CANADA
DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOGRAPHICAL BRANCH
MEMOIR 1

SOUTHAMPTON ISLAND

BY

J. Brian Bird

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1953

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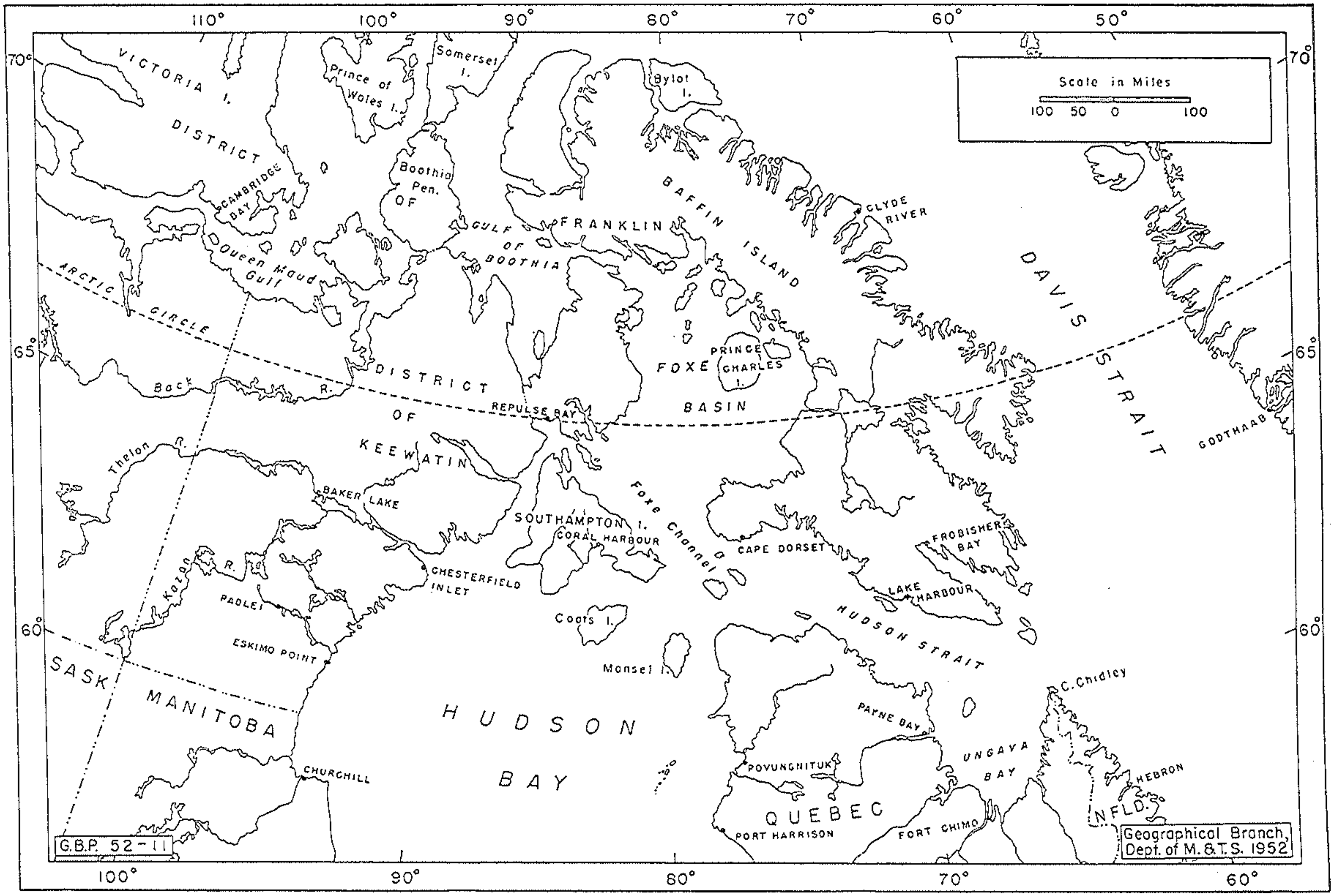

Figure 1. General map of Eastern Canadian Arctic.

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PREFACE

This memoir incorporates the results of field work undertaken, under the general supervision of Dr. N. L. Nicholson, by a Geographical Branch party in 1950. This party consisted of the following geographers: J. B. Bird, party chief, M. B. Bird, W. G. Dean, and W. D. Bell. Each geographer contributed his share both to the field work and to the material for this report. It was left to the leader of the party, however, to compile the general account from the several descriptions and records made.

The work had three main scientific objectives: to check, by ground survey, terrain interpretations that had been made from aerial photographs before going into the field; to make a detailed systematic and regional survey of the physical geography, including landforms, drainage, surface conditions, and land and sea ice; and to investigate the exact relationship between various geographical factors and location of modern and prehistoric Eskimo sites on the island.

The memoir has summarized the observations of the field party and, in addition, set forth the known findings of other observers, whether explorers, traders, scientists, or natives. It is a factual statement of what has been seen of Southampton Island or what may be interpreted from aerial photographs. Hypothetical considerations have been eschewed, except where they are well-founded deductions.

The practical application of the scientific knowledge gained by the party has also been reserved. However, it would be proper to point out here that this is not to say that there is no such application. The reader will constantly find that the observations on terrain, drainage, surface conditions, ice, vegetation, and fauna have the utmost practical significance.

Thus the description of arctic limestone terrain, one of the first of its kind, should lead to a better interpretation of that type of landscape (wherever it occurs) for purposes of building, road making, water supply, and sewage disposal. Similarly, the detailed accounts of the surface conditions should be invaluable when it comes to trail breaking, road making, or the whole problem of manoeuvreability over the different types of surface described.

The analysis of coast types, beach formations, harbourage, and ice conditions along the shore should, in the same way, have practical use for navigation or for planning coastal settlements. In this light, what the Eskimos and traders have done in adapting settlement to coast topography and drainage is very interesting. With reference to settlement, comments on water supply and on the supply of wild life should also prove valuable either in understanding the location of existing population or in the planning of new sites for settlements.

Finally, it should be remembered that the main physiographic regions of Southampton Island are only parts of much larger regions. Therefore, their analysis can be used to interpret conditions in other sections of the arctic landscape that are floored with Palæozoic limestone or Precambrian crystalline rocks, or which have been subject to similar glacial deposition and erosion, marine transgression and recession, and the other factors here set forth. Studies in comparative geography ought to make this memoir apply in areas far beyond the island that was chosen as a representative sample of so many arctic conditions and problems.

The Director of the Geographical Branch wishes to acknowledge his indebtedness to all those who assisted the authors and the members of their party while in the field (and whose help is further acknowledged by the authors in this memoir); and also to the Royal Canadian Air Force for transportation to and from the island.

J. WREFORD WATSON,
Director, Geographical Branch

Southampton Island

CHAPTER I

INTRODUCTION

GENERAL STATEMENT

Southampton Island is the largest island in the Canadian inland arctic sea known, in different parts, as Foxe Basin, Hudson Bay, and James Bay. The island is roughly triangular in shape with sides about 180 miles long. It has an area of approximately 17,000 square miles, making it comparable in size to Nova Scotia. Although Southampton Island lies just south of the Arctic Circle, by all other standards it is wholly arctic in character. Sea ice surrounds the island for 8 months of the year and the climate is distinctly less pleasant than on the Keewatin mainland to the west. This is particularly true in summer, when the surrounding cold seas cause much low cloud and fog and keep the mean summer temperatures around 43 to 46 degrees F.

Although Seahorse Point in the southeast of Southampton Island is only 50 miles west of Hudson Strait, a shipping route that has been used almost continuously since the middle of the seventeenth century, the island remained virtually unknown until the last decades of the nineteenth century, when the large numbers of whales around the shores attracted whalers of many nationalities. Today the whales in the seas around the island are almost extinct and there is very little of commercial value on or around the island. No economically workable mineral deposits are known. There are few caribou left, and the only product that enters into commerce is the arctic white fox.

To many scientists, however, the island has attractions that make it almost unique in the arctic regions of Canada. It was here that the last Canadian remnants of the prehistoric Eskimo Thule culture survived until 1902 in the Sadlermiut Eskimo. These Eskimos, now extinct, and their predecessors have left behind many villages of stone house ruins that are proving to be of considerable importance to the archæologist. The marshes of the limestone lowlands form some of the most extensive summer breeding grounds for water birds in northern Canada, and hence the island is of considerable interest to the ornithologist. For the geologist and the geographer, Southampton Island is the most southerly part of Arctic Canada in which Palæozoic sedimentary rocks are found. The limestone lowlands that have developed on these rocks form one of the flattest, most monotonous landscapes in the whole of the Canadian Arctic. On the Precambrian crystalline rocks of the Canadian Shield, which form a third of the island, uplands of considerable relief have developed, which are only matched elsewhere in the district of Keewatin by the hills around Wager Bay. It is possible, therefore, to study the two major physiographic provinces of the Canadian Arctic mainland and the southern half of the Arctic archipelago within a short distance of each other on the island.

PREVIOUS WORK

The history of geographical discovery and scientific research on Southampton Island may be divided into three periods. The first period commences in the early seventeenth century and lasts until about 1860. This was the time when the search for the North West Passage was being made intermittently and the shoreline of Southampton Island was charted, except for the south coast. The second period commences with the appearance of whalers in the northwest of Hudson Bay and lasts until the end of World War I. In this interval the southern shoreline was added to the chart, white men wintered on the island, and the first inland traverse of the island was made. The third period, continuing until the present day, has been the period of serious scientific investigation of the island.

1612-1860

Thomas Button was probably the first European to sight Southampton Island. He passed through Hudson Strait in the summer of 1612, and sailing west from Cape Wolstenholme he discovered Coats Island, naming Capes Pembroke, Southampton, and Carys Swans Nest. After wintering on the southwest side of Hudson Bay in the estuary of Nelson River, Button sailed north in the following July and entered Roes Welcome Sound, sighting Southampton Island for the first time on July 29, 1613. As the Keewatin mainland on his one side and Southampton Island on the other were converging as he sailed north, Button assumed that he was probably in a bay and turned back in about 65 degrees north. His course from then onwards is not easy to follow, but apparently he sailed south to Cape Kendall and then to Coats Island without realizing that Fisher Strait separated the two islands.

Bylot and Baffin were the next explorers to see the island, in 1615. When they failed to find Nottingham Island at the west end of Hudson Strait they stood to the west and seeing Southampton Island they followed the coast north past East Bay, which was recorded. A party was put ashore some miles south of Cape Comfort. Then they continued north past Cape Comfort and sailed into the mouth of Frozen Strait where they were stopped by ice. They believed they had sailed into a bay and turned about. After anchoring for a day in the small cove a few miles west of Cape Comfort they sailed down the east coast of the island to Seahorse Point. Bylot and Baffin named both Cape Comfort and Seahorse Point (the latter from the walrus that still abound in the area). This voyage is remarkable in many ways, not least in that they were able to sail into Frozen Strait as early as the first half of July without meeting ice. Thus within 5 years of Hudson entering Hudson Bay, both the east and west coasts of Southampton Island had been seen, although they were believed to be part of the mainland and also joined to Coats Island. The only other explorer of the seventeenth century who we can say with any certainty saw Southampton Island was Luke Foxe, in 1631.

For the next 100 years few discoveries were made in the north part of Hudson Bay. Ships entering the bay made immediately for the posts in the south of the bay, and as they passed south of Coats Island, failed to sight Southampton Island. It was not until the search for the North West Passage from Hudson Bay was revived in the middle of the eighteenth

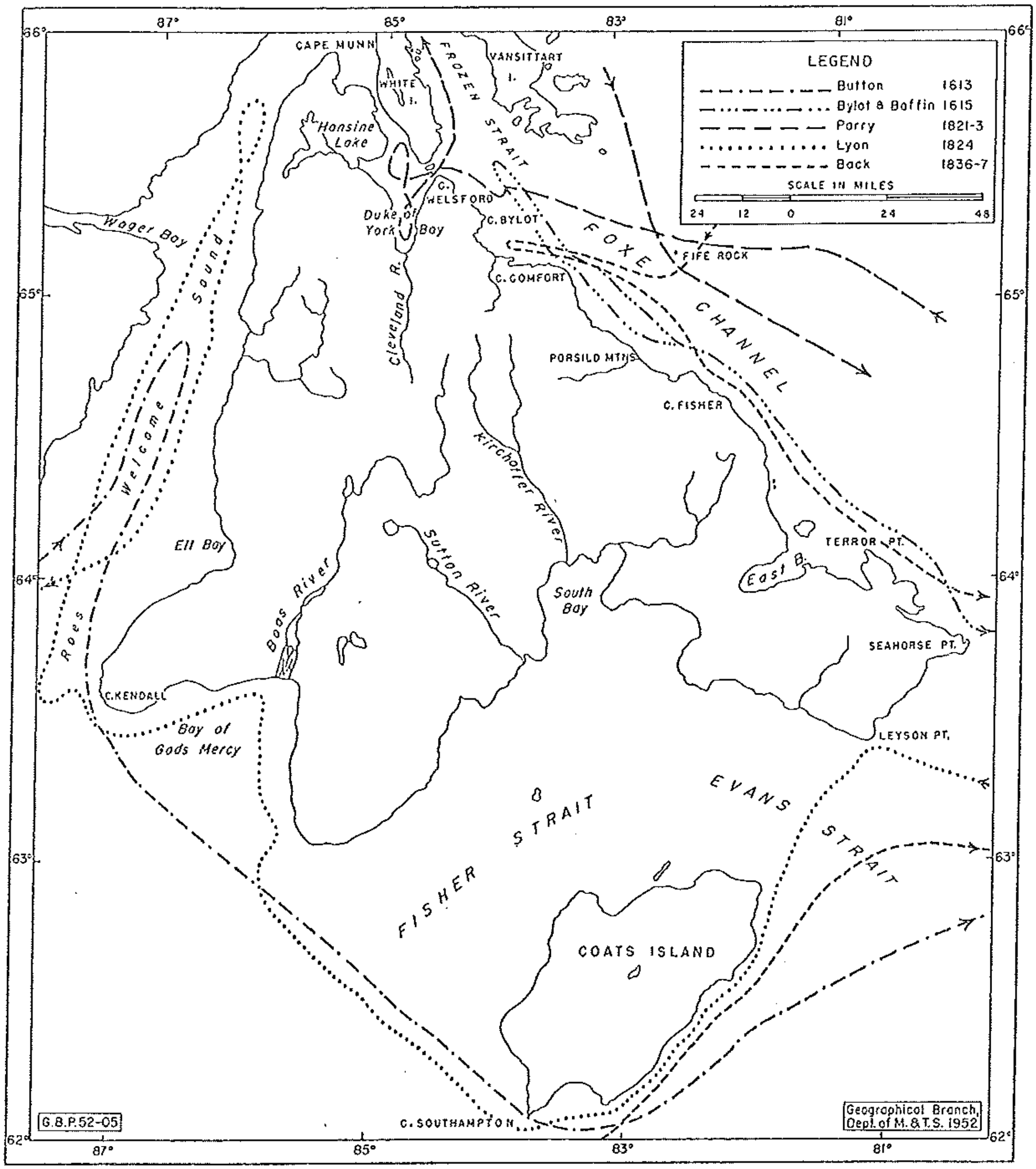

Figure 2. The exploration of Southampton Island, 1612-1860.

century that knowledge of Southampton Island increased. In 1742 Middleton sailed north through Roes Welcome Sound and discovered Wager and Repulse Bays. A party landed on the west coast of Southampton Island, which they described as resembling Dungeness (Sussex, England), and saw the high land to the east in the centre of the island. From Repulse Bay, Middleton looked southeast through Frozen Strait, which he named after the ice, towards Cape Comfort, thus showing that in all probability Southampton Island was in fact an island and that the passage through Frozen Strait was going to be difficult at any time of the summer because of sea ice.

About this time the name Southampton, which had been given by Button to a cape on Coats Island in honour of the third Earl of Southampton, began to have a wider meaning. Captain Coats apparently confused Cape Southampton and Carys Swans Nest, placing the former on the north coast of Coats Island and referring to the coast between as the Southampton shore. From that strip of coast on Coats Island the name gradually became applied to both Southampton and Coats Islands and was finally given to the former when they were shown to be separated by Fisher and Evans Straits. The renewed search by the British for the North West Passage after the Napoleonic wars, increased the charted area of Southampton Island and led to the first accurate description of the northeast coast. In 1821 Parry sailed into Foxe Channel and passed through the narrows between White Island and Cape Welsford into Duke of York Bay, under the impression (which was quickly corrected) that he had passed into the northern part of Roes Welcome Sound. The bay was surveyed and a landing was made on the east side. Parry's Journal remains to this day the only account of the Precambrian plateau near Cape Welsford by someone who has visited it on the ground. The southern entrance to Comer Strait dividing White and Southampton Islands was seen by Parry, but he did not consider it possible for a ship to pass through and the two islands are shown joined on maps for almost another century. Leaving Duke of York Bay, he sailed through Frozen Strait to Repulse Bay, thus proving conclusively that Southampton was not part of the Keewatin mainland. On the return voyage to England in 1823 Parry's two ships, the *Fury* and *Hecla* were beset in the ice off Melville Peninsula and drifted over 400 miles to the south along the west side of Foxe Basin, revealing for the first time the powerful set of the current in this part of the basin. In addition, Parry saw Fife Rock, a small islet 20 miles east-northeast of Cape Comfort, which is missing from most recent maps. Fife Rock was seen by the Geographical Branch party on September 3, 1950.

Captain Lyon, who was a member of the Parry expedition in command of H.M.S. *Hecla,* returned to the area in H.M.S. *Griper* in 1824. He sailed along the south shore of Southampton Island between Seahorse Point and Leyson Point and then made for Cape Pembroke at the eastern end of Coats Island, still believing the two islands to be one. In doing so, he passed and named Evans Inlet (Strait) but did not sail into it. Passing along the south shore of Coats Island he reached Southampton Island again, on the southwest coast, and clearing Cape Kendall, sailed into Roes Welcome Sound where a landing was made on the west coast of Southampton Island. He was forced to return to England in the autumn of 1824 by the bad weather and the unsuitability of his ship for wintering under arctic conditions. Lyon's work is valuable because his is the only account of the now extinct Eskimo inhabitants of Coats Island. He also forecast, but did not prove, that Evans Inlet, which he had discovered on the outward voyage, would be found to divide the Southampton Island of earlier charts into two or more islands.

The last naval ship to seek the North West Passage in this area was H.M.S. *Terror* with Captain Back in command. In 1836 he sailed up the east coast of Southampton making for Repulse Bay. His ship became frozen in the sea ice in September off Cape Comfort, and drifted helplessly down the east coast, generally within 5 miles off the shore, until the ice carried it away from the island, off Seahorse Point in April of the following year. Back's disastrous voyage is the last of the first exploratory period and no changes appear in the maps and charts from that time until the arrival of the whalers in the 1860s. At the end of the first period, Southampton Island was known to be separated from the mainland but White and Coats Islands were still shown joined to the main island. No Europeans had been into the interior of the country and none had remained on the island for more than a day or two.

1860-1918

The purpose of exploration and surveys of Southampton Island in the second stage are sufficiently different to warrant a marked separation from the first. Whaling, from the Hudson's Bay Company trading posts in the south of the bay had probably been inaugurated in the latter part of the seventeenth century, but it was only intermittent and on a small scale. It was not until the decade beginning about 1860 that first American and later English and Scottish whalers began whaling in the north of Hudson Bay. The short season free from ice—particularly at the point of entry through Hudson Strait—made wintering in the bay a necessity. This in turn brought contact with the Eskimos for winter food, native whaling, and small scale trading. Commencing then in 1860 when two whalers first wintered in the bay, we find an increase in knowledge of the north part of the bay, although frequently kept secret for commercial reasons, and also a change in the Eskimo pattern of life.

Roes Welcome Sound had from the first been recognized as a profitable whaling area and many whalers were attracted to this region. Southampton Island was seen on many occasions, but because of the lack of good harbours and the shallow difficult approaches to the coast it was generally avoided and few landings were made there.

The first recorded incident of a ship sailing through the strait between Coats and Southampton Islands was in 1864 when Fisher, a whaling captain, passed through. His name has subsequently been given to the western end of the strait (Wakeham, 1898), and the Evans Inlet of Lyon was renamed Evans Strait for the eastern end. Knowledge of the separation of Coats and Southampton Islands did not become general on published maps of the area until after 1873. In 1865, the year following the discovery of Fisher Strait, an American whaler found some natives at Manico Point in the southwest of the island (Bell, 1884). Contact with the natives and the island remained slight although Ferguson, another American whaler, landing on Southampton Island in September 1878, met Eskimos and records that the men wore bearskin trousers and spoke a different language from the other Hudson Bay Eskimos[1] (Ferguson, 1938).

[1] Ferguson does not state exactly where on Southampton Island he met these natives. There is a slight possibility that it was not on Southampton Island but on Coats Island. Later whalers reported that the Sadlermiut spoke essentially the same language as other Eskimos, but with a different dialect.

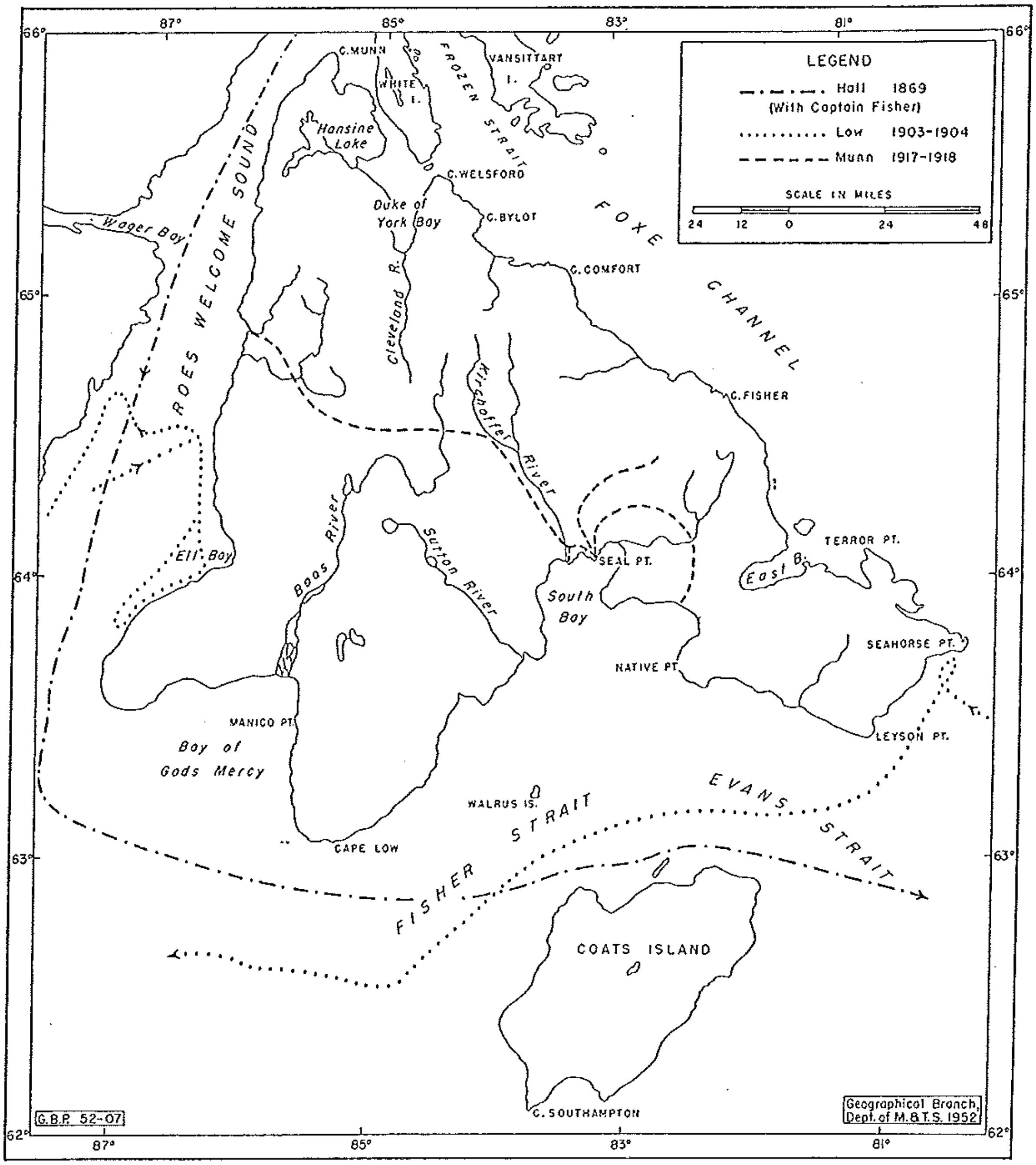

Figure 3. The exploration of Southampton Island, 1860-1918.

The second stage of exploration ends about 1920 after the establishment of temporary trading and whaling stations on the island, and the dying out of the native Sadlermiut people. The two most important of these stations were the Cape Low station established by Captain Murray from 1901 to 1903 and the South Bay station of Captain Munn from 1916 to 1918. Captain Murray carried out whaling around all the coasts of Southampton Island except the Foxe channel side, and did in fact pass through Frozen Strait on one occasion. He never published his maps. Mathiassen reproduces the only known photographs of the Sadlermiut, which were taken by Murray. In addition to trading for furs, Munn made considerable journeys inland, and was the first white man to cross the island from South Bay to Roes Welcome Sound (Munn, 1919). In the meantime another whaler, Captain Comer, was in the vicinity of the island between 1893 and 1920. It is from his writings that we have the only eyewitness account, by a white man, of the Sadlermiut culture before it became extinct (Comer, 1910, 1913). Comer showed on his maps for the first time that the southeast (Bell) peninsula of Southampton Island was not a separate island as had been thought previously, although Low in 1903 had suspected that no strait existed. Low visited both the west coast and the Seahorse Point area while officer in charge and geologist of the Dominion Government expedition to Hudson Bay and the Arctic islands in 1903 and 1904 (Low, 1906).

The second stage of the exploration is characterized by an increase in knowledge of the island, particularly the south coast and the interior, and by the extinction of the original native inhabitants and their substitution by Eskimos from the mainland of Keewatin. By 1920 the map of the island in general outline was correct. In the third stage of exploration, from 1920 until the present, the detail has been filled in coupled with intensive scientific exploration of certain aspects of the island.

The Fifth Thule Expedition in charge of Rasmussen had its headquarters on Danish Island on the opposite side of Frozen Strait from Cape Comfort. In 1922, Mathiassen crossed Frozen Strait to excavate at Kuk on the west side of Duke of York Bay. When he attempted to return to Danish Island the sea ice was too thick for the boat to pass and he was forced to spend the winter travelling about the island with natives, during which time he visited South Bay (Mathiassen, 1927, 1931). After the establishment of a permanent trading post by the Hudson's Bay Company at Coral Harbour in 1924 it became easier for scientists to remain on the island. Sutton spent a year (1929-30) studying ornithology on the island, during which time he added materially to the general knowledge of the area (Sutton, 1932). Finally, between 1933 and 1936, Manning travelled extensively all over the island, accomplishing in all twelve crossings, surveying and making general observations on the physical features and the wild life. During the last year of his survey he was aided by members of the British Canadian Arctic Expedition (of which he was the leader) and which included an ornithologist, geologist, and archæologist (Manning, 1936). Since that time numbers of scientists have visited Southampton Island for short periods, but so far have published very little.

FIELD WORK AND ACKNOWLEDGMENTS

The field work for this report was carried out during the summer of 1950. The areas studied in detail were the northeast coast, between East Bay and Canyon River, with excursions into the plateau interior, South Bay, and Bell Peninsula. Because of the extremely unfavourable ice conditions, which delayed the work, it was not possible to visit the west coast and the information on this part of the island has been compiled by reference to earlier sources, by discussions with the Eskimos who know the area, and particularly from the interpretation of air photographs. However, in 1952 on the return voyage to Coral Harbour from a survey of Wager Bay and Repulse Bay, the author was able to sail along the whole of the west coast of Southampton and to stop in four places to make traverses inland. A second attempt was made to enter Duke of York Bay in August 1952, on this occasion from the northwest through Comer Strait. Ice once again prevented entry and so Duke of York Bay is now the only part of the coast of Southampton Island that the author has not visited.

The writer wishes to express indebtedness to W. G. Dean, W. D. Bell, and M. B. Bird for their able and untiring assistance during the field season and in the writing of this report. Gratitude is also expressed for information and courtesy from the staff of the Hudson's Bay Company at Coral Harbour, the other residents of the settlement, and John Ell (Amaulik Audlanat) and his successor in 1952, Pamiulik, who, with their crew, made the sea voyages possible.

CHAPTER II

SYSTEMATIC PHYSICAL GEOGRAPHY

Since the early part of the nineteenth century when Parry entered Duke of York Bay, explorers have been impressed with the contrast on Southampton Island between the broken, often highly scenic uplands of the interior and east coast of Southampton Island, and the flat monotonous lowlands of which the remainder of the island consists. This contrast is present not only on the land but extends out from the shore onto the adjacent continental shelf, and is due essentially to the presence of two widely dissimilar rock types on which geomorphic processes, acting through geological time, have produced the different landscapes we see today.

GEOLOGICAL BACKGROUND

Southampton Island is formed around a core of Precambrian crystalline rocks that are part of the geological province of the Canadian Shield. These crystalline rocks form all the major uplands of the island in addition to lowland areas in the vicinity of Coral Harbour and the mouth of Kirchoffer River. The characteristic rock is a grey mica-gneiss, which is frequently extremely quartzose. In some areas, notably around Seahorse Point (Low, 1906), near Cape Welsford, and on both sides of the lower Kirchoffer gorge, the gneiss has a rusty colour and the surface of the rock is crumbling through the decomposition of fine grains of pyrite in the gneiss. The gneisses have been intruded by granite and granite-gneiss particularly in the vicinity of Coral Harbour and on the east coast, north of Caribou Island. All the Precambrian rocks are cut by dykes of pegmatite that vary in thickness from a few inches to over 10 feet. In the vicinity of the Ascension Islands on the east coast quartz veins are common in the gneiss. The gneiss and associated Precambrian rocks are found east and north of a line from Duke of York Bay to South Bay near the mouth of Kirchoffer River, and from the head of South Bay to East Bay. Smaller areas of gneiss are found on the Foxe Channel side of Bell Peninsula and on the Munn Hills in the southwest of the island (Figure 5). The remainder of the island is formed of limestone.

The limestone is pale yellow, cream, or, very rarely, dark grey. Thin bedded, it weathers rapidly under freeze-thaw action to form plates 2 to 3 inches thick. The weathering is so intense that outcrops of bedrock are difficult to find. They may be observed occasionally in sea cliffs, at Cape Donovan, Leyson Point, and on the Roes Welcome Sound coast; or in modern wave-cut beaches, as at Prairie Point where the waves sweep the rock clear of debris; or in stream gorges, such as the gorge near the air strip at Coral Harbour and Anderson River. The limestone strata are essentially horizontal, but dip slightly to the south at Munn Bay and gently to the north at Cape Donovan. The total thickness of the limestone is unknown, although at Cape Donovan there are vertical cliffs of limestone 1,000 feet high. The limestone was deposited during the Palæozoic era. In the extreme north of the island the limestone is reported to be of Middle Silurian (Niagaran) age whereas in the southwest there are strata of both Niagaran and Upper Ordovician (Richmond) ages (Armstrong, 1947).

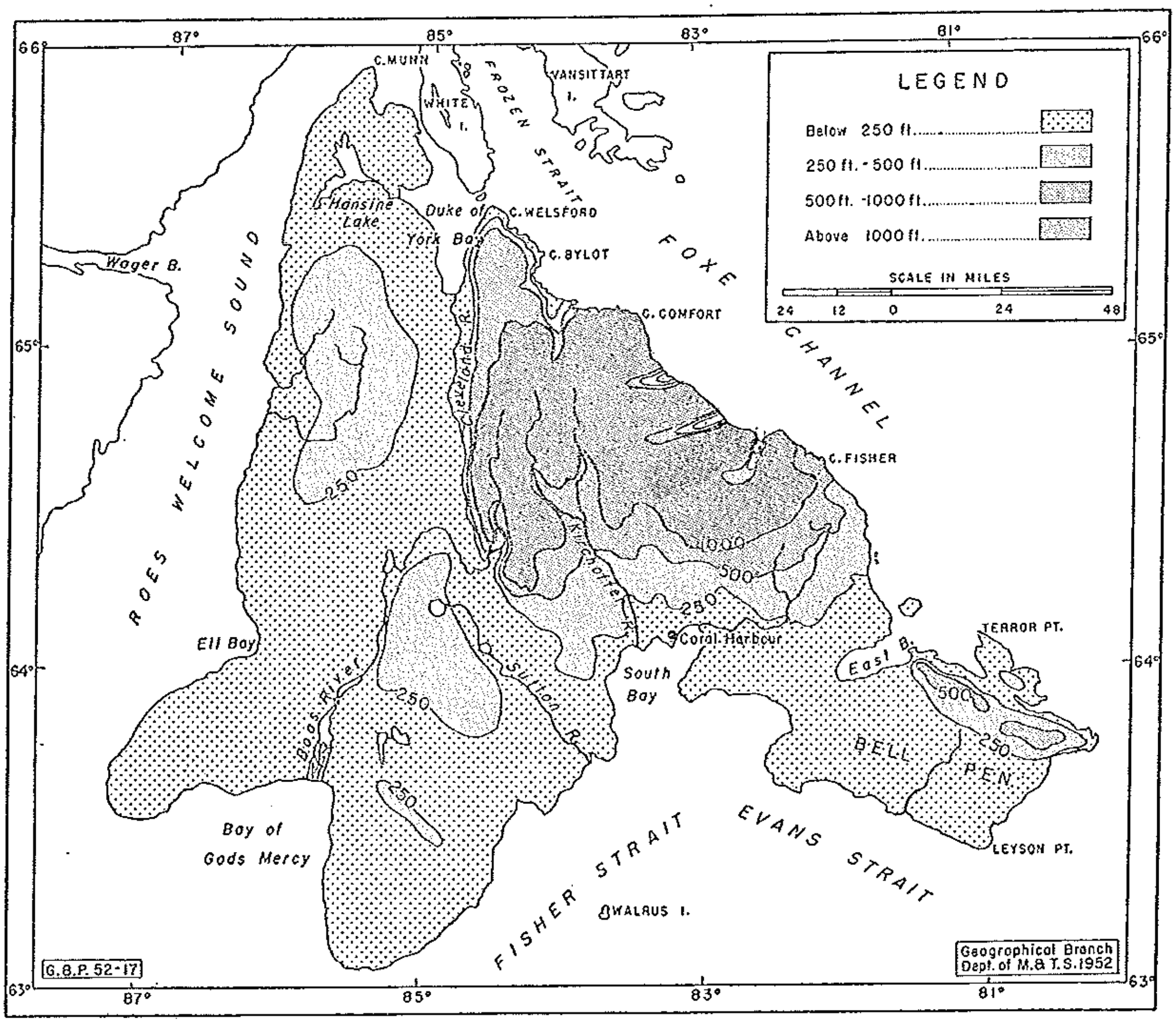

Figure 4. Southampton Island—generalized relief.

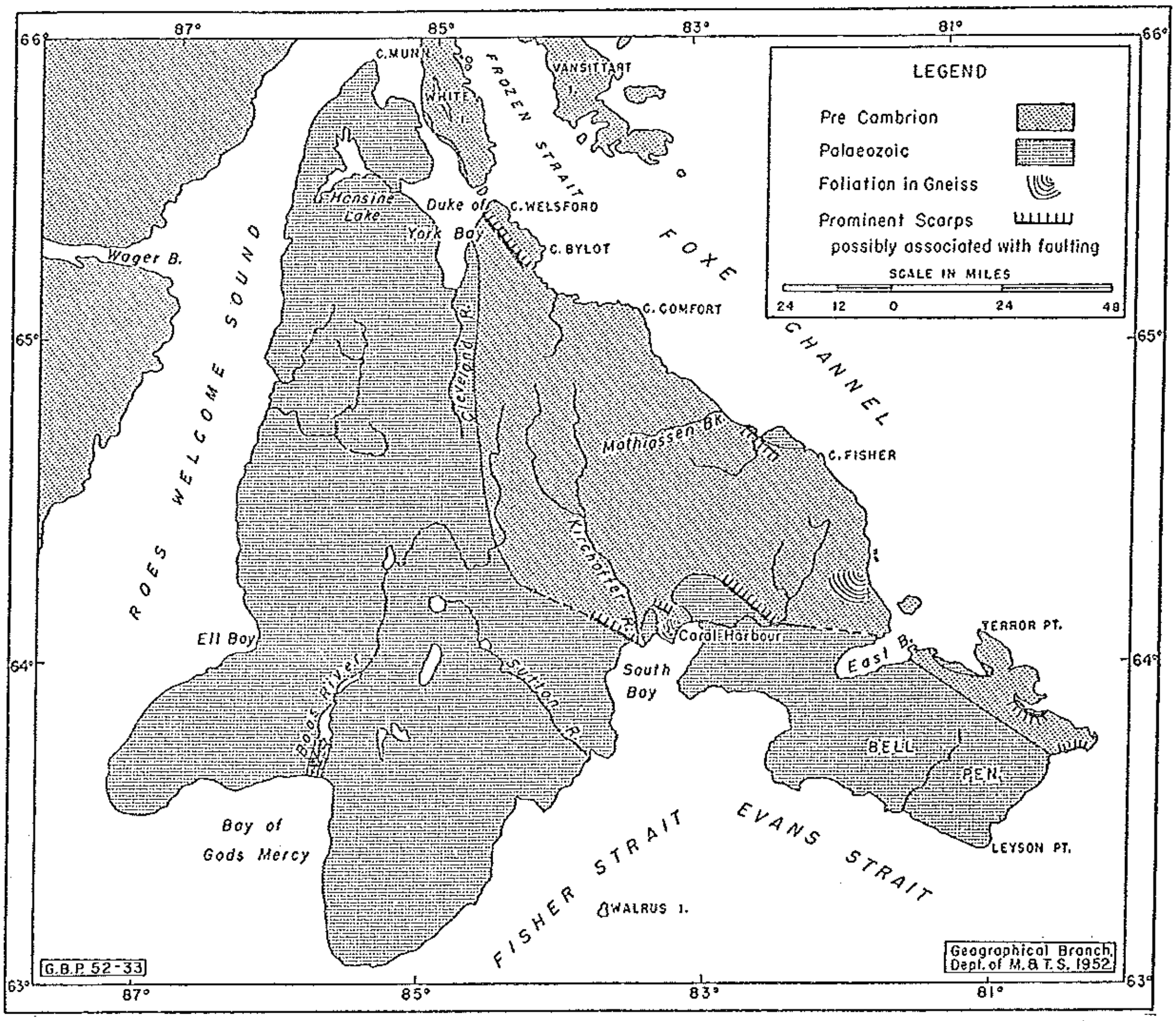

Figure 5. Southampton Island—generalized geology.

Although the distribution of the limestone at the present day is known with accuracy, its extent in former geological periods has not been mapped. The physiographer requires to know roughly the former distribution because on the answer depends firstly the history of the drainage development, whether it is consequent on the present surface or was superimposed onto the gneiss uplands from a Palæozoic cover, and secondly, whether the erosion surfaces that are observed today on parts of Southampton Island are of recent origin or have been exhumed from beneath the Palæozoic rocks.

Prior to the commencement of the present erosion cycle the Palæozoic limestones were more extensive than at present. Near Coral Harbour, in the valley of the middle Kirchoffer, in the Cape Welsford[1] region (Parry, 1824), and at Cape Donovan small outliers of limestone rest on the Precambrian gneiss. The presence of these limestone remnants in positions where they are not protected from the normal erosive forces indicates that the limestone was more widespread in the recent geological past. At Cape Donovan the upper surface of the limestone is 1,000 feet above sea-level, whereas elsewhere the highest limestone is at 400 feet in the Bell Peninsula and 350 feet in other parts of the island. As the limestone is nearly horizontal, it is highly probable that at some time in the Tertiary period the limestone was at least 350-400 feet, and possibly 1,000 feet, higher than at present, in all parts of the island.

The contact between the gneiss and limestone is difficult to observe on the ground, as it is almost invariably covered with till, recent marine deposits, or marshland. Two general types of contact may, however, be recognized. Around Coral Harbour, in the Munn Hills, and at Cape Donovan the limestone country merges into the gneiss terrain without any major topographic break. At Cape Donovan the limestone was observed to be resting directly and unconformably on an irregular gneiss floor. Manning has reported a similar contact near Coral Harbour (Manning, 1936). In other parts of the island the contact is marked topographically by linear scarps varying in height from 50 to 800 feet. The finest development of a scarp of this type is found along the western edge of the uplands, where it is 70 miles long and rarely less than 500 feet high. Members of the party examined two scarps near the mouth of Kirchoffer River (*See* Plate I B) and a third at Gordon Bay in the Bell Peninsula.

At the mouth of the Kirchoffer the contact between the limestone and the gneiss is a linear scarp that varies in height from zero to 85 feet. East of the river the scarp forms the coastline; on the west side the coast trends southwesterly and the scarp with a direction of 318 degrees runs inland, decreasing in height until after 4 miles it disappears. The line of the scarp, although not visible topographically, is continued for at least another 6 miles to the northwest as the junction between the two types of rocks. One mile inland is a second scarp 5 miles long with a direction of 309 degrees and a maximum height of 70 feet. This scarp divides an easily weathered gneiss, on the south side, from a resistant granite-gneiss on the north. The exact point of contact is not visible, being covered by large boulders at the foot of the scarp. The straightness of the scarps combined with the very different types of rock on either side suggest strongly that they owe their origin to faults. As the entire area has recently been covered by the

[1] There is some doubt whether the limestone reported by Parry from near Cape Welsford is in situ or is glacial material.

Palæozoic limestone it would follow that they were resequent fault-line scarps, formed by differential erosion. On the south side of Gorden Bay a fault-line scarp probably has a very similar origin. This scarp is 6 miles long, has a direction of 300 degrees, and is 500 feet high. It is formed of gneiss rock with limestone at the foot. Other major scarps that appear to be associated with faults are shown on Figure 5. Perhaps the most striking feature of all these scarps is that, with the exception of the western scarp edge of the interior uplands[1], they have a northwest-southeast orientation.

Although faulting has probably controlled, at least indirectly, some of the major physiographic features, it is only in part of the east coast region that structural control completely dominates the landscape. In many parts of the Canadian Shield where the drift cover is absent and vegetation is scanty, the terrain has a marked linear pattern in the valleys, lakes, and small scarps when seen from the air. A linear pattern of this type can be interpreted as being controlled mainly by faults, dykes, and joints, although other causes may be present (Wilson, 1948). Near Mathiassen Brook, linears, some of which are more than 25 miles long, control all drainage except that of the major streams. Between Cape Comfort and Canyon River there is absolute control of the drainage by linear structures. In other parts of the island structural control is less evident. Exceptions are found on the east coast between Ascension Islands and Caribou Island, and north of the Coral Harbour settlement, where strong foliation patterns in the gneiss have produced a network of gently curved rock ridges, 25 to 30 feet high, separated by marsh-filled hollows.

PHYSIOGRAPHIC DEVELOPMENT

The geological history of Southampton Island between the late Palæzoic era and the Tertiary period can at present only be surmised from our incomplete knowledge of adjacent regions. During this long interval the land was probably above the sea and subject to the normal processes of erosion, which removed a considerable thickness of Palæozoic rocks and reduced the surface to a stage of late maturity or old age. Southampton Island was at this time part of the great peneplain that extended over the Canadian Shield. The limestone and gneiss surfaces of the island were at approximately the same level. If the limestone had been appreciably lower than the gneiss (as at present over much of the island) during the early Tertiary, it is inconceivable that the streams on the scarp face between Duke of York Bay and Mount Saorre would not have developed gorges comparable with those of the streams flowing east to Foxe Channel. There is no reason to believe that the surface of the peneplain was perfectly horizontal, and it may in fact be observed in the uplands today, on the supposition that erosion of the upland gneiss surface on the stream divides has been slight since then, that the relief was of the order of 200 feet over distances of a few miles. By the middle of the Tertiary period "Southampton Island" was a gently rolling land of limestone with an area of gneiss in what is now the highest part of the main island and possibly also the summits of the Bell Hills.[2]

[1] Manning has suggested that the steep western rim of the uplands is a fault-line scarp, between the Precambrian and Palæozoic rocks. For lack of physiographic and geological evidence none of the coasts is shown associated with faults, although the relative straightness of the Foxe Channel coast from Seahorse Point to Cape Welsford, a line that is continued without deviation along the limestone gneiss contact on White Island, is suggestive of a fault structural origin.

[2] A present day contour of between 800 and 1,000 feet probably shows with some accuracy what has survived of the Tertiary surface.

Towards the close of the Tertiary period, in common with many other parts of the Canadian Shield, Southampton Island was uplifted by epeirogenic forces. In the northeast of the island the Tertiary erosion surface is between 1,200 and 1,600 feet above sea-level (*See* Plate II A). In the centre of the island between Mount Saorre and Mount Scotch Tom, it is between 1,000 and 1,200 feet, and at the most southerly point that the Tertiary surface is recognizable it is about 900 feet (near "Big Corner" by the lower Ford River). The uplift was, therefore, of unequal amounts, the old surface tilting from north to south. The elevation was not only unequal in different parts of the island but was also intermittent, at least during the final 400 feet of uplift. This is well shown on the eastern side of the island where valley cross-sections show multiple erosion facets: cut off rock-floored meanders are found between 300 and 325 feet above the present river levels; and the cliffs show well-developed wave-cut rock benches that at least predate the Wisconsin glaciation.[1] There are smaller notches suggestive of shorter still-stand periods, but the "300 foot" level is the most conspicuous and is found in many places between Liver Creek and Cape Comfort.

TABLE I

Evidence for "300 foot" level

Method	Mean height	Note
Wave-cut bench................	310	Mean from five different points on east coast.
Cut off rock meander...........	360	Mathiassen, 2 miles from present sea cliffs.
Cross-section of valley...........	300	Mean of readings in lower Mathiassen and Kokumiak Creeks.

The final stage in the physiographic history of the island sees the onset of the Pleistocene glaciation, its final withdrawal, the submergence of all lowlands by a post-glacial Hudson Bay, and finally the small scale erosion of the landscape since the retreat of the sea and ice.

GLACIATION

Before 1950 no systematic study of the glaciation of Southampton Island, or the influence of glaciation on the general physiography, had been undertaken. It is generally accepted that the whole of Southampton Island was covered by the east North American ice-sheet during the Wisconsin. Evidence for complete glaciation was sought from glacial markings, mainly striæ and grooves, erratic boulders, and eskers. All these features can be created, or at least duplicated, on Southampton Island, as elsewhere, by other geomorphic processes. For example, pseudo-glacial markings may be formed by rocks embedded in sea and river ice, erratics may be transported

[1] The term Wisconsin glaciation is used throughout this memoir to mean the last period of glaciation on the island. There is as yet no definite correlation of this glaciation with the Wisconsin of southern Canada and the northern United States—nor indeed was any evidence seen during 1950 of more than one glaciation. The author, however, interprets this lack of evidence to indicate the severity of the last glaciation rather than the absence of any previous glaciations.

by ice rafting, and many of the abundant marine spits and other shore landforms resemble eskers, particularly as the latter would be modified by the sea up to the maximum height of the post-glacial submergence.

STRIÆ AND GROOVES

No small-scale glacial markings were found anywhere on the limestone, due presumably to the very intensive physical weathering that followed the glaciation. Deep striæ were observed on the limestone at the mouth of Thomsen River by Mathiassen (Mathiassen, 1931). On a large scale there is a fluted pattern in the limestone ground moraine in the west of the island. The pattern is formed by grooves in the terrain, which are generally 10 to 15 feet deep. At their greatest development they are about 300 yards wide and 4 to 5 miles long, after which they die out imperceptibly. The ridges between are flat-topped. These features are virtually impossible to see on the ground and would probably be invisible from the air were it not for the dampness of the hollows in summer, which is sufficient to support an incomplete vegetation cover. The grooves are parallel over large areas and bear no relation to topography or structure. They are most extensive on the limestone plateau in the vicinity of the Munn Hills. Farther west, where Murray River enters Roes Welcome Sound, rather similar landforms are found, which resemble closely drumlinoids, and occasionally typical drumlins.[1]

In the lowland crystalline rock areas glacial markings are generally well preserved at the lower levels, except when the rock is of a type that decomposes rapidly. Above about 200 feet glacial markings are difficult to find, weathering having destroyed the glacial rock surface. For this reason records of glacial markings from the upper erosion surface on the upland plateau of the interior and northeast of the island are almost negligible. The 1950 field party was only able to find one undoubted and one probable area of striæ markings on the plateau. Erratics are also absent from the plateau. Absolute proof of complete glaciation of the plateau surface and hence the whole of the island is, therefore, absent. The whole of Southampton Island was submerged to a depth of at least 500 feet by a post-glacial sea. If the theory is accepted that the submergence was produced by delayed isostatic adjustment after the waning of the ice-cap, only the weight of ice many thousands of feet thick could have produced a minimum depression of 500 feet. The ice must, therefore, have covered the whole of the island.

GROUND MORAINE

The extent of the ground moraine over and above the patterned areas already discussed is not known because of the difficulty of differentiating ground moraine from frost shattered rock formed in situ. If erratics are absent it does not prove that frost shattering formed the regolith. If erratics are present they may have been ice rafted to the area. Till deposits are limited in distribution. Till is absent from the higher limestone areas but in the low swamp areas, where streams are entrenched, the stream sides frequently show heavy till-like deposits with many gneiss erratic boulders. The presence of marine shells in the clay suggests that the "till" is of post-

[1] A linear pattern in the ground moraine is a characteristic feature of large areas in northern Canada. The features have variously been named drumlinoids, flutings, and ridge and furrow topography. For an earlier use of these landforms to determine the direction of glacial movement, *See* Bird, 1951.

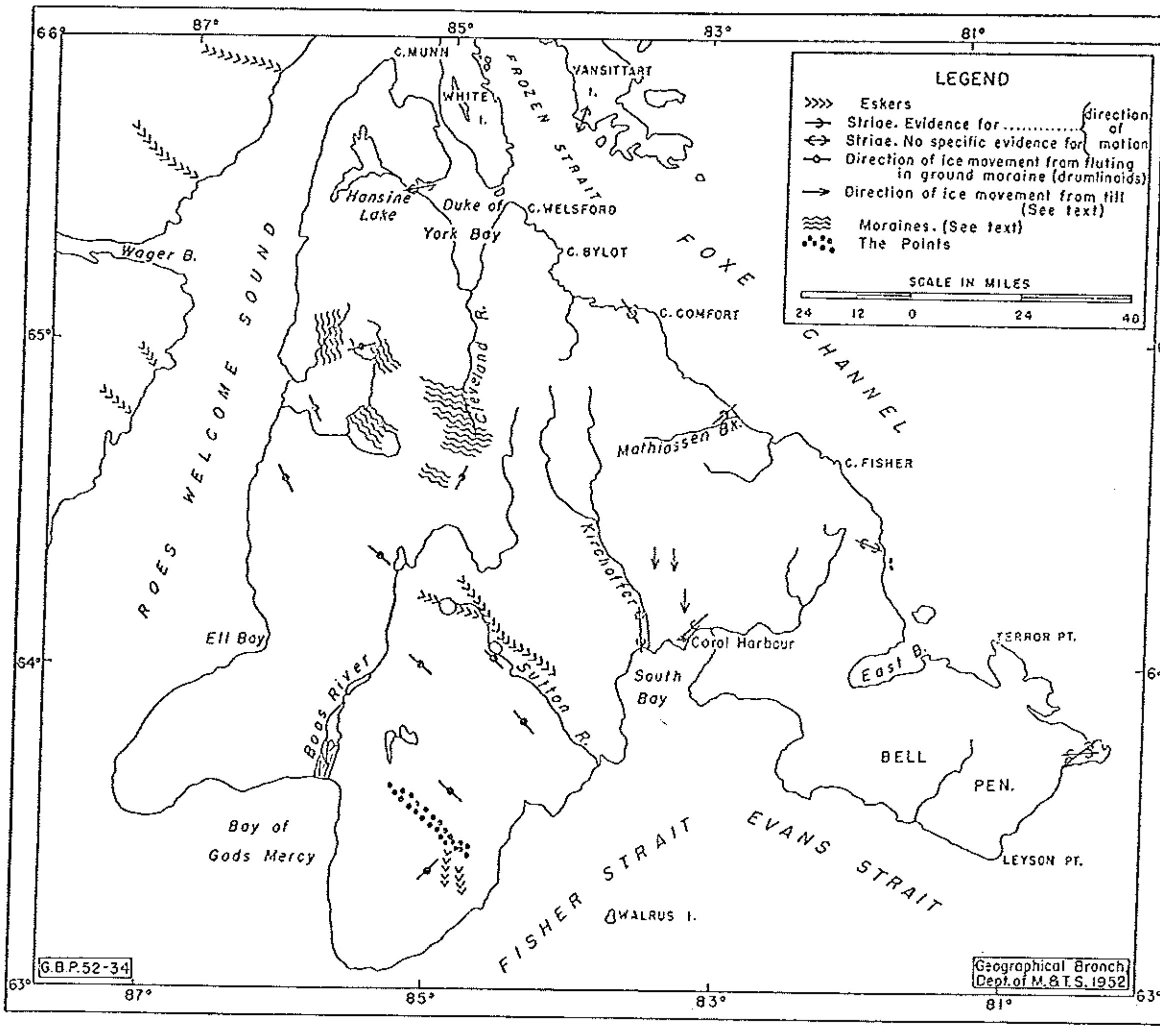

Figure 6. Southampton Island—glacial features.

glacial marine origin rather than directly due to the ice. A similar type of clay, grey-blue in colour, with many large boulders and unbroken marine shells, is found in the valleys of streams flowing into Foxe Channel. In the crystalline lowland areas (e.g., around the north of South Bay) small deposits of till are preserved on the interfluves. The till has apparently been washed off most of the lower lying rock surfaces and it is this re-sorted till that forms most of the raised beaches in the crystalline rock areas of Southampton Island. In the middle valleys of Kirchoffer and Ford Rivers till deposits are extensive and occasionally show poorly developed drumlin forms. The till in this area is frequently difficult to distinguish from solifluction deposits.

In addition to the linear drumlinoid pattern of the ground moraine in the Munn Hills area, the ground moraine shows another distinct and much more unusual type of pattern in the northwest of the island. The pattern consists of many hundreds of sinuous but parallel ridges. They are about 10 feet in height, frequently less, and from 25 to 100 yards wide. There are two outstanding features of this pattern. When the whole area is examined (some 1,000 square miles) the pattern is seen to be made up of irregular parallel arcs in one quadrant of a circle. The arcs are not complete throughout the quadrant, and in the areas where they die out faint drumlinoids at right angles to the arcs may be observed from air photographs. The origin of this ground moraine pattern is unknown and will remain so until it is practical to examine it in detail in the field. One possible explanation that fits all the observed facts is that they are small morainic ridges formed at the end of thrust planes that developed in a shrinking ice-lobe, or a small independent ice-cap that existed in the Duke of York Bay area at the close of the Wisconsin glaciation.

End moraines are rare landforms throughout the whole of the district of Keewatin. Only one is known on Southampton Island and its origin is controversial. In the southwest of the island is a line of hills 18 miles long and 1½ to 2 miles wide known as the Points. The maximum height of the hills is 580 feet above sea level or about 400 feet above the limestone plateau on which they rest. They are flat topped with well-developed strand lines on the steep sides. Small ponds are numerous on the flat beaches and the irregular slopes. The surface of the Points is composed of limestone fragments. No limestone has ever been found in situ on the Points although an outcrop has been observed at the base. Sutton considered the Points to be of glacial origin although he only saw them from a distance (Sutton, 1932); Manning believed them to be the final stage in the destruction of a high level limestone plateau (Manning, 1936, 1942). There the matter rested until air photographs were taken of the area. Evidence from the photographs lends considerable support to the glacial theory of origin. On the southwest side of the Points the ground moraine is irregular in density but shows a pronounced northeast-southwest orientation. From the Points a number of small eskers extend to the southwest. On the northeast side of the Points there is a marked linear pattern in the ground moraine from southeast to northwest. The Points, therefore, mark the junction of two ice movements that were not necessarily contemporaneous, but were undoubtedly at right angles. They have not developed by any normal processes of erosion as they dam back the natural drainage on the northeast side to form a long line of lakes parallel with the Points. If an interlobate moraine origin for the Points is accepted, all the foregoing feaures may be satisfactorily explained, assuming that the post-glacial sea that followed submerged the hills and they are then great mounds of gravel and limestone fragments formed between two ice masses. The flat tops are a result of marine planation, the ponds of the melting of enclosed ice.

ESKERS

Eskers are not prominent features of the landscape. None is found in the crystalline rock area. The only long esker occupies the valley of Sutton River. The Sutton esker is nearly 40 miles long and is only broken where it is cut by tributaries of Sutton River. The Sutton esker is "simple" in type without duplication and with only one large tributary esker. It is almost parallel with the main direction of glaciation as shown by the fluting pattern on the surface of the limestone, remaining in a furrow for 2 or 3 miles and then crossing obliquely some hundreds of yards to the next major furrow. The esker must, therefore, be younger than the fluting. Towards the southeast where the fluting dies out the esker is more sinuous in form. With the exception of the small eskers near the Points and a doubtful esker north of Ell Bay on the west coast, there are no other known eskers on the island.

DIRECTION OF GLACIATION

All the evidence that is available to determine the direction of glaciation is shown in Figure 6. All the striæ were determined by members of the 1950 party with the exception of the last two.

In addition to the striæ recorded in Table II and the fluting and other ground moraine patterns to which reference has been made, certain other features enable us to estimate the movement of the ice in the upland zone. In the area of the middle Kirchoffer are three small outcrops of limestone resting on crystalline rock. From these outcrops a trail of light-coloured till extends for some miles to the south. This is taken to indicate a general movement from the north in this area.

From Figure 6 it is obvious that one ice movement could not have produced the complex pattern of ice dispersal that is indicated. Three separate patterns can be recognized; in the southwest of the island a southwest-northeast motion terminating in the Points moraine; from the west side of South Bay to Roes Welcome Sound a strong movement of ice indicated by the ground moraine pattern. There is no indication on the island whether the ice moved from the southeast or northwest. The same direction is, however, also found on both sides of Wager Bay on the Keewatin mainland. There, the evidence indicates that the ice was moving from the southeast. As the two directions are the same and are only separated by 25 miles of water, it is assumed that on Southampton Island the movement was also from the southeast. If these two patterns are capable of a simple explanation, the third pattern occupying almost all the crystalline rock zone and overflowing into the limestone is far more difficult. If the interpretation of the morainic pattern in the Duke of York Bay-Cleveland River area is correct, then at the closing stage of the Wisconsin glaciation the ice in this area was moving from a general northeasterly direction. In the Kirchoffer and Ford Rivers area the ice was moving from the north. These directions suggest that at this period the ice was either diverging from a broad dispersal zone in the Foxe Basin or that the upland zone of Southampton

TABLE II

Observations of Glacial Striæ on Southampton Island

Location	True strike	Remarks
Coral Harbour Settlement.......	Degrees 50	Striæ are numerous in the vicinity of the Post. This figure is the mean of a large number of readings. Plucking indicated movement from northeast.
Seahorse Point (two sets)........	59 81	Obtained by W. G. Dean from grooves. He was convinced from lee and stoss effect and glacial smoothing that motion was from the east.
Liver Creek....................	116	Striæ in valley and suspect for regional direction because of topographic control.
Mathiassen Brook..............	60	Many striæ on plateau surface. Plucking indicated movement from southwest.
Cape Comfort..................	145	Plucking indicated movement from northwest.
Anchor Cove..................	126	Observed in 1952.
Mouth of Kirchoffer River.......	0	
Walrus Island.................	74	Plucking indicated movement from the southwest. Observed in 1952.
Thomsen River.................	ENE (77)	Observation by Mathiassen: op. cit., 1931, p. 15.
Vansittart Island..............	20	Observation by Mathiassen.

Island supported its own ice-cap. It is possible that both dispersal zones may have existed at different times, but the evidence from the Foxe Channel coast of Southampton Island suggests that at the very end of the glaciation the island supported an independent ice-cap. No limestone erratics from the Cape Donovan outlier could be found to the west. It seems unlikely that if the ice was moving from the east that it carried no erratics. Farther north between Mathiassen Brook and Cape Comfort the valleys show limited overdeepening, plucking, and smoothing, which suggest that the ice movement was down to the sea from the interior. The conclusion must, therefore, be reached that the upland zone of Southampton Island was itself a dispersal centre of limited extent at the close of the Wisconsin glaciation, but that there was, at the same time (or nearly contemporaneously), also ice in Foxe Basin whereas the land to the west of the upland zone was relatively clear.[1]

[1] There is no evidence on Southampton of large areas of dead ice at the close of the Ice Age such as are found north of Wager Bay and in the middle basin of Back River on the Keewatin mainland.

CIRQUES

In addition to a period when a continental ice-cap covered Southampton Island, there must also have been subglacial stages when small independent cirque glaciers existed. The Foxe Channel coast, from Ascension Islands to Canyon River, is bounded by cliffs over 1,000 feet high. Cut into the cliff face are a number of armchair-shaped hollows in which semi-permanent snow beds are still found. These hollows are undoubtedly small cirques formed when the climate was colder or there was more snow than at present. Most of the cirques are not more than 500 feet deep from the top of the cliff to the cirque floor and 250 yards from the lip to the back wall. Some, however, are much larger and more complex. Plate II B shows a cirque that has developed at two different periods. Four examples of multiple cirques (i.e., the cirque in cirque type) were seen. A few of the cirques are deep and assume valley forms. One examined between Mathiassen Brook and Kokumiak Harbour was ½ mile long, with a U-shaped cross-section, vertical sides and back wall, and unoccupied by any stream today. The absence of a notch or valley at the top of the back wall makes a water origin for such a valley most unlikely. It is probably a cirque that has been extended by back-wall sapping, possibly along a line of weakness in the rock. For such a landform to be eroded by a cirque glacier would require a long period of time.

The glaciation of Southampton Island was complex, and it modified the landscape to a certain degree although very much less than might be supposed. The single most important act of the ice was indirect. The weight of the ice depressed the land. After the ice waned the land did not immediately recover its pre-glacial height but rose slowly. In the meantime the sea invaded the low-lying areas of the island and produced many superficial modifications to the landscape.

POST-GLACIAL MARINE SUBMERGENCE

The slow isostatic recovery of the land at the close of the Wisconsin glaciation permitted the sea to submerge many of the coastal areas of Canada. On the Atlantic side of southern Canada the highest post-glacial marine beaches rise from near present day sea-level in Nova Scotia to over 600 feet A.D.[1] along the St. Lawrence Valley. On the west coast raised beaches occur at 650 feet A.D. near Vancouver. From northern Canada only isolated observations are available. They have been summarized for the western Arctic mainland and part of the Canadian Arctic Archipelago by Washburn (Washburn, 1947), and for the Hudson Bay, Quebec, Labrador area up to 1930 by Cooke (Cooke, 1930). More recent observations are incorporated in a map published by the American Geological Society (Flint, 1945). Before 1950 only scattered determinations of the altitude of the upper marine limit were available for the Southampton Island area (*See* Table III).

[1] A.D., Above Datum, is used throughout this memoir to indicate the height of a feature in feet above present sea-level. All altitude measurements made by the 1950 party used mean sea-level as their datum line. Measurements were made by compensated aneroid barometers (at least two on all occasions) reading directly to 5 feet and by estimation to 1 foot. Variations in barometric pressure during traverses were corrected by means of pressure readings at the base. The probable error for heights below 200 feet is estimated to be ± 10 feet and for heights above 200 to 600 feet ± 18 feet.

THE LIMITS OF MARINE SUBMERGENCE

At levels near the present sea-level a cursory examination of an area is frequently sufficient to show whether or not it was invaded by the sea. Accurately to determine the maximum height to which the sea rose is more difficult. Such determinations are, however, easier to make in Arctic areas where a thick vegetation cover is lacking than in temperate regions. The best positive evidence of marine submergence is the discovery of marine shells in raised beach deposits. Although it is possible that sea birds may carry shells inland, or that ice may have done so from the sea floor during the last glaciation, the presence of a considerable number of unbroken marine shells in a water-sorted or rolled deposit was taken by the Geographical Branch party to be positive evidence of submergence to that height on Southampton Island. Sand, gravel, and other water-rolled rock particles forming strand lines on the sides of hills are good evidence for submergence either by the sea or a pro-glacial lake. It is essential to take considerable care in differentiating strand lines from fluvioglacial deposits, and lateral moraines formed during the final stages of deglaciation. They may also be confused with river terraces. Strand lines are not reliable indicators of the exact water level of a former sea, particularly if the strand lines are numerous in a vertical plane and of the storm ridge type, because they may be formed by a continuously falling sea-level. Raised wave-cut benches are more valuable for the precise determination of former water planes, but are absent in both the limestone and crystalline rocks of Southampton Island. High level strand lines are generally more difficult to find and are less well preserved than those closer to present sea-level. This is probably due to a combination of factors, including the shorter period for which the highest levels were submerged; the absence of large quantities of residual material at the higher levels, particularly in the crystalline rock area; and to the longer period of weathering and mass wasting processes to which the older (and highest) beaches have been subjected. The number of marine shells also falls off rapidly in the highest beaches. This is due partly to the time lag between the disappearance of the ice-sheet and the invasion of the area by marine fauna, partly to the brackish and even fresh water characteristic of the "sea" in early post-glacial times[1], and also to the subsequent destruction of any shells that may have been present, by solifluction, frost heaving, and other weathering processes. For these reasons the height of the upper marine limit recorded in exploratory surveys is frequently considerably lower than the maximum height actually reached by the sea. The difficulties associated with determining the upper marine limit by strand lines and fossil shells led the author to evolve a third method. When the ice-sheet disappeared it left a variable thickness of ground moraine, depending on the situation and type of the underlying rock. In the crystalline rock areas of Keewatin the ground moraine usually consists of a thin sprinkling of small boulders and finer material that does not form a continuous cover over the rock surface. In this ground moraine area large boulders, in some cases weighing many tons, may be found balanced so finely on small stones beneath that they can easily be pushed over. It may be observed throughout Keewatin that at a constant height over large areas there is a clear cut lower level for the undisturbed ground moraine.

[1] The fact that the post-glacial Hudson Bay may not have been a true salt water sea at its greatest extent is of less importance to the physiographer than the fact that the area would be subjected to water submergence and wave action around the shores.

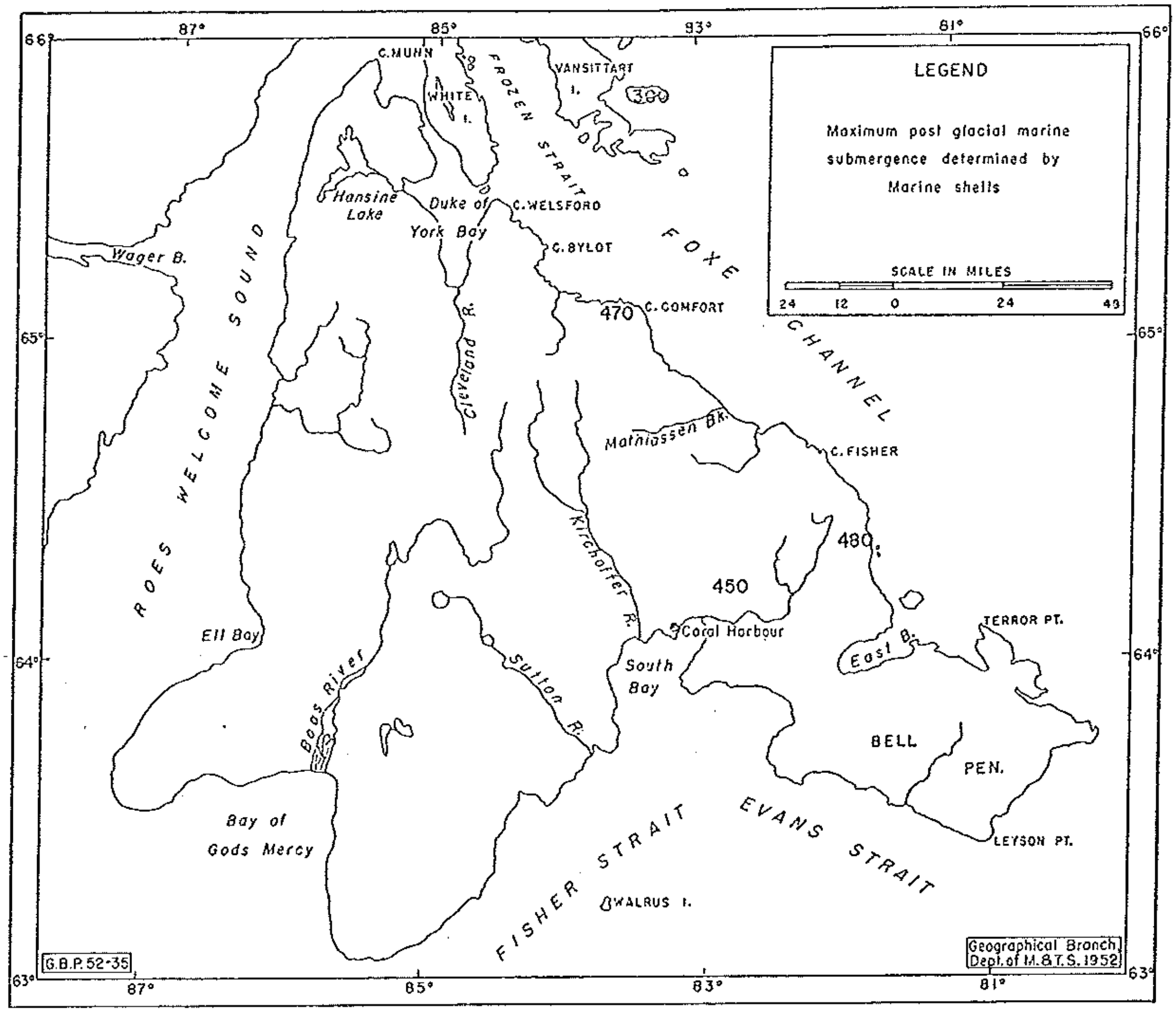

Figure 7. Southampton Island area—maximum post-glacial marine submergence determined by marine shells.

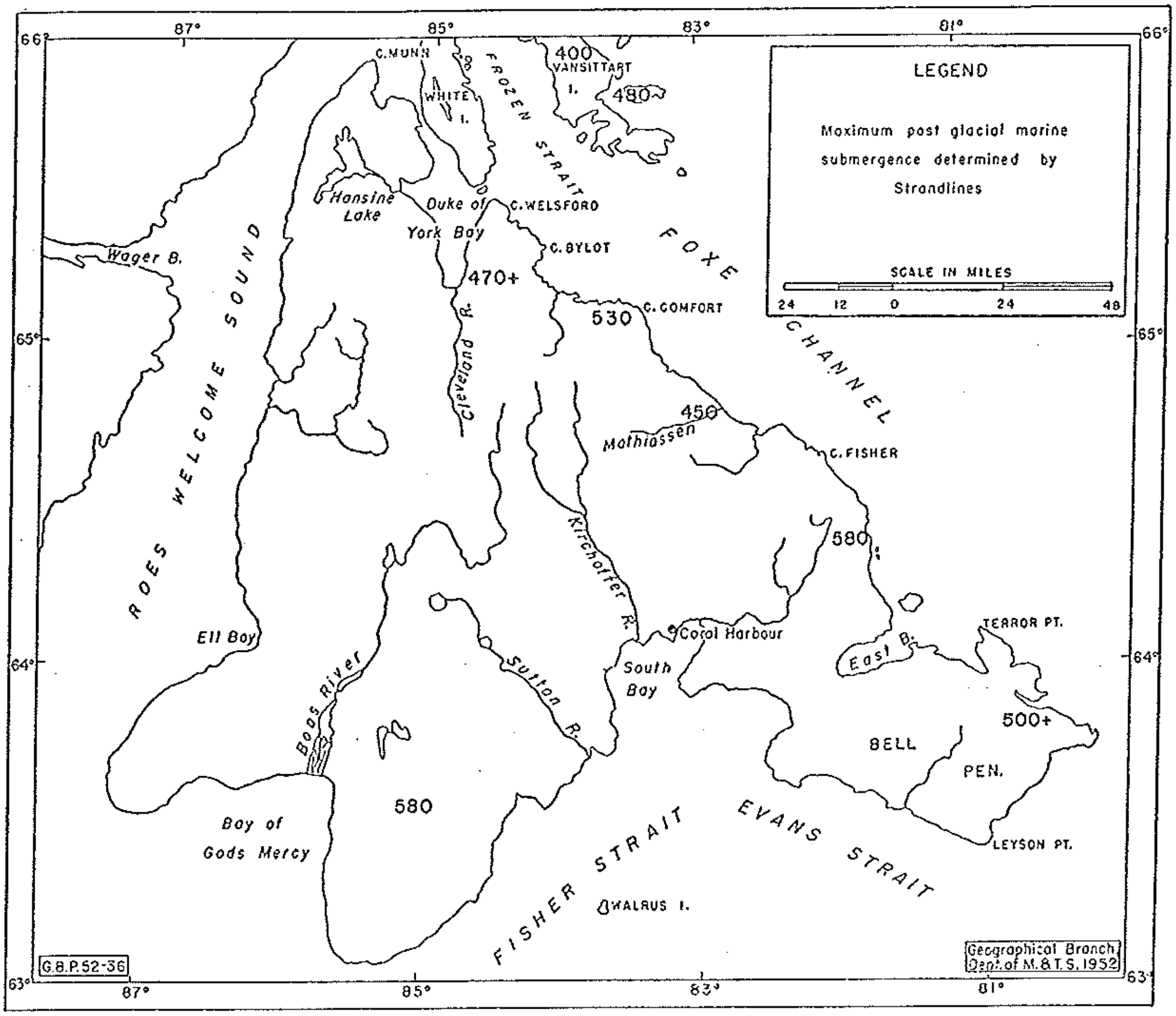

Figure 8. Southampton Island area—maximum post-glacial marine submergence determined by strand lines.

Above this height is the unsorted morainic material with perched blocks (*See* Plate III A). Below, the level rock surfaces are generally clear of morainic material. As wave action could not have failed to disturb the boulders and in some degree sort the morainic material, the lower limit of the undisturbed ground moraine has been taken to represent the upper limit of the sea. The marked contrast in the superficial deposits above and below the upper marine limit on the east side of Hudson Bay has been commented upon by Stanley (Stanley, 1936).

It must not be considered that the three methods discussed above are directly comparable even in a theoretically ideal area in which the water became salt and marine shells were present immediately the ice disappeared. On theoretical grounds one might expect the ground moraine method to give the highest reading followed by the strand line and then the shell method. In general the highest marine shells are between 60 and 100 feet lower than the highest strand line. The vertical distance between the strand line and the unsorted ground moraine varies considerably, but the former averages about 80 feet lower. Nichols (Nichols, 1936) found that the highest marine shells at Cape Wolstenholme, 60 miles southeast of Seahorse Point, were 365 feet A.D. He did not use the ground moraine method outlined above for determining the highest level of the post-glacial sea but instead used the presence of microscopic marine foraminifera in surface deposits. He found the highest level was at 550 feet A.D. The difference of 185 feet between the shells and the highest level compares favourably with an average difference of 160 feet obtained on Southampton Island.

Table III summarizes the present knowledge of the highest level of post-glacial marine submergence on Southampton Island and adjacent areas. The table shows that if the uppermost raised beach is accepted as the highest level of submergence the altitudes vary considerably without any systematic deviation. These variations may be more safely interpreted as due to lack of data, lack of formation of beaches and their frequent destruction rather than a definite variation in the upper level. Using the raised beach data conservatively, they show that the highest level was probably between 500 and 600 feet in all parts of Southampton Island, the higher level being more likely to be correct. If the ground moraine method is used the upper limit is shown to be about 600 feet. Throughout their field work on Southampton Island the party attempted to determine whether the raised beaches were tilted relative to present sea-level. Because of inadequate data, the method of determining altitudes (aneroid barometer), and the absence of well-defined beaches over any distance, it was found impossible to say whether any of the emerged strand lines are now tilted.

EROSIONAL FEATURES

After the upper limit of marine submergence had been deduced, the extent to which it had produced alterations in the landscape was investigated. Theoretically the post-glacial marine submergence could have modified the landscape by erosion, cutting cliffs, notches, and benches in both rock and unconsolidated glacial material. No such erosive landforms are, however, found in the crystalline rock area of Southampton Island. Indeed, at the present time there are no cliffs or wave-cut benches in the crystalline gneiss rocks that owe their origin to water action at the level at which the sea stands today. Everywhere the rocks dip under the sea without any break in slope. Thus, although erosion is doubtless taking

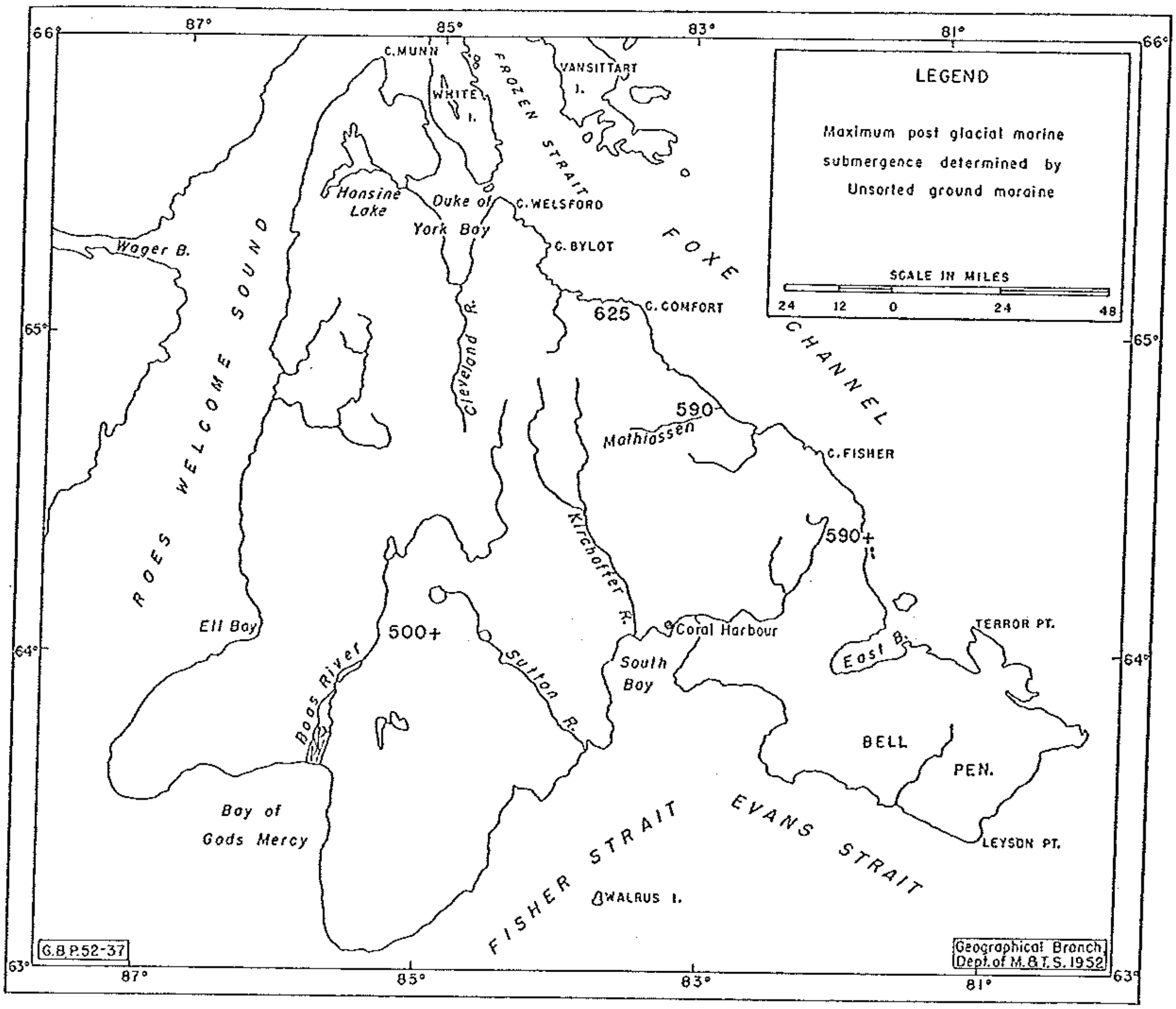

Figure 9. Southampton Island area—maximum post-glacial marine submergence determined by unsorted ground moraine.

place, it is very slow, due to the resistance of the rock and to the fact that rarely are cliffs exposed to large waves, for if a strong wind blows onshore sea ice moves in quickly and dampens down the waves. Even if the post-glacial uplift is not complete at the present day the rate of emergence is probably slower than at any time since the ice-cap disappeared. Therefore, if the sea has not been able to attack the crystalline rocks when the

TABLE III

Highest Level of Post-Glacial Marine Submergence

Position	Height in feet A.D.	Method	Observer
Bell Peninsula[1]	Over 500	Strand line	Dean (1950)
Big Corner	450	Marine shells	Manning (1942)
Munn Hills	Over 500	....	Manning[2]
The Points	Over 580	....	Manning[3]
Liver Creek	480	Marine shells	Bird
	580	Strand line	Bird
	Over 590	Unsorted ground moraine	Bird
Mathiassen Brook	450	Strand line	Manning and Bird
	590	Unsorted ground moraine	Bird
Cape Comfort	470	Marine shells	Bird
	530	Strand line	Bird
	625	Unsorted ground moraine	Bird
Duke of York Bay	470	Strand line	RCAF photo
Areas adjacent to Southampton Island:			
Vansittart Island	400	Strand line	Mathiassen (1933)[4]
Opposite Island	480	Strand line	Mathiassen
Between Gore and Repulse Bays	560	Strand line	Mathiassen

[1] A well-developed beach system at Gore Point has a maximum height of about 475 feet as measured from air photographs.

[2] In a personal communication Manning states that in all probability the Munn Hills were submerged, but that there is no direct evidence.

[3] The altitude was determined by Manning. The interpretation of the flat top as due to marine submergence is that of the present author.

[4] Mathiassen (1931) stated that marine gravels were found at 360 m. (1,200 ft.) in the upper Kirchoffer River Valley. As this is nearly twice as high as any other observation made within 300 miles of this site and none of the three main investigations on the island found any comparable height either in the same area or elsewhere on the island it is not included in the table.

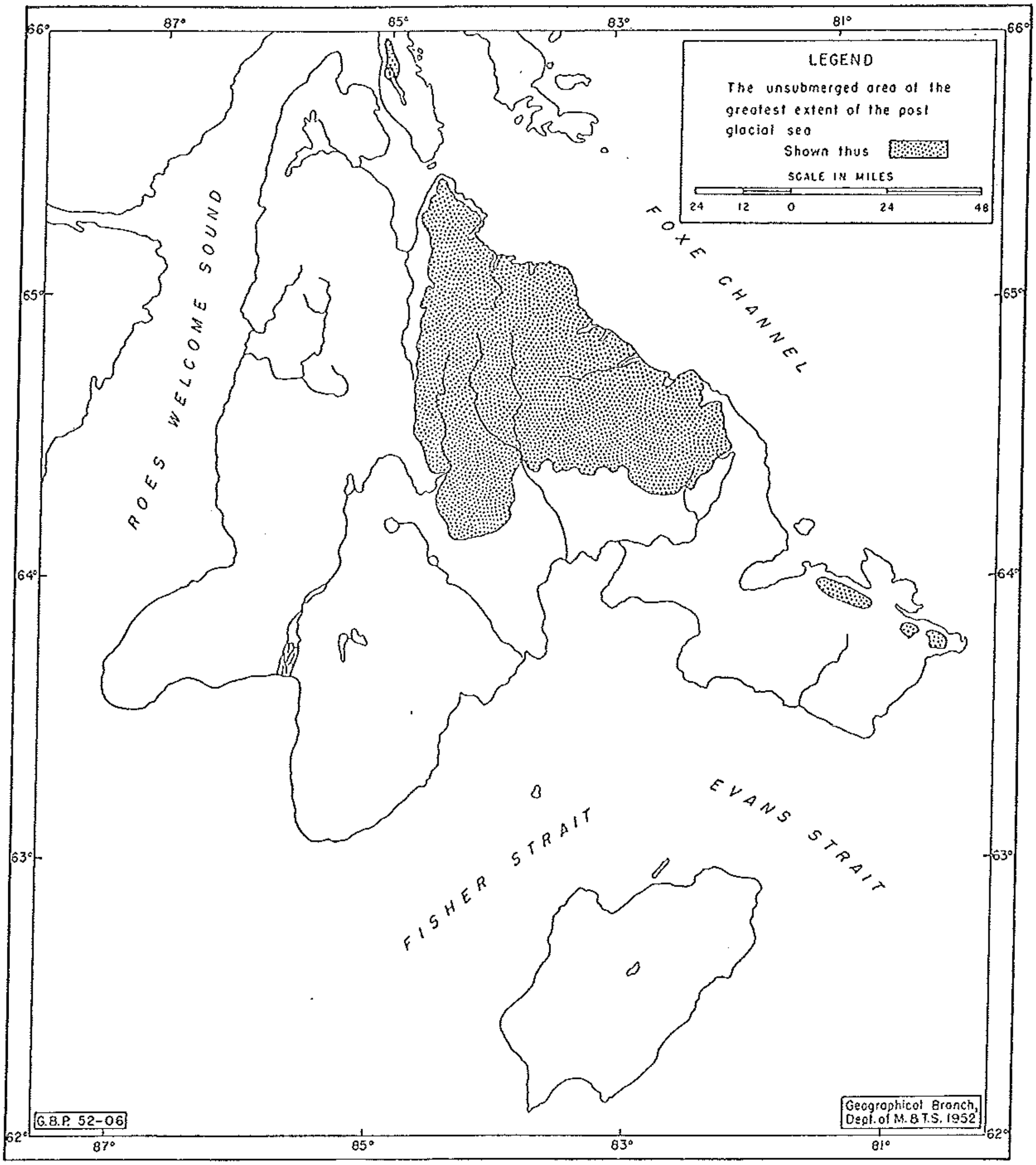

Figure 10. The unsubmerged area of the Southampton region at the greatest extent of the post-glacial sea.

rate of uplift is slow, it is even less likely to have done so when the sea-level was higher and the rate of uplift faster. Such benches and notches as do exist in the crystalline rock area have glacial striæ and smoothing on the surface, which show that they predate the last glaciation. The only variations that may be observed in the rock surface are that near the present sea-level the rock is smooth and polished whereas as one climbs upwards the surface becomes rougher and individual crystals on the rock have weathered out. The surface of the rock can then absorb a certain amount of moisture and cryptograms colonize the rock face. Even unconsolidated material in the crystalline area fails to retain bluffs cut by higher sea-levels. In this case it can hardly be that they never existed but rather that mass wasting destroyed them shortly after the sea retreated.

In the limestone areas, although the strength of the waves is no greater, the rock is less resistant and has been eroded to form cliffs in some parts of the island. How much this is due to wave action and how much to frost shattering with wave action to remove the debris so that the process is not brought to a standstill, is difficult to say. Where the offshore water is deep, cliffs exist in the limestone around the coast today, notably near Cape Donovan where they are over 1,000 feet high, in some parts of the Bell Peninsula, and on the north Roes Welcome Sound coast. These cliffs have at their base a wave-cut bench. The remnants of inland limestone plateaux are frequently bounded on one or more sides by degraded cliffs partly covered by talus. Although it is possible that the scarp edges may be of structural origin, they probably owe some of their cliff form to marine action in post-glacial times when the sea-level was higher. Elsewhere if marine submergence was responsible for erosion, the rapid weathering of the limestone since the emergence has obliterated all traces of it.

CONSTRUCTIONAL FEATURES

Although the erosional influence of the post-glacial sea has been slight, the submergence left very obvious modification in the areas that are close to present day sea-level, either by direct marine construction or by raising the base level of rivers. The constructional features often grade imperceptibly from one form to another, but for purposes of analysis they may be considered under four main groups: (1) river terraces; (2) wave-built beaches; (3) storm ridges; (4) offshore bars.

River Terraces

River terraces may be cut in bedrock or in alluvium that has in some previous period, when there was a change in base level or climate, filled in the rock valley. The latter type are not such permanent features of the landscape as the former as they are relatively easy for the river to destroy as well as to construct. Bedrock terraces formed by rivers in post-glacial times do not exist on Southampton Island. The time that has elapsed since the retreat of the ice has been so short that rivers have not been able to lower their beds by any appreciable amount and, therefore, have not cut terraces in bedrock. Where bedrock terraces do exist, such as in northeast Southampton Island, they are pre-Wisconsin in age, and as they have been glaciated the old alluvium has been removed from the surface and they are barely distinguishable in the general unevenness of the valley sides.

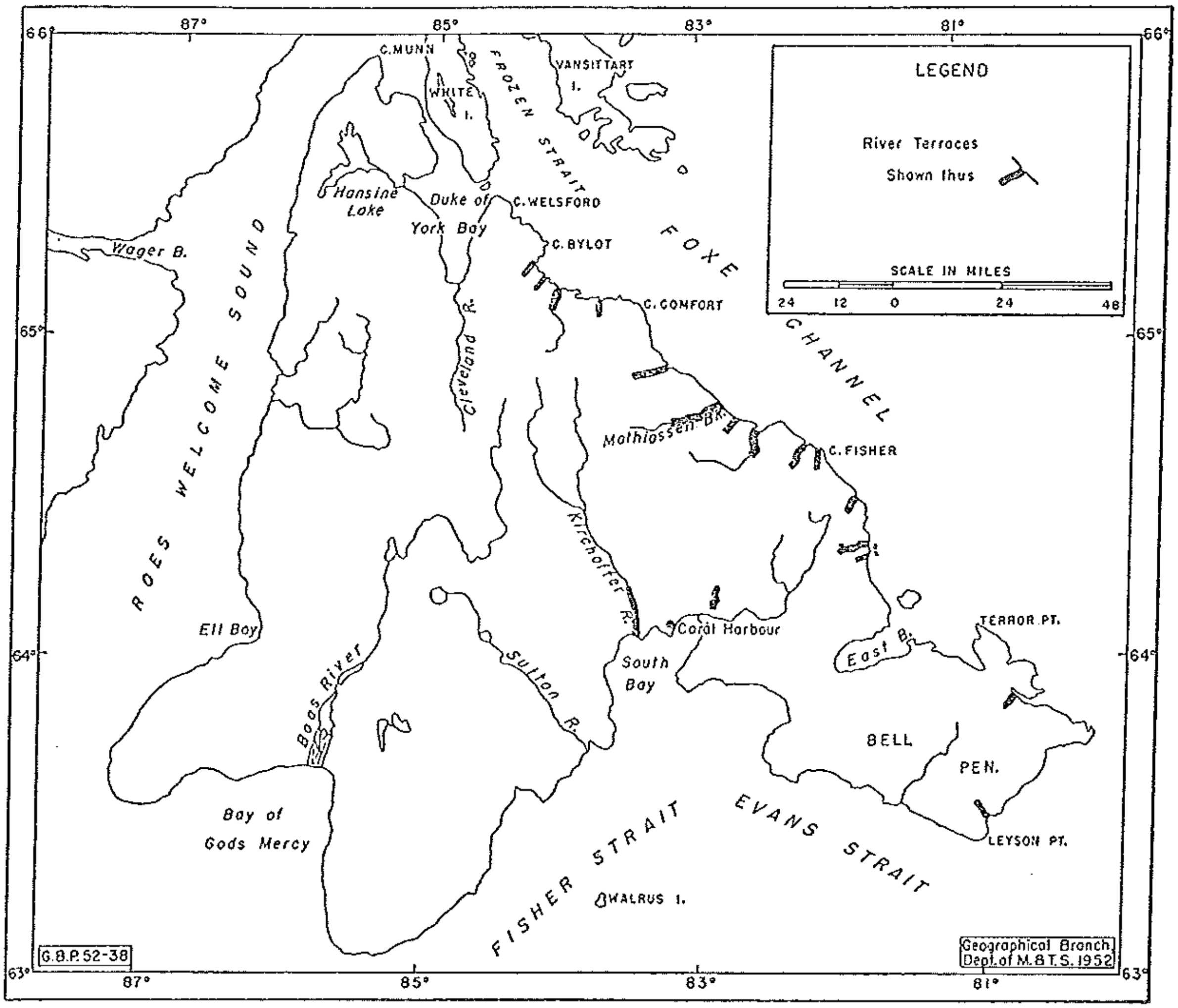

Figure 11. Southampton Island—river terraces.

Although the rivers have failed to deepen their channels in the crystalline rocks they have succeeded in entrenching into the limestone where the gradient of the river has been sufficiently steep. Even in such cases the erosion has been so rapid and accompanied by such complex frost shattering on the sides of the gorge that rock terraces have not formed.

The second type of terrace, cut in soft unconsolidated material, is numerous in certain parts of Keewatin. Till was deposited by the ice in some of the pre-Wisconsin valleys of Keewatin. On Southampton Island the middle parts of Kirchoffer and Ford River Valleys were filled in this manner. More frequently the preglacial valleys, often changed to some extent by glacial erosion, were almost empty of unconsolidated material as the ice waned and were first flooded by the sea up to the maximum height of submergence (i.e., about 600 feet), forming estuaries. Such valleys as survived through the Wisconsin glaciation in the limestone area are broad and shallow. On the crystalline rocks, many of the valleys are deep and narrow. The rivers, in the upper unsubmerged valley section carried down material and deposited it in the estuaries. The process of in-filling was hastened when ground moraine was washed from the hill-sides into the lower levels of the estuaries by streams, rain wash, solifluction, and wave action. The lower submerged parts of the valley were, therefore, filled up quickly with material. The height to which the valleys on the Foxe Channel coast were filled varies from 100 to 250 feet, but the period of time and the available material was in no case sufficient for it to exceed the higher figure. As the land emerged, the estuaries shrank in size and the base level fell until the material filling the valleys was above sea-level and subjected to river erosion. As the sea-level fell the rivers cut through the sand, gravel, and occasional boulders that form the infill, leaving terraces to mark its former level. During 1950 the Geographical Branch party measured the heights of many terraces but failed to find any correlation between adjacent valleys or frequently between opposite sides of a valley. The conclusion was, therefore, drawn that the terraces do not mark stationary periods of the base level during the emergence of the land but that they were formed by river meanderings and other accidental processes during a period of continuously falling sea-level, a fact that is borne out by examination of the marine beaches (*See* Plate III B).

Sand and gravel are the major components of the terraces. As the active layer above the permafrost is deep in summer, the surfaces of the terraces are normally dry with a vegetation cover of heath tundra or are even bare of vegetation with sand dunes. Silt deposits are so rare at any height above sea-level that no damp terraces were observed cut into them. The only wet terraces observed were those formed on glacial till, in which case the surface consists of a dense matte of sedges and grasses and is covered with hummocks or polygons.

With the exception of the terraces in Kirchoffer and Ford River Valleys the river terraces of Southampton Island are restricted to the deep V-shaped valleys found where the high crystalline plateau extends to the coast (Figure 11).

Wave-built Beaches

Three features that are a direct result of wave action are seen on the once submerged area of Southampton Island. They are wave-built beaches, storm ridges, and marine bars. Except in certain of the cliffed coasts, beaches exist all around Southampton Island at sea-level, from a point above high water to below low water. In the crystalline area beaches are restricted to bays where the plateau reaches the sea, and those parts of the coast where the backshore has a low elevation. Sand is usually present around the low water mark and the higher parts of the beach are mainly pebbles, cobbles, and boulders. This sequence is not unusual in other parts of the world, but appears to be accentuated under arctic conditions by the sea ice, which pushes the larger stones up the beach. They are then out of reach of later high tides that might wash them down again. Sand is absent from the limestone beaches and is only found at river mouths. The absence of any large number of erratic boulders, coupled with the tendency for limestone to shatter readily, has resulted in beach material of a constant size at all levels of the limestone beach. Although in the crystalline area most of the present beaches appear to be forming in situ, most of the limestone beaches, particularly in areas where the underwater gradient is slight, are offshore bars that have been built up by accumulation of material and a fall in sea-level.

Theoretically, if the sea-level drops a distance greater than the tidal range before the waves can appreciably modify the beach, an entirely new beach should be formed at the new level. If, on the other hand, the sea-level is dropping continuously, the beach is modified as it rises relative to the water-plane; the part of the beach that was around low water rises first to mean sea-level and then to high water before becoming permanently above the sea. The result, if the beach is made up of material varying in size, is that the beach is graded, the coarsest material being found at the high, old beach levels. Any large storm, or series of storms, may throw up a greater quantity of material than is washed down by normal wave action. This material remains in the form of storm ridges as the sea-level drops.

True raised beaches, preserving all parts of the former shore, are extremely rare on Southampton Island. They are found preserved in protected positions around the crystalline upland. Such raised beaches have little value for deducing tilts of strand lines as they lack continuity and owe their preservation to position rather than to height. They frequently contain marine shells. At the one extreme raised beaches grade into river terraces, at the other they degenerate into storm ridges. On the steep slopes of the limestone plateaux, features closely resembling true raised beaches are not uncommon. They may be beaches in the strict sense of the term but are more probably offshore bars that retreated inshore before the sea-level fell.

Storm Ridges

Large areas of storm ridges are common in many parts of the crystalline rock area. They occupy the backs of small bays, rising in regular steps of from 3 to 10 feet from present sea-level to as much as 400 feet in height. The material forming the ridges varies from small pebbles ($\frac{1}{2}$ inch diameter) to cobbles (6 or more inches across). The surface, particularly when formed of cobbles that are covered with lichen, is difficult and tiring to walk over. The hollows between the ridges are colonized first by vegetation and may support a dry tundra complex. The ridges are rarely covered with vegetation because of the lack of available ground water. The larger storm ridges are conspicuous features when seen from the air, forming an irregular pattern of parallel lines. Storm ridges are absent from the limestone area. The only areas in which limestone storm ridges are found are on the edge of the crystalline uplands where shattered limestone has been carried onto the older rock. The regular vertical spacing of the ridges is further evidence that the emergence of the land has been continuous rather than intermittent in post-glacial times.

Offshore Bars

Virtually all the limestone areas below 100 A.D. are covered with an extremely complex pattern of abandoned beaches and associated features. The only exception is where the surface is absolutely horizontal for long distances. In such cases beach forms do not exist, presumably because the power of the waves was spent in the very shallow water, and the tides swirling over the tidal flats tended to level any surface irregularities. Two main beach forms may be recognized in the complex pattern. The first consists of ridges formed of limestone fragments raised 5 to 10 feet above the general level of the terrain and free of, or only partly covered by, vegetation. The ridges vary in length but average about a mile. They are between 5 and 25 yards wide in the middle where the structure is a simple single ridge. At either end the single ridge breaks up into a series of recurved ends. The ridges lie at right angles to the regional slope (i.e., along contour lines). These ridges are interpreted as offshore bars, formed when the sea-level was higher than at present, with ends modified by wave action. They may be observed in process of formation today. When the slope of the coast is steep the ridges are close together, frequently only separated by narrow lagoons about 100 yards wide. When the slope is gentle they are wider apart, up to 1,000 yards, and separated by seasonal lagoons and marshland.

The second type of beach form is neither so common nor so obvious in origin. It consists of narrow ridges of fine limestone fragments lying at right angles to the offshore bars and running through them out to and under the sea. In all ways except orientation and position, they are similar to the offshore bars into which they occasionally merge. They show water-sorted material on the surface[1].

The regularity in spacing and size of the offshore bars supports the theory that uplift has been continuous and at an approximately constant rate, at least at the lower levels, and as offshore bars are still forming today that the processes have not changed in type or intensity in the recent past.

The absence of a tide gauge at Coral Harbour and the lack of accurate historical charts of Southampton Island make it impossible to establish whether the post-glacial emergence of the land is still continuing. The presence of early Eskimo settlement sites up to 80 feet above sea-level and many hundreds of yards inland would probably indicate that emergence has taken place since the area was first occupied by the Eskimo. More recent Eskimo sites of the Sadlermiut period are less valuable evidence for uplift, as it is never possible to be certain that they built their stone houses as close to the high water mark as was safe from water and ice. Although emergence has been proved during the historical period from Scandinavia, which was in an analogous position to the European ice-cap that the Hudson

[1] Very similar features have been observed by the writer on the limestone plain near Cape Churchill, where the ridges stretch from 3 miles inland to 1 mile out to sea without a break; and at Cape Kendall, where they extend 6 miles offshore.

Bay region was to the North American ice-cap, it has not proved possible to show conclusively that the shores around Hudson Bay are still rising. The physiography of Southampton Island provides three further pieces of evidence concerning the rate of uplift and its possible cessation today. In the limestone areas of the island the raised beach pattern becomes considerably more complex below 150 feet A.D. In particular, the raised marine bars are more numerous and frequently show complex recurved ends. These features may be contrasted with the higher (but still submerged in post-glacial time) limestone areas where, even when the slope and situation of the surface is the same, the marine features are rare and simple in form. This suggests that at the higher levels wave action was operating on a given area for a shorter time than on a similar area closer to present sea-level; or in other words that the rate of uplift has decreased in recent times.

An examination of the shores of the limestone region reveals that offshore bars are forming today just as they did at higher water levels in the recent past. This lack of physiographic break in the small marine-produced land forms above and below present sea-level supports the view that the geomorphic processes, including an emerging land, have not changed fundamentally since the land was at least 150 feet lower than at present. On the Foxe Channel coast from north of Mathiassen Brook to Cape Welsford the shoreline is one of submergence. The lower parts of the valleys are filled either by the sea to form estuaries or with sand and gravel brought down by the rivers. In all the valleys that were examined in this area a cross profile of the valley at the mouth of the river showed that the floor was below sea-level. Again, this is not complete proof that the sea-level is still higher today than it was in pre-Wisconsin times, as some of the valleys may be glacially overdeepened. It is, however, when taken with the other evidence suggestive that the land is still depressed below its pre-glacial height.

GEOMORPHIC PROCESSES

FLUVIAL ACTION

Under the periglacial conditions that exist on Southampton Island the rivers still fulfil the three functions of erosion, transport, and deposition that they do in temperate climates. The relative importance of the three processes varies considerably, depending on the stage in evolution that the river gradient has reached and whether the underlying rock is limestone or gneiss. In general in both the uplands and the lowlands that have developed on crystalline rocks the grade of the rivers is immature. This is in part a result of the Pleistocene glaciation but it is also due to the recent geological uplift[1] that has rejuvenated many of the rivers. The "youngest" river thalwegs are found on the Foxe Channel coast where the streams have an average fall of about 50 feet a mile. These streams are made up of fast-moving water flowing over rock beds, with rapids and falls separated by sectors of active aggradation. The longitudinal profiles of Kirchoffer and Ford Rivers come closer to grade, have fewer abrupt breaks, and an average fall of about 20 feet a mile in their middle and lower courses. The longer rivers that flow on the limestone have reached a

[1] The term geological uplift is here used to refer to the regional uplift that has raised the pre-Pleistocene erosion surfaces.

mature, and in certain instances such as Boas River, an old stage, except in the parts where ice action has interrupted the profile. These rivers have an average fall of 3 to 6 feet a mile.

Despite the high velocities of the gneiss upland rivers there has been no visible erosion, except at falls, in any consolidated material since the retreat of the ice. Even at the falls, the backcutting has been slight. On Mathiassen Brook two falls have cut back 40 feet and 65 feet respectively, and the lower falls on the Kirchoffer have retreated a maximum of 100 feet since the area emerged from the post-glacial sea. Where the streams flow over rock floors, glacial grooves and striæ are preserved as fresh looking as those that are not subjected to fluvial action. In the gorge of the lower Kirchoffer the presence of glacial marks on the rock walls, till and river terraces show that little widening has occurred since the Wisconsin glaciation. The conclusion is unavoidable that in the areas of crystalline rock, erosion by running water since the Ice Age has been negligible except in unconsolidated material. Many factors have contributed to the slight erosion. The rivers are small and all except the largest only flow for 4 months of the year; the gneiss and associated crystalline rocks are resistant to erosion and, probably of greatest importance, the length of time that has elapsed since the ice—and in low-lying areas the sea—retreated is geologically very short. Where the streams flow over limestone erosive action is also severely limited, except where the gradient is steep when the streams flow in gorges. Even here physical weathering by freeze-thaw action is probably of comparable importance to direct water erosion.

Transport and deposition by rivers of waste material from till, old river terraces, and solifluction slopes occur in summer in all parts of the island. In this way lakes and other irregularities, formed by the over-deepening of ice action in valleys, have been obliterated since the ice-sheet disappeared.

WIND ACTION

Wind as an agent of transport is limited almost entirely to the crystalline rock areas of the island where sand is found. The physical characteristics of limestone preclude the formation of large quantities of sand in those areas. Quantities of sand are found in the valleys of the Foxe Channel streams where aggradation is in process today. In such areas the good drainage, in summer, of the sand combined with a deep active layer over the permafrost leads to an incomplete vegetation cover. Under such circumstances winds blowing with considerable velocity through the narrow valleys whip up the sand into minor sandstorms; small areas of sand dunes being the visible result. In two cases it was observed that blown sand had buried large snow banks, formed during the winter in erosion gullies cut in sandy river terraces. The buried snow had turned to clear ice and was melting slowly with pseudo-kettle hollows forming on the surface above it.

MECHANICAL WEATHERING AND SOIL STRUCTURES

The intensity of mechanical weathering and mass wasting is much greater in the limestone than on the Precambrian crystalline rocks. The most striking feature of the limestone terrain is the great thickness of the regolith. All limestone surfaces, with the exception of the steepest cliffs, are covered with shattered limestone fragments that vary in breadth from a foot to a maximum of over 10 feet. Although some of the fragments may be ground moraine from the ice-sheet, the great part has formed in post-glacial times by freeze-thaw action disrupting the bedded limestone beneath. Frost shattering is so intense that, even in the abandoned bars and beaches close to sea-level and formed by the sea in a very recent period, all evidence of water smoothing has disappeared (*See* Plate IV A and B).

The limestone fragments are rarely found lying haphazardly except at the base of old cliffs or horizontally as might be supposed from their mode of origin. Instead, they are arranged in patterns that normally assume polygonal forms. Where the vegetation cover was not complete two major types of polygon were recognized. Most common is a polygonal type varying in diameter from 2 to 5 feet. The edges are formed of limestone plates standing on end. In the centre are a few horizontal limestone plates, but mainly gravel and fine limestone fragments. When vegetation is present there is a tendency for it to be in the centre of the smaller polygons, but outside the large polygons. Even in areas where polygons cannot be recognized, irregular patches of limestone standing on edge are found. They make for very tiring walking, which rapidly destroys boots or mukluks. When the limestone surface is sloping both polygonal and irregular soil structures are elongated and form stone stripes. Polygonal forms of the type discussed above are too small to be identified on high altitude air photographs but stone stripes that may reach a length of over 100 yards are visible when there are a number of parallel stripes, as they reflect different quantities of light from the normal limestone surface.

The second major soil structure type is that of clay "boils"[1]. These features are circular patches of clay $1\frac{1}{2}$ to 4 feet in diameter in which are embedded small fragments of limestone and almost invariably marine shells. The clay "boil" is wet in summer and when excavated it fills up with more clay and water as rapidly as the hole is made. Around the edge of the clay boil there is occasionally a ring of stones and always vegetation. Clay "boils" are not limited to the areas underlain by limestone but are also found in the lowland crystalline rock zones. In no case were they found above the upper limit of post-glacial marine submergence. Their position combined with the presence of marine shells and limestone fragments even in gneiss areas suggests that they are connected with the marine submergence.

In areas where a closed plant community exists polygonal forms were also observed. They are not of stone origin but are formed of peat. The polygons vary in size from 5 to 20 yards in diameter, the upper surface being covered with grasses and sedge. They are separated from each other by trenches 2 to 3 feet deep and 1 yard to 3 yards across. In the bottom of the trenches coarse gravel or limestone plates are visible, the vegetation being less complete than within the polygons. Small dwarf willows are frequently found in the trenches. Such polygons often have a hummocky surface. In some of the wettest areas where there is a layer of peat beneath sedge and grasses, polygonal forms have not developed but instead there are scattered large hummocks. These are produced by the growth of ice lenses beneath the peat, which pushes it up into hummock form. When the hummocks reach about 2 feet in height the crests begin to split and the ice lens may be seen through the peat.

[1] The term clay boil is not ideal, as it presumes a special origin for these features, although it is highly descriptive of their appearance. Perhaps nonsorted circle, as used by Washburn, 1950, is a more suitable term.

Small features connected with soil structure phenomena are the long, straight or gently winding fissures that are common on loose gravelly limestone surfaces (*See* Plate V A). The fissures are V-shaped or less frequently U-shaped in cross-section and average about 1 foot deep and 2 to 3 feet in breadth at the top. They show no relationship to slope, form no obvious patterns, and when two fissures meet they may do so at any angle.

The majority of soil structures that have been discussed here are developed in the limestone terrain and crystalline rock lowlands. In the gneiss uplands soil structures are widespread on horizontal surfaces but are not so obvious or well developed as on the limestone. The upper erosion surface on the plateau top is for the most part covered with a layer of shattered rock fragments that is as deep as the rock mantle over the limestone bedrock. It also shows both sorted and unsorted polygonal forms.

Mass movement of material in the limestone part of Southampton Island is limited. Solifluction was not observed in the lowlands, probably because in areas where the slope is sufficient for downward movement the thawed upper layer is deep and dry, whereas in the areas where the upper layer is wet the surface is horizontal. In the uplands, on the other hand, solifluction is widespread. Along the Foxe Channel coast area solifluction is rather restricted because the slopes are so steep that most mass movement is by rockfall. Solifluction reaches its greatest importance in the wide upper valleys of the Kirchoffer and the other south flowing upland streams where considerable smoothing of the more abrupt slopes has been effected by solifluction.

Frost heaving is a process of considerable importance associated with physical weathering at certain altitudes on the crystalline rocks of Southampton Island. Frost heaving is the name given to the process by which blocks of rock are raised above the surface where they proceed to disintegrate. Under arctic conditions water percolating down through joints suitably situated freezes. The resultant expansion of the ice eventually lifts a block weighing many tons. Once above the surface, the block breaks down relatively quickly and the end stage is reached when the block disappears and the only evidence for its existence is found in the square hollows on the original surface[1]. On Southampton Island frost heaving is found only in the crystalline rock areas. Around Coral Harbour, which is within 200 feet of sea-level, frost heaving has lifted the blocks only a few inches, destroying the smoothness of the glaciated surface but not displacing the surface, except in a vertical sense. Frost heaving is more intense on higher surfaces up to about 550 feet, at which level whole blocks were observed that had been lifted 5 to 6 feet and have begun to disintegrate. Above this level, corresponding roughly with the upper limit of marine submergence, rock heaving is less important because bare rock surfaces are rare, the surface being covered with either ground moraine or frost shattered rock. Since heaving apparently does not develop when the rock surface is covered by vegetation or rock debris it is absent from all the higher levels of the island.

[1] This process has been commented upon by many observers in arctic North America. One of the areas where it is best developed is on the greywacke ridges near Churchill, Man., where all stages of the process can be seen. For a detailed study of frost heaving *See* Yardley, 1951.

NIVATION

Erosion by land ice is insignificant at the present time on Southampton Island as there is no permanent ice. There are, however, large snow banks in the northeast of the island that persist from year to year, and are responsible for a limited amount of erosion. In late summer the largest banks are found in the valley gorges of the smaller streams near Cape Comfort. In September 1950 two snow banks in this area were over 150 feet high. It is difficult to estimate the amount of erosion that is proceeding beneath the snow on the rear rock wall. A number of smaller snow banks were examined in July, and the area they occupied again in September after the snow had melted. In the area occupied by snow earlier in the summer, no unshattered bedrock was visible, the shattering that had gone on around and under the snow having been far more intense than elsewhere in the vicinity. The snow was preserved until late in the season in small rocks hollows, but it could not be proved whether the hollows were formed by nivation. One thing was evident and that was that unless the shattered material could be removed in some way the nivation process would eventually come to a halt. No solifluction lobes were observed leading from snow banks resting on rock although they were from similar hollows in till. Such material as was moved was apparently carried out by small streams issuing from the foot of the snow bank, below which they deposited a fine sandy clay. Although when examined in detail the nivation processes are strong, they have done little to modify the landscape since the retreat of the ice. The areas occupied by snow banks are clearly visible long after the snow has melted as they are free from the dark rock lichens that cover the upland rock surfaces and hence appear lighter in colour.

Around the bases of some of the largest snow banks low walls of boulders were found. These were at first thought to indicate ice movement either at the present time or in the recent past. Close observation showed, however, that shattered rock from the rock wall to the rear of the snow bank occasionally glissaded down over the summer surface of the snow bank to form eventually the rock walls.

CHEMICAL WEATHERING

It has long been recognized by geomorphologists that under temperate and tropical climatic conditions a landscape that has developed on limestone (or other soluble rock) exhibits special landforms. Although large areas of the Canadian Arctic islands are underlain by limestone no attempt has been made to discover if the erosion cycle of limestone in warmer climates is also applicable to the Arctic. On Southampton Island many of the higher limestone areas are true deserts in summer. No water can be seen, soil is absent, and vegetation is negligible, and when present is only of the lowest order such as lichens. When the occasional streams do occur they occupy deep gorges.

A closer examination of the landscape shows that the differences between limestone terrains in polar and temperate latitudes are great, and that all the features of the arctic limestone terrain that simulate warmer lands may be interpreted in terms of the intense physical weathering and not chemical solution[1]. Certain small streams in the limestone area of

[1] Other authors take a different view. Manning (1942), explains the depressions on the Points as due to chemical weathering of caverns the roofs of which subsequently collapsed (*See*, however, page 18 of this memoir for another explanation). Raisz on his "Landform Map of Canada" has a legend on the west of Southampton Island that reads "Limestone + gravel plain with sinkholes and small lakes".

Southampton Island disappear suddenly, but examination shows that they do not disappear down fissures but percolate through the upper layer of shattered limestone plates, and that the water is either flowing on the unshattered limestone at the base of the plates or, more rarely, on top of the permanently frozen ground, which is frequently, in summer, 3 to 4 feet below the surface. No caves have been observed in any of the limestone outcrops inland although they are found in the modern cliffs near Leysen Point. Here they are not due to solution but are apparently normal sea caves formed by marine erosion. The origin of the stream gorges is not so certain, but it is suggested that they do not owe their main characteristics to either stream erosion or solution but rather to intense physical weathering. Lakes are uncommon where the limestone is bare of vegetation and are only numerous where there is surface vegetation and where the drainage is less complete. The shape of the lakes is not identical with solution hollows developed in limestone in other parts of the world, but the form is similar to other Arctic lakes that have developed on rocks in which structure has not been the guiding agency.

Limestone scenery has special characteristics in the Arctic but the active processes are very different from those in the south. If it is possible to consider a cycle of erosion in the Arctic where the recent physiographic disturbances have been very great, the limestone cycle is a special case of landscape as developed under normal processes of erosion and not an entirely different cycle.

ICE RAFTING

Ice rafting is of considerable importance in the physiography of Southampton Island. It has long been known that sea ice is frequently laden with debris. Many reports of islands in Arctic seas, which have on later investigation been proved non-existent, are believed to have been due to debris laden ice being mistaken for land. Since the seventeenth century explorers have commented upon the "dirty" condition of the sea ice around Southampton Island, particularly in Foxe Channel. Old sea ice is frequently covered with sand, fine gravel, and the occasional boulder. Debris may become incorporated in the ice by many ways, including falling onto the ice from cliffs, being brought down to the sea in river ice, and in the case of finer material being blown onto the ice. The most important factor on Southampton Island is, however, the freezing of inshore ice on to the bottom. In this way sand, gravel, and boulders are frozen into the sea ice. If the material is frozen at low tide, movement of the ice and freezing at other stages of the tide may add more ice and more debris throughout the winter. When the upper surface of ice and snow melts in spring the stones appear through on the surface. As the sea ice rarely melts completely before it breaks up the debris may be carried long distances before it is finally deposited. This process was observed in operation at Coral Harbour in late June when the debris on the *surface* of the inshore ice at that time was estimated to be 10 tons per acre of ice. No conclusion can be made from this figure of the quantity of material moved around the coasts in a year because it varies greatly over short distances. It must, however, be enormous, and over long periods of time, by itself, redistribute the shore material. For this reason it is difficult to draw any conclusions from erratics found on the land surface at a height lower than the maximum height of the post-glacial marine submergence.

It is believed that ice rafting is solely responsible for the limestone rocks found in the Cape Comfort area of the northeast of the island. Limestone fragments are common in the present day beaches along that coast but the amount of limestone falls off rapidly in the raised beaches until, at and above the highest level of submergence, no limestone is found.

CHAPTER III

REGIONAL PHYSICAL GEOGRAPHY

GENERAL STATEMENT

Southampton Island shows diverse landscapes as a result of the difference in structure, the varying degrees to which the different parts of the island have responded to the geomorphic processes, and the uneven physiographic development. Thus, in order to make a detailed description and explanation of the physiographic features of Southampton Island, it is desirable to divide the island into a number of smaller areas in each of which it is possible to recognize some unity of landform and physiographic development. On a basis of rock structure it has been seen that the fundamental division is between the crystalline rock area, part of the Canadian Shield, and the limestone area, physiographically part of the Hudson Bay Lowlands. The Canadian Shield area may be further subdivided into three smaller units on a basis of physiographic history. All crystalline rock areas that have been exhumed from beneath a limestone cover during the last major cycle of erosion are placed in one group, areas in which the Southampton (upper) erosion surface is completely preserved are placed in a second group, and areas where this erosion surface is only partly preserved, in a third group. These groups are finally subdivided into physiographic subregions for descriptive purposes.

In the limestone areas the criteria used for the crystalline area are unsuitable. During the field work undertaken in 1950 it was recognized that erosion surfaces, independent of rock structure, are also preserved in the limestone area. The highest of these, at Cape Donovan, is of the same age as the Southampton (upper) erosion surface on the crystalline rocks. In the south and western parts of the island lower erosion surfaces are extensive and presumably date from periods of still-stand in the regional uplift, such as produced the rock benches on the Foxe Channel coast. The limestone areas on Southampton Island may be subdivided into two parts on the basis of the preservation or absence of these lower erosion surfaces. In some cases the boundary between the two surfaces is marked by scarps and may be accurately delineated, in others, glaciation, marine erosion, and mass wasting have modified the junction between them.

CANADIAN SHIELD

KIRCHOFFER UPLAND

The largest area in which the Southampton erosion surface is preserved intact is the Kirchoffer Upland. This area in the northern interior of the island is drained by Kirchoffer and Ford Rivers and a nameless river that enters the sea near Coral Harbour. These rivers rise in the highest part of the island, in undulating marshy terrain that forms the Southampton erosion surface between 1,300 and 1,600 feet above sea-level. All three rivers show a dendritic drainage pattern. Considerable local river capture has occurred between the various tributaries and also with the Foxe Channel rivers during the present erosion cycle. The latter streams in particular

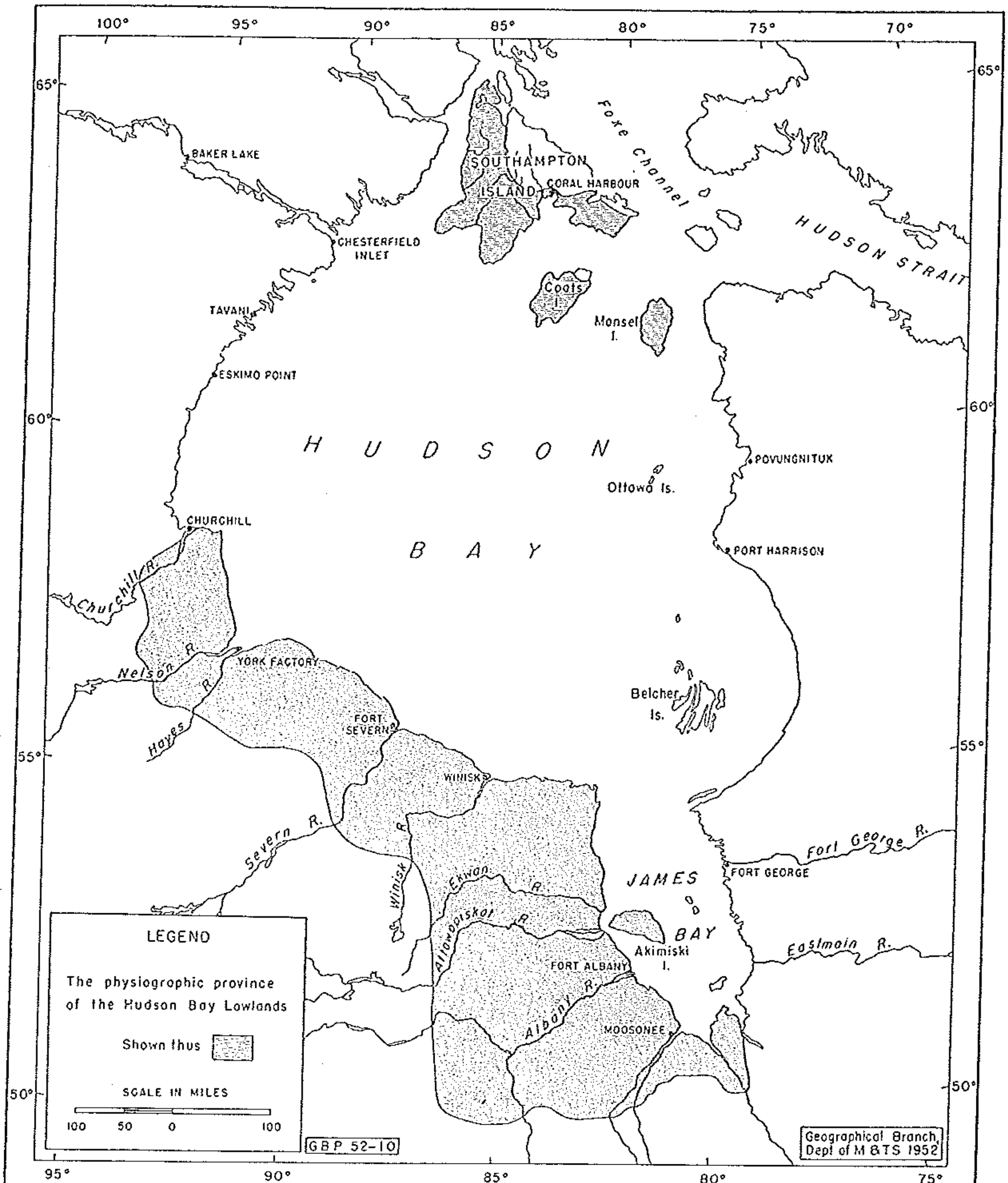

Figure 12. The physiographic province of the Hudson Bay Lowlands.

have captured the headwaters of Ford River. All three rivers flow in wide, mature valleys in which any sign of structural control, a feature common in many other parts of Arctic Canada, is absent.

There is little evidence of glaciation in the Kirchoffer Uplands. The surface is composed mainly of "Felsenmeer". Shattered fragments of the underlying rock form a continuous mantle of debris, which is damp and supports "hillock" tundra in the depressions. On the interfluves the terrain is dry and barren. The sides of the hills and the valley floors have scattered deposits of gravel and sand that are interpreted as fluvioglacial deposits from the small stagnant ice-cap that occupied the uplands during the final stage of the Pleistocene glaciation. The most striking feature of the region when contrasted with other arctic areas is the complete absence of medium or large sized lakes.

The western boundary of the Kirchoffer Upland is the 600-1,000 feet high, fretted scarp that overlooks the western limestone lowland. On the north and east the boundary is the watershed of the Foxe Channel rivers, which, unlike the rivers of the Kirchoffer Upland, are incised into the upper erosion surface. The southern boundary is not distinct along its whole length but merges with the South Bay lowland.

TABLE IV

The Physiographic Regions of Southampton Island

1. Canadian Shield	
(1) Southampton erosion surface present	A_1 Kirchoffer Upland A_2 Cape Welsford Upland A_3 Eastern Plateau
(2) Exhumed surfaces	A_4 Bell Hills A_5 Munn Hills A_6 South Bay Lowland
2. Hudson Bay Lowlands	
(1) Raised erosion surfaces present	B_1 Western Limestone Plateaux B_2 Bell Limestone Plateaux B_3 Cape Donovan Limestone Plateaux
(2)	B_4 Southampton Limestone Plains

CAPE WELSFORD UPLAND

This region, part of the Canadian Shield, lies to the north of a line from the mouth of Cleveland River in Duke of York Bay to Canyon River on Foxe Channel. On the ground this line coincides with a marked linear occupied by tributaries of Canyon and Cleveland Rivers. The upper erosion surface is believed to be present at between 750 and 900 feet above sea-level. It is, however, possible that the old erosion surface was in part formed on Palæozoic limestone that has since been almost completely removed. The whole area is criss-crossed by numerous streams, of which those flowing to the east are the longer. The valleys are steep sided, in some places gorge-like in character, in other widening out into glacially deepened, lake filled, rock basins. The lower parts of the eastern valleys

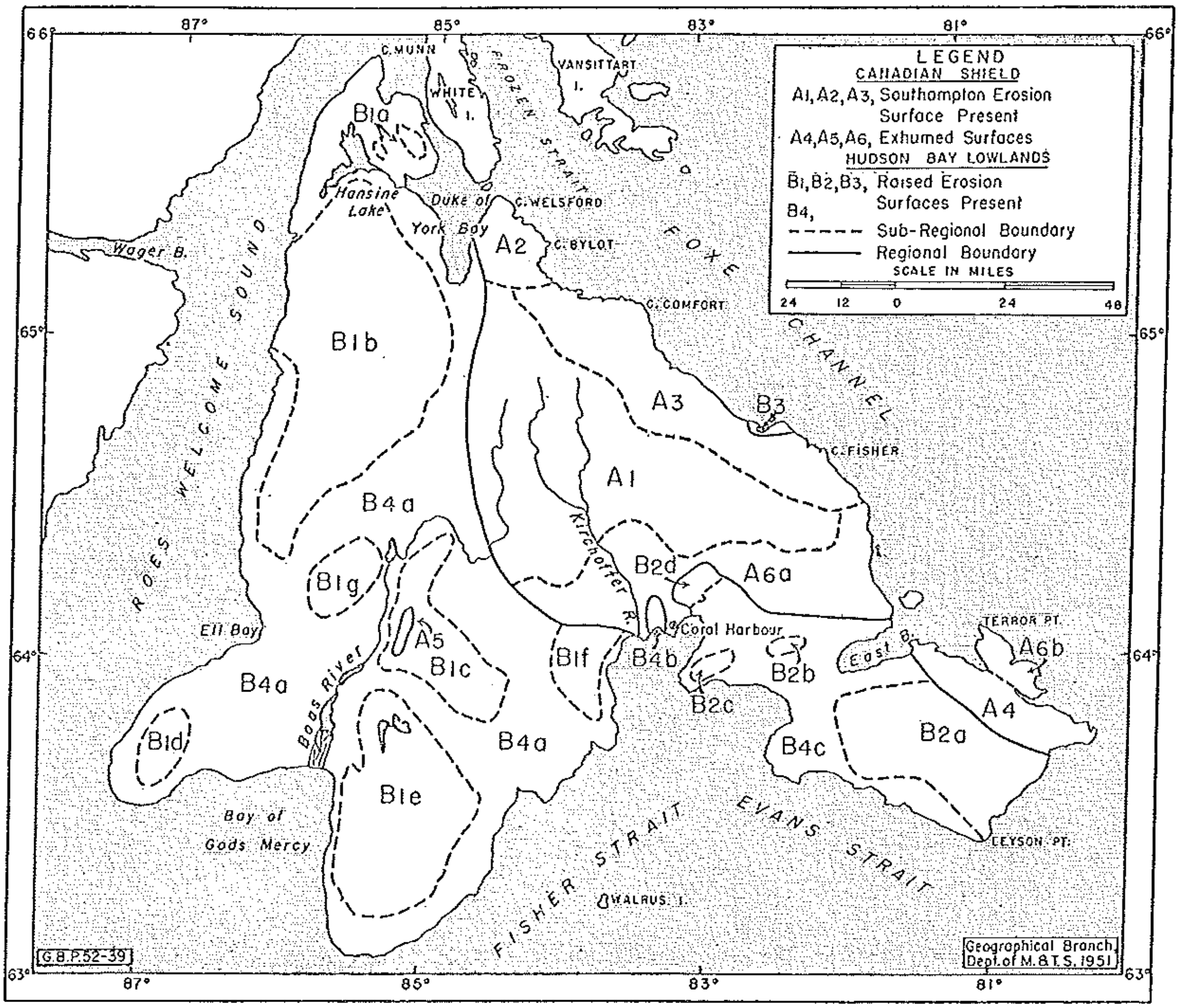

Figure 13. Southampton Island—physiographic regions.

are drowned to form small estuaries. Many of the valleys are partly controlled by short linears. One valley of greater prominence than the others is occupied by small streams and elongated lakes and extends from near Cape Welsford in a southwesterly direction for 24 miles. The linear that controls this valley is a straight line continuation of the southwest coast of White Island and they are probably structurally connected. The most conspicuous feature of the Cape Welsford Upland is the quantity of sand, limestone debris, and gneiss boulders that cover a considerable area.

EASTERN PLATEAU

The greatest relief and the most spectacular scenery on Southampton Island is found in the Eastern Plateau (*See* Plate V B). This region consists of a strip of land, 10 to 20 miles wide, extending along the Foxe Channel coast from Canyon River to a short distance north of Liver Creek. Basically the eastern plateau is part of the same Southampton erosion surface that is found in the Kirchoffer Upland to the west. The plateau meets the sea in vertical cliffs between 1,000 and 1,500 feet high, with deep water immediately offshore. The plateau is dissected by the fast flowing streams that enter Foxe Channel. The stream valleys, incised as much as 1,400 feet into the plateau, consist of broad overdeepened rock basins separated by gorges. The overdeepening appears to be associated with the Pleistocene glaciation that here moved parallel to the main direction of the valleys. The basins are either occupied by lakes or have been partly filled by the post-glacial sea and the rivers, with sand and gravel. Only one of these streams, Mathiassen Brook, has been named, but there are altogether ten major streams and an equal number of smaller creeks. Mathiassen Brook is exceeded in volume by the stream that enters the sea at Kokumiak Harbour (*See* Plate VI), and by the stream that enters on the north side of the limestone region near Cape Donovan. All the streams have rapids and waterfalls and none is navigable by even a small canoe.

Terraces are found in the lower sections of all the valleys, generally below 250 feet A.D. According to the way in which the streams enter the sea, the valleys may be divided into three categories. Some are drowned by the sea to form estuaries, which have been filled in at the head with sand and gravel. Included in this category are Kokumiak Harbour and Stanley Harbour. The fact that the mouths are drowned is not considered positive proof that the land is at present lower than in interglacial times, as the valleys in question are roughly U-shaped in cross-section and lack interlocking spurs, indicating that glacial erosion and possibly overdeepening have occurred. Streams in the second category, including Mathiassen Brook, have valley floors at approximately sea-level. Streams in the third group enter the sea by falls and occupy what are essentially hanging valleys. Most of the falls are between 140 and 170 feet high. The presence of a number of falls at similar altitudes is believed to offer further evidence that the land has risen in recent geological time independent of the isostatic changes associated with the Pleistocene glaciation. If a stream was diverted in its upper reaches by glacial action its lower valley would be empty or only occupied by a misfit stream during the subsequent interglacial. Hence the valley floor would not be deepened as rapidly as those of nearby undiverted streams. The next glaciation might well remove the cause of the stream diversion and so, after the ice had retreated, the stream would enter the sea by a fall. Although this is only one of a number of possibilities it would appear to be the most probable.

The plateau that survives between the valleys is in many respects identical with its continuation to the west in the Kirchoffer Upland. The highest points are, however, somewhat greater, reaching 1,700 to 1,800 feet. The surface is gently rolling and virtually featureless, with a thick mantle of rock waste burying the underlying bedrock. Vegetation is absent. Small streams that issue from melting snow banks in summer lose themselves quickly in the rock debris. The only lakes are small and do not exist on the erosion surface but in depressions structurally controlled and produced by differential ice erosion. In late summer the only variety on the otherwise monotonous plateau surface is formed by light-coloured rock areas that mark the position of recently melted snow banks. In the hinterland southwest of Cape Comfort the plateau surface is less dissected and somewhat lower (1,200 feet A.D.) than farther south. In detail, however, the surface is more rugged, due to numbers of ice-scoured basins and frequent low scarps.

BELL HILLS

The term Bell Hills is here applied to the ridge of gneiss rock, about 6 miles wide, which extends for 40 miles on the Foxe Channel side of Bell Peninsula from Gore Point to Seahorse Point. When seen from a distance the hills appear to have a horizontal upper surface, 600 to 700 feet above sea-level, above which Mount Minto rises to nearly 1,100 feet as an isolated monadnock. Closer examination reveals that the main ridge is dissected by streams into a number of low hills. The upper surface of the hills is generally glacially smoothed rock except at the highest levels where small rock shattered surfaces are found. The valleys between are partly filled with till and marine sorted sediments. Because of the narrowness of the ridge, it was not possible to determine whether remnants of the upper erosion surface (or intermediate levels) are preserved on the summits of the hills.

On the southwest side of the hills the gneiss sinks beneath the limestone at a height of 350 to 400 feet. The northeast face of the ridge is a fault-line scarp that forms cliffs up to 300 feet high except where the hills are joined by a low neck of land to Terror Peninsula.

MUNN HILLS

Munn Hills is the name given by Manning to the low hills in the southwest of the island. The hills are formed of crystalline gneiss and occupy an oval-shaped area whose major axis is 12 miles long. The hills have an altitude of about 500 feet (Manning, 1936). The gneiss is part of the Canadian Shield and is surrounded by the limestone plateaux. The summit of Munn Hills is the second highest point in the limestone region. For this reason, and also because the Precambrian crystalline rock is so very different in all its characteristics from the limestone, the hills are a prominent landmark in the west of the island. Their distance from the sea makes them difficult to approach except in winter.

The hills have been exhumed from beneath a limestone cover in the recent geological past. Small elongated patches of limestone as yet undestroyed by erosion have survived on the lower slopes of the hills. The elongations are parallel with the general direction of glaciation. This suggests that the final removal of the limestone from the upper surface of the hills may well have been produced by the erosive action of the continental ice-sheet. The upper surface is flat and has been swept clear of rock debris by glacial and probably post-glacial marine action. It is assumed that the hills were washed over by the post-glacial sea: there is, however, no positive evidence to support this assumption. There are three large lakes on the crystalline rock and numerous small ones. In both the present topography and the physiographic development Munn Hills are apparently a smaller and "younger" reproduction of Bell Hills.

SOUTH BAY LOWLAND

The name South Bay Lowland is given to the low-lying granite and gneiss area found on the south side of the crystalline uplands. On the northeast side of Bell Peninsula, Terror Peninsula forms a smaller but otherwise identical area. Although these two regions, the South Bay Lowland and Terror Peninsula, are geologically similar to the adjacent Precambrian areas there is little resemblance in the physiography.

The presence of small outliers of limestone in different parts of the region shows that the Palæozoic limestone covered the whole of the area in the recent geological past. The landscape we see today is, therefore, only partly a product of the moulding influences of recent geomorphic processes, as some of the landscape characteristics were acquired prior to the period of the Palæozoic deposition. In the north, Kirchoffer River enters the region in a shallow gorge, which deepens to 75 to 100 feet as the river approaches the sea. The lower course of the river is remarkably straight, and for the final 8 miles remains on resistant Precambrian rock, whereas within 5 miles on both sides are broad limestone valleys at a lower elevation. The most obvious explanation of this unusual development is that Kirchoffer River has been superimposed onto the crystalline rocks from a former limestone cover, whereas the adjacent valleys developed on limestone at a later period.

The surface of the South Bay Lowland is rolling, with ridges reaching 150 feet in height and a number of scarps. In two areas, around Coral Harbour and on the Foxe Channel coast, the ridges are controlled by folds in the granite-gneiss. Rock is exposed on most of the ridges, but in the hollows, and on all surfaces as one travels inland, there are till deposits. The till is covered with hummocky tundra vegetation except in sandy areas associated with abandoned beaches, which support heath vegetation. The scarps that characterize the region have a northwest-southeast orientation and are probably of fault origin. As the post-glacial sea submerged the whole area, raised beaches and boulder fields formed of reworked till are common.

With the exception of the three rivers (the Kirchoffer, the Ford, and the unnamed river that enters the sea near Coral Harbour) flowing into the lowlands from the Kirchoffer Uplands, the drainage is immature. Streams spill over from lake to lake without true valleys. Miniature torrents in spring, they shrink to mere trickles by late summer.

In the Terror Peninsula the relief is more subdued. Much of the surface is covered with loose debris, often of limestone origin, through which heavily jointed gneiss knobs project. All the superficial material has been reworked by marine action.

HUDSON BAY LOWLANDS

WESTERN LIMESTONE PLATEAUX

In the west of Southampton Island limestone plateaux are extensive. Eight plateaux have been recognized west of Coral Harbour. They vary in area from over 1,500 square miles to less than 10 square miles. The plateaux are interpreted as being the remnants of earlier erosional limestone plains of fluvial or marine origin, which were raised in the late Tertiary by the regional epeirogenic forces that were operating around the north of Hudson Bay. Fluvial erosion subsequently divided the raised plain into a series of plateaux, separated by lowlands. Although the majority of the plateaux form part of an erosion surface that lies between 100 and 200 feet above sea-level, remnants of a still higher erosion surface are found in small mesa-like hills that exist on the larger plateaux. Nowhere in the western limestone plateaux is the highest (Southampton) erosion surface of the Precambrian region preserved.

The surface of the plateau is generally flat or very gently undulating, more particularly where giant glacial grooves are present (region B_{1c}, *See* Figure 13). The terrain is strewn with shattered limestone, varying in size from small angular pebbles to plates about 1 foot in diameter. Although all the plateaux in this group were submerged by the post-glacial sea, frost sorting and shattering have obliterated many of the low bluffs, beach and offshore bars that must have been formed by the sea, and are such typical features of the modern limestone plains. One effect of frost sorting has been to lift the limestone plates so that they are standing on edge. When this happens a rock surface is produced that quickly cuts to pieces the pads of dogs and men's boots, if they walk over it in summer. Vegetation is almost completely lacking except around the small lakes that occupy shallow depressions in the plateaux.

An integrated drainage system has not developed on the larger plateaux (particularly region B_{1b}, west of Cleveland River). Small intermittent streams drain into lakes from which there is no obvious outlet. In some cases the small basins on the plateaux may be true areas of internal drainage because the precipitation is low and the evaporation from the limestone surface is high in summer. For the most part, however, the drainage is underground, but not in the manner of drainage in temperate and tropical limestone areas. On Southampton Island the water flows beneath the frost shattered limestone on the unbroken bedrock. Frequently the water is 3 to 4 feet below the surface and can be heard and reached by digging down to that depth. The edges of the plateaux are cliffed where they meet the sea and also in some inland localities. Elsewhere the slopes at the edges of the plateaux are gentler and covered with abandoned beaches.

BELL LIMESTONE PLATEAUX

The four limestone plateaux on the east side of South Bay are almost identical with the western limestone plateaux, and are here only considered separately on the basis of their position in the Bell Peninsula. Associated with them are three small areas of limestone on the shores of Gore and Gordon Bays. The plateaux vary in height from 200 feet to over 350 feet where the largest plateau merges with the Bell Hills. This plateau ends abruptly in cliffs between Leyson Point and Junction Bay. The upper surfaces are in general flat (part of the limestone erosion surfaces of the west of the island) and are covered with angular limestone debris (*See* Plate VII A).

CAPE DONOVAN LIMESTONE PLATEAU

This is a small area of Palæozoic limestone, 10 square miles in extent, that has been preserved on the northeast coast of the island. Its importance as evidence in determining the physiographic evolution of Southampton Island has already been suggested in an earlier part of this memoir. This limestone plateau has a much greater elevation than limestone elsewhere on the island. The surface at 1,000 feet above sea-level is part of the Southampton (upper) erosion surface found in the crystalline (A) region of the island. Intensive dissection of the plateau has only begun since the end of the Ice Age and streams flow in vertical sided gorges 30 to 40 feet deep. Lakes are lacking except in two of the lowest areas where the underlying Precambrian rock approaches the surface. Elsewhere a thick mantle of frost shattered limestone fragments bury the bedrock. The result is that when the plateau is seen from the upper surface it appears to be a rock desert without vegetation or water. The east side of the plateau is formed by a 1,000 foot high cliff against which is piled limestone talus.

Three miles northeast along the coast is a second area of limestone. It covers less than 1 square mile and has almost been eroded from the Precambrian rock on which it rests (*See* Plates VII B and VIII A).

SOUTHAMPTON LIMESTONE PLAINS

The limestone plains divide the Western Limestone Plateaux and the Bell Limestone Plateaux. All the large rivers of Southampton Island with the exception of Kirchoffer River are found in this region. The longest river is the Boas, which rises in the Kirchoffer Upland. The upper reaches of the river have been captured from Kirchoffer River. Flowing at first in a southerly direction it soon leaves the uplands and flows towards Bay of God's Mercy in a broad ill-defined channel between the four limestone plateaux of the southwest of the island. Shortly after entering the limestone plains the river widens out into a series of lakes. Fifteen miles from the sea it divides into distributaries, which occupy a strip of land 3 to 3½ miles wide. The braided character continues to the sea. At the coast the largest distributary is only 2 to 3 feet deep.

The limestone plains vary considerably in terrain characteristics. Where the limestone is close to the surface the terrain is relatively dry. Numerous abandoned limestone beaches are separated by marshland and shallow lagoons. More extensive are the flat featureless plains, poorly drained and with many irregular shaped shallow lakes. The surface is covered with a dense layer of sedge grasses and other arctic water-tolerant plants. Very occasionally a low, abandoned beach breaks the monotony of the marshland. This terrain type reaches its maximum development in the southwest of the island and in the narrow neck of land between East and Native Bays (*See* Plate VIII B).

CHAPTER IV

HUMAN GEOGRAPHY

GENERAL STATEMENT

The geographical factors influencing the location of settlement vary with the environment and the cultural level of the people concerned, and may be extremely complex (as in the location of cities) or relatively simple. This is as true of the Arctic as of the temperate and tropical regions of the world. Any study of the geographical factors influencing settlement presupposes a knowledge of the exact location of the settlement, and the nature of the environment and culture of the people who inhabit the particular settlement. When the study concerns a culture and people who are now extinct, the source material must come either from written records or, in areas of primitive communities where no written records were kept, from the archæologist.

Factors influencing the location of Eskimo settlements vary with the economy of the Eskimo group concerned. For example, in the case of the Inland (Caribou) Eskimo of the interior of Keewatin, who are dependent on the caribou for food and clothing, location factors are simple; they occupy semi-permanent settlements at traditional sites where the caribou cross the rivers in their annual migration. In the case of Eskimo groups whose economy is based essentially on sea products and is more intricate than that of the Caribou Eskimos, the location factors are more complex.

On Southampton Island the first Eskimos seen by white men were the Sadlermiuts, whose economy was based on products from the sea. Before the Sadlermiut became extinct in the winter of 1902-03, they are believed to have been the last surviving Canadian Eskimos whose culture was closely related to the once widespread North American Arctic Thule culture. The Sadlermiuts in their relative isolation on Southampton Island had developed many new cultural forms that differed from the typical prehistoric Thule culture of the mainland, but the differences between the Sadlermiuts and their neighbours on the Keewatin mainland (mainly Aivilik Eskimos) seem to have been considerably greater than the differences between the Sadlermiuts and the Thule culture peoples.

Our knowledge of the Sadlermiuts is due largely to Mathiassen (Mathiassen, 1927), who during his stay on Southampton Island in 1922 collected many stories from the Aivilik Eskimos, the present occupants of the island, who had met the Sadlermiuts before they became extinct[1]. The Sadlermiuts built permanent winter houses of stone, half of which were below ground level. The roof was built of whale ribs, baleen, and limestone and then covered with sod. Snow houses were built when travelling in winter but they were small and never occupied for a long period. In the summer a tent of sealskin held up by a whalebone frame was made. Food was entirely meat: whale, walrus, seal, caribou, birds, and fish. Heat and light came from blubber lamps, clothing and rugs from seal, caribou, and

[1] His main informants were Saorre, who died shortly afterwards, Angutimarik (Scotch Tom), who died in 1950, and Amaulik Audlanat (John Ell), who worked for the 1950 Geographical Branch party, and died in 1952.

bear skins. The sledges were of whalebone, the kayak of sealskin. Implements were made of flint, bone, and ivory. The main occupation of the Sadlermiuts was walrus hunting carried on from the ice and from kayaks. Whaling and sealing were also carried on, as well as bear and caribou hunting. The people depended, however, mainly on the sea mammals for survival, and it is in the areas in which they were most numerous and easiest to catch that the major settlements were located. Before the Thule culture peoples Southampton Island was occupied by natives with a Dorset culture. Little is known of these people.

The present inhabitants are Aivilik Eskimos originally brought from the Repulse Bay-Wager Bay areas by the whalers about 1908. The Eskimo population was increased when the Okomiut natives came to the island. The Hudson's Bay Company post on Coats Island was closed down in 1924 and re-established at Coral Harbour on Southampton Island. The Okomiuts who had, in the first place, been taken to Coats Island from south Baffin Island, were brought to Southampton Island when the trading post was established. Today almost all the implements, fuel, summer clothing, and a good deal of food, as well as untreated caribou skins used by the Eskimos on Southampton Island are bought from the Hudson's Bay Company post. The Eskimo still depends on seal for his meat, walrus for dog food, and ivory for harpoon heads, but although sea mammals still play an important part in his economy, no longer is the hunting of them his basic occupation. Instead he traps arctic fox for sale to the Hudson's Bay Company. The modern Eskimos do not build stone houses but live in snow houses during the winter and tents in the summer. In recent years even this generalization is no longer correct. Today most of the families possess a wooden shack that is their permanent dwelling place, and they only move into tents or snow houses when they are hunting and travelling.

NATIVE SETTLEMENT PATTERN BEFORE 1903

The cultural evolution of the Southampton Island natives from the earliest known Thule culture on the island to the Sadlermiut was a slow continuous process and it is neither possible nor desirable to distinguish between the two groups.

The native settlement pattern before the Sadlermiut became extinct may be deduced from three different sources. The first source is that of the written accounts of the explorers and whalers who visited Southampton Island in the nineteenth century. Unfortunately, explorers were few and were little interested in the native peoples, and whalers rarely recorded what they saw, partly because of their own inclinations and partly because of commercial rivalry with other whalers. The second source of information is from archæological sites, which are numerous on the island but have only been examined in detail by Mathiassen and Bell, and less intensively by Manning and Rowley. Thirdly, earlier population patterns may be deduced from the distribution of the non-Sadlermiut natives on the island in the present century when allowance is made for the presence of white traders in the area and the consequent change in cultural patterns.

With one exception all the sight records of natives prior to 1903 are from the south coast of the island. The exception is from the extreme north, around Duke of York Bay, a region that has been inhabited intermittently for probably at least 150 years by Eskimo from the Repulse Bay area on the mainland[1]. When Parry entered Duke of York Bay in July 1821 he wrote (Parry, 1828):

"Some of the party confidently reported that they had heard the shouting of natives, though they could not meet with them. From this circumstance as well as from the smoke which had before been observed near this place, we thought it likely that some Esquimaux were not far off, but that, never having communicated with Europeans they had perhaps been scared at our approach".

It seems unlikely from this account that the number of natives was large or Parry and his party would have found more evidence of inhabited sites, particularly as they circled Duke of York Bay in a small boat. Back failed to see any natives during his drift along the Foxe Channel coast, although he saw a number of stone rings in the north of the island.

From 1865 until 1902 the Sadlermiut were seen on a number of occasions but always in the south of the island, either in Bay of God's Mercy between Manico Point and Gibbons Point, or in South Bay at Native Point. The total number inhabiting the island at this time is unknown, but in 1896 it was at least 70 (Comer, 1910). A population of seventy is certainly a minimum figure as this was the population around Bay of God's Mercy. It is not known whether Manico Point was the main Sadlermiut settlement at this time, but it was the main area visited by the whalers, who for a time kept a whaling station there. The area is, therefore, frequently mentioned in their literature rather than the Native Point-Prairie Point areas of South Bay, which were only discovered by the whalers as the Sadlermiut were becoming extinct. Shortly after this date the Sadlermiut contracted an infectious disease, probably typhoid, and with the exception of a woman and four children who were removed from Southampton Island, became extinct. The last survivors were at Native Point.

A general impression of the population distribution in prehistoric times may be obtained by plotting the known stone house ruins and pre-twentieth century stone tent circles (Figure 14). The stone house ruins have essentially a similar distribution to that of the last of the Sadlermiuts. Of the fifteen sites on the island where stone ruins have been found fourteen are on the south coast grouped around South Bay and Bay of God's Mercy. The other important site discovered by Mathiassen is at Kuk on the west shore of Duke of York Bay. Three other stone house ruin sites are believed to exist, but have not been visited. Two of these are on the Roes Welcome coast and a third is on Caribou Island[2]. The scarcity of stone house ruins on the west coast may in part be due to lack of exploration, although Manning travelled along the whole length of that coast and could hardly have failed to observe any large stone house ruin site. The blank on the map on the northeast coast is entirely due to the absence of ruins, a close search along the whole length of this coast in 1950 having failed to discover any.

[1] See the accounts of Repulse Bay natives accidentally visiting Southampton Island, pp. 57, 58.

[2] One of the reported sites near Anchor Cove on Roes Welcome coast was visited by the author in 1952. It contains twelve house ruins.

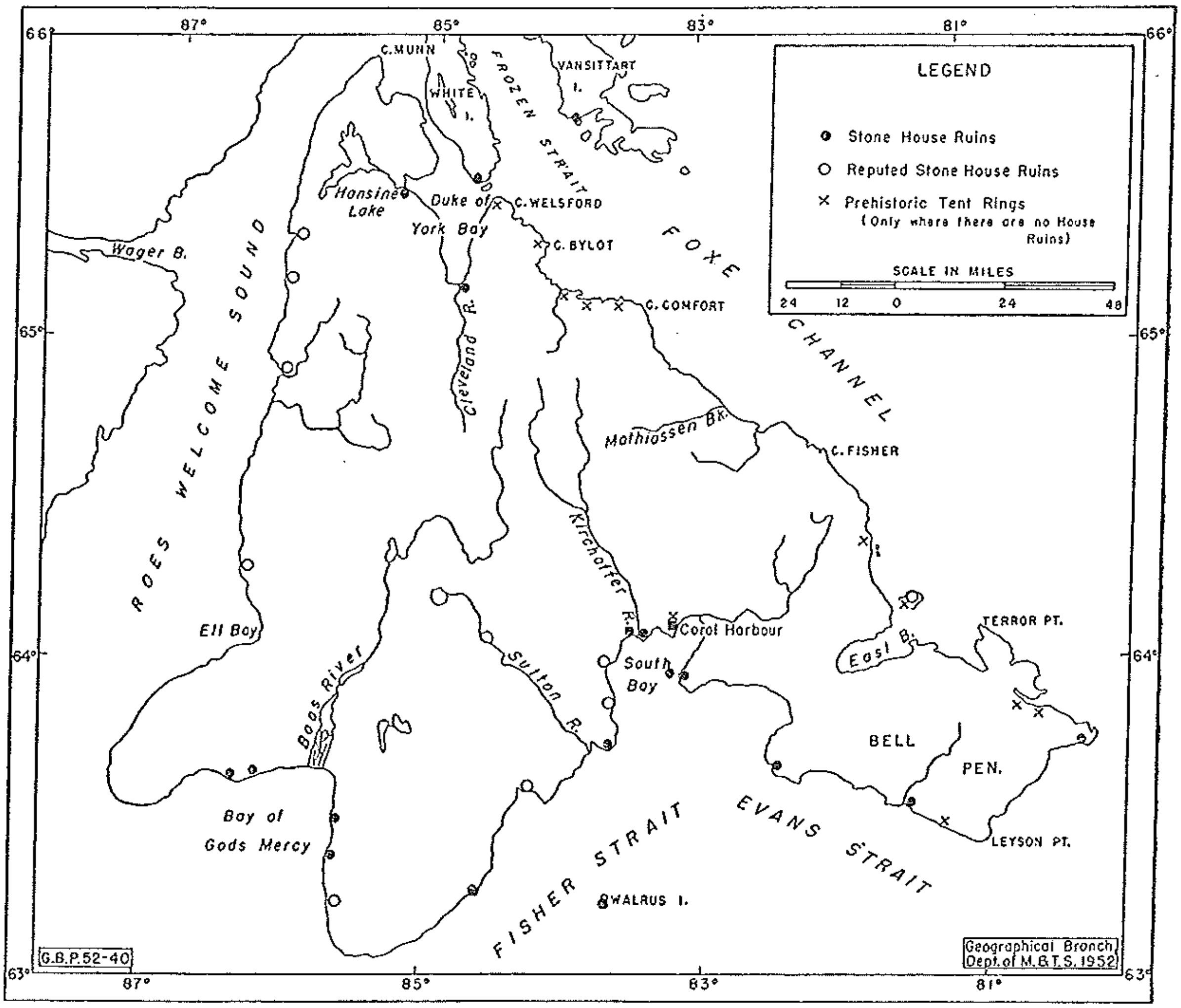

Figure 14. Southampton Island—distribution of stone house ruins and prehistoric tent rings.

Tent rings are only shown on Figure 14 where stone house ruins are absent in the vicinity. The rings indicate either summer camps when they are numerous and are associated with other semi-permanent ruins, as at Liver Creek, or the tent rings of one or two hunters, as at Seahorse Point or Cape Comfort. The two most interesting areas are at the extremities of the northeast coast on either side of the blank area from which no sites are known. At the north end it suggests that the Eskimo in spring or summer moved southeast along the coast from their permanent area around Duke of York Bay towards Cape Comfort, beyond which they would be stopped by the sheer cliffs and the absence of valleys leading onto the plateau in the hinterland. From the southeast corner of the island the natives apparently moved north in summer as far as Liver Creek where the cliffs of the Foxe Channel coast commence. The evidence from the known archæological sites supports the historical records of the distribution of the prehistoric natives. Although there is no evidence that all the sites were occupied at the same time, indeed the contrary is more probable, it does show that the south coast was the favoured area and that prehistoric natives lived neither in the interior nor on the northeast coast for any extended period of time. The highest occupation sites (at Native Point) are on a beach now 85 feet above high tide. As it is highly probable that when the houses were in use they were near high water mark, the occupation of at least part of the south coast must be old. In the northern part of the island the ruins at Kuk also suggest a long occupation, although by fewer people than in the south. The Kuk settlement was abandoned by the Sadlermiuts before they died out in the south of the island.

Finally, when discussing the distribution of the Sadlermiuts and possibly earlier prehistoric peoples on Southampton Island, certain deductions may be made from the distribution of the present-day natives, particularly in the period preceding the concentration on the Coral Harbour area after 1944. By the time Captain Munn left the island in 1918, the natives who had migrated to the island from the Keewatin mainland were permanently established. Their camps (not all occupied at the same time) stretched along the south coast from Gibbons Point on Bay of God's Mercy to Expectation Point in the east, with a concentration around South Bay. In the north one camp was maintained intermittently at Duke of York Bay. The distribution of the modern native settlements prior to the movement of the Eskimos to Coral Harbour despite the introduction of the rifle and, in later years power boats, was essentially the same as has been deduced for the earlier natives. The conclusion is obvious that, despite large changes in the Eskimo cultural pattern and in their economy, the factors at work influencing the location of settlements, at least up until World War II, were the same fundamental factors that influenced the earlier settlements.

NATIVE SETTLEMENT PATTERN AT PRESENT

The distribution of native population at the present time shows a greater concentration in a few main areas than is believed to have existed at any time in the past, either with the Aivilik and Okomiut inhabitants of the present day or with the extinct Sadlermiuts. In April 1951, the native

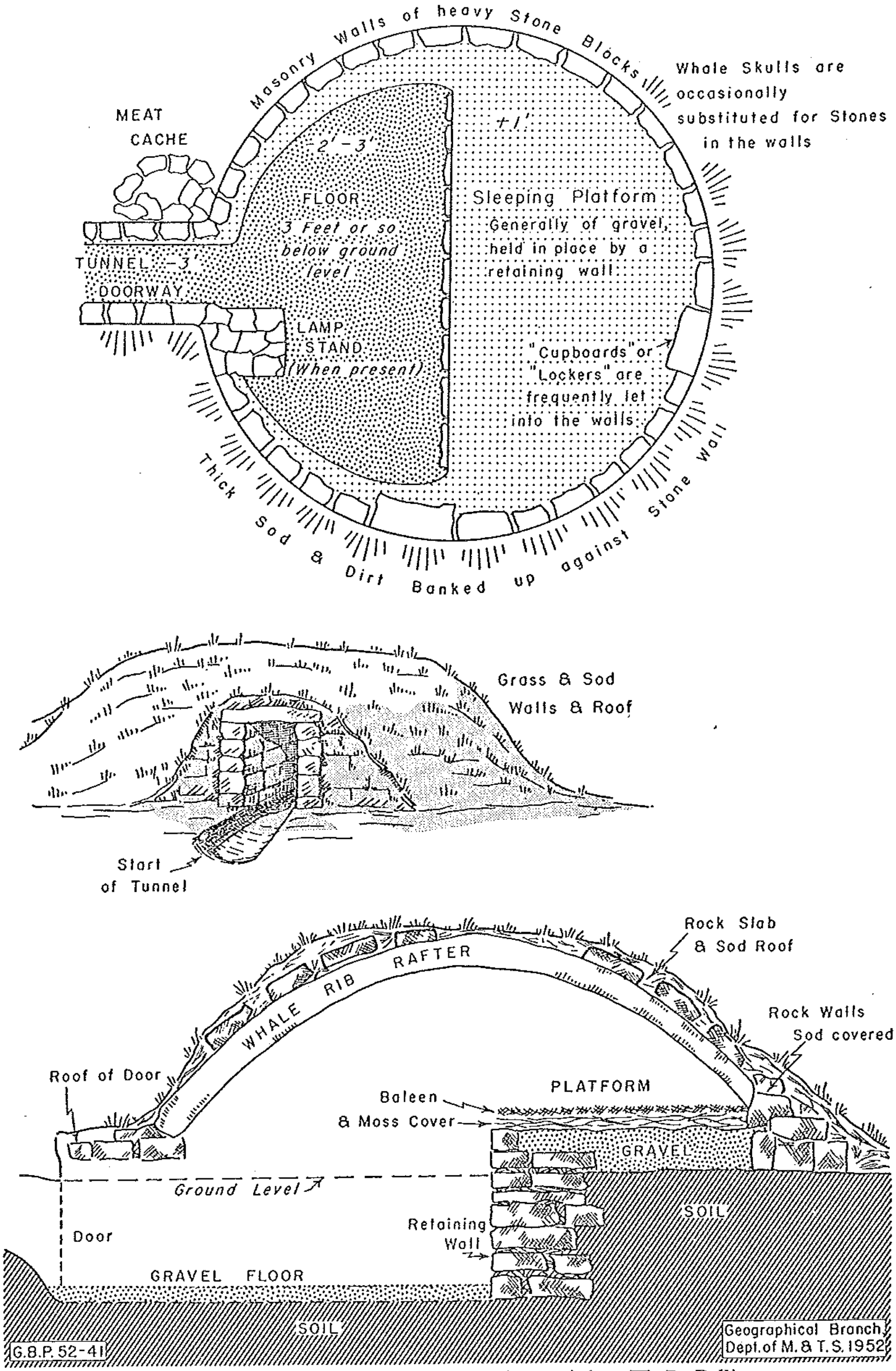

Figure 15. Reconstruction of a Thule house (after W. D. Bell).

population, Eskimo and half-breeds living as Eskimos was 238[1]. Figure 16 shows their distribution early in spring. Seventy-two were at the Coral Harbour post and 32 were a few miles away at the Munn Bay end of the road from the air strip. Nearly one-half of the native population was, therefore, living permanently at sites that had never been winter settlements before the establishment of the Coral Harbour trading post. In all, 143 natives (three-fifths) were living within one day's journey from the post. The only two groups of any size away from South Bay were the Expectation Point camp with 44 people and the Duke of York camp with 32. During the winter these figures are fluid as many of the men are away

TABLE IV

Population of Southampton Island

Year	Population	Source
1930	138	S. Ford (Hudson's Bay Company manager) quoted in G. M. Sutton, op. cit., p. 42
1934	Approx. 160	T. Manning, op. cit. p. 22
1941	139	1941 Census
1951	238	H. Copeland

hunting, either on the ice for seal, or inland for white fox. In summer, virtually the whole of the population of the south coast of the island moves to the Coral Harbour-Munn Bay area. The Duke of York Bay Eskimos move south in the summer, about every other year, generally by Peterhead boat, along the difficult Foxe Channel coast. This northern group also trades occasionally at the Repulse Bay post on the Keewatin mainland.

When the settlement pattern of Southampton Island is analysed it is found that certain geographical factors have been dominant in influencing the choice of sites of both the modern and the prehistoric Eskimos. The more important geographical factors influencing location of settlement on the island may be divided into five categories:

1. The accessibility of the different parts of the island from the mainland, the source region of the Eskimo migrations.
2. Factors connected with the distribution and exploitation of the sea mammals. These are the most important of the geographical factors, as sea mammals have formed an essential part of both prehistoric and modern Eskimo cultures. They include the physical characteristics of the sea (temperature, salinity, etc.), ice conditions around the coasts, and the form of the coast both above and below sea-level.

[1] Figures for 1951 supplied through the courtesy of H. Copeland, Welfare Officer and School Teacher on Southampton Island. Census figures and estimates of population in the years prior to 1951 are probably the minimum rather than maximum estimates of population. They show that it undoubtedly increased in the past decade.

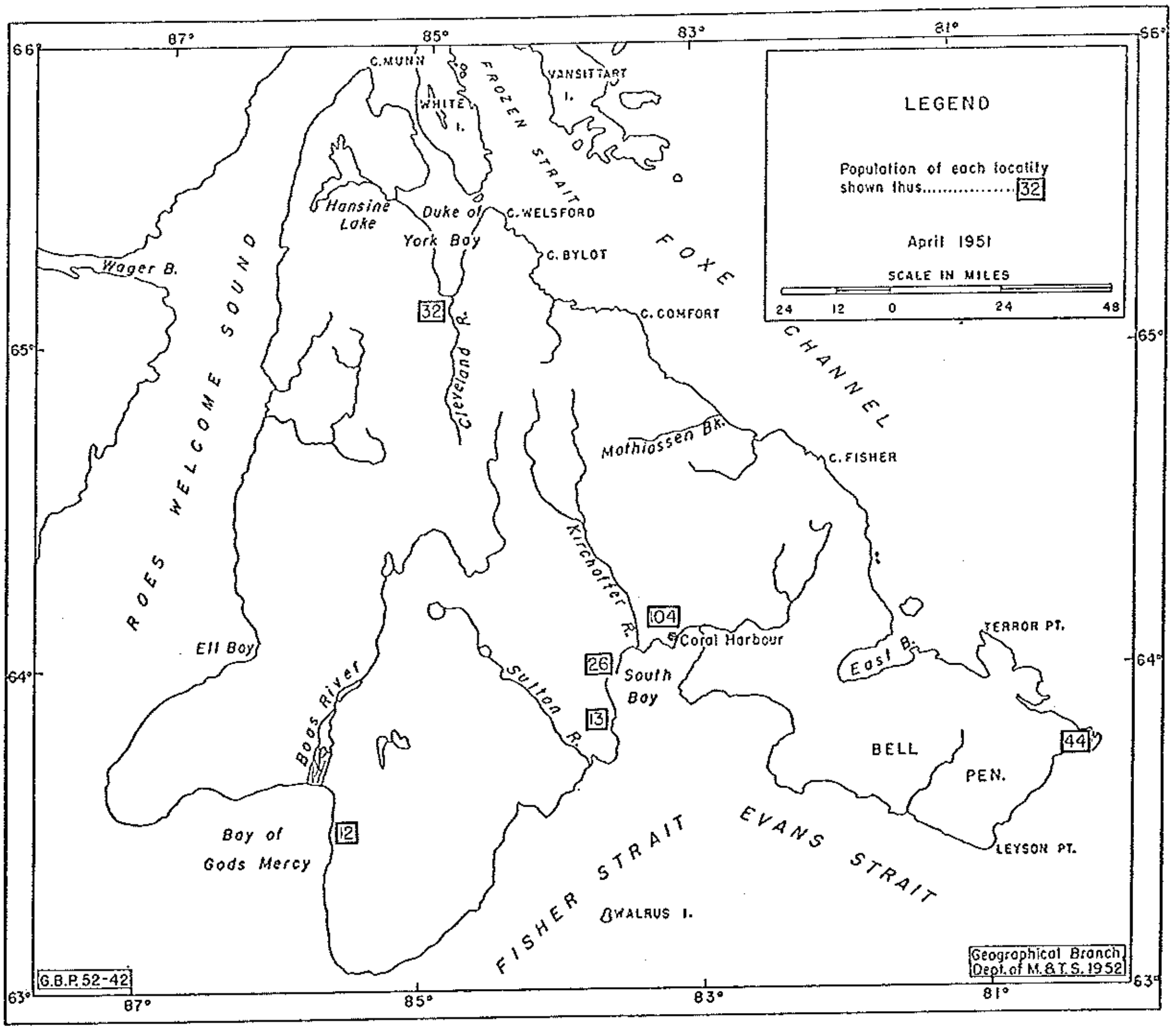

Figure 16. Southampton Island—distribution of Eskimo population, April 1951.

3. Factors connected with the distribution of animals and of raw materials on the land. These include in one case the distribution of caribou herds, bears, and birds, in the other the availability of flint, pyrite, and even wood.
4. The position of white settlements on Southampton Island—important since 1924.
5. Specific factors such as the presence of a river or well-drained ground that influenced the choice of the exact position of settlements as distinct from the general area of settlement.

MIGRATION ROUTES

There are two possible areas from which the Eskimos who occupied Southampton Island after the waning of the ice-cap and the partial retreat of the post-glacial sea may have come. The first of these is in the Keewatin mainland in the Repulse Bay area. This would involve crossing Roes Welcome Sound (minimum width 15 miles) or Frozen Strait (approximately the same distance). The second possibility is that the early natives came from Baffin Island across Foxe Channel, a minimum distance of about 90 miles. According to the tales that were recorded from the Sadlermiuts or other Eskimos who knew them, both routes were used.

Saorre (an Aivilik Eskimo) had been told by a very old Sadlermiut that:

"Once, very long ago, there was a famine among the Sikosuilarmiut in Southern Baffin Land, and they all died except four, who went over the pack-ice on Foxe Channel to Nuvualuk (Expectation Point), Bell Peninsula on Southampton Island, where they settled. Gradually as their numbers grew, they spread over the whole island" (Mathiassen, 1927). The extent of the contact with Baffin Land, if indeed it existed, is not known, although on archæological evidence from Kuk, Mathiassen considered it probable. The discovery by Bell of Dorset culture artifacts at Native Point and one Dorset type arrowhead from Liver Creek lends additional support to this view. Geographically it is the less probable point of entry. The ice conditions in winter are bad, with much moving ice. In summer boats would be required and although the Sadlermiut owned kayaks, it is not believed that they possessed the larger umiak necessary for transporting their possessions. It is not known if the Dorset culture peoples who were the earliest on the island had boats of any description.

Angutimarik ("Scotch Tom") told Mathiassen another tale of the origin of the Sadlermiuts:

"Two men and women and their children once drifted on an ice floe from Nuvuk (Point) at Wager Inlet to Southampton Island, and from them descended the Sadlermiut".

Comer heard tales from the Aivilik Eskimos of movement by Aivilik and Sadlermiut Eskimos in both directions across Roes Welcome Sound. He met a party of Aivilik Eskimos at Duke of York Bay who had been sealing on the pack ice of Repulse Bay and when the ice broke up had been carried to Southampton Island. This was not an isolated accident because when Hall visited White Island in 1865 he was told that some years previously three Aivilik Eskimos had been carried on Repulse Bay sea ice to Southampton Island from where they had returned successfully (Hall, 1879). Although the sea does not freeze every year across Roes Welcome Sound and only very rarely across Frozen Strait, there is no reason to doubt that either by accident or design natives did cross to Southampton Island in winter and spring from the Keewatin mainland in prehistoric times in the same way that the Aivilik Eskimos crossed to the mainland from Southampton Island to trade before 1924.

There is little evidence that this movement in any way affected the distribution of the prehistoric population on the island. Although certain modifications in the Thule culture on Southampton Island may be explained by contact with mainland groups, contact was rare and not looked for. The west coast of the island opposite the mainland is not favourable for settlement and there is no evidence that either Eskimos living on the island or from the mainland remained in this area permanently.

THE EXLOITATION OF THE SEAS

Sea mammals were the keystone of the whole economy of the Sadlermiuts, and even today, when the native is becoming more and more dependent on the white man, sea mammals still play an important role, particularly as a source of food. Both seal and walrus are hunted, but the seal is the only animal taken in large quantities during the 9 winter months. Depending on the species and the time of the year, seals are hunted as they lie on the ice, come up to breathe at a hole in the ice, swim at the floe edge, or, in summer, swim in open water.

No research has been undertaken into the density of the seal population around the coasts of Southampton Island. Casual observation throughout the summer of 1950 suggested they were far more numerous along the south coast than the Foxe Channel coast. In fact all sea mammals, including seal, walrus, and white whale, are probably scarce north of Caribou Island.

Walrus are most common in the summer months around Seahorse Point, an observation first made by Baffin in 1615. When the Foxe Channel sea ice drifts round Seahorse Point towards South Bay, the walrus appear to follow the ice and may be found as far west as Prairie Point. Walrus are known to be numerous in East Bay but are not found farther north along the Foxe Channel coast. It is not known whether the distribution of whales was an important factor in the location of early settlements, but probably, as so few were killed, it was of little consequence—any shallow coast being suitable for the stranding of whales.

Because of this dependence on sea mammals and on the sea and ice as hunting grounds, early settlements were located at sites close to favourable hunting areas, favourable with regard to both the numbers of animals and the condition of the sea and ice.

No detailed studies have yet been made of the bathymetry, water circulation, and ice conditions off Southampton Island. Certain general features of the oceanography may be recognized, which have influenced the distribution of Eskimo settlements. The water off the limestone coasts is shallow. The tidal range is less than 10 feet and broad tidal flats are exposed at low water, reaching 2 miles or more in width in some places. The gently sloping sea floor aids the development of very rough water when the waves are onshore, making the limestone coasts dangerous to small ships, particularly as harbours are almost entirely lacking. Off the gneiss upland coast of Foxe Channel, shore conditions are very different. The beach shelves away rapidly, and from Ascension Island to Cape Welsford depths of from 100-150 fathoms are common close inshore. This coast is probably rarely subjected to heavy seas because any onshore wind brings in the sea ice that is permanently in Foxe Channel and the ice subdues the storm waves.

Scattered information obtained from the movement of ice and the drift of ships in the ice, suggests that a current sets south along Foxe Channel from Melville Peninsula, to Cape Comfort and Seahorse Point. Parry was beset in the ice in the late summer of 1823 and drifted south along the Melville Peninsula coast and across the entrance to Frozen Strait at a rate of 7 miles a day (straight line distance). When Back was fast in the ice off Cape Comfort in 1836, he drifted southeast towards Seahorse Point at a rate of 1 mile a day throughout the winter. The difference between the observed rates at the north and south ends of Foxe Channel may be explained partly by the difference in strength and direction of the winds that the two ships experienced and partly by the Foxe Channel current, part of which is deflected through Frozen Strait and the other sea passages into Roes Welcome Sound, eventually flowing into Hudson Bay. There is no visible set of the ice during the summer in Foxe Channel, which cannot be explained by the wind or by tidal currents, which are locally strong. After passing Seahorse Point, the greater part of the Foxe Channel current continues straight on to the southeast towards Hudson Strait. Part of the current may double Seahorse Point and enter Evans Strait from the east (Dunbar, 1951) although normally when approaching from the southwest the cold air and sea ice typical of the Foxe Channel water is not met with until one is within 5 miles of Seahorse Point.

During the summer months, from late July to the end of September, sea ice is rare off the south and west coasts of the island. A certain amount is carried by the current from Frozen Strait into Roes Welcome Sound, but it is generally insufficient to interfere with shipping. On an average of once a year in the summer continuous easterly winds followed by southeasterly winds will blow loose pack ice around from Seahorse Point to Native Point and even into South Bay. It is, however, only in Foxe Channel that ice is present in quantity during the summer. The sea current apparently keeps the ice close to the shore throughout the summer, particularly along the Bell Peninsula part of the Foxe Channel coast, around Ascension and Caribou Islands and near Cape Comfort. Strong westerly or southwesterly winds blowing continually for several days are required to blow the ice off the coast, leaving an inshore lead some miles wide. When the wind ceases the ice drifts slowly back in shore, and with the first northerly or easterly wind is again packed against the shore. Duke of York Bay is generally clear of ice in the summer.

By October sheltered bays all around the island are beginning to freeze over, and within a month landfast ice stretches out some miles from the coast. As the winter progresses the sea ice becomes thicker and more extensive. In winter Foxe Channel is filled with very rough ice that is in almost continuous movement, which opens up patches of water when the wind and currents are suitable. As spring approaches, the outer edge of the landfast ice, known generally as the floe edge, begins to retreat towards the coast. By early June the Cape Low area and the coast between Leyson Point and Native Point are generally free of landfast ice although the ice may be packed back onto the shore by a southerly wind. The smooth landfast ice in South Bay continues to decrease in area as the floe edge moves north and the surface of the ice is rotten and covered with pools of fresh water. Early in July the ice edge is either at Native or Prairie Points and then after a period of northerly winds the ice will be blown out of the bay.

TABLE V

Dates on Which Sea Ice left South Bay

1917 July 14	1930 July 15
1918 August 8	1949 July 5
1925 July 12	1950 July 11
1926 July 11	1951 July 16
1927 July 8	1952 July 5

The ice conditions in Bay of God's Mercy are similar to those in South Bay except that because the re-entrant in the coastline is not so deep the ice goes out earlier. Few observations have been made on the west coast, but the ice probably remains until the end of June. In the third week of June 1904, Low found that the landfast ice was still 2 to 6 miles wide along the Roes Welcome Sound coast (Low, 1906). It is difficult to obtain accurate data on when Duke of York Bay is generally clear of ice because there is no white settlement there. In 1922 (a year in which summer came late to the north of Hudson Bay) the ice broke up in the middle of August (Mathiassen, 1931). In 1948 the bay was clear of ice not later than July 25, but on the same date in the following year only the southern half of the bay was clear of ice.

The ice conditions around the coasts differ considerably. Around the south coast, in Bay of God's Mercy and in South Bay (using the term in its broad sense to mean the bay to the north of a line between Bear Cove Point and Native Point) there is a broad belt of smooth landfast sea ice that remains stable for 6 to 7 months of the year. Beyond this is an expanse of open water that varies in width depending on the winds and divides the landfast ice from the pack ice of Hudson Bay to the south[1]. In Duke of York Bay landfast ice also develops, with leads present for at least part of the winter at the entrances to Comer Strait and Frozen Strait. On the Roes Welcome Sound coast the ice conditions are rather variable. In some years the ice is very broken and rough, and the sound may not freeze over completely, particularly at the northern end; in other years smooth landfast ice stretches out for a considerable distance from the shore. The worst ice conditions from the point of view of the Eskimos are found on the Foxe Channel coast where no landfast ice develops, leads open up frequently throughout the winter, and the ice is extremely hummocky, making travel by dog team almost impossible.

The presence of landfast ice in South Bay, Bay of God's Mercy, and Duke of York Bay, which formed with certainty every autumn and was in no danger of breaking up and becoming hummocky, combined with an almost permanent lead of open water in winter on the outer edge of the

[1] The Hudson Bay ice in this area is apparently much broken or at least is liable to break up quickly at any time in the winter. "Though it is possible that in calm weather thin ice may form between it (Walrus Island) and Southampton Island, this ice soon breaks up again, so that though the Aivilingmiut have several times tried to cross it in winter they have never been successful" (Manning, 1942).

bay ice, was probably the single most important factor in determining the location of the prehistoric Eskimo sites on Southampton Island. Of these areas South Bay is the largest and would, theoretically, support the biggest population. In South Bay the best location for the settlements of the prehistoric Eskimo, who were entirely dependent on hunting for survival, was not at the head of the bay. The head of the bay was too far from the winter and spring floe edge, a defect that was not compensated for by other factors until a trading post was established at Coral Harbour. The ideal position was farther out, nearer the floe edge in the Ruin-Bear Cove Points area on the west side and the Prairie and Native Points area on the east. Although fast ice forms in most years along the coast of Roes Welcome Sound, the wide tidal flats in the south around Ell Bay and the cliffed coast in the north are not satisfactory for the establishment of permanent hunting settlements. On the Foxe Channel coast, as mentioned previously, good ice conditions are totally lacking and sea mammals are probably fewer than elsewhere. Bay ice forms in East Bay, which is still one of the richest sea-hunting areas of the island. The shallowness of the water, which in some parts makes it almost impossible to decide where land ends and sea begins, and the danger of pack ice blowing into the bay from Foxe Channel at any time during the summer, make this area unsuitable for settlement. Only at Expectation Point did any extensive settlement take place despite the poor ice conditions. Here the large number of sea mammals and of polar bears made the area an important hunting ground. Even so, excavations of W. D. Bell show that the settlement at Expectation Point was largely for summer hunting and not an all year round settlement.

LAND RESOURCES

We know that the Sadlermiuts were primarily hunters of sea mammals, but they also hunted caribou, bears, and birds to obtain food and clothing. The distribution of these animals must, therefore, have been of some importance to the natives. Very little is known about the former distribution of the caribou, which today number no more than a few dozen—almost all in the uplands. When the Sadlermiut were alive large herds lived on the island. On the basis of the present plant food available on the island, the two least favourable areas for supporting caribou herds would appear to be the low limestone plateaux of the west side of the island and the upland zone where the drainage is towards Foxe Channel—two of the areas that were rarely frequented by the Sadlermiuts[1]. According to Mathiassen the finest caribou ground was the neck of land joining the main island to Bell Peninsula—with East Bay at the one end and Native Bay at the other. Across this marshy area the caribou moved

[1] Munn (1919) says that the caribou were plentiful on the high land during his residence on the island (1916-18) and that they came to the coast in the summer. Manning (1942) dates the decrease in numbers from the period when the Eskimo could obtain unlimited ammunition from the local trading post, rather than having to go to Chesterfield or Repulse Bay. Immediately prior to the establishment of the permanent trading post caribou were still numerous according to Mathiassen but his reference to the exceptionally large numbers of wolves suggests that the caribou herds were already depleted in 1922 when he visited the island. Certainly many of the natives now living on the island can remember herds that even allowing for a natural exaggeration must have numbered many thousands strong. In 1938 small herds spread out from the hills and were quickly shot. In 1950 they were believed to be almost extinct—one having been seen and shot during the previous winter. Members of the Geographical Branch party failed to see any caribou, but noted recent tracks at Liver Creek and Caribou Island on the Foxe Channel coast.

in the autumn back onto the larger part of the island from the Bell Peninsula. If this were so the Native Point and Prairie Point settlements were well situated for hunting.

Polar bear are found on all coasts, but particularly on the Foxe Channel coast and around Seahorse Point towards Leyson Point where they are brought into shore on the pack ice in summer. The Expectation Point settlement is the best suited for bear hunting. Natives from other parts of the island make occasional hunting trips to the east coast of Bell Peninsula to hunt bears for their skins and for dog meat. The Sadlermiuts used bearskins extensively in their clothing, invariably making the men's trousers of it, and frequently other articles of clothing as well. The large numbers of bearskins required by an individual Sadlermiut family suggest that special hunting trips would be made to obtain bears. The summer tent rings found on the Foxe Channel coast, and particularly the summer camp at Expectation Point, may have resulted from these hunting trips. There is, however, no indication that any permanent settlement was located solely because of its proximity to areas in which bears were numerous.

Birds were of less importance in the economy of the Sadlermiuts than the animals, both land and sea. Migratory birds remain on the island from late May until September. During this period water birds may be found on nearly every lake in the limestone regions. In the uplands and particularly on the Foxe Channel coast birds are few both in numbers and species, indeed one of the striking features of this part of the island in summer is the absence of bird sounds when compared with the rest of the island. Birds are so numerous in the summer around the whole of the south coast that their distribution could play little part in locating the settlements.

Fish were of minor importance in the Sadlermiut economy, and although many settlements were located close to rivers suitable for the native fishing methods, there is no evidence that sites were chosen because of this advantage. The land also supplied a few mineral products that were essential to the economy of the prehistoric peoples of Southampton Island. The most important of these was flint. The Thule-Sadlermiuts used flint in large quantities for weapon points, knives, and other tools. Limestone is the source of the flint (in reality chert). None of the limestone outcrops examined by the 1950 party on the island contained beds or nodules of chert. The exact source of the flint is, therefore, unknown. It is possible that they were able to find sufficient flint by searching the beaches, but it is not common today. The most likely source is apparently around Lake Brook where nodules are scattered in great profusion all over the ground. If this was indeed the source region, it does not appear to have attracted any large Eskimo settlements. Both slate and soapstone, important stones in the Thule cultures elsewhere in the eastern Canadian Arctic, are lacking from the rocks of Southampton Island. No slate or soapstone has been found in any of the sites from the south of the island. Mathiassen has shown how the absence of these materials led to the substitution of flint for slate and limestone for soapstone at Kuk in the north of the island (Mathiassen, 1927).

Pyrites was used by the Sadlermiuts to produce fire by striking it with flint. The modern Aivilik natives say that pyrites is still to be found in the gneiss area of Bell Peninsula. They also say that the "old people" once burned a type of stone that was brought from Bell Peninsula, although they are not certain of the exact place where it can be found. The origin of this story is obscure. It may refer to beds of carbonaceous limestone that are found on the Foxe Channel coast. Another material used by the Thule-Sadlermiut peoples was wood. The best source of supply today—other than from the white settlements—is from the coast between Canyon River and Cape Comfort where driftwood, probably brought down from the north by the Foxe Channel current, collects in a large eddy in the bay.

Although all the animals and materials listed under this heading were important, and some were essential to the prehistoric Eskimo cultures, there is no evidence that they played any considerable part in the location of the permanent settlements. Either the products were so numerous that any site would have been suitable, or special trips at the right time of the year would be made to obtain them.

WHITE SETTLEMENT AND THE DISTRIBUTION OF THE ESKIMO

Before the establishment of the Hudson's Bay Company post at Coral Harbour by Sam Ford in 1924, there was no permanent white settlement on the island. Between 1897 and 1903 a whaling station was in operation near Cape Low on Bay of God's Mercy. About 125 Eskimos were brought to the station. They were mainly Aivilik Eskimos from Repulse Bay with a few Okomiut from Lake Harbour. These natives were completely dependent upon the whaling station and when it was removed in 1903 they left with it. The only effect of the first white settlement on the population of the island was to introduce the disease that ultimately destroyed the Sadlermiut in the winter of 1902-03.

In 1908 Captain Comer took some Aivilik Eskimos to the island, landing them near Cape Kendall on the west coast. When Captain Comer returned the following year to trade with the Eskimos he was told that the Cape Kendall area was not suitable for native settlement. Comer did not go back to the island and the natives moved to the south coast, which they have occupied since that time. In 1916 Captain Munn built a small house at Seal Point, a few miles from the future settlement of Coral Harbour. He remained on the island for only 2 years, much of which time he spent in travelling. This period of residence does not appear to have influenced the location of the settlements of the Eskimos, who occupied sites almost identical with those of the Sadlermiuts.

Since the establishment of the permanent post at Coral Harbour in 1924, the influence of white settlement as a location factor for the Eskimos has increased considerably. Today Coral Harbour has become a focus for the native population of the island. The establishment of churches by the Roman Catholic and Anglican missions and a school by the Federal Government in 1950 tended to attract the Eskimo to Coral Harbour more and more frequently from their outlying settlements until at last many families moved permanently to the Coral Harbour area. The building of an air strip at the close of World War II and the permanent Department of Transport groups that remained after the wartime forces left, was an added incentive to the Eskimo to live permanently in the vicinity, with the possibility of casual employment. In the summer men are required to unload the lighters bringing in the yearly supplies. Scientists visiting the island required the services of natives as guides and interpreters. All these factors tend to keep the native at the post—a location that in former years before the white man came would undoubtedly have led to a shortage of food during the summer. Now, however, the presence of four native-manned Peterhead boats with auxiliary engines at Coral Harbour has meant the partial substitution of earlier summer hunting techniques for the occasional large scale hunt, particularly for walrus as dog food.

The Duke of York group of Eskimos lead a life more independent of the white settlement and only visit the trading post once or twice during the year.

LOCAL FACTORS INFLUENCING LOCATION OF PREHISTORIC SETTLEMENTS

During the period when the Thule and Sadlermiut peoples occupied Southampton Island the dominant factor influencing the location of settlement was the availability of sea mammals, particularly walrus and seal, which were so important in their economy. Because of the primitive hunting techniques that these people employed, hunting was controlled mainly by ice conditions around the island. Three areas, Bay of God's Mercy, Duke of York Bay, and South Bay, were especially favourable for hunting, both with regard to the numbers of sea mammals and the type and extent of sea ice. It is in these areas that most settlements took place. Within these areas, highly suitable for settlement, only a few particular sites were occupied permanently. The local factors that led to the choice of one site over another within the same general area around South Bay were studied during 1950.

Five prehistoric sites were examined, which from the size and number of the stone ruins and old tent rings had been occupied by Eskimos over many years. These sites are located at: the mouth of Kirchoffer River, Prairie Point, Native Point, Lake Brook, Expectation Point. All these sites are on the south coast of the island. Unfortunately, it was not possible to visit Bay of God's Mercy or Duke of York Bay during the summer of 1950.

KIRCHOFFER RIVER

Kirchoffer River enters the sea by a gorge. The coast on either side of the river mouth is cliffed, with a narrow band of marine-sorted gravel and limestone plates at the foot of the cliffs. There are raised beaches on the limestone backshore and the face of the cliff. Eskimo archæological sites are found on both sides of the mouth of the river. W. D. Bell only examined those on the west side of the river. He found tent rings, predating the modern natives, on the first four raised beaches above the beach that is being constructed by sea waves today. The maximum height of these tent rings is 60 feet[1]. Excavation was difficult in June when Bell was there because the ground was still completely frozen, but flint chips and thick layers of ash and bone fragments within the higher tent rings, and the fact that they were overgrown with lichen, suggest that they are prehistoric and were occupied for longer than just one hunting trip. On the fifth beach at 85 feet above present high tide is a house ruin, rectangular

[1] This and all other heights in this Chapter are referred to normal high water at spring tides.

in shape, 18 feet long by 9 feet wide and semi-subterranean in character. Many bones and numerous flint chips were found in the house and the adjacent cache. No diagnostic artifacts were found. The small number of rings and the solitary house do not suggest that the sites were permanent settlements for any long period of time.

The immediate factor influencing location appears to be the river. The steep banks prevent the river from overflowing onto the adjacent land in flood time. The swift flowing current breaks up the sea ice around the mouth early in spring. When the Geographical Branch party arrived there in late June having travelled by dog-team on the sea ice from Coral Harbour, water extended about 1,200 yards into the sea ice. The water was full of geese and ducks, which would seem to be one of the major reasons for the location of the site. In spring and early summer the river mouth is an excellent hunting ground and fish are abundant. Kirchoffer River mouth is easily accessible from the west where the parent settlements were probably located, either over the flat limestone plain or the sea ice. The semi-permanent summer camp-site at Liver Creek on the east coast and the stone house ruins at Kuk at the mouth of Thomsen River in Duke of York Bay have characteristics of location similar to those of the Kirchoffer site. At Liver Creek on a beach terrace 60 feet above high water, four tent rings and a number of smaller unidentified ruins were found.[1] The creek is considerably smaller than the Kirchoffer, but the valley it occupies is wide and was an estuary when the sea-level was higher than at present. At Kuk the topographic conditions are rather different, as it is the only one of this type entirely within the limestone country. Stone ruins are found on both sides of Thomsen River up to 2 miles from its present mouth. When the earlier sites in this area were occupied the sea was at least 20 feet higher than at present and the lower part of the river was an estuary (Mathiassen, 1927). All three sites have in common a position at the mouth of a river suitable for fishing, and a dry base of beach material consisting of pebbles and gravel.

The Kirchoffer River site has one special feature that is not shared by any other site that has been examined on the island. During the modern period of Eskimo occupation the mouth of Kirchoffer River lies at the southern end of the overland route from Duke of York Bay to South Bay. This route passes up Cleveland River, skirting the western scarp of the uplands, and joins Kirchoffer River in its middle course. The route is used in both winter and summer. It is not known whether the Sadlermiut used this very obvious routeway from the hunting area of Duke of York Bay to the more important area of South Bay, although the Aivilik certainly do. If the Sadlermiuts did so the Kirchoffer site at the southern end of the route would have a special significance.

PRAIRIE POINT

Prairie Point is a complex landform of lagoons, lakes, and marshes separated by low gravel spits. The whole area does not rise more than 50 feet above sea-level. On the seaward side the water is shallow and flats $\frac{1}{2}$ mile to 2 miles in width dry out at low tide. The Eskimo stone houses

[1] At Liver Creek the beach terraces are clearly defined and are separated by steep bluffs. The site described above is now 300 yards from the present high water mark. When the site was occupied the high water mark was most probably at the next beach below, that is, at 43 feet.

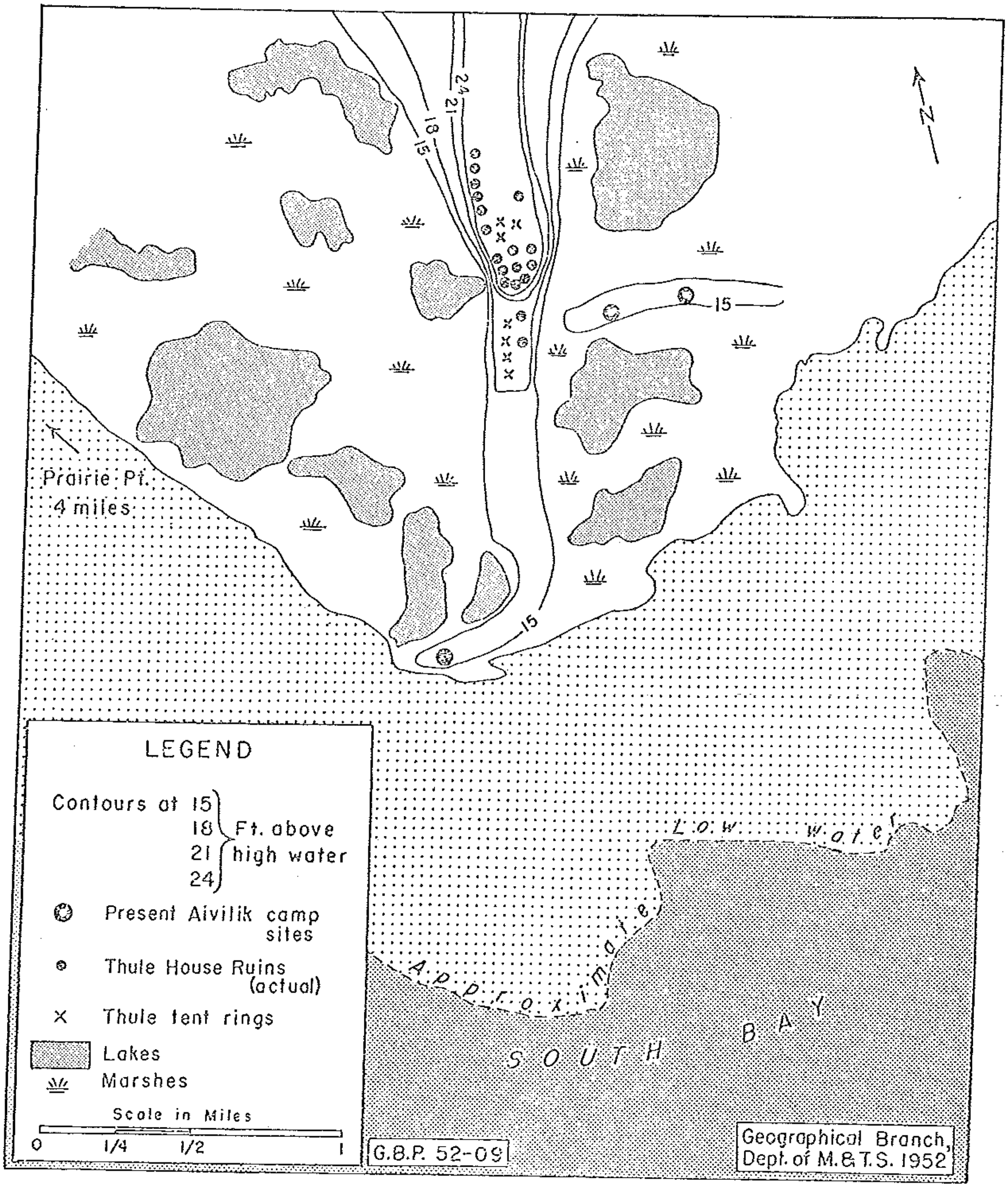

Figure 17. Eskimo settlement site near Prairie Point.

and tent rings were built on a gravel spit. This spit is at least 3 miles long and although simple in plan, lacking recurved ends, is composite in age, having been formed at three different stages as the sea-level receded. The highest step is now 25 feet above present day high water and at its closest point is now 1 mile from the sea. On this part of the spit Bell found sixteen Thule type houses as well as many caches and tent rings. The middle step of the spit is 20 feet above high water and $\frac{3}{4}$ mile from the shore. On it are two Thule type houses and twenty-three tent rings. The third and most recent level is 17 to 18 feet above high water. No Thule house ruins are found on it, only modern Aivilik camp-sites.

The location of the Prairie Point site differs considerably from the other sites visited in 1950. Under present conditions it has apparently little to offer as a location when the sea is not frozen. In summer there is no fresh water within a mile of the sea; the land on both sides of the spit is marshy and nearly impassable when the surface layers of the ground melt; the approach from the sea is so shallow and full of reefs that it is almost impossible to get closer than $\frac{3}{4}$ mile to the shore even in small boats. It is evident from the large number of Greenland and white whale bones found at the Prairie Point site that it was occupied in summer as well as in winter. However, the absence of bird bones in any numbers, whereas today this is one of the densest breeding areas on the island, suggests that the summer occupation may have been limited. In winter all the defects of the site disappear, the marsh lands become easy for sledge travel, the shallow offshore water is frozen, the depth is of no importance, and in spring the floe edge is nearby for seal and walrus hunting.

The spit in earlier stages of physiographic development would have been more suitable for occupation; it began to form when the sea was about 25 feet higher than today. At that time the marshland did not exist. The growth of the spit took place spasmodically rather than continuously over a long period of years. Each major accretion coincided with a fall in sea-level of 3 to 5 feet, until the spit was complete and as we see it today. Growth then stopped, mainly because the tidal flats that were uncovered as the sea-level fell were colonized by plant communities that became more continuous as the lagoons decreased in size and grew first brackish and then fresh, until the terrain as observed today developed.

NATIVE POINT

Native Point is the name given to the headland 25 miles across Native Bay opposite Prairie Point. The Eskimo call the headland Tunirmiut, connecting it with the half-mythical people known to them as the Tunnits and who were in fact, at least in the final stage before they became extinct, the Sadlermiut.

The site at Native Point was the most interesting examined during the summer, for at Native Point not only is there one of the most spectacular sets of Thule ruins in the whole of the Arctic, but there is also a series of middens bearing material belonging to the so-called "Dorset" culture as first described by Jenness (Jenness, 1925).

Native Point has formed around a low elongated hill of glacial till. As the sea-level fell during post-glacial times the hill appeared as a reef that was washed over by the sea and levelled at 85 feet above present high

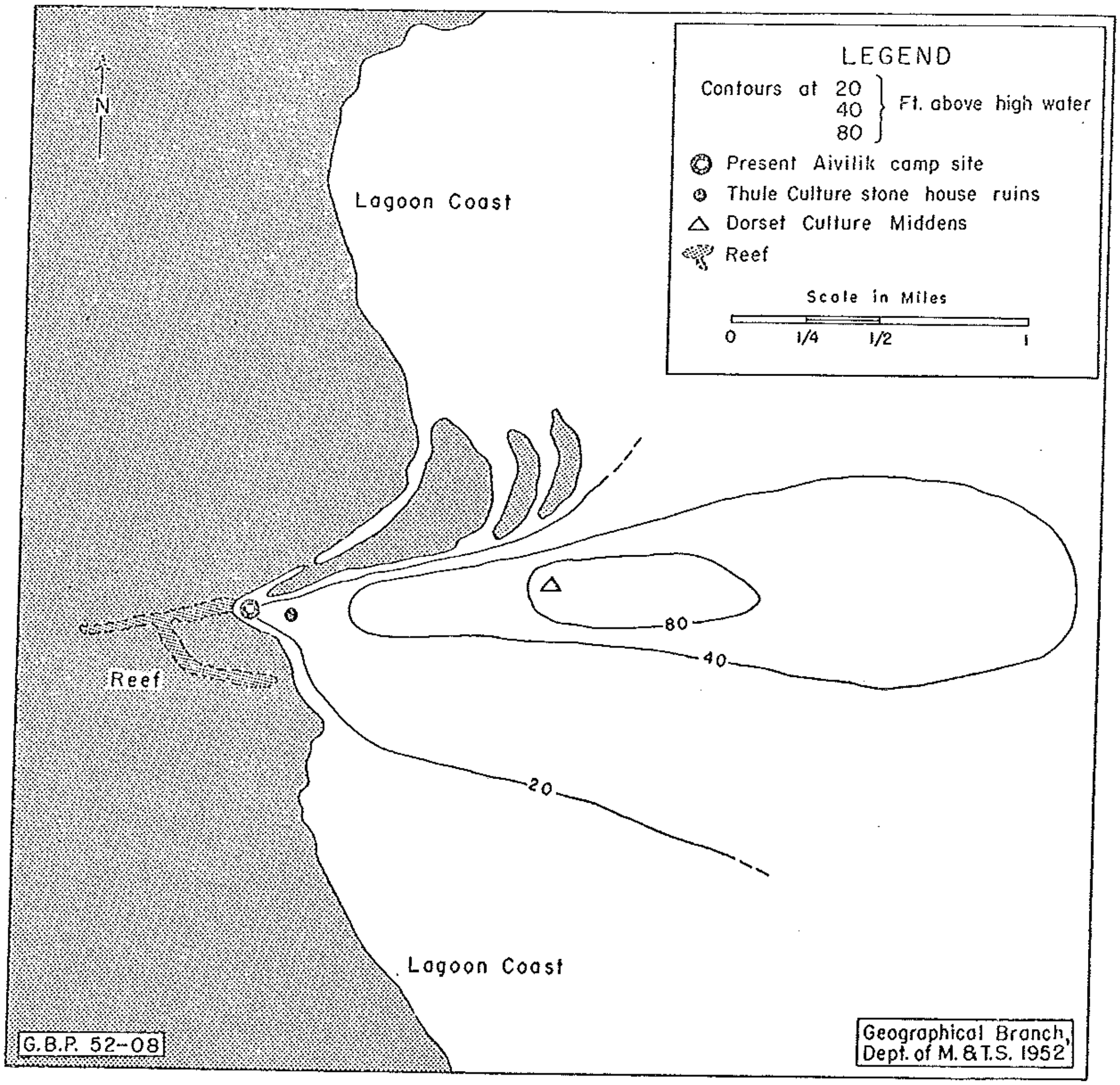

Figure 18. Eskimo settlement site at Native Point.

water. Later the reef became an island, which was eventually joined to the mainland to the east by marine spits and bars formed of limestone fragments. The seaward side of the headland is now a bluff with a step at 25 feet corresponding to a stage in the lowering of the sea-level. In addition to the two major levels at 85 feet and 25 feet there are six subsidiary raised beaches around the "island". Inland the altitude of the hill decreases to 35 feet and the terrain is marshy with small lakes and abandoned beaches. On either side of the Point are lagoons and marine bars. Offshore from the Point a spit, which dries at low water, is being built by marine agencies at the present time. The water on either side of the reef formed by this spit deepens more rapidly than at any other place along this coast. The only fresh water in the vicinity other than some of the lakes is a small creek that enters the sea north of the Point.

People of three different cultures have lived at Native Point. In the last 50 years small groups of Aivilik Eskimo have remained at the Point part of the year. Most of the tent rings and wooden shacks from this recent period are found on the lowest beach, which is 8 feet above high tide on the seaward side. The modern Eskimo has also used the second beach (at 13 feet) and to a lesser extent the third beach (at 25 feet). The position of these recent settlements is of some importance, as it shows that although, under present conditions, the Eskimo in the South Bay area will generally choose a site as close to the sea as is safe, it is not possible to deduce accurately the height of earlier stages in the post-glacial sea from individual prehistoric stone houses.

The second and earlier group of people to inhabit Native Point were the Thule-Sadlermiuts. Five of their stone house ruins are found on the two lowest beaches. The third beach (25 feet) contains fifteen houses and a fourth beach at 30 feet has fifty-five houses around its outer edge. Middens are found on these last two beaches. No Thule house ruins are found above the fourth beach, although there are a large number of graves on high beaches. Evidence of a third group of people with a Dorset culture is found on the levelled upper surface of the headland at 85 feet, now nearly a mile from the sea.

Archæological evidence establishes a long period of occupancy at Native Point in which considerable numbers of people were involved. The factors that influenced the choice of Native Point as a site for settlement seem to have been its position in relation to the floe edge in spring for hunting sea mammals; the rich tundra pasture inland, which provided the caribou, whose bones are such a typical feature of this site, with pasture; but above all, the dryness of the site with its fine gravel base and the presence of large stones, originally from the bluff face of the till, used for building purposes.

LAKE BROOK

This site differs from the others investigated on the east side of South Bay and the Evans Strait shore of Southampton Island, in its small size and obviously temporary nature. Close to the present shore are a number of modern Aivilik Eskimo summer tent rings. One hundred and fifty yards inland on a gravel spit 20 feet above high tide level are four prehistoric Thule tent rings and associated with them are stone meat-caches. Farther along the coast 2 miles to the west are four Thule stone house ruins.

Between Native Point and Expectation Point there are 75 miles of coast that, despite its suitability for hunting both on land and sea, is definitely hostile for settlement. The coast is either low lying with lagoons and marshes and shallow water offshore, or is cliffed and without harbours. So far as is known this coast was never occupied permanently by large groups, but was more probably visited occasionally by hunting parties. Such a site is the one at Lake Brook built on a dry raised gravel beach with deep water unusually close inshore—and hence a relatively narrow foreshore even at low tide in summer.

EXPECTATION POINT

Expectation Point is 6 miles west of Seahorse Point, the most easterly land on Southampton Island, and 2 miles east of the contact between the Palæozoic limestone and the Precambrian gneiss. The Point is composed of gneiss with an upper surface 75 feet above high tide. It is joined to the mainland by a low rock ridge 45 feet high and is covered in part by marine gravels. On this neck of land two sets of Thule house ruins are found. Of the nine houses in the older group, three are triple and two are double, and of the five "new" houses, four are double. In addition, the site is partly occupied by a modern Eskimo encampment that has disturbed the older sites.

On the seaward side of the point are numerous tent ring camps, kayak stands, and a "dance hall", a huge ring, roughly circular in shape, from 24 to 27 feet in diameter, and made of boulders piled 3 feet high. In the opinion of W. D. Bell, the ruins and rings suggest a small winter population, and a large population in the summer who must have moved down from the west for the summer hunting.

This is entirely in accordance with what we should expect from a knowledge of the ice conditions, and, consequently, hunting, in the area. Throughout the summer pack ice drifts south down Foxe Channel to Seahorse Point. Most of the pack continues southeast towards Hudson Strait, but some pack ice, particularly when the wind is from the east, rounds Seahorse Point and moves west. Associated with this pack are bears and walrus, and Greenland and white whales. The Expectation Point site is probably the best for hunting these animals. Any farther to the west and the site would have to be on the limestone, with the consequent shallow inshore waters and absence of harbours. Farther east towards Seahorse Point there is great danger of the ice packing in for long periods and making summer hunting by boat impossible.

CHAPTER V

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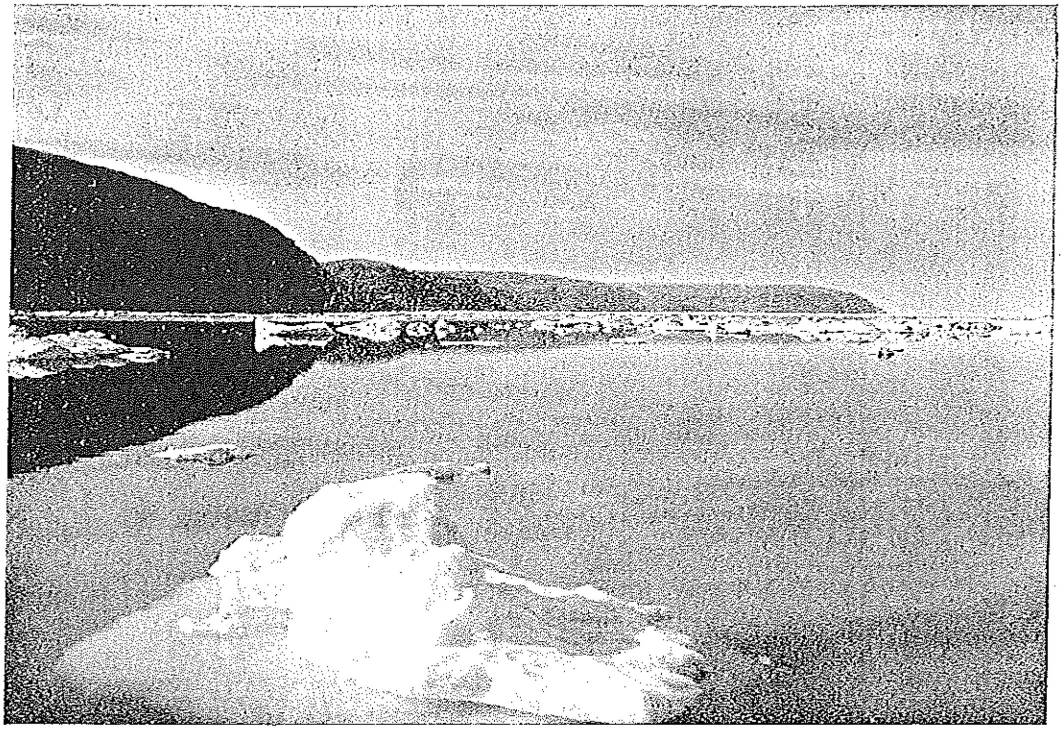
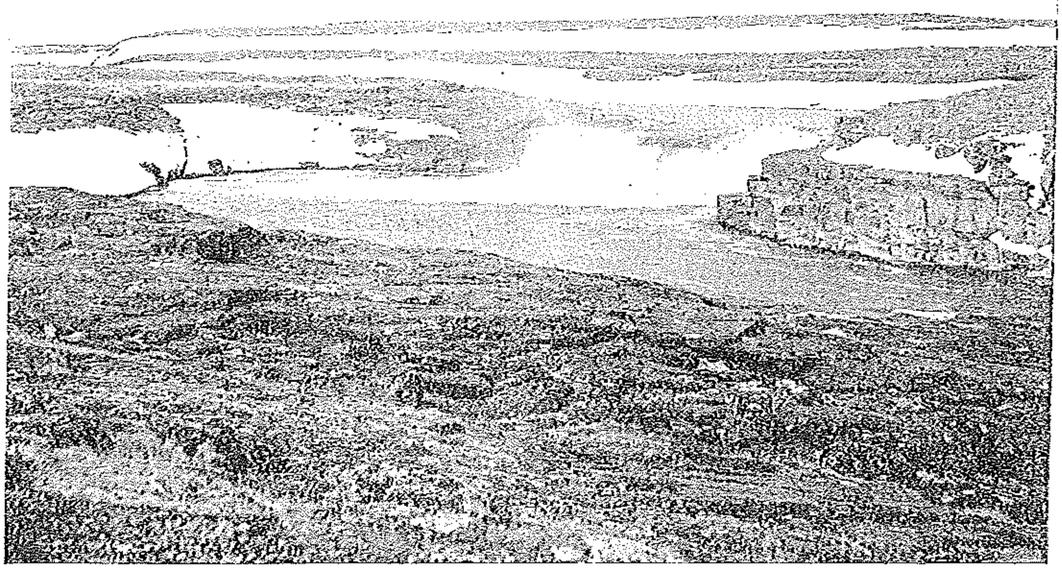


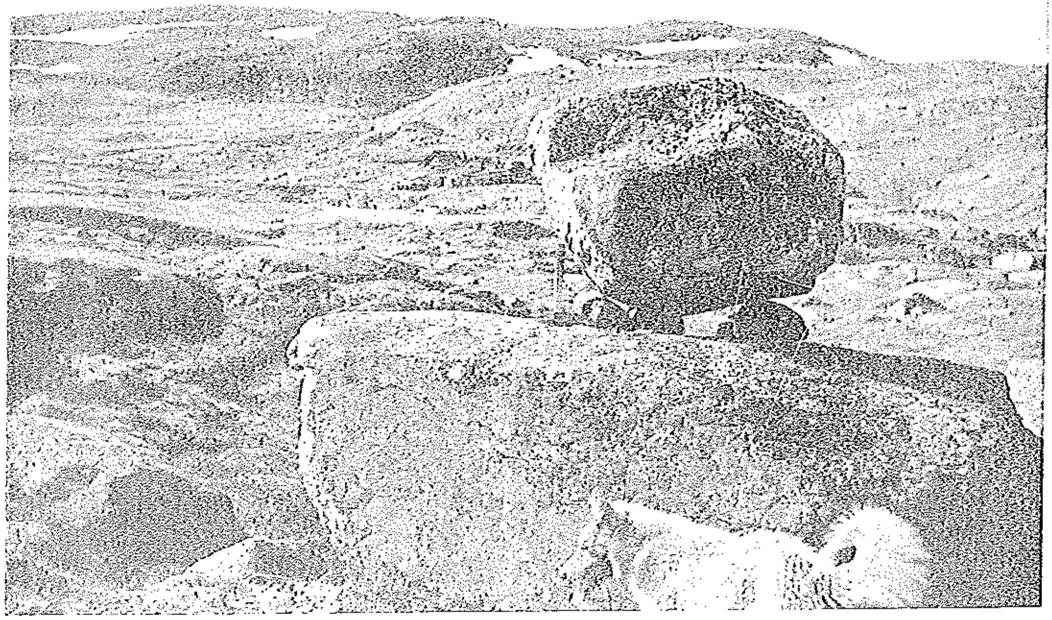
A. The east coast of Southampton Island in August 1950. (Page 9.)



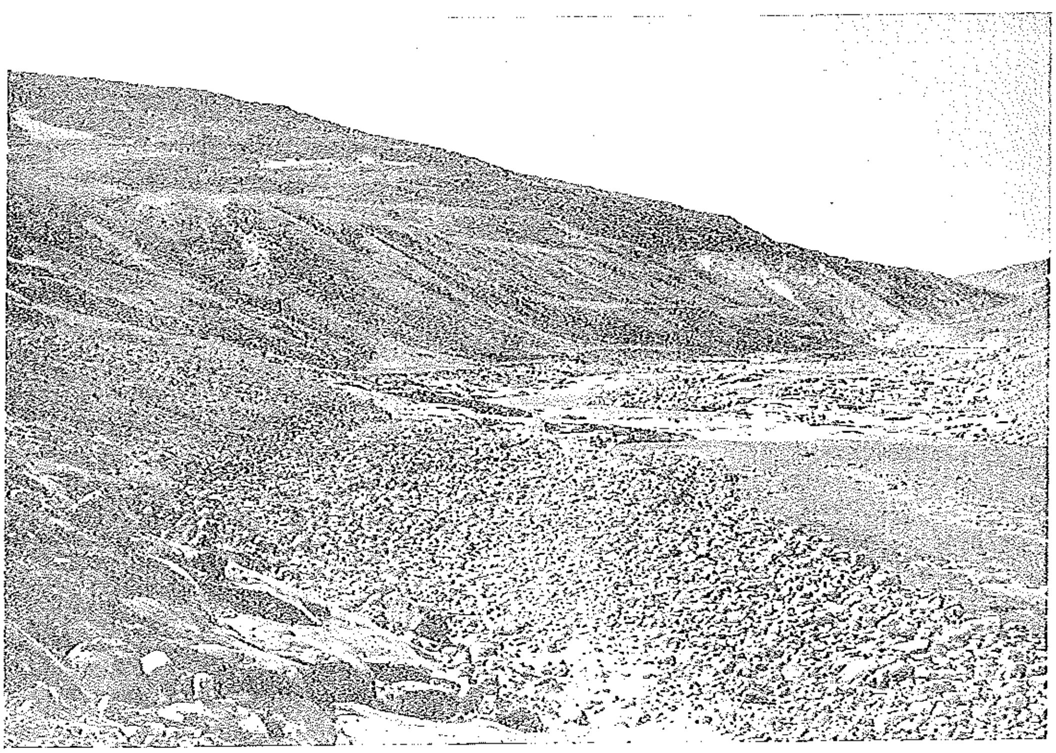
B. The falls on the lower Kirchoffer River. The ridge in the background is the second fault-line scarp. (Page 12.)

A. The upper (Southampton) erosion surface at 1,200 feet above sea-level. (Page 14.)

B. A cirque, 700 feet deep, on the east coast of Southampton Island. A second and smaller cirque may be seen on the upper part of the rear wall. (Page 20.)

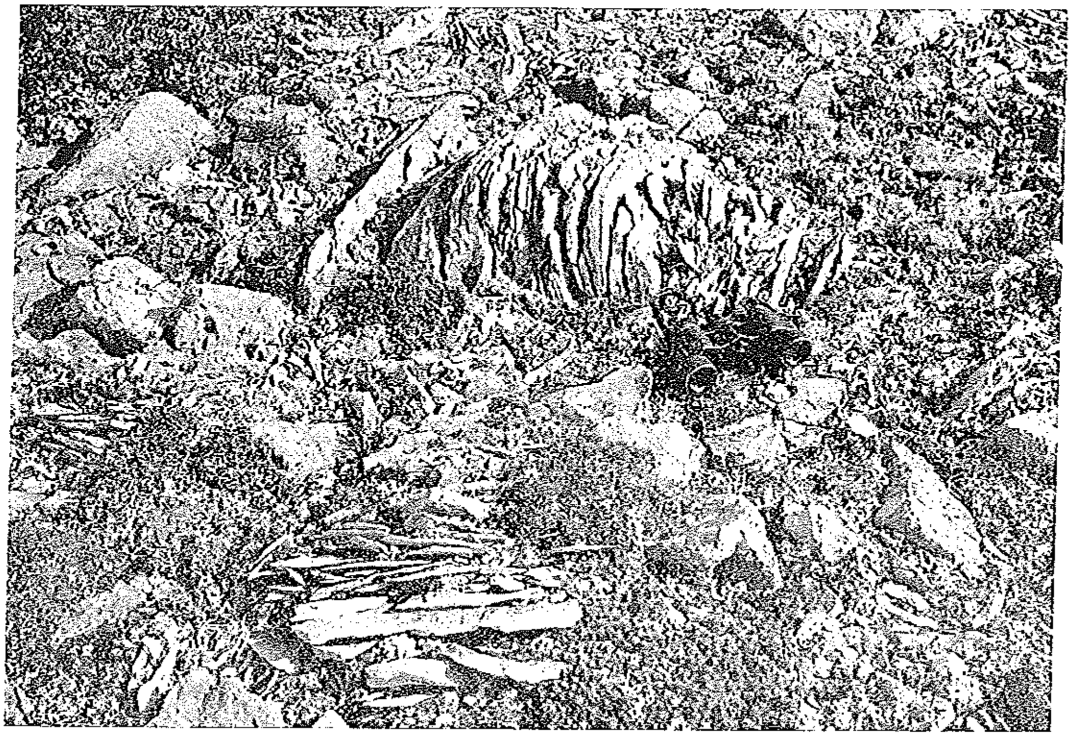


A. An erratic boulder perched on a frost-heaved block immediately above the upper limit of marine submergence in post-glacial times. (Page 24.)

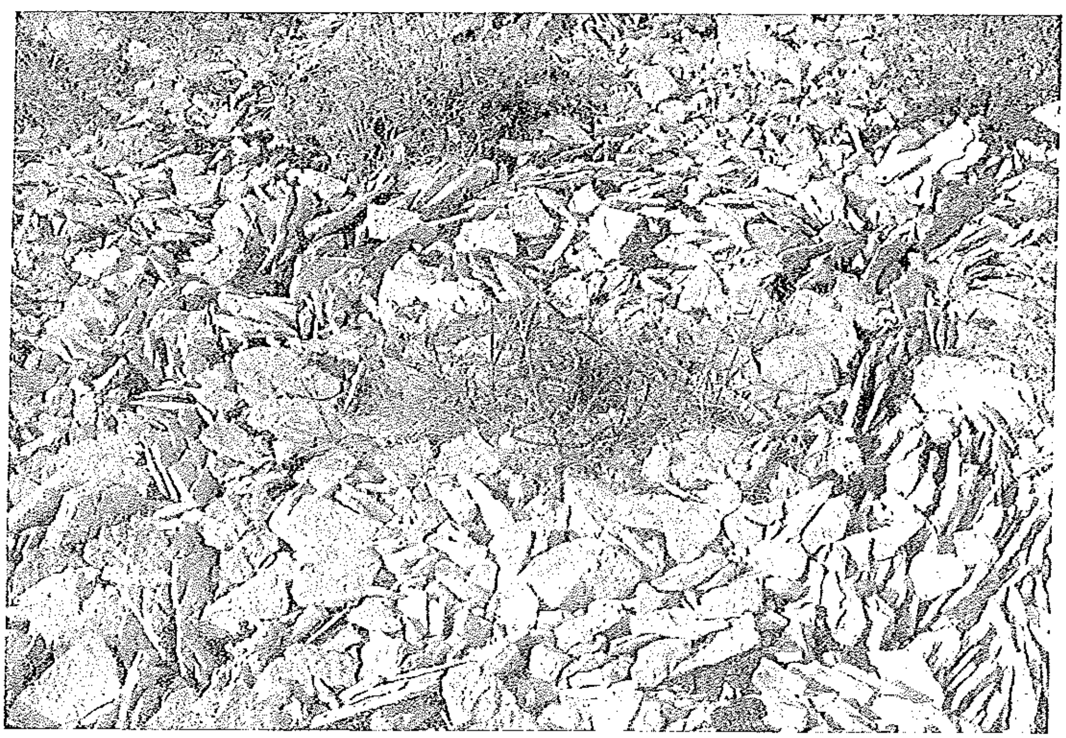


B. Mathiassen Brook. The highest visible terrace is 220 feet above sea-level. (Page 30.)

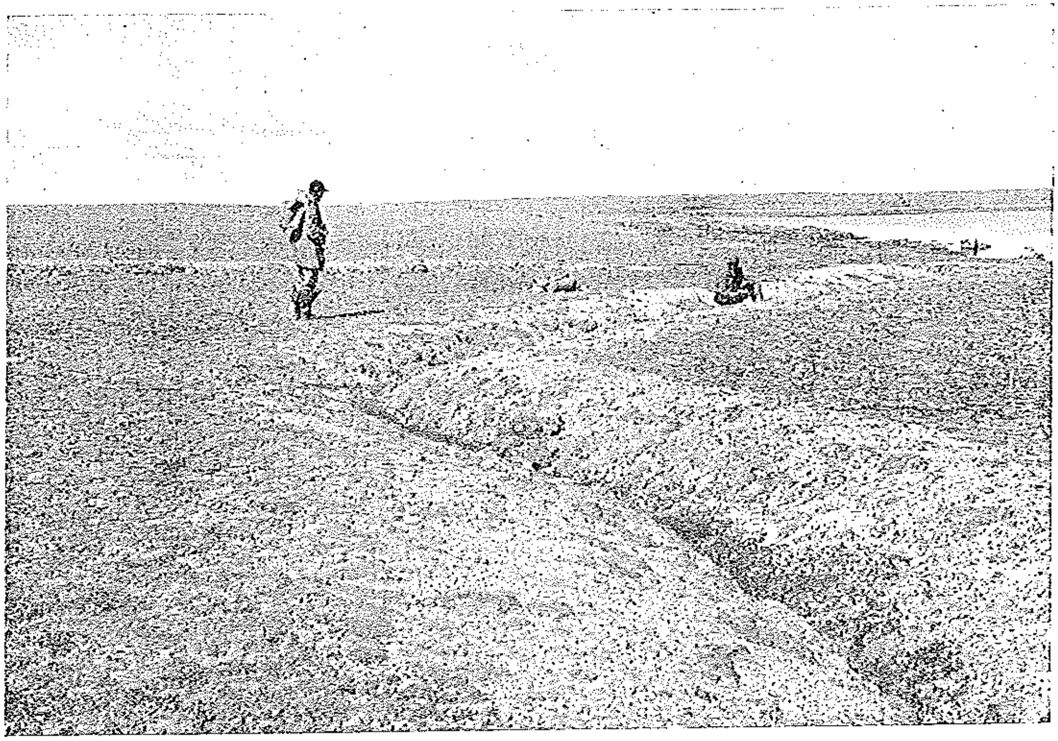
PLATE IV



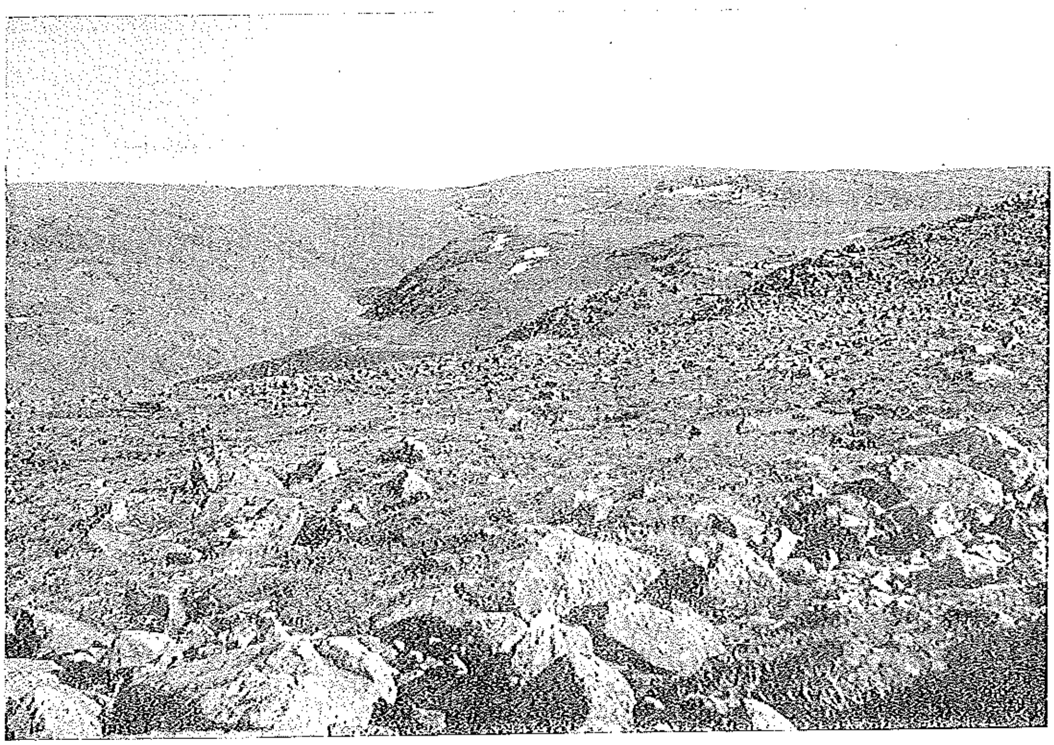
A. Limestone boulders shattering into plates. (Page 35.)



B. Shattered limestone plates standing on end and showing an early stage of patterned ground. (Page 35.)



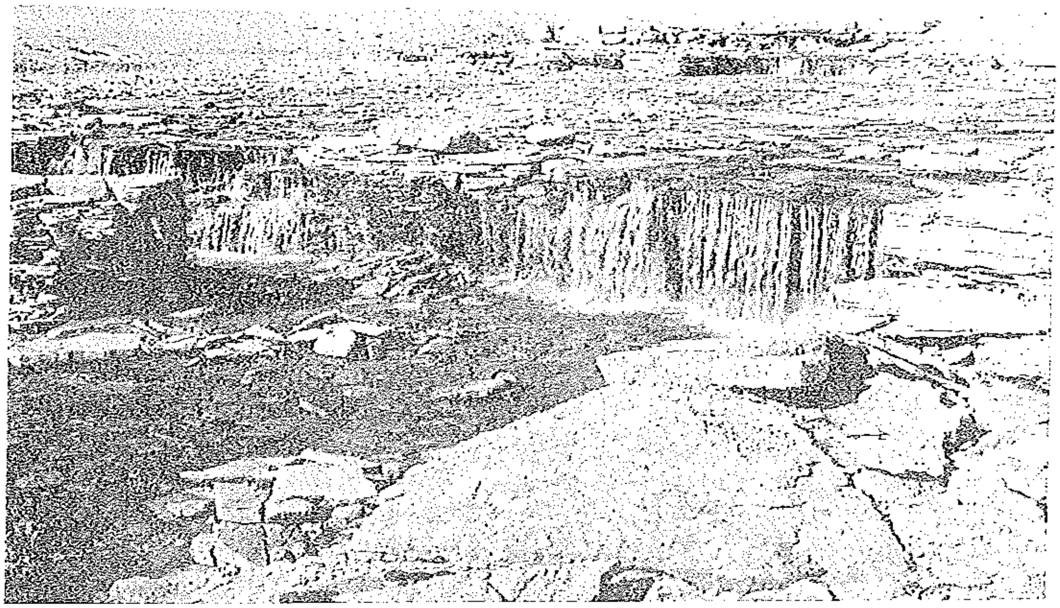
A. Two fissures crossing an abandoned gravel beach at right angles. (Page 36.)



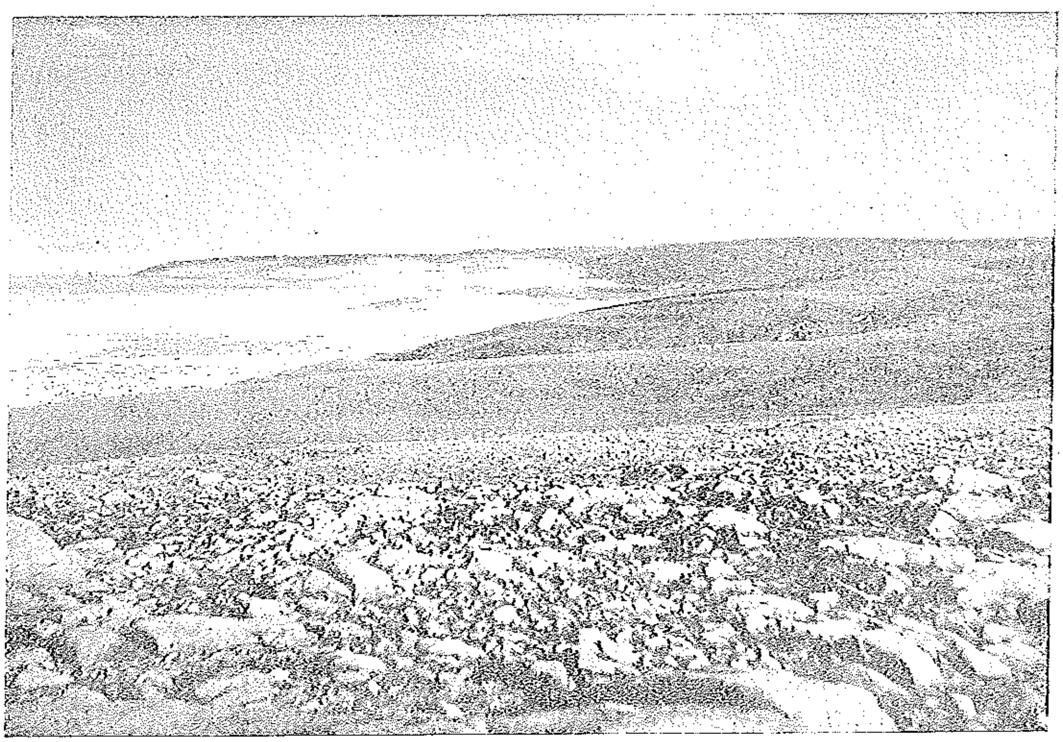
B. The eastern plateau deeply dissected by a valley. At the close of the Ice Age the ice moved from the interior of the island (the right of the picture). (Page 44.)

Plate VI

Kokumiak River on the northeast coast. (Page 44.)

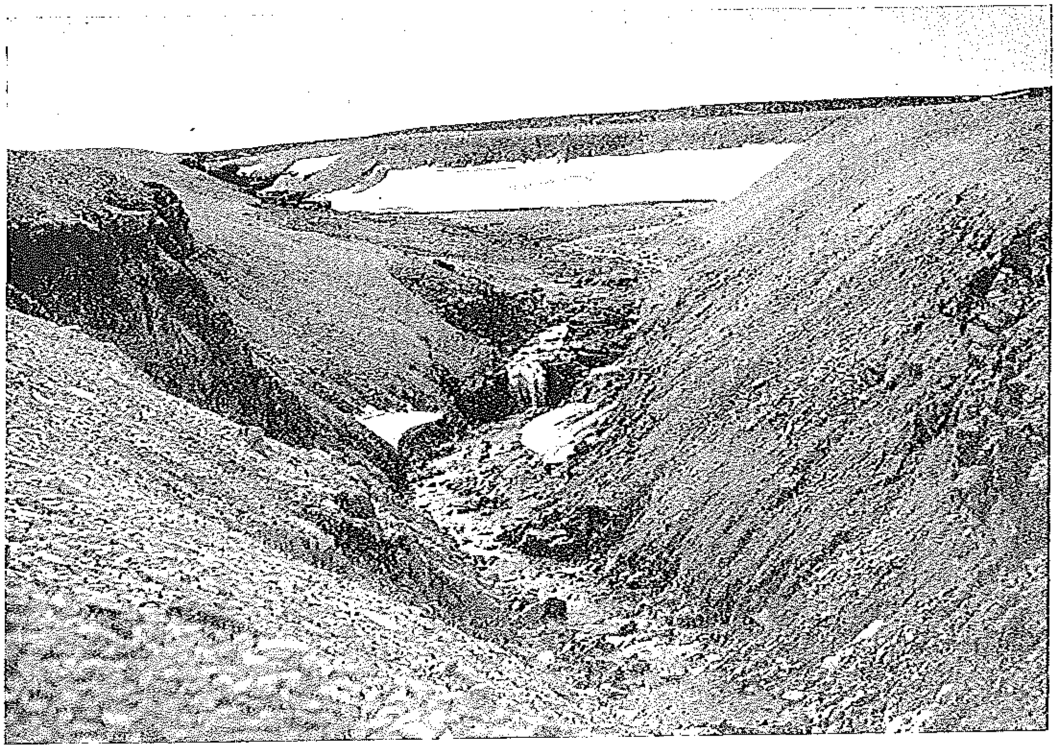


A. An unnamed stream flowing across the Bell limestone plateau. (Page 48.)



B. The limestone plateau at Cape Donovan showing the continuation of the upper erosion surface from the Precambrian rock onto the limestone. (Page 48.)

PLATE VIII



A. A post-glacial gorge forming rapidly in an older limestone erosion level. (Page 48.)

B. The flat featureless limestone lowlands. Raised marine offshore bars separate shallow lakes. The Kirchoffer Uplands are in the distance. (Page 48.)

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