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PEGMATITES AND ASSOCIATED ROCKS IN THE NEWRY HILL AREA, OXFORD COUNTY, MAINE [1]

VINCENT E. SHAININ [2] and LOUIS F. DELLWIG [3]

Abstract

The Newry Hill area, Maine, includes in approximately four square miles 37 exposed pegmatites which have been emplaced in Devonian(?) metamorphic and igneous rocks. Numerous investigations in the past have been prompted by the presence of strategic, gem, and rare pegmatite minerals in this area. The present report describes the occurrence, distribution, and quantities of beryl and other strategic minerals in these pegmatites.

The oldest known sedimentary rocks in this area were metamorphosed to form a quartz-muscovite schist that grades into a quartz-biotite schist adjacent to intruded gabbro. Partial alteration of gabbro to actinolite schist was brought about by the intrusion of the pegmatites; the pegmatites were associated with a granodiorite intrusive to the north.

The Main, Dunton, Red Crossbill, Crooker, Kinglet, and Spodumene Brook pegmatites were mapped in detail and their mineralogy and internal structure are described. Important data concerning the smaller pegmatites are tabulated.

Forty-five minerals, series, and varieties have been found in these pegmatites and are described. Outer zones consist primarily of quartz, perthite, plagioclase and muscovite with accessory black tourmaline and garnet. For the most part, the rare constituents are confined to the inner units. Mineralogy varies from one pegmatite to another.

Of economic importance are perthite, beryl, spodumene and amblygonite. Although pollucite and gem tourmaline have been mined in this area, no new deposits were found.

Introduction

Newry Hill is in the town of Newry in Oxford County in western Maine (fig. 1). The area mapped is in the towns of Newry, Andover, and Rumford (Shainin, 1949), 4 miles northwest of the village of Rumford Point.

[1] Publication authorized by the Director, U. S. Geological Survey.
[2] Deceased, 1950.
[3] Geologists, U. S. Geological Survey.

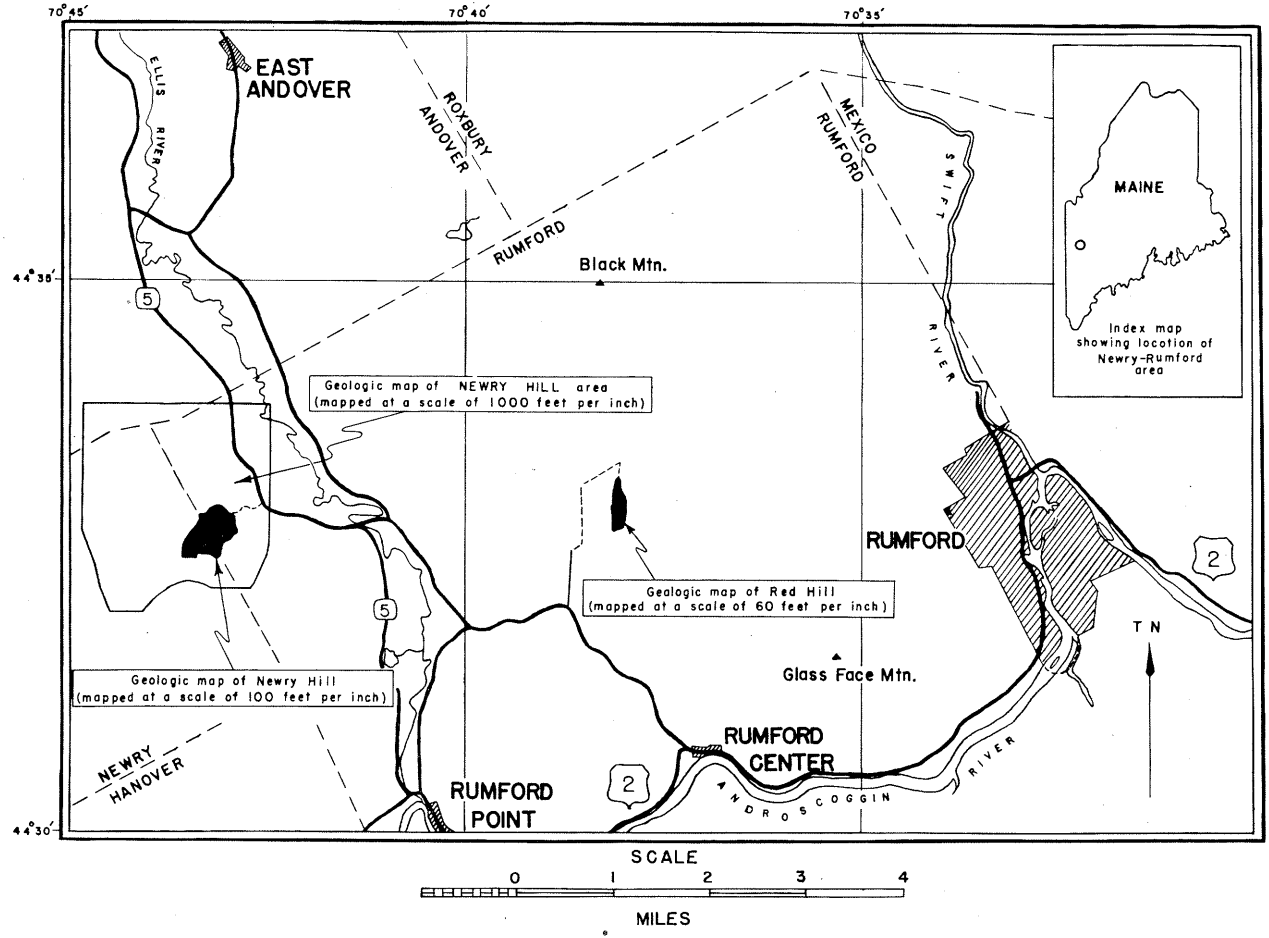

FIGURE I. INDEX MAP SHOWING LOCATION OF THE NEWRY HILL AREA, OXFORD COUNTY, MAINE

The area is about 2 miles square, and State Route 5 passes through the extreme northeast corner. The eastern slope of Plumbago Mountain is included in the area. The part of the area in the town of Newry is the property of the International Paper Company; the part in the town of Rumford is owned, from north to south, by Rena Abbott, Mrs. Edith Thurston, Homer Bartlett, and Ellery Abbott.

The Newry Hill area is well known for pegmatites that contain rare minerals, especially gem varieties. The Dunton pegmatite contains the "Gem Mine"; specimens of rare minerals and gems from this quarry are known throughout the world. Some pegmatites in the area contain the following minerals of economic or strategic value: feldspar, scrap mica, beryl, spodumene, amblygonite, columbite, tantalite, and cassiterite. Pollucite, a rare hydrous cesium aluminum silicate, was mined on Newry Hill from 1926 to 1929, but apparently was mined out. Small quantities of uraninite occur as excellent crystals.

The present investigation was undertaken by the U. S. Geological Survey as part of its program of investigation of domestic beryllium resources in cooperation with the Maine Geological Survey and partly on behalf of the Division of Raw Materials of the U. S. Atomic Energy Commission. The purpose of the study was to determine the quantity and distribution of the beryl and other strategic minerals in the area. Measurements of the exposed areas of all beryl grains were made to determine the content of beryl in each zone of selected pegmatites.

Field work and acknowledgments

About four months were spent in the field in the Newry Hill area during the period from 1947 to 1949. Newry Hill was mapped by transit and telescopic alidade at a scale of 1 inch equals 100 feet (pl. 1). The Newry Hill area was mapped by pace and compass at a scale of one inch equals 1,000 feet (pl. 2).

The writers were assisted in the field by Paul L. Cloke, Wallace J. Cropper, John J. Donohue, William A. Linton, Charles A. Sandberg, Harlan P. Beach, and K. K. Menon of the Maine Geological Survey in 1947; by Paul L. Cloke, Wallace J. Cropper, Edward W. Perkins, and Hans H. Adler of the U. S. Geological Survey in 1948; and by Wayne Plummer of the Maine Geological Survey in 1949.

The writers are indebted to H. Leslie Smith and George Crooker of the Whitehall Company, Keene, N. H., for their generous cooperation during the field investigations and to A. N. Winchell and C. S. Hurlbut for many helpful suggestions.

Prior to his death in 1950, V. E. Shainin had partially prepared the manuscript. The present report was completed from that manuscript and field data by L. F. Dellwig and staff of the U. S. Geological Survey.

Previous work

Wade (1909, p. 1129) published a very brief note on the occurrence of gems in pegmatite (presumably the Dunton pegmatite) in Newry. Bastin (1910, p. 316; 1911, p. 76-78) mentioned the occurrence of gem-bearing pegmatites in Oxford County, and he also described the Dunton pegmatite on Newry Hill as it appeared in 1906.

Fairbanks (1928, p. 21-25) published a brief description of pollucite in the Dunton pegmatite, and Palache and Shannon (1928) described beryllonite and other phosphates from the same pegmatite. Fraser (1930) wrote on the paragenesis of the Dunton, and part of the Crooker pegmatites, and Shaub (1940) differed with some of Fraser's conclusions on the origin of the pegmatites. Shaub's paper contained references to the Dunton, Kinglet, and Crooker pegmatites. Shaub called the Dunton pegmatite "Pegmatite No. 2", the Crooker was referred to as "Pegmatite No. 1", and the Kinglet as "Pegmatites Nos. 3 and 4". A list of 22 minerals from the Dunton pegmatites was published by Verrow (1940), and shortly afterwards Hess and others (1943, p. 12-20) described some rare alkalies in the Main, Dunton, and Kinglet pegmatites. Page (1954, fig. 24) made a pace and compass map of the Dunton pegmatite and parts of the Crooker and Main pegmatites in 1942. Larrabee (1954, p. 87-89) examined the Plumbago Mountain beryl deposit in the same year. Palache, Richmond, and Wolfe (1943) described amblygonite crystals from the Nevel mine.

Before the present study was undertaken, precise information was not available on the number, size, and distribution of the pegmatites, and only fragmentary references had been published on the complex internal structure of the Main pegmatite.

Geology

The Newry Hill area is underlain by a variety of igneous and metamorphic rocks. Nine types of rock were mapped: quartz-muscovite schist, quartz-biotite schist, actinolite schist, gabbro, dioritic pegmatite, hornblendite, granodiorite, greisen, and granitic pegmatite.

Outcrops are confined to hill tops, stream valleys, and cliffs as more than 70 percent of the area is covered with glacial deposits and talus, which are as much as 30 feet thick adjacent to some stream valleys.

Metamorphic rocks

The metamorphic rocks of the area are of two general types: 1) the quartz-muscovite and the quartz-biotite schists that have been formed by the metamorphism of sediments, as shown by minor limey and quartzitic layers that have retained remnants of bedding, and in which schistosity has developed parallel to the plane of the original bedding, and 2) actinolite schist that is the product of metamorphism of the gabbro.

Quartz-muscovite schist

Quartz-muscovite schist is the dominant rock in the eastern part of the area and also underlies a narrow belt in the northwest part of the area. Included in this rock type are metasediments that range from schists that are predominantly muscovite to quartzite beds that contain a minor percentage of chlorite. Limey and quartzitic layers, ½ inch to 3 inches thick, indicate the sedimentary origin of the schist. In the muscovite-rich schist crumpling of the mica flakes has developed a wavelike surface on the planes of foliation. The quartzite layers also show lineation. The quartzite may be either banded, massive, or in thin layers interbedded with layers of quartz-muscovite schist.

One thin section of the quartz-muscovite schist contained quartz, biotite, and muscovite. The micas are intergrown and for the most part form bands in the quartz matrix. A high biotite content is not normal for this type of schist. The accessory minerals are garnet, limonite, hematite, zircon, titanite, and sericite.

Quartz-biotite schist

The gray-brown quartz-biotite schist is bright and fresh. The mica is not crenulated. Calcite nodules, composed of concentric layers that are progressively lighter colored toward the center, are common. This schist is distributed in an irregular band and grades into the quartz-muscovite schist. It may represent a contact-metamorphic alteration of the quartz-muscovite schist adjacent to intruded gabbro.

Actinolite schist

Actinolite schist borders the gabbro intrusive on the northeast and southwest sides. At no place is a sharp contact exposed, and the gabbro appears to grade into the schist. As the proportion of actinolite increases at distance from the gabbro body, foliation develops until all the gabbroic structure is lost, and the rock is essentially actinolite schist. Field evidence suggests that

this alteration is the result of granitic and pegmatitic intrusions. The greater part of the alteration to actinolite schist is adjacent to the large pegmatite body on Newry Hill; the actinolite schist is not associated with the smaller intrusives.

A thin section from the northeast part of the large actinolite schist mass appears to be altered gabbro. Composition of the rock is about 45 percent actinolite, 43 percent labradorite, and less than 10 percent chlorite. Biotite, hematite, limonite, titanite, zircon, and sericite are accessory minerals.

Igneous rocks

Much of the area is underlain by igneous rocks, of which gabbro and granodiorite form the largest, most widespread bodies. Granitic pegmatite, dioritic pegmatite, greisen, and hornblendite form smaller bodies scattered throughout the metasediments and the other igneous rocks.

Gabbro

A gabbro intrusive underlies the west-central and south-central parts of the area. It contains few inclusions of the quartz-muscovite schist host rock.

The grain size of the gabbro is variable. In the fine-grained rock the texture is ophitic with 40 to 70 percent hornblende and 60 to 30 percent labradorite. With an increase in grain size the feldspar percentage decreases. The coarser varieties vary in texture from ophitic, with subhedral labradorite crystals, to equigranular, with anhedral labradorite and hornblende. Some biotite is particularly abundant near contacts and joints, possibly indicating a secondary origin. Small grains of pyrrhotite and magnetite are widespread, but locally the gabbro contains as much as 0.5 percent magnetite.

A single 0.4-inch band of anorthosite was observed in the gabbro in the south-central part of the area. The gabbro directly adjacent to the anorthosite contains some chlorite and shows parallelism of minerals, which is common along the joints in the gabbro. The band is made up of 94 percent andesine and 6 percent chlorite or actinolite. The contact is sufficiently sharp to form a plane of easy separation but is broken in places where chlorite streams pass from the gabbro into the anorthosite.

One particularly noteworthy occurrence of pyrrhotite is in gabbro adjacent to a pegmatite where a 6-foot zone of pyrrhotite-bearing gabbro grades rapidly into a slightly coarser gabbro that contains magnetite and pyrite. Until a more detailed study can be made, the possibility that the pyrrhotite resulted from contact metamorphism of the gabbro by the pegmatite can only be sug-

gested and may elsewhere prove to be an indicator of the proximity of additional pegmatites.

Dioritic pegmatite

Dioritic pegmatite occurs as a differentiate within the gabbro in the southwest corner of the main mass and also at the top of the northernmost ridge of Plumbago Mountain. Hornblende crystals reach a maximum length of 2 inches and are generally larger than the andesine crystals. Contacts with the gabbro are gradational. In the exposures of Plumbago Mountain, hornblende is concentrated in the center of the pegmatite, feldspar around the sides.

Hornblendite

Hornblendite occurs in two bodies: in an oval-shaped body 400 feet long and 250 feet wide that is completely surrounded by pegmatite 24, and in a lens, which is too small to be shown on the map, in actinolite schist near the south end of pegmatite 29. The hornblendite is estimated to consist of 90 to 95 percent hornblende and 5 to 10 percent plagioclase. The rock is fine grained and equigranular with maximum crystal size of less than 0.1 inch.

Granodiorite

Granodiorite, exposed in the northern part of the area, appears to be an offshoot of a larger mass lying farther to the west. The equigranular rock is fine to intermediate in grain size with an average size of less than 0.1 inch. In thin section the grains are predominantly anhedral. The rock is composed of 40 to 50 percent oligoclase, 20 percent orthoclase, 10 to 20 percent microcline, 10 to 15 percent quartz, 4 percent biotite, 3 percent muscovite, and accessory sericite, zircon, tourmaline, garnet, and apatite. Carlsbad-albite and albite-carlsbad-pericline twinning are common in the plagioclase.

Greisen

Greisen, as used in this report, refers to a group of scattered intrusives whose common features are 1) occurrence as narrow bodies, the composition of which is 85 to 90 percent quartz, 5 to 10 percent muscovite and accessories — garnet, tourmaline, biotite, and limonite — and 2) planar orientation of the muscovite generally parallel to the (walls) contact.

Three of these bodies are associated with pegmatitic or granitic bodies and are concordant with one intrusive. Grain size ranges from aphanitic to medium-grained phaneritic. Relationships with the wall rock and the granite and pegmatitic intrusives indicate that the greisen bodies are early intrusives

along planes of weakness that were later followed by granitic or pegmatitic bodies; the orientation of the muscovite possibly was caused by movement between two stages of intrusion, or by the second intrusion.

Granitic pegmatite

Irregularly shaped bodies of granitic pegmatite as much as 4,000 feet long occur along the slopes and crests of Plumbago Mountain and Newry Hill. Most of the commercially productive pegmatite bodies are centered on Newry Hill, with the exception of a spodumene-bearing body on Spodumene Brook and a few beryl-bearing pegmatite bodies on Plumbago Mountain. Most of the pegmatite bodies are simple assemblages of quartz, perthite, plagioclase, and muscovite; others, especially those on Newry Hill, contain many rare minerals, of which beryl and cleavelandite are the most common.

In some pegmatites, the component minerals form essentially uniform mixtures. Others are zoned; that is, their minerals are grouped into lithologic units of contrasting composition or texture that have a systematic arrangement with respect to the walls of the pegmatite. In ideal development, the zones are successive shells concentric around an innermost core.

The names of the units used in describing the pegmatites in the Newry Hill area are defined as follows:

1. Border zone. A narrow, fine-grained shell that constitutes the outermost zone in a pegmatite. In most places this zone is too narrow to be shown on the map.
2. Wall zone. The next zone inside the border zone. Generally coarser grained.
3. Intermediate zone. Any zone that lies between the wall zone and the core. A "core-margin zone" is an intermediate zone that lies just outside the core.
4. Core. The innermost zone of a pegmatite.

The classification of the internal structure of pegmatites used in this paper follows the standard terminology, developed since 1944, and presented by Cameron and others (1949).

In describing the grain size of pegmatites arbitrary divisions have been established as follows:

Very fine	less than 1.0 inch.
Fine	1.0 to 2.0 inches.
Medium	2.0 to 12.0 inches.
Coarse	12.0 inches to 2.0 feet.
Very coarse	more than 2.0 feet.

Detailed petrographic and mineralogic descriptions of those pegmatite bodies that are of economic interest are given in a later section of this report.

Structure

The fold axes in the quartz-muscovite schist and the quartz-biotite schist strike from west to N. 50° W. and thus are discordant to the regional northeast trend of fold axes in western Maine. The folds plunge 60° SE. in the eastern part of the area and 45° E. in the small anticline in the southeast corner of the map. Folding is tight and the dips on the limbs are persistently steep.

The actinolite schist has a foliation roughly parallel to the outline of the Newry Hill pegmatite bodies.

Flow structure was not observed in the granodiorite or the gabbro. The joint patterns observed in the field do not lend themselves to interpretation. The joints in the gabbro commonly are coated with chlorite or actinolite. Small pegmatite intrusives are common along joints in the granodiorite, and this may indicate that these joints are the result of cooling during intrusion of the granodiorite body.

One small fault of minor displacement was observed in the southeast corner of the area.

Pegmatites on Newry Hill

The five large pegmatites on the upper slopes and top of Newry Hill were mapped on a scale of 1 inch equals 100 feet (pl. 1). The pegmatites, designated from west to east as the Kinglet, Crooker, Dunton, Main, and Red Crossbill, differ greatly in size and shape. These pegmatites range in size from the Dunton, which is 190 feet long and about 10 feet thick, to the Main, which is 2,450 feet long and is inferred to be about 100 feet thick. Before the present study was undertaken, very little was known concerning the number of individual pegmatite bodies on Newry Hill, or about the geology of these pegmatites.

Main pegmatite

The Main pegmatite (15, pl. 2) was called by Hess and others (1943, p. 17-18) the " Triphylite Pegmatite." This name is considered to be misleading because of the small percentage of triphylite in the entire pegmatite, and also because it conflicts with the petrographic terminalogy used in this paper. As this pegmatite body is by far the largest on Newry Hill, it is more satisfactorily referred to as the Main pegmatite.

Numerous small prospect pits have been made in the Main pegmatite, but the only sizable workings are at the Nevel mine (pl. 1) on the property of the International Paper Company. Mining operations began about 1940 when the United Feldspar and Minerals Corporation of West Paris, Maine, mined for perthite.

The Whitehall Company of Keene, N. H., leased the mineral rights and operated the mine in 1948 and 1949. Perthite was the chief product recovered; spodumene, scrap mica, beryl, amblygonite, and columbite-tantalite were byproducts. Many uncommon mineral specimens also were sold by the company to collectors and museums.

In the summer of 1948 the Whitehall Company drilled five holes, totaling 435.5 feet, with a portable diamond drill, equipped with EX core-barrel bits (diameter of core about $\frac{7}{8}$ inch). All the holes were drilled in or close to the Nevel mine (pl. 1; figs. 2 and 3), and the company kindly permitted the senior author to examine the cores. Mr. H. Leslie Smith was in charge of the drilling operations. The cores are permanently stored in the company's core-house at the Ruggles mine, Grafton, N. H.

Form and attitude

This pegmatite is inferred to be a gently-dipping, tabular lens (pl. 1, sec. E - E′) that strikes about north, although locally the strike differs considerably because of irregularities in the contact. The lens appears to dip approximately 15° E. For the most part, erosion appears to have penetrated the undulating hanging-wall contact of the pegmatite only a few feet. This is indicated by 1) thin schist skims resting on the pegmatite, 2) areas of border zone still preserved at some distance from exposed contacts, and 3) many eastward dips of the eastern contact of the pegmatite. This eastern contact of the lens dips 35 to 65 degrees easterly in the northern part and 25 to 45 degrees westerly in the southern part. One theory that may be advanced to account for this variation in dip of the eastern contact is that the hanging wall is reversed and forms the footwall in the southern part whereas the footwall is below the surface along the northern end of the contact because of a moderately steep northerly plunge of the eastern edge of the pegmatite (pl. 1, sec. E - E′).

The northern end of the pegmatite plunges 50 to 70 degrees to the northeast. Lineation, represented by the axes of minute crumpling in the schist, plunges 65 degrees to the northeast. The southern end of the pegmatite is not exposed.

Internal structure

The main pegmatite contains seven zones, many medium- to small-sized fracture-controlled replacement units, and what may be one large replacement body (figs. 2 and 3). The zones are:

Border zone (Quartz-oligoclase-muscovite pegmatite). — The outermost, or border, zone ranges from ¼ inch to 2 feet in thickness. The average grain size is ⅛ inch, and the zone is estimated to contain 50 percent quartz, 32 percent oligoclase, 16 percent muscovite, 1 percent black tourmaline, and 1 percent garnet.

Wall zone (Quartz-perthite-albite pegmatite). — The wall zone is the thickest zone (4 to 100 feet) in the pegmatite and its thickness changes with the form of the pegmatite. The grain size differs from place to place in the zone; the average size is 5 inches. The zone is estimated to contain 35 percent quartz, 35 percent perthite, 25 percent albite, and 4 percent muscovite. Accessory minerals are beryl (0.007 percent), black tourmaline, garnet, and heterosite-purpurite.

Milky quartz and silvery-green muscovite books, which range from ¼ inch to 2 inches in size, commonly form intergrowths in which the mica books are subparallel and the quartz interstitial. In many of these intergrowths the aggregate of muscovite books exhibits a faint radial pattern; in some the muscovite is unoriented.

First intermediate zone (Quartz-albite-muscovite-triphylite pegmatite). — The first intermediate zone is 6 inches to 1 foot thick and has been seen only in the west wall of the Nevel mine where it is between the wall zone and the second intermediate zone. The zone apparently is discontinuous; in the Nevel mine it occurs as a band 60 feet in strike length; its other dimensions are not exposed. This zone is too small to be shown on the geologic map or sections.

The grain size ranges from 6 inches to 1 foot. The zone is estimated to contain 60 percent quartz, 15 percent albite, 15 percent muscovite, and 10 percent triphylite. The mica books are oriented perpendicular to the interzonal contacts and, in general, occupy the full thickness of the zone. The average size of the books is 8 inches in diameter and ½ inch in thickness. The mica is yellow green. Structural defects include wedging, herringbone, ruling, and tanglesheet. No sheet mica can be recovered.

Triphylite occurs in roughly lenticular masses 1 to 8 inches in diameter and is intergrown with fine-grained muscovite and granular milky quartz.

Second intermediate zone (Quartz-albite-perthite-triphylite pegmatite). — This is by far the larger of the two triphylite-bearing zones. It has been found only in the Nevel mine and vicinity where it forms a shell around the perthite-quartz zone (fig. 2). The second intermediate zone ranges from 4 to about 25 feet in thickness. The average grain size is 2 inches, and the zone is estimated to contain 39 percent quartz, 21 percent albite, 18 percent perthite, 11 percent triphylite, 10 percent muscovite, 1 percent beryl, and minor quantities of black tourmaline and columbite.

This zone is a mixture of two distinct petrographic types, designated as the triphylite unit and the quartz-perthite unit. The composition given above is a composite of the minerals found in the two units.

The triphylite unit, which occurs in irregularly shaped masses, makes up approximately half of the zone and is estimated to contain 43 percent quartz, 22 percent triphylite, 18 percent albite, 15 percent muscovite, 2.02 percent beryl, and minor black tourmaline and columbite. The beryl content is based on measurements of 148 square feet of pegmatite, in which the exposed area of 269 beryl crystals were measured.

The composition of the unit differs considerably from place to place. The composition given above is an average of estimates made in three places within the unit, as listed in table 1.

Table 1. Variation in estimated composition of the triphylite unit in the second intermediate zone in the Nevel mine.

Mineral	Entrance to mine (percent)	Ceiling at north end of South Room (percent)	Ceiling at south end of North Room (percent)
Quartz	11	69	49
Triphylite	40	15	10
Albite	35	0	18
Muscovite	12	14	19
Beryl	2	2	2
Totals	100	100	98

This triphylite unit was described by Hess and others (1943, p. 17) as fracture-controlled replacement bodies. No evidence for this origin could be found.

The quartz-perthite unit of this zone constitutes the remainder of the zone. This unit is similar in composition and texture to the wall zone (quartz-perthite-albite pegmatite). The unit forms the matrix in which the triphylite masses occur and therefore is a part of the quartz-albite-perthite-triphylite zone.

Third intermediate zone (Muscovite-quartz-perthite-cleavelandite pegmatite). — Although not exposed at the surface, this zone is known from diamond-drill hole 5 and from accounts of the miners who mined part of the zone in the floor of the Nevel Mine. It appears to form a discontinuous unit that lies outside the perthite-quartz zone and the core-margin zone (figs. 2 and 3, secs. A - A′, B - B′, and C - C′). Although little is known of the dimensions of the zone, it may range in thickness from 30 feet to the vanishing point. The strike length is also unknown.

The grain size ranges from $\frac{1}{16}$ inch to 2 feet, and the zone is estimated to contain 75 percent muscovite, 8 percent quartz, 8 percent perthite, 7 percent cleavelandite, 1.5 percent spodumene, and minor amounts of cassiterite and uraninite.

Fourth intermediate zone (Perthite-quartz pegmatite). — The perthite-quartz pegmatite is the source of the feldspar, the chief mineral for which the Main pegmatite has been exploited. The zone occurs in several segments, the largest of which is a shell that partly surrounds the core-margin zone in the Nevel mine; 15 smaller segments are exposed elsewhere in the pegmatite. Where a segment of this zone crops out, the inner zones of the pegmatite, i.e., the core margin and the core, may occur beneath the surface. On the other hand, the inner zones may not have formed within the perthite-quartz zone. Despite the fact that some zones may be missing in certain parts of the pegmatite, the relative order or sequence of the remaining zones is always the same.

In the Nevel mine the perthite-quartz zone occurs as a lens-shaped shell that partly surrounds the two innermost zones. The exact dimensions of this segment of the zone are unknown because of incomplete exposures of its margin. It is inferred to be about 200 feet long parallel to the strike of the pegmatite and to extend 155 feet down the dip. It ranges from the vanishing point to 30 feet in thickness.

The average grain size is 5 feet, and the zone is estimated to contain 64 percent perthite, 33 percent quartz, 1 percent muscovite, 1 percent cleavelandite, and 0.2 percent spodumene, with even smaller quantities of triphylite, beryl, lepidolite, cassiterite, manganoan apatite, and uraninite.

Core-margin zone (Quartz-perthite-spodumene pegmatite). — The core-margin zone surrounds the core in the Nevel mine. It ranges from 2 to 15 feet

in thickness and has an average grain size of 5 feet. The zone is estimated to contain 50 percent quartz, 42 percent perthite, 5 percent spodumene, 1 percent white and green cleavelandite, 1 percent muscovite, 0.8 percent beryl, 0.4 percent amblygonite, and very minor quantities of columbite, apatite, sphalerite, galena, lepidolite, uraninite, autunite, torbernite, eosphorite, fairfieldite, and siderite.

Core (Quartz-perthite pegmatite). — The core occurs in separate pods, the largest of which has been almost entirely mined out in the Nevel mine. The core in the mine was a roughly ellipsoidal body, the long axis of which trended almost N. 30° W. and was approximately horizontal. It had a length of at least 85 feet in the workings; its overall length cannot be determined as its southern end is south of these workings. The core was 40 feet in maximum thickness. At least two smaller segments of the core are shown in plate 2.

The average grain size is about 6 feet, and the core is estimated to contain 60 percent quartz, 37 percent perthite, and 3 percent muscovite.

Fracture-controlled replacement bodies. — Many small fracture-controlled replacement bodies of fine-grained white cleavelandite cut quartz and perthite in the fourth intermediate and core-margin zones in the Nevel mine. Most of these bodies are half an inch to 4 inches thick and 1 foot to 10 feet long; most of them are not mappable units.

The only fracture-controlled replacement body that could be mapped on the scales used is a tabular mass of white cleavelandite (55 percent), coarse milky quartz (40 percent), and silvery-green muscovite (5 percent) that formed by replacing equally the walls on either side of a fracture in the wall zone on the north bank of Bartlett Brook (pl. 1). The unit is about 2.5 feet thick and can be traced along the strike for 15 feet before it disappears beneath glacial till at each end. The strike of the body is N. 60° E. and it dips 10 degrees to the northwest. The cleavelandite plates, which are ¼ to 8 inches long, are oriented subnormal to the fracture, and the muscovite books, ¼ to 5 inches long and $\frac{1}{16}$ to 4 inches thick, have a similar orientation. The books are badly ruled and contain less than half of one percent punch or sheet-quality mica.

Units of unknown origin. — Three units of unknown origin and unknown position in the zonal sequence of the pegmatite were observed in the course of this study.

A quartz-cleavelandite unit is known only from the core from diamond-drill hole 4. This unit appears to occupy the position of the hanging wall part of the wall zone (fig. 3, sec. D - D'), but whether the unit formed by replacement of the wall zone minerals or crystallized in the primary sequence

is unknown. The unit is 14 feet thick where it is cut by hole 4 and consists of fine- to medium-grained milky quartz (75 percent), white cleavelandite (20 percent), greenish muscovite (4 percent), and minor quantities of schorl and pink garnet in subhedral dodecahedra. Some of the muscovite books are ¼ to 1 inch thick and extend completely through the EX core.

A cleavelandite-quartz-muscovite unit is also known only from the core in drill hole 4. It appears to occupy the position of the footwall part of the wall zone (fig. 3, sec. D - D′). Its genetic relation to the zones is also unknown. The minerals in the unit are fine- to medium-grained white cleavelandite (55 percent), milky quartz (30 percent), greenish muscovite (14 percent), and minor quantities of perthite, schorl, and vivianite in streaks. One buff perthite anhedron, cut by the hole, was 6 inches long and appeared to be replaced along the edges by cleavelandite. This evidence suggests that the cleavelandite-quartz unit was formed by replacement of wall-zone minerals, and that the unit is therefore secondary.

A quartz-plagioclase-muscovite unit occurs in several places in the Main pegmatite. It is best exposed in the vicinity of the Nevel mine where it is below a part of the second intermediate zone. Here the unit forms a body about 20 feet thick that has a known strike length of at least 80 feet and is inferred to extend about 190 feet down dip (fig. 3). The average grain size is ⅛ inch, although the range in size is from ½ millimeter to ½ inch. The composition is estimated to be 50 percent quartz, 45 percent plagioclase, 4 percent muscovite, and minor black tourmaline. Irregular veins, with non-matching walls, of the second intermediate zone cut the quartz-plagioclase unit, indicating that the zone is younger than the unit. As the zones of the Main pegmatite appear to have formed by successive crystallization from the walls inward, the exact place of the quartz-plagioclase unit in the sequence is unknown.

Dunton (Gem) pegmatite

The Dunton pegmatite (17, pl. 2) was first mined from 1901 to 1904 by H. C. Dunton for gem tourmaline. From 1926 to 1929 the General Electric Company mined pollucite, and at least 3,500 pounds of this mineral were recovered according to Hess and others (1943, p. 13). In 1949 Harvard University and the Whitehall Company prospected the pegmatite in a cooperative enterprise for gems and feldspar. Several tons of pegmatite were mined and the footwall of the pegmatite was exposed in the workings, but no gems or commercial grade feldspar were found.

The pegmatite is an irregularly shaped lens about 190 feet long and 10 feet thick (fig. 4, sec. A - A′), although it has a maximum outcrop width of 100 feet.

The Dunton pegmatite contains six zones, which are:

Border zone (Albite pegmatite). — This zone ranges from 1 inch to 3 inches in thickness. The average grain size is approximately 2 millimeters. The composition is white albite (99 percent), with minor amounts of green actinolite and black tourmaline. The albite crystals are chiefly equant and very few show polysynthetic twinning.

Wall zone (Quartz-albite pegmatite). — The thickness of this zone is from 8 inches to 4 feet, and the average grain size is ¼ inch. The composition is 60 percent quartz, 30 percent albite, 6 percent muscovite, 3 percent black tourmaline, and accessory garnet.

First intermediate zone (Quartz-cleavelandite-muscovite pegmatite). — This zone is 1 to 2 feet thick, and is discontinuous as it pinches out in some parts of the pegmatite. The average grain size is 3 inches. The zone is estimated to consist of 40 percent milky quartz, 40 percent white cleavelandite, 19 percent muscovite, and minor quantities of green and black tourmaline. The muscovite occurs in spear-shaped books that are 2 to 10 inches long, and are oriented subnormal to the zonal contacts. The cleavelandite plates also are subnormal to these contacts.

Second intermediate zone (Albite-quartz-perthite pegmatite). — This zone is 5 to 25 feet thick, and the average grain size is 5 inches. The zone is estimated to contain 70 percent albite, 12 percent quartz, 10 percent perthite, 4 percent muscovite, 2 percent amblygonite, and minor amounts of triphylite-lithiophilite, beryl (0.04 percent), tantalite, lepidolite, and pollucite. Practically none of the pollucite mined came from this zone. About 5 percent of the albite is blocky white albite; the remainder is cleavelandite. The beryl crystals are white to pale green subhedral prisms, the average size of which is ½ inch in diameter and 1 inch long. These crystals are considerably smaller than those in the core-margin zone and the core.

Core-margin zone (Cleavelandite-quartz-perthite pegmatite). — The core-margin zone ranges from 5 to 10 feet in thickness, and the average grain size is 6 inches. It is estimated to contain 60 percent cleavelandite, 25 percent quartz, 7 percent perthite, 5 percent muscovite, 1 percent lepidolite, and minor amounts of beryl (0.5 percent), pollucite, amblygonite, tantalite, cassiterite, and green, blue, and pink tourmaline. No pollucite was seen in place, although the bulk of the past production is reported to have come from this

zone. The beryl is in white to very pale green, flattened prisms that have an average diameter of 1.5 inches and an average length of 2.5 inches.

Core (Quartz-cleavelandite-perthite pegmatite). — The core, which has been almost completely mined out, is an ellipsoidal unit 8 feet in diameter and 12 feet long in the center of the pegmatite. The average grain size is 8 inches. The zone is estimated to contain 35 percent milky quartz, 35 percent white cleavelandite, 25 percent salmon perthite, 2 percent fresh spodumene, 1.8 percent white beryl, and minor quantities of lepidolite, dark-blue tourmaline, gem-green tourmaline, cassiterite, tantalite, and amblygonite. No other accessory minerals were seen in place by the senior author, but many of the following minerals were found on the dumps or have been reported from the pegmatite, and may have occurred in the core and the core-margin zone: beryllonite, pollucite, chalcedony, opal, eosphorite, siderite, apatite, uraninite, autunite, torbernite, zircon, microlite, herderite, pyrite, montebrasite, cookeite, francolite, reddingite, heterosite, sphalerite, triphylite, and vivianite.

Red Crossbill pegmatite

The Red Crossbill pegmatite (14, pl. 2) has a lens-shaped outcrop about 1,050 feet long and 200 feet wide. Its true form and attitude are unknown because of the paucity of exposures. The body trends N. 45° E., and its margins appear to dip outward from 5 to 85 degrees (pl. 1). The attitude of the contacts, coupled with the fact that all exposures of the pegmatite consist of either border-zone or wall-zone material, suggests that only the crest of this body has been exposed.

Except for the border zone, the wall zone of quartz-perthite-albite pegmatite forms all outcrops of the Red Crossbill pegmatite. Other, inner zones may be present at depth. As the mineralogy and the texture of the two zones that are exposed resemble closely the two outermost zones of the Main pegmatite, it is likely that other zones, if present in this pegmatite, are similar to the inner units of the Main pegmatite.

The border zone of quartz-oligoclase-muscovite pegmatite ranges from ¼ inch to 6 inches in thickness, and the average grain size is ⅛ inch. The zone is estimated to contain 55 percent quartz, 30 percent plagioclase, 13 percent muscovite, 1 percent black tourmaline, and 1 percent garnet.

The grain size of the wall zone is 4 to 6 inches, and the zone is estimated to contain 35 percent quartz, 30 percent perthite, 30 percent albite, 4 percent muscovite, and minor quantities of black tourmaline, beryl, and garnet. The beryl content of the zone is estimated to be about 0.007 percent.

Crooker pegmatite

The Crooker pegmatite (16, pl. 2) is named after George Crooker of East Andover, Maine, who has been closely associated with the mining and study of the Newry Hill pegmatites for more than twenty years. The southern part of this pegmatite was referred to by Shaub (1940) as "Pegmatite No. 1". The pegmatite, however, is a single, irregular body, about 700 feet long; its thickness is unknown. The pegmatite strikes north and the predominant dip of the walls is 65 to 80 degrees to the west. The pegmatite may be a relatively shallow bowl-shaped body, as shown in Section F-F', plate 1, but there is so little evidence concerning the attitudes of its walls that no definite statement of its subsurface form can be made.

In the period from 1926 to 1929, W. D. Nevel, representing the General Electric Company, opened a quarry at the south end of the pegmatite, and made prospect pits at three other places in the body (pl. 1). These operations were conducted primarily for pollucite, and about 1,000 pounds are reported to have been recovered.

The Crooker pegmatite has a simple arrangement of four zones: a border zone, a wall zone, a core-margin zone, and a core.

Border zone (Quartz-plagioclase pegmatite). — This zone ranges from ¼ inch to 3 feet in thickness. The average grain size is about ⅛ inch. The composition is estimated to be 50 percent quartz, 45 percent plagioclase, 3 percent muscovite, 1 percent perthite, and minor quantities of black tourmaline, garnet, spodumene, gray lepidolite, and columbite-tantalite. About 20 percent of the plagioclase is estimated to be cleavelandite that appears to have replaced parts of the zone.

Wall zone (Quartz-albite-perthite pegmatite). — The wall zone is absent in places; in other places it is as much as 6 feet thick. It has an average grain size of 1 inch. The composition is estimated to be 50 percent albite, 40 percent quartz, 5 percent perthite, 4 percent muscovite, and minor black tourmaline and garnet.

Core-margin zone (Quartz-muscovite-cleavelandite pegmatite). — This zone ranges from 6 inches to 2 feet in thickness; the average grain size is 4 inches. The composition is estimated to be 45 percent quartz, 30 percent muscovite, and 25 percent cleavelandite. The muscovite occurs in pale green books, which are 2 to 9 inches in diameter and ¼ inch to 6 inches thick, and which are subnormal to the zonal contacts.

Core (Quartz-perthite pegmatite). — The core is exposed in the quarry at the south end of the pegmatite and in a prospect pit 40 feet west of the ruins

of Nevel's bunk house. The core is at least 7 feet thick, but its lower contact is nowhere exposed so that the true thickness is unknown. The average grain size is 1 foot. The composition is estimated to be 65 percent quartz, 25 percent perthite, 5 percent muscovite, 3 percent spodumene, and 2 percent cleavelandite. Most of the cleavelandite occurs in radial clusters, the bases of which are attached to spodumene crystals.

Kinglet pegmatite

The Kinglet pegmatite (18, pl. 2) is a lens-shaped body in outcrop (pl. 1) about 650 feet long and 110 feet wide that trends N. 35° W. Its attitude is unknown as it is poorly exposed except in an old quarry, which is about 125 feet long and 30 feet wide near its southern end. This pegmatite was mined at the same time as the Crooker pegmatite for pollucite by W. D. Nevel as agent for General Electric Company.

Except for a quartz-plagioclase unit of unknown origin, the Kinglet pegmatite is very similar to the Crooker pegmatite in that it contains only four zones, which are:

Border zone (Quartz-plagioclase pegmatite). — This zone ranges from ¼ to 1 inch in thickness and is very fine grained. It is composed of quartz, plagioclase, and muscovite, with minor quantities of garnet.

Wall zone (Quartz-albite-perthite pegmatite). — This zone averages 10 feet thick and has an average grain size of 1 inch. The composition is estimated to be 50 percent albite, 40 percent quartz, 5 percent graphic granite, 4 percent muscovite, and minor black tourmaline, garnet, and manganoan apatite. A few of the graphic granite masses are 5 feet in size.

Core-margin zone (Quartz-muscovite-cleavelandite pegmatite). — The core-margin zone ranges from 6 to 18 inches in thickness and has an average grain size of 4 inches. The composition is estimated to be 45 percent quartz, 30 percent muscovite, and 25 percent cleavelandite. The muscovite occurs in pale green books that are subnormal to the zonal contacts.

Core (Quartz-perthite pegmatite). — The core is only exposed near the base of the quarry face, and its thickness is unknown. The average grain size is 1 foot. The estimated composition is 65 percent quartz, 25 percent perthite, 5 percent muscovite, 3 percent spodumene, and 2 percent cleavelandite.

The quartz-plagioclase unit is exposed in the quarry face where it forms a horizontal band in the wall zone. It is veined by material from the wall zone and has nonmatching walls. The grain size of this rock is less than $\frac{1}{16}$ inch. It is composed chiefly of quartz and plagioclase but contains about 2 percent

black tourmaline needles in radiating clusters. The origin and relationship to the zonal structure of this unit cannot be established because of poor exposures.

Spodumene Brook pegmatites

Two spodumene-bearing pegmatites (36, 37, pl. 2) that were opened in a search for spodumene in 1942 are exposed on the upper, northern slopes of Plumbago Mountain in the channel of a tributary — referred to in this paper as Spodumene Brook — of Howe Brook (pl. 2). For descriptive purposes these pegmatites have been named the East pegmatite and the West pegmatite (fig. 5).

The East pegmatite probably is a tabular body, which strikes northeast and dips gently to the northwest and which cuts across the schistosity of the quartz-muscovite schist wall rock. The following zones are present:

1) Border zone. — A discontinuous zone, 1 inch to 3 inches thick, that consists of muscovite, quartz, and minor blocky plagioclase.

2) Wall zone. — A discontinuous zone, 6 to 18 inches thick, that consists of muscovite, quartz, and plagioclase. The muscovite occurs in narrow compound books that are as much as 1 foot long.

3) Intermediate zone. — This zone differs in thickness from place to place (see fig. 5, sect. A - A′). It consists of quartz, plagioclase, perthite, and muscovite with accessory spodumene, garnet, and rare green apatite. The spodumene is in green, altered subhedral crystals that average 3 inches long.

4) Core. — A pod-shaped body with a maximum thickness of about 16 feet. It consists of coarse perthite as much as 10 feet long and coarse milky quartz in anhedral masses that range from 6 inches to 6 feet in diameter. Mineral counts indicate a composition of 92+ percent perthite and 7+ percent quartz.

The small area of wall zone and intermediate zone, west of the southernmost alaskite outcrop, may belong to the East pegmatite although its relationship is uncertain. No similar units are exposed at the alaskite outcrop, which may be either an inclusion or an apophysis in the West pegmatite. Hence, it seems more likely that this small area is part of the East pegmatite.

Insufficient exposures of the West pegmatite make it impossible to determine its form and attitude (fig. 5). The contact with the underlying alaskite may be similar to the observed contact of the East pegmatite, and the structure shown in the geologic section is based on this inference. The westernmost outcrops, mapped as " pegmatite undivided ", are covered with moss and could not be satisfactorily examined. Three crystals of beryl were seen in this pegmatite.

The following units occur in the West pegmatite:

1) A quartz-cleavelandite pegmatite unit of unknown thickness that consists of quartz, cleavelandite, muscovite, and accessory spodumene in much altered crystals that are 3 inches long.

2) A quartz-spodumene pegmatite unit, also of unknown thickness, that consists of coarse milky quartz, coarse spodumene, and accessory cleavelandite and muscovite. The spodumene, which forms 33 percent of the unit, is only slightly altered and occurs in crystals as much as 7 feet long; the average crystal size is 3 inches by 6 inches in cross section and 2 feet long.

Other pegmatites

Inasmuch as outcrops are few and widely spaced, pegmatite bodies probably are much more numerous than this work indicates. Reconnaissance indicates that the pegmatite belt extends, although somewhat more weakly, to the south.

The mapping scale used made it necessary to omit numerous small pegmatite bodies in the granodiorite. These dikes range from 1 inch to 10 inches in thickness and generally show a gradation from very fine grained at the margin to medium grained at the center. Beryl was not observed in any of these dikes, which were injected along joints in the granodiorite.

Pegmatite 29

Pegmatite 29 (pl. 2) is the best prospect for beryl in the area. It cuts across the foliation of the actinolite schist — trends N. 20° E., and dips about 35° SE. It is 1,000 feet long and has a maximum width of 350 feet. The maximum thickness is estimated to be between 20 and 30 feet. The slope of the land is about the same as the dip of this pegmatite, thus the true thickness is not exposed. The zones in the pegmatite are well exposed, and the estimates of the dip are based on the attitude of these units. The soil cover has been bulldozed from this pegmatite by the Whitehall Company, but insufficient commercial-grade feldspar was uncovered.

The wall zone is fine to very fine in texture and varies from an almost feldspar-free quartz-muscovite rock that contains accessory beryl to a very fine-grained quartz-plagioclase-muscovite pegmatite with 2-inch plagioclase crystals. This rock grades into a very fine grained material, with essentially the same composition, at the wall-rock contact.

The intermediate zone is highly variable both in grain size and in composition. The average composition, however, is about 65 percent feldspar

(perthite dominant over cleavelandite and other plagioclase), 30 percent quartz, 4.5 percent muscovite, and 0.5 percent combined garnet, purpurite, and tourmaline.

The core-margin zone is medium to fine grained and has a composition of 60 percent quartz, 20 percent muscovite, and 20 percent feldspar, with some accessory garnet and beryl. The zone averages 1½ feet thick but is discontinuous.

Exposures of the core are separated along the strike of the pegmatite by a distance of 270 feet. The unit is coarse to very coarse grained. The core exposure in the southwest corner is of massive white quartz with perthite, cleavelandite, muscovite, and beryl. All these minerals except quartz increase in abundance toward the core margin. In the northeast exposure, perthite near the margin of the zone makes up 80 percent of the core. The remainder is quartz, beryl, and muscovite. The beryl in this core segment is restricted to this feldspar-rich part adjacent to the core margin.

Pegmatite 24

Pegmatite 24 (pl. 2), also known as the Plumbago Mountain beryl prospect, is irregular in shape and extends more than 4,000 feet in a N. 45° E. direction, attaining a maximum width of 1,000 feet. Except at the northeast corner the pegmatite intrudes gabbro. The pegmatite is zoned with a core that strikes N. 85° E. and dips 25° to 30° N.W.

The wall zone is fine grained to very fine grained in texture and is composed of 70 to 75 percent feldspar, 20 to 25 percent quartz, and 5 percent muscovite. It contains accessory garnet, tourmaline, and beryl. Beryl is also associated with quartz-muscovite pods in this zone.

The intermediate zone has a medium- to fine-grained texture, and contains 70 to 75 percent feldspar, 15 percent quartz, and 10 percent muscovite. Beryl and minor quantities of cassiterite, purpurite, and garnet are associated with quartz-muscovite pods.

The core is confined to the large northernmost pod and to the ring around the hornblendite. The core is coarse to very coarse grained and is composed of 50 percent quartz, 20 percent perthite, 20 percent cleavelandite, 8 percent spodumene, and 2 percent muscovite; the muscovite is concentrated mainly along the border. Accessory minerals are apatite, pollucite, columbite-tantalite, and beryl. A poorly developed core-margin zone is made up of quartz and muscovite.

Smaller pegmatites

Table 2 sets forth the information gathered on the 21 smaller pegmatites shown on plate 2. None of these pegmatites is of sufficient economic interest to warrant a more detailed description.

Origin of the pegmatites

All these pegmatites are believed to have formed from solutions rising from the granitic magma that consolidated to form the granodiorite stock now exposed at the north foot of Plumbago Mountain (pl. 2). The Main, Red Crossbill, part of the Crooker, and most of the other pegmatites appear to have formed first while the fluids were rich in potash and poor in soda and lithia. The Dunton, Kinglet, and Spodumene Brook pegmatites appear to have formed later when the character of the solutions changed because of differentiation in the parent magma. These later solutions were characterized by soda, lithia, and the rare volatiles. Parts of the earlier formed pegmatites were invaded and replaced by these solutions. In the Main pegmatite, the fracture-controlled replacement body formed at this time, and linings of lepidolite were deposited in cavities in the core-margin zone. The cleavelandite-rich portions of the Main pegmatite, encountered at depth in diamond drilling (fig. 3, sec. D - D′), may have formed by replacement of wall-zone material at this stage.

Mineralogy

The mineralogy of the outer zones of these pegmatites is relatively simple and consists of the more common rock-making minerals: quartz, perthite, plagioclase, and muscovite. Common accessories are black tourmaline and garnet. The rare constituents are, for the most part, confined to the inner units of the pegmatites. In some, such as the Main pegmatite, the greatest development of rare constituents is in the core-margin zone whereas the core is essentially composed of the common rock-making minerals.

The Main and Red Crossbill pegmatites are richer in perthite and non-cleavelanditic plagioclase than the Dunton, Crooker, and Kinglet pegmatites, which contain relatively larger proportions of sodic plagioclase, especially cleavelandite, and proportionately more lithium minerals, such as lepidolite and spodumene. The Spodumene Brook pegmatites appear to be more closely related to the Dunton, Crooker, and Kinglet pegmatites, whereas the other pegmatites in the area are more similar to the Main and the Red Crossbill pegmatites.

Table 2. Summary of the smaller pegmatites.

Pegmatite Number (pl. 2)	Attitude	External Structure	Size	Internal Structure	Wall Rock	Remarks
1.	N. 60° E. 82° S.	Con.[1]	15′ x 200′		Qm.[2]	
4.	N. 60° W. ?	Con.	3′ x 5′	Unzoned	Qm.	Very fine to fine grained, garnet only accessory in quartz-muscovite-perthite pegmatite.
5.	N. 80° W. 80° S.	Con.	15′ x 150′	Unzoned	Qm.	Fine- to medium-grained perthite-quartz-muscovite pegmatite with quartz pods 2 to 3 feet in size.
6.	N. 75° W. 70° S.	Con.	12′ x 20′	Zoned ?	Qm.	Muscovite-rich contact, quartz-feldspar-muscovite-garnet pegmatite, intermediate zone with quartz-muscovite pods.
7.	N. 60° W. 75° S.	Con.	10′ x 25′	Unzoned	Qm.	Fine- to medium-grained feldspar-quartz-muscovite pegmatite with feldspar pods up to 4 inches in size.
8.	N. 75° W. 80° S.	Con.	20′ x 75′	Unzoned	Qm.	Gradational inward from very fine-grained to medium-grained "core" of 75 percent quartz, 20 percent feldspar, and 5 percent muscovite.
9.	N. 70° W. ?	Con.	65′ x 110′	Zoned	Qm.	Beryl in intermediate zone (up to .75 inch), 0.9 ton to 50′ depth. Core of quartz and perthite, intermediate zone of 60 percent cleavelandite, 10 percent perthite, and 30 percent quartz-muscovite pods with beryl.
10.	N. 70° W. 75° S. ?	Con.	85′ x 95′	Zoned ?	Qm.	Beryl in intermediate zone, 2.0 tons to 50′ depth. Intermediate zone of perthite, quartz, cleavelandite, and muscovite with beryl. Cleavelandite ranges up to 40 percent.
11.	N. 50° E.	Cc.[3]	150′ x 650′	Zoned	Qm.	One beryl crystal associated with cleavelandite in quartz-muscovite pod. Core of coarse perthite with minor quartz and muscovite. Intermediate zone also contains cleavelandite. Border zone has up to 15 percent muscovite, wall zone up to 23 percent with plagioclase phenocrysts.
12.	N. 75° W. 65° S.	Cc.	250′ x 650′	Zoned ?	Qm.	Wall zone very fine grained, 65 percent plagioclase, 32 percent quartz, and 3 percent muscovite. Border zone of 60 percent quartz, 35 percent muscovite, and 5 percent plagioclase. Intermediate zone is fine to medium grained with 70 percent feldspar, 25 percent quartz, and 5 percent muscovite. Intermediate zone has medium- to coarse-grained pods of 90 percent quartz and 10 percent perthite.

13.	N. 25° E. 75° W.	Cc.	24′ x 150′	Zoned, poorly	Qm.	Intermediate zone is very fine to fine grained, 40 percent quartz, 40 percent plagioclase, 19 percent perthite, and muscovite. Core is fine to medium grained with 70 percent quartz, 10 percent cleavelandite, 14 percent perthite, and 6 percent plagioclase. Core contains some kaolin.
19.	N. 65° W. 77° S.	Cc.	2′ x 10′	Unzoned	Qm.	
21.	N. 80° W. 45° S.	Con.	6′ x 700′	Zoned	Qm.	
22.	N. 35° E. 60° S.		15′ x 50′	Unzoned	Ga.[4]	80 percent perthite and plagioclase. 20 quartz-muscovite pods.
27.	N. 25° W. 80° E.	Con.	0.8′ x 10′	Unzoned	Ac.[5]	West wall of pegmatite in contact with 24 to 30 inches of greisen, which is fine grained and both concordant and conformable. Pegmatite is later intrusion on same plane.
28.	N. 65° W. 10° E. (hanging wall) 40° W. (footwall)	Cc.	3′ x 12′	Zoned	Ac.	Flat pod with 0.25 inch of tourmaline border. Quartz-feldspar-muscovite-tourmaline pegmatite intermediate zone. 4 to 6 inches of medium-grained quartz-muscovite pegmatite core.
31.	N. 15° W. 55° W.		125′ x 650′	Zoned, poorly	Ga.	Core is medium grained, 60 percent perthite, 40 percent quartz with a medium- to fine-grained margin of quartz-muscovite pegmatite. Intermediate zone is fine-grained perthite, plagioclase, quartz, muscovite, and garnet with some cleavelandite.
32.	N. 15° E. 30° E. ?		75′ x 350′	Zoned	Ga.	Beryl (0.05 ton) with quartz-perthite pegmatite core. Core margin is medium- to fine-grained quartz and muscovite. Intermediate zone is quartz and perthite with minor muscovite and tourmaline.
33.	N. 65° E. 35° S.		10′ x 45′	Zoned	Ga.	Wall zone of plagioclase-perthite-quartz-muscovite pegmatite. Intermediate zone of quartz-muscovite pegmatite.
34.	N. 30° W. 80° W.		200′ x 350′	Unzoned	Ga.	Fine-grained pegmatite of feldspar, quartz, biotite, and muscovite, which is slightly foliated.
35.	Irregular		150′ x 2,200′	Zoned	Ac.	Massive quartz core with small quantities of perthite. Intermediate zone contains quartz pods.

Abbreviations used:

[1] Con. means concordant.
[2] Qm. means quartz-muscovite schist.
[3] Cc. means crosscutting.
[4] Ga. means gabbro.
[5] Ac. means actinolite schist.

The following 45 minerals, series, and varieties have been found in these pegmatites:

Quartz
Microcline-perthite
Plagioclase
Muscovite
Spodumene
Beryl
Triphylite-lithiophilite
Amblygonite
Montebrasite
Lepidolite
Tourmaline
Columbite-tantalite
Pollucite
Vivianite
Eosphorite
Beryllonite
Herderite
Uraninite
Autunite
Torbernite
Uranophane
Gummite
Microlite
Pyrochlore
Hatchettolite(?)
Apatite
Garnet
Cassiterite
Sphalerite
Galena
Pyrite
Opal
Chalcedony
Manganite
Rhodochrosite
Fairfieldite
Reddingite
Cookeite
Siderite
Zircon
Francolite
Heterosite-purpurite
Limonite
Actinolite
Prochlorite

Description of minerals

Quartz

Quartz occurs in all zones and in the secondary units of these pegmatites. In most border and wall zones, quartz typically occurs in milky anhedral grains interstitial to the other essential minerals. Graphic intergrowths with perthite, forming graphic granite, are common in wall zones in some pegmatites; subparallel aggregates of milky quartz and ¼-inch to 1-inch muscovite books are also typical of wall zones. In many of these aggregates the muscovite books are arranged in a plumose, or subradial, pattern.

Coarse milky quartz occurs in masses from 1 foot to 15 feet long in the perthite-quartz and perthite-quartz-spodumene zones. In these zones the quartz appears to have crystallized immediately after the perthite, to which

it is interstitial. The core in the Nevel mine contained masses of milky quartz as large as 40 feet.

In the Main pegmatite, smoky quartz is found in the fourth intermediate zone of perthite-quartz pegmatite and in the core-margin zone of quartz-perthite-spodumene pegmatite. This dark quartz forms spherical halos around small anhedral to euhedral uraninite crystals. The halos range from 1 foot to 6 feet in diameter. The quartz commonly is jet black in the center of a halo and grades outward into milky quartz. Most specimens of the jet black quartz, when tested with a Geiger counter, emanated no more radioactive rays than common milky quartz.

Halos of smoky quartz surrounding radioactive nuclei have been noted at Baringer Hill, Tex., by Landes (1932) and at Branchville, Conn., by Shainin (1946), but in both these pegmatites the halos were disrupted by conspicuous fractures that radiated from the nuclei. No such fractures were observed in the Main pegmatite.

Well-formed, deep rose-quartz crystals occur in many small cavities in the core-margin zone in the Nevel mine. The crystals are simple prisms terminated by negative and positive rhombohedrons. They range from 1 millimeter to 1.59 centimeters in length and from a fraction of a millimeter to 0.95 centimeter in diameter. The crystals are commonly attached to milky quartz or muscovite, and some form radial groups. These crystals are generally closely spaced. Four doubly terminated crystals have been found that were attached to the wall of a cavity by a prism face. Four or five hundred crystals were found in 1948 and 1949. Rose-quartz crystals have also been reported from the Dunton pegmatite by Fraser (1930, p. 362) and Verrow (1940, p. 51), and the senior author has found them in a pegmatite on Plumbago Mountain.

Euhedral milky quartz crystals, 1 to 11 inches long, are common in cavities in the core-margin zone of the Main pegmatite. These crystals are commonly flattened parallel to a prism face and parallel growths of 10 to 20 crystals are common. A few eosphorite prisms were found on these crystals.

Microcline-perthite

Microcline-perthite is the most common feldspar in the pegmatites, and occurs in most zones except the border zones of all pegmatites and the three outermost zones of the Dunton and Kinglet pegmatites. Perthite grains in the wall and outer intermediate zones are anhedral; their average grain size

is about one inch. The crystals are larger and better formed in the inner zones where subhedral and euhedral crystals range from 2 to 15 feet in size.

The microcline-perthite is white to salmon, or flesh, and all the feldspar is fresh and unaltered. In addition to stringers of albite, common to all perthite, poikilitic plates of white cleavelandite, one millimeter to half an inch in length, are scattered throughout the perthite crystals in the inner zones. These poikilitic cleavelandite plates are estimated to form 1 or 2 percent of the perthite. No poikilitic albite was observed in the perthite in the outer zones.

Hess and others (1943, p. 18) made spectrochemical analyses of microcline (perthite) from the Main and Dunton pegmatites, and found the feldspar to be high in Rb_2O and Cs_2O. The data are given in Table 3.

Table 3. Spectrochemical determinations of microcline-perthite from Newry Hill. After Hess and others (1943).

	Percent				
Locality	Na_2O	Li_2O	Rb_2O	Cs_2O	Ga_2O_3
Main pegmatite	5.0	0.2	1.0	0.1	trace
Main pegmatite	5.0	0.2	1.0	0.5	trace
Dunton pegmatite	5.0	0.1	3.0	1.0	trace

Perthite crystals in the inner zones of the Main and Dunton pegmatites show unmistakable evidence of replacement by cleavelandite. In the perthite-quartz pegmatite and the perthite-quartz-spodumene pegmatite zones in the Main pegmatite, veinlets of fine-grained white cleavelandite cut through perthite crystals (fig. 6). Opposite walls of these veinlets do not match, and the veinlets commonly coalesce in larger, irregular masses of cleavelandite. In the same zones, cleavelandite has been introduced along fractures in the perthite. The cleavelandite appears simply to fill some fractures; in others it clearly replaces the walls of the fracture (fig. 7). In the Dunton pegmatite some perthite masses in the intermediate zones appear to have been replaced by cleavelandite, leaving isolated masses of perthite in crystallographic continuity but separated by cleavelandite.

Plagioclase

Plagioclase is found in all zones and secondary units. In the Main and Red Crossbill pegmatites it is an essential constituent of the border zones;

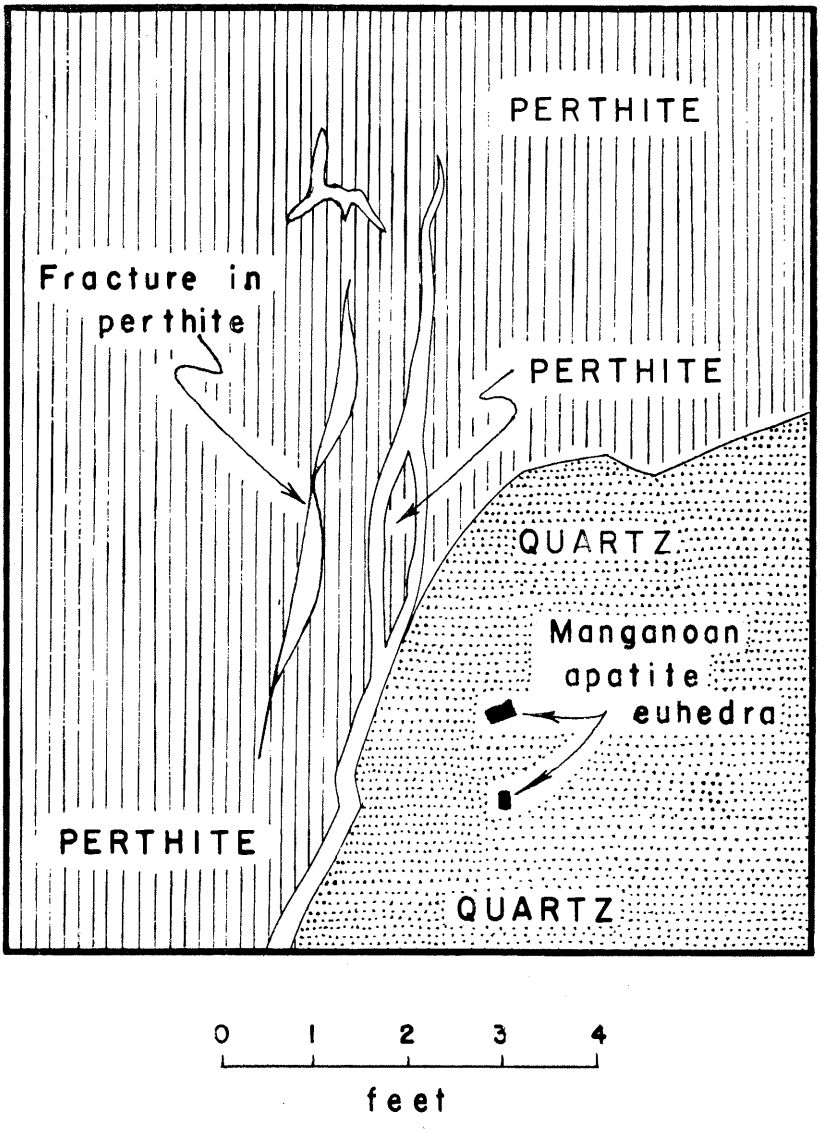

Figure 6. Cleavelandite veinlets in perthite, Nevel mine, Newry, Maine

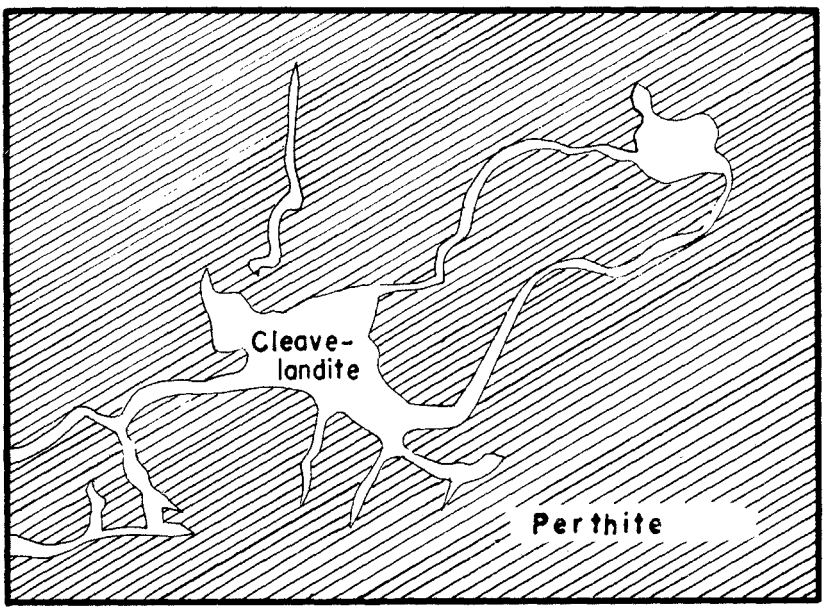

Figure 7. Perthite-cleavelandite relationship, Nevel mine, Newry, Maine

it is less common in the wall zone and the first, second, and third intermediate zones, although it is an essential component in these zones. Most of the plagioclase in the border and wall zones is blocky albite; white cleavelandite is the most common variety in the intermediate zones. In the fourth intermediate zone and the core-margin zone, plagioclase is almost entirely absent, being represented in each by about 1 percent cleavelandite. In these zones, all or most of the cleavelandite was formed later than the essential minerals by replacement or by fracture filling. Cavities in the core-margin

zone commonly contain white, transparent cleavelandite crystals, ⅛ to 1 inch long. These are attached to the walls of the cavities and project into the opening.

About 80 percent of the cleavelandite in the triphylite unit of the second intermediate zone of the Main pegmatite is pale to deep green. No other color, except white, was noted in this plagioclase. Small quantities of green cleavelandite were also found in the core-margin zone. Spectrographic analyses, given in table 4, indicate the presence of 0.002 to 0.0008 percent beryllium in the greenish cleavelandite from the two units.

Table 4. Spectrographic determinations of minor elements in green cleavelandite from zones in the Nevel mine, Newry, Maine.[1]

Color of	Percent of minor elements					
Cleavelandite	Be	Sr	Mn	Ti	Ga	Zr
Green [2]	0.0008	0.005	0.02	0.001	0.002	0.002
Gray green [3]	.002	.005	.02	.001	.002	.005

NOTE: Also looked for but not found: Ba, B, Sn, V, Y, La, Pb, Zn.

Cleavelandite, in plates ¼ inch to 4 inches long, commonly occurs in radiating clusters, the base of which is attached to spodumene, beryl, triphylite, and tourmaline. This structure is particularly well shown in the Dunton pegmatite (Shaub, 1940, fig. 11b).

Muscovite

Muscovite occurs in all zones and secondary units except the border zone at the Dunton pegmatite. It is found in anhedral books, ⅛ to ½ inch in size, in the border zones, and in larger books, ¼ inch to 3 inches in size, in the wall zones, where a subparallel intergrowth with quartz is characteristic in the Main and Red Crossbill pegmatites.

In the first intermediate zones of the Main and Dunton pegmatites, larger books, which range from 2 to 10 inches in diameter, are common, and are oriented subnormal to the zonal contacts. The books in the Dunton pegmatite are subhedral "spear-shaped" crystals, formed by the overdevelopment

[1] Spectrographic analyses by Janet D. Fletcher, U. S. Geological Survey.
[2] From core-margin zone of quartz-perthite-spodumene pegmatite.
[3] From triphylite unit in the second intermediate zone of quartz-albite-perthite-triphylite pegmatite.

of two adjacent prism faces that are combined with a pinacoid in the vertical zone.

Muscovite books have been mined and stockpiled for sale as scrap mica from the triphylite unit of the second intermediate zone in the Main pegmatite. These books are pale yellow to pale green and have an average diameter of 4 inches and an average thickness of 1 inch. The books in this unit are unoriented, although in some places near the outer zonal contact many of the books are subnormal to the contact. The books are marred by "A"-structure, herringbone, tanglesheet, ruling, and reeving.

Small green muscovite grains are intimately associated with cleavelandite masses and veins in the fourth intermediate and core-margin zones in the Nevel mine. Cavities in the Main pegmatite are commonly lined with euhedral, pale green muscovite books that are $\frac{1}{16}$ to 1 inch in diameter.

No deposit of muscovite capable of yielding more than one-half of one percent sheet mica, one inch square or larger, is known in the Newry Hill area. The Whitehall Company recovered at least 3 tons of scrap mica, derived chiefly from the second intermediate zone in the Nevel mine.

Hess and others (1943, p. 18) reported that a specimen of muscovite from the Main pegmatite contained 1 percent Na_2O, 1 percent Li_2O, 1 percent Rb_2O, 0.2 percent Cs_2O, and 0.5 percent Ga_2O_3.

Spodumene

Spodumene has been found in all the Newry Hill pegmatites except the Red Crossbill, and in the Spodumene Brook pegmatites on Plumbago Mountain. Its occurrence is limited to the innermost zones or units. It has not been found in the core of the Main pegmatite, whereas in the Dunton, Crooker, and Kinglet pegmatites it occurs only in the cores. Spodumene occurs in the inner quartz-spodumene pegmatite unit of the West pegmatite of the Spodumene Brook pegmatites.

Practically all the spodumene occurs in fresh, white to pale green, flattened subhedral to euhedral prisms. The average crystal is 2 feet long, 6 inches wide, and 3 inches thick. Crystals in the core of the Dunton pegmatite, however, are only two-thirds this size. The largest crystals occur in the core-margin zone of the Main pegmatite, where a prism 10 feet long, 4 feet wide, and 5 inches thick was exposed in the Nevel mine (fig. 8). Hess and others (1943, p. 16) report a spodumene crystal 10 feet long and 8 by 13 inches in cross section in the core of the Kinglet pegmatite, and W. D. Nevel is said to have reported a 10-foot crystal from the Dunton pegmatite (Hess and others, 1943, p. 15).

Figure 8. Large spodumene crystals in quartz and perthite, Nevel mine, Newry, Maine.

Many crystals in the Kinglet pegmatite are pale green on fresh surfaces; Verrow (1940, p. 51) and Hess and others (1943, p. 15) report pink spodumene from the Gem mine in the Dunton pegmatite. George Crooker (personal communication) found colorless, transparent, and almost flawless parts of spodumene crystals in the core-margin zone of the Main pegmatite.

Many spodumene crystals in the Dunton, Crooker, and Kinglet pegmatites are bordered by rims of radiating white cleavelandite plates that appear to have grown outward from the spodumene. The cleavelandite rims are less common in the Main pegmatite, where relatively small amounts of cleavelandite occur (fig. 9). Several crystals in the core-margin zone of the Main pegmatite are cut by fractures, along which fine-grained, unoriented greenish muscovite has replaced the spodumene (fig. 10).

Beryl

Beryl occurs in significant quantities on Newry Hill only in the Main pegmatite, where it was observed in four zones: the wall zone, the second intermediate zone, the fourth intermediate zone, and the core-margin zone. It occurs in subhedral to euhedral first-order prisms, modified by minor faces

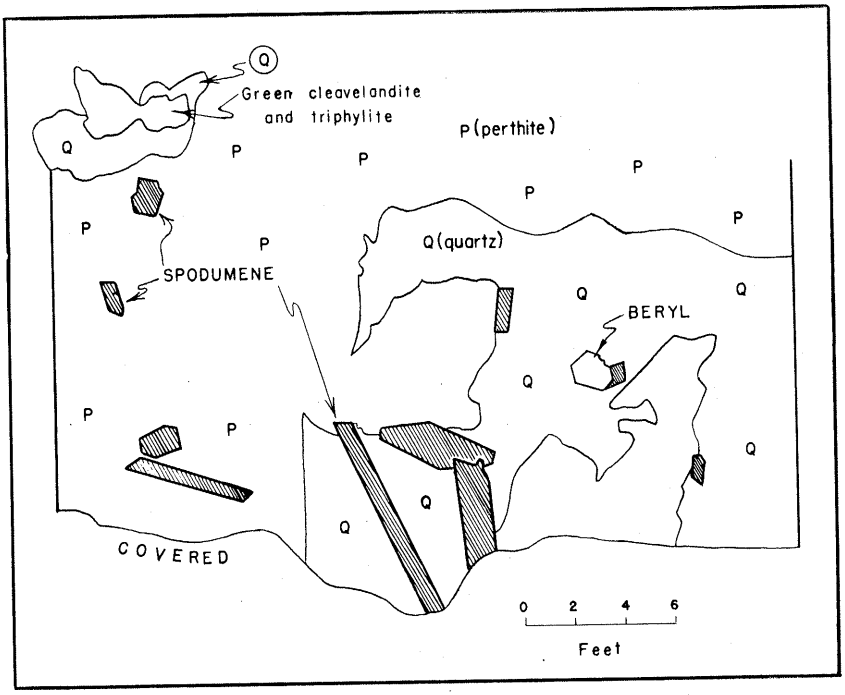

Figure 9. Spodumene crystals in quartz and perthite, southwest stope, Nevel mine, Newry, Maine

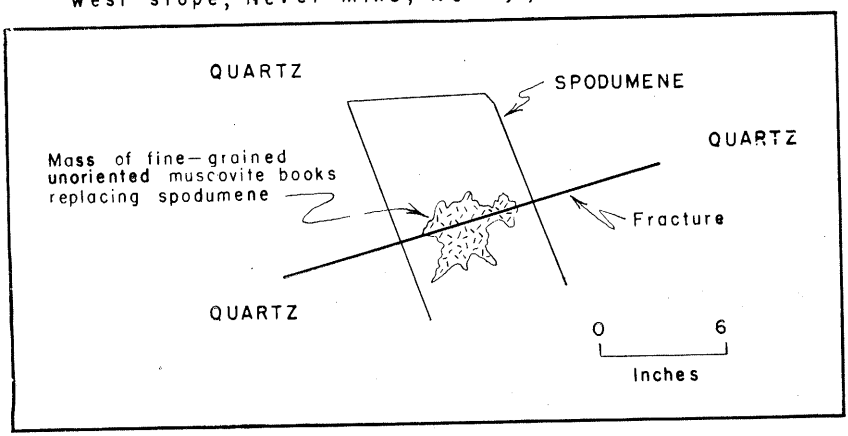

Figure 10. Greenish muscovite along fracture in a spodumene crystal, Nevel mine, Newry, Maine

of the second-order prisms. Terminations are simple basal pinacoids. The color is chalky white to pale green. About 4 or 5 percent are translucent or transparent in part; the rest are opaque. The crystals range in size from mere pin-points in the wall zone to 2 feet in cross section and 4 feet in length in the core-margin zone. Estimates of the average sizes of crystals in each of the beryl-bearing zones are given in table 5.

Table 5. Average sizes of beryl crystals in the beryl-bearing zones of the Main pegmatite, Newry, Maine.

Zone	Average diameter (inches)	Average length (inches)
Wall zone	0.05	1.2
Second intermediate zone	1.0	2.0
Fourth intermediate zone	7.0	unknown
Core-margin zone	12.0	24.0

A large proportion of beryl in the wall zone is in the subparallel intergrowths of milky quartz and muscovite. In some places one-foot square areas of this material contain 5 or 6 percent beryl.

Almost all the beryl crystals in the second intermediate zone are coated with a thin, often discontinuous, film of sky-blue vivianite. Fine-grained silvery muscovite coats crystals to a lesser extent. Milky quartz, small books of muscovite, and greenish cleavelandite are commonly intergrown with beryl in this zone and may constitute about 10 percent of the crystals, although no statistical study of this contamination was made. The crystals in this zone tend to break out of the matrix easily. Despite the small size, a couple of hundred pounds were hand-cobbed by the Whitehall Company's miners during excavation of the crosscut at the entrance of the Nevel mine.

Beryl is a rare constituent of the fourth intermediate zone of perthite-quartz pegmatite. Only two beryl crystals were found in 518,400 square inches of the zone that were examined in grain counts. Both crystals were exposed in cross section and were 7 inches in average size.

The largest beryl crystals are in the core-margin zone but are so few that the grade of the zone is only 0.8 percent beryl. The crystals typically are chalky white, possess better cleavage, and have rougher crystal faces than the beryl in the other zones. Crystals in the core-margin zone are easily confused with amblygonite, which occurs in the same zone, but can be distinguished

by a fusibility test in the field. Beryl is fusible with difficulty, and amblygonite is easily fused to a white globule with intumescence.

All the beryl exposed in the Dunton pegmatite in 1949 was white or pale yellowish green. Bastin (1911, p. 78) reported finding a loose, perfectly transparent crystal that was

> ". . . deep enough in color to be classed as emerald".

Fraser (1930, p. 360) also reported gem beryl that was green and transparent, and Verrow (1940) wrote that yellow beryl occurred in the pegmatite. Hess and others (1943, p. 14) described the occurrence of

> ". . . a few flat, pinkish-gray beryls 3 to 4 inches broad and an inch thick . . ."

from the Dunton pegmatite.

The BeO content determined from the indices of refraction of beryl crystals from the Newry Hill pegmatites ranges from 11.87 to 12.76 percent.

Triphylite-lithiophilite

The most common representative of the triphylite-lithiophilite series is triphylite, which forms about 10 percent of the first intermediate zone and about 11 percent of the second intermediate zone in the Main pegmatite. The second intermediate zone is estimated to contain at least 6,500 tons of triphylite. Only small quantities of triphylite occur in the first intermediate zone because the zone is very thin and local in occurrence.

Triphylite occurs in the second intermediate zone as fresh blue to bluish-green crystals that are almost entirely anhedral. Some subhedral prisms are found and one perfect prism, 2 inches long and about 1 inch in diameter, was collected in 1948 at the entrance to the Nevel mine by Mr. E. Lawrence Sampter. Most of the subhedral crystals are only one quarter as large as the perfect one. The pinacoids and the prism are the forms present on most of the crystals. Well-formed triphylite crystals are reported (Chapman, 1943) in only one other pegmatite in New England. Triphylite weathers rapidly on exposure, and much of the mineral in the east wall of the Nevel mine is coated with a thin film of reddish-brown oxidation products, probably in the heterosite-purpurite series.

Triphylite is also found in the Dunton pegmatite where it occurs in nodules, 1 inch to 12 inches in diameter, in the intermediate zones. Some nodules are surrounded by white cleavelandite blades in radial groups. Irregular patches of clove-brown lithiophilite, 1 inch to 2 inches in diameter, have been reported from the Dunton pegmatite. Fraser (1930, p. 360) reported that some fresh triphylite in the Dunton pegmatite is white.

Amblygonite and montebrasite

Amblygonite occurs in the Main and Dunton pegmatites, and some of the finest crystals ever found have come from the Main pegmatite. Amblygonite occurs in this pegmatite only in the core-margin zone. Amblygonite occurs in white masses, 2 inches to 2 feet in diameter, or in smaller white to colorless crystals, $\frac{1}{16}$ inch to 5 inches long, lining the walls of cavities.

The first amblygonite crystals were discovered in the Nevel mine in 1940, and were described by Palache, Richmond, and Wolfe (1943, p. 47-53). In 1948, several cavities that contained 50 or 60 crystals were discovered in the Nevel mine by the miners. These cavities ranged from half an inch to 2 feet in size, and other minerals lining the walls were quartz, beryl, triphylite, eosphorite, cassiterite, and rhodochrosite.

The crystals are colorless, white, or greenish yellow, and some are partly transparent. They are tabular and the dominant zone is parallel to the "*a*"-axis. Many of the faces are glassy and brilliant. A few crystals are doubly terminated with respect to the "*a*"-axis. Some crystals are twinned on the (111) plane. Seven new forms were discovered on the crystals from the Nevel mine and have been described by Palache, Richmond, and Wolfe (1943).

Amblygonite occurs in the Dunton pegmatite in white anhedral masses, 1 inch to 14 inches in diameter, in the second intermediate and core-margin zones and the core. It makes up less than 1 percent of the zones, except in the second intermediate zone where it is estimated to form about 2 percent. No crystal forms were observed by the authors although Fraser (1930, p. 360) wrote that

> ". . . commonly they [amblygonite] show good crystal form. They often enclose cleavelandite and other earlier minerals and sharp crystals of amblygonite are found in massive lepidolite."

Fraser also listed montebrasite, which he distinguished from amblygonite by differences in optical properties, from the Dunton pegmatite.

In the same pegmatite Hess and others (1943, p. 15) reported amblygonite in flat crystals 1 inch to 2 inches thick and 3 to 4 inches broad. One mass that was estimated to weigh 800 pounds reportedly contained a trace of cesium. The same writers (1943, p. 16) reported that

> ". . . a little amblygonite was present in small, white, flat crystals two or three times the size of one's palm"

in the Kinglet pegmatite. These crystals, according to Hess, seemed to be replaced by green tourmaline, lepidolite, and albite. No amblygonite was found in the Kinglet pegmatite during this study.

Lepidolite

Lepidolite is a common accessory mineral in the Dunton and Crooker pegmatites, but only a few crystals have been found in the Main pegmatite and none is known in the Red Crossbill pegmatite.

Purple or lilac-colored lepidolite in masses of small, ⅛-inch, unoriented books is the most common variety and is found in the inner zones of the Dunton and Crooker pegmatites. The aggregates of these unoriented books are 1 inch to 3 feet in size and are commonly intergrown with small quantities of white cleavelandite and a few crystals of brown to black microlite.

Fraser (1930, p. 358) reported single books of lepidolite 11 inches in diameter intergrown with abundant green tourmaline

"... in one quarry".

He probably referred to the quarry in the Dunton pegmatite because green tourmaline does not occur in the Crooker pegmatite, part of which he described in the same paper. Yellow and gray lepidolite are also found in the Dunton pegmatite. Fraser (1930, p. 358) found that the lilac-colored ("mauve") lepidolite was earlier than the gray.

The only lepidolite known from the Main pegmatite was found in 1949 in the core-margin zone. Two small cavities, 2 to 3 inches in size, were lined with $\frac{1}{16}$- to ⅛-inch subhedral crystals of lepidolite, yellow in one pocket and lilac-colored in the other.

Lepidolite samples, collected by the senior author from the dump at the Dunton pegmatite, were analysed for strontium-rubidium ratios by Ahrens (personal communication), who found their age to be 300 x 10^6 years.

Hess and others (1943) made spectrochemical determinations of lepidolite from two pegmatites on Newry Hill, and the data are given in table 6.

Table 6. Spectrochemical determinations of lepidolite from Newry Hill. After Hess and others (1943).

Specimen	Na_2O	K_2O	Li_2O	Rb_2O	Cs_2O	Ga_2O_3
Lepidolite, gray, 200 yards east of the Dunton pegmatite.[1]	2.0	5.0	1.0	1.0	0.2	0.5
Lepidolite, white, 500 feet northwest of the Dunton pegmatite (Crooker pegmatite).	0.5	2.0	5.0	2.0	2.0	0.1

[1] No pegmatite could be found at this locality.

Hess and others (1943) reported small quantities of white lepidolite

" . . . in plates 7 or 8 inches broad . . . "

from the Crooker pegmatite. In the same pegmatite he found some lavender spherical lepidolite, about 3 inches in diameter, and he also reported lilac-colored patches of lepidolite intergrown with muscovite. Bastin (1911, p. 77) described a mass of lepidolite, 2 feet by 3 feet by 6 feet that was intergrown with some cleavelandite and pink tourmaline.

Tourmaline

Tourmaline is generally limited to the two outer zones of the pegmatites; in these zones it is black. A prominent exception is the Dunton pegmatite where tourmaline of many colors is found in all zones except the border zone. In this pegmatite, black tourmaline occurs in the wall zone and the first intermediate zone. Pink, green, and blue tourmaline crystals, many of which are of gem quality, are crystallized in all the intermediate zones and in the core.

All the tourmaline in the Dunton pegmatite occurs in prismatic crystals. Many of the colored tourmalines show the second order prism *a*, modified by the trigonal prism *m*. In some crystals the vertical zone is represented only by the prism *a*. The terminations are complex, and Fraser (1930, p. 361), has recorded acute positive rhombohedrons and negative and positive scalenohedrons.

The colored tourmalines range from $\frac{1}{16}$ inch to 24 inches in length. Very few were exposed in 1948 and 1949, but they are reported to have occurred as linings in cavities and as tightly " frozen " crystals in solid pegmatite. Green tourmaline is common in flattened prisms between the cleavage sheets of muscovite and lepidolite books.

So-called " watermelon " tourmalines have been found in the past. These crystals are pink in the center and light green on the exterior. The contact between the two colors is commonly parallel to the " c "-axis, although some prisms have been reported that are pink at one end and green at the other. Other crystals were blue green in the center and pink on the crystal faces. According to Hess and others (1943, p. 14), W. D. Nevel reported tourmaline that was green at one end, pink in the middle, and blue at the other end.

The solutions that crystallized to form the Dunton pegmatite were evidently so rich in boron that a discontinuous layer, half an inch thick, of black tourmaline formed at the hanging wall contact. The black tourmaline crystals in this layer appear to be partly in the schist and are in contact with the border zone. Evidently they formed, at least in part, at the expense of the wall

rock. They may be regarded as part of the schist or as part of the pegmatite. The schist wall rock, close to the contact, contains many more tourmaline porphyroblasts. The crystals in the tourmaline layer are $\frac{1}{16}$ inch to 1½ inches long, are euhedral hexagonal prisms of the second order, and are terminated by trigonal pyramids. They are commonly grouped in radial or irregular clusters.

Spectrographic determinations of minor elements in the colored tourmaline crystals from the Dunton pegmatite indicate that these crystals are high in gallium and tin. Of the blue, pink, and green crystals analysed, only the green contained strontium. A complete list of elements determined is given in table 7.

Table 7. Spectrographic determination of minor elements in blue, green and pink tourmaline from the Dunton pegmatite, Newry, Maine.[1]

Color of tourmaline	Percent of minor elements						
	Be	Sr	Mn	Ti	Sn	Pb	Ga
deep blue	0.002		0.2	0.01	0.01	0.001	0.02
green	.002	0.005	.2	.005	.05	.02	.02
deep pink	.002		.2	.001	.05	.05	.01
pink	.002		.5	.001	.01		.02

Note: Also looked for but not found: Ba, Zr, V, Y, La, Zn.

Black tourmaline occurs in bands within the upper part of the wall zone of the Main pegmatite north of the Nevel mine. The bands are 50 to 60 feet long and appear to be parallel to the zonal contact. The bands are 2 inches to 2 feet thick, and consist of closely spaced subhedral hexagonal prisms $\frac{1}{16}$ inch to 3 inches in cross section. The prisms are oriented subnormal to the upper contact of the band and as the outcrop surface is roughly parallel to the contact, the crystals are exposed in cross section.

Layers of black tourmaline crystals, in which the " c "-axes are parallel to the hanging-wall contact of the Main pegmatite, were encountered in diamond-drill hole 1 at a depth of 59 feet below the collar (fig. 11). Minerals with a prismatic habit, such as beryl and tourmaline usually crystallize with the " c "-axis subnormal to the wall of the pegmatite wherever they occur within a few inches of the contact. Crystals with a tabular habit, such as the micas, usually crystallize with the basal pinacoid also subnormal to the wall of the

[1] Spectrographic analyses by Janet D. Fletcher, U. S. Geological Survey.

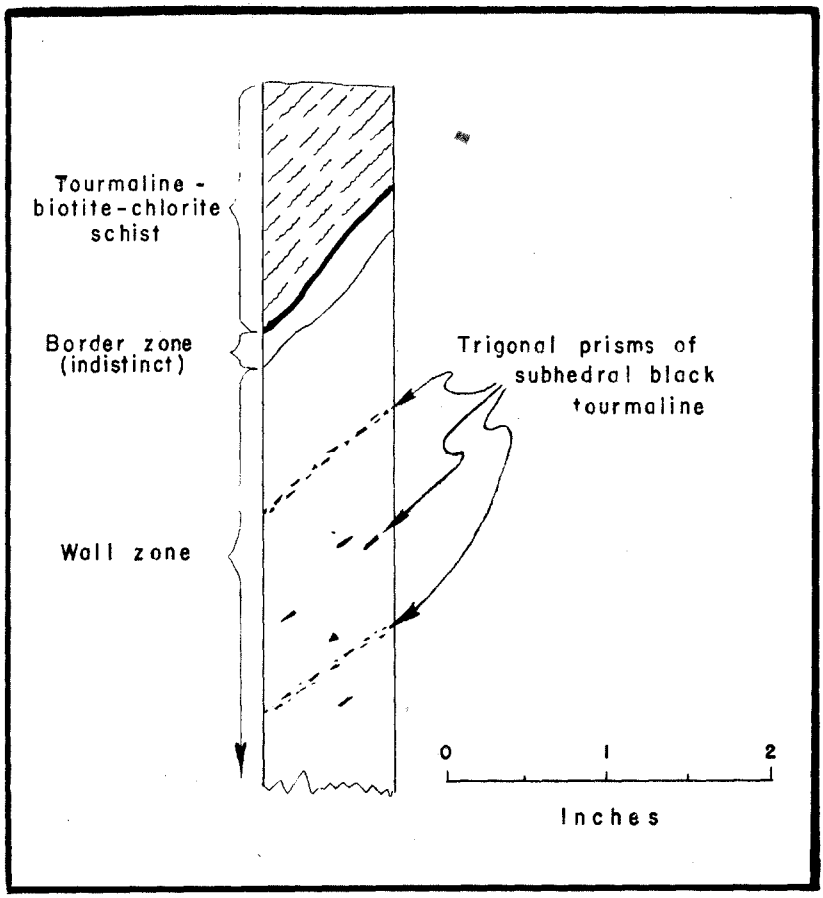

Figure 11. Black tourmaline crystals in quartz-albite-perthite pegmatite in core from diamond-drill hole 1, Nevel mine, Newry, Maine

pegmatite wherever they occur within a few inches of the contact. Furthermore the layers of tourmaline crystals in the core of diamond-drill hole 1 are parallel to the foliation in the adjacent schist. The evidence, although not conclusive, suggests that the tourmaline layers are relics of foliation in the schist, which has been replaced by pegmatite.

Columbite-tantalite

Both end members of the isomorphous columbite-tantalite series occur in the Newry Hill pegmatites. Tantalite has been found in the Dunton and Crooker pegmatites, and columbite has been identified in the Main pegmatite. Table 8 lists the results of determinations on these minerals.

Table 8. Ta_2O_5 content of columbite and tantalite from the Newry Hill pegmatites.

Location	Approx. Specific Gravity	Approx. Percent Ta_2O_5
South end of Crooker pegmatite	7.04	65
Gem mine in Dunton pegmatite	6.60	50
Nevel mine in Main pegmatite	5.65	15
Main pegmatite. Pit 200 feet southeast of Nevel mine	5.53	10

Columbite-tantalite occurs in the intermediate and core-margin zones of the pegmatites. In the core-margin zone of the Main pegmatite, columbite occurs in anhedral to subhedral plates ¼ inch to 10 inches broad and $\frac{1}{16}$ inch to 4 inches thick. The mineral probably forms no more than 0.001 percent of the zone. Columbite is no more common in the second intermediate zone, but the largest crystal seen was in the triphylite unit of this zone. This crystal was an anhedral plate that was 8 inches by 14 inches by 18 inches in size. Most of the crystals are tabular to the macropinacoids "a"; Fraser (1930, p. 358) published a drawing of tantalite from the Dunton pegmatite. Verrow (1940, p. 51) and Fraser (1930, p. 357) report "manganocolumbite" from the Dunton pegmatite, but neither provides evidence in support of this variety.

Pollucite

Pollucite is reported by George Crooker (personal communication) to have been found in the Crooker, Dunton, and Kinglet pegmatites, each of which was mined for this mineral by W. D. Nevel, representing the General Electric Company, in the period from 1926 to 1929.

According to Crooker, who mined the mineral, pollucite was very closely associated with lepidolite, spodumene, and pink tourmaline. The senior author found an ellipsoidal mass of pollucite, one inch in diameter, in the

second intermediate zone of the Dunton pegmatite. The mineral probably also occurred in the core and core-margin zone of the Dunton and in the cores of the Crooker and Kinglet pegmatites. Some large masses of pollucite were mined; Hess and others (1943, p. 15) reported that a mass weighing about 1,000 pounds was found in the Dunton pegmatite in September 1927.

Fraser (1930, p. 359-360) believed that pollucite replaced spodumene; and he also reported that pollucite is commonly found in fractured masses, the fractures of which are filled with a dull white variety of chalcedony. This association, he pointed out, is so general in the Dunton pegmatite that it can be used as a criterion to distinguish pollucite from quartz. Fairbanks (1928) stated that lepidolite and cesium-beryl were the best indicators of the presence of pollucite. Hess and others (1943, p. 15) wrote that some specimens were altered to clay. He reported that the clear mineral

> ". . . was said to carry 36 percent Cs_2O and the cloudy mineral 24 to 26 percent Cs_2O ".

Vivianite

Vivianite appears to be an alteration product of triphylite. It occurs most commonly as sky-blue coatings on or near triphylite and siderite in the Main and Dunton pegmatites. Beryl crystals in the second intermediate zone are commonly coated, in part, with this phosphate. A few subhedral crystals, ¼ to 1 inch in diameter, exhibiting highly perfect clinopinacoidal cleavage, occur in cavities in the core-margin zone at the Nevel mine. The crystals are associated with rose-quartz crystals, and less commonly with triphylite.

Fraser (1930, p. 360) states that

> "bright blue massive tourmaline . . ."

generally surrounds triphylite and also forms veins and

> "irregular replacement areas in the triphylite."

The massive habit is uncommon because of the great power of tourmaline to form crystals, especially pronounced in the Dunton pegmatite, and the bright blue color and association with triphylite suggest that the mineral actually was vivianite.

Eosphorite

Eosphorite, manganese phosphate, is widespread and occurs in the core-margin zone of the Main pegmatite and in the cores of the Crooker, Dunton, and Kinglet pegmatites. It typically occurs in amber needles, 1 millimeter to 1.27 centimeters long, which are simple crystals that show a pyramid combined with the brachypinacoids and macropinacoids. The color varies from

opaque black to transparent amber or light brown. The crystals always occur in cavities; often they are in fan-shaped groups attached to albite, quartz, muscovite, or other minerals.

A chemical analysis and optical properties are given by Palache and Shannon (1928, p. 395-396). Fraser (1930, p. 362) believed

> "... that there is a considerable variation in the manganese and iron content and the darker colored material from the northern pegmatite [Crooker pegmatite] approaches childrenite in composition."

Shaub (1940, p. 685) found eosphorite crystals on blades of coarse cleavelandite in the core of the Kinglet pegmatite, but none were seen in place during this study.

Beryllonite

The first specimens of this rare beryllium phosphate ever found in place [1] were discovered in the Dunton pegmatite by W. D. Nevel, and were described by Palache and Shannon (1928, p. 392). The crystals are white tabular prisms, flattened parallel to the basal pinacoid, and are as much as 3 inches in size. They have perfect basal cleavage and less perfect orthopinacoidal cleavage.

All the beryllonite crystals described by Palache were altered completely to herderite. Fraser (1930, p. 362) stated that the crystals include green tourmaline and other minerals. Verrow (1940, p. 51) found beryllonite

> " in good masses."

No specimens could be found during the present investigation. Beryllonite in the Dunton pegmatite is only of mineralogical interest.

Herderite

Herderite, another beryllium phosphate, has been found only in the Dunton pegmatite where it occurs in a radial, fibrous habit forming spheroidal aggregate. The masses range from 1 millimeter to 0.64 centimeter in diameter and are colorless, or range from yellow to black. It is found associated most commonly with beryllonite, from which it has formed by alteration, although Fraser (1930, p. 363) believed that this mineral was also formed from solutions.

A chemical analysis of this herderite has been published by Palache and Shannon (1928, p. 395). The mineral probably formed in the inner zones of the pegmatite, although it was not seen in place. Herderite is estimated to form less than 0.00001 percent of the pegmatite.

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[1] Beryllonite was first described from isolated crystals in a talus slope at Stoneham, Maine.

Uraninite

Uraninite occurs in subhedral to euhedral octahedra in the Main and Dunton pegmatites. This mineral is found in the third and fourth intermediate zones and the core-margin zone of the Main pegmatite. The crystals are reddish-brown to black, and range from $\frac{1}{16}$ to ½ inch in size. An aggregate of subhedral uraninite crystals consisting of a dozen individuals was found in the third intermediate zone.

The radioactivity of the uraninite appears to have caused the color in the black and gray quartz in the vicinity of the crystals. Where a uraninite crystal is completely enclosed in quartz, a well-defined halo of smoky quartz surrounds the uraninite.

The writers have not seen uraninite in the Dunton pegmatite, but Fraser (1930, p. 360), Verrow (1940, p. 51), and Hess and others (1943, p. 14) have reported it. Uraninite is only of mineralogical interest in these pegmatites.

Autunite, torbernite, uranophane, and gummite

These highly colored alteration products of uraninite form thin films that coat decomposed uraninite crystals or adjacent minerals.

Strongly fluorescent sulfur-yellow autunite and emerald-green torbernite were seen in the intermediate and core-margin zones of the Main and Dunton pegmatites. Hess and others (1943, p. 14) recorded gummite and uranophane from the Dunton pegmatite, and Fraser (1930, p. 360) described gummite from the same locality. Verrow (1940, p. 51) found autunite in minute crystals in the Dunton pegmatite.

Microlite and pyrochlore

Microlite is known only from the Dunton pegmatite where it occurs in subhedral octahedra in fine- to medium-grained lilac lepidolite, or in white cleavelandite. Specimens found on the dump appear to have come from the second intermediate zone or the core-margin zone. The crystals commonly are less than $\frac{1}{16}$ inch in diameter, but Fraser (1930, p. 357) reported well-formed crystals ¾ inch in size. He also states that

> ". . . spectroscopic analyses by Mr. Gedney have indicated the light yellow colored mineral is microlite and the dark brown mineral pyrochlore."

Verrow (1940, p. 51) lists hatchettolite, another multiple oxide of uranium containing tantalum and columbium, from the Dunton pegmatite, but he makes no comment concerning its properties. In conformity with the nomen-

clature of varietal terms adopted by Palache, Berman, and Frondel (1944, p. 749) hatchettolite should be called uranium pyrochlore.

Other minerals

Dark-green manganoan apatite is abundant in parts of the core-margin zone in the Main pegmatite. This phosphate mineral occurs in anhedral masses 1 inch to 15 inches in diameter and in separate crystals $\frac{1}{16}$ inch to 2 inches in diameter. Some apatite, especially the massive variety, is extensively veined by sugary, white cleavelandite. Parts of some apatite crystals fluoresce a faint golden yellow.

A small cavity in the fourth intermediate zone, in a pit 200 feet southeast of the Nevel mine, was lined with a quarter-inch crust of euhedral purple apatite prisms flattened parallel to the basal pinacoid. Palache, Richmond, and Wolfe (1943, p. 47) recorded pale violet apatite in cavities in the Nevel mine. The cavities, which were also lined with quartz, beryl, triphylite, amblygonite, eosphorite, cassiterite, and rhodochrosite, probably occurred in the core-margin zone.

Pink to red and reddish-brown garnet occurs in all the pegmatites studied, chiefly in their outer zones. Garnet is closely associated with black tourmaline in the wall zones of the Dunton and Main pegmatites. Aggregates of anhedral to subhedral reddish-brown garnet crystals, which are ¼ inch to 6 inches in diameter, are commonly surrounded by coatings of black tourmaline, 1 to 10 millimeters thick.

Cassiterite is widespread, occurring in several zones in most of the pegmatites on Newry Hill, but only in very small quantities. No attempt has been made to save this mineral for byproduct sale. Subhedral to euhedral black bipyramids, $\frac{1}{16}$ to 2 inches in size, occur sparsely, probably less than 0.001 percent, in the third and fourth intermediate zones of the Main pegmatite, and it has been found in loose blocks of cleavelandite from the Crooker and Dunton pegmatites.

Sphalerite occurs in reddish-brown masses ⅛ inch to 3 inches in size in the core-margin zone of the Main pegmatite. It is found most often in small cavities but also occurs in massive white cleavelandite. It is commonly associated with cassiterite, pyrite, columbite, and beryl. A perfect tetrahedron, one-third of an inch long on an edge, was found imbedded in a large beryl crystal in the Nevel mine.

An aggregate of dull gray, subhedral galena cubes, ⅛ to ¼ inch in size, was found in the collection of a local miner, who reported that he collected it in the Nevel mine.

Pyrite occurs as small euhedral cubes and pyritohedrons on the walls of cavities and on the faces of albite crystals in cavities in all the pegmatites on Newry Hill. These crystals appear to have been among the very last to form, although Fraser (1930, p. 355) states that he found pyrite inclusions in black tourmaline in the Dunton pegmatite, and he writes that they

> ". . . may have developed, due to excess of iron, in the course of crystallization of the tourmaline."

Opal occurs in small quantities in the second intermediate zone and the core-margin zone of the Dunton pegmatite. Most or all of it is colorless hyalite opal, which fluoresces a brilliant apple green, and phosphoresces a slightly duller whitish-green. The mineral occurs as thin, rough coatings on beryl, perthite, and probably other minerals.

Chalcedony, according to Fraser (1930, p. 360), fills fractures in pollucite in the Dunton pegmatite.

Manganese oxides occur commonly in the Dunton and Main pegmatites as coatings on other minerals, and Fraser (1930, p. 352) reports the species manganite.

Rhodochrosite has been reported by Palache and others, (1943, p. 47) from cavities in the Nevel mine, and small, well-formed crystals have been found in the Dunton pegmatite according to Verrow (1940, p. 51).

Fairfieldite occurs rarely in cavities in the core-margin zone of the Main pegmatite. It has been found in radiating, sheaflike groups of white crystals, $\frac{1}{16}$ to $\frac{1}{8}$ inch long, in the Nevel mine.

Reddingite has been reported by Fraser (1930, p. 363) from the Dunton pegmatite where it occurred as a reddish-brown radial fibrous deposit on herderite.

Cookeite also occurs in the Dunton pegmatite, according to Fraser (1930, p. 362), as a white coating on minerals in cavities, and as an alteration product after cleavelandite.

Siderite occurs in small brown masses and in well-formed crystals associated with triphylite and vivianite in the Main and Dunton pegmatites.

Zircon was listed by Shaub (1940, p. 683) as one of the later minerals to form in the Dunton pegmatite where he found it to be genetically associated with microlite, cassiterite, pollucite, and amblygonite.

Francolite was reported by Fraser (1930, p. 362-363) as common in the Dunton pegmatite where it occurs as light-colored radiating masses an eighth of an inch in diameter on albite, quartz, and other crystals. It is sometimes stained a dark brown by iron and manganese solutions.

Heterosite-purpurite has been formed by alteration of triphylite-lithiophilite in the Main and Dunton pegmatites. Specimens in this isomorphous series of alteration minerals are commonly brown on weathered surfaces and bright purple on freshly powdered surfaces.

Limonite crusts are found in the Main and Dunton pegmatites and appear to have formed by alteration of siderite, iron-bearing minerals, and iron-manganese phosphates.

An unknown red manganese phosphate in small, radiating needles has been reported by Fraser (1930, p. 363) from the Dunton pegmatite where it was found on herderite and other minerals. It occurs in such minute quantities that its identification is extremely difficult.

Dark-green actinolite needles have been observed in the border zone of the Dunton pegmatite and appear to have been derived by separation from the actinolite-chlorite schist of the wall rock.

Massive prochlorite is listed by Verrow (1940, p. 51) from the "Newry Mine", but it is not clear whether the mineral was found in the pegmatite or in the schist wall rock.

Mineral Deposits

Pollucite, gem tourmaline, and perthite are the minerals for which mining of the pegmatites in the Newry Hill area has been primarily directed. Beryl, spodumene, and amblygonite have been recovered as byproducts of this mining. This present investigation has yielded descriptions of the known and potentially commercial deposits of these minerals, except for the deposits of gem tourmaline as the suitability of tourmaline for use as a gem stone is controlled by too many variable factors.

The largest mineral deposits in the area are those that contain recoverable quantities of perthite, which is the mineral mined as feldspar. Beryl, spodumene, and amblygonite form mineral deposits that are smaller in size and lower in grade than the perthite deposits. The best known pollucite deposit is almost entirely mined out, and not enough is known about the other pollucite deposits for them to be described accurately.

Perthite

Mining for feldspar, or perthite, began about 1940 when the United Feldspar and Minerals Corporation started the Nevel mine and continued intermittently up through 1949. The production of feldspar during this period is not known.

The only deposit of feldspar sufficiently rich to repay mining by hand-cobbing methods is the fourth intermediate zone of perthite-quartz pegmatite in the Main pegmatite. This zone occurs in several segments, the largest of which is the shell that partly surrounds the core-margin zone in the Nevel mine. This segment of the zone has been the source of most of the feldspar produced from Newry Hill.

A second deposit of feldspar, which has not been mined, is exposed in the bed of Bartlett Brook at the northern end of the Main pegmatite (pl. 1). The grade of the deposit is estimated to be 80 percent perthite, which is higher than normal for this zone. About 90 percent of the recoverable feldspar in this zone can be qualified as No. 1 grade.

A smaller deposit of feldspar occurs in the core of perthite-quartz pegmatite in the East pegmatite of the Spodumene Brook pegmatites.

None of the other pegmatites in the area is known to contain a deposit of feldspar large enough or of high enough grade to be of commercial interest.

Beryl

Although beryl has been seen in at least 11 pegmatites in the Newry Hill area, it occurs in significant quantities only in the Main pegmatite on Newry Hill and in pegmatites 24 and 29 in the Newry Hill area.

Beryl was observed in four zones of the Main pegmatite; the wall zone of quartz-perthite-albite pegmatite, the second intermediate zone of quartz-albite-perthite-triphylite pegmatite, the fourth intermediate zone of perthite-quartz pegmatite, and the core-margin zone of quartz-perthite-spodumene pegmatite. Measurements of all exposed beryl grains were made on exposures of these zones and the beryl content of each unit was calculated on the basis of these measurements.

Large-scale recovery of beryl from the Main pegmatite would require milling because only the crystals in the fourth intermediate and core-margin zones are coarse enough to be recovered economically by hand-cobbing methods. Hence, two distinct types of beryl deposits are known in this pegmatite. One of these types — the one containing beryl that can be recovered by hand-cobbing — is of commercial interest under present economic conditions; the other will be of value only when a metallurgical technique can be worked out that will economically recover fine-grained beryl.

The deposit of beryl that can be recovered by hand-cobbing methods in the perthite-quartz pegmatite zone is in several separate pods of different dimensions. The average diameter of the beryl crystals in this deposit is 7 inches; the average length is unknown. Measurements of the beryl grains exposed

in an area of 3,600 square feet of this zone showed only 80 square inches, or 0.02 percent, to be beryl. Inasmuch as this zone contains the main feldspar deposit of this pegmatite, any beryl in it is likely to be mined and recovered despite the low beryl content of the zone.

The deposit of coarse beryl, which contains crystals having an average diameter of 12 inches and an average length of 2 feet, in the quartz-perthite-spodumene pegmatite zone is in a body that has a length of 95 feet, an average width of 60 feet, and an average thickness of 10 feet. Measurements of all exposed beryl grains in an area of 500 square feet of this zone showed 576 square inches, or 0.80 percent, to be beryl.

Beryl that can be recovered only by some method of milling occurs in the wall zone and the second intermediate zone. The average diameter of the beryl crystals in the wall zone is 0.05 inch and the average length is 1.2 inches. The wall zone has such a low content of beryl, established as 0.01 percent by measurement of all exposed beryl grains in 6,023 square feet of this zone, that the beryl probably cannot be economically recovered under any circumstances.

The deposit of fine-grained beryl crystals, which have an average diameter of 1 inch and an average length of 2 inches, in the second intermediate zone is in a body that has a length of 320 feet, an average width of 170 feet, and an average thickness of 14 feet. Measurements of exposed beryl grains made on an area of 296 square feet of this zone showed 432 square inches, or 1.01 percent, to be beryl. Intergrowths of milky quartz, small books of muscovite, and greenish cleavelandite with these beryl crystals are common, and these intergrowths may form about 10 percent of individual crystals.

Beryl occurs in the core-margin zone of pegmatite 29 in crystals large enough to be recovered by hand-cobbing. The estimated content of beryl in this zone is about 1.4 percent.

Although the beryl content in pegmatite 24 is far greater than that in pegmatite 29, the beryl is not in rich concentrations that can be easily mined. Beryl is found scattered throughout the intermediate zone, the core-margin zone, and the core, but only a small part of it in the core could be recovered by hand-cobbing. The core near the ring was previously studied in detail by D. M. Larrabee (1954, p. 87-89).

Spodumene

Spodumene occurs in the inner zones of the Main, Dunton, Crooker, and Kinglet pegmatites, and in an inner unit of the Spodumene Brook pegmatites. In the Main pegmatite it forms 1.5 percent of the third intermediate zone of muscovite-quartz-perthite pegmatite, 0.2 percent of the fourth inter-

mediate zone of perthite-quartz pegmatite, and about 5 percent of the core-margin zone of quartz-perthite-spodumene pegmatite. Spodumene forms about 2 percent of the core in the Dunton pegmatite, 3 percent in the Crooker pegmatite, and 3 percent in the Kinglet pegmatite. In the Spodumene Brook pegmatites, spodumene forms 33 percent of the quartz-spodumene pegmatite unit in the West pegmatite.

Amblygonite

Amblygonite occurs in the Main and Dunton pegmatites. In the Main pegmatite it is found only in the core-margin zone where it is estimated to form 0.4 percent of the rock.

White anhedral masses of amblygonite occur in the second intermediate zone, the core-margin zone, and the core of the Dunton pegmatite. Amblygonite is estimated to form about 2 percent of the second intermediate zone and less than 1 percent of the other zones.

Pollucite

Pollucite was mined from the Crooker, Dunton, and Kinglet pegmatites during the period from 1926 to 1929. The production records are fragmentary. Total production from the Dunton pegmatite is believed by George Crooker (personal communication) to have been about 3,500 pounds, or slightly more, and the other two pegmatites may have produced about 1,000 pounds each.

Pollucite probably occurred in the cores of the Dunton, Crooker, and Kinglet pegmatites, and in the core-margin zone of the Dunton pegmatite. It was found during this investigation in the second intermediate zone of the Dunton pegmatite.

As the core and innermost zones of the Dunton pegmatite have been removed in large part by mining (fig. 4), there probably is little pollucite left. The unmined portions of the cores in the Crooker and Kinglet pegmatites may contain pollucite, but no reliable data are available on which to base estimates of grade.

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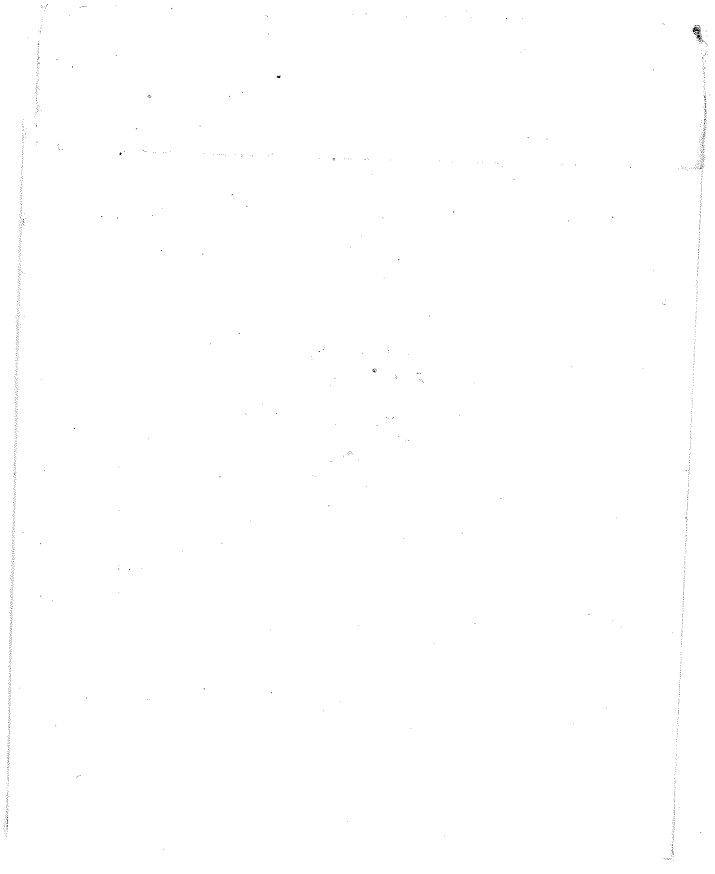

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