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MARINE GEOLOGY, EASTERN PART OF PRINCE GUSTAF ADOLF SEA, DISTRICT OF FRANKLIN

(POLAR CONTINENTAL SHELF PROJECT)

(Report and 3 Figures)

J. L. Marlowe and G. Vilks

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Polar Continental Shelf Project

By

J.I. Marlowe and G. Vilks

DEPARTMENT OF

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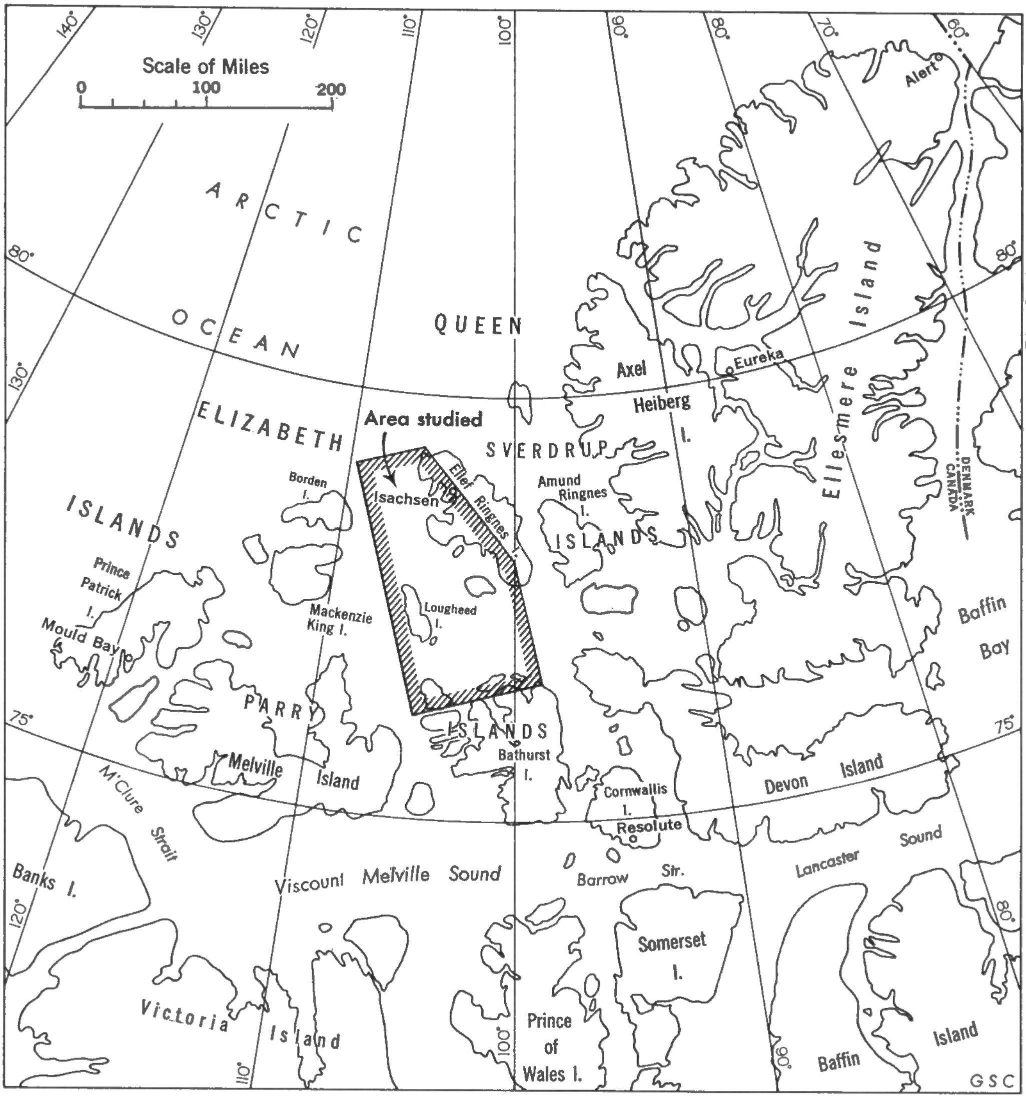

Figure 1. Index map

MARINE GEOLOGY, EASTERN PART OF PRINCE GUSTAF ADOLF SEA, DISTRICT OF FRANKLIN

Polar Continental Shelf Project

INTRODUCTION

This preliminary report is based on field observation and a partial compilation of data from the marine geology program carried out during the summer of 1962 in Prince Gustaf Adolf Sea and adjacent channels. The study is part of a regional project initiated in 1960[1] in conjunction with the Polar Continental Shelf Project (Pelletier, 1962)[2]. The area of investigation (Figure 1) includes the east half of Prince Gustaf Adolf Sea, Maclean Strait, Desbarats Strait, and the sea between Ellef Ringnes and Bathurst Islands, all in the District of Franklin.

The purpose of the study was to provide data that will lead to an understanding of the sedimentary environment and to the reconstruction of the recent physiographic history of the area. To do this, sediment samples were collected from the sea bottom in the inter-island channels, from selected areas in the near-shore zone, and from the beds of streams discharging into the areas of potential interest.

In the inshore phase of the program, traverses were made in a seaward direction from the shoreline (located by means of the tide crack in the ice). On large delta fronts, three radiating traverses were laid out to investigate longshore, as well as seaward variations in bottom sediment. To provide greatest sample coverage in the area of maximum expected sediment variation, samples were collected at logarithmically spaced intervals extending to a maximum distance of 2 miles from shore. Access holes were cut in the ice with a power auger and a snapper sampler was lowered and raised by means of a hand winch and tripod. A total of forty-nine samples was collected during the inshore phase of the program, covering the area from Hospital Bay to Noice Peninsula.

Coring operations in Prince Gustaf Adolf Sea and adjacent seas were carried out by a two-man party using a light coring rig and a Sikorsky S-55 helicopter. Traverses were made from Ellef Ringnes Island to the midline of Prince Gustaf Adolf Sea, and to Bathurst, Lougheed and Cameron Islands (Figure 2). Samples were taken by means of a gravity corer with a 6-foot core barrel. The maximum length of core obtained was about 3 feet, although the corer commonly

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[1] Pelletier, B.R., 1960, Geological Survey of Canada, unpublished data.

[2] Names and/or dates in parentheses refer to publications listed in the Selected Bibliography.

penetrated the bottom with its full length. Compaction of sediment in the nose of the corer apparently prevented better recovery.

In the final stage of the program, sixteen streams that empty into the marine areas covered by the inshore and offshore phases of the program were selected for their apparent large volume of sediment delivery. The beds of these streams were sampled from head to mouth and samples of outcrop were collected wherever significant lithologic changes occurred. During this part of the program, transportation was provided by a Bell helicopter and positions were located with the aid of aerial photographs.

Collection of samples in the near-shore zone was carried out by Vilks, who is responsible for the identification and analysis of microfauna in this paper. Sea-bottom cores and stream-bed samples were collected by Marlowe, who is responsible for the physiographic and sedimentological interpretations.

Logistical support for the program was furnished by E.F. Roots, Coordinator, and the late F.P. DuVernet, Field Supervisor, of the Polar Continental Shelf Project, based at Isachsen, Ellef Ringnes Island. I. Zemmels assisted in the offshore phase of the work. R. Blais, P. Hayes, and D. Routcliffe were attached to the party at various times. R.M. Eaton of the Canadian Hydrographic Service supplied many of the bottom soundings of the area. Thanks are also due to helicopter pilots J. Blake, J.L. Gadet, and P. Hort.

PHYSICAL ENVIRONMENT

The physical environment of the area is affected strongly by a low average temperature, which causes the sea and the soil cover on the land to remain frozen during most of the year. Oceanic currents and the action of wind influence sedimentation to a lesser degree.

Surface stream-flow reaches a peak during the spring thaw and is thereafter very sluggish or non-existent. Many of the streams which flow over sandy beds move only by underflow, and pore-pressure conditions approaching quicksand occur in several places. The energies of streams in the area are highly variable, as are those of ephemeral desert streams elsewhere. Textures of sediments in stream beds during late summer, when sampling is most practical, represent hydraulic conditions in a waning stage of flow. On Lougheed and western King Christian Islands solifluction is locally the dominant mass-wasting process; in late August, many earth flows were seen to have moved downslope as a result of thawing of the upper foot or two of mantle. These flows invariably moved over a sole of permafrost. Flows 100 feet wide and 100 to 200 feet long were common on Lougheed Island, and many of them dammed off streams, further complicating the seasonal-cyclic nature of the stream regimen.

The effect of beach-shaping agents varies greatly with the season, being greatest during periods of onshore winds when shore ice is pushed onto beaches by pressure from the pack. During times of open water, pressure blocks and other grounded ice protect part of the shoreline from wave and current action. Only during early August were there areas of open water along the coast large enough for the formation of breakers. During that period, waves about a foot high were seen breaking on the southwest shore of Ellef Ringnes Island, after 2 days of strong winds which blew over fetches of 10 to 20 miles of open water; sorting of beach materials by wave and longshore current action is therefore limited to a short period of the summer. Tidal currents are probably of little significance as erosive or transportive agents, except in large bays with restricted inlets, since mean tides, as measured at Isachsen, have a range of only 1 foot.

Wind is effective as a sorting agent on sandy beaches and may be a major factor in the transportation of fine material. Dry, loose soil is removed, often in large quantities, from the land by wind action (Heywood, 1957). Thin deposits of silt were observed in snow on the sea ice several miles west of Ellef Ringnes Island.

Prince Gustaf Adolf Sea and its adjacent coastlines are icebound during most of the year. Leads opened along the shorelines in mid-June 1962, and cracks and leads had begun to develop in the sea ice by the last week of June. During the first half of August the sea from Noice Peninsula south to Lougheed Island was open, and only drift ice was observed in that area. Ice thicknesses measured in boreholes in young ice averaged about 8 feet during May and June.

Currents in Prince Gustaf Adolf Sea are as yet imperfectly known. There is a general southward set of a slow surface current; on August 14, drift ice was observed to move through Danish Strait at a rate of 20 feet per minute in a calm.

COASTAL TOPOGRAPHY

Where sedimentary and volcanic rocks lie closely adjacent to the coast, shore features appear to be directly related to the topographic expression of these rocks. Along the northwest coast of Ellef Ringnes Island there are rounded embayments which are the heads of submarine valleys. The peninsulas and headlands in the vicinity of Deer and Station Bays are underlain by diabase bodies of various forms, some of which are divides between now-submerged valleys. Beaches on these rocks are narrow and consist mainly of talus piles, slightly modified by the action of shore ice.

The north end of Ellef Ringnes Island is covered by a deposit of unconsolidated, quartzose sand. Those parts of the north coast exposed to direct pressure from the ice of the polar pack are characterized by straight shorelines and offshore shoals. The linearity of the coast adjacent to Cape Isachsen, at the northern tip of the island, is broken only by the cape itself (Figure 2), which is a peninsula of moderate relief and which probably represents an ancient drainage divide. Deltas in the area coalesce and appear to be advancing on a broad front, probably as a result of blockage of the shore by pack ice during most of the year. Irregularly elongated sand ridges lie from 1/2 to 3/4 mile offshore, and range from a few feet to 500 yards in exposed width. These offshore barriers occur only on unprotected stretches of coast and are therefore probably caused by the great compressional force exerted on the shoreface by the pack.

From Noice Peninsula south, the west coast of Ellef Ringnes Island has numerous well-exposed arcuate deltas. Although ice-pushed ridges 2 to 6 feet high are common along the sandy beaches of this area, the deltas have not been grossly deformed by ice action. Along the south shore of Noice Peninsula and at the south end of the island there are cuspate shore features of undetermined origin. Cross-cutting relationships among beach ridges on some of the features show that they were present during higher stands of sea-level. In view of the close proximity of some of the features to stream mouths, it appears probable that they are raised and abandoned deltas. Others, however, resemble accretionary forms associated with longshore currents. Stream patterns in these areas show that a relatively recent lowering of sea-level has occurred. Raised beach ridges are arranged in arcs, concave side seaward, between the larger streams of this coast, a pattern which shows that the streams existed at the time of formation of the ridges. Numerous short, parallel streams of uniform length lie between the larger streams and flow discordantly across the beach-ridge patterns, indicating the development of a seaward drainage gradient after deposition of the ridges.

SUBMARINE TOPOGRAPHY

The topography of the floor of Prince Gustaf Adolf Sea and vicinity is characterized by elongate deep areas separated by an irregular bottom of moderate depth. Prince Gustaf Adolf Sea deepens steadily northward, toward the Arctic Ocean (Figure 2).

From Hospital Bay to Maclean Strait, the eastern third of the floor of Prince Gustaf Adolf Sea has the form of an elongate valley (Figure 2). The valley heads a few miles north of King Christian Island and lies close in to the coast of Ellef Ringnes Island. Its east side is comparatively steep and has a relief averaging 500 metres relative to the coast, while the west side lies against a low ridge and plateau with a local relief of about 100 metres. The longitudinal profile of the valley is undulating and the transverse profile is U-shaped. A small basin near its head has depths of more than 600 metres. This major valley has several morphological features similar to those in Hassel Sound, considered by Horn (in press) to be drowned subaerial stream valleys modified by glaciation. Tributary valleys head up in the arms of Deer Bay.

Extending north-northwestward from the tip of Lougheed Island is a plateau of low relief which culminates in a broad ridge at its northern end. This ridge forms a low divide between the mouth of the valley described above and deeper areas to the west. Depths over the plateau and ridge range from 300 metres a few miles off Lougheed Island to about 450 metres at the north end of the ridge. The gradient is fairly uniform and contours run roughly parallel to the north coast of Lougheed Island.

South of Ellef Ringnes Island is a broad shoal area which steepens southward to a linear deep along the north coast of Bathurst Island. Desbarats Strait, south of Lougheed Island, is shallow but deepens to the southeast toward the mouth of a large inlet between Cameron and Bathurst Islands.

Fortier and Morley (1956) postulated regional drowning of a dendritic drainage system to account for the coastal configurations and the geologic continuity of the Arctic Islands. Pelletier (1962) presented evidence that a relative rise in sea-level of approximately 400 metres has taken place. The valley trending along the west coast of Ellef Ringnes Island exhibits steep-walled, U-shaped transverse profiles and an undulating longitudinal profile. Such profiles are typical of glacially-scoured valleys and it appears that the Gustaf Adolf valley may owe its present form to glaciation. The tributary valleys in Deer Bay, as pointed out by Pelletier (1962), also may be drowned glacial valleys. The natural direction of drainage of this valley is northward, to the Arctic Ocean.

The topography of the sea floor south of Ellef Ringnes Island and east of Lougheed Island is somewhat more complex. A moderately deep, linear feature just north of the islands off the north coast of Bathurst Island may be a glacially-scoured trough. Another deep area lies off the northeast coast of Cameron Island. Fortier and Morley (1956) presented strong evidence for a Pleistocene drainage divide a short distance south of the area covered in Figure 2. Consequently the drainage from valleys off the north coast of Bathurst Island would probably have been northwestward. However, there is no clear continuity of the linear deep features off Bathurst Island with the valley west of Ellef Ringnes or with deep areas shown by soundings west of Desbarats Strait (Figure 2). Therefore, if the features owe their shape to glacial scour, it appears that the bottom configuration of Maclean or Desbarats Strait has been modified since drowning.

Pelletier (1962) pointed out a sharp break in slope at 400 metres on the submarine ridge north of Ellef Ringnes Island, and inferred that the ridge is a drowned headland. A similar break occurs off the north end of Lougheed Island at about 330 metres. If these breaks represent a long stand of an ancient sea-level, it appears that there has been at least 70 metres of differential vertical movement between the north capes of Ellef Ringnes and Lougheed Islands, a distance of approximately 100 miles. Depth contours around King Christian Island and the south end of Ellef Ringnes Island exhibit breaks in slope at about the same depth as that of Lougheed Island. It is noteworthy that the depth contours seaward of the break in slope off the north end of Ellef Ringnes Island continue to reflect the shape of the presumed drowned headland to a depth 150 metres greater than that of the break, and that a similar pattern occurs off Lougheed Island.

Inshore sampling traverses with closely-spaced soundings show that, off the mouths of streams, the shore profile is concave and steepest in its inner part. Off coasts where there is slight or no delivery of stream sediment, profiles are steep and drop off sharply from the beach. Where stream deltas are present, they do not extend below sea-level. Detailed traverses across the front of a large delta at the head of Deer Bay (Figure 3, traverses 6, 7 and 8) show that sediment delivered from the source streams has not formed a submarine fan deposit but rather a deposit with a V-shaped transverse profile. This profile is interpreted as reflecting the influence of a partly buried bedrock valley which is being filled from its head by the prograding bayhead delta.

SEDIMENTS

Sedimentary environments in the inshore study area (Figure 3), can be classified broadly as deltaic and non-deltaic. Deltaic environments are found off the mouths of present streams and are characterized by a noticeable decrease in grain size and sorting with distance from shore. In non-deltaic environments the sediment contribution of terrestrial streams is slight and no regular variation in sediment texture was noted. Most of the streams of the area deliver sand-sized detritus to the sea. Bottom sediment off stream mouths therefore contains noticeable amounts of sand, while in non-deltaic areas smaller grain sizes predominate and mask the sand fraction.

Bottom sediments in Prince Gustaf Adolf Sea and in the sea between Ellef Ringnes and Bathurst Islands are mud, sand, and mixtures of mud and sand (Figure 2; Appendix). Small quantities of granules and fine pebbles are scattered as isolated grains throughout the finer materials. Compositions of those grain-size classes which are distinguishable under a 25X binocular microscope are predominantly quartz, with reddish and black rock fragments, accessory heavy minerals and carbonaceous fragments, and rare calcareous shell fragments. Pebbles and granules are of a wide lithologic range. Textures are generally high in mud-matrix content; dominantly sandy textures were found in few cores. Sediment colours are yellowish brown to dark grey. In Prince Gustaf Adolf Sea a yellowish brown layer of varying thickness was found to overlie a grey layer. Bedding, where recognized, is very thin to laminated, flat, and undisturbed. Cyclical laminations of light- and dark-coloured layers are evident in some cores. Pebbles and granules occur as isolated grains with erratic distribution, and probably are results of ice-raft transportation.

The widespread occurrence of a yellowish brown surface layer over a grey deeper layer in Prince Gustaf Adolf Sea is considered to be indicative of a major change in sedimentary conditions. Generally, the colour transition occurs in a zone 2 to 3 centimetres thick, of interlaminated yellowish brown and grey sediment; in many cores, however, the contact between the two layers is very sharp. Horn (in press) found similar features in the sediments of Peary Channel and Hassel Sound, east of Ellef Ringnes Island. There is no clear-cut relation between sediment texture and colour, but in no sample examined were foraminiferal tests observed below the upper, yellowish brown, layer.

Sand in more than trace amounts is found near the north end of Lougheed Island and along the east flank of the mid-channel ridge. Grain sizes in this area range from very fine to very coarse. Minor amounts of fine sand are found north of Reindeer Cape. In the lower, grey layer, coarse sand occurs off the north end of Lougheed Island and fine sand is found in three cores from the valley off Noice Peninsula. Two cores from northwest of Reindeer Cape contain 35 to 60 per cent sand in the grey layer; the higher sand content is found near the coast and is well-sorted, medium-grained sand.

South and east of Maclean Strait, the conspicuous layering found on the floor of Prince Gustaf Adolf Sea is absent and the general aspect of the bottom sediment differs from that in the latter area. On the broad rise between Ellef Ringnes and Bathurst Islands, surface textures are sandy. The greatest sand percentages (65-100) were found in cores from the highest part of the rise. There is a general decrease in sand content away from the crest. Only two cores from the rise contain sand at depth. A relation exists between grain size and depth of water over the rise; cores from the crest of the rise have the largest observed average grain size of sand, while there is a decrease in size in directions away from the crest. The occurrence of abundant and relatively coarse sand on this shoal feature, together with an increase of mud content with depth below the sediment surface, suggests that winnowing of the upper few centimetres of sediment has taken place. Sediment colours in the area south and east of Maclean Strait are yellowish brown to very light grey.

In Prince Gustaf Adolf Sea, sandy sediment distribution is heaviest in those areas that would be exposed to shoal-water processes if sea-level were lowered 300 to 400 metres, and is possibly relict from a time when subaerial headlands extended farther seaward than they do at present. The sandy bottom southeast of Maclean Strait may be in part a drowned island, although its geomorphology suggests that some accretion has taken place.

The widespread and erratic distribution of pebbles in the finer bottom sediment is attributed to ice-rafting, probably from distant sources. Such fragments are common on the sea ice; a large pile of rock debris was observed on sea ice approximately 25 miles from land.

DISCUSSION OF FAUNA FROM INSHORE WATERS

The following discussion deals with the results of a preliminary study of the microfauna found in samples of sediment from the inshore waters of Prince Gustaf Adolf Sea (Figures 1 and 3). Most of the fauna consists of foraminifera and the discussion is restricted to this group of organisms. A small number of ostracods, a few sponge spicules and fragments of echinoderms and pelecypods were also found (Table II). Fauna in these waters is sparse both in numbers and variety, in comparison with other areas of the Arctic described by Carsola (1952), Loeblich and Tappan (1953), Green (1959) and Wagner (1962). The environment is unique with respect to temperature and the amount of light available, as the water is covered with ice practically all year. According to Collin (1961) and Green (1959), waters of the Arctic Ocean are very cold close to the surface, with temperatures between -2°C and -1°C within the first 200 metres. The cold zone of the Arctic water prevails also in the inshore waters of Prince Gustaf Adolf Sea, according to Pelletier (personal communication) who took temperature readings in Deer Bay in 1960. Such conditions are reflected in the faunal assemblages in that mostly arenaceous benthonic foraminifera were found, calcareous forms being extremely rare. The depth range of the stations (4-130 metres) is well within the cold zone, therefore constant temperature can be assumed to exist at the bottom represented by the samples. The results of the data do not indicate any marked bathymetric or lithological zonation of the foraminifera. The composite fauna is merely indicative of a cold environment. Reports on foraminifera from the inshore waters of the Arctic are relatively few. Loeblich and Tappan (1953) have made an intensive study of fauna off Point Barrow, Alaska, where bottom sediments were dredged from stations close to the shore to a distance of 12 miles from it. Fifteen of the twenty-one samples came from depths less than 100 metres and only one came from a depth greater than 200 metres. Bottom temperatures vary between -1.8°C and +2.9°C throughout the year within the Barrow area, according to the authors. Loeblich and Tappan also discussed changing conditions on beaches and bottom environments due to transport of sediments during storms, a phenomenon not noticed at Ellef Ringnes Island. Carsola (1952) reported on foraminifera from localities at Point Barrow, Chukchee and Beaufort Seas; 21 of his 63 stations have depths less than 130 metres. In eight samples from the Eastern Beaufort Sea arenaceous benthonic foraminifera predominate over calcareous benthonic forms, a relationship found in the present study. Carsola suggested that a combination of low salinity, high carbon-dioxide content and low temperature may increase the solubility of calcium carbonate and thus prevent the formation of calcareous tests. Green (1959) reported on foraminifera found in the area covered by Fletcher's Ice Island (T-3), which at one time moved fairly close to the Canadian Arctic Archipelago (about 300 miles to the northeast from the area covered in this report). The depth range was between 433 and 2,760 metres. Owing to the large range of depth, he found it possible to establish a depth zonation of the Arctic foraminifera. Wagner (1962) studied fauna obtained from samples collected on traverses crossing Prince Gustaf Adolf Sea, Peary and Sverdrup Channels at the inner margin of the Arctic Continental Shelf, and on a traverse running for about 120 miles northwest over the Continental Shelf. The study, although preliminary, is in accord with Green's foraminifera zones based on the dominance of a particular species within each zone. Stschedrina (1958) has summarized studies of bathymetric distribution of species in the inshore waters of the Arctic and northwest Pacific Oceans adjacent to the U.S.S.R. She defined "cold water forms" occurring at depths less than 200 metres. Three major species of the present study, Spiroplectammina biformis (Parker and Jones), Alveolophragmium crassimargo (Norman), and Reophax curtus Cushman are also common in the shallow cold waters of the Russian Arctic and are included by Stschedrina in the cold-water faunal assemblages.

Abundance of Foraminifera

The thirty-three samples examined yielded 5,812 foraminiferal tests and only three samples were barren. The abundance of foraminifera (calculated on weight of a 100-gram sample) vary from 5 tests to a maximum of 1,530 tests per 100 grams. The mean abundance is 446 tests per 100 grams of sample.

With a few exceptions foraminifera were found to be more abundant in muddy sediments, and with one exception, samples with less than 20 per cent mud did not have any fauna. (Mud is defined here as sediment that washes through a 250-mesh sieve.) Since sediments close to the shore of a deltaic environment contain very little mud, this type of environment usually does not contain any fauna. The relative reduction of foraminiferal population in deltaic environment may be due to one or several of the following factors: (1) benthonic arenaceous foraminifera may require fine bottom sediments for prolific growth; (2) the bottom materials (sediments, fauna, etc.) of the delta close to the shore are diluted with inorganic detritus as a result of increased rate of sedimentation during the summer months; and (3) the inflowing fresh water during the melting season may change the environment close to the shores to such an extent that it may become inhabitable for organisms sensitive to changes in salinity of the water.

Table I. Relative Percentages of Foraminifera

(Actual number of species in parentheses if less than 1 test per 10 grams of sample present.
List of species arranged in column according to depth of occurrences. See Figure 3 for approximate location of stations.)

Station Number	48	17	5	49	13	40	18	70	41	57	51	32	14	25	26	24	6	27	72	15	43	34	7	73	58	16	46	36	8	38	28	20	59
Depth (metres)	4.5	5	5.5	8.5	14.6	14.6	15	15	21.8	24	25	25	25	27.5	28.5	30	30	32.5	35	44.5	44.8	45.0	46.0	50.0	53.8	57.0	63.0	75.5	89.0	90.0	94.5	118.0	125.0
Distance from Shore (feet)	50	50	50	200	50	100	200	100	200	50	1600	200	200	800	1600	400	290	3200	400	800	800	800	800	800	200	1600	6400	3200	3200	2mi.	6400	1600	800
Total Number of Foraminifera	350	11	14	33	509	2	61	4		318	22	27	331	125	8	234	170	185		562	7	199	250		405	195	322	15	333	362	610	30	118
Spiroplectammina biformis (Parker and Jones)	83.1	(2)	71		65.2		44.3	(2)		12.9		33.3	42.3	73.6		57.7	18.6	(5)		4.6	100	54.3	17.6		(2)		(3)	40.0	(3)	6.4	5.4		
Trochammina nana Brady	2.9	(1)		(3)	4.3		(2)			57.5	(1)		18.7		(2)	(1)	25.0	33		62.8			42.4		7.5	(6)	18.7	(1)	7.8	51.1	41.0	(3)	10.3
Reophax atlantica (Cushman)	(3)				(1)					5.3			(2)							3			(4)		(1)						(1)		
Textularia earlandi Parker	6.0	45.5			10.2		19.7			3.8		25.9	16.3	8		17.1	18.6	10.3		6.9		18.6	6.4		(3)		4.7	(1)	(1)	6.9	1.5		
Textulariidae indet.	6.3				14.9		31.1	(2)		1.3		(3)	14		(1)	22.6	1.3	(1)		(4)		18.6	3.6					20.0		2.8	2.8		
Saccammina sphaerica Sars	(1)										18.2							5.3							18.7	26.6	3.4		7.2			(5)	34.5
Alveolophragmium jeffreysi (Williamson)	(1)												(1)		(1)					1.2					(1)	(1)			(1)	(2)	(3)		(2)
Reophax gracilis Kiaener	(1)				(1)							(3)		4.0		(5)						3.0											
Reophax sp.		(2)	29																														
Cassidulina teretis Tappan		(1)		(1)																													
Alveolophragmium crassimargo (Norman)				(1)	(4)					6.6	63.6				(3)		7.5	32.4		4.4		(1)			27.4	19	12.7	(1)		2.8	1.6	26.7	30.2
Reophax curtus Cushman				(2)	(1)					3.1							(1)			(1)					7.7	5.6	(1)		1.8				6.0
Silicosigmoilina groenlandica (Cushman)				(1)						(2)			(2)				1.9	(1)		(2)			(1)				(2)	(1)					
Elphidium orbiculare (Brady)				27.3	(1)		(1)																										
Cassidulina nocrossi Cushman				(4)																											(1)		
Elphidium cf. E. clavatum Cushman				(2)																													
Cassidulina islandica Nørvang				(4)																											(2)		
Reophax fusiformis (Williamson)				(1)						1.9																							
Hyperammina sp.					(5)	(2)					(1)												(3)										
Ammodiscus catinus Höglund					(1)																												

?Glomospira gordialis (Jones and Parker)					(1)								(1)							(1)													
Recurvoides turbinatus (Brady)										2.5			(1)		(1)		14.4	3.8		3.4			(6)		(1)		(4)			6.9	33.1		(2)
Textularia ?cf. T. torquata Parker										(3)							(1)																
Reophax nodulosa Brady										(2)	(1)		(1)					(2)		3			(1)		21.4	23.6	11.5		1.8	9.7		(3)	4.3
Trochamminella bullata Höglund										1.3								3.8		(4)					1.0		(3)				(2)		(3)
Astrorhiza arenaria Norman										1.6															5.0								
Bathysiphon filiformis Sars											(1)	18.5						(1)							1.0		3.1			7.7	11.1		(1)
?Recurvoides sp.													(1)							(1)													
?Elphidium sp.													(1)																				
Pelosina variabilis Brady													(1)																				
?Hyperammina sp.													(1)	3.2				(1)		(4)						(4)	(1)						
?Hyperammina friabilis Brady														9.6						(4)		4.0			8.0	12.8				1.1			
Globigerina sp.														(1)																			
Trochammina advena Cushman																	5.6						(3)										
Ammodiscus gullmarensis Höglund																	1.9						(1)							(1)	(1)		
Trochammina nitida Brady																	3.8	3.8		1.8			11.6				(3)	(1)	2.1	2.5	1.1		
Trochamminella atlantica Parker																		(1)		1.4									(1)				
Pyrgo williamsoni (Silvestri)																		(1)															
Saccammina ? cf. S. sphaerica Sars																				(1)			(1)										
?Hyperammina elongata Brady																				1.2								3.0				26.0	
Adercotryma glomeratum (Brady)																				(1)													
Trochammina conica Earland																				1.4										1.6			
?Hyperammina laevigata Wright																				(2)						(1)							
?Thurammina albicans Brady																						(1)										(1)	
?Rhizammina sp.																							(1)										
Trochammina sp. A																							(6)										
Rhizammina algaeformis Brady																											46.6		72.1				7.8
?Alveolophragmium crassimargo (Norman)																													1.5				
?Bathysiphon sp.																													(1)				
?Bulimina sp.																															(1)		
Bucella frigida (Cushman)																															(1)		
Quinqueloculina cf. Q. arctica Cushman																																(1)	
Polymorphida indet																																(1)	

Table II. List of Species other than Foraminifera

Station Number	48	17	5	49	13	40	18	70	71	57	51	32	14	25	26	24	6	27	72	15	43	34	7	73	58	16	46	36	8	38	28	20	59
Porifera																																	
unidentified spicules																																X	
Ostracoda																																	
unidentified Ostracoda	X																										X						
<u>Cyprideis sorbyana</u> Jones	X																																
<u>Cytheridea papillosa</u> (Bosquet)	X																																
<u>Cythere m'chesneyi</u> Brady and Crosskey																					X												
<u>Hemithycere villosa</u> (Sars)										X																							
Echinodermata																																	
ophiuroid fragment																							X										
Pelecypoda																																	
unidentified pelecypod	X																																

A few species show preference for a particular type of sediment: Spiroplectammina biformis (Parker and Jones) occurs in largest numbers in sediments containing 50-60 per cent mud, and Alveolophragmium crassimargo (Norman) is restricted to sediments with more than 80 per cent mud. Trochammina nana (Brady) is abundant in highly muddy sediments (up to 90 per cent) but occurs in largest numbers in sediments with 30-40 per cent mud. Textularia earlandi Parker appears to be tolerant to a wide range of sediments. Reophax nodulosa Brady and Saccammina sphaerica Sars are always found together and appear to prefer sediments with more than 80 per cent mud.

Distribution of Species

Fifty-three species of foraminifera were identified and assigned to twenty-five genera (see Table I). Arenaceous foraminifera far outnumber the calcareous forms by a ratio 5,780 to 32. The calcareous foraminifera are represented by seven genera, but the number of tests present at each occurrence is very small. Only one small test of Globigerina sp. was found, which perhaps was brought in by ice or currents. The following are the most abundant forms, listed in order of abundance:

Spiroplectammina biformis (Parker and Jones)
Trochammina nana (Brady)
Alveolophragmium crassimargo (Norman)
Textularia earlandi Parker
Saccammina sphaerica Sars
Reophax nodulosa Brady
Recurvoides turbinatus (Brady)
? Hyperammina friabilis Brady
Reophax curtus Cushman
Trochammina nitida Brady

Forms commonly occurring but less important are Alveolophragmium jeffreysi (Williamson), Bathysiphon filiformis Sars, Reophax atlantica (Cushman) and Reophax gracilis Kiaener. Two genera, Reophax and Trochammina, are each represented by five species and have thus the greatest species distribution. The remainder of the species (see Table I) occur in small numbers without any apparent association to each other or to the more abundant species.

The distribution of foraminifera from the inshore waters of Prince Gustaf Adolf Sea is compared with faunal distributions in Chukchee and Beaufort Seas (Carsola, 1952), at Point Barrow (Loeblich and Tappan, 1953), areas covered by the T-3 ice island (Green, 1959), and fauna collected on the shelf adjacent to the area of present investigation (Wagner, 1962). Fauna from the first three localities came from depths that overlap the depth range of the present study, and fauna from the last two came from much deeper waters.

There is a marked difference between the deep-water fauna of the Arctic Ocean and the shallow-water fauna of the present study. For example Spiroplectammina biformis (Parker and Jones), Alveolophragmium crassimargo (Norman), Alveolophragmium jeffreysi (Williamson) and Textularia earlandi Parker, occurring along the western shore of Ellef Ringnes Island and listed above, were not reported by Green or Wagner. However, the samples studied by these authors were recovered from localities relatively close to the area of present study; for instance four stations of Wagner's report are located within 40 miles of the northernmost traverses of the inshore waters of Prince Gustaf Adolf Sea. Only ten of the species found here are indicated in Wagner's faunal list. Of the 105 species reported by Green, only four species are found in the area covered by the present study. Faunas from Point Barrow, Chukchee and Beaufort Seas show a less marked difference: of the 74 species reported by Loeblich and Tappan, 14 species are conspecific with the fauna of present study; and of the 53 species reported by Carsola, 15 are common to both areas. At least 17 species recognized in this report do not occur in any of the localities discussed here. Most important of these are Trochammina nitida Brady, Reophax nodulosa Brady, ? Hyperammina friabilis Brady, and Astrorhiza arenaria Norman.

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APPENDIX

Summary Logs of Core Samples

(See Figure 2 for locations.)

Core No.	Depth (Metres)	Description (top to bottom)
1	399	5 cm yellowish brown mud with calcareous foraminifera; 18 cm grey mud.
2	463	6 cm yellowish brown, very fine sandy mud with calcareous foraminifera; 13 cm grey fine sandy mud.
3	477	21 cm yellowish brown mud with calcareous foraminifera, pelecypod valve; 42 cm grey mud.
4	199	8 cm yellowish brown mud; 7 cm yellowish brown, silty, medium sand, calcareous shell debris.
5	394	16 cm yellowish brown mud with abundant shell fragments, pelecypod valves, calcareous foraminifera, spicules, and burrows; 44 cm grey mud.
6	392	16 cm yellowish brown mud with foraminifera and shell debris; 26 cm grey mud.
7	488	10 cm yellowish brown, very fine sandy mud with foraminifera and burrows; 27 cm grey mud.
8	363	20 cm yellowish brown mud; 28 cm grey mud.
9	364	18 cm yellowish brown mud; 20 cm grey mud; 32 cm grey, fine sandy mud.
10	214	23 cm yellowish brown mud; iron-oxide stains at 18 cm; 32 cm grey mud.
11	310	23 cm yellowish brown mud; 70 cm grey mud.

Summary Logs of Core Samples (cont.)

Core No.	Depth (Metres)	Description (top to bottom)
12	374	12 cm yellowish brown mud with calcareous foraminifera; 29 cm grey slightly pebbly fine sandy mud.
13	421	4 cm yellowish brown mud with shell debris and sponge; 4 cm grey mud; 6 cm grey, muddy, fine sand; 8 cm grey mud with granules of brown mudstone.
14	395	14 cm yellowish brown mud; 13 cm grey, fine sandy mud.
15	209	12 cm yellowish brown mud with iron-oxide aggregates, burrows, and calcareous worm tube.
16	354	9 cm yellowish brown mud with calcareous foraminifera; 27 cm grey mud.
17	383	12 cm yellowish brown, fine to coarse sandy mud with pelecypod valves; 52 cm grey mud.
18	498	21 cm brown mud with irregular dark mottling; 48 cm brownish grey to dark grey mud; 1 cm light grey clay; 4 cm dark grey, very fine sandy mud with 3 cm grey-green siltstone pebble.
19	391	17 cm yellowish brown muddy fine sand; lower part of core lost.
20	327	10 cm yellowish brown mud; 20 cm grey mud.
21	355	13 cm tan mud; 33 cm grey mud.
22	440	5 cm tan fine sandy mud with shell debris; 12 cm grey, muddy, very fine to medium sand.
23	512	9 cm greyish brown silt; 16 cm grey silt; 4 cm grey, fine to medium sandy, silt.
24	326	27 cm yellowish brown, silty, very fine to medium sand; 11 cm grey, fine sandy, mud.
25	236	6 cm yellowish brown mud; 5 cm grey mud.

Summary Logs of Core Samples (cont.)

Core No.	Depth (Metres)	Description (top to bottom)
26	332	16 cm yellowish brown mud with shell fragments and foraminifera; 28 cm grey mud.
27	374	5 cm yellowish brown mud with corroded shell fragments; 7 cm light grey mud.
28	206	7 cm light brown, clayey, silt, grading to very fine sand; 3 cm grey, muddy, fine to medium well-imbricated sand.
29	360	8 cm yellowish brown, silty, fine to medium sand; 10 cm grey mud.
30	497	8 cm light brown clayey silt; 4 cm grey, muddy, fine sand with arkosic fine pebbles.
31	572	12 cm yellowish brown mud; 17 cm grey mud.
32	323	14 cm yellowish brown, slightly sandy, mud, with spicules and calcareous foraminifera.
33	281	5 cm yellowish brown mud; 16 cm grey, very fine sandy, silt with small pebbles.
34	362	12 cm yellowish brown mud with calcareous foraminifera; 18 cm grey, fine to medium sandy, mud.
35	120	11 cm grey, silty, very fine sand.
36	225	18 cm grey, very fine sandy, mud with loose pyritic aggregates; yellow-brown iron-oxide stains throughout.
37	250	14 cm yellowish brown mud with calcareous foraminifera.
38	303	7 cm yellowish brown, very fine to medium sandy, mud; 37 cm grey slightly sandy mud.
39	315	14 cm brown, very fine sandy, mud; 28 cm grey mud.

Summary Logs of Core Samples (cont.)

Core No.	Depth (Metres)	Description (top to bottom)
40	316	4 cm greyish brown, very fine sandy, mud; 7 cm grey, muddy, fine to medium sand; 10 cm grey mud.
41	133	15 cm yellowish brown, very fine sandy, mud with sparse iron-oxide grain coatings.
42	332	11 cm yellowish brown, very fine sandy, mud; 31 cm light brown, very fine sandy mud.
43	218	6 cm brown silt; 4 cm yellowish brown and grey mud, interlaminated; 15 cm grey, pebbly, fine sand.
44	248	6 cm yellowish brown mud; 31 cm grey, muddy, fine to coarse sand.
45	306	27 cm brown, fine sandy, mud with iron-oxide mottlings; 16 cm grey, fine sandy, mud.
46	212	32 cm brown mud, with burrows.
47	272	12 cm yellowish brown, fine sandy, mud with calcareous foraminifera; 37 cm yellowish brown mud.
48	348	20 cm yellowish brown mud; 6 cm greyish brown, very fine sandy, mud.
49	162	16 cm yellowish brown, muddy, coarse sand.
50	187	6 cm yellowish brown, muddy, fine sand, graded bedding in upper 2 cm; 23 cm grey very fine sandy mud.
51	153	7 cm yellowish brown, muddy, medium to coarse sand.
52	168	11 cm yellowish brown, very fine sandy, mud; 27 cm greyish tan mud with pods of sand at base.

Summary Logs of Core Samples (cont.)

Core No.	Depth (Metres)	Description (top to bottom)
53	324	32 cm brown to reddish brown mud; 4 cm greyish brown, fine sandy, mud; 4 cm light grey, medium sandy, mud; 5 cm grey, muddy, fine to medium sand with small pebbles.
54	356	12 cm yellowish brown, muddy, very fine sand.
55	469	7 cm yellowish brown, fine sandy, mud with burrows.
56	242	17 cm yellowish brown, muddy, fine sand.
57	196	Yellowish brown, muddy, very fine to medium sand. Snapper sample.
58	382	8 cm yellowish brown, very fine sandy mud with calcareous foraminifera; 28 cm greyish brown mud; 5 cm greyish brown, muddy, very fine sand.

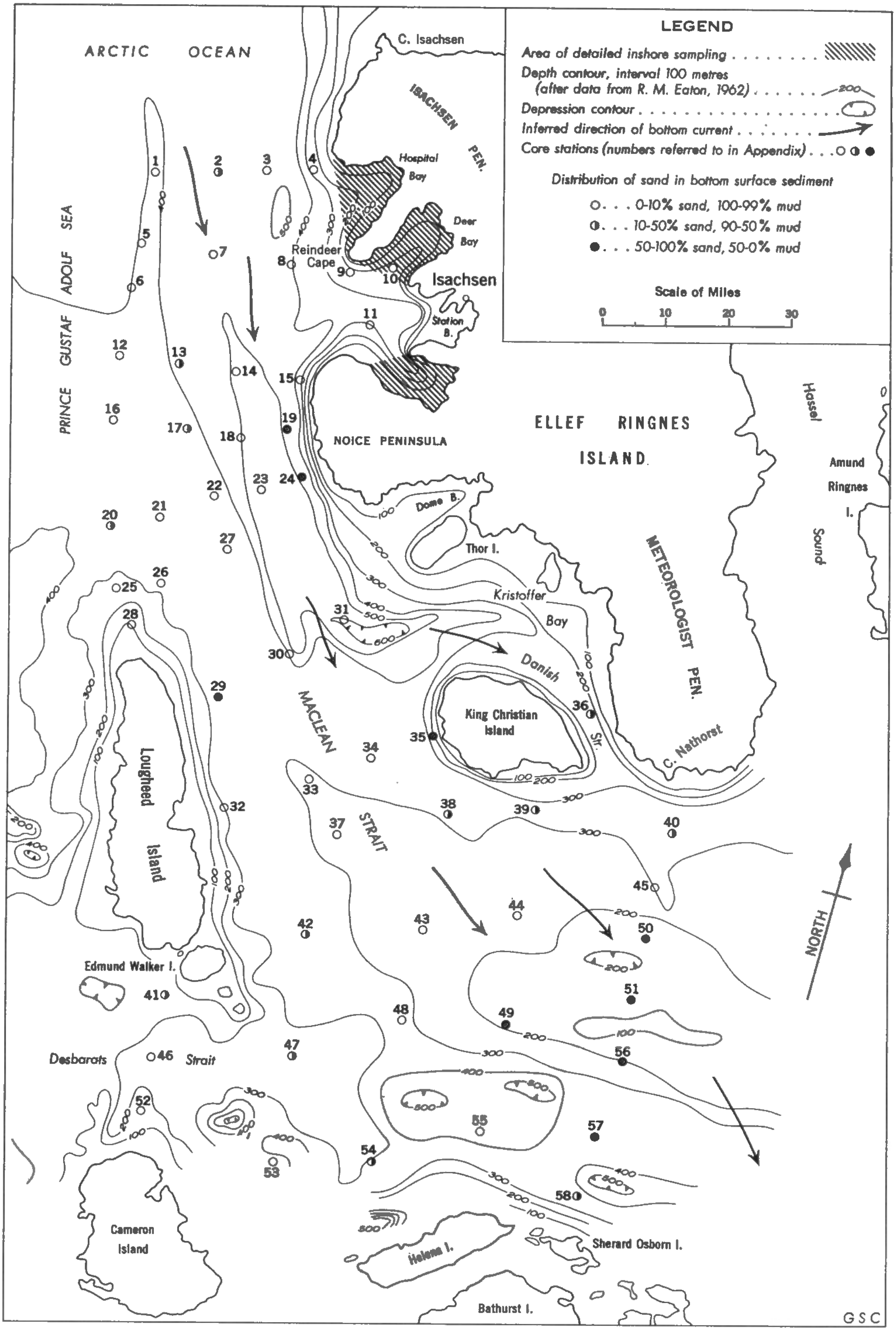
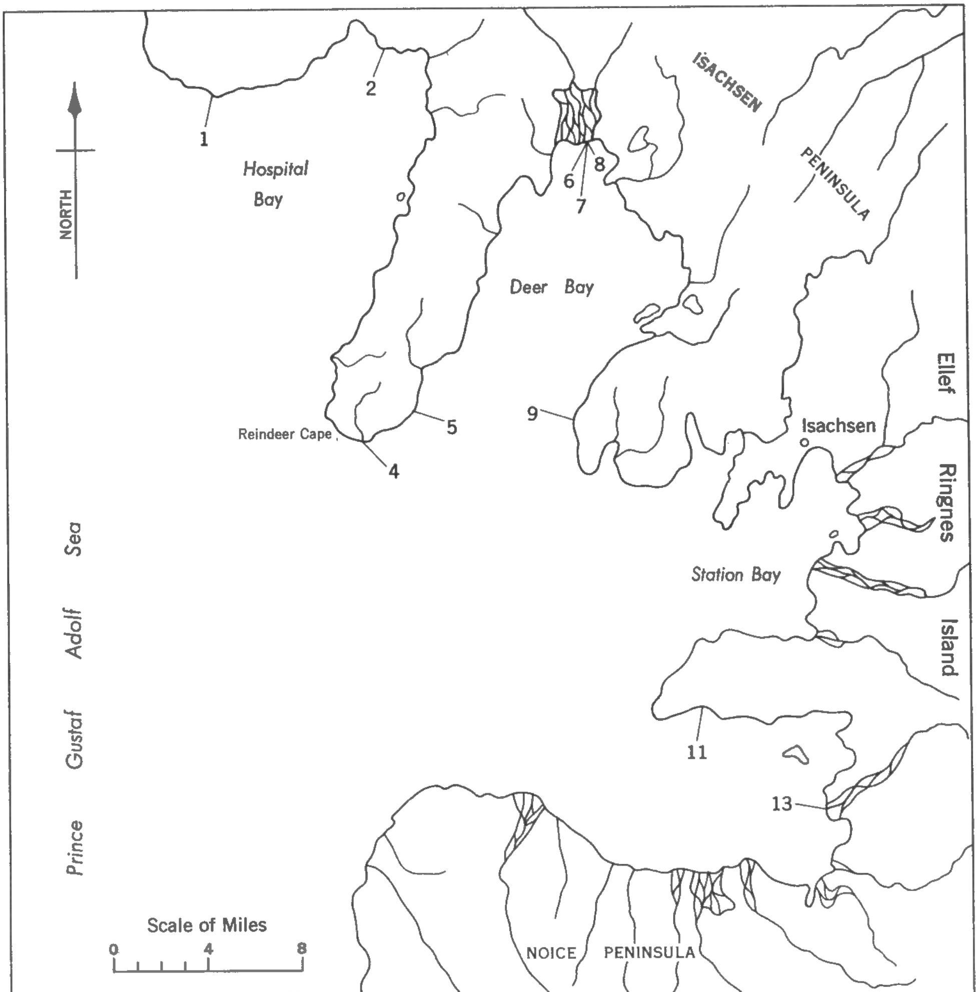


Figure 2. Location of coring stations, generalized bottom topography, and bottom surface sediment texture, Prince Gustaf Adolf Sea and adjacent seas



DISTRIBUTION OF INSHORE STATIONS

TRAVERSE	STATION DISTANCE FROM SHORE (FEET)									
	50	100	200	400	600	800	1,600	3,200	6,400	11,500
1	1		2		3					
2	5		6			7				
4	13		14			15	16	8		
5	17		18			19	20			
6	21	22	23	24		25	26	27	28	
7	30	31	32	33		34	35	36	37	38
8	39	40	41	42		43	44	45	46	
9	48		49			50	51			
11	57		58			59				
13	69	70	71	72		73				

STATIONS

GSC

Figure 3. Location of inshore traverses, Ellef Ringnes Island