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GEOGRAPHICAL PAPER No. 37

Radstock Bay, N.W.T., Compared with Resolute Bay, N.W.T., as a Potential Airbase and Harbor

R. T. Gajda

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PREFACE

This report presents results of geographical reconnaissance surveys of the settlement at Resolute and the area of Radstock Bay, carried out during the summers of 1948, 1949 and 1959. Some meteorological factors influencing sea and air navigation in northern areas have also been included.

The original results have already been utilized by various federal government departments, particularly the Departments of National Defence, Transport and Northern Affairs, but because of the more general need for geographical information about many parts of the north, it was decided to publish this report.

It is hoped that this will be of assistance to those who are concerned with the application of northern terrain characteristics and other geographical conditions to problems connected with site selection, construction, communication and transportation requirements.

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RADSTOCK BAY, N.W.T., COMPARED WITH RESOLUTE BAY, N.W.T., AS A POTENTIAL AIRBASE AND HARBOR

INTRODUCTION

The settlement at Resolute, Cornwallis Island was established after a reconnaissance survey carried out during the summer of 1947 (17). During the summer of 1948, the writer conducted a geographical reconnaissance survey of Resolute and in 1949 completed a similar survey on Devon Island in the Radstock Bay area. Both areas were revisited by the writer in 1959. This report presents the results of both surveys and discusses the potential use of the Radstock Bay area as an airbase and harbor accessible to cargo vessels.

The report describes the three principal essentials in the siting and supplying of an arctic operational base, namely the sea approaches, the preparation of airstrips, and the provision of unloading facilities and land transportation to the base. The most difficult problems faced in supplying an arctic station are the shortness of the navigation season and the lack of accurate, long-term information on freeze-up and break-up. Accordingly, the study of local ice conditions forms an important part of the reconnaissance, as transportation by sea is the most economical method of supply, the only alternative being air freight.

Because the Department of Transport meteorological station has been operating for 15 years in the Resolute Bay area, it is much better known than Radstock Bay. Accordingly this report places more emphasis on Radstock Bay although there is no meteorological station there. It is presumed however that weather conditions at Radstock Bay, only 65 miles east of Resolute, do not appreciably differ from those at Resolute, particularly the records between 1947 and 1953 which refer to the earlier station located on the west shore of Resolute Bay, 56 ft above mean sea level.* This elevation compares favorably with the elevation of a potential site at Radstock Bay, where a meteorological station could be established between the 25 and 50-ft level. Air distances between Resolute, Resolute alternates and selected arctic bases are shown in the following table (Table 1).

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*On October 1953, the station was moved to the airstrip site two and one half miles inland to the northwest. The datum level of the station is 209 ft above mean sea level.

TABLE 1

Air distances from Resolute, N.W.T.

To	Miles	To	Miles
Radstock Bay (potential airstrip)	65	Alert	690
Isachsen	330	Baker Lake	700
Eureka	380	Coral Harbour	755
Cambridge Bay	430	Yellowknife	935
Mould Bay	430	Frobisher Bay	945
Thule, Greenland	455	Churchill	1,065
		Point Barrow	1,190

GEOGRAPHICAL CONDITIONS

Sea Approaches to Resolute and Radstock Bay

There are several routes that vessels may follow to reach eastern Devon Island or southern Cornwallis Island, but Lancaster Sound and Barrow Strait have the longest ice-free season, and the approaches from the west or south through Viscount Melville Sound or Prince Regent Inlet are difficult to navigate in any season. Furthermore, the Baffin Bay-Lancaster Sound route is the shortest sea passage to Cornwallis Island and Devon Island from the eastern seaboard of North America.

Physical Setting

Lancaster Sound and Barrow Strait extend in an east-west direction from Baffin Bay to Viscount Melville Sound. Both have a uniform width of about 40 miles with a combined length of 325 miles from Philpots Island and Cape Hay to 100° west longitude. The passage bends slightly as it passes south of Devon Island and narrows to 33 miles south of Cornwallis Island; this is the narrowest section of the passage from M'Clure Strait to Lancaster Sound (Figure 1).

The south shore of Devon Island is precipitous, with hills rising more than 2,000 ft in the east and shore cliffs 1,300 ft high in the west as far as Radstock Bay. The terrain of Cornwallis Island rises gradually northwards for several miles inland. South of Barrow Strait the cliffs of Somerset Island rise abruptly from the sea, and gravel ridges extend a mile offshore. The north coast of Baffin Island is generally hilly but not precipitous and reefs are found some distance offshore.

Bathymetry

A trench extends from central Baffin Bay into Lancaster Sound with depths decreasing progressively westwards from about 450 fathoms at the entrance to the sound, to 125 fathoms at its western end. Barrow Strait west of Devon Island is mostly less than 100 fathoms in depth (Figure 2).

No major obstructions to water movement are present except for Prince Leopold Island, which is small and located well to the south. Griffith Island is west of Resolute Bay and, therefore does not greatly affect passage to Cornwallis Island from the east.

Currents

Barrow Strait and Lancaster Sound are fed with arctic water from Viscount Melville Sound and Wellington Channel. These cold currents are from the north and west and the dominant wind directions in the eastern archipelago are from the northwest and north. Thus the resultant movement of water and ice is from west to east through Lancaster Sound and southward along the eastern shore of Baffin Island (Figure 3).

Most of the arctic water in Baffin Bay comes by way of Lancaster Sound as a strong surface current that moves eastward along the south side of the sound. Its velocity has been estimated at 55 miles (88 kilometres) a day, and its volume at 650,000 cu metres/sec (2). This current is especially important in the early removal of ice from Lancaster Sound. Its velocity can be compared with that in Jones Sound (25 km/day) and Smith Sound (35 km/day).

At the mouth of Lancaster Sound a warmer ingoing or westward moving surface current flows along the south shore of Devon Island and may carry icebergs originating in Greenland and Ellesmere Island into Lancaster Sound and south into Prince Regent Inlet. A weaker warm current is also present at greater depth but does not deeply invade Lancaster Sound.

The map showing surface temperatures (Figure 4) is largely self-explanatory. As the warmest water is in the eastern and northern sections of Lancaster Sound these areas tend to be more ice-free, and break-up is usually earlier than in other areas of the sound.

Tides

Tides, in general, increase towards the east in the sounds. The greater width of Viscount Melville Sound produces a mean tide of only about 2 ft , while the westward moving water must pass more quickly through narrower Barrow Strait. Additional water entering from Wellington Channel increases the amount that must funnel into Baffin Bay. Therefore, the mean tide at Resolute Bay is 4 ft, at Griffith

Island close to 4 ft, and at Erebus Bay and Radstock Bay about 6 ft, (3,4). Dundas Harbour has experienced spring tides of 14 ft. The former have spring tides of more than 5 ft. There also appears to be an increased lack of consistency in tide heights as one moves eastward.

In Lancaster Sound, tides have some effect on the formation of shore leads, the lifting of floes on beaches and the delaying of ice formation. West of Wellington Channel the effect of tides on ice formation and distribution is less noticeable.

Winds

The greatest difficulty in navigating these waters is the presence of ice. Temperature is important in the formation of sea ice but the forecasting of break-up, and to a lesser extent freeze-up, by calculating the heat accumulation is of limited value. Temperature differences do not appear to exert much influence. Other factors such as depth of the water, salinity and wind play a large part in determining these dates.

Wind is probably the most important factor in breaking up the ice in summer and moving it eastward into Baffin Bay. Lancaster Sound clears generally between mid-July and mid-August. As a rule, west to northwest winds hasten the clearing while south to southeast winds delay it. The clearing of Lancaster Sound often progresses to about 90° west longitude, that is, about 100 miles east of Resolute Bay and then stalls, awaiting break-up and clearing of Barrow Strait and Wellington Channel. This usually is completed during the second half of August. In the region of Resolute Bay the winds are variable but dominant directions are evident; Resolute has a dominant northwest wind that hastens the eastward movement of ice. This wind, aided by the cold arctic current through Wellington Channel concentrates most of the ice along the south shore of Barrow Strait and Lancaster Sound. When such conditions occur Resolute Bay is open to navigation. However, strong winds from east to northeast are common during the navigation season and these tend to retard the eastward drift of ice. Often the ice from Wellington Channel will drift along the coast of Cornwallis Island and will enter Resolute Bay.

Less favorable conditions exist to the east at Dundas Harbour, which has recorded dominant wind directions of east and northwest. The data from both Dundas Harbour and Resolute Bay may be inconclusive because of local variation in topography but on the whole the wind direction aids the eastward movement of the ice. However, with strong winds possible from both the east and west a daily shift may greatly alter ice concentration and distribution.

RADSTOCK BAY - A POTENTIAL AIRBASE AND HARBOR

TABLE 2

Weather Data, Resolute, October 1947 to April 1954 (5)
Dominant Directions of Strong Winds and their Comparative Occurrence

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
Primary	NW.8	NW.75	NW.6	NW.5	NW.7	E.6	NW.6	NW.7	NW.8	NW.6	NW.6	NW.5	NW.9
Secondary	NE.2	E.25	E.4	E.5	E.3	NW.4	E.4	E.3	NE.2	E.4	NE.4	E.5	NE.2
	Percentage of Wind more than 13 m.p.h.												
	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
	32.6	26.4	30.0	28.3	35.0	35.8	40.0	30.6	35.8	36.4	30.3	24.7	32.2

Sea-Ice Conditions

With increased activity among the Queen Elizabeth Islands supply ships must visit the arctic stations each summer. The uncertainty of ice conditions, however, makes escort by icebreaker almost imperative, although as more is learned about break-up and freeze-up escorting may be necessary only under unusual ice conditions.

There are many variables that determine navigability in drifting ice,a few of which are concentration, thickness, type and size of floe. Because vessels differ in their ability to pass through ice, some criteria for determining navigability are necessary.

An icebreaker can move through pack ice up to nine-tenths coverage, but a concentration of large floes of nine-tenths or more is considered a barrier if it is very extensive. Furthermore, a continuous ice sheet will likely be 6 ft or more in thickness. An icebreaker can sometimes break through old ice thicker than 6 ft and showing some leads, but speed is sufficiently reduced to make waiting, or hunting for better conditions, more profitable in the long run. Pack, hummocked, or rafted old ice is impenetrable except along zones of weakness such as pressure ridges, and even then progress is slow and dangerous. Solid ice covered with at least fifty per cent puddling is usually thin enough to present little difficulty to an icebreaker.

Escorted ocean freighters with reinforced bows can handle ice of seven-tenths concentration or less providing the ice is not in the form of large floes. Unescorted freighters also with reinforced bows will seldom attempt to pass through water having more than four-tenths to five-tenths ice coverage depending on the size of floes.

The following sections show the navigability of Lancaster Sound and eastern Barrow Strait based on data recorded after the establishment of the weather station at Resolute in 1947.

Break-up and Freeze-up

The most ice-free passage to Cornwallis Island is along the west coast of Greenland to about 74° north latitude and then west into Lancaster Sound. The north side of the sound has less drifting ice, at least as far as Wellington Channel. The average dates given in the following paragraph for freeze-up and break-up are those after Baffin Bay is sufficiently open, because the ice often breaks up in Lancaster Sound before it does in Baffin Bay. The individual bays usually break up even later so a separate account is given of ice conditions in Resolute and Radstock Bays as compared with open water offshore.

Icebreaker Navigation

Data are insufficient to provide average dates of freeze-up and break-up in Barrow Strait and Lancaster Sound. However, it appears that Lancaster Sound is open to navigation by icebreaker as far east as Radstock Bay about the second week in July, the earliest recorded period being the last week in June and the latest the third week in July. Resolute Bay, on the other hand, is generally accessible one to two weeks later than Radstock Bay with early and late break-up being recorded as the first week in July and the first week in August respectively. In general, Resolute Bay is closed to icebreakers by freeze-up in early November and Radstock Bay approximately one week later; break-up occurs from east to west, and freeze-up from west to east.

Escorted Freighter Navigation

Freighters following an icebreaker find an ice coverage of more than seven-tenths exceedingly dangerous because the path cleared tends to fill in with ice immediately. However, escorted vessels can reach Resolute Bay in safety around the fourth week in July and Radstock Bay two weeks earlier.

Freeze-up sufficient to halt escorted vessels occurs about the first week in October out of Radstock Bay and the third week in September for Resolute Bay (6, 7, 8, 9 and 10) (Table 3).

Unescorted Freighter Navigation

The navigation season for vessels unaided by an icebreaker is understandably very short, and unusual ice conditions may add serious complications. Very likely icebreakers will always be kept within a reasonable distance of the area to provide aid for any vessel in distress.

RADSTOCK BAY - A POTENTIAL AIRBASE AND HARBOR

TABLE 3

Opening of Radstock Bay and Resolute Bay - 1953 to 1955 (approximate dates)

	1953	1954	1955
Baffin Bay open	July 17 - 21	July 19 - 24	June 25 - 30
Radstock Bay open	June 11 - 16	July 5 - 11	July 1 - 6
Resolute Bay open	July 12 - 16	Aug. 7 - 12	July 25 - 31
Radstock Bay closed	--	Oct. 25 - 30	Oct. 1 - 6
Resolute Bay closed	--	Sept. 19 - 24	Sept. 19 - 24

Radstock Bay may be reached by unescorted freighter usually by the fourth week in July. On occasions, the ice has cleared sufficiently by the first week in July, but may be as late as the first week in August. Resolute Bay is open to this traffic approximately 2 weeks later.

The average closing date for unescorted freighter navigation to Radstock Bay is the fourth week of September with extremes of the third week in August and the first week in October. Resolute Bay is inaccessible because of freeze-up about the first week in September with an early closing during the week previous and the latest closing occurring in 1953 during the first week of October. Unescorted freighters attempting to reach Resolute Bay would face the danger of a slightly early freeze-up preventing their escape.

The early opening of Lancaster Sound is exemplified by the year 1953 when the sound west to Radstock Bay was open by mid-June although ice in Baffin Bay provided a barrier until the fourth week in July.

Bands of Drift Ice

Ice reports prior to 1947 were largely recorded by naval observers, but the types of ice and their distribution were seldom identified. These reports are numerous, however, and the ice conditions that would prove impenetrable for freighters and difficult for icebreakers have been especially noted. In most cases, the ice is in the form of north-south bands of large floes with nine-tenths coverage or more, and occurring from Cape Hotham to Cape Rennell, from Cape Hurd to Cape Clarence, and from Cape Warrender southwards across Lancaster Sound. These ice barriers are recorded as being of a temporary nature, but nevertheless impeded navigation for several days, and in addition, they occurred during the height of the navigation season. The second and third barriers affect both Resolute Bay and Radstock Bay, but the first one isolates Resolute Bay only.

RESOLUTE BAY

Bathymetry and tides

Resolute Bay is quite shallow with an entrance depth of less than 6 fathoms at low tide. A submerged bar lies across the entrance to the Bay (Figure 5). However, towards the west side of the bar there is a channel 1,000 to 2,000 ft wide, with depths from 8 3/4 fathoms on the east to 6 1/4 fathoms on the west. Within the bay there are many shallow areas, but a channel with depths from 6 1/4 fathoms to 9 1/4 fathoms leads to an area in the head of the bay about 2,000 ft by 3,000 ft where depths vary from 10 1/4 fathoms to 14 fathoms. From an anchorage in this basin, ship-to-beachhead distance is about half a mile. Ships prefer to anchor 1½ miles off the beachhead area and outside the submerged bar but because of difficult unloading operations they take a risk by entering the bay and anchor closer to its head.

Depths during low tide are given on the map and high tide is approximately 4.5 ft above these soundings. The maximum tidal range is probably about 6 ft. The tide is not sufficiently high to produce local shore leads or break up the bay ice; when floes are forced up on the beaches they are deposited there by strong winds and often interfere with ship-to-shore transportation and unloading operations.

Wind and Drift Ice

By the middle of September the ice in Resolute Bay is freezing and breaking up for a week or two before it freezes solid. The ice attains a maximum thickness of about 6 ft during mid-May and remains so for at least one month.

Resolute Bay has a northwest-southeast orientation and the dominant wind during the navigable season is from the northwest, thus aiding the removal of ice from the bay. However, recurrent south-easterly winds are also present. Winds from the east blow some ice out into the strait, but also against the west side of the bay where the landing beach is located.

When eastern Barrow Strait is relatively free of heavy ice much is still drifting into the western entrance from Viscount Melville Sound. From March to October there are occasional strong south to southeast winds that either prevent the bay ice from moving out or re-route the eastward drifting winter ice in Barrow Strait towards the northeast. Thus, in the middle of the relatively ice-free navigation season it is possible that Resolute Bay may be plugged with winter ice. The following dates are those when ice drifted into the bay preventing entrance (or forcing a rapid exit) by supply ships and often defying efforts of icebreakers to crush it. On these days cargo vessels lying outside the harbor entrance had to move off and, therefore, all unloading ceased. All dates are later than the initial break-up of the bay for that year.

1948 - August 4 to 6
12 to 13
19 to 29
31 to Sept. 2

1949 - August 7 to 9
16 to 22

1951 - August 10 to 20

1953 - August 4

1955 - August 17 to 20

Break-up and Freeze-up

Resolute Bay is similar to many of the other southward or westward facing smaller bays in that the ice breaks up later than that in eastward facing bays where the wind can hasten its removal. The dates following will show that the bay breaks up later than the ice in Barrow Strait. The bay ice is usually impenetrable to freighters but can be broken up by icebreaker. However, there is no guarantee that the broken ice will immediately drift out. Final freeze-up is usually preceded by two to three weeks of light freezing and breaking.

TABLE 4

Break-up of Resolute Bay	Barrow Strait open to Escorted Freighters
1948 - August 2	No data
1949 - August 6	Before August 6
1950 - July 26	No data
1951 - August 4	Before July 24
1952 - August 7	Late June to early July and after August 5
1953 - No data	No data
1954 - August 1 to 6	Before August 1
1955 - After August 10, 11	Between July 1 to 6
1962 - July 19, (beginning of break-up)	

TABLE 5

Freeze-up of Resolute Bay

1947 - Sept. 11 to 20	1955 - Sept. 21 to 24
1948 - about Sept. 18	1956 - about Sept. 21
1949 - Sept. 13 to 23	1957 - about Oct. 6 (13)
1950 - about Sept. 21	1958 - not known
1951 - not known	1959 "
1952 - about Oct. 6	1960 "
1953 - about Sept. 21	1961 - about Sept. 16 (11)
1954 - Sept. 17 to 26	

Resolute Bay Area

The Resolute peninsula is composed of uplifted limestone sediments that have remained relatively horizontal, and that have been reduced to a localized peneplain by erosion. The immediate terrain is rolling but the plain is enclosed on all sides (except seaward) by flat-topped limestone hills in a recent stage of erosion. The airfield and the new site of the meteorological station are on a slight ridge sloping gently to the north. A mile and a half to the north and northeast hills rise abruptly to 500 ft and two and a quarter miles to the south and southeast to some 530 feet. About 8 miles to the east and southeast they rise to 850 ft, and near the centre of Cornwallis Island (about 30 miles north of Resolute) to 1,000 ft.

During the Pleistocene period, the peninsula was depressed and was probably about 450 ft or more below the present sea level. Subsequent to the last retreat of the ice, isostatic readjustment caused the land to re-emerge. This upward movement of land relative to sea level is probably continuing at the present time.

Repeated periods of inundation by the sea have resulted in accumulations of marine deposits, mostly beach deposits, some of which are still visible.

The bedrock is now covered with limestone till to a depth of 2 to 12 ft. Many small lakes dot the lowland and small streams cut their own channels. Allen Bay to the northwest is separated from the flat valley by 150-ft marine terraces. Three terraces 40 to 50 ft high extend across the lowland. Ice-shored ramparts have been built up on the lake beaches and are also present along the sea beaches, although the latter are higher, rising to between 4 and 7 ft. Figure 9 shows the topography and planimetric features of the Resolute Bay area.

RADSTOCK BAY - A POTENTIAL AIRBASE AND HARBOR

RADSTOCK BAY

Radstock Bay is surrounded by high terrain on its eastern and northern perimeters. On the west side is the lowland lying between Radstock Bay and Erebus Bay. The most prominent topographical feature of this valley is 600-ft Caswall Tower on the western side of the bay (Figure 6). Cape Ricketts lies to the south and like all the hills surrounding Radstock Bay it is precipitous and flattopped (Figure 7).

Bathymetry and sites

The entire bay is deeper than Resolute Bay with soundings of more than 70 fathoms at its northern end. It is easily navigable for large ships and offers excellent anchorage. The entrance is 6 miles wide and more than 40 fathoms deep. There is shallow water only in the extreme northwestern part of the bay and at the far end of the northeastern arm, due to silting from stream outlets (Figure 8). Radstock Bay should provide good shelter from winds except those from the south and the southeast. Prevailing winds from the north and west would be effectively blocked by the high terrain to the north and northwest.

The tides are similar to those in Erebus Bay to the west, with a mean range of 6 ft.

Ice Conditions

A strong wind from the south could force drifting ice from Barrow Strait into Radstock Bay, but the area is large enough to allow vessels to retreat deeper into the bay. A moderate west or north wind would probably blow the ice out. There is no record of the bay having been filled with ice during the navigation season, and indeed the evidence that does exist indicates that this would be an infrequent occurrence. This contrasts with Resolute Bay where navigation is difficult owing to the recurrent filling of the bay with ice during August. The following remarks point up the complicated ice problems in Resolute Bay in 1948. They are excerpted from daily records of the RCMP Resolute Bay Detachment, courtesy of Const. H. Aime.

Likewise difficult ice conditions were encountered during the 1949 resupply mission. On August 15 the ice in Resolute Bay was solid for about 400 yards along the boat landing area. From August 16 to August 20 ice conditions prevented the resupply ship _Wyandot_ from entering Resolute Bay. Both the icebreaker _Edisto_ and the _Wyandot_ were forced to wait for improvement of ice conditions, and lay either off the mouth of Wellington Channel or off Beechey Island. On August 21st ice still prevented the _Wyandot_

TABLE 6

July 10	Ice solid in the bay, straits partially opened
July 22	Ice broken up in the bay, drift ice in straits
July 26	Ice in bay has started to move out from shore
July 29	Ice still in Resolute Bay although open water all around the shore
Aug. 2	Bay cleared, ice driven out by north wind
Aug. 4	Bay filled with drift ice, result of south wind
Aug. 6	Bay still choked with ice
Aug. 9	Bay cleared
Aug. 10	Scattered drift ice in Barrow and Lancaster Sound. Bay filled with floating ice
Aug. 14	Bay cleared
Aug. 17	Bay and Straits filled with float ice
Aug. 18	Bay cleared
Aug. 19	The bay is again full of ice this morning
Aug. 27	The bay and strait has been generally filled with drift ice for the past week. Bay beginning to clear
Sept. 2	Bay and straits reasonably free from ice, new slush ice forming
Sept. 8	Allen Bay and Straits filled with ice
Sept. 13	Drift ice in the bay and Strait
Sept. 16	Bay freezing along the shore
Sept. 21	Bay almost completely frozen over

from entering the bay until the evening of August 22 when with northwest winds blowing the whole day the ice moved out of the bay. Between August 22 and 29 Resolute Bay was sufficiently free of ice so that unloading continued except for August 25, when operations were suspended for 12 hours owing to a heavy storm which reached almost blizzard proportions.

During the same period ice conditions were favorable in Radstock Bay. In fact, on August 19 the icebreaker Edisto entered the bay, which was completely ice-free, allowing the cruiser Greenland to carry out hydrographic reconnaissance and sounding.

Similar conditions existed in previous years, and it is a safe assumption that Radstock Bay would be accessible for the discharge of cargo during most of August and September. By contrast, the approach to Resolute Bay is hazardous at all times and at best its accessibility is confined to sporadic short periods.

Physiography

Bear Valley* is relatively level, and extends about 7½ miles east-west and 2½ miles north-south. Its western end opens out into Erebus Bay with Radstock Bay and Gascoyne Inlet lying to the east and south respectively. North and south of Bear Valley are steep cliffs rising to a plateau level of 700 to 800 ft.

*This is a local name referring to the lowland between Radstock Bay and Erebus Bay.

North of the valley, the general aspect of the terrain is that of a tableland with incised stream valleys.

West of 86° 30' west longitude, the Precambrian rock gives way to Silurian which lies horizontally and is little disturbed. It is composed of about 1,000 ft of limestone with a few narrow beds of shale, and resembles the formations found in the Resolute Bay area.

Except for occasional limestone outcrops such as east of Muskox Lake, Bear Valley appears to be in a late stage of erosion. The down-cutting may have been accomplished by a finger of a glacier passing down what is now Radstock Bay and moving westward through Bear Valley. In the vicinity of Erebus Bay, it is postulated that the glacial finger divided, moving past Beechey Island on both sides. Material eroded from the upland during the advance of the ice remained as a mantle on the valley floor. Following the disappearance of the ice, the mantle was reworked by marine action, producing the present terraces. It appears likely that much of the fragmented limestone was laid in the valley while it was covered with water and the re-working occurred with the slow emergence of the land. The numerous lakes and ponds in the central and eastern part of the valley are the result of marine terraces and strandlines that have effectively disrupted the evolution of a normal drainage pattern. Since the formation of the terraces, several large deltas and alluvial fans have been superimposed on them in the western half of the valley. Maps showing landforms and relative steepness of the slopes (Figures 10 and 11 in pocket) present in detail the physiographic features in Radstock Bay area.

The slope is very gradual in a west to east direction from Erebus Bay. From the bay to a point 1½ miles east of Loon Lake, the rise in elevation is 50 ft in approximately 4 miles. The slope is less gradual westward from Radstock Bay north of Caswall Tower. From Radstock Bay to North Lake, a distance of approximately 1½ miles there is a rise in elevation of some 60 ft. There is elevation of more than 100 ft over a small area west of Muskox Lake. Most of Bear Valley, however, is below 50 ft in elevation.

Four large lakes are located on the lowland. Loon Lake and North Lake are surrounded by marshy terrain with dissected terraces, particularly on their eastern and southern perimeters. Loon Lake appears to be very shallow with small irregular islands towards its eastern margin. The smallest lake, Muskox Lake, is slightly more than one third of a mile from Radstock Bay. This lake has an elevation of over 50 ft. The largest lake, South Lake which is very near sea level, is half a mile west of Radstock Bay and lies just east of Gascoyne Inlet.

GEOGRAPHICAL BRANCH

The central and eastern part of Bear Valley is covered with marsh, dissected and large undissected terraces, earth-polygons and strandlines (Figure 12). Three strongly delimited marine terraces lie between Caswall Tower and the cliffs on the north side of the valley. Patterned ground is particularly evident in the vicinity of the stream entering Radstock Bay north of Caswall Tower as well as southeast of the proposed airstrip (Figure 13). Two small solifluction lobes appear to exist near the headwaters of this stream, just south of a small pond.

North from the eastern part of Loon Lake, a broad belt of marine terraces is found extending northwards to the cliffs on the north side of the valley. East of this marine terracing, an alluvial fan bordered to the east and west by deposits of alluvium and streams, covers a large area between the marine terraces and North Lake.

West of Loon Lake, Bear Valley is flatter, low in elevation and covered with stream deposits. A few terraces and strandlines are found in the extreme north and south. A broad alluvial fan, which is exceedingly uniform and level, occupies a considerable area northwest of Loon Lake. The surface of this fan, somewhat dissected by frost furrows and stream beds, is bordered west and north by a braided area terminating close to Erebus Bay.

Westward, where the streams empty into Erebus Bay, an offshore bar has formed and a lagoon is presently filling with alluvium. Two small alluvial fans are to be seen in this area, one northeast of the lagoon, the other south of the stream flowing from Loon Lake to Erebus Bay (Figure 14). Close to Loon Lake regular frost mounds are present.

At the other end of the valley lies the most striking feature of the area, Caswall Tower, rising approximately 600 ft. This landmark is easily spotted from planes flying at 20,000 ft or more. Also, from Barrow Strait the mesas south of the valley can be identified by radar.

Beechey Island is located west of Bear Valley across Erebus Bay. The island, with its mesa-like topography rises to approximately 660 ft and forms a protective rampart for both Erebus Bay and Bear Valley. At the bottom of a talus slope on the northeastern side of the island, finer alluvial material tends to flow in the form of solifluction lobes and sheets above the marine terraces. The middle and upper slopes of the island are covered by mud circles in all stages of formation. Most of these have tended to flow downhill. In the case of some mud circles on gravel surface, a shallow basin has formed behind each stone. On the limestone-shingled plain on top of the island there are numerous mud circles, the average diameter of these being 15 in. The centres of these and almost all the mud circles on the island are very stony. The shingle or large stones have been turned on end. Some polygons have been produced on slopes over 30 degrees. A small sand bar extending northeast connects Beechey Island to Devon Island at low water.

Bear Valley can be approached by ship from three directions: from the west through Erebus Bay, hindered somewhat by the shallowness of the eastern reaches; Gascoyne Inlet, south of Bear Valley, limited because of its shallow northern end; through Radstock Bay, the best approach.

AIRCRAFT LANDING FACILITIES

Air transportation is invaluable in the northland; without it the isolation is broken but once yearly by the visit of a supply ship. However, aircraft require good landing facilities because alternate airstrips are often several hundred miles distant. A summer airstrip requires level land of sufficient area, and an abundance of gravel and fragmented rock for the surfacing of a runway. Low elevation and good approaches are of the utmost importance. The airstrip must be near the settlement or weather station. Both the airstrip and the settlement should be located close to a bay with depths adequate for supply ships to navigate, with good protection from prevailing winds, and with gently sloping beaches suitable for landing craft, as bulk supplies for the maintenance of both the airstrip and the settlement are brought in by ship.

In winter, level ice may occur on a small bay or large lake and may be used for a winter airstrip. Here also, the air approaches must not be obstructed by hilly or mountainous terrain. Weather conditions, particularly winds and clouds,are very important factors in Arctic air navigation.

Bedrock should not be everywhere exposed or deeply buried at any proposed site because the erection of buildings may be difficult. An adequate supply of freshwater nearby is necessary for local use.

Few sites will have all these features but without them serious problems of supply will likely result. Only after a careful study has been made of the geography of suggested station locations can the advantages and disadvantages of each be determined.

Landing Airstrip at Resolute

The Resolute airstrip is 209 ft above sea level and lies about two and a half miles north-northwest of the ionosphere station on the flat lowland of the peninsula, as the terrain nearer the station is rolling and stream-dissected. The surface of the plain is mantled with fragmented limestone and gravel but shingles up to 5 in. in diameter are found in quantity. The approaches to the airstrip are good from the north, south and west. To the northeast and east is a range of 500-ft hills less than a mile from the strip, while to the southwest a small promontory rises more than 500 ft (Figure 9).

The southern end of the north-south 8,000-ft runway had to be built up 15 ft to maintain a constant level. The airstrip was intended to be 5,000 ft in length but was lengthened to 8,000 ft and widened to 300 ft to accommodate four-engined aircraft. The site was graded, and excess material was piled in ridges 18 in. high on either side of the strip. It was planned to use the airstrip on a year-round basis but storms filled the runway with drifting snow which could only be removed with difficulty. It was soon realized that runways should be slightly higher than the surrounding terrain to take advantage of the wind.

Fragmented limestone provided a good base for the runway but much of it was too large and angular and proved somewhat rough on aircraft tires. This was partially remedied by the application of finer crushed rock.

During the summer months much of the archipelago experiences thick fog. The entire area around Resolute becomes periodically free of ice during the summer months. The warm wind circulating from the west picks up moisture and is forced upwards over the cool Resolute Peninsula where it condenses and forms heavy fog and low-lying stratus often with a 300-ft ceiling. This also occurs in Wellington Channel. The cloud may lie so close to the ground that aircraft attempting to land cannot get below it. The maximum frequency of low stratus occurs in September and the most cloud-free month is January.

TABLE 7

Average cloudiness at Resolute Bay, 1947 to 1950 in days per month (14)

	J	F	M	A	M	J	J	A	S	O	N	D
0-20%	20	15	17	15	8	3	4	5	3	7	11	19
30-70%	4	3	4	3	4	4	4	4	2	4	4	3
80-100%	7	10	10	12	19	23	23	22	25	20	15	9
Mean Cloudiness %	31	42	39	44	67	82	80	77	83	70	58	35

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The mean percentage of cloud cover for the year is 60.

Ceiling and visibility are of extreme importance in flying. The following tables show ceiling statistics, average visibility, and percentage of fog or mist at Resolute:

TABLE 8

Percentage 1,000-ft or less ceilings, Resolute Bay (15)

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
	6	6	6	4	24	34	28	34	52	37	18	24	21%

TABLE 9

Average visibility at Resolute Bay in days per month (14)

	J	F	M	A	M	J	J	A	S	O	N	D
0-1100 yd.	4	2	2	0	1	2	1	2	2	2	2	2
1100 yd.-6 mi.	4	6	4	6	4	7	4	6	8	8	7	5
over 6 mi.	23	20	25	24	26	21	26	23	20	21	21	24

TABLE 10

Percentage of time that Resolute Bay experiences fog or mist from zero to ½-mile visibility (15)

	J	F	M	A	M	J	J	A	S	O	N	D
	9.9	8.6	8.0	4.0	3.5	3.8	3.8	5.0	6.3	6.3	6.0	4.1

The foggiest months recorded in 1948-49 were: December 68 hours, August 51 hours, September 14 hours.

Recently published data on terminal weather conditions at Resolute (16) supply more detailed and useful information. Information on ceilings less than 1,000 ft, less than 500 ft, and less than 300 ft for the seven-year period 1954-1960 were taken from the above data and are quoted in Tables 11, 12, 13, 14 and 15.

TABLE 11

Occurrences of ceilings less than 1,000 ft and/or visibilities of less than 3 miles (below VFR* conditions) at Resolute 1954 to 1960

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
No. of occurrences	331	313	227	231	274	328	429	497	484	540	258	236	
% of observations	19	20	13	14	16	20	25	29	29	31	15	14	20

*Visual Flying Rules.

TABLE 12

Occurrences of ceilings less than 500 ft and/or visibilities of less than 1 mile (below IFR** landing limits) at Resolute, 1954 to 1960

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
No. of occurrences	196	157	110	97	113	137	293	329	180	223	121	110	
% of observations	11	9	6	6	7	8	17	19	11	13	7	6	10

**Instrument Flying Rules.

TABLE 13

Occurrences of ceilings less than 300 ft and/or visibilities of less than ½ mile (below IFR take-off limits) at Resolute 1954 to 1960

	J	F	M	A	M	J	J	A	S	O	N	D	Yr.
No. of occurrences	131	89	51	49	43	78	197	231	101	106	52	50	
% of observations	8	6	3	3	2	5	11	13	6	6	3	3	6

Values of ceiling and visibility below VFR (Table 11) were reported in 20 per cent of the observations. The evident seasonal variation shows a March-April minimum of 13 to 14 per cent, and July to August maximum from 25 to 31 per cent. The minimum values correspond to the time of infrequent cyclonic activity in the Arctic and the maximum ice cover of the seas and channels. The maximum July to October values are due to the frequent cyclonic activity and the minimum ice cover of the seas. The frequency distribution is fairly uniform during the remainder of the year (about 16 per cent). mostly because of blowing snow conditions. Ceilings and visibilities below IFR landing limits (Table 12) were reported in ten per cent of observations, showing only two months maximum (July and August) and fairly uniform frequency distribution during the remainder of the year, averaging 8 to 9 per cent.

Ceilings and visibilities below IFR take-off limits (Table 13) were in 6 per cent of observations, again with a July and August maximum.

The directional variation of the winds at Resolute and the occurrence of below-VFR weather with various wind directions are shown in Table 7.

TABLE 14

Relationship between wind direction and below-VFR weather at Resolute 1954 to 1960

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Calm
No. of observations	1451	777	1433	513	1338	1761	2315	641	586	267	315	311	903	1168	3134	1663	1879
Per cent	7	4	7	2	7	9	11	3	3	1	2	2	4	6	15	8	9
No. of observations below VFR	187	94	147	80	337	455	532	192	202	122	105	137	279	315	546	261	157
Per cent	13	12	10	16	25	26	23	30	34	46	33	44	31	27	17	16	8

On an annual basis, the prevailing winds are from the northwest and north-northwest, and occurred 23 per cent of the time. Winds from the second predominant direction were southeast to east-southeast with 20 per cent, while 9 per cent of the time was reported calm. Winds from the northeast were associated with good terminal weather at Resolute and were accompanied by only 11 per cent of the total below-VFR weather. With northeast winds the weather was below-VFR limits in 10 per cent of the occurrences. The greatest frequency of below-VFR weather occurred when winds were from the southeast; these accounted for 30 per cent of the time and were associated with 37 per cent of the total below-VFR weather. When winds were from the southeast the weather was below-VFR limits on 23 per cent of the occurrences. The southwest quadrant contributed only 8 per cent of the wind occurrences but accounted for 14 per cent of the total below-VFR weather. South-southwest winds, below-VFR weather, occurred on 46 per cent of the reports. The northwest quadrant, which includes the prevailing northwest direction, accounted for 33 per cent of the wind observations; 34 per cent of below-VFR weather occurred with these winds. Seventeen per cent of the prevailing northwest winds were associated with below-VFR weather conditions.

The relationship between below-VFR weather and wind speed is illustrated in Table 15.

TABLE 15

Relationship between wind speed and below-VFR weather at Resolute 1954 to 1960 showing percentage of observations in various wind-speed groups that were below-VFR

Winds	0 to 9 m.p.h.	10 to 19 m.p.h.	20 to 29 m.p.h.	30 m.p.h. and over
January	1	8	39	87
February	5	18	39	80
March	4	8	40	87
April	4	12	29	67
May	14	13	20	42
June	22	21	13	15
July	28	26	15	12
August	33	30	18	20
September	32	28	26	13
October	20	25	41	72
November	5	10	36	80
December	2	7	38	79

The analysis of this table indicates that during October through April, below-VFR conditions generally occurred when winds were in the higher speed groups. In most cases the blowing snow was responsible for reduced visibility. For the remainder of the months below-VFR conditions were associated generally with winds in the lower speed groups (16).

Alternative Landing Sites on Ice Surfaces at Resolute

During the winter visual landings at Resolute may be made on Resolute Lake, a former arm of Resolute Bay, 15 ft in elevation. One advantage is that clearance is greater over the lake than over the landing strip. A large freshwater lake produces the smoothest and thickest ice because it is not as susceptible to wind nor to the extreme pressure exerted by sea ice. Large shore leads, premature break-up and pressure ridges do not occur. Aircraft may begin using Resolute Lake for wheeled landings about mid-October but, when drifting snow covers the regular airstrip the lake can be used in winter also.

Ground landings become more difficult when the snow begins to melt in the spring and the lake ice is consequently used until June. The greatest thickness of ice occurs in late April or early May. Some indication of the thickness of ice on the lake is given below.

TABLE 16

Thickness of Ice on Resolute Lake

27 Sept. 1947	9 in.
1 Oct. 1947	14 in.
1 Dec. 1947	33 in.
7 Dec. 1947	Approximately 5 ft of ice on landing strip
31 March 1948	7 ft
1 May 1948	7 ft 6 in.
8 June 1948	Lake ice unfit for further use as landing strip
23 July 1948	Ice on lake surface, 85 per cent rotten; 15 per cent of water concentration around the edges
2 Aug. 1948	Lake cleared of ice by wind action

The maximum thickness of the ice was 7 ft 6 in., recorded on May 1st, 1948. During the 1947-1948 winter the freshwater ice was 19 in. thicker than the sea ice on Resolute Bay; the ice on Resolute Bay was only 6 ft on May 19th, the time of its maximum thickness. In the first week of June the lake was unfit for further use by aircraft. In 1948 Resolute Lake froze up on September 17th and broke up on July 5th, 1949. Maximum ice thickness recorded in 1948-1949 was approximately 8 ft.

The sea ice on Resolute Bay does not freeze as deeply as the freshwater ice but freeze-up and break-up occur about the same time. The necessity for a greater depth of sea ice than lake ice to carry the weight of the same wheeled aircraft prevents use of the bay until several weeks after freeze-up on the lake. This factor, together with the proximity of the lake and the possible roughness of the bay ice has prevented the use of the bay for winter landings.

The sea-ice measurements listed below were extracted from the records of the Resolute weather station for 1947-1948.

Measurements of sea-ice thickness for periods between 1955 and 1961 have been published by the Meteorological Branch of the Department of Transport (13).

Following are measurements of the maximum sea-ice thickness and snow depth for this period.

TABLE 17

Thickness of sea ice on Resolute Bay

27 Sept. 1947	Freeze-up	22 Dec. 1947	35 in.
13 Oct. 1947	11 in.	29 Dec. 1947	37 in.
10 Nov. 1947	20½ in.	19 Jan. 1948	46 in.
17 Nov. 1947	23 in.	7 Feb. 1948	50 in.
24 Nov. 1947	24 in.	6 Mar. 1948	57½ in.
1 Dec. 1947	26½ in.	29 Apr. 1948	69½ in.
8 Dec. 1947	28½ in.	19 Apr. 1948	72 in.
15 Dec. 1947	31 in.		

TABLE 18

Maximum sea-ice thickness on Resolute Bay, 1956 to 1961

Date	Maximum ice thickness	Snow depth
April 4, 1956	72 in.	16 in.
June 15, 1957	73 in.	13 in.
April 27, 1958	67 in.	5-24 in.
June 13, 1959	82 in.	12 in.
May 24, 1960	70 in.	16 in.
June 16, 1961	84 in.	15 in.

For 1961-1962 the available data are given in detailed form to serve as an example of the existing ice conditions and the snow cover in Resolute Bay (11).

Potential Landing Airstrip in Bear Valley, Radstock Bay area

The most favorable location for an airstrip is on an alluvial fan northwest of Loon Lake in Bear Valley (Figures 15 and 16). The fan has an approximate length of 2 miles in an east-west direction and a maximum width of 1½ miles in a north-south direction. These distances indicate that there is adequate space for an airstrip. The site is very flat and from 25 to 50 feet above sea level. Unfortunately, the intervening area between Loon Lake and the landing beach in Radstock Bay offers no large area of level ground for the building of an airstrip.

Approaches are good from both east and west. Caswall Tower lies well enough south to offer little hazard to approach from the east. Approaches from the north or south are restricted by 700-ft plateaux. An airstrip orientation of 70° east-northeast or 100° east-southeast would provide a glide path

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TABLE 19

Sea-ice thickness at Resolute Bay, 1961 to 1962

Observation Site: Approximately the centre of Resolute Bay, $2\frac{1}{2}$ miles from the weather station

Date 1961	Ice Thickness inches	Snow Depth inches	Date 1962	Ice Thickness inches	Snow Depth inches
Sept. 26	Freeze-up		Feb. 16	49	12
Oct. 1	3-4	1	Feb. 24	52	13
Oct. 8	10	2	Mar. 2	52	15
Oct. 13	8	1	Mar. 11	54	15
Oct. 21	14	2	Mar. 16	56	16
Oct. 29	18	6	Mar. 23	58	15
Nov. 3	20	6	Mar. 31	58	20
Nov. 10	20	6	Apr. 6	58	21
Nov. 17	26	11	Apr. 13	60	21
Nov. 24	29	12	Apr. 20	663	20
Dec. 3	27	6	Apr. 27	70	17
Dec. 8	30	6	May 4	65	23
Dec. 15	33	8	May 12	66	20
Dec. 22	32	11	May 19	65	20
Dec. 30	34	13	June 25	65	18
			June 2	64	19
1962			June 8	69	15
			June 15	69	-
Jan. 5	36	10	June 22	61	-
Jan. 12	40	11	June 29	52	-
Jan. 19	43	11	July 7	45	-
Jan. 26	42	10	July 13	35	-
Feb. 4	45	14	July 19	Break-up under way.	
Feb. 9	47	12			

of at least 14 miles from either west or east, passing north of Caswall Tower. The airstrip could be 8,000 ft long without encountering problems of slope or differing surface material. The best site for the building of airstrip facilities would be north of Loon Lake at the northeast end of the strip, on a flat marine terrace.

The surface material of the alluvial fan is shown in Figure 17; it is composed of fragmented limestone similar to that at the Resolute airstrip.

The surface of the fan is somewhat dissected by shallow frost furrows and stream beds. This would require levelling, and to some extent bedding of the strip surface to guard against possible frost action.

The advantages of a Radstock Bay-Bear Valley airstrip site are: construction would prove easy because of the level nature of the site and the existing surface material. It seems unlikely that any extensive raising of parts of the airstrip would be necessary as it was at Resolute. The air approaches are good from west to east. On the Resolute strip where the elevation of the airstrip is 190 to 220 ft, there is reduced visibility for considerable periods because of the prevalence of low overcast during the summer, hanging at an altitude of 300 ft above sea level. In Bear Valley, the airstrip area is only 25 to 50 ft above sea level and it would be possible for planes to come in under the overcast with good horizontal visibility. Thus the airstrip could be used in summer for most of the time when the Resolute Bay airstrip is out of action because of low clouds.

Potential Airstrip on the Plateau

There are also possibilities for an alternate landing strip on the 800-ft plateau (see Figure 20 in pocket) just north of Bear Valley. This would enable aircraft to land above the overcast or low hanging stratus prevalent in the Resolute and Radstock Bay areas. The only problem would be the construction of an access road up to the 800-ft plateau. The construction and the maintenance cost of this road would be considerable.

Alternative landing sites on ice and water at Radstock Bay

Opportunities for landing on ice exist in Bear Valley, but most of the lakes are small and shallow, and with the exception of South Lake are far removed from the main landing beach south of Caswall Tower. South Lake is sufficiently long and deep to provide a 5,000-ft runway with an orientation of 10° north-northeast. Unfortunately, the length of the approaches from the south is only 2 miles and that from the north 3 miles. A shorter strip of about 3,000 ft with a bearing of about 20° north-northeast would have a 5-mile approach from the north and an unlimited distance from the south. The distance from the north end of the strip would be about three quarters of a mile to the potential Radstock Bay settlement site.

Gascoyne Inlet or Radstock Bay have better approaches than those to South Lake. However, more problems would occur in regard to level ice and the period of use. A rougher surface is to be expected on the sea ice at either of these locales. The length of time that either could be used is shorter than that at South Lake.

Sea-planes using Radstock Bay would find the best approaches are from the north or south in order to land near the station site. The approaches from either direction are excellent. A lack of shoals and other obstructions in Radstock Bay adds to the ease of sea-plane landings. Less direct approaches are available to Gascoyne Inlet or any of the lakes. Lingering ice and the shallowness of these water bodies present hazards. Gascoyne Inlet tends to retain its ice longer than the lakes or Radstock Bay because of its bottle shape. Generally speaking, potential landing facilities on either water or ice at the Radstock Bay location seem to be better than those at Resolute.

BUILDING SITES

Building Sites at Resolute

Beach material of fragmented limestone is found inland over most of the lowland of Resolute peninsula. This could be used to make a low-grade concrete if it were properly washed and crushed to various sizes, the finest material taking the place of sand which is not available in the area. Fragmented limestone covers the bedrock to a depth of 2 to 12 ft. In the Radstock Bay area the thickness of the active layer above the permafrost varies from 9 in. in gravel and coarsely layered fragmented rock, to almost 3 ft in pebbles intermixed with fine particles of soil. At Resolute, the buildings have been erected on level mounds of gravel 2 ft high. If the frost action causes the building to shift, the gravel can be scraped away or added where the pressure is being applied.

The weather station at Resolute Bay was originally located on a marine terrace of fragmented limestone gravel at an elevation of between 40 and 50 ft above sea level. A fine clay underlies this material giving rise to boggy ground in lower areas during the summer when the ground frost melts. The original site of the station was about 395 ft from the landing beach and the same distance from Resolute Lake, with an unlimited supply of fresh water. This was a favorable location with regard to sea supply although it proved unfavorable to the operation of the landing airstrip, owing to the difference in elevation. Consequently the station was moved to the immediate vicinity of the airstrip. Ground and drainage conditions proved similar to those encountered on the airstrip, but the new site has proved to be much better than the former one.

Potential Building Sites at Radstock Bay

A number of important factors must be considered in selecting a building site in the Radstock Bay area. Access to both the landing beach in Radstock Bay and the airstrip in Bear Valley is a prime factor in location. Several acres of land are required to provide sufficient space for building and, future expansion requirements must also be considered. The site area must be level and well drained, and closeness to an adequate fresh water supply is important. Areas that could be considered suitable are shown in Figure 18 as major utility areas.

An excellent building site lies between South Lake and Caswall Tower just west of the landing beach. The main objection to this site is its distance from the potential airstrip in Bear Valley, as both the Radstock Bay landing beach and the proposed settlement site would require road connections.

The surface material in the area of the site is composed of fragmented limestone. This material is similar to that found at Resolute and the problems of permafrost may be assumed to be the same. The site area is level and well drained.

It seems safe to assume that the streams in Bear Valley flow throughout the summer but possibly in insufficient volume to meet the needs of a station. The best source of fresh water would be North Lake, about 3 miles from the landing beach. The lake is about 25 ft deep and does not freeze to the bottom during the winter. Muskox Lake and South Lake are both within a mile of the proposed site and are possible sources of fresh water, but they both appear to be shallow.

The possible location of a weather station closer to the airstrip could be considered in view of the distance between the landing beach and the airstrip. Suitable sites with sufficient areas are available on the broad alluvial fan close to Loon Lake, which seems to afford an adequate water supply.

Cargo landing operations are conducted during a relatively short period. Approximately 11 to 15 days would be required to discharge cargo proportionate to that received at Resolute in 1949. The movement of supplies from the Radstock Bay landing beach to the airstrip and possibly the associated settlement would involve a truck and tractor operation of two to three weeks. Supplies of relatively limited use, and bulk items, do not need to be moved immediately provided they are adequately stored. In the event of settlement location near the airstrip, a small depot station could be constructed for use during unloading operations.

The factors of site location do not appear to be as favorable in the vicinity of Gascoyne Inlet and Erebus Bay. However, these areas may prove valuable for an alternative landing beach. Sufficient space is available in both these areas for the construction of depot stations for use during unloading operations.

The building sites in the Radstock Bay - Bear Valley area compare most favorably with the Resolute site in regard to surface material, drainage space and fresh water supply, although the factor of distance is less favorable. This, however, can be overcome by the construction of first-class gravel roads and possibly a supplemental depot station.

UNLOADING FACILITIES

Landing Beaches at Resolute Bay

Some difficulties were encountered in landing operations in Resolute Bay. Originally the submerged bar that lies almost across the entrance to the bay prevented entrance by large cargo vessels. In the past few years the bathymetry of the bay has been well studied and cargo vessels now approach to within 75 yards of the shore.

The best beaches are located on the north side of the bay with smaller beach areas on the eastern and western sides. These beaches shelve very gradually at about 5^{o}. The foreshore is composed of gravel and fragmented limestone to a maximum width of 15 ft. At best, however, they do not provide favorable landing conditions, particularly at low tide. There are quite a few shallow spots caused by submerged boulders in the bay close to these beaches.

The beach used for landing operations in 1947 was abandoned in 1948, partly because of its shallowness and also because there was insufficient space in the vicinity for the storage of the large quantity of oil and gasoline drums. The foreshore along this beach is only about 15 ft wide, and is composed of gravel, fragmented limestone, rock detritus and a few boulders.

The best beach for unloading operations lies approximately 1,500 ft southeast of the campsite. The holding ground is good and at high tide provides excellent facilities for cargo boats of the L.C.M. type.

In 1948, experience showed that a landing at low tide was extremely difficult and discharge of the cargo was interrupted for some time. To overcome such delays a beach jetty was built in 1948 and 1949 from the beach proper to deep water.

The landing beaches were sometimes covered by large floes of ice forced ashore by strong winds and tidal currents in Resolute Bay. These hampered and prolonged unloading operations. Sometimes it was necessary to unload the cargo on the beach at the very head of the bay as this was the only beach free of ice.

Landing Beaches in Radstock Bay-Erebus Bay Area

There are four favorable landing beaches, two of which are on the western shore of Radstock Bay (Figure 19). One of them extends south of Caswall Tower on the west side of Radstock Bay, and is more than 2 miles long, north-south. The foreshore is composed of gravel and fragmented limestone. Inland from the beach are a series of low strandlines offering ample space for piling unloaded material. Cargo vessels may approach to within a short distance off the shore. There is deep water offshore in other parts of Radstock Bay, but from this beach there is good access to Bear Valley over low ground.

Alternative Landing Beaches, Radstock Bay-Erebus Bay area

The second beach north of Caswall Tower offers a good alternative landing beach if the construction of an airstrip is considered on the plateau north of Bear Valley. This site is closer to the plateau.

The third suitable landing beach is $1\frac{1}{2}$ miles long, southwest-northeast, and lies on the west slope of Gascoyne Inlet about 3 miles from its head. Good beaches are present along the whole length of this shore, but the inlet is shallow in its northern part. Numerous ice-shoved hillocks are present on these beaches. They are, however, only minor features that do not interfere with use of the beach. Unfortunately Cape Ricketts may deflect eastward-drifting ice towards the narrow neck of Gascoyne Inlet and thus present a formidable barrier to attempted landings. Aerial photographs reveal that Gascoyne Inlet appears to lose its ice later than other bays because of its bottle shape.

The fourth landing beach is located at Erebus Bay some 8 miles west of Caswall Tower. This bay, together with Beechey Island was used as a wintering quarters by Franklin and has been visited by other explorers.

The entrance to the bay is nearly 30 fathoms deep with 20 fathoms in the middle. However, it shoals to the east where the depth is only 4 ft at low tide half a mile offshore. This would make L.C.M. landings almost impossible without dock facilities, and the flat silt bottom of the shallows would make construction somewhat difficult.

Erebus Bay would probably provide good harborage because it is surrounded on three sides by high promontories of flat-lying sedimentary rock. Cape Riddle on Beechey Island lies to the west and Cape Ridley lies to the southeast. Unfortunately, a southwest wind occasionally occurs in this area and forces drifting ice from Wellington Channel to plug the bay. Pack ice was blown into the bay, cutting off the entrance, on August 18, 1910 and August 17, 1949.

The tide in Erebus Bay is higher than that at Resolute Bay with a mean range of 6 ft. Because of the shallows and tidal flats east of the offshore bar, jetties of perhaps 6,000 ft would be required.

A possible landing beach appears to lie north of Cape Riley and south of the offshore bar and lagoon area. Shallow water extends a short distance from shore and much shorter jetties would be required here than in the lagoon area to the north. The beach area is smaller than that available south of Caswall Tower but it compares favorably with the Gascoyne Inlet beach. Fairly good terrain for road construction lies along the southern side of Bear Valley as far as the proposed airstrip on the alluvial fan.

Erebus Bay is closer to the potential airstrip site in Bear Valley and this could prove advantageous in an emergency.

ROADS

Roads are of primary importance in the maintenance and operation of a northern station such as Resolute where the airstrip and the settlement cannot be placed in immediate proximity to the landing beach, as materials for the maintenance of the station are brought in once annually by ship. The amount of tonnage and the terrain conditions call for all-weather gravel roads, pliable enough to withstand heavy use and frost conditions.

Roads at Resolute Bay

The Resolute Bay site and landing beach are connected to the land and ice airstrips by roads (Figure 9). The beach material present on the lowland provides an excellent gravel base for roads, and the strandlines and terraces are ideal for their location. Such roads are not damaged by frost heave if care is given to proper side drainage.

A major road, approximately 2½ miles long connects the landing beaches with the airstrip and the settlement (DOT and RCAF Stations). An adjoining road, about 450 yards long turns off to Resolute Lake and the seismograph station. Both roads are kept in good condition throughout the year. The peninsula is level enough so that a motor vehicle can travel overland with relative ease, providing mud or deep snow is not present.

Possible Roads in Radstock Bay Area

More attention should be paid to the construction of possible roads in Bear Valley, Radstock Bay, as shown in Figure 20 (in pocket). The distances between the proposed airstrip and the settlement site and landing beaches are greater than at Resolute, and the terrain is somewhat more diverse than at Resolute Bay. The marshy areas in the central and eastern parts of the valley should be avoided wherever possible. Fortunately in this area there are suitably located strandlines and marine terraces, which also contain sufficient quantities of gravel for surfacing.

To move all the supplies for a weather station and an airstrip in Bear Valley, a distance of about 5 miles over soft ground, was beyond the facilities of the 1947 expedition and Bear Valley was thus eliminated as a site. However, the reconnaissance of 1949 proved that the construction of a road would be difficult only where it crossed marshy ground. The main area of this terrain is to be found south of North Lake to the head of Gascoyne Inlet. Similar ground also exists in the triangle formed by Muskox Lake, South Lake and Gascoyne Inlet. However, these areas can generally be by-passed.

The most favorable site for ease of construction and travel runs from the beach south of Caswall Tower around the lower end of Muskox Lake and north of the marshy area above Gascoyne Inlet. The proposed road could extend northward along marine terraces then west, crossing the marshy area just south of North Lake, to an extensive north-south terrace (see Figure 10). The part of the road south of North Lake would require some gravel fill and drainage. From the large terrace between North Lake and the proposed airstrip site, the road could extend across marine terraces and along the eastern fringe of an alluvial fan. The total length of this road is estimated as 6 1/8 miles. An alternative route to the west of Muskox Lake could use strandlines immediately north of Gascoyne Inlet (Figure 20 in pocket). The disadvantage is the low, wet ground north of the inlet that is crossed by several stream outlets.

The second road from Radstock Bay north of Caswall Tower leading to the proposed airstrip on the plateau north of Bear Valley would be a difficult and costly construction job owing to the 800-ft difference in elevation between the airstrip and the plateau.

The third most favorable road location could run from the Gascoyne Inlet beach north to a point near Loon Lake, along marine terraces and strandlines, a distance of about 6 miles. It is also possible that an alternative road could be constructed running south of Loon Lake between Gascoyne Inlet and the proposed airstrip site.

A road 1 3/8 miles long would be necessary to connect the Radstock Bay settlement with South Lake across relatively flat, well-drained terrain. If an alternative landing beach in Erebus Bay were considered, a fourth road 4 1/4 miles long would also be necessary to connect this small landing area with the proposed airstrip on the alluvial fan north of Loon Lake. The problems of road construction would be similar to those encountered between Muskox Lake and Loon Lake.

RADSTOCK BAY - A POTENTIAL AIRBASE AND HARBOR

COMPARISONS AND CONTRASTS, RESOLUTE AND RADSTOCK BAY SITES

Resolute Bay may be clear of ice for a cumulative total of some seven weeks only, whereas Radstock Bay may be open for more than nine weeks. The short period during which landing operations can be carried out at Resolute Bay is further complicated by the possibility that drifting ice may fill the bay completely or partly at any time during the summer. It may be assumed from existing reports that this is unlikely to occur in Radstock Bay. There is no natural obstruction on the eastern side of the bay likely to deflect ice far enough into the bay to suspend unloading operations. Unlike Resolute Bay, a safe retreat in storms may be secured by moving farther into Radstock Bay. Good protection from adverse winds is to be had there also, whereas Resolute Bay has a minimum of protection from the surrounding terrain. The landing beaches at Resolute are shallow and hinder landing operations. The Radstock Bay landing beach south of Caswall Tower is deep enough to accommodate landings close to shore both at high and low tide. The superiority of Radstock Bay is enhanced by two alternate landing approaches, one in Gascoyne Inlet and one in Erebus Bay.

The airstrip in Resolute is located roughly in a north-south direction, i.e. across the prevailing winds. There is plenty of room to establish an airstrip in Radstock Bay in more than one direction, (including north-south), but east-west orientation is the most favorable as far as the prevailing wind is concerned. The bottom of the valley floor in Radstock Bay is firm and solid. Minimum work and expenditure would be required to make an excellent airstrip. Field observations indicate that there are about 50 per cent fewer overcast and fog-bound days here than at Resolute, and that the below-VFR values of ceiling and visibility as well as IFR landing limits and IFR take-off limits are more favorable at Radstock Bay than at Resolute. In fact the southern side of the Bear Valley potential airstrip is protected by a 600-ft plateau that could act as a barrier resisting to the entrance of fog from the south (Lancaster Sound). The potential airstrip at Radstock Bay would average 25 to 50 ft elevation above sea level as against 209 ft at Resolute, and the occurrence of overcast skies at both locations under 300 ft would favour Radstock Bay as a landing site. Furthermore the Radstock Bay area has possibilities of construction of an alternative airstrip on the plateau some 700 to 800 ft above sea level, thus enabling aircraft to land above the overcast. An airstrip at Radstock Bay could serve as an alternate to Resolute. Alternate airports closest to Resolute (Isachsen, Eureka, Cambridge Bay, Mould Bay and possibly Thule) are roughly 330 to 450 miles away a factor that contributes much to the loss of time and money if an aircraft cannot land at Resolute owing to adverse weather conditions. It is a great advantage in arctic flying conditions with a 300 to 500-ft ceiling to have approaches at both ends of the airstrip. Radstock Bay would have this advantage. Furthermore, a radio range or radio beacon could be established at Caswall Tower which, if coupled with another beacon on Beechey Island, would enable pilots to control their approach. During the federal Department of Transport survey for a settlement site in the summer of 1959 a DC 3 aircraft carrying 56,000 lb of freight landed at the site of proposed Radstock Bay airstrip without difficulty or advance information. The chief pilot of Spartan Air Services* considers the Radstock Bay location as one of the best he has encountered in his many years of arctic flying.

CONCLUSION

Resolute Bay and Radstock Bay are very similar climatically and physiographically. Both the Resolute airstrip and the Radstock Bay site are obstructed by surrounding highlands, although Radstock Bay offers more and better space for manoeuvring. The Radstock Bay airstrip site would be slightly inferior to that at Resolute owing to its greater distance from the best landing beach in Radstock Bay. This drawback, however, is compensated for by the greater possibility of landing heavy air transports in poor weather. The sea approaches are definitely superior to those at Resolute and there are better anchorages and shelter for supply ships during unloading operations. The harbor in Radstock Bay offers an excellent anchorage with good shelter from winds, swells and ice for a considerable number of small and large ships. A further advantage is to be found in the longer navigation season at Radstock Bay.

After examination of a number of possible sites from airphoto interpretation and making a reconnaissance survey of sites in Lancaster-Barrow Straits areas it is considered that Radstock Bay has very high potential, indeed, far higher than any other site investigated. Some sites met the sea supply and harborage requirements but were not adequate from the air transport and airbase point of view, and vice versa. If, however, it were necessary in the future to establish a large operational base with extensive supplies of gasoline and oil, and with a good harbor at the same location, then the potential of Radstock Bay should be seriously considered. The development of such a base, however, should proceed carefully by stages involving firstly the preparation of an airstrip at the minimum cost, and secondly the

*Personal communication. R. Laroche, Chief pilot for Spartan Air Services visited the Radstock Bay site in 1959 and expressed the opinion that he would not hesitate to land a Mosquito aircraft there, although this plane is considered to be one of the most difficult to land in rough terrain under arctic conditions.

temporary establishment of a small weather station in order to accumulate first hand information for a number of years on which to base a final decision.

ACKNOWLEDGMENTS

The writer is indebted to Rear Admiral G. Dufek, Group Commander of the U.S.N. Task Force 80 (1948), and Captain B.N. Rittenhouse, U.S.N. Task Group Commander, 49.8 (1949) for their co-operation and for facilities extended during exploratory Arctic voyages. Appreciation is also recorded for the staff and crew of the U.S.S. Flagship Edisto for their full cooperation and help.

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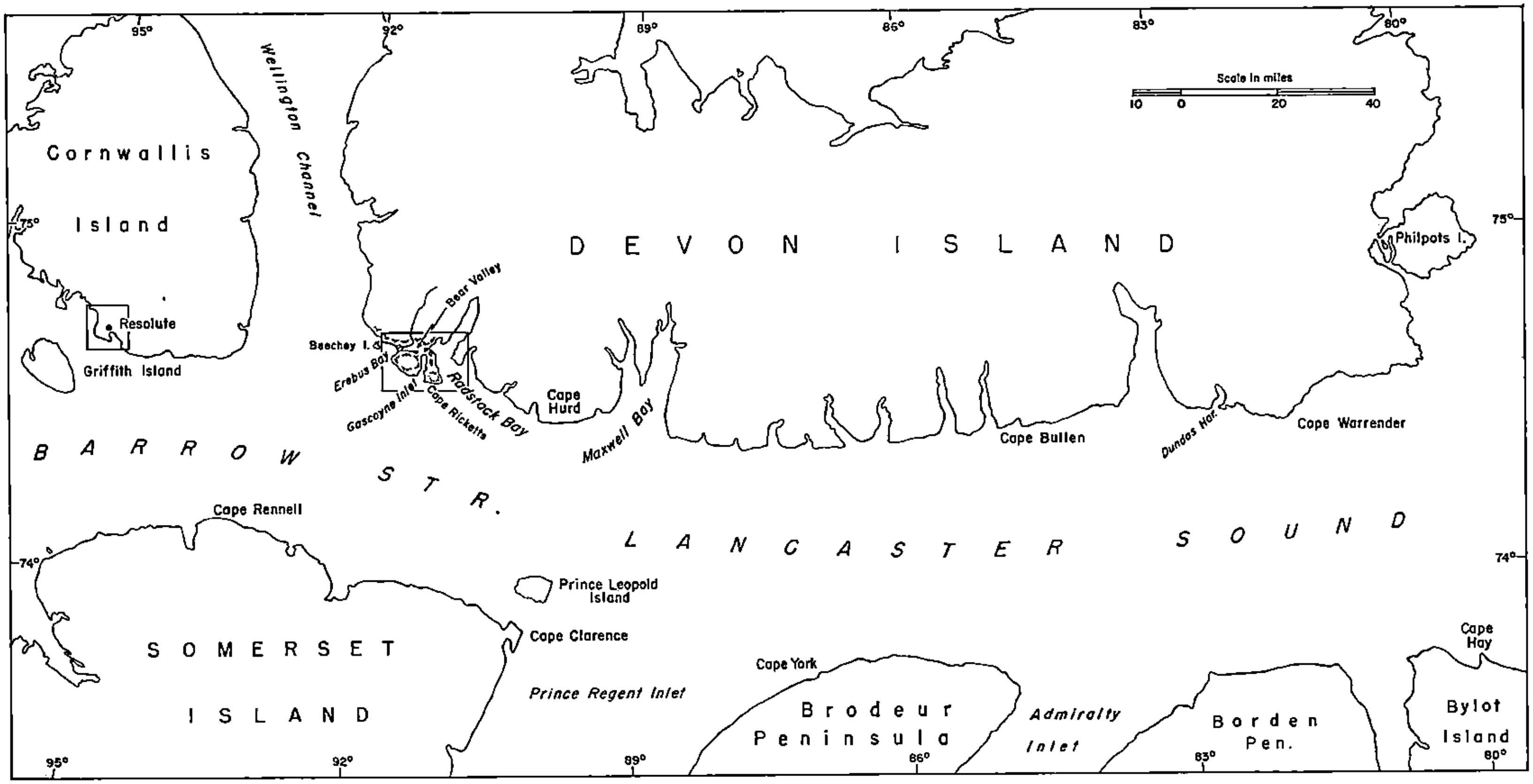

FIGURE 1. Location map

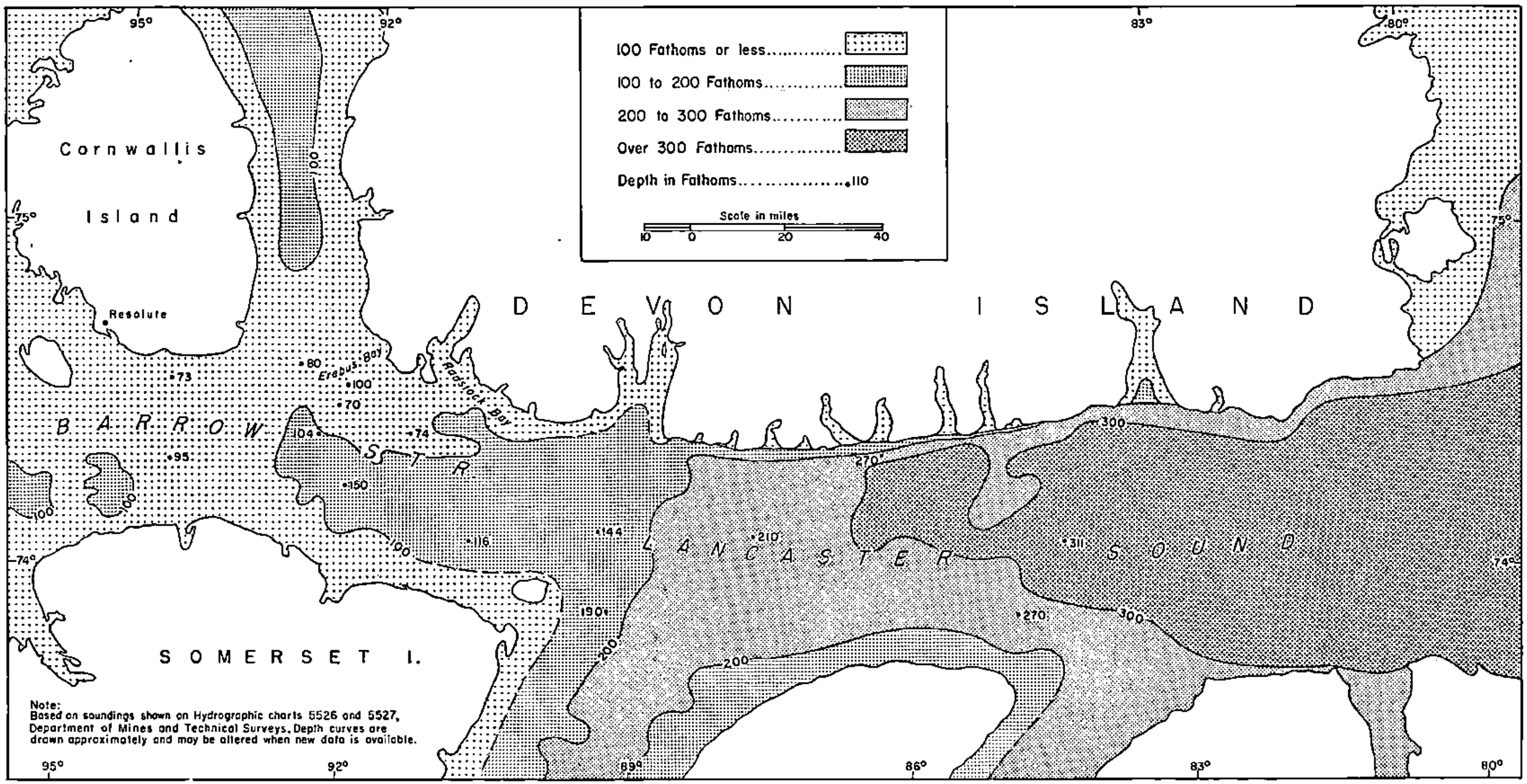

FIGURE 2. Bathymetric map of Lancaster Sound and Barrow Strait

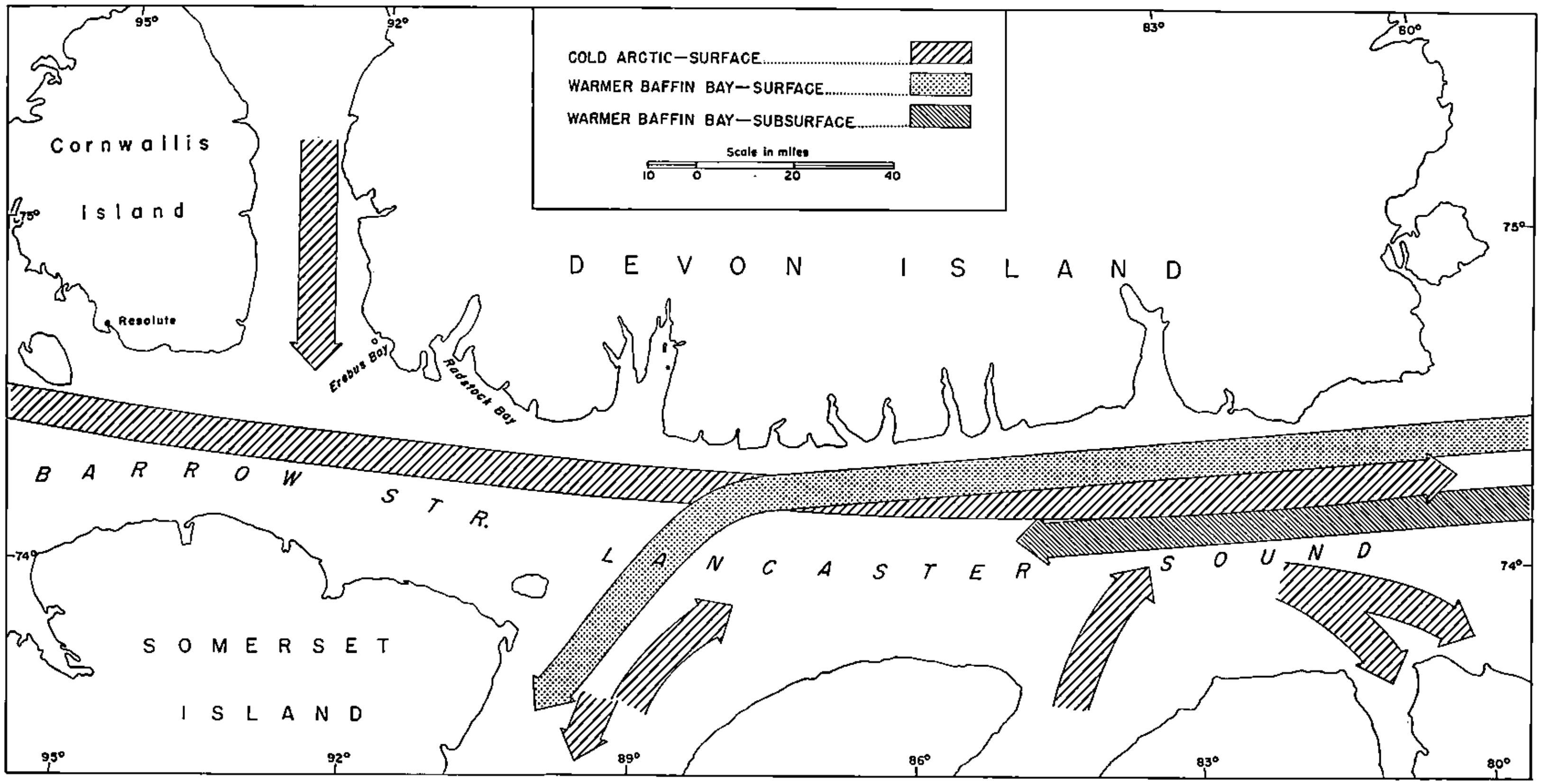

FIGURE 3. Ocean currents

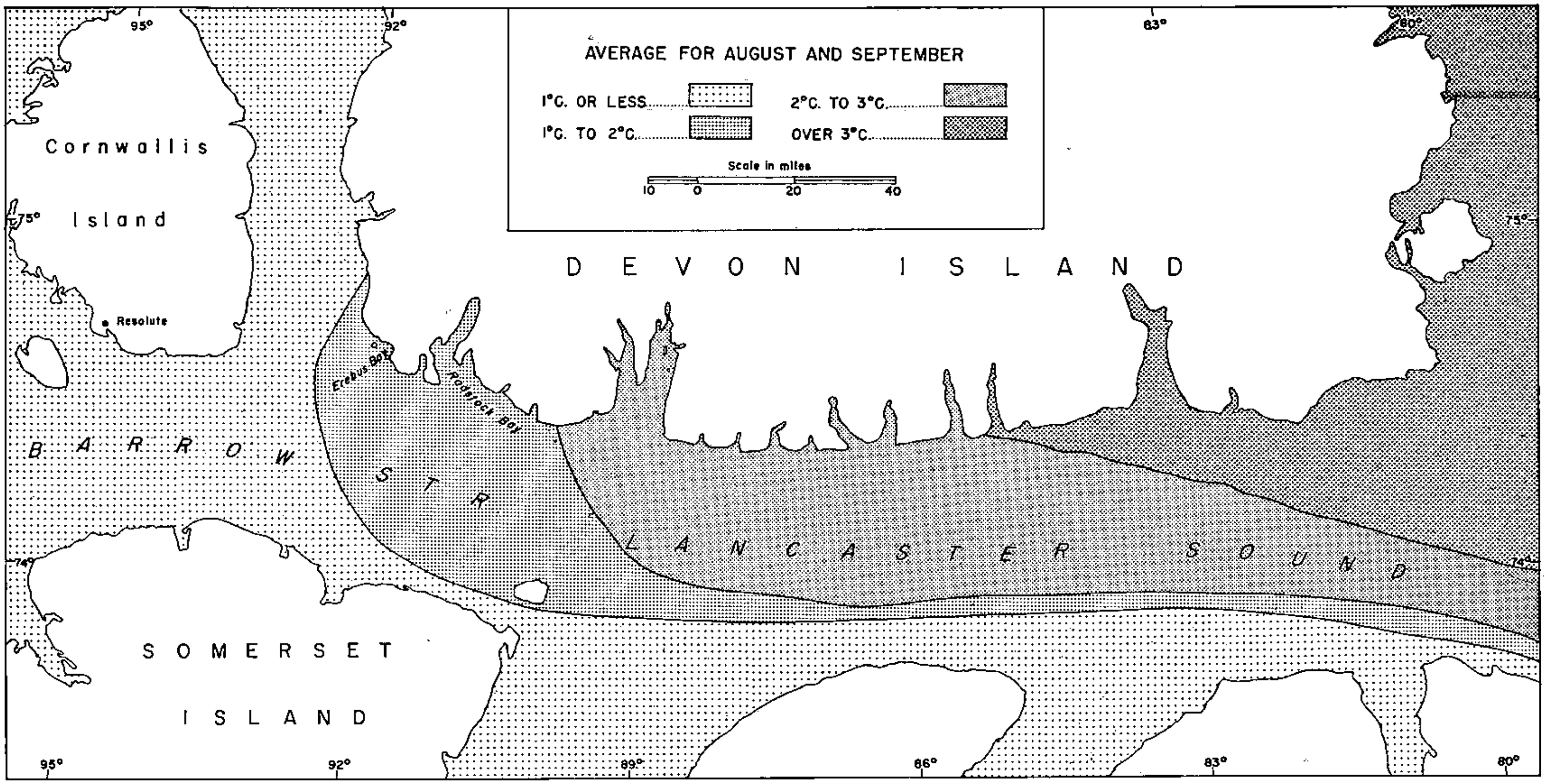

FIGURE 4. Surface temperatures

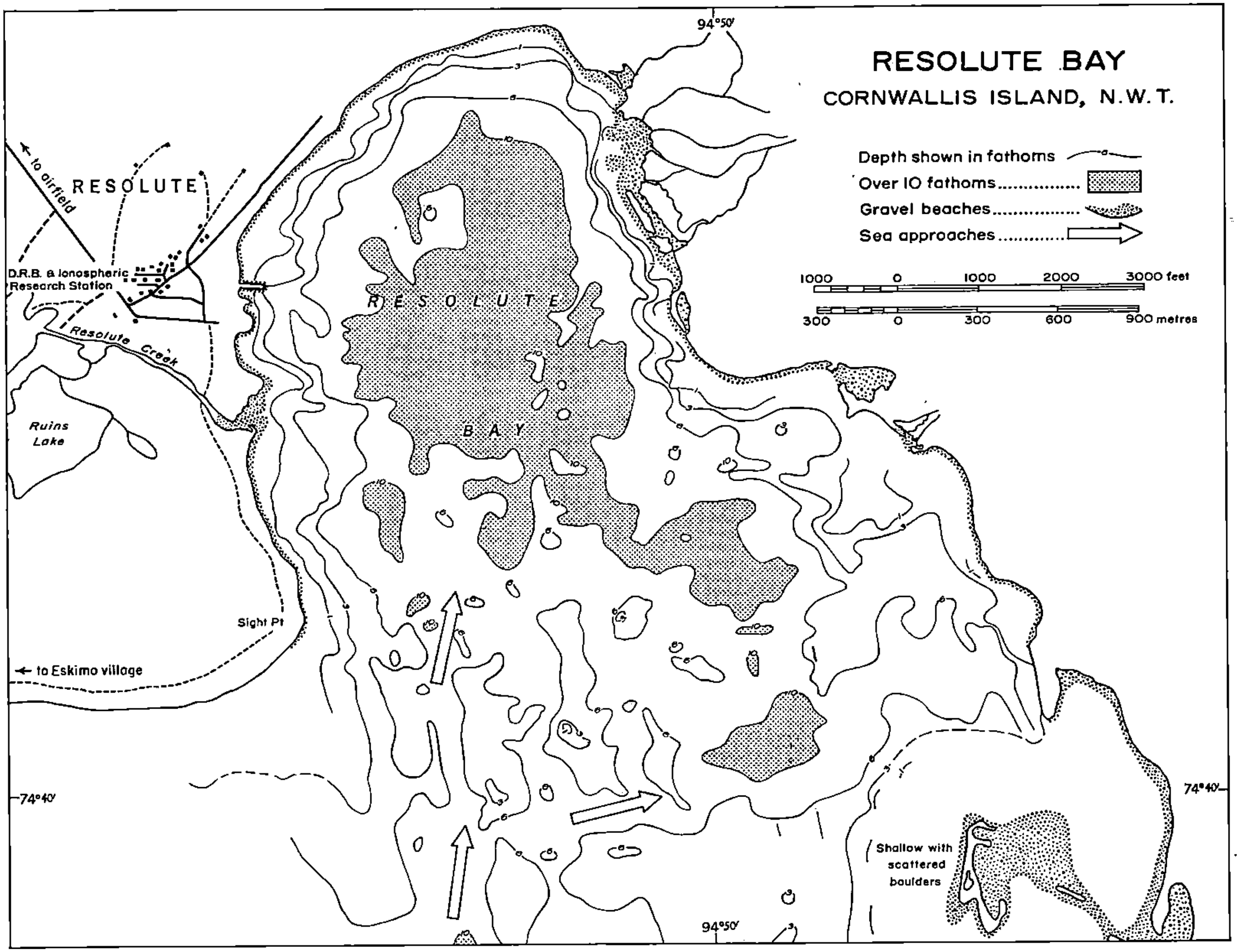

FIGURE 5. Bathymetry of Resolute Bay

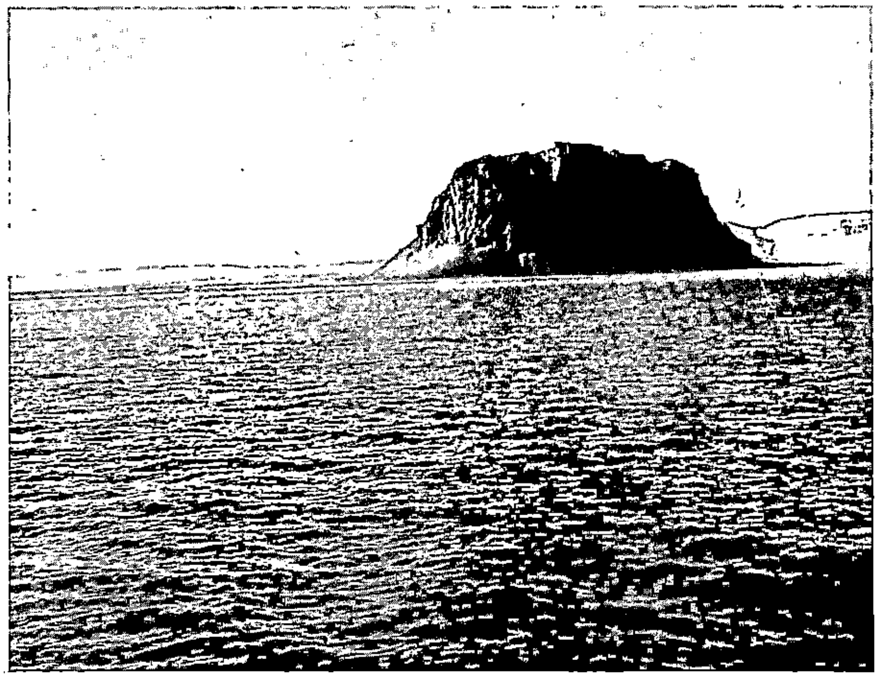

FIGURE 6

View of Caswall Tower from ship anchorage in Radstock Bay, looking northwest. Note the level beach area south of Caswall Tower

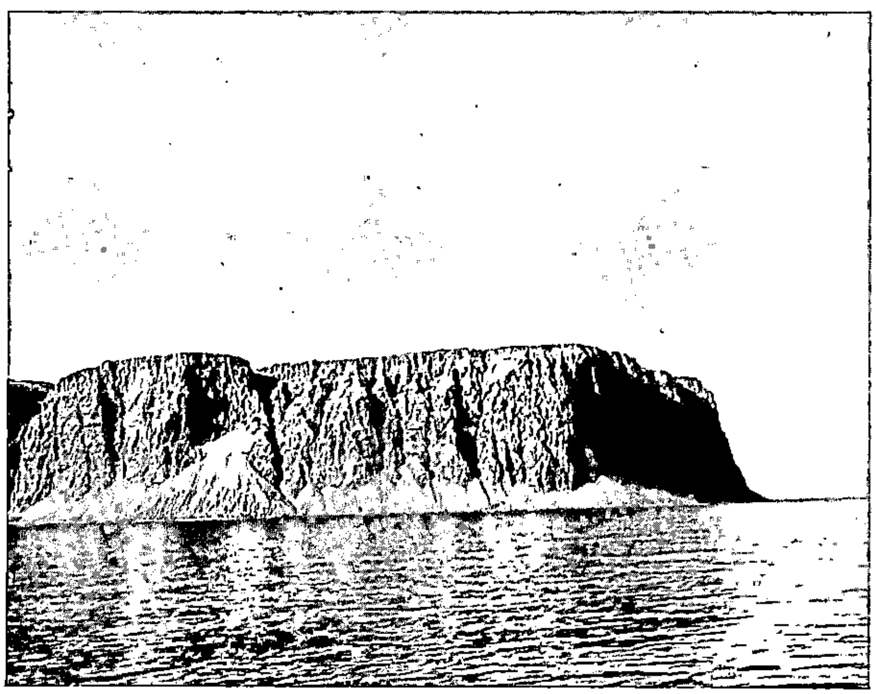

FIGURE 7

Cape Ricketts, at the entrance to Radstock Bay

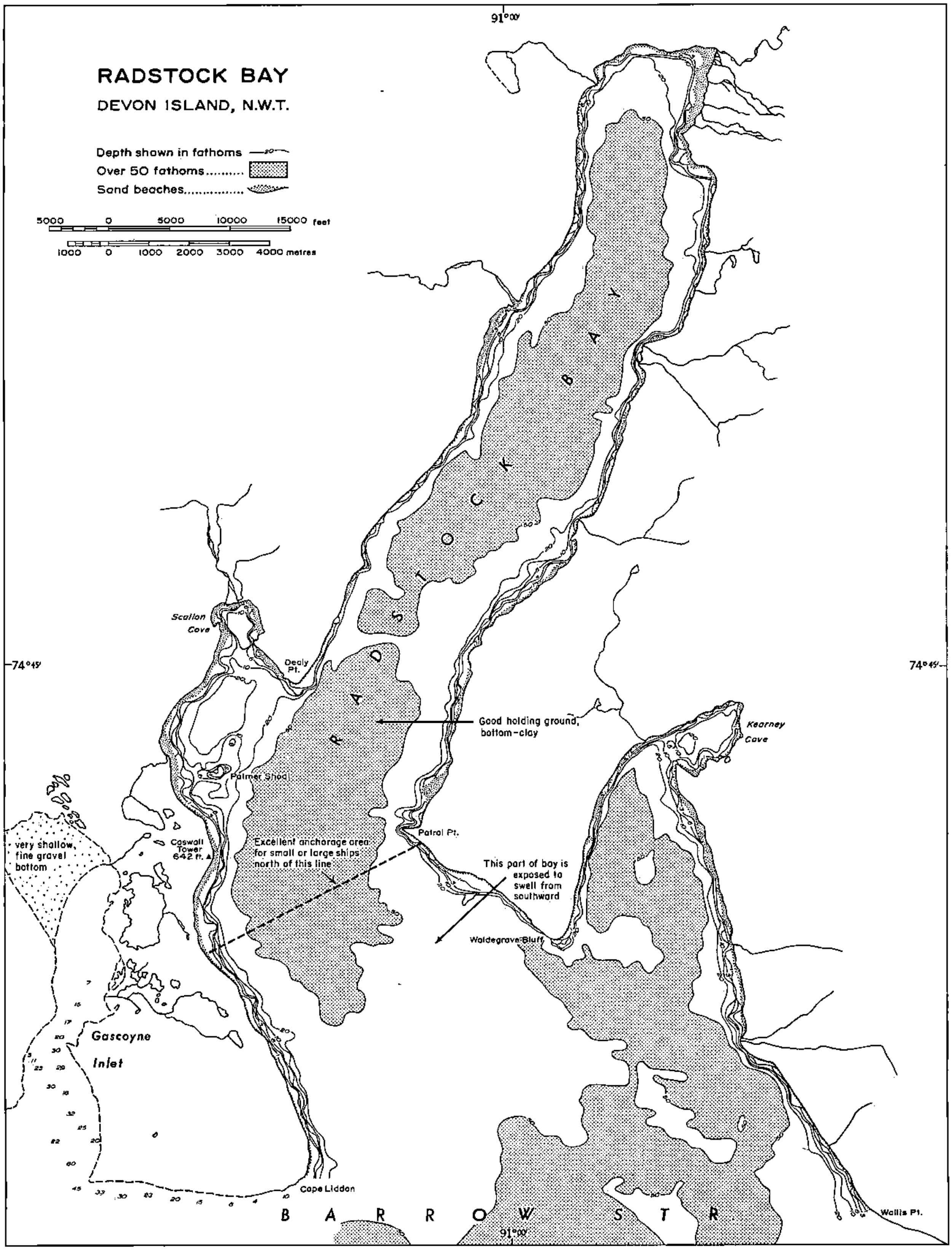

FIGURE 8. Bathymetry of Radstock Bay

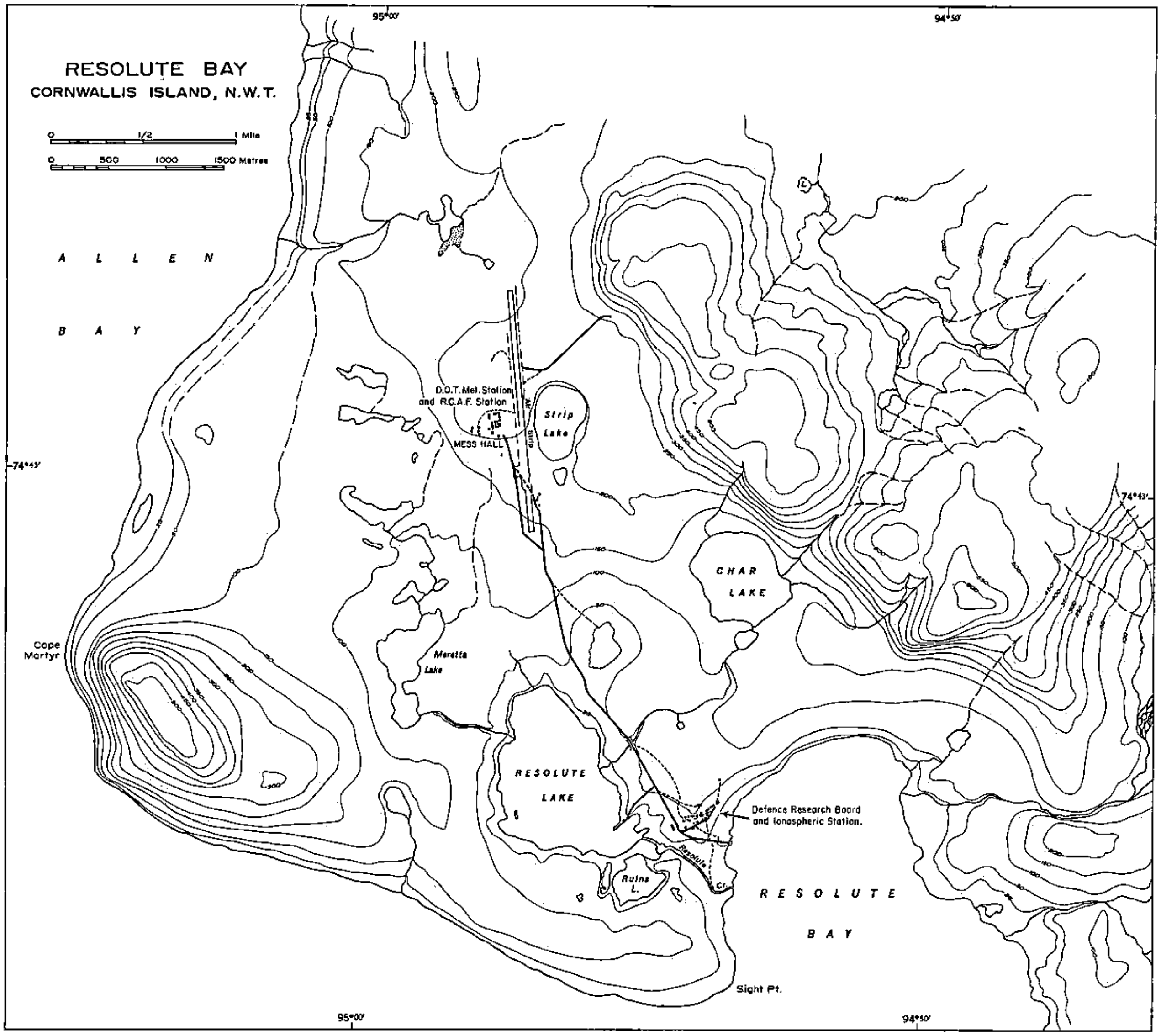

FIGURE 9. Topography of Resolute Bay

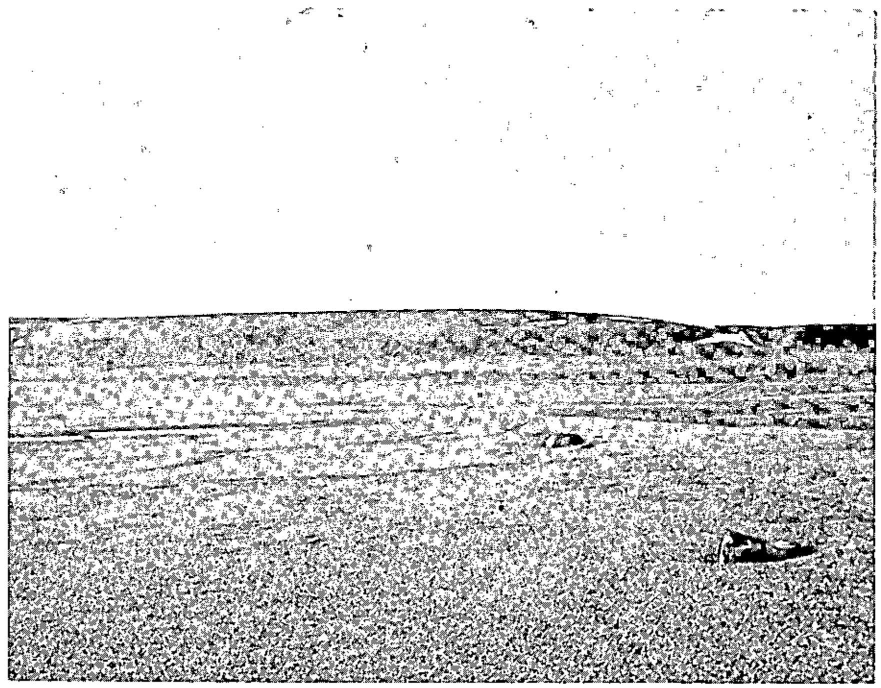

FIGURE 12

Bear Valley, Devon Island. Raised beaches 60 feet above sea level between Gascoyne Inlet and Loon Lake. Note ice-rafted boulders deposited by melting icebergs lying in a row along the beach ridge.

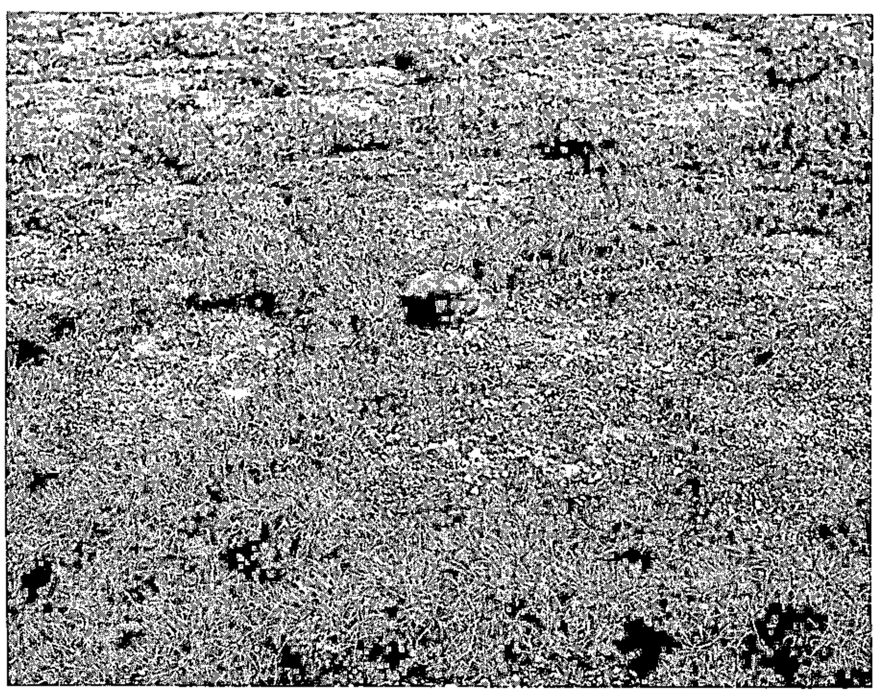

FIGURE 13

Bear Valley, Devon Island. Five-sided polygons lie to the southeast of the potential airstrip area and adjacent to water pools. The grass ridges around the perimeter of the polygons are 6 to 7 inches high and the elongated sides measure from 6 to 7 feet. The depression between the grass ridges contains small limestone pebbles, sand and silt.

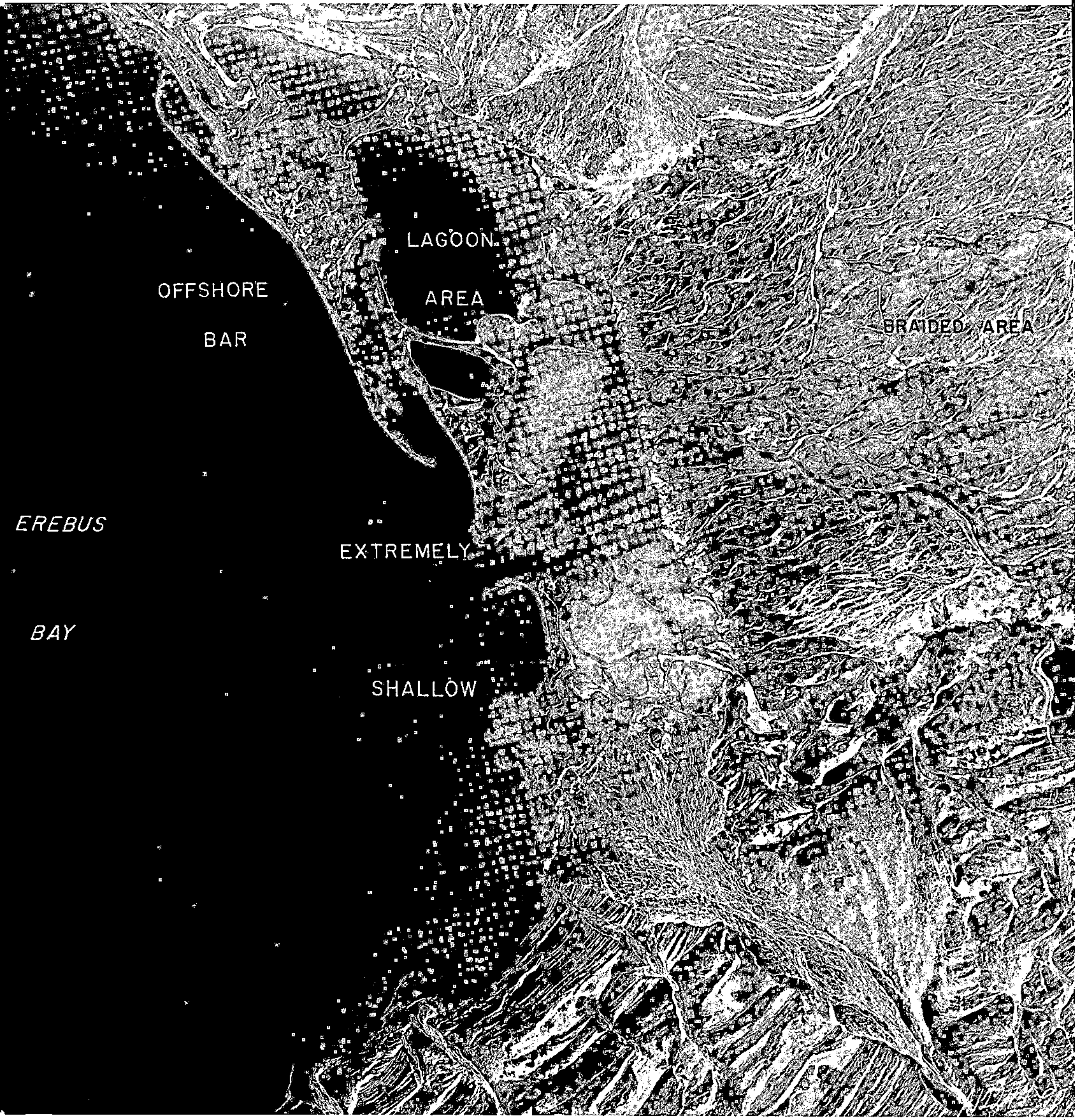

FIGURE 14. Aerial photograph showing western end of Bear Valley. Note offshore bars and the lagoon area as well as the shallow eastern approaches of Erebus Bay. (RCAF photo A12244-90)

FIGURE 15

Bear Valley, Devon Island. View of eastern part of potential airfield site, looking east towards Radstock Bay. Caswall Tower is in right background; note the frost furrows.

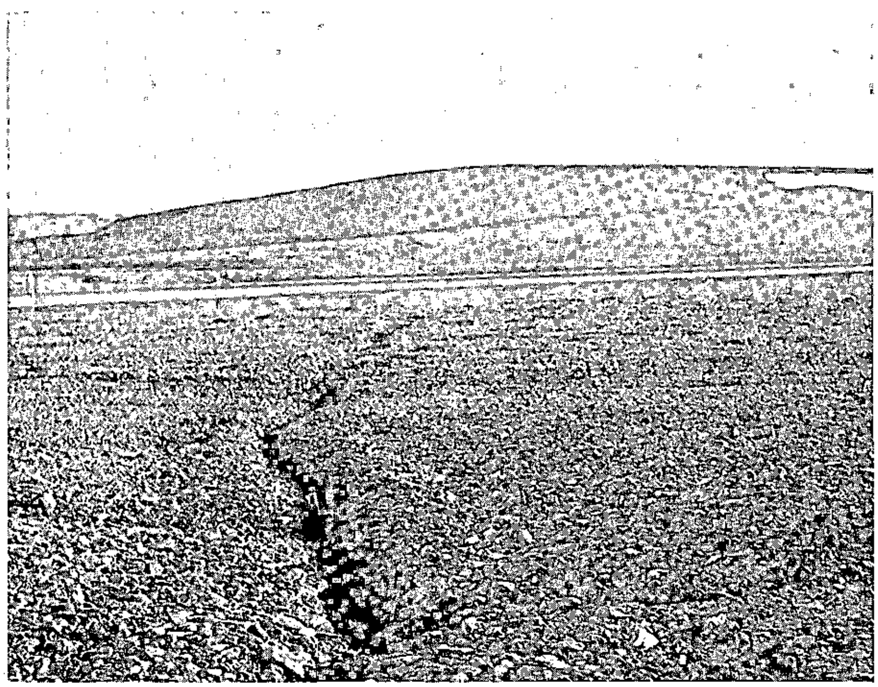

FIGURE 16

Bear Valley, Devon Island, looking south from south-central part of the potential airfield site. Frost furrows here measure 15 inches in depth; Loon Lake is in the background.

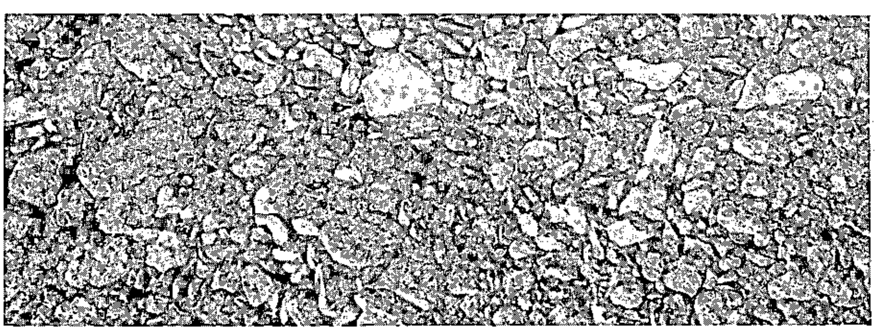

FIGURE 17

Close-up view of surface material on the potential airstrip. Note angular pieces of solution-faceted limestones varying from 1 to 5 inches in diameter.

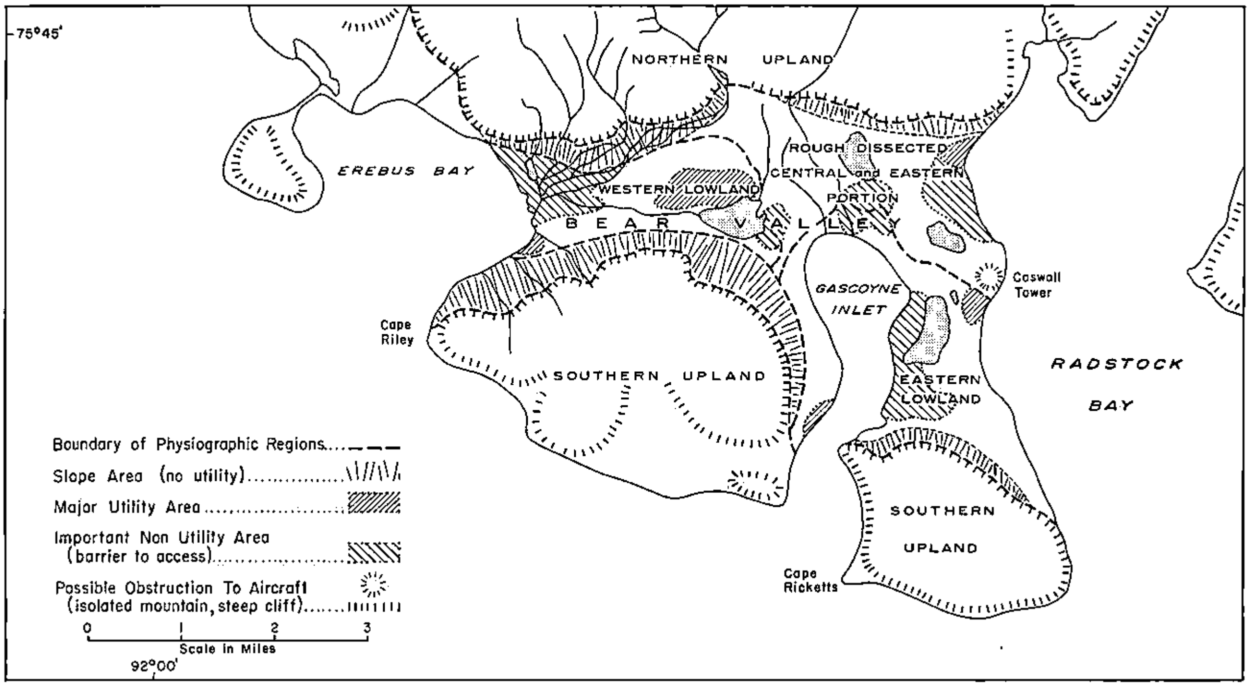

FIGURE 18. Physiography and utilization.

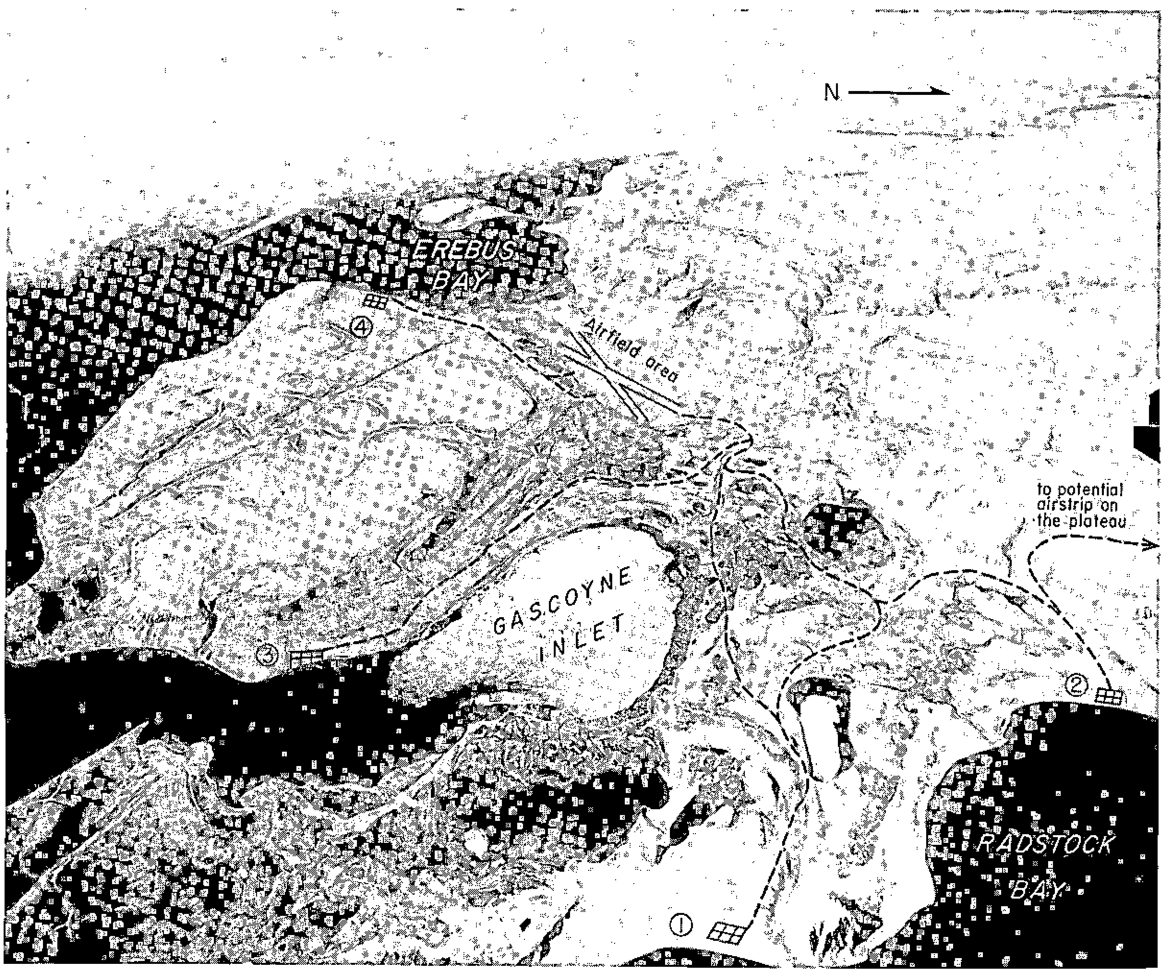

FIGURE 19. Oblique airphoto showing possible landing sites in the Radstock Bay-Erebus Bay area: 1. South of Caswall Tower; 2. Northwest of Caswall Tower; 3. At Gascoyne Inlet; 4. At Erebus Bay. Dashed lines indicate the proposed access roads. (RCAF photo T441R-109)