57-8

CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 57-8

ALKALINE ROCKS AND NIOBIUM DEPOSITS NEAR NEMEGOS, ONTARIO

(41 0/14)

By

R. W. Hodder

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Price, 50 cents

Price 50 cents Cat. No. M44-5708
Available from the Queen's Printer
Ottawa, Canada

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Illustration

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INTRODUCTION

Alkaline rocks outcrop in a ring of hills that rise up to 1,000 feet above the general hummocky surface of the Canadian Shield a few miles north of Nemegos, in northern Ontario. The outstanding features are the concentric distribution of the alkaline rocks, the intimate association of alkaline and carbonate rocks in zones of brecciation, the presence of bodies containing magnetite and apatite, and the presence of pyrochlore, a radioactive niobium-bearing mineral. This association is particularly interesting at present when, in various parts of the world, attention is being directed to complexes of alkaline and carbonate rocks and associated niobium deposits. Niobium is now the official name of the element formerly called columbium.

The writer studied part of the alkaline complex in the summer of 1956, mapping on scales of 1 inch to 200 feet and 1 inch to 100 feet. Exposures are not plentiful and wherever possible the surface mapping was supplemented by examination of diamond drill-cores. Three hundred specimens were collected for extensive laboratory studies, which were partly carried out during the winter of 1956. This report summarizes the information obtained to date, and deals particularly with the rock types and the occurrence of niobium.

Location

The alkaline rocks under discussion outcrop in McNaught and Lackner townships, Sudbury district. Seven miles of gravel road connect the camp of Multi-Minerals Limited, in the southwestern part of the area of alkaline rocks, with Nemegos station on the main line of the Canadian Pacific Railway. Chapleau is 15 miles northwest of the Multi-Minerals camp and may be reached from Nemegos by 18 miles of gravel road, part of which is Highway 129 which connects Chapleau with Highway 17 at Thessalon.

History and Development

The discovery prospect, called the McVittie pit, is in the southwest corner of the area. Two claims covering the pit and other magnetite showings in the vicinity were staked and patented early in the century. Relatively little work was done until 1949 when the deposits were found to be radioactive. This discovery prompted the formation of Nemegos Uranium Corporation

which acquired the original claims and staked seventy-two more; all are on the west side of the alkaline complex. It was determined later that the radioactivity was caused by pyrochlore, a mineral that commonly contains minor amounts of uranium. In September 1953 Sudbury Northrim Exploration Company Limited[1] took an option on the property and in December of the same year it was sold to Multi-Minerals Limited. To date the property has been mapped geologically, covered by magnetometer and scintillometer surveys, and 65,858 feet of diamond drilling has been done from the surface. Bulk samples have been sent to laboratories for ore dressing and metallurgical tests. Multi-Minerals Limited has applied for patent of forty-nine claims.

Chyka Mines Limited, Dominion Gulf Company, and several other companies and individuals have conducted geophysical and geological surveys and have done some diamond drilling on the north and east sides of the alkaline complex. No company planned work in the area in 1957.

Acknowledgments

Grateful thanks for assistance and courtesies are tendered to the management of Multi-Minerals Limited, especially to H. L. Garvie, consulting engineer, and Lloyd Otto, resident manager, and to G. E. Parsons of Dominion Gulf Company and Frank Petroski of Brochu Diamond Drilling Limited. The writer benefited from unpublished plans and reports supplied by Multi-Minerals Limited and Dominion Gulf Company.

GENERAL GEOLOGY

Regional Geology

The area covered by this report lies within the Timiskaming sub-province of the Canadian Shield. The area had not previously been mapped geologically by either the Geological Survey of Canada or the Ontario Department of Mines. However, the Ridout area, mapped many years ago for the Geological Survey by Emmons and Thomson[2], includes Tooms township, which ad-

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[1]Sudbury Northrim Exploration Company Limited and Sudbury Midzone Mines Limited were merged in April 1955 to form Midrim Mining Company Limited. Multi-Minerals Limited is an affiliate of Midrim Mining Company.

[2]Emmons, R. C., and Thomson, Ellis: Preliminary Report on Woman River and Ridout Map-Areas, Sudbury District, Ontario; Geol. Surv., Canada, Memoir 157, 1929.

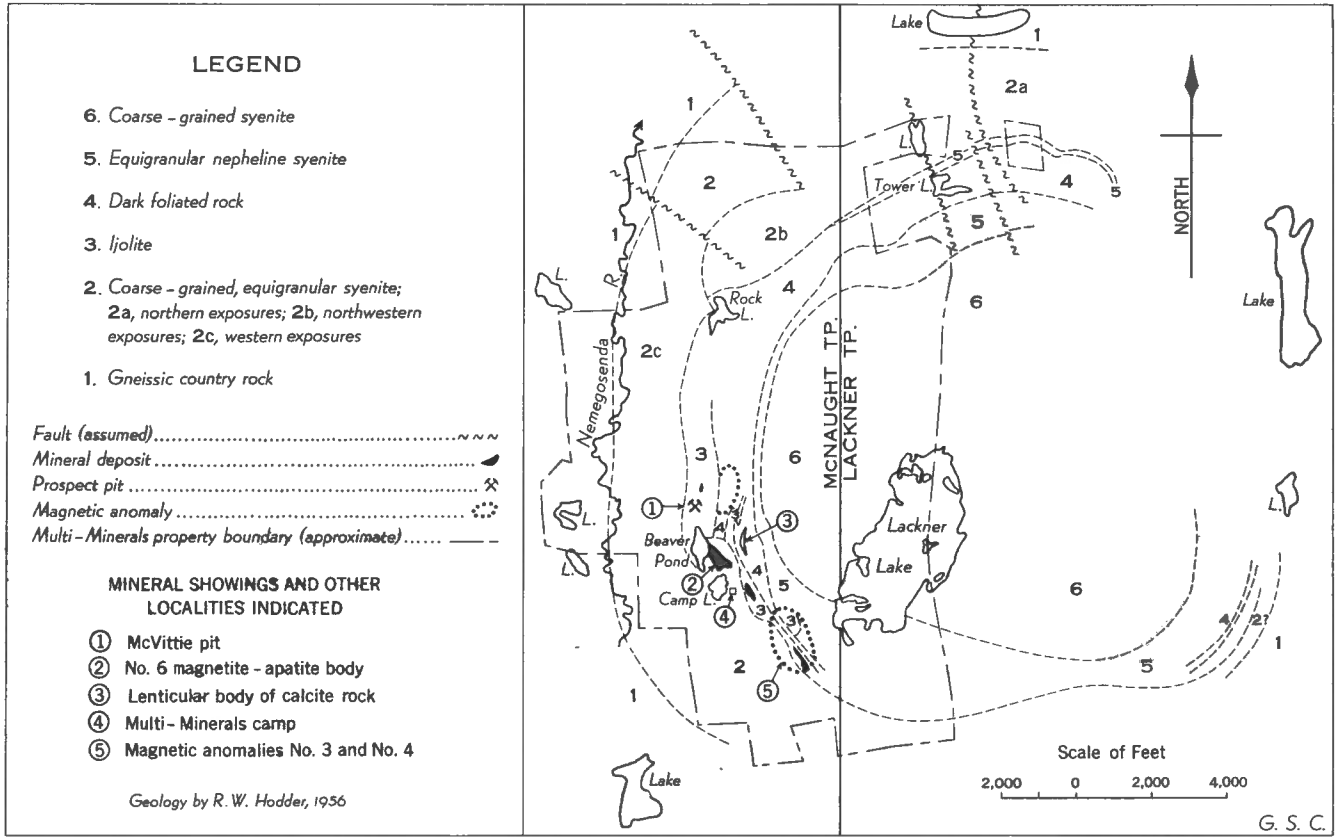

Figure 1. Sketch map of Nemegos alkaline complex, Sudbury district, Ontario.

joins the southeast corner of Lackner township. Emmons and Thomson reported highly sheared and chloritized acid to basic flows and pyroclastic rocks in Tooms township. The volcanic rocks, believed to be of Keewatin age, are cut by granite. To the northwest, in Lackner and McNaught townships, biotite gneiss outcrops in a few places and has been intersected by diamond drill-holes outside the alkaline complex.

Local Geology

Concentric rings of alkaline rocks are the predominant features of the local geology. Their shape is indicated to a large extent by hills, ponds and creeks (see Figure 1). The outermost ring, 3 miles in diameter, is marked by hills rising several hundred feet above the flat land outside the alkaline area and is composed of coarse-grained nepheline syenite (2). This syenite separates the gneissic country rock from an inner ring of dark-coloured alkaline rock, comprising ijolite (3) and foliated alkaline rock (4), that causes a slight depression. Bodies of apatite, magnetite, and carbonate rocks lie within these dark-coloured rocks.

A ring of equigranular nepheline syenite (5), pinkish brown to grey, marked by a ridge on the inside of the depression occupied by the dark rocks, lies inside the ring of dark-coloured rocks. The outcrop width of this band of syenite is extremely variable. It also outcrops between the outer syenite (2) and the dark rocks (4) in the northern part of the area. The core of the alkaline complex, within the ring of equigranular nepheline syenite, is poorly exposed but appears to be coarse-grained inequigranular syenite (6). It is best exposed at the south ends of the ravines south of Tower Lake. So far as the writer could learn, the central part of the complex has not been diamond drilled.

The coarse-grained outer syenite is in contact with ijolite 600 feet south of the McVittie pit; the relationships there are obscured by stringers of magnetite but the syenite appears to intrude the ijolite. On the west shore of Rock Lake the outer syenite has intruded the dark-coloured foliated rocks. The contacts between the dark rocks (4) and the equigranular nepheline syenite (5), and between this syenite and the inequigranular nepheline syenite (6) of the core, are gradational. The magnetite-apatite bodies and the carbonate rocks have sharp contacts with their inclusions and with the enclosing rocks. All rock types are cut by lamprophyre dykes.

Structure

The rock types are arranged in concentric zones about a centre north of Lackner Lake. Foliations in the syenite, the magnetite-apatite bodies, and the carbonate rocks have concentric strikes parallel with the contacts and dipping about 55 degrees towards the centre of the complex. Exceptions to this occur in the dark-coloured foliated rocks on the west shore of Rock Lake where the foliation dips steeply away from the centre of the complex. Diamond-drill data show that the carbonate rocks dip towards the centre, and suggest that the contacts of the other rock types also have this attitude. The lamprophyre dykes dip at low angles away from the centre of the complex and are concentric with the major ring structure.

Five faults are assumed to be present in the northern part of the area, because of the distribution of rocks and because of topographical features. They apparently strike northwesterly and northerly. Apparent displacements are small but the actual nature of the faults is unknown. Other faults may be present but unsuspected because of lack of outcrops and drill-hole data. Diamond drill-cores show many small fractures and narrow zones of gouge and breccia, especially in the ring of dark-coloured foliated rocks.

DESCRIPTION OF ROCKS

In the description of rocks the following classification of grain size is used: fine grained, less than 1 mm.

medium grained, 1-4 mm.

coarse grained, 5-30 mm.

very coarse grained, greater than 3 cm.

Percentages mentioned for the amounts of minerals present in rocks are visual estimates. These are generally stated in parentheses following the names of minerals. Optical properties of minerals were determined with the universal stage.

The distribution of the various rock types is shown in Figure 1.

Outer Syenite (2)

The syenite forming the outermost ring of the alkaline complex may be divided into three parts on the basis of texture

and mineralogy. These parts are the Western, Northwestern, and Northern Outer Syenite.

Western Outer Syenite (2c). The outer syenite that outcrops on the west side of the Multi-Minerals property is inequigranular and very coarse grained; its colour varies from white to grey flecked with black. Weathered surfaces are pitted where nepheline crystals have weathered out. Simple twinned laths of alkali feldspar (45 per cent) with -2V, 75°-80°, occur in simple twinned laths 2 mm. to 4 cm. long, and pink to grey nepheline (35 per cent) in euhedral to subhedral grains from 2 mm. to 5 mm. in diameter. Most of the feldspar and nepheline grains are unaltered but some feldspar grains are cloudy and nepheline may be partly altered to cancrinite. Aegirine-augite and biotite are the mafic constituents. Irregularly shaped grains of aegirine-augite, 5 mm. in diameter, constitute 10 per cent of the rock. It is untwinned, pleochroic in bright green and brown-yellow (X>Y>Z, positive, 2V, 64°). The biotite, comprising 5 per cent, is strongly pleochroic in dark brown to yellow (Z>Y>X). Sodalite, apatite, magnetite, calcite, cancrinite and albite are accessory minerals, totalling 5 per cent of the rock.

Northwestern Outer Syenite (2b). The outer syenite that outcrops at the northwestern edge of the alkaline complex is an inequigranular coarse-grained rock. It is grey flecked with black. The rock consists essentially of alkali feldspar (35 per cent) and nepheline (30 per cent). The feldspar, commonly perthitic and slightly altered to sericite, occurs as simple-twinned laths. The nepheline, in anhedral to euhedral grains, is generally fresh but in places altered to cancrinite. Aegirine-augite (10 per cent) is pleochroic in green and brown (X>Y>Z). The rims of the grains are darker in colour than the centres and have smaller angles of extinction, suggesting a higher content of the aegirine molecule in the margins. The aegirine-augite grains are commonly surrounded by an amphibole (10 per cent) with the following properties: large 2V, negative, Z∧C 12°-15°, pleochroic in dark brown and yellow (Z>Y>X). The biotite (8 per cent) is pleochroic in dark brown to yellow shades (Z>Y>X). In places the biotite surrounds the amphibole, which in turn surrounds the aegirine-augite. Magnetite, apatite, calcite, cancrinite, and perovskite are present as accessory minerals (7 per cent).

Northern Outer Syenite (2a). The syenite that forms the outer ring on the north side of the alkaline complex is an inequigranular coarse-grained rock. It is either brown-grey with patches of black or almost black with patches of white, if the dark minerals are in clots. The essential minerals are nepheline (35 per cent) and alkali feldspar (30 per cent). Nepheline grains are euhedral to subhedral and generally unaltered, but some show the development of cancrinite along cracks. The simple-twinned

feldspars may be zoned and perthitic and slightly clouded by a dull alteration product. Aegirine-augite (20 per cent) shows its typical pleochroism at the grain margins but has light coloured centres. Amphibole rarely borders the aegirine-augite. The biotite (10 per cent) is a variety pleochroic in red-brown and yellow (Z > Y > X). Some of the biotite grains are strained. The accessory minerals (5 per cent) present are apatite, calcite, cancrinite, magnetite, amphibole and perovskite.

"Number 4" Syenite

"Number 4" syenite outcrops on the southeast side of No. 6 mineral body. It is inequigranular, coarse to medium grained, grey to brown and composed essentially of alkali feldspar (35 per cent) and nepheline (35 per cent). The feldspar (-2V, 70°) forms needle-like laths up to 1 cm. in length, with simple twins. The nepheline is medium grained, subhedral to anhedral and contains patches of cancrinite. Aegirine-augite (20 per cent) (+2V, 84°) is pleochroic in green and yellow-brown shades (Z > Y > X). Biotite (2 per cent) is strongly pleochroic, black to yellow (Z > Y > X). The accessory minerals (8 per cent) are zeolites, fluorite, cancrinite and magnetite.

A mottled black and pink rock is associated with the "Number 4" syenite. This rock outcrops on the east side of Beaver Pond and is particularly well exposed in trenching done along a magnetite vein. The rock is fine grained and equigranular except for pink clusters of fine-grained to medium-grained alkali feldspar. The rock is composed of aegirine-augite (+2V, 80°), nepheline, minor amounts of feldspar except for the patches of feldspar grains, and magnetite. Its composition is close to ijolite except for the clusters of feldspar grains. The dark rock grades into "Number 4" syenite, with an increase in the size and number of patches of alkali feldspar.

Equigranular Nepheline Syenite (5)

The equigranular nepheline syenite outcrops between the inequigranular syenite (6) at the core of the complex and the ring of dark foliated rocks (4). This syenite is brown to grey-brown flecked with black. The alkali feldspar (35 per cent) is in simple-twinned stubby grains containing rings of minute inclusions of apatite and pyroxene. The rings of inclusions mimic the outline of the feldspar grain and generally lie closer to the edges of the grains than to the centres. The feldspar is unaltered and perthitic (-2V, 76°-80°). In places the grains are oriented so as to give the rock a faint foliation. Nepheline (40 per cent) occurs in subhedral grains with rings of inclusion. Minor amounts of cancrinite may replace the nepheline along cracks and at grain boundaries.

Aegirine-augite (20 per cent) (+2V, 80°) forms irregularly shaped grains with rounded edges. The accessory minerals (5 per cent) are biotite, magnetite, calcite, cancrinite, apatite, and a few grains of altered plagioclase.

Inner Syenite (6)

The inner syenite outcrops at the centre of the alkaline complex. It is inequigranular, coarse grained, and brown-grey. Alkaline feldspar (50 per cent) (-2V, 75°-80°) is perthitic and in tabular grains with simple and microcline twinning. Nepheline (22 per cent) is euhedral to subhedral and is completely or partly altered to cancrinite. Aegirine-augite (12 per cent) forms ragged grains with pale centres and dark green borders; the extinction angle Z^C is smaller in the margin than in the centre of the grain.

Dark-coloured Rocks

The dark-coloured rocks are subdivided into the following groups on the basis of texture and mineral composition:

1. Non-foliated dark rocks, classified as ijolite.
2. Foliated dark rocks, further subdivided into a group that contains porphyroblasts of feldspar and a group that does not.

Non-foliated Dark Rocks (Ijolite) (3). These rocks are fine grained to medium grained and mottled black and white. They are equigranular and composed essentially of 50 per cent aegirine-augite (+2V, 68°) in rounded grains and 35 per cent fresh nepheline. Biotite, pleochroic in dark brown and yellow (Z>Y>X), apatite, sphene, calcite, magnetite, sodalite or analcite, cancrinite, and pyrochlore make up 15 per cent of the rock. Thin seams of pink nepheline or yellow cancrinite traverse the rock.

Foliated Rocks (4) Containing Feldspar Porphyroblasts. These rocks are confined to a depression between the outer syenite (2) and the equigranular syenite (5). They are mesocratic to melanocratic, and equigranular to inequigranular. They are composed of from 30 to 50 per cent alkali feldspar, 12 to 40 per cent nepheline, 15 to 30 per cent aegirine-augite, and accessory amounts of olivine, cancrinite, apatite, garnet, biotite, amphibole and pyrochlore. The olivine content of some samples approaches 15 per cent.

The alkali feldspar occurs in fine-grained laths alined to give the rock a foliation, and as porphyroblasts up to 6 mm. in diameter that cut across the foliation. The feldspar is generally perthitic with simple or microcline twinning. Some of the feldspar is zoned, commonly with rings of inclusions of apatite and pyroxene. Nepheline forms euhedral to subhedral grains with or without rings of inclusions; it is generally unaltered but may alter to cancrinite along cracks. Aegirine-augite is present in small round grains and in ragged grains of medium size that include magnetite. The olivine (+2V, 56°) is colourless to slightly yellow with a red-brown alteration along cracks; it does not show crystal outlines. The dark minerals are similarly oriented and may or may not be segregated into bands. The accessory minerals are disseminated through the rock as inclusions in other minerals and as independent grains. The magnetite, amphibole, and biotite are very irregular in outline but the pyrochlore, apatite and garnet are commonly euhedral.

Foliated Rocks (4) Without Feldspar Porphyroblasts. These rocks are black to grey with white patches. They are fine grained and inequigranular. The foliation is produced by the preferred orientation of biotite flakes and the segregation of light and dark minerals into thin bands. The rocks consist essentially of from 10 to 40 per cent aegirine-augite (in small rounded grains and in ragged altered grains), 10 to 15 per cent fresh nepheline, 15 to 20 per cent alkali feldspar, and 10 to 20 per cent biotite. Pyrochlore is present in amounts ranging from accessory to major. Other minerals that total as much as 30 per cent of the rock are apatite, calcite, sodalite or analcite, magnetite, zircon, spinel, amphibole and cancrinite.

Carbonate Rocks

Only two small outcrops of carbonate rocks are known in the area. One of these lies within the foliated rocks 200 yards east of Rock Lake, and the other is on the property of Dominion Gulf Company at the east edge of the complex. However, a fairly large body of carbonate rock 650 feet long and 50 feet wide has been outlined by diamond drilling on the Multi-Minerals property north of Camp Lake.

The Rock Lake outcrop is a dense grey rock, fine grained and inequigranular, with lenses of calcite up to 2 inches long. The rock is composed of 20 per cent coarse-grained to fine-grained calcite, 15 per cent poikilitic alkali feldspar, 20 per cent fine-grained nepheline, 15 per cent magnetite, and accessory pyrochlore in patches or aggregates of grains up to 2 mm. in diameter. Pyroxene and biotite are also present in accessory amounts. Rock from the outcrop on Dominion Gulf ground has not yet been

studied microscopically, but a hand specimen consists of grey, medium-grained calcite that is more or less equigranular, and fine-grained pyroxene, magnetite, and biotite. The latter outcrop is surrounded by syenite.

The carbonate body outlined by drilling is lenticular in plan and cross-section. The carbonate rock is not enclosed within one particular rock type but traverses the banded mesocratic rocks, the ijolites, and the syenites. The contacts of the main mass with the enclosing rocks are sharp and the body is clearly outlined. Narrow veinlets of calcite do, however, cut the enclosing rock beyond the margin of the main mass. The calcite includes angular fragments of rock that are separated from the calcite by rims of pyroxene and biotite up to $\frac{1}{2}$ inch wide.

The calcite content of the lenticular body is variable. In places aegirine-augite, apatite, magnetite, biotite, sulphides, and pyrochlore, usually arranged in bands, account for 40 per cent of the rock. On the other hand, some specimens consist of almost pure calcite. The calcite grains are very coarse and show no signs of deformation.

Other Rocks

Lamprophyre Dyke Rock. Lamprophyre dykes cut all other rock types in the area. Their contacts are sharp and they do not alter the enclosing rock. The dyke rock is fine grained, grey to black, and flecked with patches of white calcite. The essential minerals are calcite (25 per cent), a pyroxene (25 per cent) that is colourless with light green borders (+2V, 36°-44°), albite (20 per cent), biotite (20 per cent) that is strongly pleochroic in dark browns and yellow (Z > Y > X), and nepheline (10 per cent) partly altered to a fibrous zeolite along cracks.

Gneissic Country Rock. Gneiss outcrops sporadically to the north and northeast of the alkaline complex, and is intersected by several diamond drill-holes west of Nemegosenda River. The rock is inequigranular, coarse to fine grained, with the light and dark coloured minerals segregated into bands. The mineralogical composition is variable. A specimen from footage 500 in drill-hole R-83 contains 35 per cent plagioclase (An_{12}), 20 per cent amphibole (-2V, 67°, Z^C 20°), 20 per cent alkali feldspar (-2V, 84°), 10 per cent quartz, 10 per cent pale green, glassy pyroxene, and 5 per cent magnetite. The crystals of plagioclase and alkali feldspar are unaltered. The large amphibole grains are pleochroic in dark brown and yellow-brown shades (Z > Y > X) and contain inclusions of zircon. The amphibole grains are generally surrounded by small flakes of biotite and small irregularly shaped grains of pyroxene. A sample from footage 131 in

the same hole, and closer to the alkaline body, is composed essentially of aegirine-augite with aegirine rims, biotite, alkali feldspar, quartz and calcite.

MINERAL DEPOSITS

Description of Deposits

The known mineral deposits in the area covered by this report contain magnetite, apatite, and pyrochlore, generally together but in places singly. All but one of the known deposits are in the property of Multi-Minerals Limited, in the southwestern part of the alkaline complex.

The deposits that have been most fully explored in the Multi-Minerals claims are ellipsoidal in plan, up to 200 feet wide and 500 feet long, and have been shown by diamond drilling to extend to depths of at least 500 feet. These deposits are composed principally of coarse-grained magnetite and apatite with minor amounts of pyroxene, nepheline, and pyrochlore. Foliation results from parallel orientation of the apatite crystals and the segregation of apatite and magnetite into bands, up to 3 inches wide. The apatite is emerald green in colour and contrasts sharply with the shiny black magnetite. Lamellae of ilmenite occur in the magnetite grains. Within the bodies of magnetite and apatite are large blocks of ijolite. Diamond drill-hole R-65 penetrated a short section of brecciated rock cemented solely by apatite grains.

In addition to the above mentioned deposits, veins of solid magnetite are exposed in the McVittie pit and in most of the outcrops from this pit eastward to Beaver Pond (see Figure 1). In the McVittie pit the magnetite veins cut ijolite and show sharp boundaries, with no alteration of the surrounding ijolite. In the outcrops around Beaver Pond, however, the magnetite veins cut "Number 4" syenite, and pyroxene and biotite are developed in the wall-rock alongside the vein. The width of the pyroxene-biotite zone is proportional to the size of the magnetite vein, generally two or three times as wide.

Pyrochlore occurs in three different ways:

1. As separate grains, and sometimes as clusters of small grains, in the ijolite, the dark foliated rocks, and the carbonate rocks. The greatest amounts of pyrochlore revealed thus far occur in this way.

2. As very fine disseminated grains in the magnetite-apatite bodies.

3. As euhedral grains in thin nepheline stringers that traverse the melanocratic rocks and the pink nepheline fillings in the brecciated dark-coloured rock at the southeast end of Beaver Pond.

The pyrochlore is honey-yellow to reddish brown and is generally in octahedral crystals. Where many crystals occur together they present a sugary appearance in hand specimens. Two analyses of pyrochlore from the Multi-Minerals property are quoted in Table I.

The principal deposits known on the Multi-Minerals property have been outlined by geophysical surveys and tested by diamond drilling. The following estimates of their tonnages and grades have been made by officers of the company, all calculations being to depths of 500 feet.

Number 6 body. This consists of magnetite, apatite, and disseminated pyrochlore. Diamond drilling indicated 5,024,250 tons averaging 69.60 per cent magnetite, 21.88 per cent apatite and 0.173 per cent Nb_2O_5.

Number 8 body. This consists of disseminated pyrochlore in mesocratic and melanocratic rocks. Diamond drilling indicated more than 50 million tons of rock averaging 0.26 per cent Nb_2O_5.

Number 3 and Number 4 bodies. These consist of magnetite, apatite, and pyrochlore, in ijolite. Diamond drilling indicated a combined total of 10,137,000 tons of rock averaging 15.5 per cent magnetite, 19.5 per cent apatite and 0.226 per cent Nb_2O_5.

Main mass of calcite rock. Diamond drilling of the mass of calcite rock north of Camp Lake indicated 1,610,000 tons of rock composed of 80 per cent calcite and averaging 0.16 per cent Nb_2O_5.

One deposit, in claims held by Dominion Gulf Company covering the southeastern part of the complex, has been partly explored by diamond drilling. This company drilled three holes, one of which intersected a pyrochlore-bearing magnetite-apatite body in dark foliated rocks. The estimated true width of this body was

judged by company officials to be 75 to 100 feet, with an average tenor of 39.04 per cent Fe (soluble), 5.04 per cent P, and 0.15 per cent Nb_2O_5. The rocks at each side of this body contain pyrochlore for true widths estimated at 25 to 50 feet, the average content being estimated at 0.15 per cent Nb_2O_5.

Theories of Origin

Surface geological mapping and diamond drilling have established the circular distribution of the rock types and their inclination towards the centre of the alkaline area. A definite statement on the origin of the complex and its associated mineral deposits cannot be made but further work done on rock textures and constituent minerals, as well as investigation of the northeastern part of the complex, may elucidate some of the problems. At present it seems reasonable to interpret the Nemegos complex as a series of cone sheets occupying steeply dipping fractures. Tentatively, the writer favours the following explanation.

Syenite magma forcefully intruded and locally metamorphosed the country gneiss. Cone-type fractures developed, much as a cone-shaped pit develops when a bullet passes through glass. The syenite magma filled the outermost cone-type fracture forming the outer ring of syenite and enclosing a ring of metamorphosed country rock. The carbonate rocks and the magnetite-apatite also filled fractures and brecciated zones. Subsidence followed the filling of the cone fractures and a ring-type fracture developed. This fracture dipped away from the centre of the complex and it was filled by lamprophyre dykes. The ijolite may be the product of magmatic differentiation or it may have been produced by contamination of the syenite magma. According to this hypothesis pyrochlore was emplaced in the foliated dark-coloured rocks by hydrothermal or metasomatic activity but was an original constituent of the ijolite, the carbonate rock, and the magnetite-apatite bodies.

An alternative explanation is that limy strata formed part of the country rocks of the area, and that the structural features now evident resulted either from folding or from a collapse caused by alteration and related volume changes of the limy rocks, probably as a result of igneous activity. This would explain the origin of the carbonate rock. A strong point against this interpretation is that limy rocks have not been observed in the area, nor have they been reported from other parts of the general region.

Suggestions on Prospecting

The rather scarce outcrops of the Nemegos complex have been prospected fairly exhaustively. The outlining of the various units of the complex indicates places favourable for further prospecting, mainly by subsurface methods, if deposits like those already found are considered of economic importance. The value of magnetometer surveys, diamond drilling, and of radioactivity detectors in testing outcrops and drill-cores has been demonstrated.

Regarding the possibility of discovering other complexes of this general kind, it is noteworthy that the alkaline rocks of the Nemegos area, of the Dominion Gulf property at Nemegosenda Lake[1], and of the Beaucage property[2] at Lake Nipissing show many geological similarities.

All three in turn are similar in many respects to the Monteregian Hills, the eight hills that extend in a line across the Eastern Townships of Quebec and whose cores are intrusions of alkaline rock. The alkaline rocks of Oka, Quebec, at the junction of the Ottawa and St. Lawrence rivers, probably should be grouped with the Monteregian rocks[3].

Alkaline rocks are related to major faults throughout the world. For example, circular bodies of alkaline rock are associated with the African Rift valleys and Barth[4] comments on the relation of alkaline rocks to normal faults in the Pribilof Islands, Alaska. In Eastern Canada the Monteregian Hills are associated with a fault zone that extends from the Eastern Townships north and west up the Ottawa Valley. This zone trends in a general way towards three other complexes of intrusive alkaline rocks, namely the one near Nemegos and the ones at Nemegosenda Lake and Lake Nipissing mentioned above. Thus the Monteregian "province" of alkaline rocks may extend westward to include these complexes. Other alkaline complexes may outcrop within this supposed extension of the Monteregian "province" and might be located by studying high-level air photographs for circular structures, by inspection of circular anomalies on aeromagnetic maps, and by the re-examination of known occurrences of alkaline rocks.

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[1]Parsons, G. E.: Nemegosenda Lake Columbium Area; Can. Min. J., Aug., pp. 83-87, 1957.

[2]Rowe, Robert B.: Notes on the Geology and Mineralogy of the Newman Columbium-Uranium Deposit, Lake Nipissing, Ontario; Geol. Surv. Canada, Paper 54-5, 1954.

[3]Rowe, Robert B.: Notes on Columbium Mineralization, Oka District, Two Mountains County, Quebec; Geol. Surv. Canada, Paper 54-22, 1955.

[4]Barth, T. F. W.: Geology and Petrology of the Pribilof Islands,Alaska, U. S. Geol. Surv., Bull. 1028, 1956.

Table I

ANALYSES OF PYROCHLORE
FROM MULTI-MINERALS PROPERTY

	Weight per cent	
	Sample A*	Sample B**
Nb_2O_5	46.1	58.1
Ta_2O_5	1.4	2.8
U_3O_8	12.6	1.2
ThO_2	4.7	—
CaO	27.0	16.9
MnO	0.2	0.3
Fe_2O_3	3.0	11.0
ZrO_2	0.5	—
TiO_2	2.5	9.1
MgO	0.4	0.28
Ce_2O_5	1.3	—
La_2O_5	0.3	0.32
Dy_2O_3	0.1	—

Source Rock: (A) Ijolite; (B) Foliated mesocratic rock with more than 30 per cent alkali feldspar.

Methods: Recalculated, semi-quantitative spectrographic analyses of pyrochlore concentrates.

*Nickel, E. H.: Interim M.D. Test Report No. 710-ML; Mines Branch, Dept. of Mines and Tech. Surveys, 1955.

**Nickel, E. H.: Interim M.D. Test Report No. 716-ML; Mines Branch, Dept of Mines and Tech. Surveys, 1955.