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PRELIMINARY REPORT ON THE SURFACE AND SHALLOW SUBSURFACE GEOLOGY OF LOWER COOK INLET AND KODIAK SHELF, ALASKA

BY

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SUMMARY

An environmental geologic study was performed during the summer of 1976 in lower Cook Inlet and on Kodiak Shelf, Alaska. Seismic information was collected over a total of 3524 nm (nautical miles) (6555 km) using single channel sparker, uniboom and 3.5 kHz (kilo Hertz) seismic profiling systems. Side-scan sonar records were obtained over 107 nm (198 km), and a bottom TV unit was utilized in lower Cook Inlet at three stations. Bottom sediments were collected at 154 stations by means of gravity and dart corers, Van Veen and a modified Van Veen grab sampler.

Lower Cook Inlet is characterized by a rather smooth bottom and strong tidal currents. The surficial sediments are sand to pebbly sand in the south becoming more pebbly to the north. The high-velocity currents during the last transgression and at the present time have formed a variety of bed-forms, including dunes that are up to one kilometer long and ten meters high.

Shallow structures, including numerous anticlines and synclines, are parallel to the major structural trends surrounding Cook Inlet. The Augustine-Seldovia Arch influences the fold style, which at the southern side of this arch is more complex and slightly different in orientation from the area to the north.

Kodiak Shelf consists of flat, relatively shallow banks that are cut by transverse troughs. Fold axes trend in a general northeast-southwest direction but are discontinuous and evidently have many deviations in orientation. Physiographic scarps, apparently representing surface faulting, occur over the shelf and are most abundant in three areas: 1) off the southeast coast of the Kodiak islands, 2) near the shelf break on Albatross Bank, and 3) on Portlock Bank. Significant slumps or sedimentary bedforms did not appear on our acoustic records on the shelf. However, several zones of slumping were found on the continental slope.

Unconsolidated sediments on Kodiak Shelf are distributed in relation to physiography. Sands bearing gravel and boulders, and commonly containing large amount of broken shell material, are characteristic of the banks. Fine sands to muds, commonly containing much volcanic ash, are characteristic of the deeper troughs. Hogback ridges, exposing siltstones and silty sandstones, occur at places on Albatross and Portlock Banks.

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INTRODUCTION

During the period June 18 through July 30, 1976 environmental geologic studies were conducted on board the R/V SEA SOUNDER in lower Cook Inlet and on Kodiak Shelf, Alaska (Fig. 1, Pls. 1, 2, Table 1). Regional information about the surface and shallow subsurface geology of both these areas was obtained primarily by seismic surveying and sediment sampling. The seismic surveying utilized a 90,000 joule sparker system, a hull-mounted uniboom system, a hull-mounted 3.5 kHz system and a magnetometer. Most sediment samples were obtained with a modified grab sampler, but several dart cores and gravity cores were also taken, as well as one dredge. Side scan sonar records were collected from selected areas, and in lower Cook Inlet four bottom television surveys were made.

All seismic records were directly studied on board ship and recognizable features were plotted on 1:500,000 scale charts. Subsamples were taken from all grab samples for smearslides and grainmounts, and grain sizes were estimated by microscopic observations. Gravity cores were split lengthwise, photographed, and radiographed. Also, routine geotechnical index properties were measured and subsamples taken.

This report contains information about the types of data collected (Table 1), locations of cruise tracks (Pls. 1 and 2), and locations of sampling stations (Pls. 6 and 9). Raw data maps from the sparker observations are given, as well as plots of the shipboard microscopic sediment analyses. In addition, separate maps showing only sand wave fields and surface faults in Cook Inlet and slumps and surface faults on the Kodiak shelf and slope, as deduced from preliminary inspection of our sparker records, are presented to clearly point out conditions of possible concern to resource development of these areas.

A shipboard regional interpretation of the sparker data from lower Cook Inlet is included in this report. However, a regional interpretation of sparker data from the Kodiak shelf has not yet been made. It will be done after the deep seismic, multichannel data, during 1975 and 1976 collected on board the research vessels CECIL GREEN and S.P. LEE, is processed and can be used as a base for the shallower, structural elements. This entire report should be considered as preliminary, and a more thorough analysis of data will be made during the winter season.

Only a limited number of references will be given in this report. For background information the reader is referred to two recent U.S. Geological Survey open-file reports (von Huene and others, 1976; Magoon and others, 1976) and the references listed in those.

Note: all seismic records, navigational and other pertinent data are on microfilm. These can be obtained from the National Geophysical and Solar Terrestrial Data Center EDS/NOAA, Boulder, Colorado 80302 or from Alaska Technical Data Unit, 345 Middlefield Road, Menlo Park, California 94025, telephone (415) 323-8111, ext. 2342.

INSTRUMENTATION AND PROCEDURES

Navigation

Two independent navigational systems were used by the scientific party. One unit consisted of a Magnavox integrated satellite-Loran C system, the other was a Motorola Mini-Ranger unit. The data from the integrated system were automatically recorded on magnetic tape, as well as typed out on a keyboard printer. The Mini-Ranger data were recorded on paper tape at 7-1/2 minute intervals.

Every 15 minutes the Mini-Ranger positions were plotted manually on a 1:500,000 scale chart, as were all acceptable satellite positions. For easy reference a shot-point number was given to each 15-mintue position. In addition to the routine plots, the locations of major course changes were also plotted. Furthermore, dead-reckoning positions, based on satellite data, the ship's single-axis speed log and the gyro, were computed every two seconds by the integrated system and stored on magnetic tape.

The Mini-Ranger system received its return signals from shore-based transponders positioned at desirable locations by a land-based support group. A maximum line-of-sight range over 80 nautical miles was obtained for some transponder locations.

The Mini-Ranger was used as the primary navigational system because of the high frequency and accuracy of the data and because most tracklines were within range limits of the system. Also, many positions obtained by the intergrated system were of low quality due to lack of adequate Loran C coverage in this region and because of a high percentage of satellite passes with elevations that precluded good position determinations.

In addition to the navigation by the scientific party, the ship's officers frequently succeeded in using radar and obtaining line-of-sight bearings. Correspondence between the ship's and scientific positions generally was very high.

Seismic Profiling and Visual Format Systems

Sparker: A total of 2419 nm of sparker data was recorded in Cook Inlet and on the Kodiak shelf, using a Teledyne system at a power of 30, 60, or 90 kilojoules. Seismic signals were received on a Teledyne 100-element, single-channel hydrophone, and the record was printed on a Raytheon model 1900 Precision Recorder. Usually, sweep and firing rates were at 2 seconds. Although several different settings were used, filters generally were adjusted to receive signals between 20 and 160 hertz. Records were annotated at 15-minute intervals with shot-point number, time (Greenwich Mean Time,GMT), and water depth.

Uniboom: Uniboom records were collected over a total of 2552 nm. The uniboom system used four EG&G model 234 power sources of 200 joules each driving hull-mounted plates. The hydrophone was an EG&G model 265. Data were recorded on an EPC 4100 recorder. Sweep and firing rates were typically at one-half second although some quarter-second rates were used. Filter settings typically were at about 600 to 1600 hertz.

Annotations were made in the same manner as those on the sparker system, but at 5-minute intervals.

High-resolution: A Raytheon TR-109 3.5 kiloHertz seismic system, with a Raytheon 105 PTR transceiver and a CESP-II correlator, was used to gather 3524 nm of high-resolution - shallow-penetration seismic data, as well as bathymetry. The system operated with 12 hull-mounted transducers, and the data were recorded on an EPC 4100 recorder. Sweep and firing rates typically were at one-half second, but quarter-second rates also were used. Annotations were made in the same manner as those on the uniboom system.

Record quality: Three factors that significantly affected quality of the seismic records were the typically coarse-grained and hard nature of the unconsolidated surficial sediments, the shallow water depth throughout most of both areas, and acoustic vibrations from the vessel.

Coarse-grained and hard sediments had the most severe effect on the uniboom and 3.5 kHz records, causing much of the outgoing energy from these high-frequency systems to be reflected directly from the sea bottom with only a minor amount of energy penetrating through to subbottom reflectors. Some of the uniboom records show subtle, irregular traces of subbottom reflectors, which can be traced and correlated only with difficulty. Many of the 3.5 kHz records show no sign of subbottom reflectors and can be used only as indicators of water depth.

The shallow water depth caused multiples to appear at small distances below the initial sea-bottom reflection, partially or totally obscuring signals from deeper reflectors.

Vibrations from the ship's engines and gear boxes proved troublesome at certain RPM's, giving a noisy signal on the recorders. This problem was minimized by cruising at the optimum, least noisy speeds.

Although these three factors each has a deleterious effect on record quality it was found by varying ship speeds and filter settings that the nature of the bottom sediments was the main reason for the seismic systems to display "poor" subbottom acoustic reflections on the records. Depth of penetration and details in the record consequently varied with type of bottom and water depth. Except for certain parts, the records allow adequate subbottom interpretation of geology.

Magnetometer: A Varian proton magnetometer was used together with an X-Y plotter. The magnetometer fish was towed about 600 feet (200 m) behind the vessel. A sampling rate of 3 seconds was used. Due to the 2-second firing of the sparker, an overwhelming noise was introduced causing the magnetometer to give very poor records when both systems were operating at the same time.

Side scan sonar: The side scan sonar unit used was an EG&G model, normally operated at a 125 m scale and towed above the bottom at 10% of the scale employed. High quality records were obtained. Although all side scan sonar surveys were run at a ship speed of 4-41/2 knots, currents could be responsible for a higher speed over the bottom. A few times a survey was interrupted or had to be discontinued due to hitting an unexpected bottom high. Also, a few times the side scan sonar unit hit bottom due to a sudden drop in ship's speed caused by a sudden decrease in current velocities. A total of 107 nm (198 km) of side scan sonar records were obtained (Fig. 2 and 3).

Normally the uniboom and 3.5 kHz units were run simultaneously with side scan sonar for depth control and possible subbottom information.

Bottom television and bottom camera: A Hydro Products bottom television unit and an underwater mercury light were mounted on a small sled, about 30 cm wide and 80 cm long. A four-point bridle was attached to the lowering wire. A multiconductor cable, leading to the camera and light, was taped at 5-m intervals to the winch cable.

The bottom television operation was conducted only in lower Cook Inlet (Fig. 2) and required four persons for smooth performance: One person operating the winch, one on the conducting cable, one on the TV monitor and tape recorder, and one on the 3.5 kHz (depth) and/or uniboom recorder. Continuous contact between the operators was maintained by means of walkie-talkie sets.

Since currents are always present in the lower Cook Inlet area it was impossible to fly the sled slowly and at a uniform distance over the bottom. Consequently a system of jumping had to be used, lowering the sled to the bottom and giving some slack wire. Due to ship's drift the cables became taut after a few seconds and the sled was then dragged over the bottom. The monitor operator then informed the winch operator to raise the unit, straighten the wire angle and lower it again.

Two fins, attached to the sled, oriented the sled in the current direction. A bar with divisions of 5 cm, and a compass attached to it, were mounted to the frame allowing direct and later measurements of bottom forms and local directions of current and/or sediment transport. Although a wide-angle lens was used, the area of observation was slightly more than 50% of the sled size, preventing observation of any bedform larger than about 50 cm.

The bottom camera was a 35 mm cassette EG&G unit mounted with its strobe in a large frame. Exposure was conducted via an electrical bottom contact, transporting the film as soon as a picture was obtained. Due to a longer focal length than the TV camera and the high amount of particulate matter, mainly organic, in the water column, few acceptable frames were obtained.

Sampling Devices

Gravity corer: The gravity corer consisted of an 800-pound weight with valve to which a 6-foot, 3-inch ID sampling pipe can be attached. In the bottom of the pipe, a brass-fingered core catcher was inserted and kept in place by a core nose. A clean butyrate tube was used as liner.

As soon as the filled liner was removed from the pipe, excess water was drained off and the core capped on both ends. The caps were secured with tape and later glued to the butyrate.

In the ship's sediment laboratory the liner was cut lengthwise using a cutter similar to that used by Deep Sea Drilling Project on the D/V GLOMAR CHALLENGER. The core was cut either with an electro-osmotic knife or with a spatula (Bouma, 1969). One half was then selected for archive storage. This half was photographed (8 x 10 in. camera), radiographed, described and color coded. In addition smear slides and grain mounts were made during the descriptive phase.

The other half - the working half - was subjected to vane shear measurements (Torvane) and hand-penetrometer tests. From the same depths, samples were collected for grain size analyses, faunal determinations (e.g., foraminifera), clay mineralogy, and geotechnical analyses (water content, bulk density, Atterberg limits).

After the shipboard processing, both core halves were placed in D-tubes and then stored in the scientific refrigerator.

Dart corer: Where seismic records indicated hogbacks of older sedimentary rocks cropping out on Albatross and Portlock Banks, a dart corer proved to be the only coring device capable of obtaining a sample. This device consisted of an 800-pound lead weight to which a 30 to 45-cm-long pipe was attached, having an inside diameter of 1-3/4 inches. The procedure consisted of lowering the corer to about 40 m off the bottom, after which the winch was placed in neutral allowing the corer to obtain near-terminal velocities before striking the bottom. Pull-out varied due to depth of penetration and type of bottom material and reached values as high as 10,000 pounds, but typically was 3,000 to 5,000 pounds. The sediment was extruded on board ship using an hydraulic ram. However, about 40% of the cores could not be extruded. Subsamples were removed from the bottom of each dart core for faunal examinations.

Van Veen grab samplers: The normal Van Veen grab sampler proved to be too light for adequate sampling of the typically sandy-gravelly bottoms. Generally successful attempts were obtained with a heavy modified grab sampler constructed by Andy Soutar of Scripps Institution of Oceanography for Ian Kaplan at UCLA.

A four-legged frame housed two vertical rails along which the actual grab could move. The top covers of the sampler could be opened completely for full access. The addition of weight up to 400 pounds on top of the grab provided sufficient force for the half-round sides to dig into coarse material during the closing operation. When rock fragments got caught between both halves of the grab, imcomplete closure resulted and part or all of the sample was lost. In general the results were good to adequate, and this instrument retrieved samples where other devices failed.

The Soutar grab sampler was teflon coated for geochemical work done by UCLA scientists. In addition to their subsamples, a core in plastic liner was taken from the least disturbed area of the grab sample for sedimentological work, and bulk samples were collected for petrographic studies.

Dredge: The rock dredge consisted of 1/2 inch by 2 inch flat-stock welded into a rectangular frame. A chain net, made from metal rings makes the basket. To the front of the frame a yoke is mounted to which the winch cable was attached.

The dredge was used without an additional weight in front. Although only one lowering was made near the Barren Islands, the dredge worked very successfully.

Other sampling devices and subsamples: On board, subsamples were collected routinely for clay mineralogical investigations (J. Hein, U.S. Geological Survey), foraminiferal studies (R. Poore, U.S. Geological Survey) and heavy metal analyses (C. Holmes, U.S. Geological Survey). Cores and bulk samples will be used for petrological, mineralogical and granulometric studies. When algae and corals were present they were sampled for R. Rezak (Texas A&M Univ.).

LOWER COOK INLET

The open waters of lower Cook Inlet are characterized by a fairly smooth bottom over which strong diurnal tidal currents move. As a consequence the surficial sediments are coarse grained, preventing significant penetration of high frequency seismic signals. It was found, however, that 30 kilojoules of the sparker system provided more than sufficient energy to obtain penetration to at least the first water-bottom multiple, and at the reduced power the strength of multiples was less. The uniboom records varied with ship's motion and coarseness of the bottom giving poor penetration in many areas. The 3.5 kHz system often failed to collect subbottom information and many records show no subbottom reflections.

The raw data map constructed from the sparker records reveals that many areas show subbottom reflectors that are more or less parallel to the bottom (Pl. 3). Although some lateral variation in intensity of such reflectors exists, no interpretation could be made due to absence of long cores and lack of public information on drill holes.

Many anticlines and synclines were encountered in the sparker profiles (Pl. 4). Density, shape and size varies between track lines making correlations occasionally questionable. Utilizing reports and personal assistance from L.B. Magoon (Magoon and others, 1976; Magoon and others, 1976 in press) an interpretation of the structural elements, as seen in the sparker records was attempted (Pl. 4). The general pattern of near surface folds is parallel to the surrounding tectonic pattern on shore. Distinctness of anticlines and synclines decreases from latitude 60^{o} N south toward a line between Seldovia and the volcanic island Augustine. This line corresponds to the location of the Augustine-Seldovia Arch (Magoon and others, 1976 in press).

South of this arch the folding is more intense and a change in direction toward the Mt. Douglas area becomes apparent. Correlation between tracklines in the same area, some of which were run in rougher seas than others, often becomes dubious. Part of the problem of correlation between tracklines is due to the presence of major unconformities that obscure deeper structural elements. In addition, the density and offset of surface and subsurface faults varies between tracklines (Pl. 5).

Adjacent to the Barren Islands specifically, and between the southwest part of Kenai Peninsula and Shuyak-Afognak Islands, is a strongly deformed zone containing small-scale faults, joints, horsts and grabens in basement outcrops, with little or no cover of unconsolidated sediments. The present density of the tracklines precludes any correlation.

Around Augustine Island the nature of the bottom sediments prevents good seismic penetration. This, together with rough seas while operating there, caused poor penetration and noisy records. Faults, likely of short length, form the major structural elements.

The raw data map (Pl. 3) also shows many dip symbols, some of them indicating smoothly dipping reflectors, others revealing a wavy character. The waviness varies and is considered to be local.

In the western part of lower Cook Inlet an escarpment was seen on many of the transverse crossings. Where the nature of this scarp is compatible between adjacent tracklines, correlations are shown (Pl. 4). To the north the scarp becomes less steep and dashed lines were used indicating possible connection. A short scarp was seen close to Augustine-Seldovia Arch. Its character differs from the longer one farther north and no indication of an escarpment was found in between.

In general, the shallow structural picture of lower Cook Inlet does not seem to be complex, except in the zone between Kenai Peninsula and Shuyak Island and around Augustine Island. Long fault lines are not apparent and most faults may be of local importance. The influence of the Augustine-Seldovia Arch is visible, but the broad nature of this arch eliminates sudden changes in the near surface structural pattern. A few dashed correlation lines are presented on the interpretation map and their significance should be considered very tentative. Since correlation between tracklines south of the arch is more difficult is it thought that the deeper structures between the arch and the Mt. Douglas area are more complex than north of the arch.

The lower Cook Inlet Draft Environmental Impact Statement (Bureau of Land Management, 1976) summarizes other information available on the hydrology and ice conditions in this area.

The pattern of textural characteristics of the surficial sediments is rather simple (Pl. 6). Except along coast lines, coarseness of the surficial sediment is directly related to the strength of the currents, which is proportional to the width of the water body. In general, the cross section of lower Cook Inlet becomes narrower going north to the 60th parallel and an increase in coarseness of surficial sediments occurs. The granules and pebbles vary in size from 2 to 6 cm and are well-rounded. It could not be demonstrated that significant transport occurs at the present. It is likely, however, that all the surficial sediment is a lag deposit of transgressional nature, undergoing little net transport at the present time. A certain amount of transport is obvious as all sediment samples normally contain significant amounts of dispersed volcanic materials. Shells and shell fragments often form an important part of the upper sediments, but whether the fragmenting of shells is only the action of crabs or is also due to currents cannot be established at the present time. Shells, shell fragments and volcanic ash are not incorporated in the textural display given on the surficial sediment map (Pl. 6).

Although all of the samples from lower Cook Inlet proper are coarse grained, it is likely that the bays have considerably weaker currents that allow fine-grained sediment to settle there. For example, Tuxedni and Chinitna Bay have exposed mudflats at lower water level, and a gravity core (#2) collected behind the Homer Spit in Kachemak Bay consisted of a black muddy sediment with a high content of organic matter.

Uniboom and 3.5 kHz records showed many areas with wavy bedforms of varying sizes (Pl. 5). Insufficient time was available for detailed surveying but a number of side scan sonar records and bottom television lowerings were obtained between northern Kachemak Bay and the axis of lower Cook Inlet, and off Kenai Peninsula (Fig. 2). The side scan sonar records conform with earlier findings of the Alaska Fish and Game Department (P. Wennekens and J. Dygas, pers. comm., 1976) that elongated narrow patches, parallel to the main tidal current regime, occur with various other types of bedforms. Plate 5 shows where wavy bedforms were observed on uniboom and 3.5 kHz records and Figure 2 shows where side scan sonar and TV observations have been made from the R/V SEA SOUNDER.

Rippled bedforms differ in size and characteristics between these patches. In central Cook Inlet (Pl. 6, sta. 44) large asymmetric underwater dunes were observed, some of them 1 km long and 10 meters high. Their asymmetry indicates a net transport to the south. However, during the television lowering over this area a northern sediment movement was observed, transporting sand via small current ripples.

In other areas northerly migrating asymmetric dunes were found, while more or less symmetric forms are not uncommon. Along some longitudinal tracklines dune fields appear and disappear without an observable change in water depth. Along such a stretch asymmetric ripples can change into symmetric ones, and even change direction of asymmetry.

Moving across lower Cook Inlet with side scan sonar a rapid change in aspect of bottom morphology can be observed without a change of depth. One field may contain dunes with straight crests and some indication of superimposed megaripples. This may suddenly change into a megaripple field, with crest distances of about 20-25 m and with slightly sinuous or slightly rhomboid crests. Another common pattern consists of sinuous megaripples with a wavelength of about 7-10 m. Those fields can alternate with patches of boulders, flat-floored bottom or flat-floored with broad, shallow grooves with megaripples in each groove.

Coverage is insufficient to determine if the large dunes and/or megaripples are locally permanent features; if they move or if they are basically stable. No detailed and repetitive bathymetric surveys, covering a long span of time, are available for such analyses as was the case in the North Sea where similar features exist. It therefore is possible that the large features are relict forms from the last transgressive phase, or that they move only when extreme high water conditions and related currents occur, or are basically stable with minor modifications due to tidal flows.

Microscopic analyses of sand sized material on board ship reveal a basic bimodal distribution of the total sediment: pebbles and sand. The sand is mainly medium grained with mixed fine-grained sand. It depends on the location of a sample, especially in the ripple fields (crest or trough) if medium or fine sand predominates (Table 4). Petrologically, five major components were distinguished: quartz, total feldspar, heavy and mafic minerals, rock fragments and glass shards. The sand samples, when not inudated by shards, were about equally divided between quartz plus total feldspar on the one hand and heavy and mafic minerals plus rock fragments on the other hand. Considerable variations occur and rock fragments plus heavy minerals in some samples constitute 75% of the total sand fraction.

The heavy mineral assemblage is varied: epidote, garnet, magnetite, hornblende and biotite are most common. The rock fragments consist predominately of weakly foliated, fine-grained dark slate and phyllitic rock types, which are characteristic of the sediment. The source area for this type of material must have consisted of a high proportion of supracrustal metasedimentary rocks with only a minor amount of granite or hypabyssal rocks.

The textural aspects of the lower Cook Inlet sediments may be characterized best by their good sorting and by the reworking of the lithic fragments. The sediments are very immature compositionally. The rounded nature of the pebbles either suggests transport at a lower stand of sea level, or slow movement continuing at the present. Transport from river mouths by ice and deposition as drop stones in lower Cook Inlet may not be disregarded as presently little is known about the transporting role of sea ice in this area. However, the absence of angular rocks makes present ice trasport doubtful.

KODIAK SHELF

The seafloor of Kodiak Shelf consists of several flat, relatively shallow areas that are cut by transverse valleys (Fig. 4). This physiography reflects the erosive action of glaciers and waves as well as some bedrock structural control.

Sparker records show that the shallow bedrock structure of Kodiak Shelf consists of a series of folds that apparently trend in a general northeast-southwest direction (Pl. 7). However, they show enough deviation in trend and discontinuity that confident regional correlations of fold axes cannot be made at this time. Especially obvious, though, are major anticlinal crests that occur near the shelf break on Albatross Bank.

Several surficial scarps, underlain by offset reflectors, also are evident on the sparker records implying surface faulting. These features are most abundant in a zone just off the southeast coast of the Kodiak island group, near the shelf break on Albatross Bank, and on Portlock Bank (Pl. 8). Confident correlation of faults between track lines cannot yet be made.

Unconformities occur at several places on the shelf. Most commonly the sparker records show a relatively smooth unconformity surface separating folded and faulted bedrock below from flat-lying sediments above. The sparker records that extend beyond the shelf break, onto the continental slope, often show one or two unconformities separating sediments with successively decreasing dips above each unconformity surface.

The uniboom and 3.5 kHz records vary in quality according to the factors mentioned earlier. The uniboom records on Kodiak Shelf commonly show slightly undulating subbottom reflectors of irregular reflectivity. Zones of transparent, opaque, and inclined sediments also commonly occur.

Hogback ridges occur on Albatross and Portlock Banks. In these areas, inclined bedrock has been sculpted by differential erosion, and a significant cover of unconsolidated sediments is absent.

The sediments of Kodiak Shelf are distributed in relation to the physiography (Fig. 4, Pl. 9). The broad, flat elevated banks are covered by sands that commonly contain coarse material, up to boulder size, but rarely contain significant quantities of silt and clay. The sediments of the troughs, on the other hand, typically are finer grained than those of the adjacent banks, and a few are composed almost entirely of silt and clay. Gravel and coarser material does occur in the deep areas, however.

As in Cook Inlet, the composition of the sand fraction is quartz, feldspar, heavy minerals (hornblende, epidote, garnet, biotite, opaques, and others), and rock fragments (schist, phyllite, and less common volcanics). Heavy minerals and rock fragments are abnormally abundant in many samples, reaching up to a total of 75%.

In addition to epiclastic debris, the sand-size fraction also contains shell material and volcanic glass. The shell material is made up of various proportions of crushed megafaunal shells and of foraminiferal tests. Although not noted on the textural map, many of the bank sediments are predominately shell material (Table 4).

Fragments of volcanic glass are present in most unconsolidated sediments recovered from Kodiak Shelf, but are most abundant in the trough areas. Some essentially pure ash layers were encountered in the troughs, and some other trough sediments contain more than 75% volcanic glass.

The gravel to boulder-size material of Kodiak Shelf consists mostly of dark-colored slate and phyllite, with granitic types present in some instances.

Bedrock recovered from dart coring of the hogback ridges is mostly olive gray to gray siltstones and silty sandstones. Most of the core samples are barren of nannofossils, although a late Tertiary to Quaternary nannofossil age was determined at one site (Table 2). Attempts to date the bedrock by foraminifera and by pollen are currently underway.

The few sediment samples recovered on the continental slope off Kodiak are muds and sands containing some gravel, pebbles, and cobbles. A more extensive sampling program is necessary to characterize the slope sediments.

According to our records, the surface of Kodiak Shelf, both on the banks and in the troughs, generally is smooth and devoid of extensive bedforms or slumps. A side-scan sonar survey (Fig. 3), run for approximately 24 nm (43 km) in a northwesterly direction approaching Marmot Island, showed a surprisingly featureless bottom configuration, with only an occasional boulder. The survey was continued around the island and then in a southeasterly direction for about 16 nm (29 km) just to the northeast of Marmot Island, in an area of bedrock outcrop. An orthogonal joint pattern was clearly evident in these records.

Slumps occur abundantly in many zones on the Kodiak continental slope (Pl. 7 and 8). Within these zones, incipient slumping is often detectable on the upper slope, with block glides and internally deformed rotational slumps abundant on the lower portions. An important question, yet to be answered, is why the slumps occur in some areas of the slope but are absent in others.

ACKNOWLEDGEMENTS

The authors are very thankful to all members of the scientific crew listed in Table 3, for their interest and cooperation in the program. We also want to thank Captain Alan McClenaghan, the officers and the crew of the R/V Sea Sounder for their enthusiasm in making the cruise so successful. Richard Tagg and William Clique provided excellent shore support for the Mini-Ranger system. Thanks go to Roland von Huene for gathering high resolution records in addition to those used here.

Tom Frost and Bob Orlando helped with getting the material ready for this report, Barbara Ingraham and Cheryl Price typed the manuscript. Phyllis Swenson and Lee Bailey did the final drafting, and Les Magoon, Roland von Huene and Gary Winkler reviewed the manuscript. While at sea, many in the home office took care of our radio requests to keep the program going.

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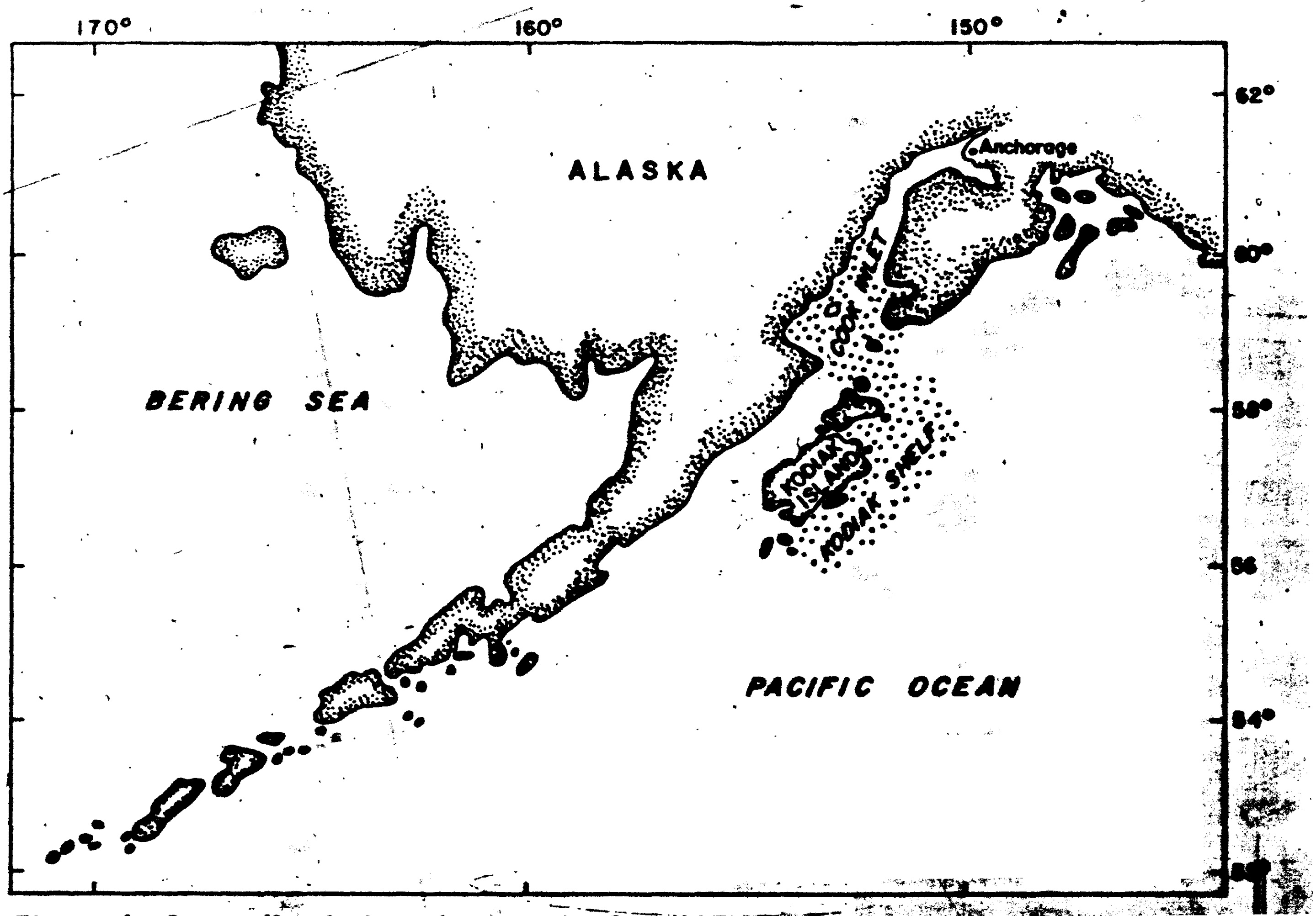

Figure I.- Generalized location map of the study area

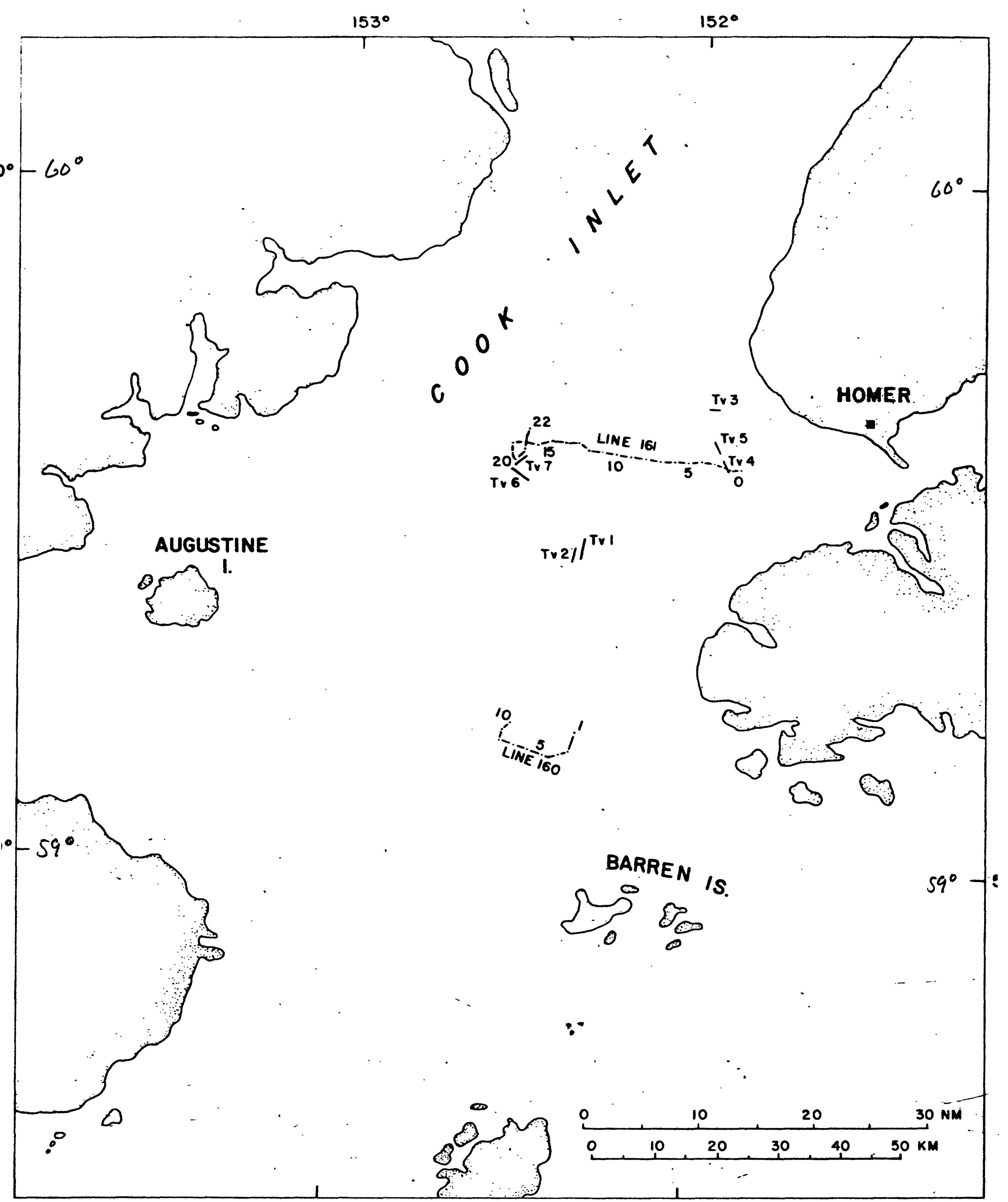

Figure 2.- Lower Cook Inlet, location of side-scan sonar lines and bottom television stations

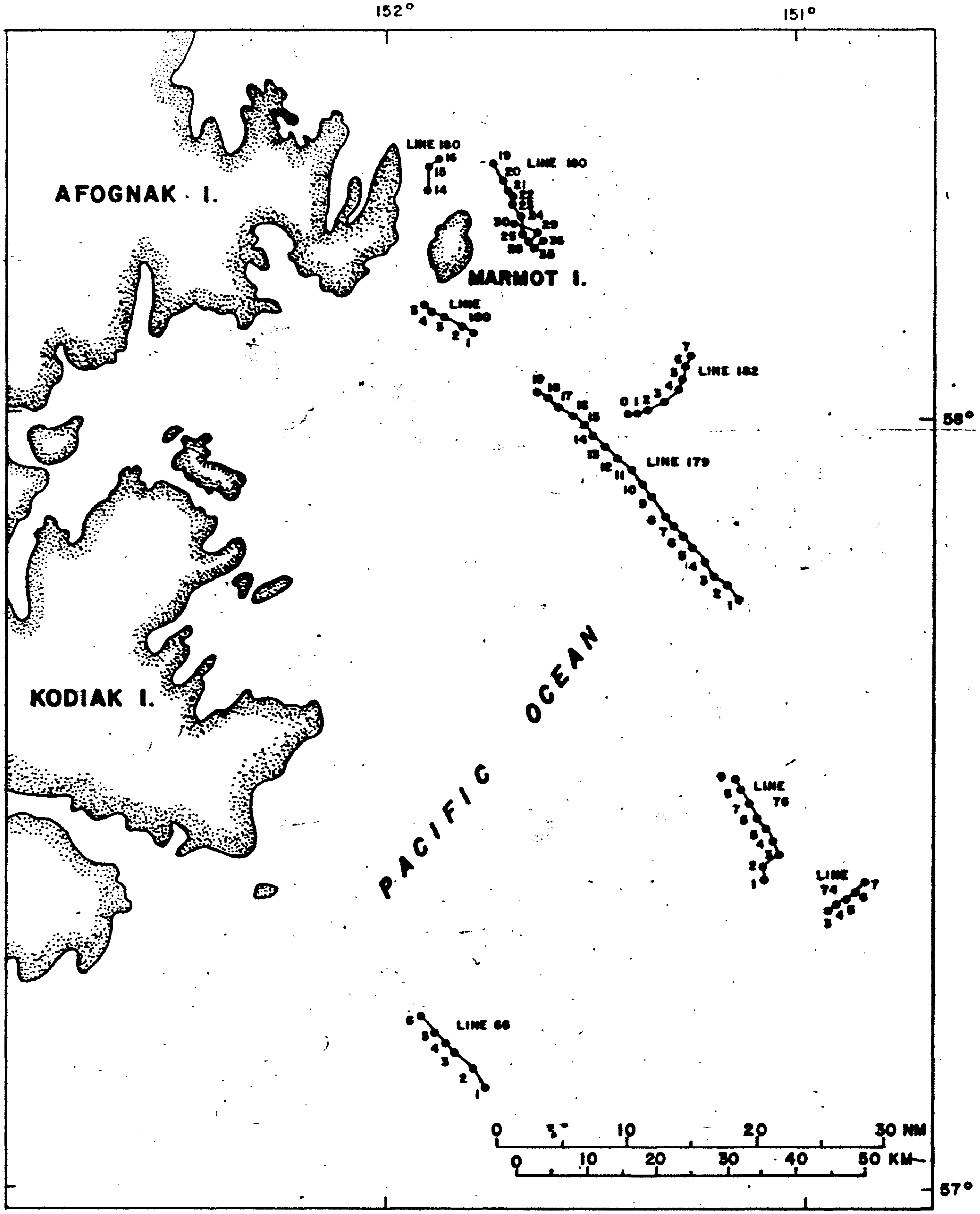

Figure 3.- Side-scan sonar lines on Kodiak Shelf

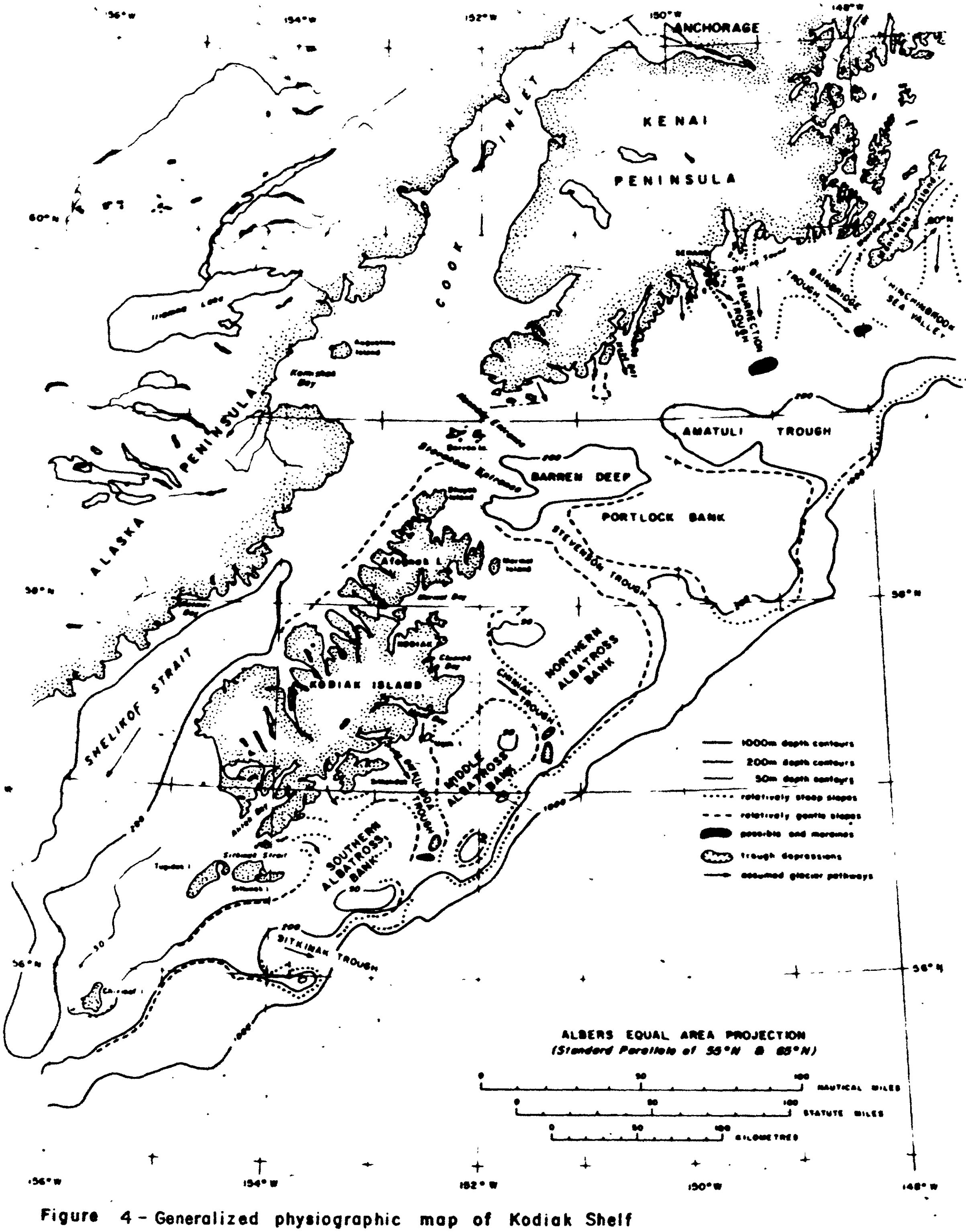

Figure 4 - Generalized physiographic map of Kodiak Shelf

Table 1. Cruise itinerary, and types and amounts of data collected on board the R/V SEA SOUNDER during 1976 in lower Cook Inlet and on Kodiak Shelf, Alaska. (Trackline distances computed using 5 nm /hr, as average ship speed)

Port	Arrive	Leave	Leg
Seward		June 18	I
Homer	June 22	June 22	I
Homer	July 1	July 3	
Homer	July 3	July 5	II
Kodiak	July 14	July 17	II
Kodiak	July 22	July 22	III
Kodiak	July 30		III

Instrument	Trackline	Remarks
Sparker	2419 nm =4499 km	12 rolls
Uniboom	2552 nm =4746 km	63 rolls
3.5 kHz	3524 nm =6555 km	73 rolls
Side Scan Sonar	107 nm =198 km	11 rolls
Magnetometer	1460 nm =2716 km	
Bottom Television		4 video tapes
Dredge		1 haul
Van Veen Grab		16 recoveries
Soutar Grab		114 recoveries
Gravity Core		9 recoveries
Dart Core		30 recoveries
Bottom Camera		1 station

Table 2. Nannofossil ages of Kodiak Shelf sediments collected during the summer of 1976. Identifications by David Bukry, 1976.

Sample and Interval	Age	Remarks or Zone
83G 118-119 cm	Quaternary (C)	Gephyrocapsa oceanica or Emiliania huxl
84G 0-2 cm	Quaternary (C)	as above
84G 160-161 cm	Quaternary (C)	--
97G 0-2 cm	Quaternary (S)*	Distephanus octangulatus
98G 0-2 cm	Quaternary (S)*	as above
98G 93-94 cm	Quaternary (S)*	Dictyocha aculeata
110D 46-47 cm	Pliocene or Quaternary (D)*	contains the diatom Denticula seminae
11D 47-48 cm	Quaternary (C)	--
116D 38-39 cm	Miocene to Quaternary (D)	--
117D 13-14 cm	Cenozoic (C)	rare Coccolithus pelagicus
133G 30-31 cm	Quaternary (C)	Gephyrocapsa oceanica or Emiliania huxl
133G 92-93 cm	Quaternary (C)	--
133G 104-105 cm	Quaternary (S)*	Dictyocha aculeata

notes: C= Coccoliths *= Diatoms abundant
D= Diatoms G= gravity core
S= Silicoflagellates D= dart core

The following samples proved to be barren of coccoliths, diatoms, and silicoflagellates:

83G 0-2 cm
99G 19-20 cm
100D 16-17 cm
101D 8-9 cm
102D 15-16 cm
103D 16-17 cm
104D 15-16 cm
106D only very small sample recovered
107D 29-30 cm
108D 24-25 cm
112D 21-22 cm
118D 19-20 cm
120D 19-20 cm
121D 9-10 cm
123D 33-34 cm
124D 19-20 cm
125D 19-20 cm
144D 22-23 cm
145D 9-10 cm
147D 11-12 cm
148D 7-8 cm
149D only very small sample recovered

Sample 116D is poorly preserved and could be upper Miocene to Quaternary.
No recovery on dart core stations 109D, 122D, 126D, 142D and 143D.

Table 3. Scientific personnel on board the R/V SEA SOUNDER during the 1976 cruise in lower Cook Inlet and Kodiak Shelf, Alaska.
(Cruise leg numbers refer to the data given in Table 1.)

Arnold H. Bouma	co-chief scientist I-III	U.S. Geol. Survey, Marine Geol.
Monty A. Hampton	co-chief scientist I-III	id.
Leslie B. Magoon	I	U.S. Geol. Survey, Oil and Gas
George W. Moore	II	U.S. Geol. Survey, Marine Geol.
James R. Hein	I	id.
Sandra J. Owen	I	U.S.G.S., Cons. Div., Los Angeles
John W. Whitney	I	U.S.G.S., Cons. Div., Anchorage
Bruce W. Turner	II	id.
Andrew Stevenson	I	U.S. Geol. Survey, Marine Geol.
Gordon L. Tanner	I,II	id.
Harry Hill	III	id.
Thomas P. Frost	I-III	id.
Robert C. Orlando	I-III	id.
Roland H. Brady, III	II,III	id.
Christina E. Gutmacher	I	id.
Richard A. Garlow	I-III	id.
Dennis R. Kerr	I	id.
David T. McTique	I,II	id.
James Evans	II,III	id.
Robert M. Egbert	I	U.S. Geol. Survey, Oil and Gas
Edward C. Ruth	I	UCLA
Mark Sandstrom	II	UCLA
Daniel Stuermer	III	UCLA
Ivan P. Colburn	II	Cal. State Univ., Los Angeles
Stuart O. Burbach	II,III	Texas A & M Univ.
Nelson M. Robinson, Jr.	II,III	id.
Michael E. Torresan	II,III	San Francisco State Univ.
Scott R. Morgan	II,III	id.
Joseph A. Dygas	I,II	Alaska Fish and Game Dept.
Ronald R. Murray	II,III	NAVOCEANO

Ships Officers

Alan McClenaghan	Captain
Don Phillips	Chief Engineer
Kelly Mitchell	First Mate

Table 4. Position, lithology, color and other shipboard characteristics of samples collected on board the R/V SEA SOUNDER in lower Cook Inlet and Kodiak Shelf.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length, cm	Lithology, color and additional remarks
1 G	2	57°56.50'	150°13.55'	191	no recovery
1 V	1	57°56.54'	150°13.56'	192	Clean ms, dark with echinoid, and worm tubes
2 G	1	59°37.55'	151°18.87'	73	Slightly sl/c, dark, high amount of organic material sl/c=10 90
3 V	2	60°05.36'	152°34.13'	40	Slightly muddy sandy g with cobble sized material, grey. Barnacles encrusted to rock fragments. g/s/sl/c=60-30-5-5
4 V	1	60°05.45'	152°34.54'	40	Sandy g with some rock fragments, greyish brown. Numerous small pelecypods and sea fans. g/s/sl/c=94-3-2-1
5 V	1	60°04.70'	152°33.83'	47	Slightly muddy pebbly s, grey. g/s/sl/c=40-55-3-2
6 V	1	59°19.02'	153°41.45'	26	Clayey sl/fs, dark grey. s/sl/c=45-40-15
7 V	1	59°16.22'	153°32.12'	32	Sl/s, dark grey, some pumice. s: 90% vf, 10% f. s/sl/c=80-15-5
7 S	1	59°16.24'	153°32.12'	32	Sl/fs, some pumice. Abundant gastropod shells, molluscs and worm tubes.
8 S	1	59°10.69'	153°44.10'	36	Slightly sandy pebbly clayey sl, dark grey. Abundant fauna: molluscs and barnacles. g/s/sl/c=30-6-58-6. Abundant shell fragments.
9 V	1	59°41.60'	152°36.10'	35	Pebbly s, dark, some sessile organisms. g/s/sl/c=30-67-2-1
10 V	4	59°41.25'	152°34.90'	51	Sandy g, dark. g/s/sl/c=95-5-tr-tr
11 V	2	59°34.50'	152°35.90'	75	Sandy g, dark grey. g/s/sl/c=95-4-tr-tr
12 V	2	59°34.60'	152°36.10'	67	Sandy g, dark grey. g/s/sl/c=54-44-1-tr
13 V	1	59°25.75'	152°50.09'	63	Ms, dark grey. 60% ms, 30% fs, 10% vfs
14 V	1	59°30.0'	152°46.01'	65	Ms, dark grey. 2% cs, 93% ms, 5% fs
14 S	1	59°30.06'	152°46.06'	61	Ms, dark grey. 5% cs, 95% ms, 5% fs
15 S	1	59°31.08'	152°54.0'	45	Ms, dark grey. Some shell debris, 4% cs, 93% ms, 3% fs

Sample No.:
G=gravity core
V=van Veen grab sample
S=Soutar modification of van Veen grab
CD=Chain dredge
D=Dart core

No. of attempts:
number of lowerings with that sampling device before an acceptable sample is obtained. If no recovery: see under remark.

Water Depth m/Core length cm:
waterdepth in meters at the time of the station without tidal correction/length of core in cm as recorded on board ship.

Lithology, color and additional remarks:
g/s/sl/c=gravel/sand/silt/clay ratio in percentages from smearslides.
tr=trace, g=gravel, vcs=very coarse sand; cs=coarse sand; ms=medium sand; fs=fine sand; vfs= very fine sand; s=sand; sl=silt; c=clay

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additional remarks
16 S	1	59°23.2'	153°06.6'	48	Pebbly s, grey. Small pebbles. g/s/sl/c=10-88-1-tr
17 S	1	59°20.7'	152°53.5'	74	Clean s, vf to c, grey. s=100%
18 S	3	59°12.15'	152°44.8'	122	Clean s, dark grey. s=98% pebbles and c 1%, ms 90%, fs 9%
19 S	1	58°56.25'	152°23.36'	75	Very slightly silty s with shell fragments (35%) s/sl/c=97-2-1. ms 90%, fs 10%
20 D	2	58°53.45'	152°25.50'	82	No recovery
21 CD	1	58°53.15' to 58°53.52	152°22.28' to 152°19.15'	- -	Chain dredge. Primarily rounded pebbles and boulders: samdstone, shale, basalt, plutonics. Varied biota: many sponges
22 S	3	58°51.20'	152°24.90'	154	Sandy g. 50% clastics and 50% shell fragments, forams, etc. g/s/sl/c=55-40-4-1
23 S	2	58°55.7'	152°34.3'	170	60-65% clastic, rest biogenic. S, grey. ms prim. g/s/sl/c=1-97-1-1
24 S	1	58°58.49'	152°31.11'	147	Sl s, grey. 10% shell fragments. s/sl/c=97-2-1
24 G	1	58°58.90'	152°30.45'	147	Tr recovery
25 S	1	59°03.2'	152°31.2'	133	Pebbly s. g/s/sl/c=5-92-2-1
26 S	1	59°08.1'	152°22.1'	119	S. 100%. Range: c-f; ms=median. Some shell fragments
27 S	1	59°26.3'	152°20.7'	74	S, less than 1% g. Clean. Range vc-m; median=coarse
28 S	1	59°21.35'	152°25.9'	78	S 100%. Range: m-f; median=m. Some shells
29 S	2	59°14.98'	152°28.15'	89	S 100%. Range: m-f; median=m. Some shells. Large phlogopite flakes.
30 S	2	59°16.65'	152°21.70'	91	Shelly s: 15% shell fragments, 85% s. Range: c-f; median=m.
31 S	2	59°20.25'	152°19.10'	90	Shelly s: 15% shell fragments, 85% s. Range: m-f; median=m.
32 S	1	59°19.45'	152°06.13'	69	Sandy g, grey. Shell fragments (25%), coral, molluscs. g/s/sl/c= 67-32-tr-tr
33 S	2	59°26.35'	152°12.49'	50	Pebbly s, much fauna on surface. 35% shell fragments. g/s/sl/c= 15-85-tr-tr
34 S	3	59°36.55'	151°52.00'	28	Fs with few animals. 20% shells, shell fragments, forams. 80% s: ms/fs/vfs=10-80-10
35 S	1	59°37.35'	152°14.30'	50	Sandy g with clams and brittle stars. g/s/sl/c=73-27-tr-tr

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additional remarks
36 S	2	59°41.50'	152°13.0'	46	Pebbly s with shells (25%). S range: vc-f; median: ms g/s/sl/c= 33-74-2-1
37 S	1	59°46.30'	151°13.0'	56	Sandy g with shells (20%). ms/fs=85-15 g/s/sl/c=69-31-0-0
38 S	2	59°44.65'	151°59.05'	18	G (100%). Rocks up to 15 cm, well rounded, one rounded cobble: 20 X 12 X 8 cm
39 S	1	59°40.75'	151°57.15'	35	G with abundant fauna: urchins, crabs, clams, etc. Very little fs. Pebbles and cobble well rounded.
40					No sample station
41 S	1	59°36.25'	151°56.00'	30	Clean ms well sorted, sub-rounded to sub-angular 10% shells. ms/fs= 85-15
42 S	2	59°36.20'	151°45.60'	30	Silty s, ms well sorted, sub-rounded to sub-angular, shells 5%, g/s= 25-70
43 S	1	59°36.63'	151°22.07'	52	Silty s, well sorted, dark, some clams, s is vfs/fs/ms=75-20-5% s/sl/c=96.5-3-0.5
44 S	2	59°35.25'	152°22.90'	62	Clean s (98%) well sorted, some shell fragments, s is ms/fs/cs= 79-20-1 g/s/shells=1-98-1
45 S	1	59°34.80'	152°36.10'	-	Muddy s with pebbles abundant fauna.
46 S	2	59°44.40	152°32.05'	71	Sandy g, some shell fragments, g/s=75-24 1% shells, s is ms/fs/c= 85-14-1
47 S	2	59°55.49'	152°28.60'	25	Sandy g, shells (5%) s poorly sorted vcs/cs/ms/fs/vfs=2-25-50-18-5 g/s/shells=75-20-5
48 S	1	60°00.50'	151°22.46'	45	Sandy c, well sorted, sub-rounded to angular, 99% s fs/vfs/ms=90-7-3 s/sl=99-1
49 S	1	59°56.00'	152°03.90'	47	Shelly g, g well rounded, g/s/shells=80-15-5 s: cs/ms/fs=80-10-10
50 S	2	59°52.50'	151°54.50'	32	Sandy g, sub-angular to rounded, s: cs/ms/fs=30-55-15, g/s/shells= 70-15-10
51 S	1	58°12.54'	151°55.74'	60	Cobbles and boulders with fauna, washed sample, no s.
52 G	2	58°24.54'	151°14.35'	107	NO SUITABLE RECOVERY-small sample g/s/c=25-75-.1
52 S	1	58°24.42'	151°13.80'	86	Pebbly s with clams (no further analyses)
53 S	2	58°12.56'	150°39.79'	175	Sandy g, with shell fragments. s: cs/ms/fs/vfs=5-10-70-10, g/s/shell= 40-15-45
54 S	2	58°07.36'	150°30.26		Muddy s, also forams and shells=10%, glass shards, lithic fragments s, ms/fs/vfs=10-75-15, g/s/sl/c=.5-89-.5-.1%

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m	/Core length cm	Lithology, color and additional remarks
55 S	2	58°01.86'	150°21.64'	184		Muddy s, ash-glass shards, s/sl=99.5-.5% s is 95% fs, well rounded
55 G	1	58°01.86'	150°21.64'	183		Pebbles, not much else.
56 S	1	57°55.22'	150°12.77'	194		S, overlain by small amount of clay and possible ash, s 100% well-sorted.
57 S	1	57°50.94'	150°03.74'	190		Muddy s, ash 97% s: cs/ms/fs/vfs=10-15-65-10%, lithics are rounded, shell fragments and forams
58 S	1	57°46.99'	149°55.40'	232		Silty s w/pebbles. ash; s=cs/ms/fs/vfs=15-15-60-10; g/s/sl-c=5-94-1
59 S	1	57°46.60'	149°29.66'	-495		Pebbly s, high amount of shards, s 90% fs to vfs. Lithics are well-rounded; g/s/sl-c=3-97-tr
60 S	1	57°45.96'	149°37.41'	444		S 99%, glass shards, lithics are rounded, s=cs/ms/fs=1-9-90% g/s/sl-c=1-99-tr
61 S	1	57°35.61'	150°24.46'	112		Pebbly s w/g, forams, shells, ash. S very well sorted, g/s/shells=25-60-15
62 S	1	57°39.05'	150°32.48'	102		Pebbly s, abundant brittle stars and clams, pebbles well rounded, s well sorted g/s/sl-c/shells=20-55-1-24
63 S	1	57°43.96'	150°39.25'	90		Pebbly s, abundant fauna, lithics well rounded, s mod. sorted, g/s/sl-c/shells=25-40-1-34
64 S	1	57°47.50'	150°45.00'	83		Sandy g, shell fragments. Lithics well-rounded, mod. sorted s, sub-angular to sub-rounded; g/s/sl-c/shells=40-20-1-39%
65 S	2	57°51.50'	150°51.50'	77		Sandy g, with ash, s 85% fs-vfs, lithics well rounded; g/s/sl-c/shells=35-20-1-44
66 S	1	57°55.10'	150°59.30'	-		Shelly s, much shell debris, glass shards, s 90% fs/vfs; g/s/sl-c/shells=5-15-1-79
67 S	3	57°59.70'	151°06.40'	82		Pebbly s, glass shards, s: cs/ms/fs/vfs=1-5-55-40, lithics rounded; g/s/sl-c/shells=10-30-1-59
68 S	2	57°28.10'	151°28.70'	154		S 97%- abundant glass shards, well sorted, s/sl/c=97-2-1
69 S	2	57°23.25'	151°10.95'	80		S 90%, about 95% ash, fs/vfs=75-25, lithics rounded; s/sl/c=90-9-1
70 S	1	57°24.08'	150°52.25'	96		Clean s, 99%, lithic fragments rounded, s:cs/ms/fs/vfs=<1%-12-80-8
71 S	1	57°20.01'	150°59.08'	95		Clean s, 99%, lithics round-subrounded, few shards, s-ms/fs/vfs=15-75-10. Clay-silt=1%
72 S	1	57°24.20'	151°05.10'	92		S 99%, lithics mostly sub-rounded, abundant shards, ms/fs/vfs=1-97-2, 1% clay-silt

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additional remarks
73 S	1	57°34.90'	151°12.15'	66	Shelly s, sample contained large basalt boulder at 86% of volume, ash, g/s/shells=.5-3-11
74 S	2	57°41.10'	151°00.40'	75	Shelly s, with cobbles and boulders, mode is rounded to sub-rounded b-c/g/s/sl-c/shell=80-4-2-tr-14
75 S	1	57°45.80'	151°08.05'	70	Shell fragments, with lithics, shards, s mod. sorted, g/s/sl-c/ shells=1-16-tr-83
76 S	1	58°06.20'	151°46.10'	95	S, dark green, shell fragments, well sorted, shards, s 98% shells 2%
77 S	1	58°11.60'	151°37.00'	38	Shelly cobbles, some forams, shell hash, g/s/sl/shells=90-3-6-1
78 S	2	58°11.41'	151°37.15'	70	Totally brittle stars; some, very little, shell hash.
79 S	1	58°12.23'	151°38.07'	-	Brittle stars, shelly pebbles, lithic are rounded, few shards, g/s/sl-c/shells=36-6-tr-58
80 S	1	58°01.50'	151°21.90'	81	Pebbly shelly s, forams, shards, s vcs-cs/ms/fs/vfs=2-1-92-5 dark, rounded
81 S	1	58°05.21'	151°14.55'	143	Sandy mud, green, rich in ash, ms/fs/vfs=tr-56-45, s/sl/c/shells= 88-10-tr-2
81 G	3	58°05.21'	151°14.55'	145	No recovery
82 S	1	58°03.60'	151°15.90'	103	Sandy g, shards, lithics are sub-angular to rounded, g/s/sl/c/shells= 50-29-1-tr-20
83 G	1	56°53.73'	151°29.84'	706/150	Coarse pebbly s with shells and mud.
84 G	1	56°55.06'	151°24.58'	859/175	Grey mud, some grit, strong H_2S odor
85 S	1	57°45.00'	151°44.00'	55	Sandy shell hash, shards, forams; lithics are rounded to sub-rounded g/s/sl/c/shells=1-3-tr-96
86 S	1	57°41.48'	151°34.70'	61	Shelly s, shards and forams; vcs/cs/ms/fs/vfs=1-1-2-90-6; g/s/sl-c/ shells=1-66-tr-33
87 S	1	57°36.50'	151°47.65'	132	Ash s 99%, very well sorted 98% fs. s/sl-c=99-1
87 G	2	57°36.50'	151°47.65'	137	No recovery
88 S	1	57°31.20'	151°38.00'	167	Ash s 76%, well sorted=fs-vfs=100%. s/sl/c/shells=76-23-tr-1
88 G	[illegible]	57°31.20'	151°38.00'	145	No recovery
89 S	[illegible]	57°28.50'	151°44.50'	70	Conglomerate, with shards, lithics sub-angular to sub-rounded, c-g/s/sl-c/shells=88-8-tr-4
90 S	1	57°25.10'	151°51.90'	67	Sandy, shell hash, ms=75% of s, lithics are rounded to sub-rounded, s/sl-c/shells=2-tr-98

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additional remarks
91 S	1	57°19.29'	152°04.82'	73	S 99% with shell has, well sorted vfs; sub-rounded. s/shell=99-1
92 S	2	56°56.50'	152°33.00'	167	Silty c, olivine-green color, H_2S odor, vfs. s/sl/c=1-3-96
93 S	1	56°53.45'	152°40.90'	128	Silty s, vfs, shards present, olive-grey color. s/sl/c=90-8-2
94 S	1	56°48.15'	152°52.60'	63	Shelly s, shards, olive-grey color; well sorted fs. g/s/sl-c/shells 49-36-tr-15
95 S	1	56°48.10'	153°21.35'	160	Conglomerate; shards; rounded to angular cobbles; g/s/sl-c/shells= 90-10-tr-tr
96 S	1	56°41.46'	153°05.90'	146	Sandy mud, well sorted; shards, s-vfs. s/sl/c=5-35-60
97 S	1	56°40.10'	153°10.02'	150	Sandy mud, well sorted round to sub-rounded. s/sl/c=4-26-70
97 G	1	56°39.90'	153°11.10'	138/100	Mud, greyish-olive, very little shell fragments
98 S	1	56°38.00'	153°16.00'	145	Silty, sandy mud, well sorted, well rounded, shards s/sc/c=3-20-77
98 G	1	56°37.80'	153°16.30'	144	Sandy mud, little recovery
99 D	2	56°24.50'	152°53.70'	55/20	Siltstone, olive grey
100 D	1	56°24.00'	152°53.50'	50/17	Siltstone, olive-grey
101 D	1	56°23.20'	152°54.10'	49/9	Sandstone, very fine grained, medium dark-grey color, silty.
102 D	1	56°23.10'	152°53.90'	45/16	Siltstone, olive-grey
103 D	1	56°22.70'	152°52.00'	50/17	Sandstone, very fine grained, silty, olive-grey
104 D	1	56°22.00'	152°50.90'	75/16	Sandstone, very fine grained, silty, olive-grey
105 S	1	56°19.04'	152°46.50'	178	No recovery
106 D	2	56°29.60'	152°43.70'	60/1	Silt, very small recovery olive-grey color
107 D	1	56°30.15'	152°44.10'	56/30	Siltstone, dark-grey
108 D	2	56°30.30'	152°44.90'	56/25	Siltstone, dark-grey
109 D	2	56°30.80'	152°46.20'	58	No recovery
110 D	1	56°31.40'	152°46.70'	64/47	Silt, medium dark-grey
111 D	1	56°31.70'	152°47.50'	65/48	Sandy silt, olive-grey
112 D	2	56°32.00'	152°48.20'	70/22	Shell hash, pale-olive color forams cs/ms/fs/vfs=2-11-85-2; s/sl/ c/shells=18-1-1-80
113 S	1	56°33.50'	152°27.20'	197	Pebbly s, color 5Y 3/2; shards; p/g/s/sl/c/shells=5-3-89-2-tr-tr
114 S	1	56°37.60'	152°34.00'	160	Sandy g, g are sub-angular to sub-rounded, forams, p/s/sl/c=40-55-2-
115 S	2	56°57.02'	152°06.28'	80	S, 5Y 4/4, sub-angular to rounded; shards, lithics; s/sl/c/shells= 91-tr-tr-9

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additonal remarks
116 D	2	57°12.00'	151°51.10'	74/39	Sandy siltstone; medium dark grey, some pebbles
117 D	1	57°10.09'	151°50.70'	54/14	Sandy siltstone, dark-grey, with pebbles
118 D	1	57°11.00	151°50.00'	54/20	Sandy siltstone, dark-grey
119 D	1	57°10.60'	151°49.10'	56/40	Coarse s, light olive-grey, shelly and pebbly
120 D	1	57°10.00'	151°48.40'	60/20	Sandy siltstone, dark-grey
121 D	2	57°09.25'	151°47.50'	70	Sandy siltstone, dark-grey
122 D	2	57°09.00'	151°46.90'	74	No recovery
123 D	2	57°08.75'	151°46.30'	76/34	Sandy siltstone, dark-grey
124 D	1	57°08.50'	151°45.60'	78/20	Fs, medium dark-grey
125 D	1	57°08.00'	151°45.00'	80/20	Fs ash, with dark sandy silt; well sorted s/sl/c=90-10-tr
126 D	2	57°07.40'	151°44.10'	80	No recovery
127 S	1	57°11.24'	151°29.59'	69	Pebbly s, shards, lithics-sub-angular to sub-rounded, vcs/cs/ms/fs/vfs=5-10-35-45-10 p/s/sl-c/shells=15-67-tr-28
128 S	1	58°31.47'	149°21.90'	121	Muddy s, with pebbles; shells and forams, shards, p/s/sl/c/shells=2-30-4-2-62
129 S	1	58°35.85'	149°14.91'	95	Pebbly s; shards, lithics sub-rounded to rounded. p/s/sl-c/shells=70-8-tr-22
130 S	1	58°42.23	149°03.38	145	S 98%, well sorted, sub-angular, few shards; cs/ms/fs/vfs=1-2-90-7, some c.
131 S	1	58°44.99'	148°58.18'	214	Silty s, sub-angular, lithics; shards; cs/ms/fs/vfs=1-4-85-10; p/s/sl/c/shells=3-76-15-5-1
132 S	1	58°49.24'	148°54.71'	236	Pebbly-silty s; shards sub-angular to sub-rounded; cs/ms/fs/vfs=5-25-65-5; p/s/sl/c/shells=10-80-44-2
133 G	1	58°54.41'	149°01.95	250/95	Sandy c, vfs; grey-green mud; s/sl/c=10-10-80
134 S	1	58°49.39'	149°14.22'	206	Pebbly s, boulders meta conglomeate and quartzite ss, mud green; p/s/sl/c/shells=11-73-6-8-2
135 S	1	58°40.39'	149°31.82'	136	S 93%; well sorted fs; sub-angular to sub-rounded; forams; s/sl/c/shells=93-2-4-1
136 S	1	58°34.90'	149°45.19'	125	S 97%, fs slightly green in color; coarser s towards bottom; sub-rounded; s/sl/c/shells=97-2-1-tr
137 S	1	58°29.46'	150°05.25'	93	Pebbly s; abundant forams; shards-bimodal sorting (due to washing?) sf; p/s/sl/c/shells=30-49-81-12

Table 4. cont.

Sample No.	No. of attempts	Latitude	Longitude	Water Depth m/Core length cm	Lithology, color and additional remarks
138 S	1	58°22.07'	150°24.07'	60	Sandy g; shell hash on top; g/s/sl/c=70-29-1-tr; shell hash removed
139 S	2	58°15.96'	150°15.30'	54	Shell incrustment on foot of one large sponge-no sample analyzed
140 S	1	58°22.20'	149°54.26'	83	Sandy pebbles; rounded to sub-rounded; p/s/sl/c/shells=70-8-tr-tr-22
141 S	1	58°13.12'	149°11.85'	120	Pebbly s w/forams abundant; well rounded pebble; shards; p/s/sl/c shells=20-13-2-tr-65
142 D	2	58°08.70'	149°04.70'	114/0	Smear recovery; pipe well dented; only noted a foram bearing c
143 D	1	58°08.00'	149°03.80'	104/0	Smear recovery; sandy silt; only enough to make smear slide; olive grey
144 D	1	58°05.92'	149°01.44'	88/23	Conglomerate; Top-olive grey foram bearing silty cs; Base-dark grey sandy siltstone; p/s/sl/c/shells=44-37-2-7-10
145 D	1	58°06.59'	149°02.46'	90/10	Coarse s dark-grey to olive-grey; pebbly w/forams; g/s/sl/c/shells= 15-54-4-2-25
146 D	1	58°05.99'	149°01.25'	88	No recovery
147 D	2	58°05.60'	148°01.00'	88/12	Silty s; dark to olive grey; abundant pebbles; forams; fine sands; p/s/sl/c/shelss=57-37-1-tr-5
148 D	1	58°04.96'	148°59.95	90/8	Sandy pebbles; dark to olive grey; siltstone; forams; shards; lithics; p/s/sl/c/shells=51-21-tr-tr-28
149 D	2	58°04.60'	148°59.50'	98/0	Sandy silt; enough for smear only. dark grey
150 S	1	59°04.55'	152°49.50'	147	Muddy s 98%; well sorted fs; sub-angular forams; s/sl/c/shells= 98-1-tr-1
151 S	1	59°11.90'	152°09.50'	112	No recovery
152 S	1	59°37.21	152°29.08'	70	S 99%; medium s well sorted; w/pebbles and shells=1% sub-angular; lithics rounded; vcs/cs/ms/fs/vf=tr-8-92-tr-tr
153 S	2	59°10.70'	152°31.55'	99	S 99% w/forams; well sorted fs; sub-angular to angular; s/sl-c/shells= 99-tr-tr-1
154 S	1	59°09.25'	153°05.63'	75	Muddy s 98%; fs, well sorted; sub-angular to sub-rounded; shards; s/sl/c/shells=98-tr-1