CANADA

DEPARTMENT

OF

MINES AND TECHNICAL SURVEYS

GEOLOGICAL SURVEY OF CANADA

PAPER 52-8

PEGMATITIC MINERAL DEPOSITS OF THE YELLOWKNIFE-BEAULIEU REGION,

DISTRICT OF MACKENZIE, NORTHWEST TERRITORIES

(REPORT AND TWO FIGURES)

By

Robert B. Rowe

OTTAWA

1952

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INTRODUCTION

The Yellowknife-Beaulieu region comprises about 5,000 square miles north of Great Slave Lake, and most of it lies east of Yellowknife (See Figure 1A). Much of the region can be reached by canoe, and the numerous lakes permit aircraft landings in every part. Aircraft, based at Yellowknife and capable of carrying payloads of 1,000 to 1,500 pounds, may be chartered at a cost of 65 to 85 cents a mile.

Besides being an important producer of gold, the region contains pegmatites that bear beryllium, columbium-tantalum, and lithium minerals. The purpose of the present investigation, which was carried out during the field season of 1951, was to examine the known economic-mineral-bearing pegmatites of the region with special reference to their internal structures, and to obtain information concerning the grade and tonnage of the more important occurrences. It is believed that the information presented in this report will be of aid in future prospecting and evaluation of pegmatitic deposits in the region.

The writer wishes to thank Dr. N. Campbell and Mr. W. R. Sproul of The Consolidated Mining and Smelting Company of Canada, Limited, and Mr. W. L. Macdonald of Yellowknife for information concerning many of the occurrences. Thanks are also due to Dr. I. C. Brown and Dr. A. B. Irwin of the Geological Survey of Canada for many courtesies, and to Mr. F.P. Brewster of DeStaffany Tantalum Beryllium Mines, Limited, for his hospitality. Capable field assistance was rendered by Mr. R. W. Hutchinson.

The terminology used in this report was developed by the United States Geological Survey as a result of pegmatite investigations conducted during World War II, and is described by Cameron, Jahns, McNair, and Page (2)[1].

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

For convenience, this report is divided into three parts. Part I deals with the general geology of the region; Part II describes the internal structure of granitic pegmatites for the use of those who do not have access to the above-mentioned publication; and Part III discusses the pegmatites of the region. Maps and reports dealing with the geology of the region (6, 7, 8, 9, 10, 11, 12, 13, 14, 15) are included in the bibliography.

PART I

GENERAL GEOLOGY

GENERAL STATEMENT

The Yellowknife-Beaulieu region is underlain by Archaean rocks consisting of lavas, pyroclastic rocks, greywacke, impure quartzite, and slate of the Yellowknife group, their altered equivalents, and granitic rocks (See Figure 1A). The following description of the regional geology was summarized, for the most part, from a paper by Henderson (11).

Isoclinally folded rocks of the Yellowknife group were intruded by granodiorite, folded along near-vertical axes, and intruded by granite. The metamorphic grade of the Yellowknife group increases toward the batholithic contacts so that the batholiths are surrounded by aureoles of high-grade metamorphic rocks. Jolliffe (15) states that the zones of high-grade metamorphism are wider around the younger granite than around the granodiorite, and it is in these that the beryllium-columbium-tantalum, and lithium-bearing pegmatites of the region occur.

TABLE OF FORMATIONS

Era	Formation	Lithology
Proterozoic		Diabase, gabbro, diorite
	Intrusive contact	
Archaean		Granite
	Intrusive contact	
		Granodiorite
	Intrusive contact	
		Diorite, anorthosite, gabbro
	Intrusive contact	
	Yellowknife group	Greywacke, impure quartzite, slate; derived, knotted, quartz-mica schist and hornfels Andesite, dacite, rhyolite, basalt, tuff, agglomerate; derived amphibolite

DESCRIPTIONS OF FORMATIONS

The volcanic rocks of the Yellowknife group are mainly light to dark green, fine-grained andesite, dacite, and basalt flows with well-preserved pillow and flow structures, and occur in an arcuate belt in the northern part of the region. These rocks have been altered in most places to amphibolite composed of hornblende, biotite, albite, quartz, epidote, and zoisite. Tuffs and agglomerate are interbedded with flows, and are especially abundant near the main contact of volcanic and sedimentary rocks. Rhyolites occur near this contact in the southern part of the belt, and are composed of quartz, plagioclase, sericite, carbonate, and biotite.

The least altered sedimentary rocks of the Yellowknife group are characterized by abundant chlorite and sericite. Greywacke, the most common type, consists of poorly sorted, broken grains of quartz and some cloudy albite (An_{4-6}) in a fine-grained, schistose groundmass of chlorite, sericite, quartz, feldspar, carbonate, and some pyrite. In many places it shows a grain gradation in coarser beds or a colour change from light grey to dark grey or black in the finer grained beds. Rocks designated as impure quartzite are coarser grained, occur in thicker beds, and weather a lighter grey than the greywackes. The quartzite has a higher quartz and feldspar content than the greywacke. The slates are grey to black and thinly bedded, have pronounced cleavage, are finer grained than the greywacke, and contain a greater proportion of chlorite and sericite.

Change in metamorphic rank is indicated by the appearance of biotite at the expense of chlorite and sericite, the disappearance of carbonate, increase in the grain size of the groundmass, and recrystallization of the detrital quartz and albite grains. The recrystallized albite grains are clear, untwinned, and slightly more calcic (An_{5-10}) than the detrital albite grains. Biotitic metasedimentary rocks are more widespread in the region than chloritic sedimentary rocks, which occur chiefly in the Gordon Lake basin.

As the granodiorite and granite contacts are approached, knotted quartz-mica schists and knotted quartz-mica hornfels are encountered. The schists can be distinguished from the hornfels by their good cleavage, due to the parallel orientation of mica grains. Biotite, muscovite, plagioclase, and small tourmaline crystals compose the matrix, which has recrystallized to the extent that the detrital quartz and feldspar grains are no longer distinguishable. The plagioclase is clear, untwinned, and more calcic (An_{10-15}) than in the less altered rocks. Knots up to the size of an egg have been found, but the average diameter is $\frac{1}{4}$ to $\frac{1}{2}$ inch. Many of the knots are nebulous aggregates, but, where well crystallized, are found to be composed of cordierite, and, less commonly, andalusite and staurolite. The knots cut across the cleavage, and show no evidence of crushing; hence it is believed that they were formed after all deformation in the region had ceased. Bedding is well preserved in these rocks, and the gritty lower parts of the beds can be easily determined by drawing a knife across the beds.

The basic intrusive body $\frac{1}{2}$ mile north of Great Slave Lake and east of François River is a gabbro-diorite-anorthosite complex believed to have differentiated from one magma (12). Dykes and sills of diorite and gabbro occur in other parts of the region, and are cut by granitic rocks.

The granodiorite is a grey to pink weathering, medium-grained rock composed of 35 to 45 per cent quartz, 40 to 50 per cent oligoclase, 10 to 20 per cent microcline or orthoclase, and 5 to 15 per cent biotite and hornblende. It contains many inclusions of biotite and hornblende gneiss.

The granite is medium to fine grained, grey to red weathering, and consists of 25 to 35 per cent quartz, 30 to 40 per cent microcline and orthoclase, 20 to 30 per cent oligoclase, and 5 to 10 per cent biotite and muscovite. It contains only a very few inclusions. The pegmatites of the region that carry one or more of the minerals beryl, columbite-tantalite, spodumene, and amblygonite occur in the aureole of knotted schists and hornfels surrounding bodies of the granite.

Basic, rusty weathering dykes ranging in composition from diorite to olivine gabbro are the youngest rocks of the region. The dykes form two sets, one striking about north 60 degrees east and the other about north 20 degrees west. Similar dykes cut the Proterozoic sedimentary rocks of Great Slave Lake.

STRUCTURE

The structure of the Yellowknife sedimentary rocks and their altered equivalents is complex and worth brief discussion here. Henderson (11) has postulated two periods of folding. The first deformation produced isoclinal folds that were closely spaced, and that had parallel trends. Later movements warped the isoclinally folded rocks into large anticlinal and synclinal structures with near-vertical plunges. Henderson states that the sedimentary and volcanic rocks strike parallel with the granite contacts but dip away from them at steep angles. He accounts for the second warping as being due to the intrusion of the granite. The thermal metamorphism, producing the knots, was accomplished after movement had ceased, and is attributed to the rise in temperature caused by the intrusion of the granite. Fortier (6) has prepared a map showing bedding trends and axial traces of significant cross-folds consequent upon these later intrusions.

PART II

THE INTERNAL STRUCTURE OF GRANITIC PEGMATITES

GENERAL STATEMENT

Granitic pegmatites may be divided into two groups: those that are simple aggregates of quartz, feldspar, and accessory minerals, which cannot be divided readily into units of contrasting mineralogy or texture; and those that are complex aggregates of quartz, feldspar, and accessory minerals, which can be divided readily into units of contrasting mineralogy or texture. Complex granitic pegmatites have received more attention than simple granitic pegmatites in the past because they are of greater interest to the geologist and mineralogist, and because they are the source of mineable concentrations of desirable minerals.

Many students of pegmatites have recognized lithological or structural units within pegmatites, but little detailed mapping was done prior to 1939, and a workable system of mapping complex pegmatites was never devised. From 1939 to 1945, the United States Geological Survey made an extensive study of strategic pegmatitic mineral deposits in the major commercial pegmatite districts of the United States for the purpose of increasing the production of mica, beryl, lithium minerals, and columbite-tantalite. This work resulted in the development of a new mapping technique based on internal structure and lithology. Use of this technique has greatly clarified many of the problems related to the mapping and evaluation of pegmatitic mineral deposits.

The following pages dealing with sections concerning internal structure, its economic significance, and the evaluation of pegmatitic deposits contain information taken from the following publications:

Cameron, E. N., and Shainin, V. E.: The Beryl Resources of Connecticut; Economic Geology, vol. XLII, pp. 353-367 (1947).

Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R.; Internal Structure of Granitic Pegmatites; Economic Geology, Monograph 2, 1949.

Page, L. R.: Uranium in Pegmatites; Economic Geology, vol. 45, pp. 12-34 (1950).

SIZE CLASSIFICATION OF GRANITIC PEGMATITE MATERIAL

The term 'pegmatitic' is inadequate for the description of the texture of individual units within pegmatites; hence the following classification has been adopted by the United States Geological Survey and is used in this report:

Term	Maximum crystal dimension
Fine	Less than 1 inch
Medium	1 inch to 4 inches
Coarse	4 to 12 inches
Very coarse	Greater than 12 inches

STRUCTURAL UNITS OF GRANITIC PEGMATITES

GENERAL STATEMENT

The primary analysis of a complex pegmatite is made on the basis of internal structure. Three types of structural units are distinguished, and are defined as follows:

1. Fracture fillings are units that are generally tabular and that fill fractures in previously consolidated pegmatite.

2. Replacement bodies are units that are formed primarily by the replacement of pre-existing pegmatite, with or without obvious structural control.

3. Zones are units that are concentric shells, complete or incomplete, and that generally reflect the shape or structure of the pegmatite body, and, where ideally developed, are concentric about an innermost zone or core. Some concentric units are not zones, but belong in one of the above categories. Incompletely developed zones form lenses, trough-like or hood-like bodies, or chains of lenses.

Contacts between structural units may be knife-edge sharp or broadly gradational, but few boundaries are so gradational that they cannot be mapped on a scale of 1 inch to 20 feet.

Zones

General Statement

Zones are quantitatively and economically the most important structural units. Where ideally developed, they are shells concentric about an innermost zone or core. The zones of a granitic pegmatite are differentiated according to mineralogical or textural differences; adjacent zones usually differ in both mineralogy and texture. In most zoned pegmatites, one or more zones are incomplete, forming pods, lenses, chains of lenses; pipe-like, trough-like, or hood-like bodies; or more irregular bodies. Two or more zones may merge along their strike or dip to form a single unit corresponding to the bulk mineralogy of the two combined zones: this is referred to as 'telescoping'. Zones are classified as follows:

1. Border zones
2. Wall zones
3. Intermediate zones
4. Cores

The outermost zone of a pegmatite is the border zone; the next zone is the wall zone; and the zones between the wall zone and the core are intermediate zones. Not all types of zones are always represented in a zoned pegmatite; for instance, many pegmatites have no intermediate zones, and hence are composed of border zone, wall zone, and core. A true picture of the internal structure of a granitic pegmatite cannot be obtained from an outcrop, because all of the zones may not be represented at that level of erosion. The principal minerals of each pegmatite unit are included in the name given the unit, and are listed in order of decreasing abundance, as, for example, quartz-cleavelandite-muscovite pegmatite.

In general, the accessory minerals are not included in the name unless they are of economic significance.

Border Zones

The border zone is the outermost zone of a zoned pegmatite. Border zones are usually aplitic to fine-pegmatitic in texture and are generally less than 3 inches thick, rarely exceeding 2 feet. The thickness is, in general, fairly constant within any one pegmatite. This zone is usually mapped with the wall zone or is exaggerated and shown diagrammatically. Contacts are commonly sharp, except in the case of pegmatites formed during the last stages of crystallization of certain granitic rocks, pegmatites formed in lit-par-lit gneisses, and pegmatites formed entirely or in part by the replacement of, or reaction with, wall-rocks. Feldspar, quartz, and muscovite are the essential minerals of most borders zones: the accessory minerals may include any mineral present in the other parts of the pegmatite, but tourmaline, beryl, apatite, and garnet are the most common. In general, the border zone contains the same minerals as the wall zone, but the proportions may vary and textures are different. Border zones commonly appear to have a composition essentially similar to the bulk composition of the pegmatite, and can be interpreted as chilled margins in such instances. The minerals of the border zone are commonly fine grained at the outer edge, becoming coarser toward the wall zone. Component minerals are in some cases oriented perpendicular or sub-perpendicular to, or parallel or sub-parallel with, the walls of border zones.

Wall Zones

Wall zones are usually coarser grained and thicker than the adjacent border zones. Their thickness is variable, but generally does not exceed 10 feet. In some cases the wall zones are asymmetrically developed or are discontinuous: many wall zones are continuous around the keel and sides of a pegmatite, but are lacking at the crest. Wall zones are of economic importance as sources of sheet and scrap mica, and beryl. Certain wall-zone minerals, such as muscovite, tourmaline, and beryl, may be coarser than the other minerals, but rarely exceed 12 inches in maximum dimension. Plagioclase, perthite, quartz, muscovite, and tourmaline are the most common minerals of wall zones: accessory minerals may include biotite, apatite and other phosphate minerals, garnet, beryl, and columbite-tantalite. Typical wall-zone assemblages are as follows: plagioclase-quartz, plagioclase-quartz-muscovite, plagioclase-perthite-quartz, perthite-quartz, and plagioclase-perthite-quartz-muscovite.

Intermediate Zones

The intermediate zones include all those between the border zone and the core. They are less common than the other zones, and are lacking in many pegmatites. Intermediate zones are commonly 'telescoped'. Some are single rows of crystals, such as perthite or muscovite, whereas others are polymineralic and relatively thick. Intermediate zones are coarser grained than wall zones, and are generally less continuous; inner intermediate zones, in turn, are coarser grained than outer intermediate zones. Giant crystals are commonly found in intermediate zones, but the interstitial minerals are generally as fine grained as the wall-zone minerals. Intermediate zones are important sources of feldspar, beryl, and lithium minerals.

Cores

The core of a pegmatite is usually symmetrical with respect to the sides, but asymmetrical with respect to the crest or keel. Irregularities in the shape of the pegmatite are generally reflected in the shape of the core. Asymmetrical cores may be found in pegmatites containing abundant lithium minerals. The core may be discontinuous, occurring only at bulges in the sides of the pegmatite body. Present knowledge of cores indicates that in many districts only massive quartz can be considered a true core in polyzonal pegmatites. On the other hand, quartz, with scattered microcline crystals, or with perthite, form the true core in some polyzonal pegmatites; other mineral assemblages are more likely to comprise the wall or intermediate zones.

Sequence of Mineral Assemblages

It has been found that there is a sequence of mineral assemblages in zoned pegmatites from the walls inward. Few, if any, pegmatites contain all members of the sequence, but those that are represented always occur in the established order. The complete sequence of mineral assemblages is as follows:

1. Plagioclase-quartz-muscovite
2. Palgioclase-quartz
3. Quartz-perthite-plagioclase$\pm$muscovite$\pm$biotite
4. Perthite-quartz
5. Perthite-quartz-plagioclase-amblygonite-spodumene
6. Plagioclase-quartz-spodumene
7. Quartz-spodumene
8. Lepidolite-plagioclase-quartz
9. Quartz-microcline
10. Microcline-plagioclase-lithia micas-quartz
11. Quartz

Fracture Fillings

Fracture fillings are pegmatite units that have been formed by the simple filling of fractures in pegmatite without appreciable replacement of the walls. They are vein-like bodies, ranging from masses of more than 100 feet in length and 10 feet in thickness to thin stringers. Some fracture fillings are confined to one zone, whereas others transect all zones and even the pegmatite-wall-rock contacts. Fracture fillings may be conformable in part with zonal structures and, as such, mistaken for zones. Quartz is the most abundant and widespread mineral of these fillings; other minerals common in them are cleavelandite, sugary albite, potash feldspars, muscovite, and lepidolite. Layering occurs in fracture fillings, and may resemble zoning or may be the result of repeated fracturing and deposition of new material.

Replacement Bodies

Replacement bodies are those units formed by replacement at a stage following the complete crystallization of the parts of the pegmatite body affected by the replacement. The distribution of most replacement bodies can be related to a definite control. They can be controlled by fractures, zones, wall-rock-pegmatite contacts or any other structural or lithological feature within a pegmatite body. Replacement bodies range up to tens of feet in thickness and more than 500 feet in length. Quartz, sodic albite (commonly occurring as cleavelandite), and muscovite are the most common components of replacement bodies.

Simple replacement bodies are merely the result of the enlargement of fracture fillings, and are easily recognized, but complete pseudomorphs after zones are known: such replacement bodies may be extremely difficult to recognize. Replacement bodies may be distinguished by the study and comparison of structures, textures, and mineralogy of the various units of a pegmatite. In order to map a unit as replacement body, it is necessary to find evidence to prove that the minerals composing it formed, entirely, or in large part, at the expense of pre-existing pegmatite, and that the material replaced was completely crystallized before replacement began.

EVALUATION OF PEGMATITIC MINERAL DEPOSITS

The distribution of desirable minerals in most pegmatites can be related to internal structural features; hence detailed structural analyses of pegmatites provide information that is useful in the prospecting, exploration, development, and mining of pegmatite deposits. Many workers in the past have not recognized systematic internal structure in pegmatites, so that the variation of a particular mineral from unit to unit, and the uneven distribution of that mineral throughout any one unit have given the impression that the grade and tonnage of a pegmatitic mineral deposit is unpredictable. The recognition that any particular economic mineral is related to one or more of the eleven lithologic zonal assemblages found in granitic pegmatites and the knowledge gained on the structural behaviour of the zonal assemblages have led to the intelligent evaluation of many pegmatite mineral deposits.

Because of the uneven distribution of any particular mineral in a given zone, the usual sampling methods do not yield reliable information on grade. Extensive bulk sampling would probably give fairly accurate determinations, but is too costly for ordinary purposes. The mineral content of any zone or mineable section can be determined by measuring the exposed area of the mineral sought, by making the necessary corrections for differences in specific gravity of the different minerals, and then by relating this area to the total area of the zone or other mineable section to determine the percentage of the mineral present. This method has been substantiated by milling tests.

As many pegmatites as possible within a particular district should be studied with respect to internal structures and lithologic assemblages, so that a three-dimensional picture may be built up. On the basis of this knowledge, the pegmatite that is lean or barren at the surface may be found to contain ore at depth.

PART III

PEGMATITES OF THE YELLOWKNIFE-BEAULIEU REGION

GENERAL STATEMENT

The pegmatites of the Yellowknife-Beauliew region are granitic pegmatites, and are of interest because many of them contain beryl, columbite-tantalite, spodumene, and amblygonite. As pegmatites are very abundant in the region, this investigation was limited to known occurrences of economic minerals and to the pegmatites in the immediate vicinity of these occurrences. The pegmatites were examined by the writer primarily to determine if they exhibit internal structure similar to that shown by the pegmatites of the commercial pegmatite areas in the United States, and to relate the occurrence of economic minerals to internal structure, if represented. Three of the pegmatites were mapped on a scale of 1 inch to 20 feet so that the grade and tonnage could be estimated.

In general, the pegmatites are well exposed. Little glacial debris was deposited in the region, and recent forest fires have removed the vegetation from the bedrock in many places, so that much of bedrock is exposed. Because the pegmatites are lighter in colour than the meta-sedimentary rocks in which they are found, they can be readily located on air photographs[1].

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[1]Vertical air photographs of the region may be purchased from the National Air Photographic Library, Department of Mines and Technical Surveys, Ottawa.

GENERAL FEATURES

Occurrence and Distribution

The pegmatites of the region that carry one or more of the minerals beryl, columbite-tantalite, spodumene, and amblygonite occur only in the aureoles of high-grade meta-sedimentary rocks that surround the batholiths and smaller bodies of granite, or in the granodiorite near intrusive bodies of granite.

The pegmatites of the Hearne Channel-Buckham Lake area are less abundant than those found in other parts of the region, but a high proportion are polyzonal and have well-developed internal structure. Many of the pegmatites in this area are lithium-rich. In the northern section of the region, the pegmatites are much more abundant, but a lower percentage are polyzonal; they are less likely to have well-developed internal structure, and lithium-rich types are less common.

A regional zonation of pegmatites outward from the Redout Lake granite was noted by Jolliffe (15), Fortier (personal communication), and the writer (See Figure 1B). This zonation occurs in the area between Redout and Ross Lakes, and features five zones. The first zone, the zone closest to the granite, contains large, irregularly shaped pegmatites that have poorly developed internal structure, and that contain graphic granite. The second zone is composed of pegmatites containing graphic granite and beryl. In this zone, the pegmatites tend to be lenticular and have a somewhat better developed internal structure. The third zone contains many pegmatites that have beryl as a component, but have no graphic granite. These pegmatites are regular in shape, are much smaller, and display a readily recognizable internal structure. The pegmatites of the fourth zone are structurally similar to those of the third, but many contain columbite-tantalite as well as beryl. The fifth zone, the one farthest from the granite, features pegmatites that are spodumene-bearing[1].

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[1]It should be pointed out that only some of the pegmatites in the various zones contain beryl, columbite-tantalite, or spodumene, as the case may be, but that all of the pegmatites fit the structural description.

The writer has been informed by Fortier that a zonation also occurs about the granite in the southwest section of the Ross Lake map-area (7).

Shape, Size, and Attitude

The shape and size of any pegmatite body in the region is controlled primarily by its proximity to a mass of granite. Those close to the granite tend to be large and of irregular shape, whereas those farther from the granite are more regular and are smaller.

The pegmatites are generally lenticular or tabular masses, but several that are arcuate-shaped were noted. In some instances, the arcuate shape is due to the fact that the structural feature controlling the intrusion of the pegmatite was the crest or trough of a fold.

The pegmatites studied vary from a few inches in thickness and a few feet in length to 1,000 feet thick and ½ mile long. Most of the pegmatites containing commercial minerals are less than 30 feet wide and 500 feet long.

Little information is available on the attitude of the pegmatite bodies because of the lack of three-dimensional exposures. Outcrops indicate that most of the pegmatites are regular-shaped lenses that vary in thickness. Offshoots and inclusions of wall-rock are rare. In general, the pegmatites cut across the foliation, but some are concordant.

Relation to Wall-rock Structures

With the possible exception of some of the large, irregular pegmatites in the immediate vicinity of the granite bodies, most of the pegmatites seem to have been intruded along fractures that cut across the foliation. These fractures occur in the high-grade meta-sedimentary rocks and granodiorite surrounding bodies of granite. Fortier (personal communication) has suggested that the fractures form a pattern about granite bodies in the Ross Lake area.

Many of the pegmatites feature contacts with the wall-rocks in places where the latter are sheared parallel with the contact, but in no instance was the shearing continuous around the entire body.

Some of the pegmatites are concordant, and occur along the limbs and at the crests and troughs of minor folds.

Internal Structure

Most of the pegmatites studied by the writer in the Yellowknife-Beaulieu region feature internal structure, although the degree of development of such structure varies greatly in individual bodies. Zoning is by far their most important structural feature, with replacement of secondary importance in the Hearne Channel-Buckham Lake area. Fracture fillings are generally small and of no economic significance. Pegmatites that do not contain lithium minerals commonly have border zones, wall zones, and pods that represent a discontinuous zone. The border zone is typically thin and discontinuous, consisting of plagioclase and quartz, with or without muscovite. Cleavelandite and quartz is the usual assemblage found in the wall zone, which is generally continuous, and, in most pegmatites, forms the bulk of the exposed rock. Perthite and quartz is the common assemblage found in the pods.

Lithium-rich pegmatites contain border zones, wall zones, one or more intermediate zones, and cores. The lithium minerals occur in intermediate zones, which are more apt to be discontinuous than wall zones.

A general sequence of mineral assemblages inward from the wall-rock contacts was recognized from a study of the assemblages of the polyzonal pegmatites of the region, and is as follows:

1. Plagioclase-quartz$\pm$muscovite
2. Cleavelandite or plagioclase-quartz$\pm$muscovite
3. Perthite or microcline-quartz-cleavelandite$\pm$ muscovite with or without graphic granite
4. Perthite-quartz
5. Lithium-rich assemblages
6. Microcline
7. Quartz

MINERALOGY

General Statement

The pegmatites of the Yellowknife-Beaulieu region are composed essentially of feldspar and quartz, with, in some instances, much spodumene; consequently, they can be classified as granitic pegmatites. In a previous investigation Jolliffe (15) dealt with the mineralogy of the pegmatites in some detail. It is not the purpose of the present report to discuss the mineralogy in full, but to describe the important rock-forming minerals, and the important economic minerals as an aid to further prospecting in the area. Quartz, cleavelandite, perthite, and muscovite are the most abundant rock-forming minerals, and spodumene, amblygonite, beryl, and columbite-tantalite the most important economic minerals. Other minerals in the pegmatites include microcline, lithiophyllite, petalite, lepidolite, cassiterite, tourmaline (red, blue-green, and black varieties), red garnet, gahnite, graphite, lazulite, hornblende, fluorite, scheelite, molybdenite, arsenopyrite, pyrite, magnetite, ilmenite, and native bismuth.

Principal Rock-forming Minerals

Quartz

Quartz was found in all of the pegmatites examined by the writer, and occurs in almost every pegmatite unit. It varies in colour from white to light grey to grey to dark grey, and in grain size from aplitic to very coarse, but is generally fine to medium grained. In graphic granite it occurs in hieroglyphic-like forms, and as rods or other elongate forms. It occurs as anhedral grains in the following assemblages: plagioclase-quartz-muscovite, plagioclase-quartz, muscovite-plagioclase-quartz, cleavelandite-quartz, perthite-cleavelandite-quartz-muscovite, perthite-quartz, cleavelandite-muscovite-quartz, cleavelandite-quartz-spodumene, cleavelandite-perthite-quartz-spodumene, perthite-quartz-spodumene, and in quartz cores. It forms subhedral to euhedral crystals in quartz-cleavelandite. Veinlets of quartz cut perthite, spodumene, and beryl crystals: a few fracture-fillings of quartz were noted in certain pegmatites.

Cleavelandite

Cleavelandite is by far the most abundant feldspar. It is a platy variety of albite that commonly occurs in radiating clusters with many of the plates curved. In the pegmatites of the region, cleavelandite varies from white to grey to pink to red, and is usually medium grained. The most common assemblage containing cleavelandite is the cleavelandite-quartz assemblage that compose the wall zone of many of the pegmatites in the region. Cleavelandite also occurs in the following assemblages: cleavelandite-muscovite-quartz; cleavelandite-quartz-spodumene; cleavelandite-perthite-quartz-spodumene; quartz-cleavelandite; perthite-cleavelandite-quartz-muscovite; and cleavelandite-beryl.

Perthite

The perthite of the pegmatites varies from white to pink to red, and is usually coarse grained and subhedral to euhedral. It is found in the intermediate zones of many pegmatites and in blocky perthite-quartz pods. The following assemblages contain perthite: perthite-cleavelandite-quartz-muscovite; perthite-quartz; cleavelandite-perthite-quartz-spodumene; and perthite-quartz-spodumene.

Muscovite

Muscovite is common in the pegmatites, but is generally an important constituent only of the border zone, where it occurs in a fine-grained plagioclase-quartz-muscovite assemblage. Several of the spodumene-rich pegmatites contain fine-grained muscovite-plagioclase-quartz bodies, which in places contain abundant tantalite, and are, apparently, replacement bodies. Muscovite, in books up to 6 inches in maximum dimension, is an important constituent of the first intermediate zone of the Riber pegmatite north of Prelude Lake.

Economic Minerals

General Statement

The important economic minerals are discussed in detail in the following pages. New field techniques for the identification of beryl and columbite-tantalite are described for the convenience of those who do not have access to the publications in which they were originally described. Considerable attention is paid to the uses of these minerals in order to illustrate their importance in industry. Current prices are also quoted for the reader's information.

Spodumene

Spodumene is an important constituent of many pegmatites in the Hearne Channel-Buckham Lake area. It is easily distinguished from beryl, the only other green mineral occurring in the pegmatites of the Yellowknife-Beaulieu region, by the fact that it has well-developed cleavage whereas beryl has no cleavage.

Composition. $LiAlSi_2O_6$ or $Li_2O.Al_2O_3.4SiO_2$; Li_2O = 8.4 per cent, Al_2O_3 = 27.4 per cent, and SiO_2 = 64.5 per cent. Most varieties contain 4 to 7 per cent LiO_2.

Crystallography. Monoclinic, prismatic. Elongate parallel with the c - axis, and striated parallel with the c - axis. Perfect, prismatic (110) cleavage at angles of 87 and 93 degrees. Occasional lamellar structure parallel with 110. May be twinned, with 100 as the twin-plane.

Physical Properties. Brittle and readily cleavable; may be splintery. Hardness = 6.5-7. Specific gravity = 3.13-3.20. Colour, greyish white, greenish white, yellowish green, emerald-green (variety, hiddenite), yellow, lilac (variety, kunzite); streak, white. Lustre, vitreous to pearly on cleavage surfaces; transparent to translucent.

Alteration. Alters to a mixture of eucryptite, $LiAlSiO_4$, and albite, or to a mixture of muscovite and albite, which has a fibrous structure and silky lustre. In places in the Yellowknife-Beaulieu region, it alters to a woody, green to black substance, which retains the outline and cleavage of spodumene.

Tests. Fuses under the blowpipe flame, throwing out fine branches at first, then fusing to a clear glass, giving a crimson, lithium flame.

General Occurrence. Only important occurrence is in certain granitic pegmatites.

Occurrence in the Yellowknife-Beaulieu Region. In the Yellowknife-Beaulieu region, spodumene is found in the intermediate zones of polyzonal pegmatites. It occurs as euhedral, green crystals of coarse to very coarse texture. The Hearne Channel-Buckham Lake area is especially abundant in spodumene-bearing pegmatites.

Spodumene is present in the following assemblages: cleavelandite-quartz-spodumene; cleavelandite-perthite-quartz-spodumene; and perthite-quartz-spodumene.

In general, the spodumene occurring at the outer margins of spodumene-bearing zones is altered or intergrown with quartz, whereas the spodumene towards the inner margins is fresh and occurs as discrete crystals.

Uses. Spodumene is used directly in industry, or is used in the production of metallic lithium and lithium compounds. It is employed directly in the manufacture of certain glasses, and in certain ceramic formulas. When used in glasses, it reduces shrinkage during cooling, and lowers the firing temperature of white-wares. In general, the presence of lithium in glasses decreases the coefficient of thermal expansion, increases electrical resistance, increases ultraviolet-transmission properties, and imparts desirable working qualities to the glass. In ceramic formulas, spodumene acts as a powerful flux, especially when used with feldspar. A spodumene-feldspar mixture is marketed under the name of lithospar. Lithium oxide, when used as a replacement for lead monoxide, reduces the tendency of a glaze to vaporize. The presence of lithium lowers the maturing temperature of glazes, and increases the gloss and fluidity. Lithium is widely used as a constituent of alloys, increasing their hardness, toughness, and strength; a few hundredths of 1 per cent lithium, for instance, gives hardness to aluminium and its alloys. In higher melting alloys, lithium acts as a degasifier, deoxidizer, desulphurizer, and general purifying agent. Lithium is generally introduced as a calcium-lithium alloy. Lithium salts are used in the pharmaceutical trade in mineral waters and lithia tablets. They are used to give the red colour to flares in fireworks; as fluxes; and in the smelting of iron ore. Much lithium hydroxide was formerly used in alkaline storage batteries, and is now used in mercerizing sulphite cellulose for rayon, and in purifying helium and other rare gases. Lithium chloride and lithium fluoride are used as welding fluxes, especially for aluminium. Lithium chloride is also used for dehumidifying air in air conditioning and industrial drying units; it is one of the most hydroscopic, inorganic substances known, and is non-volatile, non-toxic, and non-corrosive, and its solutions have a low freezing point. Lithium nitrite is used in curing meat, and lithium borate is used in dental cement. The hydride is an efficient transporter of hydrogen for self-inflating rafts and balloons, and the peroxide is a carrier of oxygen. Lithium compounds are also used in the manufacture of greases for use in extremes of heat and cold.

Current Prices. Spodumene ore in carload lots and containing not less than 6 per cent lithium oxide is worth $6 to $8 per unit lithium oxide per ton (4).

Amblygonite

The amblygonite of the Yellowknife-Beaulieu region closely resembles plagioclase in appearance. Like plagioclase, it is triclinic, with multiple lamellar turns. In general, the plagioclase of the region does not weather on exposed surfaces, whereas surfaces of amblygonite that have been exposed on outcrops for a long time weather chalky. Amblygonite (specific gravity = 2.98-3.15) is noticeably heavier than plagioclase (specific gravity = 2.61-2.76).

Composition. $LiAlFPO_4 \cdot \frac{1}{2} H_2O$ - $LiAlOHPO_4 \cdot \frac{1}{4} H_2O$ (the hydroxyl end of the series is called montebrasite). Li_2O = 10.1 per cent, Al_2O_3 = 34.4 per cent, F = 12.9 per cent, and P_2O_5 = 47.9 per cent. Sodium commonly replaces part of the lithium, so that most varieties contain about 9 per cent Li_2O.

Crystallography. Triclinic, perfect (100), good (110), imperfect $(00\bar{1})$, and distinct $(0\bar{1}1)$ cleavage; multiple lamellar twinning on $(\bar{1}\bar{1}1)$ and on (111).

Physical Properties. Occurs as blocky, coarse to very coarse, pegmatitic crystals. Hardness = 6. Specific gravity = 2.98-3.15. Colour, white, greyish white, greenish white, greenish grey, grey, pale green, pale blue, pale yellow, or brownish white. Lustre, greasy to vitreous, or pearly on basal cleavage surfaces; Subtransparent to translucent.

Tests. Easily fusible, giving a crimson, lithium flame. After fusion with sodium carbonate and dissolving in nitric acid, gives yellow precipitate when an excess of ammonium molybdate solution is added (phosphate test).

General Occurrence. Only important occurrence is in certain granitic pegmatites.

Occurrence in the Yellowknife-Beaulieu Region. In the cleavelandite-quartz-spodumene assemblage and at the outer margins of the perthite-quartz assemblage of Moose No. II dyke, DeStaffany Tantalum Berryllium Mines, Limited, property, and in certain dykes near Sproul Lake.

Uses. Similar to those of spodumene.

Current Prices. Air-floated amblygonite ore in carload lots is quoted as being worth $110 a ton (3).

Beryl

Beryl is found in many pegmatites throughout the region. It is distinguished from spodumene by its lack of cleavage and, when white, from quartz by the fact that it occurs in subhedral to euhedral, six-sided crystals.

Composition. $Be_3Al_2Si_6O_{18}$ or $3\ BeO.Al_2O_3\ 6SiO_2$. BeO = 14 per cent, Al_2O_3 = 19 per cent, and SiO_2 = 67 per cent. The beryllium is commonly replaced in part by sodium, potassium, lithium, or caesium, so that the BeO content usually varies from 10 to 14 per cent.

Crystallography. Hexagonal; forms usually consist only of first order prism $(10\bar{1}0)$ and base (0001). Cleavage is poor and is rarely shown. Frequently striated parallel with the c - axis.

Physical Properties. Occurs as subhedral to euhedral crystals elongate parallel with the c - axis; six-sided, perpendicular to the c - axis. Hardness = 7.5-8. Specific gravity = 2.63-2.91. Colour, white, pale green, pale blue, green, emerald-green (emerald is the deep green, translucent variety), golden-yellow, and pink (high alkali variety). Lustre, vitreous; sometimes resinous; transparent to translucent.

Tests. Until recently, it has been difficult to detect the presence of beryllium by ordinary analytical methods. A simple test for beryllium, and a means of distinguishing beryl from quartz, based on their different specific gravities, are described here.

The Spector-Brown Beryllium Test (17)

Chemicals Needed

1. 0.01 per cent solution of quinalizarin in acetone.
2. Sodium hydroxide pellets.

Test

1. Form a sodium hydroxide bead on a wire loop using a blowpipe or a small Lenk Automatic blowtorch.
2. Fuse a small portion of finely ground mineral into the bead by prolonged heating.
3. Dissolve the bead in 25 drops of water in a test tube.

4. Place 2 drops of reagent (quinalizarin solution) on a spot plate (wax paper may be used as a substitute), and add 2 drops of the bead solution. If beryllium is present, a blue colour appears: if there is no beryllium, a violet colour appears. It is advisable to run a blank at the same time so that the colours may be compared.

The Barlow Beryl-Quartz Test (1)

1. Use a glass tube, closed at one end, and about ½ inch in diameter, and 2½ to 3 inches long.
2. Pour in bromoform up to within 1/3 or 1/4 of the top of the tube.
3. Drop small fragments, about 1/8 inch square, of known, pure beryl and quartz in the bromoform. Both will float, as bromoform has a density of 2.90.
4. Gradually add pure benzene to the bromoform drop by drop by means of a glass rod - about 4 or 5 drops are enough.
5. Tilt the tube slightly from side to side and allow to stand for several hours. Both the beryl and quartz will sink, but the beryl sinks to a lower level.
6. Drop the unknown mineral fragment into the tube and observe where it comes to rest. If it is beryl it will come to rest near the beryl fragment; if quartz, near the quartz fragment.

Benzene eventually evaporates, and both minerals will float again. When this happens, add more benzene as described above.

Eventually, the density of the liquid equalizes throughout. Remove the cork, allow the benzene to evaporate, and add more benzene as before.

Acetylene tetrabromide may be used as a substitute for bromoform, but a little more benzene must be added. Fragments should be granular, as prismatic or tabular grains do not come to their positions quickly. This method is based on the fact that the specific gravity of quartz is 2.65 whereas that of most beryl is about 2.70.

General Occurrence. Only important occurrence is in certain granitic pegmatites.

Occurrence in the Yellowknife-Beaulieu Region. Beryl occurs associated exclusively with zonal assemblages in the Yellowknife-Beaulieu region. It is found most commonly in zones or pods, of perthite-quartz, especially along the outer margins of the zones or pods. In the Riber pegmatite beryl occurs in abundance in two cleavelandite-rich assemblages. Beryl was found in the following zonal assemblages in the region: perthite-quartz, cleavelandite-quartz, spodumene-perthite-quartz, quartz (at outer margin), perthite-cleavelandite-quartz-muscovite, perthite-quartz-muscovite, and cleavelandite.

The beryl usually occurs as crystals under hand-cobbing size (that is, with maximum dimension less than 6 inches), although crystals up to 15 inches long were seen in perthite-quartz.

In general, the beryl occurring in wall zones, usually composed of cleavelandite-quartz-muscovite, is white to pale green in colour and tends to be subhedral. Beryl associated with perthite-quartz is generally green, and euhedral. Beryl occurring in the Riber pegmatite is a golden or glassy, yellowish green.

It would appear that pegmatites containing extensive zones of coarse or very coarse perthite-quartz are especially favourable for the occurrence of significant quantities of hand-cobbing beryl.

Uses. Beryl is used directly in the production of high-grade dielectrics for use in aeroplane spark plugs, and is the source of beryllium metal and beryllium oxide. Perhaps the principal use of beryllium is in alloys. Beryllium-copper is the most important beryllium alloy: the master alloy contains 4 to 4.5 per cent beryllium, whereas the final copper-base alloy contains 0.3 to 2.5 per cent. Beryllium-copper alloy is fatigue-, corrosion-, and wear-resistant, is hard, has great tensile strength, high electrical and thermal conductivity, high electric limit, low creep tendency, and is non-magnetic and non-sparking. Some of the uses of beryllium-copper alloy are in current-carrying springs, pressure-responsive elements, switches, welding tips, disks, plater's bars, matrix metal in diamond-drill bits, valve guides, non-magnetic ball bearings, non-sparking tools and parts, tubing subjected to vibration or repeated flexing, aeroplane or other instruments (where its properties make possible the use of a smaller part), and in electrical control equipment for machinery and fire protection.

Beryllium-nickel has a much higher tensile strength than the copper alloy and is used in watch balance wheels and aeroplane parts. Beryllium-aluminium alloy has high strength and thermal conductivity, unusual oxidation resistance, and low thermal expansion. It is used in camera shutters and aircraft pistons. An addition of from 0.005 to 0.01 per cent beryllium reduces the oxidation of magnesium markedly. In zinc alloys, beryllium reduces creep, increases tensile strength, and improves corrosion resistance.

Beryllium oxide is an excellent refractory, being strong, hard, resistant to thermal shock, and having a high melting point. In combination with other oxides, it seems to impart its own property of electrical resistance at high temperatures; thus it is an excellent insulator for high-temperature furnaces, and an insulator where electrical conductivity is undesirable. The oxide has also been used in rocket combustion chambers. Beryllium oxide is a 'phosphors', that is, it has the property of transforming radiation of a given wave-length into radiation of a longer wave-length. Consequently, it finds use in fluorescent lamps, X-ray screens, and in television and other cathode-ray tubes. Manufacturers of fluorescent lamps have recently agreed to substitute non-toxic calcium halophosphate for the beryllium phosphors.

Metallic beryllium is used to make vacuum-tight X-ray tube windows, in glasses requiriring high-speed light transmission, and in radium-beryllium neutron sources. Beryllium has low absorption for neutrons, a high melting point, and is resistant to oxidation; thus it has found use as a moderator and reflector of neutrons in atomic energy investigations.

Current Prices. One ton of North Carolina beryl ore containing 10 to 12 per cent beryllium oxide is quoted as being worth $34 to $37 per unit beryllium oxide f.o.b. at the mine (5). Imported ore containing a minimum of 10 per cent beryllium oxide is worth $34 to $36.50, per unit beryllium oxide, c.i.f., United States ports (5).

Columbite-Tantalite

Columbite-tantalite occurs in many of the pegmatites of the Hearne Channel-Buckham Lake and Ross Lake-Redout Lake areas. In most places, it is the platy, high-columbium variety, which is easily recognized. The blocky, high-tantalum variety can be distinguished from cassiterite and tourmaline by its dark red to black streak.

Composition. $(Fe, Mn)(Cb, Ta)_2O_6$. The columbite-tantalite series includes four subspecies between which all gradations occur, namely: columbite (Fe, Cb_2O_6), mangancolumbite (Mn, Cb_2O_6), mangantantalite (Mn, Ta_2O_6), and tantalite (Fe, Ta_2O_6).

Crystallography. Orthorhombic. High-tantalum crystals are blocky, more or less equidimensional prisms, whereas high-columbium crystals are thin plates. Heart-shaped contact twins and penetration twins occur.

Physical Properties. Brittle. Cleavage, parallel with 100 and 010; fracture subconchoidal. Hardness = 6. Specific gravity = 5.3 - 7.3, increasing with increasing tantalum content (See table prepared by H.V. Ellsworth[1]). Colour, iron-black, grey-

[1] Jolliffe, A.W.: Rare-element Pegmatites, Yellowknife-Beaulieu Area, Northwest Territories; Geol. Surv., Canada, Paper 44-12, pp. 4-6 (1944).

black, brown-black, opaque; rarely reddish brown and translucent; sometimes iridescent; streak, dark red to black; lustre, sub-metallic, sub-resinous.

Tests. A test for columbium and other metals has been described by Van Valkenburgh and Crawford (18) and by Wahlstrom (20). Although tantalum cannot be detected by this method, the test for columbium may be used to indicate the presence or absence of tantalum, as these two elements are invariably associated.

Van Valkenburgh-Crawford Test (18, 20)

Method

About 0.1 gram of finely powdered mineral is mixed with 2 grams of ammonium hypophosphite (Mallinkrodt Chemical Works - labelled "for manufacturing use only") and heated over a Bunsen burner flame in a porcelain evaporating dish. Decomposition of the hypophosphite produces various gases, which ignite and yield thick, white clouds of smoke. Heating is continued until a clear fusion is obtained. The fusion is water soluble.

Columbium Test

Fuse the mineral as above. The mineral powder rarely completely disintegrates. Concentrated hydrochloric acid is added to the fusion; the mixture is brought to a boil; and a small piece of mossy tin is added. If columbium is present, a brilliant blue colour is produced.

General Occurrence. Only important occurrence is in certain granitic pegmatites and in deposits formed by the weathering of these pegmatites.

Occurrence in the Yellowknife-Beaulieu Region. Columbite-tantalite has a wide range of occurrence in the pegmatites of the Yellowknife-Beaulieu region. It is found in zones, and in fine-grained, muscovite-rich bodies that are, apparently, the result of replacement processes.

Columbite-tantalite was found in border zones, wall zones, intermediate zones, and cores. It occurs in the following zonal assemblages: plagioclase-quartz±muscovite, perthite-cleavelandite-quartz, cleavelandite-quartz, perthite-spodumene-quartz, perthite-spodumene-cleavelandite-quartz, spodumene-quartz-plagioclase, perthite-quartz, perthite-quartz-muscovite, and in, or near, quartz-muscovite segregations in perthite-cleavelandite-quartz-muscovite. In general, the zonal assemblages feature the platy, high columbium variety. The plates tend to be associated with cleavelandite, perthite, and beryl.

The muscovite-rich bodies contain the high-tantalum variety of columbite-tantalite, which is recognized by the blocky nature of its crystals, and which is usually much more abundant in these bodies than in the zonal assemblages. In addition to muscovite, these bodies generally contain plagioclase (commonly cleavelandite). Those containing columbite-tantalite are common in the lithium pegmatites of the Hearne Channel-Buckham Lake area.

Uses. Columbium is used as a stabilizer in stainless steels, decreasing their susceptibility to intergranular corrosion, increasing creep and impact strength, and improving weldability. It is finding use in ferrous and non-ferrous alloys for high-temperature jet engines, gas turbines, and other equipment. Tantalum is easily worked and is highly resistant to corrosion. It is used in the chemical industry in heat exchangers, condensers, absorption towers; in surgery, for skull plates and sutures; and in electronics, as a component of vacuum tubes. The carbide is used in cutting tools, dyes, and wear-resisting parts. Tantalum oxide is an important component of silica-free optical glass, which is used for the lenses of cameras in air-photographic work. Potassium-tantalum fluoride is used as a catalyst in the manufacture of synthetic rubber.

Current Prices. Columbite, containing 50 to 55 per cent combined oxides of columbium and tantalum, is quoted as being worth 100 s - 115 s per unit c.i.f., London (19). Tantalum ore, 56 to 60 per cent concentrate, commands a price of $2.00 to $2.25 per pound of tantalum oxide (5).

PEGMATITES OF THE HEARNE CHANNEL-BUCKHAM LAKE AREA

General Statement

The pegmatites of the Hearne Channel-Buckham Lake area are noted for their high content of lithium, and may be classified as lithium-rich granitic pegmatites. As in the case with lithium-rich pegmatites studied in the United States, these pegmatites exhibit remarkably well-developed internal structure, and may contain as many as seven lithologic assemblages. These pegmatites generally contain columbite-tantalite, and some of them also contain beryl.

The occurrence of lithium-rich pegmatites and the apparent lack of other types of pegmatites commonly found in other parts of the Beaulieu-Yellowknife region merit discussion. The pegmatites of the area are few in number, and all of them examined are of the lithium-rich variety. Furthermore, the Hearne Channel-Buckham Lake area contains only a few small bodies of granite, two of which are large enough to be shown on a scale of 1 inch to 4 miles (12). The pegmatites show no regional zonal relationship to these small bodies. If the zonation of pegmatites about the granite, as seen at Redout Lake, holds for this area also, it would seem that these lithium-rich pegmatites and small granite bodies are the surface expression of greater numbers of pegmatite and a larger body, or bodies, of granite to be found at depth.

Description of Properties

Moose Claims (15, 16)

(See Figures 1A, 1C)

The Moose group of fifteen claims, held by DeStaffany Tantalum Beryllium Mines Limited, 914 McLeod Building, Edmonton, Alberta, is on the north side of Hearne Channel, Great Slave Lake, about 72 miles east-southeast of Yellowknife.

The Moose Nos. 1 and 2 claims were staked by G.D. DeStaffany and A. Greathouse in July 1942 on behalf of DeStaffany Tungsten Gold Mines, Limited, to cover scheelite showings. In 1943, the group was enlarged to include two pegmatite dykes. At present, the group comprises fifteen claims, within which are two large and three small pegmatite dykes. The large pegmatites are known as the Moose No. 1 and Moose No. 2 dykes respectively. The claims are now held by DeStaffany Tantalum Beryllium Mines, Limited.

By July 1946, a shaft had been sunk on the Moose No. 2 dyke, and a mill erected at the south end of the dyke on the shore of Great Slave Lake. The following data were obtained from a report by Lord (16). The mill ran during parts of September and October 1947, and treated 3,800 pounds of ore from the Best Bet No. 1 claim and 30 tons from the Moose claims. About 1,200 pounds of concentrate were produced. In 1948, the mill produced 1,400 pounds of concentrate from ore from the Best Bet No. 1 claim.

Pegmatite workings on the Moose group of claims have been confined to the Moose No. 2 dyke. This 'dyke' refers to five pegmatite bodies that may represent one, two, or more dykes (Figure 10). The two southernmost bodies are referred to as the south section, the two central bodies as the central section, and the northernmost body as the north section. Much of the overburden has been stripped from these sections. A cut about 28 feet long, 5 feet wide, and 2 feet deep crosses the central part of the north body of the south section, and a pit about 64 feet long has been excavated at the north end of the same body. Broken rock obscures the depth and width of this pit. Four pits and a shaft comprise the workings at the north section; the largest, at the south end, is 80 feet long and has a maximum width of 38 feet; its floor is covered with broken rock, but the maximum depth is probably 10 feet. A second pit, 8 feet long, 6 feet wide, and 1 foot deep, lies 66 feet north of the large pit. A third pit, near the north end of the north body, is 62 feet long, and has a maximum width of 28 feet. Most of the pit is shallow, but the south end is deeper, the maximum depth being about 10 feet although broken rock again obscures the floor. The fourth pit lies 36 feet southwest of the third pit, and is 8 feet long and 6 feet wide. Broken rock covers the floor. The shaft is 5½ feet by 7 feet and was sunk to a depth of 40 feet.

The mill was built at the southernmost end of the Moose No. 2 pegmatite bodies on the shore of Great Slave Lake. It was designed to produce a columbite-tantalite concentrate. Equipment includes a small ore bin, jaw crusher, rolls, a two-stage dry classifier, and a D 3,400 Caterpillar diesel engine. The mill capacity is about 5 tons a day.

Moose No. 1 Dyke. This dyke is about 870 feet long, and averages between 15 and 20 feet in width. It strikes north 5 degrees west and dips 80 degrees east. Much of the dyke is obscured by overburden and lichens. The dyke is zoned, and three assemblages were noted: fine-grained quartz-plagioclase-muscovite composes the outer or border zone, which occurs only in places; coarse-grained microcline-quartz-cleavelandite±spodumene is found in places; and spodumene is especially abundant at the south end of the dyke. The spodumene crystals become coarser and less altered toward the centre of the dyke, and much of the mineral is intergrown with quartz. Several quartz masses were found, and these probably represent a discontinuous core. A few, small grains of tantalite were noted; no beryl was seen.

Moose No. 2 Dyke. This 'dyke' comprises five pegmatite exposures that may comprise parts of one or more pegmatite bodies. Its subdivision into south, central, and north sections has already been described.

The south section is composed of two pegmatite bodies each about 100 feet long, that may represent faulted parts of one dyke. Both bodies are similarly zoned although the north body contains a spodumene assemblage in addition to those featured in the south body. Because several quartz masses are exposed, it is assumed that they represent a discontinuous core. The border zone is composed of fine-grained quartz-plagioclase-muscovite; the quartz and plagioclase are grey and the muscovite is pale green. Fine-grained, irregular patches of the wall-zone assemblage occur in places in the border zone. The wall zone is medium-grained cleavelandite-quartz-muscovite, which becomes coarser in texture toward the first intermediate zone. In it the quartz is usually grey, but may be white; the muscovite is pale green; and the cleavelandite varies from grey to pink to red, becoming redder in colour towards the first intermediate zone. Coarse-grained, blocky perthite-quartz comprises the first intermediate zone. The perthite varies in colour from salmon to brick-red and is subhedral to euhedral; the quartz is white, and occurs interstitial to the perthite or as veinlets cutting it. Perthite-spodumene with minor quartz occurs in the north body, and apparently represents a second intermediate zone. The perthite is brick-red whereas the spodumene is green. Subhedral to euhedral beryl, pale yellow to green in colour, was found in cleavelandite-quartz-muscovite near the perthite-quartz boundary, in perthite-quartz, and in perthite-spodumene. Columbite-tantalite, in single and radiating plates, was found, associated with beryl, in perthite in the perthite-spodumene assemblage, and in cleavelandite of the cleavelandite-quartz-muscovite assemblage. The following table lists the pegmatite zones and mineral assemblages found in the south section of the Moose No. 2 dyke.

Zone	Assemblage
Border zone................	Quartz-plagioclase-muscovite
Wall zone..................	Cleavelandite-quartz-muscovite
Intermediate zones.........	1. Perthite-quartz
	2. Perthite-spodumene-quartz
Core.......................	Quartz

The wall-rock is sheared in places parallel with its contact with the pegmatite.

The central section of the Moose No. 2 dyke is composed of two pegmatite exposures separated by overburden, and may represent one body. The largest exposure is 180 feet long and has a maximum width of 100 feet on the surface. Both of these exposed masses are similarly zoned and will be discussed together. The outer mineral assemblage in each is quartz-plagioclase-muscovite, as in the south section, but is represented only in a few places. Cleavelandite-quartz, similar to that of the south section, occurs in places along the west side of the larger pegmatite mass. The adjacent assemblage, inward from the walls, is perthite-quartz-cleavelandite, in which coarse, pale pink perthite crystals occur in a medium-grained groundmass of quartz-cleavelandite. This is the most abundant assemblage in the central section. The innermost assemblage exposed in this section is perthite-spodumene-quartz-cleavelandite, in which the spodumene is coarse grained and fresh. Broken rock and splinters of spodumene obscure much of the larger mass, which dips between 55 and 65 degrees west. The wall-rock is sheared in places parallel with the pegmatite-wall-rock contact.

The north section (See Figure 2A) is a lenticular pegmatite body 515 feet long and 145 feet in maximum width as exposed. It is covered at its south end by muskeg. The body strikes north and dips 60 to 75 degrees west. A border zone of fine-grained quartz-plagioclase-muscovite and a wall zone of cleavelandite-quartz are exposed in places along the west side of the body. The core is, apparently, orange to red microcline, and is very coarse. Assemblages between the wall zone and the core comprise quartz-cleavelandite-spodumene±amblygonite, quartz-cleavelandite, and microcline-quartz-cleavelandite. They probably represent intermediate zones, but, as much of the pegmatite body is covered by broken rock, their relationship one to another is not clear. In these assemblages, the microcline, spodumene, and amblygonite are very coarse; the amblygonite occurs chiefly towards the south end of the body, but isolated crystals are found at the outer margins of the microcline masses. Small masses of fine-grained muscovite-quartz-plagioclase-columbite-tantalite occur in places, and appear to be replacement bodies. Beryl was found in the cleavelandite-quartz assemblage at the south end of the exposed pegmatite and in microcline near the north end. Columbite-tantalite occurs as blocky crystals in muscovite-quartz-plagioclase and as plates in microcline in the large pit near the north end of the body. An examination of the tailings at the mill suggests that the bulk of the ore milled was muscovite-quartz-plagioclase-columbite-tantalite.

The percentage of spodumene in the spodumene-bearing assemblage of the north section of the Moose No. 2 ~~dyke~~ was estimated by laying a tape measure across the spodumene-bearing assemblages at intervals and measuring the spodumene intercepted. Corrections were made for differences in specific gravity, and the percentage of spodumene by weight was calculated. On the bases of the spodumene-bearing rock exposed at the surface, and with very little interpretation, it was calculated that a minimum of 6,039 tons of spodumene-bearing rock is available to a depth of 10 feet. Because spodumene constitutes 24 per cent by weight of the spodumene-bearing material, this tonnage can be expected to yield about 1,450 tons of spodumene. The spodumene is of hand-cobbing size.

Best Bet No. 1 Claim (16)

(See Figures 1A, 1D)

The Best Bet No. 1 claim is held by DeStaffany Tantalum Beryllium Mines, Limited, 914 McLeod building, Edmonton, Alberta. The claim is on the west shore of Drever Lake about 4½ miles north-west of the camp at the Moose claims. It was staked in 1944 and was obtained at a later date by the present owners. The claim covers a lithium-bearing pegmatite sill from which, during parts of September and October 1947, 3,800 pounds of columbite-tantalite ore was treated in the mill at the Moose claims (Lord, 1951).

On the Best Bet No. 1 claim, an open-cut 40 feet long, 15 feet wide, and 10 feet deep, has been excavated diagonally across the pegmatite sill, which strikes north 35 degrees east and dips 75 degrees northwest. The sill is about 285 feet long and has a maximum width of 35 feet, but averages about 25 feet. The pegmatite is well zoned, but the internal structure is complicated, and detailed mapping is required before an accurate description can be made. The description of the pegmatite must, therefore, be regarded as preliminary. The zonal mineral assemblages from the walls inward are: fine-grained quartz-plagioclase±muscovite, fine-grained quartz-cleavelandite-muscovite, medium-grained quartz-cleavelandite±muscovite, quartz-amblygonite-spodumene, and perthite. Small masses of fine-grained, yellowish green muscovite-columbite-tantalite, that may be replacement bodies, occur in places in the quartz-amblygonite-spodumene assemblage. Platy columbite-tantalite occurs in perthite and altered spodumene, and in cleavelandite. The spodumene near the outer margins of the spodumene-bearing assemblage is altered or intergrown with quartz in places. Towards the centre of the sill, the spodumene crystals are very coarse, the largest being 14 feet long and 2½ feet wide. Pale yellowish green, subhedral beryl occurs in places in quartz-cleavelandite±muscovite, The largest crystal observed was 4 inches in diameter perpendicular to the long axis of the crystal.

It has been estimated (16, p. 121) that a medial zone, which is 115 feet long and averages 12 feet in width, is 50 per cent amblygonite, and probably contains 66 tons of amblygonite for each foot of depth. An area near the north end of the sill, 45 feet long and 25 feet wide, shows 19 per cent spodumene and 12 per cent amblygonite. This material contains 12½ tons of spodumene and 7½ tons of amblygonite for each foot of depth.

A chip sample of muscovite-columbite-tantalite, analysed by the Bureau of Mines, Ottawa, contained: tin, 3.72 per cent; tantalum pentoxide, 3.56 per cent; and columbium pentoxide, 0.09 per cent.

Tan Claims (15, 16)

(See Figures 1A, 1E)

The Tan group of four claims, held by DeStaffany Tantalum Beryllium Mines, Limited, 914 McLeod Building, Edmonton, Alberta, lies about 1 mile southwest of the Best Bet No. 1 claim, just west of Johnston Lake.

The Jade group of claims was staked in 1938 to cover gold showings near the east end of Blatchford Lake, about 67 miles east-southeast of Yellowknife. Four pegmatite bodies were discovered on the property and, in 1942 when the Jade group reverted to the Crown, the Buddy claim was staked by The Consolidated Mining and Smelting Company of Canada, Limited, and three Tan claims by DeStaffany Tungsten Gold Mines, Limited. The Buddy claim and the three original Tan claims were later acquired by DeStaffany Tantalum Beryllium Mines, Limited, and now compose the Tan group of four claims.

Workings comprise eleven shallow pits, ten of them excavated on what is known as the No. 3 pegmatite and one on the No. 4 pegmatite.

<u>No. 1 Pegmatite</u>. This pegmatite body is 265 feet long and has an average width of 5 feet. It strikes north 20 degrees

east, dips vertically, and is in part slightly disconformable with the adjacent wall-rocks, which are sheared in places along the contact. The pegmatite is zoned, and the assemblages from the walls inward as exposed are: fine-grained quartz-plagioclase-muscovite, medium-grained quartz-cleavelandite, and cleavelandite-quartz-muscovite-spodumene, which is medium grained with the exception of spodumene, which is coarse. As noted in many other pegmatites, the spodumene tends to be intergrown with other minerals and altered towards the outer margin of the zone. A few columbite-tantalite plates were found in spodumene, cleavelandite, and quartz.

No. 2 Pegmatite. This pegmatite was traced for 275 feet, and is 10 feet wide; it strikes north 25 degrees east, dips 85 degrees northwest, and is apparently a sill, with the wall-rock sheared in places along the pegmatite contact. The pegmatite body is zoned, and the following assemblages were noted: medium-grained quartz-plagioclase-muscovite, on the east side of the sill; fine-grained quartz-cleavelandite-muscovite, on the west side; and cleavelandite-quartz-spodumene-microcline-amblygonite, which occurs in the centre section of the sill. The spodumene, microcline, and amblygonite are coarse grained, and the cleavelandite-quartz medium grained. Platy columbite-tantalite and other metallic minerals were noted in the quartz-cleavelandite-muscovite assemblage, and small, irregular patches of fine-grained rose quartz occur in places.

No. 3 Pegmatite. This pegmatite body is in two sections, one 160 feet in length and the other 125 feet. These parts strike north 50 degrees west and dip 55 to 60 degrees northeast, whereas the adjacent meta-sedimentary rocks strike north 10 degrees west and dip easterly at 75 degrees. The pegmatite bodies are zoned, and the following assemblages were noted: fine-grained quartz-plagioclase; medium-grained cleavelandite-quartz-muscovite, containing in places plates of columbite-tantalite up to $\frac{1}{4}$ inch in maximum dimension and blocky columbite-tantalite aggregates up to $\frac{3}{4}$ inch in maximum dimension, in the large pit at the north end of the pegmatite; microcline-spodumene (coarse grained)-quartz-cleavelandite (medium grained), containing blocky columbite-tantalite in the outer part of the zone; spodumene-quartz (one pod about 1 foot long); coarse-grained plagioclase-quartz-spodumene; and a pod of quartz, with fine beryl crystals around its margin.

No. 4 Pegmatite. This body is Y-shaped; it is about 120 feet long, 10 to 20 feet wide, and dips about 60 degrees west. The pegmatite is zoned as follows: an outer zone, on both sides, of fine- to medium-grained quartz-plagioclase±muscovite, and an inner zone of cleavelandite-quartz-spodumene-microcline, the spodumene and microcline being coarse and the quartz and cleavelandite of medium grain. The spodumene is altered along the outer margins of the zone. A few platy grains of columbite-tantalite were seen in the outer zone and in spodumene crystals, and some blocky columbite-tantalite grains, up to $\frac{1}{2}$ inch in maximum dimension, were found in microcline and quartz in the inner zone.

A sample of columbite-tantalite-bearing pegmatite weighing 23 pounds was collected by Jolliffe (15, p. 17) and sent to the Bureau of Mines, Ottawa, for testing. It yielded 32.6 grams of concentrates, which would be equivalent to 6.25 pounds a ton. The concentrates assayed as follows: tantalum-columbium pentoxide, 66.70 per cent; tin dioxide, 15.96 per cent; and titanium dioxide, 0.20 per cent. A small fragment of columbite-tantalite from the No. 4 pegmatite showed a specific gravity of 7.54.

Big Hill Claims (16)

(See Figure 1A)

The Big Hill group of two claims lies about 4 miles west and slightly south of the camp at the Moose claims, and is held by DeStaffany Tantalum Beryllium Mines, Limited. The property has not been examined for the Geological Survey, but a sample of pegmatite from the V vein on the Big Hill No. 2 claim weighing 44 pounds was sent to the Bureau of Mines, Ottawa. It contained 0.129 per cent tantalum-columbium pentoxide, and 0.12 per cent tin dioxide.

Lita Claims (15, 16)

(See Figures 1A, 1F)

The Lita group of two claims, originally staked (September 1943) on behalf of Frobisher Exploration Company, Limited, has since been restaked as the P.N. Nos. 1 and 2 claims. These lie close to the shore at the northwest corner of Buckham Lake, about 55 miles east and slightly south of Yellowknife.

Prospectors looking for gold discovered some pegmatite bodies on the northwest shore of Buckham Lake. Jolliffe obtained information about one of these from Dr. Neil Campbell, geologist, Consolidated Mining and Smelting Company of Canada, Limited, in 1942, and examined it and other nearby pegmatite bodies on August 27, 1943. They are known as the Campbell pegmatites.

No. 1 Pegmatite. This pegmatite is 200 feet long as exposed, and averages about 15 feet in width; it strikes north 10 degrees east and dips westerly at 70 to 75 degrees. Two assemblages were noted: an outer assemblage of cleavelandite-quartz, and an inner assemblage of microcline-spodumene, with minor quartz. The rocks at the contact are sheared in places.

No. 2 Pegmatite. This pegmatite strikes north 40 degrees east and dips 70 degrees northwest. It is 5 to 6 feet wide and has a length of 190 feet, but dips under Buckham Lake at its northeast end. The pegmatite shows three zones composed of the following assemblages: cleavelandite-quartz, with minor muscovite; cleavelandite-quartz-spodumene; and quartz masses that apparently represent a disconnected core. The spodumene is altered. A few plates of columbite-tantalite and two crystals of beryl were found in cleavelandite-quartz. A smaller pegmatite body striking parallel with the No. 2 pegmatite and 80 feet northwest of it was examined. It contains two mineral assemblages: cleavelandite-quartz, and quartz-spodumene-cleavelandite. One crystal of beryl was found. The original bedding planes still discernible in the meta-sedimentary rocks are bent in towards the pegmatite, suggesting that the latter follows a shear.

No. 3 Pegmatite. This pegmatite is arcuate-shaped, as shown in Figure 1F, and dips 80 degrees to the west. It also shows evidence of having been intruded, in part, along a shear zone. Three mineral assemblages were noted in it: fine-grained quartz-plagioclase, occurring only in places along the outer margin; medium-grained cleavelandite-quartz, with minor muscovite; and cleavelandite-quartz-spodumene$\pm$microcline. Both the spodumene and microcline are coarse.

Ramona Claims (15, 16)

(See Figure 1A)

The Ramona group of four claims, held by DeStaffany Tantalum Beryllium Mines, Limited, 914 McLeod Building, Edmonton, Alberta, lies about 5 miles southwest of the north end of Buckham Lake, and about 50 miles east and slightly south of Yellowknife.

In 1940, W. L. Macdonald of Yellowknife informed the Geological Survey of Canada of the discovery of a pegmatite containing large spodumene crystals. The occurrence was examined by Jolliffe in August 1943. Lita Nos. 1 to 4 claims were staked by Mr. Macdonald in September of that year on behalf of Frobisher Exploration Company, Limited. The claims were re-staked in 1947 for DeStaffany Tantalum Beryllium Mines, Limited. They cover a spodumene-bearing pegmatite known as the Macdonald pegmatite. The writer did not examine the occurrence, but the pegmatite has been fully described by Jolliffe in the reports cited (15, 16). The spodumene-bearing part of the pegmatite body is about 400 feet long and has an average horizontal width of 22 feet. Jolliffe estimates the spodumene content to be 30.7 per cent by weight.

PEGMATITES OF THE REDOUT LAKE-ROSS LAKE AREA

General Statement

The pegmatites of the Redout Lake-Ross Lake area (15, p. 10) are zonally arranged about the Redout Lake granite in the area between Redout and Ross Lakes. Very little is known of the rocks immediately east of Redout Lake (6, 15).

The writer has distinguished five zones characterized by different types of pegmatites in this area (See Figure 1B). Near the Redout Lake granite, the pegmatite bodies are large, irregularly shaped, and have poorly developed internal structure. They are composed of a mixture of aplitic to fine-grained feldspar-quartz-muscovite, medium-grained quartz-feldspar, coarse graphic granite, fine-grained bodies of quartz-muscovite, and pods of perthite-quartz. Farther from the granite, the pegmatites become smaller and more regular in outline, and have a somewhat better developed internal structure. Some of them contain graphic granite, some beryl, and others both graphic granite and beryl. The pegmatites of the third zone are small, regular in shape, and have internal structures that can be readily mapped. None of them contains graphic granite, but many contain beryl. Still farther from the granite, is a zone of pegmatites many of which contain columbite-tantalite and, or, beryl. Finally, spodumene-bearing pegmatites are found in the zone farthest from the granite.

In general, the pegmatites of this area are not as markedly zoned as those of the Hearne Channel-Buckham Lake area. They occur in rock described by Fortier (7) as foliated granodiorite containing numerous biotite schist and amphibolite schist inclusions. He states that the granodiorite has been intruded by numerous basic dykes, some of which contain large phenocrysts of plagioclase. The Redout Lake granite is described as containing 40 per cent potassium feldspar, mostly microcline, about 20 per cent plagioclase, 30 per cent quartz, and micas in variable amounts.

Description of Property

Peg Claims (7, 15, 16)

(See Figure 1A)

The peg group of ten claims, originally held by Peg Tantalum Mines, Limited, is now owned by Tantalum Refining and Mining Corporation of America Limited. The group lies between Ross and Redout Lakes about 44 miles east-northeast of Yellowknife. A rough tractor road, about 1½ miles long links the camp with Ross Lake where aircraft land.

Officers of the Geological Survey discovered columbite-tantalite in pegmatites near Ross Lake in the summer of 1943. J.R. Saunders of Yellowknife staked the original Peg group of four claims in September 1943, and other claims were staked in the vicinity. These were acquired by Peg Tantalum Mines, Limited, which was incorporated in 1944. Several men were employed during the summer of 1945 under the direction of J. C. Finnan, and some pegmatite was hand-cobbed and piled. Mill machinery was brought in during the spring of 1946, and, by September, twenty-one men were employed building the mill and quarrying pegmatite. The mill operated briefly, but mechanical and metallurgical difficulties caused operations to cease. Milling was resumed in April 1947, and continued until mid-July under the management of J.E. Doyle. Later in the summer the mill was operated at intervals as a sampling plant. When visited in July 1951, the property was inactive.

Lord (16, p. 232) has published data supplied by J. E. Doyle from company mill records to July 18, 1947. According to this information, 940 tons of rock had been milled, yielding 3,750 pounds of concentrate. No information is available on the columbite-tantalite content of either the rock treated or the concentrate; most of the rock is believed to have come from the No. 3 dyke.

Open-cuts and pits were observed in many pegmatite bodies on the Peg claims, but quarrying has been limited essentially to the pegmatite known as the No. 3 dyke. There the pit is about 50 feet long, 25 feet wide, and up to 10 feet deep. The mill has a capacity of about 50 tons a day, and is equipped with a jaw-crusher, Hardinge rod mill, a two-compartment Denver jig, screens, a Fahrenwald sizer, two Wilfley tables, and a Denver spiral classifier. The camp consists of a frame cook-house and several tents mounted on wooden frames. An office and blacksmith shop-warehouse are located near the mill, which is about 1,000 feet north-northeast of the camp.

No. 3 Dyke (See Figure 1B). This dyke has been partly mined so that its size and shape before mining are not now apparent. A map prepared by Jolliffe (15, Figure 2) shows this body as an irregular mass 200 feet long and about 50 feet maximum surface width; it strikes north, and dips about 50 degrees east. The wall-rock is sheared in places along the contact. Most of the pegmatite body is composed of coarse to very coarse microcline in medium-grained cleavelandite-quartz-muscovite, with a few grains of blocky columbite-tantalite near quartz-muscovite segregations. Some beryl crystals were seen, the largest 7 inches long and 2 inches in diameter.

Other dykes. Six samples totalling 152 pounds were taken by Jolliffe (15, p. 12) from the No. 1 dyke for treatment by the Bureau of Mines, Ottawa. Treatment indicated that the grade was 9.13 pounds of concentrate per ton of ore. The concentrate assayed: columbium-tantalum pentoxide, 82.37 per cent; titanium dioxide, 1.59 per cent; ferrous oxide, 13.91 per cent; manganese oxide, 0.66 per cent; and tin dioxide, 0.14 per cent. Several columbite-tantalite-bearing dykes were examined. Typically, they contain the following mineral assemblages: fine-grained plagioclase-quartz, which occurs in places as a thin border; cleavelandite-quartz-muscovite, medium-grained, with coarse microcline or perthite composing the bulk of the pegmatite; and pods of blocky perthite-quartz. Much of the feldspar is red. Beryl is commonly associated with the perthite-quartz assemblage, whereas columbite-tantalite was observed in the coarse feldspars and cleavelandite near quartz-muscovite segregations. Jolliffe states that columbite-tantalite characteristically occurs in albite near quartz lenses, but was found in perthite, quartz, muscovite, and beryl. Fortier found that patches of muscovite are loci for concentrations of columbite-tantalite.

Columbite-tantalite occurs both as plates and blocky crystals associated with quartz, muscovite, or quartz-muscovite segregations. These segregations seem to occur sporadically in the cleavelandite-quartz-muscovite-microcline or perthite assemblage. The columbite-tantalite-bearing pegmatites examined by the writer were all small.

PEGMATITES OF THE PRELUDE LAKE AREA

General Statement

An area of about 10 square miles immediately north of Prelude Lake was prospected for beryl by a Geological Survey field party under Jolliffe in June 1943. Most of this area and additional ground to the north was examined by the writer.

The area is underlain by highly metamorphosed meta-sedimentary rocks intruded by numerous pegmatite masses, and is flanked on either side by the Prosperous Lake and Prelude Lake-Duncan Lake granite bodies.

The pegmatites of the area may carry beryl, but very little columbite-tantalite, and no spodumene or amblygonite were seen. Jolliffe (15, p. 23) reports that of one hundred pegmatites examined, fifty-six contained beryl. In general, the beryl is pale green, and occurs in crystals less than 6 inches in maximum dimension; the largest crystal seen by the writer had a surface area of about 60 square inches.

The pegmatites vary in size from large, near the main granite masses, to others less than 1 foot in width. In general, the larger pegmatites are poorly zoned and are composed of graphic granite±perthite-plagioclase-quartz, with minor muscovite. Most of the smaller pegmatites are zoned, and contain the following mineral assemblages: fine-grained plagioclase-quartz, with minor muscovite, which occurs as border zones; medium- to coarse-grained plagioclase-quartz±perthite, with or without graphic granite, with minor muscovite, which comprises the greater part of the pegmatites; and coarse-grained blocky perthite-quartz, which occurs as pods. Where beryl occurs, it is in association with perthite-quartz, except in the River pegmatite where it is found in cleavelandite-rich assemblages. The pegmatites of the area are characterized by abundant black tourmaline, which occurs both in the pegmatites and in the wall-rocks at the contacts.

Description of Deposits

General Statement

The Dike group of claims represents the only claims staked to cover pegmatite deposits in the Prelude Lake area (See Figure 1A). They were staked in 1943 for Frobisher Exploration Company, but have since lapsed (16, pp. 244-245).

Two pegmatites featured a significant amount of beryl-bearing pegmatite at the surface (Figure 1G). Beryl-counts were made on the beryl-bearing parts of both pegmatites, and on a scale of 1 inch to 20 feet.

Lily Pegmatite

(See Figure 1G)

This pegmatite is a C-shaped body about 110 feet long and 10 feet wide. It is strikingly zoned and contains the following mineral assemblages: fine-grained plagioclase-quartz-muscovite, which forms a very narrow border zone; coarse perthite-quartz-plagioclase, with minor muscovite and containing a few beryl crystals, which constitutes the western half of the pegmatite; and coarse to very coarse, blocky perthite-quartz-beryl, which composes the eastern half of the pegmatite. The Lily pegmatite differs from the other pegmatites of the area in that the perthite-quartz assemblages occur as a well-developed zone.

A beryl-count made on the perthite-quartz-beryl zone indicated a surface area of 259 square inches of beryl within an area of 58,890 square inches of beryl-bearing pegmatite, or a percentage of 0.44 of beryl. Most of this beryl is of hand-cobbing size, that is, the crystals have a maximum dimension of 6 inches or more.

Riber Pegmatite

(See Figures 1G, 2B)

The Riber pegmatite has an average width of 45 feet in plan, and an exposed length of 180 feet; it is covered by overburden at both ends. The pegmatite body was mapped on a scale of 1 inch to 20 feet, and a beryl-count was made on the beryl-bearing sections.

This pegmatite is strikingly zoned, and features mineral assemblages altogether different from those found in other pegmatites in the area. These assemblages, from the walls inward, are as follows:

1. Plagioclase-quartz-muscovite, fine grained
2. Plagioclase±quartz±minor muscovite, medium grained
3. Muscovite-plagioclase-quartz, coarse grained
4. Euhedral quartz-plagioclase, medium grained
5. Cleavelandite-muscovite-quartz-beryl, medium to coarse grained
6. Cleavelandite-beryl, coarse grained
7. Quartz

One pod of very coarse perthite and several small pods of fine-grained muscovite and lepidolite occur in the pegmatite. Much black tourmaline was seen, and is especially abundant in assemblages 5 and 6; a few crystals of green tourmaline and one crystal of purplish red tourmaline were noted in the quartz assemblages (7). The beryl is greenish yellow to golden in colour, and in general is under hand-cobbing size, but varies up to 18.00 square inches in surface area.

Beryl-counts were made on the beryl-bearing assemblages of the Riber pegmatite. The sum of the areas of the individual crystals gave the total area occupied by beryl crystals, and this multiplied by 100 and divided by the total surface area of the beryl-bearing pegmatite was taken as the percentage of beryl by volume. As the specific gravities of quartz, cleavelandite, and beryl are nearly the same, the percentage by weight was taken as equivalent to the percentage by volume.

Four beryl-bearing sections are exposed on the outcrop of the Riber pegmatite. The results of beryl-counts on these sections are tabulated below:

Section	Area of beryl-bearing pegmatites Square inches	No. of beryl crystals	Area of beryl Square inches	Per cent beryl in section
1	62,152	265	339.40	0.55
2	25,920	14	17.69	0.07
3	8,064	13	61.44	0.76
4	5,760	6	14.19	0.25
Total	101,896	298	432.72	0.42 per cent beryl in beryl-bearing pegmatite

PEGMATITES OF THE SPROUL LAKE AREA (15)

(See Figure 1A)

The Sproul Lake pegmatites occur just south of Sproul Lake, which is about 34 miles northeast of Yellowknife. The pegmatites range up to 3 feet in width. Several of them are well zoned, and comprise the following mineral assemblages: muscovite-plagioclase-quartz, cleavelandite- or plagioclase-quartz, cleavelandite-quartz-spodumene, and quartz. Much of the spodumene is altered to muscovite. A few plates of columbite-tantalite and some beryl crystals were found in cleavelandite-quartz, and amblygonite occurs in some of the pegmatites as a minor constituent. Concentration tests on samples from these pegmatites by the Bureau of Mines, Ottawa (15, p. 22) indicate that the columbite-tantalite content is low, and that much of the metallic material is cassiterite.

The Bore group of three claims was staked in September 1943 to cover these pegmatites, and was owned by Radium Luminous Industries, Limited, but apparently the claims have lapsed.

PEGMATITES OF THE BLAISDELL LAKE AREA (15, 16)

General Statement

Blaisdell Lake lies 34 miles northeast of Yellowknife and 2 miles northwest of Sproul Lake.

Of the seven pegmatite bodies examined in this area, six contain beryl, but only one was found to carry it in sufficient amount to warrant a beryl-count. Two of the pegmatites consisted of fine-grained perthite-plagioclase-quartz-muscovite, with pods of coarse-grained, blocky perthite-quartz containing a few beryl crystals, but four pegmatites were well zoned and contained the following mineral assemblages: fine-grained quartz-plagioclase-muscovite; coarse perthite with or without graphic granite, and medium-grained quartz-plagioclase with minor muscovite; and pods of coarse, blocky perthite-quartz±beryl.

The area examined lies near a body of granite.

Description of Deposit

(See Figures 1H, 2C)

The pegmatite to be described is in one of a group of small pegmatite bodies. It was mapped on a scale of 1 inch to 20 feet, and beryl-counts were made on the two beryl-bearing sections, which occur at the extreme north and south ends of the pegmatite. Apparently beryl occurs at the crest and trough of the pegmatite. This pegmatite lies in granite a few feet west of the meta-sedimentary rock contact.

The pegmatite comprises a border zone of fine-grained quartz-muscovite, a wall zone of medium-grained quartz-cleavelandite, and a centre zone of blocky perthite-quartz. As the border zone attains a maximum width of only 3 inches, it was mapped with the wall zone. In the north section of beryl-bearing pegmatite, which is 37 feet long and averages 3 feet in width, the beryl is scattered throughout the perthite-quartz assemblage. In the south section, the beryl occurs along the wall zone-perthite-quartz east contact for a distance of 20 feet.

A tabulation of the results of the beryl counts is given below. In each case the area of the beryl-bearing section represents the full width of the pegmatite. The largest exposure of beryl is in the south section, and has a surface area of 85.50 square inches.

	Area of section Square inches	Area of beryl Square inches	No. of beryl crystals	Per cent beryl
North section	27,648	110.10	25	0.44
South section	21,888	292.12	32	1.34

ECONOMIC OUTLOOK

Several factors enter into the evaluation of mineral deposits: grade and tonnage of ore, mining methods, milling procedure (if necessary), availability and cost of labour, transportation costs, and markets are among the more important of these. Most pegmatites can be mined by low-cost methods, and in the past the desirable minerals have been hand-cobbed. If the grain-size of these minerals is such that milling is necessary, then this additional cost must be considered. Most of the pegmatite commodities are bulky materials; hence, transportation costs are very important. In general, markets are readily available for pegmatitic minerals provided reasonable tonnages of desirable grade can be guaranteed.

Transportation costs are of prime importance in an area that is far from markets. Lord (16, pp. 19-23) has recently presented a detailed account of such costs in the District of Mackenzie of which the Yellowknife-Beaulieu region is part. The rate for water-borne freight, Yellowknife to Waterways, the southern terminus of water transportation, is quoted at $1.90 per 100 pounds. Rail freight rates from Waterways to Edmonton are given as $0.31 to $1.37 per 100 pounds. Heavy freight is hauled generally by tractor over a winter road from a mine or prospect to the nearest docking point; the cost of constructing such a road in the Yellowknife area in 1937 is given as $140 per mile. From these figures it can be readily seen that transportation costs in this region are formidable.

No pegmatite examined by the writer could be mined for columbite-tantalite or beryl alone. In general, the columbite-tantalite is too fine grained to be hand-cobbed, and would require milling. Only two of the pegmatites examined contain hand-cobbing beryl, and both are small bodies capable of providing very limited amounts of beryl. The best grade over a mineable length and width was calculated as 1.34 per cent beryl. A ton of such material contains about $5 worth of beryl at current prices.

Some of the lithium-bearing pegmatites could be mined under favourable transportation conditions, but it can be readily calculated that even the best ore available in the region would sell at a market price that would not even meet transportation costs.

Although it seems improbable that pegmatitic deposits in this region can be mined profitably at present prices, this situation in periods of stress, such as wartime conditions, might be radically changed. The North American continent depends to a large extent upon foreign sources for a supply of beryl and columbite-tantalite; thus, these minerals may be considered as of strategic importance, and as such should provide an incentive to the prospector to be on the lookout for pegmatites containing them. Also, it should be pointed out that only a small fraction of the pegmatites in the region has been critically examined, and that many favourable areas within the region remain to be prospected.

BIBLIOGRAPHY

1. Barlow, N. E.: Simple Field Test for Beryl; The Precambrian, vol. 24, No. 6, p. 13 (June 1951).

2. Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R.: Internal Structure of Granite Pegmatites; Econ. Geol. Pub. Co., Urbana, Illinois, Monograph 2, 1949.

3. E. and M. J.: Metal and Mineral Markets: McGraw-Hill Publishing Co., Inc., New York, vol. 22, No. 42, Oct. 18, 1951.

4. ____ Metal and Mineral Markets: McGraw-Hill Publishing Co., Inc., New York, vol. 22, No. 49, Dec. 6, 1951.

5. ____ Metal and Mineral Markets: McGraw-Hill Publishing Co., Inc., New York, vol. 23, No. 5, Jan. 31, 1952.

6. Fortier, Y. O.: Yellowknife-Beaulieu Region, Northwest Territories; Geol. Surv., Canada, Preliminary Map 46-23, with notes on gold mineralization, 1946.

7. ____ Ross Lake, Northwest Territories; Geol. Surv., Canada, Paper 47-16, Preliminary Map, 1947.

88. Henderson, J. F.: Beaulieu River Area, Northwest Territories; Geol. Surv., Canada, Paper 39-1, 1939.

9. ____ Gordon Lake Area, Northwest Territories; Geol. Surv., Canada, Map 644A, 1941.

10. ____ Gordon Lake South Area, Northwest Territories; Geol. Surv., Canada, Map 645A, 1941.

11. ____ Structure and Metamorphism of Early Precambrian Rocks between Gordon and Great Slave Lakes, Northwest Territories; Amer. Jour. Sci., vol. 241, pp. 430-446 (1943).

12. Henderson, J. F., and Jolliffe, A. W.: Beaulieu River, Northwest Territories; Geol. Surv., Canada, Map 581A, with descriptive notes, 1941.

13. Jolliffe, A. W.: Yellowknife River Area, Northwest Territories; Geol. Surv., Canada, Paper 36-5, 1936.

14. ____ Yellowknife Bay; Geol. Surv., Canada, Map 790A, 1942.

15. ____ Rare-element Minerals in Pegmatites, Yellowknife-Beaulieu River Area, Northwest Territories; Geol. Surv., Canada, Paper 44-12, 1944.

16. Lord, C. S.: Mineral Industry of District of Mackenzie, Northwest Territories; Geol. Surv., Canada, Memoir 261, 1951.

17. Spector, I. H., and Brown, D. F.: The Precambrian, vol. 24, No. 6, p. 13 (June 1951).

18. Van Valkenburgh, H. B., and Crawford, T. C.: Detection of Certain Metals in Minerals and Ores; Industrial and Engineering Chemistry, vol. 13, p. 459 (1941).

19. United States Bureau of Mines: Minerals Yearbook 1949; United States Government Printing Office, Washington, D.C., p. 1308 (1951).

20. Wahlstrom, E. E.: Use of Ammonium Hypophosphite in Determinative Mineralogy; American Mineralogist, pp. 385-386 (1942).