BEDROCK GEOLOGY OF MARGUERITE BAY AREA, PALMER PENINSULA, ANTARCTICA

Compiled by

RONNE ANTARCTIC RESEARCH EXPEDITION

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Prepared by

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OFFICE OF NAVAL RESEARCH

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FOREWORD

Submitted herewith is a report entitled "Bedrock Geology of Marguerite Bay Area, Palmer Peninsula, Antarctica." The report was compiled by Professor Robert L. Nichols of Tufts College in his capacity as geologist with the Ronne Antarctic Research Expedition. This report is the thirteenth in a series containing scientific information gathered by the expedition which was sponsored by the Geophysics Branch of the Office of Naval Research.

GORDON G. LILL
Head, Geophysics Branch
Office of Naval Research

PREFACE

Technical Report number 13 is one in a series completed by members of the Ronne Antarctic Research Expedition 1946-48. This report was prepared by Dr. Robert L. Nichols, Geologist, who was in charge of the geological investigations for the expedition.

In this report the Bedrock Geology of the Marguerite Bay Area, Palmer Peninsula Area of Antarctica is presented. Sledging from the expedition's wintering base on Stonington Island, Dr. Nichols and his assistant, Robert H. T. Dodson, spent 150 days out of 470 in the field gathering data and geological specimens. This is an excellent record considering the working conditions which are prevalent in the Antarctic.

The expedition was supported by the Office of Naval Research, among others, under Contract N6onr-280. This report was sponsored by the Office of Naval Research under separate Contract Nonr-979(00) with Tufts College, Medford, Mass., where Dr. Nichols is engaged as a professor of geology.

The geological program of the expedition would not have been possible without the assistance and cooperation of the Office of Naval Research. I am also indebted to the expedition's aviation-group for the constant support they gave the geological party in the field.

FINN RONNE, CAPT., USNR
Expedition Leader

ABSTRACT

Hornblende schist and a younger granite gneiss are the oldest rocks in the area. They may be Pre-Cambrian. Jurassic (?) argillites, gritstones, and conglomerates containing plant fossils are located on two small islands southwest of Adelaide Island.

Ultramafics, gabbro, diorite, granodiorite, and granite were successively injected. They are the commonest and most widespread rocks in the area. If these plutonic rocks correlate with similar rocks in southern South America, they are Cretaceous.

More than two thousand feet of rhyolitic and dacitic volcanics are present. Flow rocks with excellently developed flow banding are common. Tuffs, breccias, and agglomerates are widespread and minor amounts of water-worked pyroclastics and perhaps welded tuffs are also present. Fragments of granite gneiss, gabbro, granite, and aplite are found in the breccias and agglomerates. Some of the pyroclastic rocks are reconstructed granites composed almost entirely of fragments of quartz and feldspar formed by the mechanical break-up of older granite. Probably these volcanics once covered much of the area and if so, they have been subsequently eroded into several widely separated areas. These volcanics are younger than the plutonic rocks as they contain fragments of them. The volcanics cannot be accurately dated, but a late Mesozoic or early Cenozoic age seems logical.

A small porphyritic andesitic pluton has invaded the volcanics. A pink granite in places filled with vugs containing quartz, feldspar, pyrite, molybdenite, and other minerals has invaded the andesitic pluton, the volcanics, and other older rocks. The andesitic pluton and vugy granite may be early Cenozoic.

The area has been invaded by a multitude of different kinds of dikes. They have emplaced themselves by wedging, stoping, and to a minor degree by replacement. Single, multiple, and composite dikes are common. Aplite, pegmatite, granite, and felsite dikes are associated with the granites; felsite dikes are related to the volcanics; and fine-grained dioritic dikes are related to the diorite. Diabase and basalt dikes are common and some of them may be related to the basaltic Tertiary volcanics on the northern end of the Palmer Peninsula and to similar rocks in southern South America.

Limonite, pyrite, malachite, and molybdenite were noted but as far as is known, nothing of economic value was found.

CONTENTS

INTRODUCTION

During the period from March 1947 to March 1948 the writer, while a member of the Ronne Antarctic Research Expedition, made geologic studies in Marguerite Bay, Palmer Peninsula, Antarctica (Fig. 1). Approximately 54 9-hour days were spent in geologic study at the following localities: Alexander I Land, Mushroom Island, Terra Firma Islands, mainland east of Terra Firma Islands, Moraine Point (unofficial name), Black Thumb Mountain, Red Rock Ridge, Refuge Islands, islands between Red Rock Ridge and Black Thumb Mountain, Neny Fjord, Neny Island, Stonington Island, Roman Four Mountain, islands approximately 10 miles southwest of Adelaide Island, and islands approximately 50 miles west of Stonington Island (Fig. 2).

These are, in general, widely separated localities and, with the exception of Stonington Island, were reached by means of huskies and sledges. The outcrops varied in area from a few tens of square yards to many acres, and at each locality more or less detailed work was done. Unfortunately, the inaccessibility of the Antarctic continent and the control that season, meteorology, time schedules, and other factors have over travel usually make it impossible for the geologist to reexamine outcrops which later work proves to be critical.

To accomplish these studies, the writer was on the trail for approximately 150 days and was a member of the expedition for about 470 days. The ratio of full days spent on geologic study to the total time spent on the trail was, therefore, approximately 1:3, and the ratio of days spent on geologic study to the total time spent on the expedition was about 1:9. These are good ratios for Antarctic field work. They are due primarily to the excellent support given to the geologic program by Captain Finn Ronne, to able field assistants, and to a good bit of luck with meteorological conditions, sledging surfaces, and sea ice permanence.

Participation by the writer on the expedition was made possible by a generous grant from the Geological Society of America and by a leave of absence from Tufts College. The grant was used to pay for a replacement for the writer at Tufts College. The writer would like to record deep appreciation to Dr. Henry A. Aldrich, Secretary of the Geological Society of America, who was responsible for this grant and to Dr. Leonard Carmichael, President of Tufts College, who was responsible for the leave of absence.

Warm-hearted thanks must be given to Mr. Robert H. T. Dodson. He was the writer's sole companion on a 90-day sledge trip, one of his companions on a 30-day sledge trip, and he worked with him on many local outcrops. He collected and labelled geologic specimens, made difficult and dangerous traverses and climbs to get geologic data, and in many discussions helped the writer crystallize his ideas on the geology of the area. His skill in handling, caring for, and getting the most out of the huskies, in making and breaking camp, in crossing sea ice filled with leads, and his willingness to work long hours and to do more than his share of the trail work will never be forgotten. The writer counts himself as very fortunate in having had the willing, conscientious, and devoted help of Mr. Dodson, a hard-working geologic field assistant, a skillful and resourceful trail man, and a pleasant and stimulating companion. I make mention of these facts at some length because of my great indebtedness to him and because without him only a fraction of the work which was accomplished would have been done.

Special mention should also be made of Mr. William R. Latady who spent many days with the writer on the trail and who, as an expert photographer, was of great help.

It is a pleasure to acknowledge the interest, cooperation, and help which I received from the other members of the expedition and from the members of the Falkland Islands Dependencies Survey.

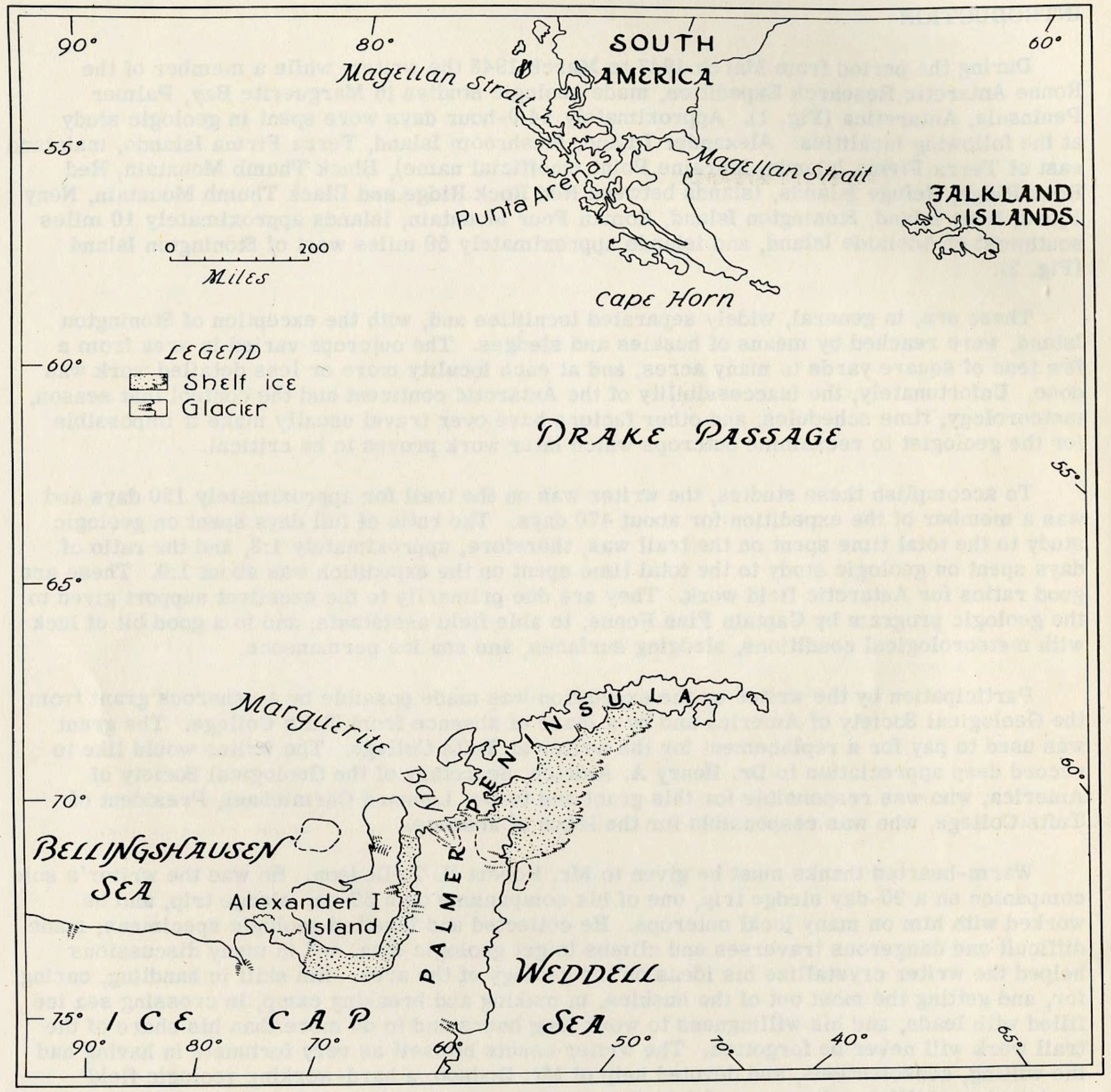

Figure 1 - Map showing South America, Drake Passage, Palmer Peninsula, and Marguerite Bay

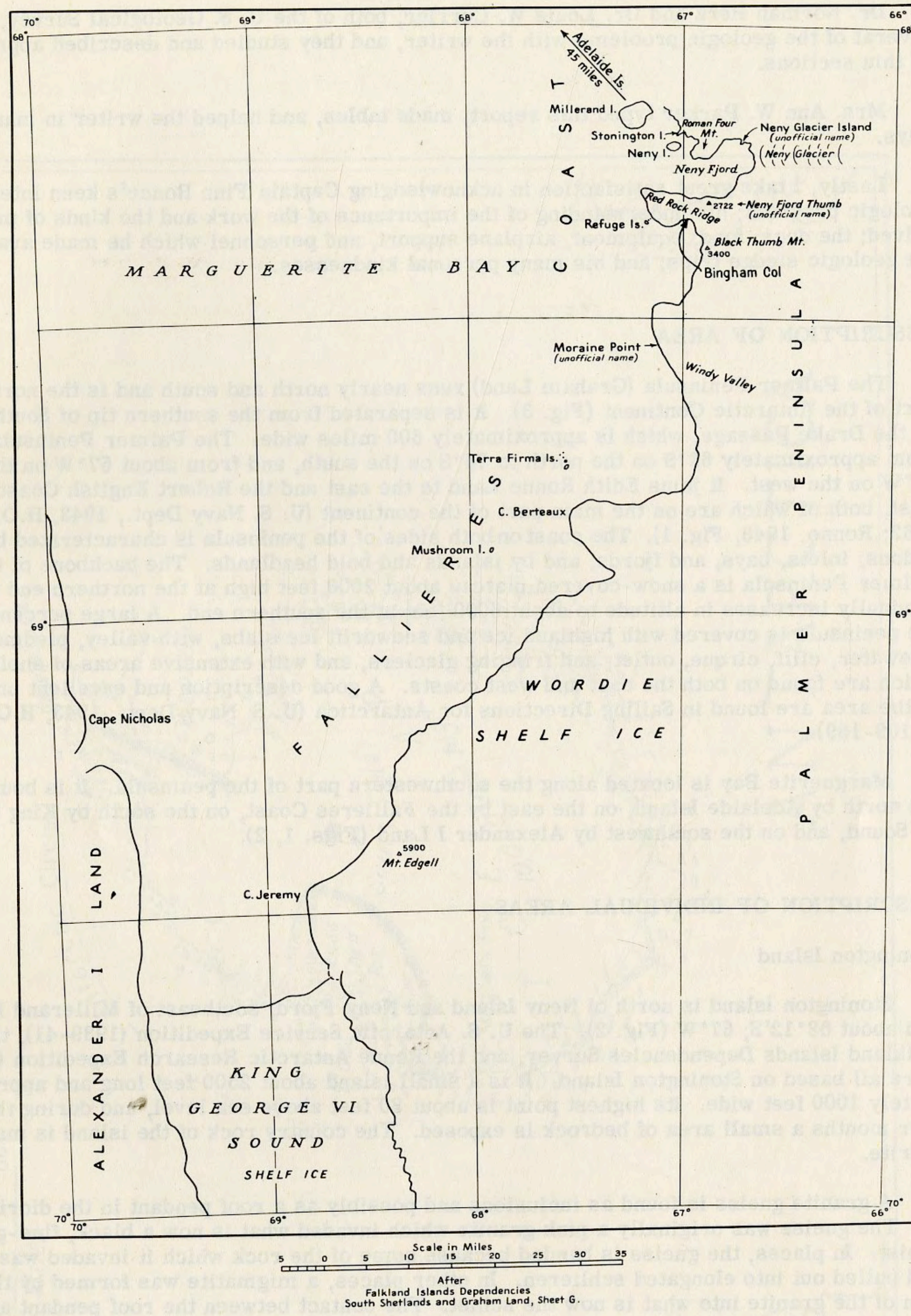

Figure 2 - Index map showing the localities studied in the Marguerite Bay area

Dr. Norman Herz and Dr. Louis W. Currier, both of the U. S. Geological Survey, discussed several of the geologic problems with the writer, and they studied and described approximately 35 thin sections.

Mrs. Ann W. Parker typed this report, made tables, and helped the writer in many other ways.

Lastly, I take great satisfaction in acknowledging Captain Finn Ronne's keen interest in the geologic program; his understanding of the importance of the work and the kinds of problems solved; the dogs, food, equipment, airplane support, and personnel which he made available for the geologic sledge trips; and his many personal kindnesses.

DESCRIPTION OF AREA

The Palmer Peninsula (Graham Land) runs nearly north and south and is the northernmost part of the Antarctic Continent (Fig. 3). It is separated from the southern tip of South America by the Drake Passage, which is approximately 600 miles wide. The Palmer Peninsula extends from approximately 63°S on the north to 74°S on the south, and from about 57°W on the east to 69°W on the west. It joins Edith Ronne Land to the east and the Robert English Coast to the west, both of which are on the main part of the continent (U. S. Navy Dept., 1943, H.O. No. 2562; Ronne, 1948, Fig. 1). The coast on both sides of the peninsula is characterized by indentations, inlets, bays, and fjords, and by islands and bold headlands. The backbone of the Palmer Peninsula is a snow-covered plateau about 2000 feet high at the northern end which gradually increases in altitude to about 6000 feet at the southern end. A large percentage of the peninsula is covered with highland ice and snowdrift ice slabs, with valley, piedmont, tidewater, cliff, cirque, outlet, and fringing glaciers, and with extensive areas of shelf ice which are found on both the east and west coasts. A good description and excellent photographs of the area are found in Sailing Directions for Antarctica (U. S. Navy Dept., 1943, H.O. No. 138, p. 109-169).

Marguerite Bay is located along the southwestern part of the peninsula. It is bounded on the north by Adelaide Island, on the east by the Fallieres Coast, on the south by King George VI Sound, and on the southwest by Alexander I Land (Figs. 1, 2).

DESCRIPTION OF INDIVIDUAL AREAS

Stonington Island

Stonington Island is north of Neny Island and Neny Fjord, southeast of Millerand Island, and about 68°12'S, 67°W (Fig. 2). The U. S. Antarctic Service Expedition (1939-41), the Falkland Islands Dependencies Survey, and the Ronne Antarctic Research Expedition (1946-48) were all based on Stonington Island. It is a small island about 2500 feet long and approximately 1000 feet wide. Its highest point is about 80 feet above sea level, and during the summer months a small area of bedrock is exposed. The country rock of the island is mainly diorite.

A granite gneiss is found as inclusions and possibly as a roof pendant in the diorite (Fig. 4). The gneiss was originally a pink granite which invaded what is now a black, fine-grained schist. In places, the gneiss is banded because some of the rock which it invaded was deformed and pulled out into elongated schlieren. In other places, a migmatite was formed by the injection of the granite into what is now the schist. The contact between the roof pendant and the country rock is sharp although irregular. This gneiss is found near the flagpole on the southwest side of the island. A somewhat similar gneiss was found on Debenham Island, which is a few miles to the north.

The country rock is a coarse-grained igneous rock which varies somewhat in texture and in composition. In places, it has a good foliation. Most of it is a diorite. Near the flagpole it contains inclusions composed of gneiss and fine- and coarse-grained black material.

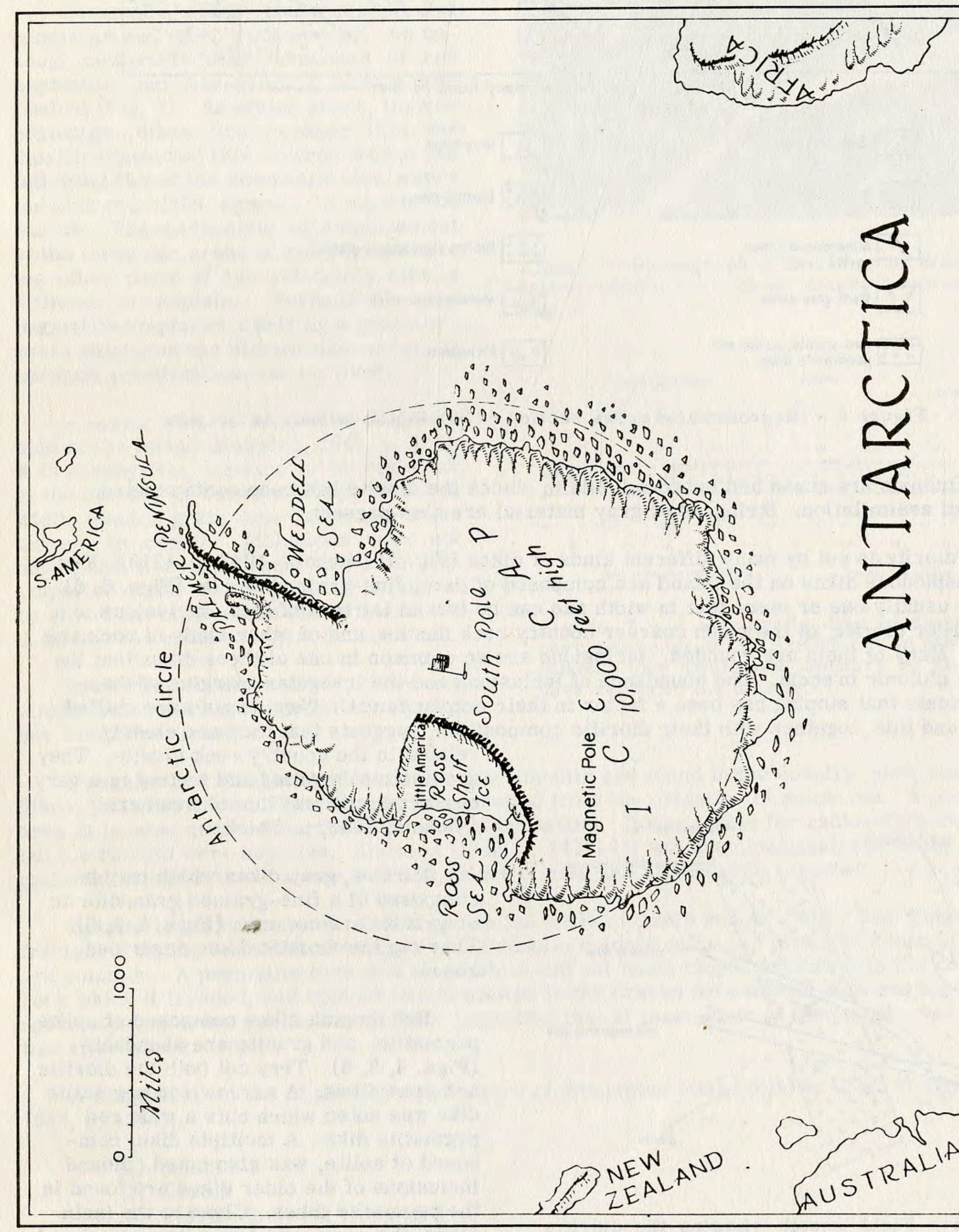

Figure 3 - Map of Antarctica showing the location of the Palmer Peninsula

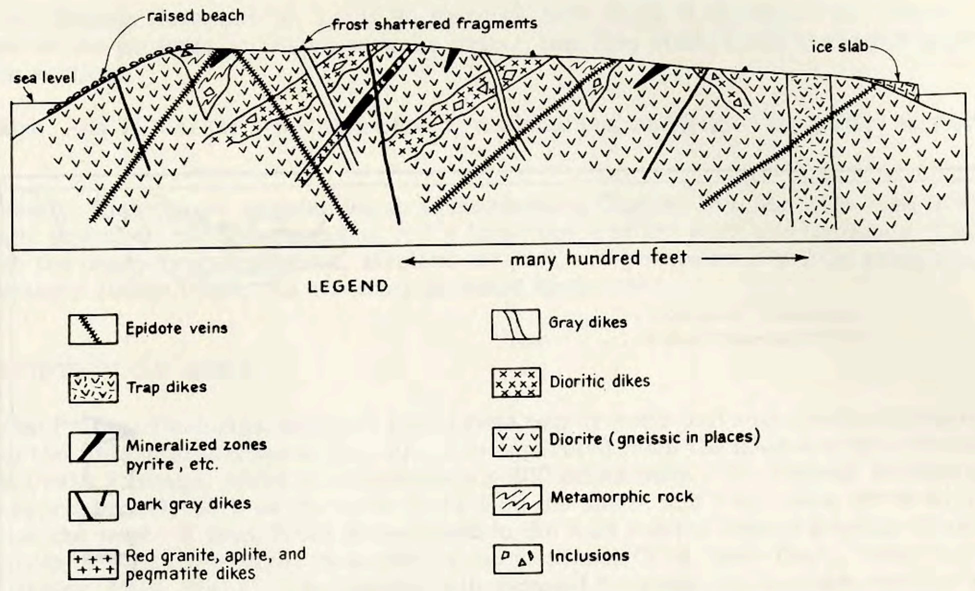

Figure 4 - Diagrammatic cross section of Stonington Island, Antarctica

Many inclusions are round and subround, and in places the diorite has been contaminated because of assimilation. Stringers of gray material are also present.

The diorite is cut by many different kinds of dikes (Fig. 4) (Nichols, 1947, p. 1213). The most conspicuous dikes on the island are composed of dark, fine-grained diorite (Figs. 5, 6). They are usually one or more feet in width and can be traced for tens of feet. Inclusions of a finer, darker diorite, of the much coarser country rock diorite, and of other kinds of rock are present. Many of them are rounded. Inclusions are so common in one of these dikes that the rock is a plutonic breccia. The abundance of inclusions and the irregular margins of these dikes indicate that stoping has been a factor in their emplacement. They do not have chilled margins and this, together with their dioritic composition, suggests that they are closely related to the country rock diorite. They are commonly pitted and fretted in a very characteristic way due to weathering (Nichols, 1953, p. 52-56).

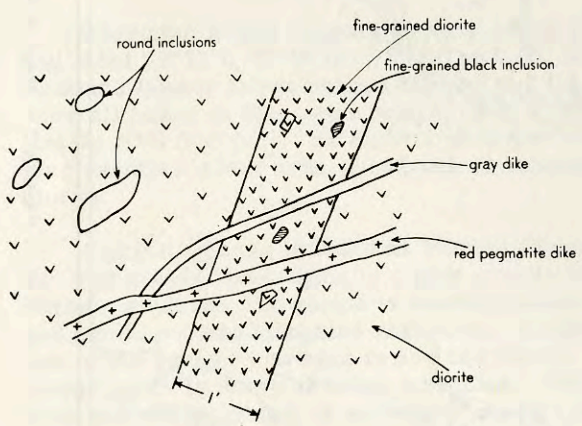

Figure 5 - Field sketch showing the dioritic country rock cut by three dikes of different ages, Stonington Island. The wide, dark-colored dike is composed of a fine-grained diorite, the gray dike is probably granodiorite or granite, and the light-colored dike is a pink pegmatite.

Narrow, gray dikes which may be composed of a fine-grained granodiorite or granite are common (Figs. 4, 5, 6). They cut the dioritic dikes described above.

Red or pink dikes composed of aplite, pegmatite, and granite are abundant (Figs. 4, 5, 6). They cut both the dioritic and gray dikes. A narrow red pegmatite dike was noted which cuts a wide red pegmatite dike. A multiple dike, composed of aplite, was also noted. Round inclusions of the older dikes are found in the pegmatite dikes. Close to the inclusions, the pegmatite loses its normal red color and becomes grayer and darker. This is probably due to assimilation by the red pegmatite of the dark-colored inclusions. The straight contacts between

these granite dikes and the country rock and the scarcity of inclusions indicate that they emplaced themselves mainly by wedging. Some of them have been faulted a few inches.

Composite dikes composed of red pegmatite and other rocks occur. An unusual composite dike composed of red pegmatite and fine-grained diorite was studied (Fig. 7). As stated above, the red pegmatite dikes are younger than the dioritic dikes; and this is suggested at the left-hand side of the composite dike, where the pink pegmatite appears to intrude the diorite. The mechanism of emplacement of the irregular areas of red pegmatite in the other parts of the composite dike is difficult to explain. Perhaps the red pegmatite emplaced itself by a grain-by-grain stoping of the dioritic dike material; perhaps granitization was involved.

A basalt dike is located on the south side of the island (Knowles, 1945, p. 138). It is porphyritic, appears to be vesicular at the center, is between 3 and 5 feet in width, and the grain size increases from margin to center. Inclusions were not noted, and it seems likely that this dike emplaced itself by wedging. It is not cut by any of the other dikes of the island and it is, therefore, the youngest bedrock unit.

In addition to these dikes, there are others which were not adequately studied nor accurately dated.

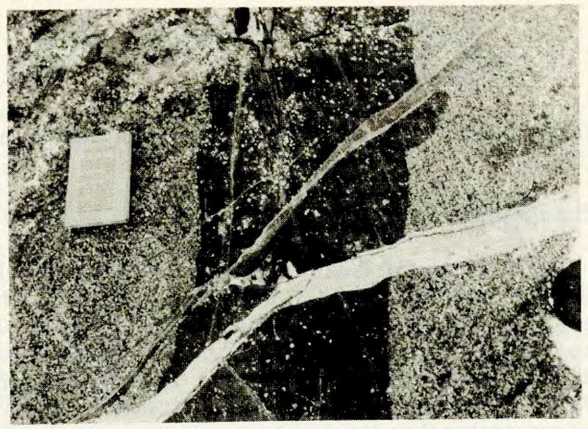

Figure 6 - Photograph of the dikes on Stonington Island which are shown diagrammatically in Fig. 5

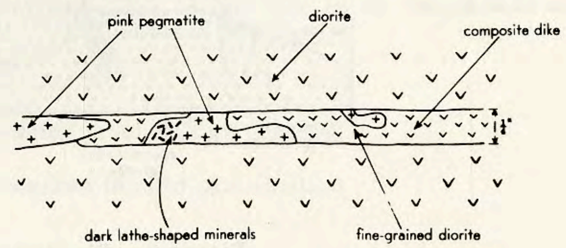

Figure 7 - A composite dike of diorite and pegmatite east of the British hut on Stonington Island. The pegmatite appears in places to have replaced the diorite.

Irregular and elongated areas stained by limonite are found in the country rock, red granitic dikes, and gray dikes. The limonite has resulted from the oxidation of sulphides. A prominent area is located near the northeastern end of the island. It was tested for radioactive material, but the results were negative. Knowles (1945, p. 143-144) had chemical analyses made of the material in one of these areas, and low values of gold and silver were reported.

Epidote is not uncommon. It is found on the walls of joints and as veins. Low ridges a fraction of an inch in width and height which contain epidote veins and bleached country rock are common. A pegmatite dike was noted which did not make close contacts with the country rock which it invaded, and epidote was deposited in the cracks between the dike and the country rock. Epidote veins cut the basalt dike, indicating that at least some of the epidote was deposited after its intrusion.

A simplified outline of the geologic history of Stonington Island follows (Fig. 4) (Nichols, 1947, p. 1213).

(1) Schist
(2) Gneiss
(3) Diorite (several varieties)
(4) Dioritic dikes
(5) Gray granodiorite or granite dikes
(6) Red aplite, pegmatite, and granite dikes
(7) Minor faulting

(8) Sulphide mineralization
(9) Basalt dike
(10) Epidote

Other rocks are present which were not adequately studied.

Refuge Islands

The Refuge Islands, a group of small bedrock islands, are located 3 mines south of Red Rock Ridge (Fig. 2). A 1-2 hour study of one of these islands showed that the country rock is a gray, massive, coarse-grained diorite (Fig. 8). It contains many angular and round dark-colored igneous inclusions. Zones of bleached country rock several feet long and approximately 1/2 inch wide are very common. The bleaching is commonly marginal to thin veins of epidote. Areas of country rock which are stained brown by limonite are present, and they stand out in sharp contrast to the much more common unstained gray areas. This staining is probably due to the oxidation of pyrite.

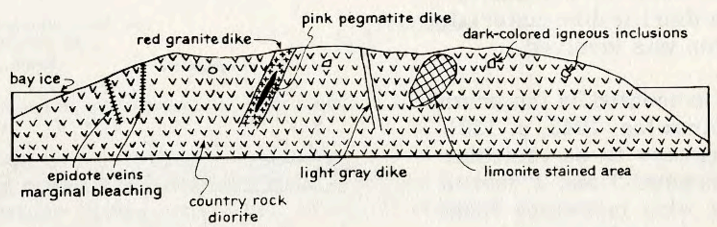

Figure 8 - Diagrammatic cross section of one of the Refuge Islands

A light gray granodiorite or granite dike several feet long and 1 to 2 inches wide, which cuts the diorite and which appeared to be similar to those which cut the diorite on Stonington Island, was seen. The diorite is also cut by both pink pegmatite and granite dikes. The pegmatite and granite are closely related. Figure 8 shows the relationship of the structures and rock units which were studied.

The bedrock geologic history of this island, based on a study of the island and other areas, follows (Fig. 8).

(1) Origin of the inclusions
(2) Formation of diorite
(3) Intrusion of light gray granodiorite or granite dike
(4) Intrusion of red granite and pink pegmatite dikes

Mushroom Island

Mushroom Island is a small island 15-20 miles south of the Terra Firma Islands (Fig. 2). Most of the island is covered with a local ice cap although a bedrock cliff approximately 300 feet high is found on the north side. The rocks in this cliff and in nearby outcrops were investigated for a few hours. The country rock is a gray, green, or black closely-jointed felsite, some of which is porphyritic. Flow banding was seen and small red features, which are probably either amygdules or spherulites associated with a red mineral which is probably hematite, were noted. Small patches of water-worked felsitic pyroclastics are also present. The felsite probably occurs as either flows or small, shallow intrusives.

Black felsitic and green felsitic dikes cut the felsite (Fig. 9). The green dikes are apparently younger than the black. An abundance of quartz veins cut the black dike but do not cut the green. The green dike is cut by epidote veins, it contains inclusions of quartz, and it was apparently localized by a breccia in which vugs formed by the deposition of quartz and epidote are found (Fig. 9). The presence of slickensides and the breccia suggest faulting.

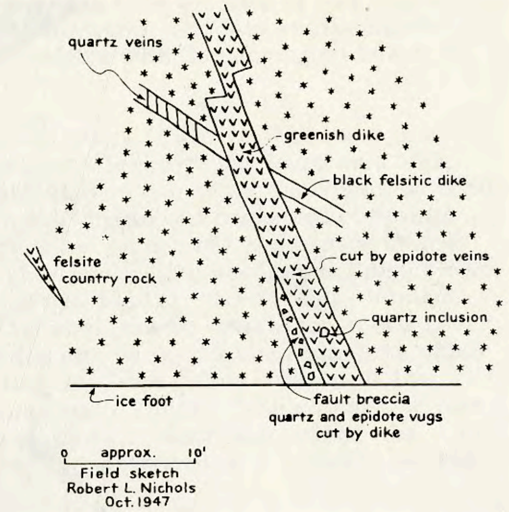

Figure 9 - Felsitic dikes cutting the felsite in the cliff on the North side of Mushroom Island

Epidote, calcite, quartz, pyrite, and limonite were identified. Veins of epidote, calcite, and quartz are common. The epidote is found as thin veins a small fraction of an inch in width. The calcite veins are much larger. A calcite vein 1 inch wide and 20 feet long was seen, and another calcite vein was 8 inches wide. Quartz vugs were found in what is probably a fault breccia. Most of the pyrite is in the form of small crystals disseminated in the felsite, although pyrite 1/4 inch in diameter was encountered. More than 50 percent of the country rock is stained by limonite which resulted, no doubt, from the oxidation of the pyrite.

The bedrock geologic history of Mushroom Island is as follows (Fig. 9):

(1) Formation of the felsite and water-worked felsitic pyroclastics
(2) Intrusion of the black dike
(3) Faulting -- slickensides, breccia
(4) Principal period of mineralization
(5) Green dike
(6) Epidote

Alexander I Land

A brief study of two outcrops proved that both igneous and sedimentary rocks are found on Alexander I Land between Cape Nicholas and the shelf ice in King George VI Sound.

A cliff composed of igneous rock is located on the east coast of Alexander I Land at a point from which Mt. Edgell has a bearing of 24° magnetic. Only general impressions of the outcrop were obtained as it was inaccessible. The country rock is massively jointed and medium colored, is in places stained with limonite, and is probably a diorite. White granite or granodiorite (?) dikes a few inches wide which cut the diorite are common. Scores of vertical black dikes also cut the diorite. Some of them are hundreds of feet long and many feet wide. They are probably trap or trap porphyry.

Layered rocks which are probably sedimentary are found not far away. The attitude of these rocks changes from place to place. A dip of 42° was noted. These sedimentary rocks may correlate with those farther south on Alexander I Land which have been described by Fleming et al. (1938, p. 509) and Fuchs (1951, p. 409, 413). The relation of the igneous rocks to the sedimentary was not here determined. A study of other areas strongly suggests, however, that the igneous rocks intrude the sedimentary.

Greenish sandstone, gritstone, and conglomerate are found approximately 20 miles to the north. No fossils were seen. The conglomerate is not well sorted and the roundstones, which are not well rounded, are, in places, 3 and more inches in diameter. Slickensides were noted.

An outline of the geologic history of this part of Alexander I Land, based upon the above observations and on studies made elsewhere, follows.

(1) Deposition of sedimentary rocks
(2) Intrusion of diorite
(3) Intrusion of white granite or granodiorite (?)
(4) Intrusion of black dikes

Figure 10 - Terra Firma Islands and the crevassed glacier on the mainland near Cape Berteaux

Terra Firma Islands

The Terra Firma Islands are located in Marguerite Bay approximately 6 miles north of Cape Berteaux (Figs. 2, 10). Diorite and felsite are the two most abundant rocks. They are cut by basic pegmatite, granite, trap porphyry, and trap dikes. The felsite is cut by veins containing epidote, calcite, chlorite, and garnet.

The diorite is found on the western end of the largest island, and at least 8 of the smaller islands are wholly or at least in part composed of it (Fig. 11A). It varies in composition as well as in texture and it contains more than one kind of inclusion. Basic pegmatitic segregations about 1 foot long and less than 1 inch wide composed almost entirely of femag minerals are also present. Some of the diorite is heavier than ordinary as it contains an abundance of a black,

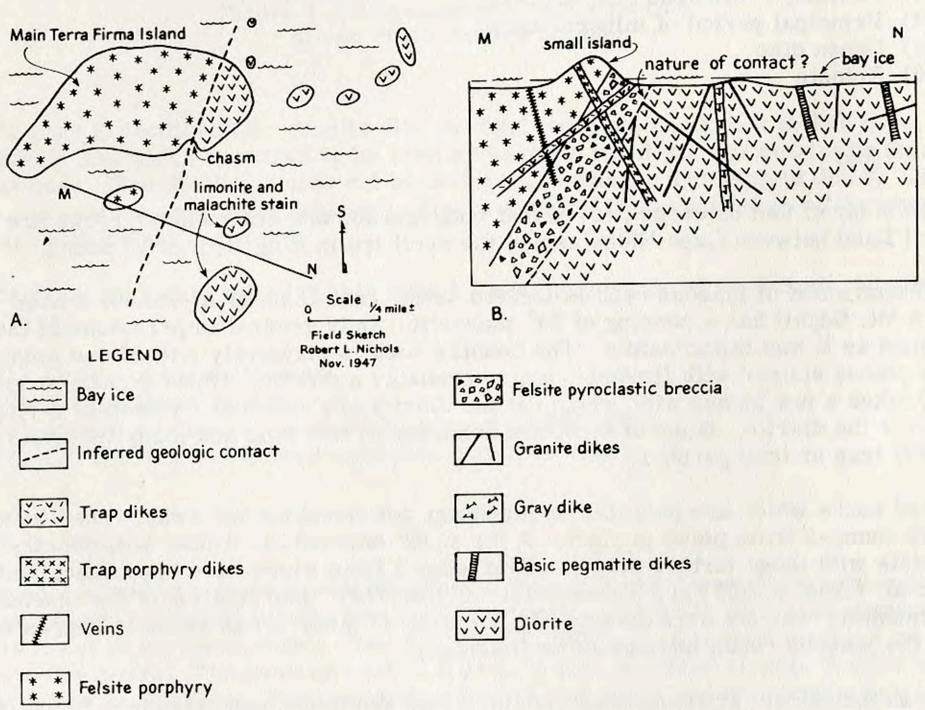

Figure 11
A. Rough field sketch showing the major bedrock units of the Terra Firma Islands, Antarctica
B. Diagrammatic cross section showing the bedrock geology along the line MN in A

heavy mineral. Basic pegmatite dikes usually about 6 inches wide and tens of feet long are common. They contain a femag mineral about 1 inch in diameter, and they cut the diorite and are in sharp contact with it. This diorite probably correlates with the Stonington Island diorite (Nichols, 1948, p. 2).

The largest island is composed mainly of felsitic volcanics (Figs. 11, 12), most of which are either black porphyry or black crystal tuff. Pyroclastic breccias are found on a high deglaciated area on the east side of the main island and also on two small islands to the north. The breccia at the deglaciated area contains many angular fragments composed of granite, granite gneiss, aplite, gabbro, and other rocks. The breccia on one of the northern islands contains fragments up to 5 inches in diameter, most of which are felsite. A prominent chasm is found at the northwest corner of the largest island (Figs. 11, 12). Here the diorite and felsitic volcanics may be in contact. The actual contact could not be seen because of a cover of ice and snow. However, the presence in the volcanics of coarse-grained fragments which are probably closely related to the diorite indicates that the diorite does not intrude the volcanics and that it is either a fault or sedimentary contact. These volcanics must be many hundreds of feet thick. They undoubtedly correlate with those at Mushroom Island, the Batterbee Mts. (Knowles, 1945, p. 141), and elsewhere, and a large area of volcanic activity is, therefore, indicated.

A coarse-grained gray (granodiorite?) dike which may be tens of feet wide and which cuts the diorite is found in the chasm at or near the contact between the diorite and volcanics (Figs. 11, 12). White granite dikes up to 1 foot in width and scores of feet long are very common. They cut both the diorite and the coarse-grained gray dike (Figs. 11, 12) and inclusions of the diorite are found in them. The coarse-grained gray dike and the white granite dikes are probably older than the volcanics as they were not seen cutting them.

A light-colored dike filled with inclusions cuts the diorite on one of the small islands southwest of the main island. It is about 4 feet wide and was traced for 15 feet. The matrix appears to be of felsitic composition and, if so, it may be related to the volcanics.

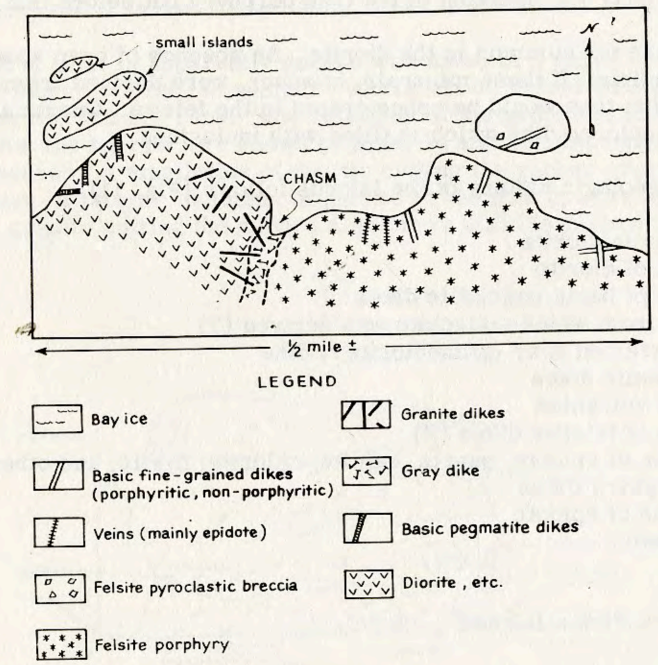

Figure 12 - Field sketch showing the bedrock geology at the north end of the largest Terra Firma Island, Antarctica

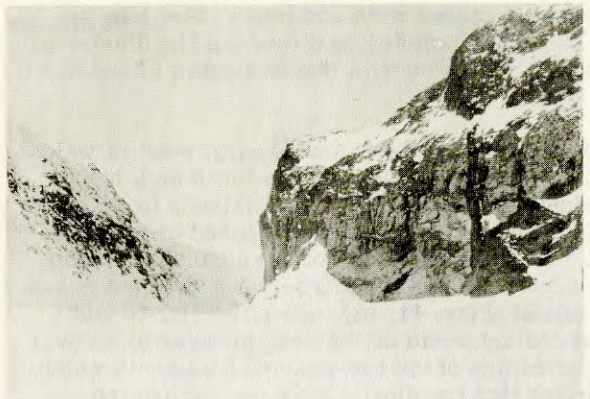

Figure 13 - Dark felsitic volcanics on the right cut by a vertical basic dike on the largest of the Terra Firma Islands

There is a light-colored grained dike about 15 feet wide not far from a defile between the main island and a small one immediately to the north. It is nearly vertical, cuts the volcanics, was traced for more than 100 feet, and its light color suggests that it may be related to the felsitic volcanics.

The volcanics are also cut my many trap and trap porphyry dikes having different attitudes and varying from a few inches in width to more than 15 feet (Figs. 12, 13). The trap dikes are younger than the trap porphyry dikes. A vertical trap porphyry dike about 3 feet wide is cut by a horizontal trap dike about 1 foot wide not far from the defile.

Malachite in thin films and veinlets in surficial cracks is commonly found on the diorite. The primary sulphide from which the malachite was presumably derived was not found. Malachite was not seen on the volcanics. The sulphides from which the malachite was derived may have been deposited after the diorite and before the volcanics. Limonite stains are common on the diorite, uncommon on the volcanics, and what appears to be a manganese stain on diorite is found on the conical island north of the main island.

The felsite in places has been mineralized, as veins as much as 2 inches in width cut the felsite. Epidote is the most abundant mineral in them, but calcite, chlorite, and garnet are also present. The felsite next to the veins has been bleached. Thin epidote veins cut the trap porphyry but not the trap dikes. The main period of mineralization was apparently later than the volcanics but earlier than the trap porphyry. A small amount of mineralization, however, apparently took place after the injection of the trap porphyry but before that of the trap dikes.

These minerals are not common in the diorite. An absence of open spaces in the diorite may have been responsible. If these minerals, however, were derived from the felsitic magma, it might be expected that they would be concentrated in the felsite. Quartz and chlorite veins are found in the light-colored dike which is filled with inclusions.

An outline of the geologic history of the islands follows (Fig. 11).

(1) Inclusions in diorite
(2) Intrusion of diorite
(3) Intrusion of basic pegmatite dikes
(4) Sulphide from which malachite was derived (?)
(5) Coarse-grained gray (granodiorite?) dike
(6) White granite dikes
(7) Origin of volcanics
(8) Intrusion of felsitic dikes (?)
(9) Deposition of epidote, quartz, calcite, chlorite, pyrite, and other minerals
(10) Trap porphyry dikes
(11) Thin veins of epidote
(12) Trap dikes

Mainland East of Terra Firma Islands

The country rock of this area is a coarse-grained pink or red granite (Main Terra Firma Island bears 274° magnetic; Fig. 2). This granite was studied at two outcrops and was very abundant as englacial fragments in a nearby barrier. Small, roundish inclusions usually less

than 4 inches in diameter and composed of a gray igneous rock are common. Aplite dikes approximately 3 inches wide and many feet long cut the granite. Trap and black porphyry erratics were also found.

The bedrock geologic history of this area, as determined by a study of this and other areas, is as follows:

(1) Origin of the inclusions in the granite
(2) Formation of granite
(3) Intrusion of aplite dikes
(4) Intrusion of black porphyry dikes
(5) Intrusion of trap dikes

Moraine Point (Unofficial Name)

Moraine Point (unofficial name) is on the mainland about equally distant between Cape Berteaux and Red Rock Ridge. From Moraine Point, Cape Berteaux has a bearing of 180° magnetic and the main Terra Firma Island a bearing of 205° magnetic (Fig. 2).

A granite gneiss is found in place in the mountains in back of the coast and fragments of it are present in the morainal material near sea level. The granite gneiss contains inclusions and is cut by acidic dikes. The foliation is plainly visible because of the presence of a wavy, elongated black mineral. A foliated white dike was seen which cuts the gneiss. The foliation of the dike is perpendicular to its walls as well as parallel to the foliation in the gneiss. If the foliation in the dike were due to flowage of the dike magma, it would probably be parallel or nearly parallel to the walls. That the foliation is not suggests that it resulted from regional stresses which were applied to both the dike and the gneiss. A granite dike was noted which cuts the gneiss and contains stringers of quartz. The stringers of quartz are perpendicular to the walls of the dike as well as parallel to the foliation in the gneiss. In general, the other rocks of the Marguerite Bay area are not foliated, and were therefore presumably formed later. This gneiss probably correlates with that found on Stonington Island, Roman Four Mt., Neny Island, and elsewhere, and it is one of the oldest rocks in the area.

A small amount of what is apparently gabbro was found in a small outcrop beneath the barrier just east of Moraine Point, in another outcrop about 50 feet seaward, and as black inclusions in the dioritic country rock. The relations of the gabbro to the other rocks in the outcrop seaward from the barrier are shown in Figs. 14 and 15. Inclusions of gabbro in the diorite and the presence of a small dike of diorite cutting the gabbro prove that the gabbro is older than the diorite. A tabular inclusion of gabbro in the pink granite and the presence of dikelets of the pink granite cutting the gabbro also prove that the gabbro is older than the pink granite (Fig. 14).

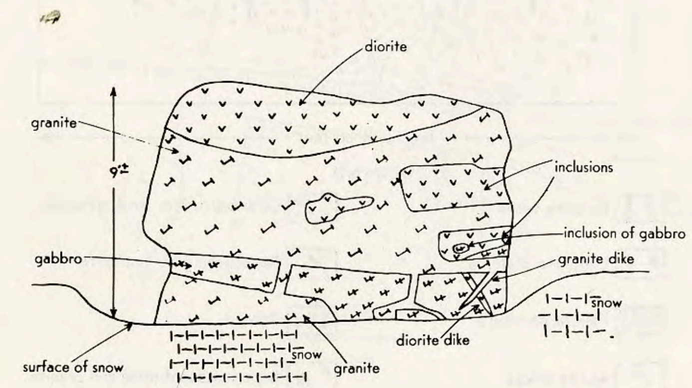

Figure 14 - An outcrop showing the relations between the gabbro, diorite, and granite at Moraine Point

Figure 15 - Photograph of outcrop at Moraine Point shown in Fig. 14

The country rock at Moraine Point is diorite. Black inclusions which are not too abundant are found in the diorite. They are usually 1, 2, or 3 inches in diameter, but may be as much as 6 inches. Irregular, black, wavy schlieren several feet long are commonly found in the diorite (Figs. 16, 17). The writer believes that they are not intrusions, nor differentiates, but elongated, deformed inclusions. They are commonly porphyritic and some of them are branching. They have obviously been much more altered by the dioritic magma than have the inclusions. No types intermediate between inclusions and stringers were seen. This lack of intermediate types suggests that the difference between the stringers and inclusions is not due solely to a difference in the duration of engulfment in the magma, but is due also to differences in initial composition. The diorite has in places a gneissic texture. At one place it appeared as if a coarse gneissic diorite were invaded by a finer gneissic diorite. The diorite gneiss is much darker than ordinary in the small outcrop beneath the barrier just east of Moraine Point. This is apparently due to the fact that it is filled with partially assimilated gabbro inclusions. The fact that the gabbro which is older than the diorite and close to it in space is not foliated and that only parts of the diorite are foliated suggests that the foliation is due to flowage and not to the application of regional stress on the diorite. The rocks which are younger than the diorite are not foliated. This is consistent with the idea that the foliation in the diorite is due to flowage of dioritic magma.

Granites, aplite dikes, and other rocks and minerals cut the diorite (Figs. 16, 17). The diorite at Moraine Point presumably correlates with that at Stonington Island, Refuge Islands, and Terra Firma Islands. In this connection, it is interesting to note that some of the diorite on Stonington Island is also foliated.

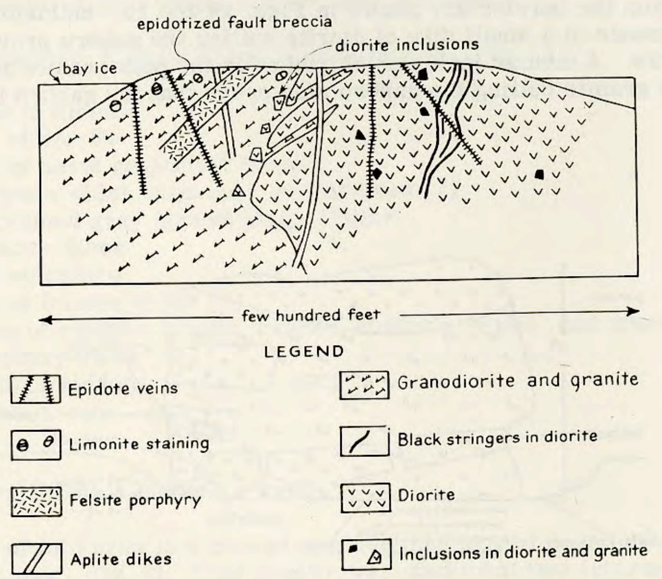

Figure 16 - Diagrammatic cross section showing the bedrock geology on a small island near Moraine Point

A granodiorite (?) is located in the mountains in back of Moraine Point. It is not gneissic and it contains little quartz. It does not resemble the granite gneiss which is found not far away and it is not like most of the diorite. It is cut by a reddish granite and it contains several kinds of inclusions. One of the inclusions suggests that it is younger than the diorite.

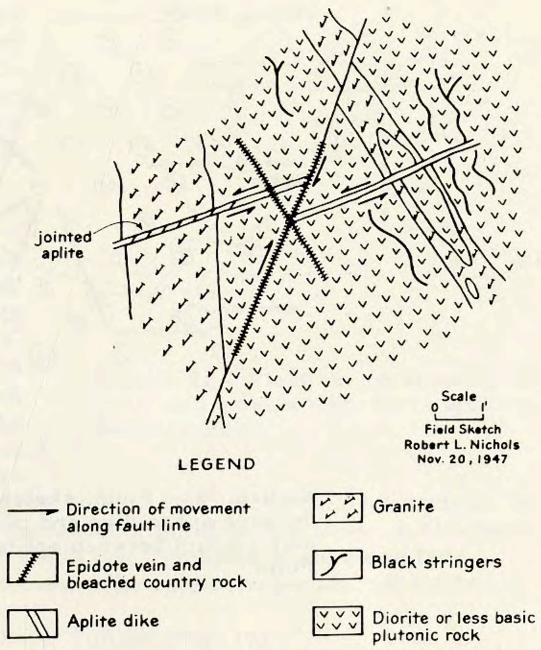

Figure 17 - Field sketch showing some of the bedrock units on a small island near Moraine Point

Granodiorite, fine pink granite, and coarse pink granite are found at Moraine Point. The granodiorite, although varying in texture, is finer-grained than either the diorite or the granites. Inclusions of diorite in the granodiorite and dikes of granodiorite in the diorite prove that the granodiorite is younger than the diorite (Fig. 16). The pink granites cut the granodiorite and the coarse-grained pink granite cuts the finer-grained pink. The pink granite is stained with limonite in places and elongated shear zones cut it.

Aplite dikes are common (Figs. 18, 19). They vary in width from 1/2 inch to 3 inches. They are commonly reddish and they cut the pink granite. An aplite dike which was faulted approximately 1 foot was seen. Pegmatite is found in the center of some of the aplite dikes. The contacts between the pegmatite and the aplite are usually sharp, although gradational contacts were noted. The sharp contacts suggest that the pegmatite was intruded into the aplite. A quartz vein with sharp contacts was found in the center of one dike.

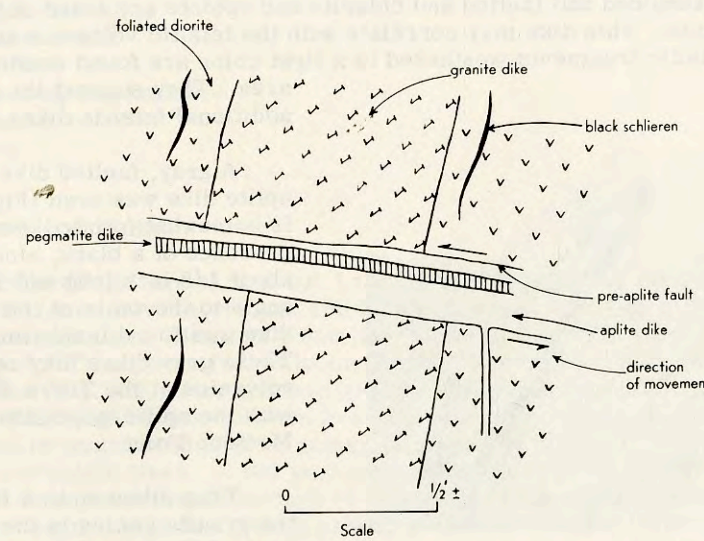

Figure 18 - Field sketch showing small scale faulting of granite dike and diorite prior to the intrusion of aplite dike, Moraine Point

An aplite dike was studied which was intruded along a contact between the granodiorite and the coarse-grained pink granite (Fig. 19). The contact between the aplite dike and the coarse

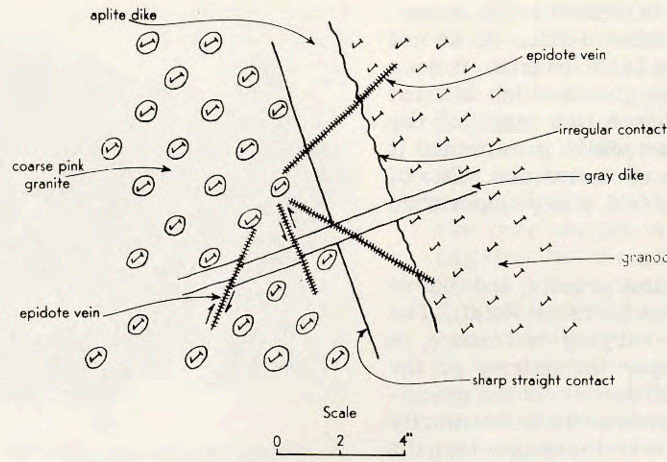

Figure 19 - Field sketch showing the straight contact between aplite dike and coarse pink granite and the irregular contact between aplite dike and granodiorite, Moraine Point

pink granite is straight and sharp. The contact between the aplite dike and the granodiorite, on the other hand, is sharp but irregular. Small, roundish protuberances and re-entrants a fraction of an inch in size characterize this contact. It seems unlikely, because of the rounded nature of the irregularities, that they have resulted from mechanical factors operating at the time of injection. If the aplite magma was similar chemically to the pink granite, little chemical reaction would have taken place between them and a straight, sharp contact might have been formed. If, however, the aplite magma was somewhat different chemically from the granodiorite, and this was probably the case, chemical assimilation of the granodiorite by the aplite magma might have taken place and an irregular contact similar to that found might have been formed. Even if this is correct, however, replacement of the granodiorite was only of minor importance in the emplacement of this dike.

A gray porphyritic felsite dike about 4 feet wide was traced for approximately 50 feet (Fig. 16). It is slickensided and faulted and chlorite and epidote are found in the fault plane. It cuts the pink granite. This dike may correlate with the felsitic volcanics at the Terra Firma Islands. Felsitic fragments weathered to a light color are found scattered over a wide area. They suggest the presence of additional felsitic dikes.

A gray, faulted dike which cuts an aplite dike was seen (Fig. 19). The dike is somewhat foliated because of the presence of a black, elongated mineral about 1/8 inch long which is aligned at an angle to the walls of the dike. A similar dike was found inside an aplite dike. These gray dikes may correlate with the volcanics at the Terra Firma Islands or with the aplite-pegmatite group here at Moraine Point.

Trap dikes up to 6 feet in width cut the granite gneiss in the mountains in back of Moraine Point (Fig. 20).

Many small faults are present. Five feet was the maximum displacement

Figure 20 - Granite gneiss cut by trap dikes in mountains behind Moraine Point. The largest dike is about 6 feet wide.

observed. They usually die out along their strikes within tens of feet. Faulting took place both before and after the injection of the aplite (Figs. 18, 21). Some of the aplite dikes have parallel joints aligned at an oblique angle to their walls, indicating that they were subjected to shearing stresses after their solidification.

Pyrite which is apparently in small dikelets of felsite is present. Round spots of limonite a few inches in diameter in places stain the granite. Larger irregular areas of limonite are also present. Both probably resulted from the oxidation of the pyrite. Chlorite is found on slickensides in the felsite. A few quartz veins as much as 3 feet long and 1 inch wide were noted. They are probably related to the aplite-pegmatite dikes. A red mineral which is probably garnet was found in one of the pegmatite dikes. Epidote veins are abundant. The rock marginal to the veins is commonly bleached. In general, the larger the epidote vein the greater is the width of the bleached zone. A bleached zone nearly 1 inch in width was noted. The epidote veins are commonly found along fault planes. A fault breccia cemented with epidote was seen. The epidote veins are not faulted.

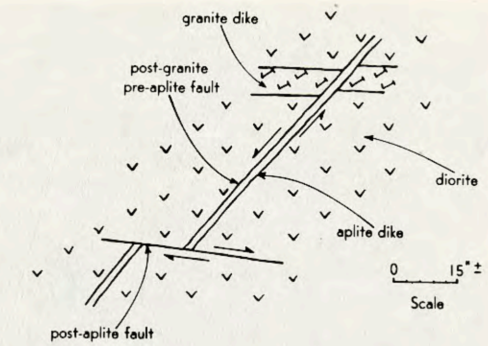

Figure 21 - Field sketch showing the pre- and post-aplite dike faulting, Moraine Point

An outline of the geologic history of Moraine Point follows (Fig. 16).

(1) Inclusions in gneiss
(2) Granite
(3) Dikes
(4) Regional metamorphism; granite gneiss
(5) Gabbro
(6) Coarse-grained gneissic diorite
(7) Fine-grained gneissic diorite
(8) Granodiorite
(9) Fine pink granite
(10) Coarse pink granite
(11) Pre-aplite faulting
(12) Aplite dikes
(13) Pegmatite dikes
(14) Quartz veins
(15) Felsite
(16) Faulting, slickensides
(17) Epidote, chlorite
(18) Trap

Chasm Island (Unofficial Name)

Chasm Island (unofficial name) is about 1 mile offshore from the coastline near Black Thumb Mt. (Fig. 2). It is between 100 and 150 feet high and it is cut by a deep chasm which may be flooded at storm tide. There is a smaller island to the north (Fig. 22). Black Thumb Mt. has a bearing of 90° magnetic from Chasm Island. The country rock is an attractive, very coarse, pink granite (Fig. 23). Fine-grained granite inclusions were found in it at several places. This granite is cut by fine-grained granite, aplite, pegmatite, trap porphyry, felsite, and trap dikes, and by quartz and epidote veins. The granite dikes are fine-grained, pink, and are cut by numerous aplite dikes. A few pegmatite dikes were noted. They contain quartz and pink feldspar, and some have small amounts of epidote. The granitic country rock and the granite, aplite, and pegmatite dikes are all probably closely related. The trap porphyry dikes are numerous and in places slickensided, and they are cut by thin veins of epidote. The phenocrysts increase in size from the margin inward. They usually reach maximum size about 2 inches in from the contact. These dikes are cut by felsite dikes. The felsite dikes are numerous and one 12 feet in width was seen. Flow lines parallel to the contact are common and in places they are beautifully developed. Some of the felsite is porphyritic. The phenocrysts are pink feldspar. Trap dikes which vary from less than 1 inch to several feet in width are present. The wide ones show grain-size variation. They are cut by minor faults which have displacements of a few inches. Pyrite is found in them and they are cut by veins of epidote. The trap dikes cut the aplite dikes, and field work elsewhere suggests that they probably cut the trap porphyry dikes and perhaps the felsite dikes as well (Fig. 23).

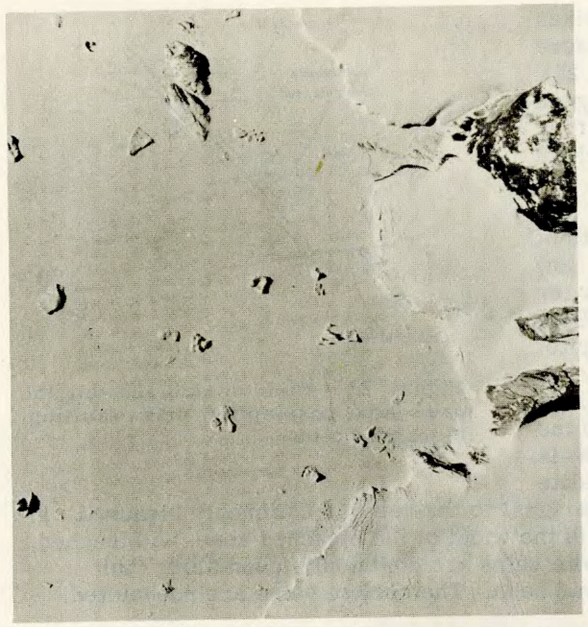
Figure 22 - Chasm Island surrounded by sea ice on the upper left hand side, black volcanics and pink granites of Black Thumb Mt. on the mainland at the right

The bedrock history of the island is as follows:

(1) Inclusions in the country rock
(2) Origin of the coarse pink granite } probably
(3) Fine-grained granite dikes } closely
(4) Numerous aplite and a few pegmatite dikes } related
(5) Trap porphyry dikes
(6) Felsite dikes
(7) Trap dikes
(8) Epidote veins

Black Thumb Mountain and Adjacent Areas

Black Thumb Mountain, which is about 3400 feet high, is a prominent feature southeast of Red Rock Ridge and northeast of Moraine Point (Fig. 2). It is composed mainly of dark volcanics and granite, but schist, ultramafic rocks, gabbro, and various kinds of dikes are also present.

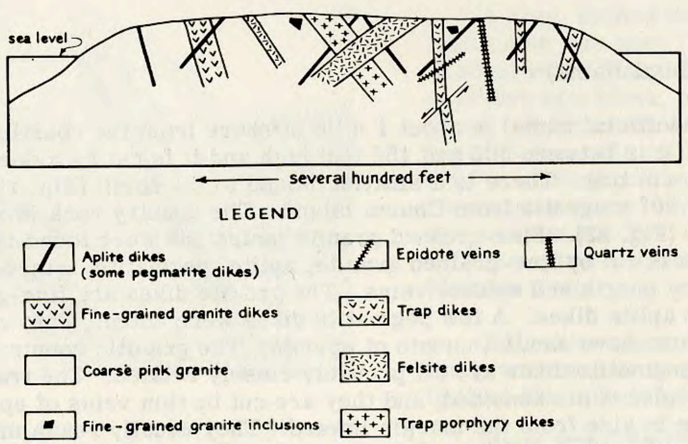

Figure 23 - Diagrammatic cross section of Chasm Island

Schists and gneisses are found at Black Thumb Mt. Gneiss occurs close to the prominent elevated beach.

Dark green ultramafic rock and several kinds of gabbro are also present. The ultramafic rock appears in places to grade into the gabbro. Some of the gabbro, however, is younger than the ultramafic rock, as inclusions of the ultramafic rock are found in it. The gabbro intrudes the schist, and the lack of schistosity in the gabbro indicates that it is also younger than the nearby gneiss. The fact that the gabbro and the ultramafic rock are approximately the same age indicates that the ultramafic rock is also younger than both the schist and the gneiss.

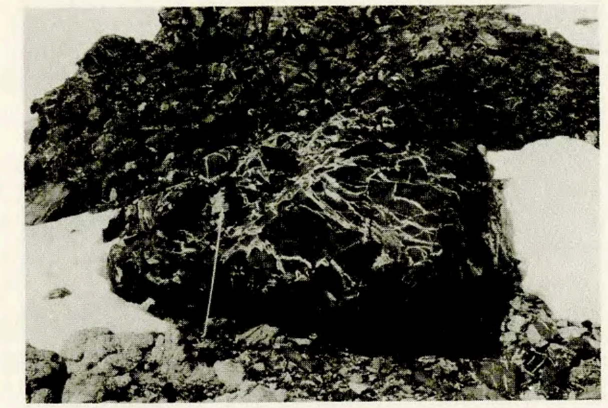
Figure 24 - White pegmatite dikes cutting dark green ultramafic rock, Black Thumb Mt.

The ultramafic rock is cut by granodiorite dikes which are in turn cut by white pegmatite dikes. The white pegmatite dikes stand out in sharp contrast to the dark green ultramafic rock (Fig. 24). The granodiorites in the area around Marguerite Bay, without known exception, are younger than the gabbros. On the basis of this relationship and because in composite batholiths the usual sequence is gabbro, diorite, granodiorite, and granite (Grout, 1932, p. 137), it is concluded that the granodiorite and white pegmatite here are also younger than the gabbro. Gneiss and other rocks are found as inclusions in the granodiorite and aplite dikes cut it as well as the ultramafic rock. The white pegmatite is probably closely related to the granodiorite, as it does not look like the reddish pegmatite which is associated with and closely related to the pink granite on Chasm Island.

Black Thumb Mt. is composed mainly of gray and black felsitic volcanics (Figs. 25, 26). Although ultramafic rock, gabbro, black schist, and trap are also present, it is the volcanics

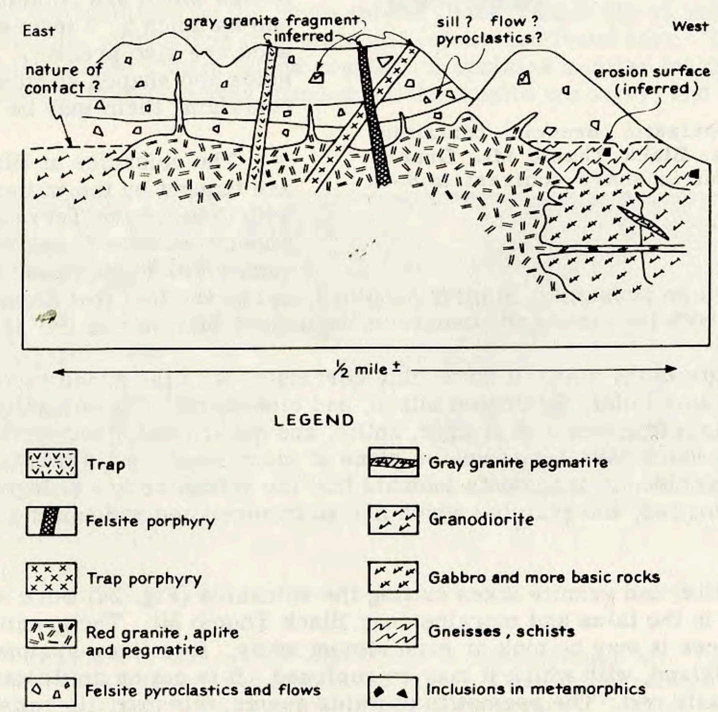

Figure 25 - Hypothetical cross section showing the bedrock geology at Black Thumb Mt.

Figure 26 - Black Thumb Mt. composed mainly of black and gray volcanics and red granite. The lighter, lower rocks on the left are granites.

Figure 27 - Pyroclastic breccia containing granitic fragments, Black Thumb Mt. Granite fragments stand out in sharp contrast to dark felsitic matrix.

which are mainly responsible for the dark aspect of the mountain. The volcanics appear to be nearly horizontal and they are probably a few thousand feet thick. Tuffs, breccias, agglomerates, and perhaps felsitic dikes, welded tuffs, and volcanic conglomerates have been identified. Some of the agglomerates are filled with gray granitic fragments as much as 6 inches in diameter, whereas other agglomerates are composed mainly of felsitic fragments (Fig. 27). Similar volcanic rocks are also found at the Terra Firma Islands. The granite and felsite fragments are usually angular or subangular, but subround granite fragments were also noted. This rounding may have resulted from attrition in the volcanics vents or perhaps from high temperature. However, felsite and granite were also seen which were well rounded. It seems likely that this rounding resulted from fluviatile action and the rock is, therefore, a volcanic conglomerate. High up on the mountain round white spots in the black volcanics can be seen. These spots may be large granite boulders.

Aligned felsitic lenses as much as 2 to 3 inches long and less than 1/2 inch wide were seen in the volcanics. Similar lenses which are commonly porphyritic and as much as 7 inches long and 1 inch wide are also present. These unusual sizes and shapes suggest that the rock containing them may be welded tuff.

The volcanics at Black Thumb Mt. are thought by the writer to correlate with those at the Terra Firma Islands, Mushroom Island, and with similar volcanics which are found elsewhere. This correlation is based on proximity, similar lithology, and on the fact that the age relation of all these volcanics to both the older and younger rocks around Marguerite Bay is similar.

The gray granite in the volcanics probably correlates with the granite found in place at Chasm Island, Moraine Point, Stonington Island, and elsewhere. The volcanics at the Terra Firma Islands contain fragments of granite, aplite, and gabbro which undoubtedly correlate with similar rocks which have been found in place at many localities in this part of the Palmer Peninsula. These accidental fragments indicate that the volcanics are younger than the closely related gabbros, diorites, and granites which are so common and widespread around Marguerite Bay.

Aplite, pegmatite, and granite dikes cutting the volcanics (Fig. 28) were seen in fragments of volcanics found in the talus and moraine near Black Thumb Mt. The granite is commonly red although in places it may be pink or even almost white. It is finer-grained than the pink granite on Chasm Island, with which it may be confused. It is cut by aplite and pegmatite dikes which are also usually red. The pegmatite contains quartz, feldspar, limonite, epidote, and chlorite. The most characteristic feature of the granite is the vugs, which may contain quarz crystals as much as 1/2 inch long. In addition to cutting the volcanics, the vugy granite, as

might be expected, also cuts the ultramafic rock-gabbro complex. The north side of Black Thumb Mt. is red where it is composed of this granite (Fig. 26). High up on this side of the mountain, the red granite can be seen intruding the black volcanics (Fig. 25).

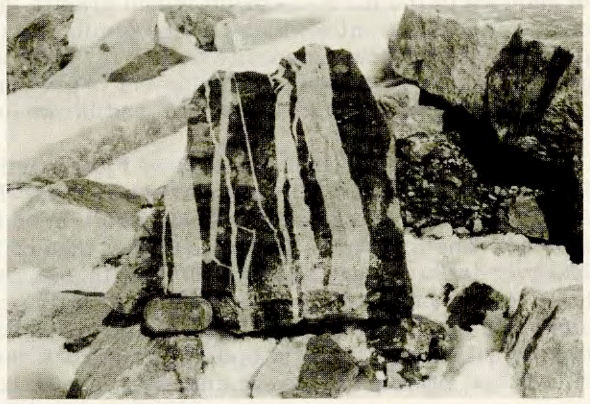

Figure 28 - Red aplite and pegmatite dikes cutting the dark gray volcanics, Black Thumb Mt.

Fragments of trap, probably derived from dikes, were found in the talus at the foot of Black Thumb Mt. Trap dikes were not seen, however, cutting the red granite which lies above the talus. This could mean that: (1) The red granite is younger than the trap dikes. (2) The dikes are younger than the granite but do not cut the face of the granite. (3) The dikes cut the face of the granite but were not seen. Based on field studies at Red Rock Ridge and elsewhere, the writer believes that the trap dikes are younger than the red granite.

Trap porphyry and felsite dikes were seen on the mainland to the south of Black Thumb Mt., perhaps on the southwest side of Black Thumb Mt. (Fig. 29), and at Chasm Island (Fig. 23). In these areas the felsite dikes are younger than the trap porphyry dikes. The relation of the felsite and trap porphyry dikes to the trap dikes, red granite, and volcanics was not determined.

Here, as elsewhere, epidote veins and limonite staining are common. Thin films of malachite were seen on the ultramafic rock. Excellent crystals of quartz up to 1/2 inch long are found in the vugs in the red granite; and the pegmatite which cuts the red granite contains quartz, feldspar, limonite, epidote, and chlorite. Sulphides were seen in a trap dike on the south side of Bingham Col.

The geology on the mainland on the south side of Black Thumb Mt. is similar to that on Chasm Island except that more kinds of granite and felsite are found here. The country rock in this area is similar to the Chasm Island granite. It contains similar inclusions and it is cut by aplite, pegmatite, trap porphyry, banded felsite, felsite porphyry, and trap dikes.

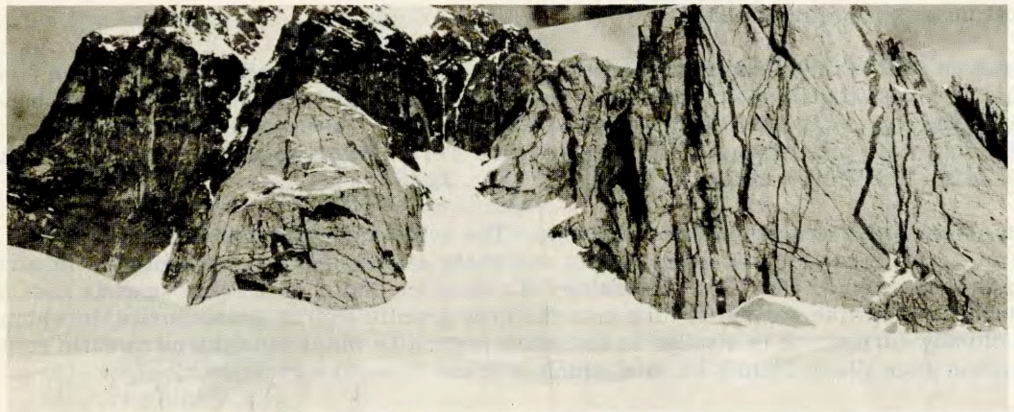

Figure 29 - Photograph of the southwestern part of Black Thumb Mt. Dark-colored volcanics on left and light-colored granite on right. Granite correlates with either the Chasm Island granite or the vugy Red Rock Ridge granite. Granite is cut by dike swarm. The black dikes, which are probably trap porphyry, appear to be cut by the lighter-colored dikes, which are presumably felsite.

In addition to the normal Chasm Island granite, a finer-grained granite which may be a facies of it, and a red granite which may be similar to the red granite at Black Thumb Mt. are also present. An unusual composite dike many tens of feet wide cutting the normal Chasm Island granite and its finer-grained facies (?) is present. It consists of fine-grained granite, aplite, green and brown porphyritic felsite, and brown-banded felsite.

Bingham Col extends from Neny Fjord southwestward to Marguerite Bay. It reaches Marguerite Bay a few miles northwest of Black Thumb Mt. (Fig. 2). The moraine which extends down to Marguerite Bay and which is on the southeast side of Bingham Col was studied. The mountains on the southeast side of Bingham Col, which are not far from Marguerite Bay, appear on the basis of this study and on a distant examination of the mountains to be composed of: (1) coarse gray granite or granodiorite which contains black inclusions, (2) pink granite which invades the gray granite or granodiorite, and (3) trap dikes containing sulphides which cut both the gray rock and pink granite. In addition, what appears to be a large, prominent area stained by limonite is also present.

An outline of the geologic history of this area follows (Fig. 25).

(1) Schists and gneisses
(2) Ultramafic rock
(3) Gabbro
(4) Granodiorite
(5) White pegmatite dikes (probably closely related to granodiorite)
(6) Felsitic volcanics (tuffs, breccias, agglomerates, welded tuffs (?), volcanic conglomerates)
(7) Red vugy granite, aplite, and pegmatite

Trap porphyry, felsite, and trap dikes are also present, but their relations to each other and to the vugy red granite and volcanics were not here determined.

Three Pup Island (Unofficial Name)

Three Pup Island (unofficial name) is a very small island between Chasm Island and the Refuge Islands. From Three Pup Island, the prominent chasm on Chasm Island has a bearing of 118° magnetic, Breccia Island (unofficial name) a bearing of 45° magnetic (Fig. 2). The country rock of Three Pup Island is in part a coarse granodiorite and in part a finer granodiorite. It contains inclusions and is cut by pink granite dikes, gray dikes, and epidote veins.

Skua Gull Islands (Unofficial Name)

The Skua Gull Islands (unofficial name) consist of one large island and three much smaller ones which are tied together by tombolos. The largest is 75-100 feet high and several hundred feet long. The Skua Gull Islands are opposite Bingham Col. From the largest island, the Refuge Islands have a bearing of 251° magnetic, the Terra Firma Islands 182° magnetic, and Breccia Island (unofficial name) 112° magnetic (Fig. 2).

The oldest rocks are schists and gneisses. The schists have been invaded by a gray granite and/or granodiorite on the southeast end of the island, and excellent lit-par-lit structure has been developed (Fig. 30). Inclusions of schist are found in the gray granite and/or granodiorite. A whitish pegmatite dike cuts the gray granite and/or granodiorite, to which it may be closely related. It is similar to the white pegmatite which cuts the ultramafic rock on the mainland near Black Thumb Mt. and which is found close to a granodiorite.

The gray granite and/or granodiorite has been intruded by a coarse, pink granite. Inclusions of the gray rock are found in the pink. Aplite, pegmatite, and fine-grained pink granite dikes which were probably derived from the same magma as the coarse pink granite are also present (Figs. 30, 31). The aplite and fine-grained pink granite dikes were seen cutting the coarse pink granite, and it is believed that the pegmatite also cuts the granite. Numerous schlieren are found in the coarse pink granite. The fine-grained pink granite dikes are faulted and are cut by veins of epidote (Figs. 30, 31).

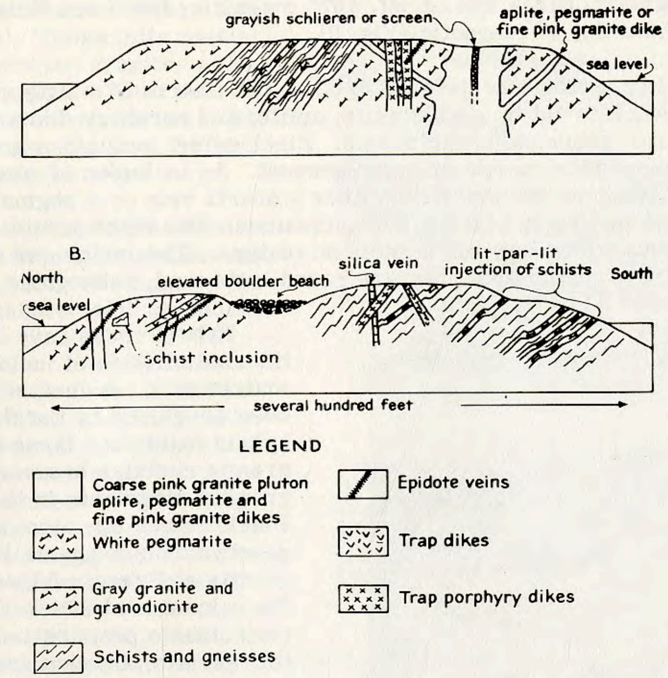

Figure 30 - Diagrammatic cross sections of the large Skua Gull Island

Trap porphyry dikes are common. They cut the pink granite and a silica vein, and are in turn cut by trap dikes and epidote veins. One trap porphyry dike nearly 12 feet in width was seen.

The trap dikes have been in places intruded along fault planes (Figs. 30, 31); in other places they have intruded the trap porphyry dikes, forming composite dikes (Fig. 30).

A thin film of malachite was seen on some of the rocks.

An outline of the bedrock history of the Skua Gull Islands follows (Figs. 30, 31).

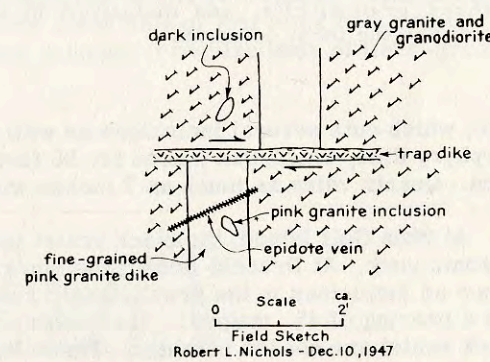

Figure 31 - Field sketch showing some of the bedrock units on the large Skua Gull Island

(1) Origin of schists and gneisses
(2) Intrusion of gray granite, granodiorite
(3) Intrusion of white pegmatite
(4) Emplacement of coarse pink granite
(5) Intrusion of aplite, pegmatite, and fine-grained pink granite dikes, silica vein
(6) Minor faulting
(7) Trap porphyry dikes
(8) Epidote
(9) Trap dikes

Breccia Island (Unofficial Name)

Breccia Island (unofficial name) is between 10 and 20 feet above sea level and it has an area of several acres. From Breccia Island, the Refuge Islands have a bearing of 270° magnetic, Chasm Island 135° magnetic, Black Thumb Mt. 107° magnetic, Red Rock Ridge 305° magnetic, and the center of Bingham Col 5° magnetic (Fig. 2).

The country rock is a plutonic breccia (Fig. 32). The matrix is mainly gray granite and perhaps granodiorite which is cut by pink granite, aplite, and porphyry dikes and by quartz and epidote veins. There are thousands of inclusions. Black schist inclusions are the most common and inclusions composed of gneiss are also present. An inclusion of quartz 6 inches long was seen which must have been derived from either a quartz vein or a pegmatite dike. One inclusion of gneiss contained many black schist inclusions. The black schist was, therefore, earlier invaded by magma which now has a gneissic texture. The inclusions vary in size from 9 feet to less than 1 inch in diameter. They are round, subround, subangular, and angular.

Figure 32 - The plutonic breccia on Breccia Island. The matrix is mainly gray granite or perhaps granodiorite, and inclusions of black schist are the most common.

Hybrid rocks have been formed by the assimilation of inclusions by the matrix rock. A gneissic texture has also been developed by the flowage of the hybrid material. Some of the gray matrix granite contains brown quartz. The gray granitic fragments in the volcanics at Black Thumb Mt. also contain brown quartz. This suggests that the gray granite at Breccia Island is older than the volcanics at Black Thumb Mt., that the volcanic processes drilled up through this granite, and that fragments of it became incorporated in the volcanics. Disregarding the hybrid rocks, there appear to be two kinds of matrix rock, one quartz-rich and the other grayer and not so rich in quartz.

Pink granite dikelets usually less than 1/2 inch wide and several feet long cut the gray matrix rock. A small aplite dike, which cuts several inclusions as well as the gray matrix rock, was noted. A small porphyry dike, which was traced for 80 feet and which varied in width from 2 to 4 inches, was seen. Quartz veins as much as 7 inches wide and much smaller epidote veins are also present.

At Skua Gull Island, the black schist is in place and has been lit-par-lit invaded by a gray plutonic rock. At Breccia Island, the black schist is not in place, but it is found in great abundance as inclusions in the gray plutonic rock. At Three Pup Island, from which Breccia Island has a bearing of 45 magnetic, the country rock is the gray plutonic rock and inclusions of the black schist are not too common. Three Pup Island is, therefore, within the gray pluton. The abundance of inclusions in the gray plutonic rock at Breccia Island indicates that the island is in the pluton and that the contact between the gray rock and the black schist is close. Skua Gull Island is outside the pluton, but not so far from the contact that the black schist has not been invaded by sills from the gray pluton.

The bedrock sequence of events is as follows:

(1) Origin of schist
(2) Formation of gneiss
(3) Quartz veins or pegmatite dikes
(4) Intrusion of gray granite, granodiorite; origin of plutonic breccia; hybrid rocks
(5) Pink granite, aplite, and porphyry dikes and quartz and epidote veins

Western End of Red Rock Ridge

Red Rock Ridge is a prominent feature located on the southwest side of Neny Fjord (Figs. 2, 33). Viewed from the south, it is seen to be composed mainly of 3 rock units which stand

out in sharp contrast because of their different colors (Fig. 34). These units consist of gabbro, an older pinkish granite, and a younger red vugy granite. The contacts between these units as seen from the south side of Red Rock Ridge are more or less straight and they dip to the west.

Figure 33 - Western tip of Red Rock Ridge in foreground; Refuge Islands, Skua Gull Islands, and Chasm Island, all surrounded by sea ice, can be seen in the middle distance. The dark mountain in the background to the left is Black Thumb Mt.

The gabbro is located near the western end of the ridge (Fig. 34). It is tabular and dips steeply to the west. It undoubtedly correlates with the gabbro at Black Thumb Mt.

A pinkish granite is found at the extreme western end of Red Rock Ridge (Fig. 34). The contact between the gabbro and the pinkish granite can be traced for more than 1000 feet on the south side of the ridge at and near the penguin rookery. It is distinct, sharp, and straight, and it can be seen at a considerable distance because of the difference in color. Here it is easy to demonstrate that the pinkish granite is younger than the gabbro, as dikes of the granite cut the gabbro and inclusions of the gabbro are found in the granite. The granite is in places banded, at one place it is mottled with basic minerals, and it contains round inclusions. These features suggest stoping and assimilation of the gabbro by the granite. The granite is in places heavily stained with limonite. One such area is 2 to 3 feet wide and 50 or more feet long. On the basis of observations made elsewhere, it seems likely that this staining has resulted from the oxidation of pyrite. Calcite veins cutting the granite were seen at the west end of the ridge. On the north side of Red Rock Ridge just north of a prominent chasm which cuts through the ridge, a large, irregular body of finer-grained

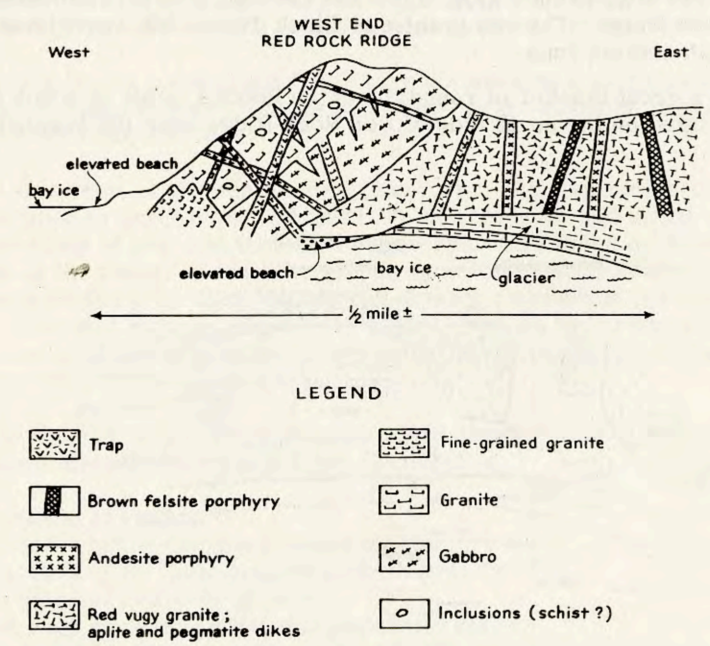

Figure 34 - Diagrammatic cross section showing the bedrock geology at western end of Red Rock Ridge

granite has intruded the coarser facies. Here the relations in plan are similar to those seen in cross section in Fig. 34.

A fine-grained granite dike about 3 to 4 feet wide which cuts the coarser granite was traced for more than 100 feet. The contact between the finer and coarser facies is not straight, as are many of the contacts on Red Rock Ridge, but wavy or rolling. The finer facies is commonly banded, darker in color near the contact, and is cut by red granite and aplite dikes.

Three-dimensional zones, a few feet long, an inch or less in width, and extending an unknown distance downward, are found in the finer-grained facies of the granite. In places they stand above the surrounding rock because of differential erosion. Some have cracks 1/4 to 1/2 inch wide and a foot or more in length in the middle of them. In general, these zones are more or less parallel. No time was available to determine whether they are elongated inclusions, segregations, or zones bleached by the circulation of ground water or volatiles given off when the magma was solidifying.

The western end of Red Rock Ridge is composed mainly of a younger red granite (Fig. 34). This granite in places is filled with vugs which contain feldspar, pyrite, limonite, and terminated quartz crystals. Scores of vugs are commonly found on an area of 1 square foot. The larger vugs have a cross section of approximately 1 square inch. Moss grows in the vugs which are cut by more or less horizontal surfaces, as they hold water. The presence of the vugs suggests that the granite crystallized at shallow depths. The granite varies in color from red to pink, it is cut by quartz veins, films of calcite are found on it, and in places it is bleached perhaps by epidote veins. The red granite is younger than the gabbro. Small dikelets of the red vugy granite usually less than 1/2 inch wide cut the gabbro at its contact with the red vugy granite. Moreover, in places the red vugy granite has a mottled appearance as it contains black inclusions which are presumably gabbro.

It is thought that the red vugy granite is younger than the pinkish granite, as red granite, pink aplite, and pink pegmatite dikes, all of which probably correlate with the red vugy granite, cut the pinkish granite.

Based on the color of the rock as seen from a distance and on an examination of morainal material, it seems likely that the country rock from Red Rock Ridge on south to the north side of Bingham Col is the red vugy granite (Fig. 35). The red vugy granite also extends further eastward along Red Rock Ridge. The red granite at Black Thumb Mt. correlates with that at Red Rock Ridge, as both contain vugs.

A rock containing a great number of round, black inclusions, most of which are about 1 foot in diameter, is located on the north side of Red Rock Ridge near its western terminus and

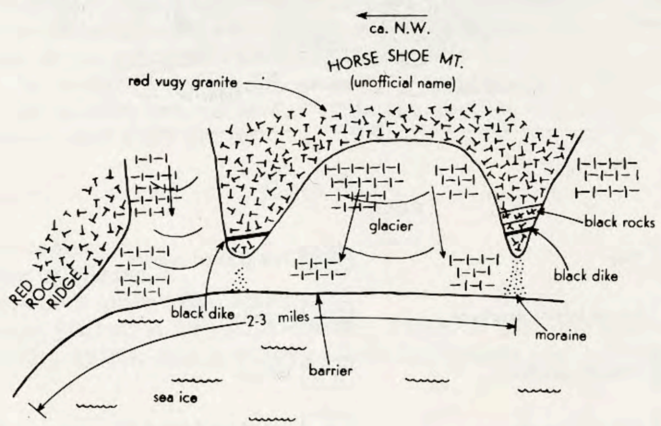

Figure 35 - Field sketch showing distribution of the red vugy granite immediately southeast of Red Rock Ridge

immediately south of the most easterly of the islands near the mouth of the fjord (Fig. 35). In places the area of the inclusions on the outcrop is greater than that of the matrix. The inclusions are commonly so well rounded that the rock looks like a conglomerate. This degree of roundness indicates that a considerable percentage of the originally angular inclusions has been assimilated by the invading rock. The matrix is in places banded, contains pink feldspar, and where the inclusions are abundant it is gray. The country rock of the area is reddish. It is assumed to be equivalent to the matrix rock because of the absence of a contact between them. The difference in color may have resulted from assimilation. Red dikes cut the inclusion rock. In places both are badly stained by limonite. A somewhat similar rock is found on Stonington Island between the British base and the large snowdrift ice slab near the southeast corner of the island. It is not known whether the matrix rock is the Stonington Island diorite, the red vugy granite, or the pinkish granite. The inclusions are probably gabbro.

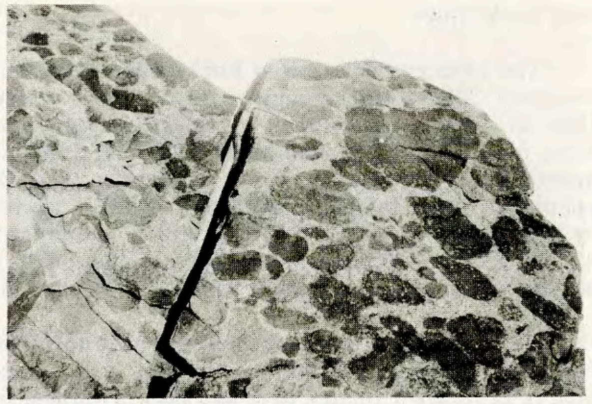

Figure 36 - Round and subround inclusions, 1 and more feet in diameter, Red Rock Ridge

Many different kinds of dikes are found at the western tip of Red Rock Ridge. Pinkish granite, red granite, aplite, pegmatite, porphyritic trap, and trap dikes were noted. Red granite, red and yellow aplite, and pink pegmatite dikes are common. Some of the red granite dikes are vugy. The vugs contain quartz, feldspar, and pyrite. The aplite dikes cut the red granite dikes. Based on composition and their close association in space, the red vugy granite, the red and yellow aplite, and the pink pegmatite dikes are correlated with the red vugy granite which makes up the greater part of Red Rock Ridge.

Trap porphyry dikes are found at the western end of Red Rock Ridge. Gray dikes with either twinned or coalescing feldspar phenocrysts and containing granite and several other kinds of inclusions were noted. They vary in width from a fraction of an inch up to a few feet. They cut the red vugy granite as well as the pinkish granite. They may be porphyritic andesite.

Fragments of a brown porphyritic felsite are common on a moraine at Red Rock Ridge. This felsite was not found in place, but its abundance in the moraine suggests that dikes of it may be present at Red Rock Ridge.

A trap dike was seen on the north side of the ridge. It is stained brown, contains small inclusions of the pinkish granite as well as black phenocrysts, and small angular holes due to differential weathering of perhaps the black phenocrysts are found on its surface. Chalcedony amygdules found in the center of the dike are its most interesting feature. A small trap dike was seen cutting a larger trap dike. Inclusions are not common in the trap dikes of the Marguerite Bay area and stoping, therefore, has not been an important process in their emplacement. The trap dikes cut granite and aplite dikes and regional studies indicate that they are probably the youngest bedrock unit.

An outline of the bedrock geologic history of the western end of Red Rock Ridge, based on a study of the ridge and other areas, follows (Fig. 34).

(1) Intrusion of gabbro
(2) Intrusion of the coarse-grained pinkish granite
(3) Intrusion of the fine-grained pinkish granite
(4) Intrusion of red vugy granite
(5) Red vugy granite, aplite, and pegmatite dikes
(6) Trap porphyry, porphyritic andesite (?), brown porphyritic felsite, and trap dikes

Red Rock Ridge

The country rock of Red Rock Ridge between the glacier near its western terminus and Bingham Col is the red vugy granite which is found near the western terminus of the ridge (Fig. 2). It is stained black with pyrolusite and/or limonite, dendrites are in places very common, molybdenite is found in the vugs and disseminated through it, and the vugs also contain quartz, chlorite, feldspar, pyrite, goethite, and perhaps siderite. It is cut by aplite, red granite, pegmatite, gray felsite, porphyritic felsite, banded felsite, trap porphyry, and trap dikes, and by quartz, chalcedony, calcite, epidote, and fayalite veins. A specimen of fayalite approximately 4 x 2 x 2 inches which was essentially one crystal was collected. It was biaxial negative, slightly magnetitic, with a 2V of about 50 degrees, and a beta index of slightly less than 1.86.

Two pegmatite dikes are located just northwest of Bingham Col. They are as much as 1-1/2 feet wide, were traced for hundreds of feet, and contain quartz and feldspar. Earlier formed quartz crystals 7 inches long and between 3 and 5 inches in diameter are surrounded by later quartz which grew around them. These pegmatite dikes cut aplite and fine-grained granite dikes and are cut by trap dikes.

The red vugy granite in this area is also cut by many trap dikes. The presence of perhaps 3 different kinds of trap dikes is suggested by differences in color.

The most conspicuous dike near Bingham Col is a greenish trap (?) porphyry. It is about 30 feet wide, in places it stands above the surrounding terrain, and it is cut by calcite and epidote. A banded felsite dike which cuts a trap dike is located near Bingham Col. It varies in width from 3 to 8 feet, joints parallel to the contacts and from 1/4 to 2 inches apart are conspicuous, and it is cut by calcite veins.

Neny Fjord Thumb (Unofficial Name) and Adjacent Areas

Neny Fjord Thumb (unofficial name) is on the south side of Neny Fjord just east of Bingham Col (Figs. 2, 37). It is 2722 feet high and about 68°19'S, 66°50'W. Neny Fjord Thumb and the area about 1/2 mile to the east, labeled A on Fig. 38, proved to be one of the most rewarding localities because of the large areas of accessible bedrock and the many rock units. A great thickness of volcanics, a dioritic pluton, a vugy orange granite, and a great number of dikes which vary in composition, complexity, and age are found here (Fig. 39). A pink granite older than the volcanics is also present.

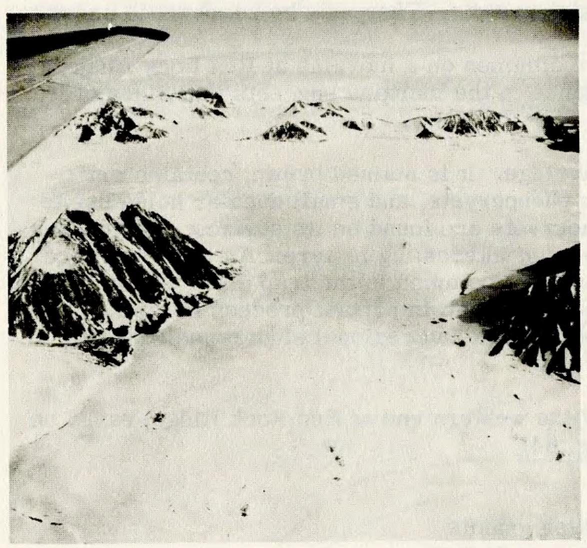

Figure 37 - Neny Island in foreground on right and Roman Four Mt. in foreground on left. Neny Fjord Thumb and area around it in background on extreme left on south side of Neny Fjord, and Red Rock Ridge in background on right.

A small area of pink granite crops out at the locality labeled I on Fig. 40. This granite does not contain vugs, is very coarse-grained, and therefore correlates with the granite at Chasm Island and not with that at Red Rock Ridge. It is cut by small gray felsitic (?) stringers as much as 1 inch wide which contain small fragments of it. It is not known whether the stringers are igneous or sedimentary dikes. They are cut by brown aplite dikes (Fig. 41). This pink granite is older than the volcanics close by, as large fragments of it are found in the pyroclastic facies of the volcanics.

Neny Fjord Thumb and its much smaller companion, the Needle (unofficial name), are composed mainly of dark

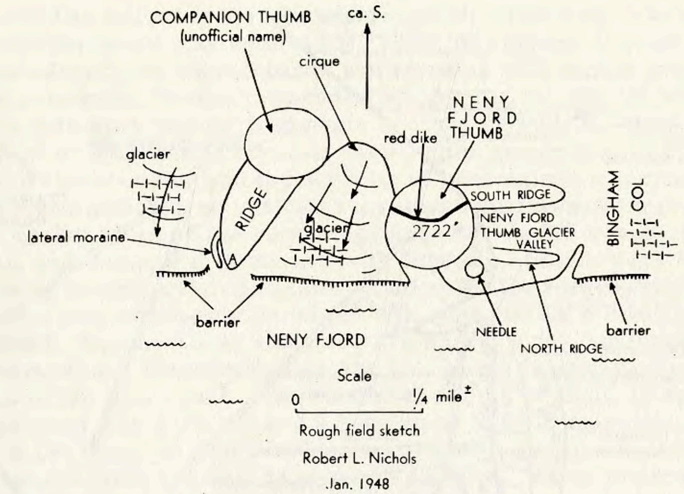

Figure 38 - Index map of the area around Neny Fjord Thumb

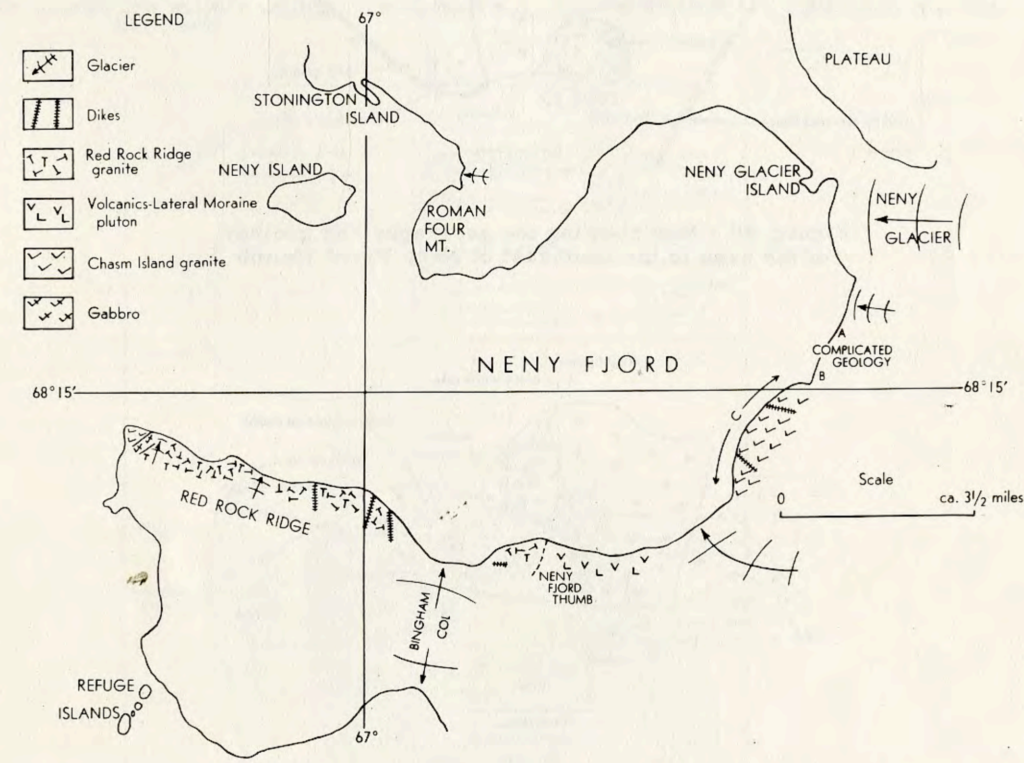

Figure 39 - Geologic map showing the distribution of the rocks on the south side of Neny Fjord

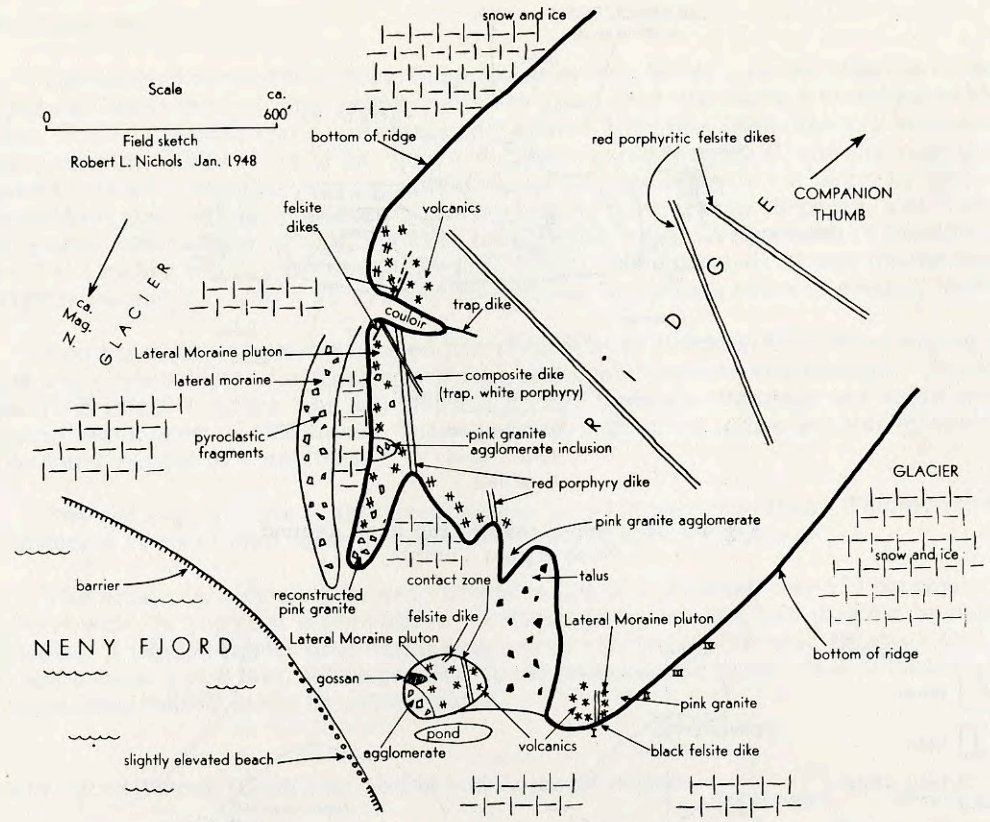

Figure 40 - Map showing the geography and geology of the area to the southeast of Neny Fjord Thumb

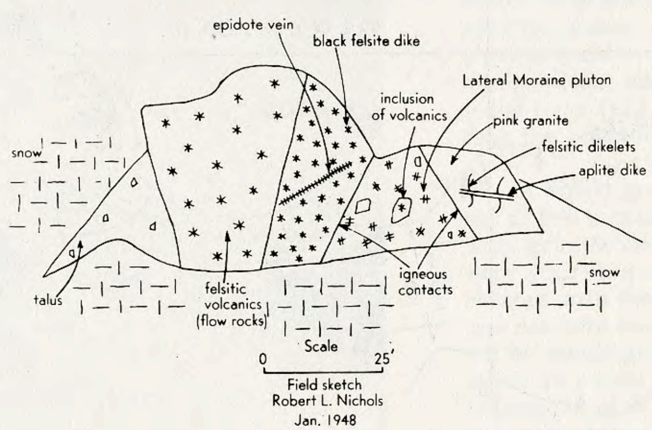

Figure 41 - Field sketch showing the volcanics, a closely related felsite dike, the lateral moraine pluton, and the pink granite which are found at the area labeled I on Fig. 40

felsitic volcanics (Fig. 42). The following varieties were noted: (1) brown, black, and gray flow-banded felsite in which the bands may be straight, wavy, or contorted, some of them are vertical and excellently developed, the coarse bands are as much as 2 inches wide and the fine ones are as little as 1/64 inch wide, (2) black unbanded porphyritic felsite, (3) black, gray, and white felsite, (4) a breccia with gray felsitic fragments in a whiter matrix. It was not determined whether this is a flow or pyroclastic breccia. The writer gained the impression, because of the abundance of flow-banding and the scarcity of breccia and agglomerate, that most of the volcanics are flows although no vesicular or amygduloidal rocks were seen. The gray felsite is commonly chalky white on the outside, presumably due to weathering, dendrites are common on the felsite, and some of it is stained with limonite. Small black felsite dikes 1 to 2 inches wide and probably closely related to the volcanics cut the flow-banded felsite, and a black dike hundreds of feet long which may be felsite was seen cutting the volcanics on the northwest face of Nany Fjord Thumb. These volcanics are surely many hundreds of feet and perhaps more than 2000 feet thick. Black volcanics are found in the upper part of Nany Fjord Thumb and gray volcanics in the lower part. The contact has a dip of about 10 degrees when seen from a point at which Neny Fjord Thumb has a bearing of N105°E magnetic. Black volcanics are also found in the upper part of the Needle and gray volcanics in the lower part. The slope of the contact viewed from the west is about 13 degrees. These observations suggest that the volcanics have a gentle dip.

A small outcrop of agglomerate is located near the lateral moraine shown on Fig. 40. It contains many granite blocks as much as 4 feet long. The granite is pink, does not contain vugs, is very coarse-grained, and appears to be similar to that found at Chasm Island (Figs. 43, 44). The blocks are mainly angular and subangular, although some are subround.

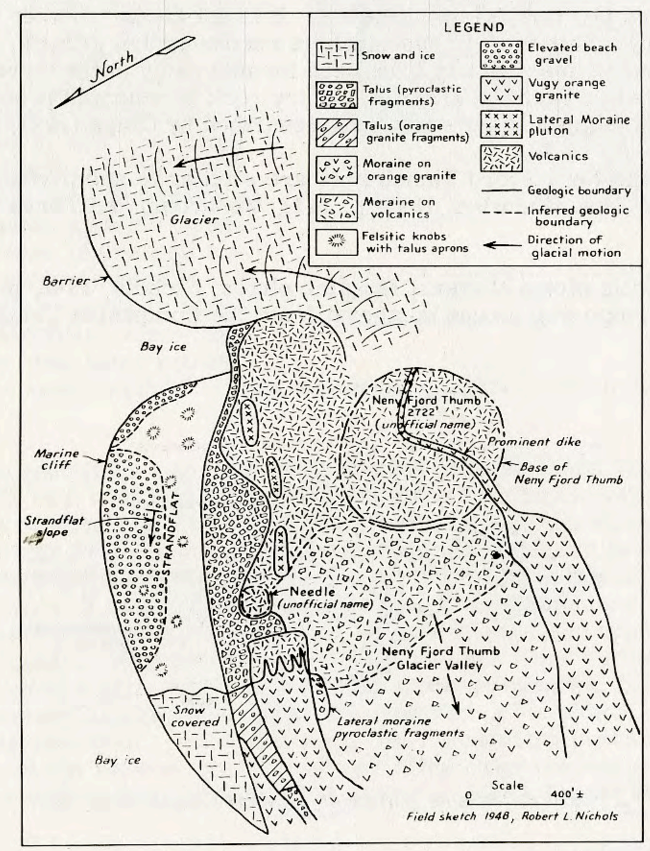

Figure 42 - Geologic map showing the distribution of the volcanics, lateral moraine pluton, and vugy orange granite in area around Neny Fjord Thumb

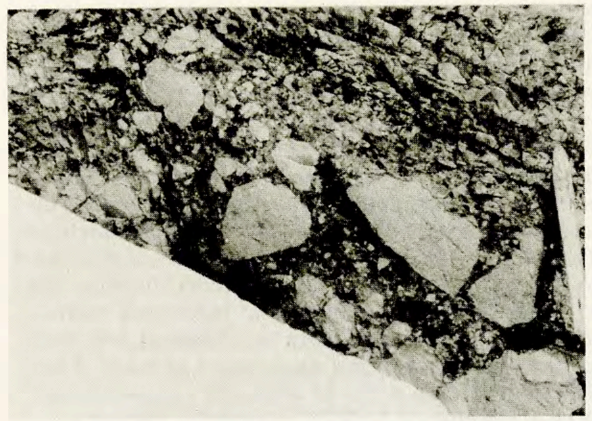

Figure 43 - An agglomerate located near lateral moraine containing large fragments of a coarse-grained pink granite

The matrix is gray or black and, therefore, similar in color to the main mass of the volcanics. A felsite dike about 30 feet long cuts the agglomerate. A similar outcrop is located about 500 feet away (Fig. 40).

The lateral moraine is composed mainly of pyroclastic material and this indicates that the Companion Thumb (unofficial name) and the ridge which runs northeast from it contain considerable pyroclastics (Fig. 38). A fragment composed of reworked tuff was found on the moraine. The moraine contains a channel filled with slightly coarser material than the fine-grained material in which it was cut.

A rock which looks pink at a distance and proves on close inspection to be fragmental is located close to the lateral moraine and the pink granite agglomerate (Figs. 40, 44, 45). The fragments are mainly pink granite or the minerals of which it is composed. The matrix is gray and probably contains ground-up pink granite together with gray felsitic material. The pink color of the outcrop proves, however, that a high percentage of it was derived from the pink granite. The rock is cut by epidote veins and by black felsitic dikelets. It is not known whether the dikelets are igneous or sedimentary. This rock is essentially a reconstructed granite. It is perhaps near the base of the volcanic series and may have been formed early in the volcanic history when vents were being drilled through the granitic country rock by volcanic processes. A somewhat similar rock at Saugus, Massachusetts has been described by Clapp (1921, p. 64-65).

The volcanics in the Neny Fjord Thumb area are similar to and probably correlate with those at the Batterbee Mts. (Knowles, 1945, p. 141), Mushroom and Terra Firma Islands, and Black Thumb Mt.

A porphyritic felsitic pluton (Lateral Moraine pluton, Nichols, 1948, p. 2) is found at Neny Fjord Thumb and the ridge which runs northeast from the Companion Thumb (Figs. 38, 39, 40,

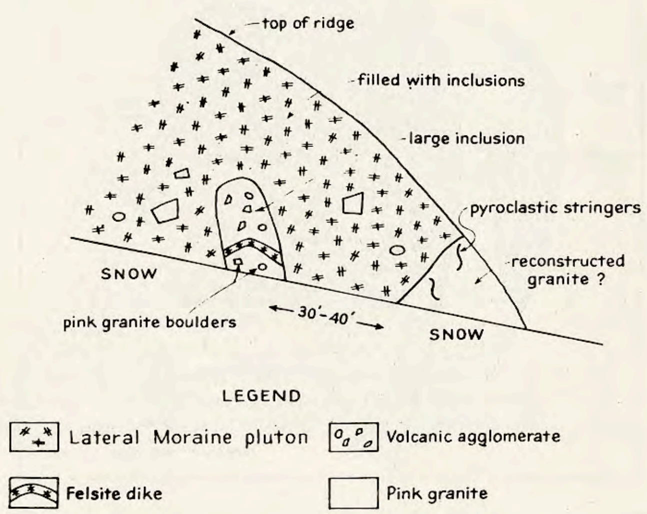

Figure 44 - An outcrop containing a large inclusion or screen of volcanics in the lateral moraine pluton

41, 42, 44). In places it is filled with inclusions, some of which are more than 30 feet long. The pink granite agglomerate near the lateral moraine is either a large inclusion or a screen in the pluton (Figs. 44, 46). Inclusions of volcanics, diorite, and other material are present. Segregations containing dark, needle-like crystals up to 1 inch in length are in places common. The material which immediately surrounds these segregations is pink instead of the normal gray.

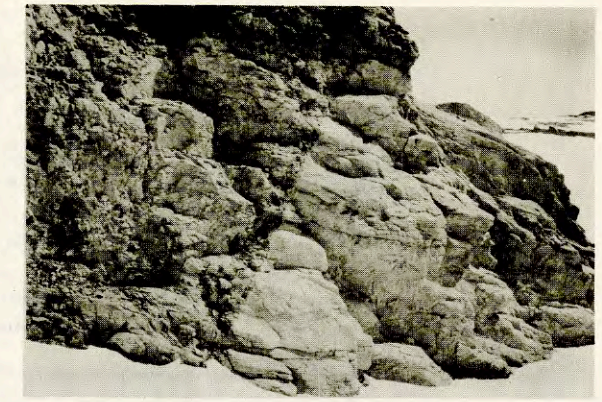

Figure 45 - The lateral moraine pluton on left has invaded the reconstructed granite on right

The Lateral Moraine pluton is younger than the volcanics as inclusions of the volcanics are found in it and dikes of the pluton cut the volcanics. The best place to see the Lateral Moraine pluton cutting the volcanics is about 200 yards east of the Needle and somewhat below its base. Here a felsite porphyry dike with gradational contacts cuts across the flow-banded volcanics (Fig. 47). The center of the dike is a felsite porphyry in which phenocrysts are very abundant. Nearer the margin it is a porphyritic felsite as the phenocrysts are smaller in number and size. The phenocrysts are rare at and near the margin, and the rock is mainly pink felsite. The pink felsite commonly contains black bands which look much like the black volcanics. This similarity of the black bands in the pink felsite near the margin of the dike to the volcanics probably means that the Lateral Moraine pluton and the volcanics are similar petrographically and chemically and closely related in time. The pluton was not identified elsewhere and it seems unlikely that large masses of it are present in the areas studied. Dikes on Stonington Island and elsewhere may, however, correlate with it.

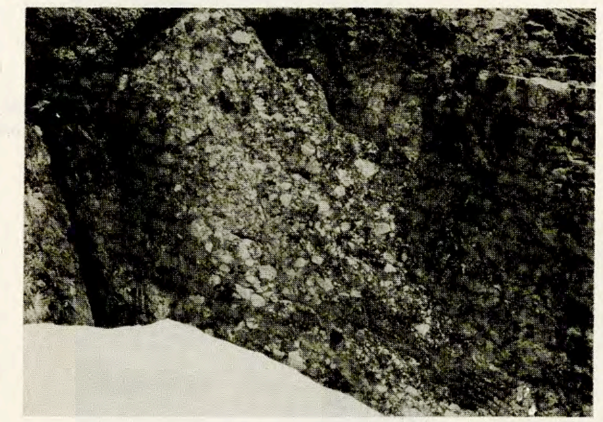

Figure 46 - Large inclusion or screen of pink granite agglomerate about 30 feet wide in lateral moraine pluton near lateral moraine

An orange granite containing vugs is found just west of Neny Fjord Thumb (Fig. 42). It is cut by quartz veins 1/2 inch wide and many feet long which may be closely related to it. Near the base of the Needle hundreds of dikelets of this granite intrude the volcanics. The most prominent and spectacular example of the granite cutting the volcanics is seen on Neny Fjord Thumb. Here a granite dike cutting the volcanics and perhaps 30 feet wide runs 2000 feet across the northwest face. It also cuts completely through the Thumb and is exposed for the total height of the Thumb on the southeastern face (Figs. 42, 48). The orange vugy granite is also younger than the Lateral Moraine pluton. A fragment was found on the talus slope below the Needle which contained a dike of this granite cutting the porphyritic facies of the Lateral Moraine pluton. Moreover, although inclusions are common in the pluton, no inclusions of the vugy granite were ever seen in it. Numerous large red dikes which probably correlate with the vugy granite also cut the Lateral Moraine pluton on the ridge northeast of the Companion Thumb (Fig. 40). This vugy granite correlates with that at Black Thumb Mt. and Red Rock Ridge.

Felsite dikes cutting the volcanics but probably closely related to them have been described above. Additional examples are found at the localities marked I and III on Fig. 40. The gray, flow-banded felsite dike at locality III cuts the volcanics and is in turn cut by the Lateral Moraine pluton.

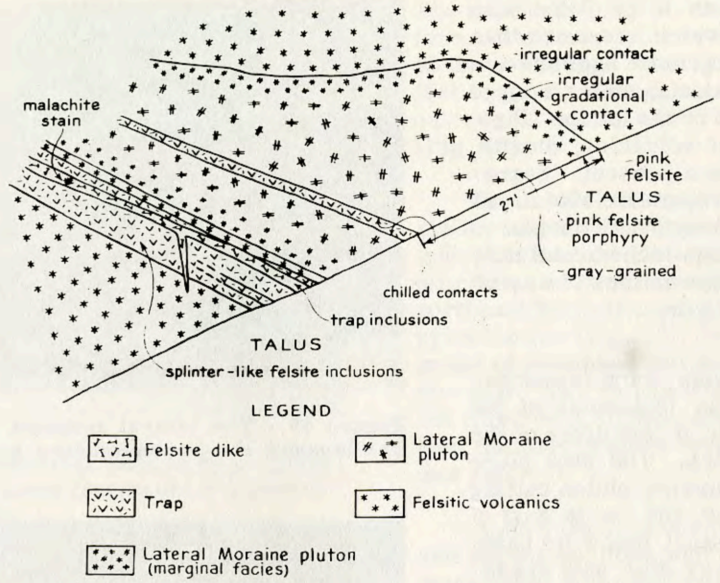

Figure 47 - Irregular gradational contact of the lateral moraine pluton where it intrudes the felsitic volcanics near the Needle

Figure 48 - Neny Fjord Thumb composed of black volcanics cut by prominent red granite dike tens of feet wide and hundreds of feet long. Dike extending from bottom to top of mountain shows in photograph.

The largest and most prominent dikes in the area, with the exception of the dike which cuts across Neny Fjord Thumb, are the red dikes which are located on the ridge extending northeastward from the Companion Thumb (Fig. 40). They are 25 and more feet wide and they extend for hundreds of yards. They are composed of felsite, felsite porphyry, and perhaps granite. They probably correlate with the orange vugy granite. This is suggested because they cut the Lateral Moraine pluton and are geographically close and petrographically similar to the orange vugy granite.

Three felsite dikes with excellent flow-banding are found at the locality marked IV on Fig. 40 and at two other places in the nearby cliff. These dikes vary from 1 to 3 feet in width. The bands are gray and black, parallel to the contacts, and in general more or less straight. An excellent platy cleavage parallel to the banding is present. One of these dikes has been intruded along the middle of one of the large red dikes. An imperfectly banded felsite dike which may be related to these is located near the lateral moraine.

Trap dikes cut the volcanics (Fig. 47), the Lateral Moraine pluton (Fig. 47), and the orange vugy granite. A greenish trap dike between 3 and 4 feet wide cuts the orange vugy granite just west of the Needle. The fact that the trap dikes weather differently suggests that they vary in composition and age.

Near Bingham Col at the west end of the southern ridge which runs westward from Neny Fjord Thumb (Fig. 38), a trap dike about 15 feet wide intruded by a felsite porphyry containing

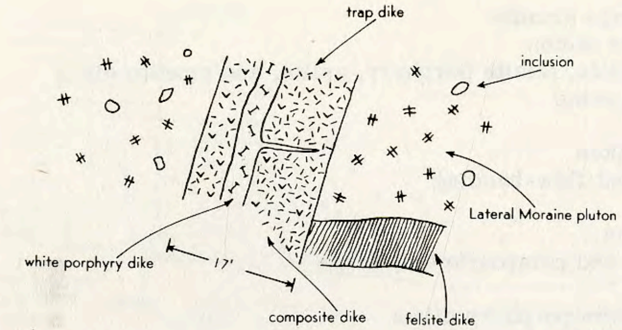

Figure 49 - A composite dike of trap and felsite porphyry cutting lateral moraine pluton and felsite dike near upper end of lateral moraine

quartz cuts the orange vugy granite. Four other composite dikes composed of trap intruded by a white felsite porphyry were seen (Figs. 47, 49, 50, 51). Three of these dikes are found a short distance east of the Needle and below its base, and another is found near the lateral moraine (Figs. 49, 50). Inclusions of trap are found in the felsite porphyry and apophyses of felsite porphyry cut the trap. These composite dikes cut the volcanics (Figs. 47, 51), the Lateral Moraine pluton (Figs. 49, 50), and the orange vugy granite. As far as is known, the felsite porphyry found in these composite dikes is the youngest rock in the area.

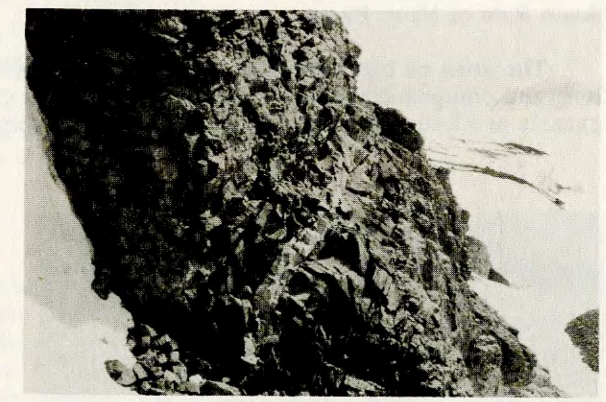

Figure 50 - Photograph of composite dike shown in Fig. 49

The volcanics are cut by epidote and quartz veins. They are also stained with limonite which has resulted from the weathering of pyrite. The Lateral Moraine pluton is in places similarly stained (Fig. 40). The trap dikes are cut by calcite veins. Small areas on three of the white porphyry dikes which cut trap dikes are stained with malachite (Figs. 47, 51).

A tentative outline of the geologic history of the area follows.

(1) Pink granite

(2) Felsitic volcanics
- Reconstructed pink granite facies
- Tuffs, breccias, agglomerates
- Reworked tuff
- Flows, dikes (igneous, sedimentary ?)

(3) Lateral Moraine pluton
- Pink felsite
- Pink porphyritic felsite
- Felsite porphyry

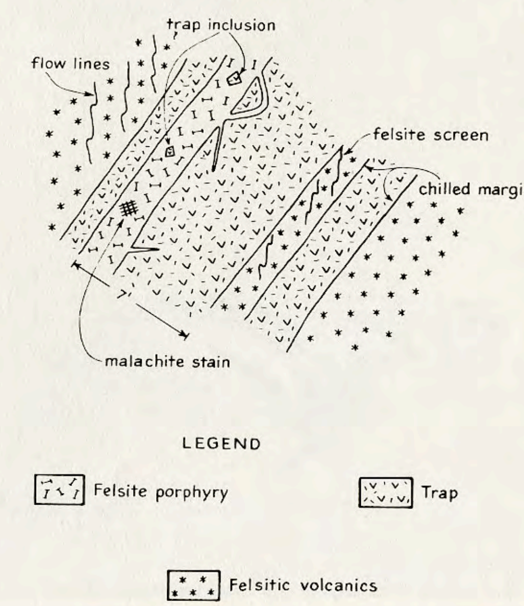

Figure 51 - Composite dike near the Needle. Volcanics cut by trap, which in turn is cut by felsite porphyry.

(4) Vugy orange granite
Massive pluton
Red felsite, felsite porphyry, aplite, and granite dikes
Quartz veins

(5) Felsite dikes
Excellent flow-banding

(6) Trap dikes
Simple and composite trap dikes

(7) White felsite porphyry dikes

There is probably more than one kind of trap dike. Other rock units are present which, however, were not integrated into this geologic history.

South Side of Neny Fjord

The area on the south side of Neny Fjord which is marked C in Fig. 39 is about 2 miles long and composed mainly of pink granite. This granite is a little finer-grained than the pink granite at Chasm Island, with which it presumably correlates. It is homogeneous and contains black inclusions which are, however, not abundant. Small areas are stained with limonite and bleached white. Cubes of pyrite are present immediately below the surface of the rock in these areas. Pegmatite, pink aplite, brown aplite-felsite, aplite porphyry, trap, and porphyritic trap dikes and epidote veins cut the pink granite. Chlorite, quartz, and epidote are found in the pegmatite dikes.

Figure 52 - Neny Glacier Island, Neny Glacier, and rocks on south side of Neny Fjord just southwest of glacier

The geology at the locality labeled B in Figs. 39 and 52 is complicated. Sufficient time to work out all of the relations was not available. Gabbro, diorite, the Lateral Moraine pluton, and pink porphyry and granite, together with trap, brown, orange, red, and pink dikes of various ages are present (Fig. 53). Additional study should prove rewarding.

The bedrock and moraine on the south side of Neny Fjord at the locality marked A in Figs. 39 and 52 were briefly studied. The country rock is a complex of many kinds of gabbros. Gray rocks which may be diorite are also present. The gabbros are in places slickensided, stained with malachite and limonite, and cut by epidote veins. Many conspicuous pink granite dikes and a reddish pegmatite dike cut the gabbros. The pink granite dikes contain vugs with quartz crystals and inclusions of gabbro. They may correlate with the vugy granite at the western tip of Red Rock Ridge. The reddish pegmatite dike cuts the granite dikes.

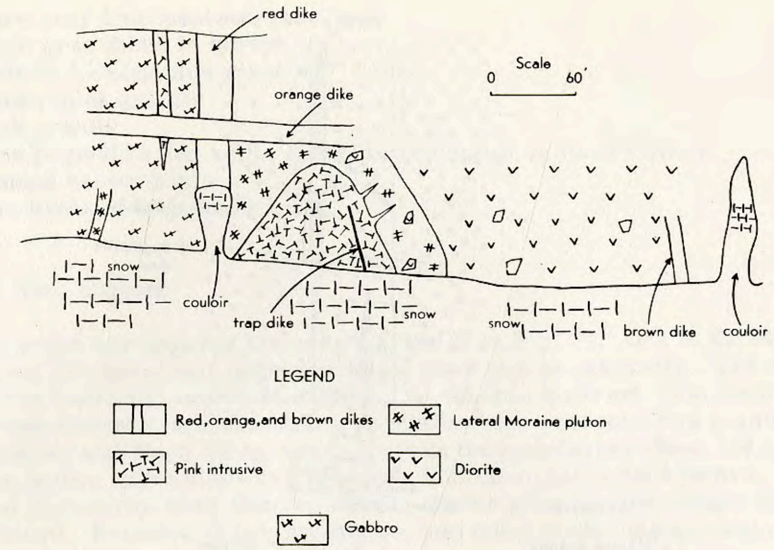

Figure 53 - Field sketch showing geology at locality labeled B on Figs. 39 and 52

Neny Glacier Island (Unofficial Name)

Neny Glacier Island (unofficial name), which is attached to Neny Glacier, is located at the northeast end of Neny Fjord (Figs. 2, 39, 52). Gabbro and pink granite are the two most abundant rocks on the island. Gabbro is the country rock at the west end of the island (Fig. 54). There are several varieties of gabbros, as they vary in grain size as well as in mineral composition. The gabbros have been epidotized and a thin film of malachite is in places found on them.

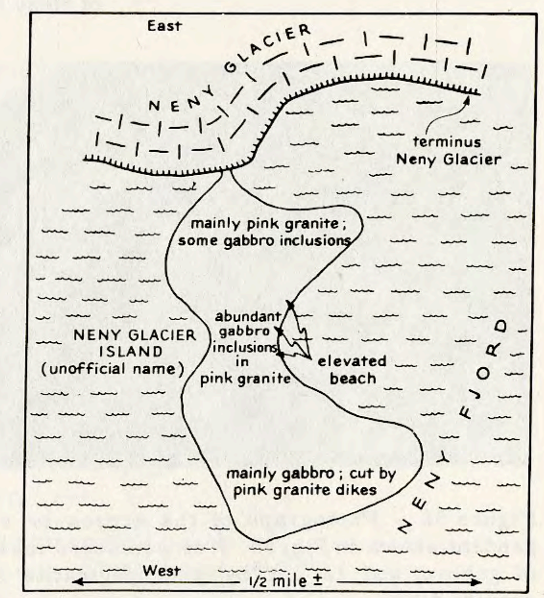

Figure 54 - Rough field sketch of Neny Glacier Island showing distribution of gabbro and pink granite

Pink granite is the country rock at the east end of the island (Fig. 54). The pink granite is younger than the gabbro, as inclusions of gabbro are found in the granite and pink granite dikes cut the gabbro. Three varieties of pink granite were noted. A watery-looking pink granite in which the mineral grains do not stand out sharply is the oldest. This has been cut by dikes of what the writer has called in his field notes aplitic granite and this, in turn, has been cut by a coarser pink granite in which the mineral grains can be more easily seen than in the watery pink granite. Pegmatite, pink aplite, and brown aplite or felsite dikes cut the pink granite, and it seems likely that they are closely related to it. Banded brown felsite and two kinds of trap dikes also cut the pink granite.

A plutonic breccia is found in the middle part of the island, which has gabbro inclusions and a pink granite matrix (Fig. 54). The inclusions make up about 50 percent of the rock. The gabbro correlates with that at Red Rock Ridge and elsewhere, and the granite, although not as coarse as that at Chasm Island, probably correlates with it.

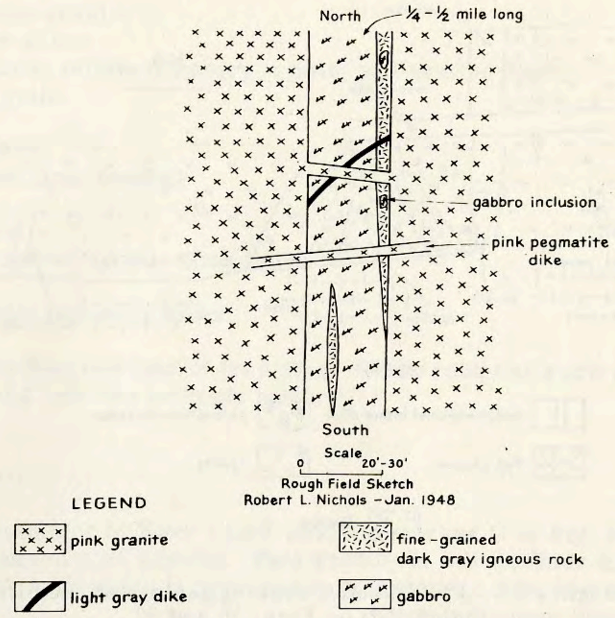

Figure 55 - A screen or roof pendant at east end of Neny Glacier Island

Figure 56 - Photograph of the screen or roof pendant shown in Fig. 55. It is composed mainly of gabbro and is cut by pink pegmatite and granite dikes.

The most interesting geologic structures found on Neny Glacier Island are two dike-like bodies which are more or less parallel located at the eastern end of the island. They are surrounded by the pink granite. One of them strikes N27°E magnetic and is between 20 and 30 feet wide and from 1/4 to 1/2 mile long. The most abundant rock in it is gabbro which is similar to the gabbroic country rock of the island (Fig. 55). The gabbro is cut by a fine-grained, dark gray igneous rock which occurs as small dikes within the gabbro and also as a dike at the margin of the dike-like body next to the pink granite country rock. The dark gray igneous rock contains several kinds of inclusions, including gabbro. Light gray dikes which are found wholly within the dike-like body cut the gabbro as well as the dark gray igneous rock. Near its southern end, the gabbro, the dark gray igneous rock, and the light gray dikes which make up the dike-like body are cut by hundreds of pink granite and pegmatite dikes. Here a considerable part of the dike-like body is a plutonic or shatter breccia with gabbro inclusions in a pink granite matrix (Fig. 56).

There are no inclusions of the pink granite in the gabbro, no dikelets of the gabbro were seen cutting the pink granite, and the gabbro does not have a chilled contact. It is, therefore, not a dike but a screen or roof pendant of gabbro lying wholly within the pink granite.

The bedrock geologic history of Neny Glacier Island follows.

(1) Origin of gabbros
(2) Epidotization

(3) Dark gray igneous rock in screen
(4) Light gray dikes in screen
(5) Watery-looking pink granite
(6) Aplitic pink granite
(7) Pink granite
(8) Pink pegmatite and aplite dikes; brown aplite or felsite dikes
(9) Banded brown felsite
(10) Two kinds of trap dikes

Outcrop Next to Neny Glacier

Two pink granites are found in the area marked D in Fig. 57. One is darker and more watery-looking and the individual minerals do not stand out as distinctly. The other is pinker and lighter and the individual minerals stand out in sharper contrast. Unidentified dark inclusions are in places common, and blackish segregations are present. Red granite-pegmatite, red and brown aplite, and black dikes, and numerous dark stringers about 1/4 inch wide cut the granite. The brown aplite dikes are in places faulted as much as 9 inches. Similar granites are found on the nearby Neny Glacier Island. These granites are thought to correlate with that at Chasm Island. Erratics of schist, diorite, and other rocks are present. A tentative outline of the geologic history of the area follows.

(1) Inclusions in pink granite
(2) Pink granite and segregations
(3) Red granite-pegmatite dike
(4) Red aplite dikes
(5) Brown aplite dikes
(6) Black dikes

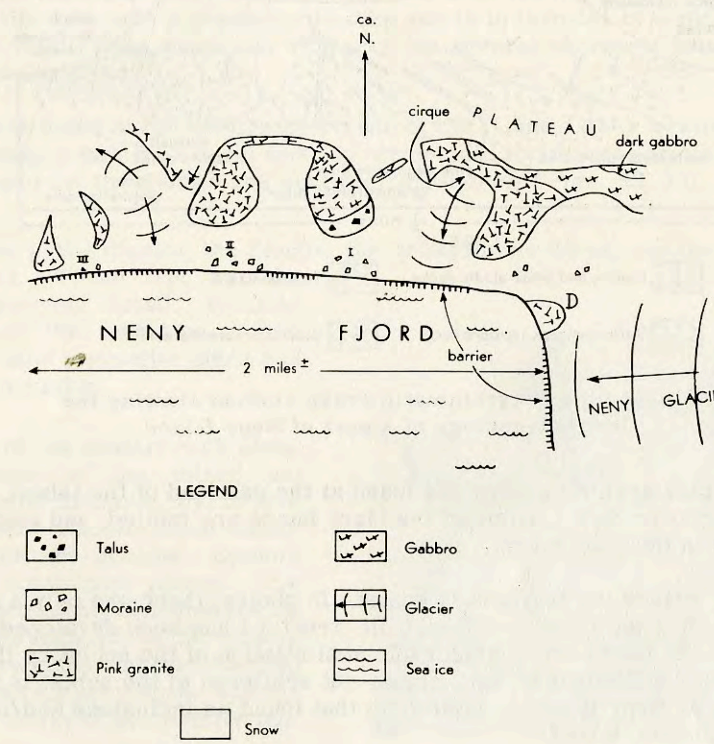

Figure 57 - Field sketch showing distribution of gabbro and pink granite at the northeast corner of Neny Fjord

Northeastern Corner of Neny Fjord

The geology at the northeastern corner of Neny Fjord is shown in Fig. 57. As none of the outcrops was easily accessible, the geology was worked out from a study of the morainal material at the localities labeled I, II, and III in Fig. 57 and by a study of the color of the outcrops as seen from the bay ice. Several kinds of gabbro and pink granite are present. Most of the granite is similar to that at Chasm Island, although some vugy granite similar to that at Red Rock Ridge is also present. The granites have invaded the gabbros. Plutonic breccia with gabbro inclusions surrounded by pink rims up to 1 inch in width in a pink granite matrix is locally very common. Two black dikes cut the pink granite in the cliffs above the moraine in the areas labeled II and III in Fig. 57.

Neny Island

Neny Island is on the north side of Neny Fjord at about 68°15'S, 67°W (Fig. 2). It is between 1 and 2 miles long and over 1000 feet high. During the summer months considerable areas of accessible bedrock are exposed on the north side of the island. Schist, gneiss, gabbro, and diorite are the most abundant rock types and they are cut by many kinds of dikes. The geology in places is very complicated and only the relations of the major rock units were definitely established.

There are several areas of contorted hornblende schist at and near the small tied island on the north side (Fig. 58). This schist probably correlates with that at Black Thumb Mt. and Breccia and Skua Gull Islands.

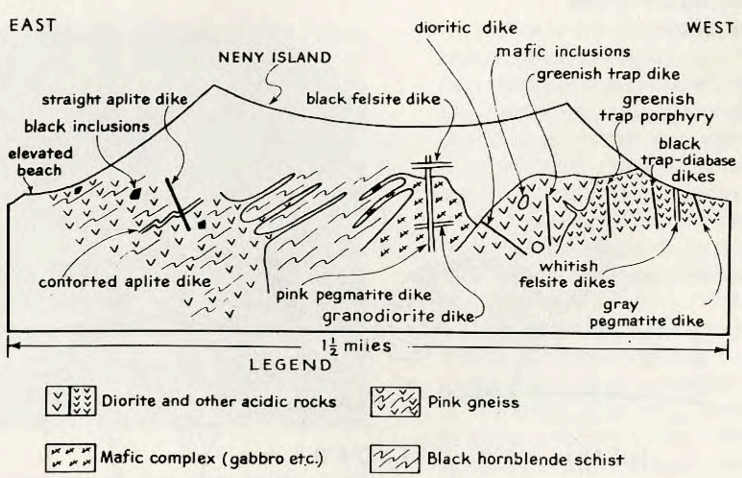

Figure 58 - Diagrammatic cross section showing the bedrock geology of a part of Neny Island

Large areas of pink granitic gneiss are found at the east end of the island. It is composed of pink and black contorted bands, some of the black bands are faulted, and angular black inclusions are found in the pink bands.

The gneiss has invaded the hornblende schist. In places, there are only a few dikes of the gneiss in the schist; in other places, a lit-par-lit structure has been developed; in still other places, there appears to have been considerable assimilation of the schist by the gneiss. Every gradation from angular inclusions to long-drawn-out schlieren of the schist is found in the gneiss. This gneiss on Neny Island is similar to that found as inclusions and/or roof pendants in the diorite on Stonington Island.

The gneiss is cut by wavy contorted aplite dikes (Fig. 58) which are probably closely related to it. The aplite contains little femag material, although it is not uncommon in the gneiss.

It is not known whether the wavy aplite came in after or before the foliation in the gneiss was developed. This wavy aplite, as well as the gneiss, is cut by straight aplite dikes similar to those which are found on Stonington Island and in many other places.

Gabbros and closely related mafic rocks are found on the north side of Neny Island. In places, they are in contact with the schist. At and near the contact, the percentage of dark minerals in the gabbro greatly increases. This strongly suggests that the gabbro chilled against the schist and is therefore younger than it. The fact that the gabbros are not metamorphosed suggests that they are also younger than the gneiss. These mafic rocks undoubtedly correlate with similar rocks which are found at Black Thumb Mt., Red Rock Ridge, Neny Glacier Island, and elsewhere.

Various kinds of diorite are found on the west and northwest sides of the island (Fig. 58). It is in places foliated, filled with inclusions, and some of it contains garnets. Equidimensional black angular inclusions up to 1 foot long, aligned schlieren many feet in length, and black elongated aligned roundish inclusions usually a few feet long with width-length ratios of from 1:5 to 1:15 are also present. Where abundant, both the schlieren and the elongated inclusions give the diorite a gneissoid appearance. The diorite is younger than the schist and gabbro, as inclusions of them are found in it. In addition to the diorite, there are also more salic plutonic rocks including pink granite, which intrude the diorite. They were, however, not carefully studied. This diorite undoubtedly correlates with that at Stonington Island, Refuge Island, Terra Firma Islands, and elsewhere.

Many different kinds of dikes cut these rocks. Simple, multiple, composite, and faulted dikes are present. Diorite, granodiorite, pink pegmatite, pink granite, black felsite, felsite porphyry, greenish porphyritic and nonporphyritic trap, and black trap and diabase dikes are found at the west end of the island. Sufficient time to determine the age relations of all of these dikes was not available. A composite dike composed of granodiorite and pink pegmatite cuts the diorite at the west end of the island. The pink pegmatite is younger than the granodiorite. A vertical pink pegmatite dike which cuts the schist and the mafic complex can be traced for hundreds of feet on the cliffs near the small tied island on the north side of Neny Island (Fig. 58). This pegmatite dike cuts a granodiorite dike and is in turn cut by a pink granite dike. A black porphyritic felsite dike which can be traced for several scores of feet cuts both the pink pegmatite and granite dikes.

Trap dikes are found at the northwestern end of the island. They weather brown, vary in width from less than 1 inch to several feet, do not contain inclusions, are diabasic when coarse-grained, and cut the diorite and pink pegmatite dikes (Figs. 59, 60).

The schlieren in the diorite, the diorite, the granodiorite dikes, and the pink pegmatite dikes are faulted. Three feet was the maximum displacement noted. Faulting took place before the intrusion of the granodiorite and pink pegmatite dikes and also after their intrusion.

Great areas of the country rock along the northwest side of the island are intensely stained with limonite. Pyrite was noted. Thin films of malachite found mainly on the mafic rocks are present. Epidote veins are found along fault planes. The country rock is commonly bleached for as much as 1/2 inch on each side of the epidote veins. The epidote veins and the bleached zones usually stand higher than the adjoining rock, due to differential weathering.

A tentative outline of the geologic history of Neny Island follows.

Figure 59 - A trap dike about 4 feet wide cutting the diorite on Neny Island

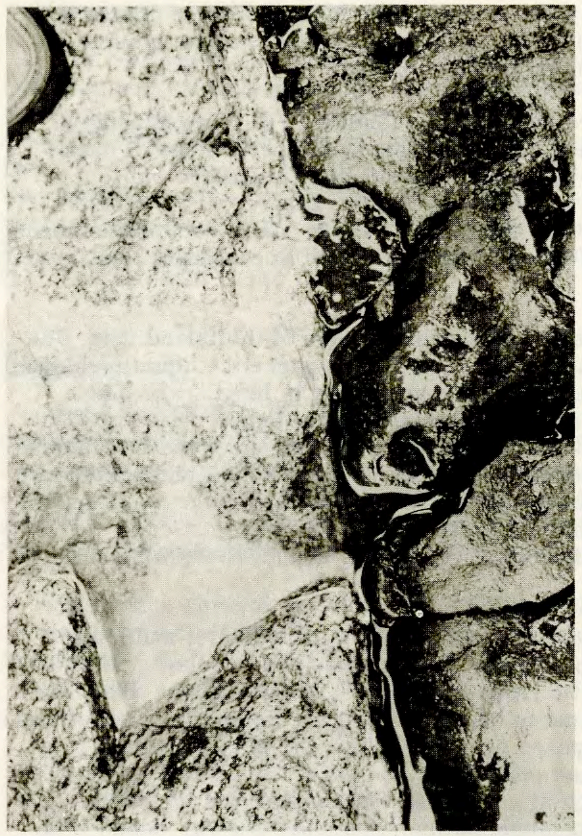

Figure 60 - A trap dike cutting the diorite and a pink pegmatite dike on Neny Island. Light meter gives scale.

(1) Origin of hornblende schists
(2) Intrusion of pink granite
(3) Metamorphism; origin of pink gneiss
(4) Intrusion of mafic complex; mainly gabbro
(5) Diorite
(6) Dioritic dikes
(7) Faulting (few feet displacement)
(8) Granodiorite dikes
(9) Pink pegmatite dikes
(10) Pink granite dikes
(11) Aplite dikes
(12) Faulting (few feet displacement)
(13) Black felsite dikes
(14) Trap and diabase dikes

Roman Four Mountain

Roman Four Mountain is on the north side of Neny Fjord, is east of Neny Island, and is about 68°15'S, 67°W (Fig. 2). The age relations of only the major rock units were determined, as only a little more than two days were available for the study of this mountain. Schist, granitic gneiss, gabbro, and diorite, which correlate with those on Neny and Stonington Islands, are present.

Red granite gneiss is the country rock at the northern end of the mountain and at the head of Roman Four Glacier (Fig. 61). The gneiss varies greatly (Figs. 62, 63, 64). A wavy and contorted as well as a more or less straight foliation is present. The gneiss has invaded a hornblende schist, as inclusions and layers of it are present in the gneiss. The gneiss is usually pink or red, although it may be gray or black where presumably considerable quantities of the schist have been assimilated. Quartz veins, 3 to 4 inches wide, several feet long, and probably closely related in time, cut it. Excellent specimens of the gneiss can be collected on the lateral moraine at the foot of Roman Four Mountain (Fig. 61).

The prominent, elongated, black, dike-like, hornblende schist inclusions or screens which are found in the gneiss are perhaps its most interesting feature. They are common, up to hundreds of feet long, wedge out at the ends, and close inspection shows that the granite gneiss as well as nonfoliated pegmatite dikes cuts them (Figs. 65, 66). At a distance, as might be expected, it is easy to confuse them with trap dikes. This gneiss probably correlates with that at Black Thumb Mt., Neny Island, Stonington Island, and perhaps with that in the mountains above Moraine Point.

Gabbro is found in much of the area on both sides of the Argentina Beacon near the southwest corner of the mountain, massive gabbro is located above the talus immediately east of the beacon, and gabbro dikes cut the gneiss near the head of Roman Four Glacier (Fig. 61). The gabbro varies in texture from place to place and it probably correlates with that found at Neny Island, Red Rock Ridge, Black Thumb Mt., Neny Glacier Island, and elsewhere.

Diorite which varies greatly is located near the Argentina Beacon. Some of it is foliated, contains elongated inclusions similar to those found on Neny Island, and is filled with inclusions of schist, granitic gneiss, and gabbro. This diorite correlates with that at Stonington Island, Refuge Islands, Neny Island, and elsewhere.

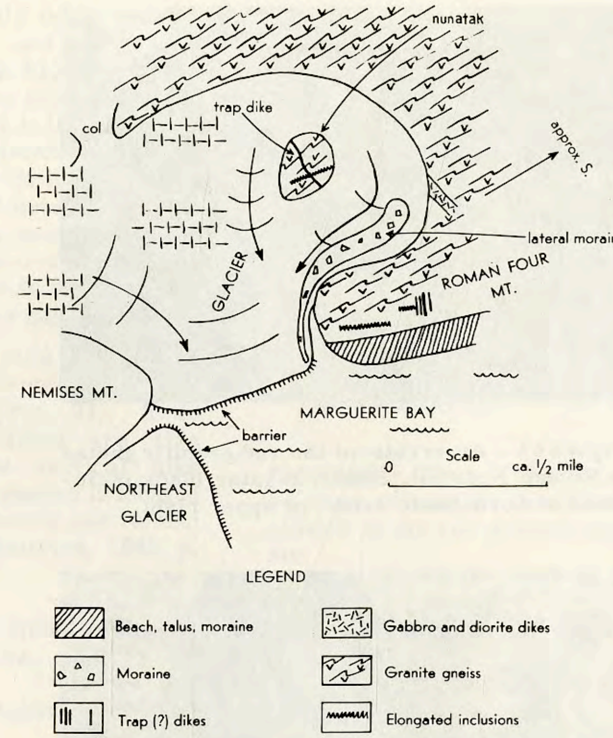

Figure 61 - A geologic map of the northern end of Roman Four Mt.

Figure 62 - One of the varieties of gneiss found at Roman Four Mt.

Figure 63 - An erratic of the red granitic gneiss at Roman Four Mt. Small, angular black inclusions of hornblende schist in upper right.

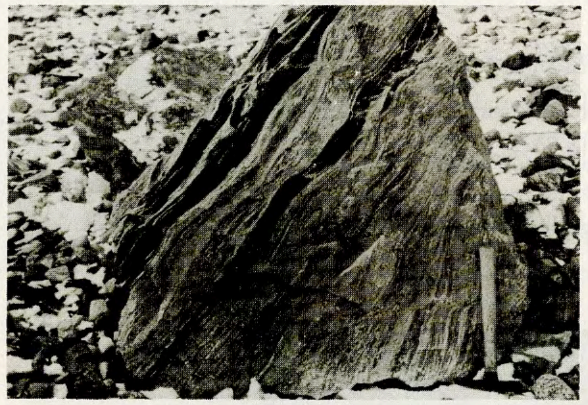

Figure 64 - Dark bands of hornblende schist in the red granitic gneiss at Roman Four Mt.

Figure 65 - A black tabular dike-like inclusion of hornblende schist in the red granitic gneiss at Roman Four Mt.

Granite and pegmatite dikes cut the gabbro near the beacon and the granite gneiss at the nunatak (Fig. 61). Pegmatite dikes also cut the granite gneiss and the dike-like inclusions found in it. An examination of the talus immediately east of the beacon suggests that the light-colored rock which is sandwiched between tabular masses of gabbro high up on the mountain side and which is conspicuous from Neny Fjord and Red Rock Ridge is white granite which presumably cuts the gabbro.

A small trap dike cuts the granite near the beacon and another cuts the granite gneiss at the nunatak (Fig. 61). Trap porphyry and diabase dikes are also present. A conspicuous vertical dike swarm cutting the granite gneiss is located between the Argentina Beacon and Roman Four Glacier (Fig. 61) (Knowles, 1945, p. 138).

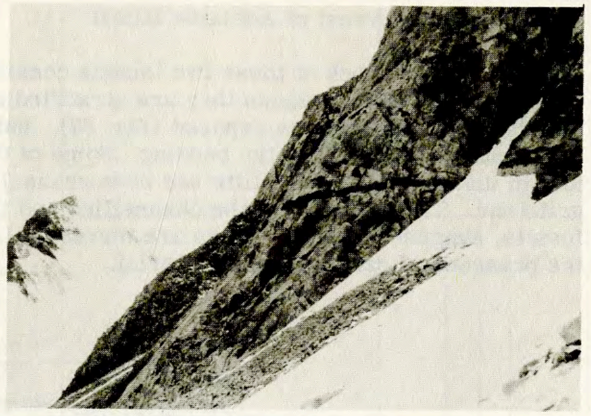

Figure 66 - Dikes of the red granitic gneiss can be seen cutting the black tabular dike-like inclusion in the red granitic gneiss at Roman Four Mt.

The diorite is cut by epidote veins, a film of malachite was found on the gabbro, and quartz veins cut the granite gneiss.

An outline of the geologic history of Roman Four Mountain follows.

(1) Schist
(2) Granite gneiss
(3) Quartz veins (?)
(4) Gabbro
(5) Diorite
(6) Granite and pegmatite
(7) Trap, trap porphyry, and diabase

Gabbro Islands (Unofficial Name)

A group of 6 or more small low-lying islands called in this report the Gabbro Islands (unofficial name) are located approximately 50 miles west of Stonington Island. They are composed of a variety of igneous rocks. The country rock is gabbro and diorite. It is cut by granodiorite, pink granite, pink aplite, and trap dikes, and also by quartz and epidote veins. Several varieties of gabbro and diorite are present. The gabbro appears to be similar to that found on Red Rock Ridge and elsewhere, and it contains basic stringers. The diorite appears to be similar to that found on Stonington Island and elsewhere, and it contains inclusions of gabbro and coarse acidic segregations. The granodiorite dikes are cut by pink granite dikes. The rock marginal to the epidote veins is commonly bleached.

The most probable bedrock geologic history of these islands, based on a study of them and other areas, follows.

(1) Inclusions in the gabbro
(2) Intrusion of the gabbro (several facies)
(3) Intrusion of diorite (several facies)
(4) Granodiorite dikes
(5) Pink granite dikes
(6) Pink aplite dikes
(7) Felsite porphyry dikes
(8) Trap dikes

Two Islands Southwest of Adelaide Island

The country rock of these two islands consists of black argillite, gritstone, and conglomerate. On one of the islands they are stratified and essentially flat, and about 100 feet of stratigraphic thickness is exposed (Fig. 67). Indistinct plant fossils are abundant. They have been flattened parallel to the bedding. Some of the conglomerates contain roundstones up to 1 foot in diameter. The argillite has been channelled in places and the channels are filled with gritstone. The presence of the channelling and the plant remains, and the absence of marine fossils, suggest that these rocks are terrestrial. The black color is due, in part at least, to the presence of carbonaceous material.

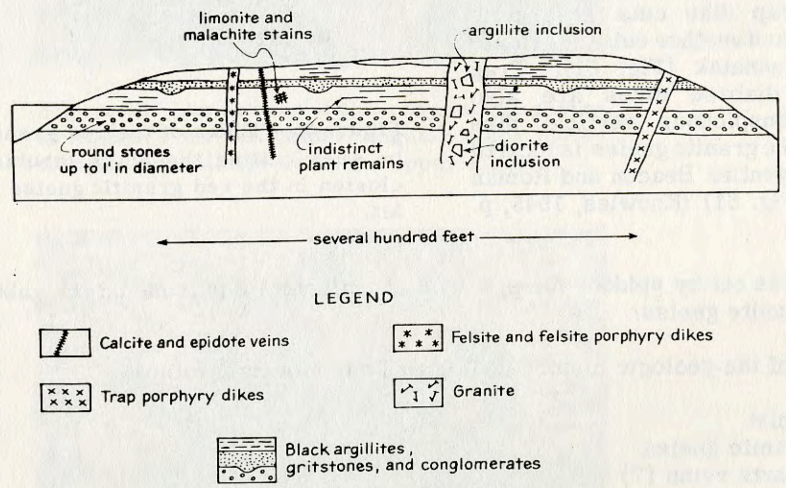

Figure 67 - Diagrammatic cross section showing the geology on two islands about 10 miles southwest of Adelaide Island, Palmer Peninsula

These sedimentary rocks are cut by felsite, felsite porphyry, trap porphyry, and granite dikes. Inclusions of argillite and diorite, containing needle-like crystals, are so common in some of the granite dikes that a plutonic breccia has been formed. Calcite and epidote veins are common. Limonite and malachite stains are present. The malachite has resulted from the oxidation of chalcopyrite.

The bedrock sequence for these islands, based on a regional study, follows.

(1) Deposition of the sedimentary rocks
(2) Origin of diorite (found as inclusions)
(3) Granite dikes
(4) Felsite and felsite porphyry dikes
(5) Calcite and epidote veins; chalcopyrite; trap porphyry dikes

DESCRIPTION OF FORMATIONS

Neny Island Schist

The Neny Island schist is the oldest formation in the area (Nichols, 1948, p. 1). It is found on Neny Island as well as on Stonington Island, Black Thumb Mt., Breccia Island (unofficial name), Skua Gull Island (unofficial name), and Roman Four Mt. (Table 1).

TABLE 1
DISTRIBUTION OF GEOLOGIC FORMATIONS IN THE MARGUERITE BAY AREA

	Stonington Island	Refuge Islands	Mushroom Island	Alexander I Land	Terra Firma Islands	Mainland East of Terra Firma Islands	Moraine Point	Black Thumb Mt.	Mainland South of Black Thumb Mt.	Chasm Island	Breccia Island	Skua Gull Island	Three Pup Island	Western End, Red Rock Ridge	Red Rock Ridge	Neny Fjord Thumb	Neny Glacier Island	Neny Fjord, South Side	Neny Fjord, North Side	Neny Island	Roman Four Mt.	Gabbro Islands	Two Islands Southwest of Adelaide Island
Neny Island Schist	Inclusions							x			x	x								x Type locality	x		
Roman Four Mt. Gneiss	x						x	x			x	x								x	x Type locality		
Jurassic (?) Sedimentary Rocks				x																			x Type locality
Black Thumb Mt. Ultramafic Rock								x Type locality												x			
Neny Glacier Island Gabbro							x	x						x			x Type locality	x	x	x	x	x	
Stonington Island Diorite	x Type locality	x		?	x		x											x		x	x	x	
Granodiorite or Gray Granite	x			?	x		x	x			x	x	x							x		x	
Chasm Island Granite	x	x				x	x			x Type locality	x	x	x	x		x	x	x	x	x	x	x	x
Terra Firma Volcanics			x		x Type locality			x								x							
Lateral Moraine Pluton																x Type locality		x					
Red Rock Ridge Granite								x	?					x Type locality	x	x		x	x				
Trap Porphyry	x			?	x	?		x	x	x	?	x		x	x					x			x
Trap Dikes	x			?	x	x	x	x	x	x		x		x	x	x	x	x	x	x	?	x	
Mineralization	S E L	E L	E P C L Q	L	E M Q L Ch C		E P Ch L Q	E L Ch M Q		E P Q	E Q	E M	E	L C P Q	Q C E	Q	E M			M L		E Q	L P C M E Chalcopyrite

Ch-- chlorite, P-- pyrite, Q-- quartz, C-- calcite, M-- malachite, S-- sulphides, E-- epidote, L-- limonite } in veins, vugs, pegmatites.

It occurs at several places on Neny Island (Fig. 58). Some of it is a fine- to medium-grained hornblende schist, as it contains about 60 percent green pleochroic hornblende, some pyroxene, and two generations of plagioclase, the older of which is altered. A granite gneiss has invaded the schist (Fig. 58). Every gradation from angular inclusions to long-drawn-out schlieren of the schist is found in the gneiss. A lit-par-lit structure has been developed in places, and there appears to have been considerable assimilation of the schist by the gneiss.

Granite gneiss is found as inclusions in the diorite on Stonington Island (Fig. 4). The Neny Island schist is found as inclusions, schlieren, and bands in the granite gneiss.

It also occurs at Black Thumb Mt. Here the schist is invaded by a gabbro (Fig. 25).

Breccia Island is composed mainly of a plutonic breccia (Fig. 32). The matrix is commonly gray granite or granodiorite, and inclusions of black Neny Island schist are the most common. An inclusion of gneiss containing inclusions of Neny Island schist was noted.

The Neny Island schist is also found on the large Skua Gull Island. It has been invaded by a gray granite or granodiorite, and excellent lit-par-lit structure has been developed (Fig. 30). The schist is also found as inclusions in the gray granite or granodiorite.

Prominent, elongated, black, dike-like, Neny Island hornblende schist inclusions or screens are found in a granite gneiss at Roman Four Mt. Some of them are hundreds of feet long, and they are cut by the granite gneiss (Figs. 65, 66).

Fleming reports the presence of phyllites and biotite schists at Beascochea Bay.* He also found schists in the southern part of the Palmer Peninsula (Fleming et al., 1938, p. 509). He writes, "A basement complex of gneisses and schists which, at the Debenham Islands, have the structure of gently dipping folds with their axes oriented north and south. This group is best exposed in the immediate neighborhood of Neny Fjord, but pebbles of these metamorphic types are to be found in many of the beaches and some of the moraines in the northern part of Marguerite Bay."

Gourdon (1908, p. 201-203) and Ferguson (1921, p. 47) also report the presence of schist. Metamorphic rocks varying from slates to gneisses were found by Knowles (1945, p. 134-142, Map 1) on both the east and west coasts of the southern part of the Palmer Peninsula. Fairbridge (1952, Fig. 10) has published a map which shows the distribution of the metamorphic rocks on the Palmer Peninsula.

There is a greywacke, which is probably Ordovician, at the northern end of the Palmer Peninsula. Schist erratics are also found in this area.** The Falkland Islands Dependencies Survey suggests that the Neny Island schist may be Pre-Cambrian. Further support for the Pre-Cambrian age of the schist is also found on Coronation Island, South Orkney Islands. Here mica-schist pebbles are found in a conglomerate which may be Upper-Ordovician (Pirie, 1905, p. 463-466).

Roman Four Mountain Gneiss

The Roman Four Mt. gneiss is found not only at Roman Four Mt. but also at Neny Island, Stonington Island, Black Thumb Mt., Breccia Island (unofficial name), Skua Gull Island (unofficial name), and in the vicinity of Moraine Point (unofficial name) (Nichols, 1948, p. 1) (Table 1).

Granite gneiss is the country rock at the northern end of Roman Four Mt. and also at the head of Roman Four Glacier (Fig. 61). It varies greatly. It is usually pink or red, although it may be gray or black where presumably considerable quantities of the schist have been incorporated in it. A wavy and contorted as well as a straight foliation is present (Figs. 62,

*Personal communication from W. L. S. Fleming.

**Personal communication from Mr. Raymond Adie, Falkland Islands Dependencies Survey.

63, 64). A thin section showed that the foliation is due to biotite and to a slight elongation of the quartz and feldspar. Forty-five percent of the rock is feldspar. The feldspar is mostly unaltered, is probably oligoclase-andesine, beautiful polysynthetic twins are present, and myrmekite is abundant. About 40 percent quartz and about 15 percent pleochroic green-brown to light green biotite make up the rest of the rock. A specimen collected at the head of Roman Four Glacier contained quartz, potash feldspar, and a plagioclase which is probably oligoclase. The feldspar was altered. Pleochroic brown biotite, chlorite resulting from the alteration of the biotite, and some magnetite are also present. Sutured boundaries are conspicuous.

Large areas of pink granite gneiss are found at the east end of Neny Island (Fig. 58). The gneiss contains altered potash feldspar, quartz, and pleochroic brown biotite. Some of the biotite has altered to chlorite and magnetite. Sutured boundaries are common.

Minor amounts of gneiss are found at Stonington Island, Black Thumb Mt., Breccia Island, and Skua Gull Island. Granite gneiss is also found in the mountains in back of Moraine Point.

Fleming et al. (1938, p. 509), Knowles (1845, p. 134-142, Map 1), Tyrrell (1921, p. 74-75), and Ferguson (1921, p. 48) also report the presence of gneiss.

It is not possible to accurately date the Roman Four Mt. gneiss. As indicated above, there is abundant evidence that it is younger than the Neny Island schist, which may be Pre-Cambrian.

The presence of Jurassic limestones, calcareous grits, and shales on Alexander I Land (Fleming et al., 1938, p. 509) and of argillites, gritstones, and conglomerates presumably of Jurassic age on two islands southwest of Adelaide Island (Fig. 67) suggests that the gneiss is Pre-Jurassic.

Jurassic (?) Sedimentary Rocks

Black argillites, gritstones, and conglomerates are found on two small islands about 10 miles southwest of Adelaide Island (Fig. 67). They are essentially flat and about 100 feet of stratigraphic thickness is exposed. Some of the conglomerates contain roundstones up to 1 foot in diameter and indistinct plant fossils are abundant in the argillites. The argillite contains graphite and pyrite and the grain size is in general less than .01 mm. The presence of untwinned oligoclase-andesine containing numerous inclusions suggests that it has been soaked by solutions from an acidic magma.

Jurassic slates, sandstones, and conglomerates containing a rich flora (Andersson, 1906, p. 24-27; Fairbridge, 1952, p. 81-83) are found at Hope Bay at the northern tip of the Palmer Peninsula. Here a giant conglomerate is also found, as some of the roundstones are more than 3 feet in diameter. Jurassic limestones, calcareous grits, and shales are also found on Alexander I Land (Stephenson and Fleming, 1940, p. 159; Fleming et al., 1938, p. 509; Fuchs, 1951, p. 409, 413; Fairbridge, 1952, p. 83, Fig. 10).

A Jurassic age is suggested for the sedimentary rocks on the two islands southwest of Adelaide Island. This is supported by the fact that these rocks are lithologically similar to the Jurassic rocks at Hope Bay and by the fact that they contain fossil plants as do the Jurassic rocks on Alexander I Land and at Hope Bay.

Black Thumb Mountain Ultramafic Rock

Ultramafic rock is found at Black Thumb Mt., Neny Island, and perhaps on the south side of Neny Fjord 1-1/2 miles west of the terminus of Neny Glacier (Nichols, 1948, p. 1) (Table 1).

At Black Thumb Mt. it is very coarse-grained, as some of the grains are as much as 1/2 inch in diameter (Fig. 24). It is composed almost entirely of a pale green pleochroic uralitic actinolitic hornblende. A minor amount of magnetite is also present. At Black Thumb Mt. it appears in places to grade into gabbro; at other places it is older than the gabbro, as inclusions of it are found in the gabbro. The gabbro intrudes the Neny Island schist. Based on the absence of schistosity in the ultramafic rock, on the proximity of the ultramafic rock and the schist, on the relation of the ultramafic rock to the gabbro, and on the intrusive relation of gabbro to schist, it is concluded that the ultramafic rock is also younger than the Neny Island schist.

The ultramafic rock at Neny Island is a feldspathic hornblendite. It is coarse-grained and it contains more than 80 percent pale green actinolitic hornblende, some highly altered plagioclase, and a little biotite. The hornblende has probably replaced pyroxene and, if so, the rock is a uralitized feldspathic pyroxenite. The ultramafic rock is very small in volume and is probably a border phase of the much more abundant gabbro.

Cape Eielsen on the east coast of the Palmer Peninsula was found by Knowles (1945, p. 139-140, Map 1) to be composed of a large, massive outcrop of hornblendite at least 3 miles long and 200 feet in height. This hornblendite probably correlates with the Black Thumb Mt. ultramafic rock (see also Ferguson, 1921, p. 45).

Neny Glacier Island Gabbro

The Neny Glacier Island gabbro (Nichols, 1948, p. 1) is found not only at Neny Glacier Island (unofficial name) but also at Moraine Point (unofficial name), Black Thumb Mt., western end of Red Rock Ridge, south and north sides of Neny Fjord, Neny Island, Roman Four Mt., and Gabbro Islands (unofficial name) (Table 1).

Gabbro is the country rock at the western end of Neny Glacier Island (Figs. 52, 54). There are several varieties of the gabbro, as it varies in grain size as well as in mineral composition. One specimen collected on Neny Glacier Island contains about 40 percent plagioclase. The plagioclase is mostly cloudy with clear rims and kaolinized centers, and its composition is close to that of andesine. The specimen also contains about 55 percent amphibole and less than 5 percent pyrite, magnetite, and deep brown biotite.

Gabbro is also present at Black Thumb Mt. (Fig. 25). It intrudes the schists and ultramafic rock found there.

A very small outcrop of gabbro was found at Moraine Point (Figs. 14, 15). Here the gabbro is older than the diorite and pink granite.

A large tabular mass of gabbro is located near the western end of Red Rock Ridge (Fig. 34). It is cut by granite dikes of two different ages and by trap dikes. Gabbro is found on the south side of Neny Fjord at the localities marked A and B in Figs. 39 and 52, and is also found on the north side of Neny Fjord (Fig. 57). On Neny Island the gabbro cuts the Neny Island schist (Fig. 58) and at Roman Four Mt. it cuts the Roman Four Mt. gneiss (Fig. 61).

In summary it can be said that the gabbro is younger than the metamorphic rocks in the Marguerite Bay area and that it is older than the more acidic plutonic igneous rocks of the area. The field work shows that gabbro is common and widely distributed in the Marguerite Bay area. Moreover, a study of the geologic literature of the Antarctic shows that it is common in other parts of the Palmer Peninsula. Knowles (1945, p. 141), Nordenskjöld (1905, p. 240-241), Andersson (1906, p. 28), Gourdon (1908, p. 158-163; 1917, p. 8-10), Barth and Holmsen (1939, p. 17-20), Holtedahl (1935, p. 26), Fleming et al. (1938, p. 509), Tyrrell (1921, p. 62-65; 1945, p. 69-72), Fairbridge (1952, p. 81), Ferguson (1921, p. 45, 46, 49), and Pelikan (1909, p. 25-27, 31-34, 40-41) have all reported gabbro from other parts of the Palmer Peninsula.

Stonington Island Diorite

The Stonington Island diorite (Nichols, 1948, p. 2) is found on Stonington Island and also at the Refuge Islands, Terra Firma Islands, Moraine Point (unofficial name), south side of Neny Fjord, Neny Island, Roman Four Mt., Gabbro Islands (unofficial name), and perhaps on Alexander I Land (Table 1).

The country rock of Stonington Island is a coarse-grained acidic igneous rock which varies somewhat in both texture and composition. In places it is foliated and is contaminated because of assimilation. It contains inclusions composed of gneiss and other rocks and has been cut successively by diorite, granodiorite, granite, aplite, pegmatite, and trap dikes (Fig. 4).

Knowles found a coarse-grained biotite diorite at the southwestern part of Stonington Island, a biotite gneiss which has about the same mineral composition as a granodiorite at the northwestern part, and an apatite monzonite at the central and eastern part of the island (Knowles, 1945, p. 137-138).

The country rock at the iron rod summit on Stonington Island is a quartz diorite which is crudely foliated. The larger grains have a diameter of approximately 3 mm. The rock contains about 25 percent quartz, 60 percent feldspar, and 15 percent biotite. The feldspar is mainly oligoclase, much of which is zoned and altered.

Fine-grained quartz diorite dikes cut the coarse-grained dioritic country rock. They contain less than 10 percent quartz, about 60 percent feldspar, approximately 20 percent pleochroic green hornblende, around 10 percent brown biotite, and some pyrite and magnetite. The feldspar is largely plagioclase and it is probably andesine. It is twinned, zoned, and lathe-shaped. These dioritic dikes commonly contain many inclusions of a finer-grained, more mafic diorite.

The country rock of the Refuge Islands is a gray, massive, coarse-grained, acidic igneous rock which is probably diorite. It is cut by pegmatite, granite, and other kinds of dikes (Fig. 8).

Diorite is found on the western end of the largest of the Terra Firma Islands and at least eight of the smaller islands are wholly or at least in part composed of it (Fig. 11). It contains basic pegmatitic segregations and it is cut by basic pegmatite dikes.

The country rock at Moraine Point is also diorite (Fig. 16). In places it is foliated and contains inclusions and schlieren. The diorite is younger than a gabbro and it is cut by granite, aplite, pegmatite, and felsite porphyry dikes.

Various kinds of diorite are found on the west and northwest sides of Neny Island. It is in places foliated, and is filled with equidimensional black angular inclusions as well as elongated aligned roundish inclusions. It is younger than the Neny Island schist and the Neny Glacier Island gabbro, and is invaded by more salic plutonic rocks (Fig. 58).

The Stonington Island diorite is, therefore, younger than the Neny Island schist, the Roman Four Mt. gneiss, the Black Thumb Mt. ultramafic rock, and the Neny Glacier Island gabbro, and it is older than other more salic plutonic rocks.

The writer's field work shows, therefore, that the Stonington Island diorite is a common and widely distributed rock in the Marguerite Bay area. Other workers have also shown it to be widely distributed in other parts of the Palmer Peninsula. Knowles (1945, p. 137-142), Andersson (1906, p. 28), Gourdon (1908, p. 149-158), Barth and Holmsen (1939, p. 20-22), Nordenskjöld (1905, p. 240-241), Fleming et al. (1938, p. 509), Tyrrell (1921, p. 60-62; 1945, p. 69, 71, 72), Ferguson (1921, p. 45, 47-50), and Pelikan (1909, p. 5-14, 20-22, 37-39) have all recorded the presence of diorite in other parts of the Palmer Peninsula.

Granodiorite

Granodiorite is found at Stonington Island, Terra Firma Islands, Moraine Point (unofficial name), Black Thumb Mt., Breccia Island (unofficial name), Skua Gull Island (unofficial name), Three Pup Island (unofficial name), Neny Island, Gabbro Islands (unofficial name), and perhaps elsewhere (Table 1).

The country rock at Three Pup Island is a granodiorite. It contains about 20 percent quartz. The quartz in thin section is seen as knots about 6 mm x 3.5 mm. The knots are made up of individual grains of quartz which are about 1.5 mm in diameter. Approximately 15 percent of myrmekitic potash feldspar and about 60 percent of andesine are also present. Albite twins, beautifully zoned phenocrysts, and corroded edges are common. Five percent brown-black to pale yellow-green pleochroic biotite and about 1 percent magnetite make up the rest of the rock.

Granodiorite is found at Moraine Point. It is composed mainly of plagioclase, most of which is altered, and of quartz, biotite, magnetite, and chlorite (Fig. 16).

Granodiorite is also found at the northwestern end of Neny Island. It is medium- to coarse-grained. It contains about 70 percent feldspar which is mainly twinned and zoned plagioclase together with some potash feldspar. Twenty percent of the rock is quartz. Biotite, titanite, magnetite, and chlorite make up the remaining 10 percent (Fig. 58).

A pluton which was called the Penguin Rookery granodiorite was very briefly described by Nichols (1948, p. 2) in a preliminary report which was written in the field. Thin sections of this rock have now been studied. It is a granite and probably correlates with the Chasm Island granite (Nichols, 1948, p. 2).

At Moraine Point, it can be shown that the granodiorite is younger than the Stonington Island diorite (Fig. 16).

Granodiorite is also widely distributed elsewhere on the Palmer Peninsula. Knowles (1945, p. 141), Fleming et al. (1938, p. 509), Tyrrell (1945, p. 71), Ferguson (1921, p. 45, 47), and Fairbridge (1952, p. 81) have all reported its presence.

Chasm Island Granite

The type locality for the Chasm Island granite is a small island which is approximately 1 mile from Black Thumb Mt. It is also found at Stonington Island, Refuge Islands, the mainland east of Terra Firma Islands, Moraine Point (unofficial name), Black Thumb Mt. area, Breccia Island (unofficial name), Skua Gull Island (unofficial name), Three Pup Island (unofficial name), western end of Red Rock Ridge, Neny Fjord Thumb (unofficial name), Neny Glacier Island (unofficial name), north and south sides of Neny Fjord, Neny Island, Roman Four Mt., two islands southwest of Adelaide Island, and perhaps on the Gabbro Islands (unofficial name) (Table 1).

The Chasm Island granite is the country rock at Chasm Island (unofficial name) (Fig. 23). It is an attractive, very coarse pink granite. It contains about 38 percent fractured quartz. Sixty percent of the rock is feldspar, most of which is potash feldspar, although some plagioclase is also present. One percent is a brown pleochroic biotite, some of which has altered to chlorite; and titanite, magnetite, and apatite together make about 1 percent of the rock. The country rock at Chasm Island is cut by fine-grained granite, aplite, pegmatite, trap porphyry, felsite, and trap dikes (Fig. 23).

Chasm Island granite is the country rock at the east end of Neny Glacier Island (Fig. 54). The granite is younger than the Neny Glacier Island gabbro which is also present, as inclusions of gabbro are found in the granite and pink granite dikes cut the gabbro. As noted above, three varieties of the granite are found in the area. This granite also crops out at the extreme western end of Red Rock Ridge. Here it contains potash feldspar, plagioclase, quartz, and about 15 percent pleochroic brown biotite, magnetite, chlorite, and pale green pleochroic actinolitic hornblende. On the north side of the western tip of Red Rock Ridge, a larger irregular body of fine-grained Chasm Island granite has intruded a coarser facies (Fig. 34). Chasm Island granite country rock is also found on the mainland east of the Terra Firma Islands, on the mainland on the south side of Black Thumb Mt., on the mountains on the southeast side of Bingham Col, near Neny Fjord Thumb (Fig. 41), and on the north and south sides of Neny Fjord.

Pink granite dikes which cut the dioritic country rock, the dioritic dikes, and gray (granodiorite?) dikes are common on Stonington Island (Fig. 4). The pink granite is composed of potash feldspar some of which has altered to kaolin, of quartz, and of biotite which is largely

altered to chlorite and magnetite. Similar pink granite dikes are also found on the Refuge Islands (Fig. 8), at Moraine Point (Fig. 19), Breccia Island, Skua Gull Islands (Figs. 30, 31), Three Pup Island, Gabbro Islands, Neny Island, and Roman Four Mt. All of these granite dikes are probably related to the Chasm Island granite.

The Chasm Island granite is found at 17 localities. It is, therefore, widely distributed and is probably the most abundant rock in the Marguerite Bay area.

It can be demonstrated that it is younger than the metamorphic rocks, the Black Thumb Mt. ultramafic rock, the Neny Glacier Island gabbro, the Stonington Island diorite, as well as the granodiorite.

The sedimentary rocks on the two islands southwest of Adelaide Island are cut by light gray granite dikes. This granite is a fine- to medium-grained rock with the grains ranging in diameter from 0.2 mm to 0.6 mm. It contains about 50 percent quartz. Around 40 percent of the rock is a highly kaolinized and zoned feldspar which is older than the quartz. Most of it is a potash feldspar but much of it is andesine and oligoclase. Approximately 3 percent pleochroic green biotite which is partially replaced by magnetite and chlorite and about 2 percent titanite are also present. This granite probably correlates with the Chasm Island granite as both granites contain altered feldspar and biotite as well as titanite, magnetite, and chlorite.

These sedimentary rocks are probably Jurassic and a Jurassic or Post-Jurassic age is therefore indicated for the gabbro-diorite-granodiorite-granite series (Fairbridge, 1952, p. 81).

Although Andersson never found the plutonic rocks cutting the Jurassic sediments (Andersson, 1906, p. 28), there is, according to Tyrrell (1921, p. 76), abundant evidence to indicate that the plutonic rocks do cut the sedimentary rocks at the northern part of the Palmer Peninsula. He writes, "There is abundant evidence to show that the plutonic rocks break through the sedimentary series in the Palmer Archipelago and on the Danco Land coast. If the great plutonic masses of Graham Land and the adjacent archipelagoes be regarded as the products of one episode of igneous activity, they must then be placed . . . probably towards the end of the Mesozoic era or at the beginning of the Kainozoic."

Terra Firma Volcanics

The Terra Firma volcanics are found not only at the Terra Firma Islands but also at Mushroom Island, Black Thumb Mt., and Neny Fjord Thumb (unofficial name) (Table 1).

The largest of the Terra Firma Islands is composed mainly of felsitic volcanics (Figs. 11, 12, 13). Most of these volcanics are either black porphyries or crystal tuffs, although pyroclastic breccias containing angular fragments of granite, granite gneiss, aplite, gabbro, felsite, and other rocks are also present. A gray breccia collected on a high, deglaciated area on the east side of the island contains angular fragments up to 20 mm in diameter in a very fine-grained ground mass. It is a rhyolitic breccia. It contains myrmekitic orthoclase, plagioclase (albite?), and glass, and the original biotite and pyroboles have been largely altered to magnetite and chlorite. Volcanics are also found on two small islands north of the main island. The Terra Firma volcanics must be hundreds of feet thick and are cut by felsite (?), trap porphyry, and trap dikes and by veins of epidote, quartz, calcite, and garnet (Figs. 11, 12).

Mushroom Island is composed mainly of gray, green, and black felsite. Small patches of water-worked felsitic pyroclastics were also noted. Black and green felsitic dikes as well as veins cut the felsite (Fig. 9).

Black Thumb Mt. is composed mainly of gray and black felsitic volcanics (Figs. 25, 26). Tuffs, breccias, agglomerates, and perhaps welded tuffs and volcanic conglomerates have been identified. Some of the breccias and agglomerates are filled with granitic fragments (Fig. 27). This granite is coarse-grained and light in color. Potash feldspar and albite are present. Some of the feldspar is beautifully zoned and twinned as well as slightly altered. Quartz and a green biotite which has in part altered to magnetite and chlorite make up the rest of the rock. The matrix surrounding the granite fragments consists of angular to subrounded grains of quartz and feldspar in a finer matrix of hematite, magnetite, quartz, and feldspar. The volcanics at Black Thumb Mt. appear to be nearly horizontal and are probably a few thousand feet thick. They are cut by red granite, aplite, and pegmatite dikes and probably by trap porphyry, felsite porphyry, and trap dikes (Figs. 25, 28).

Neny Fjord Thumb and the Needle are composed mainly of dark felsitic volcanics (Fig. 42). The following varieties are present: (1) brown, black, and gray felsite with flow-banding, (2) dark gray unbanded porphyritic felsite, (3) black, gray, and white felsite, and (4) a breccia with felsitic fragments.

A thin section of the flow-banded felsite was examined. The rock contains abundant quartz, a plagioclase which is probably andesine, and magnetite. It is, therefore, a dacite. A section of the porphyritic facies was also examined. It is a dark-colored rock with a very fine-grained matrix which contains feldspar and abundant quartz. The phenocrysts were originally probably either basic oligoclase or andesine, but they have been almost completely altered to kaolin. The rock is either a latite or a dacite.

The volcanics have a gentle dip and may be more than 2000 feet thick. Felsite, porphyritic andesite, granite, aplite, white porphyry, and trap dikes cut the volcanics.

A small outcrop of agglomerate is located near the lateral moraine shown on Fig. 40. It contains granite blocks as much as 4 feet long (Figs. 43, 44). The granite is pink and very coarse-grained. The feldspar in the granite is badly altered to kaolinite, chlorite, and calcite. Traces of plaid and carlsbad twins are present, and originally it was mainly potash feldspar. Large sutured grains of quartz are also present. The ground mass of the agglomerate is very fine-grained and the fragments are angular to subrounded. It is largely sutured quartz and badly altered potash feldspar. The ground mass is, therefore, mainly ground-up pink granite. This pink granite appears to be similar to the Chasm Island granite and it seems likely that it correlates with it. A similar outcrop of agglomerate is located a short distance away (Fig. 40).

The Terra Firma volcanics are in part rhyolites and dacites. They are a few thousand or more feet thick. They are younger than the gabbro-diorite-granodiorite-granite series described above, as fragments of these rocks are found in the volcanics. They are cut by felsite, porphyritic andesite, red granite, aplite, pegmatite, felsite porphyry, trap porphyry, and trap dikes, and by veins of epidote, quartz, calcite, garnet, and other minerals; and they were probably once more or less continuous over a large area.

Similar volcanics are widely distributed on the Palmer Peninsula, as they have been reported by Knowles (1945, p. 141), Andersson (1906, p. 27), Gourdon (1908, p. 163-182, Fleming et al. (1938, p. 509), Tyrrell (1921, p. 67-74; 1945, p. 72-75), Fairbridge (1952, p. 81), and Ferguson (1921, p. 47, 48, 50-53).

The exact relationship between the Terra Firma volcanics and the gabbro-diorite-granodiorite-granite series is one of the unsolved problems of the area. The volcanics are of course younger, as they contain numerous coarse-grained fragments of the granite. How much younger, however, is not known. The plutonic rocks may be in contact with the volcanics at the Terra Firma Islands. It must be either a sedimentary or a fault contact. If it is a sedimentary contact, there must have been a profound period of erosion between the volcanics and the plutonic rocks, and the plutonic rocks must, therefore, be considerably older. If, on the other hand, it is a fault contact, the plutonic rock must have been upfaulted relative to the volcanics and this in turn followed by a long period of erosion in order to bring the plutonic rocks to the surface and in juxtaposition with the volcanics. Further studies at the Terra Firma Islands, Black Thumb Mt., Batterbee Mts., Neny Fjord Thumb, and elsewhere may reveal the exact relationship between the volcanics and the plutonic rocks.

Lateral Moraine Pluton

The Lateral Moraine pluton is found at Neny Fjord Thumb (unofficial name), on the ridge which runs northeast from the Companion Thumb (unofficial name), and on the south side of

Neny Fjord (Figs. 40, 41, 42, 44, 46, 47, 53) (Table 1). A good place to see it is 200 yards east of the Needle. Here the pluton is a dike which cuts across the volcanics (Fig. 47). It varies greatly in width and near the talus slope it is about 40 feet wide. The center of the dike is a porphyry with a fine-grained matrix which is so filled with phenocrysts that it looks, on a casual inspection, like a coarse-grained rock. The phenocrysts decrease in number with increasing distance from the center of the dike so that near the contact it has a normal amount of matrix and looks like an ordinary porphyry. Still closer to the contact the porphyry grades into a pink felsite. Fifty percent of the phenocrysts of the rock at the center of the dike is feldspar. It is somewhat altered, is zoned and twinned, and it is andesine. Quartz is found only in the ground mass. There is abundant pleochroic brown basaltic hornblende, some of which is replaced by green biotite. Magnetic is also present. The rock is an andesite porphyry. The porphyry close to the margin of the dike contains phenocrysts of highly altered kaolinized feldspar. The ground mass is composed mainly of quartz and altered potash feldspar. Hematite is also present. The rock is a rhyolite porphyry and is a little more acidic than that found in the center of the dike.

A much larger mass of the pluton is found close to the lateral moraine (Figs. 44, 49). Here the pluton is filled with inclusions of diorite, volcanics, and other rocks, some of which are more than 20 feet long.

The Lateral Moraine pluton is somewhat younger than the volcanics as it cuts across them and contains inclusions of them. A red vugy granite cuts both the volcanics and the pluton. The Lateral Moraine pluton may be the intrusive equivalent of the Terra Firma volcanics as they are similar petrographically and closely related in time.

Red Rock Ridge Granite

The Red Rock Ridge granite is found at Red Rock Ridge, Black Thumb Mt., Neny Fjord Thumb (unofficial name), and on the north and south sides of Neny Fjord (Nichols, 1948, p. 2) (Table 1).

The Red Rock Ridge granite is the most abundant rock at the western end of Red Rock Ridge (Figs. 34, 39). This granite in places is filled with vugs which contain quartz, feldspar, pyrite, and other minerals. It is younger than the gabbro found here, as dikes of the granite cut the gabbro. It is also younger than the pinkish granite at the western end of Red Rock Ridge, as granite, aplite, and pegmatite dikes related to the Red Rock Ridge granite cut the pinkish granite (Fig. 34).

Granite, aplite, and pegmatite dikes cut the Terra Firma volcanics at Black Thumb Mt. (Figs. 25, 26, 28). The granite contain vugs, and it and the aplite and pegmatite dikes undoubtedly correlate with the Red Rock Ridge granite.

The Red Rock Ridge granite is also found just west of Neny Fjord Thumb (Fig. 42). Here it is also filled with vugs.

A specimen of the Red Rock Ridge granite was collected on the moraine on the north side of Neny Glacier. It has a sutured granitoidal texture. It contains more than 50 percent feldspar, most of which has been altered to kaolinite and sericite and which has an index of refraction less than that of quartz. It contains abundant quartz which is irregularly fractured and about 2 percent mafic minerals which have been altered to chlorite and limonite.

Hundreds of dikelets of the Red Rock Ridge granite and an aplite related to it intrude the volcanics near the base of the Needle. The aplite is medium-grained and contains about 50 percent altered feldspar and 50 percent quartz. Small quantities of chlorite and hematite are also present.

A prominent and spectacular Red Rock Ridge granite dike cuts the volcanics and runs 2000 feet across the northwest face of Neny Fjord Thumb (Figs. 42, 48). The Red Rock Ridge granite is also younger than the Lateral Moraine pluton, as inclusions of this granite are never found in the Lateral Moraine pluton, and red dikes which undoubtedly correlate with the Red

Rock Ridge granite cut the pluton. Flow-banded felsite, trap, and felsite porphyry dikes cut the Red Rock Ridge granite.

Knowles (1945, p. 137, 138, 140), Fleming et al. (1938, p. 509), Andersson (1906, p. 29, 30), Barth and Holmsen (1947, p. 23), Gourdon (1908, p. 142-149), Nordenskjöld (1905, p. 240), Holtedahl (1935, p. 9), Tyrrell (1921, p. 59, 77; 1945, p. 66, 68, 71), Ferguson (1921, p. 45, 47, 48), and Pelikan (1909, p. 15, 43, 44, 49) have all reported granite on the Palmer Peninsula. It is not known which of these granites should be correlated with the Chasm Island granite and which with the Red Rock Ridge granite.

Dikes

As indicated above, the area has been invaded by a great many dikes (Figs. 4, 11, 16, 23, 30, 34, 40, 58, 67). They vary from a fraction of an inch to more than 30 feet in width and from a few inches to hundreds of yards in length. They have emplaced themselves by wedging, stopping, andtoa minor degree by replacement. Single, multiple, and composite dikes are common (Figs. 47, 49, 51). Some have been epidotized, others have been cut by epidote veins, and a few have been faulted (Figs. 18, 19, 21). Aplite, pegmatite, granite, and felsite dikes are associated with the Chasm Island and Red Rock Ridge granites; felsite dikes are related to the Terra Firma volcanics; and fine-grained dioritic dikes and basic pegmatite dikes are related to the Stonington Island diorite.

At least five composite dikes are found in the area around Neny Fjord Thumb. In every case, a greenish-black, fine-grained dike has been intruded by a light-colored felsite porphyry (Figs. 47, 49, 51). The dark, fine-grained rock in one of the composite dikes located close to the Needle contains large quartz phenocrysts surrounded by carbonate and chlorite reaction rims; large, rounded and altered lathe-shaped feldspar phenocrysts are present; the feldspar in the ground mass is also lathe-shaped, twinned (carlsbad?), and is probably oligoclase; and a fibrous low pleochroic green amphibole which may be tremolite is also present. The rock is a dacite porphyry. The younger light-colored felsite porphyry contains phenocrysts of completely altered feldspar and rounded quartz. The ground mass is very fine-grained. It contains highly kaolinized feldspar, most of which is potash feldspar, and some plagioclase together with quartz, chlorite, and biotite. The rock is a quartz porphyry or a rhyolite porphyry. These composite dikes cut the Terra Firma volcanics, the Lateral Moraine pluton, and the Red Rock Ridge granite.

Porphyritic greenish trap dikes are found at Terra Firma Islands, Chasm Island, and elsewhere (Table 1). One of these dikes, located on the north side of Neny Island, contains long lathe-shaped feldspar phenocrysts up to 2.5 mm in length. The ground mass contains feldspar lathes about 0.5 mm across which are highly kaolinized and sericitized. Its index is less than that of balsam and it may be oligoclase. The mafics in the ground mass have in part been altered to chlorite and magnetite. The rock is a trachyte porphyry. These dikes are older than the trap dikes of the area.

Diabase dikes are found at the western end of Red Rock Ridge, at the northwest side of Neny Island, and elsewhere. The dike at the western end of Red Rock Ridge contains about 60 percent of a lathe-shaped plagioclase. There appears to have been some hornblende which has altered to chlorite. Much of the ground mass is replaced by carbonates. Magnetite is also present.

Trap dikes as indicated above are found at Stonington Island, Neny Island, Terra Firma Islands, Moraine Point, and many other places (Table 1). A trap dike which is located on the north side of Neny Island has a trachytic texture and the phenocrysts are all lathe-shaped feldspar or chlorite. The ground mass is composed mainly of dark minerals and it also contains a greenish glass (?), magnetite, and plagioclase altered to sericite. The rock is either an andesite or basalt. These trap dikes cut the Terra Firma volcanics, the Lateral Moraine pluton, and the Red Rock Ridge granite. Those trap dikes which are basaltic may be related to the Tertiary basaltic volcanics at the northern end of the Palmer Peninsula (Andersson, 1906, p. 45-49; Ferguson, 1921, p. 43-44).

ECONOMIC GEOLOGY

Large areas of rocks badly stained by limonite are widespread and common in the Marguerite Bay area. They are found at Stonington Island, Refuge Islands, Terra Firma Islands, Mushroom Island, and elsewhere (Table 1). They have probably resulted in most places from the oxidation of pyrite. Those that were studied are of no economic value as the limonite is present only as a thin surface film.

Pyrite is widespread. It was identified on Chasm Island (unofficial name), Mushroom Island, western end of Red Rock Ridge, and elsewhere (Table 1). It has no economic significance. It has also been reported by Knowles (1945, p. 143) and Tyrrell (1945, p. 68, 71, 73). Thousands of tons of pyrite have been reported from King George Island, South Shetlands (Ferguson, 1921, p. 40-42).

Paper-thin surface films of malachite are also widespread. They are found at Neny Island, Terra Firma Islands, Black Thumb Mt., Neny Glacier Island (unofficial name), and elsewhere (Table 1). They are usually found on mafic rocks and those that were investigated have no economic value. In this connection it is interesting to note that a boulder was found near Port Lockroy, Palmer Peninsula, which contained very high-grade malachite and azurite (Thomas, 1921, p. 89). Knowles (1945, p. 142) has reported the presence of chalcopyrite and malachite at Cape Eielson on the east coast of the Palmer Peninsula. Streaks and films of chalcopyrite have been reported from Coughtrey Island and Isle Casabianca by Ferguson (1921, p. 49).

A prominent manganese stain was seen on one of the Terra Firma Islands, and Knowles (1945, p. 142) reports similar staining 9 miles east of Stonington Island.

Flakes of molybdenite between 1/8 and 1/4 inch across were found in the Red Rock Ridge granite on the south side of Neny Fjord. Flakes of molybdenite up to 1/4 inch in width were seen by Knowles (1945, p. 142) in small veinlets in an outcrop about 9 miles east of Stonington Island. As far as is known, this molybdenite has no economic significance.

Several occurrences of low-grade gold and silver have been reported by Knowles (1945, p. 143-144). Knowles (1945, p. 143) found a small piece of magnetite float on a moraine on the northeast side of Roman Four Mt.

OUTLINE OF GEOLOGIC HISTORY

Pre-Cambrian? Pre-Jurassic	1. Neny Island schist hornblende schist biotite schist phyllites 2. Roman Four Mt. gneiss granite gneiss
Jurassic	3. Graphitic argillites, gritstones, and conglomerates abundant indistinct plant fossils
Post-Jurassic Late Mesozoic	4. Black Thumb Mt. ultramafic rock small mass 5. Neny Glacier Island gabbro many varieties 6. Stonington Island diorite cut by dioritic dikes and by basic pegmatite dikes which are closely related to it foliated and nonfoliated varieties 7. Granodiorite 8. Chasm Island granite cut by closely related granite, aplite, and pegmatite dikes coarse-grained facies intruded by finer-grained facies at western tip of Red Rock Ridge 3 varieties at Neny Glacier Island

Post-Jurassic Late Mesozoic or Early Cenozoic	9.	Terra Firma volcanics rhyolitic and dacitic flows, dikes, tuffs, breccias, and agglomerates few thousand feet thick
	10.	Lateral Moraine pluton porphyritic andesite and rhyolite
	11.	Red Rock Ridge granite vugy granite related granite, aplite, and pegmatite dikes
Middle Cenozoic ? (in part)	12.	Dark and light colored fine-grained dikes

CONCLUSIONS

(1) The rocks around Marguerite Bay are mainly igneous.

(2) Both extrusive and intrusive rocks are present.

(3) Rocks ranging from ultramafites to granites were successively injected. This was followed by the extrusion of widespread rhyolitic and dacitic pyroclastics and flows. Later these volcanics were intruded by a dioritic pluton and still later by a vugy granite.

(4) Whether this igneous history is the result of two magmatic cycles separated by a considerable interval of time, or the result of only one cycle, is not known.

(5) Granite is the most abundant rock type and the ultramafites the least abundant.

(6) The area has been invaded by a great many dikes which are related to these intrusive and extrusive rocks.

(7) These igneous rocks are mainly late Mesozoic or early Cenozoic.

(8) Metamorphic and sedimentary rocks are also present. The schists and gneisses are Pre-Jurassic and perhaps pre-Cambrian. The sedimentary rocks are clastic, terrestrial, and probably Jurassic.

(9) Igneous, metamorphic, and sedimentary rocks which correlate with these have been reported from other parts of the Palmer Peninsula by Andersson, Nordenskjöld, Gourdon, Holtedahl, Fleming et al., Knowles, Barth and Holmsen, Ferguson, Pelikan, Tyrrell, and others.

(10) The presence of intrusive igneous rocks precludes the existence of coal and oil in most of the area.

(11) Limonite, pyrite, malachite, molybdenite, and other metallic minerals are present, but nothing of economic value was found.

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