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GEOLOGY OF THE SOUTHERN PART OF GATINEAU PARK, NATIONAL CAPITAL REGION

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ABSTRACT

Upland areas are underlain by Precambrian rock, comprising a high grade metamorphic sequence of gneisses and marbles intruded by quartz-rich granitoid rocks, syenites, peridotites and diorites. All show some metamorphic fabric imposed during the Grenville Orogeny. Potassic aplite and associated carbonate bodies intruded the Wakefield syenite near the end of the Grenville Orogeny and this was followed by the intrusion of east-west diabase dykes.

Middle Ordovician limestones, siltstones and sandstones are poorly exposed in the lowlands and are commonly blanketed by thick deposits of Pleistocene clay. The clay is particularly susceptible to flow and banks of streams show landslip scars. Beach terraces of the Champlain Sea are well preserved in the eastern part of the area.

The plunge of fold axes varies from east to west at low angles to 45 degrees northeast. The corresponding axial planes normally trend east to north-northeast with steep dips. Linears, some of which represent steeply dipping post-Trenton age faults, have two principal directions: east-northeast and west-northwest, the latter system being the latest. The Eardley Escarpment may be a fault-line scarp resulting from a combination of these two systems.

No mining is now conducted in Precambrian rocks although small quantities of phlogopite, apatite, magnetite, barite, feldspar and roadmetal (diabase) were formerly produced. Paleozoic limestone and Recent deposits of sand and gravel are mined in the lowlands south of the Mountain Road.

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INTRODUCTION

This report is mainly concerned with the Precambrian rocks that form a positive wedge between the lowlands of the Ottawa and Gatineau Rivers. The mapped area is about 65 square miles in extent and its centre is about 10 miles northwest of the Parliament Buildings in Ottawa and can easily be reached via Quebec Highway 11, the Mine Road or the Mountain Road. The area straddles a pronounced linear feature, the Eardley Escarpment, and includes the interesting petrological areas near Meach Lake and the Forsyth Mine. Rock exposure is generally good but much of the syenite is obscured by swamp.

The Precambrian geology has previously been investigated only by reconnaissance surveys. A geological map of a large area surrounding Ottawa, on the scale of approximately 1 inch = 4 miles, was published by MacDonald (1968). An area extending southward to within one-half mile of the present map-area was mapped in detail by Béland (1954). Another area extending eastward to within one mile of the southwest corner of the present area was mapped by Sabourin (1965). The Paleozoic geology was described by Wilson (1946), the hydrogeology by Brandon (1961), and the surficial geology by Gadd (1962). A number of field excursions in the area have been described by the writer (Hogarth, 1962).

TOPOGRAPHY AND LANDSLIDES

Relief is moderate, with elevations reaching 1,317 feet in the western part of the area and a low of 210 feet in the valley of Breckenridge Creek. The most prominent topographic feature, the Eardley Escarpment, fronts the Ottawa Valley and rises to a maximum of 900 feet above it on its northeastern margin. Northward the ridge drops steeply to the valley containing Meach and Harrington Lakes, about 650 feet below. The valley forms a prominent depression parallel to the Eardley Escarpment. Still farther north hills rise 200 feet above this valley.

Meach and Harrington Lakes cover much of the northwest section. Meach, Harrington, Kingsmere and Pinks Lakes have well-defined margins, but others, such as Black, Mud, Fortune, Mulvihill and Fairy Lakes, tend to have swampy shorelines. Lakes are shallow, the maximum depth being about 70 feet at Fortune Lake.

Unstable marine clays are well known near the Ottawa River and tributary streams. The sensitivity or strength of the clay on remolding is low, commonly less than 1 per cent of the original strength in local clays (Crawford, 1961). Because of this, clays liquify on slight disturbance, flowing downhill and carrying with them topsoil, trees and large blocks of undisturbed clay. The resulting scars are typically crescentic with the open crescent pointing downhill in the direction of flow.

The Ottawa Valley is scarred by recent and ancient landslides with individual scars up to 15 square miles near Hawkesbury, Ontario. In the map-area landslip scars are common along Chelsea Brook, Breckenridge Creek and Leamy Creek. The largest landslide is on the north side of Chelsea Brook near the northeastern boundary of the map-area and affects an area of about 135 acres. A much smaller one occurred on Breckenridge Creek, 2 1/2 miles west of Larriaults Hill, in 1963 (Crawford and Eden, 1967) toppling a small tower for auxiliary power load and thereby causing a minor brush fire.

GENERAL GEOLOGY

Most consolidated rocks in the map-area are Precambrian and show some degree of fabric imposed by the latest regional metamorphism during the Grenville Orogeny, 900-1,100 million years ago. They are mapped as six metamorphic units (1-6) and five weakly metamorphic units of probable igneous origin (7-11).

Precambrian Metamorphic Rocks (units 1-6)

Diopside and amphibole-rich gneisses (1) are dark green rocks commonly intruded by pink granitic dykes and sills. Outcrops of diopside gneiss in the Black Lake – Camp Fortune area contain a great deal of pegmatite and are mapped on the basis of which rock type prevails. There is a great variation in mineral content within the gneiss. The primary ferromagnesian mineral is salitic diopside which may be altered to hornblende, although some amphibole may be primary. Phlogopite is common; oligoclase is the characteristic feldspar, with microcline locally abundant. Sphene is always present in small amounts. A coarse, dark, massive rock (1c) which characteristically contains salite, andesine, and varying amounts of scapolite, is also included in this unit. A good example of this rock extends southward through the east side of the Mackenzie King Estate and ends at a swamp 3,500 feet south of Kingsmere Lake.

East of Pinks Lake grey to white aplite (2) composed of quartz, microcline, plagioclase and varying amounts of diopside and actinolite forms a well-defined marker horizon. Near the Mine Road the ferromagnesian minerals are altered and the rock is sheared.

Grey or brown biotite gneiss (3) is common but true pelitic assemblages are found only at the southeast end of the area where biotite-almandine gneiss prevails. Sillimanite gneiss is well developed near Pinks Lake and to the southeast. Hypersthene-garnet gneiss occurs locally in this region and also near Old Chelsea and the northwest end of Meach Lake. Cordierite gneiss was identified at several localities north and east of Pinks

Lake but is not common. The plagioclase is commonly oligoclase, grading to andesine in the sillimanite and hypersthene-bearing gneisses. Albite-oligoclase is the common plagioclase in biotite gneiss below the Champlain Lookout; microcline and rarely orthoclase are the potash feldspars.

Quartzite is of two main types: thinly banded with much diopside and tremolite, and more thickly banded commonly with feldspars and phlogopite. The thinly banded type is transitional to calc-silicate rock and is included with it as unit 6f. The thickly banded type (4) is more closely related to biotite gneiss but, because it can easily be distinguished from it in the field, it is classified as a distinct unit.

Most marble (5) is calcitic. The large marble bodies north of Old Chelsea, south of Kingsmere Lake and near Pinks Lake contain little other than calcite, quartz, microcline-orthoclase and graphite. Phlogopite, diopside, actinolite and serpentine are present locally. Dolomite and dolomitic marble cannot be traced for great distances. They are found, for example, in the Dawson Field, about 3, 000 feet south of Old Chelsea, and along the northwest shore of Meach Lake. Characteristic accessory minerals are serpentine, spinel, phlogopite, chondrodite-group minerals and forsterite.

Small deposits of brucitic marble (5f) are present at several places on the west side of the map-area. Brucite nodules are commonly rimmed by dolomite; interstitial calcite and chondrodite are the only other important constituents.

Coarse green or purple calc-silicate rocks (6) are mainly composed of diopside with varying amounts of actinolite, phlogopite, feldspars and scapolite. True metapyroxenites (>90% clinopyroxene) are present north of Fortune Lake and east of the lower end of the Notch Road.

Precambrian Igneous and Meta-igneous Rocks (units 7-14)

A large part of the area is underlain by "syenite" (7) that forms the southern end of the Wakefield Batholith which extends northward beyond the map-area to Lac Lapêche and St. Pierre-de-Wakefield. It is mottled pink or, more rarely, green or grey, medium to coarse grained and commonly porphyritic. Mesoperthite porphyroids are set in a granular matrix of microcline and oligoclase, with augite, hornblende and biotite segregated into poorly-defined layers and showing subparallel linear arrangement. Magnetite rimmed by sphene can be seen under the microscope. Variants of this syenite are well foliated with chloritized biotite (near the Mountain Road below the Eardley Escarpment), massive syenite with tabular microcline as Carlsbad twins (near the brucite area south of Meach Lake), alkalic syenite with microcline, albite-oligoclase and aegirine-augite (southern edge of the syenite area) and quartz-syenite (northwest of the large aplite mass). Massive salite-andesine rock (1c) may, in part, be a dioritic phase of the syenite.

Three areas of medium-grained, greyish, quartz-rich granitoid rocks (8) are present: north and south of Pinks Lake, and northeast of Old Chelsea. The Old Chelsea mass is differentiated with a quartz diorite core surrounded by granodiorite, and with quartz monzonite on the periphery. The mass to the north of Pinks Lake is quartz monzonite and quartz diorite, whereas that south of Pinks Lake appears to be mainly altered granodiorite.

In each biotite is the common ferromagnesian mineral. Only in parts of the Old Chelsea mass is a weak foliation discernible.

Granite (9) is commonly pegmatitic with irregularly distributed aplitic portions. Most of the pegmatites are sills such as those in the Camp Fortune – Black Lake region, which are normally unzoned and contain microcline, albite, oligoclase and quartz. Most pegmatites are pink but small masses in marble and calc-silicate rocks are commonly grey. Dark minerals are rare, the most common being andradite, tourmaline and augite (Kasowski and Hogarth, 1968). Pegmatites for which a relative age can be established are mainly pre-aplite, being cut by the latter although a few are post-aplite. They tend to cap tops of prominent topographic features such as McKinstrys Ridge, Kings Mountain, some of the Camp Fortune ski hills and O'Briens Hill. Pyroxene-rich granite crops out in fields below the Eardley Escarpment.

Pink aplite with alaskite composition (10) is present in an 8/10 square mile area south of Meach Lake and is best observed in McCloskeys Field. Mafic minerals are confined to radiating tufts, orbicular structures and veins of a bluish green sodic amphibole.

Within the aplite and syenite masses are isolated occurrences of intrusive carbonate rock mostly of dolomitic composition and coarsely crystalline texture (11). Carbonate bodies transect the foliation of the syenite, which in turn parallels the regional foliation. Some carbonate masses cut across lenticles of aplite. They commonly include fragments of country rock and may pass imperceptibly into breccias, fractured zones and finally into unfractured country rock. Borders of the carbonate bodies are lined with phlogopite and soda-amphibole (Hogarth, 1966).

Two small masses of coarse, greenish black peridotite (12) outcrop near Dennison Road, one-half mile southwest of the Forsyth Mine. They contain about 50 per cent actinolite the remainder being made up of approximately equal amounts of forsterite, clinopyroxene and orthopyroxene. They have been intensely serpentinized.

Diorite (13) and diabase (14) are the only rocks with distinctive igneous texture. Diorite dykes, up to 5 feet wide, are found south of Kingsmere and elsewhere. They are composed of hornblende, augite and sodic oligoclase, whereas some of the dykes cutting the Wakefield syenite have andesine as the feldspar. All show weak effects of retrograde metamorphism. Three diabase dykes mark the last intrusive episode of Precambrian history in the region, possibly 700-800 million years ago*. The two northern dykes average 75 feet in width whereas the southern dyke is about 200 feet wide. They are composed of augite and labradorite with minor magnetite and sporadic chlorite, probably pseudomorphic after olivine. Other retrograde effects are lacking.

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* K/Ar age determinations give an age of 450 million years, equivalent to Middle Ordovician. This age is hard to reconcile with geological observation. The dyke swarm is well developed near Paleozoic rocks yet has not been observed cutting them nor have equivalent volcanic sheets been observed at the base of the Paleozoic rocks.

Metamorphism of Precambrian Rocks

In most cases pelitic mineral suites indicate that regional metamorphism produced assemblages in the hornblende granulite subfacies (granulite facies) but a few rocks in the Pinks Lake region suggest upper amphibolite facies and some north of Old Chelsea suggest pyroxene granulite subfacies (granulite facies). Metamorphism of impure dolomite commonly did not proceed beyond the diopside stage although forsterite-bearing marbles are scattered throughout the area. Near Pinks Lake quartz commonly coexists with calcite.

Superimposed on the regional metamorphism are local contact effects, such as the presence of wollastonite and vesuvianite in marble near the Wakefield Syenite. Within 15 feet of diabase the optic angle of microcline decreases, becoming almost nil at the contact, indicating high temperature. Pink marble changes to black marble near these dykes indicating a partial reduction of calcite with hematite inclusions to graphite and magnetite.

Paleozoic Sedimentary Rocks (units 15-17)

Paleozoic (Middle Ordovician) rocks outcrop only in the lowlands and were deposited on an extremely irregular surface. Nonfossiliferous Nepean Sandstone (15), containing only quartz and a very small quantity of pyrite, is present as several small outcrops on a branch of Chelsea Brook north of the Mine Road. Sparsely fossiliferous arenaceous limestones and calcareous siltstones of the Rockcliffe Formation (16) occur in the southwest and southeast portions of the map-sheet. In the southeast area there is a considerable amount of detrital andesine of unknown provenance. The Black River and Trenton Limestones of the Ottawa Formation (17) are highly fossiliferous and relatively pure, but generally become arenaceous and barren near the Eardley Fault. This may indicate that an escarpment existed in Ordovician time and that any fossils were destroyed by subsequent faulting. However, it should be noted that outcrops of Trenton and Black River Limestones are rare; the outcrops exposed in widening of the Mountain Road in 1961 were later covered over.

Structural Geology of Precambrian and Paleozoic Rocks

Folds in Precambrian rocks in the northern part of the area tend to be isoclinal. Most have steeply dipping axial planes. North of Old Chelsea axial planes trend northwards whereas south of Champlain Lookout they trend east (see inset map). This trend of axial planes contrasts markedly with those of folds immediately to the east (west of Black Lake) where axial planes bear N20°E. Similar contrasting trends are found north of Meach Lake. Proceeding south and east from Kingsmere, folds open out with axial planes trending northeast. In general, mineral lineations parallel major fold axes, which vary from east-west, with low plunge, to northeast with 45-degree plunge. A second set of folds with axes trending N50°W and plunging 40-60 degrees in that direction appears to be later because it truncates the northeast-trending set.

The Paleozoic rocks dip gently northeastward, although near large faults the dip steepens. For instance in the southeast corner of the map-area dips up to 50°E are encountered; more rarely the direction of dip is reversed.

Prominent linear features, at least some of post-Precambrian age, run transversely across the Precambrian ridge and trend N55-85°E. The most prominent of these contains Mud Lake and crosses Marshalls and Slalom hills at Camp Fortune. It has several shatter zones sealed with calcite, quartz, and chlorite. A linear extension can be traced eastward to the Gatineau River and thence 10 miles to Petite Blanche River. It is interesting that such a large, linear feature shows little horizontal displacement.

Large faults, trending N50-70°W, are marked by discontinuous shatter zones that are either open or are sealed by coarse calcite and barite. Some have produced zones of chlorite and mylonite in the surrounding rocks. Most transect the N55-85°E system and are, at least in part, post-Trenton. The Eardley Fault can be traced along the Mountain Road for 1.7 miles with a possible westward extension reappearing after another 1.2 miles and continuing for 800 feet. The Eardley Fault is downthrown on its south side, whereas the Hull-Gloucester Fault to the southeast is downthrown on its north side. The latter can be traced northward through Fairy Lake as far as Gamelin Boulevard but its extension for another 1 1/2 miles can only be inferred from topography and the distribution of Precambrian and Paleozoic rocks. Another fault system, possibly also post-Trenton, extends 3,000 feet northwest from Old Chelsea along the Meach Lake Road. A second valley to the northwest and containing Meach Lake, Harrington Lake and Lac Philippe may mark an extension of this zone. The distribution of diopside gneisses and calc-silicate rocks suggests an apparent left-hand, horizontal displacement of 4,000 feet. The Eardley Escarpment, which proceeds stepwise northwesterly, may be a result of a combination of both fault systems.

Pleistocene and Recent

Large-scale features of indisputable glacial origin are rare. There are small scattered areas of till such as those near Kingsmere Lake but eskers seem to be lacking. A long narrow trail of unsorted boulders that can be followed from the southwest end of Meach Lake along the south side of Harrington Lake is presumably a moraine.

At the close of the Pleistocene epoch the Ottawa - St. Lawrence area was greatly depressed by the burden of ice and the valleys of the Ottawa and lower Gatineau Rivers became flooded with salt water as the glaciers withdrew. This sea, the Champlain Sea, in places covered the land to depths of several hundred feet. Radiocarbon dates indicate ages of 11,500 years to 8,500 years B.P. for this marine invasion.

Raised beaches and terraces, marking the former shoreline of the Champlain Sea, are numerous but are best developed on the flat country on the flanks of the Precambrian spur. The highest strandline (elevation 690 feet) is at the western edge of Penguin Field, 3/4 mile northeast of Kingsmere Lake (Johnston, 1917, pp. 17-18). A number of lower beaches in the valley leading to Kingsmere Lake from the east are also noted by Johnston. Terraces are in evidence on Freeman Road at elevations of 255 and 310 feet. South of Pink Road beaches are developed at elevations of 305, 315, and 350 feet.

Thick unconsolidated sediments (mainly clay) of the Champlain Sea underlie the area south and east of Old Chelsea. Gadd (1962) believes that these sediments were reworked by later lake water. Deep wells near Freeman Road establish a depth of at least 200 feet of clay. Another deep trough containing Champlain sediments appears to underlie a small creek running parallel to the Mountain Road and draining westward into Lac de La Montagne. A northerly extension of this trough was shown by drilling to be 400 feet deep. Here and there lens-shaped bodies of sand and gravel are exposed in pits.

Fossil pelecypods such as Macoma balthica (Linn.), Hiatella arctica (Linn.) and Yoldia arctica (Gray) may be found in many of the gravel pits of the region and are especially abundant in the Proulx Pit. It seems probable that these have been transported to their present sites. Pelecypods are also found in the Champlain sediments along Chelsea Brook, in Leamy Creek near Dennison Road and at many other places.

Near the landslide on Breckenridge Creek and on a southward-flowing tributary a mile to the northwest, are found concretions, a few of which contain fossil fish (Mallotus villosus (Müller)).

ECONOMIC GEOLOGY

Mica (phlogopite) deposits occur in units 1 to 9 but have not been found in units 10 to 14 or in post-Precambrian rocks. They are most common in calc-silicate rocks (unit 6). Many mica deposits have accumulations of apatite and some such as those near the Mountain Road below Champlain Lookout, contain more apatite than mica.

The mica mines were small (de Schmid, 1912) and were mostly worked from pits and trenches, although a few shafts and adits were developed. The largest vein was followed for about 500 feet and was about 6 feet wide; the deepest working was about 150 feet below the surface. Most of the occurrences are shown on the map.

Apatite production reached its peak about 1890 and mica about 1910. No mines are now in operation but some of the old mica mines (for example the McConnell Mine near Meach Lake, the Headley Mine near the Notch Road and the Pinks Lake Mine) were reopened after 1945.

Magnetite has been mined sporadically since the 1850s from the Forsyth and Baldwin Mines. Considerable underground exploration has been done at the Forsyth Mine since 1957. The iron deposits are presently owned by Corgemines Ltd.

Molybdenite occurs near the Champlain Lookout, where a number of trenches were dug by the National Molybdenite Co. during World War I. Small quantities of barite, feldspar and roadmetal (diabase) have been mined in the district. Limestone is now quarried from two pits off the Cook Road and sand and gravel is excavated from several large pits south of the Mountain Road.

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