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RENFREW MAP-AREA,
RENFREW AND LANARK COUNTIES,
ONTARIO

(REPORT AND MAP)

By

H. A. Quinn

OTTAWA

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Preliminary map — Renfrew, Ontario ..... In envelope

RENFREW MAP-AREA, ONTARIO

INTRODUCTION

LOCATION

Renfrew map-area lies between longitudes 76°30' and 77°00' west, and latitudes 45°15' and 45°30' north. It includes about 420 square miles in the southeastern part of Renfrew county and in the northern part of Lanark county. Except in its hilly southwestern part, the area is well served with roads. Provincial highway No. 17 crosses the northeastern part. The main line of the Canadian Pacific Railway passes through the town of Renfrew, the Kingston and Renfrew branch serving the central and southern parts of the area. The Ottawa-Parry Sound branch of the Canadian National Railway follows the valley of Bonnechere River across the northern part of the area.

PREVIOUS WORK

The first recorded geological survey in the area was a traverse of Bonnechere River by Alexander Murray (1)[1] in 1853. Logan (2) summarized this work in his "Geology of Canada", and recorded a traverse made in 1853 of the road from Pembroke to Ottawa by J. Richardson. Further surveys, mainly to delimit occurrences of Grenville limestone, were made by H. G. Vennor (3) in 1875 and 1876. Reconnaissance of all of the area, except for a narrow strip along its northern border, was done by R. W. Ells (4) in 1896 and shown on the Perth sheet.

[1] Numbers in parentheses are those of references listed at end of this report.

In 1917, 1918, and 1919, M. E. Wilson of the Geological Survey, and assistants H. V. Ellsworth, T. L. Gledhill, and J. F. Wright, examined mineral deposits and mapped most of the geology of the area as a wartime project on a scale of 1 inch to 3,000 feet. Two publications (5, 6) describe some results of this investigation. The areal mapping is incorporated in the geological map accompanying this report.

B. C. Freeman (7) described some of the mineral occurrences for the Geological Survey in 1936.

G. M. Kay (8) in 1939, completed a stratigraphic study of part of eastern Ontario, including Renfrew map-area. In 1943, J. Satterly (9) of the Ontario Department of Mines examined mineral deposits and prepared a generalized geological map of the southern part of Renfrew county. The southeastern corner of the map-area lying in Lanark county was mapped by P. A. Peach (10) in 1948 during his work in Darling and Lavant townships.

PRESENT WORK AND ACKNOWLEDGMENTS

In 1949, G. B. Leech and assistants W. F. Green and H. S. Miller continued, on a scale of 1 inch to 1 mile, the mapping begun by M. E. Wilson. The survey of the map-area was completed by the writer and assistants F. T. Couture, J. K. Connibear, and M. H. Havers in 1950.

The writer takes pleasure in acknowledging assistance received during consultations with Dr. M. E. Wilson and Dr. A. E. Wilson on the Precambrian and Palaeozoic rocks of the area respectively. He is indebted

to many residents of the district who helped to locate mineral deposits and facilitated the work in other ways. Much useful information on the economic geology was kindly supplied by G. S. Gilbert and J. V. Huddart of Algoma Ore Properties, Limited; J. D. Turner of Cadieux Mines Limited; H. J. Logan and D. S. Baird of Renprior Zinc Mines, Limited; and H. M. Jamieson of the Jamieson Lime Company.

PHYSIOGRAPHY

As described by Kay (8), that part of the area lying northeast of the St. Patrick scarp is within the Ottawa-Bonnechere graben and that lying southwest of the scarp is within the Madawaska Highlands. Altitude of the surface increases from some 250 feet near Lac des Chats on Ottawa River, at the northeast corner, to about 1,450 feet on Mount St. Patrick in the southwestern part. Local relief, commonly less than 300 feet in the graben, is normally about 500 feet in the highlands and is nearly 900 feet along the St. Patrick scarp.

In general, the area is divided by near-vertical faults into several westerly to northwesterly trending blocks of high, relatively rugged ground, underlain by Precambrian rocks alone, and of low, relatively flat ground, underlain mainly by Precambrian rocks but with some outliers of flat-lying Palaeozoic rocks and more extensive Pleistocene deposits. From southwest to northeast these blocks consist of: (a) the high and rugged Madawaska Highlands southwest of the St. Patrick scarp; (b) the Calabogie Lowland, between the St. Patrick and Shamrock scarps; and (c) the Shamrock Upland, between the Shamrock scarp and the valley of Bonnechere River; (d) the valley of Bonnechere River, between the Shamrock Upland and the Dore scarp, characterized by flat-lying Palaeozoic outliers and flat lands underlain by great thickness of Champlain clay, the latter cut by numerous very steep-walled gullies as a result of Recent headward erosion of streams; and (e) the highland north of the Dore scarp and along the north side of Bonnechere River.

GENERAL GEOLOGY

Except for a few small infaulted outliers of Palaeozoic age, bedrock in the map-area consists of Precambrian crystalline rocks of the Grenville sub-province of the Canadian Shield. The flat-lying Palaeozoic rocks, occurring only in the westerly to northwesterly trending lowlands, are largely covered by unconsolidated Quaternary deposits, consisting mainly of glacial drift and Champlain clay and sand.

A few dykes of Proterozoic age excepted, the geology of the Precambrian rocks is extremely complex. Most of these rocks have been highly deformed and metamorphosed and now constitute a basal complex in which the various rock types are intricately intermingled and in many places gradational one into the other.

TABLE OF FORMATIONS

Age	Formation	Description
Recent		Gravel, sand, clay, marl, peat, swamp (mainly muck)
Pleistocene	Champlain beds	Sand, minor gravel and clay Clay, minor sand
		Boulders, boulder clay, gravel, sand, clay
Great unconformity		
Ordovician		Limestone, dolomitic limestone, dolomite; minor shale, siltstone, and sandstone
Great unconformity		
Proterozoic		Gabbro, diabase
Intrusive contact		
Archaean		Pegmatite
	Intrusive contact	
		Syenite, porphyritic syenite
	Intrusive contact	
		Granite, granodiorite (not markedly banded); minor syenitic facies
	Intrusive contact	
		Diorite, gabbro, meta-gabbro, amphibolite, anorthosite, pyroxenite
	Intrusive contact	

		Mixed rocks (in part hybrid gneisses, migmatites), nepheline-albite gneiss
Archaean	Bristol (Hastings?) series	Thinly banded sedimentary rocks: fine-grained, bluish grey limestone; green to black chloritic schists and phyllites; quartzite
	Erosional unconformity (?)	
	Grenville series	Interbedded: (1) Crystalline carbonate rocks, comprising limestone, dolomite, and dolomitic limestone (2) Minor metamorphic pyroxenite (3) Paragneiss: mainly biotite-garnet gneiss; biotite-hornblende gneiss, quartz-biotite gneiss and schist, sillimanite-garnet gneiss; minor quartzite (4) Hornblende schist and gneiss, hornblende-biotite schist, quartz-biotite-hornblende schist, amphibolite, dioritic and gabbroic rocks

PRECAMBRIAN

The rocks of the Precambrian basal complex consist essentially of the following groups: (1) the Grenville series, comprising interbedded, meta-sedimentary and hornblendic foliated (mainly meta-volcanic?) rocks; (2) the Bristol series, consisting of meta-sedimentary rocks, probably slightly younger than those of the Grenville series; (3) a series of igneous intrusive rocks, varying in size from batholiths to sills and dykes and comprising mainly: (a) gabbro and diorite; (b) granite, granodiorite, and their syenitic facies; (c) syenite and porphyritic syenite; and (d) pegmatite; and (4) a group of mixed rocks, resulting mainly from the action of the igneous intrusive rocks upon the meta-sedimentary and meta-volcanic rocks and including much hybrid gneiss and migmatites; and (5) late basic dykes of gabbro and diabase.

Grenville Series

Hornblendic Foliated Rocks

Hornblendic foliated rocks, although intermingled with other rock types, occur mainly in a belt that enters the map-area from the south near Calabogie Lake and can be traced north and northeasterly around both sides of the Hond Lake mass of granite and pegmatite, to where it is obscured by Pleistocene drift in the valley of Bonnechere River.

Although normally distinctly foliated and containing much hornblende, these rocks are variable in composition and texture. They consist mainly of hornblende gneiss and schist, but also include much hornblende-biotite schist, quartz-biotite-hornblende schist, amphibolite, and even some weakly foliated masses of dioritic and gabbroic rock. These rocks are commonly fine grained and dark greenish grey to black, but in a few places, as between Ashdad and Norway Lake, they are medium to coarse grained and have a mottled grey colour.

The hornblende gneiss and schist are foliated, dark grey to black rocks, whose main constituent is green hornblende. Plagioclase — oligoclase to andesine — is the second most abundant constituent, and composes most of the remainder of the rock. Small quantities of biotite, quartz, sphene, apatite, magnetite, and pyrite are also present. Porphyroblasts of red garnet up to ½ inch across occur locally; the rocks may include a little zoisite, epidote, carbonate, and sericite.

Although this group of rocks is considered to be mainly of volcanic origin, it contains some meta-sedimentary rocks and sills of basic rocks as well. Meagre and inconclusive indications of its volcanic origin noted within the map-area are: (a) ellipsoidal masses of epidote as much as 2 feet long, about a mile northeast of Opeongo; (b) cellular zones, possibly vesicular, up to 8 inches wide, between Ashdad and Norway Lake; and (c) lack of contact metamorphic effects on the other members of the Grenville series with which this group of rocks is interbanded. Smith (11) reports some agglomerate in the southwestern extension of this belt of rocks in the townships of Lavant, Palmerston, and South Canonto.

Rocks of similar lithology in nearby and other areas have been considered by Miller and Knight (12), Wilson (13, 14), Smith (15), Meen (16), Harding (17), Satterly (18), and others to be mainly older than the rocks of the Grenville series. On the other hand, some of similar rocks, generally minor in quantity, have been observed to be younger than at least some of the rocks of the Grenville series by Wilson (14, 19), Thomson (20), Smith (11), Meen (16), Satterly (9), and others. In Renfrew map-area, these hornblendic rocks are interbanded with the meta-sedimentary rocks of the Grenville series to such an extent that they are considered to be mostly contemporaneous.

It seems probable that the interbanding represents original interbedding of former sedimentary and volcanic materials, much of which may have been tuffaceous. Thus, although the Grenville series, as originally described by Logan (21), consisted of meta-sedimentary rocks alone, the series here probably includes meta-volcanic rocks as well.

Paragneiss

Interbedded with the meta-volcanic and crystalline carbonate rocks are various meta-sedimentary rocks of detrital origin, representing, for the most part, metamorphosed impure shales and greywackes. These rocks include biotite-garnet gneiss, biotite-hornblende gneiss, quartz-biotite gneiss and schist, sillimanite-garnet gneiss, and minor quartzite. Except for the wide belt south of Constos Lake, they occur in fairly narrow bands.

Biotite-garnet gneiss is the most abundant and widespread. It is a grey to dark grey or black, banded rock, locally rusty weathering, in which red garnets ½ inch or less in diameter are

abundantly disseminated in zones a few inches wide. Its main constituents are garnet, biotite, quartz, and feldspar. Common minor constituents, which may be more abundant locally, are hornblende, sillimanite, graphite, rutile, and pyrite.

The biotite-hornblende gneiss is similar to the biotite-garnet gneiss in many respects, but normally contains as much hornblende as biotite, is lighter grey in colour and is less commonly rusty weathering. In the vicinity of Constos Lake this gneiss contains abundant porphyroblasts of red garnet as much as 6 inches in diameter in zones normally less than a foot wide.

The sillimanite-garnet gneiss, well exposed in a 10-foot band in hybrid gneiss about a mile northeast of the village of Mount St. Patrick, is a pinkish grey, fine-grained, banded rock containing abundant oval, light grey porphyroblasts of sillimanite up to $1\frac{1}{2}$ inches long. These porphyroblasts have a fibrous appearance, commonly protrude $\frac{1}{4}$ inch or less above the weathered surface of the rock, and are commonly rimmed by red garnets $\frac{1}{8}$ inch or less in diameter. The main constituents are sillimanite, garnet, biotite, and quartz. At the locality cited, the gneiss also contains some pegmatitic quartz and pink feldspar in grains, blebs, and stringers up to $\frac{1}{2}$ inch wide.

Quartzite is scarce, occurring only in a few localities as beds normally less than 1 foot thick interlayered with the other meta-sedimentary rocks at wide intervals. It is a white to light grey, fine-grained, massive rock composed almost entirely of interlocking grains of quartz, but containing small amounts of feldspar, chlorite, biotite, magnetite, and sphene.

Crystalline Carbonate Rocks

Crystalline carbonate rocks, comprising mainly limestone but including some dolomite and dolomitic limestone, are abundant in Renfrew map-area. They are soft, white to grey, medium- to coarse-grained, normally banded rocks composed mainly of calcite, dolomite, and calcite with some dolomite, respectively. Graphite, phlogopite, diopside, tremolite, and serpentine are common accessory minerals. Other minerals present locally in smaller quantities are muscovite, biotite, pyrite, pyrrhotite, titanite, scapolite, actinolite, molybdenite, brown tourmaline, fluorspar, vesuvianite, and chondrodite. As most of these minerals are harder than the carbonate minerals composing most of the rock, they commonly stand up slightly on weathered surfaces and lend them a rough appearance.

The carbonate rocks commonly contain numerous fragments of other rocks such as granite-pegmatite, granite, amphibolite, quartzite, hornblende gneiss, and paragneiss. Most of these inclusions have been crumpled and otherwise greatly distorted by flowage of the carbonate rocks during deformation. At some places they are rounded, giving rise to a pseudo-conglomerate.

Although the limestone is commonly interbedded with paragneiss and meta-volcanic rocks, several bands and large irregular masses contain only minor amounts of these rocks. One of these bands extends northeasterly from near Virgin Lake, paralleling the western contact of the White Lake granite, and expands to at least 3 miles in width north of White Lake. The band contains considerable serpentine, tremolite, and accessory minerals in its narrower, southwestern part, but contains fewer of such impurities as it widens toward the northeast.

A second band of limestone, which may be continuous with the first, lies along the eastern and southeastern contact of the White Lake granite and attains a width of 2 miles or more southeast of the lake.

A third band, up to 1½ miles wide west of Norway Lake, can be traced westward from Calabogie for 2½ miles, thence north and northeast past Miller Lake to where it is obscured by glacial drift near the southeastern corner of Admaston township. The mass of limestone west and northwest of Goshen may be a continuation of this band. Lime-silicate minerals and other impurities, common in the southern part of the band, become fewer toward the northeast.

A fourth band of limestone, about 2½ miles wide at Limestone Lake at the southern border of the map-area, narrows to the north and apparently ends in a fold near Hunt Lake.

That part of the map-area southwest of Constos Lake contains abundant limestone in folded bands and irregular masses up to 1½ miles wide. Graphite, diopside, tremolite, and other impurities are abundant in this area.

Although poorly exposed, considerable limestone occurs in the area between Dacre and Constan Lake. Some of it can be traced northeastward in fairly narrow bands for a few miles; most of it grades into hybrid gneiss southwest of McDougall.

The band of limestone south of Colton Lake contains numerous bodies of granite-pegmatite up to ¾ mile long. These bodies parallel the foliation in the enclosing limestone.

Dolomite is not plentiful in the map-area. A few bands, normally less than 5 feet wide, occur in the limestone at wide intervals. One band, between 50 and 100 feet wide, is exposed in limestone about 600 feet west of the road from Calabogie to Shamrock and about 1½ miles northwest of Calabogie Lake. Another band, of unknown extent, occurs in limestone about 1,500 feet south of Madawaska River about 3 miles northeast of Burnstown.

Dolomitic limestone is more plentiful than dolomite itself. In one occurrence about 1,000 feet north of Bonnechere River, on lot 6, con. VII, Horton tp., the limestone contains up to 25 per cent dolomite as individual crystals.

Metamorphic Pyroxenite

A few bands of metamorphic pyroxenite are exposed in the map-area. These bands are commonly less than 10 feet thick and normally occur in limestone or along its contact with pegmatite. The rock consists mainly of white to pale green diopside, which may be massive or granular but is most commonly coarse grained. In many places the rock also contains a great variety of other minerals, such as calcite, apatite, phlogopite, tremolite, scapolite, tourmaline, sphene, fluorite, quartz, and molybdenite and other sulphides. This rock, as described and named by Wilson (19), is thought to have been formed from limestone by the action of siliceous emanations from igneous intrusions.

Bristol (Hastings?) Series

At the southern end of White Lake is an easterly trending band, from 500 to 4,500 feet wide, of mainly meta-sedimentary rocks that bear some lithological resemblance to rocks mapped as the Bristol series, or Bristol phase of the Grenville series, by Wilson (19) in the Arnprior-Quyon area some 14 miles to the northeast, and to rocks mapped as Hastings series type by Smith (11) in Palmerston township about 17 miles to the southwest. The band is bounded on the north by typical crystalline limestone of the Grenville series and on the south by diorite and granite. Smith notes that these rocks in Palmerston township overlie typical Grenville limestone and that they have a conglomerate at their base.

The rocks of the band south of White Lake consist mainly of bluish grey crystalline limestone, white to grey quartzite, and green to greenish and bluish grey to black, chloritic, and argillaceous to micaceous phyllites and minor schists. All are fine grained, commonly intimately interstratified in beds averaging about 2 to 4 inches thick, and closely folded (contorted). They are less metamorphosed than most rocks of the Grenville series. It seems probable that they represent a series of thinly bedded, calcareous, arenaceous, and argillaceous sediments and andesitic volcanic rocks.

Some rather thinly banded hornblende- and biotite-bearing rocks found in the vicinity of Calabogie have been included in the present mapping with the group of 'Hornblendic foliated rocks' of the Grenville series. However, Smith (11) has included some rocks of similar lithology in his group of 'Younger Volcanics', said to overlie his 'Younger Sediments' (Hastings type), and has traced them northeastward to Clyde Lake, about 7 miles south of Calabogie. In view of this, it may be that some of the similar rocks at Calabogie are also younger than the Grenville series. No proof of such later age has been recognized, however, and no correlation of these rocks with Smith's 'Younger Volcanics' has been made.

Mixed Rocks

Under the term 'mixed rocks' are included: (a) assemblages of meta-sedimentary, meta-volcanic, and intrusive igneous rocks in areas where these are too intimately intermingled to map separately; and (b) migmatites, or hybrid gneisses, in which there is an intimate intermingling of intrusive igneous material with older rocks of sedimentary and igneous origins, which in many places have been partly to largely reconstituted chemically and mineralogically. The hybrid gneisses commonly grade into granite-gneiss and granite.

Most of the hybrid gneiss is a grey to pinkish grey, fine-grained rock of alternating, mainly parallel, light and dark bands 1 inch to 6 inches wide. Most of the light bands are light to pinkish grey and have the composition and texture of granite; a few have the composition of syenite. The dark bands are dark grey to nearly black, and are composed mainly of biotite, hornblende, pyroxene, plagioclase (An_{10} to An_{35}), orthoclase or microcline, and quartz.

A smaller part of the hybrid gneiss is an injection gneiss, under which term is included paragneiss, foliated meta-volcanic rocks, and minor foliated basic to intermediate igneous intrusive rocks, into which there has been much lit-par-lit injection of granite and granite-pegmatite, or less commonly of syenite. The injected material, usually in parallel bands an inch or less in width, is light to pinkish grey, and weathers in relief. In places it cuts across the banding in the host rock.

Although noted at many places, these mixed rocks are most abundant in the northwestern part of the map-area. There they occur in a belt about 5 miles wide that extends northeasterly from Constan Lake, Dacre, and Mount St. Patrick to the vicinity of McDougall and Martin Corners, where they swing northwest and become obscured by the Pleistocene overburden in the valley of Bonnechere River.

Nepheline-Albite Gneiss

A band of nepheline-albite gneiss up to 400 feet wide and about 1 mile long lies about $\frac{3}{4}$ mile northwest of Guiney Lake on Mount St. Patrick in the southwestern part of the map-area. The band trends northeasterly and dips 50 to 85 degrees southeast. For most of its length the band has crystalline limestone on its hanging-wall and rusty paragneiss on its foot-wall. Toward its southern end, it grades into limestone. Toward its northeastern end it is cut by dykes and irregular masses of granite-pegmatite and of syenite-pegmatite.

The gneiss is a grey, fine- to medium-grained, indistinctly banded rock with a pitted surface. It is composed mainly of albite, biotite, and nepheline. The last mineral locally comprises up to 30 per cent of the rock, but averages only 10 to 15 per cent of the band as a whole. The grains of nepheline have weathered down more rapidly than the other minerals, producing numerous tiny pits as much as $\frac{1}{4}$ inch deep on the surface of the rock. Short veinlets of nepheline up to $\frac{3}{4}$ inch wide occur in the gneiss at a few places. A few grains of a pale blue mineral, possibly sodalite, were noted at one locality. Scattered crystals of brown corundum as much as 1 inch wide and $3\frac{1}{2}$ inches long occur in the gneiss near its contacts with the pegmatites.

It seems probable that the nepheline-albite gneiss was formed by the action of a magmatic phase upon a series of interbedded crystalline limestones and paragneisses, possibly by limestone syntexis as postulated by Daly (22, p. 87).

Basic Intrusions

At least six small plugs and sills of basic to intermediate intrusive igneous rock up to $\frac{3}{4}$ mile wide and 2 miles long occur within the map-area. Other, probably smaller, bodies no doubt occur, but have not been differentiated from the hornblendic foliated rocks of the Grenville series in the present mapping. Most of these bodies are composed of diorite, gabbro, amphibolite, or meta-gabbro. Pyroxenite and anorthosite are found in some of the bodies, normally only as local phases of them. Certain features of some of these bodies, particularly their substantial content of pyroxene and their field relationships, are similar to those of rocks of the Buckingham series described by Wilson (19) in the Arnprior-Quyon area a few miles to the east.

The largest of these bodies in the map-area forms a prominent hill astride the boundary between the townships of Bagot and Blithfield southeast of Calabogie Lake. This is an oval-shaped, northwesterly trending mass about $\frac{3}{4}$ mile wide and 2 miles long. It is composed mainly of dark grey to black, medium- to coarse-grained, massive to gneissic meta-gabbro cut by numerous interlacing dykes of finer grained grey gabbro and diorite. Locally, especially near its borders, much of the rock consists of amphibolite and hornblende gneiss. The meta-gabbro consists mainly of black hornblende and grey

plagioclase in about equal proportions. The grains of hornblende are ragged and have a very poikilitic habit. Some of them have a basal parting, probably inherited from pyroxene. Small clusters of tiny grains of hematite commonly occur along these partings. The plagioclase is normally bytownite (An_{75}). The coarser grained parts of the rock contain much fresh-appearing scapolite and relatively small amounts of plagioclase, suggesting that the scapolite may have been formed at the expense of the latter mineral.

The five other bodies of basic rocks are, so far as known, smaller than the one described above. Three of them are in the northwestern part of the map-area, ½ mile northwest, 1 mile east, and 2¼ miles southeast, respectively, of Martin Corners. A fourth body, about 1 mile southwest of Glasgow Station, is surrounded by Champlain beds, and its bedrock contacts are not visible. It is possible that it may be simply a local phase of the meta-volcanic rocks. The fifth body is found about a mile northeast of Calabogie where part of it occurs in the foot-wall of a magnetite orebody.

Some of these bodies consist mainly of dull greenish to dark grey, massive to slightly foliated, medium-grained gabbro, with local anorthositic and pyroxenitic phases. The gabbro is composed chiefly of pyroxene, which in some bodies is dull green augite and in others is pleochroic, colourless to pale pink hypersthene. The remainder of the rock is normally almost entirely labradorite, occurring in lath-shaped crystals and in granular masses. Pyrrhotite, pyrite, chalcopyrite, and magnetite are disseminated in the rock in small quantities. Hornblende, scapolite, biotite, and chlorite constitute up to 20 per cent of some phases. Apatite, sericite, and red garnet are very minor constituents.

Locally, these rocks consist almost entirely of pyroxene or plagioclase, and are thus pyroxenites or anorthosites, respectively.

Granite and Granodiorite

Under this heading are included bodies of granite, granodiorite, and closely related rocks, which are neither markedly banded nor contain appreciable amounts of the older rocks as inclusions. Such rocks are abundant in the map-area, occurring in masses that very in size from small sills and dykes a few indhes wide to irregular bodies and stocks up to 5 miles wide and 9 miles long.

Most of these bodies are composed of pink to pinkish grey, fine- to medium-grained, foliated to massive biotite granite. This granite normally consists of about 20 per cent quartz, 55 per cent pink potassic feldspar, either microcline or orthoclase, 15 per cent plagioclase feldspar (oligoclase), and 10 per cent or less of biotite. Some of the plagioclase occurs as microperthitic inclusions in the potassic feldspar. Accessory minerals common in small amounts are: apatite, titanite, pyrite, and magnetite.

The composition of many of these acidic intrusive bodies differs from that of the common biotite granite. In some localities, plagioclase is more abundant than potassic feldspar and the rock is a granodiorite. Some bodies, particularly sills and other small masses, contain both biotite and hornblende. Garnets are also found in such bodies in a few places. Minor parts of some bodies are low enough in quartz to constitute syenitic facies, and some of them are shown separately on the accompanying map. In many places where it intrudes limestone or is closely associated with this rock, the granite is white or light grey in colour, its potassic feldspar being white instead of pink.

The White Lake stock is the largest mass of granite in the map-area. It is a pink, fine- to medium-grained biotite granite, which in some places contains veinlets of epidote up to $\frac{1}{4}$ inch wide. Although the rock in the central part of the stock is nearly massive, that towards its periphery is strongly foliated. The foliation trends parallel with the contacts of the stock and dips steeply northwest or vertically along its northwestern contact and 30 to 40 degrees southeast along its southeastern contact. The granite becomes gneissic within a few hundred feet of its northwestern contact, where there is an interbanded zone containing many lit-par-lit sills of granite in the hornblende gneiss wall-rock.

The Hond Lake stock, about $4\frac{1}{2}$ miles wide by 9 miles long, trends northeasterly across the boundary between the townships of Bagot, McNab, and Horton. The stock contains numerous inclusions of the older rocks and is intruded by large masses of granite-pegmatite. Most of it consists of foliated, pink biotite granite, but near its external contacts and near the inclusions of older rocks is some pinkish grey gneiss. This gneiss commonly contains hornblende as well as biotite.

Numerous smaller bodies of granite occur in the map-area. Although some of these have the forms of plugs, bosses, or small stocks, many are sills and dykes. That at Hunt Lake, about $1\frac{1}{2}$ miles east of the village of Mount St. Patrick, is thought to have the form of a phacolith.

Syenite and Porphyritic Syenite

Five plugs or small stocks of syenite from $\frac{3}{4}$ mile to 4 miles across occur in the southern and northeastern parts of the map-area; the largest of these underlies the higher parts of Mount St. Patrick at the western border. The smallest mass forms a small hill about $\frac{1}{2}$ mile east of the larger one. The third body, $1\frac{1}{4}$ miles southeast of Calabogie, is oval shaped in plan, with its greatest dimension of some $1\frac{1}{2}$ miles in a northeast-southwest direction. Much of this mass is obscured by Pleistocene overburden, but good exposures are found along the Calabogie-Lanark road. The fourth body, at Spruce Hedge just southeast of Madawaska River, is roughly elliptical in plan, with a length of about $2\frac{1}{2}$ miles. The fifth body, on the eastern edge and in the northeastern part of the map-area, is well exposed at and northeast of Glasgow Station. Although the mass has not been completely mapped and some of it is obscured by Champlain beds, magnetic contours (23) indicate that it may be about $2\frac{1}{4}$ miles wide and 3 miles long.

The large mass on Mount St. Patrick is composed of pinkish grey to pink, massive, medium- to coarse-grained, fairly uniform porphyritic syenite. At most places about 70 per cent of this distinctive rock consists of a tightly packed aggregate of euhedral phenocrysts of pinkish grey microperthite up to 3 inches long. These phenocrysts stand up in relief and give the weathered rock a rough surface. Many of them are slightly sericitized, and include numerous small fragments of the mafic minerals of the groundmass. The latter is a pinkish grey, fine- to medium-grained, equigranular aggregate composed of about 65 per cent microperthite, 20 per cent biotite, 10 percent hornblende, and 1 to 2 per cent magnetite. Sphene and apatite are common accessory minerals. In a few places hornblende is more plentiful than biotite and occurs as phenocrysts up to 3 inches long.

The small body about ½ mile east of the large Mount St. Patrick porphyritic syenite mass is composed of pink, fine- to coarse-grained, massive, locally porphyritic, syenite. About 80 per cent of this rock is made up of pink, potassic feldspar, and most of the remainder is hornblende, with minor biotite, sphene, and magnetite. In some places the hornblende occurs as phenocrysts 3 inches or more in length.

The Calabogie mass is composed of pink, medium- to coarse-grained, massive, locally porphyritic, biotite syenite. Fresh surfaces of this rather beautiful rock exhibit glistening cleavage surfaces of scattered, very narrow, lath-shaped crystals of pink microcline up to 1 inch long surrounded by coarse-grained, more equigranular, pink microcline between the grains of which are evenly disseminated small grains of black biotite and dull green chlorite. Approximate percentages of the various minerals present are: microcline, 70; biotite, 15; chlorite, 10; carbonate, 3; ilmenite or magnetite, 1 to 2; and apatite and pyrite, less than 1.

The Spruce Hedge body is composed of pink, medium- to coarse-grained, porphyritic syenite.

The Glasgow Station mass is composed mainly of massive to foliated, pink, medium- to coarse-grained hornblende-biotite syenite, consisting of about two-thirds pink potassic feldspar and one-third black hornblende and biotite. At most places the hornblende predominates over the biotite. Magnetite, sphene, and apatite are minor accessory minerals. Local facies of the rock are porphyritic, with phenocrysts of pink, potassic feldspar up to ¾ inch across set in a groundmass of finer grained feldspar, hornblende, and biotite. Some hybrid syenitic rocks, including some calcareous phases, developed around the borders of the mass contain as much as 25 per cent andradite garnet[1] accompanied by a little zircon[1], magnetite, and bright green,

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[1] Identified by Eugene Poitevin, Chief, Division of Mineralogy, Geological Survey of Canada.

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high-calcium amphibole. Several lens-like bodies of dioritic rock, probably representing partly digested remnants of bands of older meta-volcanic rocks, occur within the syenite mass.

Pegmatite

Pegmatite is abundant throughout most of the map-area, occurring: as tiny stringers paralleling the foliation, particularly in some granites; as dykes and sills from a few inches to 100 feet wide; as irregular, interlacing, ill-defined zones up to several feet wide in some bodies of granite (pegmatitic granite); and as irregular, massive bodies up to 3 miles across. Although most of it occurs in and near bodies of granite, much of it is found in the meta-sedimentary and mixed rocks.

The largest body of pegmatite is within the Hond Lake granite mass. This body, roughly triangular in plan and about 3 miles wide at the base of the triangle near Hond Lake, extends northeasterly for about 6 miles. Other smaller bodies occur in and around this mass of granite.

Three other bodies of pegmatite up to ½ mile wide and 1 mile long occur ½ mile south and 2 miles southwest of Shamrock, and between Marly and Condon Lakes on Mount St. Patrick.

Most of the pegmatite is a massive pink rock, but that occurring in or near crystalline limestone is commonly white or pale grey. Its grain size is normally coarse, with feldspar crystals 2 to 4 inches across, but varies greatly within short distances and includes considerable fine material.

At least 95 per cent of the pegmatite has about the same composition as granite, its principal constituents being feldspar (microcline and albite) and quartz. The feldspar and quartz are graphically intergrown in many bodies, particularly the dykes and sills. Sparsely disseminated crystals of hornblende, as much as 6 inches long, and disseminated grains and octahedra of magnetite up to 1 inch across are the most common accessory minerals. Black tourmaline, in crystals as much as 4 inches long and in graphic intergrowths with quartz, is plentiful in some bodies. Scattered flakes and aggregates of molybdenite up to 1½ inches in diameter and flakes of muscovite and biotite occur in a few of the dykes. One dyke, on lot 1, con. III, Horton tp., contains a little radioactive, dull black to brownish black, bladed allanite[1] and greenish black, vitreous uranothorite[1]. Other constituents of this dyke are quartz, reddish

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[1] Identified by H. R. Steacy, Radioactivity Laboratory, Geological Survey of Canada.

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potash feldspar, plagioclase, magnetite, hematite, and microscopic crystals of apatite.

About 5 per cent or less of the pegmatite in the map-area has the composition of syenite and normally occurs only in or near bodies of this rock. This pegmatite, found mainly as dykes and sills up to 6 feet or more thick, is similar in many respects to the granite-pegmatite except for lack of quartz. Most of it is pink to dull pinkish red, coarse grained, and massive. Some of it consists almost entirely of pinkish red potassic feldspar.

Late Basic Dykes

The youngest Precambrian rocks in the map-area are basic dykes of Proterozoic age. These dip vertically, and most of them trend a few degrees north of west; a few trend west to southwest. They are most abundant or perhaps best exposed in a zone about 3 miles wide extending from Constan Lake southeasterly to Madawaska River near Springtown. They vary in width from a few feet to 100 feet or more and, although most of them were traced for only a few hundred feet they probably extend for several miles. They commonly occupy shallow, linear depressions.

The rock of the dykes is most commonly brown to reddish brown weathering, massive, fine- to medium-grained diabase. This has a well-developed ophitic texture, and is dark greenish grey to black on fresh fractures. The margins of the dykes are normally black and aphanitic for a few inches from their contacts with the enclosing rocks. The diabase is composed of euhedral, lath-shaped crystals of labradorite in a groundmass of augite, with a little ilmenite, magnetite, chlorite, limonite, and apatite.

Some of the wider dykes lack the ophitic texture and are composed simply of medium- to coarse-grained gabbro. Some of these have a glomeroporphyritic texture because the grains of augite in them occur in clusters.

PALAEOZOIC

Six small infaulted outliers of horizontal or near-horizontal Palaeozoic marine sedimentary rocks are known in Renfrew map-area. These consist mainly of fossiliferous limestone, with lesser shale, dolomite, dolomitic limestone, dolomite, siltstone, and sandstone. They are all of Ordovician age and overlie the Precambrian rocks unconformably.

The largest outlier is in the valley of Bonnechere River near Douglas railway station. Although it is no more than a mile wide and about 7 miles long, within the map-area, the outlier extends west for several miles to beyond Eganville. A second outlier, at Ashdad just northwest of Norway Lake, is about 4 miles long and up to 1½ miles wide. A third outlier, underlying an area about 2½ miles long and up to 1½ miles wide near Loch Winnoch in the northeastern corner of the map-area, is part of a larger mass that extends for 10 miles or so along the southern shore of Lac des Chats on Ottawa River. Two smaller outliers occur at Calabogie Lake, one near Barryvale on the east side of the lake and the other on the west side of the lake. The sixth outlier consists of a single outcrop of several hundred square feet on the north bank of Bonnechere River in lot 8, con. VI, Horton township.

Although a few fossils were collected, no detailed study of these rocks was made by the writer. Dr. Alice E. Wilson very kindly identified the fossils and supplied additional information on some of the outliers from her personal field work. Kay (8) has described some of the outliers.

Ordovician

So far as known, all of the outliers, except possibly the lower parts of those near Loch Winnoch and Douglas, are composed of the Ottawa formation[1] alone. As this matter is still under

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[1] Nomenclature of the Ordovician rocks follows that established by Dr. Alice E. Wilson of the Geological Survey in Memoir 241.

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investigation, all of the outliers are classed simply as Ordovician on the map accompanying this report.

The Ordovician rocks outcrop here and there on the flat-topped surfaces of the outliers and on the scarps that border many of the latter, but most of them are obscured by a normally thin cover of Pleistocene drift. Although the Douglas and Loch Winnoch outliers expose some 150 feet of these rocks, the other outliers are much thinner.

The strata known to belong to the Ottawa formation consist mainly of fossiliferous, massive, fine-grained, grey limestone, but include some shale, siltstone, sandstone, and dolomitic limestone, occurring chiefly as thin interbeds. Some information, including names

of fossils collected, on these strata in each of the outliers is given below:

Barryvale outlier

Fine-grained, light to bluish grey, fossiliferous limestone, probably of the Pamelia member of the Ottawa formation, outcrops south-east of Barryvale just west of Grassy Bay, Calabogie Lake, in lot 14, con. XI, Bagot township. Although only 3 or 4 feet of the formation is exposed, a 15-foot terrace suggests a thickness of probably 15 feet or more. A few thin beds of pure, very fine-grained, faintly laminated, cream-coloured, lithographic limestone occur here also.

A small brachiopod, Strophomena minuta Wilson, and an ostracod were found here.

Outlier West of Calabogie Lake

A very small outlier of grey, fossiliferous limestone of the Leray member of the Ottawa formation outcrops on the north shore of a small bay on the west side of Calabogie Lake in lot 19, con. II, Blithfield township. Little else is known about this outlier.

Ashdad Outlier

The Ashdad outlier is exposed only at a few places within ½ mile of the village of Ashdad and in a small quarry in lot 4, con. XI, Admaston tp., about 3½ miles northwest of the village. The approximate thickness of the outlier and its unconformable relations with the Precambrian rocks are well displayed by a 30-foot scarp in lots 27 and 28, con. X, Bagot tp., about 1½ miles southwest of the village.

In the vicinity of Ashdad village, the outlier, or at least the upper part of it, consists mainly of brownish grey limestone and dolomitic limestone, with lesser amounts of greyish green, calcareous, shaly sandstone and some shale, all of the Pamelia member of the Ottawa formation. The limestone is well exposed in a shallow quarry in an open field about ½ mile southwest of the village.

In the small quarry 3½ miles northwest of Ashdad, a 7-foot face exposes interbedded grey and brown limestones of the Lowville member of the Ottawa formation. An 8-inch bed of limestone about 30 inches above the floor of the quarry contains Tetradium collulosum (Hall) and Liospira sp. This bed is overlain by a 20-inch bed or band of siltstone.

Douglas Outlier

Most of the upper part of the Douglas outlier, forming part of the Bonnechere outlier mentioned by Kay (8), is composed of beds of the Leray member of the Ottawa formation and is well exposed in a section 150 feet or more thick. A specimen of Lyopora halli (Nicholson) was obtained from the north bank of Bonnechere River at the northwest corner of the map-area. According to Goudge (24), a quarry in lot 1, con. VIII, Bromley tp., about ½ mile northeast of Douglas railway station, exposes 8 feet of very fine-grained, heavily bedded, brownish grey limestone containing a few small nodules of chert and silicified fossils in its upper part. Although most of the outlier consists of grey to brownish grey limestone, it also contains some white sub-lithographic limestone, dolomite, dark grey to black shale, red and green shale, and sandstone.

Loch Winnoch Outlier

The upper 100 feet or so of the Loch Winnoch outlier are known to consist of beds of the Pamelia, Lowville, and Leray members of the Ottawa formation. These are mainly fossiliferous, grey, massive, fine-grained limestone, with minor interstratified beds of shale and calcareous siltstone. Although the beds of massive limestone are normally 6 to 10 inches thick, many of the beds, particularly the shaly ones, are between ½ inch and 3 inches thick. Some of the limestone is very fine-grained, and contains numerous, scattered, glistening crystals of secondary calcite up to ⅛ inch across. Excellent exposures are found in the bed of a small creek about 300 feet northeast of the road in lot 25, con. X, McNab tp., and in a 25-foot cliff on the west side of the outlier in concession X, just north of the southern boundary of Horton township. Ripple-marks and scour are common features.

Fossil shells are so abundant in some beds that these may be classed as coquina. Some are rubbly with crinoidal debris. Brachiopods, cephalopods, and simple corals abound. Specimens of Endoceras proteiforme Hall or Cameroceras sp. up to 24 inches long are well exposed in the upper part of the section on the farm of Archie McLaren, lot 24, con. X, McNab township. Other fossils found include Lyopora halli, stromatoporoids, Tetradium cellulosum, T. syringoporoides, Hormotoma gracilis, Orthoceras recta-cameratum, and a few fucoids.

Bonnechere River Eastern Outlier(?)

A very small outlier, exposed in a single outcrop only a few hundred square feet in area, occurs on the north bank of Bonnechere River in lot 8, con. VI, Horton township. Preliminary investigation indicates that this outcrop consists in part of fine-grained, brown weathering, grey to pinkish grey to fawn, dolomitic limestone containing angular to rounded fragments up to 8 inches across, and in part of crystalline limestone. The matrix, comprising about 70 per cent of the rock, contains numerous small flakes of muscovite. It also contains some reddish hematite mixed with a little fine-grained calcite in veinlets up to ½ inch wide and 8 inches long and in roundish, botryoidal nodules up to 3 or 4 inches across.

The fragments or pebbles, some 75 per cent of which are angular, consist of white quartz, chert, quartzite, crystalline limestone, and fine-grained, grey, sub-lithographic limestone, and many of them contain substantial amounts of hematite. One bed or large fragment 30 inches wide and exposed for a length of 3 feet strikes north, dips 80 degrees east, consists of moderately crystalline pinkish grey limestone, and has the fragmental rock on both sides of it.

As no fossils were found in the outcrop and as it is isolated, the age of the outlier is unknown. It may be a conglomerate at the base of one of the Ordovician formations; or it may be simply rock of the Grenville series that has been brecciated by faulting along Bonnechere River.

In addition to the strata of the Ottawa formation described above in the various outliers, about 50 feet of strata of unknown age occur in the lower part of the Loch Winnoch outlier and possibly in the Douglas outlier as well. In the Loch Winnoch outlier, these beds consist mainly of massive, brown weathering dolomite and dolomitic limestone in beds from 1 inch to 18 inches thick and averaging about 8 inches. Black shaly partings ⅛ to ¼ inch thick occur between the thicker beds. Dolomitic nodules are found in some of the more limy beds. A few beds are composed of bluish grey, lithographic to

fossiliferous limestone. One 5½-foot section consists of 24 inches of greenish grey shale, overlain by 18 inches of grey and purple limestone and underlain by 24 inches of dark brownish grey shale. At another location, light grey, fine-grained limestone contains numerous, rounded, non-concentric masses or concretions of slightly darker grey limestone. On weathered surfaces the rounded masses, marked by numerous small pits, stand up as much as 1 inch above the matrix, and in places comprise 30 to 50 per cent of the rock.

As fossils are rare in these lowermost strata and as no useful fossils were found, their exact age is unknown. They may be of Beekmantown, Chazy, or Black River age.

CENOZOIC

Superficial, unconsolidated material accumulated during Pleistocene and Recent Epochs of the Quaternary period conceal much of the bedrock in Renfrew map-area. Those of Recent age are very minor in quantity.

Pleistocene

The Pleistocene material is of two types and ages: (1) glacial drift and glacio-fluvial and glacio-lacustrine beds derived from the great continental glacier that covered most of northeastern North America during the earlier and greater part of Pleistocene time; and (2) beds laid down in the Champlain Sea, a large gulf of the ocean that extended up the St. Lawrence and Ottawa Valleys towards the close of Pleistocene time.

During its advance, the continental ice-sheet swept the bedrock clean of most, if not all, of the products of preglacial weathering. At the same time it eroded and polished the bedrock to some extent, forming roches moutonnées, grooves, striae, and widespread smoothed and gently rounded surfaces. Although the direction of ice-movement was influenced to some extent locally by the topography, striae and grooves indicate that the advance was in general from about 30 degrees west of north.

Glacial Drift and Glacio-fluvial and Glacio-lacustrine Beds

Material of glacial origin, including both unsorted glacial drift and sorted, glacio-fluvial and glacio-lacustrine beds, is abundant and widespread in the map-area. It is particularly abundant in the following localities: (a) north and southeast of Constan Lake; (b) in the western part of the Calabogie Lowland, mainly west of Norway and Calabogie Lakes; (c) on the northern slope of Mount St. Patrick; (d) in a belt extending southeastward from near the village of Admaston to and slightly beyond the Goshen-Burnstown vicinity; and on the high ground north of the town of Renfrew. Although most of such overburden in the valley of Bonnechere River has been either eroded or covered by Champlain beds, the upper parts of some of it is still exposed there. Wilson (6) has noted that some of it projects above the Champlain clay as small, mammillary mounds. In addition, much of the bedrock in the map-area is covered by a thin mantle of drift. Much of the glacial drift, too, at an elevation of less than 500 feet or so above sea-level has been reworked and redistributed by the waters of the Champlain Sea.

The glacial drift or till consists of unsorted material, varying in size from very small clay particles through silt, sand, and gravel up to boulders 15 feet high. In a few places this till is a 'boulder clay'. Most of the glacial drift is ground moraine, but a few remnants of recessional or end moraine were also noted, as well as a very few drumlins with flat to gently rounded tops.

Glacio-fluvial material, composed of roughly sorted to well-sorted small boulders, gravel, sand, and silt, occurs for the most part as kames and other ice-contact deposits. Fewer of them occur as out-wash, and as remnants of eskers. Many of the kames are composed of deltaic material consisting in small part of layers of boulders up to 18 inches in diameter and in larger part of well-defined beds of gravel, sand, and silt some of which dip as steeply as 30 degrees. These features are well shown in a gravel pit in lot 27, con. VI, McNab tp., just west of highway No. 17. Scour and fill are indicated in places by the truncation of some beds by others of different dip. The glacio-fluvial material in some places grades into or is succeeded by glacio-lacustrine beds.

Glacio-lacustrine beds laid down in glacial or semi-glacial lakes are composed of stratified clay, silt, sand, and minor gravel. Most of the beds are flat to gently dipping, and 2 inches or less in thickness. Some 1-inch beds of clay and clayey silt interstratified with thicker beds of sand and gravelly sand show prominent ripple-marks. Most of these features are well displayed in a pit at the south side of the road from Springtown to Burnstown in lot 17, con. II, Bagot township. A deposit of clay and silt about 20 feet thick occurs at an elevation of 1,160 feet above sea-level on Mount St. Patrick in lot 5, con. XII, Brougham township.

Champlain Beds

It has been shown by Johnston (25, p. 17) that the Champlain Sea reached an elevation of 690 feet above present sea-level near Kingsmere, several miles northwest of Ottawa. If there has been no differential uplift of the surface between Kingsmere and Renfrew, some 45 miles to the west, it may be assumed that the sea reached a similar elevation there. Goldring (26, p. 180) has indicated that the waters of the sea were brackish in the Renfrew area and that they became fresh at Pembroke to the northwest and normal marine to the east of Arnprior. Johnston (25, p. 27) states that fossil shells of marine species are found in the Champlain beds of the Ottawa area up to, but not beyond, an elevation of 510 feet. No particular search for fossils was made and none was found in the Champlain of Renfrew map-area.

Strata laid down in the Champlain Sea along Ottawa River extend up the valley of Bonnechere River in the northern part of the map-area in a belt that is 2 to 3 miles wide near Renfrew. An isolated flat extending west from the village of Mount St. Patrick for 3 miles or so may also contain Champlain beds. A third, very small area of Champlain sediments found in lot 18, con. I, Horton tp., is part of a larger area of such beds lying mainly to the north of the map-area.

In general the Champlain strata may be roughly divided into two types, which in many places grade into one another: (1) beds of stratified clay, underlying extensive plains in lowland areas, generally below 475 feet above sea-level. Near their boundaries, that is, near the shorelines of the ancient Champlain Sea, particularly where these are adjacent to extensive deposits of sandy, glacial material, many

of the clay beds contain numerous interfingering beds or bands of sand or of sand and fine-grained gravels and may grade into strata consisting mainly of sand: (2) beds of stratified sand and silt with thin interbeds of gravel and clay, underlying smaller and more local plains and gently undulating parts in upland areas, generally above 475 feet, and more commonly between 500 and 600 feet, above sea-level.

The Champlain beds in the valley of Bonnechere River consist mainly of white to light grey clay. This clay, occurring in thin, horizontal beds, underlies the valley plain, which has an elevation of about 420 feet in its eastern part and rises very gently westward to about 450 feet near Douglas. The thickness of the clay penetrated by a well on the farm of Wesley Bahm, in lot 4, con. II, Horton tp., is 204 feet. As the collar of this well, at an elevation of 360 feet, is about 60 feet below the level of the plain, it is evident that the Champlain beds in the northeastern part of the map-area have a maximum thickness of at least 264 feet. Several wells in this general vicinity show 100 feet or more of clay. One well, near Douglas railway station, shows 20 feet of clay. The maximum thickness of clay in this western part is probably much less than it is in the eastern part. Bonnechere River and its tributaries have cut down through the clay to a maximum of 155 feet below the eastern part of the plain.

Considerable sand occurs in the Champlain beds at some points near the borders of the Bonnechere Plain. At some of these places, as in a pit near the four corners in lot 18, con. VI, McNab tp., the sand predominates, and the clay occurs in stratigraphically isolated horizontal bands up to 4 feet thick. In addition, some deposits of sand and gravel of glacial origin are only partly covered by the Champlain strata and, therefore, protrude above the Bonnechere Plain in forms varying from mammillary mounds only a few feet high to hills 100 feet high.

The narrow plain extending west from the village of Mount St. Patrick for some 3 miles at an elevation of 600 to 625 feet is underlain mainly by sand and silt with a few thin interbeds of clay. As this material is isolated from other known Champlain beds and as no fossils are known to have been found in it, it is not certain that it is Champlain. It may represent the bed of a glacial lake.

The small area of Champlain sediments about a mile east of Payne, in lot 18, con. I, Horton tp., at the north edge of the map-area, consists mainly of sand, with some beds of gravel. The beds underlie an upland plain 550 to 560 feet above sea-level.

The waters of the Champlain Sea and of the streams flowing into it reworked and redistributed some of the glacial material, particularly that below an elevation of 500 feet. For this reason some of the unconsolidated material, especially that around the borders of the Bonnechere Plain, shows both glacial and marine characteristics. It seems probable that much of the Champlain sediment in the map-area was derived from erosion of glacial debris to the west and northwest.

Recent Deposits and Effects

Small quantities of Recent overburden occur in the area. The most abundant is a dark muck found in swamps. A little peat also occurs in many of the swamps. Some alluvium, consisting of clay, silt, sand, gravel, and, a few boulders, derived mainly from unconsolidated materials of glacial origin, has accumulated in stream valleys and lakes. Marl occurs in some lakes, notably in the northern end of White Lake and to a lesser extent in Colton Lake.

A prominent Recent effect is the dissection of the Bonnechere Plain by the river and its tributaries. As mentioned previously, the river has cut down through the soft Champlain clay as much as 155 feet in some places. Its tributaries, even very small, partly seasonal streams, commonly occupy steep-walled gullies up to 75 feet or so deep. Many of these gullies are being rapidly extended by headward erosion of their streams. Terraces, abandoned stream channels, former islands, and other features also mark the dissection of the plain.

STRUCTURAL GEOLOGY

The structure of the rocks of Renfrew map-area is extremely complex, and because of this and of the scarcity of recognizable and reliable primary features in the rocks much of it is very difficult to interpret. Broadly considered, however, the area is intermediate in position between vast expanses of granite-gneisses lying to the northwest and remmantal belts mainly of Grenville meta-sedimentary and meta-volcanic rocks extending into it from the south and southwest. Many of the rock masses have a lenticular pattern, and mixed rocks abound.

The rocks of the Grenville series have been complexly folded, and the intricacy of the folds has been still further complicated by flowage of the limestone members of the series. Much later, the rocks were broken into a series of subparallel tilted blocks by high-angle normal faults.

FOLDS

The rocks of the Grenville and Bristol series and the mixed rocks have been closely and complexly folded, and in many places disrupted by intrusive masses. Although most of the folds trend northeasterly, those in the northwestern part of the area trend north to northwesterly. These general trends are commonly varied at and near the borders of the larger intrusive masses, where the fold axes commonly parallel the intrusive contacts.

Some of the folds may be isoclinal, although lack of recognizable, reliable criteria makes it generally impossible to follow fold axes. Bedding is discernible in many places, but tops of beds are commonly indeterminate because of lack of recognizable, well-formed pillows or evidence of grain gradation, crossbedding, fracture cleavage, or other features normally employed in such determinations. In most of the few places where it could be determined, the pitch of the folds was found to be toward the northeast at low angles, commonly 25 degrees or less. Dips of the strata vary from flat to vertical, but are less than 50 degrees in most places and even less than 30 degrees over fairly large areas. These local areas of flat to very low dips may indicate the presence of "buried batholiths" somewhat similar to the cases described by Adams and Barlow (27, p. 19) in the Haliburton and Bancroft areas. Another indication of the probable presence of batholithic granite at fairly shallow depth throughout the area, again described by Adams and Barlow (27, p. 23), is the widespread occurrence of the Grenville limestone in the form of coarse-grained, white marble.

All of the Precambrian rocks in the area, except the Proterozoic dykes and parts of some of the larger intrusive masses, are foliated. In every case where this could be determined it was found that the foliation parallels the bedding. The foliation in the

borders of the intrusive stocks is normally parallel with the strike of the surrounding meta-sedimentary and meta-volcanic rocks.

Flowage of the crystalline limestone occurred during deformation of the rocks of the area. As a result, limestone locally intrudes pegmatite dykes and sills and breaks across bands of paragneiss and hornblende schist, thus encompassing large, angular blocks of these rocks. This flowage is well shown in lot 5, con. IX, Brougham tp., where a tongue of crystalline limestone about 24 inches wide cuts through a 36-inch sill of granitic pegmatite. Another good example is found at the north side of the highway in lot 25, con. VII, Admaston tp., where a 10-inch, dark basic sill or bed in white crystalline limestone has been contorted and broken into several isolated pieces during flowage of the limestone. The same phenomenon is exhibited on a larger scale in the outcrop just west of Loch Winnoch. There, blocks and bands of hornblende gneiss and paragneiss up to 1,000 feet wide have been broken across and completely surrounded by crystalline limestone.

In spite of the general complexity and lack of conclusive proof of their nature, some major folds may be recognized. One such fold is found at Hunt Lake, about 1½ miles east of the village of Mount St. Patrick. This fold is probably a syncline pitching to the northeast at about 25 degrees. Its eastern limb is partly overturned to the southeast, and its nose is occupied by a granite mass, probably in the form of a phacolith. A second fold, again trending and pitching northeasterly, occupies the southwestern corner of the map-area, where its limbs consist mainly of two bands of crystalline limestone up to 4,000 feet wide. A third fold, of northeasterly trend and pitch and probably synclinal in nature, straddles the southwestern part of Norway Lake.

Another fold, possibly anticlinal in nature, is found a short distance south of Martin Corners, where the formations change strike rather abruptly from northeast to northwest. The positions of still other folds and remnants of folds are indicated on the map accompanying this report.

The manner in which the older rocks occur in bands around and parallel with the contacts of both the White Lake and Hond Lake granite masses and the parallelism of the foliation in these masses with the strike of the adjacent older rocks suggests that these stocks occupy northeasterly trending anticlines. If so there would appear to have been some overturning to the northwest of the northwest limb of each of these folds.

FAULTS

The most conspicuous faults in Renfrew map-area belong to a series of normal, high-angle faults trending northwest to west approximately parallel with Ottawa River in this district. As shown by Kay (8), most of the area lies within a major trough 35 miles wide known as the Ottawa-Bonnechere graben, which is bounded by two of these faults. On the southwestern side of the graben, the St. Patrick fault and scarp separate it from the dissected block mountains known as the Madawaska Highlands. On its northeastern side, the graben is separated from the Laurentian Plateau by the Coulonge fault and its scarp, situated a few miles northeast of the map-area.

The rocks within the Ottawa-Bonnechere graben, including all of the map-area northeast of the St. Patrick scarp, have been broken by several parallel minor faults into several westerly to northwesterly trending high and low blocks, which have the form of horsts and grabens

respectively. All of the normal, high-angle faults are marked throughout parts of their length by prominent scarps or fault-line scarps up to 900 feet high.

Because of the occurrence of infaulted outliers of Ordovician rocks in the grabens or lowlands, it is known that the faults are post-Ordovician in age. Kay (8, p. 641), largely on evidence from the Lake Timiskaming, James Bay, and Monteregian Hills areas, suggests that they are of early Tertiary age. However, the parallelism in strike between most of the late basic dykes, presumably Proterozoic in age, and the faults is notable. This may indicate that the post-Palaeozoic faulting occurred along or was controlled by a zone of faulting formed in Precambrian times.

From isopachal studies of the Alleghany synclinorium, Kay (8, p. 641) estimates that the Palaeozoic sediments in the Renfrew area at the time of faulting were about 1,800 feet thick. Because of this and because the maximum throw on the faults is calculated to be 1,500 feet, he points out that the scarps are actually fault-line scarps and that the lowlands have graben form, rather than being true grabens.

As no evidence of any horizontal movement on the faults has been found, it is concluded that the displacement on them was mainly or entirely vertical.

The Calabogie Lowland is underlain by a wedge-shaped, down-dropped block 3 to 7 miles wide between the St. Patrick fault on the southwest and the Shamrock fault to the northeast. Outliers of Ordovician rocks occur in the lowland at Ashdad, 3 miles northwest of Ashdad, and at both the eastern and western sides of Calabogie Lake. The St. Patrick fault, estimated by Kay (8, p. 619) to have a maximum throw (near Foymount, west of the map-area) of 1,500 feet, traverses the area for about 15 miles in a southeasterly direction from near Dacre to the southern end of Calabogie Lake. It is marked by a prominent fault-line scarp, which has maximum relief of about 900 feet southwest of Dacre. A narrow, fairly straight, linear depression in the Madawaska Highlands south of the St. Patrick fault extends from near McCool Lake at the western side of the area in a direction slightly south of east for 8 miles or so to the vicinity of the St. Patrick fault near Calabogie Lake. This depression probably marks another high-angle fault, which possibly joins the St. Patrick fault. Another fault is assumed to branch from the St. Patrick fault just west of Constos Lake and to pass eastward along the valley of Constan Creek and into the northern part of Calabogie Lake. Still a third fault (not shown on the accompanying map) is assumed by Kay (8, p. 618) to be marked by a small scarp that diverges from the St. Patrick scarp at the west side of Calabogie Lake and passes eastward along the southern boundary of the Barryvale outlier and just south of White Lake. Study of air photographs seems to indicate that a narrow block of ground between the Shamrock fault and a straight, parallel lineament about 1 mile south of it has been down-dropped a little more than the remainder of the Calabogie Lowland block as a whole. Therefore, this lineament some 6 miles long, may mark another, minor, high-angle fault. A diabase dyke, exposed in the lineament some 3 miles west of Ashdad, may indicate that the dyke occurs in a fault or that the lineament is due simply to differential erosion of the dyke.

The Shamrock Upland, extending from the Shamrock fault to the Bonnechere Plain, comprises the higher, southern, and larger part of a tilted block of ground lying between the Shamrock fault on the southwest

and the Doré fault just north of Renfrew at the north. The surface of this block is highest in its southern part and is seen to slope gently northward to where it is overlapped by the Champlain beds of Bonnechere Valley. The Shamrock fault, estimated by Kay (8, p. 618) to have a maximum throw of 200 feet, is marked by a fairly prominent fault-line scarp that can be traced for about 8 miles from a point 2 miles southwest of Shamrock to near Ashdad. Greatest local relief along the scarp is about 200 feet. Kay (8, p. 617), on evidence from northwest and east of the map-area, infers that the "Pakenham fault" traverses the Shamrock Upland across the whole width of the map-area from a point about $\frac{3}{4}$ mile southwest of Caldwell to a point about a mile south of Madawaska River at the eastern edge of the area. No evidence of this fault was recognized by the writer in [illegible] map-area.

The highland north of Bonnechere River near Renfrew is bounded on the south, in part at least, by the Doré fault. This fault, with a maximum throw of 300 feet, was found by Kay (8, p. 614) to lie along the northeastern side of the Bromley outlier of Palaeozoic rocks to the north of the map-area, and was assumed by him to traverse the map-area for about 13 miles in a southeasterly direction from near Payne to, and beyond, Glasgow Station. The only evidence of this fault seen in the map-area is the southwest-facing scarp 1 mile to 2 miles northwest of Renfrew, where the Precambrian rocks stand about 300 feet above the Bonnechere Plain.

In addition to all of the northwesterly to westerly trending high-angle faults described above, there appear to be a few that trend northeasterly to easterly. These assumed faults, commonly marked by long, narrow, linear depressions or scarps, are parallel with the Cochrane cross-fault described by Kay (8, p. 617) as connecting two of the northwesterly trending high-angle faults between Lake Doré and Golden Lake, northwest of the map-area.

One of these faults probably occupies a narrow, linear topographic depression extending northeasterly from Grattan for 4 miles or more. This may be referred to as the Grattan fault. A second fault of this series, on direct line of strike of the Grattan fault, is assumed to extend northeasterly from near Renfrew for 6 miles or so along Bonnechere River. Flat to gently dipping Precambrian rocks occur in a scarp as much as 200 feet high on the north side of the river, but none is exposed anywhere near the river on its southern side. The occurrence of veinlets of hematite and of some fawn-coloured, iron-bearing carbonate in the crystalline limestone there may be a further indication of faulting along the river. This fault, referred to as the Bonnechere fault, is evidently along the same line of weakness as the Grattan fault.

A series of parallel, minor, high-angle faults a few feet apart and striking north 60 degrees east occur within but near the northern edge of the Glasgow syenite body about 100 feet west of the house of Angus Carswell, lot 22, con. IX, McNab township. The faults produce left-hand offsets of 1 foot to 4 feet in a 30-inch diabase dyke, which strikes north 20 degrees west. None of the faults was traced for more than 25 feet along strike.

In addition to all of the late, high-angle faults described above, some faults affecting only Precambrian formations and of various trends occur in the map-area. All of those recognized are small, showing horizontal displacements of only a few feet. Dykes of pegmatite and aplite are found along and in some of these faults.

JOINTS

Although joints occur in many directions in the Precambrian rocks of the area, a near vertical set trending northwest to west is most prominent. These seem to be best developed in and along the borders of the Calabogie Lowland, where they parallel the late high-angle faults and most of the Proterozoic basic dykes. It seems probable that intrusion of the dykes was controlled by these joints.

A system of near-vertical joints is well developed in the Ordovician rocks in lot 24, con. X, McNab township. One set strikes north 40 degrees east and the other set north 70 degrees west.

PRELIMINARY CORRELATION OF AEROMAGNETIC SURVEY WITH GEOLOGY

Renfrew map-area was surveyed with the airborne magnetometer in 1947 and 1948. Flights were made at an altitude of 1,000 feet along north-south lines spaced at about ¼-mile intervals. Results of this survey are given in Geophysics Paper 67 of the Geological Survey of Canada. A brief discussion of these results and a tentative correlation of some of them with geology are given below.

In general, the trends of the larger structural elements and the outlines of the larger intrusive masses are discernible. However, the complex geology of the area is reflected in a very complex and broken-up pattern of magnetic intensities. The greater magnetic relief shown in the eastern two-thirds of the area is probably due to the greater abundance there of magnetite-bearing hornblende gneiss and schist, granite, pegmatitic granite, and syenite. The hybrid gneiss, so abundant in the northwestern part of the area, has low magnetic relief, as have also rocks of sedimentary origin, particularly the crystalline limestone.

Some of the positive anomalies are due to bodies of syenite that have a fairly high content of disseminated magnetite. Greatest magnetic intensity in the map-area, about 2,600 gammas, is shown by the syenite mass northeast of Glasgow Station. Greatest magnetic relief of some 1,400 gammas is also shown by this mass.

Most of the Bonnechere Plain east of Renfrew has very low magnetic relief. This probably indicates that crystalline limestone underlies the Pleistocene beds there.

Anomalies due to deposits of magnetite have a magnetic relief of 1,200 gammas or less and are not very conspicuous. The Campbell-Caldwell orebody of Algoma Ore Properties, Limited, about a mile east of Calabogie, shows the greatest magnetic intensity of any of these deposits, about 2,300 gammas. Its anomaly reflects its southeasterly dip and northeasterly rake.

Some other features noted are as follows:

(1) Most of the White Lake granite mass has comparatively low magnetic intensity and relief.

(2) A positive linear anomaly extends northeasterly from ½ mile west of Hond Lake for about 8 miles to a point about a mile northwest of Glasgow Station. This anomaly, which has a maximum intensity of 2,100 gammas in granite and pegmatite about a mile southeast of Goshen, lies within the Hond Lake granite body along and near its northwestern contact. It is probably due to disseminated magnetite

in the granite and pegmatite in a zone along its contact. A similar linear anomaly extending northeasterly for about 4½ miles along the southeastern contact of the body from 1 mile southwest of Burnstown to 1½ miles southwest of Glasgow Station is apparently due to a band of magnetite-bearing hornblende gneiss.

(3) The magnetic survey gives very little or no indication of the late high-angle faults, such as the St. Patrick and Doré faults.

(4) The early basic intrusive rocks, containing some scattered pyrrhotite and other sulphides, cause no substantial anomalies.

(5) The magnetite-bearing pegmatite body between Marly Lake and Condon Lake causes an anomaly with relief of only 70 gammas or so.

(6) A positive anomaly with magnetic relief of 600 gammas near the southwestern end of Norway Lake may be due to a body of magnetite.

(7) The small anomaly about a mile northeast of Calabogie is apparently due to the presence of magnetite in the hornblende gneiss there.

(8) A rather narrow, oval, northeasterly trending anomaly with relief of 800 gammas and maximum intensity of 2,200 gammas occurring in hornblende gneiss athwart the boundary between Horton, Admaston, and Bagot townships is probably due to magnetite in the rock.

(9) A northwesterly trending oval anomaly about 1 mile long with maximum magnetic intensity of 2,300 gammas and relief of 800 gammas, occurs about 1 mile southwest of Payne. As the bedrock there is obscured by Pleistocene beds the cause of the anomaly is unknown.

ECONOMIC GEOLOGY

Although the county of Renfrew, with an area of 3,009 square miles, has been noted for many years as the source of a great variety of minerals, many of them rare and representing excellent specimen material, Renfrew map-area has provided relatively little of this material.

The mineral occurrences in the map-area include asbestos, clay, copper, corundum, dolomite, feldspar, garnet, gravel and sand, gold, graphite, iron (magnetite and hematite), lead, limestone, marl, mica, molybdenum, nepheline, pyrite, radioactive minerals, sillimanite, strontium, tourmaline, and zinc. Although there are many occurrences, most of them are too small or too low in grade to be of any economic importance. Many of them are of interest only to mineral collectors.

In spite of the relative unimportance of most of the occurrences, however, a few of them are of considerable economic significance. These include iron, and molybdenum, and constructional materials— stone, gravel, sand, and clay, which have found steady use on an increasing scale since the early days of settlement of the district. About 46,000 tons of magnetite were produced from several deposits between 1883 and 1901. Exploration by Algoma Ore Properties Limited in 1951 revealed a magnetite orebody of substantial size, and it seems probable that the district will produce iron once again. Many occurrences of molybdenite are known, and some 150,000 pounds of this mineral has been produced from nine of them, most of this amount being obtained between 1915 and 1918. Although some of the occurrences are of fairly good grade, they

are small and somewhat erratic and probably not commercial in normal times. A zinc-bearing area about 4 miles southwest of Renfrew is being explored by Cadieux Mines Limited, and Renprior Zinc Mines, Limited. Results of this work give some promise of eventual production of this metal. All of the small tonnage of celestite (strontium) mined in Canada has been obtained from a deposit in the map-area. Graphite is of widespread occurrence and commercial deposits of it may be found. Although tourmaline is abundant, deposits of the mineral in sizes presently required by industry are scarce. A small tonnage of asbestos has been produced from the one deposit of this mineral known in the map-area.

All of the mineral occurrences known to the writer in Renfrew map-area are described or listed in alphabetical order in the following pages of this report. Except for the few cases in which occurrences of certain minerals or elements are placed under the names of companies, all are listed alphabetically by townships and numerically by concessions and lots.

ASBESTOS

Blithfield Township

Concession IV, Lot 22

An occurrence of asbestos in lot 22, con. IV, Blithfield tp., about 650 feet northwest of the road from Calabogie to Black Donald, was examined by Satterly (9, p. 19) in 1943 and described as follows:

> "The workings are on the west side or top of a north-south ridge of coarse white crystalline limestone, which strikes N. 10°W. and dips 35°E. They consist of an open cut, which is 25 feet long, 10 feet wide, and 12 feet deep, and 130 feet north of the open cut a trench, somewhat overgrown, 45 feet long, 4 feet wide, and 4 feet deep, which curves from N. 45° to 65°E.
>
> "The north wall of the open cut is a slip striking N.50°E. and dipping 75°S.E. Striations on the wall pitch 25°E. The face of the open cut shows a number of additional slips branching off from the main one, and the limestone across the entire width of the open cut has been crushed and altered to a pale-green rock consisting of serpentine, talc, calcite, tremolite and more rarely chlorite. Asbestos and coarse calcite fill the slips. On the main slip coarse, white to pale-green or creamy-pink calcite forms lenses up to 1 by 2 feet, and white-weathering, pale-green, slip-fibre asbestos forms veins from paper-thin to 3 inches in width. The fibres range from 1 to 4 inches in length. No cross-fibre was seen.
>
> "In the trench a curving slip is exposed, which contains slip-fibre asbestos up to 3½ inches in length. The width of the asbestos vein is from paper-thin to 2 inches.
>
> "The occurrence is of no commercial value."

Hewitt (28, p. 2) mentions that a small tonnage of tremolite asbestos, valued at $2,925, was produced in 1945 and 1946 by L.M. Carswell of Renfrew, Ontario, from a deposit in lot 22, con. IV, Blithfield township. This production was obtained from the occurrence described by Satterly[1].

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[1]Personal communication from D.F. Hewitt.

CLAY

Although no clay is now being quarried in the area, it is abundant in the marine Champlain beds in the valley of Bonnechere River. Much of this clay is suitable for manufacture of common brick and drain tile, and some of it has been used for this purpose in the past. In addition to its role in manufacturing, the clay forms an important part of the valuable farm lands of Bonnechere Valley.

Horton Township

Concession II, Lot 10

As reported by Baker (29), Montgomery (30), and Satterly (9), the Jamieson Lime Company operated a brick and tile plant for many years in lot 10, con. II, Horton township. The plant, operated only in the summer months, had an average annual production of 1,000,000 brick and 300,000 farm tile. The clay used in the plant was obtained from two adjacent pits averaging about 10 feet in depth. One of these is about 225 feet wide and 500 feet long and the other is about 500 feet square. The section of clay quarried has been described by Montgomery (30) as follows:

> "The clay pit has a 12-foot face and consists of 4 feet of good red-burning clay overlying 8 feet of clay which burns to a light-red. Below this is at least 10 feet of buff or cream-burning clay."

The brick and tile plant burned down in 1943 and the land has since been sold and used for other purposes.

COPPER

A few occurrences of chalcopyrite, all apparently of minor importance, are known in the area. In addition to the occurrences described below small amounts of disseminated chalcopyrite are found in the basic intrusions, being particularly abundant in the body northwest of Martin Corners.

Admaston Township

Concession XII, Lot 14

A vertical shaft about 5 by 5 feet inside the timbers and reported to be 50 feet deep is situated on the south slope of a ridge in the northern part of lot 14, con. XII, Admaston township. The shaft, now filled with water to within 15 feet of surface, is reported to have been sunk for copper.

A near-vertical diabase dyke from 2 to 3 feet wide and striking north 75 degrees west is exposed in the shaft. The dyke lies in crystalline limestone cut by dykelets and larger masses of coarse-grained to pegmatitic granite. Sparse to moderate amounts of disseminated pyrite occur along the contacts of the dyke. This mineralization is most abundant where small offshoots of the dyke cut fractured crystalline limestone. Fine-grained crystalline quartz occurs in a late fracture on the south side of the dyke. No chalcopyrite or copper stain is visible.

Concession XII, Lot 5

Freeman (7, pp. 7, 8) mentions a gold occurrence in a 1-foot quartz-chalcopyrite vein in lot 5, con. XII, Admaston township. This is described later under GOLD.

CORUNDUM

Brougham Township

Concession XV, Lot 9

A few scattered crystals of brown corundum occur in and along the southeastern contact of a narrow band of grey nepheline-albite gneiss in lot 8, con. XV, Brougham township. The band of gneiss strikes north 60 degrees east and dips 50 degrees southeast. It consists mainly of albite and biotite with 10 to 20 per cent nepheline. It is intruded by numerous dykes and larger irregular masses of pink pegmatite, some of which are syenitic, others granitic. Some of the pegmatite occurs in the gneiss as narrow bands of pink feldspar paralleling the foliation.

The crystals of corundum, although also present in minor quantities elsewhere in the band of gneiss, are most abundant at and near the contacts of the syenite pegmatite, particularly along the narrow bands of pink feldspar parallel with the foliation. Most of the crystals are 3/8 inch or less in diameter. The largest one seen by the writer was $\frac{3}{4}$ inch across and about 2 inches long. Satterly (9, p. 90) mentions crystals up to 1 inch across and $3\frac{1}{2}$ inches long.

DOLOMITE

This section has reference only to Grenville dolomite of possible value for metallurgical or chemical purposes. None of this is being quarried for such uses at present. The Palaeozoic dolomite of the map-area, although fairly abundant in the lower part of the Loch Winnoch and possibly some of the other outliers, is not described here.

Bagot Township

Concession X, Lot 18

Goudge (24, pp. 178, 179) gives analyses of two samples of Grenville dolomite from points just north of the village of Calabogie. One of these contained 41.26 per cent $MgCO_3$ and had a ratio of CaO to MgO of 1.55 to 1. The other contained 42.87 per cent $MgCO_3$ and had a ratio of CaO to MgO of 1.50 to 1. These occurrences are not shown on the map accompanying this report.

Concession XII, Lots 22 and 23

A band of dolomite striking north 10 degrees east and dipping eastward at a low angle is situated athwart the boundary between lots 22 and 23, con. XII, Bagot tp., about 500 feet west of the road from Calabogie to Shamrock. A few narrow bands of biotite-hornblende gneiss occur within the band of dolomite.

Blithfield Township

Concession II, Lot 18

Some white crystalline dolomite was noted on the west shore of Calabogie Lake in lot 18, con. II, Blithfield tp., during a traverse by canoe. Nothing else is known about this occurrence.

Horton Township

Concession IV, Lot 5 (?)

Goudge (24, pp. 178, 179) gives an analysis of Grenville dolomite in or near lot 5, con. IV, Horton township. The rock contains 42.41 per cent $MgCO_3$ and has a ratio of CaO to MgO of 1.55 to 1.

McNab Township

Concession V, Lot 15

Impure, grey, medium-grained, crystalline dolomite was noted at several points on a traverse across lot 15, con. V, McNab township. One of these points is about 500 feet southeast of Madawaska River.

FELDSPAR

Pegmatite dykes containing large pure masses of feldspar suitable for quarrying are rare in Renfrew map-area. None of the few such dykes known has been worked in the past. Some of those described in this section, however, may be of commercial interest.

Admaston Township

Concession VIII, Lot 25

A pink granite-pegmatite dyke occurs about 100 feet south of the road on the farm of Thomas Martin in lot 25, con. VIII, Admaston township. The dyke, striking north 65 degrees east and dipping vertically, cuts hybrid gneiss, which here consists mainly of hornblende-granite gneiss striking north 55 degrees west and dipping 30 degrees southwest.

Although the dyke consists mainly of coarse-grained, pink, potassic feldspar and quartz, it also contains some finer grained graphic granite. Its approximate average content is probably 60 to 70 per cent feldspar and 30 to 40 per cent quartz. One section of the dyke 5 feet wide and 12 feet long consists of about 90 per cent feldspar in crystals up to 6 inches long.

Concession IX, Lot 28

A pink granite-pegmatite dyke stands up as a knoll about 25 feet high at the southwest corner of a field on the farm of Martin McHale in lot 28, con. IX, Admaston township. The dyke strikes northeast, is about 100 feet wide, and has an exposed length of 600 feet. Its southwestern part cuts gabbro, but its northeastern end is flanked by flat-lying Champlain beds.

The dyke consists almost entirely of pink potassic feldspar and white quartz. The feldspar constitutes approximately 60 to 65 per cent of the rock and occurs in crystals up to 6 inches long. Much of the quartz, which constitutes almost all of the remainder of the rock, is intimately intergrown with the feldspar.

Brougham Township

Concession XIII, Lot 12

A dyke of pink pegmatite occurs in biotite-hornblende syenite on the southeastern flank of a hill in lot 12, con. XIII, Brougham township. The dyke is about 50 feet wide, at least 200 feet long, and strikes north 85 degrees east. It consists mostly of pink, potassic feldspar in crystals from 6 to 12 inches across. Quartz, occurring mainly as graphic intergrowths in the feldspar, constitutes about 25 per cent of the dyke.

Concession XIV, Lot 13

A nearly flat sheet of dull pinkish red potassic feldspar occurs just east of the crest of a hill and 450 feet south of the road on wooded land owned by Gordon Ryan in lot 13, con. XIV, Brougham township. The sheet lies in pink, coarse-grained, hornblende syenite, which is itself pegmatitic locally. It is about 6 feet thick where exposed in a north-striking cliff of the same height for a length of 50 feet along the hillside. Although most of the exposed part of the sheet consists of feldspar alone, the southern end of it contains a few scattered hornblende crystals up to 1¼ inches across and 4 inches long. The pink syenite host rock in the vicinity of the sheet contains less than 10 per cent hornblende over wide areas and is itself a possible source of feldspar.

Concession XV, Lot 9

Numerous dykes and sills of pink pegmatite are exposed in lot 9, con. XV, Brougham township. These are most abundant in a zone along the southeastern side of a band of nepheline-albite gneiss. The largest body seen is a steeply dipping sill about 15 feet thick and at least 250 feet long. This is composed almost entirely of coarse-grained, pink, potassic feldspar, in some parts of which quartz is graphically intergrown. Euhedral crystals of scapolite as much as 1 inch across and 3 inches long occur along the walls of another nearby 4-foot sill of pink syenite-pegmatite where this cuts a steeply dipping band of hornblende gneiss.

GARNET

Garnet is abundant and widespread in the map-area, particularly as porphyroblasts in the hornblende gneiss and the biotite-garnet paragneiss. It also occurs at and near the contacts of some of the syenite intrusions with sedimentary rocks, especially where the latter contain lime. In most of its occurrences, however, the garnet is not sufficiently abundant to be of economic interest. The three occurrences described in this section are only of mineralogical interest so far as known at present, but they may indicate favourable prospecting areas for economic deposits of garnet.

Blithfield Township

Concession IV, Lot 25

Porphyroblasts of red garnet are abundant in biotite-hornblende gneiss in lot 25, con. IV, Blithfield township. They are well exposed on and near a hydro-electric power-line 300 feet north of a farmhouse and about $\frac{3}{4}$ mile south of the east end of Constos Lake. Here the gneiss is a fine- to medium-grained, light grey, speckled, well-banded rock in which the gneissosity strikes north 20 degrees east and dips 40 degrees northwest. Although the average garnet content of the rock is probably less than 10 per cent, some bands, normally less than a foot wide, contain 20 per cent or more of garnet in porphyroblasts up to 6 inches in diameter. Most bands consist mainly of light grey to white feldspar, with smaller amounts of biotite, hornblende, quartz, and garnet. Some darker bands comprise up to 70 per cent combined biotite and hornblende.

Brougham Township

Concession IV, Lot 15

Biotite-garnet gneiss occurs on top of a hill about 1,000 feet southeast of Green Lake in lot 25, con. IV, Brougham township. Abundant red garnets $\frac{1}{2}$ inch or less in diameter stand up $\frac{3}{8}$ inch or more on the weathered surface of the gneiss. Although this occurrence is not shown as a mineral deposit on the map accompanying this report, the rock contains 10 per cent or more of garnet over large areas.

McNab Township

Concession VII, Lot 19

Chocolate-brown andradite garnet[1] occurs at various points along the contacts of the Glasgow Station mass of hornblende-biotite syenite. The andradite constitutes as much as 25 per cent of the contact rock near the southwestern end of the mass in lot 19, con. VII, McNab township. Here plagioclase constitutes 50 per cent or more of the rock and is accompanied by garnet and a little zircon[1], magnetite,

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[1] Identified by Eugene Poitevin, Chief, Division of Mineralogy, Geological Survey of Canada.

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and bright green, high-calcium amphibole. The rock weathers brownish to purplish grey and is friable, being easily broken into numerous, small, equigranular grains. Although a few grains or aggregates of grains of garnet up to $\frac{3}{8}$ inch across are visible, practically all of the garnet occurs in grains 1 millimetre or less in diameter. The garnet-rich zone strikes north to northeast and is at least 10 feet wide and 150 feet long.

GRAVEL AND SAND

Deposits of gravel and sand are abundant and of widespread occurrence in the map-area. They are valuable mainly for local construction and many of them have been and are being used for this purpose. Some of the main pits are shown as occurrences on the map

accompanying this report. Many of these pits expose glacio-fluvial material. A few of them are listed here, together with brief notes on some of them.

Bagot Township

(1) Con. II, lot 18 - at south side of highway about 2½ miles southwest of Burnstown. Mainly sand.

(2) Con. VII, lot 17 - at north side of highway about 2½ miles northeast of Calabogie. Gravel, boulders, and sand.

Horton Township

(1) Con. V, lot 2 (McLaren's gravel pit) - about 4½ miles east of Renfrew and a few hundred feet west of highway No. 17. Material from this pit was used to build the Stewartville dam of the Hydro-electric Power Commission of Ontario on Madawaska River about 6 miles to the southeast. The pit is 200 to 450 feet wide, twelve hundred feet long, and in places has a face 25 feet high. It has been dug into a hill of glacial and glacio-fluvial materials surrounded by flat-lying Champlain beds.

(2) Con. VI, lot 5 - at south side of road about 1¼ miles east of Mayhew. Mainly gravel and sand.

(3) Cons. III and IV, lot 6 - at north side of No. 17 highway and track of Canadian National Railway about 1 mile southwest of Mayhew. The hill of glacial and glacio-fluvial material here has been opened up by a large pit served by a spur line from the nearby railway.

McNab Township

(1) Con. VI, lot 27 (Gillan's gravel pit) - at west side of No. 17 highway about 1½ miles northeast of Goshen. The deltaic material exposed in the pit includes layers of boulders up to 18 inches in diameter and well-defined beds of gravel, sand, and silt, some of which dip as steeply as 30 degrees. Mr. Peter Gillan, owner of the land, advises that a well 138 feet deep collared about 20 feet below the highest parts of the deposits intersected gravel throughout.

(2) Con. II, lot 17 - just north of Madawaska River at Burnstown.

GOLD

Small amounts of gold have been reported from several occurrences in Renfrew map-area, but investigation of these has disclosed no ore. Most of them are in small veins of quartz and calcite but some occurrences consist of erratic grains of gold in granite-pegmatite.

Admaston Township

Concession XII, Lot 3

Freeman (7, p. 7) describes this occurrence as follows:

"This deposit consists of gold-bearing calcite stringers in a 2-foot sheared zone in medium-grained, dark grey, somewhat magnetic gabbro. A $3 gold assay has been reported, but the exposure is very small."

Concession XII, Lot 5

Freeman (7, p. 7) described these occurrences as follows:

"There are two occurrences. The rock is Grenville limestone and grey biotite gneiss, exposed only in small knolls surrounded by drift. The dip is vertical or nearly so and the strike is about north 10 degrees east. On one knoll of gneiss, 30 feet long and 10 feet wide, a pit has been sunk to a depth of 20 feet at the intersection of a 1-foot quartz-chalcopyrite vein and a 2-inch quartz stringer. The vein strikes north 70 degrees east and dips 80 degrees to the south. It has been followed for only 60 feet. The stringer is parallel to the strike and dip of the gneiss and to the north grades into a narrow pegmatite. The ground slopes away from the knoll and is swampy. The vein appears to pinch out toward the bottom of the pit and is not disclosed in open-cuts along its line of strike.

"The other deposit on lot 5 is in limestone and is even smaller and lower in grade."

Horton Township

Concession V, Lot 3

Gold is reported to have been discovered by a Negro prospector about 1902 in a small quartz vein on the farm of David Carswell in lot 3, con. V, Horton township. The vein lies in coarse-grained hornblende-feldspar gneiss striking north 20 degrees east and dipping 25 degrees southeast. Although the quartz vein itself is only 4 to 8 inches wide, it lies in an oxidized, mineralized zone of shearing up to 3 feet wide. The vein is about 40 feet long, strikes north 10 degrees west, and dips 75 degrees east. Most of the vein is barren of ore minerals, but a little disseminated pyrite occurs in it near its walls. The latter, exposed in a pit 4 feet wide, 6 feet deep, and 15 feet long along the vein, are sheared, contain 5 per cent or so of pyrite, and are heavily oxidized in places. Three selected composite samples of the best mineralized quartz and wall-rock taken in 1950 disclosed only traces of gold and silver[1].

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[1] Assayed by Division of Mineral Dressing and Process Metallurgy, Mines Branch, Department of Mines and Technical Surveys, Ottawa.

McNab Township

Concession V, Lot 26

Gold is reported to have been discovered by William Harding about 1920 in a small quartz vein on the farm of L. W. Curtis in lot 26, con. 5, McNab township. The vein, exposed in a single pit about 4 feet deep by 5 to 6 feet in diameter, lies in pegmatitic granite. It strikes north 45 degrees east, dips vertically, has a maximum width of 7 inches, and was traced for 6 to 10 feet. A very brief and incomplete examination disclosed a little disseminated pyrite but no gold in the vein.

GRAPHITE

Graphite in Renfrew map-area occurs only in crystalline limestone or in rocks adjacent to it. Disseminated flakes of graphite ⅛ inch or less in diameter are found in this limestone throughout the area. The flakes are most numerous in bands or zones, normally less than a foot wide and parallel with the bedding, in which substantial amounts of silicate minerals also occur. Calcite, diopside, scapolite, tremolite, mica, quartz, and pyrite are commonly found in these graphite-rich bands.

Blithfield Township

Concession V, Lot 25

An occurrence of graphite in the southwestern part of lot 25, con. V, Blithfield tp., on the farm of J. B. Scully is described by Satterly (9, p. 43) as follows:

> "The shallow, leaf-filled pit is 12 by 17 feet and from 1 to 3 feet deep. It exposes a flat-lying graphitic gneiss overlain by crystalline limestone with an exposed thickness of 1 foot. The graphitic gneiss has an exposed thickness of from 1 to 2 feet and contains graphite flakes from a fortieth to a tenth of an inch in width, forming from 1 to 20 per cent of the rock. A white granite-pegmatite cuts the gneiss on the north side of the pit."

Brougham Township

Concession VI, Lot 1

Occurrences of graphite in five pits in the northeastern part of lot 1, con. VI, Brougham tp., are described by Satterly (9, p. 46) as follows:

> "The 5 pits trend in a northwest and southeast direction across the strike of the gneisses. The pits are old, and the rock exposures somewhat weathered. The work was done about 1920(?). The pits are spaced over a length of 90 feet.
>
> "The country rock is a slightly rusty garnet-biotite paragneiss striking N.20°E. and dipping 40° to 50° S.E. The two south pits show no graphite. The third pit exposes what appears to be a lens of graphite-bearing rock, 8 by 4 by 4 feet in dimensions. As little graphite now remains on the walls of the pit, it must have been largely removed.

"The fourth pit is 20 feet north of the third. A weathered graphite-bearing limestone lens about 4 by 4 feet occurs in the garnet-biotite gneiss. In the fifth pit, which is 15 feet north of the third, a band of crushed graphitic limestone about 3 feet wide is present as an interbed in the gneiss. The graphite content is very low.

"Although some very rich graphite-bearing material is present on the waste dumps from the pits, it is apparent that such material came from deposits that are lenticular in shape and of very limited extent."

Concession VI, Lot 17

Freeman (7, p. 21) describes an occurrence of graphite about 500 feet south of the west end of Green Lake in lot 17, con. VI, Brougham tp., as follows:

"The country rock is partly pure Grenville limestone and partly interbedded limestone and mica schist. The rocks strike north and dip vertically or to the east. The ore outcrops on the crest of a rocky knoll and a shaft has been sunk on it to a depth of 15 feet. The face of a 100-foot adit, driven slightly south of east from the west slope, is 40 feet under the collar of the shaft.....

"The ore is associated with diopside-bearing rock, formed by contact metamorphic action on the Grenville limestone, and with quartz-tremolite veins. .....Quarter inch, circular flakes of graphite are scattered throughout both the coarse and fine-grained (diopside-bearing) rock, but are especially plentiful where these two types of rock come together.

"The quartz-tremolite veins are about an inch wide. Some parts of them are solid clear quartz and other parts are made up of blade-shaped crystals of tremolite, one-quarter inch wide and one-eight inch thick, extending across the vein from side to side but with open spaces between the tremolite blades. There are only a few flakes of graphite in the quartz but there is a narrow selvage of pure flakes on both walls of the veins.

"Not much can be seen of the deposit due to the overburden, but judging from the few outcrops and the character of the material on the dump the deposit is both small and lean."

Concession VIII, Lot 6

Satterly (9, p. 48) describes two small pits put down in 1941 on a graphite occurrence on the farm of Patrick L. Kennelly, lot 6, con VIII, Brougham tp., as follows:

"The south pit is 5 by 6 feet and 2 feet deep. The north pit, which is 20 feet north, is 6 by 5 feet and 3 feet deep.

"The south pit exposes white granite-pegmatite containing, in accessory amount, prisms of scapolite up to 1 by 8 inches. On the west side of the pit an aggregate of coarse scapolite and disseminated flake graphite has an exposed width of 1½ feet. In the

floor of the north pit a scapolite-graphite rock appears to occur as a 1-foot band in decomposed gravelly crystalline limestone. The two occurrences may represent one band. The graphite in these occurrences is in flakes from a twentieth to a tenth of an inch in diameter and forms between 5 and 10 per cent of the rock. The showing is of no economic value."

Concession X, Lot 13

An occurrence of graphite near the west shore of Black Lake, in lot 13, con. X, Brougham tp., opened up about 1911, is described by Satterly (9, p. 48) as follows:

"The workings consist of a pit, 4 by 4 feet and 6 feet deep, 175 feet west of the lake shore, a caved-in shallow trench extending 75 feet west from the lake shore, and two other small caved-in shallow workings on a limestone ridge rising from 25 to 30 feet above the lake level.

"The pit exposes coarsely crystalline white limestone containing about 1 per cent of disseminated graphite in flakes from one-twentieth to three-twentieths of an inch in diameter. The limestone forms a band 20 feet wide and is bounded on the east by a pegmatite dyke 100 feet wide and on the west by a pegmatite dyke with an exposed width of 10 feet. To the west of the latter is another narrow, low ridge of crystalline limestone containing a negligible amount of graphite. To the east of the 100-foot dyke near the lake the shallow trench exposes decomposed limestone containing 1 per cent graphite. The pegmatite dykes and limestone bands strike from N.5° to 15°W. The bedding of the limestone dips 50°E.

"Interbedded with the graphitic limestone are grey bands containing some graphite. These represent carbonaceous shaly beds.

"The graphitic limestone band can be traced for a length of 500 feet, where it is cut off by pegmatite.

"The occurrence is too small and too low-grade to warrant any further development."

IRON

Some two dozen deposits of iron-bearing minerals are known in Renfrew map-area. Of these, nineteen are magnetite and five are hematite. A very few contain both minerals.

All of the deposits of hematite of any substantial size occur on the southeastern side of the White Lake granite mass in the southeastern corner of the map-area. All of them except one are in crystalline limestone at considerable distances from other rock types. They are considered by some observers to be of supergene origin.

All of the deposits of magnetite are found to the northwest of the White Lake granite mass, most of them in, or closely associated with, the belt of foliated, hornblendic rocks about Calabogie and Norway Lakes. All of them are thought to be replacement bodies of hypogene origin.

Hematite

Several occurrences of hematite are found east of White Lake in Bagot and Darling townships. All of these are in crystalline limestone and many of them occupy fault fissures or other fractures. Wilson (19, p. 114) points out that deposits of hematite in south-eastern Ontario are common in the Precambrian directly underlying the Palaeozoic, or in the Palaeozoic directly overlying the Precambrian. Many of them, including the McNab deposit about 11 miles northeast of the White Lake occurrences, occupy fissures in the Palaeozoic beds and are, therefore, of later age than these rocks. Both Wilson (19, p. 114) and Ingall (31, p. 19) conclude that the deposits are supergene, the iron in them being derived from ferruginous Palaeozoic beds during decomposition of the latter. If the hematite occurrences described in this section are of such supergene origin, they probably do not persist to any great depth.

Bagot Township

Concession I, Lot 1

Ells (4, p. 64) mentions the Robertson mine in lot 1, con. 1, Bagot tp., and shows an occurrence of iron in this location on the map accompanying his report. Fréchette (32, p. 82) searched for this occurrence but did not find it.

Darling Township

Concession X, Lot 23

Peach (10, p. 3) reports that hematite outcrops on a peninsula in White Lake in lot 23, con. X, Darling tp., where it is disseminated through fine-grained limestone adjoining a quartz vein. Fréchette (32, p. 83), describes the occurrences in this vicinity as follows:

> "Following in a direction S.35°W. small veins of hematite are found at several points for a distance of 1,400 feet, and also along the same line on the opposite side of a small bay of White Lake. A sample taken from a 2 ft. vein at this point gives the following analysis:-

	Per cent
Insoluble	9.51
Iron	60.10
Phosphorus	0.127
Sulphur	0.035"

Concession XI, Lot 23

A pit 35 feet long, 4 to 15 feet wide, and 1 foot to 6 feet deep; in lot 23, con. XI, Darling tp., at the eastern border of the map-area, exposes a vein of massive blue hematite 5 to 6 feet wide striking north 65 degrees west. The host rock is fine-grained crystalline limestone, which strikes north 60 degrees east and dips steeply to the northwest. Nine other pits nearby are on a zone striking north 40 degrees east and 175 feet or more long. One of these, 40 feet northeast of the pit described above, is 12 feet long,

10 feet wide, and 5 feet deep, and fragments of hematite were found on the dump beside it. Peach (10, p. 3) states that this or a nearby very similar occurrence on the same lot is exposed at intervals for a distance of about 12 chains along the strike. Fréchette (32, p. 83) describes this or another occurrence on the same lot as follows:

"....a pit had been sunk about 7 feet into hematite, at a point where a vein had been enlarged by the crossing of another small vein. The body at this point is about 30 feet by 35 feet. The vein itself is only 2 feet wide. An average sample gives the following analysis:-

	Per cent
Insoluble	3.20
Iron	62.52
Phosphorus	0.44
Sulphur	0.004 "

Concession XI, Lot 26

Fréchette (32, p. 82) describes the Fahey or Bell mine on lot 26, con. XI, Darling tp., about 1,000 feet east of the shore of White Lake as follows:

"A shaft had been sunk into a vein of hematite ore to a depth of a little over 20 feet, but at the time of my visit was full of water. There were also some old trenches across the vein. These were cleared out and several new trenches were dug.

"The ore was exposed in a trench 40 feet northeast of the shaft, showing the vein to be 15 feet wide, and in another 50 feet southwest of the shaft the vein was uncovered for a width of 10 feet, without touching either wall. Beyond these two trenches the ore could not be reached on account of the nature of the covering. The vein strikes N.40°E. and is almost vertical. Both walls are crystalline limestone. The ore is of uniform character, high in lime and low in silica, sulphur, and phosphorus."

Ells (4, p. 64) reports as follows:

".....this (hematite) also is found at Bell's mines on White lake, where both the red and black iron ores occur. The value and extent of this last named deposit has apparently never been thoroughly tested."

Other Occurrences

The map accompanying the report by Ells (4) shows other occurrences of iron in lots 24 and 27, con. XI, and lots 26 and 27, con XII, Darling township. These are not well identified in his report and are not shown on the map accompanying this report.

Fréchette (32, p. 82) mentions an iron-bearing zone about 1½ miles southwest of the Fahey pit. (It seems probable to the writer that this zone is actually southeast of the Fahey pit.) He traced this zone for about a mile along its general strike of north 23 degrees east to its northernmost exposure, about 1,000 feet northeast of the line between concessions XI and XII on lot 23. Here he reported a banded ferruginous and highly siliceous rock exposed on the face of a

hill for a width of about 35 feet. In this were small veins of hematite, up to 4 inches wide. Samples taken 1,500 and 3,000 feet from this point along the strike of the zone to the southwest contained 60.00 and 54.52 per cent iron respectively. The width of the zone at these two points was about 30 feet.

Magnetite

Many occurrences of magnetite are known in Renfrew map-area. Most of them, including all from which ore has been mined in the past, are in the Calabogie Lake-Norway Lake section, where they are in, or closely associated with, the belt of foliated hornblendic rocks there.

Many of these occurrences have been described at various lengths by Ingall (31), Ells (4), Fréchette (32), Lindeman (33), Lindeman and Bolton (34), and Satterly (9). Lindeman made magnetometric surveys in 1911 mainly of those that had produced ore in the past. Dr. M. E. Wilson of the Geological Survey of Canada examined several of the more important deposits in 1919, and mapped their geology on a scale of 1 inch to 200 feet.

A total production of 46,000 tons of ore is recorded, this having been obtained from the old Williams, Caldwell, Campbell, Bluff Point, and Martel mines between 1883 and 1901. Most of this ore was shipped to Cleveland, Ohio, Radnor Forges, Quebec, and Hamilton, Ontario.

Little interest was taken in the magnetite occurrences of the area in the 50 years subsequent to 1901. In 1951, however, Algoma Ore Properties Limited of Sault Ste. Marie, Ontario, acquired control of several of them and conducted an extensive diamond drilling campaign on one of them. This work disclosed an orebody containing several million tons of low-grade concentrating ore, giving promise that the area may produce again soon.

Most of the magnetite deposits are banded, tabular to lenticular replacement bodies of pyrometasomatic type occurring along or near contacts between crystalline limestone and foliated hornblendic rocks. Many of them are in lenses and bands of crystalline limestone and calcareous pyribole skarn within the hornblendic rocks at small distances from the main limestone contacts. Some of them evidently selectively replaced calcareous bands of meta-sedimentary rocks of mainly detrital origin.

Most of the magnetite is in disseminated grains, but there are all gradations to bands of massive magnetite up to several feet thick. It is commonly low in titanium, phosphorus, and sulphur. About 1 per cent or less of pyrite occurs in the ore, normally as disseminated grains, small lenses, bands, and veinlets paralleling the banding or foliation of the ore.

It is possible that the magnetite in the deposits may be genetically related to the late acidic intrusive rocks of the map-area. These intrusions, particularly the pegmatite and syenite, contain much disseminated magnetite themselves.

As the deposits held by Algoma Ore Properties, Limited are either most important or of most current interest, they are described first in the following pages. Following these, all other deposits are described in normal order according to their cadastral locations.

Algoma Ore Properties, Limited

Largely because their attention was drawn to them by magnetic anomalies shown by Lindeman (33) and by Lindeman and Bolton (34), Algoma Ore Properties, Limited early in 1951 acquired control of several magnetite properties in the vicinity of Calabogie. The properties now held there by the company are as follows: (1) Calabogie (Main); (2) Williams or Black Bay; and (3) Prospect on railway in lot 13, con. I, Blithfield township.

Calabogie (Main) Property

Except for a few small parcels, Algoma Ore Properties Limited controls a rectangular block of ground extending northeast from Calabogie Lake along the southeastern side of Madawaska River for about 3¼ miles and extending southeast from the river for about 2 miles to the vicinity of Stones Lake. In this block the company holds about twenty-four lots of 200 acres each or about 4,800 acres in all.

Within the Calabogie property are the following magnetite-bearing zones and areas: (a) Campbell-Caldwell ore zone; (b) Bluff Point; and (c) Martel.

Campbell-Caldwell Ore Zone. This ore zone, within which diamond drilling done in the latter part of 1951 has indicated the existence of a magnetite orebody of substantial size, is situated about a mile east of Calabogie. It lies from 50 to 800 feet northwest of the road and trends northeasterly sub-parallel with it. The zone is 100 to 400 feet wide, 3,000 feet or more long, and dips to the southeast at 40 to 45 degrees. Most of it is in the eastern half of lot 16, con. IX, Bagot tp., near the southern boundary of the lot. Some of it, however, extends southwest into the western half of lot 16, con. IX, and northeast into lots 15 and 16, con. VIII.

The parts of the zone known to them, as exposed by numerous isolated pits, have been described by Ingall (31), Lindeman (33), Lindeman and Bolton (34), and Satterly (9). Lindeman made a magnetometric survey of the zone in 1911, and it was largely because of the anomaly indicated by his work that Algoma Ore Properties Limited undertook further exploration of the zone in 1951. Dr. M. E. Wilson mapped the geology of the zone and adjacent rocks on a scale of 1 inch to 200 feet in 1919.

From 1882 to about 1901, the zone was explored at various times by numerous pits and trenches and about 15,000 tons of ore were shipped from it by different operators. The central and main part of the zone, situated in the southern part of the east half of lot 16, con. IX, was known as the Caldwell or Coe mine. It was owned or operated at various times by Mr. Coe, the Hamilton Steel and Iron Company, and Mr. T. B. Caldwell of Lanark. Most of its recorded production of 10,000 tons of ore was derived from the Jeanette, Tommy R, and T.B. pits, of which the last, with width of 80 feet, length of 90 feet, and depth of 60 feet, is the largest of the two dozen or so pits and trenches on this section of the property.

The northeastern part of the zone, exposed along the boundary between lots 16 and 15, con. VIII, was known as the Campbell or No. 4 mine. The Calabogie Mining Company or the Calabogie Iron Company and possibly others shipped a few thousand (probably 5,000 or less) tons of ore from this section of the zone prior to 1902. The open-cut from which this ore was obtained is 40 feet wide, 100 feet long, and 55 feet deep. The southwestern extension of the zone, in the west half of

lot 16, con. IX, is reported by Lindeman (33, p. 14) to show some magnetite associated with amphibolites in a shallow pit.

The rocks enclosing and adjacent to the ore zone consist mainly of hornblende-bearing schists and gneisses. They include hornblende-biotite schist, quartz-biotite-hornblende schist, hornblende-pyroxene schist, hornblende-feldspar schist, amphibolite, and at least one 60-foot band of crystalline limestone containing 10 to 30 per cent biotite, tremolite, pyroxene, serpentine, and other silicate minerals. Other members of the series, particularly those nearest the ore zone, are calcareous, comprising up to 20 per cent white calcite. The hornblende-bearing rocks are in general thinly banded, fine grained, and dark grey to grey in colour. The whole series strikes about north 55 degrees east and dips to the southeast at 40 to 45 degrees.

Lenses and bands of crystalline limestone containing tremolite and other silicate minerals occur in the hornblende-bearing schists on the hanging-wall side of the ore zone. One of these, about 1,000 feet southeast of the ore zone, is about 300 feet wide and a little less than ½ mile long.

On the foot-wall side of the northeastern part of the ore zone and about 750 feet from it is a sill of meta-gabbro. This sill is about 1,700 feet thick, trends northeasterly, and dips to the southeast. It is a grey, fine- to medium-grained, massive rock composed mainly of hornblende, plagioclase, and biotite. Toward the southwest it grades into pinkish grey, hybrid, gneissic, and schistose rocks.

The ore zone itself is marked by its higher content of magnetite, chlorite, pyroxene, hornblende, and sulphides. The rock types occurring in it include chlorite schist, amphibolite, pyroxene-hornblende gneiss, hornblende-plagioclase-scapolite gneiss, magnetite-pyroxene-calcite gneiss, chloritic quartz-biotite-hornblende and hornblende-biotite schist, quartz-pyroxene-garnet-epidote schist, and plagioclase-tourmaline-pyrite schist. Many of these, particularly the chlorite- and pyroxene-bearing types, are highly calcareous. The magnetite occurs largely as disseminated grains, strings of closely spaced grains, and veinlets less than 3 inches thick paralleling the foliation mainly in the chlorite-, hornblende-, and pyroxene-bearing rocks. Although some of the magnetite is nearly massive in bands up to 2 feet or more thick, most of it found in veinlets and bands is foliated or platy, with numerous seams and irregular masses of chlorite or other silicate minerals or calcite up to ⅛ inch thick between the laminae of magnetite. The sulphides, normally composing less than 1 per cent of the ore, consist mainly of pyrite, with lesser pyrrhotite, and traces of chalcopyrite. These occur as disseminated grains and as bands and irregular seams up to 3 inches wide in the ore parallel with its foliation. A few lenses and seams of hematite up to ¼ inch thick, associated in some places with pyrite, are found. Veinlets of white and pink calcite, normally 1 inch or less in width, occur both parallel with the foliation of the ore and cutting across it.

A typical section across the ore zone from southeast to northwest will illustrate the various rock and ore types occurring in and adjacent to it. The hanging-wall consists mainly of calcareous quartz-biotite-hornblende schist containing a few bands of pyroxene-hornblende gneiss and two bands of silicated crystalline limestone, one of these being 15 feet and the other 60 feet thick. Near the hanging-wall contact, the chlorite content increases and some bands of chlorite schist containing several per cent of disseminated magnetite

occur. From the hanging-wall inward for 50 feet or so the ore zone consists mainly of chlorite schist containing magnetite in disseminated form and in near-massive bands up to 18 inches thick. It also contains some bands of magnetite-bearing amphibolite, hornblende-plagiocalse-scapolite gneiss, and chloritized rocks of other types. Between this section and the foot-wall of the ore zone are 40 feet of a fine-grained, intimate mixture of black magnetite, pale green pyroxene of the diopside-hedenbergite series, and white calcite. The immediate foot-wall rock of the ore zone comprises several feet of calcareous chlorite schist. Below this is an epidote or skarn zone, 5 feet thick, consisting of yellowish schist composed mainly of quartz, epidote, garnet, feldspar, pyroxene, and calcite. Below this, in turn, is a 15-foot zone consisting of light grey to silvery grey schist composed mainly of plagioclase, bright green pyroxene of the diopside-hedenbergite series, and reddish brown magnesian tourmaline (dravite). The schist contains about 10 per cent pyrite, in disseminated grains and in small stringers parallel with the foliation, and small amounts of quartz, apatite, and other minerals. It is also reported to have yielded up to $1.10 a ton in gold.

About 15,000 feet of diamond drilling in 35 holes to maximum depth of 1,300 feet was done on the ore zone by Algoma Ore Properties, Limited, in the latter part of 1951. This work has indicated a body of magnetite ore 2,300 feet long and 150 feet wide having an average grade of 25 per cent iron. This orebody dips to the southeast at 38 to 40 degrees down to a depth of 500 feet. A series of diamond drill-holes to 1,000 feet vertical depth indicates that the orebody there dips at 45 degrees, is 2,100 feet long, 115 feet wide and has an average grade of 28 per cent iron. The drilling has established that the orebody rakes to the northeast at 50 degrees.

An average analysis of the orebody as known to December 1951, kindly supplied by Mr. G. S. Gilbert, Field Superintendent of Algoma Ore Properties, Limited, is as follows:

	Per cent
Total iron	26.20
SiO_2	25.40
CaO	10.15
MgO	8.26
S	0.27
P	0.21
Mn	0.38
Al_2O_3	6.04
TiO_2	0.37
CO_2	1.04

A few analyses of some of the higher grade ore from the Campbell-Caldwell ore zone have been selected from the earlier publications and are tabulated below:

Fe	SiO_2	Insol.	Al_2O_3	CaO	MgO	P	S	TiO_2
47.86	10.60	---	4.27	4.45	6.90	0.330	0.080	0.25
38.30	---	16.10	---	---	---	0.233	0.020	---
50.59	10.26	---	4.82	3.33	5.86	0.289	0.012	0.25
60.91	4.60	---	3.60	1.77	2.83	0.575	0.100	0.10
58.30	5.47	---	3.68	2.03	0.15	0.137	trace	---
47.81	15.00	---	3.85	4.86	7.05	0.390	0.015	0.25

It seems probable that, in general, the magnetite replaced parts of a band or lens of silicated crystalline limestone and adjoining calcareous bands of pyribole skarn and chloritized quartz-biotite-hornblende schist. Thus, althogh it may be said that existence of these bodies of impure calcareous rocks in part controlled emplacement of the orebody, it is uncertain why the ore minerals were introduced into these particular bodies of rocks and not into some other similar bodies elsewhere in the area. As the orebody is only a few hundred feet southeast of the contact between the calcareous, pyribole-bearing, schistose rocks in which it occurs and bodies of meta-gabbro, hybrid gneiss, and crystalline limestone, it is possible that this contact exerted a broader and more important control over its emplacement.

Bluff Point. This old mine is situated in lot 16, cons. X and XI, Bagot tp., near the southwestern end of the company's Calabogie property. It is near the northern shore of Grassy Bay on Calabogie Lake and about ½ mile south of the village of Calabogie. As it has been described at some length by Ingall (31, p. 55), Lindeman (33, p. 11), Lindeman and Bolton (34, pp. 129-130), and Satterly (9, p. 56), and as no new work has been done on it, the property will not be fully described in this report. Lindeman made a magnetometric survey of it in 1911. This work indicated the existence of several small pockets of magnetite in a northeasterly trending zone about 1,350 feet long. Dr. M. E. Wilson mapped the property on a scale of 1 inch to 200 feet in 1919.

Lindeman and Bolton (34, p. 130) describe the history of the property as follows:

> "Mining operations were commenced at Bluff Point in 1881, but closed in 1883; resumed in 1886, but again discontinued the following year. In 1894 a few shipments of ore were made from stock piles to Radnor, Quebec, by the Canada Iron Furnace Company. The following years a small amount of mining was done, but since 1901 the property has been idle. The total amount of ore shipped from Bluff Point and Campbell mines is reported to have been about 9,000 tons."

The workings on the property are numbered 1 to 5 from southwest to northeast. They include one incline shaft 300 feet deep, another 95 feet deep, some 70 feet of drifting, and several open-cuts.

The magnetite occurs in lenses along and near the contact between crystalline limestone and foliated hornblendic rocks. This contact strikes northeast and dips to the southeast at 30 to 45 degrees. Most of the magnetite apparently occurs in a calcareous pyribole-bearing zone a short distance above the main contact. Rocks and minerals mentioned by the various writers as being found in this ore zone include quartz-biotite gneiss, chlorite schist, talcose schist, amphibolite, serpentinized rock veined with carbonate stringers, crystalline limestone, hornblende gneiss, magnetite, hornblende, serpentine, actinolite, calcite, quartz, labradorite, chalcopyrite, chlorite, talc, sphene, apatite, pyrite, augite, and sericite. The ore shipped from the property is reported to have been a compact, medium-grained magnetite with a few seams of chlorite and grains of disseminated pyrite. Analysis of an average sample of a shipment of ore made by the Canada Iron Furnace Company is reported by Lindeman (33, p. 11) as follows, in percentages:

> Fe, 59.50; SiO_2, 9.10; Al_2O_3, 4.80; CaO, 0.01; P, 0.170; and S, 0.160.

Martel. The old Martel or Wilson mine is situated in lots 13 and 14, con. X, Bagot tp., about 1¾ miles southeast of Calabogie village. The workings consist of two pits. No. 1 pit, situated on the boundary between lots 13 and 14, is 55 feet long, 30 feet wide, and 60 feet deep. No. 2 pit, about 400 feet east of No. 1, is 15 feet wide, 60 feet long, and about 20 feet deep. Ingal (31, p. 61) reports that about 2,000 tons of good magnetite ore were shipped from No. 1 pit, about half of this being used at the Radnor furnace in Quebec. He reports that the orebody was 20 feet thick and dipped about 60 degrees to the southeast. As the waste dump is very small, the ore extracted probably consisted mainly of massive magnetite.

The ore occurs in dark green to black, fine- to coarse-grained amphibolite near the southwestern end of the Calabogie syenite plug. Ingal notes that quartz, calcite, and pyrite fill the spaces between some of the larger crystals of hornblende. He also reports seams and veinlets of magnetite in the amphibolite. Microscopic examination of one phase of the amphibolite reported by Ingall showed it to be composed mainly of hornblende and plagioclase, some of the latter being saussuritized. Apatite and sphene are also common constituents.

A magnetometric survey of the property made by Lindeman (33, p. 15) showed a very irregular anomaly and was considered by him to give little encouragement for finding any orebody of importance. Dr. M. E. Wilson mapped the geology of the property in 1919 on a scale of 1 inch to 200 feet.

Williams or Black Bay Mine

The Williams or Black Bay mine is situated in lot 22, con. XI, Bagot tp., about 2 miles northwest of Calabogie. It has been described by Ingall (31, p. 64), Lindeman (33, p. 16), Lindeman and Bolton (34, pp. 130-131), and Satterly (9, p. 57). Lindeman made a magnetometric survey of the property in 1911, and Dr. M. E. Wilson mapped the geology in 1919 on a scale of 1 inch to 200 feet for the Geological Survey of Canada. The mine was opened between 1880 and 1890, and it is reported that 25,000 tons of ore were shipped from it to Cleveland, Ohio.

Lindeman describes the deposit as follows:

"The magnetite occurs along the contact of crystalline limestone and a basic amphibolite. The general strike is about northeast-southwest, with a dip, judging from the inclination of the workings, of about 40 degrees towards the northwest. The limestone forms the footwall, and it is found to the south of the working, while the amphibolite lies to the north.

"The proved length of the deposit in the main working is about 240 feet, but towards both ends of the pit, the ore body becomes indefinite, ...being represented by amphibolite containing some disseminated magnetite. The open-cut has a face of about 15 feet, beyond which the ore has been followed downward in several inclines along the dip. The depths of these inclines are reported, by Mr. E. D. Ingall, to vary from 10 to 80 feet."

A sample taken by Mr. Lindeman from an ore pile gave the following analysis: iron, 51.50 per cent; insoluble, 15.85 per cent.

The main ore zone, throughout which magnetite occurs in various amounts, is about 800 feet in length. A second magnetite-bearing zone, about 260 feet long, is found along the same limestone-amphibolite contact at a distance of 675 feet northeast of the main ore zone. This second zone has been explored by two or three test pits, but no ore has been mined from it. The ore mined from the main zone is reported to have occurred in a body from 10 to 20 feet thick. Some of the magnetite occurs in crystalline limestone as ribs paralleling the structure of that rock. Most of it, however, occurs in foliated, calcareous, hornblendic rock adjoining the limestone contact. Minerals reported to occur in the ore zone include magnetite, pyrite, calcite, ferruginous dolomite, quartz, hornblende, feldspar, and chlorite.

Lindeman's magnetometric survey shows two anomalies, one about 725 feet and the other about 270 feet long. He considered that the prospects of finding an orebody of importance were not encouraging.

Railway Cut, Lot 13, Con. I, Blithfield Township

An occurrence of titaniferous magnetite in a rock-cut beside the railway, 3 miles south of Calabogie and just south of Calabogie Lake, has been described by Fréchette (32, p. 86), as follows:

> ".....a vein of magnetite, dipping at 35° to the east, is exposed for about 75 feet in length and 8 feet in height, without showing the foot-wall.
>
> "The face of the rockcut is a little over 50 feet high, with a rising hill to the east. On this hill the magnetic attraction is weak; but numerous readings taken along the edge of the swamp to the west of the railway, and in some places as much as 200 feet from it, varied from -17 to -22 degrees.
>
> "More readings could not be taken on account of the swamp.
>
> "An average sample of the exposed portion of the vein gives the following analysis:

	Per cent
Insoluble	37.40
Iron	38.80
Phosphorus	0.013
Sulphur	0.179
Titanic acid	4.96 "

The magnetite is disseminated in a band of hornblende gneiss striking north 30 degrees west and dipping 35 degrees northeast. Crystalline limestone outcrops along the eastern edge of the swamp just south of the occurrence and probably underlies the band of hornblende gneiss in which the magnetite occurs. As some crystalline limestone is also exposed at the north end of the swamp, it seems probable that the latter is underlain mainly by this rock, possibly accompanied by calcareous pyribolic bands. The magnetic attraction noted there by Fréchette indicates that these rocks contain magnetite.

Bagot Township

Concessions III and IV, Lot 22

The map accompanying the report by Ells (4) shows two occurrences of iron northeast of Chamberlain Lake in lot 22, cons. III and IV, Bagot township. The writer has no further information on these, and they are not shown on the map accompanying this report.

Concessions V and VI, Lot 23

Trenches and pits exposing some magnetite about a mile northeast of Norway Lake, in lot 23, con. VI, Bagot tp., were examined in 1919. These are found along two westerly trending zones, one about 130 feet south of the other. Pits have been put down along the southern zone for a length of 150 feet. Although most of these did not expose bedrock, two of them showed hornblende schist dipping gently southward and containing up to 50 per cent disseminated magnetite across a width of 2 feet, and a few conformable bands of massive magnetite as much as 2 inches thick. Pits are found along the northern zone for a length of 165 feet, but bedrock is not exposed in these.

Fréchette (32, p. 86) states that a magnetometric survey was made on parts of lot 23, cons. V and VI, where some prospecting has been done. He concluded that his readings indicated the presence of several small bodies of magnetite dipping very slightly to the south, and that the maximum thickness of these bodies was about 6 feet. Analysis of a composite sample taken by him from various parts of the deposits showed 31.02 per cent iron, 37.08 per cent insoluble, 0.167 per cent sulphur, and 0.312 per cent phosphorus.

Concession VI, Lot 28

Fréchette (32, p. 86) describes an occurrence of magnetite about 1,100 feet southeast of the road in lot 28, con. VI, Bagot tp., as follows:

> ".....a pit had been sunk to a depth of 18 feet into magnetite. The ore is found in alternating layers of high grade magnetite and a gneissic rock carrying magnetite. It dips to the south at about 15°. In the pit the ore is exposed for a thickness of 8 feet, but the footwall was not uncoverd. ..... No magnetometric survey was made. The following analysis is from an average sample taken in the pit:

	Per cent
Iron	42.81
Insoluble	38.00
Phosphorus	0.006
Sulphur	0.068
Titanic acid	1.37 "

Satterly (9, p. 52) states that the pit is 10 by 10 feet, and that an open-cut 150 feet to the north and facing northeast is 10 feet wide, 20 feet long, and 10 feet deep. He points out that the magnetite occurs at, and adjacent to, the contact between limestone and hornblende gneiss. He reports that material on the dump beside the pit consists of dark green, fine-grained hornblende gneiss containing little to much disseminated magnetite, and crystalline limestone containing less than 10 per cent magnetite. He observed a very little coarse magnetite and some pyrrhotite in the open-cut where crystalline limestone containing inclusions of hornblende gneiss is exposed.

Concession VII, Lot 21 (Culhane Mine)

The old Culhane mine near the south shore of Norway Lake toward its eastern end, in lot 21, con. VII, Bagot tp., has been described at considerable length by Ingall (31, p. 62), Lindeman (33, p. 15), Lindeman and Bolton (34, p. 126), and Satterly (9, p. 52), and was mapped on a scale of 1 inch to 200 feet by Dr. M. E. Wilson in 1919. Only a few of its salient features, selected from these earlier descriptions, are given here.

Small irregular lenses and bands of magnetite are exposed in four workings over a length of 900 feet along and just below the contact between crystalline limestone and hornblende gneiss. This contact and its associated bodies of magnetite strike north 40 degrees east and dip to the northwest at 25 degrees. Most of the magnetite is apparently confined to calcareous bands or lenses in the hornblende gneiss a short distance below the overlying limestone in a zone 10 to 15 feet thick.

No massive magnetite was seen in place or on the dumps beside the workings, all of the iron-bearing material consisting of grains of magnetite disseminated in gneiss and schist or of granular aggregates of magnetite with other minerals, such as calcite, quartz, pyroxene, and actinolite. A little pyrrhotite and pyrite also occur in the ore, and Ingall (31, p. 64) reports that some of the pyrite forms little veinlets across the trend of the ore.

Lindeman (33, p. 9) reports that the property was opened between 1880 and 1890, but that no ore was shipped from it. The four workings, described in order from northeast to southwest, are as follows:

(1) An open-cut about 35 feet long, 10 feet wide, and 6 feet deep. From the bottom of this cut a vertical shaft was sunk to a depth of 15 feet, and from the bottom of this an inclined shaft was sunk on the ore zone for another 20 feet. Lindeman (33, p. 15) concluded that his magnetometric survey of the property indicated this area to be the most promising.

(2) An open-cut 50 feet long, 10 feet wide, and 10 feet deep, from the bottom of which an inclined shaft 70 feet deep has been sunk on the magnetite-bearing zone. A total of 65 feet of drifting is said to have been done along the zone from the shaft at a depth of 40 feet. Satterly (9, p. 53) reports that the open-cut exposes 8 feet of rock containing about 50 per cent magnetite.

(3) An open-cut 50 feet long, from 10 to 20 feet wide, and 6 feet deep.

(4) A test pit 10 feet by 10 feet reported to have been sunk to a depth of 12 feet and to have exposed ore in its lowermost 3 feet.

At least two diamond drill-holes were put down on the occurrence. Ingall (31, p. 63, cross-section at No. 2 working) reports that one of these holes intersected a 3-foot rib of ore at a depth of about 175 feet down the slope of the ore zone. However, he does not consider that the hole was carried far enough to prove much.

Concession VII, Lot 22

An occurrence of magnetite at the northeastern end of Norway Lake in lot 22, con. VII, Bagot tp., is shown on the manuscript map of Dr. M. E. Wilson and on the map by Ells (4). No description of this occurrence has been found by the writer.

Concession IX, Lot 18

Fréchette (32, pp. 85-86) and Satterly (9, p. 55) describe occurrences of magnetite in lot 18, con. IX, Bagot tp., about a mile northeast of Calabogie and 1,100 feet northwest of the road from Calabogie to Springtown.

The main workings consist of a 10- by 10-foot shaft reported to be more than 50 feet deep; an adjacent open-cut, 15 by 15 feet, i. about 35 feet northwest of the shaft; and a trench 6 feet deep and 6 feet wide that extends southwest for 50 feet from near the open-cut.

The open-cut exposes white crystalline limestone striking northeast and dipping to the southeast at 40 degrees. In this is a conformable zone from 2 to 3 feet thick that is heavily mineralized with magnetite. Although most of the zone consists simply of magnetite disseminated in crystalline limestone, its upper 6 to 12 inches consists of a highly altered, brecciated, serpentinized hornblende rock containing grains of magnetite and hematite. Some pyrite and chlorite also occur in the zone.

Fréchette (32, p. 86) refers to another occurrence as follows:

> "About one-third of the distance along this lot (toward the southwest) another shaft had been sunk. This was examined showing the ore to be hematite, containing a little magnetite. The ore is much intermixed with rock, and is only 2 or 3 feet in thickness. The ore is in crystalline limestone, underlain by quartzite and fine-grained hornblende schist.
>
> "At the southwest end of this lot there are also showings of magnetite and hematite."

All of the occurrences mentioned above evidently constitute an iron-bearing zone extending southwest toward Calabogie. Disseminated magnetite found in a railway cut just north of Calabogie station may represent the western extension of this zone. The cut exposes a band of hornblende gneiss from 3 to 8 feet thick dipping to the southeast at 10 degrees in crystalline limestone. The gneiss contains several per cent of disseminated magnetite and a little pyrite. Two 6-inch zones, one at the bottom of the band of gneiss and the other 30 inches higher, contain as much as 40 per cent magnetite.

Concession X, Lot 10

A manuscript map of Dr. M. E. Wilson shows an occurrence of magnetite in lot 10, con. X, Bagot tp., about $\frac{3}{4}$ mile west of Virgin Lake. The description of this occurrence has not been located by the writer.

Concession X, Lot 23

Satterly (9, p. 55) describes an occurrence of magnetite in lot 23, con. X, Bagot tp., about 125 feet south of the shore and near the west end of Norway Lake as follows:

"The (Lerond) shaft is 10 by 10 feet and 12 feet to the water level. It was sunk prior to 1890. The size of the waste dump suggests that the shaft may be 50 feet deep.

"There are no outcrops around the shaft. Rock fragments on the dump consist of a hornblende-biotite-feldspar gneiss. The iron-bearing material is disseminated magnetite (50 per cent) in bands with strings of calcite grains or aggregates of calcite and actinolite parallel to the gneissic structure. Apparently the magnetite has replaced a limestone band in the gneiss."

Concession XI, Lot 18

Fréchette (32, p. 85) noted a magnetic disturbance in lot 18, con. XI, Bagot tp., in the village of Calabogie near the main road that follows the west shore of Calabogie Lake. He concluded that his magnetometric survey indicated the existence of magnetite in a series of small pockets extending for about 600 feet along the road and crossing it.

Brougham Township

Concession X, Lot 7

Lindeman and Bolton (34, p. 125) describe an occurrence of magnetite just north of the eastern end of Kennelly Lake in lot 7, con. X, Brougham tp., as follows:

".....there are some six-inch seams of granular magnetite in a contact zone between granitic gneiss and crystalline limestone. The ore is of good quality, but the quantity is too small to be of interest."

Satterly (9, p. 58) mentions that fragments of rock near a boulder-filled pit consist of magnetite-rich hornblende gneiss and of coarse white calcite with grains of deep red garnet. He also mentions that some fragments of magnetite-rich hornblende gneiss were ploughed up in a field just south of Kennelly Lake.

Concession XII, Lot 22

Some work has been done on a magnetite-pyrrhotite occurrence about 1,000 feet southwest of Blackbird Lake, in lot 22, con. XII, Brougham township. The main workings are in heavy gossan just west of a fence on the gentle southern slope of a ridge. They consist of two pits and two adjacent shallow strippings. Pit No. 1 is 8 feet wide, 10 feet long, and 8 feet deep, and Pit No. 2 is 8 feet wide, 12 feet long, and 15 feet deep. One stripping is 20 feet by 20 feet; the other is 10 feet by 50 feet. Three additional shallow strippings are found 250 feet northwest of the above workings. One of these is 15 feet in diameter, another is 8 feet wide by 25 feet long, and the third is 7 to 10 feet wide and 50 feet long.

The iron-bearing rocks, mainly hybrid gneisses with some conformable granitic bands, strike north 50 degrees west and dip northeast at low to moderate angles. The gneisses, consisting mainly of feldspar-hornblende and feldspar-pyroxene types, contain an average of 75 per cent feldspar. Their rounded and fine- to medium-sized grains were probably derived in part from clastic sediments and limestone. They are cut by pink, massive, fine- and coarse-grained granite.

The metallic minerals consist of lightly disseminated to nearly massive magnetite and pyrrhotite in a zone up to 8 feet wide and 400 feet or more long conforming with the attitude of the enclosing gneisses. They are most abundant in a band of feldspar-pyroxene rock containing considerable interstitial residual calcite and probably derived, in part at least, from crystalline limestone. Some of this rock is almost solid garnet. Magnetite is most plentiful in what appear to have been the more limy parts of the original paragneiss, whereas pyrrhotite is most plentiful in the less limy parts. Some fine-grained parts, as in Pit No. 2, contain so much disseminated magnetite that they are almost massive iron ore. Original banding is preserved in the pyrrhotite-rich rock due to preferential replacement, this feature being well shown in Pit No. 1 where pyrrhotite is particularly abundant. Mineralization in the northwestern strippings is represented almost entirely by pyrrhotite. Where traced farther northwest along strike it gradually decreases in amount and grades into typical rusty paragneiss.

Concession XIX, Lot 13 (Opeongo Road, Range D South, Lot 25)

An occurrence of magnetite about $\frac{1}{4}$ mile south of Dacre and 150 feet west of the road, in lot 25, rge. D, south of the Opeongo Road, Brougham tp., is described by Ells (4, p. 64) and Satterly (9, p. 59). Ells mentions that the deposit had recently (1901 or slightly earlier) been extensively worked by the Canada Furnace Company. Satterly describes the occurrence as follows:

> "The only working is a circular pit 25 feet in diameter, partly overgrown and filled with water. The depth to the water level is 10 feet, and the water is more than 12 feet deep.
>
> "The walls of the pit expose a hornblende-plagioclase gneiss striking about N.70°E. and dipping 45°S. Some disseminated magnetite, accompanied in some places by pyrite, was observed. No massive magnetite was found, although material on the dump indicates that bands of pure magnetite up to 2 inches thick occurred. Pink granite-pegmatite was apparently encountered in the pit, judging by the fragments present on the dump."

Other Occurrences

Magnetite in grains up to 1 inch across is widely disseminated in the body of pink granite-pegmatite in lot 9, con. XII, Brougham township. The magnetite normally composes less than 5 per cent of the rock but constitutes as much as 10 or 15 per cent of it locally.

McNab Township

Concession VIII, Lot 21

An "iron ore" pit in lot 21, con. VIII, McNab tp., was reported by Kenneth Gillan. Investigation in this vicinity disclosed two pits, each about 5 feet by 5 feet and 6 feet deep, on the steep southwestern flank of the Glasgow Station syenite mass. The pits expose a 1-foot quartz vein in a small body of hornblende gneiss partly incorporated in the syenite. The gneiss contains a few grains of magnetite, and the vein contains a few columnar crystals of an unidentified, dark mineral with a submetallic lustre.

LEAD

No galena-bearing calcite veins, such as those found in other parts of southeastern Ontario, are known in Renfrew map-area. One replacement deposit of sphalerite accompanied by a little galena is described later under ZINC.

LIMESTONE

This section describes only Grenville limestone used for making lime for the building trade. Limestone used as such for construction is described under STONE.

Horton Township

Concession II, Lot 5

The Jamieson Lime Company of Renfrew operates a quarry in crystalline limestone in lot 5, con. II, Horton tp., 2 miles southeast of Renfrew. The limestone is burned at the quarry in two kilns of 25-ton daily capacity, and the resulting high-calcium lime is sold to the building trade, partly as rock lime and partly crushed to $\frac{1}{2}$ inch size. Quarrying was begun here about 1923. Some 2,000 tons of lime were produced in 1950.

Satterly (9, p. 103) describes the property as follows:

> "The quarry faces northwest, is 500 feet long and 250 feet wide, and has a face from 25 to 30 feet high. The clean crystalline limestone is a pale blue grey colour and contains minor amounts of disseminated phlogopite and graphite in minute flakes. The heavy beds strike N.70°E. and dip 30°S. Occasional bands or inclusions rich in silicate and other minerals are present; these are discarded in quarrying. Minerals identified include phlogopite, muscovite, biotite, pyroxene, vesuvianite, and purple fluorspar."

Goudge (24, p. 179) gives the two following analyses of samples representative of the stone used for making lime:

	Sample 1	Sample 2
SiO_2	1.16	1.46
Fe_2O_3	0.26	0.24
Al_2O_3	0.26	0.18
$Ca_3(PO_4)_2$	0.06	0.04
$CaCO_3$	90.57	89.51
$MgCO_3$	7.72	8.36
S	nil	nil
CaO	50.77	50.10
MgO	3.69	3.98
CaO/MgO	14:1	13:1

Concession II, Lot 9

Parks (35, p. 328) has described the grey-banded crystalline limestone exposed in two abandoned quarries beside No. 17 highway in the northeast corner of lot 9, con. II, Horton township. The quarries were operated by J. A. Jamieson of Renfrew first for building and monumental stone and later (about 1922) for the making of lime. One quarry is 60 feet wide by 120 feet long and has a 7-foot face. The other quarry is 60 feet wide by 150 feet long and has a 6-foot face. The crystalline limestone exposed in them strikes north 65 degrees west and dips 40 degrees northeast.

Town of Renfrew

Satterly (9, p. 104) describes abandoned quarries just back of the Roman Catholic Church within the town of Renfrew as follows:

> "They expose banded, blue and grey crystalline calcium limestone and were operated from 1890 to 1923 by the Jamieson Lime Company for the making of lime and, to a limited extent, for building stone. The Roman Catholic church is built of stone from this quarry.
>
> "The two kilns operated during this period had a daily capacity of about 20 tons per day."

Parks (35, p. 328) mentions that a bore-hole in Renfrew shows the thickness of the limestone to be 700 feet. The mass is reported to include 10 feet of black mica schist at a depth of 230 feet.

Other Occurrences

Because of the occurrence of so much crystalline limestone in the map-area, it seems possible that other bodies high in lime exist. In this connection, however, Goudge (24, p. 161) reports as follows:

> ".....no Precambrian limestone was observed that is sufficiently free from magnesium carbonate to enable it to be classed as calcium limestone; the smallest quantity of magnesium carbonate in any of the samples being 5 per cent, with the average amount being 7.5 per cent. The magnesium carbonate in these calcium limestones is mostly present in the form of crystals of dolomite scattered through the calcite matrix."

MARL

Marl is being deposited in many of the lakes underlain by crystalline limestone in the map-area but, except for one occurrence, the size of these deposits has not been determined. The blue-green colour of the water in these lakes is caused by suspension of the fine-grained particles of calcium carbonate that upon deposition, form the deposits of marl.

Goudge (36) notes as follows:

"Marl suitable for making whiting substitute should be white or nearly so, be nearly free from grit and clayey material, and have a very low content of organic matter."

McNab Township

White Lake

Logan (2, p. 765) describes a deposit of marl in the northern part of White Lake, mainly in lots 6, 7, and 8, con. III, McNab tp., as follows:

"In the lower part of White Lake ..... about seven hundred acres are covered with marl, which was found to have a depth of from five to seven feet, and was covered by not more than two or three feet of water."

Other Occurrences

Other lakes underlain mainly by crystalline limestone and containing marl include Colton, Marly, Green, Limestone, Moran, and Blackbird Lakes.

MICA

Deposits of mica are scarce in Renfrew map-area, only two being described and one other reported. One of the deposits described in this report consists of muscovite in granite-pegmatite. The scarcity of deposits of this type may be related to the relatively simple composition of the pegmatites throughout the area. The second deposit consists of phlogopite in a band of rusty paragneiss interbedded with crystalline limestone. This deposit is similar in some respects to those in the Perth area to the southeast described by Dugas (37, p. 16) and Currie (38, p. 765). The scarcity of deposits of phlogopite may be related to the relative scarcity of metamorphic pyroxenite, the principal host rock for this mineral in the mica-bearing zone east of the map-area noted by Wilson (19, p. 116) as extending northeasterly from the Rideau Lake country in Ontario to the Buckingham district in Quebec. On the other hand, however, it should be noted that almost all bodies of metamorphic pyroxenite known in Renfrew map-area contain abundant sulphides, mainly molybdenite, pyrite, and pyrrhotite, and only comparatively small amounts of phlogopite and apatite. In the mica-bearing zone east of the map-area phlogopite and apatite are abundant and sulphides relatively scarce.

Admaston Township

Concession VIII, Lot 1

An occurrence of muscovite about 2 miles northwest of Ashdad on land of Patrick Shannahan in lot 1, con. VIII, Admaston tp., was worked about 1922. It is described by Satterly (9, p. 69) as follows:

> "An open cut, 20 by 35 feet and 8 feet deep ..... The country rock is a garnet-biotite schist, which strikes N.45°E. and dips 45°N.W. The open cut exposes a 3-foot crushed sill of muscovite-rich pegmatite. The books of muscovite range from 2 to 4 inches in width. None of the mica seen was free of defects such as "ruling" at quarter-to half-inch intervals, V-structures, warping, and uneven splitting. Otherwise the mica is clear and unspotted."

Brougham Township

Concession IV, Lot 2

An occurrence of phlogopite just north of and near the west end of Limestone Lake, in lot 2, con. IV, Brougham tp., last worked about 1931, is reported to have been sold to J. A. Jamieson in 1943 by P. Quilty. The occurrence is described by Satterly (9, p. 69) as follows:

> "The main working is a trench which trends N.50°E. and is 55 feet long, 6 feet in average width, and from 3 to 8 feet deep. Three other small pits nearby, now largely caved in, may have exposed small pockets of mica.
>
> "The country rock is a white crystalline limestone with interbeds of rusty sandy paragneiss. The bedding strikes N.15° - 30°E. and dips 35 E. In the trench the east wall trends N.5°E. and dips 45° - 55°W. It consists of an interbed of rusty paragneiss, 4½ feet thick, with remnants of a phlogopite vein composed of books from less than 1 inch square to as much as 5 by 7 inches in size. From the openings left the vein appears to have been from 4 to 12 inches wide, the wall of the trench being the footwall of the vein. From what can be seen it appears as if the vein had not persisted in the limestone underlying the paragneiss bed.
>
> "The phlogopite, although free of inclusions, is badly warped and zoned and shows six-rayed patterns (asterism?). It does not split uniformly."

Black Donald Creek

An occurrence of mica on Black Donald Creek in the south-western corner of the map-area was reported in 1949 by Mr. J. J. Maloney of Mount St. Patrick. The occurrence has not been examined and is not shown on the map accompanying this report.

MOLYBDENUM

Molybdenite, the chief ore of molybdenum, is abundant in Renfrew map-area. At least twenty-four occurrences are known and nine of these have produced molybdenite. Although the records are

incomplete, it is estimated that total production has been about 150,000 pounds, most of this being obtained between 1915 and 1918. Latest recorded production was in 1943.

All of the occurrences are, so far as known, small, and although some of them are fairly high grade, the molybdenite in them is rather erratic in its distribution. The main centres of mineralization and production are as follows:

(1) Hunt mine, on the contact of the body of granite-pegmatite just north of Condon Lake in Brougham township.

(2) Zenith mine, about 1 mile west of Hond Lake, near the southwestern end of the Hond Lake granite mass.

(3) Ross-O'Brien mines, about 1/3 mile southwest of Jacktar Lake, Brougham township, in a small area of hybrid and granitic gneisses.

The molybdenite is found in three main types of deposits, which are listed here in order of their importance as judged by past production:

(1) Bodies of metamorphic pyroxenite occurring along or near contacts between crystalline limestone and granite-gneiss or granite-pegmatite.

(2) Sulphide-quartz veinlets paralleling the foliation in granitic and hybrid gneisses.

(3) Disseminations in granite-pegmatite.

Of seventeen of the deposits, seven are in pyroxenite, seven in pegmatite, and three in sulphide-quartz veinlets in gneiss. About 90 per cent of the molybdenite produced in the map-area has been derived from deposits in pyroxenite.

Admaston Township

Concession IX, Lot 9 (Gorman Prospect)

The Gorman molybdenite prospect is in lot 9, con. IX, Admaston tp., 1¼ miles northeast of Shamrock and just south of the highway from Dacre to Opeongo. Most of the molybdenite occurs with pyrrhotite in a body of coarse-grained, dark green pyroxenite situated along the contact between a red granite-gneiss and a northeasterly trending band of crystalline limestone.

The deposit has been described by Eardley-Wilmot (39, p. 82) as follows:

> "The main work consists of an irregular pit on the south edge of the road, about 80 feet long, 12 feet wide, and 6 feet deep, with a 30-foot cross trench at the west end. About 100 yards to the west and 50 feet south of the road there is another pit 30 feet by 6 feet and 3 feet deep, from which the richest ore was obtained. ..... A few pockets of high-grade ore were observed, but unless very carefully selected it is probable that it would average under 0.5 per cent MoS_2.
>
> "The deposit was discovered about 60 years ago (about 1864), when the road was being made ..... In 1917, Mr. J. O. Gorman gave an option to Mr. A. J. Gravelle, of Ottawa, who with several

others formed the Opeongo Mining Syndicate, and under this name shipped to the Mines Branch, Ottawa, in November, 1917, 21.72 tons of 0.38 per cent ore, from which 117 pounds of pure molybdenite was recovered."

Concession XIII, Lot 8

Eardley-Wilmot (39, p. 83) mentions a discovery of molybdenite during the digging of a well on the farm of M. P. Kiley in the east half of lot 8, con. XIII, Admaston township. The mineral was associated with heavy sulphide mineralization.

Satterly (9, p. 71) describes a 3-foot dyke or sill of rusty pegmatite containing a few crushed flakes of molybdenite from ¼ to 1 inch in diameter exposed in a stripping and test pit, 4 by 4 feet and 3 feet deep, dug in 1918 just northeast of the farm-house. He reports that the pegmatite cuts a band of hornblende gneiss containing a 1-foot interbed of crystalline limestone striking north 60 degrees east and dipping 55 degrees southeast, the country rock as a whole being banded hybrid gneiss. Freeman (7, p. 12) considered this occurrence to be worth further investigation.

Satterly (9, p. 71) also reports an occurrence on the farm of J. F. Kiley, in the west half of the lot. Here a shallow pit in a rusty, white pegmatite cutting hybrid gneiss exposes a few scattered flakes of molybdenite from ¼ to 1 inch in diameter.

Other Occurrences

Two occurrences listed but not described by Freeman (7, p. 14), in lots 15 and 17, con. XII, Admaston tp., are not shown on the map accompanying this report.

Bagot Township

Concession I, Lot 29

An occurrence of molybdenite on the farm of Joe Kluck in lot 29, con. I, Bagot tp., is described by Satterly (9, p. 71), but is not shown on the map accompanying this report. Two pits, one 16 by 18 feet and 7 feet deep, the other 35 by 17 feet and 6 to 12 feet deep, were sunk in hybrid gneiss in 1939-40 by the Buckhorn Mining Syndicate, Limited. The pits expose bands of amphibolite up to 6 feet wide associated with diopside-phlogopite crystalline limestone, and hornblende and biotite gneisses striking north 70 degrees east, dipping 80 degrees southeast, and cut by granite-pegmatite. The bands of amphibolite are mineralized with pyrrhotite, pyrite, and a very little molybdenite.

Concession IV, Lot 26

Satterly (9, p. 71) mentions an occurrence of molybdenite about ½ mile west of the southwest end of Hond Lake, in lot 26, con. IV, Bagot township. A pit 10 to 20 feet wide, 40 feet long, and from 2 to 7 feet deep, was sunk in 1940 on a band of hybrid gneiss included within the Hond Lake granite mass. A little pyrite and a few scattered flakes of molybdenite from ¼ to 1 inch wide occur in a band of pale green pyroxenite not more than 6 feet thick underlying a 5-foot sill

of granite-pegmatite striking north 35 degrees west and dipping 40 degrees southwest. A small patch of crystalline limestone overlies the pegmatite.

Concession IV, Lot 27

An occurrence of molybdenite mentioned by Satterly (9, p. 71) in the southwest corner of lot 27, con. IV, Bagot tp., is not shown on the map accompanying this report. The workings consist of a shaft 10 by 12 feet and 30 feet deep and two trenches trending northeast, one 100 feet long and 2 feet wide and the other 60 feet long and 5 feet wide. The workings are in an inclusion of hybrid gneiss in the Hond Lake granite mass. They expose limestone, hornblende gneiss, rusty biotite paragneiss, and pegmatite. A few flakes of molybdenite are visible in a 2-inch stringer of pegmatite cutting the limestone.

Freeman (7, pp. 12, 17) reports that the Canadian Molybdenite Company, Limited, shipped 1,520 pounds of hand-cobbed ore from this lot in 1916 and 1917 and that about 60 pounds of pure molybdenite were recovered from this ore. The property was later acquired by the Eureka Molybdenite Corporation, then by Phoenix Molybdenite Corporation, Limited, and finally by Zenith Molybdenite Corporation, Limited, its present owner.

Concession IV, Lot 28, East Half

(Buckhorn Mines, Limited)

Considerable work has been done on molybdenite occurrences on the property of Buckhorn Mines, Limited, in the east half of lot 28, con. IV, Bagot township. As these occurrences have been described by Horwood (40) and Satterly (9, p. 72), a complete description of them is not given here. Horwood mapped the geology of part of the property in 1940 on a scale of 1 inch to 250 feet, and his map is included in Satterly's report.

Several pits and trenches were excavated in 1939 and 1940 and another pit in the autumn of 1942. Seven diamond drill-holes were put down in February 1943, and it is reported that this work indicated a mineralized lens from which 1,500 tons of ore averaging about 1 per cent molybdenite might be recovered by sorting.

In general, the molybdenite occurs as sparsely scattered flakes in narrow bands of pyroxenite in or along the borders of northeasterly trending larger bands of biotite gneiss, hornblende gneiss, and crystalline limestone within granite-gneiss, the whole being cut by dykes and sills of granite-pegmatite containing a little molybdenite in places. Much coarse- to fine-grained pyrite occurs with the molybdenite in the pyroxenite. Some masses of pyrite a foot or more thick contain flakes of molybdenite from 1 inch to 3 inches in diameter. It is reported that a series of pyrite-molybdenite stringers up to 16 inches wide were exposed across a width of 10 feet in No. 3 pit. Some of the gangue minerals said to occur here are garnet, carbonate, drusy, smoky, and amethystine quartz, and rosettes of specularite.

Concession IV, Lot 28, West Half

(Zenith Molybdenite Corporation, Limited)

Considerable molybdenite has been produced from the property of Zenith Molybdenite Corporation, Limited, in the west half of lot 28, con. IV, Bagot tp., about 5 miles southwest of Renfrew. As the property has been described in detail by Eardley-Wilmot (39, pp. 83-84), Freeman (7, pp. 16-20), Horwood (40), and Satterly (9, pp. 73-75), only its main features will be referred to here. Freeman mapped the surface geology by plane-table on a scale of 1 inch to 100 feet in August 1935. In the same month he also mapped the geology of the 100-foot level of the mine on a scale of 1 inch to 20 feet. Horwood mapped the surface geology in 1940 on 1 inch to 250 feet, and his map is included in Satterly's report. The latter report also contains geological plans of the 100- and 200-foot levels and an east-west vertical cross-section all on a scale of 1 inch to 50 feet.

Mr. William Warren discovered the molybdenite when digging a well on his farm, and sold the mining rights to Sir Henry Pellatt in 1914. About 81 tons of ore were produced in 1917; from this 7,800 pounds of molybdenite and 472 pounds of flake running 65 per cent molybdenite were recovered. In 1931, about 12 tons of ore grading 5 per cent molybdenite were shipped to the Mines Branch at Ottawa for test purposes. The property was purchased by the Phoenix Molybdenite Corporation, Limited, in 1924. Between then and 1937 this company sank a shaft to a depth of 205 feet, and did considerable lateral development work from this at depths of 95 and 175 feet. A 100-ton mill was erected and was operated intermittently from 1934 to 1937. During this period a total of 8,579 tons of ore was hoisted and some 15 to 22 tons of concentrates grading 80 to 85 per cent molybdenite were produced. The Zenith Molybdenite Corporation acquired the assets of the Phoenix Molybdenite Corporation in 1938. From then until September 1940, when operations ceased, 4,800 feet of trenching was done as well as some diamond drilling and development work on the 175-foot level.

The mine was operated by Wartime Metals Corporation for the Government of Canada from December 1942 to April 1943. During this period, 836 feet of underground diamond drilling and 874 feet of drifting and crosscutting were completed. Results of this work were disappointing, and only about 400 tons of ore estimated to grade 0.85 per cent molybdenite were produced. This ore yielded 14½ tons of material at the mine, composed of 22,523 pounds of lump ore grading 2.77 per cent, 4,355 pounds of fines grading 35.7 per cent, and 2,122 pounds of flake grading 4.51 per cent molybdenite. All of this was shipped to the Lacorne concentrator in northwestern Quebec where it yielded 2,274 pounds of molybdenite.

Grey to red gneissic granite of the Hond Lake mass is the most abundant rock type on the property. It includes a few bands or xenoliths of meta-sedimentary rocks of the Grenville series. Dykes of granite-pegmatite up to 375 feet wide cut rocks of both these types. Tabular to lens-shaped bodies of metamorphic pyroxenite are found along or near the contacts between gneissic granite and the included bands of meta-sedimentary rocks. The latter include crystalline limestone, biotite gneiss, and some pink and grey, banded hybrid gneiss.

The most important molybdenite-bearing zones occur in the pyroxenite bodies near dykes, sills, and irregular masses of pegmatite. Satterly (9, p. 75) notes that the mineralization discovered to date is mostly along the contact of pyroxenite and hybrid gneiss. The

molybdenite-bearing zones are relatively short, narrow, lenticular bodies striking approximately north and dipping vertically to steeply west. They range in length from 30 to 210 feet and in width from 2 to 5 feet. A typical ore shoot mined in 204 north drift was 50 feet long and 5 feet wide.

The molybdenite occurs in the pyroxenite as disseminated flakes up to 2 inches across, and as bunches, seams, or bands, commonly associated with irregular stringers of pyrite. Most of the ore is composed of pyroxene, calcite, quartz, pyrite, and molybdenite. A little disseminated molybdenite also occurs in some of the granite-pegmatite, in the paragneiss or hybrid gneiss adjacent to contacts with pegmatite or pyroxenite, and in veins up to 4 feet wide composed of pink calcite, pyroxene, and some feldspar.

Minerals reported to occur in the ore include pyroxene of the diopside-hedenbergite series, uralite, chlorite, serpentine, red iron oxide, calcite, quartz, microcline, oligoclase-albite, tourmaline, scapolite, anhydrite, hornblende, biotite, sphene, apatite, garnet, magnetite, martite, pyrite, pyrrhotite, and molybdenite.

Lang (41, p. 134) reports that one of six samples taken during an examination of the property by the Quebec Smelting and Refining Corporation showed radioactivity slightly above 0.05 R. The other five samples gave lower results.

Concession IV, Lot 29

(Bagot Molybdenite Mining Syndicate, Limited)

In 1939 or 1940, lot 29, con. IV, Bagot tp., adjoining and northwest of the properties of Zenith Molybdenite Corporation and of Buckhorn Mines, Limited, was controlled by Bagot Molybdenite Mining Syndicate, Limited. A pit and a trench 40 feet long, 4 feet wide, and 1 foot to 4 feet deep expose granite-pegmatite and hybrid gneiss. A fracture zone from 2 to 4 inches wide in the pegmatite contains crystals of smoky quartz and coarse-grained pyrite and molybdenite.

Concession IV, Lot 30

Satterly (9, p. 76) describes eleven trenches and a pit excavated by the Buckhorn Mining Syndicate, Limited, in the northern part of lot 30, con. IV, Bagot township. The workings expose interbedded crystalline limestone, hornblende gneiss, biotite-hornblende gneiss, rusty biotite paragneiss, and narrow bands of pyroxenite. A little pyrite and pyrrhotite occurs, particularly in the pyroxenite, but no molybdenite was seen. Some of the crystalline limestone contains radiating clusters of actinolite up to 4 inches long. The occurrence is not shown on the map accompanying this report.

Concession V, Lot 11

An occurrence of molybdenite in lot 11, con. V, Bagot tp., about $\frac{3}{4}$ mile northeast of Stones Lake, is in a zone of mixed rocks near the western border of the White Lake granite mass. Satterly (9, p. 76) describes it as follows:

"An old test pit, 10 by 10 feet and 6 feet deep, is now filled with water. Material on the dump consists of a grey

biotite granite gneiss containing narrow pegmatite stringers rarely mineralized with flakes of molybdenite an eighth of an inch in diameter. Some rusty unmineralized quartz and a hornblende gneiss were also seen. The strike of the gneissic structure is N.20°E., with a vertical dip."

Concession X, Lot 15

Eardley-Wilmot (39, p. 87) mentions an occurrence of molybdenite in the south half of lot 15, con. X, Bagot township. Mr. S. Hunter, who put down a pit 20 feet long, 10 feet wide, and 8 feet deep, about 1890, is reported to have picked out about 100 pounds of pure flake by hand.

Satterly (9, p. 76) describes the occurrence as follows:

"The pit was put down in a medium-grained pink pegmatite cut by a number of narrow vuggy veinlets containing white carbonate, pink feldspar crystals, and stumpy black tourmaline crystals from a tenth of an inch to 1 inch in length. A few flakes of molybdenite, from half an inch to 1 inch in width, were seen in the pegmatite. Crystalline limestone outcrops just northeast of the pit, and the veins are therefore in the pegmatite close to its contact with the limestone."

Concession XII, Lot 28

(Culhane Prospect)

An occurrence of molybdenite just east of Snake Lake on the farm of John K. Culhane in lot 28, con. XII, Bagot tp., is mentioned by Eardley-Wilmot (39, p. 87). Several pits were sunk on it and about 200 pounds of picked flake recovered from it in 1915. Satterly (9, p. 77) mentions three pits and a shallow open-cut exposing biotite gneiss and several narrow bands of coarse-grained, pale green to medium green mica pyroxenite. Bands of crystalline limestone also occur, and pink granite-gneiss is exposed on the ridge west of the pits. A little molybdenite in ½-inch to 2-inch flakes occurs in the pyroxenite. A pit near the northeast corner of Snake Lake exposes fine-grained pyrrhotite disseminated in rusty weathering paragneiss.

Blithfield Township

Concession I, Lot 29

(Quilty Prospect)

The Quilty molybdenite prospect is in the west half of lot 29, con. I, Blithfield tp., a little less than ½ mile west of Snake Lake and about 2 miles northeast of Constos Lake. The property is referred to by Eardley-Wilmot (39, p. 87) as follows:

"In 1917 Mr. Quilty sold, through Mr. Christopher, of Pittsburgh, 500 acres of mining rights to the Schutz, Schreiner, and Clyde Company of the same city. During the same year they shipped to the Mines Branch, Ottawa, 19 tons of 0.45 per cent ore, from which 120 pounds of pure molybdenite was recovered."

The occurrence is described by Satterly (9, p. 77) as follows:

"The country rock is a white crystalline limestone intruded by a sill or dyke of pink granite or granite-pegmatite about 40 feet wide. The workings consist of 2 pits. The main pit is 50 by 70 feet and from 10 to 12 feet deep. In it the mineralized zone is a pyroxenite containing disseminated pyrrhotite, pyrite, and scattered large flakes of molybdenite. Cutting the pyroxenite are a number of stringers, which fill vertical joints from a quarter of an inch to half an inch in width and are composed of coarse pyrite and scattered flakes of molybdenite. The pyroxenite occurs between the granite-pegmatite and overlying pink crystalline limestone. The thickness of the pyroxenite is about 12 feet."

The dip of the hanging-wall of the mineralized zone is reported to vary from 10 to 45 degrees southeast, and in most places it is 70 to 20 degrees. Satterly saw much pyrrhotite and pyrite in the pyroxenite but very little molybdenite.

Freeman (7, p. 12) mentions one quarry and five pits. He states that the ore is low in grade, occurring in a flat, heavy-sulphide and pyroxene contact zone between red granite and limestone.

Brougham Township

Concession XI, Lots 8 and 9

(Hunt Mine)

The Hunt mine, also known as the Belgian mine and as the Renfrew molybdenum mine, has been the largest producer of molybdenite in Renfrew map-area. It is situated in lots 8 and 9, con. XI, Brougham tp., just north of Condon Lake on the south slope of Mount St. Patrick, about 2½ miles southwest of the village of Mount St. Patrick.

The mine has been described in detail, first by Wilson (5, pp. 36-41) and later by Eardley-Wilmot (39, pp. 89-94). Freeman (7, pp. 12, 14) gives a brief summary, based mainly on Wilson's description, and Satterly (9, p. 79) gives excerpts from the descriptions of both Wilson and Eardley-Wilmot. Wilson (19, p. 64) refers to the occurrence as typical of contact-metamorphic mineral deposits. A brief summary of the main points, selected from these earlier descriptions, is given here.

Shortly after molybdenite was first discovered on the farm of Daniel Hunt an option on the property was taken by some Americans who shipped a small quantity of ore, then allowed the option to lapse. About 1913, a Belgian syndicate, operating in Canada under the title Algunican Development Company, purchased the property and did some drilling and other development work on it. All this work ceased upon the outbreak of World War I. In the autumn of 1915, the property was acquired by Renfrew Molybdenum Mines, Limited, and this firm operated the mine until it was finally closed down in the autumn of 1918. A concentrator of 25 to 30 tons per day capacity was erected and operated steadily. Total concentrates produced, including hand-picked pure flake, amounted to 96,990 pounds, 85 per cent of which averaged about 95 per cent molybdenite. All the high-grade concentrates were sent to Paul Girod, or the Societie Electrometallurgie, Ugine, France, who specified a 95 per cent product. In addition to numerous pits and trenches, underground work, almost all done between 1915 and 1918, comprised: an inclined adit, 170 feet long; two shafts, one 80 feet

deep and another, No. 2, of unstated depth; 1,800 to 2,000 feet of drifting and crosscutting on four levels at depths of 40 to 150 feet; two raises; one winze; and considerable stoping from 20 to 25 feet wide done along about 400 feet of the drifts.

The orebodies are typical of contact metamorphic deposits, occurring in metamorphic pyroxenite, which lies along contacts between crystalline limestone and granite-pegmatite. The main mass of the pegmatite overlies the limestone as a sheet or sill dipping gently northward and outcropping on the hill to the northwest of the mine workings over an area ½ mile wide and 1 mile long. A smaller sill or mass of pegmatite lies in the limestone about 50 feet below the main sill. The upper ore zone, occurring along the under side of the upper (main) body of pegmatite, has been traced east and west along the hillside by open-cuts and strippings for about 400 feet, and has an average width of 6 feet. The molybdenite content of this zone is reported to be low. It has been followed down its dip for 150 feet. The lower ore zone, occurring along the upper side of the lower mass of pegmatite, is 5 to 7 feet thick over its explored length of 400 feet. It is reported to be mineralized throughout, to be of higher grade than the upper ore zone, and to have provided most of the mine's production.

In most places the ore zones consist chiefly of green pyroxene (diopside) or of pyroxene and scapolite. In fewer places they consist mainly of pyrite and pyrrhotite. The sulphides tend to occur together and, as a result of this, the molybdenite is most abundant where pyrite and pyrrhotite are plentiful. Other minerals reported to occur in the ore zones are calcite, microcline, and stilbite.

It is reported that the mine was closed down after the great drop in the price of molybdenite at the end of World War I.

Concession XI, Lot 15

(Charron Prospect)

An occurrence of molybdenite in the south half of lot 15, con. XI, Brougham tp., said to have been worked between 1910 and 1916 by J. Charron, is described by Satterly (9, pp. 79-80) as follows:

> "A number of workings occur on the hill slope, the main open cut being 450 feet southwest of the creek outlet at the south side of Jacktar Lake.
>
> "The open cut is 30 feet long in a S.65°W. direction, 6 to 10 feet wide, and 10 feet deep. From the open cut a stripping extends 65 feet in a N.60°W. direction, ending in a pit 28 feet long, 10 feet wide, and 3 feet deep. In the same direction at 118 feet and 52 feet southwest is a pit 8 by 10 feet and 5 feet deep. At 188 feet, N.60°W. from the open cut, is another pit 15 by 10 feet and 5 feet deep, with shallow trenching and stripping to the northwest for 50 feet.
>
> "The open cut exposes biotite and hornblende paragneisses, containing a narrow interbed of limestone, cut by an irregular mass of rusty-weathering granite-pegmatite containing coarse pyrrhotite, some pyrite, and more rarely flakes of molybdenite. The gneisses strike N.30°W. and dip 35° to 45°E."

The other workings expose similar occurrences. Satterly concludes that the molybdenite is confined to irregular masses of pegmatite that occur in a contact zone between gneisses and limestone. Although the rocks are heavily rust-stained, little molybdenite is visible in them.

Concession XI, Lot 16

(Ross Mine)

The Ross or Morin molybdenite prospect is situated about ⅓ mile southwest of Jacktar Lake in lot 16, con. XI, Brougham township. It has been described by Eardley-Wilmot (39, pp. 94-95) and Satterly (9, pp. 80-81) and cited by Wilson (5, p. 36; 19, p. 64) as an example of the type of deposit in which the molybdenite occurs in veins of pyrite, pyrrhotite, and quartz in granite-gneiss. A few of the main points selected from these earlier publications are given here.

Dr. B. G. Connolly purchased the land from Mr. Austin Morin, and about 1914 sold the mining rights to Mr. C. G. Ross of the Aldfield Mineral Syndicate. This syndicate did some prospecting work, then gave an option to a Belgian Syndicate, which shipped a little ore before dropping its option. Molybdenum Limited bought the property from the Aldfield Syndicate during World War I and granted an option on it to Mr. F. G. Todd of Montreal. The International Molybdenum Company leased the property for 6 months in 1917. It is said that several carloads of ore were shipped, some to the Mines Branch, Ottawa, and some to the Renfrew concentrator, with ore from the adjoining property of International Molybdenum Company. In his tabulation, Freeman (7, p. 12) notes that 720 tons of ore were shipped and that about 7 tons of molybdenite were recovered from this, giving an average grade for the ore of about 1 per cent molybdenite.

The workings consist of two pits. The west pit is 50 feet in diameter and 20 feet deep. The east pit is 150 feet long, 50 to 75 feet wide, and 30 feet deep, with a 5- by 9-foot shaft 30 feet deep at its west end.

The pits expose rusty weathering granitic gneisses striking northwest and dipping northeast at about 20 degrees. Narrow veinlets containing quartz, pyrite, pyrrhotite, and molybdenite occur in the granitic gneisses paralleling their foliation.

Concession XI, Lot 17

(O'Brien Mine)

The old O'Brien or International mine is situated a little less than ½ mile southwest of Jacktar Lake in lot 17, con. XI, Brougham township. It has been described by Eardley-Wilmot (39, pp. 97-98) and Satterly (9, p. 81), and cited as an example by Wilson (5, p. 36; 19, p. 64). A brief summarization of these reports follows:

M. J. O'Brien worked the property in 1915, and in the following year formed the International Molybdenum Company, Limited, to operate it. This company made small shipments of selected ore to the Department of Mines, Ottawa, and to Orillia in 1916. The Mount Saint Patrick Molybdenite Syndicate acquired the property in 1942, did some surface work on it, and shipped 20 tons of ore to a concentrator at Quyon, Quebec. This ore yielded 423 pounds of molybdenite.

In October 1942, the property was acquired by Major Molybdenite Mines, Limited, and in March and April 1943 this firm had some exploration work done under supervision of Mining Research Corporation, Limited. This exploration consisted of 1,000 feet of diamond drilling in eighteen holes and a little surface work. It indicated the occurrence of molybdenite at shallow depths over an area 75 feet wide and 200 feet long in the gneiss at the old workings. Possible ore indicated by the drilling is said to be 2,000 tons averaging about 1 per cent molybdenite. Freeman (7, p. 12) indicates that a total of 500 tons of ore was shipped from the property.

The main workings, consisting of three pits and four shafts, expose banded hybrid gneisses striking northwest and dipping northeast at 15 to 20 degrees. A little molybdenite, pyrite, and quartz occur in narrow, erratically distributed veinlets paralleling the foliation of the gneiss.

Disseminated graphite is reported to occur in crystalline limestone in and near a shaft 40 feet deep situated about 600 feet northwest of the main workings.

Concession XII, Lot 8

An occurrence of molybdenite, not plotted on the map accompanying this report, is shown on Dr. M. E. Wilson's manuscript map. It is in lot 8, con. XII, Brougham tp., about 1,500 feet north 40 degrees west from the fire tower on Mount St. Patrick. It is shown as being in crystalline limestone, just east of the pegmatite mass with which the deposits of the Hunt mine are associated.

Concession XII, Lot 18

Freeman (7, p. 12) tabulates an occurrence of molybdenite on the O'Brien farm in lot 18, con. XII, Brougham township. His tabulation indicates the existence of two pits along pegmatite-gneiss-limestone contracts. This occurrence is not shown on the map accompanying this report.

Concession XIII, Lot 13

Freeman (7, p. 12) mentions many small, low-grade occurrences of molybdenite and a few small pits along ill-defined gneiss-limestone contacts on the Maloney farm in lot 13, con. XIII, Brougham township. Nothing else is known of this occurrence, and it is not shown on the map accompanying this report.

Concession XIII, Lot 14

An occurrence of molybdenite, not shown on the map accompanying this report, is plotted on Dr. M. E. Wilson's manuscript map as being just east of the road in lot 14, con. XIII, Brougham township.

McNab Township

Concession IV, Lot 19

Molybdenite occurs in a sill of granite-pegmatite exposed in a small, low cut at the east side of the road in lot 19, con. IV, McNab tp., about 2 miles northeast of Burnstown. The sill strikes approximately north, dips to the east at 35 degrees, is 30 feet or more wide, and lies in fine-grained, pink granite along the western contact of a band of paragneiss. The texture of the sill varies from fine to coarse grained to graphic. The coarser grained parts of the sill contain several per cent molybdenite in books up to 1 inch by 1 inch by 1½ inches.

NEPHELINE

Nepheline is scarce in Renfrew map-area, most of it being confined to the narrow, northeasterly trending band of nepheline-albite gneiss about ¾ mile northwest of Guiney Lake on Mount St. Patrick in Brougham township. As this band has been described in a previous section of this report under GENERAL GEOLOGY, little will be said about it here. It is well exposed just north of the barn on the farm of J. J. Maloney in lot 11, con. XIV, Brougham township. Its low content of nepheline, together with its biotite content, cause it to be of little economic interest.

A little nepheline is found in bands normally less than 5 feet wide at a few places in the hybrid gneisses in the western part of the map-area. Some nepheline occurs in a syenitic body in lot 15, con. X, Admaston tp., about 1 mile southwest of Colton Lake.

PYRITE

Pyrite is fairly abundant in the map-area but is nowhere known to occur in bodies sufficiently large to warrant mining. Its main modes of occurrence are as follows:

(1) In bodies of metamorphic pyroxenite, accompanied by the other sulphides, pyrrhotite and molybdenite.

(2) In the foliated hornblendic rocks: (a) disseminated (most common) and (b) in narrow bands and lenticular bodies paralleling the foliation of the host rock.

(3) Associated with magnetite in iron-bearing zones occurring along or near the contact between crystalline limestone and foliated hornblendic rocks.

(4) Associated with pyrrhotite, molybdenite, and quartz in tiny seams and veinlets locally paralleling the foliation in granitic and hybrid gneiss.

(5) Disseminated, along with pyrrhotite and traces of chalcopyrite, in the bodies of basic intrusive rocks.

Although none of the occurrences described below appear to be of any economic value in themselves, they are listed for sake of completeness and as possible indicators of centres or areas of sulphide and accompanying mineralization.

Bagot Township

Concession III, Lot 20

An occurrence of pyrite, reported as a molybdenite prospect, is situated about 1½ miles northeast of Springtown in the west half of lot 20, con. III, Bagot township. A nearby claim post indicates that it was restaked in 1918 by T. Quilty.

The workings consist of two trenches. One of these is 25 feet long, 8 feet wide, and from 3 to 5 feet deep, and trends north. The other trench, about 10 feet southwest of the first, is 60 feet long, 4 to 15 feet wide, 5 feet deep, and trends northwesterly. An area about 40 by 40 feet around the northern part of the second trench has been stripped.

The rock is granite containing a few scattered xenoliths of meta-sedimentary rocks. The workings expose pyroxenite, composed mainly of green pyroxene with smaller quantities of white scapolite. Pyrite, accompanied by a little pyrrhotite, forms from 25 to 70 per cent of the pyroxenite and may average 40 to 50 per cent. It occurs mainly in veinlets and in irregular to rounded aggregates up to 6 inches or more wide. In places the pyrite and pyrrhotite enclose crystals of pyroxene. The band or bands of pyroxenite probably strike northwest. No molybdenite was seen.

Concession IV, Lot 13

A very small occurrence of pyrite is found about 2 miles northeast of Stones Lake in lot 13, con. IV, Bagot township. A trench 8 feet long, 4 feet wide, and 4 feet deep exposes a pyrite-bearing quartz vein in the band of hornblende schist on the western contact of the White Lake granite mass. The schist contains sills of pink gneissic granite up to 6 inches wide. It strikes north 50 degrees east and dips to the southeast at 70 degrees. The quartz vein, following the foliation of the schist, is 10 to 12 inches wide and was traced for a length of 40 feet. The pyrite, constituting as much as 20 per cent of the vein locally, occurs mainly in numerous narrow stringers and veinlets within the quartz.

Concession IX, Lot 5

A small occurrence of pyrite is found near the south boundary of lot 5, con. IX, Bagot tp., about 1 mile southeast of Virgin (Dempsey) Lake. It lies about 500 feet west of the main contact of the White Lake granite mass in hornblende schist striking north 10 degrees east and dipping easterly at 50 degrees. Numerous sills of hornblende granite up to 40 feet or more thick parallel the foliation of the schist.

An old prospect pit about 7 feet long, 5 feet wide, and 7 feet deep exposes a band of rusty, decomposed schist 14 inches wide within a 5-foot band of hornblende schist. The rusty band contains about 50 per cent disseminated pyrite, and is locally stained yellow. It is conformable with the enclosing rocks.

Concession X, Lot 18

The dump beside an overgrown pit in lot 18, concession X, Bagot tp., about 500 feet north of the railway just north of Calabogie contains pieces of nearly massive pyrite up to 10 inches across. It also shows pieces of hornblende-biotite-quartz schist containing disseminated sulphides and magnetite. This occurrence may be on the southwestern extension of the iron-bearing zone containing the magnetite found in lot 18, con. IX, Bagot township.

Grattan Township

Concession I, Lot 3

A minor occurrence of pyrite, reported as a nickel prospect, is situated on the farm of Tom Sammon, about 1½ miles east of Balaclava, in lot 3, con. I, Grattan township. There a small shallow pit has been excavated in rusty weathering, garnetiferous quartzite striking northeast and dipping southeast at about 40 degrees. Considerable pyrite is found in the quartzite, mainly as disseminated grains but in part as small veinlets or stringers. The prospect consists simply of an especially pyritiferous paragneiss.

RADIOACTIVE MINERALS

No particular search has been made for radioactive minerals in the map-area. As only two very minor occurrences of them are known, however, it seems probable that they are relatively scarce. Both of the known occurrences are in dykes or sills of granite-pegmatite within the Hond Lake granite mass. Other bodies of pegmatite within the Hond Lake granite probably contain radioactive minerals as well.

Horton Township

Concession III, Lot 1

An occurrence of radioactive minerals is on land owned by J. S. Dempsey in lot 1, con. III, Horton tp., about 1 mile southwest of Goshen. The radioactive thorium-bearing minerals allanite[1] and uranothorite[1] are found in very small quantities in a northeast-

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[1] Identified by H. R. Steacy, Radioactivity Laboratory, Geological Survey of Canada.

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trending sill or dyke of pink granite-pegmatite at least 25 feet wide and 100 feet long, occurring within the Hond Lake granite mass about 400 feet from its northwestern contact. A sample from a shallow pit in the pegmatite showed radioactivity of 0.020 per cent U_3O_8 equivalent. The allanite occurs as dull black to brownish black bladed forms. The uranothorite occurs as vitreous, dark greenish black, microscopic grains. Other minerals occurring in the pegmatite are quartz, reddish potash feldspar, plagioclase feldspar, magnetite, hematite, and microscopic crystals of apatite. Some of the radioactivity of the sample is due to the potash feldspar and apatite.

Bagot Township

Concession IV, Lot 28

(Zenith Mine)

Radioactivity slightly above 0.05R[1] has been reported by

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[1] 0.05R means 0.05 per cent U_3O_8 equivalent, determined by radiometric test.

Lang (41, p. 134) in a sample from the property of Zenith Molybdenite Corporation in lot 28, con. IV, Bagot township. Five other samples gave lower results.

Float

Mr. Jack Mask of Renfrew reports having detected radioactivity in 1949 in a piece of float on the farm of John Nadobney in lot 7, con. II, Admaston township. The float is reported to be a specimen of red rock about 18 inches square. A sample from it tested in Ottawa is said to have shown radioactivity of 1.25 per cent U_3O_8 equivalent.

SILLIMANITE

An occurrence of sillimanite, of mineralogical interest only, is shown on the map accompanying this report about 1 mile northeast of the village of Mount St. Patrick in lot 6, con. XIV, Admaston township. It is described under Paragneiss in the GENERAL GEOLOGY section of this report.

STONE

This section deals only with stone used as such for construction purposes, mainly for building stone and road metal. Although many quarries, most of them small and for local use only, have been opened up in the map-area, none of these is being operated at present. As most of these quarries have been described by Satterly (9, pp. 99-104), they are simply listed here and shown on the accompanying map. A little information is given for three of them. Beds of massive, brown weathering dolomite and dolomitic limestone up to 18 inches thick seen in lots 25 and 26, cons. XI and XII, McNab tp., may be of interest for building purposes. Of the twelve occurrences listed below, seven are Precambrian rocks and five are Palaeozoic rocks. Five of the Precambrian occurrences are crystalline limestone, one is granite, and one is hornblende gneiss.

Precambrian

(1) Admaston township, lot 8, con. XI - $\frac{3}{4}$ mile southeast of Shamrock. Massive, pink granite exposed in shallow cut at side of road.

(2) Bagot township, lot 29, con. VIII - $1\frac{1}{4}$ miles north of Ashdad.

(3) Horton township:

(a) Lot 16, con. I - 1 mile northwest of Renfrew.

(b) Lot 14, con. II - ½ mile north of Renfrew.

(c) Lot 13, con. III - 1¼ miles northeast of Renfrew. It is thought to be from this vicinity that Bruce (42, p. 133) described reddish brown magnesian tourmaline.

(d) Lot 14, con. III - 1¼ miles northeast of Renfrew.

(e) Lot 6, con. VII - 2¼ miles northeast of Mayhew. Varicoloured crystalline limestone outcropping along base of a bluff at north side of Bonnechere River. Not shown on map.

Palaeozoic

(1) Admaston township, lot 4, con. XI - 3 miles northwest of Ashdad.

(2) Bagot township:

(a) Lot 27, con. IX - ½ mile southwest of Ashdad.

(d) Lot 14, con. XI - ½ mile southeast of Barryvale.

(3) Bromley township, lot 1, con. VIII - ½ mile northeast of Douglas railway station.

(4) McNab township, lot 25, con. XI - 1¾ miles northeast of Loch Winnoch.

STRONTIUM

The only deposit of celestite known in the map-area occurs in lot 7, con. X, Bagot tp., about ½ mile south of Virgin or Dempsey Lake and 4 miles southeast of Calabogie. It has been described by Fréchette (32, p. 88), Spence (43, pp. 77-84), Wilson (5, pp. 43-44), and Satterly (9, pp. 111-113). According to Spence it is the largest celestite occurrence of possible economic importance known in Canada. Except for small amounts obtained during sampling of other occurrences all of the 250 tons or so of celestite mined in Canada has been from this deposit.

The deposit is reported to have been discovered about 1888 by Walter Yuill. It was first opened in 1918, when J. E. Wilder mined 200 tons from an open-cut and later built a grinding plant. One ton of ore was shipped to the Mines Branch at Ottawa at that time for concentration tests. The property lay idle from 1920 to 1941, when A. E. Fletcher leased it for a few months, pumped out the open-cut and shipped 27 tons of ore, mainly from the old stock-piles. The present owner is reported to be the J. R. Stewart estate of Renfrew.

The main working, or Pit No. 1, consists of an open-cut 70 feet long, 60 feet wide, and 5 to 25 feet deep on the northern slope of an east-trending ridge of crystalline limestone. Pit No. 2, 120 feet northeast of the open-cut, is 10 feet long, 4 feet wide, and 2 feet deep. Pit No. 3 consists of an open-cut 40 feet long, 10 feet wide, and 8 feet deep, about 140 feet southwest of Pit No. 1. Pit No. 4 is a small, shallow opening 175 feet south 25 degrees west of Pit No. 3.

Pit No. 5, about 825 feet northwest of pit No. 1, is 9 feet long, 4 feet wide, and 4 feet deep.

Five occurrences of celestite are known within a northwesterly trending area 500 feet wide by 1,000 feet long. Four of the occurrences, including that in the main open-cut (Pit No. 1), are at the southeastern end of this area.

The celestite occurs in three zones of fault breccia in white to pink crystalline limestone, which has been dolomitized in and near the zones of brecciation. The zones strike from north 10 to 50 degrees east and dip to the southeast at from 40 to 60 degrees. The celestite, which contains about 15 per cent of barium sulphate and, therefore, is more properly classified as barytocelestite, has two main modes of occurrence in the breccia zones, namely: (a) in short, lenticular, vein-like masses from 3 to 6 feet long and from 1 to 2 feet wide, and (b) as a matrix enclosing and cementing the breccia fragments of dolomitized limestone. Spence points out that the vein-like material, constituting possibly 30 per cent of the total celestite in the deposit, can be recovered by hand cobbing, whereas the material occurring as matrix, comprising the remaining 70 per cent, is so mixed with dolomitized limestone that it must be milled to separate and recover the celestite.

The celestite occurs mainly as white, opaque, radiating masses and as radiating clusters of euhedral crystals. The ore is reported to have a specific gravity of 3.99.

The main open-cut (Pit No. 1), from which almost all production has been obtained, exposes a breccia zone in which most of the celestite occurs cementing the breccia fragments and a smaller amount occurs in vein-like masses. The zone is about 15 feet wide, is exposed for length of 70 feet and depth of 5 to 25 feet, strikes north 50 degrees east, and dips to the southeast at 60 degrees. Wilson estimates that the mass of celestite-bearing rock exposed in this zone averages about 30 per cent celestite. The deposit apparently pinches out at or near the extremities of the open-cut and thus appears to occur in an isolated mass. A breccia zone is exposed in Pit No. 2, however, 120 feet northeast of the open-cut and on the strike of the zone in the open-cut. It is possible that other celestite-bearing lenses occur at other points in this and other zones of brecciation. It is reported that a 60-foot vertical diamond drill-hole in the hanging-wall of the main deposit cut 14 feet of mixed celestite and dolomite at a depth of 40 feet. This intersection is said to include bands of celestite from 2 to 3 feet thick.

The second zone, exposed in Pit No. 3 and possibly in Pit No. 4 about 175 feet to the southwest, consists of a breccia zone up to 3 feet wide, with an exposed length of 25 feet, striking north 30 degrees east and dipping southeast at about 60 degrees. This zone contains masses of pure celestite up to 4 inches wide.

The third zone, exposed in Pit No. 5 about 825 feet northwest of Pit No. 1, consists of a celestite-bearing breccia zone 1 foot wide striking north 10 degrees east and dipping 40 degrees east.

TOURMALINE

Tourmaline is abundant and of widespread occurrence in Renfrew map-area. Although it is found in a few places in crystals large enough for commercial requirements, most of it occurs in small grains and in crystals less than $\frac{1}{4}$ inch in diameter and 1 inch long.

The tourmaline is of two types, each having its own typical and distinct mode of occurrence, as follows:

(1) Ordinary tourmaline - black, euhedral to subhedral grains, most common in granite-pegmatite and pegmatitic granite.

(2) Magnesian tourmaline (dravite) - small, reddish brown anhedral grains and button-shaped crystals, most common in skarn and calcareous contact metamorphic zones.

Although the ordinary tourmaline is found at hundreds of places, only two occurrences of the magnesian tourmaline are known, possibly because it has been mistaken for garnet in some cases.

Admaston Township

Concession IV, Lot 6

A northerly trending mass of pink granite-pegmatite in lot 6, con. IV, Admaston tp., about $\frac{1}{2}$ mile southeast of Opeongo, contains an unusually large amount of black tourmaline. The mineral, constituting from 5 to 15 per cent of the rock, occurs as subhedral grains and as euhedral crystals from very small sizes to at least $\frac{1}{2}$ inch by 2 inches. Microscopic examination shows that many of the crystals are zoned. Most of the remainder of the rock is composed of quartz, muscovite, and pink potash feldspar.

Concession IV, Lot 7

The body of gneissic granite found in lot 7, con. IV, Admaston tp., about $\frac{1}{3}$ mile east of Opeongo, contains numerous dykes and sills of pink granite-pegmatite about 2 feet wide. Many of these dykes and sills contain 10 per cent or so of black tourmaline in grains and euhedral crystals.

Bagot Township

Concession IV, Lot 19

A minor occurrence of tourmaline is found on the north side of the road about $\frac{3}{4}$ mile northeast of Springtown, in lot 19, con. IV, Bagot township. Euhedral crystals of black tourmaline up to $1\frac{1}{2}$ inches wide by 4 inches long are abundant in veinlets of quartz and dykelets of pegmatite in a body of massive to gneissic diorite, which has not been differentiated from the Hornblendic Foliated Rocks on the map accompanying this report. The veinlets and dykelets are few and scattered and are commonly less than 6 inches thick.

Concession X, Lot 15

Poitevin (44, p. 18) mentions crystals of tourmaline collected by Dr. M. E. Wilson in lot 15, con. X, Bagot township. Some black, prismatic crystals from microscopic sizes to 1 centimetre long occur in crystalline limestone at the immediate contact with a granite dyke.

Concession X, Lot 16

Magnesian tourmaline (dravite) is found in the foot-wall of the Campbell-Caldwell magnetite orebody of Algoma Ore Properties Limited in lot 16, con. X, Bagot township. It occurs in a 15-foot band of grey, plagioclase-tourmaline-pyrite schist lying 25 feet or so below the foot-wall of the iron ore. The tourmaline, constituting up to 25 per cent of the rock locally, occurs as small, reddish brown, anhedral to subhedral grains. Although its main constituent is plagioclase, the schist also contains about 10 per cent each of quartz, pyrite, and bright green, calcium-rich pyroxene. A little gold is found in it as well.

Grattan Township

Concession IV, Lot 11

Tourmaline and several contact metamorphic minerals are well displayed on a peninsula on the south shore of Constan Lake in the western part of lot 11, con. IV, Grattan township. The tourmaline occurs as stubby, poorly terminated crystals up to at least 4 inches across in some of the several dykes of coarse-grained, pink granite-pegmatite that cut crystalline limestone on the peninsula. Crystals of pink feldspar are found in the limestone along the walls of some of the dykes. The limestone locally contains many small, rounded, pale red grains and many rounded pale yellowish green grains of very high lustre. A pink pyroxene (diopside?) also occurs in the limestone in places. Some outcrops show a sugary textured rock composed mainly of plagioclase and rounded grains of a shiny, black pyribole.

Horton Township

Concession III, Lot 13

An occurrence of magnesian tourmaline in a limestone quarry near the town of Renfrew is described by Bruce (42, pp. 133-135). It seems probable that this occurrence is in one of the group of quarries in lot 13, con. III, Horton tp., about $1\frac{3}{4}$ miles northeast of Renfrew. The tourmaline is reported to exist as reddish brown, resinous grains and small button-shaped crystals in both grey granite-gneiss and crystalline limestone, near the contact of these two rocks. Much graphite occurs in the tourmaline. The gneiss comprises quartz, microcline, plagioclase, and a green pyroxene. The limestone consists almost entirely of calcite, but contains some graphite. Other minerals found in both gneiss and limestone include tourmaline, pyrrhotite, sphene, and muscovite.

McNab Township

Concession I, Lot 19

Tourmaline occurs in a dyke of pink granite-pegmatite near a house at the end of a lane about $\frac{3}{4}$ mile northwest of Burnstown in lot 19, con. I, McNab township. The tourmaline is found as black, euhedral crystals up to $\frac{3}{4}$ inch by 2 inches and as irregular masses up to 3 by 4 inches. The dyke is at least 20 feet wide, and strikes northwesterly. It contains crystals of pink potash feldspar up to 3 inches wide and 6 inches long and cuts gneissic, grey, fine-grained biotite-granite.

Concession V, Lot 18

Much black tourmaline occurs in a few dykes of granite-pegmatite in lot 18, con. V, McNab tp., about $2\frac{1}{2}$ miles northeast of Burnstown. The dykes, trending a little west of north, intrude hornblende gneiss and crystalline limestone.

Concession VI, Lot 26

An interesting occurrence of tourmaline is found in lot 26, con. VI, McNab tp., a mile east of Goshen. The rock there is pegmatitic granite, consisting mainly of gneissic granite containing about 15 per cent pink granite-pegmatite in narrow sills and dykelets, but in part consisting of larger dykes and irregular masses of pegmatite containing a few xenoliths of gneissic granite and hornblende gneiss. Most of the pegmatite bodies strike north 60 degrees east and dip northwest at 80 degrees, parallel with the foliation of the granite and of the xenoliths of gneiss. The pegmatite locally contains crystals of pink potash feldspar 3 or 4 inches across, and in these coarser grained parts commonly contains abundant black tourmaline. The tourmaline has two modes of occurrence: (1) in euhedral crystals up to 1 inch wide and 3 inches long; and (2) in masses and aggregates of crystals up to 10 inches long by 4 inches wide, containing about 40 per cent white quartz in small rounded masses and in narrow ribbon-like bodies of many orientations. These mixtures of quartz and tourmaline, bearing some resemblance to graphic intergrowths, are locally termed "goshenite".

ZINC

Sphalerite, the sulphide of zinc, is known to occur only in one small part of the map-area, about 4 miles southwest of Renfrew. The mineralized area, in lots 1 and 2, cons. III and IV, Admaston tp., trends northeasterly, with known length of 3,300 feet and width of 400 feet or more. It is occupied by two mining properties, the northeastern one owned by Cadieux Mines Limited, and the adjoining, southwestern one controlled by Renprior Zinc Mines Limited. Total exploration work done on the two properties to December 1951 consists of about fifty trenches, pits, and strippings, geological mapping, and about 18,500 feet of diamond drilling in ninety-two holes to a maximum vertical depth of 857 feet. In addition, the Renprior property has been surveyed magnetically and electrically, and has had a small mill constructed on it. Total production has been about 60 tons of concentrates containing approximately 55 per cent zinc, 6 per cent lead, and some silver. Exploration is continuing.

The zinc occurrences have been described at various stages of their exploration by Alcock (45, pp. 132-135) and Satterly (9, pp. 113-118), the latter giving helpful tabulations and summaries of results obtained up to 1943. First discovery of sphalerite in the area is reported to have been made in 1922 on lot 2, con. III, by Joseph Legree. Early exploration of the mineralized area, now subdivided into two mining properties controlled by two separate companies, was done on both properties as a unit, which was commonly known as the Renfrew zinc prospect. In 1925, The Coniagas Mines, Limited optioned the property and explored it by numerous trenches and strippings and by 1,483 feet of diamond drilling in five holes. Early in 1926, Ottawa Valley Mines Limited optioned the property and did 1,187 feet of diamond drilling in four holes. In the spring of 1926 the British Metal Corporation (Canada) Limited did 1,487 feet of diamond drilling in seven holes and re-sampled the trenches in detail.

Little further interest was taken in the area until about 1947 when New Calumet Mines Limited acquired control of parts of lots 1 and 2, con. III, and began diamond drilling there. In 1948, this property was transferred to Cadieux Mines Limited, and additional diamond drilling was done on it. Further diamond drilling was done in 1950 and 1951 and more is planned. In 1950, Lomega Gold Mines Limited took a lease and option on the east half of lots 1 and 2, con. IV, from Mr. John Hisko, the owner. The company used a bulldozer to do extensive stripping of the mineralized zones and to build about ½ mile of new road. Some rock trenching and sampling were done as well. In September 1950, control of the property was transferred to Renprior Mines. This company built a mill of 35 to 50 tons daily capacity, and in June and July 1951 operated the mill on ore from an open-cut in the No. 1 ore zone. In September 1951, Renprior Zinc Mines, Limited acquired the property and began more extensive exploration. This work has included about 7,000 feet of AXT diamond drilling in forty-five holes, geological mapping on a scale of 1 inch to 100 feet, and electrical and magnetic surveys conducted by Mining Geophysics Corporation.

The zinc-bearing area is situated near the central axis of a northeasterly trending band of crystalline limestone about 3,000 feet wide. Foliation and bedding in the band commonly dip to the southeast at 80 degrees or more. The band of limestone is flanked by bands of hornblende gneiss, and contains a few narrow bands or beds of quartzite, hornblende gneiss, and hornblende-biotite gneiss. It is cut by a few dykes, sills, and irregular masses of white to pink granite and granite-pegmatite. Some of it, as noted by Poitevin (44, p. 18), contains considerable colourless, white, or greyish tremolite in crystals and in feathery forms. At some points, rosettes of radiating tremolite up to 1 inch or more in diameter are so numerous that they cause the surface of the limestone to be rough and lumpy. A few small flakes of phlogopite occur in the limestone locally.

Mineralization is represented by lenticular bodies up to 125 feet long and 15 feet or more wide. Most of these bodies dip to the southeast at about 80 degrees and rake to the northeast at very low angles, in one case as low as 20 degrees. At some places at least three parallel lenses occur in rude <u>en échelon</u> arrangement.

The mineralization is represented mainly by disseminated grains of resinous, brown sphalerite in white to reddish pink, coarse-grained, crystalline limestone and in narrow, lenticular bands of skarn. The sphalerite is commonly accompanied by 5 per cent or less of pyrite in grains and cubes up to ⅛ inch across, and by a little pyrrhotite

and chalcopyrite. Galena, in grains and cubes up to $\frac{1}{4}$ inch across, constitutes several per cent of the ore in a few places; in one of the mineralized lenses it occurs along the foot-wall in the western part of the lens. The sulphides are concentrated in bands parallel with the foliation of the limestone. These bands vary in thickness from a fraction of an inch to 4 feet or so and, although they commonly contain only 10 per cent or less of sulphides, consist almost entirely of sulphides locally. Most of them strike about north 40 degrees east and dip steeply southeast at 80 degrees or more. Bands and irregular lenses of skarn up to a foot or two wide are commonly found along one or both walls of the mineralized bands and, in some cases, between these bands. This contact rock is rich in micas, containing both phlogopite and biotite. Some of its other constituents are green diopside, grossularite garnet, calcite, tremolite, apatite, plagioclase feldspar, chlorite, talc, and possibly scapolite.

Cadieux Mines Limited

Cadieux Mines Limited, controlled and managed by New Calumet Mines Limited, owns the mineral rights on about 400 acres in lots 1 and 2, con. III, Admaston township. Much trenching, pitting, and stripping were done on the property prior to 1927, and an aggregate of 3,478 feet of diamond drilling completed in thirteen holes. In 1947, New Calumet Mines Limited, put down thirteen more holes aggregating 2,287 feet. Since its incorporation in 1948, Cadieux Mines Limited, has put down four holes in 1948, totalling 1,327 feet; seven holes in 1950, totalling 2,889 feet; and seven X-ray holes in 1951, totalling 825 feet. Total diamond drilling done on the property to December 1951 consists of 10,806 feet in forty-four holes to maximum vertical depth of 857 feet. A geological map on a scale of 1 inch to 100 feet was made in 1947.

Sphalerite occurs intermittently in an area about 500 feet wide extending northeasterly for 2,500 feet from the western boundary of the property. At least three or four separate mineralized lenses have been found to date. One of these, outcropping at No. 7, trench, is about 120 feet long by 15 feet wide and averages about 10 per cent zinc. It has been estimated to contain approximately 16,000 tons of ore to depth of 100 feet. Diamond-drill intersections in another lens at Nos. 1 and 2 trenches about 800 feet farther northeast, show 17.7 per cent zinc across 5 feet, 6.6 per cent zinc across 13.6 feet, 6.5 per cent zinc across 7.6 feet, and other comparable values and widths. A deep hole about 200 feet farther east cut four separate sphalerite-bearing bands or lenses from 30 to 160 feet apart.

At least two of the seven X-ray drill-holes put down near the western boundary of the property in 1951 cut the northeastern extension of the ore lens in the Renprior No. 1 zone at depth, indicating that this lens rakes to the northeast at a low angle. The holes also indicate that the lens extends into the Cadieux property at depth for a distance of at least 100 feet.

Renprior Zinc Mines, Limited

Renprior Zinc Mines, Limited, incorporated in August 1951, holds a lease and option on the 200 acres owned by John Hisko in the east half of lots 1 and 2, con. IV, Admaston township. The property was explored by 679 feet of diamond drilling in three holes prior to 1927. In 1948, Cadieux Mines Limited, drilled one 167-foot hole on the property about 90 feet west of its eastern boundary. It has been

opened up by at least fourteen trenches and strippings, and one of these, on the No. 1 ore zone, has been developed into an open-cut. Ore from this open-cut was fed to the mill during June and July 1951, and about 60 tons of concentrates containing 55 per cent zinc, 6 per cent lead, and a little silver were produced. A more extensive exploration program was begun on the property in September 1951. This has included geophysical surveys, detailed geological mapping, and diamond drilling.

Detailed mapping and logging of diamond drill cores has supplied additional information on the geology. A few bands of light grey cherty quartzite up to 4 feet wide are found in the crystalline limestone, which underlies most of the property. A dyke or sill of dark, massive, fine-grained rock about 100 feet wide and striking about north 20 degrees east has been traced for 1,800 feet across the central part of the property. Some of the hornblende gneiss in the northern part of the property is coarse grained, and is composed mainly of hornblende and plagioclase.

Sphalerite occurs here and there in an area about 300 feet wide extending southwesterly for 800 feet from the eastern boundary of the property. Most of this sphalerite occurs in three narrow, subparallel, northeasterly trending, rudely en échelon, mineralized lenses. From south to north these are known as the No. 1, No. 2, and No. 3 zones, respectively. At many places, they show some oxidation to a depth of 10 feet or more. In some places, sphalerite replaces radiating tremolite, assuming the structure of the latter mineral. Pyrite occurs mainly in disseminated grains but is also found in a few veinlets up to $\frac{3}{8}$ inch wide.

No. 1 zone is well exposed in an open-cut and adjoining stripping about 340 feet long by 50 feet wide that extend to the eastern boundary of the property and lie about 450 feet northwest of the mill. The zone has two branches, which for part of their length are about 20 feet apart but converge toward the northeast, becoming one zone about 140 feet west of the boundary line. The zone pinches out at the surface at a point about 120 feet west of the boundary, but has been intersected at 97 feet depth in a drill-hole on the Cadieux property about 40 feet east of the boundary, indicating that it rakes to the northeast at a low angle. Both branches of the zone dip steeply to the southeast: the north branch is about 120 feet long and from 2 to 8 feet wide; the south branch is about 70 feet long and from $2\frac{1}{2}$ to 6 feet wide. Where the two branches join, the zone is reported to be mineralized across a width of about 50 feet. Galena is most abundant along the foot-wall of the two branches in their southwestern parts, and gradually decreases in amount toward the northeast. Most of the ore milled was obtained from the open-cut in the No. 1 zone. This ore, after some sorting, was found to contain a little less than 3 per cent zinc.

No. 2 zone, situated about 190 feet northwest of the western part of No. 1 zone, is exposed by numerous trenches and has been explored by several diamond drill-holes. One of these holes cut two zinc-bearing lenses or bands about 10 feet apart. The upper or southern band gave 3.06 per cent zinc over 8.5 feet, and the lower or northern one 5.20 per cent zinc over 2.5 feet. The zone has an indicated length of about 100 feet, strikes north 43 degrees east, and dips to the southeast at 80 degrees. About 200 feet to the southwest, a band 4 inches wide contains disseminated sphalerite and pyrite and has a narrow band of mica-rich skarn along its southeastern wall. Much of the limestone in and along the No. 2 zone is pink to red.

No. 3 zone, 50 to 70 feet northwest of No. 2 zone, was discovered by diamond drilling in the autumn of 1951. Preliminary results indicate that in some places it dips to the northwest at 50 degrees but that in other places the dip changes rather abruptly, producing sharp rolls. The drilling indicates that the zone varies in thickness from 1 foot to 10 feet or more, is 125 feet long, and extends to a depth of at least 125 feet. One hole indicates the existence of two, well-mineralized bands separated by 5 feet of limestone containing smaller amounts of disseminated sphalerite. The assay foot-wall of the lower band is gradational over 4 feet or so.

A pit about 380 feet southwest of the discovery hole on No. 3 zone reveals a 6- to 8-inch band of white, crystalline limestone containing about 10 per cent disseminated sphalerite and much less pyrite. The mineralized band dips to the northwest at 80 to 85 degrees, and carries much fine-grained, light-coloured mica in a 6-inch zone along its hanging-wall. Although this mineralized band is approximately on strike of the No. 3 zone, it has not been proved that it represents the southwestern extension of the zone.

The geophysical surveys are reported to have shown a strong anomaly along the contact between crystalline limestone and hornblende gneiss about 1,200 feet northwest of the No. 3 zone. This anomaly was investigated by three diamond drill-holes to a maximum depth of 350 feet, but nothing of value was encountered.

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