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DEPARTMENT OF MINES AND TECHNICAL SURVEYS

PAPER 60-12



# GEOLOGICAL OBSERVATIONS IN NORTHERN NEW QUEBEC

34 and 35 (parts of)

Ralph Kretz

Price, 50 cents

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CONTENTS



Illustrations

# GEOLOGICAL OBSERVATIONS IN NORTHERN NEW QUEBEC

This report is concerned with an area of approximately 45,000 square miles, in Northern Ungava. In July and August of 1959 a Dominion Observatory expedition entered the region to make gravity measurements. The writer was attached to that expedition to collect geological information.

The present report is based on

(1) geological observations at 320 points within the region;

(2) examination of rock specimens from 50 additional points that were not visited by the writer;

(3) more thorough observations at Port Harrison, Kenty Lake, Grunerite Lake, and a small area 20 miles south of Lac Couture;

(4) observations from a Beaver aircraft during approximately 6,000 miles of flying within the region;

(5) examination of air photographs.

Although a complete knowledge of the geology in so large an area could not be obtained in the limited time, an attempt was made to detect regional variations of metamorphic grade and structural style. Considerable attention was given to glacial geology.

## PREVIOUS EXPLORATION

Geological investigations on the east coast of Hudson Bay, within the region being considered, were carried out in 1877 by Bell (1879)[1], in 1898-99 by Low (1902), in 1933 by Gunning (1934), and in 1947 by Kranck (1951). Digges Island and Cape Prince of Wales on the south coast of Hudson Strait were visited in 1884 by Bell (1884), and the coast from Douglas Harbour to Joy Bay was examined in 1897 by Low (1899). In the interior, Aubert de la Rue (1948) made a traverse from Povungnituk Bay on the west coast to Payne Bay on the east coast. A large part of the area between Cape Smith and Wakeham Bay has been mapped by Bergeron (1957, 1959), Beall (1959), and De Montigny (1959). This work, sponsored by the Quebec Department of Mines, is presently (1959) being continued by Beall and Gold. East and southeast of the region covered by this report, is the northern part of the Labrador Trough. Considerable geological work has been done in this area by the Quebec Department of Mines and by mining companies.

Within the large region of New Quebec bounded by Hudson Bay, Hudson Strait, and Ungava Bay, nearly all of the available geological data obtained were from the coast, the Labrador Trough, and the area between Cape Smith and Wakeham Bay. The large central-interior region has remained practically unexplored.

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[1]Dates in parentheses are those of publications listed in the References.

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## PHYSIOGRAPHY

The region can be conveniently divided into four physiographic units: (1) the large interior plateau, which coincides with the area underlain by predominantly granitic rocks; (2) the Cape Smith - Wakeham Bay belt which is characterized by parallel ridges, and coincides with the belt of predominantly gabbroic rocks; (3) the area north of the Cape Smith - Wakeham Bay belt, which is a high plateau dissected by steep-walled fiords and river valleys and is underlain by gneisses and migmatites; and (4), the Hopewell Islands in Hudson Bay, which are high ridges with steep cliffs facing the mainland and which are made of gently dipping sedimentary and volcanic rocks.

### INTERIOR PLATEAU

The land surface of the interior of northern New Quebec is a gently sloping plateau. On the west it rises out of Hudson Bay and continues to rise in a northeasterly direction, reaching an elevation of about 1,800 feet near the New Quebec Crater. There the rim of the crater rises conspicuously above the plateau, to an elevation of about 2,200 feet above sea-level. Near longitude 72° W, the plateau drops more steeply to Ungava Bay. There, easterly flowing streams have cut deep valleys into the land surface, a feature not found in the western part of the plateau.

In detail, the surface of the Interior Plateau is extremely irregular and variable, although the local relief in general does not exceed 300 feet. Small scarps are numerous and tend to face the northeast. Lakes are extremely numerous. The land surface consists of exposed rock, felsenmeer, and moss-covered areas. The proportion of exposed rock ranges from 80 to 5 per cent and in general decreases with increasing elevation. In the east where the plateau is dissected by easterly flowing streams, rock exposures are locally abundant. Moss-covered terrain is more common than felsenmeer.

### CAPE SMITH - WAKEHAM BAY BELT

Towards the north there is an abrupt change from the Interior Plateau with its irregular topography and drainage, to an area characterized by easterly trending ridges; this is referred to as the Cape Smith - Wakeham Bay belt. The change coincides with a change of lithology from predominantly granitic to predominantly gabbroic rocks. It is only in the eastern part of this area that the change in topography is not conspicuous. There, various gneisses and schists take the place of the gabbroic rocks and the change in lithology is not pronounced.

In general, there is a slight rise in elevation as one enters the Cape Smith - Wakeham Bay belt from the south. As the Interior Plateau rises towards the east, the Cape Smith - Wakeham Bay belt similarly rises in that direction. At Mosquito Bay, near Cape Smith, the elevation of the highest ridges is about 1, 000 feet above sea-level, and in the east, near Wakeham Bay, elevations of about 2, 200 feet are attained. The surface of the Cape Smith - Wakeham Bay belt also falls off rapidly towards the east to Hudson Strait.

Towards the north, the Cape Smith - Wakeham Bay belt gradually merges with the high plateau of the northern extremity of the Ungava Peninsula.

In the western part of the Cape Smith - Wakeham Bay belt, ridges are well defined and continuous for several tens of miles. They are separated by broad, generally flat-bottomed valleys, which lie a maximum of 1, 000 feet below the ridge crests. Towards the east the local relief decreases to a maximum of about 400 feet. There the topography becomes more irregular in form, and much of the area is nearly flat, with occasional ridges or hills rising steeply above the surface. Still farther east, near Wakeham Bay, the ridge topography has nearly disappeared, and rivers have cut steep-sided gorges into the land, in places to a depth of 2, 000 feet.

Within the Cape Smith - Wakeham Bay belt, lakes are less numerous than to the south. The land surface is made of rock exposure, felsenmeer, and moss-covered areas. Rock exposures range from about 60 to less than 5 per cent of the land surface, and in general, are most abundant where local relief is greatest.

## NORTHERN PLATEAU

North of the Cape Smith - Wakeham Bay belt the ridges become gently rolling hills, which give way rather abruptly to a nearly flat plateau. This plateau will be referred to as the 'Northern Plateau'. The transition from ridge topography to plateau coincides approximately with a change from predominantly gabbroic rocks in the south to predominantly gneisses and migmatites in the north.

In the western part of the Northern Plateau, the land rises towards the north, whereas in the east the transition from the Cape Smith - Wakeham Bay belt to the Northern Plateau area is accompanied by very little change in elevation. Thus, in the northern part of the Northern Plateau, along the coast of Hudson Strait, the elevation of the plateau becomes uniform throughout at approximately 2, 000 feet above sea-level.

Northerly flowing streams have cut deep valleys into the plateau, and the dissected nature of the plateau is its most distinctive feature. Although some parts are remarkably flat, elsewhere the plateau contains gulleys and fiords up to 2, 000 feet deep.

Compared with the Interior Plateau, lakes are scarce. The land surface is made of rock exposure, felsenmeer, and moss-covered areas. Here also, areas of maximum rock exposure are more or less related to areas of maximum local relief. The proportion of rock exposure reaches a maximum of about 90 per cent on the northern coast. On the high flat areas of the plateau, rock exposures are scarce and felsenmeer is more abundant than areas of moss cover.

## HOPEWELL ISLANDS

The Hopewell Islands, together with the Nastapoka Islands and other parts of the east coast of Hudson Bay, form a distinct physiographic unit. The Hopewell Islands rise about 400 feet above the sea and form steep cliffs that face the Interior Plateau of the mainland. In contrast to the predominantly granitic rocks of the mainland, the islands are made of southwesterly dipping sedimentary and volcanic strata.

## BEDROCK GEOLOGY

Although the early geological explorations in northern Ungava were confined to the seaboard, they nevertheless established the major rock units, which may be summarized as follows:

- inclusions in granitic rocks, the remnants of a gneissic, pre-granite terrain;
- granitic rocks;
- gneisses and migmatites of the northern seaboard;
- the Cape Smith - Wakeham Bay belt, predominantly gabbroic rocks;
- the northern part of the Labrador Trough, predominantly metamorphosed sedimentary and gabbroic rocks;
- Manitounuk group (along the western seaboard), slightly disturbed and slightly metamorphosed basalt and sedimentary rocks;
- diabase dykes.

The present report deals with the granitic rocks and their inclusions, the gneisses and migmatites of the northern seaboard, rocks of the Cape Smith - Wakeham Bay belt, and the diabase dykes. Rocks of the Cape Smith - Wakeham Bay belt are described in greater detail by Bergeron (1957, 1959). The Manitounuk group of rocks found at the Hopewell Islands were not examined by the writer and will not be discussed.

## GRANITIC ROCKS

### Mineral Composition

Granitic rocks underlie a large part of the Interior Plateau, as outlined on the accompanying map. A remarkably large part of this area is underlain by rocks composed of quartz, potash feldspar, plagioclase, biotite, and hornblende. The potash feldspar/plagioclase ratio varies, and the rocks range in composition from granite to granodiorite. The quartz content also varies, ranging from about 30 to less than 5 per cent. Rocks with a low quartz content (syenite, diorite) are, however, relatively rare. The amount of biotite and hornblende ranges from about 30 to less than 1 per cent. Of the two minerals, biotite occurs alone more commonly than hornblende. As far as could be determined in the field, potash feldspar and plagioclase are most commonly present in approximately equal amounts, and thus quartz monzonite is the most abundant granitic rock present.

Other minerals observed in the granitic rocks are calcium pyroxene, sphene, magnetite, allanite, pyrite, epidote, chlorite, and muscovite. Epidote and chlorite occur commonly and muscovite or white mica is inferred also to be a common constituent; the remainder were rarely recognized in the field. Locally epidote occupies 5 to 30 per cent of the rock by volume, and it was not uncommon to find chlorite present to the exclusion of biotite and hornblende. Generally however, these minerals are present in minor amounts.

## Grain Size and Texture

The grain size of the observed granitic rocks ranges from 1/2 mm to 2 cm, the most common value lying within the range of 1 to 2 mm. Potash feldspar tends to form grains that are slightly larger than the rest, but distinctive porphyritic or augen textures were rarely found.

A pronounced gneissic structure is rarely present in the granitic rocks. More commonly there is either a faint gneissic structure or none at all. Linear gneissic structures were rarely observed. Locally the rocks show a distinct foliation, marked by the parallel orientation of biotite grains.

## Inclusions

Where the granitic rocks were examined in considerable detail, notably at Port Harrison, it was observed that they are not homogeneous. Instead they were found to contain inclusions of more basic rock and to be intermixed with non-granitic rocks on various scales of magnitude. These impressions were strengthened by numerous observations from the air, of interlayered light (apparently granitic) and dark (apparently amphibolitic) rocks. At many places on the ground, inclusions in the form of layers, irregularly shaped pieces, and schlieren, could be seen within single rock exposures. Although many exposures several hundred square feet in size are of granitic rock that is apparently homogeneous throughout, amphibolite or other non-granitic rock may nonetheless be present nearby. Conversely, some ground observations were entirely in amphibolite, pyroxenite, biotite-garnet gneiss, etc., but, as well as could be determined, these are only relatively large inclusions.

The inclusions are mainly assemblages of hornblende, biotite and plagioclase that may be termed amphibolite or hornblende-biotite gneiss. Minerals that occur in the granitic rocks are also common in the inclusions, such as epidote and chlorite. Other less-abundant rock types are pyroxene-hornblende-feldspar gneiss, biotite-garnet-feldspar-quartz gneiss, biotite-chlorite schist, pyroxenite, and soapstone. A foliation and gneissic structure may or may not be present.

Future mapping of the granitic terrain may locate areas in which the underlying rock contains more inclusions than elsewhere. For example, one such area is south of Klotz Lake. In contrast to areas underlain by more homogeneous granitic rock, air photographs of these areas tend to show numerous closely spaced parallel lineaments. One must conclude however, on the basis of the available data, that the lithology of the granitic terrain is so variable and the rock exposure is so inadequate that the drawing of lithological boundaries will rarely be justified.

## Structure

Planar features within the predominantly granitic terrain are marked by foliation (grain orientation), gneissic structure, tabular inclusions, and interlayered rocks of different appearance. Throughout the entire area the dominant strike is northerly and the dip is vertical. Folds have been observed within inclusions and some fold-like forms have appeared in plotting topographic lineaments. Apparently they are isolated fragments of folds, possibly remnants of a pre-granitic folded terrain.

Joint sets appear in the granitic rocks at nearly every exposure, and some of the innumerable lineaments are parallel with these joints. Some of the more conspicuous lineaments have been plotted on the accompanying map. Many of these are scarps, and it seems likely that most of them are faults.

## Metamorphism

The present study was expected to detect regional differences in metamorphic grade. Within the granitic terrain the results have been disappointing. The common assemblage--quartz, potash-feldspar, plagioclase, biotite, hornblende--is stable within the upper range of the amphibolite facies. The development of epidote and chlorite and the apparent alteration of plagioclase to white mica all indicate rather strongly that a retrograde recrystallization has taken place. Thus the last crystallization (though it may not have involved all the minerals) occurred at pressure-temperature conditions correlative with the epidote-amphibolite facies or the greenschist facies. In the granitic rocks that contain abundant epidote, the evidence that epidote has developed through retrograde rather than progressive metamorphism is not so strong or is absent, and these rocks may never have experienced temperatures greater than those of the epidote-amphibolite facies. The observed occurrences of epidote granites are indicated on the accompanying map.

The granitic assemblage, the common inclusions (hornblende-biotite-plagioclase), and some of the rarer inclusions (garnet-biotite-quartz-plagioclase, calcium pyroxene-hornblende-plagioclase) are all

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correlative with the amphibolite facies. Other inclusions however may be assigned to the epidote-amphibolite or greenschist facies. It is noteworthy that the metamorphic grade of inclusions and the enclosing rock is not always the same.

The development of inclusions in granitic rocks presents an interesting problem, one that remains practically unstudied; its solution would contribute greatly to an understanding of the development of the enclosing granitic rocks.

## GNEISSES AND MIGMATITES OF THE NORTHERN PLATEAU AREA

### Mineral Composition

Gneisses and migmatites outcrop along the northern coast and extend inland as far south as the Cape Smith - Wakeham Bay belt of predominantly gabbroic rocks.

The central part of this area, as outlined on the accompanying map, is underlain by biotite gneiss. This rock is composed of biotite, quartz, and feldspar (mainly plagioclase). Biotite comprises approximately 5 to 15 per cent of the rock by volume. Locally garnet or hornblende is present, and pyrite and magnetite can occasionally be detected.

Towards the east the bedrock becomes more heterogeneous and consists of biotite and biotite-hornblende gneisses and amphibolites interlayered with granitic rocks. These rocks may be referred to as migmatite, lit-par-lit gneisses, and veined gneisses. They are composed of biotite, hornblende, quartz, potash feldspar, and plagioclase, in various combinations and proportions. Locally garnet is present.

### Grain Size and Texture

The grain size of the common biotite-quartz-feldspar gneiss is fairly uniform, at 1 to 2 mm, but in the migmatite areas it varies widely. As is generally the case, potash feldspar and garnet when present tend to form relatively large grains.

An important feature of the gneisses and migmatites is their well-developed foliation and gneissic structure. In this way, these rocks differ from the granitic rocks to the south. Foliation is marked by a parallel alignment of biotite grains, and the gneissic, veined, and interlayered structures are produced by variations of mineral combination and proportion. These variations are apparent within areas ranging in size from a few inches to a mile square.

### Structure

The heterogeneous nature of the gneiss-migmatite rocks makes it possible to detect structural trends from the air. These trends (obtained from direct observations and air photographs) have been plotted on the accompanying map. The dominant trend is easterly, and the rocks form open irregular folds. Complex minor folds occur locally. Unlike the granitic rocks to the south, the gneisses and migmatites contain planar features which vary in dip and are more commonly inclined than vertical. With few exceptions, the rocks dip towards the north.

The area in the extreme northwest of New Quebec was not visited. The lineaments there indicate a structure similar to that found farther east, and it is inferred that this area is also underlain by gneisses or migmatites.

### Metamorphism

Eastward from Sugluk, within the area between Sugluk and Cape Prince of Wales, there appears to be an increase in the amount of migmatites and various kinds of mixed rocks. There is, however, no marked change of metamorphic grade within this area. Epidote, chlorite, and other minerals representative of the greenschist or epidote-amphibolite facies are rare, and all rocks are assigned to the amphibolite facies. At one place, however, near Foul Bay, is a rock composed of garnet, biotite, hornblende, quartz, and plagioclase, and the plagioclase has the yellow-brown colour characteristic of the granulite facies.

## CAPE SMITH - WAKEHAM BAY BELT

A belt of predominantly gabbroic rocks extends from Cape Smith to Wakeham Bay. Nickel and copper minerals were discovered in these rocks and much prospecting and exploration was done there in 1957 and 1958. In 1959 this work had almost completely stopped.

### Lithology

Volcanic and sedimentary rocks are present in the Cape Smith-Wakeham Bay belt. The volcanic rocks include basalt, andesite, gabbro, diorite, pyroxenite, and hornblendite. The grain size is commonly 1 mm or less and it is difficult to determine if the rocks have formed as flows or sills. It appears unlikely that any of the rocks formed much below the surface. Some of the basalts and andesites are massive and some show a faint and irregular cleavage; the latter also commonly contain quartz-carbonate veins. The gabbro-diorite rocks may be either massive or foliated and gneissic. In either case they seem to be composed predominantly of plagioclase, pyroxene and hornblende, with biotite appearing locally. An area in the north-central part of the belt, roughly indicated on the map, is underlain mainly by gneissic gabbro or diorite. In the eastern part of the belt also, the gabbroic rocks take on a gneissic structure; this was visible, for example, at Grunerite Lake.

Sedimentary rocks are interlayered with the gabbroic rocks but are less abundant. Towards the east, particularly in the northern part of the belt, the sedimentary rocks apparently increase in volume, and a thick section of mainly sedimentary rock is exposed in the long lake southeast of Deception Bay.

The sedimentary rocks are predominantly very fine-grained shale, argillite, slate, and phyllite. Muscovite and chlorite appear to be major constituents, and biotite appears locally. In the eastern part of the belt the sedimentary rocks change to fine-grained biotite-chlorite schists, and ultimately, in the vicinity of Grunerite Lake and Joy Bay, to coarse-grained biotite schists, biotite-garnet schists, and biotite-hornblende schists and gneisses.

An iron-bearing rock occurs at the base of the Cape Smith - Wakeham Bay rocks, and is exposed along their south contact. It was observed at intervals both on the ground and from the air between longitudes 71°50' and 75°45', and appears to be thickest in the east. The minerals found were magnetite, quartz, carbonate, cummingtonite, actinolite, and biotite. The highest content of iron is in a fine-grained, quartz-magnetite rock.

## Structure

In many places it is difficult to detect bedding planes in the rocks of the Cape Smith - Wakeham Bay belt and the structural form is hard to determine. The pronounced ridges on the land surface are evidently strike ridges for they correspond in some places with slight changes in the colour of gabbroic rocks. This would seem to establish the strike but the dip commonly remains unknown. The few data that were obtained indicate that the rocks dip north along the south contact and form broad open folds. Examination of the lineaments indicates that the folding is more irregular towards the east.

Examination of the accompanying map suggests that the entire belt is folded by shortening in an east-west direction, although it is possible that this fold-like form may in part be an attribute of the terrain on which the rocks of the belt were deposited.

## Metamorphism

The gabbroic rocks of the Cape Smith - Wakeham Bay belt evidently first crystallized at magmatic temperatures. Though the mineral compositions of many of these rocks is difficult to determine in the field, it appears that hornblende - calcium pyroxene - plagioclase is a common assemblage. As this assemblage is stable at temperatures of the amphibolite facies as well as at magmatic temperatures, it does not suggest whether or not the rocks have been recrystallized. Consideration of the texture and structure is perhaps helpful. For example, a large area in the north-central part of the belt is underlain predominantly by a gabbroic (hornblende-plagioclase) rock that displays a marked gneissic structure. Presumably this structure developed during recrystallization at pressure-temperature conditions correlative with the amphibolite facies. A similar development of gneissic structure appears towards the east, for example at Grunerite Lake and eastward, suggesting similar recrystallization there.

At several places within the belt, excluding the north-central and extreme eastern parts just referred to, a cleaved or foliated rock of andesite or basalt composition was found. Though the rocks are very fine grained, it appears that chlorite and white mica have formed. If so there has occurred at many places a retrograde recrystallization to the pressure-temperature field of the greenschist facies.

Many of the sedimentary rocks of the Cape Smith - Wakeham Bay belt are slates, phyllites, and fine-grained schists. These rocks apparently contain chlorite and muscovite, and have evidently formed from shale and other sedimentary rocks by a progressive recrystallization to rocks of the greenschist facies. This metamorphism may have occurred at the same time as that which has produced the foliated andesite-basalt rocks.

In the eastern part of the Cape Smith - Wakeham Bay belt are certain schists and gneisses. At least some of these lie immediately above the basal iron-formation and must thus be correlated with the sedimentary units that occur to the west. They are composed of various combinations of chlorite, biotite, garnet, hornblende, cummingtonite, plagioclase, and quartz. These rocks were found at Grunerite Lake, in the two outliers of belt rocks to the south, and near Joy Bay to the northeast. Biotite-hornblende-plagioclase, and biotite-garnet-plagioclase-quartz are common assemblages, both being characteristic of the amphibolite facies. The local presence of chlorite schist may have resulted either from the failure of the rocks to reach equilibrium during progressive metamorphism, or from a local retrograde metamorphism.

In summary, the last crystallization within most rocks of the Cape Smith - Wakeham Bay belt appears to have occurred at magmatic temperatures. Some rocks have recrystallized at temperatures correlative with the greenschist facies. The latter crystallization has occurred by progressive metamorphism in the sedimentary rocks and retrogressive metamorphism in volcanic rocks. In the north-central and eastern parts of the belt the last crystallization has occurred at temperatures correlative with the amphibolite facies. In the eastern part of the belt, near Grunerite Lake the transition from greenschist facies to amphibolite facies has evidently taken place within a zone less than 12 miles wide.

## Relationship of Rocks of the Belt to Rocks on Either Side

As previously noted the Cape Smith - Wakeham Bay rocks appear to dip northerly along their south contact, and thus appear to overlie the granitic rocks that are exposed to the south. Bergeron (1957) considered this contact to be an unconformity.

The southern contact was examined by the writer at Grunerite Lake and 4 miles west of Joy Bay. At both places the gneissic structure in the underlying granitic rocks is parallel with the gneissic structure, schistosity, and layered structures in the overlying rocks of the Cape Smith - Wakeham Bay belt. The section at Grunerite Lake, over an approximate length of 4 miles, is as follows:

Underlying the area southwest of Grunerite Lake is a heterogeneous granitic or syenitic rock, composed of various combinations and proportions of quartz, plagioclase, potash feldspar, pyroxene, hornblende, and biotite. Mineral distribution is irregular and grain size is about 1 mm; strike of the gneissic structure is N40°E and dip is vertical.

North of this is an area underlain by a fine-grained, biotite-quartz-feldspar rock with irregular mineral distribution and faint foliation; trend of foliation is N50°E, dip is nearly vertical. Amphibolite lenses are locally present.

North again, beyond Grunerite Lake, is a fine-grained biotite gneiss like that immediately to the south but better foliated; strike is N50°E, dip is approximately 70°NW decreasing progressively toward the north.

The biotite gneiss is overlain by iron-formation composed of various combinations of cummingtonite, magnetite, actinolite, quartz, carbonate, and biotite, with a garnet-biotite-cummingtonite-quartz schist at the base. Magnetite-quartz and magnetite-quartz-cummingtonite are common assemblages; laminated structure is conspicuous. Strike is N50°E, dip is 40°NW. Axes of crenulations plunge 10°W; minor folds of similar plunge occur locally. Thickness of iron-formation at this point is approximately 600 feet.

The iron-formation is overlain by foliated basic amphibolite and minor biotite-chlorite schist, which appear to continue north for a considerable distance.

It is uncertain at present whether the base of the succession in the belt should be placed at the base of the iron-formation, at the base of the biotite gneiss, or at the base of the fine-grained biotite-quartz-feldspar rock. In any case, the contact is parallel or nearly parallel with the gneissic structure and foliation in the underlying rocks, and there is therefore little evidence of an unconformity.

The north contact of the Cape Smith - Wakeham Bay belt was not examined by the writer, but is reported by Bergeron (1959) to be gradational and stratigraphically continuous.

The available data indicate that some of the granites and gneisses in northern New Quebec are older than the time of deposition of the rocks of the Cape Smith - Wakeham Bay belt and some are younger, while others may be contemporaneous. Much of the granitic rock to the south of the belt appears to be older, but it is possible and likely that some of it was remobilized during the folding of the belt rocks. Some granitic rocks were found within the belt (Bergeron, 1959), and are younger than the belt rocks. The granite mass east of Bilson Lake, shown on the accompanying map, appears to have been emplaced after the belt rocks were folded, and may be considerably younger than these rocks.

## MANITOUNUK GROUP

In the area, the Manitounuk group of basalt and sedimentary rocks occurs only at the Hopewell Islands. The rocks are described in detail by Low (1902).

## DIABASE DYKES

A swarm of diabase dykes, more than 120 miles long, extends southeasterly from near longitude 75° 00' through the Klotz Lake - Lac Nantais area, to beyond the eastern boundary of the map-area at longitude 72° 00'. The dykes shown on the map have been located by a few ground observations, numerous air observations, and a careful examination of air photographs.

Many dykes, for instance those at Lac Nantais, are arranged en echelon. Locally they bifurcate. The longest single dyke (i.e. an individual of an en echelon group or a swarm) is 24 miles long. The thickness ranges from about 10 feet to 300 feet.

Numerous diabase dykes were also observed along the eastern boundary of the region, north and south of latitude 61° 00'. There the trend is both northwest and northeast. Other dykes were seen at widely separated places and not all are shown on the map.

The diabase is black and is apparently composed of plagioclase and pyroxene or hornblende. The grain size is very fine near the borders, and reaches a maximum of about 2 mm in the interiors of the thickest dykes. The rock is massive, and the texture is sub-ophitic. The composition is apparently rather uniform, as is indicated by a uniform density of about 3.08 gms /cc.

The granitic rocks, the gneisses and migmatites to the north, and the rocks of the Cape Smith - Wakeham Bay belt are all cut by diabase dykes. One dyke that cuts across the southern contact of the Cape Smith - Wakeham Bay belt 20 miles west of the New Quebec Crater, is parallel with the Klotz Lake - Lac Nantais dyke swarm and may be of the same age. If so, all dykes of the swarm are younger than the layered rocks of the Cape Smith - Wakeham Bay belt.

## MINERAL DEPOSITS

The iron-bearing rock at the base of the Cape Smith - Wakeham Bay belt has already been described. This rock should be more thoroughly examined as a potential source of iron.

Several areas of gossan were observed from the air, some of which have been indicated on the accompanying map.

## SURFICIAL GEOLOGY

Northern New Quebec is an interesting place in which to study glacial and post-glacial history. Glacial features such as moraines, drumlins, striae, glacial valleys, eskers, and kames are abundant and indicate that ice moved radially from central New Quebec during late Pleistocene time.

### Ground Moraine

A large part of the land surface consists of felsenmeer, i.e. a plain of loose rock fragments. The fragments are angular to somewhat rounded, and range from pebble-size to large blocks several feet in diameter. Most of this loose material appears to be ground moraine, but some of the fragments have not moved far and the material evidently represents bedrock that has disintegrated in post-glacial time. Possibly some of these fragments formed at an earlier time but were not moved by the Pleistocene ice and cannot be considered ground moraine.

### Minor Moraines

A belt of minor moraines (see map) extends northward along the east coast of Hudson Bay from the latitude of Port Harrison (58° 30'N ) to latitude 62° 00'N, a distance of 240 miles. The belt ranges in width from about 10 to 60 miles. The general trend is northerly, with numerous arcs concave towards the interior. Individual ridges are a few feet to a few tens of feet high and are spaced at intervals of approximately 600 to 1,000 feet.

The minor moraines are composed of a mixture of rock fragments, mainly angular, that range in size from very fine to very coarse. West slopes of the ridges appear to be consistently steeper than the east slopes, and to contain coarser fragments.

### Other Features

Drumlins occur locally notably west of Lac Couture (see map). They were plotted with the help of air photographs.

Glacial striae are most abundant along the coasts, and are more conspicuous on the west coast than on the north.

Eskers are numerous and not all are indicated on the accompanying map. The most conspicuous occur east of the North Payne River. There numerous parallel eskers can be traced along straight lines for 16 miles. The eskers are commonly 20 to 40 feet high, and form remarkably sharp ridges. The ridge lines meander in both horizontal and vertical planes. Satellite ridges and masses are common. The eskers are made of material ranging in size from sand to boulders about a foot in diameter. Most fragments are faintly to moderately rounded. Locally, eskers are composed of blocks about 2 feet in diameter, and in places even larger angular blocks may be seen partly embedded in the esker material.

Kames have been seen from place to place in the area, but are not shown on the accompanying map.

U-shaped glacial valleys may be seen along the south coast of Hudson Strait.

## Direction of Ice-flow

The region under consideration is divided into seven areas, and the direction of ice-flow within each area is noted on the basis of minor moraines, drumlins, striae, and eskers. The data are presented in the table on the following page.

It is apparent that the most recent continental ice-sheet flowed northward, westward, and eastward from the interior of northern New Quebec. The inland projection of striae, drumlins, and lines normal to minor moraines do not intersect at a point in the interior. It is therefore not reasonable to consider a centre of accumulation or a centre from which ice moved radially.

It is however noteworthy that the central area, as defined in the table, is remarkably devoid of glacial features such as minor moraines, drumlins, striae, eskers, and kames. Deposits of sand are also nearly absent there, as is indicated by the absence of sand beaches on the lake-shores. The impression is that this was an area in which very little glacial material was deposited, and it is reasonable to infer that it is from this area that the ice moved radially.

It is probable that, in detail, the processes of ice accumulation and movement were complex and that the directions of ice-movement changed from time to time. An indication of this may be seen for example at Port Harrison, where glacial striae show that the ice first moved S65° W and then S45° W.

## Maximum Transport of Fragments by the Ice

The contact between predominantly granitic rocks and predominantly gabbroic rocks extends in an easterly line across the Ungava Peninsula. The presence of large granitic fragments to the north of the contact and the absence of fragments of gabbroic and sedimentary rocks to the south confirms the northerly direction of ice-movement in this part of the area. In the central part of the Cape Smith - Wakeham Bay belt, where other evidence exists to indicate a nearly northward movement of ice, it is possible to determine the distance that granitic fragments have been moved. On the basis of several ground observations, it was determined that 8 miles north of the contact, only about 1 per cent of the loose rock fragments of the felsenmeer are granitic. Nearly all of the load of the continental glacier was therefore transported less than 8 miles.

As previously noted, glacial striae and other glacial features are more abundant on the western seaboard of the area than on the northern seaboard. Evidently a larger volume of ice and rock fragments moved to the west than to the north.

Direction of Ice-flow in Northern New Quebec

| Area | Boundaries | | Direction of Flow as Inferred from | | | |
|---|---|---|---|---|---|---|
| | Lat. | Long. | Minor Moraines | Drumlins | Striae | Eskers |
| Southeast | 59° 30' - 61° | 72° - 74° | - | N40° E | - | N60° -east |
| Northeast | 61° - 62° 30' | 72° - 74° | - | N50° E | N60° E | N50° E |
| North-central | 61° - 62° 30' | 74° - 76° | - | - | north-N30° E | north-N60° E |
| Northwest | 61° - 62° 30' | 76° - 79° | S60° W-N60° W | - | west-N70° W[1] | - |
| West | 59° 30' - 61° | 76° - 79° | S50° W-N70° W | S80° W-N70° W | west[2] | west-N70° W |
| Southwest | 58° - 59° 30' | 76° - 79° | S70° W-N60° W | S85° W-west | S35° W-N65° W | - |
| Central | 59° 30' - 61° | 74° - 76° | - | west-N85° W[3] | N70° W-N65° W | S50° -N60° W[4] |

[1] Low (1902); north at Digges Sound
[2] Low (1902)
[3] Drumlins in southwest corner only
[4] Eskers nearly absent

## NEW QUEBEC CRATER

A feature of considerable geological interest is the New Quebec meteor crater (Meen, 1950, 1957; Harrison, 1954; Millman, 1956). Harrison (1954) concluded that the crater formed prior to the most recent glaciation. Observations by the writer confirm this conclusion.