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I. M. Stevenson

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ABSTRACT

This report briefly describes a geological reconnaissance of approximately 50,000 square miles of northern New Quebec, made by helicopter during 1963. The work is a continuation of Operation Leaf River, the initial phase of which was completed in 1961.

The greater part of the map-area is underlain by a mixed assemblage of Archaean granite-gneisses, ranging in composition from granite to granodiorite. Amphibolitic material in variable amounts is present as angular inclusions in the gneisses. Much of the granitic gneiss is derived from sedimentary material. Included in the gneisses are ancient metamorphosed volcanic and sedimentary rocks in which relict structures have been preserved. A yellowish green, hypersthene/clinopyroxene-bearing granite-gneiss forms a distinctive unit. Areas of massive pink to grey granite occur randomly throughout the area. Two prominent swarms of northwest-striking diabase dykes cut the granite-gneiss in the northern part of the map-area.

Volcanic and sedimentary rocks of the Cape Smith - Wakeham Bay belt, of Proterozoic age, outcrop in the northwest corner of the area. Sedimentary and volcanic rocks, preserved in synclinal basins north of Payne Bay, mark the northern limit of the Labrador Trough rocks. The Manitounuk Group of sedimentary and volcanic rocks is well exposed in the Nastapoka and Hopewell chain of islands, and around Richmond Gulf.

LEAF RIVER MAP-AREA,

NEW QUEBEC AND NORTHWEST TERRITORIES

The area dealt with in this report is a northward and westward extension of Leaf River map-area, studied in 1961 (Stevenson, 1963)[1]. In the 1963 phase of Operation Leaf River, two Bell 47G2A helicopters were employed, plus a float-equipped Otter aircraft for support purposes. In the shipping season of 1962, bulk food supplies and aviation gasoline were shipped via Hudson's Bay Company boat from Montreal and stored at the company's posts at Great Whale River, Port Harrison, Povungnituk, Payne Bay, and Fort Chimo, for use as required in 1963. Active mapping commenced on June 11th at Richmond Gulf immediately after opening of the lakes in that area. Mapping progressed northward as the lakes opened and altogether five camps were established during the season. To escape the menace of sea fog from Hudson Bay, camps were situated inland, approximately along the 76th parallel of longitude.

For a period of approximately two weeks, H.H. Bostock was detached from the main party to carry out a detailed examination of the Clearwater Lake area, in order to further the study of this phenomenon made by Kranck and Sinclair (1963). The volcanic origin of the islands in the lake was confirmed. An age determination on a specimen of dacite from one of the islands yielded an age of about 300 m.y. The results of Bostock's investigation will be published in a separate report.

The method employed in mapping the area consisted of laying out a north-south base line through each camp, which was situated close to the centre of the area to be mapped. From the base line a series of about fourteen east-west traverses, spaced equidistantly 6 miles apart, was flown. Air observations were made from as low an altitude as practical, usually from a height of less than 100 feet. Landings were made whenever necessary to identify the bedrock, but for precautionary measures, always on or close to the predetermined traverse line. It is stressed that in this type of operation, where safety and time are the main factors, the mapping is, of necessity, strictly of reconnaissance nature. Only rarely can contacts between the various rock types be accurately determined and examined.

The vegetation over practically the entire area is typically tundra-type, consisting mainly of scrub willow, caribou moss, and lichen. Black spruce and a few scattered birch trees grow in the more sheltered valleys and lake borders in the Richmond Gulf area. A comprehensive description of the vegetation of the region has been published (Hare, 1959).

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[1] Names and dates in parentheses refer to publications listed in the References.

That part of the map-area between 56°00' and 60°00'N is readily accessible by float-equipped aircraft from Great Whale River, Port Harrison, and Povungnituk. Between 60°00' and 61°00'N access is from either Povungnituk, Payne Bay, or Fort Chimo. Extreme tidal conditions at Payne Bay post make it necessary to use a narrow, deep, inland lake, named "Post Lake", 1 mile north of the village. Most of the larger lakes in the map-area are suitable for float-equipped aircraft, but the rivers are in general shallow and rapid. Although many of the latter are passable by canoe, frequent portaging is necessary.

The map-area forms part of a gently rolling, peneplaned plateau that rises from sea-level at Hudson Bay to an elevation of about 1,700 feet in the extreme northeast corner of the area. Near 73°00'W the slope of the land changes, and drainage is southeast into Ungava Bay.

Geomorphologically, the region in the vicinity of Richmond Gulf is the most interesting part of the entire map-area. Flows and sills, many displaying prominent columnar jointing, have preserved the underlying less-resistant sedimentary rocks. The region has been extensively block-faulted, and gently folded in some places. Around the gulf the hills rise more than 1,500 feet above sea-level. A comprehensive description of the Richmond Gulf area has been given elsewhere (Low, 1902; Bell, 1879).

From Richmond Gulf to about latitude 58°00'N the coast is fairly regular, with no large indentations. Inland from the coast the terrain rises sharply from sea-level to a height of almost 1,000 feet in the southern section, with the relief gradually decreasing northward toward Portland Promontory. There is apparently an ancient range of hills parallel to the coast, extending inland for several tens of miles. This range becomes gradually more subdued and narrow to the north, until only a single row of hills with an elevation of about 500 feet remains in the vicinity of Port Harrison. North of the 58th parallel the coast becomes much more indented and the topography more subdued. Individual hills composed of resistant basic rock types rarely exceed 400 feet in height. North of Portland Promontory the coastline is quite irregular, and the land surface rises relatively gently toward the east. The northeast-trending ridges of the Cape Smith - Wakeham Bay belt of rocks form a distinct physiographic unit that rises abruptly to a height of about 1,000 feet above sea-level.

The western part of the area between latitudes 60°00' and 61°00'N, with the exception of the Cape Smith - Wakeham Bay belt, is a rolling plateau with numerous lakes and rivers. Local relief varies from 100 to 300 feet, with the overall elevation increasing gradually from sea-level at the coast of Hudson Bay to more than 1,700 feet in the northeastern part of the area. East of 73°30' longitude there is a marked decrease in the number of lakes, and sheltered campsites are difficult to find. The west coast of Ungava Bay is roughly indented and affected by extremely high tides.

The Nastapoka Islands and Hopewell Islands form a distinct physiographic unit. They are composed of sedimentary and volcanic rocks that dip gently seaward, forming steeply dipping cuestas facing the mainland. Elevations of the islands rarely exceed 400 feet.

The entire area has been extensively glaciated. Glacial features such as striae, moraines, drumlins, eskers, kames, and roches moutonnees are abundant. Over much of the area, the bedrock is more or less effectively obscured by a mantle of boulders, sand, etc. Glacial striae are more abundant near the coasts, and several directions of ice-flow are indicated.

Inland from the coast the entire region was practically unexplored geologically. Early overland trips by Low (1889, 1898) were confined to the major water routes in the southern part of the area, and more detailed examinations of the coastal regions were made by Low (1901, 1902) and Bell (1879). More recently, Kranck (1951) carried out a rather detailed examination of the coast south of latitude 59°00'. Areas of economic interest have been examined at various times by Woodcock (1960), Gunning (1934), Lee (1961), Bergeron (1957), and Gross (1961). The first general geological reconnaissance of the area between latitudes 60°00' and 61°00' was made by Aubert de la Rue (1948) when he travelled by canoe from Povungnituk to Payne Bay. More recently, Kretz (1960) examined a large part of the map-area north of latitude 59°00'. Those areas near Ungava Bay underlain by iron-formation have been examined by various interested companies[1].

The greater part of the map-area is underlain by a mixed assemblage of granite-gneiss (2), derived primarily from sedimentary material. Included in these gneisses, in variable amounts, are remnants of ancient metamorphosed volcanic and sedimentary rocks (1) in which relict structures are commonly discernible. In various localities these inclusions form the dominant rock type, to the almost complete exclusion of the granite-gneiss. The inclusions are evidently remnants of a pre-granite terrain, and fragments of ancient flows, sills, and dykes are still recognizable. In a few localities, as at Porpoise Cove, bedded metamorphosed iron-formation has been preserved. Generally the inclusions consist of amphibolite, pyroxenite, meta-gabbro, hornblendite, biotite gneiss, and rare fragments of iron-formation.

The granitic gneisses of unit 2 for the most part range in composition from granite to granodiorite. Amphibolitic inclusions are almost everywhere present, although this fact is not always readily apparent from ground observations. In some localities, as at Portland Promontory, the gneisses are undoubtedly paragneisses, formed from alternate light and dark bands of quartz and biotite-rich sediments respectively. The primary bedding is well preserved and readily apparent from the air. In other areas, pyrobole inclusions are so numerous that the rock is more properly designated as amphibolite. Migmatization is a common feature of the granite-gneisses and is

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[1] Private reports on file with Geological Survey of Canada.

prevalent throughout the entire map-area, although best exposed in the coastal regions.

The common mineral assemblage of plagioclase, potash feldspar, quartz, biotite, and hornblende places the granitic gneisses of unit 2 in the amphibolite facies that is so widely distributed in Precambrian terrain. The presence of epidote, chlorite, and in a few instances, small amounts of white mica, is indicative of retrograde metamorphism, and some of the rocks may be placed in the epidote-amphibolite or even greenschist facies. The metamorphic grade of the inclusions and the host rock do not necessarily correspond. Scattered haphazardly throughout unit 2 are areas of rust-weathering, grey, garnetiferous, quartz-biotite-plagioclase schist that grades into the surrounding gneisses. Augen structure was noted at a few localities.

The yellowish green granite and granite-gneiss of unit 3 forms a distinct map-unit, characterized mainly by the resinous, olive-green lustre of the feldspars and the presence of hypersthene and/or clinopyroxene. Pink garnets, as well as blue quartz, are common constituents. In many instances, although not invariably, these "charnockitic-type" rocks reveal a distinct granulitic texture. Disintegration of the biotite through weathering imparts a friable, rust-coloured surface to much of this unit. These rocks have been described elsewhere (Eade, 1959; Stevenson, 1963).

The granites and related rocks of unit 4 are distinguished in the field by their general homogeneity and lack of structure. Horizontal sheeting with attendant vertical jointing is a common feature in the more massive areas. In outcrops, foliation is absent or faint, but from the air a distinct lineation can usually be recognized. Contacts with the surrounding gneisses are in most instances gradational, but in a few localities were found to be sharply intrusive. The rocks of unit 4 may be porphyritic, with randomly orientated individual feldspar crystals up to 3 inches long. The rocks of this unit vary from pink to grey, depending on the biotite-hornblende content. Pryobole fragments, usually angular, may be present in variable amount.

Pegmatites are everywhere present throughout the area, usually as veins cutting the host rock. In a few instances, intrusive bodies of pegmatitic material of considerable areal extent were noted. They were of insufficient size, however, to form a mappable unit.

Small plutons of basic and ultrabasic rock (6) occur as resistant knobs protruding above the surrounding terrain. They are composed mainly of pyroxene, hornblende, altered feldspar, and rarely olivine. Many of these intrusions are of gabbroic composition. An interesting body of peridotite and gabbro outcrops just north of Payne Bay (Stevenson, 1964).

Diabase dykes (7), rarely exceeding 300 feet in width, are present in two distinct swarms striking approximately N60°W and N30°W respectively between latitudes 60 and 61°. A few scattered dykes with a south-southeast strike are found west of longitude 75°.

Many of the dykes in the two main swarms are arranged en echelon. Locally, individual dykes may bifurcate. In thin section the diabase is seen to have a subophitic texture, and is composed of plagioclase, augite, and hornblende. The age of the swarm of dykes that strikes N60°W is approximately 2,200 m.y.[1], but the age of the other swarm is not known. North of the map-area, rocks of the Cape Smith - Wakeham Bay belt are cut by at least one dyke of the swarm that strikes N30°W[2].

The Cape Smith - Wakeham Bay belt of rocks (8) is a well-exposed group of northeast-trending volcanic and sedimentary rocks overlying the gneisses of unit 2. The volcanic series includes gabbro, andesite, basalt, diorite, hornblendite, and pyroxenite. The less-abundant sedimentary series includes fine-grained slate, argillite, phyllite, and shale. Both series are exposed in well-defined, parallel strike ridges that display very little structure. Where dips can be determined, they are toward the north. The belt has been divided into an upper series and a lower series by Bergeron (1957), but in the present report a distinction has been made between the sedimentary and volcanic series only.

<u>Sedimentary Series (8a)</u> - Archaean granite-gneisses of unit 2 are overlain by a series of sedimentary rocks (8a), the basal part of which consists of relatively unaltered, fine-grained, grey dolomite and limestone with interlayered white quartzite. These beds are in turn overlain by a considerable thickness of metamorphosed sedimentary rocks in the form of albite-quartz-biotite-hornblende schists, with much muscovite and chlorite as accessory constituents. These rocks belong to the greenschist facies. A few narrow bands of volcanic rocks are intercalated with the sediments.

<u>Volcanic Series (8b)</u> - These rocks consist primarily of a greyish green, fine-grained metamorphosed lava that belongs in the greenschist facies. Under the microscope the main minerals are identified as albite, chlorite, calcite, biotite, epidote, amphibole, sphene, and pyroxene. Chlorite and muscovite, locally present in considerable amounts, are indicative of retrogressive metamorphism of the lavas from the amphibolite to the greenschist facies. Accessory minerals are pyrite, pyrrhotite, hematite, and magnetite.

Original textures for the most part have been destroyed in the lavas, but a few faint outlines of pillow structures have been preserved. They apparently have the same mineral composition as the surrounding lavas.

The Cape Smith - Wakeham Bay belt has been intruded by plutonic bodies of gabbro and/or related rocks, none of which is mappable on the scale of this map. Both the volcanic and sedimentary rocks have been cut by numerous quartz veins.

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[1] Age determination by the Geological Survey of Canada.
[2] Age determination on specimen collected by the writer is at present being carried out by the Geological Survey of Canada.

The contact between the Cape Smith - Wakeham Bay belt of rocks and the underlying gneisses of unit 2 was believed by Bergeron (1957) to be an unconformity. While this may be so for the main part of the belt, that part of the contact in the map-area is believed to be a thrust fault with a steep dip to the north. In addition, it is probable that at least two major thrust faults, dipping north at about 40°, have caused repetition of the rock types in the belt. The entire sequence has been folded into broad open folds.

The sedimentary and volcanic rocks (9) of the Roberts Lake and Armand Lake (Lac Berthier) areas mark the northern limit of the Labrador Trough rocks, which, because of their great economic interest, have been thoroughly examined. The rock types in the northern part of the Trough may be correlated with those occurring farther south. According to Béland and Auger (1958) the rocks in the Roberts Lake and Armand Lake (Lac Berthier) areas are preserved as sinks, separated by a saddle. The main Roberts Lake basin is a simple syncline, around the border of which iron-formation outcrops in a practically continuous band. The iron-formation (9a) is underlain by intercalated quartzite and pelitic schist, which in turn rests unconformably upon the older Archaean gneisses. The central part of the basin is composed mainly of sedimentary rocks and mica schists (9b), intercalated with lava flows, (9c) and a few thin gabbroic sills. A body of peridotite and gabbro, of considerable size, intrudes the rocks in the central part of the syncline (Stevenson, 1964).

The iron-formation proper (9a) consists of: (1) a lower silicate iron-formation member, composed of hematite-magnetite-mica schist, cummingtonite-magnetite schist, cummingtonite-carbonate schist, and cummingtonite-garnet schist; (2) a middle metallic iron-formation member, consisting of hematite and silica, hematite-magnetite, and magnetite and silica; and (3) an upper spotted carbonate iron-formation member, composed of quartzose sediments with iron carbonate or silicates. At some localities individual members may be absent because of faulting, erosion or lack of deposition. The metallic iron-formation is the economic member, and the magnetite-hematite phase is the most persistent and important sub-member. The contact between the spotted carbonate member and the underlying metallic iron-formation is readily distinguished by their difference in colour. Much of the carbonate member has been removed by erosion.

In the Roberts Lake area, evidence of great tectonic pressures from the northeast is readily visible in the steeply dipping beds on the east side of the syncline. The iron-formation and adjacent beds have been thrust into tight, northwest-striking isoclinal folds, locally overturned toward the west. Along the western limb of the syncline the folds are open and gentle, with dips rarely exceeding N35°E.

The Armand Lake basin is not as well exposed as the Roberts Lake basin, but apparently the rock types are similar.

Some doubt exists as to the age of the rocks in the peninsula south and east of Diana Bay. This area has been intensely folded, and most of the rocks are unequivocally paragneisses and paraschists in which original bedding planes are recognizable on air photographs. The rocks are mainly dark, biotite-quartz paragneisses, locally altered to dark grey, sillimanite-bearing, micaceous schists. Interbedded with these rocks are bands of relatively unmetamorphosed, rust-weathering, white quartzite, up to 300 feet thick, locally rich in biotite and pink garnets. These schists and gneisses are gradational into pink hornblende-biotite granite-gneiss. All rocks have been cut by numerous veins of granite, pegmatite, and aplite. Veins and sills of pyroxenite and hornblendite are common. These paraschists and paragneisses strike similarly to rocks associated with iron-bearing rocks elsewhere in the Trough. Until they have been further examined, however, they are tentatively included in unit 2.

The Manitounuk Group (10, 11) of rocks, which borders Richmond Gulf and forms the Nastapoka and Hopewell Islands, has been previously examined and described by Low (1902, 1903), Bell (1879), Woodcock (1960) and others. Various divisions of the group have been made, but in this report the group is divided into an upper part (11) and a lower part (10), separated by an unconformity. On the mainland the Manitounuk Group rests on the Archaean granites with marked angular unconformity.

The Nastapoka Islands are composed of a series of sedimentary rocks (11a), consisting of hematite-rich iron-formation and well-bedded shales and quartzites, with interlayered sheets of basaltic trap rock. The iron-rich beds form a resistant cap rock on the islands, effectively protecting the softer underlying shales and quartzites from erosion. The bedding dips gently west, and as a result, steep cuestas have formed facing the mainland to the east. Trap rock forms the cap on the northern end of Cotter Island. Detailed descriptions of the major Nastapoka Islands, with accompanying measured sections, were made by Low (1903) in his investigation of the iron-rich beds.

The Hopewell Islands, first described by Bell (1879), are similar to the Nastapoka Islands in appearance and structure. They are closer to the mainland, and are capped with coarse trap rock, in which columnar jointing is well-developed. The trap is underlain by ripple-marked quartzite, black slate, and sandstone. Hematitic iron-formation is lacking.

The coastal ridge between Richmond Gulf and Hudson Bay is capped by dense, dark, porphyritic basalt (11b) with intercalated thin beds of pyroclastic rocks. These basalts extend from the southern limit of the mapped area to a point on the Hudson Bay shore some 15 miles north of Richmond Gulf. The basalt is underlain by a sequence of dolomite, quartzite, and siltstones, well-exposed on the west shore of Richmond Gulf, and dipping gently west.

Separated from the above by a distinct unconformity is a well-bedded sequence (10a) of pink and grey arkose with in places a boulder-conglomerate at the base. These coarse-grained rocks are well exposed along the shores and on the islands of Richmond Gulf. Depositional features in the arkoses include crossbeds, ripple-marks and graded beds. These rocks are in turn underlain by arkosic beds with associated overlying andesitic flows (10b).

The entire area, with the exception of the Manitounuk Group of rocks, has been extensively folded, but lack of detailed information prohibits accurate outlining of the folds. The regional trend is south-southeast, with local variations. Dips in the Archaean gneisses generally exceed 60°, and the folds are locally overturned. Isolated folds preserved in some of the relict inclusions can in some cases be outlined by lineaments on air photographs.

Faults occur throughout the entire map-area, and seem to follow no prescribed pattern. In areas where detailed work has been carried out, as in the Port Harrison area, displacements of considerable magnitude can be observed. Only a few of the more prominent and obvious faults have been designated on the present map. Ground examination of some of the major structural lineaments, so prominent on air photographs, has indicated that many of the lineaments are the result of fault scarps. In other instances no vertical or horizontal displacement is apparent, and the lineaments are assumed to be the result of jointing magnified by erosion.

Mineral Deposits

Lead, associated with some silver, occurs on the south side of Gulf Hazard in the form of galena crystals filling cavities in a bed of siliceous dolomite. This deposit has long been known, and has been described by Bell (1879), Low (1902), and Woodcock (1960).

Scattered showings of chalcopyrite, pyrrhotite, and pyrite, associated with quartz and calcite, occur along the west shore of Richmond Gulf. Sulphide deposits on Smith Island and in the adjoining Cape Smith - Wakeham Bay belt of rocks have been described by Gunning (1934) and Bergeron (1957). Pyrite-chalcopyrite-galena-bearing quartz veins cut the gneisses on the coast of Hudson Bay near Frazier Island. Numerous pyritiferous quartz veins were noted along the disturbed contact between the Cape Smith - Wakeham Bay rocks and the granitic gneisses to the south.

Pyrite, and occasionally pyrrhotite and chalcopyrite, are associated with many of the ultramafic intrusive bodies. The occurrence of nickel, copper, and cobalt in the ultramafic body north of Payne Bay has been described elsewhere (Stevenson, 1964).

The iron-formation at Roberts Lake and Armand Lake (Lac Berthier) has been examined by various company geologists. The associated lavas are heavily pyritized. Iron-formation on the Nastapoka Islands was thoroughly examined and reported on by Low (1903).

An interesting occurrence of anthraxolite was examined near the north tip of Fraley Island, south of Port Harrison. The anthraxolite is in the form of a vein, some 12 inches thick, cutting massive greenstone. The vein is of scientific interest only.

Soapstone has been quarried at various localities along the coast by Eskimos for use in carving.

Numerous gossan zones were noted in areas underlain by paragneiss. These rust-coloured zones, some of which are several hundreds of feet long, are apparently the result of weathering of biotite-rich layers containing pyrite.

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