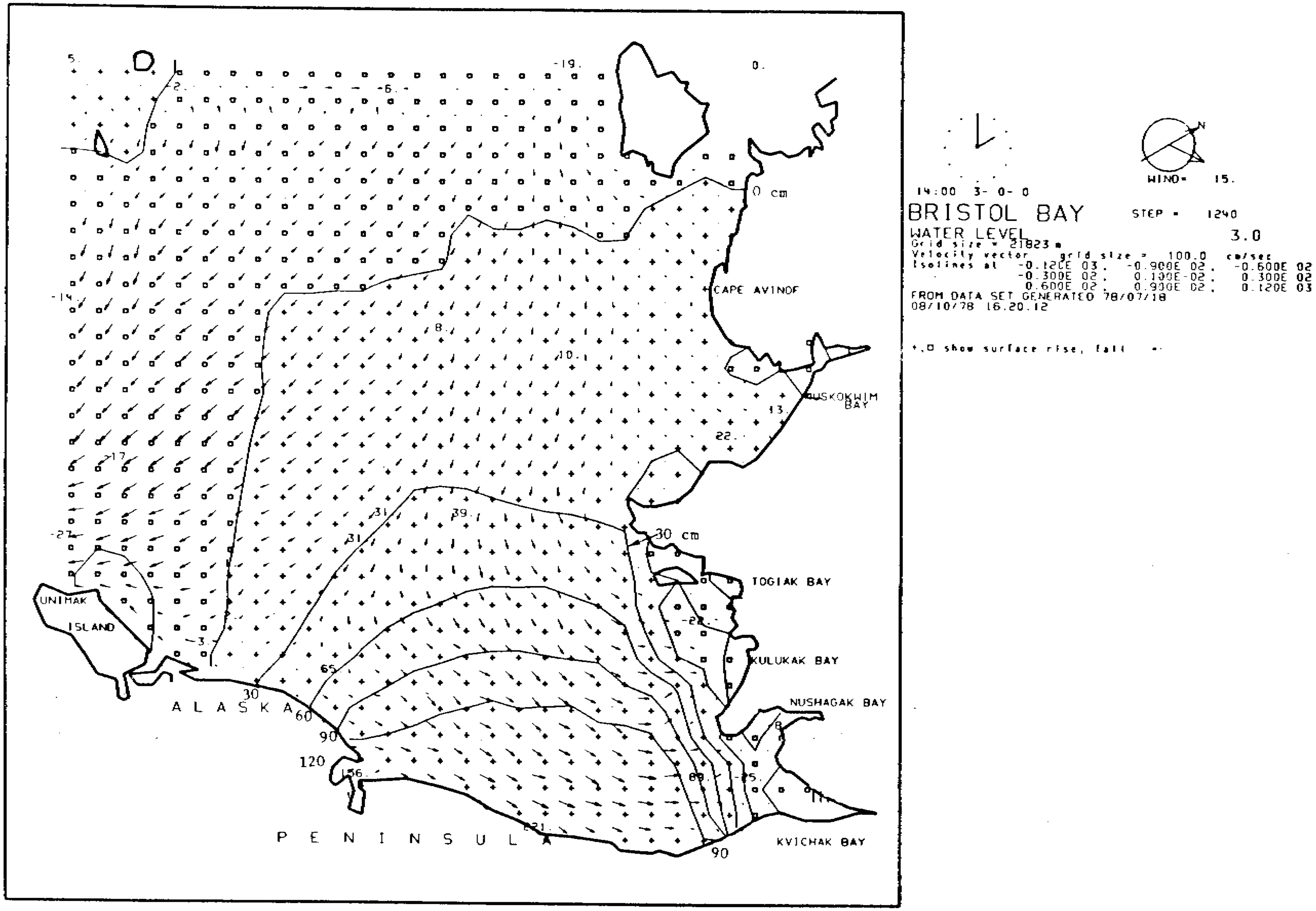

Fig. D-12--Water level contour, the rise (+) and fall (□) of water surface and the current distribution in the surface layer at 1240 p.m. June 18, 1976.

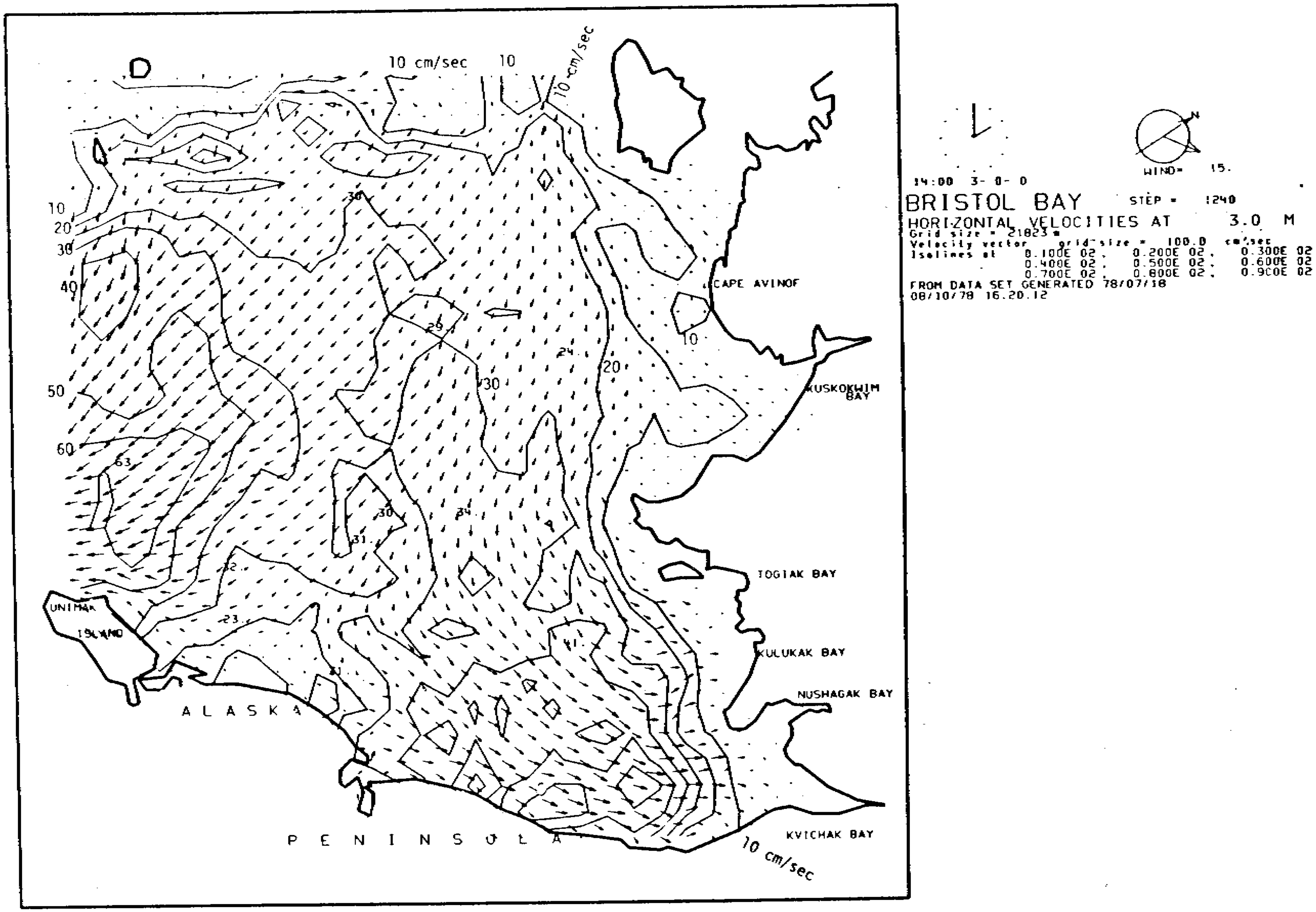

Fig. D-13--Computed current distribution in the surface layer at 1240 p.m. June 18, 1976

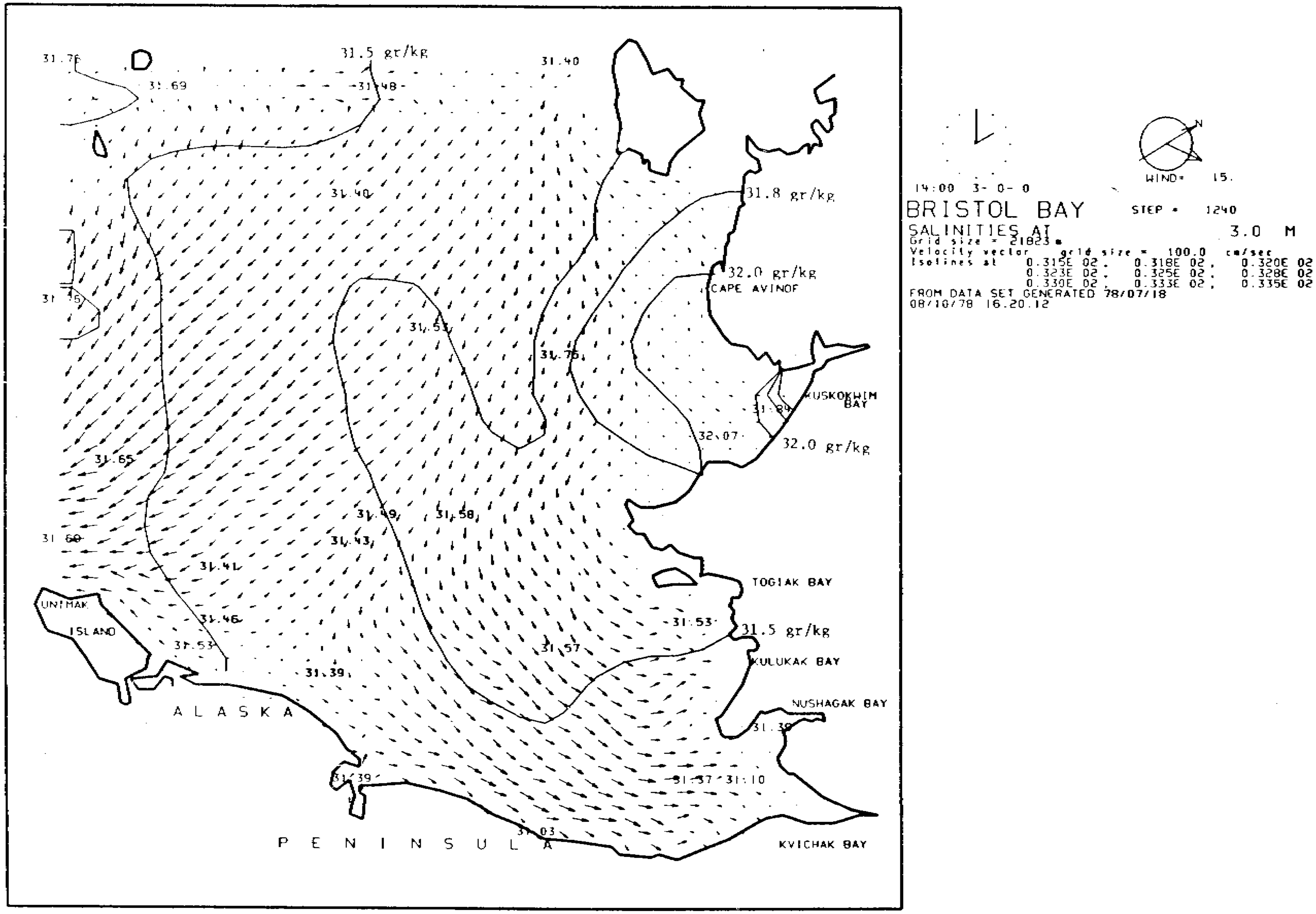

Fig. D-14--Computed salinity distribution in the surface layer at 1240 p.m. June 18, 1976

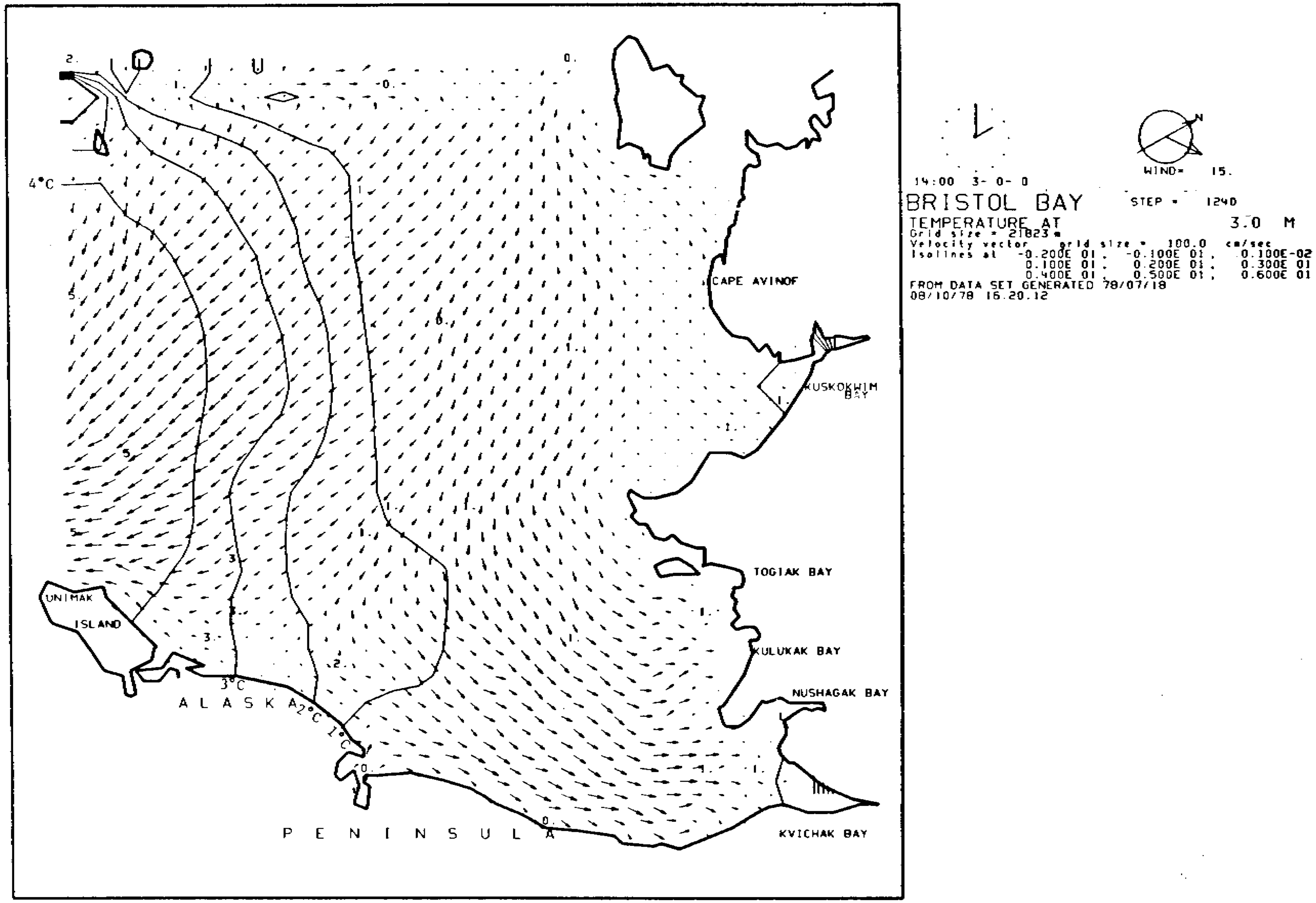

Fig. D -15--Computed temperature distribution in the surface layer at 1240 p.m. June 18, 1976

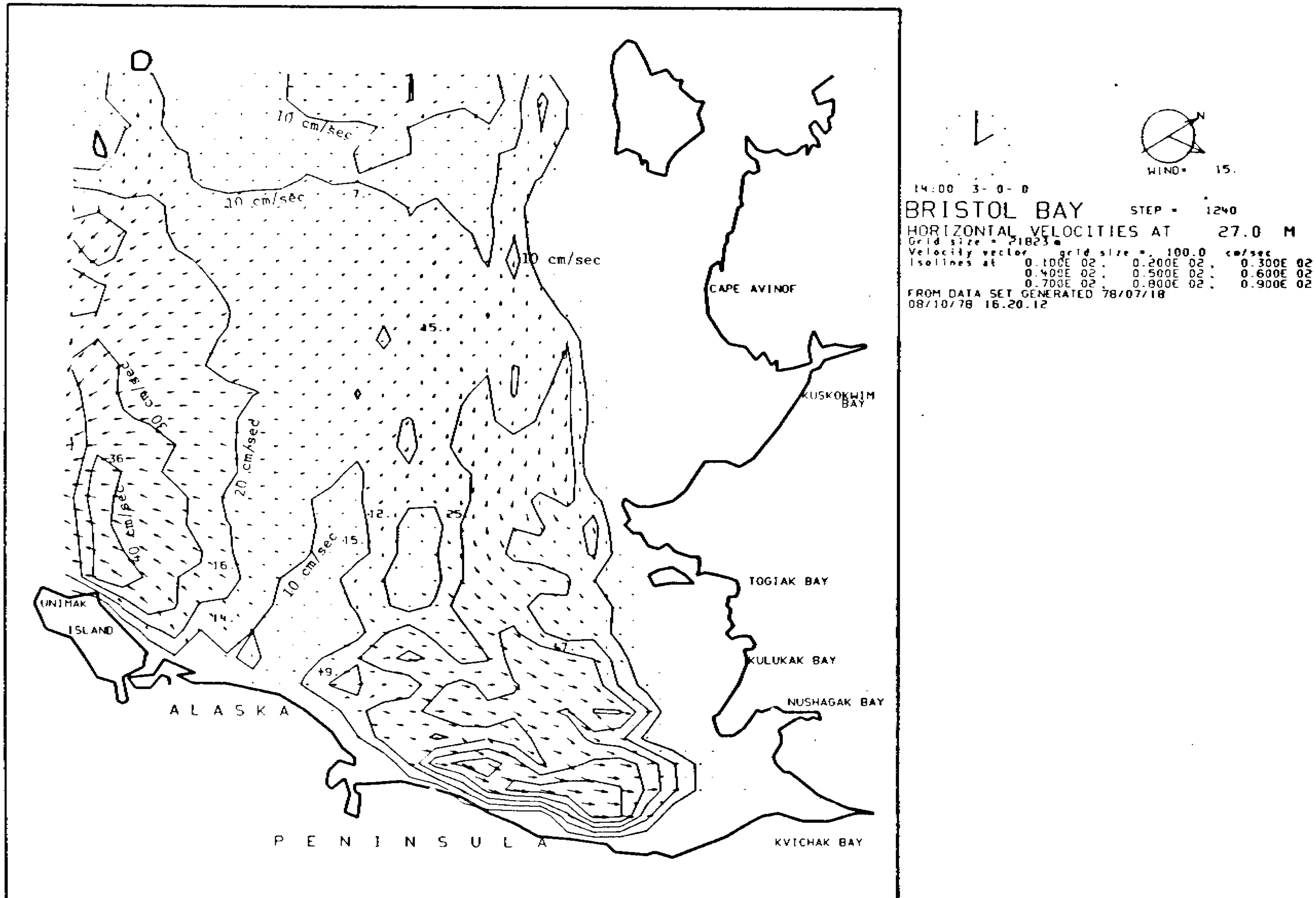

Fig. D-16--Computed current distribution at 27-meter depth at 1240 p.m. June 18, 1976

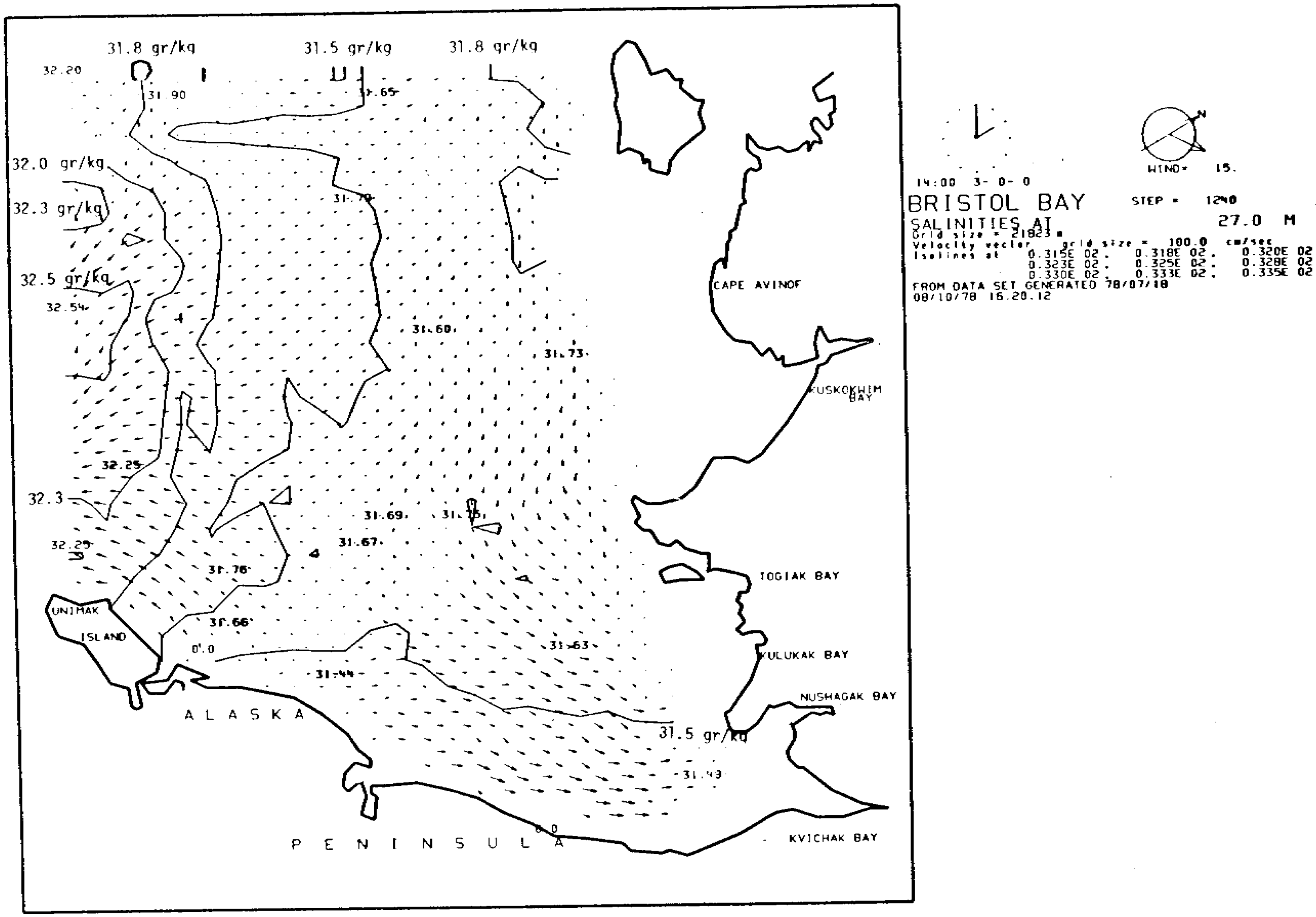

Fig. D -17--Computed salinity distribution at 27-meter depth at 1240 p.m. June 18, 1976

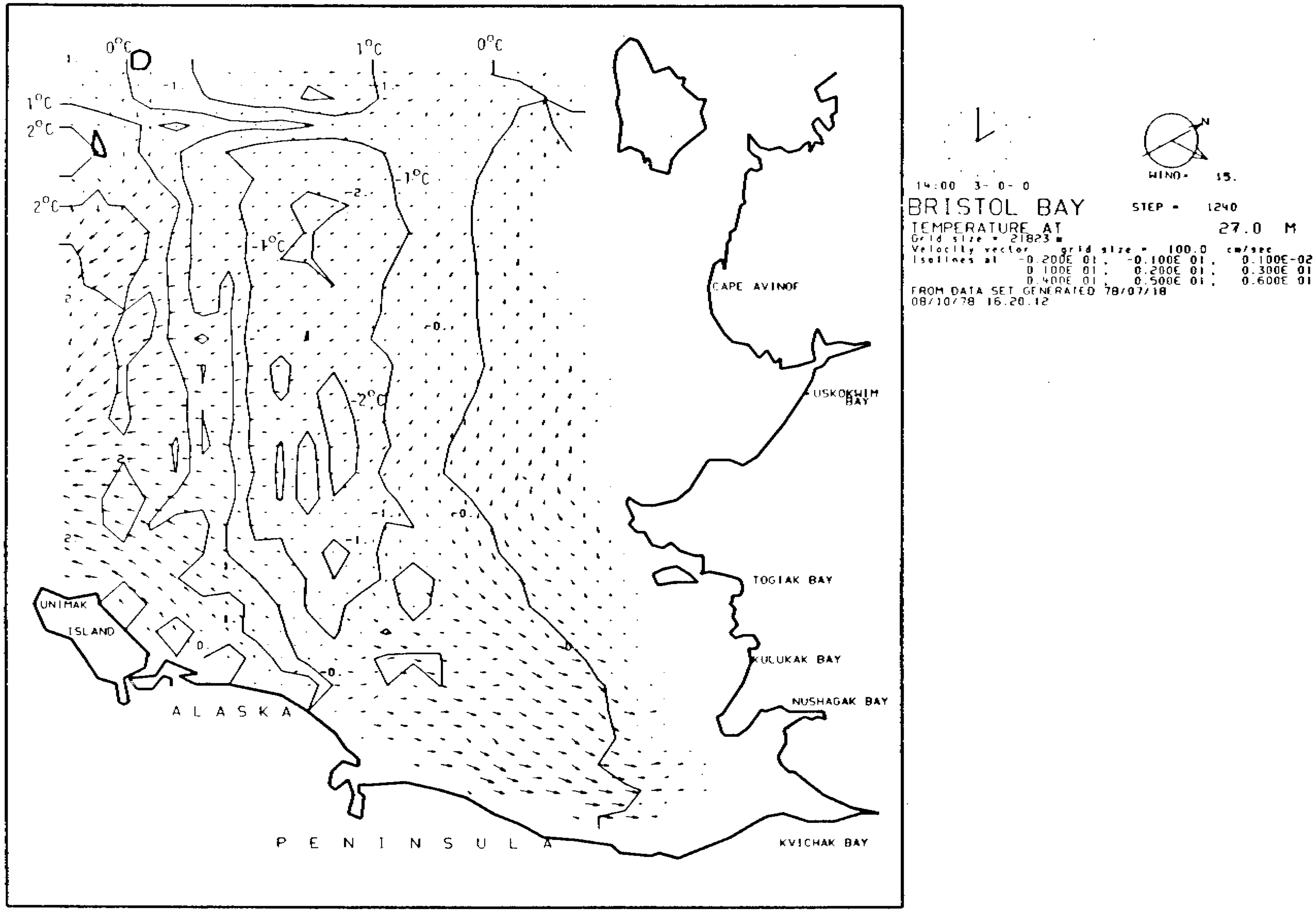

Fig. D-18--Computed temperature distribution at 27-meter depth at 1240 p.m. June 18, 1976

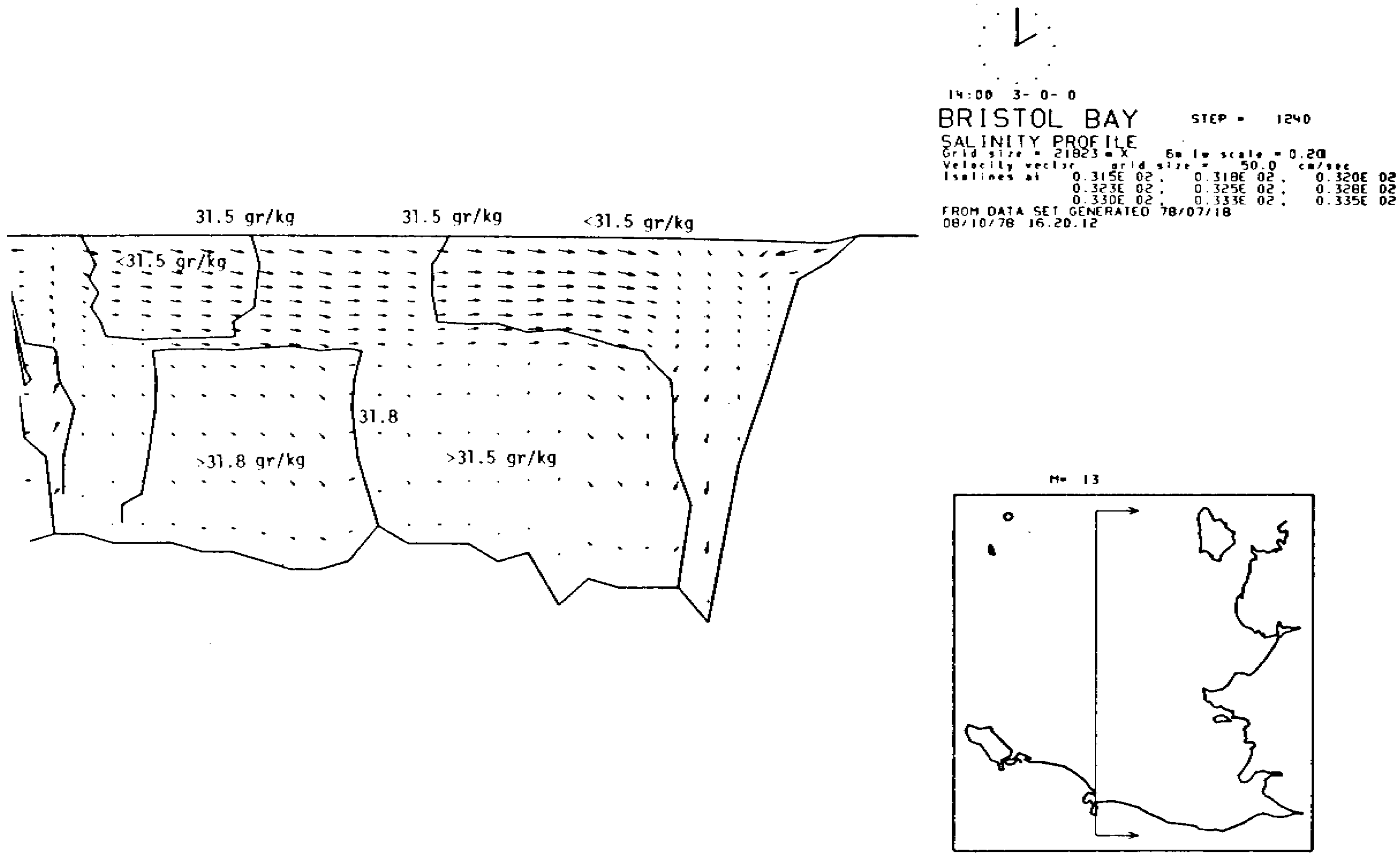

Fig. D-19--Vertical distribution of salinity and current through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

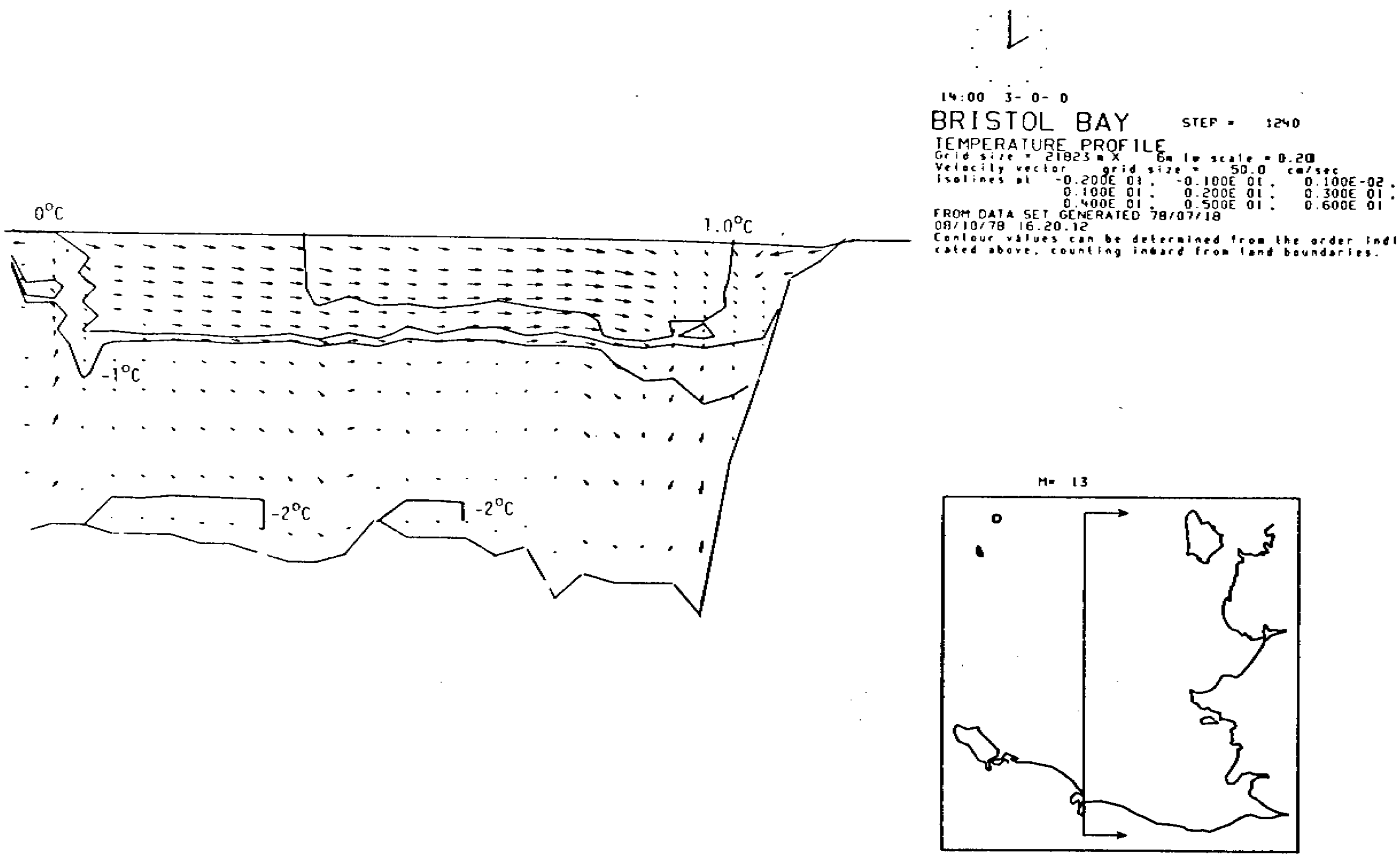

Fig. D-20--Vertical distribution of temperature and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

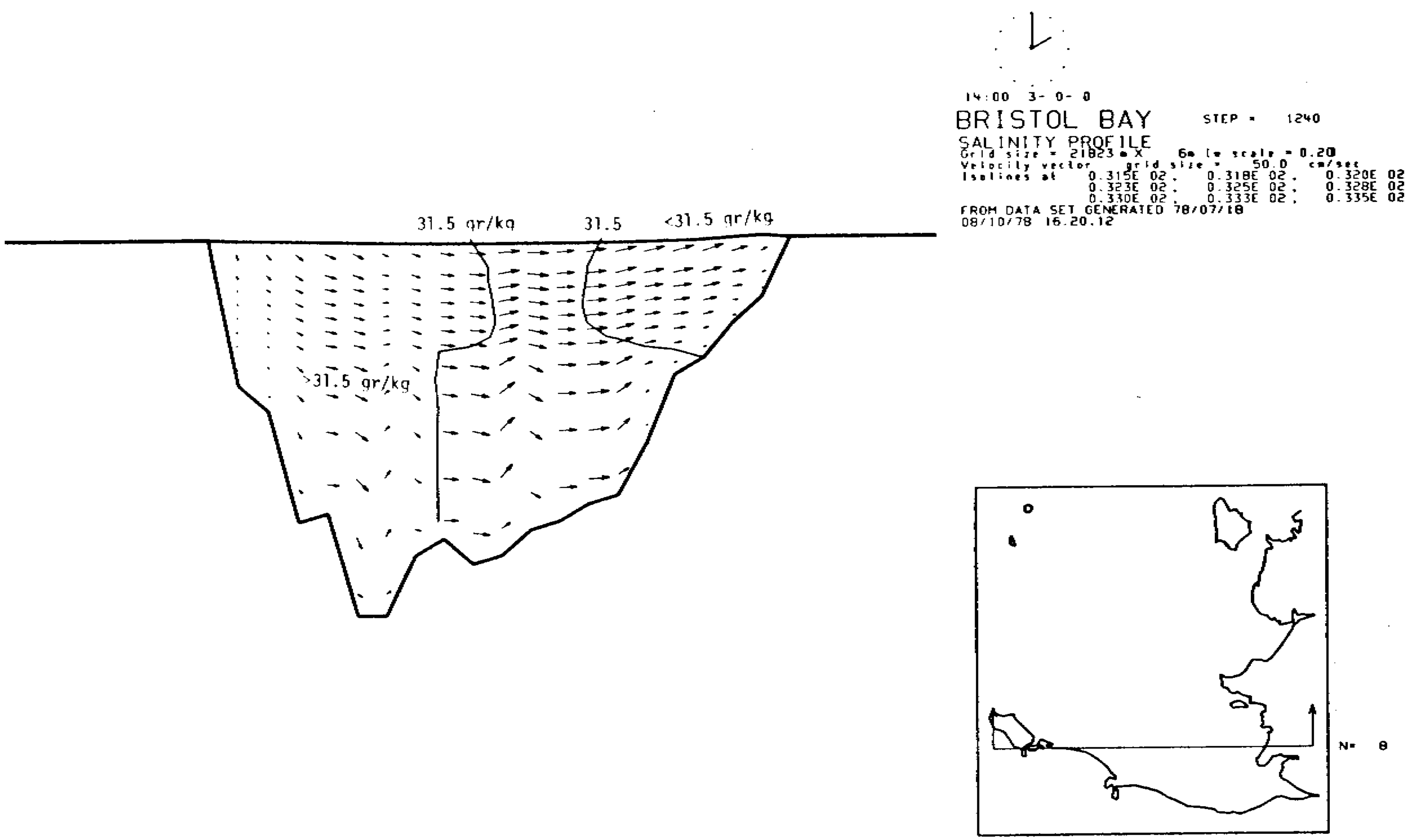

Fig. D-21--Vertical distribution of salinity and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

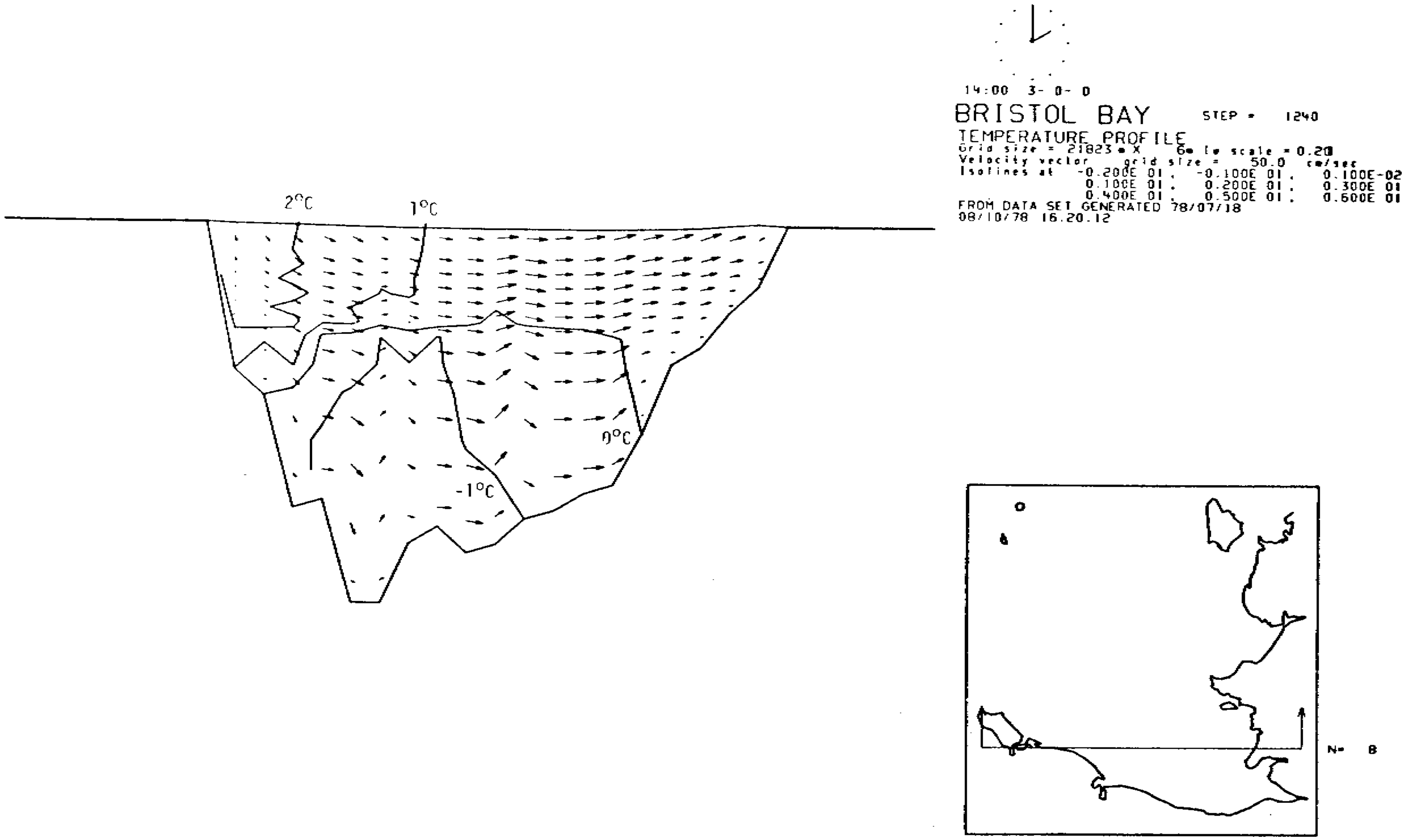

Fig. D-22--Vertical distribution of temperature and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

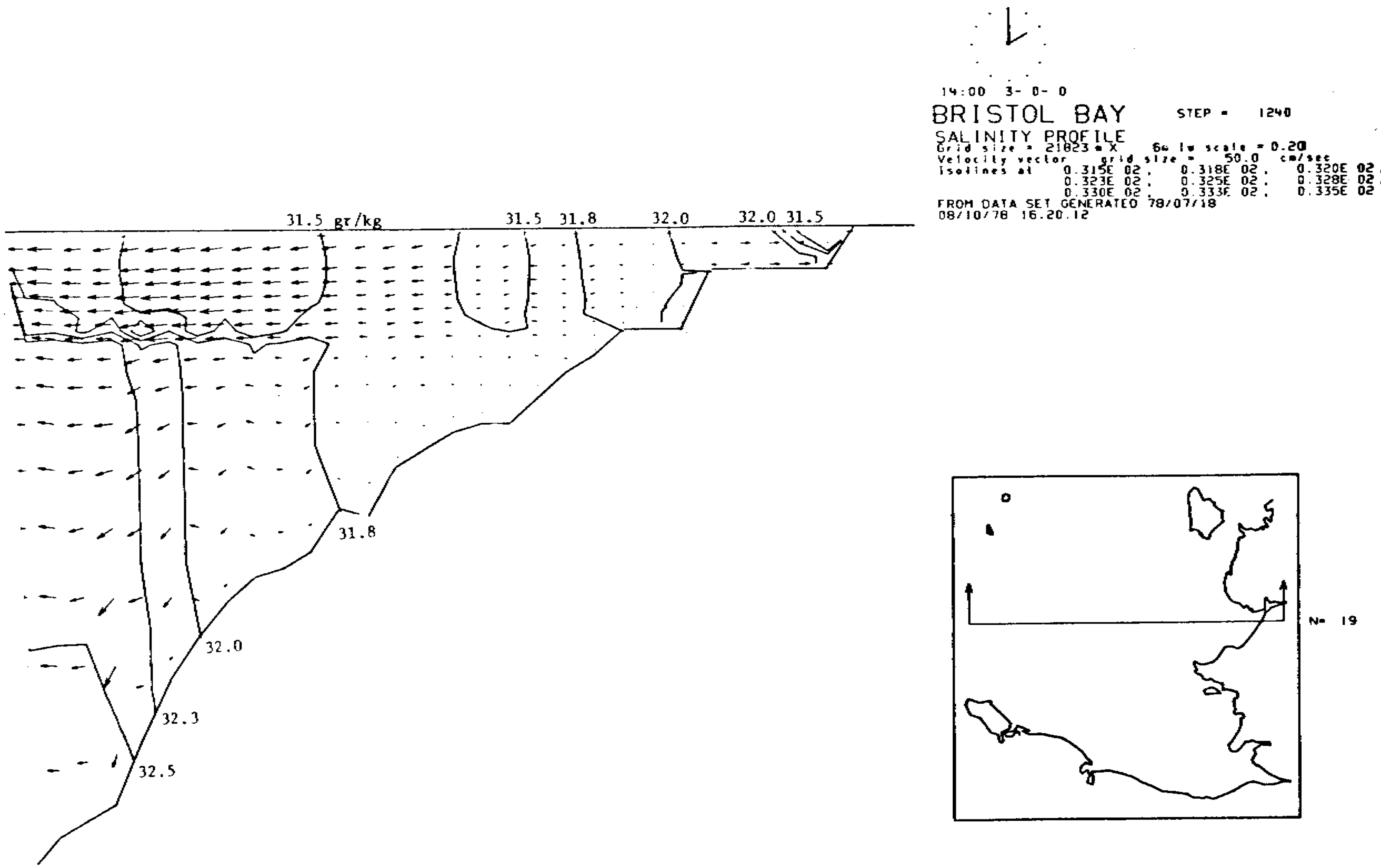

Fig. D-23--Vertical distribution of salinity and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

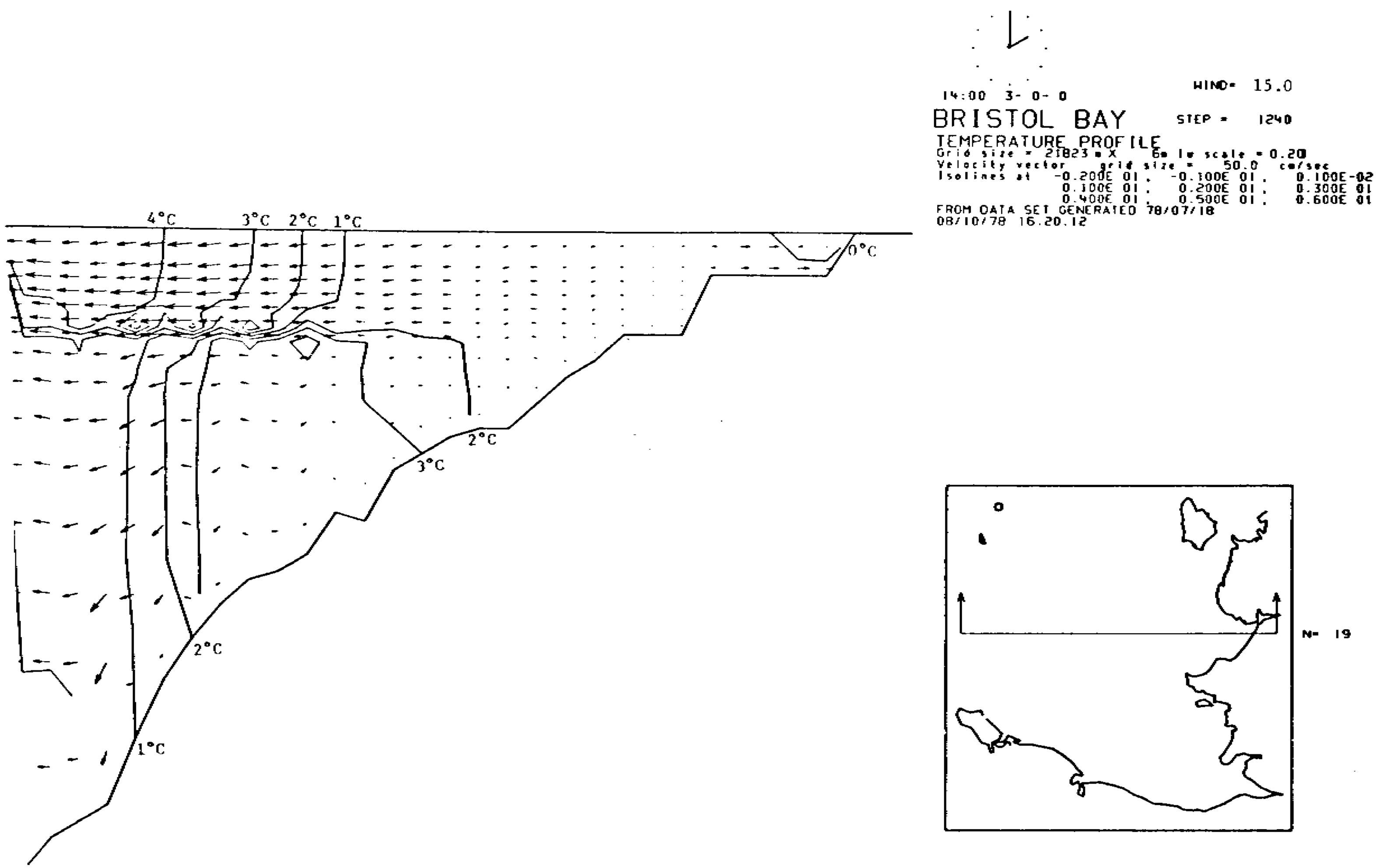

Fig. D-24--Vertical distribution of temperature and currents through a cross-section at 1240 p.m. June 18, 1976. The plotting scale for the vertical velocity component has been enlarged 727 times.

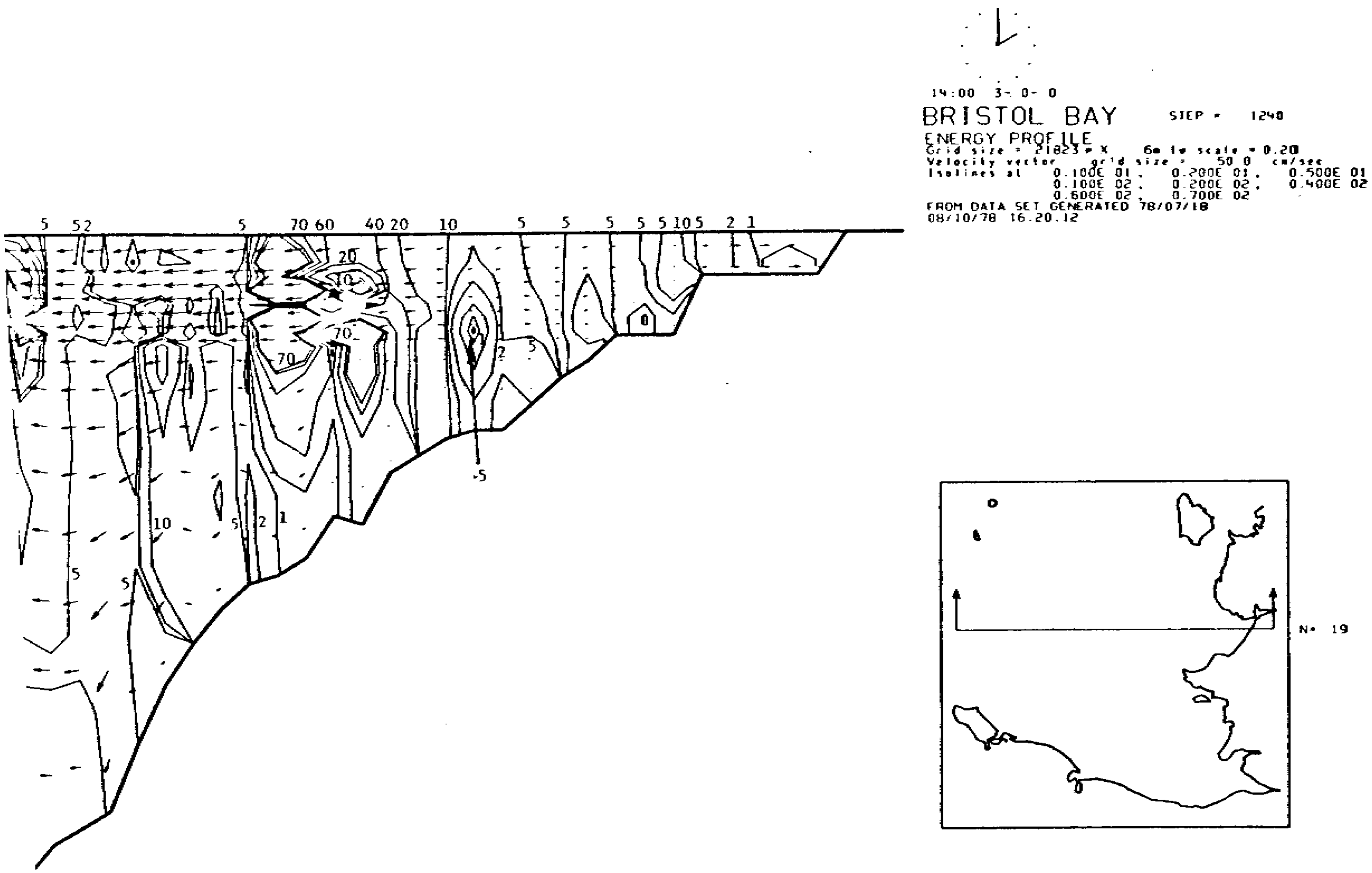

Fig. D-25--Vertical distribution of SGS turbulent energy densities and currents through a cross-section at 1240 p.m. June 18, 1976. The vertical plot scale has been enlarged 727 times.

Appendix E

COMPUTED CO-TIDAL CHARTS

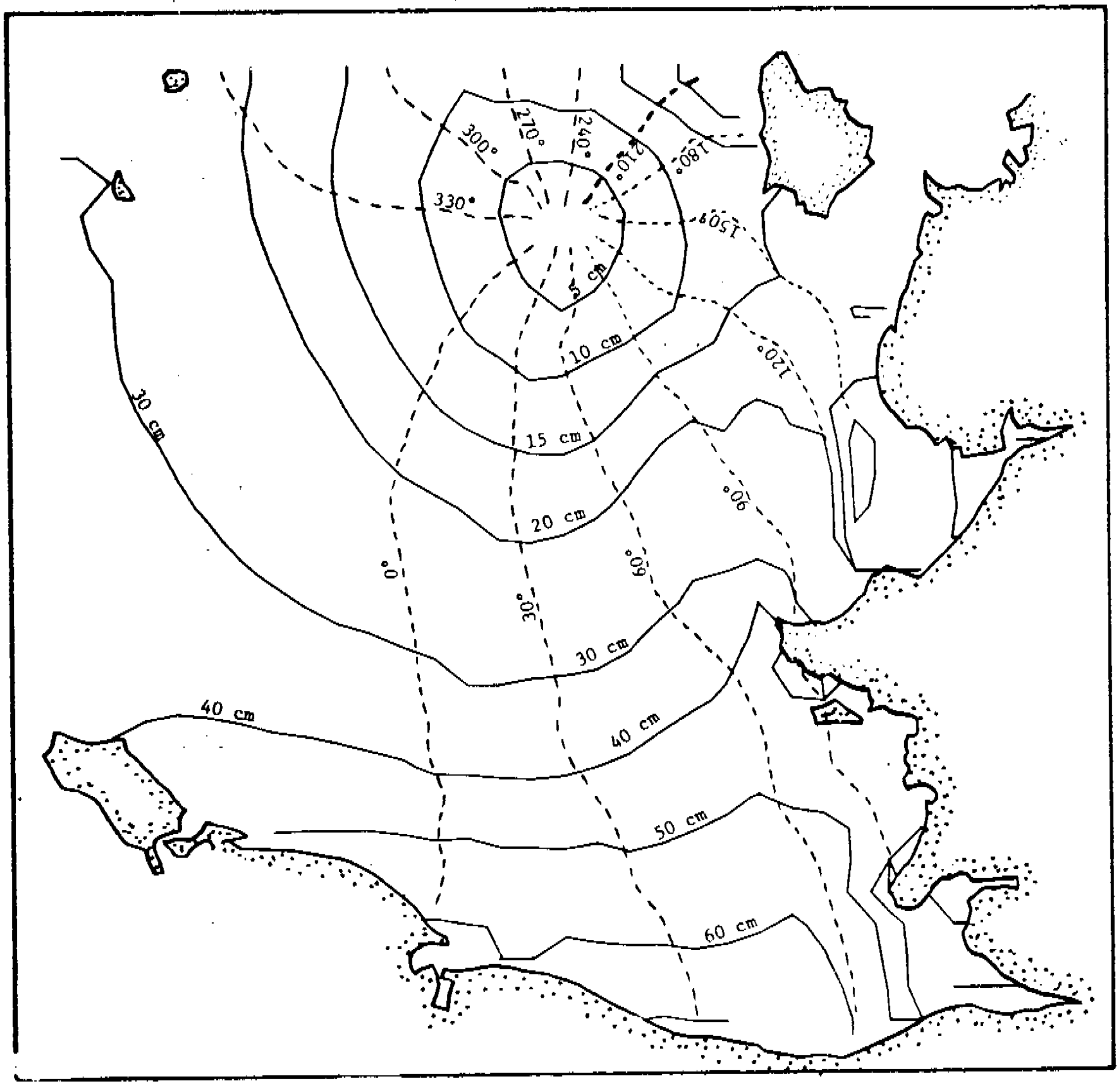

Fig. E-1--Co-tidal chart for the diurnal tidal component from the Bristol Bay three-dimensional modeling results

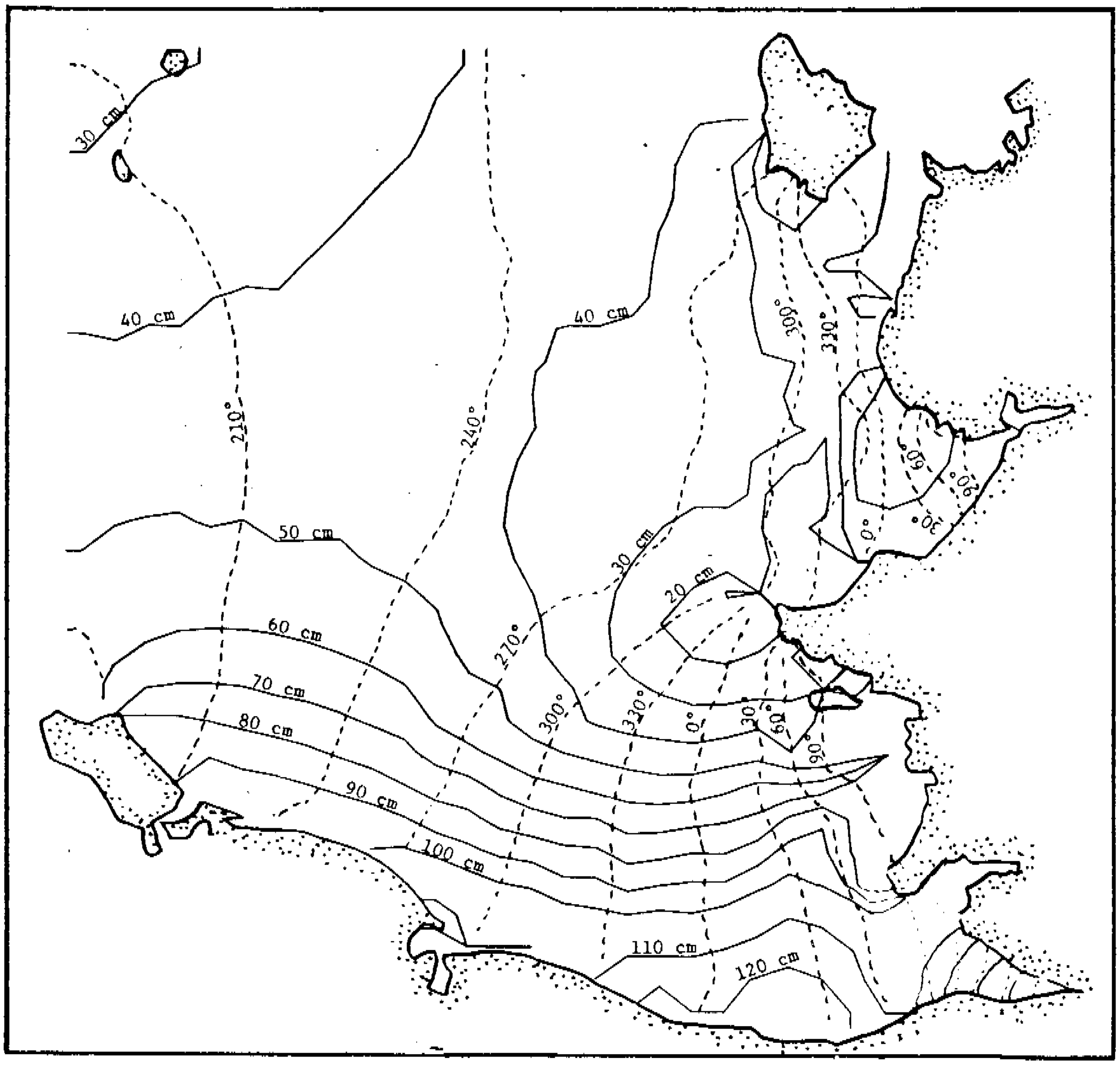

Fig. E-2--Co-tidal chart for the semi-diurnal tidal component from the Bristol Bay three-dimensional modeling results

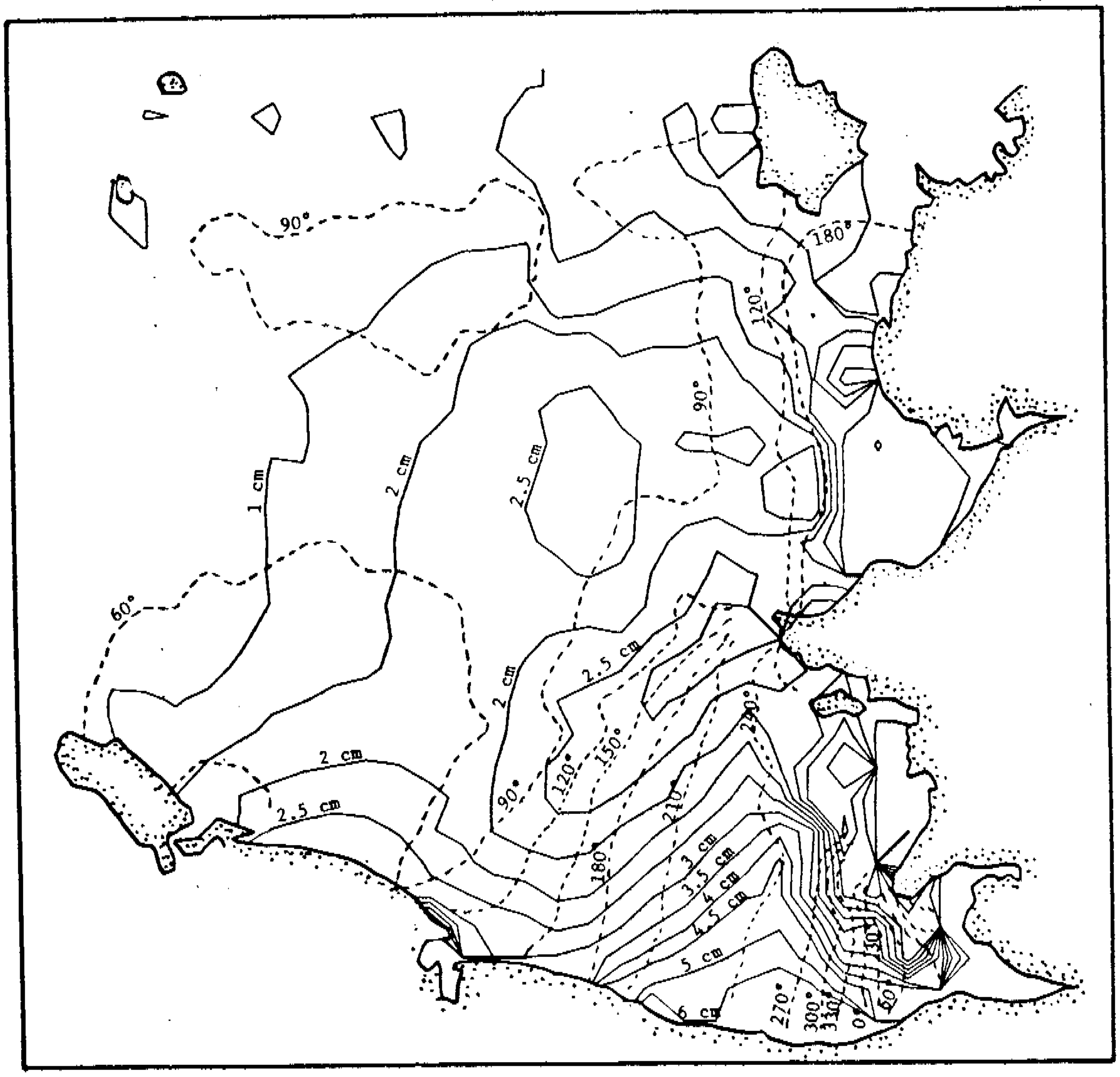

Fig. E-3--Co-tidal chart for the quarter-diurnal tidal component from the Bristol Bay three-dimensional modeling results

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QUARTERLY REPORT

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COASTAL METEOROLOGY OF THE ALASKAN ARCTIC COAST

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1 January 1979

I. Task Objectives

The objectives of this program are to investigate and model mesoscale and synoptic processes and their degree of influence on the measured surface winds of the Beaufort Sea Coast. Any attempt to understand near shore oceanic circulation relating to lagoon flushing and pollutant trajectories must include a description of air stress forcing by the surface winds.

II. Field, Laboratory Activities and Meetings

The Barrier Island-Lagoon Program Workshop at the University of British Columbia, December 11-12, provided some interesting offshore development scenarios. Attendance by Atlantic Richfield representatives made the meetings more instructive.

The following caveat must be mentioned in reference to the LGL Environmental Research Associates ecosystem model. The open water period in August 1977 was abnormal due to a six day storm producing a persistent high speed east wind. The resultant ice edge position and amount of lagoon flushing may not be representative of a normal summer season. It seems that 1978 would be a better base year for the model.

III. Results

The atmospheric data (July 20 - Sept. 1 1978) has been reduced and sent to Jim Audet, NODC OCSEAP Data Coordinator. The data consisted of: (1) wind speed, wind direction, and temperature at 10 meters from Milne Point, Cottle Island, and Cross Island, (2) atmospheric pressure corrected to sea level from Deadhorse, Umiat, Oliktok and Milne Point. There were no data gaps in the period except for Cross Island data.

The effects of the time varying thermal contrast at the coastline (Sea Breeze) have been modeled under varying synoptic conditions and comparison with measured data has been very satisfactory.

Histograms of surface wind speed and direction are presented for 1976, 1977, and 1978, plus an average of the three years (Figures 1-4). The abnormal persistence of east winds in August 1977 can readily be seen (Figure 2). In this case the above mentioned storm was the cause.

A comparison of surface winds (10 meters) on Cottle Island, versus the geostrophic winds is shown in Figure 5 in August 1976, when an offshore pressure buoy network existed simultaneously with onshore pressure stations. The additional buoy data provided an accurate estimate of the wind direction and speed in the absence of thermal effects and surface boundary layer turning.

IV. Preliminary Interpretation of Results

A. Sea Breeze

Both the model and experimental data from August 1977 show that a synoptic wind field with speeds of 6 m/s or less can be influenced and/or completely offset at the surface (10 meter level) by the sea breeze.

The Cottle Island histograms from 76-78 (mentioned above) show that greater than 50% of the measured surface winds in August fall below 6 m/s. Figure 5 shows that the August 1976 surface wind asymmetric bimodality (NE and E winds occur three times as often as W and SW winds) can be partly attributed to the coastal thermal effect offsetting the synoptic winds from the southwest quadrant (see cross-hatched area). The dashed line in Figure 5 represents the geostrophic wind directions as calculated from a surface pressure network using offshore buoy input (Simpson Lagoon is 10 km from the geometric center of the network).

Monthly summaries of surface wind directions in the OCS Climatic Atlas for Oliktok (southwest edge of Simpson Lagoon) show a bimodality in wind direction in all seasons which can be attributed to the large scale wind field. The asymmetry mentioned above appears to maximize in the months from June through September and disappears in the months from December through March. This is evidently a thermally induced mesoscale effect due to the temperature gradient across the coastline. The sea breeze model shows that the surface winds will be a function of the mesoscale thermal gradient in a zone 30 km to each side of the coastline.

The major implications are:

(1) maintenance of along shore and offshore currents which promote lagoon flushing during low synoptic (stagnant) or adverse synoptic situations which would otherwise prevent lagoon flushing,

(2) production of wind driven current shears beyond 30 km offshore where synoptic conditions are not influenced by thermal contrasts. Theoretical evidence for the existence of this effect can be seen in model output showing surface wind direction with a geostrophic wind of 5 m/s from 220°T (Figure 6).

(3) Increased persistence of upwelling conditions.

B. Negative Storm Surge

Figure 2 shows that 90% of the surface winds in August 1977 were from the northeast to east. In this case the gross assymmetry is due to a storm which lasted 6 days (August 8 to August 13, 1977). Examples of the prevailing surface winds during the storm were 85° ±5° @ 10.5 m/s ±1 m/s for 30 hours and 80° ±5° @ 12.5 m/s ±2 m/s for 75 hours.

These surface wind velocities were responsible for a negative storm surge in the Simpson Lagoon area. The decrease in water level due to a net water transport to the right of the prevailing wind was documented during the installation of a tide gauge. The gauge float was inside a hollow oil drum in 20 cm of water at 1500 August 9, 1977, with 10 m/s winds. The winds increased to 15 m/s and by 2200 the float was sitting on mud, by 1000 August 10, 1977 a stake in 23 cm of water was dry (winds greater than 15 m/s but less than 20 m/s during this time). By 2200, another stake in 35 cm of water was dry for a net decrease in water depth

78 cm in 31 hours during which the wind averaged 15 m/s from the east. By 1100 August 11, 1977 the water level increased 58 cm as the wind slowed to 10 m/s. By 1445 with the wind below 10 m/s the water level increased by 16 cm. On August 14, 1977 with east winds of 4 m/s the water level increased 24 cm for a net increase of 98 cm registered off the southwest coast of Pingok Island (Simpson Lagoon) due to the negative surge subsiding. During the storm wind waves of 1.5 meters (peak to trough) were observed in the lagoon.

C. Mountain Effect

Figure 7, taken from histograms in the OCS Climatic Atlas, shows a plot of the monthly percentage difference between occurrence of northeast-east winds and southwest-west winds at Barter Island, Oliktok, and Lonely (all on the Beaufort Coast). Positive (Δ%) implies more east winds than west winds. The months of October through March show a great disparity between Lonely and Barter Island, this is due to the "Mountain Effect" which is eastward deflection of northerly winds by the Brooks Range when the atmospheric boundary layer is statically stable.

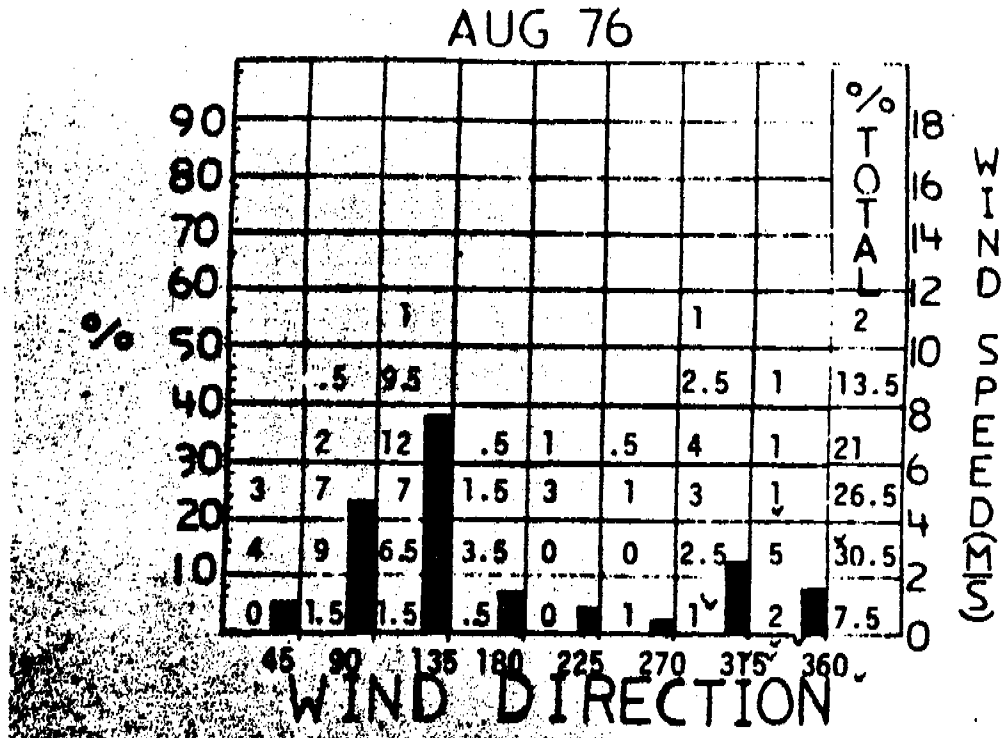
In the months of May through August when the sun is above the horizon for more than 20 hours, the land snow cover is gone or depleted, and the land boundary layer is approaching neutral stability, the three coastal stations become very similar. They show an average of northeast-east winds at 3 times the frequency of southwest-west winds. It is obvious that the "Mountain Effect" is minimized during this period (except for mechanical channelling) and the mesoscale thermal effect of the coastline becomes a major influence on the synoptic scale wind in the coastal region.

V. Problems Encountered and Recommended Changes

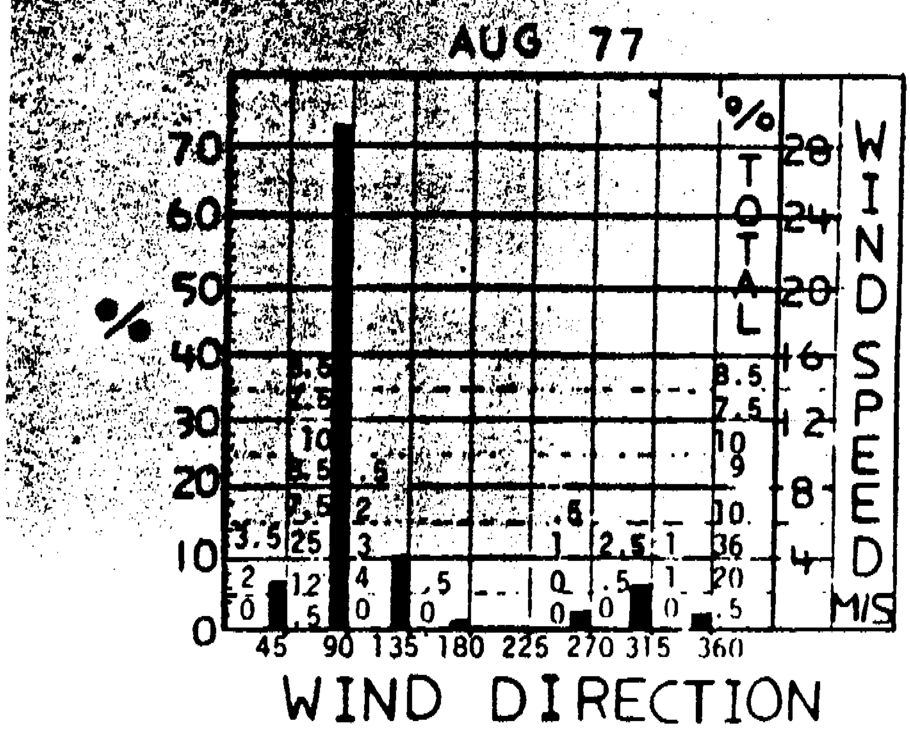
None

VI. Estimate of Funds Expended.

As of 1 January 1979, expenditures under this contract will come to $12,037.72 out of an allocation of $22,000.00

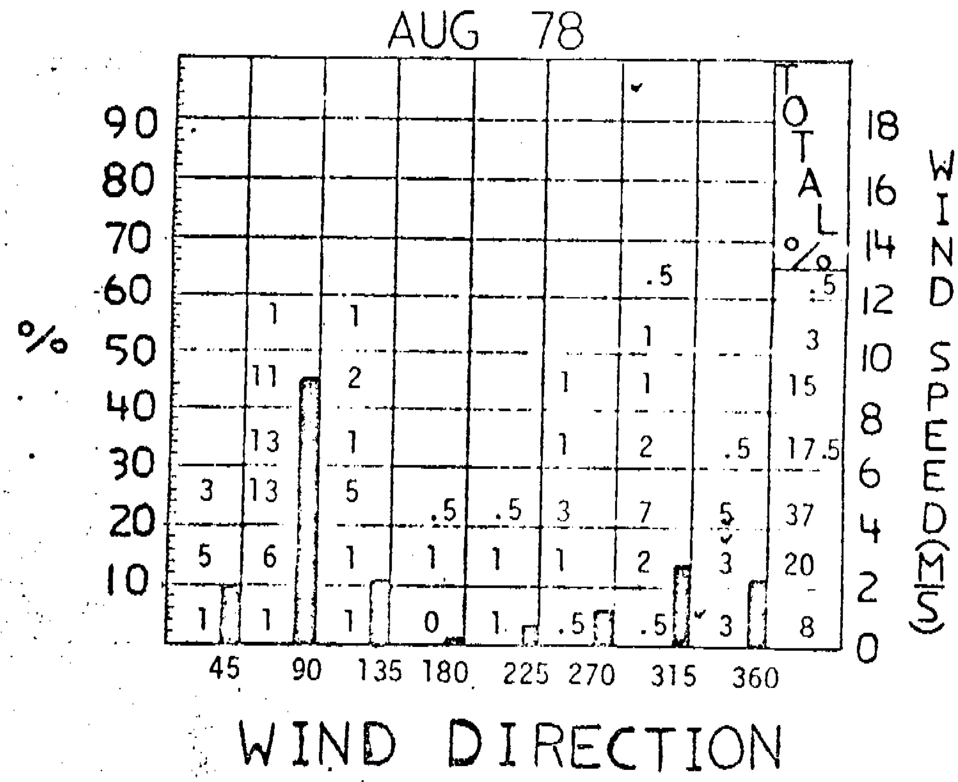


Histogram of wind speed and direction for 1976. Fig. (1)

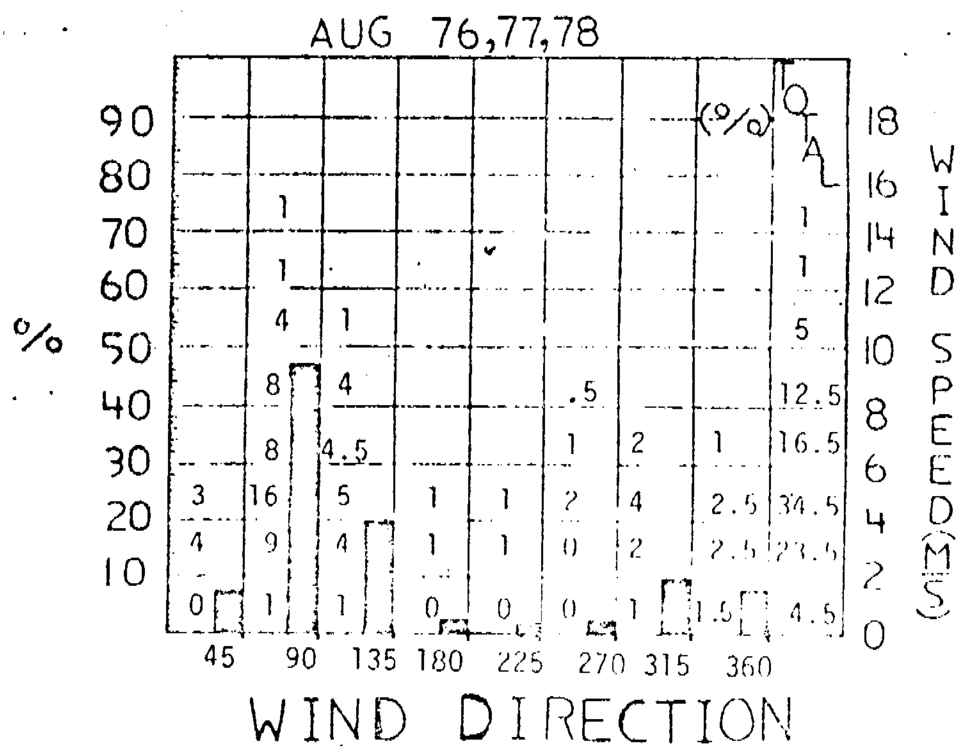


Histogram of wind speed and direction for 1977. Fig. (2)

Note: Direction Frequency - Left Scale - Bars represent % frequency of winds from each direction. Speed Frequency - Right Scale - Printed Numbers are % frequency of wind speeds observed from each direction.



Histogram of wind speed and direction for 1978. Fig. (3)



Histogram of average wind speed and direction for 1976, 1977, 1978. Fig. (4)

Note: Direction Frequency - Left Scale - Bars represent % frequency of winds from each direction. Speed Frequency - Right Scale - Printed Numbers are % frequency of wind speeds observed from each direction.

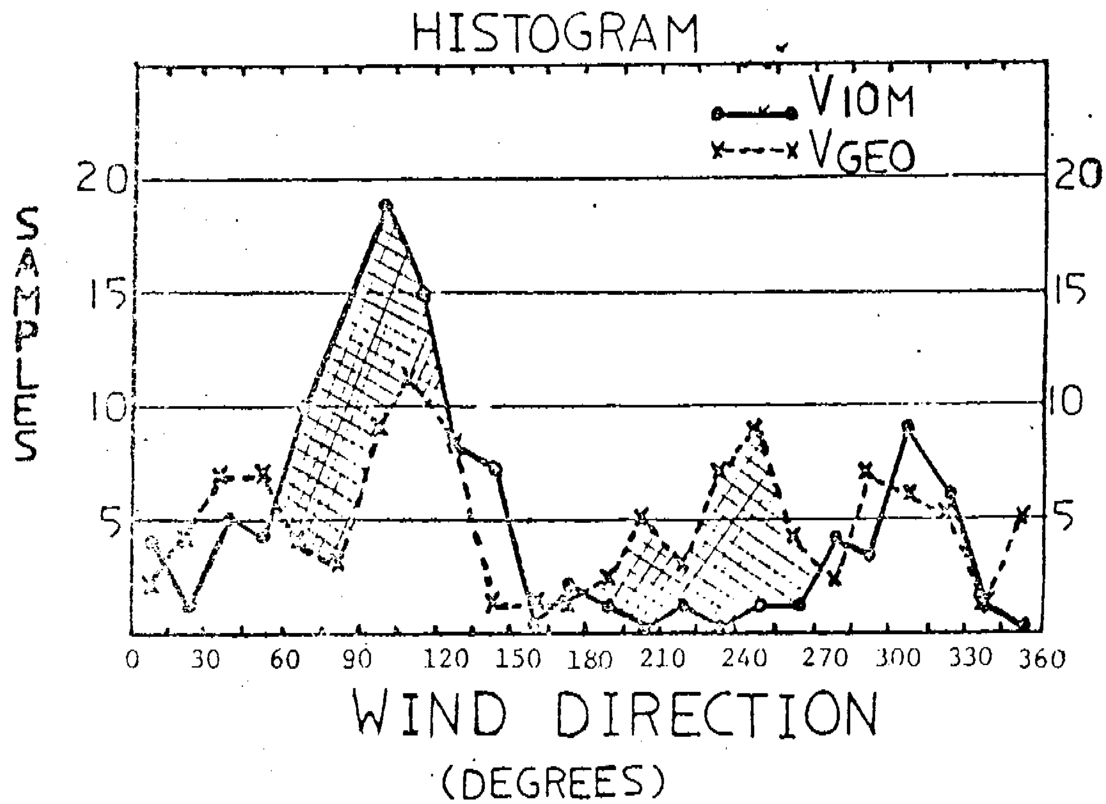
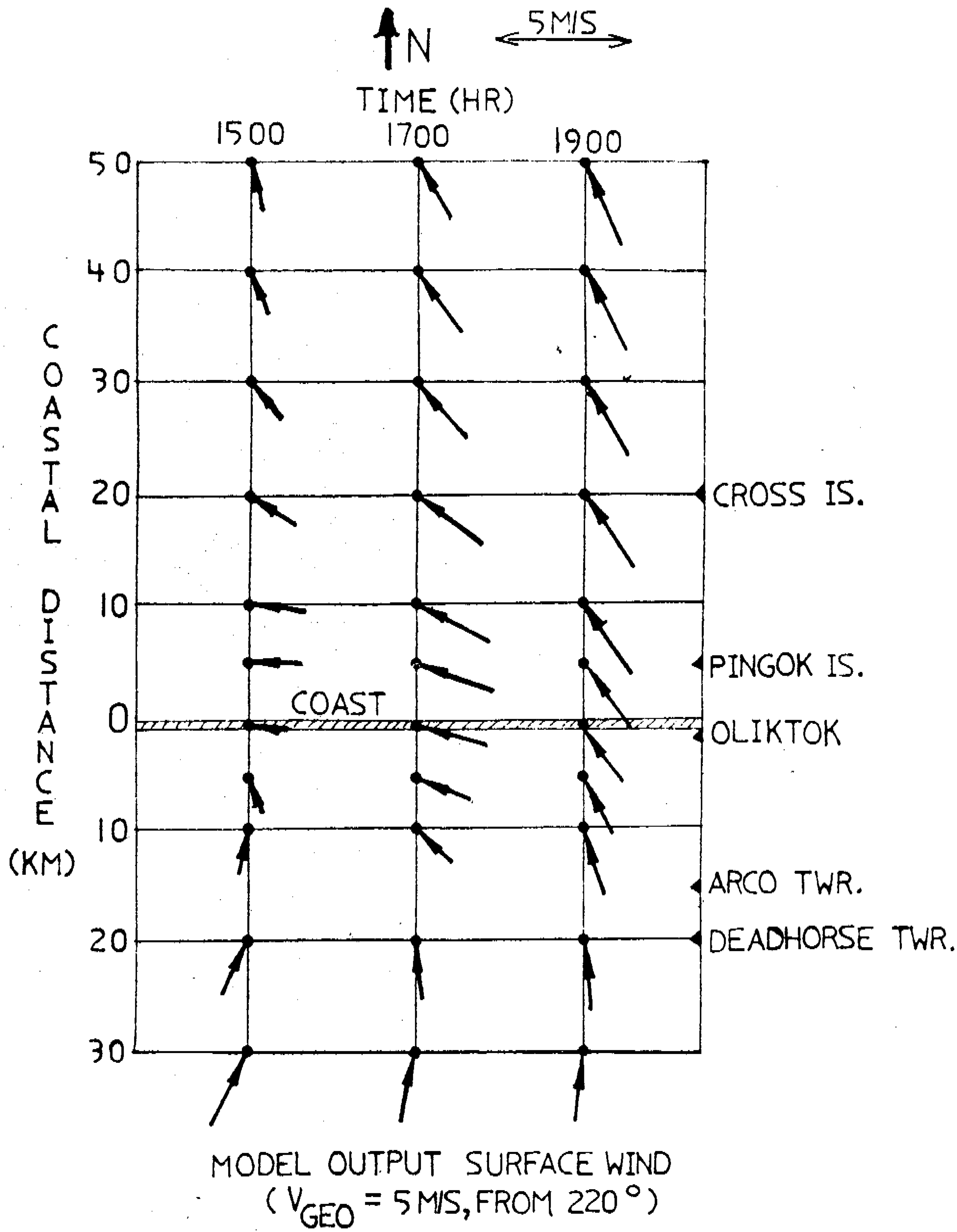


Fig. (5)

Comparison of surface winds on Cottle Island (10 meters) with geostrophic winds in August 1976. The wind directions are in 15 degree increments. The actual time period is August 13 to August 23 and August 30 to September 3, 1976.



Sea breeze model output of the surface wind vector with a geostrophic wind of 5 m/s from 220°T. Fig. (6)

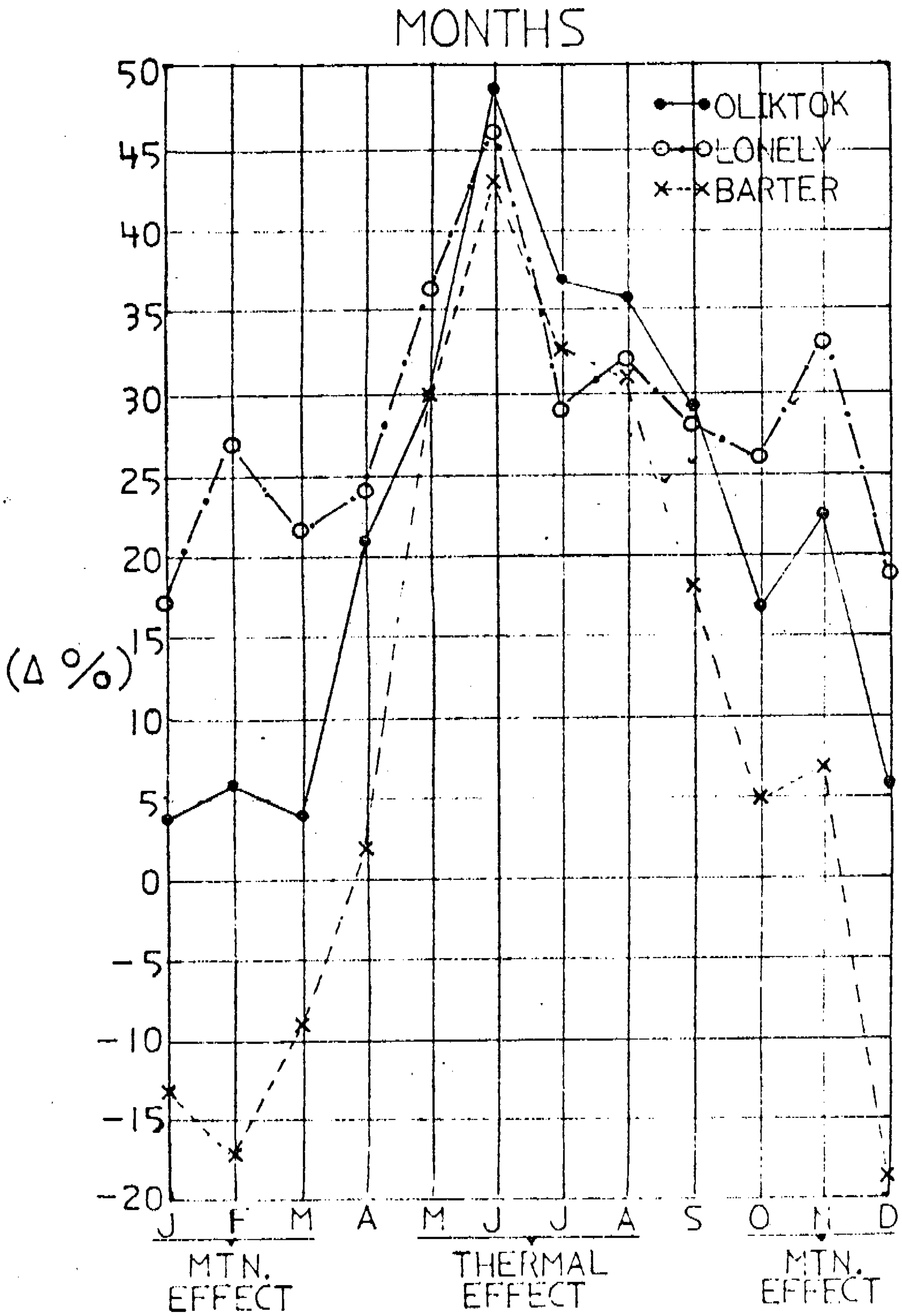


Fig. (7)

Plot of the monthly percentage difference (Δ%) between occurrence of NE-E winds and SW-W winds at Barter Island, Oliktok, and Lonely (all on the Beaufort Coast). Positive Δ% implies more east winds than west winds.

QUARTERLY REPORT

Contract #:	03-5-022-55
Research Unit #:	526-77
Task Order#:	13
Reporting Period:	10/1/78 - 12/31/78
Number of Pages:	8

CHARACTERIZATION OF THE NEARSHORE HYDRODYNAMICS OF AN ARCTIC BARRIER ISLAND-LAGOON SYSTEM

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ssociate Professor of Marine Science
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December 31, 1978

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Quarter Ending September 30, 1978

Project Title: Characterization of the Nearshore Hydrodynamics of an Arctic Barrier Island-Lagoon System

Contract Number: 03-5-022-55

Task Order Number: 13

Principal Investigator: J. B. Matthews

I. Task Objectives:

A. To review estuarine lagoon hydrodynamics.

B. Summarize knowledge of Simpson Lagoon.

C. Produce numerical predictions of Simpson Lagoon circulation under various environmental conditions.

D. Plan and execute a field program to verify the numerical model computations.

E. Produce circulation, flow and water quality estimates for use by ecological modeling group.

II. Field or Laboratory Activities:

A. Ship or Field Schedule:

9 November - 17 November 1978 Prudhoe Bay.

B. Scientific Party:

J.B. Matthews
Garry Meltvedt

C. Methods:

Field program. A new instrument deployment system was developed for use in shallow water moorings in an ice covered region. The new system is similar to standard taut wire systems but uses very short mooring lines and is modular in design to allow for rapid deployment and recovery from ice. The system is light and compact enough for helicopter deployment. Plans had to be modified slightly to accommodate the unusual open water encountered just beyond to fast ice. Instruments were deployed through the fast ice canopy or from the edge of the fast ice where large open water leads were found. Deployment sites were marked by pingers on the instrument packages.

A pair of instruments from the Egg Island channel were recovered using a pinger locator through the ice and then using divers to recover the instruments.

D. Sample Localities:

Data from an array of four meters has been recovered for use by other investigators. The station locations shown in Figure 2.

The deployment stations for the winter studies program are shown in Figure 1.

E. Data Collected and Analyzed:

Work has progressed in translating serial raw data tapes to 9 track data from the current meters and tide gauges recovered in August and September. Data from seven tide gauges and five current meters have been edited, corrected and plotted. Five more current meter records are being edited.

III. RESULTS.

Data from Egg Island channel for summer and spring show fresh water from the Kuparuk River on June 8th 1978. This is confirmed by satellite photographs of the over flow of river water onto the ice. The Egg Island channel instruments

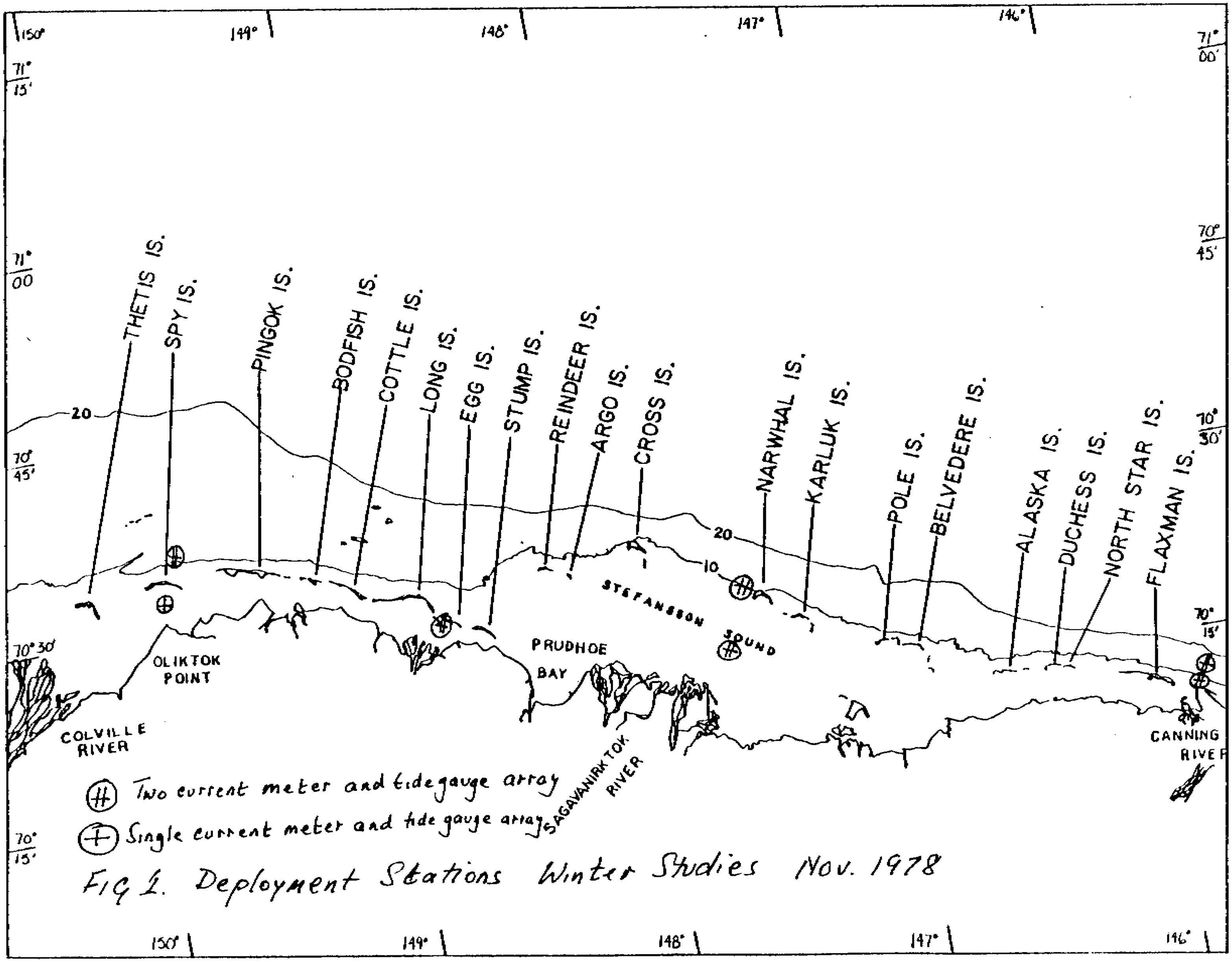

Fig 1. Deployment Stations Winter Studies Nov. 1978

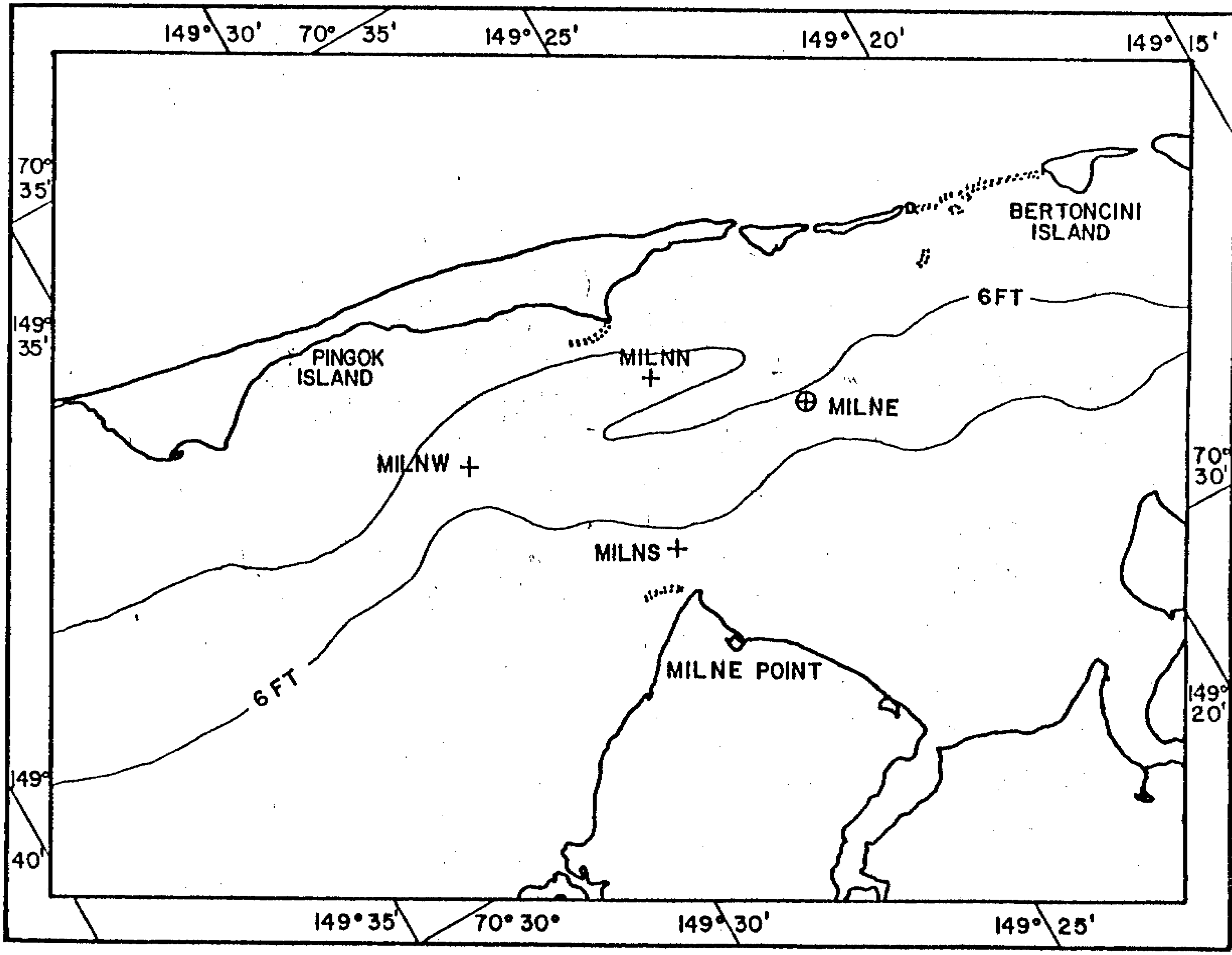

FIG 2. MILNE POINT INSTRUMENT ARRAY JULY-AUGUST 1978

were located on the bottom of the 18-20 feet deep channel. The 34°/₀₀ salinity water fell to 0°/₀₀ in about a one hour period and the water temperature rose from -20°C to 0°C. The fresh water persisted at the site until July 13, 1978, at which time the sea water returned. On that day salinity of 22-24°/₀₀ was observed. The temperature fluctuated between 0° and 7°C between 8 June when overflow occurred and 13 July. No data on currents through the channel are available because the current meter ceased operation on June 8, the day the river reached our instruments.

Data from the four Milne Point instruments shown in Figure 2 are very coherent. Major changes in salinity, temperature and current speed and direction are observed in all four instruments. For example, from 10-13 August temperatures fell from about 7°C to 1°C as salinities rose from 17°/₀₀ to 27°/₀₀ in all stations. Currents generally showed periods of about 5 days during which strong westward (WSW) currents of about 20-30 cms/sec flowed. The periods of strong westerly flow were broken by periods of weak (< 10 cm/sec) currents of all directions. During times of weak current flows tidal periodicties and sea breeze effects were visible in the records.

Surface and bottom drifters were released on 27 July 1978 on a line from Beechy Point extending seawards of Cottle Island for about 3 miles. Statistics for drifter recovery to date are 95/250 lagoon surface, 26/250 lagoon bottom 15/250 ocean surface and 3/20 ocean bottom drifters recovered/deployed. This represents an overall recovery to date of 29%.

The large recovery of ocean surface drifters (60%) resulted from thorough searches of all beaches within 10 miles of the release point during the 3 days immediately following release. Most of these drifters were found on the ocean side of Barrier Islands. The three ocean bottom drifters were also found on the ocean side of Barrier Islands.

Surface drifters from the lagoon were found within the lagoon during a period of 1 month. Some surface drifters from the lagoon releases were found at the east dock and as far east as Tigvariak Island 8 weeks after release. Bottom drifters from the lagoon were found mainly on the lagoon side beaches of Barrier Islands.

IV. PRELIMINARY INTERPRETATION OF RESULTS.

The current meter results from Egg Island channel suggest that the flushing effects of the spring breakup of the Kuparuk River persist for about a month and extend through Gwydyr Bay to the Barrier Islands. A two layer system does not appear to exist since fresh water flushed the cold saline water (34°/₀₀, -2°C) from the meters within a few hours. The initial drop from 34°/₀₀ to 9°/₀₀ salinity occurred in less than 5 minutes, the meter sampling interval. The date of the overflow appears to recur remarkably predicatably within about 5 days each year. The flushing of the channel with seawater in July, about one month after breakup also occurred with great rapidity (i.e. large salinity increase at the bottom over a 5 minute sampling interval). However it is not known if this is an annual event or not.

We have no measurements throughout the lagoon for the period of breakup. It is not possible to say how much of the lagoon is subject to flushing of the ranges described for Egg Island Channel. One could perhaps get an indication of the extent of the flushing from satellite observations of spring overflow. The photographs from several years show extensive overflow from north slope rivers which is not quite continuous along the coast at its peak and generally extends to Barrier Islands if these are present. Our best guess is that the

the region inshore of barrier islands in the lease area is subject to pronounced flushing and a very rapid change from high to low salinity at spring breakup.

The records from the Milne Point array during the open water season show fluctuations in salinity from 17°/₀₀ to 32°/₀₀ throughout the season with amplitudes decreasing towards freezup in September. The nearshore instrument has lower salinities and higher temperatures than the seaward meters. The data confirm that the lagoon acts under the influence of winds and responds as a whole. Fresh water from rivers tends to stay close to shore. Mixing occurs as boluses of water break off and mix in eddies around obstructions. Infrared satellite data taken in 1977 clearly showed water warmer than 7°C along the whole coast with larger boluses near major rivers.

Drifter data indicate that surface currents, and probably oil slicks, offshore of the Barrier Islands or in the lagoon could reach island and mainland beaches both east and west of the point of origin. If a spill occurred soon before a major storm, our drifter recoveries from 1977 suggest that it could travel westward at average speeds of 1 knot to reach barrier islands near Point Barrow in as little time as one month. Exact trajectories are not predictable since they depend on prevailing winds after the event. The difference between 1977 and 1978 drifter recoveries points up this varability. The 1977 release was immediately before the largest 10-day storm of the summer during which ENE winds below at speeds up to 30 knots. No drifters were recovered east of the release point. In 1978 variable winds occurred after the release and recoveries were made both east and west of the release point.

Bottom drifters may indicated trench of sediments and possibly of sunken oil masses. Little can be said of ocean bottom drifters since recoveries have been so few. However 38% of lagoon bottom drifters were recovered within 2 months of release suggesting fairly dynamic an environment on the lagoon floor.

These comments are from preliminary data analysis and are subject to verification. They are provided here for use in the draft impact statement.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES.

Some difficulty was encountered in recovering instruments through the ice in November. This resulted from insufficient time for training with the equipment. It is recommended that divers used in under-ice work be given a period of training and instruction in warmer ice-free waters before attempting future under-ice work.

VI. ESTIMATE OF FUNDS EXPENDED.

Approximately 1/3 of funds are expended. This results from high initial instrument and field support costs as well as data reduction charges. The winter studies program was carried out simultaneously with the large summer data reduction work.

QUARTERLY REPORT

Contract: #0302256
Research Unit: #529
Task Order: #33
Reporting Period: 10/1/78-12/30/78
Number of Pages: 8

SEDIMENT CHARACTERISTICS, STABILITY, AND ORIGIN OF THE BARRIER ISLAND-LAGOON COMPLEX, NORTH ARCTIC ALASKA

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Principal Investigator
Assistant Professor in Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

December 1978

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I. TASK OBJECTIVES

The primary objective of this program is to collect all basic data on the size distribution, mineralogy, and certain biologically "critical" chemical attributes of sediments of the barrier island-lagoon complex of north arctic Alaska. In addition, research is being directed to assess the long-term directions and net volumes of alongshore transport of sandy sediments, as well as the stability and origin of the barrier island along the Beaufort Sea coast. The other objective of this program is to collect lithological and chemical baseline data from the contiguous area of the continental shelf of the Beaufort Sea. The chief purpose of this latter effort will be to fill in the small data gaps that exist on shelf sediments, principally between Barter Island and Demarcation Point.

II. LABORATORY ACTIVITIES

Laboratory work since October 1, 1978 has included the analysis of total iron, zinc, copper, nickel, and chromium concentrations in both Simpson Lagoon (SL877) and Beaufort Sea (GLA77) sediment samples. The Beaufort Sea clay mineral data compiled by our lab over the past decade have been plotted on the supplied OCSEAP base map (Fig. 1). Detailed size analysis of the segmented vibrocore samples (PWB75) furnished by Peter Barnes of the U.S. Geology Survey in Menlo Park are now being completed to augment the information previously presented in Table V of the March 1978 annual report for this same contract: (R.U. #529-77).

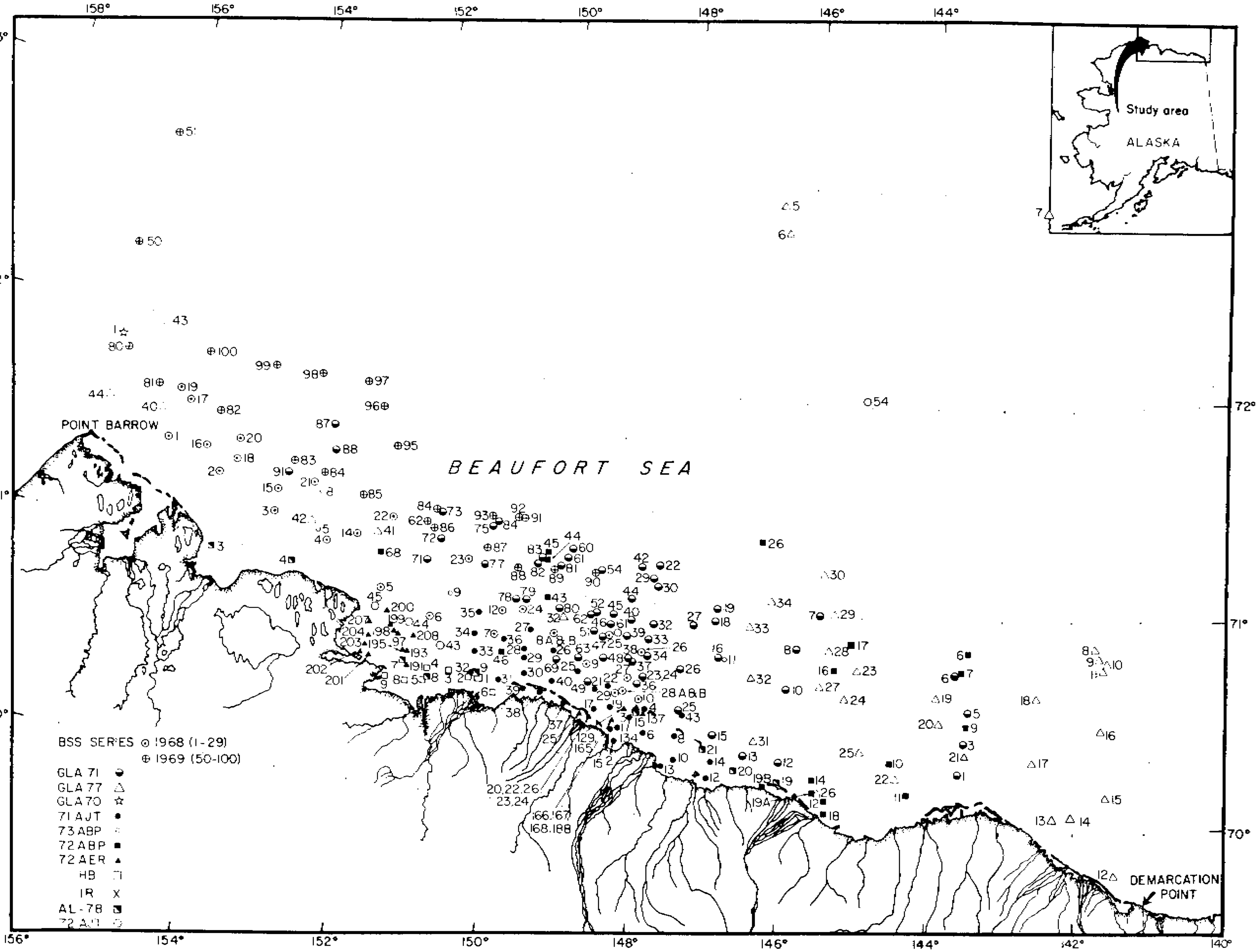

Figure 1. Station locations for Beaufort Sea clay mineral data.

Analytical Methods

For chemical analysis, sediment samples were oven-dried at 90°C. The dried samples were then finely pulverized with mortar and pestle in preparation for total elemental analysis (Naidu and Hood, 1972). The fine powders were then totally digested in concentrated hydrofluoric-nitric acid (Rader and Grimaldi, 1961). Heavy metal analyses on the total digests were accomplished with a Perkin-Elmer Model 603 atomic absorption spectrophotometer.

Station locations were updated and clay mineral abundances were plotted onto the standard OCSEAP Beaufort Sea base map by Jim Clough, graduate student (Figs. 1, 2, 3). Specifically, Expandable Component and Kaolinite-Chlorite ratio areal trends were deduced from the plotted mineral values.

Grain size distributions of the vibrocore segments are being analyzed by the usual sieving-pipetting method, and the conventional grain size parameters will be computed after the formulae given by Folk and Ward (1957). Computation of the parameters is accomplished through the use of the University of Washington (Seattle) SEDAN program: UWMS-1147, with the University of Alaska Honeywell 66/40 computer. Presently, this SEDAN program is being modified by Robert Sutherland of the Institute of Marine Sciences Data Management. A more rapid and convenient use of the program to obtain the grain size parameters is the object of this work and generally involves a change from card batch input of data to a faster time sharing operation of the computer.

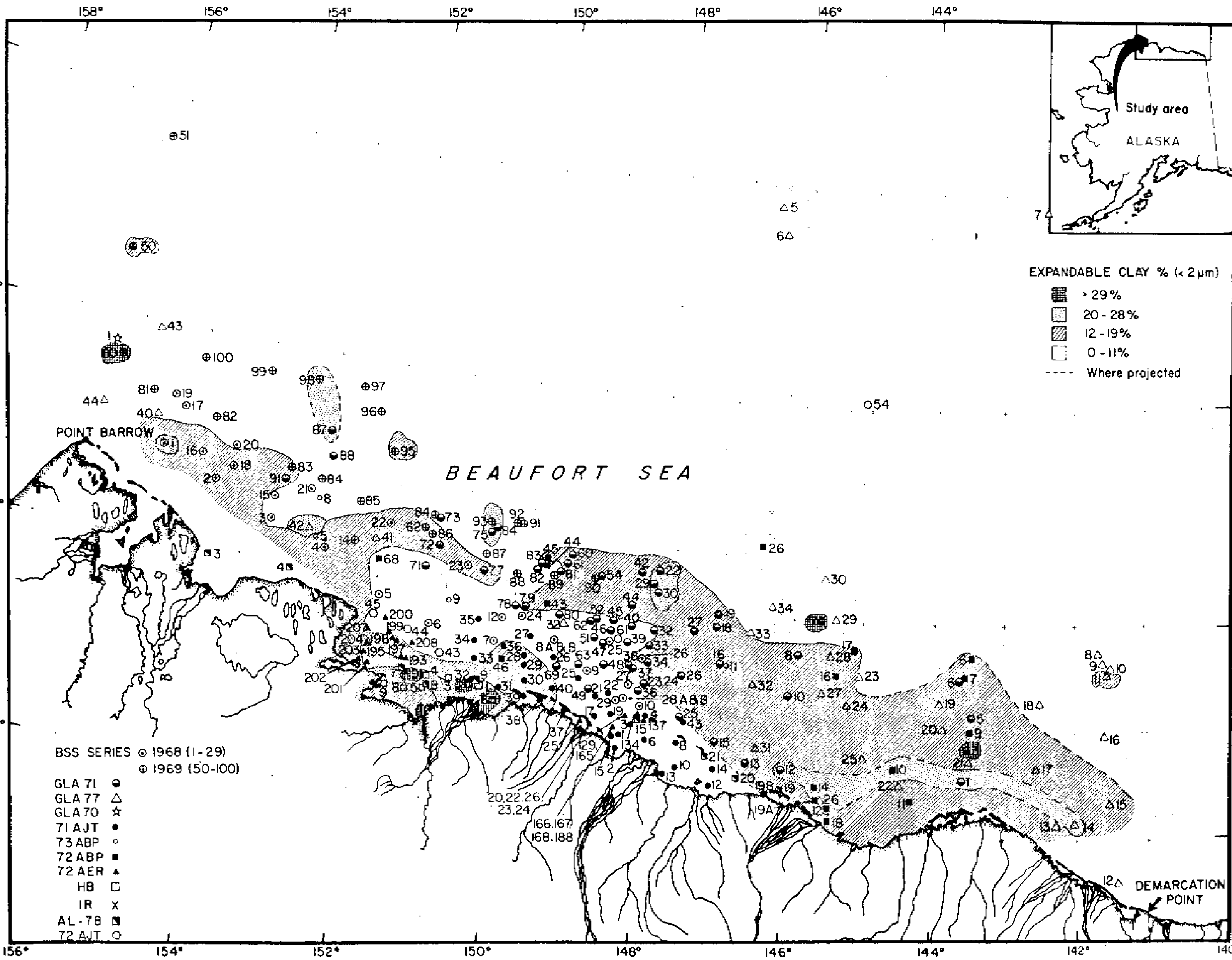

Figure 2. Expandable clay mineral distribution in Beaufort Sea surface sediments.

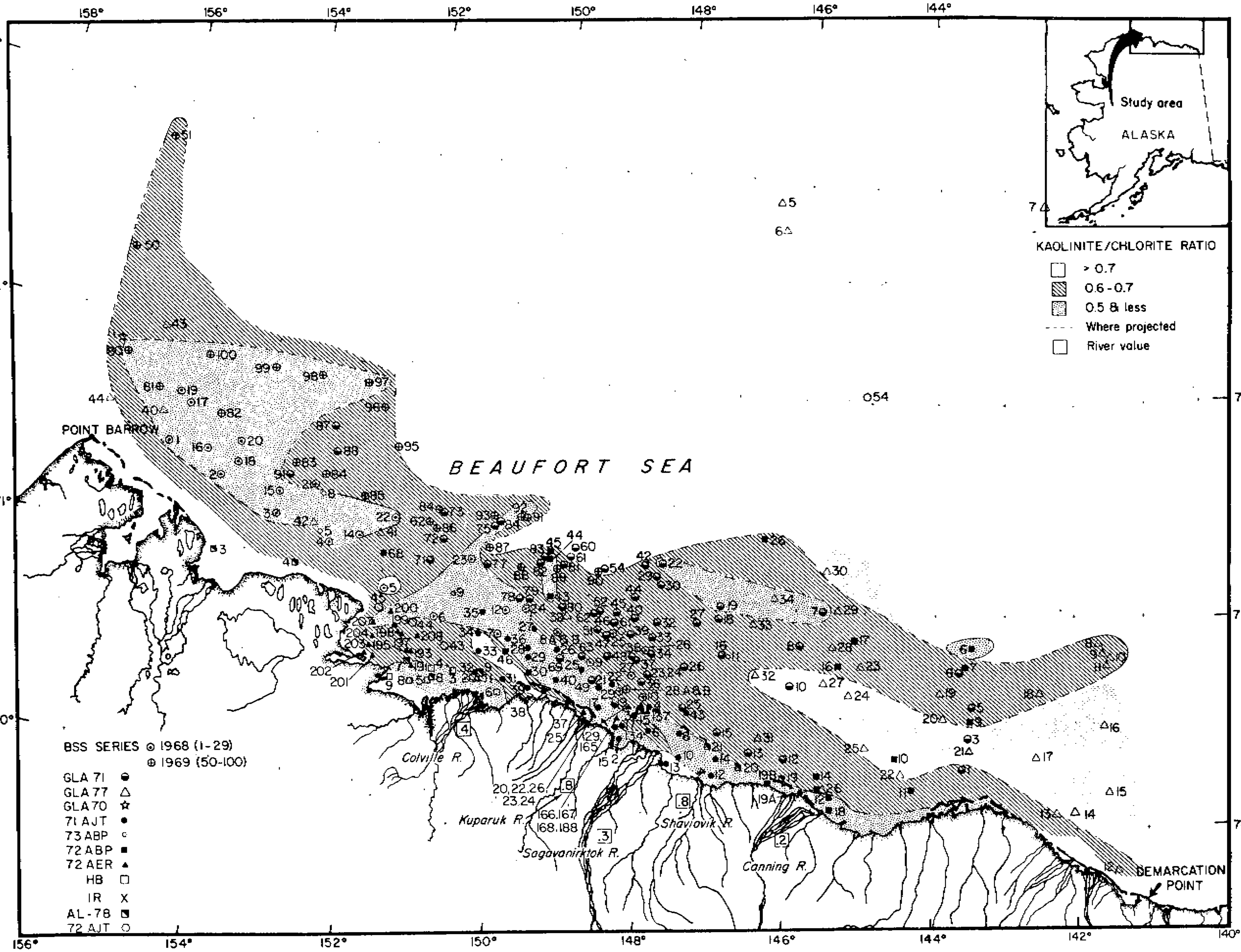

Figure 3. Kaolinite/chlorite ratio distribution in Beaufort Sea surface sediment.

III. RESULTS

Tables I and II list the concentrations of iron, zinc, copper, nickel, and chromium in the hydrofluoric-nitric acid total digests of the 1977 Simpson Lagoon and USCGS Glacier cruise Beaufort Sea sediment samples. It is quite clear that elemental abundances are significantly greater in the continental shelf and slope sediments than in the nearshore lagoon sediments. Complete interpretation of the total digest results have yet to be done.

Figures 2 and 3 show the areal distribution of the clay mineral expandable component and kaolinite-chlorite ratios, respectively, in the Beaufort Sea sediments. Information about the riverine source clay mineralogy (see Fig. 3) aided in distinguishing the areal trends from the plotted clay mineral values. Although interpretation of the clay mineral data is only preliminary, there is strong indication that the Colville River is a source for high expandable component (Naidu and Mowatt, 1974) whereas the Kuparuk and other small rivers seem to furnish relatively high kaolinite concentrations to the nearshore sediments (Naidu, *et al.*, 1975). The net westward flow of the coastal currents is born out by the similarly westward spreading of the high kaolinite areas (Fig. 3). Further interpretation of the clay mineral plots remains as of this report.

TABLE I

CONCENTRATIONS OF IRON, ZINC, COPPER, NICKEL, AND CHROMIUM IN HYDROFLUORIC-NITRIC ACID DIGESTS (RADAR & GRIMALDI, 1961) IN SIMPSON LAGOON SEDIMENTS

Refer to R.U. #529-77 Annual Report for Station Locations

Sample	Fe wt %	Zn μg/g	Cu μg/g	Ni μg/g	Cr μg/g
SL877- 2	0.70	30	9	17	21
SL877- 6	1.70	90	18	44	56
SL877-13	1.95	95	18	46	60
SL877-18	1.40	85	16	42	55
SL877-23	1.55	100	17	42	56
SL877-27	1.84	85	12	48	58
SL877-29	1.92	105	20	43	63
SL877-30	0.65	35	5	19	24
SL877-33	1.22	80	14	39	45
SL877-35	1.51	92	14	40	55
SL877-39	1.63	90	26	45	63
UG- 1	1.22	70	13	33	46
Average	1.44	80	15	38	50

TABLE II

CONCENTRATIONS OF IRON, ZINC, COPPER, NICKEL, AND CHROMIUM IN HYDROFLUORIC-NITRIC ACID DIGESTS (RODER & GRIMALDI, 1967) IN BEAUFORT SEA SEDIMENTS

Refer to R.U. #529-77 Annual Report for Station Locations

Sample	Fe in wt %	Zn µg/g	Cu µg/g	Ni µg/g	Cr µg/g
GLA77- 5	4.00	130	40	87	103
GLA77- 6	4.48	155	45	100	117
GLA77- 7	3.99	125	42	92	110
GLA77-10	3.44	105	25	77	96
GLA77-12	2.70	110	22	58	86
GLA77-15	3.34	130	31	78	98
GLA77-16	2.59	120	19	65	89
GLA77-17	3.63	150	33	90	108
GLA77-18	2.32	90	20	42	66
GLA77-20	3.00	108	19	55	70
GLA77-22	2.82	115	24	56	84
GLA77-23	3.08	130	30	71	98
GLA77-31	2.60	115	21	49	80
GLA77-33	2.94	115	30	56	74
GLA77-42	3.02	110	18	62	90
Average	3.20	120	29	69	91

IV. DISCUSSION

The results of the chemical work in this report will be followed by more detailed chemical analysis of Beaufort Sea and Simpson Lagoon sediments. Further understanding of the geochemistry of the above sediments awaits the conclusion of this concentrated study.

Additional plotting of Beaufort Sea data (textural, mineralogical and chemical) are proceeding and must be completed before a thorough synthesis of the Beaufort Sea sedimentary processes can be accomplished.

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OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 33 R.U. NUMBER: 529

PRINCIPAL INVESTIGATOR: Dr. H. S. Naidu

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4
Archived Samples			None	7/30/79	submitted	10/30/78
Simpson Lagoon	8/77		submitted	6/30/79	Submitted	10/30/78
Barrier Islands	8/77		None	6/30/79	None	None
Glacier	8/77	9/6/77	10/30/78	None	submitted	10/30/78
Summer '78 Field Season			None	None	6/30/79	None

An updated submission schedule, and the submission of data will take place on or around February 1, 1979. Absence of Principal Investigator makes update at this time impossible.

1 Data Management Plan has been submitted to the Arctic Project Office. We await approval.

Fiscal Report

Contract: 03-5-022-56

Task Order: #33

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$2,240.67	$32,781.59
Travel	181.18	3,592.18
Equipment	238.99	16,567.90
Other	5,479.10	13,239.29
Staff Benefits	236.96	4,405.42
Overhead	1,120.34	16,390.81
Total Billed	$9,497.24	$86,977.19
Total Award		$175,059.00
Total Unbilled		88,081.81

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Quarterly Report

October - December, 1978

Research Unit #530

The Environmental Geology and Geomorphology of the Barrier Island - Lagoon System Along the Beaufort Sea Coastal Plain from Prudhoe Bay to the Colville River

Principal Investigator
P. Jan Cannon
University of Alaska
Fairbanks, Alaska

I. Task Objectives

1. To determine the origin and evolution (geomorphic history) of the barrier islands and coastal lagoon.

2. To determine the source(s) of the gravel size materials that make up the barrier islands.

3. To determine the stability of the barrier island - lagoon system in respect to natural processes and man induced effects.

4. To determine the magnitude of the geomorphological relationships between the barrier island - lagoon system and landforms of the coastal plain such as the various streams, dune fields, ground patterns,thermokarst features, deltas, pingos, lugs and lakes.

5. To construct a spacial and temporal model of the environmental geology of the region.

II. Activities

1. Data search for LANDSAT imagery applicable to measuring the lateral extent of over-ice flow from the Kuparuk River.

2. Enlargement of applicable imagery to 1:63,360 scale, preparation of maps, and measurement of the area covered by over-ice flow from the Kuparuk River.

The above apply to determining the quantity of detrital material (peat soils) introduced into the lagoon system from the Kuparuk River. This work is to corroborate estimates of this quantity based on 1977 work. The methodology involves measuring the volume of detritus expelled from the river at breakup and deposited on the surface of the lagoon ice. This volume is approximately 60-80 percent of the total detritus annually transported in the river system (Carlson, 1976a and b).

Work is in progress to determine more precisely the rates of coastal erosion within the Simpson barrier island - lagoon system. Preliminary erosion rates were determined from 1:30,000 and 1:53,000 vertical aerial photography of the coast between Oliktok Point and Beechy Point. These data are applicable to determining the volume of detritus introduced into the system by coastal erosion.

Erosion rates are also being precisely determined at various localities along the Beaufort Sea coast, and along several river systems. These localities are Barrow, Cape Simpson, Cape Halkett, Kuparuk River, Prudhoe Bay, Sagavanirktok River, Flaxman Island, Camden Bay, and Barter Island. Data from these localities will provide a base for comparison of Simpson Lagoon data and an approximate mean erosion rate of the Beaufort Sea coast.

3. Data search for photography that completely covers Simpson Lagoon and the above mentioned localities.

4. Enlargement of all available photography to approximately 1:30,000 scale.

5. Review of over 500 ground and aerial photographs taken during the past summer of various areas of the coastal plain.

These photographs document landforms and landform assemblages, overland extent of storm surge debris, depositional and erosional processes, and temporal and spatial relationships of breakup and freezeup.

The areas inspected and photographed include: (1) the coast and barrier islands from the Colville River, east to Demarcation Point, (2) the Colville, Kuparuk, Sagavanirktok, and Canning Rivers, (3) moraine deposits near the Canning River, (4) areas located south of Techepuk Lake which show high reflectance on LANDSAT imagery, (5) Techepuk Lake and the Kogru River, and (6) areas enroute to those listed above.

6. Work is in progress on a terrain map based on lake density, size, and orientation of the coastal plain between the Canning River and Techepuk Lake. Data are derived from existing maps and aerial and ground reconnaissance.

7. Work is in progress on a quantitative geomorphic description of the coastal plain and delta systems.

III. Results

1. Three years of over-ice flow from the Kuparuk River are well documented on LANDSAT imagery (1973, 1977, 1978).

2. The lateral extent of over-ice flow at the time of river breakup does not vary significantly from year to year. The maximum area of sea ice covered by flow from the Kuparuk River is approximately 60 square kilometers.

3. Detrital material (peat soil) is introduced into the rivers by the same processes and sources as detrital material eroded directly into the lagoon.

4. Overflights of the Kuparuk, Sagavanirktok, and Canning Rivers during the period from mid to late summer show the capacity to be extremely low. This is documented on intermediate altitude photography.

5. Photography applicable to erosion rate studies in the areas specified is available through the Remote Sensing Archives of the Geophysical Institute at the University of Alaska, Fairbanks. This includes 1974 U-2 and 1977 NOS coverage of various coastal areas. Photography taken of part of the Simpson Lagoon area was obtained through the Naval Arctic Research Laboratory in Barrow, Alaska. Enlargements

of 1955 U.S. Geological Survey mapping photography and 1974 U-2 photography have been ordered. Completion of the erosion rate studies is dependent on receipt of this photography.

6. The areas of high reflectance on LANDSAT imagery are underlain by deposits of sand-sized clastics. The topography in these areas is more irregular (often in the form of ancient dune ridges) than the surrounding coastal plain, and the lakes do not exhibit strong orientation.

7. The topographic relief of coastal and lake shorelines is variable from almost no vertical change to several meters. There tends to be minimal changes in relief of coastal and lake shorelines in areas east of the Sagavanirktok River. This low relief shoreline morphology is also important in the Kogru River area. The occurrence of a low relief morphology may have important implications in terms of erosion and ground stability.

8. Low-sun-angle photography is extremely useful in examining areas of low topographic relief. This type of photography, obtained this past summer, enhances low relief geomorphic features such as ground patterns and ridges. Many of these features would not have been recorded under high-sun-angle conditions.

9. A bisected pingo was observed and documented under low-sun-angle conditions from an altitude of approximately 8,000 MSL. Subsequent low altitude and ground inspection showed stratification of poorly sorted outwash sediments overlying an ice core. The location of this landform is approximately 10 kilometers southeast of Milne Point in an area of high lake density. Lakes in this area are strongly oriented and several meters to about 3 kilometers in length.

10. The quantitative geomorphic description of the study area is not sufficiently developed at this time to report any results.

IV. Preliminary Interpretation of Results

Preliminary estimates of coastal erosion rates and detritus input into Simpson Lagoon from coastal erosion and river sources are adequate for modeling purposes until completion of more detailed studies.

Variation in lake density, size, and orientation may be a useful tool in interpreting substrate types. This has important implications in determining ground stability or in locating future aggregate sources.

Low relief coastal shorelines are much more susceptible to inundation and erosion than high relief shorelines. Lakes with low relief shorelines, and located adjacent to low relief coastal shorelines, are extremely vulnerable to inundation and erosion. These areas are being delineated and documented by low altitude reconnaissance and low-sun-angle photography.

V. Problems Encountered/Recommended Changes

A problem is inexpedient delivery of necessary remote sensing data. It is highly recommended that aerial reconnaissance and documentary photography be encouraged with low-sun-angle conditions.

References

Carlson, R.F., 1976a, A theory of spring river discharge into the arctic icepack, in D.C. Burrell and D.W. Hood, conveners, Proceedings Inst. Mar. Sci., University of Alaska, Fairbanks, pp. 165-166.

____________, 1976b, Environmental assessment of the Alaskan continental shelf, Unpubl. rept. to NOAA, Water Res. Inst., University of Alaska, Fairbanks.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 34 R.U. NUMBER: 530

PRINCIPAL INVESTIGATOR: Dr. P. Jan Cannon

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

1 Data Management Plan has been submitted to the Arctic Project Office. We await approval.

Fiscal Report

Contract: 03-5-022-56

Task Order: #34

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$3,323.41	$27,038.49
Travel	2,120.00	5,875.63
Equipment	-0-	-0-
Other	65.15	1,697.56
Staff Benefits	207.48	1,510.29
Overhead	1,661.70	13,519.24
Total Billed	$7,377.74	$49,641.21
Total Award		$105,875.00
Total Unbilled		56,233.79

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Contract # 03-8-022-35182
Research Unit # 531
Reporting Period: 1 October-31 December 1978
Number of Pages: 11

Oceanographic Processes in a Beaufort Sea Barrier Island-Lagoon System: Numberical Modeling and Current Measurements

Principal Investigators:

J. C. H. Mungall
Kinnetic Laboratories, Inc.
One Potrero Street
Santa Cruz, CA 93060
408/425-1474

Robert E. Whitaker
Department of Oceanography
Texas A&M University
College Station, TX 77843
713/845-7432

3 January 1979

A. Field or Laboratory Activities

1. Data from Summer Field Program

Sensors on the tower positioned off Milne Point during August 1978 provided data on the water characteristics, horizontal current components and waves. Wave data were also obtained from the ocean side of Pingok Island. The current and wave data were recorded simultaneously in analog and digital form. The analog data are being processed at Texas A&M and the digital data are being analyzed at Kinnetic Laboratories.

There are 53 records of simultaneous current and wave data. Seven of these records cover 10 minutes, the remainder are 1-1½ min. duration. In addition, there are 17 records of 10-15 min. duration from the ocean side of Pingok Island.

Figure 1 shows the preliminary comparisons of the drift current computed from the digital data. The x component of the current is alongshore positively directed nominally to the north. The y component is positive towards the shore. The wind data were obtained with a hand-held anemometer employed at the Milne Point camp. These wind data will be compared to the more reliable data from the Milne POint meteorological tower since the visual correlation between winds and currents is low. Moreover, there is a discrepancy between the sense of the digital and analog averages of the alongshore (x) current.

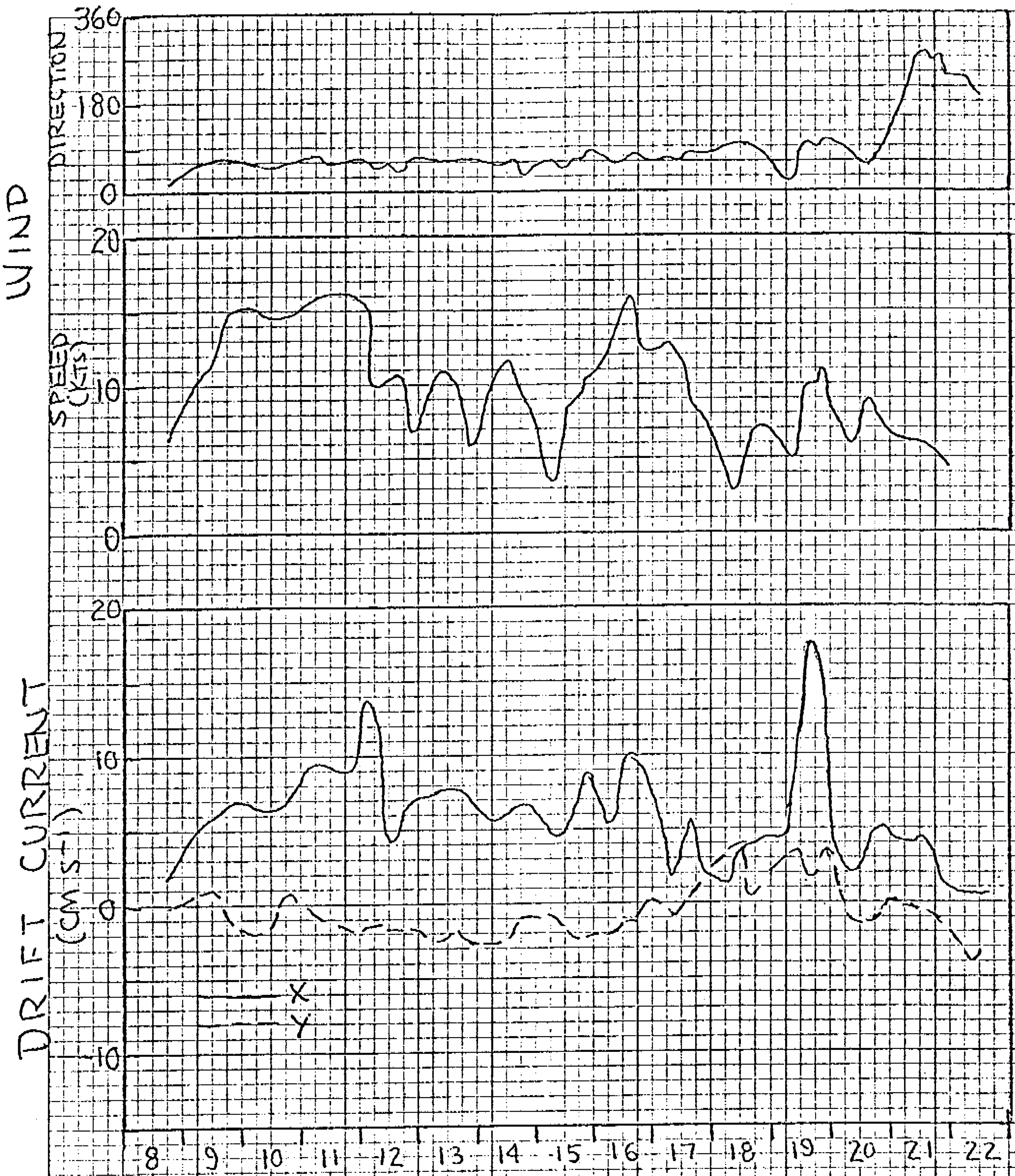

Figure 1: Comparison of winds and drift currents, Milne Point.

Digitization of the analog data has proven to be a time-consuming procedure. Briefly, the process consists of three steps. First, the analog data are electromechanically converted to digital form and stored on magnetic tape. Next, the converted data are plotted against time producing an analog version of the digital data. Lastly, the two analog traces are compared and edited.

2. Numerical Modeling

At the request of the BLM-OCS Anchorage Office, the three-space model was applied to the Beaufort Sea area to obtain the steady-state wind-driven circulation. Figures 2 through 9 show the derived flows for the July-August and October-November periods. The winds taken are the means from the four principal compass headings.

Because each of the four levels used to model the mathymetry are separated by 5m, the computed currents have been labeled upper-level.

B. Estate of Funds Expended

Total expenditures to 31 December 1978	$ 102,574.41
Outstanding Encumbrances	16,652.95
Unencumbered Balance	468.25

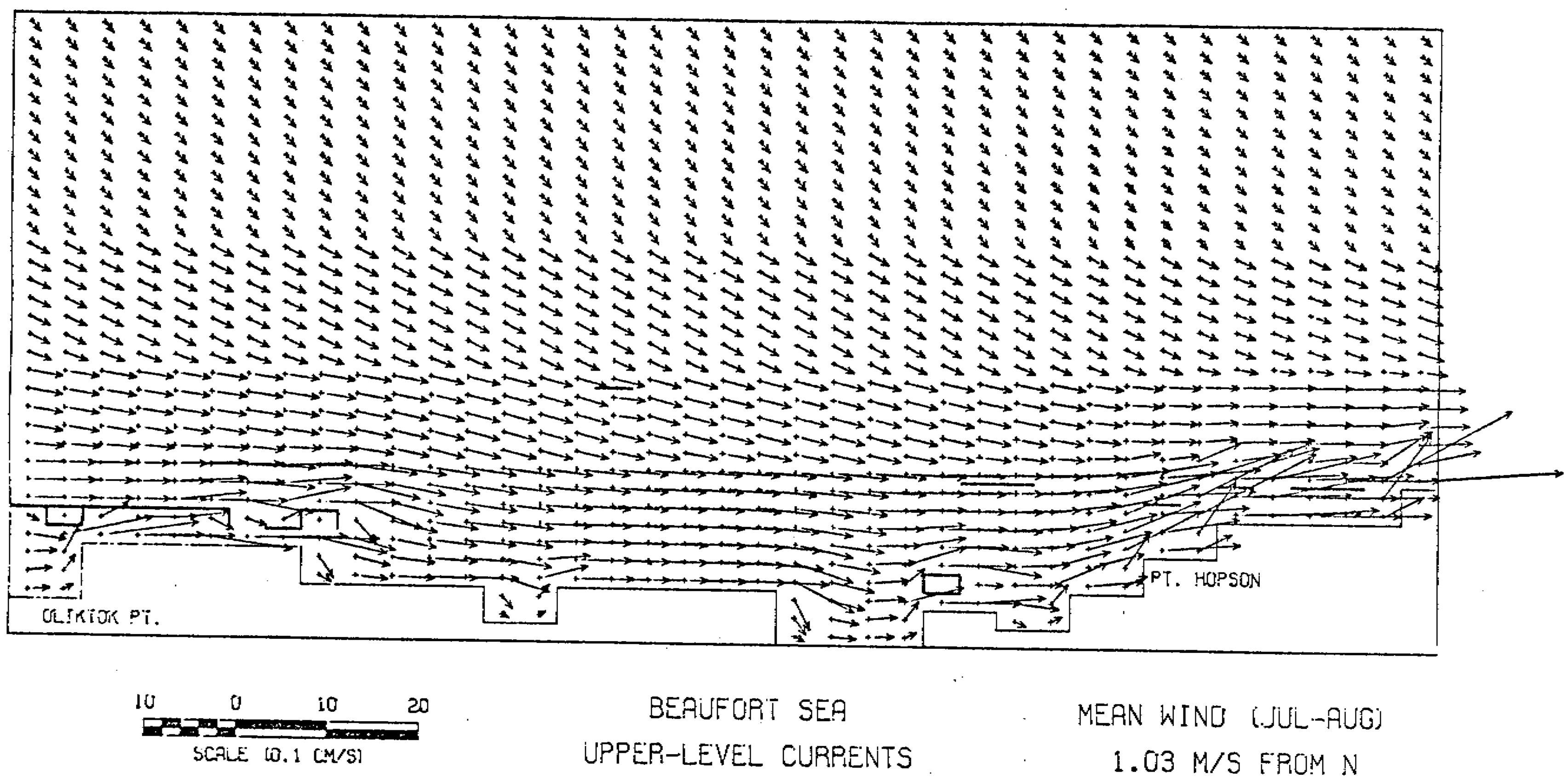

Figure 2. July-August upper-level currents, 1.03 m/s from north.

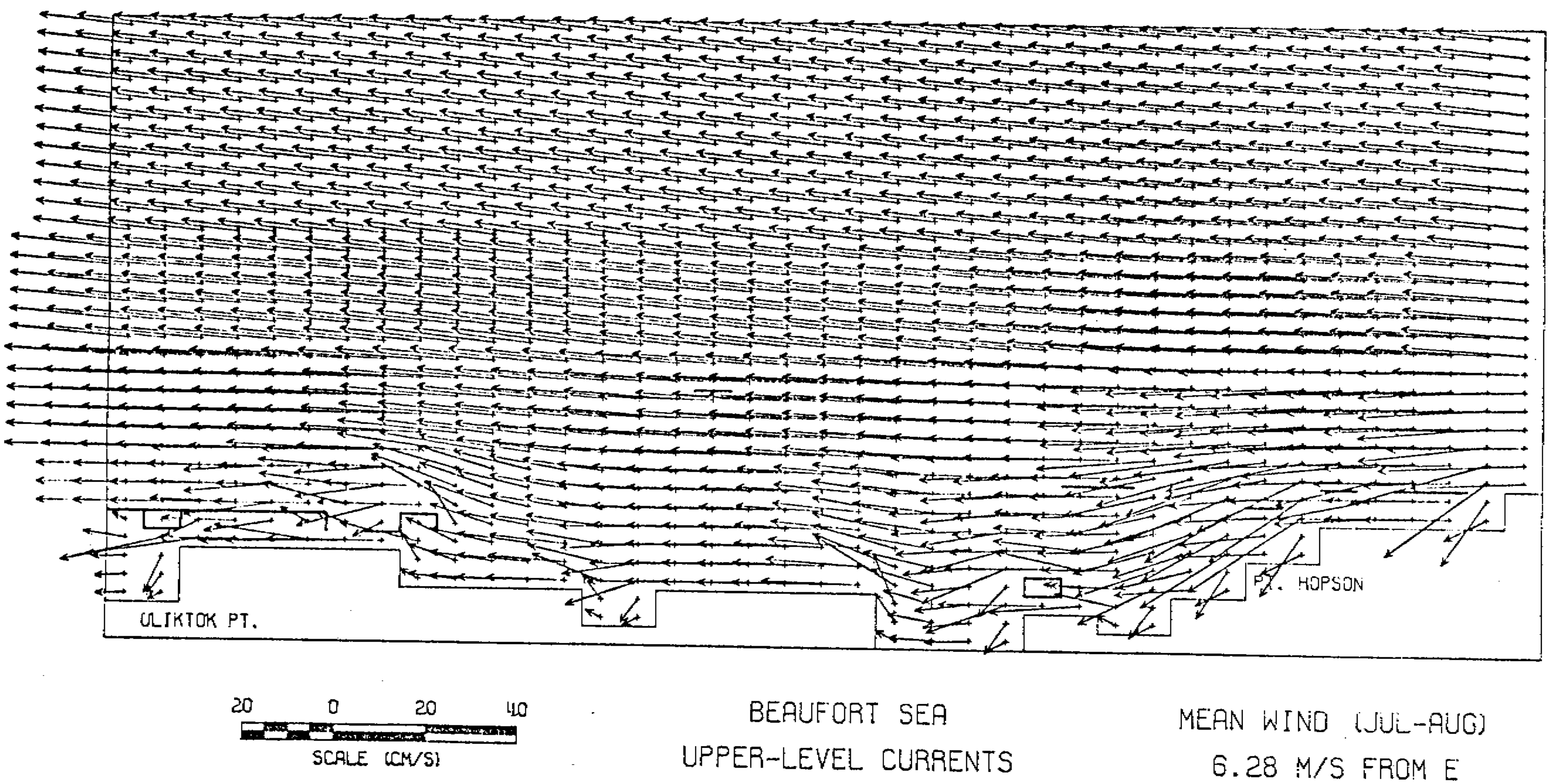

Figure 3. July-August upper-level currents, 6.28 m/s from east.

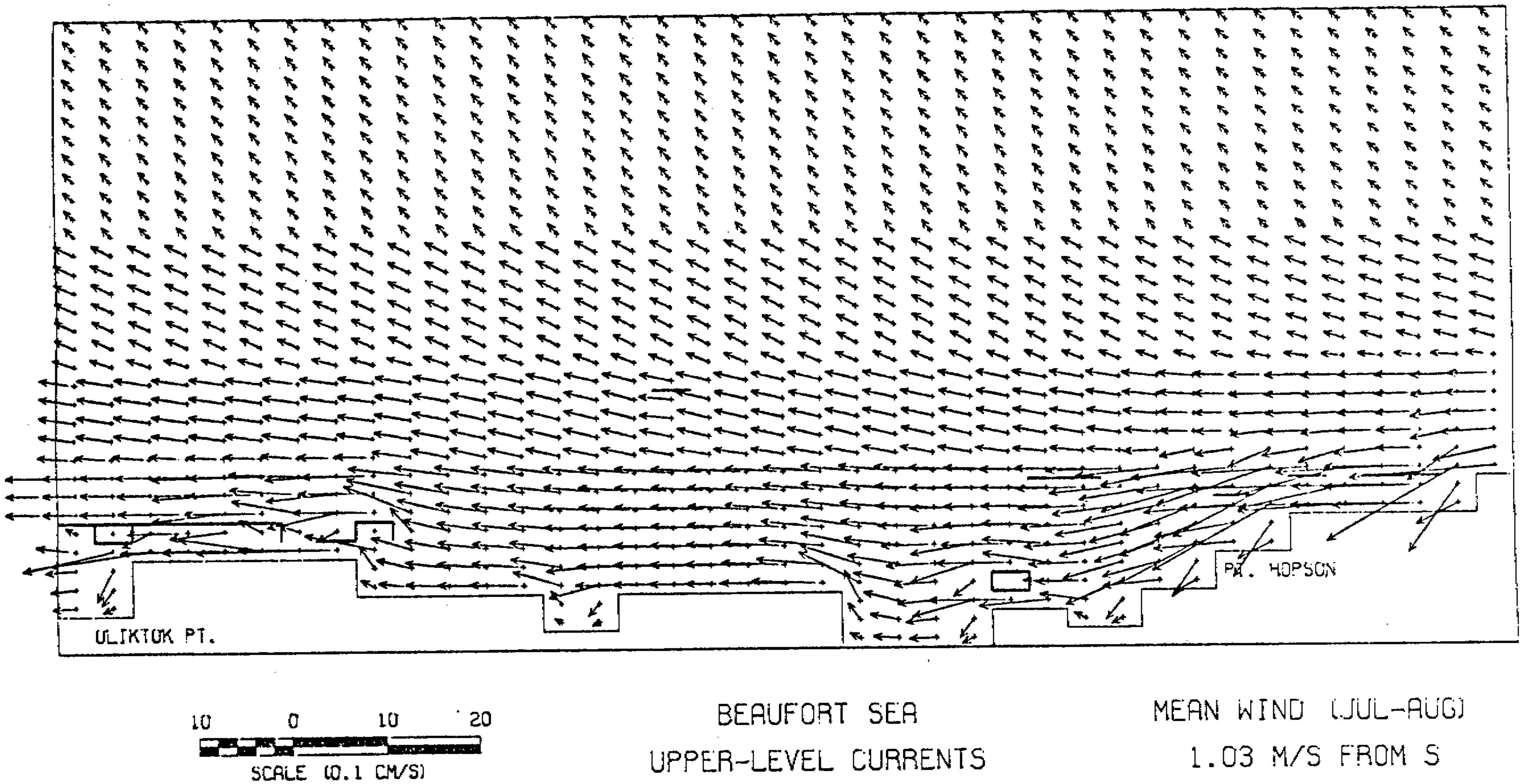

Figure 4. July-August upper-level currents, 1.03 m/s from south.

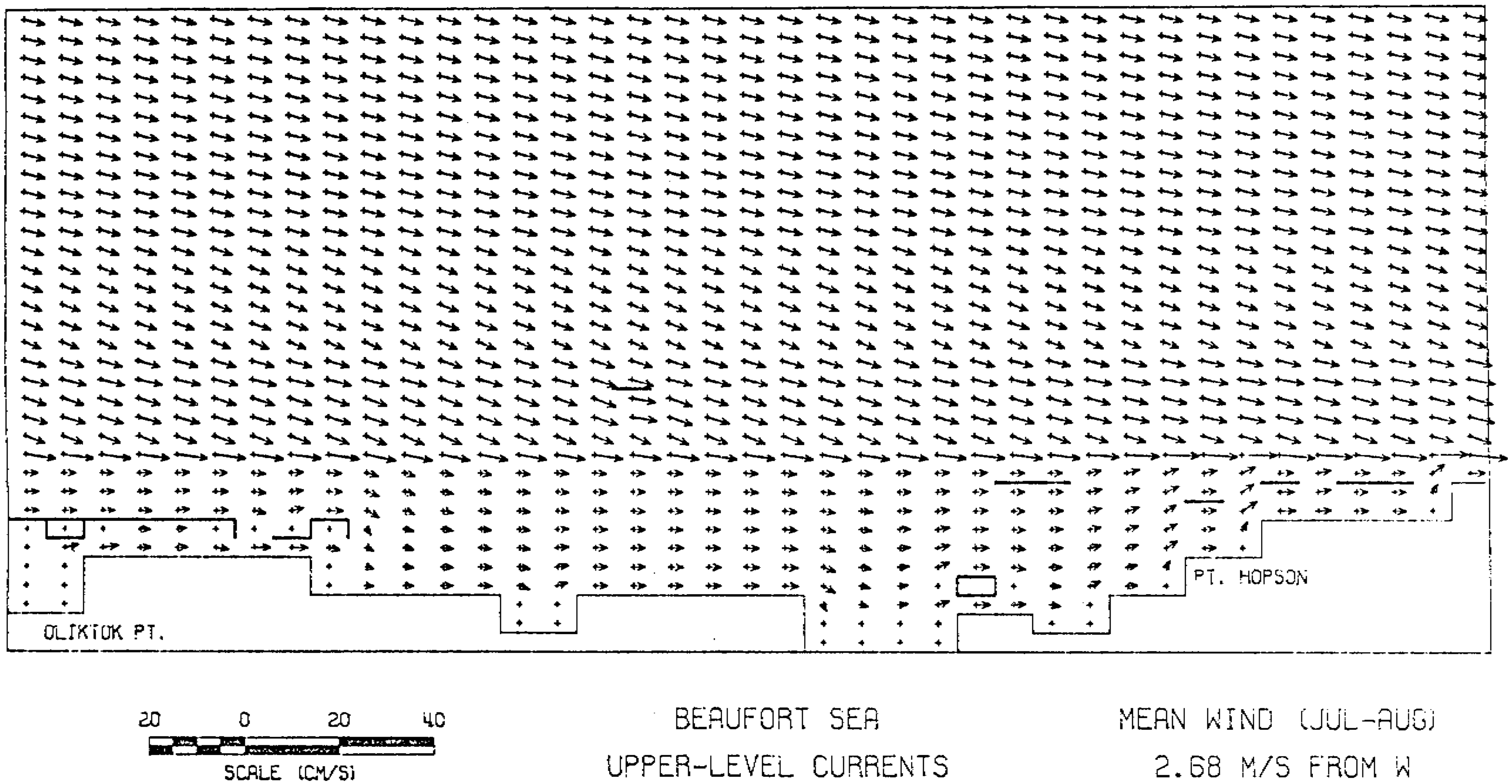

Figure 5. July-August upper-level currents, 2.68 m/s from west.

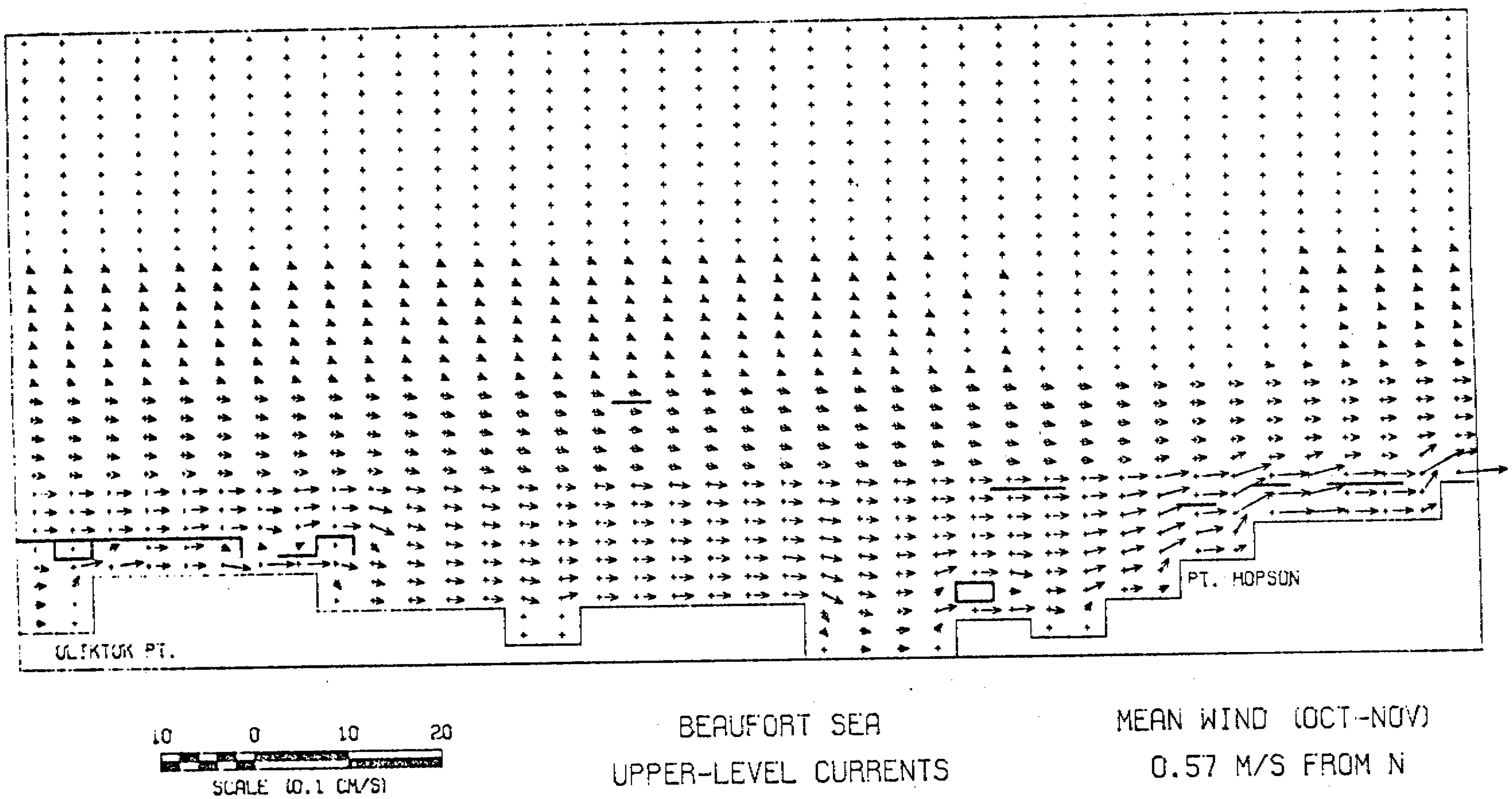

Figure 6. October-November upper-level currents, 0.57 m/s from north.

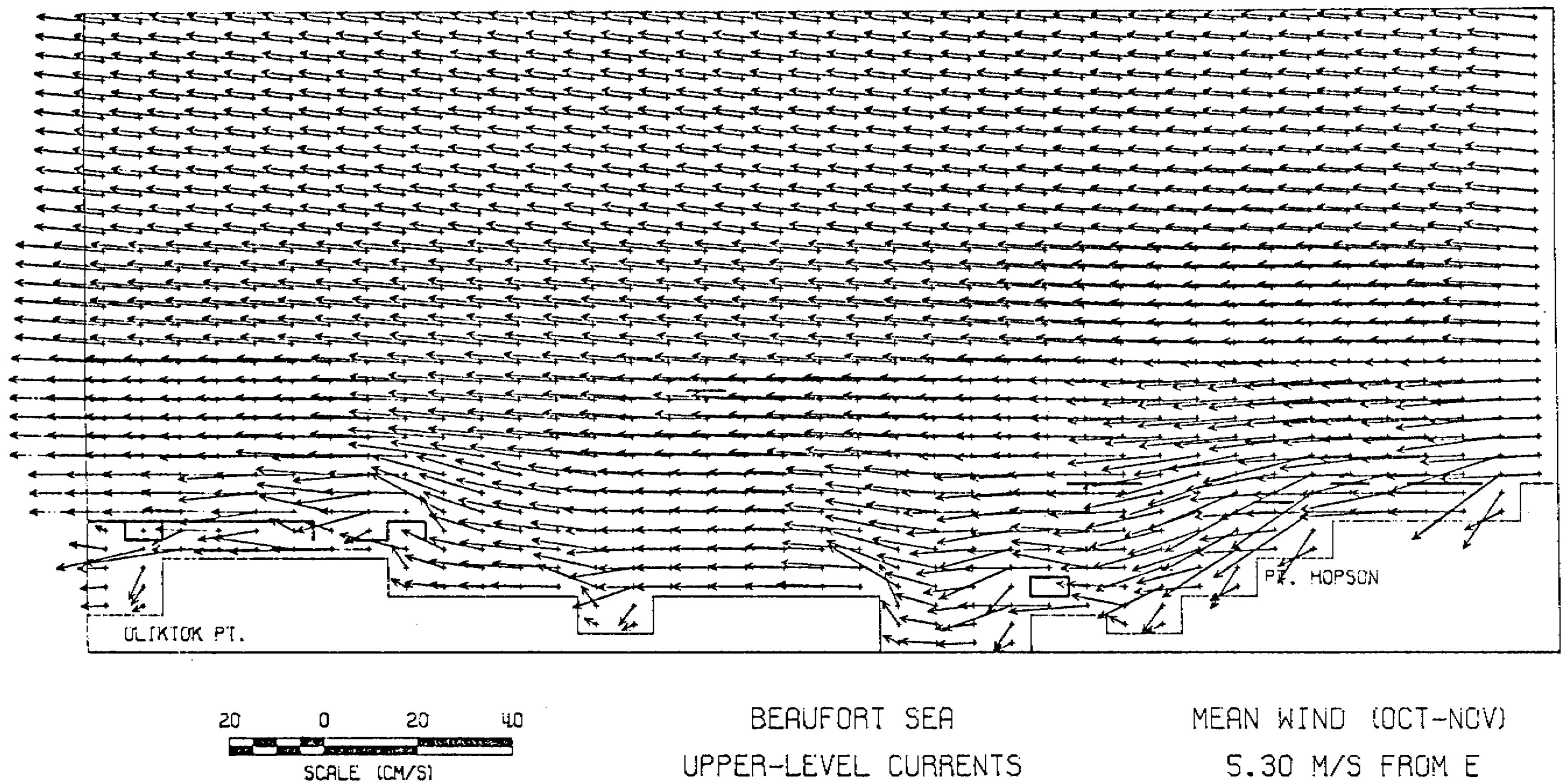

Figure 7. October-November upper-level currents, 5.30 m/s from east.

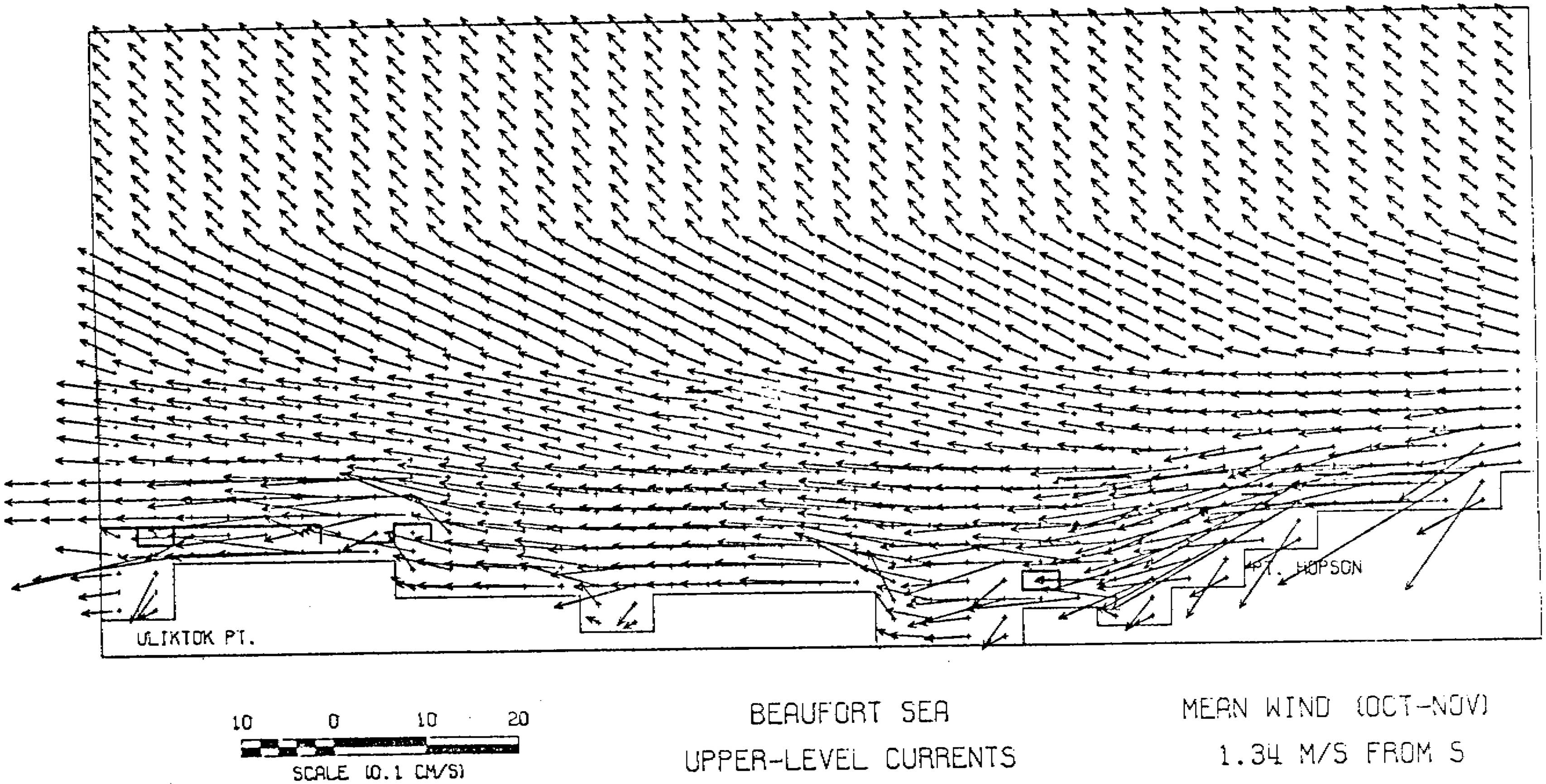

Figure 8. October-November upper-level currents, 1.34 m/s from south.

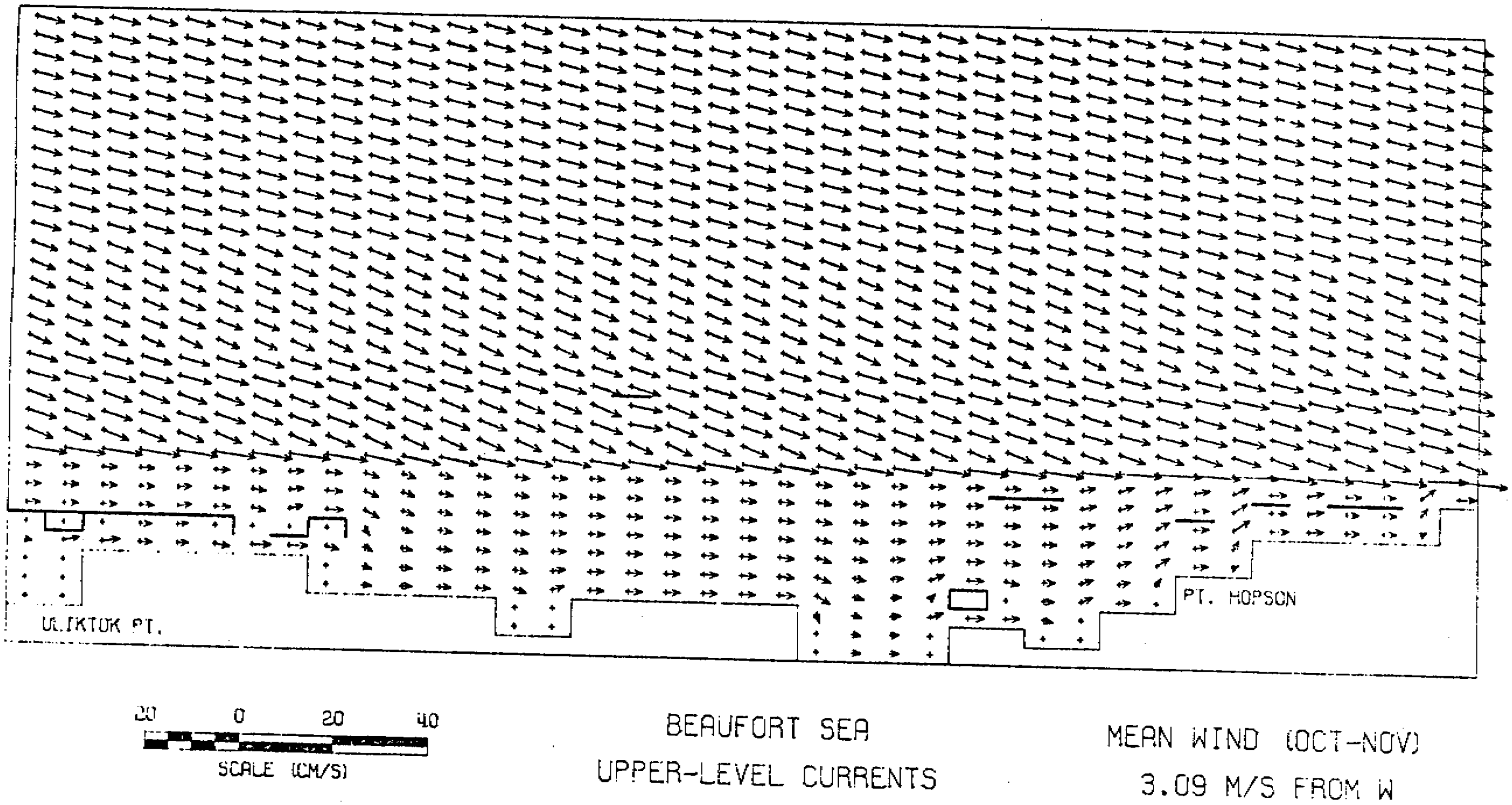

Figure 9. October-November upper-level currents, 3.09 m/s from west.

QUARTERLY REPORT

Contract No.:

03-5-022-67, TO 4

Research Unit No.:

541, 141/149

Reporting Period:

1 October - 3 December 1978

Number of Pages:

2

BRISTOL BAY OCEANOGRAPHIC PROCESSES

J. D. Schumacher
R. L. Charnell

Pacific Marine Environmental Laboratory
3711 15th Ave. NE
Seattle, Washington 98105

L. K. Coachman
T. H. Kinder

Department of Oceanography
University of Washington
Seattle, Washington 98195

20 December 1978

I. Task Objectives:

To elucidate water movement and hydrographic structure in the project area.

II. Field or Laboratory Activities:

None

III. and IV. Results and Preliminary Interpretation

"A structural front over the continental shelf of the southeastern Bering Sea" by Schumacher, Kinder, Pashinski, and Charnell has been accepted by *Journal of Physical Oceanography* and will appear in Vol. 9.

Four talks were presented at the Alaskan shelf session at the western American Geophysical Union Meeting in December (abstracts attached):

1. "Observation of a baroclinic eddy in the Southeastern Bering Sea" by Kinder, Schumacher, and Hansen.

2. "Mean and low frequency flow over the continental shelf of the southeast Bering Sea during summer" by Schumacher, Kinder, Hansen, and Pashinski.

3. "Oceanography of Arctic Shelves" by Coachman.

4. "Transition zone and finestructure between shelf and off-shore water" by Charnell and Coachman.

The first two presentations are being carried through to the manuscript level.

V. Problems encountered/recommended changes. None.

O 2 INVITED PAPER

OCEANOGRAPHY OF ARCTIC SHELVES

L. K. Coachman (Dept. of Oceanography, Univ. of Washington, Seattle, Washington 98195)

O 3

OBSERVATION OF A BAROCLINIC EDDY IN THE SOUTHEASTERN BERING SEA

T. H. Kinder (Dept. of Oceanography, Univ. of Washington, WB-10, Seattle, WA. 98195)
J. D. Schumacher (PMEL/NOAA, Seattle, WA. 98105)
D. V. Hansen (AOML/NOAA, Miami, FL. 33149)

Shallow (18 m) drogues, released during May 1977 and tracked by satellite, delineated an eddy in the southeastern Bering Sea. Located above complex topography (depth range: 200 m - 3000 m), the eddy had a diameter of about 150 km and had speeds of 7 to 16 cm/s at 50 km from its center. A CTD survey during July defined the eddy from 200 m to 1500 m depth in temperature and salinity distributions, but no hydrographic evidence for the eddy existed at the surface. A geostrophic calculation referenced to 1500 m agreed qualitatively with the drogue data, and accounted for all but 2 to 4 cm/s of the drogue speeds. This suggests that the 1500 m reference level, coincident with our deepest data, was too shallow. Examination of the TS correlation showed that the water at the eddy's core was the same as that at its periphery, in contrast with a cyclonic ring observed nearby in July 1974.

A second CTD survey in February 1978 showed that the eddy had dissipated or moved, as no trace of it remained. An earlier STD survey of the region in summer 1971 had not shown either a ring like that seen in 1974 or an eddy like that seen in 1977. In spite of the ubiquitous inclusion of permanent eddies and steady currents in Bering Sea circulation schemes, recent evidence from synoptic data suggests that the hydrographic and velocity fields are highly variable on scales of 50 to 100 km and a few weeks to a few years.

TRANSITION ZONE AND FINESTRUCTURE BETWEEN SHELF AND OFF-SHORE WATER

R. L. Charnell (PMEL/NOAA/ERL, 3711 15th Avenue N.E., Seattle, Washington 98105)
L. K. Coachman (Department of Oceanography, WB-10, University of Washington, Seattle, Washington 98195)

Transition zones between the two water masses (shelf and off-shore) at a shelf break are generally relatively narrow (25-50 km) and characterized by a single strong gradient (front) in some horizontal properties; e.g. salinity. A basic feature of the lateral water mass interaction in this zone is finestructure. Observations from outer Bristol Bay in the Southeast Bering Sea, show a broader transition zone with strong gradients forming an inner and outer front. This interaction zone is approximately 100-150 km wide and is characterized by mid-water-column finestructure with a spectrum of scale sizes. Vertical mixing energy within the zone appears low, which results in persistence of interleaving signatures induced by horizontal interaction of the two adjacent water masses. Outer Bristol Bay conditions allow enhanced examination of the processes of water mass mixing.

MEAN AND LOW FREQUENCY FLOW OVER THE CONTINENTAL SHELF OF THE SOUTHEAST BERING SEA DURING SUMMER

J. D. Schumacher (PMEL/NOAA/ERL, 3711 15th Ave. NE, Seattle, Washington 98105
T. H. Kinder (Oceanography Dept., University of Washington, WB-10, Seattle, Washington 98105
D. V. Hansen (AOML, 15 Rickenbacker Causeway, Miami, Florida 33149)
D. Pashinski (PMEL/NOAA/ERL, 3711 15th Ave. NE, Seattle, Washington 98105)

We present CTD, current meter and satellite tracked drifter data collected over the southeast Bering Sea shelf during summer 1976. These data did not show the organized flow regimes that have been presented in various atlases and circulation schemes. Instead, these data show that two distinct hydrographic and current domains existed: a stratified central shelf domain located seaward of the fifty meter isobath in which the mean velocity was weak (∿0.5 cm/s), and a well-mixed coastal domain which exhibited stronger mean flow (∿3.0 cm/s). Although 90 to 95% of the variance was tidal, correlations between low pass filtered (35 hour) current records from the lower mixed layer of the central shelf domain were r∿0.65 and r∿0.50 over horizontal separations of 30 to 60 km respectively. We found good agreement between observed mean flow and geostrophic calculations, suggesting that the horizontal density gradient between the two domains drives the flow in the coastal domain. Winds during the summer were light (∿5m/s) and variable. Correlations between winds and currents were generally not significant statistically. During a two day period in late July when wind speeds exceeded 10 m/s, however, current records and drifter trajectories indicated a strong current response (∿1% of the wind speed) in the central shelf domain.

From Eos, Trans. AGU 59(12).

QUARTERLY REPORT

Contract #03-05-022-67

Research Unit #550

Reporting Period: 1 October 1978-
31 December 1978

Number of Pages: 2

NORTON-CHUKCHI OCEANOGRAPHIC PROCESSES (N-COP)

R. D. Muench [1]

J. D. Schumacher [1]

R. L. Charnell [1]

L. K. Coachman [2]

K. Aagaard [2]

[1] Pacific Marine Environmental Laboratory

[2] Dept. of Oceanography, University of Washington

20 December 1978

I. Task Objectives.

1. Quantify fluctuations in the predominantly northward transport through the system.

2. Correlate transport fluctuation with synoptic scale meteorological variations.

3. Verify and define the bifurcation of northward flow in the Chukchi Sea.

4. Provide verification data for modelling tidal and wind-driven circulation in Norton Sound (RU 435).

II. Field or Laboratory Activities.

None

III. Results and Preliminary Interpretation.

The following paper was presented at the Autumn 1978 AGU meeting in San Francisco:

Tripp, R.B., L. K. Coachman, K. Aagaard and J. D. Schumacher (1978). Low frequency components of flow in the Bering Strait system. Eos, Trans. AGU 59 (12). (abstract appended).

IV. Problems encountered/recommended changes. Non-compatible formatting of different data such as NWRC data, digitized barograph data, NWS data and current data has required considerable additional programming/ computing time. This could have been prevented, probably, only by a universally accepted format for data formatting and archival.

LOW FREQUENCY COMPONENTS OF FLOW IN THE BERING STRAIT SYSTEM

Richard B. Tripp
L. K. Coachman
K. Aagaard (all at: Dept. of Oceanography, University of Washington, Seattle, WA. 98195)
J. D. Schumacher (PMEL/NOAA, Seattle, WA. 98105)

During 1976-77 we had eleven current meter moorings deployed between St. Lawrence Island and Cape Lisburne in the Southern Chukchi Sea. The records span periods of seven to eleven months. Nine of these meters were within the general northward flow of Pacific water into the Arctic Ocean; two from east of St. Lawrence Island, one from Bering Strait proper, and six from a line extending across the southern Chukchi Sea west from Cape Lisburne. The long period (more than a few days) components of flow from these measurements are analyzed and discussed with regard to a) time scales of major changes in the northward transport, b) correlations in the flow field, and c) the regional variability and correlations in the temperature field.

From EOS, Trans. AGU 59(12).

Quarterly Report

R.U. #562 Oil Pooling Under Sea Ice
NOAA RD. No. RK-8-0065
Report Period: 1 Oct - 31 Dec 1978

OIL POOLING UNDER SEA ICE

Principal Investigator: A. Kovacs

US Army Corps of Engineers
Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

I. Task Objectives:

The purpose of this project is to:

a. Determine the cause of the significant relief which exists under the fast ice.

b. Measuring the variation in the relief under fast ice using impulse radar.

c. Determine if the under ice relief is a series of individual pockets or consists of long rills.

d. Estimate the quantity of oil which could pool up in the under ice depressions should oil be released under the ice cover.

e. Use impulse radar to study the electromagnetic properties and anisotropy of sea ice.

II. Laboratory Activities:

During the past quarter additional field data were reduced and various reports initiated or completed.

III. New Results:

Impulse radar sounding data collected during the profiling of a snow free runway site on the fast ice has been reduced and corrected for profiling travel speed variations. The area profiled is ∿190 m long by 20 m wide. The under ice relief shows significant variations up to 48 cm. The maximum thickness measured was 1.83 m, the minimum was 1.35 m and the average thickness was 1.56 cm. The data has been used to construct 18 parallel ice thicknesses profiles which are ∿190 m long. Each profile is separated from its neighbor by 1.1 m. In addition the data has been used to construct a contour map of the under ice relief from which an estimate of the volume of oil which can be contained in this relief will be made.

IV. Reports Submitted for Publication:

Kovacs, A. and Morey, R. M., (1978) Radar Anisotropy of Sea Ice Due to Preferred Azimuthal Orientation of the Horizontal c-axes of Ice Crystals, AIDJEX Bulletin No. 38, to be published in Journal of Geophysical Research.

V. Funding:

Funded at	$26,750
Spent	2,000
Remainder	$24,750

QUARTERLY REPORT

03-78-DO-1-61

Research Unit: 567

Reporting Period: 1 Oct - 30 Sept 1978

Number of Pages: 2

THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE

Max D. Coon

R. S. Pritchard

Flow Research Company
A Division of Flow Industries, Inc.
21414-68th Avenue South
Kent, Washington 98031

I. Abstract:

This is the second quarterly report for this project and the main accomplishment has been in determining trajectories for sea ice in the Beaufort and Chuckchi Seas. Also the problem of major breakout of ice from the Chukchi into the Bering Sea has been studied.

II. Task Objectives:

The goal of the proposed work is to determine the locations to which oil spilled in or under the ice cover near Prudhoe Bay, Alaska, would be transported and to determine the behavior of the oil as the ice cover moves and deforms. Two separate tasks have been given Flow Industries. First, to determine a range of velocity fields which might be taken by the ice cover on the continental shelves of the Beaufort and Chukchi Seas by numerical modeling and synthesis of the results with manned and drifting station data. These velocity fields shall represent the climatological mean (or most probable) and extremes. As part of this task major breakouts of the ice from the Chukchi into the northern Bering Sea shall be considered. The second task is for the overall management of the program as well as to determine the likely trajectories and destination points for oil in several hypothetical scenarios by combining the relevant information obtained.

III. Field or Laboratory Activities:

None.

IV. Results:

Sea ice trajectory for light ice conditions have been calculated for twenty-five years (1953 - 1977) of historical data from the National Meteorological Center obtained through NCAR. Mean monthly trajectories and their yearly variation have been calculated. In these calculations it has been found that daily displacements must be calculated and monthly trajectories determined from these. Data are being displayed in three different manners. First, at 19 locations in the Beaufort and Chukchi Seas a plot for each month of the year showing mean monthly displacements and their variations have been constructed. Secondly, at three locations in the Bering and Chukchi Seas the actual 25 years work of trajectories are shown for each month. From these plots one can clearly see the yearly variation at the locations. Thirdly, plots will indicate the final location of oil released from the Prudhoe area on each of the 25 years starting in October and being followed for a complete year. In addition, releases made at the beginning of June in Prudhoe will be followed for each of the 25 years through to October.

V. Preliminary Interpretation of Results:

The findings thus far indicate that the ocean currents are predominate in causing the monthly motion. The component from the air stress on the ice is smaller than that from the ocean currents. However the year to year variation in the trajectories is caused by the varying wind stress. The expected predominate east/west motion along the Alaskan north slope is clearly in evidence during the winter, however, this east/west motion is not as predominate in the summer trajectories.

VI. Auxiliary Materials:

None.

VII. Problems Encountered/Recommended Changes:

None.

VIII. Estimate of Funds Expended:

The estimated expenditure under this contract through 31 December 1978 is $168,000.

QUARTERLY REPORT

Contract No: 03-78-B01-62
Research Unit: 568
Reporting Period: 1 October - 31 December 1978
Number of Pages: 2

THE TRANSPORT AND BEHAVIOR OF OIL SPILLED IN AND UNDER SEA ICE-TASK 1

Lawrence A. Schultz

ARCTEC, Incorporated
9104 Red Branch Road
Columbia, Maryland 21045

December 26, 1978

I. TASK OBJECTIVES

The objective of Task 1 of the program is to determine by field and laboratory experiments the physical processes by which spilled oil gets incorporated in, and transported in and under, sea ice. The objectives of three subtasks are further stated as follows:

Subtask 1.1: To determine how and at what rates oil moves upward through multi-year ice to the surface.

Subtask 1.2: To determine how and at what rates oil gets incorporated into pressure ridges formed from ice of various thicknesses.

Subtask 1.3: To determine how oil of different viscosities spreads and is moved by ocean currents under sea ice with different underside roughness characteristics.

II. FIELD OR LABORATORY ACTIVITIES

A. Ship or Field Trip Schedule

None

B. Scientific Party

None

C. Methods

Not Applicable

D. Sample Localities

Not Applicable

E. Data Collected or Analyzed

Not Applicable

III. RESULTS

In accordance with the schedule presented in ARCTEC's proposal for the subject work, all laboratory tests of the horizontal transport of oil beneath continuous and discontinuous ice features were completed in ARCTEC's Ice Flume during this quarter. The tests were performed in accordance with the Test Plan issued in September. The progress of these tests and the preliminary analysis of the test data was reviewed with the Project Coordinator, Dr. Max Coon, in meetings held at ARCTEC on October 26 and 27, and December 20 and 21.

ARCTEC's consultant for horizontal transport, Dr. Timothy Kao, also participated in these review meetings.

The primary effort during the next quarter will consist of the development of oil/ice interaction relationships suitable for inclusion in the oil/ice dynamics numerical model based on the results of the Ice Flume tests.

IV. PRELIMINARY INTERPRETATION OF RESULTS

Not Applicable

V. PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES

None

VI. ESTIMATE OF FUNDS EXPENDED

As of 31 December, it is estimated that approximately $85,000. will have been expended for the work of Task 1. It is estimated that the work will be completed on budget.

HAZARDS

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430	Cacchione, D. Drake, D.	U.S.G.S., Menlo Park, CA	Bottom and Near-Bottom Sediment Dynamics in Norton Sound and Lower Cook Inlet; Sediment Transport During Wintertime Conditions, Northern Bering Sea	426
483	Biswas, N. Gedney, L.	Geophysical Inst., Fairbanks, AK	Evaluation of Earthquake Activity Around Norton and Kotzebue Sounds	433

QUARTERLY REPORT

Research Unit: 16

Contract: NOAA 03-5-022-70

Task: D-5

Reporting Periods:

(1) April-June 1978

(2) July-September 1978

(3) October-December 1978

Number of Pages: 11

A SEISMOTECTONIC ANALYSIS OF THE SEISMIC AND VOLCANIC HAZARDS IN THE PRIBILOF ISLANDS — EASTERN ALEUTIAN ISLANDS REGION OF THE BERING SEA

Dr. John N. Davies and Dr. Klaus H. Jacob

Principal Investigators

Lamont-Doherty Geological Observatory of

Columbia University in the City of New York

Palisades, New York 10964

(914) 359-2900

I. ABSTRACT. We report the technical accomplishments of the first three quarters of FY78-79; i.e., April through December 1978. Interpretations of portions of the data gathered during this period have been given in the annual report for FY77-78. Further interpretations are defered to this year's annual report. The major accomplishments discussed are the submission of three quarters of hypocenter data, the servicing of the remote stations with helo support during June and August/September, and the design, fabrication and installation of an event-detecting tape-recording system at Dutch Harbor.

II. OBJECTIVES (D-5)

This work, in conjunction with a complementary study supported by D.O.E., attempts to evaluate the earthquake and volcanic hazards that exist in the Pribilof Islands - eastern Aleutian Islands region of the southeast Bering Sea and western Gulf of Alaska. This assessment is made in the context of the exploration for and possible development of petroleum resources on the continental shelves which constitute most of the region. The present work focuses on the collection and evaluation of new seismic data; however, through the companion D.O.E. study, other geophysical, geological and geochemical data are studied and the relevant results reported to NOAA.

The specific objectives of this work are: (1) to monitor seismic activity in the Shumagin Islands and Dutch Harbor regions of the eastern Aleutian Island Arc, and in the Pribilof Islands region of the southeast Bering Sea; (2) to relate this seismic activity to particular faults, if possible; (3) to monitor volcanic activity in general and that of Pavlof, Akutan and Makushin volcanoes in particular; and (4) to evaluate this seismic and volcanic activity in terms of its implications for the potential earthquake and volcanic hazard to exploration for and development of petroleum resources on the continental shelves within the study area.

III. TECHNICAL ACTIVITIES

A. FIELD WORK. Field work in support of the above objectives was carried out during three periods:

Trip 1: June 1-30. The purpose of this trip was to service as many remote stations as possible, to repair, maintain and upgrade the recording centers at Sand Point, Dutch Harbor and Saint Paul, and to provide limited support for geodetic and geological work of other L-DGO scientists. The seismolcgical work is described in our "Summary of Helicopter Operations" submitted to the project office during September. The geodetic and geological work was summarized in the FY77-78 annual report.

Trip 2: August 4 - September 20. The purpose of this trip was to finish servicing the remote stations and to continue the work of upgrading the Sand Point recording center. The helicopter supported work on the remote stations is described in the "Summary of Helicopter Operations", mentioned above. Because of the closing of the RCA site at Port Moller, the Pavlof recording center had to be relocated to Sand Point. To facilitate this, the Sand Point recording center was doubled in size and several improvements made or initiated. These improvements included work on the DC power system, the time correction system, and the electrical layout of the station. A patch panel was installed so that any seismic signal can be recorded on any channel of any recording device. There are now 32 seismic signals being recorded at Sand Point.

Trip 3: November 6-22. The purpose of this trip was to install the event-detecting tape-recording system at Dutch Harbor and to make repairs at the recording center in Sand Point.

Personnel:

Trip 1 - Seismologists

Chief Scientist: Klaus Jacob

Graduate Student: Janet Krause

Electronics Technician: Larry Shengold

Field Assistant: Tom Ray

Trip 1 - Geodicists

Chief Scientist: John Beavan

Field Assistant: Tom Ray

Trip 1 - Geologists

Chief Scientist: Margorie Winslow

Graduate Student: Steve Hickman

Trip 2 - Seismologists

Chief Scientist: John Davies

Graduate Student: Leigh House

Electronics Technician: Rezi Gahdimi

Field Assistant: Tom Ray

Trip 3 - Seismologists

Technical Manager: Doug Johnson

Field Asistant: Tom Ray

B. LAB WORK

Data Reduction: The following three quarters' data were analyzed and hypocenter cards submitted:

DATA SET	DATE DUE	SUBMISSION DATE
Jan.-Mar. 1977	1 Jul. 1977	27 Jul. 1978
Apr.-Jun. 1977	1 Oct. 1977	27 Jul. 1978
Apr.-Jun. 1978	1 Oct. 1978	25 Sep. 1978

The revised data submssion schedule (as of 25 September 1978), copies of the above three data sets, and a map of epicenters for the combined periods January - June 1977 and April - July 10, 1978 are included as appendices I through V.

V and VI. RESULTS AND INTERPRETATION

See annual reports for FY77-78 and FY78-79

Summary by Quarter:

Apr.-Jun. 1978

(1) Design event-detecting tape-recording system for Dutch Harbor and submit supplemental proposal to NOAA

(2) Prepare for field season

(3) Spring AGU

(4) First field trip

Jul.-Sep. 1978 (1) Write NOAA proposal

(2) Submit data for Jan.-Mar. and Apr.-Jun. 1977

(3) Fabricate Dutch recording system

(4) Write JGR paper on Aleutian Benioff zone

(5) Second field trip

(6) Submit field report

(7) Submit data for Apr.-Jun. 1978

Oct.-Dec. 1978 (1) Write NOAA annual report

(2) Third field trip

(3) Write D.O.E. annual report

(4) Write D.O.E. proposal

(5) Fall AGU

VII. ESTIMATES* OF FUNDS SPENT

October 1, 1977 - June 30, 1978: $42,341

October 1, 1977 - September 30, 1978: $83,456

October 1, 1978 - December 31, 1978: $4,785

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* Based on L-DGO account summaries not reconciled with Columbia University accounting.

APPENDIX I

REVISED DATA SUBMISSION SCHEDULE

25 SEPTEMBER 1978

SEQ.	DATA SET	DUE DATE	REVISED DUE DATE	REQ. MOS.	COMMENTS TECH. 1	COMMENTS TECH. 2
	Jan - Mar 1977	1 Jul 1977	Done	2		
	Apr - Jun 1977	1 Oct 1977	Done	1		
8	Jul - Sep 1977	1 Jan 1978	1 Dec 1979	3	1/2 mo off; 2 1/2 mo	1/2 mo
6	Oct - Dec 1977	1 Apr 1978	1 Jul 1979	2	1 1/2 mo	1/2 mo
4	Jan - Mar 1978	1 Jul 1978	1 Apr 1979	2	1 1/2 mo	1/2 mo
1	Apr - Jun 1978	1 Oct 1978	1 Oct 1978	1	Present Submission	
2	Jul - Sep 1978	1 Jan 1979	1 Jan 1979	3	3 full mo	
3	Oct - Dec 1978	1 Apr 1979	15 Feb 1979	2	1 1/2 mo	1/2 mo
5	Jan - Mar 1979	1 Jul 1979	15 May 1979	2	1 1/2 mo	1/2 mo
7	Apr - Jun 1979	1 Oct 1979	1 Aug 1979	1	1 mo (August in field)	
9	Jul - Sep 1979	1 Jan 1980	1 Mar 1980	3	1/2 mo off; 2 1/2 mo	1/2 mo
10	Oct - Dec 1979	1 Apr 1980	15 Apr 1980	2	1 1/2 mo	1/2 mo
11	Jan - Mar 1980	1 Jul 1980	1 Jul 1980	2	2 1/2 mo/Caught Up	

1977 1st QUARTER HYPOCENTRAL DATA JANUARY* → MARCH

* NO DATA FOR MONTH OF JAN.

LDS	19010277092235354573N161549W	1	082LGU	S	4L
LDS	19040277000405754660N159676W	21	072LGU	S	5L
LDS	19220277235117554509N162666W	63	LGU	S	5*
LDS	19230277220126855071N159350W	33	102LGU	S	6L
LDS	19240277012656354481N161720W	11	102LGU	S	4L
LDS	19270277094757354855N160270W	33	LGU	S	4L
LDS	19280277161916355096N157770W	83	LGU	S	5L
LDS	19260277201534254622N159659W	17	LGU	S	6L
LDS	19010377111314554557N160017W	28	LGU	S	4*
LDS	19010377174948755164N159266W	45	LGU	S	6L
LDS	19020377092330354520N162737W	91	157LGU	S	5*
LDS	19020377222209354812N160300W	18	088LGU	S	5L
LDS	19030377140109754865N160234W	32	097LGU	S	6L
LDS	19060377062426354429N159104W	37	111LGU	S	4L
LDS	19070377075508954899N159792W	31	070LGU	S	4L
LDS	19090377101339654972N159927W	35	080LGU	S	4L
LDS	19090377163048654939N160342W	32	094LGU	S	5L
LDS	19090377193713554798N160459W	56	135LGU	S	4L
LDS	19090377202429153760N163366W	62	195LGU	S	5*
LDS	19100377010205655454N161747W	115	123LGU	S	3*
LDS	19100377054631155105N159669W	14	076LGU	S	6L
LDS	19100377164142654721N159929W	29	114LGU	S	4*
LDS	19100377193425755478N160154W	70	089LGU	S	3L
LDS	19100377234160054676N161390W	44	099LGU	S	3*
LDS	19120377024050455543N156490W	13	146LGU	S	5*
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LDS	19140377123705255108N160790W	64	LGU	S	5L
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LDS	19220377044527654189N161325W	15	LGU	S	3*
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LDS	19230377153740554540N159653W	5	097LGU	S	5L
LDS	19230377200856254940N161483W	60	092LGU	S	4*
LDS	19230377215549954507N159477W	32	090LGU	S	3*
LDS	19260377150103055713N161225W	165	LGU	S	5*
LDS	19300377154609854817N161053W	54	LGU	S	3*

APPENDIX II

1977 2ND QUARTER HYPOCENTRAL DATA ..... APRIL → JUNE

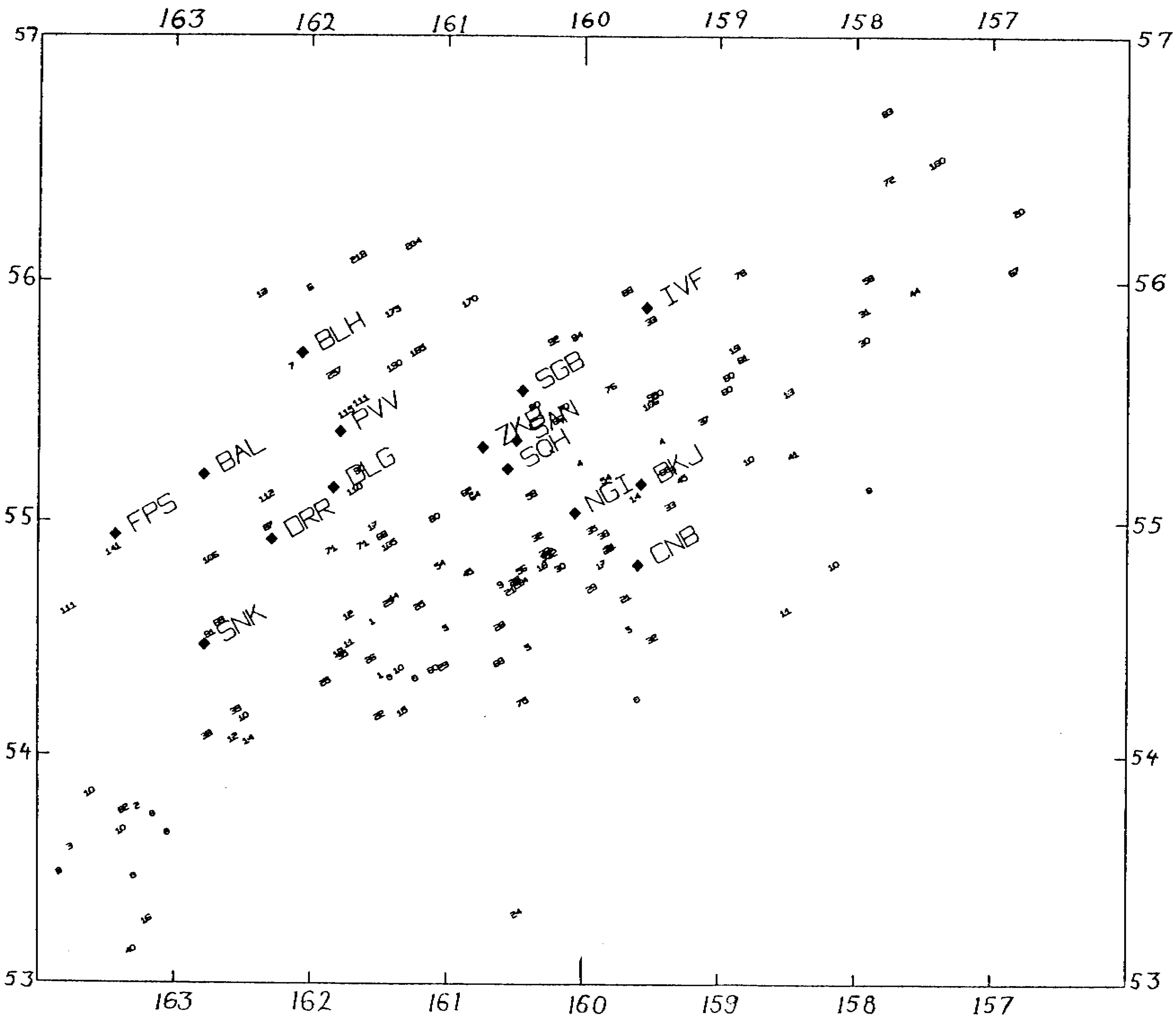
LDS 19120477041816355642N159499W 33		LGU	S	4L
LDS 19140477154813753739N163150W 0		LGU	S	3*
LDS 19170477043040355648N161394W190		LGU	S	4*
LDS 19290477113300054735N160476W 23		LGU	S	5*
LDS 19290477182905354073N162565W 12		LGU	S	4*
LDS 19290477220441255340N159415W 4		LGU	S	4L
LDS 19300477141639454103N162466W 10		LGU	S	3L
LDS 19300477194844550097N161663W219		LGU	S	4*
LDS 19020577204358955163N159624W 54		LGU	S	5L
LDS 19050577050425054173N161495W 22		LGU	S	5*
LDS 19050577060907454746N160449W 14		LGU	S	4L
LDS 19060577060303155485N160365W 80		LGU	S	5L
LDS 19070577044236755114N160367W 59		LGU	S	4L
LDS 19110577092456255240N160033W 4		LGU	S	5L
LDS 19130577224636554624N158505W 11		LGU	S	5L
LDS 19140577121413554372N161102W 60		LGU	S	4*
LDS 19130677001640855557N159447W 50	149	LGU	S	5*
LDS 19170677184545554429N151704W 35		LGU	S	5*
LDS 19190677020431454247N159569W 0	192	LGU	S	4*
LDS 19190677022140455947N162366W 13	134	LGU	S	5L
LDS 19190677125245255616N161631W257	204	LGU	S	3L
LDS 19190677211901155775N160056W 94	159	LGU	S	6L
LDS 19200677052146854414N161559W 26	170	LGU	S	6*
LDS 19210677053314455660N157936W 31		LGU	S	6*
LDS 19220677230014955965N157573W 44	174	LGU	S	7L
LDS 19230677223443955972N162014W 6	079	LGU	S	3*
LDS 19240677061913755017N161092W 60	134	LGU	S	7L
LDS 19240677150944755562N159791W 76	117	LGU	S	5L
LDS 19240677204736355217N159390W 60	099	LGU	S	5L
LDS 19250677003351455214N161649W 90	145	LGU	S	4L
LDS 19260677072356754673N160286W 33		LGU	S	7L
LDS 19260677035514454879N161851W 71	139	LGU	S	7L
LDS 19260677222309555756N160227W 92	115	LGU	S	6L
LDS 19270677034620154335N161420W 0	110	LGU	S	5L
LDS 19270677040216454747N160509W 21	093	LGU	S	7L
LDS 19280677054854755759N157936W 30	130	LGU	S	5*
LDS 19290677090212555964N159677W 89	099	LGU	S	7L

APPENDIX III

1978 2ND QUARTER HYPOCENTRAL DATA APRIL-JUNE

LDS	193000/8130532054042N161200W 25	87LGO S 5*
LDS	193000/8125654454700N160537W 21	113LGO S 7L
LDS	193000/8121830155285N158454W 41	142LGO S 6L
LDS	193000/8100040054867N159800W 26	101LGO S 7L
LDS	192900/8042754854960N161550W 17	LGO S 4*
LDS	193000/8005000153405N163839W 8	227LGO S 7*
LDS	192800/8121213755222N159332W 9	82LGO S 6L
LDS	192700/8130959254384N161025W 23	112LGO S 4*
LDS	192700/8081250954438N161790W 12	117LGO S 5L
LDS	192700/8054543854402N160018W 69	124LGO S 4*
LDS	192600/8155946654023N163776W111	195LGO S 7L
LDS	192500/8122236555503N161636W111	144LGO S 6L
LDS	192500/8063205336037N156847W 78	115LGO S 5L
LDS	192500/8032151954750N160509W 26	103LGO S 8L
LDS	192400/81771921354677N163451W141	195LGO S 5L
LDS	192200/8074514453467N163294W 0	208LGO S 4*
LDS	190200/8162347854085N162754W 36	245LGO S 3L
LDS	190200/8120145253773N163270W 2	232LGO S 3L
LDS	191405/8235306055640N162141W 7	LGO S 4*
LDS	190905/8115021554977N162308W 87	LGO S 3L
LDS	190805/8150542754371N161351W 10	LGO S 3L
LDS	190805/8104825655420N160194W 66	LGO S 3L
LDS	190805/8091757456153N161262W204	LGO S 3*
LDS	190805/8054933555726N158880W 13	LGO S 3*
LDS	190305/8121011354732N160611W 9	LGO S 3*
LDS	190305/8023655154654N161433W 23	LGO S 3*
LDS	192404/8214050154902N161619W 71	LGO S 3L
LDS	192404/8195334155494N159497W106	LGO S 3L
LDS	192104/8043507154901N161426W105	LGO S 3*
LDS	192004/8153331254763N160647W 45	LGO S 3L
LDS	191904/8201936053312N160463W 24	LGO S 3*
LDS	191004/8151952754599N161723W 12	LGO S 3L
LDS	191904/8151047954344N161489W 1	LGO S 3L
LDS	191004/8062926253270N163201W 16	LGO S 3*
LDS	191104/8152455353142N163313W 40	LGO S 3*
LDS	190004/8143115055125N160857W 62	LGO S 3*
LDS	190504/8123123654871N160257W 42	LGO S 4L

APPENDIX IV



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ZKB
SAN
SQH
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BKJ
CNB

11.

QUARTERLY REPORT
October - December 1978
Research Unit 59
Task D-4

OIL SPILL VULNERABILITY, COASTAL MORPHOLOGY, AND SEDIMENTATION OF KODIAK ISLAND AND KOTZEBUE SOUND

Principal investigator: Miles O. Hayes

Co-investigator: Christopher Ruby

Coastal Research Division
Department of Geology
University of South Carolina
Columbia, S. C. 29208

Submitted: 18 January 1979

I. ABSTRACT

The past quarter's primary emphasis was placed on the submission of all digital data (beach profiles and sediment grain size analysis) to the NODC on magnetic tape. To attain this end, program modifications were made to our NODC Conversion Program to maintain compatibility with the University computer system which itself was modified in the past year.

Thus, a magnetic tape is being forwarded under separate cover. This tape contains over 200 beach profiles (44 in Kotzebue Sound run in both 1976 and 1978 and approximately 120 run in Kodiak and Afognak Islands) and our 500 sediment grain size analyses (each calculates complete Folk and Ward parameters, mean, median, kurtosis, skewness, etc., as well as plots of Cumulative Frequency and Cumulative Weight %).

The remainder of the quarter has been spent applying our Oil Spill Vulnerability Index to Kotzebue Sound. This has required a modification of the index as it was used in the Gulf of Alaska. The modification takes into account the variability resulting from permafrost on the shoreline.

II. TASK OBJECTIVES:

The major emphasis of this project falls under Task D-4, which is to: evaluate present rates of change in coastal morphology, with particular emphasis on rates and patterns of man-induced changes and locate areas where coastal morphology is likely to be changed by man's activities and evaluate the effect of these changes, if any. The relative susceptibility of different coastal areas will be evaluated especially as they relate to potential oil spill impacts.

III. FIELD AND LABORATORY ACTIVITIES:

There were no field activities. Laboratory activities dealt with computer submission of profile and grain-size data, as well as application of our Oil Spill Vulnerability Index to the shorelines of Kotzebue Sound.

IV. RESULTS:

The primary result is the magnetic data tape to be sent under separate cover. Our final report for both Kodiak Island and Kotzebue Sound is on schedule and should be ready for the April Annual Report. Note: All Data Documentation Forms, etc., will be included with the magnetic tape.

Quarterly Report
October-December 1978
Research Unit #87

THE INTERACTION OF OIL WITH SEA ICE IN THE ARCTIC OCEAN

Seelye Martin
Department of Oceanography
University of Washington
Seattle, WA 98195

20 December 1978

I. Summary of Objectives:

Our purpose is to understand from laboratory experiments and field traverses how oil and sea ice would interact in an arctic oil spill.

II. Field or Laboratory Activities:

During the past quarter, our efforts went into the design and preparation of both field plans and equipment for our February-March 1979 SURVEYOR cruise in the Bering Sea. We have also prepared for publication a paper entitled "A field study of brine drainage and oil entrainment in first-year sea ice", which is submitted to the Journal of Glaciology.

III. Estimate of Funds Expended:

As of this date, we are about 20% expended.

QUARTERLY REPORT

R.U.#88: Dynamics of Near-shore
Ice
P.O. No.: 01-5-022-1651
Reporting Period: 30 September 1978
to 31 December 1978
Number of Pages: 4

DYNAMICS OF NEAR - SHORE ICE

Principal Investigators: A. Kovacs
and W.F. Weeks

Cold Regions Research and Engineering Laboratory
Hanover, New Hampshire 03755

I. Task Objectives

The purpose of this project is to:

a. study the motion of the fast ice and near-shore ice north of Prudhoe Bay and in the vicinity of the Bering Strait,

b. make observations on major ice deformation features that occur near the edge of the pack ice/fast ice boundary,

c. explore the use of a pulsed radar system to measure the characteristics of sea ice,

d. study the internal structure of near-shore sea ice,

e. characterize the spatial and temporal variations in sea ice pressure ridging via the use of laser profilometry and side-looking airborne radar (SLAR).

II. Field and/or Laboratory Activities

No field studies were carried out during this quarter.

A report entitled "Sea Ice Ridging Over the Alaskan Continental Shelf: was revised and submitted to the Journal of Geophysical Research for publication.

A report on shore ice pile-up and ride-up is in an advanced stage of preparation. Observations of fall ice pile-ups along the Beaufort Sea coast near Pt Barrow, Alaska have been made.

A cooperative report which addresses the interrelationship between the internal structure and the physical and mechanical properties of fast sea ice at Barrow, Alaska is in preparation.

A report dealing with studies of crystal alignments in the fast ice along the Arctic coast of Alaska, between Shishmaref Lagoon and Camden Bay is in preparation.

III. New Results

A new ice pile-ups were observed along the coast between Pt Barrow and Cape Halkett. One formation at Plover Pt consisted of ice 16 cm thick. The ice advanced 25 m inland and piled to a height of 2.5 m. Ice ride-up or pile-up was also observed on Cooper and Martin Islands and east of Pogik Point. At the latter site the ice rode up onto a 1-1/2-2 m high cliff. This thrust was about 1 km wide.

The status of recent reports is as follows:

a. Kovacs, A. (1978), Radar profile of a multi-year pressure ridge. Arctic, Vol. 31, No. 1.

b. Kovacs, A. Remote detection of water under ice covered lakes on the North Slope of Alaska. Accepted for publication in Arctic.

c. Kovacs, A. and Sodhi, D.S., Shore ice pile-up and ride-up (field observations, models, theoretical analyses). In preparation.

d. Tucker, W.B., III, Weeks, W.F., and Frank, M. Sea ice ridging over the Alaskan continental shelf. Submitted for publication in the Journal of Geophysical Research.

e. Weeks, W.F., Russer, J. (1978), Ice related environmental problems. In Report on Environmental Criteria Working Group of Committee on Offshore Energy Technology, National Research Council Report.

IV. Estimate of Funds Extended (as of 30 September 1978).

ORIGINAL	EXPENDED	REMAINING
$ 55,671	$ 14,046	$ 41,625

QUARTERLY REPORT

Contract: 03-5-022-67
Research Unit: 98
Reporting Period: 1 Oct - 31 Dec 1978
Number of Pages: 4

DYNAMICS OF NEAR SHORE ICE

Roger Colony

Polar Science Center
Division of Marine Resources
University of Washington
Seattle, Washington 98105

December 11, 1978

I. TASK OBJECTIVES

The University of Washington under Task Order No. 5 of the NOAA Contract 03-5-022-67 agreed to deploy drifting buoys to gather data on the ice movement and atmospheric conditions in the region of the continental shelf of the Beaufort and Chukchi Seas. It was agreed that 4 buoys would be purchased and deployed to track the motion of the ice cover, with one of these buoys to contain a barometric pressure sensor to determine the atmospheric condition. Data from these buoys shall be interpreted to help explain the physical behavior of the ice in this region. This information will help to increase the geographic coverage of previous buoy deployment programs so that we might know more about different regions and will help to determine year to year variability of the ice behavior in the near shore environment.

II. FIELD AND LABORATORY ACTIVITIES

A. Field Trips Scheduled

None

B. Scientific Party

None

C. Methods

All buoys discussed in this report are sampled by the Random Access Measurement System on board Nimbus VI satellite.

D. Sample Location

Four data buoys were deployed in March 1978 over the continental shelf in the Beaufort and Chukchi Seas from east of Point Barrow to Cape Lisbourne.

E. Data Collected or Analyzed

The latitude and longitude of the four buoys have been monitored since March 1978. Atmospheric pressure data is being collected from one of the buoys.

III. RESULTS

The satellite data is received weekly from NASA, Goddard Space Flight Center. The procedure is to decode the NASA data, sort the appropriate buoy platform numbers, make a long track correction to position, edit bad fixes, and smooth and interpolate the position and pressure time series. Figures 1-2 show latitude and longitude time series from the edited position data. The pressure data has not yet been processed. The smoothing and interpolation procedure has not been done. The data is for the period September-November.

IV. PRELIMINARY INTERPRETATION OF THE RESULTS

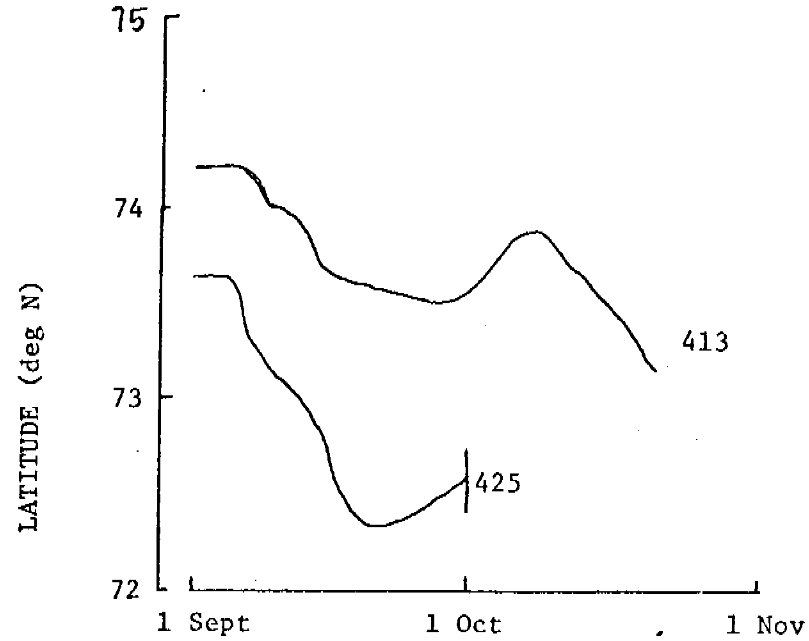
None

V. PROBLEMS ENCOUNTERED AND RECOMMENDED CHANGES

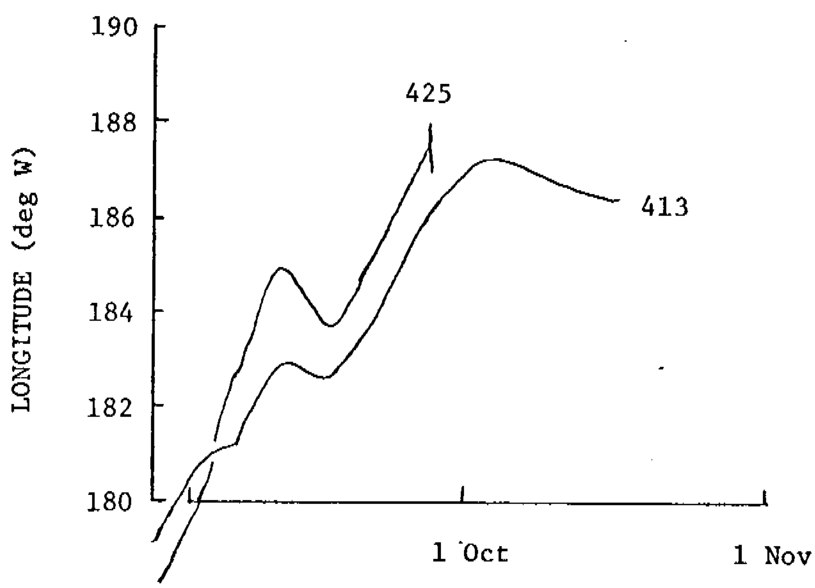
Buoy 1003 stopped reporting at the end of June and buoy 1301 stopped reporting at the end of July. Buoy 425 stopped reporting on the first of October. The launch preparation and launch (October 23) of Nimbus 7 satellite has interrupted the data acquisition of Nimbus 6. The frequency of reporting during September and October dropped to about one fix per day. NASA is just now beginning to process the backlog of data.

VI. ESTIMATE OF FUNDS EXPENDED

As of 30 September 1978 actual expenditures under this contract total about \$276,889.16. The estimated obligations for January are anticipated to be \$2,000.



75
74
73
72
LATITUDE (deg N)
413
425
1 Sept
1 Oct
1 Nov



190
188
186
184
182
180
LONGITUDE (deg W)
425
413
1 Oct
1 Nov

Research Unit No. - 105
Reporting Period - Oct. - Dec. 1978
Number of Pages - 2

Quarterly Report

to

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Arctic Projects Office
Fairbanks, Alaska

DELINEATION AND ENGINEERING CHARACTERISTICS OF PERMAFROST BENEATH THE BEAUFORT SEA

Principal Investigators:
P. V. Sellmann
E. Chamberlain

Associate Investigators:
S. Arcone
S. Blouin
A. Delaney
I. Iskandar
F. Page

United States Army
Corps of Engineers
COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
Hanover, New Hampshire

I. TASK OBJECTIVES:

The project will attempt to provide regional data on permafrost distribution in the Beaufort Sea. This will be done by reprocessing and examining commercially available seismic records for an indication of the position of the top of bonded permafrost. Analysis of drill cores and other available supplementary data will also be carried out, with no drilling done as part of this year's program.

II. FIELD OR LABORATORY ACTIVITIES:

A. Ship or field trip schedule: No field activities took place during this reporting period; the activities were of a laboratory nature involving interpretation of the seismic records. One trip was made to Canada to confer with Dr. K. G. Neave concerning some aspects of data interpretation.

B. Scientific Party: The individuals that worked on this project during this reporting period were Allan Delaney, Edwin Chamberlain, Paul Sellmann, and K. G. Neave.

C. Methods: Previously discussed.

D. Sample Locations: The seismic data acquired this quarter included data from both ice and marine surveys. The majority of the data were from ice surveys conducted along the coast. Most of these lines are normal to the coast and include a transition from the land to the sea. They are approximately equally spaced and include about 20 lines from the Kuparuk River to the Canning River. A limited additional amount of data were also obtained on lines that run parallel to the coast farther to the west. Samples of the marine data obtained extend offshore on two lines north and east of Prudhoe to several kilometers beyond the 90-meter water depth.

Additional marine data were ordered, including 1700 kilometers of records providing good regional coverage from several kilometers off the coast out to the 90-m isobath. The coverage extends from Prudhoe east to the Canadian border. These new data will be available next quarter.

E. Data Collected or Analyzed: Both the marine and ice data acquired this quarter were examined on a preliminary basis. The results of the sub-sea cone penetrometer study conducted by CRREL were prepared for publication in a new journal: Cold Regions Science and Technology (Elsevier).

III. RESULTS AND DISCUSSION:

Preliminary interpretation of 220 km of data obtained from six lines running normal to the coast from Prudhoe Bay to 35 km to the east indicate some agreement with earlier observations made by Rogers (reported in the proceedings of the Third International Permafrost Conference). The velocities observed in our data fall into two ranges. The low velocity range is comparable to the high velocity range obtained by Rogers, which was between 2.5 and 3.0 km/s. The high velocity group is in the 4.0-5.0 km/s range. These differences in the range of the observed velocities could be related to the different geometries of the arrays used in the two studies, the very shallow low velocities not being detectable in our ice survey data.

More detailed examination of these data for a line 30 km to the east of Prudhoe indicated a noticeable velocity gradient, with velocities decreasing offshore. The high velocities presumably indicate bonded permafrost since the line started on land and high velocities of 4 km/s gradually decrease to 2 km/s approximately 4 km from shore. The high velocity material near shore is capped with lower velocity sediments which are probably unbonded. These data provide a profile much like that suggested by Rogers' data near Prudhoe Bay, with rapid increase in depth to the high velocity material as one moves offshore.

Arrangements were also made to obtain data interpretation assistance from Dr. K. G. Neave. Dr. Neave was responsible for much of the interpretation of the Canadian Beaufort Sea data.

IV. PRELIMINARY INTERPRETATION OF RESULTS:

The reassuring aspect of the data examined is the agreement with observations made in the past. The data also indicate the existence of high velocity material offshore which probably represents bonded permafrost. Further examination will better determine the significance and distribution of the high velocity material.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES:

No problems have been encountered with the technical data and interpretation. Rapid transfer of this year's funds facilitated rapid acquisition of additional data.

VI. ESTIMATE OF FUNDS EXPENDED:

At the end of this quarter, approximately $19,000 of the total $65,000 has been expended.

Research Unit # 204
October 1 - December 31

Quarterly Report

Offshore Permafrost Studies and Shoreline History of Chukchi and Beaufort Seas an an Aid to Predicting Offshore Permafrost Conditions

Hopkins, D. et al.

USGS
Menlo Park, California

R.U. 204 & 473: Quarterly Report, October-November-December, 1978

OFFSHORE PERMAFROST STUDIES AND SHORELINE HISTORY OF CHUKCHI AND BEAUFORT SEAS AS AN AID TO PREDICTING OFFSHORE PERMAFROST CONDITIONS

I. Abstract of Highlights

During the later part of the quarter, we have been preoccupied with plans for participation of OCSEAP investigators in the program of permafrost and geotechnical drilling planned in the Beaufort Sea lease area by the Conservation Division of the United States Geological Survey.

A report included in our 1978 Annual Report has been revised and published as "Coastal morphology, coastal erosion, and barrier islands of the Bueaufort Sea", U.S. Geological Survey Open File Report 78-1073.

A tabulation of 22 radiocarbon dates (Table 1) provides information on stratigraphy of offshore boreholes, rates of peat and aeolian sand accumulcation, rates of ice-wedge growth, sea-level history, the age of a volcanic ash layer found in Holocene sediments along the Beaufort Sea coast, and the age of an ancient storm surge event in the Kuk River estuary.

Continuing study of the ice-rafted boulders in the Flaxman Formation establishes that they were probably derived from northern Greenland and that the most recent episode of Flaxman deposition on the continental shelf and the coastal areas of Beaufort Sea probably took place at some time between 60,000 and 30,000 years ago.

Areas where permafrost is deeply thawed on the Beaufort Sea shelf are probably valleys excavated during the last low sea-level interval. If the paleo-drainage pattern can be established on the Beaufort Sea shelf, it probably will be possible to predict the distribution of areas of deeply thawed permafrost.

III. Field and Laboratory Activities

A. D. M. Hopkins visited Institute of Sedimentary and Petroleum Geology (Geological Survey of Canada) in Calgary, Alberta on December 6 and 8th in order to discuss geology of northwestern Canada and the Arctic Islands in order to determine source of Flaxman boulders.

Washing and sorting core and outcrop samples for radiocarbon analysis and paleontological studies. Compilation of geologic maps and cross sections. Study of air photos to determine rates of coastal retreat in various places.

B. Scientific Party

D. M. Hopkins, geologist and principal investigator
R. W. Hartz, geologist
P. A. Smith, physical science technician
R. E. Nelson, palynologist

C. Methods of Analysis

Synthesis of laboratory and field observations
Paleontological and micropaleontological investigations
Radiocarbon analysis
Study of maps and air photos

D. Sample Localities

Seven offshore boreholes in Prudhoe Bay area.
Various points on coasts of Chukchi and Beaufort Seas.

E. Data Collected or Analyzed

Washing and picking of 1977 drill cores and cuttings completed.
Reports received on fossil ostracodes from PB-1, PB-2, and PB-3.
Reports received on fossil mollusks from surface samples from various places on the coast of the Chukchi Sea.
Reports received on wood samples from osshore boreholes.

IV. and V. Results and Interpretations

(1) Since December 15th, we have been intensely involved in planning and organizing our participation in the program of 22 permafrost and geotechnical boreholes to be contracted by the Conservation Division of the United States Geological Survey and with efforts to coordinate participation by other OCSEAP investigators.

(2) "Coastal morphology, coastal erosion, and barrier islands of the Beaufort Sea" by D. M. Hopkins and R. W. Hartz has been published as U.S. Geological Survey Open File Report 78-1073. A draft of this report was submitted as part of our 1978 Annual Report. The Open File Report can be obtained from United States Geological Survey Public Information Offices or from the authors.

(3) Radiocarbon age determinations completed thus far on 22 samples from offshore boreholes and from the coastal bluffs of the Chukchi and Beaufort Seas are tabulated (Table 1). They show that:

(a) Leeward accumulations of sand on bluffs along the western sides of the Canning and Sagavanirktok Rivers accumulate in two places at rates of 0.9 and 1.25 mm/year. The active cliff-head dunes were initiated within the last 5,000 years in the three places where relevant samples have been dated;

(b) A leeward sand accumulation on the east end of Flaxman Island no longer has a source and is no longer active. Evidently the sand accumulated at a time when sea level was lower and the Staines River flowed through the present site of Leffingwell Channel between Flaxman Island and Brownlow Point. Radiocarbon-dated samples indicate that the leeward sand accumulation on Flaxman Island began to develop a few centuries prior to 4,900 years ago and thus

Table 1. RADIOCARBON AGE DETERMINATIONS FROM THE BEAUFORT AND CHUKCHI SEA COASTS

Laboratory Number	Field Number	Location	Quadrangle	Latitude N & Longitude W	Material	Age Determination	Significance
USGS-132	PB-1, core 1b	Borehole at center of Prudhoe Bay	Beechey Point B-3	70°20.9' 148°19.3'	Wood	490 ± 90	This sample dates a moment shortly after the flooding of a large thaw lake to form Prudhoe Bay.
USGS-192	PB-2, cores 03a & 03c	Borehole 3 km seaward from Reindeer Island	Beechey Point B-3	70°30.6' 140°18.0'	Bulk sediment	18,000 ± 170	Expected to date overconsolidated clay but seems too young.
USGS-210	PB-3, core 17	Borehole 7 km from mainland shore of Stefansson Sound	Beechey Point B-3	70°25.8' 148°26.6'	Detrital peat	34,000 ± 2100	Sample comes from top of alluvium beneath glacial outwash, from a level that, by correlation, should be considerably older than USGS-249. True age of this sample may be considerably greater than 34,000.
USGS-249	PB-7, core T3.3-13.6	Borehole 3 km from mainland shore, Stefansson Sound	Beechey Point B-3	70°42.2' 148°33.5'	Detrital peat	42,800 ± 1440	Dates widespread detrital peat layer interspersed in glacial outwash. Small sample from same horizon in Univ. Alaska hole OH-3370 dated 22,300 ± 1200 (Au=115).
USGS-499	76Ahp90a	4.5-m terrace, Kaolak River	Wainwright A-2	70°05'00" 159°40'15"	Wood	1,730 ± 40	Dates alluviation to form lowest terrace of Kaolak River.
USGS-500	76Ahp93a	Foreset beds in 3.5-m terrace at mouth of Koalak R.	Wainwright A-2	70°07'19" 159°41'00"	Twigs	1,170 ± 45	Dates 3-m storm surge affecting valleys draining into Wainwright Inlet.
USGS-501	77Ahp182a	Triangulation Station Point 1.0 km southwest of Cape Halkett	Harrison Bay D-4	70°47'45" 152°12'00"	Peat	3,130 ± 70	Dates base of Holocene thaw-lake deposits.
USGS-503	77Ahp182g	Triangulation Station Point 1.0 km southwest of Cape Halkett	Harrison Bay D-4	70°47'45" 152°12'00"	Peat	2,930 ± 50	Dates in-situ peat accumulated after thaw lake was drained and provides measure of duration of lake on this site. Also provides estimate of age of ice wedges 2.5-3.0 m wide.
USGS-505	77Ahp84e	Gravel pit along lower Put River, Prudhoe Bay	Beechey Point B-3	70°17'25.5" 148°31'00"	Peat	26,300 ± 370	Dates the higher and younger of two interstadial or interglacial horizons interbedded with gravel, probably Sagavanirktok River outwash.
USGS-506	76Ahp29e	Bluffs at inner edge of Kasegeluk Lagoon, 1.2 km south of Akeonik	Wainwright B-5 & B-6	70°16'06" 161°53'29"	Twigs and grass	490 ± 50	This detrital peat from an ice-wedge pseudomorph at base of sandy and gravelly thaw-lake deposits dates existence of the lake.
USGS-509	77Ahp59	Left bank of Sagavanirktok River 1.75 km below highway bridge	Beechey Point B-3	70°15'46.5" 148°16'42"	Peat	2,270 ± 120	Dates base of thaw-lake deposit resting on terrace alluvium 3 m above present level of Sagavanirktok River. Two meters of aeolian sand have accumulated on river bank since deposition of this peat.
USGS-517	76Ahp87f	Right bank of Kuk River at head of delta	Wainwright B-2	70°13'55" 159°47'00"	Twigs	10,600 ± 180	Detrital peat in ice-wedge pseudomorph at base of thaw-lake sediments from early Holocene warm period. Contains willow stems at least 5 cm diameter.
I-10328	76Ahp47a	Low bluffs 1.1 km southwest of Nokotlek Point	Wainwright B-4	70°18'45" 161°03'00"	Detrital peat	9,125 ± 150	Basal peat in the deposits of the lower and older of two successive thaw lakes. Establishes that two lakes can have existed on same site within Holocene time, and with I-10329, show that older lake existed for considerably less than 3,000 years.
I-10329	76Ahp47b	Low bluffs 1.1 km southwest of Nokotlek Point	Wainwright B-4	70°18'45" 161°03'00"	Twigs	6,234 ± 120	Dates basal 10 cm of 60-cm detrital peat representing younger of two successive thaw lakes. Ice wedges 20-70 cm wide (M_d=40 cm) formed since lake was drained.
I-10330	76Ahp60A	Low bluffs 0.5 km southwest of Nokotlek Point	Wainwright B-4	70°19'33" 161°01'24"	Peat	8,275 ± 135	Dates basal 5 cm of 1.9 m thick deposit representing peat accumulated in low-center ice-wedge polygons. Provides a minimum date for time of inception of low-center polygons and basis for estimating rate of peat accumulation at Nokotlek Point.
I-10331	76Ahp-60B	Low bluffs 0.5 km southwest of Nokotlek Point	Wainwright B-4	70°19'33" 161°01'24"	Peat	9,535 ± 150	Dates cryoturbated stringers of fine-grained peat in colluvium 25 cm below base of low-center polygon peat (I-10330). Provides maximum date for inception of low-center polygons at Nokotlek Point.
I-10332	76Ahp-62	Low bluffs 0.2 km southwest of Nokotlek Point	Wainwright B-4	70°19'42" 161°01'00"	Twigs	8,435 ± 160	Dates basal 10 cm in thaw-lake deposits 1.5 m thick. Sample collected within 50 m of former lake margin and thus thought to have been deposited shortly before lake was drained. Ice wedges 35-125 cm wide (M_d=85 cm) formed since lake was drained.
I-10368	76Ahp82	Shore of tidal mudflat representing breached thaw lake 10 km southwest of Wainwright Inlet	Wainwright C-3	70°31'30" 160°17'00"	Detrital peat	9,180 ± 150	Dates basal sediments in deposits of an older thaw lake. Ice wedges 70-250 cm wide (M_d=120) have formed since lake was drained.
I-10369	77Ahp35b	Mainland shore of Canning Lagoon, 0.4 km west of mouth of eastern branch of Canning River	Flaxman Island A-3	70°04'42" 145°35'00"	Detrital peat	3,945 ± 115	Sample collected 1 cm below white ash layer in windblown sand sequence derived from Canning River bars. Gives minimum age for beginning of accumulation of windblown sand and, with I-10370, brackets age of ash.
I-10370	77Ahp35c	Mainland shore of Canning Lagoon, 0.4 km west of mouth of eastern branch of Canning River	Flaxman Island A-3	70°04'42" 145°35'00"	Twigs and detrital peat	3,315 ± 95	Sample collected 5 cm above white ash layer. With I-10369, brackets age of ash.
I-10371	77Ahp40A	East end of Flaxman Island	Flaxman Island A-4	70°10'34.5" 145°56'48"	Detrital peat	4,890 ± 230	Sample collected at depth of 3.6 m in 4.0-m layer of windblown sand derived from river bars when sea level was low and west fork of Canning River flowed through Leffingwell Channel. Sample collected 5 cm above an ash layer thought in field to be same as ash bracketed by I-10369 and I-10370.
I-10372	77Ahp40z	East end of Flaxman Island	Flaxman Island A-4	70°10'34.5" 145°56'48"	Detrital peat	2,375 + 175	Sample collected at depth of .45 m in 4.0-m layer of windblown sand. Provides maximum date for drowning of Leffingwell Channel by rising sea level.

that the river was flowing through the area at that time. Deposition ceased shortly after 2,400 years ago, probably because rising sea level inundated Leffingwell Channel.

(c) A white or pink volcanic ash has been recognized in Holocene deposits near the east mouth of the Canning River, on Flaxman Island, and in the Putalagayuk River valley. When dated, this ash layer will be useful in making field estimates of the age of young aeolian, thaw lake, alluvial, or archaeological deposits along the eastern Beaufort Sea coast. The ash layer is bracketed by samples dated as 3,300 and 3,950 years old at the mouth of the east branch of the Canning River, and the ashfall probably took place about 3,700 years ago. However, a sample which, according to our records, came from above the ash on Flaxman Island, yielded a radiocarbon age of 4,890 years. Other samples from the same section await radiocarbon assay, and when analysis is complete these will permit us to evaluate the significance of the seemingly anomalous Flaxman Island date. Radiocarbon samples bearing on the age of the ash were also collected in Holocene alluvium of the Putalagayuk River but have not yet been dated.

(d) Peat accumulates in low-center polygons at Nokotlek Point near Icy Cape at a rate of about 0.25 mm/year. Peat deposits there are about as thick as any to be seen along the Chukchi or Beaufort Sea coasts, so this may be fair approximation of the general rate of peat accumulation in marshes of the North Slope.

(e) A 1.5-m thick sequence of thaw-lake deposits near Cape Halkett accumulated within a 200-year interval, and a site south of Nokotlek Point has lain within the basin of two successive thaw lakes during the last 9,100 years. These observations are consistent with observations in the Old Crow Flats (W. W. Pettapiece in Lowden and Blake, 1977, p. 17) and on the Seward Peninsula (D. M. Hopkins, unpublished data) that individual thaw lakes rarely persist on the landscape longer than 1,500 years.

(f) Active ice wedges near Cape Halkett have been growing at a rate of about 1 mm/year, but active ice wedges in the Wainwright-Notkotlek Point area are growing much less rapidly, at a rate of only about 0.2 mm/year (Table 2 and Fig. 1). This is consistent with experimental studies that indicate average growth rates of about 1 mm/year near Point Barrow and much less than 1 mm/year on Garry Island at the mouth of the MacKenzie River (MacKay and Black, 1973, p. 188).

(g) A prograded delta-like deposit at the mouth of the Kaolak River seems to provide the record of a late summer flood and storm surge about 1,000 years ago which raised water level at least 3 m in the Kuk River estuary system (Appendix A).

Fig. 1. Rates of ice-wedge growth at Cape Halkett (Beaufort Sea) and in the Nokotlek Point-Wainwright area (northern Chukchi Sea).

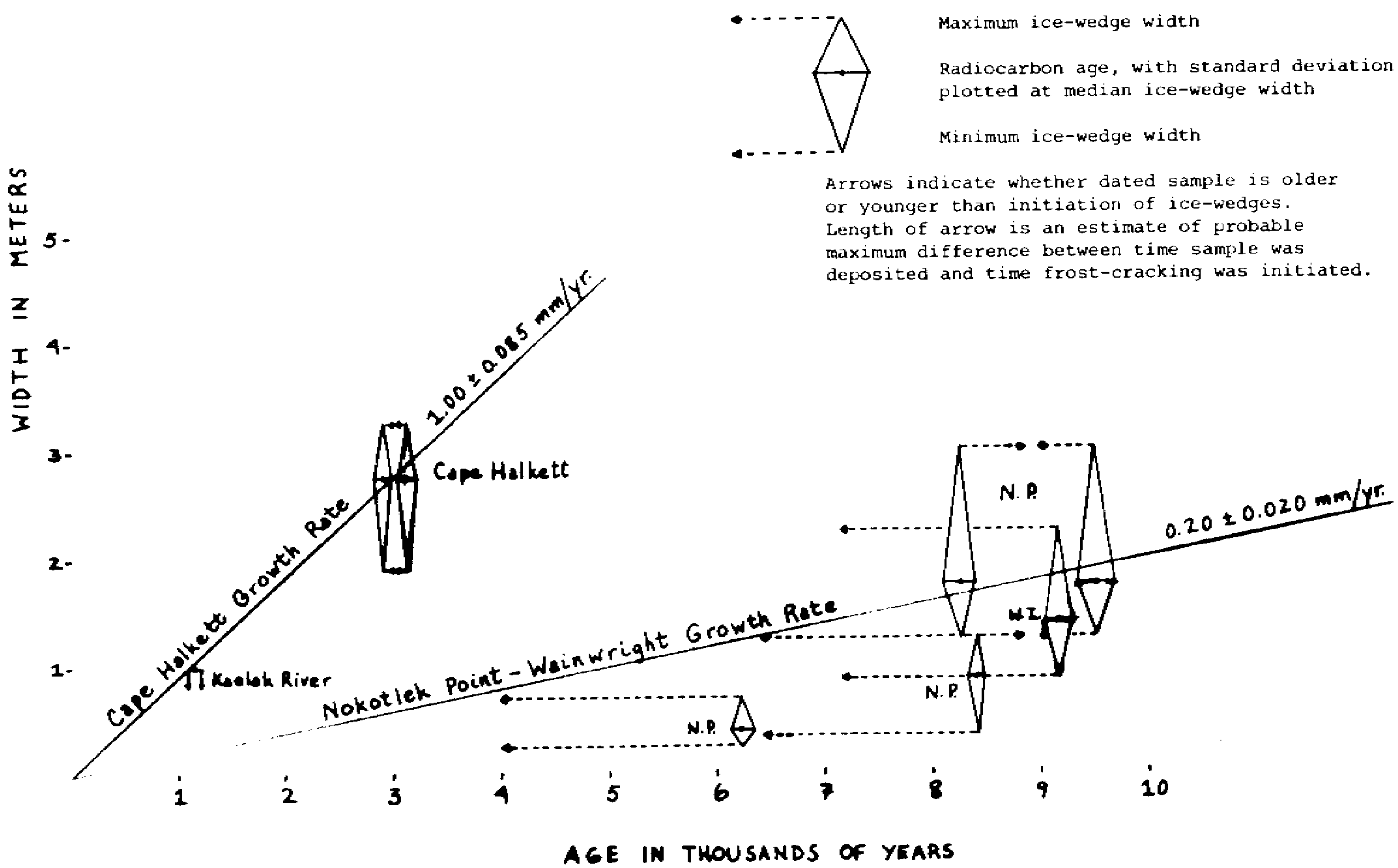


Table 2. Age of ice-wedge complexes in various places along the Chukchi and Beaufort Sea coasts.

LOCATION	AGE	RELEVANT RADIO-CARBON DATES	WIDTH OF ICE WEDGES IN M's			MEASUREMENTS[1/]	
			Min.	Median	Max.	Number	Method
Chukchi Sea							
Nokotlek Point	<6235 ± 120	I-10329	.25	.40	.70	15	(1)
Nokotlek Point	<8275 ± 135 >9535 ± 150	I-10330 I-10331	1.3	1.75	3.0	4	(1)
Nokotlek Point	<8435 ± 160	I-10332	.35	.85	1.25	20	(1)
South of Wain-wright Inlet	<9180 ± 150	I-10368	.70	1.37	2.50	8	(1)
Kaolak River	<1170 ± 45	USGS-500	"Less than 1 meter wide"			"A few"	(2)
Beaufort Sea							
Cape Halkett	<3130 ± 70 >2930 ± 50	USGS-501 USGS-502	2.0-	2.75	3.0+	Approx. 10	(3)

1/ Methods of Measurement

(1) Measured tops of wedges exposed in sea or lake bluff.

(2) Visual estimate.

(3) Measured width of sharply-defined polygon troughs in area of low-center ice-wedge polygons.

(4) Radiocarbon-dated samples from the deep gravel pits along the Put River and from the offshore boreholes (Table 1) confirm that the Sagavanirktok River once flowed through Prudhoe Bay and then turned westward through a broad valley excavated to a depth at least 50 m below present sea level in the area between the Prudhoe Bay West Dock and Reindeer Island. A zone of detrital peat about 42,000 years old, now lying 50 m below sea level in borehole PB-7, may be traceable to a paleosol and detrital peat layer still undated but separated by about 3 m of gravel from an overlying sand and detrital peat layer dated as 26,000 years old, exposed in a deep gravel pit along the lower Putalagayuk River.

(5) Ice-bonded permafrost is deeply thawed beneath the paleovalley delineated by our drill holes but lies only 10 or 15 m below the sea bottom in areas where older overconsolidated silt and clay is preserved on the sea bottom away from the paleovalley. Probably the deep thawing of permafrost resulted from infiltration of salt water into gravel in places where the overconsolidated silt and clay had been stripped away in the course of valley erosion during the low sea levels of late Wisconsinan time. If the paleodrainage pattern could be established on the Beaufort Sea shelf, it would probably be possible to predict the distribution of areas of shallow and deeply thawed ice-bonded permafrost.

Little is known, thus far, about the paleo-drainage pattern on the Beaufort Sea shelf, but one can reasonably assume that most areas of thick Holocene sediment (Barnes and Hopkins, 1978, fig. 3.5) lie within the paleovalleys and that areas of overconsolidated silt and clay and areas in which the bottom is littered by Flaxman Boulders lie between valleys (Rodeick, 1975; Reimnitz and Ross, 1979). There are other clues: the Staines River is shown in this report to have once flowed through Leffingwell Channel between Flaxman Island and Brownlow Point and changes in beach pebble lithology suggest that major passes in the Plover Islands also developed on the sites of former river valleys (Hopkins and Hartz, 1978). Given these observations, it is reasonable to assume that some of the other major passes between barrier islands may lie on the sites of former river valleys.

Based on these inferences, it seems probably that the Colville River cut a valley extending generally northward from the present river mouth and that the Sagavanirktok River flowed westward, a few kilometers north of the Return Islands to join the Colville paleovalley about 30 km northwest of Oliktok Point (Fig. 2). The Kuparuk River paleovalley may have extended northward between Egg and Stump Islands, joining the Sagavanirktok River paleovalley just to the north. The paleovalley of the Shaviovik River has not yet been defined, but the widespread distribution of Flaxman Boulders north and east of Point Brouwer indicates that it did not extend anywhere east of Newport Entrance between Karluk and Pole Islands. The Shaviovik paleovalley probably extends northward through Newport Entrance or northwestward

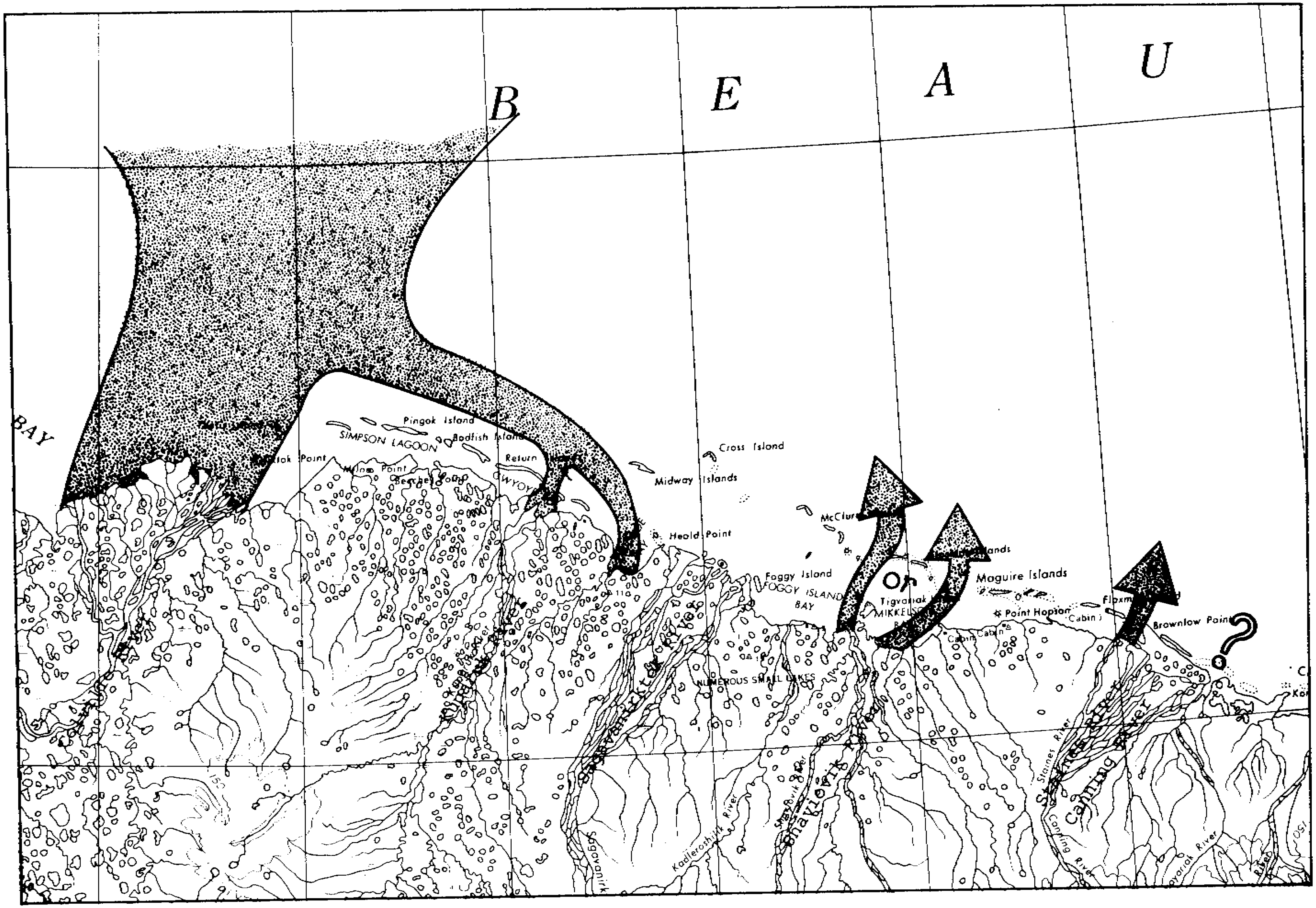


Fig. 2 Possible Locations of Major Paleovalleys on the Beaufort Sea Shelf

through Challenge Entrance between Belvedere and Challenge Islands. As noted, the Staines River evidently flowed northward through Leffingwell Channel between Flaxman Island and Brownlow Point between 5,000 and 2,000 years ago and perhaps earlier. One cannot even guess the location of the Canning, Staines, and Shaviovik paleovalleys on the open continental shelf to the north.

(6) Continuing study of the ice-rafted "Flaxman boulders" establishes that they were most likely derived from northern Greenland, rather than from Ellesmere Island or the Amundsen Gulf region as had been previously assumed. The most recent episode of introduction of erratic boulders to the continental shelf took place at some time after the last interglacial interval and at a time when relative sea level was at least 3 or 4 m higher than at present along the Beaufort Sea coast. Oxygen isotope records suggest that world sea level fell to a low level about 70,000 years ago, then underwent a partial recovery between 60,000 and 30,000 years ago, and then finally fell to its late Wisconsinan minimum position about 18,000 years ago (Shackleton and Opdyke, 1973). Thus, it seems likely that the Flaxman boulders were deposited between 60,000 and 30,000 years ago. Beaches that may have represented the Flaxman shoreline have been dated as about 36,000 years old at Point Barrow (Sellmann and Brown, 1973). However, the Sagavanirktok River paleovalley delineated by our drill holes seems to have been excavated earlier than 42,000 years ago, yet after the time of deposition of the Flaxman Boulders. The precise age of the most recent episode of deposition of ice-rafted Flaxman boulders remains uncertain.

VI. Problems encountered and recommended changes: None

VII. Estimate of funds expended to date: $13,750

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APPENDIX A

RECORD OF A PRE-HISTORIC STORM SURGE IN THE WAINWRIGHT INLET-KUK RIVER AREA

by

D. M. Hopkins, R. W. Hartz, and S. W. Robinson

Storm surges along the Beaufort and northern Chukchi Sea coasts have occasionally reached heights of 3 m above mean sea level during the present century (Aagard, 1978; Reimnitz and Maurer, 1978). The frequency of these events is not yet known, nor has there been evidence that surges of this height and intensity took place in earlier times. Evidence from the Wainwright Inlet-Kuk River area suggests, however, that storm surges of similar intensity took place in the pre-historic period. During fieldwork in 1977, we observed features along the Kaolak River which seem to record a storm surge that raised sea level about 3 m above the present level of the confluence of the Kuk and Kaoluk Rivers during a late summer storm more than 1,000 years ago.

Kuk River is a tidal estuary connected to the Chukchi Sea by way of Wainwright Inlet, forming an estuary and tidal river system that extends some 60 km southward and inland from the Chukchi Sea coast (fig. A-1. The lower 38 km of the system is brackish and lies at sea level. A confined delta 4.5 km long separates the estuarine lower Kuk River from the 18 km-long upper Kuk River, which is fresh and flowing but in which current speeds and channel form are strongly influenced by tides in the estuary. The tidal influence seems to end at the point where the Kaolak and Avalik Rivers join to form the Kuk.

The Kaolak River, in its lower 5 km, flows in a narrow valley incised into the Cretaceous bedrock of the highest, innermost, and oldest of the marine terraces comprising the Arctic coastal plain of Alaska (Williams and others, 1977). The meandering channel is confined between banks consisting alternately of bedrock and the alluvium of a series of alluvial terraces which stood 3.5-4.5, 7, and 14 m above river level on July 22, 1976[1/].

The lowest of these terraces slopes more steeply than present-day river grade, standing 3.5 m above river level near the confluence with the Avalik River and 4.5 m above river level at a point 5 km upstream. Field observations indicated that the terrace must be relatively young. Ox-bow lakes and marshes unmodified by thermokarst processes can be observed on the terrace surface, and vertical exposures show that ice wedges are sparse and small. These observations suggest that the 3.5-4.5 m terrace is of Holocene age, and that it was formed at some time within the last 10,000 years.

The 3.5-4.5 m terrace consists in most places of horizontal beds of sandy alluvium 2 to 10 cm thick; concentrations of willow and other plant leaves and driftwood twigs express the bedding planes. The only vertebrate remains found consisted of a fragment of reindeer antler. However, along the left bank of the Kaolak River at a point 250 m upstream from the confluence with the Avalik, the flat-bedded alluvium of the 3.5-4.5 m terrace passes downstream into foreset-bedded medium sand with interbeds of twigs and leaves. The inclined beds extend from river level to a height of 3.0 m and are overlain by 0.5 m of flat-bedded peat fine sand.

Radiocarbon assays show that the 3.5-4.5 m terrace of the lower Kaolak River formed during a brief period of alluviation on the order of 1,000 to

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[1/] Our reconnaissance of the Kuk and Kaolak Rivers took place at a time when the weather had been dry for about 10 days and stream discharge was relatively low.

2,000 years ago. Twigs collected at a depth of 3.7 to 3.8 m below the surface of the 4.5 m terrace, 5 km upstream, yielded a radiocarbon age of 1,730 ± 40 years (USGS-499), and twigs collected from the foreset-bedded sand at the river mouth yielded a radiocarbon age of 1,170 ± 45 years (USGS-500). Although the two samples consist of wood of different ages, the older sample may consist of wood redeposited from slightly older floodplain sediments, and have been deposited almost simultaneously with the younger sample. No unconformities, paleosols, or in situ peat were noted in a measured section at the upstream locality and there is at least a possibility that the entire 4.5 m of sediment exposed above river level was deposited during a single flood episode, simultaneously with the foreset-bedded sediments at the river mouth.

We believe that the 3.5-4.5 m terrace of the lower Kuk River was formed during a brief period of high river discharge which coincided with a Chukchi Sea storm surge. The foreset bedding in the terrace deposits at the Kaolak River mouth reflects abrupt decrease in current discharge and seems to indicate that at the time of deposition, the upper Kuk River was ponded at a level 3 m above its level of July 22, 1978. The increase in height of the Kaolak River terrace, proceeding upstream, must reflect a temporarily steepened river gradient, probably resulting from the inability of the constricted lower Kaolak River valley to accommodate a greatly increased floodwater flow. Although storm surges can take place in the Beaufort and Chukchi Seas at any season, they are most frequent and most severe during September and October (Aagard, 1978; Reimnitz and Maurer, 1978). The rivers of Arctic Alaska experience their highest discharge and their peak sediment load during the spring snowmelt (Arnborg and others, 1967), but experience occasional floods during late summer and autumn storms, as well. K. Stefansson reports evidence of recent flood levels along the Kaolak and

Ketic Rivers as high as 6 m but does not indicate the season (1946-1947 field notes filed in Alaska Technical Unit, U.S. Geological Survey, CA). The abundance of willow leaves in peaty interbeds suggests that the 3.5-4.5 m terrace of the Kaolak River were deposited during late summer or autumn rather than during spring.

Study of the terrace deposits along the Kaolak River confirms that flood levels along the Kaolak River may occasionally reach levels more than 4.5 m above normal stream grade and that these floods may coincide with intense storm surges.

REFERENCES

Aagard, K., ed., 1978, Physical oceanography and meteorology: Environmental Assessment of the Alaskan Continental Shelf; Interim Synthesis; Beaufort/Chukchi: U.S. National Oceanographic and Atmospheric Administration, Boulder, CO, p. 56-100.

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Williams, J. R., Yeend, W. E., Carter, L. D., and Hamilton, T. D., 1977, Preliminary surficial deposits map of National Petroleum Reserve-Alaska: U.S. Geological Survey Open File Report 77-868.

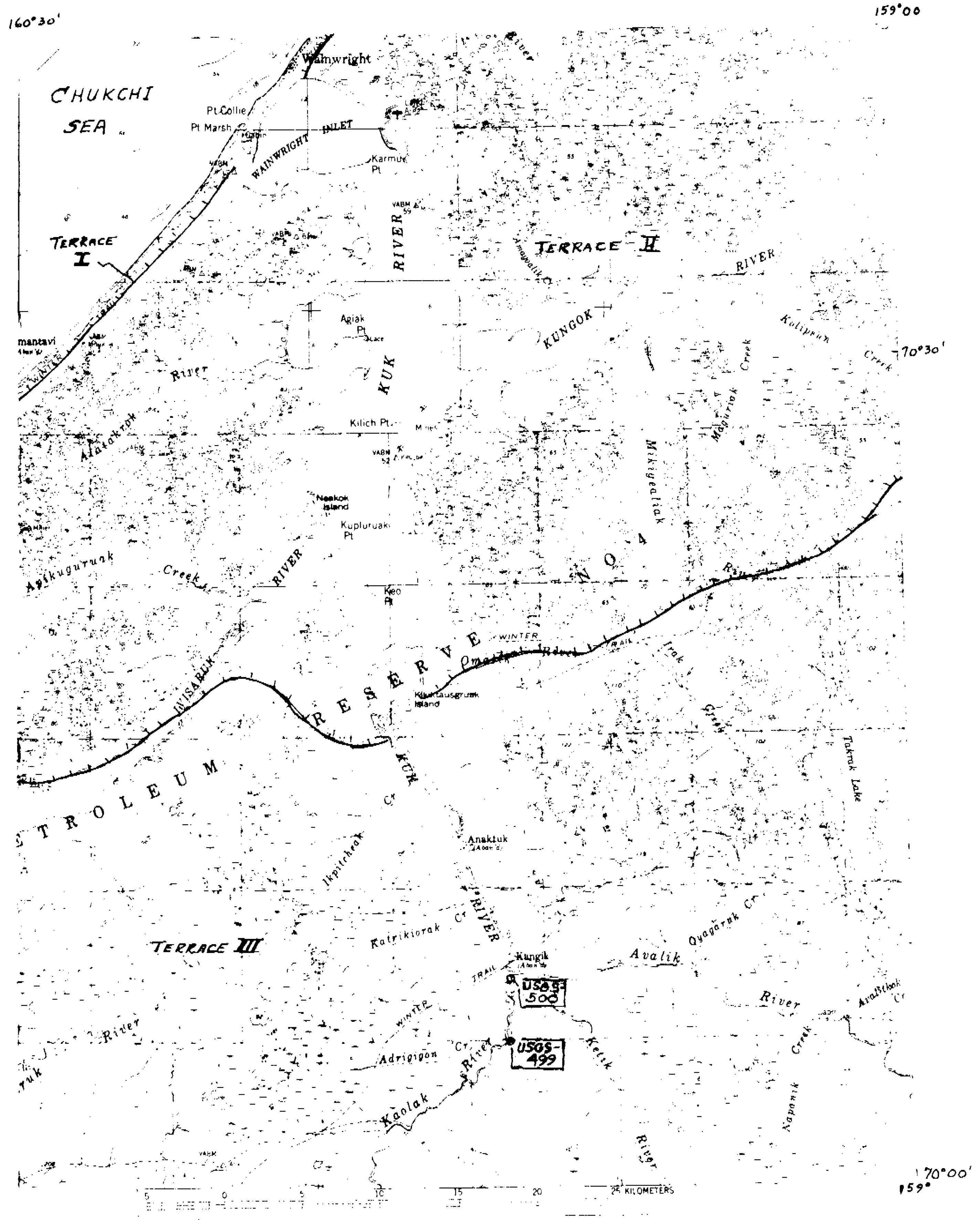

Figure A-1. Position of the Kaolak River in the Kuk River drainage basIn.

QUARTERLY REPORT

Research Unit # 208
Reporting Period 10/1/78-12/30/78
Number of pages: 3

Yukon Delta Coastal Processes Study

William R. Dupré
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University of Houston
Houston, Texas 77004

January 29, 1979

QUARTERLY REPORT

I. Task Objectives

The overall objective of this project is to provide data on geologic processes active within the Yukon-Kuskokwim delta in order to aid in the evaluation of the potential impact of scheduled oil and gas exploration and possible production. In particular, attention has been focused on the following:

1) Study the processes along the Yukon-Kuskokwim delta shoreline (e.g., tides, waves, sea-ice, river input) in order to develop a coastal classification including morphology, coastal stability, and dominant direction of longshore transport of sediments. (Task D-4, B-2).

2) Study the hydrology and sediment input of the Yukon and Kuskokwim Rivers as they largely determine the sediment budget of the northern Bering Sea. (Task B-11, B-2).

3) Determine the type and extent of Quaternary faulting and volcanism in the region. (Task D-6).

4) Reconstruct the late Quarternary chronology of the delta complex in order to determine:

    a) frequency of major shifts in the course of the Yukon River.
    b) effects of river diversion on coastal stability.
    c) relative age of faulting and volcanism.
    d) frequency of major coastal storms as recorded in chenier-like sequences along the coast.

II. Field and Laboratory Activities

A. Field trip schedule: N/A

B. Scientific party: N/A

C. Methods

1) Field Studies: N/A

2) Laboratory Studies:

a) Radiocarbon analysis (in progress) by S. Velastro (University of Texas Radiocarbon Laboratory)

b) Grain size analysis (completed) by R. Thompson (University of Houston)

D. Data collected on analysis

1) Number and types of samples collected: N/A

2) Number and types of analysis

a) Textural analysis 300-completed 30 in progress

b) Radiocarbon dates: 6 in progress

E. Milestone Chart and Data Submission Schedule:
No changes

III Results and Interpretations:

We have completed the analysis of 60 short (<1 m) cores taken throughout the delta, including approximately 300 grain size analysis of the cores as well as sediments from coastal stations nearby. One of the most striking results was the almost complete lack of clay in the delta. Only 6 samples had clay percentages in the 20-40% range, and these were in marsh, and abandoned channel, deposits. Approximately 90% of the deltaic sediments analysed had less than 10% clay.

The distribution of sand in the delta was even more unusual. Samples obtained from the R/V KARLUK last summer show an almost linear increase in sand percentage offshore. The sand percentage ranges from approximately 30% at the margin of the delta to 85-90% sand in the outer edge of the sub-ice platform. This suggests that there is significant reworking and winnowing of sediments on the outer margin of the sub-ice platform by storm waves, sub-ice flow, or both.

More detailed information will be provided in the annual report.

IV Problems Encountered/Recommended Solutions

No serious problems have been encountered, as work at present involve only the interpretation of existing data.

QUARTERLY REPORT FOR THE PERIOD

1 OCTOBER - 31 DECEMBER 1978

TITLE: Earthquake Activity and Ground Shaking in and along the Eastern Gulf of Alaska

RESEARCH UNIT: 210

PRINCIPAL INVESTIGATORS: John C. Lahr
Christopher Stephens

PREPARED BY: Christopher Stephens
John Roger
John C. Lahr

U.S. GEOLOGICAL SURVEY
345 Middlefield Road
Menlo Park, CA 94025

I. ABSTRACT OF HIGHLIGHTS

The OBS (Ocean Bottom Seismometer) instruments being developed by the USGS Office of Marine Geology performed well in a test off the coast of South Carolina. One of the five units deployed was not recovered, the loss probably caused by local fishing operations.

Preliminary earthquake locations for the period January-March 1978 are also presented.

II. TASK OBJECTIVES

Objectives:

1) Tabulate the locations and magnitudes of all significant earthquakes in the NEGOA region.
2) Prepare focal mechanism solutions to aid in interpreting the tectonic processes active in the region.
3) Identify both offshore and onshore faults that are capable of generating earthquakes.
4) Assess the nature of the strong ground shaking associated with large earthquakes in the NEGOA.
5) Evaluate the observed seismicity in close cooperation with OCSEAP Research Units 16 and 251 towards development of an earthquake prediction capability in the NEGOA.
6) Compile and evaluate frequency vs. magnitude relationships for seismic activity within and adjacent to the study areas.

III. FIELD AND LABORATORY ACTIVITIES

A. FIELD ACTIVITIES

1.) Ocean Bottom Seismic Instrumentation

Bruce Ambuter and Ray Davis of the USGS Office of Marine Geology, located in Woods Hole, Mass., have designed and built six ocean bottom seismic (OBS) recorders and two similar units for land use. These units feature 2-channel digital event recording with a total recording capacity of more than 15 hours.

Five of the OBS units were tested in shallow water off the coast of South Carolina in October 1978. The instruments were deployed in a small region with the aid of divers. One OBS instrument was lost, probably caused by local fishing operations. The remaining instruments performed well. Perhaps the most severe problem encountered was that most of the instrument triggers were caused by surf noise in the very shallow water.

In December the two land stations were shipped to Menlo Park. The units will be operated there for the next few months to determine an effective triggering algorithm for earthquake detection.

Dr. Ambuter will be building a digital playback system at Woods Hole to convert the 5-inch data tapes into computer compatible tapes. Use of his playback facility will be essential in the processing of the data from the OBS experiment in the Gulf of Alaska this summer.

2.) Station Maintenance

The station at Burwash Landing (BLY) in Canada was removed and is presently being installed along the Alaska Highway near the Alaska-Canada border. Other stations visited during this quarter were:

Cordova - A lightning and static arrester was installed to protect the amplifier.

Valdez West - Malfunctioning transmitter and receiver was repaired.

Glacier Island - Malfunctioning transmitter and receiver was repaired.

B. SCIENTIFIC AND FIELD PARTY

1.) Laboratory

John Lahr, USGS, Geophysicist, Project Chief
Christopher Stephens, USGS, Geophysicist
Kent Fogleman, USGS, Geophysicist
Mary Ann Allan, USGS, Physical Science Aid
Suzanne Helton, USGS, Physical Science Aid
Richard Archdeacon, USGS, Physical Science Aid
Mark Smetana, USGS, Physical Science Aid
Tom Cleese, USGS, Physical Science Aid
Tom Walker, USGS, Physical Science Aid

2.) Field

Marion Salsman, USGS, Physical Science Technician, stationed in Alaska

C. LABORATORY ACTIVITIES

An Open-File Report documenting the NCER A1VCO deployed in Alaska last summer has been completed for technical review. The report contains descriptions for the user not familiar with electronics, as well as more detailed information appropriate for experienced technicians and for production and testing of the units.

New circuit boards are being developed for calibration based on solid-state memory and for multi-sensor operation.

D. SAMPLE LOCALITIES

A map of seismic stations operated by the U.S. Geolocial Survey in the eastern Gulf of Alaska from October through December 1978 is shown in Figure 1.

E. DATA COLLECTED OR ANALYZED

A map and tabulations of preliminary earthquake locations along the eastern Gulf of Alaska for January through March 1978 are presented in the Appendix.

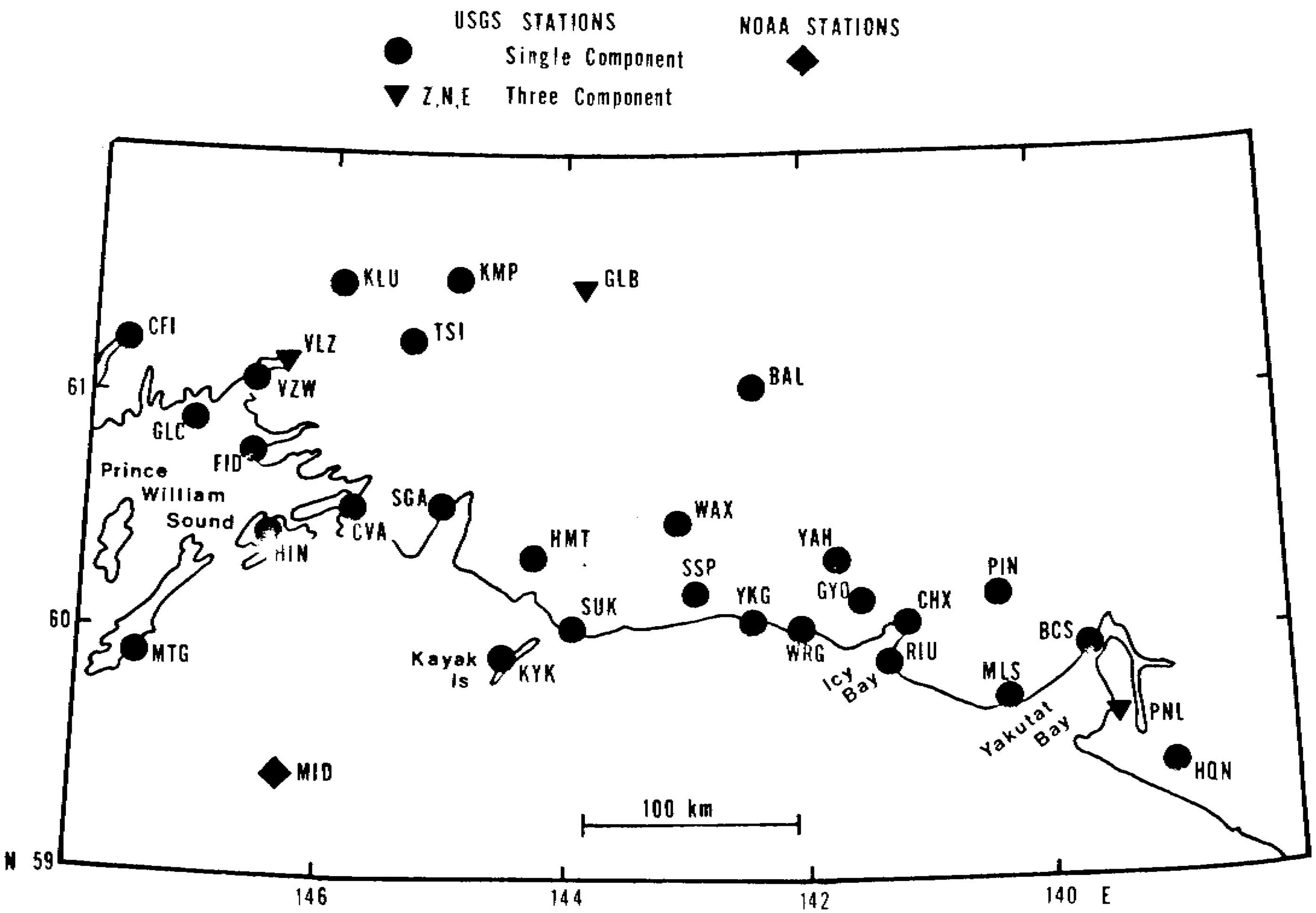

Figure 1. Seismic stations operating in southeast Alaska during October-December 1978.

IV. AND V. RESULTS AND PRELIMINARY INTERPRETATION

Seismicity during the period JANUARY-MARCH 1978

The general distribution of seismic activity along the southeastern Gulf of Alaska for the first quarter of 1978 is similar to the distribution of activity for the previous quarter. The total number of located earthquakes for the period January-March 1978 is 310, as compared to 224 for the previous quarter. Most of the apparent increase in activity is concentrated near Icy Bay and northeast of Kayak Island. The largest magnitude earthquakes that occurred offshore were located south and southwest of Kayak Island. The magnitude of the largest of these events was 4.4. Several smaller earthquakes were located less than 50 km offshore from Yakutat Bay.

Calibrations

The calibrator units installed last summer have been performing well. The calibration cycles have already been successfully used to diagnose animal damage to the installations at SSP and HQN. Records of the calibration cycles are now being collected and computer programs for analyzing the signals are being developed.

VI. PROBLEMS ENCOUNTERED AND RECOMMENDATIONS

As radio usage in Alaska increases, interference from other transmitters is becoming a serious problem. In Yakutat, a NOAA weather radio transmitter was responsible for the loss of half of our radio signals. As a result, our receiver configuration will be modified. The new design will involve the use of two different types of cavities, and should be installed by February 1979.

VIII. REFERENCES

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Lee, W. H. K., and J. C. Lahr (1972). HYPO71: a computer program for determining hypocenter, magnitude, and first motion pattern of local earthquakes, U.S. Geological Survey, Open-File Report, 100 p.

Lee, W. J. K., R. E. Bennett, and K. L. Meagher (1972). A method of estimating magnitude of local earthquakes from signal duration, U.S. Geological Survey, Open-File Report, 28. p.

PUBLISHED PAPERS

Fogleman, K., C. Stephens, J. C. Lahr, S. Helton, and M. Allan (1978). Catalog of earthquakes in southern Alaska, October-December 1977, U.S. Geological Survey, Open-File Report,28p.

APPENDIX

Preliminary earthquake locations along
the eastern Gulf of Alaska for
the period January through March 1978

This appendix lists origin times, focal coordinates, magnitudes, and related parameters for earthquakes which occurred in the eastern Gulf of Alaska region. The following data are given for each event:

(1) Origin time in Universal Time (UT): date, hour (HR), minute (MN), and second (SEC). To convert to Alaska Standard Time (AST) subtract ten hours.

(2) Epicenter in degrees and minutes of north latitude (LAT N) and west longitude (LONG W).

(3) DEPTH, depth of focus in kilometers.

(4) MAG, magnitude of the earthquake.

(5) NP, number of P arrivals used in locating earthquake.

(6) NS, number of S arrivals used in locating earthquake.

(7) GAP, largest azimuthal separation in degrees between stations.

(8) D3, epicentral distance in kilometers to the third closest station to the epicenter.

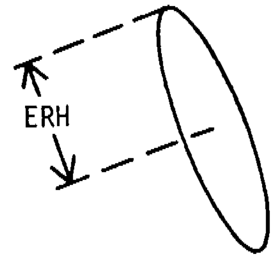
(9) RMS, root-mean-square error in seconds of the traveltime residuals:

$$RMS = \sum_i \left[(Rp_i^2 + Rs_i^2) \,/\, (N_P + N_S) \right]$$

where Rp_i and Rs_i are the observed minus the computed arrival times of P- and S-waves, respectively, at the i-th station.

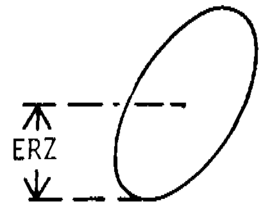
(10) ERH, largest horizontal deviation in kilometers from the hypocenter within the one-standard-deviation confidence ellipsoid. This quantity is a measure of the epicentral precision for an event. An upper limit of 99 km is placed on ERH.

Projection of ellipsoid
onto horizontal plane



(11) ERZ largest vertical deviation in kilometers from the hypocenter within the one-standard-deviation confidence ellipsoid. This quantity is a measure of the depth precision for an event. An upper limit of 99 km is placed on ERZ.

Projection of ellipsoid onto vertical plane:



(12) Q, quality of the hypocenter. This index is a measure of the precision of the hypocenter and is calculated from ERH and ERZ as follows:

Q		ERH		ERZ
A	$\leq$	2.5	$\leq$	2.5
B	$\leq$	5.0	$\leq$	5.0
C	$\leq$	10.0	$\leq$	10.0
D	$\geq$	10.0	$\geq$	10.0

This quality symbol is used to denote each earthquake on epicenter maps.

All earthquakes were located using the following horizontally layered velocity model:

Layer	Depth to Top (km)	P velocity (km/sec)
1	0	2.75
2	0.01	6.0
3	20	7.0
4	32	8.2

This model was developed by minimizing the travel-time residuals for a group of earthquakes near Valdez. It is considered a reasonable model but not necessarily the optimum model for this region. Further modifications and refinements to the model will undoubtedly take place in the future as more data are gathered.

Whenever possible S-phase arrivals are used in addition to P-phase arrivals. The S-phase velocity is assumed to equal (P-velocity)/1.78 in each layer of the velocity model.

Magnitudes are determined from the signal duration or the maximum trace amplitude. Eaton and others (1970) approximate the Richter local magnitude, whose definition is tied to maximum trace amplitudes recorded on standard horizontal Wood-Anderson torsion seismographs, by an amplitude magnitude based on maximum trace amplitudes recorded on high-gain, high-frequency vertical seismographs such as those operated in the Alaskan network. The amplitude magnitude XMAG used in this catalog is based on the work of Eaton and his co-workers and is given by the expression (Lee and Lahr, 1972)

$$XMAG = \log_{10}A - B_1 + B_2\log_{10}D^2 \qquad (1)$$

where A is the equivalent maximum trace amplitude in millimeters on a standard Wood-Anderson seismograph, D is the hypocentral distance in kilometers, and B_1 and B_2 are constants. Differences in the frequency response of the two seismograph systems are accounted for in calculating A; however, it is assumed that there is no systematic difference between the maximum horizontal ground motion and the maximum vertical motion. The terms $-B_1 + B_2 \log_{10}D^2$ approximate Richter's $-\log_{10}A_0$ function (Richter, 1958, p. 342), which expresses the trace amplitude for a zero-magnitude as a function of epicentral distance (Δ). For small local earthquakes in central California, $B_1 = 0.15$ and $B_2 = 0.80$ for Δ = 1 to 200 km and $B_1 = 3.38$ and $B_2 = 1.50$ for Δ = 200 to 600 km.

For small, shallow earthquakes in central California, Lee and others (1972) express the duration magnitude FMAG at a given station by the relation

$$FMAG = -0.87 + 2.00 \log_{10} \tau + 0.0035\,\Delta \qquad (2)$$

where τ is the signal duration in seconds from the P-wave onset to the point where the peak-to-peak trace amplitude on the Geotech Model 6585 film viewer falls below 1 cm, and Δ is the epicentral distance in kilometers.

Comparison of XMAG and FMAG estimates from equations (1) and (2) for 77 Alaskan shocks in the depth range 0 to 150 km and in the magnitude range 1.5 to 3.5 reveals a systematic linear decrease of FMAG relative to XMAG with increasing focal depth. We use the following equation, including a linear dependence on depth term:

$$FMAG = -1.15 + 2.0 \log_{10} \tau + 0.007z + 0.0035\,\Delta, \qquad (3)$$

where z is the focal depth in kilometers. Incorporating the depth term in the calculation of FMAG was found to be necessary for Alaskan data.

The magnitude preferentially assigned to each earthquake in this catalog is the mean of the FMAG (equation 3) estimates obtained for USGS stations. The XMAG estimate is given when no FMAG determinations could be made. For shocks larger than about magnitude 3.0, XMAG cannot be determined because the maximum trace amplitudes are off-scale or the traces are too faint to read. For many shocks smaller than about magnitude 2.0, the trace amplitude drops below 1 cm peak-to-peak between the P and S arrivals and FMAG is not determined.

Many of the earthquakes recorded by the stations occur outside of the network, so it is difficult to establish good depth control for these events. The procedure for locating all earthquakes is to first fix the depth and determine the optimal epicentral location, and then allow the depth to vary. Frequently for earthquakes which occur outside of the network little or no improvement to the solution is found when the depth is allowed to vary. The result is that the distribution of the depths of the final hypocentral solutions may be biased toward the initial trial depth and may not reflect the true depth of the earthquakes. The trial depth used for the earthquakes occurring in the fourth quarter of 1977 was 15 km.

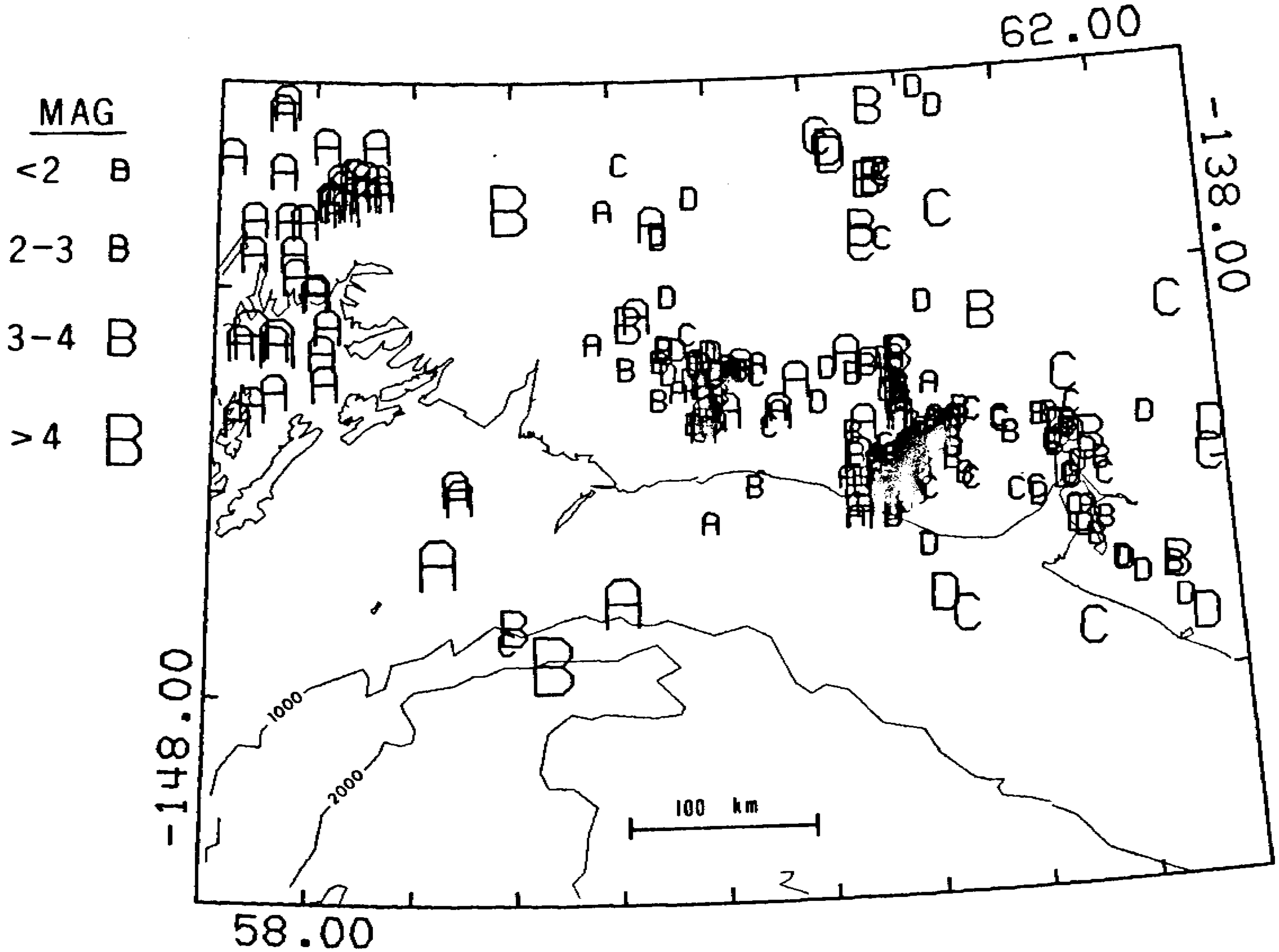


Figure 2. Map of earthquake epicenters determined by the USGS seismic network in southeastern Alaska for the period January-March, 1978. The symbol corresponds to the quality of the hypocenter solution (see text for description) and the size is proportional to magnitude.

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978

1978	ORIGIN HR MN	TIME SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
JAN 1	8 9	21.8	61 29.2	146 42.5	19.3	2.2	20	15	90	48	0.45	0.9	1.2	A
1	9 30	8.4	60 10.0	139 18.3	1.2	2.9	17	5	223	56	0.40	2.9	2.8	B
1	16 16	4.1	59 21.0	145 0.6	15.1	2.8	22	18	204	106	0.36	2.8	1.6	B
2	13 14	55.2	59 52.4	141 37.2	17.7	2.0	15	12	163	35	0.43	1.9	1.1	A
2	14 34	8.2	59 50.9	141 38.9	17.0	1.7	12	9	165	38	0.42	1.7	1.1	A
2	16 49	1.8	60 5.9	139 21.0	1.3	1.7	6	3	241	50	0.58	4.7	17.4	D
2	20 44	19.9	61 53.8	147 19.0	17.6	2.9	24	16	157	81	0.54	1.6	1.9	A
2	21 12	48.0	60 58.0	147 0.1	22.5	2.8	31	19	65	34	0.43	1.0	1.1	A
2	23 42	59.4	59 21.0	140 38.6	45.8	2.4	12	9	211	84	0.25	3.3	8.1	C
3	4 11	25.2	60 35.1	142 41.2	15.0	1.2	5	6	101	57	0.27	2.0	2.2	A
3	8 8	34.1	59 50.5	143 4.5	17.7	1.3	8	8	192	81	0.32	2.4	1.7	A
3	9 47	53.8	60 8.8	139 41.4	16.1	1.0	4	3	249	56	0.09	6.6	2.5	C
3	12 47	32.4	59 33.1	139 4.6	15.9	1.1	3	2	182	90	0.02	98.6	9.0	D
3	17 28	7.3	60 18.7	140 38.9	17.7	1.6	10	8	174	49	0.36	2.4	1.6	A
3	23 35	21.0	60 6.4	140 40.4	17.8	1.7	9	6	157	40	0.39	3.0	1.5	B
4	18 31	26.3	60 26.5	141 10.6	14.7	1.3	9	8	171	42	0.39	2.1	1.6	A
4	18 36	39.3	61 30.1	141 16.0	0.8	2.0	7	5	251	136	0.32	2.5	3.2	B
5	10 26	40.4	59 27.9	143 57.6	17.8	3.4	26	10	178	99	0.54	2.5	1.8	A
5	12 20	25.0	61 23.2	146 41.8	20.0	2.8	28	15	81	43	0.43	0.8	1.9	A
5	15 4	4.4	60 17.5	140 39.7	20.1	1.1	5	4	229	99	0.09	5.0	3.9	C
5	20 41	25.3	60 7.8	139 39.7	0.7	1.6	10	7	205	53	0.44	3.8	3.3	B
5	23 0	24.9	60 10.4	139 35.4	2.2	1.6	10	7	211	55	0.35	3.3	4.2	B
6	0 58	42.0	60 31.8	146 53.4	19.0	2.8	27	16	132	62	0.53	1.2	1.1	A
6	4 41	44.1	61 18.2	143 34.5	0.1	2.5	24	8	171	103	0.72	1.8	1.9	A
6	6 39	55.7	60 27.6	142 57.8	11.2	1.3	5	2	161	62	0.31	4.4	3.4	B
6	11 32	12.9	61 27.2	146 28.2	13.1	2.4	24	14	80	44	0.65	0.8	1.0	A
6	14 18	34.2	60 48.8	140 17.4	0.4	2.2	6	4	229	137	0.63	4.8	2.9	B
6	23 32	18.1	60 13.4	140 59.3	16.7	1.1	8	6	148	28	0.33	2.8	2.5	B
7	2 18	5.0	60 18.4	140 35.6	12.5	1.4	12	9	176	52	0.31	2.7	1.5	B
7	19 28	7.2	60 11.1	141 4.2	12.6	2.2	20	5	139	35	0.62	1.5	1.2	A
7	22 39	50.9	60 7.5	140 58.2	1.3	1.5	13	4	131	31	0.44	1.4	2.9	B
8	18 0	39.9	61 50.9	147 21.9	17.0	2.4	19	13	152	76	0.57	1.7	1.9	A
9	13 31	20.0	59 49.3	139 23.8	6.2	1.5	9	4	186	51	0.36	2.3	1.8	A
10	2 32	43.1	60 28.7	140 51.5	1.6	1.7	8	10	188	51	0.44	1.1	2.3	A
10	12 5	33.9	60 36.7	141 17.5	10.7	1.3	5	6	222	61	0.25	2.5	10.6	D
10	20 49	19.2	60 43.5	144 12.0	11.9	1.8	4	3	200	106	0.15	2.2	2.0	A
10	22 40	32.9	60 2.0	140 58.4	23.5	1.0	3	3	214	40	0.20	17.0	4.4	D
11	17 33	10.4	60 34.7	141 51.3	0.1	0.9	3	3	193	55	0.21	1.9	99.0	D
12	5 16	9.1	60 36.7	142 32.9	19.2	1.4	5	4	109	51	0.49	1.2	1.2	A
12	13 43	56.3	60 11.6	141 19.3	18.1	1.2	3	3	223	60	0.17	6.1	4.5	C
12	19 32	25.0	61 32.7	146 37.6	20.1	2.1	6	5	166	77	0.40	1.3	6.8	C
12	21 35	44.0	60 15.4	139 38.6	15.9	1.2	3	1	337	99	0.07	38.0	13.3	D
13	1 54	44.1	60 12.6	140 5.5	7.2	1.4	6	4	194	77	0.16	4.7	3.2	B
13	8 46	55.2	60 21.1	147 45.2	10.2	2.8	25	8	147	90	0.44	1.8	1.4	A
13	15 11	58.8	60 12.4	139 32.1	1.0	1.9	9	5	215	60	0.36	2.4	2.5	B

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978 (CONT)

1978	ORIGIN HR MN	TIME SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
JAN 13	23 14	55.9	59 54.2	141 10.4	8.6	1.3	5	5	192	60	0.20	3.4	2.7	B
15	0 41	17.3	60 1.6	141 27.1	15.0	1.1	7	5	190	41	0.33	2.7	2.0	B
15	9 0	47.2	60 32.7	143 13.9	15.0	1.5	3	2	249	73	0.63	8.3	13.7	D
15	9 43	7.7	60 30.8	143 8.5	15.0	1.7	4	3	185	73	0.37	7.9	8.8	C
15	21 9	0.3	59 10.0	144 38.3	13.0	4.4	29	1	202	112	0.25	3.7	2.7	B
16	10 38	32.4	61 9.7	147 13.0	11.9	2.2	15	8	72	48	0.50	1.1	0.9	A
16	11 39	14.2	59 29.0	138 55.4	12.0	1.4	3	2	192	101	0.05	98.6	9.5	D
16	15 41	11.2	60 4.7	141 9.7	11.0	1.4	5	2	175	50	0.15	4.3	1.4	B
17	12 13	37.1	60 3.0	139 13.1	0.0	1.4	6	4	221	52	0.28	2.2	2.7	B
18	5 28	42.8	61 28.1	146 34.6	19.9	2.2	19	10	85	71	0.60	0.9	1.4	A
18	7 6	6.4	60 1.0	142 37.7	4.9	1.4	5	5	264	50	0.25	3.2	2.3	B
18	7 19	25.9	60 41.6	143 20.8	17.2	1.3	4	3	180	87	0.26	13.8	18.9	D
18	7 51	36.9	59 58.8	141 5.0	15.0	1.0	3	1	200	101	0.41	26.4	10.1	D
18	10 24	33.6	60 32.7	141 36.3	15.0	1.5	8	6	160	60	0.34	1.5	2.6	B
18	11 52	26.2	60 35.0	142 51.3	0.9	1.1	3	2	210	58	0.24	12.0	70.0	D
18	13 16	31.5	60 35.3	142 57.5	25.4	1.4	3	2	175	106	0.45	17.8	18.1	D
18	14 39	30.1	60 13.8	139 30.2	2.9	1.6	6	5	218	63	0.37	3.2	2.7	B
19	20 5	14.0	61 41.2	146 23.3	22.8	2.6	27	9	96	67	0.61	1.0	1.9	A
20	1 16	5.2	61 31.8	146 29.6	23.1	2.2	15	9	87	66	0.51	0.8	1.5	A
20	4 25	44.0	60 8.1	140 51.7	16.7	2.0	13	6	136	34	0.41	1.3	1.1	A
20	5 0	59.2	61 15.5	143 30.9	16.5	1.2	4	4	170	85	0.32	36.0	16.1	D
20	10 39	20.5	60 31.0	143 5.3	3.9	1.8	9	4	146	71	0.33	1.6	1.9	A
21	1 49	51.9	60 15.6	141 38.1	17.8	1.4	6	4	143	36	0.25	2.5	1.0	B
21	7 52	28.2	60 5.0	141 1.7	4.6	1.0	5	3	188	128	0.59	4.4	3.1	B
21	11 11	22.3	60 11.2	140 59.5	17.0	1.7	12	6	142	42	0.41	1.7	1.2	A
21	19 12	17.9	59 55.9	140 4.2	0.2	1.7	6	3	157	60	0.37	5.1	3.7	C
22	21 1	34.4	61 24.7	146 46.1	19.9	2.6	27	6	84	46	0.46	0.8	1.2	A
23	0 6	50.7	60 8.3	139 39.5	16.2	1.4	8	3	206	50	0.38	4.9	2.2	B
23	9 12	12.1	60 57.0	143 25.8	7.5	0.4	3	3	189	64	0.17	2.1	25.1	D
23	9 33	49.6	60 43.5	147 22.5	6.7	3.0	30	7	135	55	0.51	1.1	1.2	A
23	18 39	32.2	60 0.1	139 33.7	0.4	2.1	8	0	201	40	0.15	5.1	12.4	D
23	21 7	49.7	59 59.2	139 32.4	13.4	0.5	4	2	221	42	0.04	8.7	3.1	C
25	9 9	26.5	60 38.7	141 39.4	15.1	2.0	14	6	169	57	0.28	1.7	1.5	A
25	11 32	9.0	60 46.0	147 38.0	15.7	3.6	33	6	79	47	0.49	1.1	1.0	A
25	19 51	32.7	60 9.1	141 10.3	11.5	1.0	4	2	167	51	0.19	4.9	3.4	B
25	22 19	33.9	60 3.7	141 12.0	0.4	1.0	5	3	118	21	0.13	3.0	38.8	D
26	5 45	54.4	60 43.5	147 44.4	11.5	2.7	26	11	116	62	0.48	1.2	1.2	A
26	8 49	32.1	61 30.9	146 45.3	19.1	2.7	26	12	94	52	0.44	0.8	1.2	A
26	11 49	37.5	60 18.4	141 10.3	16.4	1.3	9	7	153	32	0.18	2.2	1.4	A
26	16 43	45.6	60 42.3	143 28.7	15.9	1.5	4	3	188	84	0.36	10.0	14.4	D
27	9 41	3.6	60 7.1	141 26.5	14.5	1.5	8	6	137	32	0.28	3.0	2.2	B
27	18 4	13.8	61 27.4	146 31.1	20.0	2.2	23	13	82	68	0.49	0.9	1.6	A
28	8 47	18.3	61 11.6	141 13.5	12.6	1.3	4	4	235	133	0.14	5.9	3.9	C
29	3 56	11.6	62 26.4	147 3.6	3.1	2.7	11	7	244	144	0.60	5.4	2.2	C
29	4 20	21.4	60 25.0	141 57.8	32.8	1.1	4	0	202	49	0.14	20.3	28.1	D

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978 (CONT)

1978	ORIGIN TIME HR MN	SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
JAN 29	7 58	57.3	61 32.2	146 29.2	20.6	2.3	26	11	87	65	0.49	0.8	1.8	A
29	21 29	22.1	59 41.8	140 57.9	7.6	0.9	4	3	206	123	0.09	10.6	8.4	D
30	7 31	27.6	60 38.0	143 31.7	0.6	1.9	14	8	65	64	0.29	1.0	2.6	B
30	18 46	22.8	59 53.7	141 14.8	12.0	0.7	3	3	187	31	0.12	3.2	4.7	B
31	7 0	8.3	60 33.5	142 34.1	20.7	1.2	9	4	114	65	0.26	3.8	5.9	C
31	15 2	26.2	60 35.4	142 47.8	12.7	1.7	9	6	85	56	0.41	1.5	1.4	A
31	15 54	30.0	59 56.1	139 52.5	15.2	1.2	4	3	172	40	0.48	8.8	8.6	C
31	17 28	40.0	61 27.8	146 21.0	22.3	2.5	26	12	77	46	0.54	1.0	1.5	A
31	21 9	58.2	60 8.1	141 7.3	0.2	2.2	18	8	129	29	0.50	1.2	2.2	A
31	22 34	58.0	60 9.2	140 39.5	19.4	1.4	9	6	149	45	0.19	4.2	1.2	B
FEB 1	5 44	6.6	60 40.7	143 2.6	15.0	1.6	4	3	166	57	0.40	10.3	13.5	D
1	19 42	1.8	60 1.9	141 11.9	12.9	1.6	10	7	112	48	0.38	1.5	1.1	A
1	21 8	18.4	60 4.9	141 7.2	27.0	1.4	4	3	145	126	0.58	3.4	2.9	B
3	12 12	51.9	59 57.7	141 5.2	12.7	1.4	4	2	227	58	0.10	7.3	4.1	C
4	7 30	12.1	61 37.0	141 42.1	30.5	2.2	4	1	299	144	0.05	55.8	81.9	D
4	8 14	41.4	60 4.3	141 13.8	0.1	1.4	5	4	208	54	0.31	8.3	7.3	C
4	8 53	51.2	59 33.9	139 6.2	17.8	1.4	3	1	182	82	0.03	98.6	8.9	D
4	9 25	27.7	60 12.2	140 42.2	19.0	2.1	9	2	160	60	0.28	3.5	1.4	B
4	9 55	29.6	60 37.8	141 9.1	8.3	2.1	12	2	187	79	0.23	2.5	2.9	B
5	14 19	19.5	61 42.5	141 50.0	1.8	2.3	5	4	251	175	0.38	5.6	4.6	C
5	23 47	16.1	61 25.5	146 51.5	17.8	2.4	19	6	87	51	0.48	1.1	1.3	A
7	14 0	32.5	60 25.5	147 36.6	3.3	2.8	22	6	103	97	0.49	1.1	1.4	A
7	16 36	34.2	59 50.5	141 18.3	14.8	1.2	9	5	186	63	0.39	2.5	1.3	B
7	18 39	12.9	59 58.1	140 55.3	10.6	1.3	5	3	180	120	0.16	5.1	3.6	C
8	12 31	20.3	60 0.5	141 10.4	11.2	2.5	18	4	108	48	0.48	1.6	1.3	A
8	13 59	36.6	60 0.4	141 9.0	12.6	2.1	13	5	108	49	0.53	1.4	1.1	A
8	14 11	48.4	60 0.7	141 10.0	8.9	1.3	10	4	109	48	0.43	2.5	2.3	B
9	6 26	46.4	60 45.9	143 14.6	0.0	1.4	4	3	241	127	0.19	4.9	6.5	C
9	20 36	13.1	59 59.2	141 19.5	10.7	0.9	4	2	223	61	0.20	17.4	23.5	D
9	21 18	22.5	60 27.4	141 16.5	5.5	0.9	6	3	168	69	0.22	3.3	12.0	D
9	21 59	9.3	60 34.1	142 58.1	12.9	1.2	5	1	132	62	0.13	11.0	9.5	D
9	22 11	5.5	60 29.6	141 13.3	2.1	1.9	10	6	175	68	0.37	1.5	3.0	B
10	0 56	4.7	60 6.5	141 26.6	9.9	1.1	9	2	137	33	0.24	3.4	2.8	B
10	5 33	13.0	60 19.0	143 3.5	0.9	1.5	9	6	142	73	0.44	1.7	2.8	B
11	5 36	7.5	60 17.4	139 42.0	2.3	1.7	8	2	214	71	0.25	12.5	15.1	D
11	19 57	50.4	60 15.3	138 45.2	18.3	1.8	4	1	251	90	0.15	14.4	29.4	D
11	20 22	27.6	60 37.5	143 10.8	0.5	1.3	8	3	144	65	0.45	1.1	3.2	B
11	22 54	25.2	60 36.3	143 10.1	11.6	1.4	5	2	156	66	0.19	13.6	18.7	D
12	0 2	45.8	60 19.2	143 7.0	0.9	2.1	10	5	175	68	0.52	2.0	2.4	A
12	12 21	35.6	60 5.9	141 8.8	6.1	1.9	9	5	156	50	0.70	2.4	1.8	A
12	12 54	43.1	59 45.6	139 13.4	10.2	1.7	5	1	197	40	0.08	3.7	4.4	B
12	13 38	55.7	59 14.6	139 26.2	19.5	2.2	8	4	245	79	0.17	8.2	7.8	C
13	8 36	0.9	61 39.1	141 43.0	6.8	2.1	6	1	250	144	0.27	10.4	7.3	D
13	12 14	1.1	59 47.2	139 28.2	8.8	2.1	10	6	163	50	0.41	3.9	1.9	B
13	17 59	9.2	59 43.9	139 26.3	12.3	0.7	3	2	176	45	0.00	18.8	10.4	D

1978	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
FEB 13	19	57	28.1	60	5.9	141	1.2	19.2	1.2	5	5	154	103	0.27	5.8	3.0	C
13	22	28	12.8	60	21.1	141	10.7	14.5	1.5	7	5	159	59	0.31	2.0	1.6	A
14	4	41	19.0	60	14.6	140	40.1	18.7	1.3	6	5	172	61	0.13	4.8	1.9	B
14	9	35	4.7	60	26.2	141	10.6	17.5	0.9	3	2	170	92	0.22	46.7	71.0	D
14	9	42	12.2	60	29.5	141	9.5	0.2	1.0	6	4	178	66	0.19	1.3	6.8	C
14	9	54	9.4	60	28.9	141	9.2	1.6	1.4	9	5	177	66	0.30	1.6	3.6	B
14	12	53	6.2	60	28.1	141	10.4	14.4	1.2	6	3	174	65	0.19	2.5	3.9	B
14	14	30	39.5	63	19.3	147	22.0	0.1	3.3	21	5	264	213	0.34	27.9	29.6	D
14	15	10	4.0	60	0.1	141	36.9	13.8	2.1	11	4	163	41	0.46	1.9	1.2	A
14	22	22	48.0	59	58.5	141	18.8	11.5	0.9	6	1	145	60	0.23	4.8	4.2	B
15	10	19	30.1	60	40.9	146	55.3	14.1	2.7	24	11	141	59	0.50	1.1	1.1	A
15	14	42	5.2	60	1.6	138	9.7	10.3	2.2	7	3	276	82	0.41	6.6	3.7	C
16	6	33	21.0	59	40.9	139	20.0	5.4	1.4	5	1	163	36	0.11	3.4	2.6	B
16	14	25	27.3	60	22.0	143	5.2	4.9	2.0	10	8	150	74	0.41	1.4	1.6	A
16	14	35	53.0	60	17.7	143	8.8	0.2	1.4	5	4	196	94	0.19	2.1	6.5	C
16	14	52	44.6	59	39.5	145	45.1	10.1	3.8	29	2	148	99	0.47	1.5	1.6	A
16	20	53	51.7	61	23.2	145	1.6	38.2	3.5	32	1	83	65	0.28	1.4	3.3	B
16	22	19	21.6	60	8.2	141	9.0	15.5	1.7	7	5	153	50	0.36	2.8	1.3	B
17	2	38	4.8	59	58.4	141	21.9	7.1	1.2	5	3	225	63	0.10	4.1	4.8	B
17	10	43	2.0	61	14.2	143	30.8	15.0	1.1	5	4	145	86	0.29	25.7	13.7	D
17	10	57	57.0	59	30.8	138	36.3	10.5	1.8	4	3	296	75	0.22	4.9	2.2	B
17	12	9	20.6	59	31.6	138	34.7	9.3	2.0	6	2	295	75	0.13	4.7	2.1	B
17	18	6	53.7	60	43.5	147	23.2	7.1	2.4	24	12	135	55	0.49	0.9	0.9	A
17	21	48	2.9	60	2.2	141	11.0	11.8	1.2	4	2	191	128	0.16	4.6	1.7	B
18	14	27	24.4	60	29.2	143	20.9	0.2	1.7	9	6	181	82	0.28	1.4	2.1	A
18	15	53	10.8	59	21.1	138	32.2	15.5	1.6	5	1	341	90	0.10	28.5	3.6	D
18	17	58	57.9	60	0.5	141	20.2	5.3	1.5	7	4	186	61	0.24	2.6	2.1	B
18	23	33	41.6	60	51.6	143	45.3	0.9	2.1	7	5	132	79	0.59	1.3	2.5	A
19	3	32	57.2	60	28.8	139	30.9	2.6	2.7	7	2	228	114	0.47	6.4	5.6	C
19	6	4	0.2	60	21.7	143	2.1	1.0	2.1	6	4	208	84	0.43	3.1	3.8	B
19	20	11	32.4	61	19.4	140	38.6	0.5	2.5	5	1	285	154	0.50	8.1	3.3	C
21	4	36	46.3	60	41.8	143	29.3	0.2	1.6	7	6	156	73	0.31	1.3	2.9	B
21	6	8	22.2	60	20.2	142	57.8	5.4	1.5	6	3	150	85	0.51	2.1	1.8	A
21	14	57	15.7	61	35.8	143	53.2	15.2	1.4	3	2	320	140	0.11	7.9	2.6	C
22	6	8	12.1	60	10.2	141	6.6	11.7	1.4	9	2	140	87	0.33	5.6	3.8	C
22	8	35	18.6	60	19.7	143	12.5	1.5	1.7	8	4	183	81	0.38	2.1	4.0	B
22	11	29	8.8	60	35.4	142	48.4	14.8	1.8	8	4	112	56	0.27	1.7	1.6	A
22	17	2	44.2	60	26.9	143	32.9	0.2	1.6	7	6	185	93	0.32	2.1	3.3	B
22	20	44	55.9	59	52.4	141	18.2	7.3	1.7	9	5	197	63	0.44	2.7	2.7	B
22	22	34	54.9	59	59.7	141	34.7	8.8	1.6	8	5	194	75	0.25	2.8	2.1	B
22	22	40	59.3	60	0.0	141	12.4	12.8	2.6	14	3	107	50	0.37	1.9	1.2	A
22	23	23	38.9	59	50.6	141	17.0	6.8	1.5	6	1	244	64	0.26	11.3	5.2	D
23	2	22	38.8	60	20.7	143	0.3	4.4	1.4	7	2	156	85	0.23	2.7	3.5	B
23	6	35	41.0	59	57.1	141	18.1	0.1	1.2	7	2	212	60	0.40	4.6	5.8	C
23	6	47	11.5	60	12.2	141	3.2	11.1	1.4	8	4	142	46	0.30	3.3	2.6	B

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978 (CONT)

1978	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
FEB 23	8	1	2.5	60	12.0	140	45.6	17.2	1.6	8	3	155	57	0.32	4.4	2.3	B
23	8	43	44.8	61	32.0	141	11.2	0.7	1.7	4	3	257	151	0.26	5.1	3.5	C
23	9	56	28.8	61	30.3	141	12.3	0.3	1.6	4	3	255	147	0.08	5.7	7.3	C
23	15	3	1.3	59	27.5	140	50.3	1.6	2.2	4	1	245	85	0.49	5.6	99.0	D
23	23	29	15.7	60	20.1	140	27.3	3.2	1.0	4	2	210	129	0.41	3.9	7.0	C
24	2	35	50.3	60	47.5	138	24.7	1.0	2.6	9	3	266	136	0.28	5.9	3.9	C
24	6	55	13.2	61	40.3	141	47.8	3.5	1.7	3	3	306	148	0.05	2.9	6.2	C
24	17	52	39.7	60	30.7	143	6.5	2.7	1.5	6	5	148	72	0.22	1.5	3.0	B
24	18	45	28.4	60	39.5	141	9.3	7.0	1.0	7	4	194	77	0.27	3.7	6.2	C
24	19	31	55.2	60	9.3	140	51.3	17.3	0.9	4	2	143	128	0.09	8.4	3.5	C
24	20	17	17.0	60	17.0	140	43.5	16.9	1.1	5	3	175	119	0.18	7.4	3.8	C
25	7	20	49.9	60	18.2	141	31.7	5.9	2.0	11	6	137	50	0.56	1.0	2.1	A
25	15	27	47.9	60	14.8	139	31.4	0.0	1.6	8	5	218	96	0.29	4.1	3.7	B
26	4	17	34.5	60	1.8	140	33.8	13.8	1.4	5	3	166	115	0.15	3.0	1.8	B
26	11	9	28.5	61	33.6	147	20.4	15.6	2.8	26	8	108	62	0.56	1.1	1.1	A
26	13	27	54.2	60	0.3	141	14.6	14.3	1.2	6	3	122	49	0.31	1.9	1.3	A
26	14	49	54.2	59	50.1	139	30.8	0.9	1.3	5	2	165	56	0.10	3.8	5.0	C
26	15	53	39.7	60	23.3	141	13.5	13.4	1.0	5	4	207	63	0.08	3.4	2.5	B
26	16	14	50.2	60	8.2	141	17.2	17.0	1.9	9	4	125	36	0.41	1.8	1.1	A
26	21	16	46.0	61	9.4	147	37.7	24.5	2.5	25	9	90	70	0.61	1.3	1.3	A
27	11	37	18.0	60	30.2	143	8.6	2.3	1.4	5	3	186	74	0.30	1.9	3.2	B
27	19	9	48.3	60	2.1	141	30.7	15.6	1.5	9	3	144	39	0.40	2.1	1.9	A
27	19	10	35.3	59	59.8	141	13.4	11.5	1.5	10	7	106	50	0.53	1.6	1.7	A
27	19	33	23.7	60	52.7	140	52.2	10.2	1.3	3	2	236	93	0.00	10.1	98.6	D
27	20	32	22.2	59	59.4	141	24.8	21.0	1.1	3	3	209	66	0.03	5.4	5.2	C
28	7	32	8.9	60	14.4	140	57.8	15.9	1.9	7	3	153	45	0.33	2.1	1.6	A
28	11	47	2.8	60	9.0	141	4.6	20.2	1.5	5	4	147	46	0.16	11.0	9.4	D
28	14	6	35.9	60	11.2	141	7.7	14.9	1.4	5	4	155	49	0.26	3.0	2.3	B
28	18	44	4.6	61	19.4	147	37.8	20.3	2.3	25	12	76	66	0.54	1.1	1.5	A
28	18	50	25.8	60	36.0	142	43.4	9.4	2.2	15	10	89	60	0.69	1.3	1.8	A
28	20	40	47.2	60	34.6	142	44.5	15.4	1.4	4	3	164	56	0.11	5.1	4.0	C
MAR 1	8	51	7.4	60	23.4	142	52.2	6.4	2.0	13	9	90	62	0.36	0.8	1.2	A
1	12	45	44.9	61	24.5	146	50.0	24.5	2.5	22	9	85	77	0.45	1.1	1.4	A
1	13	3	45.5	60	9.0	141	36.8	5.3	1.1	7	3	178	68	0.20	1.2	2.7	B
1	16	17	26.2	60	38.5	143	9.8	0.5	1.6	5	4	178	63	0.35	1.2	7.3	C
1	22	52	4.7	61	50.6	141	17.1	0.5	2.2	6	5	263	177	0.19	2.8	2.4	B
2	4	14	31.5	61	10.9	141	26.6	1.5	2.3	8	7	229	112	0.39	2.1	6.0	C
3	3	20	43.4	61	15.0	141	25.8	0.0	2.7	11	5	228	118	0.51	3.1	2.1	B
3	3	52	11.1	61	29.3	141	20.6	3.0	2.2	6	4	251	132	0.38	3.1	2.6	B
3	5	52	59.8	60	10.7	141	4.8	1.6	1.7	9	5	157	98	0.28	1.4	3.5	B
4	12	29	10.0	60	13.7	140	57.2	11.1	2.3	10	3	162	46	0.61	2.0	1.5	A
4	16	38	20.3	60	31.0	141	13.4	12.9	1.2	6	4	227	90	0.22	2.9	2.8	B
5	6	1	37.8	59	57.3	141	9.3	36.9	1.0	3	3	134	53	0.11	3.9	4.5	B
5	20	19	24.0	61	55.3	140	48.3	33.7	1.4	4	2	280	197	0.04	16.2	99.0	D
5	23	43	28.3	61	25.8	143	10.5	19.6	0.5	3	2	222	146	0.11	10.2	8.3	D

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978 (CONT)

1978	ORIGIN TIME HR MN	SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NP	NS	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
MAR 6	0 49	5.7	60 31.7	142 10.4	5.5	2.3	9	2	124	57	0.52	1.2	2.0	A
6	1 57	19.2	60 8.8	141 36.0	13.8	2.5	14	5	117	69	0.38	1.6	1.3	A
6	4 52	57.5	60 17.3	139 47.3	1.5	1.3	5	5	235	106	0.19	4.1	4.5	B
6	11 21	42.9	60 4.9	141 6.3	5.8	1.3	3	3	264	97	0.07	5.2	12.0	D
7	6 1	59.4	61 32.2	146 35.1	20.0	2.6	22	9	91	67	0.50	1.1	1.4	A
7	13 25	36.9	61 41.2	146 53.8	8.7	2.4	21	8	119	69	0.57	0.9	1.1	A
8	1 55	40.6	59 16.5	145 4.8	10.6	1.9	10	7	281	147	0.38	5.4	2.7	C
8	9 13	52.5	60 4.7	141 3.8	16.8	1.1	5	2	169	107	0.09	13.2	5.9	D
8	21 47	40.3	60 20.9	140 34.0	12.1	1.3	8	8	188	65	0.31	2.7	1.5	B
9	2 15	47.7	60 13.7	140 47.9	17.8	1.4	10	6	159	55	0.30	2.1	1.1	A
10	5 50	36.3	60 5.0	141 23.8	9.6	1.7	11	8	115	37	0.53	1.3	1.2	A
10	12 9	34.3	60 24.8	141 8.3	13.4	1.3	8	6	170	60	0.35	3.0	1.7	B
10	12 21	59.9	60 24.3	141 9.1	8.6	1.2	6	3	181	94	0.18	5.9	6.6	C
10	13 10	59.5	60 26.1	141 8.8	7.2	1.4	7	2	172	62	0.27	1.8	5.8	C
10	17 29	18.0	59 58.5	139 12.0	0.7	1.1	5	3	238	61	0.17	4.0	5.3	C
10	22 6	57.2	59 53.9	139 51.8	2.0	1.1	4	1	177	177	0.10	13.4	4.5	D
11	21 32	57.7	60 34.6	141 26.5	17.7	2.6	22	10	169	78	0.41	1.3	1.5	A
11	22 4	25.3	61 19.2	147 6.8	12.9	2.2	23	13	80	67	0.48	1.0	0.8	A
12	10 46	0.6	60 35.3	142 44.5	16.1	1.3	4	4	163	54	0.12	4.7	3.7	B
12	10 47	2.3	60 5.2	141 3.7	22.7	1.0	4	2	198	107	0.14	16.6	5.6	D
12	11 44	22.3	60 8.8	141 15.9	15.8	1.6	6	3	150	94	0.11	3.7	1.9	B
12	15 31	31.8	60 17.6	140 45.3	16.2	1.1	4	2	210	117	0.09	11.7	7.8	D
12	16 3	31.3	60 2.5	139 27.0	12.1	0.5	3	3	236	73	0.11	12.1	10.9	D
12	16 54	9.5	61 3.2	147 11.7	15.0	2.4	24	12	104	84	0.48	1.2	1.1	A
12	19 27	44.3	60 17.6	140 11.2	7.8	1.4	8	1	197	86	0.31	9.3	6.2	C
12	20 49	7.3	60 16.2	140 11.4	0.0	1.3	7	3	198	87	0.21	5.3	5.9	C
12	21 10	0.4	59 58.2	139 31.0	0.4	1.6	8	1	201	44	0.31	3.8	4.5	B
13	4 45	38.0	61 37.7	147 52.4	0.1	2.1	17	9	110	67	0.54	1.3	2.1	A
13	5 35	35.0	61 30.9	146 22.4	27.3	2.8	19	8	84	52	0.50	1.0	1.3	A
14	0 29	47.4	60 4.0	141 19.3	1.0	1.5	6	2	210	59	0.12	9.0	15.9	D
14	20 27	51.4	60 8.9	141 15.3	14.4	1.1	6	2	149	56	0.10	3.1	1.8	B
15	3 22	58.2	60 16.3	140 51.3	17.2	1.7	6	3	164	110	0.37	2.5	1.5	B
15	20 40	42.6	61 22.3	144 4.2	15.3	1.8	5	4	143	100	0.33	2.0	1.1	A
16	13 59	50.4	61 19.3	147 17.0	15.1	2.3	23	11	80	63	0.45	1.3	1.0	A
16	20 20	44.2	60 1.7	145 34.5	12.0	2.6	21	10	189	127	0.49	2.0	1.4	A
16	22 7	25.8	60 37.1	141 10.6	10.4	1.9	8	6	191	77	0.39	1.1	1.7	A
17	1 5	38.8	60 49.2	143 50.2	0.5	2.1	6	7	161	85	0.51	1.0	3.1	B
17	3 32	40.9	60 34.9	141 27.2	20.7	1.2	7	6	173	70	0.20	1.6	4.6	B
17	9 8	23.9	60 40.7	142 59.2	7.2	1.5	5	3	128	56	0.41	1.6	10.3	D
17	17 40	32.5	60 32.8	142 59.9	0.1	1.6	6	1	136	65	0.30	2.3	4.0	B
18	4 22	32.2	60 11.6	141 20.3	13.9	1.3	4	2	134	88	0.24	5.5	4.0	C
19	3 37	5.6	63 46.3	147 29.1	1.6	3.8	18	3	108	127	0.71	1.8	3.8	B
19	18 14	52.7	60 18.3	140 49.5	17.8	1.9	9	7	173	53	0.30	1.6	1.4	A
19	20 42	18.0	60 58.6	146 58.8	16.0	2.5	19	12	102	82	0.40	1.1	1.3	A
19	20 44	22.2	60 37.2	143 5.4	3.7	1.2	4	2	125	72	0.29	4.2	50.5	D

SOUTHEAST ALASKA EARTHQUAKES, JANUARY-MARCH 1978 (CONT)

1978	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NP	NS	GAP DEG	D3 KM	RMS SEC	ERH KM	ERZ KM	Q
MAR 20	3	33	27.3	59	15.8	138	21.0	7.3	2.0	5	2	341	142	0.16	19.8	4.2	D
20	7	46	10.7	60	36.4	142	50.6	41.8	1.6	3	3	151	91	0.38	6.3	16.6	D
20	23	14	51.8	60	20.6	141	10.0	17.6	2.5	13	7	157	52	0.44	1.2	1.0	A
21	7	6	22.0	60	9.8	140	59.6	10.6	1.7	6	1	166	102	0.11	4.7	3.4	B
21	7	13	45.2	60	34.6	143	26.9	1.5	1.7	5	2	165	79	0.19	4.0	17.2	D
21	7	15	47.2	60	5.7	141	4.0	11.4	1.5	4	2	186	106	0.37	20.4	24.0	D
22	4	45	16.5	61	49.6	140	37.2	15.0	1.7	3	2	324	283	0.76	69.2	70.9	D
22	8	35	59.2	60	9.2	141	1.3	14.1	1.2	7	5	145	46	0.31	6.4	2.9	C
22	13	31	49.7	60	9.5	139	40.4	13.9	0.8	4	2	252	57	0.13	12.7	4.9	D
22	20	19	21.1	60	17.7	140	51.1	11.8	1.8	13	6	168	50	0.50	2.1	1.4	A
23	8	0	4.7	60	2.1	141	11.3	11.4	1.2	6	4	164	52	0.14	7.7	3.9	C
23	8	56	22.8	60	5.2	141	8.0	11.1	1.5	10	7	150	49	0.44	2.7	1.7	B
23	12	5	33.5	59	59.0	145	32.1	13.3	2.5	17	9	194	64	0.36	2.2	1.1	A
23	13	7	32.2	59	53.8	141	33.5	14.4	1.7	12	7	161	53	0.49	1.9	1.4	A
23	16	52	35.4	60	22.8	142	21.9	5.5	2.1	19	8	92	34	0.46	1.0	1.3	A
23	20	0	0.4	60	2.3	141	43.1	17.6	1.4	6	6	161	36	0.34	2.1	1.5	A
24	4	39	48.3	60	36.2	143	52.1	3.5	1.6	9	5	108	74	0.48	2.2	2.8	B
24	6	31	53.5	60	0.2	140	30.5	20.0	1.3	6	2	143	56	0.26	5.2	8.4	C
24	8	32	46.3	60	8.6	141	24.8	11.5	1.7	13	4	122	31	0.41	1.5	1.4	A
24	10	32	43.3	60	33.1	141	10.8	10.2	1.8	8	6	184	72	0.25	1.9	3.0	B
24	17	28	41.1	60	14.2	141	2.1	10.9	1.5	9	7	149	42	0.37	1.8	2.5	B
24	17	32	13.8	60	14.2	140	59.3	12.1	1.9	9	5	151	44	0.41	1.5	1.5	A
24	18	42	12.6	60	22.8	142	21.8	7.2	1.9	19	5	92	34	0.49	1.0	1.4	A
25	2	39	19.4	60	13.7	141	0.0	13.8	1.6	11	6	149	44	0.55	1.7	1.7	A
25	18	13	55.2	60	27.7	142	58.8	0.8	1.5	9	5	80	53	0.64	1.7	3.3	B
25	20	51	53.7	60	11.4	140	54.3	8.5	1.5	7	3	146	39	0.19	2.4	6.3	C
26	0	30	2.3	60	28.2	142	55.9	0.2	1.6	8	4	79	53	0.64	1.3	2.7	B
26	15	35	29.6	60	29.2	147	23.3	13.3	2.5	21	5	96	92	0.38	1.9	2.2	A
26	19	23	4.2	62	9.5	142	32.5	3.8	1.6	3	3	288	193	0.44	4.3	4.1	B
26	19	24	1.5	60	19.9	139	27.7	3.1	1.9	9	4	224	103	0.44	5.9	4.4	C
26	19	29	38.3	60	14.5	139	37.9	3.4	1.2	5	1	237	103	0.07	15.2	9.8	D
26	20	22	6.7	59	57.1	141	7.1	10.0	0.8	3	2	204	138	0.14	13.9	18.0	D
27	9	7	23.7	61	22.1	146	49.9	16.5	1.9	13	7	81	82	0.45	1.8	1.5	A
28	4	23	8.1	60	9.9	138	7.2	0.3	2.1	4	0	291	90	0.11	83.3	59.5	D
29	19	3	11.7	60	11.3	139	26.7	7.5	1.9	6	3	218	129	0.13	10.1	7.8	D
29	20	16	11.6	60	18.4	142	27.4	1.7	1.2	6	4	104	27	0.38	1.2	6.1	C
30	7	29	55.7	63	12.9	147	6.0	18.9	3.1	10	2	297	201	0.30	22.0	20.6	D
30	15	28	7.2	60	48.5	146	52.1	13.5	2.7	14	10	126	136	0.40	1.6	1.8	A
31	7	36	38.2	60	18.0	141	3.1	12.9	1.1	4	2	197	101	0.07	9.5	8.9	C
31	22	15	32.0	59	56.6	141	2.3	2.9	1.3	5	3	185	47	0.06	5.6	11.7	D

QUARTERLY REPORT

Contract #03-5-022-55
Research Unit #253
Task Order #1
Reporting Period: 9/1/78-12/31/78

SUBSEA PERMAFROST
PROBING, THERMAL REGIME AND DATA ANALYSIS

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OCS COORDINATION OFFICE
University of Alaska

Quarterly Report for Period Ending December 31, 1978

Project Title: Subsea Permafrost: Probing, Thermal Regime and Data Analysis

Contract Number: 03-5-022-55

Task Order Number: 1

Principal Investigators: T. E. Osterkamp and W. D. Harrison

I. Task Objectives:

To determine the subsea permafrost regime in selected near-shore areas in the Beaufort Sea using lightweight probing techniques and appropriate data analysis (D-9).

II. Field and Laboratory Work

A. Field Work

Two men visited the Tekegakrok Point study site in Elson Lagoon from October 28 to November 4, 1978. The objectives were to obtain temperature, interstitial water salinity and depth to the bonded permafrost, just after freeze up. These data are now being analyzed.

Holes on Reindeer and Cottle Islands in the Prudhoe Bay area were logged again for temperature on October 26, 1978. The temperature data and temperature profiles are included in Appendix I.

B. Laboratory Work

1. Temperature data reduction

A computerized temperature data reduction, tabulation, and plotting system has been developed, and the 1978 spring data from Barrow and Prudhoe Bay reduced. Preliminary tables and graphs are included in this report in Appendix I.

2. Interstitial water electrical conductivity

The electrical conductivity of interstitial water samples obtained with our in situ sampling probes in spring 1978 has been measured. We also developed a method for soil pore water extraction which was applied to cores of subsea sediments from Elson Lagoon and Prudhoe Bay. The electrical conductivity of these pore water samples was measured and the data are now being analyzed.

C. Analysis

1. Hydraulic conductivity

In situ hydraulic conductivity data obtained in spring 1978 from Barrow have been analyzed.

2. Gas hydrates

We have begun to compile information on gas hydrates for the purpose of evaluating potential problems associated with them.

III and IV. Results and Interpretation

A. Barrow - Chukchi Sea

One hole was jet-drilled for temperature measurements in front of the sea ice radar mast at NARL. This hole, called the Radar Site Hole in Figure 1 was $\sim$ 80 m from shore as determined by tape measure. Extremely hard drilling was encountered at $\sim$ 5 m from the sea bed in gravelly sediments. This hole was only logged one time and was found frozen shut $\sim$ 4 m below the sea bed. The temperature at the sea bed was -1.802°C.

B. Barrow - Elson Lagoon

Several types of measurements were made in holes in the Tekegakrok Point area of Elson Lagoon (see also our 1977 Annual Report.) The hole location shown in Figure 1, were determined with respect to shore and a bench mark on shore by Brunton compass and tape measure. The line of holes was also located with respect to points at the Point Barrow DEW line station by a theodolite set up over the bench mark.

The hole numbers are the distances in meters from the edge of the tundra just above the beach. Holes 504 and 397 were hand augered with a Sipre core drill to obtain soil samples. An interstitial water sampling probe was also driven through the augered hole at the 504 m site using EW rod and our portable driving rig. Holes 660 and 1189 were also driven for sampling; actually 4 separate holes within a circle of diameter of about 1 m were driven at each of these sites. Holes for temperature measurement were jet augered at the 660 and 1189 m sites, and at an intermediate site 880 m from the tundra edge. "Jet augering" means rotating a string of 3/4" water pipe with a portable power head while jetting water through the pipe and an open bit on the bottom.

1. Drilling data

The drilling data are summarized in Figures 2-6.

2. Temperature data

Preliminary computer print-outs of the temperature data are given in Appendix I. In these data zero depth is at the sea bed.

3. Interstitial water electrical conductivity

Interstitial water conductivity and other data from holes 660 and 1189 are given in Tables 1 and 2 and plotted in Figure 7.

4. Hydraulic conductivity

The results of *in situ* hydraulic conductivity measurements in holes 660 and 1189 are given in Tables 1 and 2. In Table 2, two values are given for hole 1189 at a depth of 7.8 m. The first "∞", means that the water entered the probe so rapidly that the rate may have been limited by the conductance of the proble itself, so no reliable soil hydraulic conductivity determination was made. The second value, 0.10 m a^{-1}, was obtained at the same depth, but in a hole roughly 1/2 to 1 m distant from the first. These data suggest the existence of a highly permeable layer at this depth!

C. Prudhoe Bay

Temperature measurements were made in driven or jetted holes at three sites in Prudhoe Bay (Figure 8), and, as discussed later, on three Barrier Islands. The Prudhoe Bay sites were chosen to give information complementary to that obtained in earlier OCS projects. Hole "9.5 km" was driven and jetted about 9.5 km from shore along the USGS-CRREL-UA study line bearing about N31°E from North Prudhoe Bay State #1 well near the west dock. Hole "Sag Delta" was driven near one of the seismic lines of Rogers and Morack (1978 OCS Annual Report), where their data indicate the presence of a fast layer, probably ice-bonded permafrost, at depths varying from about 10 to 30 m below the sea bed. Holes "Offshore" were jetted 5.9 km north of Reindeer Island; their location was chosen to sample conditions farther offshore than any other holes so far.

The three Prudhoe Bay holes (Figure 8) were located only by the Global Navigation System of the NOAA Bell 205 helicopter. Several independent readings, (11, 7, and 2 respectively for the 9.5 km, Sag Delta and Offshore sites) were made. Also, an attempt was made to account for system drift in 5 cases. The drift correction was estimated by calibrating the system above a navigational beacon of known coordinates near the beginning of the flight, and reading the system coordinates of the same point near the end of the flight. The coordinates and estimated errors of the three sites are given in Table 3.

1. Drilling data

Drilling data have not yet been reduced.

2. Temperature data

Preliminary computer print-outs of the temperature data are given in Appendix I. In these data zero depth is at the sea bed.

D. Barrier Islands

Holes were drilled on Reindeer Island in May and August 1978, and on Stump and Cottle Islands in August 1978, (Figure 9) for the purpose of obtaining information about soil lithology, temperature, and state of ice-bondedness. (Figure 10). The holes are still being logged for temperature, but a rough picture of the other properties is available from the drilling data. It should be pointed out that because only jet drilling was attempted and no samples were taken, the information is somewhat rough, but it is likely that the general features of the interpretation are correct. More details of the drilling, method of interpretaton, and limitations are given in Appendix II.

1. Reindeer Island

Five holes were drilled in Reindeer Island. The surface elevation is about 1 to 2 m and consists of sand with some gravel. There is no vegetation.

The litology is shown in Figure 10. Although the details may vary slightly from hole to hole, this general lithology is considered representative of the area. Some gravel is present in the top 6 m of sandy soils but absent at greater depths down to the 28 m depth reached.

The state of ice-bondedness varies significantly, both from hole to hole, and with depth in a given hole (Figure 10). This seems to be a safe conclusion, despite the difficulties associated with interpretation from this drilling method, as discussed in Appendix II. It is also likely that ice is present in areas where the sediments are not firmly ice-bonded (see our 1977 Annual Report). Therefore the permafrost regime in this area appears to be very complex. This significant result needs to be taken into account in the interpretation of data from seismic searches for bonded permafrost.

2. Cottle Island

A hole was drilled on the tundra covered portion of Cottle Island where the elevation above sea level is roughly 2 or 3 m. The lithology is shown in Figure 11. Below a surface layer of silt, gravel is present down to the 6 m depth penetrated. Except for the surface active layer the soil seems to be well ice-bonded.

3. Stump Island

Two holes were drilled 10 to 20 m apart on Stump Island, in an area where the surface is sandy gravel, with no vegetation and the elevation is roughly 1 to 2 m above sea level. The lithology is shown in Figure 12. Except for the top few meters, where gravel is present, the soil is basically fine grained down to the 11 m depth penetrated. Ice bonding of the permafrost occurs, but the details are not very well determined.

V. Problems

None.

VI. Funds Expended

$178.10 at the end of November 1978.

VII. Recommendations

A. U.S.G.S. Offshore Drilling Program

It appears that the proposed USGS drilling program will be carried out during late winter or early spring of 1979. We offer the following recommendations:

1. All raw data together with sufficient information for its interpretation should be published by the end of summer 1979.

2. Special attention should be given to the nature of the subsea sediments in the first 10 m of sea bed. Where compact clays are encountered, special effort should be made to determine the salt concentration profiles in them by frequent or continuous sampling.

3. Tracers should be used in at least 1 or 2 holes to try to estimate the amount of contamination by the drilling fluid.

4. An effort should be made to align the drill holes in a line going out from shore. The base point of the line onshore should be picked as near as possible to an existing well.

5. Should ice conditions or other problems develop which make it impossible to complete the required number of holes then priority should be given to:

a) Drilling deep holes (300') on several islands (e.g. Cross Island, Flaxman Island and Pingok Island)

b) Filling in the lines at points very near shore (i.e. within 1/2 mile)

c) Drilling deep (300') holes onshore near the beach

Consideration of the above points during execution the U.S.G.S. drilling program would enhance our ability to evaluate the subsea permafrost hazard in the lease sale area.

B. Reindeer Island Cost Well

We understand that industry will drill a cost well on Reindeer Island this winter and that temperature data will be obtained in this well. We recommend that the well be finished in such a way as to allow for future temperature logging down to the 2000 foot depth. The reason for this is that it usually takes several temperature logs obtained over a period of several years to reconstruct the temperature profile that existed prior to drilling. We would be happy (eager) to log this hole on a recurring basis over a period of 3 years. The reason for our eagerness is that we have never been able to obtain temperature data from <u>any</u> offshore hole that penetrated the permafrost. This is a serious deficiency in our data base and, as such, it hinders the development of reliable models of subsea permafrost.

C. Gas Hydrates

As noted previously, we have been gathering information on gas hydrates to use in assessing their presence and importance to offshore drilling operations. We cannot make an assessment yet, but there is a good possibility that gas hydrates exist in the proposed lease sale area and it is known that they can create problems during drilling operations.

TABLE 1

HOLE 660, TEKEGAKROK POINT

Location: 660 m from shore N56°E (True assuming 26° declination), shore to most distant bench mark = 316.6M
Time: April 21-29, 1978
Water Depth: 2.00 m freeboard 0.03 m
Ice Thickness: 1.40 m
Water under ice: 0.63 m
Tide peak to peak amplitude: $\approx$ 0.1 m observed, could be greater

Depth below sea bed	Electrical conductivity of interstitial water at 25°C	Hydraulic conductivity	
0 (water under sea ice)	$5.47 (\Omega\ m)^{-1}$		
0.7 m	7.08	1.1	$m\ a^{-1}$
1.4	9.84	1.9×10^{-2}	
2.6	10.35	2.8×10^{-2}	
4.2	10.73	3.2×10^{-2}	
5.6	7.78	6.1×10^{-3}	Unreliable-broken filter or irregular flow rate, possibly due to ice in filter
7.1	7.32	6.7×10^{-3}	
8.4	7.66	2.1×10^{-3}	
9.9	8.79	1.0×10^{-3}	

TABLE 2

HOLE 1189, TEKEGAKROK POINT ("1250 nominal")

Location: 1189 m from shore, N56°E (true, assuming 26° declination), shore to most distant bench mark = 316.6 m
Time: April 29-May 3, 1978
Water Depth: 2.52 m
Ice Thickness: not measured but close to 1.4 m
Water under ice: 1.1 m
Tide peak to peak amplitude: $\approx$ 0.35 m observed, could be slightly larger

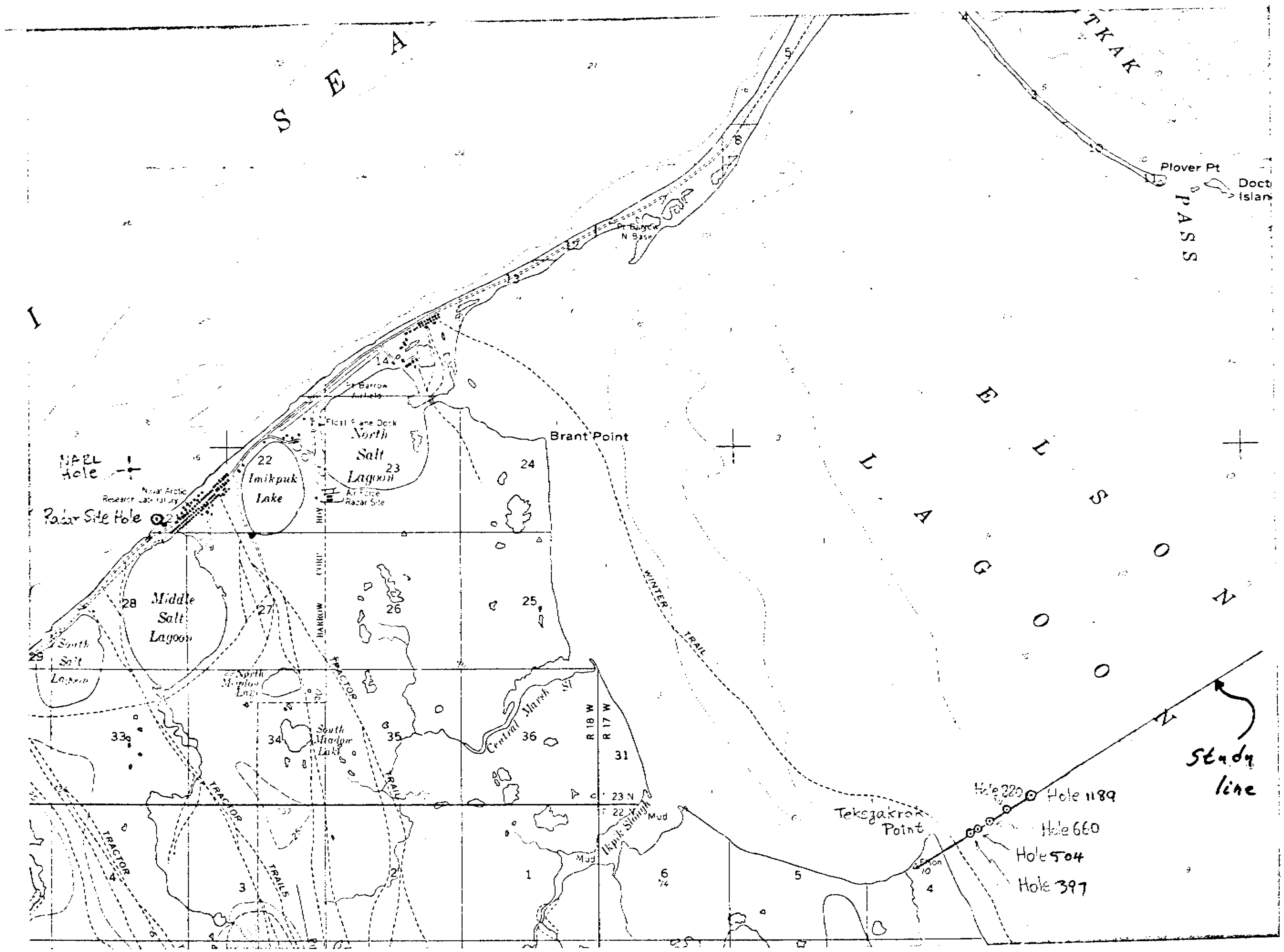
Depth below sea bed	Electrical conductivity of interstitial water at 25°C	Hydraulic conductivity
0 (water under sea ice)	5.26 $(\Omega\text{-m})^{-1}$	
1.2 m	6.10	6.1×10^{-2} m a^{-1}
2.0	7.02	7.1×10^{-2}
3.6	6.73	1.7×10^{-2}
5.2	6.91	4.4×10^{-3} → Unreliable (freezing?)
7.8	7.00	"∞"
		0.10

TABLE 3

PRUDHOE BAY SPRING 1978 HOLES

Hole	Coordinates	Water Depth	Ice Thickness
9.5 km	70° 26.90 ± 0.15'N 148° 22.69 ± 0.34' W	6.9 m	1.6 m
Offshore	70° 32.29 ± 0.27' N 148° 19.64 ± 0.58' W	17 m	1.5 m
Sag Delta	70° 25.46 ± 0.13' N 147° 57.90 ± 0.34' W	7.60	1.71

(Errors are standard deviations.)



SEA
TKAK
PASS
Plover Pt
Doct
Islan
Pt Barrow N Base
Pt Barrow Airfield
Float Plane Dock
North Salt Lagoon
Air Force Radar Site
Brant Point
NARL Hole
Naval Arctic Research Laboratory
Radar Site Hole
Imikpuk Lake
Middle Salt Lagoon
South Salt Lagoon
South Meadow Lake
Central Marsh Sl
BARROW
TRACTOR
TRAIL
WINTER TRAIL
TRACTOR TRAILS
R 18 W
R 17 W
23 N
22 N
Mud
Ikpik Slough
Tekegakrok Point
Hole 220
Hole 1189
Hole 660
Hole 504
Hole 397
Study line
ELSON LAGOON

FIGURE 1

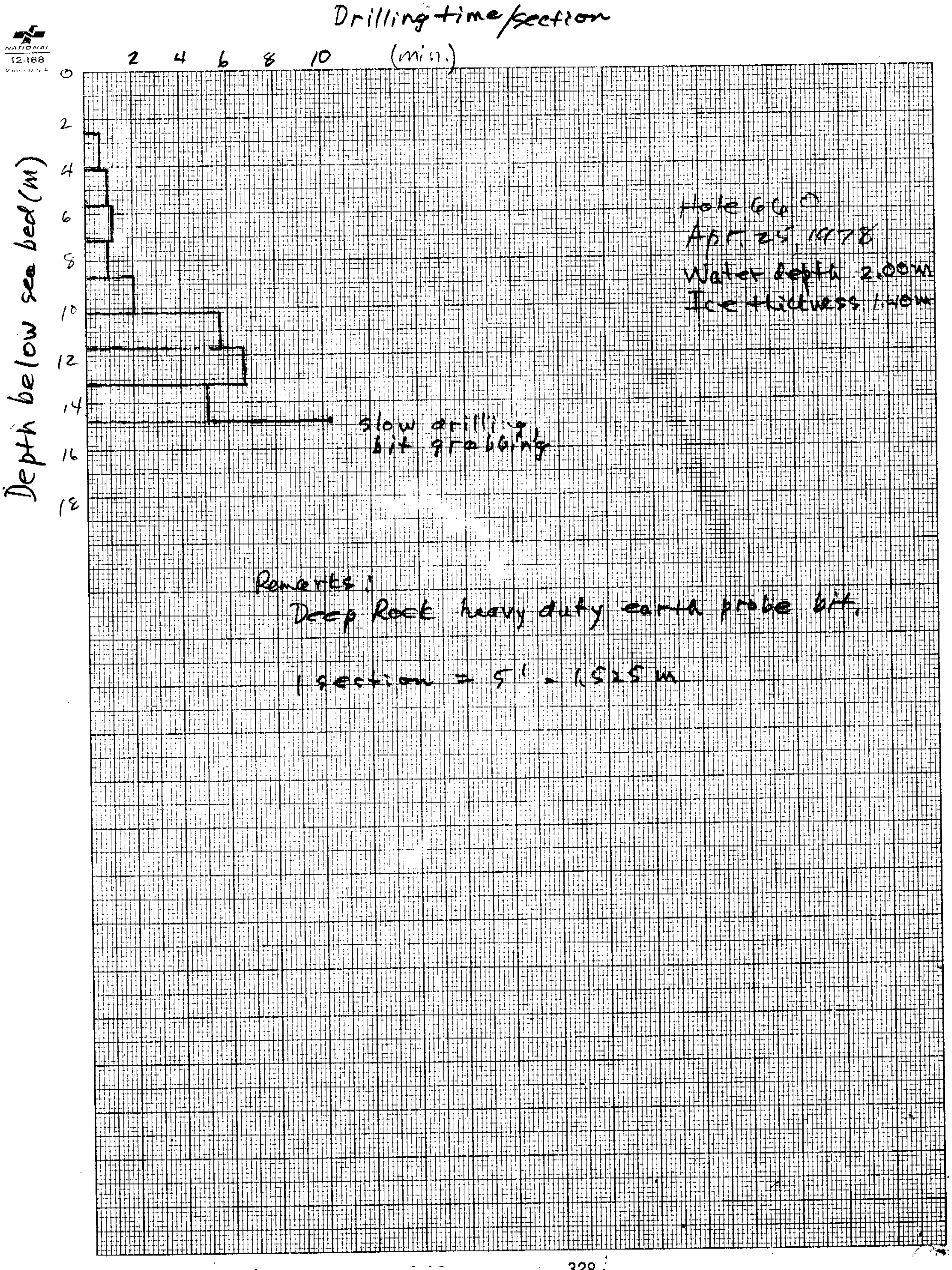

Drilling time/section
2 4 6 8 10 (min.)
0 2 4 6 8 10 12 14 16 18
Depth below sea bed (m)
Hole
Apr. 25, 1978
Water depth 2.00m
Ice thickness 1.40m
slow drilling
bit grabbing
Remarks:
Deep Rock heavy duty earth probe bit.
1 section = 5' = 1.525 m

FIGURE 2

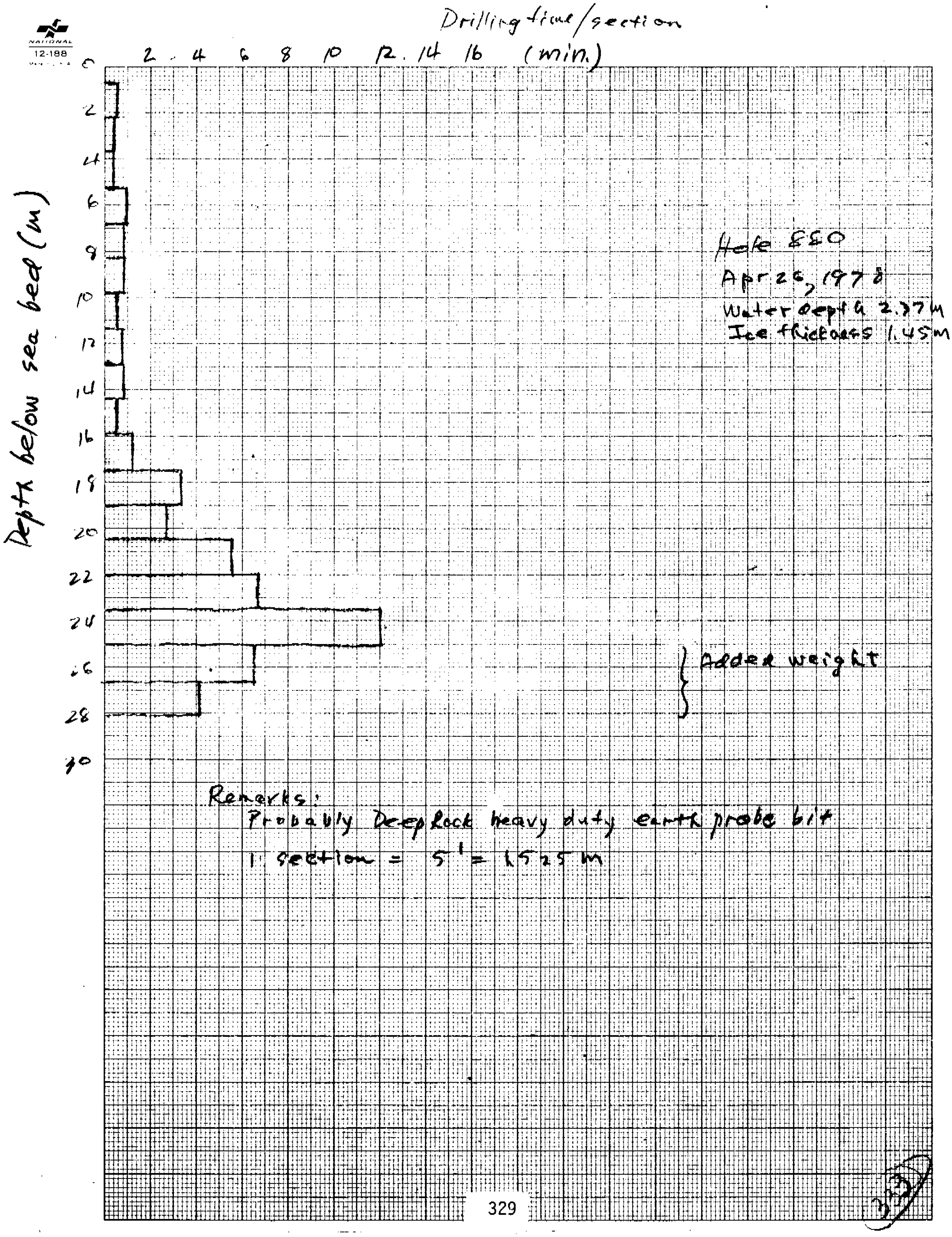
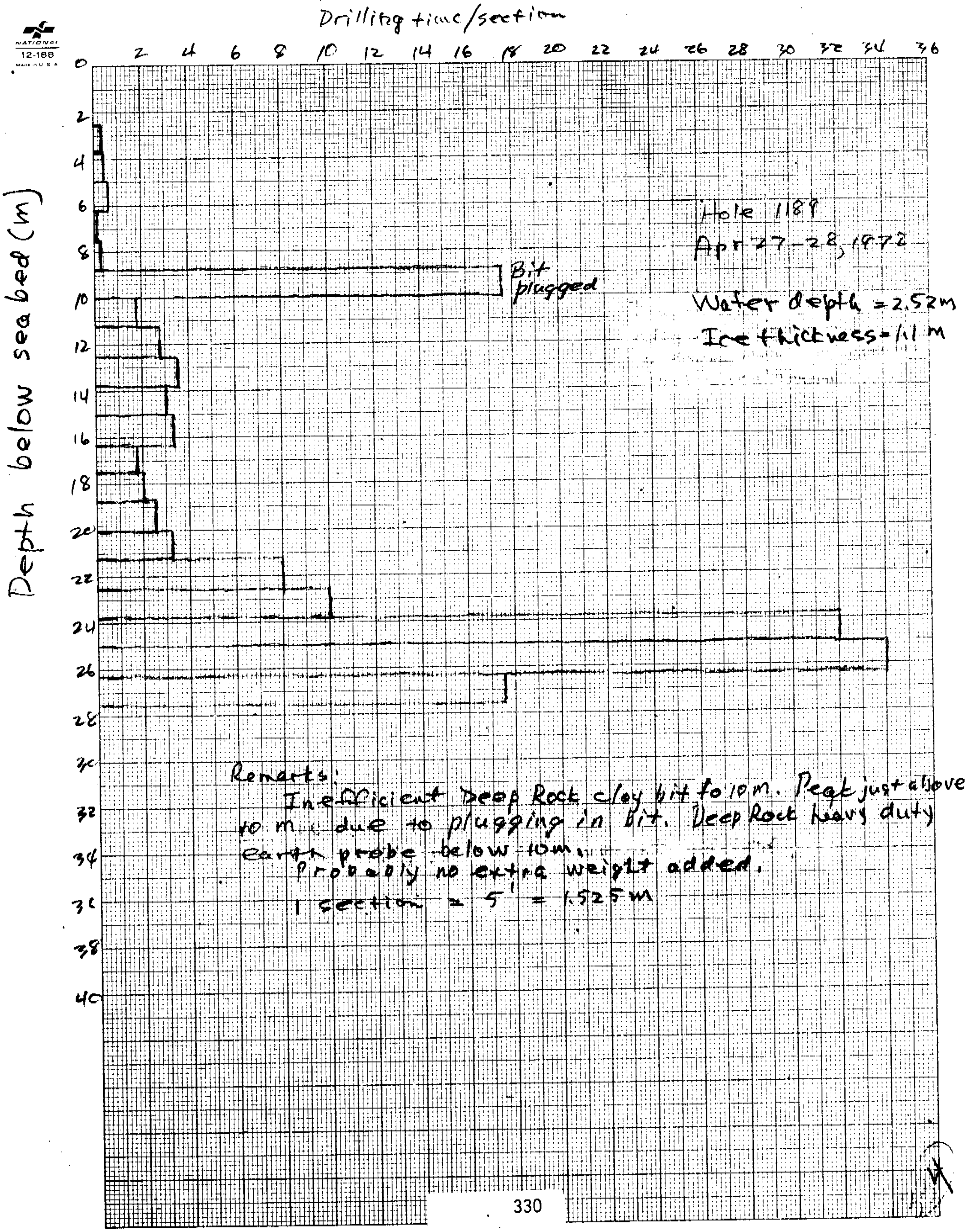

Drilling time/section
0 2 4 6 8 10 12 14 16 (min.)
Depth below sea bed (m)
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Hole 850
Apr 26, 1978
Water depth 2.37 m
Ice thickness 1.45 m
Added weight
Remarks:
Probably Deeprock heavy duty earth probe bit
1 section = 5' = 1.525 m

FIGURE 3



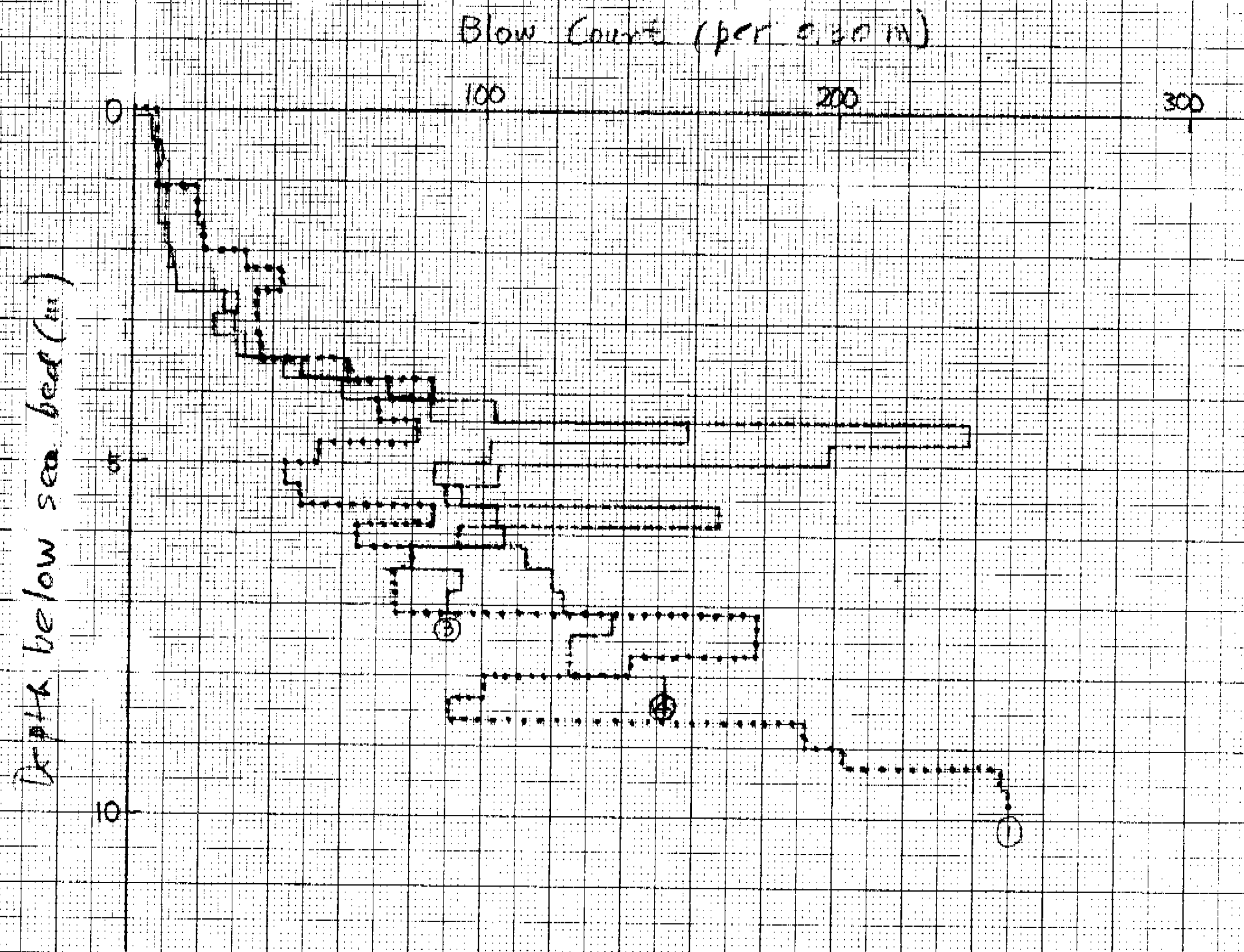
10 Millimeters to the Centimeter

FIGURE 4

HOLE 660 TEIGAEROK POINT, Apr. 21-29, 1978

Water depth: 2.00 m

Ice thickness 1.40 m



Blow count data for 3 closely spaced holes at site 660.

FIGURE 5

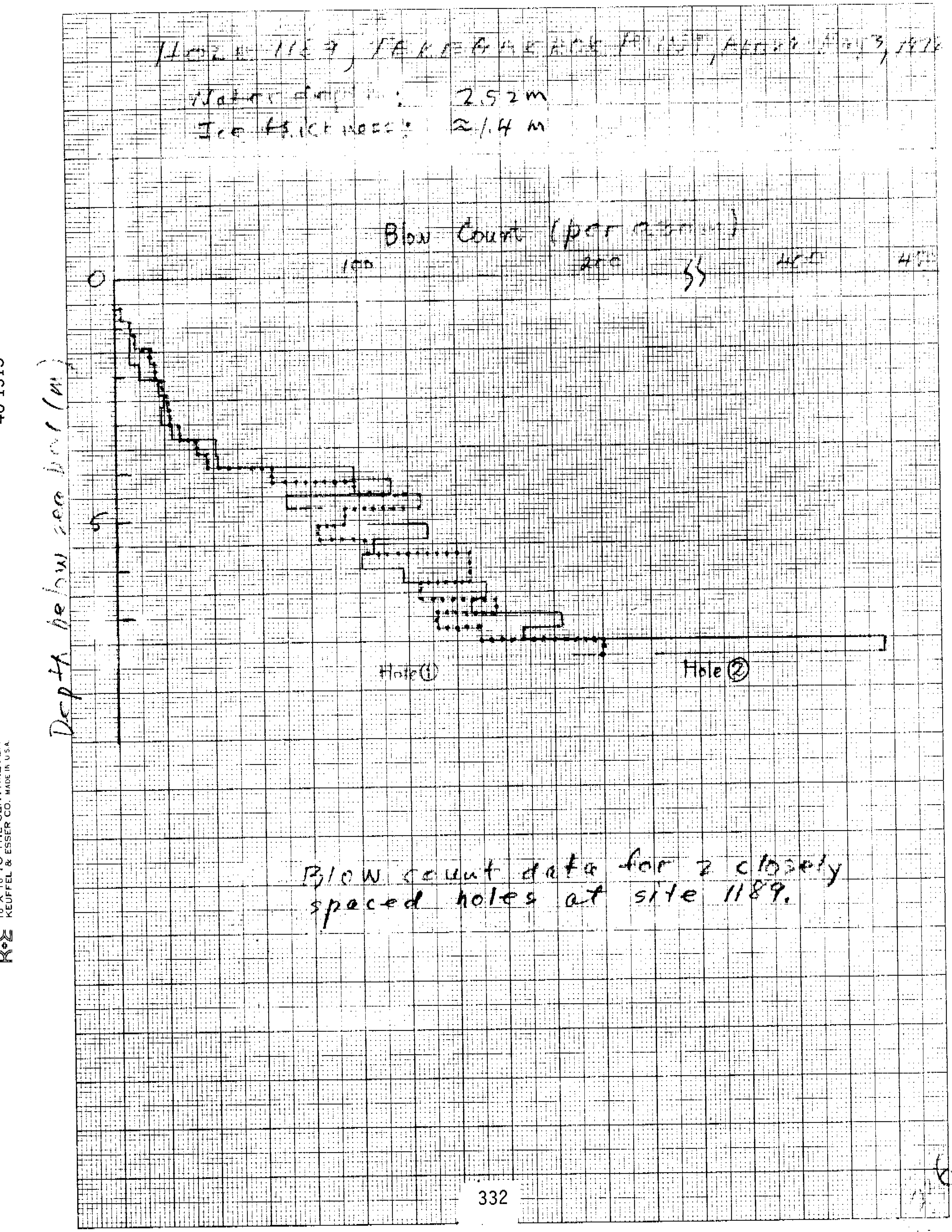

Water depth: 2.52 m
Ice thickness: ≈1.4 m
Blow Count
Depth below sea bed (m)
Hole①
Hole②
Blow count data for 2 closely spaced holes at site 1189.

FIGURE 6

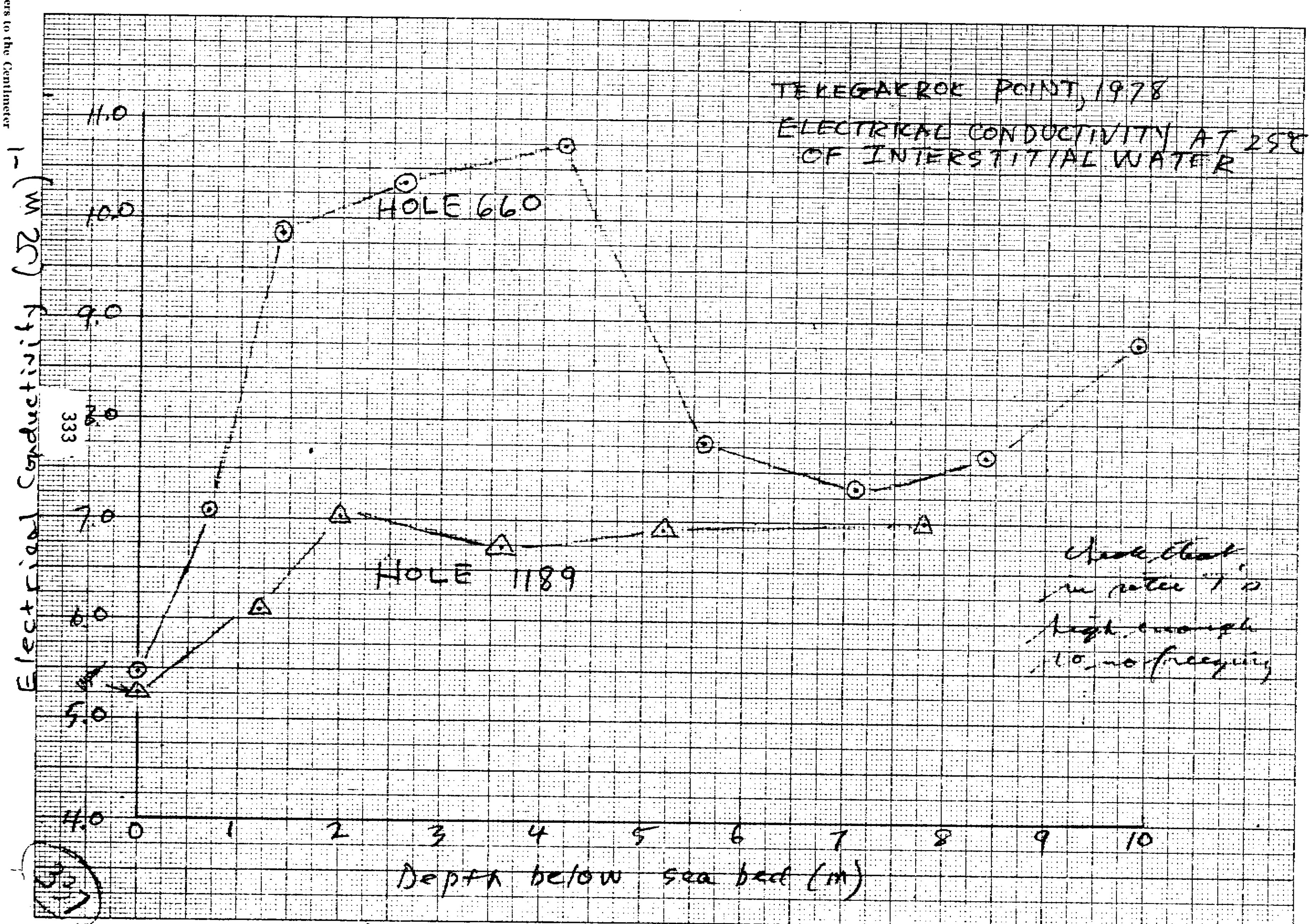

TEKEGAKROK POINT, 1978
ELECTRICAL CONDUCTIVITY AT 25°C
OF INTERSTITIAL WATER
HOLE 660
HOLE 1189
Electrical Conductivity (Ω m)⁻¹
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
0
1
2
3
4
5
6
7
8
9
10
Depth below sea bed (m)

FIGURE 7

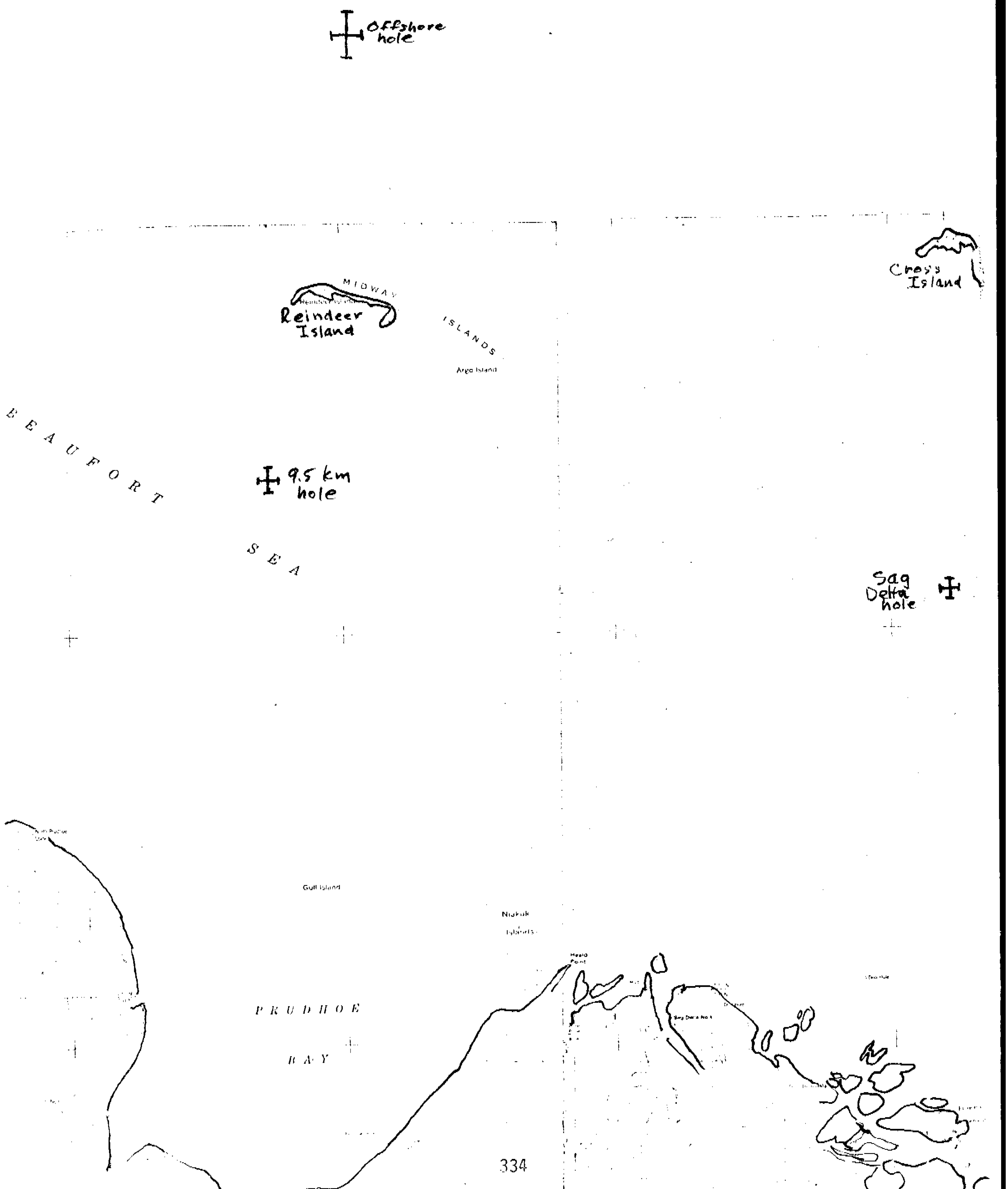

Offshore hole
MIDWAY
ISLANDS
Reindeer Island
Argo Island
Cross Island
BEAUFORT
SEA
9.5 km hole
Sag Delta hole
Gull Island
Niakuk Islands
Heald Point
PRUDHOE
BAY

FIGURE 8

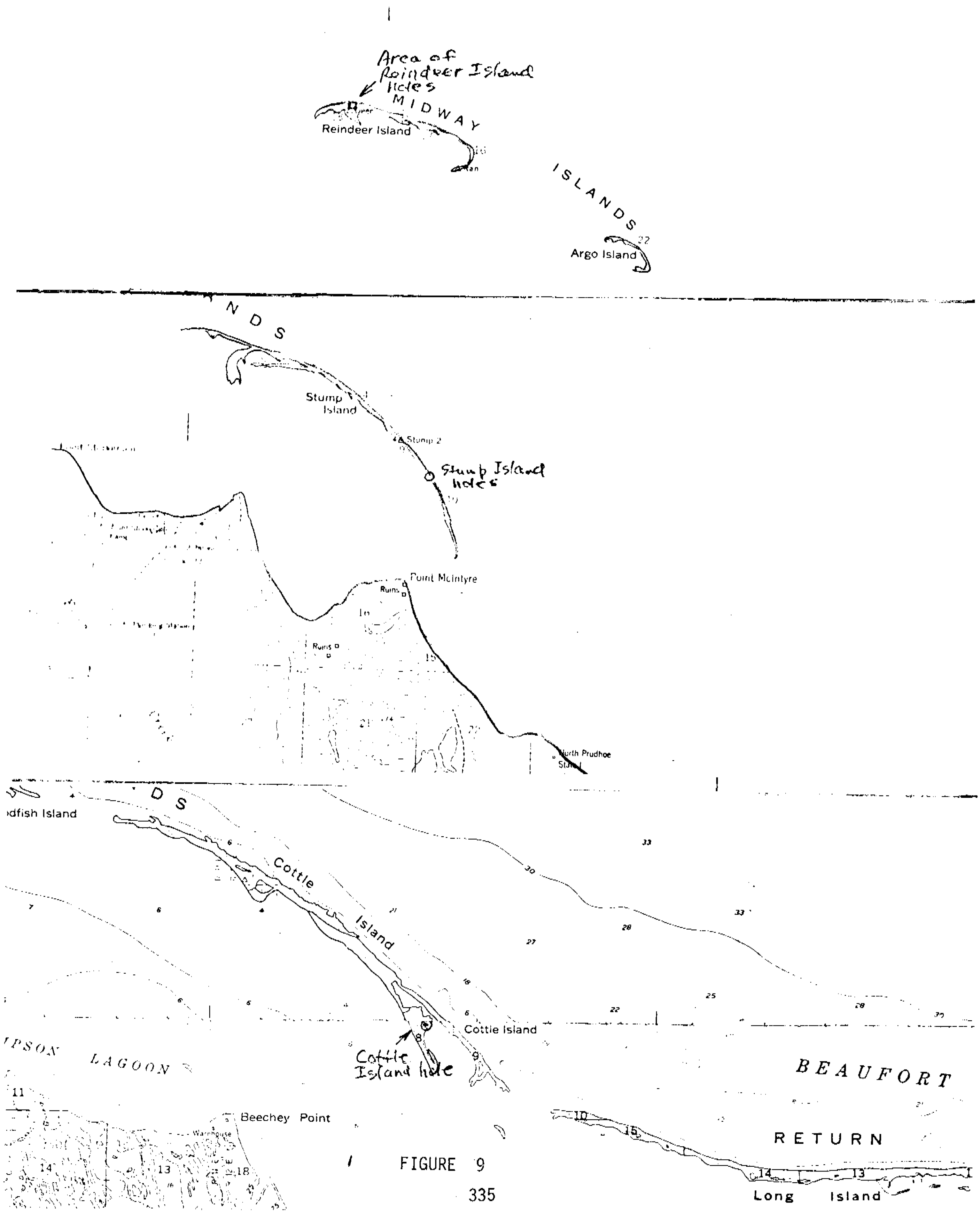
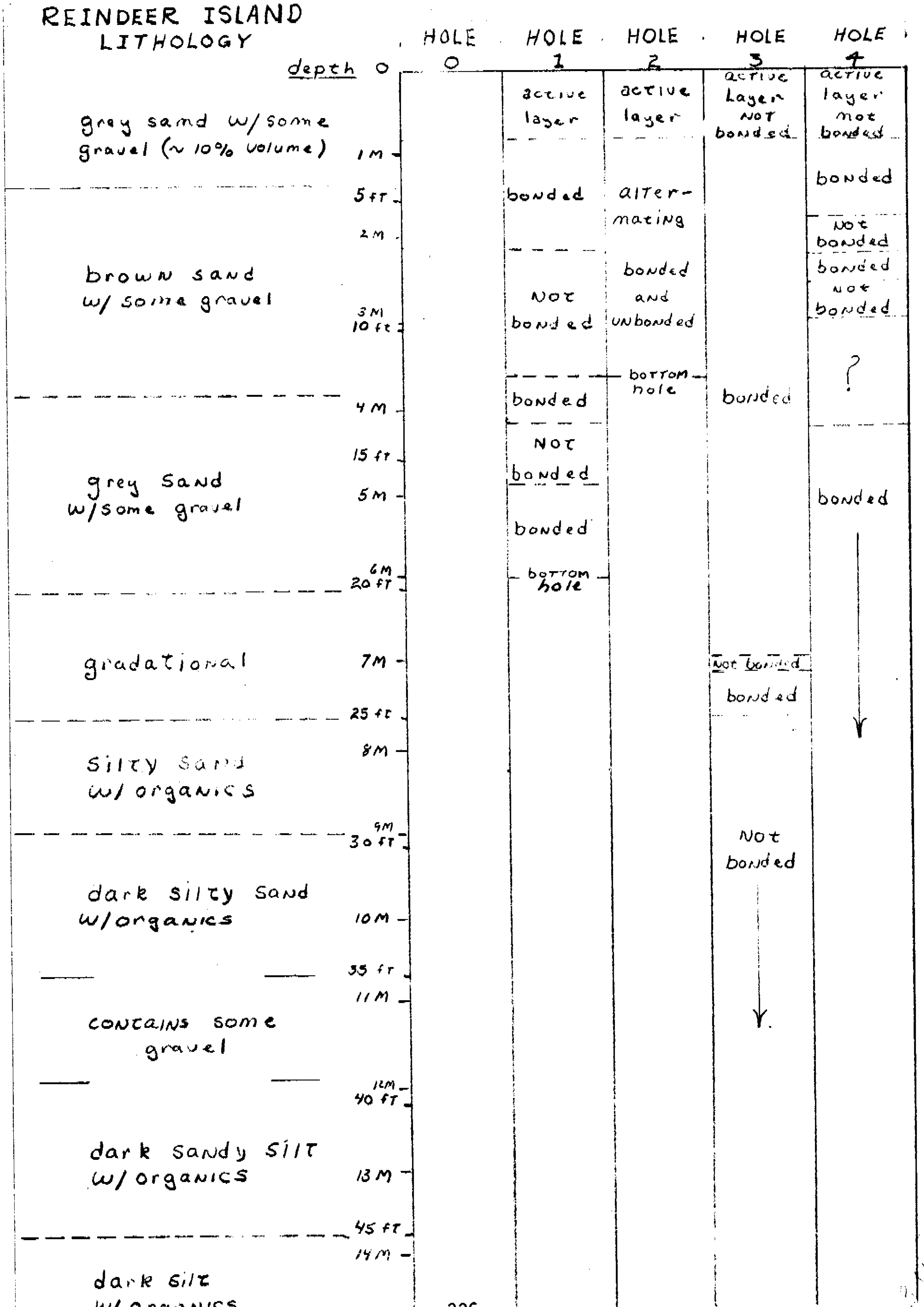

Area of Reindeer Island holes
MIDWAY
Reindeer Island
ISLANDS
Argo Island
NDS
Stump Island
Stump 2
Stump Island holes
Point McIntyre
Ruins
North Prudhoe
DS
dfish Island
Cottle Island
Cottle Island
Cottle Island hole
LAGOON
BEAUFORT
Beechey Point
RETURN
Long Island

FIGURE 9

FIGURE 10


REINDEER ISLAND
LITHOLOGY
depth 0
HOLE 0
HOLE 1
HOLE 2
HOLE 3
HOLE 4
grey sand w/some gravel (~ 10% volume)
brown sand w/ some gravel
grey sand w/some gravel
gradational
silty sand w/ organics
dark silty sand w/organics
contains some gravel
dark sandy silt w/ organics
dark silt w/ organics
1 M
5 FT
2 M
3 M
10 ft
4 M
15 ft
5 M
6 M
20 FT
7 M
25 ft
8 M
9 M
30 FT
10 M
35 ft
11 M
12 M
40 FT
13 M
45 FT
14 M
active layer
bonded
NOT bonded
bonded
NOT bonded
bonded
bottom hole
active layer
alter-nating
bonded and unbonded
bottom hole
active Layer NOT bonded
bonded
Not bonded
bonded
Not bonded
active layer not bonded
bonded
Not bonded
bonded
not bonded
?
bonded

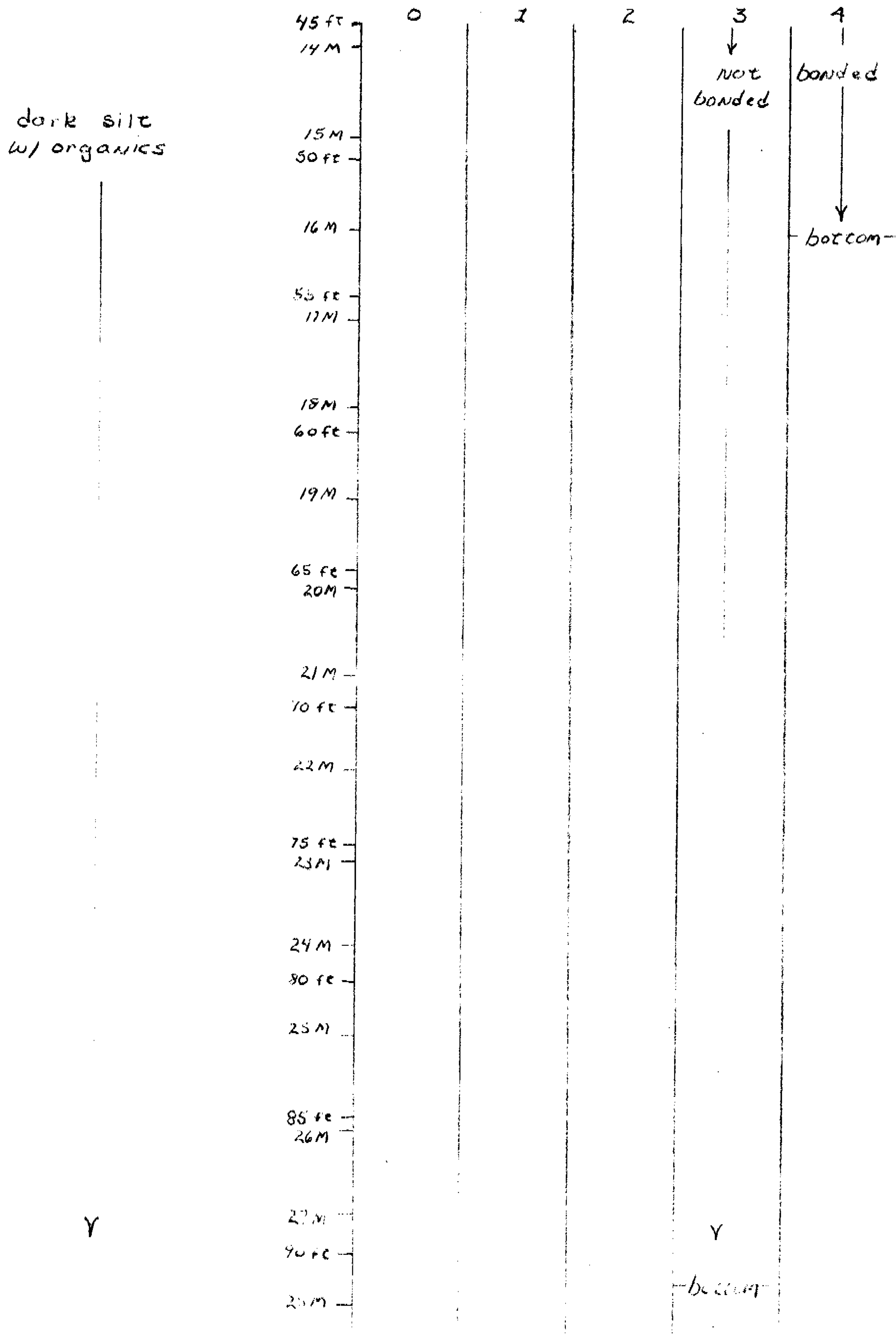
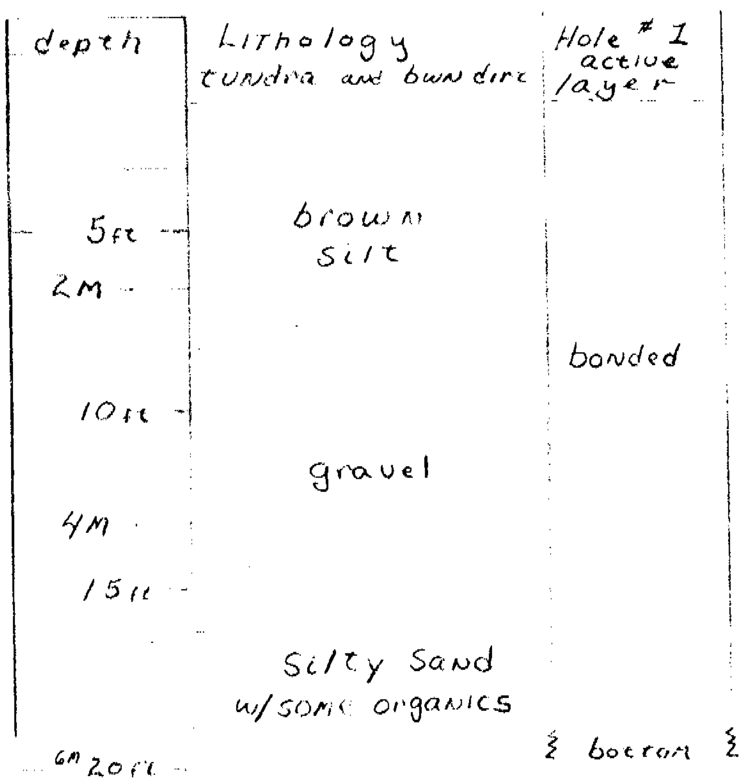

dark silt
w/ organics
45 ft
14 M
15 M
50 ft
16 M
55 ft
17 M
18 M
60 ft
19 M
65 ft
20 M
21 M
70 ft
22 M
75 ft
23 M
24 M
80 ft
25 M
85 ft
26 M
90 ft
0
1
2
3
4
not
bonded
bonded
bottom

FIGURE 11

COTTLE ISLAND

August 24, 1978



<u>Drilling Method</u>

Bit used: Heavy Duty Catch probe (Deeprock Mfg. Co.) with check valve

0 - 1.8 jetting water & rotating bit by hand occassionally

1.8 - 2.6 jetting water & rotating bit w/power head

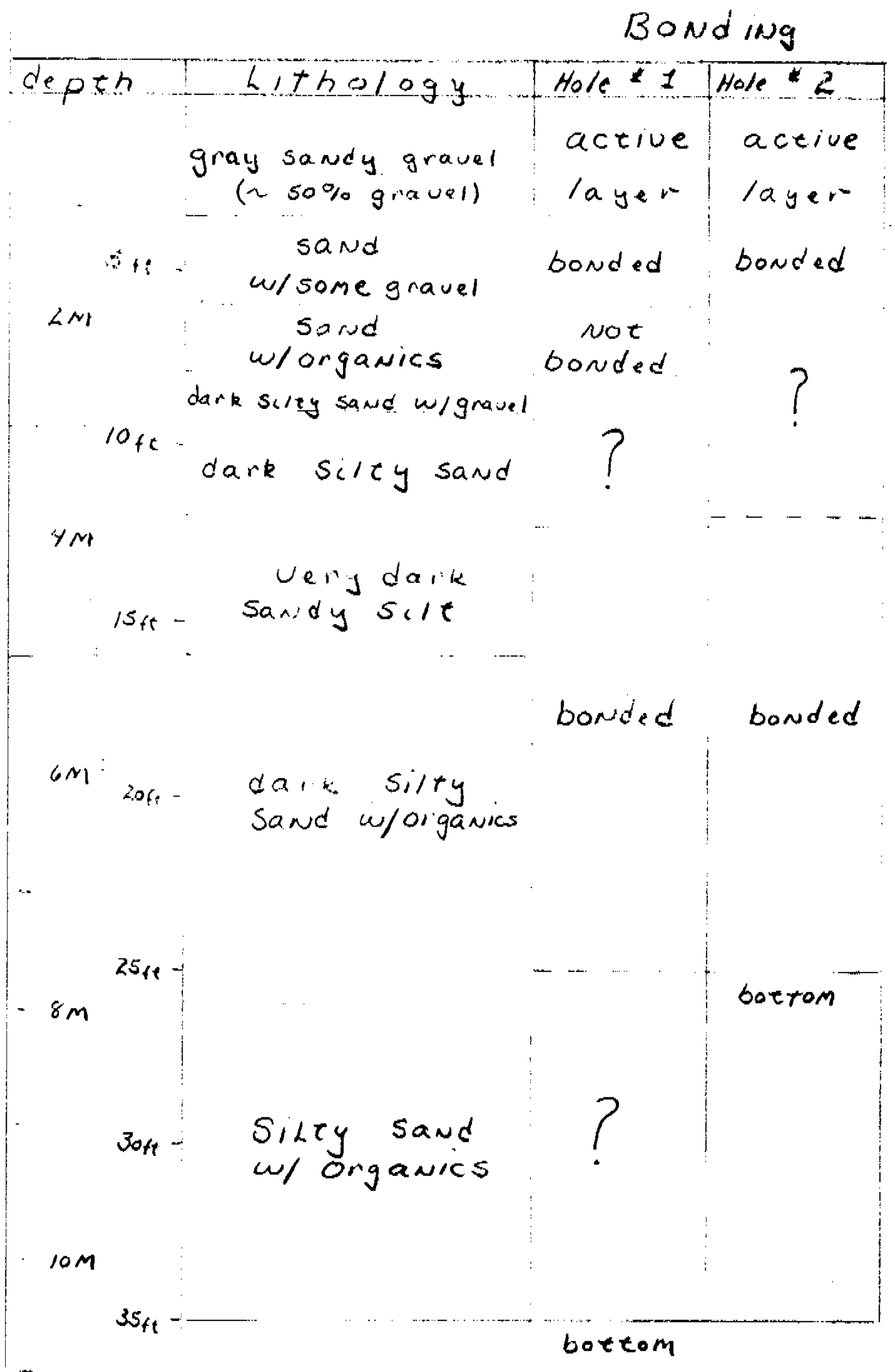
2.6 - 5.4 jetting water & rotating bit by hand

5.4 - 5.8 jetting water & rotating bit w/power head

Current Status: Hole is clear to 5.15 M for temperature Logging

FIGURE 12

STUMP ISLAND — August 21-22, 1978



Current status: No pipe was left in the ground for temperature logging.

APPENDIX I

Preliminary tables and graphs of temperature data obtained during the 1978 spring field season.

1 ELSON LAGOON
HOLE 660
780429
13:00

BRONX 136 L&N

CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
16.55	0.55	30134.0	-1.954
16.48	1.55	30033.0	-1.880
16.33	2.55	29989.0	-1.848
16.25	3.55	30003.0	-1.858
16.18	4.55	30073.0	-1.910
15.87	5.55	30253.0	-2.041
15.68	6.55	30696.0	-2.361
15.52	7.55	31198.0	-2.717
15.30	8.55	31778.0	-3.121
15.13	9.55	32248.0	-3.443
15.03	10.55	32478.0	-3.598
14.88	11.55	32664.0	-3.723
14.75	12.55	32872.0	-3.862
14.55	13.55	33034.0	-3.969
14.47	14.55	33195.0	-4.076

1

ELSON LAGOON
HOLE 660
780501
13:55

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
13.98	0.05	30789.0	-2.427
14.10	0.55	30336.0	-2.101
14.25	1.55	30079.0	-1.914
14.30	2.55	30024.0	-1.874
14.37	3.55	30032.0	-1.880
14.42	4.55	30104.0	-1.932
14.48	5.55	30291.0	-2.069
14.53	6.55	30742.0	-2.394
14.60	7.55	31235.0	-2.743
14.67	8.55	31778.0	-3.121
14.72	9.55	32227.0	-3.429
14.78	10.55	32542.0	-3.641
14.85	11.55	32772.0	-3.795
14.90	12.55	32924.0	-3.896
14.95	13.55	33092.0	-4.008
15.02	14.55	33227.0	-4.097
15.03	14.93	33280.0	-4.131

1

ELSON LAGOON
HOLE 660
780503
07:50

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
8.90	0.05	30428.0	-2.168
8.98	0.55	30258.0	-2.045
9.05	1.55	30080.0	-1.915
9.12	2.55	30022.0	-1.872
9.17	3.55	30033.0	-1.880
9.22	4.55	3011[illegible].0	-1.[illegible]37
9.48	5.55	30285.0	-2.064
9.57	6.55	30710.0	-2.371
9.63	7.55	31210.0	-2.726
9.72	8.55	31740.0	-3.101
9.83	9.55	32233.0	-3.433
9.92	10.55	32526.0	-3.631
10.08	11.55	32751.0	-3.781
10.15	12.55	32929.0	-3.900
10.27	13.55	33067.0	-3.991
10.40	14.55	33238.0	-4.104
10.67	14.93	33268.0	-4.123

1

ELSON LAGOON
HOLE 660
780521
15:40

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
15.82	0.05	30200.0	-2.002
15.83	0.55	30189.0	-1.994
16.00	1.55	30098.0	-1.928
16.05	2.55	30078.0	-1.913
16.12	3.55	30102.0	-1.931
16.18	4.55	30183.0	-1.990
16.23	5.55	30350.0	-2.111
16.28	6.55	30743.0	-2.394
16.35	7.55	31223.0	-2.735
16.43	8.55	31728.0	-3.094
16.52	9.55	32178.0	-3.395
16.58	10.55	32482.0	-3.601
16.72	11.55	32734.0	-3.770
16.75	12.55	32913.0	-3.889
16.80	13.55	33104.0	-4.016
16.88	14.55	33243.0	-4.107
17.00	14.93	33288.0	-4.137

1

ELSON LAGOON
HOLE 660
780425
16:30

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.	30183.0	-1.990
0.	1.55	30122.0	-1.945
0.	2.55	30091.0	-1.923
0.	3.55	30116.0	-1.941
0.	4.55	30198.0	-2.001
0.	5.55	30365.0	-2.122
0.	6.55	30750.0	-2.399
0.	7.55	31225.0	-2.736
0.	8.55	31722.0	-3.083
0.	9.55	32167.0	-3.388
0.	10.55	32500.0	-3.613
0.	11.55	32750.0	-3.781
0.	12.55	32920.0	-3.894
0.	13.55	33134.0	-4.035
0.	14.55	33264.0	-4.121
0.	14.93	33307.0	-4.149

ELSON LAGOON
HOLE 880
780430
10:21

BELFEN L&N — CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
10.43	0.10	15200.0	-2.056
10.50	0.60	15140.0	-1.970
10.63	1.10	15020.0	-1.796
10.73	2.10	14895.0	-1.613
10.83	3.10	14804.0	-1.478
10.93	4.10	14744.0	-1.389
11.02	5.10	14748.0	-1.395
13.17	6.10	14786.0	-1.451
13.23	7.10	14831.0	-1.518
13.33	8.10	14951.0	-1.695
13.38	9.10	15087.0	-1.893
13.43	10.10	15208.0	-2.068
13.53	11.10	15303.0	-2.204
13.58	12.10	15306.0	-2.208
13.65	13.10	15311.0	-2.215
13.70	14.10	15356.0	-2.279
13.80	15.10	15498.0	-2.480
13.92	16.10	15651.0	-2.693
13.98	17.10	15735.0	-2.810
14.13	18.10	15724.0	-2.794
14.22	19.10	15805.0	-2.906
14.28	20.10	15826.0	-2.935
14.38	21.10	15933.0	-3.080
14.50	22.10	15952.0	-3.106
14.55	23.10	16015.0	-3.192
14.63	24.10	16088.0	-3.290
14.67	25.10	16111.0	-3.321
14.72	26.10	16176.0	-3.408
14.77	27.10	16239.0	-3.491
14.95	27.80	16232.0	-3.482

1

ELSON LAGOON
HOLE 880
780504
08:00

	BELFEN L&N	CABLE BRIDGE	
TIME	DEPTH (M)	R (OHMS)	T (C)
9.17	0.10	15120.0	-1.941
9.22	1.10	14995.0	-1.759
9.27	2.10	14911.0	-1.636
9.30	3.10	14823.0	-1.506
9.38	4.10	14750.0	-1.398
9.43	5.10	14750.0	-1.398
9.48	6.10	14798.0	-1.469
9.55	7.10	14865.0	-1.568
9.60	8.10	14950.0	-1.693
9.67	9.10	15049.0	-1.838
9.70	10.10	15197.0	-2.052
9.80	11.10	15292.0	-2.188
9.87	12.10	15382.0	-2.316
9.95	13.10	15417.0	-2.366
10.03	14.10	15480.0	-2.454
10.12	15.10	15582.0	-2.597
10.17	16.10	15675.0	-2.727
10.22	17.10	15747.0	-2.826
10.28	18.10	15784.0	-2.877
10.35	19.10	15846.0	-2.962
10.40	20.10	15882.0	-3.011
10.45	21.10	15955.0	-3.110
10.53	22.10	16002.0	-3.174
10.73	23.10	16052.0	-3.241
10.80	24.10	16104.0	-3.311
10.90	25.10	16143.0	-3.363
10.95	26.10	16187.0	-3.422
12.02	27.10	16243.0	-3.497
12.10	27.80	16261.0	-3.521

1

ELSON LAGOON
HOLE 880
780521
13:20

	BELFEN L&N	CABLE BRIDGE	
TIME	DEPTH (M)	R (OHMS)	T (C)
13.32	0.	15107.0	-1.922
13.43	0.10	15100.0	-1.912
13.50	0.60	15060.0	-1.854
13.55	1.10	15010.0	-1.781
13.62	2.10	14922.0	-1.652
13.70	3.10	14839.0	-1.530
13.77	4.10	14780.0	-1.442
13.85	5.10	14782.0	-1.445
13.90	6.10	14880.0	-1.591
13.98	7.10	14891.0	-1.607
14.03	8.10	14970.0	-1.723
14.08	9.10	15084.0	-1.889
14.17	10.10	15197.0	-2.052
14.25	11.10	15286.0	-2.180
14.30	12.10	15425.0	-2.377
14.35	13.10	15506.0	-2.491
14.42	14.10	15563.0	-2.571
14.53	15.10	15630.0	-2.664
14.58	16.10	15696.0	-2.756
14.63	17.10	15761.0	-2.845
14.70	18.10	15820.0	-2.926
14.75	19.10	15871.0	-2.996
14.80	20.10	15925.0	-3.070
14.85	21.10	15975.0	-3.137
14.92	22.10	16021.0	-3.200
14.97	23.10	16077.0	-3.275
15.02	24.10	16118.0	-3.330
15.07	25.10	16158.0	-3.384
15.12	26.10	16199.0	-3.438
15.15	27.10	16250.0	-3.506
15.20	27.80	16281.0	-3.547

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ELSON LAGOON
HOLE 880
780427
12:00

BELFEN L&N — CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.	15107.0	-1.922
0.	0.10	15078.0	-1.880
0.	1.10	15000.0	-1.767
0.	2.10	14925.0	-1.657
0.	3.10	14843.0	-1.536
0.	4.10	14784.0	-1.448
0.	5.10	14788.0	-1.454
0.	6.10	14850.0	-1.546
0.	7.10	14898.0	-1.617
0.	8.10	14975.0	-1.730
0.	9.10	15075.0	-1.876
0.	10.10	15193.0	-2.046
0.	11.10	15283.0	-2.175
0.	12.10	15443.0	-2.402
0.	13.10	15527.0	-2.520
0.	14.10	15590.0	-2.609
0.	15.10	15649.0	-2.691
0.	16.10	15701.0	-2.763
0.	17.10	15763.0	-2.848
0.	18.10	15833.0	-2.944
0.	19.10	15880.0	-3.008
0.	20.10	15937.0	-3.086
0.	21.10	15979.0	-3.143
0.	22.10	16034.0	-3.217
0.	23.10	16085.0	-3.286
0.	24.10	16121.0	-3.334
0.	25.10	16166.0	-3.394
0.	26.10	16201.0	-3.441
0.	27.10	16251.0	-3.507
0.	27.80	16287.0	-3.555

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ELSON LAGOON
HOLE 1250
780501
08:12

BRONX 136 L&N — CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
8.20	0.	30102.0	-1.931
8.80	0.50	29175.0	-1.241
9.03	1.50	29488.0	-1.476
9.22	2.50	29359.0	-1.380
9.35	3.50	29176.0	-1.242
9.58	4.50	29047.0	-1.144
9.68	5.50	28960.0	-1.077
9.73	6.50	28962.0	-1.079
9.82	7.50	29022.0	-1.125
9.88	8.50	29128.0	-1.205
9.97	9.50	29212.0	-1.269
10.05	10.50	29301.0	-1.336
10.15	11.50	29380.0	-1.395
10.20	12.50	29471.0	-1.464
10.27	13.50	29566.0	-1.535
10.32	14.50	29660.0	-1.605
10.37	15.50	29741.0	-1.665
10.43	16.50	29814.0	-1.719
10.62	17.50	29886.0	-1.772
10.68	18.50	29955.0	-1.823
10.75	19.50	30014.0	-1.866
10.88	20.50	30080.0	-1.915
10.98	21.50	30137.0	-1.956
11.10	22.50	30209.0	-2.009
11.18	23.50	30270.0	-2.053
11.27	24.50	30339.0	-2.103
11.33	25.50	30385.0	-2.137
11.48	26.50	30382.0	-2.135
11.57	27.50	30441.0	-2.177
11.68	28.50	30566.0	-2.267
11.78	29.50	30647.0	-2.326
11.87	30.50	30779.0	-2.420
11.92	31.50	30880.0	-2.492
12.00	32.50	30986.0	-2.567
12.07	33.40	31102.0	-2.650

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ELSON LAGOON
HOLE 1250
780503
13:40

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
13.67	0.	30700.0	-2.364
13.87	0.50	29840.0	-1.738
14.02	1.50	29528.0	-1.506
14.10	2.50	29461.0	-1.456
14.22	3.50	29181.0	-1.245
14.30	4.50	29048.0	-1.145
14.40	5.50	28962.0	-1.079
14.48	6.50	28979.0	-1.092
14.53	7.50	29023.0	-1.125
14.58	8.50	29120.0	-1.199
14.65	9.50	29203.0	-1.262
14.68	10.50	29290.0	-1.328
14.73	11.50	29380.0	-1.395
14.78	12.50	29470.0	-1.463
14.85	13.50	29564.0	-1.533
14.92	14.50	29657.0	-1.603
14.95	15.50	29738.0	-1.663
15.00	16.50	29815.0	-1.720
15.05	17.50	29888.0	-1.774
15.10	18.50	29958.0	-1.825
15.15	19.50	30023.0	-1.873
15.23	20.50	30081.0	-1.915
15.27	21.50	30143.0	-1.961
15.30	22.50	30198.0	-2.001
15.37	23.50	30266.0	-2.050
15.42	24.50	30337.0	-2.102
15.47	25.50	30393.0	-2.143
15.55	26.50	30413.0	-2.157
15.63	27.50	30458.0	-2.190
15.75	28.50	30570.0	-2.270
15.87	29.50	30654.0	-2.331
15.93	30.50	30781.0	-2.422
16.03	31.50	30912.0	-2.515
16.00	32.50	31023.0	-2.594
16.00	33.40	31098.0	-2.647

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ELSON LAGOON
HOLE 1250
780521
10:16

BRONX 136 L&N   CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
10.38	0.	30160.0	-1.973
10.50	0.50	30000.0	-1.856
10.63	1.50	29630.0	-1.582
10.70	2.50	29453.0	-1.450
10.80	3.50	29232.0	-1.284
10.90	4.50	29096.0	-1.181
11.02	5.50	29004.0	-1.111
11.07	6.50	28982.0	-1.094
11.17	7.50	29037.0	-1.136
11.25	8.50	29119.0	-1.198
11.30	9.50	29199.0	-1.259
11.35	10.50	29286.0	-1.325
11.42	11.50	29367.0	-1.386
11.47	12.50	29458.0	-1.454
11.52	13.50	29550.0	-1.523
11.57	14.50	29645.0	-1.594
11.63	15.50	29735.0	-1.660
11.70	16.50	29810.0	-1.716
11.75	17.50	29881.0	-1.768
11.80	18.50	29959.0	-1.826
11.85	19.50	30021.0	-1.871
11.90	20.50	30089.0	-1.921
11.95	21.50	30150.0	-1.966
12.00	22.50	30215.0	-2.013
12.05	23.50	30275.0	-2.057
12.10	24.50	30340.0	-2.104
12.15	25.50	30398.0	-2.146
12.20	26.50	30465.0	-2.195
12.27	27.50	30521.0	-2.235
12.42	28.50	30589.0	-2.284
12.52	29.50	30669.0	-2.341
12.60	30.50	30770.0	-2.414
12.67	31.50	30900.0	-2.506
12.73	32.50	31030.0	-2.599
12.83	33.40	31115.0	-2.659

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ELSON LAGOON
HOLE 1250
780427
10:00

BRONX 136 L&N — CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.	0.	-1.931
0.	0.50	0.	-1.896
0.	1.50	0.	-1.597
0.	2.50	0.	-1.454
0.	3.50	0.	-1.293
0.	4.50	0.	-1.189
0.	5.50	0.	-1.118
0.	6.50	0.	-1.101
0.	7.50	0.	-1.139
0.	8.50	0.	-1.195
0.	9.50	0.	-1.256
0.	10.50	0.	-1.321
0.	11.50	0.	-1.384
0.	12.50	0.	-1.452
0.	13.50	0.	-1.521
0.	14.50	0.	-1.592
0.	15.50	0.	-1.659
0.	16.50	0.	-1.715
0.	17.50	0.	-1.767
0.	18.50	0.	-1.827
0.	19.50	0.	-1.878
0.	20.50	0.	-1.923
0.	21.50	0.	-1.968
0.	22.50	0.	-2.015
0.	23.50	0.	-2.061
0.	24.50	0.	-2.106
0.	25.50	0.	-2.149
0.	26.50	0.	-2.205
0.	27.50	0.	-2.238
0.	28.50	0.	-2.285
0.	29.50	0.	-2.341
0.	30.50	0.	-2.411
0.	31.50	0.	-2.521
0.	32.50	0.	-2.605
0.	33.40	0.	-2.654

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PRUDHOE BAY
HOLE SAG RIVER
780527
10:40

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	-0.70	25136.0	-1.837
11.72	0.30	25070.0	-1.781
11.78	1.30	24927.0	-1.658
11.87	2.30	24758.0	-1.512
11.92	3.30	24650.0	-1.418
11.97	4.30	24548.0	-1.329
12.00	5.30	24497.0	-1.284
12.05	6.30	24502.0	-1.289
12.10	7.30	24534.0	-1.317
12.15	8.30	24535.0	-1.318
12.20	9.30	24528.0	-1.312
12.25	10.30	24562.0	-1.341
12.30	11.30	24604.0	-1.378
12.35	12.30	24610.0	-1.383
12.40	13.30	24653.0	-1.421
12.45	14.30	24716.0	-1.476
12.50	15.30	24740.0	-1.497
12.55	16.30	24766.0	-1.519
12.60	17.30	24815.0	-1.561
12.65	18.30	24845.0	-1.587

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PRUDHOE BAY
HOLE SAG RIVER
780528
14:30

77-1A   CABLE
L&N   BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
14.50	0.00	25106.0	-1.811
14.83	0.30	25067.0	-1.778
14.90	1.30	24954.0	-1.681
14.97	2.30	24803.0	-1.551
15.03	3.30	24746.0	-1.502
15.10	4.30	24609.0	-1.383
15.17	5.30	24564.0	-1.343
15.23	6.30	24556.0	-1.336
15.30	7.30	24575.0	-1.353
15.37	8.30	24591.0	-1.367
15.43	9.30	24602.0	-1.376
15.50	10.30	24632.0	-1.403
15.57	11.30	24665.0	-1.431
15.63	12.30	24680.0	-1.444
15.70	13.30	24710.0	-1.470
15.77	14.30	24752.0	-1.507
15.83	15.30	24768.0	-1.521
15.90	16.30	24797.0	-1.546
15.97	17.30	24825.0	-1.570
16.03	18.30	24847.0	-1.589

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PRUDHOE BAY
HOLE SAG RIVER
780529
15:00

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
15.00	0.	25106.0	-1.811
15.20	0.30	25092.0	-1.800
15.27	1.30	24981.0	-1.704
15.33	2.30	24820.0	-1.566
15.40	3.30	24725.0	-1.483
15.47	4.30	24628.0	-1.399
15.53	5.30	24591.0	-1.367
15.60	6.30	24577.0	-1.355
15.67	7.30	24594.0	-1.369
15.73	8.30	24609.0	-1.383
15.80	9.30	24625.0	-1.396
15.87	10.30	24656.0	-1.423
15.93	11.30	24681.0	-1.445
16.00	12.30	24704.0	-1.465
16.07	13.30	24732.0	-1.490
16.13	14.30	24763.0	-1.516
16.20	15.30	24785.0	-1.536
16.27	16.30	24805.0	-1.553
16.33	17.30	24830.0	-1.574
16.40	18.30	24847.0	-1.589

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PRUDHOE BAY
HOLE SAG RIVER
780526
00:00

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.	0.	-1.811
0.	0.30	0.	-1.810
0.	1.30	0.	-1.732
0.	2.30	0.	-1.603
0.	3.30	0.	-1.529
0.	4.30	0.	-1.449
0.	5.30	0.	-1.423
0.	6.30	0.	-1.400
0.	7.30	0.	-1.404
0.	8.30	0.	-1.429
0.	9.30	0.	-1.456
0.	10.30	0.	-1.481
0.	11.30	0.	-1.494
0.	12.30	0.	-1.523
0.	13.30	0.	-1.537
0.	14.30	0.	-1.545
0.	15.30	0.	-1.561
0.	16.30	0.	-1.577
0.	17.30	0.	-1.583
0.	18.30	0.	-1.591

1

PRUDHOE BAY
HOLE 9.5
780526
14:20

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
14.50	0.	25104.0	-1.810
14.53	1.00	24982.0	-1.705
14.62	2.00	24881.0	-1.618
14.65	3.00	24787.0	-1.537
14.73	4.00	24723.0	-1.482
14.78	5.00	24677.0	-1.442
14.83	6.00	24654.0	-1.422
14.87	7.00	24659.0	-1.426
14.90	8.00	24666.0	-1.432
14.93	9.00	24711.0	-1.471
14.97	10.00	24743.0	-1.499
15.00	11.00	24747.0	-1.503
15.03	12.00	24751.0	-1.506
15.07	13.00	24759.0	-1.513
15.10	13.33	24764.0	-1.517

PRUDHOE BAY
HOLE 9.5
780529
10:10

77-1A L&N — CABLE BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
10.27	0.	25113.0	-1.817
10.38	1.00	24995.0	-1.716
10.50	2.00	24898.0	-1.633
10.62	3.00	24799.0	-1.548
10.73	4.00	24733.0	-1.490
10.85	5.00	24691.0	-1.454
10.97	6.00	24670.0	-1.436
11.08	7.00	24669.0	-1.435
11.32	8.00	24679.0	-1.444
11.43	9.00	24718.0	-1.477
11.55	10.00	24738.0	-1.495
11.67	11.00	24748.0	-1.503
11.78	12.00	24764.0	-1.517
12.02	13.00	24775.0	-1.527
12.13	14.00	24788.0	-1.538
12.25	15.00	24797.0	-1.546
12.37	16.00	24814.0	-1.561
12.48	17.00	24825.0	-1.570
12.72	18.00	24830.0	-1.574
12.83	19.00	24836.0	-1.580
12.95	20.00	24845.0	-1.587
13.07	21.00	24852.0	-1.593
13.18	22.00	24864.0	-1.604
13.30	23.00	24877.0	-1.615
13.42	24.00	24889.0	-1.625
13.53	25.00	24900.0	-1.635
13.65	25.33	24900.0	-1.635

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PRUDHOE BAY
HOLE 9.5
780530
10:00

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
10.50	0.	25103.0	-1.809
10.62	0.99	24994.0	-1.716
10.73	1.99	24904.0	-1.638
10.97	2.99	24807.0	-1.555
11.08	3.99	24743.0	-1.499
11.20	4.99	24695.0	-1.457
11.32	5.99	24672.0	-1.437
11.43	6.99	24668.0	-1.434
11.55	7.99	24677.0	-1.442
11.67	8.99	24713.0	-1.473
11.78	9.99	24736.0	-1.493
11.90	10.99	24752.0	-1.507
12.02	11.99	24760.0	-1.514
12.13	12.99	24769.0	-1.522
12.25	13.99	24784.0	-1.535
12.37	14.99	24798.0	-1.547
12.48	15.99	24806.0	-1.554
12.60	16.99	24811.0	-1.558
12.72	17.99	24821.0	-1.567
12.83	18.99	24833.0	-1.577
12.95	19.99	24846.0	-1.588
1.07	20.99	24857.0	-1.598
1.18	21.99	24864.0	-1.604
1.30	22.99	24872.0	-1.611
1.42	23.99	24881.0	-1.618
1.53	24.99	24896.0	-1.631
1.65	25.31	24896.0	-1.631

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PRUDHOE BAY
HOLE 9.5
78 120523
14:00

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.	0.	-1.812
0.	1.00	0.	-1.726
0.	2.00	0.	-1.652
0.	3.00	0.	-1.567
0.	4.00	0.	-1.510
0.	5.00	0.	-1.468
0.	6.00	0.	-1.450
0.	7.00	0.	-1.443
0.	8.00	0.	-1.454
0.	9.00	0.	-1.479
0.	10.00	0.	-1.489
0.	11.00	0.	-1.507
0.	12.00	0.	-1.526
0.	13.00	0.	-1.538

These are the extrapolated temperatures.

PRUDHOE BAY
HOLE RDEER I+4.5N
780422
14:36

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
14.63	0.	30028.0	-1.877
14.67	0.20	30008.0	-1.862
14.70	0.70	29956.0	-1.824
14.73	1.20	29870.0	-1.760
14.77	1.70	29747.0	-1.669
14.83	2.20	29712.0	-1.643
14.87	2.70	29696.0	-1.632
14.90	3.20	29675.0	-1.616
14.93	3.70	29671.0	-1.613
14.97	4.20	29669.0	-1.611
15.00	4.70	29666.0	-1.609
15.03	5.20	29669.0	-1.611
15.07	5.70	29677.0	-1.617
15.10	6.20	29677.0	-1.617
15.13	6.70	29709.0	-1.641
15.17	7.20	29729.0	-1.656
15.20	7.70	29757.0	-1.677
15.23	8.20	29763.0	-1.681
15.27	8.70	29772.0	-1.688
15.30	9.20	29787.0	-1.699
15.33	9.54	29800.0	-1.709

PRUDHOE BAY
HOLE RDEER I+4.5N
780526
09:45

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
10.28	-0.30	25116.0	-1.820
10.35	0.20	25104.0	-1.810
10.43	0.70	25085.0	-1.794
10.53	1.20	25047.0	-1.761
10.58	1.70	25005.0	-1.725
10.65	2.20	24992.0	-1.714
10.70	2.70	24981.0	-1.704
10.78	3.20	24978.0	-1.702
10.82	3.70	24977.0	-1.701
10.90	4.20	24978.0	-1.702
10.93	4.70	24976.0	-1.700
10.98	5.20	24979.0	-1.703
11.02	5.70	24979.0	-1.703
11.07	6.20	24986.0	-1.709
11.13	6.70	24988.0	-1.710
11.17	7.20	24988.0	-1.710
11.22	7.70	24990.0	-1.712
11.28	8.20	24993.0	-1.715
11.32	8.70	24993.0	-1.715
11.33	9.20	24995.0	-1.716
11.40	9.70	24994.0	-1.716
11.43	10.20	24996.0	-1.717
11.63	10.50	24995.0	-1.716

PRUDHOE BAY
HOLE RIDEER I+4.5N
780528
11:00

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
11.00	0.	25111.0	-1.816
11.40	0.20	25112.0	-1.817
11.45	0.70	25092.0	-1.800
11.57	1.20	25061.0	-1.773
11.63	1.70	24994.0	-1.716
11.68	2.20	24986.0	-1.709
11.72	2.70	24980.0	-1.704
11.77	3.20	24971.0	-1.696
11.80	3.70	24971.0	-1.696
11.87	4.20	24972.0	-1.697
11.90	4.70	24973.0	-1.698
11.93	5.20	24967.0	-1.692
11.97	5.70	24975.0	-1.699
12.00	6.20	24976.0	-1.700
12.03	6.70	24981.0	-1.704
12.07	7.20	24985.0	-1.708
12.10	7.70	24989.0	-1.711
12.13	8.20	24992.0	-1.714
12.17	8.70	24990.0	-1.712
12.20	9.20	24995.0	-1.716
12.23	9.70	25000.0	-1.721
12.27	10.20	25002.0	-1.722
12.30	10.50	25002.0	-1.722

PRUDHOE BAY
HOLE RDEER I+4.5N
780529
16:40

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
16.67	0.	25103.0	-1.809
16.83	0.20	25095.0	-1.802
16.87	0.70	25078.0	-1.788
16.90	1.20	25053.0	-1.766
16.93	1.70	25013.0	-1.732
16.97	2.20	24989.0	-1.711
17.00	2.70	24969.0	-1.694
17.03	3.20	24962.0	-1.688
17.07	3.70	24961.0	-1.687
17.10	4.20	24961.0	-1.687
17.13	4.70	24961.0	-1.687
17.17	5.20	24961.0	-1.687
17.20	5.70	24962.0	-1.688
17.23	6.20	24964.0	-1.690
17.27	6.70	24968.0	-1.693
17.30	7.20	24969.0	-1.694
17.33	7.70	24978.0	-1.702
17.37	8.20	24982.0	-1.705
17.40	8.70	24981.0	-1.704
17.43	9.20	24987.0	-1.710
17.47	9.70	24987.0	-1.710
17.50	10.20	24987.0	-1.710
17.53	10.50	24989.0	-1.711

1

REINDEER ISLAND
HOLE REIS31
780824
09:49

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
9.93	0.40	21300.0	1.750
10.02	1.40	23275.0	-0.181
10.12	2.40	24486.0	-1.275
10.20	3.40	25512.0	-2.155
10.33	4.40	26137.0	-2.671
10.58	5.40	27997.0	-4.130
12.48	5.90	28584.0	-4.567
12.18	6.40	27500.0	-3.751
12.37	6.90	26440.0	-2.917
11.02	7.40	26671.0	-3.102
12.02	7.90	29925.0	-5.530
11.13	8.40	32569.0	-7.292
11.30	9.40	31974.0	-6.910
11.42	10.40	31657.0	-6.703
11.52	11.40	31268.0	-6.446
11.62	12.40	31706.0	-6.735
11.68	13.40	31353.0	-6.503
11.77	14.33	30799.0	-6.131

*

1

REINDEER ISLAND
HOLE REIS32
780826
11:40

77-1A CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
11.85	0.40	15300.0	9.160
11.95	1.40	23578.0	-0.461
12.03	2.40	24454.0	-1.247
12.17	3.40	26053.0	-2.603
12.30	4.40	28155.0	-4.249
12.40	5.40	30419.0	-5.872
12.80	5.90	30680.0	-6.051
12.58	6.40	30356.0	-5.829
12.98	7.40	29581.0	-5.288
13.07	8.40	32952.0	-7.534
13.22	9.40	32759.0	-7.413
13.37	10.40	32292.0	-7.115
13.47	11.40	31841.0	-6.824
13.53	12.40	31867.0	-6.841
13.58	13.40	31460.0	-6.574
13.65	14.33	30865.0	-6.176

*

1

REINDEER ISLAND
HOLE REIS33
781026
13:10

BRONX 136 CABLE
L&N BRIDGE

TIME	DEPTH (M)	R (OHMS)	T (C)
13.33	1.40	35100.0	-5.291
13.50	2.40	30725.0	-2.382
13.67	3.40	34217.0	-4.737
13.80	4.40	36512.0	-6.146
13.95	5.40	38474.0	-7.276
14.08	6.40	39861.0	-8.037
14.22	7.40	40643.0	-8.454
14.35	8.40	40680.0	-8.474
14.63	9.40	40222.0	-8.231
14.77	10.40	39591.0	-7.891
14.93	11.40	38831.0	-7.475
15.12	12.40	38137.0	-7.086
15.23	13.40	37540.0	-6.746
15.38	14.40	36795.0	-6.313
15.52	15.40	35963.0	-5.818
15.65	16.40	35191.0	-5.347
15.75	17.40	34494.0	-4.912
16.07	18.40	33866.0	-4.512

*

COTTLE ISLAND
HOLE COTTL2
781026
11:25

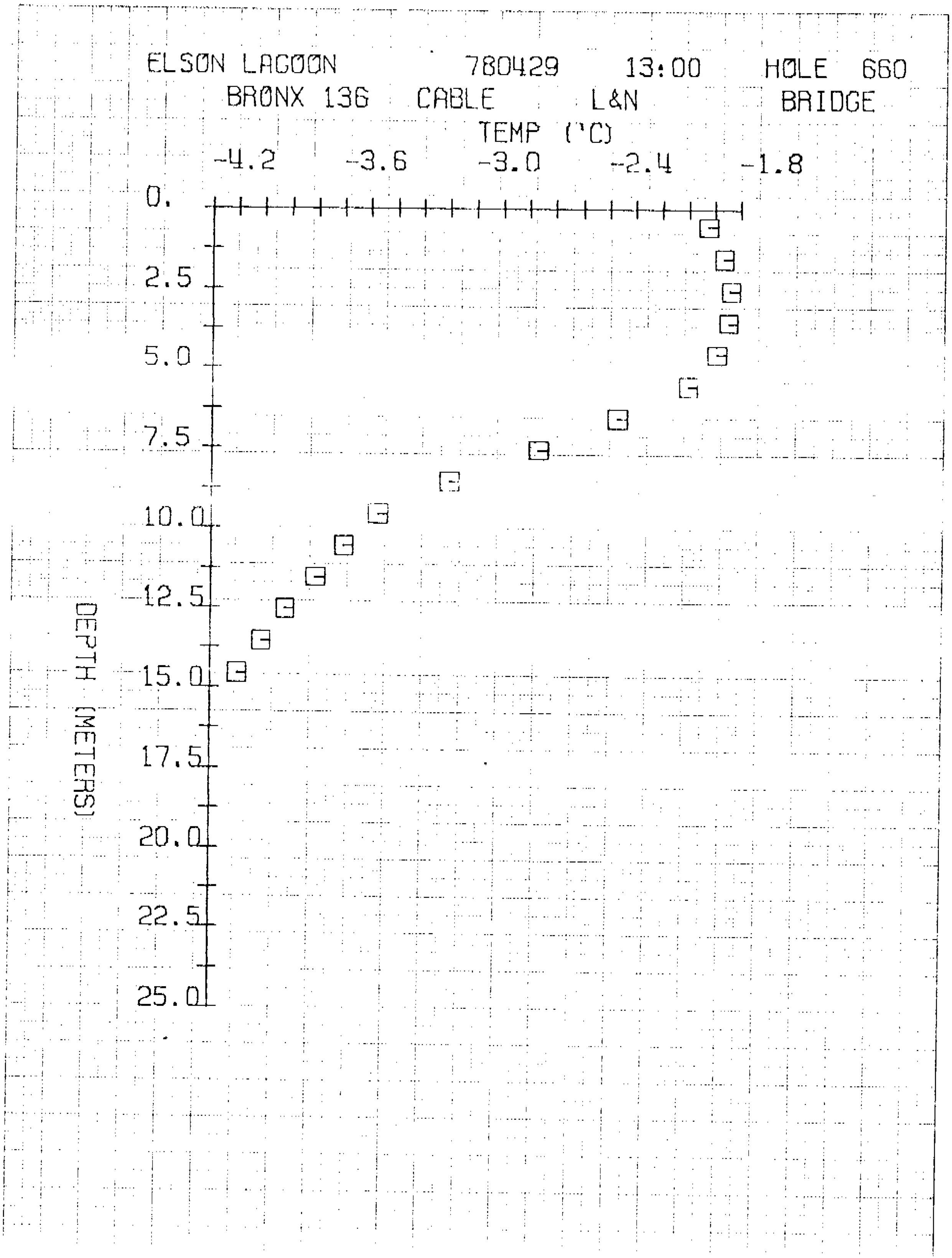
BRONX 136 CABLE
L&N BRIDGE

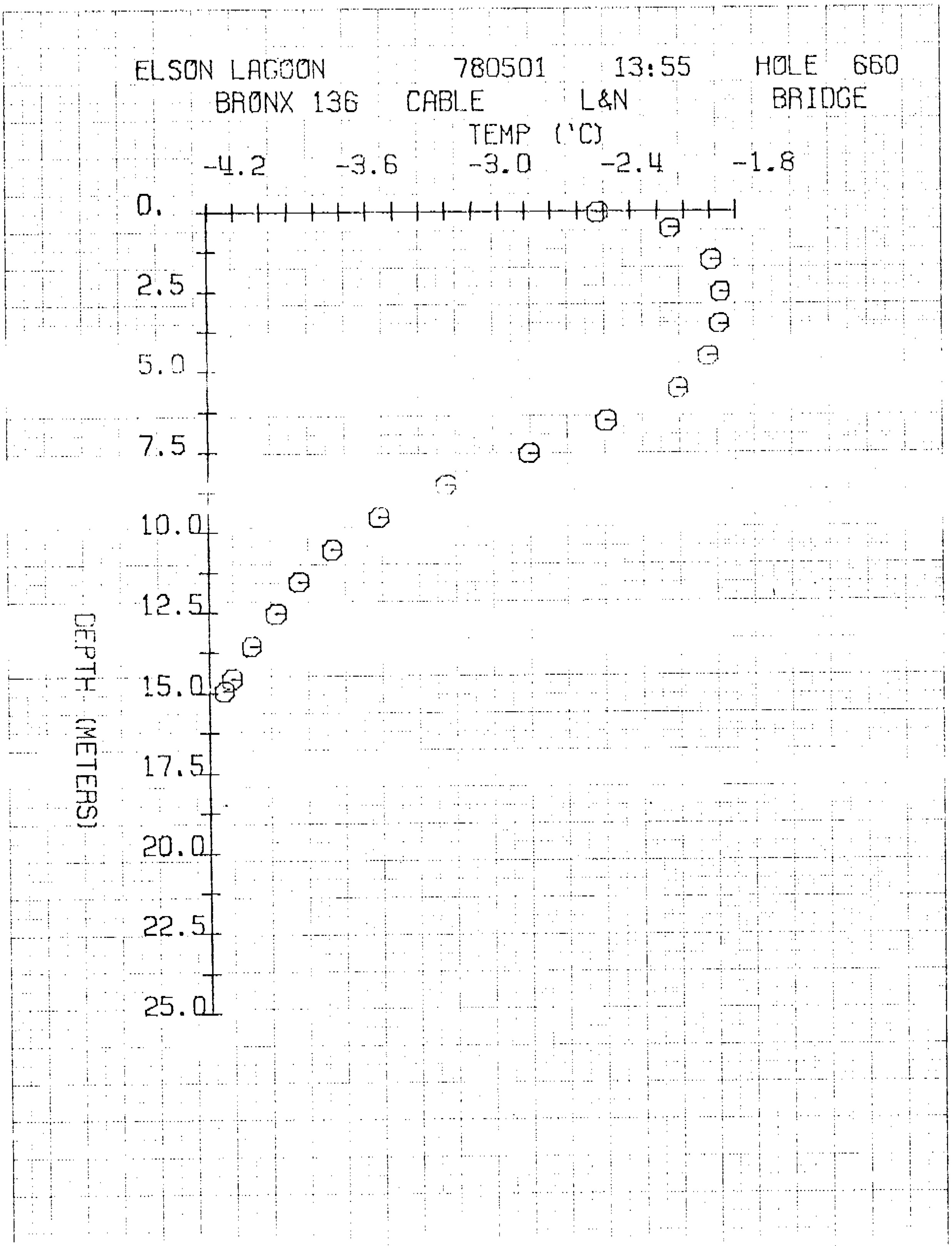
TIME	DEPTH (M)	R (OHMS)	T (C)
11.70	1.00	32164.0	-3.386
11.98	2.00	31856.0	-3.175
12.12	3.00	34117.0	-4.673
12.27	4.00	35700.0	-5.658
12.38	5.00	37160.0	-6.526
12.50	5.48	37815.0	-6.903

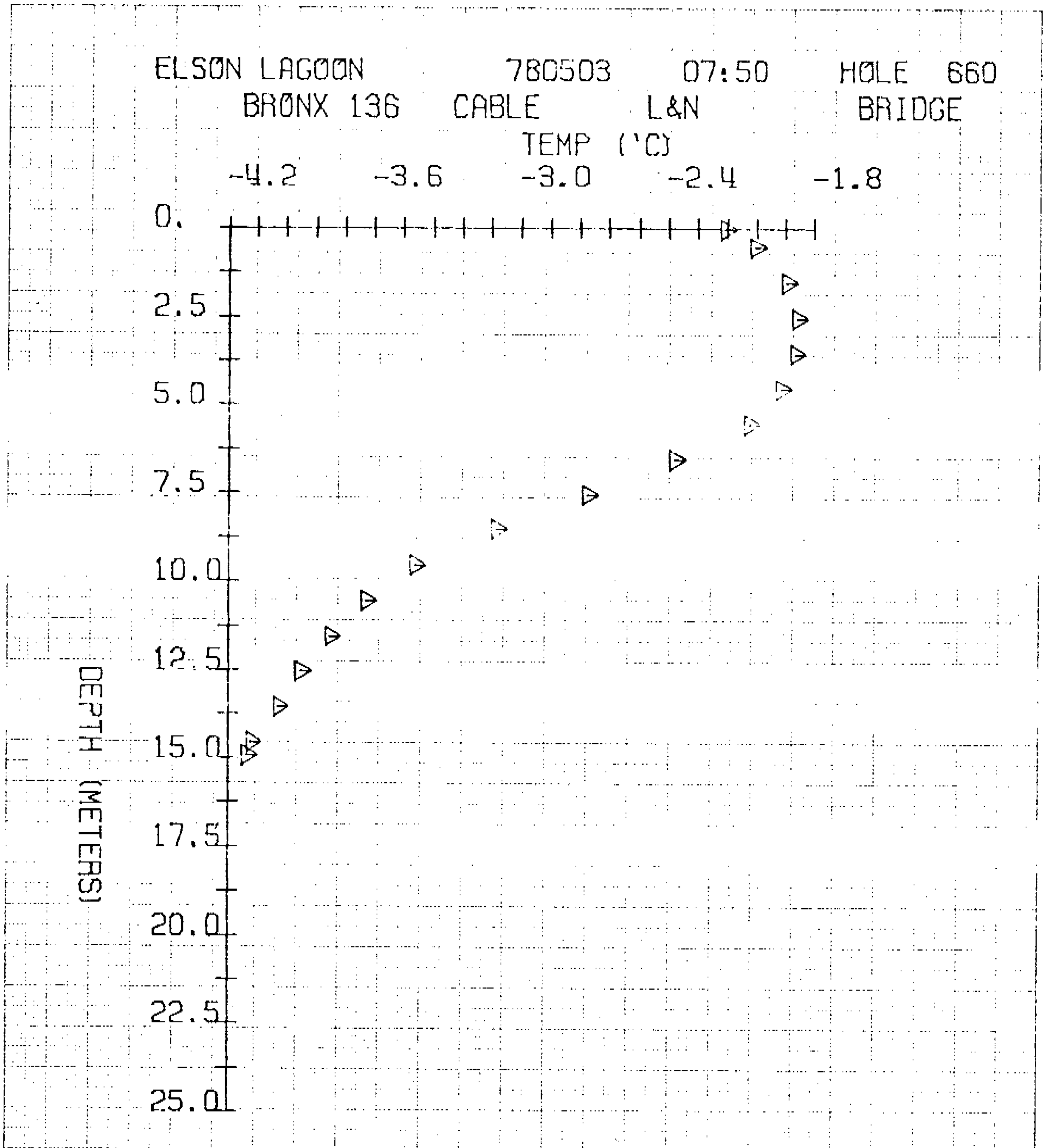
COTTLE ISLAND
HOLE COTTL1
780826
15:01

77-1A CABLE
L&N BRIDGE

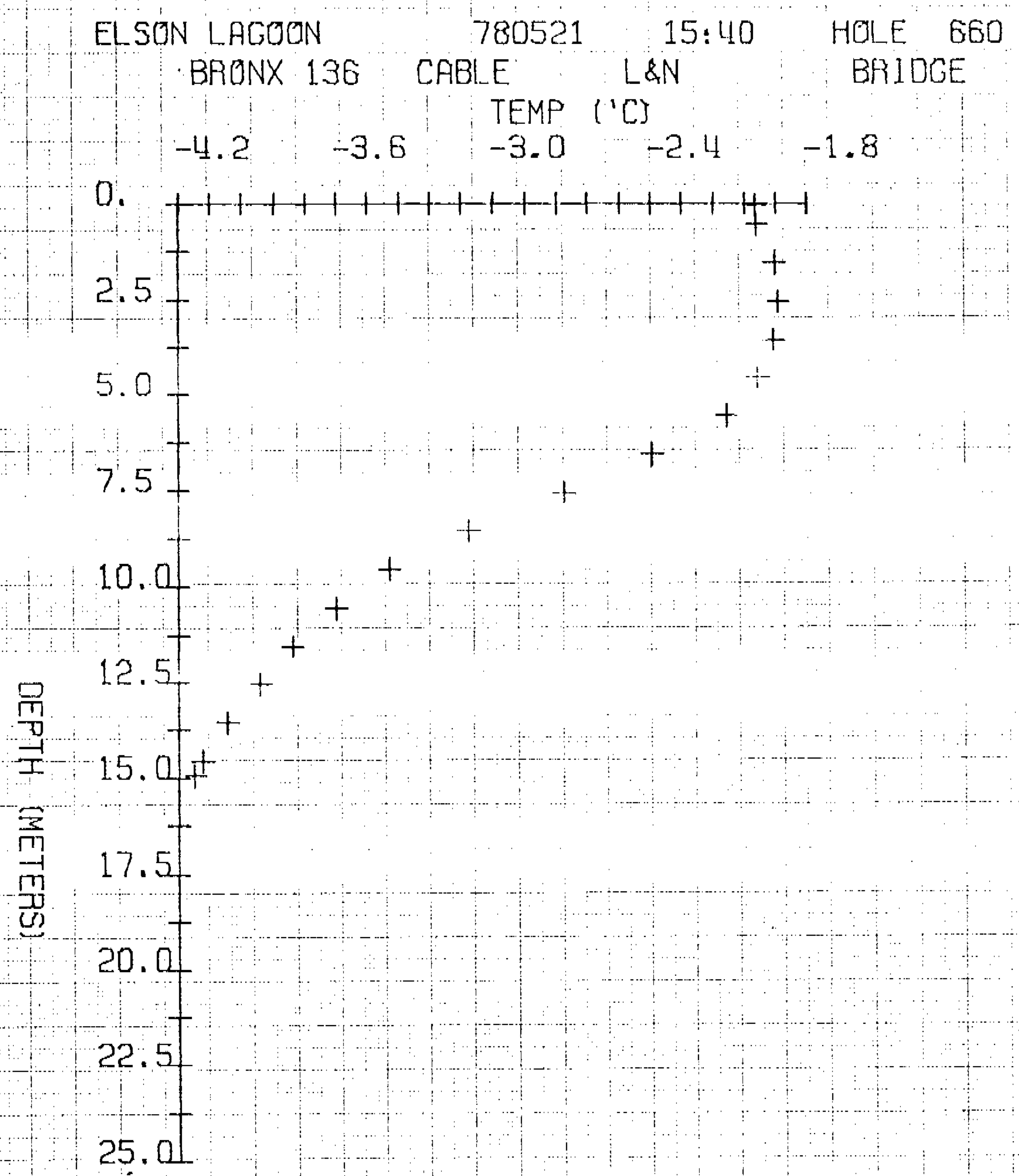
TIME	DEPTH (M)	R (OHMS)	T (C)
0.	0.50	22299.0	0.749
0.	1.00	24550.0	-1.331
0.	2.00	24554.0	-1.334
0.	3.00	24799.0	-1.548
0.	4.00	24465.0	-1.256
0.	5.00	29109.0	-4.950
0.	5.48	31013.0	-6.276

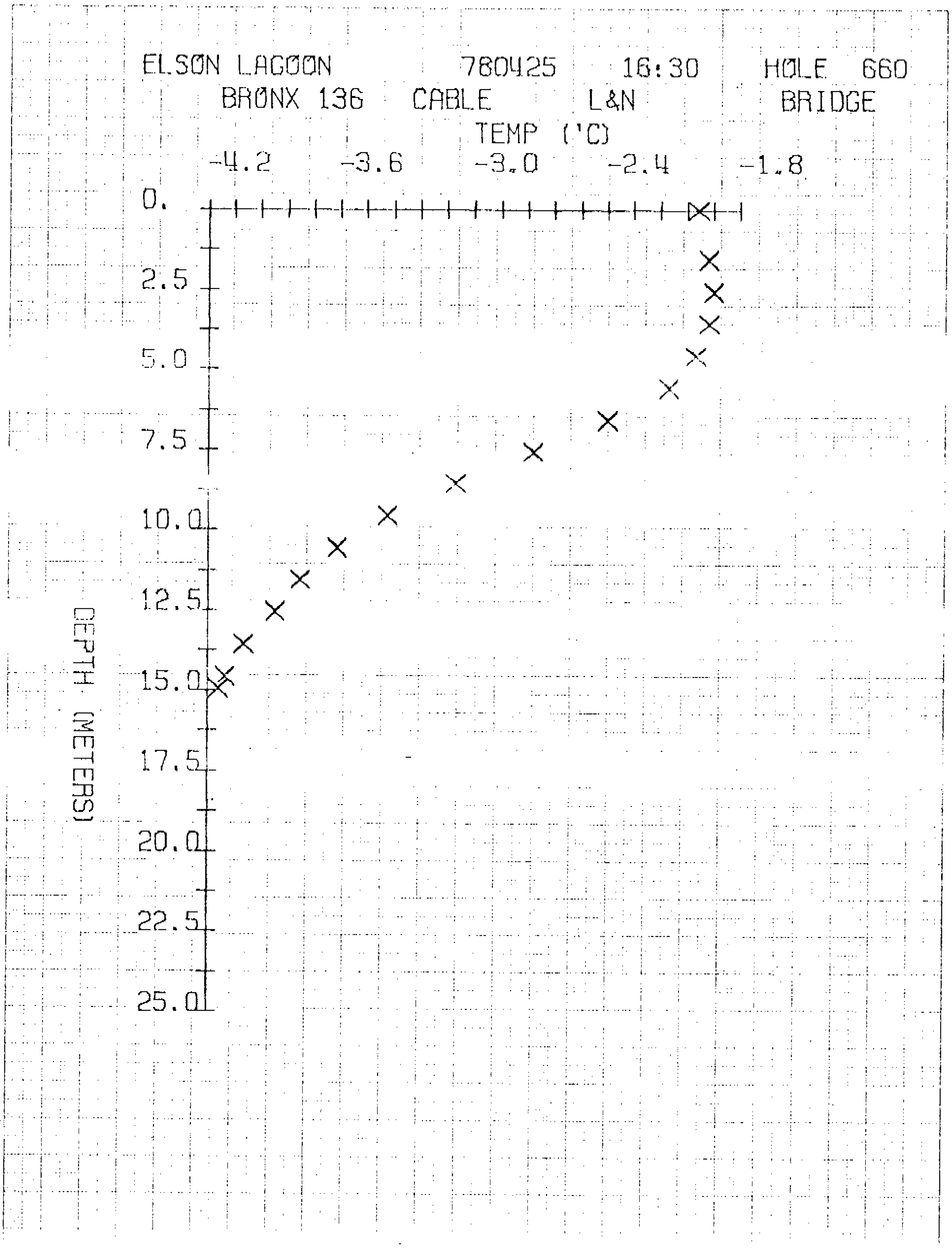

ELSON LAGOON 780429 13:00 HOLE 660
BRONX 136 CABLE L&N BRIDGE
TEMP (°C)
-4.2 -3.6 -3.0 -2.4 -1.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

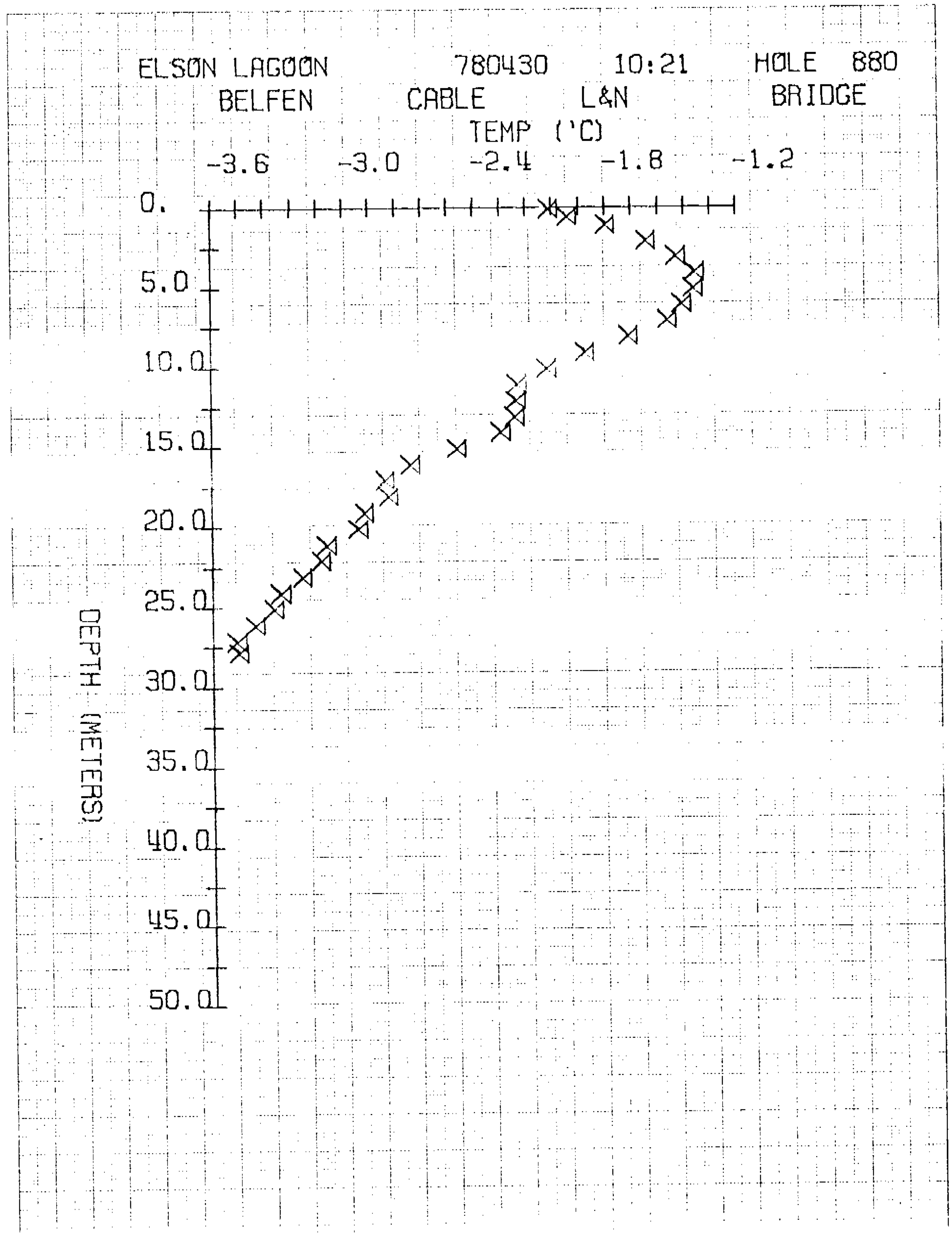

ELSØN LAGØØN 780501 13:55 HØLE 660
BRØNX 136 CABLE L&N BRIDGE
TEMP ('C)
-4.2
-3.6
-3.0
-2.4
-1.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

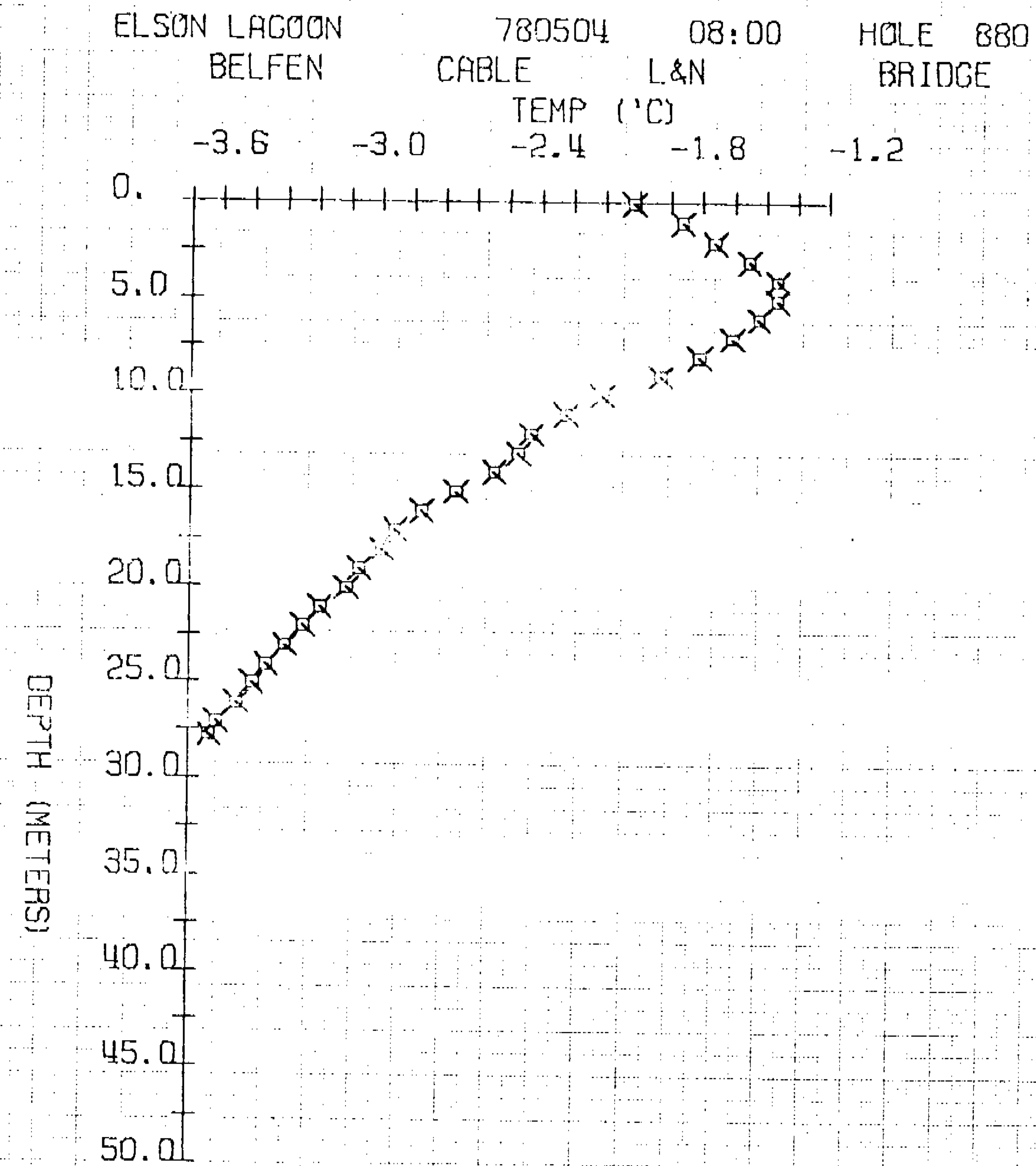


ELSØN LAGOON 780503 07:50 HØLE 660
BRØNX 136 CABLE L&N BRIDGE
TEMP ('C)
-4.2 -3.6 -3.0 -2.4 -1.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

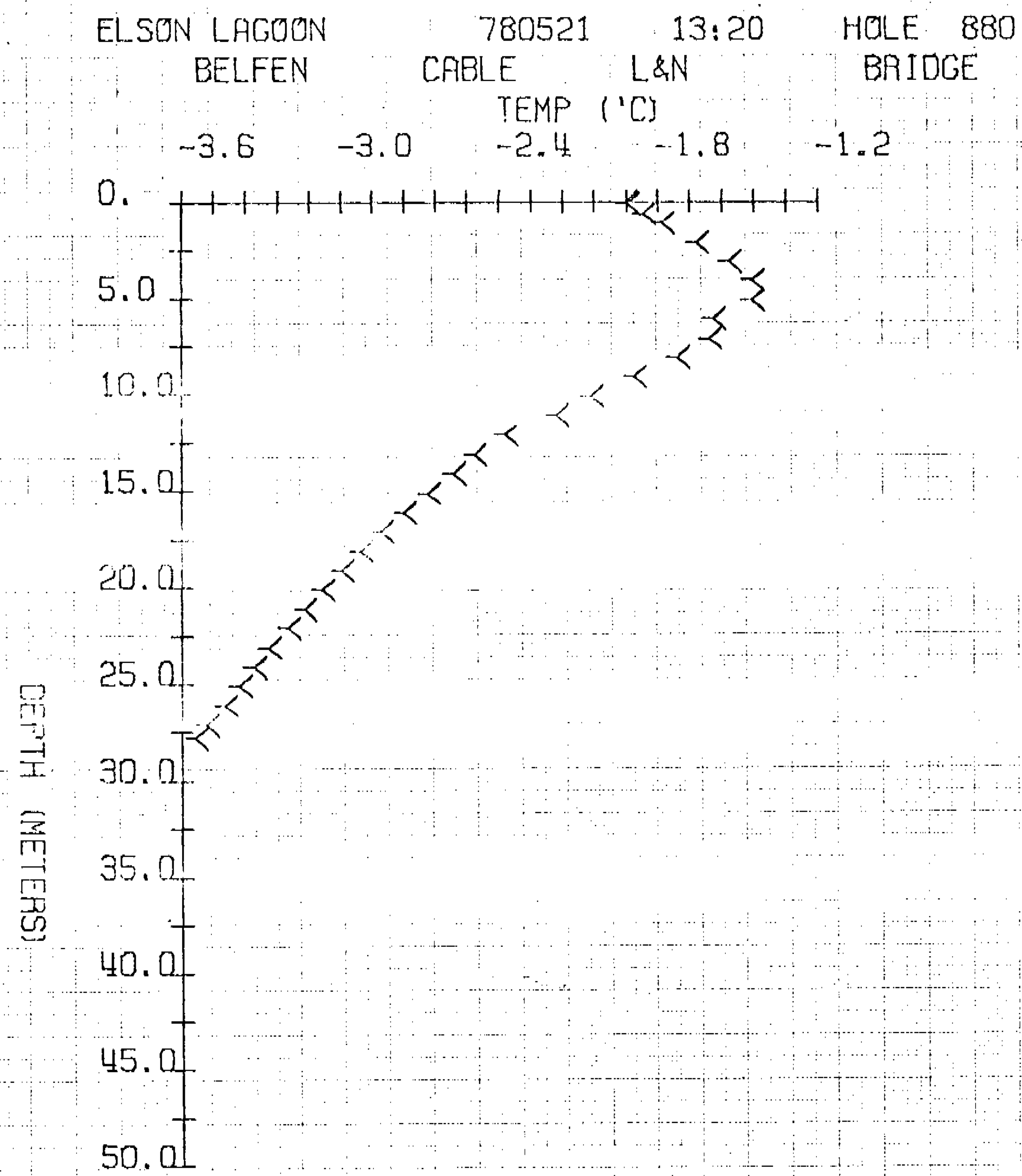

ELSON LAGOON 780521 15:40 HOLE 660
BRONX 136 CABLE L&N BRIDGE
TEMP ('C)
-4.2 -3.6 -3.0 -2.4 -1.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

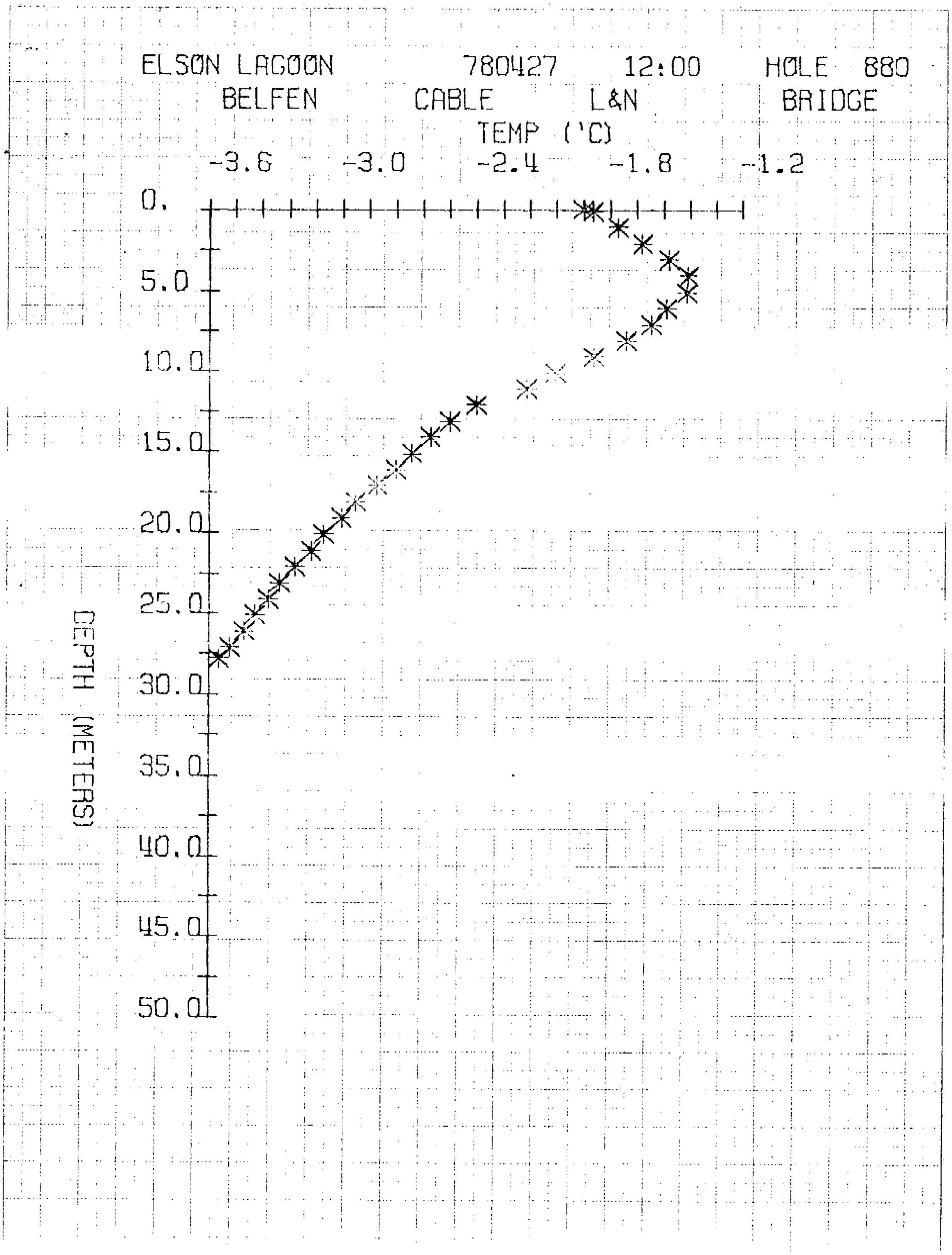

ELSØN LAGØØN 780425 16:30 HØLE 660
BRØNX 136 CABLE L&N BRIDGE
TEMP ('C)
-4.2 -3.6 -3.0 -2.4 -1.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

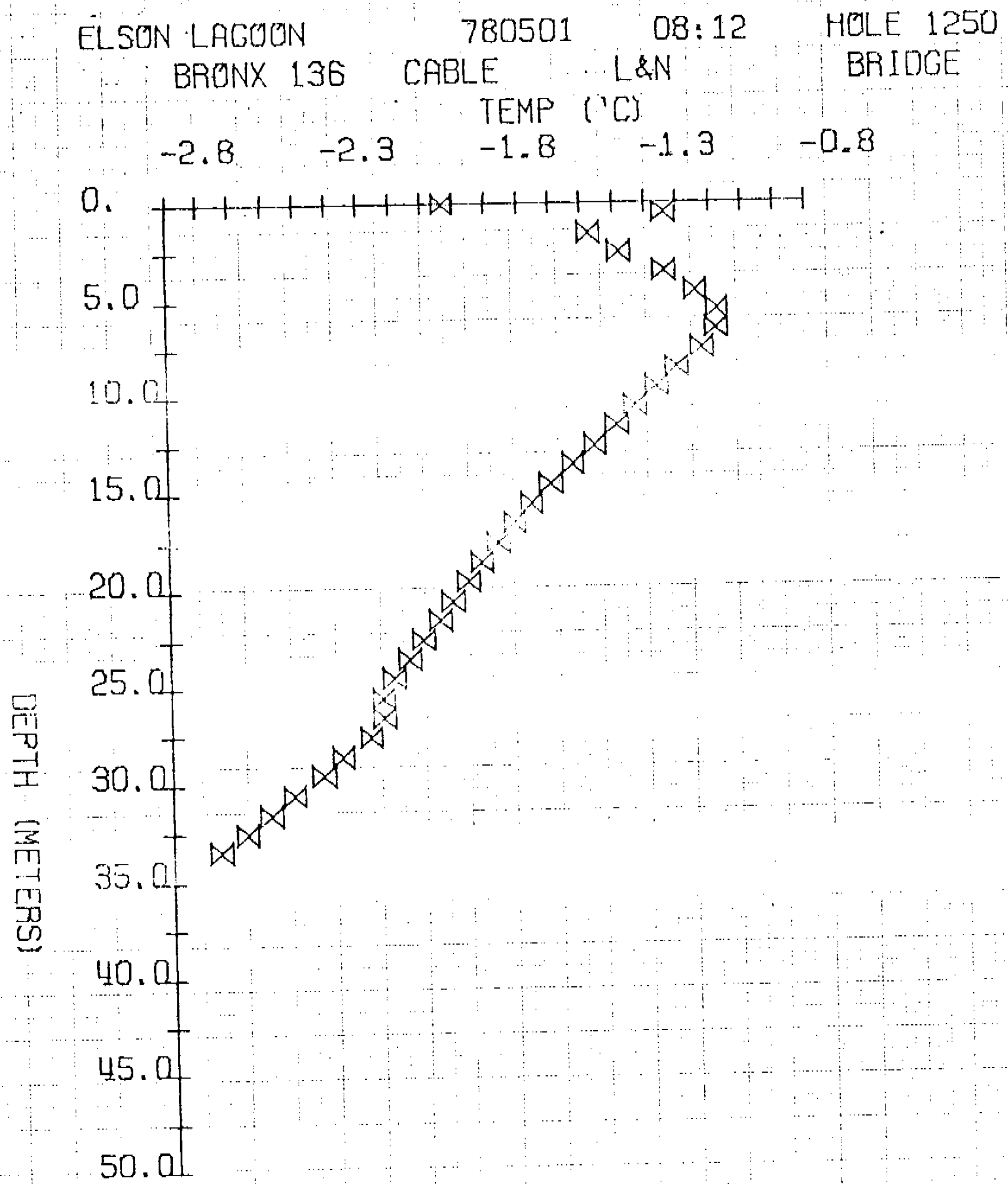

ELSØN LAGØØN
780430
10:21
HØLE 880
BELFEN
CABLE
L&N
BRIDGE
TEMP ('C)
-3.6
-3.0
-2.4
-1.8
-1.2
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)



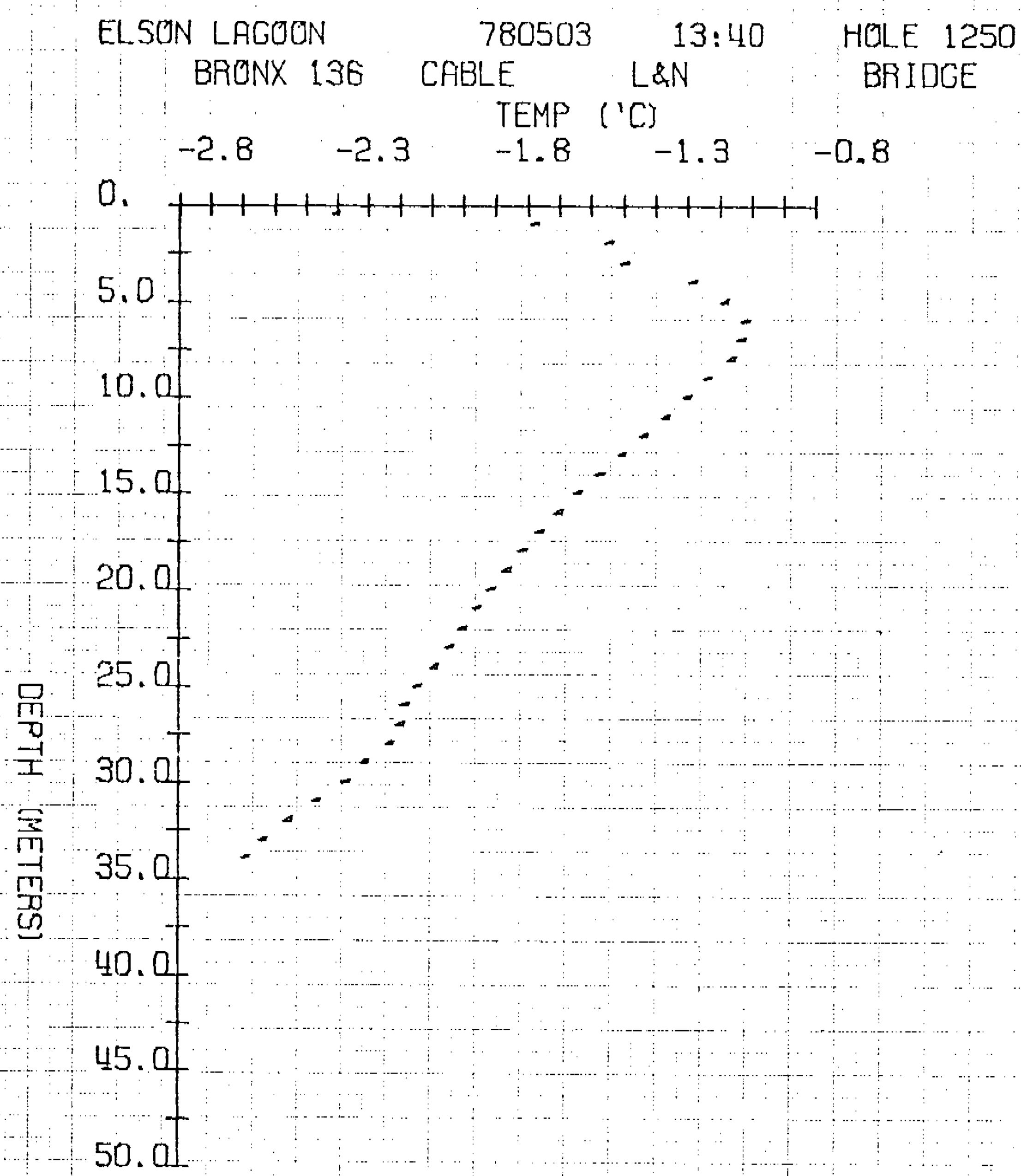
ELSON LAGOON 780504 08:00 HOLE 880
BELFEN CABLE L&N BRIDGE
TEMP ('C)
-3.6 -3.0 -2.4 -1.8 -1.2
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

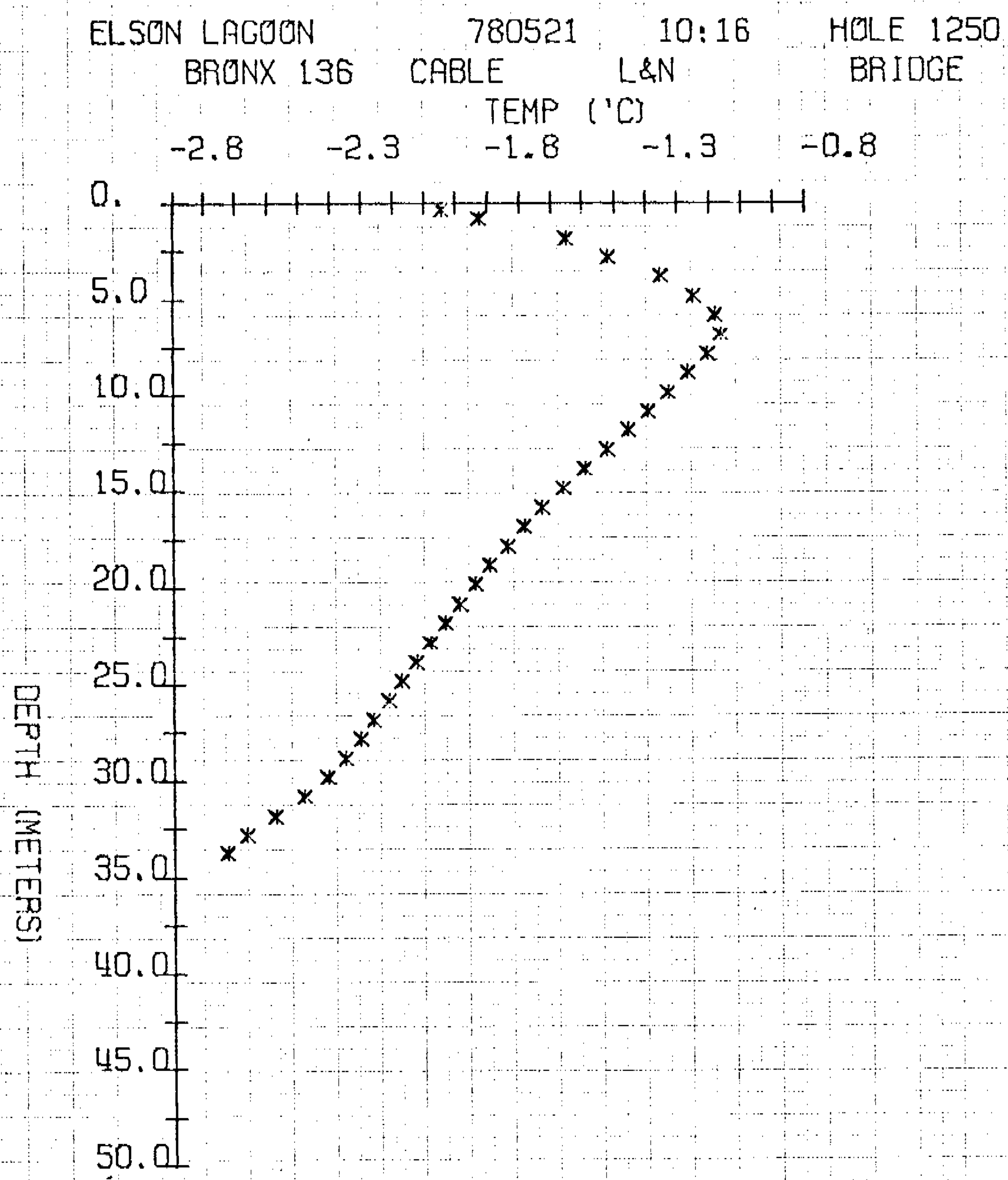

ELSØN LAGOON 780521 13:20 HOLE 880
BELFEN CABLE L&N BRIDGE
TEMP ('C)
-3.6 -3.0 -2.4 -1.8 -1.2
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

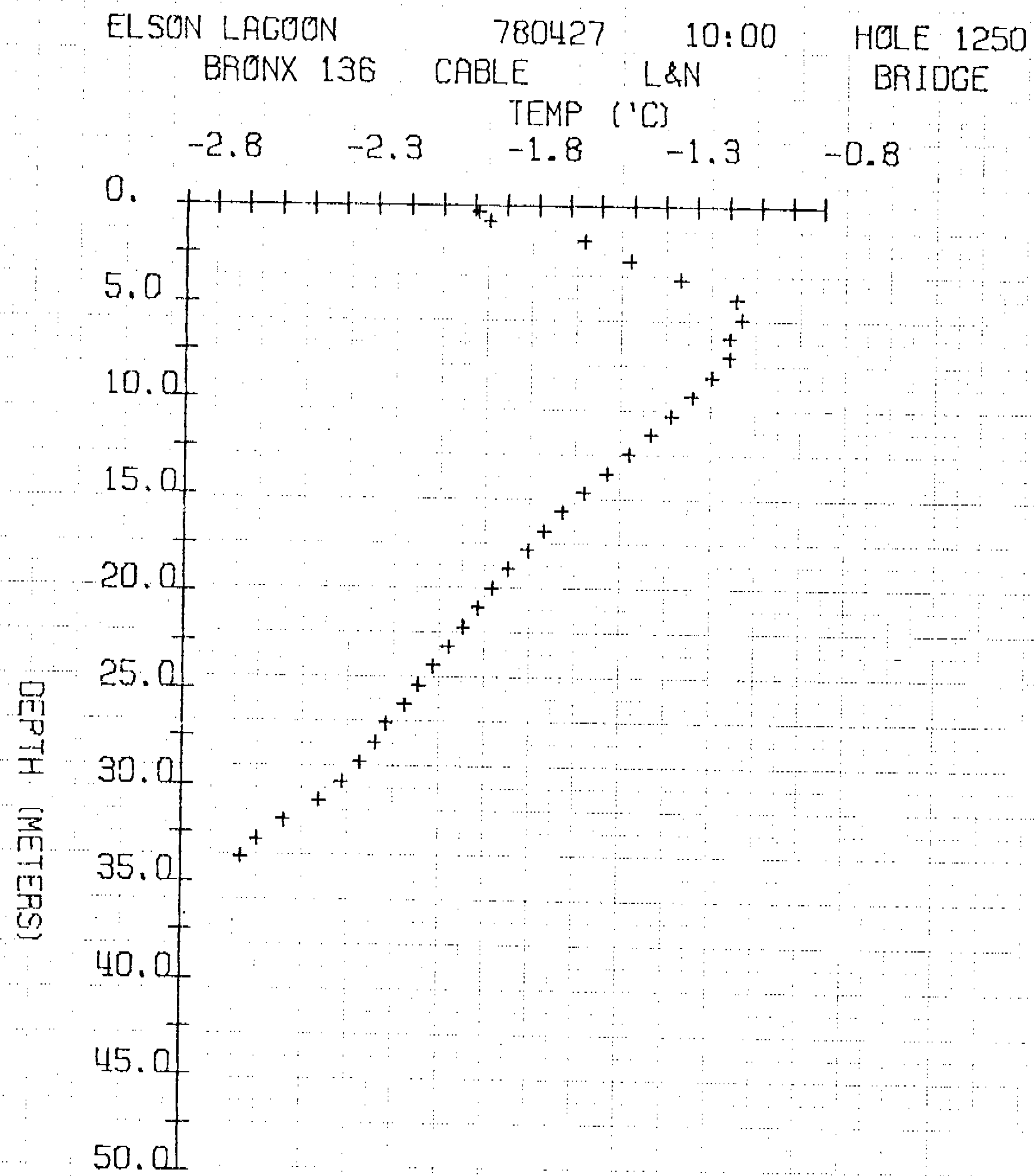

ELSØN LAGØØN 780427 12:00 HØLE 880
BELFEN CABLE L&N BRIDGE
TEMP ('C)
-3.6 -3.0 -2.4 -1.8 -1.2
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

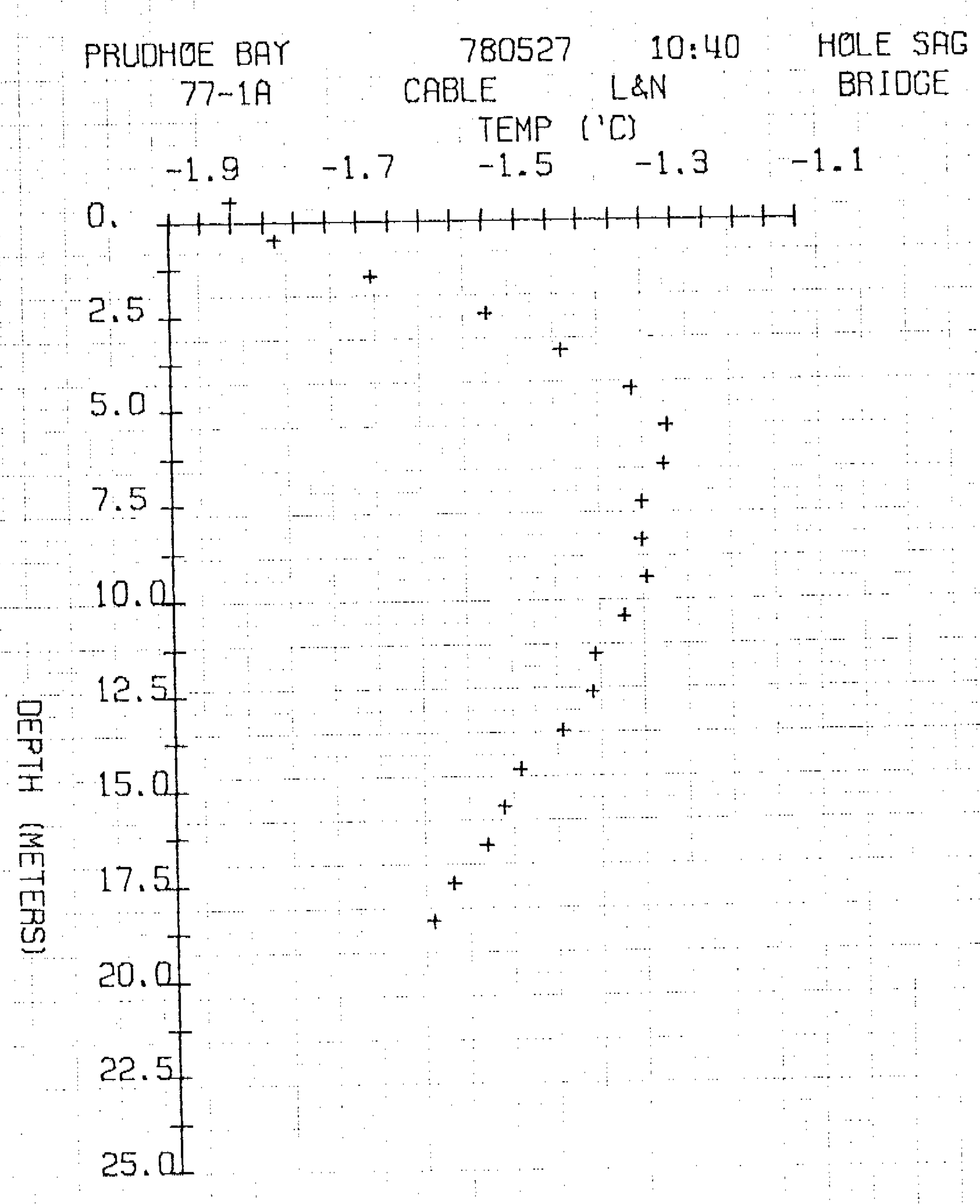


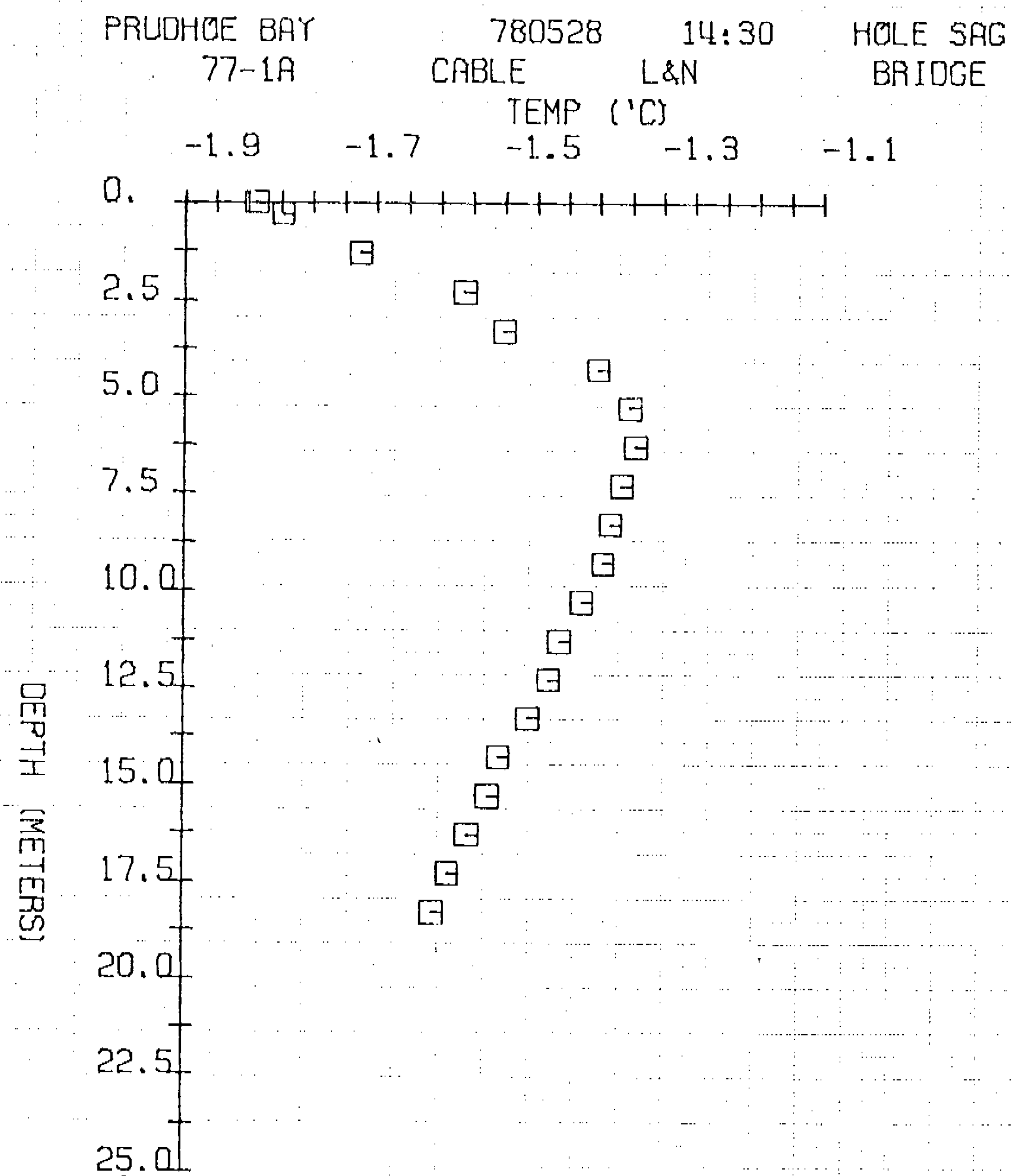
ELSØN LAGØØN
780501
08:12
HØLE 1250
BRØNX 136
CABLE
L&N
BRIDGE
TEMP (°C)
-2.8
-2.3
-1.8
-1.3
-0.8
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

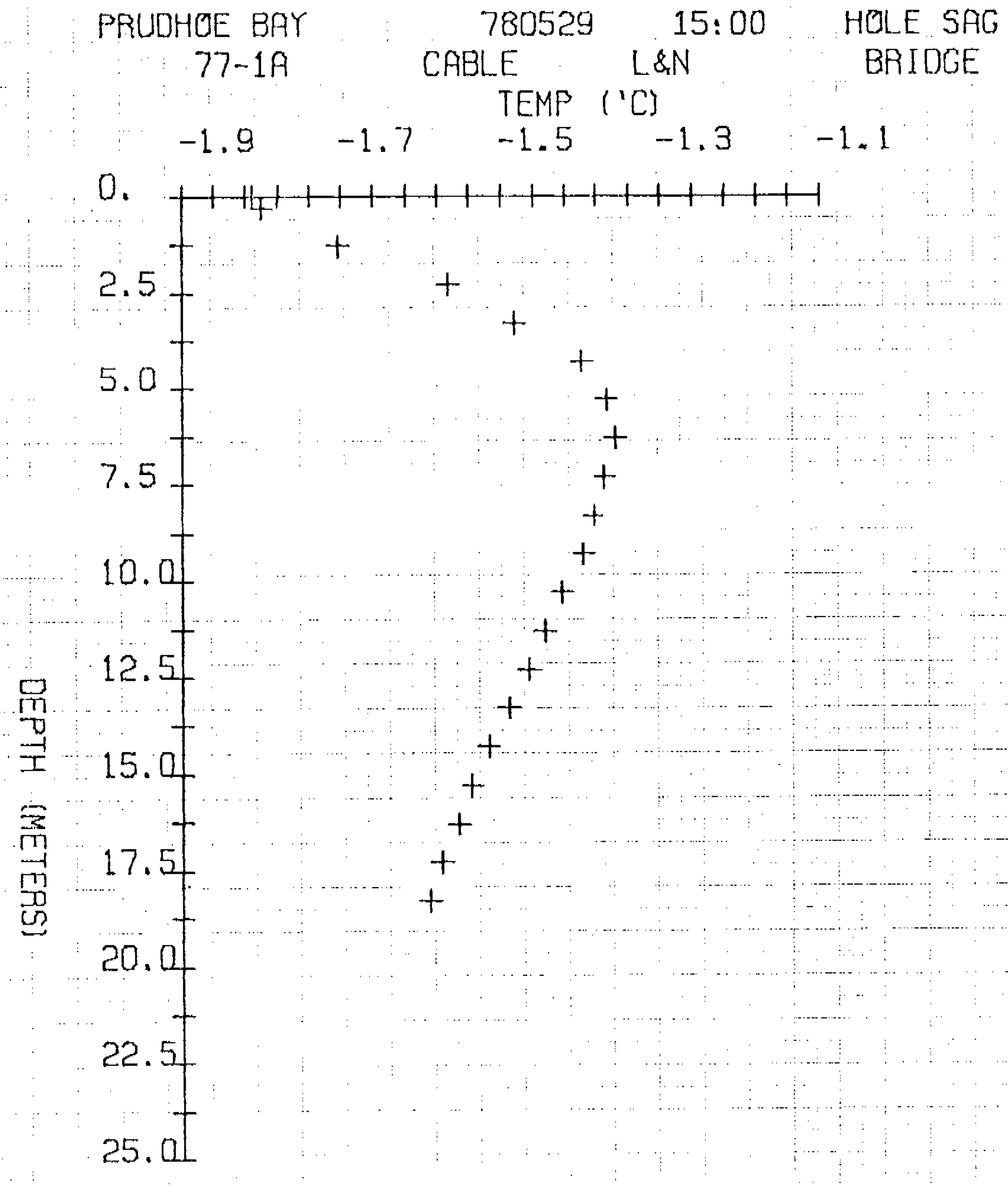

ELSON LAGOON 780503 13:40 HOLE 1250
BRONX 136 CABLE L&N BRIDGE
TEMP ('C)
-2.8 -2.3 -1.8 -1.3 -0.8
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

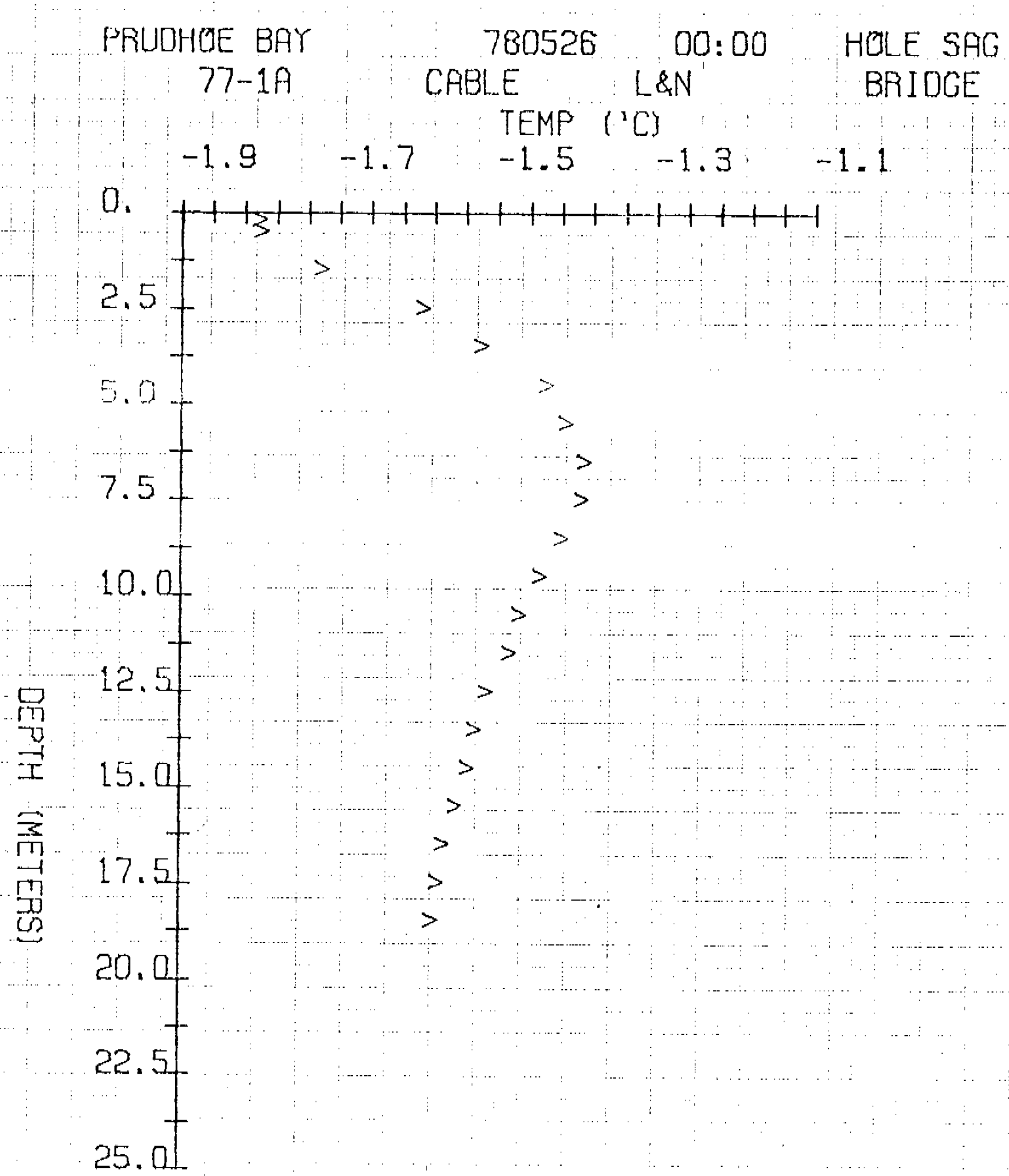

ELSON LAGOON 780521 10:16 HOLE 1250
BRONX 136 CABLE L&N BRIDGE
TEMP ('C)
-2.8 -2.3 -1.8 -1.3 -0.8
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

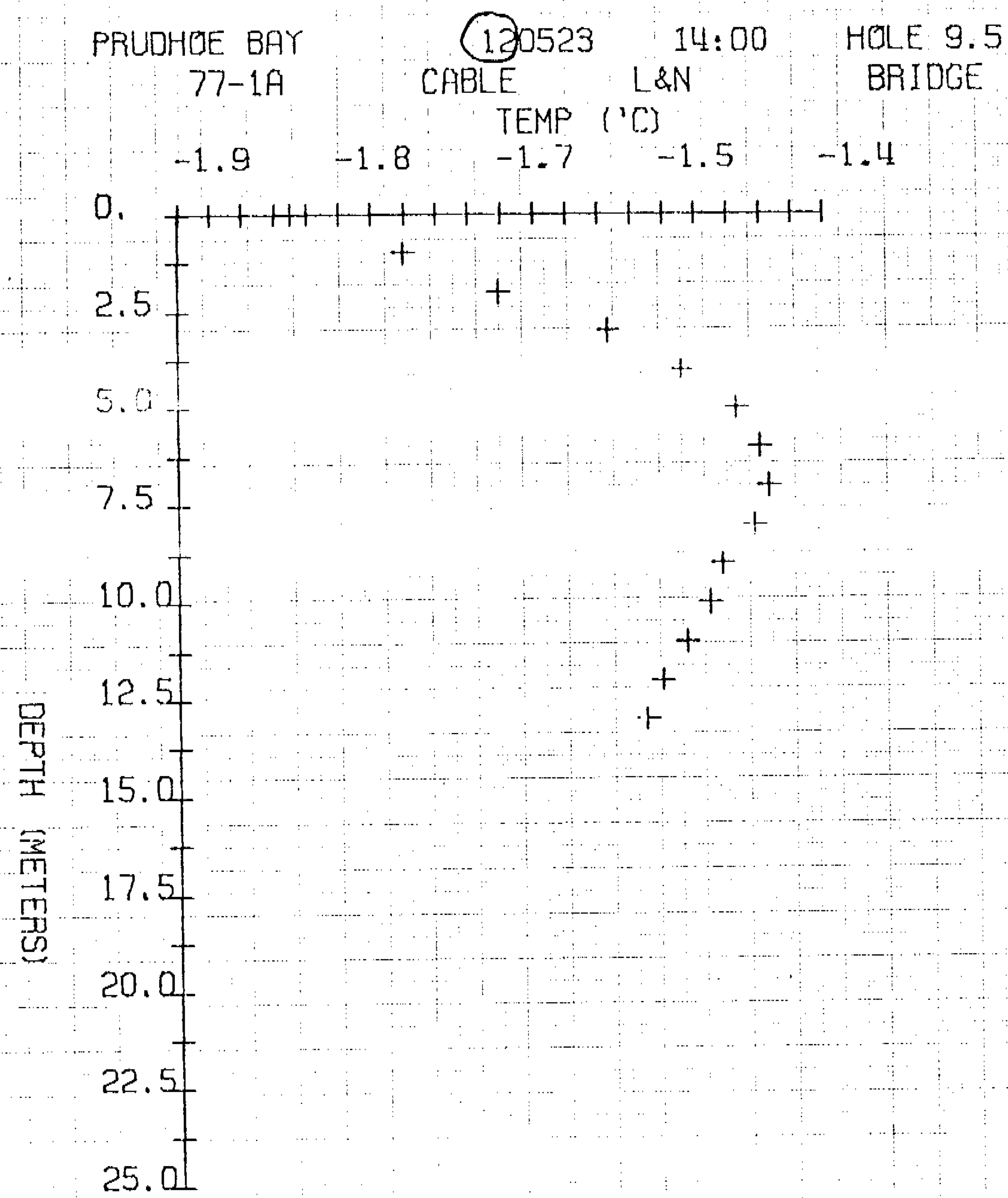

ELSØN LAGØØN 780427 10:00 HØLE 1250
BRØNX 136 CABLE L&N BRIDGE
TEMP ('C)
-2.8 -2.3 -1.8 -1.3 -0.8
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

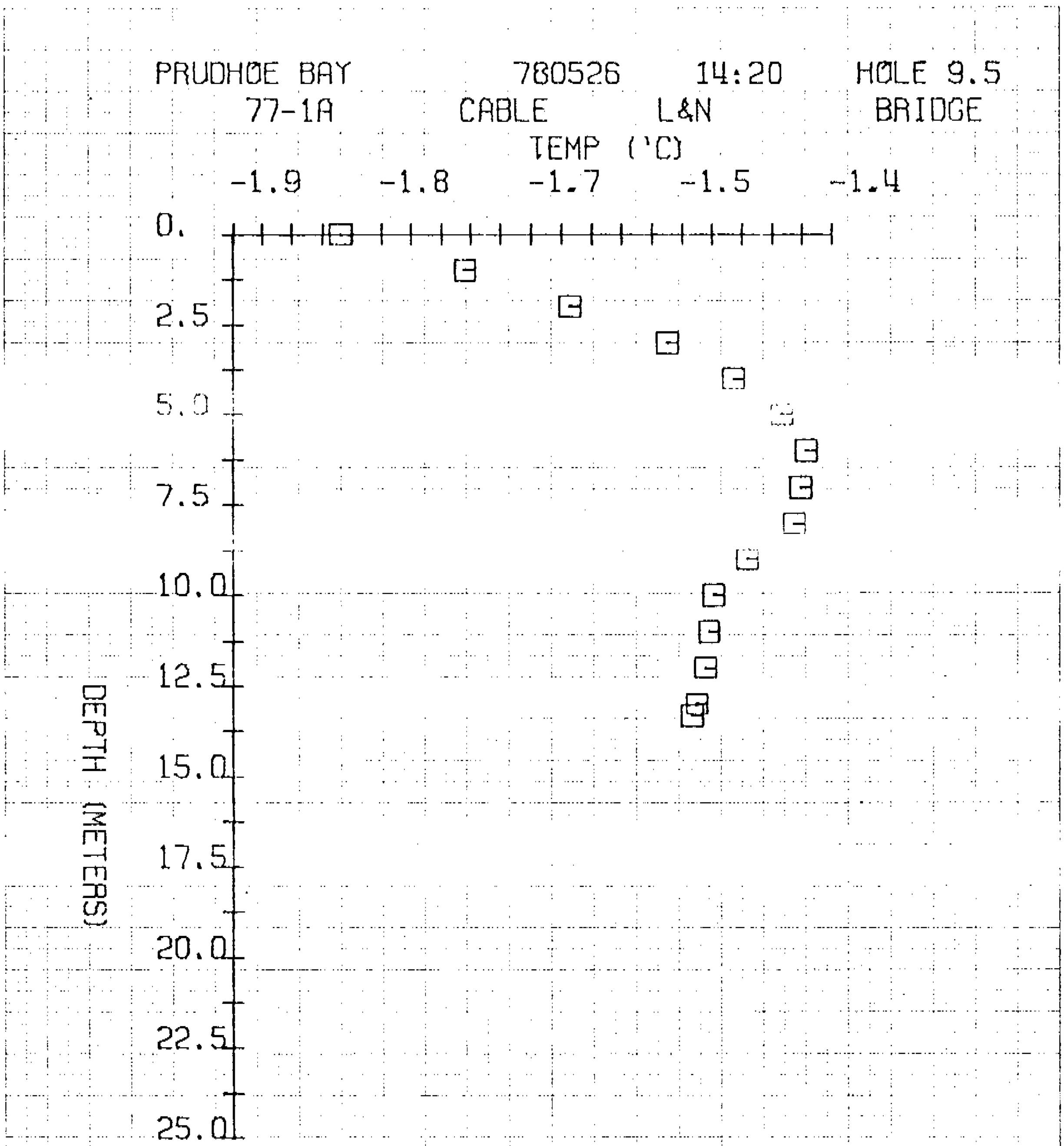

PRUDHOE BAY
780527
10:40
HOLE SAG
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.7
-1.5
-1.3
-1.1
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

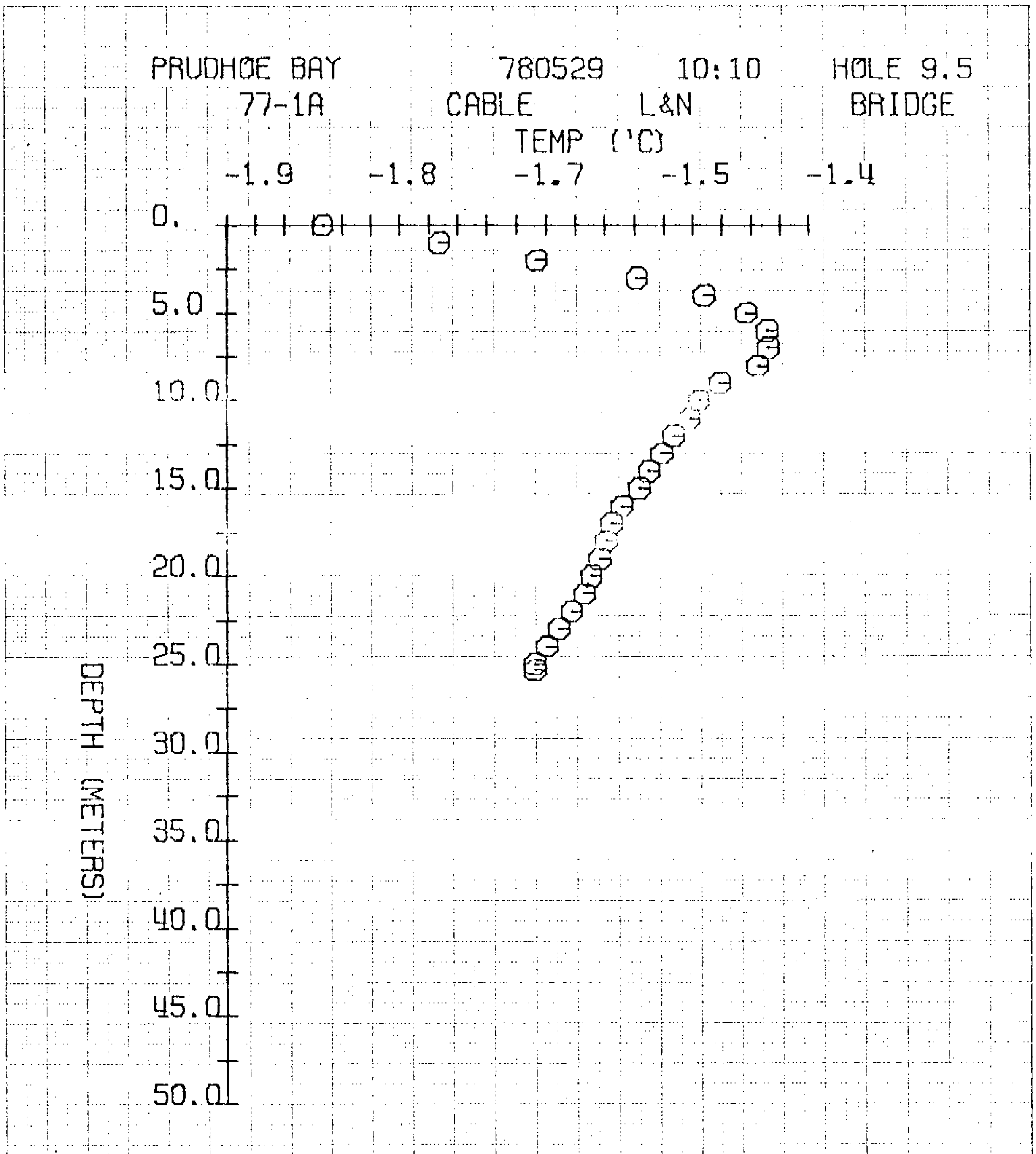

PRUDHOE BAY
780528
14:30
HOLE SAG
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.7
-1.5
-1.3
-1.1
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

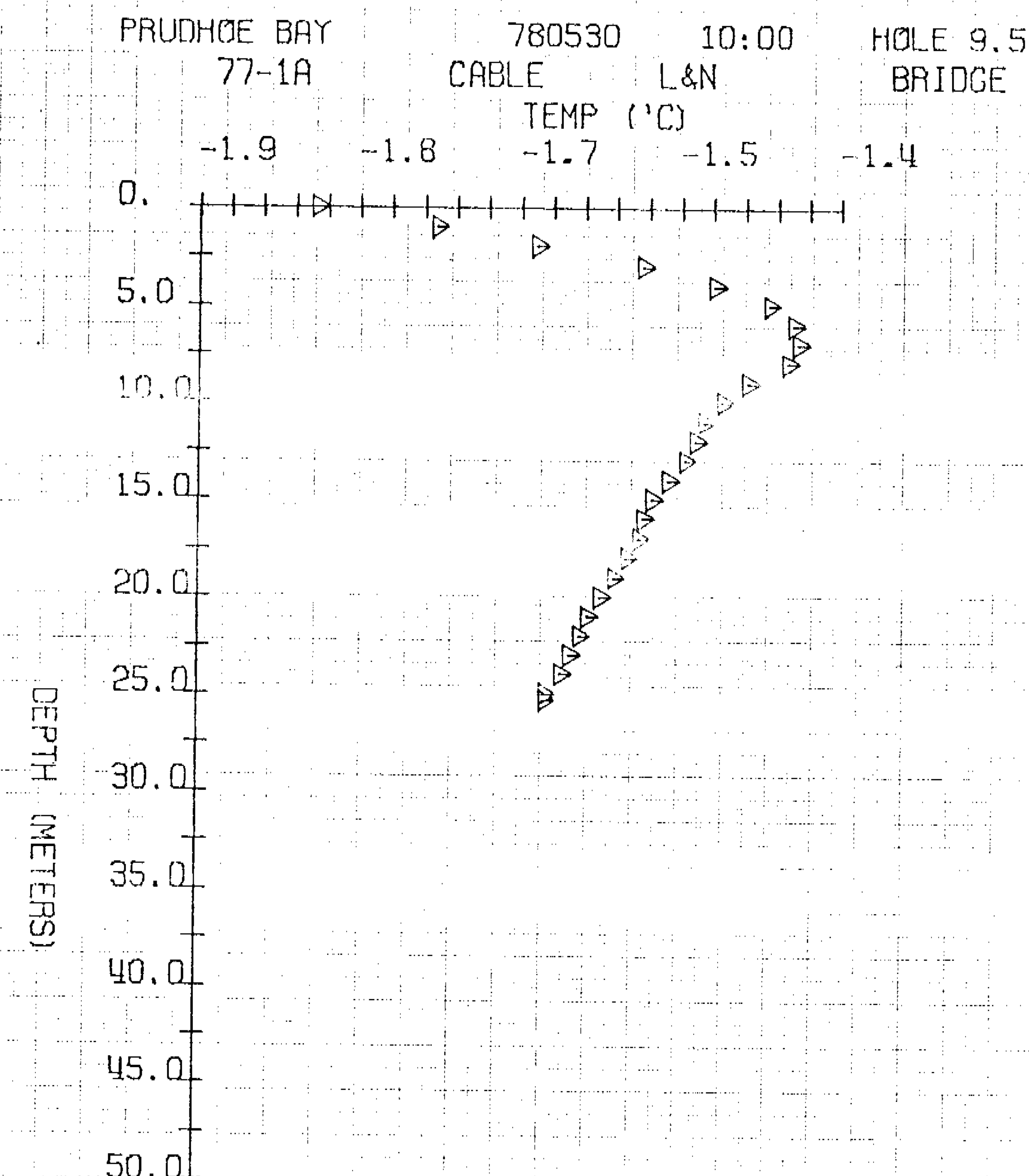

PRUDHØE BAY 780529 15:00 HØLE SAG
77-1A CABLE L&N BRIDGE
TEMP ('C)
-1.9 -1.7 -1.5 -1.3 -1.1
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)


PRUDHØE BAY
780526
00:00
HØLE SAG
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.7
-1.5
-1.3
-1.1
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

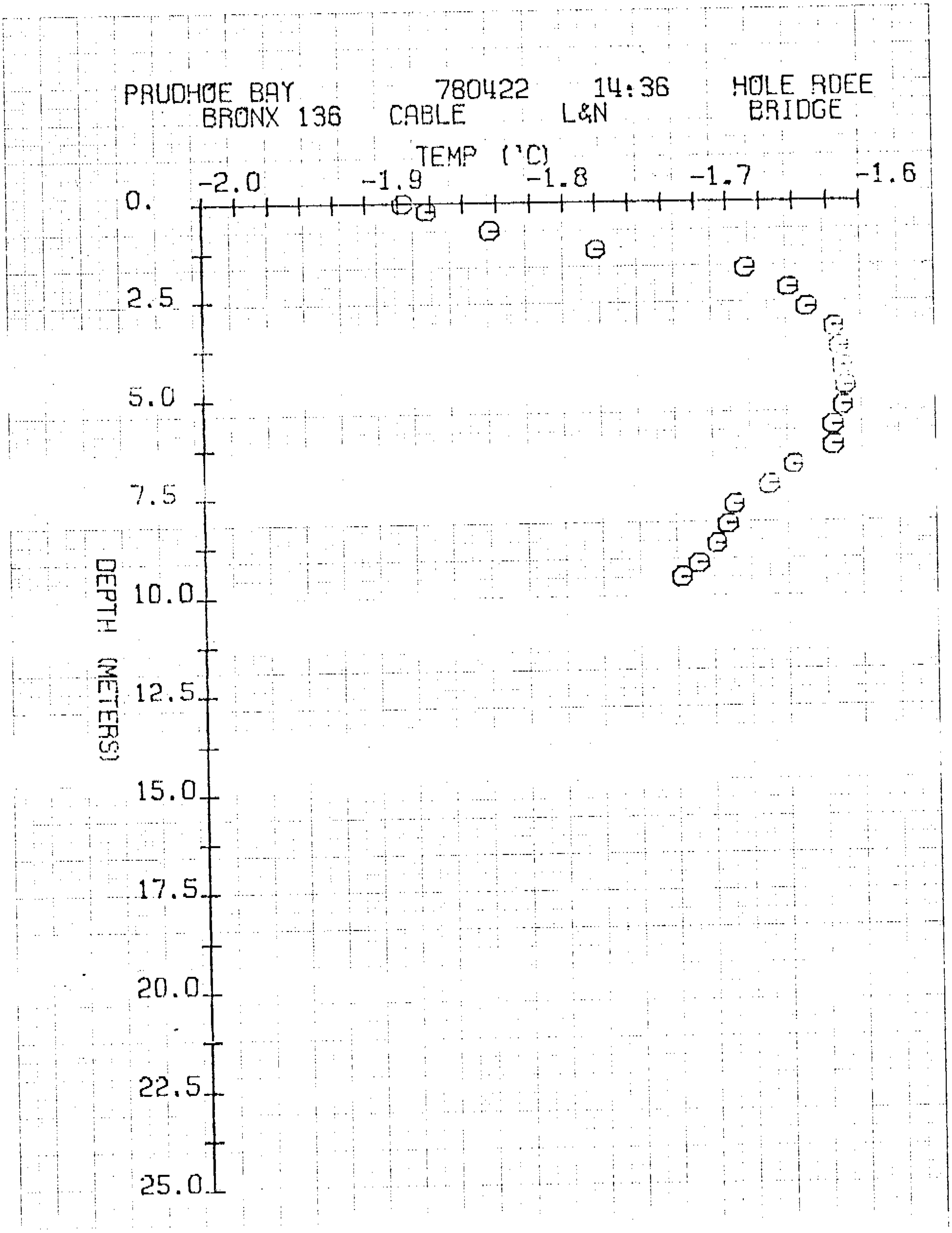

PRUDHOE BAY
120523
14:00
HOLE 9.5
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.8
-1.7
-1.5
-1.4
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

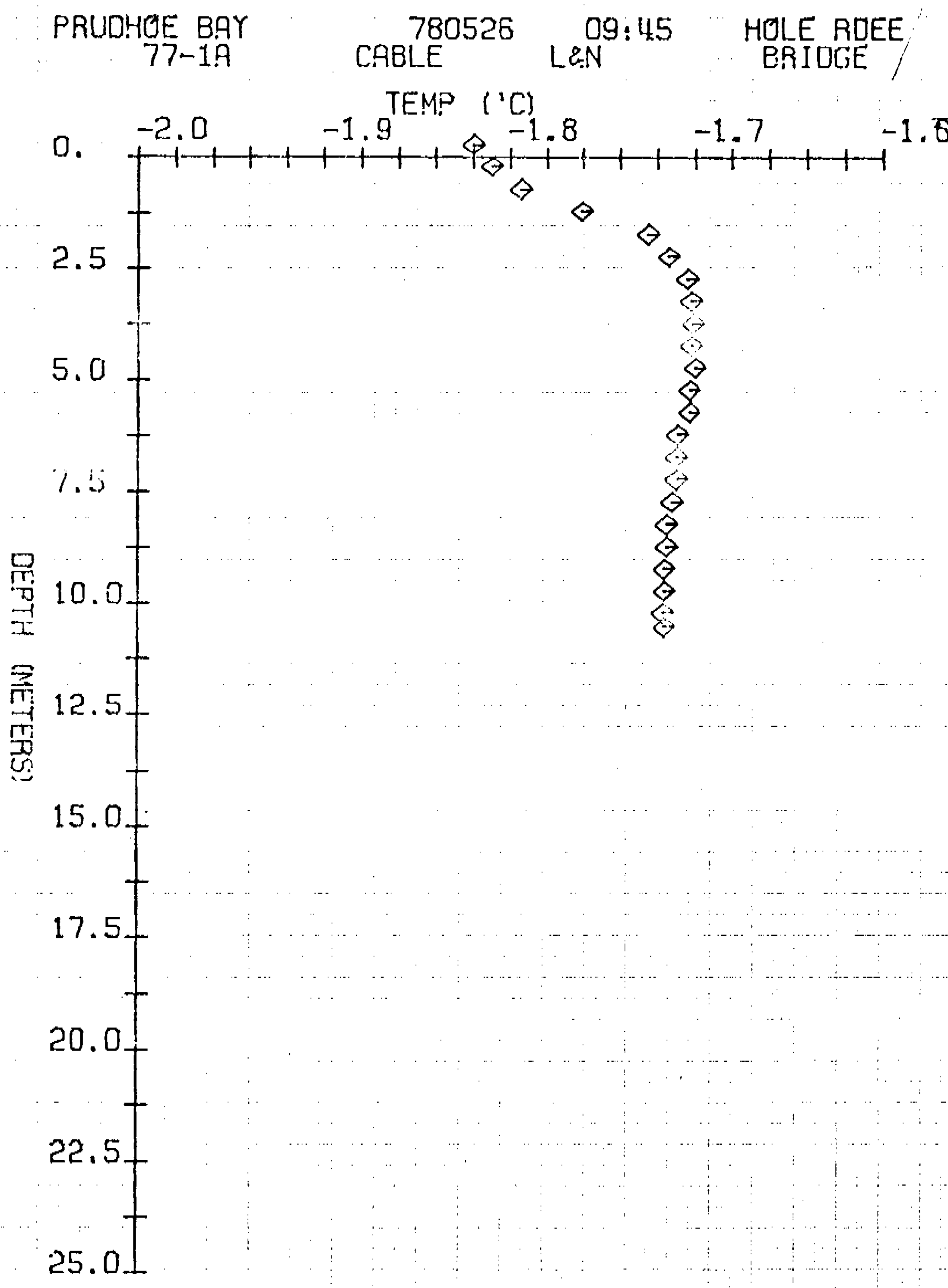

PRUDHOE BAY 780526 14:20 HOLE 9.5
77-1A CABLE L&N BRIDGE
TEMP ('C)
-1.9
-1.8
-1.7
-1.5
-1.4
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

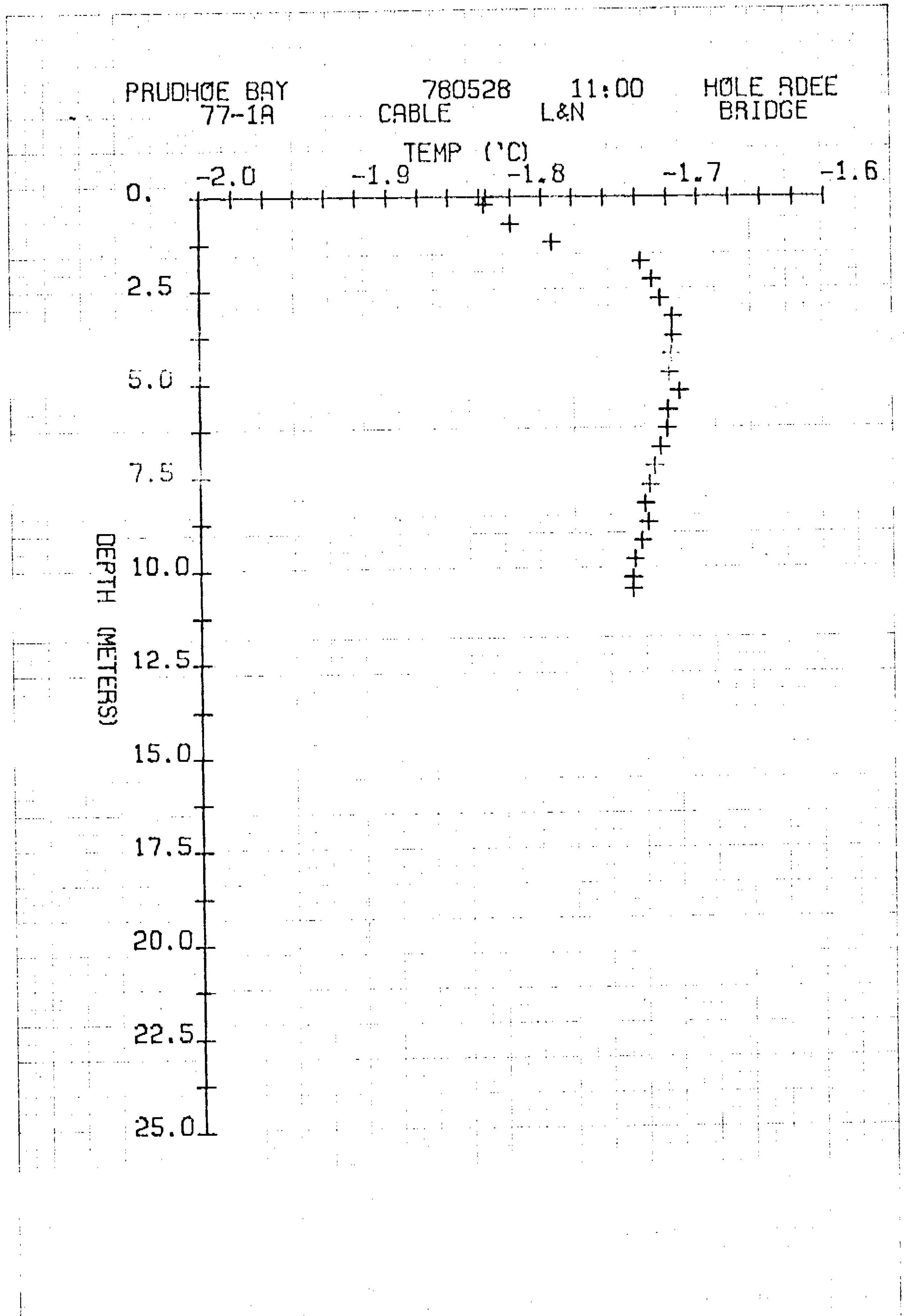

PRUDHOE BAY
780529
10:10
HOLE 9.5
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.8
-1.7
-1.5
-1.4
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)

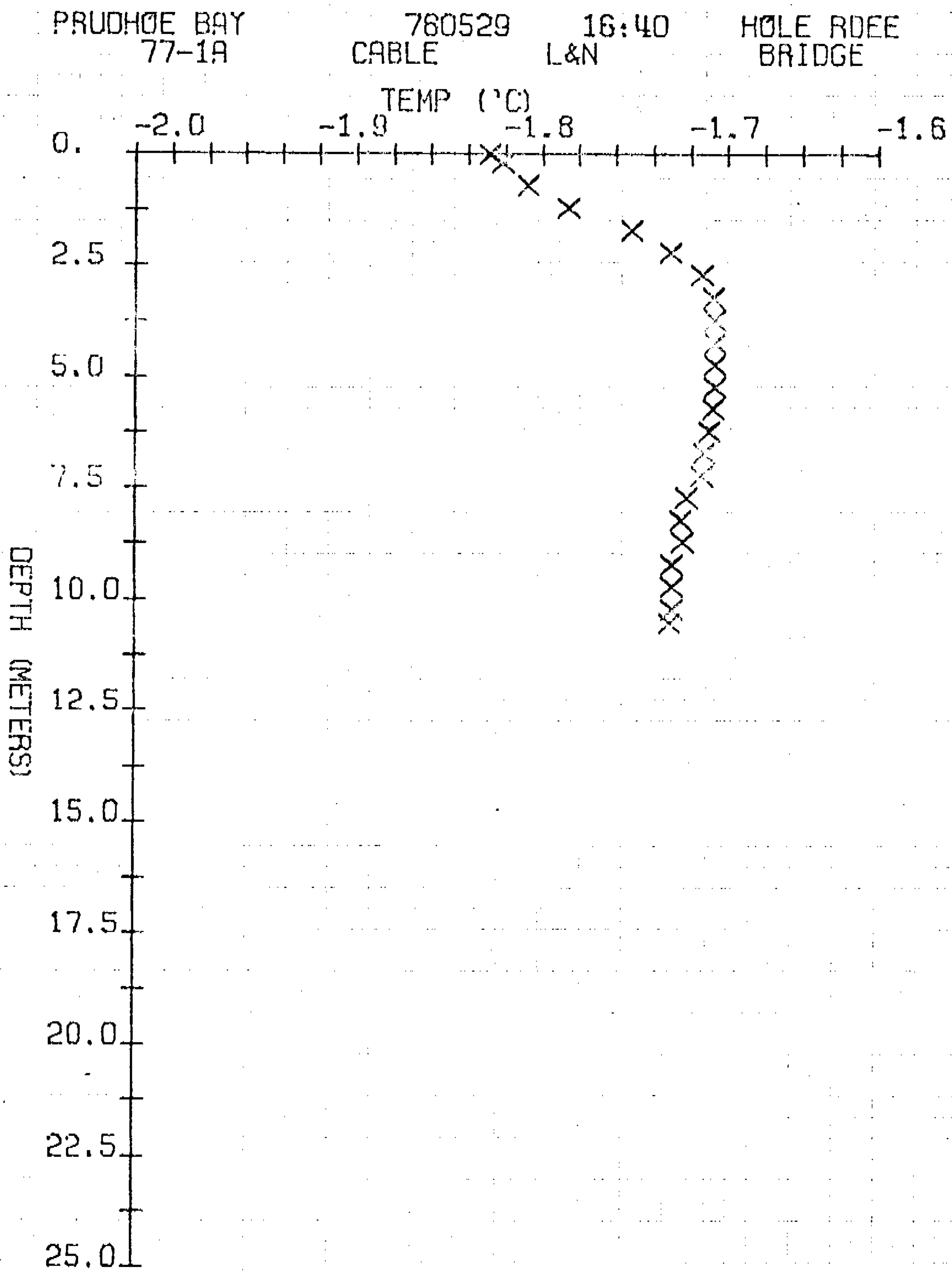


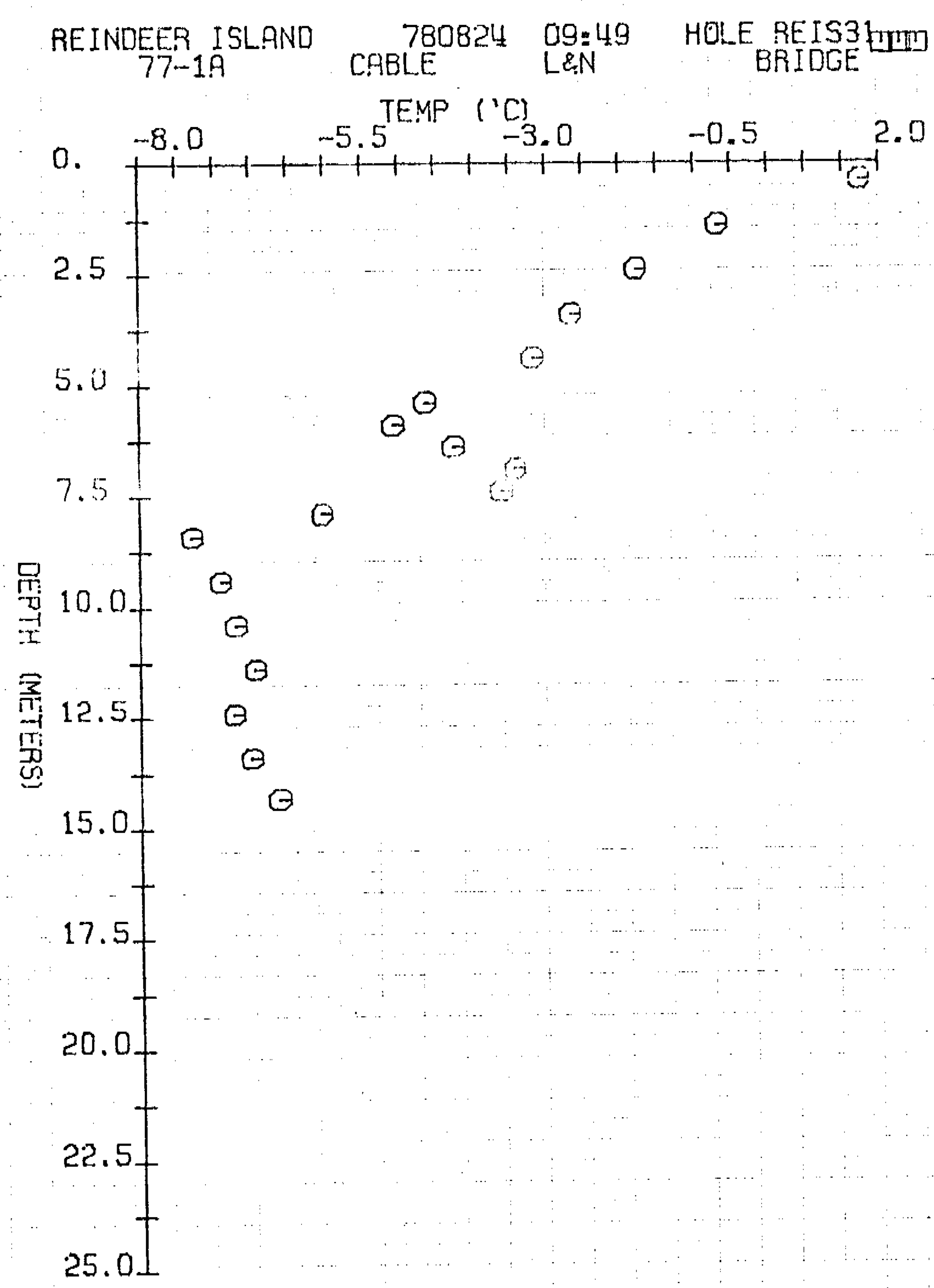
PRUDHOE BAY
780530
10:00
HOLE 9.5
77-1A
CABLE
L&N
BRIDGE
TEMP ('C)
-1.9
-1.8
-1.7
-1.5
-1.4
0.
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
DEPTH (METERS)


PRUDHOE BAY 780422 14:36 HOLE RDEE
BRONX 136 CABLE L&N BRIDGE
TEMP (°C)
-2.0
-1.9
-1.8
-1.7
-1.6
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

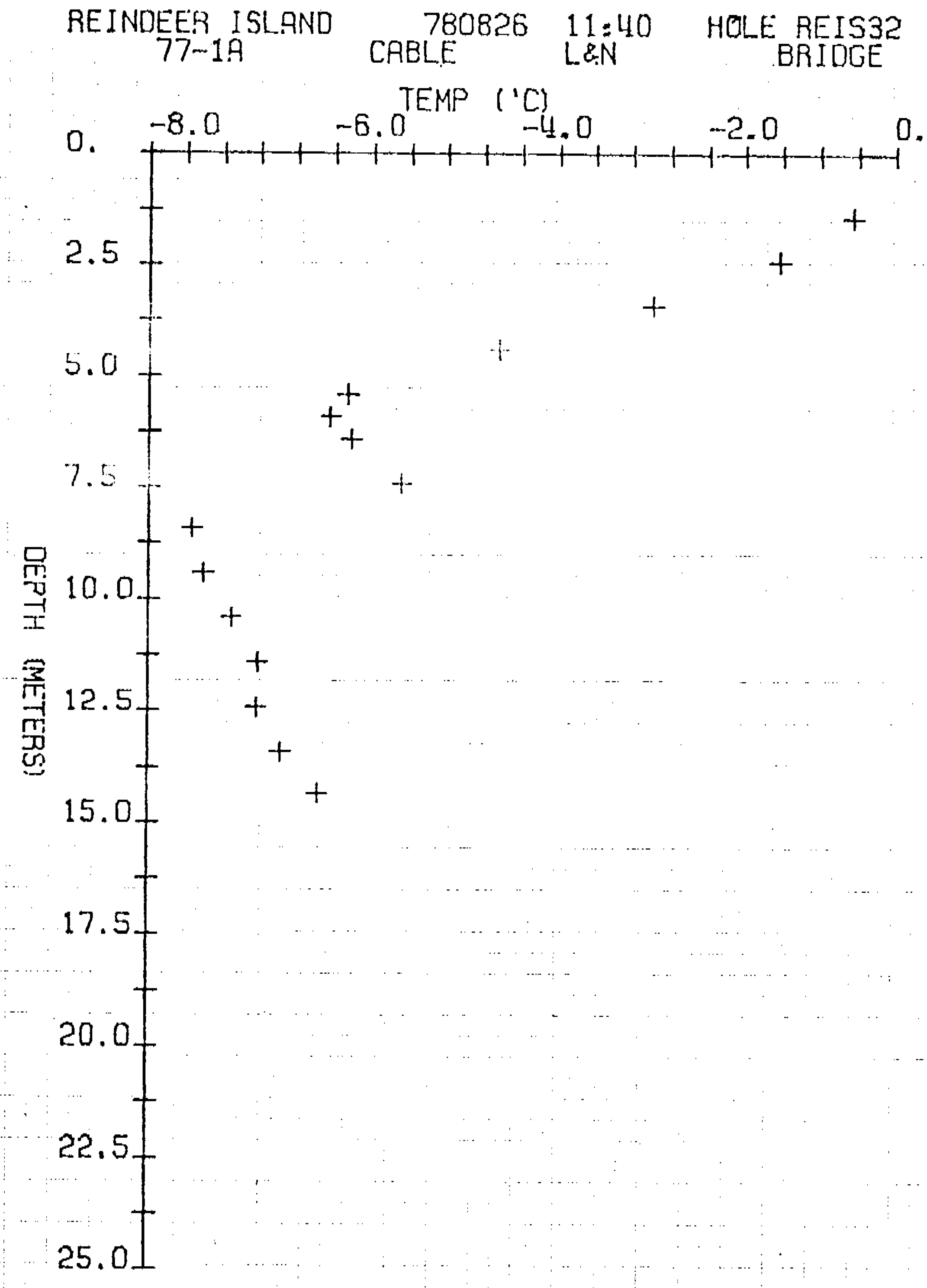

PRUDHOE BAY
77-1A
780526
CABLE
09:45
L&N
HOLE ADEE
BRIDGE
TEMP ('C)
-2.0
-1.9
-1.8
-1.7
-1.6
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

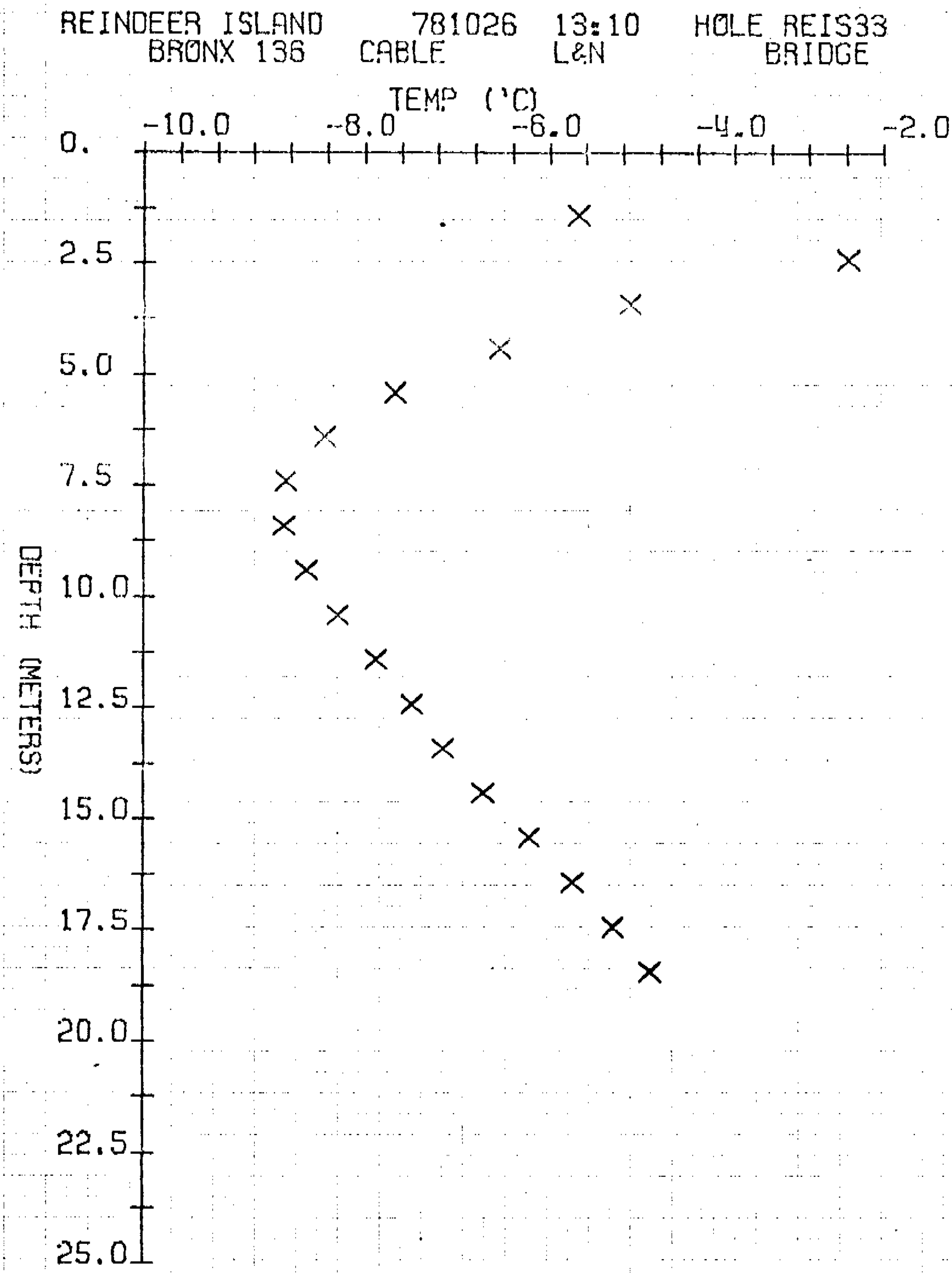

PRUDHOE BAY
77-1A
780528
CABLE
11:00
L&N
HOLE ADEE
BRIDGE
TEMP ('C)
-2.0
-1.9
-1.8
-1.7
-1.6
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

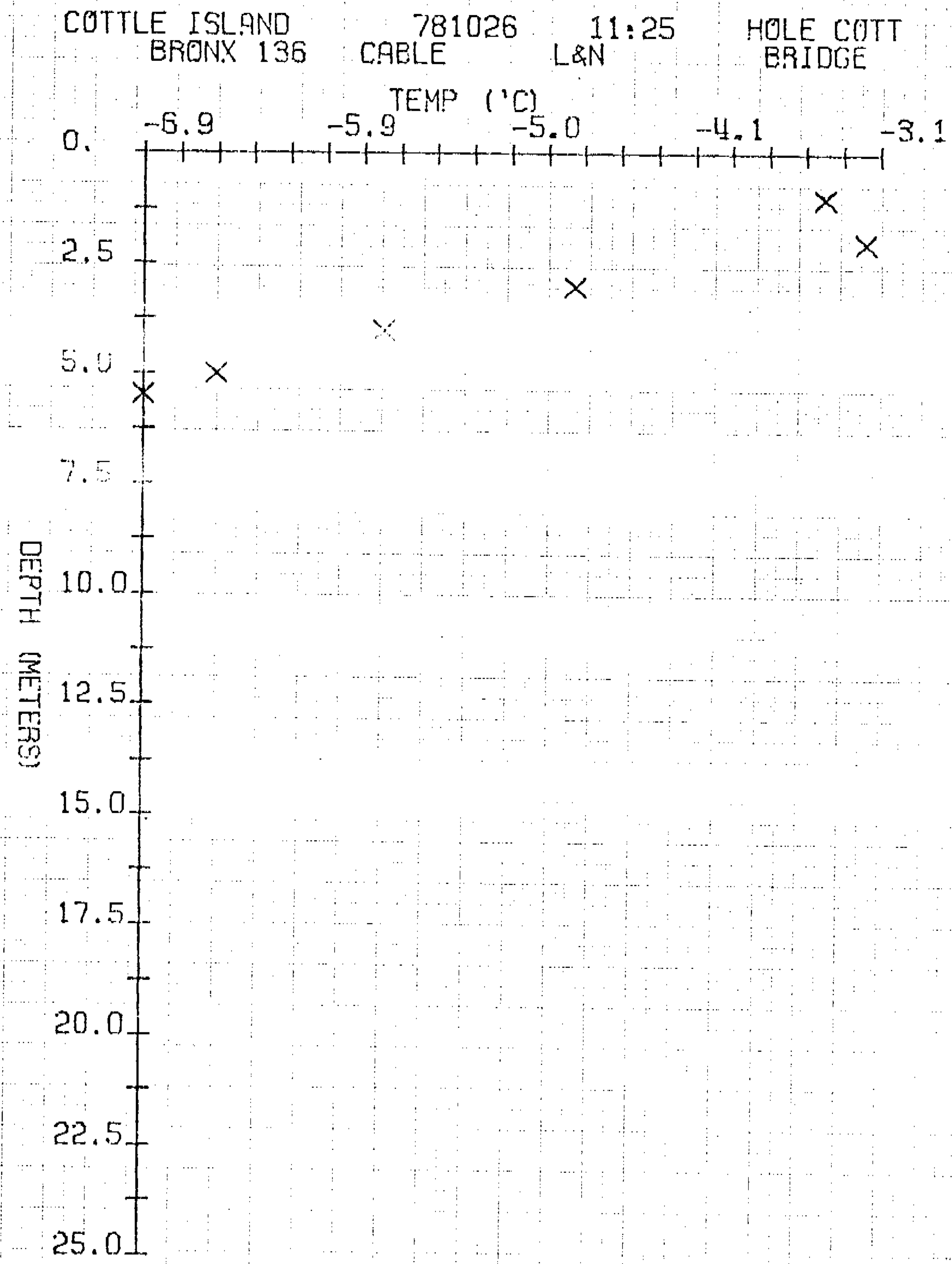

PRUDHOE BAY
77-1A
760529
16:40
HOLE RDEE
CABLE
L&N
BRIDGE
TEMP (°C)
-2.0
-1.9
-1.8
-1.7
-1.6
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

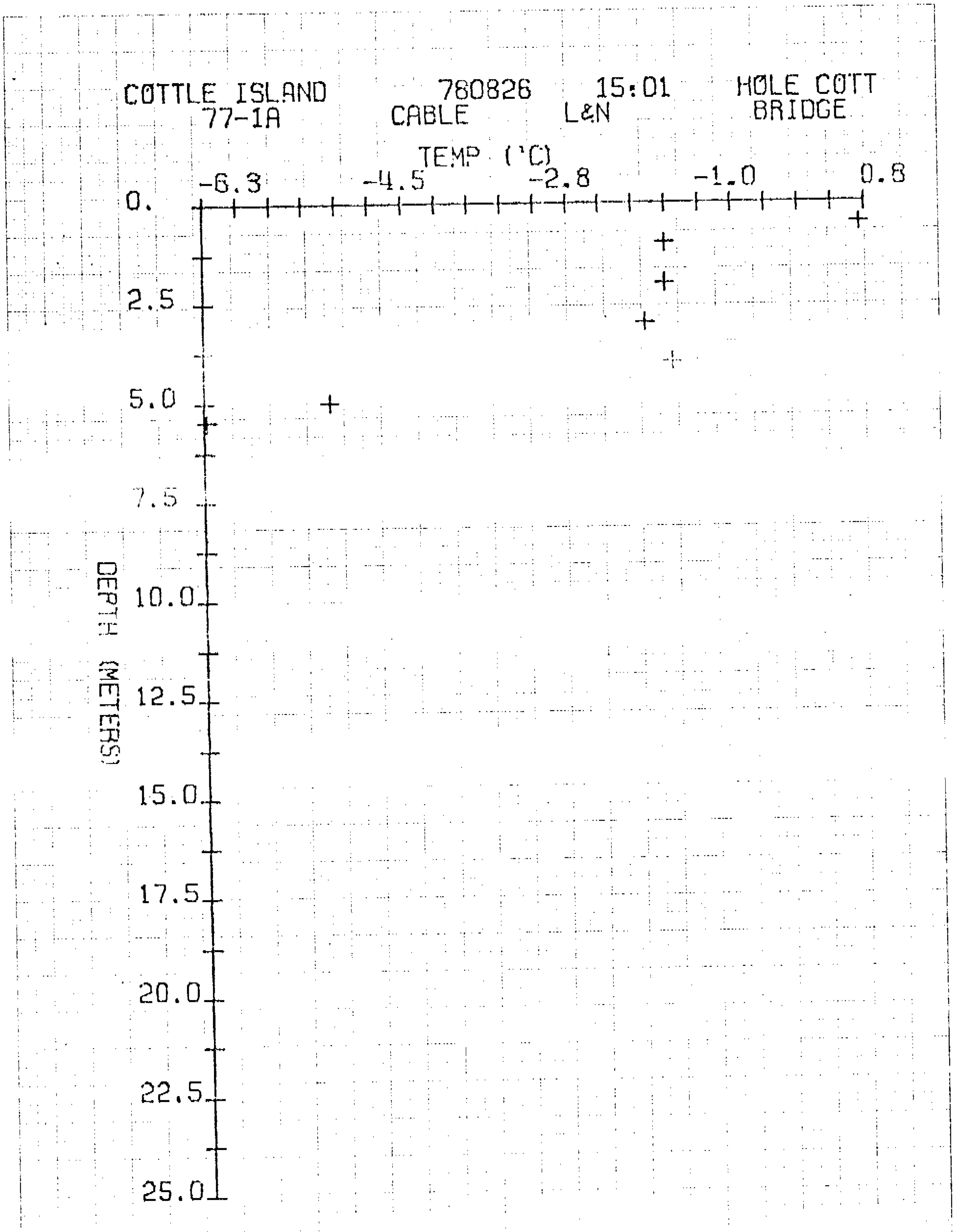


REINDEER ISLAND 780824 09:49 HOLE REIS31
77-1A CABLE L&N BRIDGE
TEMP ('C)
-8.0 -5.5 -3.0 -0.5 2.0
DEPTH (METERS)
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0


REINDEER ISLAND 780826 11:40 HOLE REIS32
77-1A CABLE L&N BRIDGE
TEMP ('C)
-8.0 -6.0 -4.0 -2.0 0.
0. 2.5 5.0 7.5 10.0 12.5 15.0 17.5 20.0 22.5 25.0
DEPTH (METERS)


REINDEER ISLAND 781026 13:10 HOLE REIS33
BRONX 136 CABLE L&N BRIDGE
TEMP ('C)
-10.0
-8.0
-6.0
-4.0
-2.0
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)


COTTLE ISLAND 781026 11:25 HOLE COTT
BRONX 136 CABLE L&N BRIDGE
TEMP ('C)
-6.9
-5.9
-5.0
-4.1
-3.1
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)



COTTLE ISLAND 77-1A
780826
CABLE
15:01
L&N
HOLE COTT BRIDGE
TEMP (°C)
-6.3
-4.5
-2.8
-1.0
0.8
0.
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
22.5
25.0
DEPTH (METERS)

APPENDIX II.

Barrier Island Drilling

The holes on the Barrier Islands were drilled by jetting water, supplied by a small portable pump, through 3/4" steel water pipe. As the jet of water removes the material by washing it up on the outside of the pipe, the pipe penetrates the ground and more pipe sections are added at the surface. Sometimes it is found advantageous to rotate the pipe string as well, which is accomplished by hand or with a motorized drive head. When the string is rotated, a bit open to water flow is used on the bottom. Sometimes a check valve is run just above the bit. When the penetration rates are low it is sometimes found to be advantageous to apply a downward force of several hundred pounds on the string (weight of one or two people).

Information about the lithology and state of ice bondedness is obtained by observing

1. materials washed to the surface
2. penetration rate
3. the "feel" of the drill string.

The experience of the driller is extremely important. Drilling in known material has been an important factor in building up our experience. For example, the materials washed to the surface can be misleading, because they can be washed off the sides of the hole somewhere along its length. Gravels have grain sizes too large to be washed to the surface at all. Gravel can be identified by feeling the large grains when raising and lowering the string off the bottom, by the roughness of the drilling, and by the fact that they are very difficult to drill with this technique. Compact clays feel like hard rubber when the string is dropped onto the bottom of the hole; bonded materials feel more like concrete and usually drill very slowly when, as usual, cold water is supplied by the jet. Unbonded silt and silty sands usually drill very rapidly.

The experience in drilling holes 1,2,3 and 4 on Reindeer Island in August 1978 illustrates some of the problems. Hole 1 was abandoned due to caving of the loose surface active layer during a long shut-down for equipment repairs. Hole 2 was abandoned when the return water flow started coming up in hole 1 5 m away. Hole 3 reached 27.7 m with great ease but froze up at 17.1 m; the pipe is now open to 18.4 m and can probably be reopened below this depth. At hole 4, only 50 m distance from hole 3, the drilling was completely different due to ice bonding, and it was only possible to drill to 16 m in the time available.

QUARTERLY REPORT

Contract #03-5-022-55
Research Unit #271
Report Period: 15th Quarter
Ending Dec. 31
Number of Pages: 6

BEAUFORT SEACOAST PERMAFROST STUDIES

James C. Rogers
John L. Morack
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

January 1, 1979

I. Task Objectives: The objectives of this study are to develop an understanding of the nature and distribution of offshore permafrost along the Alaska Beaufort Seacoast. Also of interest is the distribution of permafrost beneath the barrier islands. Emphasis is placed upon seismic methods but close cooperation with others using thermal, chemical and geological methods is an important part of the work.

II. Field Work: No field work was conducted this period.

III. Results: Data analysis is continuing, approximately 80% of the records obtained during the last field season have been scaled. Data plotting and analysis is continuing and will be completed in the following quarter and included in the Annual Report. Over 250 marine refraction records were taken during the field season. This represents the largest amount of data yet taken in a field season and has provided broader coverage than before.

IV. Preliminary Interpretation of Results: In an attempt to meet the deadline for the draft environmental impact statement we have compiled all of our refraction lines on a single chart which is shown as Figure I. The shaded areas on the chart have been sketched to indicate areas of observed shallow submarine permafrost (40 meters or less beneath the water surface). Areas where refraction lines have consistently shown high velocity refraction (velocities greater

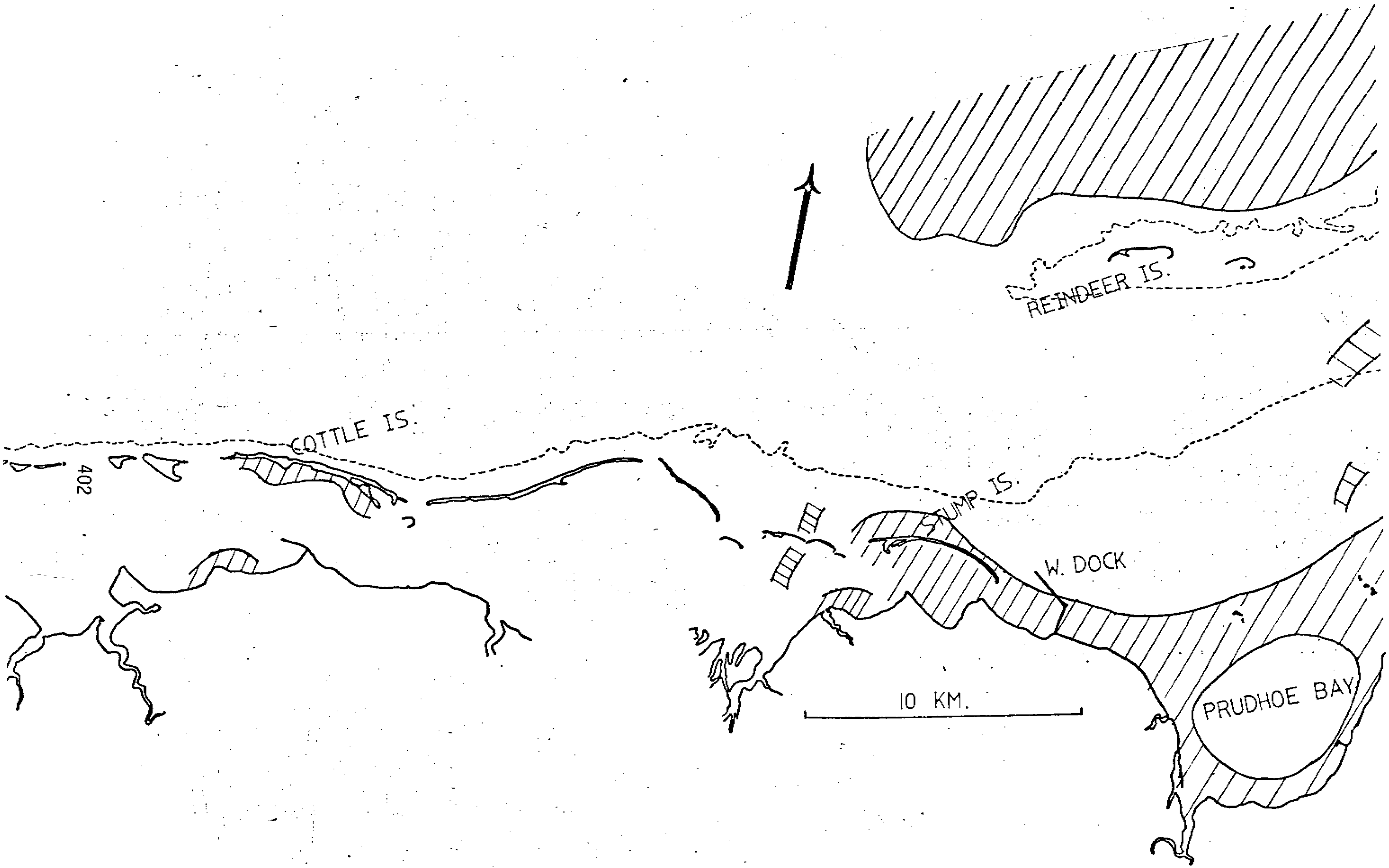


Figure 1, a Bonded Permafrost Within 40 m of Ocean Surface (hatched areas)

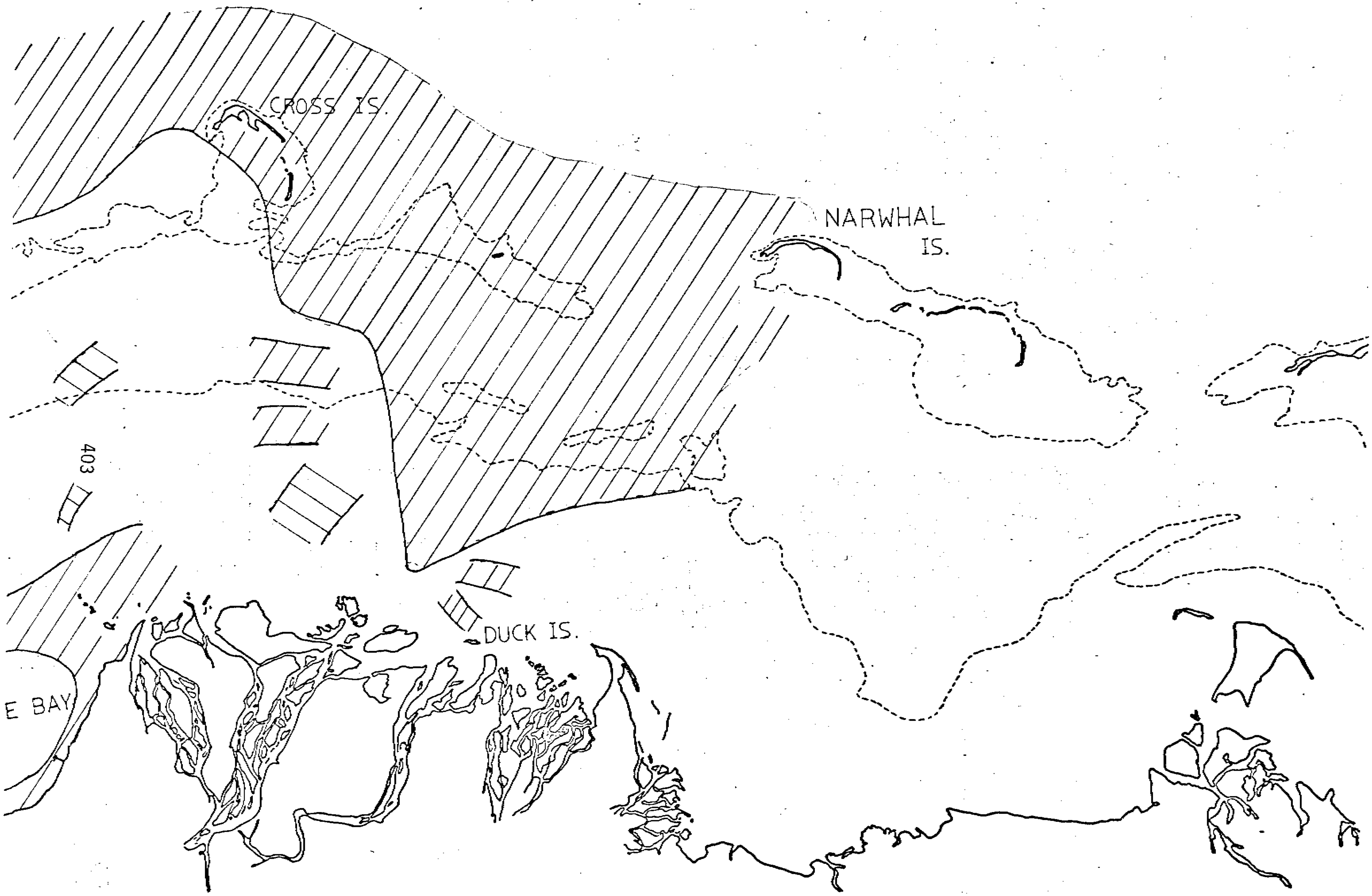


Figure 1, b   Bonded Permafrost Within 40 m of Ocean Surface (hatched areas) than 2500 m/s) have been connected together to indicate probable regions of continuous bonded permafrost at depths less than 40 meters. The area north of Reindeer Island is an example of such a region. Where refraction lines have only sporadically shown bonded materials, local shading has been used to indicate the sporadic nature of the observation. The two shaded patches just north of Duck Island are an example of this interpretation.

No correlation has yet been made with geological information. Therefore the importance of such features as the over-consolidated clays have not been interpreted.

Regions where bonded materials occur at depths greater than 40 meters have not been included because we have little information at these depths. (The present refraction system is depth limited due to energy limitations.) However, deeper permafrost is known to occur in the area between the West Dock and Reindeer Island. Reflection events on our records have indicated bonded materials to depths over 140 meters. Figure 2, a vertical section of a line from the West Dock (new ARCO dock) through Reindeer Island indicates a permafrost boundary observed with refraction and reflection techniques. Drilling information which is included on the figure corresponds quite well with the goephysical observations.

In an attempt to summarize conclusions to date, we list below a series of conclusions from past reports with appropriate modifications

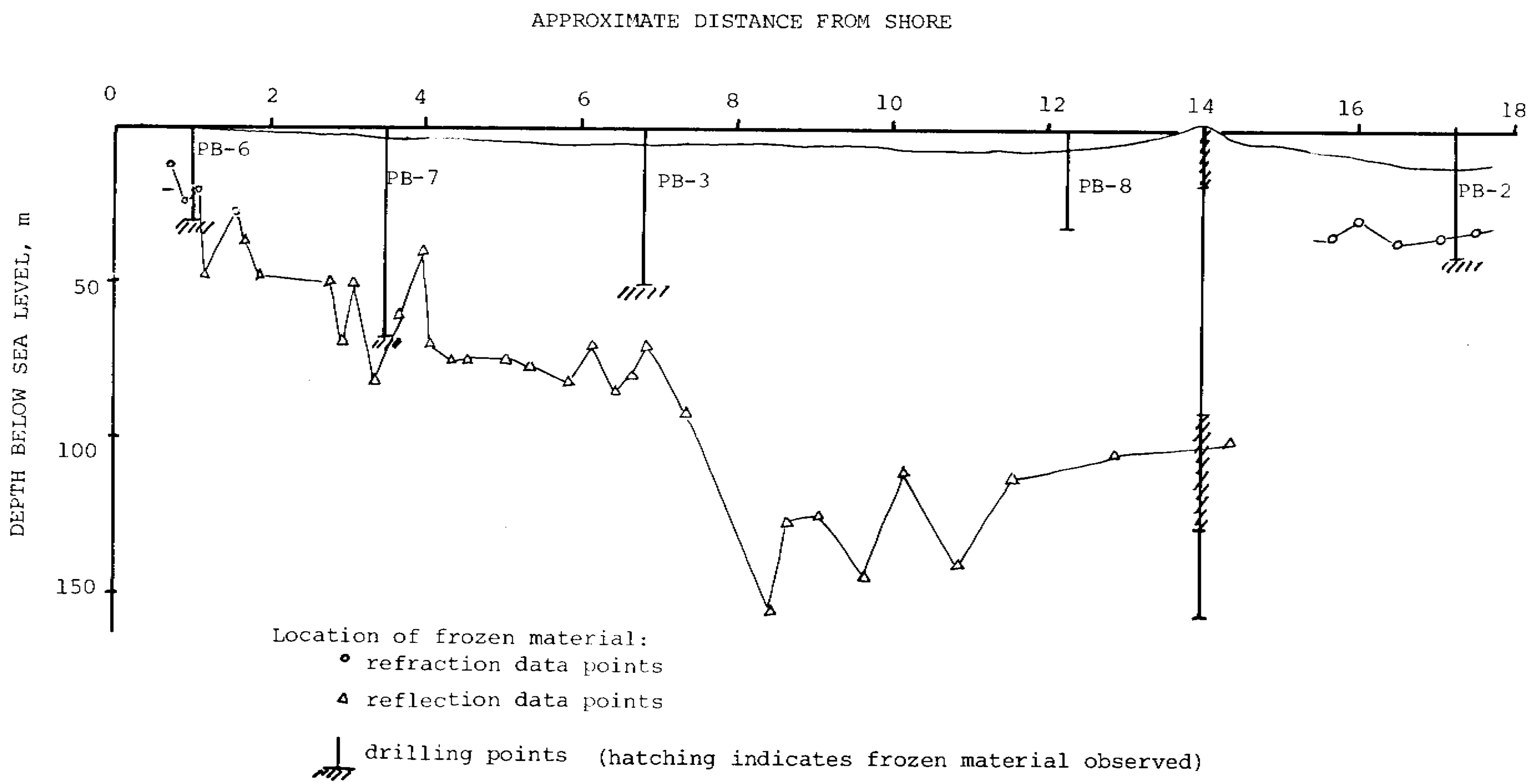


Figure 2 - Vertical section from new ARCO dock through Reindeer Island.

resulting from more recent data. It must be remembered that the rather limited geographical coverage to date means that the conclusions are perhaps regionally limited. However, the conclusions are certainly appropriate to the very important offshore area adjacent to the Prudhoe Bay oil fields.

A. In past reports we suggested that one possible way to deal with shallow permafrost near shore is to extend a causeway from shore to regions offshore where the ice-bonded permafrost is sufficiently deep so that any thaw bulb from a hot oil pipeline would not affect the permafrost. Figure 2 is a good example of a case where such a plan might be used. A 2 km long causeway extending from the shore would enable regions with shallow permafrost (less than 30 m below the ocean bottom) to be avoided. However, with more recent data as presented at the extreme right of the Figure shallow ice-bonded materials could again present design problems at distances of 15 km or so from shore. At least two occurences of relative shallow submarine permafrost (7 m and 8 m beneath the ocean bottom in water depths of 10 m and 6 m respectively) have been observed at distances up to 18 km from shore. Thus, the surface of the bonded materials is seen to be highly irregular. The surface of bonded permafrost may often dip downward offshore but this is not always the case and care must be used in applying specific design solutions regionally.

B. Seismic reconnaissance on three barrier islands indicates that they are not all completely underlain by bonded permafrost, but that some may be free of ice-bonded permafrost. Certainly this conclusion is dependent upon the history of the island; whether it is a fragment of a former shoreline or whether it is a constructional feature. Also, the width of an island, its migration rate and soil types are important. We have observed continuous bonded materials beneath Stump Island along its entire length. In contrast, no high velocity refractors have been observed on Reindeer Island. Jet drilling on the island indicates a highly variable material beneath this island some frozen and some not frozen (conversation with Will Harrison). We have observed high velocity refraction on portions of Cross Island. Thus, the islands seem to be highly variable with regard to their permafrost conditions.

C. Prudhoe Bay appears to be an old thaw lake (see the 1978, 1977 annual reports) and therefore presents a large dip or possibly a window in the surrounding bonded permafrost surface. This is site specific information, but it seems unlikely that there are other old thaw lakes offshore along the Beaufort Seacoast. Knowledge of such sites could provide permafrost free locations for bottom founded structures or, if such locations are not desirable for a particular application, old thaw lakes could be avoided. Whatever their use, knowledge of their existence can be expected to affect offshore construction activities. (Additional lines taken in the last field season have confirmed that the northern part of the bay does contain submarine permafrost as indicated by the shading on Figure I.)

D. Several island sites have been studied where seismic velocity data and drilling data seem not to agree; drilling evidence indicated frozen material, but refraction velocities were not high. Our conclusion is that ice-bearing materials should be distinguished from ice-bonded materials. Brine inclusions depress the freezing point of a material and tend to spread the freezing point from a discrete temperature to a range of temperatures corresponding to various stages of freezing. Thus a material may have ice inclusions but may not be ice-bonded and hence present a relatively low velocity compared to the totally bonded material. The distinctions between ice bearing and ice-bonded is important from the standpoint of material properties. For example, an ice-bonded material may have a high resistance to shear stress, but the same material when not ice bonded may have little shear resistance. An important parameter affecting offshore permafrost is temperature; in contrast to permafrost on land it is relatively warm and consequently more thermally fragile. This fact coupled with the presence of salt water accounts for some of its local variability

V. Problems Encountered/Recommended Changes: None this quarter.

VI. Estimate of Funds Spent to Date: $185,000.

QUARTERLY REPORT

Contract: #03-5-022-56
Research Unit: #290
Task Order: #3
Reporting Period: 10/1/78-12/31/78
Number of pages: 4

SEDIMENT SIZE ANALYSIS

Dr. Charles Hoskin
Dr. David Burrell

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

December 1978

I. TASK OBJECTIVES

There have been two principle objectives in this program. The work on benthos-sedimentary substrate interactions has been largely completed and was reported on in the Annual Report. The final objective is concerned with physical parameters and mineral composition of surface sediments from the southeastern Bering Sea continental shelf. These are being examined in order to determine the environmental processes operating in this region. This investigation will define the character, trends, and variations of the surface sediments; suggest source areas by, for example, comparing the geology of the catchment, areas of drainage systems and the various mineral assemblages of the sediments in the study area; distinguish between modern, palimpsest, and relict sediments by means of sediment texture and mineralogy; and, by interpretation, will delineate the influences of environmental forces on the sediment distribution.

II. FIELD AND LABORATORY ACTIVITIES

A. Field Work

None for this R.U. this quarter

B. Scientific Parties

N/A

C. Field Collection Methods

N/A

D. Sample Localities

N/A

E. Laboratory and Analysis Program

1. Grain size analysis of sediments has been done in the laboratory following the procedures of Hoskin (1976). Statistical parameters have been generated from the size analyses using a University of Washington computer program.

2. Thin sections have been made from each sand fraction following impregnation with artificial resin.

3. Heavy mineral separation by gravity settling in a brominated hydrocarbon liquid has been accomplished.

4. X-ray diffraction of the heavy mineral assemblage of each sample has been completed.

5. LANDSAT imagery has been studied in order to trace sediment source and movement.

6. By correlating the results of these sedimentological studies with data obtained from physical oceanographic reports, principal water masses and circulation patters that influence mineral transport will be determined.

III. RESULTS

Petrographic Analysis

Since the writing of the last report, a quantitative mineralogical identification analysis of the thin sections made from the sand fraction of each sample has been in progress. Using the petrographic microscope, the identities and textures of minerals and lithic grains are being determined and quantitative measurements of the mineral and grain content are being made with the objective of comparing percentages of the various species throughout the study area.

IV. PRELIMINARY INTERPRETATION

No discussion of the results is included in this quarterly report. These data will be summarized and discussed in a M.S. thesis.

V. PROBLEMS ENCOUNTERED

No major problems were encountered this quarter.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 3 R.U. NUMBER: 291

PRINCIPAL INVESTIGATOR: Dr. C. M. Hoskin/D. C. Burrell

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]		
	From	To	Batch 1		
Discoverer Leg I #808	5/15/75	5/30/75	Submitted		
Discoverer Leg II #808	6/2/75	6/19/75	Submitted		
Miller Freeman	8/16/75	10/20/75	Submitted		
FY '77 Data	---	---	Submitted		

All data for this task order have been submitted.

Note: [1] Data Management Plan has been approved by M. Pelto; we await approval by the Contract Officer.

Fiscal Report

Contract: 03-5-022-56

Task Order: #3

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$1,045.80	$43,882.31
Travel	---	629.26
Equipment	---	1,170.40
Other	324.50	2,892.54
Staff Benefits	---	5,941.18
Overhead	522.90	23,504.31
Total Billed	$1,893.20	$78,020.00
Total Award		$78,020.00
Total Unbilled		-0-

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

1st Quarterly Report

October - December, 1978

OCSEAP RU# 327

Shallow faulting, bottom instability, and movement of sediments in lower Cook Inlet and western Gulf of Alaska.

Monty A. Hampton
Arnold H. Bouma
U.S. Geological Survey
Menlo Park, California

December 31, 1978

I. Task Objectives

Assessment of the environmental geologic hazards of lower Cook Inlet and the western Gulf of Alaska; in particular the identification and mapping of active surface faults, characterization of gas-charged sediments, and movement of sand via a variety of bedforms.

II. Field or laboratory Activities

During the past quarter we have concentrated on producing an isopach map of the area of Kodiak (see Appendix I), and replotting of tracklines and stations (1976-1978) in lower Cook Inlet. All our TV tapes-underwater photographs have been described and are now ready for use. Maps are in preparation showing trackline coverage for 1) Sparker data, 2) uniboom and 3.5 kHz, and 3) side scan. Simulataneously we study the records and plot the subbottom features. Once completed we will make new interpretive maps. Grain size distributions are being made from Kodiak shelf samples. Soon the same will be done for Cook Inlet, although smear slide examinations will be used primarily to characterize sand/silt/clay ratios. This data will be used for classification, following Shepard's triangular diagram, from which a sediment distribution map will be produced.

As far as lower Cook Inlet is concerned we are also doing detailed studies in bedforms at locations where several tracklines cross. Detailed bathymetry will be constructed to serve as a base for plotting of bedform crests, photographs, current profiles, etc.

III. Results

All work is in progress. Only the isopach map off Kodiak was completed (see Appendix I).

IV. Preliminary Interpretation of Results

See Appendix I.

V. Problems Encountered/Recommended Changes

None.

VI. Estimate of Funds Expended

Only USGS funds expended; no BLM/NOAA funds received.

UNITED STATES

DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

GENERALIZED THICKNESS MAP OF UNCONSOLIDATED SURFICIAL SEDIMENTARY UNITS, KODIAK SHELF, WESTERN GULF OF ALASKA

by

Monty A. Hampton and Arnold H. Bouma

Open-File Report

78-729

This report is preliminary and has not been edited or reviewed for conformity with Geological Survey standards and nomenclature.

Menlo Park, California

November, 1978

GENERALIZED THICKNESS MAP OF UNCONSOLIDATED SURFICIAL SEDIMENTARY UNITS, KODIAK SHELF, WESTERN GULF OF ALASKA

A generalized thickness map of unconsolidated surficial sediments on the Kodiak shelf, western Gulf of Alaska, has been constructed using high-resolution seismic reflection records (Uniboom and 90-160 kilojoule sparker), supplemented by data from bottom sediment samples. The seismic reflection records were gathered in June-July 1976 aboard the R/V SEA SOUNDER and R/V S.P. LEE. Trackline coverage is shown in Plate 1. Microfilms of the R/V SEA SOUNDER seismic reflection records are available in U.S. Geological Open-File Report 76-848 (Hampton and Bouma, 1976). The locations of sampling stations are shown in Plate 2. See Bouma and Hampton (1976, 1978) for textural descriptions of the sediments. Thickness measurements made at 15-minute intervals along the R/V SEA SOUNDER records are shown in Plate 3, and those from the R/V S.P. LEE records are shown in Plate 4. The generalized thickness map is in Plate 5.

The map is of a generalized nature because of two factors. First, the wide spacing of tracklines necessitates omission of many small basins or highs that could be detected on single lines but not correlated between lines. Second, limitations were imposed by the seismic records, due to the shallow water and generally hard seafloor of the Kodiak shelf. Sub-bottom penetration and clarity of acoustic reflectors was poor in some profiles, and seafloor multiples were so closely spaced in many sparker records as to make measurements uncertain or impossible.

Seismic reflection signatures vary across the shelf according to sediment type. Unconsolidated sediments on Albatross and Portlock Banks are sand, typcically containing coarser material but nearly devoid of fines. Shell debris and volcanic ash are common consituents of these sediments. Depths of acoustic penetration are commonly low where these sediments occur. Sub-bottom reflectors show moderate to poor stratification, and in some cases the entire section above bedrock (see below) is unstratified. These coarse sediments from wedges with internal layers that dip toward the axes, adjacent to the major troughs that traverse the shelf.

Sediment samples from the floors of Kiliuda, Chiniak, and Amatuli Troughs consist almost entirely of fine-grained volcanic ash. These surficial units on Uniboom records are thin (less than about 20 milliseconds) and well stratified, and in some areas overlie less well stratified material that can be correlated with surficial (unconsolidated) units of the adjacent banks. Clean sands were recovered from the floor of Stevenson Trough, and seismic profiles show moderately to well stratified surficial units.

Semilithified to lithified bedrock crops out at the seafloor over broad areas of the banks and over more restricted areas of the troughs. Dart cores of this material are composed of mudstone, commonly with pebbles and/or sand. These bedrock units tend to show folding and good stratification in seismic reflection records. Where covered with unconsolidated material, a marked structural discordance typically occurs, and it is the depth to this unconformity surface that is given in Plates 3, 4, and 5.

Where the depth to bedrock was clearly evident in the records, the two-way travel time in milliseconds was measured and recorded. Many times it was not possible to pick the unconformity surface however. For example, surficial units could be seen to the limit of penetration in some Uniboom records, but the corresponding sparker records might show indeterminate stratigraphy, due to closely spaced multiples or complex seismic signatures. In these instances, a minimum thickness of the surficial unit, equal to the limit of penetration on the Uniboom profile, was recorded. In other instances, Uniboom records showed no sub-bottom stratigraphy at all, and in the sparker record, bedrock would be clearly shown extending up to the bubble pulse. Therefore, maximum possible thickness, equal to the thickness of the bubble pulse, was recorded. In intermediate cases, where shallow Uniboom penetration showed only the surficial unit and the sparker record showed bedrock extending up to the bottom of the bubble pulse, limiting minimum/maximum thicknesses were measured. Lastly, some sections of trackline had indeterminate seismic stratigraphy for both the sparker and Uniboom records. No depth measurements could be made in these areas.

References listed below include those cited in the text and other related papers containing geo-environmental information about the Kodiak shelf.

Bouma, A.H., and Hampton, M.A., 1976, Preliminary report on the surface and shallow subsurface geology of lower Cook Inlet and Kodiak Shelf, Alaska: U.S. Geol. Survey Open-File Report 76-695, 36 p., 9 maps.

Bouma, A.H., and Hampton, M.A., 1978, High resolution seismic profiles, side scan sonar records, and sampling locations from lower Cook Inlet and Kodiak Shelf, R/V SEA SOUNDER cruise S7-77-WG, September - October, 1977: U.S. Geol. Survey Open-File Report, in press.

Hampton, M.A., and Bouma, A.H., 1976, Seismic profiles of lower Cook Inlet and Kodiak Shelf, R/V SEA SOUNDER, June - July, 1976: U.S. Geol. Survey Open-File Report 76-848, 36 p., 4 maps, 9 rolls microfilm.

Hampton, M.A., and Bouma, A.H., 1977, Seismic reflection records showing stable and unstable slopes near the shelf break, western Gulf of Alaska: U.S. Geol. Survey Open-File Report 77-702, 9 p., 1 roll microfilm.

Hampton, M.A., and Bouma, A.H., 1977, Slope instability near the shelf break, western Gulf of Alaska: Marine Geotechnology, v. 2, p. 309-331.

Hampton, M.A., and Bouma, A.H., 1978, Quaternary sedimentation and environmental geology of the Kodiak shelf, western Gulf of Alaska (abs.): Tenth International Congress on Sedimentology, Jerusalem.

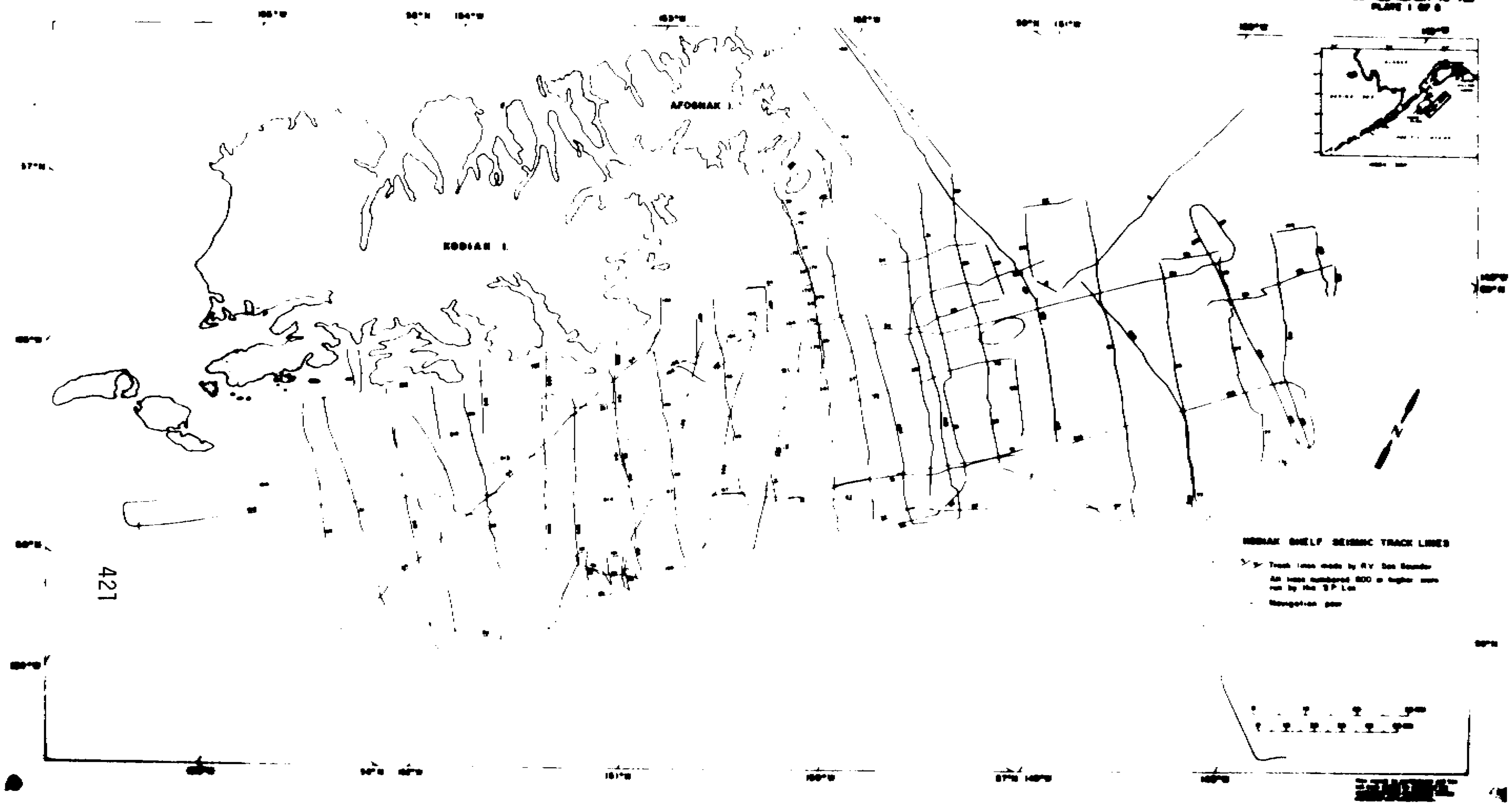
Hampton, M.A., Bouma, A.H., Frost, T.P., and Colburn, I.P., 1978, Volcanic ash in surficial sediments of the Kodiak shelf - An indicator of sediment dispersal patterns: Marine Geology, in press.

Hampton, M.A., Bouma, A.H., Sangrey, D.A., Carlson, P.R., Molnia, B.F., and Clukey, E.C., 1978, Quantitative study of slope instability in the Gulf of Alaska: Proc. Tenth Offshore Technology Conference, paper 3314.

Hein, J.R., Bouma, A.H., and Hampton, M.A., 1977, Distribution of clay minerals in lower Cook Inlet and Kodiak Shelf sediment, Alaska: U.S. Geol. Survey Open-File Report 77-581, 17 p.

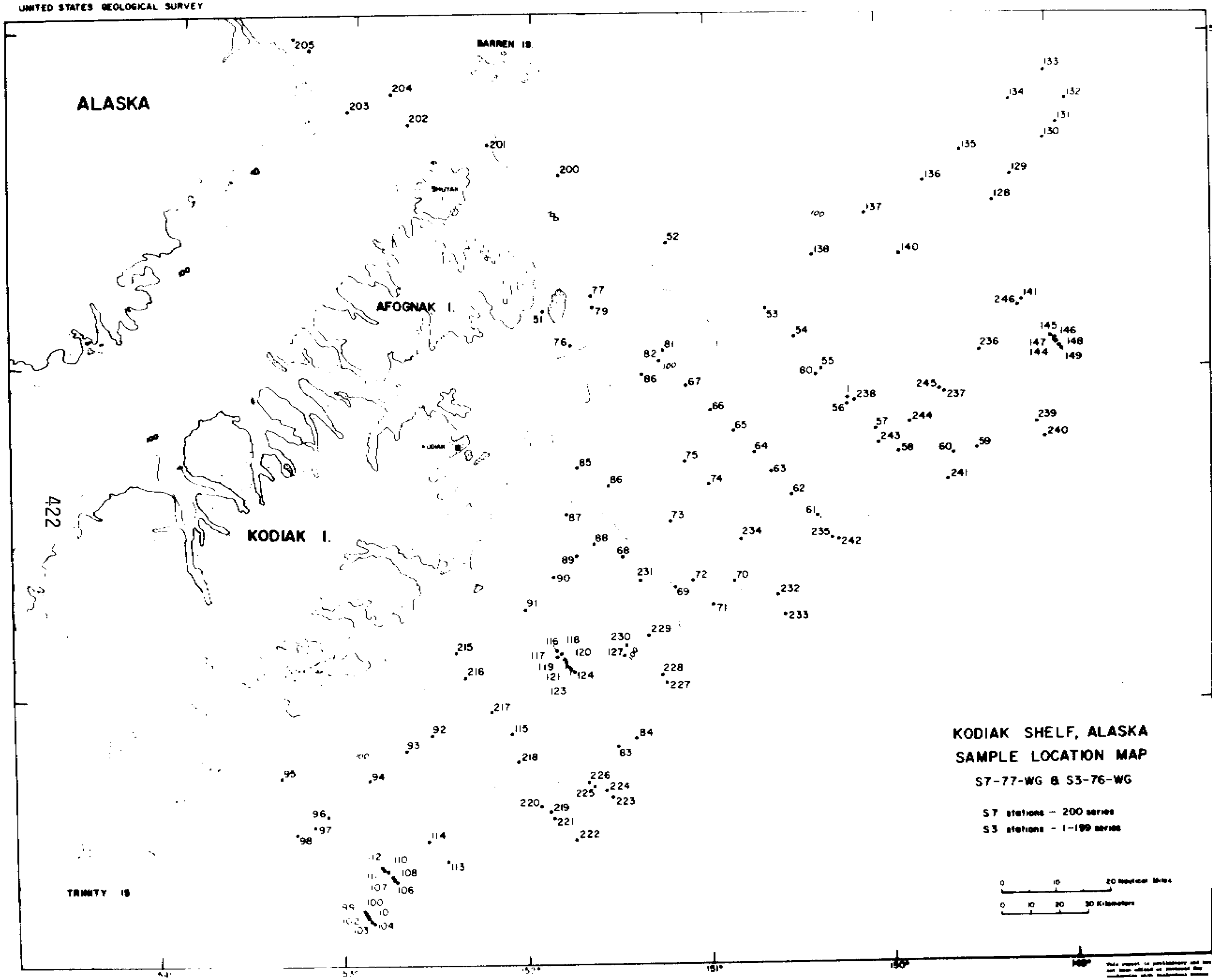
von Huene, R., Bouma, A.H., Moore, G.W., Hampton, M.A., Smith, R.A., Dolton, G.L., 1976, A summary of petroleum potential, environmental geology, and the technology, time frame, and infrastructure for exploration and development of the western Gulf of Alaska: U.S. Geol. Survey Open-File Report 76-325, 92 p.

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY



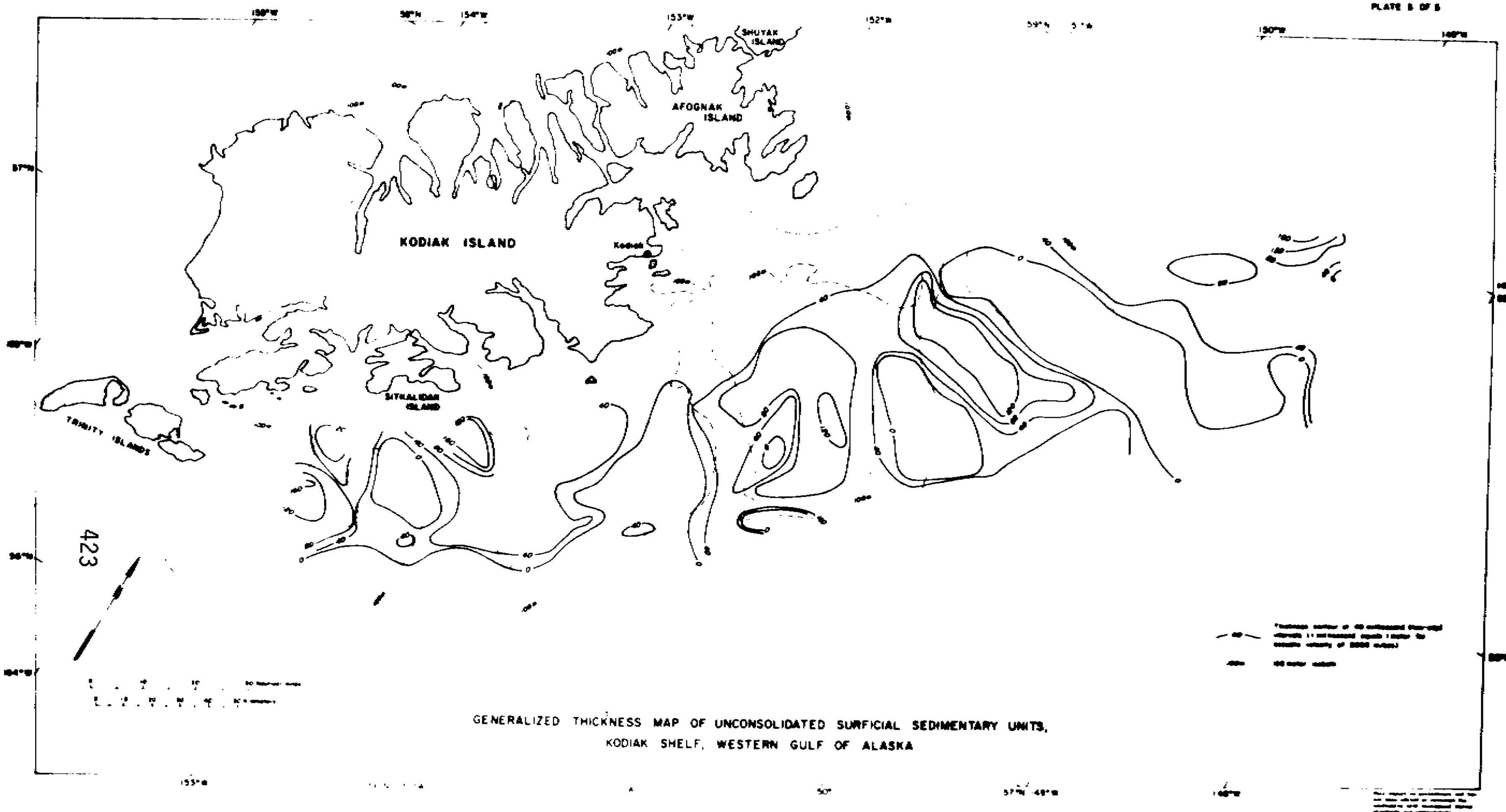
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 78 729
PLATE 2 OF 5

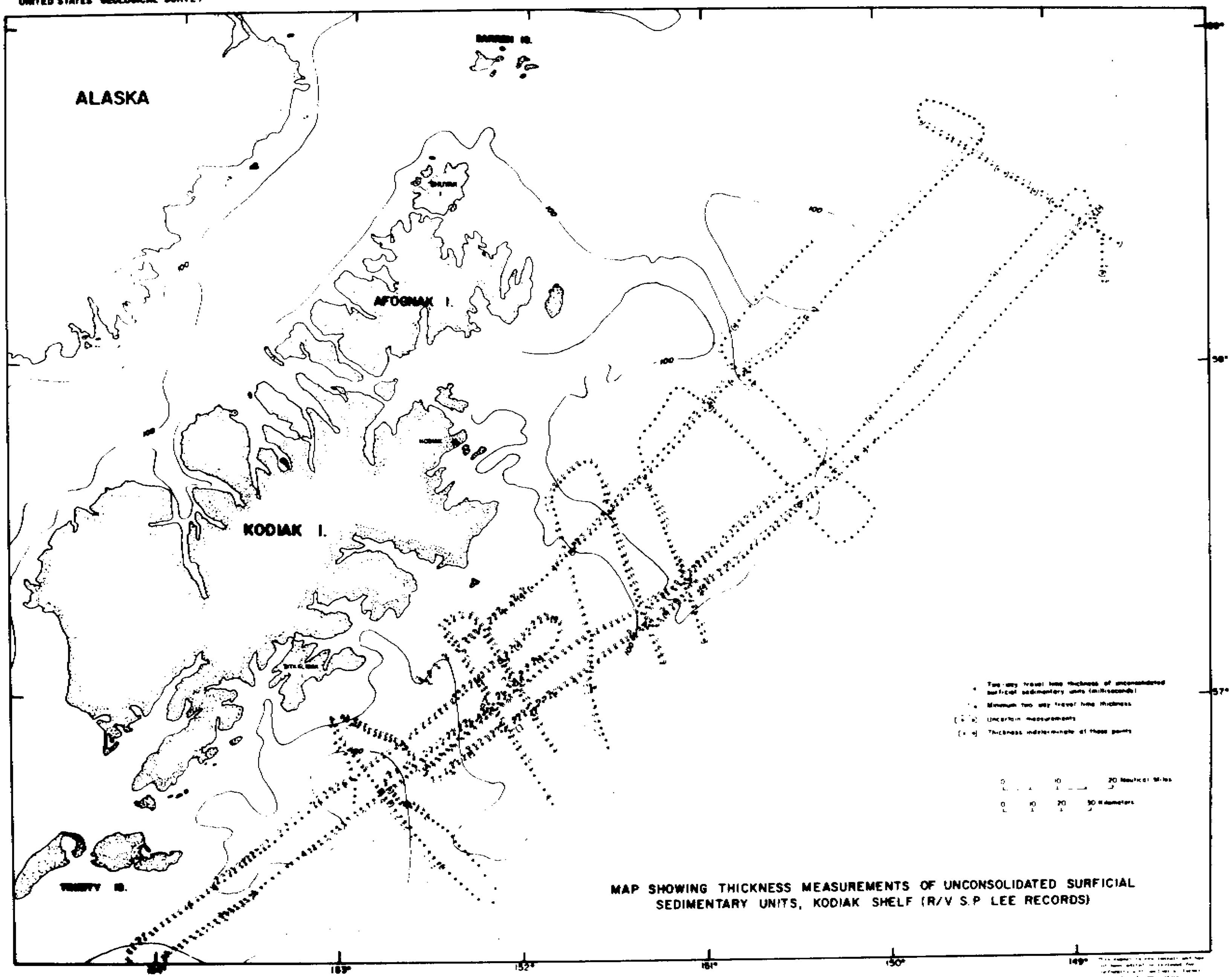


DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 78-729
PLATE 5 OF 5



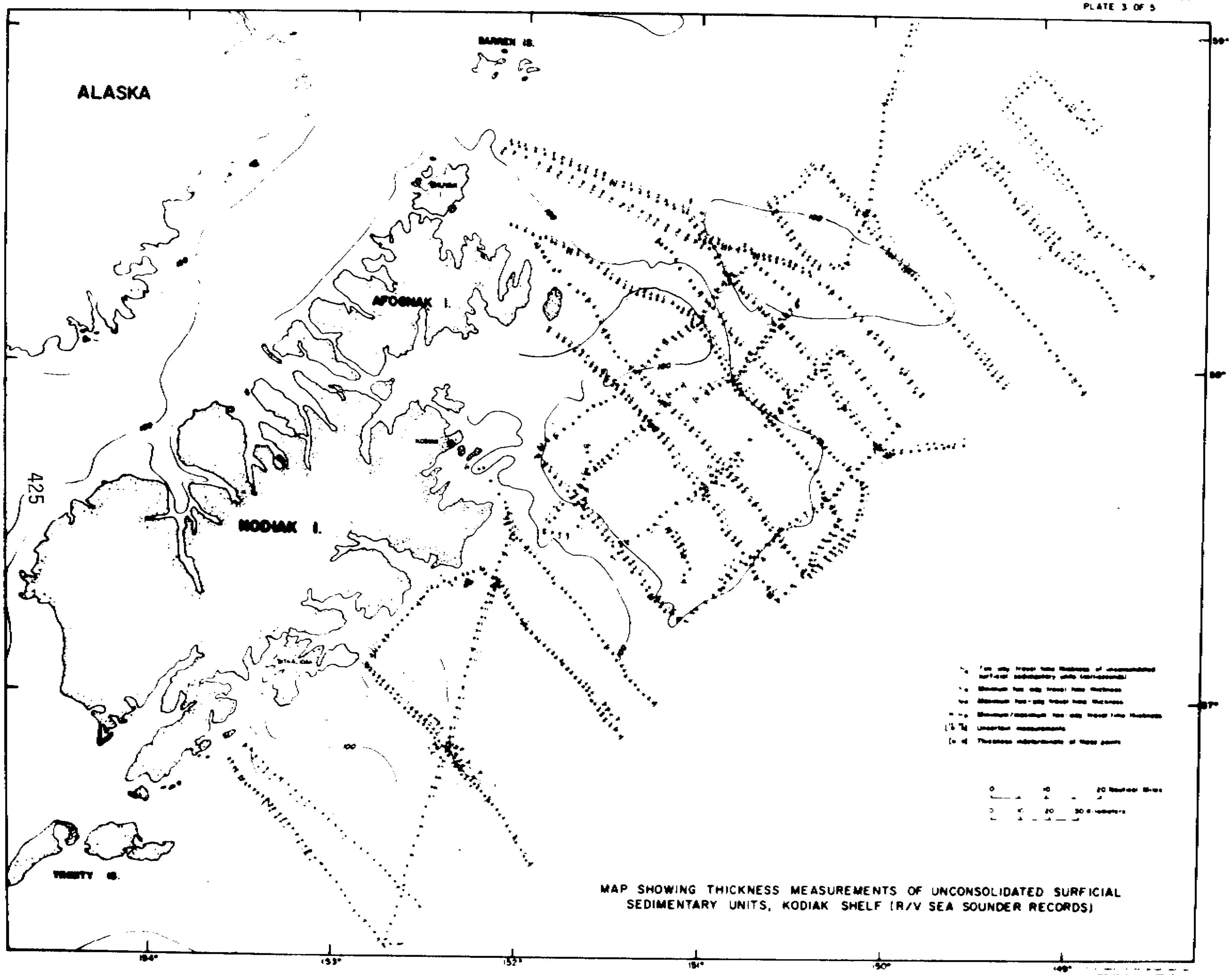
GENERALIZED THICKNESS MAP OF UNCONSOLIDATED SURFICIAL SEDIMENTARY UNITS,
KODIAK SHELF, WESTERN GULF OF ALASKA



MAP SHOWING THICKNESS MEASUREMENTS OF UNCONSOLIDATED SURFICIAL SEDIMENTARY UNITS, KODIAK SHELF (R/V S.P. LEE RECORDS)

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

OPEN FILE REPORT 78-729
PLATE 3 OF 5



MAP SHOWING THICKNESS MEASUREMENTS OF UNCONSOLIDATED SURFICIAL SEDIMENTARY UNITS, KODIAK SHELF (R/V SEA SOUNDER RECORDS)

QUARTERLY REPORT

Contract RK-6-6074
Research Unit: 430
Reporting period:
1 Oct 1978 -
31 Dec 1978

A. Bottom and Near-Bottom Sediment Dynamics in Norton Sound

B. Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet

C. Sediment Transport during Wintertime Conditions, Northern Bering Sea

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January 1, 1979

A. Bottom and Near-Bottom Sediment Dynamics in Norton Basin

I. Task Objectives

A. Development of quantitative relationships between bottom velocity shear and induced sediment entrainment for specific sites in Norton Sound.

B. Estimation of near-bottom sediment flux at various locations in Norton Sound, with particular attention to the movements of Yukon River materials.

C. Comparison of bottom sediment movements during quiescent and stormy periods at specific sites in Norton Sound.

D. Monitoring of bottom currents and light scattering/transmission (within two meters of the sea floor) to enable prediction of sediment and pollutant flux vectors at future times.

E. Measurements of near-surface and near-bottom suspended sediment distribution in Norton Basin.

II. Field and Laboratory Activities

A. No ship cruises or field trips were made during this quarter.

B. Scientific Party: not applicable

C. Methods:

1. Laboratory analysis of data collected during calendar year 1978 on R/V SEA SOUNDER and with the GEOPROBE tripod are continuing. Two scientific journal articles are currently in preparation that describe (1) the suspended sediment transport system in the eastern portion of the Northern Bering Sea; and (2) storm-generated bottom transport in Norton Sound, respectively.

D. Sample locations - Detailed sample locations and trackline charts were shown in the annual report for RU 430 (1 April 1978).

E. Data Collected and Analyzed - A complete list of data are given in the annual report (1 April 1978).

III. Results

A complete documentation of preliminary results from the GEOPROBE measurements and shipboard sampling program was presented in the annual report (RU 430 - 4/1/78). The final report for this part of the project is in preparation. A brief statement of results was given in the previous quarterly report, dated October 1, 1978.

IV. Preliminary Interpretation of Results

Analysis of the current direction data produced by the electromagnetic flow sensors on the GEOPROBE is being carried out to determine contributions to the bottom stress field due to waves, tides, and other currents. We are presently using averaging and more sophisticated digital filters to identify the bottom shear components by frequency. The tidally induced bottom stresses are predominantly polarized in an east-west direction, whereas storm-generated wave stresses are generally northeasterly - southwesterly.

Treatment of the bottom stress as a vector can possibly lead to new insights on the flux of materials that are locally resuspended by waves and storm-driven currents.

V. Problems - None.

VI. Estimate of Funds Expended: 95%

B. Bottom and Near-Bottom Sediment Dynamics in Lower Cook Inlet

I. Task Objectives

This study addresses the overall objective of evaluating geologic hazards associated with erosion and deposition on the seafloor and of characterizing bottom sediment dynamics. Specific objectives in Lower Cook Inlet are:

1. To provide a spatial and temporal description of bottom sediment transport, with particular emphasis on the areas with large sand waves.

2. To develop estimates of bottom sediment flux related to high energy events such as storms and tides.

3. To relate the magnitude of bed shear stress to the initiation of bottom sediment movement for each sedimentary environment.

4. To provide detailed descriptions of seafloor physiography and surface sediment characteristics in selected areas of observation.

5. To describe changes in the surface character of the seafloor over relatively long duration (at least one month).

II. Field and Laboratory Activities

A. Schedule

1. dates: depart Kodiak, Alaska - 20 Oct 1978
   arrive Homer, Alaska - 22 Oct 1978
2. vessel: R/V SEA SOUNDER
3. location: GEOPROBE site, Lower Cook Inlet
4. purpose: recover GEOPROBE tripod

B. Scientific party

1. D. Drake
2. G. Tate
3. P. Wiberg
4. M. Zucker
5. M. Rappeport
6. J. Nicholson
7. R. Patrick
8. M. Goud
9. P. McCrory
10. J. Oates, Magnavox Rep.
11. Bob Wilson

C. Methods

The single GEOPROBE system that was deployed at 59°27.4' N, 152°37.9'W in Lower Cook Inlet on July 30, 1978 was recovered on October 21, 1978 using the retrieval system installed on the tripod. Despite some electronic problems with the shipboard acoustic release unit, the recovery was successfully completed with no damage to the instrumentation.

D. Sample Locations

GEOPROBE site: Lower Cook Inlet, about 37 nautical miles west of Seldovia in a water depth of 65 meters.

E. Data Collected and Analyzed

Digital data collected with the two short term GEOPROBE deployments (about 3 days each) on a large sand wave feature have been decoded and transcribed onto a 9 track computer tape.

The average current speed, direction, pressure, temperature and light transmission values taken every 7.5 minutes for the approx. 3 day period have been plotted. Except for the rotor on one of the tripods which did not function properly over the entire period, the results are encouraging. Error rates in the data stream are extremely low.

The data collected on the long term GEOPROBE (about 3 months) in the large sand wave area have already been decoded and put onto 9 track computer tape. An analysis of the errors which are present in the data is underway.

III. Results

Current speeds taken with both GEOPROBES during the short term deployments were generally too low to entrain the local sediment (fine to medium sand). These measurements were taken during neap tide on the flank and near the crest of a large sand wave (~5 m high). Periods of increased turbidity recorded in the data do not appear to be correlated with abnormally high current speeds. Minor alteration of the bottom sediment ripples as detected in the photographs taken with the GEOPROBE camera suggest that some movement of bed materials did occur during this period.

The photographs taken at 4 hourly intervals over a 3 month period with the long term GEOPROBE show periods of very active alteration of the sediment ripples - responding to flood and ebb tidal cycles as well as other hydrodynamic events. The correlation of ripple migration and modification with boundary layer flow characteristics will be carried out in subsequent analysis.

IV. Preliminary Interpretation of Results:

Early analysis of the short term GEOPROBE data show two effects:

(1) little bed load or resuspension occurs duriing fairweather, neap tidal periods. Only minor changes in sediment ripples occur in response to flood - ebb cycles.

(2) Bottom surface features are significantly different on the flank and near the crest of a large sand wave. This contrast probably reflects the higher bed stress near the crest, particularly during conditions of sediment transport (spring tides, storms, etc.).

V. Problems Encountered: The recovery cruise was curtailed to only 2 days due to engineering difficulties on the SEA SOUNDER. Recovery of the long term GEOPROBE tripod was successfully accomplished despite some electronic problems with the acoustic release system.

VI. Estimate of funds expended: 95%

C. Sediment Transport during Wintertime Conditions, Northern Bering Sea

I. Task Objectives

To determine the quantity and composition of suspended matter in Norton Sound during the winter season and use this information to assess processes and pathways of sediment transport.

II. Field and Laboratory Activities

A. Field work was completed in February-March 1978. Work during the past quarter has focused on the distribution of suspended matter in the sound and analyses of the texture and composition of the particulate matter recovered from ice and water samples.

B. Methods - Combustion analysis, polarizing and scanning electron microscopy, x-ray diffraction.

C. See Annual report RU 430, April 1978 and Cruise Report prepared by Clarke H. Darnall for helicopter cruise W-29.

III. Results

1. The suspended matter within Norton Sound in February 1978 was

predominantly fine to medium terrigenous silt resuspended from the Yukon prodelta which extends across the mouth of the Sound. Plankton constituted <10% of the suspended matter in Norton Sound.

2. Within 75 km of the delta at depths <15 m the suspended matter contained substantial amounts of coarse silt and some very fine sand; this coarse material was present throughout the water column at two stations.

3. Plankton, predominantly pillbox and spindle-shaped diatoms, was progressively more abundant away from the delta. In fact, the suspended matter at stations west of Nome and off Port Clarence contained 30-50% siliceous plankton.

4. As indicated in our July report, the concentrations of suspended matter in the Sound during the winter were similar to those observed in July 1977. A more careful analysis and comparison of ice-free and ice-covered TSM values confirms this observation. In the summer the bulk of the terrigenous sediment is confined to the lower portion of the water column, whereas the vertical distribution is essentially uniform in the winter.

5. Microscope examination of the particular matter present in the pack ice shows that the sediment is composed of >95% terrigenous silt with one exception. The exception was obtained on our Port Clarence transect and contained approximately 40% diatoms and 60% fine inorganic silt.

6. The texture of the material frozen into the pack ice was typically coarser than material in suspension at a given station. Nevertheless, the pack ice sediment is predominantly silt with no more than 10% very fine sand.

IV. Preliminary Interpretation of Results

The data show that there is no decrease in the amount of suspended sediment in the western portion of Norton Sound during the winter season relative to concentrations observed during "fairweather" (calm seas and light winds) conditions in the summer. Since the effects of wind and wave-induced currents are of little or no significance in the winter, it is clear that the tidal plus mean currents are sufficient to erode the bottom sediments and maintain high levels of suspended matter. This conclusion agrees well with our summer season GEOPROBE data.

The texture of the sediment in the pack ice suggests that this material was incorporated in the ice from suspension rather than through adfreezing of material from direct bottom contact. The fact that several of the ice samples taken from distinctive layers in the pack ice contained more sediment/volume than is present near the Yukon Delta in the summer strongly suggests that such layers were formed during high energy winter events which occurred when the ice was near the delta (perhaps as shorefast ice).

Further work is continuing to pinpoint sources of the sediment in the pack ice and to identify the winter storms which may have been responsible for resuspending this material. At present there appears to have been very few intense storms (high winds) in the winter of 1977-78. This suggests that the sediment incorporated in the ice was resuspended in shallow areas by tide-generated currents. Nelson (R.U. 429) has identified scour depressions near the delta front. It is possible that these depressions are formed in the winter by intensified currents below the shorefast and pack ice.

V. Problems Encountered: None

VI. Estimate of funds expended: 95%

QUARTERLY REPORT

Contract #03-05-022-55
Research Unit #483
Task Order #12
Reporting Period: 10/1/78 - 12/31/78

EVALUATION OF EARTHQUAKE ACTIVITY AROUND NORTON AND KOTZEBUE SOUNDS

N. N. Biswas
L. Gedney
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

January 1, 1979

The University of Alaska offers equal educational and employment opportunities.

OCS COORDINATION OFFICE
University of Alaska

Quarterly Report for Quarter Ending December 31, 1978

Project Title: Evaluation of Earthquake Activity Around Norton and Kotzebue Sounds

Contract Number: 03-5-022-55

Task Order Number: 12

Principal Investigators: N. N. Biswas and L. Gedney

I. Task Objectives:

1. Test recording equipment to be installed at Nome.

2. Routine scaling of daily seismic records and computer process the data.

II. Field and Laboratory Activities:

1. The stations of the seismographic network except at Savoonga on St. Lawrence Island are operating without any outages. The signal-to-noise ratio in the recorded data has attained a satisfactory level. The station calibration data collected during the last field season have been reduced and computer processed for system magnification values. These have been incorporated in the location computer program. This will permit to compute precise magnitude values.

2. In order to eliminate the RF interference problem encountered with the installation at Savoonga, a new RF shielded box has been assembled. The laboratory tests of the field instruments once placed inside the shielded box indicate elimination of the RF interference. Preparations are underway to install the equipment package at Savoonga during January 1979.

3. The tape recorders and magnetic tape playback units required for local recording of data at Nome have been acquired. These are at present under test in the laboratory. We anticipate to install the recording system as Nome sometimes during the first quarter of this year.

4. Some of the equipment ordered for the attenuation studies around Prudhoe Bay have arrived. The laboratory tests for these equipment are progressing satisfactorily.

5. The rescaling and computer processing of the data gathered by the northeast Alaskan network around Beaufort Sea from January 1976 through December 1977 have been completed. The scaling of the data collected during the first six months of 1978 after which the network was shut down is in progress.

6. The scaling of the daily data from the western Alaskan network has been maintained up-to-date. The data gathered during January-November 1978 have been computer processed. The re-scaling of data for some earthquakes located during this period and having relatively higher location uncertainties are in progress.

III. Results: Detailed of analyses of data for both northeast Alaska and western Alaska will be presented in the next report.

IV. Preliminary Interpretation: None.

V. Problems Encountered: None.

VI. Estimate of Funds Expended: $95,000.

DATA MANAGEMENT

Contents

Quarterly Report

Contract #03-5-022-56
Research Unit #350
Reporting Period 10/1/78-12/31/78

ALASKA OCS PROGRAM COORDINATION

Donald H. Rosenberg
OCS Coordination Office
University of Alaska
Fairbanks, Alaska 99701

December 31, 1978

I. Task Objectives

This project provides for coordination of all NOAA/OCS Task Orders within the University of Alaska. It provides for a coordinator and related support services necessary for the accomplishment of the scientific programs. These services include Data Management, Fiscal Management, and Logistics Coordination.

II. Field and Laboratory Activities

Not applicable

III. Results

A. Data Management

The following batches of data have been submitted during the last quarter:

T/O 5 Hydrocarbon data for D. Shaw samples collected 8/14 - 8/25/77

T/O 1 024 zooplankton data for T. Cooney *Surveyor* cruise 6/28/77 - 7/4/77

T/O 19 STD data, only DDF was forwarded.

Tape was mistakenly sent directly to NODC.

Acona 253 cruise submitted for T. Royer
Current meter and pressure gauge data for:
Montaque Strait 11/12/77 - 5/1/78; and
Hinchenbrook Entrance 11/14/77 - 5/1/78.

T/O 1 Primary productivity data for V. Alexander UHIH operations 3/31/77 - 4/4/77

B. Travel Undertaken for Contract Coordination

H. Feder and A. J. Paul used T/O 2 monies to travel to Anchorage to attend LCI synthesis meeting.

IV. Problems Encountered

None.

V. Fiscal Reports

Attached are fiscal reports for the past quarter for all current Task Orders for Contract 03-5-022-56.

VI. Data Submission Schedules

Attached are data submission schedules for all current Task Orders for Contract 03-5-022-56.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56   T/O NUMBER: 1   R.U. NUMBER: 159/164/427

PRINCIPAL INVESTIGATOR: Dr. Vera Alexander and Dr. Ted Cooney

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

All data for this task have been submitted.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 2

PRINCIPAL INVESTIGATOR: Mr. Donald H. Rosenberg

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1]

NOTE: [1] Data Management Plan has been approved and made contractual.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 3 R.U. NUMBER: 291

PRINCIPAL INVESTIGATOR: Dr. C. M. Hoskin/D. C. Burrell

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]		
	From	To	Batch 1		
Discoverer Leg I #808	5/15/75	5/30/75	Submitted		
Discoverer Leg II #808	6/2/75	6/19/75	Submitted		
Miller Freeman	8/16/75	10/20/75	Submitted		
FY '77 Data	---	---	Submitted		

All data for this task order have been submitted.

Note: [1] Data Management Plan has been approved by M. Pelto; we await approval by the Contract Officer.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 5 R.U. NUMBER: 275/276/294

PRINCIPAL INVESTIGATOR: Dr. D. G. Shaw

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]		
	From	To	Batch 1	2	3
Silas Bent Leg I #811	8/31/75	9/14/75	None	submitted	submitted
Discoverer Leg III #810	9/12/75	10/3/75	None	None	submitted
Discoverer Leg IV #812	10/3/75	10/16/75	Submitted	None	submitted
Surveyor #814	10/28/75	11/17/75	None	submitted	None
North Pacific	4/25/75	8/7/75	submitted	None	None
Contract 03-5-022-34	Last	Year	submitted	submitted	submitted
Moana Wave MW 001	2/21/76	3/5/76	None	submitted	submitted
Miller Freeman	5/17/76	6/4/76	submitted	None	None
Glacier	8/18/76	9/3/76	None	submitted	None
Discoverer	9/10/76	9/24/76	None	submitted	submitted
Moana Wave	10/7/76	10/16/76	None	submitted	submitted
Acona	6/25/76	7/2/76	submitted	submitted	submitted
Discoverer	5/20/77	6/11/77	submitted	None	None
Acona	6/22/77	6/27/77	submitted		
Surveyor	11/03/77	11/17/77	submitted	None	None
Discoverer	5/4/78	5/17/78	3/31/79	None	None

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]		
	From	To	Batch 1	2	3
Discoverer	8/29	9/2/78	3/31/79	3/31/79	None
Alumiak	8/3	9/2/78	3/31/79	None	None

Note: [1] Data Management plan has been approved and made contractual.

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University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 8 R.U. NUMBER: 194

PRINCIPAL INVESTIGATOR: Dr. F. H. Fay

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates From – To	Estimated Submission Dates[1] Batch 1			
Data as yet to be submitted:					
Tugidak Is.	July 1977	12/30/78			
Surveyor Leg 4	4/16 - 4/20/78	12/30/78			
Surveyor Leg 7	6/19 - 7/9/78	12/30/78			
Tugidak Is.	May - June 1978	12/30/78			
Alaska Peninsula	May 1978	12/30/78			
Priblofs	7/1 - 7/31/78	12/30/78			
Alaska Peninsula	7/7 - 7/19/78	12/30/78			
Lower Cook Inlet	8/14 - 8/18/78	12/30/78			

Note: [1]Data Management Plan has been approved by M. Pelto; we await approval by the Contract Officer. Specimen data will be reported separately in tabular format.

All data beach survey due await keypunching and will be submitted soon.

Information on histology of animals reported by others and those collected by P.I. is currently being assembled by the P.I.

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University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 15/20[2] R.U. NUMBER: 5/303/281

PRINCIPAL INVESTIGATOR: Dr. H. M. Feder

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4[3]
			032	032	032	T.B.D.
LCI						
Surveyor	77/11/4 -	77/11/16	None	3/1/79	None	6/30/79
Surveyor	78/3/27 -	78/4/2	None	3/1/79	None	6/30/70
Surveyor	78/8/13 -	78/8/22	None	3/1/79	None	6/30/79
Miller Freeman	78/5/8 -	78/5/16	None	3/1/79	None	6/30/79
Miller Freeman	78/6/6 -	78/6/16	None	3/1/79	None	6/30/79
Miller Freeman	78/7/12 -	78/7/22	None	3/1/79	None	6/30/79
Kodiak						
Yankee Clipper/Commando	78/4/8 -	78/4/21	None	3/1/79	None	4/30/79
Yankee Clipper/Commando	78/5/1 -	78/5/22	None	3/1/79	None	4/30/79
Yankee Clipper/Commando	78/6/8 -	78/6/21	None	3/1/79	None	4/30/79
Yankee Clipper/Commando	78/7/9 -	78/7/21	None	3/1/79	None	4/30/79
Yankee Clipper/Commando	78/8/8 -	78/8/23	None	3/1/79	None	4/30/79
Yankee Clipper/Commando	78/11/4 -	78/11/17	None	3/1/79	None	4/30/79
Miller Freeman	78/6/19 -	78/7/9	None	3/1/79	3/1/79	4/30/79
Miller Freeman	78/3/21 -	78/3/24	None	3/1/79	None	4/30/79
Scuba	78/5/4 -	78/10/30	None	None	None	4/30/79

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4[3]
			032	032	032	T.B.D.
Scuba	78/5/4	- 78/5/19	None	None	None	4/30/79
Negoa						
Searcher	78/7/27	- 78/8/8	None	6/30/79	None	Limited data 8/1/79

Note: (1) Data Management Plan and Data Format have been approved and are considered contractual.

(2) Only data which have not been submitted are listed.

(3) Data batch 4 is feeding data, the proper format for submission is to be determined.

Data batch 1 = Grab data, File Type 032

2 = Trawl data, File Type 032

3 = Pipe dredge data, File Type 032

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University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 19 R.U. NUMBER: 289

PRINCIPAL INVESTIGATOR: Dr. T. C. Royer

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	
Acona #193	7/1/74	7/9/74	submitted	None	None	
Acona #200	10/8/74	10/14/74	submitted	None	None	
Acona #202	11/18/74	11/20/74	submitted	None	None	
Acona #205	2/12/75	2/14/75	submitted	None	None	
Acona #207	3/21/75	3/27/75	submitted	None	None	
Acona #212	6/3/75	6/13/75	submitted			
Oceangrapher #805	2/1/75	2/13/75	submitted	None	None	
Silas Bent #811	8/31/75	9/28/75	Submitted			
Discoverer #812	10/3/75	10/16/75	(a)			
Surveyor #814	10/28/75	11/17/75	submitted			
Discoverer #816	11/23/75	12/2/75	(b)	None	None	
Station 60	7/2/74	8/26/74	None	(c)	None	
Station 64	4/28/75	5/20/75	None	(c)	None	
Station 9A	-	-	-	Lost		
Station 9B	4/20	7/24/76	-	submitted	submitted	
Moana Wave MW 001	2/21/76	3/5/76	submitted			
Moana Wave MW 003/004	4/20/76	5/21/76	submitted			
Moana Wave MW005	7/22/76	8/1/76	submitted			
Moana Wave 006	9/13	9/19/76	submitted			

Cruise/Field Operation	Collection Dates From	To	Estimated Submission Dates[1] Batch 1	2	3	
Surveyor SU 003	9/7/76	9/17/76	submitted			
Surveyor	9/20/76	10/2/76	submitted			
Miller Freeman	11/1/76	11/19/76	submitted			
Moana Wave	10/7/76	11/16/76	submitted			
Miller Freeman	3/9/77	4/2/77	submitted			
Station 9C	7/22/76	11/2/76	submitted			
Acona 248	8/11/77	8/14/77	submitted			
Discoverer	11/8/77	11/16/77	submitted			
Acona 253	11/10/77	11/17/77	10/30/78			
Hinchinbrook	11/10/77	9/19/78	None	Submitted	Submitted	
Montegue	11/10/77	9/19;78	None	Submitted	Submitted	
Station 9D	11/3/76	3/29/77	None	Submitted	Submitted	
Acona	2/16/78	2/25/78	submitted			
Acona 260	4/22/78	5/8/78	submitted			
Acona 264	7/31	8/12/78	1/15/79			
Acona 266	9/17	9/30/78	1/15/79			
Hinchinbrook	9/19/78	Current	None	Scheduled when retrieved		
Monteque	9/19/78	Current	None	Scheduled when retrieved		

Note: 1 Data Management Plan and Data Formats have been approved and are considered contractual.

(a) Parent tapes were coded in PODAS format, tapes were submitted to F. Cava as requested.

(b) Data useless due to malfunction of shipboard data logger.

(c) In edit process. Development of computer editing program has held up data.

Data Batch 1 = STD/CTD
2 = Current meter
3 = Pressure guage

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 23 R.U. NUMBER: 351

PRINCIPAL INVESTIGATOR: Ms. E. R. Dieter

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 24 R.U. NUMBER:

PRINCIPAL INVESTIGATOR: Mr. David M. Hickok

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

NOTE: [1] Data Management Plan has been approved and made contractual.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 27 R.U. #441

PRINCIPAL INVESTIGATOR: Dr. P. G. Mickelson

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan.

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]	
	From	To	Batch 1	2
1976 Field Season	6/4/76	9/15/76		
1977 Field Season	5/19/77	9/30/77		

Transect data for both field seasons is currently being coded by investigators. I am assured that all data will be available soon. We will submit these data as soon as they are received. All other data due under this task order have been submitted.

1 Data management plan has been submitted and approved by F. Cava; we await contractual approval.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 32 R.U. NUMBER: 537

PRINCIPAL INVESTIGATOR: Dr. D. M. Schell

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan

Cruise/Field Operation	Collection Dates From	Collection Dates To	Estimated Submission Dates[1] Batch 1		
Dease Sampling Trip 1	3/31/77		6/30/78		
Elson Lagoon Sampling Trip 1	5/23/77		6/30/78		
Simpson Lagoon Sampling Trip	4/78 - 8/78		3/31/79		
Simpson Lagoon Stefausson Sound	11/78		6/30/79		
Smith Bay Dease Inlet, Elson Lagoon	11/78		6/30/79		

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 33 R.U. NUMBER: 529

PRINCIPAL INVESTIGATOR: Dr. H. S. Naidu

Submission dates are estimated only and will be updated, if necessary, each quarter. Data batches refer to data as identified in the data management plan

Cruise/Field Operation	Collection Dates		Estimated Submission Dates[1]			
	From	To	Batch 1	2	3	4
Archived Samples			None	7/30/79	submitted	10/30/78
Simpson Lagoon	8/77		submitted	6/30/79	Submitted	10/30/78
Barrier Islands	8/77		None	6/30/79	None	None
Glacier	8/77	9/6/77	10/30/78	None	submitted	10/30/78
Summer '78 Field Season			None	None	6/30/79	None

An updated submission schedule, and the submission of data will take place on or around February 1, 1979. Absence of Principal Investigator makes update at this time impossible.

1 Data Management Plan has been submitted to the Arctic Project Office. We await approval.

OCS COORDINATION OFFICE

University of Alaska

ENVIRONMENTAL DATA SUBMISSION SCHEDULE

DATE: December 31, 1978

CONTRACT NUMBER: 03-5-022-56 T/O NUMBER: 34 R.U. NUMBER: 530

PRINCIPAL INVESTIGATOR: Dr. P. Jan Cannon

No environmental data are to be taken by this task order as indicated in the Data Management Plan. A schedule of submission is therefore not applicable[1].

1 Data Management Plan has been submitted to the Arctic Project Office. We await approval.

Fiscal Report

Contract: 03-5-022-56

Task Order: #1

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$31,446.22	$341,650.00
Travel	851.83	14,041.41
Equipment	---	33,388.45
Other	3,909.24	60,610.59
Staff Benefits	5,144.38	55,678.48
Overhead	15,723.12	177,033.39
Total Billed	$57,074.79	$682,402.32
Total Award		$811,698.00
Total Unbilled		129,295.68

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #2

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$10,414.53	$189,267.51
Travel	1,338.86	40,674.54
Equipment	---	---
Other	15,933.60	323,812.10
Staff Benefits	2,000.70	33,246.50
Overhead	4,906.08	98,645.97
Total Billed	$34,593.78	$685,646.62
Total Award		$724,458.00
Total Unbilled		38,811.38

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #3

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$1,045.80	$43,882.31
Travel	---	629.26
Equipment	---	1,170.40
Other	324.50	2,892.54
Staff Benefits	---	5,941.18
Overhead	522.90	23,504.31
Total Billed	$1,893.20	$78,020.00
Total Award		$78,020.00
Total Unbilled		-0-

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #5

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$25,082.74	$344,085.61
Travel	1,244.14	14,841.94
Equipment	(610.00)	136,664.12
Other	2,329.09	162,838.10
Staff Benefits	3,531.79	55,648.75
Overhead	12,433.82	175,302.82
Total Billed	$44,011.58	$889,381.34
Total Award		$1,124,551.00
Total Unbilled		235,169.66

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #8

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$12,565.14	$143,157.42
Travel	741.99	15,536.56
Equipment	-0-	-0-
Other	1,352.60	24,105.70
Staff Benefits	2,241.56	25,488.50
Overhead	6,282.57	73,808.64
Total Billed	$23,183.86	$282,096.82
Total Award		313,051.00
Total Unbilled		30.954.18

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #12

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$21,750.33	$276,084.71
Travel	791.42	19,508.75
Equipment	3,070.73	52,827.44
Other	8,385,86	207,005.94
Staff Benefits	3,357.13	45,711.63
Overhead	10,819.96	144,606.42
Total Billed	$48,175.43	$745,744.89
Total Award		$880,717.00
Total Unbilled		134,972.11

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #15

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$40,155.06	$267,238.89
Travel	1,807.51	20,726.15
Equipment	195.00	7,777.40
Other	29,237.20	260,885.62
Staff Benefits	6,908.46	44,542.58
Overhead	19,924.25	132,972.52
Total Billed	$98,227.48	$734,143.16
Total Award		$831,278.00
Total Unbilled		97,134.84

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #19

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$20,305.80	$315,068.26
Travel	1,742.49	16,927.71
Equipment	-0-	44,434.62
Other	13,525.71	110,697.55
Staff Benefits	3,367.94	52,681.77
Overhead	10,152.90	161,802.89
Total Billed	$49,094.84	$701,612.80
Total Award		809,096.00
Total Unbilled		107,483.20

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #23

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$ 3,001.50	$ 93,197.26
Travel	979.85	9,215.76
Equipment	-0-	-0-
Other	40,187.22	501,722.08
Staff Benefits	403.13	15,276.07
Overhead	1,282.47	48,802.83
Total Billed	$45,854.17	$668,214.00
Total Award		886,396.00
Total Unbilled		218,182.00

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #24

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$ 9,482.87	$ 84,316.51
Travel	-0-	-0-
Equipment	631.39	2,726.64
Other	2,648.61	54,555.03
Staff Benefits	1,821.26	15,319.24
Overhead	4,672.93	42,321.77
Total Billed	$19,257.06	$199,239.19
Total Award		$243,223.00
Total Unbilled		43,983.81

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #32

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$4,358.38	$35,158.27
Travel	250.50	409.05
Equipment	416.80	663.56
Other	538.22	1,243.90
Staff Benefits	671.17	6,218.45
Overhead	2,179.19	17,579.14
Total Billed	$8,414.26	$61,272.37
Total Award		$133,412.00
Total Unbilled		72,139.63

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #33

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$2,240.67	$32,781.59
Travel	181.18	3,592.18
Equipment	238.99	16,567.90
Other	5,479.10	13,239.29
Staff Benefits	236.96	4,405.42
Overhead	1,120.34	16,390.81
Total Billed	$9,497.24	$86,977.19
Total Award		$175,059.00
Total Unbilled		88,081.81

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

Fiscal Report

Contract: 03-5-022-56

Task Order: #34

Date: December 22, 1978

Category	Billed this Quarter	Cumulative Billed
Salaries and Wages	$3,323.41	$27,038.49
Travel	2,120.00	5,875.63
Equipment	-0-	-0-
Other	65.15	1,697.56
Staff Benefits	207.48	1,510.29
Overhead	1,661.70	13,519.24
Total Billed	$7,377.74	$49,641.21
Total Award		$105,875.00
Total Unbilled		56,233.79

These data are taken from University of Alaska vouchers submitted in the three months prior to the above date.

QUARTERLY REPORT

Research Unit 362

Quarter Ending 15 December 1978

OCSEAP DATA BASE MANAGEMENT SUPPORT

Submitted by: John J. Audet
Principal Investigator
National Oceanographic Data Center
Environmental Data and Information Service
National Oceanic And Atmospheric Adminstration

January 1, 1979

The following is a summary of EDIS activities concerning OCSEAP data base management support. Rather than follow the format requested of other principal investigators involved in specific research activities, this report is divided into the major data base activities for RU 362.

DIGITAL DATA

A total of 72 new and 50 resubmitted data sets were received by NODC this quarter; five anolog data sets were received by NGSDC. The total number of final processed data sets has dropped from the previous quarter total (795 vs. 782) as a result of improved data checking, especially for acceptable taxonomic codes. The number of data sets in hold is about the same as the previous quarter; some corrections have been placed in hold awaiting investigator response. The large number of biological data sets in processing is the result of recent file type 033 data (Marine Bird Sighting) received through Hal Petersen, 025 data (Marine Mammal Specimen) from Mike Crane and a large number of file type 027 data (Mammal Sighting) received from NWAFC, all received in the past few months.

The distribution and status of all OCSEAP digital data received to date is indicated in Table 1; distribution by lease area for data received this quarter is shown in Table 2.

Table 1. Summary of OCSEAP Data Sets Received to Date.

	Received	Finaled	In Hold	In Processing
Biological	1079	559	232	288
Physical	311	204	53	54
Chemical	36	16	5	15
Geological	7	3	3	1
Totals	1433	782	293	358

Table 2. Lease Area Distribution for Data Received between September 16 and December 15, 1978.

		Lease Area								
	Total	1	2	3	4	5	6	7	8	9
015 - Current Meters	9	9	-	-	-	-	-	-	-	-
025 - Marine Mammal Specimen	34	12	5	10	1	3	1	10	-	3
029 - Primary Productivity	5	-	5	-	-	-	-	-	-	-
032 - Benthic Organisms	1	1	-	-	-	-	-	-	-	-
033 - Bird Sighting I	41	22	11	18	17	5	17	8	4	3
035 - Marine Bird Colony	21	-	-	-	20	-	-	-	-	-
101 - Wind Data	1	-	-	-	-	-	1	-	-	-
Total	112									

Lease Area Code

1 - NEGOA	4 - St. George	7 - Norton
2 - Lower Cook	5 - Beaufort	8 - Aleutions
3 - Kodiak	6 - Bristol Bay	9 - Chukchi

DATA REPORTS

A total of 21 data reports and other documents were received and filed by NODC or indicated by the Project Offices as containing data appropriate for inclusion in the data base. The reports are entered in the tracking system and include the relevant lease areas for each report. The distribution of data reports received this quarter by discipline is as follows:

Fish/Plankton	10	
Geology/Geophysics	8	(includes five analog data submissions and two maps).
Marine Mammals	3	

A total of 325 data reports have been entered in the tracking system to date.

ROSCOPS

A total of 101 ROSCOPs were received this quarter. A total of 625 have been received to date for OCSEAP cruises and surveys. ROSCOPs were received this quarter from the following:

ADF&G	43
USFWS	18
USGS	8
NMFS	6
PMEL	3
Univ. Washington	15
Univ. Alaska	8
Univ. California	4
College of Atlantic	2
Univ. South Carolina	1
Lamont-Doherty	15
Dames and Moore	9

Several ROSCOPs included multiple agencies resulting in a higher total when individually listed.

DATA REQUESTS

The following is a list of the major requests received and/or being processed this quarter. Individual request for routine information such as copies of data formats or new taxonomic codes are not included in this list.

Date Received	Date Completed	Request/Comments
8/1/78	10/2/78 (Partial)	Program Office/SAI - Physical and biological products for annual technical summary report - discussed further under 'Data Products'.
8/28/78	9/16/78	Jou (Flow Research Inc) - Data on ice movement in the Beaufort Sea.
8/29/78	10/2/78	Cava (JPO) - Updated list of PI addresses and 'Wallchart' product.
9/12/78	9/18/78 10/11/78	Pelto (JPO) - Listing, inventory and magnetic tape of archival Nansen/STD data for east NEGOA - tape and individual cruise plots (47 total) sent to Charnell 10/11.
9/7/78	9/30/78	Cava (JPO) - List of USFWS file IDs for which NODC has received DDFs (Mammal and bird studies)
9/13/78	11/28/78	Lowry (ADF&G) - Additional information and plots to supplement June request for specific benthic species in Bering/Chukchi area - 42 species plots and 5 station plots (requested through Toni Johnson).
9/18/78	10/4/78	Carey (Oregon St.) - Tape copies of all OCSEAP Beaufort Sea data for CTDs, zooplankton, phytoplankton, primary productivity and ice drift.
9/18/78	10/13/78	Carey (Oregon St.) - Tape copy of all OCSEAP file type 032 data - all lease areas (22 data sets).

Date Received	Date Completed	Requestor/Comments
9/18/78	11/20/78	Hall (USFWS) - Formatted output listing of all OCSEAP file type 027 data for NEGOA/Cook/Kodiak areas exclusive of investigator's own data. (requested through Suzy Swanner).
9/22/78	10/2/78	Cava (JPO) - Copy of all Dames & Moore DDFs submitted for OCSEAP studies (15 total)
10/4/78	10/16/78	Petersen (URI) - Copy of NAVOCEANO/ Scripps bathymetric charts for Pribilof area to be used for Hunt data (RU 83).
10/12/78	12/8/78 (Partial)	Lowry (ADF&G) - Bottom temperature values within 3 days/5 miles of approximately 200 trawl locations for Bering/Chukchi Seas - STD/CTD cruise information included with request - CTD data sent 12/8 - over 200 XBT stations will be forwarded in early January.
10/13/78	12/4/78	Hunt (Univ. Calif.) - Listing of all file type 035 food data for investigator's colony data received on 10/13 (requested through Cava).
10/26/78	10/27/78	Walter (ESIC) - Copies of updated OCSEAP list for validating ENDEX/ OASIS requests by OCSEAP PIs.
10/30/78	10/31/78	Sobey (SAI) - Copies of ocean station distribution and cruise information for east NEGOA area sent earlier to JPO/Charnell.
10/30/78	11/1/78	Zora (Bellingham, Wash.) - Information on OCSEAP data management - initially contacted Sid Stillwaugh, who forwarded OCSEAP Data Catalogs and referred him to Boulder Office for further information.

Date Received	Date Completed	Requestor/Comments
11/2/78	12/1/78	Ingraham (NMFS) - Copy of 29 OCSEAP STD/CTD data sets - sent on tape in OCSEAP format - another version in the NODC SDI format may be forwarded later by Data Services.
11/2/78	11/8/78 12/11/78	Tobias (ADF&G) - Temperature/salinity data for Hothem Inlet, Alaska - Inventory plot sent 11/8 - data requested and sent 12/11 (requested through Crane).
11/21/78	12/4/78	Wormuth (Texas A&M) - Listing of selected OCSEAP zooplankton data (file type 024) collected by Damkaer (PMEL) - (requested through Fischer).
11/29/78	12/15/78	Crane - Tape copy of Dennis Lees intertidal data (RU 417) to review for taxonomic code editing.
11/30/78	12/15/78	Ludwig (Sand Point) - Formatted listing of two OCSEAP CTD data sets from PMEL (RU 141).
12/4/78	12/5/78	Wakefield (House Approp. Comm) - Data Catalogs and information concerning EDIS role in OCSEAP data management.
12/6/78	12/7/78	Swanner (JPO) - Copy of title page and table of contents for Cooney NEGOA first year final report dated August 1975.
12/7/78	12/7/78	NWAFC (Kodiak) - Search for OCSEAP current meter data west of 170°W in Bering Sea - no stations found - part of request being completed by Data Services.

FORMAT DEVELOPMENT

The final draft of the 'WYLBUR' version of all OCSEAP formats and codes has been completed. Following the completion of the parameter index, draft versions of Part III of the Data Catalog will be distributed to OCSEAP management personnel for their review early next month. This final draft of the formats includes revisions to accomodate the NODC 12-byte taxonomic codes for a number of biological formats.

A list of Arctic investigators requiring current OCSEAP formats was received from Toni Johnson. All formats were distributed on November 22.

A 'FACT' sheet was distributed to OCSEAP data management and appropriate investigators on November 8 which included modifications to six formats, one new code and additions to seven existing codes.

DATA PROCESSING

Master tape documentation was completed for file types 028 (Phytoplankton), 063 (Marine Invertebrate Pathology) and 017 (Pressure Gauges) and information concerning questionable data values distributed to the relevant investigators for these three file types. Similar work will be completed within the next several weeks for file types 023 (Fish Resource Assessment) and 032 (Benthic Organisms). A copy of all 032 data held by NODC with taxonomic codes converted to the NODC codes has been forwarded to Mike Crane for more intensive checking.

Results of check programs and preliminary inventories have been sent to the Project Offices or the investigators for 333 data sets during the past quarter. Those data sets requiring responses or corrections have been placed in a 'hold' status.

A copy of ranges submitted to the Juneau Project Office from different investigators was received from Francesca Cava and incorporated in the current range checks where appropriate.

A memo was distributed for comments which detailed the steps necessary to pre-process the eight file types to be reviewed by Crane or Petersen prior to NODC final processing. File type 023 was used as a prototype for this procedure.

A memo was sent to Francesca Cava on November 28 indicating the status of the response of investigators to earlier master tape documentation which required verification or corrections.

A memo was distributed which documented the modifications required to biological data formats to accomodate the NODC 12-digit taxonomic code. This includes changes to 12 records for 7 file types.

PRODUCT DEVELOPMENT

The SAI products requested for the annual technical summary report have been completed except for walrus activity plots which will be completed this month. A set of 16 temperature/salinity plots was forwarded on October 2 for the Bering Sea area. Improved versions of shearwater sightings and Lagrangian plots were completed at the same time; numerous questionable locations occurred on several of the drift plots but no corrections or deletions were made.

It was decided by the Program Office not to complete the request for current meter presentations with tidal currents removed as extensive software development within NODC would be necessary. The walrus activity request encountered several data interpretation problems and difficulties in presenting understandable plots. The final products will include individual sightings, sightings where investigators did not report activity and $\frac{1}{4}°$ square summaries for land, water and ice activities on a seasonal basis.

Other products completed during the quarter include individual benthic species plots, formatted output listings of selected mammal sightings, and CTD data bottom temperatures for selected trawl depths, and other products as noted under 'Data Requests'.

DATA CATALOGS/INVENTORIES

All copies of Part II of the Data Catalog have been distributed. Rather than reprint, it has been decided to print a new version within the next two months which will include additional new data sets and minor corrections to the present version.

A tentative format for Part III of the Catalog has been established. Section 1 will consist of the format descriptions. Section 2 will be a numerical listing of all codes with each code defined; lists of all codes used for each format and alphabetical and numerical lists of code names also will be included. Section 3 will contain an index of all parameters with an indication of the file type and record types in which the parameter occurs.

Information concerning missing 'core' data and 'Data Collected' information in the tracking system was compiled and forwarded to the Program Office on (November 28) and Project Offices (on October 31) for their response.

Updates to the tracking system for this quarter consisted of 500 new records and nearly 2100 correction and modification entries.

TAXONOMIC CODES

Modifications to formats to accomodate the NODC 12-digit taxonomic code have been completed as mentioned under 'Format Development'. Copies of the entire NODC taxonomic code file were forwarded to Kaplin (UCLA) and Cline (PMEL) for potential hydrocarbon work with biological samples and a copy forwarded to Rabin (F.R.I - Univ. Washington) with a copy of file type 024 (Zooplankton).

Mike Crane has begun to check and convert data with Alaskan codes to the proper NODC codes using the latest tape copy of the taxonomic code file.

ADMINISTRATIVE

A memo indicating the status of NODC action items resulting from the Asilomar and Boulder data management meetings was forwarded to Wayne Fischer. The only action items outstanding for NODC involve distribution of Part III of the Data Catalog, which is nearing completion, and copies of data held at NODC for file types 023 and 030 to be forwarded to Crane and Petersen respectively. This last action will be completed within the next month or so.

A one-day meeting was held in Boulder on October 16 to discuss NODC's role in data base management. Following this meeting, I attended the Physical Oceanography/Meteorology workshop at Orcas Island, Washington.

A request from the Program Office for additional modifications to the RU 362 work statement was received in October 31. A response was completed and forwarded to Boulder on November 21.

Quarterly Report

RU Contract No.

497 - - - - - - -

370 03-5-022-56

Reporting Period 1 October 78
31 December 78

8 Pages

OCSEAP Alaskan Data Processing Facility

Michael L. Crane

David M. Hickok

4 January 1979

I. Introduction

The Anchorage Data Processing Facility was created to provide data management and data processing services to the OCSEA Program. Because the Anchorage facility is the only local Alaskan facility, the timely resolutions of errors and maintainence of special files have contributed to the effective improvements in data management. The facility has three areas for service. One of them is service to investigators, another is special services to OCSEAP management, and the last is service to the data base at the NODC. The purpose of this report is to document past data processing activities, to describe significant events, and to present the most urgent problems and recommended solutions.

II. Background

The Anchorage Data Processing facility has grown and evolved from recognized needs for local support. The data base identified the need for local representation when NODC proposed a digital data base to the OCSEA Program. The initial functions of the office was a liaison position between the data base and the Alaskan community of investigators and project staff. While executing these liaison duties, a deficiency of resources was identified and a proposal was submitted to solve that deficiency. In October 1976, the OCSEA Program established the facility with the University of Alaska/AEIDC in conjunction with the EDIS Liaison Office.

The first mission of the Anchorage facility was the expediting of keyentry for delinquent data sets. A keyentry staff was hired and began the enormous task of organizing and completing the data entry. The staff in Anchorage identified a new problem. The data on the coding sheets had inconsistencies or errors. The shift from unattended entry to controlled entry was instituted to reduce the errors to the OCSEA Program.

The categories of errors were isolated and the results of this review was presented in the renewal proposal. In the proposal, a shift to controlled entry was noted, and the request for data checking equipment was made. After much debate among OCSEAP management, the proposal was finally accepted. This next phase marked the beginning of detailed examination of data sets and marked the beginning of specialized support to management.

The functions of the facility have expanded to meet the challenges of a full service data processing facility. The links between investigator, management and data base have been reinforced because the data control services require direct effective communication with each component. Because the level of effort is so high and because the material is so complex, direct access to investigators is becoming a necessity.

It has been OCSEAP's policy to focus all action to the contract supervisor. This policy includes all data management items. At this time, the current policy should be reviewed in terms of the expanding complexity of data control functions. The level of work will increase dramatically for the Anchorage facility and for each contract supervisor. OCSEAP management should be aware of the impact on project management and on the service vendors. See the "Problems and Recommended Solutions" Section for more details.

III. Significant Events

The most significant events this quarter have been programming activities, data transmittals, telecommunication in a batch mode, updates to the taxonomic code file, travel to Fairbanks and Seattle, a meeting in Anchorage with the staff members from the Marine Pollution office and a hardware upgrade.

The programming activities are the most significant and the table below notes the status of the required programs for data checking.

Table I

Program Name	025	023	031	032
IDxxx	X	X	X	X
SQxxx	X	X[1]	X	NA[3]
BLxxx	in RL025A	X	X	X
TCxxx	X	X	X	X
PCxxx	X	NA[2]	X	NA
TFILExxx	X	X	X	X
TXExxx	X	X	X	X
RAxxx	in RL025A	X	X	X
RLxxx	in RL025A			
CDxxx	X	X	X	X
EXxxx	X	X	X	X

An X means the program has been written and tested. A blank entry means not completed and an "NA" means not applicable. The footnotes are described in the appendix.

The programs RL023, RL031, and RL032 require input from OCSEAP management. The completion of the remaining programs is noted in the milestone chart under programming activities.

The data processing activities continued at a normal pace and several data sets were completed. The following data transmittals were made this quarter.

TABLE II

RU	File type	No. of Data Sets	To	Material Forwarded
003	040	6	Juneau Project Office	Magnetic Tape
196	033	77	NODC	Corrections to check results
229	025	12	NODC	Data resubmission
243	025	6	NODC	Data resubmission
467	033	6	Petersen, RU527	Magnetic tape
467	038	1	Petersen, RU527	Magentic tape

The partial success of batch telecommunications between Anchorage and Washington, D.C. holds promise of greater service to users of OCSEAP data. The fully successful test of tape to tape communication between Anchorage and Juneau marks the feasibility of communication using Tektronix equipment. The promise of greater productivity can only be realized if new technological advances are implemented properly.

The taxonomic code file has been upgraded from a magnetic tape of NODC tax codes. The conversion to diskette and sorting by NODC tax code number began the process of file upgrading. Common names were merged with the scientific names and the file reduced to the proper size for conversion to Wang formatted diskettes. The file now contains over thirty thousand records.

The trips to Fairbanks and Seattle lead to new programming capabilities and the beginning of error corrections for several data types (called file types in the data base nomenclature). Each meeting had a new exchange of information or a confirmation of an uncertain point in data control. Direct contact either by phone or visit has proved to be an effective mechanism to isolate data problems and implement a solution.

During a trip to Anchorage, Mr. L. Swanson, head of the new Marine Pollution Office, discussed his plans and gathered informtion on the offices located in Alaska. At a brief meeting, the recent accomplishment of the Anchorage Data Processing Facility were presented. Further presentations are anticipated.

The new printer on the data checking equipment has improved the processing effort. Not only is the printer faster but also the choice of two sizes of characters and the choice of two line spacings are being utilized in all the programs. Special data reports or data files can be printed on 8-1/2 X 11 paper.

IV. Requests by OCSEAP

As part of the service to OCSEAP management, the staff of the Anchorage Data Processing Facility has provided additional resources to isolate, correct and document data management problems. At the request of F. M. Cava and T. Johnson, a digitized "Parameter Checklist" was created to assist project management with a detailed inventory of data fields. Reports have been drafted covering data topics and presentations have been made at OCSEAP meetings. Data check runs have been reviewed by Anchorage personnel at the request of the OCSEAP data managers. Complex and rigorous check programs were developed with the input requested by the project offices.

To summarize the specific requests this quarter the table below notes the status, action required, requestor, and date completed.

REQUESTS FROM OCSEAP

	Status	Task	Requestor	Date Completed
1	Completed	Send taxonomic listing to Lees RU417	Becker	Oct. 78
2	Completed	Letter to Truett RU467	Johnson	Oct. 78
3	Completed	Review check programs Divoky RU196	Johnson/ Audet	Oct. 78
4	In Hold	Correct check listing for Arneson RU003	Cava/Audet	-
5	In Hold	Correct taxonomic errors Lees RU 27/417	Cava/Audet	-
6	Completed	Correct 038 data format errors RU467 Send to Petersen RU527	Johnson	Oct. 78
7	Completed	Correct taxonomic codes for 038 data Gill RU341, USF&WS format	Cava/Gill	Dec. 78
8	In Hold	Check and correct taxonomic codes for Horner RU359	Johnson	-
9	Completed	Update parameter checklist	Johnson Cava	Oct. 78 Nov/Dec 78
10	Continuing	Send a inventory of new accessions not in the DTS	Cava Johnson	Oct/Nov 78 Oct 78
11	Completed	Send a list of specimen numbers to F. Fay RU194, Marine Mammal Data	Swope	Oct 78

V. Data Processing

In addition to the activities noted in Table II on page 3, there has been data processing activity for RU417, RU230, RU359, RU341, RU229, and RU243. Some items were data entry tasks (RU417, RU229, and RU243). Some items were data checking tasks (RU230, RU359, and RU341). Taxonomic code conversions were required for RU 230 and RU 341. These research units delivered material and either the investigator or OCSEAP management requested services to meet the data management objectives. The table below summarizes the data processing activities.

TABLE III

RU	Name	File Type	# of Data Sets	Service	Date Completed
417	Lees	023/030	4/5	Keyenter & check taxonomic codes print file	Dec. 15
230	Burns	025	15	Convert to the NODC taxonomic code	Dec. 15, 29
359	Horner	024/028	1/1	Check taxonomic codes	Partially completed
341	Gill	038(USF&WS)	13	Convert taxonomic code to the NODC Code	Dec. 29
229	Pitcher	025	5	Keyenter new data	Nov. 21
243	Calkins	025	4	Keyenter new data	Nov. 21
417/027	Lees	030	6	Correct tape to diskette check tax code	Partially completed

Because the principal function outlined in the renewal proposal was remedial data checking, check programs have been designed and written. The next phase after programming development is the preparation of data for review. The data types are file type 025 marine mammal specimen data, file type 023 fish resource assessment, file type 031 bird specimen, and file type 032 benthic biology.

In preparation of data checking the following data sets have been received and converted to diskette.

TABLE IV

RU	Name	File Type	No. of Data Sets
005	Feder	032	7
006	Carey	032	4
281	Feder	032	9
517	Feder	032	4

Until all check programs are written for each file type, no checking will be initiated. The work load is multiplied by each additional step during an "interim" checking procedure. The actual checking is a small part compared to the correcting phases. The experience gained in checking 025 data, plus the preparatory phases of data conversion and cataloging, has molded the current plans of executing the checking procedures.

The schedule and relative priority of data processing activities is outlined in the milestone chart for d.p. activities.

A detailed description of the data checking procedures, programs and methods is found in a document titled "A System Description: A Data Control Facility."

VI. Problems and Recommended Solutions

The first two problems are related and the two have a common solution. The data control activities are rigorous and the material is becoming very complex. The potential negative impact to all parties is great. The potential has always been extant but the scale has increased dramatically during calendar year 1978. The possibility of reduced productivity is real. If changes are effected early, the potential positive impacts are just as great. Corrected data which meets all known OCSEAP standards can be delivered to the OCSEAP data base. The choice for OCSEAP management is basically how much data will be controlled for the least amount of fiscal resources.

The remaining problems can be resolved without major policy changes. The efforts in data processing depend on the decisions of OCSEAP management. If the guidance is clear, complete and not contradictary, the staff in Anchorage can implement effective action. Recent successes such as the creation of the "Parameter Checklist" are the direct result of a clear OCSEAP management goal. The same recognition is required for these current problems.

1. Complicated communication lines and procedures have negatively impacted the data control effort.

Solution: provide either more staff in each project office and in Anchorage or streamline the access to investigators and management. Direct contact either by phone or visit is a minimum requirement.

2. Imprecise recordkeeping increases the administrative effort to execute data control procedures.

Solution: Maintain all OCSEAP data management information on a uniform, fundamental basis. This basis is the logical independent unit of a data set. Until OCSEAP management maintains its files along data sets, the level of effort to determine each data set at receipt of the material will dilute the data control activities. It takes longer to identify what is delivered than to execute the programs to check the data. Communication of processing activity becomes almost impossible because an unusually large effort is required to identify what is being processed.

By maintaining records on a data set basis and resolving discrepancies with the investigators, the data sets can be identified uniquely and precisely. This information can be transmited to OCSEAP efficiently by standard nomenclature. Any remaining discrepancies can be defined discretely. Now the closest resolution of identification is a "cruise" and cross reference to a data set has not been established. Keeping track of each data submission is hard enough without translating the information each time that a report is generated.

It would be even more desirable to record each data set before it is delivered to OCSEAP.

3. Input to the checking programs from OCSEAP management is necessary to complete the checking procedures.

Solution: compile each relational test and compile a set of ranges for each data field. Minimum data requirements should be indicated.

4. Entries for non-continuing research units should be made to the "Parameter-Checklist."

Solution: OCSEAP management should establish minimum standards for all data types and for all contracts. This list of contracts includes terminated contracts.

5. The structure in file type 023 is not adequate to report trophic information.

Solution: The format should be constructed to allow adequate separation of predator and prey information. The information should be reported as independent paramters. The draft revision to file type 023 should be reviewed by NODC and OCSEAP. Each investigator (except one) who reports trophic information has indicated that the data are maintained at the specimen level. The only exception is a group which has "pooled" the stomach contents before analysis. The isolation of independent parameters is necessary to implement proper checking procedures. The proposed revision accommodates all techniques of trophic analysis and separates variables into logically coupled sets of independent and dependent members.

Milestone Charts

The following tables mark the known activities or known programs for the remaining quarters in FY79. The schedule and completion dates will depend on data deliveries and access to the investigators. The tables are divided into programming schedules and data processing schedules.

TABLE V
Programming Milestones

Program Name	Status	Due Date
RL023	Waiting for OCSEAP input	-
RL031	Waiting for OCSEAP input	-
RL032	Waiting for OCSEAP input	-
SL023	Draft version	2 Feb 79
SL031	In Hold	2 Mar 78
SL032	In Hold	17 Mar 78
SD025	In Hold	2 April 78
SD023	In Hold	17 April 78
SD031	In Hold	2 May 78
SD032	In Hold	17 May 78

TABLE VI

Data Processing Milestones

RU	File Type	# of Data Sets	Activity	Due Date
003Arneson	040	20	Edit data errors	21 May
229Pitcher	025	5	Complete keyentry	10 March
243Calkins	025	4	Complete keyentry	10 March
230Burns	025	20	Check and correct data erros	2 May/30 Sept
417Lees	030	6	Check & correct taxonomic code errors	25 April
417Lees	030/023	5/4	Check & correct taxonomic code	25 June
485Hartt	023	4	Check & correct to "123"	30 Sept.
467Truett	023	1	Check & correct to "123"	30 Sept.

Appendix

1) The program SQ023 can verify only two kinds of sequencing techniques. The two are monotonically increasing for each record type.

2) Until file type 023 is modified for the trophies data, no predator/prey relationship can be determined.

3) The sequence number field has been so compromised that no sequence test can be made.

Research Unit 527
Nov. 1 - Dec. 31, 1978

Quarterly Report

OCSEAP DATA PROCESSING SERVICES

Harold Petersen Jr.

Data Projects Group
Pastore Laboratory
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02881

Background and Objectives

Beginning in March 1977, the Data Projects Group (DPG) initiated data management support for the Outer Continental Shelf Environmental Assessment Program (OCSEAP). This support has been primarily directed at assuring receipt by the Program of validated field data. An emerging area of support concerns the generation of product analyses from the data. This report summarizes progress made in both of these areas during the quarter ending 31 December 1978.

File Type 033 Data

A summary of this quarter's activities with regard to this type of data is given in the Field Operation Status Report shown in Appendix I. The following commentary references that report.

* New Tapes

Two tapes of data coded in the National Oceanic Data Center (NODC) version of File Type 033 format were received. The first of these contained data for 6 field operations, and was received on 23 October 1978 from Dr. Joseph Truett, RU 467. The validation products CODEPULL and LOGLIST were sent to this RU on 30 October, and have not yet been returned.

The second tape contained data for 8 field operations, and was received from Dr. George Hunt, RU 083, on 15 December 1978. No validation products have been generated from the data yet, in accordance with a set of priorities established with his office and the Juneau Project Office (JPO) concerning other RU 527 tasks. This data will be processed during the upcoming quarter.

* Total 033 Receipts

The two tapes of data received during this quarter bring the total number of 033-type field operations to 136. Of this total, 81 have been received in the U.S. Fish and Wildlife Service (FWS) version of this file type (80 from RU 337, 1 from RU 083), and 55 in the NODC version (12 from RU 108, 8 from RU 239, 12 from RU 337, 6 from RU 467, and 14 from RU 083).

* Current Processing

Validation products have been generated for 128 of the 136 field operations, the remaining ones being those from RU 083 described above.

There are 9 operations remaining for which validation products have been sent to the RU's, and not yet returned for editing. These are 6 from RU 467, and 3 from RU 196.

* Editing RU 337 Data

All of the remaining 119, which are from RU 337, have been edited and have passed the final check (validation products rerun on the edited data, and any resulting citations resolved). Of the 119, the final 39 were completed during this quarter:

FW5003 FW5006 FW5010 FW5011 FW5012 FW5020

FW5022 FW5029 FW5031 FW5038 FW6004 FW6005

FW6006 FW6010 FW6011 FW6012 FW6013 FW6014

FW6016 FW6018 FW6019 FW6027 FW6050 FW6051

FW6052 FW6067 FW6068 FW6077 FW6078 FW6082

FW6084 FW6085 FW6087 FW6088 FW6092 FW6093

FW6094 FW7026 FW7029

* Conversion of RU 337 Data

Format conversion from FWS to the NODC version are required for 81 of the 119 field operations edited (all the remaining operations were received in NODC version). During this quarter the following 63 have been converted:

FW5003* FW5004* FW5006* FW5010* FW5011* FW5012*

FW5013* FW5015* FW5016* FW5018* FW5020* FW5021*

FW5022* FW5023* FW5024* FW5025* FW5026* FW5029*

FW5031* FW5033* FW5034* FW5035* FW5036* FW5037*

FW5038* FW6002* FW6004* FW6005* FW6006* FW6007

FW6008 FW6009* FW6010* FW6011 FW6012* FW6014

FW6016 FW6019 FW6021* FW6025* FW6026* FW6028*

FW6029* FW6052 FW6057* FW6066* FW6067* FW6068*

FW6070* FW6074* FW6077 FW6078 FW6082* FW6084*

FW6085* FW6086* FW6087* FW6088* FW6089* FW6092

FW6186* FW7026* FW7027*

This brings to 72 the total number of field operations which have been converted. Many of these require additional editing as described in the previous Quarterly Report. Those for which such additional editing has been performed are indicated with an asterisk (*) following the field operation number.

* Mailings

Data for the following 46 field operations from RU 337 were mailed to NODC and to the originating RU during this quarter:

FW5004 FW5010 FW5011 FW5012 FW5013 FW5015

FW5016 FW5018 FW5020 FW5021 FW5022 FW5023

FW5024 FW5026 FW5033 FW5034 FW5035 FW5036

FW5037 FW5038 FW6006 FW6009 FW6012 FW6021

FW6025 FW6026 FW6028 FW6029 FW6057 FW6066

FW6067 FW6068 FW6070 FW6074 FW6082 FW6084

FW6085 FW6086 FW6087 FW6088 FW6089 FW6093

FW6186 FW7026 FW7027 FW7029

This brings the total number of completed operations from all RU's to 84.

* Projected Completion Date for All RU 337 033 Data

The editing, conversion, and mailing of 033-type data described above have been carried out in accordance with a prioritized list of field operations acceptable to JPO. This list (entitled "Projected Completion Date of Data from RU 337" in Appendix II) indicates that data from the Arctic Sea, Bering Sea, and Aleutians is complete, and that 28 of the 50 Gulf of Alaska operations remain to be completed during the upcoming quarter. Those operations which have an entry under "Actual Mail Date" and not under "Projected Mail Date" were sent before the prioritized list was established.

* File Type 033 Validation Procedures

The current edition (Release 6, 31 December 1978) of the "OCSEAP Data Validation Procedures" is given in Appendix III. Changes in entries since Release 5 are indicated with asterisks (*).

_File_Type_038_Data_

As a result of correspondence between FWS and this RU, information has been received which will allow the completion of code groups and other procedures necessary for the setup of validation products for this file type. Also, a tape containing data for one field operation coded in the NODC version of this format has been received (ca. 26 October 1978) from RU 467. This brings to two the number of operations received for this file type (one in FWS version, the other in NODC version). It is expected that production use of these procedures will begin during the upcoming quarter.

_File_Type_033_Analysis_Products_

Work was begun on a suite of four analysis products during the last quarter. The products, to be generated for RU 083, are based on 033-type data from this RU, but apply to any data of this type, regardless of source. The present status of each product is described below.

* Digital Density Plot

In this analysis, a survey area is divided into a 10' by 10' grid pattern and bird densities are calculated for all sightings within each grid block. The maximum, minimum, and average densities for all transects carried out within each block are expressed as number of individuals per square kilometer surveyed.

This product has been put into production mode for RU 083 data, and 49 plots of the type shown in the Figure 1 were generated and delivered to the RU. This number has resulted from the generation of one plot per field operation per each of the following species:

total birds, northern fulmars, kittiwakes, shearwaters,

murres, auklets, and all species sitting on the water

The analysis is a general one in that it applies to 033 data from any source, requiring only a definition of the unique aspects of the density algorithm that apply to a given data source. In this regard, it has been adapted to data received from RU 337, and 11 test plots have been generated and delivered to that RU for the following species observed during field operation FW7032:

all species, northern fulmars, shearwaters,

tufted puffins, forked-tail storm petrels,

glaucous wing gull, total kittiwakes, arctic terns,

total murres, horned puffins,

and brachyramphus murrelets

The display given in Figure 1 covers an area from 55 N to 58 N and 168 W to 172 W. In general, any 4 degree wide and X degree high area in the northern hemisphere can be portrayed. Other features of this display include auto-centering of the displayed area on the printout page, asterisks (*) in those grid blocks where the number to be printed is greater than 9999, and pluses (+) in those blocks where sightings were made, but one or more fields of data required for the density calculation is (are) missing. The display is accompanied by a report showing all data used in the calculation, including a block reference number. A reference plot of display block assignments and a mylar overlay showing land masses and depth contours in the vicinity of the Pribilof Islands are also available.

* Density Contour Maps

The digitized density plots summarize sightings data in 10'

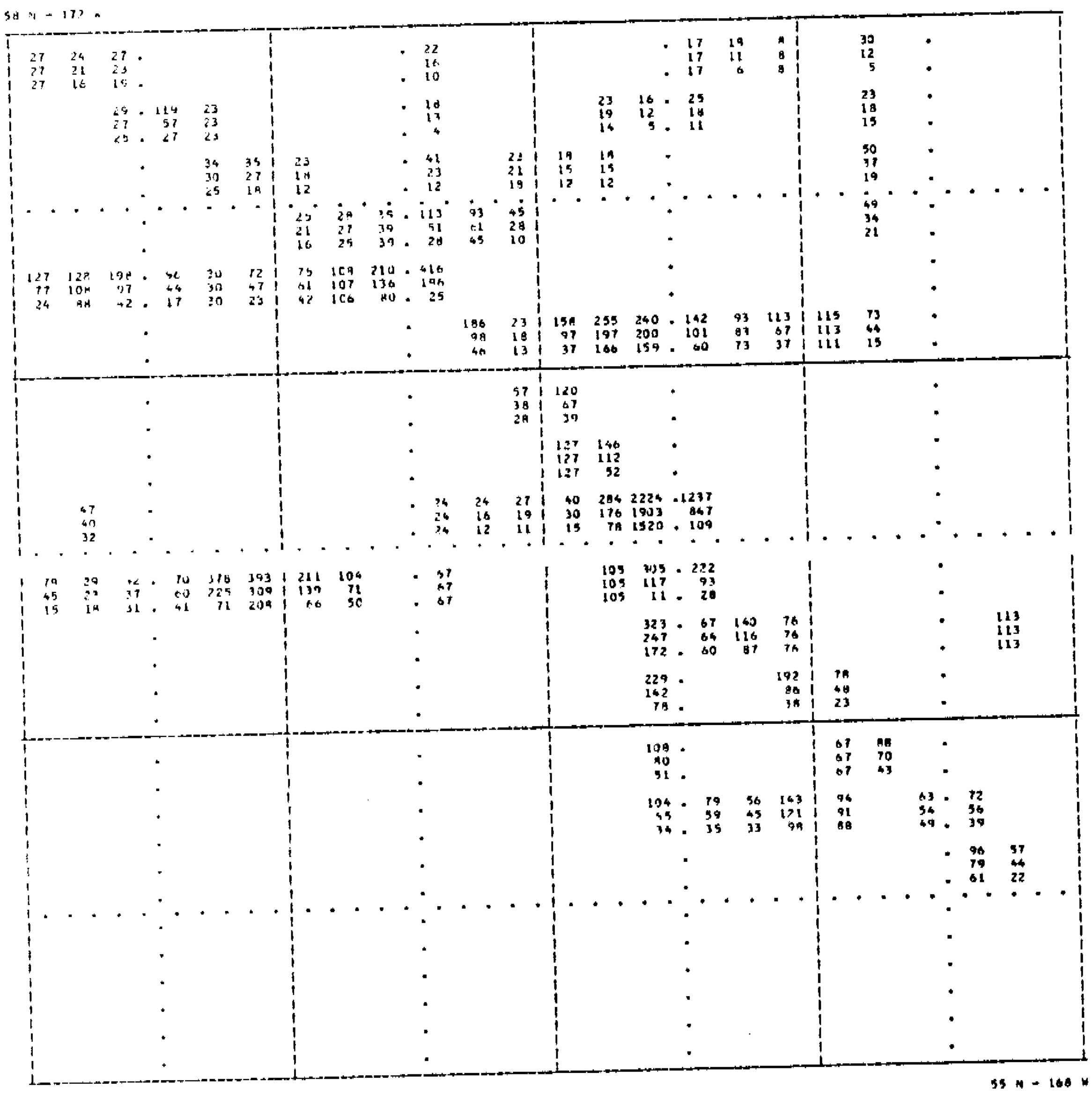
DATE OF ISSUE: OCTOBER 18, 1978

OCSEAP - MAXIMUM, MEAN, AND MINIMUM BIRDS/KM2 FOR ALL TRANSECTS WITHIN EACH 10' X 10' BLOCK

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

OC1701 - ALL SPECIES

7 JULY 1977 - 11 JULY 1977



EACH BLOCK CONTAINS THREE VALUES. THE TOP VALUE IS THE MAXIMUM NUMBER OF BIRDS/KM2 FOR ALL TRANSECTS IN THAT BLOCK. THE MIDDLE VALUE IS THE MEAN NUMBER OF BIRDS/KM2 FOR ALL TRANSECTS IN THAT BLOCK. THE BOTTOM VALUE IS THE MINIMUM NUMBER OF BIRDS/KM2 FOR ALL TRANSECTS IN THAT BLOCK. ASTERISKS INDICATE THAT THE NUMBER TO BE PRINTED WAS GREATER THAN 9999.

Figure 1

Digital Density Plot

by 10' blocks. Contour maps, on the other hand, contour individual sightings data. It is not a foregone conclusion that a contour algorithm is appropriate for census data of this type, as they do not represent a continuous function over the area to be contoured. However, its potential use is an attractive alternative to the digital density plots, allowing the user a more convenient visualization of regions of high abundance.

During this quarter, a contour program has been prepared for use. The program, written by Calcomp, Inc., allows the user several options with respect to treatment of incoming data. There is no absolute determination of the most appropriate choice of options, however a reasonable choice of a 20x20 grid, third order fit with 12 nearest neighbors is shown in Figure 2 for all birds in RU 083 field operation UCI501.

This contour map plus several others illustrating the range of options available is being sent to RU 083 for critique, and pending any other choice of parameters, the program is ready for use in a production mode.

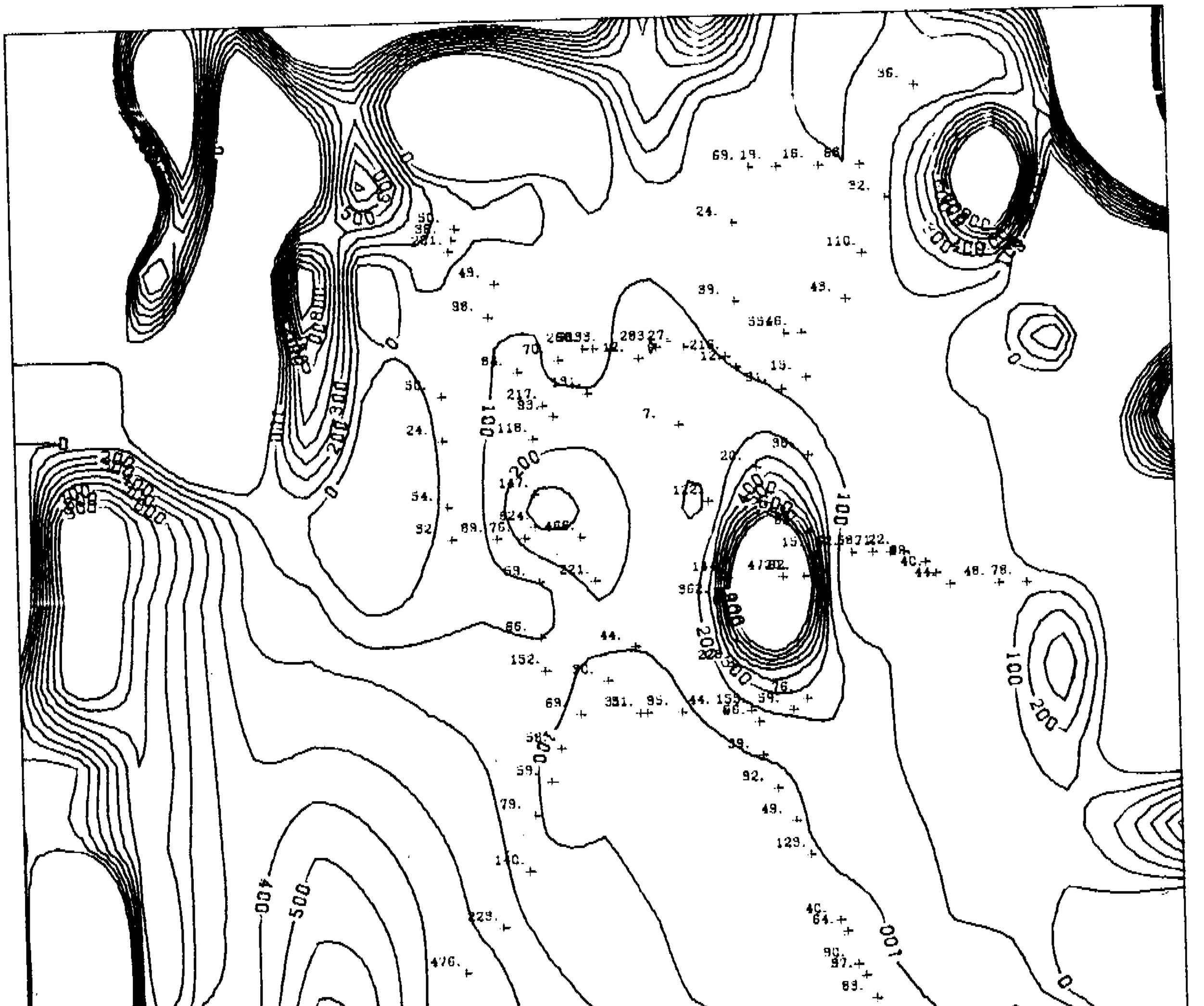
* Star Diagram

In this product, sightings data are grouped by flight direction within some block size (one degree at present). The number of birds of a given type flying in a given direction (± 15 degrees) found within that block is represented by a vector. In one option, the length of the vector (not including the arrowhead) is proportional to the number of birds whose direction is the same as that of the vector (north is at the top of the plot). In another option, the vector length is proportional to the fraction of the total birds flying in all directions within that block represented by the birds flying in a given direction. The latter option is represented in Figure 3. In either option, the origin of all vectors is the center of the block, and the number of birds is indicated at the tip of each vector.

Sample output has been sent to RU 083 for stipulation of any changes in its design. Following their implementation, the product will be ready for production. Data can be selected by species, season, field operation, time of day, etc., in its use.

* Statistical Analyses

Three programs, a stepwise multiple regression, factor analysis, and canonical correlation from the Statistical Package for the Social Sciences (SPSS), were realied for use as the fourth analysis product.



CONTOUR 20 X 20 GRID. 3RD ORDER. 12 NEIGHBORS. LEVELS 0 TO 900 BY 100

Figure 2

Contour Map

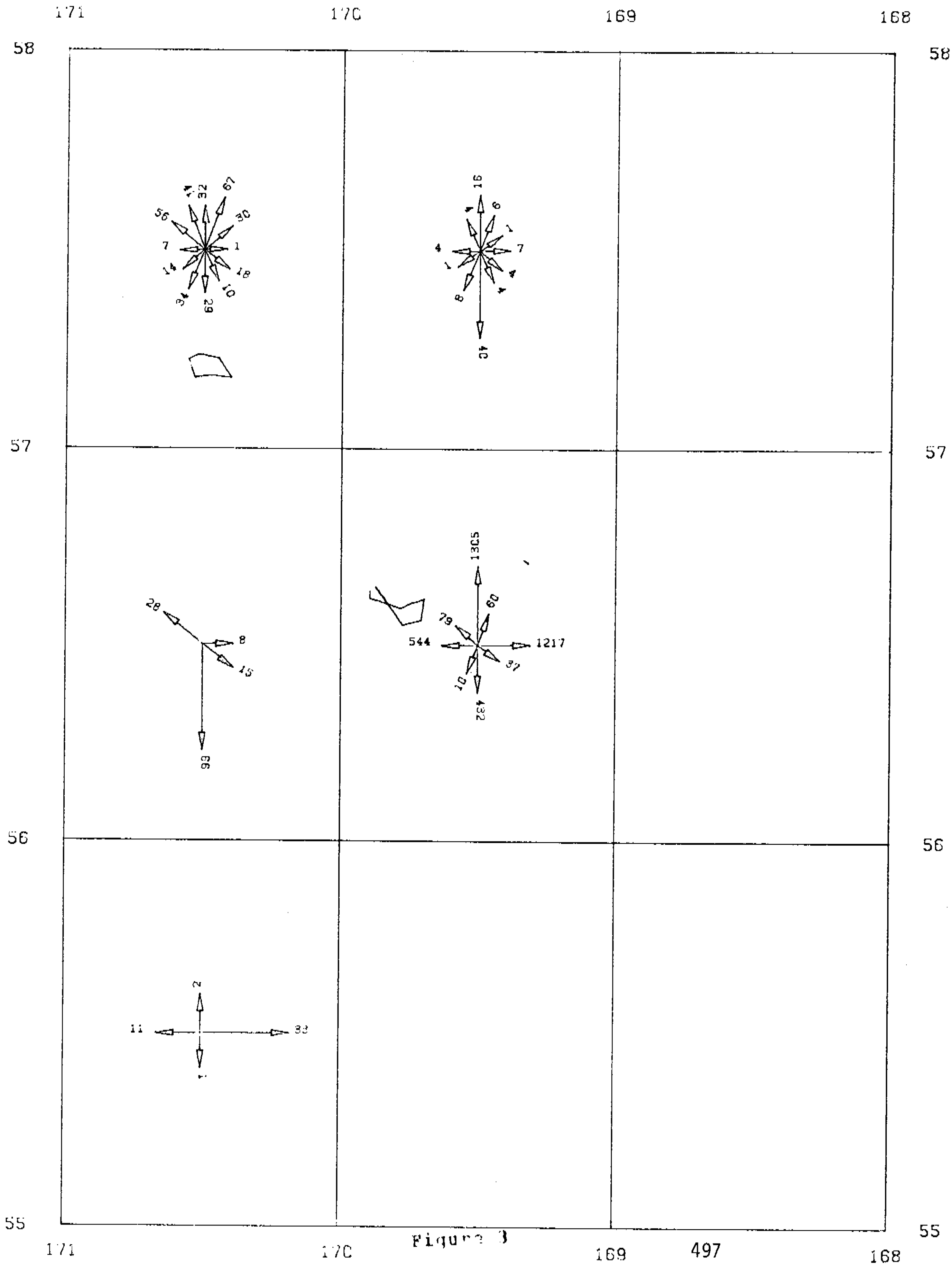


Figure 3

STAR DIAGRAM

As a test case, northern fulmar density abundance data from RU 083 field operation UCI701 have been compared with five physical parameters (distance to shelf break, distance to nearest land, sea surface salinity, sea surface temperature, and depth to bottom). The data were first considered independent of time of observation, and then again for those sightings made before 10 AM, local time. It was found that a significant portion of the variance in the density distribution could be accounted for in terms of these physical parameters in this case, suggesting that such a product can indeed form a significant part of the overall analysis of bird census data.

An interesting point with regard to this product is that there are two options available to the user for treatment of input data. In one, the analysis is carried out for a given sighting only if all five physical parameters are present for that sighting, and in the other, the analysis is carried out even if one or more of the parameters is (are) missing. There is a difference in the reliability of the results depending on the option chosen. As only one test case has been studied so far, it cannot be stated at this time which of the options gives the best results, however this will be an interesting aspect of the usefulness of this product, as there are many instances in which not all the parameters were collected.

The analysis is being sent to RU 083 for consideration. If no additional parts of the overall analysis are required, the product is ready for production use.

_Distributed_Data_Entry/Processing_

The distributed processing system first described in the previous Quarterly Report has been brought closer to installation.

The network will initially consist of Texas Instruments Model 771 Intelligent Terminals at the University of California at Irvine (RU 083), the Point Reyes Bird Observatory, Stinson Beach, California (RU's 196 and 172), the College of the Atlantic, Bar Harbor, Maine (RU 237), and the U.S. Fish and Wildlife Service Anchorage, Alaska (RU 337). A Texas Instruments Model 774 Intelligent Terminal will serve as the host site at the University of Rhode Island (RU 527).

Each of the 771's will be capable of stand-alone prompted data entry using forms design programming provided by the host site. Three of them, RU 083, RU 337, and RU's 196/172, will also have the capability for remote job entry (RJE) submission of entered data to the host site, and also receipt of product analyses using this equipment. Should the need arise, the other

771 is field upgradable. Additionally, all sites will be capable of stand-alone processing using the Basic language, or through the use of another language, Procedures, also available on the equipment. Both RU 083 and RU 337 have mainframe systems available locally, and provision has also been made for asynchronous communication between these units and the respective mainframes. RU 237 also has a mainframe available locally, and should the need arise, that unit can be upgraded to provide for such communication as well.

The host site will receive data from each 771 site either via RJE protocol or as the result of sending diskettes through the mail, and will use asynchronous and RJE communications to an ITEL AS/5 mainframe system available locally to record the data on tape for submission to NODC and also to convert the data into a data base format for use in product analyses. The results of the analyses will be transmitted to the 771 sites for use.

At this time, equipment is being ordered, and network operatior should commence during the upcoming quarter.

Financial Report

The financial report given in Figure 4 shows expenses during this quarter in terms of salaries (and indirect costs), computer expenses, rental of equipment, travel, supplies, and other.

Activity/Milestone Chart

The Activity/Milestone Chart given in Figure 5 shows actual and planned completion dates for past, present, and future activities.

Figure 4

OCSEAP Data Processing Services

Financial Report

Period Covered: 10/1/78 - 12/31/78

Salaries	$11,667.95
Indirect Costs (55% of salaries)	6,417.37
Sub-total	$18,085.32
Supplies	266.78
Travel	28.50
Equipment rental	374.00
Equipment	185.00
Computer	6,008.20
Other (Xeroxing, postage, etc.)	213.33
Total	$25,161.13

Figure 5

Activity/Milestone Chart

RU #: 527 PI: Harold Petersen Jr. -- University of Rhode Island

	1978										1979											
Major Milestones	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Choice of validation criteria for type 038 data		X																				
Procedures for validation of FWS type 038 data operational											O											
Procedures for validation of 033 data operational	X																					
Procedures for conversion of 033 data operational							X															
Completion date for editing 033 data										X												
Completion date for conversion of 033 data													O									
Feasibility study for distributed data entry and processing completed							X															
Establishment of distributed data entry and processing node at RU 527													O									
Establishment of distributed data entry sites at RU 083, RU 337, RU 237 and RU's 196/172													O									

(continued)

Establishment of format for four Program-authorized 033 data analysis products for RU 083			X							
Delivery of first of four 033 analysis products to RU 083 and JPO					X					
Delivery of evaluation samples of remaining 033 analysis products to RU 083 and JPO						O				
Quarterly Reports	X	X		X		X	O	O	O	
Annual Report	X						O			
Final Report										O

Past Contract <-- Period --><--------- Present Contract Period -------->

O = Planned Completion Date
X = Actual Completion Date
FWS = Fish and Wildlife Service
NODC = National Oceanic Data Center

Appendix I

Field Operation Status Report

*** FIELD OPERATION STATUS REPORT ***

AS OF 12/31/78

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

COLUMN HEADING DEFINITIONS:

TAPE NUMBER - IDENTIFYING NUMBER ASSIGNED TO THE TAPE AS IT IS RECEIVED BY RU 527.

RESEARCH UNIT - RESEARCH UNIT NUMBER OF THE PRINCIPAL INVESTIGATOR.

DATE RECEIVED - DATE THE TAPE WAS RECEIVED BY RU 527.

FILE FORMAT - FORMAT IN WHICH THE DATA ON THE TAPE HAVE BEEN CODED.

FIELD OPER. - NAME ASSIGNED TO THE FIELD OPERATION BY THE PRINCIPAL INVESTIGATOR. "FW" FIELD OPS. FROM DR. CALVIN LENSINK; "UCI" FIELD OPS. FROM DR. GEORGE HUNT; "W" FIELD OPS. FROM DR. JOHN WIENS; "UC" FIELD OPS. FROM DR. JUAN GUZMAN; "SP" & "DT" FIELD OPS. FROM DR. GEORGE DIVOKY; "AERSR" FIELD OPS. FROM JOE TRUETT.

CODEPULL MAILED - DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "CODEPULL" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.

LOGLIST MAILED - DATE THE OUTPUT FROM THE QUALITY CONTROL PROGRAM "LOGLIST" WAS MAILED TO THE PRINCIPAL INVESTIGATOR FOR CORRECTIONS.

CODEPULL RETURNED - DATE THE CORRECTED OUTPUT FROM "CODEPULL" WAS RECEIVED BY RU 527.

LOGLIST RETURNED - DATE THE CORRECTED OUTPUT FROM "LOGLIST" WAS RECEIVED BY RU 527.

EDITLOG COMPLETE - DATE THE CORRECTIONS WERE MADE TO THE FIELD OP. AT RU 527, THROUGH THE USE OF AN INTERACTIVE PROGRAM "EDITLOG".

FINAL CHECK - DATE THE FIELD OP. WAS READY FOR CONVERSION OR TRANSFORMATION. OCCASIONALLY ADDITIONAL PROBLEMS ARISE WHEN "CODEPULL" AND "LOGLIST" ARE RERUN AFTER EDITING. IF THESE CANNOT BE RESOLVED OVER THE TELEPHONE THE LISTINGS ARE SENT BACK TO THE PI FOR FURTHER CORRECTIONS. THIS FIELD IS NOT FILLED IN UNTIL ALL CORRECTIONS HAVE BEEN MADE.

CONVERT TO NODC - DATE THE FIELD OP. WAS CONVERTED FROM FWS FORMAT TO NODC FORMAT. AN "NA" (NOT APPLICABLE) IS ENTERED HERE FOR FIELD OPS. RECEIVED IN NODC FORMAT.

MAIL TO NODC - DATE THE FIELD OP. IN FINAL FORM WAS SUBMITTED TO NODC.

ENDNOTES - REFERENCE NUMBER TO ADDITIONAL COMMENTS FOLLOWING THE TABLE.

*** FIELD OPERATION STATUS REPORT ***

AS OF 12/31/78

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEPULL MAILED	LOGLIST MAILED	CODEPULL RETURNED	LOGLIST RETURNED	EDITLOG COMPLETE	FINAL CHECK	CONVERT TO NODC	MAIL TO NODC	END NOTES
ALASKA1	337	03/12/77	FWS	FW5004	07/12/77	08/16/77	08/29/77	10/06/77	02/15/78	02/15/78	10/06/78	10/31/78	1A,8
ALASKA2	337	03/12/77	FWS	FW5009	07/12/77	08/16/77	10/06/77	10/06/77	01/26/78	01/30/78	09/05/78	09/18/78	1A,8
				FW5013	07/12/77	08/16/77	08/29/77	10/06/77	01/24/78	01/26/78	10/17/78	11/10/78	1A,8
				FW5018	07/12/77	08/16/77	08/29/77	10/06/77	01/30/78	02/01/78	09/02/78	10/31/78	1A,8
				FW5023	07/12/77	08/16/77	08/29/77	10/06/77	02/06/78	02/14/78	11/01/78	11/10/78	1A,8
				FW5024	07/12/77	08/16/77	08/29/77	10/06/77	02/14/78	02/15/78	11/01/78	11/10/78	1A,8
				FW5030	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	08/30/78	09/18/78	6,8
				FW5032	07/12/77	08/16/77	08/29/77	10/06/77	12/01/77	12/05/77	08/30/78	09/18/78	6,8
ALASKA3	337	05/27/77	FWS	FW5008	07/14/77	08/16/77	09/06/77	09/06/77	12/09/77	12/09/77	09/07/78	09/18/78	8
				FW5016	07/14/77	08/16/77	09/06/77	09/06/77	07/25/78	07/28/78	11/15/78	11/30/78	1A,8
				FW5021	07/14/77	08/16/77	09/06/77	09/06/77	07/26/78	07/28/78	11/02/78	11/10/78	1B,8
				FW5026	07/14/77	08/16/77	09/06/77	09/06/77	01/31/78	02/01/78	11/17/78	11/30/78	8
				FW5027	07/14/77	08/16/77	09/06/77	09/06/77	02/03/78	02/06/78	09/05/78	09/18/78	8
				FW5033	07/14/77	08/16/77	09/06/77	09/06/77	07/28/78	07/31/78	11/15/78	11/30/78	1B,8
				FW5035	07/14/77	08/16/77	09/06/77	09/06/77	01/30/78	02/01/78	11/15/78	11/30/78	8
				FW6008	12/12/77	12/12/77	01/10/78	01/10/78	08/02/78	08/08/78	12/22/78		1B
				FW6027	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/26/78			1C
				FW6050	07/14/77	08/16/77	09/06/77	09/06/77	10/02/78	10/06/78			1C
				FW6051	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/27/78			1C
				FW6074	07/14/77	08/16/77	09/06/77	09/06/77	08/08/78	09/08/78	11/29/78	12/15/78	1B,8
				FW6083	07/14/77	08/16/77	09/06/77	09/06/77	07/21/78	07/24/78			1B
ALASKA4	337	06/24/77	FWS	FW5011	08/16/77	08/16/77	11/01/77	11/01/77	10/24/78	10/27/78	11/09/78	11/30/78	1C,8
				FW5012	08/16/77	08/16/77	11/01/77	11/01/77	10/17/78	10/17/78	11/16/78	11/30/78	1C,8
				FW5020	08/16/77	08/16/77	11/01/77	11/01/77	10/31/78	11/02/78	11/09/78	11/30/78	1C,8
				FW5031	08/16/77	08/16/77	11/01/77	11/01/77	10/24/78	10/26/78	12/21/78		1C
				FW5034	08/16/77	08/16/77	11/01/77	11/01/77	04/17/78	04/19/78	09/03/78	10/31/78	8
				FW6015	08/16/77	08/16/77	11/01/77	11/01/77	04/05/78	04/18/78	09/06/78	09/18/78	8
				FW6018	08/16/77	08/16/77	11/01/77	11/01/77	10/24/78	10/26/78			1C
				FW6019	08/16/77	08/16/77	11/01/77	11/01/77	12/01/78	12/14/78	12/22/78		1C
				FW6067	08/16/77	08/16/77	11/01/77	11/01/77	10/24/78	10/26/78	11/29/78	12/15/78	1C,8
				FW6068	08/16/77	08/16/77	11/01/77	11/01/77	10/24/78	10/26/78	11/29/78	12/15/78	1C,8
				FW6088	09/29/77	09/29/77	10/20/77	10/20/77	10/24/78	10/26/78	11/02/78	11/10/78	1C,8
				FW6089	08/16/77	08/16/77	11/01/77	11/01/77	07/21/78	07/24/78	11/29/78	12/15/78	1B,8
				FW6094	08/16/77	08/16/77	11/01/77	11/01/77	10/19/78	10/20/78			1C
ALASKA5	337	07/01/77	FWS	FW5015	09/29/77	09/29/77	10/20/77	10/20/77	08/08/78	08/09/78	11/15/78	11/30/78	1B,8

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THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

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ALASKA5	337	07/01/77	FWS	FW5025	09/29/77	09/29/77	10/20/77	10/20/77	07/24/78	07/26/78	12/21/78		1E
				FW6001	09/29/77	09/29/77	10/20/77	10/20/77	04/20/78	04/28/78	09/06/78	09/18/78	8
				FW6002	09/29/77	09/29/77	10/20/77	10/20/77	07/24/78	07/26/78	12/21/78		1E
				FW6007	09/29/77	09/29/77	10/20/77	10/20/77	07/24/78	07/27/78	12/22/78		1E
				FW6009	09/29/77	09/29/77	10/20/77	10/20/77	08/03/78	08/08/78	11/29/78	12/15/78	1E,8
				FW6021	10/28/77	10/28/77	11/30/77	11/30/77	07/25/78	07/26/78	12/01/78	12/15/78	1E,8
				FW6026	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	04/28/78	10/12/78	10/31/78	8
				FW6029	09/29/77	09/29/77	10/20/77	10/20/77	04/26/78	05/08/78	10/12/78	10/31/78	8
				FW6057	09/29/77	09/29/77	10/20/77	10/20/77	08/04/78	08/07/78	12/01/78	12/15/78	1E,8
				FW6064	09/29/77	09/29/77	10/20/77	10/20/77	07/21/78	07/27/78			1E
				FW6066	09/29/77	09/29/77	10/20/77	10/20/77	02/22/78	02/24/78	11/02/78	11/10/78	8
				FW6070	09/29/77	09/29/77	10/20/77	10/20/77	08/03/78	08/07/78	11/29/78	12/15/78	1E,8
				FW6095	09/29/77	09/29/77	10/20/77	10/20/77	08/08/78	08/09/78			1E
ALASKA6	337	07/07/77	FWS	FW5014	10/21/77	10/21/77	11/14/77	11/14/77	02/17/78	02/22/78	09/05/78	09/18/78	8
				FW5022	10/21/77	10/21/77	11/14/77	11/14/77	11/09/78	11/10/78	11/10/78	11/30/78	1F,8
				FW5029	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/14/78	12/21/78		1F
				FW5036	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78	11/09/78	11/30/78	8
				FW5037	10/21/77	10/21/77	11/14/77	11/14/77	06/05/78	06/07/78	11/10/78	11/30/78	8
				FW6004	10/21/77	10/21/77	11/14/77	11/14/77	12/15/78	12/18/78	12/21/78		1F
				FW6005	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78		1F
				FW6010	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78		1F
				FW6011	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/22/78		1F
				FW6012	10/21/77	10/21/77	11/14/77	11/14/77	11/09/78	11/10/78	11/29/78	12/15/78	1F,8
				FW6016	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/14/78	12/22/78		1F
				FW6028	10/21/77	10/21/77	11/14/77	11/14/77	06/07/78	06/08/78	10/11/78	10/31/78	8
				FW6052	10/21/77	10/21/77	11/14/77	11/14/77	12/18/78	12/21/78	12/22/78		1F
				FW6077	10/21/77	10/21/77	11/14/77	11/14/77	12/15/78	12/18/78	12/22/78		1F
				FW6078	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/14/78	12/22/78		1F
				FW6084	10/21/77	10/21/77	11/14/77	11/14/77	11/03/78	11/08/78	11/29/78	12/15/78	1F,8
				FW6085	10/21/77	10/21/77	11/14/77	11/14/77	10/24/78	10/26/78	11/02/78	11/10/78	1F,8
				FW6092	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/19/78	12/22/78		1F
				FW7026	10/21/77	10/21/77	11/14/77	11/14/77	10/24/78	10/25/78	10/26/78	10/31/78	1F,8
				FW7027	10/21/77	10/21/77	11/14/77	11/14/77	06/26/78	06/27/78	09/06/78	10/31/78	8
ALASKA7	083	07/07/77	FWS	UCI601	10/07/77	10/07/77	05/26/78	05/26/78	08/25/78	08/25/78	08/28/78		1G
ALASKA8	337	07/28/77	FWS	FW5038	10/28/77	10/28/77	11/30/77	11/30/77	11/21/78	11/22/78	11/22/78	11/30/78	1F,8
				FW6013	10/28/77	10/28/77	11/30/77	11/30/77	12/21/78	12/22/78			1F
				FW6025	10/28/77	10/28/77	11/30/77	11/30/77	06/15/78	06/19/78	10/11/78	10/31/78	8
				FW6082	10/28/77	10/28/77	11/30/77	11/30/77	11/16/78	11/20/78	11/29/78	12/15/78	1F,8

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ALASKA8	337	07/28/77	FWS	FW6087	10/28/77	10/28/77	11/30/77	11/30/77	11/09/78	11/10/78	11/29/78	12/15/78	1F,8
ALASKA9	337	08/03/77	FWS	FW5003	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/17/78	12/21/78		2,1H
				FW5006	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/13/78	12/21/78		2,1H
				FW5010	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/13/78	11/03/78	11/10/78	2,1H,8
				FW6006	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/13/78	11/29/78	12/15/78	2,1H,8
				FW6014	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/03/78	12/22/78		2,1H
ALASKA10	337	09/06/77	NODC	FW7032	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
				FW7033	10/07/77	10/07/77	11/03/77	11/03/77	11/22/77	11/30/77	/NA/	12/12/77	
ALASKA11	337	11/16/77	NODC	FW7034	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/10/78	/NA/	02/28/78	
				FW7035	11/30/77	11/30/77	01/04/78	01/04/78	01/06/78	01/17/78	/NA/	02/28/78	
				FW7042	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
				FW7046	11/30/77	11/30/77	01/04/78	01/04/78	01/09/78	01/16/78	/NA/	02/28/78	
ALASKA12	337	01/10/78	NODC	FW7028	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7031	01/18/78	01/18/78	01/30/78	01/30/78	02/01/78	02/02/78	/NA/	02/28/78	
				FW7036	01/18/78	01/18/78	01/30/78	01/30/78	01/31/78	02/01/78	/NA/	02/28/78	
				FW7045	01/18/78	01/18/78	01/30/78	01/30/78	02/01/78	02/01/78	/NA/	02/28/78	
ALASKA13	337	01/10/78	FWS	FW6086	01/18/78	01/18/78	01/30/78	01/30/78	07/26/78	07/26/78	10/26/78	11/10/78	1B,8
				FW6186	01/18/78	01/18/78	01/30/78	01/30/78	02/17/78	02/17/78	11/01/78	11/10/78	5,8
ALASKA14	083	04/10/78	NODC	UCI602	04/14/78	04/14/78	04/25/78	04/25/78	06/02/78	06/06/78	/NA/		
ALASKA15	083	06/13/78	NODC	UCI501	07/07/78	07/07/78	07/27/78	07/27/78	08/25/78	08/28/78	/NA/		7
				UCI701	07/07/78	07/07/78	07/27/78	07/27/78	09/05/78	09/05/78	/NA/		10
				UCI702	07/07/78	07/07/78	07/27/78	07/27/78	09/05/78	09/05/78	/NA/		10
				UCI703	07/07/78	07/07/78	07/27/78	07/27/78	08/25/78	08/28/78	/NA/		
				UCI704	07/07/78	07/07/78	07/27/78	07/27/78	08/25/78	08/28/78	/NA/		
ALASKA16	337	09/05/78	NODC	FW6093	09/08/78	09/08/78	09/18/78	09/18/78	10/23/78	10/25/78	/NA/	10/31/78	
				FW7029	09/08/78	09/08/78	09/18/78	09/18/78	10/23/78	10/25/78	/NA/	10/31/78	

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ALASKA17	467	10/23/78	NODC	AERSR1	10/30/78	10/30/78							9
				AERSR2	10/30/78	10/30/78							9
				AERSR3	10/30/78	10/30/78							9
				AERSR4	10/30/78	10/30/78							9
				AERSR5	10/30/78	10/30/78							9
				AERSR6	10/30/78	10/30/78							9
ALASKA18	083	12/15/78	NODC	UCI702									11
				UCI801									
				UCI802									
				UCI803									
				UCI804									
				UCI805									
				UCI806									
				UCI808									
OREGON1	108	05/25/77	NODC	W05220	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W05221	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W05310	10/26/77	10/26/77	01/03/78	01/03/78	05/08/78	05/17/78	/NA/	05/24/78	3B
				W05311	10/26/77	10/26/77	01/03/78	01/03/78	05/09/78	05/17/78	/NA/	05/24/78	
				W05325	10/26/77	10/26/77	01/03/78	01/03/78	05/10/78	05/17/78	/NA/	05/24/78	3B
				W06211	10/26/77	10/26/77	01/03/78	01/03/78	05/10/78	05/17/78	/NA/	05/24/78	3A
				W06221	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3A,3B
				W16140	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3B
				W16150	10/26/77	10/26/77	01/03/78	01/03/78	05/02/78	05/17/78	/NA/	05/24/78	3B
				W16161	10/26/77	10/26/77	01/03/78	01/03/78	05/12/78	05/17/78	/NA/	05/24/78	3A,3B
				W26140	10/26/77	10/26/77	01/03/78	01/03/78	05/05/78	05/17/78	/NA/	05/24/78	3B
				W36070	10/26/77	10/26/77	01/03/78	01/03/78	05/04/78	05/17/78	/NA/	05/24/78	3B
CANADA1	239	03/30/78	NODC	01UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/11/78	05/15/78	/NA/	06/12/78	4
				02UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/12/78	05/15/78	/NA/	06/12/78	4
				03UC75	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4
				01UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				02UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				03UC76	04/17/78	04/17/78	05/08/78	05/08/78	05/15/78	05/16/78	/NA/	06/12/78	4
				04UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
				05UC76	04/17/78	04/17/78	05/08/78	05/08/78	06/09/78	06/09/78	/NA/	06/12/78	4,1D
CALIF 1	196	07/18/78	NODC	1SR377	08/31/78	08/31/78							
				1SR477	08/31/78	08/31/78							

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CALIF 1	196	07/18/78	NODC	1DI577	08/31/78	08/31/78							

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ENDNOTES:

1. A. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (12/12/77), RETURNED TO RU 527 (01/10/78).
   B. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (03/16/78), RETURNED TO RU 527 (06/26/78).
   C. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (04/26/78), RETURNED TO RU 527 (07/05/78).
   D. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (05/18/78), RETURNED TO RU 527 (06/08/78).
   E. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (06/06/78), RETURNED TO RU 527 (06/26/78).
   F. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (06/27/78), RETURNED TO RU 527 (07/13/78).
   G. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (07/07/78), RETURNED TO RU 527 (07/27/78).
   H. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (07/21/78), RETURNED TO RU 527 (07/28/78).

2. TAPE WAS UNREADABLE, SENT BACK TO PI TO BE RE-GENERATED (08/31/77), RETURNED TO RU 527 (10/21/77).

3. A. UNAUTHORIZED LIGHT LEVEL AND WEATHER CODES USED BY PI, THESE WILL NOT BE INCLUDED IN SUBMISSION TO NODC.
   B. UNAUTHORIZED DISTANCE TO BIRDS ENTRY REPLACED BY OUTSIDE ZONE CODE FOR SUBMISSION TO NODC.

4. TAPE RETURNED TO PI BECAUSE SEVEN OF THE EIGHT EXPECTED FIELD OPS. COULD NOT BE FOUND (01/03/78).
   NEW TAPE WITH EIGHT FIELD OPS. RECEIVED (03/30/78).

5. FIELD OP. FW6186 IS A CONTINUATION OF FIELD OP. FW6086 BECAUSE FW6086 NEEDED MORE THAN 999 STATIONS.

6. ONE OF FIRST FIELD OPS. CONVERTED (02/28/78). FWS AND NODC FORMATS SENT TO PI FOR REVIEW.
   RETURNED TO RU527 FOR REVISIONS TO CONVERSION (07/07/78).

7. DATA FOR THIS FIELD OP. REPLACES THAT ORIGINALLY CODED IN FWS FORMAT AND RECEIVED ON TAPE ALASKA 7.

8. ADDITIONAL PROGRAM WAS REQUIRED TO CORRECT TRANSECT TYPE AND WIDTH FOR RU337.

9. TAPE HAD ONLY 2 OF 6 SPECIFIED FIELD OPS. RETURNED (10/12/78). NEW TAPE RECEIVED (10/23/78).

10. PROBLEMS WITH CODING OF ENVIRONMENT RECORDS DETECTED BY RU083 AFTER USUAL DATA VALIDATION
    COMPLETED. FURTHER CORRECTION NEEDED.

11. ADDITIONAL DATA FOR FIELD OP. UCT702 WHICH WAS ORIGINALLY RECEIVED ON TAPE ALASKA 15.

*** FIELD OPERATION STATUS REPORT ***

AS OF 12/31/78

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

SUMMARY:

TOTAL FIELD OPS. RECEIVED BY RU 527	136
CODEPULLS MAILED TO INVESTIGATOR	128
LOGLISTS MAILED TO INVESTIGATOR	128
CODEPULLS RETURNED TO RU 527	119
LOGLISTS RETURNED TO RU 527	119
TOTAL FIELD OPS. BEING EDITED AT RU 527	0
FIELD OPS. WHICH PASSED FINAL CHECK	119
FIELD OPS. CONVERTED TO NODC	72
FIELD OPS. MAILED TO NODC	84

Appendix II

Projected Completion Date for RU 337

File Type 033 Data

Projected Completion Date for RU 337

File Type 033 Data

Field Operation	Editing Stage	Ready to Convert	Processing Complete	Actual Mail Date	Projected Mail Date
Arctic Sea					
FW5008			X	09/18/78	
FW5010			X	11/10/78	
FW5021			X	11/10/78	
FW6085			X	11/10/78	
FW6086			X	11/10/78	
FW6186			X	11/10/78	
FW6088			X	11/10/78	
FW6093			X	10/31/78	
Bering Sea					
FW5011			X	11/29/78	11/30/78
FW5012			X	11/29/78	11/30/78
FW5013			X	11/10/78	
FW5014			X	09/18/78	
FW5015			X	11/29/78	11/30/78
FW5016			X	11/29/78	11/30/78
FW5018			X	10/31/78	
FW5020			X	11/29/78	11/30/78
FW5022			X	11/29/78	11/30/78
FW5023			X	11/10/78	
FW5026			X	11/29/78	11/30/78
FW5032			X	09/18/78	
FW5033			X	11/29/78	11/30/78
FW5035			X	11/29/78	11/30/78
FW5036			X	11/29/78	11/30/78
FW5037			X	11/29/78	11/30/78
FW6006			X	12/15/78	12/22/78
FW6009			X	12/15/78	12/22/78
FW6012			X	12/15/78	12/22/78
FW6015			X	09/18/78	
FW6021			X	12/15/78	12/22/78
FW6057			X	12/15/78	12/22/78
FW6066			X	11/10/78	
FW6067			X	12/15/78	12/22/78
FW6068			X	12/15/78	12/22/78

Field Operation	Editing Stage	Ready to Convert	Processing Complete	Actual Mail Date	Projected Mail Date
FW6070			X	12/15/78	12/22/78
FW6074			X	12/15/78	12/22/78
FW6082			X	12/15/78	12/22/78
FW6084			X	12/15/78	12/22/78
FW6087			X	12/15/78	12/22/78
FW6089			X	12/15/78	12/22/78
FW7029			X	10/31/78	
FW7042			X	09/14/78	
Aleutian Islands					
FW5038			X	11/29/78	11/30/78
Gulf of Alaska					
FW5003		X			01/26/79
FW5004			X	10/31/78	
FW5006		X			01/26/79
FW5009			X	09/18/78	
FW5024			X	11/10/78	
FW5025		X			01/26/79
FW5027			X	09/18/78	
* FW5028					
FW5029		X			01/26/79
FW5030			X	09/18/78	
FW5031		X			01/26/79
FW5034			X	10/31/78	
FW6001			X	09/18/78	
FW6002		X			01/26/79
FW6004		X			01/26/79
FW6005		X			01/26/79
FW6007		X			02/23/79
FW6008		X			02/23/79
FW6010		X			01/26/79
FW6011		X			02/23/79
FW6013		X			02/23/79
FW6014		X			02/23/79
FW6016		X			02/23/79
FW6018		X			02/23/79
FW6019		X			02/23/79
FW6025			X	10/31/78	
FW6026			X	10/31/78	
FW6027		X			02/23/79
FW6028			X	10/31/78	
FW6029			X	10/31/78	

Field Operation	Editing Stage	Ready to Convert	Processing Complete	Actual Mail Date	Projected Mail Date
FW6050		X			03/27/79
FW6051		X			03/27/79
FW6052		X			03/27/79
* FW6058					
FW6064		X			03/27/79
FW6077		X			03/27/79
FW6078		X			03/27/79
FW6083		X			03/27/79
FW6092		X			03/27/79
FW6094		X			03/27/79
FW6095		X			03/27/79
FW7026			X	10/31/78	
FW7027			X	10/31/78	
FW7028			X	09/14/78	
FW7031			X	09/14/78	
FW7032			X	09/14/78	
FW7033			X	09/14/78	
FW7034			X	09/14/78	
FW7035			X	09/14/78	
FW7036			X	09/14/78	
FW7045			X	09/14/78	
FW7046			X	09/14/78	
* FW7047					

* Field Operations not yet received, no estimate possible

OCSEAP DATA VALIDATION PROCEDURES
For File Type 033
(Release 6: December 31, 1978)

In order to provide data validation for the File Type 033 data from the OCSEAP Project, four areas need consideration. These include card type validation, data range and relational parameter checking, and format, code, or unit conversion. Since this is a multi-card type file, the card type designation must first be verified (an incorrect value would lead to the improper interpretation of remaining fields on that card), along with the occurrence and sequencing of card types. Second, codes used in each code field (ex. - a two digit weather code) must be compared against all valid codes for that field for verification. Next, range checks must be carried out on all appropriate fields (ex. - sea surface temperature should be between certain upper and lower limits), and relational checks on interrelated fields (ex. - wet bulb temperature readings should be less than or equal to corresponding dry bulb temperature readings). Lastly, if the data are not coded in NODC format, the necessary format changes must be carried out.

Card type designation and sequencing, and valid code field contents are checked in a program called CODEPULL. First the card type is verified. This must be between one and five, and certain other fields are also checked for further verification (ex. - a type five card must have a taxonomic code and a sequence number). Extra cards and missing cards are detected with the sequencing routine. This checks that the cards are in order, that each station has a unique one card followed by a unique two card, and that there are no duplicated or skipped sequence numbers. Then the appropriate code tables are called, and each code of each code field is compared with the appropriate table containing all valid codes for that field.

The output from CODEPULL is a listing of the file in order by station number. Any errors detected are flagged by a brief descriptive message, including a record count for ease in correcting, and, in the case of a bad code, a string of asterisks under the field. Following the file listing is a summary of all the codes used for each code field and their definitions. For a bad code, the record in which it appeared replaces the definition. Figure 1 is a list of the code groups checked and Figure 2 is a portion of a CODEPULL listing.

Data range and relatonal checking are done in a program called LOGLIST. This verifies the data coded as raw numbers, rather than as codes. The contents of the data fields are first checked for numerics, signs, and leading zeros and then compared to upper and lower limits appropriate to each field. In some cases the value of one field is dependent on the value of another field and these relational checks are also made.

LOGLIST prints a columnar listing for each card type. The columns are identified by a three character field code defined prior to the data listing. The record number is listed on the left and any errors detected are flagged in the diagnostics section on the right. A totally blank field is indicated by a row of dots and embedded blanks by an asterisk. Figure 3 is a list of the limit and relational checks made and Figure 4 is a portion of a LOGLIST listing.

These outputs are sent to the Principal Investigator for correcting. He checks the diagnostic messages and the data and marks any necessary corrections directly on the listing. These are returned to us and the updates made to the file with an interactive program called EDITLOG. Then CODEPULL and LOGLIST are rerun for final verification.

Finally the data are converted to NODC format (if they were coded in another format) and submitted to NODC. Format conversion is done with a program called CONVPROG. Many different operations are carried out at this point. For example, data fields are moved from one place to another on a given card, or onto a different card; units are converted and rounded or truncated, or converted to codes; and codes are converted to those equivalent codes acceptable to NODC. Figure 5 is a list of the conversion routines carried out. Data collected in NODC format is also run through the conversion program. This is necessary in order to standardize certain fields since coding varies between investigators, and includes providing leading zeros or blanks, and checking for signs. Figure 6 is a list of transformation routines required.

All of these programs form part of the MARMAP Information System. Their operation is directed by a Master System Table (MST). The MST has an entry for each field of each card type in a file. This contains all the information needed for processing, including field code, data type, position, upper limit, lower limit, relational checking and conversion routines. The programs therefore are data independent and readily adaptable to any file type.

NOTE: An * denotes a change in this entry since the previous report.

FIGURE 1: CODE GROUPS VALIDATED

Code Field	FWS Columns	NODC Columns
CARD TYPE 1		
Platform Type	67-68	69
Ship Activity	70	71
Sampling Technique	69	70
Collection Code	-	72
Zone Scheme	-	73
Angle of View	-	74
Observation Conditions	-	75
Speed Type	60	-
O.B.S. Region	28-30	-
Observer Location	74	-
CARD TYPE 2		
Wind Direction	-	45-46
Swell Direction	-	50-51
Sea State	-	49
Weather	16-17	55-56
Cloud Type	-	57
Cloud Amount	-	58
Water Color	-	59
Visibility	18	61
Sun Direction	-	62
Glare Intensity	61	63
Glare Area	62	64
Moon Phase	-	68
Tide Height	-	69
Debris	-	80
Observation Conditions	19	-
Turbidity	-	63
CARD TYPE 3		
Ice Cover	16,23,35	16,22,51
Ice Pattern/Description	17,24	32
Ice Type	18,25	17,23
Ice Form	19,26,34	18,24,50
Ice Relief	20,27	19,25
Ice Thickness	21,28	20,26
Ice Melting Stage	22,29	21,27
Open Water Type	30	28
Ice Direction	31,36	29,33
Distance	32,37	30,34
Lead/Polyna Width	33,39,40	31,43,44
Ship in Lead/Polyna Location	38	42
Collection Code	41,42,43	35,36,37
Mammal Trace	44,45	38,39
Pond Size	-	49
Ice Pattern	-	40,41

Code Field	FWS Columns	NODC Columns
CARD TYPE 4		
No Code Groups Appear Here.		
CARD TYPE 5		
Age Class	50	32
Sex	51	33
Color Phase	52	34
Plumage	53	35
Molt	54	36
Counting Method	-	42
Reliability	-	43
Distance Measurement Type	-	44
Association Type	55-56	50
Behavior	46-47	56-57
Special Marks	62	58
Bird Condition	63	59
Food Source Association	-	60
Debris	74	71
Oil	-	72
Habitat	-	76,77
Substrate Type	-	81
Cover Code	-	82
Outside Zone	-	83
Text Flag	77	-

NOTE: An * denotes a change to this entry since the previous report

FIGURE 2: SAMPLE CODEPULL LISTING

CODEPULL consists of two major sections. The first lists the data, sorted by station, card type, and sequence number, flagging any errors detected. The second sums the records by card type; then lists all the codes used in the file with their definitions.

Figure 2A is a page from the first section showing how the file is listed. The dashed lines divide the stations which are listed in order by card type and sequence number. The incorrect records are flagged and numbered, first by record#, which gives the location in the entire file; and second by card type#, which gives the location relative to other records of the same type. This second number corresponds to the record number on LOGLIST. The following errors have been flagged:

Bad Card Type -->
The card type is not between 1 and 5.

Missing 2 Card -->
No environment data was entered for this station.

Bad Code -->
The code entered in the field delimited by an asterisk is invalid.

Needs Seq No. -->
The 5 card is missing a sequence number.

Suspicious seq# -->
The sequence number 002 has been skipped, this also flags duplicate sequence numbers.

Figure 2B is a portion of the second section. This first gives a summary of the number of each type of record found in the file, then a list of the codes used and their definitions. For an invalid code the definition is replaced by the record number in which it appeared, as can be seen for the Visibility Code on card type 2.

```
*** CODEFILE - FOR CRUISE FW9001 - FORMAT FWS

--------------------------------------------------------------------------------------------------------------------------
                                  033FW900100170158380148240W09122021800          05+100150        1351 10
                                  033FW9001001702037 29015 2 6  43           97730 143
RECORD #     3
TYPE 0 #     1  BAD CARD TYPE -->
                                  033FW9001001706NOFU8803020201        30020          6                        004
                                  033FW9001001705GWGU8810090103      3000020                                   001
                                  033FW9001001705GWGU8810090103       102040                                   002
                                  033FW9001001705BLKI8810080301        50020                                   003
--------------------------------------------------------------------------------------------------------------------------
                                  033FW900100178158460148270W09122 21800          15+1001501159    1333 10
RECORD #     8
TYPE 2 #     1  MISSING 2 CARD -->
                                  033FW9001001785UNGU8810090100        22030                                   001
                                  033FW9001001785GWGU8810080103        40010                                   002
                                  033FW9001001785UNMU8810100300        11020                                   003
                                  033FW9001001785UNMU8810100300        22030                                   004
                                  033FW9001001785NOFU8803020201        20010          6                        005
RECORD #    13
TYPE 5 #     4  BAD CODE -->      033FW9001001785NOPU8803020201        11020          X                        006
                                                                                      *
                                  033FW9001001785NOFU8803020201        12030          6                        007
                                  033FW9001001785NOFU8803020201        10010          2                        008
521
--------------------------------------------------------------------------------------------------------------------------
                                  033FW000100270158420148220W09122021900 .         5+100150        1351 10
RECORD #    17
TYPE 2 #     2  BAD CODE -->      033FW9001002702030A 060 8 0 2  40          98130 150
                                                 *

RECORD #    18
TYPE 5 #    12  NEEDS SEQ NO. -->
                                  033FW9001002705NOFU8803020201        72040          6
                                  033FW9001002705NOFU8803020201       100020          6                        001
RECORD #    20
TYPE 5 #    14  SUSPICIOUS SEQ# -->
                                  033FW9001002705NOFU8803020201        30020          2                        003
                                  033FW9001002705NOFU8803020201        22040          2                        004
                                  033FW9001002705GWGU8810080103      1620020                                   005
                                  033FW9001002705GWGU8810080103       532040                                   006
                                  033FW9001002705GWGU8810080103      1770020        N                          007
                                  033FW9001002705GWGE881009010000001   10020                                   008
--------------------------------------------------------------------------------------------------------------------------
                                  033FW000100271158200146270W09224 21900          15+1001501090    1333 10
                                  033FW9001002712037 30018 3 6  30           9810-2516
                                  033FW9001002715GWGU8810080103        20010                                   001
                                  033FW9001002715GWGU8810080103        31020                                   002
                                  033FW9001002715GWGU8810080103        22030                                   003
                                  033FW9001002715UNLG881008010000003   22030                                   004
                                  033FW9001002715NOFU8803020201        11020          6                        005
--------------------------------------------------------------------------------------------------------------------------
```

FIGURE 2A

***** SUMMARY *****

FOR CRUISE FW9001

661 TOTAL RECORDS

113 TYPE 1 RECORDS
112 TYPE 2 RECORDS
0 TYPE 3 RECORDS
2 TYPE 4 RECORDS
433 TYPE 5 RECORDS

1 RECORDS WITH AN INVALID TYPE

RECORD TYPE 1

CODE FIELD: O.C.S. REGION - FWS(1:28-30)

CODES	COMMENT
091	NORTHWEST GULF OF ALASKA (NWGOA)
092	NORTHEAST GULF OF ALASKA (NEGOA)

CODE FIELD: SPEED TYPE - FWS(1:60)

CODES	COMMENT
BLANK	-
1	SPEED MADE GOOD

CODE FIELD: PLATFORM TYPE - FWS(1:67-68)

CODES	COMMENT
13	MOANA WAVE

CODE FIELD: SAMPLING TECHNIQUE - NODC(1:70) - FWS(1:69)

CODES	COMMENT
5	COUNT FROM SHIP TO HORIZON WITH ZONE
3	COUNT FROM SHIP TO FIXED DISTANCE WITH ZONE

FIGURE 2B

*** CODEFILE - FOR CRUISE FW9001 - FORMAT FWS

CODE FIELD: SHIP ACTIVITY - FWS(1:70)

CODES	COMMENT
1	STATIONARY/LAYING TO
3	STEAMING

CODE FIELD: OBSERVER LOCATION - FWS(1:74)

CODES	COMMENT
BLANK	-

RECORD TYPE 2

CODE FIELD: WEATHER - NODC(2:55-56) - FWS(2:16-17)

CODES	COMMENT
03	CLOUDS GENERALLY FORMING OR DEVELOPING
75	CONTINUOUS FALL OF SNOW FLAKES, HEAVY
00	CLOUD DEVELOPMENT NOT OBSERVED OR NOT OBSERVABLE
71	CONTINUOUS FALL OF SNOW FLAKES, SLIGHT
43	FOG OR ICE FOG, SKY INVISIBLE, THINNING DURING LAST HOUR
68	RAIN OR DRIZZLE AND SNOW, SLIGHT
69	RAIN OR DRIZZLE AND SNOW, MODERATE OR HEAVY

CODE FIELD: VISIBILITY - NODC(2:61) - FWS(2:18)

CODES	COMMENT
7	10-20 KM
A	*** 000017
8	20-50 KM
3	500-1000 METRES
6	4-10 KM
4	1-2 KM
5	2-4 KM
BLANK	-

CODE FIELD: OBSERVATION CONDITIONS - FWS(2:19)

CODES	COMMENT
BLANK	-

CODE FIELD: GLARE INTENSITY - NODC(2:63) - FWS(2:61)

CODES	COMMENT
BLANK	-

FIGURE 3: LIMITS AND RELATIONAL CHECKS

Field	Format	Ranges		Relations
ALL CARD TYPES				
File Type		-		Must be 033
File ID		-		Must match that of first record on file
Unused Columns		-		Must be blank
CARD TYPE 1				
Start/End Latitude	F	33-73	degrees	-
		0-599	minutes/tenths	
	N	33-73	degrees	-
		0-59	minutes	
		0-59	seconds	
		N	hemisphere	
Start/End Longitude	F	118-180	degrees	-
		0-599	minutes/tenths	
		W	hemisphere	
	N	118-180	degrees	-
		0-59	minutes	
		0-59	seconds	
		W	hemisphere	
Date		1-31	days	-
		1-12	months	
Time		0-23	hours	-
		1-59	minutes	
* Elapsed Time		0-30	minutes	Must not be omitted
Ships Heading	F	0-359	degrees	-
	N	0-35	degrees/tens	
* Ships Speed	F	0-15	knots	When platform is ship
		> 5	knots	When transect type is 71
	N	0-15	knots	For ship surveys
		60-100	knots	For aircraft surveys
				Must not be omitted

Field	Format	Ranges	Relations
CARD TYPE 2			
Wind Direction	F	0-360 degrees	(NODC uses a code)
Wind Speed		0-50 knots	-
* Swell Height	F N	0-25 feet 0-76 meters/tenths	-
* Sea Surface Temp		-3°C to +20°C	Check signs & numerics
* Wet/Dry Bulb Temperature		-20°C to +30°C	Wet bulb <= Dry bulb Check signs & numerics
Barometric Pressure		.9600-1.0400 bars	-
Barometric Trend		+, ¬, 0, or blank	Must be blank when Baro Pressure is blank
Salinity		20 o/oo to 34 o/oo	-
Thermocline Depth		0-100 meters	-
CARD TYPE 3			
Excess Sediment	F	-	Must be blank
Ice Algae	F	-	Must be blank
Other Features	F	-	Must be blank
Time of Ice Conditions	N	-	Must increase for subsequent ice cards in one station
CARD TYPE 4			
No processing required			

Field	Format	Ranges		Relations
CARD TYPE 5				
Taxonomic Code		88-92	class	Trailing blanks must be paired Species needed if subspecies coded
Direction of Flight	F N	1-12 0-35	o'clock degrees/tens	-
Begin/End Zone	F	0-30 0-60		When transect 71 or 78 When transect 70 or 77 (unless BZN coded 97-99) Begin must be < End zone
Number of Individuals			-	Must be numeric Must not be omitted

NOTES:

In the format field, F=FWS, N=NODC, and Blank=Both formats.
An * denotes a change to this entry since the previous report.

FIGURE 4: SAMPLE LOGLIST LISTING

LOGLIST lists the data for each card type individually in columnar form. Fields in each record are keyed by acronym codes, which are defined on a header page.

Figure 4A shows the header page, with acronym definitions, and a page from the listing of type 1 cards. Blank data fields are depicted by a series of dots as in the LTD and LNG fields, while leading or embedded blanks appear as asterisks as in the DAT and ELT fields. The following errors have been flagged:

* FID = FW0001 *
The ID does not match that of the rest of the file.

* HOR Field Outside *
The hour subfield of time is not between 00 and 23.

* LAT Field Missing *
* LON Field Missing *
The start latitude and longitude have been omitted.

Figure 4B shows the header page and a partial listing of type 2 cards. Here the following errors have been flagged:

* BMT Bad Trend *
The barometric trend is not +, -, or 0.

* WSP Not Match WDR *
Wind direction is not valid for a wind speed of 00.

*** LOGCOL - FOR CRUISE FW0001 - CARD TYPE 1 - FORMAT FWS

ACRONYM DEFINITIONS

FID	FIELD OPERATION
STA	STATION
SLD	START LATITUDE DEGREES
LAT	START LATITUDE
SLM	START LATITUDE MINUTES
SGD	START LONGITUDE DEGREES
LON	START LONGITUDE
SGM	START LONGITUDE MINUTES
OBR	O.B.S. REGION
DAY	DAY (SUBFIELD OF DAT)
DAT	DATE - DDMM
MON	MONTH (SUBFIELD OF DAT)
HOU	HOUR (SUBFIELD OF TIM)
TIM	TIME - HHMM
MIN	MINUTES (SUBFIELD OF TIM)
ELD	END LATITUDE DEGREES
LTD	END LATITUDE
ELM	END LATITUDE MINUTES
EGD	END LONGITUDE DEGREES
LNG	END LONGITUDE
EGM	END LONGITUDE MINUTES
ELT	ELAPSED TIME
TZS	TIME ZONE SIGN
TZN	TIME ZONE NUMBER
SPD	SPEED MADE GOOD
SPT	SPEED TYPE

ACRONYM DEFINITIONS

HED	COURSE MADE GOOD
HGT	HEIGHT OF OBS. EYES (ABOVE SEA)
PLT	PLATFORM TYPE
SMP	SAMPLING TECHNIQUE
ACT	SHIP ACTIVITY
PHO	PHOTOS TAKEN
OBN	O.B.S. NUMBER
LOC	LOCATION ON SHIP
FIL	CC 75-80 FLAG IF NON-BLANK

SPECIAL CHARACTERS

-	INDICATES A CODE FIELD
*	INDICATES A BLANK CHARACTER IN A FIELD
.	INDICATES A TOTALLY BLANK FIELD
/	FIELD IS LISTED IN THE DIAGNOSTICS IF NON-BLANK (DATA WOULD OTHERWISE NOT FIT ON ONE LINE)

FIGURE 4A

*** LOGTOL - FOR CRUISE FW9001 - CARD TYPE 1 - FORMAT FWS

	F T D /	S T A	L A T	L O N	O B S -	D A Y	T I M	L T D	L N G	F L T	T Z S	T Z N	S P D	S P T -	H E D	H G T	F L T -	S M P -	A C T -	P H O	O R N	L O C -	F I L /	DIAGNOSTICS
1:	00170		58360	148240W	091	2202	1800	.....	....	05	+	10	0150	.	...	...	13	5	1	.	10		.	
2:	00170		58460	148270W	091	22*2	1800	.....	....	15	+	10	0150	1	159	...	13	3	3	.	10		.	
3:	00270		59420	148220W	091	2202	1900	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	* FID =FW0001 *
4:	00271		53200	146270W	092	24*2	1900	.....	....	15	+	10	0150	1	090	...	13	3	3	.	10		.	* FID =FW0001 *
5:	00370		58190	148240W	091	2202	2100	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
6:	00371		53190	146040W	092	24*2	2000	.....	....	15	+	10	0150	1	090	...	13	3	3	.	10		.	
7:	00470		53230	147500W	091	2202	2200	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
8:	00471		53190	135530W	092	24*2	2100	.....	....	15	+	10	0150	1	090	...	13	3	3	.	10		.	
9:	00570		58363	148500W	091	2202	2300	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
10:	00571		53250	145410W	092	24*2	2403	.....	....	15	+	10	0150	1	095	...	13	3	3	.	10		.	* HOR FIELD OUTSIDE *
11:	00670		58440	148010W	091	2302	0000	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
12:	00671		53210	145210W	092	2502	0000	.....	....	15	+	10	0150	1	100	...	13	3	3	.	10		.	
13:	00770		58990	147300W	091	2302	0100	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
14:	00771		53190	145070W	092	2502	0140	.....	....	15	+	10	0150	1	100	...	13	3	3	.	10		.	
15:	00870		58260	147410W	091	2302	0200	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
16:	00871		53200	144560W	092	2502	0300	.....	....	15	+	10	0150	1	095	...	13	3	3	.	10		.	
17:	00970		59430	148120W	091	2302	2315	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
18:	00971		53230	141430W	092	2502	1910	.....	....	15	+	09	0150	1	037	...	13	3	3	.	10		.	
19:	01070		58400	148180W	091	2402	0010	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
20:	01071		.....	....	092	2502	2215	.....	....	15	+	09	0150	1	034	...	13	3	3	.	10		.	* LAT FIELD MISSING * * LON FIELD MISSING *
21:	01170		58380	148160W	091	2402	0130	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
22:	01171		58460	141140W	092	2602	0140	.....	....	15	+	09	0150	1	090	...	13	3	3	.	10		.	
23:	01270		59210	146320W	092	2402	1900	.....	....	*5	+	10	0150	.	...	...	13	5	1	.	10		.	
24:	01271		59330	139440W	092	26*2	2200	.....	....	15	+	09	0150	1	270	...	13	3	3	.	10		.	

*** LOGCOL - FOR CRUISE FW0001 - CARD TYPE 2 - FORMAT FNS

ACRONYM DEFINITIONS

FID	FIELD OPERATION
STA	STATION
WEA	WEATHER
VIS	VISIBILITY
OBC	OBSERVATION CONDITIONS
WDR	WIND DIRECTION
WSP	WIND SPEED
SEA	SEA STATE
SWL	SWELL HEIGHT
SFT	SURFACE TEMPERATURE
STT	TEMPERATURE (XBT)
WBT	WET BULB TEMPERATURE
DBT	DRY BULB TEMPERATURE
BMP	BAROMETRIC PRESSURE
BMT	BAROMETRIC TREND
BDP	DEPTH TO BOTTOM
SAL	SURFACE SALINITY
TMD	DEPTH OF THERMOCLINE
GLI	GLARE INTENSITY
GLA	GLARE AREA
TUR	TURBIDITY
FIL	CC 64-80 FLAG IF NON-BLANK

SPECIAL CHARACTERS

-	INDICATES A CODE FIELD
*	INDICATES A BLANK CHARACTER IN A FIELD
.	INDICATES A TOTALLY BLANK FIELD
/	FIELD IS LISTED IN THE DIAGNOSTICS IF NON-BLANK (DATA WOULD OTHERWISE NOT FIT ON ONE LINE)

FIGURE 43

```
*** IOGCOL - FOR CRUISE FW1001   - CARD TYPE 2 - FORMAT FWS

    F S      W  V O W   W  S  S  S    S    W    D    B     B B    S    T    S G T F
    T T      A  I R D   S  E  W  F    E    B    P    C     M D    A    M    L L H I
    D A      A  S C R   P  A  L  T    T    T    T    P     T P    L    D    I A R L       DIAGNOSTICS
    /        -  - -                                                        - - - /

 1:   00170 03 7 . 290 15 *2 *6 **43 .... .... .... *9773 0 *143 ... ... . . .
 2:   00270 03 A . 060 *8 *0 *2 **40 .... .... .... *9813 0 *150 ... ... . . .
 3:   00271 03 7 . 300 18 *3 *6 **30 .... .... .... *9910 - 2516 ... ... . . .
 4:   00370 03 8 . 325 *6 *0 *9 **40 .... .... .... *9813 0 *200 ... ... . . .
 5:   00371 75 7 . 230 20 *2 *6 **10 .... .... .... *9813 0 2607 ... ... . . .    * BMT BAD TREND     *
 6:   00470 03 8 . 045 *6 *0 *2 **40 .... .... .... *9810 0 *142 ... ... . . .
 7:   00471 03 7 . 140 25 *2 *6 **30 .... .... .... *9923 + 2416 ... ... . . .
 8:   00570 03 8 . 270 10 *0 *1 **40 .... .... .... *9810 0 *139 ... ... . . .
 9:   00571 03 7 . 160 19 *1 *5 **29 .... .... .... *9960 + 2315 ... ... . . .
10:   00670 03 8 . 290 *8 *0 *2 **42 .... .... .... *9806 0 *149 ... ... . . .
11:   00671 03 6 . 180 20 *1 *3 **31 .... .... .... *9876 + 2416 ... ... . . .
12:   00770 03 8 . 270 *8 *0 *0 **42 .... .... .... *9800 - *142 ... ... . . .
13:   00771 03 8 . 180 19 *1 *4 **29 .... .... .... *9880 + 2375 ... ... . . .
14:   00870 03 8 . 290 *7 *0 *4 **42 .... .... .... *9786 - *140 ... ... . . .
15:   00871 00 7 . 180 00 *1 *3 **29 .... .... .... *9903 + 2164 ... ... . . .    * WSP NOT MATCH WDR *
16:   00970 03 8 . 310 18 .. .. **43 .... .... .... *9806 0 *151 ... ... . . .
17:   00971 75 3 . 090 18 *1 *3 **39 .... .... .... 10006 0 2003 ... ... . . .
18:   01070 03 8 . 290 18 *2 10 **42 .... .... .... *9906 + *152 ... ... . . .
19:   01071 03 6 . 090 36 *3 20 **39 .... .... .... 10016 + 1830 ... ... . . .
20:   01170 03 8 . 255 20 *2 *7 **42 .... .... .... *9806 0 .... ... ... . . .
21:   01171 03 7 . 090 25 *2 12 **44 .... .... .... 10056 + *103 ... ... . . .
22:   01270 03 7 . 250 20 *3 *6 **32 .... .... .... *9813 0 2516 ... ... . . .
23:   01271 00 8 . 110 *4 *0 *0 **34 .... .... .... 10133 + **10 ... ... . . .
24:   01370 03 7 . 160 24 *2 *5 **30 .... .... .... *9853 + 2340 ... ... . . .
25:   01371 00 8 . 130 *5 *0 *0 **39 .... .... .... 10133 + **51 ... ... . . .
```

FIGURE 5: FWS - NODC CONVERSION ROUTINES

Field	FWS Cols	NODC Cols	Special Processing
CARD TYPE 1			
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Start Latitude	16-20	16-22	Degrees, minutes and tenths convert to degrees, minutes, seconds. Add hemisphere "N".
Start Longitude	21-27	23-30	Degrees, minutes, tenths convert to degs, mins, secs.
OBS Region	28-30	-	No NODC counterpart.
Date	31-34	31-36	Add year and convert from day and month to YYMMDD.
Time	35-38	37-40	-
End Latitude	39-43	41-47	Same as Start Lat above.
End Longitude	44-50	48-55	Same as Start Long above.
Elapsed Time	51-52	56-57	-
Time Zone Sign	53	58	-
Time Zone Number	54-55	59-60	-
Ships Speed	56-59	61-65	Round tenths to whole knots.
Speed Type	60	-	No NODC counterpart.
Course Heading	61-63	64-65	Round whole degrees to tens of degrees.
Height of Eyes	64-66	66-68	Convert feet to meters (multiply by 0.3048, round).
Platform Type	67-68	69	Convert FWS to NODC code.
Sampling Technique	69	70	-
Ship Activity	70	71	convert FWS to NODC code.
Photos Taken	71	-	No NODC counterpart.
OBS Number	72-73	-	No NODC counterpart.
OBS Location	74	-	No NODC counterpart.
Observation Cond	-	75	Move from col 19 of FWS card type 2.
Distance	-	76-79	No FWS counterpart.
Watch Type	-	80	No FWS counterpart.
Transect Width	-	83	No FWS counterpart.
(Blanks)	75-80	-	-

Field	FWS Cols	NODC Cols	Special Processing
CARD TYPE 2			
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Weather	16-17	55-56	-
Cloud Type	-	57	No FWS counterpart.
Cloud Amount	-	58	No FWS counterpart.
Water Color	-	59-60	No FWS counterpart.
Visibility	18	61	-
Observation Cond	19	-	Move to col 75 of NODC card type 1.
Wind Direction	20-22	45-46	Convert FWS degrees to NODC code (divide by 10, truncate, and add 1).
Wind Speed	23-24	47-48	-
Wave Ht/Sea State	25-26	49	Convert feet to NODC code.
Swell Direction	-	50-51	No FWS counterpart.
Swell Height	27-28	52-54	Convert feet to tenths of meters (multiply by 3.048 then round).
Sea Surface Temp	29-32	23-26	Move sign adjacent to first significant digit (remove embedded zeros or blanks).
XBT Temp	33-36	-	No NODC counterpart.
Wet Bulb Temp	37-40	34-37	Same as Sea Surf Temp above.
Dry Bulb Temp	41-44	30-33	Same as Sea Surf Temp above.
Relative Humidity	-	38-39	No FWS counterpart.
Barometric Pressure	45-49	40-43	Truncate left digit.
Barometric Trend	50	44	-
Bottom Depth	51-54	16-19	Convert fathoms to meters (multiply by 1.829, round).
Surface Salinity	55-57	27-29	-
Thermocline Depth	58-60	20-22	-
Sun Direction	-	62	No FWS counterpart.
Glare Intensity	61	63	-
Glare Area	62	64	-
Turbidity Code	63	-	No NODC counterpart.

Field	FWS Cols	NODC Cols	Special Processing
Light Level	-	65-67	No FWS counterpart.
Moon Phase	-	68	No FWS counterpart.
Tide Height	-	69	No FWS counterpart.
Tide Rise/Fall	-	70	No FWS counterpart.
Distance to Shore	-	71-74	No FWS counterpart.
Distance to Shelf	-	75-77	No FWS counterpart.
SECCHI Depth	-	78-79	No FWS counterpart.
Debris Code	-	80	No FWS counterpart.
(Blanks)	64-80	81-83	-

CARD TYPE 3

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Ice In Transect			
Cover	16	16	-
Pattern	17	40	Code groups not convertible.
Type	18	17	-
Form	19	18	-
Relief	20	19	-
Thick	21	20	-
Melt	22	21	-
Ice Outside Transect			
Cover	23	22	-
Pattern	24	41	Code groups not convertible.
Type	25	23	-
Form	26	24	-
Relief	27	25	-
Thick	28	26	-
Melt	29	27	-
Open Water			
Type	30	28	-
Direction	31	29	-
Distance	32	30	-
Lead/Polyna Wd	33	31	-
Visible Ice			
Form	34	50	-
Cover	35	51	-
Description	-	32	No FWS counterpart.
Direction	36	33	Code groups not convertible.
Distance	37	34	Code groups not convertible.

Field	FWS Cols	NODC Cols	Special Processing
Ship in Lead/Polyna			
Location	38	42	-
Width	39	43	-
Distance	40	44	-
Miscellaneous			
Arctic Cod	41	35	Convert FWS to NODC code.
Excess Sediment	42	36	Code groups not convertible.
Ice Algae	43	37	Code groups not convertible.
Mammal Trace	44	38	-
Other Features	45	39	Code groups not convertible.
Ice Not Coverable	46	-	No NODC counterpart.
Time of Ice Cond	-	45-46	No FWS counterpart.
Water/Land Percent	-	47-48	No FWS counterpart.
Pond Size	-	49	No FWS counterpart.
(Blanks)	47-80	52-77	-
Sequence Number	-	78-80	No FWS counterpart.
(Blanks)	-	81-83	-

CARD TYPE 4

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Text	16-77	16-77	-
Sequence Number	78-80	78-80	-
(Blanks)	-	81-83	-

CARD TYPE 5

Field	FWS Cols	NODC Cols	Special Processing
File type	1-3	1-3	-
File ID	4-9	4-9	-
Station Number	10-14	11-15	-
Record Type	15	10	-
Species Name	16-19	-	No NODC counterpart.
Taxonomic Code	20-31	18-29	Blank out trailing zero doublets.
Species Group	32-33	30-31	-
No of Individuals	34-38	37-41	-

Field	FWS Cols	NODC Cols	Special Processing
Counting Method	-	42	No FWS counterpart.
Reliability	-	43	No FWS counterpart.
Dist Measure Type	-	44	No FWS counterpart.
Distance to Birds	-	45-47	No FWS counterpart.
Begin/Outside Zone	39-40	83	Convert to Outside Zone only when coded 97-99.
End Zone	41-42	-	No NODC counterpart.
Time into Transect	43-45	16-27	Round minutes and tenths to whole minutes.
Behavior	46-47	56-57	-
Flight Direction	48-49	48-49	Convert from clock position relative to ship to compass direction in tens of degrees (multiply by 30, add rounded heading from card type 1).
Age	50	32	-
Sex	51	33	-
Color	52	34	-
Plumage	53	35	-
Molt	54	36	-
Association Type	55-56	50	Convert FWS to NODC code.
Multi-Species Link	57-59	51-53	-
No of Species	60-61	54-55	-
Special Marks	62	58	-
Bird Condition	63	59	-
Food Source	-	60	No FWS counterpart.
Tax Code for Food	64-73	61-70	-
Debris	74	71	-
Oil	-	72	No FWS counterpart.
Dist from Breed Colony	-	73-75	No FWS counterpart.
Habitat	-	76-77	No FWS counterpart.
OBS Observer No	75-76	-	No NODC counterpart.
Text Flag Code	77	-	No NODC counterpart.
Sequence Number	78-80	78-80	-
Substrata	-	81	No FWS counterpart.
Cover	-	82	No FWS counterpart.

The following fields will have Leading Zeros or Leading Blanks inserted as necessary.

Leading Zeros	Leading Blanks
Station Number	Ships Speed
Start Latitude	Height of Eyes
Start Longitude	Wind Speed
End Latitude	Sea Surface Temp
End Longitude	Wet Bulb Temp
Date and Time	Dry Bulb Temp
Course Heading	Bottom Depth
Multi-Species Link	No of Individuals
Flight Direction	
Sequence Number	

NOTE: An * denotes a change to this entry since the previous report.

FIGURE 6: NODC TRANSFORMATION ROUTINES

Field	Card:Cols	Processing
Sea Surface Temp	2:23-26	Move sign adjacent to first significant digit (remove embedded zeros or blanks).
Dry Bulb Temperature	2:30-33	Same as Sea Surf Temp above.
Wet Bulb Temperature	2:34-37	Same as Sea Surf Temp above.
Flight Direction	5:48-49	Compass reading of 36 replaced by 00 degrees.
Taxonomic Code	5:18-29	Blank out trailing zero doublets.

The following fields will have Leading Zeros or Leading Blanks inserted as necessary.

Leading Zeros	Leading Blanks
Station Number	Ships Speed
Start Latitude	Height of Eyes
Start Longitude	Wind Speed
End Latitude	Sea Surface Temp
End Longitude	Wet Bulb Temp
Date and Time	Dry Bulb Temp
Course Heading	Bottom Depth
Multi-Species Link	No of Individuals
Flight Direction	Transect Width
Sequence Number	

NOTE: An * denotes a change to this entry since the previous report.

Research Unit 563

QUARTERLY REPORT
December 31, 1978

Contract no.: 03-78-B01-53

Project no.: RK 0000-R7120815

Archival of Voucher Specimens of Biological Materials Collected under the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Support

Period of Performance: May 1, 1978 - April 30, 1979
Subsequent support subject to availability of funding.

Period covered by This Report: Oct. 1, 1978 - Dec. 31, 1978.

Institution: California Academy of Sciences
Golden Gate Park
San Francisco, CA 94118

Principal Investigator:

William N. Eschmeyer
William N. Eschmeyer
Director of Research
(415) 221-5100

Archival of Voucher Specimens of Biological Materials Collected Under OCSEAP Support

I. Abstract: Early in the quarter the voucher specimen policy was completed, approved, and distributed by the Project Office to principal investigators of all research units. Copies are on file in the Project Office. Specimen labels to be completed by research units for their voucher specimens were printed and distributed to principal investigators. Purchase of materials and supplies needed to begin the project were completed. The project workroom was completed with non-project funds. Problems of voucher specimens for phytoplankton were settled.

II. Task objectives: The extensive biological collections and studies made or to be made in conjunction with the Alaskan OCS environmental studies program are to be documented with voucher samples. OCSEAP has established a central repository, the California Academy of Sciences, for preserved specimens from those collections to insure that materials are permanently available for reference and confirmation of indentifications made previously.

The California Academy of Sciences is responsible for:

1. Specifying preservation techniques for archival voucher specimens.

2. Coordinating the shipment of materials.

3. Establishing and maintaining a fully catalogued repository for the collections; and

4. Providing quarterly data summaries on the status and content of the collections.

III. Field or Laboratory Activities: No specimens were processed during the quarter.

IV. Results: The final voucher specimen policy was submitted and approved. Specimen labels to be completed by project principal investigators were printed and 3000 of them forwarded to the Juneau Project Office on 30 October. On 6-7 November, the Project Office sent a covering letter of instruction, a copy of the final voucher policy, and specimen labels to research units associated with the Bering Sea-Gulf of Alaska Project Office. On 21 November similar information was sent to those principal investigators involved in current and terminated projects administered through the Arctic Project Office.

On November 14th, Dr. McCain (RU 73) was the first principal investigator to inform the repository that his unit was ready to send specimens.

Shipping containers, packing materials, and instructions were sent to him by us.

The project workroom/laboratory was completed during the quarter with the addition of counters and a sink. This and the approximately $7,500 of metal shelving was provided from non-BLM/NOAA funds.

At the end of the quarter all steps had been completed such that the voucher specimen program was fully operational.

V. Preliminary Interpretation of Results: No specimens were processed during the quarter.

VI. Auxiliary Material: None

VII. Problems Encountered/Recommended Changes: (1) The problem of how to provide voucher specimens of phytoplankton was elicited by Dr. Horner (RU 353). It was established by the Data Manager, Horner, and the repository that since actual specimens could not be isolated because of the large numbers of samples involved and because of technical problems of specimen isolation and preservation, that a subsample or the remaining plankton sample, accompanied by a species list for the sample, would serve very well as a voucher for the species encountered, identified, and counted in the subsamples analyzed.

(2) The University of Alaska raised questions of compliance with the voucher policy for projects well underway or completed previously. Their cost estimates for each research unit to assemble a voucher series were high. It is of our opinion that much of the expense involves the completion of rather detailed voucher specimen labels. We propose that since the specimens probably already have some data with them (cruise, station, identification) and if the remaining data (cruise report data, etc.) can be provided in text form, we will prepare the specimen labels. They would need funds for personnel to select the voucher specimens and funds for packing the specimens.

(3) Because of a lack of specimens to process, the fulltime curatorial assistant was temporarily terminated on December 19th and employed by another Academy department to conserve project funds. Provision has been made for her to return to the project as soon as sufficient material has arrived.

VIII. Estimate of Funds Expended: From 1 June 1978 (the "effective" starting date) to the end of the quarter on 31 December the following funds have been expended:

A.	Salaries	$9,233
B.	General supplies	2,443
C.	Equipment rental	1,758
D.	Permanent equipment	981
E.	Overhead 15% of A	1,385

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