Environmental Assessment of the Alaskan Continental Shelf

Quarterly Reports of Principal Investigators
April—December 1979

Volume II

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

Environmental Assessment of the Alaskan Continental Shelf

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VOLUME II

Outer Continental Shelf Environmental Assessment Program
Boulder, Colorado

March 1980

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

U.S. DEPARTMENT OF INTERIOR
Bureau of Land Management

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QUARTERLY REPORT

1 October 1979

Research Unit 59

COASTAL MORPHOLOGY, SEDIMENTATION AND OIL SPILL VULNERABILITY OF THE OUTER KENAI PENINSULA AND MONTAGUE ISLAND

Miles O. Hayes, Principal Investigator
Larry G. Ward, Co-investigator
Thomas F. Moslow, Co-investigator

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

TASK: To evaluate the variation in coastline morphology and sedimentation with particular emphasis on the relative susceptibility of different coastal environments to oil spill impact. This investigation will classify those areas most vulnerable to an oil spill and make recommendations for their protection in such an event.

INTRODUCTION

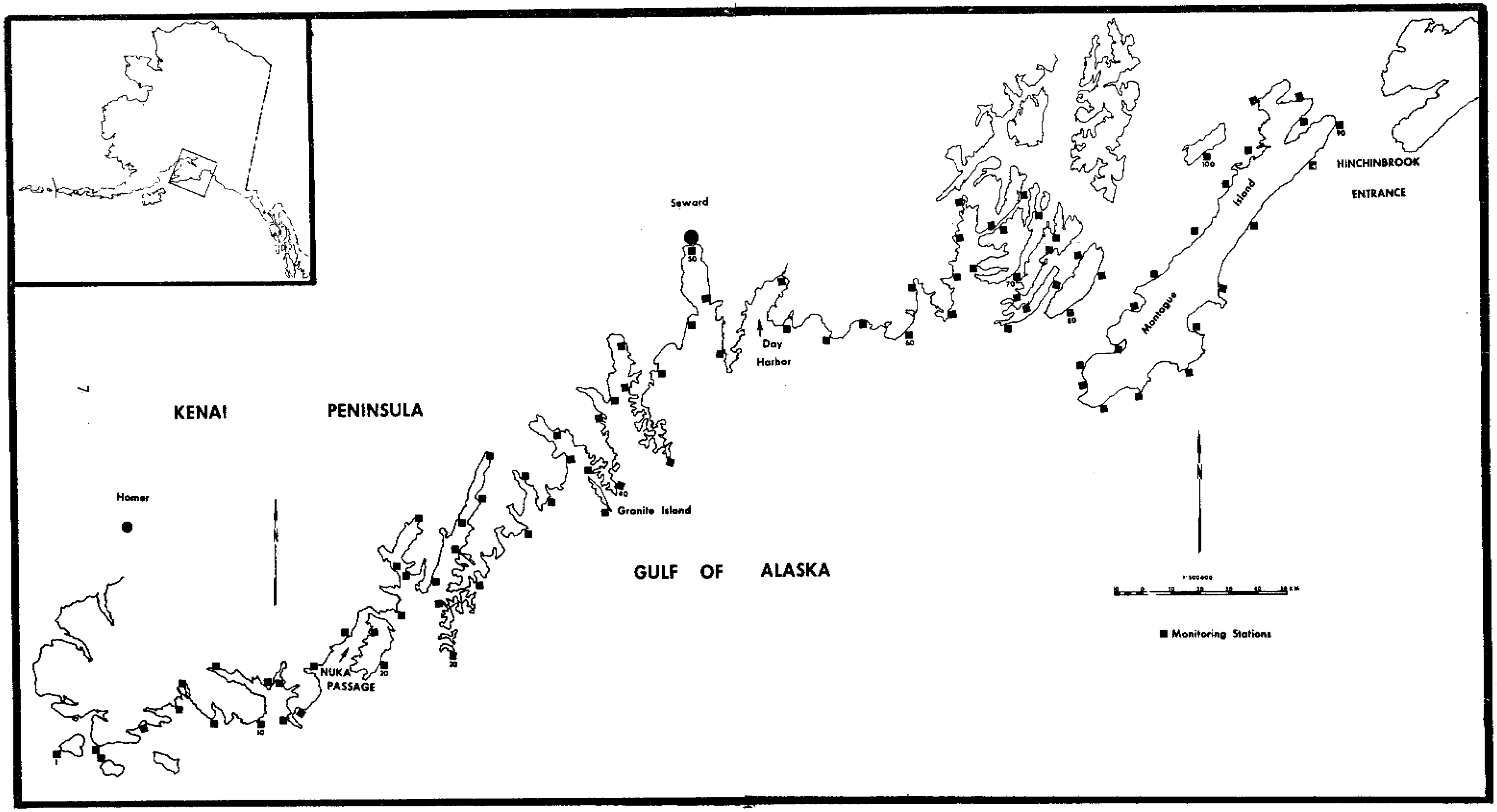
This report is a general synopsis of the work accomplished to date on the project entitled "Coastal Morphology, Sedimentation and Oil Spill Vulnerability of the Outer Kenai Peninsula and Montague Island". The study is being conducted by Miles O. Hayes (chief scientist), Larry G. Ward, Thomas F. Moslow and Kenneth Finkelstein. The field work was done from June 15, 1979 to July 3, 1979, during which the entire coastline (approximately 1500 km) (Fig. 1) was mapped, and its vulnerability to massive oil spills assessed. This report is divided into four segments. The first two parts discuss the methods used in the field and in the laboratory. The third part is a general description of the coastal environment and its susceptibility to massive oil spills. The final segment discusses the problems we have encountered with the project.

PART I: SYNOPSIS OF FIELD WORK

In order to survey such a large section of shoreline in a reasonable amount of time, special field techniques developed by our Coastal Research Division were utilized. The first four days of the field work were primarily devoted to an aerial reconnaissance. During this period, a large portion of the shoreline was mapped, and a classification scheme developed. An outline of the technique used in the aerial reconnaissance is as follows:

1. Detailed oblique aerial photos were taken using both color and infrared film.
2. General sediment transport trends were interpreted using geomorphologic indicators such as spits, barrier island recurves, tidal delta orientation and morphology, crescentic bays, and inlet offsets. These trends were then plotted on topographic maps. They were later verified with ground surveys.
3. Changes in coastal geomorphology, which had taken place since the original topographic mapping, were added to our base maps.
4. A detailed description of the general geomorphology was made using a small tape recorder.

Figure 1.



Seward
Day
Harbor
KENAI
PENINSULA
Homer
NUKA
PASSAGE
Granite Island
GULF OF ALASKA
Montague
Island
HINCHINBROOK
ENTRANCE
Monitoring Stations

Another 2½ days were required to finish the reconnaissance work. This was accomplished during the remainder of the field period.

Following the overflights, 100 field stations were chosen using a random selection process (a station was positioned every 15 km). This insured that the entire area would be studied, and no sampling biases would develop. For the remainder of the field study, each station was photographed in detail from the air; while ground surveys were made at those stations which were feasible helicopter landing sites. Only 28 stations were surveyed on the ground due to the extremely rugged terrain. At each of the ground stations, the following was done:

1. A transit line of the active beach zone was done to delineate beach morphology. These profiles are being plotted by computer.

2. Sediment samples were taken using a 15 cm coring tube. A total of 51 samples was collected. These samples were analyzed in our sedimentological laboratory, and the data will later be synthesized by computer.

3. A field sketch of each site was made to show surrounding geomorphology and geology and to aid the field observer's perception.

4. Ground photos of the profile site and sediments were taken.

5. A tape-recorded description of the site and its surrounding geology, geomorphology, sediments and marine processes was made.

Also, during the field period, the oil spill vulnerability of the entire area was determined from the maps and tape recordings made on the overflights. This was done in the field to assure no errors were made.

A detailed synopsis of the field work program was given in the Cruise Report done on September 17, 1979 and is reproduced in this report's appendix.

PART 2: SYNOPSIS OF LABORATORY WORK

Standard laboratory techniques were used for determination of the textural qualities of sediment samples collected in the field. Fifty-one samples were analyzed for composition, grain size, sorting, and relative oil retention properties.

The beach profiles were computer plotted and studied to help determine the morphology of the beaches. Aerial and ground photographs were reviewed and catalogued. This involves over 6500, 35 mm photographs. In many instances, where taking samples was impractical due to the large size of the material, photographs were taken of the sediment (i.e. boulders). Grain size and properties were then determined from the photographs.

PART 3: REGIONAL TRENDS IN COASTLINE MORPHOLOGY AND OIL SPILL VULNERABILITY

The history of tectonic activity is the study area has provided the basis for dividing this 1500 km of coastline into two regional categories:

1. Uplifted or emergent coast - Approximately 600 km (40%) of the study area shows evidence of recent emergence based on coastline morphology. This includes the majority of the area east of Day Harbor (stations 55 and 56), including all of Montague Island. Our results indicate that on an overall basis, this type of emergent coastline has a much greater susceptibility to oil spill impact.

2. Downwarped or submergent coast - The remaining 800 km (60%) of the study is characterized by coastline submergence. This is that portion of the coastline showing evidence of drowning by inundation from the sea. It includes the area west of Day Harbor to the westernmost limit of the study area at Station #1. It should be noted that Day Harbor is approximately 10 km west of the zero isobase between major zones of tectonic uplift and subsidence (Committee on The Alaska Earthquake, 1964). The axis of crustal uplifts runs directly along the western coastline of Montague Island (stations 82 - 92). The axis of uplift for the 1964 earthquake trends NE-SW through Nuka Passage (stations 14 - 18).

On a more localized scale, our results have so far provided for a preliminary coastal morphology classification scheme. This is based on our observations in the field and intensive mapping of the different geomorphic types. Each of the different coastal types is described briefly below.

1. Bedrock headlands: There are numerous stretches of coast that have high bedrock cliffs. These cliffs range from a few meters to well over 100 m in height. The coast here is characterized by sea stacks, sea caves, sea arches and large talus slopes. Beaches in the submergent portion of the study area are virtually non-existent. In the emergent portion, rock headlands are often fronted by 5-10 m wide cobble and boulder platforms (beaches?) comprised of bedrock talus. These cliffs are of extreme importance due to the large number of nesting sea birds which use them as rookeries. However, due to their high wave energy environment, these areas have a low vulnerability to oil spill impact.

2. Unconsolidated wave-cut platforms: High wave energy conditions have created scarps in the unconsolidated glacial material, producing platforms of sand, gravel and glacial erratics. These features constitute a small portion of the study area.

3. Sheltered rocky coasts: A high percentage of the coast is comprised of bedrock scarps in sheltered or embayed portions of the coastline. These scarps are generally less than 5 to 10 meters in height with gentle slopes. This coastal type is predominantly in a very low wave energy environment and has a high oil spill vulnerability.

4. Beaches: Another significant portion of the coast is represented by beaches. Our observations have provided the basis for classifying the beaches into 4 major types:

a. Beach ridge plain - rare.

b. Crenulate bay beach - very rare.

c. Pocket beaches - abundant.

d. Bayhead beaches - abundant.

Most of the beaches were comprised of cobbles and small boulders in a sand and gravel matrix. Of particular interest were those beaches profoundly effected by the recent emergence or uplift in the eastern end of the study area. There was morphologic evidence of pre-uplift cobble-boulder beaches along the western coast of Montague Island situated from 500 - 1500 m landward of the present waterline.

5. Tidal flats and marshes: The coastal types were found typically at the heads of the numerous embayments along the coast or in association with active delta systems. These areas have a high biologic productivity and are, therefore, extremely vulnerable to oil spills. The tidal flats were dominantly classified as "sheltered" in the uplifted (eastern) part of the study area and exposed in the downwarped (western) part.

6. Spits: A relatively small percentage of the study area was represented by sand and gravel spits. These have been divided into three types: cuspate, recurved and tombolo, all of relatively equal occurrence. These spits are depositional features and are more predominant in the emergent portion of the study area.

7. Consolidated wave cut platforms: In the areas where uplift was severe (i.e. Montague Island), the coastline is dominated by stretches of submerged rock platforms that were uplifted out of the sea into the intertidal zone. These platforms have been planed off by wave energy and have a relatively low susceptibility to oil spill impact.

8. Deltas: Active delta systems are typically small but numerous. However, one very large active delta system occurs at the head of Resurrection Bay (Seward). Deltas are classified by morphology (cuspate, lobate or arcuate) and by wave energy regime (high or low). Many of the deltas, like the Resurrection River delta are covered by extensive sand and gravel tidal flats as well as broad marshes. This makes them highly vulnerable to damage from oil spills.

PART 4: DISCUSSION

To date, all sediment samples have been analyzed, beach profiles plotted, and coastal morphology and oil spill vulnerability maps produced (field quality). During the remainder of the contract period, the following will be done:

1. Sediment and profile data will be put on magnetic tape,
2. Coastal morphology and oil spill vulnerability maps will be redone at publication quality, and
3. An encompassing final report will be put together detailing the entire project.

No major problems have arisen in the laboratory analysis or preparation of this report. A few minor problems occurred during the field work and were discussed in the above-mentioned Cruise Report. They were:

1. Helicopter support (N 46-RF; UH-1H) was unavailable on 6-22-79 and 6-23-79 due to the development of a cracked rotor blade. N 46 RF had to be taken to Anchorage for the necessary repairs and a mandatory 100 hour maintenance check. During this 2 day period, the scientific party used a fixed wing aircraft on 6-22-79 and a Pioneer III helicopter on 6-23-79. However, the unexpected problems with N 46 RF resulted in the loss of ½ day of field work.

2. A loss of 2½ days of field work (6-24-79 to 6-26-79) was the result of poor flying conditions (heavy rains, zero visibility) as determined to be unsafe by the pilot.

3. Seward proved to be a poor choice as a base of operations due to: a) the inability to acquire readily available and easily accessible fuel; b) Seward is an uncontrolled field which the pilot felt would be unsafe for flying during marginal weather.

4. Many of the designated sampling locations were inaccessible due to the rugged terrain (i.e. steep, narrow beaches; high vertical wave-cut scarps in bedrock) and complex nature of the beach composition (i.e., numerous scattered boulders and cobbles). Approximately 40% of the sample locations were unsafe

for landing as determined by the pilot. However, it should be noted that a fixed wing aircraft would probably have been able to safely land at less than 10% of the originally designated sample sites. We were aware of this difficulty prior to initiation of field work and accounted for it in our original scheduling.

QUARTERLY REPORT

Contract: R7120847

Research Unit #138

Reporting Period: 1 July 1979 -
1 January 1980

Number of Pages

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

J.D. Schumacher

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

December 22, 1979

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

Kodiak Island Synthesis Meeting October 1979

III. Results and Preliminary Interpretation:

1) R. K. Reed and J. D. Schumacher, The coastal flow (Kenai Current) in the western Gulf of Alaska, Trans. Am. Geophy. Union, 60(45), 856, 1979. This paper was presented by R. K. Reed at the Fall 1979 AGU Meeting in San Francisco, copy attached.

2) Current records collected during 1977-1978 under RU 138 have been quality assured and are now being submitted to NODC. The records have been loaded on R2D2 and attached is a copy of a transmittal letter for the first set of current records submitted.

3) Additional CTD data collected under OCSEAP work units and identified by Lt. J. Murphy have been received from NODC and loaded onto R2D2. We now have more than 5,000 CTD casts from the Gulf of Alaska!

4) A paper "Coastal flow in the northwest Gulf of Alaska" by J.D. Schumacher and R. K. Reed is being submitted to J. Geophy. Res.

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Pacific Marine Environmental Laboratory
NOAA Building Number
7600 Sand Point Way N.E.
Seattle, WA 98115

Date: December 13, 1979

To: NODC Attn: Dr. James Ridlon (D781)

From: Sharon Wright

Subject: Transmittal of Current Meter Data

This is to notify you that you will be receiving a shipment of (1) magnetic tape, and data documentation forms for the Kodiak Island and Cook Inlet data sets. Ther are 13 files total on the tape and the information should appear as follows:

File #	File I.D.	Time Period	Meter	Depth (in meters)
1.	K-6A	10/18/77 - 3/10/78	2248	65m
2.	K-6B	5/19/78 - 10/5/78	3296	32m
3.	K-7B	5/20/78 - 10/3/78	2513	29m
4.	K-8B	5/19/78 - 10/3/78	1827	75m
5.	K-8A	10/9/77 - 3/10/78	2500	25m
6.	K-9B	5/19/78 - 10/5/78	3185	58m
			3172	13m
			2498	142m
7.	K-10B	5/21/78 - 10/4/78	3287	149m
		5/20/78 - 10/4/78	2502	69m
8.	C-6B	5/27/78 - 10/16/78	3295	71m
9.	C-5B	5/27/78 - 10/18/78	1815	127m
10.	C-8B	5/28/78 - 10/14/78	1682	179m
		5/28/78 - 10/14/78	3179	63m
11.	C-9B	5/28/78 - 10/14/78	1973	66m
12.	C-10B	5/28/78 - 10/9/78	3175	70m
			1669	165m
			3171	25m
13.	C-11B	5/28/78 - 10/16/78	1451	82m

Please notify me as soon as you have been able to read the tapes whether successfully or not. I am retaining files that are quite costly until I hear from you. My number is FTS 399-7450. Thank you for your cooperation.

cc: Sid Stillwaugh
    Glen Cannon

Quarterly Report

Research Unit:	#152
Reporting Period:	7/1/79-9/30/79
Number of Pages:	10
Principal Investigator:	Dr. Richard A. Feely

Distribution and Composition of Suspended Matter in Lower Cook Inlet and Norton Sound, Alaska

Prepared by

Richard A. Feely and Marilyn F. Lamb

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

September 30, 1979

I. Task Objectives

The major objectives of the suspended matter program include: (1) determination of the distribution and chemical composition of suspended particulate matter in Cook Inlet and Norton Sound; and (2) determination of depositional rate for fine-grained sediments in lower Cook Inlet and Shelikof Strait.

II. Field and Laboratory Activities

A. Field Activities

1. Ship Schedule

a. DISCOVERER Cruise RP-4-Di-79A-II (7-20 May 1979)

b. DISCOVERER Cruise RP-4-Di-79A-VI (7-18 July 1979)

2. Participants from PMEL

a. Dr. Richard A. Feely, Oceanographer, PMEL

b. Mr. Gary J. Massoth, Oceanographer, PMEL

c. Mr. Anthony J. Paulson, Oceanographer, PMEL

d. Ms. Marilyn Lamb, Physical Science Technician, PMEL

e. Lt. Susan Ludwig, PMEL

f. Mr. Randy Dyer, UW student

3. Methods

a. Particulate Matter - Water samples were collected in General Oceanics 1070 10L PVC Top-Drop Niskin bottles from preselected depths. Nominally, these included: 0-2 m, 10 m, 40 m, 60 m, 80 m, and 5 meters above the bottom. Aliquots were drawn within 15 minutes after collection from each sample and vacuum filetered through preweighed 0.4 μm pore diameter Nuclepore polycarbonate filters for total suspended matter concentration determinations and multielement particulate composition analysis. Samples were also filtered through 0.45 μm pore diameter Selas silver filters for particulate carbon and nitrogen analyses. All samples were rinsed with three 10 ml aliquots of deionized membrane filtered water, placed in individual petri dishes with lids slightly ajar for a 24 hour desiccation period over sodium hydroxide and then sealed and stored (silver filters frozen) for subsequent laboratory analysis.

b. Bottom Sediment - Bottom sediment samples were collected with a Shipek grab sampler, and a three inch gravity corer equipped with a plastic core liner. The gravity corer samples and shipek samples were sectioned into 2 cm segments upon collection and frozen in individual plastic bags.

c. Nephelometry - The vertical distribution of suspended matter was determined with a continuously recording integrating analog nephelometer. The instrument was interfaced with the ship's CTD system using the sound velocity channel (14-16 KHz). Continuous vertical profiles of forward light scattering were obtained in analog form on a Hewlett-Packard 7044 X-Y recorder.

d. Conductivity (Salinity), Temperature, and Depth - These standard hydrographic data were acquired with a Plessy model 9040 Environmental Profiling System (CTD probe) and a model 8400 digital data logger using 7-track, 200B.P.I. magnetic tape. Temperature and salinity calibration data were provided by NOAA ship personnel from discrete water samples utilizing reversing thermometers and a bench salinometer, respectively. Signals from the CTD system and the nephelometer were also simultaneously interfaced with the ship's data acquisition system. This resulted in computor listings of continuous (uncorrected) data for conductivity, temperature, depth, salinity, sigma-t, and light scattering for all vertical sampling stations.

4. Station Locations

Figure 1 shows the locations of suspended matter stations occupied during Cruise RP-4-Di-79A-II (7-20 May 1979) in lower Cook Inlet and Shelikof Strait, and Figure 2 shows the station locations for Cruise RP-4-Di-79A-VI (7-18 July 1979) in Norton Sound.

5. Samples and Data Collected

We have completed both cruises scheduled for FY 79 in lower Cook Inlet and Norton Sound. During the lower Cook Inlet cruise, we collected 162 suspended particulate matter samples, 15 gravity corer samples, and 10 nephelometer profiles. In addition, 18 suspended matter samples were processed in support of hydrocarbon studies in upper Cook Inlet. For Norton Sound, 146 suspended matter samples and 3 gravity corer samples of bottom sediments were collected for subsequent laboratory analysis.

B. Laboratory Activities

1. Sample and Data Status

a. Lower Cook Inlet

Analysis of samples and data collected on Cruise RP-4-DI-79A-II (7-20 May 1979) are currently underway and will be discussed in a future report.

b. Norton Sound

Analysis of samples and data collected on Cruise RP-4-Di-79A-VI (7-18 July 1979) are currently underway and will be described in detail in a future report. However, suspended matter con-

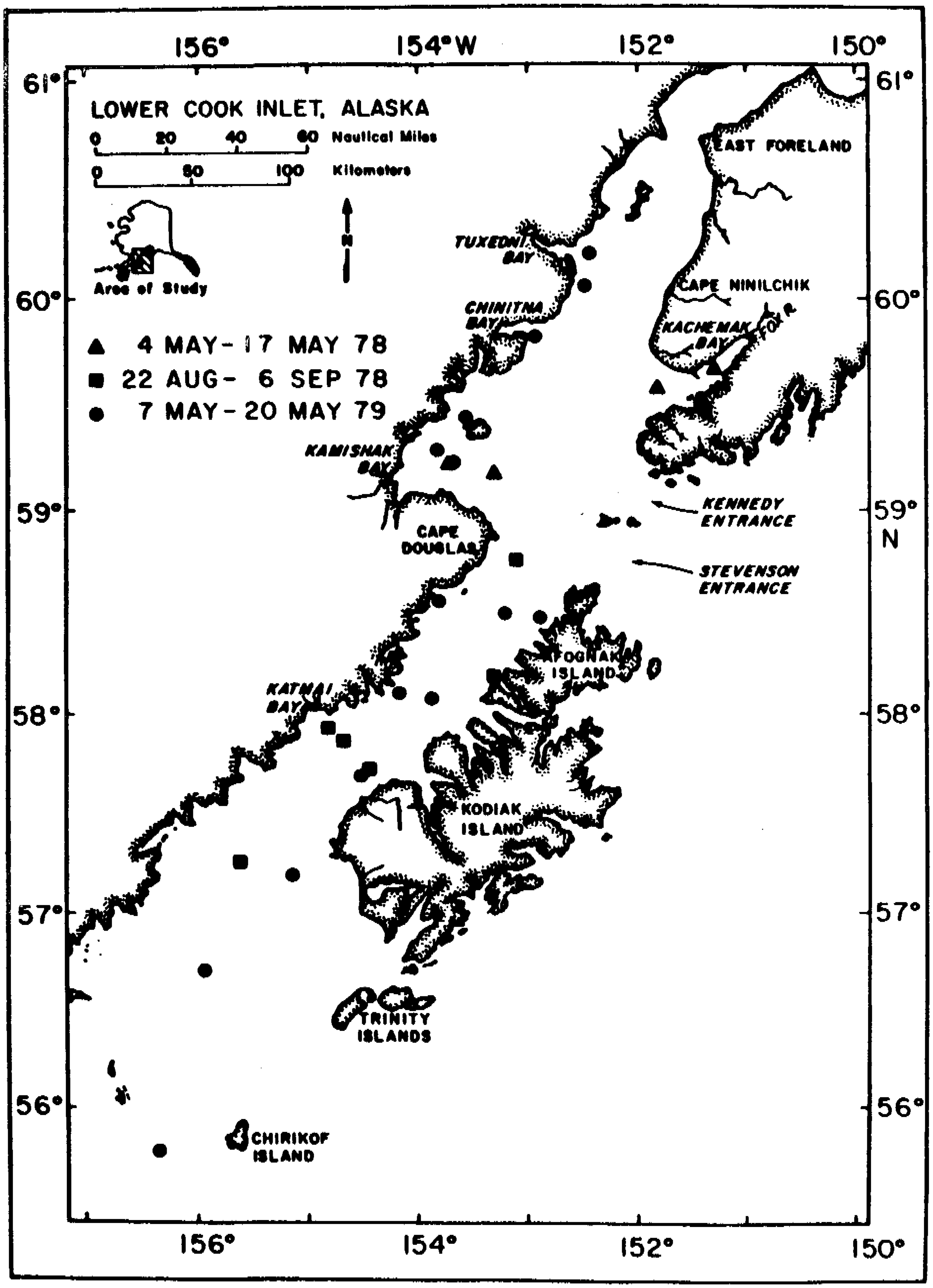


Figure 1. Locations of stations where sediment samples have been obtained for measurements of sediment accumulation rates.

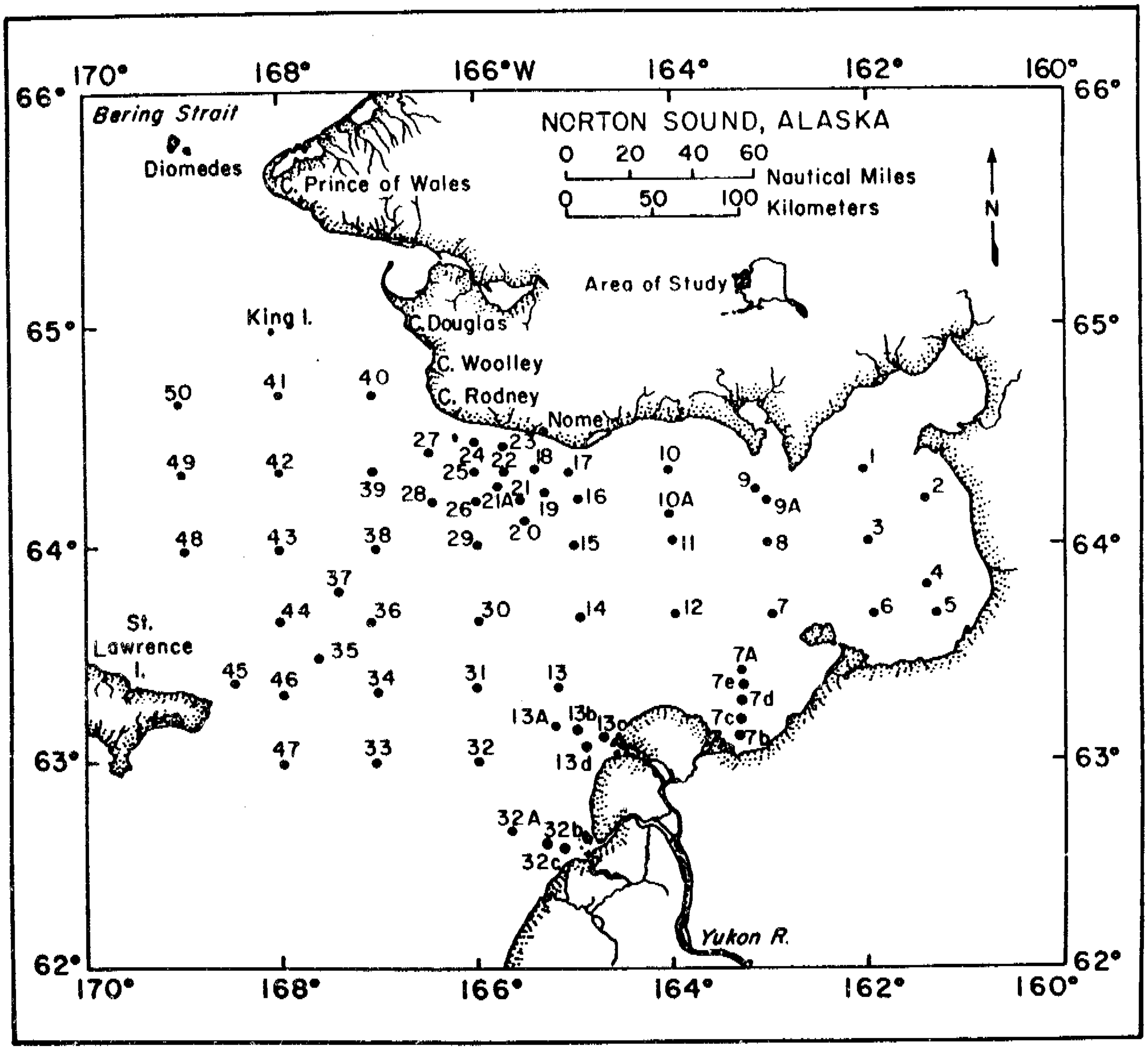


Figure 2. Locations of suspended matter stations in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

centration data are available at this time and will be briefly discussed below.

2. Results - Norton Sound

Figures 3 and 4 show the distribution of total suspended matter at the surface and 5 m above the bottom in Norton Sound during July 1979. Surface suspended matter concentrations were highest near the mouth of the Yukon River where surface concentrations ranging between 5.1 and 154.6 mg/L were observed. The Yukon River plume (as indicated by the 5.0 mg/L isopleth) extended to the north and northeast about halfway across Norton Sound. A second plume of lesser suspended matter concentrations (1.0-2.7 mg/L) extended northwest to a point about 20 km south of Cape Rodney. Both plumes appear to have originated from the Yukon River and their dispersal patterns tend to follow the general pattern of counterclockwise circulation in the Sound.

The near-bottom distributions also follow the general circulation pattern. However, in the region about 20-30 km south of Nome, a turbidity maxima with suspended matter concentrations ranging between 20 and 50 mg/L was observed. This turbid zone is centered on the Norton Sound Gas Seep (Cline and Holmes, 1977), indicating a possible interrelationship between the seeping gas bubbles and resuspension of bottom sediments.

III. Problems Encountered

We have no significant problems to report at this time.

References

Cline, J.D. and M.L. Holmes (1977). Submarine seepage of natural gas in Norton Sound, Alaska, Science 198: 1149-1153.

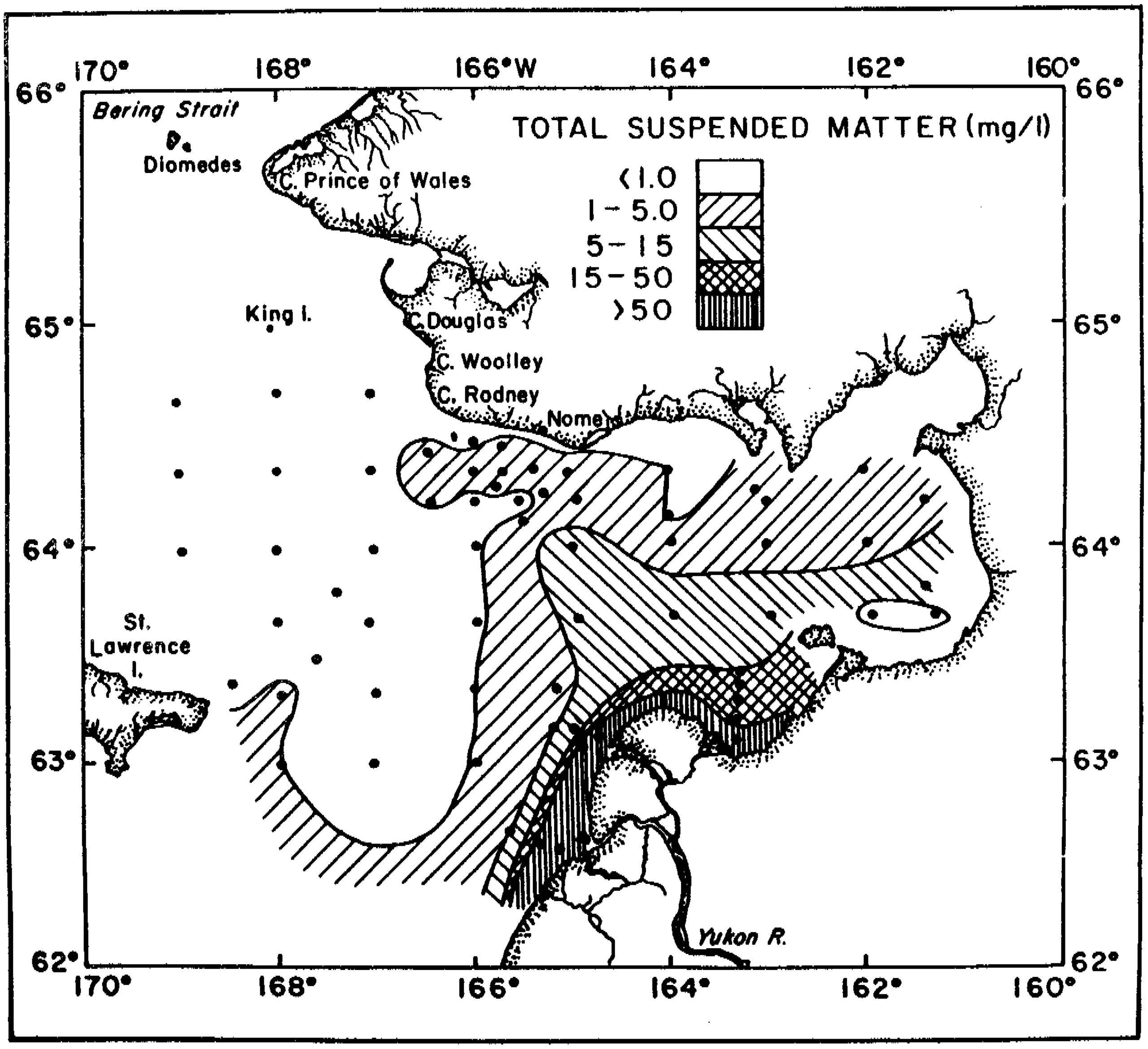


Figure 3. Distribution of total suspended matter at the surface in Norton Sound (Cruise RP-4-DI-79A-VI, 7-18 July 1979).

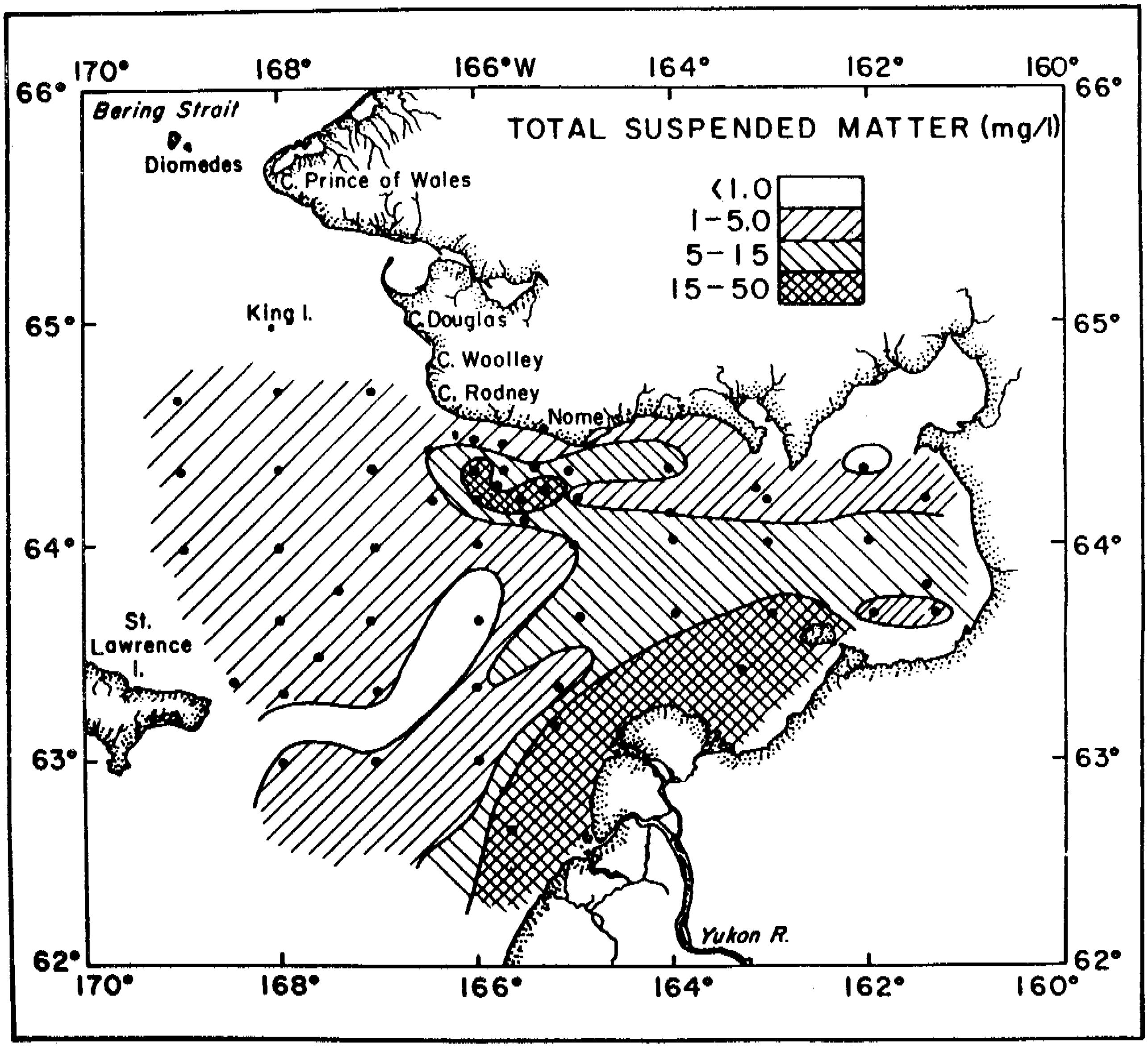


Figure 4. Distribution of total suspended matter 5 m above the bottom in Norton Sound (Cruise RP-4-DI-79A-VI, 7-18 July 1979).

QUARTERLY REPORT

Research Unit: #152

Reporting Period: 10/1/79-12/31/79

Principal Investigator: Dr. Richard Feely

Number of Pages: 13

DISTRIBUTION AND COMPOSITION OF SUSPENDED MATTER IN LOWER COOK INLET AND NORTON SOUND, ALASKA

Prepared by

Richard A. Feely

December 31, 1979

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

I. Task Objectives

The major objectives of the suspended matter program include: (1) determination of the distribution and chemical composition of suspended particulate matter in Cook Inlet and Norton Sound; and (2) determination of depositional rate for fine-grained sediments in lower Cook Inlet and Shelikof Strait.

II. Field and Laboratory Activities

A. Field Activities

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d. Ms. Marilyn Lamb, Physical Science Technician, PMEL

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3. Methods

a. Particulate Matter - Water samples were collected in General Oceanics 1070 10L PVC Top-Drop Niskin bottles from preselected depths. Nominally, these included: 0-2 m, 10 m, 40 m, 60 m, 80 m, and 5 meters above the bottom. Aliquots were drawn within 15 minutes after collection from each sample and vacuum filetered through preweighed 0.4 μm pore diameter Nuclepore polycarbonate filters for total suspended matter concentration determinations and multielement particulate composition analysis. Samples were also filtered through 0.45 μm pore diameter Selas silver filters for particulate carbon and nitrogen analyses. All samples were rinsed with three 10 ml aliquots of deionized membrane filtered water, placed in individual petri dishes with lids slightly ajar for a 24 hour desiccation period over sodium hydroxide and then sealed and stored (silver filters frozen) for subsequent laboratory analysis.

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c. Nephelometry - The vertical distribution of suspended matter was determined with a continuously recording integrating analog nephelometer. The instrument was interfaced with the ship's CTD system using the sound velocity channel (14-16 KHz). Continuous vertical profiles of forward light scattering were obtained in analog form on a Hewlett-Packard 7044 X-Y recorder.

d. Conductivity (Salinity), Temperature, and Depth - These standard hydrographic data were acquired with a Plessy model 9040 Environmental Profiling System (CTD probe) and a model 8400 digital data logger using 7-track, 200B.P.I. magnetic tape. Temperature and salinity calibration data were provided by NOAA ship personnel from discrete water samples utilizing reversing thermometers and a bench salinometer, respectively. Signals from the CTD system and the nephelometer were also simultaneously interfaced with the ship's data acquisition system. This resulted in computor listings of continuous (uncorrected) data for conductivity, temperature, depth, salinity, sigma-t, and light scattering for all vertical sampling stations.

4. Station Locations

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5. Samples and Data Collected

We have completed both cruises scheduled for FY 79 in lower Cook Inlet and Norton Sound. During the lower Cook Inlet cruise, we collected 162 suspended particulate matter samples, 15 gravity corer samples, and 10 nephelometer profiles. In addition, 18 suspended matter samples were processed in support of hydrocarbon studies in upper Cook Inlet. For Norton Sound, 146 suspended matter samples and 3 gravity corer samples of bottom sediments were collected for subsequent laboratory analysis.

B. Laboratory Activities

1. Sample and Data Status

a. Lower Cook Inlet

Analysis of samples and data collected on Cruise RP-4-DI-79A-II (7-20 May 1979) are currently underway and will be discussed in a future report.

b. Norton Sound

Analysis of samples and data collected on Cruise RP-4-Di-79A-VI (7-18 July 1979) are currently underway and will be described in detail in a future report. However, suspended matter con-

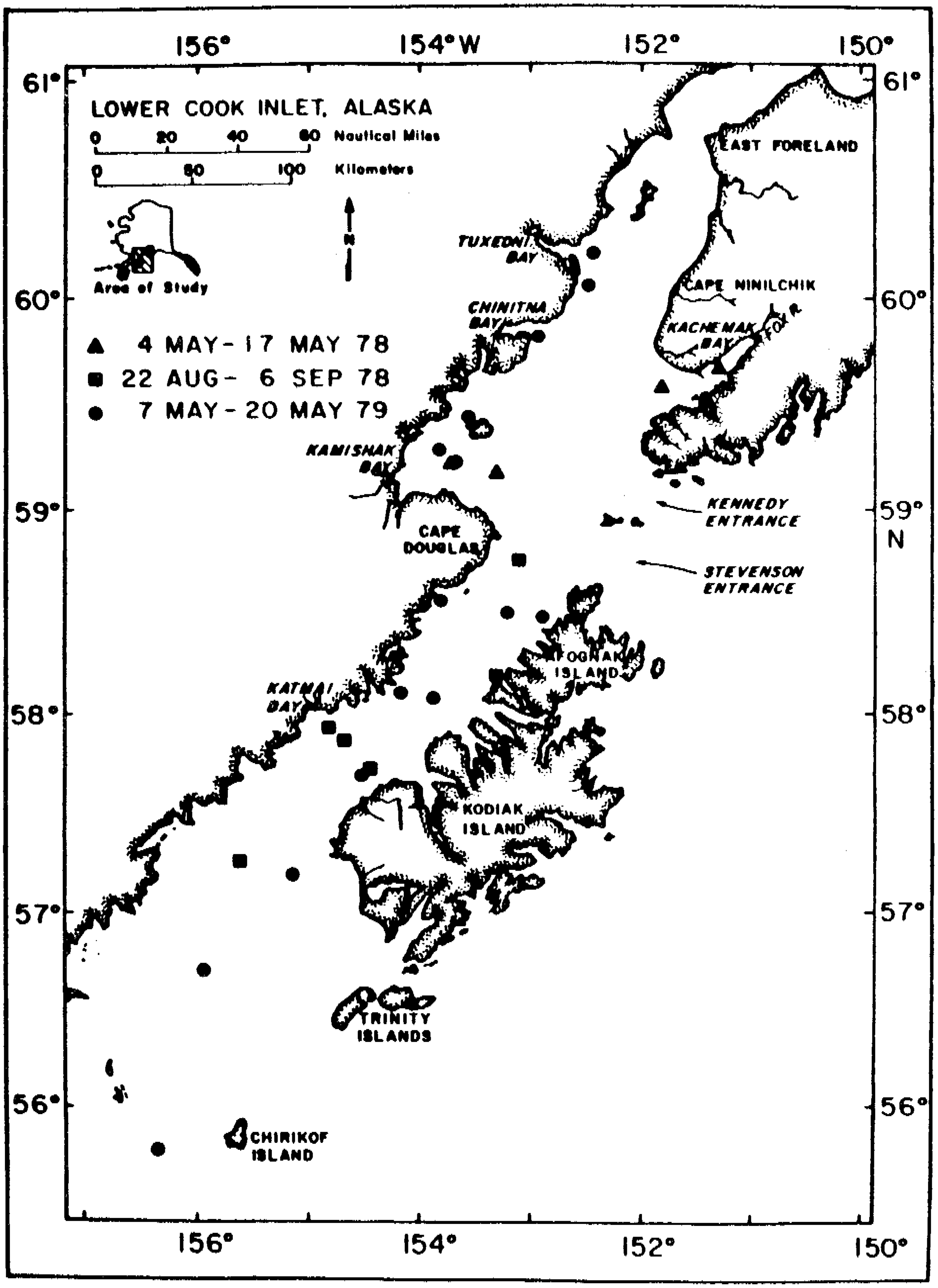


Figure 1. Locations of stations where sediment samples have been obtained for measurements of sediment accumulation rates.

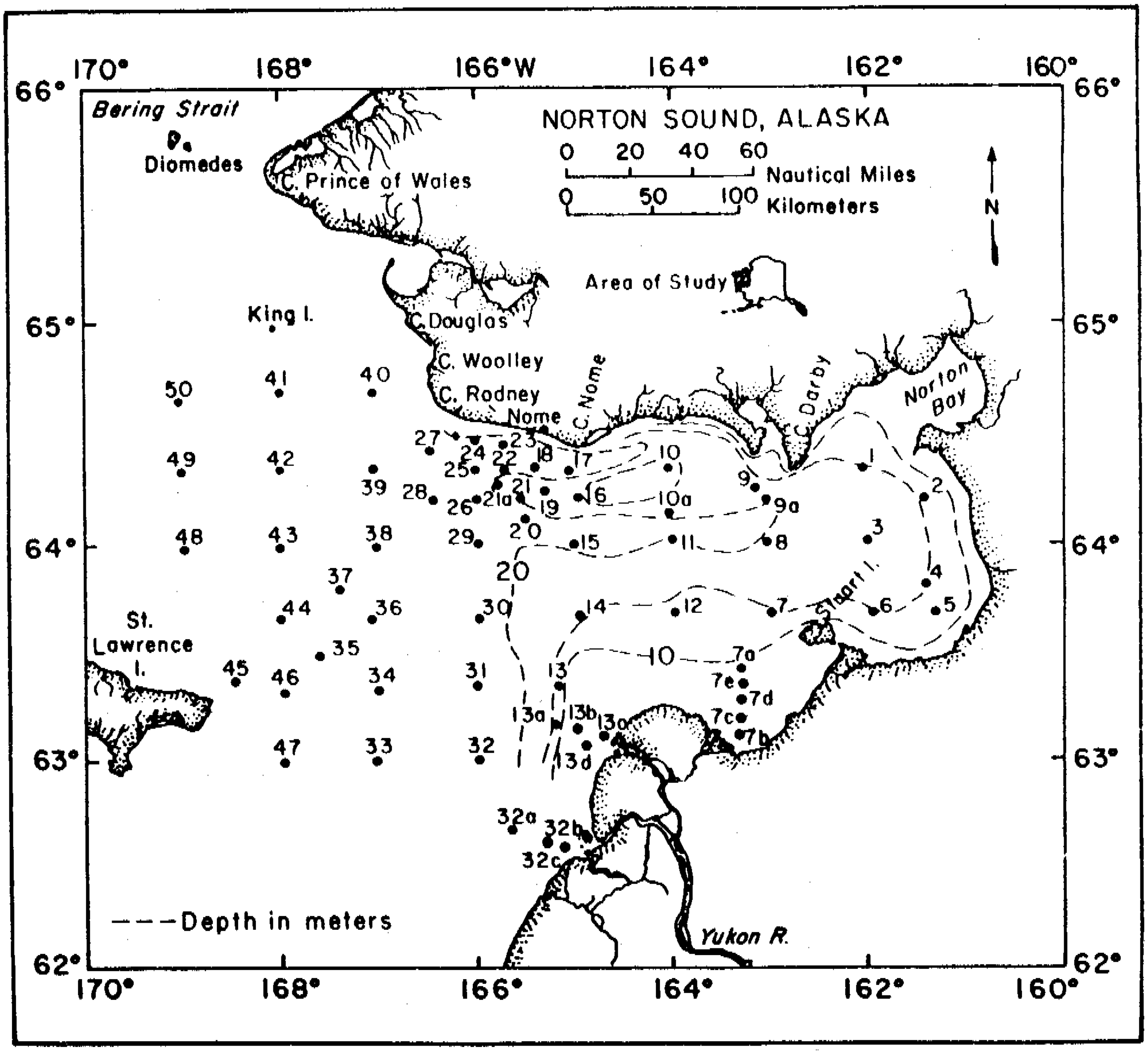


Figure 2. Locations of suspended matter stations in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

centration data are available at this time and will be briefly dicussed below.

III. Results--Norton Sound

Figure 3 and 4 show the distributions of salinity, temperature, sigma-t and total suspended matter at the surface and 5m above the bottom for the July 1979 cruise in Norton Sound. As shown in Fig. 3, surface particulate matter distributions were dominated by the discharge of sedimentary material from the Yukon River. Surface suspended matter concentrations were highest near the mouth of the Yukon River where values ranging between 100 and 154 mg/L were observed. The Yukon River plume (as indicated by the 5.0 mg/L isopleth) extended to the north and northeast across the length of the Sound. A second plume of lesser suspended matter concentrations (1.0-2.7 mg/L) extended north and northwest to a point about 20 km southwest of Cape Rodney. Both plumes appear to have originated from the Yukon River and their dispersal patterns tend to follow the general pattern of cyclonic circulation in the Sound (i.e., Yukon River material enters the Sound from the southwest, is transported north and northeast around the inside perimeter of the Sound, and exits the Sound from the northwest). These data are supported by the salinity and temperature measurements which indicated movements of low salinity (12-24^{o}/oo), relatively warm (10-11^{o}C) water to the northeast along the coast. These results are consistent with the general conclusions of Sharma et al., (1974) for suspended matter data obtained in August 1973. They are also consistent with dispersal patterns of the Yukon River Plume inferred from LANDSAT satellite photographs (Nelson et al., 1975). These features are also consistent with the data of Cacchione and Drake (1979) for surveys made during quiescent periods in September 1976 and July 1977. Thus, it would appear that the transport processes described above predominate throughout the region, at least during periods of calm weather in the summer.

The near bottom distribution of salinity, temperature, and total suspended matter also indicated evidence for cyclonic movement of low salinity (20-22 $^{o}/oo$), warm water ($\sim 10^{o}C$) to the northeast along the coast. This water mass was traced as far north as Cape Darby. Near-bottom suspended matter concentrations were highest near the mouth of the Yukon River and in the region about 20-30 km south-southwest of Nome. The near bottom plume just seaward of the Yukon River extended to the northeast along the coast in a manner very similar to the surface plume. The near-bottom concentrations were generally higher than surface concentrations, indicating that: (1) some fraction of the Yukon River material had settled to the near-bottom region during transit and/or (2) a portion of the bottom sediments had been resuspended and remained in suspension.

Figures 5 and 6 show cross sections of total suspended matter, salinity, temperature, and sigma-t for two transects across the length of Norton Sound. Transect I is near the middle of the Sound and Transect II is in the northern half of the Sound, approximately 20-30 km from the coast. Both transects show very similar water mass characteristics and suspended matter distributional patterns.

On the eastern side of the Sound, both transects showed evidence for a distinct two-layer system with the main thermocline varying in depth between 8 and 14m (i.e., stations 4, 3, and 8 from transect I and stations 1, 9, and 10 from transect II). Suspended matter concentrations in this region showed a steady increase to the bottom beginning at about 6-8m.

In the middle region (stations 15, 20, and 29 for transect I and stations 22, 25, 27, and 29 for transect II) the water column was virtually unstratified and suspended matter concentrations increased to values greater than 30 mg/L in the near bottom waters (i.e., station 25 in transect II). These water properties are characteristic of a frontal zone. The intense vertical mixing caused a complete breakdown of the main thermocline and resulted in turbulent transport of resusupended sediments up to the surface in some locations. This

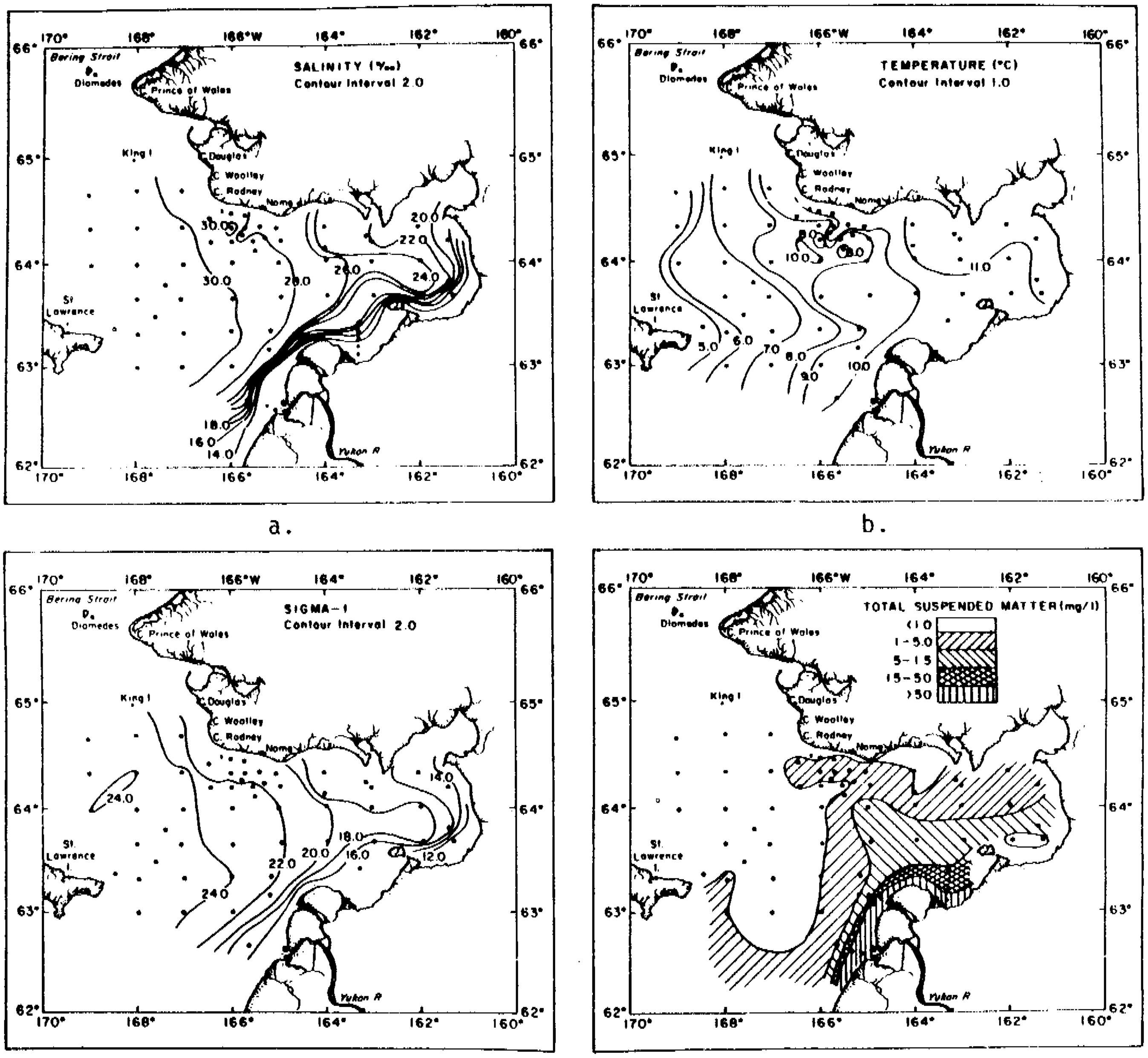


Figure 3. Distribution of: a. salinity; b. temperature; c. sigma-t; and d. total suspended matter at the surface in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

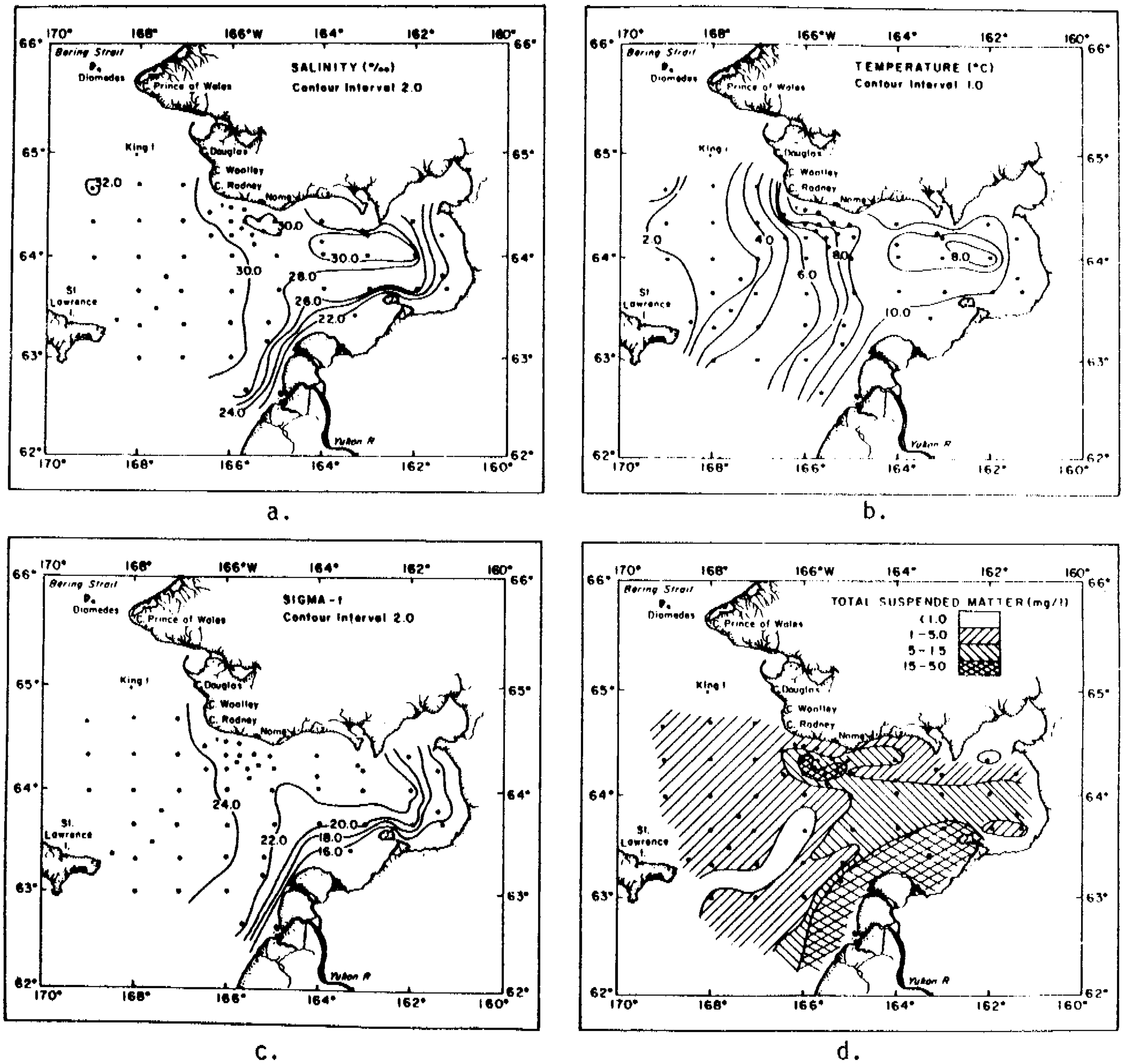


Figure 4. Distributions of: a. salinity; b. temperature; c. sigma-t; and d. total suspended matter at 5m above the bottom in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

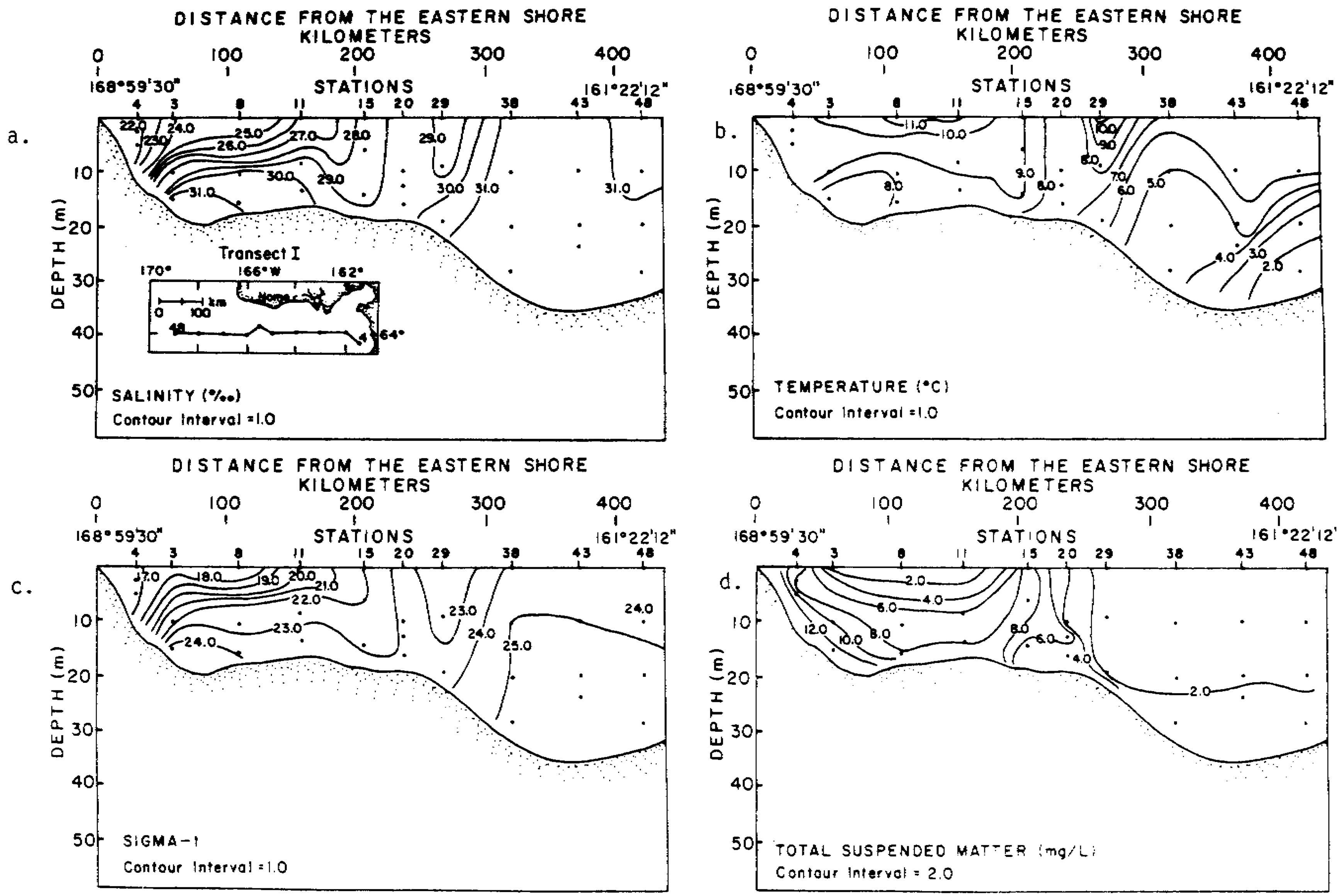


Figure 5. Vertical cross section of the distribution of: a. salinity; b. temperature; c. sigma-t; and d. total suspended matter for stations 4, 8, 11, 15, 20, 29, 38, 43, and 48 in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

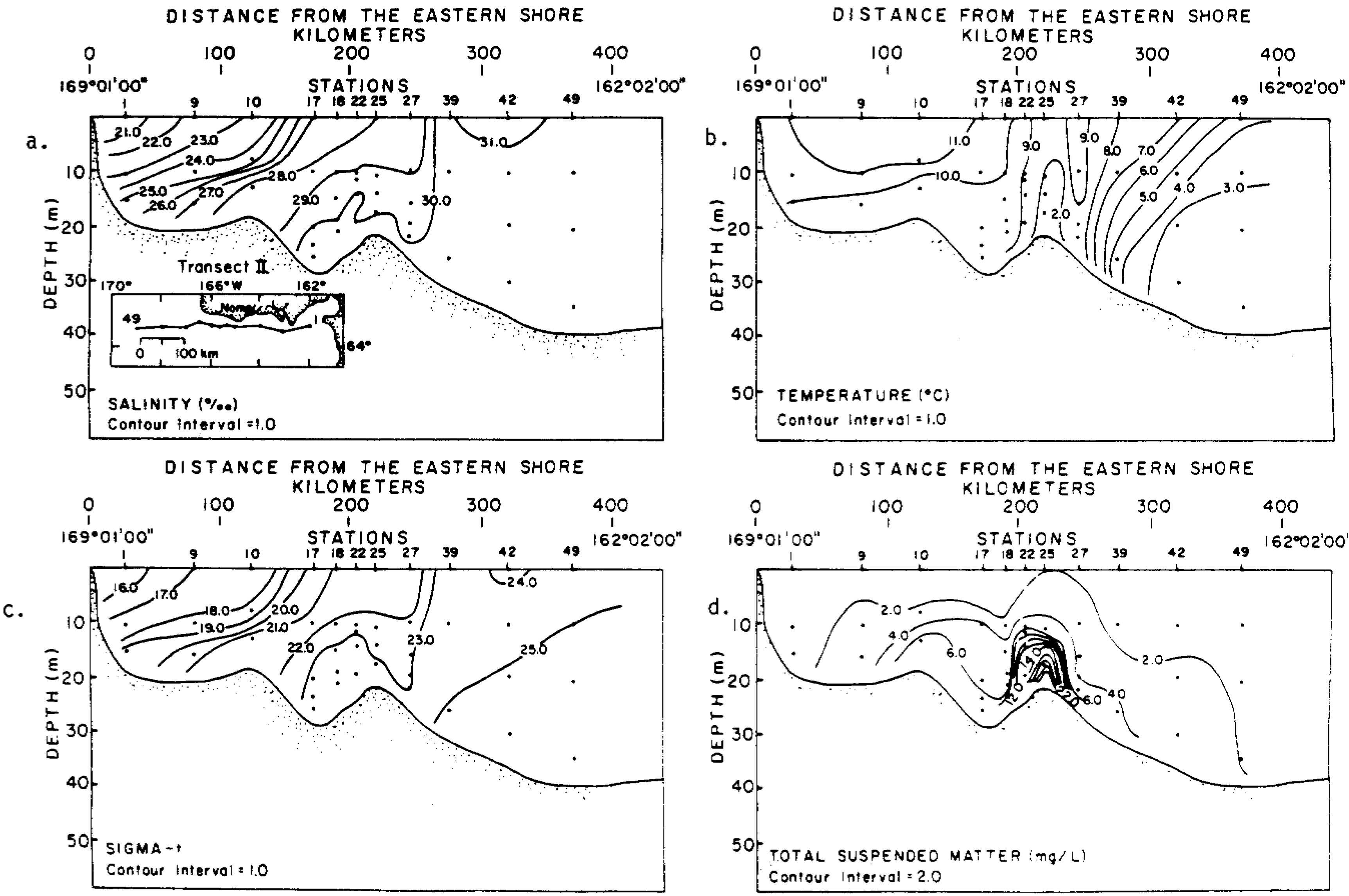


Figure 6. Vertical cross section of the distributions of: a. salinity; b. temperature; c. sigma-t; and d. total suspended matter for stations 1, 9, 10, 17, 18, 22, 25, 27, 39, 42, and 47 in Norton Sound (Cruise RP-4-Di-79A-VI, 7-18 July 1979).

anomalous feature has the same characteristics as the anomalous suspended matter plume described by Sharma et al. (1973) for data obtained in August 1973 at the same location. These data support the general conclusion of Drake and Cacchione (1979) that during quiescent periods in the Sound, resuspension of bottom sediments occurs as a result of increased tidal mixing during spring tide.

Further seaward, the water column was moderately stratified and suspended matter concentrations decreased to values below 0.5 mg/L in surface waters. In near-bottom waters suspended matter concentrations increased to values greater than 2.0 mg/L. The enriched suspended matter concentrations near the bottom were probably due to a combination of factors including advective transport of particle-laden water to the northwest from within Norton Sound and local resuspension of bottom sediments.

IV. Problems Encountered

We have no significant problems to report at this time.

V. References

Cacchione, D.A., and D.E. Drake (1979). Sediment Transport in Norton Sound, Alaska, United States Geological Survey Open File Report, 79-1555.

Nelson, C.H. and J.S. Creager (1977). Displacement of Yukon-derived Sediment From Bering Sea To Chukchi Sea During Holocene Time. Geology, 5:141-6.

Sharma, G.D., Wright, F.F., Burns, J.J. and D.C. Bunbank (1974). Sea Surface Circulation, Sediment Transport and Marine Mammal Distribution, Alaska Continental Shelf: ERTS Final Report. Natl. Tech. Service Rept. E74-10711, 77p.

Quarterly Progress Report
April 1, 1979 - June 30, 1979
Research Unit #435

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA

National Oceanic and Atmospheric Administration

J. J. Leendertse and S. K. Liu, Principal Investigators
The Rand Corporation

June 30, 1979

Progress Report

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

National Oceanic and Atmospheric Administration

April 1, 1979 - June 30, 1979

J. J. Leendertse and S. K. Liu

During the reporting period the emphasis of our studies has been in the following areas:

1. The ice model addition to the three-dimensional hydrodynamic model is near its completion. Since in the future the hydrodynamics should be simulated with not only a complete ice cover of Norton Sound, but also with a partially covered area, we have now also included the capability of simulating partially-open ice covering conditions. It is now also possible to specify if ice floes, land fast ice or rigid ice cover are included in the system. The inclusion of partial ice capability created difficulties at the open boundaries of the computational scheme; these problems have now been solved. With the final selected scheme a series of simulation tests have been conducted using a system with simple geometry. Presently the hydrodynamics of Norton Sound under winter conditions is being simulated with the summer boundaries of the tide to test the working of the model.

2. Results of tidal data analyses provided by NOAA have been used as the open boundary conditions for the Norton Sound model. A series of simulation runs have been made with the newly completed computational code for the ice-free condition in Norton Sound. Preliminary analyses of the results were made using a new time history plotting program modified from the two-dimensional simulation program. Results of the simulation, although preliminary, indicate that the computed tidal propagation and tide-induced circulation are typical of those observed in Norton Sound. The existing plotting program for horizontal current and constituents is being expanded to include computed parameters associated with the ice computation. No graphical results of current patterns from the Norton Sound simulation can therefore be presented at the time of this progress report.

   To illustrate the time series plotting program, several computed time histories from the Norton Sound simulation are presented here. Figures 1 and 2 show the computed water levels at Kwikluak Pass and Nome, Alaska. The computational starting point corresponds to midnight of July 1, 1977. Computed values for the first six hours represent the run-in period and should therefore be disregarded. Figures 2 through 6 represent the hindcasted water levels and currents for 1-2 July 1977 at station N23, which is situated in the middle of the Sound. High frequency oscillation induced by the vertical stratification is illustrated in the vertical velocity components (Fig. 6). Computed time histories of water level and velocity components at station N2 are presented in Figs. 7 through 10. Being close to the southern boundary of the model, the computed velocities exhibit pronounced nonlinear components induced by the combined effects of local bathymetry and tidal conditions. Because of the strong density gradient, vertical instability is evident in the upper two layers where the pycnocline is situated (graph showing the vertical velocity component w). The progress on the adjustment of this model has been delayed as boundary data were not made available until May 1979. Unfortunately, progress has been slow, as the two computer installations we are using are presently nearly fully loaded and in the process of installing new computers.

3. The computational program for oil trajectory simulation is nearly 80 percent complete. Several tradeoffs between resolution and simulation cost are being studied using a rectangular system with irregular bathymetry. The computational system obtains its predictive impulse response function from the main simulation program. For the ice-free condition, five basic runs are made using the main program for calm, and under four (N.E.S.W.) wind directions of average wind speed, tide conditions and vertical density profiles. Wind stress is terminated after 12 hours, and the system is left to oscillate with only the inertial components. Differences in the velocity components between the condition with and without wind at each model's grid location are then used as the impulse response function for oil trajectory simulation.

   During the oil trajectory simulation, every 12 hours a wind condition (speed and direction) is drawn from a certain weather 'type' which will last for 36 hours. The weather type is selected randomly from a transitional distribution derived from local weather statistics.

   Within each 12-hour period the current speed in the surface layer of each grid location is first computed by the convolution procedure and then extrapolated vertically upward to the water surface. The local surface drift velocity is added to the nonlinear water transport due to surface waves to obtain the final oil film transport. The wind speed and direction for the wave-induced surface transport is computed every 30 minutes from a Gaussian wind field having a mean value belonging to the 12-hour weather type plus certain assigned standard deviations. A typical oil trajectory simulation is expected to last for 60 days. To illustrate the process, oil trajectories from three oil spill simulations are presented in Fig. 11. A rectangular bay with irregular bathymetry is used for the tests. In each of the simulations, six hypothetical oil spill locations (marked by a circle) are being simulated simultaneously under the same weather conditions. The top figure (A) illustrates the results from an ice-free condition with vertical density gradient and average tide. Changes of weather type are represented by a sequence of arrows above each figure at 12-hour intervals. Within each 12-hour period additional random wind components are added at 30-minute intervals to the wind data belonging to the selected weather type. Surface transports due to waves generated by this component are added to the mean current, thence giving the final oil movement at each grid location. Statistical analyses of the random wind components are presented by two wind roses located on the right-hand side of each map. The top diagram shows the average wind speed in each direction, while the bottom rose gives the frequency of occurrence in each direction.

The middle graph (B) shows the oil trajectories of another run for the ice-free condition. The bottom figure (C) is for the winter condition when the surface of the bay is covered with ice floe. Under this condition, water transport due to waves no longer exists. The surface water movement consists of mainly tidal residual currents modified by the ice cover in addition to the momentum transfer obtained from the wind field through the ice layer. More Coriolis effects are evident due to the lack of vertical density gradient during the winter season. In order to reduce the simulation cost, the test basin has 5 layers, with a horizontal grid space of 1 km and the tide used for the computation has a period of 1 hour.

4. Technical review of the report on the Bristol Bay model verification has been concluded. Final preparations are expected to be completed in the near future.

5. The progress of the investigation is somewhat behind schedule because of the earlier mentioned access problems to the computer systems, delayed receipt of boundary data and the inclusion of the partially covered ice field in the three-dimensional simulation model. In the next three months we expect to make up some of the lost time.

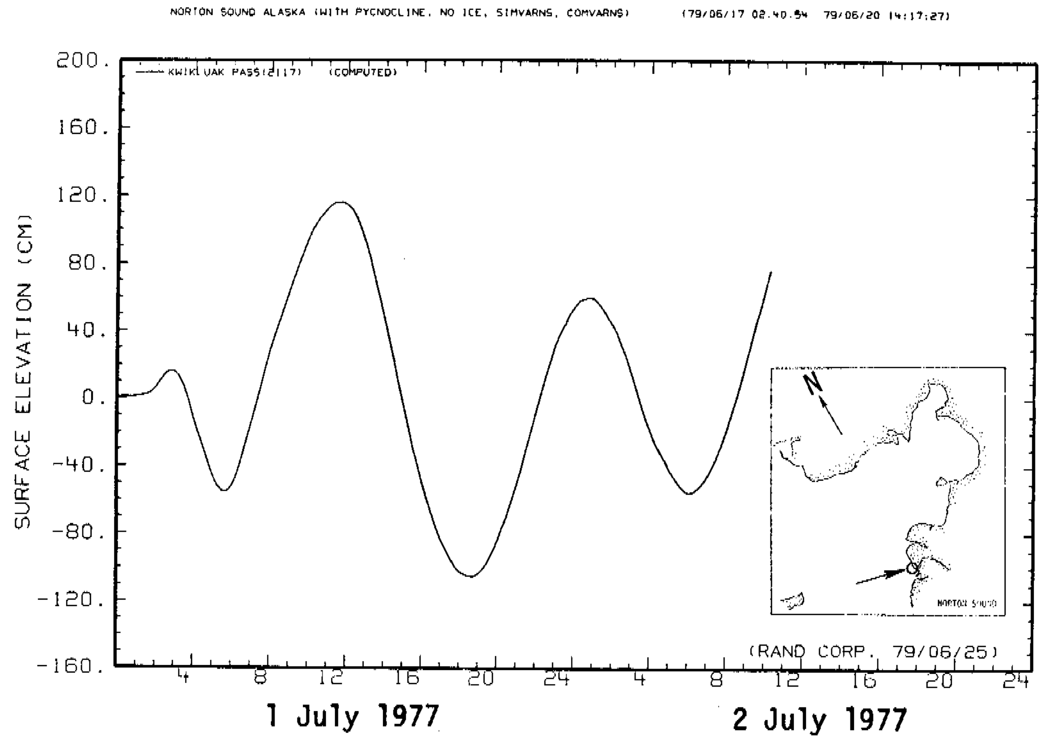


Fig. 1--Computed water level near Kwikluak Pass, Alaska

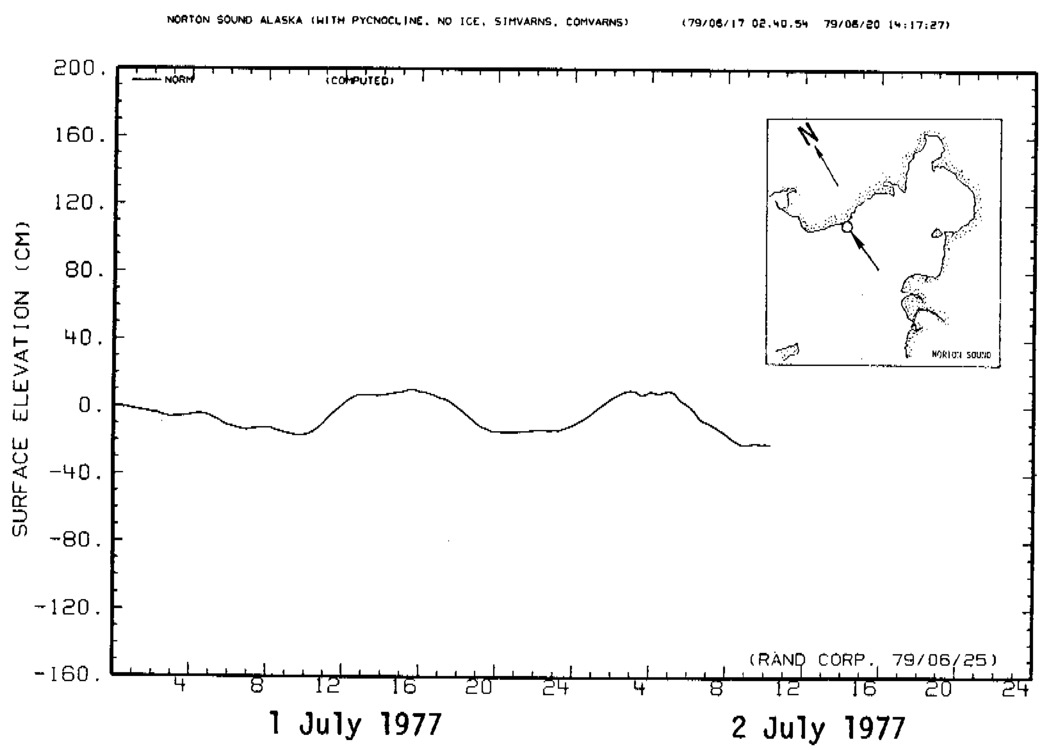


Fig. 2--Computed water level near Nome, Alaska

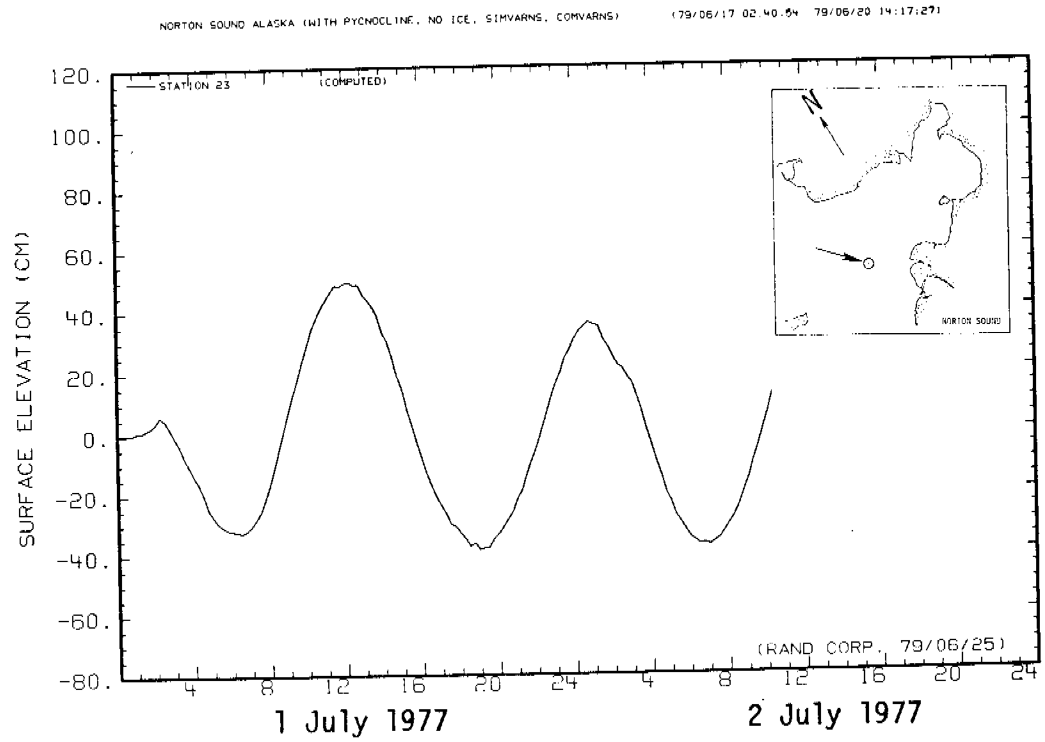


Fig. 3--Hindcasted tidal level for 1-2 July 1977 at monitoring station 23, Norton Sound, Alaska

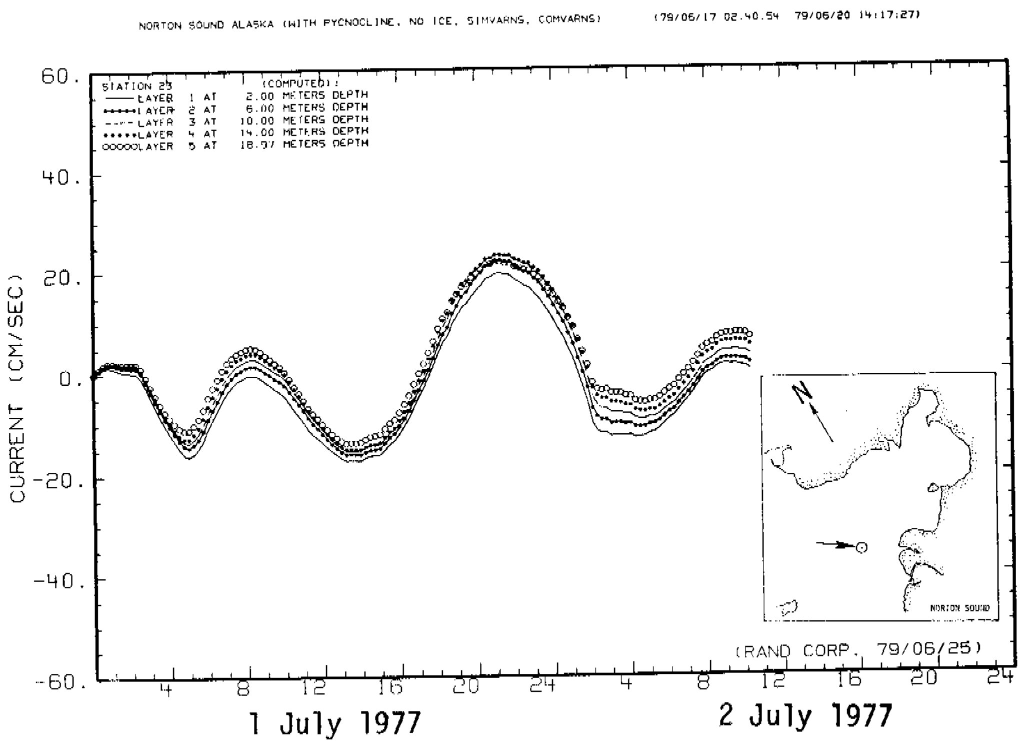


Fig. 4--Hindcasted tidal currents (u-component) for 1-2 July 1977 at monitoring station 23, Norton Sound, Alaska

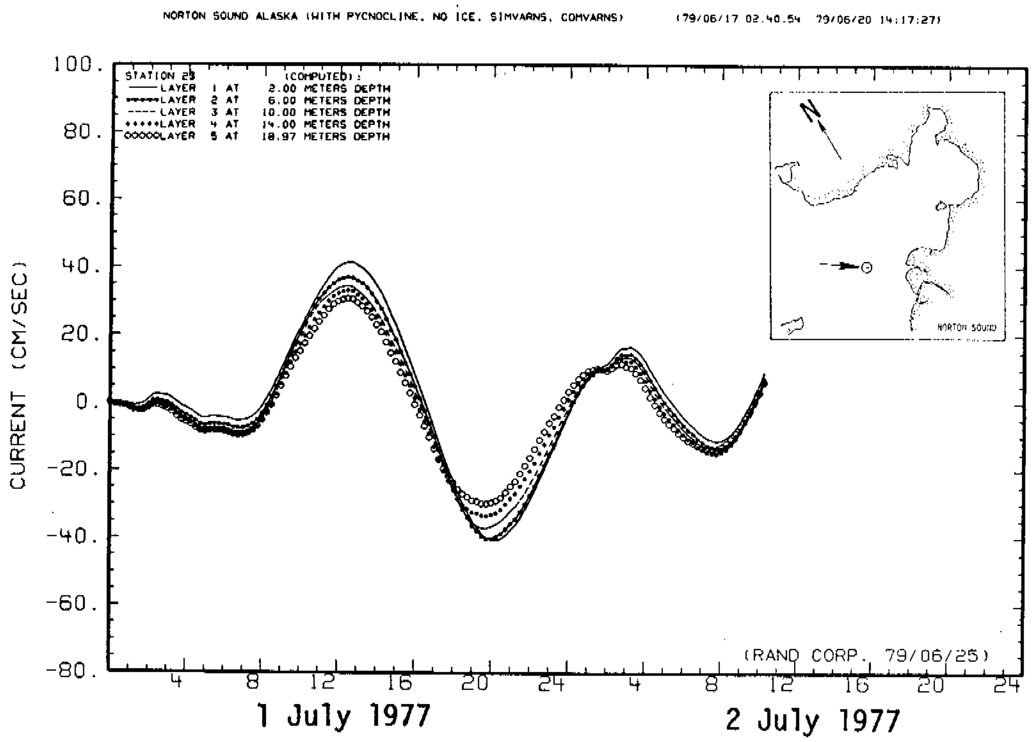


Fig. 5--Hindcasted tidal currents (v-component) for 1-2 July 1977 at monitoring station 23, Norton Sound, Alaska

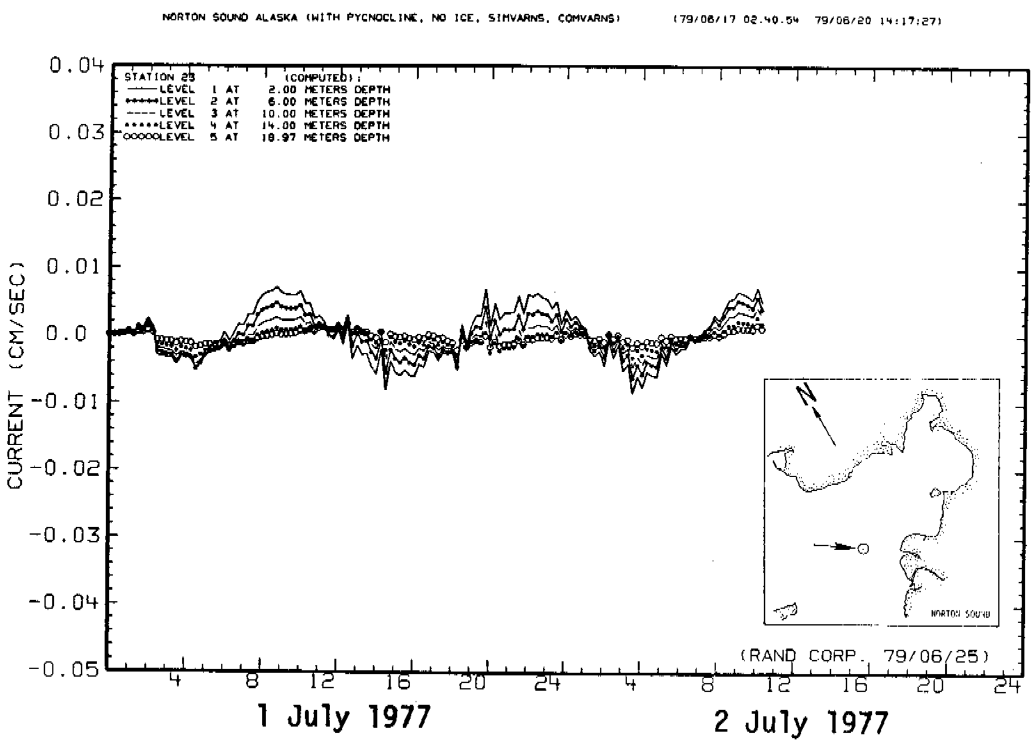
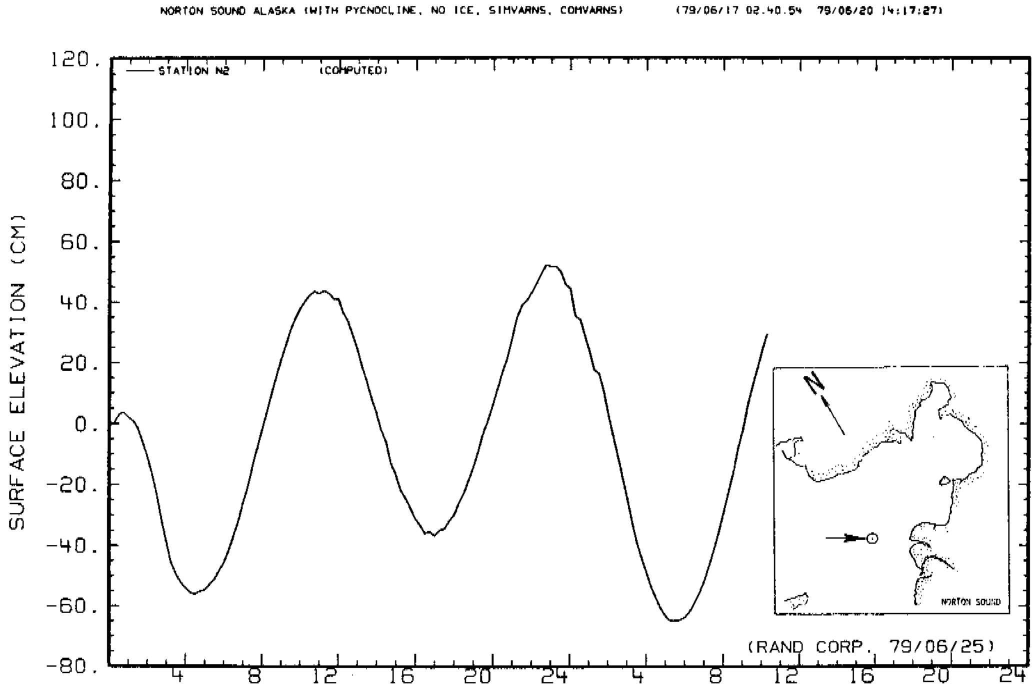
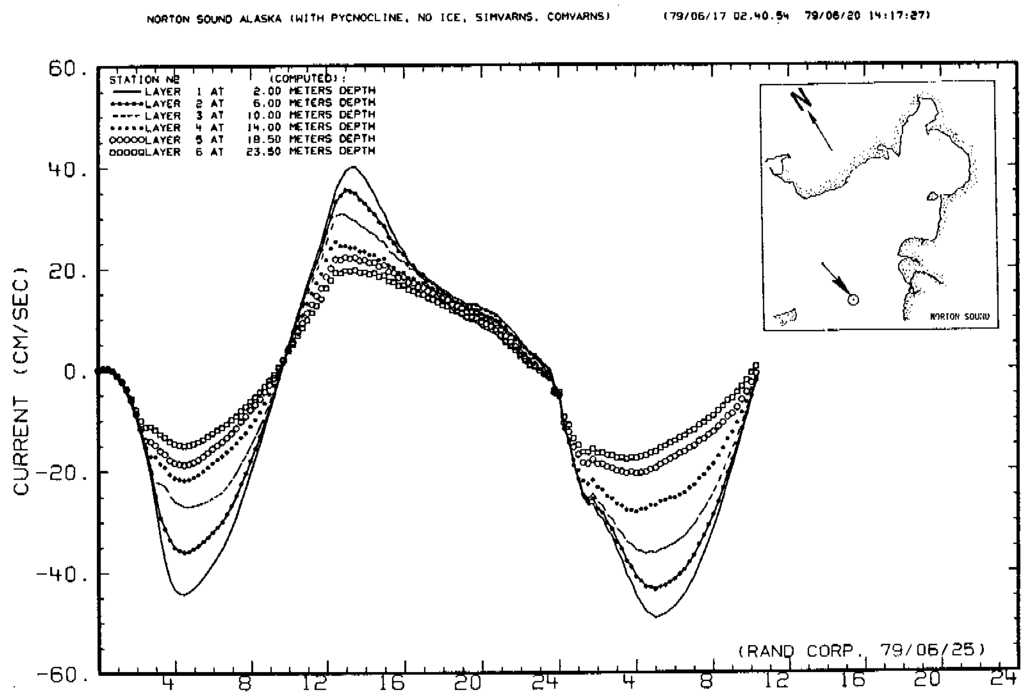


Fig. 6--Hindcasted tidal currents (w-component) for 1-2 July 1977 at monitoring station 23, Norton Sound, Alaska



1 July 1977 2 July 1977

Fig. 7--Hindcasted tidal level for 1-2 July 1977 at monitoring station N2, Norton Sound, Alaska



1 July 1977 2 July 1977

Fig. 8--Hindcasted tidal currents (u-component) for 1-2 July 1977 at monitoring station N2, Norton Sound, Alaska

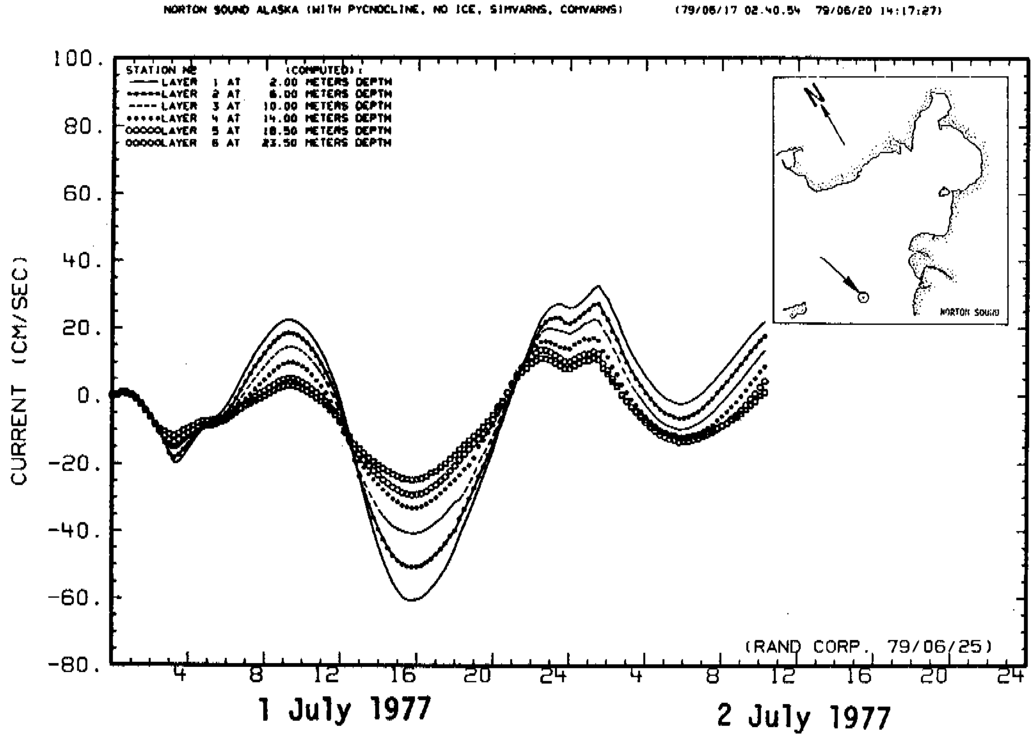


Fig. 9--Hindcasted tidal currents (v-component) for 1-2 July 1977 at monitoring station N2, Norton Sound, Alaska

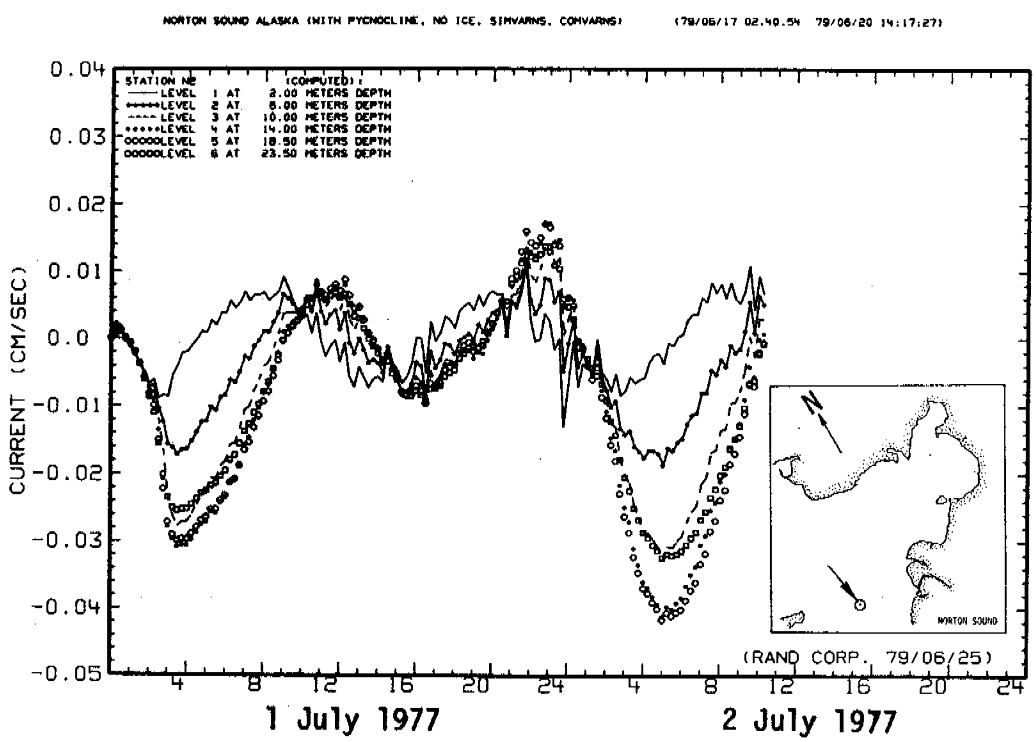


Fig. 10--Hindcasted tidal currents (w-component) for 1-2 July 1977 at monitoring station N2, Norton Sound, Alaska

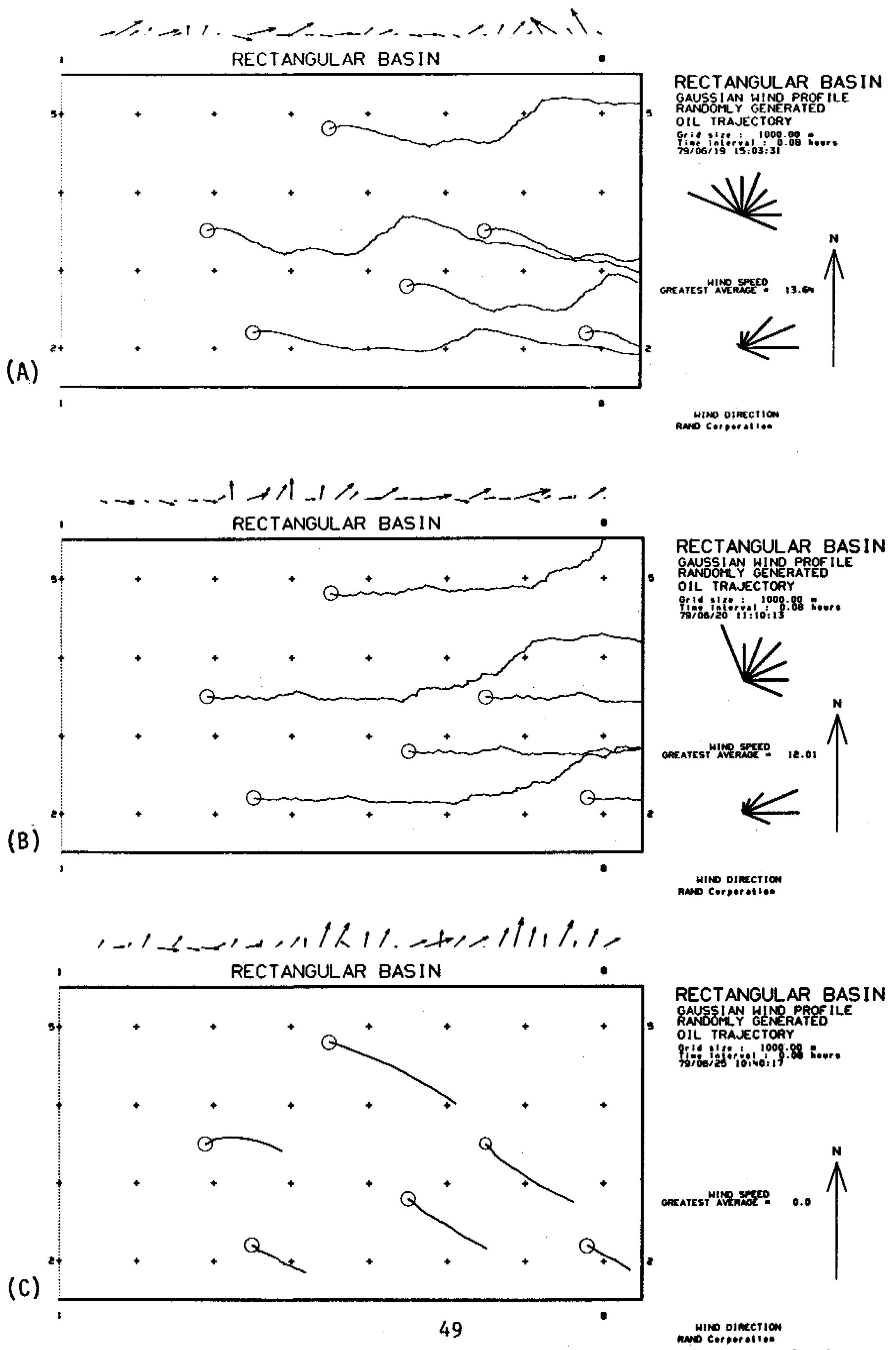


Fig. 11--Oil trajectories from three oil spill simulations at six hypothetical sites in a rectangular basin. (A), ice-free condition with vertical density gradient and average tide. (B), same situation as (A), but with different weather scenario. (C), homogeneous density structure with ice cover, no wave transport. Arrows on top of graph show the transitional wind field.

Quarterly Progress Report
July 1, 1979 - September 30, 1979
Research Unit #435

MODELING OF TIDES AND CIRCULATIONS OF THE BERING SEA
National Oceanic and Atmospheric Administration

J. J. Leendertse and S. K. Liu, Principal Investigators
The Rand Corporation

October 1, 1979

Progress Report

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

National Oceanic and Atmospheric Administration

July 1, 1979 - September 30, 1979

J. J. Leendertse and S. K. Liu

During the reporting period the emphasis of our research effort has been in the following four areas:

- o Adjustment of the Norton Sound model under ice-free conditions.
- o Refinement of the basic subgridscale (turbulent) energy computational scheme so that transient behavior of vertical density instability can be simulated more efficiently.
- o Compilation of existing ice-cover data for the simulation of ice regions in Norton Sound.
- o Derivation of oil trajectory predictive response functions using the entire computational grid of Norton Sound to determine the computational requirements for long-term prediction of oil trajectories.

1. As a result of a meeting held at the Sandy Point Project Office, Seattle, Washington, on August 23, 1979 current and water level data collected at station LD-5 during July-September 1978 will be used for the verification of the Norton Sound model under ice-free conditions. A magnetic tape containing digitized data for station LD-5 was transmitted from the University of Washington to Rand in mid-September. Using the weather data collected at Nome during the same period in 1978, the final phase of model adjustment and verification is presently underway. Station LD-5, being the only current station in the middle of Norton Sound available for verification, is located approximately on the amphidromic point of the semidiurnal tidal component, making the model adjustment somewhat more difficult.

2. During periods of seasonal heating or cooling, vertical momentum-mass exchange and turbulence level are being suppressed or enhanced. The quantitative level of suppression and enhancement have long been treated as functions of local Richardson number. Due to the scarcity of measurements, this functional relationship induces uncertainties in the vertical exchange computation. During the reporting period certain basic changes have been made in the computational method so that the exact gain in potential energy through the vertical mixing process is accounted for and taken out of the SGS turbulent energy balance. Therefore uncertainties in the turbulence and exchange computation are substantially reduced.

3. The formation, movements, and type of ice cover in Norton Sound are quite different from those observed in the areas of the Beaufort Sea and Bering Strait. To facilitate the initial ice condition for the oil trajectory computation in Norton Sound, historic data, satellite photos and personal observations have been compiled and reviewed. Computed ice movements under different weather conditions are being compared with the observed movements by means of satellite tracking data.

4. During the reporting period a series of simulations was made for the purpose of deriving the predictive response function for oil trajectory simulation. This procedure can best be described using graphs produced from the simulation series. Figure 1 shows the bathymetry of Norton Sound after schematization. Circled numbers on each isocontour line represent the order of contour isoline values tabulated in the left upper corner of the chart. For example, the first isoline is for the depth of 4 meters.

   After the preliminary adjustment, a simulation of 60 hours (or longer) is made without the surface wind stress. Results obtained from this basic run, which contains tidal- and density-induced vertical shear structure for the entire field, are used to compare with four other runs under identical tidal and density conditions except that each one is under different wind stress from NESW directions for a period of 12 hours. After this period, the system is allowed to oscillate on its own inertia. Results from these four runs are then used to derive the response function by comparing them with the basic run. Figure 2 shows the response function for the surface drift current components u and v under an easterly wind of 10 knots at the model's grid location (M=12, N=13). Similar functions for the model's grid location (M=10, N=16) are plotted in Fig. 3. The first 12-hour period when wind stress is in effect is marked on each diagram.

   From Figs. 2 and 3 it is clearly evident that under given wind components the behavior of surface drift current at each location is markedly different due to the local tide-induced energy level, vertical density-induced shear coupling, and the boundary's influence on the inertial components.

   Procedures for predicting oil trajectories using these response functions and the local weather scenario have been described in a previous report.

   Due to the late receipt of field data and the unfortunate fact that pressure observations at one critical location have been lost, the adjustment of the model appeared much more difficult than we anticipated. Presently we have to estimate the missing boundary data, make a simulation and try to deduct from simulation results errors in the boundary condition simultaneously with errors in the estimates of the dissipative factors.

   We are delaying writing our yearly note summarizing the progress of the study to a more opportune moment in the near future. Our last year's report is now ready to be printed and will be published shortly.

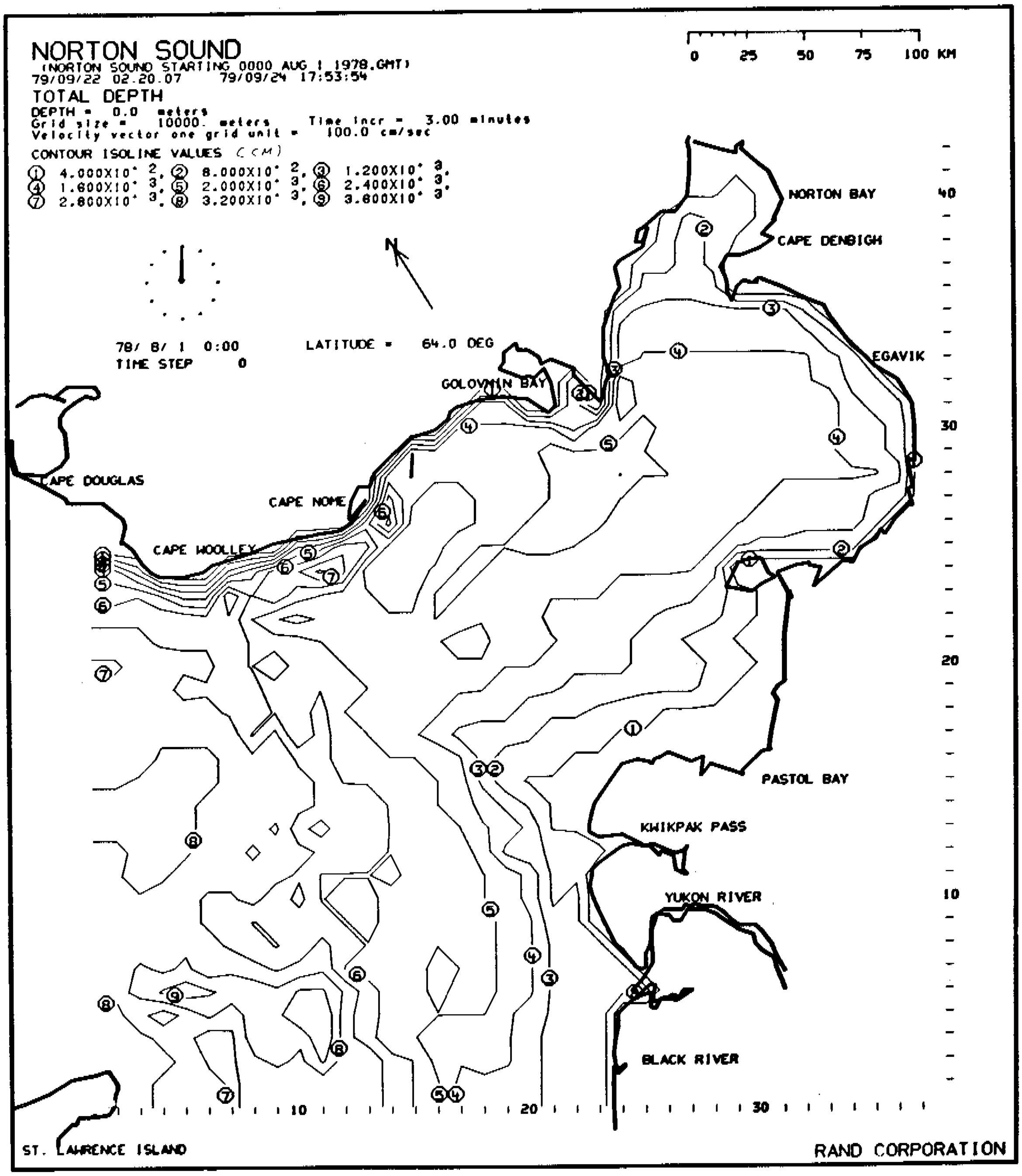
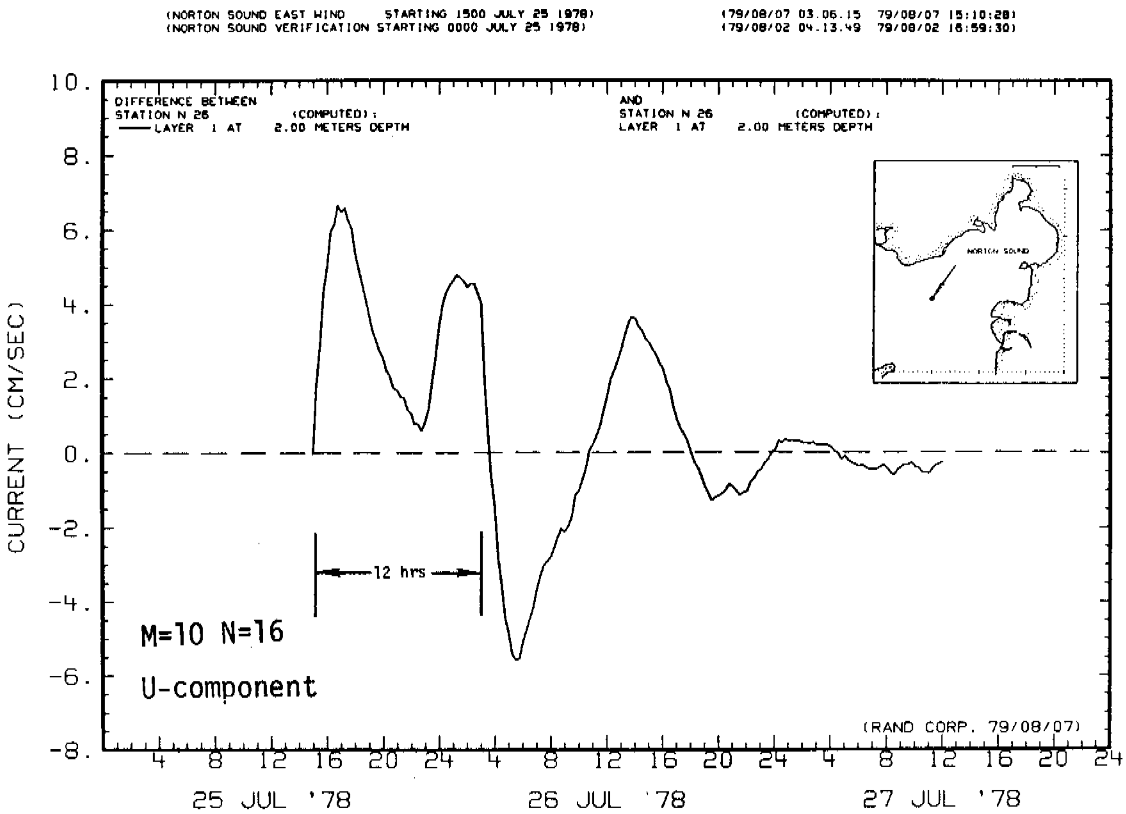


Fig. 1--Bathymetric representation in the Norton Sound model



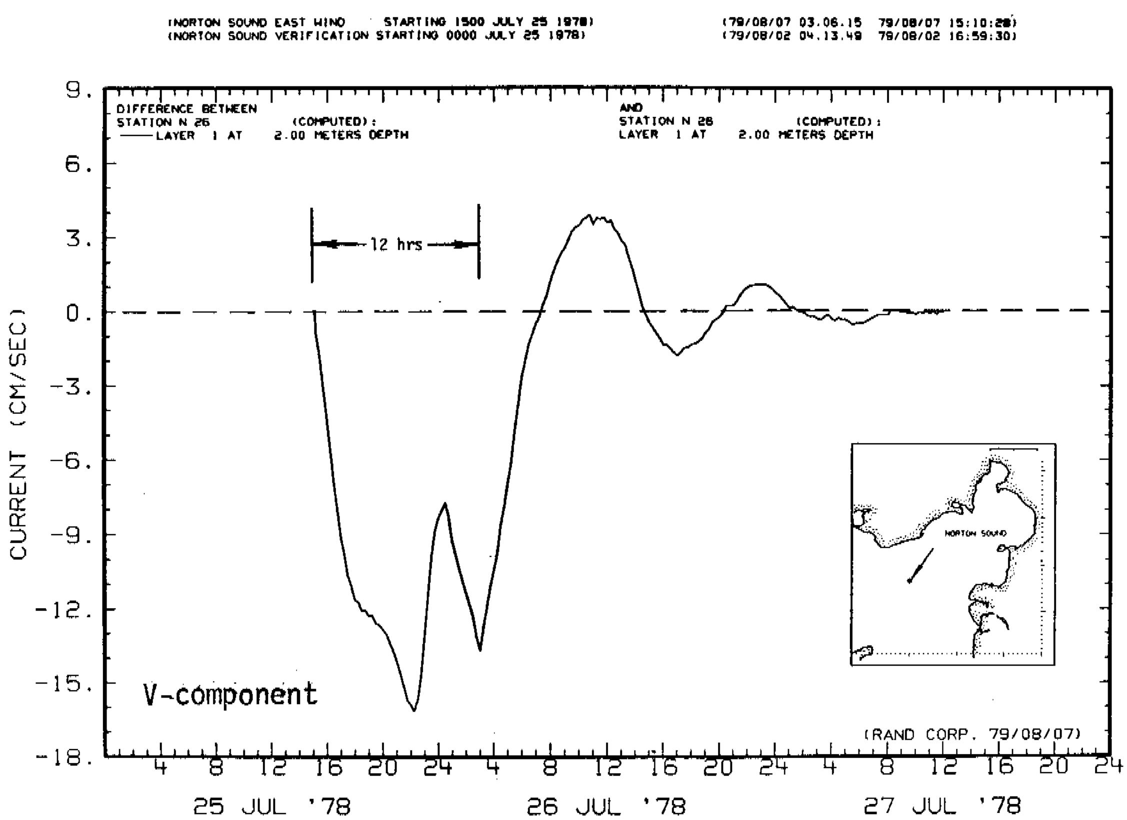
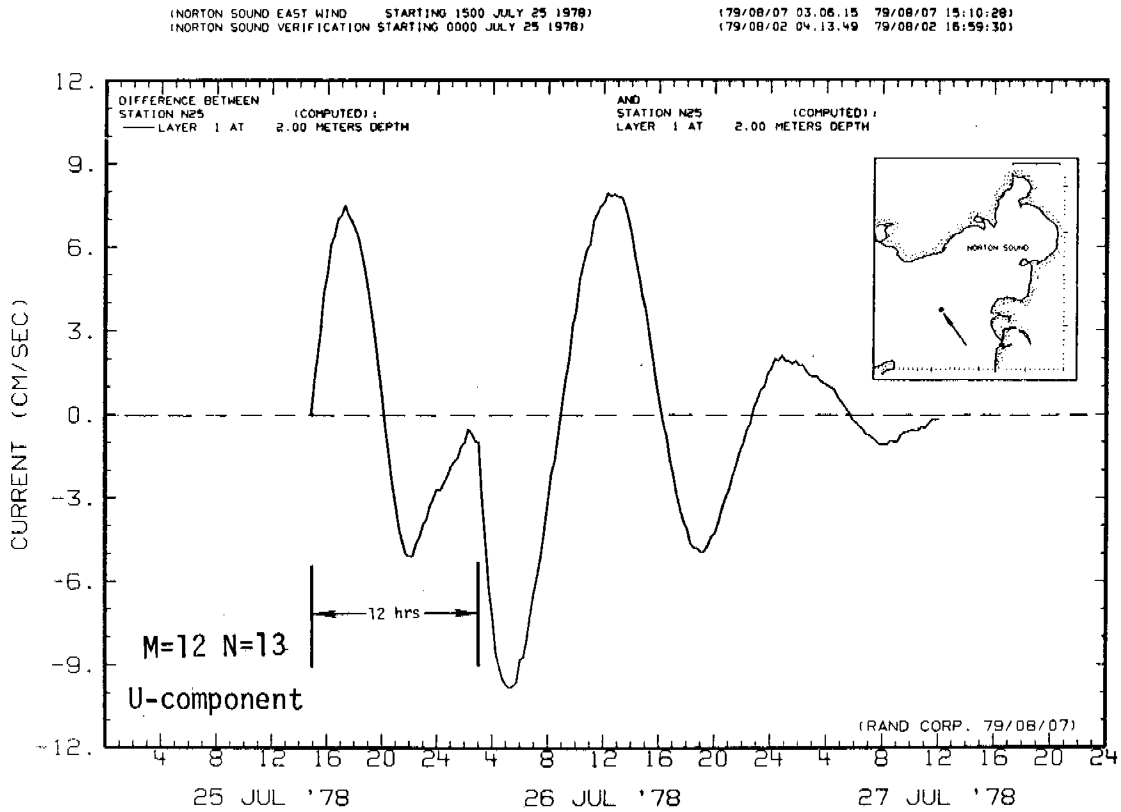


Fig. 3--U- and V-components of the response function for the surface drift under easterly wind of 10 knots at grid location M=10, N=16



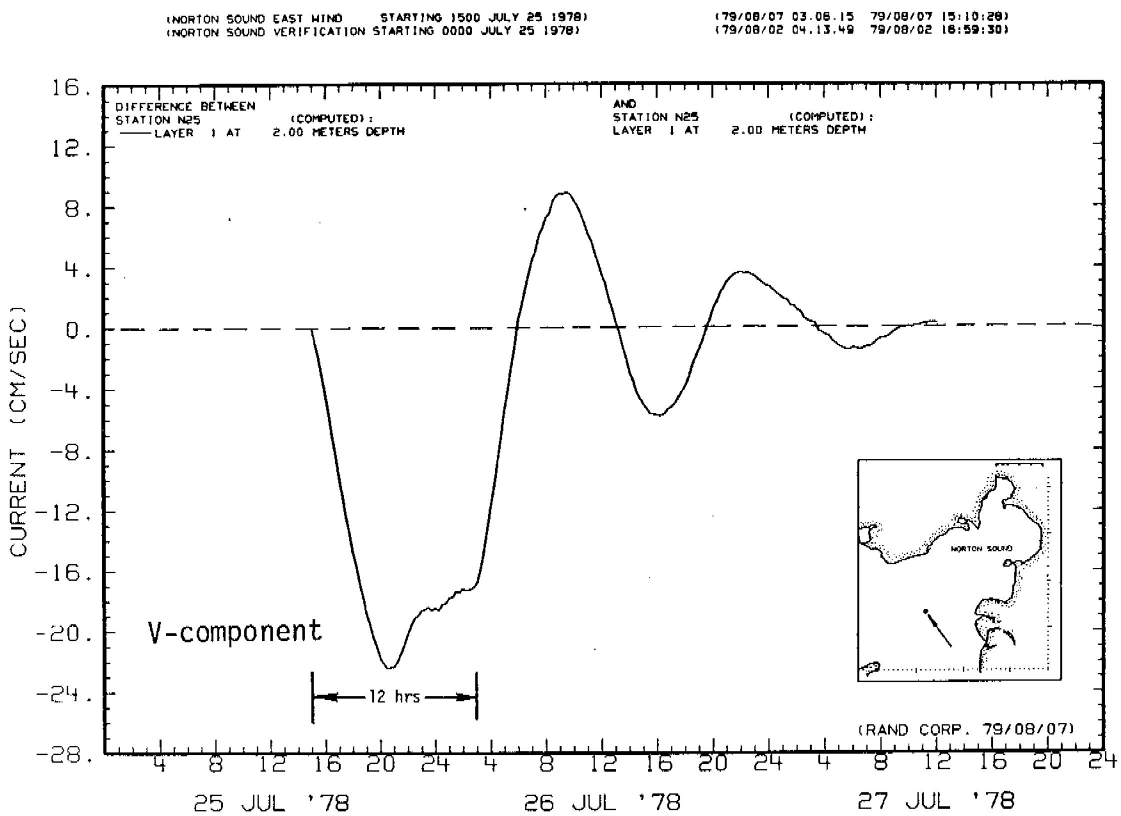


Fig. 2--U- and V-components of the response function for the surface drift under easterly wind of 10 knots at grid location M=12, N=13

Quarterly Report
July 1979-September 1979
Research Unit #480
Principal Investigator:
I.R. Kaplan
Co-Investigator:
M.I. Venkatesan

Characterization of Organic Matter in Sediments From Gulf of Alaska, Bering and Beaufort Seas

I.R. Kaplan

M.I. Venkatesan

E. Ruth

and

D. Meredith

Institute of Geophysics and Planetary Physics

University of California

Los Angeles, California 90024

October, 1979

Field Activity

Mr. Dave Meredith collected about 20 sediment samples and 2 core samples from Norton Sound area in the cruise of the R.V. DISCOVERER (July, 1979) for HMWHC analyses. About 20 samples for gas analyses were also obtained.

Laboratory Activity

1. GC/MS analyses of 6 samples (hexane and benzene fractions) collected in spring and summer of 1978 from Cook Inlet have been completed and the detailed interpretation of the results will be incorporated in the next Annual Report.

2. Location map of the stations sampled from Cook Inlet in the spring of 1979 is presented in Figure 1.

3. All the 14 samples collected have been extracted and saponified. Most of the samples have been column chromatographed and the fractions are being analyzed in the gas chromatograph. The gravimetric data are presented in Table 1 and Figure 2.

4. Most of the samples from Norton Sound (1979) have been extracted and are at different stages of analyses.

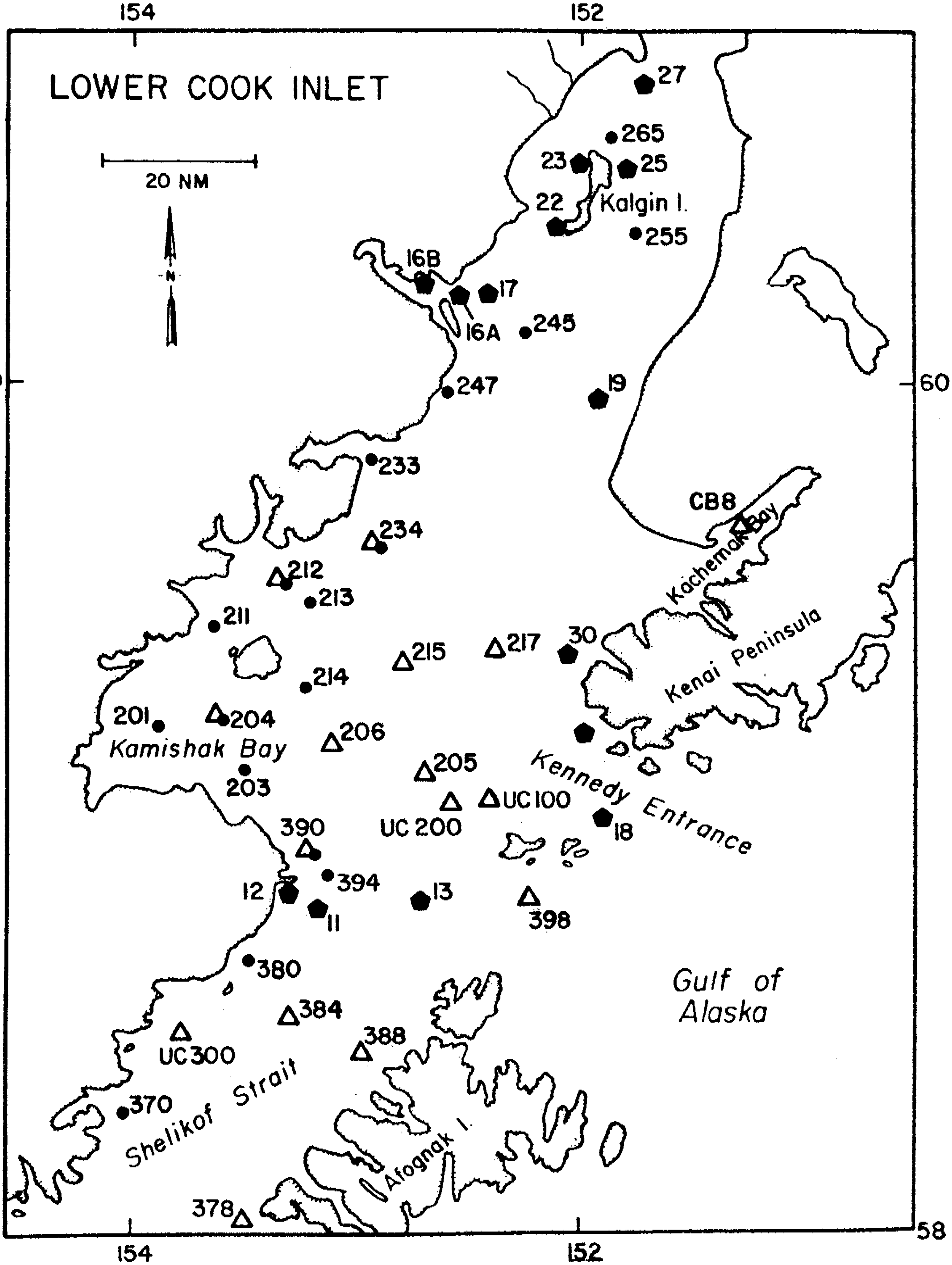


Fig. 1 ● 1978 Spring Samples △ 1978 Summer Samples

⬟ 1979 Spring Samples

Table 1. Cook Inlet Sediment Samples (1979 - Spring Cruise)

Station[1] No.	Latitude (N)	Longitude (W)	Depth (m)	Rating[2]	Nonsaponifiable[3] fr. (ppm)	Aliphatic fr. (ppm)	Aromatic fr. (ppm)
11	58°46.3'	153°9.8'	190	5	29.96	n.a.	n.a.
12	58°48.5'	153°16.3'	28	1	22.43	1.36	2.13
13	58°47.4'	152°41.5'	200	3	14.67	n.a.	n.a.
16A	∿ 60°12.0'	∿ 152°35.0'	--	--	67.74	1.52	0.66
16B	∿ 60°13.0'	∿ 152°45.0'	--	--	38.46	n.a.	n.a.
17	60°12.4'	152°54.0'	45	4	35.48	3.66	4.20
18	58°58.8'	151°53.2'	180	4	26.65	0.43	3.04
19	59°57.9'	151°54.0'	30	5	15.25	0.53	1.08
22	60°23.2'	152°05.7'	35	--	6.71	1.99	0.28
23	60°30.8'	152°00.0'	35	--	1.16	n.a.	n.a.
25	60°30.2'	151°48.8'	10	--	6.50	0.96	0.73
27	60°41.5'	151°44.4'	20	--	3.83	0.80	0.27
30	59°21.8'	152°02.8'	56	2	34.68	0.92	1.01
31	59°10.8'	151°58.6'	106	3	27.22	0.48	0.48

[1] Samples are 0-2 cm; [2] Quality of sample recovery based on a subjective scale of 5 (excellent) to 1 (poor);
[3] No elemental sulfur detected; n.a. = not analyzed

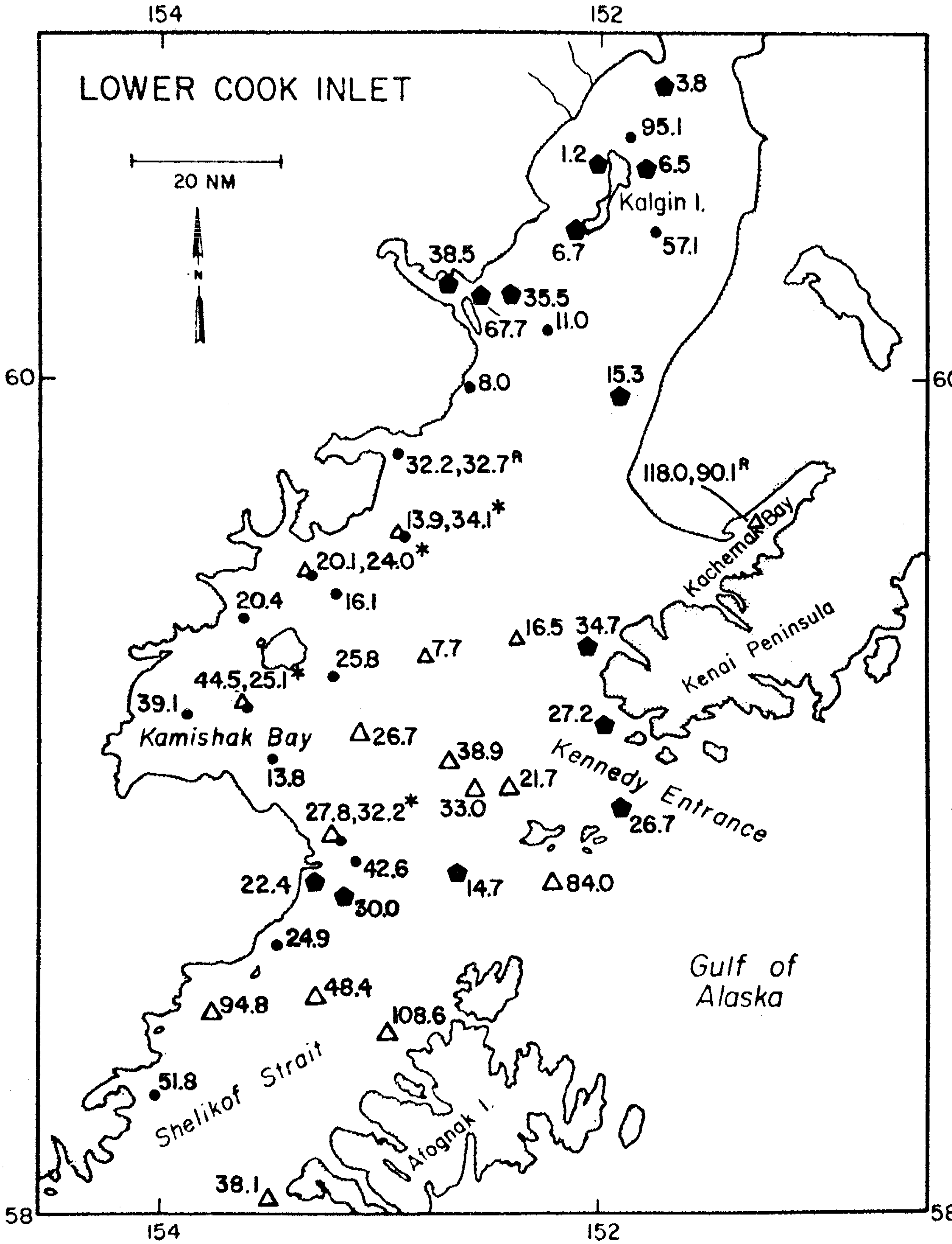


FIG. 2. NONSAPONIFIABLE FRACTIONS IN PPM.

* = SUMMER SAMPLES; R = REPLICATE

MILESTONE CHART

O - Planned Completion Date

X - Actual Completion Date
(to be used on quarterly updates)

RU # 480 PI: *I.R. Kaplan and M.I. Venkatesan*

Major Milestones: Reporting, and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	O (1978)	N	D	J (1979)	F	M	A	M	J	J	A	S	O	N	D
FIELD SAMPLING								X		X					
SAMPLE ANALYSIS & PROCESSING	←	—	—	—	—	O	—	—	—	—	—	→			
QUARTERLY REPORTS	X			X						X			X		
ANNUAL REPORT							X								

Quarterly Report
October 1979-December 1979
Research Unit #480
Principal Investigator:
I.R. Kaplan
Co-Investigator:
M.I. Venkatesan

Characterization of Organic Matter in Sediments From Gulf of Alaska, Bering and Beaufort Seas

I.R. Kaplan

M.I. Venkatesan

E. Ruth

and

D. Meredith

Institute of Geophysics and Planetary Physics

University of California

Los Angeles, California 90024

January, 1980

Laboratory Activity:

1. Analysis of stations sampled from Cook Inlet in the spring of 1979 has been completed. The concentrations of individual alkanes and characteristic parameters from gas chromatography are presented in Tables 1 and 2.

2. All the samples collected in July 1979 from Norton Sound area (including the 2 core samples) have been extracted and the aliphatic and aromatic fractions run on the gas chromatograph. Data reduction is in progress.

3. GC/MS analyses of selected samples from the above stations are in progress. The results will be discussed in the Annual Report, April 1980.

Meetings

Dr. I.R. Kaplan presented a paper entitled, "Organic Geochemistry of Surficial Sediments from Eastern Bering Sea" in the symposium on "The Bering Sea Shelf:Oceanography and Resources" held in Anchorage, Alaska on November 14-16, 1979. The final draft has been sent to Dr. D.W. Hood for publication.

Table 1. Aliphatic hydrocarbon concentrations (ng/g) in 1979 Cook Inlet sediment samples

Station*	n-C_{15}	n-C_{16}	n-C_{17}	Pristane	n-C_{18}	Phytane	n-C_{19}	n-C_{20}	n-C_{21}	n-C_{22}	n-C_{23}
11	n.d.	0.8	1.8	3.8	2.4	0.6	3.7	9.8	21.1	5.1	12.0
12	1.1	2.0	4.5	3.9	4.1	1.0	6.5	7.8	11.5	8.2	24.0
13	n.d.	n.d.	0.8	1.9	n.d.	n.d.	2.9	3.1	6.0	3.4	4.5
16A	n.d.	n.d.	0.6	0.8	0.6	0.4	0.6	0.8	1.8	1.0	2.6
16B	1.1	1.4	2.8	3.2	2.6	n.d.	3.4	3.6	15.2	7.3	21.7
17	8.5	10.0	32.5	24.0	20.3	6.8	33.4	29.2	57.0	40.8	137.7
18	n.d.	n.d.	n.d.	0.2	0.5	n.d.	1.1	1.9	2.4	2.4	3.6
19	n.d.	n.d.	n.d.	n.d.	0.4	n.d.	1.2	10.7	40.6	2.9	10.5
22*	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
23*	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
25	n.d.	0.4	1.3	1.0	1.4	0.4	3.5	2.6	2.7	4.7	16.6
27	0.3	0.5	0.9	0.5	0.9	0.5	0.7	0.8	0.7	0.7	1.0
30	n.d.	0.7	1.2	1.5	1.1	0.3	1.7	5.0	12.1	2.0	5.1
31	n.d.	n.d.	0.3	0.6	0.3	n.d.	0.3	2.5	0.3	0.3	0.5

Station*	n-C_{24}	n-C_{25}	n-C_{26}	n-C_{27}	n-C_{28}	n-C_{29}	n-C_{30}	n-C_{31}	n-C_{32}	n-C_{33}	n-C_{34}
11	5.3	21.2	5.8	48.2	5.6	38.2	3.7	26.4	2.6	8.2	0.6
12	10.7	43.6	11.4	132.8	10.0	66.6	6.0	51.3	1.3	16.5	2.1
13	3.8	5.9	4.1	10.6	4.4	13.7	4.6	18.0	4.0	5.2	1.4
16A	1.7	8.4	1.7	32.1	1.4	5.2	n.d.	2.0	n.d.	n.d.	n.d.
16B	10.3	52.0	13.8	139.8	12.7	79.4	6.8	53.7	5.1	20.1	2.1
17	65.6	186.1	46.2	319.1	36.2	201.4	37.6	133.6	15.3	52.1	4.5
18	2.9	3.5	2.3	4.2	2.2	4.0	0.9	2.9	0.7	1.2	n.d.
19	5.3	17.5	5.6	33.0	5.2	42.4	11.5	28.2	8.8	9.3	2.8
22*	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
23*	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
25	8.4	27.8	7.0	53.0	5.5	33.8	6.0	19.7	1.9	6.2	1.2
27	0.7	0.6	0.5	0.9	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
30	2.6	6.6	2.8	11.4	2.4	13.2	1.2	11.0	2.3	2.9	n.d.
31	0.3	0.6	1.0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

n.d. = not detected
* Concentrations at these stations all too low to be detected.

Table 2. Characteristic Parameters for 1979 Cook Inlet Sediment Samples

Station	Non-saponifiable fr. / Organic Carbon ($x10^4$)	Alkanes / Org. C. ($x10^4$)	Pristane / $n-C_{17}$	Phytane / $n-C_{18}$	Pristane / Phytane	Odd / Even
11	68.09	0.66	2.09	0.29	6.53	4.32
12	186.92	4.56	0.88	0.24	3.50	5.62
13	39.65	0.38	2.28	n.d.	n.d.	2.35
16A	--	--	1.41	0.67	2.00	7.42
16B	--	--	1.12	n.d.	n.d.	5.92
17	61.17	3.96	1.16	0.34	3.53	3.77
18	80.76	0.14	n.d.	n.d.	n.d.	1.66
19	66.30	1.49	n.d.	n.d.	n.d.	4.96
22	--	--	n.d.	n.d.	n.d.	n.d.
23	9.67	n.d.	n.d.	n.d.	n.d.	n.d.
25	15.85	0.67	0.92	0.29	2.50	4.19
27	63.83	0.20	0.54	0.56	0.93	1.20
30	--	--	1.24	0.25	5.31	3.24
31	181.47	0.08	2.02	n.d.	n.d.	0.87

n.d. = not detected

MILESTONE CHART

O - Planned Completion Date
X - Actual Completion Date
(to be used for updates)

RU # 480 PI: I.R. Kaplan and M.I. Venkatesan

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

	1979											1980		
MAJOR MILESTONES	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Field Sampling							0								
Sample Analysis	←	x	→												
Data Processing				0											
Data Submission (coding sheets and keypunched cards)				0											
Quarterly Reports	x			x						o				o	
Annual Report							0								

QUARTERLY REPORT

Contract #03-5-022-55
Research Unit #526-77
Task Order #13
Reporting Period: 4/1/79 - 6/30/79
Number of pages: 6

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

J. B. Matthews
Associate Professor of Marine Science
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

June 30, 1979

OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Quarter Ending June 30, 1979

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:

1. 1 April 1979 - 6 April 1979 Prudhoe Bay
2. 3 May 1979 - 25 May 1979 Prudhoe Bay

B. Scientific Party:

1. Bill Kopplin
Steve Petersen
Cliff Moore
Kate Persons

2. Steve Petersen
Cliff Moore
Kate Persons
Garry Meltvedt
Stuart Rawlinson

C. Methods:

Divers, trained and practiced in Monterey, were employed to locate and dive on instrument arrays. The arrays had previously been deployed on taut wire moorings in November through approximately 1-m thick ice. It was found that the 6-foot long antenna of the pinger locator was insufficient to penetrate the 2 m thick ice. A 12-foot long antenna was used. Some arrays had been moored by passing ice and were difficult to relocate. Most time and effort was expended in locating the arrays. It then required only the drilling of the dive hole, approximately 1 m square, in the ice. The ice from the dive hole was lifted out by helicopter. Divers then took about 20 minutes to exchange the instruments underwater for newly calibrated and serviced instruments. The recovered instruments were then returned for calibration and the data tapes for analysis.

D. Sample Localities:

Station locations of meters serviced are shown in Figure 1. Stations 11 (deployed on 30 March) and 13 (deployed on 1 April) on Figure 1 were not relocated by the field party. Station 12 was deployed as a new station and Station 8 re-deployed in May in lieu of the un-relocated arrays in order to give shear zone data.

E. Data Collected and Analysed:

The data collection is shown in the following list where the locations are shown in Figure 1.

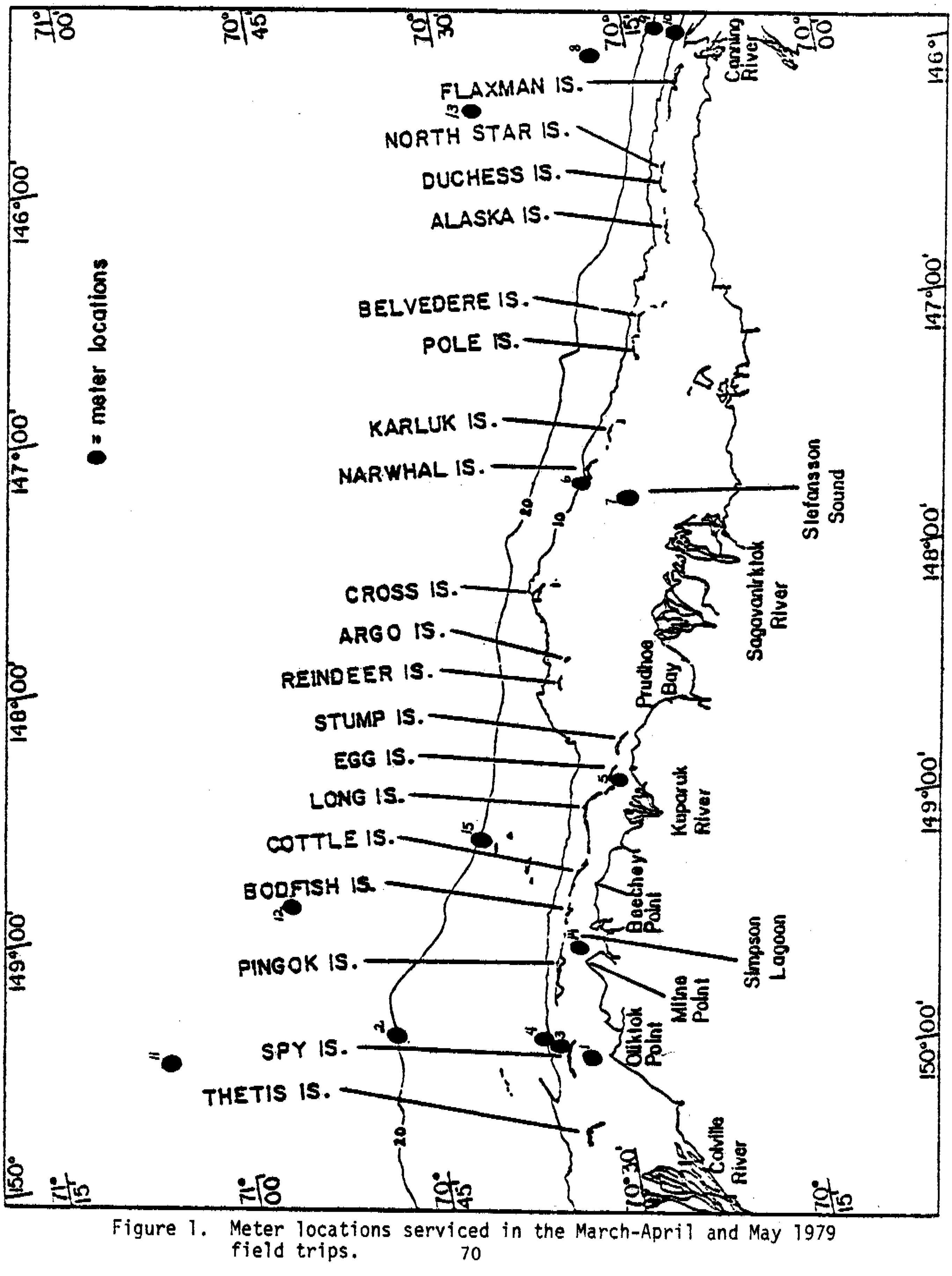


Figure 1. Meter locations serviced in the March-April and May 1979 field trips.

Location 1.	for the period			12 November	-	5 April 1979
" 2.	"	"	"	29 March	-	10 May 1979
" 3.	"	"	"	13 November	-	27 March 1979
" 4.	"	"	"	13 November	-	29 March 1979
" 5.	"	"	"	16 November	-	5 May 1979
" 6.	"	"	"	12 November	-	9 May 1979
" 7.	"	"	"	11 November	-	2 April 1979
" 7.	"	"	"	2 April	-	6 May 1979
" 8.	"	"	"	31 March	-	12 May 1979
" 9.	"	"	"	11 November	-	23 March 1979
" 10.	"	"	"	11 November	-	21 March 1979

All sites except Oliktok Point (number 1 on Figure 1) had 2 current meters and one tide guage.

The status of the data recovered is that all have now been translated. One current meter and 1 tide gauge record from Stefansson Sound (Station 7 in Figure 1) have been edited.

III. Results

All but two arrays deployed this spring were recovered except locations 11 and 13. These two arrays were in the shear ice zone and vulnerable to ice movement. However, two arrays were recovered, one each off Oliktok Point (2) and Flaxman Island (8) in 10 m water, which were in the shear ice zone. Data has been recovered from all the instruments that were retrieved.

The data from Stefansson Sound Boulder Patch has been examined for data errors. It shows a gradual buildup in salinity from 33% December 1 to 34% by the end of January. In February a gradual decline in salinity may be the result of freezing of the sensor. Temperatures from December to March vary between -1.8 and -2.3°C. Currents were generally less than 8 cm/sec towards the Northeast. These results are from a first look at un-edited data and should be viewed as preliminary.

IV. Preliminary Interpretation of Results:

It is concluded that instruments can be placed in the shear zone and recovered during the winter, but some loss must be expected. The preliminary analysis indicates that currents are generally less than 10 cm/sec under the ice and the sluggish flows suggest that this is due to brine circulation and tidal pumping. The gradual buildup in salinity is the result of ice accumulation.

V. Problems Encountered/Recommended Changes:

It proved to be expensive in time and resources to relocate instruments under 2 m of ice. It is recommended that recovery be made either in summer from a boat equipped with good navigation equipment or in November when the new ice makes the drilling of listening holes much easier.

QUARTERLY REPORT

Contract: #0302256
Research Unit: #529
Task Order: # 33
Reporting Period: 4/1/79-6/30/79

SOURCES, TRANSPORT PATHWAYS, DEPOSITIONAL SITES AND DYNAMICS OF SEDIMENTS IN THE LAGOON AND ADJACENT SHALLOW MARINE REGION, NORTHERN ARCTIC ALASKA

A. S. Naidu
Principal Investigator
Assistant Professor of Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

30 June 1979

I. TASK OBJECTIVES

The major objectives of this study are to understand the dynamics of sedimentation, to characterize benthic substrate habitats, and to elucidate the sources and depositional sites of terrigenous sediment particles in the lagoon and adjacent shelf area of north arctic Alaska. Additional goals of this program include completion of collection of baselines of a suite of heavy metals relative to sediments of the Beaufort Sea, understanding of the geochemical partitioning patterns of the heavy metals, and estimation of the rate of sedimentation in the above area.

II. LABORATORY ACTIVITIES

Laboratory work since 1 April 1979 has included the analysis of carbon, nitrogen and hydrogen in suspended particles samples that were collected from Simpson Lagoon in August 1978. Additionally, two sediment core samples, one from the middle continental shelf off the Colville Delta (71°00'N and 149°59.50'W) and another from the Simpson Lagoon off Milne Point, were taken for estimation of sedimentation rates in those two areas, *via* ^{210}Pb dating technique. Analysis on the later two samples were performed by Dr. H. V. Weiss under an OCSEAP subcontract from A. S. Naidu (see Appendix). Heavy metal analysis on various sediment phases and petrographic studies of heavy minerals separated from various North Slope rivers and barrier island sands constitute a part of the ongoing studies.

Analytical Methods

Organic carbon, nitrogen and hydrogen on the Simpson Lagoon suspensate samples were analyzed using a Hewlett-Packard Model 185B CHN analyzer. The suspensates were collected on the polycarbonate Nucleopore filter membranes (0.4 μm pore size) and were isolated by dissolving the membrane first in 30 ml 6N KOH and by centrifuging the residual. The suspensates collected were then washed in double distilled water and treated with 10% HCL to remove the carbonates. The slurries of carbonate-free samples were individually pipetted into sterilized sample boats, dried, weighed in a Cahn balance and loaded into the CHN analyzer. Acetanilide was run as a standard; the accuracy of the analysis was 97 percent.

To understand metal fractionation in sediments, a pattern of sequential extraction scheme has been adopted to isolate various chemical fractions of sediments. Iron, Mn, Cu, Ni, Co, Cr, Zn, and V are being analyzed on these fractions. The scheme was adopted after critical study of the literature. The extraction scheme presumably permits delineation of the exchangeable phase (Grieve and Fletcher, 1976; Gibbs, 1977), oxidizable organic matter (Cheng, 1961; Anderson, 1962; Gibbs, 1977), total organics (Giovannini and Sequi, 1976), as well as the oxides of manganese (Chao, 1972), amorphous iron (Pawluk, 1972; Schwertmann, 1973; Daly and Binnie, 1974) and crystalline iron (Mehra and Jackson, 1960).

III. RESULTS

The concentrations (wt. %) of organic carbon, nitrogen and hydrogen in the Simpson Lagoon suspensates appear in Table I. These samples were collected periodically from the central Simpson Lagoon at a location off the Milne Point, in the vicinity of the tripod station (Naidu, 1979).

TABLE I

Sample No.	C%	N%	H%	C/N
SL78-10	3.60	0.17	0.88	21.2
SL78-14	3.43	0.17	0.93	20.2
SL78-21	4.08	0.17	0.95	24.0
SL78-31	2.33	0.12	0.72	19.4
SL78-80	2.96	0.31	0.80	9.5
SL78-86	5.39	0.32	0.90	16.8
SL78-96	2.70	0.17	0.69	15.9

Chemical and heavy mineral analyses on sediments have not been completed as yet. It would, however, suffice to state that preliminary results sugget that the heavy mineral assemblages in the sands of the Colville, Kuparuk, Sagavanirktok, and Canning Rivers are dissimilar. Additionally, significant differences have been observed between the heavy mineral suites of the Pingok and Flaxman Island sands.

Barrier Island-Lagoon Ecological Process Studies Modelling Workshop

A. S. Naidu attended the above OCSEAP Workshop held in Seattle from 24 to 25 April 1979 and reported the data on sedimentology of the Simpson Lagoon and adjacent shallow marine region. The presentation of this workshop have been summarized and compiled by Mr. Alan Birdsall of the LGL, Edmonton and presumably will be forwarded to the NOAA-OCSEAP Office.

IV. DISCUSSION

The averages of the C/N ratios for the suspensate (Table I) and the bottom grab sediment samples (Naidu, 1978) of the Simpson Lagoon are 18 and 10, respectively. Since the origin of the suspensates in the Simpson Lagoon is presumed to occur by entrainment of surficial layers in the local deposits through wave-current erosive action (Naidu, 1979), the observed differences in C/N ratios are probably attibutable to the method of sampling utilized. Conceivably, the C/N ratios for the grab samples are not representative of the ratios of the surficial layers of the lagoon sediments. The subsurface layers of sediments which constitute the bulk of the grab sample may have a relatively lower C/N ratio and thereby overshadow the C/N ratio of surficial deposits.

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APPENDIX

SEDIMENTATION RATE IN SIMPSON LAGOON AND THE BEAUFORT SEA

By

H. V. Weiss and A. S. Naidu

The sedimentation rate in coastal regions of the Arctic Ocean has not been measured. It was intended to initiate such determination with two cores, one from Simpson Lagoon (149°27.5'W and 70°32.2'N) and another seaward of the Lagoon from the continental shelf of the Beaufort Sea (71°00'N and 149°59.50'W).

Estimation of the rate of sedimentation was carried out through isolation and determination of ^{210}Po (daughter-product of 22 year ^{210}Pb) as a function of depth in the sediment.

The analytic procedure (Koide and Bruland, 1975) consisted of drying, weighing and igniting (400°C) a discrete fraction of sediment. The ash was leached with acid and ^{208}Po isotopic tracer was added to the leachate. Upon adjustment of chemical conditions the Po isotopes were auto-electrodeposited from solution on metallic silver and subsequently analyzed by alpha-ray spectroscopy. ^{210}Po activity was normalized for chemical yield with data obtained from ^{208}Po tracer.

The disintegrations of ^{210}Pb as reflected by ^{210}Po measurement in 20 segments of each of the cores appear in Table I. From these data the a and b constants in the exponential decay $y = ae^{-bx}$ were computed. The variables y and x refer to ^{210}Pb activity and depth in the sediment, respectively. The coefficient of correlation (r^2) was also calculated. These data appear in Table II. The sedimentation rates derived from them are 2.4 and 6.2 cm/yr for the Simpson Lagoon and Beaufort Sea continental shelf cores, respectively.

The coefficient of correlation indicates that the sedimentation rates calculated are not statistically significant. Clearly, variations in ^{210}Pb activity along the length of the core were responsible for the poor correlations; moreover this factor did not provide for the proper resolution of the supported ^{210}Pb component. However this randomness is not attributable to radio-analytic inaccuracies. The statistical counting error associated with each of the measurements was usually less than 10 percent.

TABLE I

^{210}Pb CONTENT OF TWO CORES (d/m/g)

Core

Simpson Lagoon		Beaufort Sea (NW 78)	
Depth (cm)	^{210}Pb	Depth (cm)	^{210}Pb
0- 1	1.90 ± 0.1	0- 1	1.90 ± 0.18
0- 1	1.97 ± 0.14	1- 2	1.21 ± 0.12
1- 2	1.62 ± 0.1	2- 3	1.26 ± 0.06
3- 4	1.63 ± 0.16	3- 4	1.33 ± 0.06
5- 6	1.45 ± 0.1	4- 5	1.17 ± 0.09
6- 7	1.40 ± 0.1	5- 6	1.40 ± 0.1
7- 8	1.32 ± 0.1	6- 7	1.24 ± 0.1
8- 9	1.60 ± 0.1	7- 8	1.37 ± 0.1
10-11	1.56 ± 0.09	9-10	1.54 ± 0.1
12-13	1.12 ± 0.1	10-11	1.91 ± 0.1
13-14	1.37 ± 0.09	11-12	1.22 ± 0.1
14-15	1.03 ± 0.05	13-14	1.14 ± 0.1
15-16	1.29 ± 0.06	16-17	1.17 ± 0.1
17-18	1.43 ± 0.09	17-18	1.12 ± 0.1
18-19	1.51 ± 0.1	20-21	1.13 ± 0.1
19-20	1.29 ± 0.06	22-23	1.16 ± 0.04
20-21	1.61 ± 0.15	25-26	1.08 ± 0.06
21-22	1.23 ± 0.1	30-31	1.52 ± 0.15
22-23	1.33 ± 0.08	33-34	1.38 ± 0.06
23-24	1.20 ± 0.1	34-35	1.02 ± 0.1
24-25	1.28 ± 0.09		
24-25	1.20 ± 0.1		

TABLE II

EXPONENTIAL DECAY CONSTANTS, COEFFICIENT OF CORRELATION AND SEDIMENTATION RATE OF THE TWO ARCTIC CORES

Core	Constants a	Constants b	Coefficient of Correlation (r^2)	Sedimentation Rate (cm/y)
Simpson Lagoon	1.67	-0.013	0.41	2.4
Beaufort Sea	1.39	-0.005	0.12	6.2

Further, replicate analyses of the top and bottom segments of the Simpson Lagoon core clearly point to the reliability of determination.

In general, events which may lead to such results are post-depositional disturbances such as turbulence, slumpling and bio-turbation. In addition to these causes and unique to the polar environment is the process of ice-gouging which could affect deposits within the shallow lagoon. However, these sources of sediment redistribution probably do not pertain to the location where the lagoon sediment sample was collected since visual inspection of X-radiographs of additional vibro core samples available from adjacent locations revealed undisturbed sediment layers (Naidu, personal communication).

Still another factor which perhaps applies more directly to the relatively low level ^{210}Pb activity and variability to this regime is the possible influence of fluvial deposits. The waters from Kuparuk and Colville Rivers which carry considerable quantities of terrestrial matter drain into this general environment. These materials with their ^{210}Pb supported component could dilute unsupported ^{210}Pb to the extent that its contribution is not perceived. Moreover, annual variations in fluvial input with attendant variations in supported ^{210}Pb could account for the scatter in the data.

To determine whether the sedimentation rates are realistic, an examination of the ^{239}Pu content in the top and bottom 2-cm of each core was undertaken. The rationale for this approach relates to the fact that this artificially induced radionuclide was first globally disseminated in 1952 with the advent of the nuclear weapons testing program. The rate of injection of this nuclide into the atmosphere and its ultimate deposition on the earth's surface has been irregular since then as a function of the frequency of nuclear detonations. Nonetheless, were ^{239}Pu sensibly detected at the surface of a core it would be expected to find some quantity at the bottom as well, since the calculated sedimentation rates place the lower deposits at about 1968 and 1973 for the Simpson Lagoon and Beaufort Sea cores, respectively. The ^{239}Pu disintegration rate (d/m/kg) at the surface of these cores was 11.0 ± 0.1 and 5.4 ± 1; none was detected in the basal sections of these cores. These analyses strongly suggest that the sedimentation rate is considerably slower than that calculated for each of the cores. This interpretation is supported when the segments from the upper 8 cm of the Simpson Lagoon core are considered separately. An exponential fit is manifest for the segments in this range in relation to the disintegration of ^{210}Pb; the correlation coefficient is 0.9, a value significant at the 95 percent confidence level. The a and b constants are 1.84 and -0.05, respectively and the sedimentation rate derived is 0.7 cm/yr. Although the ^{210}Pb data for the remainder of this core is considerably more variable and inconsistent with this deposition rate, the rate may nonetheless be valid. Perhaps those circumstances which lead to ^{210}Pb variations did not pertain to the more recent deposits in this core. Clearly, further evaluation of the sedimenttation rate for this environment is needed.

Another conceivable explanation to account for the statistically insignificant data may be related to the absolute quantity of unsupported ^{210}Pb. If for some reason the flux of this nuclide was unusually low in this environment, the sensitivity of this dating procedure would suffer accordingly. This possible cause could be explored by examining cores recovered from the deeper lakes situated in this general area, where the effect of sediment re-working should be insignificant.

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QUARTERLY REPORT

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SOURCES, TRANSPORT PATHWAYS, DEPOSITIONAL SITES AND DYNAMICS OF SEDIMENTS IN THE LAGOON AND ADJACENT SHALLOW MARINE REGION, NORTHERN ARCTIC ALASKA

A. S. Naidu
Principal Investigator
Assistant Professor of Marine Science

Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

30 September 1979

I. TASK OBJECTIVES

The major objectives of this study are to understand the dynamics of sedimentation, to characterize benthic substrate habitats, and to elucidate the sources and depositional sites of terrigenous sediment particles in the lagoon and adjacent shelf area of north arctic Alaska. Additional goals of this program include completion of collection of baselines of a suite of heavy metals relative to sediments of the Beaufort Sea, understanding of the geochemical partitioning patterns of the heavy metals, and estimation of the rate of sedimentation in the above area.

II. FIELD ACTIVITIES

The field period extended from 20 July 1979 to 12 August 1979, with A. S. Naidu, H. V. Weiss, and L. H. Larsen participating. Milne Point OCS facility was used as the base camp. The Sediment Dynamics Sphere (SDS) was installed on a tripod at Deadhorse and air lifted to Milne Point. The SDS package was then deployed in Simpson Lagoon, in 2.9 m water depth, at a site off Milne Point (latitude 70°32.2'N; longitude 149°27.45'W) on 20 July 1979. The tripod was retrieved on 31 August 1979; L. H. Larsen and R. W. Sternberg participated in this operation.

Surface water samples were collected and their temperature measured from Prudhoe Bay, Simpson Lagoon and, vicinity (Table I) on 24 July as well as on 4, 11 and 12 August 1979. These collections coincided with the passage of LANDSAT II and III satellites over the region, and the purpose was to help develop criteria--based on sea truths--to quantify nearshore suspensate concentrations from LANDSAT images. One-liter aliquots of the water samples were filtered through pre-weighed Nuclepore filter membranes (0.4 μm pore size). Subsequently, the sediments on the membranes were washed with distilled water, and stored in an ice cellar to avoid biodegradation. About 100 ml of the filtered water samples were retained for subsequent salinity measurement, because such data are useful in the understanding of suspensate distribution in conjunction with coastal water mass movement.

On seven separate days, water samples were collected at the tripod site; from the surface as well as from the depth at which the nephelometer

TABLE I

TEMPERATURE, SALINITY, AND WEIGHTS OF SUSPENDED PARTICLES OF WATER SAMPLES COLLECTED FROM SIMPSON LAGOON AND VICINITY, ON 24 JULY AND 4, 11 AND 12 AUGUST, 1979

Station No.	Latitude (N)	Longitude (W)	Temperature (°C)	Salinity °/oo	Suspensate (mg/1)
72479-1	70°19'	148°24'	10.6	8.6	2.51
72479-2	70°20'	148°17'	12.2	6.2	3.63
72479-3	70°21'	148°15'	10.1	7.4	6.45
72479-4	70°24'	148°32'	8.8	9.0	3.59
8479-1	70°32'	149°26'	6.7	25.0	2.60
8479-1	70°32'	149°37	5.0	17.9	1.53
8479-3	70°33'	149°52'	9.7	15.6	5.61
8479-4	70°34'	149°42'	5.6	21.8	2.86
81179-1	70°30'	150°23'	9.8	4.6	119.18
81179-2	70°32'	150°20'	4.2	31.4	6.02
81179-3	70°33'	150°09'	3.8	31.2	3.65
81179-4	70°32'	149°59'	2.5	29.4	2.53
81179-5	70°33'	149°51'	4.8	24.2	1.74
81179-6	70°32'	149°52'	5.4	21.4	3.35
81179-7	70°31'	149°53'	6.4	23.6	9.20
81179-8	70°32'	149°43'	5.4	23.5	2.15
81179-9	70°34'	149°41'	5.0	24.5	2.89
81179-10	70°33'	149°32'	6.3	19.3	3.48
81179-11	70°32'	149°30'	6.4	18.2	2.96
81279-1	70°24'	148°32'			1.33

was emplaced on the tripod. The purpose of this collection was to establish a field calibration for the nephelometer. One-liter aliquots of the samples were filtered through pre-weighed Nuclepore membranes (0.4 μm pore size).

For ^{210}Pb geochronologic work, relative to sediment depositional rate estimation, eight core samples were retrieved from Simpson Lagoon and the Harrison Bay region (Table II). Since ice gouging can perturb sediment sequences and since the lagoon and bay waters freeze to about 2 m depth, all core samples by necessity had to be retrieved from deeper waters (i.e., > 2 m depth). A variety of coring units (i.e., Phleger and BENTHOS gravity corer, and a manual unit) were employed on board the R/V *Natchik* to retrieve the core samples. However, the unit which was manually driven into the bottom worked relatively the best. The other units had low penetration inspite of the fact that the units had about 600-lb loading. The sediment cores, thus, collected were at best 32 cm long, but should be adequate for the depositional rate measurements. Additionally, one sediment core sample was collected from a coastal lake (named by us the Deline Lake) at about 3.5 m water depth, using the manual coring unit from a float plane. This lake is situated at latitude 70°19'N and longitude 149°56'W. The latter core will be used to estimate the rate of sedimentation in coastal lakes and also in the better understanding of the inordinately low levels of ^{210}Pb radioactivity in contemporary sediments from the North Slope coastal area (refer to Naidu's 1979 Renewal Proposal to the OCSEAP office).

One-cm continuous sections from two core samples (i.e., one from the tripod site and another from Deline Lake) were separated at Milne Point camp. One split of each of the 1-cm sections was provided to H. V. Weiss for the ^{210}Pb assays, while the remaining second split was retained by A. S. Naidu for textural and chemical analyses.

Two additional core samples were collected from the tripod site to obtain interstitial water samples from them. Interstitial waters were expressed out at the camp from 1-cm continuous sections from one of the cores, as well as 5-cm sections from the other core. The water samples have been preserved in ULTREX HNO_3 acid for analysis of a variety of metals by neutron activation. This would help us better understand the postdepositional solution, migration and reprecipitation of metals in Simpson Lagoon.

TABLE II

LOCATIONS OF SEDIMENT CORE SAMPLES COLLECTED FROM SIMPSON LAGOON AND VICINITY FOR ESTIMATION OF SEDIMENTATION RATES

Core No.	Latitude (N)	Longitude (W)	Water Depth (m)
8579-1	70°32'	149°27'	2.9
8979-1	70°31'	150°07'	3.9
8979-2	70°31'	150°01'	3.6
8979-3	70°32'	149°57'	3.3
8979-4	70°32'	149°53'	3.0
8979-5	70°32'	149°45'	2.7
8979-6	70°32'	149°40'	2.6
8979-7	70°32'	149°35'	2.6

Two hours were spent on Flaxman Island, studying and collecting samples of boulders. A suite of 25 samples have been obtained for detailed thin section petrographic study, which should add on to our understanding of the origin of the boulders.

A sample of mud was collected from Colville Estuary at the request of Dr. S. Wellershaus of the Institute of Meeresforschung (Bremerhaven), West Germany. As part of his research, Dr. Wellershaus will be studying the effect of organic compounds on flocculation of clays.

III. LABORATORY ACTIVITIES

Laboratory work since 30 June 1979 has included the analysis of a suite of metals in the acetic acid hydroxylamine-hydrochloride extracts (Chester and Hughes, 1967) and also on a few sediment fractions separated via a sequential extraction pattern (refer to Naidu, 1979).

Salinity of the 19 water samples from Simpson Lagoon were measured by using a Beckman, Model RC-19 Conductivity Bridge.

Weights of dried suspended particles on 41 Nuclepore filter membranes were determined on a Cahn balance. After the weighing the filter membranes were stored in a freezer for further chemical analysis.

Manganese, Fe, Co, and Zn are being analyzed in the sediment interstititial water samples by neutron activation analysis. This analysis is being carried out by H. V. Weiss (NOSC), San Diego, using the University of Irvine Reactor facility.

Separation of one-cm continuous sediment sections from remaining of the nine core samples from Simpson Lagoon is in progress. One-half of these sections will be forwarded to H. V. Weiss for ^{210}Pb-^{210}Po assays, relative to the sedimentation rate estimation. The remaining one-half of the sections is being subdivided into two samples. One subsample will be used for granulometric analysis, while the other will be taken for chemical analysis (e.g., C and N gross sediments, and a suite of metals in sequential extracts) by A. S. Naidu.

Chips from 20 rock samples were separated for thin section preparation and subsequent petrographic study.

IV. OTHER ACTIVITIES

A. S. Naidu and his graduate student, M. D. Sweeney, participated in a poster session at the 30th Alaska Science Conference on 17-21 September 1979 in Fairbanks. Titles and authors of the posters are as follows:

Poster 1. Partitioning of heavy metals among selected chemical fractions of lagoon sediments, Arctic Alaska. By M. D. Sweeney, A. S. Naidu and H. V. Weiss.

Poster 2. Resuspension of nearshore sediments by wave action in north Arctic Alaska. By A. S. Naidu.

A proposal to renew funding of the ongoing studies (R.U. 529) was submitted to the Boulder OCSEAP office. Additionally, a supplemental proposal was submitted requesting an extension of the SDS tripod experiment under sea ice to the boulder patch area of Stephanson Sound. The latter proposal has been funded, and the SDS unit was deployed in water on 20 September 1979. Plans call for retrieval of the unit in November 1979.

V. RESULTS AND DISCUSSION

In Table I are included the temperature and salinity values and concentrations of suspensates in Simpson Lagoon and Prudhoe Bay waters for the periods of the passage overhead of the LANDSAT II and III satellites. As mentioned earlier, these data will serve as sea truth for developing criteria to quantify surficial suspended loads of nearshore waters, using LANDSAT density sliced images. At this moment, we are not quite sure whether LANDSAT images as well as digital data, for the field period covered by us (24 July to 12 August 1979) are available for developing the above criteria, in coordination with Mssr. Belon and George (OCSEAP R.U. 267). We are waiting to hear from the office of the NASA Goddard Space Center. In any case, it is of interest to note that there are significant regional differences in the temperatures, salinities, and suspensates of waters (Table I). It would seem that the water masses in Prudhoe Bay and vicinity are more strongly impacted by the fluvial outflows than the Simpson Lagoon region. This is obvious from the relatively warmer and less saline waters observed in the bay as compared to the lagoon (Table I). Sample 81179-1 was collected from the very well delineated Colville River turbid plume. It is of further interest to note that the water west of the new ARCO dock (S. #72479-4) is relatively more saline and cooler than samples from Prudhoe Bay. Obviously, the ARCO dock serves as a partial barrier for the movement westward of Sagavanirktok River outflow.

The weights of suspended particles, periodically collected at the SDS tripod site are included in Table III. In the absence of the final data from the tripod experiment, as well as directions and strengths of the winds for July-August at Milne Point, it is too immature to make any sense out of the suspended particle variations (Table III). First-hand information from L. H. Larsen, suggests that the SDS tripod unit functioned successfully this year.

In Table IV are included the concentrations (μg/g) of Ni, Co, Cr, and V in acetic acid hydroxylamine-hydrochloride extracts (Chester and Hughes, 1967) of a suite of sediment samples from Beaufort Sea. Comparison of the data in Table IV and those presented earlier on gross sediments (Naidu, 1978) suggests that there is a fractionation of most of the Ni, Co, Cr, and V in the crystal lattice of sedimentary particles. Additionally, with the exception of Cr, the concentrations of all metals associated with the oxides/hydroxides, carbonates and exchangeable/absorbed phases (e.g., readily mobilized fractions) increase notably in the deep-sea sediments. Presumably, this is related to the muddy nature of all deep-sea sediments and to the relatively low rates of their sedimentation as compared to the continental slope and shelf sediments. This would promote higher metal adsorption and less dilution by terrigenous particles of metals mobilized and precipitated at the surface from interstitial waters.

In Table V are included the concentrations (μg/g) of Cr, Co, and Ni in acetic acid hydroxylamine-hydrochloride extracts of a suite of Simpson Lagoon sediments. Examination of these and those obtained on gross sediments

TABLE III

WEIGHTS OF SUSPENDED PARTICLES IN WATER SAMPLES COLLECTED AT THE SURFACE AND 2.9 m BELOW SURFACE AT THE SDS TRIPOD SITES

(Latitude 70°32.2'N and Longitude 149°27.45'W)

Date	Sample	Time	Suspensate (mg/1)
7/24/1979	surface	4.05 p.m.	2.037
7/24/1974	2.9 m	4.05 p.m.	5.418
7/25/1979	surface	10.05 a.m.	4.215
7/25/1979	2.9 m	10.05 a.m.	4.112
7/26/1979	surface	5.05 p.m.	1.956
7/26/1979	2.9 m	5.05 p.m.	2.611
7/27/1979	surface	5.05 p.m.	2.990
7/27/1979	2.9 m	5.05 p.m.	2.993
7/28/1979	surface	12.35 p.m.	1.806
7/28/1979	2.9 m	12.35 p.m.	2.517
8/02/1979	surface	1.05 p.m.	2.039
8/02/1979	2.9 m	1.05 p.m.	1.997
8/04/1979	surface	11.05 a.m.	1.302
8/04/1979	2.9 m	11.05 a.m.	2.171

TABLE IV

CONCENTRATIONS (μg/g) OF NICKEL, COBALT, CHROMIUM, AND VANADIUM IN ACETIC ACID-HYDROXYLAMINE EXTRACTS (CHESTER AND HUGHES, 1967) OF BEAUFORT SEA SEDIMENTS

For sample locations refer to Naidu (1978)

Sample No.	Ni	Co	Cr	V
		Deep-Sea		
GLA77-5	23.8	23.0	3.1	82.0
GLA77-7	24.0	21.5	4.5	53.0
GLA77-8	18.5	22.0	3.4	70.0
GLA77-30	18.0	21.0	6.5	43.0
		Continental Slope		
GLA77-19	13.0	10.5	5.0	26.0
GLA77-23	16.0	19.0	3.7	17.0
GLA77-42	10.0	7.0	6.0	24.0
BSS -80	14.5	8.5	6.5	21.5
BSS -81	13.0	5.5	3.2	24.0
		Continental Shelf		
GLA77-12	7.5	6.5	3.0	13.5
GLA77-15	16.0	14.5	4.5	17.0
GLA77-17	18.0	14.0	2.5	11.0
GLA77-18	11.0	12.0	4.0	19.0
GLA77-22	11.0	7.0	4.0	14.5
GLA77-24	8.5	8.0	2.5	17.0
GLA77-25	7.5	5.5	1.0	12.0
GLA77-26	7.5	4.5	2.5	10.5
GLA77-31	10.0	9.5	5.0	14.5
GLA77-32	9.0	7.0	2.8	14.0
GLA77-40	13.0	12.5	5.5	18.5
Averages:				
Deep-Sea (> 1000 m)	21.1	21.9	4.4	64.5
Continental Slope (64-1000 m)	13.3	10.1	4.9	22.5
Continental Shelf (< 64 m)	10.8	9.2	3.4	14.7

TABLE V

CONCENTRATIONS (μg/g) OF CHROMIUM, COBALT AND NICKEL IN ACETIC ACID-HYDROXYLAMINE HYDROCHLORIDE EXTRACTS (CHESTER AND HUGHES, 1967) OF SIMPSON LAGOON SEDIMENTS

For sample locations refer to Naidu (1978)

Sample	Cr	Co	Ni
SL877-1d	1.7	0.9	3.0
SL877-2	1.0	4.0	2.5
SL877-3	0.3	6.0	5.0
SL877-4	4.0	7.0	14.0
SL877-5a	3.0	6.6	13.0
SL877-5b	1.6	2.1	14.0
SL877-5c	1.6	6.6	12.0
SL877-6	5.0	6.2	8.0
SL877-8	2.0	4.4	11.5
SL877-9	2.1	7.8	13.0
SL877-11	2.0	3.0	15.0
SL877-13	4.7	8.1	14.0
SL877-14	3.1	7.0	14.0
SL877-15	3.5	8.9	12.0
SL877-17	3.0	9.8	9.0
SL877-18	4.0	6.7	11.0
SL877-19	0.4	3.3	4.0
SL877-21d	5.0	10.7	10.0
SL877-22	4.0	9.0	16.0
SL877-24	1.1	3.2	6.0
SL877-25c	4.0	5.4	7.0
SL877-27	2.7	3.0	14.0
SL877-28	2.0	2.6	13.5
SL877-29	3.3	3.9	13.0
SL877-30	0.1	1.6	4.0
SL877-31	2.7	6.0	18.0
SL877-32b	3.5	6.9	17.0
SL877-33	3.2	6.0	12.0
SL877-37	2.6	3.8	15.0
SL877-38	3.0	6.4	16.0
SL877-40	2.1	3.9	6.0
UG-1	1.6	2.5	12.0
Averages:	2.6	5.4	11.0

(Naidu, 1978) clearly endorses that bulk of the above metals are tied in the crystal lattice of sedimentary particles.

The data summarized in Table VI are based on intensive study of six sediment samples and involving three separate patterns of sequential extraction (Naidu, 1979). It is clear that a great portion of the Fe is crystal lattice-bound in the Simpson Lagoon sediments, while Mn and Zn are partitioned almost in equal amounts in the lattice and the readily mobilized fractions. These studies have provided further insight into partitioning of the said three metals in arctic lagoon sediments. Similar analysis for Co, Cr, V and Ni are in progress.

VI. LOGISTICS

By comparison, logistic arrangements were relatively poorer than last year. A few days were lost because of lack of an adequate boat for water and sediment sampling. Two power generators supplied one after another by NARL never functioned satisfactorily, and this restricted water sample filtration. The R/V *Natchik* was available to us after two weeks of the scheduled date. However, we wish to acknowledge the great assistant provided, under sometimes difficult conditions, by Dan Brooks, Terry Hall, Jim Helmericks and Laura Hunter in the field. The SDS tripod deployment and retrieval was accomplished satisfactorily using helicopter and a boat. E. Dronenberg--the skipper of R/V *Natchik*--was extremely helpful in the sediment core sampling.

TABLE VI

SUMMARY OF THE PARTITIONING OF Fe, Mn, and Zn AMONG CHEMICAL FRACTIONS OF SIMPSON LAGOON SEDIMENTS

Data expressed as percentage of the gross sediment

% of the Chemical Fraction	Fe	Mn	Zn
Exchangeable	0.1	6.5	1.0
Carbonate	2.0	14.0	14.0
Metallic oxides/hydroxides	16.4	31.5	33.0
Crystal lattice + sulphides + organic matter	81.5	48.0	52.0

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QUARTERLY REPORT

R.U. #562 Oil Pooling Under Sea Ice
NOAA R.D. No. RK-8-0065
Report Period: 1 Oct 79 to 31 Dec 79

Oil Pooling Under Sea Ice

Principal Investigator: A. Kovacs

U.S. Army Corps of Engineers

U.S. Army Cold Regions Research and Engineering Laboratory
Hanover, N.H.

I. Task Objectives

The purpose of this program is to measure by radar echo sounding the variations in the relief under sea ice, to estimate the quantity of oil which could pool up in the under ice depressions should an under ice oil release occur and to investigate the electromagnetic properties and anisotropy of sea ice with the use of impulse radar.

II. Field/Laboratory Activities

During the fall quarter (November) instrumentation was installed under the sea ice at the Exxon ice island site. The instrumentation will become frozen into the sea ice as it grows. In March we will use the instrumentation to determine the in situ dielectric constant of the sea ice vs. depth. This information will give further insight into the electromagnetic properties of sea ice and thus a better understanding of the propagation of electromagnetic energy in sea ice as it relates to our profiling of sea ice thickness.

III. New Results

The paper, "Anisotropic properties of sea ice in the 50 to 150 MH_Z range" by Kovacs and Morey was published in the Jr. of Geophy. Res. in Vol. 84, No. C9 in September. The paper "Investigations of sea ice anisotropy, electromagnetic properties, strength and under ice current orientation" by Kovacs and Morey was drafted.

IV. Problems Encountered

None.

HAZARDS

HAZARDS

CONTENTS

HAZARDS (Continued)

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Research Unit No. - 105
Reporting Period - July-Sept 1979
Number of Pages - 5

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:
A. Delaney
K.G. Neave

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 and its velocity structure. Analysis of drill cores and other available supplementary data will also be carried out; no drilling will be done as part of this year's program.

II. FIELD CR 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 obtaining and interpretation of seismic records. Mr. Edwin Chamberlain traveled to Anchorage, Alaska to examine and discuss transport of core, obtained during USGS Conservation Division program, to USA CRREL for further testing and analysis.

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

C. Methods: The methods employed in interpretation of seismic data have been previously discussed.

D. Sample Locations: Data from Harrison Bay was received and given preliminary examination to compare it with data from the lease area.

E. Data Collected or Analyzed: Emphasis this quarter was placed on data interpretation in the proposed lease area. The analysis included construction of a near-surface velocity map and completion of velocity contour map for the offshore marine data.

III. RESULTS AND DISCUSSION:

The refraction interpretation was completed on all ice shooting data, presently available from the proposed lease area, by K. G. Neave. This data was used to construct a near-surface velocity map, which is shown in figure 1. The map was made to complement the bonded permafrost velocity structure map discussed in the previous progress report and shown in figure 2. In general the near-surface velocities are average velocities for approximately the upper 100 meters.

The trends shown in the near-surface velocity map are similar to those seen in the previous velocity structure map, although some additional details are available. In agreement with previous work, this map (figure 1) shows that near-surface velocities are greatest on land and decrease offshore. This new map also indicates that in some cases the onshore velocities begin to decrease prior to reaching the coastline. The onshore velocity zone not influenced by the marine environment has velocities greater than 4.0 km/sec. In most areas on land this grades to a band of lower velocities that parallels the coastline. This transitional velocity zone is absent along at least one section of the coastline. This 3.5 km/sec to 4.0 km/sec zone also extends offshore including the outer margins of deltas of the major streams and associated near shore land masses such as Tigvariak Island.

The next lower permafrost velocity group is mostly offshore and ranges from 3.0 km/sec to 3.5 km/sec. The 3.0 km/sec velocity contour follows the 1.0m water depth contour except in Prudhoe Bay.

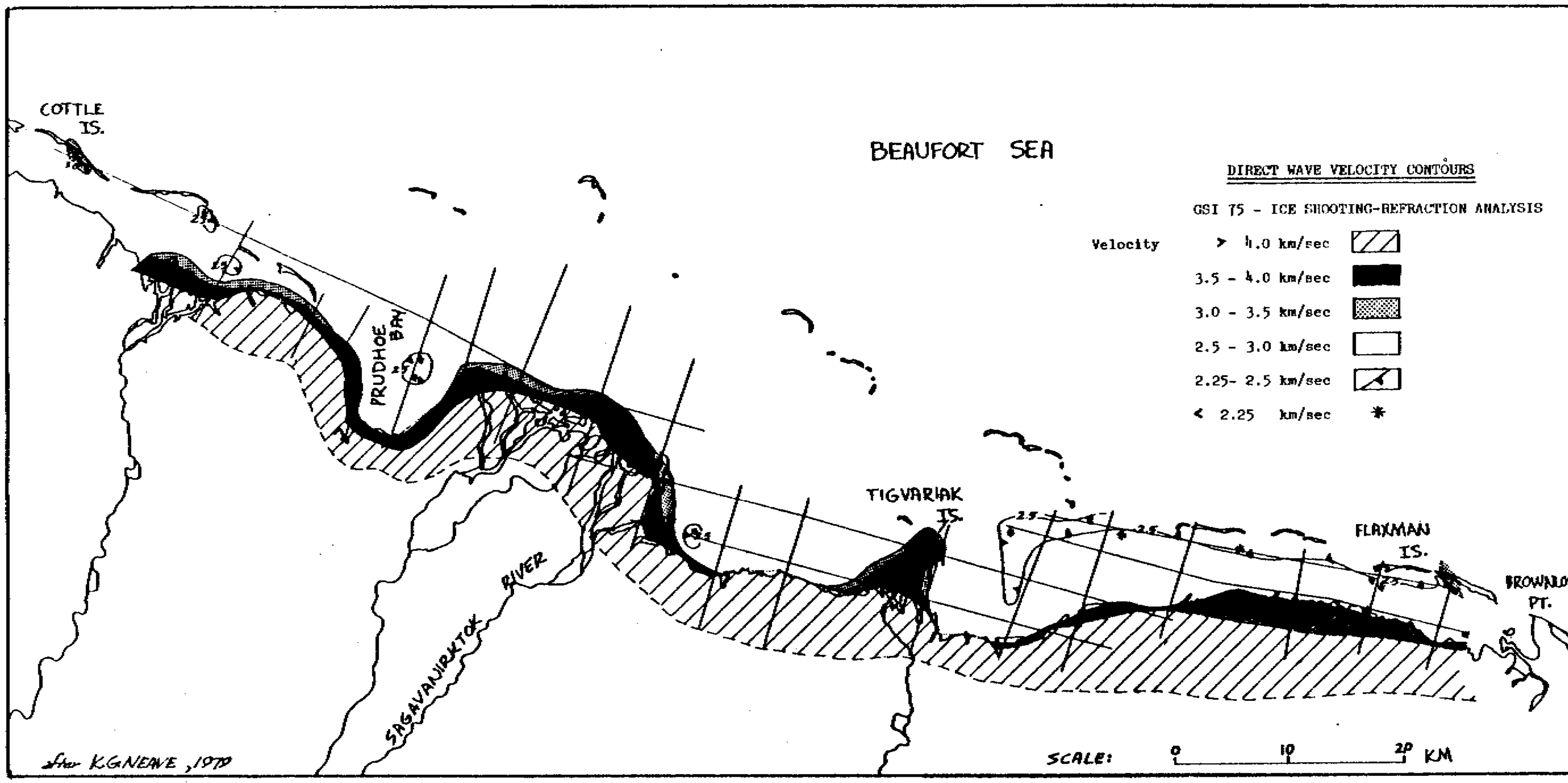


Figure 1. Near surface velocity map - data is for approximately the upper 100 meters.

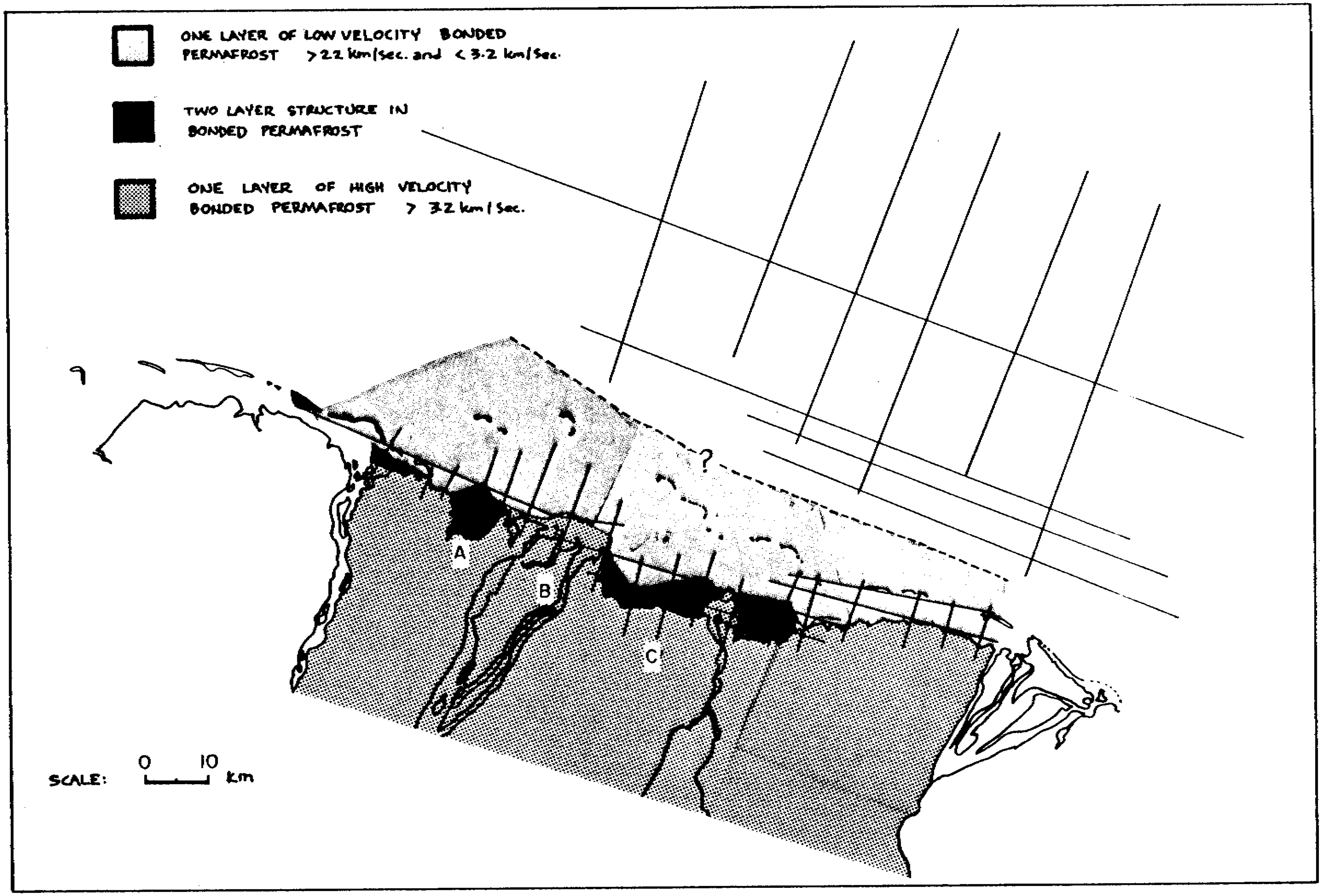


Figure 2. Permafrost velocity structure map.

The marine velocities primarily fall within the 2.5 to 3.0 km/sec range. Most of the offshore area covered by this data is uniform with the exception of several small low velocity areas. The largest and most continuous is a narrow zone inshore of the islands west of Brownlow Point. At several locations velocities less than 2.25 km/sec were observed (Figure 1).

Sufficient data is available from two offshore islands, Cottle Island in the western part of the study area and Flaxman Island to the east, for velocity interpretation. These islands both have higher velocities than the surrounding marine environment, with velocities in the 3.5-4.0 km/sec range observed on Cottle Island. These values are similar to those observed in the transition belt along the coastline.

Some of the low velocity zones in the marine environment (Figure 1) appear to be underlain by high velocity bonded permafrost as indicated in the velocity structure map shown in figure 2. Examples can be found in Prudhoe Bay and to the east of the Sagavanirktok River.

Preliminary examination of near surface velocity data obtained from the Harrison Bay region indicates extensive distribution of bonded permafrost. Bonded permafrost velocities appear on all lines examined in this area. High velocities normally associated with land extended several kilometers from shore in shallow parts of the bay. Velocity trends appear similar to those observed in the area discussed in figure 1.

In addition to contouring the marine data for the offshore lines shown in figure 2, a map of point reflection hyperbolas was constructed. As mentioned in the previous progress report bonded permafrost velocities were not observed in this region. The hyperbolas were mapped as a possible means of determining the distribution of shallow gas deposits. The hyperbolas must originate from small structures which have a high reflection coefficient. A gas accumulation trapped in impermeable sediment or ice-bonded material could cause a velocity contrast and would be of lower density than the surroundings. The density anomaly combined with the velocity contrast would give a high reflection coefficient and should be highly visible on a seismic record, possibly as indicated by the hyperbolas mapped.

IV. PRELIMINARY INTERPRETATION OF RESULTS:

The near surface velocity data (Figure 1) as previously stated suggests that bonded sediments occur throughout this area where seismic data coverage is available. Only several small zones have velocities low enough to be considered borderline values.

Comparison of the two velocity maps also providessome basis for speculation concerning coastal erosion rates. The near-surface on-land low velocity band along the coast is of varying width. The locations where it is thinnest or nonexistent could be the locations where maximum coastal retreat has occurred historically. This also appears to be supported by the fact that in these zones it appears that offshore bonded permafrost has noticeable velocity structure. A high velocity layer occurs at depth in these areas. This could indicate that thermal modification to the permafrost properties has not kept pace with the transgression rate, and that erosion rates have been great enough so that the marine environment has not modified thermal conditions on land. An extremely good example of these can be seen to the east of the Sagavanirktok River. This can be contrasted to the coastal zone with a wide band of lower on-land velocities west of Flaxman Island. This region only has a low velocity bonded permafrost layer offshore, (Figure 2) lacking the high velocity permafrost at depth. This region also has very low bonded permafrost velocities much closer to shore than can be seen in the remainder of the study area. The origin of this lower velocity offshore band is unknown, but variation in material type or possible localized stream discharge in this region should not be excluded from consideration.

The small low velocity zones seen scattered along the coast could be sites that have had thermal modification by thaw lakes prior to inundation. None of them appear to have any relationship to bathymetric features.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES:

No problems have been encountered with the technical data and interpretation. No samples have been processed from the U.S. Geological Survey Conservation Division Program since they have not yet been released by the USGS.

Research Unit No. - 204
Reporting Period - April-June 1979
Number of Pages - 11

QUARTERLY REPORT

Offshore Permafrost Studies, Beaufort Sea, Alaska

Principal Investigators:
R. W. Hartz
D. M. Hopkins

U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

R.U. #204: Quarterly Report, April-June 1979

OFFSHORE PERMAFROST STUDIES, BEAUFORT SEA, ALASKA prepared by R. W. Hartz and D. M. Hopkins

I. Abstract of Highlights

R. W. Hartz and D. M. Hopkins participated in the U.S. Geological Survey, Conservation Division's Beaufort Sea borehole program. During February and March, 1979, the engineering firm of Harding Lawson and Associates, under contract with the U.S. Geological Survey, drilled and cored twenty offshore boreholes on selected federal tracts within the proposed Beaufort Sea lease sale area.

Detailed boring logs were compiled for all the boreholes and they are summarized in this report.

Several ice-bonded sediment cores were recovered intact with some exhibiting segregated lenses of crystalline ice.

D. M. Hopkins was a co-convener of a Wenner-Gren Foundation Burg Wartenstein conference, "The Paleoecology of the Arctic Steppe-Mammoth Biome", held in Austria June 8-17, 1979.

II. Task Objective: D-9

III. Field and Laboratory Activities:

A. D. M. Hopkins, Wenner-Gren Foundation conference, June 8 to 17, 1979

B. Scientific Party:
D. M. Hopkins, U.S.G.S., Geologist and Principal Investigator
R. W. Hartz, U.S.G.S., Geologist and Co-investigator
P. A. Smith, U.S.G.S., Geologist
E. Chamberlain, C.R.R.E.L.
T. Osterkamp, Univ. of Alaska
W. Harrison, Univ. of Alaska
A. Naidu, Univ. of Alaska

C. Methods of Analysis:
Compilation of summary boring logs.
Preparation of offshore cross sections and isoplethic maps.
Radiocarbon dating.
Synthesis of field observations and laboratory data.

D. Sample Locations:
Twenty offshore boreholes, located between Long Island and Flaxman Island (see Borehole Location Map, Appendix II)

E. Data Collected or Analyzed:
Age determinations have been completed for 19 previously submitted radiocarbon samples.

Core materials collected from the U.S.G.S. Beaufort Sea borehole program. Sampling of selected boreholes will be completed in late July, the tentative date of release by Conservation Division.

Geological maps and cross sections, based on borehole data, have been compiled and are presently being analyzed.

IV. Results:

Recent studies based on seismic refraction data, bottom sediment samples, and limited borehole data have shown that ice-bonded permafrost is widely distributed on the Beaufort Sea continental shelf to at least the 20 m isobath. It is believed that this sub-sea permafrost is for the most part relict, having been formed during the last reduction in sea level when the continental shelf was exposed to subaerial temperatures for prolonged periods. Investigators have also noted a high degree of variability in the depth to the ice-bonded layer over a relatively small area.

The monumental costs of offshore drilling operations on the Beaufort Sea tend to inhibit necessary direct measurements of sub-sea stratigraphy and permafrost. During the spring of 1976 and 1977, a joint drilling program conducted by the U.S. Army Cold Regions Research and Engineering Laboratory (RU-105), and the U.S. Geological Survey (RU-204), resulted in 8 offshore boreholes drilled in the Prudhoe Bay area. This borehole data provided us an excellent insight on the distribution of sub-sea permafrost and sediment types in the Prudhoe Bay-Sagavanirktok River delta area and led to the development of our Paleo-Valley model (Hopkins, 1978) to explain and predict the distribution of offshore permafrost on a regional scale.

The proposed Beaufort Sea Federal lease sale, scheduled for late 1979, and the exploratory drilling that will follow, led to the development of the U.S. Geological Survey, Conservation Division's 1979 Beaufort Sea borehole program. We were invited to participate as OCSEAP representatives in the drilling and coring operations. During February and March, 1979 a 22-man mobile drill camp was established on the shorefast ice in the Prudhoe Bay area. Drilling operations proceeded around the clock.

Utilizing a Failing 1500 drill rig four 300-ft. holes were drilled, while a Mobile B-61 rig was used to drill the shallower 100-ft. holes. In all twenty boreholes were drilled between Long Island to the west and Flaxman Island to the east. Eleven boreholes were drilled seaward of the barrier islands, and 9 holes were drilled on the lagoon side. See Borehole Location Map, Appendix II.

Sampling was continuous through the upper fine grained section and at 10-ft. intervals through the coarse grained units. Standard 36 in. Shelby Tubes were used to recover fines. In coarse material or in tough overconsolidated fines an 18-in. split barrel core with three 6-in. brass liners was utilized. Detailed boring logs were compiled for all the boreholes and they are presented in summary form in Appendix III. These summary logs (Appendix III) also contain preliminary stratigraphic interpretations based on field observations and previous research, but as core materials are analyzed time-stratigraphic boundaries are apt to shift.

Upon completion of drilling operations but before drill casing was pulled, thermistor pipe was set in each borehole. Thermal measurements were then conducted and their results will be available when released by Conservation Division.

All of the recovered core materials are the property of the U.S. Geological Survey, Conservation Division. As of this date sub-sampling is to begin near the end of July, 1979, but release of core samples is dependent upon completion of the soils engineering test program established by Conservation Division.

We are presently compiling interpretive maps, cross-sections, and other geological diagrams based on the borehole data and the results will be reported in the following months.

V. Interpretation:
It is too early to draw specific conclusions as a result of the recent Beaufort Sea drilling program, but in general we believe that the borehole data supports our Paleo-Valley model for predicting offshore permafrost.

Paleo-Valley Model:

During the Sangamon, approx. 120,000 years ago, a thick wedge of marine silts and clays was deposited on the Beaufort Sea shelf. As continental glaciers formed sea level fell and the sediments of the continental shelf were exposed to subaerial temperatures. Ice-bonded permafrost was formed and the marine silts and clays were overconsolidated by repeated cycles of freezing and thawing.

River valleys carved by the paleo Sagavanirktok, Kuparuk, Shaviovik, Canning, and Colville Rivers, cut across the exposed continental shelf. The incision of these paleo-valleys removed the mantle of overconsolidated sediments exposing the underlying permafrost to thermal degradation. As the paleo-rivers extended across the exposed shelf they deposited large amounts of alluvium and glacial outwash.

The wane of continental glaciers brought about a rise in sea level, submerging the paleo-valleys and further inducing thermal degradation by salt advection through the highly permeable alluvium. Sea level rose to its present position and the drowned river valleys were eventually filled by Holocene sedimentation.

If this model is correct we should expect to find deep offshore permafrost associated with belts of Holocene sediment, similar to those shown by P. Barnes and E. Reimnitz (RU-205). On the other hand, we should encounter shallow ice-rich permafrost in association with the overconsolidated silts and clays.

VI. Bibliography:

Hopkins, D. M., 1978, Offshore permafrost studies, Beaufort Sea, Alaska, in Environmental Assessment of the Alaskan Continental Shelf, Quarterly Reports of Principle Investigator's, April-June, 1978: U.S. Department of Commerce, p. 253-261.

VII. Problems Encountered and Recommended Changes:
No insurmountable problems encountered.

IX. Appendices

I. The Flaxman Formation of Northern Alaska: Record of Early Wisconsinan Shelf Glaciation in the Arctic?

II. Borehole Location Map

III. Summary Boring Logs

Appendix I.

The Flaxman Formation of Northern Alaska

THE FLAXMAN FORMATION OF NORTHERN ALASKA: RECORD OF EARLY WISCONSINAN SHELF GLACIATION IN THE ARCTIC?

David M. Hopkins
U.S. Geological Survey
Menlo Park, California 94025

The Flaxman Formation (including some deposits described by Black, 1964, as the "Skull Cliff unit of the Gubik Formation") is a thin sheet of bedded sandy silt containing glacial dropstones which underlies the northernmost Arctic coastal plain of Alaska and is also preserved in patches on the continental shelf of the Beaufort Sea. The dropstones are foreign to Alaska and most probably came from northern Greenland. The Flaxman Formation is of early Wisconsin age; glaciomarine deposits similar to the Flaxman Formation but older than the last interglacial interval are also present on the Arctic coastal plain.

Boreholes on the continental shelf show that the Flaxman Formation was extensively eroded during the Holocene transgression. It is preserved in some places as a sheet only tens of cm thick and in others as a lag deposit of scattered boulders or fine sandy gravel resting on stiff, overconsolidated clay of the Gubik Formation of last interglacial age. Large paleovalleys are trenched through the Flaxman and Gubik Formations on the shelf; peat interbedded with gravel in the Sagavanirktok paleovalley is 42,800 $\pm$ 1440 years old (USGS-249). The Flaxman Formation must be older.

Flaxman Formation exposed in coastal bluffs is covered by several meters of aeolian sand and thaw-lake deposits of late Wisconsinan and Holocene age. Flaxman beds are progressively richer in stones eastward and in fossil mollusks westward along the Beaufort Sea coast. At Cape Simpson and Drew Point, frozen ice-rich sandy silt of the Flaxman Formation about 2 m thick rests on frozen, ice-poor clayey silt of the Gubik Formation, presumably of last interglacial age. The difference in ice content indicates that a sea-level regression separated the Gubik and the Flaxman transgressions.

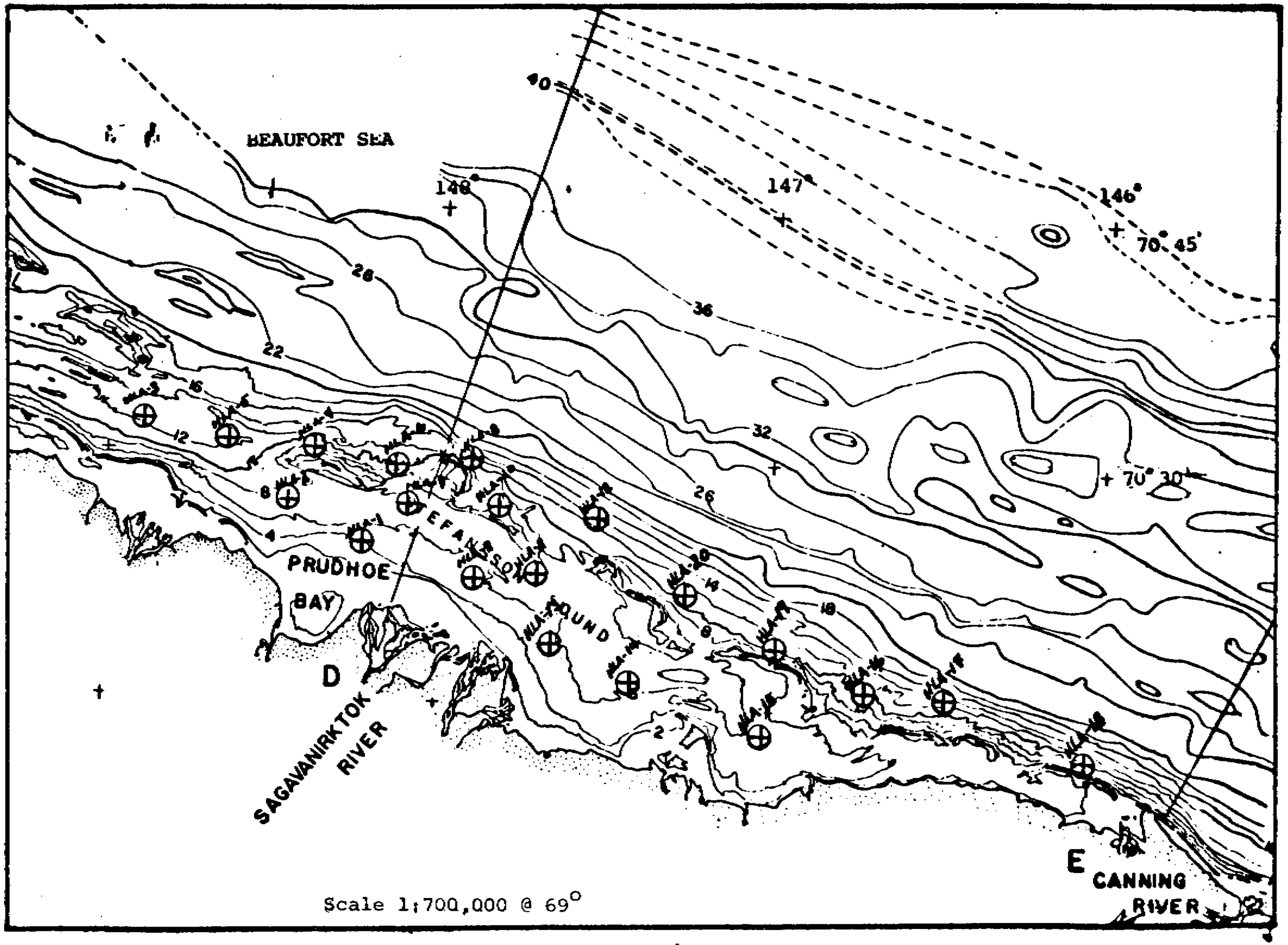
Ridges of pebbly sand cresting near 7 m MSL at Point Barrow and near Cape Simpson lie seaward of the last interglacial shoreline and probably represent the Flaxman shoreline. Worldwide sea level never stood above present MSL since the last interglacial, and the Flaxman Formation must have been deposited at a time when the coast of northern Alaska was isostatically depressed. However, a lower limit to the possible position of Flaxman sea level is provided by whale remains embedded in Flaxman Formation near Teshekpuk Lake; whales must migrate out of the Arctic during winter, and sea level therefore must have been high enough (above -50 m) to flood Bering Strait.

The Flaxman Formation evidently provides a record of early Wisconsinan glaciation on the high arctic Canadian and Greenland shelves and subsequent destruction of the shelf glaciers by rising sea level during abortive deglaciation more than 43,000 years ago. Postulated ice caps on the Barents and Kara Sea shelves probably existed during this same interval rather than during late Wisconsin/Würm time, as some have postulated.

Appendix II.

Borehole Location Map

BOREHOLE LOCATION MAP



0 10 20 N Mi.

Bathymetry in Meters

2 Meter Contour Interval

Core Hole Locations

1979 USGS Over the Ice Drilling Program

Beaufort Sea

Hole #	Latitude	Longitude
1.	70° 24' 47.6112"	148° 13' 16.5091"
2.	70° 27' 07.4789"	148° 26' 45.0535"
3.	70° 31' 54.4848"	148° 53' 53.5031"
4.	70° 30' 16.3343"	148° 22' 42.9157"
5.	70° 30' 41.0464"	148° 37' 49.5267"
6.	70° 29' 35.3739"	148° 07' 42.5130"
7.	70° 27' 12.1418"	148° 05' 16.7115"
8.	70° 30' 01.8221"	147° 53' 21.4410"
9.	70° 22' 48.2591"	147° 52' 42.3173"
10.	70° 27' 07.6444"	147° 48' 28.1534"
11.	70° 23' 00.4264"	147° 41' 00.1086"
12.	70° 26' 39.6603"	147° 30' 26.0310"
13.	70° 18' 56.6726"	147° 38' 48.4579"
14.	70° 16' 35.9599"	147° 23' 42.3768"
15.	70° 13' 18.3653"	147° 00' 20.9002"
16.	70° 16' 11.7455"	146° 42' 46.3550"
17.	70° 16' 08.5329"	146° 27' 31.5567"
18.	70° 12' 37.4033"	146° 02' 35.8526"
19.	70° 18' 48.9562"	146° 58' 03.0345"
20.	70° 21' 59.7638"	147° 14' 38.9035"

Appendix III.

Summary Boring Logs

This appendix may be obtained from the Principal Investigator.

Research Units 204 & 473

Reporting Period: October-December, 1979

Quarterly Report

to

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

Arctic Project Office

Fairbanks, Alaska

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

Principal Investigator

D. M. Hopkins

Associate Investigators

R. W. Hartz

P. A. Smith

Prepared by

R. W. Hartz and D. M. Hopkins

U.S. Geological Survey
345 Middlefield Road
Menlo Park, CA 94025

I. Task Objectives: D-9

II. Field or Laboratory Activities:

A. A manuscript by Yvonne Herman and David Hopkins entitled Arctic Oceanic Climate in Late Cenozoic Time and Its Relation to Global Events, has been accepted for publication by Science. A copy is enclosed.

Julie Brigham of the Institute of Arctic and Alpine Research visited Menlo Park in order to discuss the results of amino-acid racemization studies on mollusks from offshore boreholes, exposures along the coast of the Beaufort and Chukchi Seas, and from river-bank exposures on various parts of NPRA, and to compare these results with those that she had obtained on her own samples collected on Broughton Island on the east coast of Baffin Island. Amino-acid studies are being used as a basis for establishing age and correlation of marine units onshore and offshore in northern and western Alaska, and other shores of the Arctic Ocean. The method is still an experimental one, and Miss Brigham's visit was devoted to discussing the significance and interpretation of analytical results thus far and to planning of improved sampling techniques.

We are urging Miss Brigham to begin an independent study of the stratigraphy, paleontology, and amino-acid chronology of Skull Cliff (the 100 km long bluff extending from Peard Bay to Barrow), in order to improve methodology and to set up a well-established standard chronology. A dependable amino-acid chronology based on fossil marine mollusks will provide a basis for estimating ages of faulting and warping of coastal terraces not only along the Beaufort and Chukchi Sea coasts but also around the shores of Norton Sound.

Marine sediment samples collected during the 1979, U.S.G.S., Beaufort Sea Geotechnical Investigation, are presently being sieved by Kristin McDougall and assistants. All forams, ostracodes, shells, and organic remains will be examined and identified.

Borehole samples with potential for yielding material suitable for radiocarbon dating are being hand-picked.

B. Scientific Party:

D. M. Hopkins, geologist and Principal Investigator

R. W. Hartz, geologist and Associate Investigator

P. A. Smith, geologist and Associate Investigator

K. A. McDougall, paleontologist, U.S.G.S.

C. Methods of Analysis:

Construction of offshore stratigraphic cross sections.

Compilation of offshore structure contour maps.

Compilation of subsea isothermal map at various fixed depths.

Re-examination of microfossil data from boreholes PB-1 through PB-8.

D. Samples Locations:

Indicated on figure 1.

E. Data Collected or Analyzed:

Foraminifera and ostracodes from closely spaced vertical samples from Drew Point and Cape Simpson and from a series of grab samples from various localities between Point Barrow and the Canning River have been completed. As a result, we can now characterize the microfaunas of the Pelukian (last interglacial) deposits and of the glaciomarine faunas of the Flaxman Formation. The Pelukian faunas contain several species of foraminifera and ostracodes that are now confined to the North Atlantic Ocean; one of these, Elphidium asklundi, is apparently extinct. The Flaxman faunas are relatively impoverished; the Atlantic forms and Elphidium asklundi appear in the lowest levels but may be redeposited from underlying Pelukian deposits. The results will be reported more fully in our Annual Report.

The analysis of a variety of offshore data bearing of the depth to ice-bonded permafrost has resulted in a new paleovalley map for predicting the occurrence of relic bonded subsea permafrost on the central Beaufort Sea continental shelf.

III. Results and Discussion:

MAP OF THICKNESS OF THE UNBONDED LAYER ON THE CENTRAL BEAUFORT SEA SHELF

Introduction.--Borehole and probe studies by OCSEAP investigators (R.U. 105, 204, and 253) and by the Conservation Division of the Geological Survey have established that bonded permafrost is present everywhere, although at variable depths, throughout the Beaufort Sea lease area from the shoreline seaward to at least the 20-meter isobath. Seismic-reflection and seismic-refraction studies (R.U. 271) and reinterpretation of first returns in commercial seismic reflection records (R.U. 105) provide additional information that helps to delineate areas of shallow and deep permafrost. We have undertaken to contour the thickness of the non-bonded surficial layer on the basis of drill-hole and probe data and have used seismic data as a further guide to the recognition of areas of relatively shallow and relatively deep bonded permafrost.

The depth to the top of ice-bonded permafrost has proven to be highly variable. Bonded permafrost has been encountered as shallow as 6.5 m below the seabed at a distance of 22 km from the mainland, but unbonded permafrost as thick as 90 m has been found locally much closer to shore. Differences in thermal history including the effects of the passage of migrating barrier islands, differences in time since inundation by rising sea level and a retreating coastline, and differences in pore-water salinities all seem to play some role in determining the thickness of the surficial unbonded layer.

Salt advection following entry of sea water into alluvium exposed upon the sea floor seems to have been one important mechanism for inducing local deep thaw of sub-sea permafrost on the Beaufort Sea shelf. In earlier Quarterly and Annual Reports, we have noted that a deeply thawed area between ARCO West Dock and Reindeer Island seems to be the site of a segment of an ancient valley of the Sagavanirktok River which was eroded and then back-filled with sandy and gravelly alluvium during the last low-sea-level cycle; we postulated that sea water gained access to the alluvium during the initial flooding of the valley during the Holocene rise in sea level, prior to the deposition of a cover of marine clay and mud which now seals the alluvial sequence. The thick overconsolidated marine clay dating from an earlier interglacial which underlies areas away from the paleovalley is relatively impermeable; sea water has not penetrated deeply, and consequently the overconsolidated marine clay is generally not deeply thawed (it is worth noting that both the bonded and unbonded sediments have temperatures well below zero in all of our boreholes and that all boreholes have negative temperature gradients indicating that bonded permafrost is present at depth, even if not reached by the borehole).

If this model is correct, then areas of unbonded permafrost many tens of meters thick should be expected to occupy curvilinear tracts marking the sites of former paleovalleys. We also wish to note that if the model is correct, then a map contouring the thickness of unbonded permafrost can be used as a guide in the search for unfrozen sand and gravel, a very scarce commodity on the Beaufort Sea shelf. We have used the assumption that thick non-bonded permafrost occupies paleovalleys as a guiding assumption in contouring the sparse data on depth of thaw within the 1980 Beaufort Sea lease area, and we have felt encouraged to do so by the fact that with one exception (borehole HLA-14), all areas of deep thaw do, indeed, coincide with areas in which boreholes have encountered thick sandy and gravelly alluvium beneath Holocene marine mud.

Figure 1, then, is an interpretive map of the central Beaufort Sea continental shelf, portraying depth to the top of unbonded permafrost and also the hypothesized paleo-drainage pattern across the shelf.

Sagavanirktok paleovalley.--The form of the Sagavanirktok paleovalley was established on the basis of boreholes PB-2, -3, -4, -6, -7, and -8; the Humble Oil Company 1969 geotechnical borehole on Reindeer Island; Geological Survey boreholes HLA-2, -3, -5, and -7; and boreholes drilled in 1976 and 1978 by T. Osterkamp and W. Harrison. These boreholes reveal a steeply inclined ice-bonded surface that drops from 10 m below sea level in PB-4 at the elbow of ARCO West Dock, reaching a depth of 30 m in HLA-2 and a depth greater than 92 m in HLA-5. This bonded surface then rises to about 30 m below the seabed in PB-2 and HLA-4. The form of the paleovalley in a section from ARCO West Dock to Reindeer Island is further delineated by a thick wedge of Holocene marine sediments overlying exceptionally thick alluvium and glacial outwash, as reported in R.U. 204 Quarterly Report, April-June, 1979.

Probes and boreholes in shallow water off the Sagavanirktok River delta generally encounter bonded permafrost at very shallow depth, but Rogers' and Morack's seismic data indicate that a narrow belt of relatively thick unbonded surficial sediment extends from the eastern mouth of the Sagavanirktok River northwestward toward the Sagavanirktok paleovalley. This belt of thicker unbonded sediments probably marks the course of one of the principal channels of the Sagavanirktok River during the last low-sea-level interval.

Prudhoe Bay.--In one of our early Annual Reports, we suggested that Prudhoe Bay represents a breached thaw lake whose former northern rim lay beneath Gull Island and the Niakuk Islands. However, Cannon and Rawlinson (R.U. 530, Ann. Report, 1979) note that the Putulagayuk River is underfit and was once a much larger stream representing a distributary of the Sagavanirktok River. The ancient floodplain as mapped by Cannon and Rawlinson occupies the entire south shore of Prudhoe Bay. These observations suggest that the bay is an estuary occupying a drowned branch of the Sagavanirktok paleovalley. Unpublished dates on floodplain sediments (I-10642, I-10643, I-10644) indicate that this larger Putuligayuk River was functioning as a Sagavanirktok distributary between 7,200 and 5,500 years ago and perhaps earlier and later, but that the Putuligayuk was no longer a large stream 2,000 years ago. Prudhoe Bay evidently formed when the distributary valley was drowned about 1,000 years ago, based on the age of the oldest Holocene marine beds in borehole PB-1 (Hopkins and Hartz, 1977 Annual Report, R.U. 204). The northward course of the Putulagayuk Branch of the Sagavanirktok paleovalley is delimited by borehole PB-5 which, on the basis of stratigraphy and shallow bonded permafrost, clearly lies outside of any paleovalley.

Probe data and Rogers' and Morack's seismic data shows that a finger of shallow unbonded permafrost extending westward from Heald Point through the Niakuk Islands and Gull Island nearly isolates the thick unbonded sediment beneath Prudhoe Bay from the equally thick unbonded sediment of the Sagavanirktok paleovalley to the north. We have considered the possibility that this observation provides support for the interpretation that Prudhoe Bay is, indeed, an ancient thaw lake, but it seems more likely that the finger of shallow bonded material formed recently beneath a migrating Gull Island or beneath a migrating shoal upon which winter sea has rested directly upon the sea bottom at some time in the last few decades.

Postulated Shaviovik-Canning paleovalley.--Compilation of seismic and borehole data suggests the possibility that another paleovalley may be present in the vicinity of Tigvariak Island and that it may extend eastward to pass north of Flaxman Island. This interpretation is based upon the presence of thick, unbonded alluvial gravel in borehole HLA-15, 5 km east of Tigvariak Island, and upon the report of thick unbonded material detected by Sellmann (R.U. 105, Quarterly Report, April-June, 1979) beneath the Stockton and Belvedere Islands. The possible presence of a western tributary to this postulated sea valley is suggested by the surprising presence of more than 30 m of unbonded but overconsolidated marine clay in borehole HLA-14, about 8 km northwest of Tigvariak Island; the destruction of ground ice in this unbonded clay possibly may reflect the presence of more permeable, brine-soaked gravel nearby. The possible position of any paleovalley in the eastern part of the lease area is limited, however, by the shallow, ice-bonded overconsolidated marine clay observed in boreholes HLA-15, -17, -18, and -19 and by divers' observations of overconsolidated clay in Leffingwell Channel between Flaxman Island and Brownlow Point.

The presence of quantities of limestone and metabasalt at some levels in the gravel encountered in borehole HLA-14 suggests a Shaviovik rather than a Canning River source at these levels. If there really is a paleovalley in the Tigvariak Island area, it probably carried the drainage of the Shaviovik River, but the Canning River may also have drained to the valley through a former distributary flowing down the western margin of the Canning River fan.

We emphasize that our reconstruction of a Shaviovik-Canning River paleovalley in the Tigvariak-Flaxman Island area is highly speculative. Nevertheless, future exploration for gravel in the eastern part of the Beaufort Sea lease area should begin with a testing of the area of the postulated sea valley.

Areas of shallow bonded permafrost off Cross Island and the McClure Islands.--Bonded permafrost was encountered at depths of only 6 and 9 m in boreholes HLA-12 and -20 seaward off the McClure Islands and at a depth of 19 m in borehole HLA-8 off Cross Island. Hopkins and Hartz (1978) note that the dolomite facies gravel comprising these migrating islands is much coarser than gravel on barrier islands to the east and west and suggest that Cross Island and the McClure Islands may lie close to former hillocks of Pleistocene Flaxman Formation that have been destroyed by wave erosion and thermokarst subsidence within the last few centuries. The shallow depth to bonded permafrost in areas two or three kilometers seaward of these islands is supportive; the most reasonable explanation for shallow ice-bonded permafrost in those areas would be that they have been submerged below sea level for a shorter time than other parts of the surrounding sea floor.

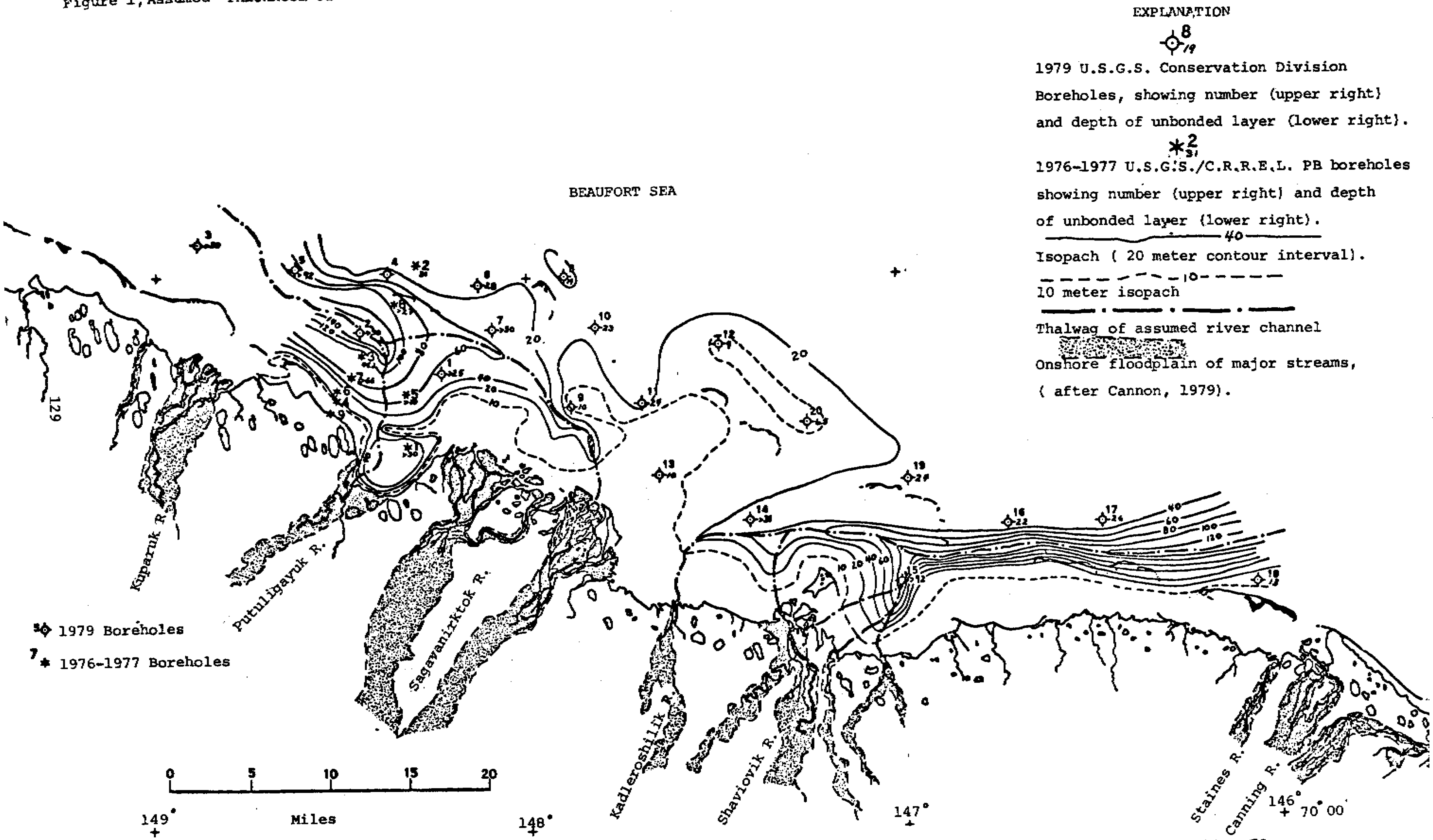
It is noteworthy that the entire area of "the Boulder Patch", an area in which the bottom is littered with large, erratic boulders presumably derived from the Flaxman Formation is also less deeply thawed than areas equally far from shore to the east and west.

Conclusions.--Borehole and seismic records can be used to contour the thickness of unbonded sediments on the Beaufort Sea lease area. The resulting map can be used to assist in delineating gravel-filled Pleistocene valleys on the Beaufort Sea shelf and can be used as a guide in the search for accessible, unfrozen sand and gravel for construction of artificial islands and causeways on the Beaufort Sea shelf.

IV. Problems Encountered and Recommended Changes:

No insurmountable problems encountered.

Figure 1, Assumed Thickness of Unbonded Permafrost on the Central Continental Shelf of the Beaufort Sea, Alaska



QUARTERLY REPORT

Research unit: 205
Reporting period: April to
June, 1979

GEOLOGIC PROCESSES AND HAZARDS OF THE BEAUFORT SEA SHELF AND COASTAL REGIONS

Peter Barnes

Erk Reimnitz

Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

July 1, 1979

QUARTERLY REPORT RU-205

I. Task Objectives

The primary goal of this project is to study the nature, distribution, stability, and thickness of Holocene and older sediments, and their relationship to sources, dispersal mechanisms, and processes. Emphasis is placed on processes that were unique to the arctic environment where ice plays a dominant role. More detailed objectives for this project are given in previous reports and in the project proposals.

In this report we address new topics of particular importance to the development of an EIS by the Bureau of Land Management. These topics include: 1) under-ice morphology and potential for oil entrapment, 2) areal extent and geologic character of the boulder patch, 3) gas analysis of surface sediment samples, 4) implications of profound sea bed changes from 1977 to 1978, and 5) observations on barrier island migrations.

II. Field or Laboratory Activities

A. Ship or Field trip Schedule - None

B. Project Personnel

Peter Barnes, Project Chief, U.S.G.S., Office of Marine Geology
Erk Reimnitz, Principal Investigator, U.S.G.S., Office of Marine Geology
Dennis Fox, Assistant, U.S.G.S., Office of Marine Geology
Edward Kempema, Assistant, US.G.S., Office of Marine Geology
Douglas Rearic, Assistant, U.S.G.S., Office of Marine Geology
Robin Ross, Assistant, U.S.G.S., Office of Marine Geology

C. Methods - Included in Section III.

D. Sample locations - Included in Section III.

E. Data collected or analyzed - Included in Section III.

III. & IV. Results and Preliminary Interpretations

Results with preliminary interpretations are included as attachements to the Quarterly Report. Below are attachment titles with brief summary statements.

Attachment A. Nearshore surficial sediment textures - Beaufort Sea Alaska. Beaufort Sea nearshore data on surficial sediments are presented here in map form to show sediment texure diversity and patchiness. Ice gouging and various environmental factors are suggested as processes to explain the diversity.

Attachment B. Additional observations on geomorphologic changes in the arctic coastal environment.
Changes in the locations and configurations of islands and coastline are reported here with illustrations. The recent trend is for the islands to divide into smaller ones and migrate to the southwest, for new entrances to form, and for tidal inlets to deepen.

Attachment A

Nearshore Surficial Sediment Textures-Beaufort Sea, Alaska

Peter Barnes, Erk Reimnitz and Robin Ross

DATA

As a contribution to other researchers in the Outer Continental Shelf Environmental Assessment Program, we present here Beaufort Sea nearshore textural data on surficial sediments from a variety of sources. The data include laboratory analyses, field notes, diving observations, and published reports. The diversity of the data sources, the ways in which the information might be used, and the data density, suggested that the classification of sediment textures of Pettijohn (1957) would be most useful. The three end members we use in this classification are gravel, sand, and mud; gravel-sand and sand-mud boundaries are nominally set at 2 mm and 0.062 mm respectively. The data are graphically displayed in figures 1-a and 1-b. Sample descriptions and other particulars are given in the Appendix.

The most striking observation derived from the data is the diversity and patchiness of the surficial sediment textures found on the inner shelf. This character is evident at large scale (Figs. 1-a and 1-b) and at a smaller scale based on observations made during diving traverses along the seabed (Reimnitz and Maurer, 1978).

Cores indicate that the diversity in sedimentary character extends vertically as well as laterally (Barnes and others, 1978). On a regional scale, a lateral sediment diversity is characteristic of the entire Beaufort Sea shelf (Barnes and Reimnitz, 1974). This diversity is not readily explained by temperate latitude shelf processes.

Small-scale variability is emphasized in diving observations along 300 to 400 m traverses off Reindeer Island where clean sand ridges were separated by burrowed muds. At some locations on the seaward side of transects, numerous

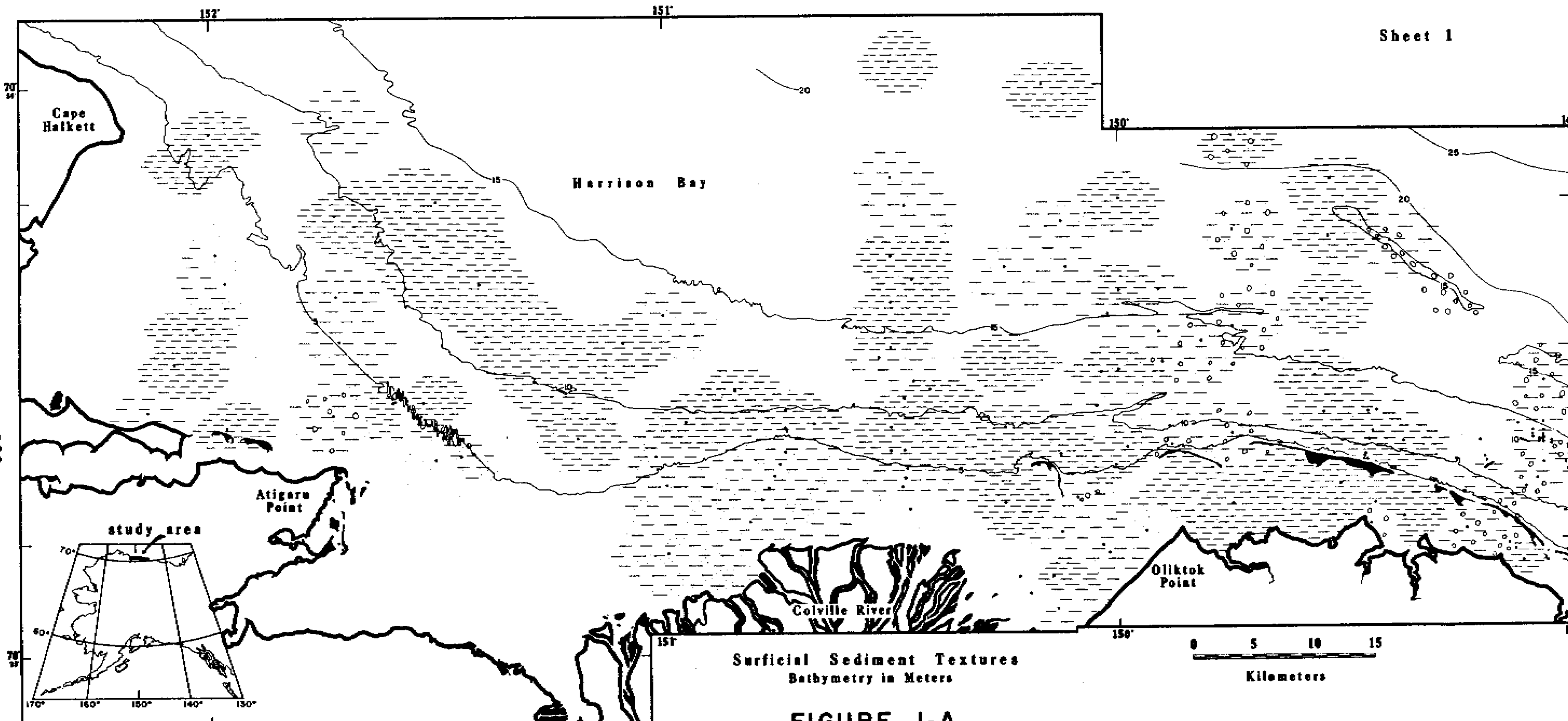

Sheet 1
152°
151°
150°
149°
Cape Halkett
Harrison Bay
Atigaru Point
study area
Colville River
Oliktok Point
Surficial Sediment Textures
Bathymetry in Meters
0 5 10 15
Kilometers

FIGURE I-A

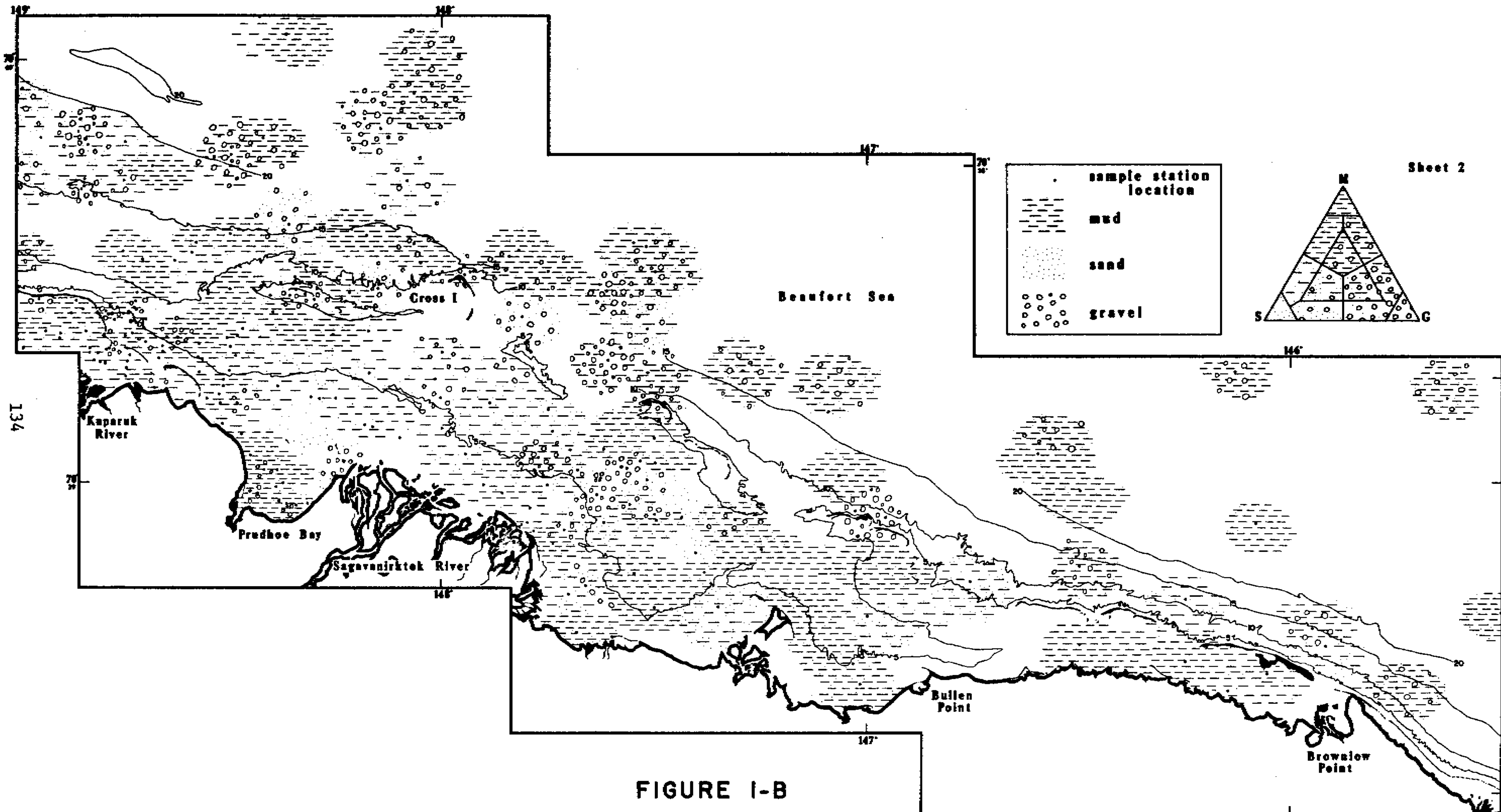
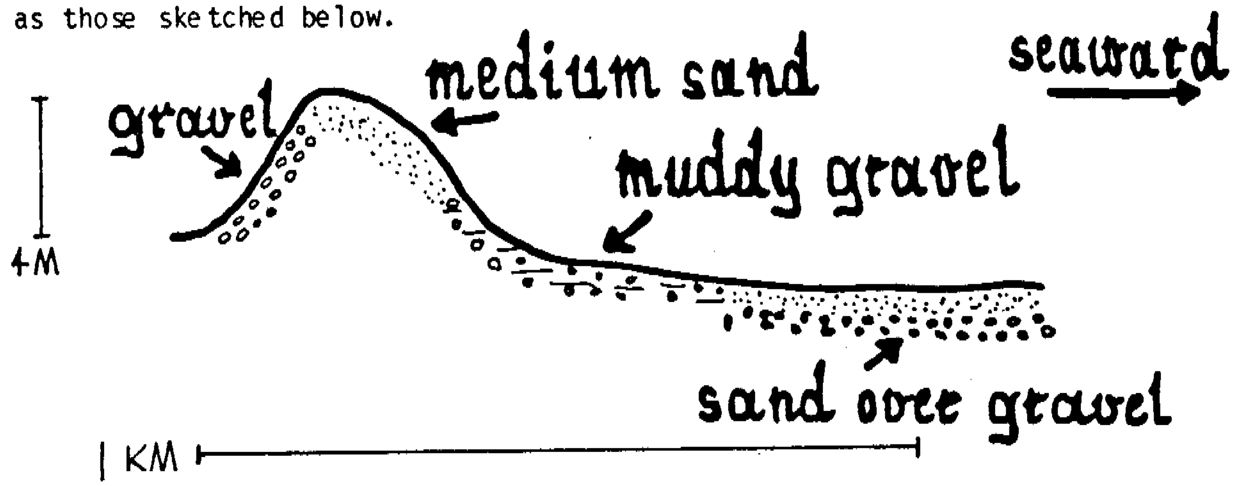

Beaufort Sea
Cross I
Kuparuk River
Prudhoe Bay
Sagavanirktok River
Bullen Point
Brownlow Point
sample station location
mud
sand
gravel
Sheet 2
M
S
G

FIGURE 1-B

blocks and slabs of a stiff, silty clay were encountered which apparently originated from nearby outcrops (Reimnitz and Barnes, 1974. p. 323). Based on diving observations made in the vicinity of the series of shoals, Reimnitz and Maurer (1978) noted that "over much of the area generalization of sediment types cannot be made because of the extreme, short-distance variations" such as those sketched below.



Diver's sketch of a shoal northeast of Oliktok Point which illustrates the variability of surficial sediment textures. Area covered is about 500 m of the seabed across and seaward of the shoal (Reimnitz and Maurer, 1978).

COMMENTS

One process responsible for the diversity is ice gouging: where ice plowing exposes sediments on the seabed which may have been initially deposited under different hydraulic and/or ice regimes than those which are in operation at present. The presence of ice at or near the sea floor also acts to locally intensify currents and consequently to locally modify sediment textures. From seismic data we know that in parts of the inner shelf Holocene marine sediments are only a few meters thick (Reimnitz and others, 1972). Thus the possibility of including sediment textures relict from earlier depositional environments by the modern process of ice gouging (Reimnitz and Barnes, 1974) and strudle scour, which can exhume sediments to depths of several meters, is almost certain (Reimnitz and others, 1974).

Contrary to the observations of Naidu and Mowatt (1975 and 1976) the inner shelf cannot be characterized on the basis of textural parameters alone. Thus geographic depositional environments such as bay and lagoon do not exist in textural terms. For example, these authors assign Harrison Bay and Prudhoe Bay to the same depositional subfacies on a textural base (Naidu and Mowatt, 1976, p. D-10). Figure 1 shows that Prudhoe Bay surface textures are muds with admixtures of sand and gravel, while Harrison Bay is dominately a sandy facies immediately off the Colville Delta with more muddy sediments seaward. A comparison of the vertical stratigraphy also shows a great disparity in the two environments (Barnes and others, 1979). However, the disparity is to be expected when environmental factors affecting sedimentation in these two areas are considered. Prudhoe Bay is a well protected shallow embayment which has only moderate fetch available for wave build-up in summer and a stable ice sheet in winter which do not suggest the possibility of ice gouging. During the summer, Harrison Bay can be exposed to fetches in excess of 50 km when ice is well offshore. During the winter the Bay is subject to ice ridge development and to repetitive gouging of the seabed by ice (Reimnitz and others, 1978, Barnes and others, 1978).

The variability of surface textural character in the nearshore sediment implies a varied biologic community. The variability of the biologic community in one texturally diverse environment off the Sagavanirktok River is emphasized by Dunton (1979). The thin nature of the Holocene cover, which is often broken by outcrops of a Pleistocene stiff, silty clay, as well as by local and areal textural variations, causes variations in the engineering character of near-surface sediments as well. Furthermore, the availability of gravel suggested by the surficial sediment distribution is tempered by the variable thickness and vertical and lateral variability of gravel-rich sediments which may exist only as a surface veneer (Barnes and Reimnitz, 1974). Thus potential gravel resources will have to be delineated by shallow drilling.

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Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 ABP 11	70°25.3'N 146°08'W	33	1.9 G 31.0 S 30.0 St 37.0 C	gsM-Tube worms and tubes, brittle stars, clams, and polychaete worms. A 1-cm ooze overlies a green, highly cohesive lower unit.
71 ABP 12	70°18.0'N 146°05'W	26	0.0 G 24.9 S 41.2 St 33.8 C	sM-Brittle stars and tube worms. Cohesive clay, no apparent pebbles.
71 ABP 13	70°20.7'N 146°34'W	31	2.7 G 25.1 S 41.4 St 30.7 C	gsM-Sandy mud with miscellaneous sized pebbles. Surface layer is a greenish-grey soup 1-2 cm thick, underlain by a stiff, grey mud with abundant pebbles(to 15 cm diameter).
71 ABP 14	70°25.0'N 147°05'W	28	7.8 G 15.3 S 40.5 St 36.3 C	gsM-Grey, plastic, slightly silty clay, with sparse sand and gravel (maximum 5-cm gravel diameter). Dark, grey clay below grey surface layer.
71 ABP 23	70°38.4'N 148°04'W	27	18.1 G 18.1 S 23.7 St 40.0 C	sgM-Brittle stars, tube worm and amphipods. Two layers: 1 cm red-brown ooze over an olive-grey, more cohesive mud.
71 ABP 25	70°31.2'N 147°31'W	26	3.1 G 13.2 S 39.8 St 43.9 C	gsM-Brittle star, snail shell, and polychaete worms. A few pebbles (<6 cm). Olive-gray clay silt of fine and very cohesive texture. Darker grey at bottom.
71 ABP 36	70°37.2'N 148°11'W	22	41.6 G 37.4 S 11.0 St 9.9 C	msG-Sample loaded with pebbles and larger rocks along with sandy clay; random scatter and roundness. A large number of reduced areas. No textural zonation or sorting.
71 ABP 49	70°36.0'N 148°50'W	22	14.2 G 49.9 S 20.0 St 15.8 C	gmS-Brittle star, tube worms. A soupy, silty clay ooze layer on top of a brown-, grey, olive cohesive clay. Some pebbles (<1 cm) dispersed in sample.
71 ABP 69	70°41.2'N 148°22'W	23	0.0 G 8.0 S 25.2 St 66.7 C	sM-Exceptionally stiff grey clay with minor sand constituent.
71 AJT 1	70°24.6'N 148°23.2'W	3.5	0.0 G 73.7 S 19.1 St 7.1 C	mS-Clean, well sorted silt. No fauna or gravel observed.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AJT 2	70°20.6'N 148°23.2'W	2.6	0.0 G 5.7 S 77.8 St 16.4 C	sM-Coarse clay or very fine silt. No gravel or organisms observed. Top 1 cm has a high H_2O content.
71 AJT 3	70°27.0'N 148°15.3'W	8.5	0.0 G 29.8 S 54.2 St 15.9 C	sM-Fine silt with 5 to 15% clay. Two 1 cm pelecypods.
71 AJT 4	70°30.0'N 148°00.0'W	11.3	0.0 G 62.4 S 32.3 St 5.3 C	mS-Very coarse silt. A minor amount of clay. Numerous worms.
71 AJT 5	70°26.2'N 148°00.0'W	6.7	2.9 G 79.7 S 12.9 St 4.4 C	gmS-Worm tubes on top. Poorly sorted. Some clays and silts, predominantly coarse sands. (largest particles <7 mm). Medium olive-grey color.
71 AJT 6	70°22.6'N 148°00.0'W	4.6	0.0 G 98.3 S 1.7 St 0.0 C	mS-Well sorted fine sand, no clay. <5% silt. No fauna observed.
71 AJT 7	70°23.5'N 147°45.0'W	7.6	0.0 G 80.6 S 13.5 St 5.9 C	mS-Silt, some bottom fauna.
71 AJT 8	70°22.1'N 147°30.0'W	6.7	0.0 G 48.0 S 38.5 St 13.4 C	sM-Silt, one fish, one live pelecypod, pelecypod valve, and worms.
71 AJT 9	70°18.5'N 147°30.0'W	5.5	39.7 G 39.7 S 14.6 St 5.9 C	mGS-Sand, silt, clay, with assorted subrounded gravel (<2.5 cm); no sorting. Top 1 cm - 1.5 cm is silt and clay. No gravel.
71 AJT 10	70°14.0'N 147°30.0'W	5.0	0.0 G 8.2 S 12.3 St 5.7 S	sM-Fine to very fine sand, some silt. Small pelecypod.
71 AJT 11	70°16.8'N 147°15.0'W	8.5	0.0 G 14.8 S 66.6 St 18.6 C	sM-1 cm of olive grey clay, high H_2O content, overlying a greyish black, slightly silty clay. One segmented worm.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AJT 12	70°11.3'N 147°02.0'W	5.2	0.0 G 45.9 S 39.9 St 14.2 C	sM-Very fine silt with clay. Very soft. High H_2O content.
71 AJT 13	70°12.8'N 147°80.0'W	4.0	0.0G 28.5 S 50.2 St 21.3 C	sM-Olive grey fine-grained clayey silt with many worm tubes.
71 AJT 14	70° 16.3'N 147°00.0'W	4.9	0.0 G 11.9 S 69.0 St 19.0 C	sM-Silty clay, very sticky, well sorted.
71 AJT 15	70°23.8'N 148°29.0'W	2.6	14.7 G 57.1 S 22.8 St 5.3 C	gmS-Fine sand and silt. Minor lenses of organic material. No stratification. No fauna.
71 AJT 16	70°26.5'N 148°30.0'W	7.0	0.0 G 56.7 S 30.6 St 12.7 C	mS-Coarse silt. A zone of fine sand and shell fragments at 5 cm. (less than 3 mm in thickness) Brown color at approximately 3 cm.
71 AJT 17	70°28.0'N 148°45.0'W	4.6	1.7 G 16.0 S 60.8 St 21.4 C	gsM-At approximately 12 cm from surface 2 cm of subangular pebbles (<2 mm, <4 mm). Fine sand layer (.5cm thick) at 3-4 cm from surface. Rest of sample is mostly clay.
71 AJT 18	70°31.0'N 148°45.0'W	13.7	0.0 G 12.7 S 49.4 St 37.8 C	sM-Clay surface 1 cm light to medium brown. High water content.
71 AJT 19	70°29.2'N 148°30.0'W	8.8	0.0 G 45.1 S 35.1 St 19.7 C	sM-Top several mm of light to medium brown clay overlies coarse silt and very fine sand with a few white coarse sand-sized fragments.
71 AJT 20	70°31.8'N 148°30.0'W	14.6	0.0 G 24.6 S 48.2 St 27.1 C	sM-Top 1.5-2 cm of fine brownish clay and silt overlies a grey, very slightly silty clay. A few worms present.
71 AJT 21	70°34.3'N 148°45.0'W	16.8	3.0 G 89.1 S 4.6 St 3.2 C	gmS-Poorly sorted sands with minor silt and pebbles. Broken shell fragments common. A whole pelecypod.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AJT 22	70°35.5'N 148°30.0'W	20.4	40.0 G 35.9 S 14.1 St 9.9 C	msG-Very poorly sorted silt, sand, subrounded pebbles and large (5 cm) pebbles, minor clay. Grey below 5 cm, brown brindle above.
71 AJT 23	70°30.9'N 149°00.0'W	11.0	2.1 G 42.0 S 42.9 St 12.9 C	gsM-A clay, silt, fine to medium-grained sand mixture, poorly sorted. Sparse gravel of uniform diameter (0.8-1.cm) also present.
71 AJT 24	70°34.8'N 149°00.0'W	17.8	1.6 G 93.7 S	mgS-Fine-grained sand with some silt and clay. Sparse gravel of uniform size (1 cm). Some reddish rust brown color to a depth of 6 cm.
71 AJT 25	70°38.3'N 149°00.0'W	18.3	19.7 G 41.7 S 18.2 St 20.2 C	gmS-Unsorted mixture of clay, silt, sand, and gravel (up to 2.5 cm).
71 AJT 26	70°43.0'N 149°22.5'W	1.7	0.0 G 98.4 S 1.5 St 0.0 C	mS-Well sorted medium-grained sand with small shell fragments. Located on top of shoal.
71 AJT 27	70°47.7'N 149°45.0'W	19.2	0.7 G 40.7 S 35.7 St 22.8 C	gsM-Clay with lenses of silt and sand, no obvious stratification. Some shell fragments. Numerous bottom fauna; worms and fish.
71 AJT 28	70°43.6'N 149°45.0'W	18.0	1.6 G 87.2 S 4.9 St 6.2 C	gmS-Fine-grained to med-grained sand with some silt. Abundant small and large pelecypod fragments. No stratification. Moderately well sorted.
71 AJT 29	70°39.4'N 149°45.0'W	14.6	23.6 G 59.2 S 9.0 St 8.1 C	mgS-Top 5 cm is coarse sand and small pebbles (maximum diameter 1 cm). Poorly sorted. Below this is 3 cm of viscous clay. No silt.
71 AJT 30	70°34.7'N 149°45.0'W	7.6	1.0 G 75.1 S 20.2 St 3.7 C	gmS-Slightly silty olive grey clay at the top grading uniformly to fine, medium-grained darker sand at 6 cm depth. Sand-size shell fragments common.
71 AJT 31	70°33.8'N 150°07.7'W	7.6	0.0 G 20.2 S 51.2 St 28.6 C	sM-An upper 1.5 cm of clay with very minor silt, overlying 4 cm of moderate to poorly sorted coarse to fine-grained sands with shell pelecypod fragments.
71 AJT 32	70°35.0'N 150°30.0'W	8.5	0.0 G 15.0 S 62.8 St 22.2 C	sM-An upper 1 cm dark yellowish brown clay overlying 5 cm of fine to very fine olive grey and black sand. Moderately well sorted. Shell fragments not observed.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AJT 33	70°40.5'N 150°30.0'W	16.2	0.0 G 42.8 S 30.0 St 27.1 C	sM-Yellowish brown clay. Minor amounts of silt are present. No variation from the top to the bottom in the 5-6 cm sample, except for the usual high water content of the surface layer. No color, or any other change with depth.
71 AJT 34	70°46.0'N 150°30.0'W	18.0	0.0 G 59.2 S 20.0 St 20.7 C	mS-Slightly silty clay with silt lenses. No variation with depth except for higher water content near the surface, and a color change from brown at the surface to grey below. Black mottling observed.
71 AJT 35	70°52.0'N 150°30.0'W	19.8	0.0 G 33.8 S 28.2 St 37.9 C	sM-0.5 to 1 cm of light olive grey clay with silt, overlying well sorted fine-grained, olive grey sand (could have been a lens, but lateral extent unknown) A bottom layer of silty, plastic, slightly organic dark grey clay.
71 AJT 36	70°44.0'N 150°07.5'W	17.1	0.0 G 90.5 S 9.5 St 0.0 C	mS-Very fine to fine-grained dark yellowish brown sand. No vertical variation.
71 AJT 37	70°29.0'N 149°06.5'W	2.1	0.0 G 34.0 S 50.0 St 15.9 C	sM-Very poorly sorted sand, silt, and clay No stratification or vertical variation.
71 AJT 38	70°31.6'N 149°26.1'W	1.5	0.0 G 45.0 S 41.3 St 13.6 C	sM-Sample 0-10 cm. Upper 5-6 cm is well sorted, fine-grained sand with considerable mud. Some sand-free clay is seen; suspect either bioturbation or mixing from ice movement. The lower 4-5 cm was well sorted, clay-free, fine-grained sand.
71 AJT 39	70°31.6'N 149°45.0'W	2.1	0.0 G 35.4 S 55.7 St 8.5 C	sM-Clayey silt. High water content in top 0.5-1 cm of brown color. Darker grey below to about 5 cm. Brown penetrates grey in a vertical, linear mottle.
71 AJT 40	70°35.3'N 149°22.5'W	10.4	0.0 G 7.2 S 70.7 St 22.0 C	sM-Olive grey clay. No apparent silt or sand, but appears to be agglomerated into small grains. The top 0.25 cm is of a brown color.
71 AJT 41	70°32.0'N 148°18.0'W	14.0	0.0 G 96.4 S 3.5 St 0.0 C	mS-Poorly sorted, yellowish brown and black, medium to fine-grained sands with abundant shell fragments. No silt and no clay.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AJT 42	70°34.3'N 148°05.0'W	22.0	20.4G 46.3 S 17.3 St 15.9 C	gmS-Olive grey clay with silt, sand, and gravel. No sorting. No vertical variation.
71 AJT 43	70°30.0'N 147°30.0'W	22.6	10.6 G 25.7 S 32.4 St 31.2 C	gsM-Dark grey clay, with small amount of sand and gravel which appears to have been added to the clay.
71 AJT 44	70°25.8'N 147°36.7'W	11.0		mG-Mostly rounded gravel up to approx. 10 cm. Appears to be an olive grey clay matrix. This is really the only station located near what appears to be year-round fast ice.
71 AJT 45	70°24.0'N 148°15.0'W	3.4	0.0 G 99.1 S 0.9 St 0.0 C	mS-Yellowish brown and black very fine-grained sand. Well sorted, nothing larger. No clay. One isopod and one shell fragment (Pelecypod?)
70 BS-A	70°29.8'N 150°02.2'W	3.5	0.0 G 5.3 S 86.8 St 7.9 C	sM
70 BS-B	70°24.5'N 148°40.6'W	1.0	13.4 G 76.4 S 7.6 St 2.7 C	gmS
70 BS-1	70°34.2'N 149°53.0'W	2.5	3.4 G 83.7 S 9.5 St 3.4 C	gmS
70 BS-3	70°35.0'N 149°53.3'W	10.0	0.0 G 99.0 S 1.0 St 0.0 C	S-clean sand.
70BS-4	70°36.4'N 149°53.8'W	10.0	0.0 G 91.5 S 5.8 St 2.7 C	mS
70 BS-5	70°37.8'N 149°54.3'W	12.0	1.2 G 61.3 S 22.9 St 14.6 C	gmS-Thin film of medium sand overlying brownish mud overlying a dark grey, slightly stiff mud.
70 BS-6	70°39.1'N 149°54.8'W	13.0	0.0 G 98.1 S 1.9 St 0.0 C	mS-Well sorted, clean, medium-grained sand, overlain by thin mud film.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
70 BS-7	70°41.0'N 149°54.8'W	16.0	0.0 G 98.8 S 1.2 St 0.0 C	mS-Clean sand. Many small, fragile clam shells of various types (taken next to ice edge).
70 BS-8	70°39.9'N 150°01.5'W	15.0	0.0 G 94.2 S 4.3 St 1.5 C	mS-Muddy sand. Small clam shells.
70 BS-9	70°37.4'N 150°02.3'W	13.0	0.0 G 34.9 S 34.7 St 25.4 C	sM-Grey mud, with a 2-cm sandy layer on top. Some shells.
70 BS-10	70°35.9'N 150°02.9'W	10.5	0.0G 69.2 S 22.3 St 8.5 C	mS-1.5 cm layers of sand and mud.
70 BS-11	70°31.9'N 150°05.5'W	3.0	0.0 G 66.3 S 29.3 St 4.5 C	mS-Grey, sandy mud.
70 BS-12	70°30.4'N 150°07.5'W	3.0	0.0 G 22.1 S 62.8 St 15.1 C	sM-Brownish grey mud.
70 BS-13	70°27.0'N 150°08.1'W	1.5	0.0 G 12.1 S 80.4 St 7.6 C	sM-Brownish grey mud with some organic debris.
70 BS-14	70°31.0'N 149°22.3'W	2.0	0.0 G 18.6 S 66.3 St 15.0 C	sM-Very muddy sand, with soft ooze on top.
70 BS-15	70°32.0'N 149°14.5'W	4.0	0.0 G 94.5 S 4.8 St 0.8 C	mS-Sand. Some small shells.
70 BS-16	70°36.1'N 148°44.8'W	19.0	0.0 G 80.1 S 9.0 St 10.9 C	mS-Sand. Numerous benthic organisms, small clam, amphipods, large turibella-like snail. Thin layer (approx. 1 cm) of muddy sediment on top.
70 BS-17	70°34.0'N 148°50.7'W	11.0	0.0 G 99.4 S 0.6 St 0.0 C	mS-Clean sand, thin (approx. 1 cm) mud layer on top. No organisms.(From a steep ridge.)

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
70 BS-18	70°22.7'N 148°09.8'W	2.0	0.0 G 95.4 S 4.6 St 0.0 C	mS-Fine sand, traces of organic matter.
70 BS-19	70°30.9'N 148°35.4'W	13.0	0.0 G 97.6 S 1.7 St 0.7 C	mS-Clean sand with tin film of mud on top. No pebbles. No shells.
70 BS-20	70°30.5'N 148°37.8'W	10.5	0.0 G 95.5 S 3.8 St 0.7 C	mS-Clean sand with thin film of mud. One small pelecypod (from top of ridge).
70 BS-21	70°31.4'N 148°34.6'W	16.0	0.0 G 34.7 S 44.0 St 21.3 C	sM-Grey mud; mud is soft above with slight stratification, and cohesive and firm below.
70 BS-22	70°36.3'N 148°25.3'W	20.0	5.5 G 36.8 S 32.8 St 24.9 C	
71 AER 2	70°18.3'N 147°00.0'W			sG-Mostly gravel.
71 AER 3	70°34.9'N 150°43.8'W	2.0	0.0 G 82.1 S 14.6 St 3.3 C	mS-Well-packed fine, brownish-grey silty sand with dark particulate organic matter.
71 AER 4	70°33.4 N 150°44.7 W	1.3	0.0 G 70.8 S 29.2 St 0.0 C	mS-Fine brown silty sand. No organic matter visible. Hard bottom.
71 AER 5	70°32.8'N 150°45.5'W	1.5	0.0 G 75.1 S 23.0 St 1.8 C	mS-Fine brownish silty sand. Slightly coarser than last station. Hard packed.
71 AER 6	70°32.4'N 150°46.2'W	1.7	0.0 G 88.8 S 9.1 St 2.0 C	mS
71 AER 7	70°31.9'N 150°47.1'W	1.8	0.0 G 64.2 S 30.0 St 5.8 C	mS-Undulating bottom. Some spots appear to be getting softer. Hard, fine, brownish silty sand. No noticeable organic matter.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AER 8	70°30.9'N 150°48.7'W	1.2	0.0 G 53.1 S 39.5 St 7.4 C	mS-No undulations. A 1-cm thick brownish silty layer overlies a grey sandy silt with much fibrous organic matter.
71 AER 9	70°34.0'N 150°44.0'W	3.6	0.0 G 9.0 S 71.0 St 20.0 C	mS-Brown sandy silt. No fauna or noticeable organic matter.
71 AER 10	70°35.0'N 150°44.0'W	7.0	0.0 G 10.1 S 72.9 St 17.0 C	sM-Brown clayey silt. Some finely disseminated dark organic matter.
71 AER 11	70°35.8'N 150°44.0'W	10.7	0.0 G 9.7 S 64.9 St 25.5 C	sM-Soft brownish silty clay, no noticeable organic matter. No fauna.
71 AER 12	70°29.4'N 150°01.4'W	3.0	0.0 G 1.4 S 77.0St 21.6 C	sM-Dark grey mottled, silty clay. Apparently no stratification.
71 AER 13	70°28.4'N 150°08.8'W	3.0		M-Silty clay. Grey to brown-grey, with burrow mottling. No stratification. Stiff at bottom end of 24-cm core.
71 AER 14	70°34.1'N 149°58.9'W	7.0		sM-Grey silty clay, very stiff at bottom of 20-cm long core. Brownish on top. Perhaps a sandy admixture. No stratification.
71 AER 15	70°19.0'N 148°19.0'W	1.0	0.4 G 59.5 S 22.9 St 17.3 C	mS-2 cm of dark, coarse silty sand overlies a 0.5 cm organic layer with fibrous material, over a dark coarse silty sand layer, over a clay-rich layer.
71 AER 16	70°18.9'N 148°20.7'W	3.0	0.0 G 6.35S 56.6 St 37.1 C	sM-Dark grey silty stiff clay. Softer and brownish in upper 5 cm. A few pebbles (up to 1 cm diam.) No organisms.
71 AER 17	70°20.0'N 148°22.5'W	10.5		M-Dark grey silty clay. No obvious structures, pebbles, or organisms.
71 AER 18	70°20.6'N 148°25.2'W	2.7	4.4 G 10.1 S 71.0 St 14.5 C	gsM-Dark grey, very stiff silty clay. No structure observed.
71 AER 19	70°21.3'N 148°27.1 'W	1.5	0.0 G 37.4 S 58.5 St 4.0 C	sM-Fine to medium-grained brownish silty sand. To 5-cm depth, no stratification. Some worm burrows, and a small clam.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AER 20	70°22.8'N 148°31.0'W	1.7	0.3 G 72.3 S 22.3 St 5.1 C	mS-Medium-grained, grey-brown silty sand with a few granules. Somewhat oxidized on top. No fauna. 100 feet further offshore showed dark, silty-clayey sand.
71 AER 21	70°23.8'N 148°31.2'W	2.6	0.0 G 12.7 S 65.6 St 21.6 C	sM-3-cm of mud with very little sand overlies a 3-cm fibrous, organic-rich layer, over silty sand. Small and large isopod.
71 AER 22	70°24.6'N 148°30.1'W	4.1	0.0 G 39.6 S 47.4 St 12.9 C	sM-Silty or muddy sand. Worms and burrows. No other fauna. Brown on the surface to grey at 8 cm depth.
71 AER 23	70°25.3'N 148°30.1'W	5.5	0.0 G 58.9 S 34.8 St 6.3 C	mS-Medium-grained, brownish grey, muddy sand, 10 to 20 worm tubes protruding per 100 cm^2 x 1 cm area. No structures in 5-cm slab.
71 AER 24	70°26.0'N 148°29.3'W	6.8	0.0 G 49.2 S 43.9 St 6.9 C	SM-Medium-grained, brownish grey silty sand. Many worm tubes protruding from the sediment surface by approx. 1 cm. A small, live clam and a complet shell of another on the surface. No structures, no change in color in 6-8 cm surface layer.
71 AER 25	70°27.0'N 148°29.0'W	8.2	0.0 G 80.2 S 14.6 St 5.3 C	mS-Medium-grained silty sand. No worm tubes.
71 AER 26	70°28.9'N 148°12.6'W	2.4	0.0 G 44.7 S 43.6 St 11.7 C	sM-Material is definitely over-consolidated. In an area where there should be sandy bottom. Relatively little material freshly deposited.
71 AER 27	70°17.9'N 147°49.4'W	1.5		mS-Fine, light grey, silty sand, no structures or organisms.
71 AER 28	70°17.9'N 147°49.0'W	0.9	0.0 G 50.9 S 46.5 St 2.6 C	mS-Slightly sandy gravel (area is 90-95% gravel), driftwood chips. Some laminaria and very fine fibrous algae. Right outside of beach the bottor turns to fine, silty sand.
71 AER 29	70°18.0'N 147°48.6'W	0.9 M	0.0 G 93.8 S 6.2 St 0.0 C	mS-Medium-grained grey sand.
71 AER 30	70°18.1'N 147°47.9'W	2.1	0.0 G 82.1 S 17.2 St 0.8 C	mS-Medium-grained, well sorted sand.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
71 AER 31	70°18.8'N 147°47.5'W	3.3	0.0 G 65.3 S 28.2 St 6.5 C	mS-Medium-grained, grey, slightly silty sand/finer brownish oxidized sand in upper 1.5 cm.
71 AER 32	70°19.9'N 147°5.0'W	4.9	0.0 G 76.5 S 19.7 St 3.8 C	mS-Slightly silty fine-grained, grey sand. No stratification, structures or organisms.
71 AER 33	70°20.6'N 147°40.8'W	6.1	25.0 G 61.2 S 9.3 St 4.5 C	mgS-Medium-grained, slightly silty sand in upper 5 cm, mixed with gravel-size material on bottom. Kelp holdfast with gravel and sand.
71 AER 34	70°21.6'N 147°37.0'W	8.5	0.5 G 32.2 S 48.1 St 19.2 C	sM-2-3 cm of silty clay overlying sandy silt, polychetes, clam shell, worm burrows, some pebbles mixed in - stiff mud below.
71 AER 35	70°23.4'N 147°32.0'W	7.6	0.0 G 32.5 S 51.9 St 15.6 C	sM-Slightly sandy, grey to dark grey mud, soft near surface - stiff below. One bivalve. No pebbles.
71 AER 36	70°20.9'N 147°29.9'W	7.3	0.0 G 39.1 S 40.8 St 20.1 C	sM-Two samples: a) 10 cm diameter, angular rock and smaller rocks with sponges and laminaria. b) Slightly sandy mud with 2-cm sand layer, no pebbles, shells, or organisms.
71 AER 37	70°18.3'N 147°26.1'W	7.0	0.0 G 62.9 S 25.3 St 11.9 C	mS-Grey, soft, sandy mud at surface - very stiff at 10 cm depth. Clam shells (including Astarte) and pebbles.
71 AER 38	70°15.7'N 147°23.0'W	6.1	0.0 G 45.5 S 40.8 St 13.8 C	sM-Slightly sandy grey mud, worms and burrows, clams, no pebbles, rusty color next to burrows and the surface layers. Stiff bottom.
71 AER 39	70°14.0'N 147°21.0'W	3.7	0.0 G 88.2 S 11.8 St 0.0 C	mS-Medium-grained sand.
71 AER 40	70°13.3'N 147°14.2'W	77.0	42.0 G 57.2 S 0.0 St 0.0 C	gS-Mostly light-colored sandy material, beach is of gravel size.
72 AER 70	70°35.15'N 151°57.8'W			M-Dark grey stiff, non-stratified, silty clay. Tiny razor clams and possibly fine shell fragments or forams.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 71	70°26.42'N 148°47.1'W			sG-Sandy gravel. Slightly off station is muddy sand
72 AER 72	70°28.33'N 148°43.4'W			gmS-Muddy sand with some granules.
72 AER 73	70°26.08'N 148°44.0'W	0.5	0.0 G 60.3 S 35.1 St 4.6 C	mS
72 AER 74	70°25.82'N 148°44.5'W	0.75	0.0 G 70.8 S 26.9 St 2.2 C	mS
72 AER 75	70°25.47'N 148°44.6'W	1.5	0.0 G 40.5 S 51.7 St 7.8 C	sM
72 AER 76	70°25.02'N 148°44.7'W	1.0	0.0 G 24.4 S 68.1 St 7.5 C	sM
72 AER 78	70°25.71'N 148°47.7'W	1.5	0.0 G 64.1 S 32.9 St 3.0 C	mS
72 AER 79	70°26.39'N 148°48.4'W			sG-Gravel overlain-by sandy gravel
72 AER 80	70°26.10'N 148°48.7'W	1.5	0.0 G 56.1 S 38.3 St 5.6 C	mS-Dark grey to black silty sand. Few pebbles, some granules, no stratification.
72 AER 81	70°25.82'N 148°49.3'W	1.2	0.0 G 89.0 S 9.4 St 1.6 C	mS-Slightly silty, medium-grained sand, no pebbles, shells, or stratification. Small pockets of fibrous organic matter.
72 AER 82	70°26.23'N 148°49.8'W	1.6	0.0G 83.6 S 14.9 St 1.5 C	mS-Slightly silty, non-stratified, medium-grained sand, several pebbles, no shells, some organic material on surface.
72 AER 83	70°26.42'N 148°49.7'W	2.5		sM-Clayey, sandy silt, much organic matter, some stratification. (In an old strudel hole.)

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 84	70°27.16'N 148°50.4'W	1.5	0.0 G 54.7 S 35.6 St 9.4 C	mS-Brown, very silty fine-grained sand with worm tubes and burrows overlying dark brown to grey slightly silty, fine to medium-grained sand with little organic debris and a few small pebbles
72 AER 85	70°28.19'N 148°50.7'W			sM-Brown to grey, slightly sandy clayey silt with some organic debris. Small amphipod, small clam.
72 AER 86	70°28.63'N 148°51.6'W	1.0	0.0 G 11.1 S 71.4 St 17.5 C	sM-Light brown clayey silt with some organic debris overlying a grey, slightly sandy, clayey silt. Small amphipod. No pebbles. Top layer has very little consolidation compared to lower layer.
72 AER 87	70°28.03'N 148°52.4'W	2.5	0.0 G 22.7 S 64.6 St 12.7 C	sM-2 cm of unconsolidated brown, clayey silt with many worm tubes overlying a more consolidated black grey silty fine-grained sand containing no worm tubes.
72 AER 88	70°27.08'N 148°53.9'W	2.0		S-Clean, fine to medium-grained sand, one pebble. No structures.
72 AER 89	70°26.86'N 148°54.0'W	1.1	0.0 G 95.4 S 3.8 St 0.8 C	mS-Clean, fine to medium-grained sand, one pebble. No sedimentary structures.
72 AER 90	70°27.16'N 148°55.9'W	1.5	0.0 G 86.0 S 14.7 St 0.0 C	mS-Clean, fine-grained sand, two pebbles (one is 1 cm in diam.) No structures. A little organic debris near the bottom of grab sample.
72 AER 91	70°27.46'N 149°00.1'W	2.0	0.0 G 50.1 S 44.1 St 5.8 C	MS-Light brown silty, fine-grained sand with little organic debris overlying grey, very fine-grained sandy silt. No pebbles seen. No stratification beyond color change.
72 AER 92	70°26.38'N 148°59.3'W	1.0	0.0 G 68.1 S 24.5 St 7.4 C	mS-Upper 2 cm is fine to medium-grained, slightly silty brown sand. Lower grey material has large pockets of organic material. No fauna. No stratification.
72 AER 93	70°27.10'N 148°47.7'W	6.0		gM-Much organic matter, tundra debris (?). Some pebbles, sticks and wood, and also some rather stiff, grey, clayey silt. (From a 6- m channel bottom.)
72 AER 94	70°25.93'N 148°40.0'W	1.8		gmS-Dark grey, fine-grained, silty sand with some pebbles (one 0.5 cm diam.). Some grasses and small amphipods. No structures or stratification

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72 AER 95	70°26.19'N 148°39.7'W	3.6		sM-Slightly sandy clayey silt. Bownish clayey silt on top.
72 AER 96	70°26.49'N 148°39.7'W	4.2		gS-Gravelly sand, no mud fraction. No shells (on a ridge that is about 1 m high).
72 AER 97	70°26.87'N 148°39.1'W	6.2		gM-Dark grey, stiff, silty clay, brownish on top. A considerable amount of pebbles.
72 AER 98	70°26.72'N 148°41.9'W	4.0		mgS-Gravelly, shelly sand, with a brownish layer of ooze on top.
72 AER 99	70°26.45'N 148°43.8'W	2.0		sM-Brown, sandy silt overlying grey sandy silt. Some organic debris. One pebble.
72 AER 100	70°27.10'N 148°43.7'W	3.8		M-Organic-rich, fibrous matter, 8 cm thick, with a layer of brown silty clay on top and in the middle.
72 AER 101	70°27.72'N 148°43.4'W	4.3		G-Clean beach gravel (on a 1-m topographic high).
72 AER 102	70°27.80'N 148°43.4'W	5.0		mS-Medium to coarse-grained sand with a mud layer on top.
72 AER 103	70°26.95'N 148°44.7'W			S-Brown, fine to medium-grained, clean sand with a small pea-size gravel layer at the bottom.
72 AER 104	70°28.22'N 148°43.2'W	7.5		mS-Brownish, soft, muddy sand with the typical ooze layer on top.
72 AER 105	70°28.63'N 144°43.2W	5.5		S-Clean, well sorted, coarse sand. Minor amount of small shell debris. No mud. No pebbles.
72 SER 106	70°29.03'N 144°43.0'W	10.5		M-Clayey silt, brownish on top, becoming darker to black at 10 cm, overlying muddy sand.
72 AER 107	70°28.40'N 148°46.0'W	6.0		M-4-5 cm of clayey silt overlying muddy sand.
72 AER 108	70°28.22'N 148°47.0'W	4.5		M-7 cm of clayey silt overlying muddy sand.
72 AER 109	70°27.79'N 148°46.3'W	4.0		M-7 cm of light brown clayey silt overlying light brown organic-rich medium-grained sand.
72 AER 110	70°31.30'N 149°08.9'W	3.4		gS-Medium-grained, clean sand with a few pebbles.
72 AER 111	70°31.87'N 149°08.0'W	9.5		M-3 cm of clayey silt, overlying sandy silt, overlying coarse sand and gravel.
72 AER 112	70°32.25'N 149°06.1'W	11.2		gS-Coarse-grained sand, a few pebbles.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 113	70°32.97'N 149°04.6'W	13.0		gmS-Slightly silty coarse sand with approx. 3% gravel.
72 AER 114	70°33.29'N 149°03.7'W	10.0		mS-Coarse-grained sand, slightly muddy
72 AER 115	70°34.95'N 149°00.2'W	10.0		S-Coarse-grained sand.
72 AER 116	70°33.40'N 149°11.3'W	6.5		S-Well sorted coarse sand (on ridge).
72 AER 117	70°33.25'N 149°10.7'W	6.0		S-Well sorted coarse sand (on ridge).
72 AER 118	70°33.57'N 149°11.6'W	12.0		S-Well sorted sand (trough outside of first ridge).
72 AER 119	70°34.30'N 149°12.2'W	9.5		S-Well sorted medium-grained sand (second ridge out
72 AER 120	70°33.50'N 149°27.2'W	4.5		gS-Medium-grained sand with several pebbles and some small clam fragments near the bottom (ridge near shore).
72 AER 121	70°33.50'N 149°27.2'W	5.8		sM-4 cm of sandy, soft mud. Muddy sand below. No pebbles. (In a trough between ridges.)
72 AER 122	70°33.72'N 149°27.3'W	9.0		M-Clean gravel with some shells on bottom, overlai by silty sand, which in turn is overlain by 3-4 of soft brown mud. Second sample of well-consolidated black silt which appears to be laminated, parting along planes. Apparently no fossils.
72 AER 123	70°33.65'N 149°27.4'W	7.0		sM-Silty sand overlain by 3 cm of brown, soft, sand mud.
72 AER 124	70°34.40'N 149°26.8'W	11.0		M-Fine mud, somewhat stiff. Soft mud on top.
72 AER 125	70°34.75'N 149°26.4'W	12.5		sM-Fine sandy silt. Soft mud on top.
72 AER 126	70°35.65'N 149°25.8'W	14.0		mS-4 cm of brown, clayey silt, overlying 3 cm brown to grey silty medium-grained sand, 6 cm light grey, clayey silt. A bottom layer of silty very fine-grained grey sand.
72 AER 127	70°33.50'N 149°27.4'W	5.0		M-Well consolidated silt, dark grey and brown mottled.
72 AER 128	70°28.10'N 148°44.2'W	5.5		gM-Highly consolidated black silt with gravel apparently on top. No real evidence of gravel in the silt.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 129	70°29.40'N 148°20.3'W			M-Black consolidated clay with a few pebbles on the bottom. Brown transient layer on top.
72 AER 130	70°29.40'N 148°20.3'W			M-Mud layer on top. Coarse-grained sand layer over gravel.
72 AER 131	70°28.90'N 148°19.2'W			gS-Coarse-grained sand with some gravel.
72 AER 134	70°31.95'N 148°12.8'W	17.0		M-Brown clayey silt, overlying 5 cm grey clayey silt, overlying slightly silty, well sorted, medium-grained sand.
72 AER 135	70°31.95'N 148°10.3'W			M-1.5 cm of a thin mud layer on top of a slightly pebbly sand (on a ridge).
72 AER 136	70°30.40'N 148°02.8'W			M-Small amount of brown mud overlying medium to coarse-grained sandy gravel with some fine sand. Segregation by pebble size yields stratification similar to barrier islands.
72 AER 137	70°29.90'N 148°00.4'W			gmS-Slightly gravelly, muddy sand. Pebbles less than 1.5 cm diameter. Some pebbles on the muddy surface as well as in the sand portion.
72 AER 138	70°31.00'N 147°49.1'W	19.5		sM-4 cm slightly sandy silt overlying a highly consolidated grey clayey silt. A few benthic organisms (worm tube, amphipod) in brown silt. (On a small knoll.)
72 AER 139	70°30.75'N 147°50.5'W	20.0		M-A brown silty thin layer overlying gravelly silty sand.
72 AER 140	70°30.47'N 147°52.5'W	18.0		gsM-Dark grey, pebbly, sandy silt. No stratification.
72 AER 141	70°30.00'N 147°55.6'W	8.0		S-Medium-grained clean sand, no pebbles, no stratification, no shells.
72 AER 142	70°29.90'N 147°56.1'W	11.0		gS-Clean, coarse-grained sand with a few pebbles and granules.
72 AER 143	70°29.82'N 147°56.8'W	5.5		gmS-10 cm of slightly silty coarse-grained sand with some granules and large pebbles.
72 AER 144	70°26.20'N 147°51.4'W			S-Medium-grained sand.
72 AER 145	70°23.70'N 147°30.8'W			gS-Coarse-grained sand with gravel overlying black, highly consolidated silt.
72 AER 146	70°22.42'N 147°44.2'W			mS-Silty sand with some shells and a few pebbles.
72 AER 147	70°21.55'N 147°41.8'W	6.0		mS-Medium-grained slightly silty sand with some shells.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 148	70°20.10'N 147°37.6'W	6.0		gmS-Rocks with coralline algae, kelp, sponges and very muddy sand with some pebbles and angular material.
72 AER 149	70°18.95'N 147°33.4'W	5.8		gmS-Very silty, medium-coarse grained sand with abundant, whole, large clam shells and pebbles.
72 AER 150	70°18.20'N 147°29.8'W	6.5		sM-Sandy silt - upper brown layer grading to grey - slightly more consolidated silty sand below.
72 AER 151	70°16.70'N 147°24.3'W	6.2		S-Fine, well sorted sand, some small shell fragments a large isopod, no mud layer on surface. No pebbles or stratification.
72 AER 152	70°15.65'N 147°32.8'W	6.0		sM-Surface of sandy silt, silt below.
72 AER 153	70°15.10'N 147°39.5'W	7.0		gS-Coarse-grained sand with small to medium-sized pebbles.
72 AER 154	70°27.00'N 148°43.5'W			M-Black, highly consolidated silt. There may be some sand.
72 AER 155	70°29.80'N 149°08.5'W			G-Pebbles from bottom of Simpson Lagoon, with hydroids attached to all but one.
72 AER 156	70°20.20'N 147°37.5'W	6.5		G-Quartzite cobbles, gneissic granite, meta sandstone - many rocks and rock fragments.
72 AER 157	70°19.40'N 147°38.0'W			G-Rock chips, 1/2 of rounded, 1/2 of angular rocks, ranging from 20-40 cm in size.
72 AER 158	70°21.70'N 147°34.2'W	7.0		G-Rocks, shells, and algae.
72 AER 159	70°26.42'N 148°47.1'W	2.5		Tundra block taken from upper tundra section in strudel.
72 AER 160	70°26.42'N 148°47.0'W	6.2		Upper lagoonal section in strudel.
72 AER 161	70°26.42'N 148°47.1'W			M-Highly consolidated sediments from walls of channel (taken in channel off of spit).
72 AER 162	70°26.42'N 148°47.1'W			M-Dark brown silt (from below lowermost tundra).
72 AER 163	70°30.60'N 148°42.7'W			M-The bottom is well packed sand, with a thin layer on top, mud and ooze, about 3 cm thick.
72 AER 164	70°26.42'N 148°47.1'W			gS-Gravel on bottom of strudel. Uppermost sand layer overlies layers of brown silty sand, and black sandy silt.
72 AER 165	70°30.25'N 148°19.2'W			sM-Taken from outcrop. Consolidated sandy silt, brown to grey, with burrows, incorporated shell fragments and a few pebbles.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 166	70°26.57'N 148°34.3'W	7.0		sM-At 3-4 cm below sea floor, sandy silt.
72 AER 167	70°25.92'N 148°34.5'W	5.5		M-At 4-5 cm below sea floor, medium-grained, silty sand. Overlain by brownish fine mud.
72 AER 168	70°25.32'N 148°34.6'W	3.5		mS-At 4-5 cm below sea floor, medium-grained silty sand.
72 AER 169	70°33.90'N 148°51.2'W			G-Gravel sample, lithologically similar to Reindeer, little balck chert. A granite angular cobble.
72 AER 170	70°34.39'N 148°50.5'W			mS-Snail, pectin, and small clams. Silty sand bottom with many organisms sticking out of surface. Patches in which gravel was 10 cm below surface, other areas just well-packed sand. At 20 cm depth in one area there is fine to medium-grained grey sand.
72 AER 171	70°34.20'N 148°50.6'W	14.0		S-All clean, brown, well sorted medium-grained sand 300 m seaward is black mud with some pebbles.
72 AER 172	70°36.60'N 148°51.4'N	16.5		msG-First grab sample: Few pebbles and worm tubes. Second grab sample: Dark grey silty sandy gravel. Well rounded, fairly large pebbles. Absence of black chert.
72 AER 173	70°32.20'N 149°18.1'W			sM-Sandy silt on very silty sand. Light grey and massive. Prominent parting from just below tundra horizon. (Taken from bluff on Bertoncini Island, north side.)
72 AER 174	70°34.22'N 149°03.8'W	14.0		M-Light brown, unconsolidated silty clay overlying dark grey, highly consolidated silty clay. Few pebbles (0.5 cm diam.) one amphipod, two small worms. (In basin between 2 ridges.)
72 AER 175	70°34.32'N 149°04.2'W	12.0		S-Well sorted, coarse-grained sand.(Inside of ridge.)
72 AER 176	70°34.27'N 149°04.3'W	13.0		(Inside of ridge.)
72 AER 177	70°34.37'N 149°04.3'W	10.0		S-Coarse-grained sand (lee side of ridge).
72 AER 178	70°34.40'N 149°03.8'W	8.0		S-Medium-grained, well sorted sand (on ridge crest).
72 AER 179	70°34.52'N 149°03.8'W	11.0		S-Medium-grained, well sorted sand (seaward side of ridge).

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 180	70°34.72'N 149°03.8'W	14.0		S-Medium-grained, well sorted sand in upper 5 cm, silty sand below. Some granules and some shells (seaward of ridge).
72 AER 181	70°35.12'N 149°03.8'W	16.5		gM-Silty clay, some pebbles (seaward of ridge, still on slope).
72 AER 182	70°36.92'N 149°03.8'W	18.5		gmS-Silty sand, 5 cm, overlying clayey silt, with some pebbles and shells.
72 SER 183	70°34.24'N 149°02.8'W	13.2		sM-Sandy mud, stiff, old, dark, with burrows. Upper 2 cm oxidized. Sand bottom covered with 3 cm thick organic ooze layer (taken from outcrop).
72 AER 184	70°34.19'N 149°02.8'W	11.5		sG-Shelly, sandy gravel at 10 cm below bottom (seaward side of ridge).
72 AER 185	70°24.45'N 149°05.2'W	12.5		S-Coarse-grained well sorted sand (lee side of next ridge).
72 AER 186	70°34.55'N 149°05.2'W	11.5		S-Medium-grained, well sorted sand.
72 AER 187	70°34.72'N 149°05.2'W	14.0		mS-Medium-grained sand, some shells, a little silt in upper layer.
72 AER 188	70°24.90'N 148°30.8'W	3.0		sM-Black consolidated sandy silt.(taken from side of strudel).
72 AER 189	70°35.30'N 150°57.2'W	8.5	0.0 G 21.7 S 67.1 St 11.2 C	sM-Silty, light grey, very fine-grained sand with thin brown transient layer on top.
72 AER 190	70°34.60'N 151°11.3'W	8.0	0.0 G 7.1 S 73.4 St 19.5 C	sM-Slightly sandy, soft clayey silt. No structures No pebbles, no organisms observed.
72 AER 191	70°33.75'N 151°26.6'W	4.5	0.0 G 71.3 S 20.1 St 8.6 C	mS-On ridge. Brown, soft, very fine, slightly silty sand, few shells, few worm tubes.
72 AER 192	70°33.65'N 151°30.0'W	2.0	0.0 G 100.0 S 0.0 St 0.0 C	S-Fine to medium-grained, very well sorted buff colored sand. No shells, pebbles or structures.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 193	70°36.20'N 151°31.8'W	5.2	0.0 G 42.0 S 48.9 St 9.2 C	sM-Fine, sandy silt. Few small shells and worm tubes. A slightly more sandy layer 5 cm thick, at 5 cm depth (top of ridge).
72 AER 194	70°36.20'N 151°35.2	4.5	0.0 G 99.0 S 1.0 St 0.0 C	S-Very well sorted medium-grained sand, shells, no structures (ridge crest).
72 AER 195	70°36.20'N 151°35.7'W	5.4	0.0 G 24.7 S 48.2 St 27.1 C	sM-Slightly sandy, light grey, unconsolidated silt. The 6 cm thick sample apparently represents the transient layer. Near bottom there is a slight increase in the amount of medium-grained sand. No shells, structures, or fauna.
72 AER 196	70°35.65'N 151°43.6'W	3.0	1.3 G 85.7 S 13.0 St 0.0 C	gmS-Clean, well-sorted, fine-grained sand, with very small clam shells and some organic debris.
72 AER 197	70°38.90'N 151°42.8'W	5.2	0.0 G 77.7 S 19.5 St 2.8 C	mS-Slightly silty, fine-grained sand with many worm tubes projecting from top. Slight layering effect from overlying clean sand and underlying slightly silty sand.
72 AER 198	70°40.89'N 151°43.2'W	7.2	0.0G 53.0 S 31.7 St 15.4 C	mS-Light brown, silty medium-grained sand (4 cm thick) overlying slightly silty dark grey clay which is not highly consolidated.
72 AER 199	70°44.40'N 151°43.4'W	10.0	0.0 G 26.2 S 53.0 St 20.8 C	sM-Brown sandy transient silt layer overlying dark grey slightly clayey soft silt. No organisms.
72 AER 200	70°43.70'N 151°53.8'W	12.5	0.0 G 42.6 S 27.3 St 30.1 C	mS-Sandy silt transient layer 6-8 cm thick overlying silty sand with large amount of broken shells. Shells were not present in upper layer. 1 large pebble (4 cm).
72 AER 201	70°34.95'N 152°00.4'W	1.8		gmS-Brown-grey, medium to coarse-grained silty sand with pebbles and some organic material.
72 AER 202	70°35.80'N 152°08.2'W	2.0	0.0 G 56.3 S 29.5 St 14.1 C	mS-Silty, medium-grained sand. Some organic matter and wood pieces. A few shell fragments. No pebbles, or structures.
72 AER 203	70°37.90'N 152°04.8'W	2.6	0.0 G 22.4 S 67.1 St 10.5 C	sM-Muddy, fine-grained sand with no layering. Some organic debris, mainly plant fragments.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AER 204	70°39.49'N 152°02.2'W	3.2	0.0 G 39.4 S 49.2 St 11.4 C	sM-Silty sand or sandy silt. Quite a bit of of fine to medium-grained sand leaked from sampler prior to opening. A few worm tubes. No structures, no shells.
72 AER 205	70°43.75'N 151°58.0'W	1.5	0.0 G 94.9 S 5.1 St 0.0 C	mS-Clean, fine-grained sand with some small black bits of organic material (lee side of Pacific Shoal).
72 AER 206	70°41.50'N 151°59.3'W	1.2	0.0 G 98.6 S 1.4 St 0.0 C	S-Well sorted, medium-grained sand. No shell fragments, no pebbles (crest of Pacific Shoal).
72 AER 207	70°46.75'N 152°03.1'W	5.3	0.0 G 23.2 S 54.3 St 22.5 C	sM-Silty, fine-grained sand with some worm tubes and a few granules.
72 AER 208	70°41.40'N 151°24.3'W	12.0	0.0 G 14.8 S 63.1 St 22.1 C	sM-Clayey silt overlying sandy silt with some shells.
72 AER 209	70°38.80'N 150°03.5'W	12.0	0.0 G 45.5 S 24.9 St 29.6 C	sM-Clayey silt overlying sandy silt with some shells.
72 AER 210	70°36.50'N 150°50.7'W	10.5	0.0 G 14.5 S 59.2 St 26.3 C	sM-Very soft clayey, sandy silt, no shells, no pebbles. Perhaps all from transient layer.
72 AER 211	70°35.20'N 150°40.2'W	3.0	0.0 G 44.9 S 47.5 St 7.6 C	sM-Recent fine-grained silty sand with some worms. Homogenous and soft. No shells or structures.
72 ABP 13	70°13.7'N 145°30.0'W	25	0.0 G 45.0 S 29.0 St 25.5 C	sM-High concentration of tube worms of two different types. Surface layer of oozey plastic mud and sand overlies a stiffer mud with some gravel (pea-size or smaller). Bottom layer has no gravel but a gritty fine sand.
72 ABP 14	70°24.0'N 145°38.0'W	37	0.0 G 37.0 S 19.5 St 43.2 C	gsM-Surface is fine to medium sandy ooze with large rocks (to 20 cm diam.). Smaller gravel also present (poorly sorted). Starfish and clam shells. Worms and tubes absent. Subsurface is fine-medium-grained sand. Gravel also prsent but not as large as surface layer. Worms and many black oxidized lines.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 ABP 25	70°21.4'N 146°36.0'W	26		sM- Oozey fine-grained sand. Subsurface has very stiff, fine to coarse, jagged in the subsurface.
72 ABP 26	70°19.6'N 146°30.0'W	17		sM-A stiff, sticky, dense, grey clay with no pebbles.
72 ABP 27	70°29.4'N 147°38.0'W	23	0.0 G 23.0 S 77.0 St and C	sM-Layer of mud on top. Gravel layer, sand layer below this, and mud layer below sand.
72 ABP 28	70°31.4'N 147°33.0'W	26		sM-Surface very fine-medium sand silt. Subsurface has very fine to medium-grained silt, much stiffer. Rocks in subsurface layer larger than 1 cm diam.
72 ABP40	70°42.0'N 148°26.0'W	27		mS-Surface is fine to medium-grained silt. Subsurface is silt and stiff mud with 2-cm size gravel.
72 ABP 41	70°35.0'N 148°41.0'W	19		M-, 3-8 cm fine mud on top. Clean, reduced sand, with H_2S odor. Solid sand down below 8 cm.
72 ABP 46	70°42.0'N 150°07.0'W	18		mS-3 layers of sand. First layer has fine to medium sand with very little mud. Second layer has dark grey to black sand with many organics. Third layer is lighter grey-brown. Both sublayers were fine to medium-grained sand interspersed with pea gravel. Tube worms and clam shells in surface layer.
72 ABP 47	70°50.0'N 150°10.0'W	24		M-Fine hydroplastic mud surface grading into very sticky lower layer with a very fine to fine clean, dark sand at~10 cm. No pebbles, a few broken shells. Tube worms are only fauna.
72 ABP 60	70°52.7'N 151°00'W	19		M-Brown mud layer 0-5 cm, mud with sand pockets below. Four pebbles of 3 cm diameter. The lower sandy mud had black layers and a H_2S smell. Clam shells, barnacle plates, worms, bryozoan.
72 AJT 3	70°29.0'N 149°03.3'W	3.0		S-Fine-grained sand in top 2 cm. Below this is grey clay.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AJT 4	70°29.5'N 148°07.6'W	2.4		sM-Silty and slightly sandy clay, with many worms and small pelecypods. Uniform.
72 AJT 5	70°27.2'N 148°10.3'W	7.3		mS-Silt or fine-grained sand, dark greenish grey. Unconsolidated.
72 AJT 6	70°25.2'N 148°10.2'W	5.5		mS-Silt or very fine-grained sand. Dark greenish grey. Unconsolidated.
72 AJT 7	70°22.8'N 148°10.8'W	2.4		mS-Silt or very fine-grained sand. Finer and seems to have more clay than stations 5 and 6, but otherwise appears to be the same.
72 AJT 8	70°21.4'N 147°56.7'W	3.7	0.0 G 11.0 S 67.6 St 21.4 C	sM-Silty clay, medium grey, with high H_2O content
72 AJT 9	70°23.8'N 147°53.3'W	6.0		mS-Silt or very fine-grained sand.
72 AJT 12	70°30.0'N 147°45.0'W	17.0		gsM-Gravelly and sandy clay.
72 AJT 13	70°31.3'N 148°04.2'W	16.0		gsM-Gravel, sand, silt, and clay.
72 AJT 15	70°18.1'N 147°37.0'W	6.0		mS-Sand, silt, clay - primarily sand.
72 AJT 16	70°14.7'N 147°41.8'W	2.7	0.0 G 66.0 S 29.2 St 5.2 C	mS-Slightly clayey silt.
72 AJT 17	70°13.6'N 147°00.0'W	6.0		mS-Slightly clayey silt, with a piece of gravel.
72 AJT 18	70°20.3'N 147°04.1'W	13.0	0.0 G 16.0 S 50.5 St 33.5 C	sM-Soft unconsolidated greenish-grey clay with lumps of grey clay.
72 AJT 19	70°16.3'N 146°45.5'W	8.0		mS-Medium sand, poorly sorted.
72 AJT 20	70°16.0'N 146°30.0'W	13.4	0.0 G 33.0 S 48.0 St 18.6 C	gsM-2 cm silty sand with gravel, poorly sorted, not at all indurated. OVerlies smooth, fairly well indurated and fairly hard uniform grey clay. Clay has black streaks and smells of H_2S.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AJT 21	70°14.4'N 146°15.0'W	13.4	0.0 G 22.0 S 78.0 St and C	mS-2 cm of dark olive green watery clay over unindurated fine impure sand.
72 AJT 22	70°11.4'N 146°15.0'W	3.0		M-Unindurated uniform silt.
72 AJT 23	70°09.8'N 146°00.9'W	2.0	0.0 G 89.0 S 10.5 St 0.0 C	mS-Totally unconsolidated silt.
72 AJT 24	70°12 145°55.0'W	12.0	0.0 G 87.0 S 9.8 St 3.5 C	mS-Uniform unindurated, very fine-grained sand, appears somewhat poorly sorted.
72 AJT 25	70°10.1'N 145°45.0'W	12.0		gsM-Gravelly plastic grey hard clay. Amount of gravel decreases down through top few cm. Top 2 cm is soft, watery, and slightly sandy. Bottom 4-6 cm is hard clay without much gravel.
72 AJT 26	70°12.2'N 146°30.0'W	4.0		M- Silt.
72 AJT 27	70°25.2'N 147°31.0'W	12.8		gsM-A sand-silt-clay mixture. Gravel up to 15 cm maximum dimension with attached organisms.
72 AJT 28	70°27.3'N 147°31.0'W	19.0		gmS-Gravelly, clayey, unconsolidated sand.
72 AJT 29	70°25.3'N 147°17.5'W	18.0		gsM-Gravelly sand, silt, and clay.
72 AJT 30	70°45.0'N 150°00.0'W	20.0	0.0 G 10.6 S 89.0 St and C	M-2 cm of olive-grey brown soupy silt over 14 cm of clay with black streaks and H_2S smell.
72 AJT 32	70°37.2'N 149°34.0'W	16.0		M-Unconsolidated offshore silt (moderate olive grey).
72 AJT 33	70°40.5'N 149°33.0'W	21.0	0.0 G 11.0 S 41.1 St 48.2 C	sM-Grey, smooth, fairly hard, sticky clay with dark streaks of medium, dark grey. No H_2S smell.
72 AJT 34	70°43.3'N 149°32.2'W	20.0		M-Medium olive grey unconsolidated silt.
72 AJT 35	70°45.8'N 149°32.0'W	21.0		sM-Dark grey very fine-grained sandy clay, seems like the grey offshore clay with a sand admixture. Not very indurated.

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72 AJT 36	70°31.7'N 150°15.0'W	3.7		M- 0.5 cm of yellowish brown unconsolidated clay over a clayey, silty, very fine-grained sand, greyish black, speckled in appearance.
72 AJT 37	70°33.0'N 150°00.5'W	4.9		M-Olive grey silty clay, unconsolidated, watery.
72 AJT 38	70°37.5'N 150°00.0'W	14.0		sM-Olive grey fine-grained sand with clay. The surface cm is strongly clayey and less sandy.
72 AJT 39	70°41.0'N 150°00.0W	16.0		sM-Dark grey smooth, grey clay, soft and watery, with some fine sand in the top 2-3 cm.
72 AJT 40	70°34.0'N 150°30.0'W	6.0		M-Smooth, uniform, semi-indurated clay. The oxidized and more watery surface layer (3-4 cm thick) olive grey.
72 AJT 41	70°38.5'N 150°30.0'W	14.0		M-Olive grey clayey silt, most clay is in the top 2 cm (watery).
72 AJT 42	70°42.5'N 150°30.0'W	18.0		M-Olive grey slightly silty clay. No vertical change in lithology.
72 AJT 43	70°40.0'N 151°00.0'W	14.0	0.0 G 76.0 S 28.0 St and C	mS-Moderate olive grey silt, slightly clayey, unconsolidated. No vertical variation noted.
72 AJT 44	70°45.0'N 151°30.0'W	12.0	0.0 G 26.0 S 74.0 St and C	sM-A very silty clay. Top 3 cm is watery, soft, and brownish.
72 AJT 45	70°48.0'N 152°00.0'W	7.0	0.0 G 38.0 S 48.2 St 13.3 C	sM-Silt.
72 AJT 46	70°42.0'N 150°15.0'W	19.0		M- Uniform unconsolidated silt (no clay). No vertical variation.
72 AJT 47	70°38.0'N 150°15.0'W	14.0		M-Top 1 cm is olive grey soupy clay, very liquid. Lower 1-5 cm is speckled silt, only very slightly clayey.
72 AJT 48	70°35.0'N 150°15.0'W	10.0		M-Olive grey silt, only slightly clayey. No vertical variation.

Vibracores 1976 and 1977

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Description of Surface Layer g,G = gravel s,S = Sand m,M = clay and silt (mud)
V-1	70°19.0'N 148°22.0'W	3		M-Medium grey silty clay to clayey silt.
V-2	70°22.3'N 148°28.4'W	1.7		sM-Irregular layers or pockets of clean oxidized fine sand. Sandy mud interbedded with sand layer
V-3	70°24.0'N 148°33.2'W	1.5		S-Medium to fine, partly oxidized sand, upper 10 cm homogenous.
V-4	70°27.3'N 148°28.2'W	6.5		mS-Grey, slightly muddy medium to fine sand, homogenous to mottled.
V-5	70°28.9'N 148°24.2'W	2.5		S-Light grey sand, fine and clean down to around 30 cm.
V-6	70°29.4'N 148°21.1'W	4.0		S-Light grey, fine, clean, homogenous sand.
V-7	70°30.5'N 148°21.6'W	11.0		mS-Clean, grey, medium-grained sand with only traces of bedding. Dark grey silty clay lumps at the surface.
V-8	70°29.8'N 148°20.8'W	8.0		S-Medium to coarse sand with a few scattered granules and small shell fragments, structureless gradually fining down to fine-medium sand.
V-9	70°20.1'N 147°31.1'W	6.5		gS-Dark grey, medium sand, angular, structureless, with a few granules and a small pebble. Two shells at surface, one live Astarte.
V-10 B	70°17.1'N 147°44.3'W	27.0		sM- Generally dark, reduced sandy mud with small olive oxidized zones at surface.
V-11	70°17.7'N 147°47.0'W	1.0		sM-Brownish grey sandy mud.
V-12	70°24.1'N 148°18.5'W	3.0		S-Medium sand, partly oxidized in upper 15 cm. Shells at 8 cm.
V-13 B	70°44.8'N 150°28.1'W	19.0		mS-Interspersed pockets of grey sandy mud and oxidized fine to medium sand.
V-14	70°41.5'N 150°27.2'W	1.5		sM- Soft, brownish grey homogenous silty clay, sandy in upper 5 cm. Several small, irregular sand pockets from 5-10 cm down in core.
V-15	70°37.0'N 150°27.0'W	12.4		mS-Grey, muddy, medium-grained sand, grading at approx. 2 cm into oxidized clean, medium-grained sand.

Vibracores 1976 and 1977

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Description of Surface Layer g,G = gravel s,S = Sand m,M = clay and silt (mud)
V-16	70°36.3'N 150°28.2'W	11.5		M-Trace of horizontal bedding, characterized by dark and light banding, and discontinuous silty laminae and pockets. No organic-rich layers.
V-17	70°34.0'N 150°28.2'W	8.5		M-Very soft and wet in upper 5 cm. Grey, homogenous clayey silt.
V-18	70°33.2'N 150°27.9'W	3.3		sM-Grey silty clay with interbedded lenses of oxidized medium to fine-grained sand. Clay contains lenses of organic matter. Bedding plane lamination and fining upwards in sands.
V-19	70°32.8'N 150°28.1'W	2.0		mS-Medium-grained, oxidized, clean sand grading downward into fine sand with some silt. There appears to be a large, irregular burrow with smaller burrows adjacent.
V-20	70°31.4'N 150°27.5'W	1.5		S-Dark brown, possible burrows. Clean fine sand, light-brown, oxidized in lower 5 cm, mottled in upper half.
V-21	70°33.8'N 151°01.0'W	4.0		mS-0.5 cm of mud. Small clam and a small razor clam. Slightly muddy, fine sand, bedding planes often marked by coal particles.
V-22	70°32.5'N 150°59.6'W	0.6		mS-Very fine sand/silt layers. Fine, brownish, well-sorted sand with slightly undulating, horizontal layering.
V-23	70°29.5'N 150°59.5'W	1.0		mS-Top 1 cm of fine/medium-grained oxidized sand. Homogenous, brownish silt, possibly some bedding
V-24	70°33.2'N 149°11.2'W	7.5		S-Slightly darker, fine to medium sand. No pebbles, no shells.
V-25	70°18.85'N 148°21.9'W	2.3		gsM-Thinly laminated sandy silt with small pockets of sand, with pebbles up to 15 mm at 8 cm.
V-26	70°19.5'N 148°26.1'W	1.5		gsM-Slightly sandy silt with horizontal bedding, small pockets of ripple structures, few scattered small pebbles and fragile shell fragments and intact shells, traces of organic matter.
V-27	70°25.77'N 148°48.3'W	1.3		mS-Muddy fine sand, disrupted by burrowing in upper 3 cm and at 6-24 cm (Polychaete?). Noted live worms (to 16 cm) when core was cut.
V-28	70°25.28'N 148°41.9'W	1.0		S-Clean, fine sand.

Vibracores 1976 and 1977

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Description of Surface Layer g,G = gravel s,S = Sand m,M = clay and silt (mud)
V-29	70°24.03'N 148°00.2'W	5.5		gS-Clean, medium-grained pebbly sand with few shells. No structure, sharp irregularities.
V-30	70°22.1'N 148°05.9'W	1.5		S-Clean, fine sand, fine cross-bedding in upper 10 cm Rather well-preserved except for some burrowing structures. Upper 10 cm has very small shells.
V-31	70°19.9'N 147°54.05'W	1.3		mS-Surface or near-surface organic layer. Fine sand with ill-defined horizontal layers.
V-34	70°23.74'N 147°28.5'W	5.0		gS-Coarse pebbly sand showing trace of bedding throughout, granules to 7 mm. Sand is sub-rounded.
V-35	70°29.1'N 147°36.8'W	19.0		msG-Hash of poorly sorted mixture of coarse, highly angular to rounded gravel to clay. Very highly compacted material.
V-37	70°29.25'N 148°09'W	10.0		gS-Well-sorted clean, medium to fine sand; with scattered, well-rounded granules and small pebbles-mostly in the upper 4 cm.
V-38	70°29.25'N 148°17.7'W	4.6		gS-Medium-grained sand with 50% granules and pebbles, well-rounded, a few shell fragments. No internal structures.
V-39	70°28.68'N 148°21.5'W	4.5		gmS-Stiff grey muddy fine sand with a few scattered granules, intensely bioturbated, polychaetes, lacking primary bedding structures.
V-40	70°28.9'N 148°21.6'W	1.0		gS-Medium to coarse-grained sand with a few scattered granules.
V-41	70°28.7'N 148°18.1'W	2.45		gS-Medium to coarse, clean, pebbly sand, homogenous. Largest clast 8 mm. Rare shell fragments.
V-42	70°29.54'N 148°20.8'W	5.3		S-Clean, light brown-grey medium, well sorted sand totally disrupted.
V-43	70°32.27'N 148°21.7'W	12.7		gS-Clean, fine sand with scattered granules up to 6 mm - thin 1.5 mm worm tubes (Polychaete).
V-44	70°34.05'N 149°0.65'W	12.75		S-Fine to medium clean sand with faint traces of primary ripple structures in upper 15 cm.
V-45	70°34.0'N 149°0.65'W	6.7		S-Very clean medium to fine sand throughout entire core, several very small fragile shell fragments, not a single pebble, granule, mud lump or organic matter.

Vibracores 1976 and 1977

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Description of Surface Layer g,G = gravel s,S = Sand m,M = clay and silt (mud)
V-46	70°33.75'N 149°01.3'W	13.8		gM-Slightly pebbly, cohesive clay, clasts from 1 mm granules to 15 mm, larger clasts rounded and smaller ones anuglar. Pockets of sand in upper 8 cm.
V-47	70°27.7'N 148°57'W	2.0		gmS-Very fine laminated silty sand alternating with 2-4 cm unit of fine to medium silty sand. A few scattered pebbles up to 15 mm. Worm tubes extend 7-8 cm.
V-48	70°30.42'N 149°14.1'W	2.5		gmS-Silty medium sand, coarse bedding in upper 15 cm. Polychaete worm tubes in upper 8 cm. Scattered fibrous organic pieces several pebbles to 8 cm.
V-49	70°32.44'N 149°30.7'W	3.0		sM-Sandy mud with ill-defined bedding. Mottled or disturbed. A few sticks and fibrous organic matter, several granule-size clasts. Finely laminated in upper 1 - 2 cm.
V-50	70°30.7'N 149°26.75'W	1.4		gS-Finely-bedded to ripple-bedded, clean, fine sand, a few scattered pebbles up to 8 cm.
V-51	70°30.4'N 149°56.4'W	2.0		S-Upper 4 cm finely laminated very fine sand.
V-52	70°36.69'N 150°24.8'W	13.0		sM-Surface is slightly sandy clayey mud, this alternates with well laminated clean sand units.
V-53	70°36.69'N 150°24.8'W	13.0		sM-Surface of cohesive slightly sandy clayey silt alternating with muds and cross-bedded clean sand units.
V-54	70°36.69'N 150°24.8'W	13.0		mS-Slightly muddy medium sand, with a few shell fragments and worm tubes.
V-55	70°33.88'N 150°28.0'W	7.0		sM-Light grey clayey silt with 5-6 cm thick fine sand layers interbedded. Sand units have fine bedding to cross bedding structures. Sands in upper part of core have burrows.
V-56	70°32.4'N 150°28.4'W	2.5		S-Surface very fine to fine clean sands with well preserved primary structure.
V-57	70°32.4'N 150°28.4'W	2.0		mS-Surface of very fine to fine clean sands with well preserved primary structure. Contains fibrous organic matter, cyrtodaria fragments and mud balls.
V-58	70°32.4'N 150°28.4'W	2.0		mS-Same as Core V-57.
V-59	70°27.68'N 150°11.7'W	1.3		S-Surface of clean fine cross-bedded sand.

Vitracores 1976 and 1977

Field No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Description of Surface Layer g,G = gravel s,S = Sand m,M = clay and silt (mud)
V-60	70°28.43'N 150°13.1'W	1.0		S-Interbedded sequences of fine to very fine sand at the surface.

Gas Samples - 1978

# 3	70°35.6'N 149°32.8'W			sM-Soft grey surface mud underlain by slightly silty fine sands.
# 4	70°38.1'N 150°31.5'W			mS-Slightly muddy fine sand.

Dive Site No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
72-1	70°35.6'N 149°27.1'W	12		M-Bioturated, soft mud. (Flat bottom.)
76-18	70°33.2'N 149°11.0'W	11.5		mS-Muddy (medium-grained) sand. (seaward foot of major shoal, between gouges.)
72-2	70°33.12'N 149°11.5'W	5.0		S-Clean, medium-grained sand with clam fragments. (Intensely gouged flat bottom on major shoal).
76-5	70°28.4'N 148°47.2'W	4.5		mGS-Undisturbed muddy sand near gouge. Sandy, muddy gravel in a flat bottom near gouge flank.
76-4	70°26.9'N 148°37.5'W	6.4		sGM-Grey, cohesive mud and very stiff, muddy, sandy gravel with some shells. (Flat bottom.)
76-6	70°26.9'N 148°30.5'W	8.5		M-Very soft surficial sediment underlain by fairly stiff layer. (Flat bottom and floor of gouge.)
76-7	70°28.1'N 148°24.0'W	8.5		M-Fairly soft 2.5 cm layer of mud with numerous clams over mud. (Flat bottom, gouge-trough, flank and floor.)
76-3	70°24.2'N 148"31.5'W	3.0		mS-Fine, muddy sand (Flat bottom).
75-1	70°19.8'N 148°23.5'W	2.5		mS-Fine, muddy sand (Flat bottom).
76-2	70°24.0'N 148°17.3'W	3.1		mS-Slightly muddy medium-fine grained sand. (Flat bottom).
76-19	70°24.9'N 148°01.0'W	7.0		mS-Muddy sand. (Rippled flat bottom).
76-8	70°19.5'N 147°51.5'W	2.5		MS-Muddy sand and very stiff mud. (Flat bottom with ripples).
76-9	70°17.2'N 147°42.8'W	3.0		gmS-Muddy sand on a flat bottom ripple field. Angular, pea-size gravel exposed.
76-10	70°12.8'N 147°41.0'W	1.6		MS-Highly muddy, medium-grained sand. (Flat bottom).
76-17	70°23.8'N 147°28.7'W	1.5		mGS-Muddy sand and pea-size gravel on the flat bottom and gouged flank.
76-15	70°18.2'N 147°18.7'W	6.0		gSM-Soft mud in the high ground covered by worm worm tubes. Muddy sand in the depression between worm tube patches. Accumulations of pebbles and shells in small patches with occasional small rounded cobbles.

Dive Site No.	Latitude Longitude	Depth (M)	%Gravel %Sand %Silt %Clay	Sample Description g,G = gravel s,S = Sand m,M = clay and silt (mud)
76-14	70°14.7'N 147°10.5'W	5.5		sM-Sandy mud on a flat bottom.
76-11	70°10.3'N 147°01.0'W	4.5		sM-Sandy mud on a flat bottom with decayed ripple train. Burrowing activity.
76-12	70°10.8'N 146°03.4'W	2.5		sM-Sandy mud. Small scale relief from bioturbation on a slightly undulating bottom.
76AER	70°21.2'N 147°46.3W	7.0		GM-Exposed boulders between 80 and 100 cm. 5 to 6 cm surface of highly bioturbated soft grey mud. Compacted granular material under the mud layer; cobbles could be felt buried within mud. Diverse benthic community.
76AER	70°13.0'N 145°57.0'W	200.0		GMS-Numerous sub-rounded to angular coarse pebbles and cobbles with brown algae and other marine growth. Medium-grained sand. Low-relief ledges of thinly bedded mud.
78AER	70°27.9'N 147°48.7'W			gS-Gravelly sand. 2-3 m undulating relief. Coarse sand in the lows, sandy gravel on the flanks, medium sand on the crests.
72 AER	70°25.4'N 147°47.3'W	7.0		S-Clean, medium-grained sand on the crest of Dinkum Sands. Muddy sand on the slope. Muddy, pebbly on the bottom (7 m).
77AER-31	70°43.1'N 149°24.4'W			gsM-A gravel, sand, and mud mixture.
77AER-32	70°40.5'N 149°15.1'W			gS-Coarse sand with gravel patches.
77AER-33	70°35.0'N 149°07.2'W			gM-Pebbly mud with gravel patches.
77AER-34	70°31.3'N 148°56.8'W			gS-Gravelly sand.

Attachment B

Additional Observations on Geomorphologic Changes in the Arctic Coastal Environment

Erk Reimnitz, Ed Kempema, Robin Ross, and Bob Olson

Effects of island changes on lease sale boundaries

Recent changes in locations and configurations of islands and coastline in the combined Federal/State lease sale area have been reported by numerous workers(Dygas et al., 1972; Wiseman et al., 1973; Short, 1973; Burrell et al., 1974; Reimnitz, 1974; Reimnitz et al., 1977; McDowell and Barnes, 1977; Barnes et al., 1977; Lewellen, 1978; Reimnitz and Kempema, 1978; and Short, 1979). However, the draft EIS for this area which shows the boundaries between State and Federal offshore lands did not take these changes into account. The boundaries were delineated on the basis of charts drafted using 1950 survey data. The one exception is the terminus of the West Dock, a gravel causeway constructed under an emergency permit during the winter 1975/76. The causeway was used as a salient point for drawing boundary arcs with a three-mile radius.

The above problems were pointed out in a letter (together with four maps and illustrations) to BLM. These illustrations are reproduced here as figures 2 through 5 with explanations in the captions, and need no further discussion. The letter also pointed out that we have not seen Dinkum Sands above sea level since 1975. Figure 5 shows the large territory which, by this island's disappearance, may be transferred from State to Federal ownership.

On a less serious note, we pointed out that the geomorphic features in figure 5 are migrating southwestward at an average rate of 11 m/yr, while the mainland shore is retreating at a rate of only 1 to 2 m/yr. A continuation of the present trend would eliminate the lagoons in 1500 to 2000 years.

Changes in land forms of the coastal zone are not only important for legal purposes, but also for several scientific projects working under OCSEAP, as well as to industrial work in the area. For this reason we are adding several illustrations prepared from recent work in the eastern portion of Simpson Lagoon, which should be of use to some colleagues.

Egg Island Channel - The major tidal inlet of Eastern Simpson Lagoon

Changes in the eastern portion of Simpson Lagoon, delineated from overlaying N.O.S. Charts 9472 and 16061, are shown in figure 6. Chart 16061 is an updated version of Chart 9472 (1950 data), and evidently is based on orthophotographic work of June 1970 as well as construction details of the West Dock. The major tidal inlet for this portion of the lagoon lies between Egg Island and the unnamed island to the west, here called Channel Island. Figure 7 shows depths in feet, taken directly from Hydrographic Survey Sheet 7854. The sheet indicates a broad ill-defined tidal inlet with a maximum depth of 9 to 10 feet (3 m). This data, if used today in studies of tidal exchange between the lagoon and the open ocean, would be misleading, as shown by our more recent data.

In the summer of 1972 the R/V Loon of the U.S.G.S. was used in a reconnaissance survey of the inlet, for the purpose of placing a current meter and in connection with diving studies. In this survey the channel axis was marked by four buoys dropped during fathometer traverses at right angles to the channel (lower part of Figure 8). A longitudinal profile of the channel floor was then recorded by running the vessel along the buoys. Navigational control was in reference to the adjoining islands using compass, visual distance estimates, and dead reckoning. The control was therefore poor. But according to this work the channel has a maximum depth of about 8 m, rather than 3 m, and has a very rough longitudinal profile. Also, the channel lies in close proximity to Channel Island, rather than being in the center between the two islands as shown by the published charts. The extremely rough longitudinal profile was studied at that time in a diving traverse along the channel axis, in which we observed vertical ledges cut into peaty, fibrous organic matter. The very rough channel axis can be caused by strudel scour which we studied here during the previous river flooding in early June.

In September of 1978 the R/V Karluk, complete with a precision fathometer and range/range navigation control from Reindeer Island and Cross Island, was used to run a closely spaced survey grid over Egg Island Channel (Figure 9). The depths determined during this survey are given in meters and are contoured in figure 10. The maximum axial depth traversed by the vessel was about 7 m, but we may easily have missed deeper spots. When compared to published data, the narrow, well-defined nature of this channel, lying close to Channel Island, is striking. A fathogram crossing of the tidal inlet from north to south is shown in Figure 11. This traverse crosses a 5.5 m deep strudel scour, which, because of the absence of a flat bottom, appears to be very recent. A study is underway to learn the longevity of such scour craters in different environments. A similar nearby strudel scour was studied in detail in 1972 (Reimnitz et al., 1974). Apparently it has been infilled by sediment since then.

Discussion

The recent rapid changes in coastal morphology raise some important questions. We will consider only several of the many questions that come to mind. Short (1979) pointed out that 55 per cent of the Alaskan and Yukon arctic coast today is characterized by barrier islands and lagoons. Based on our data, we believe that the barrier islands will be plastered against the mainland shore within a geologically short time. Should we assume that the coastal environment as witnessed by us today is in a rapid transitional stage, which will be followed by periods where no lagoons and barrier islands exist? If so, what may be the changing marine or geologic processes that lead to this transition? We could also assume that the present barrier islands, which are migrating landward, will be replaced by new ones formed offshore. If so, the shoals of the stamukhi zone which, as we have discussed in previous reports, are migrating onshore, could be the barrier islands of the future.

In a much shorter time frame of 20 to 25 years, observed changes in specific islands and inlets are striking. We can conclude that the recent trend is for the islands to divide into smaller ones and migrate to the southwest, new entrances to form, and for tidal inlets to deepen.

Figure 4 shows several good examples of island splitting. Reindeer Island consists of two parts with a deepening channel which has been observed since 1971. Argo Island and Cross Island consist of two parts, although Leffingwell and earlier explorers talk of only one island. The long axis of the southern satellite has rotated drastically, suggesting that the island is beginning to migrate independently of the main body. The channel separating the two parts now is 4 m deep as compared to 2 m in 1950. Narwhal Island is now broken into 5 separate and distinct islets and the separating channels appear to be deepening. Several of the breaches we have seen in recent years have formed since our first observations in 1971.

The deepening channels may not be as well documented as the island division of modern times. Reimnitz and Toimil (1977) reported on a diving investigation of Leffingwell Entrance east of Flaxman Island. They found that the channel depth in 1976 was 10.5 m and noted that Sir John Franklin, in 1826, reported on difficulty with shoal water in the channel. Leffingwell's observations (from 1906-1914) implied a channel depth of 5.5 m and the hydrographic survey of 1950 showed the maximum channel depth to be 7 m.

Data presented here suggests that Egg Island Channel has similarly deepened from 3 to 7 m in the 25 years since the first detailed surveys were made.

The recent trend of dividing islands and deepening channels may have begun around 1950 when the first detailed surveys of the coastal zone were made. This trend may have been initiated by a change in the marine environment and/or the ice regime. Barry (1978) reports that historical data suggest the period from 1920 until 1950 was characterized by mild ice years. From 1950 until now we have been living in a period of more severe ice conditions, perhaps similar to those of the late 19th century. One may wonder if the returning milder ice conditions and the resulting more severe wave reworking will lead to a rejoining of the many small island fragments into larger ones.

The changes in the coastal environment documented in this short report, and a discussion of a few of the remaining questions, indicate that our understanding of arctic coastal processes is just beginning. We expect that answers to many of the questions will come with experience gained during the time of shoreline development by industry, and hope that we will have the time to be careful in this development.

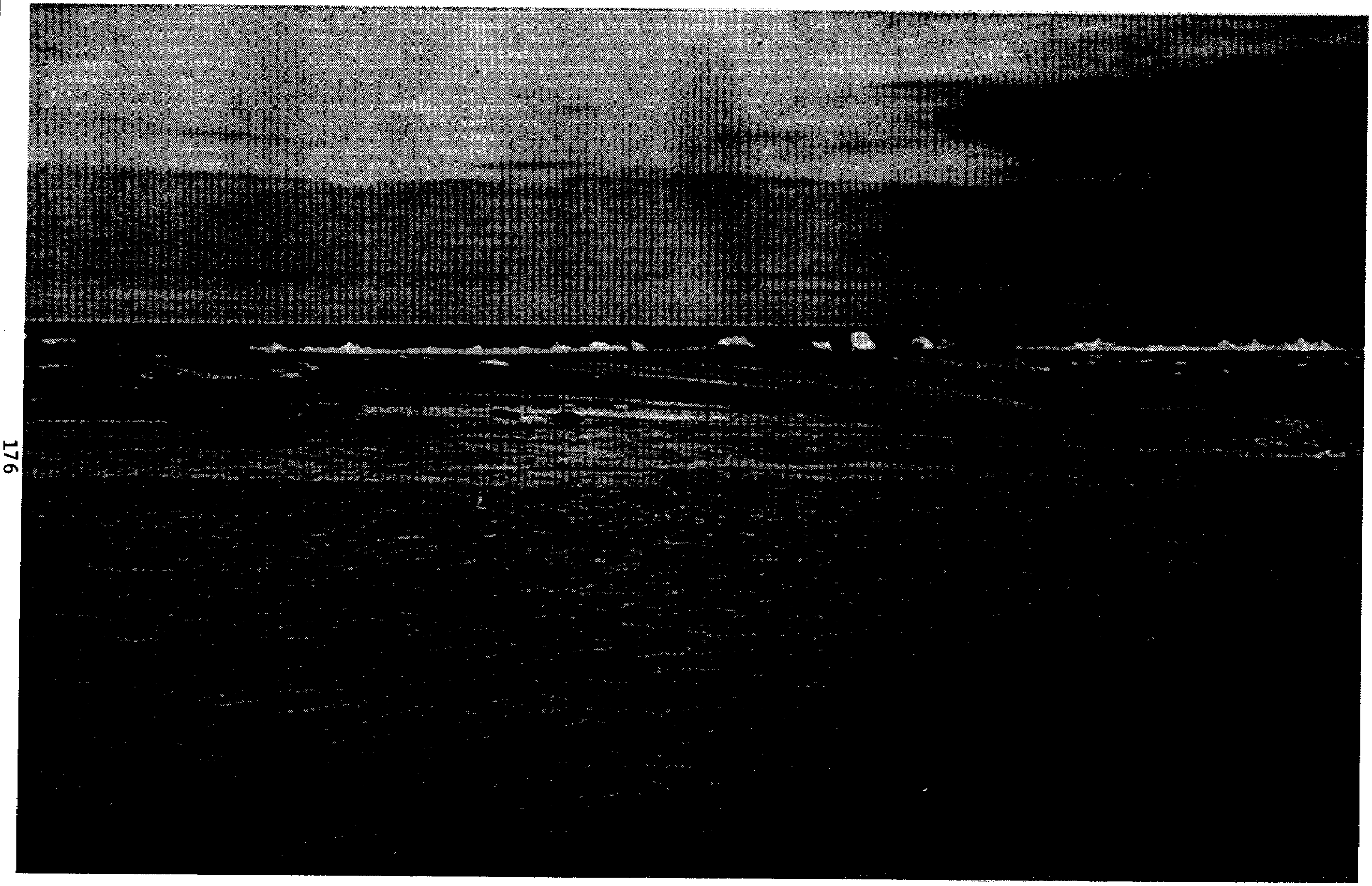

Figure 1.--Cross Island during a 15 mph northeasterly wind on Sept. 18, 1977. A lack of ice on the continental shelf caused abnormal waves which overtopped the narrow portion of the island and created overwash fans on the landward side. Migration of these islands is most rapid during ice-free years.

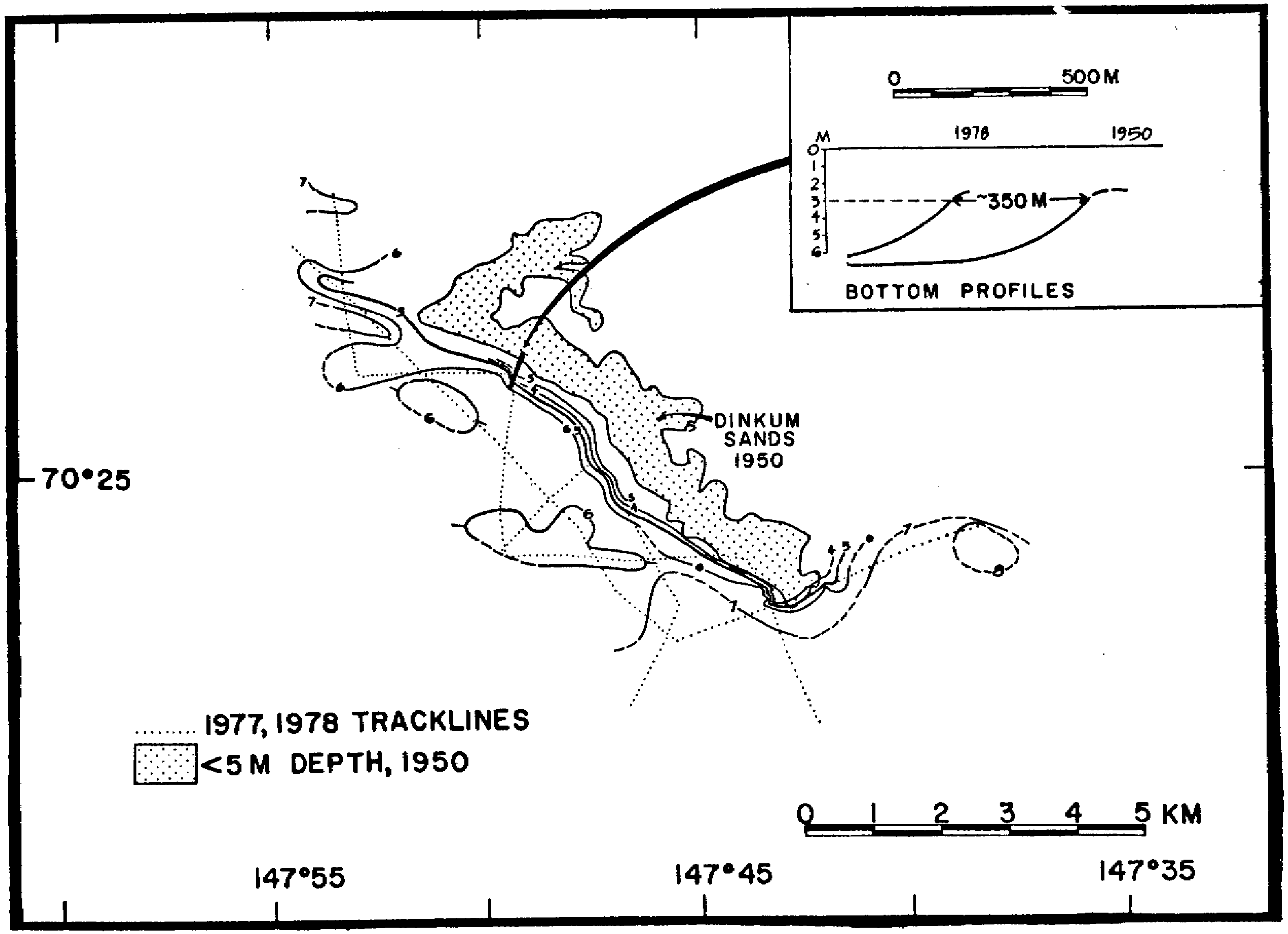

Figure 2.--Changes in Dinkum Sands and the surrounding sand shoal from 1950 until 1978. The 1950 shoal is stippled and outlined by the 5-m isobath. Smooth sheet 7761 shows that this feature "bares 3 ft at MHW" in 1950. We have not seen Dinkum Sands "bare" since 1975. Recently surveyed isobaths on the landward side of the shoal indicate a landward migration of the steep face by several hundred meters (see inset).

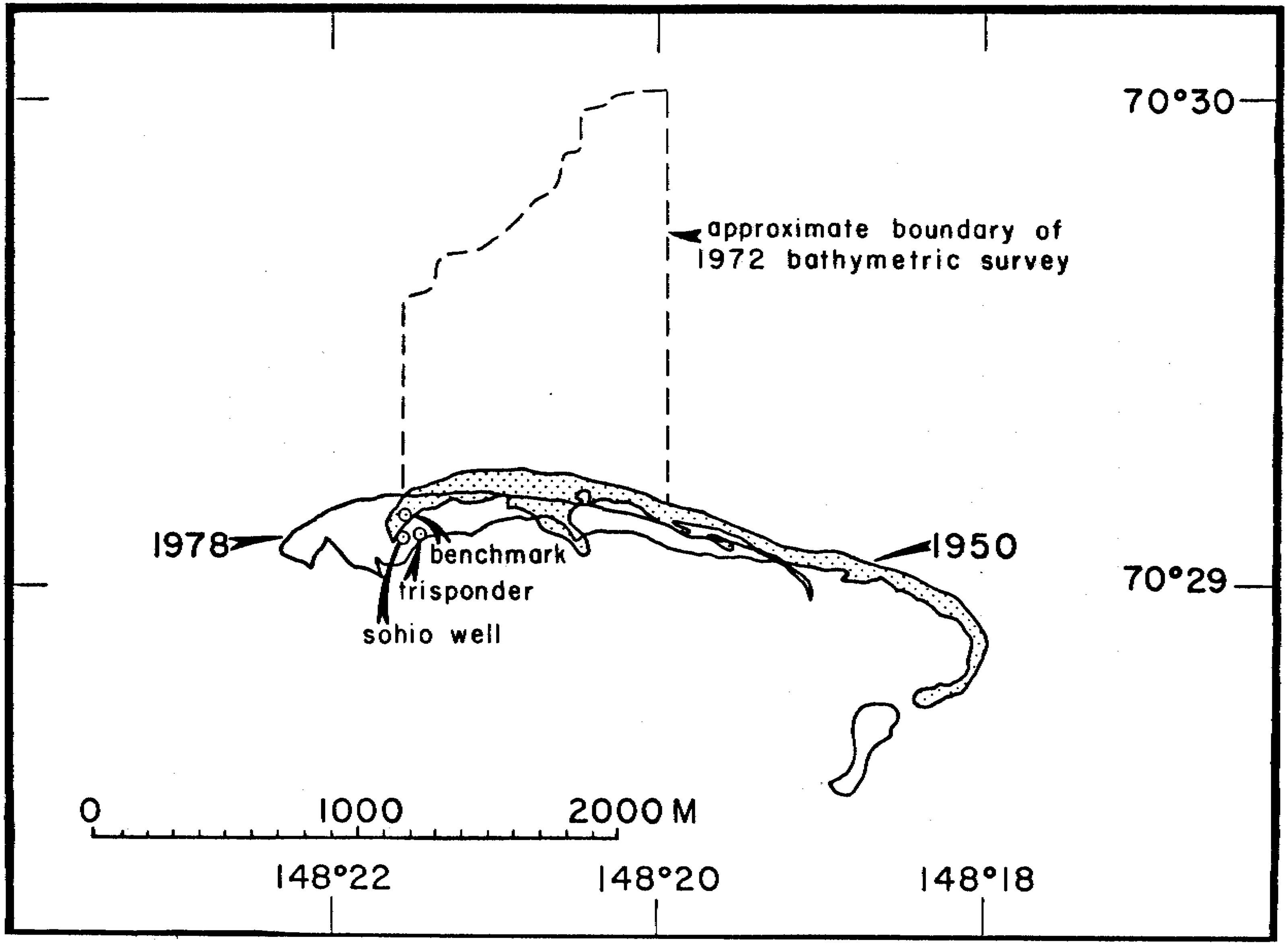

Figure 3.--A comparison of Reindeer Island in 1950 and 1978 shows how the island broke in two and migrated markedly to the southwest. The present configuration of the main portion of Reindeer Island was determined by a topographical survey done on 10/4/78. This information was made available to us through the courtesy of Sohio Petroleum Co. The eastern satellite is sketched from a recent U-2 photo.

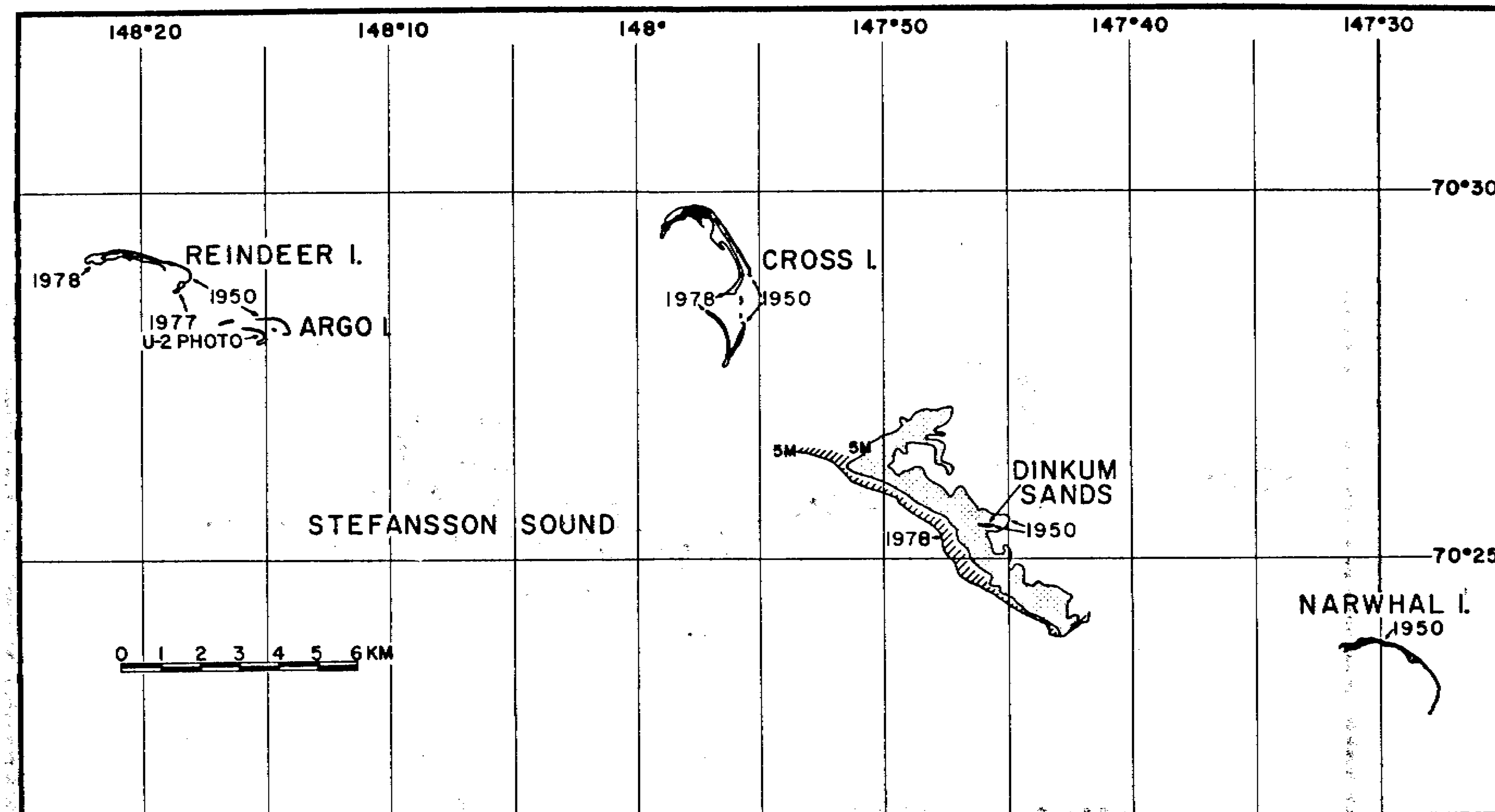

Figure 4.--Overall view of the changes in Reindeer, Argo, and Cross Islands, and Dinkum Sands from 1950 to 1977/78. The changes in Cross Island were discussed in our January 1979 report. No detailed information is available for Narwhal Island. The island now consists of five parts separated by channels still in the process of becoming deeper. All the islands within this figure have broken apart and Dinkum Sands has disappeared altogether. This suggests a very unstable environment.

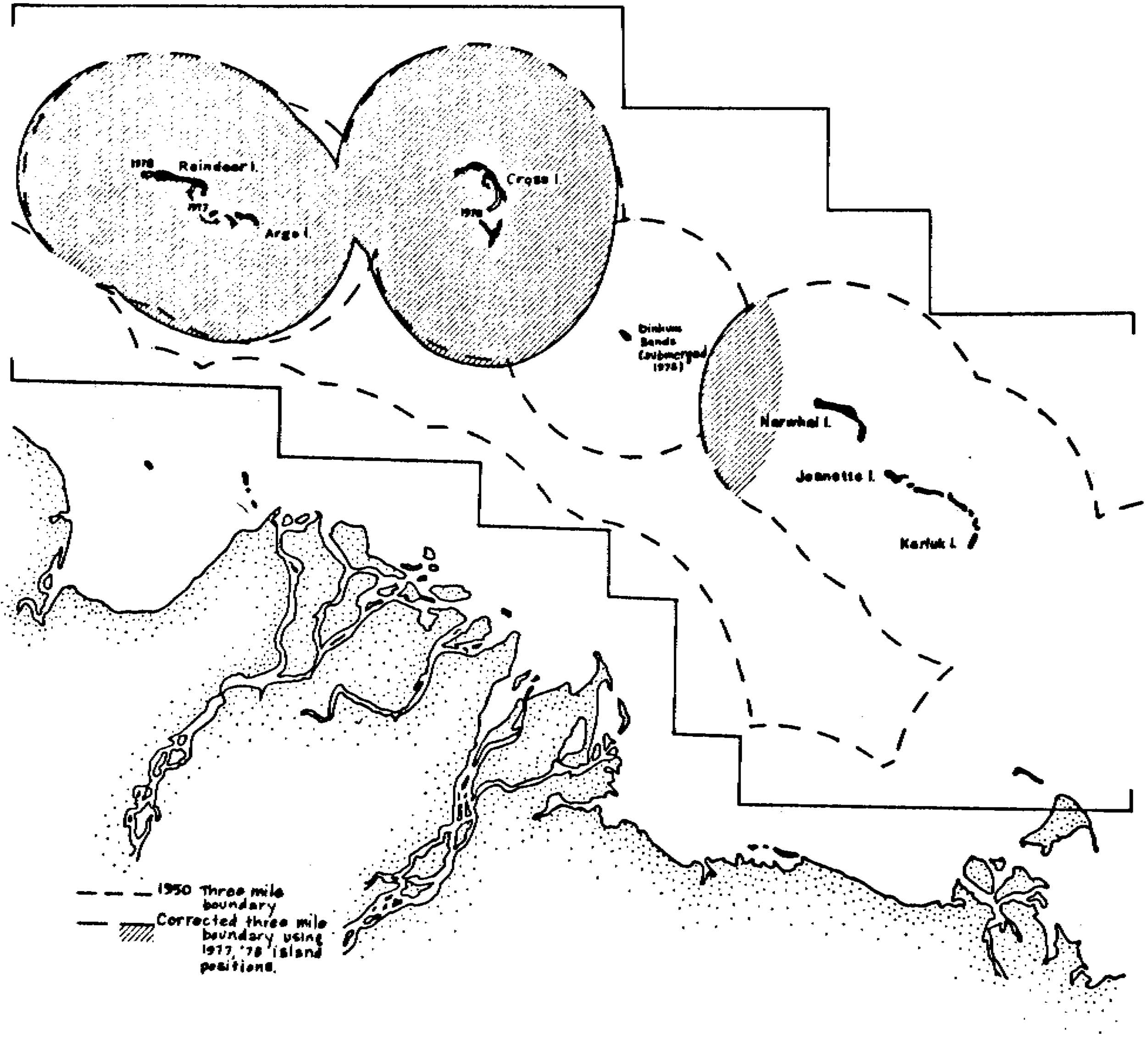

Figure 5.--The boundaries between State and Federal Lands, as shown in the EIS draft for the Beaufort Sea lease sale area, are shown compared to the boundaries using our island position data.

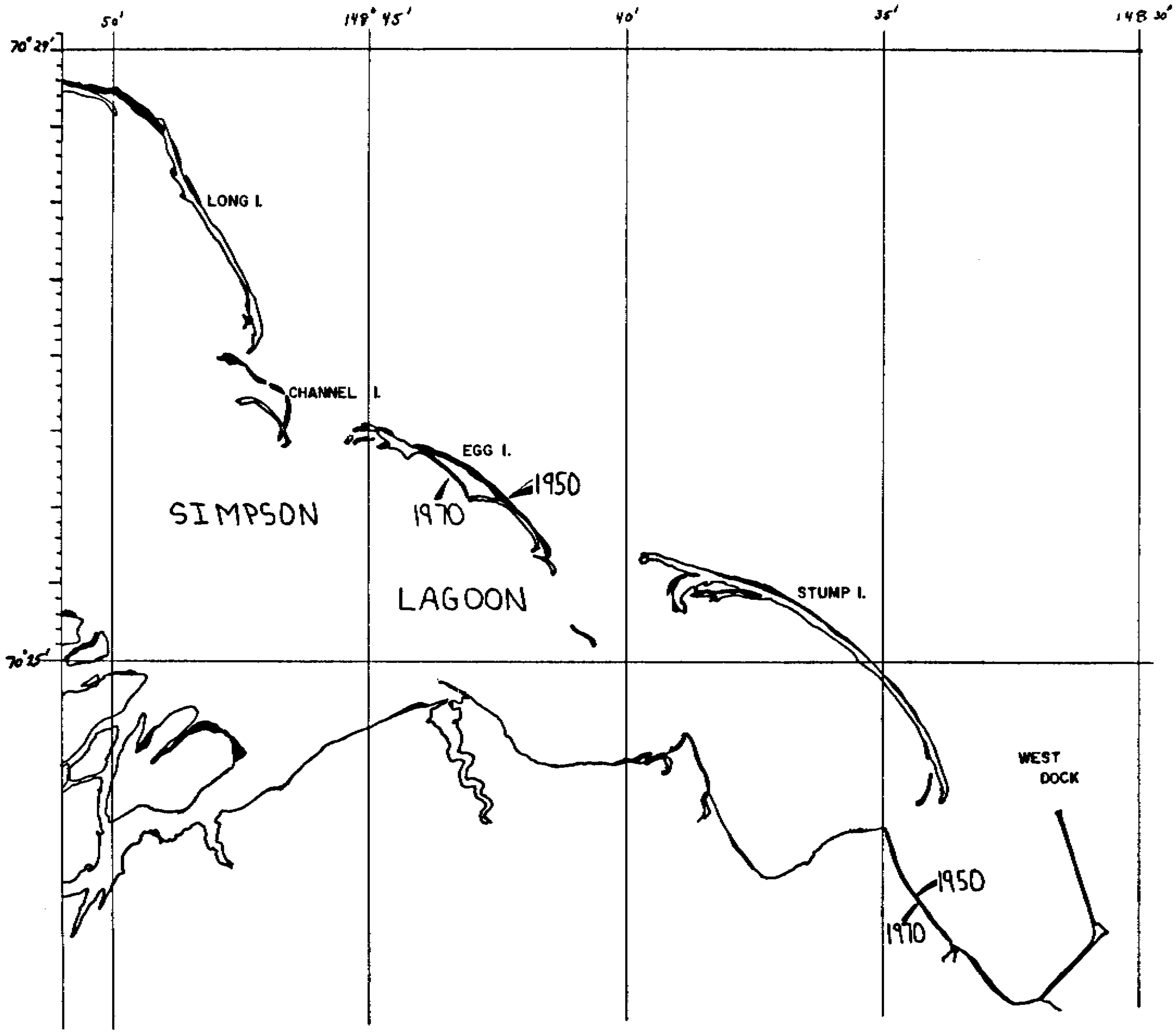

Figure 6.- Changes in coastal and island confifuration of eastern Simpson Lagoon during a 20 year period from 1950 to 1970. This illustration was by overlaying 1:50,000 N.O.S. charts 9472 and 16061

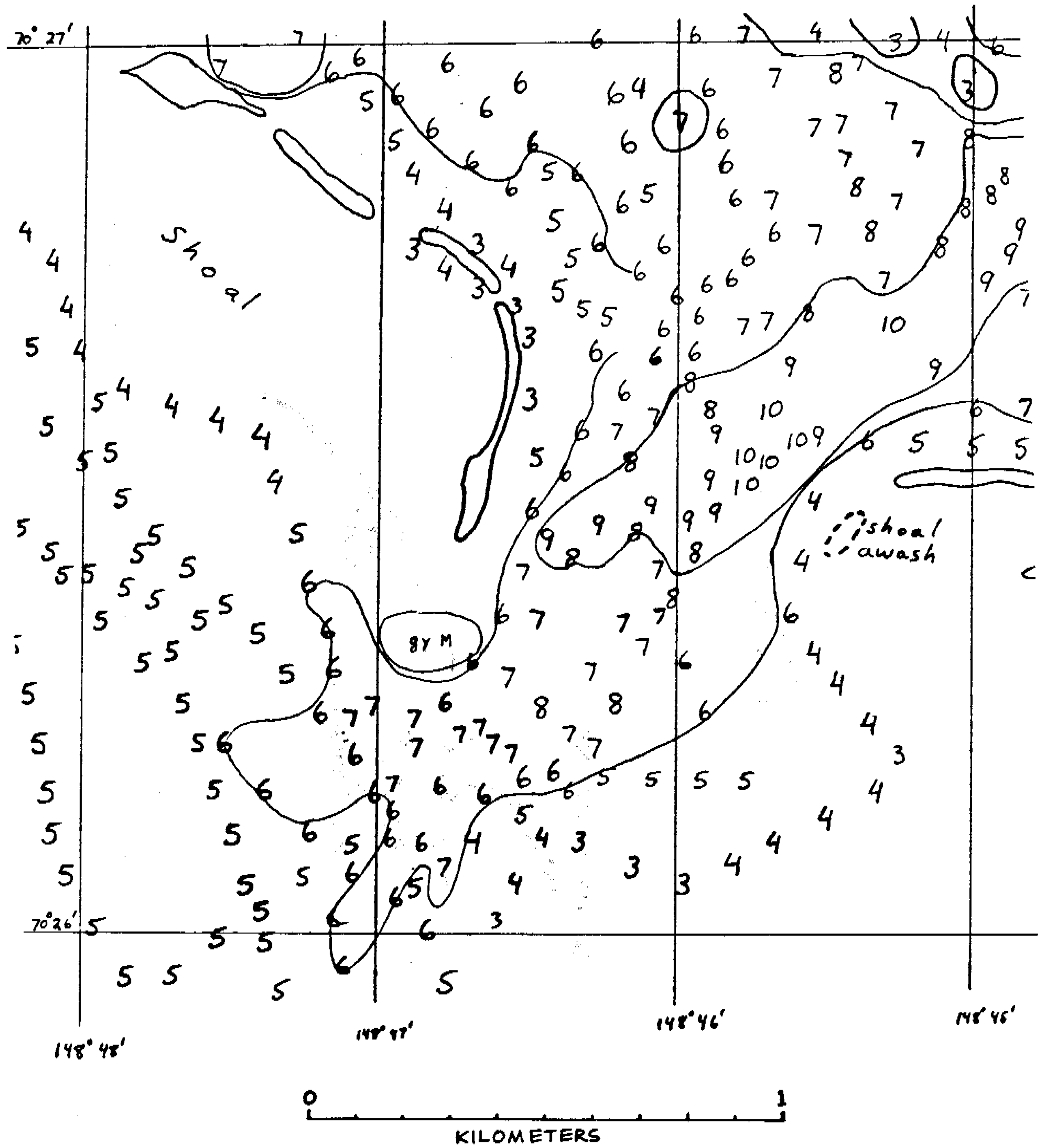

Figure 7.- Egg Island Channel, with soundings in feet, from Hydrographic Survey sheet 7854, dated 1950. The floor of the tidal inlet at that time was broad, with a maxium depth of 9 to 10 feet (3m), located at about the mid-point between the two adjacent islands.

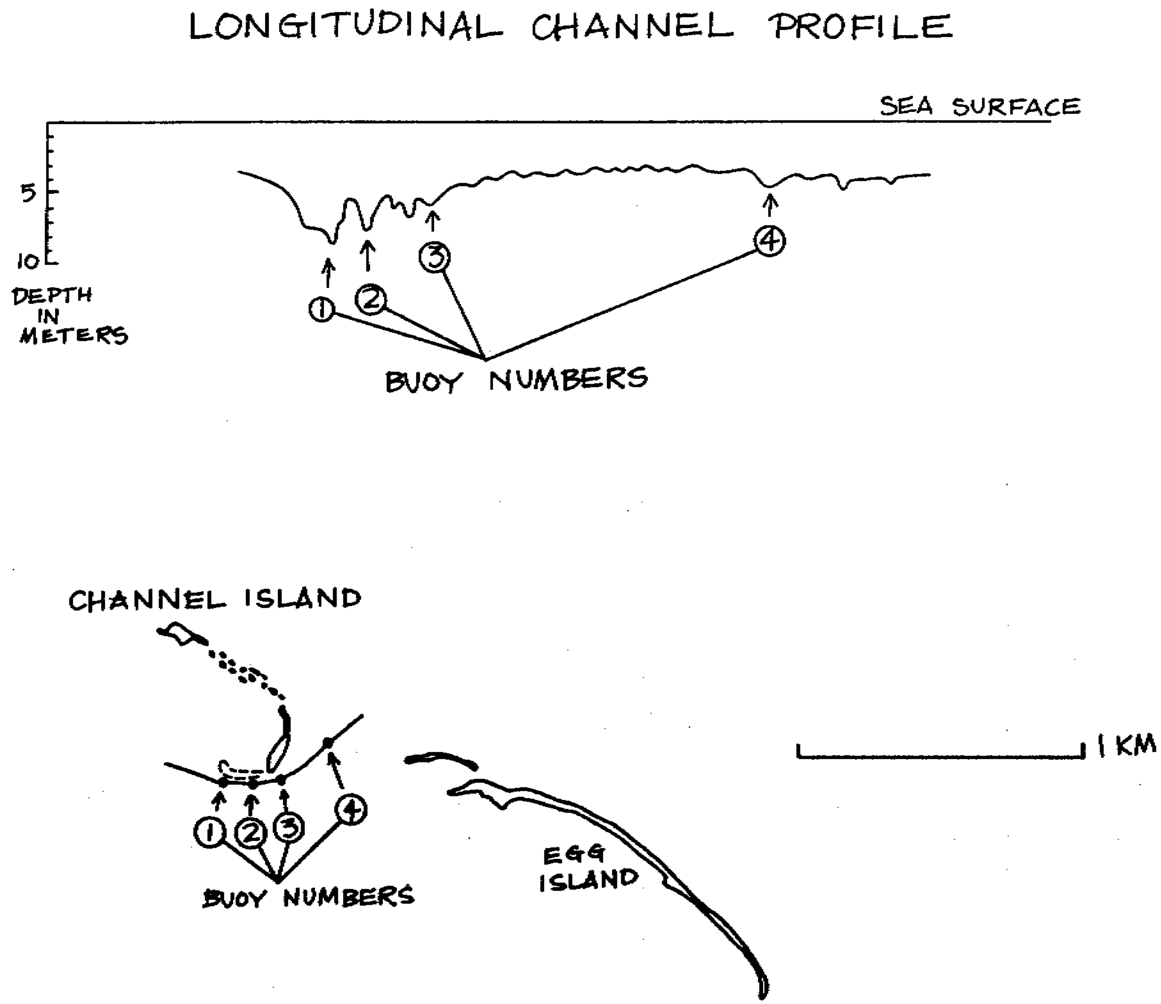

Figure 8.--Reconnaissance data from a 1972 survey of Egg Island Channel. The lower part shows the locations of buoys placed on the channel axis during transverse fathometer runs. The upper part is a longitudinal profile of the channel which was recorded on a depth sounder while steering a course along the buoys. Note that navigation was poor and that we determined positions with respect to out-dated charts. But the channel has a maximum depth of 8 m, has a very rough longitudinal profile, and lies in close proximity to Channel Island.

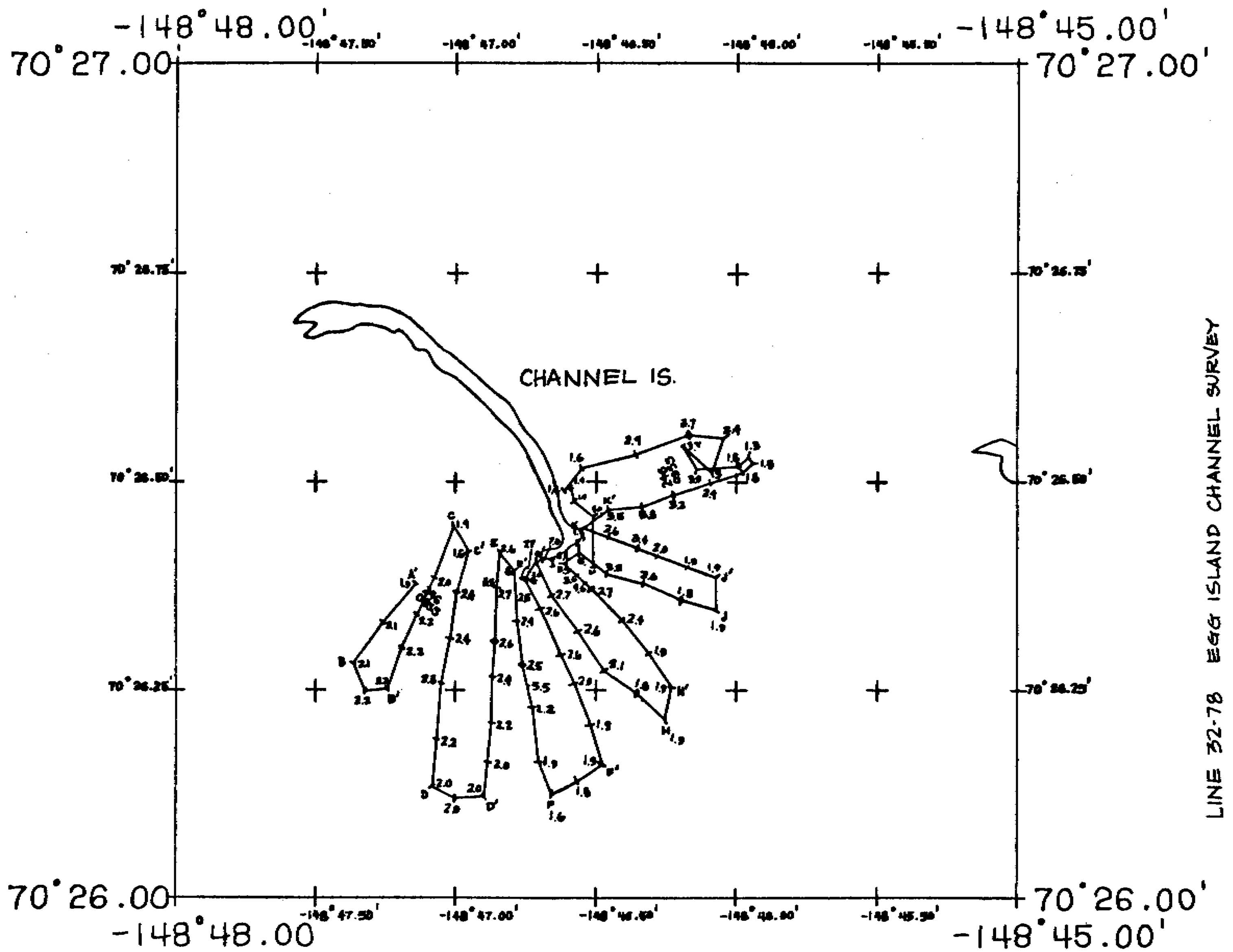

Figure 9.--Computer printout of a detailed, precise survey of Egg Island Channel in September 1978--depths are measured in meters.

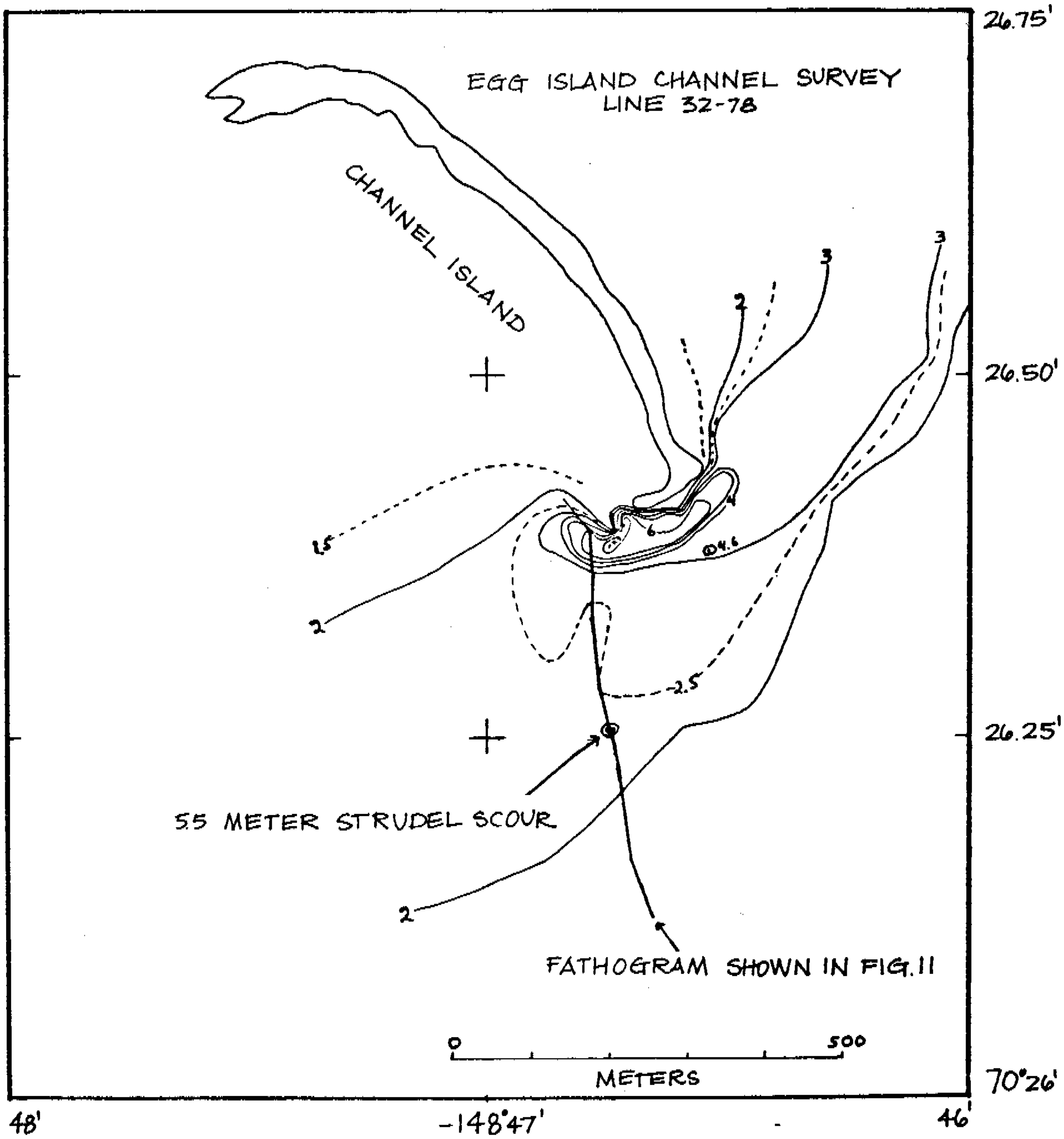

Figure 10.--Egg Island Channel--depth contours in meters. The present channel is up to 7 m deep and lies immediately adjacent to Channel Island. Note the 5.5 m strudel scour on the lagoon floor, and the location of a fathogram in figure 11 which crosses the channel and strudel scour.

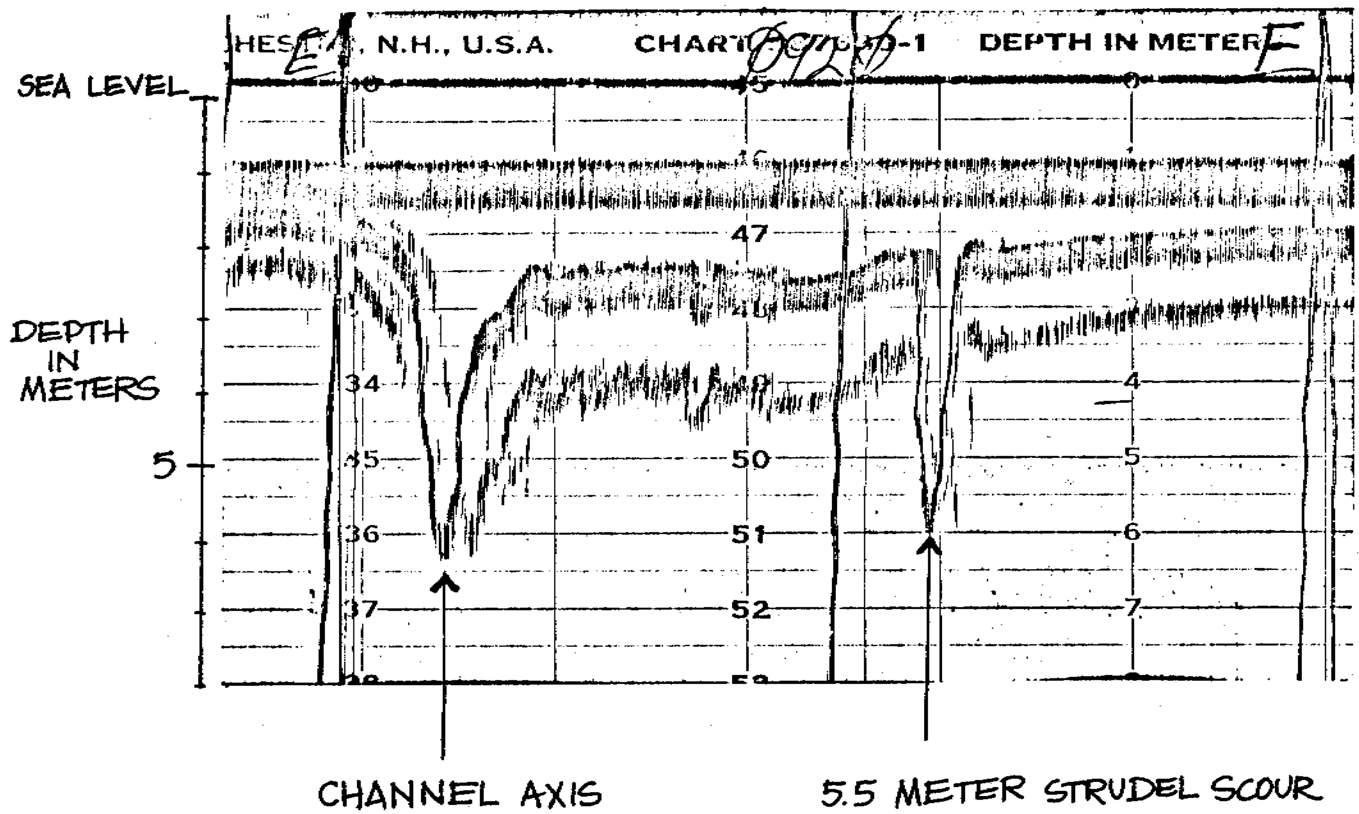

Figure 11.--Copy of a fathogram taken across Egg Island Channel and nearby strudel Scour. A chance crossing of the strudel scour at its maximum depth is unlikely, and the cross sections of tidal inlets and strudel scours are rather similar. For location of fathogram see Figure 10.

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Quarterly Report

Research unit: 205
Reporting period:
July 1-Sept. 30, 1979

GEOLOGIC PROCESSES AND HAZARDS OF THE BEAUFORT SEA SHELF AND COASTAL REGIONS

Peter Barnes

Erk Reimnitz

Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

1 October 1979

Quarterly Report, 1 October 1979 - RU 205, Barnes and Reimnitz

All but two of the place names used in this report are provisional names only and have not been approved by the U.S. Board of Geographic Names.

FIELD ACTIVITIES;

Field studies on the R/V Karluk took place during the months of July, August, and September in the area from Harrison Bay to Camden Bay, Alaska. At the time of this writing the second crew of the Karluk, led by Peter Barnes, has not returned from the field. Therefore the highlights listed here are biased towards findings of the first half of the season.

SCIENTIFIC PARTY:

P. Barnes - U.S.G.S., Geologist
E. Reimnitz - U.S.G.S., Geologist
G. Boucher - U.S.G.S., Geologist
E. Kempema - U.S.G.S., Research Assistant
P. Minkler - U.S.G.S., Research Assistant
R. Olson - U.S.G.S., Research Assistant
D. Rearic - U.S.G.S., Research Assistant
M. Boyle - U.S.G.S., Electronics Technician
H. Hill - U.S.G.S., Electronics Technician
D. Hogg - U.S.G.S., Electronics Technician
T. Kelly - U.S.G.S., Electronics Technician
G. Tanner - U.S.G.S., Electronics Technician
T. Barnett - U.S.G.S., Boat Carpenter
B. Pflaum - U.S.G.S., Machinist

HIGHLIGHTS OF THE SUMMER 1979 FIELD SEASON:

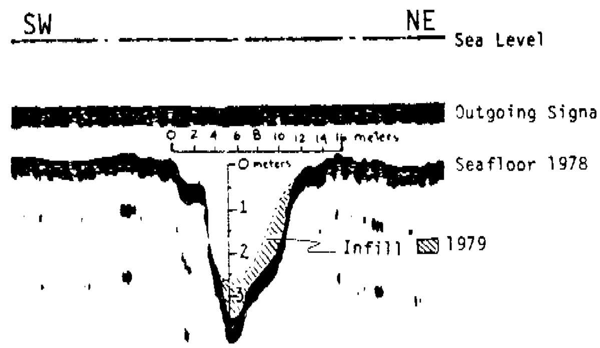
1. The seemingly unusual formation of slush ice under the fast-ice canopy (Reimnitz and Dunton 1979) was succeeded by a very widespread mud cover on the ice which was concentrated by ablation. The film of mud, studied with Ken Dunton (RU 356), contained marine bivalves and other marine organisms, pebbles, grassy material, leaves, twigs, and sticks up to 5 cm in diameter. The film of mud blanketed the entire lease sale area, far beyond the boundaries of river overflow. It was probably caused by formation of "slush ice" in the previous fall.

2. Outcrops of stiff silty clay were studied and photographed by divers in several locations seaward of the islands, ranging from Spy Island to Belvedere Island. The small-scale surface relief of such outcrops records intermittent ice gouging events and relatively frequent, intense current scouring events. Most positive-relief features are rounded and polished by currents . Well-rounded mud balls are lying nearby. The absence of bio-erosion (burrows, excavatons, sessile organisms) on these hard, current-pollished outcrops is striking.

3. Criss-crossing tracks of seismic profiles were run on each of the 20 bore holes drilled by the U.S.G.S. Conservation Division last winter. Correlation of these two sets of data should aid in interpretation of seismic reflection records elsewhere in the lease sale area.

4. We attempted to locate and investigate an ice gouge which we studied last year. We had marked the gouge by stakes to measure rates of sediment infilling, but were unable to find this gouge during our current field season. Substantial changes in bottom morphology occurred in this area of Harrison Bay during the intervening year.

5. A strudel scour off the Sagavanirktok River was studied and marked by a long stake in September of 1978 and revisited in July 1979. The crater-like strudel scour (see figure) with an original excavation depth of 3.5 m had been reduced in depth to 2.65 m as measured against our stake. Another strudel scour adjacent to Egg Island channel could not be found and has probably filled to the level of the surrounding sea floor during the intervening year.



6. Dinkum Sands, a very controversial feature in the upcoming lease sale, was sufficiently roughened by ice so that it broke the sea surface in a few steep-sided knolls. We observed this from the air on July 15, but on July 25, when a detailed bathymetric survey of the area was run, the gouged surface of the shoal had been smoothed over by waves at a level of 20 - 30 cm below mean sea level. The shoal surface remained submerged through most of the summer, except on days when strong easterly winds caused lowering of the sea level.

7. The ice gouge test lines (Barnes and Reimnitz, 1979), where rates of gouging are monitored from year to year, were re-run, and several new ones were established in the Flaxman Island area.

8. Two new boulder patches were discovered: one off Belvedere Island and one in Camden Bay. The one seaward of Belvedere Island, investigated by divers, had a lush growth of brown kelp. The other one was detected by shipboard instruments but not investigated further.

9. In order to study the survival rate of sessile animals and plants on cobbles and boulders in an ice-gouge environement, our team cooperated with Ken Dunton's group in a transplant operation. We hauled cobbles bearing marine growth from the protected boulder patch in Steffanson Sound to a place on the sea floor seaward of Narwhal Island where the water is about 6 m deep. The 'garden' will be revisited next year.

10. Several nearshore areas, where we began to monitor bathymetric features several years ago, were re-surveyed. From these studies we hope to gain insights into the processes responsible for some unusual bottom features of the Arctic nearshore zone.

11. The Exxon Ice Island was monitored throughout the summer. The base of the island was not undercut as we would have expected based on our experience in diving around grounded ice features. The typical 'sea-level notch' extended at least 3 m, and perhaps as much as 5 m under the perimeter of the subaerial portion of the island. Below this deep notch the island was surrounded by extensive ice foot which extended as much as 18 m from the subaerial outline of the island. The very thin outer edge of this foot was raised 3 to 20 cm from the sandy bottom and its smooth base could be seen separated from the sea floor as much as 2 - 3 m inward from the outer edge.

The island was eroded most rapidly from the eastern 'weather side,' and broke up and disappeared during the middle of September.

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Quarterly Report

Research unit: 205
Reporting period:
Oct. 1 to Dec. 31, 1979

GEOLOGIC PROCESSES AND HAZARDS OF THE BEAUFORT SEA SHELF AND COASTAL REGIONS

Peter Barnes

Erk Reimnitz

Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

1 January 1980

QUARTERLY REPORT RU-205

I. Task Objectives

The primary goal of this project is to study the nature, distribution, stability, and thickness of Holocene and older sediments, and their relationship to sources, dispersal mechanisms, and processes. Emphasis is placed on processes that were unique to the arctic environment where ice plays a dominant role. More detailed objectives for this project are given in previous reports and in the project proposals.

In this report we address new topics of particular importance to the development of an EIS by the Bureau of Land Management. These topics include: 1) under-ice morphology and potential for oil entrapment, 2) areal extent and geologic character of the boulder patch, 3) gas analysis of surface sediment samples, 4) implications of profound sea bed changes from 1977 to 1978, and 5) observations on barrier island migrations.

II. Field Activities

Barnes and Reimnitz spent the period from November 12 through November 21 in Deadhorse attempting to do field work that should not have taken more than two normal working days to accomplish. We are now struck by the significant information gap existing in our understanding of the highly variable marine environment from the time of freeze-up until January or February when the character of the ice is more predictable.

In spite of all the problems encountered (see pertinent section), and the destruction by ice of 80% of the equipment installed at DSenvironment from the time of freeze-up until January or February when the character of the ice is more predictable.

In spite of all the problems encountered (see pertinent section), and the destruction by ice of 80% of the equipment installed at DS-11 for monitoring anchor ice processes, some very interesting information on this important phenomenon was gathered in collaboration with Ken Dunton and Larry Larson. We are faced with a phenomenon which is a) very widespread in some years, b) is important to our total understanding of the environment, c) occurs during freeze-up, and d) cannot be observed directly with conventional methods because of the time at which it occurs.

A. Ship or Field trip Schedule - None

B. Project Personnel

Peter Barnes, Project Chief, U.S.G.S., Office of Marine Geology
Erk Reimnitz, Principal Investigator, U.S.G.S., Office of Marine Geology
Edward Kempema, Assistant, U.S.G.S., Office of Marine Geology
Peter Minkler, Assistant, U.S.G.S., Office of Marine Geology
Douglas Rearic, Assistant, U.S.G.S., Office of Marine Geology
Robin Ross, Assistant, U.S.G.S., Office of Marine Ceology

C. Methods - Included in Section III.

D. Sample locations - Included in Section III.

E. Data collected or analyzed - Included in Section III.

III. & IV. Results and Preliminary Interpretations

Results with preliminary interpretations are included as attachments to the Quarterly Report. Below are attachment titles with brief summary statements.

Attachment A: Studies of the decay of Exxon Ice Island
During the winter of 1978-79 an experimental ice island was built in Steffanson Sound. Diving observations and shipboard data collected around the ice island during the summer show a unique underwater ice pedestal. However, there are no long-lasting effects on the seabed in this particular setting.

Attachment B: Dinkum Sands
Dinkum Sands was observed during the summer both above and below water. The instability of Dinkum Sands is shown by the crest shifting 15 m to the southeast during the summer, and by a comparison with 1950 survey data that show Dinkum Sands was on the back of a northwest trending ridge and is now on a northeast trending ridge.

Attachment C: Marine geologic stuides in the Beaufort Sea, Alaska, 1979; data type, location, and records obtained
Detailed maps show the locations of tracklines, dive sites, and vibracore stations taken by the R/V Karluk from July through September 1979.

Attachment D: Ice-pushed boulder pile - Camden Bay, Alaska
A unique boulder ridge, formed along a segment of the coast in Camden Bay, is linked to ice-push from offshore by a mechanism which may sort boulders from finer sediment sizes. Offshore boulders suggest a Boulder Patch type of environment.

Attachment E: Fall storm, 1979, - A major, modifying coastal event
A five- to ten-hour storm occurred at the end of the open-water season in 1979 which significantly altered coastal features. The probability of tens of meters of erosion occurring in a single storm event will have to be a major factor in planning for any coastal structures.

V. Problems encountered

For many types of ice observation work there is no suitable means of getting to a site on the ice and remaining there to accomplish the job. Industry has been successful with many activities on the ice, including operations with large mobile field camps, during the last two thirds of the winter. But how is industry planning to cope with emergencies or pollution problems on the fast ice during October, November and much of December? Apparently those who know best stay off the ice during this critical period.

Our job was to retrieve an 800 lb instrumented tripod belonging to Larry Larsen of the University of Washington and an instrument package belonging to Brian Mathews of the University of Alaska, from DS-11 in the boulder patch. We coordinated our efforts closely with those of Ken Dunton (RU-356) who also planned extensive work at the same site. One problem we encountered was the late and 'erratic' freeze-up, coupled with short daylight and limited flying hours. The ice thickness was patchy. Poor flying weather on many of the days we were there was the chief problem. During one streak of bad weather when our preparation efforts at the site were completely hampered by refreezing and drifting snow, we investigated all possible means at the oil field for tranporting a load of people and gear to the site. There was no way, short of a skidoo and sled convoy, and this was not practical. There are no lightweight, enclosed, wheel or track vehicles which are safe, and have the necessary navigational capability, for a 5-mile trip onto the ice. Also, there is no hovercraft on the North Slope. Even a hovercraft with navigation gear could not have supported us at one site for the 12 to 16-hour period required for ice clearing, diving, and equipment retrieval. There are severe problems of surface flooding on the thin ice under a load; there are difficulties in working on flooded ice; and there are problems of adfreezing to the work platform if it is temporarily shut down. Even the light parcol over the diving access hole was subject to adfreezing, partly due to the weight of new snow drifts which formed around the shelter.

Attachment A

Studies of the Decay of Exxon Ice Island

by Erk Reimnitz, Edward Kempema, and Robin Ross

During the winter of 1978-79 Exxon Corporation built an experimental ice island in Stefansson Sound, a few kilometers north of Prudhoe Bay. This ice island presented the opportunity to study the interaction of a large mass of grounded ice with the environment, and in particular to test some of our ideas concerning the possible effects of grounded ice on sea floor processes and morphology. For example, we have puzzled for many years about the origin of broad, gentle depressions and rounded knolls on the sea floor which are characteristic of shallow water regions of the Beaufort Sea (Reimnitz, et al., 1972). These relief forms are possibly caused by the interaction between currents and flow obstructions such as large grounded floes. The depressions may also form when grounded floebergs float free and rip out large slabs of adfrozen sea floor. As another example, we have reported on the common occurrence of extensive but narrow gaps between the sea floor and grounded ice, so that the actual ice/bottom contact often is inaccessible to divers (Reimnitz, et al., 1972; Reimnitz et al., 1974). We believed that these gaps, or undercuts in grounded ice, might be due to the erosive action of water currents which are more intense around the ice/seafloor contact. The observations we made around the ice island during the summer of 1979 led to some unexpected findings.

A large, rotating sprinkler system using sea water was employed to construct the circular, dome-shaped Exxon Ice Island (Figs. 1, 2, and 3). The island was built on the fast-ice in water 3 to 4 m deep. The ice was as much as 10 m thick at the center of the island but only about 5-6 m thick around the perimeter. Our observations during construction of the island and also during the summer erosion indicate that the ice was free of sediment. This sediment-free ice suggests that the sea water was never turbid while the island was under construction. Salt exclusion by freezing caused large volumes of brine to flow toward the perimeter of the island where the brine presumably drained through the surrounding floating ice canopy. This draining of cold brine must have caused supercooling of the seawater and underwater ice formation downdrift (westward) of the island. We have no evidence, however, to support the formation of underwater ice.

Observations and data collected around the ice island during the summer consist of: a) aerial and shipboard observations of the decay of the island, b) diving observations and underwater photography, c) fathometer, subbottom profiler and side-scan sonar surveys around the perimeter of the island and across the site after the last remnants had disappeared, and d) several measurements of salinity, temperature, and light transmissivity in the waters around the island.

When we first observed the island during the middle of July it had a diameter of about 400 m and the circumference was marked by a sheer cliff

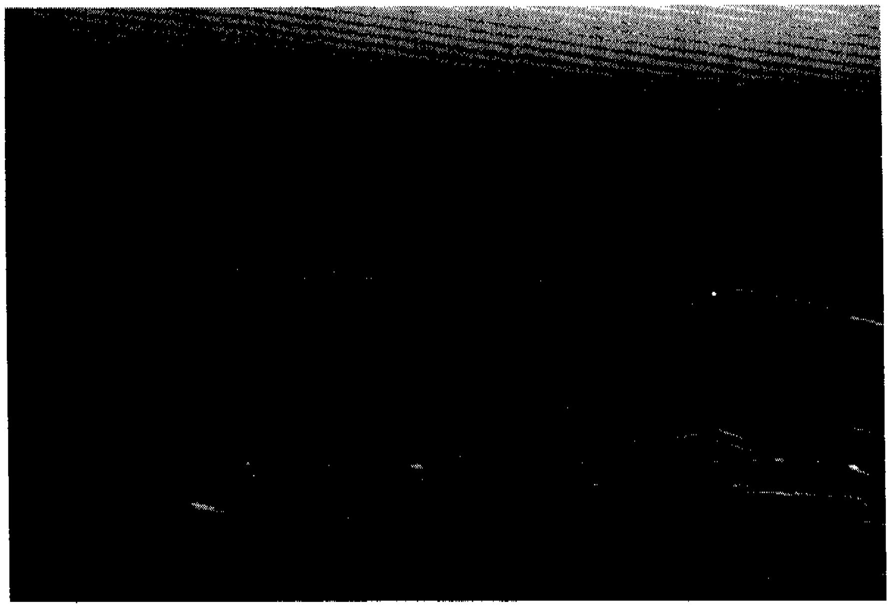

Figure 1. Aerial photograph of Exxon Ice Island in early March when the ice buildup was about half completed. Note the radial sprinkler system with the pivot point in the center of the circle.

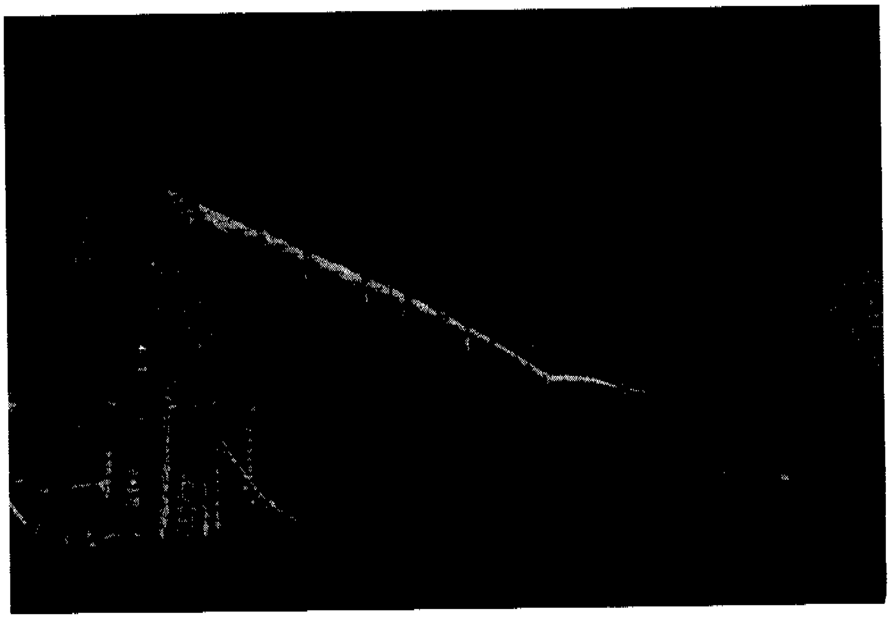

Figure 2. Closeup view of pivot point and sprinkler system.

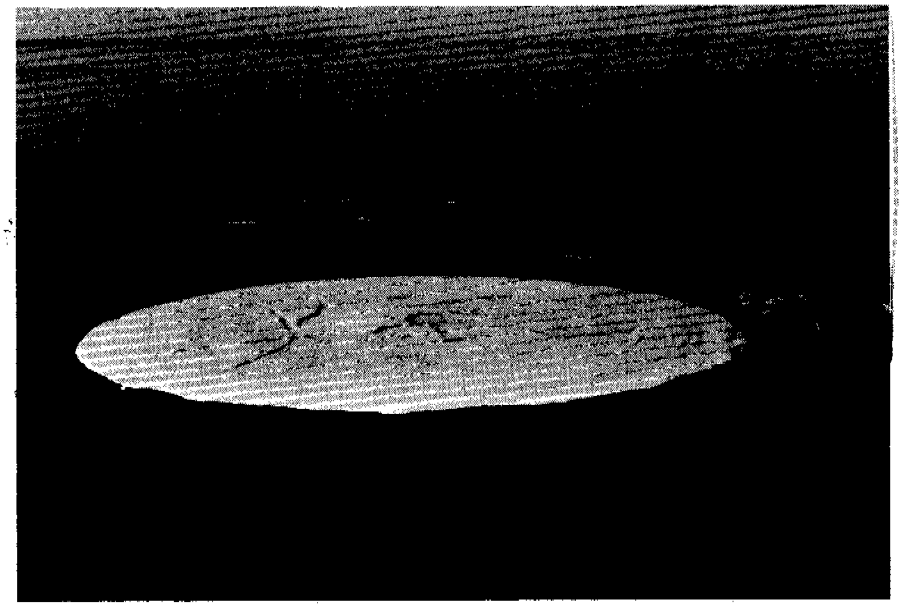

Figure 3. Oblique aerial view of Exxon Ice Island on July 20 when the island was essentially intact. Note the pivot point in the center of the island.

above the water line with a typical erosional notch undercutting the cliff at and below the water line. Thermal erosion at and below the water line, abetted by wave and current action, predominantly on the northeast"weather"-side, caused ice-calving and a rapid decrease in the size of the island. Because marine energy was focused on the northeast side, the island soon became asymmetric in shape (Fig. 4). A large tarp draped over a portion of the island perimeter to reduce undercutting and calving was swept away during late July (Fig. 5). In September the ice island was hardly recognizable (Fig. 6), and by September 10, before the major fall storms set in, the last remnants of the ice island had floated away.

We made diving observations around the island on August 16 when the wind and currents were very light and from the northwest. During several days preceding the dive the wind had been from the northeast and considerably stronger. Thus the current flow would have been westward and relatively swift for several days before the dive. Our diving traverse partially circumvented the island in a counterclockwise direction, starting from a point on the southeast side of the island and ending on the west side. The sea level notch characteristically extended from 3 to 5 or more meters underneath the ice cliffs and was absent in only a few places where calving had recently taken place. Underneath this overhang the water visibility was blurred due to the mixing of melt and sea water. Below the sea level notch the ice margin was not undercut farther toward the sea bottom as we might have expected. Instead the ice sloped gently outward from the notch to form an upwardly concave, slightly undulating surface that extended from 5 to 15 meters or more beyond the ice cliffs of the island above the sea surface. This wide base of the island will be referred to as the 'ice pedestal.' An idealized sketch of the underwater shape of the ice island is shown in figure 7. The ice pedestal typically feathered out to a sharp edge (Fig. 8), where no recent upward calving occurred, or it terminated in a small scarp 10 to 30 cm high. The outer edge of the pedestal had an irregular, crenulated configuration, with embayments 3 to 4 meters across which exposed the sandy substrate. Even within the pedestal there were a few isolated holes or 'windows' extending down to the sea floor through as much as 60 or 80 cm of ice (Fig. 9). Much of the bottom traverse paralleled the very edge of the pedestal. Along most of the perimeter, the base of the pedestal was slightly raised, forming a basal gap at the sea floor large enough to permit a diver to slide his hand between the pedestal and the sea floor. This gap varied in height from 3 to 25 cm and extended underneath the ice to at least the range of visibility (2-3 meters). Even within the holes through the pedestal the basal gap could be seen (Fig. 9), so it is assumed that the gap extended a great distance underneath the ice island. The base of the ice, where it could be seen through the gap, was smooth, paralleling the equally smooth to slightly rippled sea floor. One thin isolated slab of ice about 1 m in diameter was seen at arm's length from the margin of the pedestal, hugging the bottom. The slab rose to the surface when touched.

The sandy sea floor adjacent to the perimeter of the ice pedestal was smooth with small ripples on the east and west sides of the ice island. This smooth bottom was seen to extend underneath the ice without any noticeable change in ripple pattern. Along the north side of the island, facing the very weak current of the day, kelp (laminaria), dead isopods, and fine sand were piled against the ice perimeter, and small scour depressions had formed (Fig. 10). Although the surface of the pedestal was essentially clean around the

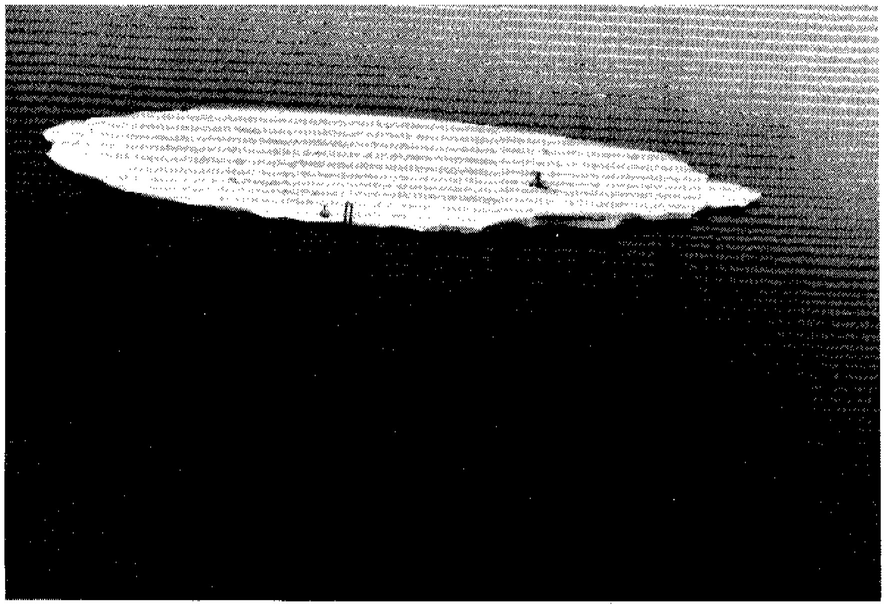

Figure 4. Aerial view of Exxon Ice Island on August 22nd. Note the asymmetry of the island with the pivot point (right center) near the weatherside shore.

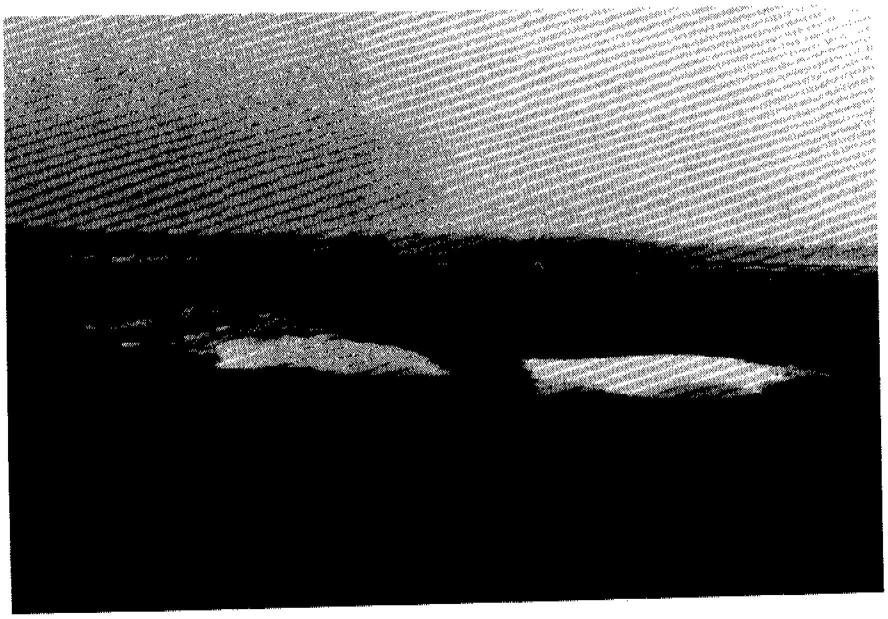

Figure 5. Calved off ice with protective tarp and support posts drifting away on July 27. Formation of a sea-level notch up to 5 m deep, and consequent calving of bluffs, was the major mechanism of erosion.

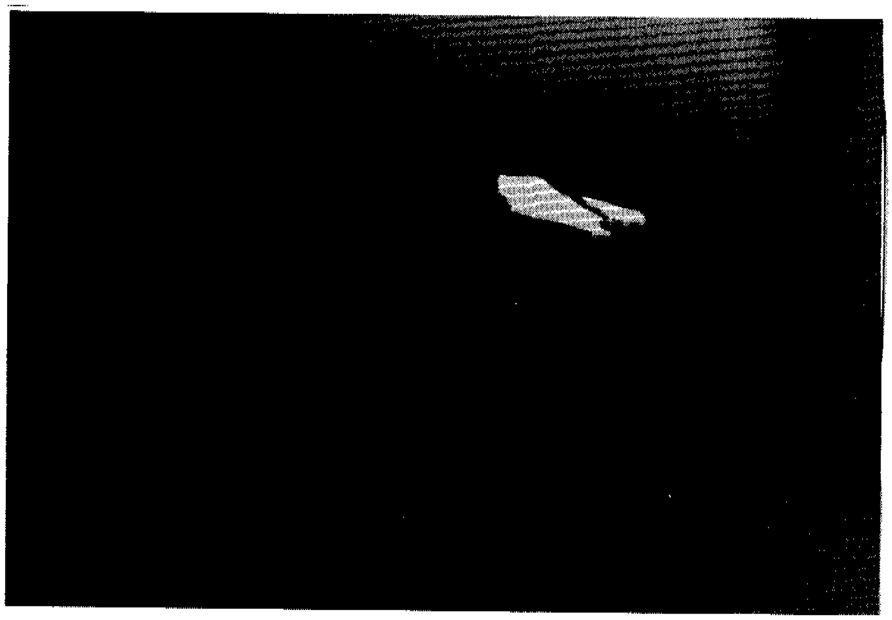

Figure 6. Aerial photograph of last remnants of the ice island on September 7.

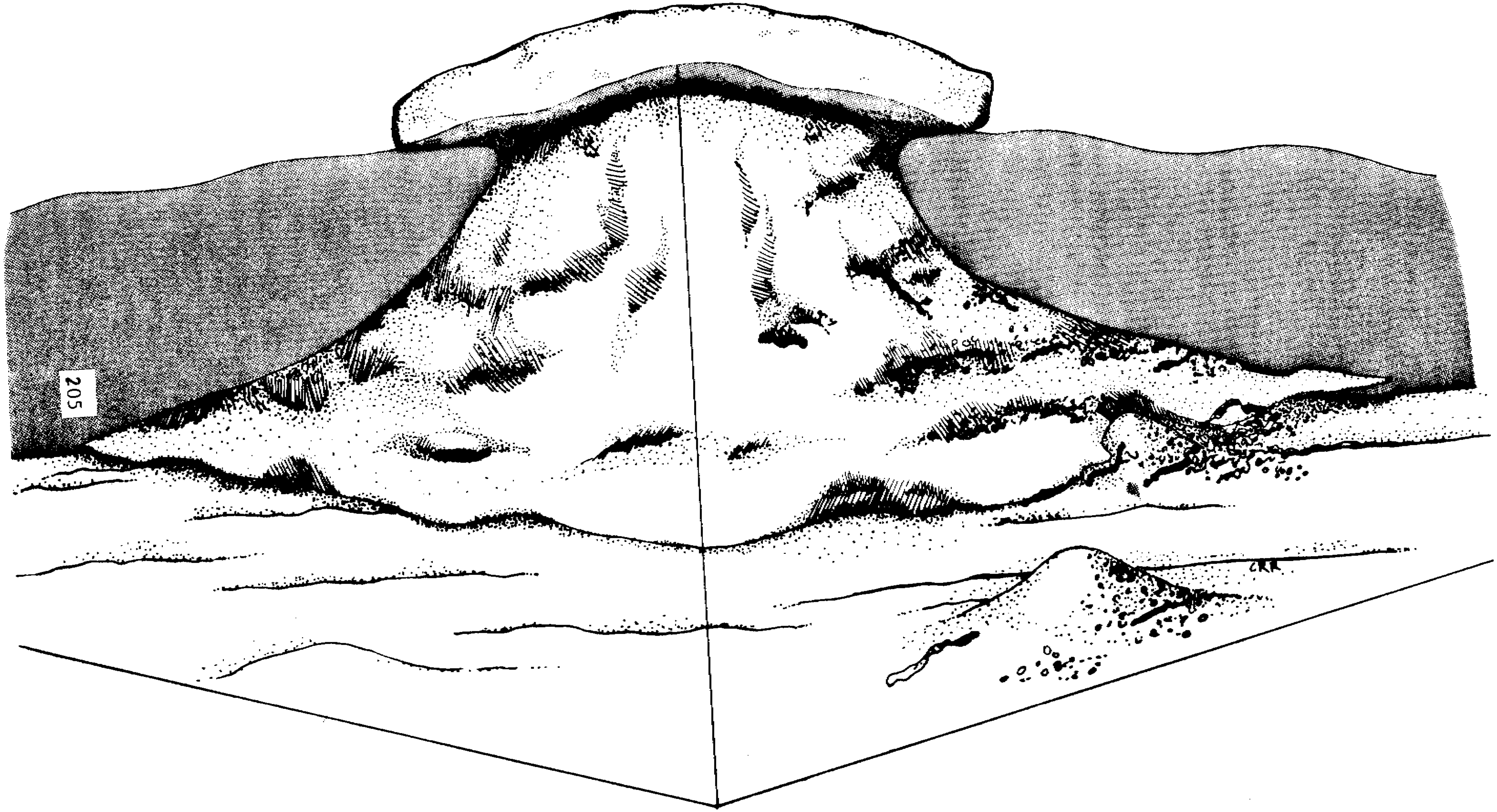

Figure 7. Conceptual representation of the decaying Exxon Ice Island. Note the accumulation of sediment and kelp on and against the rapidly retreating pedestal on the weather side.

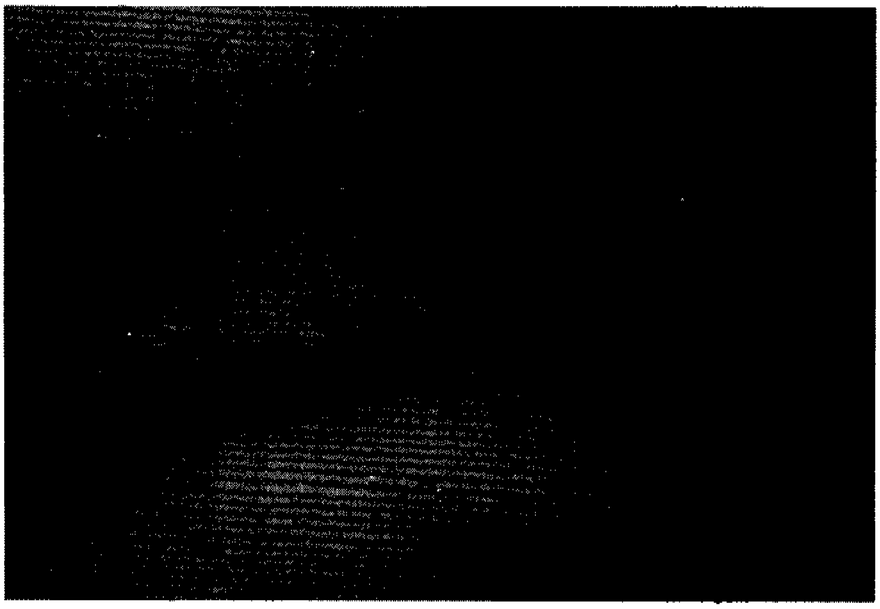

Figure 8.

Underwater photograph of the feathered edge of ice pedestal, slightly raised above flat seafloor. Note arctic cod under rim for scale.

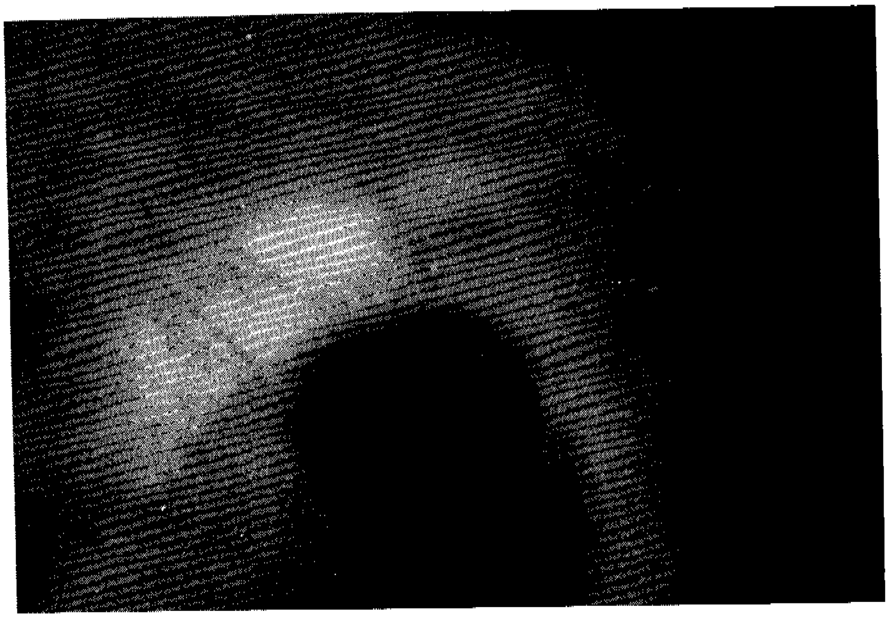

Figure 9.
Underwater photograph of 50 cm diameter hole in ice pedestal, exposing seafloor and narrow basal gap.

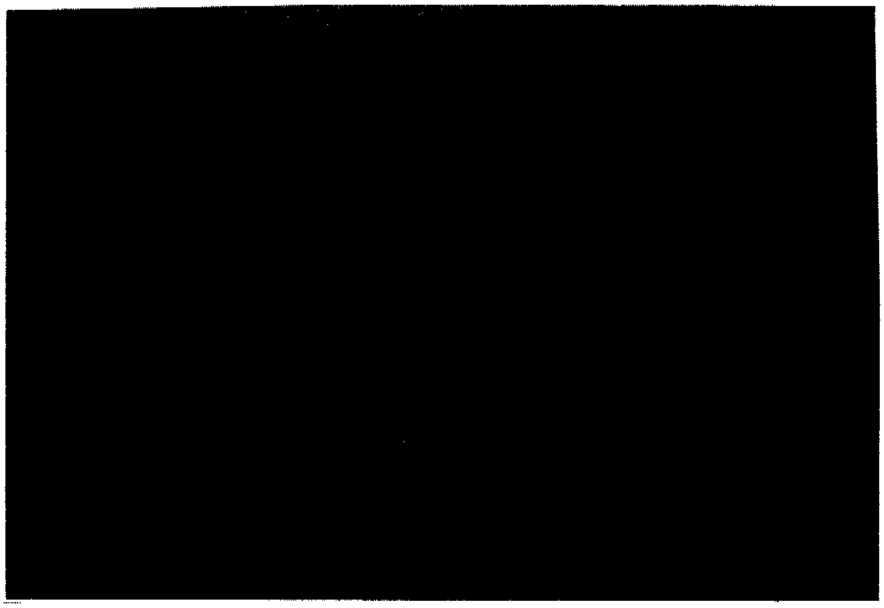

Figure 10. Weatherside of pedestal, with sediment mounds and kelp accumulation.

island, it did have a thin sediment cover on the north side, up to 4 mm thick in subtle depressions. Also, several holes in the pedestal had filled with sediment and erosion of the pedestal perimeter caused formation of irregular sediment mounds up to 40 cm high--remnants of sediment filling. We poked the sea floor adjacent to the pedestal but found no evidence of ice-bonding of sediment.

Fathometer and side-scan sonar surveys were done at the ice island on two different occasions during the summer: July 27 and September 18. The July 27 survey was run in a radial pattern around the island, approaching to within 15 m of the island and extending several hundred meters offshore. By September 18 the ice island had dissappeared and the survey was run over the area it had formerly occupied. Neither of the surveys showed any anomalous bottom morphology, except some remnants of the island's plumbing system which we observed on September 18.

In addition to these two surveys, several fathometer/sub-bottom profiler (7kHz) survey traverses were run over the ice pedestal surrounding the ice island on August 16. These traverses were run on straight courses, tangential to the island, bringing the starboard side of the vessel and the transducer mount as close to the island as possible. The record of several of these tangential traverses is shown in figure 11. The distances from the hull to the cliff, estimated in meters, along with the ships heading, are marked. The records reveal the concave upward surface of the ice pedestal, and show where the ice pedestal begins by the disappearance of a clear sub-bottom reflector 1.5 m below the surface. This reflector represents the base of Holocene marine sediments. Thus the ice, even where it is only 20 cm thick, is opaque to seismic signals at a frequency of 7 kHz.

A sketch outline of the island and the hydrographic stations taken July 27 is presented in figure 12. At the time of the measurement there were light winds blowing from the northeast. Measurements were made at the surface and near the bottom. The values of salinity, transmissivity, and temperature reflect the decay of the island. The island serves as a heat sink, and a west-northwestward trending wake is characterized by higher salinity and lower light transmissivity and temperature than the water on the updrift side. The lower light transmissivity readings in the wake may be largely the result of mixing of waters with different indices of refraction, as apparently no sediment is being added to the water by the ice or by bottom scour from currents. The higher salinity readings in the wake are evidence that the average salinity of the ice island is several parts per thousand higher than the 15.5% salinity water attacking the island from the east.

The results of our studies on the Exxon Ice Island show that there are no long-lasting effects on the physical environment in this particular setting. No large bedforms of the type seen in shallow water around Reindeer Island or Dinkum Sands (Fig. 3 of Attachment B of this report) were formed around the large mass of grounded ice.

Small-scale bedforms of scour and fill are in dynamic equilibrium with rapidly changing flow conditions and are left behind as the perimeter of the ice pedestal retreats. The pedestal shrinks back in size at the same rate as the subaerial boundaries of the ice island. On the weather side of the island this erosion rate is at least 5 m per day during the summer. The 10 - 15 m

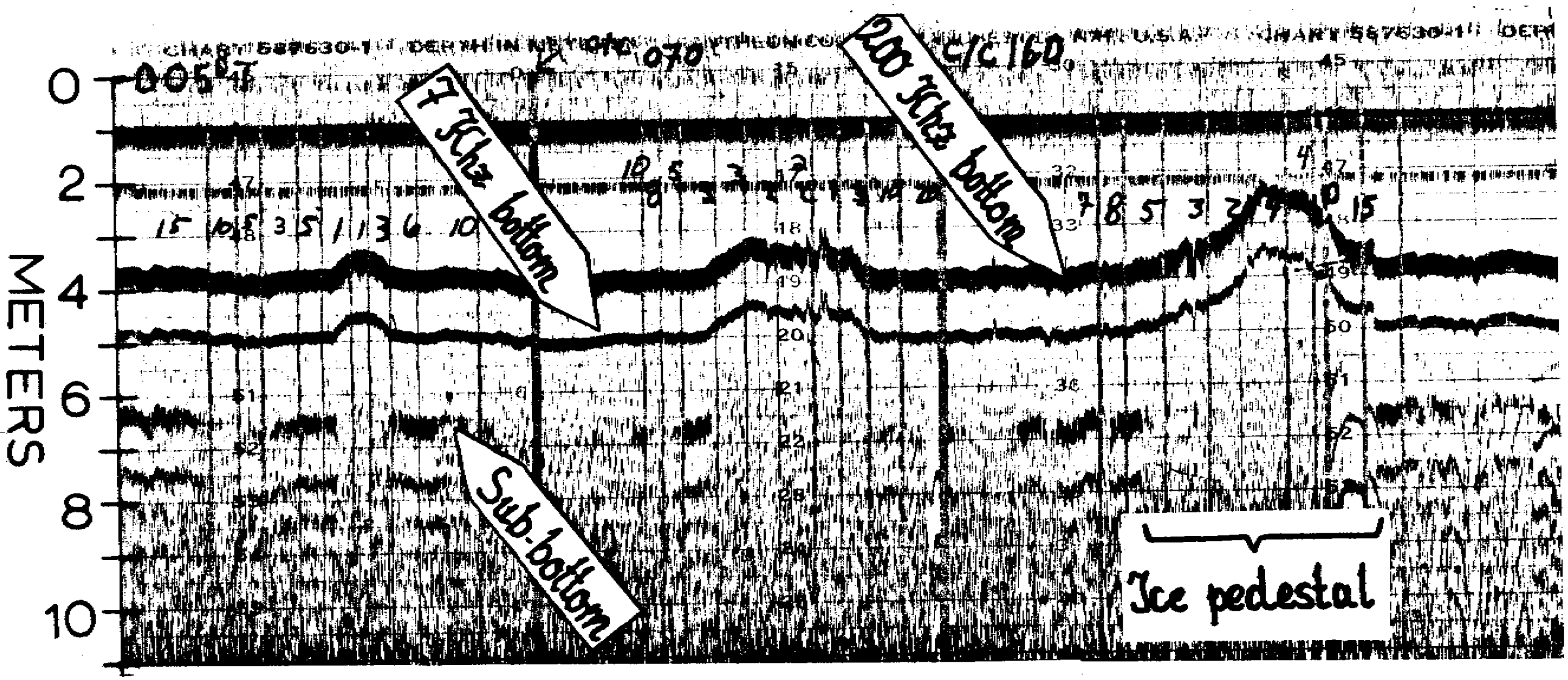

Figure 11. Fathometer/7 kHz sub-bottom profiler records of short tangential passes close to the island bluffs. The numbers above the 200 kHz bottom trace are estimated distances between the hull and ice bluff. The courses are written along the top of record. Note the concave upward shape cause by the ice pedestal, and the loss of bottom penetration in the three places where the pedestal was crossed.

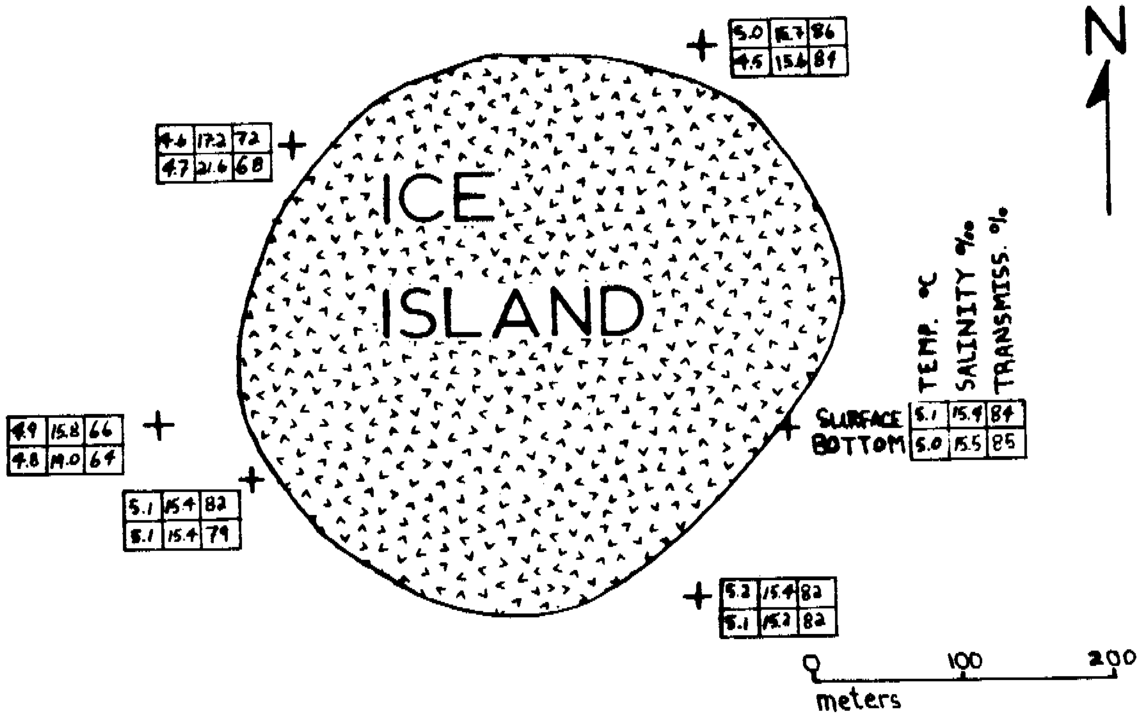

Figure 12.
Sketch of ice island on July 27. The crosses mark locations of hydrographic stations where temperature, salinity, and transmissivity were measured at the surface and at the bottom. The wind was northeasterly, and the current westerly, on this date.

extent of the submerged ice pedestal was unexpected. The combined effects of wave action and higher temperatures and flow velocities in the upper part of the water column result in higher melting rates than in the quieter and cooler bottom waters. These factors may explain the enormous extent of the ice pedestal. But the ice grown by slower natural processes prior to island construction and then depressed by surface loading also is stronger than the artificial, rapidly grown ice above. Differences in erosion resistance therefore may also affect the overall profile of the stratified ice pile. The extent and thickness of the ice pedestal margin must be a function of ice strength and buoyancy. Here the gap between the ice base and the seabed probably is due to plastic deformation caused by the buoyant force of the ice. The separation of the ice base from the sea bed suggests that the two had not been fused during the freezing process. We believe that grounded ice islands and multi-year shear ridges in the relatively warm waters of the inner shelf will assume configurations similar to that of the submerged portion of the Exxon Ice Island. The lack of observations on such submerged ice pedestals is probably due to the technical limitations in measuring underwater profiles of ice keels.

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Attachment B

Dinkum Sands

by Erk Reimnitz, Robin Ross, and Peter Barnes

The strategic position Dinkum Sands occupies in the Beaufort Sea lease sale area is shown by the news media coverage this tiny shoal received in the State of Alaska in 1979, and by plans to monitor Dinkum Sands at 5-minute intervals for the production life of the oil field. During summer field work of the R/V Karluk we had various opportunities to observe the shoal, both from the air and from the ship. We also ran a short bathymetric survey to search for the highest point on the shoal. This report summarizes our findings.

Our first visit to Dinkum Sands on July 15, 1979 was prompted by reports that the State of Alaska had rediscovered the 'island.' The shoal, as seen from a helicopter on that date, is shown by an aerial photograph in figure 1. Shallow water over the crest of the shoal is studded by a series of isolated, small, irregular mounds which break the sea surface. Many small grounded ice floes, remnants of ice piling on the shoal in the previous fall, are also shown in the photograph. Submerged sea-ice kettles and ice gouges are seen separating the line of gravel mounds.

Our next visit to the shoal was with the R/V Karluk on July 25. We made a search for the shoalest point of Dinkum Sands using precise range-range navigation and a survey fathometer, while observing the sea surface for signs of shallow water. On this day the shoal was entirely submerged. The survey ended at the shoalest spot where the vessel ran aground and one of us waded across the crest of Dinkum Sands, finding a minimum water depth of 30-40 cm.

The tracklines we surveyed on July 25 are shown in figure 2. The fathograms, with times keyed to the tracklines, are shown in figure 3. The water depths recorded are contoured at 1-m intervals, using the sea surface during the time of our survey (approx. 1200 to 1400 hrs) as a zero base (Fig. 4). Therefore this contour map does not account for tidal variation from the normal, which we estimate to be less than 30 cm at the time of the survey.

On August 23 State and Federal Officials accompanied us on the R/V Karluk for a visit to Dinkum Sands to observe a flag placed on the highest point by the State of Alaska (Fig. 5). A survey monument had been placed flush with the crest of the shoal on this spot. At the time of our visit the monument was beginning to protrude due to erosion of the surface gravel. The shoalest spot was submerged under 20 cm of water.

There were a number of flights over Dinkum Sands before and after this date, and Peter Barnes visited the shoal with the Karluk several times after our August 23 visit. The shoal was observed both above and below water during these visits. On September 8, when the sea level was very low, the crest of the shoal was 50 cm above sea level and measured 30 m by 5 m at the water line. Barnes reports that during the last visit of the season on September 23, the shoal crest was 10 cm above water and had shifted 15 m in a direction of 127^0T from the State monument. By this day gravel erosion had excavated the top 72 cm of the monument.

The twelve observations of Dinkum Sands made during the summer of 1979 by members of our team and other reliable observers, revealed that on four occasions the area was above water and on eight occasions the area was under water. On one occasion when the area was seen above water the sea level was known to be abnormally low. The very crest of the shoal shifted southeastward by at least 15 m in one month and probably continued to shift until freezeup.

Hydraulic processes are probably responsible for the overall shape of the shoal, although ice shove also plays a part. The irregular mounds breaking the sea surface at breakup were clearly the result of ice plowing on the back of the submerged linear shoal. The mounds were in disequilibrium with wave and current-related processes and therefore were removed in less than ten calm-weather days with limited fetch for wave generation.

A comparison of the bathymetry around Dinkum Sands as surveyed in 1950 and 1979 (Fig. 6) shows that the high spots are at nearly identical locations. This is surprising, because the crest shifted approximately 15 m in a period of one month and the surrounding seabed has changed substantially. In 1950 Dinkum Sands was located on the back of a northwest-trending ridge--now Dinkum Sands is on the back of a distinct northeast-trending ridge. The formerly well-defined northwest-trending ridge with a minimum depth of 3 m in the southeastern corner of the surveyed area, has been eliminated and minimum water depth there is 5 m.

The Hydrographic Survey No. 7761, from which the upper portion of figure 6 was copied, states "Dinkum Sands bares 3ft at MHW." We question the elevation datum used in the bathymetric surveys run from 1949 to 1951, because approximately three feet must be added to depths shown on published bathymetric charts in order to obtain the true depth. In extensive regions of smooth sea floor, where water depth is constant for periods of half an hour or more of ship's travel, such as in Prudhoe Bay or other shallow lagoon areas, there can be no doubt about this discrepancy between charted and true depths. Also, Lewellen (1977, p. 508) reports that the indicated elevation of the flat tundra surface bordering Simpson Lagoon is several meters too high on U.S.G.S. topographic maps. These observations suggest that Dinkum Sands may in fact have crested near or slightly below mean sea level, as is the case at the present time.

The incoherent, gentle relief forms so characteristic of shallow water areas of the Arctic are prevalent around Dinkum Sands, as shown on the fathograms in figure 3. On the bathymetric contour chart (Fig. 4) these relief forms can only be shown as isolated, semicircular mounds and depressions because trackline coverage is not dense enough to allow correlation from one crossing to another. Based on our surveying experience in other similar areas, we know, however, that additional trackline coverage would only reveal an increased number of semicircular mounds and depressions. This phenomenon is not observed in similar settings at low latitudes and we have no good explanation for it.

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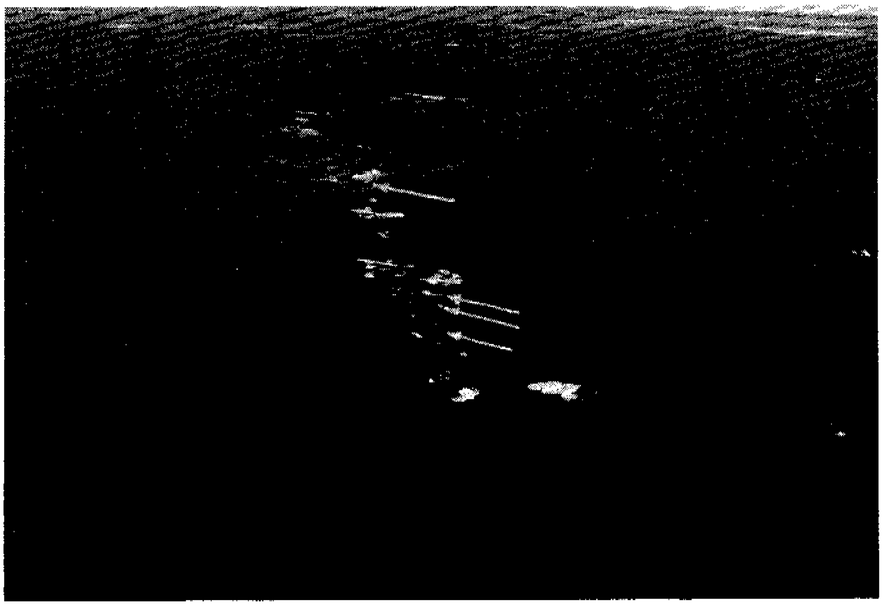


Figure 1.
Aerial photograph of Dinkum Sands on July 15, 1979. The major gravel mounds above sea level are shown by white arrows. All other white objects are ice.

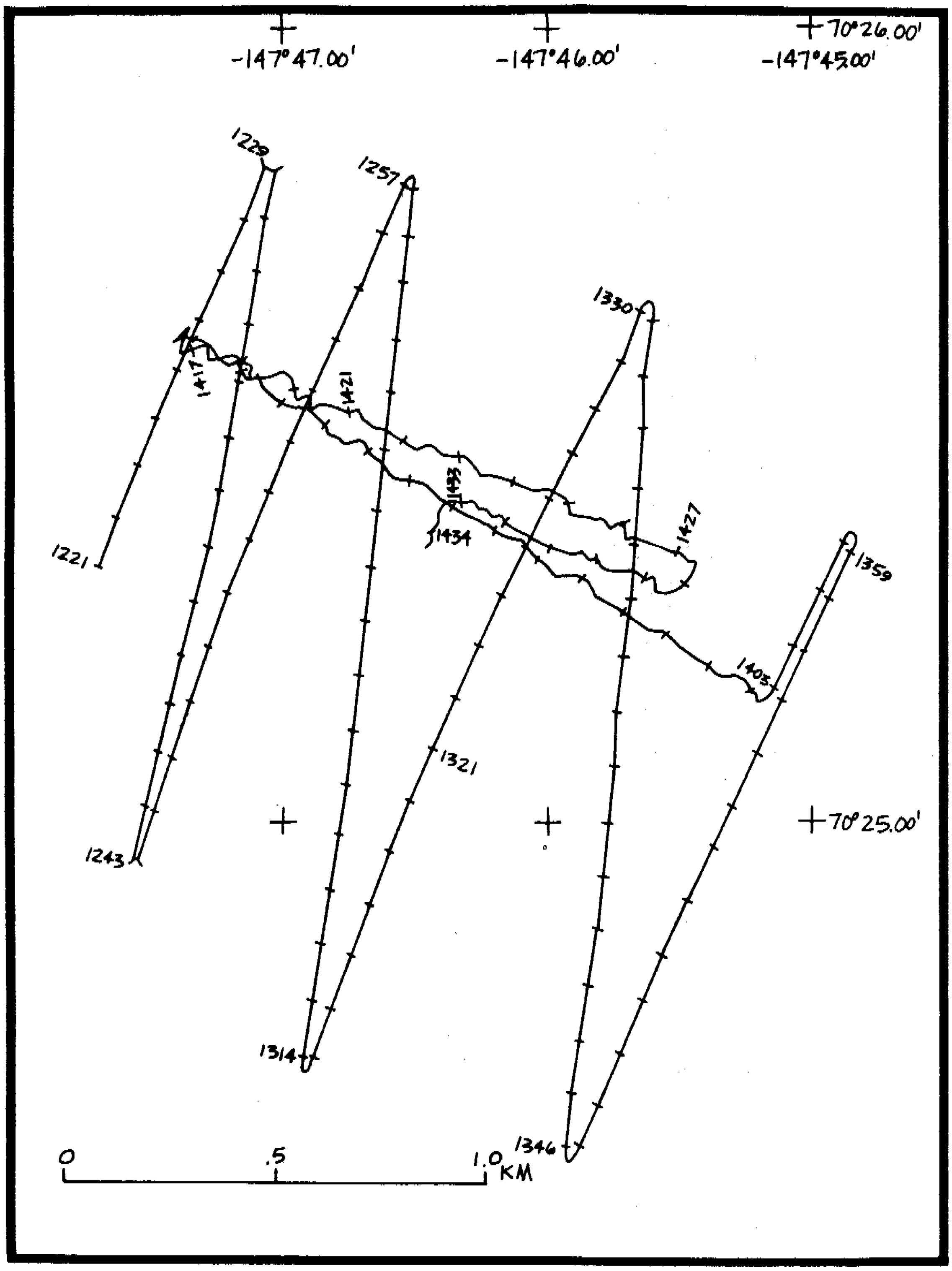


Figure 2. Tracklines surveyed on July 25, 1979 in a search for the shallowest point on Dinkum Sands. The survey ended where the vessel ran aground.

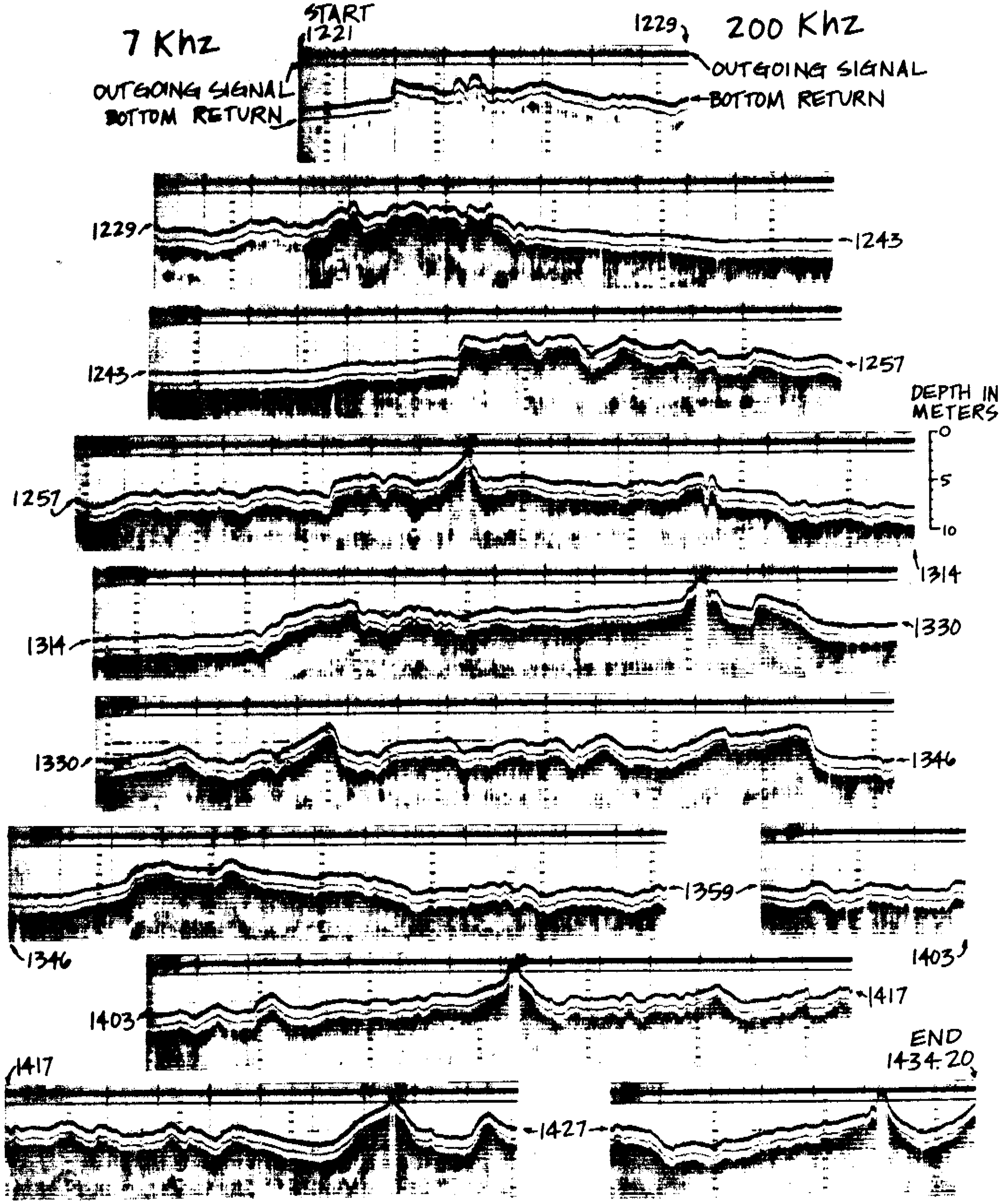


Figure 3. 200 kHz fathometer and 7 kHz sub-bottom profiles recorded along and keyed by times to tracklines of figure 2. (Prepared at Marine Science Data Center, Project Chief T.E. Chase, by Jeff Young).

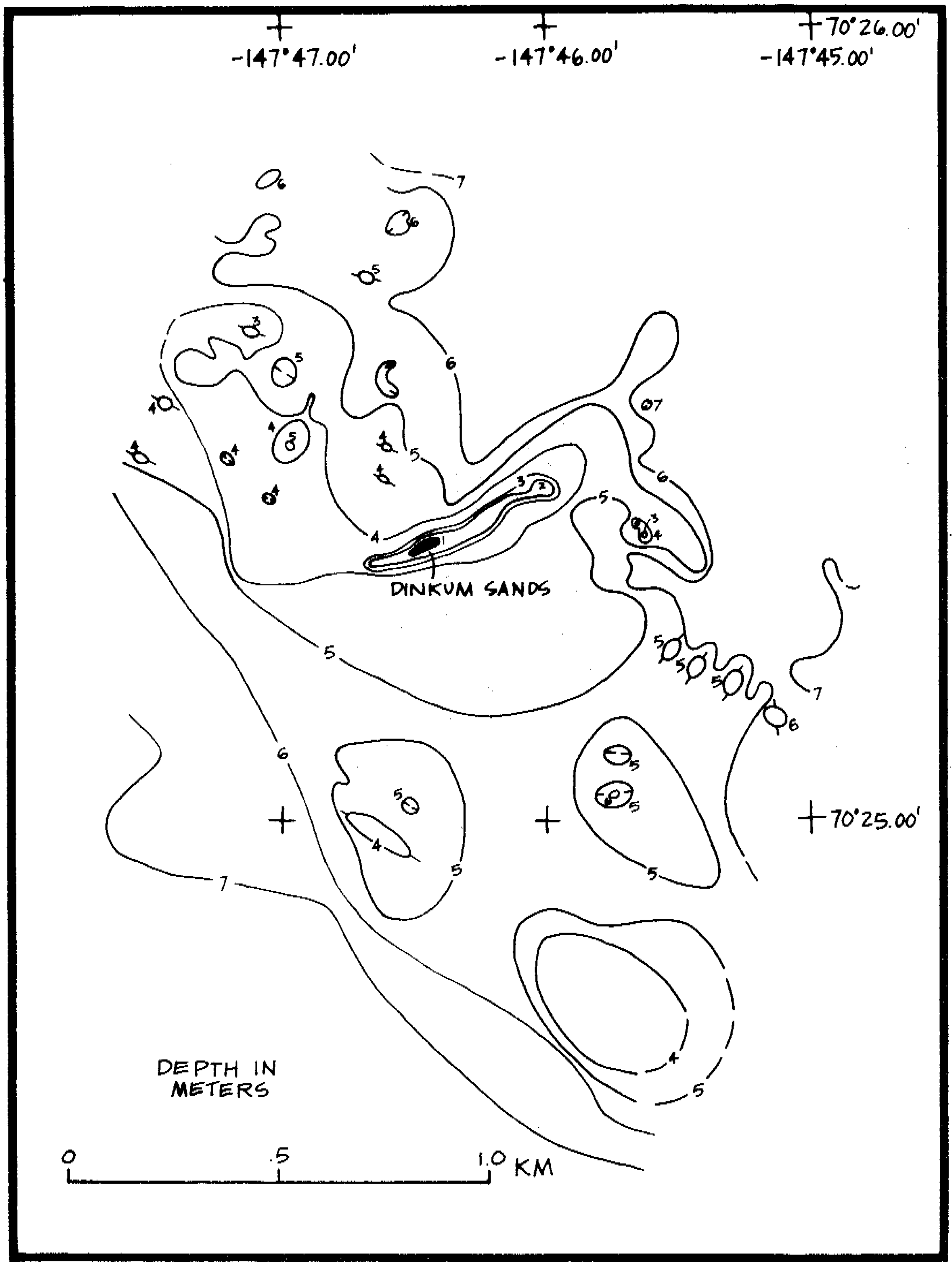


Figure 4. Water depths around Dinkum Sands, contoured in meters. Zero level is the sea surface during the time of the survey. Note numerous semicircular, closed depressions and elevations of 1 m, characteristic for Arctic shallow water areas.

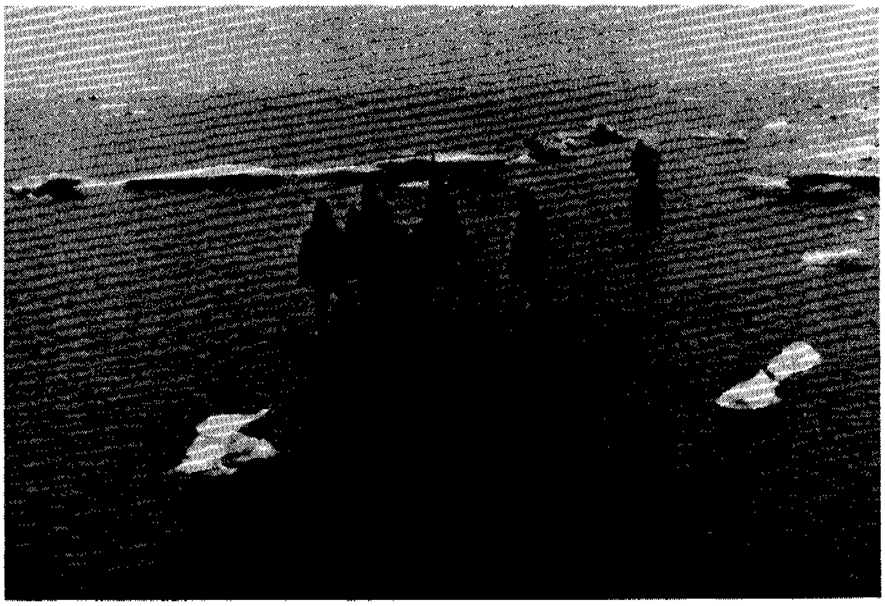
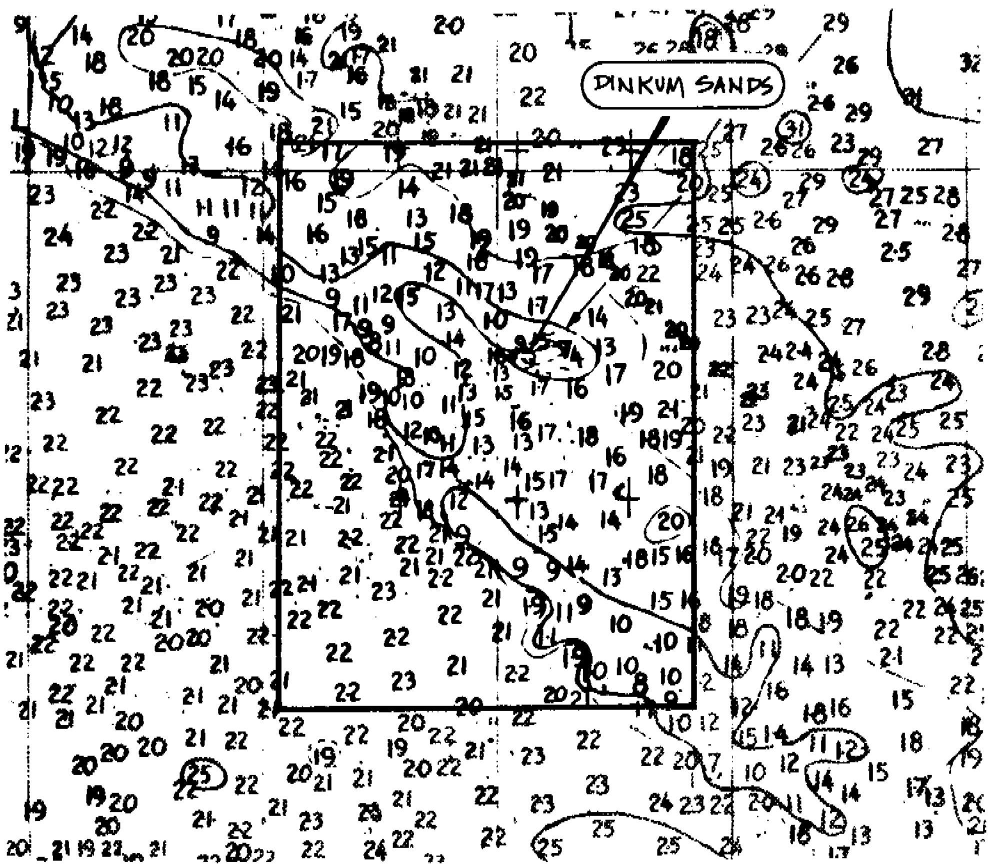


Figure 5.
Dinkum Sands with the State of Alaska flag, during a visit by State and Federal officials on August 23, 1979. Minimum water depth was 20 cm.

a)



b)

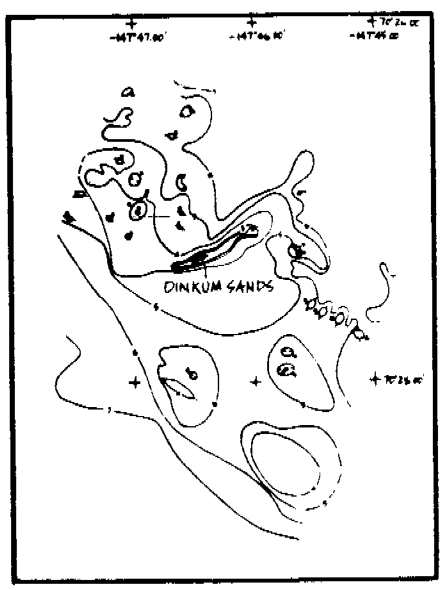


Figure 6. Comparison of bathymetry as surveyed in 1949/50 and 1979.
a) Copied from Hydrographic Survey No. 7761, with depths in fee
b) Reduced from figure 4.

Attachment C

Marine Geologic Studies in the Beaufort Sea, Alaska, 1979; Data Type, Location, and Records Obtained

Peter Barnes, Erk Reimnitz, Edward Kempema, Peter Minkler, and Robin Ross

The U.S.G.S. vessel R/V KARLUK ran approximately 1300 kilometers of trackline surveys on the inner shelf of the Beaufort Sea, Alaska, from July through September 1979. In addition to the trackline survey, 12 observational SCUBA dives were made and 20 vibracore samples were collected.

Ice and weather conditions were very favorable this year and several major areas and environments were studied in detail:

1) Several lines were run seaward of the islands between Cross and Flaxman Islands, where major data gaps existed.

2) High-resolution seismic surveys were run over the sites of 20 U.S.G.S. Conservation Division core holes that were drilled during the winter of 1979. These lines were run to see if the drill logs and seismic records could be correlated.

3) Detailed bathymetric and side-scan sonar surveys were run in several areas (test line 1, test line 2, etc.) for the purpose of determining rates of ice gouging and sediment reworking. Some of these surveys were run in order to gain information on arctic nearshore processes (Reindeer Island and Pingok Island surveys are examples).

4) Sediment samples and bottom observations were made by SCUBA diving and vibracoring in several different environments which included the boulder patch, areas of strudel scour, stiff silty clay outcrops, and ice-gouged terrain.

On most survey lines positions were plotted using a Del Norte range-range system with a distance-measuring accuracy of ± 3 meters. On most lines this system provided a position accuracy of $\pm$ 8meters. However, in areas near the baseline extension of the navigation shore stations, the position error is much greater due to the geometry involved. Lines 3, 20 and 63, for example, were run near the baseline extensions and therefore have some positioning errors. In areas not covered by the Del Norte system, radar ranges were taken from available targets, usually with an accuracy of ± 200 m.

Bathymetry was recorded on a Raytheon RTT 1000 dry paper recorder using a hull-mounted 200 kHz transducer with an 8^0 beam width, and on some lines a 200 kHz narrow beam (4^0) transducer was towed below the surface. All records are corrected for draft of vessel and tow depth. A 7 kHz transducer used in conjunction with the RTT 1000 recorded subbottom reflectors up to 20 m below the sea floor. Deeper penetration high-resolution seismic data were recorded on an EPC Model 1400 recorder at 1/4 or 1/2 second sweep, the signal was filtered to approximately 600-1600 kHz. Several different sound sources were used for the high-resolution seismic work including a 500J minisparker, a 600J EG&G Model 234 uniboom, a 500J 3-tip sparker, and a 10 $inch^3$ air gun.

The side-scan sonar records were taken using a Model 259-3 EG&G system and a Model 272 sonar fish operated with a 105 kHz 1/10 second pulse at a 20^0 beam angle depression.

Vibracore samples were obtained with a Kiel vibracorer. The vibracore uses and electric motor to drive a hammer against an anvil at the core head. The force generated by the hammer striking the anvil 2,840 times a minute drives a 2-m core barrel into the sediment. The core barrels are 10 x 10 cm metal boxes. Core lengths varied from 20 to 190 cm.

Data acquired consist of approximately 1150 km of bathymetry, 7 kHz subbottom profiles, 825 km of side-scan sonar, and 630 km of high-resolution seismic records. The data is in the form of 37 rolls of bathymetry, 30 rolls of side-scan sonar, 14 rolls of high-resolution seismic records, 2 rolls of Simrad fathometer records, and the ship's log. The ship's log contains information on systems in use on each line, system settings (scale, filters, etc.), and navigational data used in plotting the lines. In addition to the above data, 10 observational SCUBA dives were made and 20 vibracore samples were collected. All data are available for inspection at the U.S. Geological Survey, Rm. B-164, Deer Creek Facility, 345 Middlefield Road, Menlo Park, California 94025. Copies of the report and the data are available from National Geophysical and Solar-Terrestrial Data Center, NOAA, Boulder, CO 80302.

The data presented here are currently being studied by the authors as part of a long-term study of the Beaufort Sea. The authors may be contacted for a bibliography of publications using the above data and data from previous years.

Attachment D

Ice-pushed Boulder Pile - Camden Bay, Alaska

By Peter Barnes and C. Robin Ross

The interaction of sea ice with the seabed and coast is a significant factor in forming the coastal morphology and geology of ancient arctic coasts, and in determining design criteria for artifical structures in the coastal environment. A rigorous treatment of historical and recent field observations of ice pile-up and ride-up, along with a theoretical treatment of the ice dynamics involved with pile-up is given in Kovacs and Sodhi (1979). These authors also point out many of the beach and coastal features resulting from ice interaction with the coast.

This report addresses a single area where ice push has been an important mechanism in forming the coastal morphology. The boulder ridge described is apparently related to the onshore and offshore geologic environment and to the nearshore ice environment.

Environment

The arctic coast of Alaska is partly bounded by 1- to 4-m high sand and gravel islands which form barriers that protect the lagoons and sounds. The coast is composed of 1- to 10-m high bluffs of frozen marine and non-marine units of the Pleistocene Gubic Formation (O'Sullivan, 1961, Black, 1964). Sediments from the ice-rich tundra bluffs are released for transport during the summer due to the combined effects of thermal and wave erosion (Lewellen, 1977).

The seasonal growth of sea ice along the coast is generally between 1.5 and 2.0 m. Piling of ice due to ice motion within the ice field or against the coast can increase ice thickness many times at any one location. Where ice interacts with the coast, Kovacs and Sodhi (1979) noted the resulting beach morphology has typical relief of 0.5 to 2 m and rarely extends more than 10 m from the water's edge. The ice-piling events are of short duration (15-30 min.) and both thick and thin ice can be involved in ice-push events. These authors do not treat the effect boulders might have on an ice-push event.

The prevailing northeasterly winds during the long winter are instrumental in developing ice ridges where the moving pack ice interacts with the more or less stable coastal ice sheet. These ridges normally form in water 15 to 20 m deep, creating a Stamukhi zone of firmly grounded ice and thus form a deterent to subsequent onshore ice-push events (Reimnitz and others, 1978). Ice pile-up in the nearshore area has been reported, locally and/or early in the ice-growth season, particularly where islands and coastal promontories project seaward (Kovacs and Sodhi, 1979). Coastal and nearshore movements have also been reported during breakup in July (Kovacs and Sodhi, 1979; Shapiro and Metzner, 1979).

During the summer of 1979 we visited a unique boulder beach ridge inside the entrance to a lagoon on the mainland coast east of the Canning River in Northern Alaska (Fig. 1). Boulders up to 1.4 m in diameter, lying at the angle of repose, formed a ridge from the water's edge to a height of 3.5 m, apparently abutting against a 2-m high tundra bluff. The total length of this

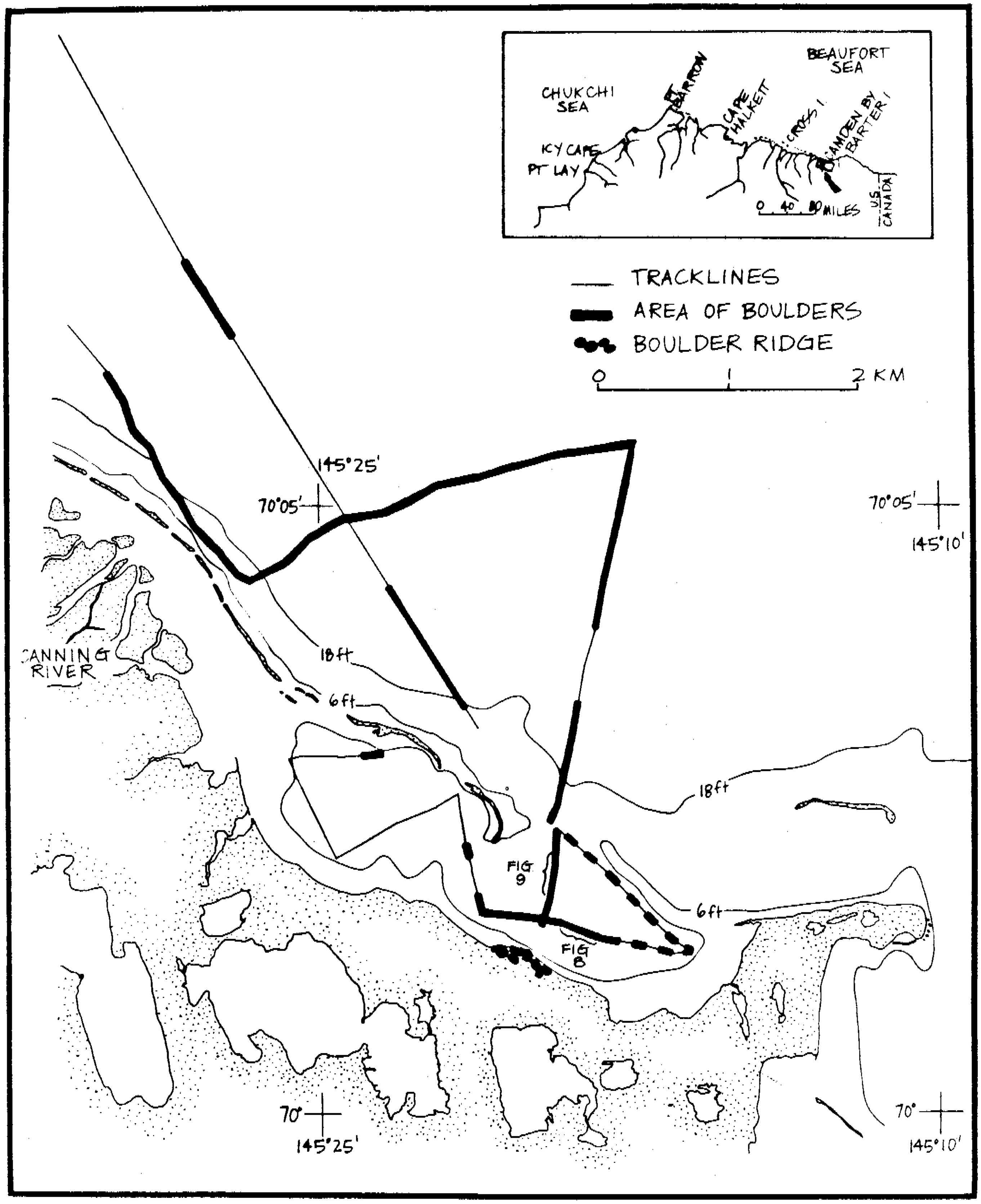


Figure 1. Location of boulder ridge and side-scan sonar tracklines east of the Canning River. Heavy segments of the side-scan lines indicate areas where boulders were interpreted from the records as in figure 8.

ridge was 300 to 400 m with height and boulder abundance decreasing laterally from the central sector. The ridge extended back from the water line 10 m but sand and gravel patches occurred on the top of the tundra up to 15 m further onshore. Sand and gravel were also present in patches on the tops of some of the boulders. (Figures 2 through 5 illustrate the above relationships.)

Evidence for lateral push from offshore was present in the form of folded tundra matts at the eastern end of the boulder ridge (Fig. 6). Additionally, a 1-m diameter boulder left a gouge several meters long, oriented perpendicular to the shoreline, and created a push-type moraine and lateral debris ridges (Fig. 7). A pipe in the central part of the ridge was bent between several boulders with the force direction coming from offshore.

Pink granites, pink gneiss and quartzite are conspicuous lithologies in the ridge. Boulder shapes vary from very angular to rounded. No remnants of marine growth were observed within the boulder ridge (Figs. 2, 5, and 7).

The tundra surface onshore from the boulder ridge contained several boulders with only their surfaces roughly flush at ground level as are those on Flaxman Island (Leffingwell, 1919). On either side of the boulder ridge (east and west) boulders were not observed at the tundra surface. (These relationships are diagrammed in figures 3 and 4.) This suggests that coastal erosion may have released these boulders as lag deposits which were then reworked by water and/or ice, leaving a lag which was subsequently concentrated into the present boulder ridge.

Offshore of the ridge boulders are widespread on the seafloor. Side-scan sonar records show small targets with distinct shadows cast by individual boulders on the seabed (Fig. 8). The side-scan records also show ice gouging inside the channel north of the boulder beach (Fig. 9). Study of the records indicates that boulder reflectors were present over much of the central and eastern part of the lagoon and extended seaward more than 8 km in water more than 10 m deep. The low sand and gravel islands to the northwest of the boulder ridge contained abnormally high concentrations of kelp but did not contain boulders. This suggests that the boulders support a 'boulder patch' type of benthos (Reimnitz and Ross, 1979). An echo sounder record taken near the boulder ridge indicated the characteristic lengthening of the bottom echo in areas of boulders but did not show the clear differences between boulder areas and non-boulder areas as was observed at sites in Stefansson Sound (Reimnitz and Ross, 1979). While we were attempting to anchor 300 m seaward of the ridge, our anchor brought up a cobble 30 cm in diamter. Laminaria and other marine growth were attached to the cobble.

The formation of the boulder ridge can be ascribed to mechanisms which involve ice. However, these mechanisms are not always consistent with our observations. Perhaps the most logical mechanism is ice-push (Kovacs, 1979) which bulldozes the lag boulders from the lagoon floor in an onshore direction, piling the boulders into the ridge. The ice would carry some sand and gravel which would be deposited when the ice melted. The seaward opening of the lagoon is directly opposite the ridge and the dominant winter northeasterly wind could provide a driving force for the ice. This is the mechanism described by Dionne (1978) for the formation of boulder ridges on lakes and rivers in northern Quebec. Dionne's illustrations show boulder ridges along the coast whose characteristics are strikingly similar to those described here from the arctic ridge building.

A) View of boulder ridge from eastern end. Note the lack of ridges in gravel and sand in foreground. Arrow points to boulder ridge and man in background for scale.

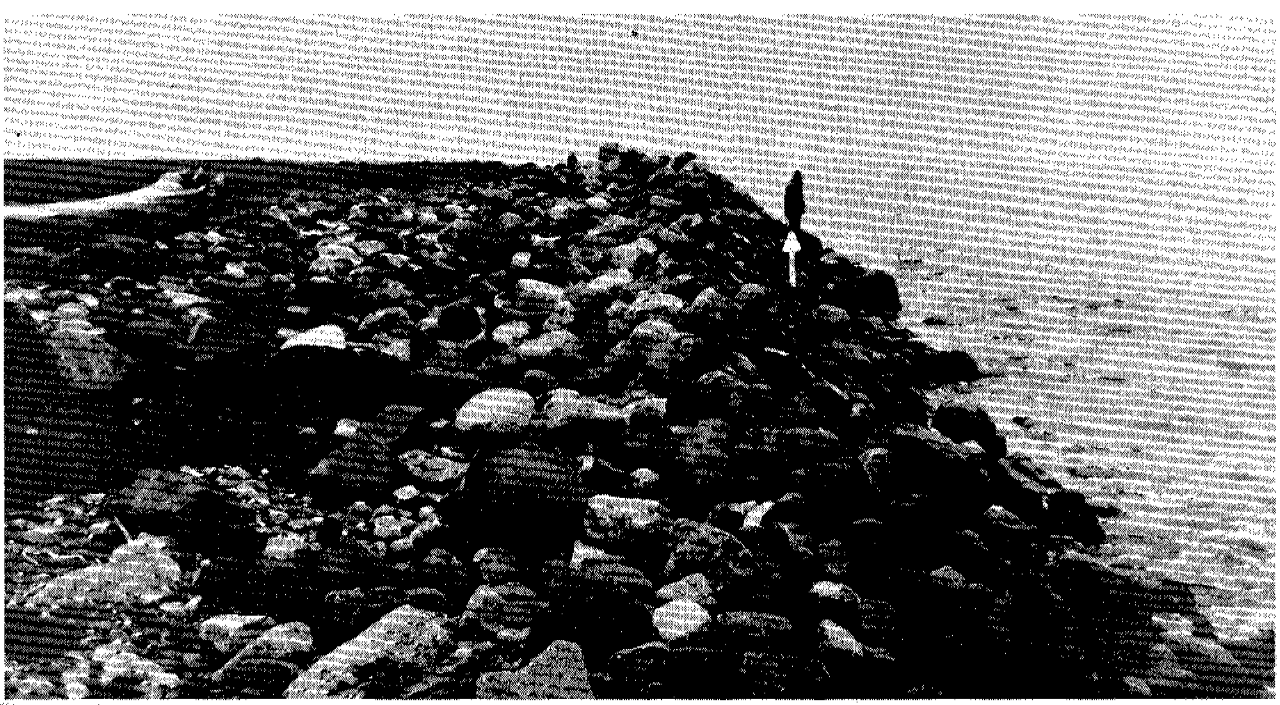


Figure 2. B) Close-up view of boulder ridge with man at water's edge for scale. Note the cleanliness and varied angularity of the clasts.

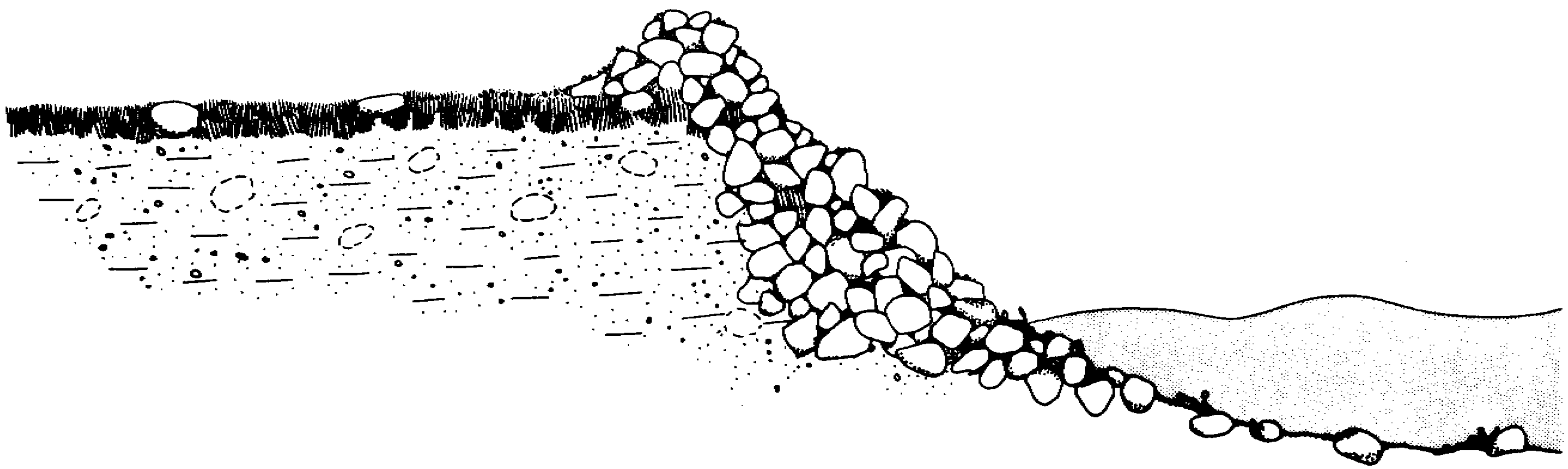


Figure 3. Diagrammatic cross section of the boulder ridge illustrating the presumed relationship of boulders in the tundra and offshore.

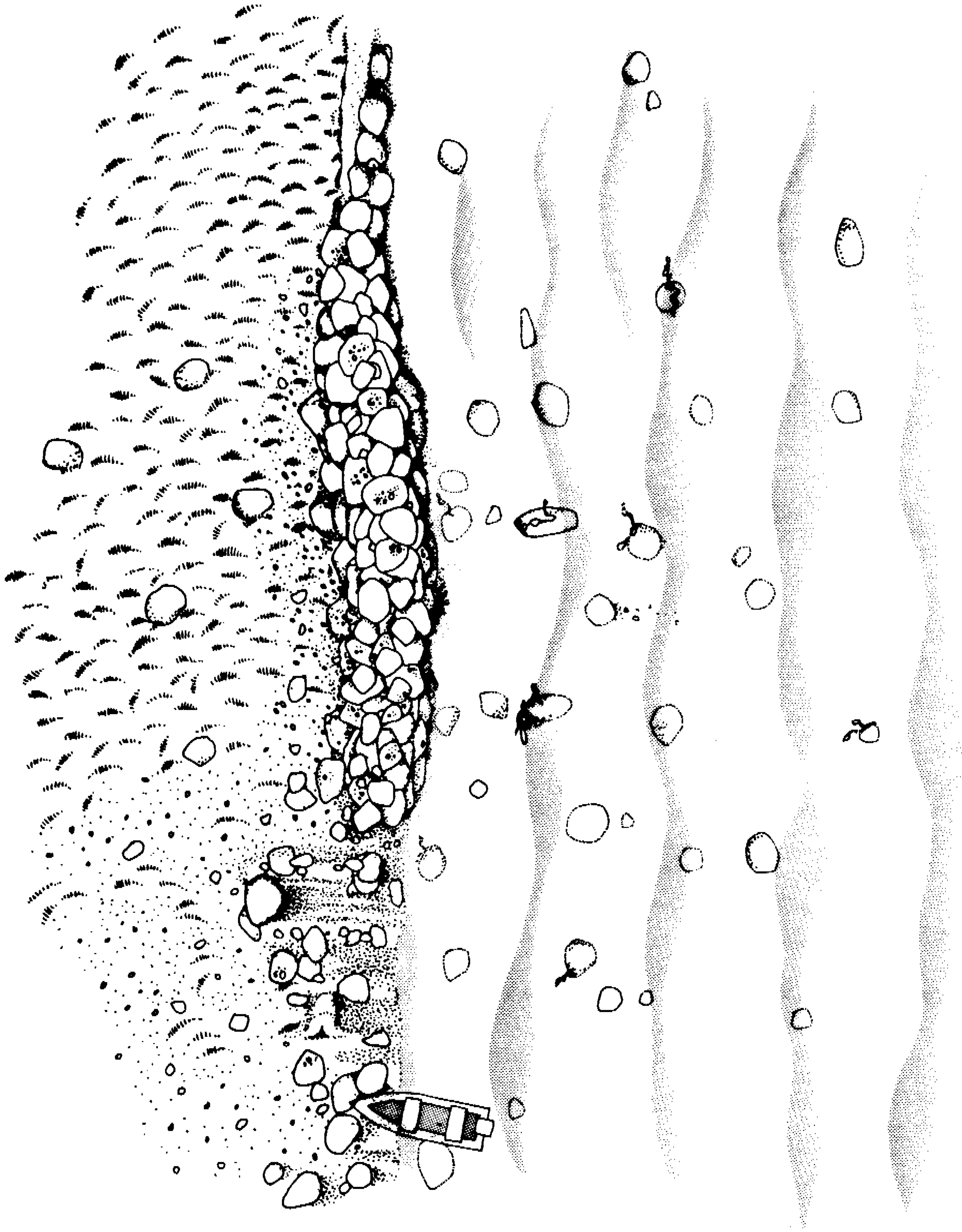


Figure 4. Diagrammatic plan view of boulder ridge--not to scale. Note the relation of the ridge to the boulders seen in the tundra offshore. Also note the distribution of gravel patches in the vicinity and on the ridge, and the ice-pushed boulders and tundra to the east (bottom).

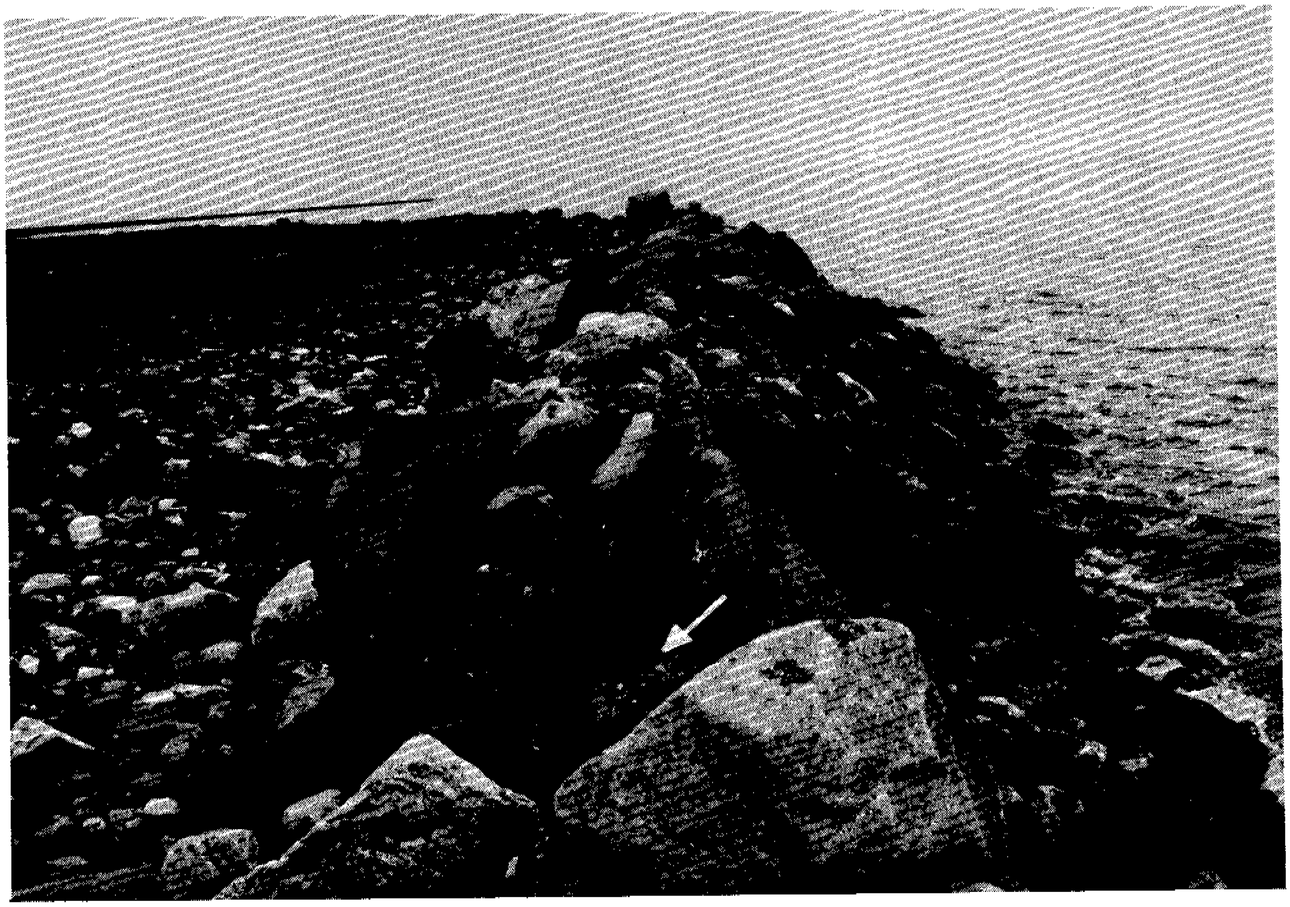


Figure 5. Close-up view of ridge from the ridge crest showing the lack of marine growth and the distribution of gravel patches behind and on top of the ridge boulders. The light-colored boulder in the foreground is about 1 m across.

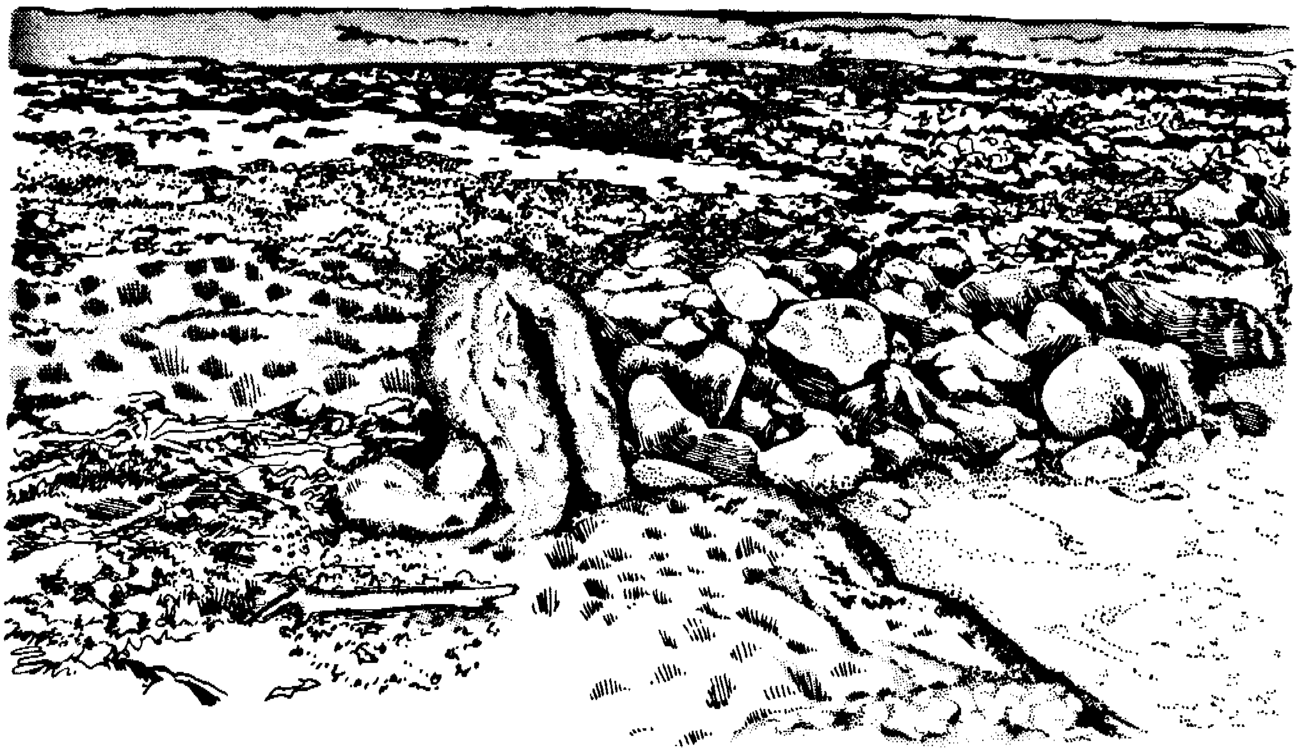


Figure 6. Folded tundra block at the east end of the boulder ridge. North is to the right. The tundra in the block is about 30 cm thick. Sketched from a photograph.

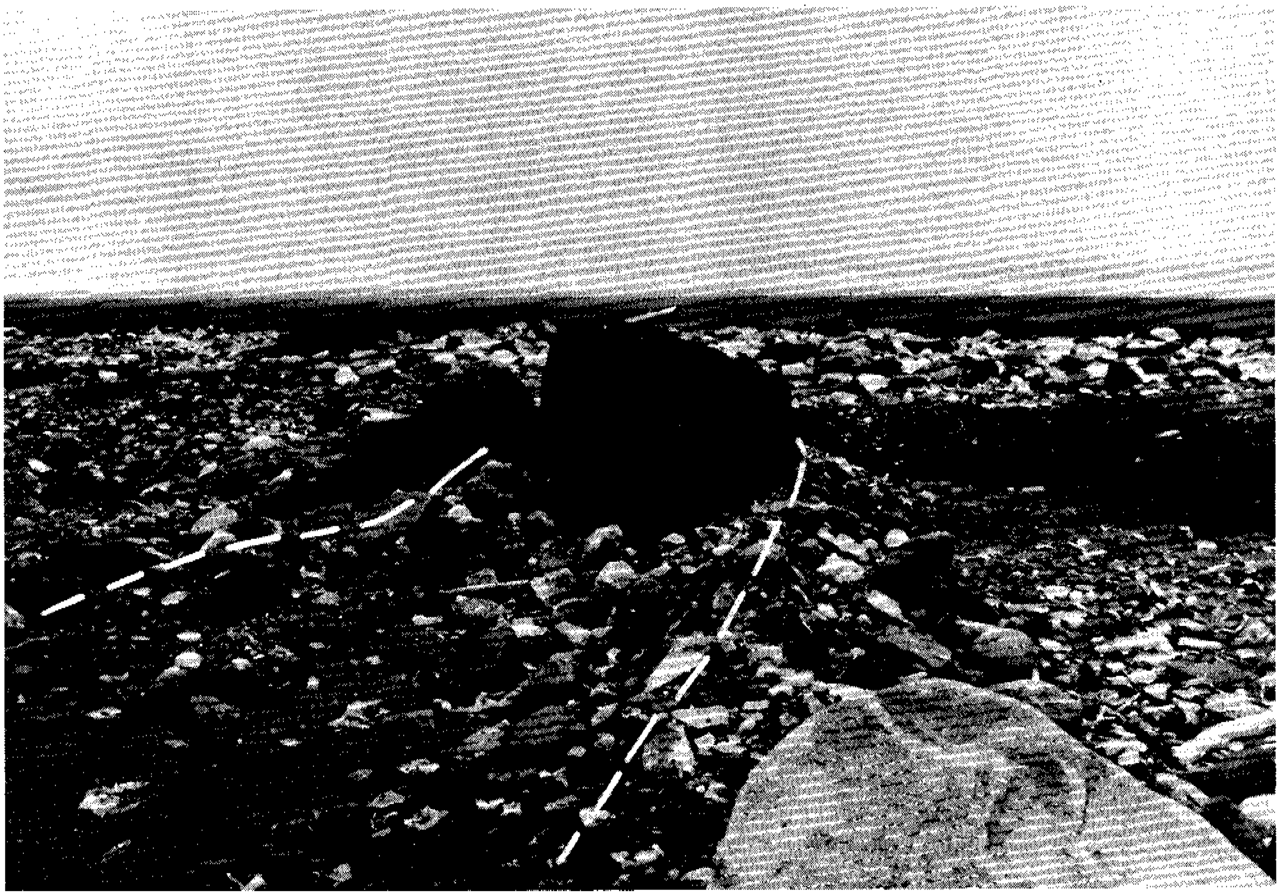


Figure 7. Ice-pushed tundra boulder looking onshore. Push moraine extends seaward from the sides of boulder (dashed line). The boulder is about 120 cm across.

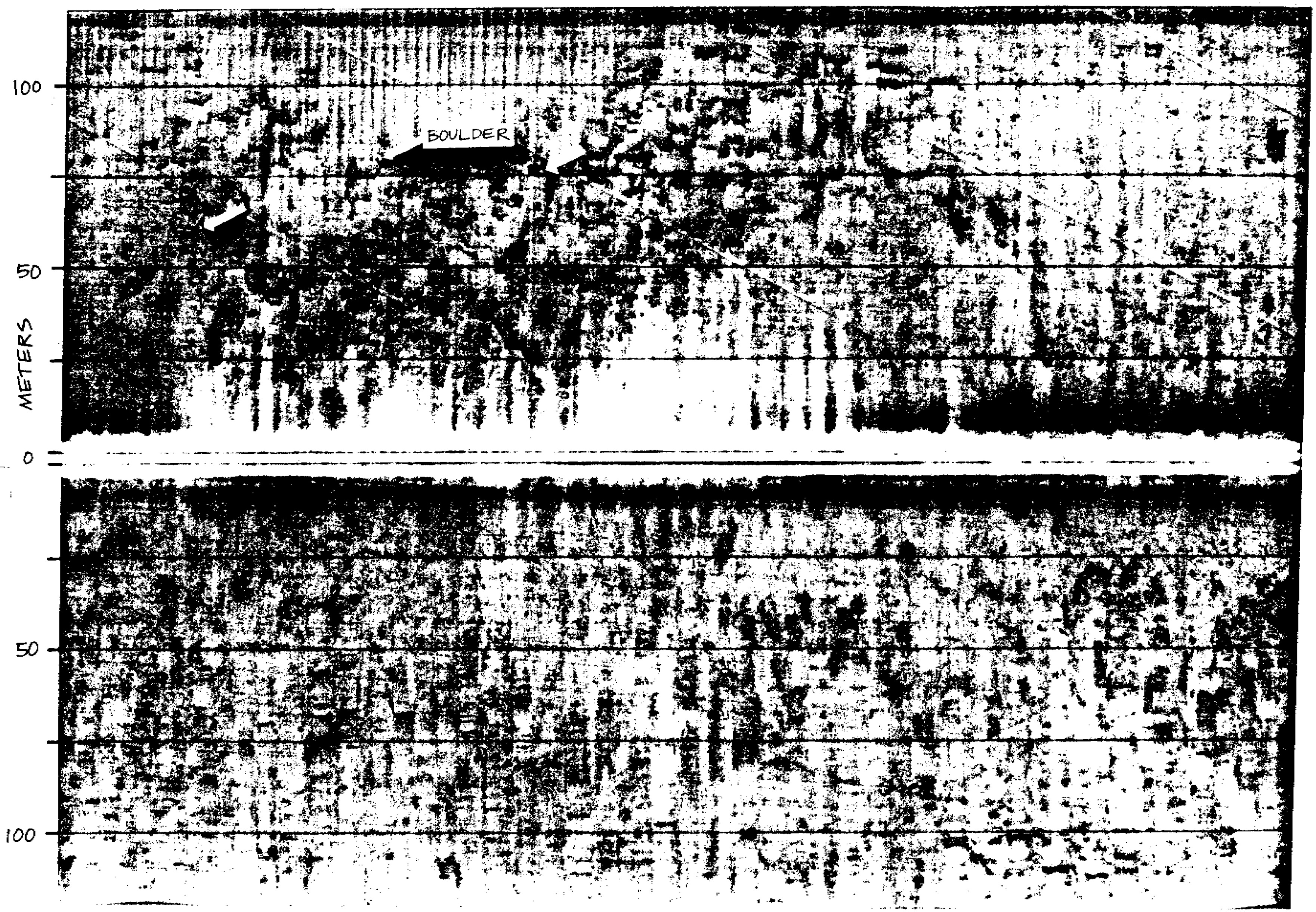


Figure 8. Sonograph of lagoon floor seaward of the boulder patch showing the character and distribution of boulders. Note the darker reflectors associated with the boulders, perhaps indicative of areas of outcrop. (See figure 1 for location.)

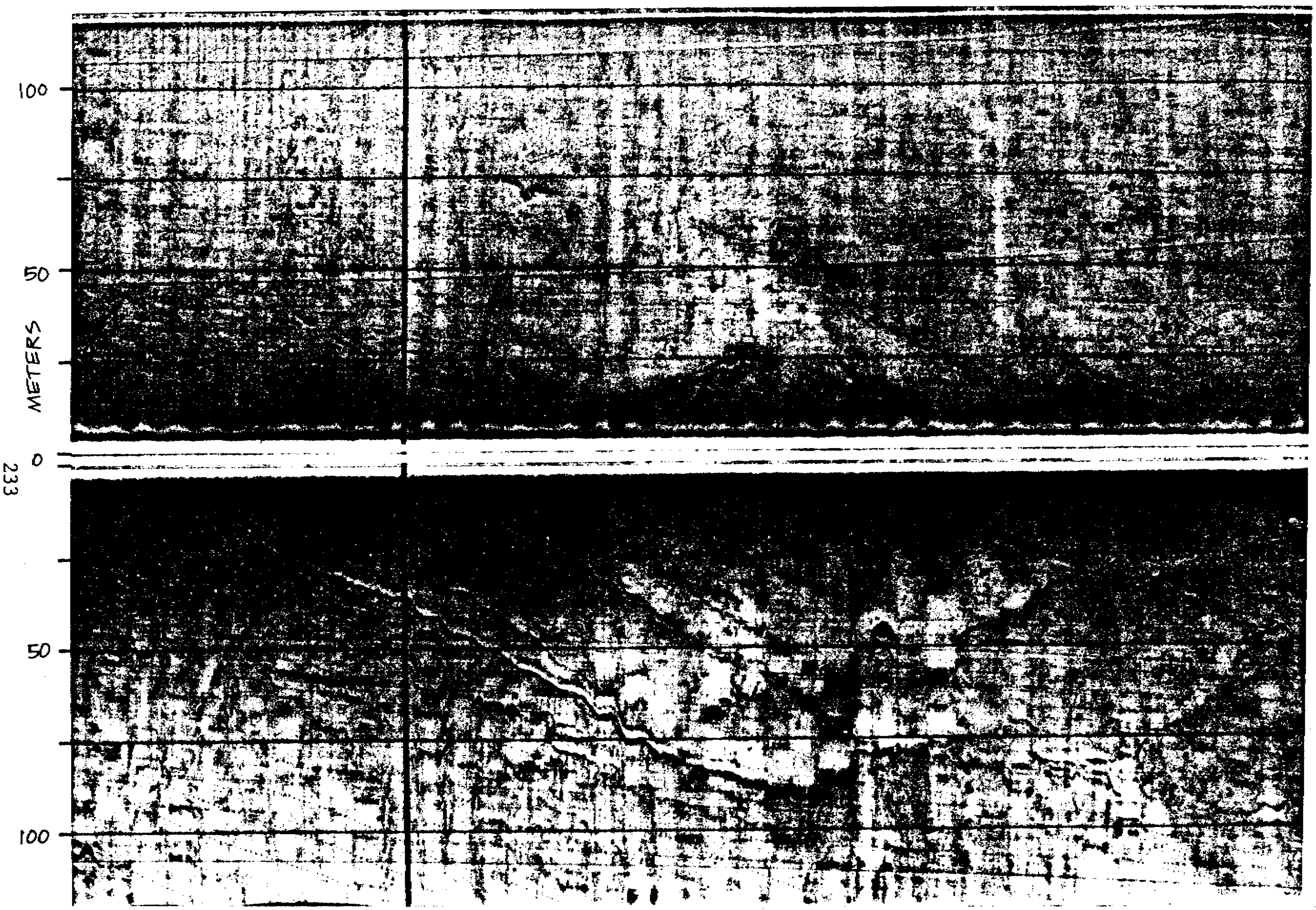


Figure 9. Sonograph of ice gouging on the sea floor at the entrance to the lagoon, seaward of the boulder ridge. (See figure 2 for location.)

If ice-push is indeed the mechanism, then there are several inconsistencies in the observations. a) Ice push from the lagoon floor should carry boulders with marine growth, although none were observed. b) Also one questions why ice-push would be limited to carrying boulders onshore as sands, gravels, and muds at either end of the boulder ridge did not show ridging due to ice-push. c) The locality is not a likely area for ice-push to occur due to the presence of islands and shoals which form barriers to ice-push forces, although the ridge is directly opposite an opening in the barrier chain. Elsewhere along the coast boulders are known to exist and they exist in locations where ice-push is more likely (e.g. Flaxman Island) yet boulder ridges have not been reported. The presence of a gravel lag on the boulder tops and ice-push moraine boulders that extend to the swash zone indicates that the event occurred recently. Given time (estimate less than 3 years) the gravels should be washed, blown or knocked off the boulders by waves, rain, wind or animals and the ice-push moraine should be subdued or obliterated by waves.

Two other observations seem pertinent. During the eight years that we have operated a small research vessel in the arctic, often in areas where boulders are abundant along the coast, we have never run into one. Either we have been extremely lucky or there is some mechanism that preferentially removes boulders from the seabed between the 1- to 2-m depth contour. Perhaps a mechanism does exist. The seasonal growth of sea ice is usually about 2 m and inclusion of large objects in the bottomfast ice could mean they would move with the ice canopy either onshore, along shore, or offshore; if and when that ice canopy would move. If boulders were involved, they would create a natural weak point in the ice. Furthermore, if the ice sheet were under stress, it could break into boulder-sized pieces which might move and tumble in much the same manner that rock boulders would. This idea will be developed further.

The second observation involves the shape of the boulder ridge when compared to ice-push ridges (e.g. Kovacs and Sodhi, 1979). The cross sections of both are strikingly similar. It is interesting to speculate that ice boulders initiated the ridging process which included rock boulders as part of the matrix because of their similarity in size. Rocks would be included because they protrude from the seabed, and may either be within the ice canopy or readily pushed onshore by overriding ice sheets or bulldozed by small ice keels. Gravels, sands and silts would be excluded for the most part because they would be too small to be readily picked up, and when included, would consitute only a small portion of the mass. As ridging continues to develop, both rock and ice boulders form a jumbled ridge, with the rock boulders tending to remain at the base of the pile due to their higher specific gravity. This mechanism is diagrammatically illustrated in figure 10. If this mechanism does operate one wonders why it has not been observed before where boulders and ice-push coexist on the Alaskan coast, such as at Flaxman and Belvedere Islands.

Conclusions:

1) A boulder ridge as high as 3.5 m formed on the coast east of the Canning River in the past few years.

2) The ridge formed along the segment of coast where a boulder-rich segment of the Gubic Formation exists.

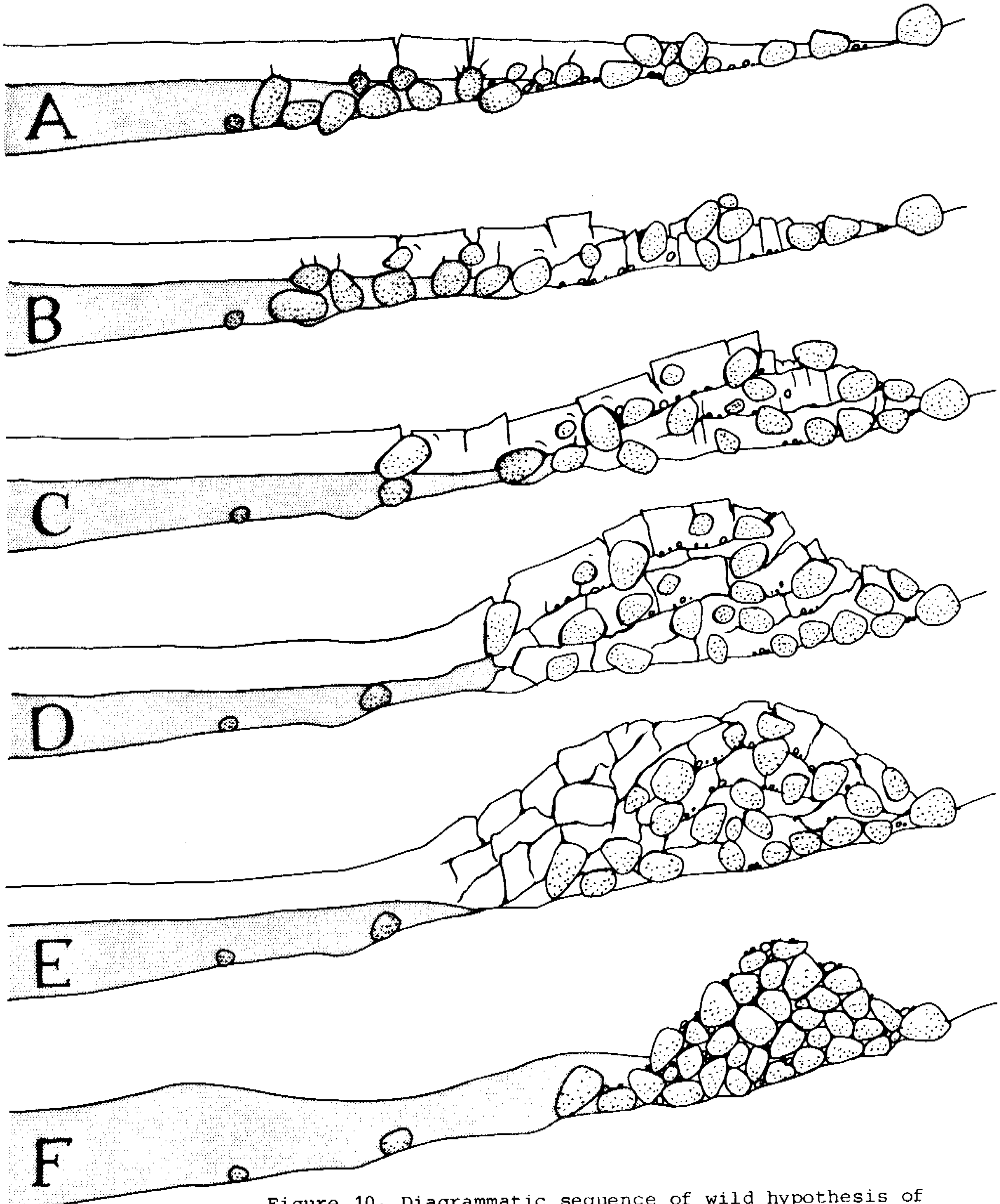


Figure 10. Diagrammatic sequence of wild hypothesis of boulder ridge formation involving interactions of ice and rock boulders inside 2-m contour.

3) The method of formation of the boulder ridge is linked to ice-push from offshore.

4) It is likely that a mechanism exists which preferentially sorts boulders from finer sediment sizes.

Implications:

Boulders used as rip-rap to protect natural and artificial islands from wave and current erosion might be more readily ridged, or plucked, from the seabed during ice movement events due to their larger grain size. The seaward face of the boulder ridge at the angle of repose may represent the most stable configuration for a boulder beach face under pressure from ice.

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Attachment E

Fall storm, 1979 - A Major, Modifying Coastal Event

Peter Barnes and Robin Ross

The occurrence of catastrophic events has always threatened and fascinated man. As agents of geologic change, these events are often more significant than the ongoing day-to-day processes. In the fall of 1979 wide expanses in the southern Beaufort Sea were ice-free. This lack of ice, coupled with persistent and occasionally strong northeasterly winds, resulted in the development of unusually large waves and swells running in from the northeast to impact the inner shelf and coast. Initially, until mid-September, large portions of the stamukhi zone remained grounded outside the island chains and decreased the force of winds and waves on coastal features. As the winds and waves continued, the stamukhi broke up, releasing ice blocks which, in some cases, moved inshore and grounded on the beaches and nearshore shoals. These ice blocks formed a rind of protective rip-rap that temporarily shielded those beaches from erosion. Continued physical and thermal erosion of coastal ice eventually removed all protection of the beaches from wave and current erosion.

To the east, at Barter Island, the winds blew from the east steadily from the 27th of September to the 6th of October. Velocities for all nine days exceeded 20 knots and the velocity exceeded 35 knots on four of the days (NOAA climatological data, Fig. 1). Wave amplitudes of 1.5 to 2 m were observed outside of the islands on the days preceding the wind event described above. In this report we describe the effects of the storm and the implications for erosion caused by such an event.

Narwhal Island

At the end of our summer field season (28 September) we visited Narwhal Island. At that time there was no ice grounded in the stamukhi zone to the northeast but there was a rind of ice tens of meters to a few hundred meters wide on the northeast coast. This rind prevented any erosion on the beach where we observed the typical ice pockmarks seen in the spring (although sediment was being eroded and transported from below in the surging ice blocks further offshore).

When we visited the island in November, familiar coastal landmarks were absent and we estimate that the coast had apparently been eroded back in excess of 50 m. Although time-lapse photographs taken during this period were plagued by darkness, fog, and rain, they show the retreat of the coast over a period of a few days following the demise of the ice rind which occurred on September 29 or 30.

Dinkum sands

Details of the movement and changes observed on this feature are described in Attachment B. The significant point for this discussion is the fact that during the month of September the shoal crest migrated 15 m to the southeast, eroding more than 70 cm of material from around the bench mark (Fig. 2). This migration was due to the increased intensity of late September and early October winds and the lack of armouring ice (ice was last seen on the 23rd of September and was absent on the 28th). We suspect that the shoal will be very different in character in 1980.

Cross Island

On September 8 the beach of Cross Island was pockmarked as a result of ice-push, combined with the melting away of remnant ice blocks, which had formed during the previous winter. Minor amounts of drift were floating and grounded in the nearshore. By the 18th of September, wind, waves and sea level changes had all affected the beaches. Large blocks of ice were present in the swash zone (greater than 5-m diameter) and all evidence of ice-push and pockmarks had disappeared from the beach (Fig. 3). Ice blocks as large as 30 cm in diameter were strewn on the beach behind the berm. On this date we measured the state benchmark on the north coast (1637S - Cross Island) as being 9.9 m behind the beach berm.

On September 22nd, four days later, we visited Cross Island again. A 6- to 8-sec swell, 1- to 2-m high, was plunging on the beach front. Large, 6 - 8 m, ice blocks were present in the surf zone and partially blocked the force of the water on the beach; this created impressive spray and splash as the waves crashed against the seaward faces of the ice blocks (Fig. 4). At lower elevations on the island, and in areas where ice blocks afforded minimal protection, waves regularly overtopped the beach berm to form overwash fans on the southwest side of the island. The benchmark on Cross Island, mentioned above, was 2.5 m seaward of the beach berm. In the previous five days the berm had moved landward 12.5 m, and the marker flags had been destroyed.

Two days later, on September 24th, we visited the island again. Only small (less than 1 m) ice blocks were present on the beach and these were well up on the berm. Almost every wave was washing over the island on the east and northeast facing shores (Fig. 5). Where overtopping was prevalent, the maximum height of the island above sea level was observed to be 1 to 1.7 m.

Our last visit to the island during the open-water season occurred on September 28. No ice was present on the coast and waves continued to overtop the eastern portion of the island (Fig. 6). The highest point near the state survey marker (berm?) was then 7.5 m landward of the marker (Fig. 7); thus the beach berm migrated landward a total of 18 m in 10 days. The westward-facing coast of Cross Island appeared to have been little affected by the northeasterly seas of September.

When we again visited the island in November, after the formation of the seasonal ice cover, ice blocks and small ice ridges (up to several meters high) were present on the beach front. We were unable to locate the state benchmark; however, a large, conspicuous iron barrel we had noted as being on the inner coast of the island during the washover in September, was now only a few meters from the beach berm.

West Dock and Niakuk 3

The Arco West Dock extends almost 4 km into Stefansson Sound and consists of a gravel-fill causeway 2 m high and 16 m wide and a gravel-fill dock head about 4 m high and about 75 m on a side. Erosion of the dock head has been noted over the years. This erosion takes the form of recurved spits, about 20 m long, on the northeast and southwest side of the dock head.

When we visited the dock head on Spetember 29, 1979, we noted that seaward vertical face had eroded back 5 to 10 m and that the southwesterly spit had been extended about 30 m. Dock head buildings and equipment that had been left for the winter were being undercut and were in danger of falling into the swash zone (Fig. 8). By the end of the open water season the dock head had eroded back further (the buildings and equipment were pulled back) and the southwesterly spit extend an additional 30 to 40 m toward Stump Island. Furthermore, the width of the causeway leading to the dock head had been reduced from approximately 16 m to 12 m (Fig. 9).

Niakuk 3 , a 3- to 4-m high artificial gravel island, about 75 m on a side, was observed to be eroding during the summer as a result of the attack of northeasterly waves which caused the development of double recurved spits. An oil well was located at the approximate center of the island. In November we flew over the island and noted that half of the island, to the northeast of the wellhead, had been removed by erosion (Fig. 9).

Implications:

The 1979 fall storm significantly changed the coastal morphology through tranportation of sediment. This suggests that observation of waves, currents, and coastal sediment transport during summer may not adequately reflect the maximum intensity of storm effects on coastal morphology. Based on our work in the Prudhoe Bay area, we believe the 1979 storm event was the most significant event to occur in the past five to ten years insofar as it affects coastal processes. The full effects of the storm cannot be assessed until next Spring when the blanket of snow and ice has melted.

In terms of projected offshore activities and construction, the event suggests that: 1) the area of the seabed artificially inundated with gravels is much larger than that originally occupied by the structure (as shown by the extension of the spit from the end of the west dock), 2) these effects must be considered as part of the environmental impact, 3) gravel mined to maintain structures will be a continuous drain on borrow sites, 4) the use of boulders or rip-rap may prevent coastal erosion although the larger clast sizes may be more susceptible to ice-push rather than over-ride as suggested in Attachment D.

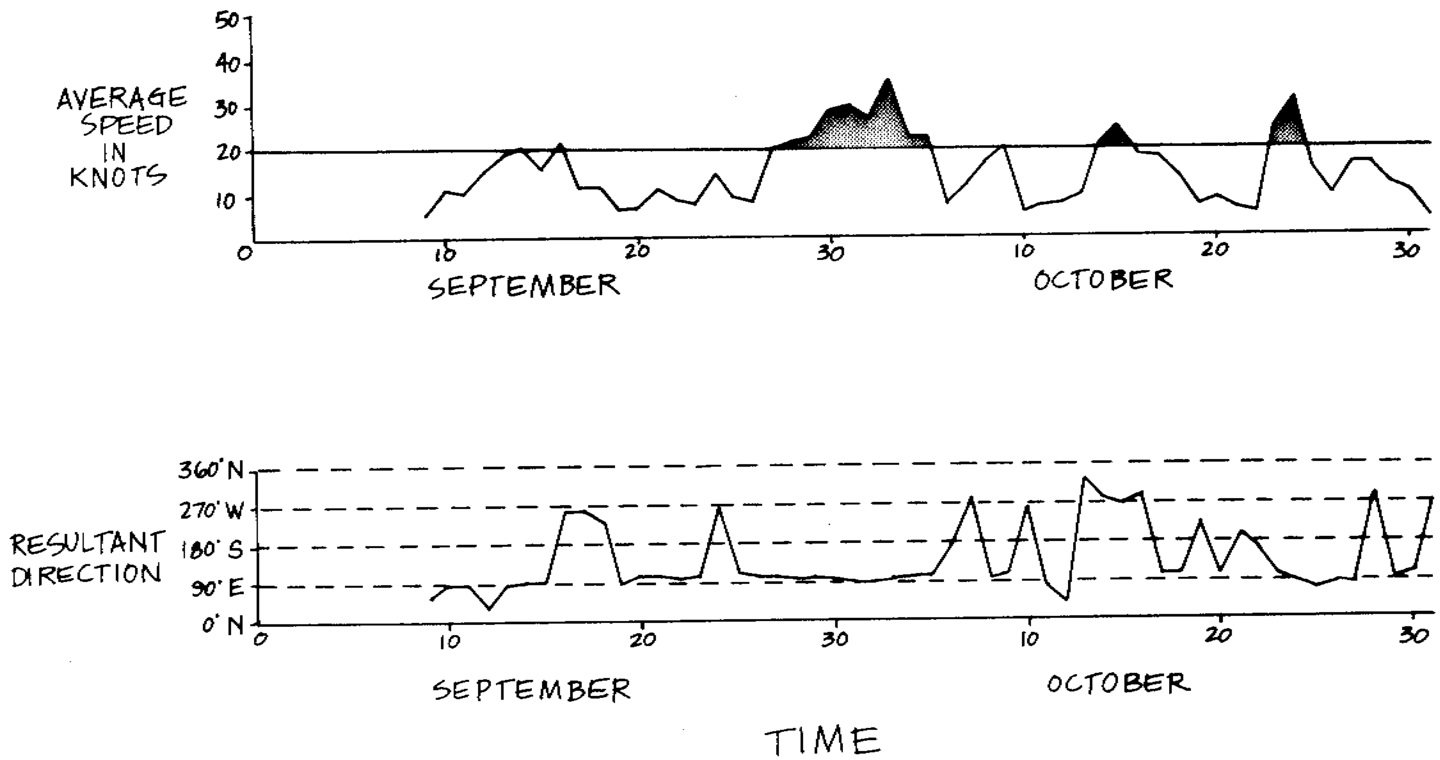

Figure 1. Wind data for September and October, 1979, from the weather station at Barter Island, about 200 km to the east of the Prudhoe Bay area.

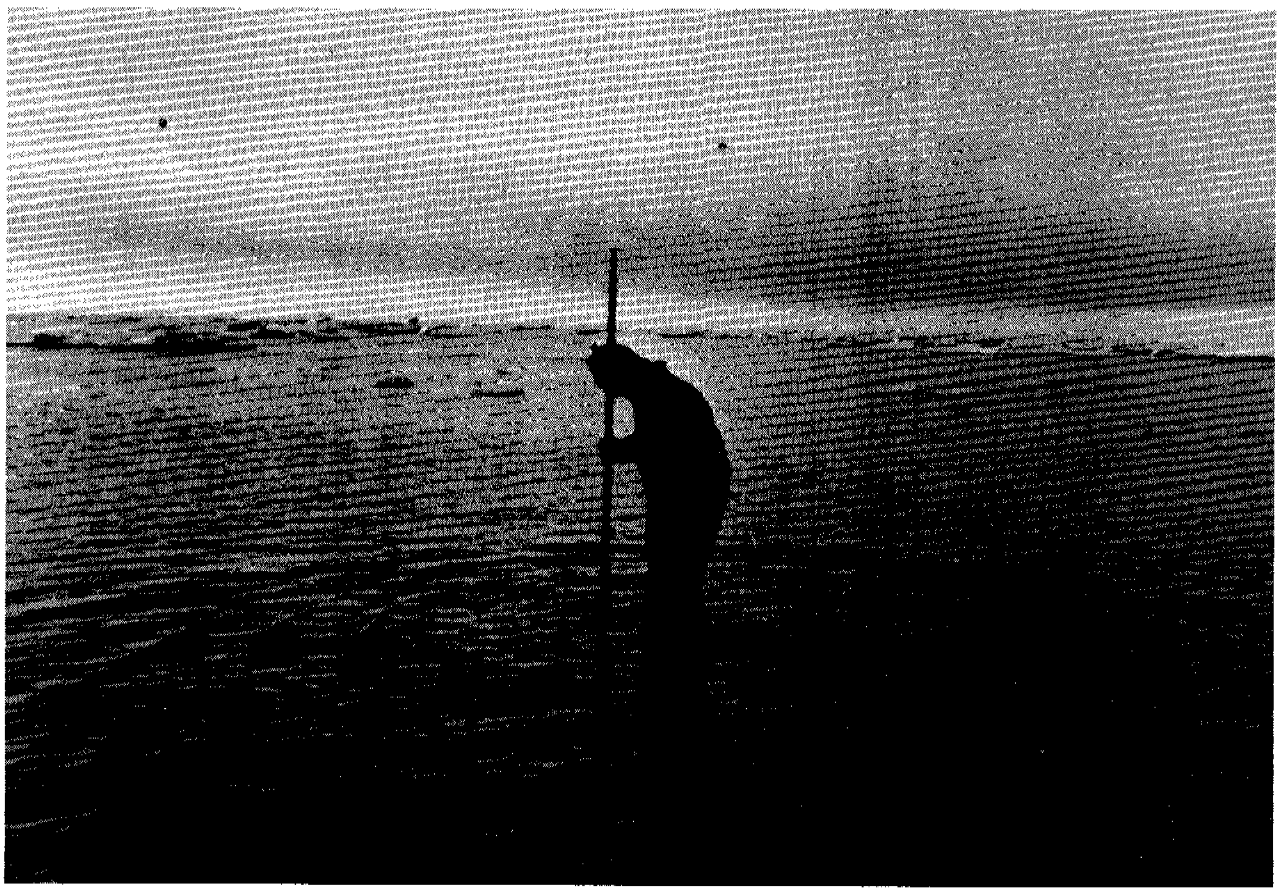

Figure 2. Bench mark on Dinkum Sands on September 23, 1979. View is to the northwest from the subaerial part of shoal.

Figure 3. Ice block distribution on Cross Island on September 18, 1979. Large block in swash zone with smaller blocks on back beach and over berm. Note man on block to left for scale(arrow).

A) Wave staff is 2.4 m long.

B) Distribution of larger ice blocks and small blocks on back beach. Note man in background for scale(arrow).

Figure 4. Ice blocks on beach front of Cross Island, armoring beach against wave attack.

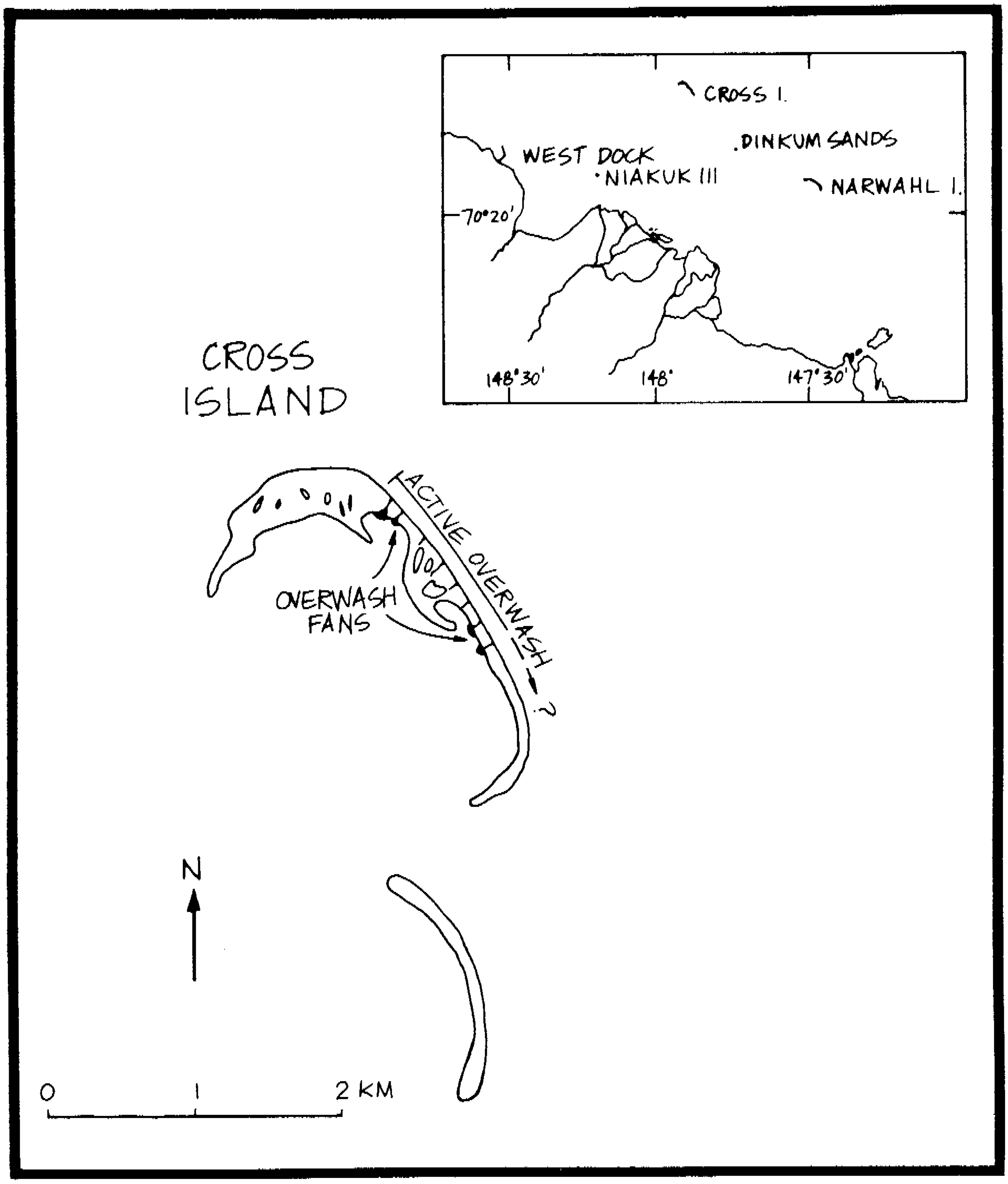

Figure 5. Areas of wave overwash at Cross Island on September 24. Inset of location discussed in text.

Figure 6. Aerial view of the northeastern shore of Cross Island on September 28, 1979, showing the wave overwashing.

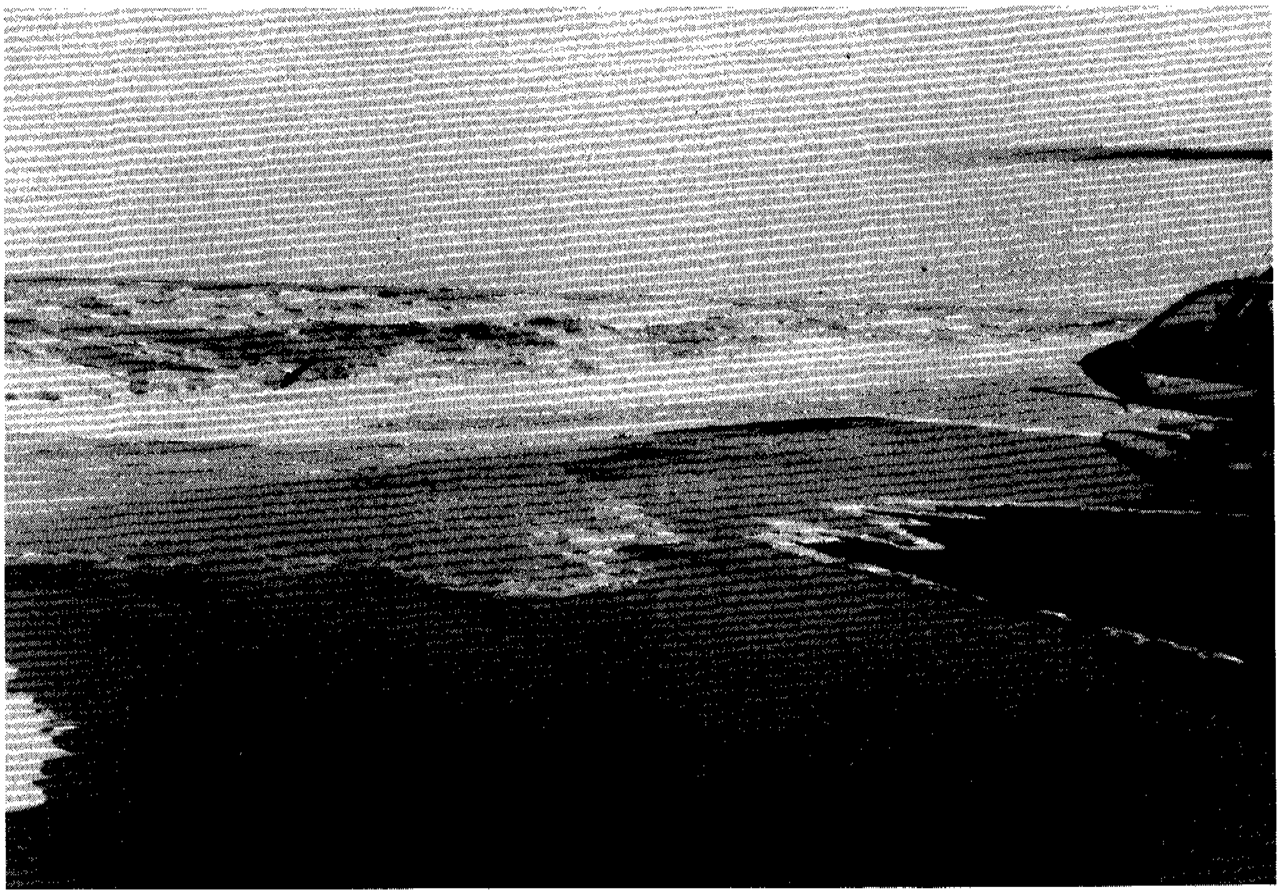

Figure 7. Bench mark on the northern coast of Cross Island on September 28, 1979, attesting to the landward migration of beach berm (arrow).

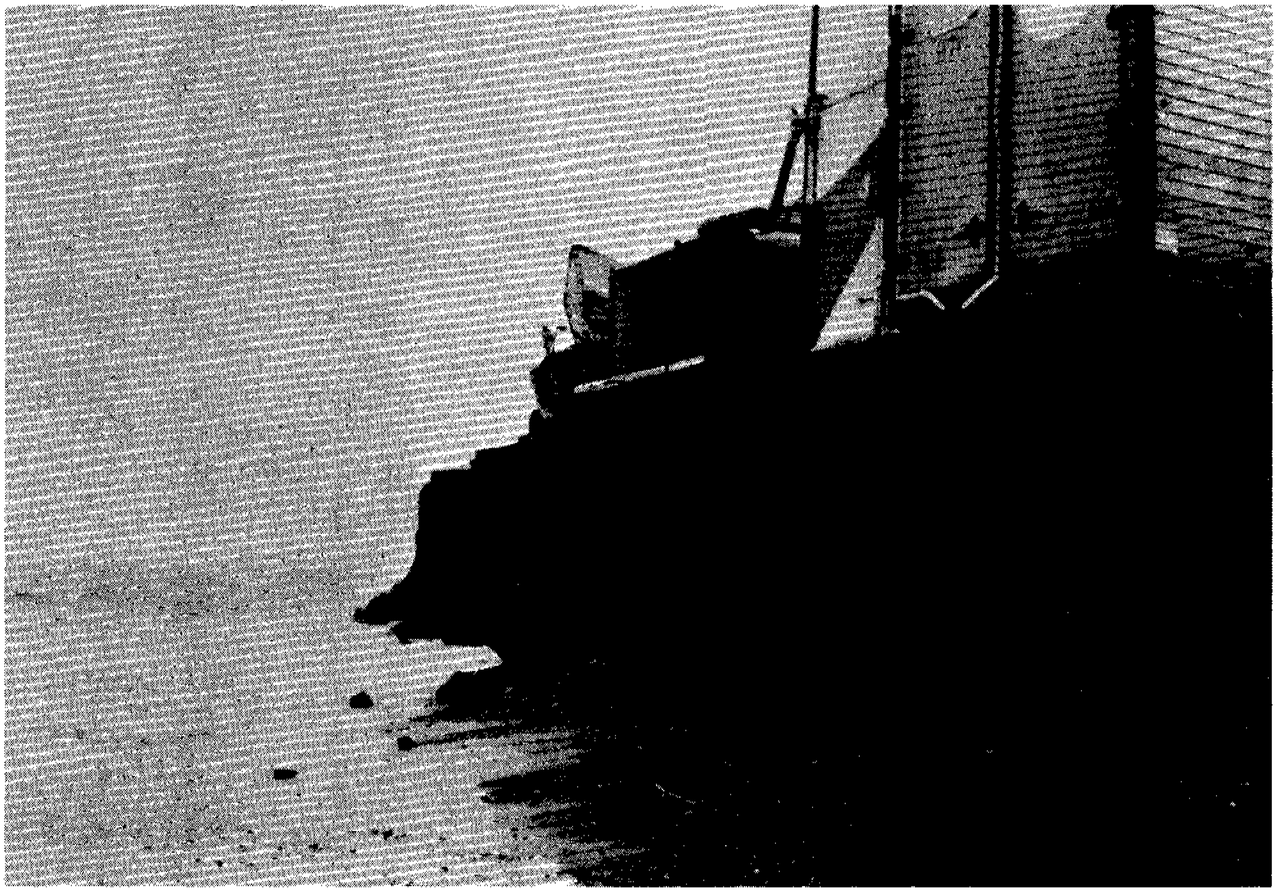

Figure 8. The head of the west dock being undercut by wave erosion on September 29, 1979.

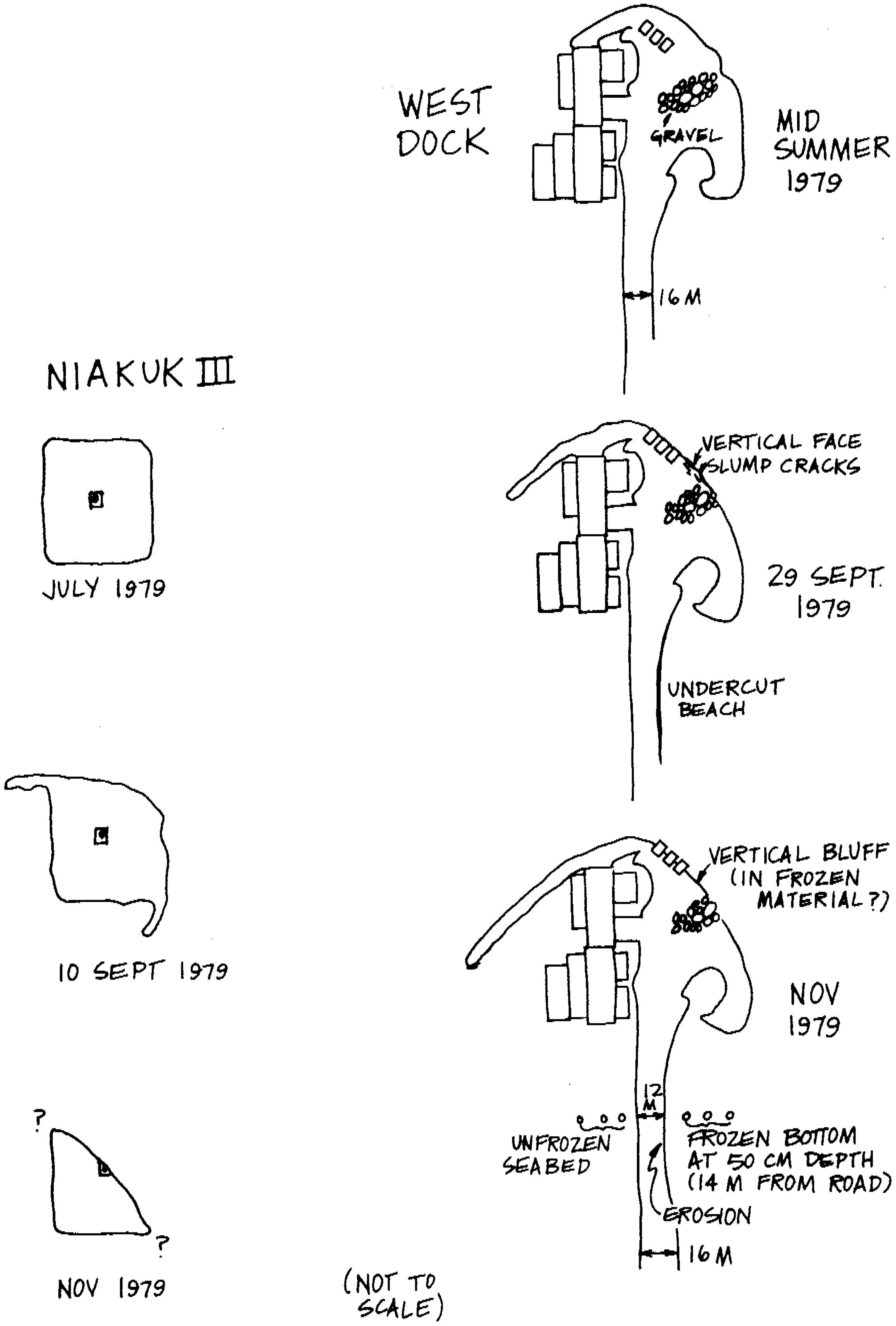

Figure 9. Diagramatic representation of the sequential erosion of the head of west dock and the artificial island Niakuk 3. Sketched from aerial photos, shipboard photos, and notebook sketches. Not to scale.

QUARTERLY REPORT

Title: Earthquake Activity and Ground Shaking in and along the Eastern Gulf of Alaska

Report by: John C. Lahr and Christopher D. Stephens and John Rogers

Principal Investigators: John C. Lahr, Christopher D. Stephens
Office of Earthquake Studies
U.S. Geological Survey
Menlo Park, California 94025

Research Unit: 210

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CONTENTS

I. Summary of objectives, conclusions, and implications with respect to OCS oil and gas development.

The objective of this research is to analyze the earthquake activity in the Northeast Gulf of Alaska (NEGOA) and adjacent onshore areas in order to develop a better model for the current tectonic framework. This information is critical to the establishment of criteria for the safe development of oil and gas. A great earthquake ($M > 8$) associated with low-angle oblique underthrusting of the sea floor beneath the continental shelf could be accompanied by strong ground shaking throughout much of the eastern Gulf of Alaska, possibly from Cross Sound to Kayak Island (Page, 1975) and could trigger tsunamis, seiches, and submarine slumping, any of which could be hazardous to offshore and coastal structures (Meyers, 1976).

During the past year particular emphasis has been placed on developing a kinematic model to represent the regional tectonic framework applicable to the NEGOA. This has involved study of the seismic data collected during the past 5 years as well as review of the historic seismic record and geologic constraints. The tectonic model developed, although still tentative, reflects our current state of knowledge.

In the proposed model, the portion of the North American plate bordering the Gulf of Alaska is divided into two sub-blocks, which are partially coupled to the Pacific plate. Based on the model, future earthquakes will be most frequent along the north dipping thrust faults of the Pamplona zone, between Icy Bay and the Aleutian megathrust. Earthquakes should also be expected, although less frequently, on the thrust contact between the Pacific plate and the Yakutat block. This hypothesized thrust boundary underlies the offshore region south of Yakutat at shallow depth and dips gently to the north or northwest.

A rough estimate of the level of seismic activity and the largest expected event has been made for each of the four principal source regions effecting the NEGOA. For example, the return period for events greater than or equal 7.3 on the thrust zone underlying the Yakutat block is estimated to be 180 years. These estimates should be subjected to further review and compared with those derived by other methods before being used in further calculations. The final step in generating parameters useful to design engineers has not been taken. This would involve generating estimates of the probability of a given level of shaking as a function of exposure time and site location.

The level of seismic activity during the past tens of years has been lower than would be expected if the rate of seismicity were constant and given by the return periods calculated. This discrepancy could be interpreted as an indication that a large percentage of the regional plate convergence takes place aseismically. Given the temporal fluctuations in seismicity observed elsewhere in the world, the sequence of magnitude 8 events that occurred at the turn of the century, and the recent magnitude 7.3 (M_S) St. Elias earthquake, we conclude that the recent low level of activity is well below the average to be expected.

II. Introduction

A. General nature and scope of study.

The purpose of this research is to investigate the earthquake potential inthe NEGOA and adjacent onshore areas. This will be accomplished by assessing the historical seismic record as well as by collecting new and more detailed information on both the distribution of current seismicity and the nature of strong ground motion resulting from large earthquakes.

B. Specific Objectives.

1. Record the locations and magnitudes of all significant earthquakes within the NEGOA area.
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 strong ground shaking associated with large earthquakes in the NEGOA.
5. Compile and evaluate frequency vs. magnitude relationships for seismic activity within and adjacent to the study areas.
6. Evaluate the observed seismicity in close cooperation with OCSEAP Research Units 16 and 251 towards development of an earthquake prediction capability in the NEGOA.

C. Relevance to problem of petroleum development.

It is crucial that the seismic potential in the NEGOA be carefully analyzed and that the results be incorporated into the plans for future petroleum development. This information should be considered in the selection of tracts for lease sales, in choosing the localities for land-based operations, and in setting minimum design specifications for both coastal and offshore structures.

III. Current state of knowledge

The eastern Gulf of Alaska and the adjacent onshore areas are undergoing compressional deformation caused by north-northwestward migration of the Pacific plate with respect to the North American plate (Figure 1). Direct evidence for continued convergent motion comes from studies of large earthquakes along portions of the Pacific-North American plate boundary adjacent to the eastern Gulf of Alaska.

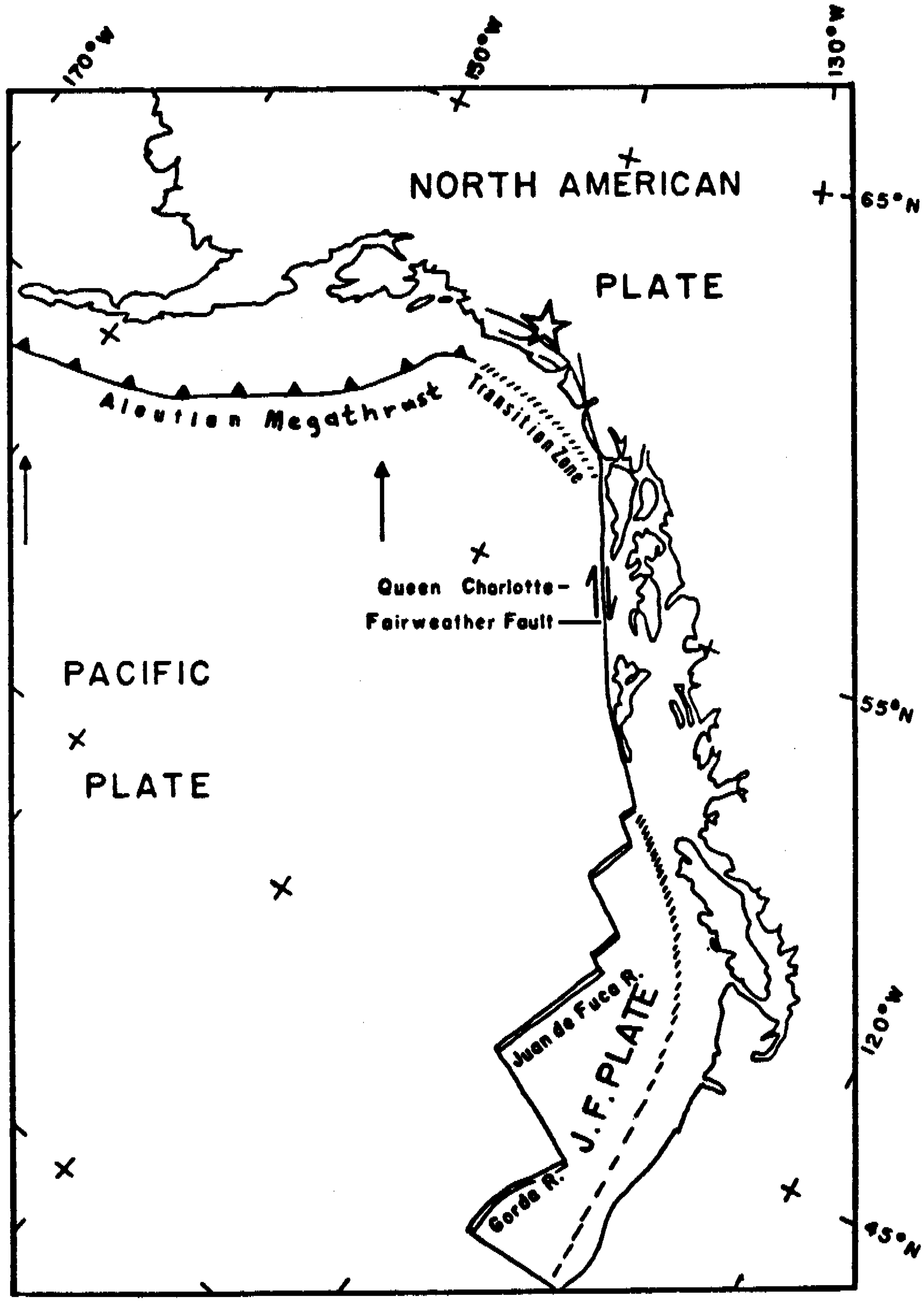

Figure 1. Current motion of Pacific plate with respect to North American plate. Juan de Fuca (J.F.) plate also shown. Star indicates epicenter of the earthquake of 28 February, 1979.

The 1958 earthquake on the Fairweather fault in southeast Alaska was accompanied by right lateral slip of as much as 6.5 m (Tocher, 1960). The 1964 Alaska earthquake resulted from dip slip motion of about 12 m (Hastie and Savage, 1970) on a fault plane dipping northwestward beneath the continent from the Aleutian Trench and extending from eastern Prince William Sound to southern Kodiak Island. In the intervening region between these earthquakes, from approximately Yakutat Bay to Kayak Island, the precise manner in which this convergent motion is accommodated is not known. The model which is presented here for accommodating the regional convergence is based on work in progress by Lahr and Plafker and has been reported on previously (Lahr et al., 1979A).

IV. Study Area.

This project is concerned with the seismicity within and adjacent to the eastern Gulf of Alaska continental shelf area. This is the southern coastal and adjacent continental shelf region of Alaska between Montague Island and Cross Sound.

V. Methods and rationale of data collection.

The short-period seismograph stations installed along the eastern Gulf of Alaska under the Outer Continental Shelf Environmental Assessment Program as well as the other stations operated by the USGS in southern Alaska are shown in Figure 1 of Chapter X. Single-component stations record the vertical component of the ground motion, while three-component stations have instruments to measure north-south and east-west motion as well. Data from these instruments are used to determine the parameters of earthquakes as small as magnitude 1. The parameters of interest are epicenter, depth, magnitude, and focal mechanism. These data are required to further our understanding of the regional tectonics and to identify active faults.

A network of strong motion instruments is also operated. These devices are designed to trigger during large earthquakes and give high-quality records of large ground motions which are necessary for engineering design purposes.

VI., VII. and VIII. Results, Discussion and Conclusions.

PROPOSED KINEMATIC MODEL FOR PACIFIC-NORTH AMERICAN INTERACTION

A working model has been developed for the Holocene Pacific-North American plate interaction along the Gulf of Alaska. In this model deformation within the North American plate is concentrated mainly on the boundaries of two blocks. First, these boundaries will be described, then the motions within the model will be given and finally the model will be compared with the available data on displacement rates. The tectonic setting and major boundaries are illustrated in Fig. 2. The Yakutat block (YB), which has been described by Plafker and others (1978), is bounded by the Transition zone (TZ), the Fairweather fault (F), and the Pamplona zone (PZ) which passes through Icy Bay (I). North and east of the Yakutat block is the Wrangell block (WB). The Wrangell block is bounded on the northeast by the Denali (D), Totschunda (T), Duke River (DR), Dalton (DA), and Chatham Strait (C) faults, and on the south by the Aleutian megathrust (AM), the Pamplona zone (PZ), and the Fairweather fault, including its offshore continuation (F). The northwestern boundary of the Wrangell block is speculative; it is tentatively assumed to diverge southward from the Denali fault, through Cook Inlet (CI), around Kodiak Island (KO) and back to the Aleutian megathrust.

The extent and configuration of the Pacific plate underlying Alaska can be inferred, at least partly, from the distribution of subcrustal earthquakes that make up the Benioff zone. These events occur within the underthrust oceanic plate near its upper surface. The 50-km isobath of earthquake foci shown in Fig. 2 northwest of the Aleutian megathrust (AM) represents an active Benioff zone (Lahr, 1975). Further east, however, northwest of the Transition

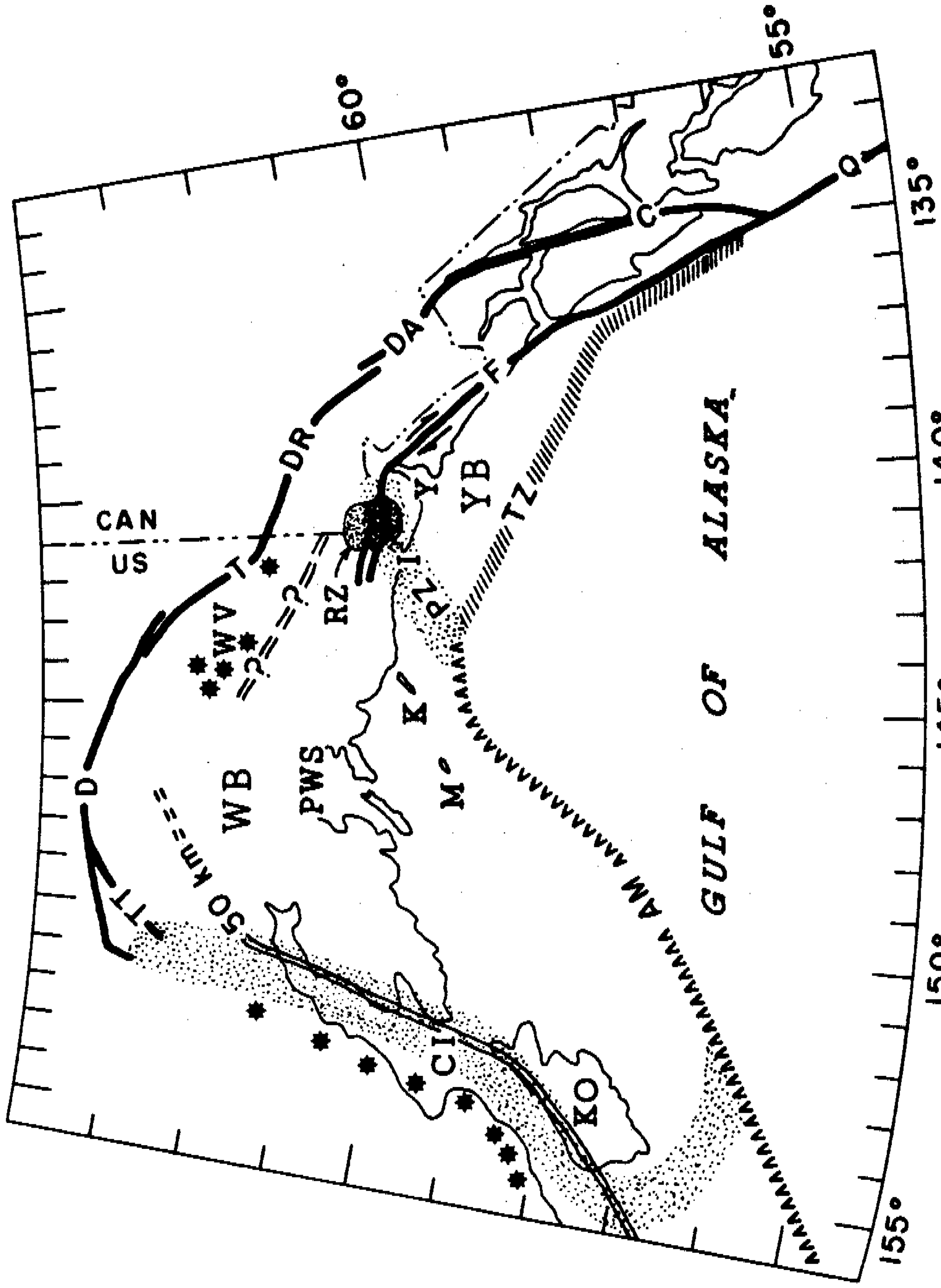

Fig. 2 Map of southern Alaska and western Canada emphasizing the principal regional tectonic features. Faults after (Clague, 1979; Beikman, 1978). KO, Kodiak Island; M, Middleton Island; K, Kayak Island; CI, Cook Inlet; PWS, Prince William Sound; I, Icy Bay; Y, Yakutat Bay; WV, Wrangell volcanics; RZ, rupture zone of 28 February 1979 earthquake; AM, Aleutian megathrust; TZ, Transition zone; Q, Queen Charlotte Islands fault; C, Chatham Strait fault; DA, Dalton fault; DR, Duke River fault; T, Totschunda fault; D, Denali fault; TT, Talkeetna fault; F, Fairweather fault; PZ, Pamplona zone; double line, 50 km isobath of Benioff zone, queried where inferred; WB, Wrangell block; YB, Yakutat Block.

zone (TZ), no earthquakes as deep as 50 km have been observed, and a Benioff zone is not defined here.

The continuity of the Pacific plate below the Gulf of Alaska and the hundreds of kilometers of convergence indicated by the Benioff zone northwest of Prince William Sound imply that a similar amount of convergence has taken place in the zone between Prince William Sound and the Queen Charlotte Islands fault. The queried 50-km isobath in Fig. 2 indicates a plausible position for the underthrust Pacific plate based on two assumptions: the first is that the andesitic Wrangell volcanic rocks (WV), (Deininger, 1972; MacKevett, 1978) are situated approximately above the 100-km isobath of the Benioff zone as is typical for andesitic volcanoes associated with an underthrust plate; the second is that the dip of the plate between 50 and 100 km depth is similar to that observed elsewhere along the Aleutian arc (Davies and House, 1979). The Wrangell volcanoes have not been highly eruptive for about 3 my, however, and may no longer be aligned above the Benioff zone. In any case it seems likely that the Pacific plate extends at shallow depths below much of the Yakutat and Wrangell blocks, a configuration that should be conducive to significant coupling between those blocks and the Pacific plate.

PLATE MOTIONS IN MODEL

Motions in the kinematic model presented in this paper are relative to the stable parts of the North American plate, in particular the interior of Alaska. First the velocities in the preferred model will be given and then they will be compared with the available data on relative rates of motion. The Pacific plate is rotating clockwise about a pole in eastern Canada, and is moving northwestward at 6.5 cm/yr along the Queen Charlotte Islands fault. The velocity increases to the southwest as distance from the pole of rotation increases. The Yakutat block is moving parallel to the Pacific plate but with a slightly lower relative velocity (~6 cm/yr). Motion of the Wrangell block is taken to be counterclockwise rotation about an axis near Kodiak Island, such that its northeastern edge moves in a right-lateral sense relative to the North American plate with a velocity of approximately 1 cm/yr. The relative rates of motion are indicated in Fig. 3.

COMPARISON OF MODEL WITH OBSERVATIONS

This kinematic model is in reasonable agreement with historical seismicity and known rates of relative plate movement, where data are available. Hisyorical large earthquakes along the Queen Charlotte Islands (Q) and the Fairweather (F) faults with dextral strike-slip motion support the viewpoint that these are principal plate boundaries (Tobin and Sykes, 1968; Gawthrop and others, 1973).

The rate of relative motion across the Fairweather fault has probably averaged roughly 5.8 cm/yr in a right-lateral sense for the past thousand years (Plafker and others, 1978), in reasonable agreement with the value of 5 cm/yr predicted by the model.

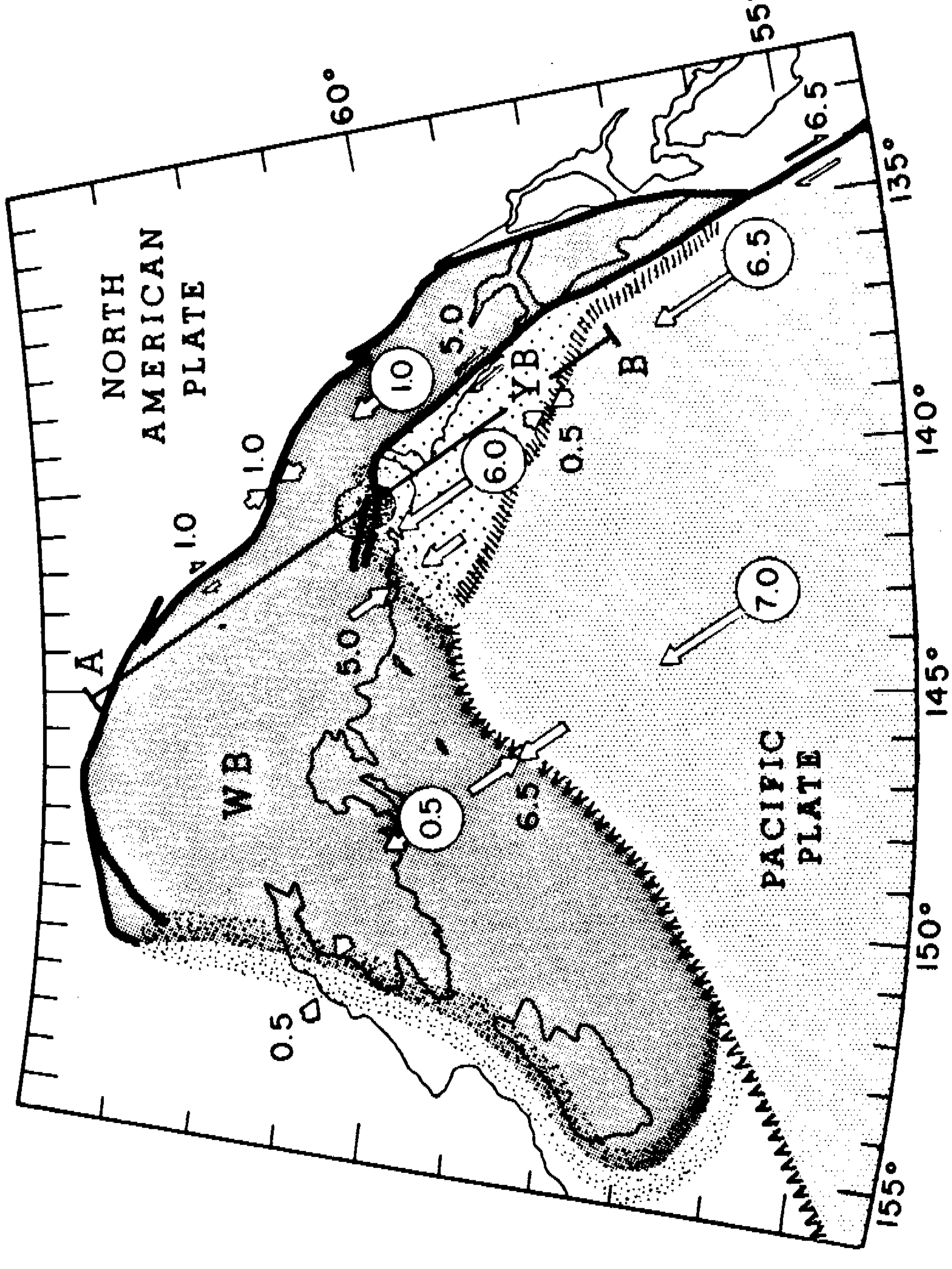

Fig. 3 Proposed model for present crustal deformation along the Pacific-North American plate boundary in southern and southeast Alaska. Circled numbers give rate of motion (cm/yr) of Pacific plate, Yakutat block and Wrangell block with respect to North American plate. Numbers next to paired vectors give rate of motion across indicated zone. Dotted bands enclose surface outcrops of major zones of deformation and faulting. A-B location of cross section of Fig. 3; WB, Wrangell block; YB, Yakutat block.

The Yakutat block may have a more northerly direction of motion than that given by the model. Convergence across the Fairweather fault is suggested by young uplift, folding and faulting along the coast in the Lituya Bay Area (Plafker and others, 1978) and uplift in the Yakutat Bay area that is best explained by movement on inferred northeast-to-north-dippling thrust faults (Thatcher and Plafker, 1977). Since the conclusions of this paper are not effected by the exact orientation of the Yakutat block motion, the simplet assumption of motion parallel to the Pacific plate motion has been used. The model rates for the Yakutat block and Pacific plate were set to give some convergence across the Transition zone (TZ), in agreement with data from the 6.7 (M_s) earthquake which occurred along the continental margin southwest of Cross Sound. The rupture zone of this earthquake, as delineated by aftershocks, was 60 km long by 15 km wide, and the focal mechanism is compatible with oblique thrust faulting (Gawthrop and others, 1973).

The Pamplona zone, which constitutes the northwestern boundary of the Yakutat block, is a broad zone of late Cenozoic onshore and offshore folds and thrust faults which dip to the northwest or north (Plafker and others, 1978; Thatcher and Plafker, 1977). Seismic activity has been recorded along both offshore and onshore portions of this zone (Page, 1975; Stephens and others, 1979).

The Denali (D) and Totschunda (T) faults of Fig. 1 have undergone 1 to 2 cm/yr average dextral displacement during the Holocene (Richter and Matson, 1971; Plafker and others, 1977; Stout and others, 1973) although some parts may not have moved during the past 1,500 to 2,000 years (Plafker and others, 1977). The Duke River (DR), Dalton (DA), and Chatham Strait (C) faults do not prove Holocene displacements, and in some places there is geomorphic evidence to support the viewpoint that they could not have moved more than one or two meters in the past few hundred years (Clague, 1979). However, because seismic activity has been noted in the vicinity of these faults (Clague, 1979), they are considered the most likely southern continuation of the Denali-Totschunda system. Dextral motion of more than a total of 0.5 km is precluded on a direct connection between the Totschunda and Denali faults by geologic data (Plafker and others, 1978). Thus, if the Fairweather fault has short circuited across the Saint Elias Mountains to connect with the Totschunda fault, this newly established break cannot be more than 25,000 to 50,000 years old.

Counterclockwise rotation of the Wrangell block (WB) would produce convergence on its northwestern edge which would be greatest towards the north, along the zone of unnamed faults (TT) that diverge from the Denali fault and trend southwestward parallel to the Alaska Range, between the Chulitna River and Tonzona/Tatina Rivers (Reed and Nelson, 1977). West of these faults, which are mostly thrust faults, there is no evidence that the Denali fault has been active in Quaternary time (Plafker and others, 1977). Rotation of the Wrangell block, as proposed here, is consistent with the change in strike between the Denali (D), Totschunda (T), and Chatham Strait (C) faults. The western boundary of the Wrangell block is hypothetical. The convergent motion across this boundary may be accommodated by a broad zone of folding.

The Pacific-North American relative motion assumed in this model is roughly 10% higher than the average found for the past 3 my by global plate-motion reconstruction (Minster and Jordan, 1978). The higher rate allows a closer fit to the observed displacement rate on the Fairweather fault and is not an unreasonable deviation since only the Holocene epoch is of concern here.

IMPLICATIONS OF PROPOSED KINEMATIC MODEL FOR EASTERN GULF OF ALASKA SEISMIC HAZARDS

Lease sale 55 is located south of Yakutat Bay on the Yakutat block. This region will be subjected to ground shaking from five distinguishable seismic source regions.

1) Underthrusting of the Pacific plate below the Wrangell block northwest of the Aleutian megathrust. The 1964 Alaska earthquake (9.2 M_w, 8.4 M_S) was of this type and ruptured from about Kayak Island to southern Kodiak Island.

2) Underthrusting of the Yakutat block and the Pacific plate below the Wrangell block. This source region extends approximately 200 km northwest from the Pamplona zone. The February 1979 St. Elias earthquake (7.3 M_S) noted on Figs. 2 and 3 was of this type.

3) Faulting along the northeast boundary of the Yakutat block. Typical of this would be the 1958 earthquake (8.2 M_w, 7.9 M_S) which involved dextral strike-slip on the Fairweather fault. Also included would be the Yakutat Bay earthquake (8.4 M_S) of 10 September 1899 which involved complex thrust faulting with as much as 14 m of vertical displacement (Thatcher and Plafker, 1977).

4) Underthrusting of the Pacific plate below the Yakutat block. Although no historic great earthquake of this type is known to have occurred, it would not be prudent to exclude the possibility of one occurring in the future.

5) Earthquakes of smaller magnitude, up to perhaps 6.5 or 7.0, could probably occur with finite probability anywhere within the Yakutat and Wrangell blocks. Although the largest earthquakes would probably fall in categories 1 through 4 and account for nearly all of the convergent motion, smaller events that may occur very near the engineering structure in question must also be taken into account. Fig. 4 shows the known seismic activity in the region south of Yakutat between 1900 and 1979. The USGS seismic network

EVENTS SOUTH OF YAKUTAT BAY
1900 – JAN 1979

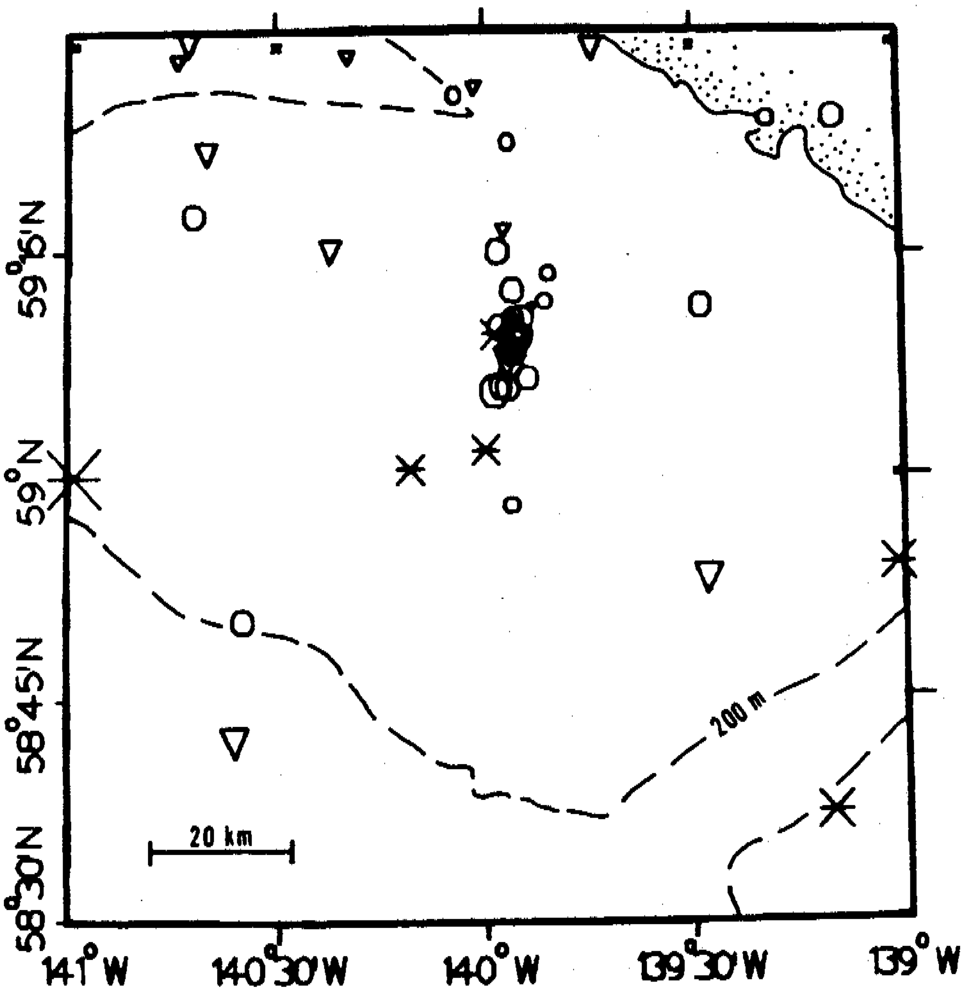

Figure 4. Map showing earthquake epicenters from NGSDC (*'s) and USGS (circles - better control; triangles - poorer control) scaled by magnitude. Most of the events occurred in a cluster near the center of the figure. The apparent north-south trend of this cluster may be due to location error.

was installed to the north in the summer of 1974. The 46 events located by the USGS network since that time are indicated by circles (better epicentral control) and triangles (poorer control) on Fig. 4. The symbols are scaled by magnitude, which ranges from less than 1.0 to 3.8. Also shown, as X's, are the events from The National Geophysical and Solar Terrestrial Data Center (NGSDC) earthquake-data file for 1900 through July 1978. This file contains 15 events in the region. The earliest and largest being a magnitude 7 (M_S) in 1908 while the three most recent have magnitudes 4.1, 4.2 and 4.4 (Palmer magnitude) and occurred in early 1974. Due to lack of depth control for these events, it is not certain whether they occurred on secondary structures within the Yakutat block or on the interface between the Wrangell block and the Pacific plate (source region 4).

ESTIMATED RECURRENCE INTERVALS

We have thus far identified the plate boundaries in the southern Alaska region that are expected to be seismically active and estimated the rate of relative displacement across each. The next step is to estimate for each region the average number of earthquakes per unit time within each magnitude interval, up to the size of the largest expected earthquake in the region.

One approach to estimating the frequency versus magnitude distribution is to use the historic record of seismicity. This has several disadvantages. First, if the rate of occurrence of small earthquakes measured over a short interval of time is extrapolated to large events, the implicit assumption is that the rate for small events does not fluctuate greatly with time. Temporal fluctuations in seismicity are known to occur, however, and are documented in the Middle East (Ambraseys. 1975), eastern China (York, et al., 1976) and California (Eaton, in press). Therefore. the statistical parameters determined from a large number of small earthquakes cannot necessarily be extrapolated to small numbers of large earthquakes. Second. the historic record of large events ($M > 7$) in southern Alaska goes back only about 80 years, so the record is too short to be used as a reliable basis for the long term rate of occurrence of large events.

An alternate method of estimating recurrence time. based on the on slip rate and maximum seismic moment for a source region, has been suggested by Molnar (1979). This method equates the rate of relative motion across a fault zone with the long term average rate of slip from earthquakes. As a result of many uncertainties which enter into these calculations, Molnar (1979) estimates the derived recurrence intervals may be in error by as much as a factor of 3 to 5. We feel these errors are still smaller than those generated by using the historic seismic record alone.

Molnar applies this method to the composite Pacific and Indian ocean subduction zones and gets good agreement with the observed record of great earthquakes during the past 50 years. Following Molnar (1979), it will be assumed that the distribution of earthquake moments in each of four principal source regions identified above can be described by the relationship

$N(Mo) = \alpha Mo^{-\beta}$, where N(Mo) is the number of events per year with seismic moment greater than or equal to Mo, and α and β are constants. If Momx is the largest moment for a region, A is the fault area of the entire region, v is the long term slip rate, μ is the average shear modulus, and β is 2/3 then

$$N(Mo) = \frac{\mu A v}{3(Momx)^{1/3}} (Mo)^{-2/3} \qquad \text{(Molnar, 1979).}$$

β is defined to be b/c where b is the coefficient in the magnitude distribution equation (log(N) = a - bM) and c is the coefficient in the magnitude-moment relationship (M = (log Mo)/c + d). A β value of 2/3 is based on c = 1.5 and b = 1.0. The recurrence interval for events with moments greater than or equal Mo but not greater than Momx is $T(Mo) = N(Mo)^{-1}$

$$T(Mo) = \frac{3(Momx)^{1/3}}{\mu A v} (Mo)^{2/3} \quad yr \qquad (1)$$

Region 1. Underthrusting of the Pacific Plate below the Wrangell block between Kayak Island and southern Kodiak Island.

For this region the 1964 Alaska earthquake is taken as the largest event. From Kanamori and Anderson (1975):

$Mo = Momx = 8.2 \times 10^{29}$ dyne cm

$A = 1.3 \times 10^{15}\ cm^2$

The values estimated for the remaining parameters are:

$\mu = 7 \times 10^{11}$ dyne cm^{-2}

$v = 6.5$ cm yr^{-1}

The recurrence relationship becomes:

$$T(Mo) = 4.7 \times 10^{-18} Mo^{2/3} \text{ yr}$$

This gives the following recurrence times:

Region 1

Magnitude M_w	Mo (dyne cm)	Recurrence Interval (yr)
~ 9.2	$\sim 8.2 \times 10^{29}$	420
≥ 8.6	$\geq 10^{29}$	100
≥ 8.0	$\geq 10^{28}$	22
≥ 7.3	$\geq 10^{27}$	4.7

The magnitudes above are based on the following moment-magnitude relationship:

$M_w = (\log Mo)/1.5 - 10.7$ (Kanamori, 1977)

Observed number ≥ 7.3 during past 40 years: 1*

Expected number ≥ 7.3 during 40 year interval: 8.5

* The 1964 Alaska earthquake with $M_w = 9.2$.

Region 2. Underthrusting of the Yakutat block and the Pacific plate below the Wrangell block.

We will assume a source region of 250 x 200 km^2 and the kinematic model underthrust rate of 5.0 cm yr^{-1}. The maximum displacement is estimated from

$$u_{max} = \frac{3\Delta\sigma w}{4\mu} \quad \text{(Molnar, 1979)} \qquad (2)$$

Assuming the stress drop, $\Delta\sigma$, is 30 bars (3 x 10^7 dyne cm^{-2}), typical of the largest events (Kanamori and Anderson, 1975); μ = 7 x 10^{11} dyne cm^{-1}; and w, the down dip length, is 200 km, then

u_{max} = 6.4 m and

$$Momx = \mu A u_{max} = 2.3 \times 10^{29} \text{ dyne cm} \qquad (3)$$

The recurrence time relationship for this region is then:

$$T(Mo) = \frac{(3)(2.3 \times 10^{29})^{1/3}}{(7\times10^{11})(5\times10^{14})(5)} (Mo)^{2/3}$$

$$T(Mo) = 1.0 \times 10^{-17} (Mo)^{2/3} \text{ yr}$$

Using this equation, the following table is derived:

Region 2

Magnitude M_w	Mo (dyne cm)	Recurrence Interval (yr)
~8.9	~2.3 x 10^{29}	380
≥ 8.0	≥ 10^{28}	46
≥ 7.3	≥ 10^{27}	10

Observed number ≥ 7.3 during past 40 years: 1*

Expected number ≥ 7.3 during 40 year interval: 3.3

*The February 1979 St. Elias earthquake with M_s = 7.3.

Region 3. Faulting along the northeast boundary of the Yakutat block.

This faulting will be taken to be strike slip although, as mentioned previously, the northern end includes complex thrusting as well. The largest events in this region will be assumed to have an average of 4 m of strike slip motion on a 350 x 20 km portion of the Fairweather fault.

The estimated maximum moment is

$$M_{omx} = \mu A u_{max} = (3.3 \times 10^{11})(7 \times 10^{13})(400) = 9.2 \times 10^{27} \text{ dyne cm}$$

The recurrence interval equation, using the kinematic model's 5 cm yr slip rate, is then

$$T(Mo) = \frac{(3)(9.2 \times 10^{27})^{1/3}}{(3.3 \times 10^{11})(7 \times 10^{13})(5)} (Mo)^{2/3}$$

$$T(Mo) = 5.5 \times 10^{-17} (Mo)^{2/3} \text{ yr}$$

The following table gives recurrence intervals and rates of occurrence for events in a few size categories.

Region 3

Magnitude M_W	Mo (dyne cm)	Recurrence Interval (yr)
~ 7.9	~ 9.2×10^{27}	240
≥ 7.3	≥ 10^{27}	55
≥ 6.6	≥ 10^{26}	12

Observed number ≥7.3 during past 40 years: 1*

Expected number ≥7.3 during 40 year interval: 0.73.

* The 1958 Fairweather earthquake with $M_S = 7.9$.

Region 4. Underthrusting of the Pacific plate below the Yakutat block.

The maximum fault area for this zone is the triangular region with area approximately ½ (150 x 300) km . The maximum displacement can be estimated from

$$u_{max} = \frac{3\Delta\sigma w}{4\mu}.$$

If, as in the case of region 2, we assume an effective downdip length of 200 km, the maximum displacement would be approximately 6.4 m and

$$M_{omx} = \mu A u_{max} = 10^{27} \text{ dyne cm}.$$

Using the kinematic model underthrust rate of 0.5 cm yr , the recurrence relationship becomes:

$$T(Mo) = \frac{(3)(10^{29})^{1/3}}{(7\times10^{11})(2.25\times10^{14})(0.5)}(Mo)^{2/3}$$

$$T(Mo) = 1.8 \times 10^{-16}\ (Mo)^{2/3} \text{ yr}$$

This gives the following recurrence times:

Region 4

Magnitude M_W	Mo (dyne cm)	Recurrence Interval (yr)
~ 8.6	~ 10^{29}	3800
≥ 8.0	≥ 10^{28}	830
≥ 7.3	≥ 10^{27}	180
≥ 6.6	≥ 10^{26}	39

Observed number ≥ 6.6 during past 40 years: 1*

Expected number ≥ 6.6 during 40 year interval: 1.

* The Cross Sound earthquake of 1973 with $M_S = 6.7$.

The uncertainties in the calculated recurrence intervals should not be disregarded. One assumption inherent in the calculations was that all of the slip takes place seismically, as opposed to a slow creep process. If aseismic slip does take place, then the earthquake recurrence intervals would be proportionately greater.

SENSITIVITY OF CALCULATED RECURRENCE INTERVALS TO MODEL CHANGES

For Region 2, which involves underthrusting of the Yakutat block and the Pacific plate below the Wrangell block, the effects of changing the model parameters will be explored. The recurrence time interval, T (Mo), as estimated in equation 1, has the following dependence on fault length (L), downdip width (w), shear modulus (μ), and maximum moment (Momx):

$$T(Mo) \propto (Lwv\mu)^{-1} \, Momx^{1/3}$$

The upper limit of moment, Momx, when estimated from equations 2 and 3, has the following dependence on L, w and stress drop ($\Delta\sigma$):

$$M_{omx} \propto Lw^2 \Delta\sigma \, .$$

If, for example, the downdip width were actually 100 rather than 200 km, then Momx would be reduced by a factor of 4 to 5.6 x 10^{28}, or equivalently the largest events would be reduced from 8.9 M_w to 8.5 M_w. The recurrence intervals would be increased by $2x(\frac{1}{4})^{1/3} = 1.26$. Thus, the effect of reducing the width of the zone by a factor of two is to increase the recurrence intervals by only 25% while reducing the maximum event by 0.4 units of M_w. The summary table for this region would become:

Region 2

Magnitude M_w	Mo (dyne cm)	Recurrence Interval (yr)
$\sim$ 8.5	$\sim 5.6 \times 10^{28}$	190
$\geq$ 8.0	$\geq 10^{28}$	60
$\geq$ 7.3	$\geq 10^{27}$	13

PREVIOUS RECURRENCE ESTIMATES FOR THE OUTER CONTINENTAL SHELF OF THE EASTERN GULF OF ALASKA

Thenhaus et al. (1979) have calculated recurrence rates for the Yakutat block (zone 13 in their report) which has almost the same boundaries as Region 4. Based on the past observed seismicity they obtain a b value of 0.6 and the following annual rates if occurrence:

Magnitude	Annual Rate (yr^{-1})
8.2-8.8	.00124
7.6-8.2	.00280
7.0-7.6	.00637
6.4-7.0	.0146
5.8-6.4	.0335
5.2-5.8	.0768
4.6-5.2	.176
4.0-4.6	.403

Their estimate for the magnitude of the maximum earthquake is 8.8. These numbers reflect corrected values, and differ from those published in the draft EIS of BLM (1979) (Paul Thenhaus, personal communication, 1980).

The following table compares Thenhaus' results with those for Region 4 based on the recurrence equation calculated previously. This assumes their magnitudes are equivalent to M_w.

Magnitude M_w	M_0 (dyne cm)	Recurrence Interval (yr) $1.8 \times 10^{-16} (M_0)^{2/3}$ Region 4	Recurrence Interval (yr) Thenhaus Zone 13
≥ 8.2	$\geq 2.2 \times 10^{28}$	1430	806
≥ 7.6	$\geq 2.8 \times 10^{27}$	360	248
≥ 7.0	$\geq 3.5 \times 10^{26}$	90	96
≥ 6.4	$\geq 4.5 \times 10^{25}$	23	40

In this study a b value of 1.0 is assumed while Thenhaus et al. uses 0.6. This accounts for the fact that the estimates agree for $M \geq 7$, while Thenhaus et al.'s recurrence times for the largest events are significantly shorter than ours. Considering the complications, errors and biases (Utsu, 1971) which can enter into calculated b values, we do not feel it is possible to regionalize them in a significant way on the basis of historic seismic data. In addition, Thenhaus et al. (1979) remove aftershocks from consideration in their recurrence estimates. If this modification were made to Molnar's method the recurrence estimates would be increased. A model for aftershock occurrence would have to be developed to quantitatively remove their effect. Considering the differences in method and the errors inherent in both methods, the results are remarkably similar.

COMPARISON OF SEISMIC RECORD WITH RECURRENCE ESTIMATES

Utsu (1971) has pointed out many of the complexities of the Gutenberg-Richter log N(M) versus M linear relationship. Although the relation appears to be valid for large sets of data, its use in small regions and extrapolation above or below the observed data may be risky. There are many complications, such as: bias in the magnitude calculations which may change the slope of the distribution; aftershock sequences and the variation in their sizes and upper magnitude limits with region, depth, and size of the main shock; and variation in the upper bound magnitude with region and depth.

Keeping these problems in mind, the seismicity in the 140 x 140 km^2 area including the 1979 St. Elias earthquake and its aftershocks was reviewed as a sample portion of Region 2. During the 20 year interval from 1958 to 1978 6 events occurred with magnitudes greater than or equal 5.0. During the 5 year interval, 1974-1979 there were 7 events with magnitudes greater than or equal 4.0. These numbers would translate into recurrence intervals of 3.3 years for $M \geq 5$ and 0.71 year for $M \geq 4$. Assuming a b value of 1, the 3.3 yr recurrence time for magnitude 5 and above would give a .33 yr recurrence time for 4 and above. We will assume that the shorter recurrence interval determined from the 20 yr sample is closer to the true distribution. Extrapolating this recurrence time up to magnitude 7.3 and greater yields 658 years. Assuming this portion of Region 2 is typical of all of Region 2, the recurrence time for the entire Region 2 for magnitudes greater than or equal 7.3 is 258 yrs. This recurrence time is roughly a 20 times greater than that calculated previously for Region 2.

The Pacific-North American plate boundary between Yakutat Bay and Kayak Island has been identified as a seismic gap on the basis of its long period of relative quiescence for large events as compared with adjoining regions (Tobin and Sykes, 1968; Kelleher, 1970; Sykes, 1971). Although large events (M>7) were used in identifing this region as a seismic gap, Sykes (1971) points out that the level of both moderate activity and microearthquakes may be low as well. Davies and House (1979) propose an episodic behavior for earthquake activity with four periods: (1) preseismic, (2) seismic, (3) postseismic, and (4) interseismic. The interseismic period of tens or hundreds of years would produce a "seismic gap" with relatively little seismic activity occurring.

Although it is possible that the recurrence intervals calculated by Molnar's (1979) method are an order of magnitude too short, it would be most prudent at this time to assume that Region 2, which is within the identified seismic gap, has been in a period of lower than average seismicity during the past tens of years and that this condition may not continue long into the future.

IX. Needs for further study

Toward the goal of developing improved seismic exposure maps for the NEGOA region, considerable additional research is needed. It would be beneficial to develop an integrated model for the adjoining Gulf of Alaska OCSEAP regions based upon data from all of the principal investigators involved. Various approaches should be explored in setting the level of seismicity and the size of the largest events expected for each region. Data from other regions in the world with a similar tectonic setting but longer historic record should be sought, as this data may help overcome the problem of Alaska's short historic record. Additional geologic work that might lead to a better estimate of the frequency of great earthquakes in Alaska is highly desirable. One example of this would be the study of marine terraces.

Once the source regions and moment distributions have been agreed upon, they may be used as the input to statistical programs that generate the return times for given levels of acceleration or velocity at a grid of points. These values may then be contoured and used in seismic hazard planning.

Careful thought should be given to the possibility of including the record of past events in the estimates of future ground motions. As the seismic gap hypothesis gains credence it becomes tempting to enhance the probability of strong ground shaking in regions of seismic gaps and reduce the probability elsewhere. In the light of the nonuniform temporal distributions observed, such as occasional clusters of large events, however, the gap hypothesis should not be given undue emphasis.

The fifth category of earthquakes, events on subsidiary structures. has not been addressed yet in terms of the moment-rate calculations.

X. Summary of 4th quarter 1979 operations.

The 1979 field season work began in Alaska approximately on June 10, 1979 and ended on October 1, 1979. John Rogers was in Alaska for the entire time period, John Lahr until the end of June, Lars Gustavson for July and August, and Greg Condrotte for the month of September. The overall goal for this year's field season was a continued effort at seismic site "hardening" , the installation of two new seismic stations and the installation of 5 Geotech SMA-1 strong motion film recorders. In addition, the improvement of several receive sites was also an important goal as they related to the introduction and trial use of new VHF radio equipment.

As the work of this years' field season fits into several categories, they will be discussed in this way and maps will be used to give the reader more detail on work performed at particular sites.

1) NEW SEISMIC STATIONS

Three new seismic field stations and three non-seismic radio relay sites were installed this summer in areas not previously instrumented. These stations are indicated as darkened circles and diamonds in Figure 1. One station (CGL) is at the junction of the Chitina and Logan Glaciers. This station goes through a radio relay (SHOT), installed this summer, located about 10 miles southwest of McCarthy at over 5600 feet of elevation. From this point it is radioed to the Alascom Microwave repeater station, Tolsona, where it is multiplexed into the phone circuit for transmission to Palmer.

The second station is located above the Bremner River near its confluence with the Copper River. This station is radioed over Marshall Pass to a radio relay installed above Sheep Creek at the 5700 foot level. From this point the

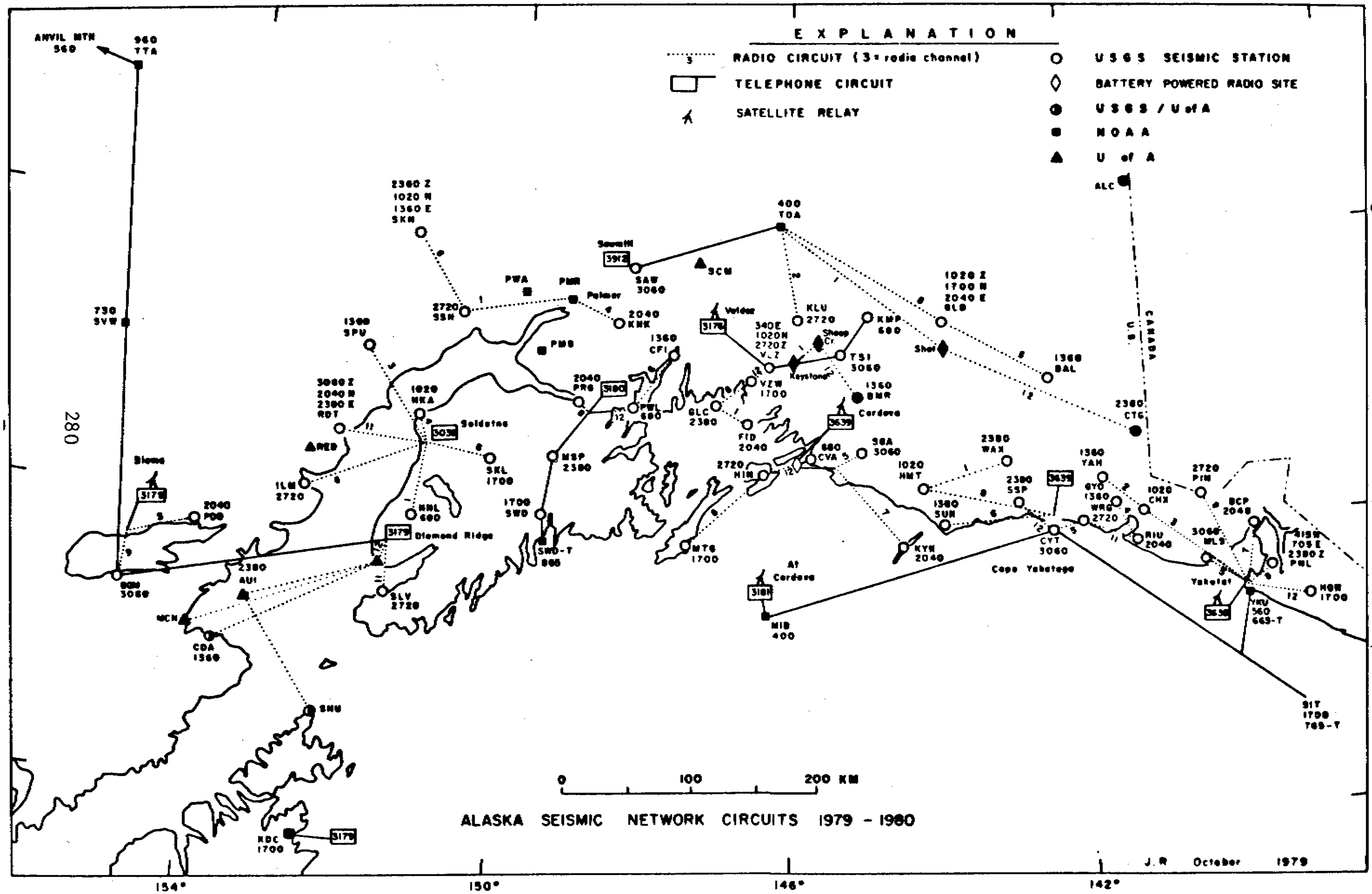

Figure 1

Three new seismic stations, darkened circles, and three new radio-relay sites, darkened diamonds.

signal is shot across Keystone Canyon to an Alascom Microwave Repeater where a battery powered receiver site was installed 50 feet above the Alascom installation. A cable then brings the signal into the microwave repeater facility where it is put on the phone circuit along with TSI and KMP.

Finally, a new seismic station to replace the one at Burwash Landing was installed on the Alaska-Canada border at Alcan. This station records on an on-site Helicorder which is maintained by U.S. Border officials. The Timing Base is in a specially constructed sliding rack built after the unit from Burwash was damaged. This unit has plug-in cards for easy repair by untrained personnel.

2) SMA-1 STRONG MOTION RECORDER INSTALLATIONS

Perhaps the most challenging aspect of this summers' field season was the installation of free-field SMA-1 strong motion event recorders. These recorders respond to larger events by recording 3 components of seismic data plus time on film. Installation required the pouring of a concrete pad inside a culvert upon which a custom fiberglass enclosure is mounted using stainless steel bolts. In addition, a special cable from the SMA pit was routed to the AlVCO pit. This cable allows signalling the AlVCO that the SMA-1 is recording. The AlVCO in turn outputs a seismically quiet signal which can be used for accurate timing. This quiet signal is generated by a special trigger card located in the fourth slot of the AlVCO. To avoid confusion this signal is referenced to the crystal so its duration is very precise. The use of this fourth card slot represents the first application of the AlVCO's multi-channel capability.

Approximately 48 hours are required for the concrete to set. After this period, the SMA-1 is installed along with the trigger card. Installation of the SMA-1 requires setting the clock, installing 4 gell-cell batteries, leveling the unit, loading the film, running test records, calibration, and many other details.

Originally, it was intended to install SMA-1 recorders at KYK, TSI, BAL, GYO and SSP. Due to weather problems (thick fog and gale force winds) it was not possible to land at KYK (Kayak Island) although one unsuccessful attemptwas made. The other four SMA-1 recorders were successfully installed at the four other sites, and indicated by darkened circles in Figure 2.

3) A1VCO SEISMIC ELECTRONICS

The A1VCO which was first introduced during the summer of 1978 has been working well and to date only three failures have been found. Two of these, however, involved lightning and as such could not be considered failures of the A1VCO unit itself. Figure 3 shows the sites which were converted to the A1VCO installation this year. Figure 4 shows all sites currently operating with A1VCO's. As can be seen, the goal of replacing of the older "202" units is almost complete with the exception of the horizontal component stations and 4 vertical component stations. This replacement has eliminated the carrier frequency drift associated with the "202" VCO. To date no A1VCO has drifted off frequency. This stability is due to a crystal reference.

In addition to being frequency stable, the A1VCO does not need to operate from ultra-stable but expensive Lithium batteries. Thus all A1VCO units (except HIN, PDB and BGM) currently operate from the same power source (air-cells) as the VHF radio. The increase in current drain is less than 1% so no significant shortening of radio battery life is expected. The savings per year in Lithium batteries, however, should be about $1,500. Additionally, reliability will be increased by having only one power source and inventory problems will also be lessened.

Another significant advantage to using radio power for the VCO is the inclusion of the the radio battery level as part of the calibration. This should lead to cost savings and more reliable station operation in the future.

In order to achieve the running of the A1VCO on external (radio) power the

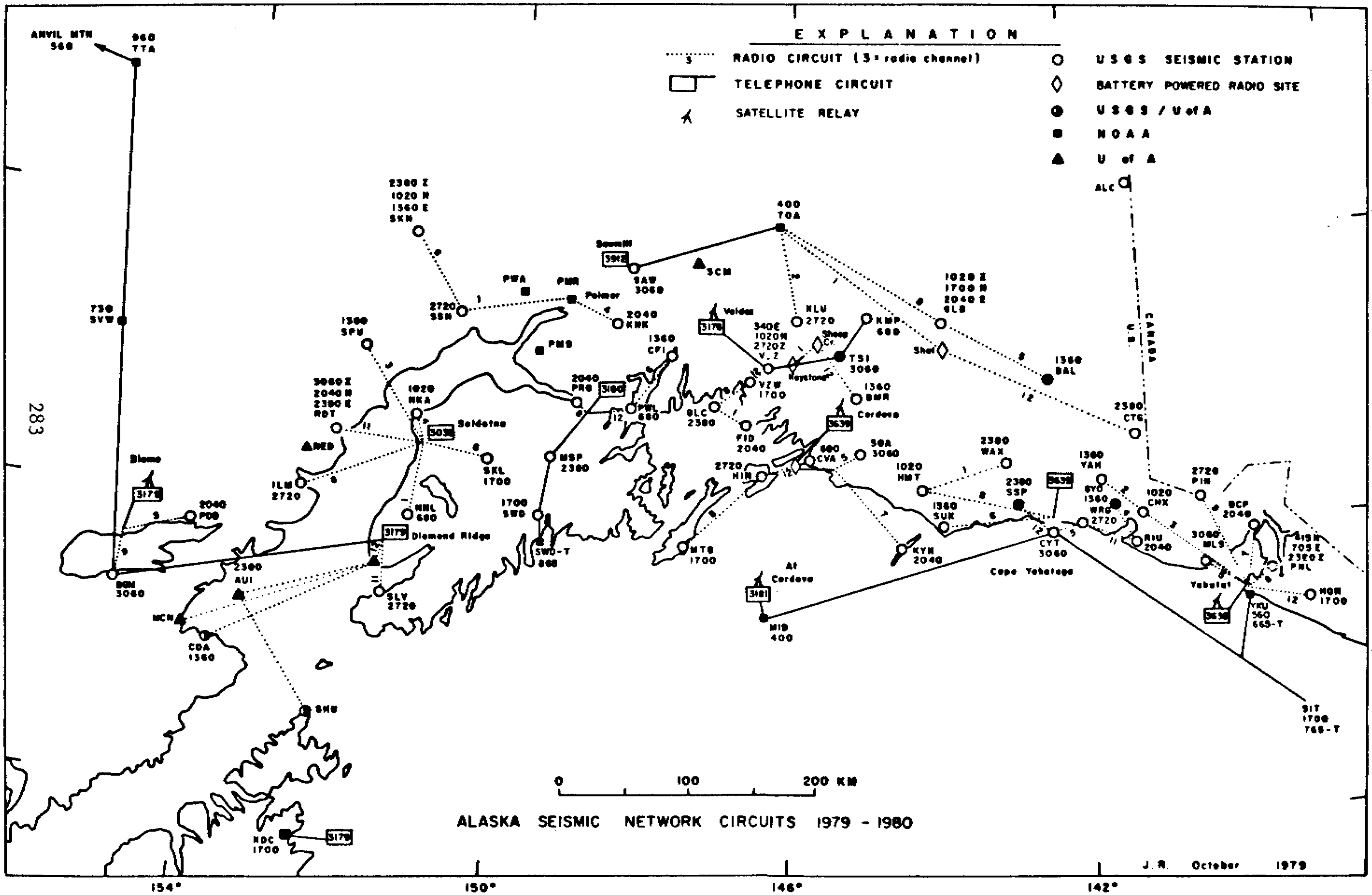

Figure 2

Four new SMA-1 sites shown as darkened circles.

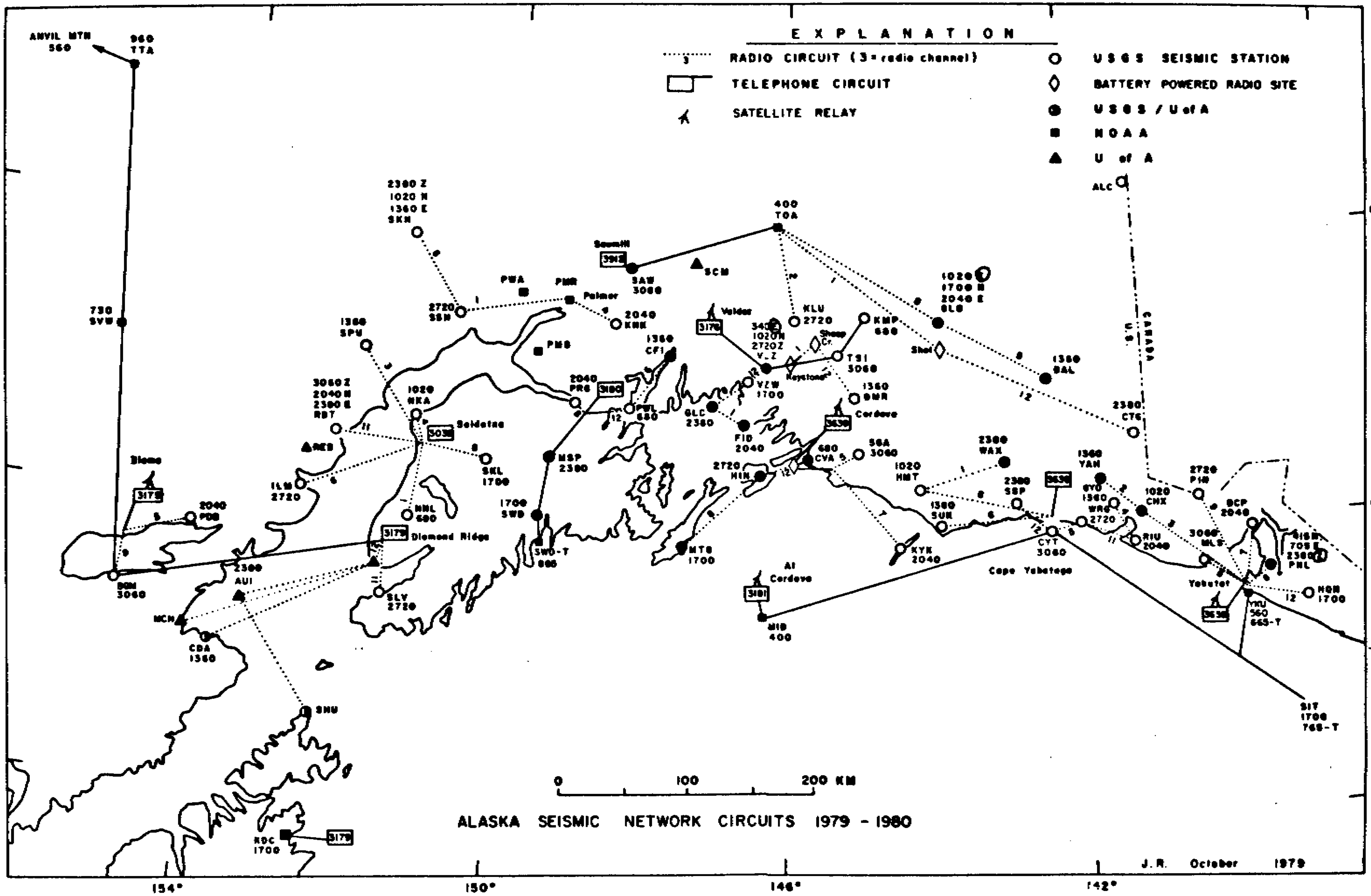

Figure 3

Seismic station converted to A1VCO units during summer, 1979, shown as darkened circles.

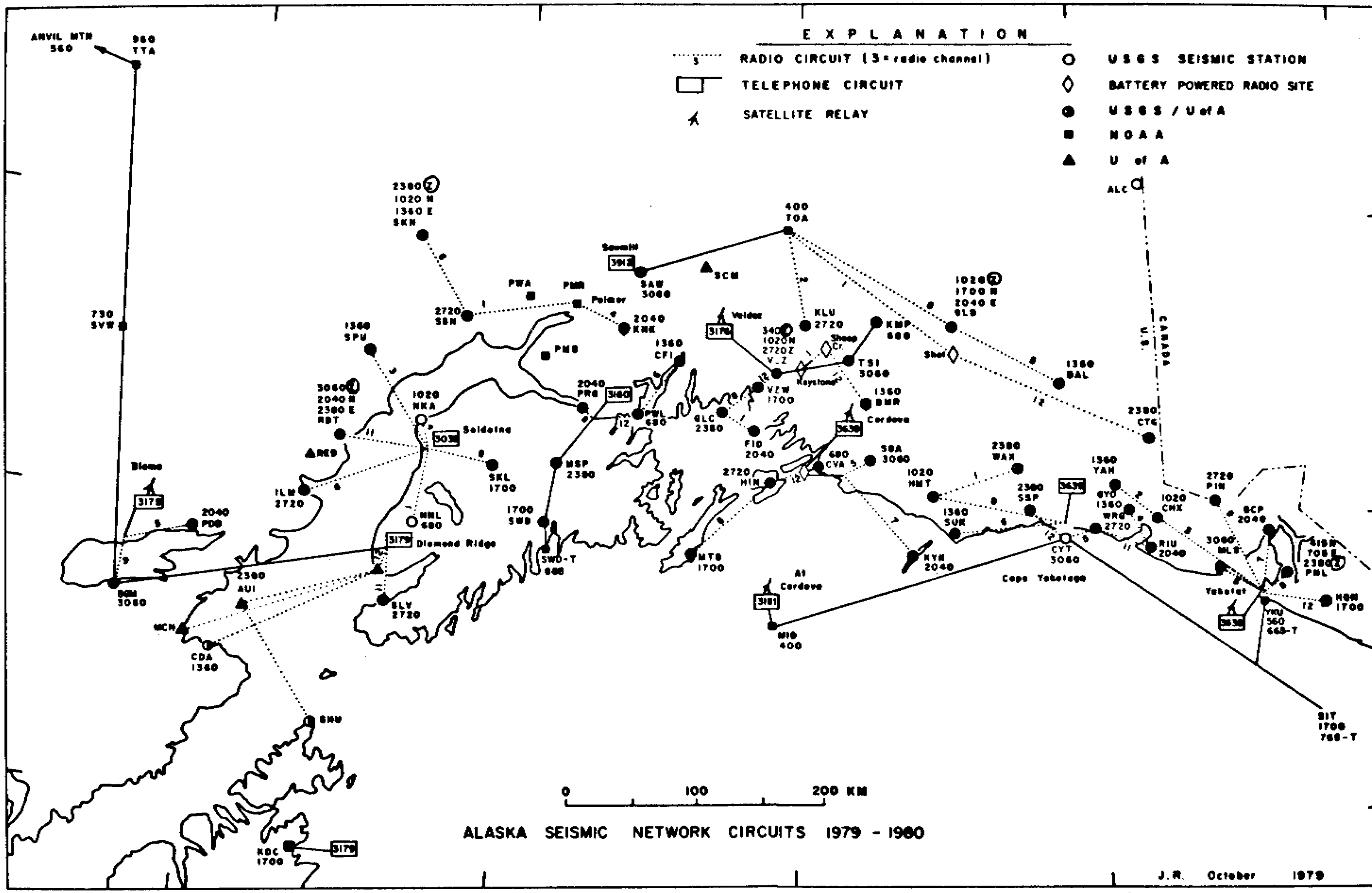

Figure 4

All sites currently operating with A1VCO units are indicated by darkened circles.

stations indicated in fig. 5 had their Skydyne (outer enclosure) box modified and rewired. This also allows for future multi-channel operation or externally initiated signalling. This feature is discussed below under SMA-1 Installations.

Finally, Figure 6 shows those stations which go directly into a phone circuit via cable. By rebuilding the sites at KMP, HIN, MSP, TSI and SAW all the stations indicated in Figure 6 (except VLZ) now are running from air-cell power. The advantage over Lithium batteries (besides having one standard power source) is that these stations will operate for many years on a single set of batteries. This will help reduce field maintenance at these stations.

4) SITE HARDENING

Site hardening as used here relates to the effort expended to reduce the likelihood of animal, weather or unintentional human damage at a seismic field station. Chronic problems at the sites fall into these categories:

1) Snow and ice load causing antenna and mast damage.
2) Cable damage by animals.
3) Geophone disturbances from animals.
4) Broken wires or poor electrical contacts inside culvert.

Antenna and mast damage has been greatly reduced by the introduction of specially designed antenna masts, log period antennas, and wire rope harnesses. Figure 7 shows those stations which had their antennas upgraded this summer. At CHX special "dead men" made of steel highway markers were installed, along with new harnesses. At SSP the radio and antenna were removed from a tree where they were damaged by animals and an antenna with steel mast was installed. The antenna harness installation has the coaxial cable running up through the mast and thus cannot be damaged by animals, such as has occurred at RDT, BCS, SSP, and FID in the recent past. Figure 8 shows these stations still needing significantly more antenna work.

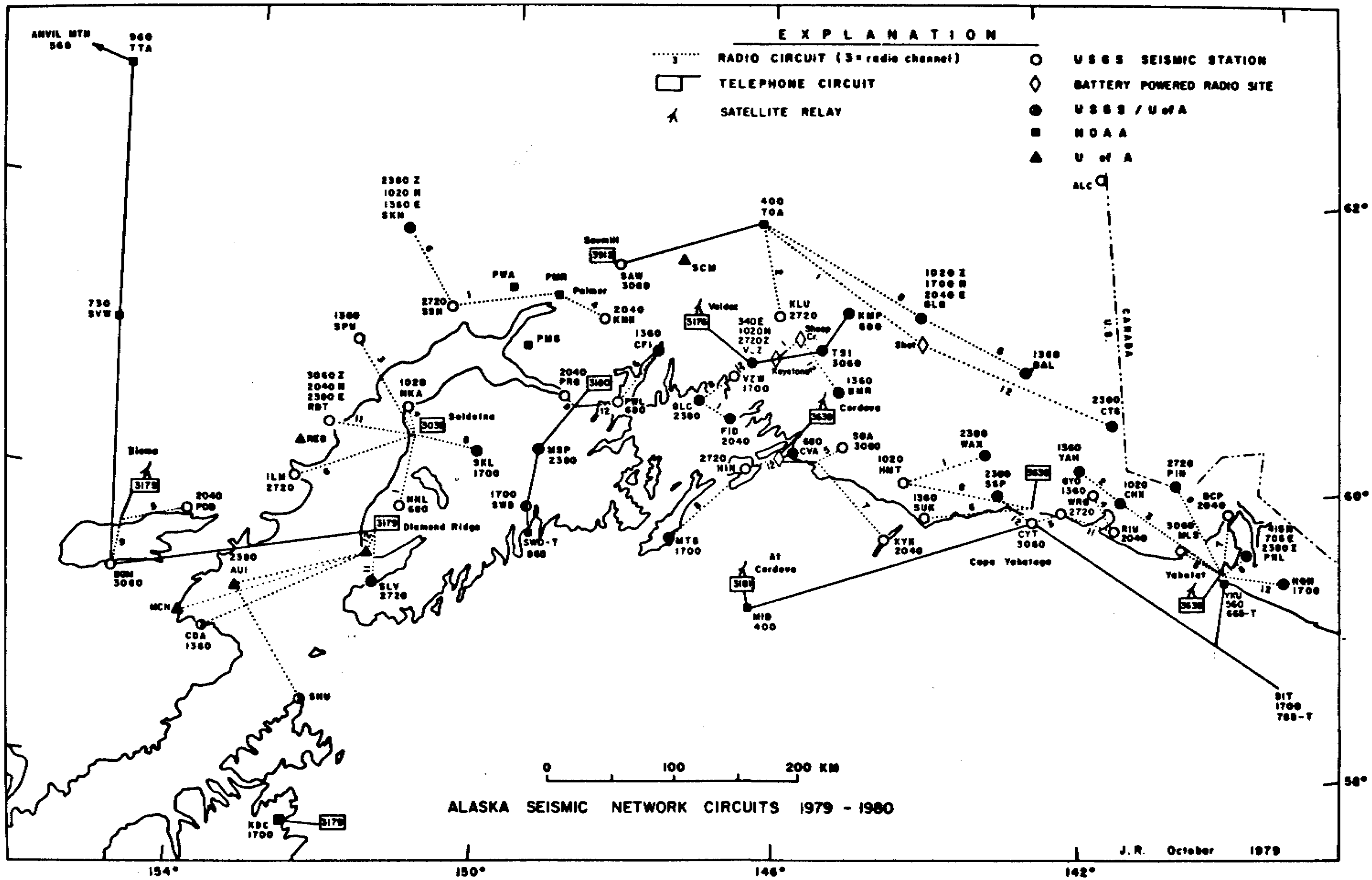

Figure 5

Stations which have a Modified Skydyne Box and are powered by air cells are indicated by darkened circles.

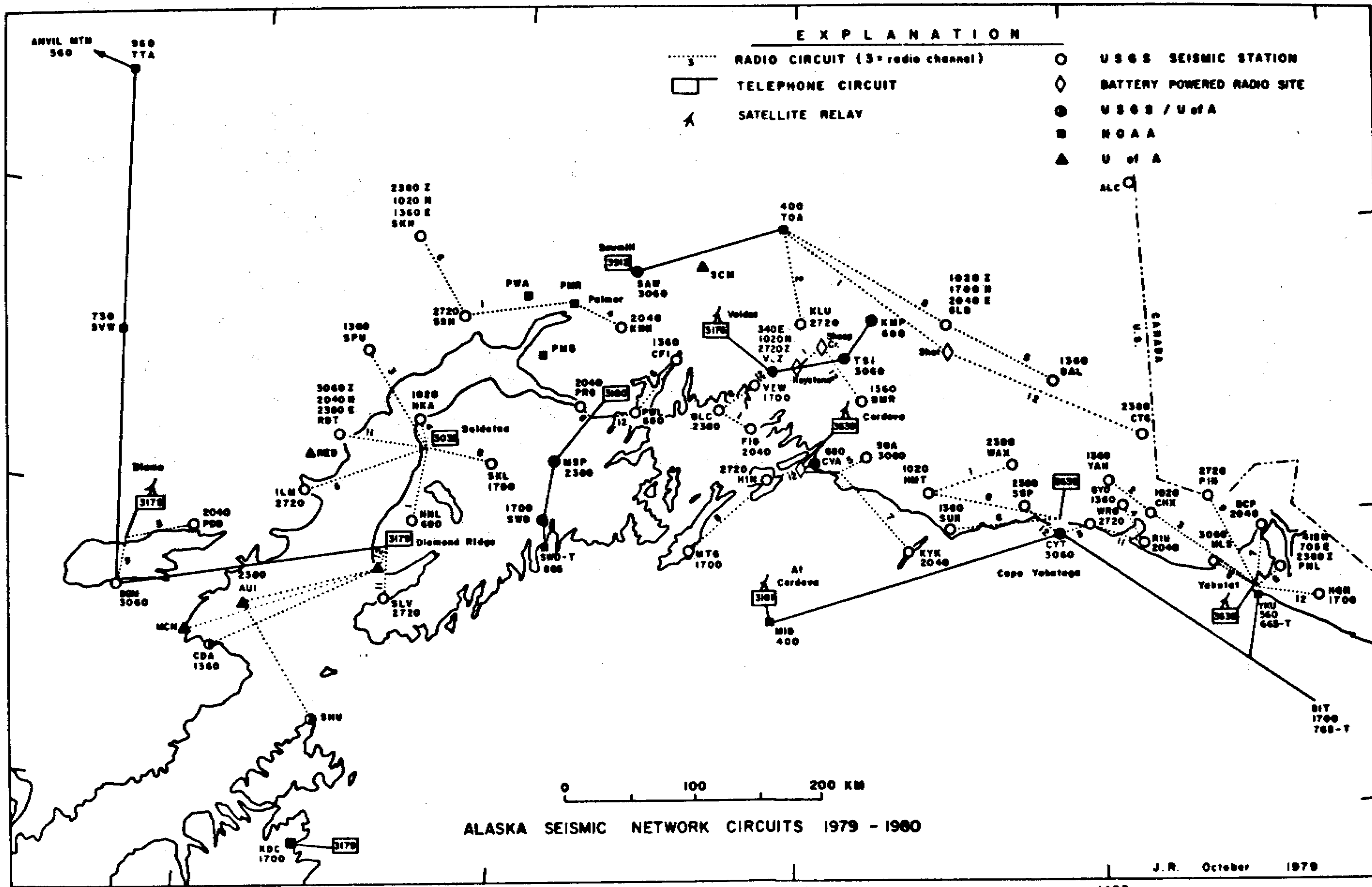

Figure 6

Stations which are cabled into phone circuit are indicated by darkened circles.

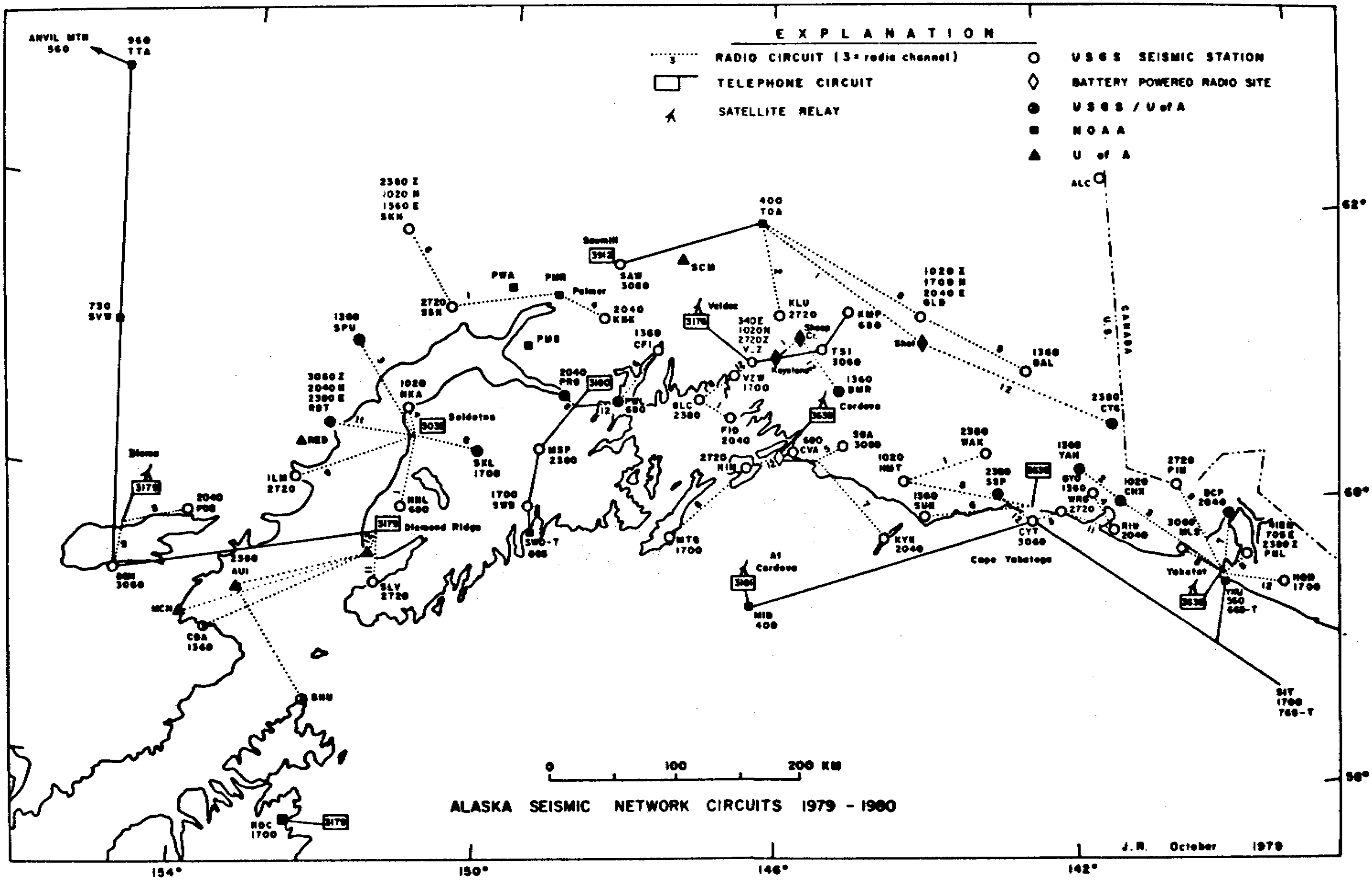

Figure 7

Stations which received heavy duty antenna hardware indicated by darkened circles and darkened triangles.

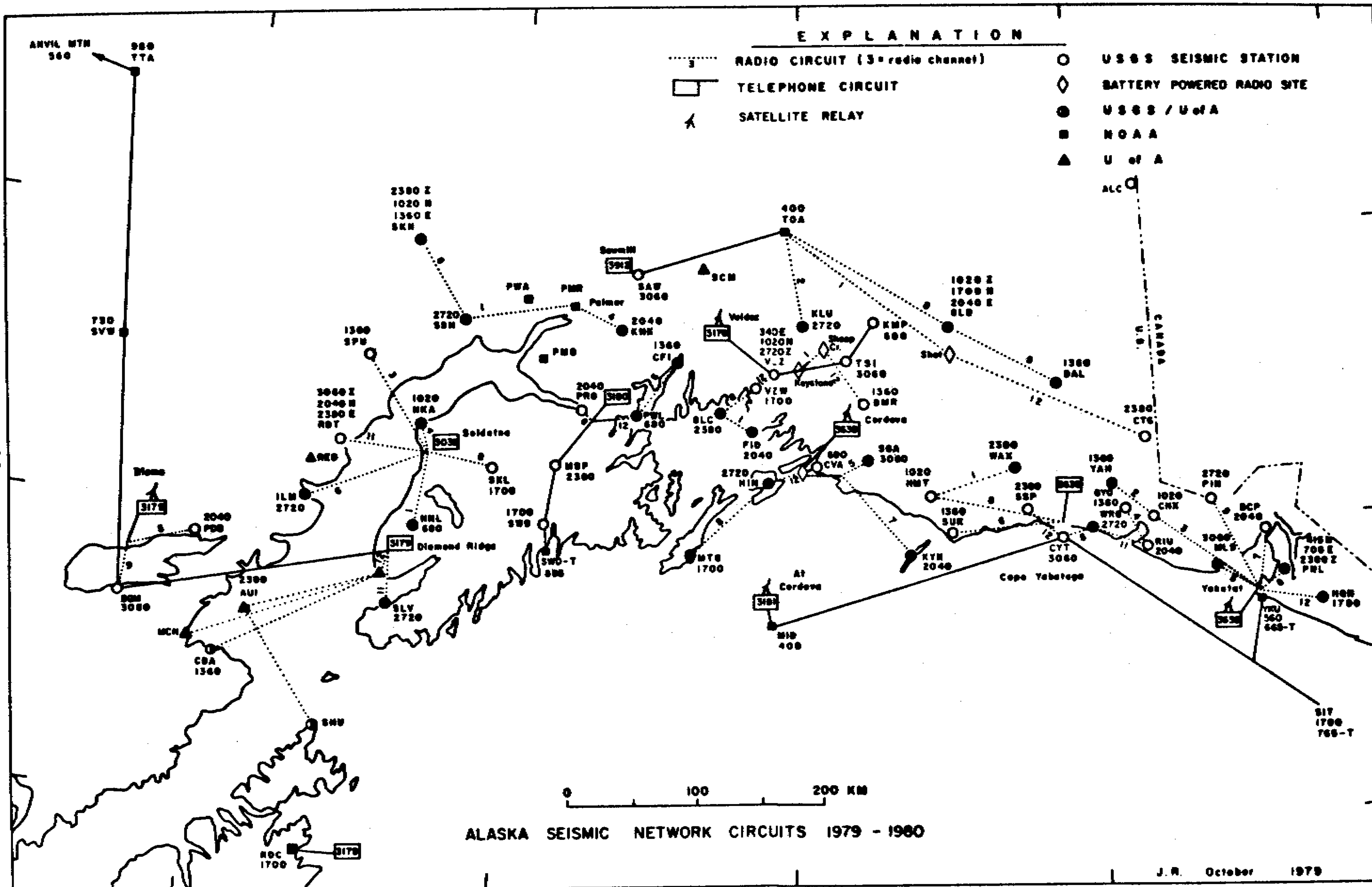

Figure 8

Stations needing further antenna work indicated by darkened circles.

Another site-related problem has been faulty or poor wiring inside the culvert. Figure 9 shows stations which have been completely rewired, using a standard wiring layout which is identical from site to site. In addition, an instrument platform has been installed. This instrument platform, together with the standard wiring layout and antenna installation should make field visits shorter and reduce the chances of needing an unusual item not normally carried on the helicopter.

At WRG the geophone cable was rerouted to come out from under the pit, as opposed to coming out under the lid. This should reduce the possibility of geophone disturbances by animals, such as occurred at SSP, PNL and RDT. However, it is not possible to bury the cable and geophone deep enough to prevent bears from digging up the installation. One goal for next year's field season is the design of a more nearly bear-proof geophone installation.

5) VHF FIELD RADIOS

The effort to find a substitute for the aging Motorola HT-200 radio has not yielded any good low power candidates as of this date. This effort will continue, as radio problems are now a leading cause of excessive noise or unrecordable data. For use where A.C. power is available, however, the GE Master II has proved effective.

The purchase of a portable high accuracy frequency counter from Data Precision has enabled us to adjust the transmitter frequency in the field. This should yield some improvement in signal quality as this adjustment is now part of the field procedure.

In an attempt to minimize the problems associated with the Motorola radios, the entire set (about 40 radios) went through a quality control test procedure three separate times during the summer. This proved to be necessary, as about 25% of the total each time had to be returned to California for retuning or repair.

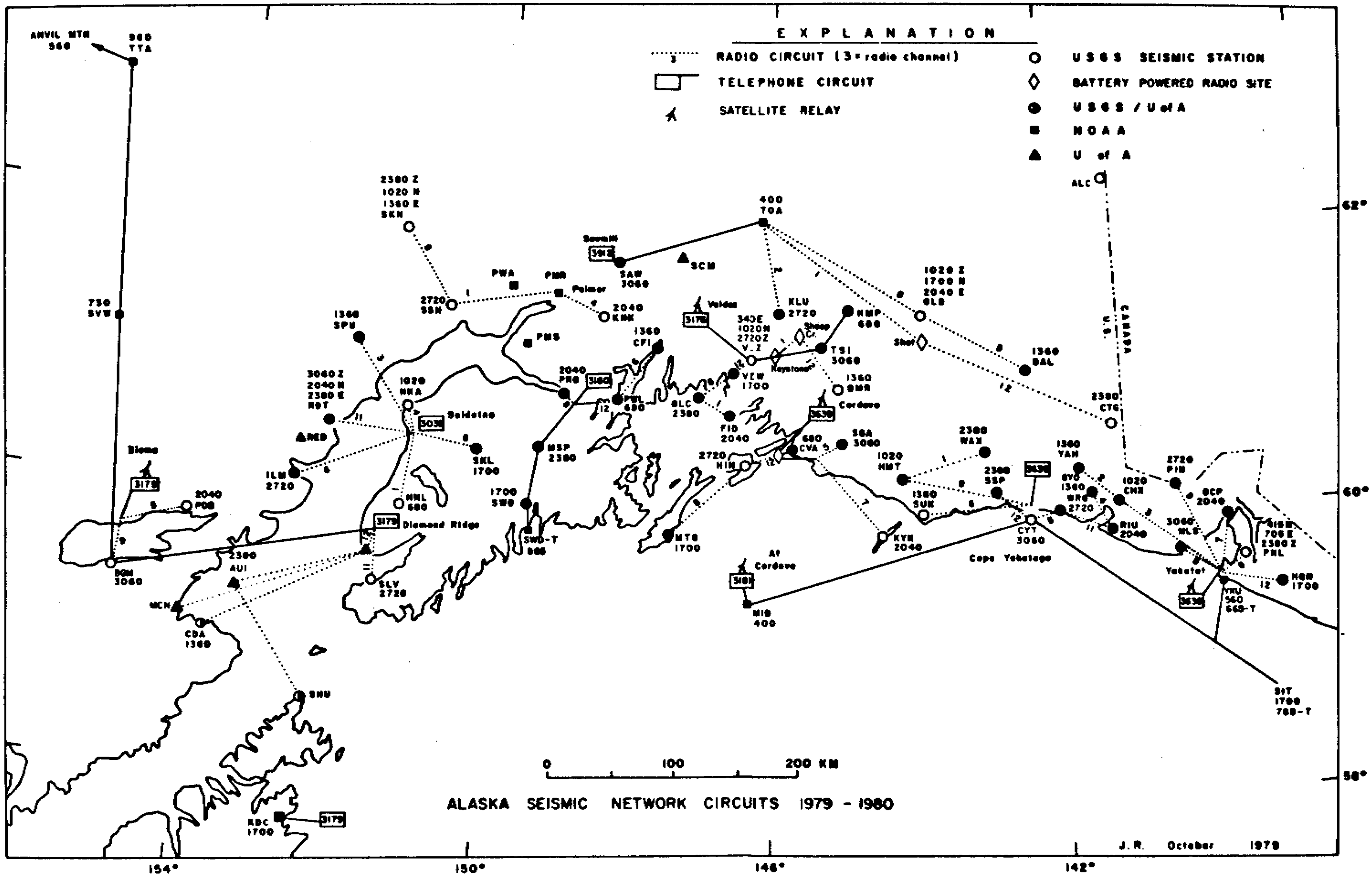

Figure 9

Stations rewired with standard layout indicated by darkened circles.

Fig. 10 shows those sites which had their radio air cell batteries changed this summer.

6) <u>RECEIVE SITE WORK</u>

<u>Yakutat</u>

The filter bridge rack has been moved from the satellite earth station to a previously vacant room in the transmitter building located about 100 yards from the U.S.G.S. range tower receiving array. This is possible under an agreement established with the FAA. A multi-pair cable was laid from the tower into the building. This move allows the data to be filtered before the signals are multiplexed, thus reducing interference problems. The noise reduction should be enhanced by the use of a newly designed 4-stage filter card. This card, containing a state-of-the-art hybrid filter IC, has twice as many stages as the older version. Filter cards for this installation and several others were prepared using computer aided design techniques.

<u>Whittier</u>

The receiver installation at Whittier was replaced by a rack mounted GE receiver and filter bridge. The filter bridge contains 4-stage filter cards for higher noise rejection. The rack should allow for easier maintanence and possible later installation of monitoring equipment. The use of a GE receiver here (for PWL-CFI) is intended to increase the chance of recording during the winter and spring. In the past damage at the PWL has prevented reception for part of the year.

<u>Soldotna</u>

A GE receiver was installed at the Alascom White Alice Site, along with a filter bridge and four stage filter cards. The GE receiver is for ILM, which is one of the longest radio shots in the network.

<u>Tolsona</u>

A GE receiver was installed for GLB-BAL, the second longest radio shot.

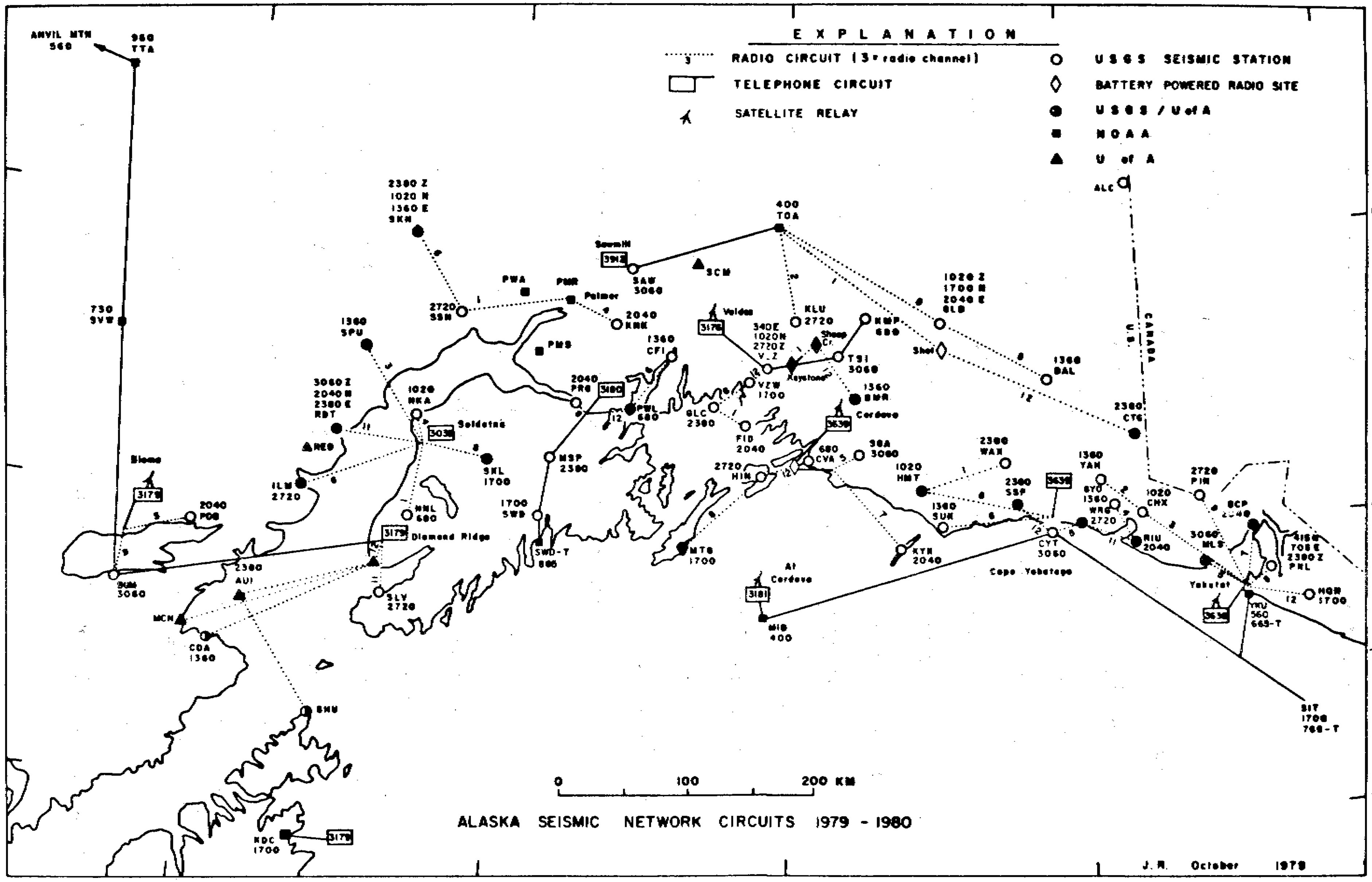

Figure 10

Sites with air cell batteries changed during 1979 indicated by darkened circles and darkened diamonds.

In addition, some work on the antennas was performed to reduce interference between antennas.

7) FACILITIES

Since logistics is one of the most time consuming aspects of Alaska field work, a lab area was set up in an FAA building in Yakutat. This area is on the second floor of the transmitter building in the range tower area. As mentioned above, an equipment rack is located in this room, of which about 100 square feet of space is reserved for U.S.G.S. use. In addition, a lab work bench was constructed with a generous amount of shelf space. This area allows for storage of a large part of our field gear, reducing the time and money spent each year shipping the same items in and out of Yakutat. The lab bench is very helpful in testing field equipment prior to visiting the stations.

In Anchorage several days were spent reorganizing the warehouse area and a separate outside storage facility has been assigned to the project for the storage of large items, such as batteries, culvert lids and antenna masts.

8) WINTER WORK IN ALASKA

Time did not permit completion of all work during the summer months. Projects needing to be completed are:

-Installation of an SMA-1 recorder at Tolsona.

-Installation of a specially designed filter bridge with a SMA-1 trigger circuit at Cape Yakataga.

-Moving the receiving equipment for KYK-SGA at the Cordova airport from the VHF building to the Flight Service Station. (The VHF building was slated to be torn down 11/79). Equipment to be installed will include a new filter bridge, cards, and a GE receiver.

-Installation of a new filter bridge in Valdez at a better location inside the earth station.

-Installation of 2 additional A1VCO units in Valdez. One of these will be operated at 340 Hz. Because 34o Hz is near the phone circuit lower frequency cutoff, this will be an experiment to increase data transmission efficiency by 12% without increased costs.

-Installation of rack-mountable oscilloscopes at the FAA in YUakutat and the Alaska Railroad in Whittier. This equipment will allow Alaska Railroad and FAA personnel (who have expressed the desire to help) to involve themselves in troubleshooting problems and monitoring USGS equipment.

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QUARTERLY REPORT

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Research Unit #: 251
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SEISMIC AND VOLCANIC RISK STUDIES WESTERN GULF OF ALASKA

H. Pulpan
J. Kienle

Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

September 30, 1979

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OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Period Ending September 30, 1979

Project Title:	Seismic and Volcanic Risk Studies Western Gulf of Alaska
Contract Number:	03-5-022-55
Task Order Number:	C1
Principal Investigators:	H. Pulpan and J. Kienle

I. ABSTRACT

The main emphasis during this report period was on field operation. The annual service of the seismic network was accomplished and field expeditions were staged to Augustine and Redoubt Volcanoes.

II. TASK OBJECTIVES

It is the purpose of this research to determine the seismicity of Lower Cook Inlet, Kodiak Island, and the Alaska Peninsula, and to evaluate the seismic risk to onshore and offshore development and also to evaluate eruption potential and volcanic risk of Redoubt and Augustine Volcanoes in Cook Inlet.

III. 1979 FIELD ACTIVITIES

A. Field Trip Schedule

1. Seismic Network Service

May 21 - June 9, Kodiak network

June 23 - June 28, Chirikof Island, Chowiet Island service with NOAA vessel Surveyor.

July 22 - August 8, Alaska Peninsula Lower Cook Inlet station service.

August 11, Redoubt (RED) service.

September 2 - September 7, Rearrangement of Alaska Peninsula network telemetry, in order to be able to record at King Salmon.

2. Homer Recording Center: Service and Calibration

May 5 - May 24
May 29 - June 6
July 19 - July 22
July 24 - August 1
September 8 - September 9

3. Volcanology

June 8 - June 21, Augustine Volcano: Tephra Chronology

August 5 - August 11, Redoubt Volcano: Geologic reconnaissance in cooperation with the State of Alaska, Dept. of Natural Resources, Div. of Geological and Geophysical Surveys.

B. Scientific Parties

1. Seismic Network Service

May 21 - June 9: Ron Foster, Electr. Technician; John Pender, Student.

June 23 - June 28: Jim Benich, Electr. Technician.

July 22 - August 8: Ron Foster, Electr. Technician; Jim Benich, Electr. Technician; Ken Grant, Field Assistant.

August 11: Juergen Kienle, Principal Investigator.

September 2 - September 7: Hans Pulpan, Principal Investigator; Jim Benich, Electr. Technician.

2. Homer Recording Center

May 5 - May 24: Dick Siegrist, Technical Coordinator.

May 24 - June 6: Hans Pulpan, Principal Investigator

July 29 - August 1: Dick Siegrist

September 8 - September 9: Hans Pulpan

3. Volcanology

June 8 - June 21: Juergen Kienle, Principal Investigator; Samuel Swanson, Participating Scientist.

August 5 - August 11: Juergen Kienle, Samuel Swanson, Peter MacKeith (Student), Daniel Solie (Field Assistant), all Geophysical Institute, University of Alaska.

Jim Riehle, Karen Emmel, Participating Scientist and Field Assistant from State of Alaska, Dept. of Natural Resources, Division of Geological and Geophysical Surveys.

IV. PRELIMINARY RESULTS AND INTERPRETATION

A. Seismic Risk Studies

Routine data analysis was performed during the report period. Epicenter maps for the time period, January through March 1978 are given in Appendix 1. The most remarkable feature is the high level of seismic activity in the southwestern portion of the study area. The largest of these events is the Magnitude 6.5 event of February 13, which occurred southwest of Chirikof Island (Fig. A-3). Since this event and its aftershock sequence are located outside our network, the location given in Figure A-3 might be in error (The USGS's preliminary epicenter determination service gives the following hypocentral parameters: Latitude: 55.54N, Longitude: 157.131W; Depth: 24 km). In spite of these uncertainties it is evident that the Semide Island area southwest of Sitkinak Island has been unusually active. This area is believed to be part of the Shumagin seismic gap and over the past years has displayed a much lower level of seismic activity than for example the area off Kodiak Island. It is presently not clear whether this activity might be a precursor to a large event in the Shumagin gap.

Two shallow events of nearly magnitude 4 occurred in Bristol Bay, the first apparent events of that size detected in that area. Again these events were located outside our network and their location and magnitude might be in substantial error. We shall perform a special study on these events.

Preliminary hypocenter determinations have been completed for July and the parameters have been forwarded to the University of Texas for assistance in their data search from the Ocean Bottom Seismometer. These instruments had been deployed off Kodiak Island from June 20 through August 30. Our August develocorder films have been read and the preliminary hypocentral parameters for that month will be available shortly.

B. Volcanic Hazard Studies

1. Augustine Volcano

Tephrachronologic, petrologic and geochemical investigations continued this year on the northern half of Augustine Island, which in the past 100 years has been exposed to repeated pyroclastic flow and nuée ardente activity. J. Kienle was joined in the field by Dr. Samuel Swanson, our new staff petrologist of the Division of Geosciences at the University of Alaska.

We measured tephra sections at 3 different sites, 2 on the Burr Point pyroclastic flow terrane and 1 on the NE-flank of the volcano. The soils were sampled for dating by the C^{14}-method and the tephra for petrologic and geochemical analyses.

We also resampled the 1976 pyroclastic flow on the NE-flank of the volcano searching for rock inclusions to study the eruption mechanism, which probably involves magma mixing. Some of the older terrane at the higher northern flank of the volcano was also sampled for petrologic and geochemical analyses.

The samples are now being analyzed.

Finally, we erected a disassembled shelter, which was donated by NOAA-ERL/WPL to our Augustine project, when their summer 1978 operations on the SE-flank of Augustine ended. The building is now located on the "West-Lagoon", the most easily accessible site for float-plane landings.

2. Redoubt Volcano

This years field investigations were closely coordinated with personnel from the State of Alaska, Department of Natural Resources, Division of Geological and Geophysical Surveys, who are currently conducting a coastal geohazard study along the western shore of Cook Inlet.

S. Swanson and J. Kienle continued to collect a reconnaissance suite of samples from all helicopter accessible sites on the volcano. However, there are disappointingly few sites. Geochemical, petrologic and K-Ar dating analyses are in progress.

Glacier motion studies were continued on "North Glacier", where all recoverable stakes planted last year were resurveyed from the 2 new bench marks on the north side of the Drift River Valley. A new set of Black and White aerial photography of the North glacier was acquired in order to monitor the down-glacier movement of a patch of debris, deposited on the upper reaches of the glacier during the 1966 eruptions.

The State of Alaska team and J. Kienle also investigated and mapped extensive volcanic mudflow and lahar deposits in the Drift River and Crescent River valleys, where a massive lahar reaches the coast. A reconnaissance trip was made up Redoubt Creek, at the head of which another glacier descending from Redoubt Volcano is nearly blocking the valley. Several tephra sections were measured in the three valleys (Crescent River, Redoubt Creek, and Drift River). C^{14}-datable material was recovered from the lahars and the tephra sequences and have been sent to the dating laboratory.

APPENDIX 1

Epicenter Locations Maps

This appendix shows plots of epicenters for January 1979 through March 1979. The one-letter code shows the epicenter location with the following depth code:

A	$0 \leq 25$
B	$26 \leq 50$
C	$51 \leq 100$
D	$101 \leq 125$
E	$126 \leq 150$
F	$151 \leq 175$
G	$176 \leq 200$
etc.	

The size of the letters is proportional to the magnitude of the event. The size of the numerals giving the geographic coordinates cooresponds to magnitude 2.

The following is a list of figures:

Figure	Caption
A-1	Epicenter map, Kodiak-Alaska Peninsula January-March 1979, all locatable events.
A-2	Epicenter map, Kodiak-Alaska Peninsula, January-March 1979, class 1 events.
A-3	Epicenter map, South of 57°N, February 1979, all locatable events.
A-4	Epicenter map, Lower Cook Inlet, January-March 1979, all locatable events.
A-5	Epicenter map, Lower Cook Inlet, January-March 1979, class 1 events.

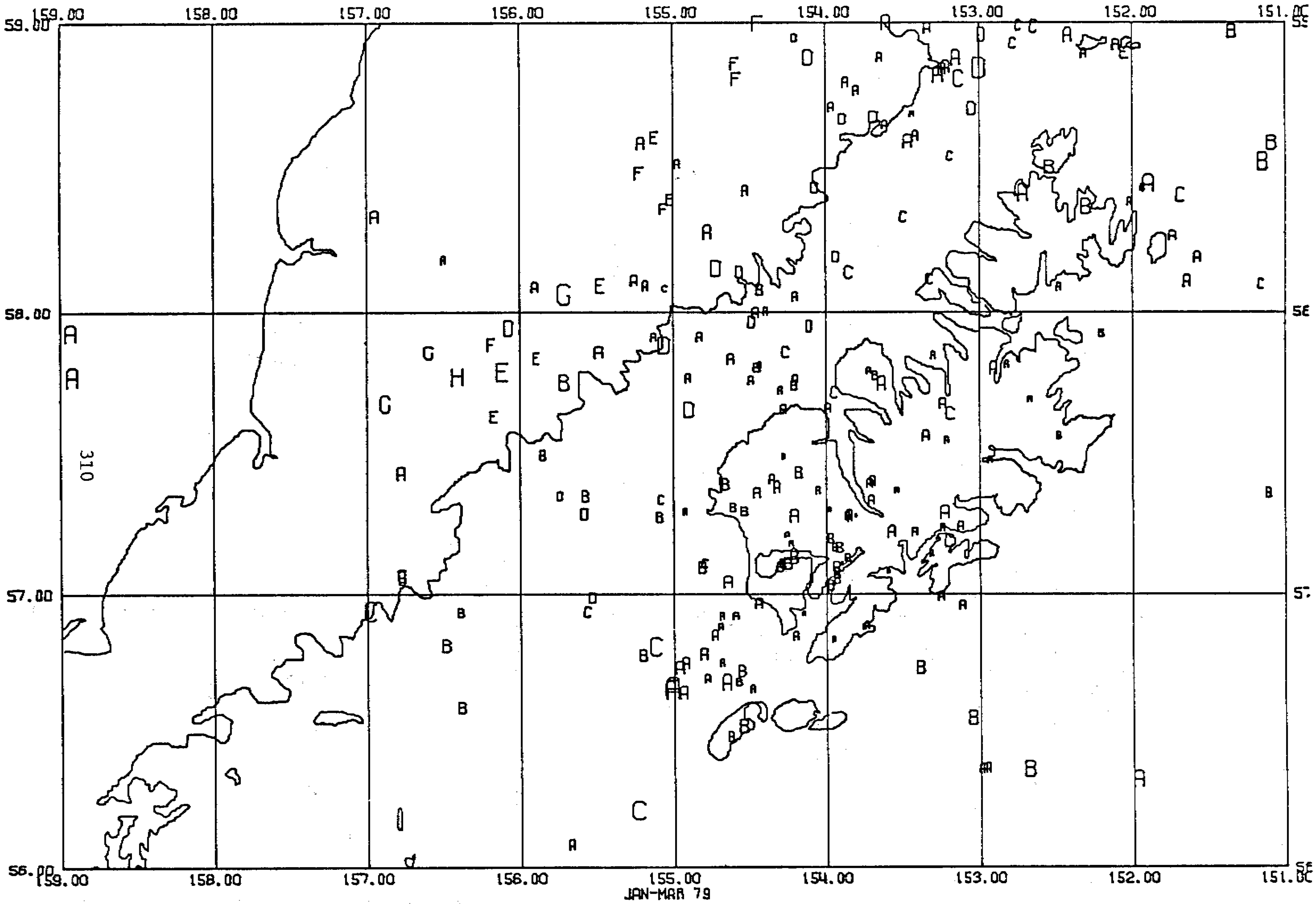

Figure A-1. Epicenter map, Kodiak-Alaska Peninsula, January-March 1979, all locatable events.

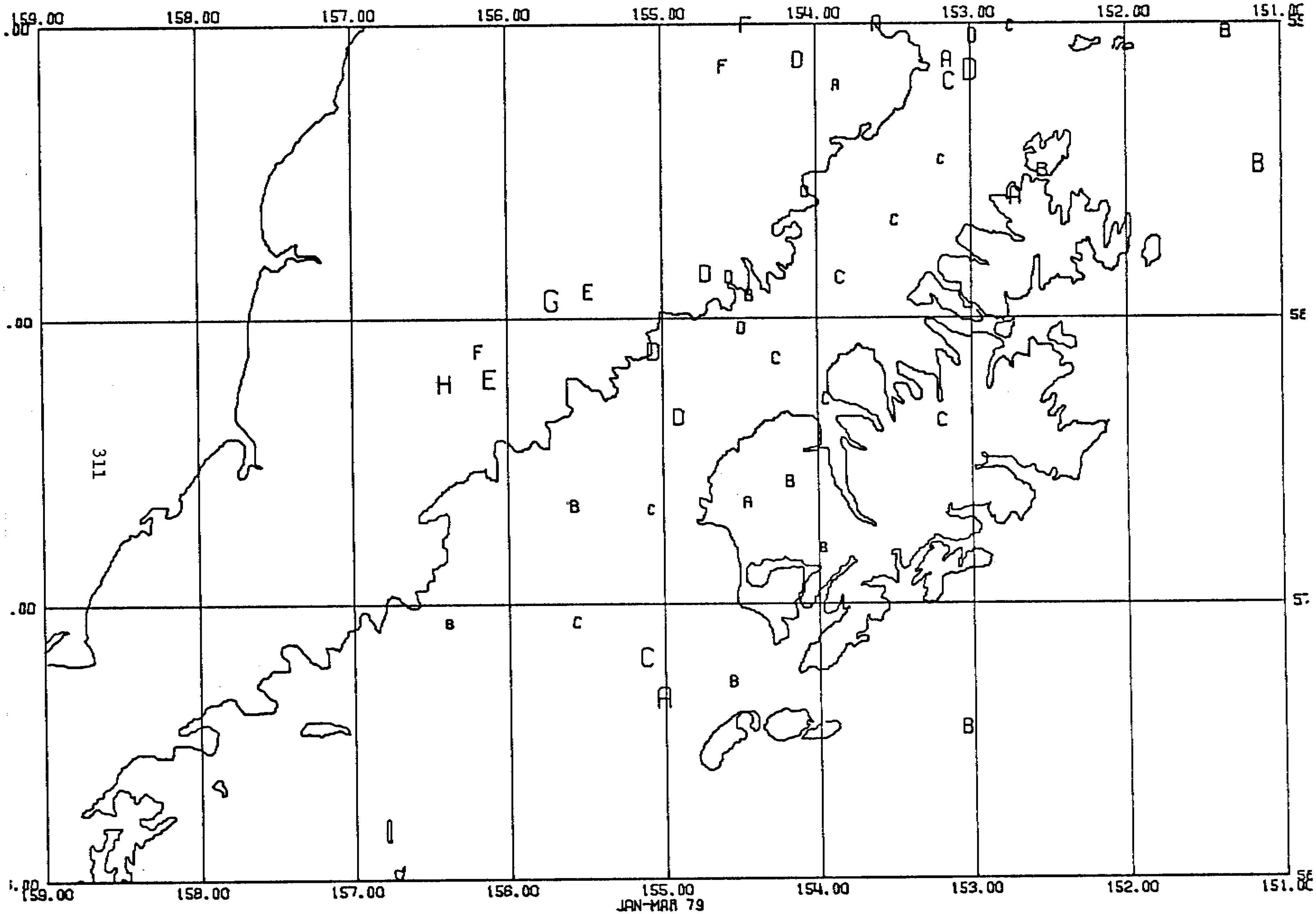

Figure A-2. Epicenter map, Kodiak-Alaska Peninsula, January-March 1979, class 1 events.

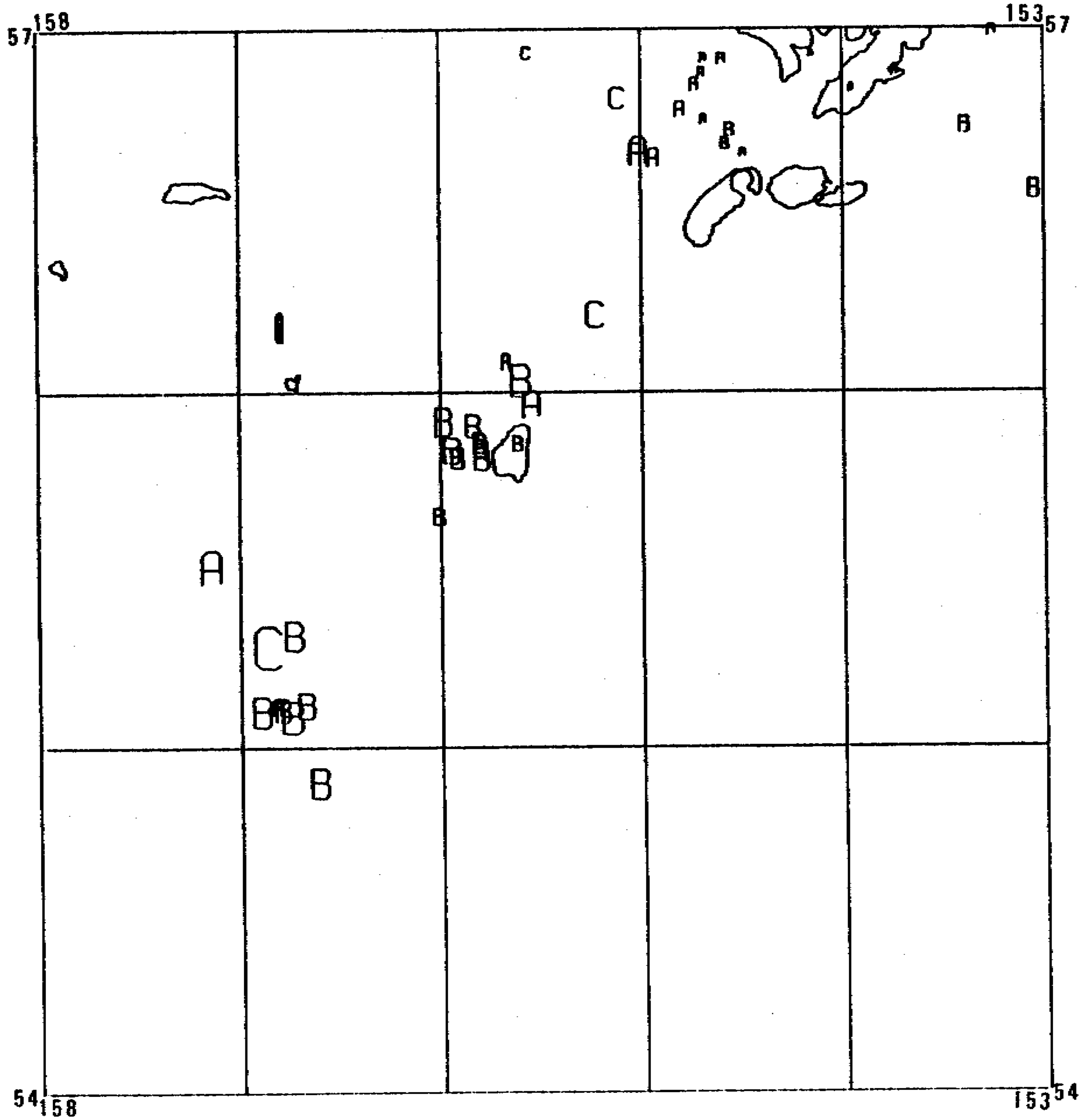

Figure A-3. Epicenter map, south of 57°N, February 1979, all locatable events.

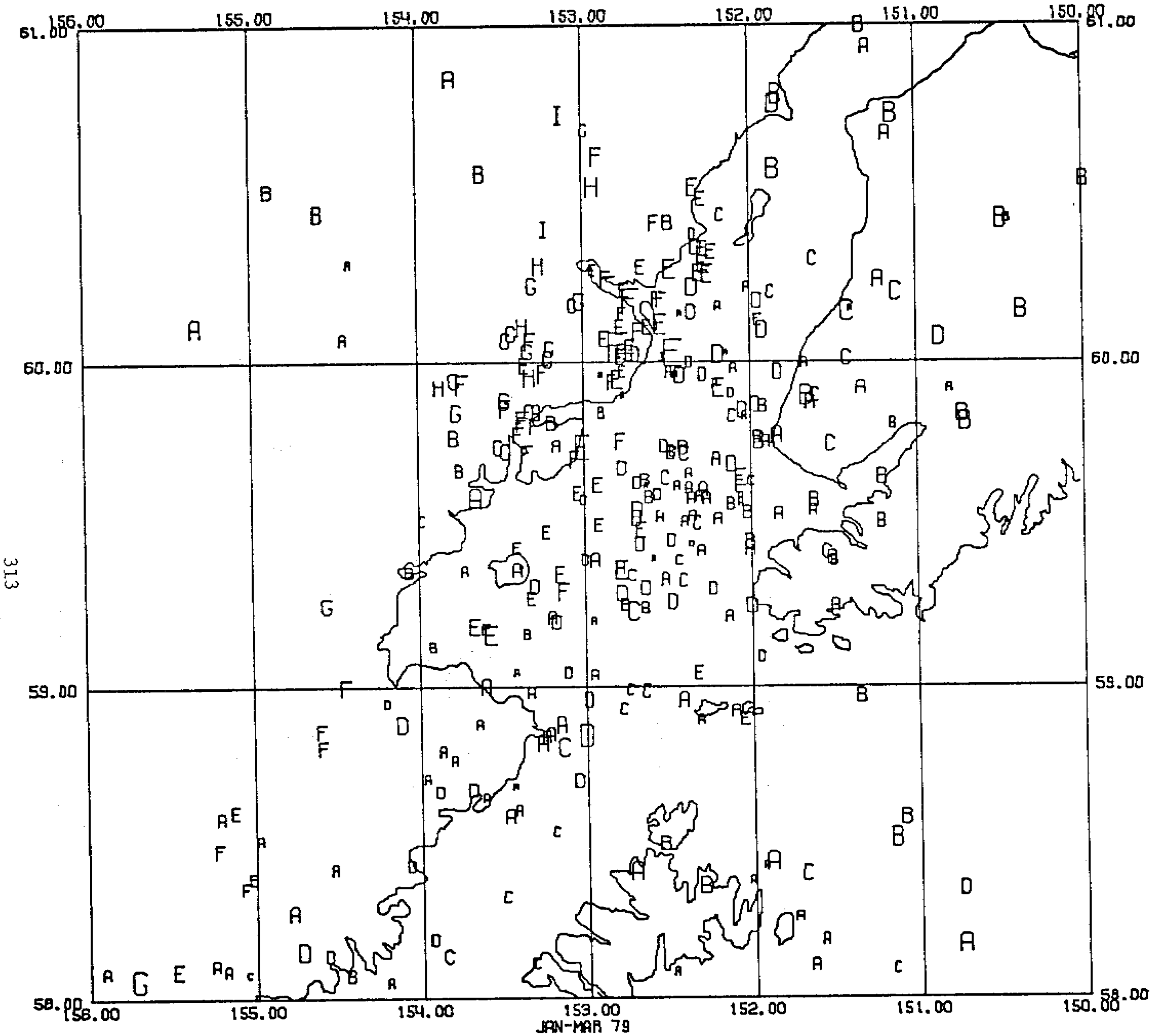

Figure A-4. Epicenter map, Lower Cook Inlet, January-March 1979, all locatable events.

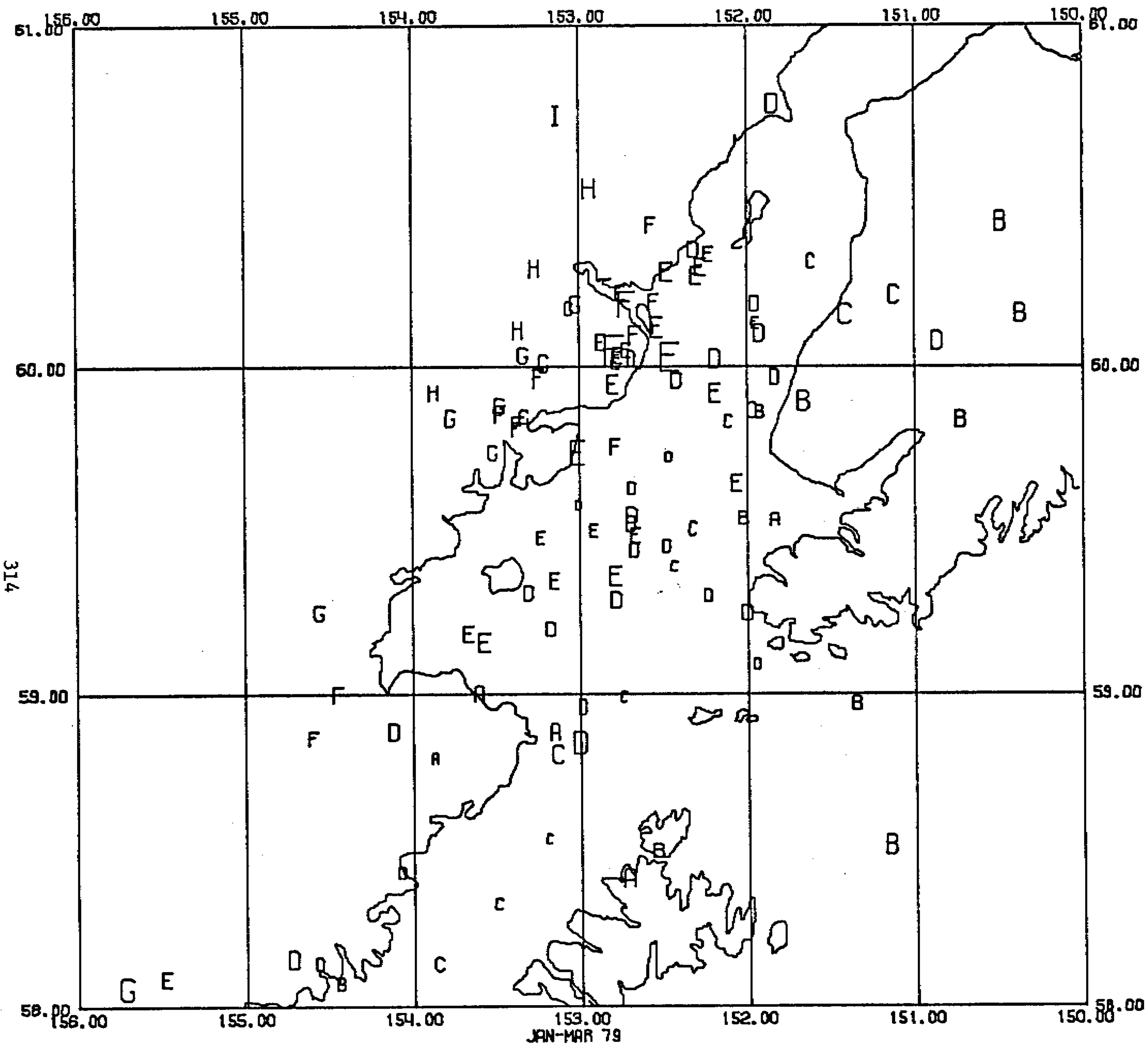

Figure A-5. Epicenter map, Lower Cook Inlet, January-March 1979, class 1 events.

APPENDIX 2

Hypocenter Listings for Cook Inlet,
Kodiak, and Alaska Peninsula

January 1979 through March 1979

Table A1-1 All Events

This appendix lists origin times, focal coordinates, magnitudes, and related parameters for earthquakes which occurred in the lower Cook Inlet, Kodiak, and Alaska Peninsula areas. The following data are given for each event:

(1) Origin time in Greenwich Civil Time (GCT): 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 N).

(3) DEPTH, depth of focus in kilometers.

(4) MAG, magnitude of the earthquake. A zero means not determined.

(5) NO, number of P arrivals used in locating earthquake.

(6) GAP, largest azimuthal separation in degrees between stations.

(7) DM, epicentral distance in kilometers to the closest station to the epicenter.

(8) RMS, root-mean-square error in seconds of the travel time residuals:

$$RMS = \sum_i (R^2_{Pi} + R^2_{Di}) / (NP + NS)$$

Where R_{Pi} and R_{Si} are the observed minus the computed arrival times of P and S waves, respectively, at the i-th station.

(9) 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.

(10) 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.

(11) Q, quality of the hypocenter. This index is a measure of the precision of the hypocenter and is the average of two quantitites, QS and QD, defined below:

QS	RMS (sec)	ERH (km)	ERZ (km)
A	< 0.15	≤ 1.0	≤ 2.0
B	< 0.30	≤ 2.5	≤ 5.0
C	< 0.50	≤ 5.0	
D	Others		

QD is rated according to the station distribution as follows:

QD	NO	GAP	DMIN
A	≥ 6	≤ 90°	≤ DEPTH or 5 km
B	≥ 6	≤ 135°	≤ 2x DEPTH or 10 km
C	≥ 6	≤ 180°	≤ 50 km
D	Others		

The following table is included:

Table A1-1   Cook Inlet, western Gulf of Alaska
All Events

TABLE A1-1

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JAN 1	1	2	4.5	57	38.6	154	0.4	5.0	1.9	3	180	19	0.	0.	0.	C
1	3	55	53.8	57	22.7	153	43.8	5.0	1.7	3	217	35	0.	0.	0.	C
1	8	51	33.6	58	27.3	155	14.5	140.0	2.5	4	316	116	0.12	0.	0.	C
1	8	59	18.6	57	32.9	152	29.6	38.1	1.3	4	219	22	0.	0.	0.	C
1	15	33	34.7	55	57.1	152	38.9	2.5	2.3	4	333	137	0.70	0.	0.	D
1	21	22	18.7	59	20.2	155	4.9	132.2	2.1	4	263	67	0.10	0.	0.	C
2	2	58	25.3	60	1.0	153	13.6	161.3	2.9	10	314	40	0.30	22.4	22.1	D
2	3	11	47.1	59	19.4	153	10.5	105.3	2.7	10	85	11	0.18	3.9	6.4	B
2	3	27	46.9	56	56.8	154	27.8	6.3	2.1	4	273	34	0.	0.	0.	C
2	4	33	53.2	57	38.7	156	54.6	153.2	3.3	7	329	84	0.13	31.8	28.2	D
2	5	34	27.8	58	33.6	155	13.5	5.0	2.3	4	239	84	0.95	0.	0.	D
2	9	16	44.7	58	24.4	154	5.2	91.1	2.3	7	206	66	0.17	3.6	6.9	D
2	10	51	18.4	58	58.7	153	37.6	5.9	2.8	7	127	35	0.28	2.9	4.4	C
2	11	17	54.7	57	41.5	153	56.2	69.2	2.4	6	185	14	0.06	1.5	2.8	C
3	14	11	59.2	56	36.9	155	2.8	5.0	4.0	5	170	83	0.20	3.4	447.4	D
3	16	16	2.1	57	24.5	154	12.0	43.0	2.4	5	108	27	0.10	1.9	3.0	C
3	19	29	51.1	59	36.8	152	38.4	5.0	0.9	3	251	56	0.10	0.	0.	C
4	6	38	31.1	59	57.1	152	30.2	6.9	2.0	4	152	54	0.21	0.	0.	C
5	13	57	1.7	60	15.9	152	18.2	113.8	3.0	20	78	31	0.54	3.0	4.7	C
5	19	40	32.6	60	27.9	152	18.7	114.6	2.6	6	228	118	0.26	10.3	16.6	D
6	6	55	45.8	59	46.8	153	19.2	129.9	2.4	8	303	15	0.11	8.5	11.0	D
6	9	52	12.7	59	20.8	152	48.5	5.0	2.3	3	163	41	0.	0.	0.	C
6	15	51	8.5	57	16.3	153	48.6	5.0	0.6	3	187	22	0.	0.	0.	C
6	19	54	18.9	57	36.5	156	11.8	104.6	2.2	4	126	12	0.	0.	0.	C
7	7	15	11.0	60	9.4	153	2.8	156.9	3.1	15	178	57	0.46	6.1	7.4	D
7	11	12	46.2	56	20.0	152	42.2	29.2	3.2	7	275	94	0.21	16.1	6.0	D
7	12	41	34.8	59	47.3	150	44.4	41.9	3.3	7	328	260	0.22	67.7	334.0	D
7	13	26	24.9	60	23.6	152	30.4	45.1	2.6	5	228	14	0.45	151.5	182.4	D
7	15	0	9.4	57	50.1	154	17.2	57.1	2.3	6	212	31	0.25	6.1	6.9	D
7	16	9	37.9	59	49.4	153	18.3	8.9	2.6	5	207	72	0.48	10.4	9999.9	D
7	16	16	52.8	60	18.9	152	18.1	103.9	2.7	7	219	28	0.19	8.5	11.6	D
7	17	25	2.7	57	58.6	154	28.7	5.0	2.2	5	189	65	0.77	14.9	9999.9	D
7	22	13	3.5	59	47.4	153	13.0	29.6	2.6	4	200	74	0.14	0.	0.	C
8	4	51	44.3	59	22.3	152	27.4	69.4	2.0	7	98	51	0.22	2.7	6.1	C
8	8	3	15.8	58	58.4	152	45.6	66.4	2.1	8	98	45	0.13	1.4	2.7	B
8	9	25	46.2	59	44.5	153	48.7	40.6	2.7	4	229	95	0.39	0.	0.	D
8	11	4	17.5	56	54.1	157	0.7	71.5	3.6	9	286	56	0.55	15.5	12.4	D
8	14	21	43.0	60	42.6	151	10.6	41.3	3.5	26	67	74	0.69	3.0	737.1	C
8	15	29	40.0	59	57.0	152	54.2	5.0	1.1	3	242	52	0.32	0.	0.	D
9	0	14	9.1	58	7.0	154	35.2	86.6	2.3	15	126	62	0.36	2.5	6.7	C
9	9	56	29.0	56	57.9	155	32.9	80.2	2.1	4	220	68	0.	0.	0.	C
10	6	25	51.2	60	23.8	150	31.1	33.5	3.4	17	167	58	0.52	4.3	2.9	D
10	11	29	20.5	59	16.0	153	9.3	147.9	3.1	4	177	16	0.04	0.	0.	C
10	13	57	49.5	60	21.8	152	21.5	96.8	2.2	5	187	23	0.26	15.7	8.7	D
10	22	21	24.2	59	43.6	153	10.8	5.0	2.1	4	157	80	0.21	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JAN 11	5	36	12.5	59	36.9	152	1.1	69.4	1.9	6	164	21	0.24	16.1	23.9	D
11	10	11	54.3	60	17.2	151	38.3	71.7	2.4	15	97	33	0.45	3.5	4.7	C
12	2	46	25.3	57	12.1	153	35.5	5.0	2.2	3	167	25	0.	0.	0.	C
12	6	44	59.5	58	41.4	153	58.6	5.0	1.9	3	199	47	0.	0.	0.	C
12	9	21	8.9	59	2.0	153	26.0	5.0	1.3	3	154	44	0.	0.	0.	C
12	20	27	22.0	60	4.8	153	23.5	177.8	3.0	20	181	51	0.35	4.4	4.2	D
12	22	38	59.9	59	24.1	152	1.9	0.2	2.8	10	126	26	0.93	5.4	22.8	D
13	6	20	3.0	59	56.5	151	51.4	85.2	2.8	9	217	33	0.24	4.2	5.1	D
14	9	52	24.9	57	43.3	153	39.8	0.4	2.8	6	256	48	0.80	18.5	34.4	D
14	11	25	7.9	57	10.0	153	13.7	74.2	2.6	4	168	8	0.15	0.	0.	C
14	13	12	46.8	57	2.0	156	47.7	38.5	2.6	7	194	93	0.51	7.3	774.0	D
14	19	41	17.6	59	13.4	152	1.6	75.4	2.8	7	147	37	0.14	3.1	5.0	C
14	20	55	55.3	57	6.4	154	14.2	34.9	2.6	4	140	16	0.	0.	0.	C
15	1	55	51.6	57	55.8	154	7.6	77.9	2.2	5	231	59	0.06	7.4	17.2	D
15	3	5	42.4	58	46.7	154	36.5	127.4	2.7	8	213	43	0.19	5.6	12.2	D
15	19	39	53.4	59	30.9	152	2.6	38.3	2.4	5	159	26	0.05	2.0	1.4	C
15	21	57	24.9	59	42.8	152	26.1	41.3	2.6	4	218	45	0.16	0.	0.	C
16	19	43	25.8	59	41.4	153	22.5	130.7	3.2	8	237	39	0.33	12.0	13.7	D
16	21	19	31.5	57	2.5	156	47.8	172.5	2.6	6	191	112	0.73	19.6	29.9	D
17	1	43	18.0	57	19.5	155	35.9	41.2	2.2	5	231	50	0.21	6.9	2.8	D
17	4	48	8.5	58	18.5	153	31.1	60.2	2.2	7	119	34	0.18	2.4	4.9	B
17	10	17	59.9	59	49.7	153	29.8	145.1	3.1	13	177	55	0.43	5.6	5.5	D
17	11	53	27.9	57	0.0	153	59.7	5.0	0.4	3	242	9	0.01	0.	0.	C
17	12	43	33.6	57	36.9	153	13.0	60.2	2.5	6	114	45	0.18	3.2	5.6	C
17	14	36	2.0	59	52.4	151	37.9	62.1	2.6	7	222	23	0.32	10.5	9.1	D
17	15	44	31.3	59	34.2	152	19.9	5.0	1.9	3	255	40	0.	0.	0.	C
17	18	24	25.5	59	10.6	153	12.1	92.2	2.7	5	133	21	0.11	6.3	9.6	D
17	21	53	12.7	59	34.4	153	4.0	110.8	2.5	5	226	33	0.34	36.0	38.6	D
18	23	50	17.1	59	11.5	152	57.8	5.0	1.6	3	194	30	0.	0.	0.	C
19	3	53	36.3	59	23.2	152	35.9	5.0	1.2	3	221	46	0.02	0.	0.	C
19	6	48	19.7	59	25.0	152	41.6	87.7	2.6	7	134	40	0.20	5.4	9.7	C
19	7	13	21.3	58	5.3	151	40.0	7.6	2.4	4	253	61	0.15	0.	0.	C
19	8	33	26.2	59	30.7	152	22.1	5.0	2.0	6	151	44	0.88	25.4	26.9	D
19	8	39	20.4	59	33.8	152	38.1	42.9	2.3	4	245	35	0.05	0.	0.	C
19	9	59	52.7	58	33.9	153	29.4	2.7	2.7	6	164	59	0.60	9.4	21.7	D
19	14	28	5.3	59	20.5	153	44.6	5.0	1.8	3	277	112	0.56	0.	0.	D
19	15	59	59.3	60	29.6	154	54.4	36.4	2.6	7	324	335	0.76	281.6	179.6	D
19	16	59	34.9	59	36.3	152	27.3	5.0	1.6	4	166	44	0.	0.	0.	C
19	17	6	28.2	58	38.7	153	54.4	75.6	2.2	4	250	53	0.07	0.	0.	C
19	20	17	14.8	60	23.4	152	35.6	133.6	2.8	19	85	81	0.51	3.5	6.2	C
20	3	16	45.0	59	33.6	153	1.5	89.3	1.8	5	89	15	0.07	2.3	4.1	C
20	6	16	1.3	57	59.3	154	24.6	6.4	1.7	4	279	74	0.03	0.	0.	C
20	16	27	58.6	55	34.9	155	31.9	31.9	3.7	9	313	28	0.18	72.5	12.6	D
21	10	13	49.0	58	24.1	154	32.5	5.0	1.9	3	208	80	0.	0.	0.	C
21	11	23	19.2	57	23.5	154	22.1	21.2	1.8	4	156	17	0.01	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JAN	21	13	37	29.6	60	29.8	152	21.6	115.9	3.0	5	270	24	0.24	24.4	29.9	D
	21	22	11	16.5	59	42.4	152	28.9	86.5	1.8	7	129	42	0.10	1.7	3.2	B
	22	5	37	33.9	57	17.5	153	59.3	5.0	1.0	3	214	22	0.	0.	0.	C
	22	16	38	27.8	58	4.4	152	29.6	5.0	1.6	3	272	36	0.36	0.	0.	D
	22	21	2	31.3	59	55.1	152	13.3	5.0	1.7	3	173	61	0.	0.	0.	C
	23	1	34	7.4	59	4.4	151	57.8	76.4	2.0	7	166	49	0.16	4.9	4.1	C
	23	4	22	10.5	59	25.6	152	1.7	41.4	2.4	7	138	25	0.38	20.1	18.0	D
	23	7	42	21.1	59	29.0	152	20.9	51.0	2.4	7	197	43	0.55	3.6	6.9	D
	23	12	37	40.7	59	54.9	153	48.5	164.4	2.9	5	299	68	0.18	27.5	26.1	D
	23	13	50	10.0	57	22.8	153	43.0	5.0	2.1	3	179	35	0.	0.	0.	C
	23	16	38	25.2	57	22.0	154	41.0	44.4	2.3	6	248	4	0.93	28.8	23.1	D
	23	19	52	25.1	59	53.9	153	53.5	189.5	2.8	7	279	46	0.08	6.1	7.6	D
	23	20	37	24.1	59	29.9	152	13.1	0.9	2.2	6	168	36	0.84	20.4	101.0	D
	23	21	0	14.3	59	51.0	153	30.7	156.1	3.2	5	296	27	0.02	3.6	4.9	D
	24	4	38	1.2	60	22.5	153	15.2	207.4	2.8	7	297	116	0.16	18.8	18.4	D
	24	6	50	22.7	58	10.4	153	57.0	89.5	1.9	4	241	48	0.	0.	0.	C
	24	20	36	43.8	57	16.0	153	14.9	5.0	2.6	3	155	15	0.	0.	0.	C
	25	0	59	51.4	56	49.9	154	13.1	5.0	1.7	3	274	30	0.01	0.	0.	C
	25	1	26	41.1	59	49.5	153	21.2	155.6	2.5	7	175	73	0.16	4.7	7.6	D
	25	1	33	29.6	57	48.1	152	50.1	5.3	1.5	4	140	21	0.20	0.	0.	C
	25	2	47	20.9	58	29.6	154	59.3	5.0	1.9	4	235	81	0.82	0.	0.	D
	25	4	30	36.0	60	6.6	151	58.2	109.2	2.1	5	215	56	0.02	1.1	1.1	C
	25	5	55	44.7	56	27.7	154	38.8	38.9	1.9	4	318	30	0.	0.	0.	C
	25	8	53	35.2	57	45.0	154	55.0	5.0	1.8	3	272	49	0.23	0.	0.	C
	25	9	52	26.1	56	20.7	152	58.5	9.5	2.2	4	291	78	0.60	0.	0.	D
	25	10	7	36.3	56	40.6	154	47.8	5.0	1.7	3	299	39	0.13	0.	0.	C
	25	13	28	43.9	59	15.2	153	20.6	113.2	2.2	4	161	10	0.05	0.	0.	C
	25	16	25	20.0	57	2.3	153	56.8	29.8	1.8	4	120	5	0.	0.	0.	C
	25	19	30	5.9	59	59.8	152	50.4	129.8	5.5	29	91	44	0.34	1.8	2.2	C
	25	19	42	4.9	59	37.2	152	32.2	58.1	2.5	7	170	39	0.87	25.6	41.8	D
	25	21	34	59.0	57	37.4	154	55.9	75.9	3.1	8	223	36	0.19	5.5	8.1	D
	26	0	39	3.6	59	49.1	153	48.1	172.3	3.1	6	231	37	0.10	5.5	7.1	D
	26	0	55	19.9	58	33.5	151	6.7	31.4	2.8	5	260	72	0.51	28.9	9.3	D
	26	1	0	51.8	58	8.8	150	46.3	5.0	3.3	4	291	106	0.61	0.	0.	D
	26	1	59	42.1	59	59.3	152	48.1	109.2	2.2	5	149	44	0.06	2.5	3.9	D
	26	3	24	17.9	57	1.3	154	40.1	0.5	2.4	4	213	34	0.18	0.	0.	C
	26	8	25	41.9	59	48.8	150	45.2	37.8	3.0	22	159	39	0.50	2.9	1.8	C
	26	17	49	53.8	57	21.4	153	33.1	5.0	1.2	3	157	35	0.	0.	0.	C
	26	20	43	59.3	56	33.9	156	24.3	37.3	2.4	6	262	95	0.37	67.0	46.3	D
	26	23	49	49.2	57	17.5	154	37.8	46.4	1.7	4	237	4	0.17	0.	0.	C
	27	4	14	0.8	60	10.7	151	9.2	70.4	3.3	17	146	17	0.70	5.2	5.8	D
	27	7	11	9.0	56	20.8	153	0.1	9.4	2.0	4	291	76	0.60	0.	0.	D
	27	7	30	31.1	59	59.9	152	47.7	107.9	2.6	6	149	45	0.09	2.8	4.5	C
	27	8	23	1.4	57	44.3	156	26.3	188.6	3.4	21	225	165	0.46	7.2	6.8	D
	27	13	1	47.9	59	54.3	150	48.8	5.0	1.5	3	284	64	0.01	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	LAT N MIN	LONG W DEG	LONG W MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JAN	27	17	6	41.2	59	24.5	153	25.8	113.6	2.0	5	203	29	0.20	12.8	10.0	D
	27	18	8	10.0	56	17.8	151	59.9	2.3	3.2	9	278	117	0.30	12.1	18.3	D
	28	5	29	49.0	57	8.0	153	19.4	5.0	1.2	3	185	15	0.	0.	0.	C
	28	8	3	19.4	56	45.3	155	13.1	29.2	2.2	5	280	67	0.36	21.0	8.4	D
	28	9	23	37.1	56	39.1	154	40.9	10.9	3.0	6	254	32	0.25	6.9	429.9	D
	28	9	29	47.4	58	54.7	152	47.8	64.7	1.9	4	151	40	0.	0.	0.	C
	28	12	42	43.4	59	57.1	152	47.1	101.3	2.1	4	271	41	0.	0.	0.	C
	28	13	27	10.5	60	40.4	153	0.3	159.8	2.4	4	323	114	0.07	0.	0.	C
	29	0	21	17.3	57	43.2	155	44.5	32.3	3.2	7	145	47	0.77	25.6	36.3	D
	29	0	26	11.3	59	49.6	152	4.3	99.2	2.6	9	252	48	0.24	14.0	15.4	D
	29	0	37	39.9	59	22.0	151	31.2	43.3	2.1	4	227	12	0.84	0.	0.	D
	29	2	3	53.6	58	19.8	150	46.1	91.9	2.7	4	281	98	0.	0.	0.	C
	29	7	42	7.9	60	15.4	152	57.4	121.1	2.0	4	197	20	0.	0.	0.	C
	29	9	15	21.4	60	0.1	152	32.6	208.4	1.8	4	142	48	0.	0.	0.	C
	29	11	46	35.9	59	28.6	152	56.2	106.0	2.3	6	127	25	0.25	5.9	8.8	C
	29	19	1	52.5	57	4.6	153	57.1	26.5	2.1	4	225	1	0.	0.	0.	C
	29	19	21	9.0	59	33.8	152	22.8	5.7	2.2	5	181	46	0.91	37.2	42.3	D
	29	23	9	24.3	58	5.7	153	20.5	51.7	2.1	4	233	11	0.	0.	0.	C
	30	1	10	32.3	60	13.4	152	52.9	147.6	2.7	8	288	66	0.25	22.5	21.5	D
	30	3	47	17.4	59	44.8	151	58.6	35.2	2.4	6	216	21	0.26	10.2	4.7	D
	30	4	6	19.1	56	47.3	156	30.3	37.9	2.4	5	263	120	0.28	17.5	619.6	D
	30	5	12	48.1	60	32.4	153	38.3	33.0	3.0	4	324	318	0.33	0.	0.	D
	30	7	8	23.6	58	50.1	154	37.1	132.6	2.4	7	230	38	0.05	1.5	2.3	C
	30	12	46	26.3	59	21.9	153	23.2	5.0	0.6	3	273	2	1.25	0.	0.	D
	30	13	29	56.4	59	1.2	152	58.0	5.0	1.8	3	162	56	0.01	0.	0.	C
	30	14	14	59.6	58	57.8	153	21.2	5.0	2.1	3	247	69	0.02	0.	0.	C
	30	18	49	55.9	60	5.0	152	48.2	122.5	2.4	4	288	53	0.02	0.	0.	C
	30	18	51	37.4	59	29.1	151	14.3	39.4	2.6	4	294	114	0.02	0.	0.	C
	30	21	29	57.7	59	54.8	152	51.3	139.2	2.6	7	309	35	0.23	20.5	21.2	D
	30	23	30	19.3	57	42.5	154	18.6	5.0	1.5	3	257	72	0.03	0.	0.	C
	31	4	20	46.1	59	31.5	151	38.6	4.4	2.0	4	230	7	0.02	0.	0.	C
	31	6	36	43.0	57	16.4	154	33.4	47.9	2.0	4	240	41	0.	0.	0.	C
	31	7	45	41.0	57	48.9	154	38.5	5.0	2.0	4	263	90	0.94	0.	0.	D
	31	10	34	59.1	56	56.7	153	7.9	21.9	1.7	4	229	24	0.	0.	0.	C
	31	13	24	29.7	57	15.4	153	51.5	5.0	1.3	3	182	19	0.	0.	0.	C
FEB	1	2	13	17.8	59	29.8	153	59.9	61.9	2.0	5	249	46	0.51	29.6	55.9	D
	1	2	30	52.9	59	47.2	153	23.9	149.1	3.6	18	109	17	0.33	2.7	3.0	C
	1	5	51	58.7	58	28.5	152	33.9	45.7	2.8	9	141	21	0.20	2.4	2.9	C
	1	6	44	36.8	56	41.9	154	34.7	39.8	2.1	5	235	28	0.17	7.3	2.6	D
	1	7	36	51.0	57	46.9	153	43.7	5.0	1.2	3	217	45	0.02	0.	0.	C
	1	9	9	13.9	57	44.8	154	13.1	5.0	1.6	3	253	71	0.01	0.	0.	C
	1	12	29	4.8	60	8.5	152	45.2	131.3	4.7	24	89	81	0.40	2.1	3.6	B
	1	12	49	55.6	59	59.6	152	13.3	85.6	3.4	20	75	49	0.42	2.5	3.8	B
	1	15	17	11.2	59	2.3	154	13.3	10.0	1.8	4	248	62	0.	0.	0.	C
	1	16	39	3.0	58	4.7	151	10.7	53.7	2.1	4	276	86	0.	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
FEB	1	19	24	12.6	57	9.0	153	57.7	36.3	1.6	4	117	7	0.	0.	0.	C
	1	19	47	38.7	59	11.6	153	13.1	5.0	2.3	3	253	80	0.	0.	0.	C
	2	0	13	52.8	59	45.0	153	25.4	140.1	3.0	4	286	46	0.12	0.	0.	C
	2	6	35	30.3	60	4.2	151	57.2	81.9	3.1	17	77	36	0.46	3.0	4.0	B
	2	7	36	4.1	58	1.5	155	45.1	152.6	4.1	20	135	34	0.51	6.5	7.3	C
	2	11	50	10.0	60	5.1	152	38.3	114.3	2.4	4	185	38	0.20	0.	0.	C
	2	12	2	22.9	59	16.9	152	15.1	94.2	2.3	8	123	43	0.17	3.1	4.1	C
	2	15	31	14.3	59	43.1	152	32.7	96.3	2.3	6	126	39	0.41	9.7	14.2	C
	2	16	58	4.9	57	10.2	154	14.4	5.0	1.1	3	189	19	0.02	0.	0.	C
	3	4	0	59.2	60	8.7	153	5.1	157.9	2.6	10	137	35	0.33	7.0	6.8	D
	3	10	45	26.9	59	59.5	152	47.9	135.1	2.6	7	149	44	0.33	9.8	12.6	D
	3	14	30	3.4	58	52.8	152	20.0	5.0	1.8	3	185	28	0.01	0.	0.	C
	3	17	13	13.9	60	0.4	152	47.6	111.6	2.8	5	150	45	0.12	5.1	8.1	D
	4	0	42	38.7	60	14.4	152	19.8	107.9	3.0	17	92	31	0.55	4.7	4.5	C
	4	3	26	32.0	56	52.3	153	44.9	5.0	1.4	3	166	27	0.01	0.	0.	C
	4	6	34	57.0	57	21.6	154	20.4	5.0	2.1	3	141	18	0.	0.	0.	C
	4	7	19	11.7	60	7.6	150	24.0	36.0	3.1	12	176	50	0.74	8.4	4.7	D
	4	17	1	32.7	58	4.0	155	30.1	118.4	2.7	8	236	96	0.17	4.2	7.0	D
	4	19	2	28.4	60	1.3	152	44.3	102.9	2.7	6	144	44	0.05	1.5	2.6	C
	4	19	16	38.0	60	15.7	153	17.4	191.7	2.8	7	232	33	0.10	4.8	5.5	D
	4	22	36	57.6	57	19.0	153	43.6	19.6	1.9	4	110	29	0.	0.	0.	C
	5	3	42	59.1	60	1.3	152	9.1	5.0	1.0	3	190	56	0.	0.	0.	C
	5	15	52	45.9	57	32.5	153	22.1	9.2	1.9	5	119	45	0.28	4.1	627.8	D
	5	18	52	5.0	59	23.5	151	33.9	59.1	2.4	4	297	98	0.04	0.	0.	C
	6	11	23	26.1	59	39.5	152	8.3	92.8	2.8	6	221	61	0.51	20.2	21.5	D
	6	12	7	44.0	60	8.4	152	25.5	5.0	0.8	3	179	36	0.	0.	0.	C
	6	12	57	17.8	59	27.6	152	41.3	108.4	2.6	7	96	37	0.21	3.9	5.7	C
	6	20	37	57.8	58	44.8	153	49.2	5.0	2.0	7	194	69	0.67	19.6	9999.9	D
	6	22	52	0.7	60	44.6	151	52.5	90.1	3.5	21	107	61	0.54	2.7	5.7	C
	7	6	43	51.1	57	13.2	153	15.3	5.0	1.7	3	130	12	0.01	0.	0.	C
	7	12	8	39.1	57	13.5	153	8.6	1.5	1.9	4	151	7	0.48	0.	0.	D
	8	3	53	40.2	57	47.1	154	28.3	36.0	1.9	4	237	51	0.08	0.	0.	C
	8	14	24	48.8	59	50.5	151	59.8	68.6	2.8	8	184	47	0.16	2.5	4.2	C
	9	3	48	57.2	57	21.3	154	3.9	5.0	1.5	3	204	30	0.	0.	0.	C
	9	4	24	20.2	59	40.3	153	5.1	134.4	3.0	4	165	42	0.	0.	0.	C
	9	6	53	13.3	60	42.8	153	9.8	213.1	3.2	8	320	39	0.13	8.5	9.6	D
	9	13	54	35.4	58	15.3	154	47.9	5.0	2.6	6	218	98	0.81	15.5	9999.9	D
	9	18	49	24.8	59	59.0	152	30.3	102.1	5.0	26	78	50	0.62	3.0	3.9	C
	10	3	55	55.4	57	50.0	153	18.7	5.0	1.4	3	175	26	0.01	0.	0.	C
	10	5	9	37.2	57	15.8	153	52.7	5.0	1.6	3	183	20	0.	0.	0.	C
	10	5	36	1.9	59	47.5	153	24.1	131.7	2.2	25	134	18	0.44	2.7	3.1	C
	10	7	46	57.9	59	59.0	152	22.9	91.8	1.9	4	166	53	0.	0.	0.	C
	10	8	43	7.1	57	8.7	153	56.3	35.8	2.1	4	105	6	0.02	0.	0.	C
	10	15	6	44.0	60	9.0	151	24.0	5.0	1.0	3	256	76	0.01	0.	0.	C
	10	20	38	6.5	57	56.6	154	30.6	85.6	2.3	6	220	80	0.08	2.7	4.1	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
FEB 11	0	14	6.9	60	25.2	152	11.8	50.1	2.4	4	252	31	0.25	0.	0.	C
11	2	46	15.6	57	20.5	154	28.5	5.2	2.1	5	140	9	0.28	4.6	5.2	D
11	4	49	25.3	60	11.8	152	22.6	80.2	3.1	4	193	33	0.	0.	0.	C
11	5	21	52.7	59	38.9	153	46.6	37.7	2.2	6	211	102	0.73	16.0	9999.9	D
11	5	22	33.4	60	35.2	152	56.1	138.1	3.3	9	193	20	0.59	20.8	10.5	D
11	11	19	14.2	60	15.0	152	30.4	111.3	3.3	16	115	23	0.63	4.8	5.5	C
11	13	5	11.1	56	37.2	155	2.9	21.9	4.2	10	177	53	0.45	4.6	4.0	D
11	13	19	16.4	57	19.7	155	45.6	80.5	1.9	4	221	52	0.02	0.	0.	C
11	21	47	52.7	58	22.8	152	44.6	6.1	3.4	8	128	35	0.17	1.5	1.5	C
11	22	10	31.9	57	3.3	153	56.9	28.6	2.0	4	118	3	0.	0.	0.	C
12	1	7	7.5	56	55.3	154	9.5	5.0	0.9	3	211	22	0.	0.	0.	C
12	2	11	59.8	56	36.9	154	57.6	5.0	2.7	6	154	80	0.46	5.3	804.8	D
12	2	53	44.4	57	45.6	153	42.0	32.2	1.7	5	174	46	0.06	2.0	12.4	D
12	3	39	2.3	60	39.6	151	12.3	5.0	2.8	3	296	90	0.46	0.	0.	D
12	4	34	45.3	56	51.9	154	42.5	5.0	1.5	3	228	46	0.01	0.	0.	C
12	6	26	41.3	59	49.3	152	2.9	5.0	1.4	3	177	47	0.	0.	0.	C
12	7	7	9.6	59	56.1	152	26.7	80.4	2.8	5	155	54	0.02	0.5	1.0	C
12	12	5	15.5	58	29.3	151	10.7	26.6	3.4	6	229	112	0.09	2.4	1.1	C
12	13	22	30.9	57	24.2	156	48.0	14.4	2.6	5	145	3	0.46	16.0	13.4	D
12	15	44	27.5	55	3.6	156	55.9	38.1	4.5	12	232	121	0.44	7.3	539.8	D
12	15	55	23.3	55	52.4	155	51.8	29.2	3.3	7	282	18	0.36	16.6	6.6	D
12	18	4	58.5	56	10.6	155	16.0	52.3	3.7	8	319	79	0.20	48.8	23.2	D
13	2	0	35.3	59	15.8	152	48.2	84.4	2.8	9	101	36	0.21	3.5	6.1	C
13	3	11	15.8	58	10.6	156	58.0	5.0	2.4	5	279	225	0.36	29.1	813.8	D
13	5	34	25.5	55	13.4	156	55.6	55.2	6.5	34	171	109	0.70	5.1	5.0	D
13	6	9	51.6	57	5.5	154	18.2	32.2	1.8	4	232	20	0.67	0.	0.	D
13	6	23	58.4	55	5.1	156	42.8	36.9	3.9	10	232	110	0.27	11.4	342.8	D
13	6	31	45.6	57	5.2	154	16.5	32.8	2.4	6	232	19	0.55	61.0	22.6	D
13	6	50	19.0	55	47.0	155	49.5	34.5	3.4	8	314	16	0.21	66.7	19.0	D
13	7	27	34.4	55	56.1	155	34.9	24.4	3.7	6	212	10	0.20	173.4	135.7	D
13	8	1	6.7	55	47.1	155	56.5	34.5	3.2	5	309	23	0.03	1.7	0.4	C
13	8	10	6.4	55	37.6	156	1.9	47.7	2.7	6	334	36	0.05	20.5	8.6	D
13	8	13	56.3	57	4.7	154	19.4	33.2	1.7	4	239	22	0.63	0.	0.	D
13	9	51	16.2	58	56.6	151	22.3	39.0	2.8	5	218	60	0.18	5.8	2.5	D
13	10	39	52.2	55	59.3	155	38.6	39.1	4.7	8	324	17	0.22	50.0	313.6	D
13	11	32	5.3	54	51.2	156	39.3	26.1	4.6	10	242	129	0.24	11.3	3.3	D
13	11	35	56.3	55	2.5	156	47.2	29.5	4.8	12	234	117	0.29	4.9	2.6	D
13	13	39	33.3	55	48.9	155	49.3	32.2	3.1	5	303	15	0.11	62.7	20.0	D
13	16	14	32.0	59	57.9	153	22.8	122.5	2.7	4	211	35	0.08	0.	0.	C
13	20	7	21.2	57	47.9	154	27.0	5.0	1.4	3	269	81	0.	0.	0.	C
13	20	13	51.9	55	4.5	156	49.4	29.7	3.5	8	232	115	0.09	2.7	1.1	D
13	21	59	0.8	57	38.3	154	17.9	13.5	1.8	4	205	39	0.11	0.	0.	C
13	22	2	47.8	55	28.2	157	11.0	5.0	4.8	10	198	108	0.70	10.3	14.9	D
13	23	49	3.2	55	43.1	155	58.5	36.2	4.0	8	305	25	0.22	64.0	16.5	D
14	3	35	59.6	57	43.3	154	13.7	41.0	1.8	4	210	49	0.11	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
FEB	14	4	50	36.8	55	5.6	156	50.3	38.7	2.2	12	231	114	0.35	5.7	432.3	D
	14	11	12	37.1	55	49.8	155	50.0	32.4	3.1	6	297	15	0.04	20.8	7.1	D
	14	12	31	19.6	59	20.2	153	26.0	5.0	2.6	3	205	37	0.	0.	0.	C
	14	15	39	1.9	59	35.7	152	23.4	2.7	2.1	4	326	47	0.06	0.	0.	C
	14	23	43	35.1	60	13.4	151	15.0	5.0	2.8	5	324	127	0.21	601.4	840.8	D
	15	1	15	18.2	56	37.8	155	3.1	2.5	2.8	5	137	82	0.24	3.8	529.5	D
	15	3	40	20.5	57	27.8	152	56.5	5.0	1.2	3	205	34	0.	0.	0.	C
	15	10	32	16.3	59	12.3	152	44.6	73.9	3.2	4	190	41	0.	0.	0.	C
	15	19	56	30.5	55	52.8	156	1.5	28.6	4.1	7	256	28	0.39	12.3	6.4	D
	15	23	10	8.1	57	53.8	155	8.3	5.0	1.6	4	188	69	0.36	0.	0.	D
	16	4	25	41.3	56	58.7	153	16.1	5.0	1.7	3	257	23	0.14	0.	0.	C
	16	4	54	14.6	57	28.8	154	17.4	5.0	0.9	3	174	26	0.	0.	0.	C
	16	9	15	57.6	56	49.8	154	45.1	0.6	2.0	4	297	56	0.33	0.	0.	D
	16	11	59	45.7	57	0.9	153	59.5	28.2	2.0	4	120	8	0.	0.	0.	C
	16	15	46	17.2	59	33.0	151	38.7	29.3	2.7	5	280	90	0.33	32.3	9.3	D
	16	18	15	37.4	58	10.3	151	35.8	5.0	2.1	4	259	67	0.69	0.	0.	D
	16	22	58	59.2	56	46.5	155	8.8	57.1	3.4	8	215	63	0.20	3.6	6.3	D
	17	2	17	4.0	55	16.6	156	46.3	48.8	4.4	26	170	97	0.36	6.7	8.0	D
	17	12	50	29.3	57	45.3	156	8.9	120.5	3.6	8	191	8	0.06	1.5	2.5	C
	17	15	29	0.2	59	22.1	152	57.5	5.0	2.6	3	183	35	0.02	0.	0.	C
	17	16	36	36.9	57	6.8	153	52.4	30.7	1.6	4	145	5	0.	0.	0.	C
	18	1	24	16.3	56	54.9	155	35.0	57.5	2.0	6	190	74	0.12	2.6	8.4	D
	18	4	7	27.0	56	44.1	154	41.9	0.4	1.5	4	242	37	0.17	0.	0.	C
	18	4	51	26.5	60	14.1	152	16.9	109.1	3.2	4	322	83	0.	0.	0.	C
	18	19	9	2.8	59	43.8	151	58.7	40.7	3.2	9	138	93	0.96	11.4	9999.9	D
	19	2	30	34.2	55	50.2	155	38.3	34.4	2.2	5	292	3	0.05	3.6	1.7	D
	19	5	0	18.5	57	20.5	151	7.3	29.7	1.9	4	322	93	0.24	0.	0.	C
	19	6	56	14.8	57	50.3	155	30.3	16.8	2.3	7	172	47	0.46	6.3	10.5	D
	19	7	3	53.0	56	4.1	155	41.5	1.6	2.2	4	220	26	0.94	0.	0.	D
	19	19	0	56.5	59	20.0	154	4.7	44.9	2.2	4	247	59	0.73	0.	0.	D
	19	21	28	34.5	57	53.9	154	50.5	5.0	1.6	5	184	87	0.68	12.4	9999.9	D
	19	22	53	15.6	60	0.5	153	21.7	156.7	2.8	5	335	40	0.13	5.6	6.7	D
	20	5	59	19.1	59	42.0	153	30.0	152.1	2.7	4	295	16	0.	0.	0.	C
	20	7	31	27.7	57	6.3	153	54.3	5.0	-0.5	3	157	3	0.	0.	0.	C
	20	7	42	33.2	58	57.9	152	39.9	50.6	2.6	4	177	41	0.	0.	0.	C
	20	7	55	50.0	58	4.1	155	55.1	5.0	2.0	5	302	160	0.69	85.2	9999.9	D
	20	8	33	1.5	56	45.6	154	49.6	0.1	2.2	5	251	45	0.28	5.6	11.0	D
	20	10	51	3.1	59	59.3	151	26.5	52.6	2.6	5	307	38	0.79	82.7	37.6	D
	20	14	39	13.9	56	42.4	153	24.6	35.0	2.6	4	229	50	0.	0.	0.	C
	20	14	58	24.2	58	31.4	153	12.4	65.6	1.7	5	241	51	0.01	0.7	0.7	C
	20	16	33	33.5	59	41.9	152	30.1	41.2	2.6	4	223	48	0.33	0.	0.	D
	20	18	19	2.3	58	25.0	151	56.7	5.0	1.4	3	251	33	0.01	0.	0.	C
	21	2	1	27.1	59	19.5	152	44.2	53.0	2.2	5	252	39	0.31	45.7	49.1	D
	21	2	35	13.1	58	20.2	152	19.6	44.5	3.1	4	201	32	0.	0.	0.	C
	21	3	11	2.9	59	14.0	152	46.8	32.6	2.4	4	233	38	0.37	0.	0.	D

COOK INLET–WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	TIME MN	SEC	LAT N DEG	LAT N MIN	LONG W DEG	LONG W MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
FEB 21	9	11	10.9	60	3.4	152	41.8	141.0	3.7	27	87	73	0.51	2.5	4.1	C
21	14	16	35.8	59	43.3	151	32.8	72.0	2.7	6	225	28	0.33	11.0	10.2	D
21	19	8	50.2	57	15.8	155	36.0	83.9	2.3	4	220	58	0.02	0.	0.	C
22	1	11	27.0	60	25.3	154	36.8	32.2	3.0	8	326	372	0.21	56.5	25.3	D
22	4	57	0.7	57	31.9	153	13.8	5.0	1.4	3	163	42	0.	0.	0.	C
22	11	6	7.9	57	19.0	155	6.1	63.3	1.8	6	165	28	0.06	1.4	1.6	C
22	21	3	35.8	56	54.3	154	36.6	5.0	1.5	3	212	44	0.	0.	0.	C
22	21	20	51.3	59	25.9	152	30.0	96.0	2.3	7	103	48	0.25	4.8	6.9	C
23	4	1	17.6	57	12.3	153	26.3	4.1	1.7	4	145	22	0.	0.	0.	C
23	4	15	29.5	59	29.7	152	24.8	6.8	1.7	5	162	47	0.87	39.2	79.5	D
23	6	7	23.9	57	5.6	154	49.0	61.8	1.7	4	235	28	0.	0.	0.	C
23	9	17	39.2	58	46.7	153	53.3	2.1	1.8	5	152	40	0.13	2.3	4.4	C
23	-1	59	47.0	60	31.0	150	0.8	30.2	2.8	5	330	131	0.11	96.8	24.6	D
23	13	21	18.2	59	35.2	152	18.6	1.0	2.5	4	221	43	0.78	0.	0.	D
23	13	44	58.2	59	37.2	151	14.2	39.4	2.8	5	306	25	0.49	78.3	10.3	D
24	5	28	33.1	59	30.4	152	23.3	5.0	1.9	3	233	49	0.	0.	0.	C
24	6	13	51.9	59	32.6	152	8.5	40.5	2.2	5	212	32	0.55	131.8	100.7	D
24	9	49	39.7	59	42.8	153	32.6	158.6	2.9	7	255	42	0.14	7.8	9.1	D
24	12	55	52.9	57	54.7	152	12.9	41.2	1.5	4	218	24	0.	0.	0.	C
24	13	13	36.5	58	22.1	152	2.0	5.0	1.7	3	237	34	0.	0.	0.	C
24	14	16	35.3	59	6.4	153	56.3	41.0	2.0	4	141	15	0.33	0.	0.	D
24	15	40	33.0	56	38.5	154	30.1	5.0	1.3	3	272	21	0.26	0.	0.	C
24	15	59	24.3	56	54.4	154	42.0	0.8	1.3	4	224	47	0.17	0.	0.	C
25	0	24	25.1	57	12.0	154	16.1	5.0	1.1	3	180	22	0.05	0.	0.	C
25	0	59	43.6	59	39.7	156	2.4	78.8	2.9	4	316	240	0.81	0.	0.	D
25	9	8	25.2	59	34.4	152	4.6	5.0	1.4	3	149	30	0.	0.	0.	C
25	18	41	8.6	57	48.9	155	54.8	104.0	2.2	5	200	23	0.09	9.9	17.6	D
25	23	44	48.3	59	31.1	152	42.8	82.5	2.9	7	97	32	0.07	1.0	1.8	B
26	0	57	0.4	59	36.4	152	42.6	94.9	2.3	6	106	29	0.15	3.0	4.8	C
26	1	21	29.0	56	31.2	153	4.5	34.4	3.0	10	229	68	0.43	6.9	2.9	D
26	2	33	24.8	53	5.4	155	16.2	5.0	2.2	4	217	72	0.76	0.	0.	D
26	16	27	13.5	57	15.7	153	52.2	5.0	2.0	3	183	20	0.01	0.	0.	C
27	10	3	45.5	59	39.2	152	47.9	93.2	2.5	4	105	24	0.	0.	0.	C
27	15	42	25.1	60	19.0	152	20.7	98.3	2.9	7	220	26	0.17	6.9	9.9	D
27	18	4	35.6	59	41.7	152	25.6	58.2	2.7	7	214	45	0.75	54.4	85.4	D
27	23	20	24.7	60	9.8	152	34.4	142.4	2.7	11	165	30	0.23	5.5	7.3	D
28	8	24	57.1	59	18.4	152	26.0	69.8	2.4	4	185	59	0.	0.	0.	C
28	9	33	41.2	59	13.6	154	35.1	163.7	2.9	12	173	26	0.22	3.7	4.0	C
28	9	44	7.5	57	4.4	153	36.0	5.0	0.7	3	202	21	0.	0.	0.	C
28	12	4	44.4	60	12.2	153	19.9	164.0	2.9	5	210	39	0.17	14.3	20.1	D
28	12	7	55.3	60	9.3	152	11.9	3.3	1.5	4	203	43	0.93	0.	0.	D
28	15	4	22.7	59	25.7	152	22.2	80.8	1.0	4	272	54	0.	0.	0.	C
28	15	48	28.7	58	52.4	152	4.2	121.6	2.4	4	188	31	0.	0.	0.	C
28	16	17	6.3	60	11.4	152	46.4	110.9	2.6	8	140	25	0.13	2.4	3.0	C
28	16	27	42.0	58	7.0	153	52.4	66.7	2.4	6	188	42	0.02	0.4	0.6	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
FEB 28	19	28	55.9	56	39.8	154	35.6	40.9	1.7	4	244	27	0.	0.	0.	C
28	23	21	16.2	59	53.5	152	13.0	104.1	3.3	7	170	58	0.20	4.9	6.9	D
28	23	21	23.4	56	49.5	153	57.7	5.0	1.0	3	156	29	0.	0.	0.	C
28	23	55	8.7	59	43.8	152	48.3	125.8	2.8	9	111	75	0.32	5.0	8.3	C
MAR 2	0	34	41.0	59	44.9	151	51.8	5.0	3.0	3	227	77	0.01	0.	0.	C
2	18	17	41.9	60	15.0	152	16.5	131.2	2.3	4	274	33	0.04	0.	0.	C
2	18	20	46.8	60	4.9	155	21.2	5.0	3.3	3	308	128	0.13	0.	0.	C
3	8	19	2.6	60	2.5	153	29.5	170.5	2.9	10	271	45	0.23	13.8	14.5	D
3	15	3	7.6	57	50.0	156	37.0	161.6	2.6	7	246	24	0.17	9.5	14.5	D
3	16	55	59.6	58	46.6	153	10.1	66.0	3.4	6	167	50	0.14	2.5	4.6	D
4	0	17	15.5	56	42.4	154	59.2	0.7	2.5	5	217	52	0.17	8.3	37.9	D
4	6	1	7.4	56	43.4	154	56.7	0.7	2.4	6	213	50	0.22	4.6	23.4	D
4	9	14	24.2	59	18.7	152	32.2	10.6	2.3	4	118	50	0.23	0.	0.	C
4	11	56	54.5	57	28.4	155	52.1	39.2	2.0	4	199	59	0.27	0.	0.	C
4	20	20	45.2	60	3.7	153	27.6	156.8	2.9	4	281	47	0.13	0.	0.	C
4	23	25	8.9	59	22.5	151	32.1	28.8	2.5	4	223	11	0.	0.	0.	C
5	8	15	33.6	60	7.6	152	22.5	88.2	2.7	4	200	66	0.31	0.	0.	D
5	10	17	59.3	58	51.9	153	39.6	5.0	1.9	3	201	40	0.01	0.	0.	C
5	18	44	40.5	58	54.4	152	7.4	5.0	2.1	5	215	33	0.40	6.8	13.4	D
5	19	39	23.5	59	48.8	152	8.1	70.4	2.4	6	168	49	0.10	2.7	10.0	C
5	22	20	40.3	60	29.7	152	58.2	179.9	3.5	26	82	13	0.54	3.1	4.7	C
6	7	10	54.0	59	53.9	151	21.1	5.0	2.4	3	256	97	0.01	0.	0.	C
7	5	22	34.3	60	55.1	151	18.6	4.2	2.5	10	311	138	0.54	64.0	84.6	D
7	12	10	36.5	59	41.9	153	3.0	119.9	4.3	27	86	45	0.71	3.3	5.2	C
7	18	44	28.8	59	16.9	152	39.6	81.8	2.7	4	156	52	0.	0.	0.	C
8	0	3	36.6	58	40.6	153	4.3	75.1	2.5	4	247	42	0.14	0.	0.	C
8	3	32	7.1	59	43.9	151	55.6	5.0	2.4	3	223	73	0.	0.	0.	C
8	5	31	59.5	59	12.0	152	9.2	9.7	2.1	4	217	44	0.90	0.	0.	D
8	9	33	16.1	59	22.4	153	0.9	94.7	2.1	4	164	33	0.	0.	0.	C
8	10	1	32.2	60	3.3	154	27.5	5.0	2.0	3	254	82	0.08	0.	0.	C
8	18	47	28.2	58	4.2	155	3.7	61.9	1.3	4	311	42	0.11	0.	0.	C
9	5	56	15.7	59	9.7	153	37.0	128.7	2.0	4	229	22	0.02	0.	0.	C
9	6	38	37.0	59	36.1	152	56.6	106.3	2.4	4	131	17	0.	0.	0.	C
9	10	4	32.3	59	57.9	152	6.7	5.0	1.8	4	187	62	0.25	0.	0.	C
9	12	33	35.7	58	10.1	156	30.3	5.0	1.4	3	310	16	0.	0.	0.	C
9	13	32	15.0	59	53.3	152	46.4	5.0	1.1	3	235	59	0.	0.	0.	C
9	14	40	20.1	59	54.3	152	18.4	97.6	2.4	4	168	59	0.	0.	0.	C
10	0	46	7.0	59	51.1	151	40.0	9.9	2.7	4	218	42	0.03	0.	0.	C
10	2	19	26.1	59	35.8	152	5.6	102.5	2.3	5	271	64	0.09	74.2	39.1	D
10	3	6	20.2	57	15.2	154	14.2	5.0	2.6	3	243	118	0.	0.	0.	C
10	8	17	27.1	59	33.3	152	4.4	5.0	1.5	3	211	66	0.	0.	0.	C
10	22	4	11.0	59	17.3	153	19.8	99.0	2.5	6	129	7	0.07	2.0	2.9	B
10	22	52	2.7	59	14.4	152	30.0	80.7	2.6	4	145	58	0.	0.	0.	C
11	2	51	22.1	58	35.3	153	26.1	5.0	2.1	3	236	63	0.02	0.	0.	C
11	7	25	41.4	60	2.0	153	20.6	126.7	3.2	4	191	42	0.	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
MAR 11	18	18	36.2	58	3.4	154	27.2	28.6	2.2	8	125	81	0.51	5.7	7.9	D
12	0	32	22.5	59	54.0	153	45.7	145.3	3.4	4	208	40	0.04	0.	0.	C
12	1	5	14.0	59	57.0	152	27.5	5.0	1.3	3	156	54	0.01	0.	0.	C
12	1	40	25.4	60	16.9	154	25.0	5.0	1.5	4	266	91	0.20	0.	0.	C
12	16	55	45.4	58	7.3	154	45.0	85.8	3.3	10	141	59	0.13	1.5	3.8	C
13	21	46	31.2	59	58.8	151	41.2	5.0	1.8	5	225	56	0.87	21.2	9999.9	D
14	5	21	16.8	59	34.5	152	35.0	99.2	2.0	4	111	37	0.	0.	0.	C
14	6	11	28.4	59	56.1	153	16.3	150.0	3.3	13	173	31	0.34	4.9	6.0	C
14	7	56	33.5	59	51.8	151	41.7	48.6	3.6	18	189	23	0.73	7.0	10.0	D
14	12	54	53.8	60	24.7	150	28.0	39.5	1.7	4	300	106	0.19	0.	0.	C
15	0	9	4.1	60	2.8	150	53.7	75.2	3.3	18	152	60	0.42	3.1	5.1	D
15	17	22	7.1	60	12.5	152	1.9	3.3	1.7	4	223	47	0.90	0.	0.	D
15	19	17	1.7	60	18.4	152	15.0	105.1	2.6	7	222	31	0.15	3.6	4.3	D
15	19	20	51.9	59	53.1	152	7.9	86.2	1.8	4	177	55	0.	0.	0.	C
17	6	39	54.8	59	13.9	151	31.0	19.4	2.3	4	223	26	0.05	0.	0.	C
17	12	8	34.0	59	59.0	153	14.3	153.5	3.0	12	179	36	0.33	5.0	5.3	D
17	21	50	58.7	57	46.5	152	55.9	1.4	2.5	4	237	26	0.23	0.	0.	C
18	1	29	3.5	59	1.2	152	20.8	108.7	2.4	4	139	43	0.	0.	0.	C
18	2	44	21.3	58	22.6	151	43.0	58.7	2.9	4	209	46	0.10	0.	0.	C
18	9	49	15.0	59	19.7	152	48.9	101.6	3.5	17	84	34	0.43	3.0	3.7	B
18	11	33	10.0	60	32.9	151	53.2	35.2	3.6	6	134	121	0.90	11.3	9999.9	D
18	11	41	58.4	60	7.1	151	26.8	67.5	3.7	10	149	52	0.33	3.4	6.0	D
18	13	56	27.4	59	30.7	151	51.3	5.0	2.5	5	115	16	0.79	1.2	2.3	D
18	21	53	4.6	57	51.0	155	5.3	89.6	3.5	6	151	26	0.20	5.6	6.2	D
18	22	43	9.9	60	2.7	152	53.8	118.9	2.9	17	93	47	0.49	5.0	9.6	C
18	23	20	38.8	58	47.6	153	17.7	5.0	3.2	3	195	57	0.02	0.	0.	C
19	6	0	5.9	59	47.4	151	9.6	26.8	2.0	4	305	42	0.19	0.	0.	C
19	18	59	40.4	59	33.1	153	41.3	14.1	3.6	10	328	385	0.34	78.3	70.1	D
19	19	0	4.6	60	46.2	151	51.7	34.6	3.5	7	216	124	0.37	8.0	572.8	D
20	1	18	47.2	60	9.8	152	33.0	131.1	2.5	4	287	68	0.	0.	0.	C
20	9	38	40.1	59	1.5	153	7.6	83.7	2.1	4	199	38	0.06	0.	0.	C
20	9	48	34.8	57	39.5	153	15.5	5.0	2.0	3	198	46	0.01	0.	0.	C
20	18	1	15.8	60	15.7	152	40.3	122.5	2.5	4	292	107	0.	0.	0.	C
20	13	14	13.3	58	39.1	153	42.6	79.0	2.4	7	136	57	0.72	10.2	18.8	D
20	22	1	39.4	59	54.8	152	49.6	102.4	3.3	5	122	56	0.07	2.0	3.4	C
20	22	36	29.5	59	29.7	152	42.9	80.0	2.8	5	94	33	0.04	1.2	2.6	C
21	7	47	52.6	58	56.1	152	26.3	5.0	2.7	3	142	34	0.	0.	0.	C
21	22	38	49.8	60	5.1	152	34.0	106.2	3.4	24	84	38	0.67	3.3	4.7	C
22	5	20	45.3	59	30.5	152	33.9	5.0	1.9	3	206	52	0.	0.	0.	C
22	17	12	57.9	57	54.9	156	6.1	92.2	3.0	7	182	24	0.77	18.8	30.4	D
23	18	36	58.6	59	49.5	152	54.8	30.2	2.1	4	183	66	0.14	0.	0.	C
23	22	10	26.5	60	0.3	152	44.3	105.8	2.0	4	143	46	0.	0.	0.	C
23	23	46	43.8	60	7.5	152	47.2	129.3	2.2	5	170	32	0.37	36.4	40.6	D
24	6	25	40.6	58	37.9	153	37.7	11.4	1.6	4	171	61	0.27	0.	0.	C
24	11	50	28.3	59	40.9	152	13.5	5.0	2.2	3	216	43	0.01	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
MAR	24	11	53	5.6	60	9.5	151	58.9	95.5	3.0	9	223	58	0.37	6.9	8.1	D
	24	18	31	16.5	59	37.1	152	39.5	45.6	2.3	5	188	32	0.35	20.1	38.7	D
	24	18	56	29.5	58	14.8	151	45.3	5.0	1.9	3	257	54	0.	0.	0.	C
	24	21	34	11.9	58	54.3	154	28.4	135.1	2.9	6	198	21	0.04	1.3	2.9	C
	25	11	37	32.6	59	24.2	152	19.1	3.7	1.9	6	150	42	0.91	44.5	116.5	D
	25	23	48	6.3	59	7.8	153	35.9	120.7	3.3	8	118	24	0.22	4.5	7.2	C
	26	3	38	55.4	59	8.9	153	22.1	41.3	1.7	5	144	21	0.61	825.2	701.0	D
	26	4	2	53.8	60	49.5	153	48.8	5.0	2.8	8	318	365	0.42	74.8	593.0	D
	26	4	23	55.6	60	58.7	151	20.8	47.9	2.8	14	118	148	0.26	7.0	30.6	D
	26	7	52	5.3	59	9.7	153	41.6	114.8	2.8	9	141	24	0.17	3.3	5.1	C
	26	13	5	49.1	58	56.0	153	0.5	83.5	2.7	6	160	50	0.06	2.5	3.9	C
	27	3	57	19.7	59	24.7	151	55.6	5.0	3.3	3	252	34	0.01	0.	0.	C
	27	9	1	29.7	58	4.4	155	11.5	5.0	2.0	4	213	75	0.03	0.	0.	C
	27	16	17	27.5	57	4.4	154	49.8	31.9	2.2	4	244	52	0.96	0.	0.	D
	27	22	33	37.2	58	40.3	153	26.9	5.0	1.2	3	160	64	0.01	0.	0.	C
	28	3	55	4.1	58	56.0	154	12.8	77.1	1.6	6	255	18	0.14	9.7	13.0	D
	28	9	41	19.0	59	50.6	151	56.7	39.8	2.4	5	189	46	0.06	1.7	1.1	C
	28	14	55	50.5	60	11.4	151	53.5	64.6	2.3	5	229	55	0.28	16.3	23.1	D
	28	16	45	11.5	58	22.2	155	2.1	119.7	2.0	5	264	72	0.05	7.4	10.8	D
	28	18	8	20.9	58	49.3	153	15.5	5.0	2.3	3	186	57	0.	0.	0.	C
	28	19	22	22.2	56	29.6	154	34.1	39.8	2.6	4	313	24	0.01	0.	0.	C
	28	19	56	28.8	58	51.2	154	8.5	94.3	2.9	5	206	27	0.	0.2	0.4	C
	28	21	2	50.7	58	34.8	155	6.5	122.9	2.2	5	209	79	0.08	4.5	12.2	D
	29	1	5	36.9	58	51.2	153	10.8	5.1	2.9	11	152	54	0.39	2.4	2.6	D
	29	2	3	58.8	58	49.4	153	14.4	5.0	2.6	4	124	56	0.04	0.	0.	C
	29	7	53	15.8	57	16.8	154	56.0	5.0	1.5	6	151	62	0.66	8.1	9999.9	D
	29	8	11	32.8	57	15.2	155	6.5	37.6	2.0	4	163	62	0.06	0.	0.	C
	29	11	17	28.5	57	10.6	153	59.5	32.0	2.2	5	116	10	0.09	1.4	2.3	C
	29	14	29	4.2	57	51.6	156	12.6	131.7	2.5	8	212	16	0.09	2.5	3.5	C
	29	16	57	2.2	60	0.0	152	42.6	96.6	2.7	6	273	84	0.13	9.0	8.3	D
	29	17	28	49.6	56	54.9	156	24.3	27.0	1.8	5	251	60	0.15	8.9	8.5	D
	30	0	47	17.6	59	33.6	152	17.3	0.7	2.2	4	215	41	0.71	0.	0.	D
	30	7	57	24.4	57	44.6	154	30.3	5.0	1.6	3	153	60	0.	0.	0.	C
	30	15	11	8.5	59	27.4	153	15.0	105.4	2.3	7	215	17	0.27	7.7	9.5	D
	30	15	50	8.8	59	13.5	152	39.6	45.9	2.0	5	141	45	0.99	54.5	162.6	D
	31	1	55	50.8	59	37.1	152	5.4	100.4	3.0	7	232	33	0.13	6.1	7.6	D
	31	11	51	58.1	57	40.7	152	40.6	5.0	1.2	3	148	13	0.	0.	0.	C
	31	14	25	8.3	53	48.5	153	2.2	77.9	4.0	30	50	44	0.57	2.3	3.6	C
	31	21	36	35.2	59	55.5	153	21.3	175.2	3.1	9	269	65	0.26	12.3	12.9	D

QUARTERLY REPORT

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SEISMIC AND VOLCANIC RISK STUDIES
WESTERN GULF OF ALASKA

H. Pulpan
J. Kienle

Geophysical Institute
University of Alaska
Fairbanks, Alaska

February 4, 1980

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OCS COORDINATION OFFICE

University of Alaska

Quarterly Report for Period Ending December 31, 1979

Project Title:	Seismic and Volcanic Risk Studies Western Gulf of Alaska
Contract Number:	03-5-022-55
Task Order Number:	C1
Principal Investigators:	H. Pulpan and J. Kienle

I. ABSTRACT

Development and testing of a seismic event detection system continued during the report period. Six months of data were processed for addition into the earthquake catalogue of the study area. High level of seismic strain release, near the Semidi Islands, that began early 1979, continued with a M_L = 5.8 event on May 20, 1979.

II. TASK OBJECTIVES

It is the purpose of this research to determine the seismicity of the Western Gulf of Alaska, with emphasis on the offshore areas of Lower Cook Inlet, Shelikof Strait, Bristol Bay, and off Kodiak Island, and to evaluate the seismic risk to petroleum-related onshore and offshore development. It is also the purpose to evaluate eruption potential and volcanic risk of volcanoes in the area, especially of Redoubt and Augustine volcanoes in Cook Inlet.

III. FIELD AND LABORATORY ACTIVITIES

The only field trip during the report period was a repair and maintenance trip by Jim Benich, Electronic Technician, to the Homer seismic recording center. This trip took place from October 4 through October 15, 1979.

Laboratory activity was primarily concerned with the further development of the microprocessor controlled seismic event detection and recording system. This system will become necessary with the extension of the network into the Bristol Bay area, without having to lease additional commercial telephone lines. The system has been operating well for several months at Fairbanks. Field deployment was delayed because of the unexpected long delivery time of a new time standard that could be interfaced with the microprocessor. This satellite-linked clock was delivered late December and failed shortly thereafter. It is now operating satisfactorily. We expect to install the system at King Salmon within a month.

Other laboratory activities concerned the preparation for this summer's service and expansion of the seismic network.

IV. RESULTS AND INTERPRETATION

Compilation of an earthquake catalogue for the study area continued. Epicenter maps for the time period from April through September 1979 are given in Appendix 1. Appendix 2 provides the hypocentral parameters and parameter indicating the quality of the hypocenter determinations. The most important aspect of the seismic activity during this period is the continued high level of seismicity near the Semidi Islands, south-west of Kodiak Island. This activity (fig. A-1) is primarily associated with a M_L = 5.8 event on May 20. (The USGS's Preliminary Determination of Epicenters Service gives a body wave magnitude of 6.5 for their event; The University of California, Berkeley Seismological Laboratory, a body wave magnitude of 6.2). This event is about 130 km north, north-east from the M_L = 6.8 event of February 13, 1979.

Seismic activity, as detected by our land-based network, off the south coast of Kodiak Island has been rather low, also during the development of Ocean Bottom Seismometers by the University of Texas on the Kodiak shelf. This took place from June 23 through August 6, 1979. Fig. A-9 shows all events that could be located during this time period. We have provided the University of Texas with the arrival times of our stations. A joint hypocenter determination will be made after completion of the event search at Texas.

Work has continued on the determination of fault plane solutions of selected earthquakes from the data of both our network and the World Wide Standard Seismograph Network (WWSSN). Details of and conclusions from this work will be discussed in the next report.

APPENDIX 1

Epicenter Locations Maps

This appendix shows plots of epicenters for March 1979 through September 1979. The one-letter code shows the epicenter location with the following depth code:

A	$0 \leq 25$
B	$26 \leq 50$
C	$51 \leq 100$
D	$101 \leq 125$
E	$126 \leq 150$
F	$151 \leq 175$
G	$176 \leq 200$
etc.	

The size of letters is proportional to the magnitude of the event. The size of the numerals giving the geographic coordinates corresponds to magnitude 2.

The following is a list of figures:

Figure	Caption
A-1	Epicenter map, Kodiak-Alaska Peninsula, April-June 1979, all locatable events.
A-2	Epicenter map, Kodiak-Alaska Peninsula, April-June 1979, class 1 events.
A-3	Epicenter map, Lower Cook Inlet, April-June 1979, all locatable events.
A-4	Epicenter map, Lower Cook Inlet, April-June 1979, class 1 events.
A-5	Epicenter map, Kodiak-Alaska Peninsula, July-September 1979, all locatable events.
A-6	Epicenter map, Kodiak-Alaska Peninsula, July-September 1979, class 1 events.
A-7	Epicenter map, Lower Cook Inlet, July-September 1979, all locatable events.
A-8	Epicenter map, Lower Cook Inlet, July-September 1979, class 1 events.
A-9	Epicenter map, Kodiak Island area, June 23-August 6, 1979, all locatable events.

Class 1 events are those which are located with at least 5 stations, RMS travel time residual less than 1 second, and a probable error in the vertical and horizontal direction of less than 10 km.

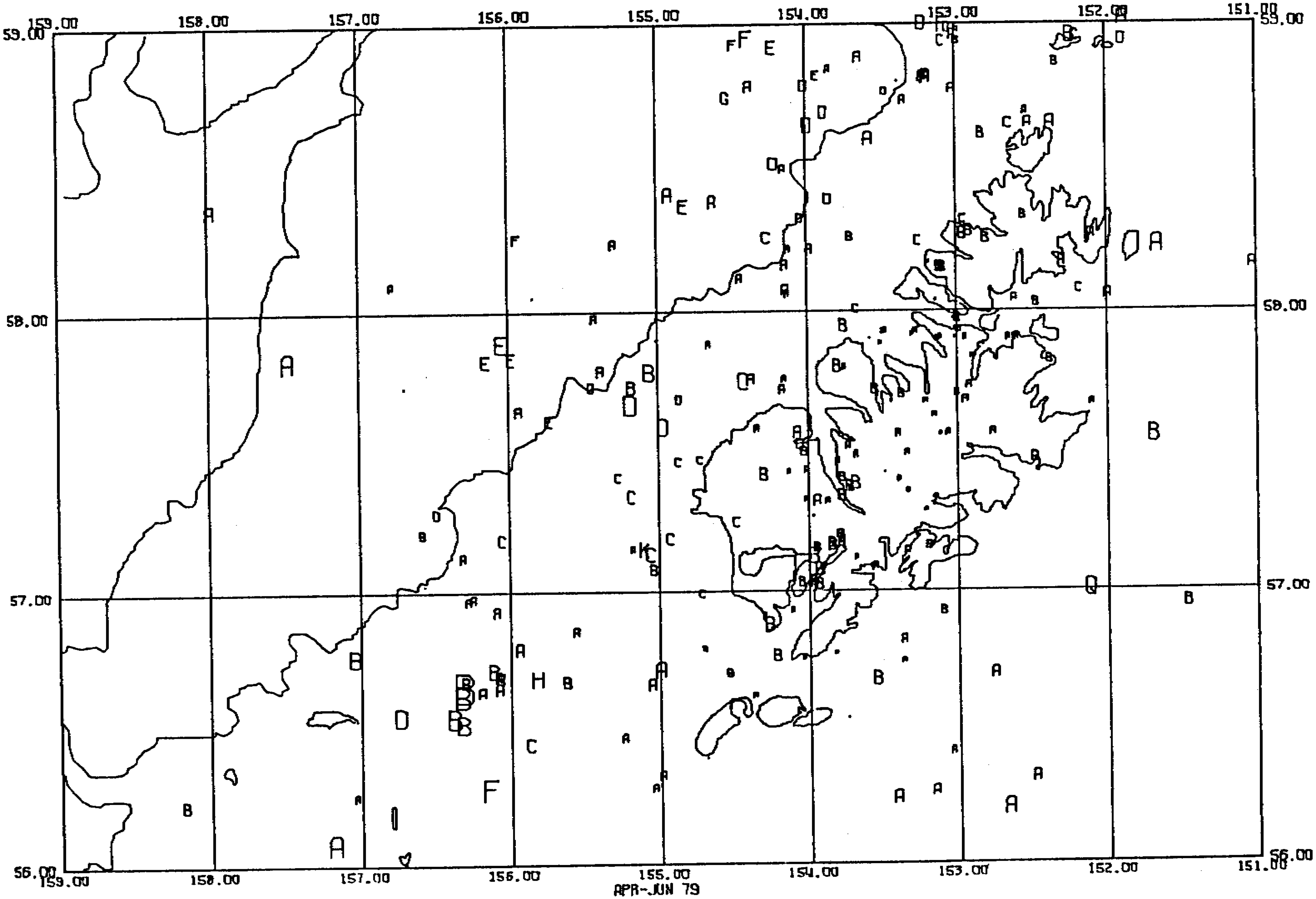

Fig. A-1 - Epicenter map, Kodiak-Alaska Peninsula, April-June 1979, all locatable events.

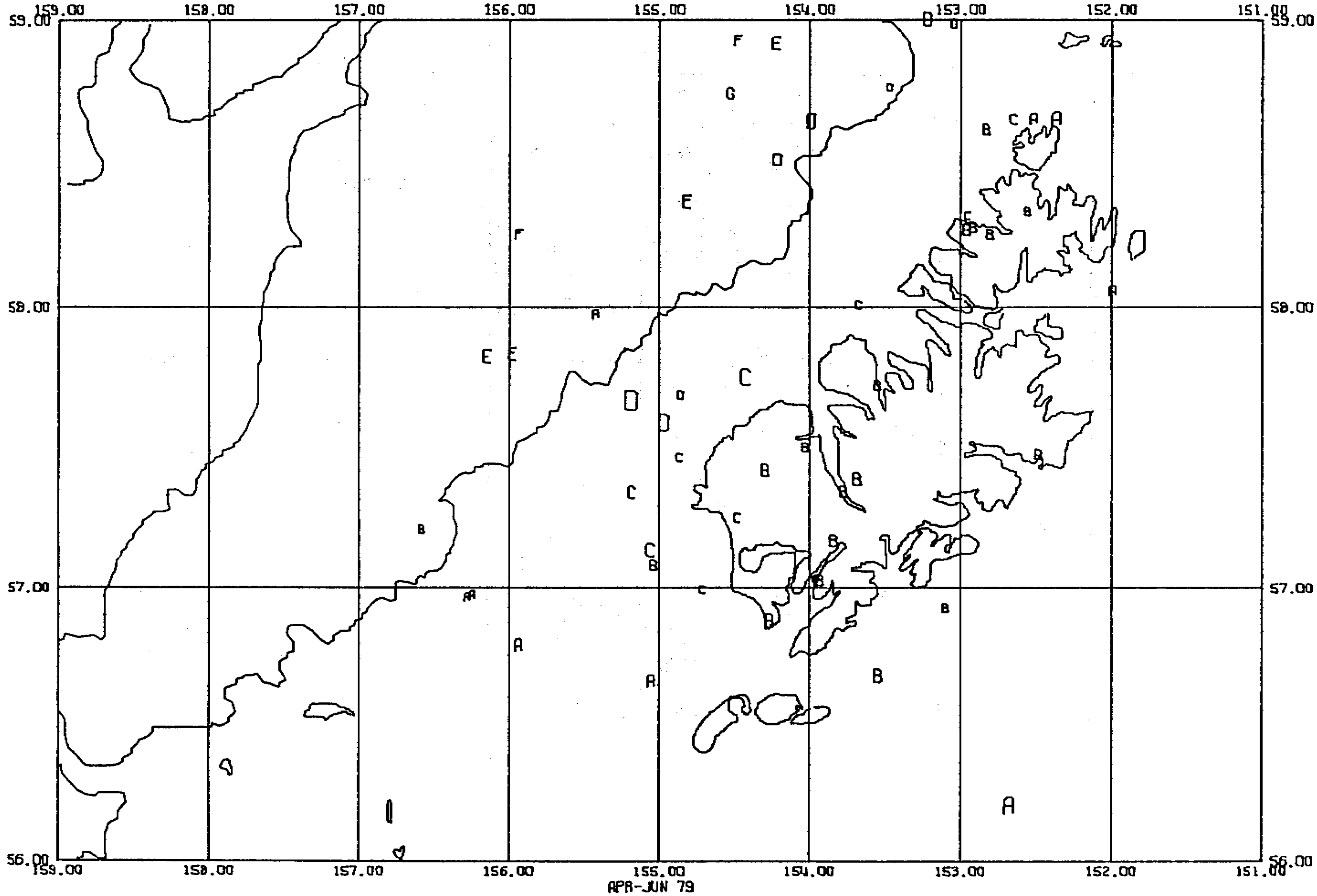

Fig. A-2 - Epicenter map, Kodiak-Alaska Peninsula, April-June 1979, class 1 events.

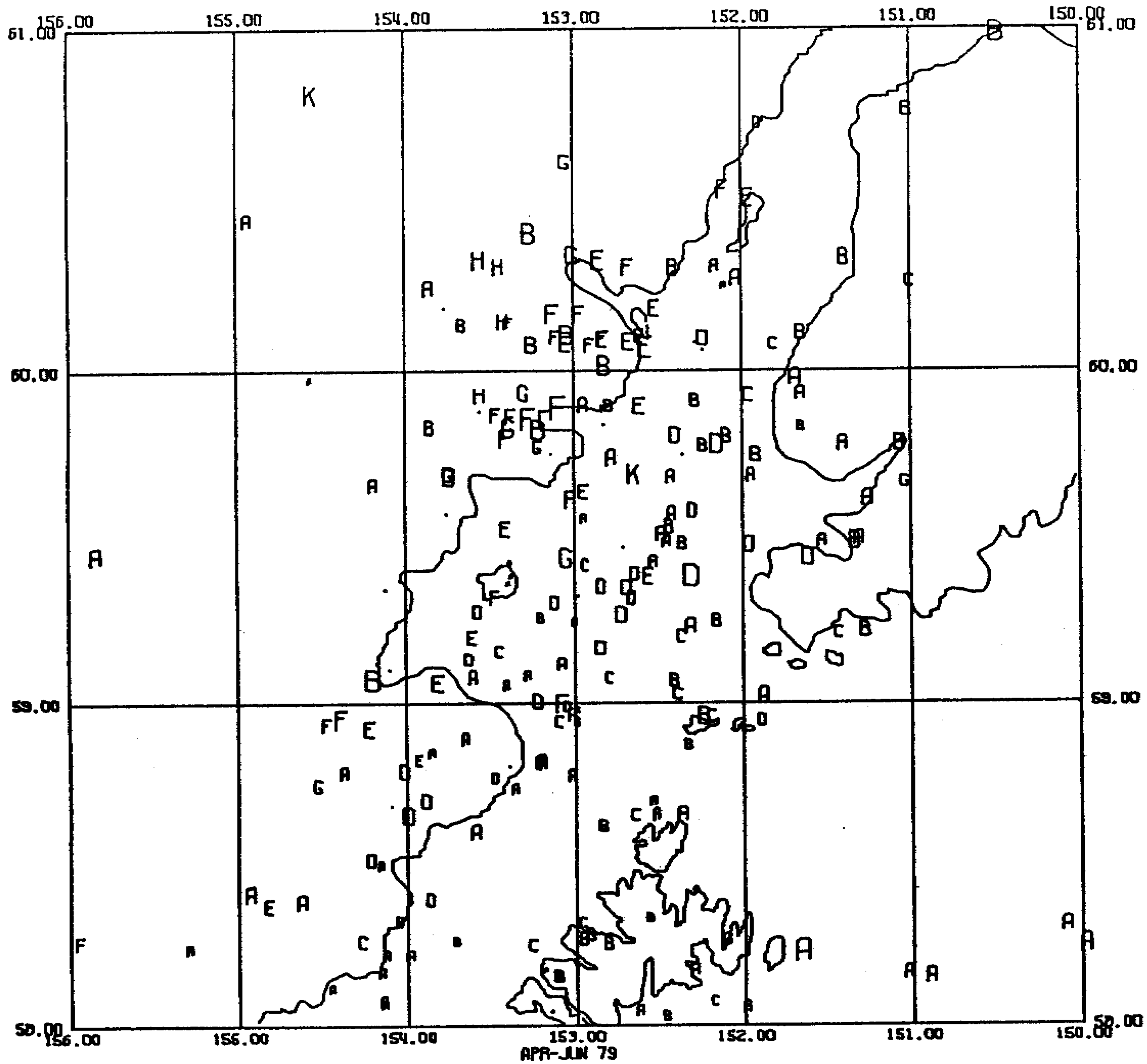

Fig. A-3 - Epicenter map, Lower Cook Inlet, April-June 1979, all locatable events.

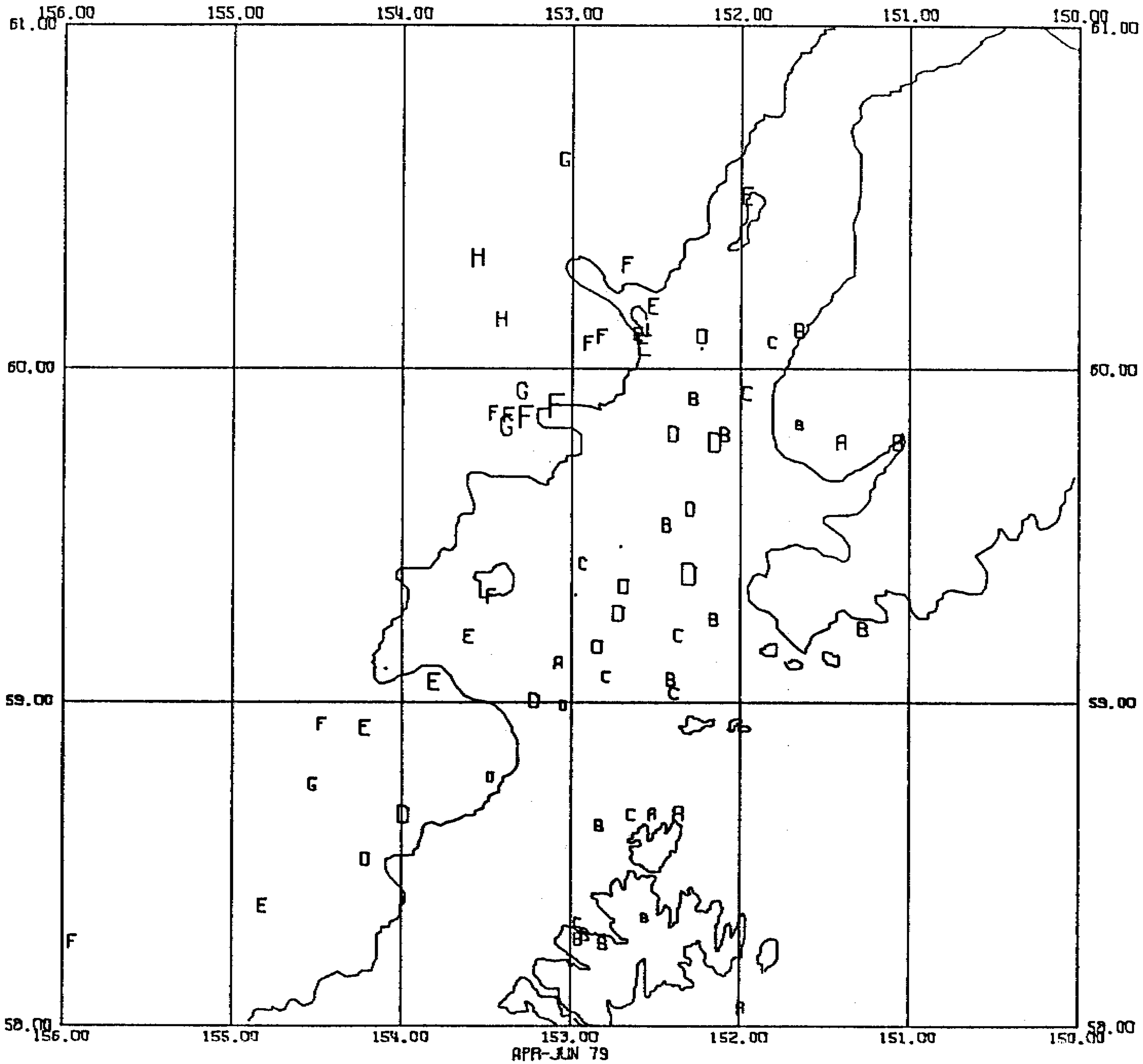

Fig. A-4 - Epicenter map, Lower Cook Inlet, April-June 1979, class 1 events.

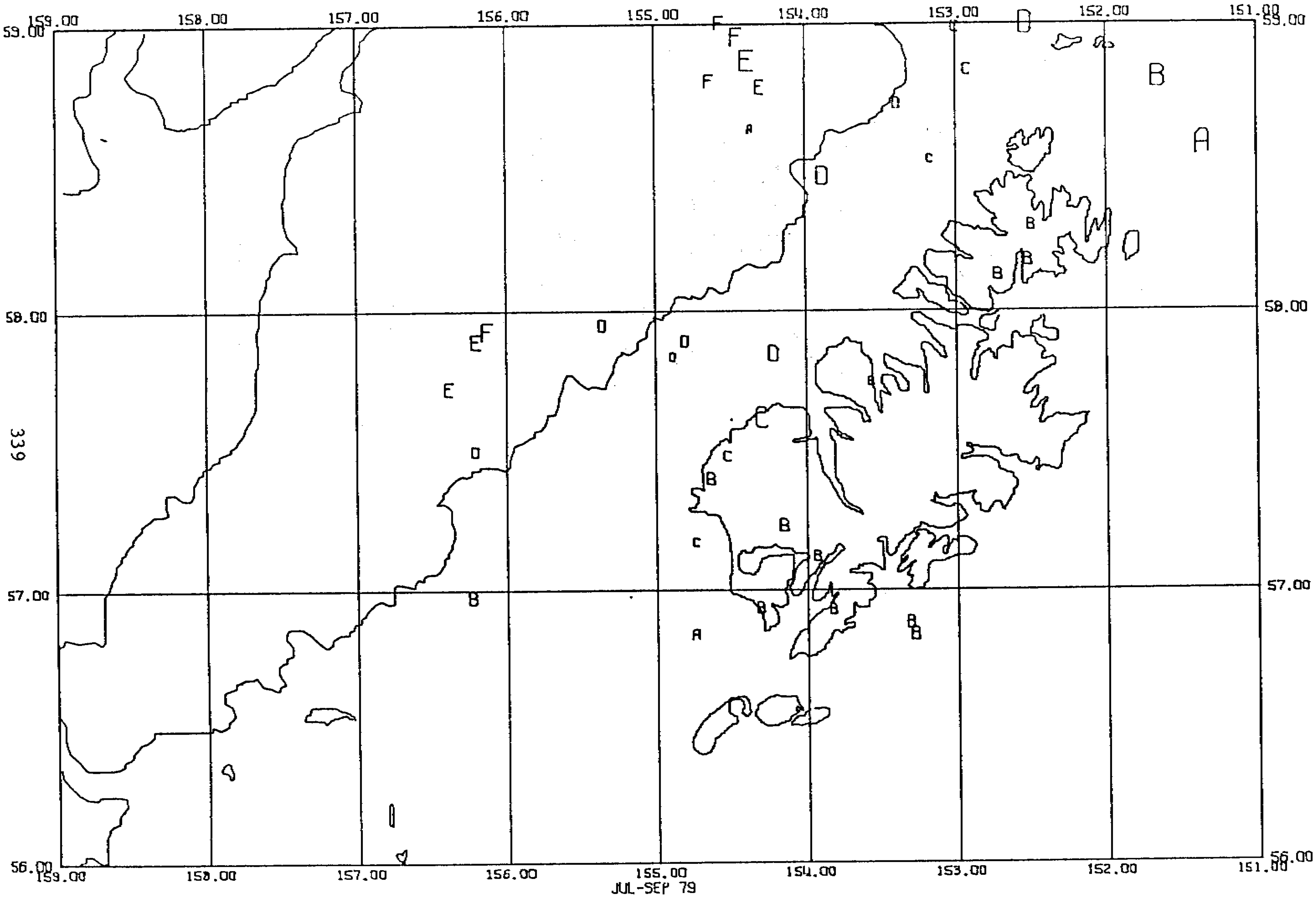

Fig. A-5 - Epicenter map, Kodiak-Alaska Peninsula, July-September 1979, all locatable events.

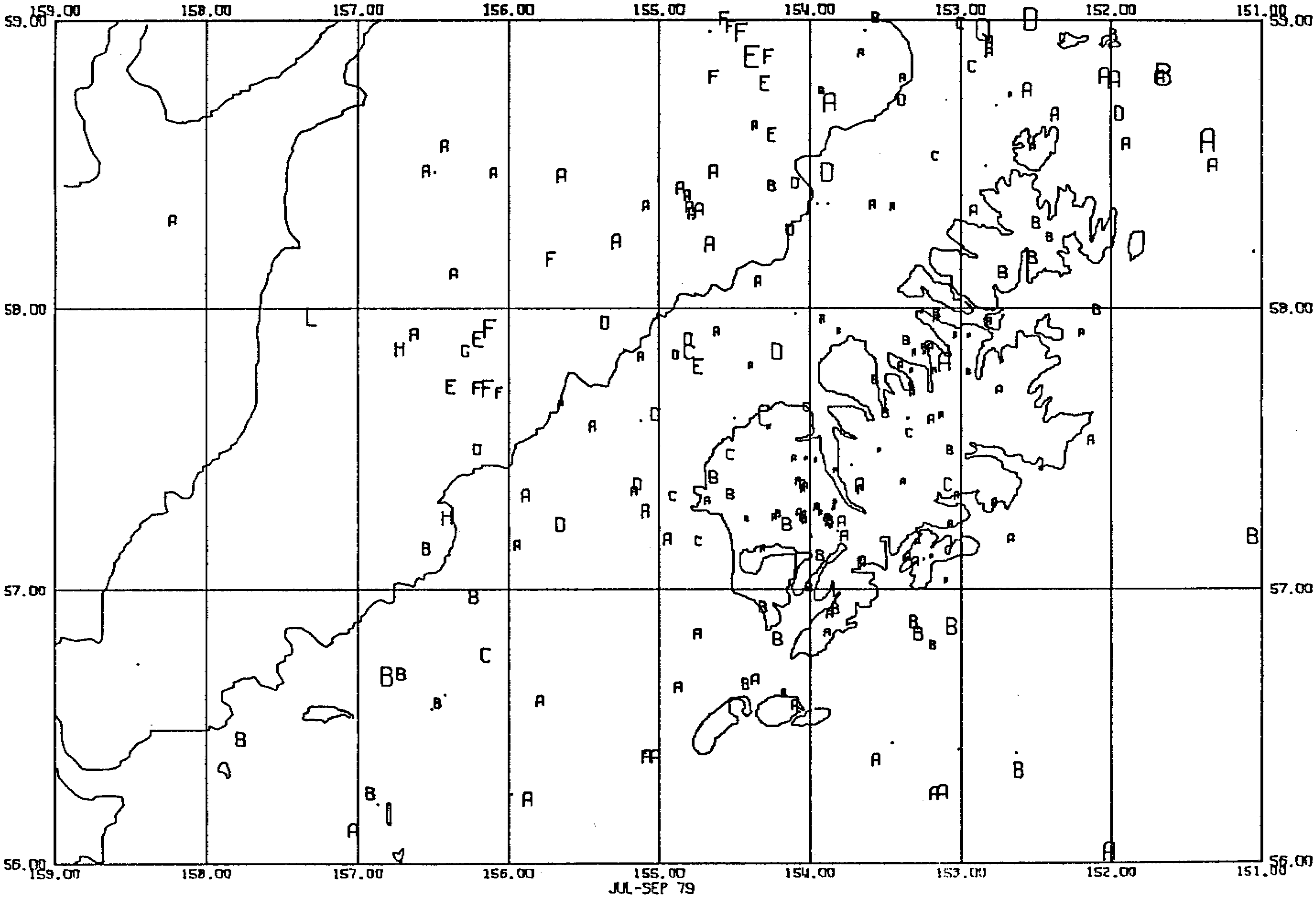

Fig. A-6 - Epicenter map, Kodiak-Alaska Peninsula, July-September 1979, class 1 events.

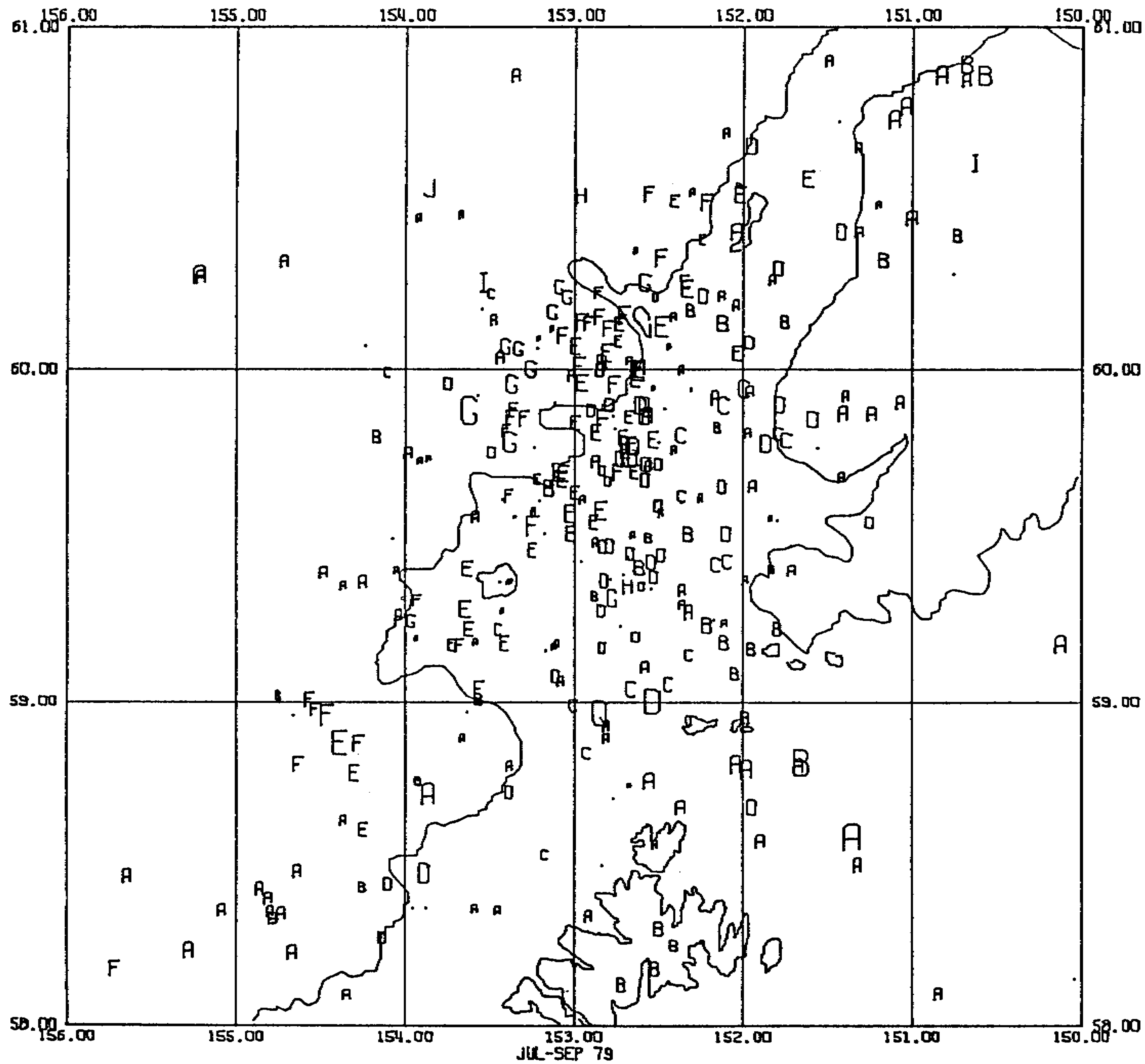

Fig. A-7 - Epicenter map, Lower Cook Inlet, July-September 1979, all locatable events.

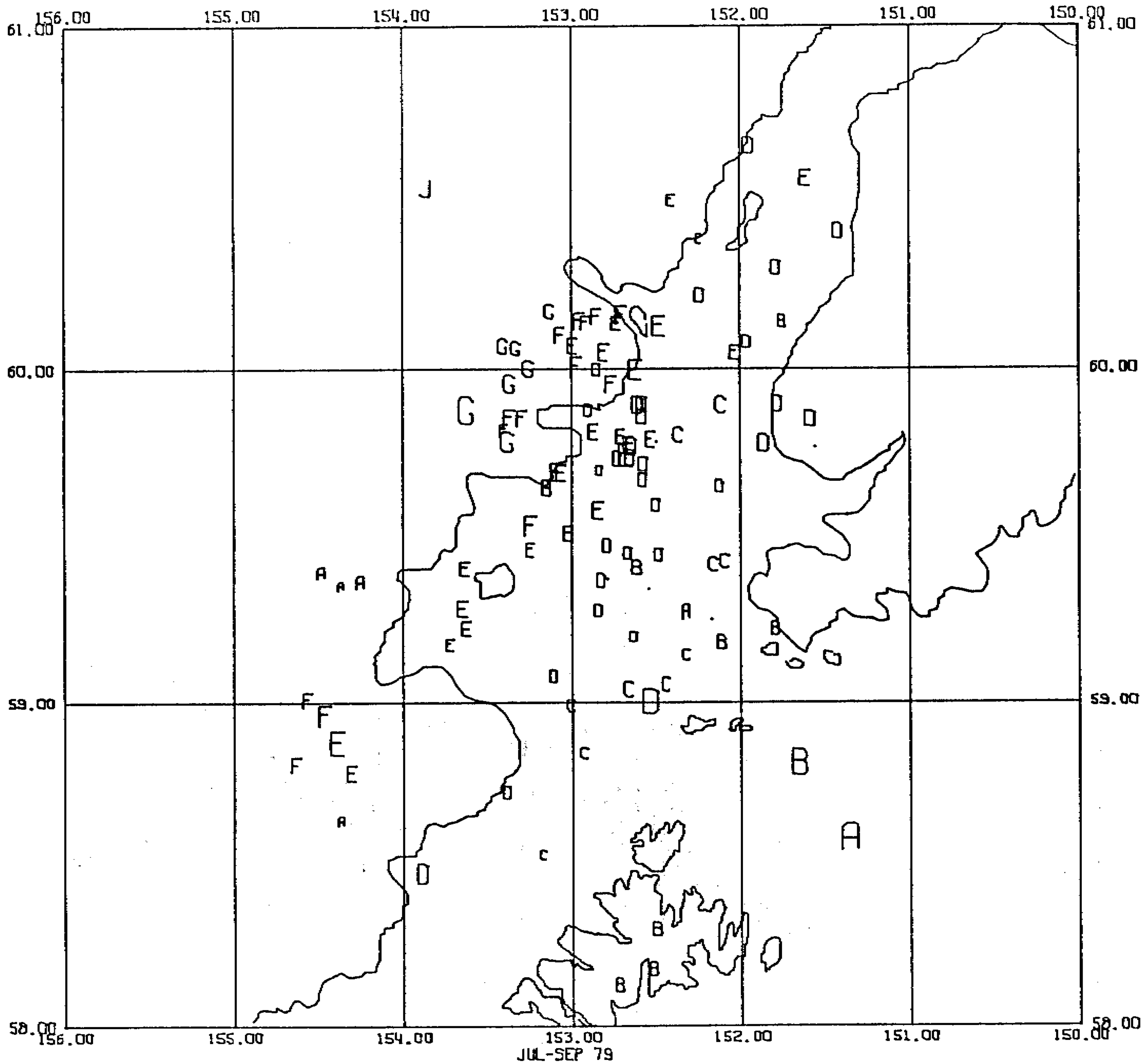

Fig. A-8 - Epicenter map, Lower Cook Inlet, July-September 1979, class 1 events.

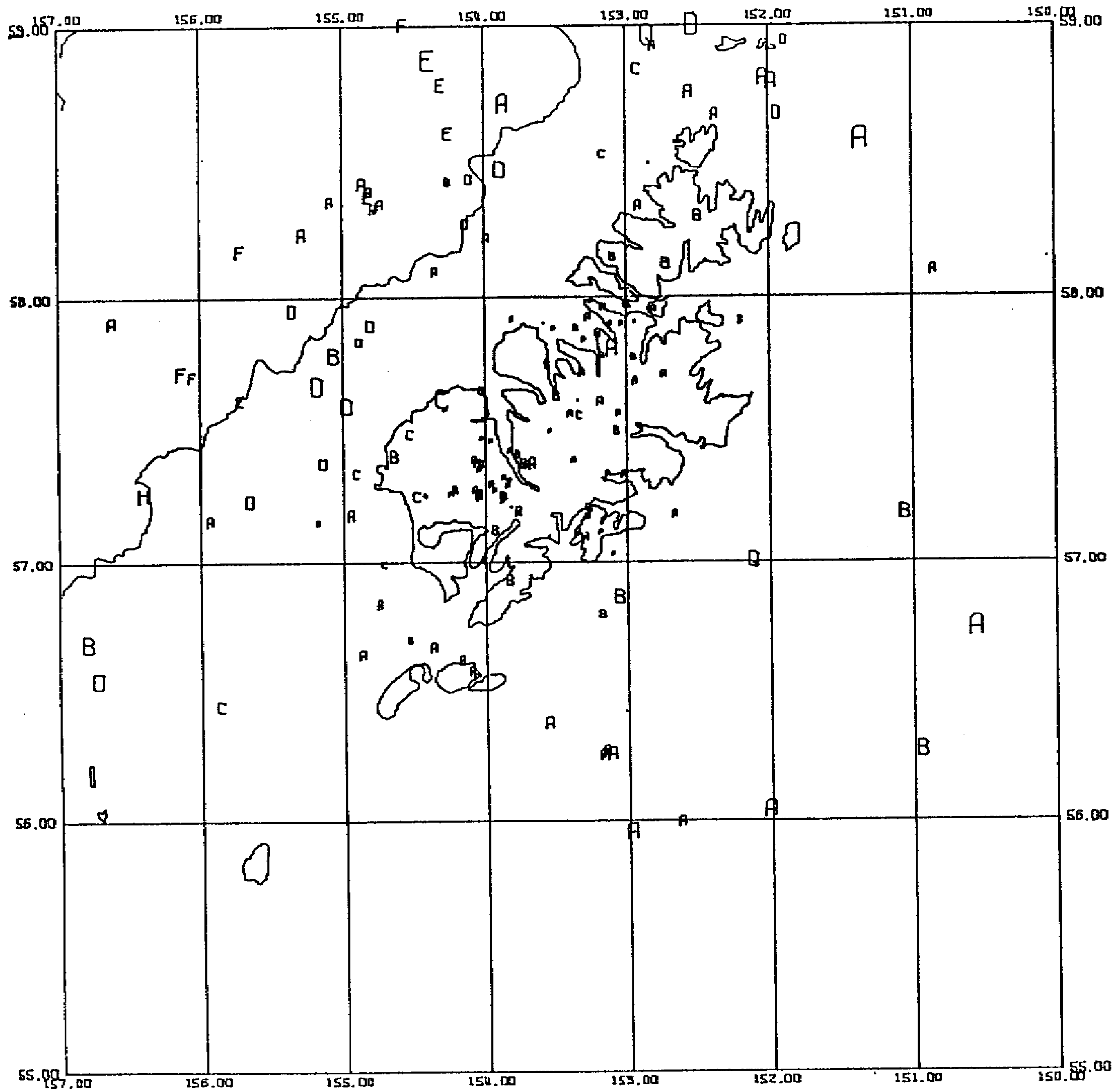

Fig. A-9 - Epicenter map, Kodiak Island area, June 23-August 6, 1979, all locatable events.

APPENDIX 2

Hypocenter Listings for Cook Inlet, Kodiak, and Alaska Peninsula

April 1979 through September 1979

Table A1-1 All Events

This appendix lists origin times, focal coordinates, magnitudes, and related parameters for earthquakes which occurred in the lower Cook Inlet, Kodiak, and Alaska Peninsula areas. The following data are given for each event:

(1) Origin time in Greenwich Civil Time (GCT): 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 N).

(3) DEPTH, depth of focus in kilometers.

(4) MAG, magnitude of the earthquake. A zero means not determined.

(5) NO, number of P arrivals used in locating earthquake.

(6) GAP, largest azimuthal separation in degrees between stations.

(7) DM, epicentral distance in kilometers to the closest station to the epicenter.

(8) RMS, root-mean-square error in seconds of the travel time residuals:

$$RMS = \sum_i (R^2_{Pi} + R^2_{Di}) / (NP + NS)$$

Where R_{Pi} and R_{Si} are the observed minus the computed arrival times of P and S waves, respectively, at the i-th station.

(9) 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.

(10) 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.

(11) Q, quality of the hypocenter. This index is a measure of the precision of the hypocenter and is the average of two quantitites, QS and QD, defined below:

QS	RMS (sec)	ERH (km)	ERZ (km)
A	< 0.15	≤ 1.0	≤ 2.0
B	< 0.30	≤ 2.5	≤ 5.0
C	< 0.50	≤ 5.0	
D	Others		

QD is rated according to the station distribution as follows:

QD	NO	GAP	DMIN
A	≥ 6	≤ 90°	≤ DEPTH or 5 km
B	≥ 6	≤ 135°	≤ 2x DEPTH or 10 km
C	≥ 6	≤ 180°	≤ 50 km
D	Others		

The following table is included:

Table A1-1. Cook Inlet, western Gulf of Alaska
All Events

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
APR	1	0	18	35.0	59	14.3	153	13.3	49.6	1.8	4	191	15	0.61	0.	0.	D
	1	6	57	48.0	59	30.5	152	27.8	37.8	2.5	5	180	49	0.07	3.9	2.5	D
	1	8	6	30.9	59	52.0	152	38.4	120.3	3.0	5	270	74	0.19	15.6	17.0	D
	1	8	52	20.8	59	28.1	151	33.3	8.2	2.1	4	219	1	0.	0.	0.	C
	1	10	49	54.1	59	27.9	152	28.5	2.0	2.1	4	171	50	0.01	0.	0.	C
	1	11	15	17.0	57	11.5	156	36.0	42.1	1.9	5	236	27	0.53	0.3	0.3	D
	1	11	22	5.7	56	56.9	150	49.0	40.0	2.1	4	323	134	0.13	0.	0.	C
	1	12	16	58.5	56	26.8	155	15.6	7.5	1.9	4	259	106	0.13	0.	0.	C
	1	15	33	16.4	60	18.5	153	2.6	165.6	3.2	5	293	110	0.12	25.6	29.1	D
	1	22	30	36.3	59	15.1	153	36.1	86.7	2.5	4	250	38	0.48	0.	0.	D
	2	1	54	4.4	60	8.1	152	59.7	137.6	3.1	6	178	92	0.26	7.0	17.5	D
	2	1	54	9.0	60	3.0	153	16.7	39.7	2.9	7	163	101	1.26	15.4	9999.9	D
	2	6	13	52.1	58	8.8	154	10.1	5.0	1.9	4	211	60	0.98	0.	0.	D
	2	6	47	10.3	58	45.5	153	2.6	5.0	2.0	3	222	42	0.	0.	0.	C
	3	0	33	15.9	57	39.7	152	7.1	21.8	1.3	4	233	24	0.	0.	0.	C
	3	3	31	5.8	58	58.7	153	15.0	79.7	2.7	5	141	41	0.06	3.6	7.8	D
	3	8	18	30.0	60	6.8	153	41.3	46.7	2.4	6	291	125	0.71	23.1	140.5	D
	3	9	27	18.8	57	9.1	153	12.9	5.0	1.6	3	180	8	0.	0.	0.	C
	3	13	20	4.1	59	47.9	153	25.2	156.1	3.3	9	139	51	0.27	3.9	6.1	D
	3	16	20	39.1	59	8.1	153	28.1	57.3	2.2	5	125	22	0.62	14.3	26.5	D
	3	16	45	3.6	57	46.5	155	24.5	2.5	2.0	4	168	6	0.45	0.	0.	D
	3	16	46	24.3	59	34.9	153	3.1	129.1	3.0	10	213	34	0.31	7.3	10.1	D
	3	18	50	42.6	60	8.0	153	9.6	149.6	3.5	7	173	90	0.26	5.1	11.6	D
	3	22	25	33.7	57	11.6	153	48.7	5.0	1.6	3	165	14	0.	0.	0.	C
	4	2	34	30.5	60	22.0	153	17.9	34.9	3.7	16	91	138	2.17	11.4	9999.9	D
	4	4	51	37.4	60	28.5	151	60.0	104.2	3.1	17	108	93	0.54	3.5	7.9	C
	4	7	9	45.4	57	9.2	153	52.3	30.7	2.3	4	128	9	0.	0.	0.	C
	4	8	16	15.8	60	16.8	153	28.4	192.6	2.7	19	95	101	0.85	6.0	11.0	C
	4	10	35	19.9	58	4.9	156	47.6	0.4	1.6	4	275	27	0.06	0.	0.	C
	5	1	39	33.7	58	56.1	152	13.3	54.3	2.3	4	161	35	0.	0.	0.	C
	5	7	4	29.0	58	43.0	153	22.4	5.0	1.9	5	102	60	0.94	12.8	9999.9	D
	5	7	45	37.0	59	52.4	152	48.8	30.4	2.3	4	284	69	0.32	0.	0.	D
	5	10	0	53.8	59	45.1	152	15.6	36.2	2.3	5	254	49	0.42	227.1	59.4	D
	5	10	37	32.1	58	55.7	153	0.5	39.1	1.6	4	218	50	0.63	0.	0.	D
	5	14	59	44.6	58	57.9	153	0.3	1.3	1.4	6	123	53	0.97	9.1	50.5	D
	5	19	54	27.2	57	52.3	154	40.6	3.9	1.4	4	179	51	0.36	0.	0.	D
	5	20	42	4.3	60	7.3	153	26.7	182.8	2.6	8	164	87	0.27	5.2	9.7	D
	5	22	24	52.0	57	45.1	154	10.6	5.0	1.2	4	149	69	0.06	0.	0.	C
	5	22	26	6.4	60	13.3	153	53.1	1.1	2.6	4	302	154	0.26	0.	0.	C
	5	23	8	40.3	59	22.3	145	2.8	5.0	3.8	6	331	371	0.34	144.8	523.8	D
	5	23	30	28.4	57	55.2	153	29.4	5.0	0.9	3	214	25	0.	0.	0.	C
	5	23	56	25.6	57	47.6	153	46.3	5.0	1.2	3	222	46	0.	0.	0.	C
	6	4	31	45.1	58	14.8	153	44.0	44.8	1.8	5	236	39	0.59	26.0	24.5	D
	6	6	36	34.6	57	23.5	155	18.1	61.7	2.0	7	127	44	0.48	6.8	16.5	C
	6	9	19	1.7	59	1.9	153	50.5	118.6	3.0	15	66	21	0.62	4.2	6.6	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR MN	SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
APR 6	10 11	36.9	58 1.8	152 38.4	5.0	1.7	3	181	30	0.	0.	0.	C
6	12 45	54.5	59 54.2	153 34.8	186.6	2.6	6	263	96	0.14	11.7	16.5	D
7	2 23	49.2	60 35.1	153 4.5	164.0	2.7	6	205	24	0.08	3.9	4.6	D
7	7 3	45.0	58 0.8	152 29.3	39.8	1.9	4	173	29	0.	0.	0.	C
7	10 22	28.5	58 8.6	151 3.2	5.0	2.3	4	282	93	0.50	0.	0.	D
7	14 17	18.8	59 38.7	151 3.7	157.7	2.1	4	302	32	0.02	0.	0.	C
7	17 49	20.7	59 52.7	152 58.1	6.9	2.4	4	187	61	0.30	0.	0.	C
7	19 34	33.3	57 21.8	153 42.9	31.3	2.6	6	90	34	0.35	4.5	5.9	C
8	3 13	26.4	58 15.6	152 56.4	44.9	2.3	18	114	25	0.39	2.1	4.2	C
8	11 55	19.3	60 4.5	153 8.1	131.3	2.2	6	201	43	0.24	9.2	15.1	D
8	12 24	42.8	60 44.3	151 2.5	33.1	2.7	6	303	101	0.40	211.5	17.4	D
8	15 46	15.7	56 46.1	153 50.1	5.0	0.8	3	177	31	0.	0.	0.	C
8	16 17	3.4	59 50.1	153 23.9	141.6	2.7	5	280	22	0.05	7.2	9.6	D
8	17 45	11.5	58 14.1	155 57.8	147.7	2.2	6	241	57	0.09	4.9	7.0	D
8	19 50	24.5	59 0.3	152 24.8	57.4	2.3	9	132	42	0.27	2.6	5.4	C
8	23 56	28.6	58 6.1	154 28.0	8.1	1.6	4	206	72	0.18	0.	0.	C
9	2 38	47.1	56 54.8	153 7.2	31.7	1.8	5	234	28	0.16	5.8	2.9	D
9	5 48	48.2	59 2.4	153 25.4	7.7	1.7	4	127	32	0.02	0.	0.	C
9	7 1	54.8	59 10.7	152 23.8	72.1	2.4	6	123	56	0.20	3.8	8.4	C
9	11 58	14.6	60 46.7	154 35.3	270.7	3.4	6	298	146	0.55	89.4	81.8	D
9	13 8	45.5	57 44.4	154 23.8	2.5	2.1	4	264	77	0.23	0.	0.	C
9	14 15	36.0	58 3.2	154 9.0	5.0	1.5	3	200	58	0.	0.	0.	C
9	16 7	23.6	57 59.5	153 42.0	51.7	1.8	6	109	32	0.10	1.5	2.8	B
9	16 37	51.9	60 3.1	152 55.7	129.4	2.5	11	173	84	0.43	5.8	8.7	D
9	20 14	48.3	57 15.7	156 30.6	93.3	2.0	6	210	26	0.13	7.2	11.2	D
10	0 19	31.9	59 32.9	152 26.6	4.1	2.5	6	150	45	0.96	21.4	32.1	D
10	5 36	1.6	57 9.9	156 4.5	63.3	2.2	8	179	53	0.64	12.1	28.5	D
10	5 43	9.5	58 9.4	152 19.3	5.0	2.2	3	204	50	0.	0.	0.	C
10	7 46	25.6	58 13.5	155 18.7	5.0	1.7	3	265	51	0.35	0.	0.	D
10	8 0	14.4	57 27.0	154 53.3	65.3	1.7	5	157	52	0.02	0.6	1.5	C
10	9 15	30.5	59 12.5	152 20.3	9.6	2.7	6	125	52	0.61	5.9	9999.9	D
10	9 35	17.8	59 3.3	153 37.8	14.4	2.5	4	298	88	0.09	0.	0.	C
10	10 14	23.0	57 1.1	154 4.5	33.7	1.9	4	198	10	0.	0.	0.	C
10	11 35	17.2	59 46.6	152 7.5	32.7	2.7	6	219	30	0.21	8.9	4.1	D
10	11 37	27.4	59 11.5	151 27.5	54.2	2.1	5	232	32	0.22	54.8	82.8	D
10	12 46	53.2	59 13.5	152 11.3	29.0	2.4	9	135	44	0.81	7.6	7.3	C
10	18 21	10.4	59 39.8	152 27.0	5.0	2.3	3	281	53	0.89	0.	0.	D
10	20 11	47.8	57 5.2	153 35.1	5.0	0.7	3	196	22	0.01	0.	0.	C
10	20 35	40.1	57 57.9	155 26.6	3.9	1.6	5	166	21	0.11	3.0	5.7	D
11	3 23	15.8	58 14.2	154 17.5	74.1	2.4	5	223	69	0.13	7.2	14.9	D
11	6 24	39.1	59 2.8	152 26.2	38.5	2.3	6	155	63	0.11	2.8	3.3	D
11	6 47	26.9	57 52.6	152 49.8	5.0	0.7	3	234	28	0.01	0.	0.	C
11	6 56	36.7	59 29.9	153 26.1	107.4	2.6	4	329	15	0.01	0.	0.	C
11	9 7	57.6	58 45.8	154 24.0	5.0	2.4	3	264	84	0.17	0.	0.	C
11	10 36	2.8	57 43.3	152 56.2	21.3	1.6	4	120	26	0.20	0.	0.	C

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
APR 11	10	39	27.0	61	20.9	148	18.6	38.4	3.3	6	304	354	0.39	50.5	673.4	D
11	11	17	21.5	57	41.7	153	1.3	5.0	1.4	3	165	32	0.	0.	0.	C
11	12	48	1.8	57	48.8	152	24.2	33.0	1.7	4	268	52	0.05	0.	0.	C
11	14	42	8.8	57	23.7	154	19.5	34.0	2.6	7	123	40	0.18	1.9	1.8	B
11	15	33	35.0	56	2.2	157	13.3	0.1	4.1	9	296	105	0.20	24.3	17.1	D
11	16	39	39.9	56	36.7	154	22.7	5.0	1.1	3	270	13	0.01	0.	0.	C
11	20	8	0.1	58	14.9	152	59.0	39.9	2.4	6	165	23	0.34	8.6	4.6	D
11	20	48	58.2	59	44.9	152	11.5	81.1	3.3	13	159	32	0.42	4.6	5.7	C
12	2	50	13.5	56	39.0	155	38.8	37.3	2.2	6	249	111	0.18	6.7	319.5	D
12	9	22	11.5	59	44.9	153	14.5	158.5	2.3	8	239	90	0.35	12.4	16.8	D
12	13	29	44.7	61	39.7	152	43.1	219.6	3.1	5	227	166	0.61	76.9	112.6	D
12	15	26	52.0	57	42.4	154	11.3	5.0	1.8	4	142	70	0.17	0.	0.	C
12	15	37	8.6	56	40.7	152	47.1	5.0	2.1	3	250	155	0.04	0.	0.	C
12	18	38	40.8	60	3.2	153	4.7	122.0	2.7	6	268	82	0.15	13.2	16.1	D
12	20	29	51.9	59	27.0	151	59.9	78.2	3.0	7	283	77	0.17	20.8	11.6	D
13	10	53	28.4	58	51.1	152	21.1	34.5	1.8	4	185	25	0.	0.	0.	C
13	11	22	52.0	58	40.9	152	33.2	6.7	1.6	5	185	13	0.66	33.0	29.5	D
13	21	58	42.6	58	14.8	152	7.9	5.0	2.2	3	222	44	0.	0.	0.	C
14	1	1	3.3	56	41.2	155	1.6	6.8	3.1	7	201	53	0.60	8.0	912.7	D
14	1	3	38.3	58	58.2	153	4.1	87.6	1.9	10	89	45	0.18	2.1	4.1	B
14	8	35	42.9	57	46.9	153	49.9	41.0	2.5	4	226	50	0.07	0.	0.	C
14	8	46	16.7	55	45.5	157	44.0	37.9	0.	12	290	135	0.29	11.9	358.2	D
14	10	48	45.7	57	55.2	153	30.5	5.0	1.2	3	217	25	0.	0.	0.	C
14	14	51	38.5	58	55.2	153	6.9	71.9	2.2	6	157	49	0.75	15.0	26.0	D
14	22	25	55.4	59	6.7	153	39.0	87.6	2.0	7	119	27	0.50	20.5	33.3	C
15	10	27	56.7	63	6.8	151	1.3	34.9	2.6	8	209	173	0.78	12.6	9999.9	D
15	17	10	0.8	58	2.5	152	0.8	3.6	1.9	6	204	43	0.20	3.8	3.7	D
15	20	43	5.2	61	16.0	151	7.2	5.0	2.2	4	247	242	0.02	0.	0.	C
15	21	9	21.0	57	52.8	150	59.7	5.0	1.6	5	248	115	0.63	24.4	9999.9	D
16	8	4	37.5	57	0.9	154	0.9	32.4	1.2	4	191	8	0.	0.	0.	C
16	8	5	2.2	58	12.2	154	8.6	5.4	1.6	4	285	60	0.68	0.	0.	D
16	9	12	49.0	56	44.8	154	3.2	5.0	1.0	3	168	22	0.01	0.	0.	C
16	11	10	38.2	59	5.9	154	5.9	145.4	0.	15	66	5	0.47	3.9	5.6	B
17	11	44	9.0	57	19.3	153	48.1	31.5	2.3	6	96	27	0.14	1.7	4.5	B
17	15	7	21.5	58	18.4	154	3.9	85.6	1.9	5	200	59	0.18	7.7	12.5	D
17	18	37	44.1	58	49.9	153	51.9	5.0	1.5	3	173	35	0.	0.	0.	C
17	21	55	57.4	58	12.0	151	41.9	0.2	3.8	8	213	61	0.32	4.3	12.3	D
17	22	7	29.3	57	28.6	153	42.1	5.0	1.4	3	187	46	0.01	0.	0.	C
18	6	40	41.9	58	45.8	154	2.3	86.8	2.5	7	164	38	0.74	18.0	29.8	D
19	11	16	1.0	58	29.5	154	14.4	87.1	2.4	8	139	67	0.06	0.7	2.4	C
19	23	3	47.6	60	23.8	140	26.5	26.0	3.9	4	200	100	0.	0.	0.	C
20	2	8	29.0	57	19.9	148	49.1	34.0	3.2	4	322	253	0.25	0.	0.	C
20	7	59	38.1	58	22.3	153	52.9	95.9	2.2	4	307	54	0.05	0.	0.	C
20	8	38	30.0	57	37.8	155	57.1	5.0	2.1	3	275	134	0.01	0.	0.	C
20	8	42	32.1	59	20.8	152	20.7	89.3	3.9	21	108	45	0.45	2.5	3.3	C

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
APR 20	12	49	6.3	59	55.4	140	30.9	114.2	6.0	5	172	69	0.09	110.9	236.6	D
20	21	58	39.4	59	59.8	140	36.6	90.3	4.4	5	170	77	0.16	55.9	148.6	D
21	3	23	46.1	63	8.2	149	47.9	5.0	3.4	6	216	218	0.52	10.9	906.1	D
21	6	51	49.1	59	24.5	152	33.4	5.0	2.1	5	182	50	1.07	1.0	1.9	D
21	12	36	56.6	60	22.6	140	21.5	28.4	4.3	4	200	95	0.	0.	0.	C
21	15	8	3.3	63	42.6	147	13.6	4.5	4.2	5	264	186	0.57	42.6	86.2	D
21	15	18	14.6	59	42.9	152	48.3	5.0	2.6	3	285	74	0.95	0.	0.	D
21	15	19	29.2	59	8.6	152	52.4	82.9	2.3	7	120	38	0.18	3.0	5.6	C
21	16	4	1.4	58	40.3	153	54.6	80.7	2.5	8	117	50	0.62	9.2	25.3	C
21	16	39	15.3	58	34.6	153	36.8	5.0	2.6	3	212	63	0.	0.	0.	C
21	17	17	32.1	59	17.5	152	41.2	75.9	2.6	4	156	42	0.	0.	0.	C
21	19	19	49.5	58	17.2	150	7.2	0.0	2.6	4	295	135	0.	0.	0.	C
21	19	23	39.5	59	4.2	153	17.7	5.0	1.6	3	170	30	0.	0.	0.	C
21	21	19	34.2	59	54.5	153	19.4	170.2	2.7	15	97	28	0.39	3.1	4.5	C
21	22	40	11.3	56	51.3	154	17.5	37.9	2.7	5	123	32	0.03	0.7	0.5	C
22	0	49	11.8	56	44.1	153	23.1	5.0	0.9	3	227	51	0.06	0.	0.	C
22	7	29	44.6	59	43.2	151	57.0	38.0	2.6	4	259	34	0.04	0.	0.	C
22	13	49	13.8	58	37.9	152	23.6	10.7	2.7	6	108	2	0.23	3.4	1.7	C
22	14	4	36.6	59	49.8	141	10.3	38.7	4.0	4	162	102	0.25	0.	0.	C
22	17	5	6.6	58	38.3	152	32.5	17.0	2.0	11	136	73	0.63	4.7	6.3	D
23	1	39	35.9	56	14.4	157	3.0	13.2	1.4	4	298	130	0.35	0.	0.	D
23	2	17	13.8	57	55.6	153	47.4	26.1	2.5	5	245	40	0.50	15.2	9.0	D
23	3	11	11.0	57	40.2	154	53.2	77.3	2.0	6	131	39	0.24	4.4	8.9	C
23	4	8	0.8	58	56.7	153	2.3	2.1	2.2	5	138	48	1.12	44.0	98.0	D
23	5	20	28.2	63	37.8	150	49.5	0.8	2.9	7	112	204	0.37	4.9	46.1	D
23	6	53	11.1	55	50.4	155	44.0	29.4	1.6	4	247	9	0.	0.	0.	C
23	17	29	50.8	58	14.0	152	49.8	47.6	2.2	6	127	27	0.12	2.2	2.7	B
23	17	39	42.7	60	4.2	152	51.0	148.1	2.6	6	186	88	0.17	4.3	6.3	D
23	18	28	32.6	58	3.6	154	9.8	15.8	2.0	5	250	59	0.36	15.4	118.5	D
24	5	13	21.3	60	9.5	152	33.0	113.9	2.7	5	286	93	0.01	1.4	1.4	C
24	12	48	22.3	59	3.3	152	49.0	74.1	2.1	8	98	46	0.29	3.8	7.6	C
24	14	40	7.1	56	39.3	153	34.8	38.3	2.8	9	226	38	0.25	4.0	1.4	D
24	20	14	3.8	62	9.6	147	58.1	5.0	3.4	7	290	322	0.38	25.2	580.2	D
25	0	1	51.7	55	33.7	158	54.5	20.8	3.6	12	308	211	0.39	27.4	477.0	D
25	0	27	59.8	63	22.2	149	39.8	33.8	4.0	12	161	192	0.48	4.1	584.5	D
25	5	48	49.7	57	48.8	156	0.5	115.6	2.6	7	174	29	0.28	6.0	9.3	D
25	6	33	10.4	57	30.5	153	45.1	5.0	1.5	3	195	48	0.	0.	0.	C
25	21	34	1.5	58	7.8	150	55.7	5.0	2.6	5	244	99	0.62	23.2	9999.9	D
25	23	9	41.8	58	35.9	152	51.4	30.2	2.2	5	109	29	0.07	1.2	1.4	C
26	5	17	44.6	57	25.1	154	8.5	5.0	1.2	3	236	38	0.	0.	0.	C
26	9	49	21.5	58	47.8	153	12.8	6.0	2.0	7	123	53	0.58	5.5	887.1	D
26	9	54	45.7	58	47.6	153	13.6	4.3	2.7	11	67	54	0.70	4.9	10.5	D
26	9	57	19.5	58	47.9	153	14.4	5.0	2.1	6	124	55	0.48	7.6	14.3	D
26	12	34	8.4	60	2.5	149	22.6	30.9	3.3	11	209	134	0.88	10.7	9999.9	D
26	14	22	24.9	59	33.4	152	19.6	77.9	2.4	12	117	43	0.27	2.5	3.6	C

1979	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
APR 26	16	28	52.7	60	4.6	152	38.2	114.2	2.5	7	150	38	0.16	3.3	4.6	C
27	0	9	0.1	59	19.3	152	43.1	97.6	2.6	7	89	40	0.12	1.7	3.5	B
27	2	42	39.5	57	42.1	153	34.7	40.4	2.2	5	193	47	0.05	1.2	0.8	C
27	7	26	35.3	56	56.2	151	29.5	32.3	2.3	4	310	99	0.12	0.	0.	C
27	10	34	3.7	58	37.9	152	40.1	72.6	2.2	8	96	18	0.13	1.6	2.5	B
28	3	29	15.6	56	38.4	155	5.1	20.3	2.4	8	109	56	0.21	1.7	2.7	C
28	6	48	53.8	57	19.0	155	12.8	61.0	2.5	10	88	53	0.31	2.4	6.9	B
29	5	30	53.3	59	32.5	152	57.7	5.0	1.6	4	131	78	0.66	0.	0.	D
29	8	45	44.6	59	10.3	153	38.1	105.9	2.6	6	194	21	0.17	5.5	4.7	D
29	11	14	43.2	58	53.6	154	15.0	120.2	2.7	9	144	23	0.21	2.5	4.4	C
30	11	48	0.9	58	13.7	153	16.8	56.8	2.1	11	88	20	2.09	16.5	31.4	C
30	11	54	19.3	56	46.0	155	57.8	19.0	2.6	10	156	88	0.27	2.4	3.0	C
MAY 2	0	40	10.1	57	51.3	156	4.9	124.6	3.4	14	102	19	0.94	13.6	20.5	C
2	1	44	29.4	59	21.2	152	35.3	110.3	2.8	4	240	43	0.01	0.	0.	C
2	6	55	57.8	56	55.3	154	7.6	5.0	1.2	3	204	21	0.01	0.	0.	C
2	12	24	19.8	56	12.1	158	11.7	25.7	2.1	8	285	156	0.39	19.5	550.7	D
2	16	47	58.9	57	54.7	153	19.0	5.0	0.8	3	186	19	0.	0.	0.	C
3	6	23	42.0	59	16.7	153	8.8	77.5	2.3	5	125	15	0.54	22.7	35.2	D
3	22	53	41.4	58	59.8	151	54.7	5.0	2.9	3	195	56	0.01	0.	0.	C
4	11	9	51.9	58	18.1	152	58.7	52.6	1.7	7	118	29	0.15	2.1	3.0	B
4	11	37	57.1	59	12.8	146	10.6	5.0	3.1	11	158	294	0.82	6.7	9999.9	D
4	12	37	14.9	57	17.2	153	13.3	5.0	0.6	3	146	16	0.	0.	0.	C
4	14	2	29.1	59	23.6	152	57.4	67.8	2.2	5	139	32	0.76	0.6	1.1	D
4	14	30	29.4	57	8.5	153	58.0	34.4	1.8	4	194	6	0.	0.	0.	C
4	20	2	50.6	59	39.8	153	46.6	158.1	2.4	6	280	30	0.24	22.4	26.1	D
4	21	2	33.2	59	29.2	152	30.7	5.8	2.5	5	157	44	1.07	39.7	55.4	D
5	6	50	38.9	62	58.2	148	18.3	30.8	4.0	11	168	146	0.35	3.0	441.8	D
5	16	13	37.2	63	11.3	150	59.3	32.2	2.9	10	138	180	0.79	7.0	9999.9	D
5	17	47	7.4	56	46.8	154	43.2	43.1	1.2	4	210	41	0.	0.	0.	C
5	18	15	57.3	59	28.3	151	20.1	5.0	2.7	3	353	13	18.61	0.	0.	D
6	11	16	21.2	57	27.1	153	49.4	3.8	1.7	4	198	41	0.	0.	0.	C
7	0	2	38.1	56	17.6	152	31.2	5.0	2.4	4	254	102	0.36	0.	0.	D
7	0	21	51.7	60	2.2	152	36.7	110.0	3.6	8	191	55	0.15	2.8	3.2	D
7	4	54	31.8	61	37.2	151	5.8	5.0	2.6	3	247	240	0.	0.	0.	C
7	11	1	10.8	59	39.2	153	46.3	77.1	3.2	7	131	87	0.53	6.6	18.3	C
7	20	31	48.4	58	43.4	154	33.2	151.2	2.2	5	243	94	0.02	2.0	1.8	C
7	21	24	23.2	60	57.3	150	31.5	47.1	3.7	13	138	61	0.53	4.4	19.4	D
8	15	15	4.0	58	23.0	154	57.4	5.0	2.9	9	183	75	2.17	19.2	9999.9	D
8	21	26	35.4	57	10.2	154	57.0	57.7	2.2	4	262	60	0.	0.	0.	C
10	14	38	28.9	57	19.5	154	1.6	5.0	1.0	3	221	26	0.	0.	0.	C
10	20	30	9.6	59	27.5	152	22.9	27.6	2.3	5	199	45	0.39	138.2	95.2	D
10	21	38	54.0	60	16.6	152	26.2	38.2	2.8	12	93	101	1.46	9.2	9999.9	D
11	1	43	47.2	56	50.3	155	35.1	5.0	1.9	7	199	91	0.27	3.8	417.3	D
11	4	55	43.9	60	17.7	153	35.7	183.7	3.2	7	180	107	0.09	2.7	4.0	D
11	10	51	50.8	57	48.0	156	10.7	120.8	2.6	14	119	11	0.20	3.0	4.4	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
MAY 11	13	11	40.5	58	28.9	154	10.5	5.0	1.7	4	203	69	0.75	0.	0.	D
11	13	40	32.8	57	29.0	154	3.0	36.1	1.9	6	133	44	0.12	2.4	3.1	B
11	18	51	52.4	58	52.2	153	40.4	5.0	2.1	3	201	39	0.	0.	0.	C
12	3	18	10.6	58	55.1	154	25.4	138.2	3.3	7	234	24	0.29	10.5	15.1	D
13	1	33	43.2	56	23.7	153	3.9	5.0	1.6	3	286	71	0.27	0.	0.	C
13	22	42	56.6	56	57.4	156	15.9	19.9	2.0	6	163	61	0.16	2.3	3.7	C
14	8	49	50.6	56	57.3	156	17.8	22.0	1.6	5	217	60	0.05	1.3	1.3	C
14	20	14	36.1	61	42.0	150	48.2	55.6	2.6	8	96	49	0.64	7.3	15.1	C
15	6	30	47.6	58	45.1	153	29.6	77.7	1.6	5	142	56	0.01	0.3	0.6	C
16	14	19	19.9	59	55.6	140	54.5	93.9	4.4	5	165	78	0.64	40.6	98.0	D
17	8	10	38.6	62	27.9	147	57.7	25.3	3.1	11	148	101	0.29	2.8	2.4	D
17	14	4	20.2	61	18.9	147	22.5	27.6	3.2	8	154	98	1.01	13.5	11.4	D
18	9	13	28.2	57	7.8	153	21.6	5.0	1.5	3	185	17	0.	0.	0.	C
19	1	24	20.8	56	48.3	153	23.2	5.0	1.8	3	235	47	0.01	0.	0.	C
19	10	24	40.4	59	17.6	153	29.9	126.2	2.5	7	186	8	0.14	6.1	8.2	D
20	8	14	0.8	56	35.8	156	21.9	30.0	5.8	12	215	97	0.76	10.9	10.4	D
20	8	47	40.4	56	15.9	155	3.9	5.0	1.8	3	182	57	0.14	0.	0.	C
20	8	52	27.3	56	18.6	155	0.7	5.0	1.9	3	183	63	0.15	0.	0.	C
20	11	24	8.4	56	14.1	156	11.0	137.3	4.4	13	114	58	0.83	16.0	24.4	C
20	14	28	58.5	57	18.4	153	58.2	5.2	2.3	4	211	24	0.05	0.	0.	C
20	16	39	23.0	56	43.8	157	4.5	38.5	3.3	4	291	135	0.13	0.	0.	C
21	8	49	39.8	56	39.9	156	5.3	22.8	2.2	4	247	97	0.28	0.	0.	C
22	3	48	10.6	58	37.3	154	1.3	96.7	3.1	11	205	54	0.20	2.8	2.6	D
22	4	30	29.5	59	24.5	151	39.1	87.4	3.2	6	175	8	0.11	15.8	29.6	D
22	5	39	54.2	60	3.5	152	14.2	26.2	0.	6	201	55	0.63	1.1	1.8	D
23	13	44	41.2	56	34.5	156	21.9	37.6	4.3	13	289	126	0.43	16.2	514.9	D
23	17	51	29.0	56	28.8	156	21.4	29.9	3.8	6	274	107	0.19	14.5	12.3	D
23	18	0	47.6	56	30.0	156	25.2	37.3	4.0	15	275	103	0.32	8.3	371.6	D
23	18	5	45.1	56	40.8	156	8.7	29.0	3.2	6	235	91	0.38	12.4	5.9	D
23	20	15	42.6	57	47.6	157	30.7	24.8	3.8	11	225	222	0.59	9.3	738.8	D
24	0	34	29.2	57	5.9	154	0.2	30.7	3.1	4	195	2	0.	0.	0.	C
24	1	13	28.5	56	37.5	156	6.2	5.0	2.3	6	172	93	0.68	8.2	9999.9	D
27	7	33	56.3	59	11.7	151	18.3	40.4	2.5	19	179	34	0.75	5.0	3.5	D
27	9	0	52.5	59	54.0	151	59.7	66.2	2.7	16	92	33	0.43	3.3	6.1	C
27	9	12	16.0	56	13.1	153	26.8	16.3	2.7	10	239	59	0.51	11.4	5.7	D
27	11	19	40.4	60	11.0	153	45.7	203.3	0.	8	255	60	0.19	15.5	28.0	D
27	15	38	3.0	63	6.7	150	54.2	25.0	3.4	9	174	192	0.71	8.0	951.4	D
27	18	10	49.5	57	25.4	154	1.9	5.0	1.5	3	151	37	0.	0.	0.	C
27	20	23	36.0	57	3.7	155	3.7	43.4	2.1	6	153	39	0.11	1.7	3.8	C
28	4	12	21.6	59	54.5	151	40.9	5.0	2.5	4	242	83	0.02	0.	0.	C
28	7	2	33.1	57	1.8	153	59.4	30.4	1.6	4	177	6	0.	0.	0.	C
28	7	24	11.9	56	36.8	156	12.7	5.0	2.1	8	180	94	0.77	7.2	9999.9	D
28	9	37	46.1	57	53.9	155	0.9	5.0	0.	7	186	75	2.77	33.3	9999.9	D
28	13	3	17.0	59	53.2	152	18.4	34.2	2.5	10	148	45	0.31	2.5	2.4	C
28	14	45	26.7	56	54.7	156	6.7	5.0	2.1	6	156	70	1.77	19.7	9999.9	D

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
MAY 28	18	6	56.7	56	10.7	152	42.4	14.1	3.2	14	248	100	0.58	9.3	5.6	D
29	4	28	17.1	56	38.9	156	19.6	29.8	2.4	6	186	89	0.38	180.3	171.3	D
30	2	3	7.8	57	6.4	156	19.9	5.0	1.9	3	225	45	0.01	0.	0.	C
30	6	58	22.2	60	4.1	152	51.3	123.1	2.4	7	162	39	0.07	3.0	10.4	C
30	7	14	23.6	59	46.8	152	25.7	77.3	2.7	6	141	47	0.06	1.1	2.9	C
30	9	0	13.6	60	29.9	152	8.8	132.5	3.2	5	269	35	0.16	18.6	26.8	D
30	11	3	18.8	56	40.4	156	6.1	5.0	1.9	4	170	93	0.33	0.	0.	D
30	11	32	35.8	60	14.8	152	3.7	3.3	2.8	4	227	43	0.79	0.	0.	D
30	14	5	12.9	60	3.4	152	42.1	111.3	3.0	6	141	40	0.20	7.3	16.9	D
30	18	25	39.0	60	16.6	152	42.3	147.5	2.8	13	158	16	0.24	3.9	4.3	C
30	19	20	33.7	56	28.2	160	58.4	30.3	3.8	7	337	471	0.62	100.1	292.6	D
31	4	22	55.4	61	47.4	149	47.8	36.2	3.3	12	63	16	0.99	7.6	4.7	C
31	4	26	21.4	59	14.4	152	45.2	84.2	2.9	5	162	39	0.10	4.1	6.4	D
31	4	38	33.4	60	4.2	152	15.5	75.7	2.7	16	95	48	0.48	3.0	5.9	C
31	13	19	40.6	60	17.7	152	52.9	114.9	3.2	5	172	15	0.06	7.0	17.4	D
JUN 1	21	14	30.3	58	58.1	153	6.6	130.3	3.0	8	199	44	0.83	28.4	25.4	D
3	1	45	23.7	59	39.9	151	58.8	5.0	2.3	3	162	31	0.01	0.	0.	C
3	20	41	1.8	63	26.9	149	55.0	0.6	3.1	7	160	200	1.58	20.3	112.2	D
4	2	5	58.4	62	52.8	149	43.6	35.2	3.1	9	143	137	0.35	3.5	465.2	D
4	4	16	29.3	59	44.7	152	21.4	5.0	0.	3	148	53	0.	0.	0.	C
4	5	6	58.2	59	51.1	153	7.9	136.0	4.0	18	50	54	0.46	3.1	4.1	B
5	2	11	39.0	56	32.2	153	45.0	5.0	0.	3	245	26	0.01	0.	0.	C
5	7	57	1.1	58	21.7	154	39.2	14.5	2.6	10	224	84	0.88	15.3	10.9	D
5	8	55	8.2	58	13.4	150	0.5	0.6	3.2	4	290	166	0.92	0.	0.	D
5	12	53	7.6	60	9.3	152	42.5	122.8	0.	8	147	29	0.08	1.7	3.1	C
5	15	52	30.6	59	57.2	151	43.1	5.0	2.9	3	220	54	0.01	0.	0.	C
5	15	56	41.5	60	7.0	153	24.6	126.8	2.2	4	176	48	0.	0.	0.	C
5	23	52	2.6	58	48.1	153	23.6	5.0	0.	6	230	59	0.76	18.3	9999.9	D
6	0	11	30.0	62	42.7	151	48.3	5.0	1.9	3	275	216	0.01	0.	0.	C
6	0	21	16.1	59	25.2	155	52.2	15.8	2.9	7	254	36	0.53	17.0	9.9	D
6	1	14	8.5	58	3.6	152	12.2	54.0	1.7	4	298	56	0.05	0.	0.	C
6	4	55	12.8	59	45.6	151	26.0	1.7	2.6	5	240	33	0.07	6.5	7.9	D
6	5	1	11.9	58	19.1	152	34.7	45.9	1.8	5	196	44	0.08	4.0	4.1	D
6	10	50	15.9	57	33.2	153	7.5	5.0	0.8	3	226	44	0.	0.	0.	C
6	11	4	4.4	59	34.2	153	45.6	5.0	0.	3	162	85	0.01	0.	0.	C
6	11	16	24.9	57	56.2	153	1.3	5.0	0.4	3	241	16	0.	0.	0.	C
6	12	1	31.0	57	16.1	153	58.4	16.0	0.4	4	195	20	0.38	0.	0.	D
6	14	17	33.0	58	54.6	154	30.0	147.5	2.1	5	219	122	0.02	1.8	1.8	C
6	14	48	41.1	57	4.1	153	22.3	5.0	0.5	4	214	20	0.26	0.	0.	C
7	6	2	2.2	57	6.8	153	42.1	5.0	1.0	3	182	15	0.01	0.	0.	C
7	6	17	25.0	60	5.2	151	40.9	31.5	2.5	8	234	68	0.39	6.1	3.8	D
7	8	44	17.6	57	23.6	153	24.7	5.0	1.0	3	190	32	0.	0.	0.	C
7	9	17	57.0	57	21.2	153	20.4	5.0	0.6	3	187	26	0.01	0.	0.	C
7	9	25	23.0	57	40.6	153	27.1	5.0	0.7	3	137	21	0.	0.	0.	C
7	10	39	30.6	59	45.3	151	5.6	25.2	2.7	8	264	41	0.19	4.3	1.8	D

1979		ORIGIN HR	TIME MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JUN	7	19	56	8.5	57	27.3	152	30.6	39.6	2.1	5	146	15	0.04	0.9	0.7	C
	8	5	12	30.5	63	56.3	147	48.7	5.0	2.8	8	244	270	1.00	26.3	9999.9	D
	8	6	46	31.3	57	3.3	153	57.6	29.7	2.6	4	166	3	0.	0.	0.	C
	8	8	9	25.7	59	27.8	152	42.6	107.4	0.	5	161	42	0.03	2.4	7.1	D
	8	12	31	7.3	59	24.9	153	23.6	5.0	0.9	3	321	4	0.49	0.	0.	D
	8	13	49	57.2	59	19.0	152	58.7	85.2	0.	7	107	22	0.14	2.1	3.1	B
	9	0	32	7.1	55	57.2	157	24.0	5.0	4.4	12	323	348	0.25	48.4	310.5	D
	9	6	53	39.2	57	27.5	154	44.5	52.5	1.5	4	259	15	0.	0.	0.	C
	9	9	39	5.6	60	4.5	153	4.5	31.9	3.4	11	121	180	0.78	5.4	972.2	D
	9	16	22	28.6	57	0.3	153	57.9	32.8	2.5	5	167	9	0.07	1.6	1.0	C
	9	21	4	19.0	59	48.4	153	52.8	35.5	2.6	6	139	17	0.69	80.1	50.2	D
	9	21	55	25.1	57	4.5	153	34.6	16.0	1.5	4	202	23	0.01	0.	0.	C
	10	3	53	22.3	59	35.4	151	17.1	13.3	2.8	6	173	119	0.50	10.3	13.8	D
	10	22	47	41.0	56	53.9	154	18.9	5.0	1.2	3	270	52	0.15	0.	0.	C
	11	2	49	36.6	57	33.1	154	5.7	5.0	2.2	3	233	52	0.01	0.	0.	C
	11	8	48	50.0	61	18.5	152	20.7	5.0	2.6	3	215	208	0.17	0.	0.	C
	12	3	53	0.4	59	39.3	152	40.6	265.6	3.3	5	199	31	0.67	58.4	163.4	D
	13	11	5	38.2	57	42.5	155	12.6	36.9	2.7	4	138	63	0.70	0.	0.	D
	14	18	31	10.4	57	40.2	153	13.3	5.0	1.1	3	167	34	0.	0.	0.	C
	15	5	50	27.0	57	53.8	152	40.6	5.0	1.1	3	254	33	0.03	0.	0.	C
	15	6	26	4.1	57	10.0	153	50.8	5.0	0.5	3	146	11	0.	0.	0.	C
	15	8	13	39.1	59	59.1	152	51.2	35.8	3.3	8	127	197	0.77	8.2	9999.9	D
	15	9	35	23.4	58	48.3	153	57.0	109.2	1.8	4	331	94	0.04	0.	0.	C
	15	9	44	43.2	57	8.9	153	52.1	39.5	2.3	5	145	8	0.08	1.8	1.2	C
	15	12	31	46.9	57	21.4	153	20.6	5.0	0.8	3	223	47	0.	0.	0.	C
	15	13	49	46.4	57	42.0	153	32.2	5.0	-0.1	3	140	15	0.	0.	0.	C
	15	17	24	1.0	59	2.2	154	14.1	39.7	3.7	7	166	125	0.83	14.3	9999.9	D
	15	18	54	34.1	57	31.7	151	43.6	40.6	3.3	9	216	51	0.64	12.9	5.2	D
	16	5	58	8.3	57	30.6	154	4.6	89.3	1.9	4	222	33	0.82	0.	0.	D
	16	6	15	43.9	57	53.7	152	37.1	5.0	1.1	3	259	36	0.04	0.	0.	C
	16	10	28	6.8	57	54.0	153	7.1	5.0	0.6	3	186	18	0.	0.	0.	C
	17	7	15	41.9	57	6.4	155	5.4	62.4	2.8	5	270	68	0.01	0.5	0.6	C
	17	22	12	9.5	57	42.9	155	28.0	82.8	1.8	4	307	101	0.	0.	0.	C
	17	22	36	54.4	57	8.7	153	52.5	57.9	0.	4	146	8	0.02	0.	0.	C
	18	4	34	52.7	57	9.7	153	48.3	7.8	1.9	4	139	12	0.27	0.	0.	C
	18	8	29	32.0	57	43.2	154	27.8	73.9	3.4	5	251	41	0.07	4.3	4.1	D
	18	8	52	32.9	57	50.1	152	54.9	5.0	0.8	3	247	29	0.	0.	0.	C
	18	10	50	10.1	56	39.1	155	51.3	184.2	3.3	5	310	103	0.25	58.7	72.1	D
	18	20	48	31.0	57	56.5	153	15.8	5.0	0.5	3	149	14	0.	0.	0.	C
	19	7	44	1.8	57	41.3	153	23.8	49.3	1.9	4	143	23	0.	0.	0.	C
	19	12	17	37.1	56	23.1	154	41.5	5.0	0.	5	164	37	0.98	20.7	14.6	D
	19	21	15	13.4	57	34.2	154	21.6	5.0	1.6	3	257	58	0.	0.	0.	C
	20	8	18	32.4	60	53.8	147	56.3	39.3	3.4	9	255	95	0.64	18.4	859.0	D
	20	10	42	52.7	58	8.2	153	8.1	48.6	2.0	4	316	8	0.24	0.	0.	C
	21	7	33	36.0	58	55.9	152	16.1	40.0	3.1	12	142	110	0.39	3.8	477.3	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN	TIME		LAT N		LONG W		DEPTH	MAG	NO	GAP	DM	RMS	ERH	ERZ	Q
1979	HR	MN	SEC	DEG	MIN	DEG	MIN	KM			DEG	KM	SEC	KM	KM	
JUN 21	8	10	42.5	57	56.0	153	16.6	5.0	0.4	3	150	15	0.01	0.	0.	C
21	8	23	9.3	57	33.3	152	47.0	5.0	1.5	3	224	47	0.	0.	0.	C
21	8	42	58.6	59	46.6	147	34.5	1.3	3.4	9	136	196	0.95	9.5	67.6	D
21	10	24	40.2	57	29.0	153	21.3	2.2	1.4	4	145	39	0.36	0.	0.	D
21	12	1	44.2	57	53.7	152	57.7	5.0	0.9	3	218	21	0.	0.	0.	C
21	14	10	44.3	57	43.9	156	41.6	210.0	0.	5	309	174	0.54	21.6	23.3	D
21	19	27	21.2	56	44.6	154	14.5	35.6	2.3	4	204	20	0.	0.	0.	C
22	5	21	2.3	57	55.2	152	59.9	5.0	1.1	3	215	18	0.	0.	0.	C
22	5	52	8.1	57	25.4	153	29.5	5.0	0.1	3	201	40	0.	0.	0.	C
22	5	53	50.4	58	8.2	153	7.0	46.4	2.0	4	316	8	0.22	0.	0.	C
22	7	55	52.9	57	37.2	153	10.2	5.0	1.1	3	218	39	0.01	0.	0.	C
22	9	44	57.7	57	7.5	155	8.0	271.8	2.8	4	315	71	0.18	0.	0.	C
22	9	59	39.9	57	54.1	153	1.1	1.2	0.6	4	208	19	0.19	0.	0.	C
22	11	53	27.1	58	2.3	153	9.1	5.0	-0.6	3	188	2	0.	0.	0.	C
22	12	52	13.0	57	1.2	153	58.9	30.0	1.4	7	120	7	0.19	2.3	1.9	B
22	16	30	11.8	57	20.1	153	9.9	5.0	0.4	3	165	19	0.01	0.	0.	C
22	18	43	51.5	58	10.0	153	11.5	5.0	0.7	3	313	11	0.42	0.	0.	D
22	23	40	10.2	57	8.6	153	58.1	17.1	1.5	4	194	6	0.12	0.	0.	C
23	0	30	51.9	57	18.9	153	53.3	5.0	1.1	3	196	25	0.	0.	0.	C
23	2	40	30.4	57	54.0	153	7.7	5.0	0.9	3	184	18	0.	0.	0.	C
23	6	9	42.1	57	18.3	153	10.1	5.0	0.5	3	161	16	0.	0.	0.	C
23	8	41	3.7	57	38.0	155	13.5	82.8	4.0	14	116	62	0.30	2.2	4.3	C
23	10	46	56.2	61	59.1	150	8.9	0.6	4.1	7	150	39	0.31	4.4	12.8	C
23	12	11	27.6	59	58.3	141	15.6	46.7	3.5	4	175	98	0.	0.	0.	C
23	12	26	28.1	57	33.2	153	25.1	5.0	1.4	3	163	31	0.01	0.	0.	C
23	14	13	45.3	57	54.3	152	57.4	5.0	0.7	3	220	21	0.01	0.	0.	C
23	15	10	32.5	56	25.0	155	53.9	74.9	2.6	9	169	67	0.21	4.1	12.3	D
23	19	3	18.8	57	53.7	153	8.9	5.0	0.8	3	210	18	0.01	0.	0.	C
24	5	24	35.7	63	11.2	150	36.5	32.3	3.9	7	142	175	0.56	7.4	857.1	D
24	9	50	25.9	58	20.2	158	0.4	5.0	2.8	3	342	258	0.54	0.	0.	D
24	11	7	34.1	57	52.7	153	31.6	5.0	1.0	3	179	19	0.01	0.	0.	C
24	11	31	11.3	56	41.2	154	33.3	25.6	1.6	5	260	26	0.23	11.0	5.4	D
24	12	40	52.8	66	15.3	152	13.2	5.0	3.3	3	255	68	0.49	0.	0.	D
24	13	43	12.7	57	55.0	153	17.7	0.9	1.4	4	149	17	0.94	0.	0.	D
24	13	58	14.9	57	5.8	153	33.5	5.0	0.4	3	192	24	0.	0.	0.	C
24	14	57	6.3	57	23.5	153	47.9	40.2	1.9	4	166	35	0.	0.	0.	C
24	15	51	37.8	57	35.5	155	45.2	120.0	2.2	4	314	119	0.	0.	0.	C
24	21	44	28.2	56	30.7	156	46.3	78.8	3.5	7	222	99	0.85	40.1	87.3	D
24	22	7	17.8	58	8.2	153	7.5	49.4	1.9	4	316	8	0.34	0.	0.	D
25	4	28	37.8	60	34.2	146	44.9	39.7	3.7	8	120	171	0.46	4.1	649.9	D
25	5	40	17.9	56	14.3	150	58.7	39.5	3.7	4	313	201	0.70	0.	0.	D
25	6	58	46.8	56	58.5	152	9.5	413.6	3.4	5	276	59	0.43	25.0	70.0	D
25	8	27	10.8	57	19.0	153	52.1	5.0	0.2	3	174	26	0.01	0.	0.	C
25	14	7	30.8	57	33.6	155	0.4	76.1	3.4	5	267	77	0.11	8.6	9.1	D
25	14	45	2.7	57	54.2	153	35.4	5.0	0.1	3	202	19	0.02	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN	TIME		LAT N		LONG W		DEPTH	MAG	NO	GAP	DM	RMS	ERH	ERZ	Q
1979	HR	MN	SEC	DEG	MIN	DEG	MIN	KM			DEG	KM	SEC	KM	KM	
JUN 25	16	0	9.9	57	13.7	154	30.4	50.6	2.1	5	232	36	0.08	3.3	3.5	D
25	16	43	34.0	56	58.6	154	44.2	51.0	1.6	5	250	48	0.07	3.4	3.8	D
25	19	51	35.6	57	33.2	153	4.8	5.0	1.3	3	185	43	0.	0.	0.	C
25	21	18	55.4	57	40.3	152	57.8	5.0	1.6	3	202	44	0.	0.	0.	C
26	4	26	33.0	59	49.1	153	18.5	138.7	3.8	8	134	49	0.28	4.8	6.3	C
26	4	26	34.7	59	47.6	153	14.8	36.8	3.4	12	130	193	0.93	6.6	9999.9	D
26	7	37	32.2	59	21.9	152	40.4	95.4	2.5	9	140	38	1.11	16.9	27.3	D
26	17	17	3.3	62	18.0	150	4.7	39.1	3.7	7	338	254	0.44	210.4	357.6	D
26	18	13	4.4	60	25.3	154	57.5	5.0	2.3	4	306	120	0.19	0.	0.	C
26	18	31	1.4	59	36.8	152	58.0	104.7	2.3	12	94	15	0.68	8.6	10.7	C
26	19	8	18.2	62	27.7	147	49.3	5.0	3.6	11	294	348	0.29	17.5	361.3	D
26	19	25	32.0	60	42.3	151	55.6	91.6	2.0	10	249	56	0.73	17.9	13.8	D
26	20	55	28.9	60	14.3	151	1.5	56.6	2.3	8	278	91	0.23	13.2	18.5	D
26	21	5	39.4	59	38.2	154	12.8	6.3	2.2	4	237	16	0.01	0.	0.	C
26	22	36	10.8	55	55.4	153	1.3	15.5	3.4	15	251	101	0.46	7.4	3.6	D
26	23	58	14.0	56	14.8	153	11.3	9.2	2.2	4	296	70	0.70	0.	0.	D
27	1	24	49.0	58	20.8	154	50.7	103.3	2.5	10	204	91	0.18	4.9	7.7	D
27	7	10	49.1	57	45.3	155	5.8	32.1	3.3	4	276	100	0.	0.	0.	C
27	8	26	10.9	59	21.3	153	24.0	5.0	0.6	3	256	2	0.13	0.	0.	C
27	9	55	12.1	59	50.3	153	29.5	145.2	2.7	9	130	25	0.20	4.7	7.7	C
27	11	57	16.6	60	18.2	151	25.6	41.3	2.9	7	265	75	0.15	5.1	227.6	D
27	12	11	15.0	58	12.1	154	0.2	0.4	1.8	4	289	51	0.05	0.	0.	C
27	13	11	38.3	59	52.5	153	33.4	5.0	0.	3	141	30	0.	0.	0.	C
27	22	25	22.9	57	21.3	153	45.2	39.0	2.2	4	156	32	0.	0.	0.	C
27	22	33	1.4	57	21.5	153	43.9	39.4	1.1	4	152	33	0.	0.	0.	C
28	2	9	46.8	61	49.0	150	50.6	9.0	2.7	8	254	187	0.17	5.0	8.8	D
28	2	16	21.4	59	24.5	153	5.2	171.0	3.2	4	255	21	0.34	0.	0.	D
28	2	36	11.8	61	44.7	151	13.3	34.2	2.9	14	247	169	0.41	8.4	490.0	D
28	4	47	13.2	59	27.5	151	22.1	35.0	3.1	5	300	12	0.24	10.9	3.0	D
28	10	22	33.1	59	22.6	153	23.0	5.0	0.6	3	281	3	0.55	0.	0.	D
28	22	13	0.9	59	5.9	153	6.1	9.5	2.3	11	115	32	0.47	3.2	3.4	C
29	1	58	32.0	59	50.2	152	49.3	120.8	0.	4	118	60	0.	0.	0.	C
29	3	50	8.7	57	10.6	153	47.6	5.0	1.3	3	135	14	0.	0.	0.	C
29	6	51	50.2	60	3.4	151	50.3	64.7	2.2	16	114	65	0.44	2.8	6.2	C
29	7	9	40.6	60	4.7	152	16.7	5.0	0.	3	186	46	0.	0.	0.	C
29	8	19	32.9	59	45.9	153	26.3	140.7	3.1	7	114	42	0.19	5.3	16.6	C
29	10	29	37.1	57	58.3	153	1.8	24.1	0.5	4	220	12	0.47	0.	0.	D
29	10	49	9.4	57	8.6	155	11.7	0.5	1.3	5	274	75	0.40	21.0	888.7	D
29	20	50	1.0	59	57.8	154	34.6	5.0	1.1	3	288	83	0.01	0.	0.	C
29	21	21	28.9	57	54.0	153	7.1	5.0	0.3	3	186	18	0.	0.	0.	C
29	22	24	47.4	60	17.4	152	11.0	0.4	2.1	5	226	35	0.37	85.5	531.0	D
29	23	56	41.5	57	57.5	153	1.3	25.7	2.0	4	218	14	0.45	0.	0.	D
30	6	29	24.2	59	13.8	153	0.8	5.0	1.5	3	274	48	0.33	0.	0.	D
30	6	59	15.5	58	55.4	151	54.9	98.6	2.2	9	200	41	0.24	7.0	13.2	D
30	10	8	23.8	59	48.9	151	40.4	37.2	1.8	8	214	38	0.04	0.8	0.4	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JUN 30	10	29	17.7	59	19.5	152	52.3	89.0	2.6	7	269	27	0.15	10.4	13.4	D
30	21	20	58.6	60	14.2	152	7.4	5.0	1.2	3	221	41	0.	0.	0.	C
JUL 1	2	49	24.1	56	46.8	153	12.3	30.0	1.8	4	296	43	0.	0.	0.	C
1	3	39	42.7	62	8.4	145	51.7	5.0	3.3	6	313	417	0.68	83.9	658.8	D
1	3	51	20.5	59	15.3	152	52.2	84.6	2.3	11	111	30	0.35	4.7	5.9	C
1	6	58	28.9	59	56.4	152	18.8	5.0	0.	3	167	59	0.	0.	0.	C
1	9	40	3.1	60	26.3	153	41.4	5.0	1.5	3	279	50	0.22	0.	0.	C
2	6	47	34.2	61	59.1	150	46.6	33.0	2.7	11	104	60	0.72	6.5	6.7	C
2	23	25	46.7	59	54.8	151	59.1	2.4	2.2	4	193	54	0.73	0.	0.	D
3	2	41	52.4	59	56.2	152	32.6	5.0	0.9	3	147	49	0.	0.	0.	C
3	8	37	44.1	59	50.2	152	36.1	5.0	2.8	6	134	65	0.66	7.1	9999.9	D
3	11	38	27.5	61	27.1	150	18.6	11.8	3.4	14	259	176	0.92	22.0	14.6	D
3	13	45	53.8	64	9.2	150	26.5	5.0	3.3	4	172	262	0.63	0.	0.	D
3	17	15	3.6	57	14.5	154	3.9	21.5	2.1	4	217	18	0.38	0.	0.	D
3	17	59	48.3	59	13.5	152	7.8	5.0	1.4	4	233	41	0.20	0.	0.	C
3	21	29	42.5	59	54.2	151	24.9	5.0	1.8	3	244	49	0.01	0.	0.	C
4	0	15	25.6	59	47.2	139	7.9	234.0	3.9	4	284	19	0.13	0.	0.	C
4	6	27	4.7	57	19.1	154	55.9	64.5	1.9	4	298	64	0.04	0.	0.	C
4	8	15	36.7	59	50.0	153	40.3	162.0	4.7	18	63	29	0.20	1.7	1.8	B
4	14	1	44.2	59	28.8	152	21.2	38.3	2.7	6	164	43	0.13	15.4	12.5	D
4	14	47	49.9	58	8.7	150	2.7	2.5	0.	9	270	172	0.99	32.8	31.2	D
5	0	25	11.9	58	19.4	154	45.5	5.0	2.4	5	220	85	0.36	11.0	796.4	D
5	11	14	23.8	57	35.6	153	13.0	5.0	1.8	3	167	48	0.	0.	0.	C
5	20	29	1.7	57	50.1	153	19.3	5.0	1.1	3	148	26	0.	0.	0.	C
5	21	38	49.7	57	54.1	152	13.1	5.0	1.5	3	285	58	0.27	0.	0.	C
5	21	52	45.3	58	22.5	154	50.1	5.0	2.0	3	310	104	0.98	0.	0.	D
6	0	51	30.8	59	3.3	153	8.0	91.2	2.4	11	129	35	0.16	2.0	2.6	B
6	9	43	17.9	57	22.4	153	23.8	5.0	1.3	3	168	30	0.01	0.	0.	C
6	18	53	26.0	57	28.9	153	6.0	25.7	1.8	4	181	35	0.	0.	0.	C
7	1	8	54.4	57	51.0	153	13.2	5.0	1.3	3	165	23	0.	0.	0.	C
7	2	41	33.2	57	13.8	156	26.1	191.4	2.9	4	329	150	0.27	0.	0.	C
7	2	57	4.5	56	50.1	153	5.9	35.1	3.2	4	243	36	0.	0.	0.	C
7	3	58	36.6	58	6.2	152	45.0	36.3	2.5	5	262	24	0.15	9.0	2.8	D
7	4	57	16.5	57	58.8	153	15.9	8.2	0.8	4	165	10	0.47	0.	0.	D
7	5	52	5.4	59	52.8	152	28.2	5.0	0.	6	148	62	0.13	1.5	225.2	D
7	9	25	13.3	60	6.4	152	9.3	27.5	3.0	4	200	48	0.32	0.	0.	D
7	16	3	2.0	63	15.0	150	10.4	5.0	0.	4	287	297	0.10	0.	0.	C
7	21	50	4.1	59	45.7	152	34.0	101.0	2.8	7	129	39	0.11	2.1	8.6	C
8	1	4	45.2	59	15.9	153	26.4	5.0	1.1	3	333	11	0.05	0.	0.	C
8	3	58	21.3	59	14.6	152	10.6	66.8	0.	11	135	42	0.17	1.7	3.6	C
8	6	28	30.2	60	22.6	151	27.1	83.7	2.8	10	270	73	0.23	8.9	9.1	D
8	6	57	33.1	60	40.4	152	7.7	11.6	2.1	4	298	129	0.26	0.	0.	C
8	11	43	8.5	60	20.0	152	39.3	5.0	1.3	3	237	11	0.	0.	0.	C
8	14	36	39.1	60	16.2	151	49.4	86.4	2.8	13	244	55	0.25	5.8	6.5	D
8	18	4	0.7	60	1.0	153	27.5	0.3	2.2	5	284	42	0.25	339.5	25.4	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

079	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JL 8	22	20	31.2	57	41.8	152	45.8	10.7	1.6	5	169	44	0.31	5.2	694.9	D
8	22	54	42.4	56	21.3	153	35.4	5.0	2.4	3	283	43	0.05	0.	0.	C
8	22	57	45.5	59	42.3	152	45.6	96.0	2.7	10	184	27	0.29	6.2	5.4	D
8	23	54	10.1	56	0.5	152	3.0	0.7	3.7	4	311	143	0.03	0.	0.	C
9	2	1	54.4	59	53.6	152	11.6	5.0	2.4	5	259	64	0.41	21.8	908.4	D
9	2	5	50.7	57	10.1	152	41.3	5.0	1.6	3	285	23	0.02	0.	0.	C
9	2	50	53.5	59	25.2	152	30.8	75.8	2.4	7	104	53	0.37	5.0	9.5	C
9	2	53	37.3	58	50.1	154	25.8	124.5	4.2	12	211	80	0.08	1.8	1.7	C
9	3	46	50.1	60	11.5	152	16.1	98.0	2.5	7	202	37	0.10	2.2	3.5	C
9	5	4	50.6	56	42.7	150	36.2	21.0	4.0	12	292	127	0.29	14.7	5.2	D
9	5	52	59.3	60	25.8	153	56.2	5.0	1.4	3	284	64	0.07	0.	0.	C
9	7	44	16.7	60	50.0	150	52.0	5.0	3.1	5	308	114	0.56	58.5	41.1	D
9	10	15	11.7	59	49.5	153	19.6	146.7	2.8	11	120	19	0.22	4.4	5.5	C
9	13	31	14.3	60	11.7	152	32.5	100.0	1.6	4	173	28	0.	0.	0.	C
9	15	6	31.1	59	41.4	152	36.5	97.7	2.8	11	119	35	0.30	3.8	5.0	C
9	16	14	44.2	57	45.8	152	58.2	41.6	1.4	4	204	35	0.01	0.	0.	C
9	16	25	22.2	59	50.8	151	26.3	5.0	2.5	4	292	97	0.05	0.	0.	C
9	22	31	13.9	57	42.0	153	20.4	5.0	1.6	3	150	26	0.	0.	0.	C
10	1	19	51.6	59	28.8	153	2.8	112.6	2.6	10	90	21	0.30	4.3	5.7	B
10	3	37	15.3	57	25.0	153	50.6	5.0	1.0	3	175	37	0.	0.	0.	C
10	4	4	19.7	63	4.4	150	38.1	5.0	4.6	12	281	273	0.31	12.5	377.1	D
10	4	47	1.4	59	21.3	153	24.0	5.0	0.4	3	256	2	0.13	0.	0.	C
10	6	1	38.3	59	21.7	153	23.8	5.0	0.7	3	260	2	0.15	0.	0.	C
10	6	21	50.3	59	51.5	152	46.4	5.0	0.	3	228	34	0.06	0.	0.	C
10	6	58	46.7	56	13.9	153	9.2	19.0	2.9	8	278	73	0.60	21.5	7.8	D
10	10	4	8.7	57	4.9	153	19.5	5.0	1.9	4	213	17	0.43	0.	0.	D
10	12	59	43.2	60	0.5	152	39.2	5.0	1.1	3	227	46	0.03	0.	0.	C
10	16	56	12.9	59	58.3	154	7.7	74.8	1.9	4	266	61	0.05	0.	0.	C
10	17	48	37.6	61	33.4	145	21.1	35.4	4.1	9	336	413	0.22	133.6	296.0	D
10	19	15	41.6	57	46.3	153	11.5	5.0	1.3	3	171	32	0.	0.	0.	C
10	20	3	24.0	59	32.4	151	51.0	5.0	1.1	3	162	17	0.	0.	0.	C
10	20	15	31.2	59	58.9	152	38.5	6.3	2.5	4	220	49	0.14	0.	0.	C
10	21	55	35.8	59	55.3	152	47.9	126.8	3.2	11	125	38	0.25	4.3	5.5	C
11	2	43	24.0	59	34.1	152	32.0	85.3	2.4	13	109	40	0.30	3.0	4.2	C
11	13	57	45.7	60	3.9	154	14.1	5.0	0.	3	274	72	0.04	0.	0.	C
11	16	26	0.0	60	4.9	153	13.3	5.0	0.9	3	155	45	0.01	0.	0.	C
11	16	59	59.1	60	3.4	153	13.1	5.0	0.	3	150	45	0.	0.	0.	C
11	18	18	11.7	60	43.4	151	26.5	5.0	0.	3	298	80	0.55	0.	0.	D
11	19	54	2.4	59	49.1	152	45.8	80.9	0.	4	214	32	0.	0.	0.	C
11	21	1	24.1	56	49.3	154	46.2	1.3	2.0	5	239	46	0.02	0.5	1.1	C
11	21	57	54.9	60	2.2	153	21.5	160.3	2.5	8	158	43	0.10	3.0	4.3	C
12	2	57	11.2	57	27.8	154	33.2	71.4	2.0	6	212	15	0.06	1.8	2.3	C
12	3	13	44.6	60	29.2	152	35.4	143.5	2.8	12	221	12	0.73	14.6	15.8	D
12	5	47	37.4	59	8.2	151	58.6	45.5	2.3	12	165	43	0.74	8.4	24.8	D
12	6	22	55.3	57	6.1	153	57.5	32.2	2.3	5	109	1	0.02	0.4	0.6	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

)79	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JL 12	9	16	36.0	59	58.3	153	17.3	155.7	3.1	13	142	35	0.22	4.5	5.2	C
12	11	11	31.7	57	34.4	154	17.3	5.0	0.9	3	256	37	0.03	0.	0.	C
12	12	13	10.9	58	18.8	154	46.9	5.0	0.	6	211	85	0.34	7.5	587.5	D
12	12	57	57.7	57	15.6	154	13.6	38.3	1.5	4	246	25	0.	0.	0.	C
12	13	40	4.8	56	54.6	153	51.6	29.7	2.3	5	148	20	0.03	0.6	1.2	C
12	14	2	49.4	58	18.7	154	48.3	5.0	2.1	6	189	86	0.33	6.2	578.3	D
12	14	19	53.8	59	45.7	151	33.8	75.2	0.	14	224	32	0.31	4.5	5.1	D
13	4	6	4.8	58	57.8	152	34.8	88.1	4.4	17	115	39	0.54	4.3	6.9	C
13	10	37	28.5	56	59.5	154	1.7	29.8	1.8	4	179	11	0.	0.	0.	C
13	10	45	16.6	59	52.8	151	5.9	3.0	2.2	9	258	110	0.50	35.3	93.6	D
13	12	56	40.2	56	37.4	160	13.6	5.0	4.4	17	297	301	0.55	22.2	632.9	D
13	15	39	45.2	57	6.7	153	12.4	2.5	0.9	4	214	9	0.43	0.	0.	D
13	16	14	56.6	57	21.1	153	41.8	5.0	2.5	3	186	33	0.	0.	0.	C
13	17	5	48.9	59	21.4	153	26.5	1.5	0.3	4	183	0	0.	0.	0.	C
13	17	35	6.0	62	17.2	150	54.8	42.0	3.8	13	112	89	0.44	3.1	533.4	D
13	19	46	31.7	59	21.4	153	23.6	5.0	0.5	3	264	2	0.18	0.	0.	C
13	19	54	26.3	59	21.5	153	22.8	5.0	0.8	3	278	3	0.61	0.	0.	D
13	23	49	13.7	60	6.5	152	56.9	141.5	2.6	16	117	35	0.30	3.8	4.3	C
13	23	52	47.1	58	49.2	152	57.0	56.6	2.2	13	135	63	0.44	3.9	9.9	D
14	1	57	10.4	60	6.5	152	45.9	114.2	2.6	6	138	34	0.16	5.1	7.9	D
14	2	50	49.7	59	7.4	152	20.8	65.2	2.0	11	132	55	0.25	2.2	4.2	B
14	3	15	56.9	57	15.7	154	5.3	19.3	1.5	4	220	20	0.52	0.	0.	D
14	5	11	20.8	57	46.8	153	8.7	5.0	3.6	3	178	31	0.	0.	0.	C
14	5	57	36.9	57	37.9	154	2.9	50.4	1.9	4	233	21	0.	0.	0.	C
14	11	30	53.5	57	13.5	153	53.8	5.0	0.9	3	173	15	0.01	0.	0.	C
14	15	39	5.3	57	56.5	157	20.2	292.5	3.4	4	332	212	0.35	0.	0.	D
14	19	5	31.1	60	7.6	152	53.1	142.4	2.9	13	128	33	0.24	5.0	6.2	C
14	19	12	40.5	62	36.1	151	10.1	38.5	3.5	17	120	125	0.57	3.4	649.2	D
14	21	14	42.7	56	39.1	154	23.3	5.0	2.2	3	220	16	0.01	0.	0.	C
14	22	29	32.7	62	5.8	151	34.2	0.5	3.3	10	248	197	1.01	26.1	71.9	D
15	1	26	56.5	58	19.3	152	56.4	5.0	2.1	3	340	129	0.96	0.	0.	D
15	4	44	28.1	59	46.3	152	44.4	104.2	2.4	15	118	30	0.32	3.6	4.4	C
15	5	47	4.3	60	17.7	151	12.3	25.8	2.8	11	262	87	0.76	17.4	5.6	D
15	8	4	14.2	57	52.2	153	23.0	31.8	1.7	6	135	25	0.67	10.4	6.8	C
15	8	20	35.1	60	53.2	151	31.1	5.0	1.9	3	308	86	0.75	0.	0.	D
15	9	2	28.0	59	49.9	152	37.1	97.4	2.8	12	132	39	0.29	3.8	5.0	C
15	10	47	19.5	60	28.2	151	13.0	5.0	1.3	3	284	85	0.15	0.	0.	C
15	11	25	23.7	57	12.4	155	41.2	99.0	2.7	4	321	105	0.19	0.	0.	C
15	12	25	18.1	59	40.7	152	51.3	88.9	1.8	5	217	21	0.03	1.8	3.5	C
15	15	27	32.5	57	43.2	153	20.4	5.0	0.9	3	192	26	0.	0.	0.	C
15	19	21	54.0	59	51.7	152	38.6	91.3	3.2	12	133	40	-0.32	4.0	5.8	C
15	19	36	18.3	57	27.1	153	58.5	5.0	0.9	3	201	36	0.	0.	0.	C
16	3	53	49.0	58	26.4	153	55.4	81.7	3.5	14	126	61	0.29	2.7	4.8	C
16	4	54	28.2	58	39.2	152	23.8	2.5	2.3	8	167	79	0.50	5.7	708.1	D
16	5	3	33.4	55	58.4	152	39.4	16.1	2.1	4	319	135	0.18	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JUL 16	6	1	1.5	62	53.7	151	59.0	192.2	3.8	5	266	205	0.83	10.2	7.0	D
16	7	0	50.8	58	4.9	150	52.3	5.0	2.1	3	323	135	0.53	0.	0.	D
16	7	4	31.7	61	53.6	152	7.5	32.2	3.3	5	234	167	0.85	50.5	9999.9	D
16	8	15	56.6	60	1.4	152	50.4	129.8	2.9	12	126	44	0.29	5.2	6.7	C
16	8	35	27.8	58	30.6	153	11.6	53.9	1.8	5	178	50	0.07	3.5	3.1	D
16	9	24	47.4	56	33.9	154	7.4	5.0	1.8	3	252	3	0.29	0.	0.	C
16	11	11	58.6	60	14.8	151	50.7	5.0	1.8	3	240	54	0.06	0.	0.	C
16	13	36	7.4	58	24.0	154	53.2	5.0	2.4	9	206	97	0.63	8.8	839.5	D
16	16	2	40.7	57	22.7	154	40.0	46.8	2.5	5	248	53	0.13	6.2	8.5	D
16	18	45	3.5	58	45.2	154	20.0	123.8	2.9	11	151	39	0.11	1.7	3.4	C
16	19	7	54.9	60	6.6	153	8.6	5.0	1.0	3	155	40	0.	0.	0.	C
16	19	27	37.2	60	29.6	149	18.5	33.8	3.3	9	303	170	0.26	21.3	344.6	D
16	22	45	8.8	59	32.4	153	3.2	110.8	2.9	4	138	16	0.01	0.	0.	C
17	1	30	29.5	59	16.9	152	48.6	162.6	3.1	6	309	32	0.13	130.4	311.9	D
17	3	16	49.3	59	0.8	152	41.7	74.6	2.9	14	104	47	0.33	2.6	4.5	C
17	3	28	28.3	57	36.5	153	21.1	5.0	0.4	3	200	30	0.	0.	0.	C
17	7	35	18.6	57	22.5	154	5.8	5.0	1.4	3	219	33	0.	0.	0.	C
17	10	58	32.3	60	12.2	152	52.9	148.0	2.1	6	136	24	0.07	3.7	11.9	C
17	17	7	51.9	59	51.8	152	9.1	71.2	3.0	11	173	54	0.31	3.8	6.3	D
17	18	5	35.0	57	21.5	154	4.5	5.0	2.0	3	215	31	0.	0.	0.	C
17	20	44	27.5	62	12.1	148	10.1	5.0	4.7	11	290	316	0.35	20.1	443.5	D
17	21	43	47.3	59	1.8	152	28.4	57.1	2.6	15	125	45	0.48	3.3	6.8	C
18	1	29	38.9	59	20.2	154	23.0	2.9	1.5	6	144	28	0.07	0.8	1.5	B
18	3	0	47.9	56	37.6	154	53.8	9.6	1.9	6	272	44	0.32	13.0	550.0	D
18	3	26	27.4	60	15.4	162	19.7	5.0	3.6	4	330	378	0.22	0.	0.	C
18	6	45	3.1	59	44.6	152	41.9	100.7	3.0	14	119	31	0.34	3.6	5.1	C
18	9	8	17.8	57	17.1	153	51.2	1.1	0.9	5	169	23	0.91	12.5	59.7	D
18	9	36	59.0	57	14.0	153	53.3	31.3	1.7	4	172	16	0.01	0.	0.	C
18	12	2	56.2	59	55.4	153	24.3	155.1	3.4	12	141	31	0.23	4.9	5.4	C
18	12	37	32.1	59	58.5	153	0.6	126.2	3.5	12	174	37	0.26	5.2	4.9	D
18	12	39	27.3	56	37.0	156	25.2	40.5	0.	19	216	101	0.74	7.5	837.3	D
18	14	26	18.5	59	22.2	154	30.4	1.0	2.2	7	250	34	0.04	0.7	2.4	C
18	16	28	29.4	58	4.8	154	21.9	10.5	1.8	4	284	50	0.41	0.	0.	D
18	18	44	8.0	57	21.2	155	10.0	87.5	2.3	4	305	78	0.03	0.	0.	C
18	19	41	47.6	56	39.1	156	50.7	35.5	3.7	17	229	119	0.52	6.4	591.0	D
18	23	52	30.6	58	16.6	152	31.6	40.8	2.4	8	149	44	0.15	1.8	1.4	C
19	1	20	8.9	57	14.6	154	26.2	41.0	1.1	4	274	33	0.29	0.	0.	C
19	4	57	33.4	57	27.7	154	2.0	5.0	0.9	3	211	36	0.01	0.	0.	C
19	14	38	26.3	57	49.1	154	54.4	89.2	1.8	5	273	67	0.	0.2	0.2	C
19	15	24	16.6	57	17.0	153	58.4	5.0	1.3	3	195	21	0.	0.	0.	C
20	2	35	14.5	57	18.3	153	50.4	5.0	0.6	3	168	25	0.	0.	0.	C
20	4	3	34.1	59	20.0	152	37.3	81.6	1.5	4	224	49	0.	0.	0.	C
20	5	31	3.0	59	10.2	153	36.1	8.8	1.3	5	346	20	0.05	30.8	4.2	D
20	6	1	50.6	57	9.7	153	18.3	5.0	1.3	3	249	13	0.	0.	0.	C
20	6	18	45.8	60	23.1	151	20.1	1.0	1.9	4	259	79	0.56	0.	0.	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JUL 20	8	35	1.2	57	14.8	154	4.1	21.3	1.4	4	218	18	0.38	0.	0.	D
20	9	24	49.4	59	39.6	152	46.4	130.8	3.1	7	184	25	0.29	29.0	18.9	D
20	10	39	28.2	57	14.0	154	3.3	22.6	1.5	4	215	17	0.36	0.	0.	D
20	11	10	17.5	59	23.7	152	34.6	90.4	2.7	8	180	44	0.22	6.3	13.4	D
20	11	56	38.9	59	57.8	153	2.2	2.5	2.2	4	179	52	0.20	0.	0.	C
20	13	54	0.9	59	51.3	152	55.9	89.2	2.3	6	196	28	0.08	2.8	7.2	D
20	15	44	46.1	57	14.9	154	15.3	5.0	1.3	3	252	25	0.03	0.	0.	C
20	17	40	42.0	60	31.7	151	38.8	108.0	2.9	6	279	63	0.05	6.5	8.5	D
20	19	52	7.5	57	53.6	153	3.4	5.0	1.2	3	199	19	0.	0.	0.	C
20	20	44	19.7	57	14.8	153	54.3	5.0	1.5	3	195	18	0.01	0.	0.	C
20	22	3	42.7	59	0.6	153	35.8	139.0	3.0	4	341	108	0.03	0.	0.	C
21	6	21	46.6	59	43.8	153	30.8	82.2	2.1	4	303	18	0.32	0.	0.	D
21	7	25	32.3	59	8.7	150	9.4	13.0	3.1	7	281	183	0.42	114.0	71.8	D
22	8	42	4.6	58	34.8	154	16.7	113.1	2.4	4	318	87	0.07	0.	0.	C
22	9	13	8.5	59	14.3	149	8.7	5.0	0.	3	287	236	0.01	0.	0.	C
22	9	44	51.2	57	36.6	153	31.4	46.1	2.2	4	129	22	0.	0.	0.	C
22	11	52	12.4	59	44.5	152	40.8	92.7	3.0	10	104	32	0.36	4.8	6.5	C
22	12	48	1.3	59	32.2	153	36.8	5.0	2.3	3	271	115	0.56	0.	0.	D
22	13	49	12.3	58	8.8	155	44.9	148.5	2.7	4	316	124	0.18	0.	0.	C
22	22	17	18.0	57	17.2	153	58.0	5.0	1.2	3	210	22	0.	0.	0.	C
23	7	17	53.1	59	54.7	152	1.9	55.7	3.3	6	178	35	0.47	26.3	32.4	D
23	8	38	11.5	58	32.6	151	24.2	22.2	4.6	17	166	103	0.48	3.8	2.9	D
23	9	7	7.8	61	37.0	150	27.5	49.5	2.9	9	94	31	0.42	4.2	6.8	C
23	9	57	26.9	57	20.7	154	3.7	5.0	1.1	3	212	29	0.	0.	0.	C
23	14	12	24.7	59	55.0	153	34.6	142.1	0.	9	137	35	0.90	14.7	18.6	D
24	0	3	10.5	57	6.6	156	41.4	5.0	0.	4	273	157	0.74	0.	0.	D
24	22	23	18.2	53	43.3	160	44.9	5.0	4.1	3	212	181	0.	0.	0.	C
25	4	4	32.3	60	4.5	148	36.0	28.3	3.6	11	225	140	0.54	7.9	6.6	D
25	5	48	35.7	58	44.0	152	35.2	5.0	2.7	4	211	82	0.10	0.	0.	C
26	12	17	54.9	57	54.5	153	49.5	5.0	1.2	3	242	42	0.11	0.	0.	C
26	13	30	18.1	56	24.0	155	6.0	57.9	0.	6	244	59	0.09	5.7	7.1	D
26	17	30	56.0	57	1.6	153	7.0	5.0	0.9	3	270	15	0.15	0.	0.	C
26	21	22	29.5	57	16.1	153	56.6	5.0	1.0	3	188	20	0.	0.	0.	C
26	22	6	14.4	59	15.0	152	21.1	24.2	2.5	10	137	50	0.52	4.0	5.1	D
27	0	49	57.5	58	45.8	152	0.9	5.0	3.3	5	176	82	0.27	4.9	606.9	D
27	1	20	33.7	57	18.3	153	50.9	5.0	1.0	3	170	25	0.	0.	0.	C
27	7	18	28.8	59	12.4	152	14.6	33.2	2.7	6	140	47	0.73	108.7	119.1	D
27	15	54	10.9	57	10.5	153	47.7	5.0	2.2	3	198	43	0.01	0.	0.	C
27	22	51	38.3	58	24.5	154	16.5	34.7	2.0	4	258	114	0.20	0.	0.	C
28	3	24	5.9	59	44.8	153	25.4	154.2	3.7	17	164	40	0.40	4.7	3.6	C
28	4	26	49.2	57	9.6	154	58.4	5.0	2.4	3	263	61	0.	0.	0.	C
28	6	14	43.0	57	44.0	153	35.2	43.6	1.8	5	120	11	0.11	2.4	2.9	C
28	6	47	46.4	57	55.7	155	23.2	98.3	2.6	10	160	18	0.28	4.5	7.4	C
28	7	46	34.3	59	44.9	151	54.1	80.6	3.1	17	75	17	0.90	6.2	7.7	C
28	7	55	16.3	57	40.8	156	5.2	127.4	2.1	5	299	138	0.09	15.6	15.4	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
JUL 28	9	12	11.8	57	57.2	153	11.1	5.0	1.3	3	168	12	0.	0.	0.	C
28	15	7	57.7	56	14.1	153	12.2	10.1	2.4	5	277	70	0.55	36.6	9999.9	D
28	15	46	25.3	55	13.1	160	21.8	5.0	3.8	6	329	400	0.33	140.5	564.8	D
28	16	2	10.7	59	8.8	153	42.2	128.3	2.3	4	342	125	0.03	0.	0.	C
28	18	40	17.4	57	8.5	155	57.8	5.0	2.0	4	227	103	0.10	0.	0.	C
28	21	35	8.4	57	32.5	153	21.7	66.3	1.7	4	146	34	0.	0.	0.	C
29	2	17	27.2	59	39.0	152	49.2	88.1	1.8	6	195	23	0.13	26.3	66.1	D
29	3	6	0.8	58	55.6	152	53.7	421.2	4.3	6	156	54	0.17	71.8	647.0	D
29	7	58	12.6	58	39.1	151	58.6	92.3	2.8	7	188	94	0.40	8.3	19.5	D
29	8	22	22.1	58	46.9	152	4.6	14.2	3.1	8	226	98	0.94	20.0	14.8	D
29	8	29	5.0	55	33.9	159	40.6	5.0	3.2	5	324	343	0.25	109.5	548.3	D
29	8	40	28.4	59	21.2	152	33.6	82.6	2.4	7	236	45	0.56	18.7	20.4	D
29	8	47	58.1	59	52.3	152	49.2	92.7	2.3	4	259	33	0.06	0.	0.	C
29	9	54	50.2	56	25.6	157	48.3	37.9	3.0	5	331	223	0.23	126.3	508.9	D
29	13	8	46.5	60	49.5	150	42.5	5.0	2.4	3	310	121	0.11	0.	0.	C
29	17	23	7.8	60	21.8	149	43.1	1.5	2.6	4	314	144	0.04	0.	0.	C
30	2	37	27.9	58	41.0	153	54.4	0.6	3.7	6	177	77	0.11	1.8	191.9	D
30	17	22	38.8	57	6.1	153	22.4	5.0	1.6	3	199	19	0.	0.	0.	C
30	17	26	9.0	54	27.2	160	20.3	5.0	3.9	5	335	442	0.22	268.8	470.8	D
30	17	57	49.8	58	25.0	154	7.4	97.1	2.1	4	309	69	0.05	0.	0.	C
30	19	20	28.2	59	11.6	153	39.1	118.9	2.6	9	128	20	0.13	2.4	3.9	B
30	21	1	1.3	57	52.3	154	50.0	89.6	2.3	5	156	64	0.08	2.5	7.3	D
30	22	3	39.1	60	44.6	151	4.3	5.0	3.2	3	302	99	0.64	0.	0.	D
30	22	22	6.5	57	12.4	153	49.4	5.0	0.4	3	151	15	0.01	0.	0.	C
30	22	35	54.1	57	41.2	156	10.3	148.8	3.2	5	301	143	0.11	21.0	21.7	D
31	1	46	56.4	59	19.4	152	42.7	183.3	2.6	4	310	40	0.01	0.	0.	C
31	2	39	35.1	60	42.3	151	8.5	5.0	3.1	3	300	94	0.55	0.	0.	D
31	3	11	5.9	57	53.3	156	38.9	8.9	2.4	4	213	25	0.	0.	0.	C
31	9	27	27.7	59	32.8	152	52.6	113.2	3.2	11	104	33	0.16	1.7	2.1	B
31	11	4	55.4	60	8.5	153	9.6	156.0	2.8	7	159	37	0.06	2.3	3.4	C
31	12	58	16.8	59	9.3	152	8.5	30.5	2.6	6	152	47	0.83	9.0	9.3	D
AUG 1	5	20	53.7	60	28.2	152	26.3	102.0	2.2	7	222	19	0.20	4.7	5.3	D
1	9	27	1.4	60	4.2	153	5.8	136.6	2.8	14	103	42	0.52	5.6	6.6	C
1	21	31	50.9	60	30.2	152	19.2	5.0	1.4	3	286	101	0.01	0.	0.	C
2	0	13	33.9	58	29.6	152	50.4	5.0	0.	3	139	32	0.	0.	0.	C
2	9	48	34.2	57	56.5	152	49.8	5.0	1.6	3	193	23	0.	0.	0.	C
2	10	4	39.1	57	29.3	153	33.4	5.0	0.9	3	195	32	0.01	0.	0.	C
2	13	6	45.0	58	12.6	155	18.7	5.0	2.7	7	246	103	1.47	34.9	9999.9	D
2	17	9	2.7	59	48.5	152	52.1	134.0	4.1	15	99	55	0.99	10.4	14.3	C
3	1	25	52.0	58	58.8	154	35.7	141.3	2.6	8	152	26	0.09	2.3	4.2	C
3	2	25	4.9	60	34.6	150	39.6	216.0	2.8	5	301	117	0.06	44.1	68.0	D
3	3	12	43.9	57	9.5	151	5.7	37.2	3.1	7	277	76	0.33	15.8	4.4	D
3	9	53	50.1	60	8.4	152	25.9	5.0	1.5	3	179	36	0.01	0.	0.	C
3	10	5	51.6	60	17.9	152	31.1	143.8	3.1	11	272	106	0.28	11.9	11.8	D
3	12	22	50.9	58	54.5	152	50.2	5.0	2.1	3	218	42	0.	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
AUG 3	13	2	17.6	57	34.9	154	20.4	53.1	4.1	14	170	39	0.35	2.9	5.2	C
3	16	0	59.4	58	20.3	155	6.6	13.2	2.1	4	311	102	0.44	0.	0.	D
3	16	42	18.4	60	37.5	151	59.3	99.4	3.2	8	245	48	0.33	9.1	7.3	D
3	17	43	53.3	57	21.3	154	3.1	5.0	1.6	3	211	30	0.01	0.	0.	C
4	2	34	38.0	58	15.1	154	9.5	86.2	2.2	4	295	59	0.02	0.	0.	C
4	2	57	37.0	56	24.9	153	1.3	5.0	0.	3	285	73	0.24	0.	0.	C
4	8	15	24.8	56	36.7	154	11.5	5.0	1.5	3	200	5	0.	0.	0.	C
4	9	10	13.1	59	46.7	152	30.4	94.5	0.	11	117	50	0.33	3.9	6.4	C
4	13	29	49.9	57	19.4	153	2.6	5.0	1.4	3	192	17	0.	0.	0.	C
4	20	2	55.3	59	49.1	153	24.3	144.8	3.4	21	54	44	0.46	2.8	4.1	B
4	20	12	6.7	62	34.3	149	30.6	5.0	4.4	7	280	296	0.40	22.1	610.3	D
5	7	21	19.0	56	22.2	155	6.9	5.0	2.5	3	195	61	0.	0.	0.	C
5	7	56	33.9	60	12.5	152	22.1	116.8	3.1	10	207	73	0.54	9.4	10.4	D
5	8	30	44.1	57	49.1	154	15.1	76.4	3.1	10	103	29	0.08	0.7	1.4	B
5	11	19	27.6	56	12.9	156	51.9	25.4	0.	5	295	132	0.36	100.0	10.0	D
5	12	37	12.5	58	17.4	158	14.8	5.0	2.0	3	323	115	0.71	0.	0.	D
5	13	31	20.4	60	2.4	153	1.6	119.9	2.9	5	148	44	0.	0.2	0.4	C
5	15	42	43.7	60	9.1	152	20.6	46.4	2.2	5	183	38	0.49	7.2	17.5	D
5	16	15	40.8	56	23.9	152	38.2	30.6	0.	8	277	89	0.22	9.0	2.6	D
5	18	1	8.3	59	20.5	152	51.2	78.0	2.4	9	106	73	0.29	3.4	9.5	C
6	7	20	32.1	57	15.5	155	7.1	5.0	2.6	7	162	72	0.74	7.5	9999.9	D
6	11	10	45.5	58	59.3	153	35.4	47.4	2.2	5	189	39	0.58	49.1	149.2	D
6	11	53	24.2	56	56.5	152	7.2	37.6	0.	9	272	51	0.36	13.6	2.3	D
6	22	27	13.3	58	9.3	152	33.1	39.4	2.5	10	157	37	0.23	1.9	1.1	C
7	2	12	35.9	58	55.4	154	29.9	144.4	3.7	22	94	26	0.37	2.2	3.7	C
7	2	22	41.4	59	46.9	151	49.3	58.5	2.5	6	195	37	0.15	7.6	15.0	D
7	3	17	57.9	57	18.9	155	54.6	5.0	2.4	6	151	57	0.67	8.1	9999.9	D
7	4	44	44.2	59	25.9	146	43.9	5.0	3.7	4	313	355	0.60	0.	0.	D
7	8	0	41.4	57	49.8	156	18.4	151.1	2.4	4	322	151	0.12	0.	0.	C
7	9	15	0.9	58	41.9	153	24.8	81.9	2.3	11	115	62	0.14	1.7	3.1	B
7	13	49	36.7	57	9.4	154	45.8	61.3	1.8	5	250	49	0.02	0.8	0.9	C
7	14	41	49.6	56	49.9	153	54.3	5.0	1.4	3	156	28	0.	0.	0.	C
7	17	46	27.5	59	0.3	154	46.2	42.0	1.8	5	223	93	0.78	29.4	9999.9	D
7	17	49	5.2	58	37.2	154	23.2	1.6	1.8	7	96	54	0.35	3.1	6.8	D
7	21	41	51.1	59	59.7	152	52.0	33.1	2.8	5	174	47	0.65	104.6	102.5	D
7	23	21	17.2	56	53.8	153	53.2	5.0	1.5	3	147	21	0.01	0.	0.	C
8	3	35	14.0	59	46.5	152	23.9	74.9	2.8	9	123	44	0.32	4.4	8.1	C
8	3	46	52.8	58	50.7	154	18.3	133.2	2.9	9	229	109	0.23	5.7	11.4	D
8	4	48	23.7	58	57.1	154	33.5	149.6	2.4	5	295	128	0.06	12.4	8.9	D
8	5	14	49.3	59	46.4	154	11.7	35.8	2.4	5	234	107	0.76	424.9	561.7	D
8	8	17	49.1	58	6.2	156	23.1	5.0	2.0	3	293	7	0.21	0.	0.	C
8	9	1	44.9	56	12.5	155	54.2	5.0	2.9	4	283	113	0.84	0.	0.	D
8	11	47	30.5	56	34.5	155	48.9	5.0	2.0	5	257	111	0.51	26.7	9999.9	D
9	5	2	27.3	58	42.1	152	46.2	50.7	0.	4	259	25	0.66	0.	0.	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

	ORIGIN		TIME	LAT N		LONG W		DEPTH	MAG	NO	GAP	DM	RMS	ERH	ERZ	Q
1979	HR	MN	SEC	DEG	MIN	DEG	MIN	KM			DEG	KM	SEC	KM	KM	
AUG 9	19	4	57.4	58	57.8	153	38.3	2.7	0.	4	179	35	0.	0.	0.	C
10	3	21	30.1	56	29.3	156	11.2	40.1	0.	5	186	81	0.18	4.0	409.0	D
10	16	31	1.2	56	51.6	153	20.4	30.8	2.6	9	210	37	0.25	3.3	1.7	D
11	0	51	19.0	57	36.2	155	7.6	11.6	0.	4	151	69	0.11	0.	0.	C
11	1	44	53.8	59	59.6	152	40.0	5.0	1.7	3	133	47	0.	0.	0.	C
11	6	1	59.2	59	45.5	152	43.7	83.2	2.2	4	125	30	0.	0.	0.	C
11	8	10	37.6	57	47.2	153	25.0	5.0	1.5	3	176	21	0.01	0.	0.	C
11	10	41	59.4	60	16.6	150	45.6	78.0	0.	4	289	84	0.03	0.	0.	C
11	19	40	3.1	57	12.6	154	11.0	39.1	2.5	5	202	19	0.15	4.3	2.5	D
11	20	57	29.3	56	18.7	152	38.9	41.7	2.9	4	307	98	0.24	0.	0.	C
11	21	16	47.2	59	47.7	151	59.5	5.0	1.8	3	221	71	0.	0.	0.	C
12	0	26	8.7	56	48.9	153	18.5	30.1	2.7	9	243	41	0.20	4.3	1.4	D
12	0	54	31.5	60	7.6	152	44.4	130.5	3.2	16	89	59	0.44	3.1	5.1	B
12	2	56	40.4	56	26.2	153	27.3	5.0	0.	3	271	46	0.14	0.	0.	C
12	3	49	20.2	57	33.9	155	27.8	5.0	2.1	4	180	85	0.80	0.	0.	D
12	4	6	16.7	59	23.3	152	11.5	67.0	2.6	8	110	36	0.26	3.3	5.6	C
12	4	30	53.0	60	15.1	155	14.3	5.0	2.3	3	287	137	0.75	0.	0.	D
12	7	44	19.8	57	20.1	155	11.3	5.0	1.8	3	311	79	0.01	0.	0.	C
12	8	4	50.1	60	10.3	153	32.8	167.4	0.	4	220	50	0.	0.	0.	C
12	12	24	55.3	59	28.8	152	7.9	85.6	2.7	4	276	64	0.01	0.	0.	C
13	0	14	39.6	59	36.0	152	23.3	72.1	2.1	4	121	47	0.	0.	0.	C
13	11	53	3.3	57	34.9	156	56.5	130.5	0.	4	229	20	0.	0.	0.	C
14	0	44	44.7	56	47.8	154	14.5	38.9	2.5	7	157	26	0.58	11.6	4.4	D
14	5	51	8.5	59	22.5	153	39.5	120.3	2.5	9	158	11	0.17	3.9	3.8	C
14	14	4	7.9	60	0.8	152	41.5	5.0	1.5	3	138	45	0.	0.	0.	C
14	23	39	0.5	60	1.3	152	50.6	124.9	2.9	9	157	44	0.29	6.7	8.8	D
15	0	26	0.6	57	38.8	150	43.7	41.9	3.6	15	222	97	0.40	5.3	472.2	D
15	4	0	26.3	60	25.2	139	20.7	100.1	3.1	4	245	83	0.96	0.	0.	D
15	5	50	30.5	62	28.0	151	12.8	41.0	3.1	10	94	114	0.31	2.4	398.9	D
15	15	24	30.4	61	46.0	151	32.6	36.8	2.5	4	241	164	0.34	0.	0.	D
15	16	48	35.5	59	29.6	153	16.8	130.3	3.7	15	94	15	0.31	2.4	2.9	C
15	17	17	44.0	60	51.8	150	43.0	28.6	3.2	6	248	123	0.26	13.0	8.7	D
15	18	30	57.2	59	42.4	152	43.3	116.2	3.9	18	58	29	0.34	2.2	2.9	B
15	22	2	16.9	59	51.0	146	2.8	5.0	3.4	7	145	247	0.52	7.2	787.7	D
16	1	51	43.0	54	18.0	152	24.0	5.0	3.9	10	310	265	0.37	34.8	479.8	D
16	18	33	52.4	57	18.3	154	41.8	5.0	1.5	3	289	50	0.10	0.	0.	C
16	18	38	4.2	59	33.0	153	21.6	5.0	0.5	3	195	13	0.04	0.	0.	C
16	19	42	37.5	57	54.0	152	57.4	5.0	0.7	3	219	21	0.	0.	0.	C
16	21	24	22.2	59	20.5	154	16.5	9.6	2.3	10	144	27	0.36	2.6	3.3	C
17	0	10	30.8	57	51.6	153	15.4	5.0	1.0	3	158	23	0.	0.	0.	C
17	2	13	25.3	57	6.2	153	15.1	5.0	0.5	3	210	12	0.	0.	0.	C
17	3	39	36.5	57	6.0	153	40.8	5.0	0.8	3	186	17	0.	0.	0.	C
17	3	57	7.9	59	39.0	153	14.4	110.4	1.9	4	313	31	0.	0.	0.	C
17	20	13	47.4	59	2.8	153	5.9	5.0	1.9	3	167	37	0.03	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
AUG 17	22	22	18.3	56	21.9	155	3.3	5.0	2.7	3	191	58	0.12	0.	0.	C
18	5	24	55.4	57	8.2	154	20.0	5.0	1.4	3	282	23	0.33	0.	0.	D
18	7	53	6.4	60	13.5	152	37.2	151.5	3.2	8	290	72	0.16	15.4	14.8	D
18	8	5	17.2	57	48.3	152	44.7	3.6	1.0	4	154	16	0.84	0.	0.	D
18	12	0	12.1	57	46.4	153	20.2	5.0	1.0	3	149	25	0.	0.	0.	C
18	12	12	21.2	60	7.7	153	29.7	5.0	1.9	3	154	51	0.	0.	0.	C
18	15	19	14.4	57	57.1	153	56.2	5.0	1.4	3	280	23	1.00	0.	0.	D
18	15	27	13.4	58	46.8	154	39.9	140.7	2.6	11	235	44	0.12	3.2	3.5	D
18	15	46	55.1	60	22.1	150	45.8	42.2	2.4	5	292	93	0.16	18.0	366.5	D
18	16	7	18.4	59	35.8	153	24.7	139.9	2.3	6	200	12	0.17	9.9	15.1	D
18	17	46	37.9	60	27.5	152	15.1	131.3	3.0	9	258	29	0.30	13.7	15.8	D
18	18	6	33.9	59	58.5	152	52.8	96.5	2.4	7	162	40	0.15	4.3	4.8	C
18	19	13	33.3	59	31.3	151	16.7	81.9	2.1	4	292	18	0.03	0.	0.	C
19	3	9	49.1	59	33.7	153	15.5	5.0	1.4	3	196	10	0.03	0.	0.	C
19	3	37	46.0	59	5.1	152	36.3	9.3	2.0	4	135	53	0.84	0.	0.	D
19	3	57	21.8	59	59.1	152	22.9	5.0	1.4	3	166	53	0.	0.	0.	C
19	10	1	27.6	63	14.5	152	8.9	20.1	4.9	8	87	198	0.67	5.8	947.4	D
19	14	31	52.8	60	13.5	153	34.3	204.4	3.3	9	240	49	0.21	8.2	11.4	D
19	21	24	3.2	57	21.1	153	6.9	62.0	2.4	4	134	20	0.	0.	0.	C
20	2	55	33.4	58	44.1	152	41.1	5.0	0.9	3	143	22	0.	0.	0.	C
20	3	56	35.1	60	7.1	151	46.8	31.4	2.3	5	250	64	0.86	4.0	3.0	D
20	6	3	5.6	57	57.9	153	10.9	25.5	2.0	5	130	10	0.63	48.4	87.6	D
20	17	41	46.4	57	47.1	154	24.7	5.0	1.4	3	267	80	0.01	0.	0.	C
20	17	43	23.3	59	22.1	152	47.1	82.7	0.	10	104	36	0.35	3.9	5.5	C
20	18	35	53.0	59	48.9	153	1.5	119.1	2.6	9	152	21	0.47	8.6	10.9	D
20	22	14	10.8	59	26.9	152	49.1	80.9	2.3	10	116	32	0.34	6.1	9.3	C
21	0	2	29.0	57	13.3	153	52.5	5.0	0.8	3	167	15	0.	0.	0.	C
21	1	39	34.9	60	2.5	153	26.2	156.3	2.7	12	199	44	0.22	5.4	5.7	D
21	2	36	36.6	57	15.9	153	56.5	6.8	0.6	4	187	19	0.33	0.	0.	D
21	5	9	22.5	57	36.6	153	8.8	5.0	1.5	3	221	40	0.	0.	0.	C
21	5	30	5.6	62	19.0	150	16.2	5.0	2.8	4	270	250	0.14	0.	0.	C
21	7	2	25.7	59	21.7	153	23.8	5.0	-0.0	3	260	2	0.15	0.	0.	C
21	16	29	55.7	59	39.6	151	26.6	5.0	2.0	3	250	100	0.	0.	0.	C
21	18	11	1.6	56	38.1	154	27.3	35.8	2.2	4	269	58	0.	0.	0.	C
21	20	11	21.1	59	52.1	151	48.9	99.6	2.7	9	204	46	0.17	3.3	5.1	D
22	5	49	10.2	59	21.3	153	23.3	5.0	0.2	3	270	2	0.09	0.	0.	C
22	7	47	10.9	60	12.2	153	30.9	74.4	1.9	6	242	47	0.20	11.7	17.8	D
22	8	0	41.9	59	21.7	153	23.8	5.0	0.0	3	261	2	0.20	0.	0.	C
22	9	28	40.5	60	29.0	152	3.1	111.6	2.9	7	266	40	0.20	16.5	23.4	D
22	9	33	10.1	59	42.4	152	41.4	92.3	3.0	22	64	31	0.81	4.4	5.5	C
22	9	36	14.1	57	27.4	154	7.2	5.0	1.2	3	225	39	0.	0.	0.	C
22	10	43	34.9	59	10.9	153	56.7	2.0	1.0	4	179	17	0.16	0.	0.	C
22	13	50	22.5	57	21.1	153	40.8	5.0	1.2	3	143	34	0.	0.	0.	C
22	16	9	45.2	57	21.6	153	41.8	5.0	0.	3	147	34	0.	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN HR	MN	TIME SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
AUG 22	21	44	37.6	59	15.2	153	40.5	115.1	2.8	10	141	16	0.19	4.8	3.4	C
22	22	13	39.2	58	46.4	151	41.9	40.2	4.5	18	163	78	0.38	2.5	2.8	D
22	22	25	26.6	58	55.9	152	0.7	35.3	2.3	4	340	90	0.11	0.	0.	C
22	22	54	32.7	57	50.4	153	14.9	5.0	0.7	3	160	25	0.	0.	0.	C
23	3	45	30.4	57	41.3	153	20.5	5.0	1.3	3	194	26	0.	0.	0.	C
23	3	47	44.3	57	30.9	152	9.3	5.0	2.0	3	279	68	0.	0.	0.	C
23	6	17	57.2	60	12.0	152	9.0	5.0	1.8	3	209	42	0.01	0.	0.	C
23	8	44	57.4	57	4.8	153	41.1	5.0	2.2	3	197	16	0.	0.	0.	C
23	11	24	58.7	59	27.9	152	53.7	5.0	1.6	3	286	28	0.01	0.	0.	C
23	16	23	26.5	58	55.4	152	20.5	62.2	1.9	6	312	76	0.06	36.7	8.2	D
23	21	40	27.1	58	57.6	154	40.0	141.2	0.	4	248	31	0.02	0.	0.	C
24	1	36	39.3	58	13.8	152	25.9	40.8	2.0	4	223	46	0.	0.	0.	C
24	2	18	52.6	59	55.9	152	59.1	112.7	2.8	7	168	34	0.35	9.1	10.3	D
24	2	23	37.8	56	54.9	154	20.5	41.5	2.3	5	214	30	0.	0.1	0.	C
24	3	22	53.6	60	1.4	152	4.0	110.0	2.6	10	198	59	0.24	4.8	6.0	D
24	4	17	16.3	58	28.4	151	21.1	5.0	2.7	5	255	115	0.34	17.5	759.3	D
24	10	16	17.6	59	38.6	152	36.7	99.9	2.7	9	98	34	0.23	3.8	4.9	C
24	13	1	22.3	57	26.7	153	43.6	5.0	0.	3	156	35	0.	0.	0.	C
24	13	29	56.2	57	53.7	156	9.7	128.1	3.7	11	111	19	0.26	4.1	7.8	C
24	17	18	35.2	60	22.6	152	4.4	5.0	3.0	3	246	38	0.01	0.	0.	C
24	17	33	23.5	59	50.6	151	16.2	5.0	2.5	9	252	105	0.93	54.3	150.6	D
24	18	34	55.8	59	42.7	153	55.8	5.0	1.3	3	267	40	0.01	0.	0.	C
24	18	51	9.1	59	19.0	152	23.2	5.0	2.1	3	202	48	0.	0.	0.	C
24	21	55	15.4	59	10.6	152	39.6	77.1	2.0	9	189	47	0.27	6.2	7.6	D
25	1	45	9.3	57	41.8	156	24.8	124.9	2.8	11	148	9	0.23	4.9	7.5	C
25	8	23	0.4	60	14.7	140	40.1	30.3	3.6	6	187	94	0.51	21.3	12.1	D
25	8	42	18.6	56	14.3	156	7.6	1.3	0.	5	268	125	0.79	67.6	100.3	D
25	11	21	48.4	60	29.2	147	31.1	36.9	3.7	10	122	139	0.96	8.5	9999.9	D
26	11	13	43.6	57	58.9	154	5.6	69.4	0.	4	266	31	0.02	0.	0.	C
26	14	1	5.2	59	49.3	151	37.6	79.7	3.1	9	210	18	0.47	8.2	8.6	D
27	2	32	57.7	59	16.9	153	57.1	133.6	2.1	4	190	24	0.	0.	0.	C
27	20	5	14.5	59	42.4	152	53.9	5.0	2.0	3	256	70	0.04	0.	0.	C
27	21	30	11.9	59	41.8	152	34.9	5.0	1.8	3	121	61	0.	0.	0.	C
28	12	56	43.6	59	26.6	152	51.5	94.4	2.3	7	119	72	0.35	5.6	11.6	C
28	17	6	7.3	60	49.8	150	36.7	28.6	3.3	11	250	126	0.67	14.5	6.4	D
28	18	6	54.2	60	17.8	154	44.3	5.0	2.1	4	297	109	0.27	0.	0.	C
28	20	36	8.4	60	14.0	152	22.6	108.9	2.4	6	194	30	0.18	9.0	18.2	D
29	6	48	40.9	57	7.5	156	33.8	40.4	2.3	4	149	35	0.29	0.	0.	C
29	7	14	23.1	59	18.2	152	54.0	29.8	1.7	4	183	77	0.99	0.	0.	D
29	7	34	4.3	59	14.5	154	3.6	5.0	2.1	3	218	17	0.05	0.	0.	C
29	16	57	9.5	59	36.3	153	12.4	5.0	0.	3	196	93	0.	0.	0.	C
29	18	49	36.3	60	3.9	152	46.1	124.5	2.0	4	186	39	0.04	0.	0.	C
29	19	38	11.6	61	57.3	150	48.1	75.2	3.8	9	132	59	0.27	3.6	8.2	C
30	21	17	53.6	57	36.7	154	30.2	58.0	0.	17	85	46	0.52	2.7	6.2	C
31	4	39	51.4	57	50.1	156	44.7	178.1	2.6	4	327	177	0.05	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
AUG 31	21	35	9.5	59	56.8	152	40.3	118.0	2.9	7	137	45	0.40	10.5	13.3	D
SEP 1	8	32	31.2	59	9.0	153	45.1	107.8	2.3	8	130	26	0.12	4.0	4.9	C
1	9	44	31.5	60	37.9	151	20.3	5.0	1.8	3	293	82	0.36	0.	0.	D
1	14	27	27.8	57	20.5	153	40.9	5.0	0.	3	143	33	0.	0.	0.	C
1	20	44	10.3	60	31.5	152	2.6	38.1	1.2	4	273	41	0.22	0.	0.	C
1	22	38	23.6	60	10.1	152	3.9	5.0	2.1	4	215	48	0.40	0.	0.	D
2	4	17	5.0	58	58.1	153	1.7	64.9	2.3	5	193	46	0.06	4.9	4.8	D
2	16	16	4.7	60	21.7	152	15.9	109.9	1.7	6	191	28	0.25	8.4	6.6	D
2	21	48	0.6	59	25.5	152	41.8	82.2	2.3	9	100	39	0.34	4.1	6.5	C
2	23	2	22.5	56	40.3	156	44.3	36.9	2.5	6	210	53	0.21	11.0	12.2	D
3	1	1	5.9	59	26.0	153	16.5	122.5	2.5	9	122	11	0.07	1.4	1.8	B
3	6	54	24.3	59	36.1	152	30.7	5.0	0.	3	246	49	0.15	0.	0.	C
3	10	31	20.7	57	11.3	153	59.6	5.0	0.	3	202	11	0.	0.	0.	C
3	11	10	14.3	60	6.5	152	45.6	132.1	2.4	10	130	34	0.37	5.8	7.7	C
3	19	43	7.6	60	25.1	151	2.0	24.5	2.8	4	288	95	0.18	0.	0.	C
4	8	41	59.6	59	50.3	152	42.0	108.7	2.1	8	121	36	0.40	7.1	10.4	C
4	14	13	45.3	59	16.7	152	22.8	5.0	1.6	3	246	50	0.	0.	0.	C
4	20	15	50.6	60	3.5	152	27.3	5.0	1.0	3	167	43	0.	0.	0.	C
4	22	7	53.6	59	41.8	152	31.7	88.0	2.0	4	125	39	0.	0.	0.	C
5	12	21	20.8	57	46.2	154	46.4	108.6	2.7	4	304	59	0.36	0.	0.	D
6	0	0	11.2	57	15.1	153	54.3	5.0	0.	3	178	18	0.	0.	0.	C
6	4	29	13.0	61	18.5	160	52.1	38.2	4.2	4	333	444	1.85	0.	0.	D
6	4	29	50.7	60	14.9	155	15.3	5.0	3.2	3	287	138	0.43	0.	0.	D
6	5	1	45.6	59	55.9	152	19.0	59.8	0.	4	154	48	0.	0.	0.	C
6	12	46	23.4	57	58.7	152	7.1	37.5	2.0	4	294	62	0.20	0.	0.	C
6	19	54	8.4	59	13.3	153	59.6	154.0	2.3	6	181	17	0.11	8.1	10.5	D
6	23	22	58.3	57	43.7	153	20.6	5.0	0.7	3	149	25	0.	0.	0.	C
6	23	56	10.7	59	39.7	153	5.4	118.8	2.8	8	110	7	0.26	5.4	7.0	C
7	2	34	23.4	57	36.2	155	3.1	94.3	2.6	4	295	78	0.	0.	0.	C
7	5	16	18.5	57	13.5	153	48.6	5.0	2.0	3	151	17	0.	0.	0.	C
7	6	49	57.2	59	23.0	154	4.0	5.0	1.4	3	224	32	0.	0.	0.	C
7	6	59	43.0	60	50.3	153	22.7	5.0	2.2	3	311	57	0.49	0.	0.	D
7	7	38	59.3	59	56.3	153	46.2	78.9	1.9	6	302	44	0.15	10.1	21.1	D
7	9	40	28.3	58	32.6	156	26.9	5.0	2.3	4	261	93	0.62	0.	0.	D
7	10	49	52.9	61	4.4	153	29.9	5.0	1.4	3	332	82	0.39	0.	0.	D
7	13	22	5.7	56	13.9	156	56.8	29.5	2.7	7	304	170	0.20	22.7	310.6	D
7	13	46	19.1	60	30.0	153	53.4	228.9	3.2	8	280	62	0.05	3.1	3.2	D
7	14	37	13.8	59	3.9	152	4.4	35.5	2.2	6	164	53	0.37	10.3	13.0	D
7	17	1	10.4	59	21.7	153	23.0	5.0	0.4	3	274	3	0.10	0.	0.	C
7	17	26	29.6	60	5.5	152	49.8	135.3	2.8	8	160	36	0.46	12.8	14.9	D
7	22	28	36.6	60	6.5	152	59.3	131.6	3.0	9	181	36	0.25	7.0	7.9	D
7	23	57	10.2	59	23.9	152	7.3	62.0	2.5	11	118	31	0.25	2.5	4.2	B
8	0	0	7.5	56	44.9	156	19.3	5.0	0.	5	253	84	0.67	30.7	9999.9	D
8	0	0	52.2	57	13.4	153	5.3	5.0	1.3	3	210	6	0.	0.	0.	C
8	5	24	23.0	59	35.6	152	58.4	5.0	1.7	4	287	15	0.39	0.	0.	D

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979		ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
SEP	8	8	45	44.9	57	54.9	150	54.2	28.5	3.2	5	320	134	0.16	160.0	23.1	D
	8	9	49	14.8	56	57.1	156	15.3	33.4	2.6	7	240	61	0.24	7.6	6.9	D
	8	11	51	42.0	59	37.5	152	9.0	90.0	2.2	5	140	36	0.04	1.4	1.9	C
	8	14	27	39.8	59	43.8	152	43.8	104.3	2.7	5	186	29	0.34	52.4	29.8	D
	8	14	36	39.1	58	20.0	154	49.2	12.2	2.1	4	308	89	0.34	0.	0.	D
	8	20	51	40.9	56	5.9	157	3.4	11.9	2.6	4	311	186	0.35	0.	0.	D
	8	23	40	32.2	58	44.5	153	56.6	48.3	1.6	6	165	42	1.21	17.1	27.5	D
	9	4	12	42.7	59	11.8	151	49.5	26.5	2.5	7	256	89	0.20	4.6	2.3	D
	9	4	52	30.3	57	19.2	154	33.2	41.2	2.1	4	278	44	0.04	0.	0.	C
	9	5	28	49.7	56	44.2	156	10.7	54.6	2.8	7	127	84	0.39	9.4	66.4	C
	9	5	42	11.4	60	13.0	153	7.3	161.4	2.5	7	209	29	0.20	16.5	49.4	D
	9	7	48	53.0	58	12.1	154	41.6	2.5	2.7	14	128	68	0.50	2.2	586.4	D
	9	10	48	27.2	57	17.9	152	47.7	5.0	1.6	3	244	22	0.01	0.	0.	C
	9	11	55	9.8	59	9.2	153	26.3	112.1	2.5	6	170	20	0.15	13.3	10.4	D
	9	20	26	33.9	57	41.7	156	13.6	139.2	2.4	4	321	146	0.03	0.	0.	C
	10	3	19	10.6	59	43.9	154	0.2	5.0	2.0	3	272	44	0.02	0.	0.	C
	10	4	57	36.9	59	40.3	152	39.9	121.4	2.2	5	233	31	0.03	14.5	6.3	D
	10	11	51	20.1	59	20.0	152	33.1	64.5	0.	9	119	45	0.22	2.4	4.7	B
	12	5	7	26.5	59	36.6	153	1.2	100.4	2.1	4	154	12	0.05	0.	0.	C
	12	14	13	9.5	59	13.5	152	43.9	5.0	0.	3	209	55	0.	0.	0.	C
	13	2	2	29.3	56	33.8	156	30.4	58.3	0.	6	250	71	0.20	10.2	13.0	D
	13	18	3	49.9	62	29.4	151	47.8	5.0	2.4	3	276	221	0.09	0.	0.	C
	14	7	46	22.3	59	48.4	152	10.7	48.0	1.9	6	225	34	0.37	29.9	36.8	D
	14	10	51	4.8	58	21.7	153	52.6	5.0	0.	3	202	53	0.01	0.	0.	C
	14	11	14	1.9	56	34.2	156	29.3	37.9	2.0	4	142	61	0.05	0.	0.	C
	14	17	0	51.4	57	51.9	156	13.5	124.0	2.8	12	114	17	0.30	3.6	3.7	C
	15	6	53	59.6	58	33.1	151	55.4	5.0	2.4	5	262	90	0.11	6.5	235.8	D
	15	14	58	54.2	59	17.3	152	50.8	29.9	0.	6	113	46	0.68	15.3	19.6	C
	15	15	34	44.4	57	28.7	156	13.7	88.8	2.3	6	181	26	0.15	4.3	5.3	D
	15	20	8	1.4	61	7.7	152	28.5	105.1	0.	5	208	80	0.64	30.1	30.3	D
	15	20	13	9.4	59	37.8	151	57.9	5.0	1.9	3	168	18	0.01	0.	0.	C
	15	21	11	34.9	59	43.2	153	52.8	5.0	1.3	3	267	37	0.	0.	0.	C
	15	21	47	37.9	57	53.2	159	18.5	5.0	3.1	3	266	142	1.18	0.	0.	D
	15	23	17	30.0	59	46.9	152	54.0	110.9	2.8	6	229	23	0.02	1.8	2.1	C
	16	11	52	52.7	59	22.7	152	42.8	5.0	0.	3	235	42	0.06	0.	0.	C
	17	9	51	32.6	59	38.6	153	6.0	109.3	2.9	7	171	7	0.20	12.5	14.5	D
	17	12	42	24.1	63	3.6	150	44.1	28.0	3.5	9	137	163	0.56	5.7	757.7	D
	17	15	12	9.9	58	52.4	153	40.9	11.6	1.6	4	294	39	0.23	0.	0.	C
	17	15	43	41.9	58	47.0	151	42.1	3.6	2.6	4	297	77	0.12	0.	0.	C
	17	16	38	29.0	58	28.2	156	29.2	5.0	0.	3	316	178	0.	0.	0.	C
	17	19	3	42.4	59	23.6	152	39.2	71.0	0.	7	129	39	0.09	3.6	7.3	C
	17	20	49	22.2	58	20.8	153	36.4	5.0	1.7	3	175	41	0.	0.	0.	C
	18	3	39	54.4	59	45.6	151	46.5	65.4	2.7	9	245	13	0.21	17.2	17.6	D
	18	6	22	4.6	58	26.3	155	40.6	5.0	2.6	3	301	135	0.	0.	0.	C
	18	8	17	27.4	59	21.2	152	0.3	5.0	1.6	3	269	76	0.01	0.	0.	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR	MN	SEC	LAT N DEG	MIN	LONG W DEG	MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
SEP 18	16	37	22.7	59	8.5	152	51.7	76.4	2.1	7	125	37	0.19	4.4	10.8	C
18	21	28	35.4	59	36.0	152	22.0	116.6	0.	4	164	41	0.02	0.	0.	C
19	0	49	17.8	63	0.8	150	47.8	5.0	3.6	5	278	265	0.46	36.4	9999.9	D
19	6	15	32.8	56	15.2	155	58.8	5.0	0.	3	268	51	0.05	0.	0.	C
19	6	36	37.0	59	30.0	153	10.5	1.6	0.	5	139	17	0.57	12.1	90.4	D
19	9	43	26.4	58	20.5	153	28.1	5.0	1.6	3	162	36	0.	0.	0.	C
19	10	37	55.8	59	29.4	154	4.8	5.0	0.	3	281	138	0.04	0.	0.	C
19	14	41	7.3	58	27.3	156	33.9	5.0	2.3	3	317	182	0.	0.	0.	C
19	19	43	1.5	60	28.9	152	59.2	176.4	2.7	5	301	93	0.04	15.8	13.2	D
19	22	9	29.9	60	11.3	153	4.2	166.0	2.5	4	333	60	0.	0.	0.	C
20	3	27	46.3	59	29.5	152	39.9	5.0	1.3	3	309	36	0.01	0.	0.	C
20	3	48	12.1	58	27.1	156	7.2	5.0	2.1	3	310	158	0.	0.	0.	C
20	4	19	54.2	59	37.1	153	10.5	27.6	2.7	8	139	5	0.08	1.5	0.9	C
20	13	18	26.8	59	21.3	153	24.0	5.0	0.3	3	256	2	0.13	0.	0.	C
20	17	32	15.6	60	3.4	151	59.4	82.0	2.3	9	216	48	0.25	4.4	6.4	D
20	19	43	44.8	59	36.0	152	16.3	5.0	1.6	3	194	41	0.	0.	0.	C
20	23	16	26.9	59	25.1	152	57.8	0.3	0.	5	180	27	0.15	16.3	143.7	D
21	0	12	40.1	59	52.3	152	36.8	86.4	2.6	6	178	42	0.12	2.6	3.3	C
21	3	9	58.5	58	32.9	152	32.3	5.0	1.4	3	186	65	0.	0.	0.	C
21	3	51	6.2	57	49.2	154	49.6	57.4	2.8	5	166	41	0.16	10.1	10.3	D
21	9	24	52.6	59	36.6	153	25.6	103.2	0.	6	209	12	0.63	24.8	27.2	D
21	10	26	37.8	59	30.2	154	55.7	5.0	0.	3	297	186	0.	0.	0.	C
21	11	59	20.9	59	28.7	152	34.9	35.9	1.7	6	254	41	1.01	29.3	21.5	D
21	15	11	9.3	57	48.9	155	8.4	5.0	1.8	3	177	67	0.	0.	0.	C
22	18	10	18.0	61	27.9	150	57.1	1.3	2.7	5	247	204	0.42	22.0	60.7	D
22	18	38	41.1	59	26.0	152	41.0	30.4	0.	5	119	39	0.47	13.5	16.1	D
23	4	30	13.1	59	51.3	153	23.1	137.0	2.4	4	264	24	0.05	0.	0.	C
23	7	33	35.5	58	21.7	153	57.1	5.0	0.	3	209	57	0.	0.	0.	C
23	8	45	19.5	59	33.4	152	30.4	5.0	1.5	3	320	42	0.09	0.	0.	C
23	11	25	31.8	59	9.4	153	8.1	5.0	1.3	3	355	25	0.62	0.	0.	D
23	14	18	22.2	58	23.7	160	52.9	3.6	0.	4	326	253	0.70	0.	0.	D
24	8	51	42.0	59	9.0	153	10.0	83.0	0.	6	111	31	0.25	9.0	21.8	C
24	9	28	24.9	57	54.3	154	38.3	5.0	1.8	3	292	89	1.79	0.	0.	D
24	12	14	14.6	59	9.6	153	7.1	5.0	1.4	3	188	55	0.	0.	0.	C
24	16	22	57.5	58	27.2	154	40.0	5.0	2.5	3	248	90	0.05	0.	0.	C
24	23	17	9.8	59	44.8	152	25.8	5.0	1.5	3	248	56	0.	0.	0.	C
26	0	45	20.5	62	31.3	151	42.2	5.0	0.	3	257	225	0.02	0.	0.	C
26	8	27	41.6	59	39.7	153	7.5	120.5	3.2	6	113	6	0.20	3.8	5.4	C
26	8	48	14.9	59	53.8	153	7.0	141.0	0.	6	253	28	0.20	25.2	32.9	D
26	9	12	19.4	59	22.8	152	38.4	26.3	2.6	6	111	45	0.44	5.2	8.4	C
26	11	38	40.6	59	31.0	152	54.6	111.1	2.4	4	144	23	0.08	0.	0.	C
26	19	18	24.0	59	3.1	149	57.8	3.5	2.7	4	307	197	0.48	0.	0.	D
26	23	51	42.3	58	47.2	153	24.2	5.0	1.7	3	175	57	0.	0.	0.	C
27	3	0	39.7	57	39.3	155	40.1	5.0	1.3	3	246	16	0.02	0.	0.	C
27	7	22	35.6	59	47.7	153	25.7	131.9	2.3	5	295	19	0.01	1.5	1.9	C

COOK INLET-WESTERN GULF OF ALASKA EARTHQUAKES

1979	ORIGIN TIME HR MN	SEC	LAT N DEG MIN	LONG W DEG MIN	DEPTH KM	MAG	NO	GAP DEG	DM KM	RMS SEC	ERH KM	ERZ KM	Q
SEP 27	9 11	28.9	59 32.5	151 47.8	5.0	0.	3	156	14	0.	0.	0.	C
27	21 14	43.4	59 37.5	152 7.9	5.0	0.	3	244	27	0.01	0.	0.	C
28	20 57	25.2	59 58.3	152 39.0	111.0	3.0	9	259	48	0.19	13.3	13.5	D
29	0 15	38.3	60 5.5	152 31.5	107.5	3.7	14	191	62	0.47	5.6	6.4	D
29	8 48	44.6	58 52.3	152 50.0	5.0	1.9	3	219	82	0.	0.	0.	C
29	10 4	49.6	59 57.7	152 39.5	105.1	3.7	14	91	47	0.30	2.4	3.5	C
29	10 49	11.1	59 45.6	153 14.1	131.4	0.	4	272	11	0.13	0.	0.	C
30	10 38	27.7	56 43.7	158 27.5	23.8	0.	4	180	16	0.30	0.	0.	C

*

Research Unit No. - 473
Reporting Perid - April-June, 1979
Number of Pages - 8

QUARTERLY REPORT

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

Principal Investigators:

D. M. Hopkins

R. W. Hartz

U.S. Geological Survey
Menlo Park, California

R.U. #473: Quarterly Report, April-June 1979

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

I. Abstract of Highlights

Radiocarbon dates received this quarter provide information on the age of archaeological sites, the growth of ice wedges, and the changes in location of major streams draining the arctic coast.

II. Task Objectives

The objective of this project is to predict the distribution of subsea permafrost, the formation and stability of the barrier island chains, and the extent of coastal erosion hazards by studying the processes which have been and still are active along the arctic coastline.

III. Field or Laboratory Activities

A. Ship or Field Trip Schedule

David M. Hopkins was a co-convener of a Wenner-Gren Foundation Burg Wartenstein conference, "The Paleoecology of the Arctic Steppe-Mammoth Biome", held in Austria June 8-17, 1979.

B. Scientific Party

D. M. Hopkins, Principal Investigator
R. W. Hartz, geologist

C. Methods

1. Synthesis of information from topographic maps, air photos, and literature
2. Analysis of materials from barrier islands, storm beaches, and coastal bluffs for grain-size distribution, radiocarbon age determinations, and amino-acid racemization.

D. Sample Locations

No new samples were collected, but locations of samples for which radiocarbon dates have recently been received are presented in Appendix I.

E. Data Collected or Analyzed

Nineteen radiocarbon age determinations have been reported within this quarter.

IV. and V. Results and Preliminary Interpretation of Results

Radiocarbon dates provide information on occupation of archaeological sites along the Chukchi coast, the growth of ice wedges in coastal areas, and the former locations and depositional history along major streams draining the arctic coast. These dates are presented as Appendix I of this report.

VI. Auxiliary Material

A. Bibliography: None

B. Papers in preparation or in print

Hopkins, D. M., 1979, Development of the northern hemisphere ice sheets during the past 120,000 years; an aspect of the paleogeography of the arctic steppe biome: Paper prepared for Wenner-Gren Foundation Burg Wartenstein Conference #81, "Paleoecology of the Arctic Steppe-Mammoth Biome", Austria, June 8-17, 1979.

Hopkins, D. M., and Smith, P. A., in progress, Dated wood from Alaska; implications for forest refugia in Beringia.

C. Oral presentations: None

VII. Problems Encountered/Recommended Changes

Much of the synthesis work for this project has been delayed by the necessity of quickly preparing site location maps and summary logs for the offshore boreholes drilled this spring in conjunction with project R.U. 204.

IX. Appendix: Radiocarbon dates from the Beaufort and Chukchi Seas

RADIOCARBON DATES FROM THE BEAUFORT AND CHUKCHI SEAS

APPENDIX I

P. A. Smith and D. M. Hopkins

Radiocarbon age determinations completed this quarter for 19 samples from the Beaufort and Chukchi Sea coasts have been tabulated and are presented in this report. Simplified location maps showing collection sites are also included.

The significance of these radiocarbon dates are only beginning to be analyzed, but some preliminary interpretations are possible. Several dates may be used to calculate growth of active ice wedges along the arctic coast. The dates provide further information on rates of accumulation of sand along river bluffs and of peat in thaw lake deposits. An understanding of the drainage history of the Putuligayuk and Sagavanirktok Rivers may be furthered by the dates received on terrace materials and organic horizons exposed along the Putuligayuk River.

Two radiocarbon dates reported earlier this year (Hopkins and Robinson, 1979) bracketed the age of an ash layer at the mouth of the Canning River between 3950 and 3300 years old. A peat sample collected 5 cm above what was presumed to be the same ash unit on the eastern end of Flaxman Island yielded a rather disturbing radiocarbon age of 4890 years.

It was hoped that other samples from the Flaxman Island section would explain this older date, but instead they may simply add to the puzzle. An age of 4250 years B.P. has recently been determined for a peat sample collected 10 cm below the ash unit on Flaxman Island. Perhaps both the 4890 year old peat above the ash and the 4250 year old peat below it reflect redeposition of older detrital peats into a younger aeolian section. A sample collected 3 m above the ash at the top of the thinly bedded silt and peat sequence has yielded a radiocarbon age of 2775 years, which clearly establishes an upper limit on the ash's age.

References Cited

Hopkins, D. M., and Robinson, S. W., 1979, Radiocarbon dates from the Chukchi and Beaufort Sea coasts, in Environmental Assessment of the Alaskan continental shelf, annual reports of principal investigator's for the year ending March, 1979, Appendix 4 to P. A. Smith and D. M. Hopkins, Offshore permafrost studies and shoreline history of Chukchi and Beaufort Seas as an aid to predicting offshore permafrost conditions.

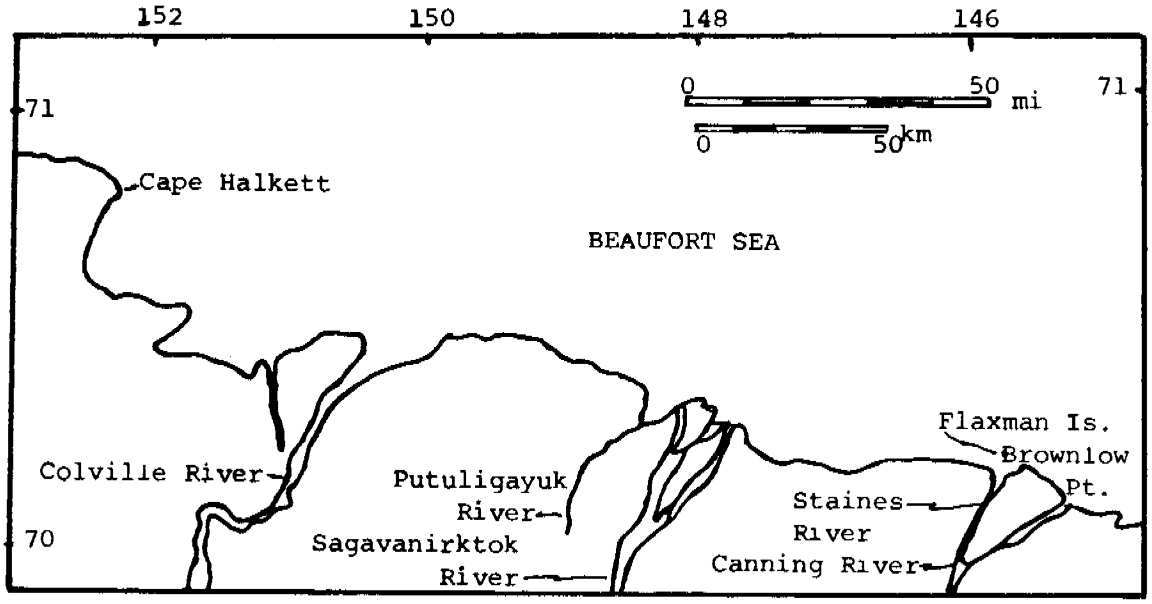

Figure 1a. Beaufort Sea coast location map. indicates site of radiocarbon samples referred to in Table 1.

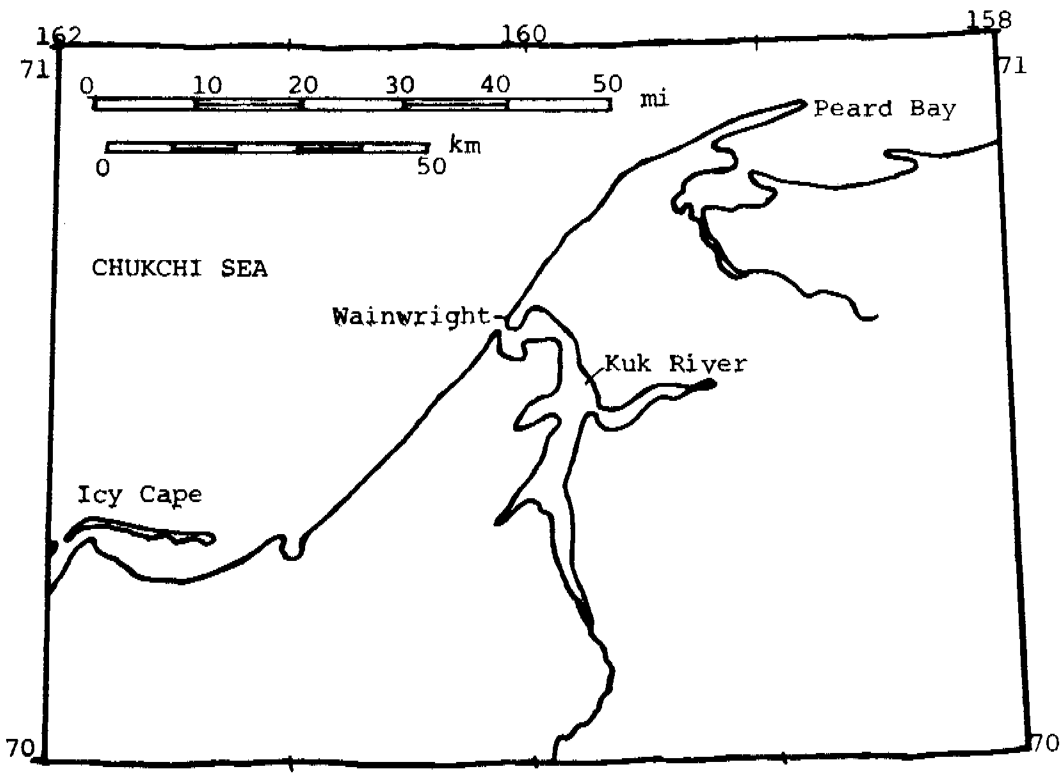

Figure 1b. Location of Wainwright - Kuk River area. indicates site of radiocarbon samples referred to in Table 1.

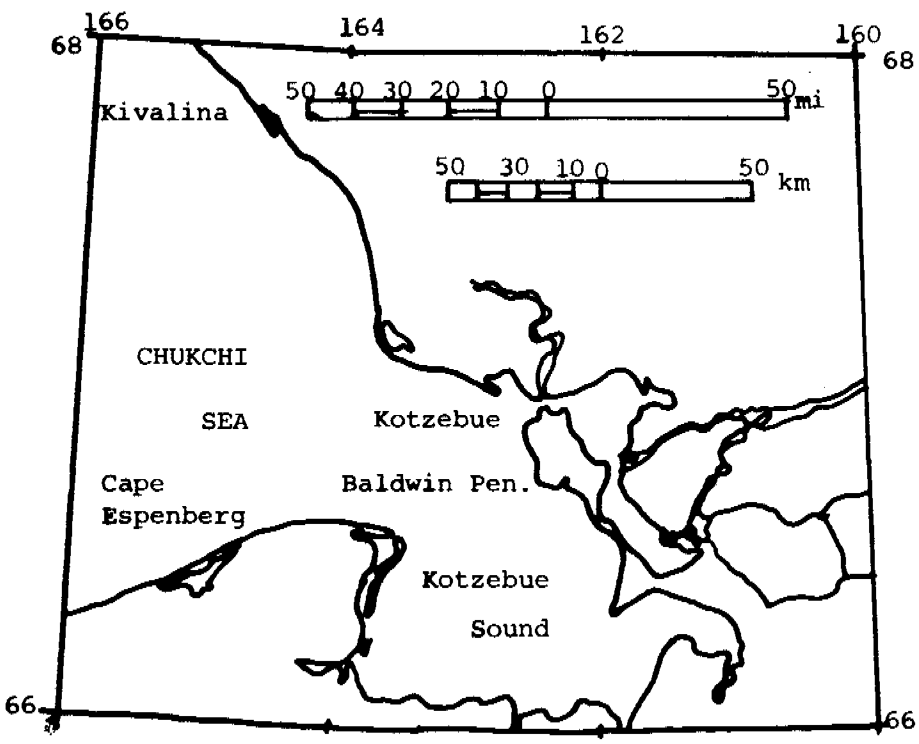

Figure 1c. Kivalina - Kotzebue Sound location map. indicates site of radiocarbon samples referred to in Table 1.

RADIOCARBON AGE DETERMINATIONS FROM THE CHUKCHI AND BEAUFORT SEA COASTS

FIELD NUMBER (LAB NUMBER)	AGE (yr. B.P.)	MATERIAL	QUADRANGLE	LATITUDE N. LONGITUDE W.	LOCATION	SIGNIFICANCE
76Ahp146b (USGS-514)	150±40	Wood (*Salix*)	Kotzebue C-1	66°39'27" 162°17'24"	10 m high coastal bluff on Baldwin Peninusula, Kotzebue Sound	Dates base of alluvium lying on Kotzebuan? silt 5 m above sea level, expected age 20,000 yr B.P.
76Ahp151 (I-10622)	>40,000	1 m long rooted logs (*Picea*)	Kotzebue C-1	66°39'45" 162°08'06"	12 m high coastal bluff on Baldwin Peninsula, Kotzebue Sound	Dates base of thaw lake deposit overlying Kotzebuan silt and loess, 1.5 m below surface of exposure. Expected age 10,000 yr B.P.
76Ahp174b (I-10634)	<185	Wood and charcoal	Noatak D-6	67°48'18" 164°43'30"	Beach ridge along Kivalina Lagoon, N. of town of Kivalina	Dates occupation of house on beach ridge. Expected age 1,000 yr B.P.
76Ahp26c (I-10621)	<185	*Picea* wood and charcoal	Wainwright B-5,6	70°18'20" 161°43'00"	South end of small thaw lake near Icy Cape	Collected in lens of wood, charcoal, bone, and flakes. Dates flaking site.
76Ahp84c (I-10620)	5410±110	Twigs (*Salix*)	Wainwright C-3	70°32'01" 160°15'03"	Low coastal terrace 8 km south of Wainwright Inlet	Dates inception of younger thaw lake, estimated age 5000 yr B.P.
76Ahp84e (USGS-508)	7040±90	Detrital peat	Wainwright C-3	70°32'01" 160°15'03"	Low coastal terrace 8 km south of Wainwright Inlet	Gives maximum age for diapiric intrusion of coal into thaw lake sequence.
76Ahp84a (USGS-507)	6260±80	Rooted heath (*Cassiope*?)	Wainwright C-3	70°32'01" 160°15'03"	Low coastal terrace 8 km south of Wainwright Inlet	Was expected to yield age older than 84e--pod of peat near base of thaw lake.
76Ahp87a (USGS-516)	9590±80	Twigs (*Salix*)	Wainwright C-3	70°13'55" 159°47'00"	4 m high bluff along the Kuk River at head of delta	Detrital peat at base of Holocene thaw lake, dates inception of lake.

FIELD NUMBER (LAB NUMBER)	AGE (yr. B.P.)	MATERIAL	QUADRANGLE	LATITUDE N. LONGITUDE W.	LOCATION	SIGNIFICANCE
77Ahp178a (USGS-512)	5980±60	Peat	Harrison Bay D-4	70°47'34" 152°15'12"	4 m high bluff 2.75 km southwest of Cape Halkett	Dates thaw lake sequence overlying loess or silt.
77Ahp141c (USGS-510)	4580±75	Peat	Harrison Bay C-4	70°34'30" 152°17'12"	Thaw lake sequence on south side of Kogru Peninsula	Gives maximum age for ice wedges 1.5 to 1.75 m across.
77Ahp83 (I-10643)	2150±160	Peat	Beechey Pt. B-3	70°15'51" 148°38'15"	Putuligayuk River near Prudhoe Bay	Collected from base of aeolian layer, dates time when the Putuligayuk River was a channel of the Sagavanirktok, provides data on rates of aeolian sand accumulation.
77Ahp99a (I-10642)	5470±110	Peat	Beechey Pt. B-3	70°16'45" 148°32'24"	Gravel pit along Putuligayuk River	Dates terrace just before abandonment of oxbow, predates a pink ash layer.
77Ahp84 (I-10644)	7200±180	Twigs	Beechey Pt. B-3	70°15'57" 148°38'24"	Holocene terrace along the Putuligayuk River	Twiggy peat in stream terrace, dates diminishing flow in Putuligayuk River, expected age 1,000 yr B.P.
77Ahp84d (USGS-504)	35,600±550	Twigs (*Salix*) *Populus* wood	Beechey Pt. B-3	70°17'25" 148°31'00"	Gravel pit along Putuligayuk River	Dates lower and older of two organic horizons interbedded with gravel, probably Sagavanirktok River outwash. Upper horizon previously yielded a date of 26,300 ±370 (USGS-505).
77Ahp40f (I-10638)	2775±125	Peat	Flaxman Is. A-4	70°10'34" 145°56'48"	East end of Flaxman Island	Expected to date top of thinly bedded peat and wind-blown silt sequence which contains an ash layer near its base. Date should be younger than ash.

FIELD NUMBER (LAB NUMBER)	AGE (yr. B.P.)	MATERIAL	QUADRANGLE	LATITUDE N. LONGITUDE W.	LOCATION	SIGNIFICANCE
77Ahp40d (I-10637)	4250±170	Detrital peat	Flaxman Is. A-4	70°10'34" 145°56'48"	East end of Flaxman Island	Collected 10 cm below Canning River ash bed, expected to give maximum age for ash.
77Ahp40i (I-10639)	10,080±170	Twiggy peat	Flaxman Is. A-4	70°10'34" 145°56'48"	East end of Flaxman Island	Collected near base of older thaw lake sequence, gives maximum age for Canning River flowing through Leffingwell Channel.
77Ahp43b (I-10640)	9280±150	Peat	Flaxman Is. A-4	71°11'13" 145°59'09"	North end of Flaxman Island	Taken near base of thaw lake sequence overlain by wind-blown silt, dates inception of thaw lake, expected age 10,000 yr B.P.
77Ahp36 (I-10625)	5360±110	Wood (*Salix*)	Flaxman Is. A-3	70°04'45" 145°34'30"	Canning Point, near mouth of Canning River	Collected in ice wedge collapse below thin ash layer at base of aeolian sand, dates inception of dunes, predates Canning River ash.

Quarterly Report

Contract #03-5-022-56
Research Unit #530
Task Order #34
Reporting Period 4/1/79-6/30/79

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

Dr. P. Jan Cannon

Institute of Marine Science
University of Alaska
Fairbanks, Alaska

QUARTERLY REPORT FOR QUARTER ENDING JUNE 30, 1979

Project Title: 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: Dr. P. Jan Cannon

I. Task Objectives

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

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 the 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 spatial and temporal model of the environmental geology of the region.

II. Activities

Attended modelling workshop on Beaufort Sea barrier island - lagoon ecological process studies in Seattle, Washington, on April 23-25, 1979. The LGL group provided an excellent situation for information exchange between principal investigators and workshop attendees.

At the workshop this investigator provided evidence that causeways would have no adverse geologic effects on the islands. The fact that the causeways would have no adverse geologic effects was well accepted by workshop attendees.

During this quarter the compilation of a folio of remote sensing data of the study area was begun. The purpose of this remote sensing folio is to provide a spatial and a temporal view of the study area.

III. Results

Landsat scenes are being collected with their associated meteorological data. The next step is to collect the physical oceanographic data which corresponds to same Landsat scenes. This is being undertaken to provide a dynamic picture of the processes occurring at specific times.

Figure 1 is an unusual scene in that it was taken as the satellite travelled poleward on the night side of the earth. The sun was only 14

Figure 1: This is a band 7 Landsat scene (of the Beaufort Sea Lease Area) taken at 2015 hours local time on July 7, 1977. The satellite was on the ascending node of its orbit. The sunlight is from the north at a low angle. This low-angle north lighting provides a good enhancement of minor geomorphic features. Temperature 43°F, Wind was from 070° at 8.8 mph.

degrees above the horizon. The low angle lighting enhances minor geomorphic features on the coastal plain.

Figure 2 is an important scene in that it shows the movement of very fine sediment along the coast and in Teshekpuk Lake. The NOAA climatic data are listed with figures 2,3, and 4, for their corresponding dates. Figures 3 and 4 are RBV Landsat scenes. The RBV Landsat scenes have a resolution of about 35 meters. The RBV Landsat scenes will enhance the interpretation of field data collected during 1978 and 1979.

IV. Preliminary Interpretation of Results

The most important landforming process in the area is the loss of ground ice. The term permafrost is not used here because it only refers to subsurface materials which have a temperature below 0° year around and does not infer that ice is present. Hence, to better communicate the actual process, the term ground ice is preferred. The natural stabilities of the landforms are directly related to the rates at which the ground ice is lost.

The basic approach used in this study was to measure the actual rates of change in physical features and to determine that process, or those processes, which were responsible for the measured changes. The measurements were taken from aerial photography and other remote sensing data acquired by various sources over a 25 year period (Table I). The identification of specific landforms was made from field observations. The identification of the naturally occurring processes and the magnitude of those processes was made from year-around field observations.

Table I. Average Horizontal Rates of Retreat Due to Loss of Ground Ice.

Area	Average rate
Tundra Islands, Simpson Lagoon	1.6 m/yr.
Coastline, Simpson Lagoon (Lewellen, 1976)	1.2 m/yr.
Seaward shoreline, Flaxman Island	2.1 m/yr.
Lagoon shoreline, Flaxman Island	1.1 m/yr.
Total Flaxman Island shoreline	1.4 m/yr.
Coastline, Point Thomson to Brownlow Point	0.8 m/yr.
Total Prudhoe Bay shoreline	1.9 m/yr.
Total coastal plain talik lake shorelines	0.4 m/yr.
Total Sagavanirktok River bank	0.7 m/yr.
Total coastline, Camden Bay	1.9 m/yr.

The major landforms of the area are listed and described in Table II. There are two types of islands which make up the Barrier Island chains. One is composed of tundra covered, frozen, coastal plain material which has been left behind as the coastline has retreated due to loss of ground ice. The other is composed of non-frozen gravel materials derived from the destruction of tundra islands or coastal promontories. Most of the islands

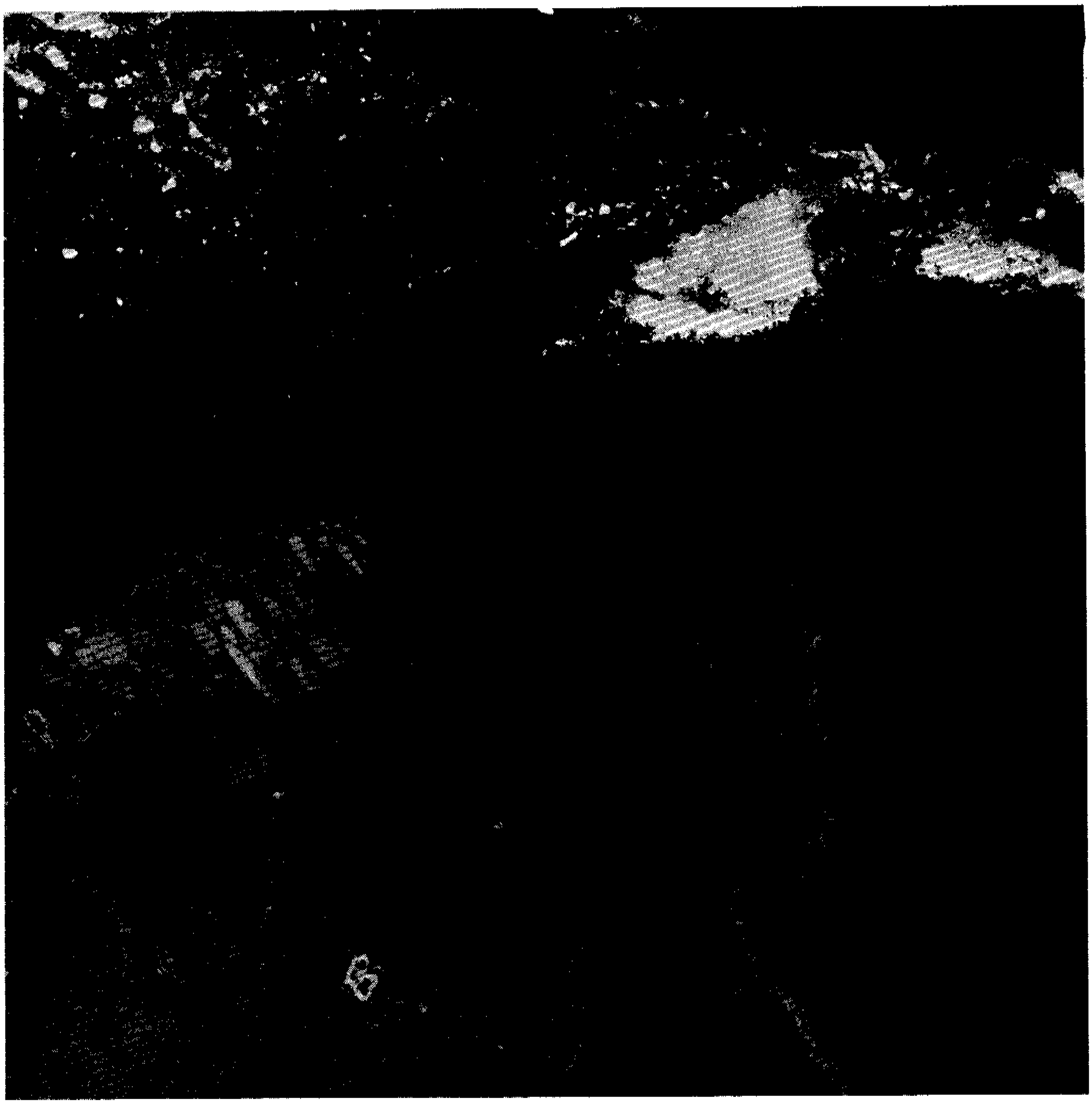

Figure 2: This is a band 5 Landsat scene of the Harrison Bay area taken on August 14, 1977. This is a normal descending node scene. The sediment plumes along the shore show the movement of very fine materials. The sediment plumes can also be seen in Teshekpuk Lake. The climatic data for this date are:

Temperature: 47°F
Dew Point: 44°F
Barometric pressure: 29.92 in.
Wind from 090° at 10.9 mph.

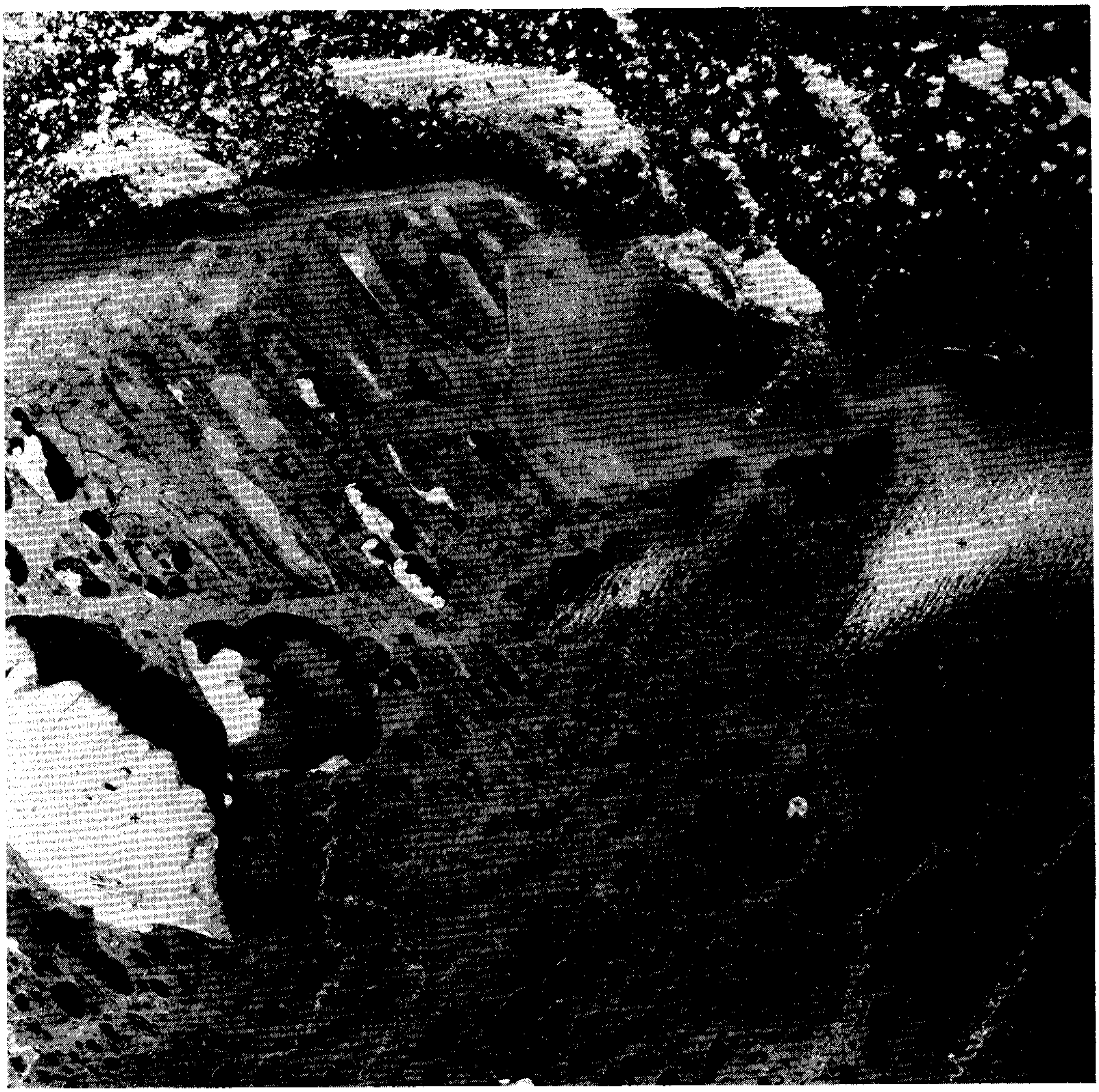

Figure 3: This is a RBV Landsat scene of the Harrison Bay Area taken on July 15, 1978. Both the drifting ice and the sediment plumes can be seen well. The climatic data for this date are:

Temperature: 36°F
Dew Point: 33°F
Barometric Pressure: 30.12 in.
Wind from 060° at 14.8

Figure 4: This is a RBV Landsat scene of the Harrison Bay area taken on August 18, 1978. The patterns of drifting sediment show up well. The climatic data for this date are:

Temperature: 48°F
Dew Point: 40°F
Barometric Pressure: 29.94 in.
Wind from 070° at 8.5 mph.

Table II. Landforms of the Beaufort Sea Coastal Zone

Tundra Islands	Tundra covered remnants of the coastal plain. Shorelines of the islands are retreating at an average rate of 1.6 meters per year.
Gravel Islands	Shoestring gravel bars derived from the destruction of tundra islands. Wave action slowly works the gravels towards the coast, and disperses the gravels on to the seafloor.
Spits	Gravel bars extending from the ends of tundra islands and coastal promontories, which are the gravel sources, respectfully. The spits are often reworked extensively during storms.
Coastal Plain	A gently sloping, tundra covered plain. It is poorly drained and covered with talik lakes.
Beaches	Narrow strips of gravel with minor amounts of sand along the shores of the islands and coastline.
Talik Lakes	Shallow lakes on the coastal plain formed by the loss of ground ice.
Lagoons	Shallow bodies of sea water protected by a seaward barrier of gravel and/or tundra islands. The lagoons are formed by the coalescing of talik lakes which are breached by the retreating shoreline.
Steams	Channels which begin by the loss of ground ice. The larger channels transport materials derived from their banks.
Deltas	Broad fan-shaped areas of very fine sediment at the mouths of the larger streams. Some small deltas occur at the mouths of streams which run into drained lakes.
Sand Dunes	Minor features of sand derived from large streams and of sand derived from beach materials on some tundra islands. Far inland and west of the Colville River is a large paleo sand-sea, but in and around the lease area there is very little sand. There are no sand dunes on the gravel islands and there are no islands composed only of sand.

have a recurved, umbrella shape. The islands are not true barrier islands like found along other coasts because the materials of the islands are not being derived from the streams on the coastal plain and transported hundreds of kilometers by a totally dominant longshore current. The umbrella shape of the islands is due to the effects of two alternating longshore current directions.

Since the coastal plain slopes toward the coastline, the bluffs along the beach should become higher as the coastline retreats. However, the bluffs appear to have maintained a low height of 1-3 meters. If coastline retreat had started just at the islands, the coastal bluffs should be over 10 meters in height. From this, it appears that vertical subsidence of the surface due to loss of ground ice is occurring along with the horizontal retreat of the coastline. In any consideration, it would be illogical to assume that loss of ground ice would only be at the coastline in an horizontal direction.

References Cited

Lewellen, Robert, 1976, A study of Beaufort Sea coastal erosion, northern Alaska, *in* D.W. Hood and D.C. Burrell, eds., Assessment of the Arctic Marine Environment: Selected Topics, Occas. Publ. No. 4, Inst. Mar. Sci., Univ. of Alaska, Fairbanks, 469 p.

V. Problems Encountered/Recommended Changes

None

QUARTERLY REPORT

Contract 03-5-077-56
Research Unit 530
Task Order 34
Reporting Period 7/1-9/20/79

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

P. J. Cannon
Department of Geology
University of Alaska
Fairbanks, Alaska

September 1979

QUARTERLY REPORT FOR THE PERIOD ENDING SEPTEMBER 30, 1979

Project Title:	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:	Dr. P. Jan Cannon

I. Task Objectives

During FY 79 this investigation was part of the barrier island-lagoon studies; its purpose was to determine the geological and geomorphological environments of specifically, Simpson Lagoon and generally, the entire coast of the lease area. Remote sensing methods, supplemented with field observations, were used to determine geomorphic features of the islands and nearshore coastal plain, and to assess (1) possible hazards associated with features (e.g. instability, etc.), (2) possible impacts associated with petroleum development (e.g. construction of artificial gravel islands and causeways), and (3) resources (e.g. gravel).

During FY 80 this study will be completed by examining the morphology and stability of the Colville, Kuparuk, Sagavanirktok and Canning River deltas, and developing a comprehensive report describing the geomorphic history and probable future of the Alaskan Arctic coastal plain. The objectives are listed below.

1. Perform quantitative and qualitative analyses of the stability and morphology of the Colville, Kuparuk, Sagavanirktok and Canning River systems, emphasizing the deltas, and their influence on the coastline and offshore areas.
2. Perform an analysis of the timing and magnitude of drainage basin and alluvial valley discharges of water and sediment, and the resulting influence on deltaic processes within the systems given above. This analysis includes identification of areas within the

drainage basins and alluvial valleys that have the greatest influence on other parts of the systems.

3. Construct a comprehensive geomorphology of the Alaskan Arctic coastal plain using FY 80 results and others reported previously. This final report will contain, but not be limited to:

   a. description and quantification, where possible, of the geomorphic processes active on the coastal plain and offshore areas;

   b. the history of the landforms (islands, lagoon systems, lakes, river deltas, water courses, etc.);

   c. the projected future of these landforms in the absence of external (man-made) influences; and

   d. an estimate of the influence of petroleum development (using scenarios described in the OCS draft environmental impact statement) on the projected future of landforms as described in "c".

II. Activities

1. Finalization of renewal proposal; submitted 7-2-79.

2. Planning logistics. This included purchasing, organization, and shipping of equipment.

3. Field work was conducted between July 31-August 8 by Rawlinson, and between August 3-August 8 by Cannon. This work included:

   a. sampling of major drainage systems on the Arctic Slope. Gravel and sand samples were collected in the Canning, Ivashak, Sagavanirktok, Putuligayuk, Kuparuk, Itkilik, Anaktuvuk, Chandler, Colville, Awuna, and Etivluk Rivers;

   b. sampling of the recently excavated gravel pit near the Ugnuravik

River; gravel and sand samples were collected;

c. sampling of terrains differentiated and mapped on the bases of lake density, size and orientation, and on the degree of ground wetness, within the Beechy Point Quadrangle; seventeen sub-surface sediment samples were collected with grain sizes from clay to pebbles; and

d. aerial and ground reconnaissance of linear features observed on Landsat imagery and aerial reconnaissance of man-induced preferential thermal erosion; reconnaissance was concentrated in coastal plain areas north of Teshekpuk Lake, south of Barrow, and south of Point Oliktok.

4. Initial grain morphology analyses of Sagavanirktok River gravels.
5. Laboratory and equipment preparation for heavy mineral analyses of river samples.
6. Preliminary inspection of terrain samples of "c" above.

III. Results

Petrographic (which here includes grain structure), composition, and grain morphology analyses of gravel samples from the major fluvial systems are in progress. The petrology and composition of these gravels will be compared with published descriptions of lithologies within the fluvial systems for provenance determination.

Grain morphology refers to the sphericity and roundness, which are functions of grain structure, composition, and transport history. Given grain structure, composition, and morphology, transport history can be delineated. Once delineated, transport history will corroborate other analyses.

Heavy mineral analysis is perhaps the most sensitive tool for determining clastic provenance and transport history since certain rock types have specific heavy mineral assemblages. This analysis of collected sand samples has not yet been started. Sand samples collected in the delta areas by Dr. A.S. Naidu (R.U. 529) will compliment those of this study.

The gravel and sand analyses will enable designation of "critical areas" within the fluvial systems. Critical areas here defined, supply the largest volume of clastics to other parts of the fluvial systems, particularly the deltas and receiving basins. Analyses of samples collected 12 meters below the tundra surface will also indicate the provenance and transport history of these grains. Results of the sand and gravel analyses are not yet available.

Quantitative textural analyses of samples taken in each mapped terrain unit (Figure 1) is in progress. The following generalizations are possible at this time: (1) ground ice is commonly encountered within 0.3 meter below the surface in areas designated "wet"; (2) ground ice is encountered within 1 meter below the surface in all lake-based terrain units; (3) areas mapped as river floodplains (RF) contain large amounts of gravel which may be at depth (approximately 10 meters); (4) wet areas with a high density of small lakes have about 0.3 meter of tundra and peat underlain directly by ice; (5) wet areas with a low density of lakes have a thin tundra cover underlain mostly by silt and sand to a depth of about 1 meter, where ice is encountered; and, (6) pingos (conical mounds raised by hydrostatic pressure and cored with ice) are most common in wet areas with moderate to high lake densities.

Results of investigations of linear features will appear in future reports as this work is still being synthesized.

Thermal erosion, enhanced by a road trending roughly east-west, is responsible for draining two relatively large talik lakes south of Oliktok Point (Figure 2). These lakes appear on 1955 U.S. Geological Survey topographic maps (Figure 3). Gravel roads show effects of preferential thermal erosion soon after their abandonment. Initially, thaw depressions form within these roads, often in the form of underlying ice-wedge polygons. Later, thaw depressions form along the sides of these roads. The thaw depressions usually are small pits, but may coalesce to form water-filled trenches.

IV. Interpretation of Results

No interpretation of the gravel sampling program will be extended this quarter.

The terrain map of the Beechey Point Quadrangle (Figure 1) is primarily an evaluation of the ability to determine coastal plain stability based on talik lakes and ground wetness. The orientation, size, and ground density of talik lakes, in addition to the relative wetness of the land surface, at least in part, are influenced by the thickness and grain size of coastal plain surficial deposits, and the depth to ground ice. Thus, other parts of the coastal plain can probably be similarly mapped on these bases, providing large-scale stability maps. This requires verification, some of which may come with the completion of the quantitative analyses.

Based on previous studies, ground subsidence is indicated in areas where there is little or no bluff along shorelines, whether river, lake, or ocean. Wet coastal plain areas, usually with a high density of small talik lakes (Figure 1 - areas designated HDSL), have very shallow depths to ground ice and most often exhibit bluffless shorelines. These areas, then, are highly unstable; development here should be dissuaded or should include optimal effort to exclude adverse environmental impact.

Abandoned roads, runways, drill pads, and other man-made gravel structures cause adverse environmental impact if no protective measures are taken. Recommended measures are removal or dispersal of gravel followed by revegetation.

Gravel sources are a major concern for Arctic coastal plain development. Some small fluvial systems were in the past larger, and transported considerably more coarse clastics than presently. Within these abandoned floodplains (Figure 1 - designated RF) large amounts of gravel suitable for developmental use are available.

V. Problems Encountered

None.

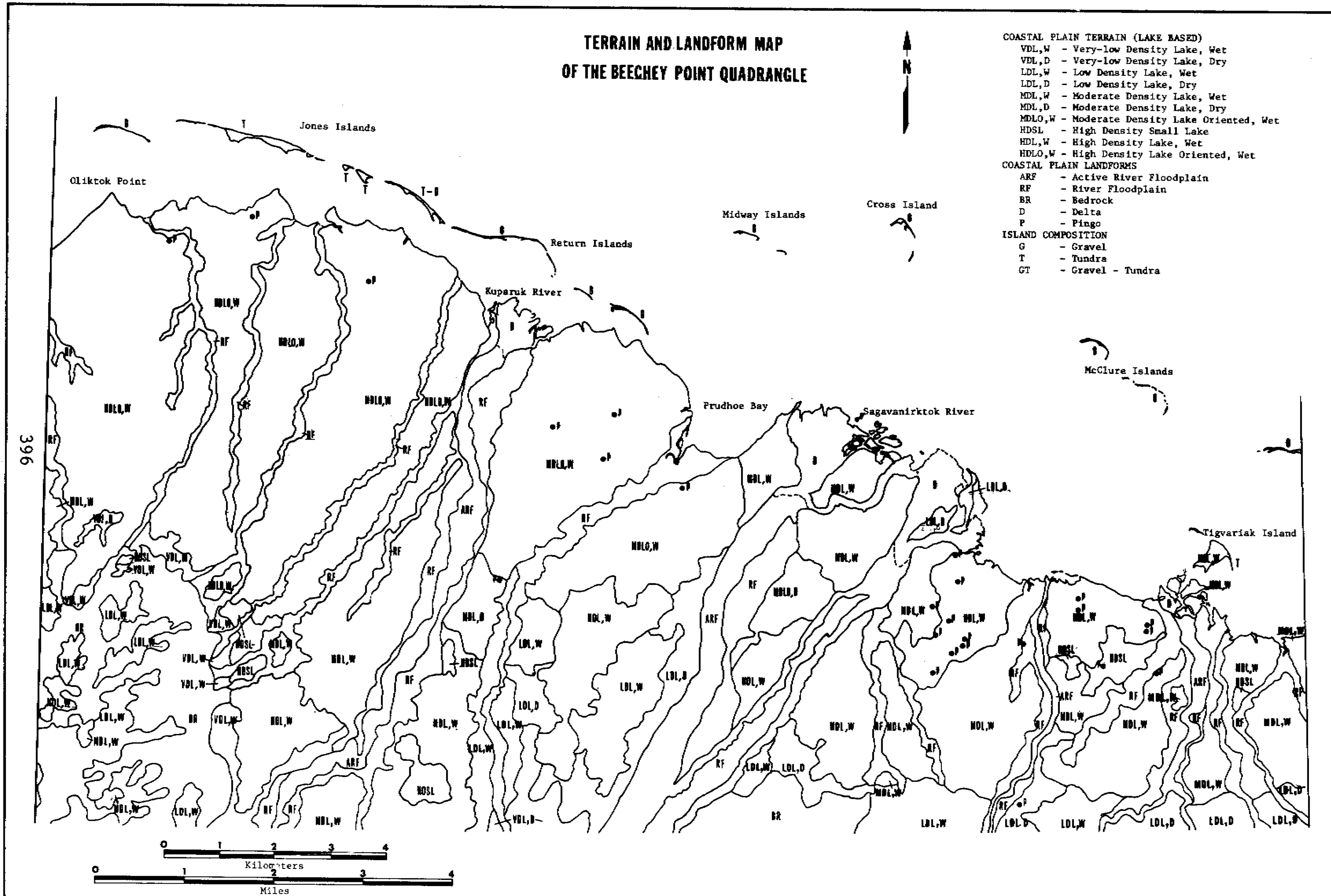

Figure 1 - Terrain and landform map of the Beechey Point Quadrangle based on talik lakes and ground wetness. Scale: as shown X10.

Figure 2 - Drained talik lakes (dark areas, lower center) in close proximity to thermally eroding abandoned road. Note preferential drainage along the road. Photograph taken July, 1979; scale 1:60,000.

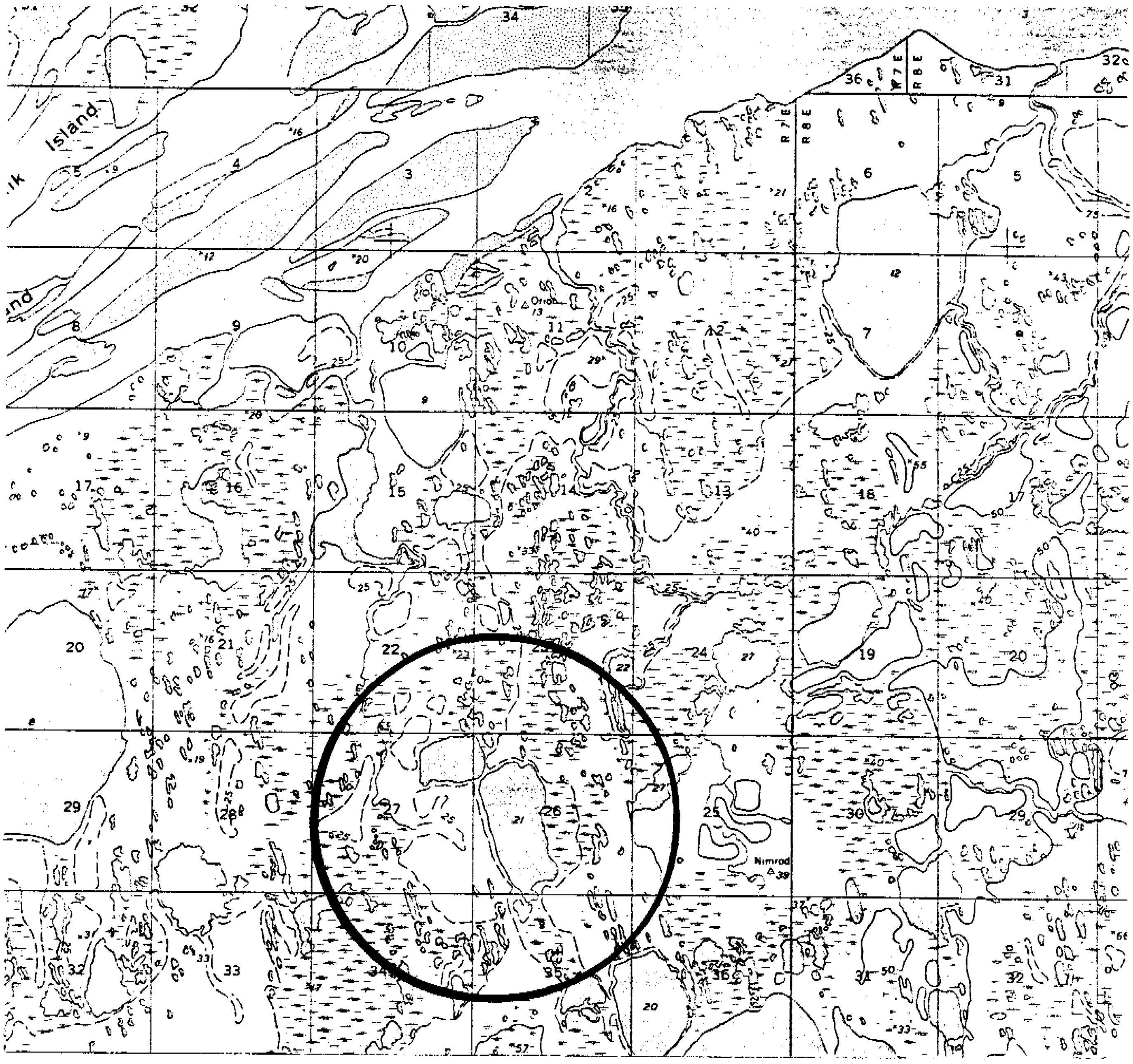

Figure 3 - Topographic map showing the presence in 1955 of the presently drained lakes (circled). Base: U.S. Geological Survey map; Harrison Bay (B-1), 1955; scale 1:63,360.

QUARTERLY REPORT

Contract 03-5-077-56
Research Unit 530
Task Order 34
Reporting Period 10/1/79 - 12/31/79

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

P. J. Cannon
Department of Geology
University of Alaska
Fairbanks, Alaska

December 1979

QUARTERLY REPORT FOR THE PERIOD ENDING DECEMBER 22, 1979

Project Title: 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: Dr. P. Jan Cannon

I. Task Objectives

During FY 79 this investigation was part of the barrier island-lagoon studies; its purpose was to determine the geological and geomorphological environments of specifically, Simpson Lagoon and generally, the entire coast of the lease area. Remote sensing methods, supplemented with field observations, were used to determine geomorphic features of the islands and nearshore coastal plain, and to assess (1) possible hazards associated with features (e.g. instability, etc.), (2) possible impacts associated with petroleum development (e.g. construction of artificial gravel islands and causeways), and (3) resources (e.g. gravel).

During FY 80 this study will be completed by examining the morphology and stability of the Colville, Kuparuk, Sagavanirktok and Canning River deltas, and developing a comprehensive report describing the geomorphic history and probable future of the Alaskan Arctic coastal plain. The objectives are listed below.

1. Perform quantitative and qualitative analyses of the stability and morphology of the Colville, Kuparuk, Sagavanirktok and Canning River systems, emphasizing the deltas, and their influence on the coastline and offshore areas.
2. Perform an analysis of the timing and magnitude of drainage basin and alluvial valley discharges of water and sediment, and the resulting influence on deltaic processes within the systems given above. The analysis includes identification of areas within the drainage basins and alluvial valleys that have the greatest in-

fluence on other parts of the systems.

3. Construct a comprehensive geomorphology of the Alaskan Arctic coastal plain using FY 80 results and others reported previously. This final report will contain, but not be limited to:

    a. description and quantification, where possible, of the geomorphic processes active on the coastal plain and offshore areas;

    b. the history of the landforms (islands, lagoon systems, lakes, river deltas, water courses, etc.);

    c. the projected future of these landforms in the absence of external (man-made)influences; and

    d. an estimate of the influence of petroleum development (using scenarios described in the OCS draft environmental impact statement) on the projected future of landforms as described in "c."

II. Activities

Activities this quarter were preparation of sediment samples for heavy mineral, grain size, and composition analyses; literature syntheses addressing the geology within Arctic Slope river basins and the pros and cons of the origin of the Flaxman Formation; submission of a common Flaxman boulder for K-Ar dating; and selection and procurement of remotely sensed and other data applicable to the task objective.

The purposes of the above listed sediment analyses are presented in this Research Unit's quarterly report for the period ending September 30, 1979. Preparations of sediment samples for these analyses are involved and time-consuming. Organic and authigenic constituents are removed from the sample by adding first hydrogen peroxide, and then a combined hydrochloric acid-stannous chloride solution. The sample is then washed with distilled water to remove soluble salts. Silt and clay (fine fraction) are separated from sand and gravel (coarse fraction) by washing the cleaned sample through a 62.5 micron sieve.

For the heavy mineral analysis, the coarse fraction is subdivided into suitable size fractions by sieving. Light (specific gravity >2.89) and heavy (specific gravity >2.89) separates are obtained by centrifuging the desired size fraction in Bromoform; the heavy mineral grains accumulate in the bottom of the centrifuge tube. They are removed by freezing the Bromoform in the lower part of the tube and pouring off the top Bromoform.

These procedures have been recently completed for samples collected during the 1979 summer. Microscopic identification will be completed in the forthcoming quarter.

Also outstanding are the preparation and examination of thin sections from gravel samples. The compositions of gravels collected concurrently with the sands will substantiate provenance interpretations based on the heavy mineral assemblages. The procedure here is to determine the various lithologies of gravel in each sample bag by visual inspection and to quantify the relative abundance of each lithology. The relative abundance is assumed proportional to the nearness to source, considering grain stability. The thin section analysis will also be completed in the forthcoming quarter.

Textural analyses of samples collected in the various terrain units discussed in the quarterly report for the period ending September 30, 1979 were temporarily discontinued to initialize the above described sample preparations. It is considered essential that all parts of the overall analyses be at least organized and in the initial stages of completion.

A literature synthesis of the bedrock and surficial geology of the Colville, Kuparuk, Sagavanirktok, and Canning River drainages was initiated this quarter as a supplement to the provenance studies. The Canning and Sagavanirktok River drainages were considered this quarter.

Leffingwell (1919) defined the Flaxman Formation as foreign glacial till containing large boulders and possibly glacial ice. He also notes that the boulders are distributed all along the coasts of the Beaufort and Chukchi Seas. The origin of the Flaxman Formation has been speculated since it was defined in 1919. Implications of the real origin are important to the interpretation of the Quaternary history of the Alaskan Arctic coastal plain. For this reason, a literature synthesis of the following topics was completed this quarter: the character, stratigraphic position and age of the formation, sea level and glacial histories on the coastal plain, modes of clastic transport, and lithologies of possible source areas. A Flaxman boulder was also submitted for a K-Ar date this quarter as part of the Flaxman study. Thin sections of this boulder were made to check its suitability for dating. The literature syntheses incorporated a commercial computer reference search.

A large part of this quarter's activities involved selection and procurement of remote sensing data. Landsat images of the study area are being compiled and annotated with meteorological data corresponding to the acquisition time of the image (Figure 1). Several Landsat mosaics have also been constructed to provide a regional reference for specific locations within the study area.

Photographic data from 1955 and 1979 were recently acquired of the four delta systems and other areas under study. These data will be used to map geomorphic features and to determine rates of change. The early photography was obtained through Eros Data Center, South Dakota. The recent photography was printed by this research unit from 1978-79 color U-2 photography. Noncommercial processing allows minimal variation between prints, positive or negative prints, and reduction or enlargement of specific areas (Figure 2). Optimal data are derived from such flexibility in processing.

III. Results

Activities related to the sediment analyses have thus far been preparatory. No results concerning this aspect of the study are included this quarter.

Literature syntheses this quarter produced two draft reports. One outlines the bedrock and surficial geology within the Canning and Sagavanirktok River drainage basins; the other, discusses various hypotheses for the origin of the Flaxman Formation, and the factors essential to these hypotheses. The draft nature of these reports precludes their inclusion at this time; however, the abstracts and reference lists are included in the appendix.

Results of the K-Ar age date for the Flaxman boulder are not yet available.

Preliminary examination of sequential photography show marked changes in geomorphic features near the mouths of deltas and on some of the offshore islands over the past 24 years. As an example, Narwhal Island shows marked segmentation and each segment is very recurved (Figure 3). These changes have not yet been quantified.

Results of the computer referencing service are not as good as expected. Much of the data are either too general or too specific, and there is considerable repetition of listings.

IV. Interpretation of Results

The preliminary extent of the sediment analyses preclude interpretations in this regard. A literature synthesis concerning the geology within the Sagavanirktok and Canning River drainage basins indicates few lithologies similar to those of the Flaxman boulders. Other interpretations from this synthesis are given in the appendix.

It is apparent from another literature synthesis that many factors enter into the interpretation of the origin of the Flaxman Formation. Several of these factors have inherent difficulties in terms of corroborating certain hypotheses. Four of these are discussed below in no particular order.

If one assumes that boulders of the Flaxman Formation are remnants of a moraine left by a glacier emergent from the Mackenzie River drainage and shorefast along the Beaufort Sea coast, then one would expect indications such as coastal scouring and glacial landform development. There are no apparent such indicators. Leffingwell (1919) first considered this possibility but discounted it for the given reasons.

Flaxman boulders are apparently found inland to elevations of about 10 meters. Hopkins (1979) suggests that the Flaxman Formation was deposited during the Pelukian Transgression that encroached inland to elevations of about 7 meters. There is no water depth differential in this case; nevertheless, if there was, it would probably not be sufficient to account for the draft of bergs or ice islands capable of transporting 3500 to 4500 kilogram boulders.

MacCarthy (1958) indicates that rocks on Ice Island T-3 were sufficiently different from those he observed along the Beaufort Sea coast to be discounted from the same source. Contrarily, a gabbro sample collected on Bodfish Island (west of Prudhoe Bay) compares in hand-specimen very well with a gabbro collected by NARL personnel from Ice Island Arlis II.

There are apparently a number of localities in Canada and Greenland with lithologies similar to those of the Flaxman Formation. It seems premature to assign specific sources at this time. To definitely establish a source of the Flaxman boulders, a detailed sampling and petrographic analysis study is required. With definite source(s) established, the transport mechanism(s) will follow.

Usable output from the computerized reference service requires selected input, which in turn requires considerable research and computer time.

Time spent researching the input might be better used for a manual reference search.

Geomorphic processes ongoing at the time of remotely-sensed data acquisition will be considerably better understood with the addition of meteorological data. Spatial and temporal interpretations of these processes requires more data than has presently been acquired. Acquisition of data is proceeding.

V. Problems Encountered

No problems were encountered during this past quarter.

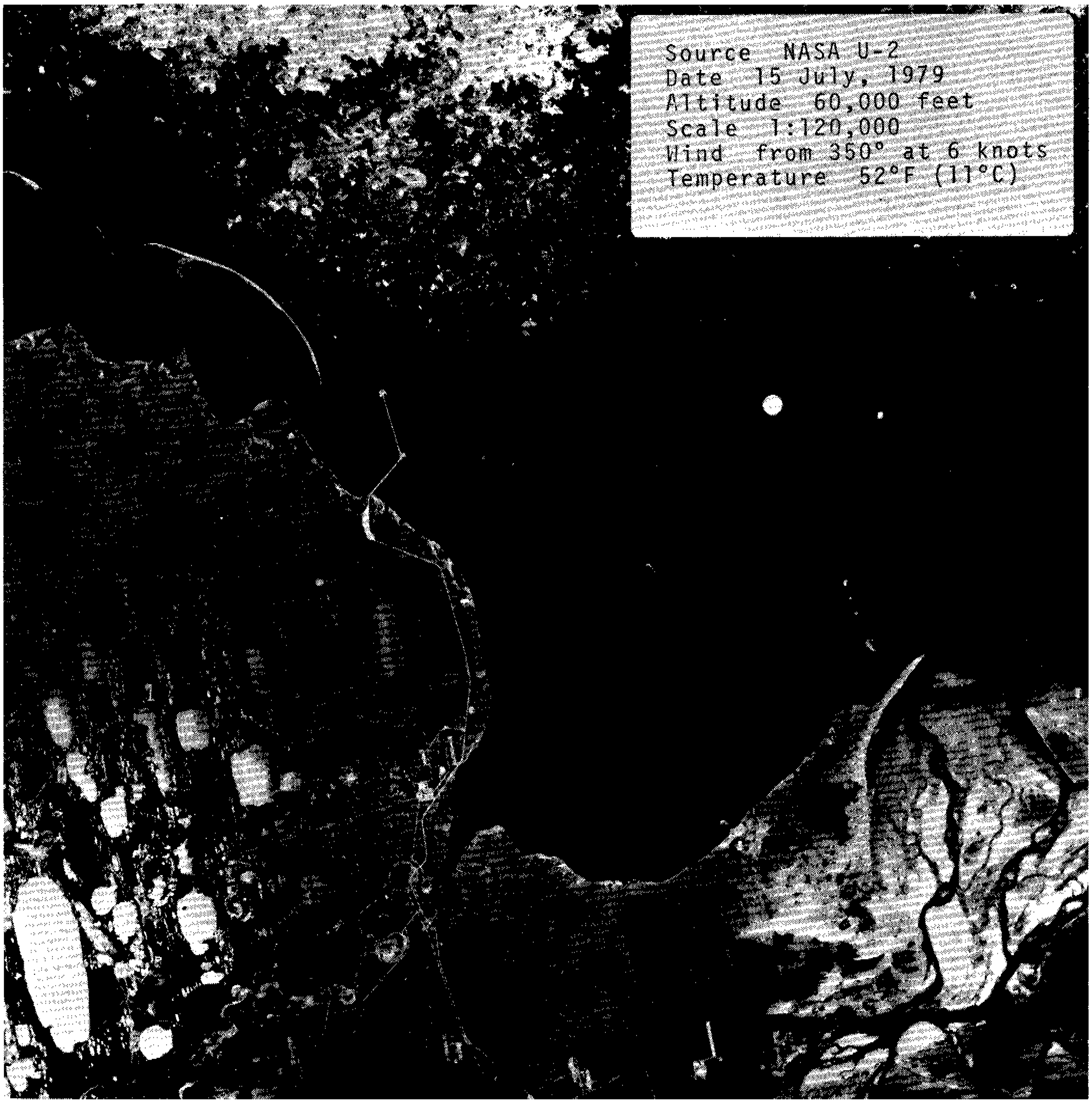

Figure 1. Photograph of Prudhoe Bay, annotated with meteorlogical and other data.

Figure 2. Photograph of the ARCO west dock at Prudhoe Bay; it illustrates the degree of information possible with enlarged scales 408

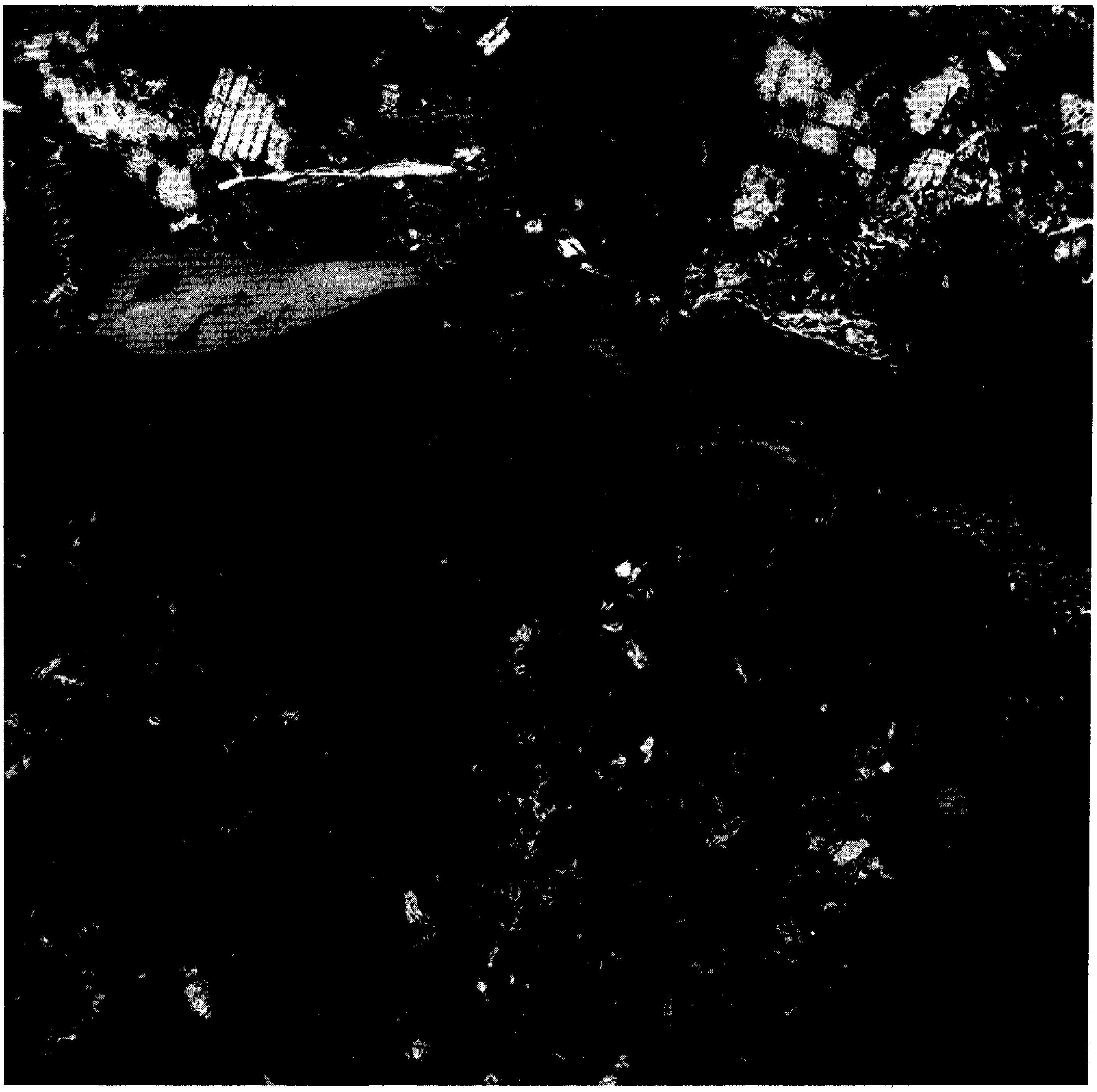

Figure 3. Photograph of Narwhal Island; it illustrates segmentation and the recurving of each segment.

APPENDIX

Abstracts and References from Literature Synthesis Reports

ABSTRACT

The Flaxman Formation consists of clay and silt containing large, sometimes glacially striated boulders. It is exposed along the Beaufort and Chukchi Sea coasts of Alaska and is Pleistocene in age. The origin of this formation has been speculated since it was defined in 1919 by E. Leffingwell.

Two schools of thought provide the numerous hypotheses of the origin of the Flaxman Formation, in particular, the boulders: they are remnants of early Pleistocene moraines left by glaciers that originated in the Brooks Range or interior Canada; and they were ice-rafted from easterly sources (Mackenzie Delta, Canadian Archipelago, and Greenland) and subsequently deposited.

Factors essential for an interpretation of the origin of the Flaxman Formation are: the character, stratigraphic position and age of the formation, sea level and glacial histories on the coastal plain, modes of clastic transport, and lithologies of possible source areas. These factors are discussed but no conclusions of the origin of the formation are formulated.

The implications of the real origin are important to the interpretation of the Quaternary history of the Alaskan Arctic coastal plain.

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ABSTRACT

This paper summarizes the lithologies and areal distribution of rocks within the Canning and Sagvanirktok River drainages; it also summarizes the structural geology. The rock and structure data are part of a sediment dispersal study based on heavy minerals. These data are used to predict mineral assemblages within the drainage systems and to suggest provenance areas for those assemblages.

Lithologic units within the drainages are predominately sedimentary clastics and non-clastic carbonates. Plutonic and volcanic rocks consist of mafic sills, flows, tuffs, and agglomerates. Outcrops of these rocks are small.

The carbonate units will probably contribute few heavy minerals to the drainage systems. The predominate heavy mineral assemblages will probably be those associated with reworked clastic rocks. Assemblages associated with mafic igneous rocks will also probably be present but to a lesser extent than the clastic rocks.

The geologic structure is dominated by east-west trending folds and thrusts. Most of the folds are overturned to the north and thrusting is from the south. The structure has little effect on sediment dispersal in terms of creating areas of anomalous supply.

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DATA MANAGEMENT

DATA MANAGEMENT

CONTENTS

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QUARTERLY REPORT

Contract Number: 03-7-022-35139
Research Unit Number: 527
Reporting Period: 7/1/79-9/30/79

OCSEAP DATA PROCESSING SERVICES

Harold Petersen Jr.
Data Projects Group
Pastore Laboratory
University of Rhode Island
Kingston, Rhode Island 02881

1 October 1979

Background and Objectives

The Data Projects Group (DPG) at the University of Rhode Island provides a variety of services to the OCSEA Program in general and to the Juneau Project Office (JPO) in particular. Through these auspices, services are also made available to several Research Units (RUs).

Over the lifetime of the contract, DPG has used a data management system known as the MARMAP Information System (MIS). The MIS was earlier designed and developed by DPG for the National Marine Fisheries Service. As related to this work, the MIS has provided the means to carry out batch-styled data set validations, to create and maintain a significant data base, and to retrieve those portions of the data base appropriate to any of a variety of analysis products.

More recently, and in response to a need for real-time data validation, this RU has developed the Interactive Data Entry and Analysis (IDEA) System. The distributed data processing system, described in the previous Quarterly Report submitted by this RU, allows investigation to validate field data during its real-time entry into OSCEAP/NODC designated formats, thereby avoiding many problems associated with carrying out these steps in the traditional non-quality controlled, non-real-time environment.

The coupling of the IDEA and MIS systems provides the resources necessary to efficiently carry out the primary objectives of this work, which include the orderly conveyance of validated data from investigator sites to the Program, and the provision of data analysis support to selected investigators.

Report Overview

During this quarter, efforts were directed in three main areas, including:

-Continued development of the IDEA System

-Analytical product support

-Continued processing of received data sets

The sections that follow detail progress made in each of these areas.

Continued Development of the IDEA System

At the close of the previous quarter, the equipment which comprised the basic system had been put in place, programs distributed, and initial user training carried out. During this quarter, much progress has been made in systematizing the development and distribution of system enhancements. These efforts fall into two complementary areas - data entry programs and system support programs and procedures.

A first version of a data entry program for File Type 033 data was distributed last quarter when equipment was installed at the various user sites. Experience gained from user's comments regarding use of this program has led to the development and issuance of Version 2.0 of this program during this quarter. An accompanying program, SUMM033, was also developed to aid users in reviewing the status of an entered 033 data set prior to its submission to the Program.

Two other data entry programs were also developed and distributed during this quarter. These include Version 1.0 of File Type 034, Marine Bird Sighting-Land Census data, and Versions 1.0 through 4.0 of File Type 031, Marine Bird Specimen and Feeding Studies. In the latter case, its use revealed the need for several format modifications, and these were implemented in the data entry program upon receipt of Program authorization.

New versions of the CATNATE, SEPRATE, and STAR programs were prepared and distributed. These new versions now apply to all data entry programs prepared to date.

So that these and future updates, additions, etc. to the IDEA System can be readily incorporated into daily practice by system users, a documentation manual including all current program and procedure descriptions was prepared and distributed along with a system diskette. As new material is distributed, users need only add it to their System manuals and diskette libraries, removing obsolete versions of programs and documentation as necessary. Two portions of this manual, Version 4.0 of the File Type 031 data entry program and the SUMM033 program, are included here as Appendix I. Complete manuals are available from this RU and from JPO.

It is expected that the majority of data received at the host site, RU 527, will be either on diskettes recorded on TI771 terminals or by 3780 telecommunications protocol, via telephone link. However, data may also arrive via diskettes recorded on another manufacturer's equipment. Since many manufacturers have unique diskette recording formats (as distinct from the data formats referenced above), transfer of such data can be achieved only if these manufacturers also agree to provide utilities designed to convert data to/from some universally agreed-to form.

For many reasons, that recording technique is one developed by IBM, and Texas Instruments (TI), among others, provides the necessary utility programs. This RU has had mixed success, however, using these utilities to read diskettes recorded in "IBM" format on a Wang system at RU 370/497. In some cases, conversion to TI format proceeds with no problem, yet at other times, diskettes are unreadable. Resolution of this problem is being sought. In such cases, data have also been requested on tapes, which have been read with no problem.

A variety of other programming has either been started during this quarter or is planned for initiation during the upcoming quarter. These programming tasks include, but are not limited to, development of a File Type 135 data entry/validation program, updating of the support programs CATNATE, SEPRATE, STAR, and SUMMXXX, development of a user-oriented ediitor which addresses a specific record-field rather than the more general purpose editor presently available as a TI utility, development of a program which allows validation of data previously entered by other means (ex. keypunch), and more support and/or management programs.

Analytical Product Support

This quarter has witnessed a major effort aimed at providing File Type 033 analysis products for the Bering Sea synthesis report. As indicated in the previous Quarterly Report, the work has been carried out with RU 083 under the auspices of JPO. A suite of ten product types has been developed since this work was begun, including five new ones during this quarter. The new ones include a Sightings Effort Table, Sightings Effort Plot, Transect Catalog, Graduated Symbol Plot, and Bird Density Histogram. A product compendium containing a sample of each product plus an accompanying brief description was also produced, and is included here as Appendix II.

Those products which were produced in volume during this quarter are listed below. Unless otherwise specified, data used for these analyses were collected by RUs 083, 108, 239, and 337 during the period 1975-1978, and which had been validated, delivered to NODC, and included in RU 527's MIS data base as of 10/1/79 - see Appendix III for a complete list of these field operations.

- 12 Sightings Effort Plots for data taken around Kodiak Island

- 12 Sightings Effort Plots for data taken around the Pribilof Islands

- 17 Contour diagrams of bird density data in the vicinity of the Pribilof Islands

- 54 Graduated Symbol Plots of bird density data in the Bering Sea

- -9 Bird Density Histograms, 17 bird species each, for data in the vicinity of the Pribilof Islands
- -13 Digital Density Plots for bird data taken in the Bering Sea
- -8 Data Summary Tables for RU 083 1978 data
- -1 Sightings Effort Table for Bering Sea data
- -1 Sightings Effort Table for data taken in the vicinity of Kodiak Island
- -46 Statistical Analyses for data taken in vicinity of Pribilof Islands

Since these products involve data collected by several RUs, and since each RU has carried out the census experiment itself in a slightly different manner, the algorithms used to calculate bird densities were different for each RU. Generation of many of these products, therefore, involved different precursor steps in order to result in one unified portrayal of the results. Although not indicated in the number of analyses, these variations in the method actually contribute significantly to the overall effort required in their production.

Generation of these products depend in part on the availability of data in the data base. As referenced in the previous Quarterly Report, updating the data base with information critical to the products continues as a significant task.

File Type 033 Data Validation

A Field Operation Status Report for File Type 033 data is included as Appendix III to this report. Please refer to that report in conjunction with this section.

Four data submissions were received during this quarter. On 8/20/79, two tapes were received from RU 337, the first containing data for 10 field operations, and the second for 25 field operations. Field operations dating from 1975 through 1979 were included on each tape. Validation products CODEPULL and LOGLIST are being prepared for all 35 field operations, and will be sent to RU 337.

A tape containing data for 10 field operations was received from RU 467 on 9/20/79. The data were collected during 1978 field operations. Validation products are being generated for these data as well.

A diskette containing data collected during a 1979 field operation carried out by RU 196 was received on 8/20/79. The data were entered on the IDEA system by RU 083. As with the first receipt of data entered on the IDEA system, validation products were prepared and sent to the contributing RU. This is done primarily to ensure compatibility of validation between the batch CODEPULL and LOGLIST approach and the interactive IDEA approach. The two approaches will be run in parallel until both yield identical results, and then the batch approach will be discontinued for receipt of new data entered in the format via the IDEA system.

These data receipts bring to 190 the total number of data sets of this type received to date. Validation products have been produced for all of them.

One LOGLIST was received during this quarter for the first data set entered via the IDEA system (field operation UCI478, received 6/4/79, CODEPULL and LOGLIST mailed 6/29/79). CODEPULL was not returned as no code errors were found. The data were edited on the basis of errors found by LOGLIST, and sent to NODC on 8/15/79.

This brings to 135 the number of LOGLIST products returned, the remaining 55 consisting of the 46 referenced above plus those others from RU 196 which have been outstanding for some time (see Appendix III, tape numbers CALIF1, CALIF2, and CALIF3). A similar number of CODEPULL products remain. Of the 135 sets returned, all have been edited, and a total of 132 data sets sent to NODC. The other three still await RU 083's resolution of non-CODEPULL or LOGLIST-related errors.

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											X											
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 from FWS to NODC format													X									
Feasibility study for distributed data entry and processing completed							X															
Establishment of distributed data entry and processing node at RU 527																X						

(continued)

	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
Establishment of distributed data entry sites at RU 083 and RU's 196/172													X									
Establishment of distributed data entry sites at RU 337 and RU 237															X							
Preparation of data entry/validation programs for IDEA system																						
1. File Type 033 - Version 1.0													X									
2. File Type 033 - Version 2.0																	X					
3. File Type 031																		X				
4. File Type 135																						0
5. File Type 034																			X			
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											X											
Delivery of production runs of 033 analysis products to RU 083 for use in Final Report												X---	---	---	---	---	---	---	---			
Conversion of NODC version of File Type 033 data into MIS data base																X---	---	---	---	---	---	---

(continued)

Major Milestones	1978 M	A	M	J	J	A	S	O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D
Development of additional analyses for File Type 033 data - for use in Bering Sea synthesis study																			X			
Production use of entire suite of 033 analysis products for Bering Sea synthesis study																		X-	---	---	---	---
Preparation of IDEA system support programs																X-	---	---	---	---	---	---
Maintenance of systems and applications programs	X-	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Quarterly Reports	X				X			X			X			X			X			X		
Annual Report	X													X								
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

IDEA = Interactive Data Entry and Analysis

MIS = MARMAP Information System

Appendix I

Sample Portions of IDEA System
Operations Manual

```
      d
      d
      d
   dddd    ppp    999
  d   d   p   p  9   9
  d   d   p   p  9   9
   dddd   pppp    9999
          p          9
          p       9  9
          p        999
```

DATA PROJECTS GROUP
333 Pastore Hall
University of R.I.
Kingston, RI 02881
(401) 792-2320

FIELD SPECIFICATIONS AND GENERAL INSTRUCTIONS FOR TI DATA ENTRY OF FILE TYPE 031

MARINE BIRDS SPECIMEN AND FEEDING STUDIES

VERSION 4.0

INCLUDES RECORD TYPES A,D,E,F,G,H,I,T

COLUMN HEADING DEFINITIONS AND NOTES

Field - Name of each field as displayed on the VDT screen.

Tab - Tabstop. The cursor jumps to these fields when the "Tab" key is depressed.

Init - Initial value of the field. Using the "Field" key will retain this value, the "Skip" key will delete it. Fields that are self-initialized retain the value last entered.

Char - Allowable characters, where digits include 0-9 and numbers include 0-9, +, -.

Req - Required field, must be filled in. Asterisks (see below) can be entered in most fields if uncertainty exists (illegible data source) or data fails range test. This will allow data entry to continue and permit convenient editing. Where no data is available, required fields should be blank-filled. For OCSEAP Format 031, the following fields are needed for proper sequencing of records or are essential to interpretation of associated fields, and thus cannot be asterisk-filled:

File ID (Header)
Station Number (A)
Specimen Number (D)
Food Sample Source Code (F)
Item Number (G)
Unit of Measurement (H,I)
Interval Value (H,I)

Range - Allowable range for data being entered. Code groups are also verified by range limits.

Just - Justify. Numeric data is automatically right justified and/or zero filled based on these codes. However, note that the Prey Tax Code on Record Type G must be left-justified by the user.

Proc - There are six subroutine procedures used for special processing:

Ltln - Splits Latitude or Longitude fields and checks range of degrees, minutes, seconds and hemisphere. Lat and Lon require all but the seconds field.

Ck31 - Checks data for numerics and ranges while still allowing blanks and asterisks. Fills field with asterisks if one is entered.

Taxn - Converts 4 character abbreviation into taxonomic code via a look-up file called Taxons. Also allows tax code to be entered directly provided it begins with 91 or 92 and has an even number of digits.

Prey - Detects embedded blanks or asterisks in Prey Tax Code field.

Order - Checks that lengths or weights of prey parts (on Record Type H or I) are in order from smallest to largest. Field error mode will occur when a length/weight entry lacks its associated number. Once a length/weight field is skipped, blank-filled, or asterisk-filled, then the remaining length/weight felds on the record must also be skipped, blank-filled, or asterisk-filled to avoid field error mode.

Init - Initializes global variables for use by other checking procedures.

Notes - Any extra information about the field.

Asterisks - Entry of one asterisk followed by SKIP will asterisk-fill the field. This is useful for finding the field and noting its length when using the TI Editor. All asterisks entered must be corrected before submitting the data to OCSEAP.

Special Note

- Format 031 Unit of Measurement Code, Records H and I, defines the unit of length or weight used in subsequent fields on the same record. For example, if the Unit of Measurement Code, Record H, is 7, then units are 0.1 mm. Since length fields have 3 digits, the maximum length which can be coded on this record is 99.9 mm. For larger sizes, a new Record H should be generated with a suitable unit code. Record I is treated similarly, where measurements are weights rather than lengths.

RECORD TYPE SEQUENCING FOR FORMAT 031

1. Each station must begin with a Record A. Records B and C are not implemented in this version of OCSEAP Format 031.

2. One or more Records D are permitted per station. Each Record D defines a specimen.

3. One Record E per Record D is optional.

4. One or more Records F are permitted per specimen. Each Record F defines a Food Sample, as designated by the Food Sample Source Code.

5. Zero, one, or multiple Records G are permitted per Record F (per Food Sample). Records G (and Records H and I) are associated with appropriate F Records by means of the Food Sample Source Code, which appears in column 19 of Record F and is repeated in column 75 of Records G,H, and I.

6. Each Record G (which defines a Prey Item), can have zero, one, or multiple Records H and zero, one, or multiple Records I. Records H and I must be preceded by a Record G. Prey sizes (Record H) and weights (Record I) are associated with Prey Identification and other parameters (Record G) by means of the Item Number.

7. The Text Record T is linked to the appropriate record by Specimen Number and Citation. For simplicity, data entry is designed to accept text records at the end of a series of records defining a given Specimen. That is, after entering Record T, only A,D, or T can be selected.

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OCSEAP FILE TYPE 031

MARINE BIRDS

SPECIMEN AND FEEDING STUDIES

FILE ID: ______

VER 4.0 OK? _

HEADER RECORD

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File Type								Fixed "031"
2. File ID	tab		all	req				Need all 6 characters, starting with a letter
3. Version								Fixed "Ver 4.0"
4. OK?	tab			req	Y,N			"Y" enters record, displays RT "N" returns for correction to File ID.

```
    FILE ID: FWXXXX  RECORD TYPE: A  STATION: _____

*****************************************************************

*  LOCATION RECORD                                              *
*                                                               *
*                                                               *
*          LATITUDE      LONGITUDE      DATE       TIME         *
*          _______       ________       ______     ____         *
*          ddmmssh       dddmmssh       yymmdd     hhmm         *
*                                                               *
*                                                               *
*                                                               *
*          SEQ                                                  *
*          1__                                 OK? _            *
*                                                               *
*                                                               *
*****************************************************************
```

RECORD TYPE A

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "A"
3. Station	tab		all	req				Need all 5 characters, copied to other records. Within a File ID, every Record A must have a new unique station number.
4. Latitude	tab		dgt	req	33-73 deg		Ltln	
			dgt	req	0-59 min			
			dgt		0-59 sec			
				req	N,S hem			
5. Longitude	tab		dgt	req	118-180 deg		Ltln	
			dgt	req	0-59 min			
			dgt		0-59 sec			
				req	E,W hem			
6. Year	tab		dgt	req	75-79		Ck31	Autoskip
7. Month			dgt	req	1-12	Z	Ck31	Autoskip
8. Day			dgt	req	1-31	Z	Ck31	
9. Hour			dgt		0-23	Z	Ck31	Autoskip
10. Minute			dgt		0-59	Z	Ck31	

RECORD TYPE A
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
11. Blanks								A 37 character blank field (not visible on screen) used to space out to seq no.
12. Sequence	tab		dgt			Z		Automatically entered as 001. Incremented for each record in station. End output recor
13. OK?	tab				Y,N			"Y" enters record, displays RT "N" returns for corrections, use "Field" or "Tab" to pass over good entries.

```
   FILE ID: FWXXXX  RECORD TYPE: D  STATION: 00001  SPEC: ___

*************************************************************************
*  SPECIMEN FIELD DATA                                                  *
*                                                                       *
*          TAXONOMIC      COLLECTION   CARCASS   SEX   AGE              *
*            CODE           METHOD       DISP                           *
*          ____________       _           _       _     _               *
*                                                                       *
*   COLOR    PLUMAGE   BROOD   BEHAVIOR    NUMBER BIRDS    COLLECTION   *
*                      PATCH              IN COLLECTION    ID NUMBER    *
*     _         _        _        __            __            __        *
*                                                                       *
*                                                                       *
*    SEQ                                                                *
*    ___                      OK? _  NEXT REC(A,D,E,F,T): ________      *
*                                                                       *
*************************************************************************
```

RECORD TYPE D

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "D"
3. Station								Copied from RT A
4. Specimen	tab		all	req				Need all 3 characters, copied to other records for this specimen.
5. Tax Code	tab		all	req		L	Taxn	Enter 4 character abbreviation (converted to Tax by proc) or actual Tax (91 or 92, with even number of digits).
6. Collection Method					1-7			NODC Code 0228
7. Carcass Disposition					1-5			NODC Code 0229
8. Sex					0-5			NODC Code 0101
9. Age Class Group					0-2,4-8,A-H, J-N, P-S			NODC Code 0112
10. Color Phase					0-9			NODC Code 0115

RECORD TYPE D
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
11. Plumage					0-8,A			NODC Code 0043
12. Brood Patch					0-4			NODC Code 0230
13. Behavior					00-18,20-54, 60-99,A1-A8		Ck31	NODC Code 0142
14. Number of Birds in Collection			dgt			R	Ck31	
15. Collection ID Number, "Linkage Number"			dgt			R	Ck31	
16. Blanks								A 34 character blank field (not visible on screen) use to space out to seq no.
17. Sequence	tab		dgt					Automatically entered and incremented for each record in station. End output reco
18. OK?	tab				Y,N			"Y" enters record, "N" returns for corrections
19. Next Rec					A,D,E,F,T			Converts to 8 character TI code for next Record Type desired and displays it.

FILE ID: FWXXXX RECORD TYPE: E STATION: 00001 SPEC: 001

****

SPECIMEN MEASUREMENTS

TARSUS	CULMEN	BILL WIDTH	RIGHT WING
tenths mm	tenths mm	tenths mm	whole mm
____	____	___	___
BURSA	**TOTAL LENGTH**	**TOTAL WEIGHT**	**DRY WEIGHT**
tenths mm	whole mm	whole grams	tenths g
___	____	_____	____
FAT FREE WT	**VISCERA WEIGHT**	**GONAD SIZE**	**FAT CODE**
tenths g	whole grams	tenths mm	
______	____	____	_

SEQ

___

OK? _ NEXT REC(A,D,F,T): ________

****

RECORD TYPE E

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "E"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Tarsus	tab		dgt			R	Ck31	Tenths millimeter
6. Culmen			dgt			R	Ck31	Tenths millimeter
7. Bill Width			dgt			R	Ck31	Tenths millimeter
8. Wing Length			dgt			R	Ck31	Whole millimeters
9. Bursa Length			dgt			R	Ck31	Tenths millimeter
10. Total Length			dgt			R	Ck31	Whole millimeters
11. Total Weight			dgt			R	Ck31	Whole grams
12. Dry Weight			dgt			R	Ck31	Tenths gram
13. Fat Free Weight			dgt			R	Ck31	Tenths gram
14. Viscera Weight			dgt			R	Ck31	Whole grams
15. Gonad Length			dgt			R	Ck31	Tenths millimeter

RECORD TYPE E
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
16. Fat Code			dgt		1-5			NODC Code 0119
17. Blanks								A 14 character blank field (not visible on screen) used to space out to seq no.
18. Sequence	tab		dgt			Z		Automatically entered and incremented for each record in station. End output record
19. OK?	tab				Y,N			"Y" enters record, "N" returns for corrections.
20. Next Rec					A,D,F,T			Converts to 8 character TI code for next record type desired and displays it.

FILE ID: FWXXXX RECORD TYPE: F STATION: 00001 SPEC: 001

****

FOOD SAMPLE CONTENTS

FOOD SAMPLE SOURCE	STOMACH FULLNESS	GUT PORTION	WET WEIGHT tenths g
_	_	_	______

FOOD VOLUME whole ml	DRY WEIGHT tenths g	NON-FOOD WEIGHT tenths gram
______	______	______

SEQ

___ OK? _ NEXT REC(A,D,F,G,T): ________

****

RECORD TYPE F

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "F"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Food Sample Source	tab			req	1-7			NODC Code 0147 Copied to Records G,H,I.
6. Stomach Fullness					1-7			NODC Code 0092
7. Gut Portion					1-4			NODC Code 0240
8. Wet Weight			dgt			R	Ck31	Tenths gram
9. Food Volume			dgt			R	Ck31	Whole milliliter
10. Dry Weight			dgt			R	Ck31	Tenths gram
11. Non-food Weight			dgt			R	Ck31	Tenths gram
12. Blanks								A 32 character blank field (not visible on screen) used to space out to seq no.

RECORD TYPE F
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
13. Sequence	tab		dgt			Z		Automatically entered and incremented for each record in station. End output recor
14. OK?	tab				Y,N			"Y" enters record, "N" returns for corrections.
15. Next Rec					A,D,F,G,T			Converts to 8 character TI cod for next record typo desired and displays it.

FILE ID: FWXXXX RECORD TYPE: G STATION: 00001 SPEC: 001

****

PREY IDENTIFICATION AND COUNT

PREY TAX CODE	PREY SPECIES GROUP	NON-FOOD ITEM	PREY PART IDENT
____________	__	__	__

NUMBER OF PREY OR PARTS	ALIQUOT FACTOR	WHOLE PREY EQUIVALENT	LIFE HISTORY	VOLUME METHOD
___	01	____	_	_

PREY VOLUME % to tenths	PREY DRY WEIGHT grams to 0.001	PREY WET WEIGHT grams to 0.001	VOLUME OF PREY tenths ml
___	_____	______	____

FOOD SOURCE	ITEM NO.	SEQ	OK?	NEXT REC (A,D,F,G,H,I,T)
_	__	___	_	________

****

RECORD TYPE G

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "G"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Prey Tax Code	tab		dgt	req		L	Prey	To subspecies, even number of digits.
6. Prey Species Group			dgt			Z	Ck31	
7. Non-food Item					XA-XH		Ck31	NODC Code 0237
8. Prey Part Identification					AA-AN,AP-AU, AZ		Ck31	NODC Code 0231
9. Number of Prey or Prey Parts			dgt			R	Ck31	Whole number. When number of items is too large, an aliquot is used.
10. Aliquot Factor	tab	01	dgt		01-10	Z	Ck31	NODC Code 0232 02 is an aliquot of 1/2, 10 is an aliquot of 1/10, et 01 indicates a total count.
11. Whole Prey Equivalent			dgt			R	Ck31	Whole number. The number of whole prey that the numbe prey parts is equivalent to.

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RECORD TYPE G
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
12. Life History Code					A-M,P-Y,0-9			NODC Code 0148
13. Volume Method					A,B,C			NODC Code 0233. Leave blank when using Volume of Prey
14. Prey Volume			dgt			R	Ck31	Percent to tenths. Leave blank when using Volume of Prey
15. Prey Dry Weight			dgt			R	Ck31	Grams to thousandths
16. Prey Wet Weight			dgt			R	Ck31	Grams to thousandths
17. Volume of Prey			dgt			R	Ck31	Volume to tenths of milliliters
18. Blanks								9 character blank field (not visible on screen) used to space out to Food Source.
19. Food Source								Copied from RT F
20. Item No.			all	req				Each prey or non-food item is assigned a consecutive number Need 2 characters. Copied to Records H,I,T.
21. Sequence	tab		dgt			Z		Automatically entered and incremented for each record in station. End output record
22. OK?	tab				Y,N			"Y" enters record, "N" returns for corrections.
23. Next Rec					A,D,F,G,H,I,T			Converts to 8 character TI code for next Record Type desired and displays it.

```
FILE ID: FWXXXX  RECORD TYPE: H  STATION: 00001  SPEC: 001

**********************************************************************
*  PREY SIZE CLASSES                                                 *
*        UNIT OF MEASUREMENT                  INTERVAL VALUE         *
*                7                                  _                *
*                                                                    *
*         SIZE CLASS 1      SIZE CLASS 2      SIZE CLASS 3           *
*        NUMBER  LENGTH    NUMBER  LENGTH    NUMBER  LENGTH          *
*         ___     ___       ___     ___       ___     ___            *
*                                                                    *
*         SIZE CLASS 4      SIZE CLASS 5      SIZE CLASS 6           *
*        NUMBER  LENGTH    NUMBER  LENGTH    NUMBER  LENGTH          *
*         ___     ___       ___     ___       ___     ___            *
*                                                                    *
*         SIZE CLASS 7      SIZE CLASS 8      SIZE CLASS 9           *
*        NUMBER  LENGTH    NUMBER  LENGTH    NUMBER  LENGTH          *
*         ___     ___       ___     ___       ___     ___            *
*                                                                    *
*        FOOD SOURCE  ITEM NO.  SEQ   OK?      NEXT REC              *
*             _          __     ___    _    (A,D,F,G,H,I,T)          *
*                                              ________              *
**********************************************************************
```

RECORD TYPE H

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "H"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Unit of Measurement		7		req	1-8, or blank			NODC Code 0234 If coded, Interval Value will be blank.
6. Interval Value				req	3,7,8, or blank			Subset of NODC Code 0234 If coded, Unit of Measuremen will be blank.
7. Size Class 1, Number			dgt	req		R	Ck31	Whole number of prey or prey p
8. Size Class 1, Measurement of Length			dgt	req		R	Order	Length of prey or parts. Measurements must be in orde from smallest to largest. Each length must have corresponding number.
9-24. Size Classes 2-9								See Size Class 1 Note.
Number			dgt			R	Ck31	
Length			dgt			R	Order	

RECORD TYPE H
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
25. Food Source								Copied from RT F
26. Item								Copied from RT G
27. Sequence	tab		dgt			Z		Automatically entered and incremented for each record in station. End output record.
28. OK?	tab				Y,N			"Y" enters record, N returns for corrections.
29. Next Rec					A,D,F,G,H,I,T			Converts to 8 character TI code for next Record Type desired and displays it.

FILE ID: FWXXXX RECORD TYPE: I STATION: 00001 SPEC: 001

****

PREY WEIGHT CLASSES

UNIT OF MEASUREMENT	INTERVAL VALUE
D	_

WEIGHT CLASS 1		WEIGHT CLASS 2		WEIGHT CLASS 3	
NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
___	___	___	___	___	___

WEIGHT CLASS 4		WEIGHT CLASS 5		WEIGHT CLASS 6	
NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
___	___	___	___	___	___

WEIGHT CLASS 7		WEIGHT CLASS 8		WEIGHT CLASS 9	
NUMBER	WEIGHT	NUMBER	WEIGHT	NUMBER	WEIGHT
___	___	___	___	___	___

FOOD SOURCE	ITEM NO.	SEQ	OK?	NEXT REC (A,D,F,G,I,T)
_	__	___	_	________

****

RECORD TYPE I

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "I"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Unit of Measurement		D		req	A-F, or blank			NODC Code 0235 If coded, Interval Value will be blank.
6. Interval Value				req	A,D, or blank			Subset of NODC Code 0235 If coded, Unit of Measurement will be blank.
7. Weight Class 1, Number			dgt	req		R	Ck31	Whole number of prey or prey pa
8. Weight Class 1, Measurement of Weight							Order	Weight of prey or parts. Measurements must be in order from smallest to largest. Each weight must have corresponding number.
9-24. Weight Classes 2-9								See Weight Class 1 Note.
Number			dgt			R	Ck31	
Weight			dgt			R	Order	

RECORD TYPE I
(continued)

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
25. Food Source								Copied from RT F
26. Item								Copied from RT G
27. Sequence	tab		dst			Z		Automatically entered and incremented for each record in station. End output recor
28. OK?	tab				Y,N			"Y" enters record, N returns for corrections.
29. Next Rec					A,D,F,G,I,T			Converts to 8 character TI code for next Record Type desired and displays it.

```
FILE ID: FWXXXX  RECORD TYPE: T  STATION: 00001  SPEC: 001
******************************************************************
TEXT RECORD


        CITATION
    RECORD TYPE  ITEM NO.

         _          __


    TEXT:

    ________________________________________________________



    SEQ
                             OK? _  NEXT REC(A,D,T): ________
    ___

    **************************************************************
```

RECORD TYPE T

Field	Tab	Init	Char	Req	Range	Just	Proc	Notes
1. File ID								Copied from Header, not output
2. Record Type								Fixed "T"
3. Station								Copied from RT A
4. Specimen								Copied from RT D
5. Citation Record Type	tab			req	A,D-I,T			
6. Citation Item Number								Copied from preceding RT G if Citation Record Type is G,I
7. Text			all					
8. Sequence	tab		dgt			Z		Automatically entered and incremented for each record in station. End output record
9. OK?	tab				Y,N			"Y" enters record, N returns for corrections.
10. Next Rec					A,D,T			Converts to 8 character TI code for next Record Type desired and displays it.

```
    d
    d
    d
 dddd     ppp      ggg
d   d    p   p    g   g
d   d    p   p    g   g
 ddd     pppp      gggg
         p            g
         p        g   g
         p         ggg
```

DATA PROJECTS GROUP
333 Pastore Hall
University of R.I.
Kingston, RI 02881
(401) 792-2320

SUMM033 PROGRAM

SUMM033 is a program written to produce a Data Entry Summary Report. It is run on a data set created by running an A033 (any version) data entry program; and displays the summary report on the VDT screen. This is followed by a list of taxonomic codes and their frequencies. It also checks for and flags certain errors in the data which should be corrected before submitting the data set to DPG. A sample output is attached.

The Data Entry Summary Report first lists the Field Operation; then the number of Records in the file, the Number of Stations, Number of Sightings, and Number of Errors flagged. This is displayed on the VDT screen. To obtain a printing use the "Print" key. Next, the screen is cleared and the taxonomic code and frequency report is displayed. SUMM033 sets up a table and stores each unique tax code encountered, then counts the number of times it occurs. These codes and counts are displayed in the frequency report. There may be several pages of these and again the "Print" key can be used to list them. This version of the program can only store 100 unique tax codes, if any more are found they will be listed as encountered but counts will not be kept. This limit will be increased in later versions if necessary.

Several errors are checked for, including un-edited asterisks, multiple field operations, and record sequencing. These are listed in detail below. They are flagged with a brief message followed by the incorrect record. In some instances the previous record is also listed for clarity. When running SUMM033 error flags and records can be listed on the printer or written to a file; which can then be displayed on the VDT screen (with the SF Utility) or listed on the printer (with the CC Utility). If the SF Utility is used, some graphics characters will appear at the end of each line. These are the carriage-return and line-feed codes for the printer.

SUMM033 is made up of a main program called SUMMSRC, and four subroutines: OUTFSRC, CSTASRC, CTAXSRC, and SREPSRC. These are all written in the TI Procedures language. Details for compiling them are listed below. Following is a brief description of each.

SUMMSRC is the main procedure, it reads the input A033 data file and controls other program processing, including the calling of the subroutines. It checks each record for un-edited asterisks, then reads the Record Type and determines the processing for that type. For example: an additional Header Record (RT0) will be compared to the first Header for matching File ID; an RT2 must follow an RT1; and RT5's will have the tax code checked and summed. SUMMSRC also keeps track of the counts of records, stations, sightings, and errors for the summary report.

OUTFSRC requests and opens the output file for the error flags and records. This file can be LP01 or a data file. The data file will be automatically created if it does not exist by using the TI CREATE subroutine. If it does exist, the user is asked if he wants to overwrite it (this way the same file can be re-used to check corrections made to the input data set). If the user does not wish to overwrite it, another output file is requested.

CSTASRC does the RT1 processing. It stores each unique station number in a table and compares each incoming station against all the previous stations for duplicates. In this first version of the program, the table can hold only 250 stations, any beyond that will not be checked. This limit will be increased in later versions if necessary. CSTASRC also flags any station which did not have any RT5's. Even if there were no sightings, an RT5 should be included with a tax code of 91 and a 0 for the number of individuals.

CTAXSRC does the RT4 and RT5 processing. It first checks that the sequence numbers are in ascending order starting with 001. Any skipped numbers are flagged. Then the taxonomic code is checked. It should start with 91 or 92 and have no asterisks or un-converted four character abbreviations. The tax codes are stored in a table with their frequency counts. The table can hold only 100 codes, so any beyond that will be listed as encountered but not counted.

SREPSRC displays the Summary Report on the VDT screen, first listing the record, station, sighting, and error counts. These are followed by the taxonomic codes and frequency counts. There is a pause at the end of each full screen allowing the user to read, have printed, or write down the information before continuing.

RUNNING SUMM033

1. Insert the Program diskette into DS01.

2. Insert the diskette containing the A033 data set in DS02.

3. Start SUMM033 by using the COMMAND MODE and F1 keys.

4. Enter the pathnames requested:
   INPUT pathname: A033 data set name
   OUTPUT pathname: LP01 or another data set name

5. SUMM033 will read the input file and write any error flags to the output file.

6. The Data Summary Report is displayed. Enter "Y" when ready to continue.

7. The Taxonomic Codes and Frequencies Report is displayed. Enter "Y" to continue with additional pages.

8. JOB COMPLETED is displayed.

9. If a data file was used as the output pathname, it can be displayed on the screen with the SF Utility or printed on LP01 with the CC Utility (off the UTIL diskette).

```
    DATA ENTRY SUMMARY REPORT

PLEASE CORRECT ANY ERRORS FLAGGED
BEFORE SUBMITTING DATA SET TO DPG


INPUT FILE PATHNAME:  DS02.AUCI478
OUTPUT FILE PATHNAME: LP01________

     FIELD OPERATION: UCI478



SUMMARY
    NUMBER OF RECORDS:        2745
    NUMBER OF STATIONS:       230
    NUMBER OF SIGHTINGS:      2286
    NUMBER OF ERRORS:         3

                                                  CONTINUE? _
                                                  PRINT COMPLETE
```

TAXONOMIC CODES AND FREQUENCIES

912901030103	279
9128020103	169
912901	12
91290103	631
911004	6
911201180201	4
9109020407	1
9112011301	5
9128020301	175
912103	1
912901050201	1
9110040106	2
9129020103	5
9129011101	10
9109020201	552
912901030202	240
9129011102	100
9128020101	7

CONTINUE? _

T. ONOMIC CODES AND FREGUENCIES

9129011401	20
910903020101	20
9128020302	8
91230103	3
910901030202	1
912802020301	1
91020201	1
91290110C1	16
912401030103	1
91280203	2
9128C301	3
919999999999	1
9129010801	1
9129020301	1
9129	1
912802010101	4
9112010907	2

468

JOB COMPLETED

```
DUPLICATE STATION NUMBER
11W020553800N1634100W0420781935          15+119  22   91234      44 030

INVALID RECORD SEQUENCE
11W185570800N1682200W0425780245          15+1112 04   91234      56 030
11W186562700N1672100W0425781638          15+1112 03   91234      56 030

NO SIGHTINGS FOR STATION
11W185570800N1682200W0425780245          15+1112 04   91234      56 030
```

ERROR FLAGS

UNEDITED ASTERISKS - Incorrect Record
Asterisks were found in the record.

MULTIPLE FIELD OPERATIONS - 1st Header - unmatching Header
A header record containing a File ID that did not match the original File ID.

DUPLICATE STATION NUMBER - Incorrect Record
A station matching one previously entered.

NO SIGHTINGS FOR STATION - RT1 for that Station
A station with no associated RT5's.

INVALID RECORD SEQUENCE - Previous Record - Incorrect Record
An RT1 was not followed by an RT2.

INVALID STATION NUMBER - Incorrect Record
A station not matching the associated RT1.

INVALID SEQUENCE NUMBER - Previous Record - Incorrect Record
A sequence on an RT4 or RT5 did not increment by one.

INVALID TAXONOMIC CODE - Incorrect Record
A tax code not begining with a 91 or 92.

Appendix II

File Type 033 Analysis Products

OCSEAP

Bird Census Analysis Products
(Release 2.0; 1 September 1979)

```
      d
      d
      d
   dddd     ppp      ggg
  d    d   p   p   g    g
  d    d   p   p   g    g
   ddd     pppp      gggg
           p            g
           p       g    g
           p         ggg
```

Dr. Harold Petersen, Jr.
Research Unit Number: 527
Data Projects Group
Pastore Laboratory
University of Rhode Island
Kingston, Rhode Island 02881

BACKGROUND

A series of ten products have been identified by OCSEAP for use in the analysis of bird census data. Developed through the auspices of the Juneau Project Office, Dr. George Hunt (RU 083), and the Data Projects Group (RU 527), these products are based on data acquired in File Type 033 format, and are stored, retrieved, and portrayed through the use of the MARMAP Information System.

The ten products are entitled Data Summary Table, Digital Density Plot, Density Histogram, Graduated Symbol Plot, Contour Plot, Star Diagram Plot, Statistical Analyses, Transect Catalog, Sightings Effort Table, and Sightings Effort Plot. Along with these, three previously existing products, Station Position Plot, Cruise Track Plot, and Report Writer, are capable of using File Type 033 data as input. This report describes these products and includes sample output from each.

FILE TYPE 033 DATA SUMMARY TABLE

The Data Summmary Table serves as a reference point for use with the other analysis products. It lists a variety of raw data parameters for each transect. Along with the resolution of taxonomic codes into common names, two parameters listed are derived from other raw data in the file. These parameters are the transect length (in meters) and the area surveyed (in square kilometers). Also listed is a block reference number defined in the Digital Density Plot description.

The example contains data collected on field operation UCI701. The Data Summary Table has used as input data collected on field operations conducted by RU 083 and RU 337. These field operations include UCI501, UCI601, UCI602, UCI701, UCI702, UCI703, UCI704, UCI801, UCI802, UCI803, UCI804, UCI805, UCI806, UCI808, UCI478, and FW7032. Input from any data in File Type 033 format may be used by this program.

OCSEAP - FILE TYPE 033 DATA SUMMARY

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

UCI701

7 JULY 1977 - 11 JULY 1977

10' X 10' BLOCK NUMBER AND POSITION (DEG & MIN) BLK	LATITUDE	LONGITUDE	FIELD OPER.	DATE DD MM YY	TIME HHMM	TRAN. LENG. (M)	AREA SURV. (KM2)	ENVIRONMENTAL CONDITIONS STMP	SAL	BDEP	DNSH	DSB	OBSERVATIONS NAME	NUMBER SEEN	BC	DC
139	58 06 N	168 52 W	UCI701	11 07 77	0240	4015	1.20	89	319	70	67	112	BLACK-LEGGED KITTIWAKE	1	32	
													MURRE SP.	1	01	
													MURRE SP.	1	20	05
													MURRE SP.	1	20	22
													MURRE SP.	1	32	
													MURRE SP.	2	20	09
													NORTHERN FULMAR (LIGHT)	1	32	
140	58 01 N	168 45 W	UCI701	11 07 77	0340	4015	1.20	90	314	70	64	105	BLACK-LEGGED KITTIWAKE	6	20	18
													BLACK-LEGGED KITTIWAKE	10	32	
													BLACK-LEGGED KITTIWAKE	51	20	18
140	58 03 N	168 45 W	UCI701	11 07 77	0330	4015	1.20	90	314	70	66	107	BLACK-LEGGED KITTIWAKE	1	32	
													BLACK-LEGGED KITTIWAKE	1	99	
													BLACK-LEGGED KITTIWAKE	3	32	
													BLACK-LEGGED KITTIWAKE	9	32	
													JAEGER (JPO)	1	32	
													JAEGER (JPO)	1	99	
													NORTHERN FULMAR	1	32	
													NORTHERN FULMAR (LIGHT)	1	32	
													SOOTY SHEARWATER	1	20	09
140	58 05 N	168 45 W	UCI701	11 07 77	0320	3706	1.11	88	314	70	68	109	BLACK-LEGGED KITTIWAKE	1	99	
													JAEGER (JPO)	1	20	05
													JAEGER (JPO)	2	99	
													NORTHERN FULMAR	1	32	
140	58 07 N	168 45 W	UCI701	11 07 77	0310	3706	1.11	88	314	70	69	110	BLACK-LEGGED KITTIWAKE	22	32	
													NORTHERN FULMAR (DARK)	1	20	18
140	58 09 N	168 46 W	UCI701	11 07 77	0300	4015	1.20	88	314	69	71	116	BLACK-LEGGED KITTIWAKE	1	32	
													BLACK-LEGGED KITTIWAKE	2	32	
													BLACK-LEGGED KITTIWAKE	3	20	05
													JAEGER (JPO)	1	20	18
													MURRE SP.	1	20	05
													NORTHERN FULMAR	1	32	
													NORTHERN FULMAR (DARK)	1	32	
													NORTHERN FULMAR (LIGHT)	1	20	09

DIGITAL DENSITY PLOT and BLOCK IDENTIFICATION NUMBER DISPLAY

This analysis produces a digital plot of bird densities, using a high speed printer. The area portrayed corresponds to the geographical area in which the data were collected. The area is separated into blocks with the block size being specified by the user. Blocks may be 10, 20, 30, or 60 minutes in width or length. A reference number for each block is included in the File Type 033 Data Summary Table. A Block Identification Number Display is similar in appearance to the plot, but contains block reference numbers instead of bird densities. This master reference is used to relate a block number on the plot with transect data in the Data Summary Table.

Three values are obtained for each block. They are the largest number of birds per square kilometer on any transect, the mean number of birds per square kilometer for all transects, and the smallest number of birds per square kilometer seen on any transect. The values are printed in a position on the plot which corresponds to the particular block. The mean value is printed in the middle, with the largest and smallest density values printed above and below the mean, respectively. To assist in interpreting the plot, a mylar overlay, which shows land masses and bottom depth contour lines in the area being studied, may be constructed.

Densities can be calculated with respect to any time of day, behavior, season, month, subset of species, or combination of these parameters. Also, the user may specify that only a certain portion of the total area surveyed be displayed. The densities in the example were calculated using data collected on UCI701. Digital Density Plots have been created from data collected on seventy-four field operations conducted by RU 083, RU 108, RU 239 and RU 337 in the Bering Sea during the years 1975 through 1978. The program is capable of using File Type 033 data from field operations in any other area as well.

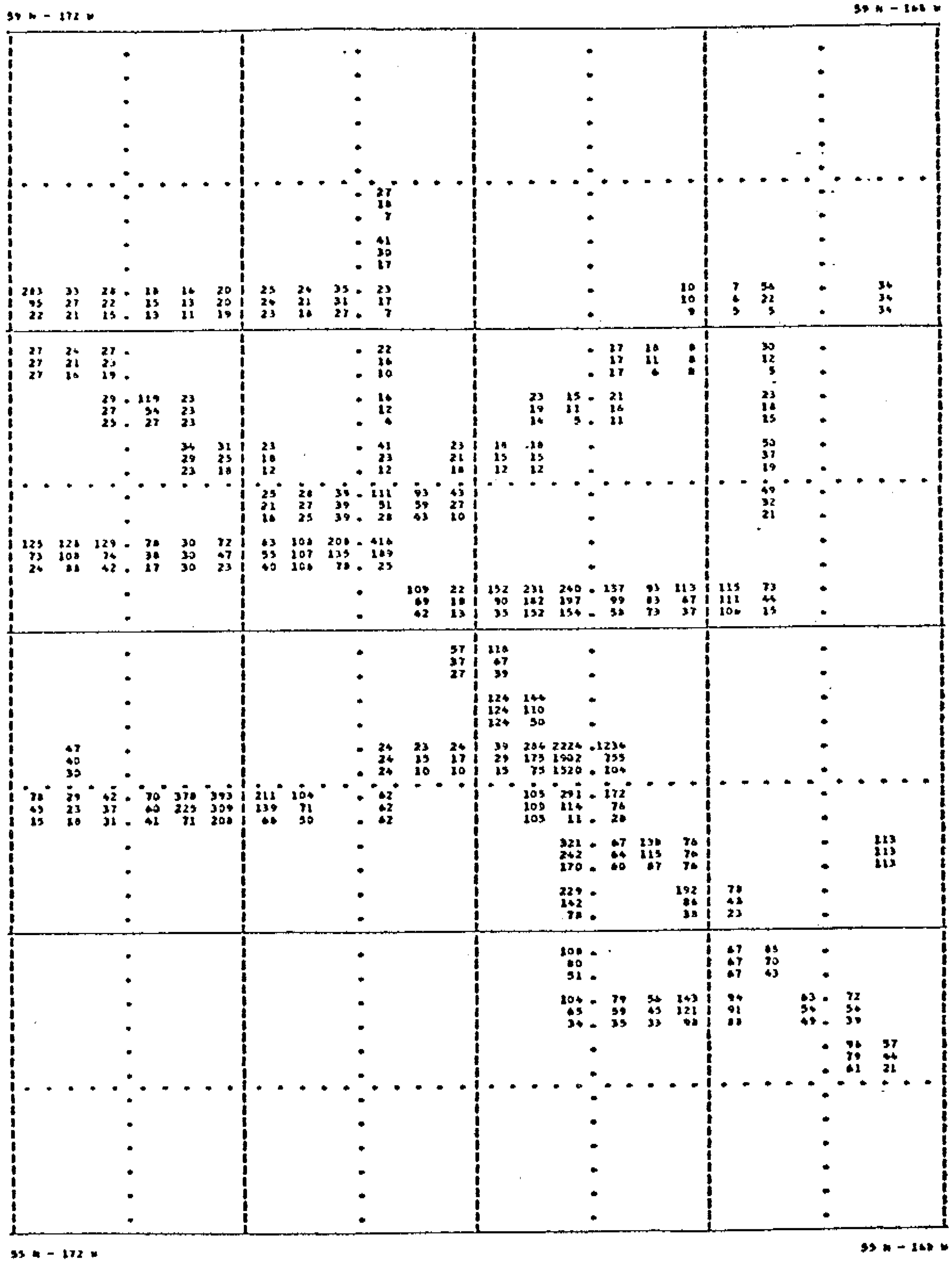
UCSEAP - MAXIMUM, MEAN, AND MINIMUM BIRDS/KM2 FOR

ALL TRANSECTS WITHIN EACH 10' X 10' BLOCK

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

UCI701 - 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. PLUS SIGNS INDICATE THAT, WHILE SIGHTINGS WERE REPORTED IN THAT BLOCK, NO TRANSECT IN THAT BLOCK CONTAINED ALL OF THE DATA REQUIRED FOR THE CALCULATION OF BIRDS/KM2 VALUES.

BLOCK IDENTIFICATION NUMBER DISPLAY

This product is used in association with the Digital Density Plot and is explained in that section.

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

BLOCK IDENTIFICATION NUMBERS

TOTAL MAP BOUNDARIES - LATITUDES 55 N TO 59 N, LONGITUDES 168 W TO 172 W

59 N - 172 W | 59 N - 168 W

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192
193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216
217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264
265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312
313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360
361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384
385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408
409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432
433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456
457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480
481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504
505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528
529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552
553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576

55 N - 172 W | 55 N - 168 W

DENSITY HISTOGRAM

The Density Histogram displays bird densities as a function of angle and distance from a given point source. Each column contains a density for each species group being studied. At the top of each column will be found the number of transects used in the calculation of the densities in that column and the distance range from the central point to the area in which the transects occurred.

Densities may be displayed for any number of species groups given a variety of conditions. The user has a choice of calculating densities for any group of species given a behavior, time of year, time of day, or any combination of these parameters. Along with placing conditions on the species to be studied, the user may desire to exercise any one or a combination of a number of other useful options. The width of the "distance to shore" bands and the width of the arc into which the area around the central point may be sectioned are at the discretion of the user. Also, a maximum distance boundary may be set so that only transects within a given distance of the central point will appear in the histogram. Finally, densities may be calculated only from transects for which "distance to nearest shore" information is available or all transects may be used by approximating the distance to the nearest shore through the use of the distance between the midpoint of the transect position and the central point. This output may portray File Type 033 data from as many field operations as desired. The Density Histogram has been produced for field operations UCI501, UCI602, UCI701, UCI702, UCI801, UCI803, and UCI806, as in this example.

OCSEAP - BIRD DENSITY HISTOGRAM

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

UCI501,602,701,702,801,803,806

5 KM INTERVALS FROM ST. GEORGE IS

135 TO 224 DEGREES FROM NORTH

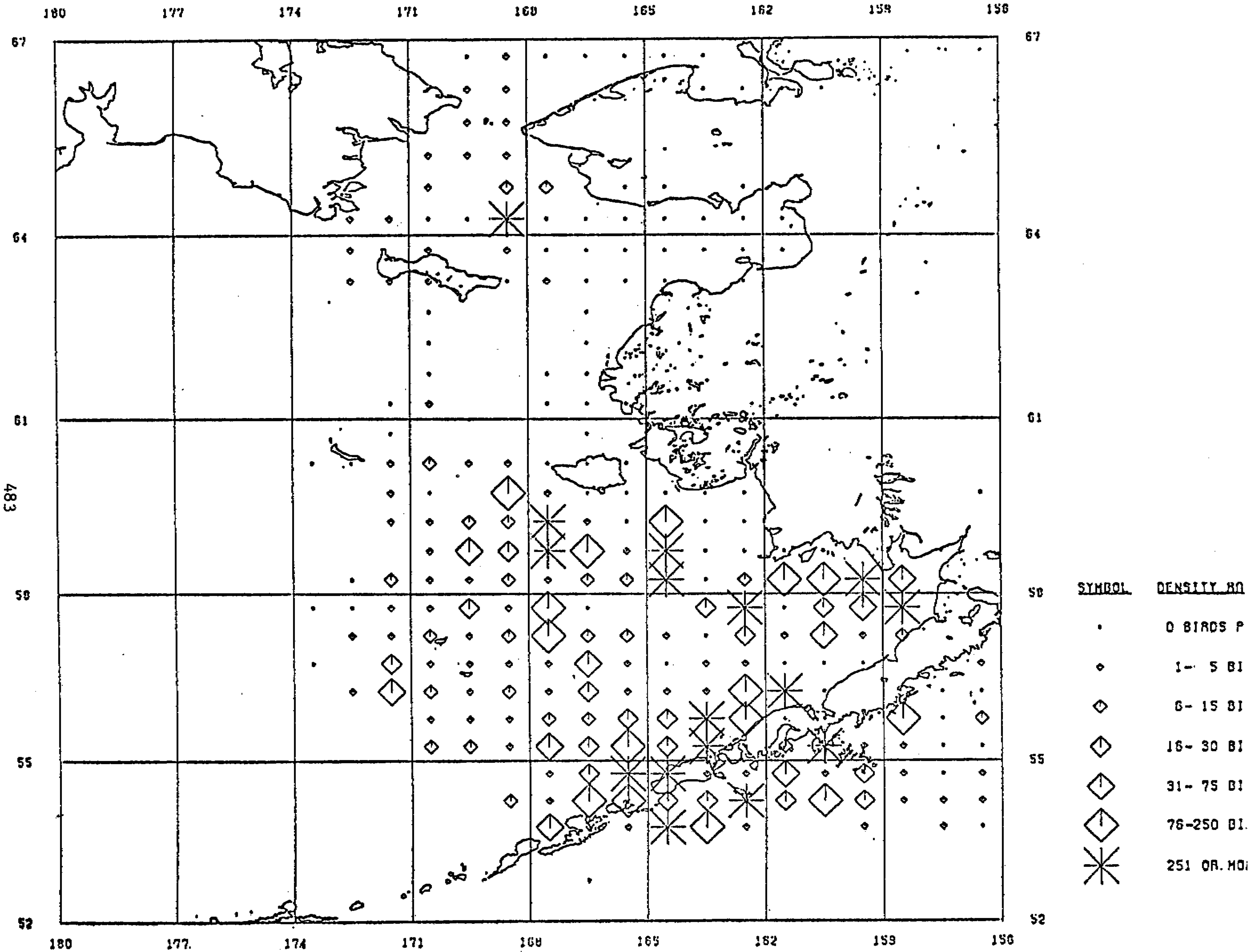
NUMBER OF TRANSECTS ->	6	18	15	6	15	17	15	11	18	12	15	21	20	12	18	19	12	15	27	14	14
DISTANCE -> / NAME	0 TO 5	5 TO 10	10 TO 15	15 TO 20	20 TO 25	25 TO 30	30 TO 35	35 TO 40	40 TO 45	45 TO 50	50 TO 55	55 TO 60	60 TO 65	65 TO 70	70 TO 75	75 TO 80	80 TO 85	85 TO 90	90 TO 95	95 TO 100	100 TO 105
AUKLET	69	4	2	0	1	0	0	0	0	3	0	1	1	1	4	0	4	3	1	0	1
BLACK-LEGGED KITTIWAKE	5	4	6	11	5	10	4	7	7	7	6	4	2	6	3	2	4	2	5	5	3
COMMON MURRE	0	0	0	1	1	1	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
FORK-TAILED STORM PETREL	0	0	0	1	5	1	6	7	26	6	51	8	39	9	26	1	1	2	5	2	2
HORNED PUFFIN	3	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KITTIWAKE	17	11	32	53	28	36	28	16	39	30	22	24	19	17	12	9	10	7	10	11	8
LEAST AUKLET	61	3	2	0	1	0	0	0	0	2	0	0	1	1	4	0	4	3	1	0	1
MURRE	150	36	13	25	23	21	67	16	9	8	2	7	19	10	2	5	5	7	7	1	6
NORTHERN FULMAR	21	16	14	9	55	15	12	12	16	52	33	25	38	16	10	37	12	7	12	18	20
NORTHERN FULMAR (DARK)	2	6	3	1	28	4	2	4	6	26	11	13	20	7	4	7	7	3	7	11	11
NORTHERN FULMAR (LIGHT)	17	8	6	4	23	4	4	7	6	21	14	9	13	6	5	5	4	2	3	4	6
PARAKEET AUKLET	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RED-FACED CORMORANT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RED-LEGGED KITTIWAKE	9	5	25	42	22	18	11	10	16	15	15	19	17	11	8	6	6	5	5	6	4
SHEARWATER	0	0	0	0	0	0	4	0	4	10	2	3	1	1	1	1	1	3	3	10	3
THICK-BILLED MURRE	2	1	2	0	1	4	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
TUFTED PUFFIN	12	0	1	2	1	1	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0

GRADUATED SYMBOL PLOT

The Graduated Symbol Plot displays the abundance of data over a given area by varying symbols and/or symbol sizes. The data for the display is the density per square kilometer calculated for a specified block of area. Blocks may be 10, 20, 30, or 60 minutes in width or length. Symbols may represent densities calculated with respect to any time of day, behavior, season, month, subset of species, or combination of these parameters. The user specifies the density ranges for up to ten symbols or symbol sizes. These are compared to the calculated density at each geographic point and the appropriate symbol of the specified size is drawn. A logo is included defining each symbol with its associated density range. A land mass of the given area is superimposed on the plot.

The example shows File Type 033 data for all shearwaters in the summers of 1975 through 1978 in the Bering Sea area using a Miller Projection. The area has been segmented into 30' x 60' blocks. This is the combined data of seventy-four field operations from RU 337, RU 083, RU 108, and RU 239.

This product is available for any file type with abundance data collected at recorded coordinates.



SHEARWATERS

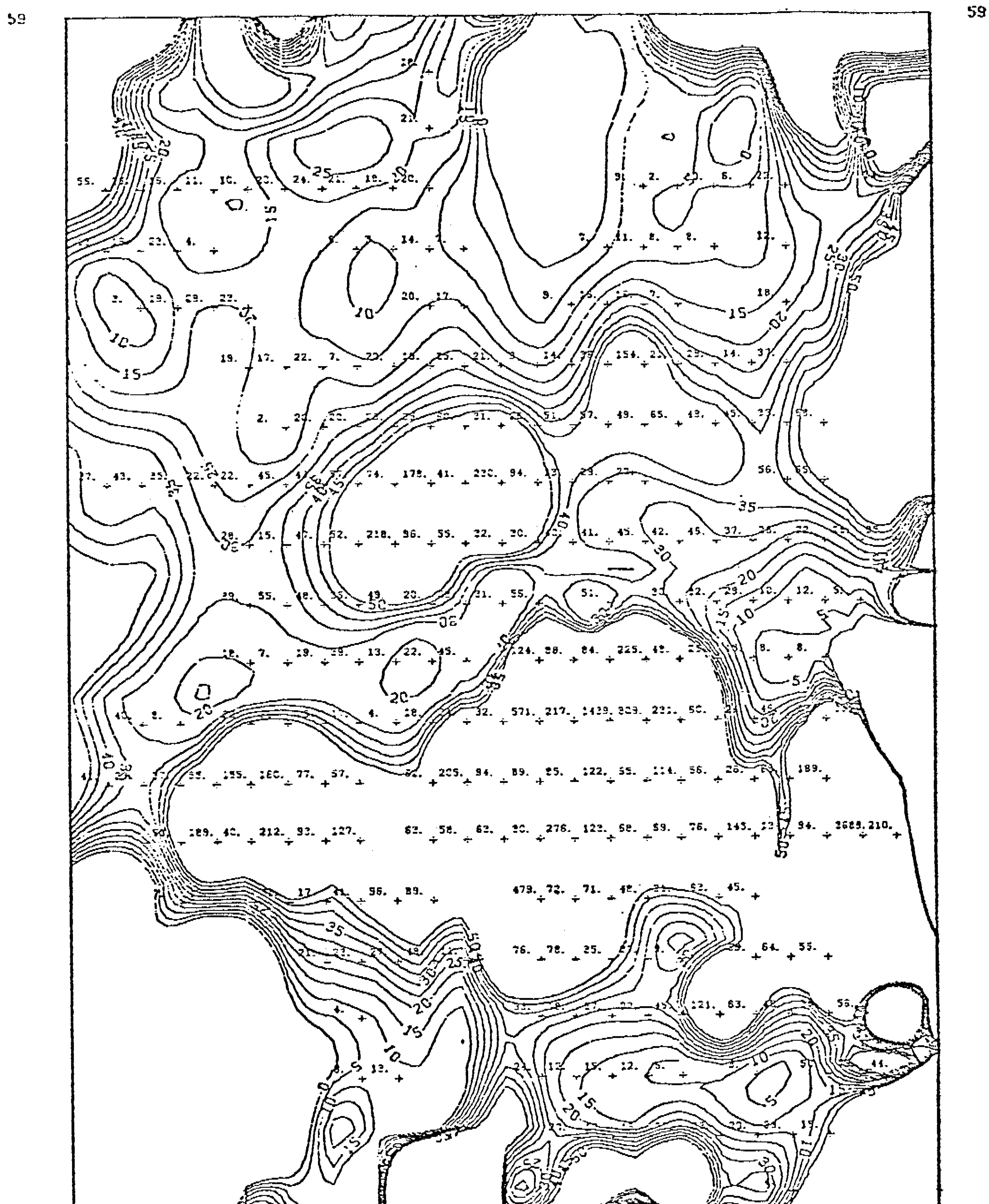
AIR & SHIP SURVEYS : JUNE - AUGUST

CONTOUR PLOT

Surfaces of constant abundance (numbers of indviduals per square kilometer) are plotted in this horizontal contour plot. Sightings in each block of area are used to calculate the density per square kilometer, and, together with geographic location, are used as input to a horizontal contour analysis program written by Calcomp, Inc. Blocks may be 10, 20, 30, or 60 minutes in width or length. The average density for a block may be calculated with respect to a particular species or group of species, time of day, behavior, season, month, or combination of these parameters. A grid pattern covering the requested area is established, and input location and density data are used to determine the abundance at each grid intersection. From this regular array, contours of constant abundance are determined and drawn.

In the example shown, File Type 033 data for all species is combined from Field Operations UCI501, UCI601, UCI602, UCI701, UCI702, UCI703, UCI704, UCI801, UCI803, UCI806, and UCI808. The block size is 10' x 10'. The contour levels are 0 to 50 by 5.

This product is available for any file type for which a regular array of location and abundance data can be established.



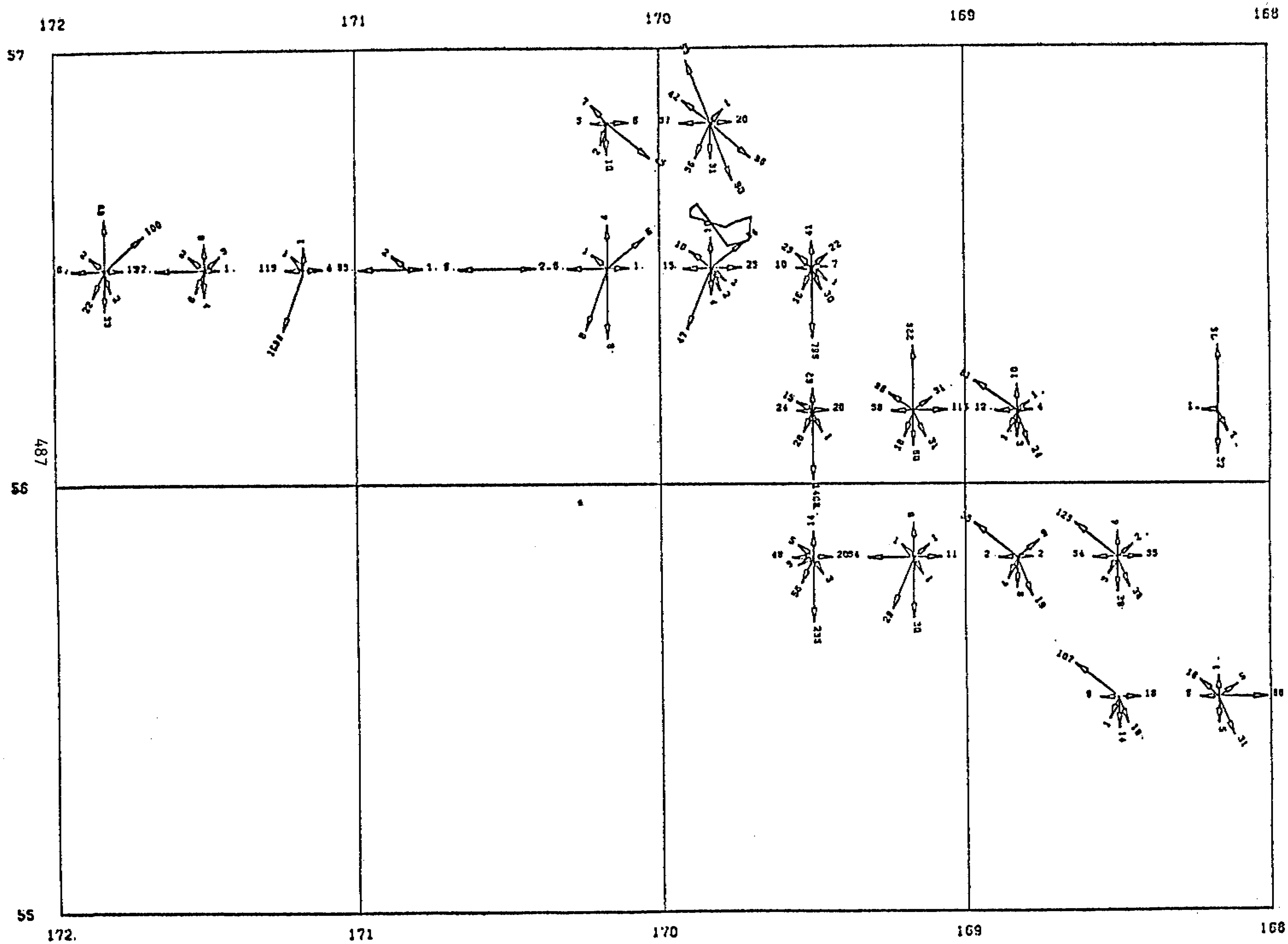
CONTOUR OF ALL SPECIES, DENSITIES BY 10' BLOCK, LEVELS 0-50 BY 5

STAR DIAGRAM PLOT

This analysis produces a plot showing bird flight patterns. The survey area represented is divided into blocks of specified size, and, within each, abundance data are summed as a function of flight direction over thirty degree intervals. A vector, the length of which is proportional to the number of individuals flying in a given direction, is then drawn. A Square Projection is used to eliminate vector distortion. The star pattern results when all vectors within a block are drawn from a common origin. The number of individuals represented is recorded following each vector arrowhead. A table (not shown), printed on a high speed printer, accompanies each star plot. The information in the table is divided by blocks and lists the angles and numbers of individuals displayed on the plot. It is a backup reference for use when the plotted numbers overlap or are unclear.

The accompanying example shows File Type 033 data in the Pribilof area (segmented into 20' x 20' blocks) from Field Operation UCI701. As with the other products, blocks may be 10, 20, 30, or 60 minutes in width or length. Abundance may be reflected with respect to any time of day, behavior, season, month, subset of species, or combination of these parameters.

Though this example shows bird flight patterns, it can be used for other directional parameters as well with Wind Roses and Current Vectors being two examples.



STAR DIAGRAM

STATISTICAL ANALYSES

In this product, the interdependence of bird density and physical parameter data is evaluated through use of selected programs from the Statistical Package for the Social Sciences (SPSS). Three analyses are performed: stepwise multiple regression, factor analysis, and canonical correlation.

The stepwise multiple regression routine is used to examine variations in the number of birds per square kilometer (the dependent variable) as a function of variations in sea surface temperature, surface salinity, distance to shelf break, distance to nearest shore, and bottom depth (the independent variables). A linear regression formula is calculated along with a table showing which independent variable(s) is (are) the best predictor(s) of the dependent variable.

The factor analysis subroutine attempts to reduce the number of variables required for study by examining the intercorrelations of all variables and indicating a small number of variables which account for most of the variance in all of the variables. Unlike stepwise multiple regression, factor analysis does not explain dependent variable variance in terms of independent variable variance. It maximizes the explained variance of all variables available to it.

Canonical correlation analysis takes as input two sets of variables (the densities vs. the physical parameters) and attempts to account for a maximum amount of relationship between them. This is done by deriving a linear combination from each of the sets of variables in such a way that the correlation between the two linear combinations is maximized.

The example displays a multiple regression which resulted from data collected on UCI701. This program has been used on data collected by RU 083. See the description of the Data Summary Table for a complete list of field operations. SPSS is capable of handling data from a variety of sources.

DENSITY STATISTICS - UCI701 - ALL SPECIES

FILE BIRDSKM2

* M U L T I P L E R E G R E S S I O N * * * * * * * * * * * * * * VARIABLE LIST :
REGRESSION LIST :

DEPENDENT VARIABLE.. BKM2 NUMBER OF BIRDS PER SQUARE KILOMETER

VARIABLE(S) ENTERED ON STEP NUMBER 1.. DSB DISTANCE TO SHELF BREAK-WHOLE NAUT MI

MULTIPLE R	0.52491
R SQUARE	0.27553
ADJUSTED R SQUARE	0.27179
STANDARD ERROR	181.45740

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	1.	2429356.95543	2429356.95543	73.7805
RESIDUAL	194.	6387796.74076	32926.78732	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
DSB	-2.72222	-0.52491	0.31692	73.781
(CONSTANT)	246.81947			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
STMP	-0.30201	-0.35391	0.99407	27.63
SAL	-0.64861	-0.58224	0.58301	98.98
BDEP	-0.48990	-0.48047	0.69688	57.92
DNSH	-0.24126	-0.28162	0.98713	16.62

489

* *

VARIABLE(S) ENTERED ON STEP NUMBER 2.. SAL SURF SALINITY-TENTHS OF PARTS PER 1000

MULTIPLE R	0.72189
R SQUARE	0.52113
ADJUSTED R SQUARE	0.51617
STANDARD ERROR	147.90928

ANALYSIS OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	2.	4594862.79383	2297431.39691	105.0150
RESIDUAL	193.	4222290.90236	21877.15493	

------------------ VARIABLES IN THE EQUATION ------------------

VARIABLE	B	BETA	STD ERROR B	F
DSB	-4.89227	-0.94334	0.33809	209.384
SAL	-46.15919	-0.64861	4.63953	98.985
(CONSTANT)	15267.79751			

------------- VARIABLES NOT IN THE EQUATION -------------

VARIABLE	BETA IN	PARTIAL	TOLERANCE	F
STMP	-0.20637	-0.29076	0.95059	17.73
BDEP	-0.30923	-0.34517	0.59665	25.96
DNSH	-0.04284	-0.05603	0.81925	0.60

FILE TYPE 033 TRANSECT CATALOG

The Transect Catalog is similar in use to the Data Summary Table in that it serves as a reference point for use with other analysis products, in this case the Sightings Effort Table and the Sightings Effort Plot. Listed are the RU number, principal investigator name, transect date, field operation, transect number, platform type, location, start time, and duration of each transect. Also listed is a 30' x 60' block reference number which is identical in use to the block number defined in the description of the Digital Density Plot. The catalog may contain transects from any number of field operations and principal investigators. The example is one page of the Transect Catalog that has been created from data collected on seventy-four field operations conducted by RU 083, RU 108, RU 239, and RU 337 in the Bering Sea during the years 1975 through 1978. The program is capable of using any File Type 033 data and may be adapted for use with other file types in which the transect position is recorded.

SEE LAST PAGE FOR NECESSARY KEYS

OCSEAP - FILE TYPE 033 TRANSECT CATALOG

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

BERING SEA

RESEARCH UNIT IDENTIFICATION		BLOCK	TRANSECT INFORMATION						
RU #	PRINCIPAL INVESTIGATOR	NUMBER	DATE DD MM YY	FIELD OPER.	TRANSECT NUMBER	POSITION LATITUDE	POSITION LONGITUDE	START TIME	DURATION (MIN)
083	GEORGE HUNT	466	30 04 78	UCI808	H8005	57 00 08 N	170 26 05 W		
					H800A	57 13 02 N	170 19 00 W	2044	09
					H8001	57 10 02 N	170 32 05 W	2053	04
					H8002	57 10 03 N	170 41 00 W	2057	02
					H8003	57 09 01 N	170 40 02 W	2059	06
					H8004	57 09 01 N	170 29 03 W	2105	
					H8006	57 01 02 N	170 20 06 W	2131	06
					H8007	57 05 04 N	170 20 09 W	2137	14
					H8008	57 09 08 N	170 00 01 W	2151	08
					H8011	57 12 03 N	170 00 05 W	2211	05
					H8012	57 16 04 N	170 00 07 W	2216	04
					H8015	57 17 09 N	170 01 01 W	2226	11
083	GEORGE HUNT	467	30 04 78	UCI808	H8009	57 07 07 N	169 48 08 W	2159	07
					H8010	57 11 09 N	169 52 04 W	2206	05
					H8013	57 16 05 N	169 54 05 W	2220	03
					H8014	57 18 07 N	169 55 06 W	2223	03
					H8016	57 28 06 N	169 57 02 W	2237	13
083	GEORGE HUNT	491	01 05 78	UCI808	H8020	56 43 00 N	169 08 00 W	2326	20
					H8021	56 33 00 N	169 08 00 W	2346	02
					H8022	56 33 01 N	169 13 01 W	2348	10
					H8023	56 43 00 N	169 13 01 W	2358	02
083	GEORGE HUNT	491	02 05 78	UCI808	H8024	56 43 01 N	169 18 00 W	0000	08
					H8025	56 33 00 N	169 18 05 W	0008	03
					H8026	56 33 04 N	169 23 00 W	0011	07
108	JOHN WIENS	349	17 08 76	W06211	00001	59 43 42 N	167 44 54 W	0500	30
108	JOHN WIENS	470	17 08 76	W06211	00002	57 26 06 N	166 53 06 W	1700	30
					00003	57 15 12 N	166 47 24 W	1800	30
					00004	57 04 18 N	166 41 00 W	1900	30
108	JOHN WIENS	494	17 08 76	W06211	00005	56 54 48 N	166 34 30 W	2000	30
					00006	56 44 30 N	166 26 54 W	2100	30
108	JOHN WIENS	543	17 08 76	W06211	00008	55 34 12 N	165 45 18 W	0330	30
108	JOHN WIENS	567	18 08 76	W06211	00009	55 17 12 N	165 36 00 W	0500	30

SIGHTINGS EFFORT TABLE

This analysis summarizes the number of transects carried out in each 30' x 60' block of area for the entire region specified by the user. The table may contain material from as many field operations conducted by as many principal investigators as desired. The hardcopy output consists of the number of transects undertaken in each block with the total number of transects divided into seasonal counts. The user may print summaries regarding all principal investigators, all platform types, particular principal investigators, a particular year, specific platform types, or a combination of these alternatives.

The example refers to data collected in the Kodiak area. This product has been used in conjunction with data collected on over one hundred field operations in the Bering Sea and Kodiak area during the years 1975 through 1978. The principal investigators who conducted these field operations are RU 083, RU 108, RU 239 and RU 337. Any File Type 033 data may be used by this program. The program may be adapted to other file types in which transect position and transect date are recorded.

OCSEAP - FILE TYPE 033 SIGHTINGS EFFORT TABLE

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

KODIAK AREA

ALL INVESTIGATORS - 1975

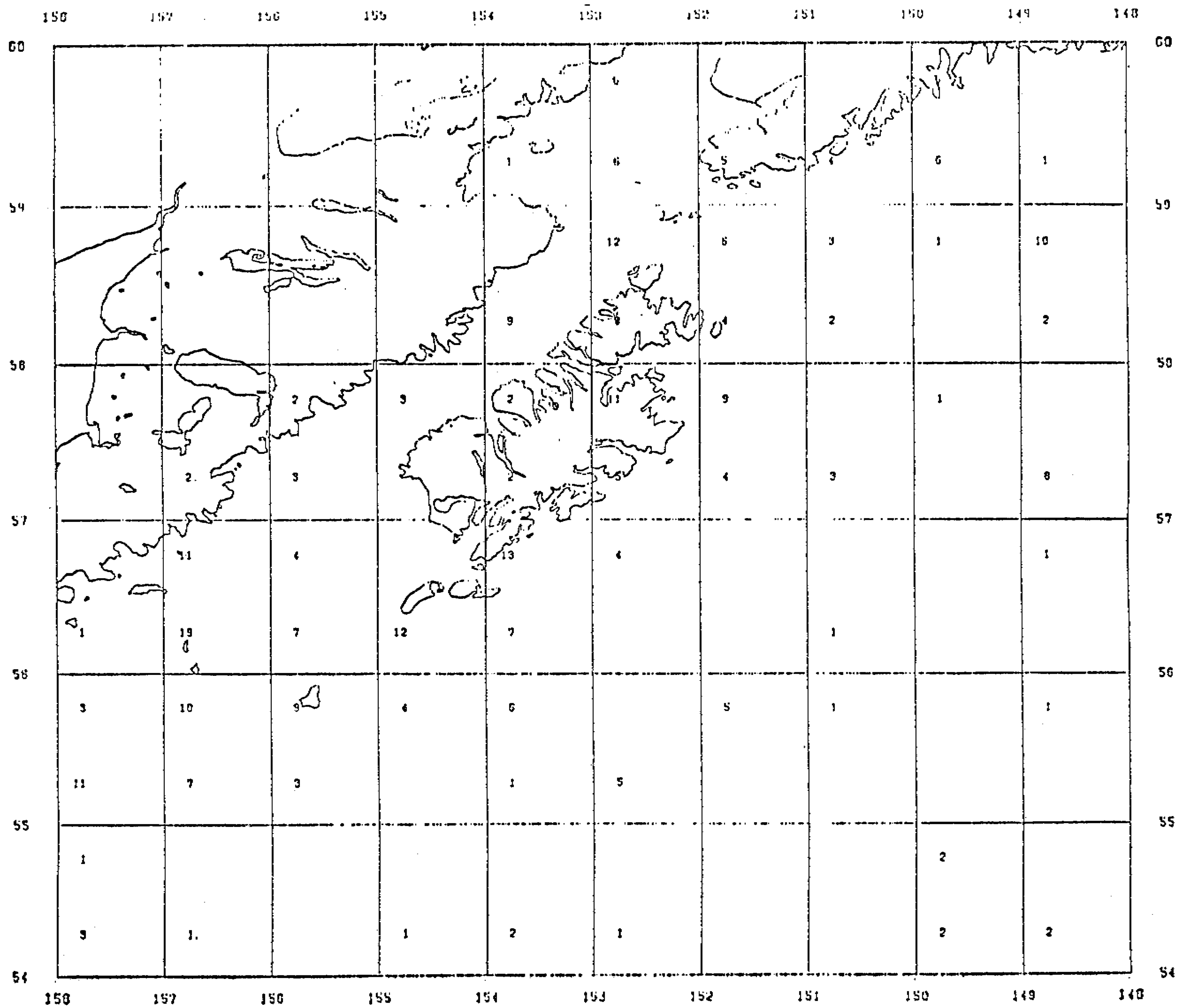
BLOCK NUMBER	POSITION OF SE CORNER OF 30' X 60' BLOCK AREA LATITUDE	LONGITUDE	SEASON	NUMBER OF TRANSECTS
3	59 30 N	156 00 W	SUMMER	1
6	59 30 N	153 00 W	SUMMER	1
7	59 30 N	152 00 W	SPRING	3
			SUMMER	13
			AUTUMN	3
9	59 30 N	150 00 W	SPRING	1
			SUMMER	1
			AUTUMN	1
10	59 30 N	149 00 W	SPRING	9
			SUMMER	12
			AUTUMN	29
11	59 30 N	148 00 W	SPRING	14
			SUMMER	3
			AUTUMN	19
12	59 30 N	147 00 W	SPRING	21
			SUMMER	3
			AUTUMN	20
18	59 00 N	153 00 W	SUMMER	9
19	59 00 N	152 00 W	SPRING	2
			SUMMER	15
			AUTUMN	5
20	59 00 N	151 00 W	SPRING	5
			SUMMER	3
			AUTUMN	0

SIGHTINGS EFFORT PLOT

This is a plotted version of the Sightings Effort Table. The number of transects which occur in each 30' x 60' block of area are summed according to geographic position and season, with further refinement to individual principal investigators and particular years being available. Values are then plotted on a 12 inch drum plotter along with a land mass in any projection.

The example shows the combined effort of File Type 033 data sightings in the Kodiak area in the Spring of 1976, using a Miller Projection. It includes ninety-seven field operations from RU 337, RU 083, RU 108, and RU 239.

This product is available for any file type in which transect position and transect date are recorded.



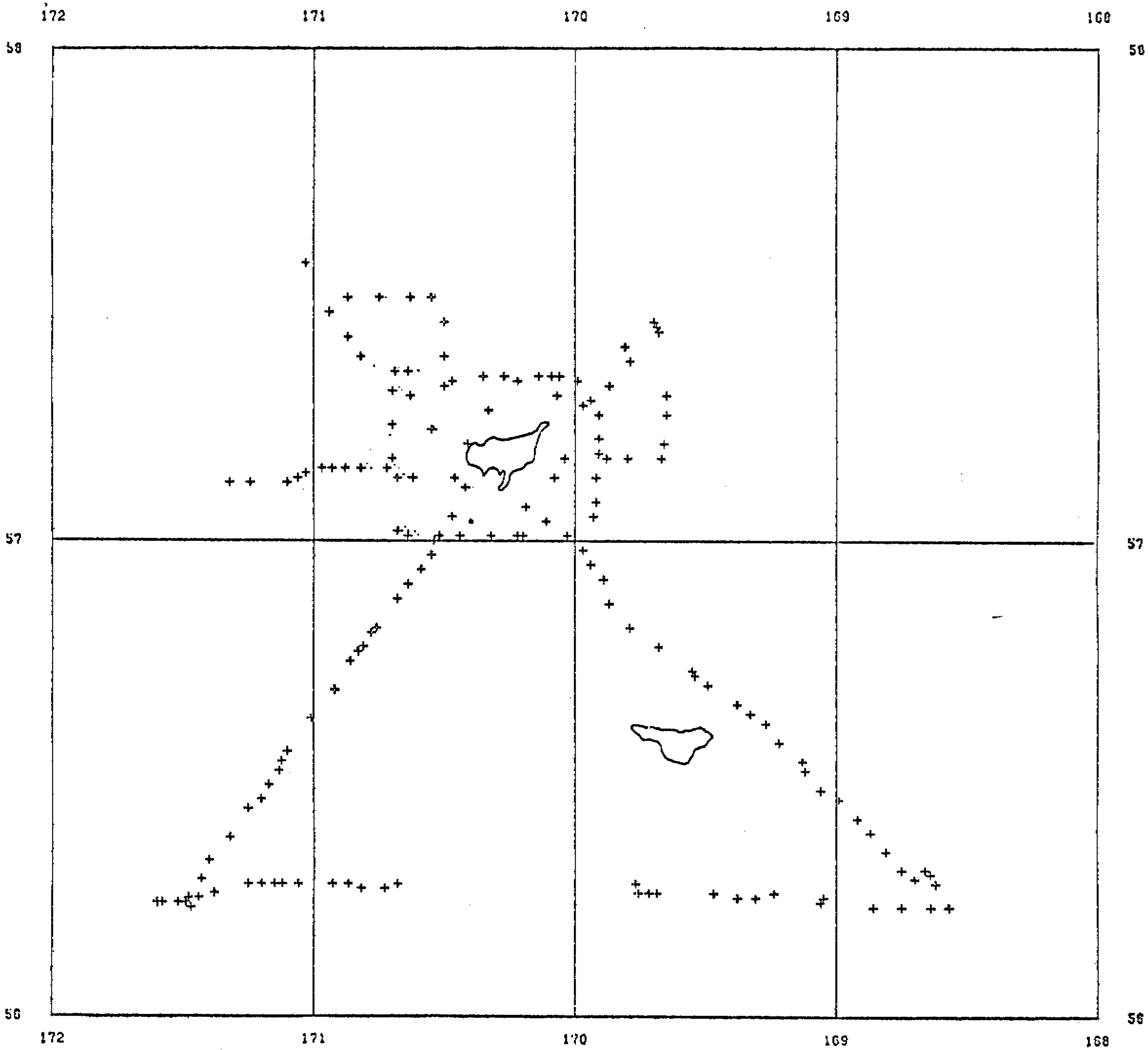
KODIAK EFFORT : JUN 76 - AUG 76

STATION POSITION PLOT

This product produces a plot with a symbol at each geographic coordinate at which a transect occurred. It is drawn on a 12 inch drum plotter and includes a land mass of the specified area in any projection.

The example shows File Type 033 data in the Pribilof area from Field Operation UCI501 using a Mercator Projection.

This product is available for any file type in which transect position is recorded.



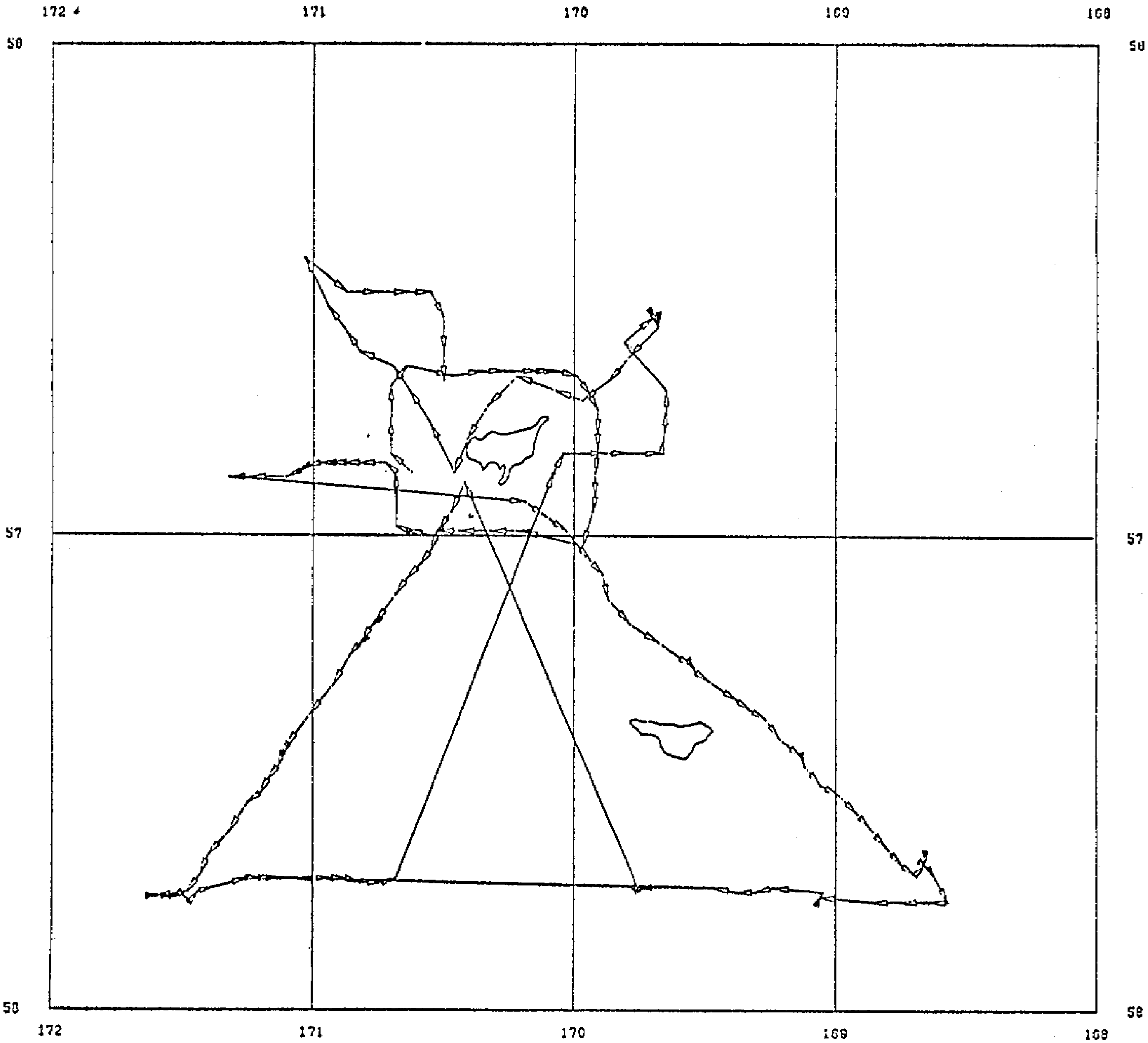
STATION POSITIONS

CRUISE TRACK

This product produces a plot of sighting locations connected by vectors, depicting the start and direction of each transect. The resultant plot shows the overall cruise track or flight pattern of the craft. It is drawn on a 12 inch drum plotter and includes a land mass of the specified area in any projection.

The example shows File Type 033 data in the Pribilof area from Field Operation UCI501 using a Mercator Projection.

This product is available for any file type in which transect position, date, and start time are recorded.



CRUISE TRACK

REPORT WRITER

The Report Writer is a generalized reformatting program designed for use with multiple input and output formats. The output of the Report Writer is a valid PL/I source program containing the statements required to read an input data file, execute user-specified routines and write an output data file in a user-specified format. The user may specify title and sorting information so that the report may be generated with output in a user-specified sequence with the proper headings. The formats of the input and output data files may be a combination of unit record, card type or the hierarchical MARMAP Information System (MIS) format. In combination with the MIS hierarchical data base extraction program, the Report Writer is capable of producing detailed reports covering tightly defined topics of user interest.

Examples of File Type 033 outputs produced through the use of the Report Writer are the File Type 033 Data Summary Table and the File Type 033 Transect Catalog. No other example accompanies this description.

Appendix III

Field Operations Status Report for File Type 033 Data

*** FIELD OPERATION STATUS REPORT ***

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 JUAN GUZMAN; "SR" & "DI" FIELD OPS. FROM DR. GEORGE DIVOKY; "AERSR" FIELD OPS. FROM BRIAN HARVIE.
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 TELE-PHONE 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 ***

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	01/12/79	1B,8
				FW6027	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/26/78	01/02/79	01/12/79	1C,8
				FW6050	07/14/77	08/16/77	09/06/77	09/06/77	10/02/78	10/06/78	01/02/79	01/16/79	1C,8
				FW6051	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/27/78	01/02/79	01/16/79	1C,8
				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	01/02/79	01/16/79	1B,8
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	01/09/79	1C,8
				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	01/02/79	01/12/79	1C,8
				FW6019	08/16/77	08/16/77	11/01/77	11/01/77	12/01/78	12/14/78	12/22/78	01/12/79	1C,8
				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	01/02/79	01/16/79	1C,8
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	1E,8

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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	01/09/79	1E,8
				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	01/09/79	1E,8
				FW6007	09/29/77	09/29/77	10/20/77	10/20/77	07/24/78	07/27/78	12/22/78	01/12/79	1E,8
				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	01/03/79	01/16/79	1B,8
				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	01/02/79	01/16/79	1E,8
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	01/09/79	1F,8
				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	01/09/79	1F,8
				FW6005	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78	01/09/79	1F,8
				FW6010	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78	01/09/79	1F,8
				FW6011	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/22/78	01/12/79	1F,8
				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	01/12/79	1F,8
				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	01/16/79	1F,8
				FW6077	10/21/77	10/21/77	11/14/77	11/14/77	12/15/78	12/18/78	12/22/78	01/16/79	1F,8
				FW6078	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/14/78	12/22/78	01/16/79	1F,8
				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	01/16/79	1F,8
				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	02/08/79	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	01/05/79	01/12/79	1F,8
				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	01/09/79	2,1H,8
				FW5006	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/13/78	12/21/78	01/09/79	2,1H,8
				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	01/12/79	2,1H,8
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/	02/08/79	
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/	02/08/79	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/	02/08/79	
				UCI704	07/07/78	07/07/78	07/27/78	07/27/78	08/25/78	08/28/78	/NA/	02/08/79	
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	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR2	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR3	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR4	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR5	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR6	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR7	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12,14
ALASKA18	083	12/15/78	NODC	UCI702	01/18/79	01/18/79	02/02/79	02/02/79	05/18/79	05/18/79	/NA/		11,1J
				UCI801	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
				UCI802	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
				UCI803	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
				UCI804	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
				UCI805	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
				UCI806	01/18/79	01/18/79	02/02/79	02/02/79	05/18/79	05/18/79	/NA/	06/25/79	1J
				UCI808	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	1J
ALASKA19	337	08/20/79	NODC	FW5007	10/01/79	10/01/79							
				FW5028	10/01/79	10/01/79							
				FW6069	10/01/79	10/01/79							
				FW8006	10/01/79	10/01/79							
				FW8007	10/01/79	10/01/79							
				FW8008	10/01/79	10/01/79							
				FW8029	10/01/79	10/01/79							
				FW8032	10/01/79	10/01/79							
				FW8100	10/01/79	10/01/79							
				FW9001	10/01/79	10/01/79							
ALASKA20	337	08/20/79	NODC	FW5038	10/01/79	10/01/79							15
				FW6096	10/01/79	10/01/79							
				FW6100	10/01/79	10/01/79							
				FW6200	10/01/79	10/01/79							
				FW6300	10/01/79	10/01/79							
				FW6400	10/01/79	10/01/79							
				FW7047	10/01/79	10/01/79							
				FW7050	10/01/79	10/01/79							
				FW7051	10/01/79	10/01/79							
				FW7052	10/01/79	10/01/79							
				FW7053	10/01/79	10/01/79							
				FW7054	10/01/79	10/01/79							
				FW8012	10/01/79	10/01/79							

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ALASKA20	337	08/20/79	NODC	FW8014	10/01/79	10/01/79							
				FW8015	10/01/79	10/01/79							
				FW8016	10/01/79	10/01/79							
				FW8017	10/01/79	10/01/79							
				FW8018	10/01/79	10/01/79							
				FW8019	10/01/79	10/01/79							
				FW8023	10/01/79	10/01/79							
				FW8024	10/01/79	10/01/79							
				FW8025	10/01/79	10/01/79							
				FW8026	10/01/79	10/01/79							
				FW8027	10/01/79	10/01/79							
				FW8028	10/01/79	10/01/79							
ALASKA21	467	09/20/79	NODC	AER801	10/01/79	10/01/79							
				AER802	10/01/79	10/01/79							
				AER803	10/01/79	10/01/79							
				AER804	10/01/79	10/01/79							
				AER805	10/01/79	10/01/79							
				AER806	10/01/79	10/01/79							
				AER807	10/01/79	10/01/79							
				AER808	10/01/79	10/01/79							
				AER809	10/01/79	10/01/79							
				AER810	10/01/79	10/01/79							
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

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CANADA1	239	03/30/78	NODC	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					/NA/		
				1SR477	08/31/78	08/31/78					/NA/		
				1DI577	08/31/78	08/31/78					/NA/		
CALIF 2	196	02/06/79	NODC	1SR678	02/12/79	02/12/79					/NA/		
CALIF 3	196	05/18/79	NODC	3AL877	06/11/79	06/11/79							
				3AL878	06/11/79	06/11/79							
				3GL877	06/11/79	06/11/79							
				1SR578	06/11/79	06/11/79							
				1SR678	06/11/79	06/11/79							13
TIDISK1	196	06/04/79	TI	UCI478	06/29/79	06/29/79		07/18/79	07/19/79	07/23/79	/NA/	08/15/79	
TIDISK2	196	08/20/79	TI	UCI903	09/26/79	09/26/79							

*** FIELD OPERATION STATUS REPORT ***

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

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).
   J. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (03/02/79), RETURNED TO RU 527 (05/09/79).

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. UCI702 WHICH WAS ORIGINALLY RECEIVED ON TAPE ALASKA 15.

12. CODEPULLS AND LOGLISTS WERE NOT RETURNED; INSTEAD A LETTER WITH CORRECTIONS WAS RECEIVED.

13. DATA FOR FIELD OP. 1SR678 REPLACES THAT ORIGINALLY RECEIVED ON TAPE CALIF 2.

14. FIELD OP. AERSR7 SPLIT OFF FROM AERSB4.

15. STATIONS 1-404 OF FIELD OP. FW5038 WERE RECEIVED WITH TAPE ALASKA8 IN JULY, 1977. FW5038 ON ALASKA20 CONTAINS STATIONS 405-459.

*** FIELD OPERATION STATUS REPORT ***

AS OF 10/01/79

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

SUMMARY:

TOTAL FIELD OPS. RECEIVED BY RU 527	190
CODEPULLS MAILED TO INVESTIGATOR	190
LOGLISTS MAILED TO INVESTIGATOR	190
CODEPULLS RETURNED TO RU 527	134
LOGLISTS RETURNED TO RU 527	135
TOTAL FIELD OPS. BEING EDITED AT RU 527	0
FIELD OPS. WHICH PASSED FINAL CHECK	135
FIELD OPS. CONVERTED TO NODC	81
FIELD OPS. MAILED TO NODC	132

QUARTERLY REPORT

Contract Number: 03-7-022-35139
Research Unit Number: 527
Reporting Period: 10/1/79-12/31/79

OCSEAP DATA PROCESSING SERVICES

William Johnson
Data Projects Group
Pastore Laboratory
University of Rhode Island
Kingston, Rhode Island 02881

1 January 1980

Background and Objectives

The Data Projects Group (DPG) at the University of Rhode Island provides a variety of services to the OCSEA Program in general and to the Juneau Project Office (JPO) in particular. Through these auspices, services are also made available to several Research Units (RUs).

Over the lifetime of the contract, DPG has used a data management system known as the MARMAP Information System (MIS). The MIS was earlier designed and developed by DPG for the National Marine Fisheries Service. As related to this work, the MIS has provided the means to carry out batch-styled data set validations, to create and maintain a significant data base, and to retrieve those portions of the data base appropriate to any of a variety of analysis products.

A need for real-time data validation arose among the OCSEAP Rus. DPG responded to this need by developing the Interactive Data Entry and Analysis (IDEA) System. This system was described in a previous quarterly report submitted by this RU. It has significance in allowing investigators to validate field data during its initial entry into the OCSEAP/NODC formats, thereby reducing the time needed for the validation process under previously used procedures.

The coupling of the IDEA and MIS systems provides the resources necessary to efficiently carry out the primary objectives of this work, which include the orderly conveyance of validated data from investigator sites to the Program, and the provision of data analysis support to selected investigators.

Report Overview

Efforts were made in three major areas during this quarter, including:

-Analytical product support

-Continued development and distribution of the IDEA System

-Further processing of data sets submitted to DPG

Each of the above mentioned areas will be discussed in the remainder of the report.

Analytical Product Support

During this quarter we concluded the production of data analyses for the Bering Sea synthesis report and for the final report of RU083. This work has been continuing for the last three quarters with RU083 under the auspices of JPO. The suite of ten products documented in the previous Quarterly Report was expanded with the addition of three new products. The latest additions to the product suite include a Food Analyses Table for File Type 031 data, and File Type 033 products titled Density and the Variability of Distribution Summary and Ratio Table of Fulmar color phases. Examples of these products are included herein as Appendix I. An additional feature was made available for the plots of the Bering Sea. Contour lines for 50, 100, 200, 1000, and 2000 m were digitized and can be incorporated into Bering Sea plots. The principal investigator can choose which line or lines are to be plotted. An example of this option is also included in Appendix I.

A significant volume of some of our products were produced during this quarter, these being listed below. Unless specifically requested otherwise, these analyses included data collected by RUs 083, 108, 239, and 337 over the 1975-1978 period, and which had been validated, delivered to NODC, and included in RU527's MIS data base as of 10/1/79. A complete list of these field operations can be found in Appendix II.

-204 Graduated Symbol Plots of bird density data in the Bering Sea.

-28 Graduated Symbol Plots of bird density data in the area of the Pribilof Islands.

-36 SightingsEffort Plots for data recorded in the area of the Pribilof Islands.

-3 Sightings Effort Tables for the Pribilof Islands area.

-8 Star Diagrams of Shearwaters in the Bering Sea.

-1 Table which supplement information of the above mentioned Star Diagrams.

-12 Updated Sightings Effort Plots for the Bering Sea data.

-3 Updated Sightings Effort Tables for the Bering Sea data.

-1 Set of product examples which were included in our last report. These were sent to NODC.

-72 File Type 031 Food Analyses Tables for the Bering Sea.

-18 File Type 033 Density and Variability of Distribution Summary Tables.

-1 Sightings Effort Table without block segmentation listing transect totals by RU number, craft, year and month.

-9 Ratio Tables for color phases of northern fulmars.

In addition to these products, a magnetic computer tape of the following data was created for RU083. For each of the stations of this RU's 15 field operations, two densities were calculated for each of sixteen bird species groups. One density was for all the birds observed and the other was restricted to those birds sitting on the water. This tape was to be used by RU083 in conjunction with Statistical Package for Social Sciences (SPSS) programs.

Continued Development of the IDEA System

Throughout this quarter the work of systematizing further development and distributing system enhancements was continued. The efforts continue to be of two types -- data entry programs and system support programs and procedures.

The DPG has begun the development necessary for a new data entry program designed for File Type 135. One of our staff members researched this format and then made a trip to RU341 in Alaska to resolve a finalized form. Work on the actual data entry program has begun. It is anticipated that a working version will be complete during the next quarter.

Programming support for File Types 031, 033, and 034 through enhancements has also continued. Several of the principal investigators have encountered individualized difficulty with the entry of their data. The DPG has been able to resolve these problems with specialized programming effort. Updates have been made to SEPRATE, CATNATE, A033 version 2.0 and A033 version 2.1. Appropriate updates to the IDEA documentation have accompanied these distributions.

Another major accomplishment was the development of a program which allows validation of data which had been previously entered by means other than the TI data entry programs. It is anticipated that this program will be of great value in the validation of File Type 033 data by RU196 in the next quarter. To further facilitate this validation, the data for eight cruises have been prepared and placed on diskettes.

Texas Instruments (TI) has updated the operating system for their 771 and 774 systems. We have studied these updates and expect to distribute the new operating system next quarter.

File Type 031 Data Validation

One very large data set (UCI031) was received from RU083. These data have been partially edited and were then used to generate some exploratory products despite the fact that some errors remain. The sequencing for the 031 version of CODEPULL is completed. The CODEPULL and LOGLIST programs will be developed to ensure that the IDEA approach to data validation is compatible with the validation with batch CODEPULL and LOGLIST. When both yield identical results in validation, the batch approach will not be applied to data entered with the IDEA system.

A conversion program has been developed which converts File Type 031 data to the MIS format which is used for product generation.

File Type 033 Data Validation

A Field Operation Status Report for File Type 033 data is included as Appendix II to this report. Please refer to that report in conjunction with this section.

Three data submissions were received this quarter on 10/25/79 a TI diskette containing data collected during a 1979 field operation by RU083 was received. A second diskette with data from another field operation was received on 11/16/79 from the same RU. Validation products have been sent out for these data. A third diskette containing data from three field operations conducted by RU196 was received this quarter also. These operations had been conducted during 1976.

NODC has forwarded two 033 data sets collected by RU237 to be included in future 033 products.

The data from field operations UCI801, UCI802, UCI803, UCI804, UCI805, UCI806, UCI808 are being checked for errors which were indicated by NODC check programs. Field operations UCI901, UCI902, and UCI903 are nearly ready for submission to NODC.

These data receipts bring to 195 the total number of File Type 033 data sets received to date. Validation products have been produced for all but three of them.

Twelve CODEPULLS and thirteen LOGLISTS were received by this RU during the quarter and these are currently being used to edit the data sets. This brings the total returned CODEPULL and LOGLIST products to 146 and 148, respectively. The 46 and 44 outstanding products remain with RU337, RU083, and RU196. The latter have been outstanding for lengths of time varying between 16 and 6 months. Editing activities were curtailed this quarter due to the significant increase in Analytical Product Support. Therefore, the number of edited data sets (135) and the number of data sets sent to NODC (132) have not changed.

File Type 038 Data Validation

During this quarter, we received the CODEPULL and LOGLIST products from RU467 for the two data sets MWATCH and MWAT78. In addition, we received one tape, DDF and listing of taxonomic code check program for RU467 called MWAT78.

Activity/Milestone Chart

RU #: 527 PI: Harold Petersen Jr. -- University of Rhode Island

Major Milestones	1978										1979												1980			
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Choice of validation criteria for type 038 data		X																								
Procedures for validation of FWS type 038 data operational											X															
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 from FWS to NODC format													X													
Feasibility study for distributed data entry and processing completed							X																			
Establishment of distributed data entry and processing node at RU 527																X										

(continued)

Activity/Milestone Chart

	1978										1979												1980			
Major Milestones	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Establishment of distributed data entry sites at RU 083 and RU's 196/172													X													
Establishment of distributed data entry sites at RU 337 and RU 237															X											
517 Preparation of data entry/validation programs for IDEA System																										
1. File Type 033 - Version 1.0													X													
File Type 033 - Version 2.0																	X									
File Type 033 - Version 3.0																						X				
2. File Type 031 - Version 1.0																		X								
File Type 031 - Version 2.0																			X							
File Type 031 - Version 3.0																			X							
File Type 031 - Version 4.0																				X						
File Type 031 - Version 5.0																				X						
File Type 031 - Version 6.0																					X					
3. File Type 135																							O			
4. File Type 034 - Version 1.0																			X							
File Type 034 - Version 2.0																				X						
File Type 034 - Version 3.0																				X						

(continued)

Activity/Milestone Chart

Major Milestones	1978 M	A	M	J	J	A	S	O	N	D	1979 J	F	M	A	M	J	J	A	S	O	N	D	1980 J	F	M	A
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											X															
Delivery of production runs of 033 analysis products to RU 083 for use in Final Report											X	-	-	-	-	-	-	-	-	-	-	-				
Conversion of NODC version of File Type 033 data into MIS data base																X	-	-	-	-	-	-				
Develepoment of additional analyses for File Type 033 data - for use in Bering Sea synthesis study																			X	-	-	-				

(continued)

Activity/Milestone Chart

	1978										1979												1980			
Major milestones	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
Production use of entire suite of 033 analysis products for Bering Sea synthesis study																		X	-	-	-	-				
Preparation of IDEA system support programs																X	-	-	-	-	-	-				
Maintenance of systems and applications programs	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-				
Quarterly Reports		X			X			X			X			X			X			X			X			O
Annual Report		X												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

IDEA = Interactive Data Entry and Analysis

MIS = MARMAP Information System

APPENDIX I

File Type 033 Analysis Products

DATE OF ISSUE: JANUARY 9, 1980

SEE LAST PAGE FOR NECESSARY KEYS

OCSEAP - FILE TYPE 031 FOOD ANALYSIS TABLE

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

UCI031

NORTHERN FULMARS

SAMPLE SIZE: 10 PREY VOLUME (ML): 33 WHOLE PREY COUNT: 34

FOOD TYPE	PERCENT OCCURRENCE	PERCENT VOLUME	PERCENT NUMBER	FOOD TYPE	PERCENT OCCURRENCE	PERCENT VOLUME	PERCENT NUMBER
ACANTHOCEPHALA	0.00	0.00	0.00	EUCARIDA DECAP. PLEO. AN.	0.00	0.00	0.00
POLYCHAETA	0.00	0.00	0.00	PAGURIDAE	0.00	0.00	0.00
NEREIDAE	0.00	0.00	0.00	LITHODIDAE	0.00	0.00	0.00
NEPHTYIDAE	0.00	0.00	0.00	HAPLOGASTER	0.00	0.00	0.00
MOLLUSCA	0.00	0.00	0.00	HAPLOGASTER GREBNITZKII	0.00	0.00	0.00
GASTROPODA	0.00	0.00	0.00	DERMATURUS MANDTII	0.00	0.00	0.00
ACMAEIDAE	0.00	0.00	0.00	COLLEMBOLA	0.00	0.00	0.00
GASTROPODA EUTHYNEURA	0.00	0.00	0.00	OSTEICHTHYES	60.00	12.12	47.06
LIMACINIDAE	0.00	0.00	0.00	MALLOTUS VILLOSUS	0.00	0.00	0.00
LIMACINA HELICINA	0.00	0.00	0.00	EVERMANNELLIDAE	0.00	0.00	0.00
POLYPLACOPHORA	0.00	0.00	0.00	MYCTOPHIDAE	0.00	0.00	0.00
BIVALVIA	0.00	0.00	0.00	PARACANTHO. GADIF. GADOI.	0.00	0.00	0.00
CEPHALOPODA	40.00	21.21	32.35	GADIDAE	0.00	0.00	0.00
THEUTHIDIDA MYOPSIDA	0.00	0.00	0.00	THERAGRA CHALCOGRAMMA	10.00	60.61	11.76
ANTHROPODA MANDIB. CRUST.	10.00	3.03	2.94	POLLACHIUS VIRENS	0.00	0.00	0.00
COPEPODA	0.00	0.00	0.00	ZOARCIDAE	0.00	0.00	0.00
CALANIDAE	0.00	0.00	0.00	ACANTHOPTERYGII GASTEROS.	0.00	0.00	0.00

DATE OF ISSUE: JANUARY 9, 1980

SEE LAST PAGE FOR NECESSARY KEYS

OCSEAP - FILE TYPE 033 DENSITY AND VARIABILITY OF DISTRIBUTION SUMMARY

DATA PROJECTS GROUP
PASTORE LABORATORY
UNIVERSITY OF RHODE ISLAND

BERING SEA

LATITUDE: 59 00 N - 63 30 N, BOTTOM DEPTH: 0 M - 199 M, SEASON: SUMMER

NUMBER OF TRANSECTS: 170

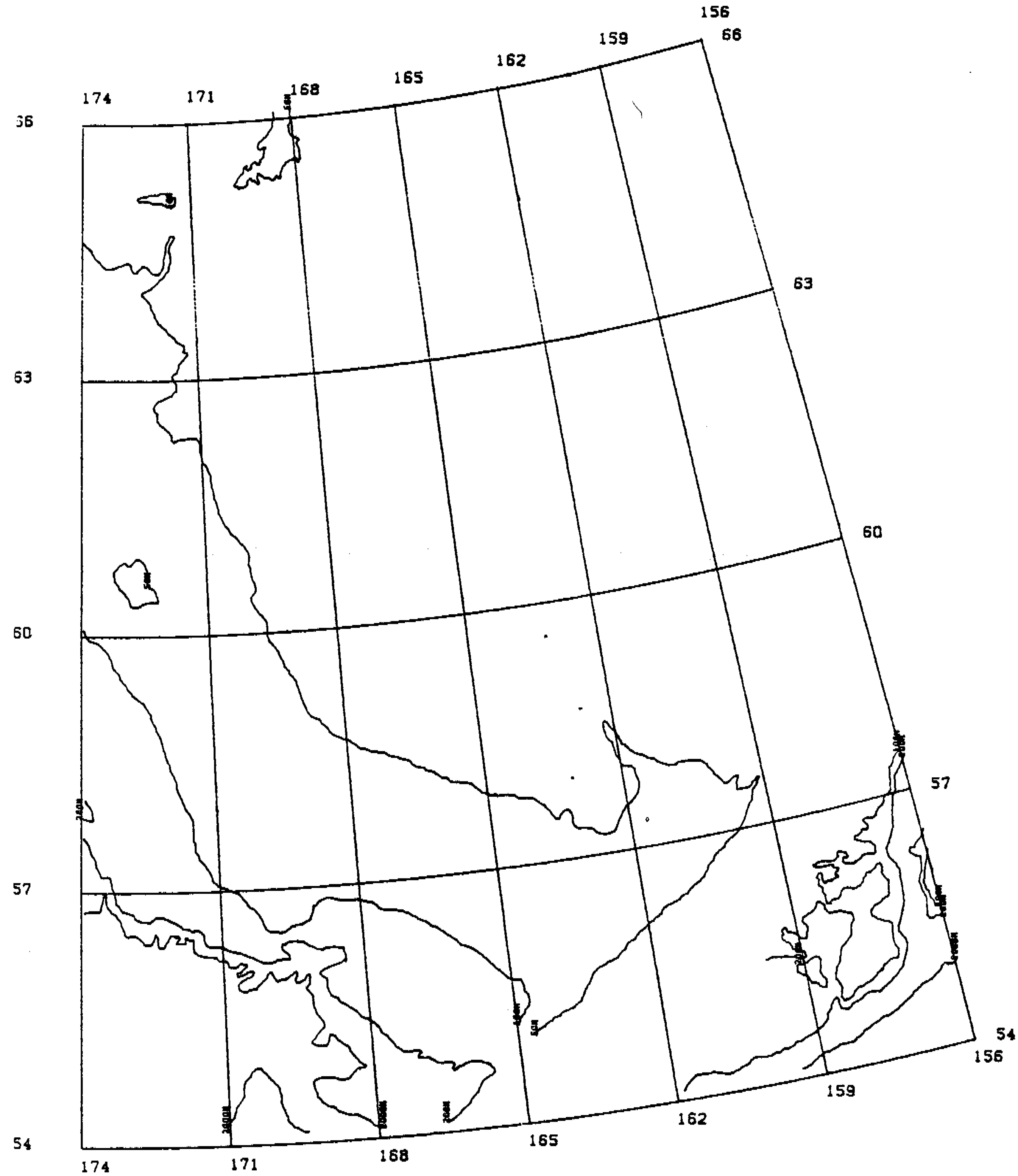
# TRANSECTS WITH NO BIRDS:	5	MEAN DENSITY:	522.0	LOG MEAN DENSITY:	1.316
% TRANSECTS WITH BIRDS:	97.06	MEAN DENSITY + 2 STD. DEV.:	11271.5	LOG MEAN DENSITY + 2 STD. DEV.:	2.724
HIGHEST TRANSECT DENSITY:	70124.1	MEAN DENSITY - 2 STD. DEV.:	-10227.5	LOG MEAN DENSITY - 2 STD. DEV.:	-0.092
LOWEST TRANSECT DENSITY:	0.0	DENSITY VARIANCE:	28888025	LOG DENSITY VARIANCE:	0.496

SPECIES NAME	NUMBER RECORDED	% OF TOTAL	MEAN DENSITY	DENSITY VARIANCE	% OF OCCURRENCE
1 SHEARWATER	83251	92.35	491.6	28870963	43.53
2 NORTHERN FULMAR	215	0.24	0.9	4	25.29
3 NORTHERN FULMAR DARK	14	0.02	0.1	1	1.18
4 NORTHERN FULMAR LIGHT	77	0.09	0.4	0	3.53
5 STORM PETREL	25	0.03	0.1	0	3.53
6 RED-FACED CORMORANT	0	0.00	0.0	0	0.00
7 KITTIWAKE	1154	1.28	4.0	88	79.41
8 BLACK-LEGGED KITTIWAKE	723	0.80	2.6	76	47.65
9 RED-LEGGED KITTIWAKE	7	0.01	0.0	0	0.59
10 MURRE	3281	3.64	14.3	306	70.59
11 COMMON MURRE	1236	1.37	6.7	44	19.41
12 THICK-BILLED MURRE	18	0.02	0.1	0	4.71
13 HORNED PUFFIN	108	0.12	0.4	2	18.82
14 TUFTED PUFFIN	224	0.25	1.1	8	27.65

PRIBILOF ISLANDS: NORTHERN FULMAR RATIOS (LIGHT/DARK)

SUMMER - AIR

LATITUDE	LONGITUDE	LIGHT	DARK	LIGHT/DARK
56 10 N	171 10 W	2.9	4.0	0.7
56 10 N	170 00 W	0.0	0.0	
56 10 N	169 20 W	0.0	0.0	
56 10 N	169 10 W	5.9	3.6	1.6
56 10 N	169 00 W	4.2	0.5	8.4
56 10 N	168 50 W	10.7	5.4	2.0
56 10 N	168 40 W	23.2	32.1	0.7
56 10 N	168 30 W	40.1	56.1	0.7
56 10 N	168 20 W	27.3	22.7	1.2
56 10 N	168 10 W	13.8	11.7	1.2
56 00 N	171 30 W	0.0	0.0	
56 00 N	171 20 W	0.0	0.0	
56 00 N	171 10 W	2.6	1.3	2.0
56 00 N	170 00 W	0.0	0.0	
56 00 N	169 30 W	0.0	0.0	
56 00 N	169 20 W	2.5	1.0	2.5
56 00 N	169 10 W	0.6	0.0	
56 00 N	168 50 W	0.0	0.0	
56 00 N	168 40 W	0.0	0.0	
56 00 N	168 30 W	0.0	0.0	
56 00 N	168 20 W	0.0	0.0	
56 00 N	168 10 W	0.0	0.0	
56 00 N	168 00 W	0.0	0.0	
55 50 N	170 00 W	0.0	0.0	
55 50 N	169 20 W	2.2	0.0	
55 50 N	169 10 W	0.0	0.0	



OCSEAP CONTOUR LINES (50, 100, 200, 2000)

APPENDIX II

Field Operations Status Report for File Type 033 Data

*** FIELD OPERATION STATUS REPORT ***

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 JUAN GUZMAN; "SR" & "DI" FIELD OPS. FROM DR. GEORGE DIVOKY; "AERSR" FIELD OPS. FROM BRIAN HARVIE.

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 ***

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

TAPE NUMBER	RESEARCH UNIT	DATE RECEIVED	FILE FORMAT	FIELD OPER.	CODEFULL MAILED	LOGLIST MAILED	CODEFULL 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	6,9
				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,9
				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	01/12/79	1B,8
				FW6027	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/26/78	01/02/79	01/12/79	1C,8
				FW6050	07/14/77	08/16/77	09/06/77	09/06/77	10/02/78	10/06/78	01/02/79	01/16/79	1C,8
				FW6051	07/14/77	08/16/77	09/06/77	09/06/77	10/24/78	10/27/78	01/02/79	01/16/79	1C,8
				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	01/02/79	01/16/79	1B,8
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,9
				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	01/09/79	1C,8
				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	01/02/79	01/12/79	1C,8
				FW6019	08/16/77	08/16/77	11/01/77	11/01/77	12/01/78	12/14/78	12/22/78	01/12/79	1C,9
				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	01/02/79	01/16/79	1C,8
ALASKA5	337	07/01/77	FWS	FW5015	09/29/77	09/24/77	10/20/77	10/20/77	08/08/78	08/09/78	11/15/78	11/30/78	1E,8

*** FIELD OPERATION STATUS REPORT ***

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	01/09/79	1F,8
				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	01/09/79	1F,8
				FW6007	09/29/77	09/29/77	10/20/77	10/20/77	07/24/78	07/27/78	12/22/78	01/12/79	1F,8
				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	1F,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	1F,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	1F,8
				FW6064	09/29/77	09/29/77	10/20/77	10/20/77	07/21/78	07/27/78	01/03/79	01/16/79	1F,8
				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	1F,8
				FW6095	09/29/77	09/29/77	10/20/77	10/20/77	08/08/78	08/09/78	01/02/79	01/16/79	1F,8
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	01/09/79	1F,8
				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	01/09/79	1F,8
				FW6005	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78	01/09/79	1F,8
				FW6010	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/21/78	01/09/79	1F,8
				FW6011	10/21/77	10/21/77	11/14/77	11/14/77	12/08/78	12/14/78	12/22/78	01/12/79	1F,8
				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	01/12/79	1F,8
				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	01/16/79	1F,8
				FW6077	10/21/77	10/21/77	11/14/77	11/14/77	12/15/78	12/18/78	12/22/78	01/16/79	1F,8
				FW6078	10/21/77	10/21/77	11/14/77	11/14/77	12/14/78	12/14/78	12/22/78	01/16/79	1F,8
				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	01/16/79	1F,8
				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	02/08/79	1G
ALASKA8	337	07/28/77	FWS	FW5038	10/26/77	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	01/05/79	01/12/79	1F,8
				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

*** FIELD OPERATION STATUS REPORT ***

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
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	01/09/79	2,1H,8
				FW5006	10/28/77	10/28/77	11/30/77	11/30/77	10/02/78	10/13/78	12/21/78	01/09/79	2,1H,8
				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	01/12/79	2,1H,8
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	02/17/79	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/	02/08/79	
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/	02/08/79	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/	02/08/79	
				UCI704	07/07/78	07/07/78	07/27/78	07/27/78	08/25/78	08/28/78	/NA/	02/08/79	
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	09/08/79	09/08/78	09/18/78	09/18/78	10/23/78	10/25/78	/NA/	10/31/78	

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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
ALASKA17	467	10/23/78	NODC	AERSR1	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR2	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR3	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR4	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR5	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR6	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12
				AERSR7	10/30/78	10/30/78	06/06/79	06/06/79	06/25/79	06/25/79	/NA/	07/03/79	9,12,14
ALASKA18	083	12/15/78	NODC	UCI702	01/18/79	01/18/79	02/02/79	02/02/79	05/18/79	05/18/79	/NA/		11,13
				UCI801	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
				UCI802	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
				UCI803	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
				UCI804	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
				UCI805	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
				UCI806	01/18/79	01/18/79	02/02/79	02/02/79	05/18/79	05/18/79	/NA/	06/25/79	13
				UCI808	01/18/79	01/18/79	02/02/79	02/02/79	05/11/79	05/18/79	/NA/	06/25/79	13
TIDISK2	083	08/20/79	TI	UCI903	09/26/79	09/26/79		10/18/79					
TIDISK3	083	10/25/79	TI	UCI902	11/05/79	11/05/79	11/13/79	11/13/79					
TIDISK4	083	11/16/79	TI	UCI901	12/11/79	12/11/79	12/26/79	12/26/79	01/07/80				
ALASKA19	337	08/20/79	NODC	FW5007	10/01/79	10/01/79							
				FW5028	10/01/79	10/01/79							
				FW6069	10/01/79	10/01/79							
				FW8006	10/01/79	10/01/79							
				FW8007	10/01/79	10/01/79							
				FW8008	10/01/79	10/01/79							
				FW8029	10/01/79	10/01/79							
				FW8032	10/01/79	10/01/79							
				FW8100	10/01/79	10/01/79							
				FW9001	10/01/79	10/01/79							
ALASKA20	337	09/20/79	NODC	FW5038	10/01/79	10/01/79							15
				FW6096	10/01/79	10/01/79							
				FW6100	10/01/79	10/01/79							
				FW6200	10/01/79	10/01/79							

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OREGON1	108	05/25/77	NODC	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					/NA/		
				1SR477	08/31/78	08/31/78					/NA/		
				1DI577	08/31/78	08/31/78					/NA/		
CALIF 2	196	02/06/79	NODC	1SR678	02/12/79	02/12/79					/NA/		
CALIF 3	196	05/18/79	NODC	3AL877	06/11/79	06/11/79							
				3AL878	06/11/79	06/11/79							
				3GL877	06/11/79	06/11/79							
				1SR578	06/11/79	06/11/79							
				1SR678	06/11/79	06/11/79							13
TIDISK1	196	06/04/79	TI	UCI478	06/29/79	06/29/79		07/18/79	07/19/79	07/23/79	/NA/	08/15/79	
	196	12/04/79	NODC	2GL976									
				2GL876									
				3AL876									

*** FIELD OPERATION STATUS REPORT ***

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
ALASKA20	337	08/20/79	NODC	FW6300	10/01/79	10/01/79							
				FW6400	10/01/79	10/01/79							
				FW7047	10/01/79	10/01/79							
				FW7050	10/01/79	10/01/79							
				FW7051	10/01/79	10/01/79							
				FW7052	10/01/79	10/01/79							
				FW7053	10/01/79	10/01/79							
				FW7054	10/01/79	10/01/79							
				FW8012	10/01/79	10/01/79							
				FW8014	10/01/79	10/01/79							
				FW8015	10/01/79	10/01/79							
				FW8016	10/01/79	10/01/79							
				FW8017	10/01/79	10/01/79							
				FW8018	10/01/79	10/01/79							
				FW8019	10/01/79	10/01/79							
				FW8023	10/01/79	10/01/79							
				FW8024	10/01/79	10/01/79							
				FW8025	10/01/79	10/01/79							
				FW8026	10/01/79	10/01/79							
				FW8027	10/01/79	10/01/79							
				FW8028	10/01/79	10/01/79							
ALASKA21	467	09/20/79	NODC	AEP801	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP802	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP803	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP804	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP805	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP806	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP807	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP808	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP809	10/01/79	10/01/79	11/16/79	11/16/79					
				AEP810	10/01/79	10/01/79	11/16/79	11/16/79					
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

*** FIELD OPERATION STATUS REPORT ***

AS OF 10/01/79

THE DATA PROJECTS GROUP — OCSEAP - GULF OF ALASKA PROJECT

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).
   J. LOGLIST AND CODEPULL SENT BACK TO PI FOR ADDITIONAL CORRECTIONS (03/02/79), RETURNED TO RU 527 (05/09/79).

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. UCI702 WHICH WAS ORIGINALLY RECEIVED ON TAPE ALASKA 15.

12. CODEPULLS AND LOGLISTS WERE NOT RETURNED; INSTEAD A LETTER WITH CORRECTIONS WAS RECEIVED.

13. DATA FOR FIELD OP. 1SP678 REPLACES THAT ORIGINALLY RECEIVED ON TAPE CALIF 2.

14. FIELD OP. AERSR7 SPLIT OFF FROM AERSR4.

15. STATIONS 1-404 OF FIELD OP. FW5038 WERE RECEIVED WITH TAPE ALASKA8 IN JULY, 1977.
    FW5038 ON ALASKA20 CONTAINS STATIONS 405-459.

*** FIELD OPERATION STATUS REPORT ***

THE DATA PROJECTS GROUP

OCSEAP - GULF OF ALASKA PROJECT

SUMMARY:

TOTAL FIELD OPS. RECEIVED BY RU 527	195
CODEPULLS MAILED TO INVESTIGATOR	192
LOGLISTS MAILED TO INVESTIGATOR	192
CODEPULLS RETURNED TO RU 527	146
LOGLISTS RETURNED TO RU 527	148
TOTAL FIELD OPS. BEING EDITED AT RU 527	13
FIELD OPS. WHICH PASSED FINAL CHECK	135
FIELD OPS. CONVERTED TO NODC	81
FIELD OPS. MAILED TO NODC	132

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