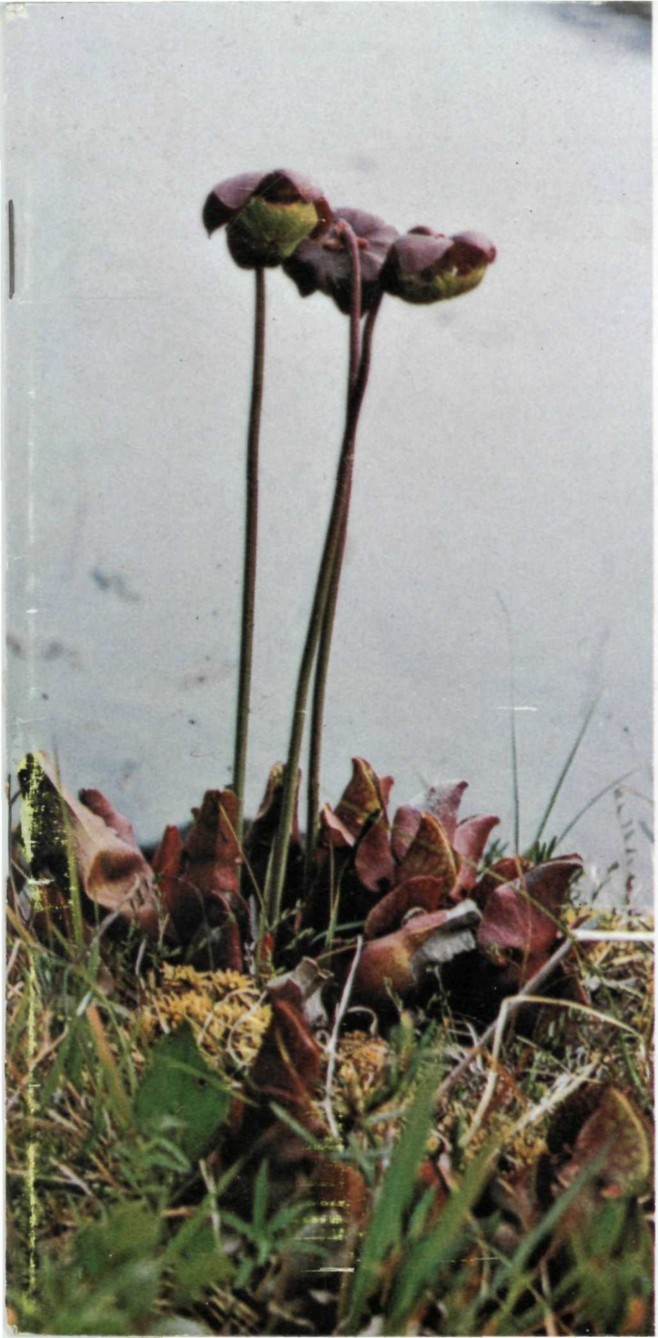

GEOLOGICAL SURVEY OF CANADA · 1842 ·

Rocks and scenery of TERRA NOVA NATIONAL PARK

D. M. Baird

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TERRA NOVA NATIONAL PARK

David M. Baird

MISCELLANEOUS REPORT 12

Issued by

THE GEOLOGICAL SURVEY OF CANADA

Department of Energy, Mines and Resources, Ottawa

$1

Available by mail from the Queen's Printer, Ottawa,
from the Geological Survey of Canada, 601 Booth Street, Ottawa,
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Price $1.00 Catalogue No. M41-8/12

Price subject to change without notice

ROGER DUHAMEL, F.R.S.C.
Queen's Printer and Controller of Stationery
Ottawa, Canada
1966

Page

COVER —

The pitcher plant *(Sarracenia purpurea)*, the provincial floral emblem of Newfoundland, is found in many bogs and other wet areas in the province.

The one on the cover was photographed on the brink of a small pond. The yellow and green mosses and grasses in the foreground are typical surroundings.

The Island of Newfoundland comprises some 42,000 square miles of rugged cliffs and long sandy beaches, steep rocky hills and elevated plateaus, long finger lakes and shallowly flooded boulder fields, and deep luxuriant woods and open bogs. It has had an interesting and varied geological history, which has resulted in a complex of rocks ranging in age from the ancient *Precambrian,* more than 1,000 million years ago, to the *Carboniferous,* about 280 million years ago, and a great variety of scenic phenomena. Its long isolation from the mainland, combined with its history of recent glaciation, has produced a unique assemblage of plants and animals.

TERRA NOVA NATIONAL PARK, in the northeastern part of Newfoundland, has been set aside for the enjoyment of the people of Canada. It is an area of a little more than 150 square miles of typical rolling country and indented shoreline similar to the scene above, a view down Clode Sound from just west of Bunyan's Cove.

BOUNDARIES OF THE PARK

The park is in the northeast corner of the main body of the Island of Newfoundland with its centre at approximately 53 degrees 55 minutes west longitude and 48 degrees 34 minutes north latitude. This corresponds generally with the position of the park headquarters area and installations. The boundaries of the park consist partly of artificial lines across the land and partly of lines across marine areas to include the shorelines.

The northernmost tip of the park lies on a point of land just east of Traytown on Alexander Bay. The boundary follows Alexander Bay for about 3 miles to the east, from where it crosses the shoreline and proceeds across the land to North Broad Cove. From here it extends to the northeast, past the northeast tip of Swale Island, then turns southwest past Hurloc Head and along Clode Sound to Northwest Arm. A small area around the village of Charlottetown, on the north side of Clode Sound, makes an indentation in this otherwise natural boundary. From the head of Northwest Arm the boundary of Terra Nova National Park proceeds generally northward and northeastward along a series of surveyed lines back to the northernmost point.

The northwest entrance to Terra Nova National Park crosses an artificial boundary line on the land about 2 miles southwest of Traytown, while the southern entrance crosses a surveyed boundary close to the shoreline of Northwest Arm.

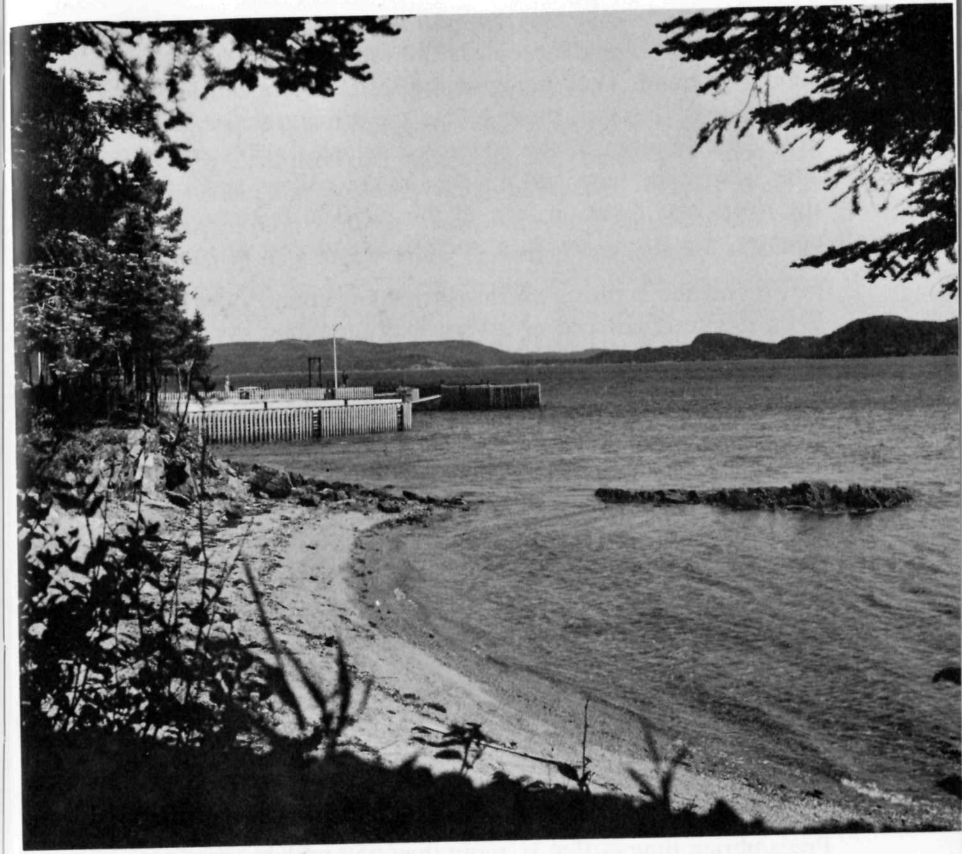
THE ROCKS OF TERRA NOVA NATIONAL PARK

As an island off the northeast corner of North America, Newfoundland might be expected to show the general characteristics of the eastern margin of the continent. And in studying the eastern side of North America we do, indeed, find that Newfoundland is but a prolongation of a series of geological formations and structures that extend all the way from the Gulf of Mexico and even continue past the island northeastward beneath the ocean. The whole eastern seaboard of the continent thus shows a similarity of geological history, with individual variations in each locality.

The eastern margin of North America shows a set of mountain ranges that more or less parallels the present shoreline, exclusive of Florida, Cape Hatteras, and other small protuberances. Geologists have long believed that these mountains were produced when a large block of the earth's crust under the Atlantic Ocean pushed against the main buttress or framework of the continent in a generally northwesterly direction. The great forces that wrinkled up the mountains, made the rock structures that are visible today, and formed belts of altered and *folded* rocks under the coastal plains, began about 400 million years ago and continued to act until as recently as 100 million years ago. Since the last of the great mountain building activity, the land we know today has undergone erosion in a series of cycles, interrupted now and again by changes in its level in relation to the oceans.

The agents of erosion — the rivers and glacial ice, and the waves and currents along the coasts — cut into the rocks

The even skyline as seen from the Ochre fire tower is typical of most of central and eastern Newfoundland. The flat surface was probably formed at a time of prolonged erosion, when the land stood closer to sea-level than now. The head of Newman Sound angles in from the right centre. The light patches beyond the water are parts of the park road system.



A curving beach and a rocky point, a salt water bay and rolling hills in the distance—these are typical of the shoreline of Terra Nova National Park. The scenery has resulted from a long history of rock-making, from the carving of the land by river erosion and glaciation and, finally, from the drowning of the land to form the bays and headlands.

below the surface in the vast period that has elapsed since the rocks were wrinkled, folded, and broken in the northeast-southwest trend. They removed the softer layers and left the harder ones. Because these follow the structural trends, the northeasterly grain in the country dominates all its scenery. This is why the bays and headlands, the valleys and ridges, the rivers and lakes, in fact all the physical features of the country, are strung out in a northeast-southwest line.

Newfoundland is thus a northeast-trending country because it is on the northeast end of a very long mountain system and all the structures in the rocks, and the scenery developed on these rocks, trend northeasterly-southwesterly.

Information from road-cuts, stream valleys, and the rocky shoreline shows that Terra Nova National Park is crossed by a number of northeast-southwest-trending belts of rocks, which may be distinguished from one another on the basis of their history and the kinds of rock found within them.

All the rocks to the east of a line that passes just east of the Louil Hills through Southwest Arm, thence southward through the head of Newman Sound and across the land to Bread Cove, belong in an unit called the "Connecting Point Group". These rocks, which consist of green-to-black *quartzite, slate,* and *greywacke,* began as sand, mud, and mixtures of sand and mud on the bottom of the sea in Precambrian time — that is, more than 550 million years ago.

Another belt of rocks, called the "Love Cove Group", extends from the shoreline of Clode Sound between Charlottetown and Platter Cove northward to well beyond the park boundaries. It seems much older than any other group of rocks in the area, for it is more severely deformed and very much altered.

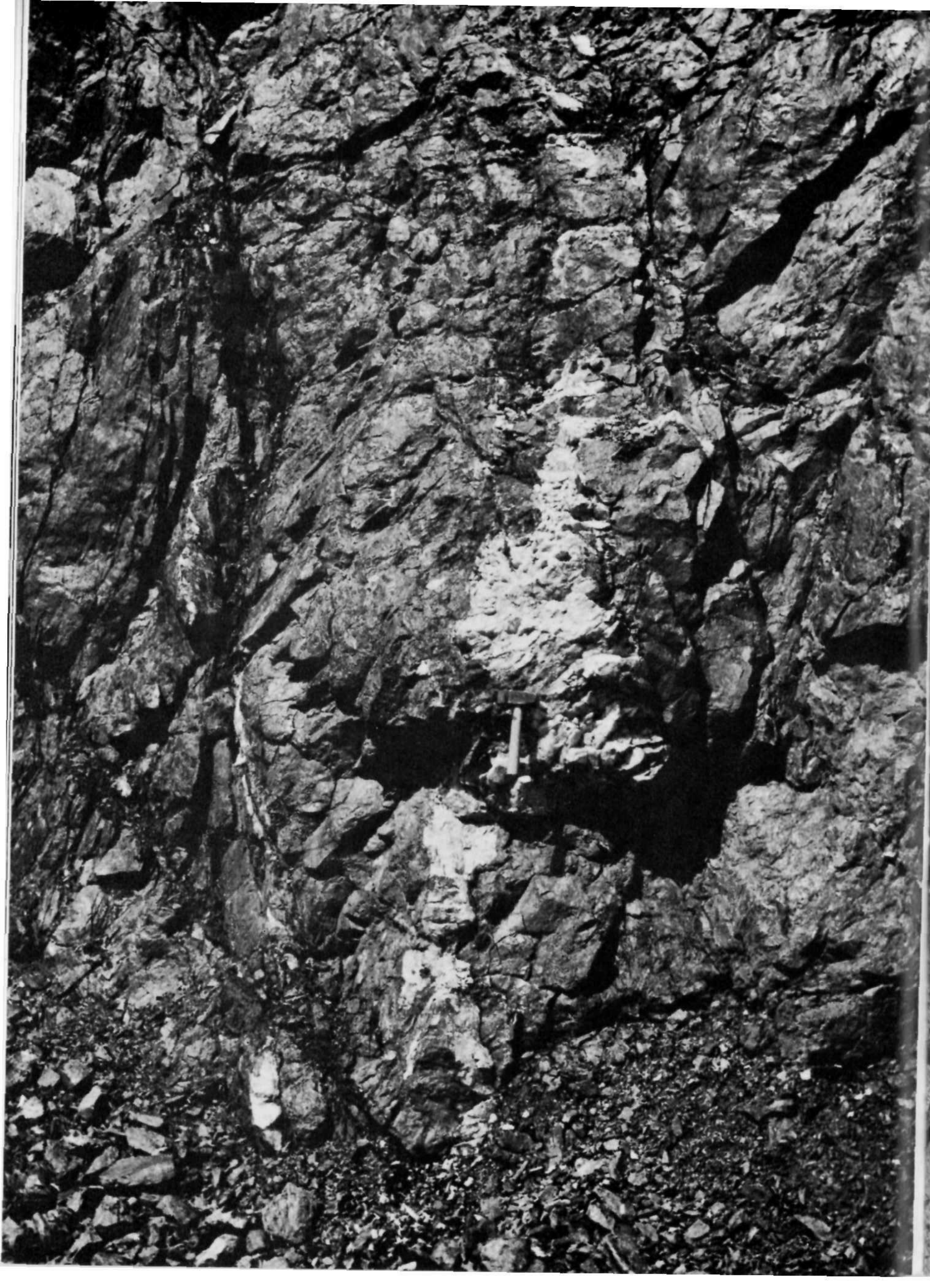
A third belt, the "Musgravetown Group", in much fresher condition than the other two, occupies two areas in the park. One is triangular and very much elongated, with its peak at Southwest Arm and its base between Charlottetown and Bread Cove on Clode Sound. The other lies in the southwestern section of the park in the region west of the line between Platter Cove and Dunphy's Pond. The rocks mostly are reddish with some greys and greens and include sandstone, conglomerate, and some volcanic rocks.

Large masses of granite occur just west of the boundary of Terra Nova National Park in the vicinity of Pitts Pond. A small mass of granite occurs in the Louil Hills area in the northern part of the park, and bodies of granite a few feet across occur in some other places. These granites are younger than any of the other rocks.

Now, having seen in a general way that the park area consists of three principal groups of *sedimentary* and *volcanic* rocks, intruded by granitic rocks, let's examine each group separately to see where it is found, what kind of rocks may be expected in it and something of its history.

The Love Cove Group

Geologists name rock groups usually from the places where they are first described or where they are best exposed. The Love Cove Group is thus named for *Love Cove,* some 3 miles southwest of Charlottetown, on the south shore of



Clode Sound. The rocks found there are now *sericite and chlorite schists*. These are grey-green or pale yellow crinkled rocks in which original layering and most other original structures have been destroyed during the severe deformation that the rocks have been through in their long history. As sedimentary and volcanic rocks can be recognized in a few places where alteration has not been quite so severe, we believe that many of the original rocks were probably impure, clay-rich sediments and that others were volcanic rocks.

The severely deformed rocks of the Love Cove Group are exposed in several long rock-cuts along the Trans-Canada Highway between the road to Charlottetown and the large quarry near Platter Cove. In all these outcrops the rocks tend to break along planes that are steeply *dipping* or sloping and that *trend* or are generally aligned close to north-south. The extreme fragmentation of the rocks in the exposures of the Love Cove Group makes it very difficult, in most of them, to get a piece of solid rock larger than a few inches in diameter.

Age of the Love Cove Rocks. The rocks of the Love Cove Group are more deformed and altered than any other rocks in the area. This alone suggests that they are older and have gone through more periods of deformation than the other rocks. They are considered to be *Precambrian* in age because they appear very similar to rocks known to be Pre-

Almost any road-cut in the rocks of the Love Cove Group shows shearing and breakage of the rocks due to earth movements like this. In addition to breakage, the rock has suffered alteration of a mineralogical and chemical nature. Pods, lenses, and veins of quartz and calcite are common and, in many places, have probably come from the rocks themselves during their alteration.

cambrian that lie in the Burin and Avalon peninsulas to the south and southeast. This means they are at least 600 million years old.

The Connecting Point Group

The whole eastern half of Terra Nova National Park is underlain by a mass of rocks, which at one time were sand, mud, and impure sediment but which are now altered to quartzite, slate and greywacke respectively. A section of volcanic rocks at the west end of Newman Sound opposite the park headquarters area is included by some geologists in the Connecting Point Group.

Almost all the rocks of the group weather to a dull white or light grey. The contrast between the light, weathered rock at the surface and the darker colours of the fresh rock is sometimes vividly shown in road-cuts, rock slides, and places where boulders have fallen out of the cliffs.

The slates of the Connecting Point Group are pale green, grey, or black. In some the *slaty cleavage* — the property in rocks of breaking along flat planes — is very well developed, but in others it is only poorly developed. In most outcrops it is difficult to see the original *bedding* or layering in the altered rock, although thin, fine-grained sandstone layers of irregular thickness and spacing sometimes indicate the original bedding.

The most abundant rock type in the Connecting Point Group is *greywacke* — material that started as sand highly charged with fragments of rocks of different kinds. These greywackes

are the rocks that are exposed for miles along the seacoast of Clode Sound, Newman Sound, and Swale Island and generally present a dull grey to light grey appearance without much indication of internal structures.

Age of the Connecting Point Group. It seems likely from comparison with similar rocks in other parts of eastern Newfoundland and from their general condition of alteration and structural deformation that the rocks of the Connecting Point Group are of Precambrian age. They appear to be younger than the rocks of the Love Cove Group on the one hand because they display much less severe structural and mineralogical alteration. On the other hand they are older than those of the third belt of rocks, the Musgravetown Group, because, where Connecting Point type rocks come close to Musgravetown rocks, it is readily apparent that the latter are much less deformed than the Connecting Point Group. Furthermore, pebbles and cobbles of Connecting Point rocks are commonly found in conglomerates of the Musgravetown Group. This could happen only if the Connecting Point rocks had already been solidified and were being eroded by the time the Musgravetown rocks were being laid down as sands and gravels.

The Musgravetown Group

These rocks are named from *Musgravetown,* which is on Goose Arm, several miles south of the nearest point in Terra Nova National Park. The reddish sandstone, conglomerate, and argillite of the Musgravetown Group extend northward into the park in two separate belts. The eastern belt is in the form of a tall, thin triangle with its base on Clode Sound

Rocks of the Musgravetown Group include many conglomerates. In this exposure, just below the fire lookout at Ochre Pit Hill, most of the boulders and pebbles in the conglomerate are of volcanic rocks and show a great variety of colours and textures.

between Bread Cove and Charlottetown and its peak just reaching the south shore of Southwest Arm, in the northern part of the park area. A western belt is exposed west of Platter Cove and on the shores of Dunphy's Pond. It is the reddish rocks of this group that are exposed close to the park headquarters and on the shore near the neighbouring wharf area. A particularly good series of exposures of the Musgravetown Group may be seen at and around the Ochre fire tower.

Sandstone is the most common rock type within the Musgravetown Group. It is generally pale red, but greyish green beds and zones are also fairly abundant. In almost all outcrops the weathered surface is of a much lighter colour than the fresh rock beneath. The sandstones began as sands containing large quantities of fairly fresh feldspar, quartz, and small fragments of various rock types. To the geologist this composition indicates that the sands accumulated rather rapidly under conditions that were unfavourable for chemical alteration. This means that when the Musgravetown rocks were being laid down as sediments, the climate was dry or cold or both.

Conglomerates that are of a variety of colours and contain a considerable variety of rock fragments are very common through the Musgravetown Group. Boulders and cobbles of sandstone and conglomerate, a variety of *schists* that suggest the Love Cove Group, quartzite and quartz, and several varieties of volcanic rocks, are set in a sandy *matrix*.

Lava flows are common in the Musgravetown Group. They show a wide range in composition and therefore a considerable variation in colour and texture. Black *basalt,* grey to green *andesites,* and light red *rhyolite* are massive to highly *vesicular* and *amygdaloidal.* A lava is said to be *vesicular* when it contains small circular spaces once filled with gas bubbles that were formed at the time the lava flow was spilled out onto the surface of the land. The lava is said to be *amygdaloidal* when the gas bubbles or vesicles are filled with some later mineral, which is usually of a light colour. Where these structures are visible, it is interesting to think that preserved in the rock are bubbles of steam or perhaps carbon dioxide that were formed hundreds of millions of years ago when hot rock poured out over the surface of the land.

Age and Relations of the Musgravetown Group. The reddish rocks of the Musgravetown Group are the least deformed in the three groups that occur in Terra Nova National Park. From this and the fact that small fragments of the other two groups are found in the conglomerate of the Musgravetown Group, it is concluded that it must also be the youngest. Reddish sandstones and conglomerates are found in other parts of eastern Newfoundland and, in each place, appear to be the youngest Precambrian rocks exposed. The bright red hills around Bay de Verde and those in the Signal Hill — Cape Spear region are the best examples.

Granite

Very large areas of central Newfoundland are underlain by massive granite. This rock shows abundant evidence of having been at one time very hot and highly fluid. It is formed,

The glacially rounded Louil Hills, on the north side of the Park near Traytown, are made of granite that seems to be a small offshoot of the main granite masses, which lie to the west. Forest fires have laid them bare.

furthermore, only at great depths. So our seeing it now at the surface must mean that an overlying cover has been stripped off by deep erosion. Granite is usually found in regions of highly folded rocks and very often in regions of old rocks.

A small mass of granite underlies the Louil Hills at the northernmost point of the park. Just outside the westernmost boundary are very large areas of the same rock, and from them come the great swarms of granite boulders found all over the park. Pieces of fresh granite broken from such glacial boulders supply much of the stonework in the park headquarters area.

The granite in the Louil Hills is readily accessible from the road along the shore in the northernmost part of the park. In the road-cuts it may be noted that the granite is broken into angular blocks by numerous joints and fractures. Narrow, white, quartz veins are common in some outcrops. Close inspection of a fresh piece of granite shows that it is made of aggregates of glassy quartz, pale pink feldspar, and patches of a blue-green substance. In some places this substance is seen to be made up of needle-like crystals of a mineral of the *amphibole* family.

The Terra Nova granite seen so commonly in boulders throughout the park is a coarse-grained material made up of crystals of pink feldspar and glassy quartz and a scattering of dark minerals. In some places the feldspar crystals are as much as 2 inches long.

Age of the Granites. The granite in the Louil Hills cuts across rocks of the Love Cove *schists* and the Connecting Point Group — a fact that indicates to a geologist that they must therefore be younger than both. To the southwest of the park the Terra Nova granite is known to cut and alter rocks of the Musgravetown Group and is thus conclusively shown to be later than the Musgravetown rocks. It seems likely, from comparison with other parts of the island, that these granite masses are part of the general invasion of granites that took place in central Newfoundland sometime in

mid-Paleozoic time, or approximately 350 million years ago. If this is so, as seems likely from all the evidence that can be gathered, the granites are much younger than the sedimentary and volcanic rocks that they intrude in the Terra Nova National Park area.

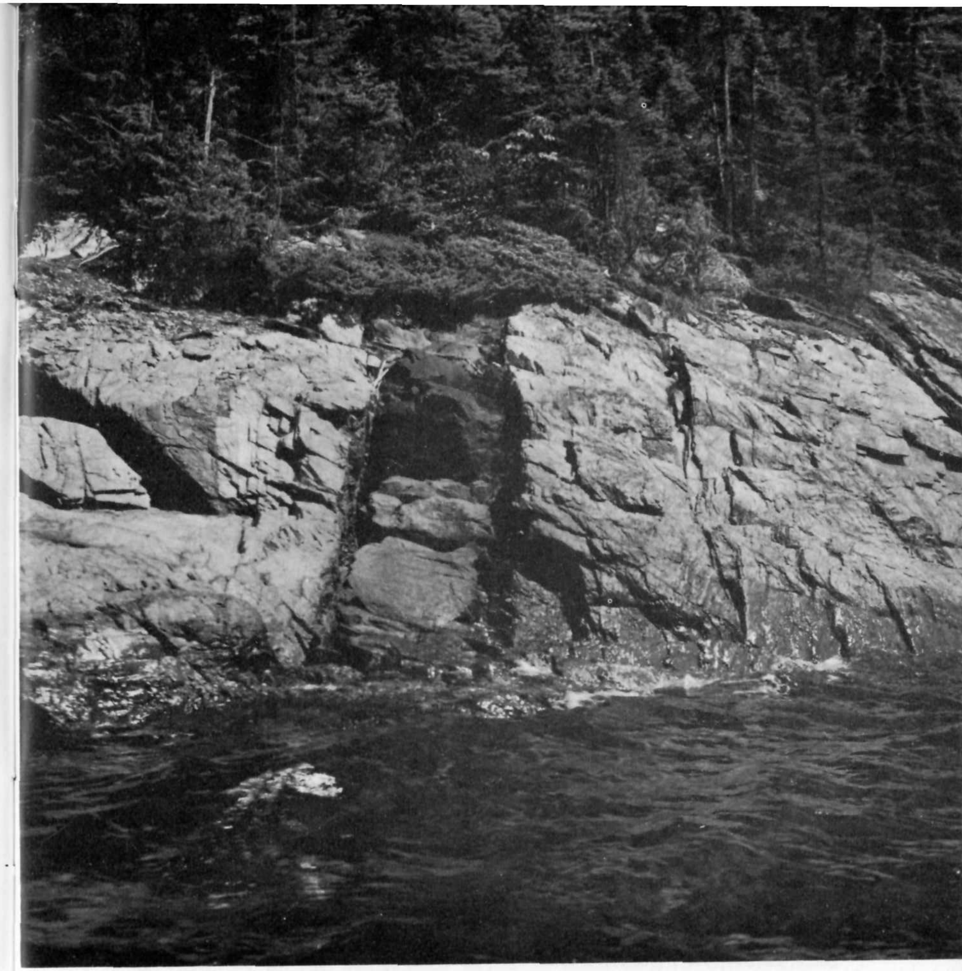
Dyke Rocks

Dykes are described as thin, tabular masses of *igneous* rock — that is rock that at one time was molten — that intrude other rock masses along joints or fissures cutting across their structures. Dykes of a wide variety of compositions may be seen at many places in the rocks of Terra Nova National Park. Dykes are especially common along the shores of Newman Sound, and several large ones, as much as 60 feet thick and several hundred feet long, are visible near Mount Stamford. Many of the dykes in Newman Sound trend northwest-southeast, apparently following a system of fractures.

Most of the dykes may be said to be of a diabasic composition — that is, they are fine- and medium-grained, dark rocks that weather to brownish grey. A few light coloured dykes are seen, however, and have a slightly different mineral composition. In some places the dykes may appear much finer grained along their margins than in their centres. This is related to their origin as liquid masses that squeezed up cracks and joints in pre-existing rocks. The edges thus cooled faster than the centres and are consequently finer grained.

Within granite masses, both west of the park and in the Louil Hills, zones of fine-grained pink material cut the coarser

A close view of a glacial boulder of granite shows the mixture of light and dark crystals that make up the body of the granite and also a light-coloured dyke that cuts across the granite. The bottom edge of the boulder appears to be made of the same light dyke rock.



Thin, tabular masses of igneous rocks, called dykes, cut the older rocks all along the shores of Terra Nova National Park. The dyke rock squeezed into cracks and fissures as a liquid and then solidified. This one is on the shore of the inner part of Newman Sound, just southwest of The Narrows, and cuts rocks of the Connecting Point Group.

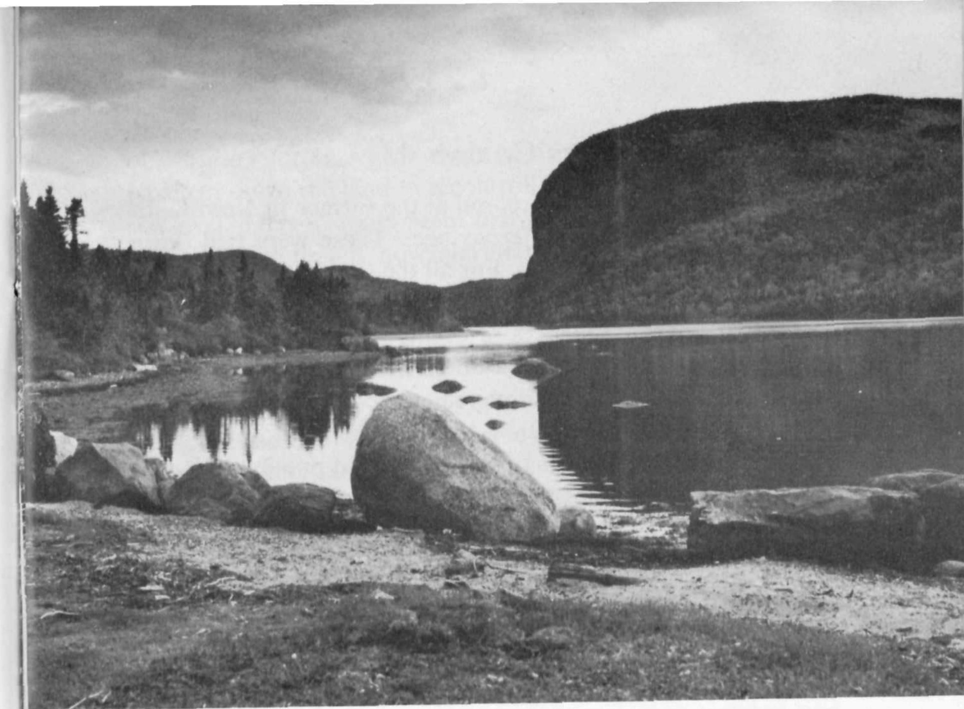
granite. It is likely that these dykes most of which have very indistinct edges, were formed in a last stage of the granite intrusion itself.

Age of the Dykes. Dykes cut all known rocks in the Terra Nova National Park area and are therefore younger than any of the other formations. In other areas it has been found that dykes of a composition commonly found in the park are usually the result of the last event in the *igneous* history of a region. For these two reasons the dykes are looked upon as the youngest rocks in the park area.

THE SURFACE OF THE LAND

Where you stand on the top of a hill or beside a waterfall or on a curving beach, the scenery you look at and admire is the result of millions of years of geological history. This is because the scenery at any one place owes its peculiarities to the rocks that underlie it and the particular tools nature has used to sculpture the land at that place. The rock story may have begun hundreds of millions or even billions of years ago; and the story of erosion, which by its nature has to be the last chapter in the development of the scenery, may have begun tens of millions of years ago.

In some regions the scenery is the direct result of the kinds of rocks that underlie the country. Masses of dense, tough rocks stand out as hills or form long thin points of land in the sea because softer rocks around them have been worn away. In other regions the scenery may be the result of the particular way that water or ice or wind have eroded the rocks, or of the way the sea has flooded the land after a long



A view southwestward from the causeway over the Tickle between Broad Cove and Southwest Arm shows the ever-present glacial boulders in the foreground and a steep-sided hill of volcanic rocks of the Connecting Point Group beyond.

history of erosion has already unfolded. The scenery in Newfoundland and Terra Nova National Park has resulted from the action of several agents of erosion cutting into rocks that may be a billion years old.

Let us see how this was done and what accounts for the park's scenic features — the rolling hills, the lakes and ponds, the rivers, the bogs, and the deeply indented shorelines.

Before the Glaciers Came

The youngest rocks now exposed at the surface in Newfoundland are those of *Carboniferous* age. These were laid down about 275 million years ago. For all the time since the Carboniferous age we have nothing of record and may conclude that either of two sequences of events took place. It may be that younger rocks were laid down in Newfoundland in the earlier part of the 275-million-year period and that in a later stage of development erosion stripped them off completely, leaving no record of them behind. A second possibility is that the land has been undergoing continuous erosion since Carboniferous time. In the nearby Maritime Provinces the rock record extends in time beyond the Carboniferous into the *Triassic* period, which is thought to have ended about 175 million years ago. Thus it is conceivable that the same kinds of events once took place where Newfoundland now is. There is really no way of telling with certainty which of the two sequences took place.

Whether or not rocks younger than Carboniferous were laid down in this area, we do know that erosion has been going on for many tens of millions of years in Newfoundland and the adjacent parts of North America.

If you stand on the top of a hill almost anywhere in Newfoundland and look at the skyline you will see at once that it is very flat. The tops of other hills seem to blend into a flat surface into which valleys and lowland areas have been cut. Those who have studied the origin of scenery know that large flat surfaces can come about only through very long periods

of erosion, during which rivers and other agents of erosion have cut down the land to a controlling level, which is usually sea-level. Thus it would seem that the surface represented by a flat skyline that is now elevated some distance above the sea was at one time at sea-level. As soon as the surface was uplifted, it would be expected that new rivers would start carving the land to reduce it once again to the base level or to sea-level.

In Newfoundland we find evidence of three such surfaces, one above the other and all tilted so that they are much higher in the southwest than in the northeast. Much of the land surface in Terra Nova National Park can be related to the lowest, or third, of these levels.

We may thus summarize the history of the development of the preglacial scenery of Terra Nova National Park as one of long-continued erosion during which a flat surface was developed at or close to sea-level. It was then uplifted and tilted to the northeast so that rivers carved valleys into the old surface, leaving residual hills. Now, however, we might ask ourselves where sea-level was at this time, for this would affect the depth of cutting of the preglacial scenery, and also how far underneath the present sea the agents of erosion were effective in preglacial times. Part of the answer may be found by a study of marine charts.

Clode Sound, to the south of Terra Nova National Park, and Newman Sound, northeast of it, extend out under the sea for many miles and seem to form part of a network that looks rather like an ancient river system with branching valleys. We can conclude from this that sea-level in an earlier time was a great deal lower than it is now and that the rivers of the day cut valleys deeply into land that is now under the sea.

The Coming of the Glaciers

An important event in the history of the scenery of Terra Nova National Park began about 1 million years ago. At that time the climate in the northern part of the world, including what is now Newfoundland, began to get gradually cooler. As it did, the snow that fell in winter began to stay on the ground longer and longer each spring and to come a little earlier each winter. As the climate continued to get colder, the snow began to stay on the ground all year round, first in sheltered spots such as steep valleys and the north slopes of hills, and finally everywhere. Eventually the whole country was covered with a great blanket of permanent snow. As this in turn continued to thicken, the weight of the upper layers of snow gradually changed the lower ones to solid ice. And as the tremendous covering of snow and ice grew thicker the weight of ice on top squeezed the bottom layers so that they began to flow outward from the higher parts of the country toward the lower edges and the sea. This produced an ice-cap of exactly the same type as those now observed in Greenland and in the South Polar regions.

For many thousands of years Newfoundland and most of the rest of the northern part of North America lay beneath the great ice-cap. Eventually, however, the cycle that had brought the cold in the first place brought a warming of the climate, so that over the succeeding centuries the ice-cap began to

A large mass of granite occurs just west of Terra Nova National Park. Glaciers of the great Ice Age moved countless boulders and chunks of the granite eastward and dropped them over the face of the land. Large boulders of this granite occur all along the roadside in this view near the northern edge of the park.

lose a little more of its volume by melting than it gained on top from fresh snowfalls. Thus it began to shrink. As thousands of years passed, melting uncovered some parts of the country and left remnants of the ice-cap in others. At last they too were gone, but the country was never again the same.

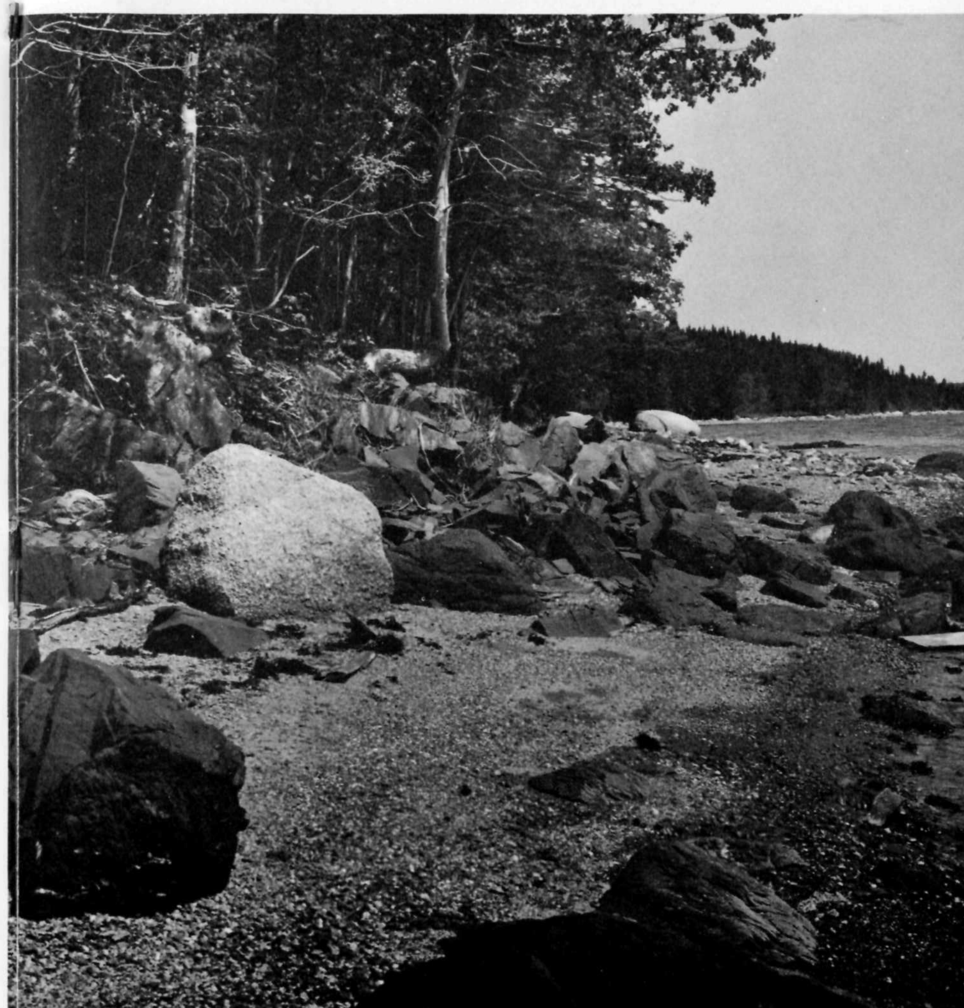
What the Glaciers Did to the Country

The great mass of ice pushing over the face of the land scraped everything loose before it. Soils were torn up and carried away. Great blocks of solid rock were plucked from the earth and carried off to be dropped later, sometimes many miles from their starting points. The bedrock was scraped clean and polished by the moving ice, which was armed with boulders and debris frozen into it. Hills were rounded off and old river valleys were scoured out. Where the ice came down to the sea, it scooped and wore away the inlets, deepening some, straightening others, and making new ones where there had been none before.

As the ice melted, the materials it was carrying were deposited in a scattered manner all over the country. Piles of rock debris and the old soil scrapings were dumped here and there, making mounds in some places, filling valleys level in others. The meltwater from the ice washed some of the debris to the coastline and into valleys. Hills that were scraped bare by the moving ice were left naked when it melted except for scattered boulders.

At the height of glaciation the ice-cap that covered Newfoundland was only part of a much larger one that covered almost all of northern North America. In the later stages, however, Newfoundland supported an independent ice-cap, which moved outward in all directions from the high central plateau. Local variation due to the shape of the land underneath the moving ice-cap was marked so that now we find scratches and boulder patterns, which tell us that the ice moved off the highlands into the valleys, even on a local scale, and off the peninsulas into the bays.

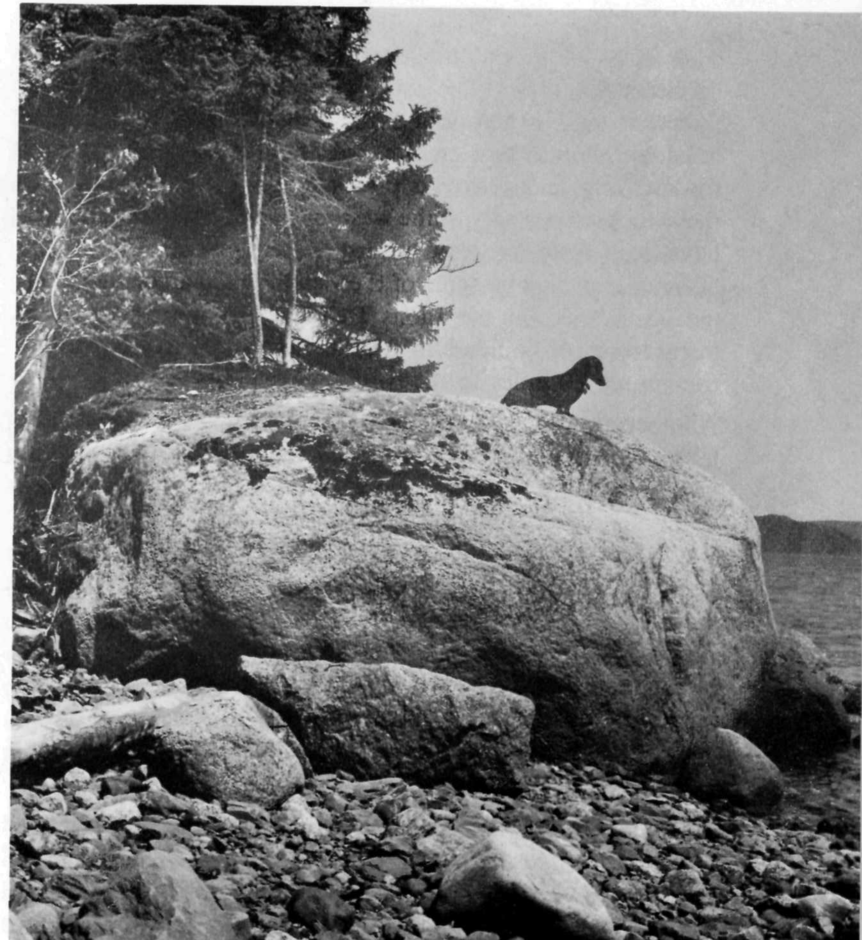
The shoreline just north of the wharf is made largely of reddish boulders derived from outcrops of Musgravetown rocks lying nearby. Occasional erratics or glacial boulders of granite, like the one to the left of centre, add interest and diversity.



What All This Has Meant to Terra Nova National Park

The surface of Terra Nova National Park is a typical glaciated land surface with fresh, scratched, and polished bedrock exposed on the hilltops, on valley walls, and along the seacoasts. Deposits of glacial debris range in thickness from a few inches to several hundred feet. Scattered all over the countryside are glacial boulders, many made of rocks that are not exposed in the park itself. The drainage of the country is disrupted in that glacial deposits have dammed up low-lying areas and valleys to form lakes, and rivers have been pushed out of their courses to flow in new ones, which are often studded with rapids and waterfalls.

Travelling through Terra Nova National Park one soon sees that its westernmost parts are quite different in general scenic aspect from its eastern parts. The reason is that great quantities of glacial debris, in large part re-worked by the running waters at the time of the melting of the glaciers, have blanketed the western area, whereas in the eastern areas much more of the original glaciated surface is evident. In a drive along the branch road from the main Trans-Canada Highway toward the village of Terra Nova you cross a wide track of this western depositional belt and you may notice that rock outcrops are rare. You may also notice that the glacial debris is full of granite boulders and fragments of granite. The fact that granite does not occur in this part of the park itself but does occur in large masses to the west can only mean that in this district the glaciers moved from the west toward the east.



The nature trail north of the wharf passes close to this large glacially transported boulder of granite.

The study of glacial boulders in other parts of the park confirms this view. The shore of Newman Sound, a region underlain entirely by rocks of the Connecting Point Group, is lined with boulders of granite, reddish rock of the Musgravetown Group and scattered pieces of Love Cove schists. As these rocks occur only to the west, once again movement must have been from the west toward the east. Some idea of the distance travelled by some of these boulders may be had from the occurrence, at the Lions Den and on the islands even farther east, of boulders of granite from the Terra Nova district, some 20 miles to the west.

Another clue concerning the direction of ice movement is found in the pattern of scratches made on the rock by the passing ice, and by the boulders and cobbles of hard rock that were frozen into the ice bottom. The pattern over the whole of Newfoundland suggests a movement generally outward from a centre near the Buchans region, with very strong local control along the margins of the island. This control means that the moving ice tended to follow deep valleys or deep indentations in its path rather than to cross them. What few *striae* or glacial scratches are visible in Terra Nova National Park confirm this explanation.

The best place to see such scratches is either along the shoreline, where waves are removing the protective cover of sands and gravels, or on the tops of road-cuts where recent construction has similarly exposed the rock surfaces as they were left long ago by the waning ice.

The drainage in Terra Nova National Park is typical of country that has been recently glaciated. Numerous ponds

and lakes show where valleys have been dammed by glacial debris. The brooks of the area are full of waterfalls and rapids because they have been pushed out of their old courses and forced to carve new valleys. Boulders and bouldery rapids occur along the brooks and, with the banks of sand and drift, indicate where the glaciers have deposited their load. Along the shoreline it is not uncommon to find waterfalls where brooks have been forced out of old courses and now tumble over the cliffs.

In many places the passing of the glaciers is also shown by extensive bogs, which may develop when shallow lakes gradually fill with the plant debris from their sides and with various mosses and aquatic plants that grow along their edges. The process by which the shallow lake fills up may continue until all the water is covered with boggy vegetation, and the lake may eventually disappear. Another kind of bog is produced when a different set of plants grows on boulder- or drift-covered areas that are nearly flat or gently sloping. When the layer of organic matter, which consists of roots and stems and partly decayed plants, gets to be several feet thick, it acts like a huge sponge and holds rain water and melted snow. This may mean soggy walking even in the midst of a dry summer. Several of these very large bogs exist in Terra Nova National Park and may be seen from some places along the highway or from the tops of hills as, for instance, from the Ochre fire tower. Some have several feet of peat, which is the accumulation of the particular kind of mosses and sedges that grow in them.

Glimpses of many beautiful inlets and arms of the sea may be had from the main highway. This view into the head of Southwest Arm is from a point about a mile south of the Trayton road junction.

In the past few years scientists have become increasingly interested in bogs, many of which have been accumulating plant debris for thousands of years. This means that as we dig down through these bogs, we go deeper and deeper into the record of recent geological history. The spores and seeds, the stems and roots, and other fragments of plants that are

preserved in them provide a more or less continuous record of the history of the vegetation in the area since the bogs began.

Sea-Level Changes over the Ages

When you travel to the seashore, you at once notice variations in sea-level as the waves come in and out and the tides rise and fall. Most people, however, think of the level of the sea as permanent in relation to the land. Engineers and surveyors view sea-level as the *datum plane* from which their land surveys begin. Wharves and harbours are built with the expectation that the level of the water will remain more or less constant. In some parts of the world on the other hand, seas are known to be withdrawing from the land and getting shallower. In others the sea is visibly encroaching upon the land. Studies of individual coastlines show that the sea-level has risen and fallen at different times in the geological past.

Deeply indented shorelines with numerous islands invariably mean that the ocean has invaded the land. Rivers carve valleys and leave hills behind. Glaciers sometimes modify their handiwork later. These processes take place largely on land. So if we find what look like river valleys submerged in the sea, with hills sticking up as islands, we can safely assume that at one time the sea-level was lower.

The deep coastal indentations of northeast Newfoundland in the general neighbourhood of Terra Nova National Park are a classic example of a drowned shoreline. Clode Sound and Chandler Reach to the south of the park, Newman Sound in the central area, and Alexander Bay to the north are all clearly parts of a river valley system that has been flooded by the sea. That it was modified by glacial action is indicated by the rounding of the topography, the great piles of boulders and glacial debris, and the glacial scratches along the sides. Marine charts show that the valley system to which these bays and inlets belong continues out underneath Bonavista Bay for many miles. This must mean that in the geological past the sea was much lower than it is now, with the result that a river system could carve the valley system where it is. It is likely that the principal valley systems were established long before glacial times.

When the whole of northern North America and many other parts of the world were covered with a great sheet of ice the withdrawal of water from the sea to form the ice on the land must have caused a considerable lowering of the sea-level. Estimates of the volume of ice on the land at that time and a knowledge of the area of the oceans has shown that the sea-level must have gone down at least 250 feet at the maximum of the glacial period. Thus, at this time the glacial ice was able to carve and modify the surface, which is now deep beneath the ocean, as though it were an ordinary landscape.

All around Newfoundland and up and down the eastern continental seaboard there is abundant evidence that at one time in the geological past the sea-level was much lower than it is now. The valley of the St. Lawrence River can be traced across the bottom of the Gulf of St. Lawrence and out under the Atlantic through what is now called Cabot Strait. Tributary valleys lead into the main valley on the gulf floor. Like Clode Sound, Newman Sound, and Alexander Bay, most of

the other deep inlets in Newfoundland can be followed out underneath the sea for many miles. It is interesting to speculate that at this time much of the Grand Banks must have been dry land. Scientists who have studied the ocean bottom in some of these areas are convinced that in times past, present-day sandy bottoms from off Cape Cod to Newfoundland existed as shore areas.

Until now we have looked only at the submergence of the land beneath the sea. The flat terraces visible on a trip to Eastport or Happy Adventure, just beyond the northeastern boundary of the park, indicate that the land has been uplifted from the sea in very recent geological time. Many of the villages of Newfoundland are built on flat terraces at the heads of bays or along their sides. Several low terraces may be seen along the shores and at the heads of coves within the park. These terraces are made of sand, gravel, or clay, which in many cases are clearly stratified or layered. Some of them contain recent marine shells of species still to be found in the sea nearby. One can only conclude that these deposits were laid down at a time when the sea was a little higher than it is now and that since then the sea has withdrawn.

What we have said about sea-level sounds almost self-contradictory, for in one place we say that the land has risen from the sea and in another that it has been submerged and that old valleys now lie deep beneath the surface of the ocean. Pondering a little further, however, we find that we need only to sort out the events. If a black-hulled vessel painted red below the water line were very heavily loaded, it would sink deep into the water, submerging all the red. If a small part of the load were taken off, the vessel would rise a little, perhaps enough to leave visible some of the red paint and certainly enough to expose evidence of having been more heavily laden. Newfoundland now appears to be in a similar condition, having slightly emerged in very recent times after having been very deeply submerged in times past. This sequence of events accounts for the obviously submerged coastline with valleys under the sea and the islands and inlets along the shore, and also for the uplifted terraces containing marine fossils.

Now, as you travel the shoreline of Terra Nova National Park, you will be aware that the ocean has not always been at today's level. In fact, many of the present features of the scenery were formed because the ocean rose and fell with relation to the land level. The story of shorelines seems all the more grand to us who have only a few score years to observe them when we think that their long evolution of rising and falling has taken place over millions of years.

Present Depth of the Sea

As you travel about Terra Nova National Park, you will often have occasion to look out over the flat surface of the sea and you may wonder about the shape of the bottom far below. We have already described how the principal inlets such as Newman Sound and Clode Sound are formed by submerged river valleys and have shown that the islands offshore are the tops of what once were hills. The rest of the bottom must be much like any rolling landscape, the one difference being that in this area the submerged valleys are a

great deal deeper and are steeper walled than the corresponding land that remains above the sea. For example, the submerged valley opposite where the trend of the shoreline changes from north-south to northeast-southwest, in the main body of Chandler Reach south of the Lions Den, goes as much as 800 feet below the present surface of the sea, and in some places is 600 feet deep within a few hundred feet of shore. It is very steep-sided indeed. The sea between Happy Adventure and Swale Island is as much as 900 feet deep, which means that below sea-level the relief is much greater than it is anywhere nearby above sea-level.

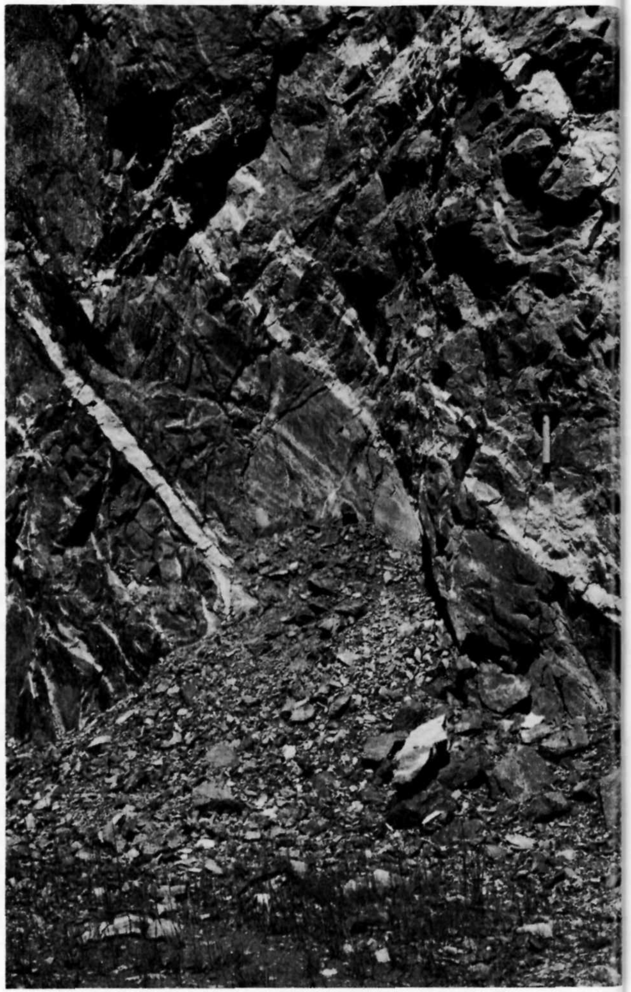
The bay at the head of Newman Sound, opposite the park headquarters area, is as much as 170 feet deep in spots but is generally pretty shallow. At its head even the gentle tides of this part of the coast uncover extensive flats. Beyond the narrows the water deepens gradually from 150 feet through 300 feet down to the greatest deeps which are opposite Sandy Cove. In the process it follows a more or less gently sloping profile, the main thread of the submarine valley passing out to the northeast on the north side of Swale Island. On the south side of the park the general trend is the same: a submerged valley gradually deepens seaward. Opposite Platter Cove the deepest waters are about 180 feet, and there is a considerable shallowing at the narrows just to the east. Between Charlottetown and Bunyan's Cove the deepest waters are 250 feet in the submarine valley, the maximum depths being more or less in the centre of Chandler Reach and gradually increasing seaward.

Knowing all of these things we can realize more clearly and with added interest — perhaps as we travel out over the sea or even as we let our eyes wander over its surface while standing on land — that a landscape still steeper than the dry one behind us, with hills and deep valleys, rugged broken places and extensive flats, lies buried out of sight beneath the waves.

ROADLOG

Stop No.	Miles from North-west Entrance	Miles from South-west Entrance	
1	26.2	0.00	Southwest gate, Terra Nova National Park, at Northwest Arm. Outcropping rocks in this section are generally reddish Musgravetown sandstone. Just outside the park boundary to the west can be seen extensive road-cuts and brook exposures of similar Musgravetown rocks.
2	24.6	1.6	Red and green outcrops of Musgravetown sedimentary rocks in road-cuts and ditches.
3	24.1	2.1	Picnic site, south side of the road. Scattered outcrops of red, sedimentary Musgravetown rocks can be seen along the road in this section. The picnic site is built on a flat terrace-like area a few feet above sea-level. Just back of the beach the terrace is seen to be underlain by sand and gravel, which have come from the reworking by water of glacial debris. All along the beach itself can be seen segregation of the particles according to size and mineral composition.
4	21.4	4.8	Mouth of a brook and a small beach at the head of Platter Cove. Debris pushed aside when the main highway was being built has made this beach much less attractive than it was in its natural state. Outcrops to the west of the head of Platter Cove are of Musgravetown rocks, while those to the east are of the Love Cove Group.

White veins of quartz (very hard) and calcite (much softer) occur in the sheared and broken rocks of the Love Cove Group in road-cuts near the quarry at Platter Cove.



ROADLOG (cont.)

Stop No.	Miles from North-west Entrance	Miles from South-west Entrance	
5	21.1	5.1	Cliffs of the Love Cove Group below a quarry. Dark grey-green rocks of the Love Cove Group form cliffs along the east side of the road in this section. They are streaked with veins of quartz and carbonate. You can see how very much the rock bleaches on weathering by contrasting the light grey to white surface on the top of the hill with the dark grey-green, fresh rock below. A very large quarry, from which much of the stone along the Trans-Canada Highway in the park area came, lies on the flank of the hill above these outcrops.
6	16.8	9.4	Series of long road-cuts in rocks of the Love Cove Group are conspicuous in this section.
7	15.8	10.4	Branch road to Charlottetown. Not far down this road a quarry is located in the rocks of the Love Cove Group, which are generally dark grey-green. The village of Charlottetown lies outside the park area about a mile beyond the turnoff. At Charlottetown itself the rocks are generally of the Love Cove Group. Musgravetown Group rocks, however, occupy the peninsula that lies southeast of the main part of Charlottetown and also east of a sharply marked gully northeast of the main settlement.
8	13.1	13.1	Bridge over Bread Cove Brook. The course of this brook is typical of those in glaciated country as it wanders from the high bogs,

ROADLOG (cont.)

Stop No.	Miles from North-west Entrance	Miles from South-west Entrance	
8 (*cont.*)			down through the gently rolling country into Bread Cove Pond and then into Bread Cove and the sea.
9	11.5	14.7	Branch road to the Ochre fire tower. A drive of exactly 2 miles will take you to a parking spot at the end of the road, a few hundred feet beyond which is the Ochre fire tower. In the magnificent view thus provided out over Terra Nova National Park, the dark-green coniferous forests and brown-yellow-green bogs give way here and there to the waters of the large lakes and the sea. The rocky knoll on which the fire tower stands is an excellent exposure of Musgravetown rocks, in which sandstone, conglomerate, and coarse aggregates of a variety of volcanic rocks are common. The park headquarters area at the head of Newman Sound is visible to the north.
10	10.8	15.4	Branch road to Terra Nova. Within the park area this road is almost devoid of outcrops, but a few exposures of the Love Cove Group occur near the park boundary. All along the road, but particularly to the west of the park boundary, large granite boulders that have come from very large areas of granite to the west are visible in road-cuts and in the woods beside the road. Extensive sand flats made of ground-up granite are also characteristic.

A road-cut below the quarry at Platter Cove shows the bleached white surface rock and the dark, grey and green of the fresh rock of the Love Cove Group now exposed. The covering on much of the road shoulders is from the quarry back of the hill to the right.

ROADLOG (cont.)

	Miles from		
Stop No.	***North-west Entrance***	***South-west Entrance***	
11	8.7	17.5	Bridge over Big Brook. This brook, which derives much of its headwater drainage from large peat bogs, empties into the head of Newman Sound.
12	7.7	18.5	Branch road to the park headquarters. A short distance down this road are the administration buildings of Terra Nova National Park. The main building is constructed of pieces of granite taken from glacial boulders on the western edge of the park. Outcroppings of rocks in the park headquarters area and at the dock on the shore of Newman Sound are of the Musgravetown Group. The shore of Newman Sound in the dock area and below the cabins, like the shore everywhere in this part of Newfoundland, is lined with glacial boulders of great variety. They are, however, mostly from outcroppings just to the west of their present location. Large white granite boulders are sometimes found.
13	5.6	20.6	Salton Brook crossing.
14	4.3	21.9	Branch road to the fire tower overlooking Blue Hill Pond. A walk into this fire tower will provide another expansive view of Terra Nova National Park.

◀ Official buildings in each of Canada's national parks are made of local stone. In Terra Nova National Park boulders of Terra Nova granite from glacial drift are used and give this appearance to the administration building.

ROADLOG (cont.)

Stop No.	Miles from North-west Entrance	Miles from South-west Entrance	
15	3.4	22.8	Southwest Brook crossing. This brook, with its valley lined with boulders and cobbles picked up by the glaciers as they passed over the land to the west, is typical of glaciated country.
16	1.8	24.4	Roadside stop for a view down Southwest Arm to East Arm. Several places near this point offer excellent views of Southwest Arm and the rolling hills.
17	1.2	25.0	Branch road to Traytown. The village of Traytown lies outside the park boundaries a little more than a mile and a half from this junction. The rounded granite knobs of the Louil Hills, which are in the park area, may be seen from the Traytown road at the top of the hill above the village. The shore road from Traytown to Eastport enters the park around the south shore of Northwest Arm and stays within the park boundaries for several miles. Granite of the Louil Hills forms road-cuts near the water level for about a mile and a half. Beyond the Broad Cove bridge, outcropping rocks are of the Connecting Point Group.
18	0.00	26.2	Northwest entrance to the park. The road along this section of the Trans-Canada Highway traverses an area of peat-covered, glacial debris formed mostly of very large

ROADLOG (cont.)

Stop No.	
18 *(cont.)*	boulders of granite of a great variety of kinds, grey and green chunks of slate and volcanics of the Love Cove Group, and a sprinkling of other rock types from farther afield. A small, glacially ponded lake south of the highway is visible from just inside the park boundary.

EPILOGUE

Terra Nova National Park is an area of typical coastal country in northeastern Newfoundland. Here you can penetrate the land deeply along protected arms of the sea or walk the shoreline on wave-washed rocks that show a variety of geological phenomena. You can walk in deep, dark woods of spruce and fir spangled with white birch and poplar or climb to hilltops to look out over bogs, lakes, and rolling hills to the sea. Here you can camp in quiet places where volcanoes once rumbled and spewed angular chunks of debris over the land. Here you can walk along road-cuts in rocks and scan in a few seconds the results of hundreds of thousands of years of slow sedimentation on the bottom of the sea, or place your hand on glacial scratches that were made on the rock 20,000 years ago. Here you can arouse the sensitivity to environment that lies deep in the instincts of us all.

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INDEX (cont.)

INDEX (cont.)

For more information on the geology of Terra Nova National Park see the following publications.

General Principles and Descriptions

A Guide to Geology for Visitors in Canada's National Parks, by D. M. Baird. Published by the National Parks Branch, Department of Northern Affairs and National Resources. Available from the Queen's Printer, Ottawa, or from any of the National Parks. This pocket-size book, written in layman's language, sets forth the general principles of geology with special reference to the National Parks of Canada (second edition, 1964, 153 pages, 48 illustrations).

Geology and Economic Minerals of Canada. Economic Geology Series No. 1 of the Geological Survey of Canada. Available from the Queen's Printer, Ottawa, or from the Geological Survey of Canada. This is a rich source of information on the geology and mineral deposits of all of Canada.

Maps and Technical Information

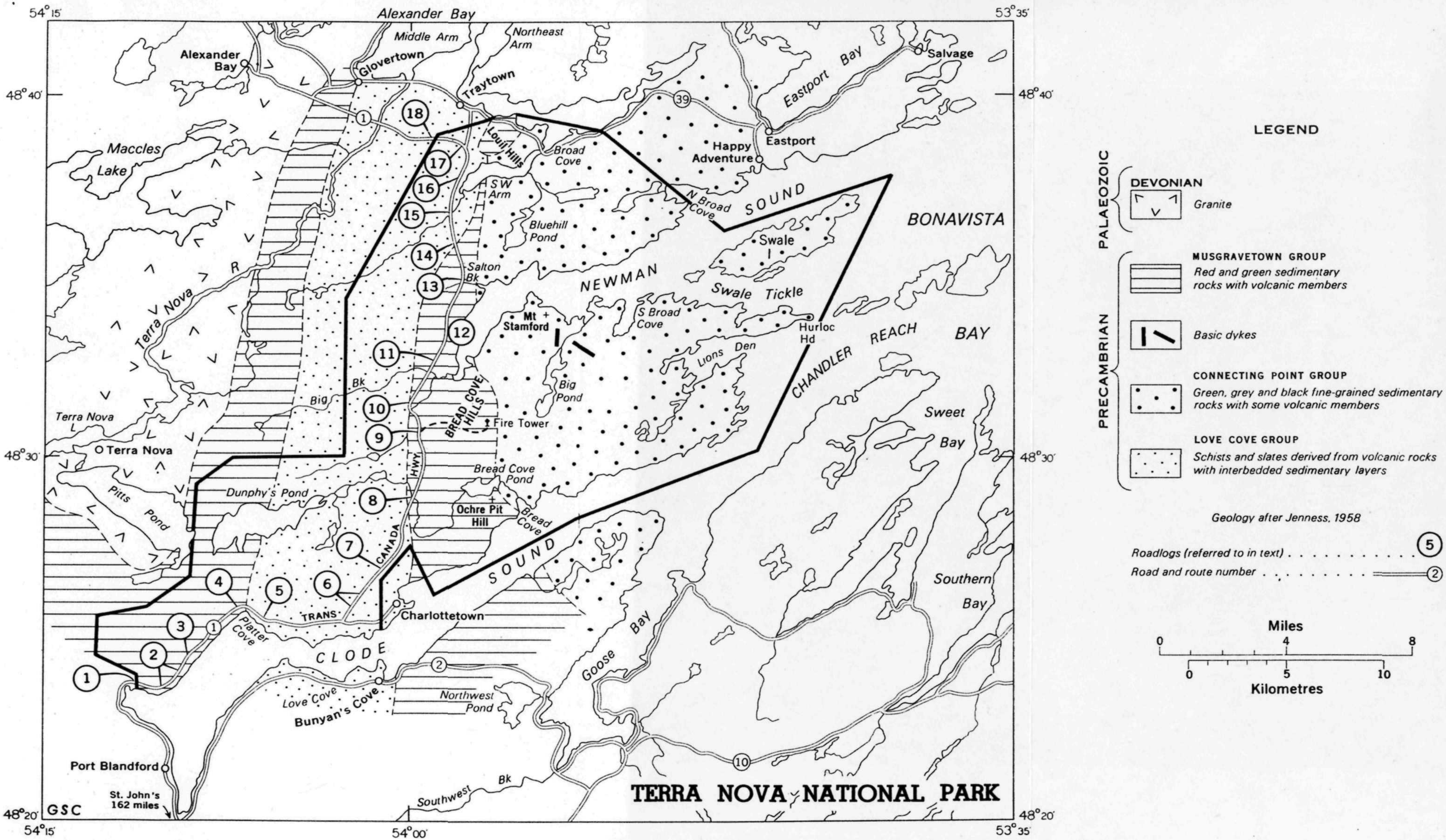
Geological Map of Newfoundland, by D. M. Baird. Scale: 1 inch to 12 miles. Geological Survey of Newfoundland (1954).

Geology of the Newman Sound Map-Area, Northeastern Newfoundland, by S. E. Jenness. Geological Survey of Newfoundland, Report No. 12 (1958).

Terra Nova and Bonavista Map-Areas, Newfoundland, by S. E. Jenness. Geological Survey of Canada, Memoir 327 (1963).

Particular questions of a geological nature concerning Terra Nova National Park should be addressed to the Director, Geological Survey of Canada, Ottawa.

For information on all other matters concerning the parks, write to the Director, National Parks Branch, Department of Indian Affairs and Northern Development, Ottawa.



TERRA NOVA NATIONAL PARK
Alexander Bay
Middle Arm
Northeast Arm
Glovertown
Traytown
Salvage
Eastport Bay
Eastport
Happy Adventure
Maccles Lake
Louil Hills
Broad Cove
SW Arm
N Broad Cove
NEWMAN SOUND
BONAVISTA BAY
Bluehill Pond
Salton Bk
Swale I
Swale Tickle
Mt Stamford
S Broad Cove
Hurloc Hd
Lions Den
Big Pond
CHANDLER REACH
Terra Nova R
Terra Nova L
Terra Nova
Big Bk
BREAD COVE HILLS
Fire Tower
Sweet Bay
Pitts Pond
Dunphy's Pond
Bread Cove Pond
Ochre Pit Hill
Bread Cove
TRANS CANADA HWY
SOUND
Southern Bay
Platter Cove
Charlottetown
CLODE
Goose Bay
Love Cove
Bunyan's Cove
Northwest Pond
Port Blandford
St. John's 162 miles
Southwest Bk
GSC
54°15'
53°35'
48°40'
48°30'
48°20'
54°00'
LEGEND
PALAEOZOIC
DEVONIAN
Granite
PRECAMBRIAN
MUSGRAVETOWN GROUP
Red and green sedimentary rocks with volcanic members
Basic dykes
CONNECTING POINT GROUP
Green, grey and black fine-grained sedimentary rocks with some volcanic members
LOVE COVE GROUP
Schists and slates derived from volcanic rocks with interbedded sedimentary layers
Geology after Jenness, 1958
Roadlogs (referred to in text)
Road and route number
Miles
Kilometres

GSC Miscellaneous Report 12