CANADA

DEPARTMENT OF MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 54-5

NOTES ON GEOLOGY AND MINERALOGY OF THE NEWMAN COLUMBIUM-URANIUM DEPOSIT, LAKE NIPISSING, ONTARIO

By

Robert B. Rowe

OTTAWA
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Price, 50 cents

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THE NEWMAN COLUMBIUM-URANIUM DEPOSIT, LAKE NIPISSING, ONTARIO

INTRODUCTION

Three deposits carrying columbium and uranium have been discovered on or near islands in Lake Nipissing, Ontario, and are known as the Newman, Calder, and Great Manitou deposits. The property is held by Beaucage Mines Limited, 170 Regina Street, North Bay, Ontario.

The deposits are of particular interest because they occur in metamorphic rocks, and not in pegmatite bodies, and are potential, large tonnage sources of columbium mineral concentrates. In the deposits, the columbium and at least some of the uranium are contained in uranian pyrochlore[1].

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[1]In this report, the terminology followed by Palache, Berman, and Frondel (1944, p. 43)[2] is used, and the mineral is called uranian pyrochlore rather than ellsworthite, hatchettolite, or uran-pyrochlor.

[2]Dates in parentheses are those of references in Bibliography at end of this report.

Columbium is in demand as a component of high-temperature and non-creep steels, and the present source is deposits in granitic pegmatites and deposits resulting from the weathering of granitic pegmatites. These types of deposits are small and they do not supply sufficient columbium to meet current industrial demands; consequently, there has been an intensive search for nonpegmatitic deposits. It is hoped that the deposits on the Beaucage property will produce columbium concentrates, and that the knowledge gained through this study will lead to the discovery of similar occurrences.

The property is in the exploration stage of development. Diamond drilling is proceeding to outline the extent of known deposits and to search for new deposits, and concentration tests are being conducted by several agencies, including the Mines Branch, Ottawa.

The Newman deposit was selected for special study because more information concerning it was available, and because it is apparently the largest of the three known deposits. Most of the information is obtained from diamond drill-core because the deposit is almost entirely under the lake. Core from six representative diamond drill-holes[1] was examined by the writer from May 5-26, 1953,

[1]The six representative diamond drill-holes were kindly selected by Mr. T. M. Kerr, Inspiration Mining and Development Company Limited.

and seventy-nine specimens were collected from the core for laboratory study. This report describes the minerals and rocks of the Newman deposit.

ACKNOWLEDGMENTS

The writer thanks Beaucage Mines Limited, and Inspiration Mining and Development Company Limited, 170 Regina Street, North Bay, Ontario, for generously making available information concerning the property. The latter company is in charge of the exploration program. In particular, the writer is greatly indebted to Mr. Karl Graber, general manager, Messrs. T. M. Kerr and R. D. Devlin, mining engineers, and Mr. O. E. Owens, geologist, Inspiration Mining and Development Company Limited. The writer also thanks Mr. James J. Kenmey, North Bay, for information. Dr. K. R. Dawson of the Geological Survey kindly stained the potash feldspar in eight thin sections. Capable field assistance was given by Mr. Harold Rasian.

LOCATION

The Beaucage property consists of 8,000 acres, of which 328.6 acres are occupied by a group of five islands known as the Manitou Islands and the remainder by water of Lake Nipissing (See Figure 1). Great Manitou Island is the largest of the group and the others are named Little Manitou, Calder, Newman, and Rankin Islands. These islands are about 5 miles west of the city of North Bay, Ontario.

HISTORY

In August 1952, Mr. James Strohl, Tunkhannock, Pennsylvania, using a geiger counter, discovered that certain outcrops on the Manitou Islands are radioactive. The outcrops were examined by Mr. Martin Van Clieaf, North Bay, who was associated with Mr. James J. Kenmey, also of North Bay. A specimen was sent to the Mines Branch, Ottawa, for uranium analysis, and was found to contain 0.11 per cent uranium oxide equivalent. Dr. J. E. Thompson, Ontario Department of Mines, examined radioactive outcrops on the islands and collected eight specimens that assayed from 0.01 to 0.12 per cent uranium oxide equivalent.

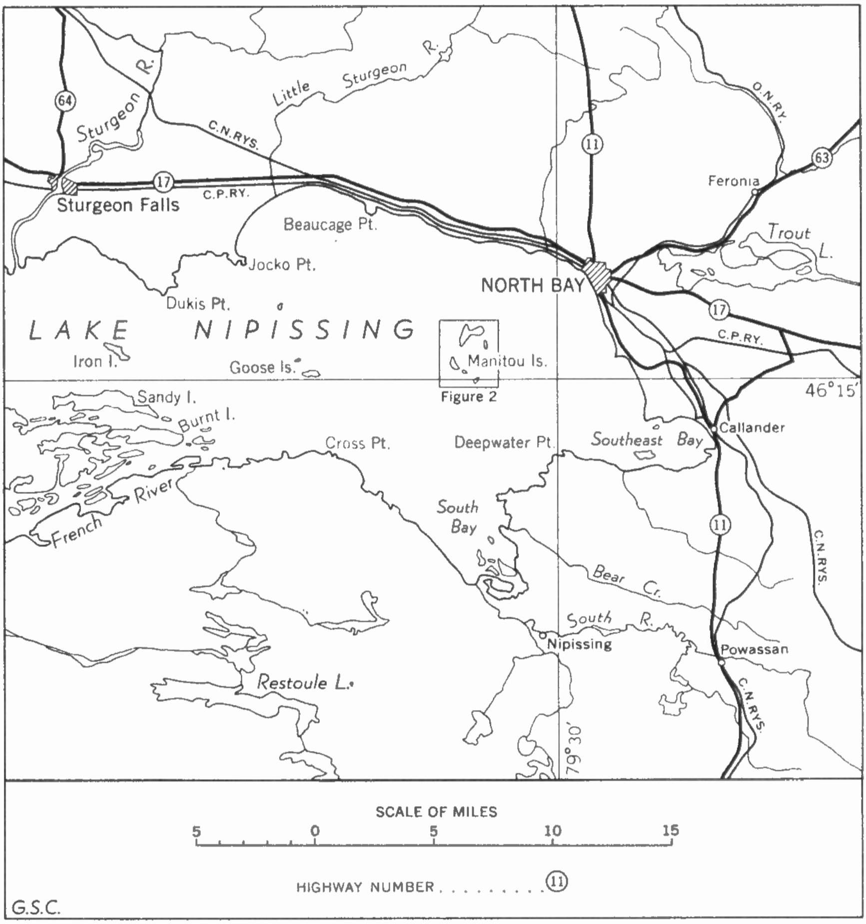

Figure 1. Index map, showing location of Manitou Islands, Lake Nipissing.

X-ray diffraction studies in the laboratories of the Geological Survey showed that a rock specimen from the Manitou Islands contained a member of the pyrochlore-microlite mineral series, and, on December 26, the mineral was reported as ellsworthite, a uraniferous, high-columbium member of the series. Further work on a specimen submitted by Mr. Kenmey confirmed the presence of uraninite or pitchblende. Mr. Kenmey then sent a sample to Union Carbide and Carbon Company, Niagara Falls, New York, to be analysed, and the analysis showed 0.08 per cent uranium oxide and 1.00 per cent columbium-tantalum oxides.

On February 17, 1953, Beaucage Mines Limited was formed to take over the Manitou Islands property held by Messrs. Kenmey and Van Clieaf. Inspiration Mining and Development Company Limited is a shareholder in Beaucage Mines Limited.

WORK DONE

Diamond drilling was commenced during the winter of 1952-53 to trace the eastward extension of the radioactive rock found on the east shore of Newman Island. By break-up, twenty diamond drill-holes had been put down totalling 7,793 feet. Most of the holes were drilled from the ice on the lake, and a zone of columbium- and uranium-bearing rocks was traced to a distance of about 1,100 feet east of Newman Island. During the spring, summer, and autumn months of 1953, diamond drilling was done on the islands. Nineteen diamond drill-holes were put down on Calder Island, forty-two on Great Manitou Island, nine on Newman Island, and one on Little Manitou Island.

A magnetometer survey made by Geo-Explorers Limited, Noranda, Quebec, in January 1953, outlined a magnetic anomaly lying immediately east of Newman Island, and extending for a distance of about 3,800 feet east of the island, and an airborne magnetometer survey of the entire property was undertaken by Aeromagnetic Surveys Limited, Toronto, Ontario, during August 1953.

Detailed scintillometer and geological surveys have also been conducted on the islands.

The exploration procedure has been to diamond drill in the vicinity of outcrops of radioactive rocks, and to test the drill-core with a geiger counter. Core above background in radioactivity is split, and samples are sent to various laboratories to be analysed for columbium and uranium oxides. Samples for concentration tests have been sent to the Mines Branch, Ottawa, and to other agencies.

GENERAL GEOLOGY

GENERAL STATEMENT

Barlow (1908, pp. 215-216) noted that the Manitou Islands are underlain by Precambrian rocks consisting chiefly of altered hornblende-granite gneiss, crystalline limestone, dykes of basic rocks, and small outliers of the Birds Eye and Black River formations of Ordovician age. The basic dyke rocks were of particular interest to Barlow, and he described one as follows (pp. 113-115): "The rock doubtless belongs to the group which includes the alnoites, monchiquites, and fourchites but it is now so decomposed that its exact position cannot be determined". He concluded that the crystalline limestone represents: "portions of the clastic Grenville series".

Owens (1953) has studied the outcrops and diamond drill-core, and describes the general geology as follows: "The rocks exposed on the islands and observed in drill cores are mainly gneisses, crystalline limestone and various intrusives: a complex assemblage typical of the Grenville province, but with local peculiarities, notably concentrations of sodium, phosphorus, fluorine, uranium, and columbium".

He assumes a circular-shaped band of acidic silicate, basic silicate, and carbonate rocks that is apparently bounded on the outer margin by quartz-feldspar gneiss, and on the inner west margin principally by diorite (See Figure 2). The Newman, Calder, and Great Manitou deposits occur in the rocks of the circular band.

The information in the sections on lithology and structural geology is from an unpublished report by Owens (1953).

LITHOLOGY

The quartz-feldspar gneiss consists of 5 to 20 per cent quartz, 60 per cent pink feldspar, and 20 per cent ferromagnesian minerals that are altered in places to biotite or epidote. Although this rock is generally medium grained, Owens has noted coarse-grained segregations and narrow pegmatite veins near the contact with the rocks of the circular band. Both concordant and discordant chlorite-epidote veinlets up to 1/2 inch in width also occur near the contact. Owens regards this gneiss as the oldest rock occurring on the Manitou Islands.

The acidic silicate rocks of the band are divided into two types by Owens: acidic silicate rock with grey feldspar; and acidic silicate rock with red feldspar. These rocks consist of about 70 to 90 per cent feldspar, 5 to 25 per cent acmite, and lesser amounts of calcite, hematite, magnetite, apatite, and pyrite, and contain uranian pyrochlore in places. The texture is irregular and the feldspars are clouded. Owens notes that the intensity of the red coloration of the feldspars is greatest where the rock is pyrochlore-bearing.

The basic silicate rocks of the circular band are those that contain 50 per cent or more dark silicate minerals. Owens has divided this group into five types: those rocks with biotite as the dominant mineral; those with dark silicate minerals and calcite as the dominant minerals; those with dark silicate minerals and feldspar as the dominant minerals; those with dark silicate minerals and apatite as the dominant minerals; and basic dyke rocks. These rocks contain pyrite, hematite, magnetite, and uranian pyrochlore in places.

Owens recognizes four types of carbonate rocks: laminated, grey carbonate rock; white carbonate rock; white carbonate rock with porphyroblasts of dark minerals; and carbonate dykes. The white, porphyroblastic carbonate rock consists of white calcite, acmite (altered in places), apatite, pyrite, magnetite, and hematite. This rock contains columbium and uranium in places.

The diorite has been intersected by diamond drill-holes collared on Great Manitou, Little Manitou, and Newman Islands. Owens describes the diorite as a homogeneous rock consisting generally of about 60 per cent grey feldspar and 40 per cent dark minerals with minor amounts of pyrite, magnetite, and calcite. This rock has not been examined under the microscope and "diorite" is used as a field name. Owens notes that the diorite north of Newman Island contains reddened feldspar and altered dark silicate minerals.

Diabase bodies, generally concordant, are found on Great Manitou Island, and sheared and altered lamprophyre dykes, from 1 foot to 10 feet in width, occur in many places.

Weathered Precambrian rocks have been encountered in places to a depth of 790 feet.

Ordovician conglomerate and limestone unconformably overlie the Precambrian rocks.

STRUCTURAL GEOLOGY

The acidic silicate rocks, the basic silicate rocks, and the carbonate rocks are conformable and form a circular-shaped band of rocks that is bounded on the outer margin by quartz-feldspar gneiss, and on the inner west margin by diorite.

Owens notes that the rocks of the circular band generally dip outward from the centre of the Manitou group of islands at an angle of about 70 degrees. Folding within the band has been noted on Calder and Great Manitou Islands (See Figure 2). Owens believes that the deposit on Great Manitou Island follows the axial plane of an isoclinal syncline.

Except for a few radioactive outcrops on the east shore of Newman Island, the Newman deposit lies under water, and the widely spaced diamond drill-holes do not reveal the structure in detail.

THE NEWMAN DEPOSIT

GENERAL STATEMENT

The Newman columbium-uranium deposit is one of three such deposits located on the Beaucage Mines property (See Figure 2). Information presented in this report concerning the Newman deposit was obtained from a study of the core of six representative diamond drill-holes, and a microscopic examination of seventy-nine thin sections made from specimens collected from this core.

In the deposit, the columbium and at least some of the uranium are contained in uranian pyrochlore, and uraninite or pitchblende was detected in a sample submitted to the Radioactive Resources Division of the Geological Survey. The uranian pyrochlore occurs as disseminated, euhedral to subhedral crystals ranging from less than 0.008 to 3.54 mm. in diameter.

The Newman deposit appears to be a block of rocks that is uranian-pyrochlore-bearing in places. It has been traced eastward from the east shore of Newman Island for a distance of about 1,100 feet by shallow diamond drill-holes (See Figure 2). Further work is necessary before the entire dimensions of the deposit will be known. Because the diamond drill-holes are widely spaced, the structural details of the deposit and the mineralized shoots are not known.

The rocks within the deposit consist chiefly of varying amounts of acmite, potash feldspar, and calcite. Those that contain uranian pyrochlore are distinguished by a relatively coarse texture, a massive appearance, by the presence of hydrous alteration products, and by the presence of one or more of pyrite, reddened potash feldspar, and apatite. The uranian pyrochlore-bearing rocks are divided by the writer into three principal types: acmite-potash feldspar-uranian pyrochlore rock; potash feldspar-acmite-uranian pyrochlore rock; and acmite-calcite-uranian pyrochlore rock. These rocks have both sharp and gradational contacts and probably occur as lenses. In places, the acmite-calcite-uranian pyrochlore rock contains important amounts of one or more of magnetite, biotite, and apatite. In general, acmite-rich rocks are the most favourable host rocks for uranian pyrochlore mineralization. Potash feldspar-acmite gneiss, carbonate rock, and trap dyke rocks are not known to carry uranian pyrochlore. The gneiss, which is the most abundant non-pyrochlore-bearing rock, shows post-crystalline deformation in many places, whereas the pyrochlore-bearing rocks show no evidence of such deformation.

Fault zones, marked by various hydrous iron oxides, brecciation, and gouge, were noted in the diamond drill-core.

MINERALOGY

General Statement

Minerals of the uranian pyrochlore-bearing rocks of the Newman deposit include: acmite, calcite, potash feldspar, apatite, biotite, chlorite, fluorite, hematite, magnetite, various other iron oxides, monazite, plagioclase, pyrite, sericite, soda-hornblende (probably arfvedsonite), and uranian pyrochlore. These minerals were identified using optical properties as described by Winchell and Winchell (1951). In addition, X-ray diffraction powder patterns were made of acmite and uranian pyrochlore, and the potash feldspar in eight thin sections was stained using the sodium cobaltinitrite method (Chayes, 1952). Calcite was identified by means of its ready solubility in cold, dilute acid. The presence of uraninite or pitchblende in a specimen of rock from this deposit was detected in the laboratories of the Radioactive Resources Division of the Geological Survey. A small amount of pyrrhotite was identified in specimens examined by Stevenson (1953). The rare minerals acmite and uranian pyrochlore are described in detail.

Acmite

The pyroxene acmite ($NaFeSi_2O_6$) is an essential mineral in all of the uranian pyrochlore-bearing rocks and in the most abundant non-pyrochlore-bearing rock encountered in the diamond drill-core examined by the writer. It occurs as single, euhedral to subhedral crystals, as aggregates and bands of short, prismatic crystals, and as aggregates of radiating, slender, prismatic crystals (See Figures 4, 6, 7, 10, and 11). The acmite is green and varies from very fine to coarse in texture[1]: in general, in pyrochlore-

[1]The following size classification is used in this report:

	Millimetres
Very fine grained	-0.25
Fine grained	0.25-1.0
Medium grained	1.0 -5.0
Coarse grained	+5

bearing rocks it is medium to coarse grained. In thin sections, the acmite is strongly pleochroic in shades of yellow and green, the elongation is negative, and the maximum extinction angle of z∧c measured is -109.5 degrees. The optical determination was confirmed by X-ray diffraction powder patterns. Acmite occurring in the uranian pyrochlore-bearing rocks is replaced in places by the following: ragged aggregates of minerals, including a fibrous mineral (probably an amphibole), calcite, and opaque minerals (See Figures 5 and 9); soda-hornblende (probably arfvedsonite) (See Figure 9); biotite (See Figure 10); and chlorite. The soda-hornblende is strongly pleochroic in shades of yellow, slate grey, and robin's egg blue, has a negative elongation, and a maximum extinction angle of x∧c of +43 degrees.

Uranian Pyrochlore

The columbium and at least some, if not all, of the uranium in the Newman deposit are contained in uranian pyrochlore. An X-ray fluorescence analysis made in the laboratories of the Radioactive Resources Division of the Geological Survey of uranian pyrochlore from this deposit gave 7.3 per cent U_3O_8. A complete chemical analysis has not been made; however, three analyses of uranian pyrochlore from elsewhere (Palache, Berman, and Frondel, 1944, pp. 750-751) show the following compositional ranges:

		Per cent
Na_2O	....	..... to 1.37
K_2O	....	..... to trace
CaO	....	8.87 to 13.62
MnO	....	..... to 0.51
FeO	....	..... to 2.19
MgO	....	..... to 0.36
Y_2O_3) Er_2O_3) Ce_2O_3)	....	..... to 0.62
Di_2O_3) La_2O_3)	....	..... to 0.12

		Per cent
UO_2	....	..... to 11.40
UO_3	....	4.41 to 15.50
ZrO_2	....	..... to 4.12
SnO_2	....	..... to 1.44
ThO_2	....	..... to 0.52
SiO_2	....	..... to 2.68
Fe_2O_3	....	..... to 3.80
TiO_2	....	1.61 to 11.37
Cb_2O_5	....	31.33 to 34.27
Ta_2O_5	....	4.27 to 29.83
F	....	..... to 0.49
H_2O	....	4.29 to 11.42
Rem.	....	..... to 0.54

The uranian pyrochlore seen by the writer occurs as disseminated, subhedral to euhedral crystals, ranging from less than 0.008 to 3.54 mm. in maximum dimension, and aggregates of crystals (See Figures 3, 4, 5, 7, 9, 10, and 11). Uranian pyrochlore is chocolate-brown and generally resinous to submetallic in lustre. Under the microscope it is found that the crystals may be composed of light- and dark-coloured varieties of uranian pyrochlore or entirely of the light variety (See Figures 3A, 3B, 4, 5, 6, 7, 9, 10, and 11). The light variety ranges from almost colourless to brown, whereas the dark variety is dark brown to opaque and submetallic in lustre. The two varieties produce identical X-ray diffraction powder patterns. Uranian pyrochlore is isometric and many of the crystals are six-sided. Some of the uranian pyrochlore crystals are zoned, and in places the occurrence of the dark variety follows the zonal structure (See Figures 3A, 4, 5, and 6). In other crystals, the dark variety apparently is associated with fractures (See Figure 3B). In one thin section, uranian pyrochlore crystals were found that are replaced in part by aggregates of a very fine-grained, green, chlorite-like mineral: the resultant aggregates are surrounded by orange-red hematite (See Figure 3C). Uranian pyrochlore crystals in biotite have pleochroic haloes, and crystals in apatite are commonly much embayed, suggesting replacement by the apatite (See Figures 3B and 11).

DESCRIPTION OF URANIAN PYROCHLORE-BEARING ROCKS

Acmite-Potash Feldspar-Uranian Pyrochlore Rock

Megascopic Description

Acmite, feldspar, calcite, biotite, pyrite, and uranian pyrochlore can be identified in hand specimens of this rock, which is dark in colour, generally equigranular, and medium grained. The acmite is dark green, forms subhedral to euhedral crystals up to

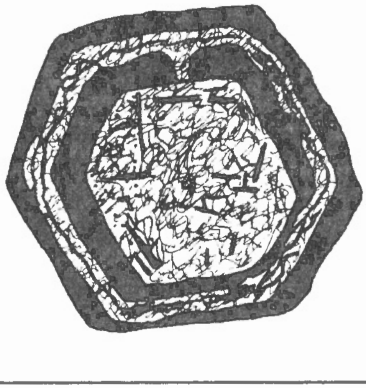

Figure 3A. Camera-lucida drawing of uranian pyrochlore crystal showing zonal arrangement of light and dark varieties of uranian pyrochlore.

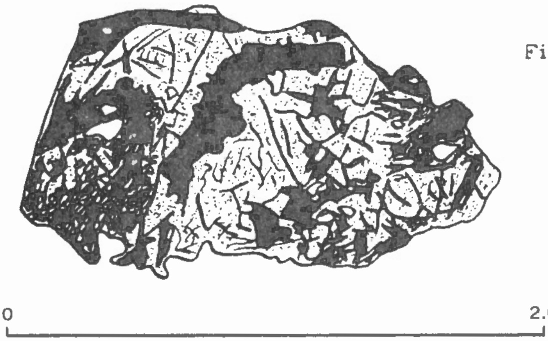

Figure 3B. Camera-lucida drawing of uranian pyrochlore crystal occurring in a matrix of apatite. Note distribution of light and dark varieties of uranian pyrochlore, and the embayment of the crystal.

Figure 3C. Camera-lucida drawing of aggregate composed of uranian pyrochlore (pecked pattern), very fine-grained crystals of a green chlorite-like mineral (white), and orange-red hematite (black).

Figure 3. Camera-lucida drawings of uranian pyrochlore crystals illustrating the distribution of the light and dark varieties of uranian pyrochlore, and relations to apatite and alteration products.

8 mm. in length, and commonly comprises 60 to 90 per cent of the rock. Reddened feldspar occurs as aggregates of anhedral crystals, and is present in amounts up to about 30 per cent. Calcite occurs in veinlets and as anhedral crystals interstitial to acmite and feldspar, and generally comprises less than 10 per cent of the rock. A few crystals of brown biotite occur in places. Disseminated, fine-grained pyrite generally comprises less than 5 per cent of the rock. Uranian pyrochlore is visible as disseminated crystals up to about 2.5 mm. in maximum dimension. These crystals vary in lustre from vitreous to resinous to submetallic.

Microscopic Description

Under the microscope, several additional features of this rock can be seen, and some of these are shown in Figures 4 and 5. In places, the acmite is partly or entirely replaced by soda-hornblende, or by a ragged aggregate of minerals composed of a fibrous material, probably amphibole, carbonate, and opaque minerals. The feldspar is principally potash feldspar that contains opaque, grey dust, probably a clay mineral, and orange-red dust, probably hematite. Perthite is present in one thin section, and a few very fine-grained plagioclase crystals were seen in other thin sections. Fine- to medium-grained calcite occurs interstitial to acmite and potash feldspar, and very fine-grained carbonate is found as an alteration product of acmite, and in minute veinlets. Biotite is present in some thin sections as small, shred-like grains and ragged, poikiloblastic crystals up to 0.50 mm. in maximum dimension. Uranian pyrochlore crystals range from less than 0.008 to 1.75 mm. in maximum dimension, and occur singly or as aggregates of crystals in acmite, potash feldspar, and calcite. Minor constituents of the rock include apatite, black submetallic to metallic minerals, fluorite, monazite, and sericite. Grain counts[1] were made on three representative thin sections, and the sections were found to have the following average composition by volume:

[1] The counts were made along traverses 1 mm. apart and the stations were spaced about 1/3 mm. apart.

	Per cent
Acmite (including fibrous amphibole)	69.5
Feldspar (mostly potash feldspar)	15.0
Carbonate	5.9
Pyrite	2.7
Uranian pyrochlore	2.1
Opaque minerals, mostly various iron oxides	1.6
Soda-hornblende	1.4
Chlorite	0.7
Sericite	0.7
Biotite	0.4
Monazite, apatite, and fluorite	a few crystals

Figure 4. Camera-lucida drawing of acmite-potash feldspar-uranian pyrochlore rock, showing acmite (A), potash feldspar (F), calcite (C), uranian pyrochlore (P), and dark purple fluorite (Fl). Note light and dark varieties of uranian pyrochlore. Stippling represents hematite dust.

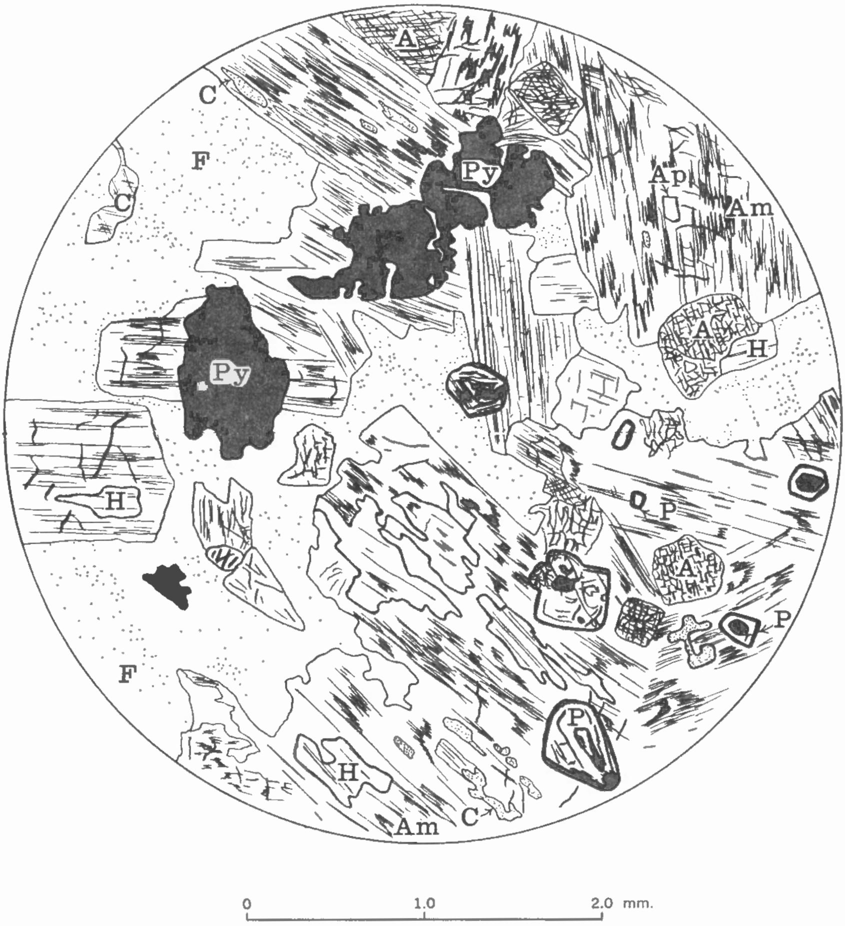

Figure 5. Camera-lucida drawing of acmite-potash feldspar-uranian pyrochlore rock, showing acmite (A), potash feldspar (F), uranian pyrochlore (P), soda-hornblende (H), calcite (C), fibrous amphibole (Am), pyrite (Py), and apatite (Ap). Stippling in the potash feldspar represents hematite dust.

Potash Feldspar-Acmite-Uranian Pyrochlore Rock

Megascopic Description

Reddened feldspar generally comprises more than 50 per cent of this rock, and other recognizable minerals include acmite, calcite, uranian pyrochlore, pyrite, and fluorite. The rock is medium to coarse grained, and varies from equigranular to markedly inequigranular. In the equigranular variety, the feldspar occurs as aggregates of interlocking crystals, whereas in the inequigranular variety it occurs as euhedral, lath-like crystals. The largest crystal of feldspar measured in the diamond drill-core is 3/10 inch in length. Green acmite occurs as aggregates of short, prismatic crystals, and as aggregates of radiating, slender, prismatic crystals. Calcite occurs as aggregates of anhedral crystals and in veinlets. Ragged aggregates and veinlets of pyrite, which constitutes generally less than 1 per cent of the rock, are found in places associated with pyroxene-rich patches. Clusters of crystals and single crystals of uranian pyrochlore are recognizable. Purple fluorite occurs as small aggregates of very fine-grained crystals and in veinlets, commonly with calcite. Although abundant in places, fluorite is a very minor constituent of the rock. Irregular patches of very fine-grained, black, metallic to submetallic minerals occur in places.

Microscopic Description

Thin section examination shows that the feldspar is principally potash feldspar that is clouded due to the presence of opaque, grey and orange-red dust. The orange-red dust occurs in irregular patches, along fractures, and along grain boundaries, and is probably hematite (See Figure 6). A few very fine- to fine-grained plagioclase crystals were seen in some thin sections, and these are relatively free from dust. Short, prismatic crystals of acmite are shown in Figure 6, and Figure 7 illustrates an aggregate of radiating, slender, acmite crystals. In places, the acmite is cloudy, or is partly replaced by aggregates of very fine-grained chlorite and biotite. Apatite crystals and aggregates of fluorite crystals are found in some of the calcite veinlets and patches of calcite. Most uranian pyrochlore crystals are pale brown, but some are colourless: a few zoned crystals contain dark brown to opaque varieties (See Figure 6). The richest thin section was found to contain 63.6 per cent pyrochlore by volume. Maximum diameters of uranian pyrochlore crystals vary from less than 0.025 to 0.65 mm. Grain counts made on three representative thin sections of this rock give the following average mineral composition by volume:

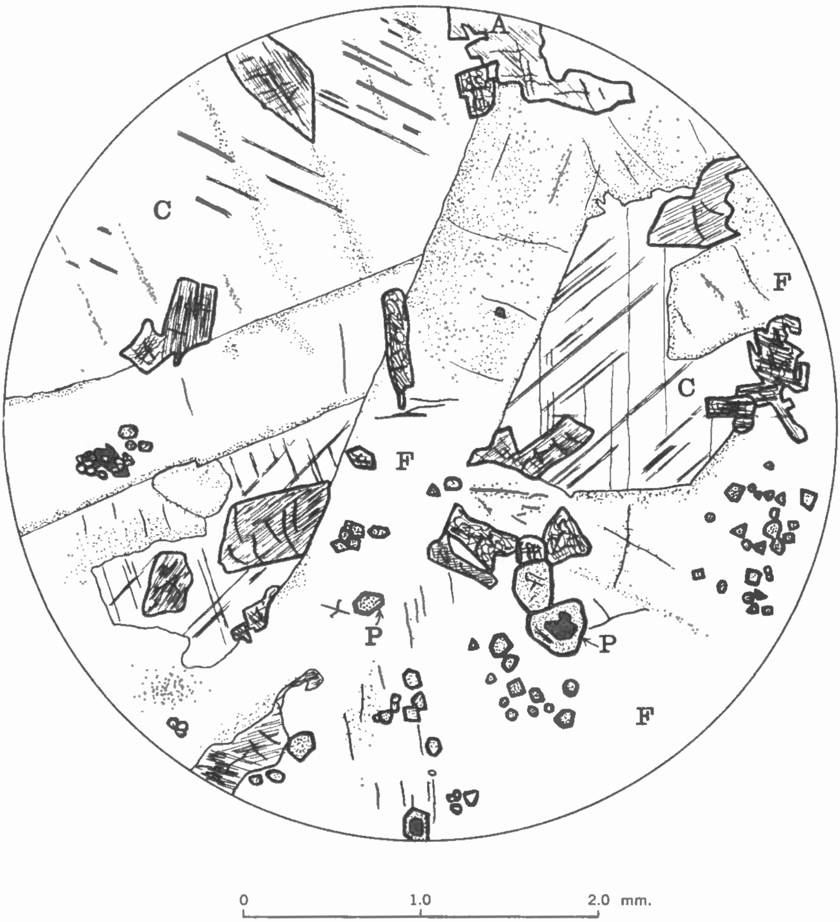

Figure 6. Camera-lucida drawing of potash feldspar-acmite-uranian pyrochlore rock, showing acmite (A), potash feldspar (F), calcite (C), and uranian pyrochlore (P). Stippling in the potash feldspar represents hematite dust.

Figure 7. Camera-lucida drawing of potash feldspar-acmite-uranian pyrochlore rock, showing acmite (A), potash feldspar (F), and uranian pyrochlore (P). Stippling in the potash feldspar represents hematite dust. Note aggregate of radiating, slender, acmite crystals.

	Per cent
Feldspar (mostly potash feldspar)	55.3
Acmite	27.6
Carbonate	7.5
Uranian pyrochlore	5.4
Opaque minerals, in part various iron oxides	2.8
Biotite	0.6
Chlorite	0.5
Fluorite	0.2
Monazite	0.1
Apatite	a few small crystals

Acmite-Calcite-Uranian Pyrochlore Rock

Megascopic Description

This rock is generally medium grained, and is composed chiefly of acmite and calcite. Foliation, consisting of very narrow, alternating bands of acmite and calcite, is present in places. The acmite is green, and generally occurs as subhedral to euhedral, medium-grained crystals and aggregates of crystals in a groundmass consisting principally of white, medium-grained calcite. Chocolate-brown, resinous to submetallic uranian pyrochlore occurs as crystals up to 3.5 mm. in maximum dimension, and as aggregates of crystals. Dark brown biotite is present in places as shred-like grains and coarse- to medium-grained porphyroblasts, and comprises up to about 50 per cent of the rock. Apatite occurs in places as dark grey to pale green aggregates of very fine-grained crystals. The contacts between apatite aggregates and the other minerals indicate that apatite has formed by replacement of pre-existing minerals, especially calcite (See Figure 8). Anhedral crystals and aggregates of crystals of reddened feldspar occur in places, but these generally comprise less than 10 per cent of the rock. Disseminated pyrite commonly forms up to 10 per cent of the rock, and magnetite from 0 to 50 per cent or more. Small aggregates of very fine-grained purple fluorite are present in places. Where biotite or magnetite are abundant, the uranian pyrochlore is masked and is difficult to identify.

Microscopic Description

As in the other uranian pyrochlore-bearing rock types, acmite is replaced in places by soda-hornblende, biotite, chlorite, and an aggregate consisting of a fibrous mineral (probably amphibole), very fine-grained calcite, and opaque minerals (See Figure 9). Biotite has formed chiefly at the expense of acmite, and generally occurs as medium- to coarse-grained porphyroblasts, but very fine-grained aggregates are also found. In one thin section the texture

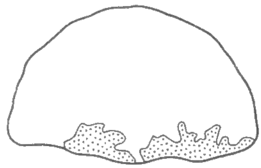

Figure 8. Sketch of specimen of diamond drill-core showing aggregates of very fine-grained apatite crystals (pecked pattern) in acmite-calcite-uranian pyrochlore rock.
Natural size.

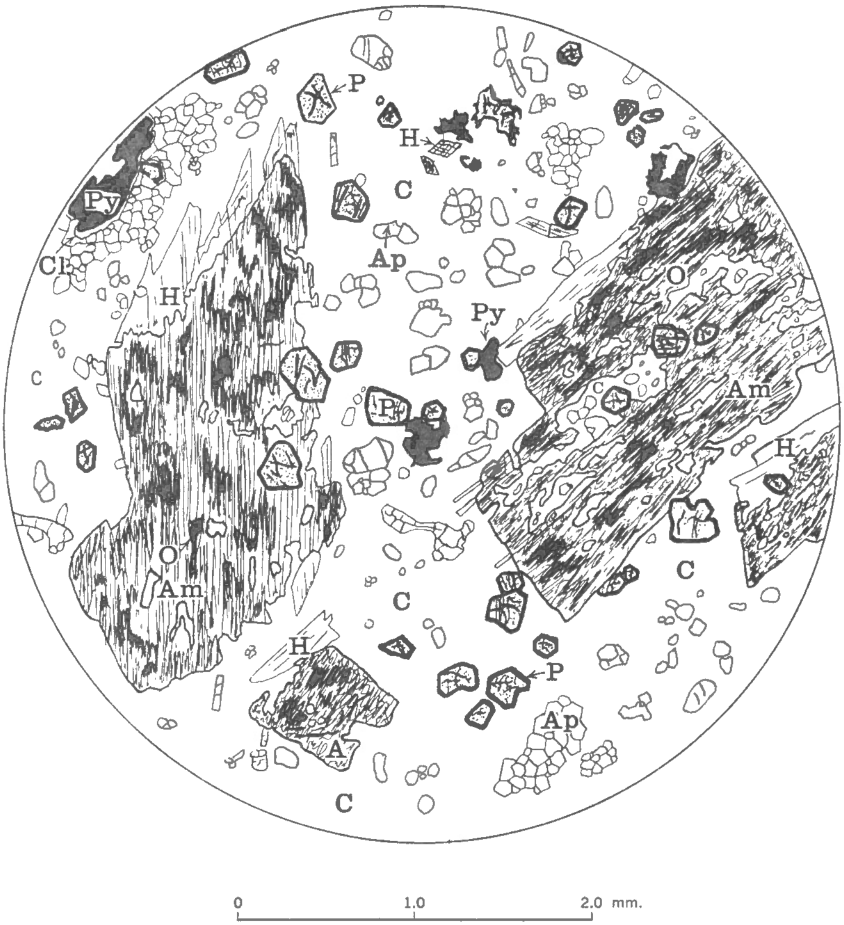

Figure 9. Camera-lucida drawing of acmite-calcite-uranian pyrochlore rock, showing acmite (A), calcite (C), uranian pyrochlore (P), fibrous amphibole (Am), opaque material (O), apatite (Ap), soda-hornblende (H), pyrite (Py), and chlorite (Cl).

indicates the partial replacement of a uranian pyrochlore crystal by a biotite crystal. In places, the biotite porphyroblasts are replaced along the edges by fine-grained chlorite, and some of the biotite aggregates have been completely replaced by chlorite. A direct association of biotite and uranian pyrochlore was seen in one thin section: here the pyrochlore crystals occur in or near the biotite porphyroblasts (See Figure 10). The potash feldspar is much reddened by hematite dust. Apatite occurs in places as very fine-grained crystals and aggregates of crystals, and appears to have replaced calcite, acmite, feldspar, biotite, and uranian pyrochlore (See Figure 11). In places, magnetite and pyrite are altered to hematite and orange-red iron oxides. A few small aggregates of very fine-grained purple fluorite occur in calcite, and a few crystals of monazite were seen. Both the light and the dark varieties of uranian pyrochlore occur, and crystals range in size from less than 0.025 to 3.45 mm. in maximum dimension. Figure 11 illustrates corroded uranian pyrochlore in apatite-rich rock. Acmite-calcite-uranian pyrochlore rock can be divided into several sub-types depending upon the varietal mineral constituents. Grain counts were made on several thin sections that are representative of the various sub-types, and the average composition by volume was calculated as follows:

	Per cent
Acmite (including fibrous alteration product)	39.3
Calcite	23.5
Apatite	13.7
Pyrite	6.2
Biotite	5.5
Uranian pyrochlore	3.8
Soda-hornblende	3.5
Feldspar (mostly potash feldspar)	1.9
Opaque minerals, mostly magnetite and various other iron oxides	1.8
Chlorite	0.4
Monazite	0.3
Fluorite	0.1

DESCRIPTION OF OTHER ROCKS

Potash Feldspar-Acmite Gneiss

Megascopic Description

In general, the rock is very fine to fine grained and equigranular. Green acmite crystals generally constitute less than 20 per cent of the rock, and occur in parallel bands and lenses that are generally about 1 mm. in width. The potash feldspar varies in

Figure 10. Camera-lucida drawing of acmite-calcite-uranian pyrochlore rock, showing acmite (A), calcite (C), uranian pyrochlore (P), and biotite (B). Note association of uranian pyrochlore crystals with porphyroblast of biotite.

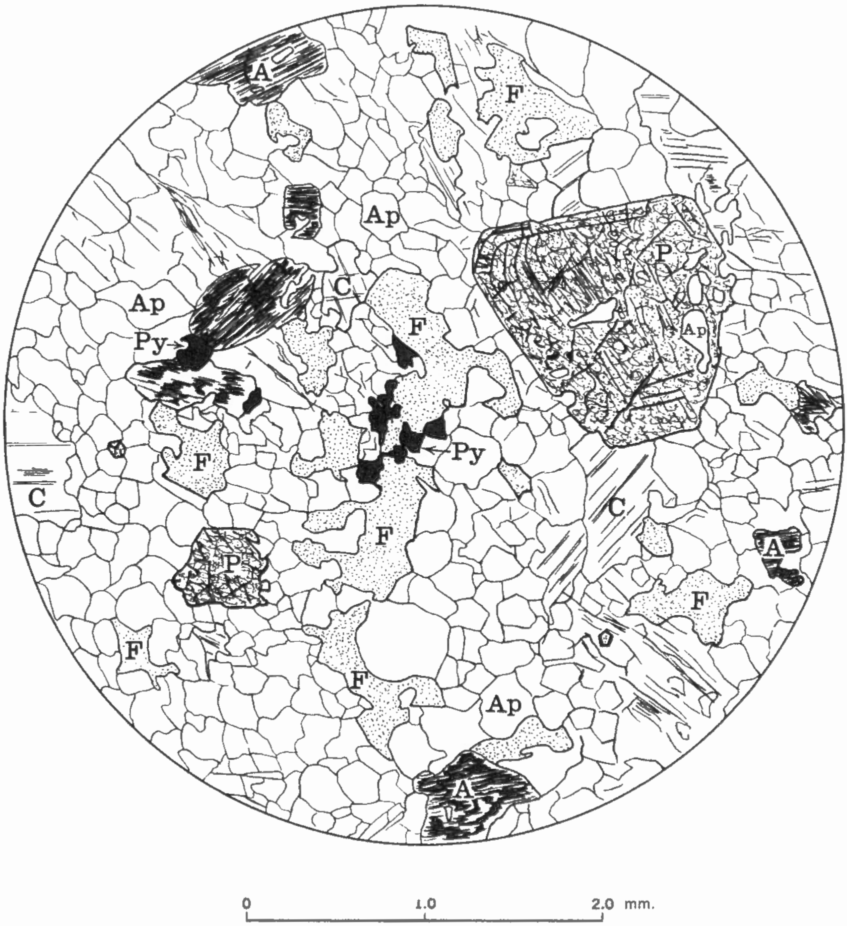

Figure 11. Camera-lucida drawing of apatite-rich phase of acmite-calcite-uranian pyrochlore rock, showing acmite (A), apatite (Ap), calcite (C), potash feldspar (F), uranian pyrochlore (P), and pyrite (Py).

colour from white to pale pink. Very fine-grained carbonate can be detected by means of dilute acid. Veinlets containing calcite with or without red iron oxide, apatite, fluorite, quartz, and pyrite are found in places and range up to 5 inches in width, but most are less than 3/4 inch.

Microscopic Description

Microscopic study emphasizes the textural and mineralogical differences between this rock and the potash feldspar-acmite-uranian pyrochlore rock. The potash feldspar crystals are generally less than 1 mm. in maximum dimension, and carry a dusty material that is light grey in reflected light. In places, the potash feldspar contains small amounts of orange-red dust. In several thin sections, mutual boundaries between feldspar crystals are sutured. The acmite crystals generally range from less than 0.05 to 0.50 mm. in maximum dimension, and in places are altered to biotite and chlorite. Soda-hornblende is absent. In places, the acmite bands are bent and displaced by microfaults. Minute fractures are present in many of the thin sections, and some of these carry vein carbonate and quartz. A few very fine-grained crystals of purple fluorite and apatite were seen.

Carbonate Rock

Megascopic Description

Sections of very fine-grained to coarse-grained carbonate rock, ranging from a few inches to 21 feet, occur in places in the diamond drill-core. The rock is white to grey, and in places contains grains of dark-coloured minerals.

Microscopic Description

Two thin sections of carbonate rock were examined. One section is composed of parallel, elongate grains of calcite with some shred-like green biotite, pale purple fluorite, magnetite, pyrite, and orange-red iron oxide. The other thin section consists chiefly of calcite containing dusty material that is grey in reflected light, and lesser amounts of biotite, apatite, magnetite, hematite, and orange-red iron oxide.

Trap Dyke Rocks

Megascopic Description

Dark-coloured, very fine-grained dykes occur in the diamond drill-core examined by the writer, and outcrop in places on the islands. These dykes range from a few inches to a few feet in width. In places, several of these dykes contain spots of hematite, and a few phenocrysts of feldspar were seen. The dykes apparently do not contain uranian pyrochlore, and disseminated pyrite was found in only one of those encountered in the drill-core.

Microscopic Description

Three thin sections of dyke rock were studied by the writer. The rock consists chiefly of very fine-grained feldspar laths, carbonate, chlorite, and sericite. Phenocrysts of altered feldspar, hematite-rich patches, and aggregates of very fine-grained biotite were observed in places.

ORIGIN

A precise theory of the origin of the Newman columbium-uranium deposit cannot be formulated at present because the detailed geology of the deposit is not known. Two features of the deposit are apparent; the host rocks are alkalic rocks; and the uranian pyrochlore is closely associated with secondary minerals that were formed by processes involving the introduction of water, sulphur, iron, phosphorus, and fluorine, and possibly other materials. Pyrochlore occurs in alkalic rocks at many localities (Palache, Berman, and Frondel, 1944, p. 752), and this association is probably genetic.

It is probable that the host rocks of the Newman deposit, in part at least, were originally Grenville-type sedimentary rocks. Carbonate rocks, ranging from finely laminated to those with porphyroblasts of acmite and biotite, have been found on several of the islands and in diamond drill-core.

The mineralized shoots within the Newman deposit may have formed by recrystallization in conjunction with the introduction of material. In support of this, the writer has observed that uranian pyrochlore-bearing rocks are generally medium grained and show no sign of post-crystalline deformation, whereas acmite-potash feldspar gneiss, the principal wall-rock, is fine grained and shows evidence of such deformation.

RECOMMENDATIONS FOR PROSPECTING

Although the columbium-uranium deposits were discovered by means of a geiger counter, it is possible that deposits of non-radioactive columbium minerals and columbium-bearing minerals occur elsewhere in Canada under similar geological conditions. In prospecting for such deposits and deposits of the Newman type, the association of columbium with alkalic rocks is important. Attention should be paid to the accessory minerals of alkalic rocks of metamorphic, intrusive, or volcanic origin because these accessory minerals may be columbium minerals or certain titanium and zirconium minerals that contain appreciable amounts of columbium (Fleischer, Murata, Fletcher, and Narten, 1952). Zones of contact metasomatism about alkalic intrusive rocks also merit attention, particularly if these zones contain carbonate-rich rocks. Contact metasomatism associated with intrusive rocks in the Grenville subprovince may be recognized in some cases by the presence of such minerals as garnet, wollastonite, scapolite, titanite, spinel, feldspar, pyroxene, amphibole, quartz, pyrite, pyrrhotite, chalcopyrite, molybdenite, and magnetite (Engel and Engel, 1953, pp. 1021-25).

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