Environmental Assessment of the Alaskan Continental Shelf

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July - September 1975 quarterly reports from Principal Investigators participating in a multi-year program of environmental assessment related to petroleum development on the Alaskan Continental Shelf. The program is directed by the National Oceanic and Atmospheric Administration under the sponsorship of the Bureau of Land Management.

ENVIRONMENTAL RESEARCH LABORATORIES / Boulder, Colorado / 1975

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EFFECTS OF CONTAMINANTS

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Semiannual Report

THE PHYSIOLOGICAL EFFECTS OF ACUTE AND CHRONIC EXPOSURE TO HYDROCARBONS AND ASSOCIATED HEAVY METAL CONTAMINANTS OF PETROLEUM ON THE NEAR-SHORE FISHES OF THE BERING SEA.

Grant Number

USDC NOAA 03-5-027-86

Principal Investigator

Arthur L. DeVries, Ph.D.

Scripps Institution of Oceanography
University of California, San Diego

October 31, 1975

I. Objectives

Our proposed investigation is to take into account the effect of petroleum hydrocarbons and associated trace metals on the survivability of the fish fauna living in close association with the ice of the Bering Sea. Species are selected with respect to their importance as a food to the human populations and as to their importance in the food chains supportive to other fish, birds and seals. Specifically, it is desired that we determine the concentrations at which these petroleum hydrocarbons will affect the metabolic processes of these fish on acute toxic and chronic exposure levels. Concerning the latter, the respiration rate of both the fish as a live organism and as isolated tissue samples will be studied. In addition, the effects of petroleum hydrocarbons on the fish's ability to produce blood serum antifreezes, which are necessary for acclimation to freezing temperatures, will be observed.

For the summer of 1975, collection of specimens occurred only in the Nome region of Alaska. Equipment and accomodations were available to us here from Fish & Game and we had previous knowledge of the area with respect to fish species present. Research was implemented at Auke Bay National Marine Fisheries Laboratory and Scripps Institution of Oceanography.

II. Field and Laboratory Activities

A. The following is a field trip schedule for the members involved in this investigation:

1. Schedule for A. L. DeVries

Date	Location
9/2 to 9/3	San Diego to Nome
9/16 to 9/17	Nome to Juneau
9/19	Juneau to San Diego

2. Schedule for S. S. Graves

Date	Location
9/2 to 9/3	San Diego to Nome
9/13	Nome to Juneau
9/23	Juneau to Nome
9/27	Nome to Juneau
9/29	Juneau to San Diego

During this time no aircraft, NOAA or otherwise were chartered. Travel was accomplished by commercial flight. Fish sampling was accomplished by an Alaska Department of Fish & Game craft.

B. Scientific party was composed of:

Name	Affiliation	Position
Dr. Arthur L. DeVries	S.I.O.	Principal Investigator
Scott S. Graves	S.I.O.	Research Assistant

C. Methods

Field sampling was first attempted by setting three 50 meter length gill nets, one of 2.5 cm mesh, one of 3.8 cm mesh, and a third of approximately 7.6 cm mesh.

The nets were set from a 16 foot flat bottom riverboat powered by a 25 h.p. Johnson outboard.

Once set the nets were inspected three times a day, morning, noon and late afternoon for seven days. The numbers of captured fish were high, primarily _E. gracilis_ (saffron cod), _P. stellatus_ (starry flounder) and _L. glacialis_ (arctic flounder). However, the size of these fishes was much too great in order to accomodate our equipment for oil toxicity tests at Auke Bay National Marine Fisheries Lab. These large specimens, 100 grams to .5 kilograms, did prove invaluable for blood serum collection, necessary for determining serum freezing resistance in near shore summer fishes.[1] Fortunately, we accomplished collection of the proper sized specimens, approximately four to seven grams in weight, through the use of a small, 5 meter long, otter trawl. By trawling through the dense beds of brackish-water grasses, we caught our necessary specimens in both the numbers and size we required.

Fish were maintained in 48 quart capacity Igloo Ice chests. The water was aerated by small battery powered bait tank air pumps. Specimens were shipped by air in this manner also.

Lab analysis in Nome was only the sampling of blood of various fishes, primarily _P. stellatus_, _L. glacialis_, _E. gracilis_, and various sculpins of the genus Myoxocephalus. This sampling was made to determine whether whether or not these summer fishes possessed freezing resistance.

Freezing point studies were carried out in a temperature regulating bath, a variated method of Ramsay and Brown.[2] The sample solution was placed in a capillary tube which was then sealed and inserted into the bath. The temperature at which an ice crystal began to increase in size was recorded as the freezing point.

Analyses at Auke Bay consisted of establishing accurate data concerning the toxic effects of Cook Inlet crude oil on the cod, _E. gracilis_, at summer sea temperatures 8.0-8.6°C and at colder temperatures 2.8-4.0°C. These cod were also exposed to fuel oil at a temperature range of 7.4-7.6°C. In addition the resistance of the arctic flounder, _L. glacialis_, to the toxic components of oil was tested at 7.5-8.2°C. Owing to the numerous species of sculpin and their few numbers, a toxicity study was not run on these fishes at this time.

The fish were placed in pairs in 20 liter jars filled with 18 liters of sea water and various concentrations of solubilized hydrocarbons according to the methods of Karinen and Rice.[3] The results were calculated by computer using Probit analysis with a 95% confidence interval. Each analysis was calculated at the end of 24 and 96 hours. Results were given as TL_{50}, the toxic lethal dosage necessary to kill one-half the population. Soluble fractions of the oil were measured by two means. Paraffins, the relatively non-lethal hydrocarbons of oil, were measured by infrared spectophotometric techniques. Values of parts per million could be assigned as the paraffins were the only hydrocarbons at this wave length, 3200 to 2750 cm^{-1}. Napthalenes, on the other hand, could be measured by an ultraviolet spectophotometer and values were indicated as absorbance at the wavelength scan from 240 to 210 mμ. Parts per million could not be calculated using this technique because of the numerous hydrocarbons at this absorbancy range. (For a more complete explanation see the publication by Karinen and Rice.)

Laboratory analysis at Scripps has been establishing baseline tissue oxygen consumption of cod and sculpin using a Gilson respirometer. In addition, the acclimation of sculpin to freezing temperatures has been implemented.

D. Field sampling

Sampling locality was the lagoon within Safety Sound, approximately 20 miles southeast of Nome. The water was 1 to 2 meters deep depending upon the tides and configuration of the bottom of the estuary. A channel coursed its way through the area we worked (see map).

E. Data collected and analyzed

We are yet in the process of keying-out the fish species obtained. However, the following are known species inhabiting Safety Sound this time of year (September). Eleginus gracilis (cod), Platichthys stellatus (starry flounder), Liopsetta glacialis (arctic flounder), Palasina barbata (tube nose poacher), Myxocephalus *scorpius* (sculpin), *Hexagrammos stelleri* (greenling) and *Salvelinus malma* (dolly varden).

About 500 *E. gracilis* were caught. About one-half the s.p. died in transit to Auke Bay. [200 sculpin and 300 *L. Glacialis* and *P. stellatus* were also taken.]

Analyses were:

1. Freezing resistance in sculpins, cod and flounder.
2. Toxicity of Cook Inlet oil on cod and flounder.
3. Baseline oxygen consumption of cod and sculpin tissues.
4. Initiation of acclimation to freezing temperatures for sculpin.

No tracklines have been set.

III. Results

A. The blood serums of the arctic fishes (collected during the summer of 1975, water temperature ~ 6°C) froze at approximately - .7°C, a temperature typical of fish without any special adaptation to resist freezing temperatures.

B. The toxicity of Cook Inlet oil on cod and flounder and the toxicity of fuel oil on cod are represented by the following table:

Species	Temp.	% Salinity	Oil	24 hr. TL50 with 95% confidence interval	96 hr. TL50
cod	8.0-8.6	29	Cook Inlet	1.83 ppm - I.R.* .043 U.V.O.D. **	1.029 ppm - I.R. .034 U.V.O.D.
cod	2.8-4.0	29	Cook Inlet	2.48 ppm - I.R. .102 U.V.O.D.	2.28 ppm - I.R. .092 U.V.O.D.
cod	7.4-7.6	29	fuel oil	no kills	4.4 ppm - I.R. .123 U.V.O.D.
Arctic flounder	7.5-8.2	29	Cook Inlet	> 3.6 ppm - I.R. > .228 U.V.O.D.	> 3.6 ppm - I.R. > .228 U.V.O.D.

*parts per million determined by infrared spectrophotometric method.

**optical density at 210 - 240 mμ.

C. Oxygen consumption of white muscle and liver in microliters (stp) per gram of dry weight per hour (values given in range at this time).

Species	White muscle	Liver	Gill
E. gracilis 6 specimens	121.3 - 460.9	346 - 851.9	-
Sculpin	292.9 - 584.4	534.1 - 1149.4	711.2 - 1210

D. Acclimation studies have only just commenced.

IV. Interpretation of Results

A. The fact that no blood serum "antifreeze" was found in these arctic fish corroborates other work done by A. L. DeVries. When summer temperatures are high enough so that freezing is not a problem, the fish stops the production of antifreeze compounds. This makes our study all the more important as petroleum hydrocarbons may be capable of inhibiting the initiation and full scale production of these compounds.

B. As can be seen by the preceding table, the cod are relatively vulnerable to the toxic hydrocarbons of Cook Inlet oil. Interestingly, the survivability of the fish increases with the drop in temperatures. Perhaps a lower metabolic rate is responsible for this. Fuel oil evidently lacks the higher concentration of toxic hydrocarbons that is prevalent in crude oil.

The flounder, among all the species most resistant to fatalities during capture, were practically immune to the toxic hydrocarbons.

C. The baseline tissue oxygen consumption results indicate liver to be more metabolically active than white muscle in both saffron cod and sculpin. The gill lamellae of the sculpin shows a higher rate of metabolic activity than the other two tissues.

V. Problems

No insurmountable problems were encountered during our studies. However, transportation of our live fish was somewhat difficult. Due to the high concentration of material shipped by air, our fish were delayed, lost, or mishandled. We were nearsighted in our estimate of funds required for transportation.

At this time we have no recommended changes.

VI. Expenditure (up to 10-20-75)

Category	Total Amount Funded	Amount Spent	% Spent
Salary	$ 9,322.50	$ 2,885.79	30.9
Supply & Expense	1,999.88	1,204.56	60.2
Travel	3,000.00	2,837.62	94.6
Equipment	4,000.00	3,903.85	97.6
Employees benefits	1,311.00	227.97	17.3
Overhead	5,346.62	1,461.13	27.3
Total	24,980.00	12,520.82	50.1

References

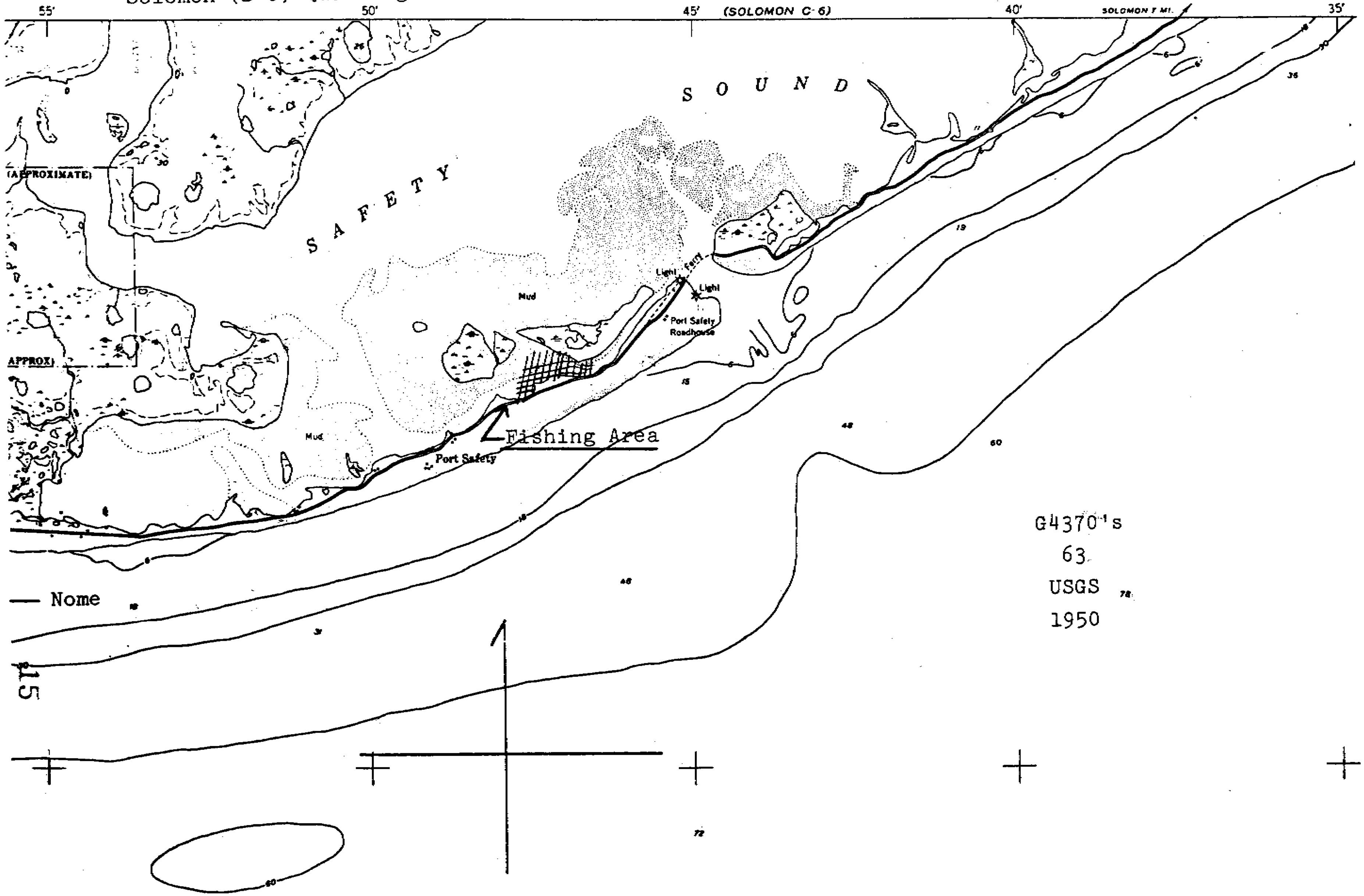
1. Duman, J. G. and A. L. DeVries, 1974a. Freezing resistance in winter flounder, *Pseudopleuronectes americanus*. *Nature* (London) *247*, 237-238.
2. Ramsay, J. A. & R. H. Brown, 1955. *J. Sci. Instrum.* *32*, 372.
3. Karinen, J. F. and S. D. Rice, 1974. Effects of Prudehoe Bay crude oil on molting tanner crabs, *Chionoecetes* bairdi. *Mar. Fish. Rev.* *36*(7): 31-37.

UNITED STATES
DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS

OR

Solomon (B-6) Quadrangle

SCALE 1:63360



This project seems to be Moving Ahead VCC

Semi-Annual Report

RU 71 -- Physiological Impact of Oil on Pinnipeds

NEGOA

I. Task Objectives

A. To determine the thermal conductance of both normal and oiled fur seal pelts.

B. To measure the effects of oil fouling on the number, depth and frequency of dives made during feeding excursions.

C. To measure the impact of oil fouling on the metabolic rates of fur seals in air and in water.

II. Field and Laboratory Activities

A. Laboratory (June 1 to September 3, 1975):
The contract physiologist tested harness designs, designed and fabricated depth-time (D-T) recorders for fur seals in his laboratory at Scripps Institution of Oceanography. Field (September 4 to October 17, 1975), see below.

B. Scientific Party:
Dr. G.L. Kooyman (contract physiologist), Mr. D. Urquhart (assistant), Scripps; Dr. R.L. Gentry, NMFS Marine Mammal Division (Principal Investigator), Mr. G. McGlashan (field assistant).

C. Field Methods:
The contract physiologist, Gentry and the two assistants equipped three female fur seals with harnesses and dummy D-T recorders to test the reliability of instrument retrieval and harness function. The females were released to sea. On their safe return four females were instrumented with D-T recorders, and all four were subsequently recovered. One recorder was sent out a second time and has not been recovered by October 18. In addition, four immature fur seals were captured and transported to Scripps for initial tests of metabolic rates.

D. Sample Localities:
St. George Island, Alaska and adjacent Bering Sea.

E. Data Collected and Analyzed:
Four tapes were obtained from the D-T recorders, each of which contained a trace representing depth of the recorder over time. The shortest tape

contained four days, the longest eight days of diving data. Preliminary analyses were performed, including dive depth and duration of the deepest dives, frequency and depth of intermediate dives, and intervals between diving sequences. All tapes were photographed.

A

III. Results

Attached is the rough analysis performed in the field for one of the recorders. Copies of the other analyses, and of the calibration curves are presently unavailable since they are in transit to Scripps.

IV. Preliminary Interpretation of Results

Normal (non oiled) females seem to make three types of dives, (a) deep dives (maximum to date 625 ft) which are brief (5 minutes) and infrequent, and which may be interpreted as exploratory; (b) intermediate dives (mostly to 300 to 350 ft) which occur in clusters at semi-regular intervals (9 to 12 hours) and which may be interpreted as feeding dives and; (c) shallow dives (mostly between 30 and 60 ft) which may be associated with traveling, or which may be instrument artifacts.

These thoughts are not to go outside the Project Office.

V. Problems Encountered/Recommended Changes

A. Harnesses. Some caused chafing which necessitated a design change.

B. D-T recorder. The time base needs to be re-calibrated. Also the instrument should be further tested on laboratory animals to determine whether the shallow dives (c above) are real or artifacts.

VI. Estimated Funds Expended

Contract with University of California	$59,700.00
Travel	600.00
TOTAL	$60,300.00

DTR #1

Caught Sept 23
Instrument Recovered Oct 13

Recovered From #6

Hour	# Dives feet 30 to 60	Atmospheres 3	4	5	6	7	8	9	10	11	One at Atmos. Other	[illegible]	Remarks
Calibration 118													Do not recall when animal was caught.
14.4													Continuous Trace begins
43.0													Swimming Diving Trace begins. Small dives go above & below base line.
43.5 —													
46.4													Many shallow quick dives 30 to 60
46.4		1											
46.8		1											
47.0			1										
47.6		1											Trace is so good looks like There are many shallow dives between these deeper dives Can't be counted faithfully
47.6				1									
49.1		1											On these dives there is no hanging on ascent or descent
49.3					1								
49.5			1										
49.9			1										
50.0							1						
51.3								1					
53.5	2												
53.6					1								
54.0		1											
54.1				1									
54.5 —													
54.8	8												Approximately (24) and shallow very close together
55.6	1		1										
55.8	1	1											
55.9								1					
56.2		1											
56.4	1		1										
56.5	2												
56.6			1										
56.7	1			1									
56.8		1											
56.9						1							
7.0 ~~60.0~~					1						13		
58.5											Atmos.		
58.7			1								15	4	
59.1						1							about 3 minutes apart.
63.3	1												
68.0	1												
68.1					1								
68.6						1							
68.8						1							Time at depth looks like
69.0													
69.1				1									
69.25	1												
69.3				1									
69.3 —													
69.5	4												Very 2 distinct
71.0													
72.8 —													
73.0	4												

DTR #1 page #2

Hour	* feet 0-30	2	3	4	5	6	7	8	9	10	one at other depth	D
73.5 —												
74.0		11 dives to 60 feet very distinct.										
74.5	2											
75.3			1	(An extremely interesting series from 75.0 to 81.0)								
75.5		1										
75.6			1									
75.8											12	4
76.0									1			
76.8											14	
76.9 —												
79.5	66 Dives at 3 to 5 Atmospheres, mainly 4, about 3 minutes apart. The last three dives of the 66 are extended and the deepest.											
80.5											15	
80.7					1							
80.8											14	
~~82~~ 82.5											11	
82.6											14	5
85.4							1					
85.5							1					
85.8											12	
88.0								1				
88.2											13	
91.0			1									
91.1 —												
91.6				8	Time spent at depth							
91.6			1									
91.7 —												
91.9		4										
92.3								1				
92.7 —												
94.5	I believe this section shows animal swimming											
9[illegible] —												
96.6	Many shallow dives?											
96.7								1				
96.9								1				
97.4 —								2				
98.3	25 dives at 2 to 4 Atmospheres											
99.0 —												
99.7	≈ 20 dives at 3 to 4 Atm.											
103.2 —												
103.6	14	Very distinct										
103.7							1					
103.9											12	
106.9											12	
112.1											13	
113.5 —												
114.3	76 dives 3 to 4 Atmospheres & 2½ minutes apart.											
114.5 —												
115.7	Animal Swimming											
117.1 —												
118.3	Animal Swimming											
121.6 —												

DTR #1 page #3

# of Dives

Hour	Feet 0-30	Atmospheres 2	3	4	5	6	7	8	9	10	Other	Min Dives
~~[illegible]~~												
123.2		1										
123.3			1									
123.5 –												
123.7	≈ 7 dives to 2 Atm											
123.7 –												
124.4	13 dives at 4 to 5 Atm											
133.8 –												
134.8	16 Dives every 4 to 6 mins 4 to 5 atmospheres.											
134.8 –												
136.5	38 Dives 3 to 4 Atm.											3.5
137.0						1						
142.7							1					
143.6 –												
145.1	Many shallow dives											
145.8 –												
146.3	≈ 13 dives at 2 to 3 Atm.											
146.3 –												
146.6	6 Dives at 5 to 6 Atm.											
147 –												
155	Animal seems to be inactive											
155.4				1								
157.5				1								
157.8 –												
158.1	5 Dives at 3 Atm											
158.1 –												
158.4	≈ 8 dives 2 to 3 Atm.											
158.5 –												
158.7	4 at 2 to 3 atm.											
167.7 –												
168.1	≈ 13 dives at 2 to 3 Atm											
168.1						1						
168.2 –												
168.5	9 Dives 4 Atms.											
168.5 –												
169.7	21 Dives about 2½ mins long, 4 to 6 Atms. last dive of series											
169.7								1				
179.6 –												
180.3			13									
180.5 –												
181.4	≈ 30 dives at 1 to 2 Atmospheres											
190.1 –												
190.5			6									
204.7		1										
205.9	1											
206.5				1								
208.7				1								
208.8				1								
209.3				1								
209.7				1								

Paper may be incomplete the last 20 hours due to tracking Problem.

DTR #1 Report

#6 came back aboard 8:00 AM Oct 13. The harness was removed at 3:00 PM and the animal was released. As expected after twenty days, the instrument was not running. The harness was in fine shape as long as it had been when attached; the animal was not abraded. It is not known whether or not #6 found her pup.

The instrument was closed when opened. There was a wrapping. All the tape was on the take up reel. Both B[illegible] registered approximately zero rolling. The tape is gorgeous! Ascent + Descent all the way through. A good trace the length of the paper, quite easy to read. Only problem is that the paper was not tracking straight and is severely wrinkled on one edge toward the end of the roll. The trace ends at 210.2, begins at 11.8. The paper ended 8.26 days into the voyage.

The trace is so good that I'm able to distinguish between 0-30 feet and 30 to 60 feet. Note Page #2 DTR #1.

Roger took photos of the tape. He took centered duplicates of areas that he wishes to have blown up.

REPORT OF PROGRESS

July 1 - Nov. 1, 1975

(Research Units 72a, 72b, 331, and 334)

by

John F. Karinen
Stanley D. Rice

Acute and Chronic Toxicity, Uptake, and
Depuration of Sublethal Metabolic
Response of Alaskan Marine Organisms
to Petroleum Hydrocarbons

I. Subtask Objectives

A. To determine acute and chronic toxicity of Alaskan crude oil to non-commercial species which may contribute substantial biomass to the ecosystem (Unit 72a).

B. To determine the effects of extreme low temperatures on oil toxicity (Unit 72a).

C. To determine the sublethal effects of oil on whole organism and tissue metabolic rates, respiration, growth, autotomy, and histopathology, and compare doses of oil causing sublethal effects with acute toxicity (Unit 72b).

D. To determine uptake and depuration rates of hydrocarbons and the effects of temperature thereon (Unit 72b).

E. To determine effects of oil on early egg development in crabs (Unit 331).

F. To determine effects of oil on salmon fry respiration (Unit 334).

II. Laboratory Activities

A. Scheduling of Experiments (From original work plan)

1. Acute toxicity tests -- untested species and life stages start -- September 15, 1975 -- end September 15, 1976. Specific dates depend on animal availability.

2. Acute toxicity -- different temperatures, Salmon fry -- August 1975, Scallops -- September 1975, Shrimp -- October 1975, and two other species -- 1976 (rescheduled to be after November 1).

3. Chronic toxicity to shrimp, shrimp eggs, crab eggs, and herring eggs. Preliminary -- spring and summer 1975. Final -- spring 1976. (Preliminary work not done since transfer of monies was to slow).

4. Uptake and depuration determinations for untested species start September 15, 1975, end September 15, 1976. Depends on animal availability -- U.V. analysis will be completed within 30 days after exposure and data from contracted G.C. analysis will be expected 60 days after samples sent.

5. Uptake and depuration determination at various temperatures. Salmon fry--August 1975, Scallops -- September 1975, Shrimp -- October 1975, and two other species -- 1976. (Rescheduled for spring).

6. Determine effect of oil on metabolism.

   Salmon fry -- Start June 1975 end September 1, 1975 (Completed).

   Crabs -- Fall 1975

   Other Species -- 1976

7. Determine effect of oil on tissue metabolism.

   Summer 1976

8. Determine effect of oil on scallop growth and behavior.

   Summer 1975 and 1976 (Preliminary work completed)

9. Determine effect of oil on crab autotomy response.

   February 1, 1976 to May 15, 1976

10. Samples for histopathology using routine histology, enzyme histochemistry, microscopy, and scanning electron microscopy will be taken from selected exposures and tissues during routine oil exposures in acute and chronic tests. Samples will be analyzed inhouse and/or in cooperation with similar studies at the NWFC under Donald Malins.

B. Research Team and Individual Responsibilities

1. John Karinen, Principal Investigator - Program Manager. General administrative and overall research planning, review, supervision and administrative -personnel coordination.

   Specific research responsibilities --

   a. crab autotomy;
   b. early egg development;
   c. Macoma clam studies;
   d. Other responsibilities -- manuscript review, animal collections diver.

2. Dr. Stan Rice, Principal Investigator Overall and specific research planning, review and supervision.

   Specific research responsibilities --

   a. salmon respiration;
   b. metabolism;
   c. uptake and depuration;
   d. general physiology
   e. Other -- publications.

3. Sid Korn, Wet Laboratory Supervisor Specific research responsibilities --

   a. acute toxicity bioassays;
   b. oil versus temperature bioassays;
   c. uptake and depuration exposures;
   d. effects of temperature on uptake and depuration;
   e. Benzene-Napathalene metabolism and toxicity;
   f. other -- animal collection, wet lab facilities diver.

4. Jeff Short, Chemistry Laboratory Supervisor Specific research responsibilities --

   a. chemical support - R&D for analytical techniques;
   b. biochemical support;
   c. metabolism, uptake-depuration, sub-cellular effects;
   d. acute toxicity - data analysis.

5. Loren Cheatham, Bio-Chemist
   Specific research responsibilities --

   a. chemical support - R&D for analytical techniques;
   b. routine analyses - U.V., IR, G.C. tissue.

6. Patricia Arasmith, Chemistry support
   Specific research responsibilities --

   a. routine oil/water analyses;
   b. data work-up.

7. T. A. Mechlenburg, Crustacean Physiologist
   Specific research responsibilities --

   a. effects of oil on invertebrate respiration and metabolism.

8. Malin B. Bonnett, Histologist-Fishery Biologist
   Specific research responsibilities --

   a. histopathology of tissues following oil exposure and recovery.

9. Christine Booderson, Biological Support
   Specific research responsibilities --

   a. chronic shrimp egg experiment;
   b. scallop growth study.

10. Charlotte Misch, Analytical Support
    Specific research responsibilities --

    a. statistical analyses;
    b. data work-up;
    c. miscellaneous support - animal collection.

11. Robert Budke, Biological Technician, Diver
    Specific research responsibilities --

    a. animal collection.

12. Tamra Taylor, Biological Support
    Specific research responsibilities --

    a. Macoma clam bioassays;
    b. R&D - mark and release of invertebrates.

13. Adam Moles, Biological Technician
    Specific research responsibilities --

    a. biological support (OCSEAP) - wet laboratory.

14. Dr. Robert E. Thomas, Physiologist -- research on salmon fry respiration and metabolism (terminated)

15. In addition to personnel designated above the following part-time or fulltime personnel are assisting in OCSEAP studies:

    Allan Edwards - Wet Laboratory (PT)
    Kelly Wheller - Chemistry Laboratory (PT)
    Jeanette Fisher - Data workup, Histology, Publications (FT)

C. Methods

Methods are essentially the same as described in the proposals.

Static acute bioassays are being conducted with several organisms and developmental stages at temperatures ranging between -1 to 10°C. Water soluble fractions of crude oils are being prepared by a standard method. Oil exposures are monitored by chemical analyses, i.e. infrared and ultraviolet spectroscopy, and gas chromotography. Chemical dynamics and degradation of exposure solutions are being investigated. The identity and concentrations of the major toxic components are being determined. Organism response data from bioassays are being analyzed by Probit and 95 percent confidence intervals for 0, 24, 72, and 96 hour TLM values determined. Organism viability is frequently tested in a standard bioassay using dodecylaulphate as a standard toxicant.

Chronic bioassays and special studies of sublethal effects are conducted using either flow through exposures with frequently prepared water soluble fractions or static exposures with daily replenishment of toxic solutions. Sublethal metabolic responses of organisms are measured by standard physiological and biochemical procedures. Metabolic rate changes are monitored through respiratory changes, operculas movements, pumping rates, enzyme rates and growth. Pathological changes are measured by routine histology and histochemistry. Morphological changes are detected by scanning electron microscopy. Behavioral changes are noted in all bioassays and followup experiments are conducted if the change in behavior is believed to have significant potential of influencing survival of the organism.

d. Sample Localities

The majority of organisms for our studies have been collected in the vicinity of Auke Bay, Alaska. Exceptions to this are (1) shrimp collected at Little Port Walter, Alaska and (2) saffron cod and miscellaneous fish collected in cooperation with Dr. Arthur DeVries near Nome, Alaska. Collection of adequate numbers of organisms for acute bioassays has been somewhat of a problem this fall, either because seasonal movements and abundances of organisms have made them unavailable or our collecting techniques need to be made more efficient. Apparently the former is a major factor because recently our success in catching various non-commercial shrimp species has greatly increased. Bob Budke has been collecting animals full time for the past two months and has now caught up with our immediate demands for organisms. This situation may rapidly change, however, as we move on to new organisms. In addition to using some of the large pelagic zooplankton for our tests (mysids, euphaussids, amphipods) we are investigating the availability of suitable intertidal organisms for test animals. As our operation has expanded availability of animals has become more apparent to us as a limiting factor in the production of certain types of data. Collection and sorting of animals for bioassays consumes a considerable number of man hours and is major part of the total man effort expended. Completion of certain sub-tasks is highly dependent upon availability of organisms.

E. Data Collected and Analyzed

According to the work plan schedule (II-A in this report) we are somewhat behind schedule with regard to progress on some experiments. Lack of progress in one area, however, is usually offset by increased progress in another because we operate as a team and focus the efforts of the team on the completion of a sub-task when scheduling and logistics permit. Following is a summary of accomplishments according to scheduled experiments under II-A.

1. Acute toxicity tests with Cook Inlet crude oil, Prudhoe Bay crude oil, fuel oil, or dodecylsulphate have been completed for the following species and life stages:

Species	Life Stage	Toxicant
Dock Shrimp (Pandalus)	adult	Dodecylsulphate
Scallops (Chlamys hericius)	juvenile	Dodecylsulphate
Humpy shrimp (Pondalus goniurus)	adult	Dodecylsulphate
Dock shrimp (Ponadalus danae)	adult	Cook Inlet (WSF)
Eualus shrimp (Eualus sp.)	adult	Cook Inlet Hydroted (WFS)
Green sea urchins (Strongulocentralis droorachisrsis)	juvenile	Cook Inlet and Prudhoe Bay Creek (WSF)
Saffron cod (Elagines gracilis)	juvenile	Cook Inlet (WSF) at 8° and 4°C
Saffron cod (Elagines gracilis)	juvenile	Fuel oil (WSF) at 8°C
Arctic flounder (Liopsetta facialis)	juvenile	Cook Inlet (WSF)

Analyses of these data are not complete.

*Macoma clam (Macoma balthica)	adult	Prudhoe Bay crude (WSF)

* A study, partially funded by OCSEAP to determine the toxicity of WSF of crude oil and oil contaminated sediment to Macoma clams resulted in some interesting behavioral observations of the clams burying activities. An abstract of a draft report is attached.

2. Acute toxicity at different temperatures.
   Progress in this area is behind schedule somewhat because of:

   1. unexpected difficulties in experiment logistics due to changes in the experimental design;
   2. effects of temperature on physical solubilities of oil as well as on biological responses of organisms requires separate experiment for each;
   3. availability of organisms of suitable size;
   4. delays in hiring support people.

   Research and development experiments were conducted with scallops at various temperatures. Size of the organism presented logistical problems for mixing required volumes of toxicant. Temperature/oil bioassays with a smaller organism were more satisfactory. Acute bioassays were conducted with Cook Inlet (WSF) and Saffron cod (<u>Elegine gracilis</u>) at two temperatures, 4^{o} and $8^{o}C$. Experimental apparatus for preparation of WSF for bioassays at various temperatures has been redesigned albeit at a greater than anticipated labor cost to the project.

3. Chronic toxicity to shrimp, herring, and crab eggs.
   Preliminary experiments - some progress.
   Final experiments -- not scheduled.
   Funding came too late to initiate more than a token effort to determine the chronic toxicity of oil to newly extruded crab eggs. Preliminary experiments were conducted on a limited number of king and tanner crabs. Exposure of eggs attached to king crab females is logistically difficult because of their large size and the problem of keeping the mass to volume of dose less than the recommended 1 gm per liter. Tanner crab females do not present such a difficult problem because of their smaller size. The preliminary experiments with tanner crab females provided us with some insight into the potential difficulties of these experiments but also provided us with experience which will aid us in designing the final experiment. Design of these experiments for spring 1976 is underway.

4. Uptake and depuration experiments have been rescheduled for later this winter (January 1). Problems with animal availability, delays in hiring support personnel, and redesign of wet laboratory exposure and mixing facilities make this change necessary.

5. Uptake and depuration at various temperatures is also behind schedule for the same reasons expressed in sections 2 and 4.

6. a. Effect of oil on salmon fry respiration and metabolism -- This study is well ahead of schedule. Experiments were completed and a manuscipt describing results of the study is in laboratory review. Dr. Rice will make an oral presentation of the paper at a Symposium on Physiology and Pollution on November 4 at the NMFS Milford Laboratory. An abstract of the manuscript is attached and a copy will be sent when the figures have been completed. The respiratory portion of the study was funded by OCSEAP.

   b. Respiration studies on crabs is on schedule. Apparatus has been set up and tested by Tony Mechlenburg and data collection is underway.

7. Effect of oil on tissue metabolism was not scheduled.

8. A preliminary experiment was completed to determine effects of oil on scallop growth. The experiment is feasible.

9. Effect of oil on crab autotomy response was not scheduled.

10. Tissue samples (mainly liver) for histophathology were taken from coho salmon pans exposed to lethal levels of WSF's of crude oil. Samples were also taken from pink salmon fry during sub-lethal constant-dose experiments. Processing of these and other back-logged samples has been initiated with the recent hiring of a technician. Crab tissue samples (gill and digestive gland) will be collected during exposures for studies on crab respiration.

F. Activities Planned for the Next Six Months

Planned activities for the next six months are essentially those listed in II-A. Sections 2, 4, 5 will be set back about two to three months but otherwise the schedule is as given. Considerable research activity will be in progress from now through the contract period with the period from January 1 to July 1 a particularly busy one. Senior personnel have a commitment to complete a report of research conducted under a prior contract by January 1. Following completion of this commitment direct personal involvement of senior personnel in research activities will return to normal levels.

III. Results

A. Scheduled experiments

1. a. Acute toxicity tests have been conducted with a number of new species but analyses of these data have not been completed. Preliminary indications are that TLM values will fall within the 1-5 pp. values (by IR spectroscopy) reported from our previous studies (see attached abstract). Our data suggests that lower TLM values may be obtained at lower temperatures but precise control of temperatures of mixing and exposure in a large series of bioassay is needed to verify this observation. 95 percent confidence intervals for TLM values from good data in our prior bioassay tests have ranged from ± 6% to ± 20%. With more precise temperature control we expect to reduce this variability.

   b. Bioassays with Macoma clams provided verification that this organism is probably a good choice for long term monitoring in baseline studies. The attached abstract provides a summary of the study. A report of this initial study with Macoma will be provided the OCSEAP Program Office. OCSEAP funding supported the toxicity studies with WSF and contaminated sediment. A small amount of additional data collection should result in refined manuscript of publishable quality.

2. No significant results are available from temperature/oil bioassays.

3. Preliminary experiments with early stages of crab eggs resulted in the following:

   a. egg samples were collected and preserved daily for the first 20 days of development from several control and exposed king and tanner crabs. Exposed crabs and control crabs had clutches of newly extruded eggs, which in the exposed crabs were subjected to 24 hours of either a high or low dose of the water soluble fractions of Cook Inlet crude oil under static conditions.

   b. Oil appeared to have little effect on the firming up and attachment of eggs to pleopodal setae.

   c. Eggs from these exposures are being tested with various staining techniques to facilitate examination to determine whether differences occur in development rates between exposed and control eggs.

   d. Some success with a staining technique has been obtained but it is not entirely satisfactory. Examination and recording of developmental stages of eggs prior to preservation may be necessary in final experiments planned for spring 1976.

4. No significant results are available from uptake and depuration studies.

5. No significant results are available from uptake and depuration studies at various temperatures.

6. a. Results of the effects of oil on pink salmon fry metabolism and respiration is explained in the attached Abstract. The final manuscript will be forwarded to OCSEAP about November 15.

   b. No significant results are available from crab respiration studies.

7. Not scheduled.

8. A preliminary scallop growth study was completed and experimental design was feasible. Results were inconclusive due to too few doses and low growth rates but suggest that water-soluble fractions of Prudhoe Bay crude oil do affect scallop growth. This study will be repeated during the spring bloom of plankton to acquire better growth potential.

9. Not scheduled.

10. No significant results to report from histophathology studies.

IV. Preliminary Interpretation of Results

Interpretation of results is included in the attached abstracts. The manuscript on salmon fry respiration will soon be presented at a scientific meeting and the abstract on acute toxicity summarizes a presentation at a recent meeting, therefore, no restrictions in dissemination of this information is necessary.

Information and interpretation of data in the Macoma balthica study should be considered preliminary and provisional and limited to the Project Office until it has received sufficient peer review and approval for release by our Laboratory Director.

V. Problems Encountered/Recommended Changes

Experiments have been conducted on the effect of temperature on toxicity, with enough results to suggest this is a very significant variable affecting toxicity. These experiments have also pointed out the complexities of the problem requiring more experimental equipment and changes in experimental design.

Temperature will affect toxicity for the following reasons:
(1) changes in animal susceptibility by changing metabolic rate uptake depuration rates,
(2) changes the chemical composition of the water soluble fractions by affecting what oil components get into solution;

(3) changes the chemical composition of the water soluble fractions by affecting what remains in the water column during a four day exposure.

Experimental designs that would answer these questions have been formulated. We have much of the equipment and personnel to answer these questions, but lack the following --

1. additional temperature control unit;
2. liquid scintilation counter uptake-depuration rate measurements;
3. 1.5 additional man years of labor.

VI. Estimate of Funds Expended

Budget summary as of October 31, 1975.

	Annual Plan	Project Costs to October 31	Actual Costs to October 31
Salary Costs	94.5	31.5	29.2
Travel	10.8	3.6	1.6
Contracts	15.0	5.0	1.3
Equipment and Supplies	11.1	3.7	11.8
Other Direct Costs	6.4	2.1	1/
	137.8	45.9	43.9

1/ Shipping costs, communications, SLUC not included.

Salary costs are less than projected for the period to October 31, because we were not fully staffed until October 28. Actual labor costs are higher per man year than indicated because we are being forced to hire at higher grade levels than anticipated to get or retain qualified and experienced technicians. Equipment and supplies spending is ahead of schedule because of inflation in prices, modifications in experimental designs, unforeseen costs associated with new equipment, and additional costs associated with animal procurement and holding.

Behavioral Response of the Clam, Macoma balthica to Unmixed Crude Oil, the Water-Soluble Fraction, and the Sediment Adsorbed Fraction of Prudhoe Bay Crude Oil in Laboratory Studies,

Don F. Karinen 1/ Tamra Taylor 1/ Howard Feder 2/ and Richard Myren 1/

ABSTRACT:

The small clam, Macoma balthica, occurs throughout the coastal areas of Alaska in the upper 4-8 cm of mud flats. Because it is a deposit and suspension feeder it is potentially susceptible to oil slicks on the mud, and to water-soluble or sediment-adsorbed fractions of crude oil. Settling of unmixed oil slicks on the mud during five simulated low tides (2-3 h each) had negligible effects on buried adult M. balthica held for two months. Concentrations of the WSF from 5-100% prepared from 1% oil/water mixtures (UVOD at 221nm 0.013 to 0.324) inhibited the burrowing of some unburied clams. Preliminary data indicates the TLm value is ____ for ability of unburied clams to burrow. The WSF in concentrations of 10-100% (UVOD at 221nm 0.059 to 0.318) caused many buried clams to come to the surface--the response was proportional to ~~dose~~ strength of WSF and time elapsed. The greatest response occured within 3 days at high concentrations (100%) and 9 days at low concentrations (10%). Although at the lower concentration the response took longer to occur more clams came to the surface.
In our tests many of the clams recovered from exposure but under natural conditions ~~they~~ might have ~~fallen~~ disappeared as prey to predators. Oil adsorbed on sediment and allowed to settle over buried M. balthica also stimulated movement to the surface. The proportion of clams that moved to the surface increased as the depth of oil-contaminated sediment increased.

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2/ University of Alaska, Fairbanks, Alaska

THE EFFECT OF PETROLEUM HYDROCARBONS ON BREATHING RATES, COUGHING RATES, AND HYDROCARBON UPTAKE-DEPURATION IN PINK SALMON FRY

by

Stanley D. Rice,[1] Robert E. Thomas,[2] and Jeffrey W. Short[1]

ABSTRACT

Pink salmon fry (Oncorhynchus gorbuscha) were exposed to the water-soluble fraction of Cook Inlet and Prudhoe Bay crude oils, and No. 2 fuel oil. Concentrations of oil in water were measured by UV (ultraviolet) and IR (infrared) spectroscopy. Breathing and coughing rates were measured in free swimming fry without anesthesia or surgery. Initially, breathing and coughing rates increased as the dose increased but decreased after several hours during 22 h exposures. A significant increase in breathing and coughing rates was caused by exposures to oil concentrations as low as 30% of the 96 h TLm (median tolerance limit) as determined by UV spectroscopy.

The breathing and coughing rates of fry during exposure to a constant dose for 72 h was similar to the 22 h exposures. However, after the initial 24 h, the breathing and coughing rates decreased but did not return to control levels. Tissues of fry exposed for up to 4 days to water-soluble fraction of Cook Inlet crude were analyzed by GC-MS (gas chromotography-mass spectrometry) for nonpolar hydrocarbons. Toxic aromatic hydrocarbons were taken up, but were being eliminated from the tissues during the exposures. The energy demand for detoxifying and eliminating hydrocarbons is likely greatest during the first 24 h when enzyme synthesis is needed. Continued exposure with continually elevated energy demands may be detrimental to the survival of a population.

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Acute Toxicity of Two Alaskan Crude Oils and Fuel Oil

to Crustaceans, Molluscs, and Fish of Southeast Alaska

S.D. Rice, J.W. Short and J.F. Karinen

Static acute bioassays partially funded by a group of oil companies and the National Marine Fisheries Service were conducted with a variety of organisms from southeast Alaska. We tested the toxicity of water soluble extracts and oil-water dispersions of Prudhoe Bay crude oil, Cook Inlet crude oil, and fresh Cook Inlet crude straight from the wellhead (hydrated oil) and No. 2 fuel oil. Representative organisms of several groups were used in the tests including king crab, four species of shrimp, two species of scallop, pink salmon fry, and Dolly Varden smolts. We monitored solutions with infrared and ultraviolet spectroscopy (IR quantitates paraffins and UV-naphthalenes). All solutions were most toxic in the first 24 hours of the 96 hour bioassays. Oil concentrations in the bioassay waters decreased with time and were only 20 and 15% of the initial concentrations after 96 hours (measured by IR and UV, respectively). Probit analyses of 96 hour bioassays with crude oil indicated similar mean tolerance levels for most animals tested (i.e., 1-5 ppm by IR at 2930 cm^{-1} and .05- .20 UV absorbance at 221 nm). The TLm values (based on IR analyses) are slightly less than those reported for similar species from Puget Sound and the Gulf of Mexico, but within the same order of magnitude (oil concentrations were based on IR analyses in both instances). Comparison of TLm values based on IR and UV analyses for a number of species with the two crude oils suggests that toxicity correlates best with UV absorbance at 221 nm rather than IR analyses--this reinforces the theory that dinuclear aromatic compounds are the most toxic components in short term exposures. Although Prudhoe Bay crude oil is more viscous than Cook Inlet crude and therefore requires more energy to get the water soluble components into solutions, once in solution the water soluble fractions of the oils are about equally toxic. Hydrated Cook Inlet crude oil did not differ significantly in toxicity from dehydrated oil. Fuel oil was generally more toxic than crude oil on the basis of IR analysis, but less toxic when concentrations of water solubles were measured by UV. This difference may be caused by presence of UV absorbing unsaturated components in fuel oil with relatively low toxicity. Results of the study emphasize the need to (1) indicate the methods used to measure oil concentrations when expressing TLm values for crude oils, (2) the need to identify and measure the toxicity of each individual component of the petroleum, and (3) the need to determine TLm values of total crude oil based on concentrations of each major toxic component within the mixture so that synergistic and antagonistic parameters may be evaluated.

RU #73 SUBLETHAL EFFECTS AS REFLECTED BY MORPHOLOGICAL, CHEMICAL, PHYSIOLOGICAL, AND BEHAVIORAL INDICES

I. Task Objective

Identify and evaluate in selected marine organisms the effect of chronic exposure to petroleum hydrocarbons and trace metals. Specifically, changes in tissue structure and ultrastructure, chemosensory perturbations and related behavior modifications, life history stages most sensitive to physiological disruption, and alterations in properties of mucus.

II. Laboratory Activities

A. Schedule

Partial emphasis through the first reporting period has been directed toward equipment purchase, hiring of scientific personnel, scheduling interfaces between investigators, and planning of activities to coincide with availability of seasonal organisms. Progress in laboratory studies has been concerned with organization of facilities, accumulation of baseline data, and preliminary experiments to determine the most productive avenues of future research.

B. Scientific Party

Personnel and their percentage involvement in studies under Research Unit 73 are listed below. Investigators employed specifically for this program are indicated by starting dates; other scientists were already on permanent NWFC staff.

D. Malins, Ph.D.	NWFC, Principal Investigator	20%	
H. Hodgins, Ph.D.	" " "	20%	
D. Weber, M.S.	" " "	60%	
H. Sanborn, M.S.	" , Oceanographer	50%	
U. Varanasi, Ph.D.	" , Chemist	90%	12 Oct.
F. Johnson, M.S.	UW Graduate School	50%	1 Oct.
S. Miller, B.S.	" " "	50%	1 Oct.
J. Hawkes, Ph.D.	Histopathologist	100%	1 Jan.
L. Mumaw, B.S.	UW Graduate School	25%	1 Oct.
Vacancy, B.S.	Histopathological tech.	100%	1 Jan.
J. Robbins	Community College Undergraduate	50%	1 Oct.

The remainder of this progress report through Section V deviates from the proposed format since as a multidisciplinary study the approach, methods and analysis of data are specific for each discipline. Each of the four task objectives are presented separately with the understanding that considerable interaction exists not only within Research Unit 73, but also with Research Unit 74 and to a lesser extent with Units 75, 72, 331, and 334.

Changes in Tissue Structure and Ultrastructure

Background:

Several preliminary experiments concerning the effects of short-term exposure of coho salmon (Oncorhynchus kisutch) and English sole (Parophys detulus) to water soluble oil fractions, and long-term exposure of rainbow trout (Salmo gairdneri) to whole crude oil in food have been undertaken. We utilized LC-50 data, which had been compiled for fish at the Auke Bay Laboratory to form a basis for exposure of fish to sublethal doses and to tentatively identify tissues and cell types, which are most sensitive to hydrocarbon contamination.

METHODS

Two methods were used to expose the fish to oil: adding the water-soluble fraction (WSF) of crude oil to the water or whole oil to the food. To prepare the WSF 10 ml of Prudhoe crude oil per liter of salt water was stirred for 20 hours, allowed to settle for 3 hours, and the bottom fraction removed. The fish were exposed to a 13% solution of the WSF in aerated tanks and maintained at 10°C. Fish and water samples were taken 2 hours, 24 hours, and 5 days after addition of the WSF. The concentration of WSF was measured spectrofluorometrically and data stored for subsequent analysis.

In the food phase of the experiments, 2.5 ml of crude oil was dissolved in 10 ml of Freon and absorbed to Oregon Moist Pellet. Freon was allowed to evaporate and the pellets then fed to the fish as 0.05% crude oil of body weight. The total food supply was 2% of body weight per fish fed five days per week for 2-1/2 months. A total of 4 replicates of both experimental and control fish were sampled. The controls were treated exactly the same as the experimental fish except that crude oil was omitted from the Freon-treated food.

In both the WSF immersion and feeding studies, samples of skin (1 cm^2) from the head, mid-dorsal, and ventral body and from the dorsal and ventral tail and the gill were fixed overnight in a trialdehyde solution, rinsed in buffer, and dehydrated in an ethanol series. The ethanol was replaced with Freon and the tissues were subsequently critical point dried, coated with gold palladium, and examined by scanning electron microscopy (SEM). Additional samples prepared for future transmission electron microscopy (TEM) included head and middorsal skin, gill, duodenum, liver, spleen, and kidney. Initial fixation with the same trialdehyde fixative used for SEM was followed by a buffer wash and postfixation in osmium tetroxide, and dehydration in ethanol was followed by infiltration and embedding in Spurr plastic. Thick sections (0.5μ - 1.0μ) were stained with toluidine blue and a special polychrome for plastic sections.

III. Results[1/]

Fish sampled after 2 weeks of feeding indicated differences in the levels of glycogen reserves in the liver. The liver cells of the control fish comprised high glycogen levels, whereas those of the experimental fish had virtually none. These changes were evident in the 0.5μ sections stained with toluidine blue. The polychrome method, which stains mucopolysaccharide moieties bright red when the cytoplasm is blue was used on 1.0μ sections to differentiate glycogen deposits in the cells (Figs. 1, 2).

All fish gained weight and no mortalities were observed at 2-1/2 months. The control fish increased in weight by 95.5%, the oil-fed fish 70.5%. After 2-1/2 months of oil feeding, stored glycogen in the liver showed a similar depletion as observed after 2-weeks exposure. The glycogen stores were so small that only a rare cell showed differential staining with the polychrome method. In addition, lipid reserves were depressed in the oil-fed fish (Figs. 3, 4). Thick sections of gut, skin, spleen, kidney, and gill were examined; no major differences were apparent.

Oil-Immersion Studies

The skin and gills of coho salmon and flatfish were evaluated for changes after oil immersion. Changes in the mucous glands indicated that surface glands had discharged their contents; however, the numbers and degree of discharges varied considerably in both experimental and control fish (Figs. 1A, 2A). Skin from five locations on the coho and three on flatfish have been processed

1/ We request that this portion of the progress report not be distributed and is intended for the Project Office only.

for both TEM and SEM. The analysis of this material has only begun.

Sections of liver taken from both salmon and flatfish (22 in all) at each of the sampling times have been evaluated at the light microscopic level; no gross changes, no massive damage, and no mortalities were observed. Particular attention was paid to the distribution of glycogen and lipid. As expected, the amounts of these substances varied in the controls since none of the fish were fed during the experiment and the flatfish, which had been captured a week before the experiment, did not eat in captivity.
Although the number of cells with glycogen reserves in the control varied considerably, there was a consistent lack of glycogen in the oil-treated animals. The suggestion of difference indicates that in future studies the experimental design should be refined and quantified.

IV. Preliminary Interpretation

The reduction and, in some cases, complete loss of glycogen storage in the liver of fish exposed to oil were consistent in these initial experiments. Field studies of <u>Fundulus</u> taken from oil-polluted waters showed a similar decrease in glycogen (Sabo <u>et al.</u>, 1975).
In <u>Fundulus</u>, the increased activity of glucose-6-phosphate dehydrogenase in the liver of oil-contaminated fish indicated increased depletion of "energy stores." The lipolysis found in <u>Fundulus</u> corroborates our finding of a decrease in lipid reserves in oil-fed fish.

The causes of glycogen depletion should be explored. For example, is the intestine damaged by the oil so that assimilation is hampered or does the oil act directed on the liver? Radioactively labeled oil fractions could be introduced in the fish's food or water and blood samples could be taken at specific times for scintillation counting to ascertain whether assimilation has occurred. Liver samples for radioactivity assay could also be taken.

This study has shown a definite metabolic response of fish to crude oil and suggests the need for additional studies. Determining the effects on other organs has yet to be completed; the tissues are prepared and await future examination.

One of the most obvious needs unearthed by this study is background information on "normal" fish and on the range of variability within the norm. In response to this need, a study of healthy fish was begun at the histological level. Two different fixatives and five staining methods were used on paraffin sections of gill, liver, duodenum, spleen, and kidney. Serial sections of an entire liver were stained with a trichrome, which differentiates connective tissue from cellular components, and are being studied to trace bile ducts in the hepatic vascular system.

Chemosensory Perturbations and Related Behavioral Modifications

A. Background

Distance chemoreceptors of decapod crustaceans have been identified behaviorally (Copeland, 1923; Hajleh, 1971; Shelton and Mackie, 1971; Mackie, 1973) and electrophysiologically (Hodgson, 1958; Ache and Case, 1969; Ache, 1952). Behavioral data show that the receptors are present on the antennules, and electrophysiological studies indicate that they are responsive to amino acids and tertiary amines. Recent investigations suggest that sublethal concentrations of petroleum hydrocarbons interfere with food gathering, migration, and reproduction apparently through disruption of the chemosensory modality (Atema, Jacobson and Todd, 1973; Takahashi and Kittridge, 1973).

B. Methods

Behavioral:

Our preliminary efforts have been directed toward establishing a baseline response in spot shrimp (*Pandalus platycerus*). Responses measured include lines crossed/minute (i.e., level of activity), antennule clicks/minute, antennule cleanings/minute, feeding movements/minute, and time to contact of stimulus source.

A series of stimulants have been selected including amino acids (taurine, proline, glutanic acid, and valine), betanine (a quaternary ammonium base), tertiary amines and other related compounds (trimethylamine hydrochloride (TMA), creatinine, and creatine). In addition, whole extracts of shrimp and mussel as well as artificial mixtures based on analyses of squid and clam (*Tapes japonica*) are being assessed. Chemosensory stimulants tested on control shrimp and those giving the most defined response will then be tested on shrimp treated to varying concentrations and durations of exposures to water-soluble oil fractions.

Electrophysiology:

Attempts will be made to record chemosensory responses either from the antennules themselves or from the sub-esophageal ganglia. Stimulants will be those which gave the greatest behavioral response. In all tests, the degree of hunger and stimulus concentrations will be taken into account.

C. Results

Thus far the baseline response, as a function of hunger (days since feeding to satiation), has been analyzed (Fig. 5). There is a definite increase in the activity level (lines crossed/minute) occurring 3 days after feeding (T test = 9.652 p = .05). In addition, the amount of sampling of the environment through antennule clicks/minute also shows a dramatic increase with increasing hunger. No change in antennule cleaning or feeding movements were observed in 9 days without food.

While analysis of data from stimulants has not yet been completed, some qualitative observations can be made. Stimulants seem to fall into three groups:

(1) Very low or no response stimulants: taurine, present in shark blood, mussels and oysters, is the only one found in this group thus far.

(2) Moderate response stimulants: these show no response at levels less than 10^{-3}M. This group includes most amino acids tested, valine (present in fish protein), proline (present in squid mantle extract), and glutamic acid.

(3) High response stimulants: these include stimulants showing significant responses on day 0 or 3 to 10^{-4} or 10^{-5}M concentrations. They include creatinine (end product of creatine metabolism and a normal constituent of urine), trimethylamine (degradation product of nitrogenous plant and

animal substance), betaine (a quaternary ammonium salt widely distributed in plants and animals), and carnitine.

In another behavioral study area, we are attempting to quantitate responses of Dungeness crabs (Cancer magister) by monitoring cardiac and gill bailer (scaphognathite) rates to determine if, and what type of changes occur in these parameters in response to chemosensory stimulation.

To obtain an electrocardiogram, two electrodes are inserted through the carapace directly above the heart and glued in position. A pressure transducer with a cannulus was inserted in the brachial chamber. The transducer responds to water pressure fluctuations associated with scaphognathite activity. Responses were recorded on a polygraph; an example is shown in Figure 6. In the upper part of Figure 6 is the response elicited by 1 ml of standard extract of mussel (Mytilus edulis) applied to the antennule region via a 1 meter tube affixed to the carapace. The standard is prepared by mixing 1 g of mussel tissue in 1 liter of salt water and then filtering through No. 1 Whatman paper. At high stimulus concentration (1 X) there is a reversal of gill bailer flow and disruption of the cardiac output recording due to overt movement. At 10^{-5} dilution the crab responds to the extract by a slowing and stoppage of the gill bailer rate and simultaneous brachicardia; there was no noticeable overt behavior.

The value of this approach to quantitate behavioral responses is still being assessed. The elicited responses are fairly consistent in a non-enriched environment (i.e., no sand or cover). When the crabs are allowed to bury in the sand, a lethargic state often enthuses with a resulting non-responsiveness to chemical stimulation.

LIFE HISTORY STAGES MOST SENSITIVE TO PHYSIOLOGICAL DISRUPTION

Initial research on the early life history stages of selected invertebrates, and subsequent identification of the stages most sensitive to the disruption of physiological response, has been directed toward the aquacultural aspects of the target species. The spot shrimp *Pandalus platycus* has been successfully reared from eggs through the larval and juvenile stages. Facilities for rearing and holding numbers of shrimp required for testing have been constructed. Female shrimp with eggs will be available in December and testing of these animals will commence at that time.

Molluscs chosen to be tested are the mussel *Mytilus* spp. and the oyster *Crassostrea gigas*. Adult *Mytilus edulus* and *Crassostrea gigas* have been collected and are being conditioned for spawning. Some of the facilities necessary for holding, conditioning and spawning these forms have been constructed with completion scheduled by December.

Holding of adult invertebrates and the rearing of larval forms has necessitated the development of food sources. A student helper has been employed to culture algae, rotifers, nudibranchs, and brine shrimp which are required for maintenance of test animals.

In this first reporting period, much of the effort concerning larval crustaceans and molluscs has been conducted under Research Unit 74. Some scanning electron microscopy has been conducted on larval shrimp to determine baseline structure and identify fouling diatom growth present on the carapace.

ALTERATIONS IN PROPERTIES OF MUCUS

Background

Recent studies (Varanasi, U., Robisch, P. A., and Malins, D. C., Nature, in press (1975)) from our laboratories have shown that small concentrations of lead and mercury produced structural alterations in the epidermal mucus of rainbow trout (Salmo gairdneri) as evidenced by electron spin resonance spectrometry (ESR). Large differences in the degree of accumulation and depuration were observed for lead and mercury; however, both metals caused "fluidization" of the mucus as shown by the increase in the tumbling frequency of the spin label (N,N - dimethyl-N-dodecyl-N-tempoylaminumbromide). Moreover, it was shown that the "fluidization" of the mucus persists even after the removal of water-borne metals for a period of two weeks.

These preliminary studies prompted us to investigate in detail the effect of water-borne trace metals on hydrodynamic and immunological properties of the epidermal mucus of salmonids and flatfish. The work on the project has started as of October 12, 1975, with appointment of Dr. Usha Varanasi to the staff.

Methods

Fish (25-30 per each experiment) will be kept in closed seawater tanks (the tanks are being cured at our Mukilteo facility and will be ready in a week). A group of fish will be exposed to water-borne metals (.005 to 0.5 ppm of lead or cadmium chlorides) for a period of one month. The exact times and levels of exposure will be decided after preliminary experiments with relatively high (1 ppm) levels of metal chlorides. Several data points will be taken during the length of experiment. The metal-exposed fish will then be placed in metal-free waters for a period of two weeks; one or two analyses will be performed to study rate of depuration. Concomitantly, changes in the structural properties will be determined to ascertain whether damage (alteration) to the mucus is reversible or not.

We plan to measure the accumulation and depuration of metals in the mucus using atomic absorption spectrometry. These results will be correlated with the changes in fluorescence and electron spin resonance spectra of the mucus. Certain measurements on the miscosity and other physical properties of the mucus will also be made.

As this project was only recently initiated we have not had time to begin analysis of the samples. Certain preliminary preparations have begun: (1) the fish (coho salmon) are placed in a closed seawater (prepared from instant ocean, salinity 32 o/oo) tank to acclimate them to laboratory conditions before initiation of exposure studies (2 weeks). (2) It appears that the epidermal mucus of rainbow trout is naturally fluorescent, giving rise to a workable excitation spectrum. It is hoped that the mucus of coho salmon will yield a similar spectrum, thus providing a suitable technique to study alterations in metal-exposed mucus. These experiments will begin as soon as the fish are acclimatized (2-3 weeks).

V. Problems Encountered and Recommended Changes.

At present there are no discernible problems. We anticipate some minor additions in the chemosensory-behavior study area through inclusion of chemically induced escape responses and their modification resulting from exposure to petroleum hydrocarbons and trace metals. This addition will also encompass a wider range of marine organisms then previously considered in the original proposal.

FIGURE LEGENDS

Figures 1-4. Light micrographs of liver of rainbow trout prepared with a polychrome stain adapted for plastic sections.

Figure 1. Control fish. The glycogen stores (arrows) are bright red against a blue background. Parts of the larger glycogen reserved were lost during preparation. Lipid droplets (circled); red blood cells (R).

Mag. X 600

Figure 2. Oil-fed fish. No glycogen reserves are seen in this section. The cytoplasm is an overall blue tone with components of the endoplasmic reticulum and mitochondria appearing as fine striations.

Mag. X 580

Figure 3. Control fish. Arrows denote lipid reserves in the form of multisized lipid droplets.

Mag. X 570

Figure 4. Oil-fed fish. These cells are virtually depleted of lipid.

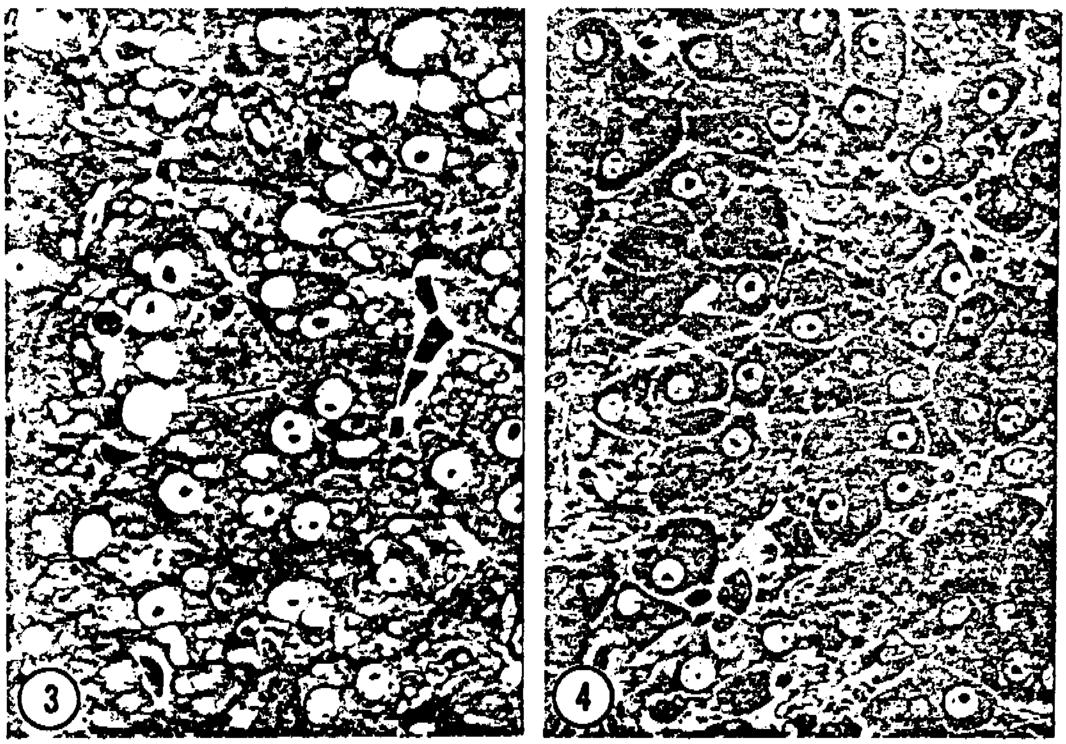
Mag. X 520

Figure 1A. A scanning electron micrograph (SEM) of the skin surface of an untreated English sole. The mucous glands (arrows) are liberally scattered throughout the normal skin between the keratinocytes (filament-containing cells) which are sculptured on their outer surface by microridges.

X 2600

Figure 2A. English sole, five days after exposure to a 13% solution of the water-soluble fraction of crude oil. The mucous glands (arrow) are numerous and conspicuously open.

X 2650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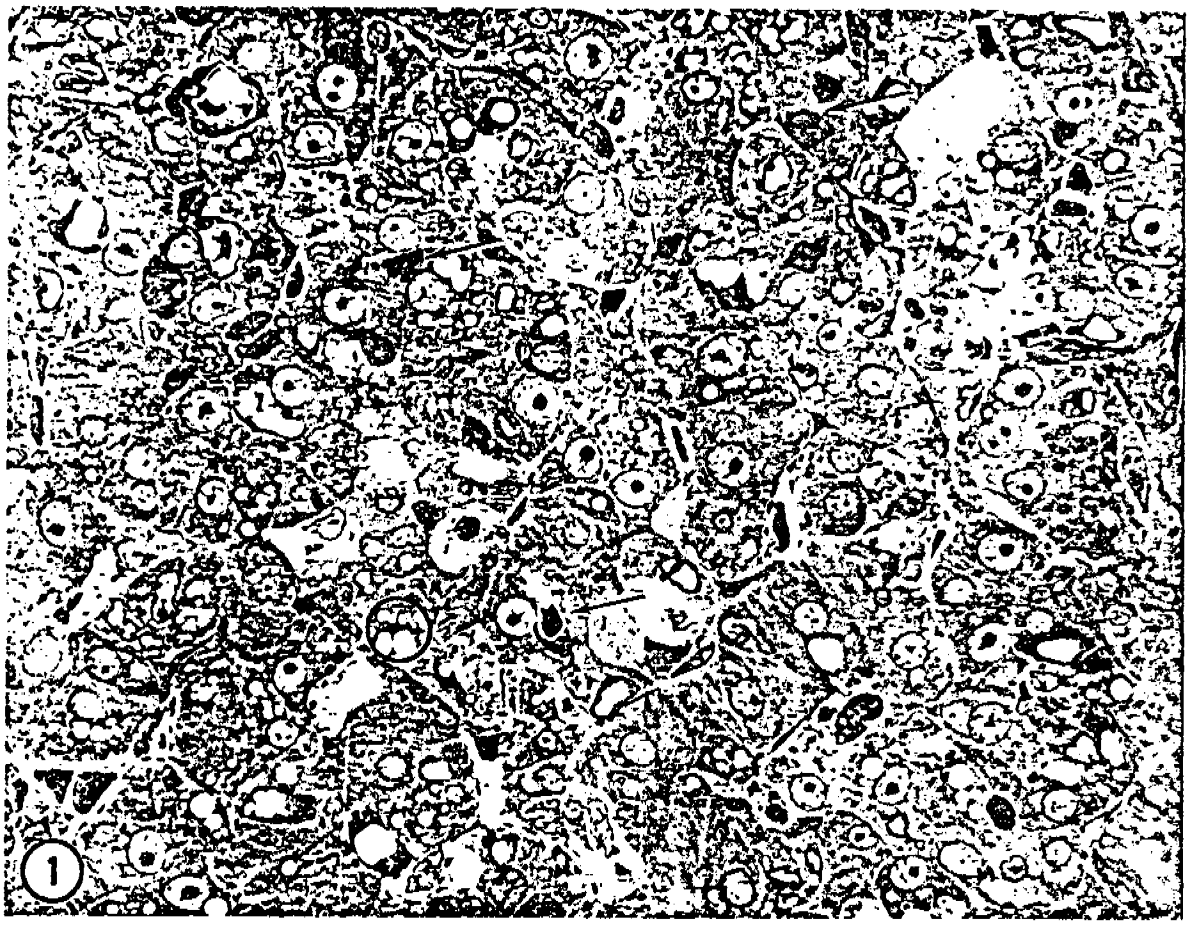
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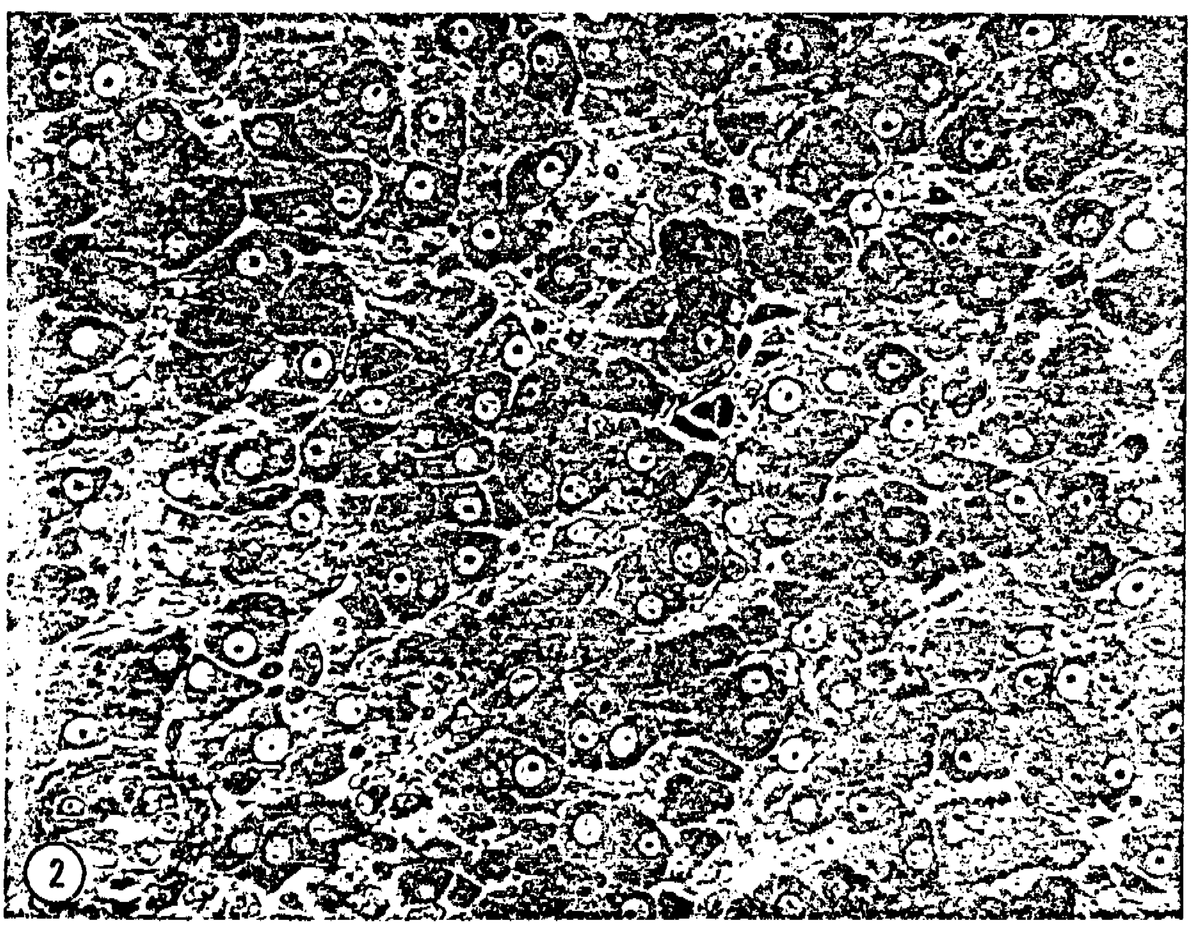
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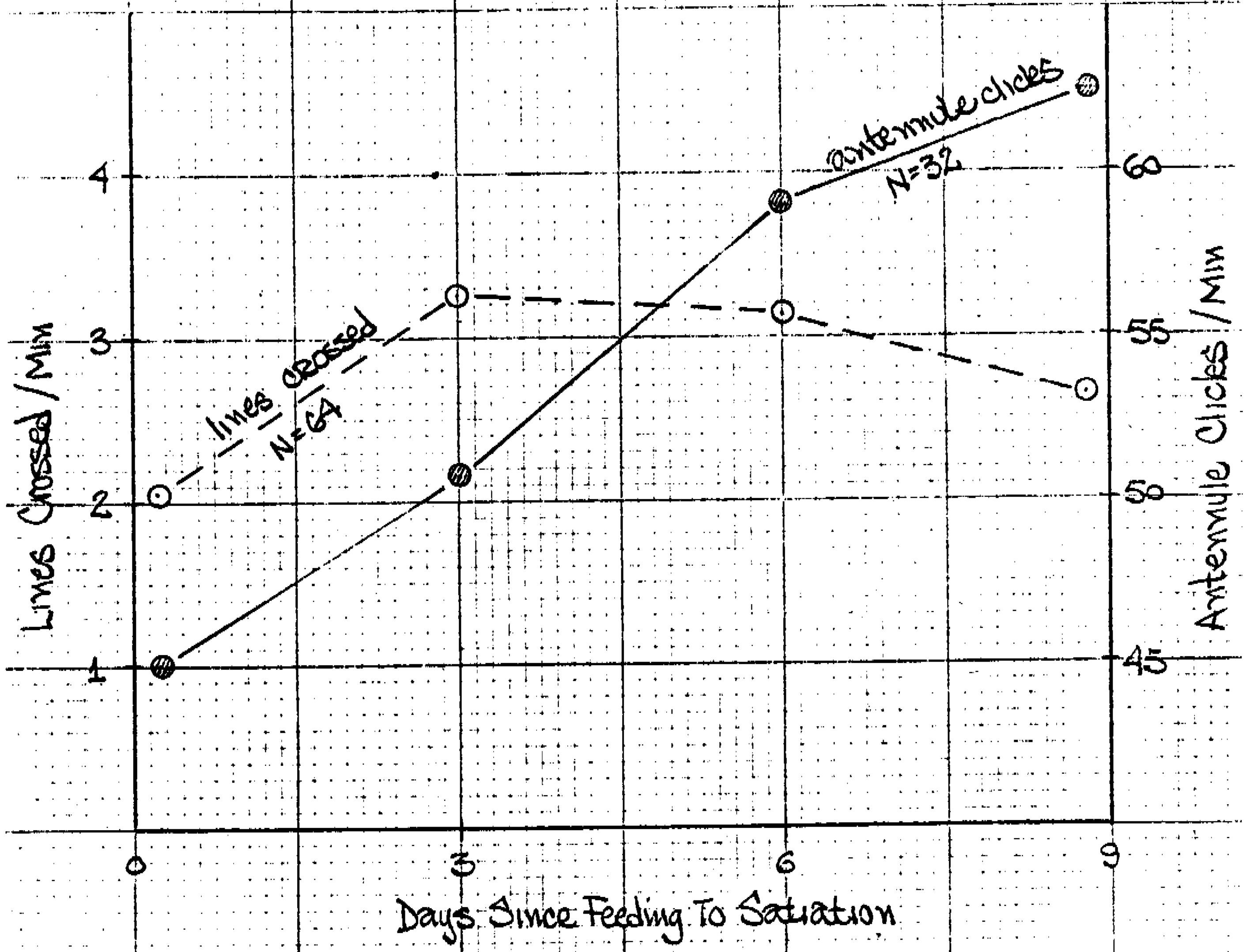
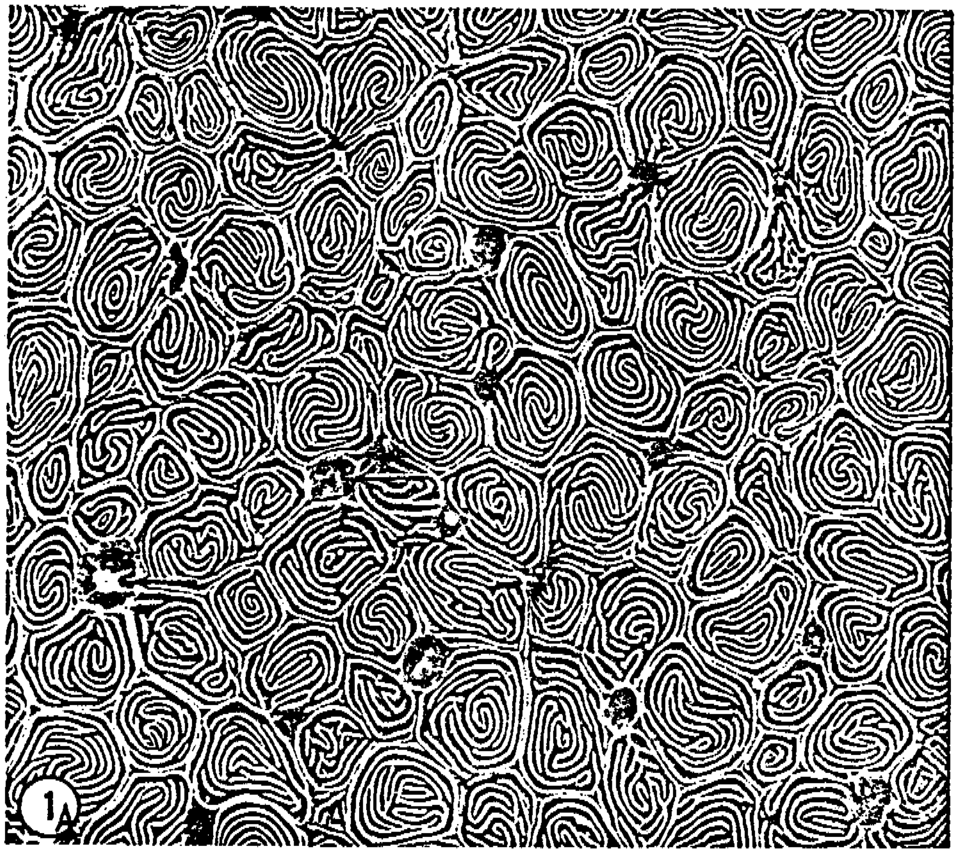


Figure 5. ACTIVITY OF SPOT SHRIMP (WITHOUT STIMULUS) AS A RESULT OF INCREASING HUNGER (AVERAGED VALUES)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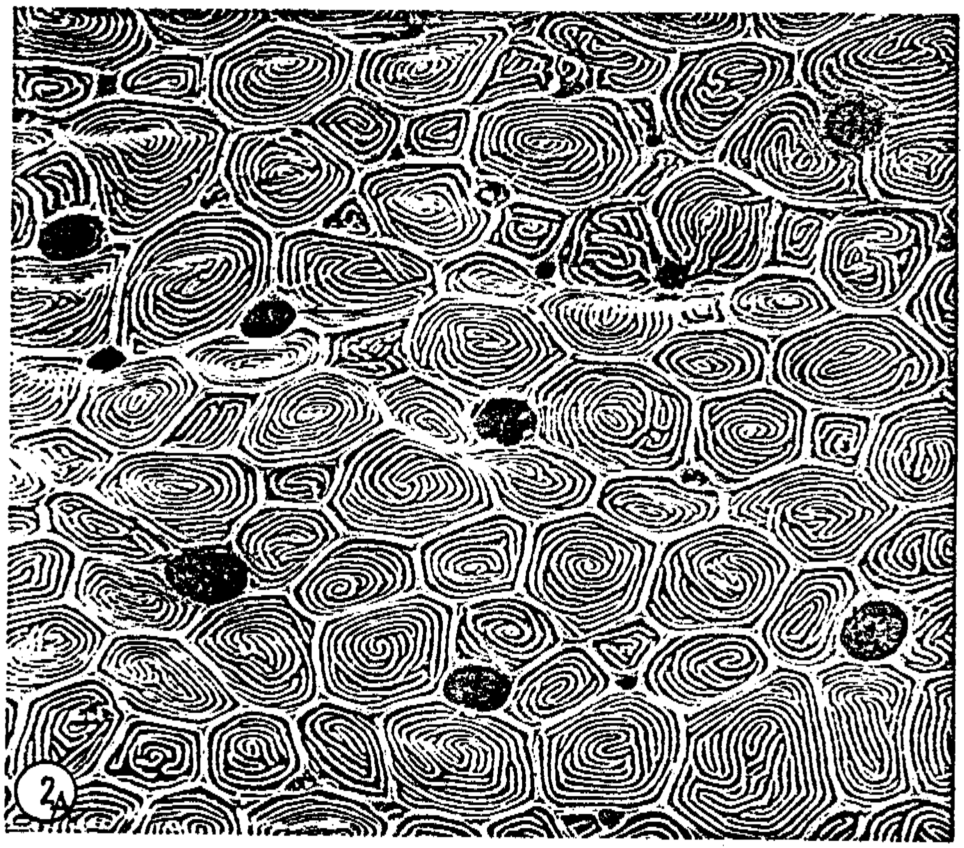
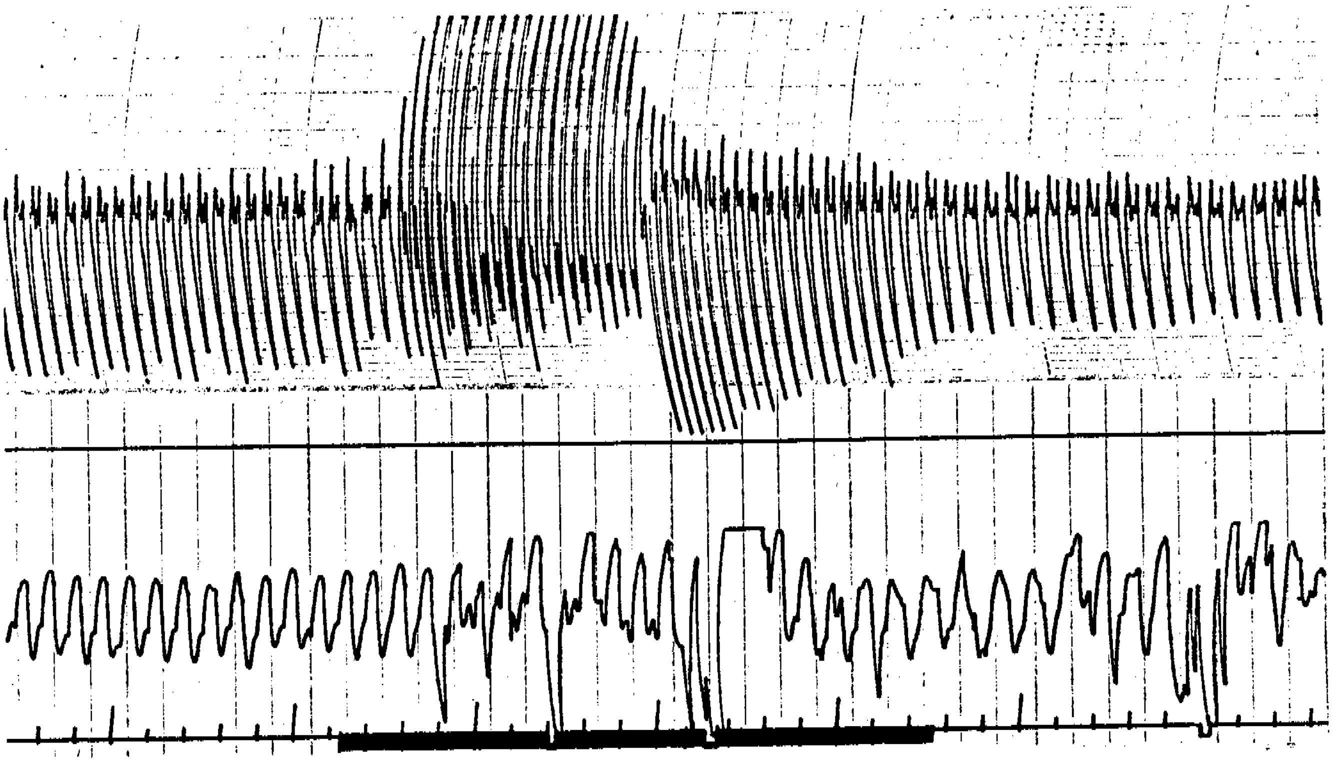

2A

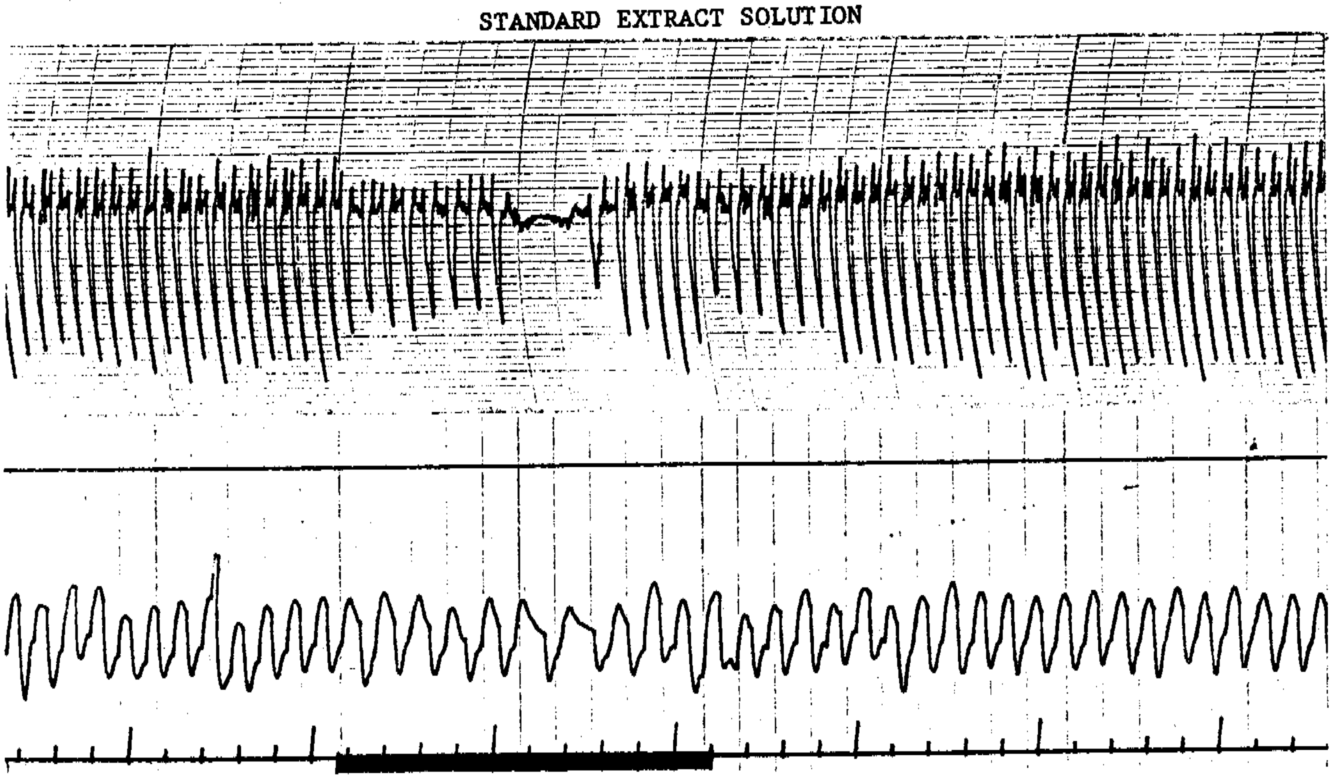
Figure 6. DUNGENESS CRAB GILL BAILER (TRACE A) AND CARDIAC (TRACE B) RESPONSES TO MUSSEL EXTRACT STIMULUS (EVENT AND TIME MARKER, TRACE C)

A

B



STANDARD EXTRACT SOLUTION



10^{-5} DILUTION OF STANDARD

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OUTER CONTINENTAL SHELF ENERGY PROGRAM
JUNEAU PROJECT OFFICE
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JUNEAU, ALASKA 99802

RU #74 IDENTIFICATION OF MAJOR PROCESSES IN BIOTRANSFORMATION OF PETROLEUM HYDROCARBONS AND TRACE METALS

I. Task Objectives

Initial studies on hydrocarbons will: (a) determine the degree to which different compounds accumulate in biota from continuous exposure to nonlethal doses; (b) determine effects of environmental conditions, such as temperature and exposure levels, on accumulation of petroleum hydrocarbons; (c) identify whether specific sites exist in fish where accumulations result in damage to normal physiology; (d) determine the metabolic stability (biological half-life of selected aromatic hydrocarbons in the test organisms).

Initial studies on metals will: (a) measure the uptake and accumulation of lead, cadmium, and vanadium in salmon and flatfish employing both radioactive and non-radioactive trace metals; (b) delineate the relative distributions of the trace metals in key tissues (e.g., liver, kidney, and gills) in salmon and flatfish; identify interactions with cellular components via techniques, such as autoradiography.

II. Laboratory Activities

SCIENTIFIC PARTY

Personnel and their percentage involvement in studies under Research Unit 74 are listed below. Investigators employed specifically for this program are indicated by starting dates; other scientists were already on permanent NWFC staff.

D. Malins, PhD	NWFC, Principal Investigator	10%	
W. T. Roubal, PhD	" " "	25%	
W. L. Reichert, PhD	" " "	25%	
H. R. Sanborn, MS	" " "	30%	
S. J. Stranahan, BS	" , Chemist	100%	Oct. 10

The remainder of this progress report through Section V deviates from the proposed format since as a multidisciplinary study the approach, methods and analysis of data are specific for each discipline. Considerable interaction exists not only within Research Unit 74, but also with Research Unit 73 and to a lesser extent with Units 75, 72, 331, and 334.

METHODS

Exposure of fish to water-soluble fractions of petroleum oil

A continuous flow-through system has been developed for exposing fish to water-soluble fractions of petroleum oil. In several weeks, this system will be installed at our Mukilteo field station in conjunction with refrigeration equipment which was purchased with OCSEP funds. A GS-5 chemist has been hired and is actively employed on the project. As planned, we will expose fish (initially salmon, then starry flounder) to water-soluble fractions of Prudhoe Bay crude oil at temperatures of 2^{o} and 10^{o} C for periods of up to three months. The exposure regime will involve levels of from 0.1 ppm to 1.0 ppm of the water-soluble fractions, although some modifications in this range may be made as circumstances dictate. After the designated exposure periods, the fish will be pathological changes by histology and electron microscopy (see Research Unit 73). The work will be carried out under the supervision of Dr. Joyce Hawkes who was recently hired as an electron microscopist. Related alterations observed so far by electron microscopy after chronic exposure of fish to water-soluble fractions of Prudhoe Bay petroleum oil are glycogen depletion, lipid depletion, and ultrastructural anomalies of liver, such as proliferation of endoplasmic reticulum. Also observed were changes in the skin surface, as evidenced by damage to mucus-secreting cells. The studies of structure and ultrastructure will add a useful dimension to the chemical data in that hydrocarbon/metabolite levels in target organs would be related to observed morphological changes.

Exposure of fish to isotopically labelled aromatic hydrocarbons

Suitable challenge conditions for fish exposed to isotopically labeled hydrocarbons are being employed by Dr. Roubal's group. Moreover, they have developed chemical analytical techniques that allow for the determination of both the hydrocarbons and metabolic products (e.g., mono- and di-hydroxy derivatives) in target organs. These techniques are the subject of a current manuscript. At present, preparations are being made to employ these techniques for evaluating the accumulation of isotopically labeled napthalene and anthracene in tissues of salmon and starry flounder. The isotopes will be presented in the food. In sacrificed for analyses of the following tissues: blood, liver, kidney, gallbladder, brain, gill, intestine, and skin. The tissues will be subjected to chemical analysis for hydrocarbons, which will involve measurements by photofluorometric, ultraviolet, and infrared analyses. This approach will reveal levels of total hydrocarbons and of certain polynuclear fractions in the tissues. Alternatively and preferably, however, we hope to conduct analyses on the hydrocarbons by GLC-MS using the facilities of the NOAA National Analytical Laboratory (see V-2(a)). Such an approach will lead to a detailed evaluation of the individual hydrocarbons and permit an assessment of those molecular species that are preferentially stored in the target organs. Moreover, this technique will allow us to evaluate the presence of certain volatile hydroxy derivatives (e.g., monohydroxy compounds) that are metabolic products of the aromatic hydrocarbons.

At this stage we are confident that the continuous flow-through system at Mukilteo will be satisfactory in practice; however, if long-term problems should arise unexpectedly we will carry out our experiments with the water-soluble fractions impregnated in the diet.

The preparations for the challenge experiments are proceeding satisfactorily and suitable analytical techniques are at our disposal. In fact, the challenge experiments are scheduled to be initiated by the end of the calendar year. In addition to the chemical analyses, the target organs will be examined for current work we have exposed fish for five days to 5μg of ^{14}C-labeled hydrocarbon/100g of body weight/day.

The fish will be fed the diet containing the isotopically labeled hydrocarbons for periods of up to 3 months. At the termination of the experiments, data on both hydrocarbons and metabolites will be acquired for the selected target sites. The studies with the isotopically labeled hydrocarbons will complement the work with the water-soluble petroleum oil fractions in that a wider spectrum of metabolic products (e.g., mono- and di-hydroxy compounds; gluconorides, etc.) will be identified by thin-layer chromatography and ^{14}C assay techniques. Moreover, as a complementary approach, certain hydroxy derivatives may be examined by GLC-MS techniques.

Exposure of invertebrate larval forms to isotopically labeled aromatic hydrocarbons

Initial studies of the effects of naphthalene on the larval stages of the spot shrimp, *Pandalus platyceros*, were made on stages I and V. The hydrocarbon was in solution as ^{14}C-labeled naphthalene (such complexes are likely to occur in the marine environment). Flow-through conditions were maintained by the constant addition of sea water to aquaria at 10°C. The water level in the tanks was kept constant by using a stand pipe to spill the excess water. The animals and the water were sampled for periods up to 60 hours and the concentration of naphthalene was determined by measuring radioactivity with a liquid scintillation spectrometer. After a 24-hour test period, some animals were transferred to clean water with the same flow rate and temperature as when naphthalene was present. Samples of animals and water were removed periodically and the concentration of naphthalene was determined. The animals were sampled during uptake and depuration and frozen for later determination of the metabolic fate of naphthalene. The metabolites are being evaluated by a two-step process involving solvent partition techniques and thin-layer chromatography. This procedure was developed by Dr. Roubal's group.

The equipment presently in use for introducing the naphthalene is ideally suited for the introduction of the soluble fraction of crude oil. The experimental regime employed for isotopically labeled naphthalene will be used in future studies to determine the uptake and depuration rates, and the metabolic fate of naphthalene for adult and for other larval stages of the spot shrimp. Similar studies will be made with other labeled aromatic hydrocarbons and with water-soluble fractions of petroleum oil. Experiments with the water-soluble fractions will be initiated early in 1976. Accumulated levels of hydrocarbons will be evaluated quantitively, preferably by GLC-MS. Also, samples will be examined by employing histological and electron microscopic techniques. The studies will, in some cases, be duplicated at 2° and 10°C to determine the effect of temperature on uptake, depuration, and metabolism. Measurements of respiration and feeding rate will also be made. A graduate student is now actively engaged in research on this project.

An algal culture system is being finished and a student helper is culturing algae, rotifers, nudibranchs, and brine shrimp which are necessary as a food source for the larval invertebrates during the longer studies.

III/IV. Results and Preliminary Interpretations: Hydrocarbons (Information for project office only)

Fish

The achievements to date are summarized as follows:

1. The GS-5 chemist was hired and is actively engaged in project activities; space for the work at the NWFC and at Mukilteo has been assigned and cooperative experiments between Research Units 73 and 74 initiated.

2. Good progress was made on development of a system to expose fish to refrigerated salt water containing soluble fractions of crude oil. This system will allow us to conduct experiments for periods of up to three months under simulated arctic conditions. Installation of the equipment at Mukilteo is expected to take place in several weeks. Tanks will be placed in operation at that time.

3. Plans have been made to acquire coho salmon for the initial experiments and starry flounder (immature) for later experiments. The coho were chosen for these initial studies so that our existing data will form a suitable basis for pinpointing significant effects arising from this project.

4. As a prelude to our proposed challenge experiments, Dr. Roubal's group has established solvent partition and thin-layer chromatographic techniques for the separation of isotopically labeled aromatic compounds (e.g., benzene-^{14}C, naphthalene-^{14}C, and anthracene-^{14}C) which are assayed for ^{14}C by liquid scintillation spectrometry. This work revealed certain significant facts about the fate of aromatic compounds in fish. It was shown that a wide variety of metabolic derivatives are rapidly produced in vivo when the aromatic hydrocarbons are administered via intrahepatic injection to coho salmon. As an example, 72 hours after the administration of naphthalene-^{14}C the brain, liver, and flesh contained 24%, 45%, and 14% of naphthalenic metabolites (e.g., hydroxy and ester derivatives) in the total aromatic fraction of the tissues. These data emphasize the importance of determining the metabolite composition in the projected studies under Research Unit 74. Accordingly, this work provided important data that will guide us in our challenge experiments with both the water-soluble fractions and the ^{14}C-labeled aromatic hydrocarbons.

5. Generally, the preparations for the experimental and analytical aspects of the work are on schedule with respect to the stated objectives of the project. It is anticipated that samples from chronic exposures will be available for chemical analyses early in 1976.

Invertebrates and larval forms (Information for project office only)

The results to date indicate that spot-shrimp larval stages I and V accumulate naphthalene and protein bound-naphthalene from the water. Maximum concentrations in the animals were reached in 2-8 hours. Concentrations of protein-bound naphthalene accumulated to approximately one-third the concentration of the unbound napthalene. All test animals died in 24-36 hours when concentrations in the water were in the low part-per-billion range.

Depuration of naphthalene from animals that survived after 24 hours of exposure did not result in more than about 75% loss of hydrocarbons in 5 days. During this depuration time, there was no increased mortality.

Initial results indicated that the shrimp metabolized the naphthalene, i.e., some of the radioactivity in the animals was present as naphthalene but metabolic products were present. These derivations represented the major portion of the labeled compounds in the animals. Further work is required to confirm these results.

II. Laboratory Activities: Heavy Metals

METHODS

The experimental regime for obtaining the required data on the uptake, accumulation, and relative tissue distribution of metals (lead, cadmium, and vanadium) in salmon and flatfish (starry flounder) is established. We have elected to employ radioactive metals to facilitate the detection and quantification in both the sea water and the tissue sites. Fish (initially coho salmon, later starry flounder) will be held in a closed seawater system designed to minimize interference from outside contamination. Four closed seawater systems are being installed. Two tanks will be used to expose fish and two will be used to acclimatize fish prior to their use in experiments. In fact, 25 coho salmon are now in these tanks and will soon be employed in initial experiments. As presently envisioned, fish will be exposed in artificial sea water for periods of up to a month with samplings occurring once a week. The temperature conditions will be 2° and $10^{\circ}C$ and the salinity will be maintained at 32. The fish will be fed a diet of Oregon moist pellet once a day for 5 days each week. The levels of the radioactive Pb, Cd, and V in the ambient water are tentatively established as 0.50, 0.05, and 0.005 ppm. The metal levels in the water will be monitored via assays of radioactivity. The experimental conditions are similar to those employed for the study of mucus in Research Unit 73.

The rates of accumulation of the metals in fish at the two temperatures will be evaluated in the tissue sites described previously (see hydrocarbon section: II. Methods), by both radioactivity-counting techniques and autoradiography. The latter method is presently being employed successfully by Dr. Reichert's group. The nature of the interactions at the target sites will be examined by techniques available in our laboratory, such as electron spin resonance spectrophotometry (ESR), photofluorometric spectroscopy, and protein fractionation techniques (gel chromatography). Such techniques will provide data on possible alterations that take place with membranes and other cellular components. The photofluorometric techniques are highly sensitive tools in the detection of alterations in native fluorescent molecules (e.g., tryptophan); however, fluorescent probes may be added to the tissue systems when such fluorescent nuclei are either too weak or absent. It is anticipated that the equipment for the challenge experiments will be ready in several weeks and that analyses of tissues and other biochemical aspects of the work will be initiated early in 1976. We intend to examine select samples of tissues for possible morphological alterations via histological techniques and electron microscopy as described previously for the hydrocarbon work.

III/IV. Results and Preliminary Interpretations: Heavy Metals (Information for project office only)

The status of the work so far is summarized as follows:

1. A GS-5 chemist has been hired and is actively employed on the project. Space for the challenge experiments and chemical work has been allotted, and the necessary equipment for the challenge experiments is being installed. The challenge experiments are expected to be initiated by the end of 1975.

2. Necessary background work to enable us to identify and quantitate radioactive Pb, Cd, and V in tissues is almost complete. We still have some work to conduct on methods to identify metal interactions with cellular components (e.g., via photofluorometry); however, we anticipate being in a favorable position to examine this aspect by early 1976.

V. Recommendations for Future Work

2a Preliminary studies indicate the high percentages of the aromatic compounds retained in organs of fish are in the form of metabolic products. Work from the laboratories suggests that these compounds may be more toxic than the parent compounds. If these compounds accumulate, as our own studies suggest, it is conceivable that they may be important for future monitoring operations. The gas chromatograph-mass spectrometer (GS-MS) will permit better analyses and more definitive identification of many of the metabolites than the techniques we have used in preliminary studies. The NOAA Analytical Facility, which will have the GC-MS, will be in operation this winter. Consequently we recommend that a relatively small (15.0-20.0K) project be initiated with the Analytical Facility to perform qualitative and quantitative analyses of metabolic components in exposed animals.

2b. In connection with the hydrocarbon and trace metal studies in Research Units 73 and 74, a strong requirement exists for ways of identifying changes wrought by these contaminants on cellular components. One aspect of cellular structure which we would like to examine is viscosity of fluidic membranes because we have shown that such properties are most susceptible to alteration in response to the contaminantsin question. We would be in a very good position to undertake studies on phase transitions and degrees of order in fluid use of a microviscosimeter. This instrument can determine the viscosity of fluids or of fluidic membranes through fluorescence of a built-in fluorescent moiety or of a fluorescent probe introduced into the system. Accordingly, in connection with the request to point out modifications in existing efforts, extension of our present work will probably include the submission of a proposal for the purchase of a microviscosimeter at a cost of about $12,000.

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NEGOA

ASSESSMENT OF AVAILABLE LITERATURE ON EFFECTS OF OIL POLLUTION ON BIOTA IN ARCTIC AND SUBARCTIC WATERS

I. Task Objectives

To compile literature covering research already completed on effects of petroleum oil and its components as well as heavy metals on marine biota with special reference to what occurs in Arctic and Subarctic environments. From such material prepare a critical review concerning potential toxicity of such contaminants toward species at different life stages and under different exposure conditions.

II. Activities

C. Methods

Literature is being compiled primarily from existing bibliographies or by use of OASIS, the NOAA computerized scientific information system. Direct examination of portions of the literature by hand search through abstract journals is to be used as a spot checking system to see how thoroughly the machine search recovers desirable material. The literature references recovered by these means are to be funneled to scientific experts mostly within NWFC of NMFS for preparing portions of the critical review within the field of expertise of the individual specialists.

E. Data Collected

A trip was made to Auke Bay, Anchorage, and Fairbanks where numerous references were found in libraries and laboratories of various state and federal agencies. Using OASIS and employing 25 carefully selected key words, about 450 references were recovered from Biological Abstracts and Chemical Abstracts. A very valuable recent bibliography of articles dealing with petroleum in the environment has just been received. It was prepared by the Marine Biological Laboratory of the United Kingdom, is current up to June 1975, and covers about 2,300 abstracts of papers published during the past 100 years. Although many of these abstracts are outside the field of our main interest, we should recover an additional 200 pertinent articles from this source. Contacts with the Canadian Government have elicited some very important recent interim reports which are especially useful because they deal directly with investigations in North America under Arctic conditions. We have yet to investigate availability of reports prepared for commercial oil companies, many of which may be considered to be confidential.

III. Results

Specific results from this project will not be achieved until we get into the next phase, which will involve a start toward preparing critical reviews based upon literature references currently being assembled.

V. Problems Encountered

The research papers recovered so far related to a very large extent to work connected with oil spills in non-Arctic areas. Most of the research to date covers work in temperate environmental areas. Only a very few papers deal directly with Arctic and Subarctic environments.

Recommendations for future work

Already we can see that much more research on actual effects of petroleum and its components on the biota under Arctic and Subarctic conditions is badly needed. We are finding a startling paucity of papers in this field. More will doubtlessly be said on this point as the work proceeds.

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Effects of Crude Oil on Herring Roe

Contract Number: 03-5-022-56

Task Order Number: 18

Principal Investigator: Dr. Ronald L. Smith
Assoc. Professor of Zoology/Biology
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

Objectives for this quarter included finding a research assistant to participate in this project. Also, we were to initiate a literature survey of the project subject area.

II. Field and Laboratory Activities

None.

III. Results

We were able to locate a suitable graduate research assistant and have taken steps to hire her onto the project. Our request for retrospective search of six data bases by OASIS has been submitted and the search completed. This search supplied about twenty pertinent references.

IV. Problems Encountered

None.

V. Estimate of Funds Expended

	Total Budget	3 mos Expended	Remaining
Salary & wages	36,609.00	0	36,609.00
Staff Benefits	6,224.00	0	6,224.00
Equipment	490.00	0	490.00
Travel	1,500.00	0	1,500.00
Other	9,400.00	0	9,400.00
Total Direct	54,223.00	0	54,223.00
Indirect	20,940.00	0	20,940.00
Total Cost	71,163.00	0	71,163.00

FIRST SEMI-ANNUAL PROJECT REPORT

(Research Unit #183, OCSEP)

Project Title: Acute and Chronic Toxicity of Seawater Extracts of Alaskan Crude Oil to Zoeae of the Dungeness Crab, *Cancer magister* Dana

Principal Investigator: Richard S. Caldwell, Oregon State University Marine Science Center, Newport, Oregon 97365

Geographic Area: Gulf of Alaska

Project Budget: $38,687.00

October 31, 1975

I. Task Objectives:

This project is addressed exclusively to Task C-2 of the Alaskan OCS study (Determine the acute and chronic effects of crude oil, its component fractions, and other petroleum-associated chemicals on physiological and behavioral mechanisms of selected arctic and subarctic organisms).

The specific objectives are:

1. To determine the concentration of the total seawater soluble extract of Alaskan crude oil which causes mortalities in the first zoeal stage of the crab in 96 hr acute exposures.
2. To determine the concentration of the total seawater soluble extract of Alaskan crude oil which affects hatching success of eggs and prezoeal development.
3. To determine in continuous exposure tests, the concentrations of the total seawater soluble extract of Alaskan crude oil and possibly 1 or 2 specific components (e.g., naphthalene methylnaphthalene, benzene) which impair the normal development of crab larvae from the 1st zoeal stage to at least the 5th (last) zoeal stage and, if possible, through the megalops to 1st postlarval crab. Some chronic experiments may employ toxicant exposures during only limited segments of the developmental sequences in order to identify the most sensitive stages.
4. To attempt to characterize in such variously exposed larval crabs such sublethal effects as impaired tolerance of unnatural salinities or temperatures or impaired behavior (e.g., swimming abnormalities, abnormalities of photo- or geotrophic responses, etc.).

II. Field or Laboratory Activities:

The schedule of laboratory activities as given in our work schedule is as follows:

"During the initial months of the project we will devote our efforts to developing and perfecting our analytical methodologies and adapting existing culture facilities for use in flowing water bioassays with seawater extracts of oil. The bulk of the actual experimental work with crab-larvae will commence in mid-December 1975 and continue through June 1976, the period of the year when Dungeness crab larvae are available. We expect to be able to complete objectives 1 and 2 by the end of January 1976. Objective 3 will be accomplished during the period January 1976 to May 1976. We will attempt to accomplish objective 4 during the period March 1976 to June 1976. During the period July 1976 through September 1976 we will devote our efforts to data analysis and the preparation of the project final report."

In accordance with this plan, the work during the initial period of the project has been minimal. We are in the process now of adapting our existing culture facilities for use in flowing water bioassays with seawater extracts of oil. Specifically, we are making necessary repairs to culture aquaria, modifying our facilities for the constant supply of high salinity seawater to the laboratory and developing the toxicant dosing and diluting apparatus. In addition, in anticipation of the heavy workload which will occur during the actual bioassay period this winter and spring, we are developing our detailed bioassay protocol and system of data recording (to be used in the chronic exposure experiments detailed in objective 3). We have arranged with Dr. Stan Rice of the Auke Bay National Marine Fisheries Laboratory for the shipment of crude oil from the same stock as used in their studies.

III. Results:

None to date.

IV. Preliminary Interpretation of Results:

None to date.

V. Problems Encountered/ Recommended Changes:

None to date.

VI. Estimate of Funds Expended:

Salaries and Wages	$ 3,000
OPE	500
Services and Supplies	1,000
Travel	--
Equipment	--
Indirect Costs	1,500
Total to Date	$ 6,000

VII. Other Comments (Re: Memo from Herbert Bruce dated October 9, 1975):

None at present.

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Sublethal Effects - Effects on Seagrass

Contract Number: 03-5-022-56

Task Order Number: 17

Principal Investigator: Dr. John G. Pearson
Assistant Professor of Chemistry
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

Procurement of equipment and initial calibrations. Procure seagrass samples and initial long-day rate studies. Determine baseline levels of napthalene, toluene, and dodecane.

II. Field and Laboratory Acitivities

None.

III. Results

The time schedule listed in the work statement for this project indicated a need for early procurement of supplies and equipment. Funding was not established until August and as a consequence, the necessary instrumentation has not yet been delivered nor has any data been obtainable.

We have determined, however, that a static chambers system is not an adequate model for contaminant uptake studies. The inadequacy arises from the fact that in a static environment, seagrasses rapidly deplete the experimental system of nutrients and consequently alter the physiological state of the plant. We have designed a flow system that overcomes this difficulty.

IV. Problems Encountered

Late accessability to funds has delayed initial experimental efforts.

V. Estimate of Funds Expended

	Total Budget	3 mos Expended	Remaining
Salary & wages	28,460.00	0	28,460.00
Staff Benefits	4,838.00	0	4,838.00
Equipment	19,000.00	0	19,000.00
Travel	3,000.00	0	3,000.00
Other	6,100.00	0	6,100.00
Total Direct	61,398.00	0	61,398.00
Indirect	16,279.00	0	16,279.00
Total Cost	77,677.00	0	77,677.00

CHEMISTRY AND MICROBIOLOGY

CHEMISTRY AND MICROBIOLOGY

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CHEMISTRY AND MICROBIOLOGY - Continued

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Semi-annual Report No. 1

Assessment of Potential Interactions of Microorganisms and Pollutants Resulting from Petroleum Development of the Outer Continental Shelf in the Beaufort Sea

(Contract No. 03-5-022-85)

Submitted to: Outer Continental Shelf Energy Program
National Oceanographic Atmospheric Administration

By: Ronald M. Atlas, Principal Investigator
University of Louisville
Louisville, Kentucky 40208

Date: November 1, 1975

I. Progress to Date.

A. Task Objective 1: Summarize and evaluate existing literature and unpublished data on the distribution and abundance of the microbiological community in the Beaufort Sea.

An extensive search of the literature relating to the microbial community in the Beaufort Sea has been conducted using the computer search facilities of OASIS and of the Lockheed data base. A bibliography of the pertinent literature is being compiled.

A review of all works relating to petroleum microbiology in the Arctic has been completed and will be published as part of a book on petroleum microbiology to be published by Marcel Dekker, Inc. (W. Finnerty, ed.). There have been several reports showing that hydrocarbon biodegradation occurs in nearshore areas of the Beaufort Sea.

There have been several reports of food poisoning in Eskimo communities following ingestion of seal. The causative organism has, in some cases, been identified as *Clostridium botulinum* type E. Studies on the occurence and distribution of this and other human pathogens in the Beaufort Sea have not been reported. Similarly, there have been a lack of reports of comprehensive studies of the microbiota anywhere in the Beaufort Sea.

B. Task Objective 2: To characterize marine microbiological communities in sufficient detail to establish a baseline description of microbiological community characteristics on a seasonal basis.

Samples were collected in the Beaufort Sea during August and September 1975 between Barrow and Prudhoe Bay. Sampling was largely performed by Dr. Tatsuo Kaneko (postdoctoral research associate), Mr. George Roubal (research assistant), and Mrs. Teiko Kaneko (research technician). Samples were collected jointly with Dr. Morita's research group. Samples in Elson Lagoon and Prudhoe Bay was done from a Boston whaler. Aircraft were used to transport the samples collected in Prudhoe Bay back to NARL at Barrow for processing. Some samples were also collected from the USGS *Beaver* aircraft.

Surface water samples were collected with Niskin bacteriological sterile water samplers. A total of 39 surface water and four surface ice samples were collected. Sediment samples were collected with a Kahl scientific mud snapper. A total of 33 sediment samples were collected. Aliquots of all samples were immediately filtered and frozen for later nutrient analysis by Dr. Vera Alexander. Salinity and temperature was recorded with a Yellow Springs Instrument salinity meter. A listing of the samples collected and of several environmental parameters is shown in Table 1.

An aliquot of each sample was also preserved with formaldehyde for microscopic determination of total microorganisms in the sample. Direct microscopy will be performed at the University of Louisville using acridine orange fluorescence microscopy.

Immediately upon return to NARL samples were plated onto various bacteriological media for enumeration of viable microorganisms according to differing physiological classes. Platings were done in triplicate. Two different media, Marine agar 2216 (Difco) and modified seawater yeast extract agar (protease peptone #3, yeast extract, Bacto agar, Rila salts mix) were used for enumeration of total heterotrophic microorganisms. Incubation was either at 4C for three weeks for enumeration of psychrophilic and psychrotrophic populations or at 20C for two weeks for enumeration of mesophilic populations. Results of enumeration of total viable heterotrophic aerobic bacteria are shown in Table 2. Data shown in Table represents the mean of the three determinations. Results are shown as colony-forming units/ml for water and ice samples and as colony-forming units/gram dry weight for sediment samples. The highest count on either medium is taken as an estimate of the total viable microbial population capable of growth at that incubation temperature. Results will have to be subjected to statistical analysis before interpretation of the data is possible.

The populations of selected groups of bacteria that contain important human pathogens were estimated using selective culture media. For enumeration of *Vibrio* spp. TCBS agar (BBL) was used. Because of low numbers of *Vibrio* in the samples millipore filter enumeration techniques were used. Incubation for *Vibrio* spp. was at both 4 and 20C to separate mesophilic from psychrophilic and psychrotropic populations. *Pseudomonas* spp., potentially pathogenic for man, were enumerated on millipore filters using Pseudosel agar (BBL). Incubation was at 37C for four days. *Salmonella* and *Shigella* spp. were also enumerated on millipore filters using the same incubation conditions. Results of the enumeration of these presumptive genera of bacteria are shown in Table 3. For enumeration of *Clostridium* spp. Clostricel agar (BBL) inoculated with sediment samples was incubated at 20C for seven days under anaerobic conditions using the GAS PAK (BBL) system. No *Clostridium* colonies developed from any of the samples.

Samples W3, B3, W20, B16, W27, B22, W24, B20, and W26, B21 were selected as representative sites for detailed numerical taxonomic analysis of the micribial community. Twenty-five colonies from the highest plate count medium used in the total viable count enumeration procedure at each incubation temperature were selected and purified for numerical taxonomic analysis. Five organisms each from other sites will also be tested. A total of 300 characteristics will be tested to describe each organism. Six hundred organisms will be tested initially. Completion of these tests will take several months.

No work has been initiated on isolation of potential human pathogens from fish or shellfish collected from the Beaufort Sea. Dr. Carey's group was unable to complete their sampling and to supply fish and shellfish samples for us and all attempts to collect all such samples ourselves failed.

C. Task Objective 3: To determine the role of microorganisms in the biodegradation of petroleum hydrocarbons including determination of rates and limiting factors of this process in surface water and sediment.

Organisms capable of hydrocarbon utilization were enumerated on agar plates containing Prudhoe crude oil as sole source of carbon. Incubation was at 4 or 20C. Control plates lacking added oil were also run. Statistical analysis of the counts on the two media is required before an accurate estimate of the hydrocarbon-degrading population in each sample can be made. Initial enumeration indicates, however, that sediment samples contained between 0 and 10^3 hydrocarbon-degrading organisms per gram dry weight.

Sediment samples were also incubated at 4C with Prudhoe crude oil with ^{14}C labelled hexadecane added. $^{14}CO_2$ was trapped for counting. Results, however, are not yet completed.

The range of hydrocarbon substrate utilization will be determined initially for ten organisms isolated randomly from plates at each incubation temperature from samples B3, B16, B22, B20 and B21. One hundred hydrocarbon substrates or intermediary products of hydrocarbon metabolism will be tested. These organisms will also be subjected to numerical taxonomic analysis.

II. Problems to Date.

The major problem encountered to date was the adverse ice conditions that existed in the Beaufort Sea this summer. The ice prevented sampling offshore along the originally proposed transects and forced most samples to be taken within the barrier islands. In addition to the ice the USGS *Beaver* aircraft was not a reliable sampling aircraft because of the need for ideal weather conditions before it could be landed at a station, and because of the difficulty of holding position at a sampling station. A better sampling platform is needed for future work. The use of anchors on the *Beaver* might have solved the latter problem, but these were lost in transit to Barrow. Several other pieces of equipment or supplies were also temporarily lost in transit to Barrow which complicated sampling operations. A safer, more reliable method of shipping to and from Barrow needs to be found.

Microbiological sampling operations in the Beaufort Sea are tied to the facilities at NARL as this is presently the only adequate laboratory there. The lack of suitable autoclave facilities at NARL has been overcome by addition of a new larger autoclave. Lack of incubation space at NARL is seen as a serious problem in future operations when projects, other than our OCSEP project, requiring incubators, are working there at the same time. A letter has been sent to Dr. Larry Underwood at NARL apprising him of this forthcoming problem.

Considering the logistic problems encountered in working in the Beaufort Sea sampling went well. However, future operations must be able to collect offshore samples repeatedly if a baseline description of the Beaufort Sea, suitable for the OCSEP program, is to be obtained.

III. Budget Status. It is estimated that $52,500 remains of the budget as of November 1, 1975. Inflation is causing great budgetary problems as much of our work requires disposable plasticware and agar products, the price of which have risen 200-300% during this year. Most of the remaining budget is committed for salaries and travel from Louisville to Barrow with $1,000-2,000 left for other operating expenses.

Table 1. ENVIRONMENTAL PARAMETERS OF COLLECTED SAMPLES

Location Area	Station No.	Date	WATER					SEDIMENT				
			U of L Sample	Seral Sample	Depth (Ft.)	Salinity o/oo	Temp. (°C)	U of L Sample	Seral Sample	Depth (Ft.)	Salinity o/oo	Temp. (°C)
Elson Lagoon	1a	8/20	W1	2	3	26.0	3.0	B1	1	5	--	3.0
	1	8/20	W2	4	3	26.5	3.2	B2	3	7	--	3.2
	10	8/28	W3	15	3	23.8	-0.5	B3	16	28	--	--
Pt. Barrow	12	8/28	W4	17	3	22.5	2.0	B4	18	6	22.8	--
Barrow	5b	8/30	*W5	19	--	0.0	--	--	--	--	--	--
Elson Lagoon	11	8/31	W6	21	3	17.0	2.0	B5	20	10	17.0	2.0
Pt. Barrow	12	8/31	W7	23	3	21.0	1.5	B6	22	10	--	1.5
Barrow	6	8/31	W8	24	3	25.5	2.0	--	--	--	--	--
Elson Lagoon	3	9/5	W9	30	3	20.0	-0.2	B7	29	34	--	--
Plover Pt.	4	9/5	W10	32	3	20.5	-.02	B8	31	24	--	--
Oligtok Pt.	30	9/5	W11	34	3	12.1	1.9	B9	33	6	--	2.9
Prudhoe Bay	40	9/5	W12	35	3	18.8	1.8	B10	36	6	--	1.8
	52	9/5	W13	37	3	20.0	1.5	--	--	--	--	--
	53	9/8	W14	38	3	11.8	-0.8	B11	39	6	19.2	-0.8
	55		W15	40	3	11.1	-0.8	B12	41	7	19.8	-0.4
	55		W16	42	7	19.8	-0.4	--	--	--	--	--
	51		W17	43	3	11.4	-0.5	B13	44	8	19.8	-0.2

*Ice sample.

(cont'd)

Table 1. ENVIRONMENTAL PARAMETERS OF COLLECTED SAMPLES (cont'd)

Location Area	Station No.	Date	WATER U of L Sample	Seral Sample	Depth (Ft.)	Salinity o/oo	Temp. (°C)	SEDIMENT U of L Sample	Seral Sample	Depth (Ft.)	Salinity o/oo	Temp. (°C)
Prudhoe Bay	54	9/8	W18	45	3	9.0	-0.4	B14	46	5	17.5	-0.2
Elson Lagoon	1	9/11	W19	53	3	18.3	-0.5	B15	54	7	--	--
	2		W20	51	3	18.2	<0	B16	52	6	--	--
	3		W21	49	3	18.5	<0	B17	50	34	--	--
	4		W22	47	3	18.8	<0	B18	48	24	--	--
Prudhoe Bay	53	9/12	W23	55	3	14.5	1.0	B19	56	8	19.5	1.0
	55		W24	57	3	16.0	1.5	B20	58	10	20.0	1.5
	56		W25	59	3	19.5	1.5	--	--	--	--	--
	70		W26	60	3	20.0	1.0	B21	61	9	21.0	1.0
	71		W27	62	3	21.5	0.5	B22	63	23	22.5	0.0
	50	9/13	W28	64	3	17.8	2.5	B23	65	5	17.5	2.3
	51		--	--	--	--	--	B24	66	7	19.3	2.2
	52		W29	67	3	18.1	1.9	B25	68	8	18.5	2.2
	57		W30	69	3	16.2	2.2	B26	70	5	19.2	1.8
	70		W31	71	3	18.5	1.5	B27	72	20	21.5	0.3
	71		W32	73	3	20.2	0.3	B28	74	19	21.3	0.0

(cont'd)

Table 1. ENVIRONMENTAL PARAMETERS OF COLLECTED SAMPLES (cont'd)

Location Area	Station No.	Date	WATER U of L Sample	WATER Seral Sample	WATER Depth (Ft.)	WATER Salinity o/oo	WATER Temp. (°C)	SEDIMENT U of L Sample	SEDIMENT Seral Sample	SEDIMENT Depth (Ft.)	SEDIMENT Salinity o/oo	SEDIMENT Temp. (°C)
Prudhoe Bay	72	9/14	W33	75	3	16.0	1.9	B29	76	15	19.2	0.6
	73		W34	77	3	15.8	2.3	B30	78	7	20.2	1.5
Elson Lagoon	1	9/17	W35	89	3	22.0	-0.5	B31	90	6	--	-0.5
	2		W36	87	3	22.2	-0.5	B32	88	7	--	-0.5
	3		W37	85	3	22.2	-0.5	B33	86	7	--	-0.5
Barrow	9a	9/23	*W38	99	--	0.0	--	--	--	--	--	--
	9b		*W39	100	--	0.0	--	--	--	--	--	--
	9c		*W40	101	--	0.0	--	--	--	--	--	--
Elson Lagoon	5a		W41	96	0	27.0	-1.0	--	--	--	--	--
Barrow	5b		W42	97	0	25.5	-1.0	--	--	--	--	--
	8	9/25	W43	98	0	26.0	-1.2	--	--	--	--	--

*Ice sample.

Table 2. TOTAL VIABLE MICROBIAL COUNTS

	WATER (count/ml)				SEDIMENT (count/gm dry wt.)				
	4°C		20°C			4°C		20°C	
Sample	Marine Agar 2216	MSWYE	Marine Agar 2216	MSWYE	Sample	Marine Agar 2216	MSWYE	Marine Agar 2216	MSWYE
W1	1.9×10^{2}*	1.1×10^{2}*	6.3×10^{3}	2.5×10^{3}	B1	1.0×10^{4}*	7.4×10^{3}*	3.0×10^{3}	1.4×10^{4}
W2	7.0 x 10*	3.7 x 10*	1.5×10^{3}	7.8×10^{2}	B2	5.4×10^{4}*	9.2×10^{3}*	5.9×10^{4}	6.8×10^{4}
W3	4.8×10^{3}	1.4×10^{3}	4.4×10^{2}	4.3×10^{2}	B3	5.3×10^{4}	6.6×10^{4}	1.3×10^{4}	1.8×10^{4}
W4	1.8×10^{4}	1.7×10^{3}	1.2×10^{4}	5.8×10^{3}	B4	6.8×10^{5}	3.9×10^{5}	7.7×10^{5}	8.6×10^{5}
W5	6.0×10^{2}	3.7×10^{2}	1.7×10^{2}	1.2×10^{2}	B5	4.5×10^{4}	5.4×10^{4}	1.8×10^{5}	2.3×10^{4}
W6	4.0×10^{3}	9.6×10^{2}	3.2×10^{3}	8.8×10^{2}	B6	3.1×10^{4}	1.9×10^{4}	1.9×10^{5}	1.6×10^{4}
W7	2.4×10^{3}	8.1×10^{2}	8.0×10^{2}	4.7×10^{2}	B7	1.9×10^{5}	1.2×10^{5}	1.4×10^{5}	5.0×10^{4}
W8	7.7×10^{2}	2.4×10^{2}	3.7×10^{2}	2.6×10^{2}	B8	7.8×10^{5}	3.1×10^{4}	5.0×10^{5}	8.1×10^{4}
W9	8.4×10^{2}	2.5×10^{2}	3.3×10^{2}	3.0×10^{2}	B9	8.7×10^{4}	3.4×10^{4}	2.5×10^{5}	3.3×10^{4}
W10	1.5×10^{3}	4.6×10^{2}	3.7×10^{2}	2.2×10^{2}	B10	5.4×10^{4}	2.7×10^{4}	4.1×10^{4}	2.6×10^{4}
W11	1.0×10^{4}#	8.2×10^{3}	8.5×10^{3}	1.5×10^{3}	B11	6.2×10^{4}	4.9×10^{4}	4.5×10^{4}	6.2×10^{4}
W12	6.7×10^{3}#	8.7×10^{3}	1.6×10^{4}	1.0×10^{3}#	B12	4.4×10^{4}	6.1×10^{4}	8.2×10^{4}	4.1×10^{4}
W13	1.0×10^{4}#	1.3×10^{4}	2.8×10^{4}	1.6×10^{4}	B13	3.4×10^{4}	6.7×10^{4}	2.7×10^{4}	3.6×10^{4}
W14	1.8×10^{4}	2.3×10^{4}	1.7×10^{4}	1.0×10^{4}	B14	1.2×10^{5}	5.6×10^{4}	1.6×10^{5}	3.4×10^{4}
W15	2.2×10^{4}	3.0×10^{4}	1.3×10^{4}	1.7×10^{4}	B15	2.2×10^{5}	2.0×10^{5}	$\geq 2.5 \times 10^{5}$	4.3×10^{5}
W16	1.6×10^{4}	1.8×10^{4}	1.2×10^{4}	1.1×10^{4}	B16	1.3×10^{5}	1.1×10^{5}	5.7×10^{4}	3.6×10^{4}

*Incubation for only two weeks.
#Approximate figure.

(cont'd)

Table 2. TOTAL VIABLE MICROBIAL COUNTS (cont'd)

Sample	WATER (count/ml) 4°C Marine Agar 2216	4°C MSWYE	20°C Marine Agar 2216	20°C MSWYE
W17	2.6×10^4	2.2×10^4#	1.2×10^4	1.3×10^4
W18	1.8×10^4	1.6×10^4	1.1×10^4	1.1×10^4
W19	6.1×10^3	1.8×10^4	6.7×10^3	6.0×10^3
W20	3.1×10^3	8.1×10^3	2.2×10^3	2.4×10^3
W21	5.1×10^3	8.2×10^3	1.0×10^3	1.0×10^3
W22	1.3×10^3	1.7×10^3	1.9×10^2	2.8×10^2
W23	2.7×10^4	5.9×10^2	2.7×10^4	5.8×10^3
W24	2.1×10^4	6.9×10^2	1.9×10^4	3.8×10^3
W25	1.4×10^4	2.2×10^3	1.6×10^4	2.2×10^3
W26	9.6×10^3	1.3×10^2	1.3×10^4	1.4×10^3
W27	9.7×10^3	1.8×10^2	9.6×10^3	1.2×10^3
W28	2.6×10^4	3.1×10^4	9.4×10^3	1.2×10^4
W29	2.9×10^4	3.0×10^4	8.8×10^3	1.1×10^4
W30	1.9×10^4	1.9×10^4	1.5×10^4	8.8×10^3
W31	9.2×10^3	6.5×10^3	6.9×10^3	8.1×10^3#
W32	5.9×10^3	2.9×10^3	3.8×10^3	4.9×10^3
W33	1.8×10^4	2.3×10^4	1.0×10^4	1.0×10^4

Sample	SEDIMENT (count/gm dry wt.) 4°C Marine Agar 2216	4°C MSWYE	20°C Marine Agar 2216	20°C MSWYE
B17	---	2.1×10^4	1.6×10^4	1.0×10^4
B18	2.4×10^5	7.7×10^5	7.7×10^5	9.4×10^5
B19	2.7×10^5	1.9×10^5	1.4×10^6	2.5×10^5
B20	2.3×10^5	9.8×10^4	3.6×10^5	4.7×10^5
B21	4.1×10^4	2.0×10^4	4.1×10^4	8.1×10^4
B22	3.2×10^4	4.1×10^4	5.2×10^4	5.8×10^4
B23	1.8×10^6	1.1×10^6	1.5×10^6	1.7×10^6
B24	6.8×10^4	4.5×10^5	3.2×10^5	4.0×10^5
B25	1.3×10^5	3.0×10^5	5.3×10^4	1.5×10^5
B26	4.0×10^5	1.1×10^5	1.3×10^6	7.3×10^5
B27	6.8×10^4	1.1×10^5	1.8×10^5	1.8×10^5
B28	9.7×10^4	9.7×10^4	1.6×10^5	8.8×10^4
B29	1.1×10^5	8.3×10^4	2.7×10^5	2.0×10^5
B30	2.9×10^5	1.9×10^5	7.0×10^5	5.3×10^5
B31	1.0×10^5	1.0×10^5	8.1×10^4	7.8×10^4
B32	1.1×10^5	7.5×10^4	1.1×10^5	1.2×10^5
B33	6.5×10^3	9.5×10^3	2.9×10^3	3.8×10^3

#Approximate figure.

(cont'd)

Table 2. TOTAL VIABLE MICROBIAL COUNTS (cont'd)

WATER (count/ml)

Sample	4°C		20°C	
	Marine Agar 2216	MSWYE	Marine Agar 2216	MSWYE
W34	2.3×10^4	3.0×10^4	1.4×10^4	1.4×10^4
W35	3.5×10^3	8.6×10^3	3.9×10^3	3.6×10^3
W36	1.4×10^3	5.4×10^3	5.7×10^2	6.5×10^2
W37	7.1×10^2	4.0×10^3	7.4×10^2	7.3×10^2
W38	3.3×10^3	4.5×10^3	1.6×10^3	1.5×10^3
W39	2.3×10^4	1.6×10^4	1.4×10^3	1.2×10^3
W40	3.1×10^2	2.0×10	2.0×10	2.0×10
W41	2.3×10^3	8.0×10^3	8.6×10^2	1.1×10^3
W42	9.8×10^2	2.4×10^3	4.1×10^2	7.0×10^2
W43	1.7×10^3	5.1×10^2	3.1×10^2	2.7×10^2

(NO ADDITIONAL SEDIMENT SAMPLINGS)

Table 3. BACTERIAL COUNTS ON SELECTIVE MEDIA

Sample No.	TCBS 4°C	TCBS 20°C	SS	Pseudosel	Sample No.	TCBS 4°C	TCBS 20°C	SS	Pseudosel
W1	3.3×10^2	0	0	1.6×10	B1	0	0	--	--
W2	5.6×10^2	0	0	2.0×10	B2	0	0	--	--
W3	8.5×10	9	0	0	B3	1.3×10^2	2.0×10	-	--
W4	5.0×10^2*	5.0×10^2*	2.9×10	1.7×10	B4	4.2×10^2	2.6×10^2	--	--
W5	0	0	4.5×10^2	2.9×10^3	B5	1.4×10^3	0	--	--
W6	2.0×10^2	1	0	0	B6	1.6×10^3	0	--	--
W7	2.7×10^2	0	0	3.0	B7	1.6×10^3	5.4	0.6	0
W8	1.3×10^2	0	0	0	B8	0	1.3	0	0
W9	1.2×10^2	2	0	4.0	B9	3.7×10^2	4.2×10	1.3	0
W10	1.6×10^2	1	2.0	1.0	B10	1.0×10^2	2.5	1.3	0
W11	1.6×10	1	3.0	3.0	B11	4.6×10	7.2×10^2	0	0
W12	1.5×10^2	5	5.0	1.0	B12	1.1×10^2	3.8	0	0
W13	1.5×10	2	1.0	1.0	B13	1.0×10	0	0	0
W14	7.5	0	0	7.0	B14	3.0×10	9.5	0	0
W15	4.3×10	1.3×10	0	6.5×10	B15	1.4×10^2	2.0	0	0
W16	3.0×10	1.0×10	0	1.0	B16	2.3×10^3	0	0	0
W17	1.5×10	0	0	3.0	B17	6.0×10	1.2×10	0	0
W18	1.5×10	2.5	0	3.0	B18	2.3×10^3	1.1×10^2	0	0
W19	2.6×10^2	0	0	0	B19	6.0×10	0	0	0
W20	1.8×10^2	0	0	0	B20	7.0×10	0	0	0
W21	1.7×10^2	0	0	0	B21	3.8×10	0	0	0
W22	1.1×10^2	2.5	0	1.0	B22	4.2×10^2	0	0	0
W23	5.3×10	0	0	2.0	B23	1.2×10^2	2.8×10	0	0
W24	6.0×10	0	0	1.0	B24	1.9×10^2	0	0	0
W25	2.3×10	7.5	0	0	B25	1.4×10^2	7.0	0	0
W26	0	0	1.0	0	B26	5.0×10	4.0×10	0	0
W27	2.0×10	0	0	0	B27	1.5×10^2	0	0	0
W28	4.3×10	2.5	1.0	0	B28	1.2×10^2	0	0	0
W29	5.0	0	0	0	B29	4.6×10^2	0	0	0
W30	2.3×10	2.5	0	1.0	B30	1.0×10^2	0	0	0
W31	0	2.5	0	3.0	B31	3.2×10^3	4.8×10	0	0
W32	5.0	5.8×10	1.4×10	3.4×10^2	B32	3.8×10^3	4.0×10	0	0
W33	1.0×10^2	0	0	0	B33	1.1×10^3	5.5	0	0
W34	5.0×10	5.0	0	3.0					
W35	4.4×10^2	2.0×10	3.0	1.0					
W36	1.7×10^2	2.5	0	0					
W37	2.4×10^2	1.0×10	0	0					
W38	3.5×10	2.0×10	0	0					
W39	2.5×10^2	5.8×10	0	0					
W40	3.5×10^2	1.0×10	0	0					
W41	3.6×10^2	5.0	5.0	0					
W42	4.3×10^2	1.8×10	2.0	6.0					

*Approximate figure.

Semi-Annual Report No. 1

<u>Assessment of Potential Interactions of Microorganisms and Pollutants Resulting from Petroleum Development of the Outer Continental Shelf in the Gulf of Alaska</u>

(Contract No. 03-6-022-35109)

Submitted to: Outer Continental Shelf Energy Program
National Oceanographic Atmospheric Administration

By: Ronald M. Atlas, Principal Investigator
University of Louisville
Louisville, Kentucky 40208

Date: November 1, 1975

I. Progress to Date.

A. Task Objective 1: Summarize and evaluate existing literature and unpublished data on the distribution and abundance of the microbiological community in the Gulf of Alaska.

An extensive search of the literature relating to the microbial community in the Gulf of Alaska has been conducted using the computer search facilities of OASIS and of the Lockheed data base. Copies of the pertinent publications and reports are being obtained and a bibliography of this literature will be prepared.

There appears though to be only very few studies that have dealt with the microbiology of the Gulf of Alaska. There are several studies that have examined microorganisms associated with the same species fish or shellfish found in the Gulf of Alaska, but the samples were not obtained there. Such related publications are also being compiled.

With respect to microbial degradation of hydrocarbons studies have been reported on work within Cook Inlet and within Port Valdez. These studies indicate that natural microbial degradation of petroleum hydrocarbons is a significant process in these areas. No reports or studies on hydrocarbon biodegradation in other areas of the Gulf of Alaska have been found.

B. Task Objective 2: To characterize marine microbiological communities in sufficient detail to establish a baseline description of microbiological community characteristics on a seasonal basis.

Sampling activities were begun five months prior to the

B. <u>Task Objective #2</u>: (cont'd)

original schedule. Samples were collected from the NOAA ship *Discoverer* between October 8 and October 16, 1975, by Dr. James Hauxhurst, Postdoctoral Research Associate, and Mr. Charles Pennington, Research Assistant. Samples were collected at Gulf of Alaska Shelf Study stations, Nos. 101, 102, 103, 104, 105, 106, 119, 121, 124, 133, 134, 137, 145, 146, 148, 156, and 159 (Table 1).

Surface water samples, 1-3m, were collected with a Niskin bacteriological sterile water sampler using a hand winch, located on the gangway boom, starboard side, of fantail. A total of 15 surface water samples were collected. Sediment samples were collected either with a VanVeem grab sampler or a Haps corer. Five grams of sediment from the 0-2 cm. layer were aseptically removed from the larger grab or core sample. A total of five sediment samples were collected.

Aliquots of the water samples were filtered and frozen for nutrient analysis by Dr. Vera Alexander. Aliquots of these samples were also preserved with formaldehyde for direct microscopic determination of total microorganisms. Direct microscopy will be performed in the laboratory at the University of Louisville.

Samples were plated immediately following sample collection for enumeration of viable microorganisms. For enumeration of total heterotrophic microorganisms marine agar 2216 and modified seawater yeast extract agar were used. Total fungal counts were determined on Saboraud dextrose agar. Plates were incubated at

B. Task Objective #2: (cont'd)

4C for enumeration of psychrotrophic and psychrophilic microorganisms, and at 16C for enumeration of mesophilic microorganisms. The plates are still being incubated, therefore no results are presently available. Following incubation random colonies will be isolated for numerical taxonomic analysis to characterize the microbial community present in the sample.

Potential human pathogenic microorganisms were enumerated using selective media: SS agar for enumeration of *Salmonella* and *Shigella*, TCBS agar for enumeration of *Vibrio*, Pseudosel agar for enumeration of *Pseudomonas*, Clostrisel for enumeration of *Clostridium*, and EMB agar for enumeration of enteric bacteria. Incubation for potential pathogens was at 16C.

Shellfish samples are being supplied by Alaska's Department of Fish and Game for analyses of microorganisms associated with Alaskan shellfish that are potentially pathogenic to man. Razor clams and Dungeness crabs have been received at the University of Louisville, and the associated microbiota is being characterized. Enumeration and characterization of the microbiota associated with the shellfish is being performed by Dr. Lois Cronholm (co-Principal Investigator) and Mr. Charles Pennington (research assistant). Shellfish samples are being dissected into various tissue types, e.g. muscle, gills, gut, and the microbiota associated with each tissue type characterized. The presence of potential human pathogens, e.g. *Salmonella* sp., *Shigella* sp., enteric bacteria, *Clostridial* sp., and *Vibrio* sp., is being determined using selective enrichment media. The overall microflora of the

B. Task Objective #2: (cont'd)

shellfish is also being characterized using nonselective media. Enumeration procedures are being performed at a variety of salinities and temperatures to insure recovery of any potential human pathogens that are present. Microorganisms isolated from these specimens that appear to be potential human pathogens will be positively identified using the API identification system.

C. Task Objective #3: To determine the role of microorganisms in the biodegradation of petroleum hudrocarbons including determination of rates and limiting factors of this process in surface water and sediment.

Twelve samples were collected during the October 8-16 *Discoverer* cruise for determination of the presence of hydrocarbon-degrading microorganisms. A medium containing nutrient salts and Prudhoe crude oil as sole source of carbon was used. Streptomycin was added to some plates to separate fungi from bacteria. Incubation for hydrocarbon-degrading microorganisms was performed at 4C and 16C. Further incubation is necessary before numbers of hydrocarbon-degrading microorganisms in the samples can be determined. Enrichment cultures were also begun onboard ship to assess changes in crude oil caused by the degradative activities of the total microbial community present in the samples.

II. Problems to Date.

Shipment of supplies to Alaska and of samples to Louisville has been difficult. The problem has to do with the irregular scheduling of flights and shipment of freight. Some supplies have been temporarily lost by the airlines. It would be advantageous if we could preship supplies for field work and have someone confirm their arrival before we depart for the field. Also, our samples must be refrigerated or frozen during shipment to Louisville. Some samples have been allowed to warm while in transit. An instance of this is one shipment of clams from Alaskan Fish and Game which arrived in Louisville thawed, and was unusable. We are attempting to find surer ways of shipping samples via alternate freight companies and carriers.

With respect to facilities onboard the *Discoverer* (as well as on the *Miller Freeman* for later cruises) there should be a winch capable of handling 1/4-5/16" hydrowire. At present we are limited to surface sampling with a hand winch. Location of such a winch should be starboard amidship on the *Discoverer* (away from bilge and head pumps). Within the oceanographic laboratory a 20° C incubator (size of two refrigerators) and a barrel-size autoclave should be added. At present incubation for mesophiles must be done at deck temperature which will not be suitable in March. There is an autoclave aboard the *Discoverer* with the physician, but this unit has only limited access. In order to freeze samples for nutrient analysis we need dry ice. No dry ice was available in Kodiak. Addition of a few cylinders of CO_2 and an inexpensive dry ice maker is needed.

III. Budget Status. It is estimated that $66,500 remains of the budget as of November 1, 1975.

TABLE I

Sampling Locations

Station Number	Approx. Latitude	Approx. Longitude
101	59 19.8	152 24.1
102	59 09.9	152 04.1
103	59 00.0	151 45.1
104	58 50.0	151 26.4
105	58 39.9	151 07.1
106	58 28.1	150 47.7
119	57 06.9	156 00.0
121	56 43.2	155 27.9
124	56 07.1	154 39.4
133	55 46.3	158 51.0
134	55 33.4	158 38.3
137	54 54.3	157 59.0
145	55 03.1	161 24.4
146	54 49.4	161 12.5
148	54 36.2	161 00.7
156	54 29.2	165 11.3
159	53 51.9	164 34.0

GULF OF ALASKA/BERING SEA - OSCEP PROJECTS

Semi-Annual Report

December, 1975

Prepared by

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I. TASK OBJECTIVES

A. To aid the University of Alaska in the NEGOA hydrocarbon baseline study and to complete the NBS baseline study in the Prince William Sound.

B. To serve as a quality assurance laboratory for hydrocarbon analysis in sediments and water.

C. To develop sampling methodology for the analysis and identification of hydrocarbons in sea ice and at the sea ice-water interface.

D. To identify and quantify individual 3- to 6-condensed ring polynuclear aromatic hydrocarbons (PAH) in water, sediments and tissues at the ng/kg level.

II. A. FIELD ACTIVITIES

On October 27 through October 29, 1975, a joint sampling trip was conducted with Dr. D. Shaw (University of Alaska) and Dr. H. Hertz (NBS) aboard the NOAA Ship Surveyor. The samples were collected outside the Icy Straits (near Juneau) at latitude 58°, 25' N and longitude 135° 00' W. The water temperature was 5.5 °C, pH was 6.5, and the air temperature was 0 °C. Although it was initially agreed to sample four separate sites, only one site could be sampled due to the insufficient number of sample bottles provided by Dr. Shaw. Only surface water samples were collected, since Dr. Shaw's sampler used an open bottle and therefore was not usable for 10m-depth samples. Twelve water samples were brought back to NBS instead of the expected 50 (triplicates at each of four sites plus back-ups to allow for any breakage.) The samples returned to NBS were identified as follows:

Sample Number	
4100-4105	Surface water NBS sampler
4106-4111	Surface water Dr. Shaw's sampler

On discussion with the Project Office, it was concluded that another sampling trip by NBS personnel to the Northeastern Gulf of Alaska in September 1975 would not provide additionally needed information. Instead the Auke Bay Laboratory party was to collect surface water and sediment samples for NBS at three sites - Cape Yakataga, Katalla River and Middleton Island. Due to inclement weather, the Auke Bay Laboratory party did not reach the sites mentioned so no samples were collected. As previously reported to the Project Office, an NBS sampling party did not participate in the sampling trip to the sea-ice front in the Bering Sea (November 1975). By discussion with Dr. Ted Cooney, IMS, University of Alaska, it was learned that the November cruise might not be able to reach the ice front. As a result, sea-ice sampling will be deferred until the March cruise.

B. LABORATORY ACTIVITIES

Water and sediment samples collected in the Prince William Sound and the Gulf of Alaska in the spring of 1975 have been analyzed using headspace sampling, gas chromatography, and coupled-column liquid chromatography. Water samples collected with Dr. D. Shaw as part of the NBS quality assurance program have been similarly analyzed. The developmental work for the determination of polynuclear aromatic hydrocarbons (PAH's) utilizing fluorescence detection has begun.

III. RESULTS

The results for the water samples collected in the spring of 1975 (physical data reported in the July 1975 progress report) are reported in Table 1. The results on the water samples are presented in terms of total hydrocarbon concentration (μg/kg) and percentage composition by molecular weight region. The PAH content of these water samples as determined by coupled-column liquid chromatography is presented in Table 2. Data from the sediment samples are presented in Table 3. These data also are presented in terms of both total hydrocarbon concentration (μg/kg wet weight) and percentage composition by molecular weight region. The data reported include the number of samples analyzed and the standard deviation of replicate values from the mean. The results of the joint surface water sample split conducted with Dr. D. Shaw are presented in Table 4.

The liquid chromatography data are expressed in phenanthrene equivalents. When collection and identification of individual compounds in a complex mixture of polynuclear aromatic hydrocarbons is not feasible, "absolute" quantitation is not possible. Peak heights (or areas) are not directly convertible into concentration units for two reasons: (1) Recovery of these compounds from water increases as an inverse function of their solubilities in water. (2) The UV detector (254 nm) monitors a single wavelength (generally not at the maximum absorbances for the PAH's), and thus the sensitivity of detection varies randomly with elution time. Approximate quantitation is obtained here by expressing quantitative results in terms of equivalents of one particular compound whose recovery from water has been determined and whose UV response at 254 nm has been measured. For the purposes of this baseline study, phenanthrene was selected as the reference compound and all quantitative results are expressed in terms of phenanthrene equivalents. See Appendix 1 for the procedure for quantitating mixtures of PAH's in terms of phenanthrene units.

Table 1. Hydrocarbon content of water samples collected Spring 1975.

Site	Total maximum Hydrocarbon content (μg/kg) obtained by headspace sampling	Percent of total hydrocarbon by molecular weight regi			
		Mesitylene	Naphthalene	Trimethyl-naphthalene	Phenanthre
Anchor Cove 10M	12 ± 2 (3)*	21 ± 8**	5 ± 3	11 ± 4	62 ± 9
Boswell Bay 5M	3.6 (1)	48	7	10	36
Boswell Bay Surface	2.7 ± 0.4 (2)	18 ± 3	11 ± 2	21 ± 4	50 ± 4
Cape Yakataga Surface	7 ± 3 (4)	26 ± 6	16 ± 3	22 ± 6	35 ± 8
Katalla River Surface	2.6 ± 0.04 (2)	61 ± 6	5 ± 3	3 ± 0.4	31 ± 8
Middleton Island Surface	4.2 ± 0.2 (2)	31 ± 9	22 ± 1	5.3 ± 0.02	42 ± 11
Old Valdez Surface	1.7 ± 0.1 (2)	48 ± 13	10 ± 1	13 ± 4	29 ± 8
Siwash Bay 10M	2.8 ± 0.4 (3)	26 ± 4	20 ± 5	9 ± 1	44 ± 10
Siwash Bay Surface	2.6 ± 0.7 (2)	49 ± 35	3.8 ± 0.5	14 ± 9	33 ± 25
Squirrel Bay 1[illegible]	6.1 ± 1.4 (3)	51 ± 5	27 ± 2	7 ± 2	16 ± 5
Squirrel Bay	3.8 ± 1.2 (3)	9 ± 5	4 ± 1	6 ± 0.3	81 ± 5
Hinchinbrook Is. Surface	4.6 (1)	9	5	7	79
MacLeod Hbr Surface	1.8 (1)	23	5	7	65
Katalla River Seep site	130 ± 22 (3)	18 ± 6	23 ± 4	20 ± 3	40 ± 7

* (n) denotes number of samples analyzed.
** Values include standard deviation of replicate values from the mean of the replicate values.

Table 2. Aromatic hydrocarbon content of water samples as determined by coupled-column liquid chromatography using UV detection

Site	Aromatic hydrocarbon content (μg/kg) expressed in phenanthrene equivalents*
Anchor Cove 10M	0.11
Boswell Bay Surface	0.64
Cape Yakataga Surface	0.11 (1.09)**
Katalla River Surface	0.28
Middleton Is. Surface	0.06
Old Valdez Surface	0.11
Siwash Bay Surface	0.26
Squirrel Bay Surface	0.32
10 M	0.40
MacLeod Hbr Surface	0.10
Katalla River Seep site	106

* See text for discussion of phenanthrene equivalents.
** Discussed in text.

Table 3. Hydrocarbon content of sediment samples collected Spring 1975

Site	Total maximum hydrocarbon content (µg/kg) wet weight) obtained by headspace sampling	Percent of total hydrocarbon by molecular weight region			
		Mesitylene	Naphthalene	Trimethylnaphthalene	Phenanthrene
Hinchinbrook	32 ± 17 (2)*	63 ± 6**	18 ± 1	4.8 ± 0.4	15 ± 4
Middleton - 1	298 ± 30 (7)	25 ± 2	17 ± 1	22 + 1	36 ± 3
Middleton - 2	30 ± 4 (4)	52 ± 7	18 ± 1	18 ± 5	12 ± 2
Middleton - 3	41 ± 8 (3)	57 ± 6	15 ± 1	9 ± 2	19 ± 5
Boswell Bay	15 ± 2 (4)	43 ± 5	17 ± 1	16 ± 2	24 ± 6
MacLeod Hbr	77 ± 4 (3)	40 ± 8	10 ± 2	18 ± 5	32 ± 14
Cape Yakataga	391 ± 94 (4)	28 ± 1	19 ± 2	26 ± 2	26 ± 2
Old Valdez	68 ± 4 (3)	26 ± 2	11 ± 1	17 ± 6	46 ± 4
Katalla River	670 ± 116 (4)	29 ± 4	22 ± 1	21 ± 2	28 ± 2
Siwash Bay	42 ± 16 (3)	46 ± 5	12 ± 1	19 ± 7	23 ± 3
Squirrel Bay - 1	72 ± 14 (4)	28 ± 7	10 ± 2	30 ± 7	33 ± 6
Squirrel Bay - 2	32 ± 8 (2)	17 ± 4	12 ± 1	18 ± 7	53 ± 2
Squirrel Bay - 3	38 ± 9 (2)	15 ± 1	7 ± 1	6 ± 2	72 ± 1
Anchor Cove	NO SEDIMENT COLLECTED				

* (n) denotes number of samples analyzed.
** Values include standard deviation of replicate values from mean of replicate values.

Table 4. Hydrocarbon content of water samples collected on joint sampling trip, October 27-29, 1975*

	Total maximum Hydrocarbon content (μg/kg) obtained by headspace sampling	Percent of total hydrocarbon by molecular weight region			
		Mesitylene	Naphthanlene	Trimethyl-naphthalene	Phenanthrene
University of Alaska Sampler	1.4 ± 0.5 (4)**	38 ± 28***	17 ± 9	23 ± 9	22 ± 19
NBS Sampler	1.0 ± 0.2 (5)	45 ± 15	10 ± 3	16 ± 8	30 ± 22

* All water samples returned to NBS in acid-cleaned one-liter bottles provided by NBS.

** (n) denotes number of samples analyzed.

*** Values include standard deviation of replicate values from mean of replicate values.

Results are reported for the first time on water collected at a new sampling site at the petroleum seep near the Katalla River. Since the Katalla River sediment had shown positive petroleum contamination, it was decided to collect and analyze some water and sediment from a seep site that drains into the river. It is interesting to note that there is a 100-fold increase in the hydrocarbon content at that site (as compared to all others). This increase appeared in both the molecular weight range analyzed by headspace sampling and in the PAH fraction analyzed by coupled-column liquid chromatography. At the Katalla River site sampled previously, the large flow of fresh water - due to melting snow - reduced the hydrocarbon content of the water to essentially that found at other sites. However, new sediment samples from the original River site had essentially the same hydrocarbon burden as in the fall of 1974.

Water samples collected at Cape Yakataga gave two distinctly different results (see Table 2) for the PAH concentration. This difference could be due to sample inhomogeneity. Since Cape Yakataga is near known oil seeps, PAH contamination of the one water sample could have occurred in the form of individual globules of weathered oil. In the April 1975 Quarterly Report two separate values were reported for the Cape Yakataga sediment collected in the fall of 1974. Three replicate analyses from the sample bottle showed a maximum hydrocarbon content of 72 ± 28 μg/kg (wet weight) while the fourth analysis from the same bottle showed 367 μg/kg. It was concluded at that time that the samples collected were microscopically inhomogeneous; the hydrocarbon burden was associated with a single grain (or very few grains) of the well-mixed sediment sample. The results presented in Table 3 (391 ± 94 μg/kg wet weight) for Cape Yakataga sediment do indicate some hydrocarbon contamination. A GC-MS analysis of this sediment is pending.

Hydrocarbon contamination was found upon analysis of sediment taken in the fall of 1974 at Middleton Island (see April 1975 Progress Report). For this reason three different sites in the intertidal zone at the Eastern end of the island were sampled in the spring of 1975. As seen in Table 3, two of the sites appear to be very clean (Site 2 - coarse gravel beach at low tide, Site 3 - sandy sediment) while the third site appears to be contaminated (Site 1 - greasy, clay-type sediment). Upon receipt of samples from the Auke Bay Laboratory sampling party, GC-MS analysis will be performed on the Site 1 sediment to determine if the contamination is of petroleum origin.

The sampling site at Squirrel Bay also showed a high maximum hydrocarbon content (see April 1975 Progress Report) when it was sampled in the fall of 1974. Here again multiple samples were taken on the spring 1975 sampling trip (see July 1975 Progress Report). It was suspected that the high hydrocarbon content observed previously was due to the adsorptive nature of the sediment and the consequent low recovery of the internal standard added for quantitation. Realizing these problems, a larger dose of internal standard was added this time and more replicate samples were run to improve statistics. The results reported in Table 3 indicate that Squirrel Bay is a relatively pristine site.

Table 4 contains the results of the analyses performed on the water samples obtained during the joint sampling trip with Dr. D. Shaw, University of Alaska. These low values for maximum hydrocarbon content (essentially the value of the analytical blank) indicate no apparent differences in the water samples collected using the two sampling devices. (These analytical results have not been transmitted to Dr. Shaw and at this writing NBS has not yet received his analytical results.)

IV. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

A primary function of NBS this fiscal year is to serve as the quality assurance laboratory for hydrocarbon analysis in water and sediments. Contrary to the experience of the October

27-29th trip, strict attention to original plans in joint sampling trips is necessary, if NBS is to conduct a realistic quality assurance program. Intercalibration exercises are particularly important to ensure the credibility of the data obtained, since the several NOAA contractors and sub-contractors are using various analytical methodologies to obtain their results.

APPENDIX 1

Procedure for Quantitating Mixtures of Polynuclear Aromatic Hydrocarbons in Terms of Phenanthrene Units

1) Identify and label the internal standard peak (phenanthrene).

2) Tabulate the peak height (or area) of the phenanthrene peak.

3) From the laboratory notebook, note the amount (in micrograms) of phenanthrene added to the sample prior to analysis.

4) From the laboratory notebook, note the weight of sample analyzed.

5) Mark the best tangential baseline on the chromatogram and measure all peak heights (areas) from this baseline.

6) Calculate the total PAH concentration in terms of phenanthrene equivalents, as shown in equation 1.

$$\frac{\sum_{p=1}^{p=n} h_p \cdot W_{phen}\ (\mu g)}{h_{phen} \cdot W_{sample}\ (kg)} = \text{Concentration } (\mu g/kg) \text{ in phenanthrene equivalents} \qquad (1)$$

where,

h_p = peak height (or area) of peak p in the chromatogram

W_{phen} = weight (μg) of the phenanthrene internal standard added to the sample

h_{phen} = height (or area) of the phenanthrene peak

W_{sample} = weight of the sample analyzed (kg)

7) Convert phenanthrene equivalents into concentration units for any single identified component in the chromatogram using equation 2.

$$\frac{R_{phen}}{R_x} \cdot \text{phenanthrene equivalents of compound } x = \text{Concentration of } x\ (\mu g/kg) \qquad (2)$$

where

R_{phen} = the response factor of phenanthrene (units/mg)

R_x = the response factor for the compound of interest (units/mg)

8) Calculate response factors by doing the following:

   a) Add a known amount of the compounds of interest to approximately 500 ml of water in a headspace-sampling flask.

   b) Headspace sample for four hours, as previously described.

   c) Take the residue from the headspace-sampling flask and analyze by the coupled-column LC procedure.

   d) Mark the best tangential baseline on the chromatogram and measure the peak heights (area) from this baseline.

   e) Calculate the response factor by dividing each peak height (or areas) by the weight of that compound added.

UNITED STATES DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

August 25, 1975

Dr. Gunter Weller
Project Manger
Artic Project Office
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Dear Dr. Weller:

Project Report - Quarterly

Project: Determination of Selected Inorganic Elements in Water and Sediments.

Principal Investigator:

Dr. I. L. Barnes
National Bureau of Standards
Analytical Chemistry Division
A25, Physics Bldg.
Washington, D. C. 20234

Progress to August 31, 1975

We have obtained the necessary sample collecting containers, storage containers and tools. These have been cleaned and tested and are ready for the first collecting trip which we understand will be in mid - September.

Sincerely,

I. L. Barnes / LGM

I. L. Barnes, Chief
Analaytical Spectrometry Section
Analytical Chemistry Division

Task Title: Light Hydrocarbon and Particulate Matter Programs

PI: Dr. J.D. Cline and Dr. Richard A. Feely, PMEL

OUTER CONTINENTAL SHELF ENERGY PROGRAM
JUNEAU PROJECT OFFICE
P. O. BOX 1808
JUNEAU, ALASKA 99802

I. TASK OBJECTIVES

Low Molecular Weight Hydrocarbons (C_1-C_4)

In accordance with the guidelines of OCSEP, the first of six field programs was initiated in the southeastern Bering Sea (DISCOVERER, Leg III, 1975). The principal focus was to evaluate the spatial and temporal variations in the concentrations of the low molecular weight hydrocarbons, methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), propane (C_3H_8), propylene (C_3H_6), iso- and normal butanes (C_4H_{10}). A detailed description of these studies is presented in work unit #153/155.

Particulate Matter Program

The primary objective of the suspended matter in these areas will be to address Task B-11 (characterize physically and chemically sediment influx, transport and deposition) of the Study Plan. During the course of this program we will address portions of Tasks A-33 (trace elements in suspended particulate matter) and A-34 (particulate nutrients in suspended particulate matter).

II. FIELD OR LABORATORY ACTIVITIES

A. Ship Schedule

1. Leg II of the SURVEYOR (10 August - 29 August 1975)
   Participant from PMEL - Gary Massoth, Geochemist
   Results - Cruise aborted because of engine breakdown

2. Leg III of the DISCOVERER (13 September - 3 October 1975)

Participants from PMEL

Dr. Richard Feely - Chief scientist; co-principal investigator; Particulate Matter and Light Hydrocarbons, PMEL

Dr. Joel Cline - Oceanographer; co-principal investigator; Particulate Matter and Light Hydrocarbons, PMEL

Mr. Gary Massoth - Geochemist; Particulate Matter, PMEL

Ms. Jane Fisher - Oceanographer; Particulate Matter, PMEL

Ms. Joyce Quan - Physical Science Tech; Particulate Matter, PMEL

Mr. Willian Landing - Graduate Student; University of Washington

Mr. Anthony Young - Oceanographer; Light Hydrocarbons, PMEL

Mr. Lee Ohler - Oceanographer; Light Hydrocarbons, PMEL

B. Light Hydrocarbons

1. Field sampling and shipboard analysis

Water samples were taken with 5- or 10-L Niskin® samplers and temporarily stored in 1-L glass-stoppered bottles to which was added 100-200 mg of sodium azide to suppress bacterial activity. Within two hours of sampling, hydrocarbons were quantitatively "stripped" from solution and absorbed on activated alumina at -196°C, After approximately 20 minutes of stripping, the cold trap was warmed and the hydrocarbons chromatographed on Poropak® Q and detected with a FID. Complete sample analysis, including stripping, up through C_4 required about 30 minutes.

2. Station locations

The sampling for low molecular weight hydrocarbons was carried out in concert with the particulate matter program (Figure 1). In addition to the proposed study, five EBBS stations were also sampled, together with a detailed grid (11 station) near Izembek Lagoon. The latter region was investigated because of abnormally high methane concentrations observed near the lagoon.

3. Sample analysis

A total of 72 stations were occupied, resulting in the analysis of 298 water samples for the aforementioned hydrocarbons. Approximately 3 to 5 standard depths were sampled at each station (e.g., 0, 10, 20, 30, bottom -5). The number of depths selected at each station varied, depending on the station sampling protocol and the elapsed time between stations. In all cases, hydrocarbon sampling was optimized to preclude prolonged sample storage.

Quality control was maintained each day through routine standardization and replicate sampling at selected stations.

Short term temporal changes were examined at two stations, EBBS-37 (36 hours) and PMEL-46 (24 hours). The first of these was located in central Bristol Bay to the west of the Pribilof Islands, the latter near Unimak Pass. Sampling was carried out at standard depths every 4 hours.

C. Particulate Matter Program

1. Methods

Water samples were collected in 10-L Top Drop Niskin® bottles and filtered under vacuum through (1) preweighed 0.4 μm Nuclepore® filters, (2) 0.4 μm Selas silver filters, and (3) 0.45 μm preweighed and pretreated Millipore filters. The filters were removed from the filtration apparatus, placed into individually marked petri dishes, dried in a desiccator for 24 hours and stored for shipment to the laboratory.

2. Sample locations

Figure 1 shows the locations of the stations where suspended matter samples were collected during Leg III.

3. Data collected

Particulate matter samples were collected from all of the proposed PMEL stations and 20 out of 22 of the EBBS stations. Samples were taken from several preselected depths depanding on location. Nominally, these depths included: surface, 10m, 20m, 40m, 60m, and 5 meters above the bottom. Since time and weather conditions were favorable, 5 additional stations were added to the sampling grid to provide more information about local sources for particulate matter. In addition, EBBS station 37 was occupied for 36 hours with sampling occurring every 4 hours.

III. RESULTS

Low Molecular Weight Hydrocarbons

Data processing is proceeding at a normal rate and should be finalized by December 1, 1975.

Particulate Matter

No results are available at this time.

IV. PRELIMINARY INTERPRETATION OF RESULTS

No interpretations are available at this time.

V. SAMPLING AND LOGISTIC DIFFICULTIES

Shipboard Contamination

Hydrocarbon sampling from standard oceanographic platforms (i.e., DISCOVERER) is tenuous at best. Some difficulties were encountered during Leg III from hydrocarbon--contaminated sampling bottles resulting in a time-consuming clear-up procedure. The contamination arose from either 1) storage of the Niskin® samplers on the fantail of the DISCOVERER and thus subject to the effects of stack effluents, or 2) the introduction of the rosette sampler through a surface oil slick. It is recommended that the samplers be stored inside the ocean lab when not in use and cocked just prior to sampling. If this is not feasible, a cover could be placed over the rosette and removed just before sampling. As an additional precaution, the rosette should be flushed thoroughly below the mixed layer prior to sampling. Under no circumstances should the holding tanks or bilges be pumped while on station.

Kodiak Logistics

The analysis of "light" hydrocarbons requires either liquid nitrogen or dry ice to effectively trap and concentrate the sample. Currently, our staging operation from Kodiak is severely limited because Wien Airline refuses to fly either liquid nitrogen or dry ice to Kodiak on a commercial flight. Currently, transportation of liquid nitrogen or compressed gases to Kodiak can only be satisfied through Sea Land, Inc., but long lead times, handling, and limited scheduling lead to large losses in these valuable cryogenics. This problem could be alleviated by moving ship departure points to parts on the mainland (i.e., Anchorage, Seward, etc.), where surface transportation from Anchorage can be utilized.

Particulate Matter Program

The nephelometer that was planned to be deployed on the near-bottom current meter array will not be completed until mid-December. Therefore, we suggest (after consulting with the physical oceanographers) that the deployment of the nephelometer on the near-bottom current meter array be delayed until mid-January.

VI. ESTIMATE OF FUNDS EXPENDED

	Allocated	Expended to Date	Balance
Particulate Matter Program			
Salaries and overhead	125.6K	33.5K	92.1K
Travel (Leg III only)	23.5	3.0	20.5
Equipment			
Current meter	5.0	2.0	3.0
Nephelometers (1 finished and 2 more in final stages of development)	35.0	27.0	8.0
Cahn electrobalance and supplies	5.0	3.5	1.5
X-Y recorder and supplies	3.0	3.0	0.0
Filtration equipment	4.0	4.0	4.0
X-ray fluorescence system	70.0	0.0	70.0
Computer time	9.8	.5	9.3
Expendable supplies		8.0	0.0
Publications	6.0	0.0	6.0
Total	300.0K	84.5K	215.5K

	Allocated	Expended to Date	Balance
Low Molecular Weight Hydrocarbon Study			
Salaries and overhead	63.0K†	21.0K	42.0K
Major equipment	26.5	15.0	11.5
Expendable supplies	17.5	7.1	10.4
Travel and per diem	7.0	1.4	5.6
Shipping	4.0	0.7	3.3
Publications	4.0	0.0	4.0
Total	122.0K	45.2K	76.8K

†Salaries and overhead were computed for the months June through October 1975. or 5/15 of 63.0K.

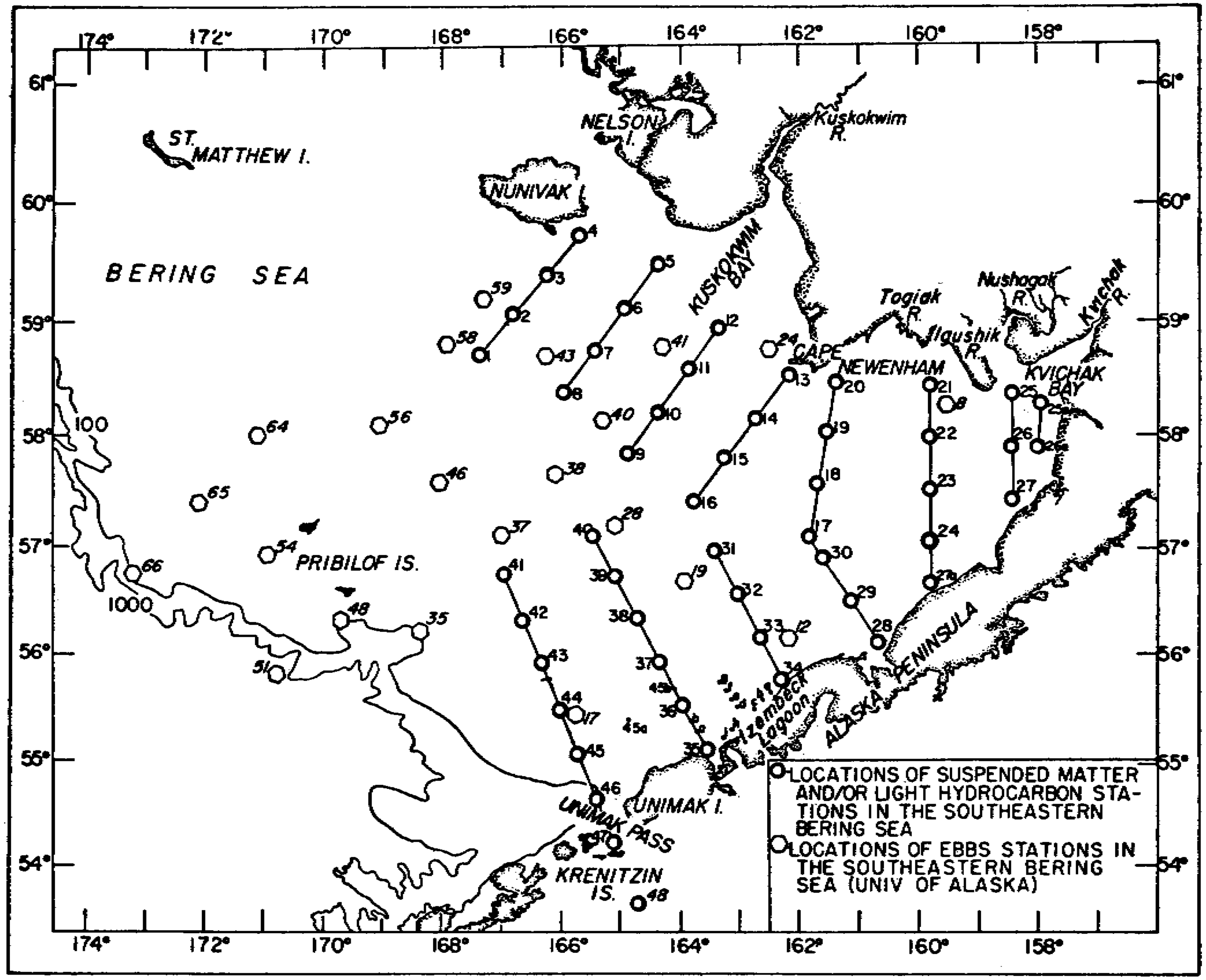
VII. RECOMMENDATIONS FOR FUTURE CRUISES

A. After having some first-hand experience conducting field studies with NOAA ships, it is our recommendation that future field studies in the Bering Sea be reduced from the present plan of 23 days to 17-18 days.

B. The cruises in Gulf of Alaska could probably be reduced from 23 days to 18-20 days, depending on weather conditions.

C. The cruise on the SURVEYOR in the GOA which is tentatively scheduled for 4 May - 10 May has been scheduled for a very poor time slot. The water resources data indicate that the river discharge is relatively low at that time of the year. We would rather have that cruise scheduled around 7 July, just before the summer cruise in the Northeast Gulf.

D. The cruise on the SURVEYOR in the Bering Sea which is tentatively scheduled for 27 July - 31 July, has been scheduled at a time when <u>all</u> of our people will be on another ship. This cruise should be rescheduled for a later date (i.e., early September).



BERING SEA
ST. MATTHEW I.
NUNIVAK
NELSON I.
Kuskokwim R.
KUSKOKWIM BAY
CAPE NEWENHAM
Togiak R.
Igushik R.
Nushagak R.
Kvichak R.
KVICHAK BAY
PRIBILOF IS.
ALASKA PENINSULA
Izembeck Lagoon
UNIMAK I.
UNIMAK PASS
KRENITZIN IS.
100
1000
LOCATIONS OF SUSPENDED MATTER AND/OR LIGHT HYDROCARBON STATIONS IN THE SOUTHEASTERN BERING SEA
LOCATIONS OF EBBS STATIONS IN THE SOUTHEASTERN BERING SEA (UNIV OF ALASKA)

FIGURE 1

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Natural Distribution of Trace Heavy Metals and Environmental Background in Three Alaska Shelf Areas.

Contract Number: 03-5-022-56

Task Order Number: 12 RU#, 62/165/288/293/312

Principal Investigator: Dr. D. C. Burrell
Associate Professor
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. Task Objective

The primary objective of this program is to characterize the trace metal contents of sea water, sediment and selected indigenous animal and plant species in the three defined study areas: the Gulf of Alaska, the Bristol Bay Basin region of the Bering Sea and the Beaufort Basin region of the Beaufort Sea as defined in the above referenced Task Order Work Statement. The program also incorporates "sediment dynamics" and sediment grain size analysis and clay minerological programs as described in that Work Statement. A "previous work" literature search is being done for each subsection of the project.

Immediate objectives pursued during the preceeding quarter have been almost entirely concerned with field work sampling and an up-date of the required laboratory facilities.

II. Field Activities

Field work has been given top priority in order to both take advantage of summer conditions and to provide as long a lead time as possible for the chemical analysis programs.

(a) Bering Sea

1) Discoverer Leg II, June 2 - 19, 1975

This cruise occupied a broad-based station grid over the entire Bering Sea study area. The grid was designed to permit chemistry, benthic biology and geology samples to be taken from the same localities. Water samples were collected for analysis of soluble trace metal constituents by voltammetry and neutron activation. The drop-top Niskin sampling bottles mounted on the CTD rosette were used for these. Surface sediment samples were collected using the Batelle NW Haps trace-metal corer. Splits of these samples were taken for the various participating laboratories (IMS, Batelle and NBS). Some additional samples for the geology programs were taken from the benthic Van Veen Grabs.

2) Discoverer Leg III, September 25 - October 3, 1975

This cruise has largely duplicated the above track. It was re-occupied for this program to provide water and sediment samples for direct ship-board analysis for Se and Cr. These operations could not be included in the previous cruise because of the lead time required for purchase of the specialized equipment.

3) Surveyor Leg II, August 4 - 29, 1975

Intertidal benthic samples have been collected for our use on this cruise by Dr. Steven Zimmerman.

4) Miller Freeman Legs I - III, August 17 - October 26

Trawler biota samples have been collected for us from these cruises.

(b) N. E. Gulf of Alaska

1) Townsend Cromwell May 5 - 19, 1975

This cruise re-occupied a number of the standard E. Gulf of Alaska stations and some additional sites in Prince William Sound. Water and sediment samples were collected. The former voltammetric analysis and Van Veen sediment samples primarily for the geological portions of this program.

2) Silas Bent Leg I, August 31 - September 17, 1975

Personnel from this project participated in this cruise in order to obtain Haps core samples because the necessary sampling bottles were unavailable.

3) North Pacific

Trawler biota samples have been collected for us on these cruises.

(c) N. W. Gulf of Alaska

No chemistry cruises have operated in this region during this quarter.

(d) Beaufort Sea

Suitable logistic support has not been available in this region during this quarter.

III. Results

Samples have been cataloged and are now being distributed to the geological participants and to the sub-contracting laboratories and N.B.S. Analytical work is in progress on Townsend Cromwell, Discoverer and Surveyor samples. We are updating our laboratory facilities as needed. One major concern which has been addressed has been an attempt to standardize our sample collection and storage procedures. The water samples are now collected in drop-top Niskin bottles and sediment for trace metal analysis are in short Haps cores. Sample bottles for both water and sediment have been purchased in bulk, prepared by Batelle N. W. Laboratories and used for all recent cruises.

IV. Problems Encountered

(a) Logistic problems have prevented us from obtaining samples from the Beaufort Sea.

(b) Our reliance on other OCS programs for collecting the bulk of the needed biota samples has not been entirely successful.

(c) The late funding of the project in relation to the summer field season, coupled with the long lead time needed to obtain some of the specialized equipment items has caused some problems.

(d) The lengthy period of time needed to finalize the sub-contracts has severely hampered their full participation during this quarter.

V. Estimate of Funds Expended

	Budget Total	(6 months) Expended*	Remaining
Salary & wages	158,353.00	19,102.13	139,250.87
Staff benefits	26,750.00	3,185.40	23,564.60
Equipment	42,450.00	24,844.96	17,605.04
Travel	18,869.00	939.78	17,929.22
Other	143,228.00	3,236.10	139,991.90
Total Direct	389,650.00	51,308.37	338,341.63
Indirect	90,577.00	10,926.42	79,650.58
Task Order Total	480,227.00	62,234.79*	417,992.21

* Preliminary costs data, not yet fully processed.

SEMIANNUAL REPORT ON TASKS A-27, B-9 and C-2

TITLE: Baseline study of microbial activity in the Beaufort Sea and Gulf of Alaska and analysis of crude oil degradation by psychrophilic bacteria.

SUBMITTED TO: National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado

SUBMITTED BY:

Richard Y. Morita
Principle Investigator
Professor of Microbiology
and Oceanography
Department of Microbiology
Oregon State University
Corvallis, OR 97331

Robert P. Griffiths
Co-Investigator
Research Associate
Department of Microbiology
Oregon State University
Corvallis, OR 97331

DATE SUBMITTED: October 30, 1975

I. Task objectives

During our first field trip, we had several objectives. Our first objective was to determine the relative heterotrophic potential and the population density of microorganisms in the Beaufort Sea (task number A-27). It was hoped that we would have an opportunity to sample locations of sufficient diversity to obtain a significant "summer" sampling of these parameters in a number of different types of water. Samples of both water and sediment were to be taken and analyzed.

Our second objective was to isolate and characterize psychrophilic hydrocarbon utilizing microorganisms which are presumed to be present in the Beaufort Sea (task number B-9). Isolates were to be taken from enrichment cultures made with sediments, sea water and crude oil taken from this region. Once isolated in the field, these cultures were to be transported to our laboratory at Oregon State University for characterization. After selected organisms were characterized, we planned to conduct basic physiological experiments which would illustrate how these organisms function under the conditions found in Arctic marine waters.

Our third objective (task number C-2) was to determine the acute and chronic effects of crude oil on the heterotrophic activity of the natural microbial populations found in the Beaufort Sea. These studies were also going to be supplemented by a variety of studies which would help to define the role of microorganisms in these waters. It was our hope that by combining our talents with those of Dr. Atlas and his group, we would be able to obtain the most comprehensive picture possible of microbial function in Arctic waters.

II. Field activities

A. Field trip schedule

1. A field team made up of three persons arrived at NARL (Barrow, Alaska) on 12 August, 1975. We used this as a base laboratory until we left on 31 October, 1975. All personnel remained at NARL during this period with the following exceptions; Dr. Griffiths at Oliktok DEW line station and Prudhoe Bay from 9/3/75 - 9/5/75, Dr. Hayasaka at Prudhoe Bay (VE camp) from 9/5/76 - 9/12/75, and Mr. Dunlap at Prudhoe Bay (VE camp) from 9/12/75 - 9/19/75.

2. The following sampling trips were made in either the Beaver or a Boston Whale Boat:

Date	Duration (hours)	Location P=Prudhoe Bay E=Elson Lagoon	Mode B=Beaver W=Boston Whale Boat
8/20	2	E	W
8/21	4	E	W
8/28	3	E	B
8/31	2	E	B
9/3	2	P	B
9/5	7	P	W
9/5	4	E	W
9/7	3	P	W
9/8	3	P	W
9/10	3	P	W
9/11	4	E	W
9/12	3	P	W
9/13	2	P	W
9/14	3	P	W
9/18	4	E	W

Note: all of the above sampling trips were made in collaboration with Dr. Atlas's group and did not include the sampling trips made on land.

B. Scientific party: All of the participants in the summer field trip were from the Department of Microbiology, Oregon State University

Dr. Robert P. Griffiths, Co-Investigator and leader of the field team
Dr. Steven S. Haysaka, Research Associate
Mr. Paul Dunlap, Graduate Student

C. Methods

1. Sampling procedures

a. Water samples

All water samples were taken in sterile Niskin plastic water sample bags fitted on Niskin "butterfly" water samplers. A check was made to determine if these bags had an affect on microbial activity and none was found. All water samples were taken within one meter of the surface except sample number 42 which was taken at two meters. Once the water sample was taken, it was placed in an ice chest for storage and transport. A 150 ml subsample was placed in a 500 ml acid washed plastic bottle and immediately frozen in dry ice. These samples were to be later transported to the University of Alaska for nutrient analysis by Dr. Alexander's group.

b. Sediment samples

All sediment samples were taken with a small grab sampler. Normally two or three grab samples were taken at the same location and combined along with some of the interstitial water in a sterile 250 ml glass sample bottle. These samples were then handled like the water samples. Both water and sediment samples were returned to the laboratory at NARL for processing within two hours after the collection of the last sample and were maintained at or below the in situ temperature. Processing of the samples was initiated as soon as they were received at the laboratory.

c. Ice samples

The ice samples were taken from the waters adjacent to the beach. They were removed from the water and placed into sterile sample bags and returned immediately to the lab. They were allowed to melt at room temperature for 4 hours. The resulting melt water was removed and the remaining ice was allowed to thaw for 24 hours at 5 C. This ice water melt was then used in the ice melt experiments.

2. Heterotrophic potential studies

The kinetics of soluble organic nutrient uptake by natural microbial populations was made using the basic method of Wright and Hobbie (1969) which was modified by Hobbie and Crawford (1969) and more recently further modified by Griffiths, Hanus, and Morita (1974). [U-^{14}C] L-glutamic acid with a specific acitivity of 237 mCi/mmole(New England Nuclear) was used in the water sample experiments. The final added substrate concentration ranged in the reaction bottles was from 0.6 to 4.6 µg/l. The subsamples were incubated within 3 C of the in situ temperature for eight hours (see Table 1). The reaction was terminated by the addition of 0.2 ml of 5 N H_2SO_4. The reaction vessels and membranes were washed with sea water at 0-3 C.

Assays were run on a Beckman model LS-100 liquid scintillation counter. Radioactivity in both the CO_2 and cell (macromolecular) fractions was monitored. From these measurements were calculated the following parameters: the maximum velocity of metabolism (total Vmax), the maximum velocity of respiration (CO_2 Vmax), the turnover time (T_t), the transport constant plus the natural substrate concentration ($K_t + S_n$) and the percent respiration. In addition, the correlation coefficient was calculated and reported on tables 1 and 2 for the average value of each of four substrate concentrations tested about a straight line.

The total Vmax represents the highest level at which the natural microbial population can incorporate glutamic acid into macromolecules and oxidize glutamic acid to CO_2 under in situ conditions. It was once thought that even though the cells were acid fixed, as they were in this study, the amount of activity associated with the cell fraction represented all bound and pooled glutamic acid as well as the glutamic acid incorporated into macromolecules. We now know that only the later material is counted using this procedure (Baross, Hanus, Griffiths and Morita 1975). The CO_2 Vmax is the maximum velocity of respiration for glutamic acid under in situ conditions. The turnover time is the time required by the natural microbial population, under in situ conditions, to respire and incorporate the naturally occurring glutamic acid into macromolecules. The percent respiration is the amount of glutamic acid oxidized relative to the total amount oxidized and incorporated into macromolecules.

The sediment samples were prepared somewhat differently than the water samples. These samples contained from 30-50% sediment with the balance made up of interstitial water. Just prior to use, they were shaken by hand until all of the material was in suspension. One ml subsamples were taken for dry weight determinations and another one ml subsample was diluted 1000 times with a 32 o/oo (w/v) solution of sterile artifical sea water which was cooled to the in situ temperature. This sediment dilution was then handled essentially the same as a water sample. The substrate used in these experiments was [U-^{14}C] L-glutamic acid with a specific activity of 10 mCi/mmole (Amersham/Searle). The concentration range used was higher than that used in the water samples; 10.5-84.0 μg/l. Duplicate one ml subsamples of the sediment slurry were dried at 100 C for 24 hours and then weighed to determine the dry weights. These dry weights were then used to calculate the Vmax values in terms of grams dry weight of sediment.

An experiment was conducted to determine the experimental error in this technique. We found that at the 95% confidence level, the error was approximately ± 15%. This is close to that observed by us in the past.

3. Temperature studies

Water samples were taken at stations 5a and 5b which gave representative samples of both Elson Lagoon water and ocean beach water. Duplicate subsamples were prepared as described above and incubated at each of the temperatures indicated in Figures 1 and 2. In cases where there were fluctuations in the incubation temperature, the temperature reported is the mean temperature (in most cases, the fluctuation observed was less than one degree C). In order to reduce the chance of significantly altering the substrate concentrations during the course of the experiment, the incubation time for samples incubated at high temperatures was reduced. Samples incubated at the following temperatures were incubated for the following periods: 20.5 C and 14.5 C, 4 hours; 10.0 C, 6 hours; 4 and 1.5 C, 8 hours; -2.0 C, 10 hours.

4. Studies on the acute effects of crude oil extract on the observed heterotrophic potential

Five mls of crude oil taken from Prudhoe Bay was added to 45 mls of sterilized sea water in a 150 ml separatory funnel. The mixture was shaken and then allowed to separate for three hours at 5 C. The aqueous phase was removed into another separatory funnel and allowed to set for an additional ½ hour before dispensing one ml subsamples of the aqueous phase into the reaction mixtures. At the start of the incubation period, each reaction vessel contained 9 mls of the sea water sample to be tested and one ml of the crude oil extract. In the controls, the one ml of crude oil extract was replaced by one ml of sterile sea water.

5. Studies on microbial activity changes with time in oil enrichment cultures

Water samples were taken two meters off the beach at NARL and placed into sterile gallon jugs fitted with rubber stoppers and glass siphoning tubes. Two and one half liters of water were added to each of two jugs. In the first experiment (Figures 3 and 4), 2 mg of yeast extract was added to the control and 5 ml of Prudhoe crude oil was added to the oil enrichment culture. In the second experiment (Figures 5 and 6), nothing was added to the control and 1.0 ml of Prudhoe crude oil was added to the oil enrichment culture. The cultures were incubated at 5 C. At various times, subsamples were siphoned off and used in the heterotrophic potential determinations and plate counts. The heterotrophic potential studies were conducted at 1.5 C. The incubation times for these studies ranged from 8 hours to 4 hours when glutamic acid was used and from 8 hours to 1.5 hours when acetate was used. [U-^{14}C] Acetic acid, sodium salt, with a specific activity of 59 mCi/mmole (Amersham/Searle) was used in a concentration range of 6.5 to 42 μg/l.

6. Isolation of sulfate reducing bacteria

One or two ml of sediment were added to sterile test tubes filled with a modified M10E medium (a differential medium for sulfate reducing bacteria). The M10E medium was similar to that described by Morita and Zobell (1955) except the sodium sulfite and the ascorbic acid was deleted and a 0.1% (w/v) concentration of sodium formaldehydesulfoxylate was added. The capped enrichment tubes were incubated at 4 C for several weeks. Evidence of the presence of sulfate-reducing bacteria was noted by the formation of black ferrous sulfide. Sediments with the following sample numbers were tested: 3, 5, 8, 10, 16, 18, 20, 22, 25, 27, 33, 38, 41, 44, 46, 50 and 52.

7. References

a. Baross, J. A., F. J. Hanus, R. P. Griffiths, and R. Y. Morita. 1975. Nature of incorporated ^{14}C-labeled material retained by sulfuric acid fixed bacteria in pure cultures and in natural aquatic populations. J. Fish Res. Board Can. 32:1876-1879.

b. Griffiths, R. P., F. J. Hanus, and R. Y. Morita. 1974. The effects of various water-sample treatments on the apparent uptake of glutamic acid by natural marine microbial populations. Can. J. Microbiol. 20:1261-1266.

c. Hobbie, J. E., and C. C. Crawford. 1969. Respiration corrections for bacterial uptake of dissolved organic compounds in natural waters. Limnol. Oceanogr. 14:528-532.

d. Morita, R. Y. and C. E. Zobell. 1955. Occurence of bacteria in pelagic sediments collected during the Mid-Pacific Expedition. Deep-Sea Res. 3:66-73.

e. Wright, R. T. and J. E. Hobbie. 1966. Use of glucose and acetate by bacterial and algae in aquatic ecosystems. Ecology 47:447-464.

D. Sample localities

The following list gives the approximate locations of the stations sampled during this report period. In our final report, we will include both an analysis of the data as it relates to geographical location and figures which show the geographical location of each of these stations.

Station numbers	Description
1,2,3,4,5a,11,12	Elson Lagoon, Barrow, Alaska
5b,6,7,10	Ocean side of beach, Barrow, Alaska
30	Landward side of Pingok Island, Oliktok DEW line station
40	Landward side of Egg Island near Prudhoe Bay
50 to 57 70 to 73	Prudhoe Bay

E. Data collected or analyzed

1. Period from June 15 to August 10, 1975.

During this time, a number of pilot experiments were conducted in preparation for the field study period at Barrow. In addition, plans were made for logistical support and the experimental design to be followed.

2. Period from August 12 to September 31, 1975.

a. Ninety five water and sediment samples were taken from shallow waters in the vacinity of Barrow and Prudhoe Bay. Measurements of salinity, temperature, pH, and the kinetics of microbial metabolism were made on most of these samples. Of these, 50 water and 26 sediment samples were analyzed for heterotrophic potential using UL-^{14}C- glutamic acid (Tables 1 and 2 respectively).

The severe icing conditions that were encountered during this field period prevented us from following the sampling grid that we had agreed to cover. The additional restrictions imposed on us by the lack of a suitable sampling platform dictated the range of sample sites available to us. Out of necessity, we spent most of our sampling efforts in the sheltered waters of Elson Lagoon and Prudhoe Bay.

b. The heterotrophic potential of melted ice was measured in 7 ice samples. The effects of mixing this low salinity water with natural seawater on heterotrophic potential was measured in two experiments (Table 4).

c. In 5 experiments, the effects of an aqueous crude oil extract on heterotrophic potential was measured using glutamic acid (Table 5).

d. Two crude oil enrichment experiments were conducted in which the heterotrophic potential of natural microbial populations was measured using both labeled acetate and glutamic acid. These studies were designed to follow functional changes in a natural microbial population with exposure to crude oil over an extended period of time (Figs. 3-6).

e. Two experiments were conducted on 4 water samples to determine the effects of incubation temperature on heterotrophic potential measurements made on the same water sample (Figures 1 and 2).

f. Enrichment cultures of oil and water samples with sediment or fish gut were made so that obligate psychrophilic marine bacteria might be isolated. Samples of these enrichments were plated onto crude oil agar plates for selection of crude oil degrading bacteria. These plates and samples of the original enrichments were shipped to our laboratory at Oregon State University for further analysis.

g. Water samples were frozen and shipped to Dr. Alexander for inorganic nutrient analysis. Subsamples were also pickled with formaldehyde and shipped to Oregon State University for total bacterial count determinations using epifluorescent microscopy.

h. Experiments were also conducted to determine the relative heterotrophic potential using n-acetylglucosamine, hexane, and acetate.

i. Chitinase activity in fish gut and sediment samples was determined as was the magnitude of experimental error in the measurement of the heterotrophic potential in Arctic waters.

j. Sulfate reducing bacteria were isolated from 18 marine sediment samples. Isolates from these cultures are currently being analyzed in our laboratory at Oregon State University. These organisms may play an important role in the ecology of drilling muds in the Arctic.

3. Anticipated data collection between the present and the end of FY 1976.

   a. We plant to continue the determination of direct counts of natural microbial populations in water samples using epifluorescent microscopy.

b. We also plan to establish a series of oil enrichment studies in which water samples are exposed to Prudhoe Bay crude oil. Heterotrophic potential will be followed using glutamic acid and acetate. Direct microscopic counts as well as plate counts using crude oil agar plates will be made to determine population densities.

c. The crude oil plates and samples of oil enrichment cultures will be used to isolate hydrocarbon degrading bacteria. Once isolated, physiological and taxonomical studies will be initiated which will define the potential role such organisms might play in the breakdown of crude oil under in situ conditions.

d. To date, most of our efforts have been directed toward collecting, processing and recording the data collected during the last field study period. During the balance of this fiscal year, we will be analyzing this data and correlating it with the data reported by Drs. Altas and Alexander. In addition, the data that we will be accumulating from the above mentioned studies will be analyzed in light of these findings.

III. Results

A. Tables

1. Summary of physical and heterotrophic potential data for all water samples studied.

2. Summary of physical and heterotrophic potential data for all sediment samples studied.

3. Summary of date-time-location data for all samples.

4. Comparative heterotrophic potential measurements of ice melt, associated sea water and a mixture of the two.

5. Acute effects of aqueous crude oil extract on heterotrophic potential in natural microbial populations.

6. Occurrance of sulfate reducing bacteria in sediments.

B. Figures

1. A comparison of the effects of incubation temperature on the maximum velocity of metabolism in two water samples.

2. Same as Figure 1 but with two different samples.

3. Changes in the maximum velocity of metabolism with time in a crude oil enrichment culture using glutamic acid.

4. Same as in Figure 3 except acetate was used instead of glutamic acid.

5. Another experiment measuring the same parameters as those illustrated in Figure 3 except there was no yeast extract in the control.

6. The same experiment as illustrated in Figure 5 except acetate was used in the measurement of heterotrophic potential.

IV. Discussion of the results

A. It should be noted that the conclusions stated below should be considered as being tentative and might well be altered as we continue to collect related data. It should also be kept in mind that we have not had sufficient time to analyze in depth the data that we have accumulated to date thus the discussion of these results should not be disseminated outside the Project Office.

The same sample numbering system has been used by both our group and Dr. Atlas's so that any data corresponding to a given sample number refers to the same sample.

B. Routine heterotrophic potential studies in sea water and sediment samples (Table 1 and 2).

1. These studies are designed to show the relative metabolic activity of natural microbial populations. Both the results of our studies on sea water and sediments show maximum velocities (Vmax) which are on a level normally found in relatively productive waters.

2. The percent respiration was significantly lower in the sediment samples than in the water samples. This probably reflects the fact that the bacterial cells in the sediment are in a more balanced growth situation than those in the water column. A lowering of this parameter suggests that more of the nutrients that are taken up by the cells are incorporated into cellular material. Further studies should be conducted to determine the significance of this phenomenon since this could have a bearing on the degradation dynamics of crude oil in both water and sediments.

3. On a volume to volume basis, the sediments show microbial activity which is at least 1000 times that of found in the water column.

C. Effects of incubation temperature on the observed heterotrophic potential (Figures 1 and 2).

1. The effects of incubation temperature on the maximum velocity of metabolism was measured in two ocean and two lagoon water samples. It is well established that temperature is one of the most important parameters in the degradation of crude oil by microorganisms. For this and other reasons, we felt it important to study the effects of this parameter on microbial activity.

2. All samples showed a marked increase in microbial activity with increasing temperature.

3. In both experiments, where ocean and lagoon waters were compared, there was a difference in the relative increase in activity with increased temperature even though they showed approximately the same level of activity at the in situ temperature. This may indicate that we may be dealing with two different types of populations in these two waters.

D. Microbial activity in ice melt (Table 4).

1. One component of the marine ecosystem that will play a significant role in the degradation or retention of crude oil in the Arctic marine environment is ice. For this reason we studied the level of microbial activity in ice melt samples and the effects of the addition of this water to sea water on microbial activity.

2. In both experiments, the microbial activity was as high or higher in the ice melt - sea water mixture than would be predicted from the levels of activity observed in both samples.

3. The ice water melt samples had activities in approximately the same range as that measured in the surrounding sea water.

E. The acute effects of crude oil extract on microbial activity (Table 5).

1. In order to obtain a first approximation on the effects of crude oil on microbial metabolism, an aqueous extract of crude oil was added to the reaction vessels used in the determination of heterotrophic potential. This experimental approach only measures a limited number of functions using one substrate under highly artificial conditions.

2. In the five experiments in which this was measured, there did not appear to be any consistant alteration in activity as the result of adding the crude oil extract.

F. Changes in microbial activity in crude oil enrichment cultures as measured with glutamic acid and acetate (Figures 3-6).

All that can be said about the results of these experiments at this time is that there was a difference in microbial activity with time when the oil enrichment culture was compared with the control. Also, there was a significant difference between the activity when it was measured using glutamic acid than when it was measured using acetate. These observations suggest that the presence of crude oil affects both a qualitative and a quantitative alteration in the natural microbial population with time.

G. Isolation of sulfate reducing bacteria from Arctic marine sediments.

A total of 18 sediment samples were tested for the presence of sulfate reducing forms. In all cases, sulfate reducing bacteria were found to be present. In all but one sample (number 52) it took from 2 to 3 weeks for a visable indication of sulfate reduction to occur at 4 C. Visable sulfate reduction was found in sample 52 within 10 days. Sulfate reducing bacteria appear to be very common in Arctic marine inshore sediments.

IV. Recommendations.

A. Logistics

1. The Beaver was an unsatisfactory platform from which to conduct oceanographical studies. The weather conditions had to be just right in order to fly and land on the water (a set of conditions that rarely occurred). Usually it was too foggy to fly or too windy to land. A more serious difficulty, was that the engine had to be going all the time we were on station. In order to maintain a satisfactory rpm to keep the oil pressure up, the engine had to run at a level that propelled the aircraft through the water at approximately five knots. At that speed, it was almost impossible to keep a water sampler in the water much less obtain a sample.

2. Almost all of the samples that we were able to obtain came from the beach or from trips in a 16 ft. open Boston whale boat. Of course this boat was good only for relatively short sampling trips in sheltered waters. When the temperature dipped below freezing, it was very difficult to work for any length of time.

3. If any meaningful off-shore data is to be collected, we will need a suitable vessel for the job. Hopefully, the warping tug, which is scheduled for deployment in the Beaufort Sea next summer, will have the facilities that we will need to carry out our work. Our requirements include the following if sampling trips of more than a few hours are to be attempted.

a. An incubator with roughly a 20 cubic foot capacity and a 0-5°C ± 0.5° range.

b. Eight feet of bench space with under-bench storage.

c. Living quarters and mess facilities for 2-3 persons.

The following are our requirements regardless of the length of the sampling trip.

a. A powered wench with 2000 meters of ¼' or smaller diameter steel (hydrographic) wire.

b. Line current of 110 volts A.C.

It must be kept in mind, that if we are to coordinate our observations with those of Dr. Atlas, his requirements must be included with ours.

B. Coordinating research with other groups

1. We strongly recommend continuing the coordinated microbial studies with Dr. Atlas and his associates. This still appears to be the best approach for realizing the most gain for our research efforts. Likewise we recommend continuing the arrangement we have with Dr. Alexander's group for the determination of inorganic nutrients in our water samples.

2. We will continue to collaborate with Dr. English's group in the field. We found it quite profitable to coordinate our sample with his group. As a result, we will have some primary productivity data which can be correlated with our results (mostly from Prudhoe Bay).

3. Our preliminary sediment data suggest a major role of sediments in carbon recycling. Hopefully we will be able to coordinate some of our efforts with those of Dr. Carey's group to our mutual benefit.

C. Recommended future research on microbial processes

1. The temperature studies that were initiated during the last field trip should be continued since they show promise as a means of differentiating different populations.

2. It seems obvious that the sediments are very important in the cycles of matter and are thus potentially important in the degradation of crude oil. Even though sediments are notoriously difficult to work with, studies should be continued in the role of microbial populations in sediments. Our efforts at measuring heterotrophic potential in marine sediments were the first application of this technique on a large scale. Judging from the correlation coefficients, this is a feasable approach.

3. During our field studies in the Beaufort Sea, we also looked at chiniase activity in both fish guts and in sediments. Although we could find no activity in the sediments, the fish guts showed very high activities. Since chitin represents a significant fraction of particulate organic carbon in many waters, and since its degradation is primarily (and probably exclusively) a microbial process, the role of fish and their associated chitinoclastic bacteria should be studied. In particular, the effects of crude oil on their metabolism should be studied.

4. The pilot studies on the long term effects of crude oil on microbial metabolism should be continued and expanded to include systems that more closely reflect the conditions found in Nature. By correlating labeled substrate metabolism measurements with direct microscopic and plate counts, a great deal could be learned about the dynamics of crude oil breakdown under natural conditions.

5. In view of the recent discovery that plasmids can carry genetic information for the enzymes responsible for the biodegradation of crude oil, we recommend that similar genetic studies be conducted on whatever psychrophilic or psychrotrophic hydrocarbon utilizing bacteria we might isolate. This type of work could very well lead to the production of a so called "super bug" through genetic engineering. Such a bacterium could be designed to degrade crude oil at very high rates under the conditions found in the Arctic marine environment. Within our department, we have the expertise to conduct these studies.

D. Recommendations for the dissemination of data collected during the OCSEP project.

It might be helpful if, when submitting the final report, everyone included a summary which contains the following information:

1. What implications do the studies have for the exploration, drilling and transportation of crude oil.

2. In general nontechnical terms, why the study was proposed, what was accomplished during the study and what conclusions can be drawn from the data collected. The style should be such that persons without a technical background can easily determine the significance of the study and how that information might be used in other disciplines.

3. These summaries could be bound into one volume and disseminated to any groups that might have use for this information.

VI. Estimate of funds expended (As of September 30, 1975)

Total Contract (FY 75 and 76)	110,600
Indirect costs	-18,898
Contract funds for PI to work with	91,702

Category	Budgeted	Expended	Balance
Personnel (+ fringe benefits 15%)	52,613	12,236	40,377
Equipment	17,518	16,228	1,290
Consumable Supplies + other items	14,971	4,440	10,531
Travel	6,660	1,364	5,236
Total	91,702	34,268	57,434

TOTAL AMOUNT EXPENDED: 34,268

Table 1. Summary of physical and heterotrophic potential data for all water samples studied. All heterotrophic potential data was measured using ^{14}C glutamic acid. The total Vmax is the maximum velocity for both macromolecular synthesis and respiration reported as ($\mu g \times L^{-1} \times hr^{-1})10^{-2}$. The CO_2 Vmax is the maximum velocity of respiration (mineralization). (*) indicates ice melt samples. (NO) indicates no observation made.

Sample number	Station number	Sample temp.	Salinity 0/00	Incubation temp.	Sample pH	Total Vmax	CO_2 Vmax	Tt (hrs. x 10^2)	Kt + Sn ($\mu g \times L^{-1}$)	Percent Respiration	Correlation Coefficient
2	1a	3.0	26.0		NO	NO					
4	1	3.2	26.5		NO	NO					
6	1	3.0	20.1		NO	NO					
7	2	2.5	21.0	0.0	NO	8.3	4.6	0.7	6.1	56	.99
9	3	2.0	20.0	0.0	NO	9.0	5.9	0.6	5.3	67	.99
11	4	3.0	25.0	0.0	NO	9.1	4.9	0.6	5.5	57	.99
11a	7	NO	NO	4.0	NO	10.5	6.5	2.2	23	62	.99
12	7	3.0	31.0		NO	NO					
13	7	2.0	23.0	1.0	NO	2.5	1.7	0.7	1.7	68	.98
13a	*7	NO	0.5	1.0	NO	17.0	7.1	0.7	12	56	.91
14	7	3.0	23.0	1.0	NO	1.0	0.7	1.2	1.2	69	.99
15	10	-0.5	23.8	0.0	NO	1.4	0.9	0.8	1.1	71	.99
17	12	2.0	22.5	2.0	NO	11.6	4.5	0.5	5.4	51	.99
19	5b	2.0	25.0	2.0	NO	11.8	6.4	0.7	7.9	61	.99
19a	*5b	NO	0.0	1.0	NO	0.2	0.1	14.2	3.2	60	.99
21	11	2.0	17.0	2.0	NO	1.4	0.9	2.0	2.8	68	.99
23	12	1.5	21.0	2.0	NO	4.0	2.9	1.0	3.8	72	.99
24	6	2.0	25.5	2.0	NO	0.5	0.3	12.7	6.2	76	.96
24a	7	1.0	25.0	2.0	NO	2.9	1.9	1.6	4.5	67	.99
26	1	0.4	20.0	0.0	NO	5.1	3.9	1.7	8.7	54	.96
28	2	-0.5	20.5	0.0	NO	1.0	0.5	68.0	65.0	61	.99
30	3	-0.2	20.0	0.0	NO	1.5	0.9	3.2	4.8	59	.97
32	4	-0.2	20.5	0.0	NO	0.9	0.6	2.7	2.4	60	.99
34	30	1.9	12.1	4.0	NO	2.6	1.3	0.6	1.6	49	.98
36	40	1.8	18.8	4.0	NO	5.9	3.0	0.6	3.2	53	.93
37	50	1.5	20.0	4.0	NO	3.3	1.7	0.5	1.7	54	.99
38	53	-0.8	11.8	2.0	7.9	7.7	3.4	0.4	2.8	49	.97
40	55	-0.8	11.1	2.0	7.9	11.3	5.2	0.2	1.8	52	.99
42	55	-0.4	19.8	2.0	7.9	6.5	3.3	0.3	1.8	50	.98

Table 1. Continued

Sample number	Station number	Sample temp.	Salinity 0/00	Incubation temp	Sample pH	Total Vmax	CO_2 Vmax	Tt (hrs. x 10^2)	Kt + Sn ($\mu g \times L^{-1}$)	Percent Respiration	Correlation Coefficient
43	51	-0.5	11.4	2.0	7.9	3.8	1.7	0.4	1.6	47	.99
45	54	-0.4	9.0	2.0	7.9	7.8	3.7	0.6	4.5	47	.99
47	4	-0.5	18.8	0.5	7.9	0.9	0.6	4.3	3.9	44	.99
49	3	-0.5	18.5	0.5	8.0	0.4	0.3	8.1	3.6	66	.98
51	2	-0.5	18.2	0.5	8.0	1.3	0.7	1.6	2.1	62	.99
53	1	-0.5	18.3	0.5	8.0	1.8	0.9	3.0	5.5	55	.91
55	53	1.0	14.5	1.0	7.9	6.0	3.0	0.5	3.2	51	.99
57	55	1.5	16.0	1.0	8.0	6.9	3.3	0.7	5.1	52	.97
59	56	1.5	19.5	1.0	8.0	2.8	1.3	1.4	3.8	53	.95
60	70	1.0	20.0	1.0	8.0	1.9	1.0	1.0	2.0	53	.99
62	71	0.5	21.5	1.0	8.0	2.0	1.0	0.8	1.6	52	.97
64	50	2.5	17.8	2.0	7.8	4.8	2.3	0.8	3.7	51	.98
67	52	1.9	18.1	2.0	7.8	3.2	1.5	1.3	4.2	55	.98
69	57	2.2	16.2	1.5	7.9	2.9	1.6	1.3	3.1	55	.99
71	70	1.5	18.5	1.5	8.0	1.2	0.6	1.6	1.9	55	.99
73	71	0.3	20.2	1.5	8.0	0.5	0.3	7.8	4.2	58	.97
75	72	1.9	16.0	1.5	8.0	2.0	1.0	1.1	2.1	52	.99
77	73	2.3	15.8	1.5	8.0	4.0	2.0	0.8	3.0	52	.99
79	7	2.0	25.5	1.5	8.0	2.6	1.6	5.8	15.9	68	.87
80	5b	2.0	25.2	1.5	8.0	1.2	0.8	3.0	3.6	66	.99
81	5b	1.5	25.0	1.5	8.0	2.4	1.5	0.5	1.1	66	.99
82	*5b	NO	1.2	1.5	NO	0.1	Too low	13.0	1.7	86	.99
83	*5b	NO	0.5	1.5	NO	2.2	1.2	1.4	3.0	60	.98
84	*5b	NO	2.0	1.5	NO	0.9	0.8	2.6	2.4	75	.93
85	3	-0.5	22.2	1.0	7.9	1.1	0.6	1.9	2.1	63	.99
87	2	-0.5	22.2	1.0	7.9	1.3	0.8	2.2	2.9	64	.94
89	1	-0.5	22.0	1.0	7.8	4.7	2.4	1.0	4.5	57	.99
91	5a	-1.0	25.0	1.5	7.9	2.8	1.1	1.7	4.8	55	.90
92	5b	-1.0	26.0	1.5	7.9	4.0	2.4	2.3	9.1	55	.98
93	*5b	NO	9.0	1.0	7.7	3.4	2.5	1.8	5.9	67	.99
94	*5b	NO	6.0	1.0	7.6	6.8	4.6	2.2	15.1	64	.95
95	5b	2.0	26.0	1.0	7.9	2.8	1.7	0.7	2.0	62	.99

Table 2. Summary of physical and heterotrophic potential data measured in sediment samples. The "Total Vmax" data represents the maximum velocity for both macromolecular synthesis and respiration in μg glutamate x g dry weight sediment^{-1} x hr^{-1}. The "CO_2 Vmax" represents the maximum velocity of respiration only (mineralization). The temperature and salinity data was collected from the water directly above the sediment. The "Associated Water Sample Number" is the number of the water sample taken on the surface above the sediment analyzed. (S) sediment samples that were too sandy to be accurately measured using this technique. (NO) not observed.

Sample number	Station number	Sample Depth ft.	Associated Water Sample number	Water Temperature	Water Salinity	Sediment pH	Total Vmax x10	CO_2 Vmax x10	Percent Respiration	Correlation Coefficient
16	10	28	15	-0.5	23.8	NO	Too high			
18	12	6	17	1.5	22.8	NO	1.2	0.9	39	.82
20	11	10	21	2.0	17.0	NO	3.8	2.4	65	.99
22	12	10	23	1.5	21.0	NO	5.2	2.6	64	.82
25	1	7	26	0.4	20.0	NO	13.0	5.9	43	.99
27	2	6	28	-0.5	20.5	NO	1.1	0.5	41	.98
29	3	6	30	-0.2	20.0	NO	0.6	0.3	41	.99
31	4	6	32	-0.2	20.5	NO	0.7	0.2	37	.99
33	30	6	34	1.9	12.1	NO	7.8	2.9	39	.99
35	40	6	36	1.8	18.8	NO	S			
39	53	6	38	-0.8	19.2	7.4	11.0	4.2	35	.99
41	55	7	40,42	-0.4	19.8	7.6	6.4	2.9	36	.99
44	51	8	43	-0.2	19.8	7.5	6.5	2.1	32	.99
46	54	5	45	-0.2	17.5	7.5	10.0	3.6	34	.98
48	4	24	47	-0.5	18.8	NO	2.9	1.2	44	.99
50	3	34	49	-0.5	18.5	NO	0.2	0.1	71	.99
52	2	6	51	-0.5	18.2	NO	1.1	0.5	48	.99
54	1	7	53	-0.5	18.3	NO	S			
56	53	8	55	1.0	19.5	7.6	S			
58	55	10	57	1.5	20.0	7.4	S			
61	70	9	60	1.0	21.0	NO	17.0	5.6	32	.99
63	71	23	62	0.0	22.5	NO	2.9	1.0	39	.99
65	50	5	64	2.3	17.5	7.3	4.2	1.5	35	.97
66	51	7		2.2	19.3	7.6	6.7	3.0	32	.99
68	52	8	67	2.2	8.5	7.3	5.1	1.7	34	.99

Table 2. Continued

Sample number	Station number	Sample Depth ft.	Associated Water Sample number	Water Temperature	Water Salinity	Sediment pH	Total Vmax x10	CO_2 Vmax x10	Percent Respiration	Correlation Coefficient
70	57	5	69	1.8	19.2	NO	S			
72	70	20	71	0.3	21.5	NO	S			
74	71	19	73	0.0	21.3	NO	S			
76	72	15	75	0.6	19.2	7.7	3.0	0.9	51	.99
78	73	7	77	1.5	20.2	7.6	3.2	1.0	54	.99
86	3	10	85	-0.5	22.2	7.3	Too low			
88	2	7	87	-0.5	22.2	7.2	6.5	2.2	35	.99
90	1	6	89	-0.5	22.0	7.2	5.2	2.1	40	.99

Table 3. Summary of date-time-location data for all samples. All sampling was accomplished between the hours of 0930 and 2130. (B) samples taken in the Barrow area. (P) samples taken in the Prudhoe Bay area.

Sample #	Date	Time	Location	Sample #	Date	Time	Location
1	8/20	AM	B	41	9/8	PM	P
2	8/20	AM	B	42	9/8	PM	P
3	8/20	AM	B	43	9/8	PM	P
4	8/20	AM	B	44	9/8	PM	P
5	8/21	AM	B	45	9/8	PM	P
6	8/21	AM	B	46	9/8	PM	P
7	8/21	AM	B	47	9/11	PM	B
8	8/21	AM	B	48	9/11	PM	B
9	8/21	AM	B	49	9/11	PM	B
10	8/21	AM	B	50	9/11	PM	B
11	8/21	AM	B	51	9/11	PM	B
11a	8/24	AM	B	52	9/11	PM	B
12	8/26	AM	B	53	9/11	PM	B
13	8/28	PM	B	54	9/11	PM	B
13a	8/27	PM	B	55	9/12	AM	P
14	8/27	PM	B	56	9/12	AM	P
15	8/28	PM	B	57	9/12	AM	P
16	8/28	PM	B	58	9/12	AM	P
17	8/28	PM	B	59	9/12	AM	P
18	8/28	PM	B	60	9/12	AM	P
19	8/30	AM	B	61	9/12	AM	P
19a	8/30	PM	B	62	9/12	AM	P
20	8/30	PM	B	63	9/12	AM	P
21	8/30	PM	B	64	9/13	PM	P
22	8/30	PM	B	65	9/13	PM	P
23	8/30	PM	B	66	9/13	PM	P
24	8/30	PM	B	68	9/13	PM	P
24a	9/2	AM	B	69	9/14	AM	P
26	9/5	AM	B	70	9/14	AM	P
27	9/5	AM	B	71	9/14	AM	P
28	9/5	AM	B	72	9/14	AM	P
29	9/5	AM	B	73	9/14	AM	P
30	9/5	AM	B	74	9/14	AM	P
31	9/5	AM	B	75	9/14	PM	P
32	9/5	AM	B	76	9/14	PM	P
33	9/5	PM	P	77	9/14	PM	P
34	9/5	PM	P	78	9/14	PM	P
35	9/5	PM	P	79	9/16	AM	B
36	9/5	PM	P	80	9/16	PM	B
37	9/5	PM	P	81	9/17	AM	B
38	9/8	AM	P	82	9/16	AM	B
39	9/8	AM	P	83	9/16	AM	B
40	9/8	AM	P	84	9/16	AM	B

Table 3. Continued

Sample #	Date	Time	Location
85	9/17	PM	B
86	9/17	PM	B
87	9/17	PM	B
88	9/17	PM	B
89	9/17	PM	B
90	9/17	PM	B
91	9/20	AM	B
92.	9/20	AM	B
93	9/20	AM	B
94	9/20	AM	B
95	9/21	AM	B

Table 4. Comparative heterotrophic potential measurements in samples of ice melt, associated sea water, and 50/50 percent mixtures of the two. (*) Theoretical result of mixing

Experiment Number	Sample Number	Sample Type	Vmax ($\mu g \times L^{-1} \times hr^{-1}$)$10^{-2}$	Tt (hr. $\times 10^2$)	Kt + Sn_1 ($\mu g \times L^{-1}$)	Percent Respiration
25	82	ice	0.1	13.3	1.7	86
	83	ice	2.2	1.4	3.0	60
	84	ice	0.9	2.6	2.4	75
	81	seawater	2.4	0.5	1.1	66
	84 + 81	mixture	2.2	2.0	4.4	65
	*		1.6	---	---	70
29	93	ice	3.4	1.8	5.9	67
	94	ice	6.8	2.2	15.1	64
	95	seawater	2.8	0.7	20.0	62
	93 + 95	mixture	5.7	2.0	11.5	65
	*		3.1	---	---	65

Table 5. Acute effects of aqueous crude oil extract on heterotrophic potential in natural microbial populations using ^{14}C labeled glutamic acid. "Exposure Time" is the time between the addition of the extract and the addition of the labeled substrate.

Sample Number	Exposure Time (hr)	Extract added	Vmax ($\mu g \times L^{-1} \times hr^{-1}$)$10^{-2}$	Tt (hr. x 10^2)	Kt + Sn ($\mu g \times L^{-1}$)	Percent Respiration
14	0	no	1.0	1.2	1.3	69
		yes	0.7	1.8	1.3	75
24a	0	no	2.9	1.6	4.5	67
		yes	3.0	2.0	5.9	65
25a	2	no	2.6	1.9	5.0	65
		yes	3.6	2.6	9.3	66
79	0	no	2.6	5.8	14.9	68
		yes	1.9	7.9	14.4	71
98	0	no	0.7	11.2	8.1	70
		yes	0.6	11.7	6.7	70

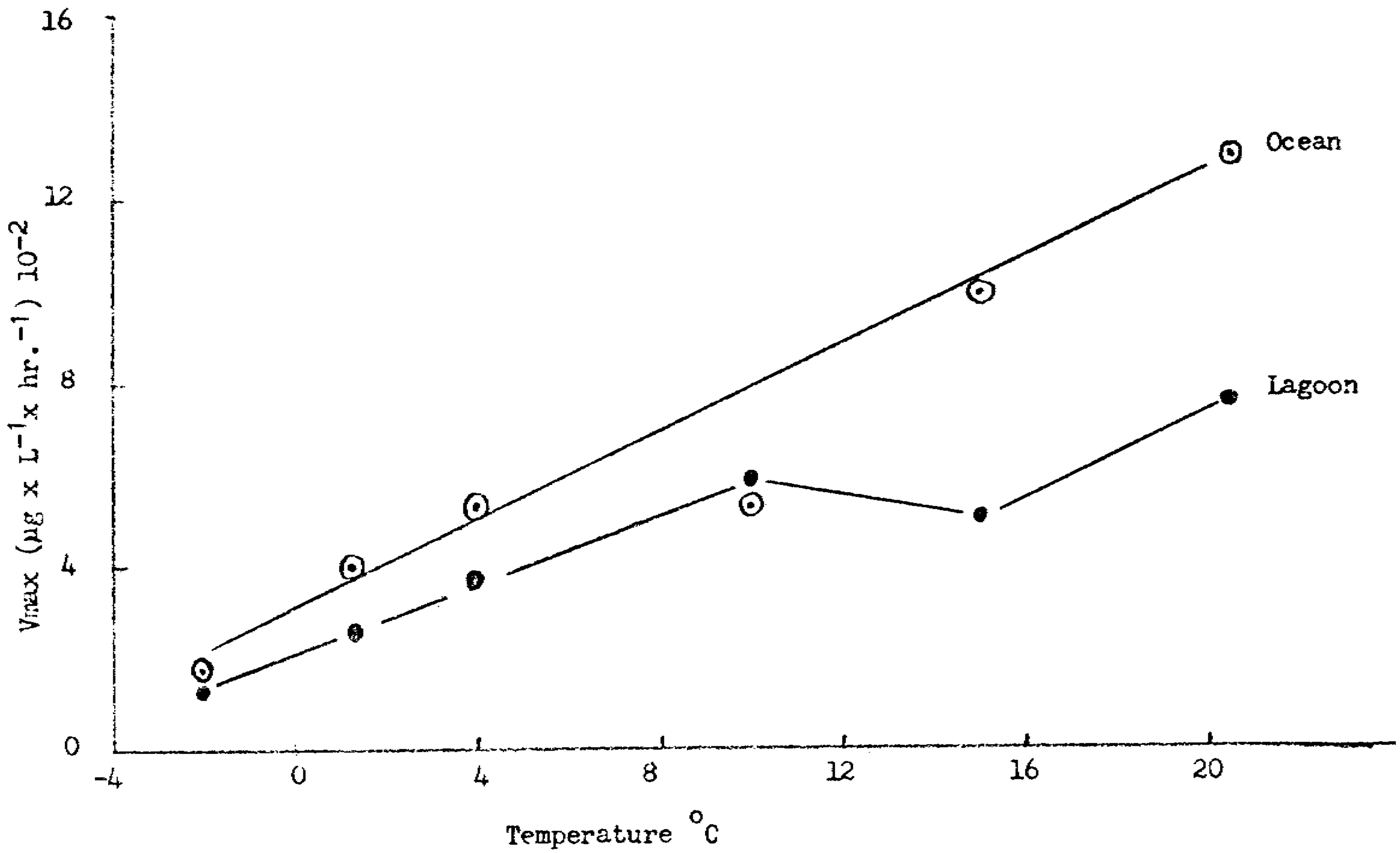


Figure 1. A comparison of the effects of incubation temperature on the maximum velocity of metabolism (Vmax) in the natural microbial populations found in an ocean (⊙) and a lagoon (●) water sample.

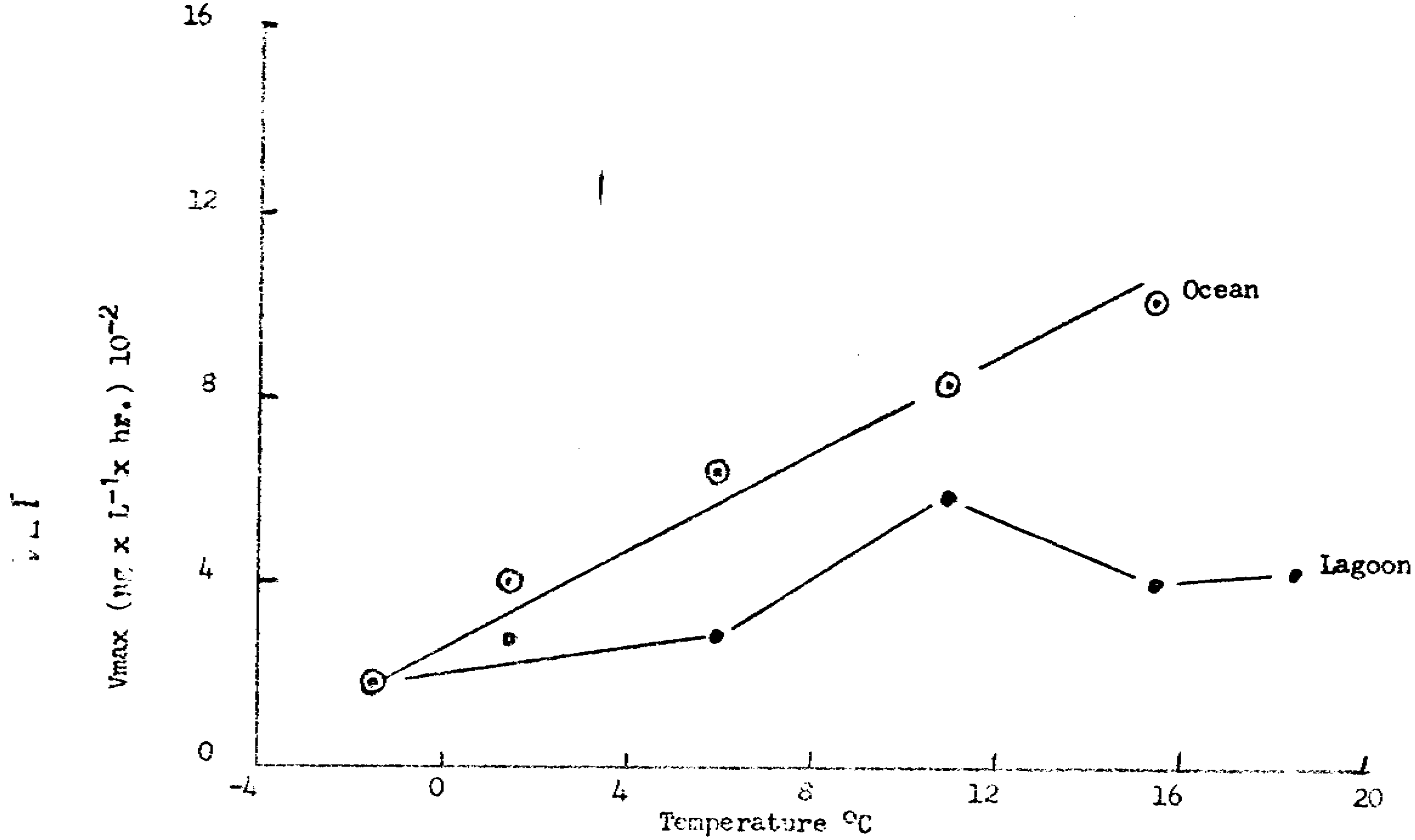


Figure 2. Another experiment using the same parameters described in Figure 1.

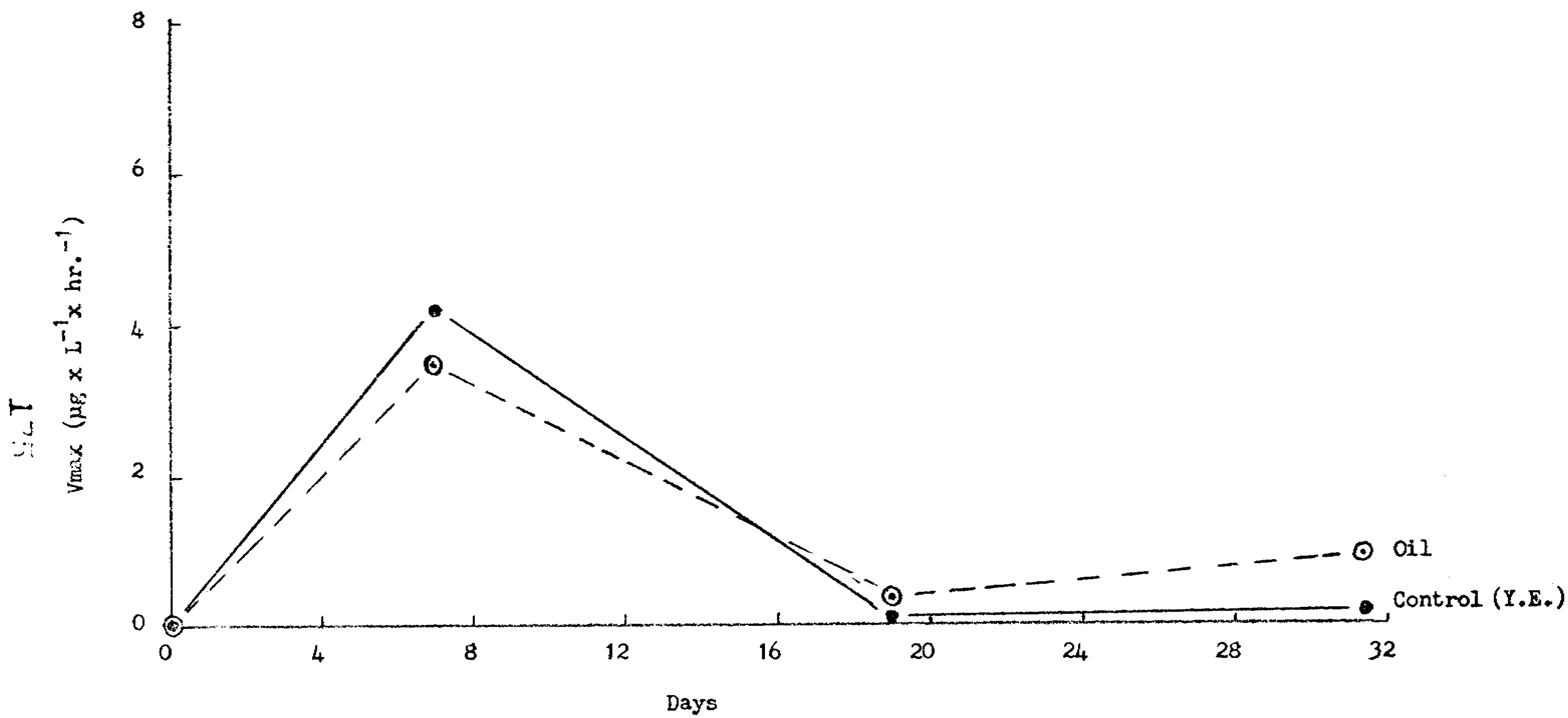


Figure 3. Changes in the maximum velocity of metabolism (Vmax) with time in a crude oil enrichment culture (⊙) and control (●) using ^{14}C glutamic acid as the assay substrate.

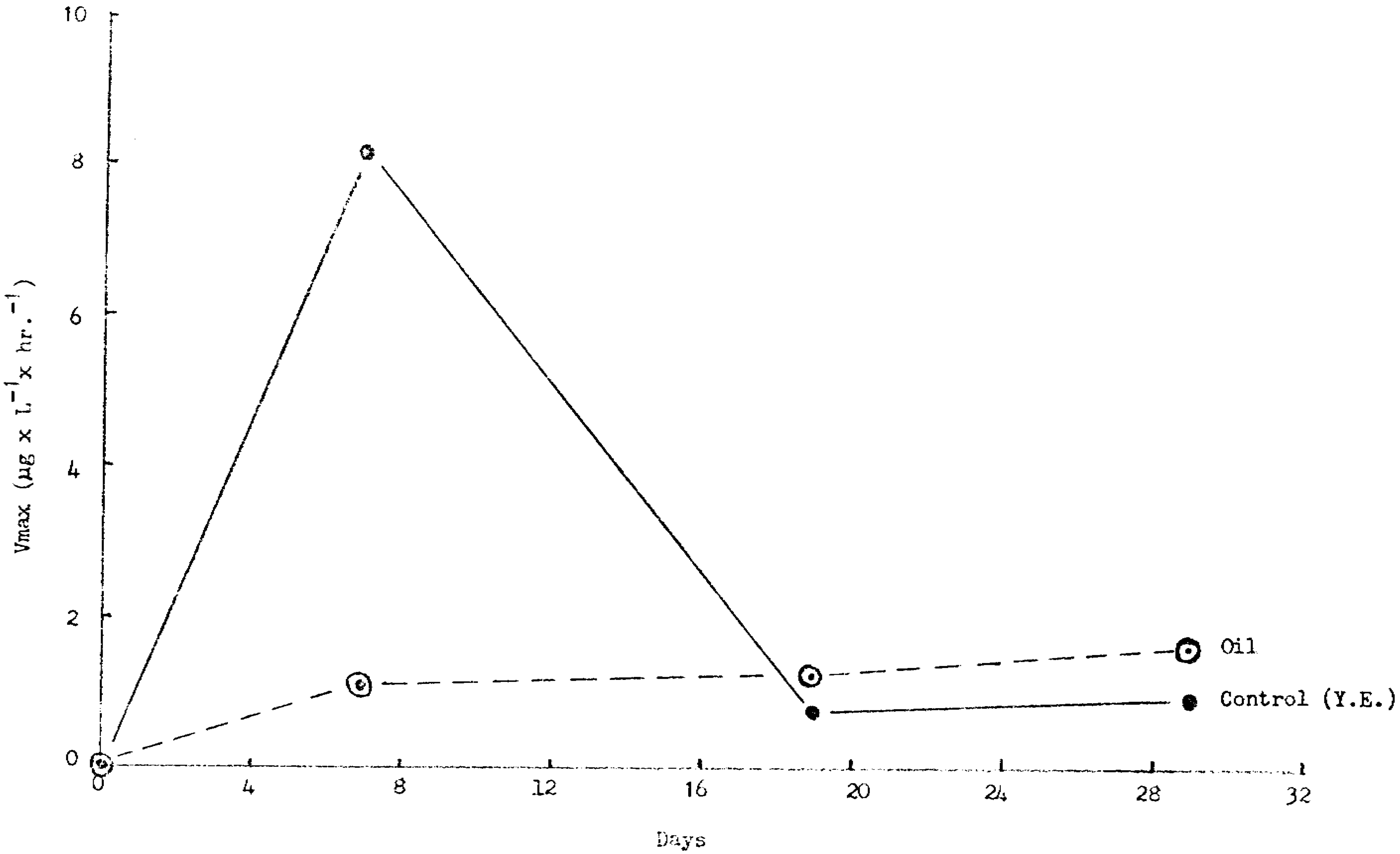


Figure 4. Same as in Figure 3. except acetate was used as the assay substrate.

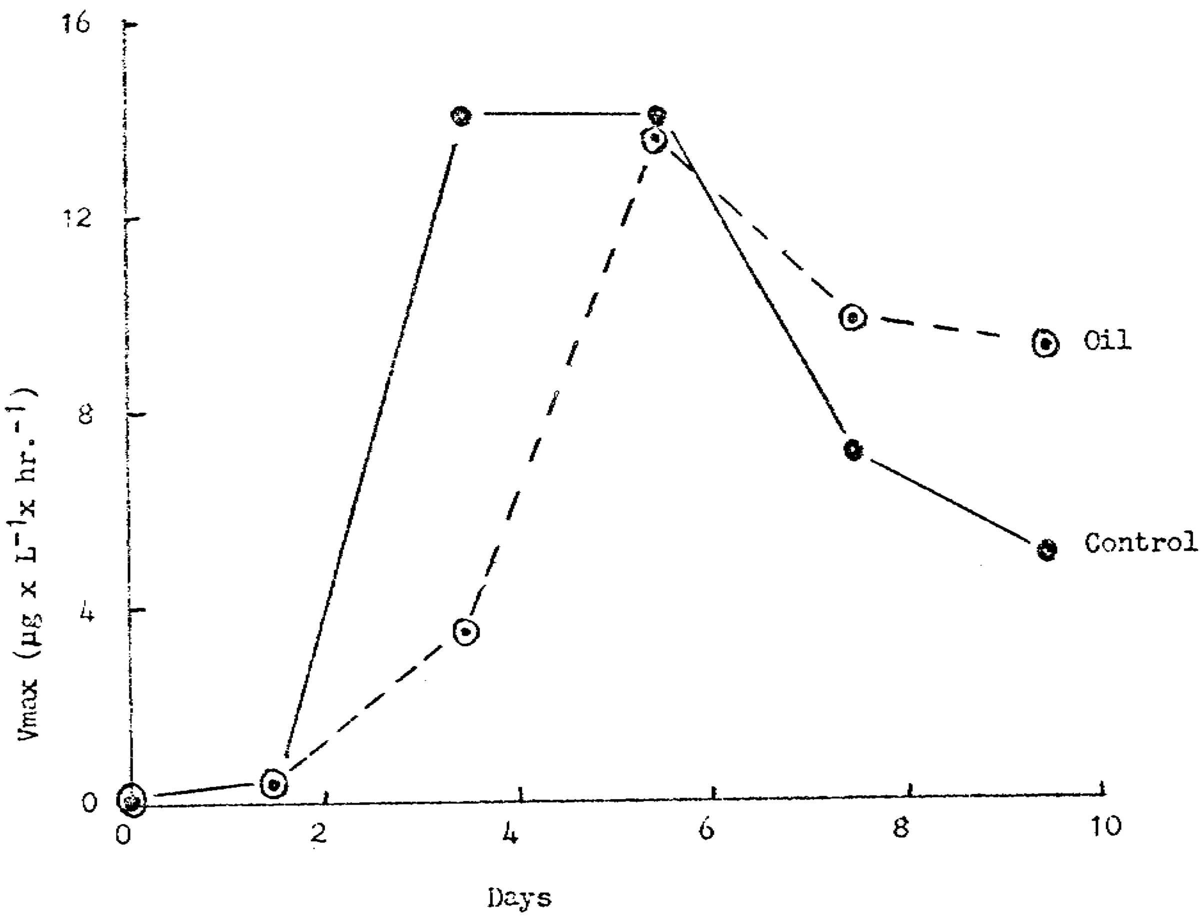


Figure 5. The same parameters as those descibed in Figure 3 except the control did not contain 0.8 mg yeast extract per liter as was the case in the previous experiment.

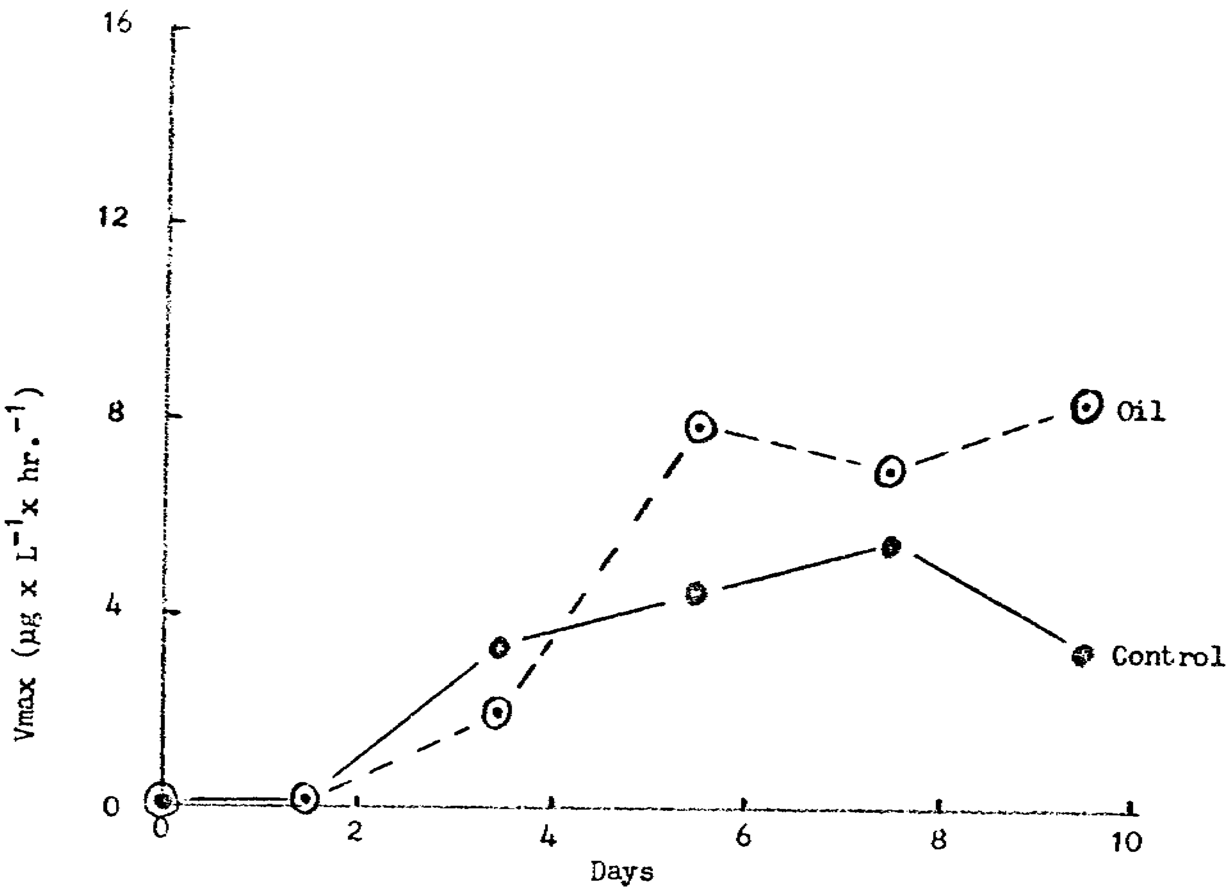


Figure 6. The same parameters as those described in Figure 4. except the control did not contained 0.8 mg yeast extract per liter as was the case in the previous experiment.

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Hydrocarbons: Natural Distribution and Dynamics on the Alaskan Outer Continental Shelf

Contract Number: 03-5-022-56

Task Order Number: 5 RU 275/276/294

Principal Investigator: Dr. David G. Shaw
Assistant Professor of Marine Science
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

The primary objective of this program is to produce data on the kinds and amounts of hydrocarbons in waters and sediments of the Gulf of Alaska and the Bering Sea OCS areas.

II. Field and Laboratory Activities

A. Field

1. Biological samples (28) were obtained during the cruise of the "North Pacific" by H. M. Feder in the Gulf of Alaska.

2. Surface water (24) and floating tar (11) samples were collected during the cruise of the "Silas Bent" in the Gulf of Alaska.

3. At the end of this report period collections of benthic biota by the "Miller Freeman" and of benthic sediment and floating tar by the "Discoverer" were in progress.

B. Laboratory

1. A Hewlett Packard model 5930/5933 GC/MS data system has been ordered for use in this project.

2. Continued experimentation with the "Tenax" system for extraction of hydrocarbons from water (see also first annual report) has led to the conclusion that this method is not satisfactory for use with packed column gas chromatography. The carbon-tetrachloride extraction is now being used for water analysis.

3. Methods are being checked for the analysis of hydrocarbons in biota. The methods being used are similar to those agreed upon at the BLM/Aerospace Hydrocarbon Seminar.

III. Results

No results have yet been obtained.

IV. Problems Encountered

A. No intertidal biota have yet been obtained due to lack of response by the concerned biologist.

B. No field work has been accomplished in the Beaufort Sea because the required logistic support has not been available.

C. The intercalibration program has not become operational.

V. Subcontractor Activities

A quarterly report describing I. R. Kaplan's progress in sediment collection and analysis will be forwarded in approximately two weeks.

VI. Estimate of Funds Expended

	Total Budget	6 mos Expended*	Remaining
Salaries & wages	105,577.00	8,322.18	97,254.82
Staff Benefits	17,948.00	1,414,77	16,533.23
Equipment	135,300.00	117,150.00	18,150.00
Travel	6,004.00	664.98	5,339.02
Other	106,100.00	91,135.59	14,964.41
Total Direct	370,929.00	218,687.52	152,241.48
Indirect	60,391.00	4,760.29	55,630.71
Total Cost	431,320.00	223,447.81*	207,872.19

* Preliminary data, not yet fully processed.

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R.U. #278

UNIVERSITY OF ALASKA
FAIRBANKS, ALASKA 99701

October 22, 1975

Dr. John Robinson
NOAA, U.S. Department of Commerce
Environmental Research Laboratories
Boulder, Colorado 80302

Re: Contract Number: 03-5-022-56, Task Order #7
Quarterly Report

Dear John:

Enclosed is Dr. Barsdate's quarterly report for quarter ending September 30, 1975.

Sincerely yours,

Donald H. Rosenberg
OCS Coordination Office

/brm

Enc.

cc: Dr. G. Weller
Dr. H. Bruce

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Microbial Release of Soluble Trace Metals from Oil-Impacted Sediments

Contract Number: 03-5-022-56

Task Order Number: 7

Principal Investigator: Robert J. Barsdate
Professor,
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

The principal goals for this quarter have been to acquire the specialized supplies and equipment necessary for the experimental work and to acquire the necessary samples.

II. Field and Laboratory Activities

Several cores of Bering Sea/Bristol Bay sediments were acquired for this project during the June 1975 Discoverer cruise by Dr. David Burrell. Additional samples of sediments and eelgrass (Zostra marina L.) detritus from Izembek Lagoon near Cold Bay also are available from other projects. At this time it appears unlikely that any field activities within this project will be necessary.

III. Results

There is very little to report as sample processing has not yet begun. The specialized glassware has arrived, however, and the experimental work can start as soon as the equipment now on order arrives.

IV. Problems Encountered

No problems have been experienced as yet, but it is anticipated that some will arise with the change of laboratory location of this project. The move (early in the spring of 1976) will result in the loss of the cold room space now being used as a refrigerated shaker facility. Freezer space also may be a problem.

V. Estimated Funds Expended:

*Preliminary cost data, not fully processe

	Total Budget	6 mos Expended*	Remaining
Salaries & wages	8,233.00	0	8,233.00
Staff benefits	1,383.00	0	1,383.00
Equipment	2,500.00	0	2,500.00
Travel	1,300.00	0	1,300.00
Other	3,300.00	254.52	3,045.48
Total Direct	16,716.00	254.52	16,461.48
Indirect	4,709.00	0	4,709.00
Total Cost	21,425.00	254.52*	16,461.48

OUTER CONTINENTAL SHELF ENERGY PROGRAM
JUNEAU PROJECT OFFICE
P. O. BOX 1808
JUNEAU, ALASKA 99802

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RU #332. DETERMINE THE INCIDENCE AND PATHOLOGY OF MARINE FISH DISEASES IN THE GULF OF ASLASKA, BERING SEA, AND BEAUFORT SEA

I. Task Objectives - A-28

The objective of our investigation is to obtain baseline data on the incidence and pathology of disease of demersal fishes in the Gulf of Alaska, Bering Sea, and Beaufort Sea.

II. Field Activities

A. Ship schedule

1. R.V. Miller Freeman, Second Leg

Dates: September 8 to September 29, 1975

Vessel: R.V. Miller Freeman

Scientific Party: Dr. S.R. Wellings, M.D., PhD, Chairman
Department of Pathology
School of Medicine
University of California
Davis, California 95616
(Abbreviated Med-Path, Davis)
(Co-Principal Investigator and leader of scientific party)

Mark Myers
Staff Research Assistant I
Med-Path, Davis
(Responsible for microbiology and gross pathology)

Charles Alpers
Visiting Fellow
Med-Path, Davis
(Aided Dr. Wellings in pathology procedures)

2. R.V. Miller Freeman, Third Leg

Date: October 2 to October 24, 1975

Vessel: R.V. Miller Freeman

Scientific Party: Mark Myers (see above)

B. Vessels supplying samples

1. Vessel: R.V. Oregon

   Date Received: September 16, 1975

   Supplier: Karl Niggol
   NMFS, Northwest Fisheries Center
   Seattle, Washington 98112
   (With OSCEP Research Unit #175)

C. Methods

1. R.V. Miller Freeman

Demersal fishes captured by otter trawl were distributed according to species into baskets. The fish in these baskets were then examined by our party for the presence of externally visible pathological abnormalities. In addition, subsamples of fish were routinely autopsied for internal pathology. Diseased fish were speciated, measured, weighed, sexed, photographed, autopsied, aged by examination of otoliths, and the symptoms recorded. Pertinent catch data were also noted; including haul number, location, and bottom type. For each haul, the incidence of each type of disease was recorded.

Autopsy procedures included the taking of specimens for histopathological, bacteriological, virological, and hematological examinations. Tissues to be subjected to histological procedures were preserved in 10% buffered formalin and/or 2% glutaraldehyde for light and electron microscopy, respectively. Bacteria were isolated by inoculating Petri dishes, containing either trypticase soy agar (TSA) or Ordal's seawater cytophaga agar be obtained when the vessel returns to Seattle in November 1975. The hauls from which the two existing samples were taken were made at stations in the general area of 55°N, 163°W to 56°N, 161°W.

E. Data collected

1. R.V. Miller Freeman

During the Second Leg, 67 trawls were examined for diseased fish. Of fish species which had a significant number of fish with diseases, about 15,000 were examined and approximately 180 diseased fish were found and processed. Roughly 20,000 other fish were examined without detecting pathological abnormalities.

2. R.V. Oregon

Twenty-three tumor-bearing rock sole were delivered to our laboratory. An equal or greater number are expected in November 1975.

III. Laboratory Activities

A. Personnel

Dr. Bruce B. McCain, PhD
Med-Path, Davis and
NWFC, Seattle, WA, 98112
(Principal Investigator, coordinator of field activities; and responsible for microbiology, and examination of diseased fish from cooperating research vessels)

B. Methods

Persons in other OCSEP research units responsible for obtaining samples of demersal fishes have been asked to preserve any fish with disease symptoms and to send them to our laboratory.

Diseased fish sent to our laboratory from the R.V. Oregon were processed in much the same manner as described for the R.V. Miller Freeman, except these fish were frozen and thus unfit for histopathological and hematological examination. The fish were photographed, measured, autopsied, and aged.

IV. Results

A. Field Results

1. R.V. Miller Freeman

The three most commonly observed diseases of demersal fishes during the Second Leg were (1) adenomas of the pseudobranch of Pacific cod, *Gadus macrocephalus*, (2) epidermal papillomas of rock sole, *Lepidopsetta bilineata*, and (3) lymphocystis of yellowfin sole, *Limanda aspera*. The incidence of these diseases are described in Table I.

The cod adenomas were always bilateral, and remnants of normal-appearing, dark-red pseudobranch were usually found on the surface of the tumor or deep inside the tumor. The smallest tumors measured about 1.5 x 1.0 x 0.8 cm and the largest about 4.5 x 3.5 x 2.0 cm. External surfaces were lobulated, smooth, and pale yellow or yellow-pink (see Fig. 2). Portions were necrotic and liquified. Some of the liquid was purulent, but relatively odorless. Samples taken for histological, hematological, and microbiological procedures are either being examined now in the laboratory or are presently on board the R.V. Miller Freeman.

Epidermal papillomas on rock sole resembled those found on several species of flounder in Puget Sound, Washington. The tumors occurred on both the "eyed" side and "blind" side. Only one tumor was observed per fish specimen. The tumors varied in size from 2.5 x 3.1 x 0.8 cm to 9.1 x 6.0 x 1.0 cm. All tumors were pigmented and had cauliflower-like surface configurations (see Fig. 3). Tumor-bearing fish ranged in length from 180 to 320 mm. Ages have not yet been determined. Tissue specimens were collected and processed as described for adenomas.

Lymphocystis disease is a disease of marine and fresh-water fish characterized by the presence of wart-like growths on the fins and skin surfaces (Templeman, 1965). The disease is caused by a virus (Weissenberg, 1965).

This disease was only detected by us on the yellowfin sole. The largest warts were found on the pectoral fin on the blind side (Fig. 4). Most warts were on fins. The warts were pink to red in color, ovoid, and varied from 1 mm to

25 mm in greatest dimension (Fig. 5). The pathognomonic lymphocystis cells were usually observed as 1 to 3 mm spheres in fresh tumors. Tissue specimens were processed as described above.

Other diseases which were observed to occur in two or more fish included "green liver disease," found in Pacific pollock, Theragra chalcogramma; and "ulcers and boils" disease, seen in Pacific cod. The former abnormality may or may not be pathological and is being investigated in the same manner as the above mentioned diseases. The "ulcers and boils" disease is a type of epidermal hyperplasia with patches up to 2 mm thick. The patches were sometimes centrally ulcerated. These symptoms resemble somewhat the disease furunculosis caused by the bacterium Aeromonas salmonicida.

B. Laboratory results

On September 16, 1975, 23 rock sole with epidermal papillomas were received from the R.V. Oregon. The fish were captured August 8 and 9, 1975 at a previously mentioned location in the southern Bering Sea, and were kept frozen until delivered to the laboratory. The lengths of the fish ranged from 110 mm to 250 mm, which corresponded to otolith-determined ages of three and six years, respectively. Six of the 23 fish had two tumors, the remainder had one. In general the tumors were the spreading type of papilloma shown in Figure 3, and ranged in size from

2.0 x 2.0 x 0.5 cm to 5.5 x 7.5 x 1.0 cm, with an average of 3.0 x 3.0 x 0.7 cm. The tumors had extended to both sides of the fish in 18 of 23 cases. Photographs were taken of all the fish. Due to the fact that the fish had been frozen, no histological, microbiological, or hematological specimens were taken.

C. Reliability of results

Incidence data and pathological characteristics obtained from fish examined on the R.V. Miller Freeman are accurate. As will be mentioned later in this report, improvements can be made in the number of fish examined for disease symptoms. Our party could only examine a small portion of the total number of fish processed by the crew. If the crew were to be trained to identify pathological abnormalities on fish, then disease incidence could be calculated from a greater sample size.

With respect to the fish received from the R.V. Oregon, nothing can be said concerning disease incidence. The crew of these smaller vessels process enormous numbers of fish and cannot carefully examine each fish for abnormalities. At best we can determine the gross pathology, age-length relationship, location when captured, species, and sex from the fish received from the R.V. Oregon.

V. Preliminary Interpretation of Results

A. Field results

Adenomas of Pacific cod have been reported previously in the northeastern Pacific Ocean (Wellings _et al._, 1967). But our incidence data is the first reported for this disease. Also, for the first time specimens have been carefully preserved for light and electron microscope histology, and have been subjected to microbiological procedures. The cause of the disease is not clear. Several tumors appeared to secondarily be infected with bacteria. The fact that both pseudobranchs were always affected would suggest a systemic disease, but until the function of the pseudobranch is better defined a systemic cause may be difficult to prove.

Epidermal papillomas of flounder have been studied extensively by us in Puget Sound, Washington (Miller and Wellings, 1971; Wellings _et al._, 1975). In Puget Sound, the tumor disease affects mostly the young-of-the-year (0's) and one-year old fish (1's). The disease is seasonal, with incidences reaching as high as 50% in the fall among 0-age fish and decreasing to 5% by late spring in the same year class. As the flounder grow older, the tumor incidence continued to decline.

The 0.8% incidence of papillomas on rock sole in the Bering Sea appears to be the value one would expect to find in older fish near an area where tumor incidence is quite high among the younger fish of that species. The large number of tumor-bearing rock sole captured by the R.V. Oregon in their trawls of shallower waters supports this assumption, since rock sole 0 to 3-aged fish are generally found in the shallow waters near beaches. However, only careful sampling of shallow coastal waters of the Bering Sea can offer conclusive evidence for a high tumor incidence in young rock sole.

Lymphocystis disease has never before been reported in the literature to occur in marine fish on the northern Pacific coast of North America. Although the causative agent of the disease is known to be a virus, the method of transmission is not known. Templeman (1965) found a 1% incidence of lymphocystis in American plaice, *Hippoglossoides platessoides*, from the eastern Grand Bank of North America, and hypothesized that the disease could be caused by one or more of the following: (1) lymphocystis disease is endemic to the Grand Bank, (2) fish damaged by nets are made susceptible to the disease, (3) the virus was not present in the Grand Bank until brought there on the nets of European trawlers. Another theory is that flounder in or near estuaries are made more susceptible by (1) the presence of large amounts of sediments which could absorb and transmit virus, (2) the lower salinity could lower the rate of mucus secretion and make the skin more vulnerable to infection, or (3) the higher water temperatures in these areas may increase the disease incidence

(Shelton and Wilson, 1973). Since the yellowfin sole captured by the R.V. Miller Freeman had a relatively high lymphocystis incidence of 4.25%, it is possible that estuaries of the Bering Sea may have an even higher incidence.

VI. Problems and Recommendations

A. Field activities

1. R.V. Miller Freeman, Second Leg

Our party had difficulty in gaining access to the compound and dissecting microscopes aboard ship. In the future we will supply our own.

In terms of sampling as many different stations as possible, we had some problems. Three to four days of the cruise were spent trawling the same station in cooperation with two other vessels. Such a practice could probably not be avoided, but some of our time was not used as efficiently as it could have been.

As mentioned above, more fish could have been examined for pathological abnormalities if the crew were trained to recognize various fish diseases. Prior to next year's cruise we will offer the crew members a brief program on dealing with diseases of demersal fishes.

2. Cooperating sampling vessels

The receipt of tumor-bearing rock sole from the R.V. Oregon was of great help to our research program. Nevertheless, there were certain limitations. The fact that the fish were frozen reduced the types of procedures that could be performed with the fish. Next year we will provide all the NOAA vessels sampling for demersal fish in Alaska with plastic 5-gallon containers, formalin, and bags in which to preserve diseased specimens.

Due to the large volume of fish processed by crew members on these small vessels, little time is allowed for careful examination of fish for disease symptoms. Therefore, no incidence data can be derived from the collection of diseased fish by these vessels. If some fish hauls could be occasionally subsampled into smaller lots, and these fewer fish examined more carefully, then the catch data would provide more information concerning disease incidence.

B. Future field activities

So far arrangements have been made to examine fish diseases in the Bering and Beaufort Seas. We need to find means of sampling the Gulf of Alaska. In addition, it is very important that we have an opportunity to determine the extent of fish pathology in shallow coastal waters of the Bering Sea and Gulf of Alaska. The incidence of both epidermal papillomas and lymphocystis could be very much higher in these areas than in the deeper water so far sampled by the R.V. Miller Freeman and Oregon.

Ideally our research unit could provide three to four people to work with another unit whose sampling program takes them into protected shallow water regions of the Bering Sea or Gulf of Alaska. If necessary we could supply the nets and sampling expertise.

VIII. Estimate of Funds Expended

As of October 24, 1975, about $5,000.00 has been spent as follows:

$1,500	supplies
2,000	travel
1,500	salaries
$5,000	Total

VIII. List of Refererences

1. Miller, B.S. and S.R. Wellings. 1971. Epizootiology of tumors on flathead sole (Hippoglossoides elassodon) in East Sound, Orcas Island, Washington. Trans. Amer. Fish. Soc. 100, 247-266.

2. Templeman, W. 1965. Lymphocystis disease in American plaice of the eastern Grand Bank. J. Fish. Res. Bd. Canada 22, 1345-1356.

3. Wellings, S.R. 1969. Neoplasia and primitive vertebrate phylogeny: Echinodermus, Prevertebrates and Fishes - A Review. Nat. Can. Inst. Mono. No. 31, 59-128.

4. Wellings, S.R., B.B. McCain, and B.S. Miller. 1975. Papillomas in pleuronectid fishes: the current state of knowledge, with particular reference to etiology. In: Proceedings of the Symposium on Neoplasms in Aquatic Animals as Indicators of Environmental Carcinogens. (In Press).

5. Weissenberg, R. 1965. Fifty years of research on the lymphocystis virus disease of fishes (1914-1964). Ann. NY Acad. Sci. 126, 362-74.

6. Shelton, R.G.J. and K.W. Wilson. 1973. On the occurrence of lymphocystis, with notes on other pathological conditions, in the flatfish stocks of the North-East Irish Sea. Aquaculture 2, 395-409.

Table 1.--Incidence of the three most common diseases of demersal fish captured during the 2nd Leg of R.V. Miller Freeman Cruise M-75-1 in the Bering Sea.

Disease	Species Affected	Total Fish Examined	Number of Diseased Fish	Percent Incidence
Adenoma of pseudobranch	*Gadus macrocephalus*	2,096	87	4.1
Epidermal papilloma	*Lepidopsetta bilineata*	11,151	9	0.8
Lymphocystis Disease	*Limanda aspera*	1,857	79	4.3

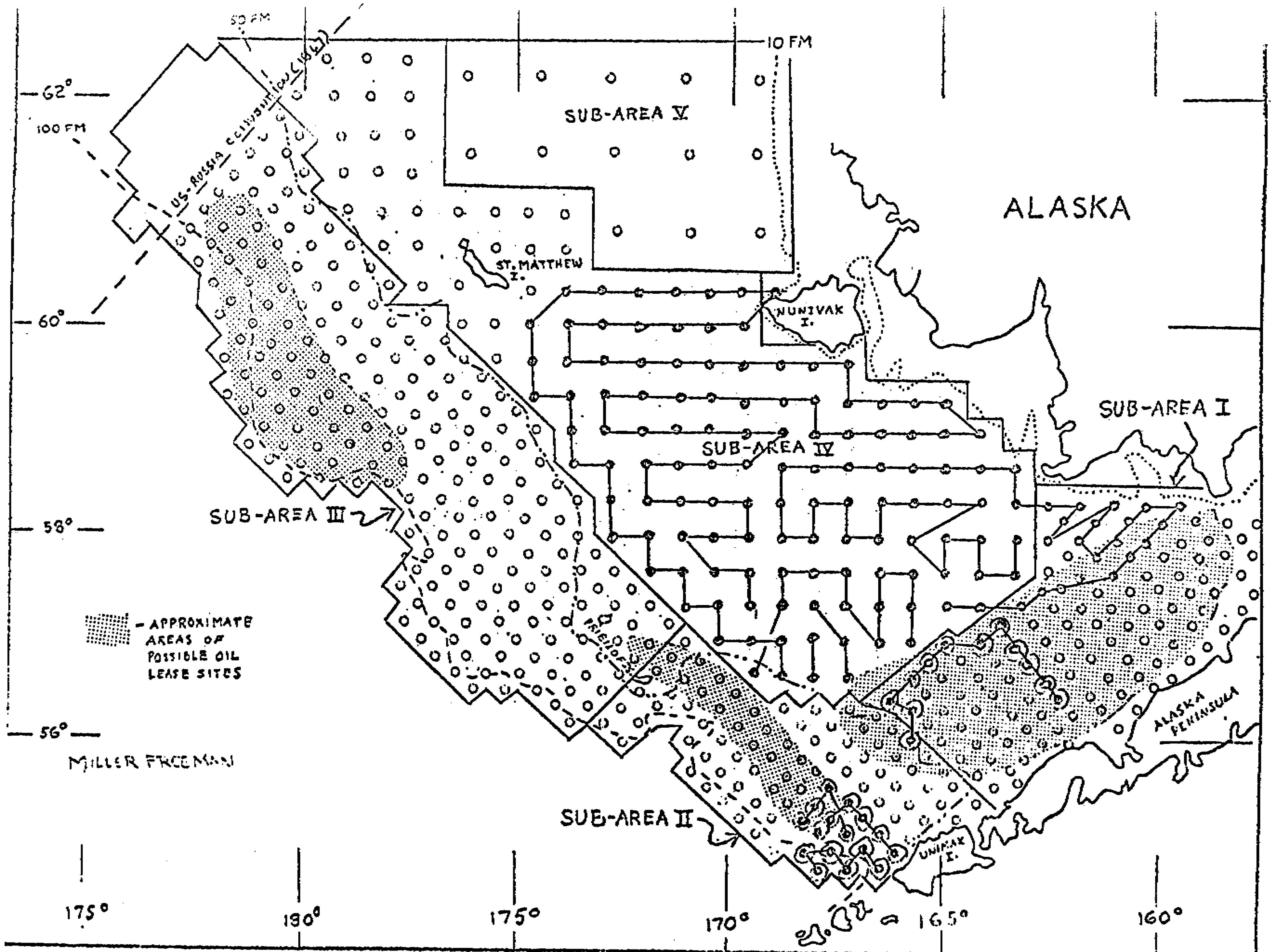
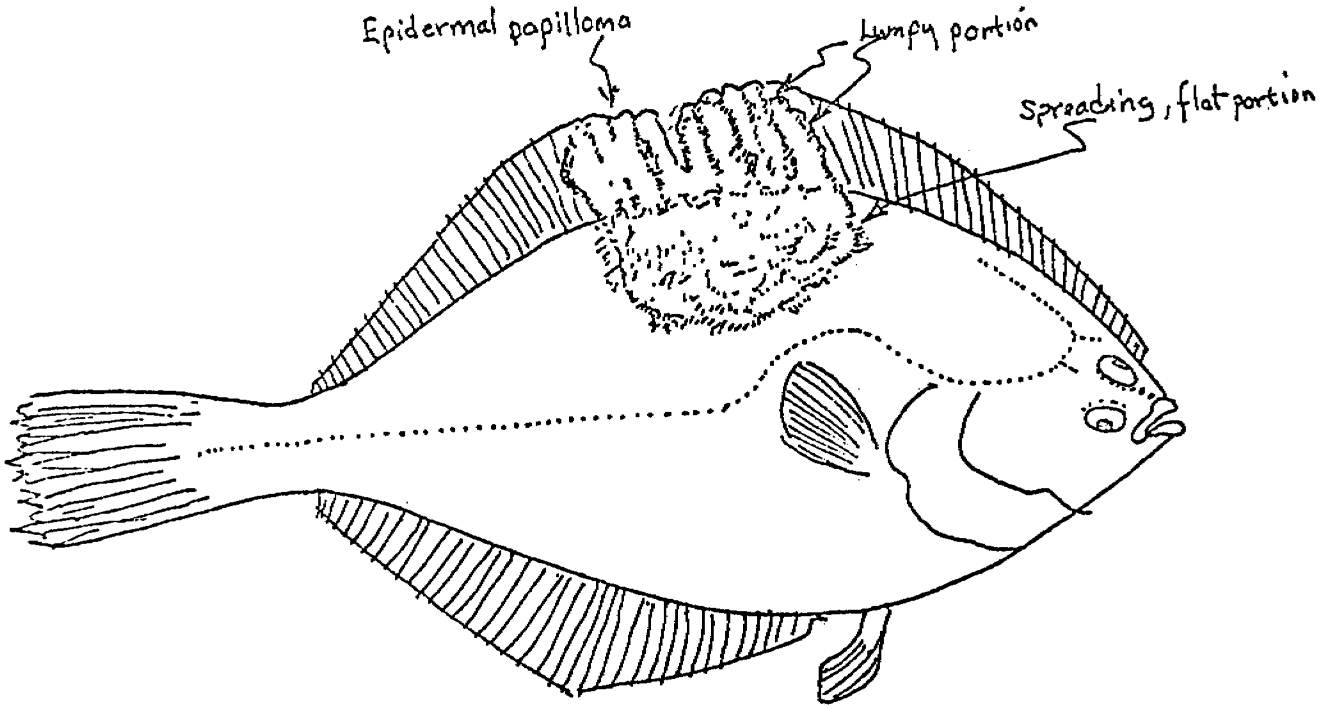


Figure 1.--Stations sampled by the R.V. Miller Freeman during Cruise M-75-1, Leg 1 through 3. Leg 2 stations are designated as ⊙.



Lepidopsetta bilineata (Ayres) 1855

1/3 size

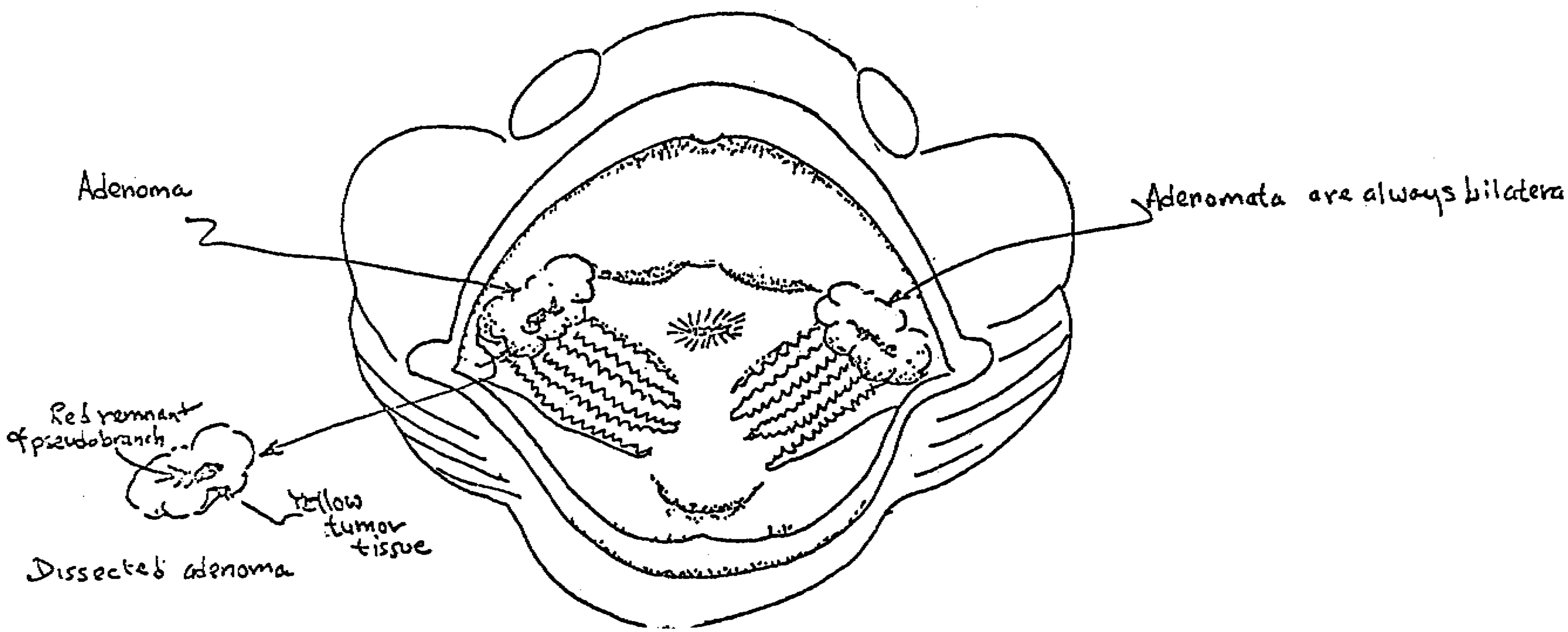
Collected:
Noaa Vessel Miller Freeman
Bering Sea. Leg #2, Hawl #92

S.R. Wellings.

13 Sept, 1975.

Figure 3.--Schematic drawing of an epidermal papilloma of a Lepidopsetta bilineata captured as described in Figure 2.

Adenoma of Pseudobranch.

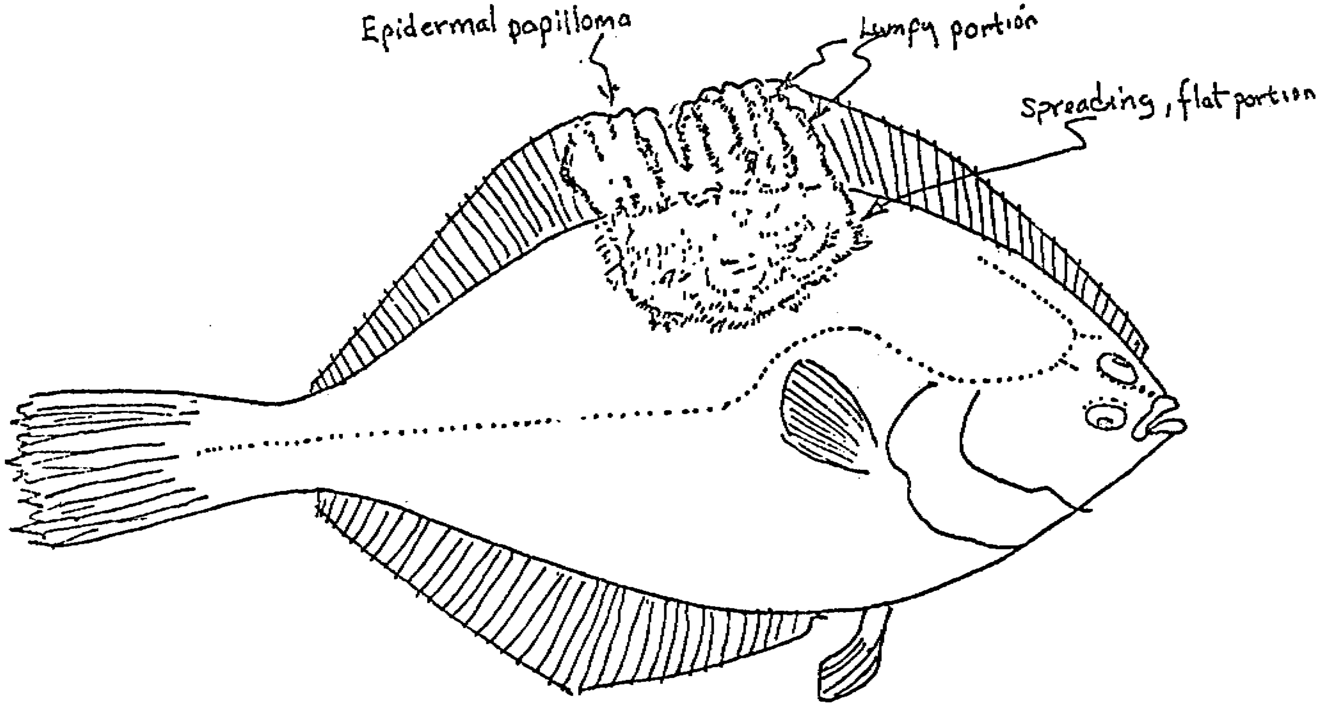


Gadus macrocephalus

Collected on
Miller Freeman, Leg #2
26 Sept., 1975
Hawl 147.

S.R. Wellings

Figure 2.--Schematic drawing of an adenoma of pseudobranch in a Gadus macrocephalus captured during Leg 2 of R.V. Miller Freeman Crui M-75-1.



Lepidopsetta bilineata (Ayres) 1855

1/3 size

Collected:
Noaa Vessel Miller Freeman
Bering Sea. Leg #2, Hawl #92

13 Sept, 1975

S.R. Wellings.

Figure 3.--Schematic drawing of an epidermal papilloma of a Lepidopsetta bilineata captured as described in Figure 2.

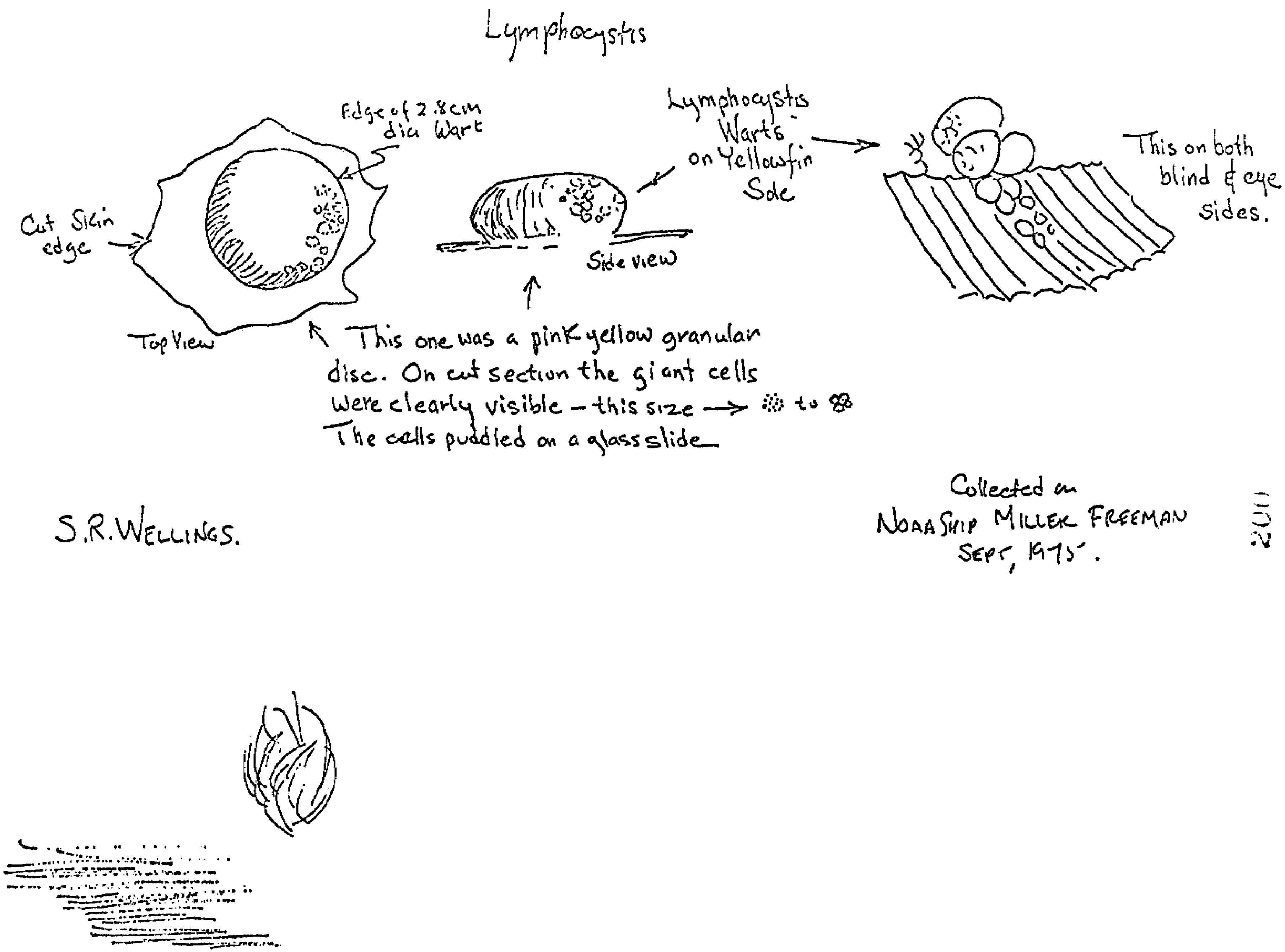


Figure 5.--Schematic drawing of individual lymphocystis warts seen in Figure 4.

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PHYSICAL OCEANOGRAPHY

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PHYSICAL OCEANOGRAPHY – Continued

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347	Harold W. Searby AEIDC William A. Brower NCC	Marine Climatology of the Gulf of Alaska and the Bering and Beaufort Seas	295
357	F. Favorite NMFS/NWFC J. H. Johnson NMFS/PEG	Physical Oceanography of the Gulf of Alaska	297
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SEMI-ANNUAL REPORT

RU48 - Development and Operation of HF Current-Mapping Radar Units -- Physical Oceanography

I. Task Objectives

The primary objectives of the proposed program are twofold: (i) to implement a proven radar concept into a transportable, easily assembled and operated pair of units capable of producing a map of near-surface currents on location in real time, and to calibrate the system as to its accuracy; (ii) to operate the radars at coastal areas of interest along the Beaufort and Gulf of Alaska seacoasts in support of the OCSEAP objectives in physical oceanography. We plan to request a series of recommendations on where specifically we will operate; possibilities include (in addition to geographic areas of interest with respect to leasing) "restricted" water areas such as fiords and regions between the coast and an ice edge, and also in areas and at times when oil-spill experiments are planned.

II. Field and Laboratory Activities

1. Laboratory Activities. Nearly all activities since the beginning of the program have been of a laboratory nature, viz., the analysis, design, simulation, and construction of a pair of current-sensing radar units. Mr. Michael Evans was designated Project Leader of the overall program, under Dr. Donald Barrick, Chief of the Sea State Studies Program Area of the Wave Propagation Laboratory. Karl Sutterfield has been with the program since its inception, in charge of the effective utilization of the computer systems for the operation, suppport, and control of the radars. Mr. Jack Riley joined the team February 1975, and is in charge of developing the graphic and display software for the system. Dr. Bob Weber is implementing all of the software for the reduction and mathematical processing of the received radar signal data. Mr. Don Lund joined the group in August 1975, and at present is primarily responsible for the construction of several of the RF elements of the system. Messrs. Dan Law, Jack Hawkins, and William Everard are designing and assembling several of the digital components of the field units.

2. Field Activities. The decision was made in August 1975 that the first field-unit pair would be tested near Miami, Florida during the winter-spring period of 1976. This decision was made for several reasons: (i) the very first tests -- during the winter -- should not be encumbered by cold weather difficulties, inasmuch as many people and untried hardware will be involved. It is expected that final system hardware and software changes will result from these tests, occurring before operation in Alaska in summer, 1976. (ii) The relatively well-known current patterns of the Gulf Stream should facilitate in assessing the accuracy of the system. (iii) Logistic and technical support has been offered for these tests by NOAA/AOML, the University of Miami, and Nova University.

Mr. Evans conducted site surveys in Florida during November, in preparation for these field tests. He discussed logistic support with representatives of the above three organizations, as well as with personnel from other government installations in the area (such as Coast Guard and Department of Defense facilities). He obtained photographs as well as topographic and aerial maps of the area and potential sites. As a result, it is planned that one site will be located at the south end of the Miami Beach peninsula and the other near Fort Lauderdale (at Nova University) about 40 km away.

III. Results

1. Designs. All system-level designs have been completed. Over 80% of the hardware components that are to be constructed in-house have been designed.

2. Procurements. All items to be procured externally have been ordered; nearly all of these have been delivered, with the final items due to arrive before 15 January 1976. The major hardware components purchased externally include: (i) electronic laboratory test gear; (ii) computer support facilities; (iii) the radar receivers; (iv) the minicomputers for the field units.

3. In-House Fabrication. Several hardware items have been designed and are being constructed in-house. These include: (i) transmitter-drivers; (ii) transmitter power amplifiers; (iii) receiving antennas; (iv) transmitting antennas; (v) radio telemetry gear (between sites); (vi) fast Fourier-Transform digital hardware; (vii) array-processing digital hardware; (viii) data-acquisition board, consisting of the sample and hold circuits, the analog-to-digital converters, and the digital pre-averaging circuits; (ix) semi-conductor buffer memory; (x) graphic display hardware; (xi) systems-integration hardware, including special high-efficiency power supplies, power sequencing circuitry, and fault-analysis circuitry. Prototype designs and models of all of the above components have been completed and are operating. The team is presently in the process of completing the construction of the final operational versions of these components.

4. System Integration. As the individual hardware items are delivered or constructed, they are being integrated into the overall system which will go into the field. Each radar unit consists of two weather-proof fiberglass cases containing shock-mounted racks; all of the digital and RF gear necessary for operation in the field at one site is to be contained in two such cases. About 35% of this system integration is now completed. A photo of the cases (40" high x 24" wide) is attached here, with about 35% of the components actually in place. Each case (when completed) will weigh less than 150 pounds, easily capable of being handled by two persons. A considerable amount of attention is being given to system reliability and interference shielding.

5. System Performance Analyses. Based upon the system design specifications, an analysis of system performance has been completed. This study shows that the maximum range from each radar unit should be of the order of 70 km. An analysis of azimuthal angle-of-arrival accuracy shows that insignificant position errors will result when signal-to-noise ratio exceeds 10 decibels. An optimization study indicates that the ideal separation between the two units is approximately 40 km.

6. System Software. Integration of operating-system software for control of the various hardware components is well underway. Graphics and display software (for making on-site current maps) has been completed. The radar-signal data-processing software has also been completed and checked out.

7. System Simulation. Using the graphics/display software and the signal data-processing software, simulations have been run in the laboratory. These simulations -- instead of using actual radar signals -- employ simulated signals consisting of the (random) sea-echo signal and a (random) noise signal, as would be received by the actual radar at each of the three antenna terminals. The sea-echo signal includes the effect of the current pattern on the Doppler shift. Any desired current pattern can be inserted on the signal. These simulated signals are then processed by the same software to be used in the field. Hence, such simulations permit one to: (i) debug and check out the system software before actually going into the field; (ii) obtain a feel for the accuracy of the output product (i.e., the current maps); (iii) modify and improve the system software where certain inaccuracies and weaknesses are detected from the simulations. An example of such a simulation is attached here as a map for sites at Yakutat Bay; the input current pattern used there was a 0.5 knot uniform field moving away from the bay. The vectors shown on the map reflect the accuracy of the software in recovering the actual current field in the presence of noise (signal-to-noise ratio was selected here to be 20 decibels).

8. Theoretical Analyses. Several non-system, oceanographic factors will limit the accuracy of the system for measuring near-surface currents. One of these is the nonlinear interactions of surface waves, which generates Doppler-shift errors that are not associated with the currents. Examination of this mechanism theoretically shows that such errors -- expressed in terms of radial current velocity -- can always be expected to be less than 10 cm/s, with typical errors of the order of 5 cm/s.

9. Reporting Activities. A major technical report has been prepared and is presently being typed. This report describes the theory behind the concept, the system design as presently configured, analyses predicting system performance, and system simulations showing current-field maps produced by the actual radar field software using realistic input signals. This report should be cleared for distribution by about February 1976.

IV. Preliminary Interpretation of Results

None.

V. Problems Encountered/Recommended Changes

Except for delays in obtaining funding from the two other agencies participating in the program (i.e., the Coast Guard and ERDA), and minor problems in obtaining the staffing required to perform the effort, no major problems have thus far been encountered. The program is still relatively close to being on schedule. Keeping the program on schedule can only be accomplished by over-running our present OCSEAP resources while awaiting funding increments from ERDA. Our staffing problems -while not satisfactorily resolved over the long term -- have been met temporarily by using students and part-time personnel whenever possible.

VI. Estimate of Funds Expended

(1 March - 30 September 1975)

1. Funds Expended (Salaries and Other Objects) $340,000

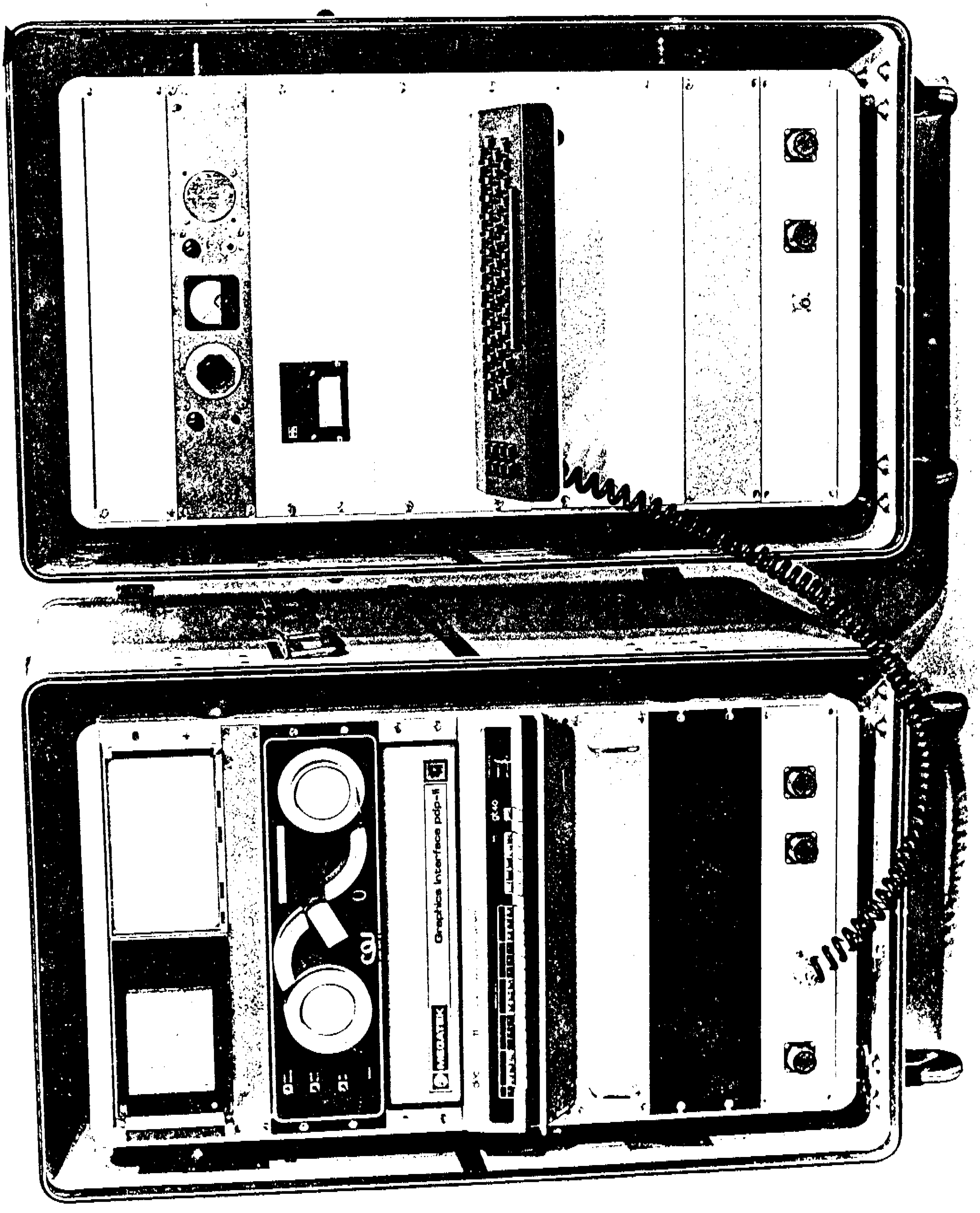
2. Funds Obtained/Anticipated

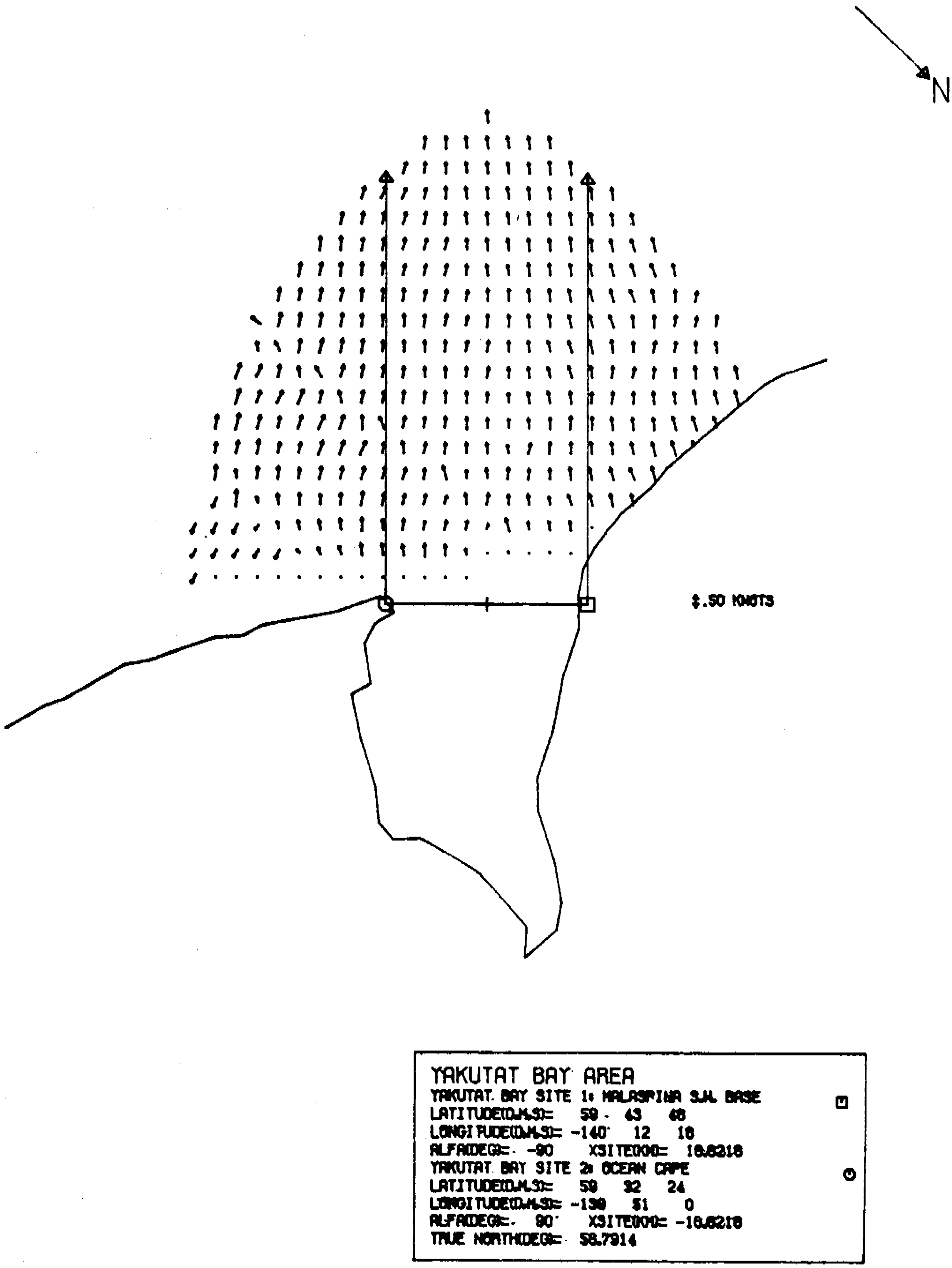
   a) NOAA/ERL
      FY75 $40K

   b) OCSEAP
      FY 75 $240K
      FY 76 $ 40K

   c) Coast Guard
      FY 75 $50 K
      FY 76 ($50 K - 100 K anticipated)

   d) ERDA
      FY 75 $0 K
      FY 76 ($100 K anticipated)
      FY 77 ($100 K anticipated)


Graphics Interface pdp-11
MEGATEK


N
$.50 KNOTS
YAKUTAT BAY AREA
YAKUTAT BAY SITE 1: MALASPINA S.W. BASE
LATITUDE(D.M.S)= 59 43 48
LONGITUDE(D.M.S)= -140 12 18
ALFA(DEG)= -90 XSITE(KM)= 16.6218
YAKUTAT BAY SITE 2: OCEAN CAPE
LATITUDE(D.M.S)= 59 32 24
LONGITUDE(D.M.S)= -139 51 0
ALFA(DEG)= 90 XSITE(KM)= -16.6218
TRUE NORTH(DEG)= 58.7914

RU 81

"Beaufort Shelf Surface Currents"

G. L. Hufford
U.S. Coast Guard

Project cancelled for summer field season 1975 because of unfavorable ice conditions. Project has been rescheduled for summer 1976.

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography
Cable Address: UNIWADO

30 October 1975

Dr. Gunther Weller
Project Manager
Arctic Project Office
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

SUBJECT: Semi-Annual Report for Period 1 April 1975--30 September 1975, *Current Measurements in Beaufort Sea,* Contract No. 03-5-022-67, TA 3.

I. Objectives

To provide long-term Eulerian time series of currents at selected locations on the outer shelf and slope of the Beaufort Sea, where the ice cover may not be seasonally removed. The measurements are aimed at contributing necessary information relating to the circulation and dynamics of the outer shelf and slope.

II. Field/Laboratory Activities

See attached. Note: Mauri Pelto be advised that, where data format is mentioned, this is an in-house format only. We will submit data in the agreed format.

III. Results

No field activity as yet.

IV. Preliminary Interpretation of Results

None as yet.

V. Problems Encountered/Recommendations

Some change in the schedule for in-water tests of the system prior to field deployment. However, this will not impact the overall field schedule.

VI. Estimate of Funds Expended

1. Salaries:

Staff	7,412.60		
		Total	7,412.60

VI. Estimate of Funds Expended (cont.)

2. Benefits

	Total	1,111.90

3. Indirect Costs

	Total	1,392.10

4. Supplies and Equipment

Aanderaa RCM-4 current meters	23,808.00		
Ross depth recorder	4,100.00		
Tape drives and modules	3,788.00		
Battery pack	2,874.95		
Microcircuit RCA CD4061	825.00		
Misc. supplies	531.37		
APL Administrative Fee	2,223.78		
		Total	38,151.10

5. Travel

	Total	413.00
	Total Expenditures	48,480.70

Knut Aagaard
by [signature]

Knut Aagaard
Research Associate Professor
Co-principal Investigator

KA:jd
Attachment
cc: D. Haugen, APL
F. A. Richards
R. B. Tripp

University of Washington Correspondence

INTERDEPARTMENTAL

Date: 14 October 1975

To: Dr. Knut Aagaard, Oceanography, WB-10

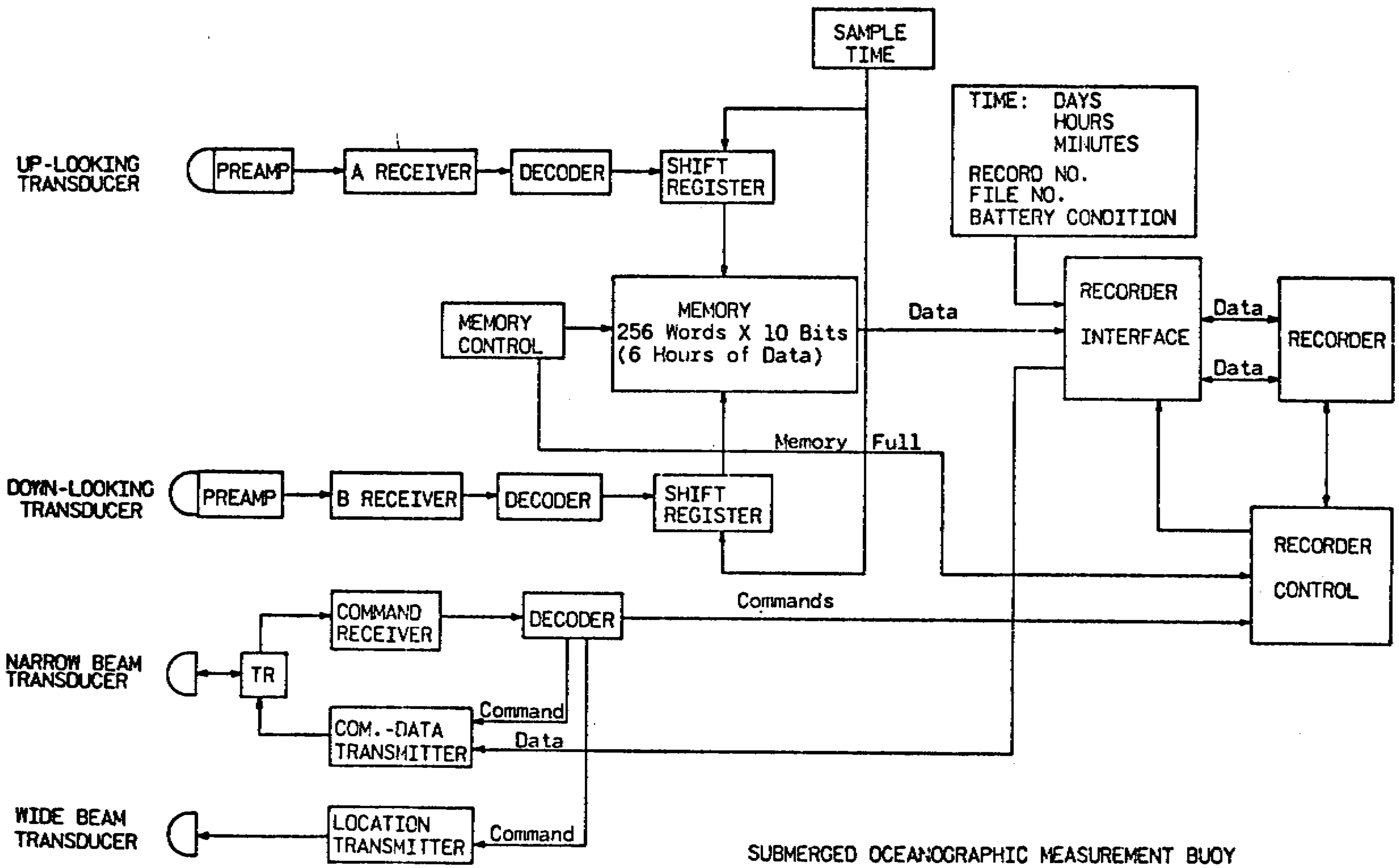
From: Dean Haugen, Fred Brune, Applied Physics Laboratory, HN-10 DPH ja

Subj: Progress Report, Submerged Ocean Measurement Buoy

The progress report for the past quarter (July - September) is enclosed.

DPH:FB:gm
Encl.

cc: R.E. Francois



SUBMERGED OCEANOGRAPHIC MEASUREMENT BUOY
BLOCK DIAGRAM

Type of Recording

Phase Encoded, 3200 phase reversals/inch (1600 Bits/inch)
15 inches/sec., 4-track serial.

Format

14 zeros are recorded as a preamble, followed by the most significant bit of the first data word.

	MSB — LSB		
	0 0 0 X X X X X X X	Days (Hundreds, Tens))	BCD 0 to 799
	0 0 0 0 0 0 X X X X	Days (Units))	
	0 0 0 0 X X X X X X	Hours (Tens, Units)	BCD 0 to 23
	0 0 0 X X X X X X X	Minutes (Tens, Units)	BCD 0 to 59
	X X X X X X X X X X	Record No.	BCD 0 to 399
	0 X X X X X X X X X	Battery Condition, Binary, 3 Bits ea. for +12, ±28	
1st Data Sample (	X X X X X X X X X X	Sample time, Hours (Units), Minutes (Tens, Units) BCD	
(	X X X X X X X X X X	Reference No. Binary	
(	X X X X X X X X X X	Temperature Binary	
(	X X X X X X X X X X	Not used	
(	X X X X X X X X X X	Not used	
(	X X X X X X X X X X	Compass Binary	
(	X X X X X X X X X X	Speed Binary	

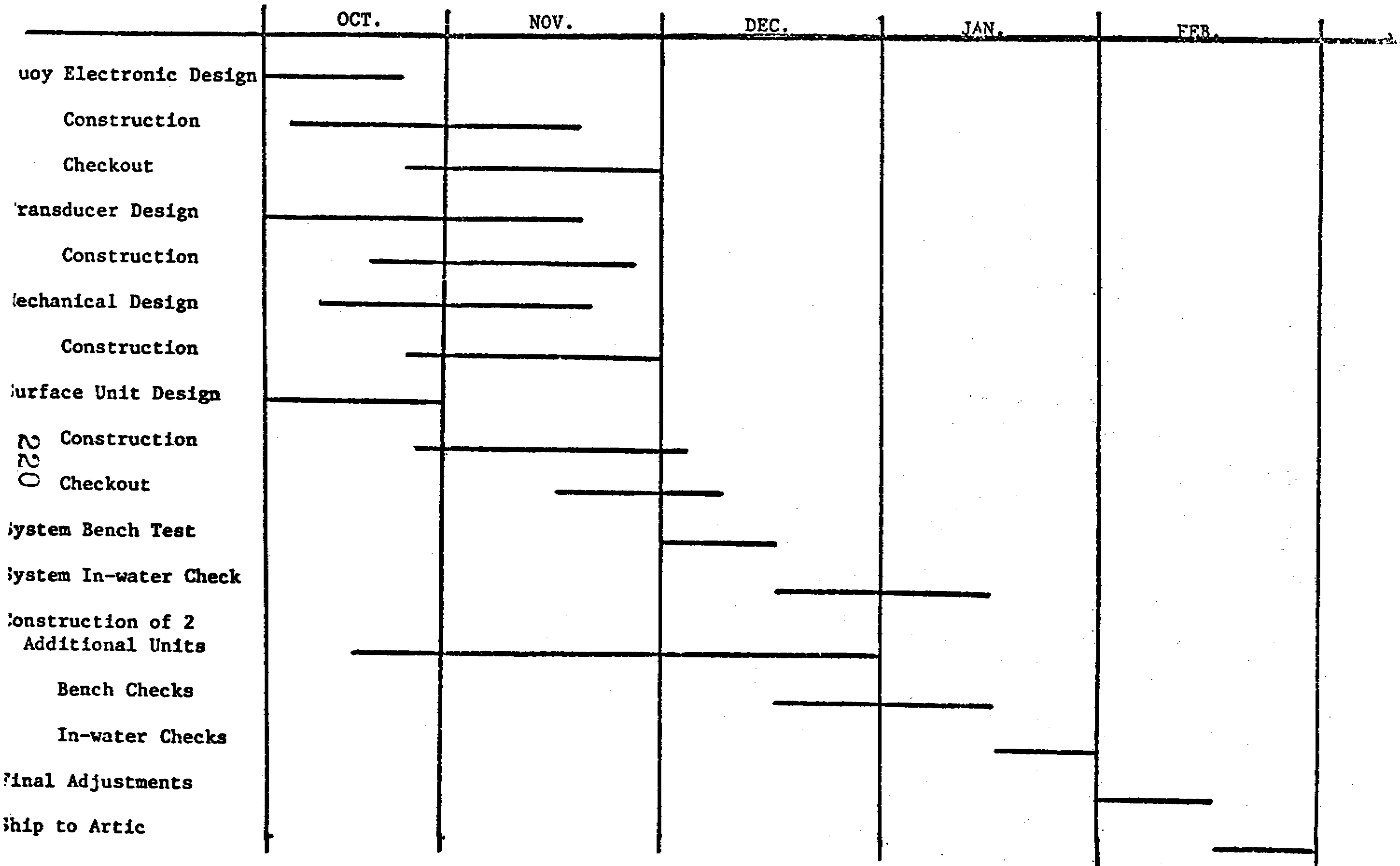
2nd thru 36th Data Samples

14 zeros are recorded as a postamble following the least significant bit of the last data word.

1" Record Gap.

Recorded Data Format, Submerged Ocean Measurement Buoy

OCEAN CURRENT MEASUREMENT BUOY CONSTRUCTION SCHEDULE



DEVELOPMENT SCHEDULE, SUBMERGED OCEAN MEASUREMENT BUOY

SUBMERGED OCEANOGRAPHIC MEASUREMENT BUOY

Progress Report, July - September 1975

Buoy Design

Transducers: Receiving transducers for the Aanderaa Current Meter acoustic data have been designed and a single prototype built and tested. The transducer pattern has a 30 dB null in the back direction which should eliminate interference between the signals from the two current meters.

The narrow beam data transmitting transducer and the wide beam location transducer have not yet been designed.

Electronics: A block diagram of the electronic package is enclosed. Design of individual circuits is approximately 60% complete. Design of the following circuit elements is complete or very nearly so:

- Current meter signal preamplifiers and receivers
- Memory
- Memory control
- Internal data generation circuits
- Timekeeping circuits
- Data routing circuits

Batteries have been received from the manufacturer. The tape recorders have been ordered with an expected delivery date of approximately 1 November. The data recording format is shown on the attached sheet.

Mechanical: The buoy mechanical design has just been started and is expected to be complete by 1 November.

Surface Interrogation Package

Circuit design of this unit has not started. This design is expected to be complete by 1 November with construction starting prior to then.

Schedule

A revised development schedule is also enclosed. The main change in the schedule is in the in-water tests for the prototype system. We will not be ready to initiate this phase until mid-December. This will not impact the overall development schedule.

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Effects of Seasonability and Variability of Streamflow on Nearshore Coastal Areas

Contract Number: 03-5-022-56

Task Order Number: 4

Principal Investigator: Robert F. Carlson
Professor of Hydrology
Director of IWR
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

The initial task has been to outline the basic analysis plan for the project. This has been accomplished and a copy of the outline is appended to this report. A data gathering effort is proceeding at present and the data will be prepared for computer analysis.

II. Field Activities

None.

III. Results

None

IV. Problems Encountered

None.

V. Estimate of funds Expended

	Total Budget	(6 months) Expended*	Remaining
Salary & wages	26,200.00	776.53	25,423.47
Staff Benefits	4,430.00	132.01	4,297.99
Equipment	-0-	-0-	-0-
Travel	855.00	-0-	855.00

(continued

	Total Budget	(6 months) Expended*	Remaining
Other	3,900.00	0	3,900.00
Total Direct	35,385.00	908.54	34,476.46
Indirect	14,987.00	444.18	14,542.00
Total Task Order	50,372.00	1,352.72*	49,019.28

* Preliminary cost data, not yet fully processed.

UNIVERSITY OF ALASKA

O.C.S.

Basic Analysis Plan - September, 1975 - September 1976

INITIAL ORGANIZATION AND STUDIES:

1. Assemble bibliography and background studies for related work in the Gulf of Alaska, Bering Sea, Beaufort Sea, sedimentation studies, streamflow records. (Seifert - Sept. 1 - Sept. 20)

2. Assemble all available streamflow records for Alaska relevant to coastal studies. Relevant data in this field is available from the following sources:

   a. USGS Water Resources Division

   b. IWR Data

   c. Data sources listed in "A catalog of hydroclimatological data for Alaska's coastal zone."
   (R. Seifert/P. Fox, et al - Sept. 23 - Sept. 30)

DESIGN FOR CHARACTERIZATION OF STREAMS:

1. Classification by Region

   Since the OCS leasing will be handled regionally, it is felt that the river information to be assembled would be more convenient to users if it were grouped according to the following OCS designated regions:

   a. Southern coastal drainage and Kodiak Island (Gulf of Alaska)

   b. Bering Sea drainage

   c. Bering Sea drainage

   d. Chukchi-Beaufort Sea drainage

   These regions are also climatically similar and therefore make it possible to compare observations within a region rather than trying to cope with the diversity of rivers over the entire state.

2. Classification by Basin Area

   This classification is one of the steps toward our ultimate goal of deriving "most probable hydrographs" for the coastal rivers of Alaska. Each river will be classified according to basin size. To accomplish this, it will be necessary to graphically analyze

2. Classification by Basin Area (Contd.)

how basin size correlates with the stream hydrograph, i.e., the date of spring break-up, freeze-up, concentration curve, recession, and peak flow. Since the correlations must be made before the classification scheme is derived, this classification will be possible only after most of the statistical analysis is completed.

3. River Characterization

A characterization of the coastal rivers will be done using statistical calculations to determine the most probable dates of freeze-up, break-up, etc. as determined from past records. Unique or unusual features of each river will also be described, especially as they relate to the predictability and reliability of the "most probable hydrograph."

4. Characterization by Snowmelt Pattern

Snowcover and snowmelt are directly related to the topographical uniqueness of each basin. It is expected that each basin will contain determinant topographic features which relate directly to the annual pattern of snowmelt and the melt rate. These will be noted and described.

The study of snowmelt patterns will be accomplished through extensive use of LANDSAT (ERTS) and NOAA satellite imagery. With the daily synoptic information provided by NOAA imagery since February 1974 and the detailed information available from LANDSAT, characterization of snowmelt patterns should be possible.

Use of satellite data can also supply synoptic information on sediment plumes. The characteristic sediment load for each river will be calculated from all available data sources.

Satellite imagery will also be used to indicate areas of overflow water on sea ice during the first few days of spring break-up of the North Slope rivers.

Ice jam floods will be mapped using both ERTS and NOAA imagery. A historical record of flooded areas and flood dates will be sought.

<u>QUARTERLY AND FINAL REPORT DATES:</u>

All of the above tasks will be completed from October 1, 1975 to June 30, 1976 by R. Seifert, D. Kane, and R. F. Carlson. Some assistance will be required from P. Fox, the IWR statistician. Quarterly progress reports will be supplied to Mr. Don Rosenberg in September, December, 1975 and March, June and September, 1976, with each report outlining the progress made toward the goals outlined in this report and the proposal (Research Unit #111).

INFORMATION PRODUCTS:

Intermediate data compilations on streamflow characteristics will be organized according to the four geographic regions outlined in (1.) above. These will include information on characteristics such as expected date of freeze-up, expected date of break-up, date of maximum sediment discharge and any other important features of the streamflow regime.

In particular, graphs and tabulations will be provided which show the mean runoff and probability of extreme variations from the mean for streams discharging into estuaries likely to be impacted by oil development. These are the Copper, Kvichak, Nushagak, Kuskokwim, Colville, and Kuparuk Rivers. As stated in the proposal, these data inputs will be provided to other workers as data for oil spill scenarios in estuarine circulation models which are affected by the influx of fresh water.

Information compiled from existing data should be available in Spring 1976. For basins with less than adequate gage data, the discharge curves will be estimated using models. These estimates will be available later in the project.

Task Title: Gulf of Alaska Study of Mesoscale Oceanographic Processes (GAS-MOP)

PI: Dr. Stan P. Hayes, PMEL
Dr. Jim D. Schumacher, PMEL

I. Task Objectives:
- measurement of along and cross-shelf sea slope
- direct measurement of velocity field
- regional and time-series observations of the density field
- analysis of temporal and spatial variability in sea slope and velocity field
- correlation of wind, sea slope, and currents

Reprogrammed Task Objectives

Measure surface wind and upper ocean currents using a moored buoy. These data will be used to describe the temporal variations of the near-surface horizontal velocity field and the response of the upper ocean to variable winds.

This task was not included in the initial physical oceanographic program. However, it is apparent that such measurements are vital to the shelf dynamics study. Hence, through use of existing equipment supplies, a modest experimental program was begun.

II. Field and Laboratory Activities:

A. Cruises:
NOAA Ship SURVEYOR-OCSEP LEG II RP-4-50-75C (15-23 Sept 75)

B. Scientific Party:
Pat Laird, Chief Scientist, PMEL
D. Carlone, Electronics Tech, PMEL
D. Stith, Phy. Sci. Tech., PMEL
S. Raaum, Phy. Sci. Tech., PMEL

C. Methods:
Plessey 9040 CTD
Plessey 8400 Digital Data Logger
Aanderaa RCM-4 current meters
AMF 242 acoustic release

D. Sample Localities:
STA62 - NEGOA 59°32.95' N, 142°05.28' W
STA WGC-2 - GOA 57°28.1' N, 150°29.0' W
25-hr CTD time series near WGC-2

E. Data collected or analyzed
1. STA 62D recovered - 4 current meters tapes have been translated and are being edited and printed out in standard format.
STA 62E deployed - 4 current meters
STA WGC-2 deployed - 2 current meters

2. 25 CTD casts, tapes have been translated, edited and are now on tape in 1 meter averages. Field correction factors were calculated to be +0.02°C and -0.07 ppt.

III. Results

Current meter tapes from STA62D are being translated and edited. The four current meters on this array will result in approximately 428 days of records and have extended the period of continuous observations at this site to 13 months. These data will appear in format similar to NOAA Technical Memorandum ERL-PMEL-3. In addition, current meter records from FY75 are being analyzed for alongshore coherence.

The principal efforts thus far in the contract year have been directed towards preparation for the upcoming deployments and analysis of the bottom pressure record collected off Icy Bay during the previous contract year.

The prototype bottom pressure/temperature gauge PTG-100 which was designed and constructed last contract year was successfully tested off Oregon June - July 1975. A thirty-day record was obtained in 50 m of water. This was compared with the record from an Aanderaa pressure gauge in 150 m depth and with coastal tide data at Newport. The results indicate that all instruments performed well. The low pass filtered (40 hour cut off) records show non-tidal water level changes of a few centimeters which are coherent at the 50 m and 150 m depths. These are easily resolved by the pressure gauges.

In conjunction with the field tests, laboratory studies of the calibration of the gauges has progressed. Results by other investigators (NBS calibrations and H. Mofjeld at AOML) and by ourselves show that the Paroscientific quartz crystal pressure transducer (used in both Aanderaa gauges and the PTG) has a temperature dependence. The temperature dependence is different for each transducer. A worst case is about 1 mbar (about 1 cm of water) per degree centigrade. In our calibration studies we used four temperatures 25°C, 8°C, 5°C, and 3°C. The emphasis on the low temperatures corresponds to the temperatures expected in the Gulf of Alaska. The pressure measurements will be corrected for the measured temperature effects.

We have now completed the construction of all three PTG units for November deployment. Calibrations are in progress. A technical report discussing the PTG and its calibration is in the initial stages of preparation.

Processing has continued on the single Aanderaa pressure gauge (TG-2A) which was deployed from February to May 1975 at station 63-1/2 off Icy Bay. Problems were encountered in reducing the data tape which limited the useful record to 74 days from 3 February to 12 April. This record has been low pass filtered (cut off at 40 hours). Some initial interpretations are given below.

IV. Preliminary Interpretation of Results

A principal objective of last year's pilot study was to ascertain the magnitude of the sea level change measured in 100 m depth and to compare this with the instrument response. The low pass filtered bottom pressure record is shown in figure 1 for the first month of data. For comparison the sea level data at Yakutat (from NOS hourly values of water height) has also been low pass filtered and corrected for atmospheric pressure changes. It is the middle graph in figure 1. Clearly the two records are very coherent. In both cases the magnitude of the sea level changes is about 20 cm. These large excursions occur during the periods of high winds which were discussed in the last annual report. It is reasonable that the sea level changes at Yakutat and 63-1/2 should be roughly the same since the shelf off Yakutat is quite narrow. The 100 m contour is only a few kilometers offshore.

The bottom curve in figure 1 is the alongshore water velocity measured 10 m off the bottom at station 63-1/2. The close correlation with the changes in sea level is obvious. If we assume no sea level change at the shelf break, then the inferred sea level slope is sufficient to geostrophically balance the observed current changes. Further study of the relations between the bottom pressure and the water currents are continuing. The data from station 62 is being compared with that from station 63-1/2 in order to extend the analysis.

V. Problems Encountered/Recommended Changes

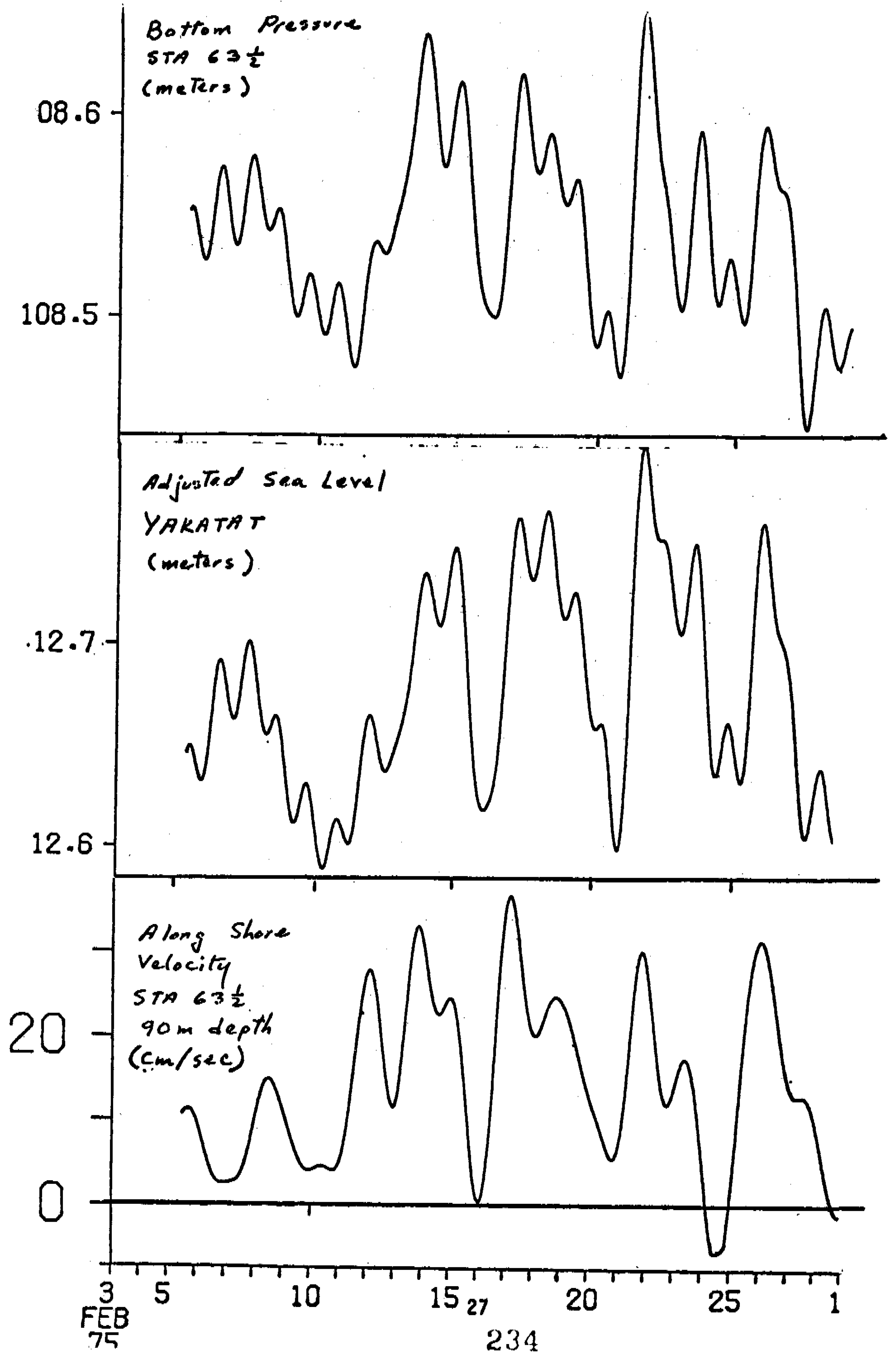
No particular problems have arisen. The pressure/temperature gauges are being constructed on schedule.

VI. Estimate of Funds Expended by Dr. S.P. Hayes

A. Total expended $36,000

B. Major expenses:

Item	Quantity	Cost
Pressure cases for PTG	7	$ 5,900
AMF acoustic release	1	6,000
Sea Data electronics for PTG	6	15,000
Buoys		4,000



Bottom Pressure
STA 63½
(meters)
08.6
108.5
Adjusted Sea Level
YAKATAT
(meters)
12.7
12.6
Along Shore
Velocity
STA 63½
90m depth
(cm/sec)
20
0
3
FEB
75
5
10
15
27
20
25
1

GAS-MOP PI's Response to Amended Instructions

1. Recommendations for future research

The sea slope experiment is designed to be in operation for one year beginning in January 1976. Thus the first requirement for FY77 will be the completion of field operations and time alloted for data analysis and interpretation of results. We anticipate maintaining one Icy Bay line, with wind measurements and three moored bottom pressure/current meter arrays through FY77.

The mooring off Seward (STA-9) should be supplemented with a bottom pressure gauge on STA-9, and another current meter/pressure gauge array located between STA-9 and Seward. Then this line and the Icy Bay line will provide continuity in NEGOA with previous measurements and will permit contras-s to be drawn with a more intense effort we visualize for the NWGOA in FY77.

The dynamics in the Western Gulf of Alaska may be quite different from those in the N.E. The offshore current intensifies in the western region. This has been related to a change from an Eastern boundary current to a western boundary current as the coastline swings to the southwest. The effect of this on the shelf currents is not known. The present field experiment is intended to provide a pilot study for designing future work. We anticipate that at least two cross shelf lines of moorings with current meters and pressure gauges will be required. In addition surface wind measurements must be extended into this region. To supplement the present surface drifter experiments, shipboard drogue studies of the Alaskan stream might be useful for examining the kinematics of the high frequency changes in this current. We expect that continued measurements at WGC1 and WGC2 will be profitable to provide continuity with existing records. Finally, an STD program throughout the Gulf should be continued. The offshore lines should extend sufficiently far in order to resolve the boundary current structure.

An informal meeting of the principal investigators in early December (perhaps at the San Francisco AGU meeting) would be useful for discussing progress and formulating plans. At present, we limit ourselves to some general speculations on the problems which the program should address.

2. Modification of existing efforts

A) Through discussions with several P.I.'s and other scientists interested in the Alaskan shelf studies, it became clear that the measurements of surface winds and upper ocean currents which were initiated last year should continue. It was possible, by using existing equipment and purchasing some new components, to prepare a surface buoy (ICY-2) for deployment in November, 1975 off Icy Bay. This buoy in 100 m of water measures wind and currents at 5 and 10 m depths. It will remain implanted until late April, 1976. We strongly urge that these measurements be continued beyond April. Knowledge of the surface wind fields is critical for interpreting the sea level slope data, the intermediate depth current meters, and for providing accurate inputs into dynamical models. The near-surface current measurements are important for oil spill trajectory estimates.

We further recommend that the surface buoy measurements should be supplemented by a shore station at Icy Bay. These cross-shelf wind measurements will be useful in determining the usefulness of coastal wind data.

B) Additional current meter deployments have become possible through use of the DISCOVERER equipment. These have been used to strengthen the existing arrays. For example, two current meters will be deployed in November 1975 on SLS-5. We recommend that the cross-shelf coherence between currents be determined on the pressure gauge line. This would involve about 4 additional current meters and would supplement the measurements at STA 62.

C) It would be highly advisable to have a meteorological station (wind velocity and atmospheric pressure) set up on Middleton Island in the Gulf of Alaska. This is far less difficult to maintain than a moored station and if funds (about $8K) were available, could be undertaken during FY76.

Task Title: Numerical Studies of Alaskan Region

PI: Dr. J.A. Galt, PMEL

I. TASK OBJECTIVES
- diagnostic model of Gulf of Alaska
- development of stocastic representations for time dependent wind and current transport
- initial development of diagnostic model in Bristol Bay area
- initial development of baroclinic circulation model for Bering Sea
- review of ice modeling of AIDJEX and analysis of ice cover as it affects storm surge models in Beaufort Sea

II. ACTIVITIES

A. Work was performed at PMEL using University of Washington library and computing facilities.

B. Those participating included

Jerry A. Galt, oceanographer;

C.S. Smyth, oceanographer;

Carol Pease, oceanographer/computer programmer;

Dan Tracy, NOAA commissioned corps.

III. RESULTS

A. Gulf of Alaska Diagnostic Modeling. A number of analytic solutions have been developed for steady-state flows with the same physical basis as the Ekman-geostrophic diagnostic model. These solutions are comparable to those obtained by finite element solution of the model equations where adequate resolution of significant small scale features is allowed. A considerable body of knowledge has been developed regarding the numerical model's sensitivity to geometrical constraints. Model runs with observed density fields and NEGOA geometry have been made. Preliminary results agree with direct current measurements.

B. Bering Sea Diagnostic Modeling. None.

C. Gulf of Alaska Stochastic Modeling. Two types of stochastic models have been developed: random walk and Markov process. Programs for computation of statistical parameters from field current measurements have been developed for both types. Some test cases from current meter data have been run. Both representations seem to demonstrate similar ability to model current velocity variability about the mean as a random process.

D. Distribution of Variables Model. No work has been performed.

E. Beaufort Sea Ice Dynamics. A literature review and consultations with the AIDJEX group are underway.

F. Bering Sea General Circulation Modeling. Two general circulations models have been modified to run on the University of Washington computing system. Configuration of model geometry for both to the Bering Sea is underway.

V. PROBLEM

One oceanographer/numerical modeler has not yet been successfully hired.

VI. FUNDS EXPENDED(10-1-75)

Salaries and overhead	\$17.0K
Travel	1.5K
Computer	4.3K
Total	\$22.8K

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES
Pacific Marine Environmental Laboratory
3711 - 15th Avenue, N.E.
Seattle, WA 98105

Date : October 29, 1975

RECEIVED
OCT 31 1975
NEGOA

To : Dr. Herbert E. Bruce, Project Manager, OCSEP

James D Schumacher

From : Dr. James D. Schumacher, Oceanographer

Subject: Semi-Annual Report

Enclosed is the PMEL Semi-Annual Report and Dr. L.K. Coachman's (UW) contribution to OCSEP and some results from last year's work.

I wish to inform you that three PI's from our lab (Drs. Feely, Cline and J. Larrance) were involved with field operation for OCSEP when the amended instructions - October 9 - arrived at PMEL. As soon as they return, I will encourage them to consider the importance of these instructions and respond to them.

cc: Dr. R. Burns

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography
Cable Address: UNWADO

28 October 1975

Dr. Herbert E. Bruce
Project Manager, OCSEP
Juneau Project Office
P.O. Box 1808
Juneau, Alaska 99802

SUBJECT: Semi-Annual Report for Period 1 April 1975--30 September 1975, *Bristol Bay Oceanographic Processes*, Contract No. 03-5-022-67, TA 4.

I. *Objectives*

This study is a joint program with Pacific Marine Environmental Laboratory, ERL, NOAA to provide water mass circulation information over the eastern Bering Sea shelf region for the Outer Continental Shelf Energy Program. This program is outlined in detail in Dr. Jim Schumacher's report.

II. *Field Activities*

See attached cruise report.

III. *Results*

Mooring BC-4A will not be retrieved until early November. The reduction and processing of the C-T-D data is under Dr. Schumacher's supervision.

IV. *Preliminary Interpretation of Results*

None as yet.

V. *Problems Encountered/Recommendations*

See attached letter.

VI. *Estimate of Funds Expended*

1.	Salaries:	Staff	2,572		
		Students	1,728		
				Total	4,300
2.	Benefits:			Total	539
3.	Indirect Costs:			Total	1,884

University of Washington
Department of Oceanography
Seattle, Washington 98195

Preliminary Report

University of Washington Participation in NOAA Ship *Discoverer* Cruise RP-4-DI-75B

Bristol Bay Oceanographic Processes
2-11 September 1975

by

Richard B. Tripp

NOAA Contract 03-5-022-67 TA 4

Approved by:

L. K. Coachman
Professor
Principal Investigator

Francis A. Richards
Associate Chairman for Research

Ref: M75-96

VI. *Estimate of Funds Expended (cont.)*

4. Supplies and Equipment

Aanderaa RCM-4 current meters	17,372		
Aanderaa TG-2A pressure gauges	24,100		
AMF 242 releases	22,115		
ORE subsurface floatation	2,250		
Miscellaneous	1,042		
		Total	66,879

5. Travel	Total	1,222
	TOTAL EXPENDITURES	74,824

Lawrence K. Coachman, Professor
Co-principal Investigator

LKC:jd
Attachments
cc: F. A. Richards
J. Schumacher
R. B. Tripp

BRISTOL BAY OCEANOGRAPHIC PROCESSES

1. *Objectives*

This study is a joint program with Pacific Marine Environmental Laboratory, ERL, NOAA to provide water mass circulation information over the eastern Bering Sea shelf region for the Outer Continental Shelf Energy Program (OCSEP).

The Leg II portion of Cruise RP-4-DI-75B on the NOAA ship *Discoverer* was the first phase in the program directed towards accomplishing this research. The objectives of this cruise were: 1) Deployment of three current meter and pressure gauge moorings in the eastern Bering Sea; 2) deployment of a current meter mooring, south of Unimak Pass, for the NEGOA project; 3) a series of C-T-D stations selected from the Bristol Bay Oceanographic Processes (B-BOP) program master grid; 4) small-scale mapping of surface temperature and salinity fields; 5) a 12-hour time-series of C-T-D casts near mooring BC-2A.

2. *Cruise Track and Narrative*

The NOAA ship *Discoverer* departed Kodiak, Alaska at 2200 GMT, 2 September 1975 and proceeded to the survey area (Fig. 1).

The following moorings were deployed as follows:

1) Station WGC-1 deployed at 1910 GMT, 4 September in 188 meters water depth at latitude 54°01.72' North; longitude 162°59.84' West, consisting of two current meters, acoustic release, and surface marker attached to the mooring.

2) Station BC-1A deployed at 0213 GMT, 6 September in 201 meters water depth at latitude 55°24.63' North; longitude 167°57.46' West, consisting of two current meters, a pressure gauge, an acoustic release, a pinger and a surface marker float attached to the mooring.

3) Station BC-4A deployed at 1808 GMT, 7 September in 55 meters water depth at latitude 58°36.96' North; longitude 168°13.96' West, consisting of two current meters (30; 47 meter depths), a pressure gauge, an acoustic release and a pinger.

4) Station BC-2A deployed at 1820 GMT, 8 September in 65 meters water depth at latitude 57°04.29' North; longitude 163°19.47' West, consisting of two current meters, a pressure gauge, an acoustic release and a pinger. A witness buoy was deployed approximately 100 yards from this mooring.

Hydrographic stations were occupied at the following B-BOP C-T-D master grid stations: Nos. 15, 37, 48, 61, 39, 19, 4, 22, 44, 64, 76, 68, 88, 122, and 96 (Appendix A). In addition, after each mooring was deployed a C-T-D cast was accomplished, including a 12-hour time-series at Station BC-2A. Due to severe weather, the time-series was reduced from the proposed 25 hours and eight C-T-D stations were deleted from the intended cruise plan.

A total of 224 surface salinity samples and temperature measurements were collected between C-T-D stations.

The NOAA ship *Discoverer* anchored at Dutch Harbor, Alaska, 2230 GMT, 11 September. The University of Washington representatives debarked the ship at that time.

3. *Methods*

Aanderaa RCM-4 current meters were employed on each mooring set to record data (current speed and direction, temperature, conductivity and pressure) at a timing interval of 15 minutes. The meters on mooring BC-4A did not have a conductivity sensor and had a timing interval of 20 minutes.

An Aanderaa TG-2A pressure gauge was housed in an anchor well on each of the Bering Sea moorings. These units were set to record data at 15 minute intervals.

A Helle model #2250 pinger (27 KHz) was attached to each Bering Sea mooring to aid in the recovery of the mooring.

Acoustic releases used on each mooring were AMF model 242, Channel 1 (WGC-1); Channel2 (BC-1A), Channel 4 (BC-4A) and Channel 3 (BC-2A).

C-T-D casts were taken on each hydrographic station utilizing a Plessy model 9040 Environmental Profiling System. Data were stored on 9-track magnetic tape for reduction ashore. In order to determine field correction factors for the conductivity and temperature sensors, a 10-liter Niskin bottle was attached to the rosette sampler.

Water samples for the small-scale (8-9 km) sea-surface and temperature field mapping program were taken every 70 minutes between hydrographic stations. These samples were collected both from bucket samplers and the ship's seachest. The salinity samples were analyzed using a Hytech model 621 Portable Inductive Salinometer.

4. *Personnel*

PMEL/ERL/NOAA

Dr. J. Schumacher	Principal Investigator/Chief Scientist
Mr. R. Newman	Electronics Technician
Mr. D. Stith	Physical Science Technician

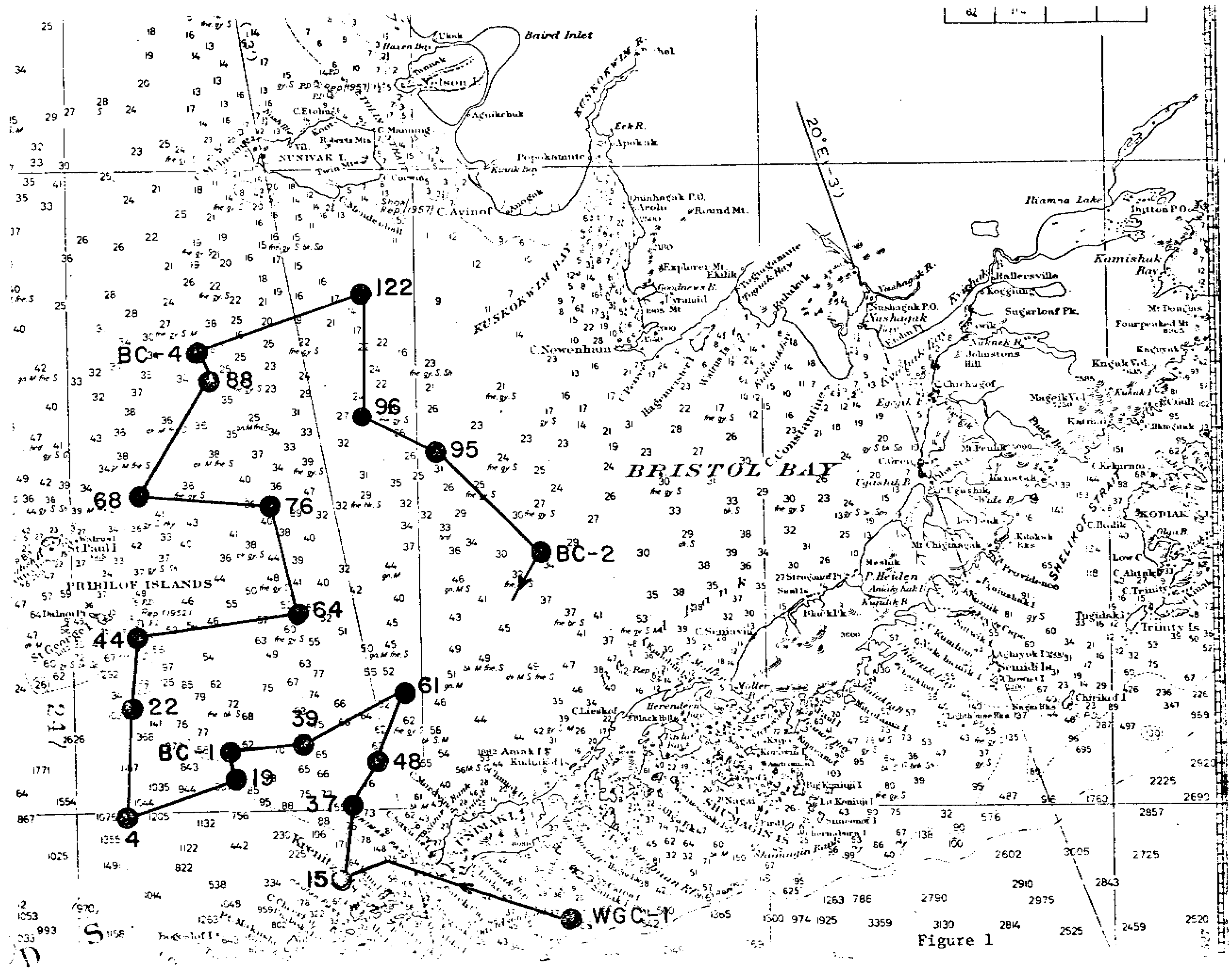
APPENDIX A

Ocean Station Activities Log

Master Station No.	CTD No.	Julian Day	GMT Start	GMT End	Latitude N	Longitude W	Depth meters	Operations Description
WGC1	--	247	-	-	54°01.72 N	162°59.84 W	188	Current Meter Mooring
WGC1	50	247	1940	2007	54°01.82 N	162°59.81 W	161	Hydrocast- 155 meters
15	51	248	0432	0513	54°23.73 N	166°18.85 W	613	Hydrocast- 600 meters
37	52	248	0811	0830	55°02.82 N	166°04.07 W	130	Hydrocast- 125 meters
48	53	248	1053	1108	55°23.38 N	165°44.28 W	120	Hydrocast- 114 meters
61	54	248	1410	1426	55°55.59 N	165°24.24 W	97	Hydrocast- 92 meters
39	55	248	1905	1925	55°29.86 N	166°52.64 W	135	Hydrocast- 125 meters
BC1	--	249	-	-	55°24.64 N	167°57.47 W	201	Current Meter Mooring
BC1	56	249	0240	0315	55°24.20 N	167°57.10 W	203	Hydrocast- 190 meters
19	57	249	0417	0447	55°17.55 N	167°55.94 W	350	Hydrocast- 340 meters
4	58	249	0943	1045	54°55.65 N	169°25.25 W	2740	Hydrocast-1500 meters
22	59	249	1457	1547	55°49.92 N	169°20.88 W	1701	Hydrocast-1500 meters
44	60	249	1851	1907	56°27.64 N	169°08.16 W	99	Hydrocast- 95 meters
64	61	250	0030	0053	56°35.34 N	166°58.34 W	100	Hydrocast- 93 meters
76	62	250	0435	0447	57°21.23 N	167°15.44 W	72	Hydrocast- 68 meters
68	63	250	0919	0933	57°30.46 N	169°02.11 W	73	Hydrocast- 67 meters
88	64	250	1408	1419	58°18.26 N	168°00.53 W	65	Hydrocast- 60 meters

<u>University of Washington</u>

Dr. L. K. Coachman	Principal Investigator
Mr. R. Tripp	Senior Oceanographer
Mr. S. Harding	Student Assistant



Baird Inlet
Nelson I.
NUNIVAK I.
C. Avinof
KUSKOKWIM BAY
Kuskokwim R.
Iliamna Lake
Kamishak Bay
C. Newenham
Nushagak
BRISTOL BAY
PRIBILOF ISLANDS
St. Paul I.
P. Heiden
UNIMAK I.
SHUMAGIN IS.
SHELIKOF STRAIT
KODIAK
Trinity Is.
Amak I.
20°E (-3')
122
BC-4
88
96
95
68
76
BC-2
64
44
22
61
39
BC-1
48
19
37
4
150
WGC-1

Figure 1

Master Station No.	CTD No.	Julian Day	GMT Start	GMT End	Latitude N	Longitude W	Depth meters	Operations Description
BC4	--	250	-	-	58°36.96 N	168°13.96 W	55	Current meter Mooring
BC4	65	250	1826	1839	58°37.18 N	168°13.40 W	54	Hydrocast- 50 meters
122	66	251	0129	0140	59°02.97 N	165°50.29 W	24	Hydrocast- 20 meters
96	67	251	0550	0600	58°10.22 N	165°55.63 W	45	Hydrocast- 43 meters
95	68	251	1148	1200	57°44.50 N	164°42.11 W	53	Hydrocast- 48 meters
BC2	--	251	-	-	57°04.29 N	163°19.42 W	65	Current Meter Mooring
BC2	69-81	251-252	2313	1110	57°04.31 N	163°18.28 W	66	Hydrocast (Series)- 61 meters

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography

28 October 1975

TO: Herb Bruce, Project Manager OCSEP
P.O. Box 1808
Juneau, Alaska 99802

FROM: Lawrence K. Coachman
Co-principal Investigator

SUBJECT: Bristol Bay Oceanographic Processes
Contract No. 03-5-022-67, TA 4
Response to Amended Instructions, 9 October 1975

Dear Herb:

I am forwarding these recommendations and modifications directly to you as well as incorporating them in the Progress Report because I believe them to be sufficiently important that they shouldn't "fall through the cracks".

1. Recommendations for future research

Strongly recommend that the moorings with current meters deployed fall 1975 and scheduled for recovery after one year in September 1976 be continued for a second year (9/76--9/77). The few data available from previous years show large year-to-year variations in distributions of T and S, suggesting large variability in circulation patterns. It is certain that no single year can be considered representative.

Concurrently, analysis of the year-long current records obtained in 1975-6 and the data from the 3 extensive STD surveys planned for early June, mid-summer and September 1976 should be undertaken. Analyses would be directed toward defining the gross circulation patterns in terms of the history of atmospheric events.

2. Modification of existing efforts

Strongly recommend deployment of approximately one dozen drogues to be tracked by satellite to coincide with the summer 1976 intensive STD program. Lagrangian data in conjunction with the STD data may prove indispensable in interpreting the circulation patterns from the property distributions (reconciling ambiguities, for example). The drogue measurements can be added to the program relatively cheaply. There are two alternatives: (1) AMOL extend their drogue studies in the Gulf of Alaska to include Bristol Bay in their program; (2) We contract for drogues suitable for our purpose (see enclosed letter from B. M. Buck). In either event, deployment could be in early June from the vessel engaged in mooring deployment.

I urge implementation of alternative (2), as the cost ($36,000) is very competitive and cheap and would provide us the needed results most directly.

Sincerely,

Lawrence K. Coachman
Co-principal Investigator

LKC:jd
cc: J. Schumacher
F. A. Richards
R. B. Tripp

POLAR RESEARCH LABORATORY, INCORPORATED

7 October 1975

Dr. Larry Coachman
Department of Oceanography
University of Washington
1013 N.E. 40th
Seattle, WA 98105

Dear Larry:

This is regarding our conversation at POAC 75 concerning a Bering Sea current measuring project using small drifting buoys instrumented as surface platforms for the NIMBUS 6 RAMS (Random Access Measurement System). I'd like to bring you up to date on this possibility.

NDBO (NOAA Data Buoy Office) is considering having us develop a small, economical data buoy of the type we discussed. I believe the chances of them actually funding this are very good. If they do, then we could provide you with a dozen or so of the developed systems before the middle of next year. The system they want will look something like the enclosed sketch. It will be equipped with a ribbon drogue and have a battery life of 10-11 months. The prime function of the buoy will be tracking and the only sensor information will be from a load cell in the buoy connected to the drogue line. This enables a determination of drogue presence (on their NOVA buoys they have not had much luck so far in drogue longevity). Evidently for their work they consider it important to measure true currents and want to minimize surface driven current effects - and at least to know when the buoy is in surface current control (i.e., lost drogue). The aim of the development will be to come up with a complete buoy, ready to ship and deploy for $3,000.

If you are interested in pursuing this project and can arrange for the $30-36K (10 or 12 buoys) funding, then the other action needed would be for you to contact the following man in NASA to find out the procedure for becoming a NIMBUS 6 RAMS user:

Mr. Chuck Cote
Code 952
NASA
Goddard Space Flight Center
Greenbelt, MD 20771 (301) 474-9000

123 Santa Barbara Street - Santa Barbara, California 93101 - 805 [illegible]

He can tell you what to write up and to whom it has to be sent for NASA approval. If approved, you will be given the necessary buoy identification numbers. After you install the buoys and they are working with the satellite, you will be furnished weekly with a computer printout and IBM cards (if desired) giving locations, etc. on all of your buoys. There is no charge for that service.

If you have questions on the NDBO development of COSRAMS (Continental Shelf RAMS) the man to contact there is:

Mr. Edmund Kerut
NOAA
National Data Buoy Center
Mississippi Test Facility
Bay St. Louis, MS 39520 (601) 688-2800

We *may* be able to help you out a bit further on this project in that we would construct a couple of more drifting buoys but these would be equipped with acoustic ambient noise instrumentation. If you would install these we would make available to you the tracking information. All of this hinges on approval of our Scientific Officer of course, and it has not been discussed at this point.

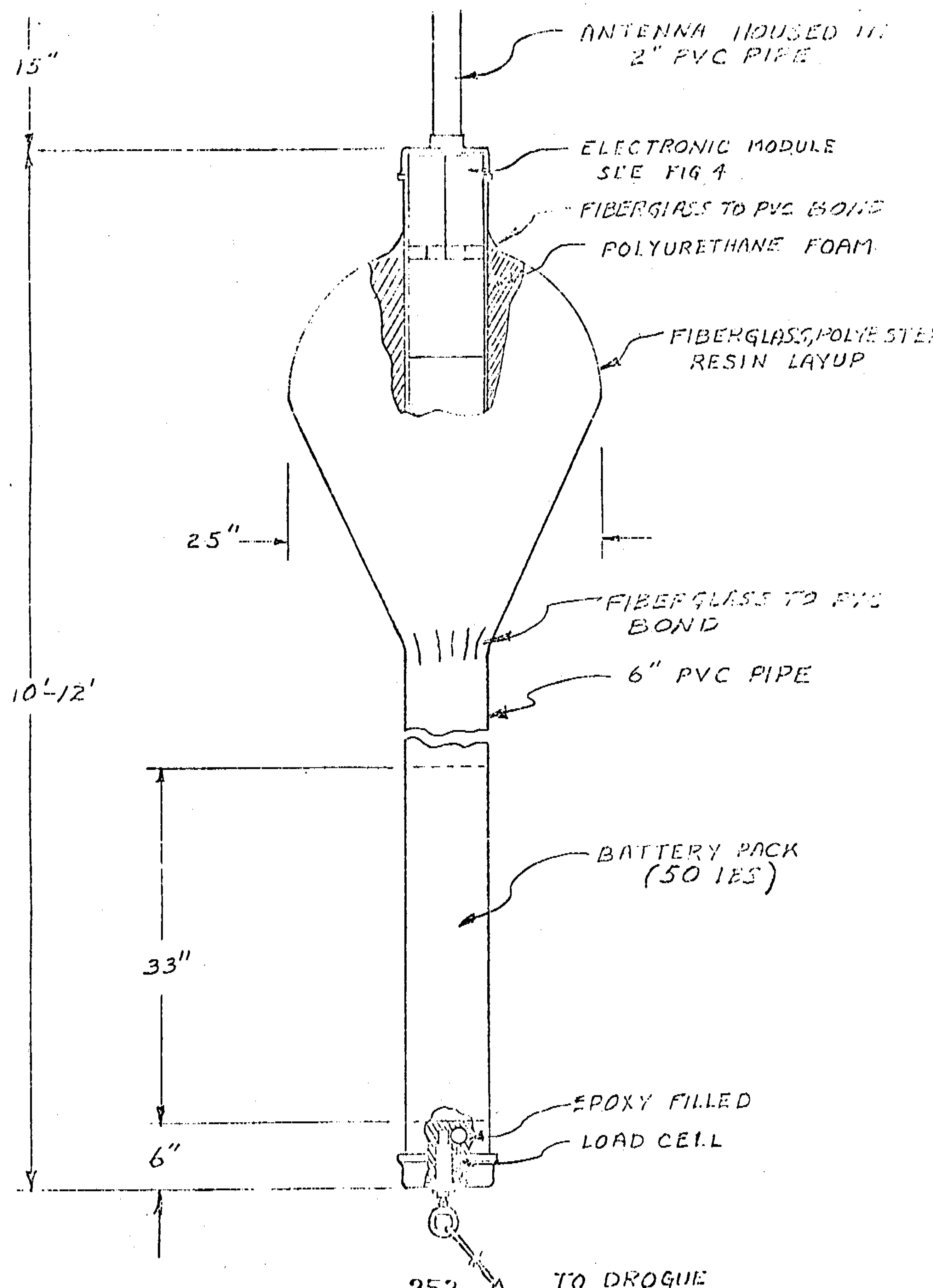
Well Larry, think it over and let me know what your thoughts are. It seems to me to be a good opportunity to get your science done at minimum cost since NDBO would be funding the development.

Sincerely,

B. M. Buck,
President

Enclosure

cc: E. Kerut


15"
ANTENNA HOUSED IN 2" PVC PIPE
ELECTRONIC MODULE SEE FIG 4
FIBERGLASS TO PVC BOND
POLYURETHANE FOAM
FIBERGLASS/POLYESTER RESIN LAYUP
25"
FIBERGLASS TO PVC BOND
6" PVC PIPE
10'-12'
BATTERY PACK (50 LBS)
33"
EPOXY FILLED
LOAD CELL
6"
TO DROGUE

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography
Cable Address: UNIWADO

29 October 1975

Dr. Gunther Weller
Project Manager
Arctic Project Office
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

SUBJECT: Semi-Annual Report for Period 1 April 1975--30 September 1975, *STD Mappings of the Beaufort Sea Shelf*, Contract No. 03-5-022-67, TA 1.

I. Objectives

To provide seasonally distributed temperature—salinity mappings of the Beaufort Sea Shelf and the dynamically related region of the slope. Such mappings are an essential prerequisite to and component of, all physical oceanographic studies of the shelf. These mappings are necessary input for the accomplishments of task elements B-2 to B-4.

II. Field/Laboratory Activities

The C-T-D system was tested in local waters prior to the first field activity scheduled for late October 1975.

III. Results

None as yet.

IV. Preliminary Interpretation of Results

None as yet.

V. Problems Encountered/Recommendations

None this reporting period.

VI. Estimate of Funds Expended

1.	Salaries	0
2.	Benefits	0
3.	Indirect Costs	0

VI. Estimate of Funds Expended (cont.)

4. Supplies and Equipment

Calibration of salinometer	820		
Plessy sensor system	17,145		
Esterline XYY' plotter	3,000		
Amergraph cable	780		
Generator	555		
Misc. supplies	364		
		Total	22,664

5. Travel 0

TOTAL EXPENDITURES 22,664

Knut Aagaard
by [signature]

Knut Aagaard
Research Associate Professor
Principal Investigator

KA:jd
cc: F. A. Richards
R. B. Tripp

November 12, 1975

TO: Project Manager, Gulf of Alaska Project

FROM: D. Hansen, Director, Physical Oceanography Laboratory

SUBJECT: Program Report on Gulf of Alaska Work

I. Task Objectives: To obtain Lagrangian current and environmental data from the Gulf of Alaska OCS.

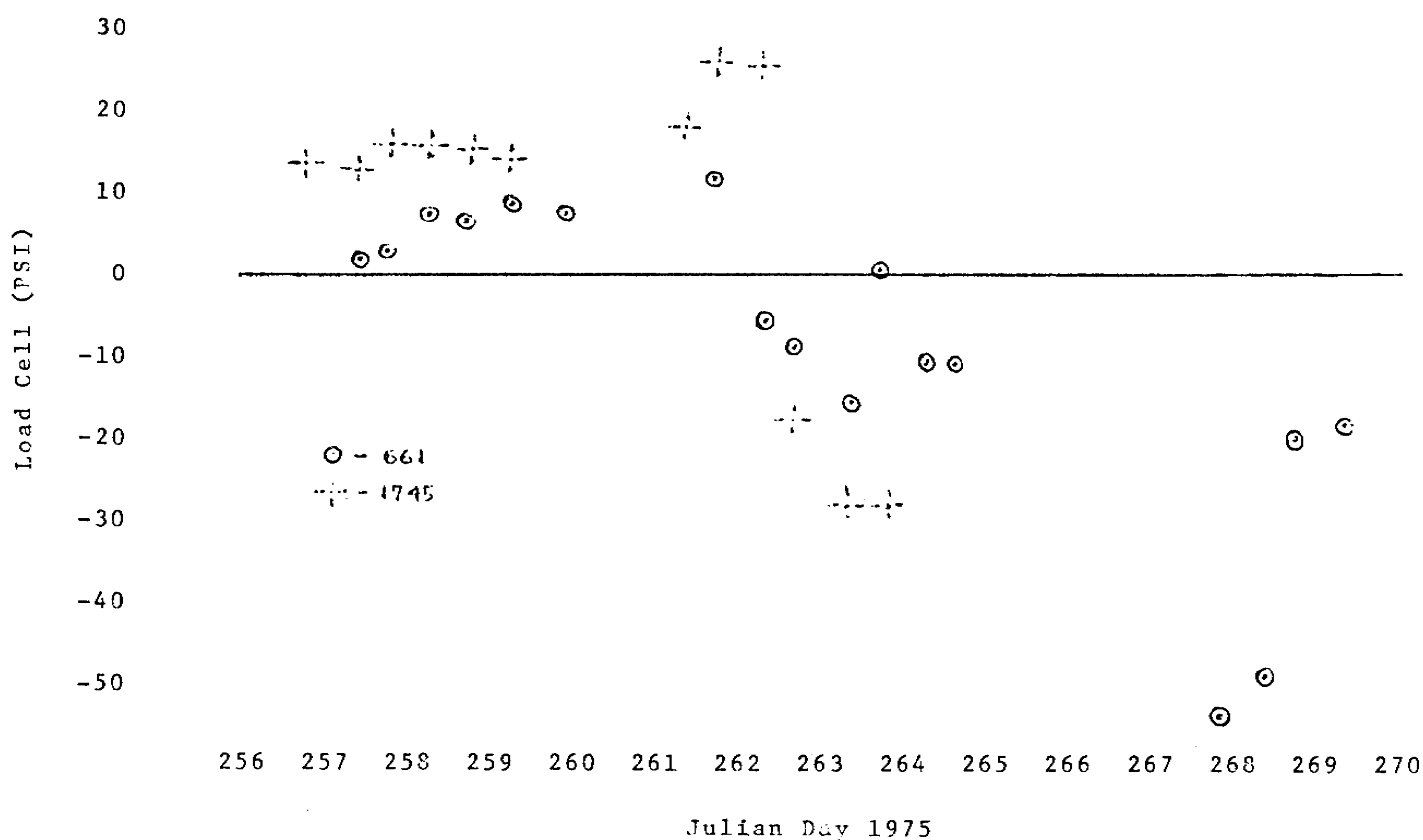
II. Activities: Three free drifting buoys were deployed from the NOAA Ship SURVEYOR on September 12, 1975. Scientific Party for this activity consisted of Mr. D. J. Pashinski of PhOL/AOML. Trajectories of the buoys developed during the ensuing period are shown on the attached chartlet. Twenty-four buoy days of position (currents) and other data were collected.

III.-IV. Results: This first attempt at making these observations must be considered a partial success. Discovery of a generic engineering defect in the buoys subsequent to shipment to Kodiak but prior to deployment forced a field modification to all three buoys. This was accomplished at Kodiak by Mr. Pashinski. The modification seems to have been very successful on two out of the three buoys, but structurally weakened the third to the extent that it survived at most a few hours at sea. The two buoys that functioned satisfactorily provided short but interesting records. Perhaps because they were deployed in the lee of Fairweather Ground, both operational buoys depicted eddy motions with little net motion for several days after deployment. Ultimately, both moved closer inshore and evidently became entrained in a coastal jet. The buoy initially deployed closest inshore (25 miles) entered the jet first, and subsequently moved rapidly ($\sim$ 25 miles/day) alongshore and ultimately grounded on Cape Suckling. The second buoy, after becoming entrained in the coastal jet, but more than 120 miles behind the first buoy, ceased functioning without explanation at almost the same time that the first buoy went aground. It may also have lost its sea anchor and gone ashore.

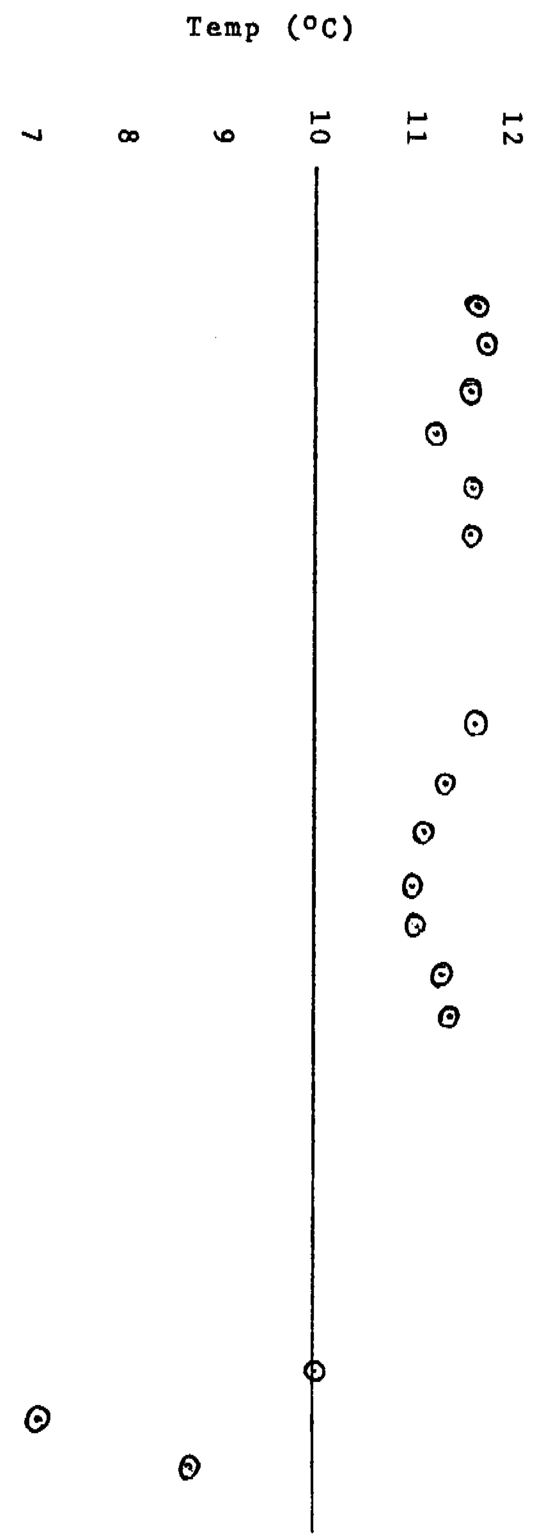
Although the lifetime of these buoys was only about one tenth of what was hoped for, the discovery of the coastal jet close inshore may turn out to be of great significance to the investigation. As an absolute minimum accomplishment, we have obtained one data set suitable for scenario fabrication for a pollutant trajectory from several possible points of origin on the OCS in the vicinity of Yakutat Bay that impinge upon Cape Suckling.

V. We believe that the generic buoy problem has now been solved so that future depoyments should be characterized by greater reliability, at least independently of the more severe weather conditions expected through the Winter. The November deployments are to be made somewhat farther to the lee of Fairweather Ground in order to obtain measurements more typical of the general OCS region.

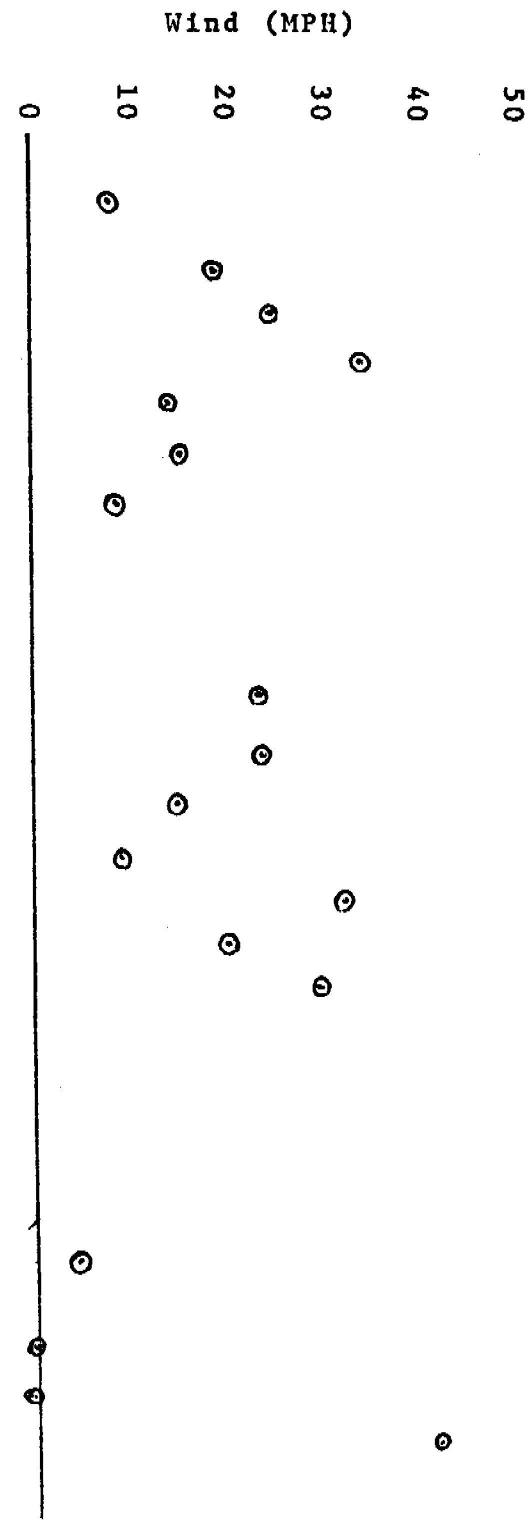
VI. Estimate of funds expended: Approximately $60 K of the $98 K allocated have been expended to date, but the ERL budget office is the office of record, and due to a change of computer systems in Boulder, we have not had a complete statement of costs since 2 August.

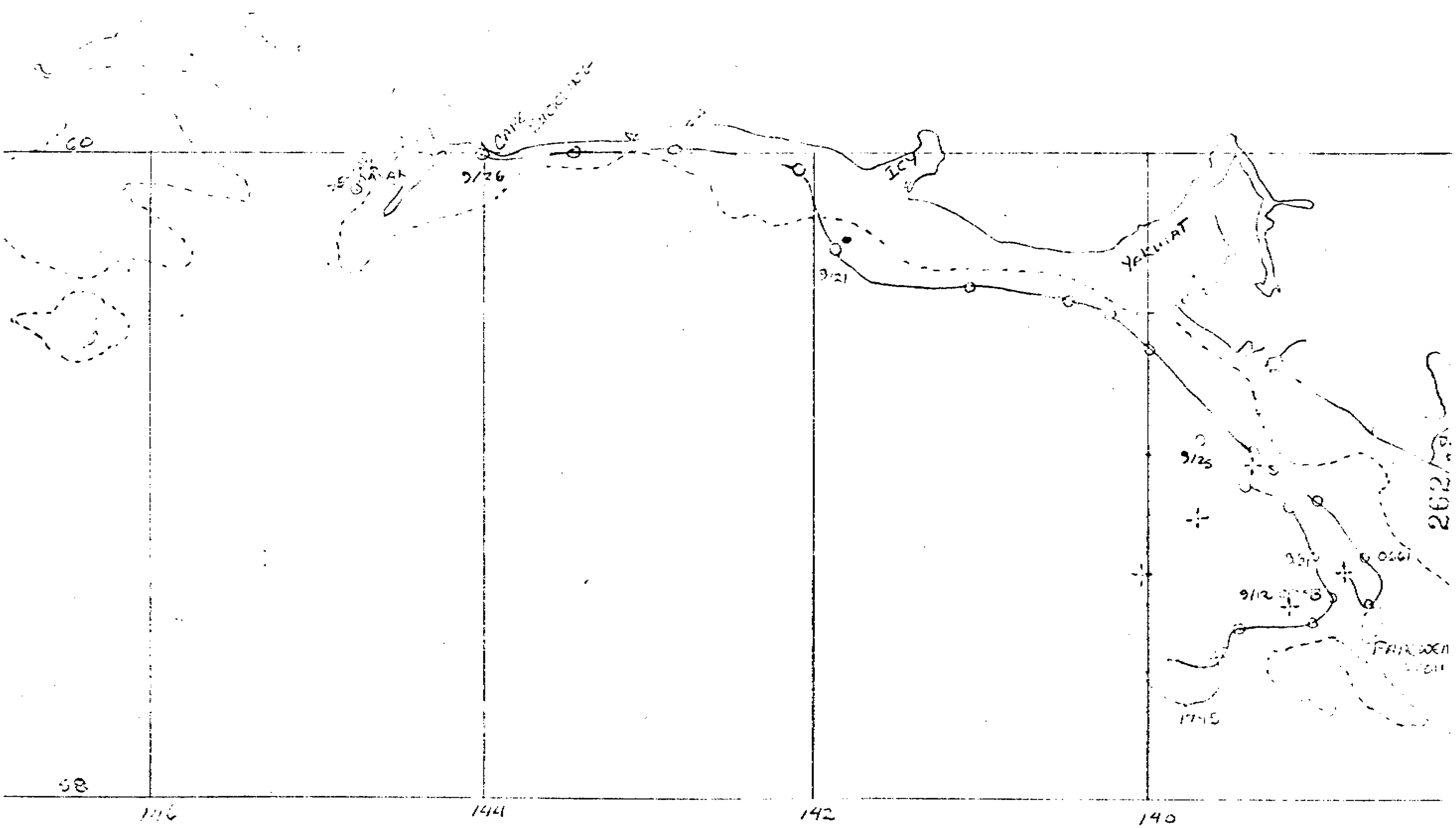


Load Cell (PSI)
30
20
10
0
-10
-20
-30
-40
-50
⊙ - 661
+ - 1745
256
257
258
259
260
261
262
263
264
265
266
267
268
269
270
Julian Day 1975



Temp (°C)
7
8
9
10
11
12


Wind (MPH)
0
10
20
30
40
50



OCSEP DRIFT PROGRAM

PHASE I 9/12 → 9/21

ENVIRONMENTAL PREDICTION RESEARCH FACILITY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93940

IN REPLY REFER TO:
NEPRF/TL:st
3900 A.1
16 Oct 1975

From: T. Laevastu
Department of Oceanography
Environmental Prediction Research Facility
Naval Postgraduate School
Monterey, CA 93940

To: Dr. Herbert E. Bruce
Project Manager
Gulf of Alaska-Bering Sea Projects
U.S. Department of Commerce, NOAA
Environmental Research Laboratories
P.O. Box 1808
Juneau, Alaska 98802

Subj: Progress Report, Research Unit 235

I. Task objectives.

Preparation of Hydrodynamical-Numerical and 3-parameter small-mesh atmospheric models for coastal waters in the Gulf of Alaska.

II. Field or laboratory activities.

None.

III. Results.

A. Two-layer Hydrodynamical-Numerical (HN) models have been programmed for three areas along the Alaskan coast with overlapping boundaries. The models have been debugged and tested with tides (examples enclosed).

B. Small-mesh 3-parameter atmospheric model with oceanic feedback has been programmed and debugged for Gulf of Alaska (example of surface pressure output after 36 hours prediction enclosed).

IV. Interpretation of results.

The testing and verification of the models (both HN and 3-parameter atmospheric models) is in progress, but lack of funds (see below) hampers this work. The preliminary results of testing indicate that the models correspond to our optimistic expectations.

NEPRF/TL:st
3900 A.1
16 Oct 1975

Subj: Progress Report, Research Unit 235

V. Problems.

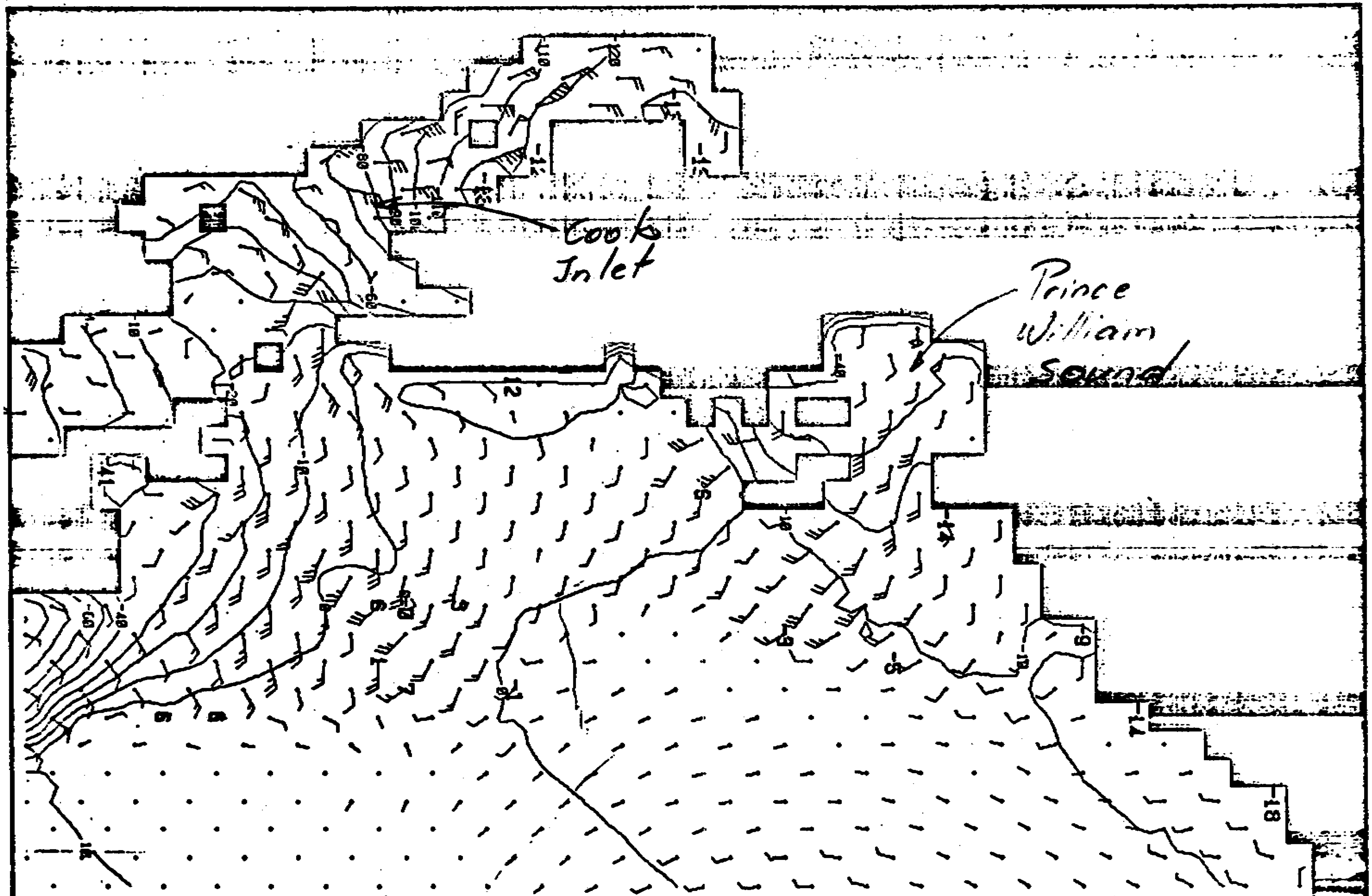
Only $15,800.00 has been transferred to us so far. We have not been able to let the subcontracts for preparation of climatology and for preparation of initial analysis (the latter for atmospheric model).

We have reached the final stage of the project where we need to write the report and programme documentation (involving considerable amount of typing and drafting). We are experiencing difficulties in obtaining these timely services from our organization. If these conditions continue, we will contact OCS Programme Office for help.

VI. Estimates of funds expended.

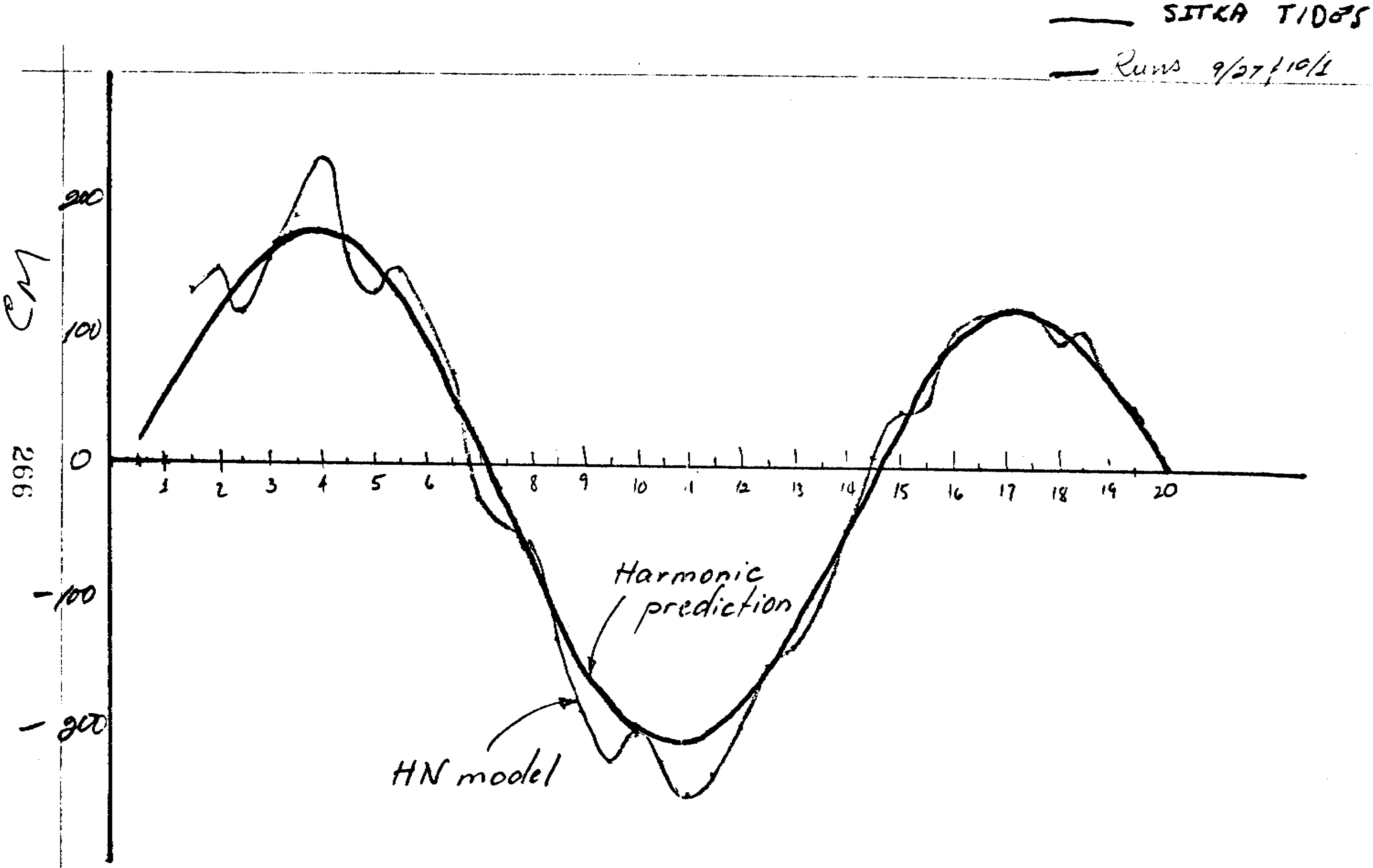
(See V above).

Taivi Laevastu

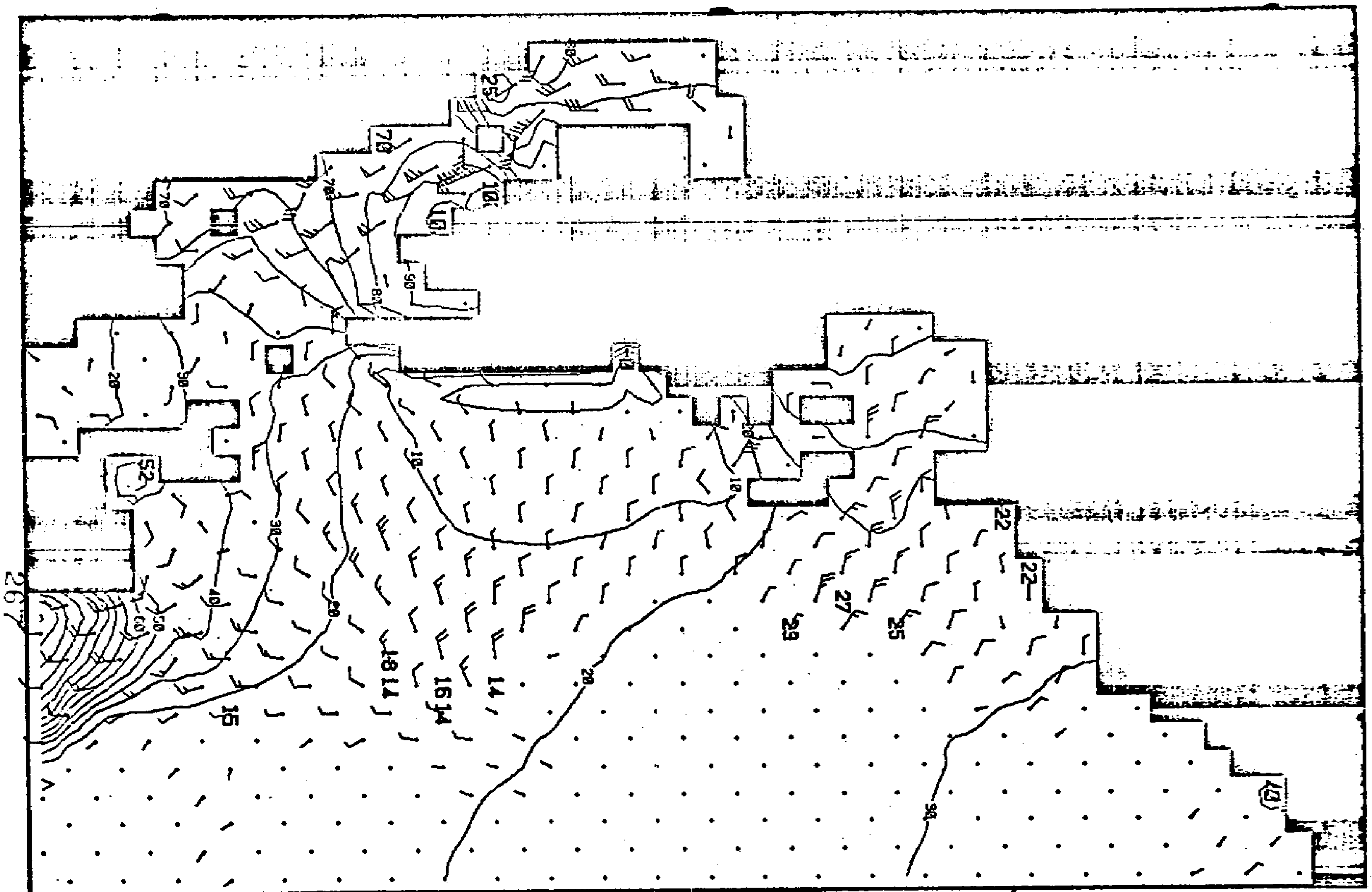


Currents and sea level 3 hours before High Water at Kodiak
(Max. ebb at Cook Inlet)

LAYER 1. TIME(S.) 54000.

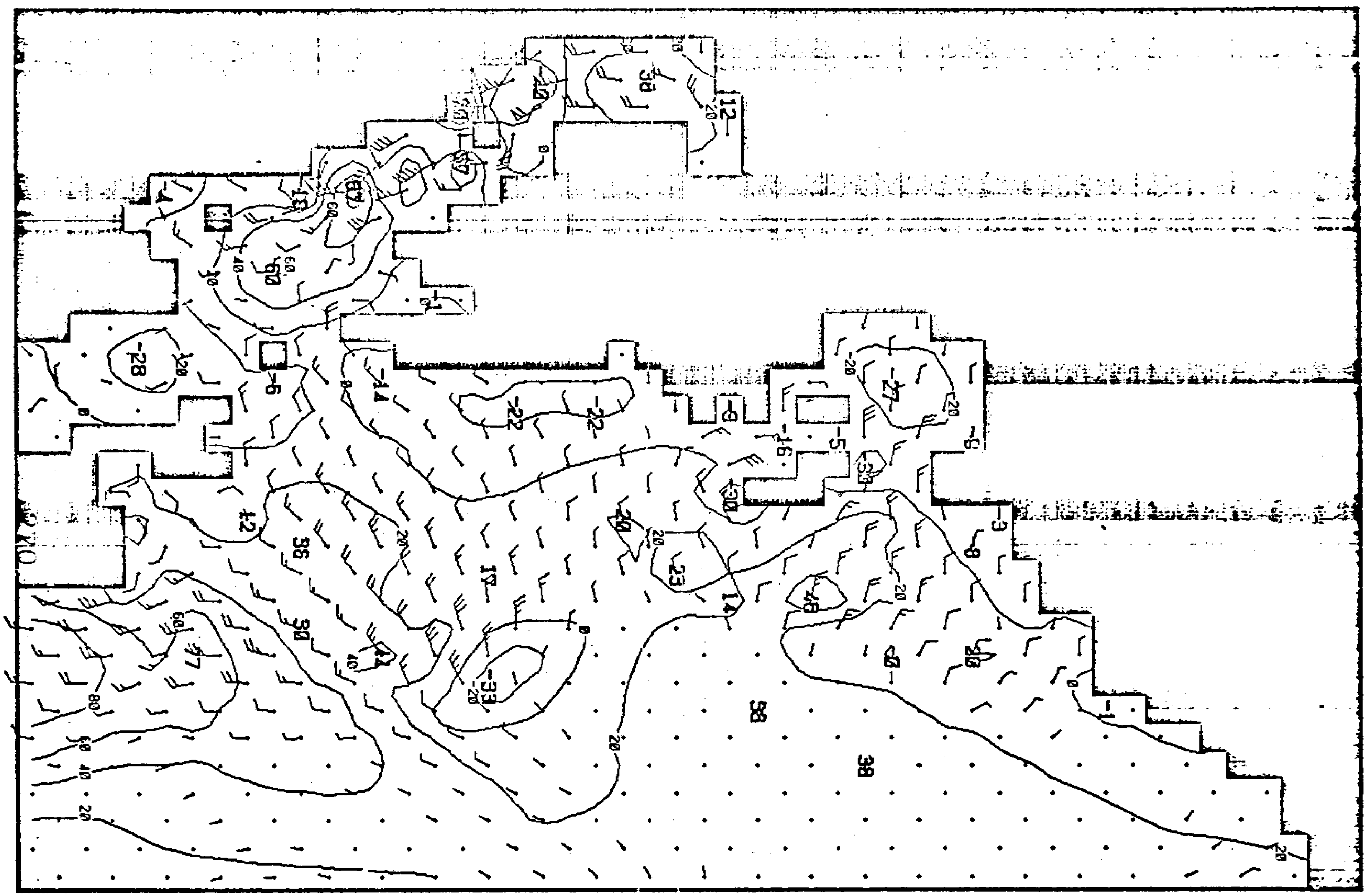


Comparison of tides at Sitka, as predicted with harmonic method and as computed with HN model

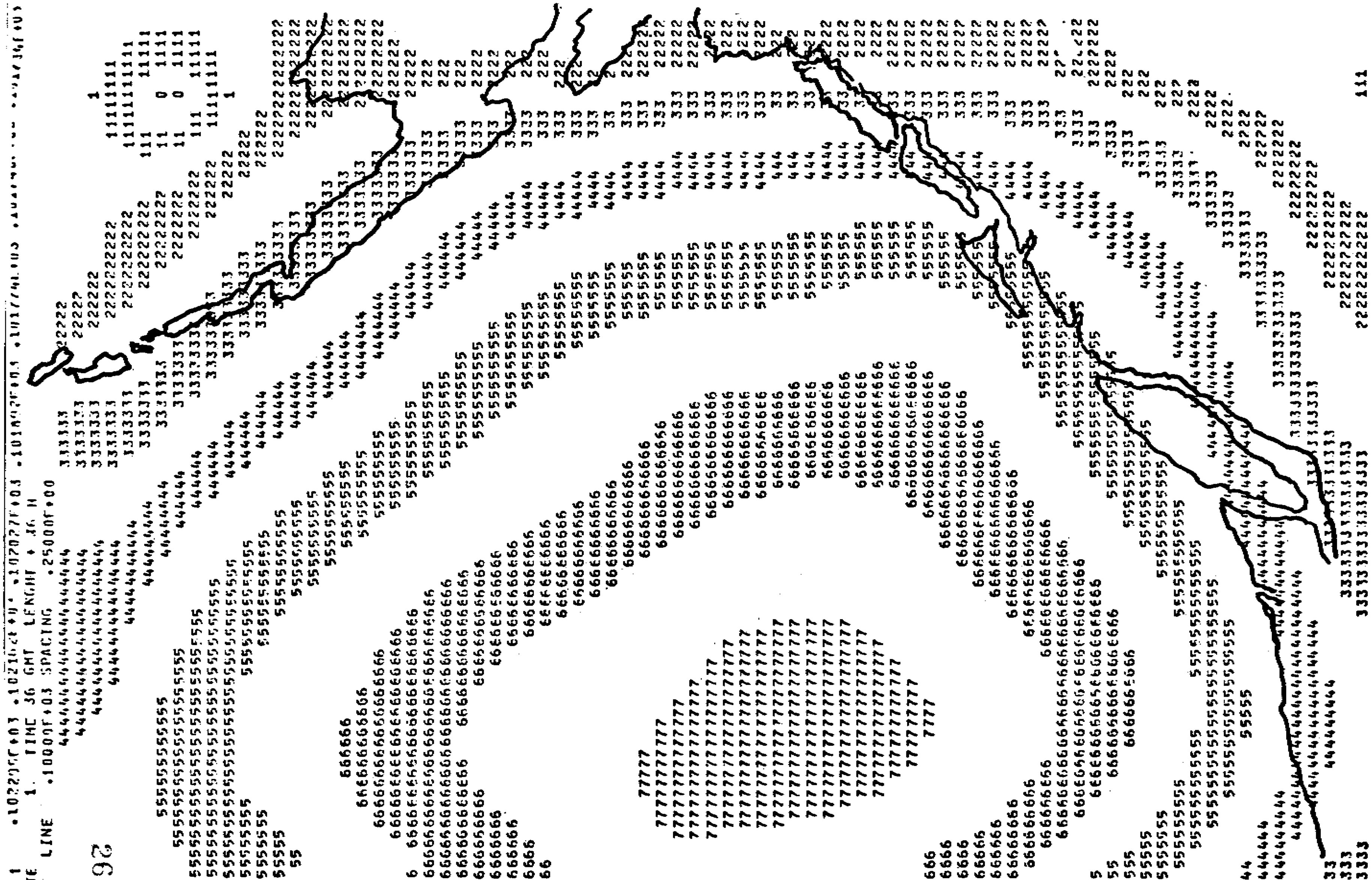


Currents and sea level at Low Water at Kodiak
(Max flood at Cook Inlet)

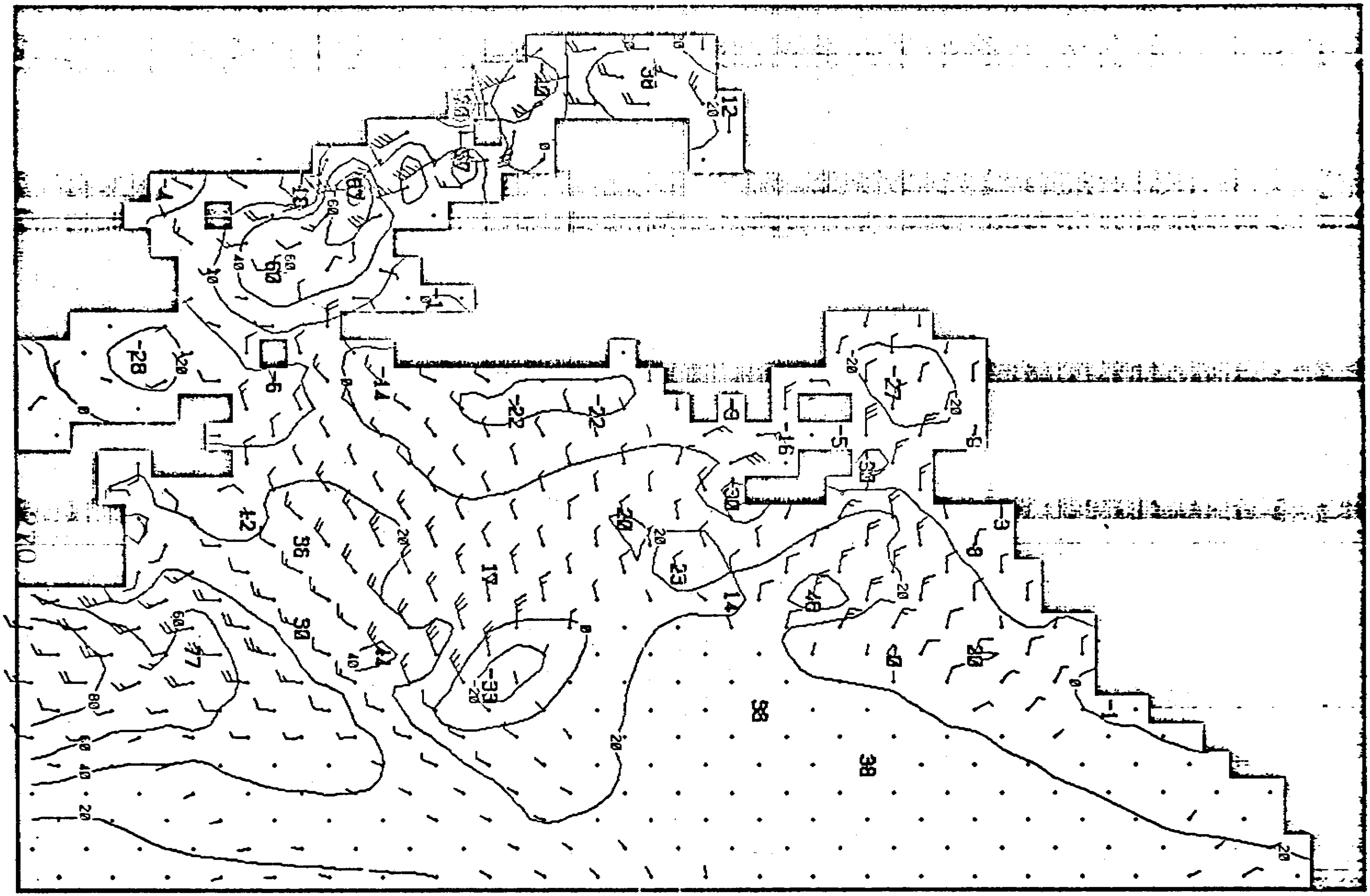
LAYER 1. TIME(S.) 72000.



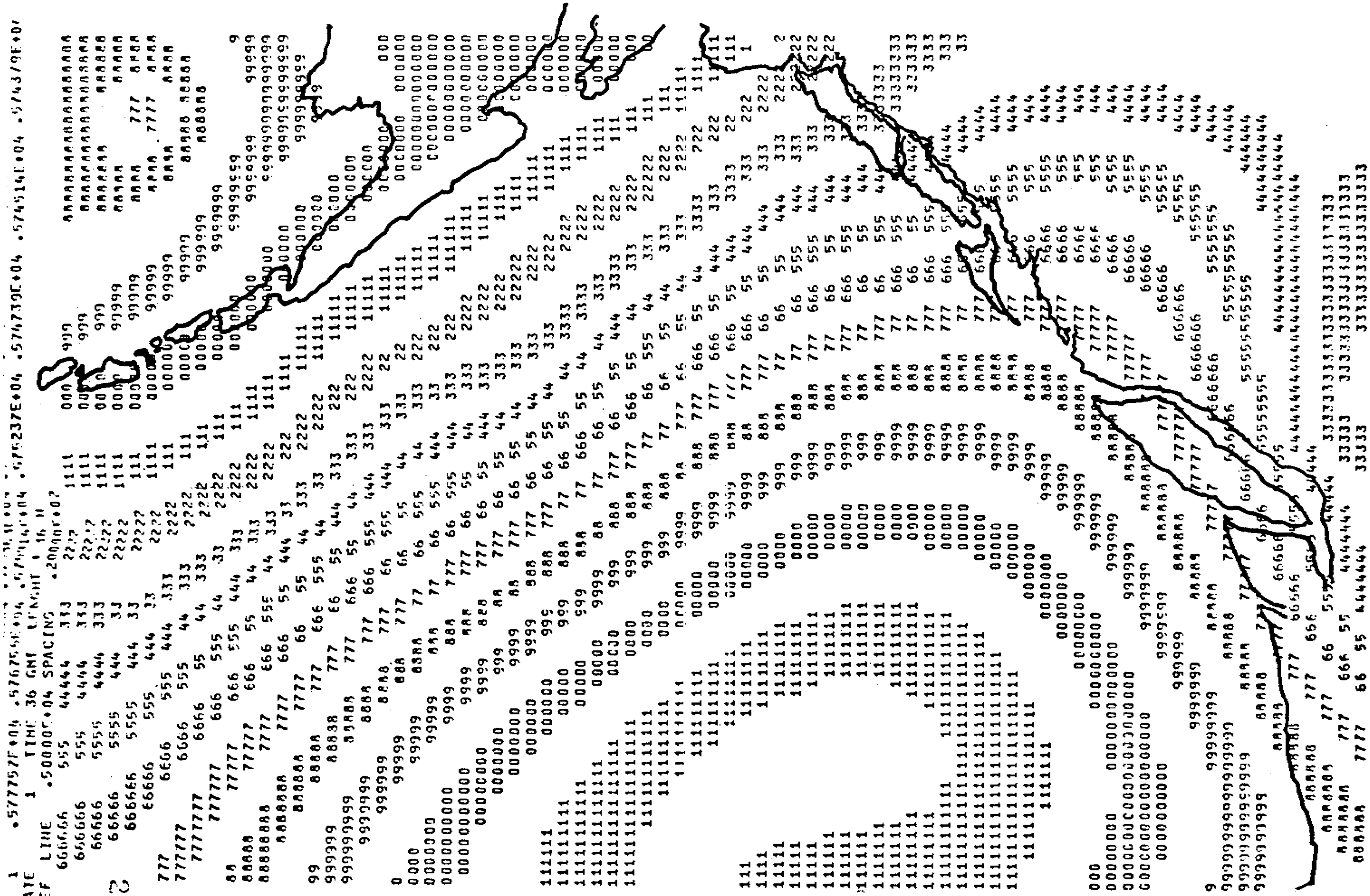
LAYER 2. TIME(S) 72000.



36 hours surface pressure forecast for 00Z 1 June 1973



LAYER 2. TIME(S) 72000.



36 hours 500 mb forecast for 00Z 1 June 1973

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Mesoscale Currents and Water Masses in the Gulf of Alaska

Contract Number: 03-5-022-56

Task Order Number: 19

Principal Investigator: Dr. Thomas C. Royer
Associate Professor
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

To begin gathering hydrographic data over the continental shelf region of the Gulf of Alaska for both the eastern portion, GASSE (Gulf of Alaska-East) and the western portion, GASSO (Gulf of Alaska Shelf Study-Other). Begin a permanent current and sea level station in the Gulf of Alaska.

II. Field Activities

Project personnel participated in two legs of a cruise aboard the SILAS BENT in the Gulf of Alaska from 31 August to 14 September and 17-28 September 1975. A total of sixty-five hydrographic stations were occupied in GASSE with five of them located in Prince William Sound. Salinity-temperature-depth (STD) measurements were taken at each station. Sixty-three hydrographic stations were taken in GASSO. The permanent current meter array site was established on 18 September at station 9 (58°41.7'N, 148°24.9'W) with an array containing five Aanderaa current meters and a sea level gauge. It is expected that this array will be renewed on subsequent cruises.

III. Results

Data from previous cruises is being worked up as data reports giving details of the hydrographic data gathered in FY 75. A final report for the previous year's work was written. It is expected that the SILAS BENT data will be available in final form from this office by 15 October.

IV. Problems Encountered

The late scheduling of a ship for the August cruise presented some problems with personnel scheduling. However, the SILAS BENT proved to be an agreeable substitute. There are some difficulties in transferring personnel and equipment in Kodiak. For example, the SURVEYOR was to transfer gear to Seward, but due to organizational problems aboard, we never offloaded the equipment in Seward. No serious consequences will arise from this situation, only some inconvenience.

The tapes containing the NODC hydrographic data for the North Pacific obtained from the NORPAX (North Pacific Experiment) office had areas of missing data. We expect new tapes in the next few weeks.

In July, a request for the U.S. Coast Guard data for their North Pacific lines was made to both Dave Drury in Boulder and the OCSEP office in Juneau. No response has been received on this request.

V. Estimate of Funds Expended

	Total Budget	3-mos Expended*	Remaining
Salaries & wages	132,358.00	9,669.19	122,688.81
Staff Benefits	22,501.00	1,643.76	20,857.24
Equipment	31,000.00	295.00	30,705.00
Travel	8,719.00	1,383.74	7,335.26
Other	22,100.00	561.03	21,538.97
Total Direct	216,678.00	13,552.72	203,125.28
Indirect	75,708.00	5,530.78	70,177.22
Total Cost	292,386.00	19,083.50*	273,302.50

* Preliminary data, not yet fully processed.

Quarterly Report for Quarter Ending September 30, 1975

Project Title: Statistical and Historical Data Analysis and Ship-of-Opportunity Program for the Southeastern Bering Sea

Contract Number: 03-5-022-56

Task Order Number: 14

Principal Investigator: R. D. Muench
Chief, Ecological Research
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

Obtain historical data and integrate them into historical and statistical data analyses. Obtain data from ships-of-opportunity and incorporate them into the historical and statistical data analyses.

II. Field Activities

CTD data were obtained during two cruises on the R/V *Discoverer*; one in June 1975 and one in August 1975.

III. Results

Data from past IMS cruises carried out in the Bristol Bay - Unimak Pass region from 1965 - 1970 have been partially analyzed. Presence of an apparent upwelling area in central Bristol Bay has been verified. The region of upwelling north of Unimak Pass has been investigated. The general regional fields of temperature, salinity, dissolved oxygen and inorganic nutrients have been characterized for those times of year (summer) during which data are available.

IV. Problems Encountered

The historical data tapes obtained from EDS(NODC) were defective, causing delay to the point where useable data have still not been obtained from this source. The data from the *Discoverer* June 1975 cruise was only received here from EDS on 23 September, and therefore it has not yet been analyzed; this tape is also proving defective. This delay between data acquisition in the field and receipt of the preprocessed tape is unacceptable, and some faster way of data flow must be found.

V. Estimate of Funds Expended

	Total Budget	(6 months) Expended*	Remaining
Salaries & wages	43,724.00	5,187.65	38,536.35
Staff benefits	7,399.00	857.75	6,541.25
Equipment	2,500.00	2,510.00	(10.00)
Travel	5,774.00	712.37	5,061.63
Other	7,400.00	581.92	6,818.08
Total Direct	66,797.00	9,849.69	56,947.31
Indirect	25,009.00	2,967.34	22,041.66
Task Order Total	91,806.00	12,817.03*	78,988.97

* Preliminary data, not yet fully processed.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY
200 S.W. 35TH ST.
CORVALLIS, OREGON 97330

December 3, 1975

RECEIVED

DEC 1 1 1975
907
OCS PROGRAM
OFFICE

Dr. John H. Robinson
Outer Continental Shelf Energy Program
NOAA, ERL
Boulder, CO 80302

Dear Dr. Robinson:

Enclosed is a report entitled "Transport of Pollutants in the Vicinity of Prudhoe Bay, Alaska" describing progress on the project assigned to the Coastal Pollution Branch under terms of the Department of Commerce-EPA Interagency Agreements R5-0813 and R6-0813.

Due to the nature of the field program, Mr. Callaway arranged with Dr. Weller to submit a semi-annual report rather than two quarterly reports.

The requirements of the Data Management Article in the IAG are being pursued in discussions between Mr. Pelto and Mr. Callaway. At present, the data format available is not able to accommodate the tide data acquired in our project.

The financial status of the project is as follows:

I. Agreement # R5-0813
    Allocated: $29,100
    Spent: 29,100

II. Agreement # R6-0813
    Allocated: $ 7,000
    Spent: 4,200

The remaining balance will not be sufficient to complete the non-field portion of the project. The budget needs for the remainder of the fiscal year will depend primarily on whether or not a field data collection effort can be considered in the 1976 summer season. We recommend this field effort and would question the value of pursuing the project any further if it were not to be considered feasible.

Other budget needs include revised expectations for computer, travel, and personnel costs. An estimate is being prepared which can be provided according to any program requirements or restraints you wish us to consider. In the meantime, the balance of the funds will be spent primarily on computer costs and salary for a student intern working on the mathematical model applications.

Sincerely yours,

D. J. Baumgartner

D. J. Baumgartner, Chief
Coastal Pollution Branch

Enclosure

cc: Dr. McErlean
Regional Administrator, EPA, R-X

TRANSPORT OF POLLUTANTS IN THE VICINITY OF PRUDHOE BAY, ALASKA

SEMI-ANNUAL PROGRESS REPORT TO BLM/NOAA
OUTER CONTINENTAL SHELF PROJECT
JUNE-NOVEMBER 1975

Richard J. Callaway
Principal Investigator

Chester Koblinsky
Co-Investigator

Coastal Pollution Branch
Corvallis Enviromental Research Laboratory
Environmental Protection Agency
200 SW 35th St.
Corvallis, Oregon

Conducted with NOAA funding under Interagency Agreement R5-0813 + R6-0813

INTRODUCTION

This semi-annual report discusses aspects of the Prudhoe Bay Pollutant Transport project which is part of the BLM/NOAA Outer Continental Shelf Program.

The main purpose of the project was to apply a multi-layer numerical circulation model to Prudhoe Bay and its vicinity in order to determine flushing rates, transport, and retention times of pollutants. The obvious application is to oil spills, of course.

Verification data were to be obtained during the 1975 ice-free season, the USCG cutter *Glacier* was to be used for installation of current meters and tide recorders offshore. The *Glacier* was loaded in Kodiak and boarded in Barrow by one of us (RJC). The mission was aborted, however, due to the heavy pack ice around Barrow and because of commitment of the Coast Guard regarding the barge fleet attempting to put into Prudhoe Bay. Although gear setup was completed on board the *Glacier*, there were several parties onboard who seemed to have first call on ship time. This point is discussed further later on.

Although the main part of the verification field program was not carried out, limited data were obtained on tides in the region. Further, modeling schematization and trial runs have been conducted. The main part of this report discusses these aspects.

Tide Recorder Installation

Two Bass Engineering optical lever tide recorders were installed inside Thetis and Stockton Islands. These were prepared in Barrow at the Naval Arctic Research Laboratory (NARL) and installed from float planes on August 7, 1975.

The recorders were mounted on tripods, fitted with a 50 pound weight and lowered to the bottom with polypropylene rope. A 14" diameter Viny buoy was used as a marker. Table 1 gives statistics on the recorders.

Upon their return to Corvallis from the field experiment, the recorders were dismantled, examined for damage, and cleaned. No physical damage to the instruments themselves was observed. The data records from the enclosed Rustrak recorders were then examined visually for content and time marks annotated. Both records showed inner record gaps although both were functioning at the time of installation and at the time of recovery. Time, a critical variable in tide measurements, was kept accurately by both instruments. The mechanisms' inner record gaps, created by friction in the scale shift mechanism, were speculated to be due to the extremely low temperature of the underwater environment on the electronics.

To check the effect of low temperatures and to keep track of accuracy, post-experiment calibrations were done on the instruments at both room temperature and at 0°C. The room temperature calibrations were done to compare with the last pre-experiment calibrations which had been performed by Bass Engineering. The calibrations were performed using a method similar to that of Bass using a controlled pressure head. The cold temperature calibration was performed by placing the instrument in a controlled temperature bath of fresh water. Instrument response to rapid temperature changes was also performed.

The data records from the experiment and calibration were sent to the Oregon State University Computer center for digitization. This project has recently been completed and the data is now under analysis. The data handling scheme for the tidal records is diagrammed in Figure 1.

The original intent of employing two tide recorders was to allow for use of Fourier methods on the data to determine the phase and amplitude of the major tidal constituents and to determine the direction of incidence of the tidal waves. After scanning the raw data we retrieved we became pessimistic that the use of Fourier methods would be possible considering the overall length of records and the density of inner record gaps. Digitization, however, was still deemed worthwhile since it would increase the accuracy of the transfer equation and permit the possible use of advanced data analysis tools to fill in some of the gaps by curve fitting and interpolation schemes.

Other Equipment

Four Aanderaa current meters and two Aanderaa tide recorders were to have been installed about twenty miles offshore. The current meters were purchased; the tide recorders were rented at an outrageous price - the money for rental was lost since the instruments were not used. Such are the problems one encounters while trying to cut corners and save money because of time and budget constraints.

EPA sonic release mechanisms were to be used; the entire system was readied for use on board the Glacier. A similar arrangement is envisioned for the 1976 season (if there is such).

MODEL PROGRESS

The computational model for describing the ocean mass transport is comprised of three phases the first being for grid building, editing and setting of initial values. The second phase is the main computational scheme and the third phase is for output handling by a plotter including specialized data handling features such as tidal ellipses and progressive vector diagrams at specified points. All three phases have been in operation by CERL since May 1975 with phases II and III being subject to revisions by both ourselves and Compass Systems. At present, phases I and III are used on the Oregon State University CDC 3300 and phase II on the Bonneville Power Administration CDC 6500. A project to convert phase III to the BPA CDC 6500 is nearing completion to take advantage of the obvious increased use of data transfer from Phase II to Phase III and the superior plotting facilities. A fourth phase or addition to the third phase is the inclusion of an advection model that will compute the pollutant dispersal by advection. The addition of this program, which we have in hand as a CDC 1604 version, to our BPA CDC 6500 program library will take place as soon as the conversion of Phase III is completed. The addition of plotting routines to handle the output from the advection program in the form of contour maps will be added by one of us (CJK) in the future.

In the meantime, initial runs have been made on Prudhoe Bay using 1/4 nm horizontal spacing between computation points (Fig. 2). With this model we have made short runs to check stability and the effect of variation of various input parameters e.g. tide phase and amplitude and wind and bottom stress coefficients.

We are now in the process of schematizing grids of even finer mesh resolution at 1/4 km distance spacing. These grids are obtained by digitizing the bottom topography shown on the Original Hydrographic Survey of the Coast and Geodetic Survey (now National Ocean Survey (NOS)) with reference to the latest NOS nautical charts of the area. The inclusion of the new ARCO unloading dock has been made via a drawing we have obtained thru EPA's Anchorage Office. In this regard, and for other facets of the model as will be pointed out later, airplane photographs would be helpful and we are awaiting the release of the June - October 1975 photo's. We envision presently two different configurations for the fine mesh grid. The first, which is completed and being transferred now to punch cards, is bordered on three sides by land and on the forth by a line passing through Gull Island, starting in the Niakuk Islands and ending on the western shore of the bay approximately 1 mile east of the ARCO wharf. The second will be a larger grid, initially stretching from Long Island, North of Gwydyr Bay, to Foggy Island at the mouth of the Sagavanirktok River and will include all points shoreward. (See Figure 3). However, due to the extent of this grid, we will only be able to use smaller sections of it for any one computational run. This grid is now in the process of being schematized.

Our largest grid will include the area between Cape Halkett and the Canning River mouth. However, work on this grid has not begun yet nor will it start until the work on the smaller grids is well along.

DATA ACCESSIONS

The computational model requires the input of various sets of previously acquired data from the study area. These data input include: tidal information, the winds during the time of model simulation, river input, hydrographic information, and submarine topography and land boundaries.

The acquisition of the first and the last of these items has been described in Sections II and IV, respectively.

Data for the other three items have been scarce for the months of July and August, 1975. For hydrographic information we know of none therefore must rely on previous measurements taken in the years 1950-1972 that have been filed at the National Ocean Data Center and a few other isolated measurements. Unfortunately, most of these measurements have been taken too far offshore to be of much help in determining the stratification of the near shore regions which becomes important when extending the model to include more than one layer.

Meteorological data is more prevalent and we have ordered copies of the archived files at the National Climatic Center for June - October of 1975 from the stations at Nome, Barrow, Deadhorse and available data sent to NCC from any other operating station near the Beaufort Sea. The reason for acquiring the Nome data is to compare its pressure records with Barrow's. This can lend some insight into the general ocean dynamics of the Southern Beaufort Sea ala Mountain (1974). Wind records will be smoothed by averaging depending on the sampling density for input to the model. If sufficient stations are available and variation from station to station deemed large enough in the wind vector a weighting scheme as used by Platzman (1963) may be employed.

River flow data is very good for the Kuparuk, Sagavanirktok and Putuligayuk Rivers since they all have working gauges near their mouths which are serviced by the USGS. We will be acquiring this data for June thru October 1975 as soon as it is available. Unfortunately, the Colville River, which has the largest flow, especially in ice free season, is not gauged. We have been able to obtain some flow information gathered by Walker of Lousiana State University for 1962, which will act as our guess justification in the larger scale models. Flow information is also not available for the Saviovik or Canning Rivers. Although these are less substantial than the Colville, they will play a role in the larger grid. In relation to river flow information it may be that airplane photographs could provide a great deal of information. I. R. photographs in particular may be able to aid us in seeing the effect of river flow on the near shore circulation patterns.

MODEL MODIFICATIONS

In conjunction with another project being carried out by CERL, computer program modifications are being performed by Compass Systems, Inc. These modifications will be put to use in the Beaufort Sea Project as their timing leads that of our project.

In essence, there are three sub-objectives that will be used:

1) inclusion of non-linear convective terms in those situations where they are required. Testing of the affect of the terms around simulated islands has been completed and the stability of the computational scheme has been assured.

2) Inclusion of a routine to allow for uncovering shallow areas during offshore wind conditions or surges. These conditions do occur in the shallow shelf waters and may be quite important in the evaluation of pollutant transport.

3) Comparison of various types of dispersion schemes. An attempt to eliminate the numerical dispersion inherent in explicit schemes is being tested. A Monte Carlo dispersion scheme is also to be tested which <u>might</u> have applicability to pack ice flow.

DISCUSSION

Because of the unusual ice year, our planned field investigation didn't get off the ground (or out to sea). This could, of course, occur again next year but it is assumed that a persistency forecast doesn't apply to seasonal happenings.

The possibility of not being able to carry out the very simple field program we had envisioned exists even though the ice season may be ideal (in 1976). This is due to committments of the Coast Guard to allocating the prime ship time to CG personnel. This is certainly to be expected and we were made aware of this in the 1975 survey. It would, however, be highly desireable to pursue alternative ship or helicopter installation and retrieval of our instrument packages.

Because of the extreme hassle on rental of tide recorders we are not anticipating their use in 1976 unless they can be purchased outright.

Considerable money was expended transporting equipment and personnel to: Kodiak to onload the Glacier; 2) to Barrow to board the Glacier; 3) to Long Beach to off load the Glacier; 4) to Fairbanks for discussions with project, university and government personnel. These monies were, for the most part, lost. In order to complete the project additional money will be required. These figures, plus money for possible project modification will be given in the annual report.

REFERENCES

Mountain, D. G. 1974. Bering Sea water on the North Alaskan Shelf. PHD Thesis. Univ. Wash. 147 pp.

Platzman, G. 1963. The dynamical prediction of wind tides on Lake Erie. A.M.S. Meteorological Monographs Vol. 4 #26, 44 p.

TABLE 1

Tide Recorder Data, Beaufort Sea, 1975

Inst.#	Location	Date Installed	Time (AST)	Date Recovered	Time (AST)	Lat. °N	Long °W	Depth	Remarks
117	Stockton I	Aug 7, 1975	1414	Aug 29, 1975	1222	70°17.5'	147°01'	10 ft.	
121	Thetis I	Aug 7, 1975	1520	Aug 29, 1975	1114	70°33'	150°10'	8 ft.	Possibly submerged in mud. Damage to rear pedestal leg.

DATA PROCESSING PROCEDURES FOR SEA LEVEL DATA OBTAINED AUGUST,1975.

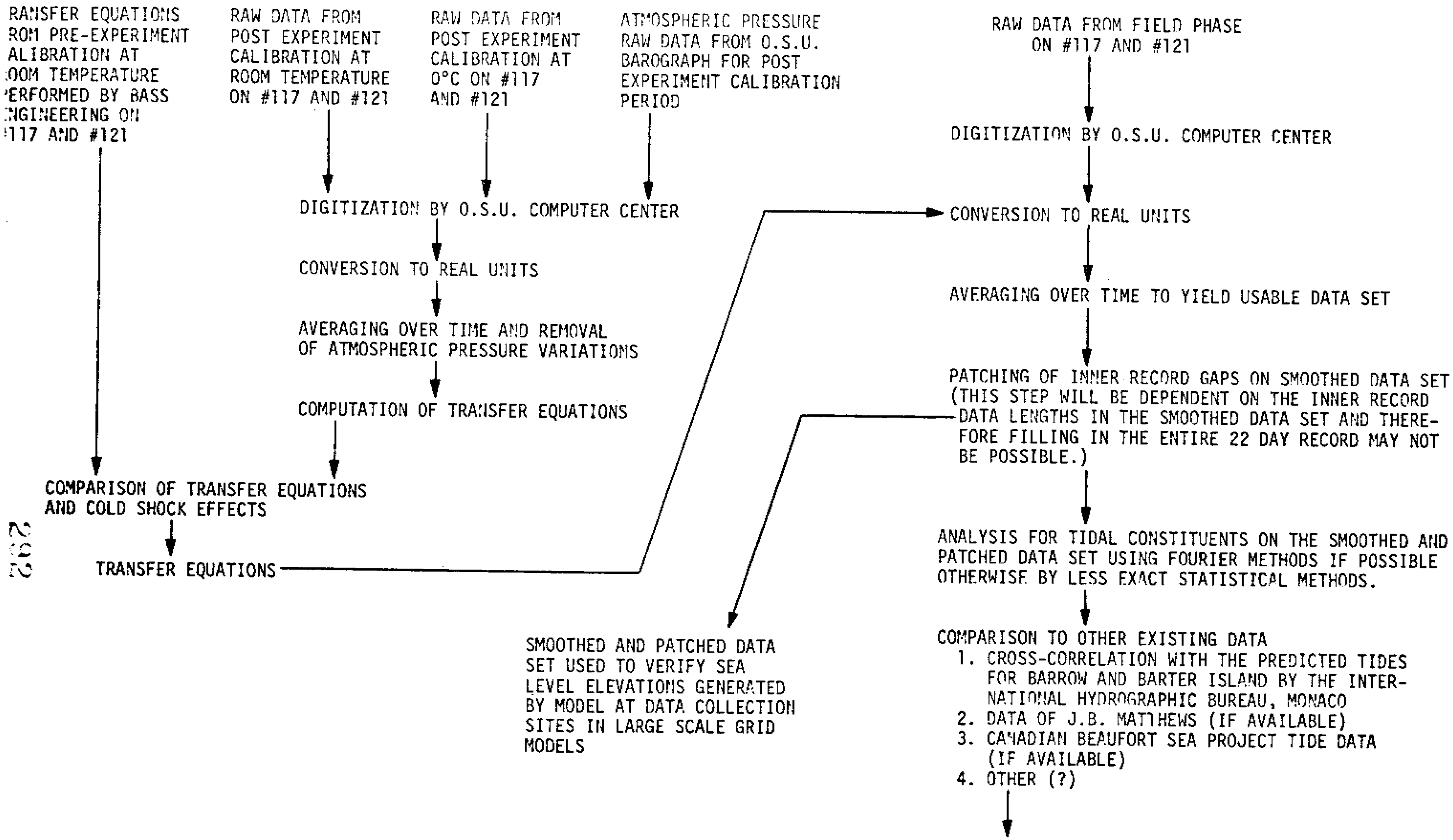
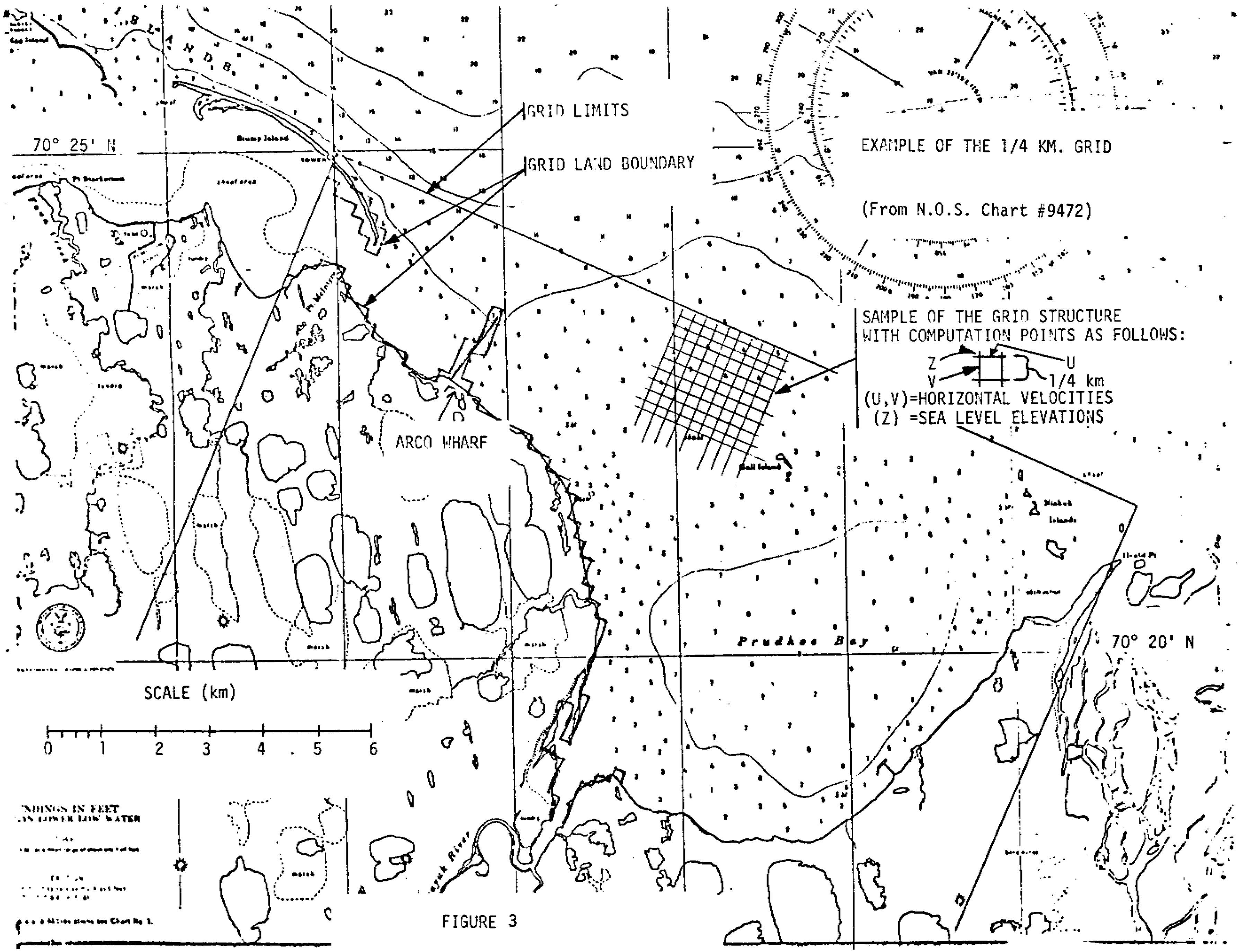


FIGURE 1



GRID LIMITS
GRID LAND BOUNDARY
70° 25' N
EXAMPLE OF THE 1/4 KM. GRID
(From N.O.S. Chart #9472)
SAMPLE OF THE GRID STRUCTURE
WITH COMPUTATION POINTS AS FOLLOWS:
Z
U
V
1/4 km
(U,V)=HORIZONTAL VELOCITIES
(Z) =SEA LEVEL ELEVATIONS
ARCO WHARF
Prudhoe Bay
70° 20' N
SCALE (km)
0 1 2 3 4 . 5 6

FIGURE 3

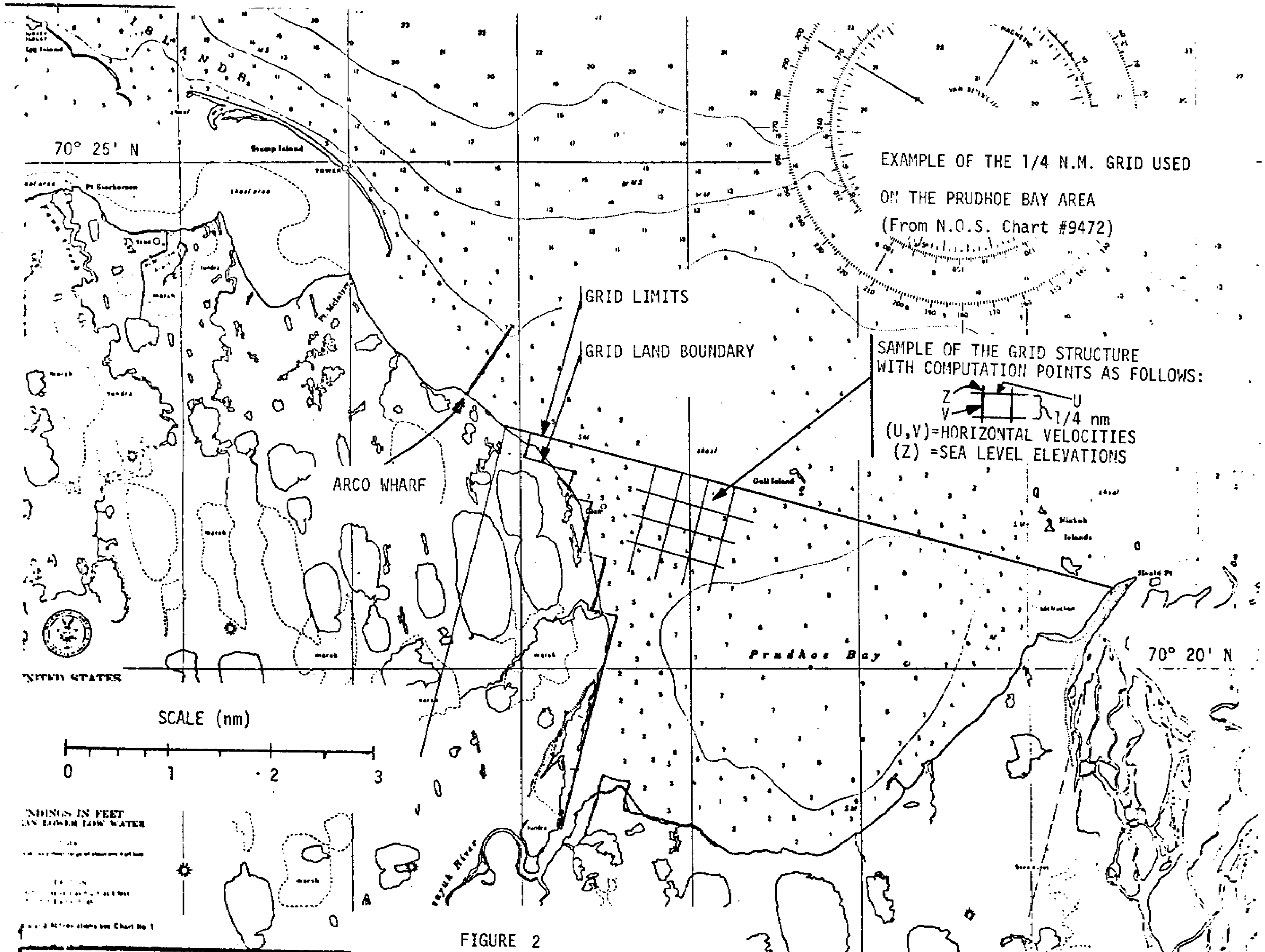

EXAMPLE OF THE 1/4 N.M. GRID USED
ON THE PRUDHOE BAY AREA
(From N.O.S. Chart #9472)
GRID LIMITS
GRID LAND BOUNDARY
SAMPLE OF THE GRID STRUCTURE
WITH COMPUTATION POINTS AS FOLLOWS:
Z
V
U
1/4 nm
(U,V)=HORIZONTAL VELOCITIES
(Z) =SEA LEVEL ELEVATIONS
ARCO WHARF
70° 25' N
70° 20' N
Stump Island
Gull Island
Niakuk Islands
Prudhoe Bay
SCALE (nm)
0
1
2
3

FIGURE 2

Quarterly Report for Quarter Ending September 30, 1975

Project Title:	Marine Climatology of the Gulf of Alaska and the Bering and Beaufort Seas
Contract Number:	03-5-022-56
Task Order Number:	25
Principal Investigator:	Harold W. Searby Associate in Climatology Arctic Environmental Information and Data Center University of Alaska 707 A Street Anchorage, Alaska 99501

I. Task Objectives

To determine and publish the knowledge of the climatological conditions of that portion of Alaska that is important to OCS development.

II. Field and Laboratory Activities

None.

III. Results

None - data has not yet been received from the National Climate Center.

IV. Problems Encountered

None.

V. Estimate of Funds Expended

	Total Budget	3 mos Expended*	Remaining
Salaries & wages	19,700.00	0	19,700.00
Staff Benefits	3,349.00	0	3,349.00
Equipment	0	0	0
Travel	0	0	0
Other	883.00	0	883.00
Total Direct	24,932.00	0	24,932.00
Indirect	11,268.00	0	11,268.00
Total Cost	36,200.00	0*	36,200.00

*Preliminary data not processed pending task order approval.

PHYSICAL OCEANOGRAPHY OF THE GULF OF ALASKA

Task Objectives

This study is intended to satisfy the requirements of Task B-1--Summarize and evaluate existing literature and unpublished data related to circulation and transport.

II. Field or Laboratory Activities

No field work is to be accomplished by this project, and laboratory activities have centered around obtaining processed data and display equipment.

A. Historical monthly mean sea surface temperatures by 5x5° grid have been compiled (PEG) and annual means and anomalies plotted. These data will be compared with other parameters.

B. An updated NODC geofile of oceanographic station data has been obtained on tape. Unfortunately several administrative obstacles were encountered in acquiring the display equipment to be used to analyze these data, but we expect these studies to resume in December.

C. Mean monthly fields of sea level pressure at 5x5° grid points 1899-1972 have been constructed and various components of water transport derived.

D. Daily values of sea level pressure, stress magnitude, Ekman transport, upwelling index and vertical velocity have been computed for the period 1973-75 at various locations in order to investigate interrelations between these parameters.

E. Historical mean monthly sea level at all stations around the gulf have been obtained from NOAA and corrected for mean monthly pressure.

III. Results

Annual mean sea surface temperatures for the gulf (MS 195-3) have trends similar to those off the California coast (Fig. 1). Warming is evident in 1958 and 1963 and a general progressive cooling trend is evident subsequent to 1963.

The intensity of the Aleutian low pressure system (1899-1972) as indicated by monthly mean minimum pressure on a 5x5° grid (Fig. 2) indicates the specific months of intense lows (<985 mb), which occurred in December and January. Numerous centers with pressure <990 mb occurred in February and an abrupt increase in the minimum pressures is evident in March. The winters of 1939-40, 1940-41 and 1941-42 were marked by unusually low pressures in the Aleutian low.

Daily values of conditions along the coast, represented by data at 57°N, 137°W (Fig. 3 a&b), indicate the short-term pulsing of vertical components of flow as indicated by Ekman transport and interior vertical velocities. The periodicity, continuity, magnitude and other characteristics of these pulses are being investigated.

Mean sea level fluctuations, represented by data at Ketchikan (Fig. 4) indicate the irregular periods of positive and negative anomalies. These will be correlated with various transports to ascertain relations with other parameters.

IV. Preliminary Interpretation of Results

Although much of the descriptive work is in progress, interpretations will depend on statistical analyses that have not been conducted. Some aspects of this study have been used as background for two oral presentations: Favorite, Felix. 1975. Short-and Long-Term Fluctuations of

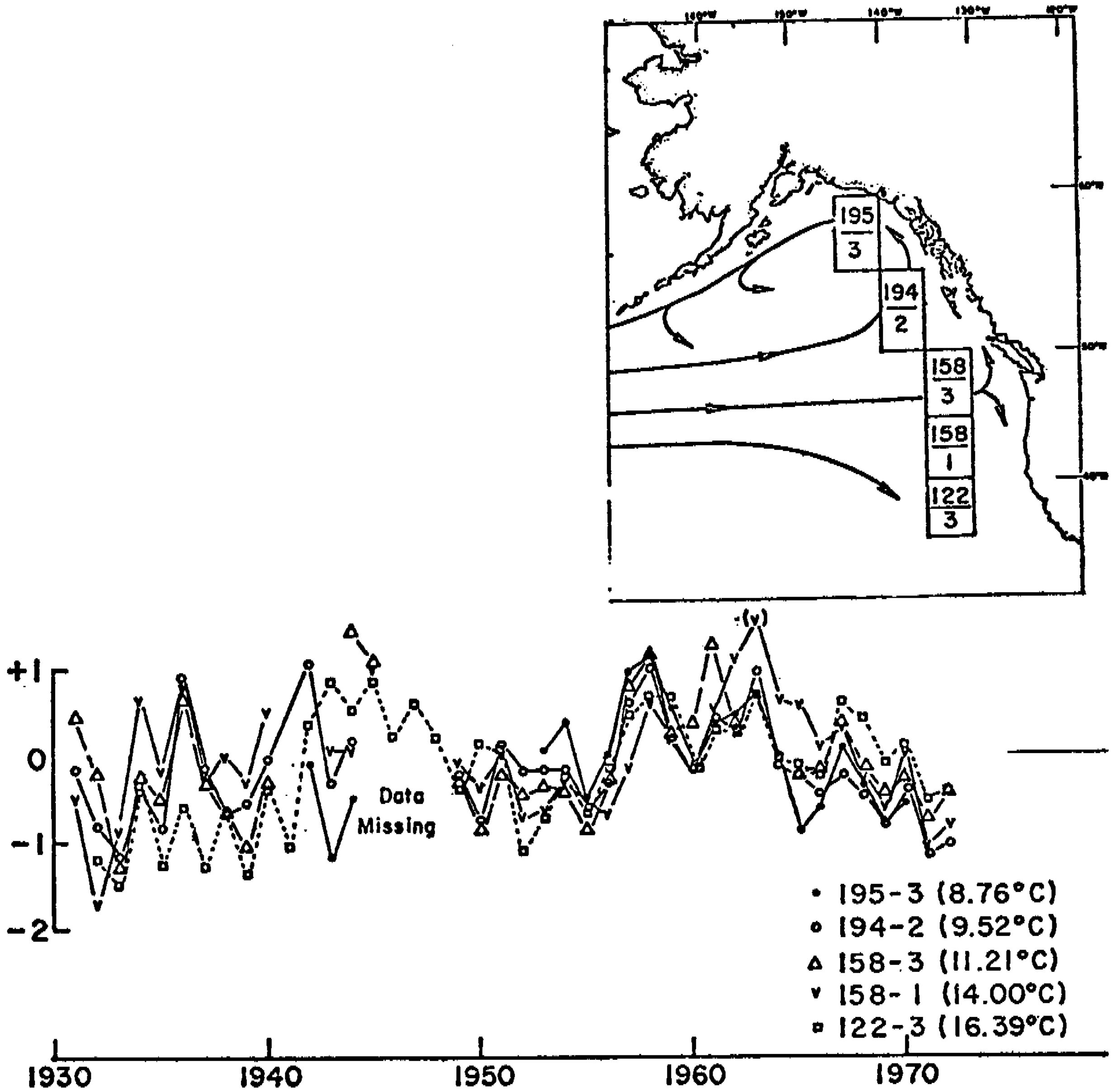


Fig. 1. Annual mean sea surface temperature anomalies (1948-67 mean) in selected Marsden quadrants.

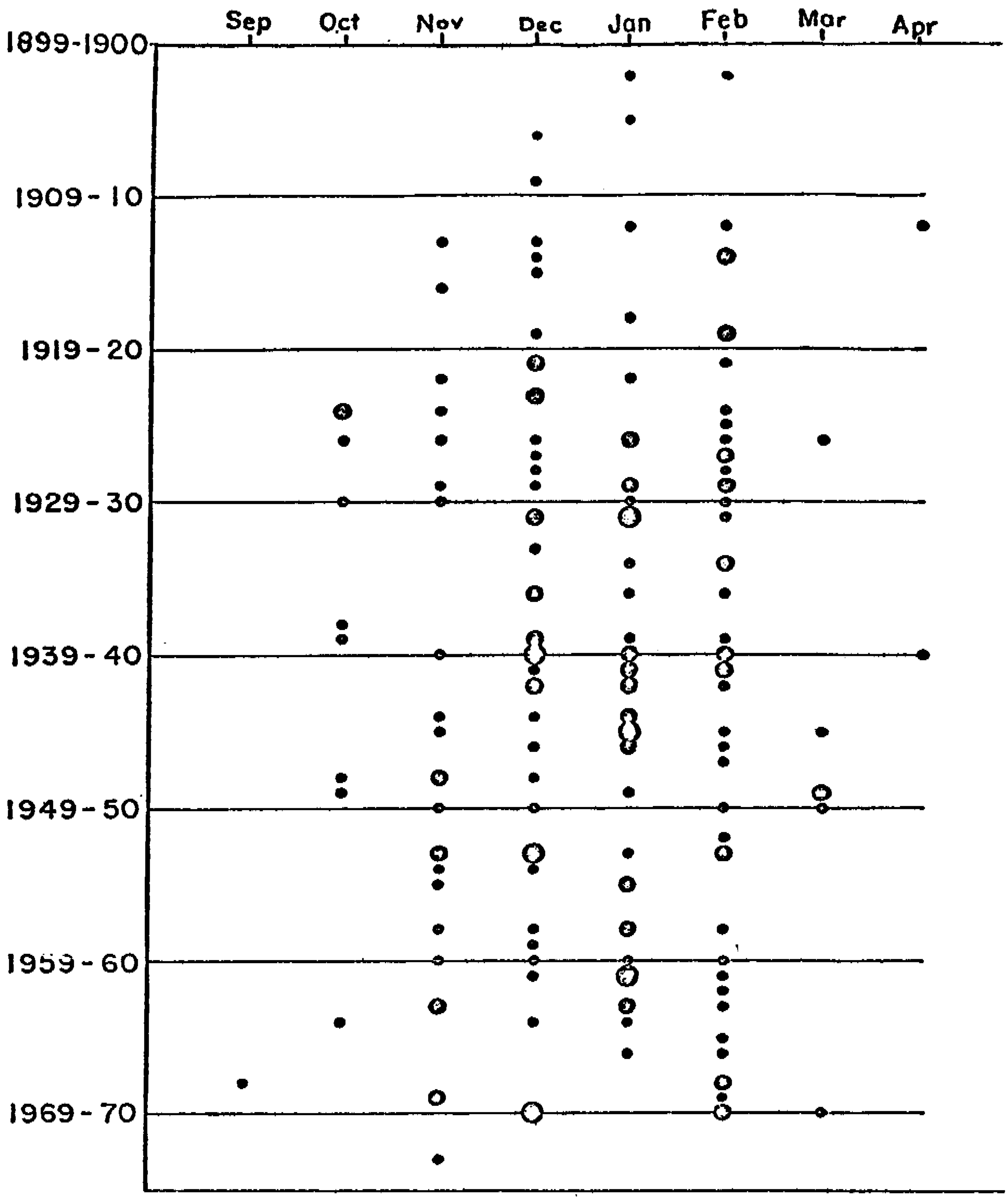


Figure 2. Frequency of monthly mean sea level pressure minima of the Aleutian low <995 mb (•), <990 mb (●), and <985 mb (⬤).

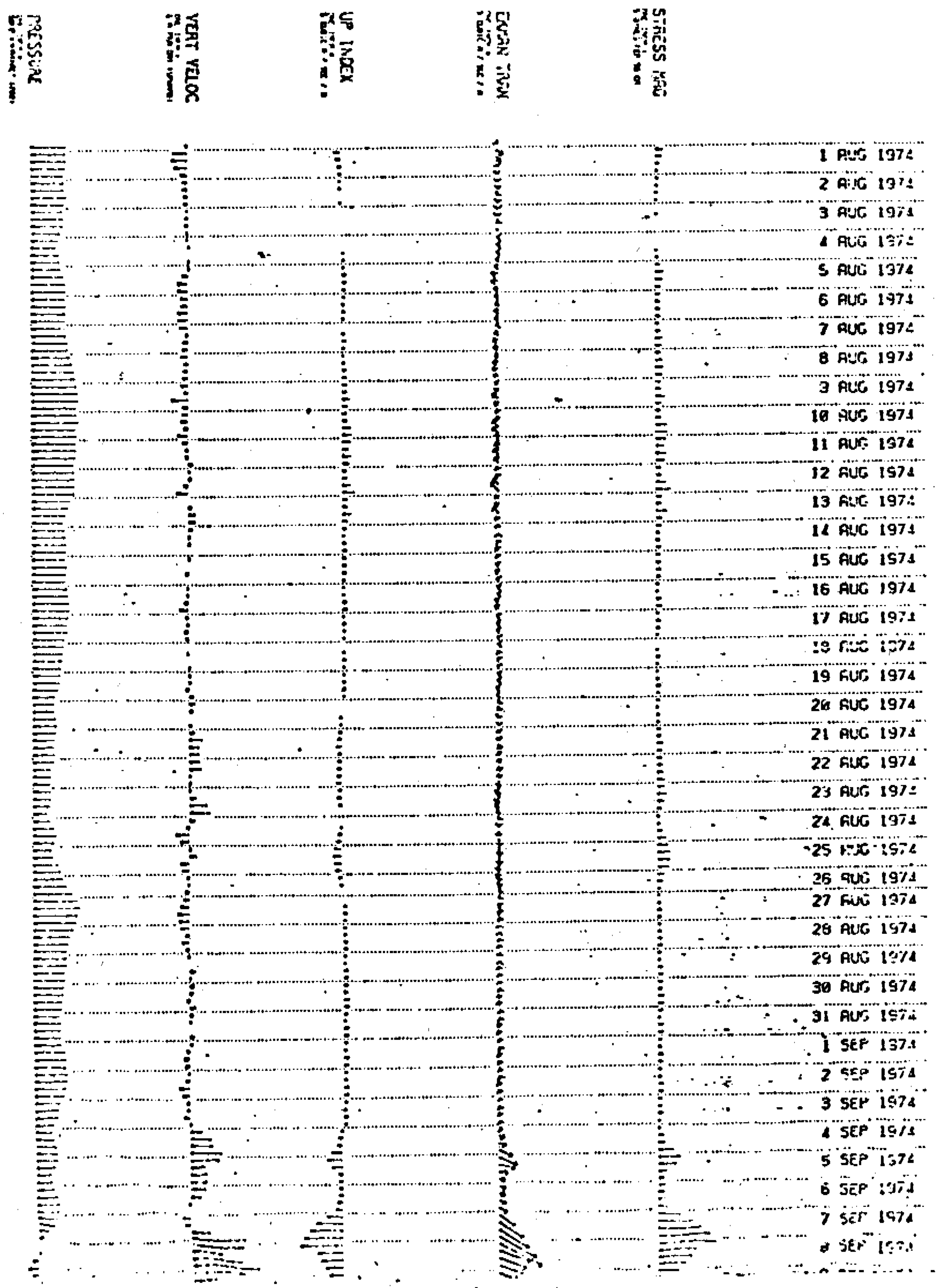


Figure 3a. Examples of daily values during summer of sea level pressure, wind stress, Ekman transport, upwelling index and vertical velocity at 57°N, 137°W.

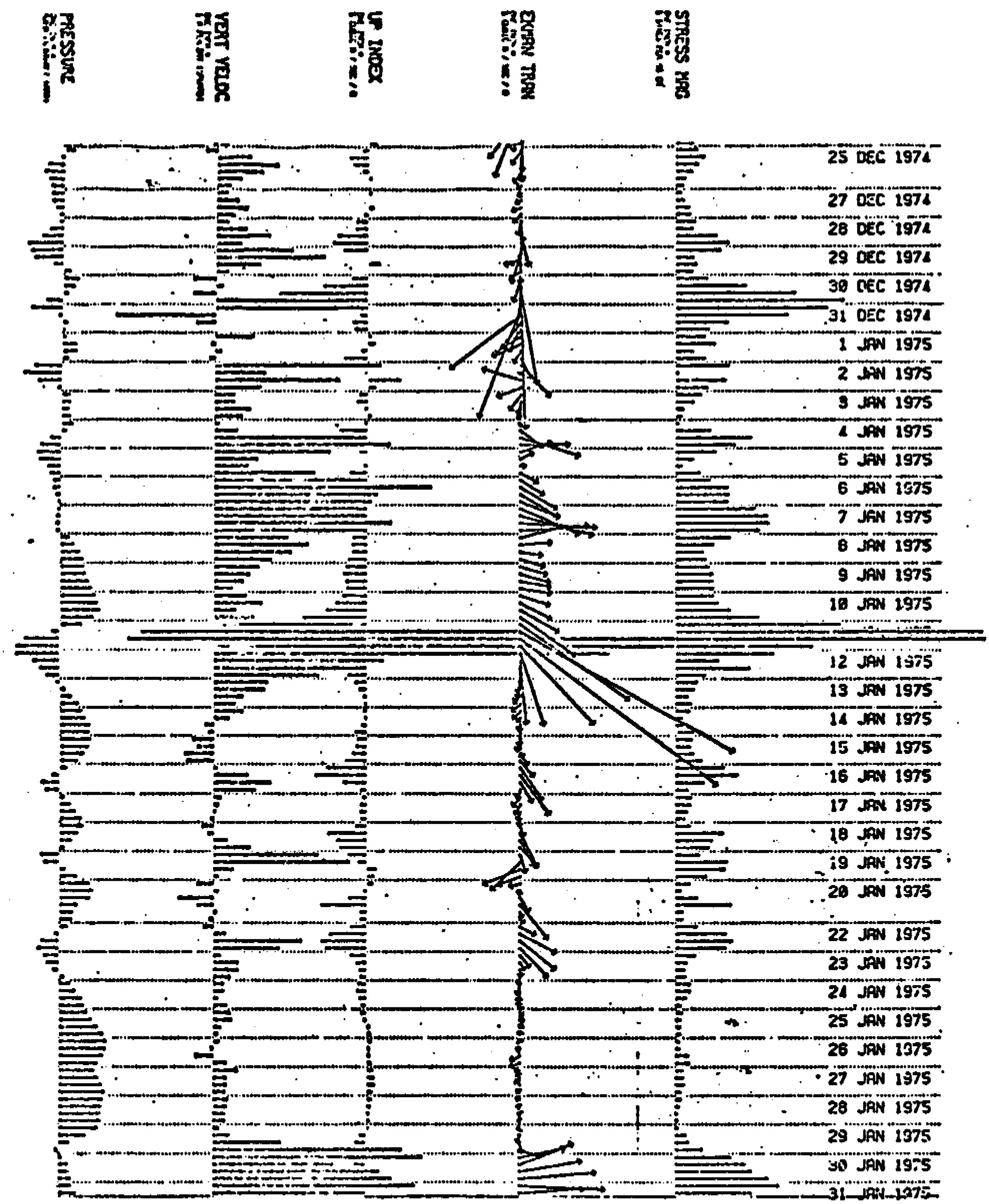


Figure 3b. Examples of daily values during winter of sea level pressure, wind stress, Ekman transport, upwelling index and vertical velocity at 57°N, 137°W.

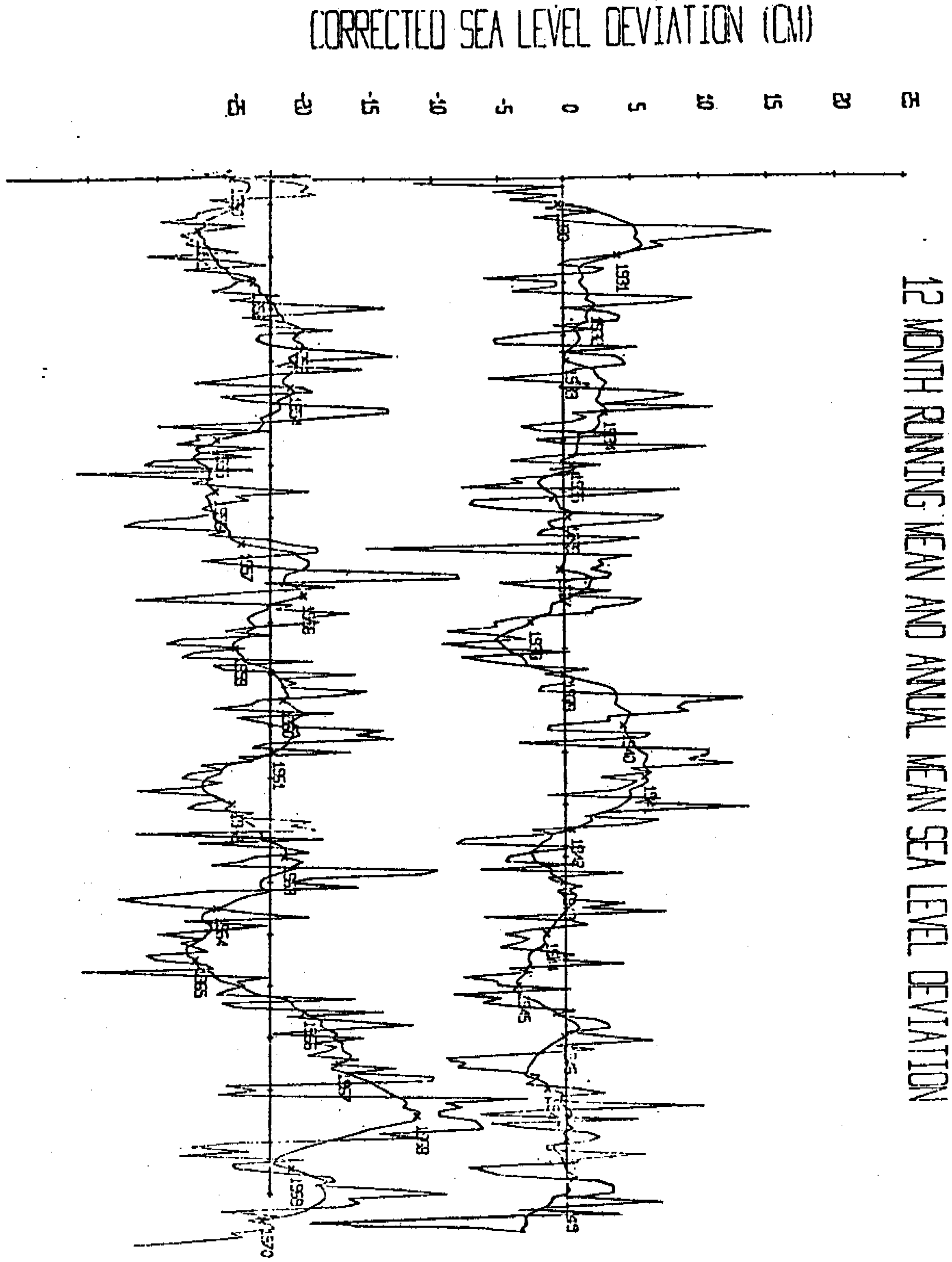


Figure 4. Sea level anomalies, Ketchikan.

Environmental Conditions in the Eastern Subarctic Pacific Region (abstr.), Thirteenth Pacific Science Congress, Vancouver, B.C.; and Favorite, Felix. 1975. Physical Environment of Biological Systems in the Gulf of Alaska (abstr.), Symposium on Science, Resources and Technology in the Gulf of Alaska, Anchorage, Alaska.

V. Problems Encountered/Recommended Changes

Other than typical problems associated with handling of masses of data, the only unforeseen problem was the delay in approval of data display equipment. This is not considered critical at this time.

VI. Estimate of Funds Expended

A.	Salaries and Wages	4.0
B.	Benefits	0.5
C.	Equipment (obligated)	(14.9)
D.	Travel (Bakun to NWFC-Sept.)	0.5
E.	Other direct costs (computer)	1.0
F.	Indirect costs	2.0
		$22.9 K

Task Title: Meteorological Observations in NEGOA

PI: R.M. Reynolds

I. Task Objectives

Reports of standard meteorological observations are being collected; both surface and upper air reports, synoptic maps, and satellite photos are included. This information along with climatic atlases will be used to determine not only the average climate in the study area, but transient effects of individual cyclones, fronts, etc. Synoptic scale circulations produce various modes of air-sea interaction, as for example during the strongly unstable conditions arising when cold dry continental air moves out over the warmer oceanic water. A study of the effects of these air modification processes is underway, particularly in terms of the relationships of surface wind stress to geostrophic winds under varying conditions. The study includes an analysis of the collected data mentioned above as well as a field study program utilizing radiosondes, balloon borne boundary layer profiler (BLP), and ship mounted instrumentation for the study of horizontal variation of surface parameters.

II. Field or Laboratory Activities

C. Methods

1. A historical summary of data from EB-33 and EB-03 is being processed, with special attention to surface winds. Geostrophic winds are available from the Fleet Numerical Weather Center, and these will be used to explore variations in surface wind veer.

2. A review of computer models of atmospheric boundary layer modification is being undertaken. Several models with various degrees of sophistication are available, and these are presently being evaluated.

3. A balloon-borne boundary layer profiler (BLP) is being constructed which will measure mean atmospheric variables from the sea surface up to about 1000 meters. It is operatable from a ship, and will be used on an upcoming cruise in the Northeast Gulf of Alaska.

4. A meteorological package for shipboard surface measurements is being developed. The package will mount on a boom extending from the ships bow and measure winds, temperature, humidity, and solar incident radiation. Data will be telemetered aft to a recording station. The system will be simple, lightweight, and flexible so that it can be used on any ships operating in the study area.

III. Results

Preliminary investigations in February 1975 indicate interesting offshore development of the boundary layer. This data is expected to be submitted to a scientific journal during the coming quarter.

IV. Estimate of funds expended

Radiosondes and supplies for winter cruise	\$ 1600
Boundary Layer Profiling Balloon	3000
Ship mounted instrumentation	1300
Computer costs	<500

Response to Amended Instructions

1. Recommendations for future research

The recommendation below (2) could be undertaken next fiscal year, but strongly recommend implementation this year.

2. Modification of existing efforts

It is necessary to obtain in situ surface win measurements out over the water along the continental shelf line in the Alaskan Gulf. This can be done by obtaining measurements from instrumentation placed on weather buoys or a combination of buoys and automated weather stations. It is suggested that automated weather stations capable of gathering and transmitting weather data be installed on Middleton Island and at Cape St. Elias on Kayak Island. In addition meteorological buoys should be installed at or near the following positions:

$58^{\circ}41.1'$N	$148^{\circ}21.6'$W
$59^{\circ}33.2'$N	$142^{\circ}16'$W
$57^{\circ}40'$N	$142^{\circ}30'$W
56°N	155°W

These stations in addition to EB-03 and EB-33 would provide good data coverage for the Gulf of Alaska. It would also be extremely valuable to place a number of automated weather stations at strategic positions on the coast itself. These would be able to provide a representative indication of what the surface wind field is at the coast. This is difficult to obtain at present because of where several of the present wind recording sites are located with respect to local topography.

GEOLOGY

GEOLOGY

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99	P. Jan Cannon Dept. of Geology U. of SCalif.	The Environmental Geology and Geomorphology of the Gulf of Alaska Coastal Plain	365
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271	James C. Rogers Geophys. Inst. U. of Alaska	Beaufort Seacoast Permafrost Studies, May 1, 1975	419
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RU 16

"Seismotectonic Analysis of the Seismic & Volcanic Hazards in the Pribilof Islands - Eastern Aleutian Islands Region of the Bering Sea"

John Davies
Lamont-Doherty Geological Observatory of Columbia University

Report in preparation; will be forwarded when received.

UNIVERSITY OF RHODE ISLAND
KINGSTON • R. I. 02881

Department of Geology

October 16, 1975

To: Dr. Lou Butler
Outer Continental Shelf Energy Program
Juneau Project Office
P. O. Box 1808
Juneau, Alaska 99802

From: Jon C. Boothroyd
Project RU 59, Coastal Morphology and Sedimentation, Gulf Coast of Alaska

Subject: Informal Progress Report

My area of responsibility for Project RU 59 covers the section in the work statement concerning glacial sedimentation and environmental problems, particularly in the Icy Bay area. This report and those following will be addressed to these problems. This first report will: 1) present a partial list of data gathered; 2) comment on coordination with other workers; 3) outline some environmental problems; and 4) make some suggestions for future research.

1. 1975 Field Season - In Alaska, June 6th to August 19th. In Icy Bay field area, June 12th to August 13th. Partial list of data obtained:

    a) Twenty-four high resolution bottom profiles (70 kilometers total running distance) in Icy Bay, covering primarily nearshore areas on the east side of the bay. Priority was given to those areas most likely to be considered for ship anchorages.

    b) Twenty-two kilometers of longitudinal profiles of active and inactive outwash fans (theodolite survey). These lines functioned as base lines connecting stations occupied for clast size measurement, bar morphology, etc.

    c) In-depth study of New Yahtse River, the major sediment provider for Icy Bay. Fifteen stations occupied with velocity, temperature, suspended sediment, and other grain-size data collected. This aspect also includes a limited number of stations occupied in the bay proper, off the New Yahtse delta. Suspended sediment and salinity data were collected.

d) Weather station records from June 18th to August 11th at a location on the east side of the bay. Continuous recording of temperature, relative humidity, and barometric pressure. Precipitation gauge checked twice daily. Wind direction and speed recorded twice daily.

e) Observation of bay ice movement and disposition at least twice daily. Aerial photographic survey of bay ice seven times during the summer.

f) Ground check of most of West Malaspina Foreland by foot and trail motorcycle to field check environmental mapping from aerial photographs.

g) Obtained approximately 2,000 aerial and ground photographs to aid in preparation of information products.

2. Coordination with other workers - I have been in contact with Dr. Austin Post, U.S.G.S. glaciologist. He has agreed to furnish me with unpublished 1:63,360 topographic maps of the Icy Bay area. These maps include revisions up to 1972, and will be used as a base for the environmental mapping.
Dr. Jan Cannon, RU 99, visited our field camp from July 29th to August 2nd. We discussed means of exchanging field and remote sensing data.

3. Some environmental problems - A partial listing is presented at this time.

   a) Exposure of parts of the Bay to storm-wave conditions. The west side of the bay is open to southeast swells, particularly the area in which Icy Bay Lumber Company now has a dock facility. This aspect will be covered by Miles O. Hayes in his section of the overall study.

   b) The upper half of the bay was ice-choked much of the time, precluding navigation by all but small boats. This ice sometimes moved down and blocked access to most of the bay.

   c) The protected lower east side of the bay is dominated by large shoal areas delineated by our bottom profiles. Some deeper areas are off the active New Yahtse delta. The only good harbor appears to be just east of Moraine Island. This area, known as "Seal Camp" to persons familiar with Icy Bay, is used as a harbor of refuge by fishing boats and as a base of operations by seismic crews working in the area this summer. Maximum depth at the entrance is about fifteen meters as indicated on our bottom profiles.

d) Mapping has delineated a compact basal-till unit that appears to underlie most of the land area along the lower east side of the bay. This unit probably extends beneath the bay. There is also an abundance of large (tens of cubic meters) ablation-till boulders in the shore zone along the lower eastern bay. They have also been identified on the bay floor by bottom profiling.

4. Suggestions for future research - A complete study of the geology of the bay proper should be undertaken to answer the following questions:

   a) Type, extent, and thickness of bay sediments, especially the basal-till horizon. These units could be tied to units already delineated onshore.

   b) More detailed bathymetry, especially in potential harbor areas.

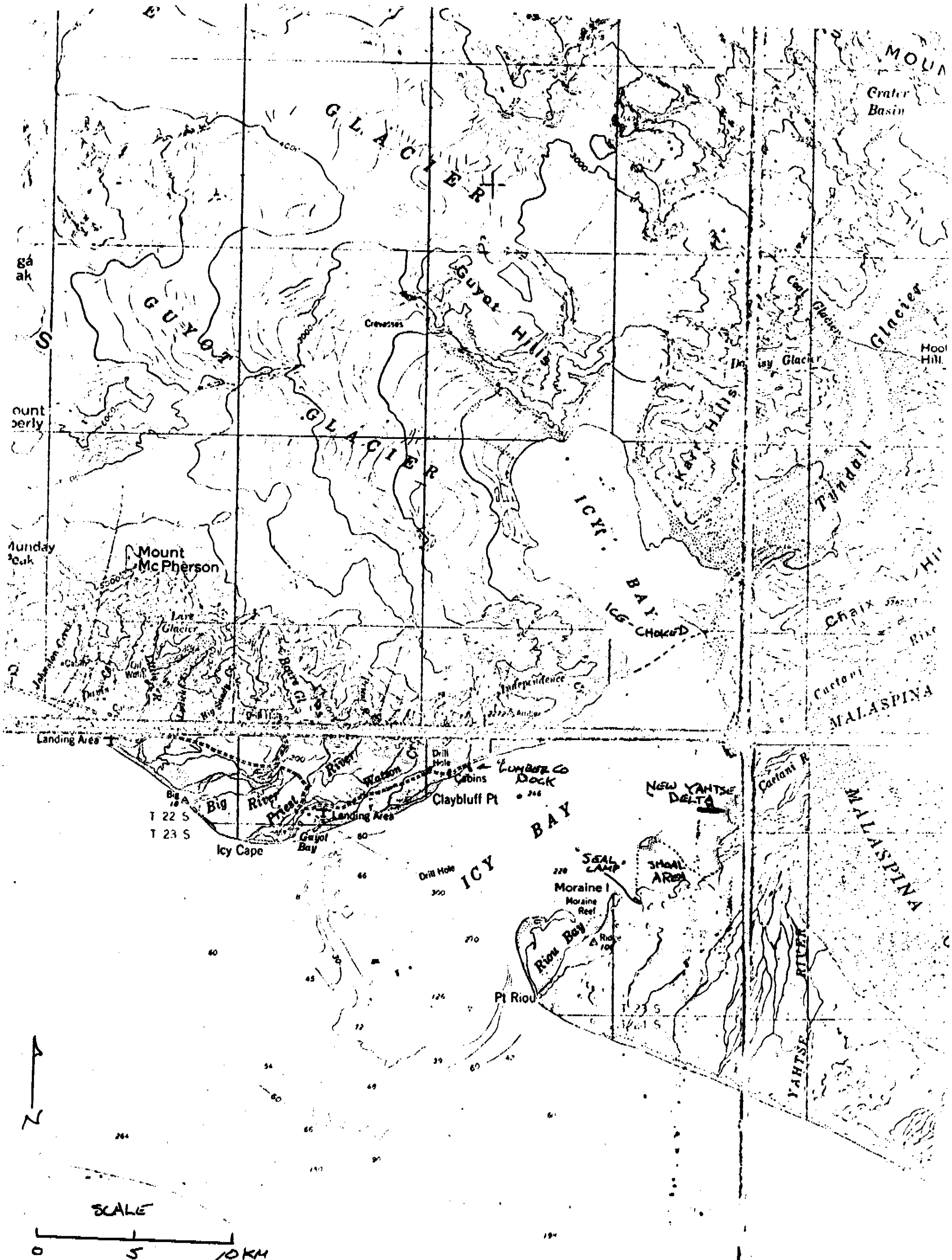
   c) Study of the movement of ice in the bay. Preliminary observations suggest it moves in response to both wind and tidal currents.

   d) Detailed environmental and engineering geology of potential sites for shore facilities. Some potential sites would be an information product of this study. Others have been favored by shore-based parties in the past.

A report in more detail covering the above topics will be forthcoming in about fifteen days.

Sincerely,

Jon C. Boothroyd


GLACIER
GUYOT
GLACIER
Guyot Hills
Crevasses
Crater Basin
Coal Glacier
Glacier
Tyndall
Kāts Hills
Chaix
MALASPINA
Mount McPherson
ICY BAY
ICE CHOKED
Independence Cr.
Landing Area
Big River
Priest River
Watson Cr.
Drill Hole
Cabins
LUMBER CO DOCK
Claybluff Pt
Landing Area
Guyot Bay
Icy Cape
T 22 S
T 23 S
NEW YAHTSE DELTA
SEAL CAMP
SHOAL AREA
Moraine I
Moraine Reef
Riou Bay
Pt Riou
ICY BAY
Drill Hole
Caetani R
MALASPINA
YAHTSE RIVER
N
SCALE
0
5
10KM

COASTAL MORPHOLOGY AND SEDIMENTATION,

GULF COAST OF ALASKA

Coastal Research Division
Department of Geology
University of South Carolina

Contract No. 03-5-022-82

Semi-annual Report
May 1, 1975 - November 1, 1975

TASK OBJECTIVES

The major emphasis of this project falls under Task D4, which is to: evaluate present rates of change in coastal morphology, with particular emphasis on rates and patterns of man-induced changes, and locate areas where coastal morphology is likely to be changed by man's activities and evaluate the effect of these changes, if any. The relative susceptability of different coastal areas will be evaluated.

FIELD AND LABORATORY ACTIVITIES

Our field activities were carried out by groups working somewhat independently. Therefore, each group will be discussed separately.

Group 1 - Study of regional geomorphology from Copper River Delta to Icy Point; Detailed study of beach morphology and sediments between Cape Yakataga and Dry Bay.

A. Field trip schedule

20 May, 1975 - 1 July, 1975

3 man field team with one Cessna 180 and pilot full time (chartered from Gulf Air Taxi, Yakutat).

B. Scientific party

Miles O. Hayes, principal investigator; Chairman, Department of Geology, University of South Carolina

Christopher H. Ruby, graduate assistant; graduate student, Marine Science Program, University of South Carolina

Jane Zenger, undergraduate assistant; undergraduate student, University of South Carolina

C. Methods

1st 10 days

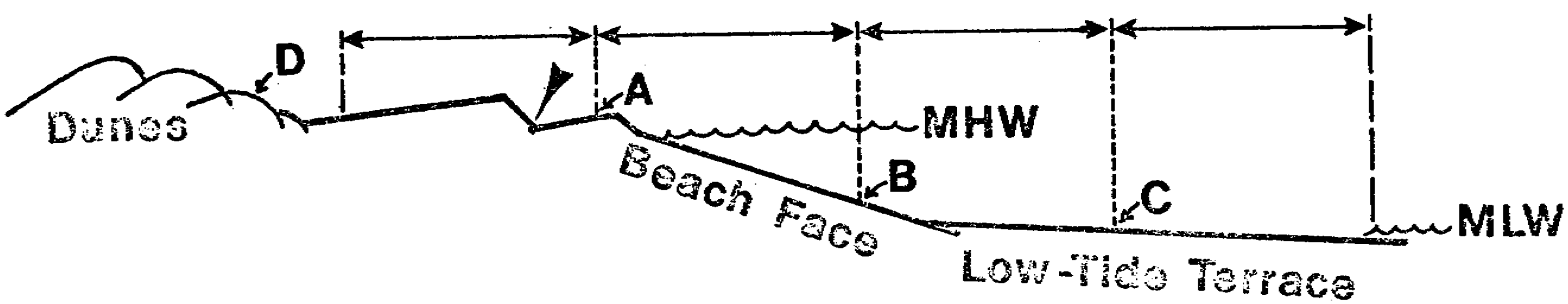
1. Relocation and measurement of 15 permanent beach profiles established in 1970. Twelve were relocated; three were lost due to erosion.
2. Resampling of original profile locations following the method illustrated in Figure 1.
3. Relocation and description of changes that had taken place over the past 4 years at the 18 original zonal sites.
4. Study of post-earthquake (1964 Good Friday Earthquake) changes on the barrier islands of the Copper River Delta.
5. Detailed oblique aerial photography of the coastline enclosed by profile locations (Fig. 2). These photographs will be compared with similar coverage taken during 1970-71.

Last 30 days

1. Establishment and measurement of beach profiles at 3 km intervals over the 300 km section of coast between Dry Bay and Cape Yakataga, with special emphasis on the Icy Bay area. A total of 99 stations were established.
2. Sediments were sampled (Fig. 1) and photographed at the 99 stations. A total of 401 sediment samples were collected and 152 photographs were taken of the coarse gravel stations.
3. Complete oblique aerial photography of the study area between Dry Bay and Cape Yakataga.

Figure 1. Typical beach profile for the study area, showing sampling plan. Letters indicate sampling localities, which are located between the upper limit of normal high waves and the low water line. B is in the center of the sampling zone, and stations A and C are located at the midpoint of the upper and lower halves of the sampling zone. D is usually a dune sample. A core sample 15 cm in length is taken at each station.

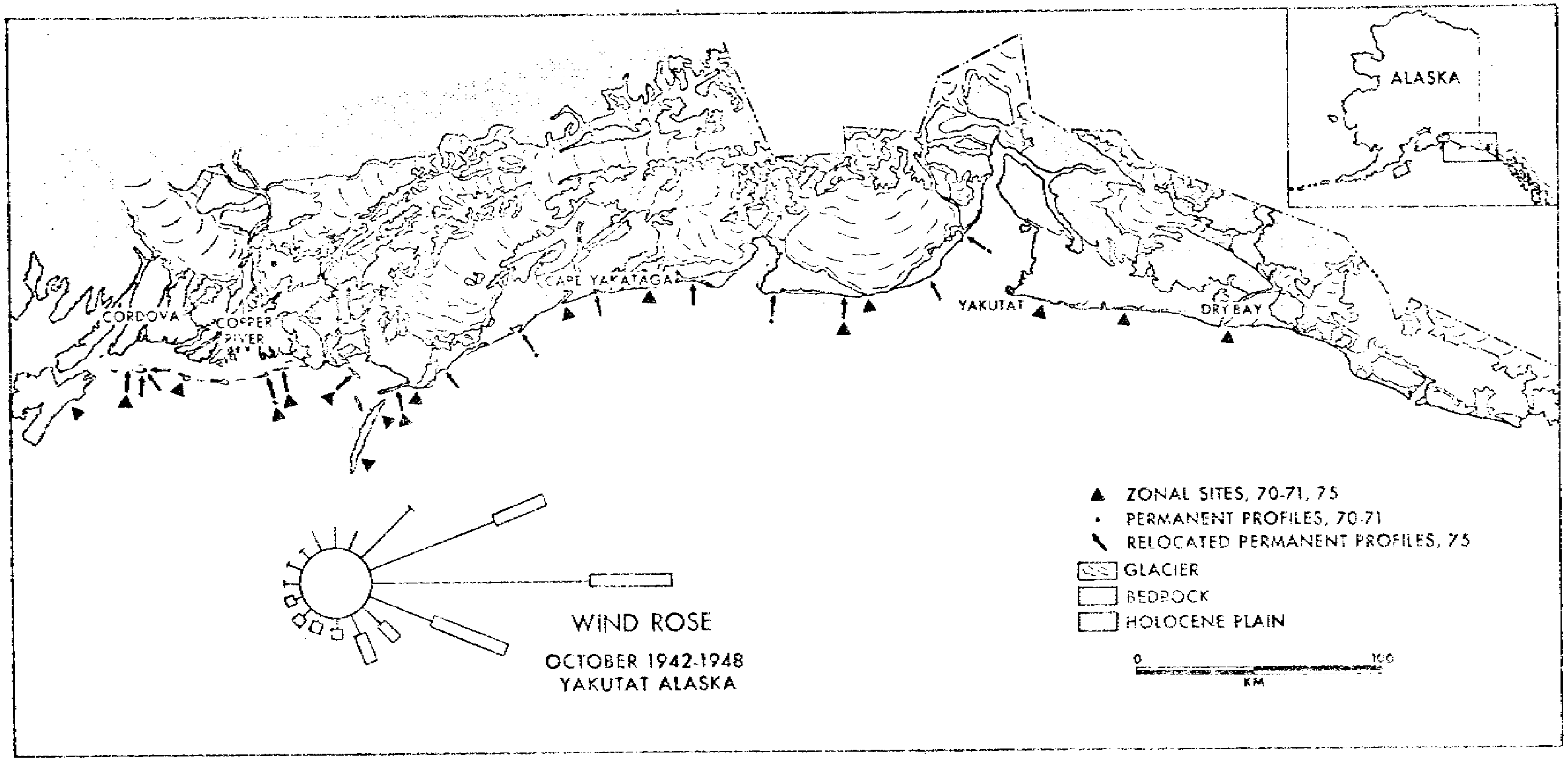
BEACH ZONE SAMPLING PLAN



SPRING HIGH TIDE SWASH LINE

A-D SAMPLING LOCATIONS

Figure 2. Location map.


ALASKA
CORDOVA
COPPER RIVER
CAPE YAKATAGA
YAKUTAT
DRY BAY
ZONAL SITES, 70-71, 75
PERMANENT PROFILES, 70-71
RELOCATED PERMANENT PROFILES, 75
GLACIER
BEDROCK
HOLOCENE PLAIN
0
100
KM
WIND ROSE
OCTOBER 1942-1948
YAKUTAT ALASKA

4. Correlation studies linking grain size, sediment source and process parameters with geomorphic variability.

D. Sample localities (Figs. 2 and 3)

1. The 15 profiles of 1970-71 are located on Figure 2.

2. The locations of the 12 beach profiles resurveyed in 1975 are shown on Figure 2.

3. The 18 zonal sites studied in 1970 and 1975 are located on Figure 2.

4. The 99 beach profiles and sampling localities in the Icy Bay to Cape Yakataga area are shown on Figure 3.

E. Data collected or analyzed

1. A total of 401 sediment samples were collected. Laboratory grain size analysis, by sieving and settling tube, has been completed for 230 of these samples.

2. A total of 189 beach profiles have been measured. Eighty of these have been plotted.

3. Approximately 10,000 ground and aerial photographs have been made.

Group 2 - Detailed studies of beach morphology of Malaspina Foreland area; Resurvey of permanent beach profiles.

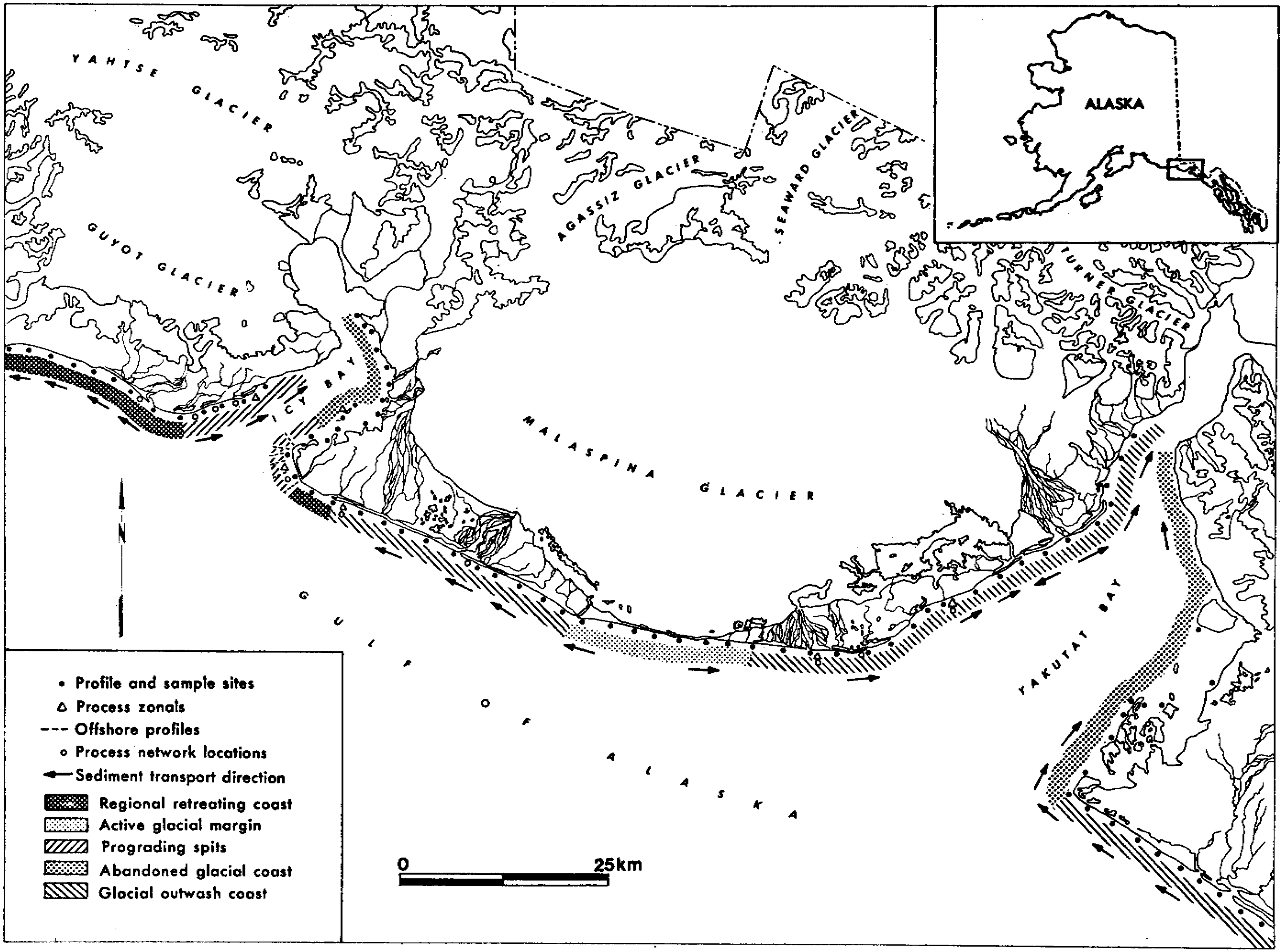
A. Field trip schedule

1 July, 1975 - 22 July, 1975; 8 August, 1975 - 10 August, 1975

2 man field team with one Cessna 180 and pilot part-time

(chartered from Gulf Air Taxi, Yakutat)

Figure 3. Location of area in southern Alaska studied in detail during summer of 1975. Arrows indicate dominant longshore sediment transport direction on the basis of combined morphological and process data. Patterns indicate erosional and depositional trends. Locations of sampling and data collection stations is also shown.


YAHTSE GLACIER
GUYOT GLACIER
AGASSIZ GLACIER
SEAWARD GLACIER
TURNER GLACIER
MALASPINA GLACIER
ICY BAY
YAKUTAT BAY
GULF OF ALASKA
ALASKA
N
0
25km
Profile and sample sites
Process zonals
Offshore profiles
Process network locations
Sediment transport direction
Regional retreating coast
Active glacial margin
Prograding spits
Abandoned glacial coast
Glacial outwash coast

B. Scientific party

Christopher H. Ruby, graduate assistant; graduate student, Marine Science Program, University of South Carolina

Stephen J. Wilson, undergraduate assistant; undergraduate student, University of South Carolina

C. Methods

1. Detailed grain size study of a 30 km section of coast from Yana Stream outlet to tip of Riou Spit. At each sampling station, which were located at 1 km intervals, grain size estimates were made (and photographs taken) at 8 points spaced equidistantly between low water level and the crest of the storm berm.
2. An array of beach profiles were measured at Yana Stream inlet in order to determine the three-dimensional shape of the inlet.
3. Photographic study of the changes of the morphology of the outlets of Yakataga River and Fountain Stream brought about by seasonal floods.
4. Study of dispersal of logs away from a wrecked barge at the mouth of Alder Stream.
5. Remeasurement of the 12 permanent profiles. Michael F. Stephen assisted in this work.

Group 3 - Study of the dynamic coastal process of the Malaspina Foreland area

A. Field trip schedule

23 July, 1975 - 19 August, 1975

3 man field team with one Cessna 180 and pilot part-time (chartered from Gulf Air Taxi, Yakutat)

B. Scientific party

Michael F. Stephen, research scientist; Coastal Research Division, Department of Geology, University of South Carolina

Christopher H. Ruby, graduate assistant; graduate student, Marine Science Program, University of South Carolina

Stephen J. Wilson, undergraduate assistant; undergraduate student, University of South Carolina

C. Methods

1. Establishment of stations to monitor beach processes from Icy Bay to Icy Cape.
2. Establishment of zonal sites at 6 locations with 6 profiles at each station.
3. Measurement of beach processes at each station for 48-hour period.
4. Continuous weather data obtained at these stations.
5. Suspended sediment sampling within surf zone.
6. Wave observations (type, period, height, breaker angle and velocity, and direction of longshore drift) at 2-hour intervals over 48-hour period.
7. Fathometer profiles run to aid in computation of volumetric estimates of sediment in Riou Spit.
8. Extensive oblique aerial photography.

D. Sample localities (located on Figure 3)

E. Data collected or analyzed

1. A total of 15 surf sediment samples were collected.

2. 60 comparative beach profiles were measured.

3. 7 offshore fathometer profiles at Riou Spit were run.

4. 120 separate wave parameter observations were made.

5. Numerous oblique aerial photographs were taken.

Group 4 - Study of surficial deposits, Icy Bay, Alaska, area; With detailed morphological and sediment studies of Yahtse River

A. Field trip schedule

8 June, 1975 - 10 August, 1975

3 man field crew with one Cessna 180 and pilot part-time (chartered from Gulf Air Taxi, Yakutat)

B. Scientific party

Jon C. Boothroyd, co-principal investigator; Assistant Professor of Geology, University of South Carolina (now assistant professor at University of Rhode Island)

Ray Levey, graduate assistant; graduate student, Department of Geology, University of South Carolina

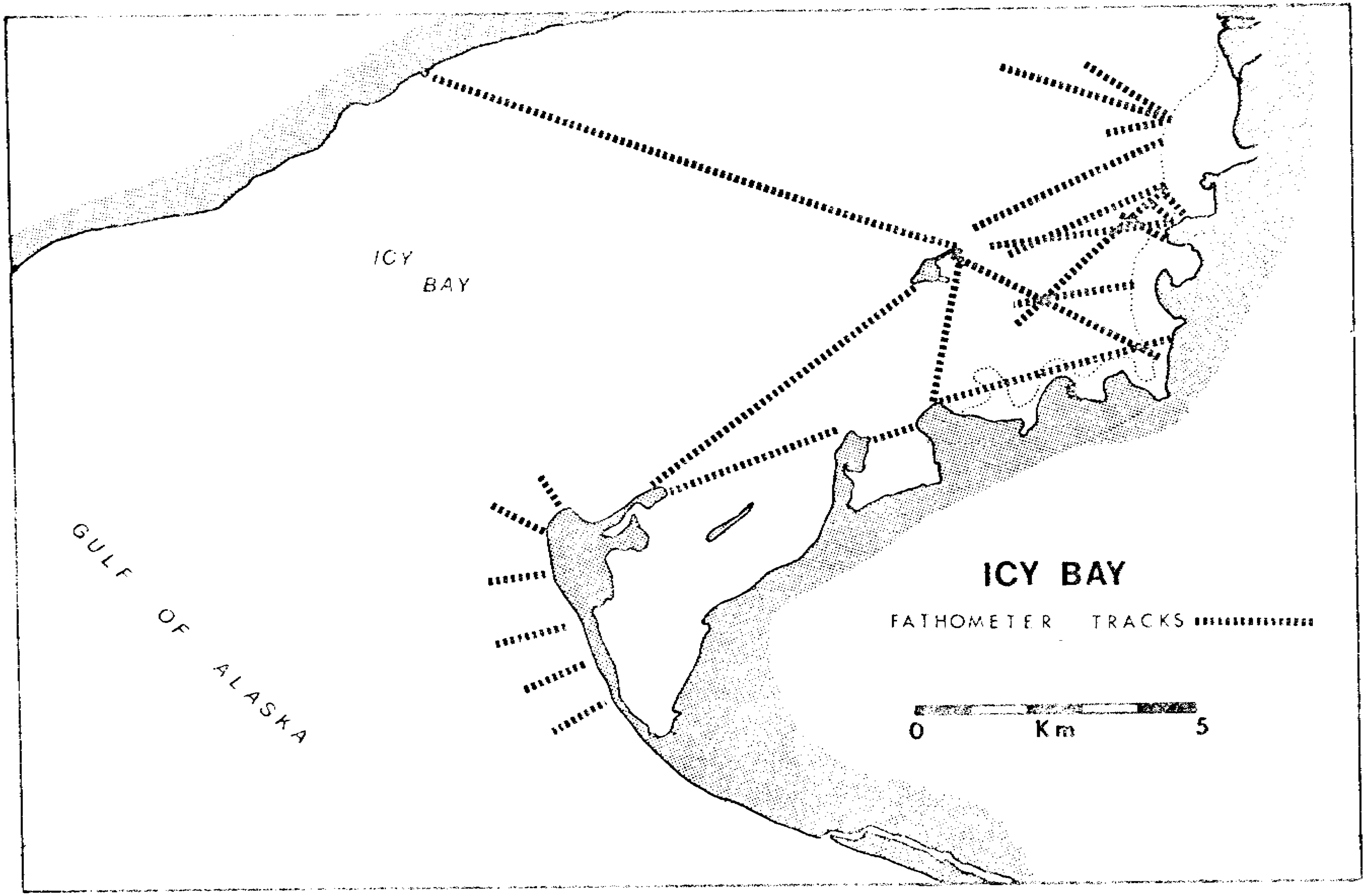
Mark Cable, undergraduate assistant; undergraduate student, University of South Carolina

C. Methods

1. Extensive fathometer profiling, east shore of Icy Bay, Alaska (profile line locations on Figure 4).

2. Trenching of exposed sedimentary materials to determine former flow directions for use in interpreting geomorphic history of Icy Bay.

Figure 4. Fathometer profiles of Icy Bay.


ICY BAY
GULF OF ALASKA
ICY BAY
FATHOMETER TRACKS
0 Km 5

3. 15 sample stations established on new Yahtse River for clast and transverse rib measurements and relationships (½ km intervals).

4. Suspended sediment samples taken and surface velocities measured at established stations.

5) Wood samples taken (where possible) at base of bluffs for C^{14} dating.

6. Photographic reconnaissance of fountain to establish location of hydrostatic head for Yahtse system.

7. Pace and Brunton mapping with clast measurements of point bar, Yahtse River.

8. Sampling of basal till outcrops.

9. Sediment samples taken from distal parts of old Yahtse River.

10. Extensive aerial reconnaissance and photography for use in mapping and historical comparisons.

11. Two till fabric analyses were conducted following standard techniques (n=100).

12. Complete weather monitoring.

D. Sample localities

1. Fathometer profiles of Icy Bay are located on Figure 4.

2. Sample stations of new Yahtse River located every ½ km over 7.5 km. Clast and transverse rib measurements made at same localities. Suspended sediment samples and surface velocities at same localities.

3. Wood samples for C^{14} dating taken along 6.2 to 5.0 km stretch of river.

RESULTS AND PRELIMINARY INTERPRETATIONS

Several papers are under preparation and abstracts have been submitted on the findings of this study. Information on the area of detailed study this summer, Dry Bay to Cape Yakataga, was included in a short manuscript submitted to the 1976 Conference on Coastal Engineering in Honolulu, Hawaii. That paper follows on pages 36-40.

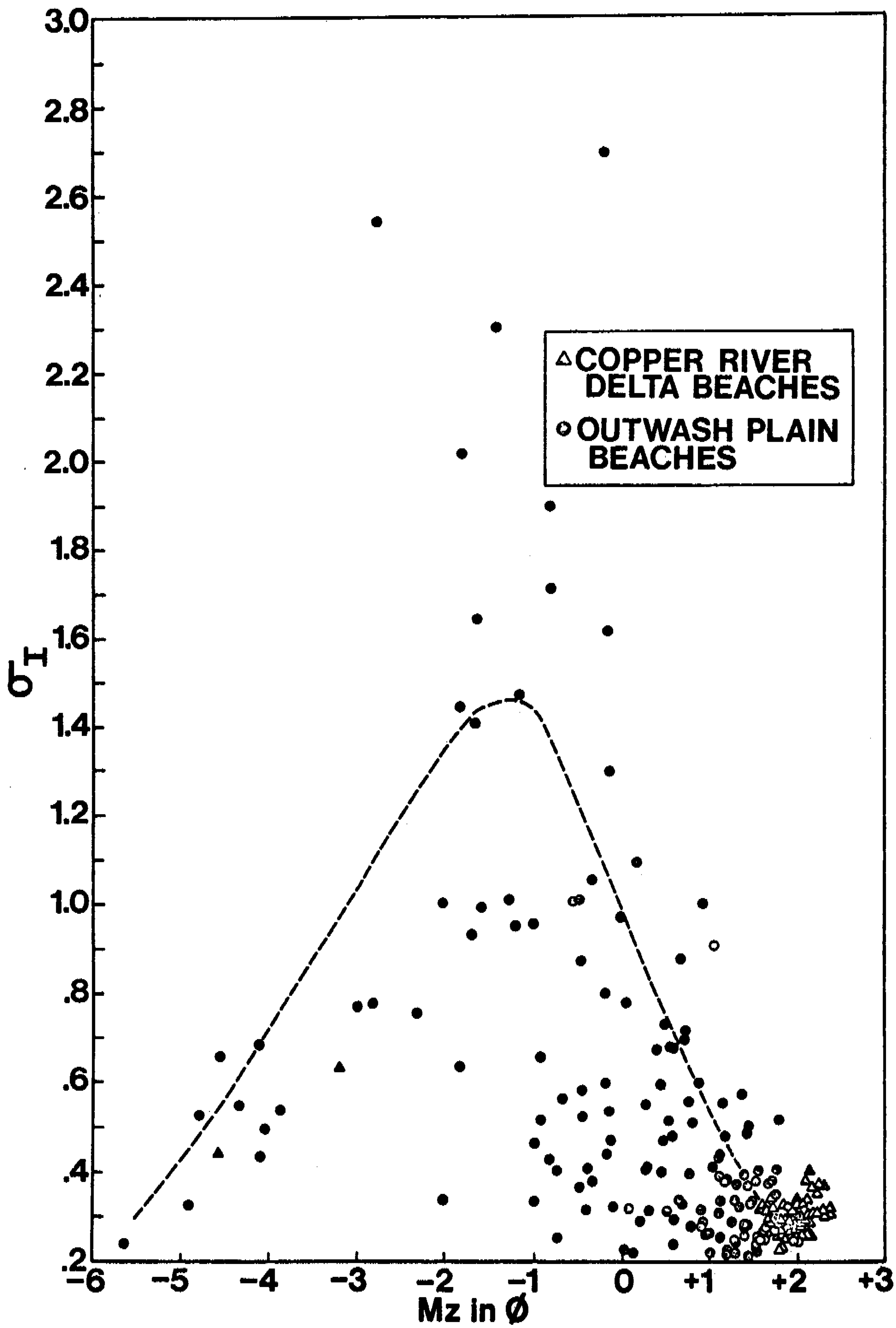
Hayes and Ruby presented a paper on the development of the barrier islands of the Copper River Delta, a paper inspired by the data obtained when the permanent profiles were resurveyed this summer, at the annual meeting of the Geological Society of America in Salt Lake City on 20 October. A copy of the abstract is given on page 41.

In that paper, a distinction was made between the coastline of the Copper River Delta and the rest of the study area, which is mostly an outwash plain area. The grain size of the sediments of the Copper River Delta beaches is generally finer than for the outwash areas (Fig. 5). Also, the Copper River Delta beach sediments are more quartz rich than the outwash areas (Fig. 6). However, all the samples plot in the litharenite class of Folk's (1974) sandstone classification (Fig. 7).

Figure 8 shows the variation of three parameters, downdrift offset, tidal delta size, and inlet width, along the front of the delta. All three of these parameters increase in a westerly direction. This is thought to result from increasing size of the tidal prism from east to west, because of infilling of the estuaries at the eastern end of the delta by river sediments.

Concentrated study on the largest of the islands, Egg Island, shows some

Figure 5. Scatter plot of mean size (M_Z) versus Inclusive Graphic Standard Deviation (σ_I) for beach samples of the Holocene shoreline of the northern Gulf of Alaska. Note that the Copper River Delta beach samples are generally finer-grained and better sorted than the samples from the outwash plains. Grain size parameters used are the graphical parameters of Folk (1974).



3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
.8
.6
.4
.2
σ_I
△COPPER RIVER DELTA BEACHES
○OUTWASH PLAIN BEACHES
−6
−5
−4
−3
−2
−1
0
+1
+2
+3
Mz in Ø

Figure 6. Percent quartz in beach samples from the study area (Fig. 2). Note that the Copper River Delta beaches, which are generally finer-grained, contain more quartz than the outwash plain beach sediments.

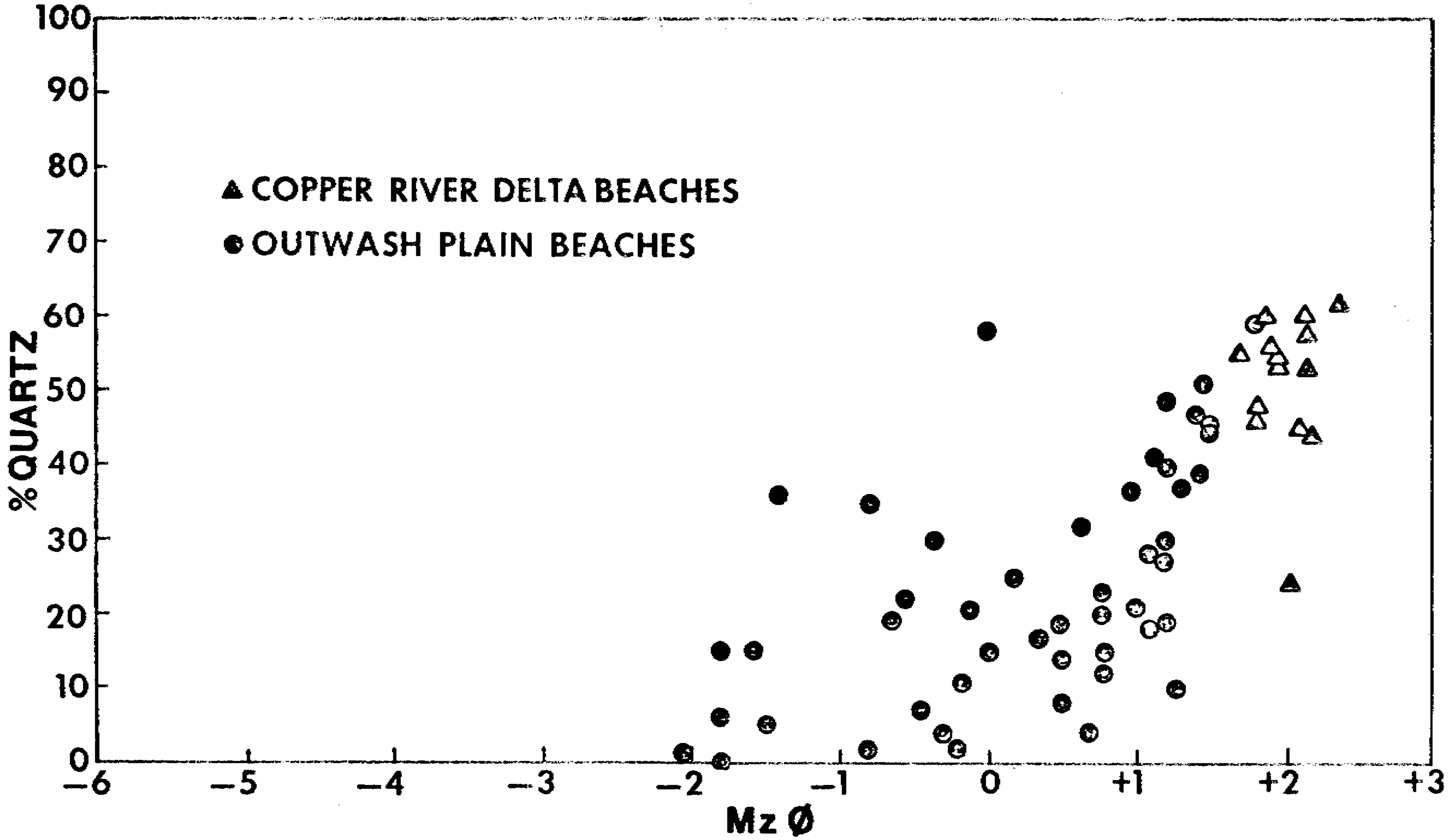

COPPER RIVER DELTA BEACHES
OUTWASH PLAIN BEACHES
% QUARTZ
Mz Ø
100
90
80
70
60
50
40
30
20
10
0
−6
−5
−4
−3
−2
−1
0
+1
+2
+3

Figure 7. Compositional classification of beach samples from the study area (Fig. 2). All samples fall in the litharenite class of Folk (1974).

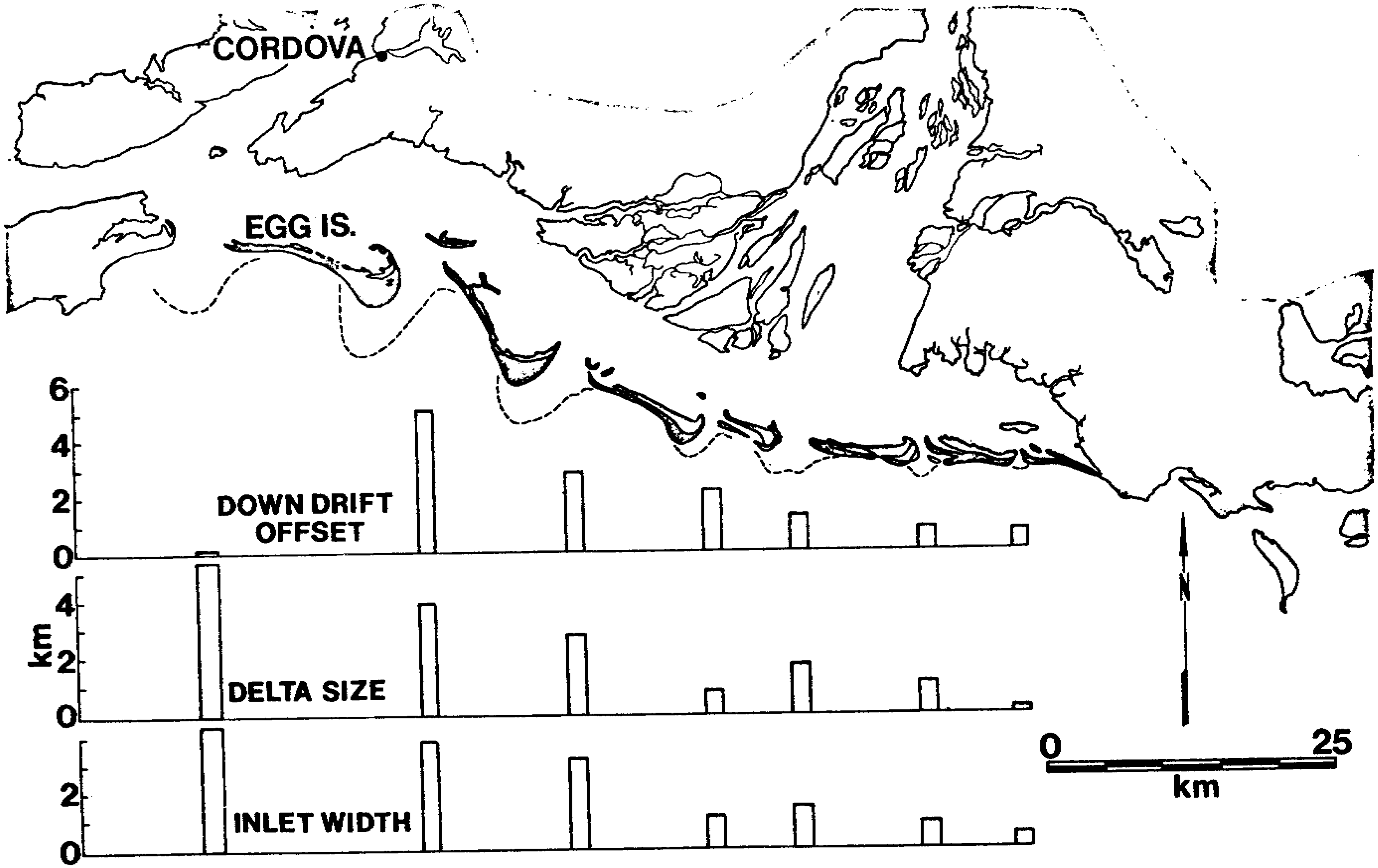
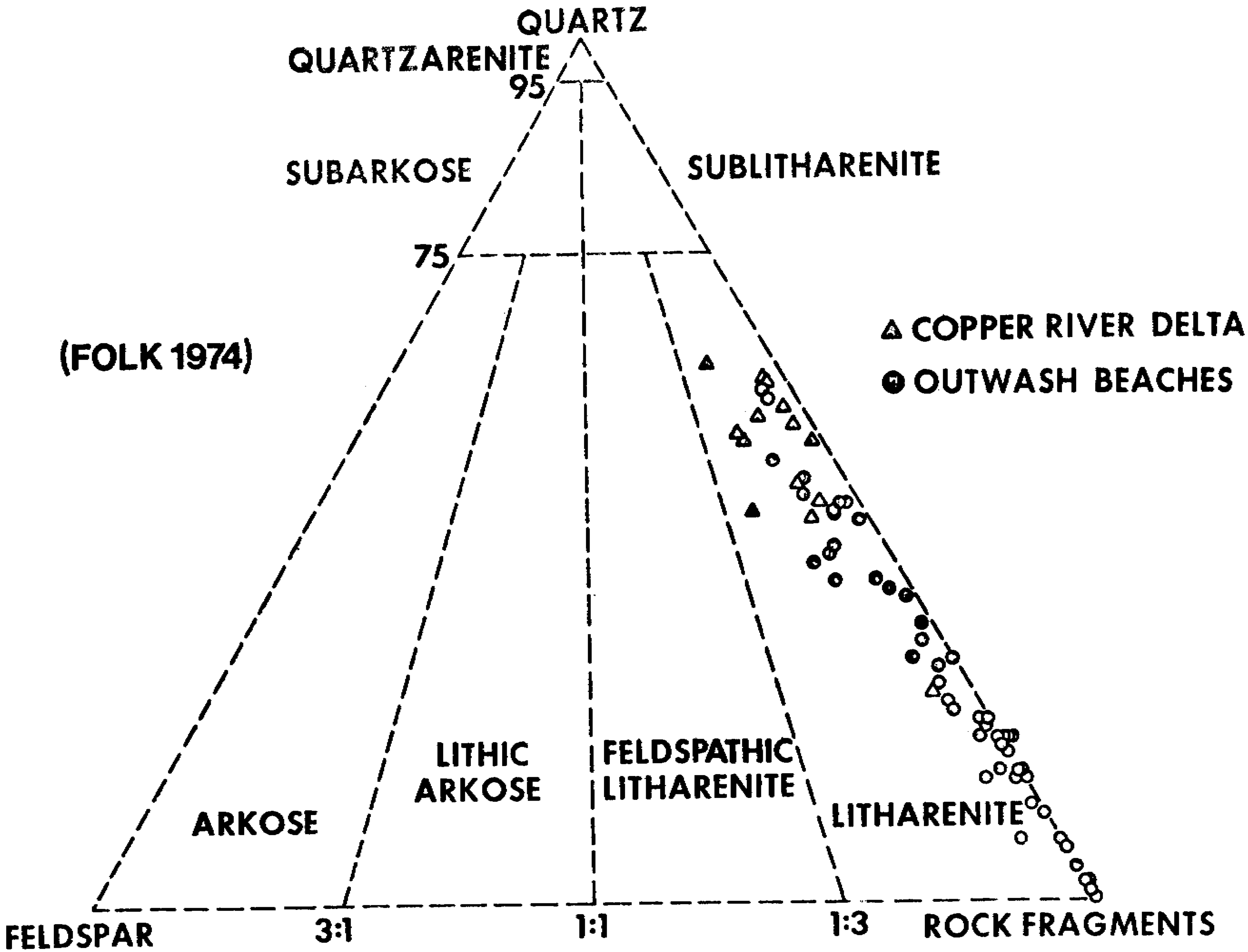

CORDOVA
EGG IS.
DOWN DRIFT OFFSET
DELTA SIZE
INLET WIDTH
km
6
4
2
0
4
2
0
2
0
N
0
25
km

Figure 8. Copper River Delta, Alaska. Lower graphs show a general increase in downdrift offset, ebb-tidal delta size, and inlet width in a westerly direction.


QUARTZ
QUARTZARENITE
95
SUBARKOSE
SUBLITHARENITE
75
(FOLK 1974)
COPPER RIVER DELTA
OUTWASH BEACHES
LITHIC ARKOSE
FELDSPATHIC LITHARENITE
ARKOSE
LITHARENITE
FELDSPAR
3:1
1:1
1:3
ROCK FRAGMENTS

phenomenal changes of the island since the Good Friday Earthquake of 1964. Using a) aerial photos taken immediately after the earthquake, b) our field data collected in 1969-71, and c) our field data of the summer of 1975, a trend of shoreline change was established (Fig. 9). Generally speaking, the island erodes at the east end, builds out seaward in a huge bulge just west of the inlet, and builds westward by recurved spit growth at the western end. At Egg Island, the east end eroded 56 m between February, 1970, and May, 1975, (Fig. 10) and the bulge west of the inlet grew seaward over 400 m during that period. In fact, the island has almost doubled in size since 1964. A generalized model of barrier island development for the Copper River Delta is given in Figure 11.

Such remarkable and drastic shoreline changes are very common in the whole study area because of three factors:

1. Land movement affiliated with earthquakes.
2. Large waves and strong tidal currents.
3. Huge sediment supply because of the glaciation of the area.

A general paper comparing the outwash fans of Alaska with those of Iceland and Death Valley was given by Boothroyd and Nummedal at the Geological Society of America meeting in Salt Lake City. The abstract for this paper is given on page 42. Levey, Cable and Boothroyd have submitted an abstract entitled "Neoglacial and Recent History of Icy Bay, Alaska" to the regional meeting of the Geological Society of America to be held in Washington, D. C., in April, 1976. A copy of that abstract follows on page 43. Another abstract entitled "Littoral Processes and Geomorphic Variability on a Storm-dominated, Glacial Shoreline, Malaspina Foreland, Gulf of Alaska" has been submitted by Stephen, et al., to the 1976 joint meeting of AAPG-SEPM to be held in New Orleans in May, 1976. A copy of that abstract follows on page 44.

Figure 9. Shoreline changes at Egg Island between 1964 and 1975. The 1964 shoreline was derived from vertical aerial photographs taken 10 days after the Good Friday Earthquake of 1964. EG-1, EG-4 and EG-8 are permanent beach profile localities established in February, 1970.

EGG ISLAND DEPOSITIONAL HISTORY

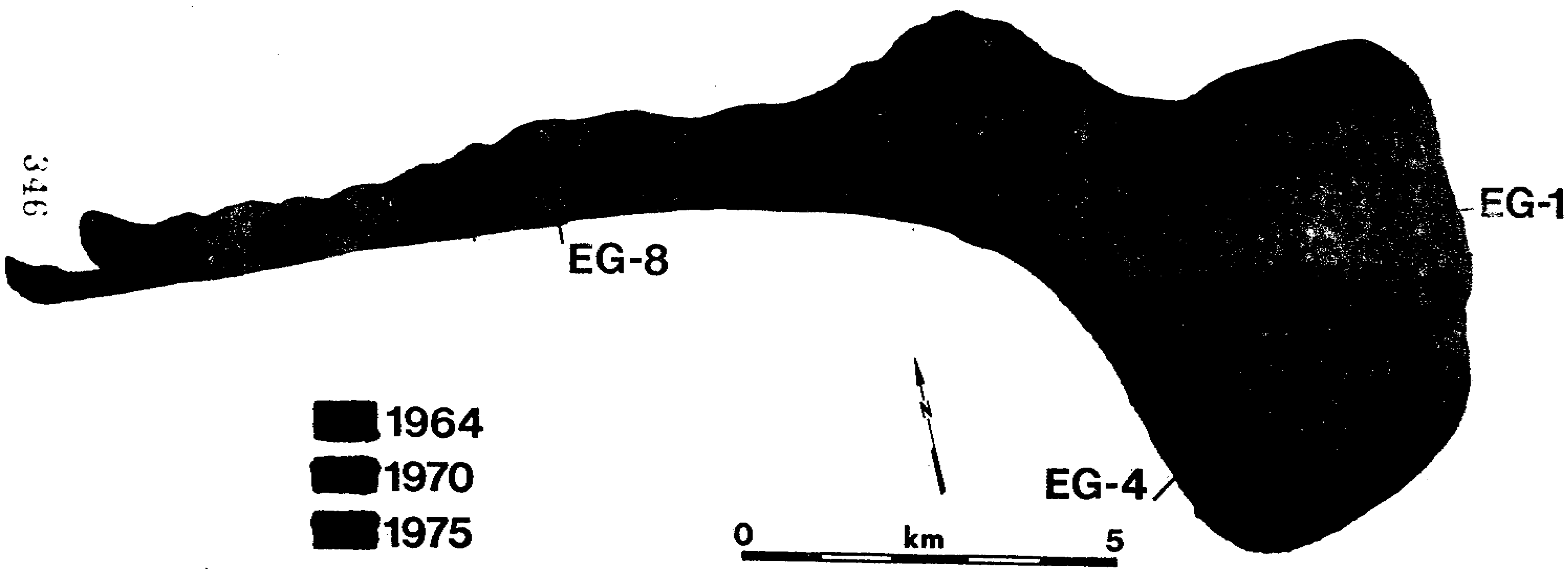


Figure 10. Changes at 3 permanent beach profiling localities on Egg Island between February, 1970, and May, 1975. Scarp erosion of 56 m occurred at EG-1, and the shoreline built out over 400 m at EG-4. See Figure 9 for profile locations.

EGG ISLAND PROFILES

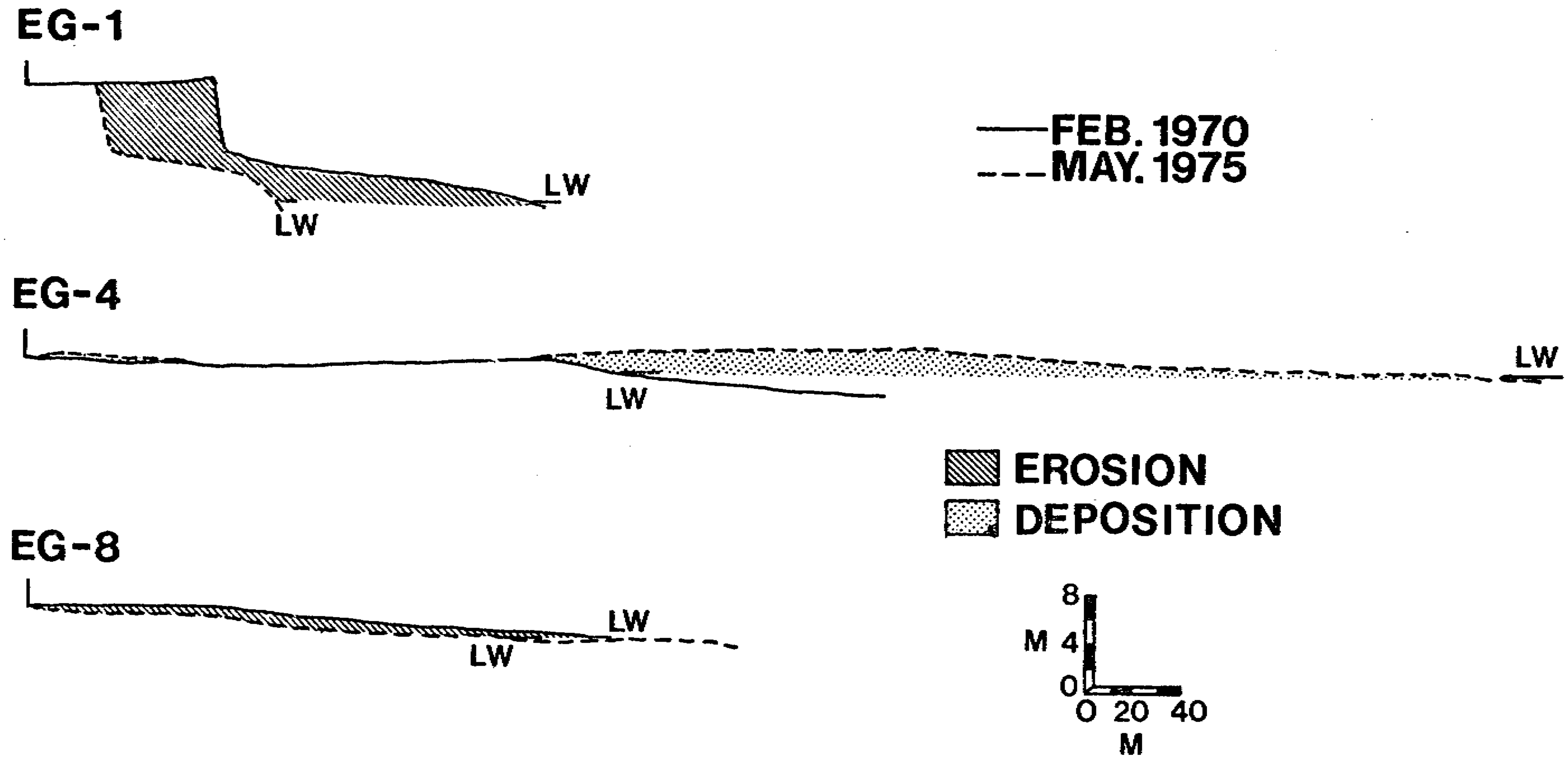
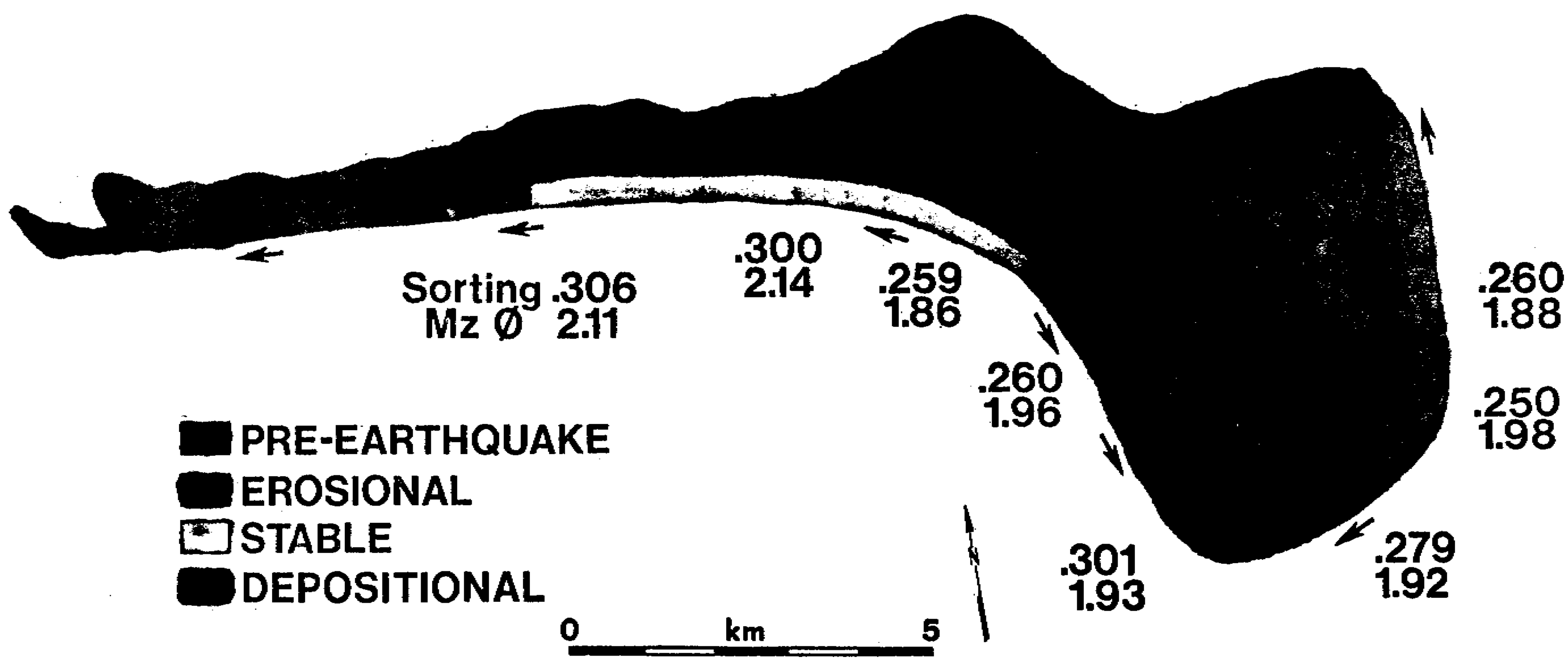


Figure 11. General depositional-erosional model for Copper River Delta barrier islands. A major erosional area occurs at the east end of the island. Depositional areas occur just west of the inlet and on the western end of the island. The middle of the island is generally stable. Numbers are real values of sorting and mean size for Egg Island beach stations. In general, sediments of the erosional and stable areas are slightly coarser and slightly better sorted than the sediments of the depositional areas.

BARRIER MODEL



PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES

All field work outlined in the original proposal was accomplished without any major problems. I do not anticipate any changes in our approach to the field work. Laboratory work and data analysis is proceeding on schedule.

One setback in the field was increased costs due to the "Great Alaska Oil Rush". We are dangerously far along in our spending (see estimate of funds expended). However, it seems that the volume of data gathered exceeds our expectations.

RECOMMENDATIONS FOR FUTURE RESEARCH

Our use of the zonal method to cover broad regions of the shoreline appears to be turning out abundant results with a minimum amount of field time and at a relatively low cost. My first recommendation would be to apply this method (see discussion in original proposal) to other large segments of the Alaska coast. The Kenai Peninsula-Cook Inlet area would appear to be a logical next area to study. The shoreline of Prince William Sound is also a good possibility. These studies would pinpoint areas of potential geological hazards, delineate zones of erosion and deposition, establish regional sedimentation patterns, etc. If the field work were carried out in the summer of 1976, preliminary recommendations could be made by Christmas, 1976.

A second recommendation would be to conduct more detailed studies on the inlet hydrodynamics and tidal flat sedimentation of the Copper River Delta area. The potential of oil spills in that area is high because of the proximity to Valdez. No basic data is available on either the water circulation patterns or on the mechanism of sedimentation of the tidal flats. The same statement could be made about the tidal flats of the Cook Inlet area (in the vicinity of Anchorage). Our recent experience with the *Metula* oil spill in Chile indicates that oil from a major spill can remain on a tidal flat for many months (Hayes and Gundlach, 1975).

REFERENCES CITED

Folk, R. L., 1974, Petrology of sedimentary rocks: Hemphill's, Austin, Texas, 170 pp.

Hayes, M. O., and Gundlach, E. R., 1975, Coastal geomorphology and sedimentation of the *Metula* oil spill site in the Straits of Magellan: Report to Advanced Environmental Research and Technology, National Science Foundation, Washington, D. C., 103 pp.

ESTIMATE OF FUNDS EXPENDED

Classified positions (technician salary)	1,651.73
Unclassified administrative personnel (summer salary for co-principal investigator: Jon C. Boothroyd)	3,600.00
Graduate staff assistants (summer salaries for field assistants in Alaska)	3,000.00
Temporary help - non-student (emergency drafting help)	402.00
Undergraduate student assistants (summer salaries for field assistants in Alaska and salary for part-time laboratory assistant)	3,760.00
Freight (shipping of equipment and samples)	2,769.00
Travel (airline fares and subsistence for summer field crews in Alaska)	16,669.09
Repairs	136.24
Other contractual services (chartering of airplane with pilot, leasing of equipment)	19,023.12
Educational supplies (film, aerial photographs, camping equipment, small items of field equipment)	7,777.60
Food supplies (purchase of canned goods for use while camping in Alaska)	1,509.00
Equipment (CB radios, Brunton pocket transits, tents, meteorograph)	2,944.40
Fringe Benefits	183.96
Overhead	3,067.94
TOTAL:	66,495.19

APPENDIX

Published Papers and Abstracts

*

DEVELOPMENT AND DYNAMIC PROCESSES OF THE BEACHES OF A TECTONICALLY ACTIVE, GLACIATED COAST, SOUTHERN ALASKA

Miles O. Hayes
Christopher H. Ruby
Michael F. Stephen
Stephen J. Wilson
Coastal Research Division
Department of Geology
University of South Carolina

The shoreline of the Cape Yakataga to Dry Bay area of southern Alaska is an exceptionally dynamic area because of intense tectonic activity, large waves, strong tidal currents and presently active glaciation. Huge volumes of sediment derived from glacial sources have built a 30 km wide coastal plain on this predominantly uplifting collision shoreline (Inman and Nordstrom, 1971). Uplift of 47 ft occurred at the head of Yakutat Bay during a single earthquake in 1899. Advance and retreat of the glaciers cause sudden and dramatic shifts in loci of erosion and deposition along the beaches. For example, a glacier that fronted on the ocean in 1900 has retreated up Icy Bay 45 km (Tarr and Martin, 1914; Shepard and Wanless, 1971), exposing the downdrift (western) beaches to intensive erosion. Beach retreat of several hundred meters has been recorded in that area.

The study area (Fig. 3) was first visited by the senior author in the summer of 1969, and seasonal studies were conducted through 1971 under the sponsorship of the Office of Naval Research. Renewed activity in oil exploration on the continental shelf off these beaches, as well as a need to develop shore facilities there, has generated new interest in the area on the part of the Bureau of Land Management, USGS, and NOAA. The area was revisited in the summer of 1975 under the sponsorship of NOAA to conduct process studies and to continue our study of the coastal morphology and sedimentation.

The coastal geomorphology was studied by combining field data on processes, measurement of beach profiles, and sediment sampling with studies of sequential aerial photographs and charts. Beach profiles were measured and sediment samples were collected at 3 km intervals along the coast (99 stations). On the basis of these data, the beaches have been organized into 5 classes (Fig. 3) based primarily on the glacial history of the area.

1) ACTIVELY ERODING GLACIAL MARGINS:

These beaches are subject to large scale erosion. Profiles are short and steep and are backed by steep erosional till scarps. Beach material is composed of a mixture of sand and angular gravel with many large erratic blocks left behind as the scarps retreat. Steep beaches with multiple cuspate berms composed of pure, well-sorted gravel are located just downdrift of these areas.

2) GLACIAL OUTWASH COASTS:

These beaches are generally prograding, with abundant mixed sand and gravel spits trailing toward the west, except inside Yakutat Bay where a major transport reversal occurs (Fig. 3). Beach-ridge plains develop downdrift of the major river mouths. Beach profiles contain abundant ridge-and-runnel systems; rhythmic topography is common. Variations of profiles occur as the quantity and type of sediment supplied by the outwash streams change.

3) REGIONAL RETREATING COAST:

This is the area located downdrift of Icy Bay, which is now experiencing widespread erosion because of the retreat of the glacier. Profiles are flat and often highly scarped. Sediments are mixed sand and gravel. Older beach ridges, outwash areas and the till areas on either side of Icy Bay are all being cut back severely. Washover terraces are advancing over the low lying areas.

4) ABANDONED GLACIAL COASTS:

These areas, which are located inside Icy Bay and Yakutat Bay, are characterized by unconsolidated tills and kame terraces which are fronted by steep, well sorted gravel beaches with multiple cuspate berms. The profiles usually have high, vegetated storm berms which indicate infrequent but violent storms. Sand and gravel spits occur on the downdrift sides of the till islands in Yakutat Bay.

5) PROGRADING SPITS:

Spits are building into deeper waters on either side of Icy Bay as the shoreline around the mouth of the bay erodes. Profiles are relatively flat, and the spits are composed predominantly of sand.

Process observations were obtained at two levels during July-August, 1975:

A) Process Network (Fig. 3). Regional process variability was determined by multiple observations during stable meteorological conditions.

B) Six Process Zonals (Fig. 3). 48-hour continuous monitoring of meteorological, wave, littoral, and morphological variability at single sites selected as representative of shoreline segments.

Regional process parameters document littoral transport in directions that correlate with regional morphology. Dominant south and southeast waves yielded sediment transport away from eroding till cliffs and from the mouths of outwash streams.

Process zonal measurements allowed documentation of the passage of a complete storm cycle. Commonly two distinct wave trains were monitored. Under such conditions, drift directions and velocities were erratic and strong rip currents were prevalent. Dominant wave approach was a function of the path of low pressure systems moving through the Gulf of Alaska. Southerly waves were characteristic of calm conditions, and southeasterly waves were characteristic of storm conditions.

Breaker heights averaged 1.5 to 2.0 m, with a maximum measured height of 4 m recorded during a storm. Suspended sediment concentrations taken from the bore of plunging waves were as high as 150 gms/liter. Measured beach profiles revealed up to 15 cm of accretion to the beach face during one tidal cycle.

These field data, in conjunction with wave hindcast data, wave energy flux calculations, and air photo determinations of spit accretion will be used to compute volumetric longshore transport and dispersal rates. The process data, plus the general morphological data, should be useful for engineering considerations pertaining to the development of petroleum shore facilities in the Icy Bay and Yakutat Bay areas.

REFERENCES CITED

Inman, D. L. and Nordstrom, C. E., 1971, On the tectonic and morphological classification of coasts: Journal of Geology, v. 79, p. 1-21.

Shepard, F. P., and Wanless, H. R., 1971, Our Changing Coasts: New York, McGraw-Hill, 579 p.

Tarr, R. S., and Martin, Lawrence, 1914, Alaskan Glacier Studies: National Geographic Society, Washington, D. C.

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ABSTRACT FORM – 1975
See instruction sheet for deadlines and addresses.

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BARRIER ISLAND DEVELOPMENT ON A TECTONICALLY ACTIVE DELTA, COPPER RIVER DELTA, ALASKA

Hayes, Miles O., Coastal Research Division, Department of Geology, University of South Carolina, Columbia, South Carolina 29208;
Ruby, Christopher, Coastal Research Division, Department of Geology, University of South Carolina, Columbia, S. C. 29208

Barrier islands of the Copper River Delta, Alaska, have undergone major changes in morphologic and sedimentary patterns since the Good Friday Earthquake of March, 1964. Several feet of seafloor uplift, coupled with the high sediment yield of the Copper River, have brought about shoreline progradation and reorientation measured in 100's of meters.

Studies of sequential aerial photographs, sediment analysis, and repeated surveys during 1970, 1971, and 1975 of permanent beach profiles established in February, 1970, lead to the following conclusions: 1) Dominant sediment transport is from east to west, as indicated by westward sediment fining and overall westward migration of the barrier island. This sediment transport pattern is brought about by frequent extra-tropical cyclones which generate dominant southeasterly winds. 2) The characteristic shape of the barrier island is that of a drumstick, with the fat end of the drumstick occurring on the updrift end of the island. 3) Sedimentation is accentuated downdrift of the tidal inlet, producing downdrift offsets. At Egg Island Channel, the amount of offset has increased over 1 km since the earthquake. 4) Amount of downdrift offset and size of ebb-tidal deltas increases from east to west, presumably as a result of increasing tidal prisms of the inlets in that direction (mean tidal range = 3.08 m). 5) Progradation is brought about through the development of multiple ridge-and-runnel systems which migrate landward and downdrift, eventually welding onto the beach.

These conclusions, combined with detailed measurements of sedimentary structures, are used to construct a depositional model for deltaic sedimentation in a tectonically active, high sediment yield, high energy environment.

☒ Oral ☐ Discussion ☐ Poster ☐ Symposium ______________ (title of symposium)

Speaker Miles O. Hayes

Indicate authors who are not GSA members Christopher Ruby

Indicate authors who are not members of the appropriate section for which this abstract is submitted ______________

Percentage of paper previously presented 10%

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- geology
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  - education
  - engineering
  - environmental
  - experimental
  - extraterrestrial
  - general
  - historical
  - history of
  - marine
  - mathematical
  - Pleistocene
  - structural
- geomagnetism
- geomorphology
- geophysics
- geoscience information
- hydrogeology
- mineralogy
- paleontology
  - micro
  - invertebrate
  - vertebrate
- petrology
  - igneous
  - metamorphic
  - sedimentary
- sedimentology X
- stratigraphy
- tectonics
- OTHER

DEPOSITIONAL PATTERNS OF ALASKAN AND ICELANDIC COASTAL SANDURS COMPARED WITH SOME DEATH VALLEY ALLUVIAL FANS

Boothroyd, Jon C., Coastal Research Division, Department of Geology, University of South Carolina, Columbia, South Carolina 29208; Nummedal, Dag, Coastal Research Division, Department of Geology, University of South Carolina, Columbia, South Carolina 29208.

Similar depositional patterns are present on sandurs (glacial-outwash or alluvial fans) of the Northeastern Gulf of Alaska and southeastern Iceland. Each individual braided-stream system has a regional gradient ranging from 6-17 m/km in the proximal zone to 2-3 m/km at the distal margin. Maximum clast size (long-axis) decreases regularly downfan from 50 cm (proximal) to sand (distal). Proximal bars are longitudinal; distal bars are linguoid.

Sandy distal facies are best developed on Icelandic sandurs and are absent on Alaskan sandurs of less than 8-10 km in length. Inactive stream areas support an extensive wind-tidal flat in Iceland but are marsh covered in Alaska. Glacier-burst (jokulhlaup) channels are common on proximal Icelandic sandurs but have not been identified in Alaska.

A comparison of these sandurs with two arid fans in Death Valley reveals some fundamental differences. The Death Valley fans are steeper; gradients may reach 98 m/km in the proximal zone, ranging down to 17 m/km at the toe of the fan. Proximal clast size is similar (30-45 cm) to that of the proximal sandur facies, but clasts exhibit no regular decrease in size downfan. Longitudinal bars are poorly developed; linguoid bars are absent. Even more important, Death Valley fans: 1) contain a greater percentage of mud as matrix in the gravel; 2) exhibit only rare sand lenses in the gravel; and 3) have no distal sand facies.

These fundamental differences suggest that Alaskan and Icelandic sandurs may be a better model than arid alluvial fans for some fluvial conglomerates in ancient rocks.

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ABSTRACT FORM

See instruction sheet for deadlines and addresses.

Exact format shown on instruction sheet must be followed.

NEOGLACIAL AND RECENT HISTORY OF ICY BAY, ALASKA

Levey, Raymond A., Department of Geology, University of South Carolina, Columbia, S. C. 29208; Cable, Mark S., Department of Geology, University of South Carolina, Columbia, S. C. 29208; Boothroyd, Jon C., Department of Geology, University of Rhode Island, Kingston, R. I. 02881

The surficial geology of Icy Bay, Alaska, which is located on the northeast shore of the Gulf of Alaska, is mostly due to the advances and retreats of glaciers during neoglacial time. Glacial and fluvio-glacial deposits occur extensively along the northern and eastern periphery of the Bay. Both active and abandoned braided streams, and their associated deltaic deposits, exist in the northeastern section of the Bay. The mouth of the Bay is characterized by active spit development resulting from sediment transport along the Malaspina Foreland. Comparison of recent aerial photographs along with ground truth verification has resulted in several modifications of the surficial geological map of the Malaspina district constructed by Plafker and Miller.

It appears from historical accounts that the Bay has occupied at least two different positions since the late 1700's. Retreat exceeding 40 km since 1900 has resulted in major morphological changes that are still occurring at the head of the Bay. Due to this rapid retreat, large volumes of dead ice have been isolated in the upper Bay area. Subsequent wastage in conjunction with high precipitation rates produces adequate runoff to modify glacially deposited features. Understanding of the dynamics of these post-glacial systems is essential in examining and interpreting the surficial geology of the Bay area.

☒ Oral ☐ Discussion ☐ Poster ☐ Symposium ____________________ (title of symposium)

Speaker Raymond A. Levey

Indicate authors who are not GSA members Raymond A. Levey, Mark S. Cable

Indicate authors who are not members of the appropriate section for which this abstract is submitted ____________________

Percentage of paper previously presented 0

I will be available to serve as a cochairman for a technical session on or concerning ____________________

For correspondence purposes, list address of senior author if different from above ____________________

Phone numbers and dates where senior author can be contacted (803) 777-6759

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  - extraterrestrial
  - general
  - historical
  - history of
  - marine
  - mathematical
  - Pleistocene
  - structural
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- geomorphology 1
- geophysics
- geoscience information
- hydrogeology
- mineralogy
- paleontology/paleobotany
  - invertebrate
  - micro
  - paleobotany
  - palynology
  - vertebrate
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Address. Title of Paper

STEPHEN, M. F., M. O. HAYES, C. H. RUBY, and S. J. WILSON, Coastal Research Division, Department of Geology, University of South Carolina, Columbia, S. C. 29208.

LITTORAL PROCESSES AND GEOMORPHIC VARIABILITY ON A STORM-DOMINATED, GLACIAL SHORELINE, MALASPINA FORELAND, GULF OF ALASKA.

The shoreline of the Malaspina Foreland, located on the Gulf of Alaska, consists of an actively eroding glacial margin with short, steep beaches backed by till and kame scarps. Flanking the eroding glacial margin are active outwash plains, with progradational barrier spits forming beach-ridge plains downdrift of the major river mouths. Prograding spits build into the deeper waters of Icy Bay and Yakutat Bay to the west and east of the Malaspina Foreland.

Regional process parameters document littoral transport in directions that correlate with regional morphology. Dominant south and southeast waves result in sediment transport away from eroding till cliffs and from the mouths of outwash streams.

Detailed littoral process observations were obtained at two levels during July-August, 1975:

A. Process Network: Regional process variability was determined by multiple observatior during stable meteorological conditions.

B. Six Process Zonals: 48-hour continuous monitoring of meteorological, wave, littoral, and morphological variability at single sites selected as representative of shoreline segments.

Process zonal measurements allowed documentation of the passage of a complete storm cycle. Commonly, two distinct wave trains were monitored. Under such conditions, drift directions and velocities were erratic and strong rip currents were prevalent. Dominant wave approach was a function of the path of low pressure systems moving through the Gulf of Alaska. Southerly waves were characteristic of calm conditions, and southeasterly waves were characteristic of storm conditions.

Breaker heights averaged 1.5 to 2.0 m, with a maximum measured height of 4 m recorded during a storm. Suspended sediment concentrations taken from the bore of plunging waves were as high as 150 gms/liter and averaged 60 gms/liter. Longshore drift velocities ranged as high as 150 cm/sec. Measured beach profiles revealed up to 15 cm of accretion to the beach face during one tidal cycle.

These field data, in conjunction with wave hindcast data, wave energy flux calculations, and air photo determinations of spit accretion will be used to compute volumetric transport and dispersal rates.

EMPLOYER'S PERMISSION TO PUBLISH, IF REQUIRED, IS AUTHOR'S RESPONSIBILITY

Mailing address of senior author: Michael F. Stephen, Coastal Research Division, Dept. of Geology, Univ. of S. C., Columbia, S. C. 29208

Speaker: Michael F. Stephen

Quarterly Report for Quarter Ending September 30, 1975

Project Title: The Environmental Geology and Geomorphology of the Gulf of Alaska Coastal Plain

Contract Number: 03-5-022-56

Task Order Number: 6

Principal Investigator: P. Jan Cannon
Assistant Professor, Geology
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

To produce three maps of the coastal plain section of the Gulf of Alaska.

II. Field and Laboratory Activities

Preliminary field reconnaissance of the area from Dry Bay to Cape Yakataga was undertaken in August. This preliminary reconnaissance was hampered by the lack of the SLAR data. The SLAR data was not obtained until the first of October. The SLAR data is of good quality (for X-band radar imagery) and will provide a good information base for some of the mapping.

III. Results

Compiled list of previous literature and mapping of region and obtained copies of pertinent papers and maps. Reviewed LANDSAT files for sequential imagery of Yakutat - Icy Bay area. EROS data retrieval system is faulty and a complete listing of usable scenes is only obtainable by laboriously reviewing the imagery of each applicable orbit. The gathering of the usable LANDSAT scenes from July 1972, up to April 1975, was completed in mid-September. The listing of LANDSAT scenes from April 1975 to November, 1975, should be completed in December 1975. Copies of some of the LANDSAT scenes were purchased for study and 1:250,000 scale enlargements of four of the best scenes were made. These enlargements are being used as a mapping base and data source.

IV. Problems Encountered

During August, a tremendous amount of time was consumed in efforts to acquire the SLAR data.

V. Estimate of Funds Expended

	Total Budget	6 mos Expended*	Remaining
Salaries & wages	14,887.00	402.97	14,484.03
Staff Benefits	2,505.00	69.35	2,435.65
Equipment	0	0	0
Travel	2,560.00	641.56	1,918.44
Other	1,600.00	194.78	1,405.22
Total Direct	21,552.00	1,308.66	20,243.34
Indirect	8,515.00	230.47	8,284.53
Total Cost	30,067.00	1,539.13*	28,527.87

*Preliminary cost data, not yet fully processed.

DEPARTMENT OF THE ARMY
U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE 03755
P.O. Box 282

CRREL-EN

3 SEP 1975

Dr. Gunter Weller
Outer Continental Shelf Energy Program
Elvey Building
University of Alaska
Fairbanks, Alaska 99701

Dear Dr. Weller:

Inclosed is the USACRREL first quarter report for project "Delineation of a Subsea Permafrost and its Engineering Characteristics in The Beaufort Sea (#105)" for the period May, June and July 1975.

If there is any additional information required, please contact Mr. Paul Sellmann. If you do not intend to circulate these reports amongst collaborators in other institutions or agencies, please let us know so we can keep them informed.

Sincerely yours,

D. R. Freitag
D. R. FREITAG
Technical Director

1 Incl
As stated

QUARTERLY REPORT

(May, June and July 1975)

DELINEATION OF SUBSEA PERMAFROST AND ITS ENGINEERING CHARACTERISTICS (UNIT #105) - PAUL V. SELLMANN (P.I.) - USACRREL, HANOVER, NH

The first quarter's activity was primarily devoted to planning for the 1976 spring program and coordination with other related geologic OCS projects.

Dr. Richard Berg attended the Seattle OCS meetings on geology in early May. Mr. Paul V. Sellmann and Dr. Jerry Brown attended a meeting called by the USGS at Menlo Park in July which covered a review of spring 1975 activities, proposed 1975 summer field work and details of the 1976 spring drilling program.

Preliminary logistic requirements were supplied for the 1976 program. Planning of the data management was initiated and will be reported upon more fully in the next report. Review of the appropriate Soviet permafrost and geomorphological literature was initiated. The Canadian Beaufort Sea reports were obtained. Dr. Brown visited Dr. Lewellen's drilling project at Barrow in early June as part of other activities in Alaska. Dr. Lewellen provided USACRREL with samples of the subsea permafrost from the area southeast of Barrow. Plans for the drilling contract and services were further developed by Mr. Sellmann and final plans will be decided during the next quarter. There are no insurmountable problems requiring resolution at this time. The initial $10,000 for FY 75 was received and expended in June. A second increment of $100,000 was in the process of transmittal at the close of the quarter.

Task Title: Light Hydrocarbon and Particulate Matter Programs

P Dr. J.D. Cline and Dr. Richard A. Feely, PMEL

OUTER CONTINENTAL SHELF ENERGY PROGRAM
JUNEAU PROJECT OFFICE
P. O. BOX 1808
JUNEAU, ALASKA 99802

I. TASK OBJECTIVES

Low Molecular Weight Hydrocarbons (C_1-C_4)

In accordance with the guidelines of OCSEP, the first of six field programs was initiated in the southeastern Bering Sea (DISCOVERER, Leg III, 1975). The principal focus was to evaluate the spatial and temporal variations in the concentrations of the low molecular weight hydrocarbons, methane (CH_4), ethane (C_2H_6), ethylene (C_2H_4), propane (C_3H_8), propylene (C_3H_6), iso- and normal butanes (C_4H_{10}). A detailed description of these studies is presented in work unit #153/155.

Particulate Matter Program

The primary objective of the suspended matter in these areas will be to address Task B-11 (characterize physically and chemically sediment influx, transport and deposition) of the Study Plan. During the course of this program we will address portions of Tasks A-33 (trace elements in suspended particulate matter) and A-34 (particulate nutrients in suspended particulate matter).

II. FIELD OR LABORATORY ACTIVITIES

A. Ship Schedule

1. Leg II of the SURVEYOR (10 August - 29 August 1975)

Participant from PMEL - Gary Massoth, Geochemist

Results - Cruise aborted because of engine breakdown

2. Leg III of the DISCOVERER (13 September - 3 October 1975)

Participants from PMEL

Dr. Richard Feely - Chief scientist; co-principal investigator; Particulate Matter and Light Hydrocarbons, PMEL

Dr. Joel Cline - Oceanographer; co-principal investigator; Particulate Matter and Light Hydrocarbons, PMEL

Mr. Gary Massoth - Geochemist; Particulate Matter, PMEL

Ms. Jane Fisher - Oceanographer; Particulate Matter, PMEL

Ms. Joyce Quan - Physical Science Tech; Particulate Matter, PMEL

Mr. Willian Landing - Graduate Student; University of Washington

Mr. Anthony Young - Oceanographer; Light Hydrocarbons, PMEL

Mr. Lee Ohler - Oceanographer; Light Hydrocarbons, PMEL

B. Light Hydrocarbons

1. Field sampling and shipboard analysis

Water samples were taken with 5- or 10-L Niskin® samplers and temporarily stored in 1-L glass-stoppered bottles to which was added 100-200 mg of sodium azide to suppress bacterial activity. Within two hours of sampling, hydrocarbons were quantitatively "stripped" from solution and absorbed on activated alumina at -196°C, After approximately 20 minutes of stripping, the cold trap was warmed and the hydrocarbons chromatographed on Poropak® Q and detected with a FID. Complete sample analysis, including stripping, up through C_4 required about 30 minutes.

2. Station locations

The sampling for low molecular weight hydrocarbons was carried out in concert with the particulate matter program (Figure 1). In addition to the proposed study, five EBBS stations were also sampled, together with a detailed grid (11 station) near Izembek Lagoon. The latter region was investigated because of abnormally high methane concentrations observed near the lagoon.

3. Sample analysis

A total of 72 stations were occupied, resulting in the analysis of 298 water samples for the aforementioned hydrocarbons. Approximately 3 to 5 standard depths were sampled at each station (e.g., 0, 10, 20, 30, bottom -5). The number of depths selected at each station varied, depending on the station sampling protocol and the elapsed time between stations. In all cases, hydrocarbon sampling was optimized to preclude prolonged sample storage.

Quality control was maintained each day through routine standardization and replicate sampling at selected stations.

Short term temporal changes were examined at two stations, EBBS-37 (36 hours) and PMEL-46 (24 hours). The first of these was located in central Bristol Bay to the west of the Pribilof Islands, the latter near Unimak Pass. Sampling was carried out at standard depths every 4 hours.

C. Particulate Matter Program

1. Methods

Water samples were collected in 10-L Top Drop Niskin® bottles and filtered under vacuum through (1) preweighed 0.4 μm Nuclepore® filters, (2) 0.4 μm Selas silver filters, and (3) 0.45 μm preweighed and pretreated Millipore filters. The filters were removed from the filtration apparatus, placed into individually marked petri dishes, dried in a desiccator for 24 hours and stored for shipment to the laboratory.

2. Sample locations

Figure 1 shows the locations of the stations where suspended matter samples were collected during Leg III.

3. Data collected

Particulate matter samples were collected from all of the proposed PMEL stations and 20 out of 22 of the EBBS stations. Samples wère taken from several preselected depths depanding on location. Nominally, these depths included: surface, 10m, 20m, 40m, 60m, and 5 meters above the bottom. Since time and weather conditions were favorable, 5 additional stations were added to the sampling grid to provide more information about local sources for particulate matter. In addition, EBBS station 37 was occupied for 36 hours with sampling occurring every 4 hours.

III. RESULTS

Low Molecular Weight Hydrocarbons

Data processing is proceeding at a normal rate and should be finalized by December 1, 1975.

Particulate Matter

No results are available at this time.

IV. PRELIMINARY INTERPRETATION OF RESULTS

No interpretations are available at this time.

V. SAMPLING AND LOGISTIC DIFFICULTIES

Shipboard Contamination

Hydrocarbon sampling from standard oceanographic platforms (i.e., DISCOVERER) is tenuous at best. Some difficulties were encountered during Leg III from hydrocarbon--contaminated sampling bottles resulting in a time-consuming clear-up procedure. The contamination arose from either 1) storage of the Niskin® samplers on the fantail of the DISCOVERER and thus subject to the effects of stack effluents, or 2) the introduction of the rosette sampler through a surface oil slick. It is recommended that the samplers be stored inside the ocean lab when not in use and cocked just prior to sampling. If this is not feasible, a cover could be placed over the rosette and removed just before sampling. As an additional precaution, the rosette should be flushed thoroughly below the mixed layer prior to sampling. Under no circumstances should the holding tanks or bilges be pumped while on station.

Kodiak Logistics

The analysis of "light" hydrocarbons requires either liquid nitrogen or dry ice to effectively trap and concentrate the sample. Currently, our staging operation from Kodiak is severely limited because Wien Airline refuses to fly either liquid nitrogen or dry ice to Kodiak on a commercial flight. Currently, transportation of liquid nitrogen or compressed gases to Kodiak can only be satisfied through Sea Land, Inc., but long lead times, handling, and limited scheduling lead to large losses in these valuable cryogenics. This problem could be alleviated by moving ship departure points to parts on the mainland (i.e., Anchorage, Seward, etc.), where surface transportation from Anchorage can be utilized.

Particulate Matter Program

The nephelometer that was planned to be deployed on the near-bottom current meter array will not be completed until mid-December. Therefore, we suggest (after consulting with the physical oceanographers) that the deployment of the nephelometer on the near-bottom current meter array be delayed until mid-January.

VI. ESTIMATE OF FUNDS EXPENDED

	Allocated	Expended to Date	Balance
<u>Particulate Matter Program</u>			
Salaries and overhead	125.6K	33.5K	92.1K
Travel (Leg III only)	23.5	3.0	20.5
Equipment			
Current meter	5.0	2.0	3.0
Nephelometers (1 finished and 2 more in final stages of development)	35.0	27.0	8.0
Cahn electrobalance and supplies	5.0	3.5	1.5
X-Y recorder and supplies	3.0	3.0	0.0
Filtration equipment	4.0	4.0	4.0
X-ray fluorescence system	70.0	0.0	70.0
Computer time	9.8	.5	9.3
Expendable supplies		8.0	0.0
Publications	6.0	0.0	6.0
Total	300.0K	84.5K	215.5K

	Allocated	Expended to Date	Balance
<u>Low Molecular Weight Hydrocarbon Study</u>			
Salaries and overhead	63.0K†	21.0K	42.0K
Major equipment	26.5	15.0	11.5
Expendable supplies	17.5	7.1	10.4
Travel and per diem	7.0	1.4	5.6
Shipping	4.0	0.7	3.3
Publications	4.0	0.0	4.0
Total	122.0K	45.2K	76.8K

†Salaries and overhead were computed for the months June through October 1975, or 5/15 of 63.0K.

VII. RECOMMENDATIONS FOR FUTURE CRUISES

A. After having some first-hand experience conducting field studies with NOAA ships, it is our recommendation that future field studies in the Bering Sea be reduced from the present plan of 23 days to 17-18 days.

B. The cruises in Gulf of Alaska could probably be reduced from 23 days to 18-20 days, depending on weather conditions.

C. The cruise on the SURVEYOR in the GOA which is tentatively scheduled for 4 May - 10 May has been scheduled for a very poor time slot. The water resources data indicate that the river discharge is relatively low at that time of the year. We would rather have that cruise scheduled around 7 July, just before the summer cruise in the Northeast Gulf.

D. The cruise on the SURVEYOR in the Bering Sea which is tentatively scheduled for 27 July - 31 July, has been scheduled at a time when <u>all</u> of our people will be on another ship. This cruise should be rescheduled for a later date (i.e., early September).

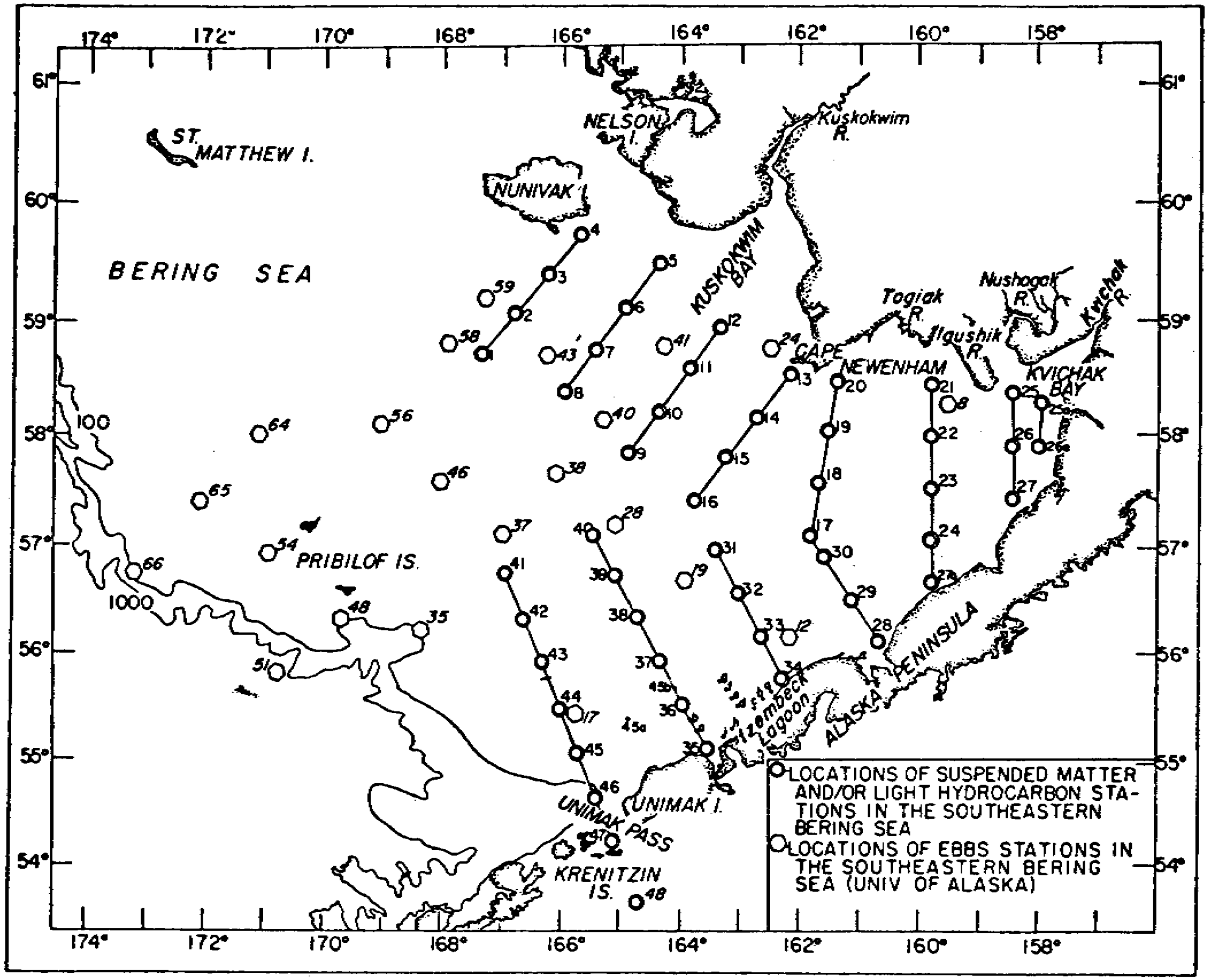
ST. MATTHEW I.
NUNIVAK I.
NELSON I.
Kuskokwim R.
KUSKOKWIM BAY
BERING SEA
Togiak R.
Nushagak R.
Kvichak R.
Igushik R.
CAPE NEWENHAM
KVICHAK BAY
PRIBILOF IS.
Izembeck Lagoon
ALASKA PENINSULA
UNIMAK I.
UNIMAK PASS
KRENITZIN IS.
LOCATIONS OF SUSPENDED MATTER AND/OR LIGHT HYDROCARBON STATIONS IN THE SOUTHEASTERN BERING SEA
LOCATIONS OF EBBS STATIONS IN THE SOUTHEASTERN BERING SEA (UNIV OF ALASKA)

FIGURE 1

RU 204

"Offshore Permafrost Studies,
Beaufort Sea"

Peter Barnes &
Erk Reimnitz
U.S. Geological Survey

Project does not begin until Spring 1976 field season.

RU 205-G

"Marine Environmental problems in the Ice Covered Beaufort Sea Shelf and Coastal Regions"

Peter Barnes
Erk Reimnitz
David Drake
USGS

During most of the 1975 field season, the Beaufort Sea was ice-locked. The USGS collected some high resolution seismic data, side scan sonar records, and took a small number of bottom samples. However, since so little data was collected it is not appropriate to submit a report at this time. Since the field work will begin in the spring of 1976 no report is now available.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Pacific Artic Branch of Marine Geology
345 Middlefield Road
Menlo Park, CA. 94025

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RU# 206

October 20, 1975

Dr. Herbert E. Bruce
NOAA - Environmental Assessment Program
Alaska Project Office
P. O. Box 307
Juneau, Alaska 99802

Dear Bruce:

Enclosed is a progress report for the Southern Bering Sea OCSEP. As you know, the R/V Lee returned to San Francisco after experiencing difficulty with the rudder and was unable to carry out the objectives of its second cruise, which was designed to evaluate environmental hazards in the Saint George Basin area. I am planning a 4 to 6 weeks' cruise with the same objectives during the early summer of 1976. Data from that cruise should be ready by November of 1976.

Sincerely yours,

T. L. Vallier

T. L. Vallier

Enclosure

I. Task objectives

The major objective is to outline and document problems related to seafloor instability in the St. George Basin area of the southern Bering Sea. This area includes the St. George and Amak basins, the Bering and Pribiloff submarine canyons, and the outer shelf and upper slope that flanks them.

II. Field and laboratory activities

Because the R/V Lee returned to San Francisco with rudder problems, she was not available for the planned cruise during October of 1975. Some preliminary interpretations can be made, if necessary, from existing data, but these will not be available until early spring, 1976. A cruise is planned for the early summer of 1976.

III. Results

No results at this time.

IV. Preliminary Interpretation of Results

V. Problems encountered/recommended changes

Coordination of efforts with researchers at the University of Washington and University of Alaska has not been satisfactory. However, I am continuing my efforts to work with them. They are not currently being funded through NOAA.

VI. Funds expended

Funds for instrumentation are exhausted and the remainder will be spent to prepare the R/V Lee and/or a second vessel for an extended stay in the Bering Sea next summer. Contact Dave Scholl for specific information.

Reply to October 7, 1975 memorandum with amended instructions

1. Recommendations for Future Research

   The evaluation of potential environmental hazards should be extended into the Navarin Basin region. Also, some effort must be made to better understand the sediment dynamics and the pre-Wisconsin sedimentation history of the Bering Sea shelf and slope.

2. Modification of Existing Efforts

   Each NOAA ship should have a good single channel seismic system that is run routinely during all underway operations. I recommend a 3.5 kh z system as a minimum.

3. Integration and Coordination

   This is one area that needs continual updating and effort. For example, samples should be of a size that allows several investigators opportunity for study. A general meeting of investigators should be held once a year for this coordination effort and small meetings between all investigators from a specific area should be encouraged.

4. No comment.

5. No comment.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Pacific Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, CA. 94025

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November 17, 1975

Dr. Herbert Bruce
Project Manager
Outer Continental Shelf Energy Program
P. O. Box 1808
Juneau, Alaska 99802

Dear Dr. Bruce:

Enclosed is an amendment to my progress report on the Southern Bering Sea that was submitted last month. It includes comments on the five items that deal with data management which were listed on your October 28, 1975 memorandum.

1. The data that will be collected include high resolution seismic records from single channel equipment (3.5 khz, uniboom or mini sparker, and 160 kj arcer), side scan sonar, photographs of the sea floor (35 mm and possibly television), and bottom samples from box, gravity, dart, and possibly piston corers.

2. My cruise is scheduled for the middle of the summer, 1976. I think the seismic records should be ready by November and splits from samples a little earlier. Interpretive data and data from sediment analyses won't be ready until the following year.

3. The data will be submitted through the data management group in the U. S. Geological Survey and should be compatible with the data base retrieval system.

4. The amount of data is difficult to estimate. However, I anticipate a large amount if the cruise is at least one month in length.

5. Quality control will be assured through the U. S. Geological Survey's peer review and data management procedures.

Sincerely yours,

T. L. Vallier

T. L. Vallier

Y UKON DELTA COASTAL PROCESSES STUDY

Semi-annual progress report

Principle Investigators:

William R. Dupre'

David M. Hopkins

TASK D-4

I Task Objectives:

Evaluate present rates of change along the 250 Km shoreline of the Yukon-Kuskokwim Delta; locate areas where coastal morphology is changeing rapidly and establish rates of change; and evaluate possible effects of future human activities. In particular, establish causes and frequency of large-scale diversions which have resulted in large changes in the position of the mouths of the Yukon and Kuskokwim Rivers in order to predict liklihood of future changes and extent to which man's activities and intervention may precipitate or inhibit such a change.

II Field Activities:

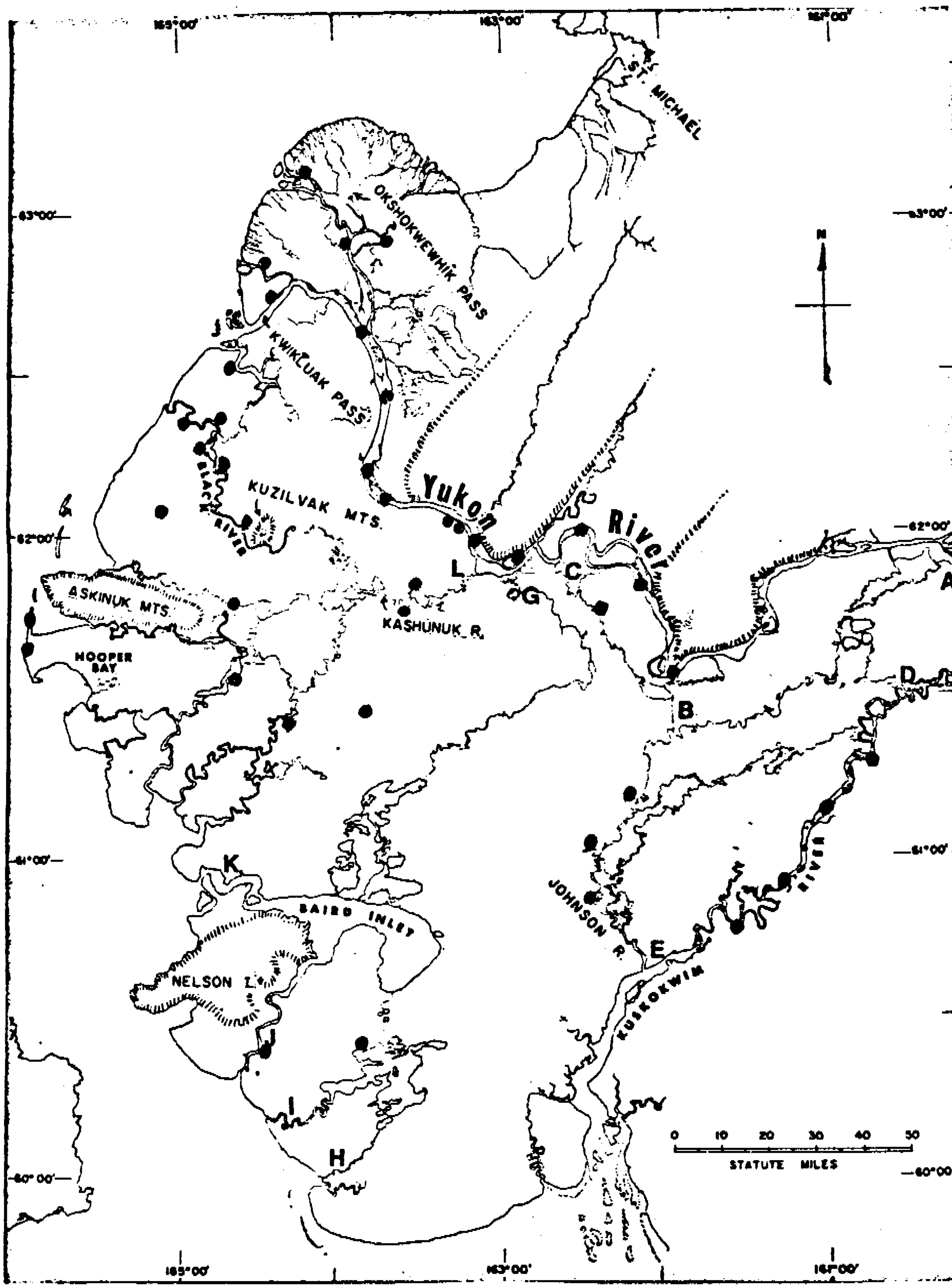
A. Field Trip Schedule
  1. 8/14-8/29 : chartered fixed wing aircraft on floats for regional reconnaissance in the Yukon-Kuskokwim delta region.

B. Scientific Party
  1. William R. Dupre' - Geologist - Principle Investigator
     Department of Earth & Environmental Sciences
     Wesleyan University
     Middletown, Connecticut, 06457

C. Methods
  1. Photo-interpretation of available (1952) aerial photography
  2. Aerial reconnaissance in order to:
     a) take oblique, hand-held photos to serve as a data base to document changes in river and coastal morphology
     b) field-check photo-interpretation
     c) collect samples for radiocarbon dating

D. Sample Localities
   (See attached map)

E. Data Collected
  1. Number and types of samples/observations
     a) Approximately 650 35mm slides taken both from the ground and light planes.
     b) Twenty (20) samples for possible radiocarbon dating
  2. Number and types of analyses
     (None)
  3. Miles of trackline
     (N/A)



MAP SHOWING SAMPLE LOCALITIES (• = sample location)

III Results:

A geologic map of the Quaternary deposits in the delta region is being made largely on the basis of photo-interpretation. The map will include where possible, the delineation of individual subdeltas as well as previous courses of the Yukon River. A derivative map of coastal stability is also being prepared on the basis of short-term changes (1952 to present), historic changes (1895 to present), and long-term changes (e.g. Holocene).

IV. Preliminary Interpretation of Results:

1. Coastal Processes

a) Deltaic processes: The development of major subdeltas of the Yukon Delta can be differentiated in both constructional and destructional phases (c.f. Mississippi Delta). The constructional phase consists of the development and elongation of distributary mouth bars, coupled with the progradation of mudflats along the interdistributary parts of the active delta. Progradation may also occur tens of miles down-drift from the mouths of major distributaries. Major shifts in the course of distributaries (river avulsion), perhaps triggered by ice jams, mark the inception of the destructional phase characterized by erosion of the shoreline.

b) Role of storms: The progradation of the shoreline has been discontinuous, even where rates of sediment input are high, because of erosion of the shoreline during major storms. This erosion is marked by a complex series of "beach ridges" which, when dated, should provide a basis for evaluating the relative frequency of major storms in the region.

c) Rates of change: Comparison of old bathymetric maps (1893), aerial photographs (1952), and recent aerial reconnaissance indicates that rates of shoreline change are relatively slow. Long-term rates of change should be available after radiocarbon dating of the beach ridge sequences.

2. River Processes

The rates of change in the configuration of the Yukon is much greater than those along the coast. In addition, it seems apparent that much of the spatial and temporal changes in coastal morphology are largely the result of major changes in the main river systems. The relative age of some of the older courses of the Yukon River can be determined by the relative degree of modification by thermokarst processes. Exact age determinations must await the results of the radiocarbon dating.

V. Problems Encountered/Recommended Changes:

In spite of its size (approximately 20 million acres), outcrops are surprisingly rare over much of the delta. Where sediments are exposed, they often record eolian or thaw lake deposition, rather than the original deltaic deposits. It was thus impossible to obtain datable samples from much of the delta region given the limited time in the field. This is particularly unfortunate as the results of the radiocarbon dating seem increasingly important in all phases of the project. It also appears evident that river processes play a more important role in coastal stability than previously realized. Ice jams during breakup appear to be a major mechanism for river diversion in the delta region. Thus an additional trip to the delta to observe breakup, as well as collect additional samples, is planned for next spring if funds allow.

Lastly, the aerial photo coverage of the delta is adequate in space, but not in time. Good quality coverage is only available for the early 1950's. Earlier maps of coastal configuration are limited to some areas with U.S. Coast and Geodetic maps of various quality and reliability. Estimates of post 1950 changes are limited to those recognized in field reconnaisance and ERTS imagery. It thus seems likely that the maps of coastal stability will be more qualitative than previously anticipated.

VI. Estimate of funds expended
(N.B. includes cost of entire project, including Tasks B-10 and D-6)

A. Salary, 4 pay periods @ $775/period	2,980.00
B. Field expenses	
1. Round trip air fare Hartford to St Marys, Alaska	760.00
2. Fixed wing aircraft on floats, chartered (approx. 32 hours)	3,000.00
3. Per Diem (8/14-9/29)	890.00
4. Equipment (estimated)	400.00
C. Misc. reference material (e.g. maps, photos)	170.00
	$8,200.00

Original funding (7/1/75 to 9/30/76)	15,000.00
Supplemental funding* by Alaska Geology Branch	2,475.00
Spent (7/1/75 to 11/1/75)	8,200.00
Balance (as of 11/1/75)	9,275.00

*provided for additional flight-time with chartered aircraft.

TASK B-10

I. Task Objective:

Determine the types and characteristics (grain size distribution, mineralogy) of suspended and bedload sediments brought to Bering Sea by Yukon and Kuskokwim Rivers; estimate annual mass introduced to sea and mass stored on delta and on beaches.

II. Field Activities

A. Field trip schedule:
   Same as Task D-4
B. Scientific party
   Same as in Task D-4
C. Methods
   1 & 2 . Same as Task D-4
   3. Collection of samples for textural and mineralogical analysis along the Yukon and Kuskokwim Rivers
D. Sample localities
   See attached map
E. Data Collected
   1. Number and type of samples/observations
      a.) Approximately 650 35mm slides taken both from the air and on the ground
      b.) 20 samples collected for possible radiocarbon dating
      c.) 15 samples collected for mineralogical and textural analysis
   2. Number and type of analyses
      -None-
   3. Miles of trackline
      -None-

III. Results:
   -None-

IV. Preliminary Interpretation of results
   -None-

V. Problems encountered/recommended change

1. Poor recovery of suspended sediment samples will increase reliance on U. S. G. - Water Resources Division to provide suspended sediment samples from the Yukon. Resampling of the Yukon and Kuskokwim with better sampling devices is scheduled if additional field work is possible.
2. Calculation of rates of delta storage must await results of radiocarbon dating, as no absolute, long-term time scale is available.
3. Absence of vertical photo coverage taken at different times has made it difficult to calculate rate of change, hence rate of storage of sediment in the delta and on beaches. (Also see Section V, Task D4)

VI. Estimate of funds expended
   See Task D-4

TASK D-6

I. Task Objective

Determine and map distribution, mode of faulting, age of most recent movement, and magnitude of major faults extending across delta and onto submerged shelf.

II. Field Activities

A. Field trip schedule
   Same as Task D-4
B. Scientific party
   Same as Task D-4
C. Methods
   1-4, Same as Task D-4
D. Sample localities
   See attached map
E. Data collected
   Same as Task D-4

III. Results

A preliminary tectonic map is being compiled which will include 1)previously mapped faults, 2) probable faults, photo linears, and joint sets in the Quaternary deposits, and 3) distribution of areas of Quaternary volcanism, including possible structural control of vents.

IV. Preliminary interpretation of results

The Yukon-Kuskokwim delta complex is in a tectonically-active region characterized by Quaternary faulting and volcanism. The age of the most recent faulting is unknown, as radiocarbon dates have not been obtained. Nevertheless, there is abundant evidence of tectonic fracturing at several localities throughout the delta. At least one major fault zone has been found in the course of this study.

There is no evidence for the extension of the Kaltag fault through the northern part of the modern sub-delta. It seems more likely that is swings to the southwest, perhaps paralleling the base of the Andreski Mountains, where it may then diverge to the northwest along a previously unmapped fault zone..

Active tectonism has proved to be a significant problem in some coastal areas, where increased flooding due to subsidence has caused at least one village to be moved farther inland.

V. Problems encountered/recommended changes

The recognition of photolinears has proved easier than establishing proof of tectonic movement. In some areas this will require detailed investigations (e.g. trenching, drilling) which are beyond the scope of this project. Thus evidence of active faulting along some zones may remain circumstantial until such time as detailed studies are deemed necessary.

VI. Estimate of funds expended
   See Task D-4

DATA MANAGEMENT PLANS

A. Data Collected:

1.) 35 mm slides to serve as base-line data against which changes in river and coastal morphology may be measured
2.) Samples for radiocarbon dating, textural and mineralogic analysis
3.) Photos and maps to document the rates of change in delta morphology

B. Data Submission:
The maps and final report will be submitted by Sept. 30, 1976

C. Format:

Samples will be stored with the Principle Investigators for at least 5 years, after which time they may be discarded unless requests to the contrary are received. Splits of samples will be made available to other scientists working on related problems.

Oblique aerial photos (35mm format) will be permanently stored by the Alaska Geology Branch as they provide valuable base-line information for future studies.

A series of maps and a written report will also be submitted, as indicated in the original proposal.

D. Amount of data to be sumitted

Approximately three maps and a written report will be submitted to the Project Office. The approximately 100 samples and 1000 slides will remain on file with the Principle Investigator.

E. Quality control

The final report and maps will be extensively reviewed by scientists in various branches of the U. S. G. S. to provide quality control. In addition outside reviewers may be called upon to evaluate various parts of the report.

MODIFICATIONS OF EXISTING EFFORTS

1.) The increased reliance on radiocarbon dating in all aspects of the project will necessitate a reallocation of funds, as no money was originally budgeted for dating.

2.) A trip to the delta is tentatively scheduled in May to observe break-up, as ice appears to play a major role in the formation of the delta. This will also provide an opportunity to collect additional suspended sediment samples and samples for radiocarbon dating.

3.) Additional field work will necessitate the use of a helicopter for at least part of the time, as most of the coast is relatively inaccessible by fixed wing aircraft.

4.) The map of coastal stability will be less quantitative than previously planned because of the lack of aerial photos covering various time intervals.

5.) It presently seems unlikely that the age of faulting will be well established in most areas. Rather areas of potential faulting will be delineated necessitating more detailed site investigations should the need arise.

6.) Oblique photo coverage is being provided in lieu of benchmarks in order to measure future shoreline changes.

RECOMMENDATIONS FOR FUTURE RESEARCH

As presently funded, the Yukon delta project will terminate in September, 1976, with the submission of a report and set of maps. We feel that the area is too large (20 million acres), the time spent in the field too short (10 days), and the significance of the delta to the Norton Sound region too great, for the project study to be terminated at this early stage. Thus our recommendation is for the continuation of this study, suitably modified to take advantage of the results of the first years work.

In particular, more detailed studies are needed on the interrelationship of coastal energy regime and sources of sediment input on coastal stability. In addition, the effects of long-term changes in climate, sediment yield, and location of major rivers should be studied as they have effected sedimentation patterns within the Bering Sea. This work would be done in close cooperation with the Marine Geology Branch of the U. S. G. S., which has long standing studies of the history of the Bering Sea. More attention should be paid to geologic processes on the delta plain, including those associated with active river migration, ice breakup, permafrost, and tectonics, as all present significant constraints to development in the region. Lastly, the study of the Yukon delta should provide new perspectives as to the role of climate on delta formation, thereby serving as a valuable analogue for future petroleum exploration in Alaska.

OUTER CONTINENTAL SHELF ENERGY PROGRAM
JUNEAU PROJECT OFFICE
P. O. BOX 1808
JUNEAU ALASKA 99802

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PROGRESS REPORT (Research Unit #209)

Fault history of the Pribilof Islands and its relevance to bottom stability in St. George Basin

D. M. Hopkins, P.I.

I. Task Objectives:

1. Determine and map distribution, mode of faulting, age of most recent movement, and magnitude of offset for major faults extending from the sea floor onto the Pribilof Islands (Task D-6)

2. Summarize existing knowledge (unpublished) on the frequency of volcanic eruptions on and near the Pribilof Islands (Task D-5)

3. Evaluate rates of change in coastal morphology (Task D-4).

II. Field or Laboratory Activities

A. Field Trip Schedule

St. Paul Island, June 17-30. Island reached by commercial aircraft.

B. Scientific Party

D. M. Hopkins, U.S. Geological Survey, geologist with extensive experience on Pribilof Islands;
M. L. Silberman, U.S. Geological Survey, geochronologist specializing in K/Ar dating.

C. Data Collected

39 samples for possible K/Ar-age determination
15 samples for possible C_{14}-age determination
19 rock samples for possible geochemical study
30 samples for granulometric, biostratigraphic, and paleoenvironmental study
3 beetles, part of modern beetle fauna.

Analytical work has just begun and no results to report as yet, except that one of the beetles is apparently new to Alaska, according to J. V. Matthews (Geological Survey of Canada).

III. Results

Map showing known faults and vents on St. Paul and St. George Islands is attached. Map is based on unpublished geologic and paleomagnetic studies by D. M. Hopkins and Th. Einarsson in 1965 and 1970.

IV. Preliminary interpretation

The following interpretation is based on published geophysical studies of southern Bering Sea by Scholl and Hopkins (1969), and Marlow (in press), a published geological, paleomagnetic, and geochronological study by Cox and others (1966), and unpublished geologic and paleomagnetic studies Hopkins and Th. Einarsson in 1965, Hopkins and O. M. Petrov in 1971, and Hopkins and Silberman in 1975.

The Pribilof Islands are centers of persistent basaltic volcanism controlled by tensional fractures along the crest of a broad structural high, the Pribilof Arch of Scholl and Hopkins (1969). The St. George eruptive center was initiated about 3 m.y. ago and eruptive activity ceased about 1 m.y. ago. St. Paul Island became active about 300,000 years ago and is still an area in which eruptions must be expected from time to time. The smaller islands--Walrus Island, Sea Lion Rock, and Otter Island are also ancient eruptive centers but had shorter histories of activity. Some shoals in the vicinity of the Pribilof Islands may also be extinct volcanic centers. Analogy with other areas of basaltic volcanism suggests that individual Pribilof volcanoes erupted for periods ranging from a few months to a few years and that individual eruptions were separated by long periods of dormancy. Many of the lava flows seem to have flowed out over snow.

Eruptive vents on St. George Island have been denuded by subsequent erosion and some are buried beneath younger lavas, so that the total number and frequency of eruptions cannot be calculated meaningfully. On St. George Island, 36 eruptive vents have formed during a period of less than 320,000 years, 11 of these formed during the last 120,000 years, and two of these during the last 10,000 years. These figures seem to indicate that eruptions are fairly evenly spaced and have a recurrence interval of about 10,000 years.

Both islands show evidence of faulting during the period of volcanic eruptions, and extensive faulting has taken place on St. George Island since eruptive activity ceased. Faults of two kinds are recognized on St. Paul Island: extremely complex and ramified systems of closely spaced faults that are confined to certain ancient lava flows have probably resulted from intrusion of sill-like or laccolith-like bodies at shallow depth. Other, more extensive faults are evidently of tectonic origin. The tectonic faults seem to have moved repeatedly over periods of several hundred thousand years; the older flows are cut by more faults and the older faults display larger surface displacements. One of the two Holocene lava flows shows fracture traces, indicating that faulting is a continuing process on St. Paul Island.

St. George Island has been extensively disturbed by a ramifying and generally east-northeast-trending fault system since volcanism ceased. The disruption by faults there is an order of magnitude greater than the disruption of St. Paul Island, suggesting that fault activity there has continued during much and perhaps all of the million-year interval since volcanic activity ceased. The net effect of the faults has been to raise the general level of the island.

Precision-depth-recorder records show very young faults that define a shallow graben in the submerged area between St. Paul and Otter Island.

We have recognized a complex sequence of wind-blown sand deposits on St. Paul Island which, when and if we can date them, will provide an improved basis for estimating the age of the youngest fault scarps there. Information bearing on shoreline stability is also in hand but has not been thought about yet. Meanwhile, the following preliminary conclusions can be drawn:

1. St. Paul Island is an active volcanic center. Eruptions are infrequent and are generally separated by intervals of as much as 10,000 years. The chances of an eruption during any single century is something like one percent.

2. St. George Island is not an active volcanic center.

3. Future tectonic movements that will break the surface of the land and the sea floor must be expected on and near both islands. The faults recognizable in the Pribilof Island are an aspect of continuing deformation on the Pribilof Arch. These particular faults are unlikely to extend into the St. George Island, but some of them would probably cross the route of a pipeline on the sea floor between the St. George Basin and either St. George or St. Paul Island. The faults must also be considered if petroleum storage facilities are planned on the Pribilof Islands. We do not yet have sufficient data to estimate the frequency of fault movement but our geochronological studies will provide an improved data base for fault prediction.

V. Problems Encountered

There are no vertical air photos of St. George Island and vertical air photos of St. Paul Island are less than ideal. Because of this, fault scarps are difficult to recognize and it is impossible to determine whether the faults on St. George Island are active or not. The lack of adequate air photos also makes it most difficult to evaluate existence and rates of shoreline change.

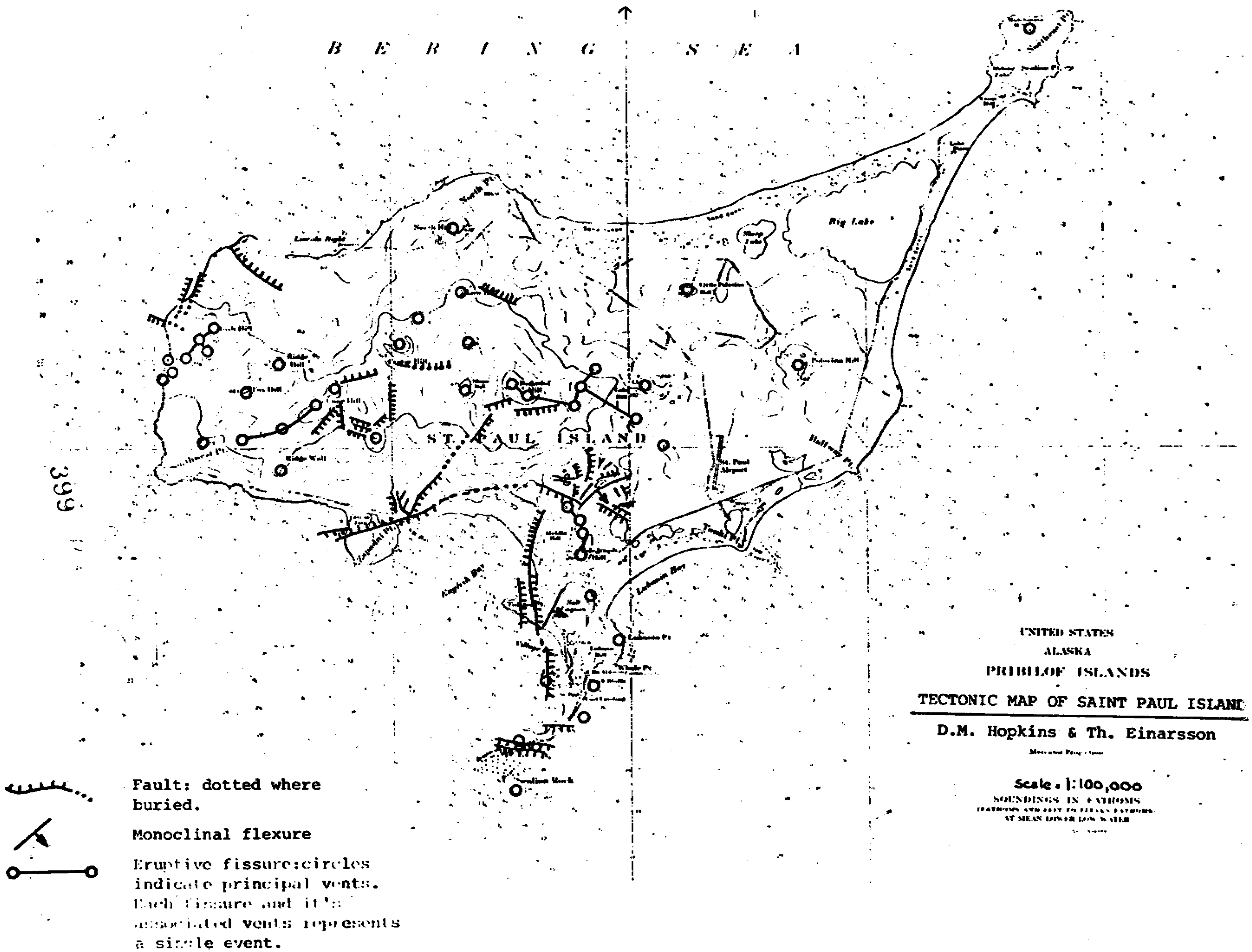
I urge that OCSEAP undertake to have air photos of scale 1:20,000 or 1:40,000 made for the Pribilof Islands. They will be useful for study of potential biological impact on petroleum exploration on the Pribilof Islands as well as for studies of faulting and shoreline instability.

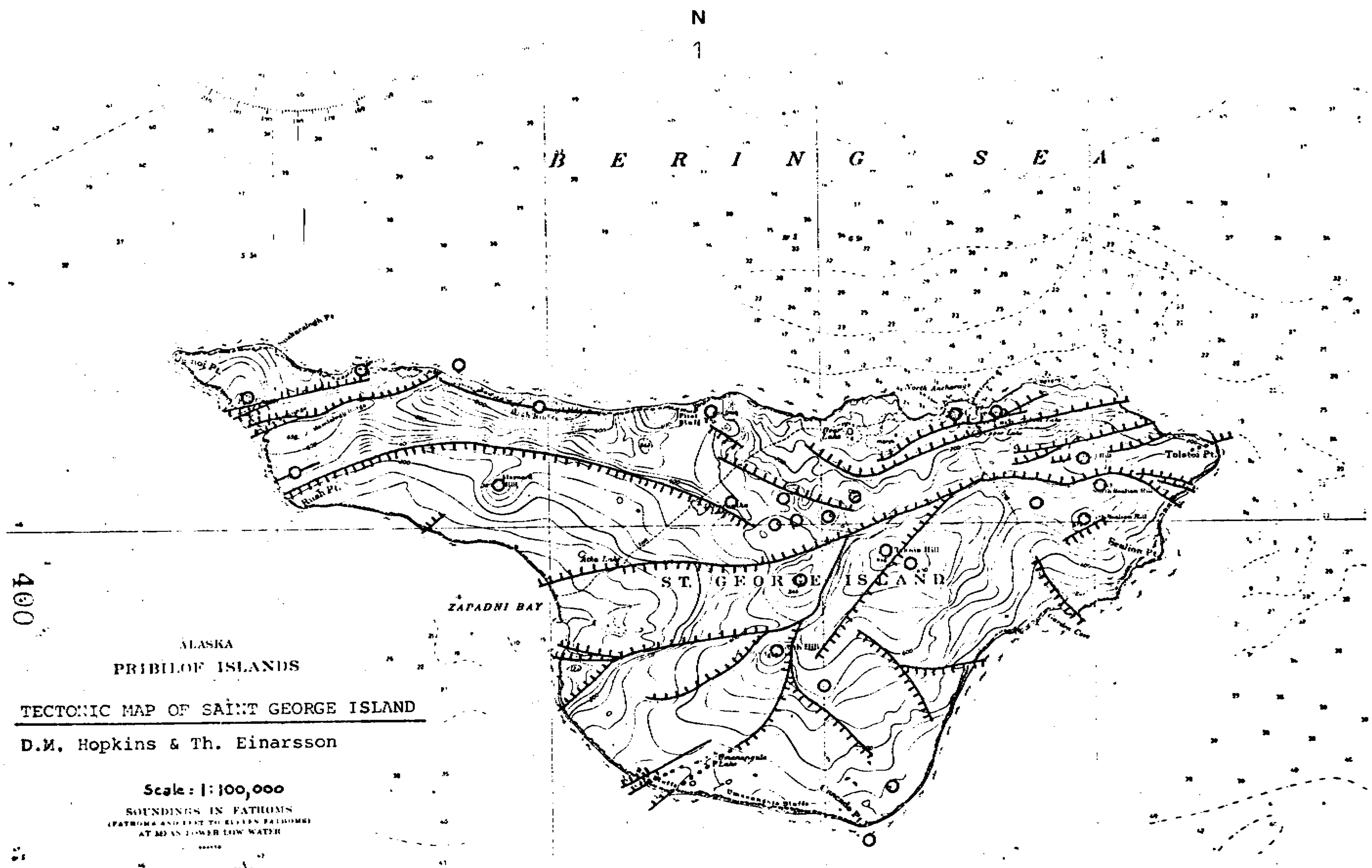
We did not revisit St. George Island as we had planned, because an anticipated shared charter did not materialize during the time available for our field work. However, I have about 10 samples for K/Ar dating available from previous field work there, so that the critically needed dating program can proceed.

VI. Expenditures

		FY 1975		FY 1976 through 10/31
Salaries:				
D. M. Hopkins	1 p.p.	$1,376	4 p.p.	$5,504
M. L. Silberman	1 p.p.	839		
R. Hartz			2 p.p.	588
Travel:				
Air fares		1,555		-----
Subsistence		1,600		
Air freight		130 *		40
Chemical analyses, supplies, repairs to equipment		000 *		208
		$5,500		$5,340

* Actual cost of air freight was $158 and miscellaneous supplies and equipment acquired during FY 1975 in the amount of about $200 not charged against contract.


B E R I N G S E A
ST. PAUL ISLAND
Big Lake
UNITED STATES
ALASKA
PRIBILOF ISLANDS
TECTONIC MAP OF SAINT PAUL ISLAND
D.M. Hopkins & Th. Einarsson
Scale 1:100,000
SOUNDINGS IN FATHOMS
Fault: dotted where buried.
Monoclinal flexure
Eruptive fissure: circles indicate principal vents. Each fissure and it's associated vents represents a single event.



ALASKA

PRIBILOF ISLANDS

TECTONIC MAP OF SAINT GEORGE ISLAND

D.M. Hopkins & Th. Einarsson

Scale: 1:100,000

SOUNDINGS IN FATHOMS

Fault: dotted where buried.

Monoclinal flexure

Eruptive fissure: circles indicate principal vents. Each fissure and it's associated ve repres a single event.

RU 210

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

Robert A. Page &
John C. Lahr
USGS

Report in preparation; will be forwarded when received.

UNITED STATES GOVERNMENT
Memorandum

RECEIVED
NOV 20 1975
NEGOA

TO : OCSEP Program Office - Juneau

DATE: November 14, 1975

Bruce F. Molnia

FROM : Bruce F. Molnia and Paul R. Carlson - Principal Investigator: Erosion and Deposition of Shelf Sediments: Eastern Gulf of Alaska

SUBJECT: FY 76 - Semi-annual Report

I. Task Objectives: Task B-10 - Determine the types and characteristics of bottom sediments.

II. Field or Laboratory Activities

A. Ship Schedule - As yet we have not formalized our ship schedule. However, it is likely that 1976 field work will begin in May or June.

B. Scientific Party. - Not known.

C. Methods.

1. Piston and vibra-coring, box coring, dart and gravity coring, underwater television and bottom camera.

2. Laboratory analysis is continuing with the following procedures being used: Size analysis - hydrophotometer and sieve analysis, clay mineralogy - X-ray defraction and peak area analysis. Sand mineralogy will begin at a later date. Shape parameters are being analyzed by a Fourier harmonic analysis.

D. Sample locations were included in the FY 75 year-end report and are also included here (Fig 1).

E. No new data has been collected since June 1975. We have a field assistant on the present Discoverer cruise and he will collect a bottom sample (Shipek) at each of the grid stations.

1. Approximately 400 sediment samples were collected.

2. Fifty have been analyzed for size. Fifty have had clay mineralogy run.

3. Surveyor- approximately 5000 km

Thompson approximately 6000 km

Cromwell approximately 50 km

III & IV. Results have been presented to you in an interpreted form in a series of Open File Reports and in the FY 75 year-end report which was sent to you last week. No new interpretations have been made since then.

V. Problems - Changes -- None

VI. Expenditures - $5000 - temporary salaries.

Additions to original format (Oct 9, 1975 Memo).

A. I have two recommendations for future work in the project area:

1. Onshore source areas need to be sampled (i.e., each major river and bay needs to be sampled for sediments).

2. The nearshore area needs a high-resolution geophysical survey and sediment sampling.

B. Modifications - None

C. Better Integration and Coordination:

1. Keep the ship schedule for any leg rigid - we have had two experiences where arbitrary decisions on the part of an NOS ship skipper have ruined pre-planned logistics and caused loss of valuable sampling and geophysical work time.

2. Have the Project Office assist in the logistics of people and equipment movement.

D. Focus on OCS Activities - The Project Office could periodically generate a memo listing the status of BLM draft and final EIS's, hearing schedules and plans, sale dates and significant court activities.

E. Environmental Study Results - No suggestions but a comment. We have released many of our findings to the public via the Open File Report route. In addition, we have kept BLM posted on what was taking place from the very start of our project.

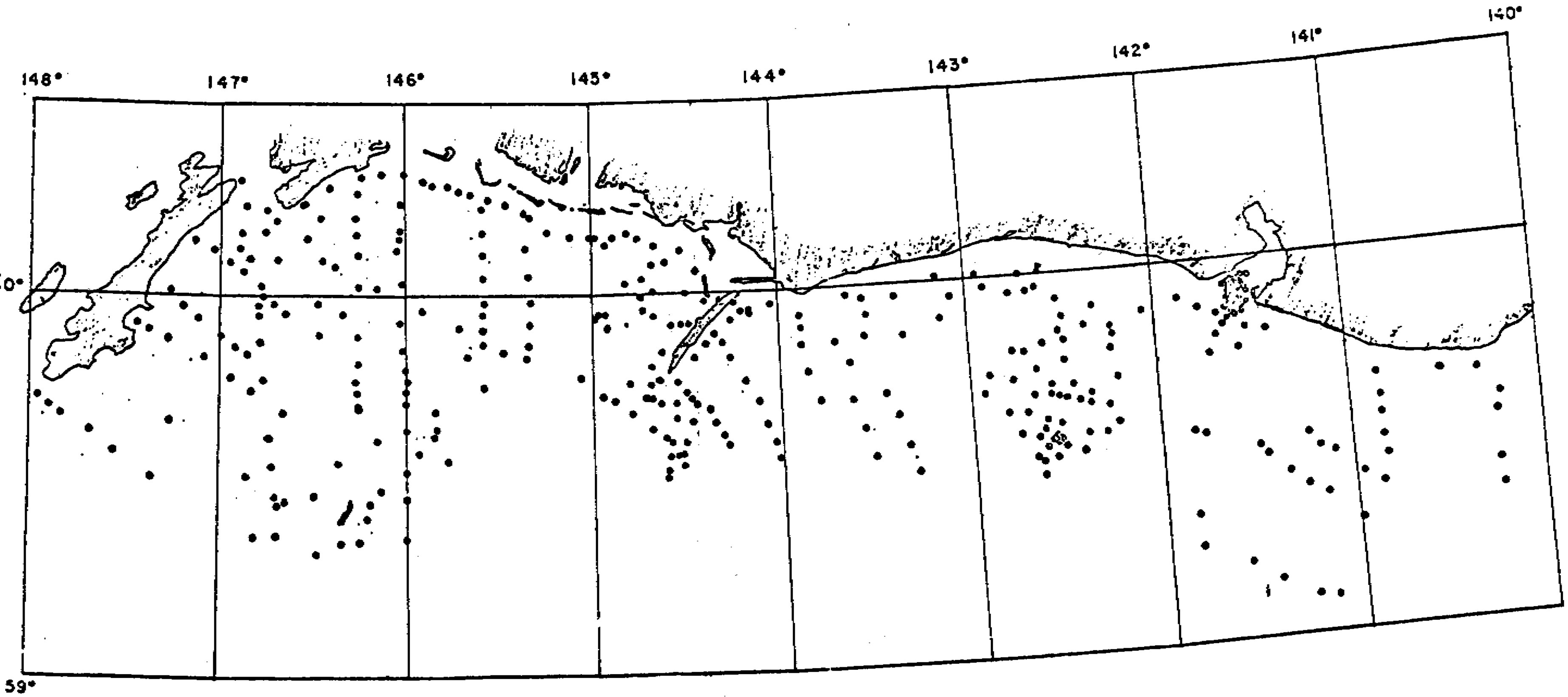


Fig 1. Location of Cromwell Sediment Samples.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

November 18, 1975

Memorandum

To: Herb Bruce and Lou Butler, NEGOA-OCSEP Project

From: ~~Paul~~ Carlson and Bruce Molnia, Principal Investigators,
RU #216 Paul Carlson

Subject: Semi-annual progress report

Enclosed is our progress report for the first one-half of fiscal year 1976. Cruises completed and data collected prior to July 1, 1976 are discussed in our fiscal 1975 year-end report which was recently sent to your office.

Enclosure

SEMI-ANNUAL PROGRESS REPORT ON

FAULTING AND INSTABILITY OF SHELF SEDIMENTS, EASTERN GULF OF ALASKA

P.I. Paul R. Carlson
Bruce F. Molnia

U.S. Geological Survey
Menlo Park, California

I. Task Objectives

D-2-Determine the types and extent of natural seafloor instability. Compile maps indicating relative susceptibility to instability hazards.

D-6-Determine and map the distribution, mode of faulting, age of most recent movement, and magnitude of offset for major faults.

II. Field or laboratory activities

A. October 25 - November 10, 1975; cruise of NOAA Ship Discoverer in the Gulf of Alaska.

B. Jack Hampson, a U.S.G.S. Geologic Field Asst., participated in this cruise. He collected samples of seafloor sediments at as many of the suspended sediment stations as time allowed.

C. Methods of field sampling were:
Shipek and VanVeen grab samples.

D. Laboratory analyses will be started on these samples in the next few weeks. Samples collected last summer (May-June,

1975) are being analyzed for size, mineralogy, foraminifers and shear strength.

Analyses are continuing on the high resolution seismic profiles collected during the past year. Profiles are being analyzed for presence of faults and submarine slides.

E. Samples collected on the cruise of the Discoverer are located along the lines of traverse occupied for the suspended matter sampling (fig. 1).

F. A total of 38 grab samples were collected on the Discoverer cruise of Oct.-Nov. '75. Analyses will begin as soon as possible.

III. Results of our preliminary interpretation of Gulf of Alaska data have been released in a series of 5 open-files and have been incorporated in our fiscal '75 year-end report which was recently sent to the NEGOA-OCSEP office.

The open-file reports are listed below:

USGS OPEN-FILE NO.

75-504 Carlson, Paul R., Bruns, Terry R., and Molnia, Bruce F., Submarine slides and near surface faults, northern Gulf of Alaska

75-505 Molnia, Bruce F., and Carlson, Paul R., Surface sediment distribution, northern Gulf of Alaska

75-506 Molnia, Bruce F., and Carlson, Paul R., Base map of the northern Gulf of Alaska

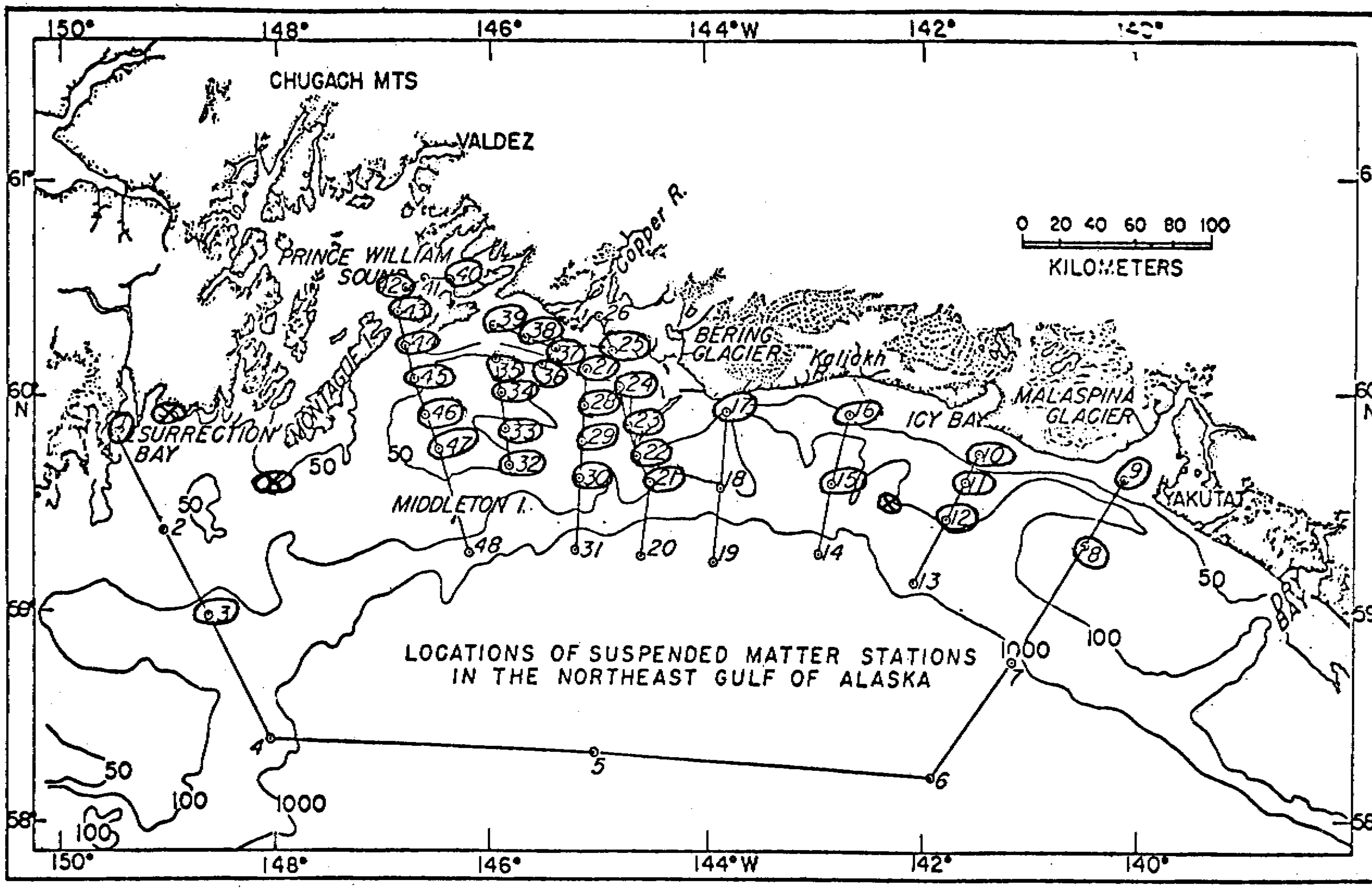


FIGURE I.

The encircled sites are where bottom grab samples were collected

75-507 Carlson, Paul R., and Molnia, Bruce F., Preliminary isopach map of Holocene sediments, northern Gulf of Alaska

75-508 Bruns, Terry R., and Plafker, George, Preliminary structural map of part of the offshore Gulf of Alaska Tertiary province

The following talks were given at the Geological Society of America annual meeting and the Symposium on Science and Natural Resources in the Gulf of Alaska:

Carlson, Paul R., and Molnia, Bruce F., 1975, Massive submarine slide in the Gulf of Alaska: GSA Annual Meeting, Salt Lake City, Oct. 1975, Geol. Soc. America, 1975, Abstracts with Programs, v. 7, no. 7, p. 1018.

Molnia, Bruce F., and Carlson, Paul R., 1975, Geology of Pamplona Ridge, northern Gulf of Alaska: GSA Annual Meeting, Salt Lake City, Oct. 1975, Geol. Soc. America, 1975, Abstracts with Programs, v. 7, no. 7, p. 1203.

Carlson, Paul R., 1975, Submarine slides and faults that disrupt surficial sedimentary units, northern Gulf of Alaska: Symposium on Science, Resources and Technology in the Gulf of Alaska, Oct. 1975, Arctic Inst. of No. America, Anchorage, Alaska, p. 3b.

Molnia, Bruce F., 1975, Surface sediment types of the northern Gulf of Alaska continental shelf: Symposium on Science, Resources and Technology in the Gulf of Alaska, Oct. 1975, Arctic Inst. of No. America, Anchorage, Alaska, p. 3a.

IV. Preliminary estimate of funds expended: Salaries of temporary employees--$4500.

V. Tentative cruise plans.

To supplement existing data we are planning a cruise for early summer '76 to study some of the mapped faults in greater detail. By studying the fault scarps with high resolution seismic equipment, TV, and bottom cameras and collecting strategically located bottom samples, we hope to be able to determine more precisely the age, sense of movement and continuity of the fault traces. We also plan to sample, with piston corer and box corer, some of the areas of potential slump and slumped sediment to determine physical characteristics of these sediments.

VI. Recommended future investigations.

1. Drill a series of shallow stratigraphic holes to determine continuity of formations and to identify units mapped from seismic data. This would also be valuable for obtaining samples for tests of engineering properties (i.e. bulk densities, strength, porosity, and permeability). These samples obtained at depth in the section could be compared to surface samples to determine degree of loading, compaction, consolidation, and lithification.

2. Sea-bottom seismographs would aid in the location of low-level seismicity. This would provide important information regarding degrees of activity along faults.

3. Investigate and sample fault scarps, submarine slides, rock outcrops, submerged glacial moraines, etc. with a research submersible.

VII. How to make information available to user groups.

We are trying to keep "user groups" aware of our work by releasing open-files and giving talks at professional meetings and at public symposia--see item III.

Second Quarterly Report
Contract 03-5-022-55 Task Order #2.
"Seismic and Volcanic Risk Studies - Western Gulf of Alaska"
Principal Investigators: Juergen Kienle and Hans Pulpan, Geophysical Institute, University of Alaska

Report Period: 1 July 1975 - 1 October 1975

The following seismic stations have been successfully installed during the second quarterly report period:

		Longitude (W)	Latitude (N)	Source of Funding for Purchase of Station	Logistics, New Installations	Servicing of Existing Stations
Lower Cook Inlet:						
OPT	Oil Point	153°16'	58°07'	ERDA	OCS	
BNB	Bruin Bay	152°12'	58°54'	OCS	OCS	
MNR	McNeil River	154°23'	59°05'	ERDA	OCS	
CDA*	Cape Douglas	153°23'	58°55'	USGS	OCS	
AUG	Augustine Island - 6 stations	153°23'	59°22'	NSF, Sea Grant Program		OCS
SHU	Shuyak Island	152°21'	58°38'	USGS		OCS
RED	Redoubt Volcano	152°46'	60°25'	NSF		OCS
Kodiak:						
ZRB	Zachar Bay	153°32'	57°30'	OCS	OCS	
SPL	Spiridon Lake	153°46'	57°46'	OCS	OCS	
RAI	Raspberry Island	153°10'	58°04'	OCS	OCS	
Repeater	Pyramid Mountain	152°33'	57°48'	OCS	OCS	
SII	Sitkinak Island	154°09'	56°34'	ERDA	OCS	
SKS	Sitkalidak Island	152°58'	57°09'	OCS	OCS	
MRS	Marine Range	152°24'	57°33'	OCS	OCS	
MMC*	Middle Cape	154°44'	57°18'	ERDA		OCS
Semidi Islands:						
CTI	Chowiet Island	156°43'	56°02'	ERDA		OCS
CRI	Chirikof Island	155°37'	55°47'	ERDA	OCS	

* New Locations

Second Quarterly Report
Contract 03-5-022-55
Page 2

The following seismic stations are still being installed or serviced at this time:

		Longitude (W)	Latitude (N)	Source of Funding for Purchase of Station	Logistics, New Installations	Servicing of Existing Stations
Kodiak Island:						
DMB	Deadman Bay	153°52'	57°11'	OCS	OCS	
Alaska Peninsula:						
PNM	Pinnacle Mountain	157°35'	56°48'	ERDA		OCS
YCB	Yellow Creek Bluff	158°23'	56°38'	ERDA		OCS
PUB	Puale Bay	155°31'	57°46'	ERDA		OCS
BMT	Blue Mountain	164°53'	54°36'	ERDA		OCS
KSL	King Salmon					
FLP	Featherly Pass	156°18'	57°41'	ERDA	OCS	
UKL	Ugashik Lake	156°18'	57°26'	OCS	OCS	

SECOND QUARTERLY REPORT

October 7, 1975

OFFSHORE PERMAFROST - DRILLING, BOUNDARY CONDITIONS, PROPERTIES, PROCESSES AND MODELS

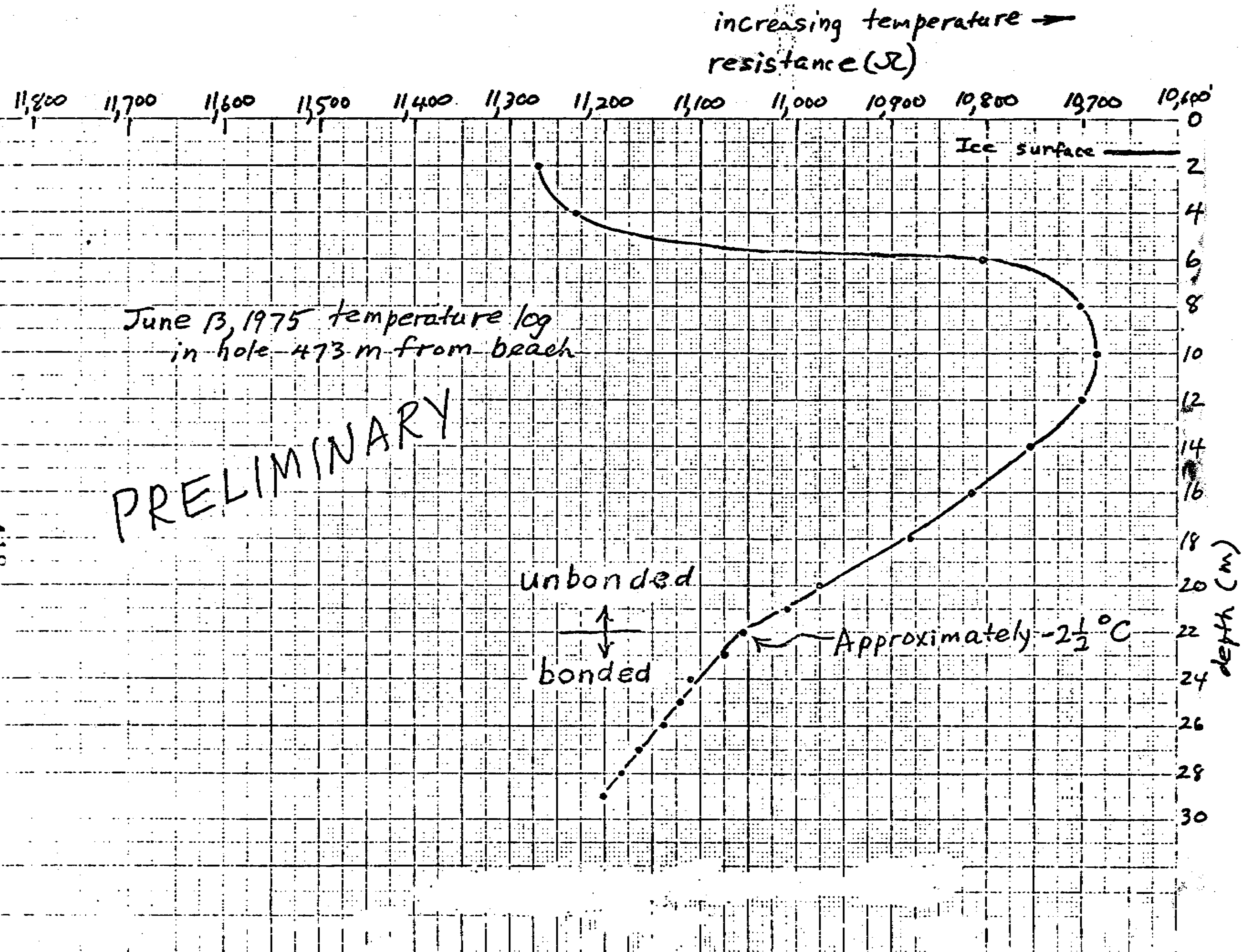
Task Order #1

The off-shore permafrost field site in Prudhoe Bay has been visited three times since the completion of drilling in May. Borehole temperatures were logged in late May and in mid-June. All the off-shore holes were destroyed during break-up, although it appears that enough data were obtained previously to calculate equilibrium temperatures. In late July, a 10 m borehole on land was logged, and shallow temperatures were measured by probing into sea-bed sediments off a small boat.

The temperature data reduction is nearing completion. Some preliminary data from the most interesting hole, 473 m from shore, are attached. From these data we estimate that the ice-bonded permafrost table here is melting down at a rate of the order of 0.01 or 0.02 m per year.

Analysis of samples obtained during the drilling is in progress, and most of the Shelby tube samples have been analyzed.

Some of our work to date on a theoretical framework for off-shore permafrost was presented at the August POAC conference. Unlike conventional thermal models, this work focuses on the importance of salt transport in the melting of ice-bonded off-shore permafrost.



increasing temperature
resistance (Ω)
11,800
11,700
11,600
11,500
11,400
11,300
11,200
11,100
11,000
10,900
10,800
10,700
10,600
Ice surface
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
depth (m)
June 13, 1975 temperature log
in hole 473 m from beach
PRELIMINARY
unbonded
bonded
Approximately -2½ °C

2nd Quarterly Report
Beaufort Sea Coast Permafrost Studies
for 3rd Quarter, July thru Sept. 1975
James C. Rogers
Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701 Task Order #3

I. Task Objectives: Seismic refraction studies of Beaufort Sea Coast permafrost.

II. Field Work: Most of July was filled with arrangements for equipment procurement, assembly, and shipping. As well, observations were made of a similar program undertaken by the Canadian Geological Survey along the Canadian Arctic Coast.

Although an August 3 departure from Barrow was planned, ice conditions along the Arctic Coast prevented this and the equipment was ultimately flown from NARL to Wainwright for installation on the Karluk on August 23. The Karluk arrived at NARL on Aug. 30, 27 days behind the original schedule.

A series of refraction lines was run at four locations along the Coast: In Wainwright Lagoon (approximately 11 miles of line), off Skull Cliff (approximately 16 miles), in Prudhoe Bay (approximately 12 miles), and in Elson Lagoon (approximately 8 miles of line). The total line length, 47 nautical miles, is somewhat less than the one hundred plus miles estimated before the field season. However, in view of the very unusual ice conditions and subsequent curtailment of vessel operating schedules, the total line length is thought to be a good figure.

Of particular value are the lines run in Elson Lagoon and Prudhoe Bay, two areas where sub-bottom sampling and temperature measurements have been accomplished. Also, the later location will be the site of further drilling in the spring of 1976. In both locations the refraction lines closely followed the track of the drilling operations. A sketch map of the Prudhoe Bay line is attached.

III. Results: The data obtained are presently in the form of 24 channel analog records that require scaling and interpretation to delineate probable areas of offshore permafrost.

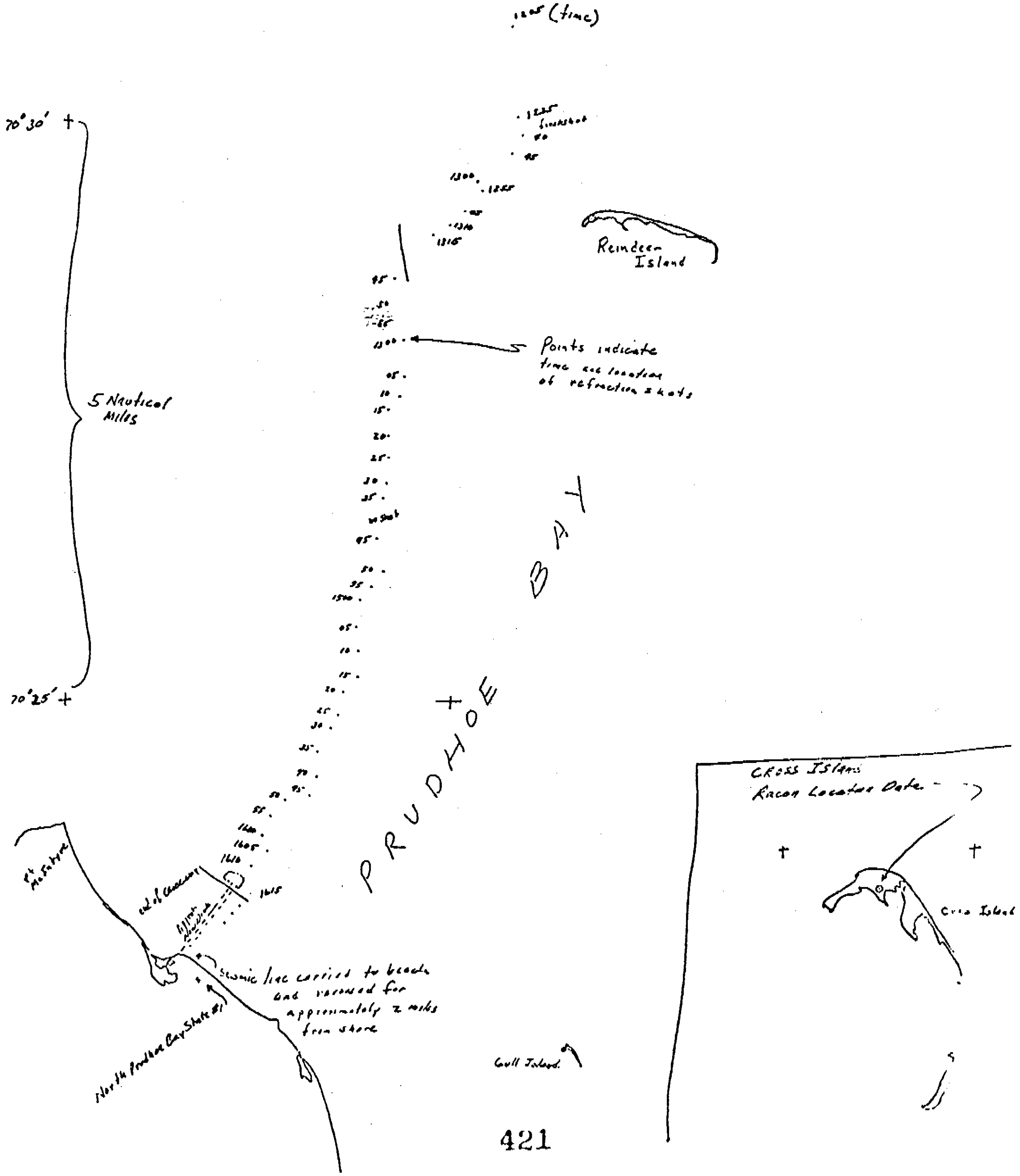
IV. Preliminary Interpretation of Results: Same data analysis was performed in the field which indicated at least two areas of sub-bottom permafrost: Wainwright Lagoon and Prudhoe Bay. Further analysis will be required of the data from Skull Cliff and Elson Lagoon.

V. Problems Encountered/Recommended Changes: Receipt of cargo proved to be a sometime thing at NARL and at Prudhoe Bay, particularly so for the latter. At each location a definite flow of cargo should clearly be established. There are many ways to ship items: U.S. mail, air freight, expedited small parcel (small luggage like items), and NARL aircraft. Usually these methods involve separate people with only peripheral or no knowledge of the OCSEP and separate inquiries must be made of each.

It is recommended (1) that a clear marking scheme be derived to identify OCSEP items, (2) that one person - an expeditor perhaps - be responsible for marshalling at each location all incoming items, (3) that storage (inside and outside) arrangements at Prudhoe Bay be further refined.

VI. Estimated Funds Expended: About $60,000

SKETCH MAP OF FIELD WORK
9/02/75 JCR



Quarterly Report for Quarter Ending September 30, 1975

Project Title: Benthos - Sedimentary Substrate Niteractines

Contract Number: 03-5-022-56

Task Order Number: 3

Principal Investigator:

Charles M. Hoskin
Assoc. Professor of Biogeology
Institute of Marine Science
University of Alaska
Fairbanks, Alaska 99701

I. Task Objectives

Equipment and supplies were, and are, being purchased and a graduate student - Ms. G. H. Kris Tommos, now working for NOAA on Gulf of Alaska projects, was recruited. Ms. Tommos will join the project in January 1976. A laboratory in the Irving II building was designed to provide space for sample analysis.

II. Field Activities

Two cruises under the direction of Dr. Howard Feder provided about 60 samples of bottom sediment from the Bering Sea for grain size analysis. These samples are now stored, frozen.

III. Results

Laboratory analysis has not yet begun.

IV. Problems Encountered

Laboratory bench space is not yet available to conduct grain size analysis of the samples acquired. As soon as bench is available, and when Ms. Tommos joins the project, laboratory analysis will begin, and should proceed rapidly.

V. Estimate of funds Expended

	Total Budget	(6 months) Expended*	Remaining
Salaries & wages	23,296.00	1.430.32	21,865.68
Staff Benefits	3,955.00	243.15	3,711.85
Equipment	550.00	-0-	550.00
Travel	1,500.00	-0-	1,500.00
Other	3,000.00	1,123.34	1,876.66
Total Direct	32,301.00	2,796.81	29,504.19
Indirect	13,325.00	818.95	12,506.05
Total Task Order	45,626.00	3,615.76	42,010.24

* Preliminary cost data, not yet fully processed.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
Pacific-Arctic Branch of Marine Geology
345 Middlefield Road
Menlo Park, California 94025

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November 28, 1975

R. U. #327

Dr. Herbert E. Bruce
NOAA-Environmental Assessment Program
Alaska Project Office
P.O. Box 307
Juneau, Alaska 99802

Dear Dr. Bruce:

Enclosed is a semi-annual report for OCSEP Research Unit #327. Please excuse my tardiness in getting this report to you.

Roland von Huene and Arnold Bouma, who will be working with me in the western Gulf, will be arriving at Menlo Park in early December. At that time, we will go over the GSI records in detail and start planning for 3 to 6 weeks of geophysical and sampling work in the western Gulf this Spring or Summer.

Sincerely,

Monty A. Hampton

Enclosure

Progress Report-Research Unit #327

Faulting and Instability of Shelf Sediments,
Western Gulf of Alaska

Monty A. Hampton, Principal Investigator

I. Task objectives:

Assessment of the environmental geologic hazards of the western Gulf of Alaska continental shelf; in particular the identification and mapping of active surface faults and areas of sediment instability.

II. Field Activities:

During June-August, 1975, the M/V Cecil H. Green, a seismic vessel contracted from Geophysical Service Inc., acquired approximately 5500 line kilometres of geophysical data in the Gulf of Alaska between approximately Unimak Pass and Cross Sound. This activity was directed by Terry R. Bruns. Data acquired over the 5500 km include 24 or 48-fold multichannel seismic reflection data, gravity, magnetics, and bathymetric data. In addition, high resolution data were acquired over approximately 2350 km of these track lines.

Of the multichannel, gravity, magnetic, and bathymetric data, approximately 1700 line km are on the Kodiak shelf roughly between Middleton Island and the Trinity Islands (southwest of Kodiak Island), and 450 line km on the Shumagin Shelf between the Trinity Islands and Sanak Island, for a total of approximately 2150 line km on the Kodiak-Shumagin Shelf. Approximately 350 line km of additional gravity, magnetic, and bathymetric data were run in this area for a total of approximately 2500 line km of these data.

Unfortunately, high resolution data were acquired on only about 150 km of this total due to (1) the high resolution equipment not being obtained and placed aboard ship by GSI until almost three weeks into the program and (2) severe mechanical and electrical problems with the high resolution equipment at both the beginning and end of the cruise when most of the Kodiak-Shumagin shelf data were obtained.

Despite the lack of high resolution data, much information about near surface sediments, faults, and hazards on the Kodiak and Shumagin shelves can be interpreted with the multichannel and bathymetric data. Preliminary inspection of the records suggests that much of the area appears to have hard lithified rock near the sea floor, and may be covered with only a thin veneer of recent unconsolidated sediments. In this case, the bathymetric data will give valuable information on the extension to the sea floor of faults identified on the multichannel records.

In general, although the loss of the high resolution data is serious, much valuable information on the near surface sediments and faults is still available through the combined used of the multichannel and bathymetric data.

An amount of $60,000 of Research Unit #327 funds were spent for the GSI contract.

RECEIVED OCT 28 1975

NEGOA

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL DATA SERVICE
National Geophysical and Solar-Terrestrial Data Center
Boulder, Colorado 80302

Date : October 24, 1975

To : Herbert E. Bruce, Project Manager, Gulf of Alaska, Bering Sea Projects, Juneau, Alaska

From : Herbert Meyers, Acting Chief, Solid Earth Data Services Division, NGSDC, Boulder, Colorado

Subject: Progress Report: Seismicity of the Gulf of Alaska, Bering Sea, and Beaufort Sea

I. Task Objectives.

Historical earthquake information, including both instrumental results and cultural effects, will be compiled for the Alaskan regions. The data will be computerized and summarized in forms which can be easily used to detérmine the seismicity of any particular locality.

II. Field or Laboratory Activities.

A. No. field work is anticipated for this project.
B. The principle investigator is Herbert Meyers. He is being assisted by numerous geophysicists, technicians and computer programmers within the National Geophysical and Solar-Terrestrial Data Center of NOAA.

C. Material within the files of NGSDC are being used to compile the seismicity summaries.

D. Since most off-shore areas around Alaska are involved in this project, and since there is a good change that earthquakes occurring anywhere in Alaska could effect the off-shore operation and related land facilities, the seismicity summaries will include all of Alaska and the adjacent regions.

E. Approximately 10,000 earthquakes will be included. Many of these earthquakes were detected instrumentally and not actually felt within Alaska (primarily due to sparse population). There will be approximately 4,000 reports on the effects of the earthquakes at various communities within Alaska.

III. A series of products will be prepared to depict the seismicity of Alaska. The first product, which we expect to have available in about 3 months, will document the data, describe the sources, and summarize the 10,000 earthqukes in the Alaska file. In addition to this report, there will be a computerized file of the earthquakes. Under separate cover, we are sending preliminary printouts of this file . Additional products which will follow later on will include such things as seismicity maps, earthquake intensities felt at the varous cities, etc.

IV. Interpretation of results are not yet available.

V. There are no unusual problems or recommended changes.

VI. Approximately half of the $24.7K allocated for this project has been expended thus far.

Separate Cover

cc: J. Lander

RU 407

"A Study of Beaufort Sea Coastal
Erosion, Northern Alaska"

R. Lewellen
Arctic Research

Work not started until Fall 1975 - no report at this time.

SEA ICE

ICE

Research Unit	Proposer	Title	Page
87	Seelye Martin Dept. Of Ocean. U. of Wash.	The Interaction of Oil with Sea Ice in the Beaufort Sea	439
88	William F. Weeks A. Kovacs CRREL	Dynamics of Near-Shore Ice (Near-Shore Radar Transponder and Fast Ice Studies)	441
89	William J. Campbell U. of Puget Sound W. F. Weeks CRREL	A Remote Sensing Program for the Arctic Offshore	443
98	Norbert Untersteiner U. of Wash.	Dynamics of Near-Shore Sea Ice in Shear Zone (Data Buoys)	447
244	Roger G. Barry INSTAAR	Study of Climatic Effects on Fast Ice Extent and Its Seasonal Decay Along the Beaufort Sea Coast	469
250	Lewis H. Shapiro William D. Harrison Geophys. Inst. U. of Alaska	Mechanics of Origin of Pressure Ridges, Shear Ridges, and Hummock Fields in Landfast Ice	469
257	W. J. Stringer Geophys. Inst. U. of Alaska	Morphology of Beaufort Near-Shore Ice Conditions by Means of Satellite and Aerial Remote Sensing	471
258	W. J. Stringer Geophys. Inst. U. of Alaska	Morphology of Bering Sea Near-Shore Ice Conditions by Means of Satellite and Aerial Remote Sensing	475
259	Richard D. Nelson William M. Sackinger Geophys. Inst. U. of Alaska	Experimental Measurements of Sea Ice Failure Stresses near Grounded Structures	479
261/ 262	William R. Hunt Claus M. Naske Geophys. Inst. U. of Alaska	Beaufort Sea Historical Baseline Ice Study Proposal	481
265	Lewis H. Shapiro William M. Sackinger Richard D. Nelson Geophys. Inst. U. of Alaska	Development of Hardware and Procedures for <u>in situ</u> Measurement of Creep in Sea Ice	485

Research Unit	Proposer	Title	Page
267	Albert E. Belon Geophys. Inst. U. of Alaska	Operation of an Alaskan Facility for Applications of Remote-Sensing Data to Outer Continental Shelf Studies	487

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON 98195

Department of Oceanography WB-10
Cable Address: UNWADO

25 September 1975

TO: Dr. Gunter Weller, Project Manager
Arctic Project Office

FROM: Dr. Seelye Martin
Department of Oceanography
University of Washington

SUBJECT: Quarterly Progress Report, Research Unit #87

Since the beginning of our contract on 1 July 1975, we have constructed our laboratory tank for the growth of sea ice in a wave field. We have also run some preliminary experiments, which show that both slush and pancake ice form in the tank. We next plan to measure the void space, growth rate and crystal structure of this ice, and then carry out a number of small oil spills.

We are also preparing our equipment for our field traverses in late October - early November.

Sincerely,

Seelye Martin

Seelye Martin

SM:uh

DEPARTMENT OF THE ARMY
U.S. ARMY COLD REGIONS RESEARCH AND ENGINEERING LABORATORY
HANOVER, NEW HAMPSHIRE 03755

CRREL-EM

3 September 1975

Dr. Gunter Weller
Arctic Project Office
Geophysical Institute
University of Alaska
Fairbanks, AK 99701

Dear Gunter:

Inclosed is a brief statement of the progress made during the last quarter (?) on the Dynamics of Near-Shore Ice program. I hope it is sufficient for your needs.

Please note in the progress report that the towers which will be erected on Cross and Narwhal Islands are climbable and that they may be made available to other researchers for equipment installations. A meteorological study is an example of the type of investigation which could be made on the towers.

Sincerely yours,

Austin

AUSTIN KOVACS
Research Civil Engineer
Foundations and Materials
Research Branch

1 Incl
As stated

QUARTERLY PROGRESS REPORT NO. 1

Dynamics of Near-Shore Ice

Preparations for the Shear Zone Experiment are nearly complete. At this time nearly 12 tons of equipment have been shipped to Fairbanks for transport to Prudhoe Bay and on to the main camp on Narwhal Island in September. A precision radar tracking system which will be used to monitor the motion of the pack ice in the shear zone has arrived at CRREL and is presently undergoing field trials and operator familiarization tests. Programs to be used in the system are also being compiled. Plans have been made to erect the radar tracking system base line towers in late September. One tower will be erected on Cross Island and another on Narwhal Island. Each tower will be 150 ft high. These towers are climbable and may be made available for use by other investigators during the winter of 1976 by contacting Austin Kovacs at CRREL (603-643-3200).

U.S. DEPARTMENT OF (.MMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES

OCS Arctic Project Office
Elvey Bldg - Geophysical Inst
University of Alaska
Fairbanks, AK 99701

R.U.# 89

November 13, 1975

MEMO

TO: Distribution

FROM: Gunter Weller

SUBJECT: USGS Remote Sensing Progress Report

The weekly progress reports for the USGS aircraft operations at Barrow, distributed by Judy Wayenberg, stopped on 13 September. Enclosed are the reports for the period 14 September to 7 November. This brings us up to date and we hope to distribute weekly reports from now on.

GW:tmj

encl.

Distribution:

- L. Newcombe, USGS, Menlo Park
- W. Campbell, USGS, Tacoma
- W. Weeks, CRREL, Hanover
- R. Cameron, NSF, Washington, D.C.
- W. Denner, NARL, Barrow
- A. Belon, U of A, Fairbanks
- H. Skibitzke, USGS, Barrow

USGS Remote Sensing Program

PROGRESS REPORTS: 14 September to 7 November

14-20 September	No flights
21-27 September:	
9/23/75	Barrow transect (SLAR) Point Barrow to Wainwright & return (SLAR) Cape Simpson transect (SLAR) Lonely transect (SLAR) Cape Halkett to Barrow (SLAR)
9/24/75	Wainwright transect (SLAR) Wainwright to Barrow (SLAR) Barrow transect (SLAR) Barrow to Cape Simpson (Photography) Simpson transect (Photography)
9/25/75	C1 - C2 and C9 - C10 (SLAR) Barrow to Wainwright (Photography) Wainwright transect (Photography)
9/27/75	Barrow to Wainwright & return (SLAR) Pt. Barrow to Prudhoe Bay & return (SLAR)
28 Sept - 4 Oct:	
9/28/75	Barrow transect (Photography) Cape Simpson transect (Photography) Lonely transect (Photography)
9/29/75	Barrow to east of Prudhoe Bay (SLAR) Prudhoe Bay to B7 and B8 (SLAR)
5-11 October:	
10/5/75	Barrow transect (SLAR)
10/10/75	Parallel SLAR flight lines from north of Barrow to north of Prudhoe & return (B1-B2; B2 - north of Prudhoe; north of Prudhoe Bay - B7; B7-B8)
12-18 October:	
10/18/75	Barrow transect (SLAR)
19-25 October:	
10/21/75	Parallel SLAR flight lines from north of Barrow to Prudhoe Bay & return (B1-B2; B2-B3; B6-B7; B7-B8)
10/23/75	Lonely transect (SLAR)
10/25/75	Parallel SLAR flight lines Barrow to Wainwright & return (C1-C2; C9-C10)
26 Oct - 1 Nov	No flights -- The Mohawk is undergoing periodic maintenance; skis are being installed on the Beaver for winter infrared operations; the Cessna 310 is being equipped for laser profilometry.
2-8 November	No flights -- see above.

All the above SLAR imagery has been received at the Arctic Project Office in Fairbanks. Photographic rolls for the flights on 24, 25, and 28 September have also been received.

GW:tmj:11/13/75

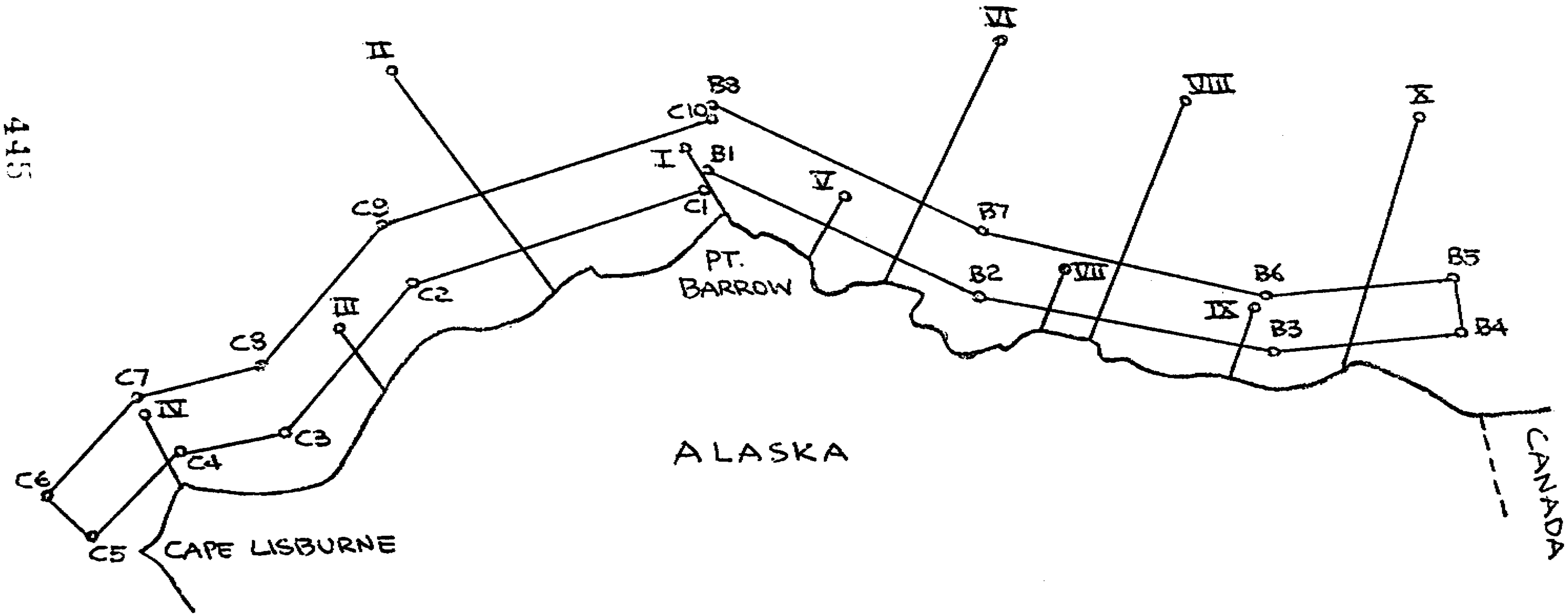
USGS REMOTE SENSING FLIGHTS

CHUKCHI SEA TRANSECTS

I. BARROW
II. WAINWRIGHT (200km)
III. PT. LAY
IV. PT. HOPE

BEAUFORT SEA TRANSECTS

V. CAPE SIMPSON
VI. LONELY (200km)
VII. OLIKTOK
VIII. CROSS ISLAND (200km)
IX. BROWNLOW POINT
X. BARTER ISLAND (200km)



Status of Research

Dynamics of Near-Shore Sea Ice (Data Buoys)

The University of Washington, under Task Order No. 5 of NOAA Contract 03-5-022-67, agreed to deploy 20 ice buoys to gather data on ice movement and oceanographic and atmospheric conditions in the near-shore areas of the Beaufort and Chukchi Seas of the Arctic Ocean. Dr. Norbert Untersteiner, Professor of Atmospheric Sciences and Geophysics and Program Director of the Arctic Ice Dynamics Joint Experiment (AIDJEX), is the principal investigator for the program. The plan calls for the deployment of 12 buoys in the Autumn of 1975, four of which are instrumented with atmospheric pressure and temperature sensors, two current meters at 3 and 30 meters below the ice, and a random measuring system (RAMS) platform to permit tracking of the buoys. The other eight buoys were designed to be dropped by parachute from aircraft and carry only a RAMS platform to permit tracking. Design, development, and procurement of the buoys is the responsibility of NOAA Data Buoy Office (NDBO) which subcontracted the production of the air droppable buoys (ADRAMS) to Polar Research Laboratory, Inc., of Santa Barbara and of the meteorological/oceanographic buoys to the Applied Physics Laboratory, University of Washington.

During the design and production of the buoys, Mr. Patrick C. Martin, Technical Coordinator of the AIDJEX staff, worked closely with NDBO and the contractors to assure that the buoys would meet the program requirements.

The four meteorological/oceanographic buoys were deployed along the continental shelf break in early November by helicopter from Deadhorse, Alaska,and, the AIDJEX main ice station on the Beaufort Sea. Deployment dates and locations of the buoys, identified by the RAMS platform number, were as follows:

RAMS platform	1451,	2 Nov.	71°20'N - 149°W
	1416,	2 Nov.	71°32'N - 147°W
	1245,	3 Nov.	71°N - 135°W
	1143,	5 Nov.	73°44'N - 130°W

Position measurements for buoy platforms 1451, 1416, and 1245 are made about twelve times a day from Numbus F, and the other sensors are sampled every three hours. Data is being received and processed from the buoys. Further analysis, presently underway, is necessary to evaluate the data. Platform 1143 was damaged when it fell during deployment. Repairs were made in the field at the deployment site and the buoy's transmissions were monitored briefly following deployment, then the transmissions ceased. Increasing darkness and inclement weather precluded a trip to recover the buoy and it must be presumed lost. While the loss of the buoy is regrettable, the nature of the environment makes such operations difficult and hazardous and despite careful planning and testing some risks cannot be eliminated.

The eight ADRAMS buoys scheduled for Autumn deployment were undergoing field tests at the Naval Arctic Research Laboratory at Barrow, Alaska on 11 December and it is expected that they will be deployed in the next few days.

With the approval of the NOAA Environmental Research Laboratories Contracting Office, the University entered into a subcontract with PRL to provide technical staff support for the field testing and deployment of the ADRAMS.

STUDY OF CLIMATIC EFFECTS ON FAST ICE EXTENT AND ITS

SEASONAL DECAY ALONG THE BEAUFORT SEA COAST

Quarterly Report: NOAA OCS Energy Program
Arctic Project #410 September, 1975

Institute of Arctic and Alpine Research
and Dept. of Geography,
University of Colorado,
Boulder, Colorado 80302

Principal Investigator: R.G. Barry
Research Assistant: R.E. Moritz

Outer Continental Shelf Energy Program
Arctic Project Office
Elvey Building (Geophysical Institute)
University of Alaska
Fairbanks, Alaska 99701

attn. Dr. Gunter Weller

STUDY OF CLIMATIC EFFECTS ON FAST ICE EXTENT AND ITS SEASONAL DECAY ALONG THE BEAUFORT SEA COAST

Summary

A field visit to Barrow by R. E. Moritz in late May enabled familiarization with the ice environment and spot measurements of ice thickness and temperatures to be made. Coordination with other OCS ice projects was facilitated by a visit to the Geophysical Institute. ERTS (LANDSAT), NASA U-2, and DMSP remote sensing data, and meteorological records from NCC (Asheville) are on order. Objective typing of similar MSL pressure patterns for the period 1946-1974 is under way. A computer program for classifying the patterns has been adapted to the sector (N 60-80^{o}, W 130-170^{o}), and is being tested with varying map-similarity criteria and grid orientations prior to the main classification run. Air photo analysis and selection of an ERTS quarter-frame for the LARSYS digital classification of fast ice are ready to proceed pending receipt of USGS-OCS remote sensing data (mapping camera).

Introduction

This report described the status of research with respect to the schedule in the Work Statement (p. 5-6).

The project is concerned with the identification of climatic effects on fast ice extent and decay along the Beaufort Sea coast of Alaska. Fast ice behavior and characteristics will be established in space and time by maps generated by Dr. Stringer for the OCS project, and by our analyses of ERTS and other remote-sensing data since 1972. The relationships between atmospheric parameters at coastal stations (Barrow, Lonely, Oliktok, Deadhorse, Barter Island: 1970-1974) and seasonal ice conditions will be examined. A synoptic climatology will be established on the basis of an objective classification of daily MSL pressure patterns derived from a sample of NMC pressure grid data for the period 1946-1974, and the associated meteorological data above. The effects of atmospheric circulation patterns on the extent and decay of fast ice will be assessed in this synoptic climatological framework, with particular attention paid to short-term meteorological events responsible for extremes in ice behavior. The frequency of occurrence of such patterns will be determined for the period of study. The application of the LARSYS digital classification system to automatic ice-type mapping from ERTS data tapes will be explored.

Field Data Collection and Analysis

The primary purposes of the visits to Barrow and Fairbanks by R. E. Moritz were: 1) Familiarization with the fast ice environment on the Beaufort Sea coast; 2) Coordination with other OCS ice projects, particularly that of Dr. Stringer; 3) Coordination of our data requirements with the USGS remote sensing missions from Barrow (Work Statement, p. 2). Some point measurements and observations of ice parameters were made in the field near Barrow. These activities are detailed in Appendix I.

Data Needs

Data needs for the project have been identified during this period and coordinated as far as possible with other OCS projects. On this basis, the following data have been ordered:

1) 130 ERTS-1 7.3" positive film transparencies,; coverage from 5/72-5/74 (listed in Appendix 2).

   Status: Recieved 9/18/75

2) 45 NASA U-2 CIR photographs-9" paper positives; coverage in 6/74 (listed in Appendix 3).

   Status: On order, delivery in 4-5 weeks

3) DMSP Tactical Terminal visible and IR transparencies; coverage in summers, 1973 and 1974 (loan at no charge from SSEC, Madison, Wisc.).

   Status: On order, delivery when available

4) Hourly TD-14 meteorological data on magnetic tape from NCC, Asheville, N.C.
   a) Barrow, Barter Is. - 1970-74 inclusive
   b) Deadhorse - 1/71-3/73

5) Hourly meteorological data on microfilm from NCC ETAC unit.
   a) Lonely, Oliktok - 1970-74 inclusive

   Status: (4) and (5) Recieved 9/15/75

USGS aircraft underflight requirements were filed with the Project Office. Information on the availability of completed flight data has not been recieved as yet. Analysis of underflight imagery and Dr. Stringer's maps will be effected when these products become available.

Objective Typing of Pressure Patterns

An objective pressure-pattern typing program (Kirchofer, 1973) has been adapted to the Alaskan sector. Preliminary trials have shown the program to be running correctly. The relative merits of testing map pattern similarity on the basis of: 1) a latitude-longitude grouping of grid points into rows and columns, or 2) the NMC cartesian grid rows and columns have been evaluated, and a row and column scheme of type (1) has been selected (see attached map, Fig. 1). Some preliminary runs on data from 1946 indicates a high persistence and low variability for pressure patterns in the region, particularly during the winter. The program is now being tested with more stringent threshold criteria for determining map pattern similarity than have been used in other geographical areas. When the criteria have been established, a 58 month sample will be selected from the period 1946-1973. Each month of the year (except two) will

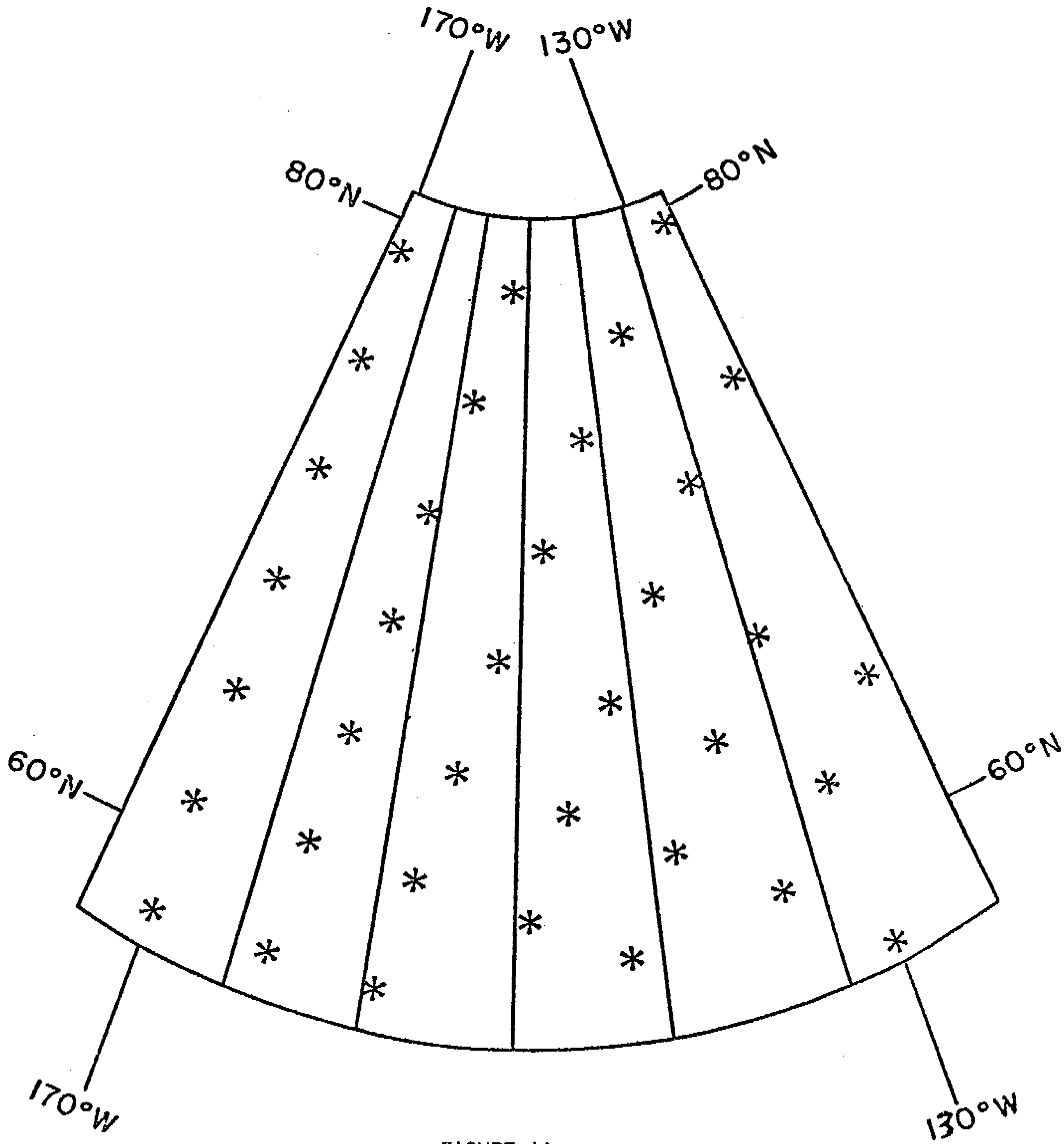


FIGURE IA
Column Grouping for Pressure Pattern Similarity Tests
(NMC points shown)

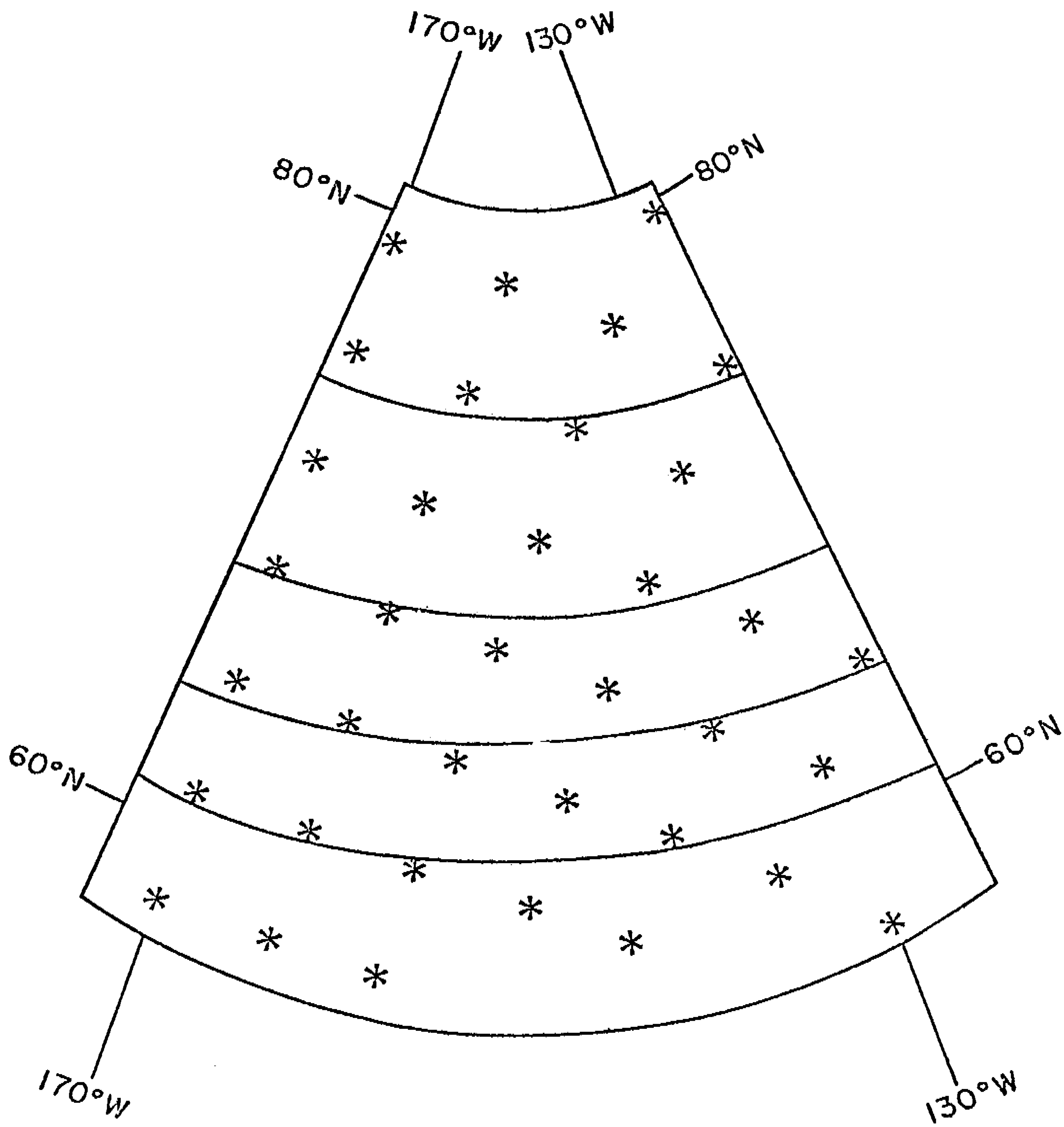


FIGURE 1B
Row Grouping for Pressure Pattern Similarity Tests
(NMC points shown)

have five representatives in the sample, selected so that the general circulation is relatively zonal in two months, relatively meridional in two months, and intermediate in the final month. The restriciton to 58 months was made because of mass-storage limitations in the computer. The description of each pressure pattern type, its frequency during the period of study, and a catalog of circulation types by day will be available in the January report.

LARSYS

The proposal from LARS for digital classification under the subcontract to Purdue University (scheduled to begin 1/1/76) has been submitted in revised form to the University of Colorado Office of Contracts and Grants. The proposal is for one supervised and one unsupervised digital classification of an ERTS quarter-frame (revised from two ERTS quarter-frames to conform to the amount budgeted for LARSYS in our contract from NOAA). Steve Luther, the LARS Principal Investigator for this project, visited INSTAAR in August. Six weeks lead time is usually required between ordering and receiving ERTS data tapes from EROS. Thus, in order to select an appropriate frame during early November, we require cloud-free USGA-OCS mapping camera photography for an area viewed by ERTS MSS within a day or two of the underflight. In order for LARS to proceed with the LARSYS analysis during January, we require the aircraft photography no later than mid-October. It may be necessary to extend the starting date of the subcontract if the data is not available by this time.

Preliminary discussions between R. Weaver, INSTAAR; W. D. Stringer and J. Miller, Geophysical Institute; and J. C. Barnes, Environmental Research and Technology, Inc., were held in Fairbanks in mid-August to determine if a comparative study of three different computer classification routines could be done on the same ERTS frame. To our knowledge no comparative study of digitally processed ERTS data for sea ice has been attempted. To date INSTAAR and the Geophysical Institute have agreed in principle to carry out such a comparative study.

Issues Requiring Resolution

1) USGS-OCS remote sensing data as noted above.

Meetings Attended

Mr. R. Weaver attended the POAC-75 conference 11-15 August in Fairbanks, Alaska and presented a paper entitled: "Fast Ice Studies in Western Davis Strait."

Project discussions were held in Fairbanks with Drs. G. Weller, A. Belon, and W. Stringer, and in Seattle with Dr. R. Brown (U. Wash., Dept. of Meteorology) during R. E. Moritz's trip.

Reference

Kirchhofer, W., 1973: Classification of European 500 mb Patterns. Swiss Meteorological Institute, Arbeits no. 3, 16 pp.

APPENDIX I

Preliminary Report: Activities at Barrow, Fairbanks, and Seattle, May/June, 1975

R. E. Moritz

-I. Objectives

The objectives of the Alaska visit during the early phase of the project were:

1) General familiarization with the fast ice environment of the Beaufort Sea Coast of Alaska.

2) Measurement of ice thicknesses, temperature and salinity profiles, and snow depths in zones of smooth, first-year fast ice.

3) Coordination of this study with related OCS fast ice projects at the Geophysical Institute, University of Alaska.

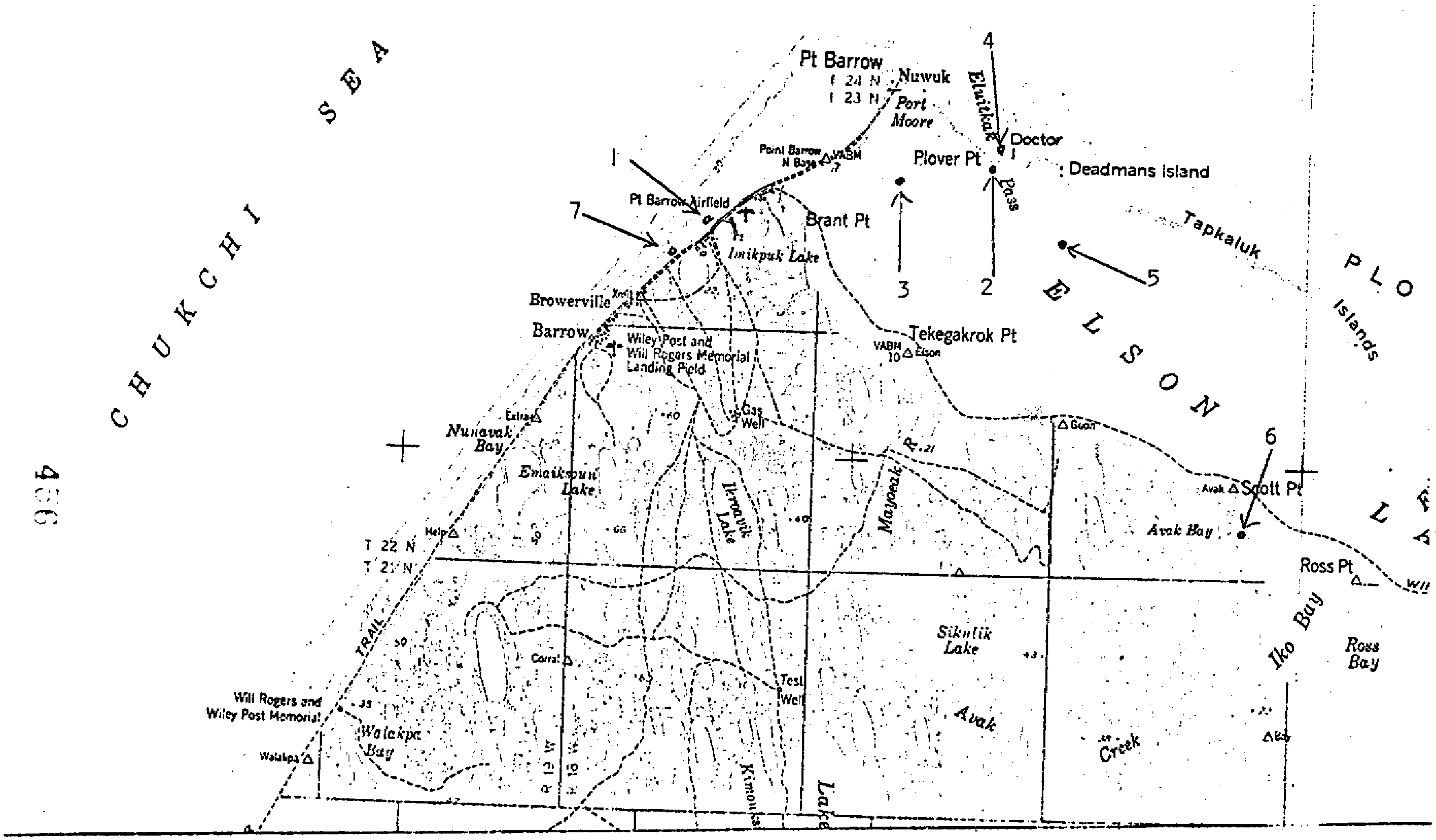
4) Identification of project data needs and resources including remote sensing products.

5) Assembling data relevant to ice-climate interaction studies.

-II. General Ice Environment

The fast ice in the Chukchi sea west of ARL was observed on foot. Reconaissance trips and measurements were based at the University of Alaska's radar hut just SW of the laboratory grounds (Figure 1, site 7; and Figure 2). The fast ice in the area extended approximately 3 to 4 km from shore, and several distinct 'zones' roughly paralleling the shore could be distinguished as one moved seaward:

1) ca. 200 m belt of flat, first-year ice with tidal cracks near



FIGURE

SITE LOCATIONS FOR POINT MEASUREMENTS

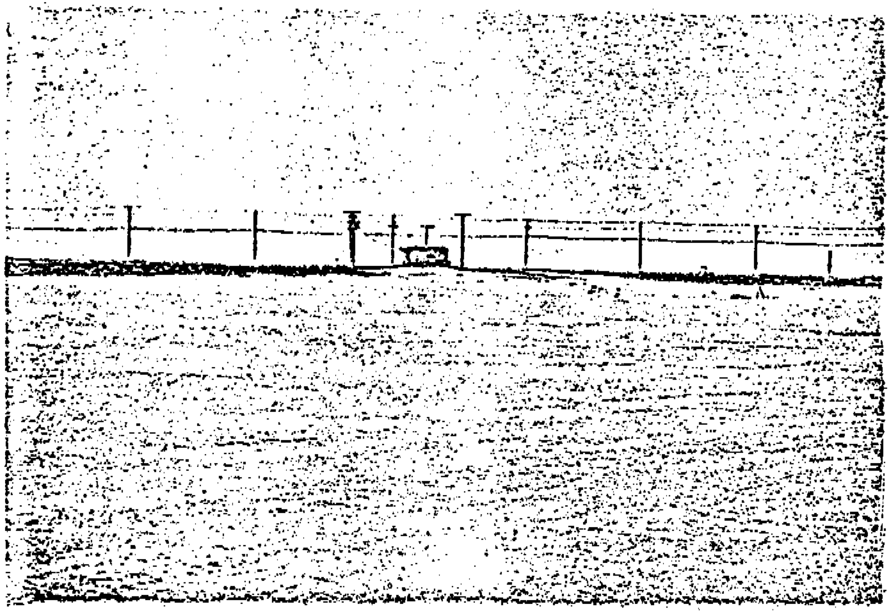


FIGURE II
Radar Hut and Fast Ice

FIGURE III
Smooth Fast Ice West of ARL

shore (this zone widened to the north, extending about 1 km. out from shore west of the split leading to Pt. Barrow - Figure 3).

2) ca. 600 m of light hummocks in the first-year ice, occasionally littered with giant blocks of rafted multi-year ice, perched up to 4 m above the surrounding ice (Figure 4).

3) ca. 700 m belt of heavier hummocking interspersed with cakes and small floes of frozen-in multi-year ice.

4) ca. 50 m belt of brecciated ice with chaotic orientation of the blocks. This feature trended NE-SW in quasi-linear fashion almost parallel to the shore. Dr. L. Shapiro (Geophysical Institute) believes this may be an early-season position of the shear zone during the fast ice formation.

5) ca. 9 m high pressure ridge grounded in 12 m of water, followed by two lower ridges to seaward. (Figure 5)

6) Remaining area of multi-year cakes and small floes bordered by piles and ridges of first-year ice.

7) Open lead 3-4 km from shore.

Snow depths varied from 5 to 40 cm on the uniform ice near shore, but drifting in the hummocked and ridged zones caused depth of 1 m to occur. Some high points on the multi-year floes were snow free. The snow near shore melted earlier here than in Elson Lagoon, presumably due to advection of warm air from the ARL grounds by the ENE winds. Several people with experience on the ice in this area noted that conditions in spring are:

1) Highly variable between years.

2) Very dependent upon Fall/Early-winter events.

The ice in Elson Lagoon appeared very different than the Chukchi ice

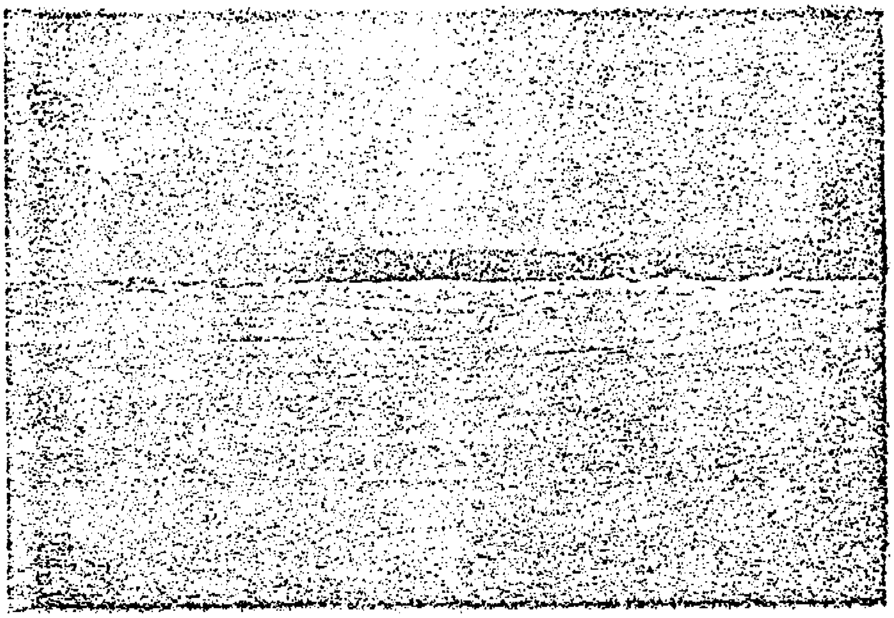


FIGURE IV
Hummocks in the Fast Ice

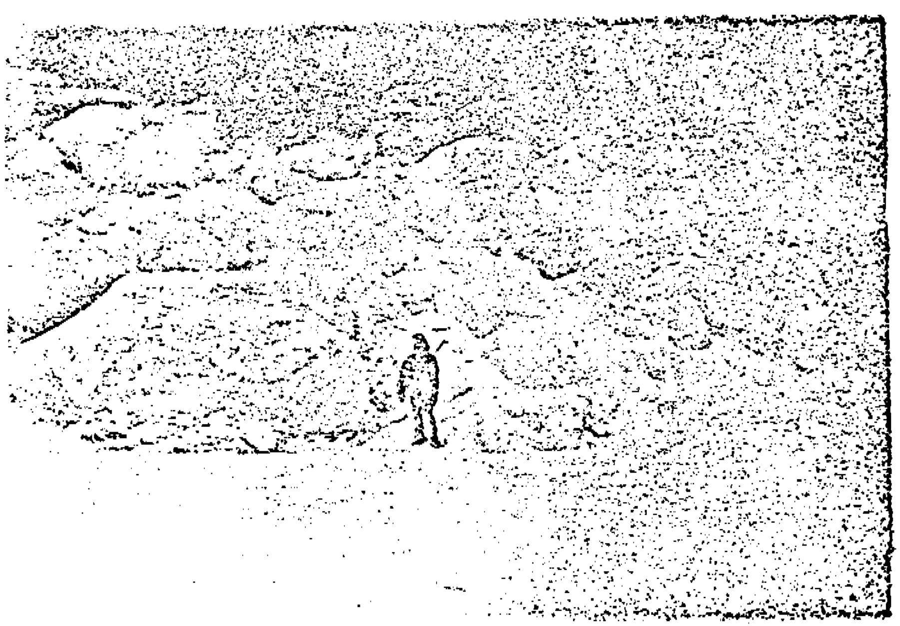


FIGURE V
Pressure Ridge

(Figure 6). For the most part it was flat, undisturbed first-year ice with a 15 to 40 cm snow cover. Fairly smooth ice was visible for some distance seaward of the barrier islands, but its extent is not known. Tidal cracking and occasional light ridges and rafts were noted near shore.

One reconaissance flight, from ARL to Pt. McIntyre and back, provided an opportunity to view the ice on a somewhat larger scale. Much of Harrison Bay appeared to be covered by a canopy of fairly flat first-year ice, although the view to the side was very limited due to 200 ft. flight altitude. The sastrugi and snow drifts all indicated an ENE wind. During a transect from the Lonely DEW-line station on a 310° magnetic heading, about 6-7 n mi of smooth-looking fast ice were observed extending out from shore. Following this was a narrow (ca. 2 n mi) belt of light hummocks. Long, low, sinuous ridges were evident, spaced about 400 m apart, for the next 6 n mi. Further on the ice became increasingly complex and chaotic, presumably the zone of present shear between the fast and pack ice.

-III. Field Measurements

Spot measurements of ice, snow and atmospheric properties provide insight into the general conditions prevailing on the ice during the spring, although systematic temporal and spatial sampling were ruled out by time and logistics constraints. Table I provides a summary of spot measurements and comments. The site of each sample is numbered on the map for cross-reference with the Table. In addition to general ice observations, a series of thermocouple temperature profiles for late May, 1975 are available in Table 2. These data are from the flat first-year ice about 75 m offshore from the radar hut (courtesy of R. Metzner, U. of Alaska).

The general conclusions derived from the data are:

TABLE IA

Point Measurements of Snow and Ice Parameters near Barrow

SITE # (Fig.)	DATE	TIME (local)	SNOW DEPTH (cm)	SNOW TEMPERATURE (ºC)		SNOW DENSITY (gcm^{-3})	ICE PARAMETERS	
				top 2cm	ice sfc.		Z(cm)	$\overline{S}$(o/oo)
1	5/17/75	15:30	10	0.6	–	–	–	–
1	5/18/75	14:00	22	-0.6	-3.9	–	–	–
2	5/21/75	11:00	29	-7.5	-8.3	0.39	196 201	–
3	5/23/75	15:00	30	1.0	-5.0	0.41	203	5.5
4	5/24/75	18:00	24	-3.5	-5.0	–	196	6.1
5	5/25/75	14:00	15.5	-1.5	-5.0	–	206	–
6	5/25/75	17:00	11	-3.5	-7.5	–	80*	–
7	Several May Samples –			–	–	–	173**	6**

* This ice was frozen to the bottom in a shallow bay.
** Figures represent means of six samples at site 7.

Z is the thickness of the ice at the given site. $\overline{S}$ is the mean salinity of the sample.

TABLE 2

THERMOCOUPLE PROFILES*
(Site 7)

Surface	7.6 cm	25.4 cm	45.7 cm	61 cm	91.4 cm	Date
-5.0°C	-5.1	-4.7	-4.6	-4.5	-4.2	May 17
-3.7	-4.4	-4.5	-4.5	-4.5	-4.0	May 18
-2.3	-4.6	-4.6	-4.6	-4.6	-4.1	May 19
-5.6	-4.5	-4.4	-4.3	-4.4	-4.0	May 21
-2.6	-4.2	-4.2	-4.2	-4.0	-3.7	May 24
+3.0	-1.3	-2.5	-3.3	-3.4	-3.3	May 31

*These data are reported here in order to give continuity to the description of cold content of fast ice in the text. The data were made available by R. Metzner, University of Alaska Research Asst. at Barrow during May-June, 1975. A more complete set of data is being established in connection with the Geophysical Institute's radar studies of fast ice, and any formal publication of the data will come from that source.

1) The ice in Elson Lagoon is probably representative of first-year ice forming *in situ* by freezing processes. Thicknesses were generally about 2 m. Salinities of 6 o/oo were common, and are typical of this age category of ice. In shallow areas the ice is frozen to the bottom, although tidal surges tend to lift and crack the ice.

2) The Chukchi sea fast ice off the radar hut exhibited lower thicknesses (about 180 cm), somewhat higher salinities in the upper strata, and a much more limited extent of smooth, uniform first-year ice. The lower ice thicknesses are attributed to: a) the exposure of the site which encourages early-season disruption of fast ice and delays the establishment of stationary ice; b) the above-mentioned advection of warm air off the ARL grounds; c) the deeper water prevailing on this coast allowing more turbulent interchange between the freezing plane and warmer waters beneath. The high salinities in the upper strata may be the result of post-freezup flooding on the ice, in which case brine drainage would be slowed by the ice beneath. If this is the case, then the top layer is superimposed ice.

3) The ice and snow still had considerable 'cold content' in late May. The top of the snowpack appeared to heat rapidly in the absence of wind. Presumably, high winds are capable of maintaining a large cold content in the snow even when the solar radiation is continuous if the air temperature is sufficiently below freezing. The radiative energy absorbed (*ca*. 15% of incoming total) must be dissipated by turbulent heat transfer to

the air. If this is true, it follows that a mid-late May 'event' consisting of high radiation totals and low wind speeds may accelerate the critical albedo change that signals the onset of the melt season. Detailed measurement of snow temperatures, wind speeds and solar radiation are necessary to confirm this hypothesis.

IV. Project Data: Needs and Resources

As our project is built around the synoptic classification scheme using surface pressure data, the major data needed are meteorological in nature. These include grid-point pressures, weather maps, and station observation reports. Thermodynamic modelling of ice and snow melting processes should be restricted to the radiation components because attempts at modelling the turbulent fluxes are bound to be frustrated by a lack of data. In order to model the radiation balance, we need maps of cloud type and amount, surface temperatures, and surface type, all of which should be available from the high-resolution DMSP imagery at least twice daily. Any surface-types that can be mapped by Dr. Stringer will also aid us in this regard. SSEC at the University of Wisconsin should be able to provide us with what we need for past years. Distributions of screen temperatures are necessary for completing the radiation balance, utilizing the equation of Maykut and Church. These data can be extrapolated from the coastal stations to the fast ice. Detailed analysis of climate/ice interaction will necessitate project remote sensing data, ERTS images, Dr. Stringer's maps, and any historical data which became available. Detailed Geostrophic wind indices may be computed by interpolation of the NMC data. Also, Dr. R. Brown of University of Washington (AIDJEX) has indicated that wind stress data from his boundary layer model may be available to us in 1976.

V. Data Obtained

Ice-climate interaction data obtained during the trip include:

1) 1:250,000 scale maps of the coast from Barrow to the Canadian border.
2) Radiation data taken by the University of Washington field parties at Barrow.
3) Copy of ERTS identifiers for the region of interest
4) Preliminary numerical classification of ice from ERTS data.

APPENDIX 11

ERTS Images on order from EROS

	Identifier Number	Bands		Identifier Number	Bands
1.	1220-21404	7	25.	1345-21342	4,7
2.	1228-20435	7	26.	1349-21564	4,5,6,7
3.	1234-21175	7	27.	1356-20540	5,7
4.	1234-21233	7	28.	1358-21052	4,7
5.	1236-21292	6	29.	1374-20534	4,7
6.	1241-21580	7	30.	1432-21153	5
7.	1247-20493	7	31.	1438-21495	4
8.	1250-21062	7	32.	1448-21034	4,7
9.	1254-21292	7	33.	1449-21092	4,7
10.	1256-21405	7	34.	1453-21321	4,7
11.	1264-20435	7	35.	1455-21433	4,6
12.	1265-20493	7	36.	1583-21524	7
13.	1266-20545	7	37.	1590-20495	7
14.	1283-20493	7	38.	1593-21063	7
15.	1287-21120	7	39.	1594-21122	7
16.	1295-21575	7	40.	1596-21234	7
17.	1305-21115	7	41.	1601-21522	7
18.	1311-21461	7	42.	1606-20380	5
19.	1409-20475	4,7	43.	1607-20435	7
20.	1321-21000	4,7	44.	1616-21345	7
21.	1326-21284	4,5,6,7	45.	1617-21403	7
22.	1329-21455	4,5,6,7	46.	1625-20432	6
23.	1331-21570	6	47.	1634-21342	7
24.	1344-21283	4,5,6,7	48.	1646-20594	7

APPENDIX II (continued)

	Identifier Number	Bands		Identifier Number	Bands
49.	1648-21111	7	62.	1710-2115	4,5,6,7
50.	1649-21165	7	63.	1719-21031	4,5,6,7
51.	1650-21223	7	64.	1721-21143	4,5,6,7
52.	1651-21281	6	65.	1722-21202	4,5,6,7
53.	1653-21394	6	66.	1723-21260	4,5,6,7
54.	1654-21452	6	67.	1740-21194	4,7
55.	1661-20423	7	68.	1760-21302	4,7
56.	1665-21405	7	69.	1773-21011	4,7
57.	1667-21162	7	70.	1775-21124	4,7
58.	1699-20522	4,7	71.	1817-21460	4,5
59.	1702-21093	4,5,6,7	72.	1805-21453	4,5,6,7
60.	1703-21151	4,5,6,7	73.	1817-21453	4,7
61.	1706-21322	4,5,6,7			

APPENDIX III

NASA AIRCRAFT PHOTOGRAPHY
(on order)

Photo Identification No.	Frames First	Frames Last	No. of frames
574001819963300	9638	9641	4
574001819966200	9662	9675	14
574001819965500	9655	9661	7
574001819964900	9649	9654	6
574001819964200	9642	9646	5
574001819967600	9676	9684	9

UNIVERSITY OF COLORADO
INSTITUTE OF ARCTIC AND ALPINE RESEARCH
BOULDER, COLORADO 80302
(303) 492-6387

August 25, 1975

Dr. Gunter Weller, Project Manager
OCS Arctic Project Office
Elvey Building (Geophysical Institute)
University of Alaska,
Fairbanks, Alaska 99701

Dear Dr. Weller:

In reference to Bulletin #6 (8/15/75), this note briefly describes our progress to date.

General familiarization with the fast ice environment including point measurements of ice parameters (thickness, salinity, temperature) on flat, first-year fast ice was accomplished by a visit to Barrow in late may by R. E. Moritz. Organization and coordination of the climatic study with other OCS studies was facilitated by visits to the Geophysical Inst. on the same trip.

Literature recording anomalous ice conditions on the Beaufort coast (either 'heavy' or 'light' years) and specific short-term events of significance to fast ice behavior is being researched to provide sample dates for detailed analysis.

In order to establish a link between the basic climatological data available and the atmospheric circulation, an objective pressure-pattern classification scheme is being applied to NMC grid-point pressure data for a 58-month sample of maps taken from the period 1946-1974. The sector under analysis is enclosed by meridians 130°W and 170°W and parallels 60°N and 80°N. Once the type groups are established, the entire period will be classified. Climatic data from Barrow, Lonely, Oliktok, Deadhorse, and Barter Island are on order from NCC, Asheville, N.C. for the years 1970-1974.

Documentation of ice conditions and behavior occurring simultaneously with the meteorological data mentioned above will be provided by the maps generated by W. Stringer and our own analysis of LANDSAT and DMSP satellite imagery. 130 LANDSAT frames are now on order from EROS for this purpose. DMSP high resolution TRANSTERM data has just arrived and is presently being analyzed for summer, 1974.

Digital classification of fast ice types by the LARSYS system should commence with the funding of our subcontract to Purdue (Jan. 1, 1976). OCS project remote sensing data (mapping camera, SLAR) are needed in conjunction with simultaneous LANDSAT imagery with low cloudiness in order to choose the frames for analysis and 'ground truth' the classification.

I am sending off my progress in detail to Dr. Barry in Canberra for the first quarterly report for NOAA (due Sept. 30), which will describe the research in some quantitative detail. I hope this note will suffice as a progress report of items covered to the present.

Sincerely,
Richard Moritz
Richard Moritz

SECOND QUARTERLY REPORT

TITLE: Mechanics of Origin of Pressure Ridges, Shear Ridges and Hummock Fields in Landfast Ice.

PERIOD: 1 July 1975 - 30 September 1975

PRINCIPAL INVESTIGATORS: Lewis H. Shapiro and William D. Harrison, Geophysical Institute, University of Alaska

I. TASK OBJECTIVES: To determine the mechanics of origin of pressure ridges, shear ridges and hummock fields in landfast ice. Task Order #11. RU 250

II. FIELD AND LABORATORY SCHEDULE: Continuation of review of radar data and compilation of existing information.

III. RESULTS: 1. Data relating to this problem which was collected during two field seasons and through study of radar imagery, was summarized in a paper presented at the 3rd International Conference on Port and Ocean Engineering under Arctic Conditions (POAC) in August.

2. In early July, the ice at Barrow was driven onto the beach by on-shore winds, forming several pressure ridges in shallow water. Approximately 8 man-days were spent in the field mapping and studying these features. Most of the movements were recorded by the radar system although the equipment was down during part of the time during which the movements occurred. An 8 mm movie camera mounted on the radar tower did operate properly however, and time-lapse motion pictures of the event were acquired. The data are presently being analyzed, and a report is in preparation.

3. A series of preliminary calculations were made to determine the energy distribution in grounded pressure ridges as a function of ridge height and water depth, and the associated force limits. These represent a first step towards a theoretical approach to the problem.

IV. PRELIMINARY INTERPRETATION: None.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: None.

VI. ESTIMATED FUNDS EXPENDED: $10,000.

RESEARCH UNIT NO. 257

SECOND QUARTERLY REPORT

CONTRACT NO.: 03-5-022-55

TITLE: Morphology of Beaufort Near Shore Ice Conditions by Means of Satellite and Aerial Remote Sensing

TASK ORDER NO.: 8

PERIOD: July 1 - September 30, 1975

PRINCIPAL INVESTIGATOR: W. J. Stringer
Geophysical Institute
University of Alaska

I. TASK OBJECTIVES: The objective of this study is to develop a comprehensive morphology of near shore ice conditions in the Beaufort Sea. This morphology will include a synoptic picture of the development and decay of fast ice and related features along the Beaufort Sea coast, and in the absence of fast ice, the nature of other ice (pack ice, ice islands, hummock fields, etc.) which may occasion the near shore areas in other seasons. Special emphasis will be given to consideration of potential hazards to offshore facilities and operations created by near shore ice dynamics. A historical perspective of near shore ice dynamics will be developed to aid in determining the statistical rate of occurrence of ice hazards.

II. FIELD AND LABORATORY SCHEDULE: This project has no field schedule. All remote sensing aircraft data is to be provided by project management. The work to be done does not involve laboratory activities.

III. RESULTS: (Note: Because of our internal management requirements, no funds were expended nor was work performed until contract negotiations were final on June 30, 1975). During this period Landsat coverage maps were prepared for each Landsat cycle. A near-shore ice map will be drawn for each of these data cycles. These maps will generally be produced at 1:500,000 scale by using 70 mm Landsat Transparencies displayed at 1:500,000 scale on the I^2s color-

Additive Viewer provided by University of Alaska OCS project 10. However, hard copy of 1:500,000 scale prints has been ordered for the earliest Landsat cycle with reasonably complete coverage for each winter season. At this time, approximately 50% of the order has arrived.

The Color Additive Viewer obtained by project #10 has been unpacked and is nearly ready for use.

In order to expedite the map-making process, 1:500,000 scale prints of the scenes selected for hard copy for the winter, 1974 season were ordered from the Geophysical Institute's special photo section. This process is considerably more expensive than ordering prints from the USGS Sioux Falls Photographic Laboratory. Unfortunately, although every attempt was made by us to insure proper scale, the resulting prints were produced at a scale quite far 1:500,000. As a result, all attempts at mapping were postponed until arrival of the Sioux Falls hard copy and the Color-Additive Viewer. As noted above, these requirements are now nearly met.

A major accomplishment during this reporting period was the preparation of the transparent map overlays to be used to transfer the Landsat data to a geographic map at 1:500,000 scale Lambert Conformal Curic Projection map prepared by the Department of Commerce. Second, bathymetric data was transferred from NOAA Coast and Geodetic Survey Nautical Charts at varying scales around 1:500,000 by means of a pantograph. These overlays will become the map base for the maps produced by this OCS project.

During this reporting period we moved into larger quarters and took delivery of our drafting table, map cases and other equipment described in the University of Alaska OCS 5 and 8 budgets.

IV. PRELIMINARY INTERPRETATIONS: During this period we prepared and presented the paper "Ice Motions in the Vicinity of a Granded Floeberg" at the POAC Conference at Fairbanks. Many of the conclusions drawn here will be useful to this OCS project. The written version of this paper will be prepared shortly and will be forewarded to project management immediately.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: See problem described in section III. We would recommend that University of Alaska project 10 be requested to insure that the

Geophysical Institute photo department can prepare Landsat maps to scale on request.

VI. ESTIMATE OF FUNDS EXPENDED: Funds expended or encumbered as of 9/30/75 are estimated to be $5,000. Little principal investigator time has been used to date.

VII. APPENDICES: None

RESEARCH UNIT NO. 258

SECOND QUARTERLY REPORT

CONTRACT NO.: 03-5-022-55

TITLE: Morphology of Bering Near Shore Ice Conditions by Means of Satellite and Aerial Remote Sensing

TASK ORDER NO.: 5

PERIOD: July 1 - September 30, 1975

PRINCIPAL INVESTIGATOR: W. J. Stringer
Geophysical Institute
University of Alaska

I. TASK OBJECTIVES: The objective of this study is to develop a comprehensive morphology of near shore ice conditions in the Bering Sea. This morphology will include a synoptic picture of the development and decay of fast ice and related features along the Bering Sea coast, and in the absence of fast ice, the nature of older ice (pack ice, hummock fields, etc.) which may occasion the near shore areas in other seasons. Special emphasis would be given to consideration of potential hazards to offshore facilities and operations created by near shore ice dynamics. A historical perspective of near shore ice dynamics will be developed to aid in determining the statistical rate of occurrence of ice hazards.

II. FIELD AND LABORATORY SCHEDULE: This project has no field schedule. However attempts will be made through project management to obtain reconnaissance flights by light aircraft along the Bering coast. The work to be done does not involve laboratory activities.

III. RESULTS: (Note: Because of our internal management requirements, no funds were expended nor was work performed until contract negotiations were final on June 30, 1975).

During this period Landsat coverage maps were prepared for each Landsat cycle. A near-shore ice map will be drawn for each of these data cycles. These maps will generally be produced at 1:500,000 scale by using 70 mm Landsat Transparencies displayed at 1:500,000 scale on the I^2s Color-Additive Viewer provided by University of Alaska OCS project 10. However, hard copy of 1:500,000 scale prints has been ordered for the earliest Landsat cycle with reasonably complete coverage for each winter season. At this time, approximately 50% of the order has arrived.

The Color Additive Viewer obtained by project #10 has been unpacked and is nearly ready for use.

In order to expedite the map-making process, 1:500,000 scale prints of the scenes selected for hard copy for the winter, 1974 season were ordered from the Geophysical Institute's special photo section. This process is considerably more expensive than ordering prints from the USGS Sioux Falls Photographic Laboratory. Unfortunately, although every attempt was made by us to insure proper scale, the resulting prints were produced at a scale quite far 1:500,000. As a result, all attempts at mapping were postponed until arrival of the Sioux Falls hard copy and the Color-Additive Viewer. As noted above, these requirements are now nearly met.

A major accomplishment during this reporting period was the preparation of the transparent map overlays to be used to transfer the Landsat data to a geographic map at 1:500,000 scale Lambert Conformal Curic Projection map prepared by the Department of Commerce. Second, bathymetric data was transferred from NOAA Coast and Geodetic Survey Nautical Charts at varying scales around 1:500,000 by means of a pantograph. These overlays will become the map base for the maps produced by this OCS project.

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V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: See problem described in section III. We would recommend that University of Alaska project 10 be requested to insure that the

Geophysical Institute photo department can prepare Landsat maps to scale on request.

VI. ESTIMATE OF FUNDS EXPENDED: Funds expended or encumbered as of 9/30/75 are estimated to be $5,000. Little principal investigator time has been used to date.

VII. APPENDICES: None

UNIVERSITY OF ALASKA

M E M O R A N D U M

TO: Mr. John Robinson
Deputy Director, OCSEP Program
Environmental Research Laboratory
NOAA
Boulder, Colorado

FROM: Richard D. Nelson, Acting Head
DEPARTMENT OF MECHANICAL ENGINEERING

DATED: 15 October 1975

SUBJECT: PROGRESS REPORT JULY-SEPTEMBER, 1975
RESEARCH UNIT 259
(EXPERIMENTAL MEASUREMENTS OF SEA ICE FAILURE NEAR GROUNDED STRUCTURES) Task Order #7.

Work during this period has centered itself on the build-up of experimental equipment for use on the ice. An early reconnaissance of the grounded ice feature to be instrumented indicated the necessity of using radio telemetry links between ice stress sensors around the island and the central data gathering station. A later reconnaissance confirmed this decision, as ice features exceeding 30 feet in height were noted.

Equipment necessary for two experiments employing six transducers each has been designed and is 50% complete. The equipment uses FM telemetry to supply a central processor with information on the stress at each location at a rate of 100 points/second. The central processor scans all data inputs and records significant changes on magnetic tape. All units will be portable and battery powered.

/cab

QUARTERLY REPORT

PERIOD ENDING SEPTEMBER 30, 1975

PROJECT: Beaufort Sea Historical Baseline Ice Study Proposal

CONTRACT: 03-5-022-55

TASK ORDER: 4 RU 261/262

PRINCIPAL INVESTIGATOR: William R. Hunt, Department of History
Claus-M. Naske, Department of History
University of Alaska
Fairbanks, Alaska 99701

Claus-M. Naske has examined the ice records of the Point Barrow relief station from 1891-1896. These are shore ice observations which include information on wind conditions and should be valuable.

William R. Hunt has examined ice observations made by an Arctic ship operator from 1889-1925. These records have yielded considerable data on ice movement for this period.

In reference to the call for recommendations for future research, we believe that a similar study to this one of ice movements in the Bering Sea would be a useful contribution. Maritime traffic has been much heavier in the Bering Sea than the Beaufort Sea. Additionally, records kept at Nome, Teller, and other settlements contain much data.

SECOND QUARTERLY REPORT

TITLE: Development of Hardware and Procedures for *In-Situ* Measurement of Creep in Sea Ice

PERIOD: 1 July 1975 - 30 September 1975

PRINCIPAL INVESTIGATORS: Lewis H. Shapiro, William M. Sackinger and Richard D. Nelson, Geophysical Institute, University of Alaska

I. TASK OBJECTIVE: To develop hardware and procedures for *in-situ* measurement of creep sea ice. Task Order #6.

II. FIELD AND LABORATORY SCHEDULE; Literature search, design of experiments

III. RESULTS 1. A series of experiments were conducted at Barrow in May to determine the effectiveness of flatjacks as loading devices for the experiments to be conducted in the coming field season. The results were satisfactory, and some preliminary values of Young's modules and the coefficient of Newtonian viscosity were obtained. A paper describing the experiments was presented at the 3rd International Conference on Port and Ocean Engineering under Arctic Conditions (POAC) in August.

2. Design of sensors to be used in the field tests is in progress and apparatus for testing these in a cold room has been built. Required equipment has been ordered.

IV. PRELIMINARY INTERPRETATION: None.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: None.

VI. ESTIMATED FUNDS EXPENDED: $15,000.

SECOND QUARTERLY REPORT

TITLE: Development of Hardware and Procedures for *In-Situ* Measurement of Creep in Sea Ice

PERIOD: 1 July 1975 - 30 September 1975

PRINCIPAL INVESTIGATORS: Lewis H. Shapiro, William M. Sackinger and Richard D. Nelson, Geophysical Institute, University of Alaska

I. TASK OBJECTIVE: To develop hardware and procedures for *in-situ* measurement of creep sea ice. Task Order #6.

II. FIELD AND LABORATORY SCHEDULE; Literature search, design of experiments

III. RESULTS: 1. A series of experiments were conducted at Barrow in May to determine the effectiveness of flatjacks as loading devices for the experiments to be conducted in the coming field season. The results were satisfactory, and some preliminary values of Young's modules and the coefficient of Newtonian viscosity were obtained. A paper describing the experiments was presented at the 3rd International Conference on Port and Ocean Engineering under Arctic Conditions (POAC) in August.

2. Design of sensors to be used in the field tests is in progress and apparatus for testing these in a cold room has been built. Required equipment has been ordered.

IV. PRELIMINARY INTERPRETATION: None.

V. PROBLEMS ENCOUNTERED/RECOMMENDED CHANGES: None.

VI. ESTIMATED FUNDS EXPENDED: $15,000.

OPERATION OF AN ALASKAN FACILITY
FOR APPLICATIONS OF REMOTE-SENSING DATA TO OCS STUDIES

Quarterly Report No. 2
October 15, 1975

Contractor: Geophysical Institute
University of Alaska
Fairbanks, Alaska 99701

Principal Investigator: Albert E. Belon

Report Prepared for:
National Oceanic and Atmospheric Administration
Contract No. 03-5-022-55, Task No. 10
Effective Date: June 12, 1975
Contract Monitor: John H. Robinson
OCSEP Deputy Director
Environmental Research Laboratory
NOAA
Boulder, Colorado 80302

This is the second quarterly progress report for the period July 1 to September 30, 1975 under NOAA contract No. 03-5-022-55, Task 10 (Project 418), "Operation of an Alaskan Facility for Applications of Remote-Sensing Data to OCS Studies". This project is identified with task A-29 of the NOAA OCS Program. Its primary objective is to assemble and to assist in the analysis of remote-sensing data to provide a comprehensive assessment of the development and decay of fast ice, sediment plumes and offshore sediment patterns along the Alaskan coast from Yakutat to Demarcation Bay.

A. SIGNIFICANT ACTIVITIES DURING REPORTING PERIOD

The work statement on the project specified three principal objectives. Significant activities during the reporting period under each of these objectives are described below.

1. Operation of the remote-sensing data library.

In July we prepared a remote-sensing data catalog which listed all the low-cloud-cover LANDSAT satellite and NASA aircraft imagery acquired over the Alaskan coastal zone from July 1972 to May 1975. This catalog, along with a description of the remote-sensing data library and information on how to search, select and order data was distributed to all OCS investigators on August 15, 1975 as an appendix to Arctic Project Bulletin No. 6.

Once the catalog was completed we placed an order with the EROS Data Center (EDC) for 566 low-cloud-cover LANDSAT scenes of the Alaskan coastal zone acquired from May 1974 to May 1975 for a total cost of $5660.00. These data products, which are gradually being received from EDC, complete our files of LANDSAT data from the launch of the satellite, July 1972, to May 1975 with at least the following data products:

- 70mm positive transparencies of multi-spectral scanner (MSS) spectral bands 4, 5 and 7.
- 70mm negative transparency of MSS, spectral band 5
- 9½" print of MSS, spectral band 6

We continued to receive and catalog daily copies of NOAA satellite imagery of Alaska. This imagery is currently provided to us free of charge by a NOAA-sponsored project; but this project terminates on October 31, 1975 and presumably the data flow will stop then unless other arrangements are made or we pay for the imagery. Unfortunately these costs were neither anticipated nor included in the project's budget.

We assisted several OCS investigators in searching for and selecting remote-sensing data for their studies. Most investigators have utilized data available in our files; but some of them, in particular Dr. Stringer (University of Alaska OCS Project, Tasks 5 and 8), asked us to order enlarged prints of selected data for mapping purposes. Data orders placed by OCS investigators during the reporting period totalled $1838.00.

We continue to search periodically for new LANDSAT imagery entered in the EDC data base. These scenes are plotted on base maps which will be used to prepare an updated catalog and to compile a summer 1975 LANDSAT data order which will be placed with EDC in early November.

We have recently learned that NASA acquired remote-sensing data over several areas of the Alaskan coastal zone during missions in 1967 and 1970. We have initiated negotiations with NASA to obtain copies of these data.

2. Operation and maintenance of data processing facilities.

During the first reporting period we had issued a purchase order to International Imaging Systems (I^2S) for converting our model 6040 multi-spectral color-additive viewer to a model 6040 PT which has the additional enlargement, tracing, and projection capabilities desired by several OCS investigators. In view of the delays and problems that a conversion would have caused, I^2S eventually agreed to a trade-in of our model 6040 viewer for a model 6040 PT which they manufactured for us at the price quoted for the conversion, \$4700. The new 6040 PT viewer arrived from I^2S late in the reporting period and was assembled and tested. Although it is currently operational, there is an objectionable amount of scattered light inside the instrument which limits its use as a photographic printer. This deficiency will be overcome by the installation of additional baffles and black foam wall covers.

An Itek viewer/printer for aerial film up to 5" wide was received free of charge from the EROS Data Center. Although the viewer is surplus equipment and arrived in damaged condition, the needed repairs are not major and it should be a useful addition to our line of optical equipment available to OCS investigators.

Except for the above two instruments all data processing equipment is currently operational and its capabilities have been demonstrated to several local and visiting OCS investigators. However, owing to the pressure of field activities during the short summer season, only a few local OCS investigators have extensively used the equipment so far.

3. Assistance to OCS investigators in remote-sensing data acquisition, processing and interpretation.

In order to familiarize OCS investigators with the available remote-sensing data, processing equipment and interpretation techniques we prepared two reports which were included as appendices to Arctic Project Bulletins Nos. 6 and 7, and distributed to all OCS investigators active in studies of the Beaufort and Bering Seas and the Gulf of Alaska. These appendices are attached to this quarterly progress report.

The appendix to Arctic Project Bulletin No. 6 described the operation of the remote-sensing data library, provided catalogs of LANDSAT and aircraft data available in our files and provided instructions to OCS investigators on the selection and ordering of these data.

The appendix to Arctic Project Bulletin No. 7 described the facilities and techniques available for analysing remote-sensing data and included a scientific report in which these facilities and techniques are used to analyse and interpret remote-sensing data in three representative investigations of the Alaskan continental shelf: sea-surface circulation and sediment transport in Alaskan coastal waters, studies of sea-ice morphology and dynamics in the near-shore Beaufort Sea, and mapping of terrestrial ecosystems along the Alaskan coastal zone.

In addition to this general assistance we held numerous discussions with at least fifteen OCS investigators on the applicability of remote-sensing data to their studies, and assisted them in data selection and the use of data processing equipment. We expect that this individual assistance type of activity will increase substantially during the next reporting period.

B. PROBLEMS ENCOUNTERED

None

C. FINANCES

At the end of August 1975 the funds remaining for the project totalled $94,654,34 from an initial amount of $112,000.00. Thus the project's expenditures are approximately in line with the planned schedule.

D. FUTURE ACTIVITIES

The activities described in the project's work statement will continue to be implemented as rapidly and efficiently as possible. Specific scheduled activities are described below.

In order to provide more working space in the remote-sensing data library and more convenient access to optical data processing equipment the Geophysical Institute has made available the room adjacent to the data library. This room is currently being prepared for the installation of additional light tables and most of the optical data processing equipment.

The locally available NOAA satellite imagery acquired since February 1974 will be indexed and catalogued.

The USGS/OCS remote-sensing data acquired during summer 1975 will be indexed and catalogued as received. So far we have only received one roll of aerial photography acquired in July 1975 and 5 short strips of SLAR imagery.

We have recently learned that NASA aircraft missions occurred in 1960(?), 1967 and 1970 over several areas of the Alaskan coastal zone. We have initiated negotiations with NASA to obtain copies of these remote-sensing data.

In cooperation with Dr. Jan Cannon, a University of Alaska OCS investigator, we are discussing with the U.S. Army, Alaska, the possibility of flying SLAR training missions over the Alaskan coastal zone.

In early November the EROS Data Center data bank will be searched again for all LANDSAT scenes of the Alaskan coastal zone acquired since July 1975, and following a selection process, an order will be placed for these data.

About the end of November we will distribute to all OCS investigators, probably as an appendix to an Arctic Project Bulletin, a new catalog of available imagery from LANDSAT and NOAA satellites, and NASA and USGS remote-sensing aircraft.

Finally it is expected that with the end of the current field season the maintenance of data processing facilities and the need for interpretation assistance to OCS investigators will increase substantially.

E. ATTACHMENTS

Remote-sensing Data for OCS Studies

- Appendix to Arctic Project Bulletin No. 6
- Appendix to Arctic Project Bulletin No. 7

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