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Columbium (Niobium) Deposits of Ontario

By

STEWART A. FERGUSON

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MAP
(in back pocket)

Aeromagnetic maps of carbonatite-alkalic complexes in Ontario; Ontario Dept. Mines and Northern Affairs, Prel. Map P.452 (revised).

Figure 1

ONTARIO

DISTRICTS AND COUNTIES

COLUMBIUM (NIOBIUM) DEPOSITS OF ONTARIO

By

Stewart A. Ferguson[1]

INTRODUCTION

The story of the discovery and choice of a name for this metal is given in the Rare Metals Handbook, second edition and also by Barton (1962, p.14). Element 41 was discovered in 1801 by Charles Hatchett, an English chemist, who analyzed an ore sample sent to the British Museum from what is now Connecticut, United States of America. He named the metal columbium after Columbia, the synonym for America, and the columbium ore he called columbite. The element was rediscovered by Heinrich Rose a German chemist in 1844 and he called the metal niobium after Niobe, daughter of Tantalus. In 1866 Jean Charles Marignac a Swiss chemist determined that the metals described as columbium and niobium were the same element, and in 1950 the International Union of Pure and Applied Chemistry agreed to use niobium. However, dual nomenclature for the metal has persisted and mining and metallurgical engineers, mining companies and publications serving them have continued to use columbium.

The Ontario deposits where columbium is the principal metal are briefly described in this circular. The deposits are arranged alphabetically by district or county. Within these geographical areas they are arranged by township or by latitude and longitude where no township exists. The latitude and longitude unit used is 15 minutes by 15 minutes and is defined by the latitude and longitude of the southeast corner. The deposits are classified as prospects or occurrences depending on their state of development. A brief description is given of the geology with emphasis on the economic features. The type of development work and the years that it was in progress and by whom it was performed is noted. Map, text, and file references list documents from which the information was obtained.

The sources of information used in this circular have come mainly from Ontario Department of Mines and Northern Affairs publications and assessment work files, and publications by the Geological Survey of Canada and the Mineral Resources Branch of the Department of Energy, Mines and Resources, Ottawa. Additional information has been obtained from the Canadian Mines Handbook, and the Survey of Mines published by the Financial Post, as well as a few other sources which are given where they occur.

Ontario Department of Mines and Northern Affairs Map P.452 (revised) issued in 1970 (back pocket) shows the aeromagnetic maps of carbonatite-alkalic complexes in Ontario and their locations.

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[1]Chief, Data Retrieval and Education Section, Geological Branch. Manuscript approved for publication by The Director, Geological Branch, 10 September 1971.

Acknowledgments

Dr. J.E. Thomson, Director, Geological Branch suggested this compilation. Dr. J. Satterly, Senior Geologist, Ontario Department of Mines and Northern Affairs provided copies of his files on Carbonatite-Alkalic Complexes of Ontario and also a copy of his report "Some Radioactive Mineral Occurrences in the Counties or Districts of Frontenac, Haliburton, Hastings, Manitoulin, Nipissing, Parry Sound, Peterborough and Renfrew" (1954-1957) which since that time has been released as Open File Report 5057. Also he has suggested other sources of information and generally been most helpful. G.E. Parsons, Consulting Geologist, has given information and advice on certain properties with which he is familiar. Fred E. Hall of Argor Explorations Limited kindly supplied an unpublished report on the Alpha-B Columbium Deposit, James Bay Lowlands, northeastern Ontario.

COLUMBIUM

General History

The following account of the history and development of uses is taken from Metals Week, April 24, 1967 and from other sources:

1801: Metal identified.

1907: Columbium metal first produced by Werner von Bolton, a Polish chemist working in Germany.

1918: Experimental batch of ferrocolumbium made.

1929: Columbium rod and sheet metal produced by Fansteel Metallurgical Corporation and exhibited before the American Chemical Society.

1933: The research staff of the Electro Metallurgical Company found that columbium added to chromium stainless steel kept the steel ductile without loss of corrosion resistance and resistance to oxidation at elevated temperatures. Also the addition of columbium to steels of 18 percent chromium and 8 percent nickel type prevented intergranular corrosion at high temperatures as well as a chemical corrosion. Columbium was added in alloy form which resulted in the Electro Metallurgical Company, Niagara Falls, New York producing ferrocolumbium which is a major use of the metal. Until this development producers of tantalum ores containing columbium were not paid for the columbium content.

1935: From this date European steelmakers began to replace tantalum in stainless steels because it was found to be more effective, in greater supply and less expensive.

1940-1955: Columbium alloys were used for jet planes and gas turbines and the government of the United States stockpiled columbium ore and controlled the sale of ferrocolumbium and ferrotantalum-columbium.

1953: A process was developed for extracting columbium from pyrochlore and mining of pyrochlore ores began at Söve, Norway.

1959: The demand for columbium products increased as several new columbium base alloys were introduced during the year and exhibited such excellent characteristics that utilization in various research and development programs began immediately.

1960: In the United States domestic metal production increased 75 percent. Technological developments included Battelle Memorial Institute's process for hydrogen reduction of columbium pentachloride to produce metallic columbium and Naval Research Laboratories' method for protecting columbium from high temperature oxidation by coating it with zinc.

1961: Columbium and tantalum came to a parting of the ways in their historic geological relationship as a result of the introduction of pyrochlore as an ore of columbium. St. Lawrence Columbium and Metals Corporation began production from their property at Oka, Quebec.

1962: Pyrochlore from Canada was commercially accepted and St. Lawrence Columbium and Metals Corporation became a leading supplier of columbium concentrates.

1963: Pyrochlore now accounted for more than 50 percent of the columbium ores imported into the United States.

1966: Brazil became the leading country in production of pyrochlore concentrate.

1967-1970: There has been a sharp increase in the amount of columbium metal used and also a steadily expanding use of ferrocolumbium due to the qualities of the metal and an assured supply at a reasonable price.

Columbium Minerals

Most columbium minerals are classed as multiple oxides, that is they contain oxides of more than one metallic element. Unlike many other metals columbite forms no natural sulphide compounds and niocalite is the only important columbium silicate mineral. Many of these minerals are slightly to strongly radioactive.

Columbium minerals are difficult to study because they are chemically complex and generally are noncrystalline pseudomorphs of the original mineral. They are identified by X-ray powder photographs taken after heating and presumably the mineral has reverted to the original crystal structure.

Table 1. List showing the Columbium and Tantalum pentoxide content of some minerals.

Mineral	Cb_2O_5 percent	Ta_2O_5 percent
Columbite	47.22 - 78.88	Tr. - 28.50
Fergusonite	34.79 - 46.66	...
Samarskite	27.7 - 46.44	1.81 - 27.03
Pyrochlore	26.22 - 63.64	...
Ilmenorutile	21.73 - 32.15	Nil - 23.48
Niocalite	16.8 -	...
Eschynite-Priorite	15.08 - 36.68	Low or absent
Betafite	8.51 - 45.80	...
Euxenite-Polycrase	3.83 - 41.43	1.01 - 47.31
Niobium Perovskite	- 25.99	- 5.08

Metal Properties and Fabrication

The following information of metal properties and fabrication is from Stevens (1965, p.254, 256):

> "Columbium is a silver-gray, lustrous metal about as hard as copper. It is characterized by high melting point [2,468±10 degrees Centigrade or 4,474±18 degrees Fahrenheit], resistance to corrosion, and ease of fabrication. At elevated temperatures the metal is an excellent interstitial absorber of common gases, but the massive metal rapidly becomes coated with a non-volatile oxide which retards deeper penetration. It is a relatively good conductor of heat and electricity and an excellent thermionic emitter of electrons in vacuum tubes. It has about the same density as steel and a relatively low thermal-neutron-capture cross section of 1.1 barns.
>
> "Columbium fabrication and working are affected by several characteristics of the metal. Since the metal, when hot, readily absorbs gases that cause embrittlement, all forming, stamping, and drawing are done cold or in an inert atmosphere. The metal also seizes and tears easily so that caution must be used during machining. Columbium is comparable with mild steel in its ability to be drawn, stamped, or formed. Columbium work hardens at a much slower rate than most other metals, and reduction in thickness of 60 percent or more, without an intermediate anneal, is standard practice. Columbium

can be welded to a number of other metals by either resistance welding or inert-gas arc welding. For welding the metal to itself, however, arc welding is used exclusively. Oxygen and other common gases must be excluded from the weld zone. Because of its tendency to oxidize at elevated temperatures, columbium must be protected during arc welding with an inert atmosphere of helium or argon."

Ferrocolumbium and Ferrotantalum-Columbium

The following description of ferrocolumbium and the analyses of columbium-tantalum master alloys and the description of ferrotantalum-columbium is taken from Barton (1962, p.5-7):

"Specifications for ferrocolumbium, a silvery metal, vary, depending on the manufacturer and process used. Alloy made in an electric furnace contains 50 to 65 percent columbium and 5 or 6 percent tantalum (ranging from 10:1 to 13:1 in columbium-tantalum ratio). Silicon does not exceed 8.0 percent, and carbon is less than 0.4 percent.

"Aluminothermic alloy contains 58 to 63 percent columbium and 3 to 6 percent tantalum. Silicon does not exceed 1.5 percent and carbon is less than 0.15 percent. Aluminum may be as high as 1.5 percent.

"Special-grade ferrocolumbium, which is especially low in high neutron capture cross-section elements such as tantalum and boron, is made for steels to be used in reactors.

"Commercial stock sizes of ferrocolumbium are minus 2-inch, minus 1/2-inch, minus 1/4-inch, minus 8-mesh, and minus 20-mesh. Finer sizes down to minus 150-mesh can be obtained by special order.

"Eutectic alloys of iron and columbium (about 73 percent columbium) were produced experimentally in 1960 and were expected to increase in favor as a steel additive in place of regular ferrocolumbium. The special grade ferrocolumbium shown in table [2 of columbium-tantalum master alloys] approaches the eutectic composition.

"Ferrotantalum-columbium, a silvery metal, usually contains 40 to 45 percent columbium and 15 to 20 percent tantalum. It contains about 25 percent iron and not more than 0.3 percent carbon. It is available in the same stock sizes as ferrocolumbium.

Table 2. Typical Analyses of Some Columbium-Tantalum Master Alloys in Percent (from Barton 1962, p.7).

Alloy	Cb+Ta	Cb	Ta	C	Si	Al	Sn	Ti	Mn	Cr	Fe
Ferrocolumbium:											
Electric furnace	65.00	60.00	5.00	0.40	8.00	...	0.03	0.75	2.50	...	25.00
Aluminothermic	68.50	63.00	5.50	.10	.16	1.55	.16	.42	2.00	...	25.75
Special grade	70.60	65.60	5.00	.02	.98	0.29	.02	.20	2.18	...	28.00
Ferrotantalum-columbium:											
Electric furnace	60.00	45.00	15.00	.30	8.00	...	...	...	...	...	25.00
Aluminothermic	65.00	45.00	20.00	.40	.02	1.50	.60	.10	3.0	...	29.00
Chromcolumbium	60.00	55.00	5.00	.10	7.50	...	.10	.90	...	29.00	2.00
Ferrochromcolumbium	...	20-50	...	1.0	3-8	...	...	...	...	20-25	Balance
Tantalum-Columbium-Aluminum	40.59	27.76	12.83	...	.54	49.85	...	...	...	...	1.45

"..[United States] Stockpile Purchase Specification P-88-R1 requires a minimum of tantalum plus columbium of 45 percent; the columbium-tantalum ratio must be less than 8:1 but at least 3:1 by weight. Aluminum must not exceed 3.0 percent; silicon 3.0 percent; tin, 0.15 percent; titanium, 4.0 percent; sulfur, 0.03 percent; phosphorus, 0.03 percent; and carbon, 0.2 percent. Two sizes are accepted: Size I (minus 2-inch) and size II (minus 1/2-inch)."

Uses

The following excerpt is taken from Stevens (1965, p.256-257):

"Ferrocolumbium (50-70 percent columbium) or ferrotantalum-columbium (approximately 40 percent columbium and 20 percent tantalum) is added to some austenitic stainless steels. About 1 percent columbium and tantalum will act as a carbide stabilizer. Columbium also increases the strength and impact properties of low-carbon and low-alloy steel. It is also a useful constituent with aluminum in the nitriding of steels. Uses of columbium- or tantalum-bearing steel include aircraft engine exhaust systems, welded equipment for the chemical, oil and food industries, heavy construction equipment, and aircraft landing gear. Examples of columbium-bearing steels are type 347, 19-9WX, Croloy 15-15N, and GLX-W. Columbium-bearing electrodes are used for welding stabilized stainless steels.

"Columbium is added to special steels and nonferrous "superalloys" in quantities up to 5 percent for use at elevated temperatures. Examples of such alloys are S-816, Inconel-X, MST-821, and Gamma-Cb. New columbium-base alloys have recently been marketed, such as Du Pont 80-Cb, 10-Mo, 10-Ti, Fansteel 80 and 82, and General Electric F-48 and F-50. Jet engines, automotive gas turbines, research programs on nuclear- and rocket-powered aircraft, and missiles all use such alloys.

"British Standard aluminum casting alloy LM 7 specifies 0.05 to 0.30 percent of columbium and titanium. Columbium acts as a grain refiner in these alloys for use in cylinder blocks and crank cases.

"Columbium is sometimes used as a getter and electron emitter in electronic tubes. In addition to ability to absorb and hold the residual gases when heated, the metal offers a high melting point, ease of fabrication, and efficient thermionic electron emission. A new type of miniature electronic valve, the cryotron, consists of a tiny strip of tantalum around which a fine columbium wire is wrapped. The combination becomes superconductive in a bath of liquid helium at about -270° C. Such a component has a considerably lower power consumption than a thermionic valve, and a hundred such devices will fit into a thimble. They offer revolutionary possibilities for computer design and great improvement in radar devices.

"Columbium metal is used as a fuel-alloying element in the Experimental Boiling Water Reactor, Argonne, Ill., and as fuel cladding in the reactor at Dounreay, Scotland. Columbium, with a neutron-absorption cross section of 1.1 barns, also withstands the corrosive action of coolants and stabilizes the proportions of the fuel element. When used as a fuel-alloying element, columbium prevents violent reaction between the fuel and leaking coolant. Columbium 95 radioisotope is produced at Oak Ridge National Laboratory for use as a radioactive tracer.

"Columbium carbide can be used separately or blended with tungsten and tantalum carbides and cemented with cobalt metal. Such carbides are used in hot-forging dies, cutting tools, jet engine turbine blades, valves, valve seals, and valve guides, and for coating graphite rocket nozzles."

The use of columbium in industries in the United States was approximately: steel 78 percent; and nonferrous alloys 21 percent (Wigle 1971, p.195). The improved strength-to-weight ratio due to the use of columbium in steel gives weight savings in ship building and for oil and gas pipelines that are 20 percent lighter than conventional steels.

Possible Additional Uses

Columbium metal and nonferrous columbium base alloys have exceptional high-temperature properties which should find increasing use in nuclear power reactors, gas turbines, jet engines, and missile and aircraft structures. Columbium base alloys which resist both the elevated temperatures encountered during reentry and the low temperature of outer space are desirable materials for space vehicles.

At temperatures near absolute zero (minus 460 degrees Fahrenheit) certain metals suddenly lose all resistance to electric current and become perfect conductors (Fortune Magazine, November 1970, p.78-81, 131, 132 and 136). Superinconducting magnets could markedly raise the efficiency of generators, transformers and electric motors while greatly reducing their bulk and cost. The first electric motor using superconducting columbium-tin wire in a copper matrix was put into service in Great Britain in 1970. A large role for superconductive metals is believed to be in power transmission cables as a thin film of ultrapure columbium electroplated on copper carries alternating current with extremely low losses. Such superconductive metal installations with their cooling systems are close to being competitive with conventional methods for underground electrical conductors. Other superconductive metal associations are columbium-tantalum, columbium-titanium, columbium-tin and columbium-zirconium.

Magnets of superconducting columbium alloys are being used in attempts to control nuclear fusion reactions. The extremely high temperatures of fusion reactions exceed the melting points of all known materials and must be contained by a magnetic force. Superconducting columbium alloys produce a containing magnetic field without requiring the continued addition of electrical energy.

Prices of Metals and Alloys

The price of metals for a particular year are taken from the last issue of Metals Week for that year or the last issue of the year where a quotation is given. The price of columbium metal contained in ferrocolumbium has been fairly steady since 1934 to the present except for a period of higher prices in the period 1949 to 1959, and there has been a gradual increase in the price since 1966, as shown on the accompanying Figure 1.

Table 3. Prices, per pound, for Ferrocolumbium (Metals Week)

Date	Low-Alloy and Standard in ton lots U.S. dollars	High Purity in ton lots U.S. dollars
December 28, 1970	2.85 - 4.12	4.79 - 6.76
June 7, 1971	2.45 - 2.65	4.12 - 6.81

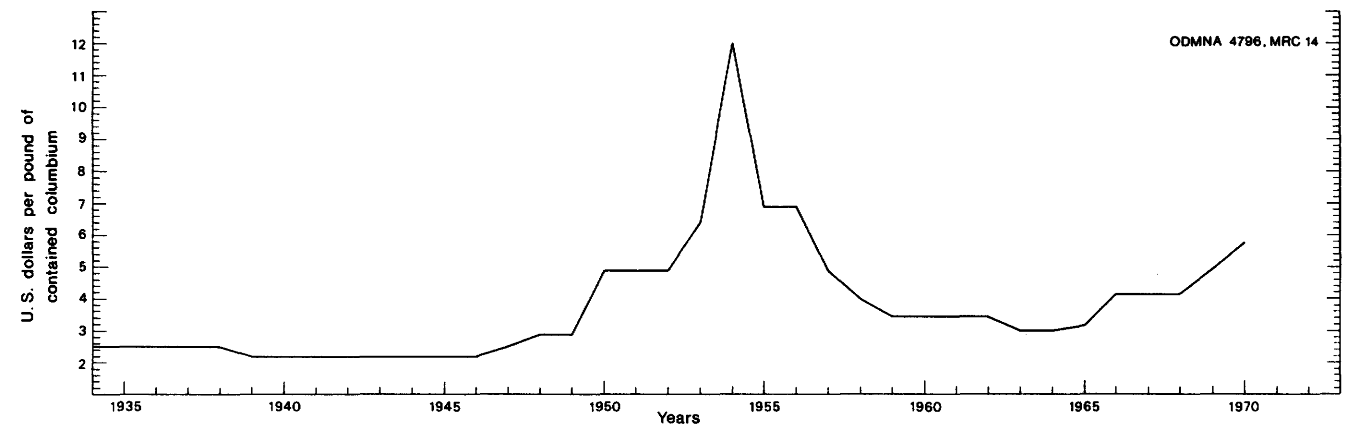

Figure 2 – Average price per pound of columbium in ferrocolumbium, high purity grade.
Modified after Jones 1957, p.5 with additional information from Metals Week and Canadian Minerals Yearbooks.

The price for columbium metal depends upon the specification and the form in which the metal is required. Since 1957 there has been an advertised price for the metal and in that year the price was U.S. $55 for powder or roundel per pound and U.S. $80 for ingot per pound. Metal prices decreased sharply in 1959 and again in 1966 as shown on the accompanying Figure 2. Since 1966 both powder or roundel and ingot types have been offered in metallurgical and reactor grades with little price difference between the grades. In December 1970 powder or roundel was quoted as U.S. $12 to 13 for reactor grade and U.S. $11 to 12 for metallurgical grade, with ingot U.S. $17.50 to 28 for reactor grade and U.S. $16 to 28 for metallurgical grade.

DESCRIPTION OF COLUMBIUM MINERALS

Columbium minerals and columbium-bearing varieties of other minerals that have been found in Canada are described and other minerals are listed. These mineral descriptions are quoted, with slight modification, from Rowe (1958, p.8-12).

Betafite Series
(See pyrochlore)

Composition. $AB_3O_9 \cdot H_2O$?, with A = U, Ca, Th, Pb, Ce, Y, and B = Ti, Cb, Ta, Fe, Al. Strongly radioactive. Betafite is commonly more or less altered to a yellowish material of high water content and diminished radioactivity. The Cb_2O_5 content ranges from 8.51 to 45.80 percent, and the Ta_2O_5 content from trace to 28.50 percent. The chemistry of the betafite series and its relationship to the pyrochlore-microlite series require further investigation.

Physical properties. Occurs as masses, grains, and octahedral crystals. Fracture conchoidal. Brittle. Hardness 4 to 5-1/2. Specific gravity 3.7 to 5, with low values probably due to alteration. Generally metamict.

Optical properties. Colour yellow, brown, greenish brown, reddish brown, black. Lustre waxy to vitreous to submetallic. Transmits light in thin fragments. Colour in thin section colourless, brown, reddish brown. Isotropic. High relief.

Columbite

Composition. Columbium-rich members of the columbite-tantalite series are called columbite. The general formula for columbite is $(Fe, Mn)(Cb, Ta)_2O_6$. The Cb_2O_5 content of columbite ranges from 47.22 to 78.88 percent.

Physical properties. Columbite-tantalite occurs as grains, subhedral crystals, and orthorhombic crystals ranging from short prismatic to thin tabular. May occur in groups of parallel, subparallel, or radiating crystals.

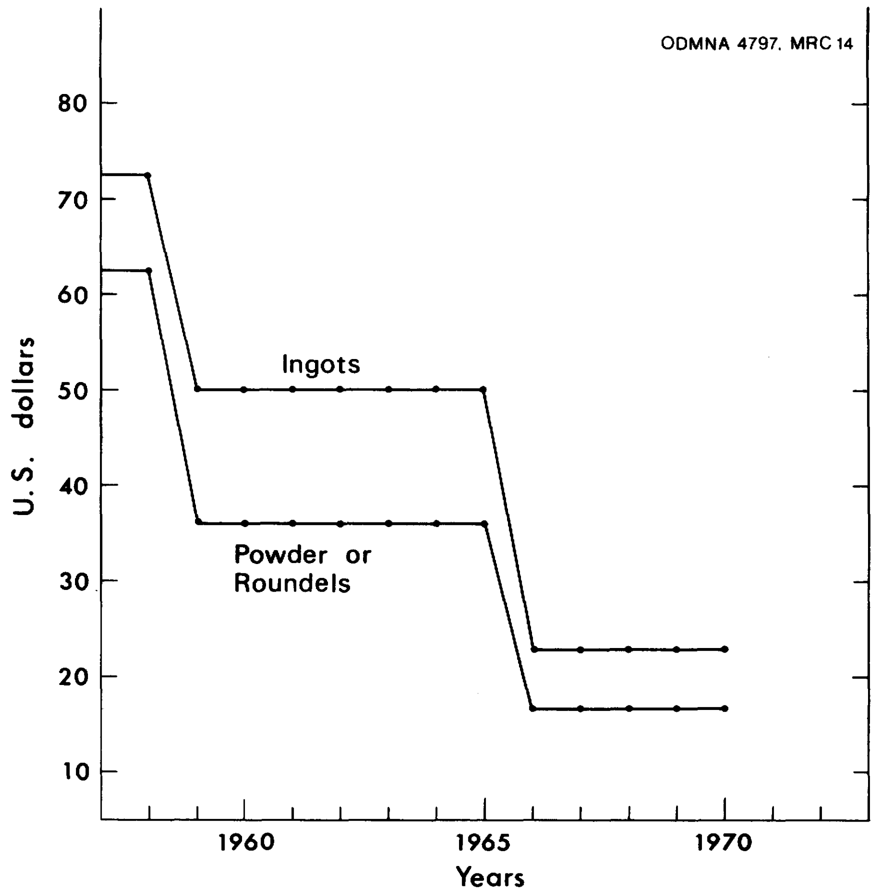

Figure 3 - Average price per pound of ingots and powder or roundels of columbium metal (prices from Canadian Minerals Yearbooks and Metals Week)

Heart-shaped contact twins and penetration twins occur, and may be repeated giving pseudohexagonal trillings. Brittle. Cleavage (010) distinct, (100) less distinct. Fracture subconchoidal to uneven. Hardness 6 to 7. Specific gravity of members of the series ranges from 5.12 to 8.20, increasing with increasing Ta content.

Optical properties. Colour black to greyish black to brownish black, with reddish brown internal reflections (especially in the manganian varieties). Commonly tarnished iridescent. Streak dark red to black. Colour in thin section red, reddish yellow, reddish brown, some varieties are strongly pleochroic; in polished section grey-white with brownish tint, red or reddish brown internal reflections.

Varieties. Ferroan. Manganian. Tungstenian? Uranian (toddite).

Eschynite-Priorite Series

Composition. AB_2O_6, with A = Ce, Y, Er, Ca, Fe^2, Th; and B = Ti, Cb. Eschynite contains Ce, priorite contains Y and Er. Cb_2O_5 content ranges from 15.08 to 36.68 percent. Ta low or absent.

Physical properties. Occurs as grains, masses, and prismatic to tabular orthorhombic crystals. Cleavage, (100)? Fracture conchoidal. Brittle. Hardness 5 to 6. Specific gravity 4.95 to 5.19. Commonly radioactive.

Optical properties. Colour yellow, brown, black. Streak reddish yellow to brown to almost black. Lustre resinous to waxy to submetallic, commonly dulled by alteration. Colour in thin section light brown to reddish brown. Isotropic (metamict).

Euxenite-Polycrase Series

Composition. The formula AB_2O_6, with A = Y, Ce, Ca, U, Th; B = Ti, Cb, Ta, Fe^3. The predominant constituents are Y, Ca, Ti, Cb, and Ta. Euxenite is high Cb + Ta member; polycrase is high Ti member. The Cb_2O_5 content ranges from 3.83 to 41.43 percent, and the Ta_2O_5 content ranges from 1.01 to 47.31 percent. Commonly altered to yellowish material rich in water.

Physical properties. Occurs as grains, masses, stout prismatic and flattened orthohombic crystals, and parallel, subparallel and radial aggregates of crystals. Twinning common on (201), rare on (101) and (013). Fracture subconchoidal to conchoidal. Hardness 5-1/2 to 6-1/2. Specific gravity 4.9 to 5.9. Generally radioactive.

Optical properties. Colour black, commonly with a greenish or brownish tint, amber, mottled amber and black. Streak yellowish, greyish, reddish brown. Transparent in thin splinters. Lustre, greasy to vitreous to submetallic. Colour in thin section brown, yellowish brown, reddish brown. Isotropic (metamict).

Varieties. Tantalian (tanteuxenite). Lyndochite (high in Ca and Th, low in U).

Fergusonite

Composition. Columbium-rich members of the fergusonite-formanite series are called fergusonite. The formula of the series is ABO_4, with A = Y, Er, Ce, La, Di, U^4, Zr, Th, Ca, Fe^2. B = Cb, Ta, Ti, Sn, W. Fergusonite is considered to be essentially (Y, Er, Ce, Fe) (Cb, Ta, Ti) O_4. Cb_2O_5 content of fergusonite ranges from 34.79 to 46.66 percent.

Physical properties. Occurs as grains, prismatic to pyramidal tetragonal crystals, and irregular masses. Cleavage (111). Fracture subconchoidal. Brittle. Hardness of members of the series ranges from 5-1/2 to 6-1/2. Specific gravity of members of the series ranges from 5.6 to 5.8, increasing with increasing Ta content. Commonly radioactive.

Optical properties. Colour grey, yellow, brown, dark brown. Streak greenish grey, yellowish brown, brown. Lustre vitreous to submetallic on fresh surface. Colour in thin section, light brown to dark brown. Uniaxial, negative. Metamict material is isotropic. Weak pleochroism.

Varieties. Titanian (risorite). Uranian. Erbian.

Niocalite

Niocalite was discovered and named recently by E.H. Nickel of the Mines Branch, Ottawa.

Composition. Columbium calcium silicate. A chemical analysis by J.A. Maxwell of the Geological Survey gave the following results:

	Percent
CaO	46.8
Na_2O	0.7
Cb_2O_5	16.8
Rare earths and Al_2O_3	2.0
SiO_2	26.8
H_2O	0.2
F	1.7

Physical properties. Occurs as grains and elongate orthorhombic crystals that are four-sided in section perpendicular to the C-axis. Specific gravity 3.3. Hardness 5 to 6.

Optical properties. Colour yellow. Lustre vitreous. Streak colourless. Colourless in thin section. Relief moderate. Under crossed nicols the mineral shows very complex twinning. Sections parallel or almost parallel to the long axis give lemon-yellow, grey, and blue-grey interference colours, and sections perpendicular to the long axis give red and blue colours.

Pyrochlore

Composition. Columbium-rich members of the pyrochlore-microlite series are called pyrochlore, whereas tantalum-rich members are designated as microlite. The formula of the series is regarded as $A_2B_2O_6$(O, OH, F), with A = Na, Ca, K, Mg, Fe^2, Mn^2, Sb^3, Pb?, Ce, La, Di, Er, Y, Th, Zr, U, and B = Cb, Ta, Ti, Sn? Fe^3?, W?. Pyrochlore is essentially $(Na,Ca)_2$ Cb_2O_6F. The Cb_2O_5 content of pyrochlore ranges from 26.22 to 63.64 percent.

Physical properties. Occurs as grains, octahedral crystals, subhedral crystals and irregular masses. Spinel-law twins, twin plane (111), are rare. Cleavage (or parting?) octahedral, usually not distinguishable but may be distinct in thin section. Fracture subconchoidal to uneven to splintery. Brittle. Specific gravity of members of the series ranges from 4.2 to 6.4, increasing with increasing Ta content. Hardness of members of the series ranges from 5 to 5-1/2. Commonly radioactive.

Optical properties. Colour white, grey, pale yellow, honey-yellow, pale brown, brown, reddish brown, black. Lustre vitreous, resinous, submetallic. Streak light brown, yellowish brown. Isotropic, but non-metamict material may have weak anomalous birefringence. Relief high. Colour in thin section colourless, grey, pale brown, brown, reddish brown, dark brown to opaque. Zonal structure common.

Varieties. Uranium (betafite, ellsworthite, hatchettolite, uranpyrochlor). Betafite, long regarded as a separate species, has been shown by D.D. Hogarth to be uranian pyrochlore with a generally higher content of uranium (over 15 percent metal) than hatchettolite or ellsworthite (Traill 1970, p.442). Titanian, TiO_2 found in amounts up to 13.5 percent. Cerian (koppite). Ferroan, contains FeO in amounts up to 10.0 percent. Ferrian, contains Fe_2O_3 in amounts up to 9.7 percent. Thorian.

Samarskite

Composition. The formula is probably AB_2O_6, with A = Y, Er, Ce, La, U, Ca, Fe^2, Pb, Th; and B = Cb, Ta, Ti, Sn, W, Zr? The Cb_2O_5 content ranges from 27.77 to 46.44 percent, Ta_2O_5 content ranges from 1.81 to 27.03 percent. Commonly altered by hydration to yellowish or brownish material.

Physical properties. Occurs as grains, masses, and prismatic to tabular orthorhombic crystals. Cleavage (010) indistinct? Fracture conchoidal. Brittle. Hardness 5 to 6. Specific gravity 5.69 to 6.2. Commonly radioactive.

Optical properties. Colour velvet black, commonly with a brownish tint; grain and crystal surfaces commonly brown to yellowish brown due to alteration. Lustre vitreous to resinous to submetallic to splendent; commonly dull on grain and crystal surfaces. Streak dark reddish brown to black; grey to yellowish brown on altered material. Transparent in thin splinters. Colour in thin section light brown to dark brown. Generally metamict and isotropic.

Other Columbium Minerals

Other columbium minerals are as follows: scheteligite $(Ca, Y, Sb, Mn)_2 (Ti, Ta, Cb)_2 (O, OH)_7$; yttrotantalite (Fe, Y, U, Ca, etc.) $(Cb, Ta, Zr, Sn)O_4$; polymignyte (Ca, Fe^2, Y, etc., Zr, Th) $(Cb, Ti, Ta)O_4$; ishikawaite (U, Fe, Y, etc.) $(Cb, Ta)O_4$; stibiocolumbite Sb $(Ta, Cb)O_4$; bismutotantalite Bi $(Ta, Cb)O_4$; calciosamarskite $(Ca, Y, etc., U, Th, Zr)_3(Cb, Ta, Fe, Ti, Sn)_5O_{15}$; mossite Fe $(Cb, Ta)_2O_6$; ixiolite (Fe, Mn) $(Cb, Ta)_2O_6$; hjelmite (Y, Fe^2, U^4, Mn, Ca) $(Cb, Ta, Sn, W)_2O_6$; ampangabeite $(Y, Er, U, Ca, Th)_2(Cb, Ta, Fe, Ti)_7O_{18}$?

COLUMBIUM-BEARING VARIETIES OF OTHER MINERALS

Ilmenorutile

Ilmenorutile was proposed by Koksharov (1854) as a name for a new variety of rutile. Analyses show that ilmenorutile contains appreciable amounts of columbium and lesser amounts of tantalum. Palache, Berman, and Frondel (1944, p.558) described ilmenorutile as columbium rutile that is black, and that has a specific gravity of 4.2 to 5.6. Three analyses show columbium oxide contents of 21.73, 23.48, and 32.15 percent, and tantalum oxide contents of nil, 14.70 and 23.48 percent. Hutchinson (1955, p.447-451) studied ilmenorutile crystals from M'ba, French Cameroons, and the Tonkolili District, Sierra Leone, using rotation properties and polarization figures on polished surfaces, and X-ray powder pictures. He found that these specimens consist of intergrowths of columbite and rutile.

Columbium Perovskite

Composition. The formula for perovskite can be regarded as (Ca, Ce, etc.) $(Ti, Cb)O_3$. Ordinary perovskite is Ca TiO_3. Columbium perovskite or dysanalyte is the columbium-bearing variety, and loparite is the variety that contains columbium and rare earths. Analyses show that the Cb_2O_5 content ranges up to 25.99 percent. As much as 5.08 percent Ta_2O_5 has been reported.

Physical properties. Occurs as masses, grains, as cubic, octahedral and cubo-octahedral crystals. Pseudoisometric, possibly monoclinic. Twinning on (111) as penetration twins and complex lamellar twins. Cleavage (001) imperfect. Fracture uneven to subconchoidal. Brittle. Hardness 5-1/2. Specific gravity 4.01 to 4.04.

Optical properties. Colour black, greyish black, brownish black, dark purple, dark purplish brown, reddish brown, yellowish brown. Streak colourless, greyish. Lustre adamantine to metallic, may be dull on crystal surfaces. Colour in thin section, colourless to reddish brown to dark brown. May be weakly pleochroic. Isotropic or weakly birefringent. Complex twinning common. In polish section dark bluish grey with brown internal reflections.

Others

Several titanium and zirconium minerals commonly contain columbium and these include anatase, brookite, ilmenite, sphene, zircon, and eudialyte.

COLUMBIUM ORES

Columbite Concentrate

Until after World War II known columbium and tantalum deposits were almost exclusively in pegmatites or from weathering products derived from them. The ore mineral was columbite and usually was recovered as a byproduct in tin mining operations. Columbite-tantalite form a solid solution series and on that account some tantalum is always present in a concentrate of columbite.

Pyrochlore Concentrate

In 1952 the price of columbium-tantalum concentrates was doubled by an agency of the United States government, which greatly stimulated prospecting for columbium. In the following year a process was developed for extracting columbium from pyrochlore and mining of pyrochlore began at Sove, Norway. This deposit was discovered in 1918 and was explored during and after World War II, and was in production from 1953 to 1965. The first major columbium deposit in Canada was discovered in the Manitou Islands, Lake Nipissing, Ontario in 1952. This was followed by major discoveries at Oka, Quebec in 1953; at Lackner Lake, Ontario in 1954; Nemegosenda Lake, Ontario in 1955 and at Southbluff Creek, Ontario in 1964 or 1965. A pyrochlore deposit at Araxá, Minas Gerais, Brazil was developed by 1960 and is believed to be the largest and highest grade columbium deposit in the world. Reserves are reported as 300 million tons and mill feed averages from 3 to 4.5 percent Cb_2O_5 (Mineral Trade Notes, Bureau of Mines, United States Department of the Interior, January 1971, p.5). This mine became the leading world supplier of pyrochlore concentrates in 1966 and produces a concentrate that averages 59 percent Cb_2O_5 with production in 1968 of 4,999 metric tons of which 3,021 metric tons was exported, and in 1969, 8,663 metric tons was produced and 6,206 metric tons exported (Mineral Trade Notes, January 1971, p.6).

Concentrate Specifications and Prices

Columbium ore or concentrate is marketed on the basis of 65 percent combined columbium and tantalum pentoxides in specified ratios as 10 to 1 and 8-1/2 to 1 Cb_2O_5 and Ta_2O_5 respectively. For all grades the following maximum permissible impurities are usually specified FeO 25 percent, MnO 8 percent, TiO_2 8 percent, SnO_2 12 percent and phosphorous should not exceed 0.03 percent.

Pyrochlore concentrates are now widely accepted in world markets. Three grades of columbium concentrates are sold by St. Lawrence Columbium and Metals Corporation and analyses of these products are given in Table 4.

Table 4. Analyses of Columbium Concentrates, St. Lawrence Columbium and Metals Corporation (Canadian Minerals Yearbook 1962, p.418).

	Type A percent	Type B percent	Type C percent
Cb_2O_5	50.0+	52.0 to 56.0	55.0 to 58.0
TiO_2	4.0 to 7.0	4.0 to 7.0	4.0 to 6.0
SiO_2	1.5 to 4.0	1.0 to 4.0	0.5 to 1.0
P	0.08 to 0.25	0.03 to 0.05	0.03 to 0.05
S	0.3 to 0.6	0.03 to 0.05	0.03 to 0.05
SnO_2	0.01 to 0.02	0.01 to 0.015	0.005to 0.01
H_2O	0.01 to 0.3	0.01 to 0.3	0.01 to 0.3
Cb:Ta ratio:	100:1	100:1	100:1

Some recent prices of columbite and pyrochlore concentrates are given in Table 5.

Table 5. Price in U.S. dollars per pound of Columbium Pentoxide in concentrates (Metals Week).

Year	Columbite containing a Cb_2O_5:Ta_2O_5 ratio of 10:1	Pyrochlore			
		Canadian		Brazilian	
	Spot	Long Term	Spot	Long Term	Spot
1967	0.90	0.95 f.o.b. mine	1.02-1.07 f.o.b. mine	0.955 f.o.b. shipping pt.	0.955 f.o.b. shipping pt.
1968	0.80-0.89	0.92-0.98 cost, insur., and freight to U.S. ports	0.955, one year contract	0.955 f.o.b. mine	...
1969	1.12-1.16 cost, insur., and freight to U.S. ports	1.00-1.05 delivered	...	0.955 f.o.b. mine	...
1970	1.00-1.05	1.15-1.20 delivered	...	1.15 f.o.b. mine	...

World Resources and Production of Columbium and Tantalum

Columbium-tantalum resources of the world are given in Table 6, modified after Barton (1962, p.26-28). Changes in the table are mainly revisions and additions of the Canadian reserves. The major change in world reserves has been the development of the mine at Araxá, Brazil with a reserve of 200 million tons containing 3.0 percent Cb_2O_5 and 7 million tons grading 5.0 percent Cb_2O_5. Canadian reserves are mainly in Ontario and Quebec with the content of Cb_2O_5 approximately 0.5 percent.

The sources of world supply of columbium concentrates have changed drastically with the production and recovery of columbium from pyrochlore. This change began after World War II and has increased since 1962 with the availability of concentrates from Oka, Quebec, and from Araxá, Brazil since 1965. In 1969 the three leading producers of concentrates were Brazil 9,549 tons; Canada 3,010 tons and Nigeria 1,670 tons with a total world production of 14,596 tons which includes 301 tons of tantalite concentrate or mixed columbite-tantalite concentrate. Production of columbite-tantalite concentrate from 1960 to 1969 is given in Table 7.

Table 6. Columbium-Tantalum Resources of the World (modified after Barton 1962, p.26-28).

Location and Property Name of Locality	Reserve Thousands of tons	Grade (contained oxides) percent	Cb_2O_5 tons	Ta_2O_5 tons	Main Ore Mineral and Remarks
North America:					
Canada:					
British Columbia					
Bugaboo Creek	...	...	5,100	...	Euxenite-polycrase; placer.
Manitoba					
Bernic Lake	1,900	0.23	...	43,700	Tantalite
Ontario					
Consolidated Morrison, Cochrane Dist.	62,500	0.52	325,000	...	Pyrochlore
Nemegosenda Lake Sudbury Dist.	20,000	0.47	94,000	...	Pyrochlore
Newman Island Lake Nipissing	5,100	0.82	41,900	...	Pyrochlore
Multi-Minerals Sudbury Dist.	123,700	0.24	291,600	...	Pyrochlore, some zones contain magnetite and apatite
Quebec					
Oka Area					
Columbium Mining Products Ltd.	106,000	0.25	266,000	...	Pyrochlore
Manoka Mining and Smelting Co. Ltd.	200	0.6	1,200	...	Pyrochlore
Quebec Columbium	30,000	0.60	180,000	...	Pyrochlore
Ltd.	25,000	0.35	85,000		
St. Lawrence	3,125	0.487	15,200	...	Pyrochlore
Columbium and Metals Corp. Ltd.	2,000	0.544	10,900	...	Pyrochlore
Dubuc County St-Honoré	22,500	0.48	108,000	...	Pyrochlore; estimated to a depth of 500 feet
Total oxides, Canada	...	...	1,423,900	43,700	
United States:					
Colorado					
Powderhorn	40,000	0.25	100,000	...	Pyrochlore
Idaho					
Bear Valley	...	...	8,000	2,000	Euxenite; placer
Dismal Swamp	...	...	1,000	100	Black sand placers

Table 6 cont.

Location and Property Name of Locality	Reserve Thousands of tons	Grade (contained oxides) percent	Cb_2O_5 tons	Ta_2O_5 tons	Main Ore Mineral and Remarks
Arizona					
Yavapai County	...	...	1,000	...	Pegmatites
New Mexico					
Rio Arriba County	...	...	1,000	...	Placers and pegmatites
Montana	...	...	...	...	Placers, syenite and carbonate veins
Arkansas					
Bauxite	44,000	.10	44,000	...	...
Titanium deposits	8,000	0.05-.15	8,500	...	Inferred resources exceed 100,000 tons of Cb_2O_5
Alumina plant wastes	2,000	.13	2,600	...	...
Oklahoma					
Otter Creek Valley	374,400	.004	14,300	...	Placer
Total oxides, United States			180,400	2,100	
Total oxides, North America			1,604,300	45,800	
South America:					
Brazil:					
Araxá	200,000	3.0	6,000,000	...	Pyrochlore
	7,000	5.0	350,000		
Tapira	...	...	...	...	Some reports indicate 8 million tons of Cb_2O_5
Other Areas	...	...	4,000	10,000	Tantalite, pegmatites
French Guiana:	300	.4	1,200	...	Tantalite, placer
Total oxides, South America	...	...	6,355,200	10,000	

Table 6 cont.

Location and Property Name of Locality	Reserve Thousands of tons	Grade (contained oxides) percent	Cb_2O_5 tons	Ta_2O_5 tons	Main Ore Mineral and Remarks
Europe:					
Germany:					
Kaiserstuhl	750	.5	3,750	...	Pyrochlore
Norway:					
Sove	11,000	0.2-0.5	38,500	...	Pyrochlore; additional reserves of at least 50 million tons of ore probably are available
Total oxides, Europe	...	...	42,250	...	
Africa:					
Congo, Republic of the (formerly Belgian Congo)	...	...	50,000	50,000	Columbite-tantalite; additional reserves not tabulated
Kenya:					
Mrima Hill	26,000	.78	202,800	...	Pyrochlore
Nigeria:					
Kaffo Valley	140,000	.26	364,000	...	Pyrochlore
Other Areas	...	...	100,000	10,000	Columbite; several hundred million tons of reserve inferred
Tanganyika:					
Mbeya	3,800	.79	30,000	...	Pyrochlore
	14,000	.34	50,000	...	
	63,000	.30	190,000	...	
Uganda:					
Tororo	202,000	.20	404,000	...	Pyrochlore
Total oxides, Africa	...	...	1,390,800	60,000	
Total oxides, Asia	...	...	...	...	
Total oxides, Oceania: Australia	...	...	1,000	...	Placer and pegmatite
Total Cb+Ta oxides, World	...	...	9,393,550	115,800	

Table 7. Noncommunist World Production of Pyrochlore, Columbite, Tantalite, and Microlite Concentrates (modified after U.S. Mineral Yearbooks).

Year	Brazil Pyrochlore tons	Brazil Columbite tons	Brazil Tantalite tons	Canada Pyrochlore tons	Congo, Republic of the Columbite tons	Congo, Republic of the Tantalite tons	Malaysia Columbite tons	Mozambique Columbite, tantalite, and microlite tons	Nigeria Columbite tons	Nigeria Tantalite tons	Other Countries Columbite, tantalite (by difference) tons	Total Pyrochlore, columbite, tantalite, and microlite tons
1960	...	13	128	...	114	166	104	168	2,294	12	511	3,510
1961	1,684	19	132	60	57	82	106	154	2,629	13	Nil	4,936
1962	112	19	161	920	28	114	123	173	2,533	19	596	4,798
1963	...	21	116	1,476	82	74	99	139	2,253	17	639	4,916
1964	356	12	90	2,075	...	51	63	208	2,620	11	260	5,746
1965	1,318	44	182	2,276	22	80	52	151	2,854	15	321	7,315
1966	5,264	65	176	2,537	64	497	76	157	2,493	13	102	11,444
1967	5,099	112	226	2,159	...	50	97	175	2,155	21	109	10,203
1968	5,510	69	299	2,181	...	125	57	168	1,264	13	236	9,922
1969	9,549	n.a.	n.a.	3,010	...	110	66(est)	n.a.	1,670	7	184	14,596
Total	28,892	374	1,510	16,694	367	1,349	843	1,493	22,765	141	2,958	77,386

MAIN GEOLOGICAL TYPES

General Features

Columbium deposits are found in a few rock types with the columbium mineralization disseminated throughout the rock. In many of these occurrences the columbium minerals are accessory minerals in the rock at the time of formation but in some cases the columbium minerals were added to the rock by a later metamorphic process. Secondary deposits of columbium minerals form from the weathering of primary deposits or from the weathering and transportation of the weathered products.

Deposits in Granite

Columbite is found in the younger granite series of Nigeria and the mineral species is at or close to the columbite end of the columbite-tantalite isomorphous series (Barton 1962, p.44-45). The Rayfield-Gona and Forum biotite granite phases of the Jos-Bukuru complex are the richest in columbite and average 0.5 pounds of columbite per cubic yard (2,400 pounds), and in the richer parts 7.5 pounds of columbite per cubic yard. Large parts of the granite are weathered to a depth of at least 100 feet but some parts have been protected by a cover of laterite or by Tertiary sedimentary or volcanic deposits.

Deposits in Pegmatites

Two large pegmatite laccoliths, Manono and Kitotolo, near Manono in Katanga Province, Republic of the Congo contain the world's most important source of tantalum and large amounts of columbium (Barton 1962, p.42). The columbite-tantalite mineral species contains approximately equal amounts of tantalum and columbium oxides, and is associated with feldspar, spodumene, quartz, mica and cassiterite. These two pegmatites have surface exposures of 1.2 million and 1.35 million square metres and are believed to have an average depth of 400 metres. The content per cubic metre is 5.5 pounds of cassiterite and 0.16 pounds of tantalite-columbite.

A small Canadian production has come from the Yellowknife-Beaulieu area, Northwest Territories from the Ross Lake beryl pegmatites and the lithium-beryllium pegmatites at Hearne Channel, Great Slave Lake. Tantalum Mining Corporation of Canada Limited began production from a deposit at Bernic Lake, Manitoba in 1969. The Bernic Lake deposit is a complex, zoned pegmatite with zones that contain stanniferous tantalite in crystals up to one eighth of an inch in length. Analyses of this mineral show that it contains Ta_2O_5 70 percent, Cb_2O_5 1.3 percent and SnO_2 13.2 percent (Canadian Minerals Yearbook 1968, p.187).

Carbonatite-Alkalic Complexes
Carbonatite Dikes etc., and Associated Alteration Zones

Many complexes are circular or elliptical in plan but others are less uniform. The ring complexes show a concentric structure built usually around a central core. In vertical section individual zones generally dip vertically or steeply inward. One of the conspicuous features of carbonatite-alkalic complexes is their small size. Examples from Ontario are the Manitou Island Complex, Nemegosenda Lake and Multi-Minerals of 3, 9, and 13 square miles respectively and in Quebec of the St-Honoré and Oka of 6 and 7 square miles. Other examples are Phalaborwa, South Africa and Araxá, Brazil of 2 and 12 square miles respectively.

The intrusive rocks, commonly consist of a circular ring of alkalic rocks with such varieties as pulaskite, a feldspar-rich syenite; malignite, containing about equal amounts of feldspar and mafic minerals; foyaite, with approximately equal amounts of feldspar, mafic minerals and nepheline; and juvite, a nepheline-rich syenite. Forming partial rings or crescentic zones within or adjacent to the feldspathic rocks are commonly zones of ijolite consisting mainly of nepheline and mafic minerals. Magnetite which is generally titaniferous may be abundant as one of the mafic minerals. Core carbonatites may be situated more or less centrally in the ring complex or carbonatite dikes may form radial or ring-dikes or breccia zones of carbonatite within the complex. The zones of mafic minerals containing abundant magnetite are easily detected by ground or airborne magnetic surveys.

Fenitization is the alteration of the country rocks adjacent to the ring complex to produce rocks called fenites. The end products of fenitization depends upon the type of country rock involved in the process as well as upon the type of metamorphosing fluids. The lighter coloured fenite may contain up to 25 percent mafic minerals but rocks with larger amounts of dark coloured minerals may be called mafic fenite.

The Consolidated Morrison property at Southbluff Creek south of Moose Factory, Ontario is a large carbonatite dike within the Kapuskasing Granulite Complex. This dike trends in a northerly direction and makes an angle of 20 to 30 degrees with the trends of the granulite complex. Within the drilled area much of the dike consists of carbonate with a mafic zone on the footwall containing hornblende, diopside, augite and biotite as well as inclusions of country rock.

A sill from 4 to 8 feet in thickness occurs in flat-lying Ordovician limestone at St. Michel, Montreal Island, Quebec (Steacy and Jambor 1969). The sill consists mainly of feldspar and dawsonite, a basic carbonate of aluminum and sodium ($Na_3Al(CO_3)_3.2Al(OH)_3$). Zirconium is present as zircon and in weloganite ($Sr_5Zr_2(CO_3)_9.4H_2O$) and columbium as pyrochlore with analyses indicating an approximate content of 0.09 percent ZrO_2 and 0.11 percent Cb_2O_5.

Age and Distribution of Carbonatite Complexes

Gittins *et al.* (1962, p.65) gives the following ages in millions of years for carbonatites in eastern Canada and states that columbium mineralization is found in carbonatites of each age group.

Table 8. Ages of Carbonatite Complexes in Eastern Canada

Age millions of years	Geological Age
125	Mesozoic:Cretaceous
565	Paleozoic:Cambrian
1,075	Late Precambrian:Grenville
1,560?	
1,700	Middle Precambrian:Hudsonian

These authors also suggest that it appears unlikely that carbonatite emplacement is related to any regional fault system.

Mineralogy and Geochemistry

The following extract is from Parsons (1961, p.4 and 6):

> "A rather characteristic and diagnostic suite of minerals is encountered in these [columbium]-bearing, carbonate-alkaline complexes. The chief silicate minerals are alkali feldspar, nepheline, soda pyroxene, and ferric biotite. Locally, garnets, wollastonite, and titanite are also present.
>
> "The chief carbonate is calcite; however, dolomitic, ferruginous, and manganiferous types are present or indicated. The simple oxides include magnetite, ilmenite-magnetite, and hematite. The sulphides - pyrite and pyrrhotite - are common minor accessory minerals. Occasionally sphalerite, chalcopyrite, and galena are noted.
>
> "Other minerals present in varying amounts are apatite, zircon, scapolite, sodalite, zeolites, pyrochlore, fluorite, monazite, olivine, serpentine, barite, and riebeckite.
>
> "Certain mineralogical and geochemical characteristics and tendencies warrant special notation, as for example:
> The feldspars are all of the alkali (Na,K) types;
> Ca in silicate form is found in such minerals as garnet, wollastonite, and titanite.

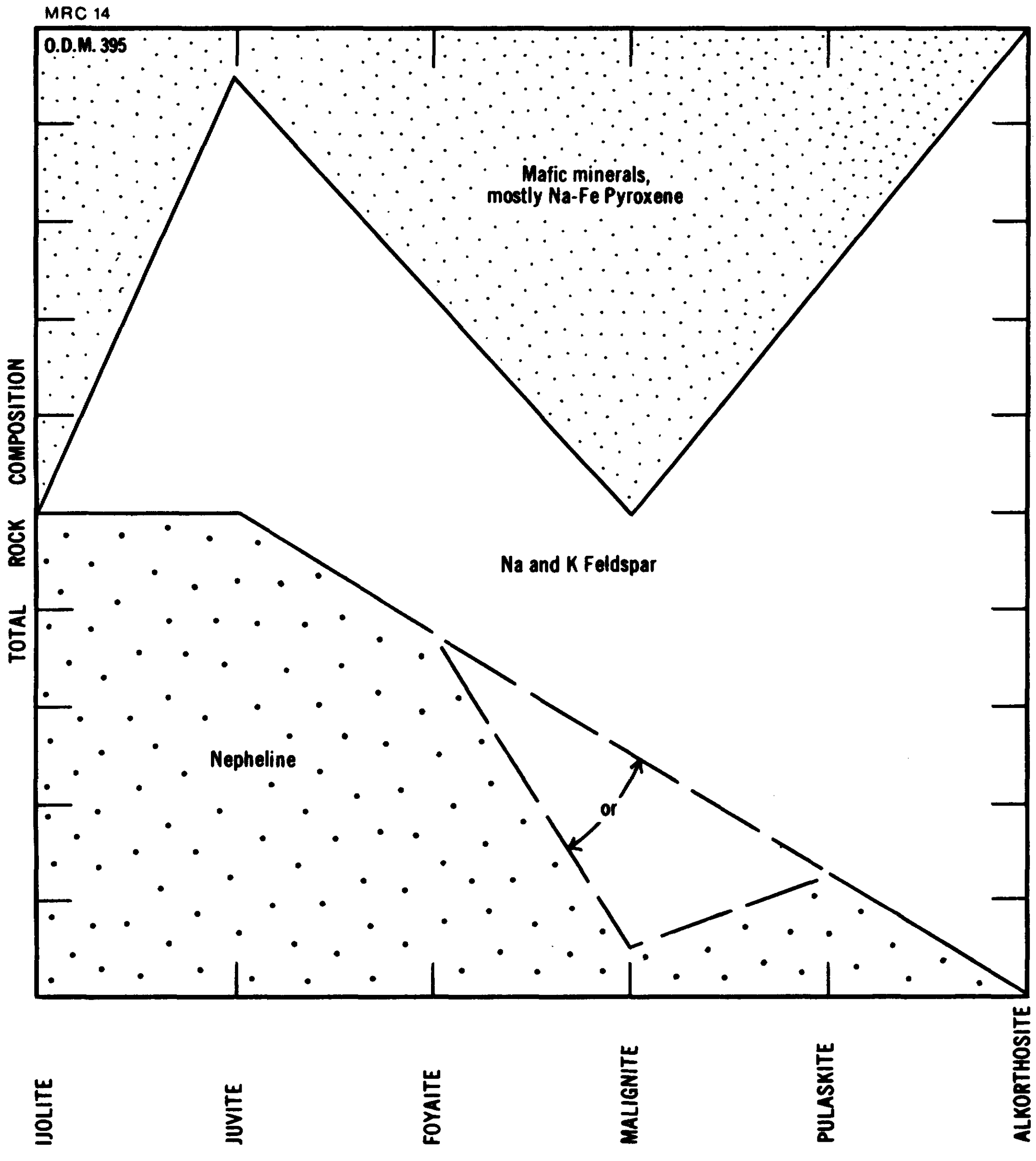

Figure 4 — General composition of alkalic silicate rocks.
Parsons 1961, p. 4

The mafic minerals are generally Na or iron-rich types or both, such as aegirite and aegirite-augite or ferric biotite.
Quartz is absent except as a secondary mineral in faults, and the silica-deficient mineral nepheline is abundant in the silicate rocks.
In some complexes Ca is abundant in the form of carbonates and locally also as apatite.

"A distinct accumulation in these complexes of such elements as Na, K, Ca, Fe, Ti, P, Zr, Mn, C, Cb, U, Th, Ce, F, Ba, and Sr is indicated."

Names of Rock Types

Some names for the rock types found in alkalic complexes are given below and have been taken from Parsons 1961, p.3 or from Heinrich 1966, p.12 and 13 and other sources:

Alkali, Alkalic, and Alkaline. These terms are used in a similar sense by different authors to designate minerals and rocks relatively rich in sodium and potassium.

Alnöite. A lamprophyre consisting of biotite, augite, olivine and melilite. Apatite perovskite, nepheline and opaque oxides are common accessories.

Carbonatite. A carbonate-rich rock (50 percent or more of carbonate minerals) of apparent magmatic derivation or descent.

Fenite. Light coloured altered country rock around alkalic complexes, containing up to 25 percent aegirite-augite and a minimum of 52 percent silicon dioxide.
Varities. Mafic Fenite: Darker coloured altered country rock around alkalic complexes containing more than 25 percent aegirite-augite.
Ringite: Fenite containing calcite with aegirite-augite either more or less than 25 percent.

Foyaite. The original Foya type from Portugal has orthoclase as its chief constituent with nepheline, sodalite, and various ferromagnesian minerals. The composition referred to in this report [Parsons 1961] and in the accompanying figure is that used by Brögger and von Eckermann for their classical memoirs on Fen in Norway, and Alnö in Sweden, respectively.

Ijolite. This is a rather melanocratic crystalline rock consisting of nepheline and soda pyroxene. Strictly speaking it defines rocks containing about equal proportions of these two minerals; however, normally the percentages may be highly variable. Melteigite is a related type rich in soda pyroxene, and urtite is a type rich in nepheline.

Juvite. This is a leucocratic variety of nepheline syenite consisting of about equal proportions of nepheline and alkali feldspar and minor ferromagnesian minerals. Here it has been used for a distinctive coarse nepheline-rich syenite in the Nemegosenda complex.

Jacupirangite. This is used here for a melanocratic series of rocks consisting of varying amounts of apatite, magnetite, and pyroxene. Strictly speaking it applies to rock consisting essentially of titanian augite with accessory magnetite, apatite, nepheline, etc.

Malignite. This is a mesocratic to melanocratic variety of nepheline syenite. Here it has been specifically used for rocks with about equal proportions of alkali feldspar and sodic pyroxene.

Okaite. A feldspathic ultramafic rock composed primarily of melitite and hauyne(hauynite) and containing accessory biotite, perovskite, apatite, calcite and opaque iron oxides.

Pulaskite. This term is used for feldspar-rich alkalic syenite with minor amounts of nepheline and mafic minerals.

Sövite. Nearly pure calcium carbonate with a maximum of 10 percent of other minerals and may be medium-grained or coarse-grained. Varieties of these carbonate-rich rocks are called biotite sövite, apatite sövite and sövitic fenite (see ringite).

Secondary Deposits

Eluvial Deposits

Eluvial deposits formed from weathering have been important in Nigeria where columbite occurs mixed with cassiterite from weathered lodes or greisen in the granite. About two-thirds of the tin leases contain columbite and in about one percent of these the ratio of columbite to cassiterite is at least 1 to 3 (Barton 1962, p.45). At Odegi, Nigeria there are large reserves of columbite, cassiterite, and hafnium-rich zircon in soil, clay and rotten rock. In Pulaski and Saline Counties, Arkansas, U.S.A.

a titanium-bearing bauxite derived from nepheline syenite contains from 0.05 to 0.15 percent Cb_2O_5 (Stevens 1965, p.257).

Placer Deposits

Until the exploitation of pyrochlore as an ore of columbium the cassiterite-columbite ores were of world importance. Columbium concentrates are produced in conjunction with the recovery of cassiterite from placer tin operations in Nigeria and Malaya. Placer deposits in unconsolidated sediments in Idaho, U.S.A. have an inferred reserve of 11,000 tons of Cb_2O_5. Pyrochlore, euxenite and polycrase occur about 25 miles from Spillimacheen, British Columbia in gravels derived from the erosion of the Bugaboo granite stock. The deposit contains 65 million cubic yards of gravel from which 0.11 pounds of columbium could be recovered per yard (Barton 1962, p.29-30).

Mine Tailings, etc.

Some tailings from tin mining operations and smelter slags contain columbium in significant amounts. The red mud and black sand waste products of the Arkansas alumina plants contain about 0.13 percent columbium pentoxide (Stevens 1965, p.257).

DESCRIPTION OF DEPOSITS

ALGOMA DISTRICT

Firesand River Occurrence

Main Metals: Cb.

Location: About 4-1/2 miles east of Wawa, Township 29, Range 23 and the adjacent part of Township 28, Range 23; best mineralization on claims SSM21653, 21654, 21661, unsurveyed claims west and north claim SSM21685 and also mineralization on claim SSM21690, Township 28, Range 23.

Carbonatite-Alkalic Complex: Firesand River.

Regional Geological Map: ODM Map P.184, Michipicoten area.

Geological Map: ODM Map 2006, Firesand River area.

Aeromagnetic Map: ODM-GSC Map 2191G.

SE Corner of NTS Square: 42N/15E, Lat. 47°45', Long. 84°30'.

Geology and Geophysics: A dolomite carbonatite core with surface diameters of 3,500 feet and 5,400 feet is surrounded by a calcite carbonatite ring with a maximum diameter of 9,300 feet. Local zones of mafic carbonatite consisting predominantly of biotite or biotite and pyroxene with calcite occur within the calcite carbonatite or altered greenstone. The complex intrudes mafic volcanics, granite, syenite and transects a diabase dike. Columbium-bearing pyrochlore is most abundant in the calcite carbonatite and is associated with magnetite.
On aeromagnetic map ODM-GSC 2191G a generally circular area 2-1/2 miles in diameter is contained within closed contours. The central dolomite core is magnetically low and is surrounded by a magnetic high underlain by magnetite-bearing calcite carbonatite. Radioactivity is generally slight, several times background being the highest obtained. At one occurrence of coarse pyrochlore the radioactivity is only very slightly above background.

Radiometric Age: 1,048 million years (Gittins et al. 1967, p.653).

Economic Features: Mineralization is noted on ODM Map 2006, Firesand River Area at the following locations:
Location A, a trench in calcite carbonatite assays 0.29 percent Cb_2O_5 over a width of 20 feet. Location B, an exposure 15 feet wide and boulders contain crystals of pyrochlore. Location C (Claim SSM21654), pyrochlore with magnetite, apatite and biotite is present in disintegrated calcite carbonatite. Location D (SSM21662), assays up to 1.32 percent Cb_2O_5 were obtained in rusty, dolomite carbonatite.

Drilling Results:

Hole Number	Intersection feet	Core Length feet	Cb_2O_5 percent
11	780-830	50	0.30
18	17-70	53	0.24
19	160-190	30	0.25
20	540-680	140	0.25

History: 1951-58: Geological survey and dip needle survey. 9 drill holes, 4,509 feet, to explore the iron possibilities of the deposit, holes 10 to 22 with a total length of 7,700 feet and 6 short holes, 197 feet, were to investigate the columbium content. Work was by Algoma Ore Properties Ltd.
Circa 1960: Prospecting and trenching by N. and R. Morrison, W. Jarvis and F. Krimpotich.

Ownership: The Algoma Steel Corporation Ltd., Algoma Ore Division.

References: ODM 1961, GR3, p.23-32.
Canadian J. Earth Sci. 1967, Vol.4, No.4, p.653.
Files: ODMNA Asses. Work Lib., Toronto, 63.675, Tp.29, R.23, Rept.15.

Seabrook Lake Occurrence

Main Metals: Cb, Ti.

Location: Fifty eight miles northeast of Sault Ste. Marie, Township 5E, southwest part, south end of Seabrook Lake.

Carbonatite-Alkalic Complex: Seabrook Lake.

Regional Geological Map: ODM Map 2108, Sault Ste. Marie-Elliot Lake.

Geological Map: ODM Map 2005, Seabrook Lake.

Aeromagnetic Map: ODM-GSC Map 2228G.

SE Corner of NTS Square: 41J/14W, Lat. 46°45', Long. 83°15'.

Geology and Geophysics: The central core rocks are about 1,200 feet in diameter and consist of dolomite carbonatite surrounded by calcite carbonatite. Small carbonatite bodies are found outside the central area. The carbonatite core is almost completely surrounded by a mafic breccia zone 3,000 feet in diameter. A tongue of ijolite, pyroxenite and related breccia over 500 feet wide and a mile long outcrops south of the concentric zones. The granite has been altered adjacent to the later intrusive rocks. Fluorite, magnetite, hematite, pyrochlore and an unidentified radioactive mineral are present in small amounts. Aeromagnetic map ODM-GSC 2228G shows a zone of closed contours one mile

in diameter. Ground magnetic anomalies occur in the area underlain by mafic breccia and an anomaly is correlated with the zone of ijolite and pyroxenite.
Radioactivity is weak over much of the area with the highest readings about ten times background. Rocks containing pyrochlore are radioactive but the highest columbium content does not correspond with the highest radioactivity.

Radiometric Age: 1,103 million years (Gittins et al. 1967, p.653).

Economic Features: At location A on Map 2005 a narrow, magnetite-rich carbonatite zone contained more than 1.0 percent Cb_2O_5. A carbonatite dike at location B Map 2005 assayed 0.33 percent Cb_2O_5. A concentrate of magnetite crystals contained from 1 to 10 percent titanium and from 0.5 to 5.0 percent columbium (ODM 1961, GR3, p.20).

History: 1955: Three holes, 431 feet, drilled by W. Bussineau.
1957: Magnetometer survey, 9 drill holes, 567 feet by Tarbutt Mines Ltd.
1964: Trenching, sampling and geochemical soil survey by F.R. Joubin.

References: ODM 1961, GR3, p.11-22.
Canadian J. Earth Sci. 1967, p.651-655.
Files: ODMNA Assess. Work Lib., Toronto, 63.799, 63E.1, Tp.5E, 6-1-249, 6-1-250, 6-3-251, 2-3-252, 6-2-253, 6-2-254.

COCHRANE DISTRICT

Clay Township Prospect

Main Metals: Fe, Cb.

Location: 32 miles northeast of Kapuskasing, Clay Township, northwest part; drilling mainly on claims S78535, 78536.

Carbonatite Complex: Clay-Howells.

Regional Geological Map: ODM Map 2166, Hearst-Kapuskasing.

Geological Map: Figure 14, ODM MP10, p.70.

Aeromagnetic Map: ODM-GSC 2286G.

SE Corner of NTS Square: 42G/16E, Lat. 49°45', Long. 82°00'.

Geology and Geophysics: The carbonatite complex is a roughly circular stock of aegirine syenite approximately 8 miles in diameter which intrudes a gneiss complex. Zones of carbonatite up to 150 feet in thickness are present in the syenite and dip inward at 70NW. The carbonatite consists of carbonate, amphibole, garnet and from 10 to 80 percent magnetite.

The aeromagnetic anomaly in Clay Township is a blunt ellipse with diameters of 1.8 miles and 1.3 miles and a magnetic relief of 3,300 gammas. A ground magnetic survey outlined two subparallel, arcuate, northeast-striking anomalies. The stronger anomaly is 3,500 feet long, 300 feet wide with a magnetic relief of 4,000 gammas. Vertical drill hole No. 6 on claim S78535 had a section from 277.6 to 278.3 feet where the radioactivity was 6 to 7 times background but most of the magnetite-rich sections of the drill core were only slightly radioactive.

Radiometric Age: 1,010 million years (Gittins et al. 1967, p.653).

Economic Features: A large tonnage of magnetite ore was indicated by drilling (Canadian Mines Handbook 1960, p.156). Milling tests on a small sample of magnetically concentrated ore assayed 70 percent iron, less than 2 percent silica, less than 2 percent manganese, 1.25 percent aluminum and approximately 0.06 percent sulphur (ODM MP10, p.69). The magnetite is non-titaniferous. Columbium was present in the concentrate and tailings of a sample used for a mill recovery test.

Ownership: Mattagami Mining Company Ltd. (subsidiary of Pickands Mather and Co., The Steel Company of Canada and Interlake Iron Corporation).

History: 1954: The aeromagnetic anomaly discovered by Lundberg Explorations Limited, and about 2,000 feet of drilling was done by a grubstake syndicate of Lundberg Exploration employees.
1955: 12 drill holes, 7,116 feet, were recorded as assessment work by C.C. Huston as agent for Mattagami Mining Company Limited.

References: ODM 1967, MP10, p.68-70.
Canadian Mines Handbook 1960, p.156.
Files: ODMNA Assess. Work Lib., Toronto, Clay Township, Rept. 13-1-47, 13-5-45, 13-7-46.

Consolidated Morrison Prospect

Main Metals: Cb.

Location: Twenty five miles south of Moose Factory on South Bluff Creek.

Rock Structure: Consolidated Morrison Dike.

Regional Geological Map: ODM Map 2171, Moosonee Sheet.

Geological Map: ODM P.367, Partridge River.

Aeromagnetic Map: ODM-GSC 2345G.

SE Corner of NTS Square: 42P/05E, Lat. 50°45', Long. 80°30'.

Geology and Geophysics: In the area of detailed drilling Precambrian basement rocks are overlain by 40 to 110 feet of Paleozoic rocks and overburden.

Pleistocene deposits vary in thickness from zero to 40 feet and consist of silty sand with numerous boulders of limestone and granitic rocks and minor beds of gravel and clay. The Sextant Formation is up to 110 feet in thickness and consists of loosely consolidated conglomerate interbedded with sandstone and mudstone.
The Precambrian country rocks are part of the Kapuskasing Granulite Complex and consist of about 50 percent plagioclase, 20 percent quartz, 10-20 percent hornblende and 10-15 percent biotite. The rocks of this complex strike N40E and contain narrow gabbro sills.
The carbonatite is a dike-like body explored by drilling for 8,400 feet and ranges from 350 to 800 feet wide with a bulge about 1,100 feet wide. The carbonatite zone dips 75 to 85E with a general strike N20E with a local swing to N20W. The carbonatite consists mainly of dolomite 60 to 80 percent, apatite 5 to 15 percent, riebeckite 5 to 10 percent, phlogopite 5 to 10 percent, titaniferous magnetite 2-15 percent and pyrochlore. Another phase of the carbonatite forms bands 20 feet wide containing little pyrochlore with a mineral assemblage consisting mainly of calcite with some associated apatite and phlogopite.
Toward the western side of the carbonatite are mafic bands containing hornblende, diopside, augite, biotite and carbonate with altered inclusions of country rock and this part of the dike contains little columbium mineralization.
Plans and sections accompanying a feasibility study by Canadian Bechtel Limited show the mineralized zone in the intensively drilled area to be 1,400 feet long and from 530 to 650 feet wide with drill-indicated reserves to a depth of 475 feet.
Columbium mineralization consists mainly of pyrochlore but on the eastern side a zone from 50 to 200 feet wide contains pyrochlore and columbite. In this zone columbite has formed as an alteration product of pyrochlore and magnetite has altered to hematite. Rare earth minerals are lacking or present in very small quantities.
Ground magnetic surveys outlined two adjacent, elongated magnetic anomalies with a relief of 1,500 and 2,500 gammas over a strike length of 4,600 feet. The larger and stronger anomaly is in the area containing the best columbium mineralization, although on the eastern side of the deposit magnetite has altered to hematized martite and has a low magnetic relief. To the north of the intensively drilled area the carbonatite does not show any magnetic relief.
The rocks of the mineralized zone are not radioactive and no uranium or thorium minerals have been identified. In short wave ultraviolet light apatite fluoresces pale green and zircon fluoresces bright yellow.

Radiometric Age: 1,655 million years (Gittins et al. 1967, p.653, James Bay Lowlands (N)).

Economic Features: 62,500,000 tons averaging 0.52 percent Cb_2O_5; the higher grade zone contains 10,000 tons per vertical foot averaging 0.82 percent Cb_2O_5 (Canadian Mines Handbook 1970-71, p.105).

Ownership: Consolidated Morrison Explorations Ltd.

History: 1965-70: Ground magnetic and electromagnetic surveys, 65 holes, 24,000 feet of drilling, shaft to 125 feet, and 90 feet of crosscutting, 300-ton sample treated to establish concentrating process, feasibility studies on open pit or underground mining methods, marketing, etc., on a proposed operation of 1,000 tons per day or 4,500,000 pounds of concentrate per year.

References: Canadian Mines Handbook 1967-68, p.94-95
ODM 1969, MP25, p.23-24.
Canadian Mines Handbook 1970-71, p.105.
Project Terrane the Alpha-B Columbium Deposit, Private Rept. supplied to ODMNA.
Files: ODMNA Assess. Work Lib., Toronto, 83.1-46, 83.1-47.

KENORA DISTRICT, PATRICIA PORTION

Carb Lake Occurrence

Main Commodities: Cb, Ce, La, vermiculite.

Location: One hundred and ten miles northwest of Big Trout Lake, and six miles southeast of the Ontario-Manitoba border. Drilling on claims KRL59378, 59382, 59383, 59388.

Carbonatite Alkalic Complex: Carb Lake.

Regional Geological Maps: ODM Map 2177, Swan Lake-Sachigo River.
ODM Map 2178, Stull Lake-Sandy Lake.

Aeromagnetic Maps: ODM-GSC Maps 3685G, 3693G.

SE Corner of NTS Squares: 53J/13W, Lat. 54°45', Long. 91°45'.
53K/16E, Lat. 54°45', Long. 92°00'.

Geology: No rocks of the intrusive complex outcrop but boulders of carbonatite and alkalic rocks were found on the shore of a small lake which is unofficially called Carb Lake. Drilling indicated that the central part of the intrusive consists of about 80 percent calcite and dolomite in about equal amounts although in any specimen one usually predominates over the other. The calcite-dolomite carbonatite zones consist largely of carbonates accompanied by about 20 percent apatite, magnetite, biotite, pyrochlore and mafic rock fragments. Interbanded with the carbonatite are bands of mafic rocks consisting of 30-60 percent magnetite associated with apatite, amphibole, biotite, pyrite and pyrochlore. Hole 6742-2 drilled in the most strongly magnetic zone contained approximately 40 percent mafic rocks but hole 6742-3 in a weakly magnetic zone near the central part of the intrusive contained 2 percent mafic rocks. All variations exist between the carbonatite and magnetite-rich zones. The contacts between rock types appear to dip vertically.
The amphibole is believed to be eckermannite and sodic actinolite. Minerals identified by X-ray diffraction methods are pyrite, hematite,

fluorite, vermiculite, pyrochlore, and the rare earth minerals synchysite and ancylite.
An aeromagnetic survey flown at 100 feet above ground level and 1/8 mile spacing indicated a generally circular anomalous area 1-3/4 miles in diameter. The general magnetic relief is 3,000 gammas above background with an area in the southern part 3/4 mile by 1/2 mile where the magnetic relief is 4,000 gammas with a peak of 7,000 gammas (ODM 1969, MP27, Fig.4, p.41). A radiometric anomaly generally is superimposed on the magnetic anomaly but is displaced about a quarter of a mile southward due to glacial transport of soil and boulders. Readings were made on a gamma ray spectrometer carried in the aircraft in conjunction with magnetic survey. Anomalous areas along the flight lines showed an average value of the total gamma radiations as 130 counts per second above background with the highest value 260 counts per second.

Economic Features: Pyrochlore formed from 3 to 5 percent of the minerals in two thin sections (ODM 1969, MP27, p.43). Disseminated pyrochlore is reported to be present in much of the drill core but no estimates of the amount of pyrochlore or assays of the columbium content have been released. Spectrographic analyses of a boulder indicated 2 percent cerium and 1 percent lanthanum (ODM 1969, MP27, p.43). Vermiculite occurs in cavities and vugs (ODM 1969, MP27, p.43).

Ownership: Larandona Mines Ltd. 50 percent and Big Nama Creek Mines Ltd. 50 percent.

History: Aeromagnetic maps ODM-GSC 3685G and 3693G show a circular anomaly. Exploration staff of M.J. Boylen Engineering Ltd. investigated the area underlain by this anomaly and discovered boulders of carbonatite-alkalic rocks.
1967-70: A combined aeromagnetic and aeroradiometric survey, ground magnetic survey of part of the property, four holes,1,849 feet of drilling, work jointly by Larandona Mines Ltd. and Big Nama Creek Mines Ltd.

References: ODM 1969, MP27, p.40-43.
Canadian Mines Handbook 1970-71, p.210.
Files: ODMNA Assess. Work Lib., Toronto, 63.2317, Carb Lake Area Rept.10.

Big Beaver House Occurrence

Main Commodities: Cb, Cu, apatite.

Location: 100 miles north of Central Patricia. ODMNA claim map M2749, Misamikwash Lake. Drilling on claims PA28110, 28111, 28133, 28153.

Carbonatite-Alkalic Complex: Big Beaver House.

Regional Geological Map: GSC Map 2-1963.

Geological Map: None.

Aeromagnetic Map: ODM-GSC 939G.

SE Corner of NTS Square: 53A/13W, Lat. 52°45', Long. 89°45'.

Geology and Geophysics: The only exposures of rocks of the complex are on the south shore of Camp Lake. A carbonatite dike outcrops along the shore and strikes northwest and has an average dip of 45NE. The dike is exposed for a length of 130 feet and a width of 30 feet with the footwall in contact with fenetized gneiss and the hanging wall beneath the waters of Camp Lake. The carbonatite exposure consists of calcite with bright green amphibole, colourless apatite with magnetite and barite in local areas. Pyrochlore, as minute olive green to dark brown crystals, occurs throughout most of the dike, particularly in the amphibole-apatite seams. Drilling intersected vertically-dipping zones of calcite carbonatite interbanded with mafic zones consisting of magnetite, apatite, bronze to green mica and calcite with disseminated pyrrhotite and blebs of chalcopyrite and mafic rock fragments. In drill holes 1, 2 and 7 the mafic rock content varies from less than 1/4 to more than 1/2 of the total core length with narrow zones less than 20 feet and a few wide zones from 150 to 300 feet. Zones of mixed rock types are present, there are great variations in the amounts of particular minerals and rock contacts are gradational.

The aeromagnetic maps show an approximately round anomaly 3.2 miles in diameter. Within this area the magnetic relief is 6,700 gammas with one central peak. The outcrop of carbonatite dike is only slightly radioactive with a reading of approximately twice background.

Radiometric Age: 1,005 million years (Gittins et al. 1967, p.653).

Economic Features: DH4, 54-267 feet contains narrow apatite seams containing up to 10 percent pyrochlore. DH5 B, 148.5-193.7 feet contains disseminated pyrochlore in carbonatite. DH6 B, 220-358.5 feet contains disseminated pyrochlore in carbonatite. Minor amounts of chalcopyrite occur with the mafic rocks in the drill core (ODMNA Assess. Work Lib., Toronto, Misamikwash Lake Area Rept.11).

History: 1961-62: Surface exploration, 9 holes, 2,847 feet of drilling by Many Lakes Exploration Company.

References: Files: ODMNA Assess. Work. Lib., Toronto, Misamikwash Lake Rept.10 and 11.

NIPISSING DISTRICT

Newman Prospect

Main Metals: Cb, U.

Location: Six miles southwest of North Bay, Manitou Islands, Lake Nipissing, shaft on Newman Island.

Carbonatite-Alkalic Complex: Manitou Islands.

Regional Geological Map: ODM P.381, North Bay.

Geological Map: Fig.2 accompanying GSC Paper 54-5, Geological sketch map of Manitou Islands.

Aeromagnetic Map: GSC 1488G.

SE Corner of NTS Square: 31L/5W, Lat. 46°15', Long. 79°30'.

Geology and Geophysics: The Manitou Island Complex consists of a stock about 8,000 feet by 10,000 feet. The central part of the stock consists of mafic alkalic syenite and alkalic pyroxenite. Surrounding the core rocks is a ring of aegirine-potassic feldspar fenite ranging in width from 500 to 1,300 feet and containing minor carbonatite intrusions. The surrounding rocks are quartz fenite which in a few places are overlain by Ordovician limestone and conglomerate. At Newman Island the rocks dip 60 to 70S which is away from the core of the complex.

Columbium mineralization is present in uranian pyrochlore in the outer concentric ring of the complex and occurs in crystals up to 3.5 millimetres in size, and as clusters of crystals. The pyrochlore occurs in a potash feldspar-soda pyroxene rock and also in a rock composed mainly of soda pyroxene, biotite, calcite and apatite and mineralized zones cut across the contacts of these rock types in both strike and dip. The ore zone has been traced along the strike for 1,000 feet and is about 300 feet wide. Within this zone three or four persistent mineralized shoots are from 20 to 60 feet wide.

Uraninite and uranian pyrochlore have been identified and radioactive surface specimens contain from 0.01 to 0.12 percent uranium oxide equivalent. Drill core containing higher than background radioactivity was analyzed for columbium and uranium oxides. The aeromagnetic map shows closed contours with the highest contours 100 gammas above the regional magnetic level. The highest magnetic values overlie the Newman deposit and extend southeast to Rankin Island.

Radiometric Age: 570 million years (Gittins et al. 1967, p.653).

Economic Features:

Location	Not in Reserve tons	Reserve tons	Tons per vertical foot	U_3O_8 percent	Cb_2O_5 percent
Newman 300-foot level to lake bottom	3,000,000	-	-	0.042	0.613
Below 300-foot level	-	2,695,500	6,990	0.042	0.69
		1,824,000	4,560	0.05	0.88
		617,000	1,540	0.075	1.06
Great Manitou		27,000	-	0.10	0.38
Calder				0.11/5 ft.	0.48/10 ft.

(Newman from Mines Branch, Mineral Resources Division 1954, MR8, p.14 and Mines Branch, Mineral Resources Division 1957, Memorandum Ser. No. 135, p.221, Great Manitou and Calder, ODM 1971, GR94, p.83).

History: 1952: Radioactivity was discovered on the Manitou Islands by James Strohl.
1953: Aeromagnetic and ground magnetic surveys of property.
Newman Deposit:
1953-56: 20 surface drill holes, 13,024 feet, 60 underground drill holes, 13,055 feet, shaft to 425 feet on 275-foot level, 77 feet of drifting, on 400-foot level 1,142 feet of drifting and 1,287 feet of crosscutting, 13,473 tons of ore hoisted, pilot flotation mill handled 25 to 50 tons per day for a period of 7-1/2 months. Work by Beaucage Mines Ltd.
Great Manitou Deposit:
1953: 20 short vertical holes drilled by Beaucage Mines Ltd.
Calder Deposit:
1953: 19 holes drilled by Beaucage Mines Ltd.
Manitou Islands
1971: Ground magnetic survey and drilling by Nord Resources Corp. Ltd.

References: GSC 1958, Econ. Geol. Ser. No.18, p.45-62.
ODM 1957, Vol.66, pt.2, p.120.
ODM 1971, GR94, p.51-52, 81-83.
GSC 1970, Paper 69-45, p.447.
Canadian J. Earth Sci. 1967, Vol.4, No.4, p.653.
Files: Resident Geologist, Toronto, Beaucage Mines Ltd.
Assess. Work Lib., Toronto, 86.4.

SUDBURY DISTRICT

Multi-Minerals Prospect

Main Commodities: Fe, apatite, Cb.

Location: Thirteen miles southeast of Chapleau, McNaught Township, eastern part; 51 patented claims with mineralized zones on claims WD275, 276, S52495, 52497, 52498 and 53379. No. 6 zone is on claim WD276.

Carbonatite-Alkalic Complex: Lackner Lake.

Regional Geological Map: ODM Map 2116, Chapleau-Foleyet.

Geological Map: ODM Map 2008, Lackner Lake area.

Aeromagnetic Map: ODM-GSC Map 2232G, Chapleau.

SE Corner of NTS Square: 410/14E, Lat. 47°45', Long. 83°00'.

Geology and Geophysics: A body of nepheline syenite 17,000 feet by 19,000 feet intrudes slightly altered granitic gneiss. Within the syenite there is a partial ring of inward dipping dark coloured alkaline rocks

consisting mainly of aegirine-augite and nepheline with minor amounts of biotite, apatite, calcite, magnetite, sodalite, etc. Parts of this zone are brecciated and contain veins of magnetite. Magnetite, apatite and pyrochlore are the main minerals of economic interest and occur together in the zone of dark coloured alkaline rocks or in brecciated parts of this zone in the southwestern part of the complex.
The aeromagnetic map shows a crescent-shaped magnetic anomaly which corresponds to the distribution of the partial ring of dark coloured alkaline rocks. Pyrochlore is associated with magnetite and on that account ground magnetic surveys have been helpful in locating zones of economic interest. On Chart A (accompanying ODM 1961, GR3) areas with magnetic values over 5,000 gammas are due to magnetite veins, or to bodies of massive magnetite-apatite.
Radioactivity is widespread and generally is most pronounced in rocks that contain apatite, dark green garnets and magnetite. Pyrochlore in No. 6 zone contains approximately 17 percent combined U_3O_8 and ThO_2, and rare-earth minerals such as monazite are also radioactive.

Radiometric Age: 1,090 million years (Gittins et al. 1967, p.653).

Economic Features:

Zone	Length feet	Width feet	Reserve tons	Magnetite percent	Apatite percent	Cb_2O_5 percent
No. 3	1,600	80	-	-	-	-
No. 4	1,500	75	-	-	-	-
No. 3 and 4			37,000,000	21.3	13.7	0.198
No. 5	600	100	-	-	-	-
No. 6 (Main)	800	150	5,024,250	69.6	21.9	0.173
No. 8	1,500	-	80,000,000	-	-	0.25
Calcite)	-	-	880,000	-	-	0.9
)			760,000			0.23

(ODM 1961, GR3, p.61-68, Canadian Mines Handbook 1968-69, p.229, Canadian Mines Handbook 1969-70, p.241).

Ownership: Multi-Minerals Ltd., leased to Fetio Industrial Developments Ltd.

History: Circa 1900: Claims WD275 and 276 patented as an iron deposit.
1949: Archie Burton and Martin Burton prospected the area and discovered the radioactive zone.
1950-52: Surface exploration, magnetic survey, 8,200 feet of surface drilling directed toward developing apatite, magnetite and uranium deposits.
1951: Columbium was detected on the property. Work by Nemegos Uranium Corporation.
1953-59: Geological survey, total drilling increased to 75,000 feet, in 1958 some 30,000 tons of magnetite-apatite mined by open pit method and sold for use as a heavy aggregate, metallurgical tests indicated a satisfactory separation and recovery of magnetite and apatite with work by Multi-Minerals Ltd.
1965-70: Process development by Klockner-Humboldt-Deutz Aktiengesellschaft indicated the following products: Magnetite concentrate assaying 66.3

percent iron, 5.86 percent TiO_2 and 0.21 percent SiO_2; apatite concentrate containing 76 percent BPL (bone phosphate of lime $Ca_3P_2O_8$ which also may be expressed as 35.1 percent phosphorous pentoxide P_2O_5) and thorium and yttrium.
1970: Property leased to Fetio Industrial Developments Ltd. with mining and concentrating to be handled by Kipco Metals and Chemicals Ltd. Production is planned for late 1971 at the rate of 1,000 tons per day to give 700 tons of titaniferous magnetite with the tailings available for upgrading as a high phosphate concentrate.

References: ODM 1961, GR3, p.61-68.
GSC 1958, Econ. Geol. Ser. No.18, p.35-45.
Canadian J. Earth Sci. 1967, Vol.4, No.4, p.653.
Survey of Mines 1970, p.118.
Northern Miner, Dec. 10, 1970, p.1339, 1344.

Nemegosenda Lake

Main Metals: Cb, U, Th, rare earths.

Location: Nineteen miles northeast of Chapleau, Collins Tp., adit and drilling on SW1/4 of S1/2 lot 9, con. I (S82919) and SE1/4 of S1/2 lot 10, con. I (S82918) also in Chewitt Tp., drilling on W1/2 of S1/2 lot 8, con. VI (S86983, 86987).

Carbonatite-Alkalic Complex: Nemegosenda Lake.

Regional Geological Map: ODM Map 2116, Chapleau-Foleyet.

Geological Map: ODM Map 2007, Nemegosenda Lake, GR3.

Aeromagnetic Maps: ODM-GSC Maps 2232G, 2233G.

SE Corner of NTS Square: 42B/03E, Lat. 48°00', Long. 83°00'.

Geology and Geophysics: The central part of the complex is a zone of alkalic syenites with surface diameters 9,000 feet by 13,000 feet. The syenites consist of a number of rock types that are generally light coloured and contain varying proportions of alkali feldspars, nepheline, biotite, soda pyroxene and amphibole. Partial envelopes of altered rocks surrounding the syenite core are the syenitic contact zone, pyroxenitic fenite zone and red alkalic fenite zone. Late mafic and porphyry dikes and carbonate-quartz-chlorite dikes and carbonate veins cut the earlier rocks.
Pyrochlore is the columbium-bearing mineral and is most abundant in the pyroxenite fenite zone with smaller amounts in the red alkalic fenite zone. It occurs as disseminated grains which are generally visible to the unaided eye and the better grade mineralization is associated with aegirite, magnetite, apatite, wollastonite and garnet. Possible byproduct minerals are uranium, thorium, rare earths (cerium, yttrium, neodymium lanthanum), zirconium, apatite and magnetite.
There is no direct relationship between magnetic intensity and the amount of columbium present. In the mineralized D zone the syenitic contact

zone is most strongly magnetic with a weaker magnetic intensity in the adjacent rocks of the pyroxene fenite zone. Consequently the highest content of pyrochlore is on the outer flank of the magnetic anomaly. There is a marked correlation between the relative amounts of radioactivity and columbium. A scintillometer reading of 250 counts per second on a rock exposure could be expected to indicate about 0.25 percent Cb_2O_5. However, radioactivity of several thousand counts per second from a rock containing green garnet, wollastonite and apatite was found to be due to rare earth mineralization.

Radiometric Age: 1,010 million years (Gittins et al. 1967, p.653).

Economic Features:

Location	Length feet	Width feet	Depth feet	Core Length feet	Reserve tons	Cb_2O_5 Percent
D Zone	800	600	600	-	20,000,000	0.47
A Zone	300	-	-	38	-	0.45
B Zone	1,700	-	-	17	-	0.43
E Zone	-	-	-	11	-	0.43
F Zone	1,500	-	-	56	-	0.37
G Zone	400	-	-	-	-	-

(ODM 1961, GR3, p.46, 50).

Ownership: Dominion Gulf Company.

History: 1954-58: Aeromagnetic survey, ground magnetic survey, geological survey with scintillometer, readings in outcrops, boulders and certain soils, 68 surface drill holes with a combined length of 35,306 feet, adit driven 580 feet and about 1,000 tons of mineralized material removed of which 40 tons were shipped for metallurgical tests, work by Dominion Gulf Company.
1958-62: Pilot plant research completed indicating 90 percent columbium recovery.

References: ODM 1961, GR3, p.33-50.
Canadian J. Earth Sci. 1967, Vol.4, No.4, p.653.
Canadian Mines Handbook 1970-71, p.128.
Files: ODMNA Assess. Work Lib., Toronto, 63.681.

THUNDER BAY DISTRICT

Chipman Lake Occurrence

Main Metals: Cb and Cu adjacent to the intrusive complex.

Location: Twenty miles northeast of Longlac, O'Meara Township, east side of Chipman Lake.

Carbonatite-Alkalic Complex: Chipman Lake.

Regional Geological Map: ODMNA Map 2202, Caramat-Pagwa River Sheet.

Aeromagnetic Map: ODM-GSC Map 2161G.

SE Corner of NTS Squares: 42E/16E, Lat. 49°45', Long. 86°00'
42E/16W, Lat. 49°45', Long. 86°15'.

Geology and Geophysics: The intrusive complex consists mainly of an alkalic syenite body about two miles in diameter. The point extending north from the southern end of the wide part of Chipman Lake is underlain by hornblende gneiss intruded by dikes of syenite and carbonatite. Carbonatite dikes are up to 15 feet in width and contain magnetite, mica, apatite, actinolite and locally pyrochlore.
To the east of this point near the eastern shore of Chipman Lake two parallel sulphide zones 170 feet apart are present in basalt near the margin of the syenite intrusion. The northern zone is exposed in trenches for a length of 110 feet and in most exposures consists of 3 feet of massive sulphides and 9 feet of disseminated sulphides, although in the most westerly exposure the whole zone is massive sulphide. Fine-grained pyrite, pyrrhotite and chalcopyrite can be identified, and no nickel, gold or silver were present in the samples analyzed. Assays for copper and sample lengths are as follows: 0.36 percent for 12 feet, 0.34 percent for 3 feet, and 0.34 percent for 3 feet.
The southern zone is exposed at the western end in two trenches which indicate a strike length of 70 feet and a combined width of massive and disseminated sulphides of 8 feet. Two other trenches give a possible strike length of 290 feet. Copper assays and sample lengths shown on the geological plan are as follows: 0.23 percent for 2.8 feet, 0.26 percent for 2 feet, and 0.21 percent for 3 feet.
The aeromagnetic plan shows an irregular circular area about two miles in diameter with a magnetic relief of 500 gammas, which presumably is underlain by syenite. Carbonatite dikes and rusty cracks outside this zone are weakly radioactive. A self potential survey outlined the extensions and possible extensions of the sulphide zones.

History: 1955: Trenching, geological mapping and self potential survey of the sulphide zones and adjacent area by The Mining Corporation of Canada Ltd.
1961: Prospectors working for Kimberly-Clark Pulp and Paper Company located carbonatite rocks on the southwest shore of Chipman Lake.
1966: Aeroelectromagnetic survey carried out over the syenite for Consolidated Morrison Explorations Ltd.

References: Files: ODMNA Assess. Work Lib., Toronto, 63.554, 63.2081.

Abbreviations Used In Tables

Assess.	Assessment (Work Library, Toronto).
Con.	Concession.
GR45	Geological Report and number.
GSC	Geological Survey of Canada.
Mem.	Memoir.
Metals	Metals column includes minerals (see below).
MRC4	Mineral Resources Circular and number.
IMR21	Industrial Mineral Report and number.
N,S,E,W	North, south, east, west
OBM	Ontario Bureau of Mines.
ODM	Ontario Department of Mines.
ODMNA	Ontario Department of Mines and Northern Affairs.
OFR 5057	Open File Report and number.
Rept.	Report
Survey of Mines	Financial Post Survey of Mines.
Tp.	Township.
Vol.	Volume.

Metal and Mineral Reference

ap	Apatite
be	Beryl
bio	Biotite
Cb	Columbium (niobium)
Ce	Cerium
cor	Corundum
Fe	Iron
fel	Feldspar
fl	Fluorite
Li	Lithium
mus	Muscovite
qtz	Quartz
Ta	Tantalum
U	Uranium
verm	Vermiculite

MINERAL OCCURRENCES

ALGOMA DISTRICT

Location and Name	References	Metals	Remarks
Tp. 29, Range XVI, east shore of Lake Superior, 7½ miles northwest of MacGregor Cove, claims SSM 19084, 19086. SE corner of NTS square: 41N/07E, Lat. 47°15', Long. 84°30'. (Franz Occurrence)	ODM Map 2108, Sault Ste. Marie-Elliot Lake Sheet. ODM 1955, Vol.64, pt.3, p.20-21. GSC 1952, Econ. Geol. Ser.16, p.130 GSC 1970, Paper 69-45, p.447	U Cb	Granitic rocks at the contact with ore, radioactive over a width of up to 8 feet and contain a small amount of pitchblende and pyrochlore (ellsworthite). The property is known as Franz and also J.G. McCombe.

COCHRANE DISTRICT

Location and Name	References	Metals	Remarks
Steele Tp., con.V, SW¼ of S½ lot 5. SE corner of NTS square: 32E/04W, Lat. 49°00', Long. 79°45'. (Steele Township Occurrence)	ODM Map 2161, Coral Rapids-Cochrane Sheet. ODM Map 2018, Steele, Bonis and Scapa Townships. Aeromagnetic Map: ODM-GSC Map 2366G. ODM 1962, GR8, p.29-30.	Cb Ta	Columbite-tantalite is present in a zoned pegmatite dike containing spodumene, muscovite and tourmaline.
Valentine Tp., southwest part. SE corner of NTS square: 42I/04E, Lat. 50°00', Long. 81°30'. (Valentine Township Occurrence)	ODM Map 2161, Coral Rapids-Cochrane Sheet. ODM-GSC Aeromagnetic Map 2306G. Files: ODMNA Assess.Work Lib., Toronto, Valentine Tp., Rept. 11 and 12.	Cb	1969: Holes V-2-2 to 2,362 feet and V-2-3 to 2,000 feet both at a dip of 50 degrees, drilled by Argor Explorations Ltd. Carbonatites interbanded with syenitic rocks were intersected at depths from 410 to 500 feet from surface, underlying Paleozoic sediments and overburden. In hole V-2-3 from 1,738 to 1,995 feet, the carbonatite averaged 0.22 percent Cb_2O_5.
Fifty miles northeast of Hearst. SE corner of NTS square: 42J/06W, Lat. 50°15', Long. 83°15'. (Martison Lake Occurrence)	ODM-GSC Aeromagnetic Map 3960G. Canadian Mines Handbook 1966-1967, p.322. Files: ODMNA Assess. Work Lib., Toronto. No technical surveys or drilling on file February 1971.	Cb	1965-66: Work jointly by Falconbridge Nickel Mines, Uranium Ridge Mines Ltd. and Matachewan Consolidated Mines Ltd. One hole drilled to investigate an airborne electromagnetic conductor superimposed a magnetic anomaly. The hole was all in overburden with abundant magnetite in the sand from 358 feet to the end of the hole at 544 feet. Examination of the core from a boulder intersected at 358 feet, was considered to be that of a gossan overlying a carbonatite deposit and contained oxidized titaniferous magnetite and a hydrous basic phosphate probably from the breakdown of apatite, columbium and strontium.
SE corner NTS square: 42N/02W, Lat. 51°00', Long. 84°45'. (Albany Forks Occurrence)	ODM-GSC Aeromagnetic Map 3894G. Files: ODMNA Assess. Work Lib., Toronto, 63.2617, Area South of Lorne Lake (M3091), Rept. 10.	Cb Fe	1969: Work on property by Keevil Mining Group Ltd. A ground magnetic survey indicated an anomalous area with a magnetic relief of 11,000 gammas striking NW 5,000 feet by 3,200 feet. Drill hole HA69-1 was drilled in a southwesterly direction at a dip of 80 degrees to a depth of 1,203 feet and intersected 140 feet of overburden, 590 feet of Paleozoic limestone, with the balance of the hole in dolomite carbonatite. The hole was drilled down the dip of the carbonatite containing bands of non-titaniferous magnetite and weak pyrochlore mineralization.

FRONTENAC COUNTY

Location and Name	References	Metals	Remarks
Loughborough Tp., con. IX, lot 11, west side of Long Lake. SE corner of NTS square: 31C/07E, Lat. 44°15', Long. 76°30'. (Foxton Occurrence)	ODM Map 2054, Gananoque Area. ODM 1967, IMR21, p.19. GSC 1932, Econ. Geol. Ser.11, p.232,262. GSC 1952, Econ. Geol. Ser.16, p.146. GSC 1970, Paper 69-45, p.204.	fel Cb	1920-21: Production of 1,250 tons of feldspar by S. Orser and O'Brien and Fowler. A zoned pegmatite 30 feet wide contains small amounts of euxenite, allanite and gadolinite.
Miller Tp., SW Range, lot 15. SE corner of NTS square: 31F/03E, Lat. 45°00', Long. 77°00'. (Whytock Occurrence)	ODM 1956, Vol.65, pt.6, p.20. ODM 1967, IMR21, p.64. GSC 1970, Paper 69-45, p.445. ODM OFR 5057, p.2-3.	Cb	A zoned granite pegmatite contains pyrochlore which contains 50 percent Cb_2O_5.
Olden Tp., con. VII, lot 8. SE corner of NTS square: 31C/12W, Lat. 44°30', Long. 76°45'. (H.G. Quinn Occurrence)	ODM Map 1947-5, Olden-Bedford area. GSC 1958, Econ. Geol. Ser.18, p.95.	Cb	Euxenite-polycrase reported.

HALIBURTON COUNTY

Location and Name	References	Metals	Remarks
Cardiff Tp., con. VIII, S½ lot 12, etc. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°00'. (Dyno Mine)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.43-45. GSC 1958, Econ. Geol. Ser.18, p.92.	U Cb	1954-60: Dyno Mines Ltd. and Canadian Dyno Mines Limited operated the property. Shaft to 1,720 feet with 10 levels, mill operated 1958 to 1960 and produced 802,998 pounds of U_3O_8 valued at $8,526,729. A small amount of uranian pyrochlore is associated with the uranium mineralization.
Cardiff Tp., con. XI, N½ lot 27, S½ lot 28, etc. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°00'. (Bicroft Mine)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.30-36. ODM 1967, MRC4, p.16-17.	U Cb	1955: Bicroft Uranium Mines Ltd. formed by amalgamation of Centre Lake Uranium Mines Ltd. and Croft Uranium Mines Ltd. 1961: Macassa Gold Mines Ltd., Bicroft Division with shaft to 1,843 feet and production of uranium concentrates valued at $44,054,075. Small amounts of pyrochlore (betafite) and euxenite-polycrase are associated with uraninite and uranothorite.
Cardiff Tp., con. XII, lot 9. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°00'. (Canada Radium Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. GSC 1970, Paper 69-45, p.444. ODM 1956, Vol.65, pt.6, p.41-42.	Cb fel	Pyrochlore-microlite occurs in calcite veins on the property of Canada Radium Mines Ltd. 1932-36: Shaft to 400 feet with three levels and mill testing for recovery of feldspar by Canada Radium Mines Ltd. 1954-55: Surface work and drilling by Canada Radium Corporation Ltd.
Cardiff Tp., con. XII and XIII, lot 10. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°00'. (C.E. Earle Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. GSC 1932, Econ. Geol. Ser.11, p.227,260. GSC 1970, Paper 69-45, p.443.	Cb	A calcite vein contains black mica, apatite and pyrochlore (ellsworthite). The alteration product on the ellsworthite contains 23.44 percent Cb_2O_5.
Cardiff Tp., con. XIV, S½ lot 11. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (Mindus Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.67-68. GSC 1962, Econ. Geol. Ser.16, p.253.	U Cb	1953-55: Mindus Corporation Ltd. 1955-56: Mindustrial Corporation Ltd. Trenching, geological and radiometric surveys, 2 holes 601 feet. Uranothorite, allanite, uraninite and pyrochlore (ellsworthite) in granite rocks.
Cardiff Tp., con. XV, N½ lot 6. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (Halo Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.62-63.	Cb	Two veins consist of calcite, fluorite, apatite and biotite with scattered crystals of pyrochlore (betafite) either occurring as single crystals or in clusters associated with biotite. Formerly called Hogan property and in 1953-54 optioned by Stratmat Limited and in 1954 acquired by Halo Uranium Mines Ltd.
Cardiff Tp., con. XVIII, lots 4 and 5. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°00'. (Cardiff Township, Con. XVIII, Lots 4 and 5 Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. GSC 1970, Paper 69-45, p.444.	Cb U	Pyrochlore (betafite) has been identified in specimens from the Halo Uranium Mines Limited property.
Cardiff Tp., con. XXI, lot 5. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (Fission Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. GSC 1970, Paper 69-45, p.444. ODM 1956, Vol.65, pt.6, p.56-58.	Cb U	Pyrochlore (betafite) and euxenite-polycrase have been identified in specimens from the Fission Mines Ltd. property. 1922: Uraninite discovered on an adjacent lot by W.M. Richardson. 1929-33: Ontario Radium Corporation and International Radium and Resources did surface and underground exploration and mill testing. 1937: Wilberforce Minerals Ltd. 1946-55: Additional surface and underground work by Fission Mines Ltd.
Monmouth Tp., con. III, lot 4; con. IV, lots 2-4. SE corner of NTS square: 31D/16W, Lat. 44°45', Long. 78°15'. (Sovereign Occurrence)	ODM Map 2174, Monmouth Tp. ODM 1956, Vol.65, pt.6, p.88-89. GSC 1958, Econ. Geol. Ser.18, p.95.	U Cb	1955-56: Surface work and shallow drilling by Fairley Red Lake Gold Mines Ltd. on Sovereign property. Circa 1962: Cassiar Rainbow Gold Mines Ltd. Accessory minerals in a granite pegmatite are zircon, allanite, uranothorite and euxenite-polycrase.
Monmouth Tp., con. V and VI, lots 18, 19 and 20. Shaft on SE corner, con. VI, lot 19. SE corner of NTS square: 31D/16E, Lat. 44°45', Long. 78°15'. (Blue Rock Occurrence)	ODM Map 2174, Monmouth Tp. ODM 1956, Vol.65, pt.6, p.23,96-99. GSC 1970, Paper 69-45, p.209.	U Cb	1954-56: Rare Earth No. 2 Shaft 440 feet with three levels with 56,761 feet of surface drilling and 16,817 feet of underground drilling mainly by Rare Earth Mining Company Ltd. Uranium mineralization in leucogranite contains accessory amounts of titanite, uranothorite, uraninite, uranophane and fergusonite as black resinous grains and crystals.

Location and Name	References	Metals	Remarks
Monmouth Tp., con. IX, N½ lot 7. SE corner of NTS square: 31C/16W, Lat. 44°45', Long. 78°15'. (Canadian All Metals Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. ODM 1956, Vol.65, pt.6, p.20. GSC 1970, Paper 69-45, p.444.	Cb	Pyrochlore-microlite occurs in calcite veinlets on the property of Canadian All Metals Exploration Ltd.

HASTINGS COUNTY

Location and Name	References	Metals	Remarks
Faraday Tp., con. XII, lot 10. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Greyhawk Mine)	ODM Map 1951-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.117-121. ODM 1967, MRC4, p.38-39. GSC 1970, Paper 69-45, p.209,443.	U Cb	1954-59: Greyhawk shaft, 402 feet, with three levels and 5,965 feet of drifting and 5,965 feet of crosscutting. Uranium production 1957-59 valued at $834,889. by Metal Mines Ltd. Pegmatites contain small amount of allanite, uranothorite, uraninite, pyrochlore and fergusonite.
Faraday Tp., con. XV, lot 6. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Faraday Township, Con. XV, Lot 6 Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. GSC 1970, Paper 69-45, p.447.	Cb	A calcite vein in granite pegmatite contains pyrochlore (betafite).
Faraday Tp., con. XV, lot 31. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (Silver Crater (Basin) Mine)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1943, Vol.52, pt.3, p.59. ODM 1949, Vol.58, pt.2, p.88. ODM 1956, Vol.65, pt.6, p.20, 123-132. ODM 1957, Vol.66, pt.3, p.76-78. GSC 1958, Econ. Geol. Ser.18, p.62-65. GSC 1970, Paper 69-45, p.205,444.	bio Cb	A carbonate body is 400 feet long, about 500 feet wide and extends for 350 feet down the dip. The rock consists of 70 to 80 percent calcite with biotite, soda hornblende, apatite, allanite, fluorite, molybdenite and pyrrhotite. Zones of pyrochlore (betafite) crystals have been followed by underground workings and a mineral analysis indicated 34 percent Cb_2O_5 and 19 percent U_3O_8.
Faraday Tp., con. A, lots 21-24. SE corner of NTS square: 31C/04W, Lat. 45°00', Long. 77°45'. (Bonville Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1956, Vol.65, pt.6, p.107-108. GSC 1970, Paper 69-45, p.443.	U Cb	1954: Twenty-five holes 9,642 feet drilled by Bonville Gold Mines Ltd. Pyrochlore grains occur in a hornblende syenite pegmatite associated with other radioactive minerals.
Faraday Tp., con. B, N½ lot 4. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (York River Occurrence)	ODM Map 1957-1, Cardiff and Faraday Tps. ODM 1967, IMR21, p.64.	U Cb	Pyrochlore occurs in a syenite pegmatite.
Herschel Tp., con. I, lot 30. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (D.A. Brown Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. GSC 1952, Econ. Geol. Ser.16, p.137 GSC 1970, Paper 69-45, p.445.	Cb	Pyrochlore-microlite is reported to occur in a zoned pegmatite.
Herschel Tp., con. XVI, lots 17-18. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (W.A. Patterson Occurrence)	ODM Map 1957b, Haliburton-Bancroft area ODM 1956, Vol.65, pt.6, p.134. GSC 1958, Econ. Geol. Ser.18, p.94. GSC 1970, Paper 69-45, p.205.	Cb	Euxenite-polycrase and eschynite-priorite have been identified from specimens taken from granite pegmatite exposed for widths up to 40 feet on a property held in 1956 by W.A. Patterson.
Herschel Tp., con. XVI, lot 31. SE corner of NTS square: 31E/01E, Lat. 45°00', Long. 78°00'. (Herschel Township, Con. XVI, Lot 31 Occurrence)	ODM Map 1957b, Haliburton-Bancroft area.	Cb	Pyrochlore-microlite occurs in a zoned pegmatite.
Herschel Tp., con. VIII, lot 39, west of Hastings Road. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Peter Rock Occurrence)	ODM Map 1957b, Haliburton-Bancroft area ODM 1956, Vol.65, pt.6, p.135. GSC 1970, Paper 69-45, p.444.	U Cb	A dike up to eleven feet wide consists of feldspar, quartz, and biotite with accessory amounts of pyrochlore, euxenite, uranothorite and allanite. 1955: Held by Peter-Rock Mining Company Ltd.
Herschel Tp., con. VIII, lot 40, west of Hastings Road. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Herschel Township Road, Con. VIII, Lot 40 Occurrence)	ODM Map 1957b, Haliburton-Bancroft area GSC 1970, Paper 69-45, p.205,444.	Cb	Pyrochlore-microlite and euxenite-polycrase is reported from this property.
Monteagle Tp., con. IV, lots 11 and 12. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (J. Quirk Occurrence)	ODM Map 1954-3, Monteagle and Carlow Tps. GSC 1962, Econ. Geol. Ser.16, p.272.	U Cb	Pyrochlore (ellsworthite), uranothorite and thorite occur in a granite pegmatite.
Monteagle Tp., con. VI, lot 20. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Plunkett Mine)	ODM Map 1954-3, Monteagle and Carlow Tps. ODM 1954, Vol.63, pt.6, p.40. ODM 1967, IMR21, p.64.	fel Cb	A pegmatite dike 20 feet wide contains pyrochlore (ellsworthite), euxenite, titanite and fluorite. 1921: American Molybdenite Company. 1927: S. Orser did further work with a total production of 2 cars of feldspar.
Monteagle Tp., con. VI, N½ lot 24. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (R. McCormack Showing)	ODM Map 1954-3, Monteagle and Carlqw Tps. ODM 1954, Vol.63, pt.6, p.42.	fel Cb	1926: P.J. Dwyer. Pyrochlore (ellsworthite), allanite, magnetite and titanite occur in a dike 15 to 20 feet wide.

Location and Name	References	Metals	Remarks
Monteagle Tp., con. VII, lot 14. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Genesee No. 2 Mine)	ODM Map 1954-3, Monteagle and Carlow Tps. ODM 1954, Vol.63, pt.6, p.48-49,69. GSC 1952, Econ. Geol. Ser.16, p.144. GSC 1970, Paper 69-45, p.205,446.	fel Cb	1926-31: Operated by Genesee Feldspar Company. 1948-51: Operation resumed by D. Vardy and W. Jessop with total production of 2,846 tons of feldspar. A zoned pegmatite, 20 feet wide, contains accessory amounts of pyrochlore-microlite and euxenite.
Monteagle Tp., con. VII, N½ of lots 18 and 19. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (P. MacDonald Mine)	ODM Map 1954-3, Monteagle and Carlow Tps. ODM 1954, Vol.63, pt.6, p.43-47. GSC 1932, Econ. Geol. Ser.11, p.200-209.	fel U Cb	1919-35: Property owned by Peter MacDonald, operated by Pennsylvania Feldspar Company, Verona Mining Company and Genesee Feldspar Company and produced 35,048 tons of feldspar. A coarsely crystalline zoned pegmatite contained pyrochlore (ellsworthite), cyrtolite, allanite and uranothorite.
Monteagle Tp., con. VII, lot 21. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Cairns Mine)	ODM Map 1954-3, Monteagle and Carlow Tps. ODM 1954, Vol.63, pt.6, p.47.	fel Cb	1920-24: Operated by Messrs. Dillon and Mills, by Feldspar Mines Corporation and by P.J. Dwyer with a total production of 2 cars of feldspar. Pyrochlore (ellsworthite) occurs with titanite, magnetite and pyrite.
Monteagle Tp., con. VIII, lot 17. SE corner of NTS square: 31F/04W, Lat. 45°00', Long. 77°45'. (Woodcox Mine)	ODM Map 1954-3, Monteagle and Carlow Tps. GSC 1932, Econ. Geol. Ser.11, p.209-213. ODM 1954, Vol.63, pt.6, p.50-51. GSC 1952, Econ. Geol. Ser.16, p.149. GSC 1970, Paper 69-45, p.161,446,478.	fel Cb	Feldspar dike exposed for a length of 330 feet and a width of 30 feet. Granite pegmatite contains dark coloured radioactive minerals, zircon, columbite, calciosamarskite and pyrochlore (hatchettolite). 1921-23: From open pit 4,087 tons of feldspar mined by Feldspar Mines Corporation. 1948-49: Exploration by Northern Uranium Mines Ltd.

KENORA DISTRICT

Location and Name	References	Metals	Remarks
Brownridge Tp., S. of Mavis Lake. SE corner of NTS square: 52F/15E, Lat. 49°45', Long. 92°30'. (Mavis Lake Occurrence)	ODM Map 2115, Kenora-Fort Frances Sheet. GSC 1970, Paper 69-45, p.161.	Cb Li	Spodumene-bearing pegmatites contain columbite-tantalite.

KENORA DISTRICT, PATRICIA PORTION

Location and Name	References	Metals	Remarks
SE corner of NTS square: 53A/12E, Lat. 52°30', Long. 88°30'. (Schryburt Occurrence)	Aeromagnetic map ODM-GSC 938G. GSC Map 2-1963. GSC 1963, Paper 63-1, p.43-44. Heinrich(1966, p.398).	Cb ap	1960: 30 claims staked by Many Lakes Exploration Company. The complex is principally carbonatite and varies from nearly pure calcite to almost pure apatite with bands of massive magnetite several feet in thickness. Pyrochlore is present as an accessory mineral.

LANARK COUNTY

Location and Name	References	Metals	Remarks
Bathurst Tp., con. IX, N½ lot 22. SE corner of NTS square: 31C/16W, Lat. 44°45', Long. 76°15'. (C. Innes Occurrence)	ODM Map 2054, Gananoque area. GSC 1952, Econ. Geol. Ser.16, p.137. GSC 1962, Econ. Geol. Ser.16, p.248. GSC 1970, Paper 69-45, p.205.	fel Cb	Euxenite, fergusonite and cyrtolite have been identified from the dump of a feldspar operation.
North Burgess Tp., con. VI, lot 23. SE corner of NTS square: 31C/16W, Lat. 44°45', Long. 76°15'. (J.P. Quinn Occurrence)	ODM Map 2054, Gananoque area. GSC 1958, Econ. Geol. Ser.18, p.95.	Cb	Pyrochlore-microlite and euxenite-polycrase reported.
South Sherbrooke Tp., con. V, lot 13. SE corner of NTS square: 31C/15E, Lat. 44°45', Long. 76°30'. (Maberly Occurrence)	ODM Map 2054, Gananoque area. GSC 1932, Econ. Geol. Ser.11, p.262. GSC 1952, Econ. Geol. Ser.16, p.146. GSC 1970, Paper 69-45, p.204-205.	Cb	Euxenite has been found in a pegmatite dike on the Maberly property at one time held by Orser-Kraft Feldspar Company.

MUSKOKA DISTRICT

Location and Name	References	Metals	Remarks
Chaffey Tp., con. V, lot 23. SE corner of NTS square: 31E/6E, Lat. 45°15', Long. 79°00'. (Melissa Occurrence)	GSC 1970, Paper 69-45, p.445. ODM 1967, IMR21, p.65.	Cb	Pyrochlore-microlite is reported to occur in granite pegmatite near the Melissa Post Office. 1948: International Ceramic Mining Company.

NIPISSING DISTRICT

Location and Name	References	Metals	Remarks
Butt Tp., con. VII, S½ lot 13, adjacent to Mica Lake. SE corner of NTS square: 31E/11E, Lat. 45°30', Long. 79°00'. (D'Eldona Occurrence)	ODM 1919, Vol.28, pt.1, p.94-95. GSC 1960, Paper 59-10, p.35. Survey of Mines 1955, p.259. GSC 1958, Econ. Geol. Ser.18, p.91.	Cb U mus	Open cut 40 by 4 by 7 feet deep on pegmatite dike from which about a ton of mica was sold. Columbite, uraninite, fergusonite, and euxenite are present in small amounts. 1955: Property held by D'Eldona Gold Mines Ltd.
Butt Tp., con. IX, S½ lot 5, showing exposed in waterfall on the Magnetawan River. SE corner of NTS square: 31E/11E, Lat. 45°30', Long. 79°00'. (Yankee Dam Occurrence)	GSC 1958, Econ. Geol. Ser.18, p.91. GSC 1970, Paper 69-45, p.445.	Cb	Pyrochlore-microlite associated with fergusonite and eschynite-priorite occurs in granite pegmatite.
Calvin Tp., con. I, lots 11 and 12. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (W. Stewart Occurrence)	GSC 1952, Econ. Geol. Ser.16, p.138. GSC 1970, Paper 69-45, p.209.	U Cb	Fergusonite was identified in samples from the property.
Calvin Tp., con. II, lots 15, 16 and 17. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (Calvin Township, Con. II, Lots 15, 16 and 17 Occurrence)	GSC 1970, Paper 69-45, p.447. Canadian Mineralogist 1962, Vol.7, pt.2, p.314-318.	Cb	Pyrochlore occurs in blebs up to an inch in diameter with small amounts of associated euxenite in the border phase of zoned pegmatites.
Calvin Tp., con. IV, lot 22. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (Calvin Township, Con. IV, Lot 22 Occurrence)	GSC 1962, Econ. Geol. Ser.16, p.250. Mines Branch, Ottawa, Publication 731.	Cb	Euxenite is reported to be present in a granite pegmatite.
Calvin Tp., con. IX, lot 20. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (Molybdenum Corporation Occurrence)	GSC 1932, Econ. Geol. Ser.11, p.189. GSC 1952, Econ. Geol. Ser.16, p.147-148. GSC 1960, Paper 59-10, p.21-22. GSC 1970, Paper 69-45, p.206.	U Cb	Circa 1900: Feldspar recovered by Andrew Ryan. Circa 1950: Molybdenum Corporation of America optioned the property from Bobjo Mines Ltd. and did bulk sampling. A zoned pegmatite 20 feet wide contains scattered grains of columbite, euxenite-polycrase and allanite.
Calvin Tp. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (J.W. MacFarlane Occurrence)	GSC 1952, Econ. Geol. Ser.16, p.137.	U Cb	Granitic pegmatite is radioactive and contains allanite and euxenite-polycrase.
Dickens Tp., con. V, lot 27. SE corner of NTS square: 31F/12W, Lat. 45°30', Long. 77°45'. (N.B. Davis Occurrence)	ODM 1944, Vol.53, pt.3, p.122-123. GSC 1952, Econ. Geol. Ser.16, p.142. GSC 1970, Paper 69-45, p.206,447.	mus fel Cb	1943: Muscovite and feldspar recovered by N.B. Davis. Euxenite, pyrochlore (ellsworthite) and monazite occur in a pegmatite. Pyrochlore-microlite also is present on the same property.
Dickens Tp., con. XIII, lot 9. SE corner of NTS square: 31F/12W, Lat. 45°30', Long. 77°45'. (F.G. Armstrong Occurrence)	GSC 1932, Econ. Geol. Ser.11, p.192-194. GSC 1952, Econ. Geol. Ser.16, p.142.	Cb	A pemgatite dike 50 feet wide consists of feldspar, quartz and muscovite with small amounts of garnet, monazite and either euxenite or samarskite.
Mattawan Tp., con. II, lot 29. SE corner of NTS square: 31E/07W, Lat. 46°15', Long. 78°45'. (C. Palangio Occurrence)	ODM Map 53d, Mattawan-Olrig area. GSC 1952, Econ. Geol. Ser.16, p.147.	U Cb	A speciman from the property contained euxenite-polycrase.
Mattawan Tp., con. III, lot 29. SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (O'Brien and Fowler Occurrence)	ODM Map 53d, Mattawan-Olrig area. ODM 1944, Vol.53, pt.6, p.46-47. GSC 1932, Econ. Geol. Ser.11, p.189-191. GSC 1952, Econ. Geol. Ser.16, p.148. GSC 1970, Paper 69-45, p.206.	fel Cb	1925-26: Feldspar produced by O'Brien and Fowler Ltd. 1950: Bulk sampling by Molybdenum Corporation of America. A dike consisting mainly of feldspar and quartz contains euxenite in masses from pea size up to a diameter of five inches.
Murchison Tp., con. IV, N½ lots 14 and 15. SE corner of NTS square: 31E/09E, Lat. 45°30', Long. 78°00'. (J.G. Gole Mine)	ODM 1944, Vol.53, pt.3, p.120. ODM 1945, Vol.54, pt.2, p.4. ODM 1967, IMR21, p.21. GSC 1952, Econ. Geol. Ser.16, p.147. GSC 1970, Paper 69-45, p.209.	qtz fel Cb	1938-44: 8,639 tons of quartz and 1,520 tons of feldspar mined by D.L. Rose and Company also called Madawaska Feldspar. Crystals of fergusonite up to two inches in length are found in biotite in the pegmatite.
Murchison Tp., con. XI, lot 17. SE corner of NTS square: 21E/09E, Lat. 45°30', Long. 78°00'. (Cameron and Aleck Mine)	ODM 1967, IMR21, p.21,65.	fel Cb	1949-53: 1,869 tons of feldspar produced by Cameron and Aleck. Fergusonite and allanite are present in granite pegmatite.
Murchison Tp., con. VIII, lot 22. SE corner of NTS square: 31E/09E, Lat. 45°30', Long. 78°00'. (Cameron Mine)	ODM 1944, Vol.53, pt.3, p.121. GSC 1952, Econ. Geol. Ser.16, p.138. GSC 1970, Paper 69-45, p.205.	fel Cb	1942-43: Property worked for feldspar by Keystone Contractors Ltd. 1950: Worked by K. Bowser. Euxenite and allanite occur in the pegmatite dike.
Olrig Tp., con. C, SE¼ of S½ lot 1, (claim S36274). SE corner of NTS square: 31L/07W, Lat. 46°15', Long. 78°45'. (Mica Company of Canada Occurrence)	ODM Map 53d, Mattawan-Olrig area. ODM 1944, Vol.53, pt.6, p.21,32-33.	mus Cb	1943: Muscovite recovered by the Mica Company of Canada Ltd. A dike 8 feet wide consists of feldspar, quartz, muscovite, biotite, tourmaline and a black mineral resembling euxenite.

Location and Name	References	Metals	Remarks
Peck Tp., cons. III and IV, lot 6. SE corner of NTS square: 31E/07W, Lat. 46°15', Long. 78°45'. (J.G. McLennan Occurrence)	ODM Map 52a, Haliburton area. ODM 1967, IMR21, p.65.	Cb	Pyrochlore occurs in a granite pegmatite.
Sabine Tp., con. I, S½ lots 2 to 8. SE corner of NTS square: 31E/08E, Lat. 45°15', Long. 78°00'. (Sabine Township, Con. I, S½ Lots 2-8 Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. Survey of Mines 1957, p.252. GSC 1958, Econ. Geol. Ser.18, p.96.	U Cb	1956: Stripping and geological and radiometric surveys by Sabine Uranium Mines Ltd. Eschynite-priorite reported.
Sabine Tp., con. I, lot 28. SE corner of NTS square: 31E/08E, Lat. 45°15', Long. 78°00'. (Mahoney and Morin Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. GSC 1970, Paper 69-45, p.205. GSC 1932, Econ. Geol. Ser.11, p.195-196. ODM 1967, IMR21, p.21.	Cb	1924-25: 200 tons of feldspar produced. A dike 20 feet wide contains euxenite in masses up to four inches in diameter.
Sabine Tp., con. XV, S½ lot 32. SE corner of NTS square: 31E/08E, Lat. 45°15', Long. 78°00'. (Gal-Wood Occurrence)	ODM 1971, OFR 5057, p.53-54. Northern Miner Sept. 6, 1956, p.	U Cb	1956: Open cut, 25 feet by 30 feet, excavated by Gal-Wood Mines Ltd. A coarse-grained pegmatite consists of feldspar, quartz, biotite and a radioactive mineral identified as euxenite-polycrase.
Springer Tp., con. VI, SW¼ of N½ lot 5, carbonate veins. SE corner of NTS square: 31E/05W, Lat. 45°15', Long. 79°45'. (Lavergne Occurrence)	ODM Map 2188, Sudbury-Cobalt Sheet. ODMNA Assess. Work Lib., Toronto, File 63A.556 rept. and map. ODM 1971, GR94, p.85, Map 2216.	Ce fl	1968-69: Geological mapping, one hole 706 feet by Geophysical Engineering & Survey Ltd. Carbonate veins in fenite contain bastnaesite (fluorcarbonate of barium and the cerium group metals), fluorite, pyrite and iron-titanium oxide minerals. No columbium or uranium mineralization was reported.
SE corner of NTS square: 31L/05E, Lat. 46°15', Long. 79°30', Burritt Island, Lake Nipissing. (Burritt Island Occurrence)	ODM Map 2216, North Bay area. ODM 1971, GR94, p.51,81. GSC Aeromagnetic Map 1488G.	U	Disseminated radioactive pyrochlore crystals are present in a carbonatite intrusion exposed for a length of 200 feet and a width of 50 feet.
SE corner of NTS square: 31K/05W, Lat. 46°15', Long. 79°45', Iron Island, Lake Nipissing. (Iron Island Occurrence)	ODM 1971, GR94, Fig.5, p.80. ODM 1971, GR94, p.50-51, 79-81. ODM Map 2216, North Bay area.	Cb	1951-54: 26 drill holes 21,300 feet by Nipiron Mines Ltd. Hole No. / Core Length feet / Cb_2O_5 percent / U_3O_8 percent 13 / 5 / 0.30 / 0.10 9 / 0.30 / 0.07 20 / 0.30 / 0.03

PARRY SOUND DISTRICT

Location and Name	References	Metals	Remarks
Carling Tp., Wall Island. SE corner of NTS square: 41H/08E, Lat. 45°15', Long. 80°00'. (Wall Island Occurrence)	ODM Map 2118, Parry Sound-Huntsville area. ODM 1967, IMR21, p.65. ODM 1971, OFR 5057, p.62-64.	U Cb	Pyrochlore and uranophane occur in a radioactive granite pegmatite.
Chapman Tp., con. VIII, lot 3. SE corner of NTS square: 31E/12E, Lat. 45°30', Long. 79°30'. (W. Raney Occurrence)	GSC 1962, Econ. Geol. Ser.16, p.256. GSC 1970, Paper 69-45, p.445.	Cb	Granitic rock contains columbite-tantalite and pyrochlore-microlite on property owned by W. Raney, Sr.
Conger Tp., con. IX, lots 9-10. SE corner of NTS square: 31E/04W, Lat. 45°00', Long. 79°45'. (McQuire Mine)	ODM Map 2118, Parry Sound-Huntsville area. ODM 1942, Vol.51, pt.2, p.57. GSC 1932, Econ. Geol. Ser.11, p.174-186. ODM 1967, IMR21, p.21. GSC 1970, Paper 69-45, p.478.	U Cb	1925: 618 tons of feldspar produced by McQuire and Robinson from pit on the lot line. The pegmatite dike contains uraninite, calciosamarskite, thucolite and cyrtolite.
Conger Tp., con. IX, lot 10. SE corner of NTS square: 31E/04W, Lat. 45°00', Long. 79°45'. (Conger Township, Con. IX, Lot 10 Occurrence)	ODM Map 2118, Parry Sound-Huntsville area. GSC 1952, Econ. Geol. Ser.16, p.141.	Cb	Calciosamarskite was found in a dike.
Conger Tp., con. X, lot 7. SE corner of NTS square: 31E/04W, Lat. 45°00', Long. 79°45'. (Brignall Mine)	ODM Map 2118, Parry Sound-Huntsville area. GSC 1952, Econ. Geol. Ser.16, p.141. ODM 1948, Vol.57, pt.2, p.2-3. GSC 1960, Paper 59-10, p.22. ODM 1967, IMR21, p.68. GSC 1970, Paper 69-45, p.161.	fel Cb	1923-25: Brignall property operated by McQuire and Robinson. 1946-47: Feldspar mined by Opeongo Mining Company and property taken over by Conger Feldspar Mining Company Ltd. Columbite and euxenite crystals up to an inch in length occur associated with muscovite, garnet and feldspar in a lenticular zone.
Henvey Tp., con. I, lot 6, about 200 yards south of Britt railway station. SE corner of NTS square: 41H/05E, Lat. 45°45', Long. 80°30'. (Britt Station Occurrence)	ODM Map 51a, Portions of the Districts of Parry Sound and Muskoka. GSC 1960, Paper 59-10, p.20.	Cb	A pegmatite dike contains small amounts of euxenite, allanite, thorianite and thorite. Circa 1960: Surface work and diamond drilling.

Location and Name	References	Metals	Remarks
Henvey Tp., con. A, lot 3, ¼ mile north of Britt station. SE corner of NTS square: 41H/05E, Lat. 45°45', Long. 80°30'. (Ambeau Mine)	ODM Map 51a, Portions of the Districts of Parry Sound and Muskoka. ODM 1942, Vol.51, pt.2, p.58. GSC 1932, Econ. Geol. Ser.11, p.173. GSC 1960, Paper 59-10, p.18-19. GSC 1970, Paper 69-45, p.203,207.	Cb	1926-27: Property called Ambeau Mine with production of 1,000 tons of feldspar by Wanup Feldspar Mines Ltd. A granitic pegmatite 25 feet wide contains a few crystals of euxenite and eschynite-priorite.
North Himsworth Tp., NE part, Callander Bay, Lake Nipissing. SE corner of NTS square: 31L/03W, Lat. 46°00', Long. 79°15'. (Callander Bay Occurrence)	ODM Map 2216, North Bay area. ODM 1971, GR94, p.52-53,83-85. Files: ODMNA Assess. Work Lib., Toronto, 83.1-53, North Himsworth Rept. 1-4-243.	Cb	1956: 4 holes 645 feet by Beaucage Mines Ltd. 1966-67: Magnetic and electromagnetic surveys, 7 vertical drill holes 1,190 feet by Min-Ore Mines Ltd. Surface samples of carbonatite from McPherson Island contained up to 0.05 percent Cb_2O_5. Drill hole 67-6 from 80 to 92 feet assayed 0.03 percent Cb_2O_5.

PETERBOROUGH COUNTY

Location and Name	References	Metals	Remarks
Cavendish Tp., con. III, lot 3. SE corner of NTS square: 31D/09W, Lat. 44°30', Long. 78°15'. (Windover Occurrence)	ODM 1956, Vol.65, pt.6, p.167-168. GSC 1970, Paper 69-45, p.209.	Cb	1955: Stripping, trenching and nine drill holes 3,766 feet by Silanco Mining and Refining Company Ltd. A pegmatite dike at No. 3 showing consists of feldspar, with accessory amounts of magnetite, zircon, sphene, pyrite, uranothorite and fergusonite.
Cavendish Tp., con. V, lot 14. SE corner of NTS square: 31D/09W, Lat. 44°30', Long. 78°15'. (Cromwell Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. ODM 1956, Vol.65, pt.6, p.20. GSC 1970, Paper 69-45, p.443.	Cb	Pyrochlore (betafite) occurs in a granite pegmatite and a mineral analysis indicated 30 percent Cb_2O_5.
Cavendish Tp., con. VIII, IX, Lot 15. SE corner of NTS square: 31D/16W, Lat. 44°45', Long. 78°15'. (Cavendish Township, Con. VIII, IX, Lot 15 Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. GSC 1958, Econ. Geol. Ser.18, p.92.	Cb	Fergusonite has been identified.
Galway Tp., con. VIII, lot 26. SE corner of NTS square: 31D/09W, Lat. 44°30', Long. 78°15'. (Lun-Echo Occurrence)	ODM Map 1957b, Haliburton-Bancroft area. GSC 1958, Econ. Geol. Ser.18, p.93. Survey of Mines 1956, p.218.	Cb	Pyrochlore-microlite identified. 1956: Property held by Lun-Echo Gold Mines Ltd.

RENFREW COUNTY

Location and Name	References	Metals	Remarks
Alice Tp., con. XV, lot 13. SE corner of NTS square: 31F/14W, Lat. 45°45', Long. 77°15'. (R. McCoshen Occurrence)	ODM Map 53b, Renfrew area. GSC 1970, Paper 69-45, p.206. GSC 1962, Econ. Geol. Ser.16, p.246.	Cb	Euxenite-polycrase occurs in a granite pegmatite.
Lyndoch Tp., con. XV, lot 23. SE corner of NTS square: 31F/06W, Lat. 45°15', Long. 77°15'. (T.B. Coldwell Occurrence)	ODM Map 1952-2, Brudenell-Raglan area. OBM 1898, Vol.7, pt.3, p.234-237. ODM 1943, Vol.52, pt.3, p.97-98. GSC 1932, Econ. Geol. Ser.11, p.228-230. GSC 1936, Mem. 195, p.30. ODM 1953, Vol.62, pt.5, p.36-42. GSC 1960, Paper 59-10, p.25. GSC 1970, Paper 69-45, p.205.	fel be Cb	1926: Beryl recovered by T.B. Coldwell. 1939: Production of beryl and feldspar by Canadian Beryllium Mines and Alloys Ltd. Columbite masses varied in size from half inch spheres to plates a foot in diameter, less than half an inch in thickness. Euxenite-polycrase (lyndochite) is associated with columbite and monazite, and columbium anatase has been identified.
Lyndoch Tp., con. XV, lot 25. SE corner of NTS square: 31F/06W, Lat. 45°15', Long. 77°15'. (Universal Light Metals Occurrence)	ODM Map 1953-2, Brudenell-Raglan area. ODM 1953, Vol. 62, pt.5, p.83-84. GSC 1952, Econ. Geol. Ser.16, p.146.	be Cb	Circa 1952: Universal Light Metals Company carried out stripping and pitting. Columbite, euxenite-polycrase (lyndochite) and monazite are associated with the beryl.
Lyndoch Tp., con. XV, lots 30 and 31. SE corner of NTS square: 31F/06W, Lat. 45°15', Long. 77°15'. (Renfrew Minerals Occurrence)	ODM Map 1953-2, Brudenell-Raglan area. GSC 1932, Econ. Geol. Ser.11, p.230 ODM 1953, Vol.62, pt.5, p.42-45. GSC 1936, Mem. 195, p.30-31. GSC 1960, Paper 59-10, p.25. GSC 1970, Paper 69-45, p.161.	be fel Cb	1935-36: Feldspar produced by Renfrew Minerals Ltd. 1948-50: 300 tons of feldspar and 57,100 pounds of beryl valued at $7,882 produced by Canadian Beryllium Mines and Alloys Ltd. Columbite and euxenite occur with magnetite in the dike.
Raglan Tp., con. XVIII, lots 3 and 4. SE corner of NTS square: 31F/05E, Lat. 45°15', Long. 77°30'. (Craigmont Corundum Mine)	ODM Map 1953-2, Brudenell-Raglan area. ODM 1953, Vol.62, pt.5, p.56-60,85,102-116. GSC 1932, Econ. Geol. Ser.11, p.230-231. GSC 1952, Econ. Geol. Ser.16, p.141.	cor	1899-1908: Production of corundum by Canada Corundum Company. 1909-13: Operations carried on by Manufacturers Corundum Company. 1919-21: Operated by Corundum Limited. 1944-46: Wartime Metals Corporation retreated the tailings. Total production 11,605 tons of corundum produced, valued at $1,224,473. Allanite and euxenite occur in the pegmatite workings.

Location and Name	References	Metals	Remarks
Richards Tp., con. XIV, lot 2. SE corner of NTS square: 31F/13E, Lat. 45°45', Long. 77°30'. (E. Betz Occurrence)	ODM Map 53b, Renfrew area. GSC 1958, Econ. Geol. Ser.18,p.96.	Cb	Fergusonite and eschynite-priorite reported.

SUDBURY DISTRICT

Location and Name	References	Metals	Remarks
Carter Tp., near Mile 98 and Bethnal station. SE corner of NTS square: 41P/04W, Lat. 47°45', Long. 81°45'. (Leach and Johns Occurrence)	ODM Map 2046, Timmins-Kirkland Lake Sheet. GSC 1932, Econ. Geol. Ser.11, p.173. GSC 1952, Econ. Geol. Ser.16, p.150.	fel Cb	A radioactive mineral identified as probably euxenite occurs in a pegmatite dike which was explored for feldspar.
Chewitt Tp., con. III, NE¼ of N½ lot 11. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Continental Occurrence)	ODM Map 2007, Nemegosenda Lake. ODM 1961, GR3, p.50.	Cb	Circa 1960: Property owned by Continental Wood Products, a subsidiary of Canadian International Paper Company. A dike four feet wide contains orthoclase, aegirite and visible pyrochlore.
Dill Tp., con. II, W½ lot 2. SE corner of NTS square: 41I/07W, Lat. 46°15', Long. 80°45'. (Cubar Occurrence)	GSC 1970, Paper 69-45, p.207,447. GSC 1952, Econ. Geol. Ser.16, p.142. GSC 1958, Econ. Geol. Ser.18, p.93.	Cb	Uranian pyrochlore and euxenite occurs in granite pegmatite on the property of Cubar Uranium Mines Ltd.
Dill Tp., con. III, lot 4. SE corner of NTS square: 41I/07W, Lat. 46°15', Long. 80°45'. (Dill Township, Con. III, Lot 4 Occurrence)	GSC 1932, Econ. Geol. Ser.11, p.171 GSC 1970, Paper 69-45, p.161.	fel Cb	One carload of feldspar was shipped from a pegmatite dike which is exposed for a length of 100 feet and for widths up to 40 feet. Microcline, quartz, muscovite, biotite, garnet and plagioclase are the main minerals present. Columbite (toddite) occurs sparingly in grains usually not over ¼ inch in diameter.
Lackner Tp., southwest part, drilling from 2,300 to 4,800 feet SE of Lackner Lake. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (M. Silverman Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.68. Files: ODMNA Assess. Work Lib., Toronto, 63.518, Lackner Tp., Rept. 11,12,13,22,23,24.	Cb	1954: Magnetic survey, 14 drill holes 4,117 feet. The highest assay obtained from drilling 0.29 percent Cb_2O_5 over 5 feet. Work by M. Silverman.
Lackner Tp., southwest part, drilling 5,200 to 6,400 feet SE of Lackner Lake. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Apamag Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.60. Files: ODMNA Assess. Work Lib., Toronto, Lackner Tp., Rept. 19,20,21.	Cb	Magnetic survey by Dominion Gulf 1955: 5 drill holes 2,130 feet by Apamag Mines Ltd.
Lackner Tp., northwest part, drilling 1,900 to 2,200 feet east of No. 2 post, S58584. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Claymac Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.60. Files: ODMNA Assess. Work Lib., Toronto, 63.553, Lackner Tp., Rept. 15,16.	Cb	1954: Magnetic survey, 9 drill holes 2,722 feet. Hole C6 from 203 to 274 feet assayed 0.13 percent Cb_2O_5. Work by Claymac Mines Ltd.
Lackner Tp., northwest part, surveyed claims S53643-53645, 54097, 54098, 54101. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (LeBrasseur-Derraugh-MacDonnell Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.5.	Cb	1952: Magnetic survey, 4 holes 1,007 feet jointly by LeBrasseur Lackner Incorporated, Derraugh Lackner Incorporated and MacDonnell Lackner Incorporated. Small pods of magnetite and apatite assay up to 1 percent Cb_2O_5.
Lackner Tp., northwest part, east of Hebden (Portage) Lake. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Chyka Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.68-69. Files: ODMNA Assess. Work Lib., Toronto, 63.552, Lackner Tp., Rept. 10.	Cb	1951-54: Magnetic survey, 31 drill holes 11,358 feet by Chyka Mines Ltd. The Portage Complex is a subsidiary complex of Lackner Lake Complex with the main rock type, ijolite consisting of nepheline and soda pyroxene. In drill holes 18 and 19 sections up to 15 feet long of biotite, carbonatite or biotite-pyroxene rock contain up to 0.17 percent Cb_2O_5 and a length of 55.8 feet averages 0.069 percent Cb_2O_5.
Lackner Tp., southwest part, S108080-108086, S108542-108547, etc. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Falconbridge Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.60-61. Files: ODMNA Assess. Work Lib., Toronto, 63.333, 63.1016, Lackner Tp., Rept. 18.	Cb	1952-54: Geological and magnetic surveys, 3 holes 1,988 feet by Dominion Gulf Company. Hole D1 from 400 to 600 feet assayed 39 percent Fe, 5 percent P and 0.15 percent Cb_2O_5. 1959: Magnetic survey by Falconbridge Nickel Mines Ltd.
McNaught Tp., SE part, drilling 2,400 to 4,300 feet SW of No. 3 post, S52494. SE corner of NTS square: 41O/04E, Lat. 47°45', Long. 83°00'. (Ontario Rare Metals Occurrence)	ODM Map 2008, Lackner Lake area. ODM 1961, GR3, p.68. Files: ODMNA Assess. Work Lib., Toronto, 63.483, McNaught Tp., Rept. 5-5-261.	Cb	1954-55: Magnetic survey. 5 diamond drill holes 2,281 feet by Ontario Rare Metals Ltd. Traces of columbium were obtained from assays of drill core.
Servos Tp., con. VI, lot 6. SE corner of NTS square: 41I/02E, Lat. 46°00', Long. 80°30'. (Graham Lake Occurrence)	ODMNA Map 2188, Sudbury-Cobalt Sheet. GSC 1970, Paper 69-45, p.207. GSC 1952, Econ. Geol. Ser.16, p.149.	Cb	Circa 1952: The Graham Lake Mining Syndicate held the property. Radioactive specimens from a granite pegmatite contain euxenite-polycrase.

Location and Name	References	Metals	Remarks
Whalen Tp. SE corner of NTS square: 41P/13W, Lat. 47°45', Long. 81°45. (Redore Occurrence)	GSC Aeromagnetic Map 1529G Canadian Register of Dormant and Defunct Companies, p.329. ODM 1967, IMR21, p.68	Cb	1940: Work by Redore Mining Co. Ltd. on columbite-tantalite mineralization in granite pegmatite.
Whitefish Lake Indian Reserve No. 6 south side of Nemag Lake. SE corner of NTS square: 41I/06W, Lat. 46°15', Long. 81°15'. (Nemag Lake Occurrence)	ODM Map P.597, Whitefish Lake Indian Reserve No. 6, Louise-Eden area. ODM 1969, MP32, p.37.	Cb	A circular mafic intrusion is cut by dikes of granite pegmatite up to six inches in width. Rutile in the dikes contains small amounts of columbium and tantalum.

THUNDER BAY DISTRICT

Location and Name	References	Metals	Remarks
SE corner of NTS square: 42E/02E, Lat. 49°00', Long. 86°30', north side of Prairie Lake. (Prairie Lake Occurrence)	ODM Map 2137, Nipigon-Schreiber Sheet. ODM-GSC Aeromagnetic Map 2148G. Abstract, 16th Annual Meeting, Institute on Lake Superior Geology 1970, p.44. Abstract, Annual Meeting Geological Assoc. of Canada - Mineralogical Association of Canada 1970. Canadian Mineralogist 1971, Vol.10, pt.5, p.921 (abs.).	Cb	A carbonatite-alkalic complex about a mile in diameter consists of an outer ring of calcite-biotite-apatite carbonatite and a central core of nepheline-pyroxene rocks. Pyroxene-rich rocks contain magnetite and biotite and nepheline-rich rocks are characterized by garnet, wollastonite, alkali feldspar and calcite. Geological age is 1,112 million years (Inst. Lake Superior). Pyrochlore is present in the carbonatites and in lenses of calcite in pyroxenites. Analyses of pyrochlore indicate that the Cb_2O_5 content varies from 25 to 65 percent and the U_3O_8 content from 1 to 30 percent.
SE corner of NTS square: 42E/05W, Lat. 49°00', Long. 87°45', north of Blay Lake. (Brink Occurrence)	ODM Map 2056, Georgia Lake area. ODM 1965, GR31, p.30,62.	Li Cb	The Brink dike has an average width of 13 feet and consists of feldspar with 25 percent spodumene and small amounts of columbite. Work by Aumacho River Mines Ltd.
SE corner of NTS square: 52H/01E, Lat. 49°00', Long. 88°00', west of Cosgrave Lake. (Moschuk-Neborac-Wilson Occurrence)	ODM Map 2056, Georgia Lake area. ODM 1965, GR31, p.47.	Li Cb	A pegmatite dike consists of feldspar, quartz, spodumene, muscovite and tourmaline. Small amounts of columbite and cassiterite are present. Work by prospectors Moschuk, Neborac and Wilson
SE corner of NTS square: 42E/05W, Lat. 49°15', Long. 87°45', west side of Parole Lake. (Parole Lake Occurrence)	ODM Map 2056, Georgia Lake area. ODM 1965, GR31, p.30,76-77.	Li Cb	A pegmatite dike consists of feldspar, quartz, spodumene, and muscovite with small amounts of columbite. Work by Jean Lake Lithium Mines Ltd.
SE corner of NTS square: 52H/08W, Lat. 49°15', Long. 88°15', east side of Forgan Lake. (Lun-Echo No. 1 Occurrence)	ODM Map 2056, Georgia Lake area. ODM 1965, GR31, p.81.	Li Cb	A pegmatite with an average width of 30 feet consists of feldspar, quartz and 30 percent spodumene. Columbite in crystals up to 1½ inches in diameter occurs sporadically. Work by Lun-Echo Gold Mines Ltd.

TIMISKAMING DISTRICT

Location and Name	References	Metals	Remarks
Auld Tp., con. IV, SE¼ of S½ lot 5, west shore of Lepha Lake. SE corner of NTS square: 41P/09E, Lat. 47°30', Long. 80°00'. (H.G. Walton Occurrence)	ODM Map 2046, Timmins-Kirkland Lake Sheet. GSC 1958, Econ. Geol. Ser.18, p.91 Files: ODMNA Resident Geologist, Kirkland Lake, Auld Tp., Walton-Quinlan.	U Cb	Narrow zones of aplite in diabase are radioactive and contain fergusonite. 1956-57: Trenching and two drill holes 69 feet by H.G. Walton.

SELECTED REFERENCES

Barton, William R.
1962: Columbium and tantalum; United States Bur. Mines, Information Circ. 8120, 110p.

Canadian Minerals Yearbook (annually)
- Dept. Energy, Mines and Resources, Ottawa, Mineral Resources Branch, Mineral Rept.

Canadian Mines Handbook (annually)
- Northern Miner Press Ltd., Toronto 247.

Černý, P., and Turnock, A.C.
1971: Niobium-tantalum minerals from granitic pegmatites at Greer Lake, southeast Manitoba; Canadian Mineralogist, Vol.10, pt.5, p.755-772.

Douglas, R.J.W. (Sci. Ed.)
1970: Tantalum and niobium; p.220 in Geology and economic minerals of Canada; 5th edition, Geol. Surv. Canada, Economic Geology Rept. No. 1, 838p. Accompanied by separate case with 8 maps and 4 charts.

Ellsworth, H.V.
1923: Recent discoveries of radioactive minerals in Ontario; Geol. Surv. Canada; Summ. Rept., pt.Cl, p.6-20.

1932: Rare-element minerals of Canada; Geol. Surv. Canada; Economic Geology Series No.11, 272p.

Gittins, J., Macintyre, R.M., and York, D.
1967: The ages of carbonatite complexes in eastern Canada; Canadian J. Earth Sci., Vol.4, No.4, p.651-655.

Gold, D.P., Valee, M., and Charette, J.-P.
1967: Economic geology and geophysics of the Oka alkaline complex, Quebec; CIM, Trans., Vol.70, p.245-258.

Hampel, C.A.
1961: Rare metals handbook; second edition, Reinhold Publishing Corp., New York, N.Y., 715p.

Heinrich, E.W.
1966: The geology of carbonatites; Rand McNally & Co., Chicago, 555p.

Hodder, R.W.
1958: Alkaline rocks and niobium deposits near Nemegos, Ontario; Geol. Surv. Canada, Paper 57-8, 15p.

Jones, R.J.
1954: Columbium and tantalum in Canada; Dept. Mines and Technical Surveys, Ottawa, Mines Branch, Mineral Resources Division, Mineral Resources Information Circ., MR8, 15p.

1957: Columbium (niobium) and tantalum; Dept. Mines and Technical Surveys, Ottawa, Mines Branch, Mineral Resources Division, Memorandum Series, No.135, 56p.

Lang, A.H.
1952: Canadian deposits of uranium and thorium; Geol. Surv. Canada, Economic Geology Series No.16, 173p.

Lang, A.H., Griffith, J.W., and Steacy, H.R.
1962: Canadian deposits of uranium and thorium; Geol. Surv. Canada, Economic Geology Series No.16 (second edition), 324p. Accompanied by Map 1045A-M1.

Metals Week (bi-weekly)
- McGraw-Hill Publications Co., 330 W. 42nd St., New York, N.Y. 10036, USA.

Parsons, G.E.
1961: Niobium-bearing complexes east of Lake Superior; Ontario Dept. Mines, GR3, 73p. Accompanied by Maps 2005, 2006, 2007, and 2008, scale 1 inch to 1/4 mile.

Rose, E.R.
1960: Rare earths of the Grenville Sub-Province, Ontario and Quebec; Geol. Surv. Canada, Paper 59-10, 41p.

Rowe, Robert B.
1954: Notes on the Newman columbium-uranium deposit, Lake Nipissing, Ontario; Geol. Surv. Canada, Paper 54-5, 25p.

1958: Niobium (columbium) deposits of Canada; Geol. Surv. Canada, Economic Geology Series No.18, 108p.

Sherwood, E.M.
1961: Columbium; p.149-177 in Rare metals handbook (C.A. Hampel, ed.), second edition, Reinhold Publishing Corp., New York, N.Y., 715p.

Steacy, H.R., and Jambor, J.L.
1969: Nature, distribution and content of zirconium and niobium in a silico-carbonatite sill at St-Michel, Montreal Island, Quebec; Geol. Surv. Canada, Paper 69-20, 7p.

Stevens, Richard F., Jr.
1965: Columbium; p.253-261 in Mineral facts and problems, 1965 edition, United States Bur. Mines, Bull.630, 1118p.

Survey of Mines (annually)
- The Financial Post, Maclean-Hunter Limited, Toronto 101.

Traill, R.J.
1970: A catalogue of Canadian minerals; Geol. Surv. Canada, Paper 69-45, 649p.

Tuttle, O.F., and Gittins, J. (Editors)
1966: Carbonatites; Interscience Publishers, a division of John Wiley and Sons Ltd., New York, N.Y., 591p.

Valée, M., and Dubuc, F.
1970: The St-Honoré carbonatite complex, Quebec; CIM, Bull., Dec., p.1384-1394 (or CIM, Trans., Vol.73, p.346-356).

Wigle, G.P.
1971: Columbium (niobium) and tantalum; p.193-198 in Canadian minerals yearbook 1969, Dept. Energy, Mines and Resources, Ottawa, Mineral Resources Branch, Mineral Rept. 19, 583p. Accompanied by Map 900A, 20th ed. 1970.

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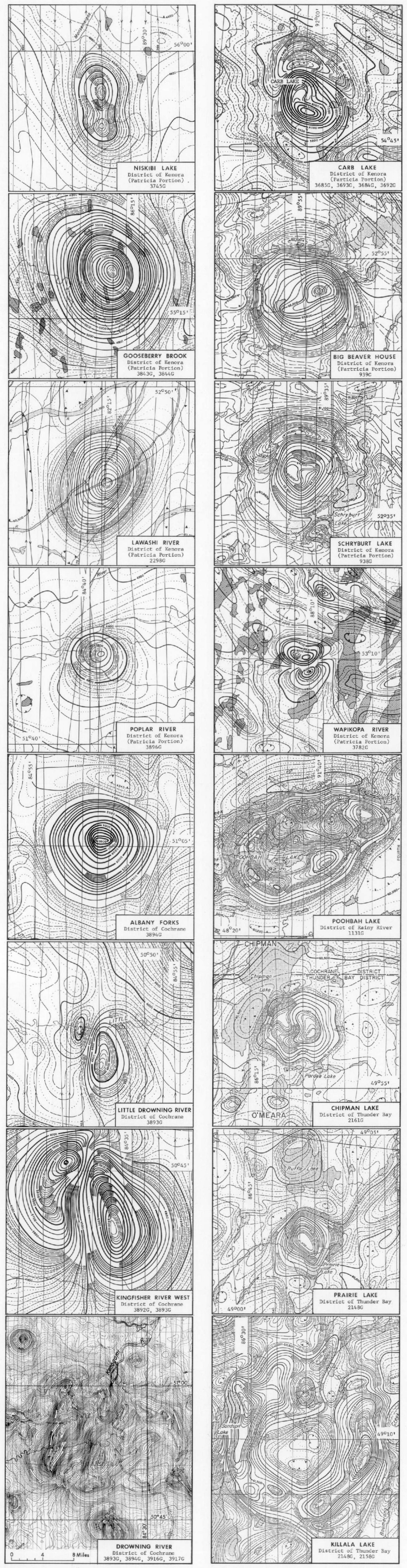
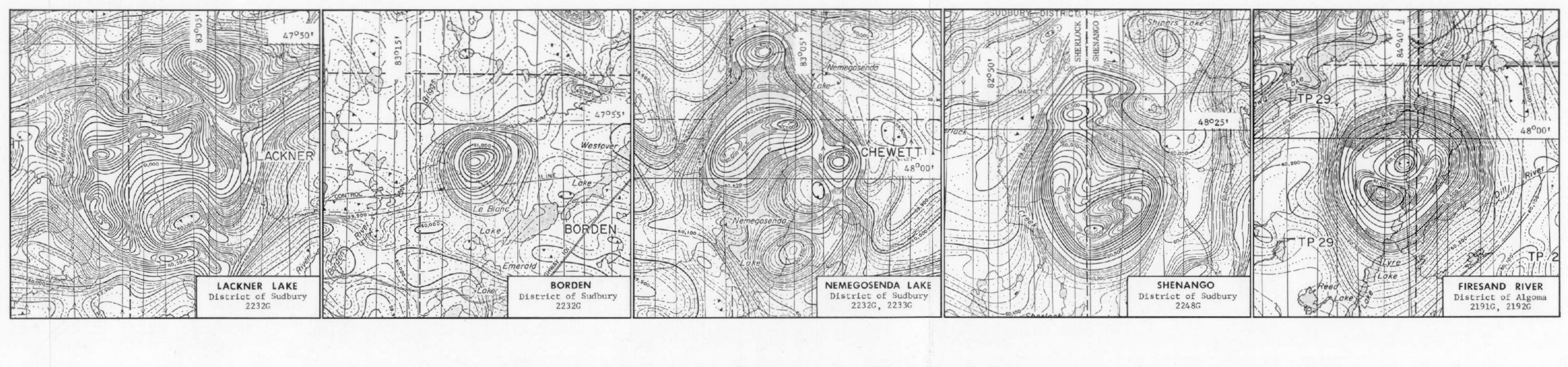
Ontario Department of Mines
and Northern Affairs

PRELIMINARY MAP No. P.452 (REVISED)

AEROMAGNETIC MAPS OF CARBONATITE-ALKALIC COMPLEXES IN ONTARIO





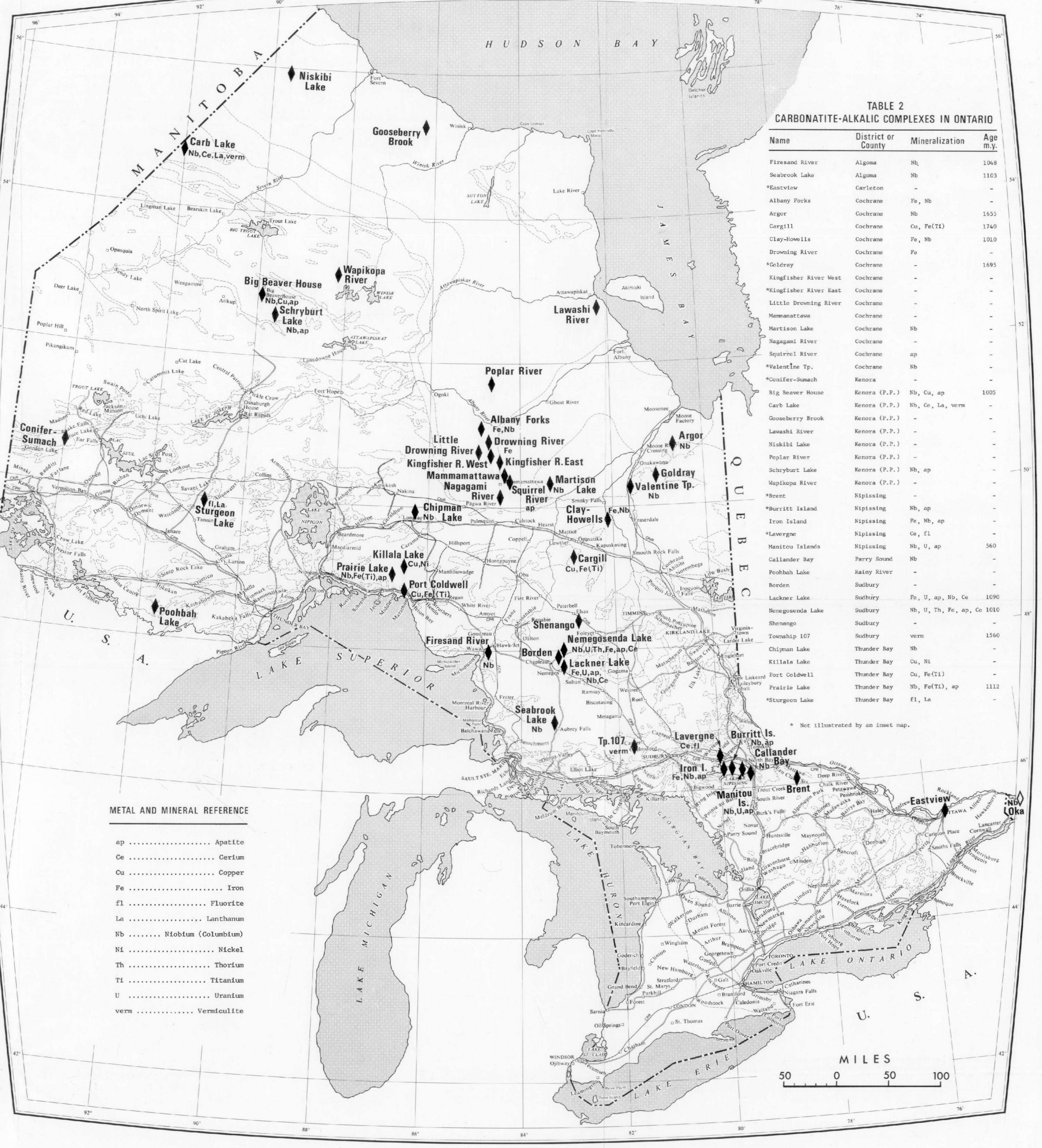


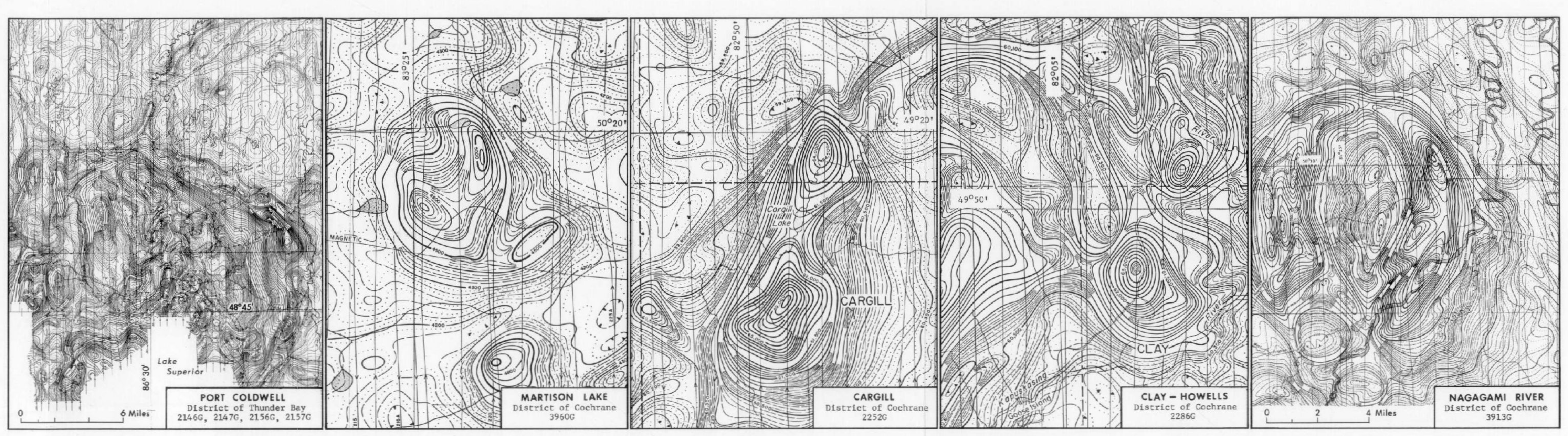
TABLE 2
CARBONATITE-ALKALIC COMPLEXES IN ONTARIO

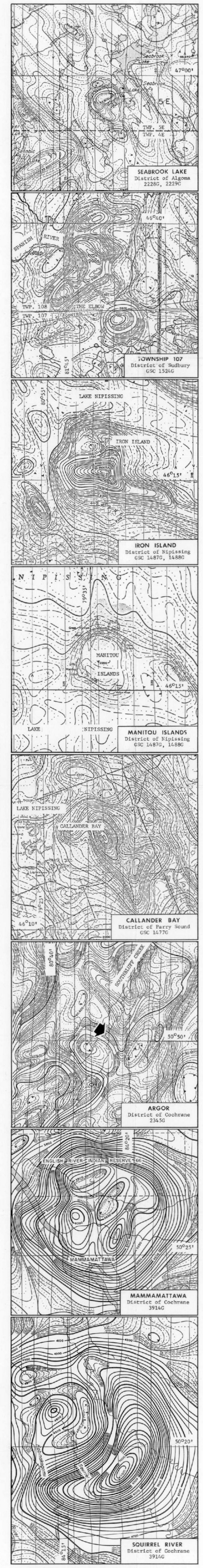
Name	District or County	Mineralization	Age m.y.
Firesand River	Algoma	Nb	1048
Seabrook Lake	Algoma	Nb	1103
*Eastview	Carleton	-	-
Albany Forks	Cochrane	Fe, Nb	-
Argor	Cochrane	Nb	1655
Cargill	Cochrane	Cu, Fe(Ti)	1740
Clay-Howells	Cochrane	Fe, Nb	1010
Drowning River	Cochrane	Fe	-
*Goldray	Cochrane	-	1695
Kingfisher River West	Cochrane	-	-
*Kingfisher River East	Cochrane	-	-
Little Drowning River	Cochrane	-	-
Mammamattawa	Cochrane	-	-
Martison Lake	Cochrane	Nb	-
Nagagami River	Cochrane	-	-
Squirrel River	Cochrane	ap	-
*Valentine Tp.	Cochrane	Nb	-
*Conifer-Sumach	Kenora	-	-
Big Beaver House	Kenora (P.P.)	Nb, Cu, ap	1005
Carb Lake	Kenora (P.P.)	Nb, Ce, La, verm	-
Gooseberry Brook	Kenora (P.P.)	-	-
Lawashi River	Kenora (P.P.)	-	-
Niskibi Lake	Kenora (P.P.)	-	-
Poplar River	Kenora (P.P.)	-	-
Schryburt Lake	Kenora (P.P.)	Nb, ap	-
Wapikopa River	Kenora (P.P.)	-	-
*Brent	Nipissing	-	-
*Burritt Island	Nipissing	Nb, ap	-
Iron Island	Nipissing	Fe, Nb, ap	-
*Lavergne	Nipissing	Ce, fl	-
Manitou Islands	Nipissing	Nb, U, ap	560
Callander Bay	Parry Sound	Nb	-
Poohbah Lake	Rainy River	-	-
Borden	Sudbury	-	-
Lackner Lake	Sudbury	Fe, U, ap, Nb, Ce	1090
Nemegosenda Lake	Sudbury	Nb, U, Th, Fe, ap, Ce	1010
Shenango	Sudbury	-	-
Township 107	Sudbury	verm	1560
Chipman Lake	Thunder Bay	Nb	-
Killala Lake	Thunder Bay	Cu, Ni	-
Port Coldwell	Thunder Bay	Cu, Fe(Ti)	-
Prairie Lake	Thunder Bay	Nb, Fe(Ti), ap	1112
*Sturgeon Lake	Thunder Bay	fl, La	-

* Not illustrated by an inset map.

METAL AND MINERAL REFERENCE

ap .... Apatite
Ce .... Cerium
Cu .... Copper
Fe .... Iron
fl .... Fluorite
La .... Lanthanum
Nb .... Niobium (Columbium)
Ni .... Nickel
Th .... Thorium
Ti .... Titanium
U .... Uranium
verm .... Vermiculite





MARGINAL NOTES

In the last ten years carbonatite-alkalic complexes have become increasingly important as producers or potential sources of niobium, rare-earths, uranium, thorium, zirconium, phosphate, vermiculite, iron, titanium, copper, and nickel. In many complexes the orebodies are very large. Three of the more important world producers are: Palabora, Transvaal (see Table 1) containing 315,000,000 tons of ore grading 0.7% Cu, with by-product magnetite, phosphate, and in another orebody vermiculite; Mountain Pass, California in which the Sulphide Queen carbonatite body contains in excess of 25,000,000 tons grading 5-10% rare-earth oxides; and Araxá, Minas Gerais, Brazil with an orebody of 300,000,000 tons grading 3.3% Nb_2O_5. In Canada the only producer is St. Lawrence Columbium and Metals Corp. from the Oka complex in Quebec (see Table 1).

Although the classification of carbonatite-alkalic complexes is controversial, both Heinrich (1966, p.11) and Tuttle and Gittins (1966, p.417-541) present data indicating the occurrence of over 200 complexes in the world with about 110-120 in Africa, over 40 in Eurasia, and 10 or more in South America. The writer lists 43 in Ontario (Table 2) and their location is shown on the adjoining map. Aeromagnetic maps of 34 of these are shown in the inset maps, all at the scale of 1 inch to 2 miles, unless otherwise indicated.

A number of mafic alkalic complexes, such as Port Coldwell, Killala Lake, Drowning River, Mammamattawa and Squirrel River are included in Table 2 because they are related in origin and age to the carbonatite-alkalic complexes and have similar outlines on the aeromagnetic maps. Little is known about the geology of many of the complexes (e.g. Niskibi Lake, Gooseberry Brook, Wapikopa River, Lawashi River, Poplar River, Nagagami River) revealed by the aeromagnetic surveys but they are included in Table 2 at the present time. For the remainder of Canada, Tuttle and Gittins (1966) describe 2 in Quebec and possibly 4 in British Columbia.

Many of the complexes have been found by aeromagnetic or aeroradiometric surveys by mining companies or government agencies. The complexes are indicated on aeromagnetic maps (see inset maps) by circular, oval, elliptical, crescent-shaped or horseshoe-shaped anomalous areas. In the simplest complexes carbonatite cores show as a central magnetic low, and surrounding concentric highs may be caused by either magnetite-bearing carbonatite or rings of alkalic rock. More complex rock relationships and mineralized bodies containing magnetite as an essential mineral are revealed by various lenticular, high anomalous areas. Because many carbonatite-alkalic complexes are poorly exposed detailed ground magnetometer surveys combined with the known distribution of boulder erratics have proved especially valuable in delineating the best areas for exploration by diamond drilling. Moreover, scintillometer surveys are also effective tools in exploration because of the radioactivity commonly associated with pyrochlore mineralization.

In Ontario some occurrences have been known for many years but were not recognized as carbonatite-alkalic complexes at the time of their discovery. The recognition of these complexes in the 1950's resulted in the exploration of the Firesand (Algoma Ore Properties, 1951-8), Manitou Islands (Beaucage, 1952-6, see Table 1), Nemegosenda (Dominion Gulf, 1954-8), Lackner (Multi-Minerals, 1954-8, see Table 1), Clay-Howells (Steel Co. of Canada, 1954-5), Cargill (Continental Copper, 1954-7, 1967), Chipman Lake (1954-5), Iron Island (Nipiron, 1952-4), and more recently, Big Beaver House (Many Lakes, 1962), Port Coldwell (Anaconda, 1962-), Carb Lake (Big Nama Creek and Larandona), Albany Forks, Drowning River, Mammamattawa, and Squirrel River (Keevil Mining Group).

Joint aeromagnetic surveys of northern Ontario during the years 1959-1967 by the Ontario Department of Mines and the Geological Survey of Canada have revealed numerous, previously unknown complexes; a number of these are under a cover of Paleozoic sedimentary rocks in the James Bay Lowland. One of these, the Argor carbonatite body (Consolidated Morrison, 1966-), contains an economically significant tonnage of Nb_2O_5 as uranium-free pyrochlore (see Table 1)

The ages of the carbonatite-alkalic complexes in eastern Canada (Gittins et al. 1967) fall into four groups. These are 125, 565, 1075, and 1700 m.y., with a possible fifth at 1560 m.y. Niobium is found in carbonatites of each age group.

SELECTED BIBLIOGRAPHY

Ayres, L.D., Bennett, G., and Riley, R.A.
1969: Geology and mineral possibilities in northern Patricia district, Ontario; Ontario Dept. Mines, Misc. Paper 28, 54p. (see p.16, 25, 27, and 38)

Bennett, G., Brown, D.D., George, P.T., and Leahy, E.J.
1967: Operation Kapuskasing; Ontario Dept. Mines, Misc. Paper 10, 98p. (see p.21-22, 66-70, 71-72)

Bennett, G., and Riley, R.A.
1969: Carb Lake carbonatite; p.40-43 in Operation Lingman Lake, Ontario Dept. Mines, Misc. Paper 27, 52p.

Gittins, J., Macintyre, R.M., and York, D.
1967: The ages of carbonatite complexes in eastern Canada; Canadian J. Earth Sci., Vol.4, p.651-655.

Heinrich, E. Wm.
1966: The geology of carbonatites; Rand McNally & Co., 555p.

Lumbers, S.B.
1970: Geology of the North Bay area; Ontario Dept. Mines, Open File Rept. 5045, 187p. (see p.84-101, 148-158)

Parsons, G.E.
1961: Niobium-bearing complexes east of Lake Superior; Ontario Dept. Mines, Geol. Rept. No.3, 73p.

Rowe, Robert B.
1958: Niobium (columbium) deposits of Canada; Geol. Surv. Canada, Econ. Geol. Series No.18, 108p.

Tuttle, O.F. and Gittins, J. (Editors)
1966: Carbonatites; Interscience Publishers (John Wiley and Sons Ltd.), 591p.

Table 1 ORE RESERVES AND PRODUCTION

ARGOR — Consolidated Morrison Explorations Ltd.

Ore Res: 10,000 tons/vert. ft. grading 0.82% Nb_2O_5 (Northern Miner, June 18, 1970).

LACKNER — Multi-Minerals Ltd.

Ore Res: Nos. 3-4 Zones: 37,000,000 tons
21.3% apatite, 13.7% magnetite, and 0.198% Nb_2O_5.

No. 6 Zone: 5,024,250 tons
69.6% magnetite, 21.9% apatite, and 0.173% Nb_2O_5.

No. 8 Zone: 80,000,000 tons 0.25% Nb_2O_5.

Calcite Zone: 880,000 tons 0.9% Nb_2O_5.
760,000 tons 0.23% Nb_2O_5.

MANITOU ISLANDS — Nova Beaucage Mines Ltd.

Ore Res: 1,893,000 tons 0.049% U_3O_8 and 0.86% Nb_2O_5
2,962,000 tons 0.041% U_3O_8 and 0.69% Nb_2O_5
Idle since 1956.

OKA, Quebec — St. Lawrence Columbium and Metals Corp.

Ore Res: 3,125,000 tons aver. 0.487% Nb_2O_5 (Oct. 1, 1969)

Production 12 mos. to Sept. 30:	1964	1965	1966	1967	1968	1969	1969/1970*
Tons milled	321,585	383,553	406,698	369,642	360,194	475,201	350,762
Niobium pentoxide, lbs.	2,091,725	2,203,985	2,647,667	2,368,225	2,005,989	3,059,052	2,461,000
Production revenue, $	2,164,443	2,328,638	3,188,114	2,799,982	1,966,937	3,107,514	2,650,794
Average per ton, $	6.53	6.52	7.85	7.57	5.46	6.53	7.56

*6 months

PALABORA, Transvaal — Palabora Mining Co. Ltd.

Ore Res: 315,000,000 tons aver. 0.69% Cu (1963)
80,000,000 tons vermiculite (to 70 feet, 30% rec.)

Production	1966	1967	1968	1969
	short tons	short tons	short tons	short tons
Copper (99.49% Cu)*	68,276	84,370	79,433	85,198
Magnetite conc. (66.1% Fe, 0.88% TiO_2)*	347,405	961,556	800,505	1,137,908
Sulphuric Acid (95.3% H_2SO_4)*	53,254	109,873	106,849	111,096
Vermiculite (91.1% Verm.)*	113,732	110,840	121,298	141,963

*1969 values

ARAXA, Minas Gerais, Brazil — Companhia Brasileira de Metalurgia e Mineracão (CBMM)

Production	1966	1967	1968	1969
Niobium pentoxide, lbs., in pyrochlore concentrates (averaging 59% Nb_2O_5)	6,210,909	6,017,103	6,502,269	6,667,000

SOURCES OF INFORMATION

Compilation by J. Satterly, 1968; revised with additions 1970.
Aeromagnetic maps of Ontario Department of Mines - Geological Survey of Canada, and Geological Survey of Canada.
Ontario Department of Mines files.
Palabora Mining Company, Limited, annual reports.
St. Lawrence Columbium and Metals Corporation, annual reports.
United States Bur. Mines, Mineral Trade Notes, Vol.66, No.1, Jan. 1969, p.8; Vol.66, No.12, Dec. 1969, p.10. (Brazil)
Base map directly from Ontario Department of Mines map 2190.

First edition, 1968.
Second edition, revised and issued 1970.