Pegmatites of the Crystal Mountain District, Larimer County, Colorado

GEOLOGICAL SURVEY BULLETIN 1011

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By WILLIAM R. THURSTON

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CONTENTS

ILLUSTRATIONS

[Plates 1-13 are in pocket]

TABLES

PEGMATITES OF THE CRYSTAL MOUNTAIN DISTRICT, LARIMER COUNTY, COLORADO

By William R. Thurston

ABSTRACT

The Front Range of Colorado is composed chiefly of schists of the Idaho Springs formation of pre-Cambrian age which have been intruded by a variety of granitic batholiths. In the Crystal Mountain district the Mount Olympus granite, a satellite of Fuller's Longs Peak batholith, forms sills and essentially concordant multiple intrusions in quartz-mica schist that dips southward at moderate to steep angles. A great number of pegmatites accompanied and followed the intrusion of the sills and formed concordant and discordant bodies in schist and granite.

More than 1,300 pegmatites in the Hyatt area north of the Big Thompson River are mapped and individually described. There are 27 pegmatites in the area that are made up of a wall zone and a core, and one, the pegmatite at the Hyatt mine, is composed of five zones. The largest pegmatites in the area are discordant in schist and occupy zones that are interpreted to be tear faults and tension fractures produced by the successive intrusion of granite that formed multiple sills. The majority of pegmatites in the large multiple sills were emplaced along the foliation and fractures.

The pegmatites were intruded over a period of time and probably were derived from a granitic magma at different stages during differentiation. Ninety-six percent of the pegmatites are granitic, 3.5 percent are quartz-rich pegmatites, and a few are tourmaline-rich. Solutions escaping from many of the pegmatites tourmalinized and silicified the wall rocks for a few inches to 2 feet, but chemical and spectrographic analyses fail to show the transport of any other constituents.

Perthite, plagioclase, and quartz are the essential minerals of the pegmatites, and muscovite is a minor but widespread constituent. Tourmaline, garnet, beryl, and apatite are common accessory minerals; and lithiophilite-triphylite, bismuthinite, uraninite, columbite-tantalite, and chrysoberyl are rare constituents. Beryl is found in 350 pegmatites, or 27 percent of the total, and makes up 0.01 percent or more of 77 pegmatite bodies. The beryl-bearing pegmatites are richest in two of the three large granite masses, and are somewhat less rich at a distance of more than a thousand feet from the margins of the intrusives, but contain the least beryl in the thousand-foot belt immediately surrounding the intrusives. The Hyatt pegmatite [1] is by far the richest deposit of beryl in the area mapped.

Most of the pegmatites mapped are "unzoned" or homogeneous pegmatites of uniform texture and mineral distribution. All gradations are visible between homogeneous pegmatites and zoned pegmatites. The interpretation is made that, for most pegmatites, the initial composition determines whether or not zones will form. Pegmatites containing many zones can form from a magma composed of the elements in perthite, plagioclase, quartz, and muscovite, depending on the proportions of the components crystallizing at any given time. The complexly zoned deposits depend for their formation on the presence of several of the rarer

[1] The names of the pegmatites are purely economic terms and are not to be confused in any way with formal stratigraphic nomenclature.

elements, principally lithium. Replacement textures in zones result from the interaction of the rest-liquid with the earlier-formed solid crystals. No mappable pegmatite in the Crystal Mountain district formed from the replacement of preexisting pegmatite by solutions escaping from the rest-liquid, or by solutions originating outside the pegmatite.

Three beryl-bearing zoned pegmatites, the Hyatt, Big Boulder, and Buckhorn Mica deposits, were explored by core drilling. Each deposit is mapped and described in detail, and the mineral reserves are evaluated. The exploration indicates a total of 2,000 tons of beryl, of which 480 tons is estimated to be recoverable by hand sorting. The mapping of the 3¾ square miles in the Hyatt area indicates beryl in substantial additional resources.

Small tonnages of scrap mica and perthite may be obtained from the Hyatt and Big Boulder prospects, and columbite-tantalite may occur in sufficient amounts at the Buckhorn Mica mine and Tantalum claim to produce several hundred pounds as a byproduct of beryl mining. Dumps at the various deposits contain 25 to 50 tons of beryl.

INTRODUCTION

In mid-1942 the wartime demand for tantalum, mica, and beryl caused the United States Geological Survey to undertake a greatly expanded program of pegmatite investigations; and in the following 2½ years, work was done in most of the important pegmatite mining districts of the country. These studies entailed approximately 68 man-years of work by 39 geologists (Cameron and others, 1949). The wartime investigations were focused on deposits containing minerals of strategic importance; limitations on time and manpower precluded examination of deposits not known to contain strategic minerals or study in detail of the regional relationships.

From 1946 to 1950, regional studies were made of the geology and beryl resources of 10 pegmatite districts. (See pl. 1.) The work included the preparation of detailed geologic maps of the districts, large-scale maps of individual pegmatites of unusual interest, sampling and diamond-drill exploration of selected deposits, and mineralogic studies. More emphasis was placed on regional investigations which included study of the country rock, structure, and economically unimportant pegmatites and their relation to deposits of economic interest. The study of the Crystal Mountain district, Larimer County, Colo., is but one phase of this post-World War II pegmatite program, in part carried out by the Geological Survey on behalf of the Division of Raw Materials of the Atomic Energy Commission.

DESCRIPTION OF THE AREA

The Crystal Mountain district is an unincorporated mining district without precise boundaries. In this report the name refers to an area north of the Big Thompson River and south of Buckhorn Creek in Tps. 6 and 7 N., Rs. 71 and 72 W., sixth principal meridian. The district is in the Front Range of the Rocky Mountains, approximately

16 miles west of Loveland and Fort Collins, Larimer County, Colo. The northern part of the district, near Crystal Mountain, is reached by way of unimproved ranch roads that branch southward from the Buckhorn Creek road at a bridge 21 miles west of the town of Masonville. (See fig. 1.) The Hyatt pegmatite area is reached by a private road which branches northward from the Glen Haven road at a bridge 500 yards west of the town of Drake. (See fig. 1.) The ranch roads and the Buckhorn Creek road may be closed for several weeks during severe winters. The road in the steep-walled parts of Buckhorn Creek is washed out occasionally by spring floods.

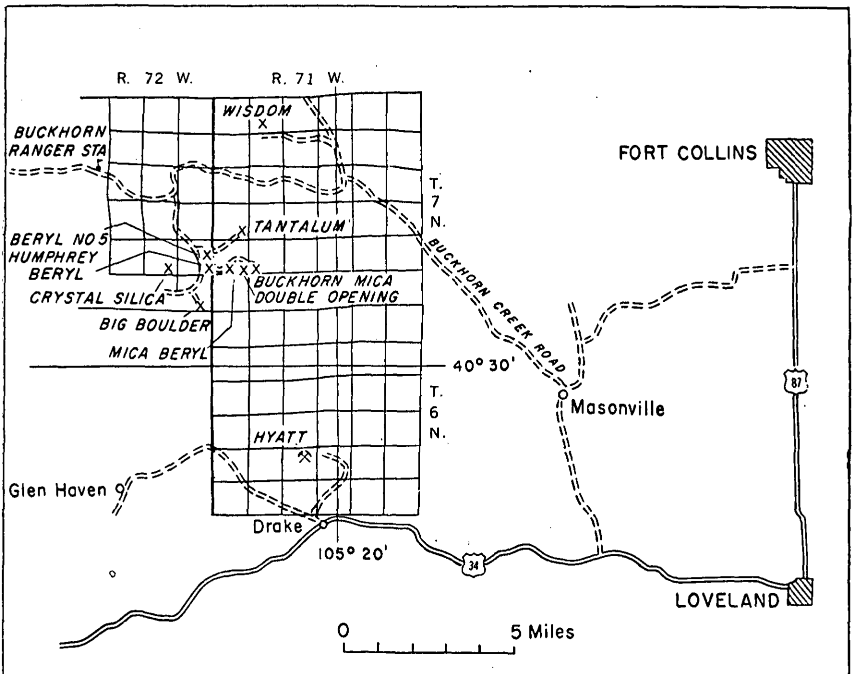


FIGURE 1.—Index map of the Crystal Mountain district, Colorado

The topographic sheets which cover the district are the Livermore quadrangle for the northern part and the Mount Olympus quadrangle for the southern part. The lowest altitudes in the Crystal Mountain district are 6,500 feet on Buckhorn Creek, which bounds the district to the north, and 6,100 feet on the Big Thompson River, which bounds it to the south. Rugged valley walls rise steeply from these streams for about 1,000 feet to a maturely dissected rolling upland. The highest points on the upland surface are Lookout Mountain (10,633 feet), Crystal Mountain (9,952 feet), and Storm Mountain (9,915 feet). Most of this area is thickly forested with conifers, principally lodgepole pine, but with some *Ponderosa* pine, blue and Engelmann spruce, Douglas-fir, and various junipers. Cottonwood, aspen, box-elder, and chokecherry are found along the smaller intermittent streams. There are many small meadows bordered by aspen groves around Crystal Mountain; the Hyatt ranch occupies much of a large meadow called Cedar Park.

The principal economic activities in the area are lumbering and summer grazing. The Dickerson family, at a ranch in Box Prairie, and the Hyatt family, at a ranch in Cedar Park, were the only permanent residents during the time the fieldwork was in progress.

HISTORY OF MINING

Mining has never been an important activity in the region, though the area has been prospected for various commodities since frontier days. Gold mining and milling near Masonville, copper mining just east of the Crystal Mountain district, and various attempts to mine pegmatite minerals have been marginal to submarginal ventures. Scattered throughout the area are caved and weed-covered pits and trenches of unknown date.

The earliest recorded pegmatite mining in this district was at the Buckhorn Mica mine in 1884. It is reported that some time prior to 1900 the Crystal Silica deposit was opened. In 1913 the district was visited by Sterrett (1923, p. 59–61) who described the Buckhorn Mica mine and "another mica prospect [which] was opened by Parkson and Kitchen about a quarter of a mile west of the Buckhorn mine"; the unnamed deposit may be the one known now as the Double Opening prospect. A claim to the Double Opening prospect was filed in 1934. The Big Boulder prospect and the Hyatt pegmatite were opened in 1936. About a dozen other pegmatite deposits have been prospected, but little or no development work has been done; four of them have been described by Hanley, Heinrich, and Page (1950). Since completion of the wartime studies in 1945, the only production has come from the Hyatt pegmatite in 1948. The production record, insofar as it is known, is compiled in table 1.

PREVIOUS WORK

The geology of the Front Range area of Colorado has been studied because of its many metallic ore deposits and their relation to regional structure and stratigraphy. Burbank and Lovering (1933, p. 272–311) summarize the general geology of Colorado and part of Wyoming and list the principal references. In an earlier paper, Lovering (1929) describes the geologic history of the Front Range. Pegmatite deposits are not considered, nor are there maps or descriptions which give the relations in the Crystal Mountain district. The reports on the Georgetown quadrangle by Ball (1908), the Montezuma quadrangle

TABLE 1.—*Pegmatite minerals produced in Crystal Mountain district, Colorado*

Property and location	Commodity produced	Amount	Date
Hyatt mine, NE¼NW¼ sec. 28, T. 6 N., R. 71 W.	Beryl	*Pounds* 1,500	1936–42
	do	*Tons* 34	1943
	do	14	1948
	Potash spar	400	1948
	Scrap mica	30	1948
Buckhorn Mica mine, SW¼ sec. 29, T. 7 N., R. 71 W.	Scrap mica	180	1884–1942
	Sheet mica	(1)	1884–1942
	Beryl	*Tons* 2–3	1884–1944
	do	1	1944–50
Big Boulder prospect, SE¼ sec. 36, T. 7 N., R. 72 W.	do	10.5	1936
	do	*Pounds* 600	1941
Crystal Silica claims, sec. 26, T. 7 N., R. 72 W.	Bismuth minerals		Prior to 1900
	Fusing quartz		
Total recorded production	Beryl	*Tons* 62.8	1884–1950
	Potash spar	400	1948
	Scrap mica	210	1884–1948

[1] A few hundred pounds.

by Lovering (1935), and the Front Range generally by Lovering and Goddard (1950) contain abundant information on the schist, granite, and pegmatities of those areas that are helpful in studying similar rocks in the Crystal Mountain district. The descriptions are detailed and precise, and comparisons can be made though the areas are 50 miles apart.

A general map by Lovering (1935, pl. 5) shows the relationships in the area south of the Crystal Mountain district but ends at the southern boundary of the district. The features of the pre-Cambrian structure along the Big Thompson River described by Fuller (1924) and the observations on the granites of the Longs Peak-St. Vrain batholith by Boos and Boos (1934) are too generalized to be applicable to the detailed studies made in the Crystal Mountain district.

The first description of pegmatites in the Crystal Mountain district was made in 1913 by Sterrett (1923) in the course of an appraisal of mica deposits of the United States. Between September 21 and October 10, 1942, L. R. Page and J. B. Hanley mapped in detail about 20 beryl-bearing pegmatites at 9 properties in the district, including two described previously by Sterrett. Continued studies at the Hyatt pegmatite resulted in revision and remapping in 1943 and 1944. The results of this work have been described by Hanley, Heinrich, and Page (1950, p. 86–103).

FIELDWORK AND ACKNOWLEDGMENTS

The field and laboratory work on which this report is based was begun in August 1947 and completed in December 1950. From

August to November 1947 the previously described deposits in the Crystal Mountain district were reexamined and five prospects were remapped with the assistance of A. J. Lang. As a result of this reexamination three beryl-rich pegmatites, the Hyatt, Big Boulder, and Buckhorn Mica deposits, were selected for exploration, and preparations were made during the winter for diamond drilling. The three deposits were core drilled between July 16 and November 7, 1948, by the Fillmore Drilling Co., of Deadwood, S. Dak., for the Geological Survey. For 7 weeks A. E. Grass and E. V. Dedman were samplers under the supervision of W. I. Finch. For the remaining 9 weeks the sampling was done by R. E. Roadifer and the writer. During July and August 1948, H. D. Wright mapped in the vicinity of the Hyatt pegmatite, and Wright and Finch mapped and studied 45 pegmatites in the meadow north of the Hyatt ranch.

While core drilling was in progress, an area a quarter of a square mile surrounding the Big Boulder deposit was mapped, and an eighth of a square mile in the vicinity of the Buckhorn Mica mine was mapped. For 2 weeks the writer was assisted by C. S. Robinson. From October 4 to November 5, 1948, W. R. Griffitts was associated with the project and mapped in the vicinity of the Big Boulder and Buckhorn Mica deposits. In the winter of 1948–49, 255 samples of drill core were prepared for analysis; the core data were studied and compiled. In 1949 the Hyatt area was mapped on aerial photographs at a scale of 1:6,000: a total of 12 man-months were spent by E. N. Hinrichs and the writer in mapping more than thirteen hundred pegmatites in 3¾ square miles.

The topographic maps of the district were of too small a scale for detailed mapping, so aerial photographs were used. The geology was plotted in the field directly on United States Forest Service photographs enlarged to a scale of approximately 1:6,000. The topographic relief in the Hyatt area is sufficient to require a contoured base map for the representation of the geology (pl. 2). The base was prepared from photographs of the area, using the Mahan Stereoscopic plotter.[2] The work was done by John W. Zydik, of the Topographic Division of the Geological Survey, and the writer. Vertical control for orientation and contouring was obtained from a six-man altimeter survey between benchmarks. The writer is grateful to J. W. Adams, J. R. Stacy, A. F. Trites, Jr., and D. J. Varnes for their help in making this survey.

Planimetric maps were made directly from the photograph in the small areas of low relief around the Big Boulder prospect (fig. 2), and

[2] Instrument and procedure are described in U. S. Geol. Survey, Topographic instructions: chap. 3 C 12 [in preparation].

the Buckhorn Mica mine (fig. 3). Distortion in the photograph has not been corrected, but it is probably not great.

Over 500 determinations were made of the indices of refraction of plagioclase and beryl from the pegmatites; studies were made of other minerals, and 55 thin sections were examined.

Special thanks are due the members of the Hyatt and Dickerson families for their courtesies and hospitality while the writer was working near their homes.

GEOLOGY

The Crystal Mountain district is such a small part of the Front Range that studies within the district give little direct information on the regional setting. To understand the geologic details and discuss the problems within the district, the broader relations must be considered. Excellent summaries of the geology and history of the Front Range have been written by Lovering (1929) and Burbank and Lovering (1933, p. 272–316, especially p. 272–285). A condensation of geologic history of the pre-Cambrian is taken from these sources.

SUMMARY OF THE GEOLOGIC HISTORY OF THE FRONT RANGE

The Front Range is a mountainous uplift 30 to 35 miles wide and 175 miles long, composed of pre-Cambrian metamorphic and igneous rocks, cut locally by Tertiary intrusive rocks. Paleozoic and younger sedimentary formations are upturned along the flanks of the range. The metamorphic rocks comprise a thick series of schists, gneisses, and greenstones; they were derived by dynamic and contact metamorphism from dominantly argillaceous and sandy sediments with intercalations of limy and pebbly beds, and probably some eruptive rocks. The schists grade from fine-grained quartz schist on the east through mica-quartz schist to biotite-sillimanite schist on the west. Lime silicate rocks and hornblende-rich rocks are minor components of the schists. Ball (1908, p. 37) gave the name Idaho Springs formation to the succession of metamorphic rocks in the Georgetown quadrangle, Colo. The name has been extended by common usage to include much of the schist of the Front Range, though the continuity of the formation from place to place has not been established. The metamorphic rocks along the Big Thompson River have been called the Big Thompson schist by Fuller (1924) and in the Coal Creek area have been divided into the Coal Creek quartzite and the Ralston schist by Adler.[3] The various units of the schist exposed along the Big Thompson River seem to be conformable.

The schists and gneisses of the Idaho Springs formation are cut by quartz monzonite gneiss, pegmatites, and hornblende-quartz diorite;

[3] Adler, Joseph, 1930, geologic relations of the Coal Creek quartzite in Colorado: unpublished thesis in files of University of Chicago.

these are the oldest intrusives recognized in the Front Range. The schists and quartz monzonite gneiss are intruded by a series of granite batholiths and their satellite stocks, pegmatites, and hornblende-quartz diorite or gabbro bodies. The quartz-monzonite of pre-Cambrian age of the Georgetown quadrangle is probably of the same age as the Boulder Creek granite gneiss of Boos and Boos to the east. The Pikes Peak granite of the central part of the Front Range in Colorado and the Sherman granite in the northern part of the Front Range in southern Wyoming are approximately contemporaneous according to Boos and Boos (1934, p. 307). The Silver Plume, Cripple Creek, and Longs Peak (of Fuller) granites are petrographically similar, are younger than the Pikes Peak and Sherman granites, and are probably contemporaneous with each other. The Mount Olympus granite has been designated by Boos and Boos (1934, p. 311 and 323–324) as a satellite facies of the Longs Peak batholith. The granite intrusives are so related structurally and petrographically that, despite certain marked differences, Lovering (1929, p. 64) believes they belong to one great period of batholithic invasion. Maps by Lovering (1935, pl. 5) and Boos and Boos (1934, fig. 1) show the distribution of the main masses of the intrusives.

Van Hise and Leith (1909, p. 827) date the schists and gneisses as Archean, because their structural and lithologic complexity is similar to the "basal complex" of many other regions, and date the later quartzites and quartz schists as Algonkian. A tentative correlation of the Front Range rock units with the Lake Superior section was made by Lovering (1929, p. 74) on the basis of similarities in history when he stated that the Idaho Springs formation might be correlated with Lower and Middle Huronian, the Pikes Peak granite might be assigned to the early Algoman, and the Silver Plume and associated granites to the late Algoman—all included in the Algonkian.

The structural grain of the pre-Cambrian rocks of the Front Range trends generally east-west (Burbank and Lovering, 1933, p. 273, p. 274, and fig. 11) and is bowed locally by the intrusion of batholithic masses. During Paleozoic and Mesozoic time the main lines of deformation gradually rotated clockwise, culminating in the formation of a north-trending highland in the Front Range region during the Laramide revolution. There are no important Paleozoic or younger rocks in the Crystal Mountain district.

GEOLOGY OF THE CRYSTAL MOUNTAIN DISTRICT

Quartz-mica schists of the Idaho Springs formation are the oldest rocks in the Crystal Mountain district and have been intruded by sills of Mount Olympus granite and by pegmatites that are probably related to the granite batholith of Longs Peak. In the Hyatt area (pl. 2) the schist is in open folds that have an average plunge of 60° S. and a general eastward strike. Most of the granite occurs in sheets which are essentially concordant with the foliation of the schist. The two largest granite masses, north and southwest of the Hyatt ranch, are multiple sills. Two smaller granite bodies, one almost surrounding the Hyatt pegmatite and the other about a thousand feet to the east, seem to be pluglike masses with southward plunging axes and almost circular horizontal sections, but the contacts are poorly exposed.

Around the Big Boulder prospect, the strike of the schist ranges from north to northeast (fig. 2), and the dip is eastward at steep angles; the plunge of linear structures is steep and to the southeast and south. The strike of the schist in the vicinity of the Buckhorn Mica mine (fig. 3) is about east-northeast, and the dip is steep and to the south. The mile of unmapped country between the two deposits has been traversed without observing unusual changes in structure so it may be inferred that the deposits are on the same broad fold; however, linear elements in the schist near the Buckhorn Mica mine plunge erratically, suggesting that between Big Boulder and Buckhorn Mica deposits there are concealed structural complexities.

Most of the thirteen hundred or more pegmatites mapped in the Hyatt area (pl. 2) are concordant, although about 30 of the largest pegmatites in the area are discordant, dipping northward at steep angles.

Most of the pegmatites in this area are feldspar-rich though some are quartz-rich and a few are tourmaline-rich. The dominant minerals of the pegmatites are, in order of abundance, perthite, plagioclase, and quartz. Muscovite is an everpresent minor constituent. Tourmaline is the commonest accessory mineral and the commonest mineral in the altered wall rock. Beryl and garnet are present in about 27 percent of the pegmatites. The Hyatt pegmatite contains a varied suite of minerals, which are described separately.

COUNTRY ROCKS

SCHIST

The most common metamorphic rock in the Crystal Mountain district is quartz-mica schist of the Idaho Springs formation. It is fine to coarse grained; fresh surfaces are generally light gray and weathered outcrops are dark grayish brown. The facies of the formation range from quartz schist to mica schist, the types grading into each other by changes in the proportions of the dominant minerals, quartz, muscovite, and biotite. The schist is exposed on the steep valley walls in jagged irregular outcrops and on the flatter parts of the upland surface as widely scattered low mounds. In much of the area, outcrops are rare, except at the margins of pegmatites.

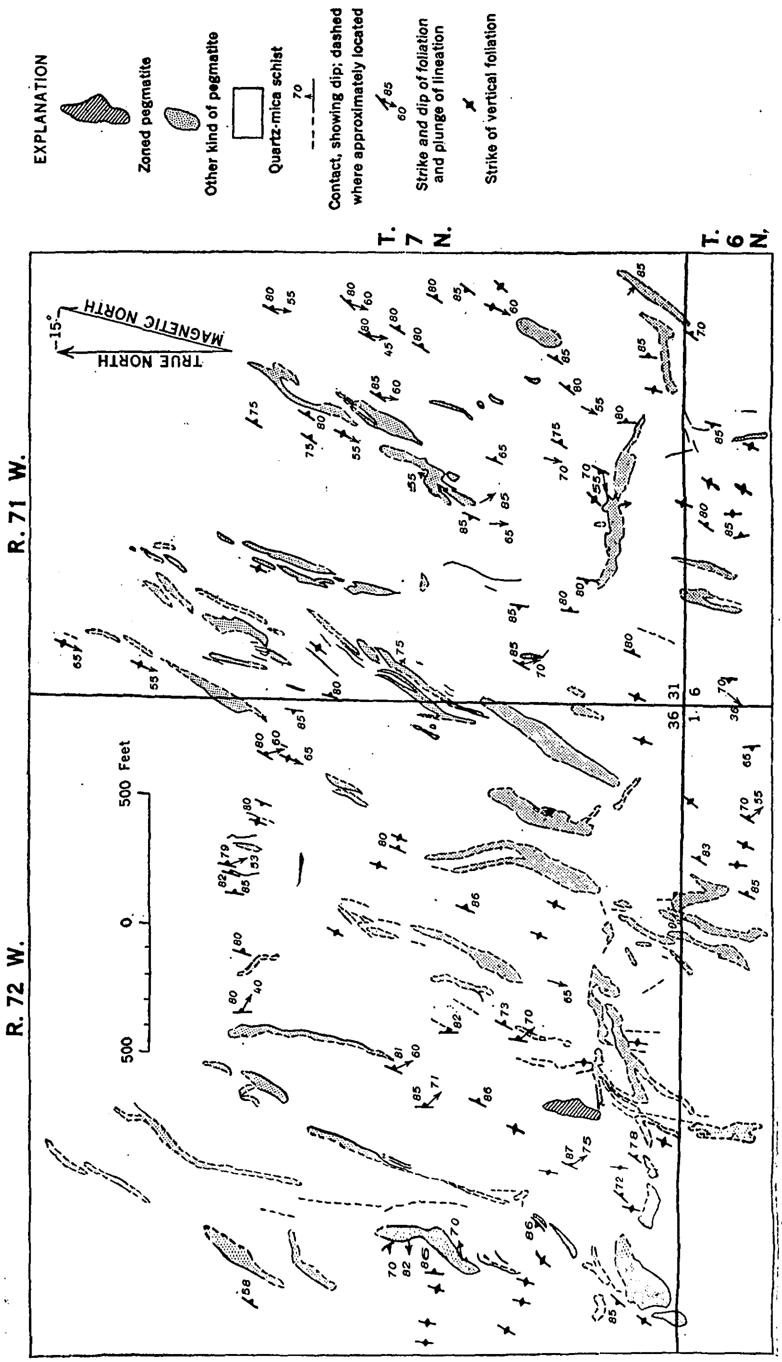


FIGURE 2.—Geologic map of the Big Boulder prospect area, Crystal Mountain district, Colorado.

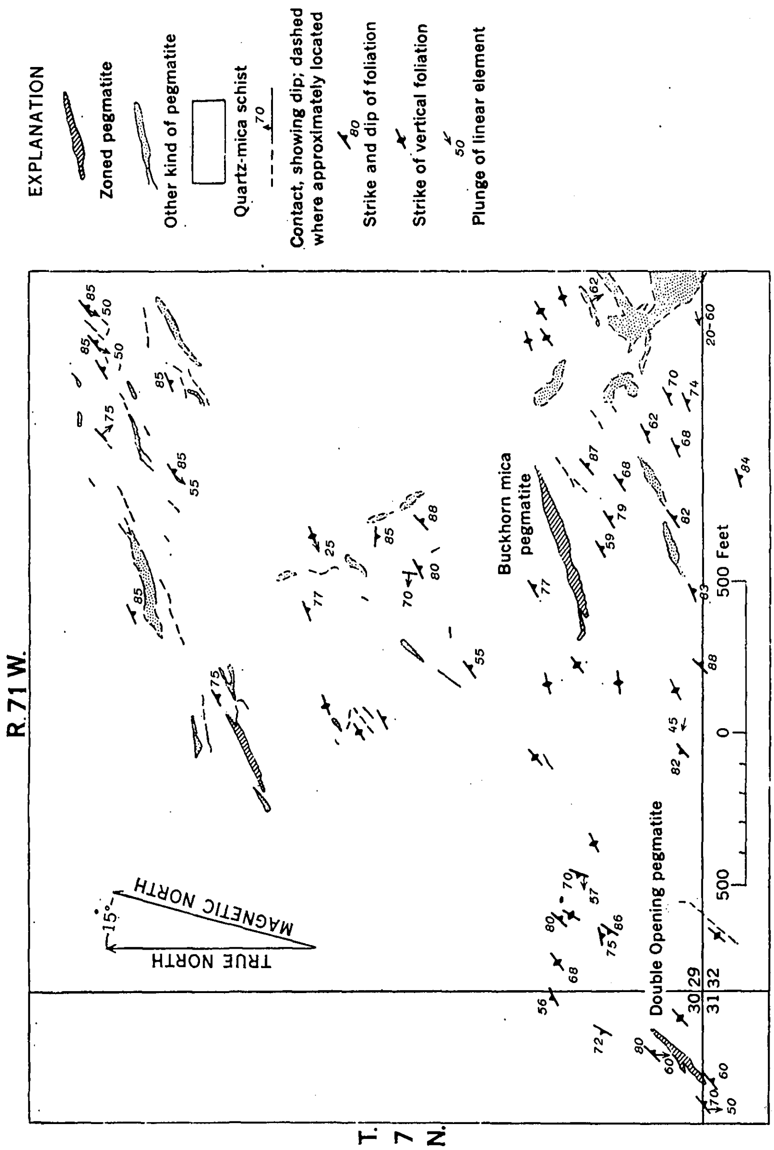


FIGURE 3.—Geologic map of the Buckhorn Mica mine area, Crystal Mountain district, Colorado.

The foliation of the schist is approximately parallel to the bedding in most places. Wherever recognizable bedding diverges from the foliation at an angle of more than 15°, it has been mapped separately (pl. 2). The linear structures of the schist include drag folds, ranging from minute crinkles to those 2 feet in cross section; elongation of mineral grains, principally biotite and quartz; and "pencil structure" produced by the intersection of closely spaced planes of fracture. The plunge of the linear elements, with few exceptions, is a reliable indicator of the attitude of the nearby fold.

The most abundant type of schist is characterized by the alternation of thin mica-rich and quartz-rich layers. Commonly, there are from 5 to 50 layers per inch; in places they are thicker. The color, composition, proportions of minerals, or grain size of layers may differ. Quartz, as grains with rounded outlines, is the most abundant mineral. Granulated and strained grains as well as grains with intricately sutured boundaries are rare. The proportions of biotite and muscovite vary widely. The biotite is coarser grained than the muscovite; some books are as much as 0.3 inch in diameter. Feldspar is not abundant, but in many layers it may constitute 5 to 15 percent of the granular material. Orthoclase, microcline, and plagioclase have been identified; orthoclase is the most common.

Tiny euhedral to subhedral crystals of apatite, zircon, and magnetite or ilmenite are present in all thin sections of schist that were examined. Chlorite, as large flakes and as felted masses of small shreds, is a common accessory. Staurolite, andalusite, and garnet are widely distributed throughout the quartz-mica schist but are rarely abundant. Staurolite crystals range from 0.02 to 1.1 inches in length; equant grains of andalusite range from 0.02 to 0.3 inch in diameter; and garnet crystals average 0.02 inch in size—the largest is about 0.2 inch. Sillimanite is a rare accessory mineral in the Hyatt area except in a few small lenticular beds west of the Hyatt ranch. Sillimanite needles, intergrown with quartz, are abundant in clumps which form white buttonlike masses in the mica schist. On Buckhorn Creek sillimanite clusters, oriented with the long dimension parallel to the schistosity, are conspicuous in some outcrops. Mappable beds of staurolite-mica schist and garnet-mica schist occur in a few places (pl. 2). Minor quantities of staurolite, garnet, and other accessory minerals are widespread in other types of schist in the Hyatt area.

Small needles of black tourmaline are plentiful in some schist layers, but quantitatively are a minor constituent. Tourmaline crystals as much as 1 inch long, however, are in the schist bordering some pegmatites. The tourmaline decreases in size and abundance away from the pegmatite borders, and the tourmalinized zone rarely exceeds 2 feet in thickness.

Textural facies of the quartz-mica schist are conspicuous in places. Several beds in the area are characterized by closely spaced, roughly ellipsoidal knots. The knots are from ⅛ to 1 inch in longest dimension, are oriented with the shortest dimension normal to the schistosity, and are composed of essentially the same minerals as the schist, though not necessarily in the same proportions. They are spaced irregularly, from ½ to 4 inches apart. In some exposures the folia of the schist seem to pass through the knots and in others to pass around the knots. The material composing the knots is not uniform, but it is always different from the enclosing schist. The component grains may be finer or coarser; they may be aggregated in a different manner; the proportions of minerals may be different, and invariably the knots weather differently. The knots have irregular boundaries, in some cases gradational. A thin section across several knots shows them to be composed almost entirely of medium-grained muscovite in flakes of random orientation; the surrounding schist is made up predominantly of fine- to medium-grained quartz, with subordinate quantities of fine-grained biotite, muscovite, and chlorite, and accessory magnetite, zircon, and apatite. The knots in another bed contain the same minerals as the schist (principally quartz, micas, chlorite, and staurolite), but the aggregate is outlined by a band rich in interstitial limonite, and the schistosity passes around the limonitic shell. Lovering (1935, p. 7–8) describes a "knotted schist" in the Montezuma quadrangle which he likens to the schist with "ellipsoidal masses" described by Ball (1908, p. 41) and to the "pebble-bearing gneiss" of Spurr (Spurr, Garrey, and Ball, 1908, p. 177). Lovering states that the knots consist of medium-grained quartz with small amounts of sillimanite and attributes them to extreme metamorphism attended by the migration of siliceous and aluminous material. The knots in the schist of the Hyatt area are more varied in composition but may be, nevertheless, the result of the migration of material during metamorphism; the muscovite in the knots may have been formed by retrograde metamorphism of original andalusite or sillimanite.

Quartz schist is less common than the quartz-mica schist, though the varieties are gradational and have not been mapped separately. Massive quartzites are rare, but directly south of pegmatite 504 a quartzite with a maximum width of 2 feet trends westward for 430 feet (pl. 2). Between the Hyatt pegmatite and pegmatite 631, a 7-foot quartzite bed trends approximately N. 15° W. for 120 feet.

A few rounded boulders of a rock composed of lime silicate minerals have been found in the Crystal Mountain district These apparently were derived from thin limy beds, but none have been recognized in the abundant outcrops along the steep valley walls. The dominant minerals are plagioclase (labradorite, An_6Ab_4), epidote, and quartz; abundant accessory minerals are hornblende and garnet. Magnetite, siderite, zircon, and sericite are present in minor quantities.

The schist has undergone no serious deformation since the schistosity was formed and recrystallization was completed. Shredded and bent mica flakes and strained quartz grains are very rare. Andalusite, staurolite, sillimanite, and tourmaline grains and needles are intact despite their susceptibility to dislocation. Retrograde metamorphism has caused the local degeneration of some andalusite to quartz and mica, and of biotite to chlorite. There is no record, however, of large-scale retrogressive metamorphism. The metamorphism of the schists, as indicated by andalusite and sillimanite, is high grade in places, although the more widespread and abundant staurolite and garnet suggest that most of the rocks are middle grade. The well-developed schistosity and foliation, as well as the widespread and well-marked linear arrangement of biotite and, to a lesser extent, of quartz, indicate that these rocks recrystallized under great stress characteristic of the middle grade of metamorphism of Harker (1932, p. 198–199). Harker's (1932, p. 203) distinction between schistosity and foliation is "* * * schistosity is the result of the orientation of minerals into plane parallelism, foliation is due to segregation of minerals into planes or thin layers of contrasting composition."

GRANITE

The granite in the Crystal Mountain district is a medium- to coarse-grained biotite granite that has many textural and color variations. It is correlated with the Mount Olympus granite because of its similar composition, its mode of occurrence, and its closeness to areas of Mount Olympus granite described by Boos and Boos (1934, p. 323–324, 308, and fig. 2; 1948, p. 1398). The typical Mount Olympus granite forms irregular masses, large sheets, and sills. It is not confined to a single more or less regular mass as are the larger and better known granites of the Front Range. With two possible exceptions, the granite in the Hyatt area forms essentially concordant bodies. Isolated sills range from 1 to perhaps 200 feet in thickness; the average is about 15 feet. The marginal members of multiple sills have approximately the same range of thickness, but the central members may be much thicker. The two largest granite masses, to the north and southwest of the Hyatt ranch, are multiple sills. The full extent of the northern mass has not been mapped, but the part shown in plate 2 has been demonstrated to be a multiple sill by the flow structures and schist partings that parallel the contacts and structure of the country rock. The southern mass, though smaller, has a more massive core of granite flanked by marginal sills and many satellite sills to the south. The granite in both masses is intricately interfingered with the schist; the majority of the relatively smooth contacts shown on plate 2 are concealed contacts.

The schist partings are in some places pendants of wall rock, in others they appear to be isolated slabs or screens. The partings range from slabs of schist 20 feet thick to mere films having the dark color, fine grain, and oriented quartz and mica typical of schist. They range from 2 feet to several hundred feet in length. Schist partings in the granite masses are distinctly weak zones, readily etched out by weathering and erosion, that become steps or notches which gather talus or a thin stony soil capable of supporting trees and shrubs. More schist partings probably exist than were observed, but they could not be discriminated readily from joint-controlled features.

The isolated sills are consistently concordant. Discordance of any part of the large multiple sills is not obvious in the field, but the shapes of the two large granite masses indicate some discordant contacts.

The granite is composed principally of orthoclase, microcline, and quartz, with lesser amounts of biotite, muscovite, and plagioclase, and minor quantities of apatite, magnetite, and zircon. A few minute crystals of tourmaline are present in one thin section, and another contains siderite along the edges of magnetite grains. A red-brown mineral, probably hematite, clouds the orthoclase of one sill. Orthoclase commonly has been sericitized along fractures and cleavage lines, and generally the orthoclase shows pronounced zoning and twinning. The biotite is partially chloritized, and it ranges in texture from very fine grained to coarse grained The margins of the sills in some places show a border zone, ⅛–½ inch wide, of finer grain than the bulk of the sill.

The Mount Olympus granite has a different appearance in different sills. It is light to medium gray, depending upon the size and abundance of biotite flakes. One brick-red sill owes its color to the myriad of red-brown specks, probably hematite, that cloud the orthoclase. In another sill a tapiocalike effect is caused by large rounded grains and aggregates of orthoclase in a fine-grained dark matrix of quartz and accessory biotite, muscovite, magnetite, and apatite. The orthoclase grains in some sills are larger than the rest of the minerals and give the rock an irregular mottled appearance. In sills where the major constituents are roughly of equal size the rock has the speckled "salt-and-pepper" appearance of typical granite. Longitudinal fractures, thin pegmatites, and biotite flakes in many exposures are parallel to the sill wall and appear to be related to flowage at the time of intrusion.

Straight parallel-sided quartz veins, ranging in width from a knife edge to 3 inches, cut the granite and are in turn cut by pegmatite. Quartz veins intersected by pegmatites are in some instances displaced as much as 6 inches. The relative displacement is always in the same direction: the northwest wall moved northeastward on northeast trending pegmatites.

DIORITE

Scattered boulders of porphyritic, fine-grained black diorite are found in a small area between pegmatites 77 and 80 in the northern part of the Hyatt area. Individual pegmatites are identified by number in plate 5, Index map to pegmatites in the Hyatt area, Crystal Mountain district, Colorado, for location on plate 2. Judging from the fineness of grain the boulders probably came from a dike similar to many dikes known in the Front Range. The rock is composed of plagioclase and hornblende with accessory magnetite and minor amounts of apatite and quartz. There are two distinct ages of plagioclase: the early generation of large laths are andesine (Ab_6An_4), and the late generation of small interstitial grains are andesine-oligoclase (Ab_7An_3). The andesine phenocrysts and the hornblende are slightly sericitized. Only a few grains of quartz and apatite are present.

SURFICIAL DEPOSITS

The rolling upland surface has a fairly deep soil presumably Pleistocene in age. The steep valleys of the latest cycle of erosion are strewn with boulders, talus cones, and rock slides. In the intermediate zone between the new valleys and the old upland, the old soil is being removed by slope wash and soil creep and by gullying of the meadows and mountain parks as the stream valleys reduce the area of upland surface in the process of developing a mature drainage system at the new base level for the Front Range.

STRUCTURE

The schist of the Hyatt area strikes approximately east and dips southward. Folds in the schist plunge southward at angles ranging from 25° to 75°. The schist in the vicinity of the Hyatt pegmatite forms small symmetrical folds that plunge to the south. The schist on the hanging wall of the northern granite mass dips southward at angles of 25° to 60°—locally 75°—and is part of a broad fold. West and north of the northern granite mass the metamorphic rocks dip from 45° to 65° southward and strike uniformly east-northeast. (See pl. 2.) The attitude of the schist in the vicinity of the southern granite mass is more irregular; here the schistosity dips more steeply than in the rest of the area.

Granite sills and the majority of pegmatites occurring in schist are concordant with the metamorphic structure, as shown in the structure sections (pl. 3). The granite, intruded as several individual bodies along the schistosity of the metamorphic rocks, formed multiple sills in many places.

About thirty of the widest and longest pegmatites in the area are discordant, dipping northward at angles of 65° to 89°. The exact nature and age of the structures controlling the attitude of the discordant bodies are not known. The discordant bodies are concentrated, with few exceptions, in linear groups having two general trends, eastward and north-westward. (See pl. 4.)

The major folds and fractures apparently resulted from the intrusion of the large multiple sills. It is assumed that the granite, the pegmatites, and the fractures containing the discordant pegmatites were formed during the same period of intrusive activity. The northern multiple sill was formed in schist of moderate dip under a broad fold or asymmetrical dome; the doming produced a few tear faults trending northwestward, and fractures arranged in belts trending eastward. Pegmatites were formed both parallel to the schistosity and flow structure and across it in faults, fractures, and joints.

Near the middle of the northern mass a few faults displace pegmatites. The faults do not exceed 500 feet in length, and the maximum displacement is about 20 feet. The fault planes are straight, narrow, and without gouge, breccia, or marginal fractures; they are little more than joints along which minor movements have taken place. The fault planes dip from 45° to 70° to the northwest, and the relative displacements are everywhere in the same direction; the northwest block moved diagonally upward and to the northeast.

The writer infers from the distribution and refractive indices of beryl that there is probably a granite mass, somewhat larger than the ordinary sills, buried at no great depth in the vicinity of the Hyatt pegmatite. The granite which almost surrounds the Hyatt deposit and the body a thousand feet to the east may be attached or closely related to the hypothetical mass, and the anticlinal fold plunging south-southeastward from the Hyatt pegmatite may represent the bowing of the schist by the intrusion of this hypothetical mass. The shape and attitude of the fold suggest that the mass may be a concordant body about 700 feet wide and 500 feet thick, shaped more like a crude cylinder than a tabular sill; the granite exposed near the Hyatt pegmatite may be a part of its irregular top. The fold flattens out abruptly to the north of the Hyatt pegmatite and tapers out gradually southeastward.

The area has not undergone important deformation since the consolidation of the pegmatites.

PEGMATITES

DISTRIBUTION

The pegmatites of the Hyatt area are part of a group that extends about 5 miles east and south and at least 10 miles north and west of the area. Examination of a few deposits outside the area suggests that they are similar mineralogically and structually to those mapped in the Hyatt area. Some discordant bodies attain larger size and more irregular shape than the concordant bodies, but otherwise there is no correlation between the pegmatites and their environment. The different mineralogic and textural types of pegmatites are found in all kinds of country rock and structure. Four types of internal structure are recognized in the pegmatites of the district, but they are all widely distributed.

SHAPE AND STRUCTURE OF PEGMATITES

The shape and structure of the pegmatite body can be approximated from a study of the pegmatite contacts, the zones and zonal boundaries, and the structure of the country rock. The shape of the pegmatite is controlled to a large degree by the nature of the country rock and the kinds of openings that can be developed in that rock. In competent rock such as granite the pegmatites are predominantly tabular, branching with angular bends and having relatively linear courses. (See pl. 2.) In well-foliated rock such as mica schist, the concordant pegmatites are predominantly lenticular, with smoothly curving outlines and tapering ends. The discordant pegmatites in schist usually have irregular and serrate margins which reflect the jagged fracture of schistose rock. Pegmatites controlled by intersecting structures (such as several systems of fractures or schistosity cut by fractures) may develop highly irregular shapes, but the shapes can be determined if the relation between structure and pegmatite can be established. In well-foliated rock the schistose structure, linear elements, and details of the contact give evidence of the structure of the pegmatite body. Jahns (1951, p. 54) found the plunging structures of pegmatites in New Mexico consistently conformable with the plunge of numerous minor structural elements in the adjacent country rock. Cameron and others (1945, p. 372) describe the pitch of rolls in some pegmatites of New England as related to structural elements of the enclosing rock. According to Bannerman (1943, p. 8), in certain districts of New Hampshire the types of pegmatites that follow the foliation in schist are inclined to wedge out suddenly but, generally speaking, to conform in strike and plunge with the linear structures of the schist.

The direction and plunge of linear structures impressed on the schist by the pegmatite furnish data for determining the plunge of contact features. The data will rarely, if ever, provide a single complete solution, but it will set limits to the extent, shape, and attitude from which a reasonable generalized picture can be evolved. The zones reflect to varying degrees the shape of the pegmatite; data on the attitude and dimensions of a zone contribute to the determination of the shape of the neighboring zones and the body as a whole.

Pegmatites whose shapes are controlled by more than one factor present more problems than those controlled by a single factor such as schistosity. The greater part of the Hyatt pegmatite is in granite, but both ends extend beyond the granite into schist (pl. 9). The contacts between schist and granite are not exposed. The contacts between pegmatite and wall rocks give a wide range of possible attitude, but the zonal relationships limit the reasonable interpretations to a somewhat narrower range. The shape and attitude of the Hyatt deposit as finally interpreted from the results of drilling (pl. 10) are reasonably close to that of the composite picture postulated in advance of exploration.

In a bulbous pegmatite, such as the Big Boulder, the lower side of which is concealed, the exposures of pegmatite indicate the attitude of the roughly convex upper surface, and the dips and plunges do not necessarily relate to the converging lower surface. A small keel-shaped exposure in the undercut outcrop at the north end of the deposit (pl. 11) was used as the principal basis for postulating the location and inclination of the lower side of the body; two diamond-drill holes based on this interpretation did not intersect the pegmatite because the plunge of that small exposure was steeper than the plunge of the entire body.

The Buckhorn Mica pegmatite has been extensively eroded, but the contacts along the western part of the deposit do not indicate the plunge of the west end of the body. Indecisive evidence suggested that a crest might plunge steeply westward or a keel might plunge eastward. (See pl. 13.) Drilling indicated a keel with a moderate eastward plunge, and the Buckhorn Mica pegmatite proved to be smaller than the "compromise body" postulated before drilling. The structures in the schist and the plunge of the line of intersection of the contacts in the eastern part indicated that the keel at the east end plunged about 40° to the west; exploration confirmed this interpretation.

The structure of internal units in many pegmatites reflects the structure of the nearest contact with remarkable fidelity. "Rolls" in the contact (anticlinal or synclinal bends or folds) in some places determine the localization in internal units of shoots or pockets of valuable minerals. The relationship between the two features is well exposed in some districts by mining, and examples have been described by Cameron and others (1945, p. 377–380, 388), Bannerman (1943, p. 11–12), and Jahns (1951, p. 54). The information obtained by studies in other districts has been useful in projecting external and internal structures below the surface to determine shape and attitude of pegmatites and to interpret the results of drilling.

The pegmatites of the Hyatt area have a wide variety of sizes and shapes as shown in plate 2, but a few examples to indicate the maximum sizes may prove useful in making comparisons with other districts.

The longest pegmatite completely enclosed in granite is pegmatite 272. It has a length of 1,050 feet, an average width of 8 feet, and a maximum width of 12 feet. Pegmatite 259 in the same area is the widest, ranging from 11 to 24 feet and averaging 15 feet; it is 830 feet long.

The longest concordant pegmatite enclosed in schist is pegmatite 584. It is 2,675 feet long and 2 to 4 feet wide. The widest concordant pegmatite (585) is 2,100 feet long; it ranges from 2 to 18 feet in width and averages 12 feet. The greatest width of concordant multiple pegmatite is 200 feet (pegmatite 846). The discordant pegmatites in schist vary widely in size. Multiple pegmatite 448 is the longest with an over-all length of about 2,500 feet; the maximum width is 130 feet. Pegmatite 1197, which has the greatest width, is as much as 250 feet wide. If pegmatites 1197 and 1199 should prove to be a continuous body, it would be the largest mass of pegmatite in the Hyatt area.

Despite the relatively small average dimensions of the individual bodies in the western part of the northern granite mass, the myriad of interconnected pegmatites exposed there probably contain the greatest concentration of pegmatitic material in the area. Pegmatites are generally more extensive in schist than in granite, however.

TEXTURES

The textures of individual units within pegmatites vary widely. The grains commonly attain sizes so much larger than those in other rocks that the ordinary descriptive terms must be redefined. The size classification used in this report is that given by Cameron and others (1949, p. 16):

Term	General grain size (inches)
Fine	Less than 1
Medium	1 to 4
Coarse	4 to 12
Very coarse	Greater than 12

Statements with regard to the grain size of a pegmatite or unit indicate the general appearance in exposures; grain size is a qualitative expression of the size of the grains comprising the bulk of the material. Interstitial grains may be very much smaller, and a few grains or masses may be much larger than the average size or range indicated. (See pl. 8.) Bastin (1911, p. 10) regards this irregularity of grain of pegmatites as more distinctive than the coarseness that is so widely emphasized.

The texture and range of grain size of the principal zones of the explored pegmatites are summarized in table 2. All the minerals increase in average grain size toward the center of the pegmatite, but each mineral seems to have its own rate of change in grain size. The increase is most spectacular in zoned pegmatites, but the change is apparent in homogeneous pegmatites. Perthite exhibits the most obvious increase in grain size. Quartz, whether in single grains or aggregates, increases in size manyfold from the border zone inward. Muscovite in a few places shows a great increase in size, as for example, from the contact to the inner intermediate zone at the Hyatt pegmatite and from the contact to the outer intermediate zone of the Buckhorn Mica mine, but ordinarily the increase in grain size of muscovite is less marked than that of perthite and quartz. Plagioclase shows the lowest rate of increase. Though the minerals may be present near the center of a homogeneous pegmatite in approximately the same proportions as near the contact, the increase in size of the

TABLE 2.—*Grain sizes of three zoned pegmatites in Crystal Mountain district, Colorado*

Location of pegmatite	Texture	Range in size of the majority of grains (inches)	Range in size of all grains (inches)
Hyatt deposit:			
Border zone	Fine	<1	0.01–4
Wall zone, upper and lower	Coarse	4–12	.01–36
Inner intermediate zone	do	4–12	.01–60
Core	Very coarse	>12	.01–120
Big Boulder prospect:			
Border zone	Fine	<1	.01–1
Wall zone	do	<1	.01–3
Upper intermediate zone	Medium	1–4	.01–8
Lower intermediate zone [1]	Coarse	4–12	.01–30?
Hood	Very coarse	>12	.01–72
Core [1]	do	>12	.01–60?
Buckhorn Mica mine:			
Border zone	Fine	<1	.01–5
Wall zone	do	<1	.01–3
Outer intermediate zone	Medium	1–4	.01–12
Inner intermediate zone	do	1–4	.01–24
Core	Coarse	4–12	.01–36

[1] Maximum dimension inferred from drill core.

perthite and quartz is more conspicuous because the plagioclase is in part interstitial to the larger grains and in part masked by weathering, staining, and plant matter. The changes in grain size for the minerals of a well-exposed zoned pegmatite and a typical homogeneous pegmatite are summarized in table 3.

TABLE 3.—*Comparison of changes in grain size in a zoned pegmatite and homogeneous pegmatite, Crystal Mountain district, Colorado*

	Hyatt pegmatite		Homogeneous pegmatite	
	Grain size in wall zone (inches)	Grain size in or near core (inches)	Grain size within 5 inches of contact (inches)	Grain size near center of pegmatite (inches)
Perthite	0. 01–4	0. 01–120	0. 01–1	0. 01–10
Quartz	. 01–3	. 01–48	. 01–. 7	. 01–10
Plagioclase	. 01–1	. 01–8	. 01–. 4	. 01–1
Muscovite	. 01–2. 5	. 01–15	. 01–. 4	. 01–2. 5
Beryl	. 01–1. 75	. 01–48	. 01–. 8	. 01–2
Tourmaline	. 01–2	. 01–4	. 01–1	. 01–2
Garnet	. 01–. 2	. 01–. 6	. 01–. 2	. 01–1

Boundaries between pegmatite units are more generally gradational than abrupt because of the over-all coarseness of the component minerals. The boundaries between well-exposed fine- and medium-grained units of contrasting composition can be fixed ordinarily within a foot or two, but the boundaries between coarse- and very coarse-grained units are less well marked, especially if the mineralogy is closely related. The general sequence of mineral assemblages (table 6) shows that most assemblages are closely related mineralogically to those earlier and later in the sequence. The average composition and texture of a zone may contrast sharply with the average for those adjacent to it, but the boundaries are in most places gradational. A pegmatite zone is a lithologic unit, and its boundary does not necessarily follow the margins of individual mineral grains. In the Big Boulder deposit the boundary between the hood of perthite-quartz pegmatite and the core of quartz pegmatite (pl. 11) must be drawn between zones with a common mineral and also across a texture featuring the interlock of grains as much as 6 feet in size. The boundary is drawn so that the average composition of the core does not include more than 5 percent of perthite, although a trench along the boundary as drawn might show that some perthite grains overlap the boundary or some isolated perthite crystals were present in the quartz core. In all the maps of zoned pegmatites the boundaries between zones have been drawn as relatively smooth lines, whereas development work will inevitably show an intricate serrate relationship between the individual mineral grains.

The textures developed in a pegmatite result from the complex but orderly progress of crystallization in a multicomponent chemical system whose composition and environment make possible greater (or at least more obvious) growth and segregation of minerals than is found ordinarily in igneous rocks.

INTERNAL STRUCTURE OF ZONED PEGMATITES

The lithologic and structural units found within pegmatite bodies differ in mineralogy or texture, or both. Three basic types of units are distinguished and are defined by Cameron and others (1949, p. 13–24) as follows:

1. *Fracture fillings* are units, generally tabular, that fill fractures in previously consolidated pegmatite.
2. *Replacement bodies* are units formed primarily by replacement of pre-existing pegmatite, with or without obvious structural control.
3. *Zones* are successive shells, complete or incomplete, that reflect to varying degrees the shape or structure of the pegmatite body. Where ideally developed they are concentric about an innermost zone or core. Some concentric units, however, are not zones but belong in the categories above.

The term "unit" includes all three types of bodies defined above.

FRACTURE FILLINGS

Fracture fillings are common although minor features of pegmatites in the Crystal Mountain district. Quartz-filled fractures are the most abundant and rarely exceed 30 feet in length. They commonly are from 1 to 12 feet long and from a knife edge to 3 feet wide. Pegmatitic fracture fillings in homogeneous pegmatites are apparent because of differential weathering; they invariably differ in texture from the enclosing body and are etched out by weathering.

Fracture fillings may be homogeneous or zoned and occur within homogeneous or zoned pegmatites. Pegmatite 645 (pl. 2) is not zoned, but one fracture filling is a zoned unit containing a wall zone of plagioclase-perthite-quartz-muscovite pegmatite, and a core of perthite-quartz-plagioclase pegmatite. At the Big Boulder prospect a fracture filling composed of perthite-quartz pegmatite extends from the hood-shaped inner intermediate zone across the outer intermediate and the wall zones. (See pl. 11.) The fracture filling has a gently curved trace and steep dip, but its vertical extent is not known. It can be traced into the hood for about 4 feet where it merges with the minerals of the inner intermediate zone.

The margins of fracture fillings are fine grained and in some places contain oriented muscovite flakes and quartz grains. Beryl crystals in the wall zone of the fracture filling in pegmatite 645 (pl. 2) are oriented with the long axis normal to the wall of the fracture. Pegmatite 448 (pl. 2) contains two beryl-bearing fracture fillings at the east end. Both are nearly flat lying and occur near the top of the body. In one fracture filling 161 beryl crystals are exposed, and the beryl content is about 0.28 percent. In the other fracture filling 52 crystals are exposed, and the beryl content is 0.3 percent. Pegmatite 645 (pl. 2) contains many fractures with an average strike and dip of N. 60° W., 40° S., but only a few contain beryl-bearing pegmatite; the best exposed fracture filling has over 500 small beryl crystals, and the rock has a beryl content of 0.9 percent. The beryl-bearing fracture fillings rarely exceed 3 feet in thickness, the maximum being about 5 feet. The average dimensions of fracture fillings are about 1 foot thick, 60 feet long, and 15 feet wide, and the tonnage of contained beryl is small.

REPLACEMENT BODIES

No mappable replacement bodies have been recognized in the pegmatites of the Crystal Mountain district. Cameron and others (1949, p. 83–97) have described replacement bodies in other parts of the country.

ZONES

A zoned pegmatite is one consisting of two or more successive shells, and may or may not contain fracture fillings or replacement bodies. Zoned pegmatites are comparatively rare in the Crystal Mountain district. Of the 1,300 bodies mapped in the Hyatt area, 28 have been designated as zoned pegmatites. Of these, 27 consist of two zones and are listed in table 4; one, the Hyatt deposit, has five zones.

Zones have been classified by Cameron and others (1949, p. 20) as border zones, wall zones, intermediate zones, and cores.

BORDER ZONES

The border zone is the outermost zone of a pegmatite and constitutes a fine-grained selvage that is not more than a few inches thick in most pegmatites. In most border zones the minerals, especially muscovite and quartz, show a preferred orientation normal to the contact. Minerals with an elongate habit, such as tourmaline and beryl, exhibit preferred orientation to a marked degree when present in the border zone.

Quartz and muscovite, and in some places plagioclase, are the dominant minerals of border zones adjacent to schist; the texture of these border zones is universally fine grained, the minerals averaging less than a quarter of an inch in diameter. The line between schist and border zone is invariably sharp and distinct.

Border zones of pegmatites in contact with granite are somewhat less regular and not so well defined. The minerals of the border zone interlock noticeably with those of the granite even where there is a

TABLE 4.—*Pegmatites consisting of two zones, Hyatt area, Crystal Mountain district, Colorado*

[Essential minerals are stated in order of decreasing abundance, perthite (P), plagioclase (Pg), quartz (Q), and muscovite (M)]

Pegmatite no.	Mineralogic composition		Beryl content [percent]
	Wall zone	Core	
405	P, Pg, Q	Q	0.09
441	Pg, P, Q	P, Pg, Q	0
442	P, Pg, Q	P, Pg, Q	Tr.
443	P, Q, Pg	P, Pg, Q	Tr.
464	Pg, P, Q	P, Pg, Q	0
512	Pg, Q, P	P, Pg, Q	Tr.
527	Pg, P, Q	P, Q, Pg	.10
563	Pg, Q, P	Pg, P, Q	0
565	Pg, Q, P	P, Pg, Q	.02
566	Pg, P, Q	P, Q, Pg	.07
567	Pg, P, Q	P, Q, Pg	.31
571	Pg, P, Q	P, Q, Pg	Tr.
642	P, Pg, Q	P, Pg, Q	Tr.
748	P, Pg, Q	Q	Tr.
766	P, Pg, Q	Q	Tr.
773	P, Pg, Q	Q	0
774	P, Pg, Q	Q	0
779	P, Q, M	Q	.56
781 [1]	P, Pg, Q	Q	Tr.
827	P, Q, Pg	Q	.15
859	P, Pg, Q, M	Q	0
939	P, Pg, Q	Q	0
1017	Pg, P, Q	P, Pg, Q	Tr.
1039	P, Pg, Q	P, Q, Pg	0
1068	P, Pg, Q	Q	.02
1111	Pg, Q, P	P, Pg, Q	Tr.
1284	P, Q, Pg	Q	0

[1] One member of a multiple pegmatite.

seemingly sharp contact between the two rocks. In both rocks, quartz and feldspars are the dominant minerals, and muscovite is a minor accessory; plagioclase is subordinate to perthite in most border zones in contact with granite. The margins of many pegmatites grade into granite over a width of an inch or two. Gradational contacts are ordinarily irregular, and it is impossible in some places to fix the precise limits of the border zone. In a strict sense, perhaps, there is no border zone in these places.

WALL ZONES

The wall zone is inside the border zone and is generally coarser grained and thicker. In describing the zoning of some pegmatite deposits in Brazil the term "border zone" has been used by Pecora and others (1950a and 1950b) to include both the border zone and wall zone as here used. A common practice in pegmatite mining districts of the United States is to include border zone and wall zone, as defined here, in the term "wall zone."

Wall zones of pegmatites in the Crystal Mountain district are invariably composed of feldspars and quartz; in some deposits perthite is much more common than plagioclase, and in others the reverse is true. Quartz is subordinate to the feldspars, and muscovite is a minor constituent. Beryl, tourmaline, and garnet are present in many wall zones as accessory minerals. In a few deposits the beryl content is about 1 percent.

The texture of most wall zones is medium to fine grained, and the minerals have a random orientation. Some minerals in wall zones exhibit a preferred orientation with the long dimension normal to the wall of the pegmatite, for example, the beryl crystals in the wall zone of the fracture filling of pegmatite 645 (pl. 2). Tourmaline crystals, though uncommon in the wall zone in the Crystal Mountain district, are oriented similarly in some deposits.

INTERMEDIATE ZONES

Any zone between the core and wall zone is an intermediate zone; if there are two or more, they can be designated by letter, number, or such terms as "inner," "middle," and "outer." Most intermediate zones are shells around a core, but some, as in the Hyatt pegmatite, are discontinuous and lenticular. The Hyatt, Big Boulder, and Buckhorn Mica pegmatites all contain more than one zone between the wall zone and the core. Perthite-rich intermediate zones of some pegmatites are discontinuous and show a marked tendency to be concentrated in the upper part of the pegmatite; such a domelike deposit, concave inward and downward, is referred to as a "hood." The Big Boulder pegmatite contains a prominent hood of perthite-quartz pegmatite. The other zoned pegmatites described in this report contain only wall zones and core in addition to the very thin border zones. In each of the polyzonal deposits the texture and mineralogy are sufficiently distinctive and well exposed that more than two mappable units can be distinguished.

CORES

The core is the innermost zone and occurs at or near the center of the pegmatite, commonly as an elongate lens or a series of disconnected segments. Cores of pegmatites in the Crystal Mountain district are, for the most part, quartz or perthite, or both. The core of the Hyatt deposit is perthite pegmatite (pl. 9) and that at Big Boulder prospect (pl. 11) is quartz pegmatite. The core of the Buckhorn Mica pegmatite (pl. 13) is the only exception in this district and it is composed of cleavelandite-quartz-spodumene(?) pegmatite. The texture of the cores is very coarse. The cores of thin pegmatites are invariably thin and may be discontinuous. The core of the Buckhorn Mica deposit has the shape of a flat lens with a maximum width of 12 feet and a length of 160 feet. Bulbous bodies like the Hyatt and Big Boulder pegmatites have somewhat ovoid cores consistent with the shape of the entire body. Pegmatite 464 is a narrow pegmatite with a pronounced bulge near the middle, and a quartz core is present only in the bulge (pl. 2). A similar relationship has been described by Cameron and others (1945, p. 383) at the United Mine, Grafton, N. H., and the E. E. Smith mine, Alexandria, N. H., and other deposits. There is no fixed ratio between the size of the pegmatite and the size of the core; in some bodies the core constitutes a small percentage of the pegmatite, and in others, such as the Crystal silica deposit described by Hanley, Heinrich, and Page (1950, p. 93–96), the core seems to make up more than half of the pegmatite.

TELESCOPED ZONES

Two or more zones that are clearly defined in parts of a given pegmatite may appear elsewhere to merge along their dip or strike into a single unit whose composition corresponds to the bulk composition of the two zones. Such "telescoped" zones bear the same relationship to the adjacent zones as that occupied jointly in the other parts of the pegmatite by the zones into which the single unit can be traced. Telescoping may present the reverse impression to the one described above: a zone continuous around the core may show a local segregation of minerals so marked that two mappable units are formed. The bulk composition of the segregated units corresponds to that of the full zone into which they can be traced. At the Hyatt pegmatite the hanging-wall side of the intermediate zone of plagioclase-quartz-perthite-muscovite pegmatite shows such a segregation of minerals into two mappable units: an outer intermediate zone of perthite-quartz pegmatite and an inner intermediate zone of plagioclase-quartz-muscovite pegmatite.

SHOOT

The terms "shoot," "streak," "pocket," and "lens" are used to describe local concentrations of particular minerals or textures within a zone and carry the connotations established by general use in mining. The minerals of a particular zone may be uniformly disseminated but commonly are more irregularly distributed; this is especially true of the minor constituents. Tourmaline, beryl, garnet, and the rare minerals commonly occur within a zone as local concentrations separated by relatively barren rock. The beryl in the inner intermediate zone of the Hyatt pegmatite is found in pockets of coarse-grained crystals and masses. The pockets discovered by past mining (pl. 9) were 6 to 12 feet long, generally extended the full width of the zone, and were 10 to about 35 feet apart. The fine-grained beryl in the wall zones of the Hyatt, Big Boulder, and Buckhorn Mica pegamatites is not segregated into pockets or shoots, but the distribution is sufficiently irregular to necessitate extensive sampling in order to obtain a representative analysis. Large books of muscovite are scattered irregularly throughout the inner intermediate zone of the Hyatt pegmatite, but much of the fine-grained muscovite has been found concentrated in streaks 1 to 30 feet long and from 1 inch to 5 feet wide. The mica streaks overlap the beryl pockets to some extent, but do not everywhere coincide with them. At the Big Boulder prospect garnet occurs in pockets of closely packed euhedral and subhedral crystals. The individual crystals are as much as one inch in diameter, and the pockets are ½ to 3 feet in size.

HOMOGENEOUS PEGMATITES

A pegmatite that consists of a single zone enclosed between border zones—that is, uniform from wall to wall except for the selvages—was designated as a "homogeneous pegmatite" by Johnston (1945, p. 1025). Most of the pegmatites of the Crystal Mountain district are of this type, and differ from zoned pegmatities in grain size and degree of segregation of the essential minerals. Bodies exhibiting uniform texture and proportions of minerals from wall to wall are almost as unusual in the Crystal Mountain district as those made up of sharply contrasted zones. Even the zones within zoned pegmatites may show widely differing proportions of the essential minerals on short distances. (See appendix A.)

Perthite, plagioclase, quartz, and muscovite are the most common minerals in homogeneous pegmatites of the Hyatt area. Perthite has the most variable grain size. Quartz grains increase in size and form aggregates in progressively larger clots or pods toward the center of the pegmatite. Muscovite, although a minor constituent, forms distinct books in the interior of the bodies in contrast to the tiny flakes near the walls. Plagioclase grains increase in size toward the center, but the increase is less than that of the other minerals.

The relative proportions of the various minerals may change as well as the grain size; generally perthite and quartz increase in abundance as the plagioclase decreases. The texture and mineral distribution in a great many pegmatities is irregular because perthite, and quartz, or both, occur in clots scattered throughout the perthite-plagioclase-quartz pegmatite which forms the bulk of the deposit. In other bodies the clots are centrally located. A group of pegmatites could be selected to show, like the diagrammatic sequence of figure 4, gradation from homogeneous bodies to pegmatites consisting of a wall zone and core. In discussing pegmatites in New England, Cameron and others (1945, p. 373) note that there is no sharp distinction between zoned bodies and "unzoned" or homogeneous bodies.

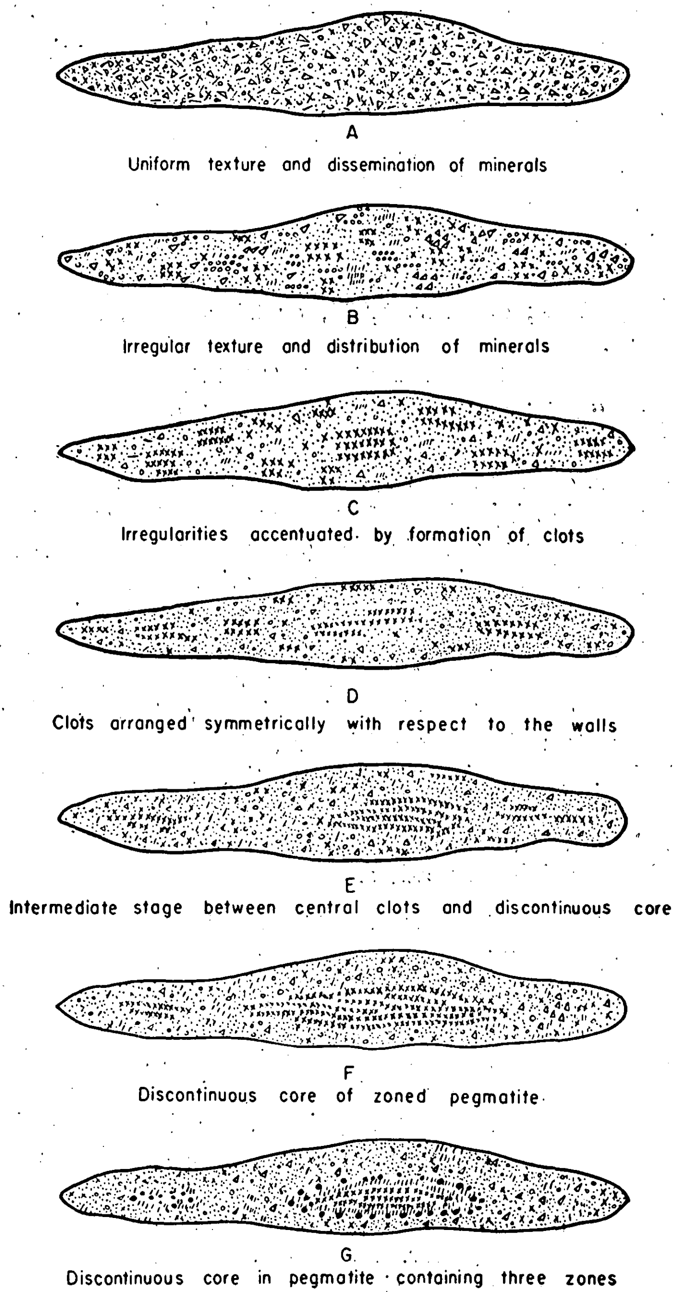


Figure 4.—Idealized plans of pegmatite bodies, showing sequence of types between homogeneous pegmatites and zoned pegmatites.

For purposes of this report an arbitrary limit has been drawn between homogenous pegmatites containing scattered clots of minerals and zoned pegmatites containing cores. If the centrally located concentrations of clots are continous for at least a quarter of the length of the pegmatite and have a width of at least a fifth of the width of the pegmatite, they are considered cores, and the pegmatites in which they occur are designated as zoned bodies. This definition of the lower limit of zoning places about 2 percent of the pegmatites of the Hyatt area in the zoned class. More than 1,300 pegmatites are plotted in plate 2; of these 1,234, or 94 percent, are classed as homogeneous.

MULTIPLE PEGMATITES

The term "multiple intrusion" is credited to Holmes (personal communication) by Stokes and Varnes[4] and defined as: "A term applied to sills, dikes, laccoliths, and other intrusions formed by two or more successive injections of approximately the same magma." The term "multiple pegmatite" is used in this report to designate bodies mapped and described as one pegmatite which consists of two or more pegmatitic masses separated by screens or partings of country rock or by border zones. In many parts of the Crystal Mountain district there are clusters of pegmatities so narrow and so closely spaced that they can not be plotted individually at a scale of 1:6,000. The members of multiple pegmatities are, with few exceptions, homogeneous bodies. Pegmatite 846 is a continuous mass of pegmatite but is made up of a number of individual members. Between pegmatites 723 and 746 (pl. 2) are about 75 individual intrusions forming a series of 24 multiple pegmatites.

BANDED PEGMATITES

The term "banded" is used to describe the appearance and internal structure of a few pegmatites in the Hyatt area composed of alternating bands of light and dark minerals. Feldspar and quartz predominate in the light bands and muscovite and quartz predominate in the dark bands. Tourmaline is abundant in the dark bands of a few banded pegmatites and greatly intensifies the contrast between bands. In pegmatite 629 (pl. 2), tourmaline constitutes about 1 percent of the dark bands. The banding is most sharply defined in very fine-grained pegmatites where the grains average less than a quarter of an inch in diameter. With increasing grain size the banding becomes less distinct. Banding is roughly parallel to the walls whether the pegmatite is in schist or in granite, or whether concordant or discordant. Pegmatite 625 is partly discordant, but the banding parallels the walls throughout the body. No pegmatite is known to

[4] Stokes, W. L., and Varnes, D. J., Preliminary glossary of selected geologic terms (manuscript report).

be uniformly banded throughout its length; banded portions merge with homogeneous material either along the strike or across the width. Within a single exposure, banded pegmatite may appear to cut and be cut by typical unbanded pegmatite. The narrow east-trending offshoot of pegmatite 432 is discordant and crudely banded. The banding is parallel to the contact but is separated from the contact by a 2-foot, fine-grained, feldspar-rich layer. A 3-inch wide fracture filling cuts across the feldspathic layer from the banded layer to the wall. The fracture filling is not banded but is of the same composition and grain size as the banded rock. The fracture filling is neatly outlined by garnet grains and muscovite flakes.

This use of the term "banded" differs from that of Ball (1908, p. 63) who states: " * * * granular pegmatites grade along their strike into rudely banded dikes, quartz being commonly segregated in the center (fig. 17) * * *." The description and figure 17 in Ball's report refer to a pegmatite that the writer would describe as a pegmatite with a feldspar-rich wall zone and a quartz- and biotite-rich core.

MINERALOGY

The internal units of pegmatites are designated by names that express composition in terms of essential minerals. The order of mineral names in the designation is in approximately the decreasing order of abundance and in most cases includes those that are present in the unit in excess of 5 percent. The essential minerals of a majority of the pegmatites in the district are perthite, plagioclase (albite and cleavelandite), and quartz. Muscovite is an essential constituent in the inner intermediate zone of the Hyatt deposit. Tourmaline is an essential mineral in a few small bodies. In order to distinguish the core from the innermost intermediate zone at the Buckhorn Mica mine, it is necessary to include the name of a relict mineral in the designation: the inner intermediate zone is quartz-cleavelandite pegmatite, and the core is quartz-cleavelandite-spodumene(?) pegmatite, though the spodumene is represented only by aggregates of fine-grained albite and sericite, pseudomorphous after spodumene. In the field the difference in the units is very apparent, but the mineralogy is approximately the same, except for the pseudomorphs.

Proportions of minerals were determined in the field by inspection and noted as percentage composition. The beryl content of each outcrop was determined by measuring the area of every discernible grain of beryl and calculating the percentage with respect to the area of the exposure. In pegmatites that contain over 0.1 percent beryl, the total area of rock studied by grain counting was at least 1 percent of the calculated surface area of the deposit. Experience has shown that careful grain counting yields an accurate measure of percentage composition: estimates of ore grades at the Hyatt, Big Boulder, and Buckhorn Mica pegmatites based on grain counts made by Hanley, Page, and the writer between 1942 and 1948 were confirmed by mine productivity at the Hyatt mine in 1948 and by bulk assays made in 1949 and 1950. Similar confirmations have been obtained from the work in South Dakota.

MINERALOGIC TYPES OF PEGMATITES

Six mineralogic types of pegmatites, based on bulk mineralogic composition, are recognized in the Hyatt area. Five of the types are mineralogic assemblages common in many pegmatite districts, but the sixth is an anomalous assemblage in which tourmaline constitutes more than 5 percent of the unit. The types and the number of pegmatites included in each type are given in table 5.

The descriptions of individual pegmatites in the Hyatt area are arranged in appendix B by mineralogic types in the same order as in table 5. The individual bodies are numbered to correspond with the index map (pl. 5), from which they can be identified on the geologic map (pl. 2). A few small pegmatites are shown without numbers or corresponding descriptions.

TABLE 5.—*Mineralogic types of pegmatites in the Hyatt area, Crystal Mountain district, Colorado*

Mineralogic type	Pegmatites (number)	
I. Feldspar-rich pegmatites:		
A. Plagioclase-perthite-quartz pegmatite	------	144
B. Perthite-plagioclase-quartz pegmatite:		
1. Ratio of perthite to plagioclase approximately 1:1	198	
2. Ratio of perthite to plagioclase approximately 3:2	614	
3. Ratio of perthite to plagioclase approximately 2:1	303	
Total		1,115
Total	------	1,259
II. Quartz-rich pegmatites	------	45
III. Tourmaline-rich pegmatites	------	3

Sequences of mineral assemblages as units of zoned deposits have been determined for many districts, and the assemblages in four districts have been summarized by Cameron and others (1949, p. 59–70); the assemblages in the Black Hills, S. Dak., have been described in detail by Page and others (1953). The mineralogic types of pegmatites in the Hyatt area are analogous to mineralogic units recognized in pegmatites of the Black Hills. Page's tabulation of mineral assemblages is reproduced as table 6, with the addition of small arrows to indicate the mineralogic types of pegmatites observed in Hyatt and other areas in the Crystal Mountain district.

Comparison of table 5 with table 6 shows that the pegmatites of the Hyatt area have a relatively limited range of composition. Those of the first four types (table 5) contain perthite, plagioclase, and quartz and comprise 96 percent of the bodies in the area. These are all variants of assemblage 3 (table 6). Those of the fifth type are representatives of assemblage 12 (table 6).

TABLE 6.—*General sequence of mineral assemblages* [1] *and observed lithologic types in pegmatites in Black Hills, S. Dak., and Crystal Mountain district, Colorado*

[Arrow indicates lithologic types observed in Colorado]

Minerals of zones		Essential minerals in order of abundance	
Essential minerals	Common accessory minerals	Dominant	Minor
1. Muscovite (M).	Tourmaline.	→a. Q, M	Pg
Quartz (Q).	Beryl.	→b. M, Q	Pg
Plagioclase (Pg):	Biotite.	→c. Q, M, Pg	
a. Albite	Perthite.	d. Pg, Q	M
b. Oligoclase.	Apatite.	e. Q, Pg	M
	Cassiterite.	f. Q, Pg, M	
	Columbite.	g. Pg, M, Q	
		h. Pg, Q, M	
2. Quartz (Q).	Tourmaline.	a. Pg, Q	
Plagioclase (Pg):	Beryl.	→b. Q, Pg	
a. Albite	Perthite.		
b. Oligoclase.	Apatite.		
	Muscovite.		
	Cassiterite.		
	Columbite-tantalite.		
3. Perthite (P).	Tourmaline.	a. Pg, M, Q, P	
Quartz (Q).	Beryl.	b. Pg, Q, M, P	
Muscovite.	Li, Mn, Fe, phosphates.	c. Pg, Q, P, M	
Plagioclase (Pg):	Columbite-tantalite.	d. Pg, Q, P	M
a. Albite	Apatite.	e. Pg, P, Q, M	
b. Oligoclase.	Löllingite.	f. Pg, P, M, Q	
	Biotite.	→g. Pg, P, Q	M
		h. P, Pg, Q, M	
		→i. P, Pg, Q	M
		j. Q, Pg, M, P	
		k. Q, Pg, P, M	
		l. Q, Pg, P	M
		m. Q, P, Pg, M	
		n. Q, P, Pg	M
		o. Q, P, M	Pg
		p. P, Q, Pg	M
		q. P, Q, M	Pg
		r. Q, Pg, P	M
		s. Q, Pg, M	P
4. Perthite (P).	Tourmaline.	→a. Q, P	
Quartz (Q).	Beryl.	→b. P, Q	
	Plagioclase.	→c. P	Q
	Li, Mn, Fe, phosphates.		
	Muscovite.		
	Columbite-tantalite.		
	Apatite.		
	Löllingite.		
5. Perthite (P) (or microcline).	Tourmaline.	a. A	
Quartz (Q).	Beryl.	b. Q, P, A	Pg
Plagioclase (Pg)	Cassiterite.	c. Q, P, Pg, A	
(usually cleavelandite).	Tantalite-columbite.	d. Q, Pg, A, P	
Amblygonite (A).	Muscovite.	e. Pg, Q, A	P
Spodumene (S).	Apatite.	f. Pg, Q, A, S	P
		g. P, Pg, Q, A, S	
		h. Q, P, S, A	Pg
		i. P, Q, S	
		j. Q, Pg, P, S	

[1] Page, L. R., and others, 1953.

TABLE 6.—*General sequence of mineral assemblages*[1] *and observed lithologic types in pegmatites in Black Hills, S. Dak., and Crystal Mountain district, Colorado*—Continued

[Arrow indicates lithologic types observed in Colorado]

Minerals of zones		Essential minerals in order of abundance	
Essential minerals	Common accessory minerals	Dominant	Minor
6. Plagioclase (Pg): a. Cleavelandite. Quartz (Q).	Tourmaline. Beryl. Cassiterite. Tantalite. Muscovite. Apatite. Amblygonite.	→a. Q, Pg →b. Pg, Q c. Pg	 Q
7. Plagioclase (Pg): a. Cleavelandite. Quartz (Q). Spodumene (S).	Beryl. Tourmaline. Muscovite. Cassiterite. Tantalite. Apatite.	a. Q, Pg, S b. Pg, Q, S	
8. Quartz (Q). Spodumene (S).	Microcline. Plagioclase. Lepidolite. Beryl.	a. Q, S	
9. Plagioclase (Pg): a. Cleavelandite. Quartz (Q). Lepidolite (L).	Microlite. Spodumene. Beryl. Amblygonite. Tantalite-columbite. Cassiterite. Microcline. Tourmaline. Apatite.	a. Q, Pg, L b. Pg, Q, L c. Pg, L d. L	 Q Pg, Q
10. Quartz (Q). Microcline (P).	Spodumene. Muscovite. Plagioclase. Apatite.	a. Q, P b. P, Q	
11. Microcline (P). Plagioclase (Pg). Lithia-Micas? (LiM). Quartz (Q).	Cassiterite. Apatite.	a. P, Pg, LiM, Q	
12. Quartz (Q).	Plagioclase. Beryl. Microcline. Muscovite	→a. Q	

[1] Page, L. R., and others, 1953.

The dominant units of zoned pegmatites in the Hyatt area consist of assemblages 3 and 4, or 3 and 12. The border zones are quantitatively insignificant; many have the composition of assemblage 1, and some, principally those in granite, are of assemblage 3. Many homogeneous pegmatites contain clots of perthite or quartz, or both, which may be regarded as incipient development of assemblages 3 and 4. The Hyatt pegmatite is the only body with more complex zoning and is considered separately.

Lithium minerals are not abundant in the district and, therefore, assemblages 5, 7, 8, 9, and 11 are not represented. The presence of trace quantities of lithium at the Hyatt, Big Boulder, and Buckhorn Mica pegmatites is indicated by minor amounts of Li-Mn-Fe phosphates and by relict spodumene; in these three bodies assemblage 6, plagioclase-quartz pegmatite, is well developed. This is the assemblage that Cameron and others (1949, p. 67–69, and table 5) list as a variant of plagioclase-quartz-spodumene pegmatite.

Fersman (1940) classifies pegmatites by the mineral assemblages (though they are not designated as such) and by the characteristics of certain diagnostic minerals. The individual groups are called "geophases" and labeled A to L. The paragenetic diagrams by Fersman (1940) and the illustrations and descriptions in reports by Tscherbakov,[5] Labuntzov (1939), and Sinegub (1943) show that essentially the same mineral assemblages found in American pegmatites are recognized in Russian deposits and in the same sequence as shown in table 6. The pegmatites of the Hyatt area have been assigned tentatively to Fersman's geophase E, the descriptive group, without accepting his genetic and geochemical-geophysical interpretation of that group.

FELDSPAR-RICH PEGMATITES

The average composition of the feldspar-rich pegmatites, type I of table 5, of the area approximates that of granite. This type has been subdivided into three classes in which the ratios of perthite to plagioclase are approximately 1:1, 3:2, and 2:1. The members of each class are distributed at random throughout the area, and there is no clear correlation between mineralogic composition of the pegmatites and structural control, beryl content, indices of refraction of beryl or plagioclase, accessory mineral content, country rock, or relation to intrusive masses.

The feldspar-rich pegmatites predominate in the area and exhibit the widest range in size and shape. Perthite makes up as little as 20 percent of the plagioclase-rich pegmatites and as much as 65 percent of the perthite-rich pegmatites. Plagioclase generally composes from 15 to 60 percent of the same types of deposits, and the quartz content ranges from 5 to 35 percent.

QUARTZ-RICH PEGMATITES

The quartz-rich pegmatites, type II, tables 5 and 17, are minor bodies rarely consisting of more than lenses of massive quartz containing scattered feldspar and muscovite crystals. Quartz-rich pegmatites are generally 6 inches to 3 feet wide and 5 to 85 feet long. They are more commonly concordant than discordant and consist of either single continuous bodies or closely spaced lenses separated by 1-inch to 2-foot schist partings. The largest of the quartz-rich pegmatites is pegmatite 1033 (pl. 3) which has an inferred length of 650 feet.

[5] Tscherbakov, D. I., 1936, Genetic types of berryllium deposits in the USSR: Redkie Metally [rare metals], v. 5, p. 35–41. [Translation, in files of U. S. Geol. Survey].

Quartz-rich pegmatites are gradational with the other types of pegmatites (table 5). Pegmatite 1023 is 55 percent quartz, pegmatite 1145 is 60 percent quartz, and pegmatites 525 and 598 are each 85 percent quartz; they comprise a connecting series between the feldspar-rich pegmatites and the typical quartz pegmatite containing over 95 percent quartz. Perthite and plagioclase are both common in quartz-rich pegmatites, but the proportions vary greatly. Only a few grains of feldspar and flakes of muscovite are identifiable in most pegmatites of this type.

Gradation between the quartz-rich and tourmaline-rich types of pegmatites is illustrated by pegmatites 260 and 404; both tourmaline and quartz are essential constituents, and perthite is an accessory constituent.

TOURMALINE-RICH PEGMATITES

The classification and interpretation of the tourmaline-rich pegmatites, type III in table 5, are much in doubt. They are poorly exposed and have a maximum width of 1 foot and a maximum inferred length of 30 feet. Only 3 pegmatites, 260, 398, and 404, are of mappable size; but about 5 other bodies are known. The tourmaline content ranges from 12 to 90 percent, and it may occur as a marginal or as a central segregation. In these bodies tourmaline is associated with quartz, with quartz and perthite, and with plagioclase, perthite, quartz, muscovite, and garnet (appendix B). There are all gradations in mineralogy from a typical pegmatitic assemblage to a quartz-tourmaline vein. The tourmaline-rich bodies may be classified either as variants of assemblages 1, 2, or 3 (table 6), in which the tourmalinizing and silicifying fractions that ordinarily escape and alter the wall rock were retained in the pegmatitic liquid, or as the early fugitive fractions from a granitic or pegmatitic magma that were concentrated and trapped as fillings of fractures. They also may be considered deposits transitional between pegmatites and hydrothermal veins; if so, they would be similar to the chalcopyrite-bearing tourmaline-quartz veins found near Pecos, N. Mex., described by Krieger (1932, p. 463); the tourmaline-rich silver, lead, and gold veins of the Helena region, Montana, described by Knopf (1913, p. 45–54); and the tourmaline-bearing tungsten veins of the Isla de Pinos, Cuba, described by Page and McAllister (1944, p. 177–246).

DESCRIPTIONS OF MINERALS

The minerals observed in the pegmatites of the Crystal Mountain area are described in their approximate decreasing order of abundance, and the properties of a group of minerals found in a miarolitic cavity are described at the end of the section.

Perthite, plagioclase, and quartz are the most abundant; muscovite is rarely an essential mineral; beryl, tourmaline, and garnet are the commonest accessory minerals, and apatite is less common.

Of the following rare minerals found in trace amounts, some are known in only one locality and others in eight: Biotite, columbite-tantalite, microcline, lithiophilite, triphylite, sillimanite, bismuthinite, hematite, magnetite, limonite, chrysoberyl, bertrandite, fluorite, and uraninite and related minerals. For convenience in reference the description of microcline follows that of perthite, and the description of biotite is included with that of muscovite, though both microcline and biotite are very rare in these pegmatites.

PERTHITE

Perthite is the dominant mineral in 85 percent of the pegmatites in the Hyatt area and is an essential mineral of assemblages 3 and 4 (table 6). The perthitic structure, an intergrowth of albite in microcline from which the name "perthite" is derived, is generally visible without the aid of a hand lens. The microcline ranges in color from milky white to deep salmon but is usually a dull pinkish white; the albitic stringers form an anastomosing network and are lighter in color than the microcline.

Perthite is an abundant and readily identifiable constituent of most pegmatites, both as small grains near the walls and large masses and aggregates in the interior. It is closely associated with quartz in most occurrences. Perthite is the principal constituent of the hood at the Big Boulder prospect, and it is the only essential constituent of the core of the Hyatt deposit, where it contains innumerable minute inclusions of muscovite, plagioclase, and quartz. Perthite grains range in size from microscopic (in border zones, banded pegmatites, and matrix) to large crystals up to 10 feet across. The mineral varies in abundance from less than 1 percent in some quartz pegmatites to about 96 percent in the core of the Hyatt pegmatite.

In zones where both perthite and plagioclase are essential minerals, perthite is almost invariably more abundant in the upper part of the zone than in the lower part. The causes or methods of this segregation have not been determined, but it is a widespread phenomenon, recognized in other districts by Cameron and others (1945), Jahns (1946), Cameron and others (1949), Page and others (1953), and Staatz and Trites (in press). Some zones of the explored deposits are divided into an upper perthite-bearing zone and a lower plagioclase-rich zone. (See pls. 10, 12, and 13.) The upward segregation of perthite is not confined to the wall zones; the formation of a perthite-rich hood, such as that of the Big Boulder deposit (pl. 12) is another example of the same phenomenon wherein the potash feldspar of an interior zone is segregated toward the top or roof of the pegmatite. Another example is the perthite-rich outer intermediate zone of the Hyatt pegmatite (pl. 10), which is developed only on the hanging-wall side of the deposit. Page and others (1953) and Staatz and Trites (in press) describe similar perthite occurrences.

Graphic intergrowths of perthite and quartz are common in many pegmatites but never abundant in any of them. It is not recorded separately in appendix B because graphic granite does not seem to have any consistent relationship to the composition or structure of the pegmatites in the Crystal Mountain district.

MICROCLINE

Nonperthitic microcline has been recognized only in a few scattered occurrences. It occurs as a few light-salmon grains about 1 inch in diameter in the plagioclase-quartz pegmatite of the lower wall zone from diamond-drill hole BB–5 in the Big Boulder pegmatite. Only a small part of the grains exhibit gridiron twinning, and the indices of refraction are somewhat lower than for most specimens: the beta index, determined by W. T. Pecora, of the U. S. Geological Survey, is 1.519.

Microcline is an essential constituent of assemblages 10 and 11 (table 6) and is present in assemblage 5 in some pegmatites. However, assemblages 5, 10, and 11 are directly related to lithium-rich units. The Crystal Mountain district is a lithium-poor region, and microcline is not found as an essential mineral. In its few occurrences it constitutes only a rare accessory mineral.

PLAGIOCLASE

Although plagioclase is the dominant feldspar in the 144 pegmatites of type IA (table 5 and appendix B), it is less abundant in the district than perthite. It is milky white to pale pink and generally shows polysynthetic twinning under the hand lens. The grains are usually smaller than those of the associated perthite and quartz, even where plagioclase is the most abundant mineral, and it is found more as groundmass and interstitial material than as distinct crystals or aggregates. Plagioclase forms small equidimensional grains in most pegmatites, but in some bodies the grains become elongate and platy toward the center of the deposit. In the central units of the larger zoned deposits, the plates become well formed and as much as 8 inches long; the name cleavelandite is applied to this variety of plagioclase. Plagioclase is a persistent associate of muscovite and beryl and can be found around or intergrown with them wherever they occur.

The ranges in indices of refraction and composition of 237 plagioclase specimens from the Hyatt area are given in figure 5. The determinations are of the minimum index of refraction (N_2) on (010) cleavage fragments. The ratio of albite to anorthite is taken from a

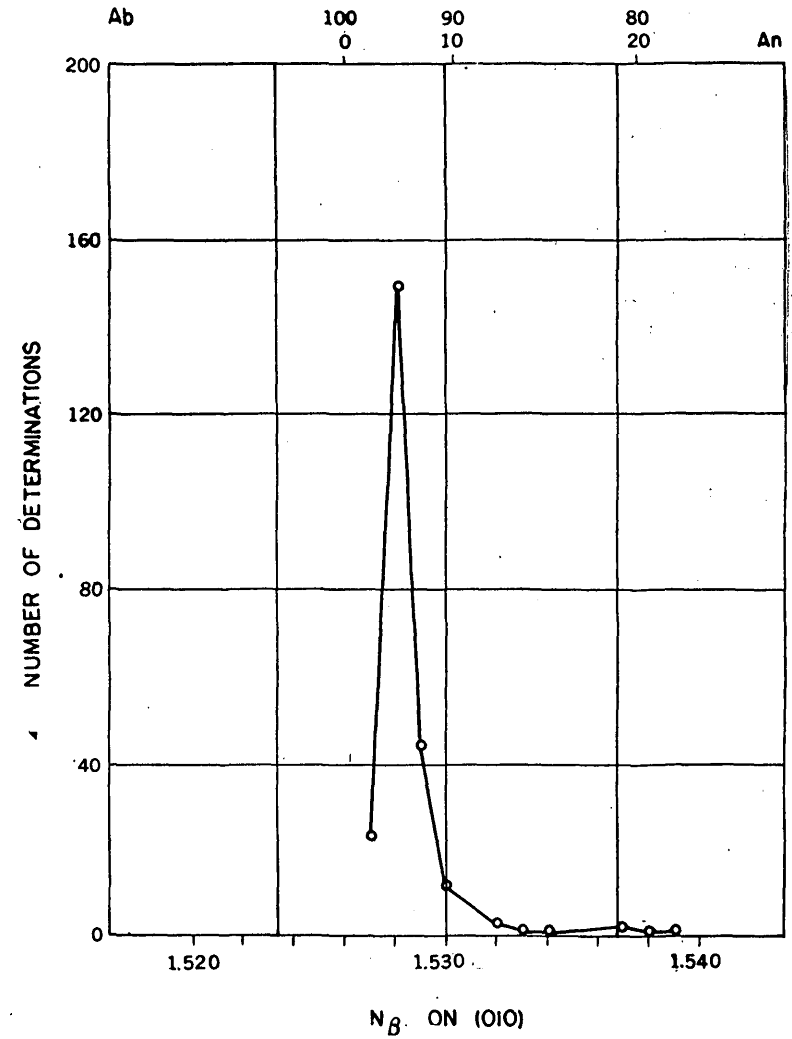


FIGURE 5.—Distribution of plagioclase indices.

table by Grout (1932, p. 468) which correlates the variation in index of refraction with changes in composition. The composition ranges from Ab_{78} to Ab_{99}, but 91 percent of the determinations are between Ab_{94} and Ab_{99}. The cleavelandite variety of albite has a compositional range of Ab_{94} to Ab_{99}.

The writer has attempted, without success, to correlate the variations in composition of the plagioclase in the Hyatt area with (1) the composition of the enclosing pegmatite, (2) the structural position of the pegmatite, (3) the type of country rock, (4) distance from the granite masses, and (5) association with other minerals, especially beryl. The range of composition of the majority of specimens is so limited that no systematic variation is discernible, and the few specimens with compositions outside the dominant range are scattered seemingly at random throughout the area.

Several hundred determinations of index of refraction of plagioclase from the drill cores are not included in figure 5. The exploration furnished 14 excellent cross sections through three well-zoned deposits. The composition in these bodies ranges from Ab_{92} to Ab_{99}, with an average of about Ab_{96}. The composite results for the three deposits show a slight decrease in the anorthite content from the wall to the core of the pegmatite. Several holes show no systematic change in index, and in others the change is confined to the outermost few feet of the pegmatite.

Plagioclase is the dominant mineral in the lower part of the wall and intermediate zones of the Hyatt, Big Boulder, and Buckhorn Mica pegmatites. Cleavelandite is an essential constituent of the core and inner intermediate zone of the Buckhorn Mica deposit and the lower intermediate zone of the Big Boulder pegmatite. The abundance of plagioclase is not easily determined in all outcrops. Because the plagioclase grains are generally smaller than their associates, they weather more rapidly and form hollows that are invariably stained and crusted; and masses of the mineral, even where large, are not conspicuous beside perthite and quartz. Plagioclase and quartz are found in graphic intergrowth in many small areas and in places make up sizable parts of a zone, as in drill hole BB-5, Big Boulder prospect, where the inner part of the plagioclase-quartz pegmatite contains 7 feet of rock of which about half is composed of graphic material.

QUARTZ

Quartz is the dominant and in some places almost the only mineral in the quartz-rich pegmatites, but in the other types it is subordinate to the feldspars. Quartz, as milky-white to light-gray anhedral grains, most commonly forms from 5 to 35 percent of the pegmatite. Glassy chips are not common, and according to Hanley, Heinrich, and Page (1950, p. 95), even the clearest material at the Crystal Silica property (fig. 1) is slightly milky. Smoky to black quartz is found in contact with radioactive minerals.

Quartz ranges in size from microscopic grains in border zones and interstices between other minerals to large masses in the interior zones. The difficulty in recognizing the precise boundaries of anhedral grains precludes giving exact measurements, but continuous masses (that may be aggregates of grains) of quartz are as much as 5 feet across in the core of the Big Boulder pegmatite. The perthite core of the Hyatt deposit contains, in addition to minute inclusions of quartz, rounded masses as much as 1½ feet wide and 4 feet long.

Some of the quartz in the perthite-quartz pegmatite of the hood in the Big Boulder pegmatite has the appearance of a "quartz breccia" with a perthite matrix. This "breccialike" material occupies irregular but somewhat rounded areas 1 to 6 feet in cross section. There is no continuity between the areas nor any semblance of alinement or planar arrangement to suggest that it is a tectonic feature. The quartz is separated by a network of irregular fractures into sharply angular fragments, the pieces gradually increasing in size so that the "breccia" grades outward into normal massive quartz cut by a few joints and fracture planes. The central parts are made up of dark-gray pieces ranging in size from 0.01 to 0.2 inch, the color becomes lighter as the fragments increase in size. The dark color of the quartz suggests that radioactive minerals might be present and that perhaps the fracturing might be related to their presence. The interstices are filled by material that would normally be available during crystallization but not likely to be transported into the fractures after consolidation of the hood.

MUSCOVITE AND BIOTITE

Muscovite is a minor, but universal, constituent of pegmatites in the Crystal Mountain district. Despite the abundance of biotite in the related granite intrusives and in the schist wall rock, it has been found in trace quantities in only three bodies, pegmatites 1014, 1225, and 1244. The Crystal silica pegmatite described by Hanley, Heinrich, and Page (1950, p. 93–96) contains both muscovite and a mass of lodestone of large but undetermined size, but no biotite is found. Staatz and Trites (in press) found that biotite supersedes muscovite in the Quartz Creek district as the iron content of the pegmatites increases and magnetite becomes an accessory mineral.

The principal deposit of muscovite in the Crystal Mountain district is in the outer intermediate zone of the Buckhorn Mica pegmatite. It has been described by Sterrett (1923, p. 59–60) and Hanley, Heinrich, and Page (1950, p. 88–90) and is reported to have yielded some sheet mica, but most of the muscovite is suitable only for grinding. About 30 tons of scrap mica is reported to have been mined from the inner intermediate zone of the Hyatt deposit. The books attain sizes as much as 15 inches long and 6 inches thick, but are wedge shaped and show ruling, "A" structure, and abundant mineral inclusions. The muscovite shoots are found in plagioclase-rich zones, but the pegmatites, as a whole, are rich in perthite and such deposits generally yield muscovite with little or no sheet mica, according to Cameron and others (1945, p. 383, 392) and Jahns (1951, p. 55). Bannerman (1943, p. 12) and Cameron and others (1945, p. 382) also note that beryl and phosphatic minerals are associated in many places with imperfect mica; beryl is a common associate of muscovite in the Crystal Mountain district.

In the majority of pegmatites mapped in the Hyatt area, muscovite ranges from microscopic size to three-quarters of an inch in diameter and rarely attains 2 inches. The average size is about a quarter of an inch. It rarely exceeds 1 percent of the pegmatite and is present in excess of 5 percent only in the two zones mentioned previously.

Muscovite is associated with tourmaline in fracture fillings in the Big Boulder pegmatite and in late networks of fine yellow and white scales, some of which are lithium-bearing. The lithium-bearing muscovite fills fractures cutting all previous structures and minerals and is interesting because of its relation to relict spodumene. The scales of fine mica are in large part slightly curved, and many of them have one index below 1.55, which, based on findings in South Dakota, is interpreted as indicating the inclusion of lithium in the composition of muscovite. Sericite present in a miarolitic cavity is described in a later section.

TOURMALINE

Columnar crystals of black tourmaline with well-developed prism faces are present in the schists, granites, and pegmatites of the Crystal Mountain district. The tourmaline crystals range from microscopic in size to a maximum of 4 inches in length, but the tourmaline in pegmatites of type III (table 5 and appendix B) occurs in masses as much as 4 by 4 by 6 inches in size. Much of the tourmaline in the schist and granite is derived from solutions escaping from the pegmatites, but some of it is native to the country rock. In granite the tourmaline of replacement origin is markedly poikilitic and 10 to 100 times larger than the minute delicate needles of primary crystallization. Tourmaline in the schist is commonly alined in the plane of foliation, and in some places there is a linear parallelism concordant with drag folds and other lineation. Crystals in the country rock do not exceed three-fourths of an inch in length, and the individual crystal invariably has parallel sides. Tourmaline in pegmatites generally forms long columnar crystals, but a number of irregular skeletal and tapering crystals have been found. (See pl. 8.) One tapered crystal, about 3 inches long, measures a quarter of an inch in diameter at one end and 1 inch at the other and contains veins and inclusions of groundmass material. A small pegmatite 3 feet southwest of pegmatite 137 is only 5 inches wide, but contains tourmaline crystals as much as 2½ inches long and 1½ inches in diameter which are uniformly oriented normal to the walls of the body.

Tourmaline in pegmatites of type III (table 5 and appendix B) constitute 12 to 90 percent of the rock, and in altered wall rocks it comprises as much as 40 percent of the schist. Tourmaline grains observed in the drill core of the Hyatt and Big Boulder deposits indicate that this mineral is present in all zones, including the quartz core. Tourmaline and muscovite fracture fillings occur in the Big Boulder pegmatite. Tourmaline also was found in a miarolitic cavity.

BERYL

The Crystal Mountain district is one of about a dozen beryl-rich pegmatite areas in the country, and the present larger study was made primarily to determine the distribution and quantity of beryl. Beryl occurs as an accessory mineral only in the pegmatites; none has been recognized in the granites or schist, though spectrographic assays indicate the presence of traces of beryllium in the wall rocks of the three explored deposits (table 13). Beryl is widely distributed throughout the area in pegmatites that contain from traces to about 2 percent. It occurs in homogeneous and banded as well as zoned pegmatites but has not been found in quartz pegmatites or tourmaline-quartz pegmatites of the Hyatt area. Its general associations do not seem to preclude the possibility that better exposure or more extensive examination of these bodies might disclose the presence of beryl.

Beryl is difficult to recognize in many parts of the Crystal Mountain district. It is usually a dull greenish gray to light bluish green, but white, yellowish, and blue varieties have been found. Beryl associated with lithium-bearing minerals is a dull-white mineral that is particularly difficult to distinguish from milky quartz and feldspar. Only two tiny, greatly fractured chips of clear aquamarine-blue beryl were found. Crystals of a wide variety of shades of blue green occur in close proximity, and there is no discernible external control of the color. Fersman (1940, p. 97–98) states that this pale grayish- and bluish-green beryl, distinct from the yellow, golden, brown, rose, green, and aquamarine varieties, is typical of the beryl of his "geophase E."

Beryl generally forms euhedral crystals on which the only common face is the hexagonal prism (110), but anhedral grains have been found in many bodies and are especially abundant in the zoned deposits (figs. 7–12, 21, 22, and 23–27). Commonly, the prismatic crystals are tapered, in some places producing strikingly conical shapes. In other places crystals are broken along the basal cleavage and the parts recemented with the enclosing minerals. One specimen exhibits a series of steplike offsets along the basal cleavage, similar to that described by Johnston (1945, p. 1032–1033). Such beryl indicates movement within the pegmatite after the formation of that particular crystal but before complete crystallization of the material forming the nearby groundmass.

The largest beryl crystal found in a homogeneous pegmatite or the wall zone deposits of zoned pegmatites was 8 inches long and 3 inches in diameter, but the common range is from 0.01 to 2 inches. The beryl grains are considerably larger in interior zones: in the inner intermediate zone of the Hyatt pegmatite, the range is from 2 inches to 5 feet; the average is about 1 foot. One beryl crystal at the Big Boulder prospect, mined from the inner side of the hood, as reconstructed from the weight, the known depth of the pit, and part of the cast of the crystal remaining in the rock, was approximately 6 to 7 feet long and 1.8 feet in average diameter. It is also reported that the crystal tapered towards both ends. The other minerals in the associated perthite-quartz pegmatite are as much as 6 feet in cross section, so the size of the beryl crystal was proportional to the surrounding crystals.

In zoned pegmatites the plagioclase- and muscovite-rich units are the most likely to be beryl-bearing, though other units may contain beryl if the deposit is beryl-rich. Even in homogeneous pegmatites the plagioclase- and muscovite-rich areas in or surrounding the clots or cores of perthite and quartz are more likely places to find beryl than in the clots themselves. No beryl is exposed in the Hyatt deposit in either the perthite of the core or the perthite-quartz pegmatite of the outer intermediate zone, although the spectrographic assays (figs. 15 and 16) indicate the presence of a small percentage of BeO. The beryl-bearing hood of perthite-quartz pegmatite in the Big Boulder deposit contains interstitial plagioclase and muscovite. Most beryl contains abundant inclusions of plagioclase, muscovite, quartz, and perthite and, in addition, a thin layer of fine-grained muscovite may coat the crystal.

The theoretical formula of beryl, $Be_3Al_2(SiO_3)_6$, contains 14.0 percent BeO, but natural beryl contains varying amounts of Na_2O, Li_2O, Cs_2O, and combined water. Unpublished studies by W. T. Schaller, of the Geological Survey, show that the indices of refraction of beryl increase as the alkali content increases. The increase in alkali is made almost entirely at the expense of beryllium, so the variation in the omega index of refraction is also a measure of beryllium content. The results of almost 300 determinations of the omega index and corresponding BeO content of beryl from pegmatites in the Hyatt area are shown in figure 6. The dotted line superposed on the distribution graph represents the symmetrical curve that could be derived by smoothing out the irregularities in the graph of actual determinations. It is the sort of curve produced by deviations which are free to fall in either direction from a mean value. The curve indicates that the beryl of the Hyatt area contains an average of about 13.4 percent BeO, but no attempt has been made to confirm

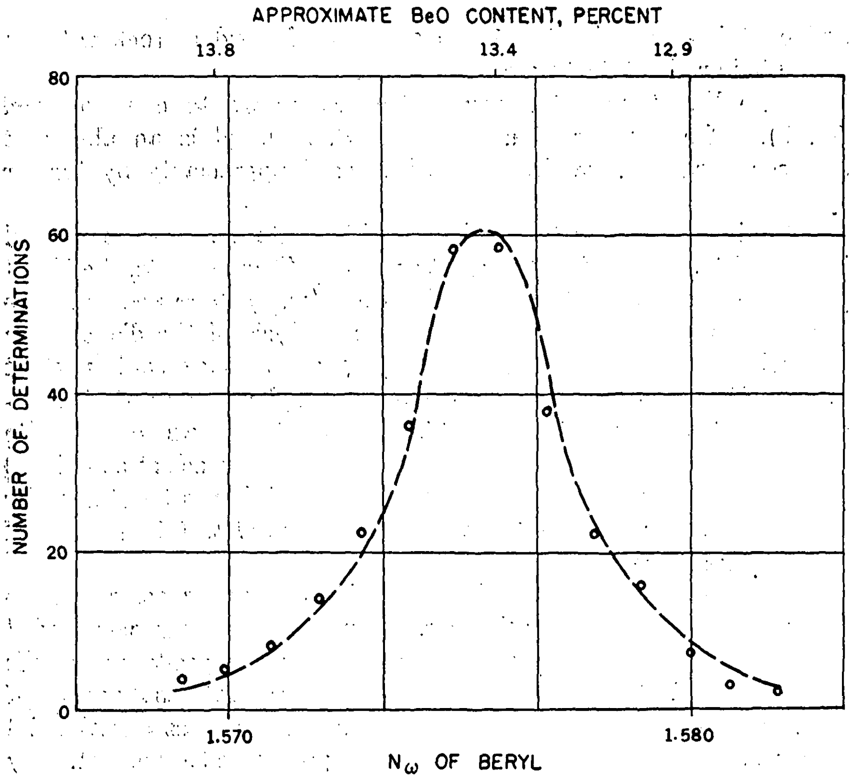


FIGURE 6.—Distribution of beryl indices.

the average by analysis of a composite sample. The geographic position and index of each specimen, plotted in plate 6, show a systematic distribution of the variations in alkali and beryllium ratio that can be contoured with relatively smooth lines. The highest indices are in the areas of the two large granite masses and in the vicinity of the Hyatt pegmatite where there are two small pluglike masses of granite.

A high proportion of pegmatites in the Crystal Mountain district contain beryl as an accessory mineral, the abundance in different bodies ranging from about 2 percent in a particular zone to a single crystal in an entire pegmatite. Commonly several crystals or grains occur in close proximity even in small bodies; therefore, an arbitrary distinction has been made between a "rare accessory" and an "abundant accessory." If the estimated beryl content is less than 0.01 percent it is considered a rare accessory and reported in appendix B as a trace amount. If the estimated quantity of beryl contained in a pegmatite is less than 1 ton it is not considered a potential source of the mineral. The beryl resources considered in tables 7 and 8, therefore, represent the deposits where beryl is an abundant accessory, and contains an estimated 1 ton or more of beryl in rock with an estimated grade of 0.01 percent or more.

In the Hyatt area 350 pegmatites are known to contain beryl (pl. 7). The number of deposits in which beryl is an abundant accessory probably would not be increased appreciably by further search.

A total of 77 pegmatites (tables 7 and 8) contain over 1 ton of beryl in rock with a grade of 0.01 percent or more. Two deposits, the Hyatt pegmatite and the small body to the south (pl. 2), were known before the present study was undertaken. An analysis of the distribution of beryl deposits shows that the Hyatt pegmatite is the most important source of beryl in the area. Of the known beryl resources, 27 discordant pegmatites in schist contain 28 percent, 31 pegmatites in granite contain 62 percent, and 20 concordant pegmatites in schist contain 10 percent. The northern granite mass is much richer in beryl deposits than the southern mass—20 percent as compared to 0.05 percent of the beryl resources.

The three principal areas of granite, the two large masses and the plug which almost encloses the Hyatt pegmatite, are each surrounded by belts a thousand feet wide in which beryl deposits are small: the thousand-foot belt around the northern mass contains 2 percent of the beryl resources, the belt around the southern mass contains 0.3 percent, and the one around the Hyatt plug contains 0.4 percent. By contrast, the next thousand-foot belt, concentric to the first belt, contains, in the same order, 9 percent, 9 percent, and 6 percent of the beryl resources. The 13 deposits that are not within the masses and their concentric belts contain 11 percent of the resources of the area (table 7).

TABLE 7.—*Distribution of beryl with respect to granite intrusives in Hyatt area, Crystal Mountain district, Colorado*

Pegmatites	Percent of pegmatites	Percent of beryl resources
In granite mass:		
Northern mass	40	20. 0
Southern mass	1	. 05
Mass at Hyatt mine	1	42. 0
In 1,000-foot belt around mass:		
Northern mass	5	2. 0
Southern mass	1	. 3
Mass at Hyatt mine	3	. 4
In belt 1,000 to 2,000 feet around mass:		
Northern mass	25	9. 0
Southern mass	2	9. 0
Mass at Hyatt mine	8	6. 0
In the remainder of the area	13	11. 0

These comparisons suggest that beryl deposits occur with somewhat greater frequency in granite masses which contain both large and small pegmatites than in granite masses with only small pegmatites, that discordant bodies are more commonly beryl-bearing than concordant ones, and that beryl deposits are least abundant in pegmatites immediately adjacent to granite masses.

Next in importance to deposits in granite are the discordant pegmatites; the pegmatites concordant in schist are the least important group. The comparisons are given in table 8.

TABLE 8.—*Distribution of beryl-bearing pegmatites according to country rock and structure, Hyatt area*

Range of inferred resources (tons)	Pegmatites concordant in schist and isolated sills		Pegmatites discordant in schist		Pegmatites in granite	
	Number of pegmatites	Total beryl (tons)	Number of pegmatites	Total beryl (tons)	Number of pegmatites	Total beryl (tons)
1 to 5	12	25	10	32	16	38
5 to 50	7	171	15	323	11	145
More than 50	None	None	2	209	4	1,070

GARNET

Garnet is a common accessory mineral in the schist but is relatively uncommon in pegmatites and has not been found in the granite. The crystals in schist range from microscopic in size to one-quarter of an inch in diameter; the average is about 0.01 inch. The garnet in pegmatite has about the same average size, but crystals as much as 1¼ inches in diameter can be found in a few bodies. Most garnet crystals are reddish brown, but a few minute trapezohedral crystals are bright red and transparent. Garnet usually occurs in scattered groups of a few individual crystals and, more rarely, in rows near the pegmatite contact. Pockets ½ to 3 feet in diameter of closely packed euhedral to anhedral grains are found in the hood of perthite-quartz pegmatite at the Big Boulder deposit. The grains are as much as an inch in diameter, and heavily stained with manganese oxides. Associated with this garnet are quartz, muscovite, plagioclase, tourmaline, and iron and manganese phosphates.

The specific gravity of individual fragments was calculated from weighings on a Berman microbalance, and the specific gravities of entire suites of grains from single localities were obtained by use of the pycnometer. The microbalance indicates that the specific gravity of garnet varies within single layers of schist and within individual pegmatite outcrops. The overall range is from 3.72 to 4.31, but there is little correlation between the specific gravity of individual grains and the bulk specific gravity of entire suites. Records of previous determinations do not exceed 4.25, so it is assumed the higher readings signify the presence of heavy impurities. The results of 24 microbalance determinations are given in table 9; the compositions are stated in terms of the percentages of theoretical end members: pyrope ($Mg_3Al_2Si_3O_{12}$), almandite ($Fe_3Al_2Si_3O_{12}$), spessartite ($Mn_3Al_2Si_3O_{12}$), grossularite ($Ca_3Al_2Si_3O_{12}$), and andradite ($Ca_3Fe_2Si_3O_{12}$) (indicated by PY, AL, SP, GR, and AN, respectively). The compositions are approximate, and are taken from the data tabulated by Winchell (1947, p. 174–183).

TABLE 9.—*Approximate composition of garnet in Hyatt area*

[Manganese concentration in garnets: +, present; −, absent]

Pegmatite no.	Mn	Sp gr individual grain	Index of refraction	Proportion					Sp gr entire suite
				PY	AL	SP	GR	AN	
144	+	4.06	1.81			76	11	13	
185	+	3.80	1.81			30	35	35	
316	+	4.06	1.81			76	11	13	
397	−	3.86	1.81	33	38			29	
483	+	4.06	1.81			76	11	13	
495	+	3.75	1.81			21	41	38	4.10
584	+	4.07	1.81			77	10	13	} 4.22
584	+	3.77	1.805			26	38	36	
827	+	4.00	1.80			86	8	6	
863	+	4.22	1.81		36	64			4.06
972	+	4.15	1.81		20	77		3	
1050	−	4.06	1.81	21	71			8	
1054	−	3.95	1.81	28	53			19	
1068	+	3.72	1.81		15		48	37	3.90
1128	+	4.14	1.81	16	84				
1131	−	3.87	1.81	34	37			29	
1157	−	4.02	1.81	23	65			12	
1164	+	4.00	1.81			83	4	13	
1194	+	3.91	1.81			66	14	20	3.71
1201	−	4.14	1.81	16	84				
1285	+	3.98	1.805			82	7	11	
Unnumbered	+	3.94	1.81			72	10	18	
Schist	+	3.97	1.795	27	53			20	
Schist	−	3.87	1.81	34	37			29	

The index of refraction was measured by immersion in liquids of known index of refraction. A few indices are equal to 1.81, but most are slightly below 1.81 and above 1.805, and a few others are as low as 1.795.

The presence or absence of manganese was tested with borax beads. Garnets from some pegmatites contain manganese and others do not. Two specimens from pegmatite 584, selected from different parts of the body, indicate widely differing compositions. Many garnets from schist, not included in table 9, were tested for manganese; and the results were consistently negative. A thorough study of garnet compositions and their distribution will require much more extensive sampling.

APATITE

Deep-green, bluish-green, and lilac apatite has been found in the explored deposits and in pegmatites 807, 1212, and 1246 as grains ranging from 0.1 to 0.6 inch in diameter. Apatite is commonly dark and distinctive, but a few grains of light bluish-green material were mistaken at first glance for beryl, for example, in the outer part of the wall zone at the Big Boulder deposit. Lilac apatite occurs in the inner intermediate zone of the Hyatt deposit. It is a very rare constituent of the pegmatites and is recognized principally because of its distinctive color. Apatite is present also in a miarolitic cavity. Apatite is more abundant in the country rocks but is visible only under the microscope.

SILLIMANITE

The schist contains sillimanite in fine acicular crystals, but the only specimen found in pegmatite consists of a cluster of parallel columnar crystals 0.5 to 1.5 inches long and averaging 0.1 inch in diameter. The crystals are a translucent grayish white, have a vitreous luster, and are somewhat fibrous. Sillimanite is associated with quartz, plagioclase, muscovite, and perthite and occurs within 2 inches of the contact of pegmatite 1146. There are no indications that the sillimanite was derived by alteration of an argillaceous inclusion; if it is the result of contamination, the material was thoroughly digested before crystallization of the sillimanite and surrounding pegmatite.

LITHIOPHILITE-TRIPHYLITE

The phosphatic minerals lithiophilite and triphylite are end members of a continuous series between $LiMnPO_4$ and $LiFePO_4$. Ordinarily the phosphates of Fe, Mn, and Li are coated with dark-brown to dull-black products of oxidation and hydration. The alteration products constitute a number of minerals of which only purpurite is readily identifiable in the field. Members of the lithiophilite-triphylite series were found only in the three explored and one unexplored deposits.

A member of the lithiophilite-triphylite series was exposed in the upper part of the inner intermediate zone of the Hyatt pegmatite by mining operations in 1948. The fresh material is medium blue, and the lowest index of refraction is about 1.675. According to Winchell (1947, fig. 78, p. 150) this indicates an approximate composition of lithiophilite$_{80}$ triphylite$_{20}$. It is associated with quartz, pyrite, and lithia mica, and the aggregate forms blocky masses from 1–20 cubic inches. Cinnamon-brown lithiophilite-triphylite was found in the lower part of the inner intermediate zone of the Hyatt deposit. The beta index of refraction is about 1.69, indicating a composition of about lithiophilite$_{45}$ triphylite$_{55}$. It is estimated that the lithiophilite-triphylite content of the workings made in the inner intermediate zone in 1948 was of the order of 0.00X percent. Workings antedating 1948, yielded about 300 pounds of the brown to black altered material, and the content of that part of the zone may have been as high as 0.01 percent.

COLUMBITE-TANTALITE

A single block of rock found on the dump of the Buckhorn Mica mine contains more columbite-tantalite than has been found in the remainder of the Crystal Mountain district. The mineralogy of this sample indicates that it came from the core of the deposit. Three clusters of tabular crystals have an aggregate volume estimated to be about 11 cubic inches. The plates are from 0.01 to 0.23 inch thick, 0.2 to 3 inches long, and 0.1 to 2 inches wide. A block of what appears to be "massive" columbite-tantalite is about 1 inch by 1 inch by 0.7 inch. The Tantalum claim and the Crystal Silica claims described by Hanley, Heinrich, and Page (1950, p. 93–96, 98–99) and the Beryl No. 5 claim, the Big Boulder deposit, the Hyatt pegmatite, and two small bodies not included in the areas mapped contain from a single crystal to three crystals of columbite-tantalite. The mineral dimensions range as follows: 0.02–0.1 inch in thickness, 0.3-0.9 inch in width, and 0.5–1.1 inches in length. From determinations of specific gravity it is possible to estimate the Ta_2O_5 and Nb_2O_5 content of columbite-tantalite: specific gravity of specimens from the Crystal Mountain district ranges from 6.2 to 7.3, indicating a range in Ta_2O_5 content from about 39 to 76 percent and in the Nb_2O_5 content of from about 10 to 48 percent. A specimen from the Tantalum claim has the highest reported specific gravity and tantalum content (Hanley, Heinrich, and Page, 1950, p. 99). The columbite-tantalite content of the Buckhorn Mica pegmatite and the Tantalum claim deposit may amount to a few hundred pounds; however, the columbite-tantalite found in the other pegmatites is negligible.

BISMUTHINITE

Bismuthinite (Bi_2S_3) and its alteration product, bismutite, a bismuth carbonate, occur in the inner intermediate zone of the Hyatt pegmatite. The writer estimates the content in the zone exposed by mining in 1948 amounted to 0.00X percent. In one place the bismuthinite formed a matrix for large grains of perthite and quartz and filled fractures in other minerals. The main mass of bismuthinite was intergrown with plagioclase, muscovite, and quartz. The field determination of bismuthinite was verified chemically, and the bismutite was identified by J. J. Glass of the Geological Survey. The bismutite is very fine grained but has the following characteristics: some grains are isotropic and others biaxial negative; mean index of refraction of biaxial grains is 2.20; the mineral occurs as square plates, is yellowish to light green, gives positive bismuth test, and effervesces with acid. X-ray examination by J. M. Axelrod, of the Survey, confirms the identification. A related alteration mineral also has been found: it is a greenish gray, amorphous or cryptocrystalline bismuth carbonate.

It is reported that bismuth minerals were mined at the Crystal Silica property prior to 1900, but the amount and source are unknown.

URANINITE AND RELATED MINERALS

The inner intermediate zone of the Hyatt pegmatite contains uraninite and its alteration products in minute quantities. Smoky quartz and reddish-brown feldspar are found in the vicinity of radioactive minerals. It is reported that masses of uraninite as large as an inch in diameter were found in the inner intermediate zone when the deposit was first opened. Still visible are masses of quartz as much as 4 feet in diameter which darken inward (from gray edges to jet black centers) indicating that uraninite was once present. Fractures in the quartz contain scales and flakes of yellow autunite, gray metatorbernite, and orange gummite. A specimen from the mine dump contains a dozen grains of dull-black uraninite, ranging from 0.03 to 0.15 inch in diameter, embedded in perthite. Though not in actual contact with the uraninite, quartz grains in the specimen are black.

Autunite and gummite are present in pegmatite 824, but no uraninite is exposed.

Metatorbernite was identified in a specimen submitted to the U. S. Geological Survey Trace Elements Laboratory and is reported to have the following properties: radioactive and faintly fluorescent; small $2V$, uniaxial positive; beta and gamma indices of refraction close to 1.632; anomalous blue and purple interference colors in anisotropic sections; qualitative chemical tests show the presence of P, Cu, and U. It occurs as small green flakes.

No uraninite can be seen at the Big Boulder pegmatite, but the intermediate zone contains the alteration products and smoky to black quartz. The associations are similar in the two deposits. The zones contain beryl, scrap mica, phosphatic minerals, columbite-tantalite, smoky quartz, and perthite. The Hyatt deposit contains, in addition, bismuth minerals.

Despite the variety of uranium-bearing minerals in pegmatites, the total quantity of uranium obtainable from them is probably minor or negligible. The subject has been reviewed by Page (1950, p. 12-34).

The writer estimates that the uraninite content of the exposed parts of the intermediate zones at the Hyatt and Big Boulder deposits is of the order of 0.000X percent.

RELICT SPODUMENE

No unaltered spodumene has been found in the Crystal Mountain district, but there is evidence that spodumene crystallized in the interior zones of the Hyatt, Big Boulder, and Buckhorn Mica pegmatites. The spodumene was altered to an exceedingly fine-grained aggregate of albite and sericite which has preserved the lathlike shape and the lamellar structure parallel to the (100) face. Some pseudomorphs are 3 feet long and 2 to 4 inches thick. Spectrographic analyses of two specimens of the aggregate were made by A. T. Myers, Trace Elements Section, Denver Laboratory, U. S. Geological Survey. Each specimen contains lithium in the order of 0.X percent; the specimen from the Big Boulder pegmatite is slightly richer than the one from the Buckhorn Mica pegmatite.

The field relations indicate that, during the crystallization of the Big Boulder pegmatite, perthite crystallized in the outer and upper parts of the wall zones and as a hood in the intermediate zones, albite formed in these units (cleavelandite in the inner parts), and lithium crystallized as spodumene in the inner part of the intermediate zone. The spodumene, however, was not in equilibrium with the rest-liquid during later crystallization and was altered by reaction to albite and sericite. The resorbed lithium was redeposited, partly with iron and manganese phosphates as lithiophilite-triphylite and partly as a minor element in lithium-bearing muscovite and sericite.

The sequence at the Buckhorn mica pegmatite is similar, but simpler mineralogically. Albite and quartz grade inward into cleavelandite and quartz, and the spodumene that crystallized with cleavelandite and quartz was later altered by reaction; the freed lithium was incorporated in micas.

HEMATITE AND MAGNETITE

Hematite and magnetite were found in pegmatite 899. This quartz pegmatite contains tourmaline crystals, as much as 0.2 inch in diameter and 1.1 inches long, and one small mass of hematite and magnetite, 0.3 inch by 0.4 inch, and 0.03 inch thick. No feldspar or mica was found. Lodestone occurs intergrown with quartz and muscovite near the east margin of the quartz core of the Crystal silica pegmatite.

CHRYSOBERYL

Pegmatites 1039, 1148, 1155, and 1158 contain asparagus-green to yellowish-green chrysoberyl in plates, masses, and imperfect crystals. The crystals are found in groups of 3 to 8 per pegmatite and are 0.05

to 0.1 inch thick and 0.2 to 0.6 inch long. The chrysoberyl in pegmatite 1039 occurs in the core of perthite-quartz-plagioclase pegmatite. At the Beryl No. 5 prospect (fig. 1) a fracture in quartz is filled with many small plates of chrysoberyl which form an almost solid layer 0.02 inch thick, 4 inches long, and 2.5 inches wide. Many of the plates are stellate twins showing fine featherlike striations on the (100) face.

Chrysoberyl is a rare mineral in the Crystal Mountain district, but 5 miles to the north at the Wisdom Ranch prospect (S½ sec. 5, T. 7 N., R. 71 W.) described by Hanley, Heinrich, and Page (1950, p. 102–104) numerous plates and masses of chrysoberyl have been found; however, it is quantitatively rare, even at the Wisdom Ranch prospect.

MIAROLITIC MINERALS

An irregular miarolitic cavity in the Hyatt pegmatite contained a compact mass of a yellowish-green micaceous mineral and minute crystals of a variety of minerals. The cavity was about 0.4 inch in average diameter and occurred in a fine-grained aggregate of quartz, plagioclase, and muscovite that fill the interstices between large perthite masses. The material was identified by J. J. Glass, of the United States Geological Survey.

The micaceous material is sericite; and the associated minerals, in the order of their abundance, are bertrandite, apatite, fluorite, tourmaline, hematite, and limonite.

The sericite is dominantly platy, but a small portion is fibrous, has a waxy luster, and does not yield a lithium flame. It is biaxial negative, $2V$ variable from 30° to 70°, the finer grained material having the smaller optical axial angle. The gamma index is 1.577. A quantitative spectrographic analysis of the sericite, made by J. D. Fletcher, of the United States Geological Survey, is given in table 10.

TABLE 10.—*Quantitative spectrographic analysis of sericite from the core of the Hyatt pegmatite, Crystal Mountain district, Colorado*

[Plate examined for Ag, Mo, W, Ge, Pb, As, Sb, Zn, Cd, Tl, Co, Ni, V, La, Th, Nb, Ta, and U, but not found. J. D. Fletcher, spectrographer]

Constituent	*Percent*	*Constituent*	*Percent*
Be	0. 04	Ti	0. 02
Cu	. 002	Zr	. 0007
Sn	. 01	Sr	. 01
Bi	. 004	Ba	. 04
Mn	. 3	B	. 02
Ga	. 008	Fe_2O_3	. 3–0. 6
Cr	. 0002	CaO	. 1– . 3
Sc	. 001	MgO	. 1– . 3

The bertrandite is colorless, exhibits twinning, and has perfect cleavage in three directions. The mineral is biaxial negative, the angle $2V$ is 78° to 80°, extinction is parallel. The indices of refraction are N_α, 1.590; N_β, 1.603; and N_γ 1.614. Bertrandite is a rare hydrous beryllium silicate ($H_2O \cdot 4BeO\ 2SiO_2$).

The apatite has the properties of fluorapatite: uniaxial negative, specific gravity about 3.3; the pale-grayish, sapphire-blue fragments have indices of refraction $N\epsilon$, 1.630 and $N\omega$ 1.633, and the colorless fragments have indices $N\epsilon$, 1.632 and $N\omega$ 1.635.

Tourmaline is present as small columnar crystals on albite at the edge of the cavity. It is black in the hand specimen but brown to greenish gray in thin grains. It is uniaxial negative with the indices N_ϵ 1.626 and N_ω 1.646.

Hematite and limonite are present as crustlike specks on the cleavage planes of the albite and as pale-pink and pale-yellow stains throughout the specimen.

RELATION OF PEGMATITES TO WALL ROCKS AND STRUCTURE

WALL-ROCK ALTERATION

The alteration of schist and granite wall rock in contact with pegmatites of the Crystal Mountain district is in most places inconsequential. Black tourmaline has been added to schist and granite in quantities ranging from negligible to 40 percent; intense alteration is unusual and rarely extends more than 5 inches from the contact. Tourmaline crystals range from microscopic sizes to an inch in length. Intensely altered mica schist contains about 20 percent tourmaline. Tourmalinization decreases outward from the contact and disappears at a distance of about 2 feet. Because tourmaline is a common accessory mineral in some schist layers, as well as being widespread around most pegmatites, it has been recorded as a wall-rock alteration product only where it is especially concentrated. Bannerman (1943, p. 9) describes black tourmaline as a particularly common mineral in the contact zones in many districts in New Hampshire.

Tourmaline forms rosettes of acicular crystals in minute fractures between pegmatite and granite in the northern multiple granite sill. The needles are 0.1 to 1 inch long and as much as 0.05 inch in diameter, and the rosettes or clusters are no more than one-tenth of an inch thick. The tourmaline is attached to the pegmatite but not to the granite. Tourmaline rosettes have been found in only a few places; their exposure depends on fortuitous breakage.

The granite in contact with pegmatite is almost invariably silicified sufficiently to increase its resistance to erosion. The silicified wall rock forms low ridges flanking recessed pegmatites on the bare surfaces of the northern multiple sill. Narrow ridges of resistant granite are found along jointlike cracks which are in some places connected with pegmatites.

Granite and schist in direct contact with the Hyatt, Big Boulder, and Buckhorn Mica pegmatites were analyzed for BeO, and the determinations are given in tables 11 and 12. Most samples represent about 1 foot of rock at the pegmatite contact, but samples from drill holes HY-4, HY-6, BB-4, and BH-2 represent greater distances. The locations of the samples are given in figures 13-20 and 28-32. The range of BeO content in the granite is from a trace to 0.015 percent; the average of samples without visible alteration is 0.005 percent, and the average of all granite samples (table 11) is 0.007 percent. As the limit of accuracy of the analytical method is about ±0.001, there is no significant difference between the averages, and it is apparent that addition of BeO to granite is not important.

TABLE 11.—*BeO content of granite near Hyatt pegmatite, Crystal Mountain district, Colorado*

Drill hole	Sample no.	Footage	BeO content (percent) [1]	Material included in the granite
HY-1	C 223	56.8- 57.4	0.011	Few quartz veins and pegmatitic blebs.
HY-1	C 231	85.0- 95.0	.015	Aplite and pegmatitic stringers.
HY-2	C 201	104.0-104.9	.008	None.
HY-2	C 218	165.6-166.8	.009	Quartzose patches.
HY-3	C 175	131.8-132.5	.004	Pegmatitic blebs.
HY-3	C 200	209.6-210.6	.008	None.
HY-4	C 145	169.0-170.0	.009	None.
HY-4	C 159	213.4-214.5	.001	None.
HY-4	C 160	217.5-218.7	.009	Pegmatitic patches.
HY-4	C 163	220.9-221.8	.001	None.
HY-4	C 165	222.2-224.4	.01	Quartzose and pegmatitic patches.
HY-4	C 167	227.8-228.2	.001	None.
HY-4	C 173	234.3-235.0	.006	None.
HY-5	C 144	83.6- 85.0	.01	One slickensided quartz vein.
HY-6	C 123	54.0- 55.0	.0033	Quartz vein.

[1] Quantitative spectrographic analyses of C 123 and C 144 by Saratoga Laboratories, and the rest by National Spectrographic Laboratories.

The range of BeO content in altered schist at the contact with pegmatite is from a trace to 0.041 percent. Schist that is not visibly altered contains an average of 0.003 percent BeO. The average BeO content of all samples in table 12 is 0.008 percent. Pegmatitic stringers and impregnations add BeO to the schist, but there is no simple and consistent relationship between the addition of pegmatitic material and the beryllia content. The average of all schists, 0.008 percent, and of all granites, 0.007 percent, indicates that both types of country rock are about equally enriched in beryllia, though the content in the schist is more varied.

TABLE 12.—*BeO content of schist near the explored deposits, Crystal Mountain district, Colorado*

Drill hole	Sample no.	Depth (in feet)	BeO content (percent [1])	Nature of the schist
HY-1	C 222	55.0- 56.8	0.001	Granitized and pegmatitic.
HY-1	C 225	60.0- 62.0	.001	Pegmatitic impregnations.
HY-6	C 111	29.0- 30.0	.0180	Tourmalinized; weathered.
HY-6	C 113	34.0- 34.4	.034	Tourmalinized and silicified.
HY-6	C 116	39.2- 40.5	.0055	Do.
BB-3	C 110	82.4- 83.2	.0027	Not visibly altered.
BB-4	C 79	56.0- 57.0	.0027	Do.
BB-4	C 95	130.8-133.0	.0045	Pegmatitic stringers and blebs.
BB-4	C 96	133.0-134.1	.0088	Do.
BB-5	C 63	107.7-109.0	.0019	Not visibly altered.
BB-5	C 78	178.1-179.1	.0046	Do.
BH-1	C 56	72.5- 73.5	.0028	Do.
BH-2	C 40	84.0- 86.8	.041	Pegmatitic impregnations.
BH-2	C 41	86.8- 90.5	.0078	Not visibly altered.
BH-2	C 48	112.7-114.4	.015	Pegmatitic stringers and blebs.
BH-2	C 50	115.1-120.0	.0029	Do.
BH-2	C 55	132.0-133.2	.0038	Not visibly altered.
BH-3	C 26	64.0- 65.2	.0028	Tourmalinized.
BH-3	C 39	89.0- 90.0	.0021	Not visibly altered.
BH-4	C 11	17.8- 18.8	.0016	Tourmalinized.
BH-5	C 10	131.5-132.4	.0028	Silicified.

[1] Quantitative spectrographic analyses of C 222 and C 225 by National Spectrographic Laboratories and the rest by Saratoga Laboratories.

CONTROL BY WALL-ROCK STRUCTURES

PEGMATITES CONCORDANT WITH SCHISTOSITY

Pegmatites concordant with the foliation of the schist have simple lenticular shapes. The exact ends of concordant pegmatites are rarely exposed, but from the steady narrowing of the exposed parts of the bodies and the diminution of the size of float, it is inferred that the ends of the pegmatites are wedge shaped.

PEGMATITES DISCORDANT TO SCHISTOSITY

Pegmatites that are discordant to the foliation of the schist usually occupy simple fractures. The contacts may be irregular in detail, but the general shapes of the discordant pegmatites are remarkably regular in comparison with those in other districts. For abundant maps and descriptions of pegmatites of more complex shape, the reader should refer to papers by Bannerman (1943), Cameron and others (1949), Hanley, Heinrich, and Page (1950), Jahns (1946), Olson (1942), and Smith and Page (1941). Some of the more irregularly shaped bodies in the Hyatt area (pl. 2), such as pegmatites 448 and 645, are multiple bodies whose members are moderately straight and simple. The branching patterns of pegmatites 645, 673, 674, and 675 are produced by concordant offshoots of discordant bodies. Pegmatite 1108 follows intersecting fractures, and pegmatite 1045 is concordant in the eastern half and discordant in the western half. Irregular pregmatites 442, 463, 196, 248, 249, 898, and 900 have been but little eroded and might present more regular outlines if they were more completely exposed.

Pegmatite 432 seems to have been the feeder for the flat-lying pipelike body which constitutes pegmatite 430. Pegmatite 432 is a steeply dipping body that trends eastward; pegmatite 430 branches northward from pegmatite 432. The lower contact of pegmatite 432 is an irregular surface with an average southerly dip of 20°, exposed in small outcrops for 200 feet north of the junction. The structure controlling the emplacement of pegmatite 430 is not exposed, but it may have been the low-angle line of intersection of two nearly parallel joints with opposed directions of dip. Other pegmatites in the area show apophyses following planes of weakness that diverge from the structure localizing the main body: the southwestern end of the concordant branch of pegmatitie 645 follows a plane dipping 45°–55° NE.; the southwest-trending discordant branch of pegmatite 846 rests in part on a plane striking N. 70° W. and dipping 25° NE.; along the south side of pegmatite 695, the pegmatite bulges outward for a few inches to rest on a joint striking N. 31° W. and dipping 6° NE. in schist.

PEGMATITES FILLING JOINTS IN GRANITE

Pegmatites that occupy joints in granite are tabular bodies with straight courses and angular bends. Some joint-controlled pegmatites end abruptly and squarely against other joint surfaces, and some taper to a knife edge as the walls converge. Most joint-controlled pegmatites lose their identity in a network of other joint-controlled bodies. Pegmatites form a veritable maze of interconnected bodies at the western end of the northern multiple granite sill: in the western part (pl. 2) are shown all the pegmatites more than 5 feet in width and as many of the remaining bodies more than 1 foot wide as can be plotted at a scale of 1:6,000. Eastward from pegmatite 300, all bodies more than 1 foot wide and many of the persistent narrower ones are mapped. North and east of pegmatite 105, bodies less than 3 inches wide and less than 50 feet long are common but were not mapped.

The relation of many bodies to wall-rock structure is not apparent in the field and only those that are clearly joint-controlled are so designated in appendix B. The various networks of pegmatites centering around pegmatites 278, 375, 332, and 384 are similar to the more extensive and intricate networks made up of narrower bodies.

PEGMATITES PARALLEL TO FLOW STRUCTURE

Many pegmatites within granite sills are parallel to the flow structure or are along the hanging wall or footwall of the sills. These bodies have the same structural characteristics as pegmatites concordant with the schist. Pegmatites 85, 87, and 88 dip southward parallel to the footwall contact of the northern granite mass and give the impression of being concordant in the longitudinal fractures of marginal sills.

AMOEBOID PEGMATITES IN GRANITE

There are small irregular patches of pegmatitic material in parts of the large multiple granite sills that are not fracture controlled pegmatites. They are amoeboid in shape, with intricately embayed outlines and gradational contacts; but they are clearly fine-grained pegmatites. The material has the minerals typical of the granitic pegmatites of the district: perthite, plagioclase, quartz, and muscovite and contrasts sharply with the biotite granite host rock. These bodies range from a few inches to 2 feet in maximum width and from 1 to 5 feet in maximum length. They are not alined in any recognizable pattern with respect to the structure of the enclosing granite. Comparison of the mineralogy of the pegmatite with the host indicates that the pegmatitic material contains more plagioclase and muscovite, less potash feldspar, and no biotite or magnetite; the pegmatite therefore must have crystallized from material higher in alkalies and water and lower in iron than the surrounding granite.

These pegmatitic patches are so small, irregular, and rare that they are quantitatively unimportant, but they pose an interesting genetic problem. The writer interprets these pegmatitic patches as segregations of material rich in hyperfusibles which probably originated by differentiation of the granite after emplacement as a sill. The hyperfusibles apparently accumulated in pockets as the sill solidified. Irregular patches of this kind would correspond, according to this interpretation, to the early generation of pegmatites discussed by Grout (1932, p. 220–221). The origin proposed for these pegmatites is similar to that postulated by Kelley and Branson (1947, p. 708) for the pegmatites of Rabb Canyon, N. Mex.

CONTROL BY WALL-ROCK MINERALOGY

Six broad mineralogic types of pegmatites are recognized in the area, but no single type is restricted to any particular lithologic or structural environment. Garnet does not occur more abundantly in pegmatites under one condition than any other. The distribution of moderate to intense tourmalinization of country rock shows no preference for association with a mineralogic type of pegmatite. Tourmalinization does seem more prevalent in granite than in schist, but the writer hesitates to draw conclusions from this simply because tourmalinized granite is so much more striking to the eye than tourmalinized schist; equivalent tourmalinization in schist might go unrecorded, particularly because the granite is usually better exposed than schist. Only beryl exhibits a discernible preference in distribution. It is slightly more abundant in discordant than in concordant pegmatites in schist and is found in more deposits away from the large multiple granite sills than immediately adjacent to them. (See table 7.)

Throughout the Georgetown quadrangle, Ball (1908, p. 64) finds a fairly constant relation between the mineralogy of the country rock and that of the pegmatites. There are many exceptions, but the following correspondence is noted:

1. Biotite-bearing pegmatites are mostly in biotite-bearing older granites.
2. Hornblende-bearing pegmatites are chiefly in quartz diorite and hornblende gneiss.
3. Muscovite-bearing pegmatites occur mostly in the Idaho Springs formation.
4. Pegmatites in quartz monzonite areas are characteristically without ferromagnesian minerals, and many of them contain, instead of an alkali feldspar, a soda-lime feldspar.
5. Allanite-bearing pegmatites are conspicuous in allanite-bearing quartz monzonite. Ball (1908, p. 64) concludes that in the Georgetown area the pegmatite fluid abstracted, prior to solidification, sufficient material from the enclosing rock to modify the chemical composition of the pegmatite. Ball infers that magnetite was an original constituent of the pegmatite magma because it alone of the ferromagnesian constituents of the pegmatites is not influenced by the rock intruded. In the Montezuma quadrangle Lovering (1935, p. 15–16) found the same general relationship between the composition of the country rock and the pegmatites; he adds that quartz-sillimanite-tourmaline-bearing pegmatites occur in quartz-sillimanite-tourmaline-bearing schist. Lovering describes a pegmatite transgressing the contact between biotite granite and muscovite schist: the pegmatite contains biotite between granite walls, muscovite between schist walls, and both biotite and muscovite in the vicinity of the contact between granite and schist.

The sills of Mount Olympus granite in the Hyatt area are everywhere rich in biotite despite their irregularities in texture, fabric, and color. The schist contains biotite in all exposures. With three minor exceptions muscovite is the only mica in the pegmatites. No biotite has been found as an essential constituent or even as an important accessory in any deposit. Sillimanite is a common minor accessory in the schist, but only one small cluster of sillimanite (in pegmatite 1146) has been found. Garnet and tourmaline are common accessories in the schist and are abundant in and near pegmatites; tourmaline, at least, is native to the granite; therefore, these minerals do not offer a means of correlating mineralogy of pegmatite with wall rock. The widespread tourmalinization of granite and schist and the moderate silicification of granite indicate that solutions escaped from the pegmatite magma and contributed material to the country rock, but the compositions of the pegmatites do not indicate significant or even any detectable assimilation of wall rock.

MINOR ELEMENTS IN WALL ROCKS

Analyses of 24 samples of wall rock show small but generally consistent amounts of rare elements. In the course of the exploration, the drilling of some holes furnished cores of virtually unweathered granite and schist. Samples of wall rock for spectrographic analyses were cut from cores at the Hyatt, Big Boulder, and Buckhorn Mica deposits. Each sample is half of the drill core split from a 5-foot section; the sections are taken at 15-foot intervals from the pegmatite contact but do not include wall rock within 10 feet of the pegmatite. The positions of the 24 wall rock samples are marked in figures 13, 14, 19, 20, 28, and 30, and the semiquantitative spectrographic analyses are given in table 13.

The analyses indicate that the granite contains small and erratic quantities of silver, molybdenum, and a trace of bismuth not found in the schist; and the schist contains small but consistent amounts of yttrium and lanthanum not present in the granite. The schist is also richer than the granite in cobalt, chromium, vanadium, zirconium, boron, and magnesium. The granite seems to have a somewhat greater amount of lead, calcium, strontium, and barium. The differences, however, are not striking and are no more than one unit in the order of magnitude scale. In samples taken more than 10 feet from the contact, there is no indication of a systematic increase or decrease in the content of any component in either the schist or the granite outward from the wall of the pegmatite.

If there were such systematic variations, it might indicate that the emplacement and crystallization of the pegmatite had effected some changes in the surrounding rock by the addition or subtraction of material. The absence of discernible systematic variation means that either the contact aureole is so large that the samples represent rocks that have been affected equally, or the wall rocks have been so little altered chemically that the change is not detectable with the methods used. The first alternative seems so improbable that the writer believes the analyses in table 13 are truly representative of the trace elements in the normal country rock at each deposit. If there is a contact aureole, it must extend less than 10 feet from the pegmatite.

TABLE 13.—*Semiquartitative spectrographic analyses of wall rock of explored deposits, Crystal Mountain district, Colorado*

[J. D. Fletcher, spectrographer]

Property and location	Wall rock	Drill hole	Depth (in feet)	Sample	Constituents [1] (percent)										
					BeO[2]	Cu	Ag	Mo	Pb	Bi	Mn	Co	Ni	Fe_2O_3	Ga
Hyatt pegmatite, NE¼ NW¼ sec. 28, T. 6 N., R. 71 W.	Biotite granite	HY-1	100 -105	C232	0.001	0.00X	--------	--------	0.000X	--------	0.0X	0.000X	0.00X	1-3	0.00X
			30 - 35	C233	.001	.00X	--------	--------	.000X	--------	.0X	.000X	.000X	1-3	.00X
			10 - 15	C234	.001	.00X	0.0000X	--------	.00X	--------	.0X	.000X	.00X	1-3	.00X
		HY-2	30 - 35	C235	.001	.00X	--------	--------	.000X	--------	.0X	.000X	.000X	1-3	.00X
			50 - 55	C236	.001	.00X	0.0000X	0.00X	.00X	--------	.0X	.000X	.00X	1-3	.00X
			70 - 75	C237	.001	.00X	--------	--------	.000X	--------	.0X	.000X	.000X	1-3	.00X
			90 - 95	C238	.002	.00X	--------	--------	.000X	--------	.0X	.000X	.00X	1-3	.00X
			110.2-115.2	C239	.001	.0X	--------	.00X	.00X	--------	.0X	.000X	.00X	1-3	.00X
			130.2-135.2	C240	.001	.0X	.000X	.00X	.00X	0.00X	.0X	.000X	.00X	1-3	.00X
			150 -155	C241	.001	.00X	--------	.00X	.00X	--------	.0X	.000X	.000X	1-3	.00X
Big Boulder prospect, SE¼ sec. 36, T. 7 N., R. 72 W.	Quartz-mica schist.	BB-4	16 - 21	C242	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			36 - 41	C243	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
		BB-5	7 - 12	C244	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			27 - 32	C245	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			47 - 52	C246	--------	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			67 - 72	C247	.001	.0X	--------	--------	.000X	--------	.0X	.00X	.00X	3-6	.00X
			87 - 92	C248	.001	.0X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
Buckhorn Mica mine, SW¼ sec. 29, T. 7 N., R. 71 W.	do	BH-1	12 - 17	C249	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			32 - 37	C250	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			52 - 57	C251	--------	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			107 -110	C252	.003	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
		BH-3	7 - 12	C253	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			27 - 32	C254	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X
			105 -110	C255	.001	.00X	--------	--------	.000X	--------	.0X	.00X	.00X	1-3	.00X

[1] Plate examined for Ge, Sn, As, Sb, Zn, Cd, Tl, Nb, and Ta, but not found.
[2] Approximate BeO content determined on plates exposed for general scanning and not for precise determination of BeO alone.

TABLE 13.—*Semiquantitative spectrographic analyses of wall rock of explored deposits, Crystal Mountain district, Colorado*—Continued

[J. D. Fletcher, spectrographer]

Property and location	Wall rock	Drill hole	Depth (in feet)	Sample	Constituents [1] (percent)										
					Cr	V	Y	La	Ti	Zr	CaO	SrO	Ba	MgO	B
Hyatt pegmatite, NE¼ NW¼ sec. 28, T. 6 N., R. 71 W.	Biotite granite	HY-1	100 -105	C232	0.00X	0.00X	--------	--------	0.0X	0.00X	1-3	0.0X	0.0X	0.1-.3	0.00X
			30 - 35	C233	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			10 - 15	C234	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.0X	.1-.3	.00X
		HY-2	30 - 35	C235	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			50 - 55	C236	.0X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			70 - 75	C237	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			90 - 95	C238	.0X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			110.2-115.2	C239	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.X	.1-.3	.00X
			130.2-135.2	C240	.0X	.00X	--------	--------	.X	.00X	1-3	.0X	.0X	.1-.3	.00X
			150 -155	C241	.00X	.00X	--------	--------	.X	.00X	1-3	.0X	.0X	.1-.3	.00X
Big Boulder prospect, SE¼ sec. 36, T. 7 N., R. 72 W.	Quartz-mica schist.	BB-4	16 - 21	C242	.0X	.0X	0.00X	0.00X	.X	.0X	.1-.3	.00X	.0X	.3-.6	.0X
			36 - 41	C243	.0X	.0X	.00X	.00X	.X	.0X	.1-.3	.00X	.0X	.3-.6	.0X
		BB-5	7 - 12	C244	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	.3-.6	.0X
			27 - 32	C245	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	.3-.6	.0X
			47 - 52	C246	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	.3-.6	.0X
			67 - 72	C247	.0X	.0X	.00X	.00X	.X	.0X	.6-1	.00X	.0X	1-3	.0X
			87 - 92	C248	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	1-3	.0X
Buckhorn Mica mine, SW¼ sec. 29, T. 7 N., R. 71 W.	do	BH-1	12 - 17	C249	.0X	.0X	.00X	.00X	.X	.0X	.1-.3	.00X	.0X	1-3	.00X
			32 - 37	C250	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	1-3	.0X
			52 - 57	C251	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	1-3	.00X
			107 -110	C252	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	1-3	.0X
		BH-3	7 - 12	C253	.0X	.0X	.00X	.00X	.X	.0X	.6	.00X	.0X	1-3	.00X
			27 - 32	C254	.0X	.0X	.00X	.00X	.X	.0X	.6	.00X	.0X	1-3	.00X
			105 -110	C255	.0X	.0X	.00X	.00X	.X	.0X	.3-.6	.00X	.0X	1-3	.0X

[1] Plate examined for Ge, Sn, As, Sb, Zn, Cd, Tl, Nb, and Ta, but not found.

AGE RELATIONS OF PEGMATITES

The sills of Mount Olympus granite were intruded over a period of time, probably from a magma source to the south that might have been subsidiary to the Pikes Peak granite. Minor variations in composition of the granite, major variations in its texture and fabric, and the structural relations of the sills to the schist and to each other are evidence that the sills were emplaced as successive injections. Quartz veins, less than 3 inches in width and not more than a few tens of feet in length, were deposited in fractures that formed late in the cooling history of the sills. After the granite was well crystallized, joints developed which in some places cut across the margins between members of the multiple intrusives and across the contacts between schist and granite. Pegmatites were emplaced in the joints, the walls moving apart so as to cause a few inches of displacement of the quartz veins.

The pegmatites were also emplaced over a period of time. The mineralogic types, limited in number as they may be, correspond to the progressive changes in composition of a granitic magma during crystallization. The mineralogic types are unsystematically intermingled throughout the area, apparently indicating that the pegmatitic materials were fed sporadically into the area from an underlying source of magma undergoing fractional crystallization. From the relations in the Georgetown area, Ball (1908, p. 64) concluded that the pegmatite magmas left the cooling mass of granite at widely differing times and themselves differed from each other in chemical composition. Lovering (1935, p. 15), states that the structural relations of the pegmatites to each other and to other rocks in the Montezuma quadrangle indicate that their intrusion took place over a long period. Few of the intersecting pegmatites in the Hyatt area show conclusive age relations. Pegmatite 1192 is younger than the northwest branch of pegmatite 1197 and is probably younger than pegmatites 1190, 1191, and 1193 (pl. 2). Pegmatites 117 and 116-b are parallel; they are cut by pegmatite 116-a. Pegmatite 263 is a multiple body, made up of an anastomosing network of pegmatites 2 to 18 inches thick; it intersects several pegmatites, but only its relative age with pegmatite 264 can be determined. Pegmatite 263 cuts pegmatite 264 as indicated by fine-grained border-zone material along two of its branches in pegmatite 264.

ORIGIN

At one time there seemed to be little question that pegmatites were true eruptive rocks formed by crystallization of a magma derived from a source within the earth's crust. In 1925 this view was changed by three independent papers by Schaller, Hess, and Landes. Each advocated that part or all of the zonal and related internal structures of complex pegmatites were developed by hydrothermal or pneumatolytic replacement of earlier formed pegmatite or aplite. These ideas have been used and elaborated since by a number of geologists, notably Landes (1928, 1933), Gevers and Frommurze (1929), Anderson (1931), Fersman (1931), Bjorlykke (1937), Quirke and Kremers (1943), and possibly by Uspensky (1943). In these papers there is the tacit assumption that the pegmatite magma and the later fluids of replacement, if any, are derived from granitic magma. By any hypothesis of the formation of granite—whether by the melting of a deep section of the sialic crust, by the differentiation of a basaltic substratum, or by the transformation and mobilization of rock without a magmatic stage—a fraction with granitic composition rich in hyperfusibles can be derived which will serve for pegmatite magma.

Cameron and others (1949, p. 97–106) have reviewed the literature and the field evidence offered by a large number of zoned pegmatites in many parts of the country. Additional reviews and evaluations of field evidence are contained in district studies by Bannerman (1943), Cameron and others (1945), Hanley, Heinrich, and Page (1950), Jahns (1946), Olson (1942), Page and others (1953), and Staatz and Trites (in press). The mode of origin of internal structures agreed upon by these men is summarized below, but no attempt is made to review their evidence or arguments.

Pegmatitic magmas are derived as a byproduct of the differentiation of granitic magma. They are formed over a period of time and vary somewhat in composition, depending on differences in place as well as time of escape from the parent chamber. Granitic pegmatite magma is composed of the same essential elements as granite: sodium, potassium, aluminum, silicon, and oxygen in large quantities; magnesium, calcium, iron, and manganese in relatively small quantities; and beryllium, fluorine, boron, phosphorus, lithium, and many less common metallic and rare-earth elements in widely differing, but, generally small, quantities. Water is an important part of the solution and is present in relatively large proportions as compared with the water content of the parent granitic magma (Ingerson, 1950).

The pegmatite magma invades the country rock in much the same manner as other eruptive rocks: it moves under pressure, follows the path of least resistance, accommodates itself to preexisting structures, and is capable of deforming its wall rocks. With declining pressure and loss of heat and some of the more fugitive mineralizers (boron and water, for example), viscosity increases and eventually the magma comes to rest. In some magmas crystallization starts before the last movements are completed, and gneissic and flow structures develop.

Solidification proceeds from the walls inward and follows the normal order of crystallization of the minerals of igneous rocks. Fractional crystallization of pegmatite solutions rich in mineralizers and trace elements produces zones characterized by distinctive mineral assemblages arranged in a constant sequence. The process may be interrupted by deformation and fracturing, by escape of hyperfusibles, or by intense reaction between earlier formed pegmatite minerals and the rest-liquid. Once crystallization starts it does not proceed uniformly in all pegmatites: the development of asymmetrical and telescoped zones attest to the fact that the crystallizing magma may deposit simultaneously assemblages of differing compositions. The differentiation of a pegmatite magma is undoubtedly similar to that of other igneous rocks and is brought about by similar processes such as liquid streaming, diffusion, and crystal settling. Plagioclase-rich zones in the lower parts, perthite-rich zones in the upper parts, and quartz-perthite pegmatite in hoods of zoned pegmatites are too common and too consistent in their occurrence to be accidental or unique features of particular bodies. The systematic variation in composition of persistent or recurring minerals in the zonal sequence indicates that fractional crystallization produces a rest-liquid progressively richer in hyperfusibles. As stated by Bastin (1950, p. 8):

> A crystallizing magma is a system characterized by changing conditions of equilibrium in the still liquid portions. Such changes in equilibrium may lead to changes in the composition of the minerals deposited and/or to resolution of minerals already formed.

The unceasing attempt to establish equilibrium between the solid phases and the residual liquid phase of the complex system produces a host of replacement textures. In the final stages of the process of fractional crystallization the rest-liquid becomes so rich in mineralizers by residual concentration that it has more of the characteristics of a hydrothermal than a magmatic solution. Movement of the rest-liquid (or fractions thereof) into solidified parts of the pegmatite or into the wall rock produces replacement bodies. There is no evidence that zones or replacement bodies in pegmatites are formed from solutions that invaded the pegmatite body from outside sources.

The papers referred to in the preceding paragraphs and the theory of origin outlined above are concerned almost exclusively with the internal structure of zoned pegmatites. There does not seem to be any question that "simple unzoned" bodies, the homogeneous pegmatites, are deposits of orthodox magmatic origin. About 98 percent of the pegmatites in the Hyatt area are not zoned; of the 28 zoned bodies 43 percent show only rudimentary zoning. Only one pegmatite in the Hyatt area is sufficiently well zoned to rank with those discussed in previous papers. The study of the Crystal Mountain district has not disclosed new data concerning zoned pegmatites, but it provides supplementary information on a number of points:

1. The district provides examples that confirm the nature and sequence of six of the mineral assemblages described by Cameron and others (1949, p. 61).
2. There is independent verification that plagioclase-quartz pegmatite should be included as a distinct assemblage preceding plagioclase-quartz-spodumene pegmatite in the general sequence of mineral assemblages as proposed by Page and others (1953).
3. Where there is a systematic variation in the composition of beryl, it consistently indicates a centripetal increase in the alkali content of the solution from which it was deposited. That is, the later beryl is higher in alkalies.
4. The fracture filling at the Big Boulder deposit shows that the shell of partly solidified pegmatite was broken after the border zone, wall zone, outer intermediate zone, and a 4-foot thickness of the hood were formed; a portion of the solution from which perthite-quartz pegmatite was being deposited was drawn into the fracture; the liquid continued normal crystallization, and perthite-quartz pegmatite was deposited, which is continuous with and indistinguishable from the material composing the hood (pl. 11).
5. The amoeboid pegmatites in granite sills are evidence that pegmatites can be formed by segregation of the liquid rich in hyperfusibles which is concentrated in the last stage of the crystallization of granite.

The writer believes the principal contribution that the study of the Crystal Mountain district can make to the problem of the origin of internal structures of pegmatites is in the relation of homogeneous to zoned deposits. What seems like a monotonous array of unzoned pegmatites contains many variations in texture, mineral proportion, and distribution. There is an insensible gradation from (1) pegmatites composed of uniformly disseminated grains of small size, through (2) bodies containing crudely segregated clots of minerals in a homogeneous matrix, and (3) two-zoned pegmatites whose cores are coalescing clots, to (4) multizoned deposits of contrasting mineral assemblages and grain sizes. Each of these groups or kinds passes into the next in a continuous series containing structures and essential minerals of the contiguous groups in the series. (See fig. 4.) The zones of the multizoned bodies are also gradational units containing some or all of the structures and minerals of the adjacent zones. No member of the series contains evidence of the action of solutions coming from outside the pegmatite body. All members of the series show the same kinds of changes in grain size and distribution of minerals, and the changes are of the same kinds exhibited by common eruptive rocks.

The relation between homogeneous and zoned pegmatites gives some basis for speculation on the factors that control or promote zoning. A series of hypothetical cases will illustrate one set of conditions visualized by the writer which will be compared with a different set discussed later:

1. A pegmatite magma containing the same elements as granite and in the same proportions as granite, with the addition of the barest essentials of mineralizers (perhaps water, boron, and phosphorus) to promote supragranitoid grain size, will crystallize as the simplest type of homogeneous pegmatite with the composition of assemblage 3 (table 6).

2. A magma with the same elements but in different proportions will crystallize with rudimentary zonal structure.

a. A slight excess of silica will produce quartz clots; a marked excess will produce a quartz core, as in assemblage 12.

b. Lesser amounts of silica will leave perthite as the dominant mineral crystallizing at the last, forming clots or a core of assemblage 4.

c. An excess of the elements of plagioclase will promote early saturation of the magma with respect to plagioclase and a plagioclase-rich wall zone will form of the composition of assemblage 1 or 2.

These hypothetical cases are believed to be representative of the processes that formed the zoned pegmatites of the Hyatt area, with the exception of the Hyatt pegmatite. The mineral assemblages developed hypothetically are the same as those actually found in the area, and the list is limited to assemblages 1, 2, 3, 4, and 12. Assemblage 4 is closely related to assemblage 10, and 1 and 2 are akin to 6, but 6 and 10 have not been found except in the association discussed below. The recurrence of minerals in nearly identical assemblages but with different structural positions within the pegmatites must require conditions not commonly met even by those unusual pegmatites that develop two zones.

Variations in proportions of the elements of common granite-forming minerals can produce a limited variety of zones. Other factors control or promote the development of the complex patterns of internal structure typical of well-zoned deposits: the wide range of textures, the recurrence of certain essential minerals in more than one assemblage, the marked segregation of accessory minerals, and the development of special units (such as perthite-rich hoods) and the growth of replacement bodies. In the Crystal Mountain district the homogeneous pegmatites have the widest range of shape, size, type of country rock, and structural environment; therefore, it is not the amount of magma, nor the cooling rate, nor the pressure conditions that determine whether or not zones will develop. The well-zoned deposits, Hyatt, Big Boulder, the Buckhorn Mica pegmatites, are distinctive by comparison with nearby pegmatites only by reason of their content of such elements as bismuth, tantalum, niobium, lithium, uranium, phosphorus, fluorine, and the rare earths. The writer infers that the initial composition of the pegmatite magma, particularly the content of minor constituents, determines in most magmas whether or not it will become a complexly zoned deposit.

There is no evidence that zoning is developed through the action of one of the rare elements listed nor does it seem likely that all are necessary. Not all the well-zoned pegmatites contain the same elements. There must also be a lower limit to the concentration and combination of minor elements effective in promoting the development of zonal structure because recognizable crystals of minerals containing rare or mineralizer elements are found in a few places in homogeneous pegmatites. Lithium-bearing compounds are essential constituents in four mineral assemblages and are present, at least in trace quantities, in so many complexly zoned deposits that the presence of lithium is considered a major factor in promoting extensive zoning. The concentration of beryllium does not seem to be important in promoting zonal structure. Pegmatites 132, 357, 387, 402, and 606 contain approximately the same percentage of beryl as the Big Boulder and Buckhorn Mica deposits, but they are not zoned; pegmatites 441, 563, 773, 774, 859, and 1039 are zoned bodies but contain no beryl.

The quartz-rich bodies are classed as pegmatites rather than quartz veins because most of them contain at least trace quantities of feldspar and muscovite and resemble the quartz cores of pegmatites of type I (table 5 and appendix B). But, as in the case of the tourmaline-rich bodies of type III, they may be transitional genetically between pegmatites of magmatic origin and veins of hydrothermal origin, or may actually be products of crystallization from hydrothermal solutions.

MINERAL RESOURCES OF THE CRYSTAL MOUNTAIN DISTRICT

Beryl, perthite, scrap mica, and columbite-tantalite are the principal resources of the pegmatites of the Crystal Mountain district. These minerals are not being mined at the present time because the grain sizes and the concentrations are too small to be recovered at a profit by hand sorting. The future of the district depends upon the development of milling methods which will profitably separate beryl, perthite, mica, and columbite-tantalite from the associated minerals. The irregularity of the shapes and grain boundary relationships of beryl and other minerals (pl. 8) may necessitate elaborate milling to effect high recovery of clean beryl.

Beryl is the most important mineral in the district. It is present in 78 pegmatites in quantities of 1 ton or more and occurs as a minor constituent of at least 271 pegmatites. The beryl grains range from microscopic in size to 7 feet long, but most are less than 3 inches. The beryl content ranges from trace quantities in many pegmatites to about 2 percent in some units of zoned deposits. It is present in all types of feldspar-rich pegmatites. Beryl-bearing pegmatites are not restricted to any special structural environment or type of country rock, but there appear to be fewer rich deposits in the thousand-foot belts immediately adjacent to granite masses of the Hyatt area than in the masses themselves or in the areas farther than 1,000 feet from the masses. Discordant beryl-bearing pegmatites in the Hyatt area contain richer deposits than the concordant pegmatites.

Beryl has been produced from fortuitous exposures, and there has been comparatively little waste rock to move. The top of the Hyatt pegmatite has been eroded to the level of the inner intermediate zone and many large crystals were exposed before mining. Greater-than-average thicknesses of beryl-rich rock were available for mining in the gentle folds of the crest of the same zone in the upper opencut (pl. 9). Future mining will undoubtedly expose large crystals, but the principal reserves of beryl are in grains less than 3 inches in size. The pegmatites will have to be milled to recover the beryl, and the reserves of potash feldspar, scrap mica, and columbite-tantalite will constitute byproducts of value.

Perthite constitutes as much as 70 percent of some pegmatites, but more commonly ranges from 20 to 60 percent. It makes up 96 percent of the core of the Hyatt pegmatite. The perthite grains in most pegmatite range from microscopic in size to 15 inches; only in zoned pegmatites are there perthite crystals as much as 10 feet in diameter. The average size of perthite grains in the district probably does not exceed 3 inches. Perthite of such small average size and intergrown with other minerals is not exploitable at this time.

Muscovite is a minor constituent of the pegmatites, but it probably could be recovered by almost any milling process and is therefore a potential byproduct of value.

Columbite-tantalite is a rare constituent of the pegmatites at the Buckhorn Mica mine and Tantalum claim and is present in trace quantities in five other deposits in the district. Several hundred pounds of columbite-tantalite may be obtained from the Buckhorn Mica mine and the Tantalum claim, and small quantities might be recovered from other deposits if they were milled for beryl, perthite, and scrap mica.

The plagioclase and quartz of the Crystal Mountain district have no present value. The plagioclase is dominantly albite and could be used in commerce, if recovered by milling. The albite is generally fine grained, grayish white to pink, and intimately intergrown with other minerals; it seems improbable that this material could compete in the near future with the coarse-grained feldspar mined in other districts. The current market for soda spar is more limited than that for potash spar. Light-gray to smoky quartz has no special properties that make it a salable product.

The pegmatites of Tps. 6 and 7 N., and Rs. 71 and 72 W. have been prospected intermittently since about 1934, and it is improbable that outcrops of coarse-grained beryl, perthite, or mica have been overlooked. Within some of these pegmatites, however, concealed zones may contain crystals that can be hand-cobbed. Three mineralogic relationships, which suggest that the pegmatite is zoned, may help locate concealed deposits: albite that increases markedly in size and developes a platelike structure towards the interior of the pegmatite; stringers and patches of fine-grained curved muscovite; and fine-grained aggregates of sericite and albite cutting all other minerals.

Many of the pegmatites of this area that contain an unusually high proportion of fine-grained beryl in the outer part of the body also contain medium-grained beryl in the interior. Beryl is generally associated more intimately with plagioclase and muscovite than with quartz and perthite; therefore, the plagioclase- and muscovite-rich units of zoned deposits and clots of homogeneous pegmatites should be examined with care. Certain features of the occurrence of beryl are deceptive: in some pegmatites and fracture fillings it is concentrated close to the margin and gives a false appearance of abundance; a beryl-bearing fracture filling that cuts across a large barren pegmatite may give the impression that the large pegmatite is rich in beryl.

DESCRIPTIONS OF INDIVIDUAL PEGMATITES

More than 1,300 of the pegmatites mapped in the Hyatt area have been individually examined and described, and the essential information as to their size, shape, structure, and composition is given in appendix B. Pegmatite numbers correspond with those on the index map (pl. 5), and the descriptions are arranged in groups according to mineralogic composition as outlined in table 5. Such pegmatites as exhibit special features or constitute nearly ideal examples of some typical relationship have been discussed in the appropriate sections of this report. Most of the pegmatites have characteristics that fall well within the types considered in preceding sections.

Hundreds of pegmatitic patches, small pegmatites, and quartz veins were cored in the course of drilling the three zoned deposits;

some are satellites and offshoots of the main body, some are barely more than pegmatitic impregnations of the wall rock, but others are individual pegmatities distinct from the deposits being explored.

The small bodies are mineralogically like the homogeneous deposits mapped in the Hyatt area, and many are also like the wall zones of the zoned deposits. Analysis of 32 samples shows that BeO is present in amounts ranging from 0.001 to 0.50 percent, and averages about 0.03 percent. Some of the small bodies are as rich or richer in BeO than the wall zones of the adjacent zoned deposits. Samples C 21 to C 25 (table 14) are taken from a concealed zoned body; it is closely related mineralogically to the nearby Buckhorn Mica pegmatite, but the structural relations are unknown. It is interpreted as an independent pegmatite, not connected directly with the larger zoned body.

TABLE 14.—*BeO content of concealed zoned pegmatite cored in drill hole BH-3, Crystal Mountain district, Colorado*

Sample no.	Footage	BeO content (percent)[1]	Internal structure and mineralogy
C 21	47. 5–48. 4	0. 0014	Wall zone of quartz-plagioclase-muscovite pegmatite.
C 22	48. 4–48. 9	. 0043	Intermediate zone of cleavelandite-quartz pegmatite.
C 23	48. 9–50. 4	. 0011	Core of quartz pegmatite.
C 24	50. 4–51. 2	. 058	Intermediate zone of cleavelandite-quartz pegmatite.
C 25	51. 2–51. 8	. 036	Wall zone of quartz-plagioclase-muscovite pegmatite.

[1] Quantitative spectrographic analyses by Saratoga Laboratories.

DEPOSITS EXPLORED BY CORE DRILLING

HYATT PEGMATITE

The Hyatt pegmatite is about 23 miles by road west of Loveland, Colo., in the NE¼NW¼ sec. 28, T. 6 N., R. 71 W., sixth principal meridian. It is reached from Drake on U. S. 34 by going west on the Glen Haven road for 500 yards and then turning northward on to a private road (fig. 1). The private road goes to the Fred Hyatt ranch on which the deposit is found.

The deposit was discovered in 1936 by Roy Hyatt, but little work was done until September 1942 when it was leased to the United Beryllium Ores and Metals Corp. of Denver. The pegmatite was mined intermittently during the fall of 1942, and operations continued steadily from June to December 1943 under a financial arrangement with the Reconstruction Finance Corporation. The mine was idle from 1944 to 1948. In the spring of 1948 a lease was granted to the Beryl Ores Co. who operated the Hyatt mine from May to October 1948. The mine was inactive during 1949 and 1950. Since 1936 about 50 tons of beryl, 30 tons of scrap mica, and 400 tons of potash spar have been produced. The potash spar was mined from the core of the pegmatite and the other minerals from the inner intermediate zone. The deposit has been opened by three opencuts and a number of shallow prospect trenches. One of the opencuts has been back filled and all but one of the trenches have been destroyed by later workings. The Hyatt pegmatite is shown both prior to mining and after the 1943 operations in two maps and two photographs by Hanley, Heinrich, and Page (1950, pls. 13 and 14). The extent of the mine after the activities of 1948 is shown in plate 9.

The Hyatt pegmatite was mapped by Hanley and Page in October 1942, and additional studies and maps were made in September 1943 and June 1944 by Hanley, Heinrich, and Page (1950, p. 99–102). In September 1947 the writer and A. J. Lang remapped the deposit.

GEOLOGY

The Hyatt pegmatite cuts across a small pluglike mass of gray biotite granite which crops out along the crest of a small anticline in quartz-mica schist (pl. 2). Pegmatites are abundant in the vicinity but none are zoned bodies though a few of them are beryl bearing. The contact between the granite plug and the schist is not exposed, and the contact between the Hyatt pegmatite and the granite is visible only in the workings on the northwest (hanging-wall) side.

The contact between granite and pegmatite is gradational and somewhat irregular. The feldspars and quartz interlock and are indistinguishable even under the microscope, but biotite is restricted to the granite. Viewed under the microscope the quartz and feldspars of the granite exhibit strain shadows, and the biotite flakes are bleached for a fraction of an inch beyond the limits of definitely recognizable pegmatitic material. The force of intrusion of the pegmatite magma probably deformed the grains, and solutions escaping from the pegmatite altered the biotite. The pegmatite has no border zone in many places at the contact with granite, and though the position of the contact can be fixed within a few inches, the attitude of the contact can only be approximated. At the contacts with schist the border zone is well developed, and the attitude is readily determinable.

The Hyatt pegmatite is 365 feet long and has a maximum width of 70 feet. It is a roughly lenticular, asymmetrical body whose long axis trends N. 60° E.; it has an average dip of 60° NW. The northeast end has a flat plunge to the southwest which steepens in the granite (pl. 10). The southwest end plunges about 42° northward, so the pegmatite has approximately the shape of half a lens tapering downward and to the northwest. The core of the pegmatite is crossed by a curving and branched fracture filled with granular friable gouge about 4 inches thick. The fracture has a general trend of N. 50° E., dips steeply southeast, and seems confined to the core of the deposit. A few 1- to 4-inch, irregular aplite dikes cut all zones of the pegmatite.

The Hyatt pegmatite is divided into the following zones: A wall zone of plagioclase-perthite-quartz pegmatite, an outer intermediate zone of perthite-quartz pegmatite, an inner intermediate zone of plagioclase-quartz-muscovite pegmatite, and a core of perthite pegmatite. The wall zone and inner intermediate zone are continuous around the deposit, but the outer intermediate zone is restricted to the hanging-wall side of the body. Drilling disclosed that in the lower part of the body the wall zone contains almost no perthite and confirms that the outer intermediate zone is not present on the footwall side. The average composition of the entire pegmatite, calculated from the composition of the individual zones, is plagioclase 50 percent, perthite 35 percent, quartz 15 percent, and muscovite less than 1 percent.

The concentration of perthite in the upper part of the pegmatite is so marked that zonal boundaries have been drawn (pl. 10) on the basis of its distribution.

The upper wall zone consists of about 50 percent plagioclase (albite), 25 percent perthite, and 25 percent quartz. This zone has an average width of about 25 feet but ranges from 1 to 60 feet. The texture is fine grained, and the grains average slightly less than 1 inch in diameter, though perthite grains are as much as 4 inches in length. Muscovite is a common accessory in flakes and books from microscopic in size to 2½ inches in length. Beryl occurs as irregularly disseminated euhedral to anhedral blue-green crystals. The sizes and shapes of the beryl grains found in the drill core are shown in figures 7-12. Tourmaline is present near the contact as crystals 0.01 to 0.7 inch long, and in the southwestern end of the pegmatite as clusters of columnar crystals up to 2 inches long.

A sample of the wall zone, weighing almost 300 pounds, was taken from the southwest trench (pl. 9). The BeO content determined by quantitative spectrographic analysis is 0.078 percent and by the nuclear reaction method it is 0.066 percent. An average of the determinations of index of refraction of beryl in this zone shows that the beryl contains about 12.4 percent BeO. The analyses, therefore, indicate about 0.6 percent beryl in the sample; this is higher than the average for the entire zone but confirms the measurement of beryl grains made in and near the trench.

The results of chemical analysis and semiquantitative spectrographic analysis of the same sample are given in tables 15 and 16, respectively. The proportions of "standard mineral molecules" or "normative minerals" are calculated from the chemical analysis

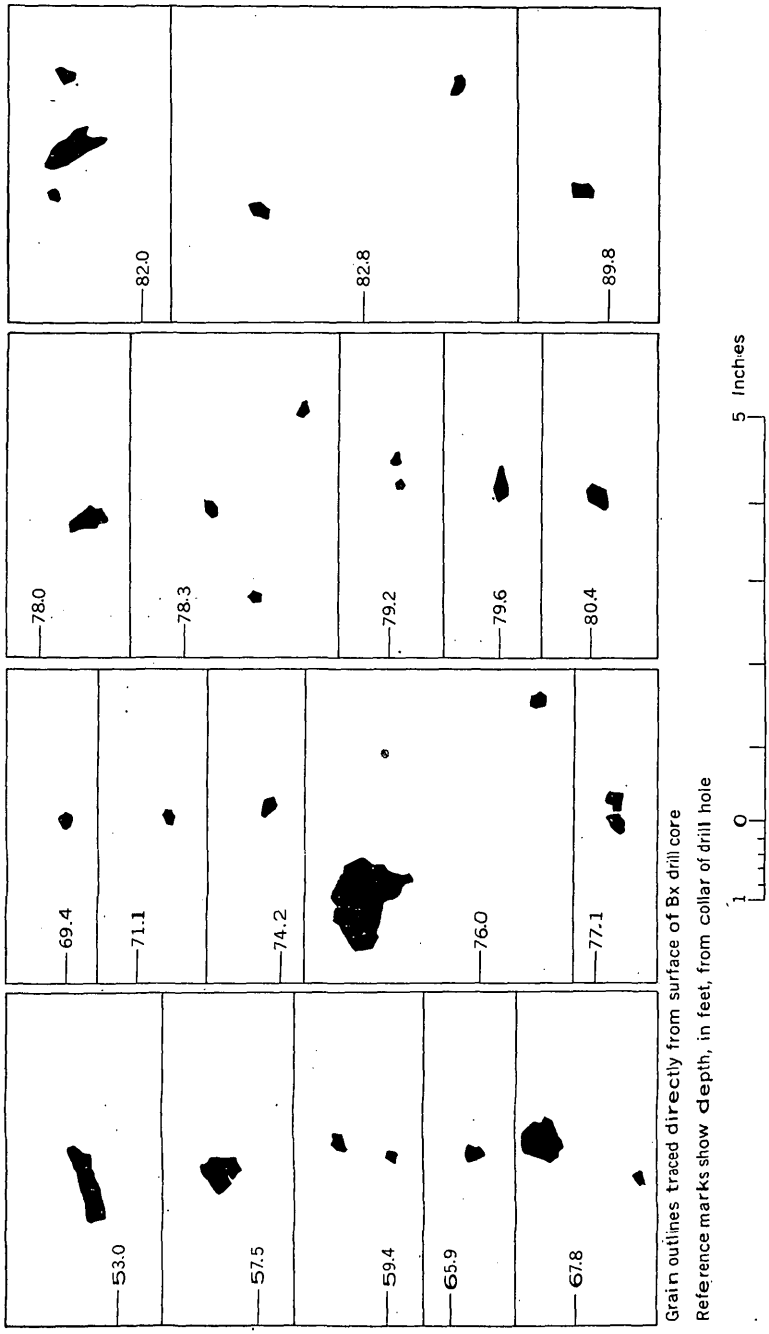


FIGURE 7.—Plan of beryl grains exposed on diamond-drill core from hole HY-1, Hyatt pegmatite, Larimer County, Colo.

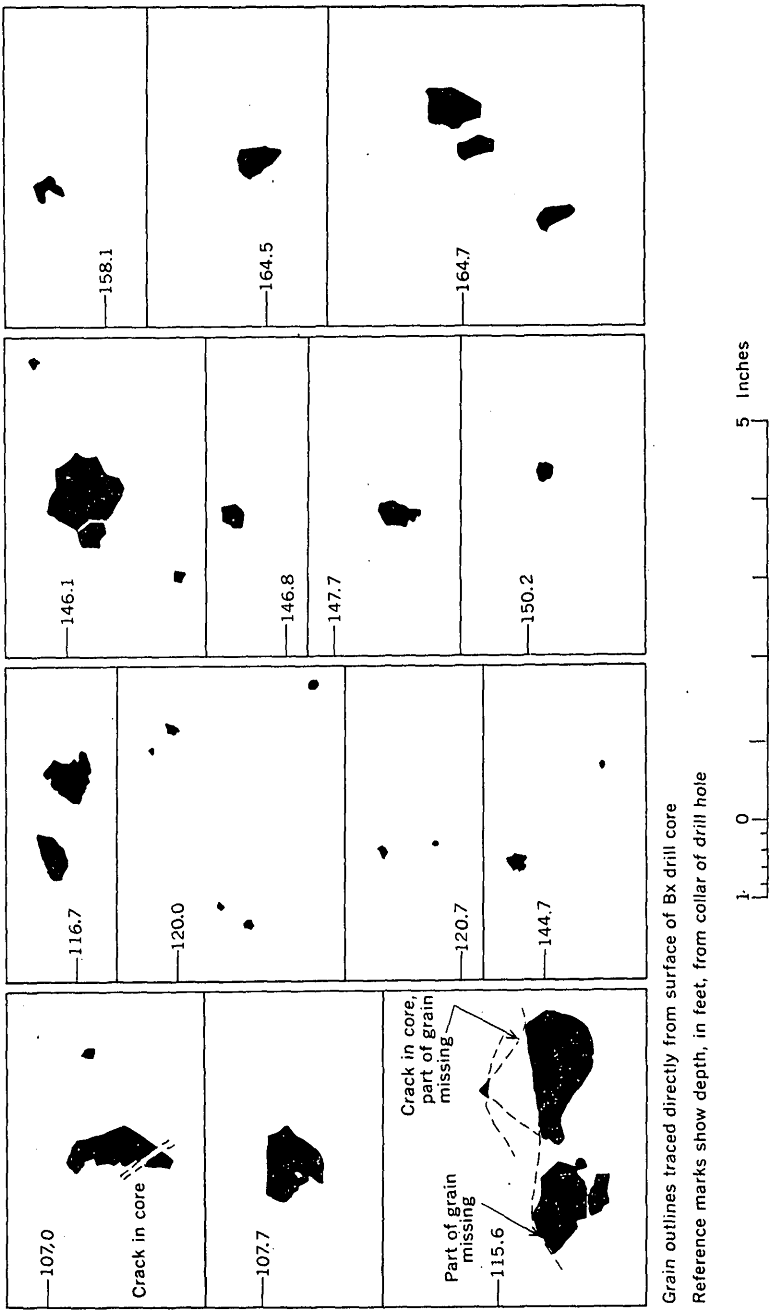


FIGURE 8.—Plan of beryl grains exposed on diamond-drill core from hole HY-2, Hyatt pegmatite, Larimer County, Colo.

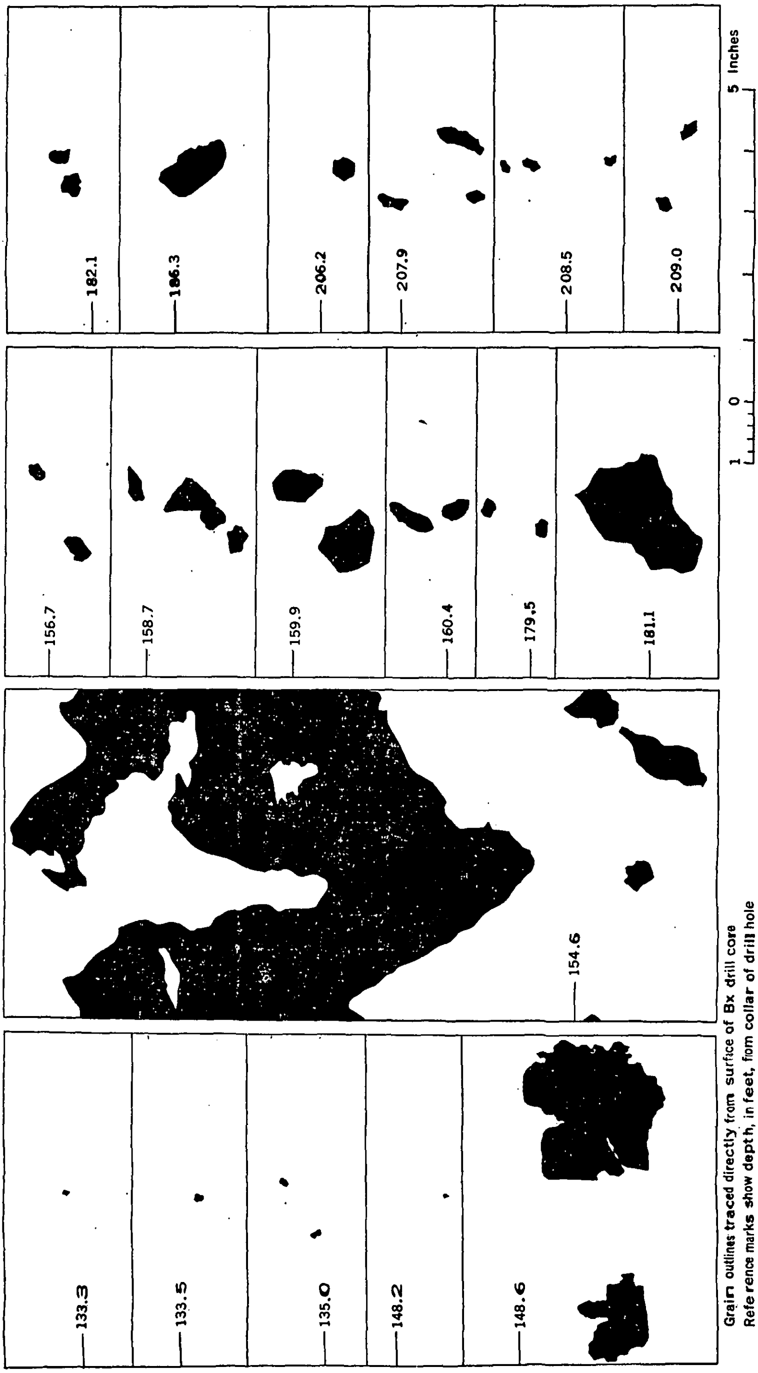


FIGURE 9.—Plan of beryl grains, exposed on diamond-drill core from hole HY-3, Hyatt pegmatite, Larimer County, Colo.

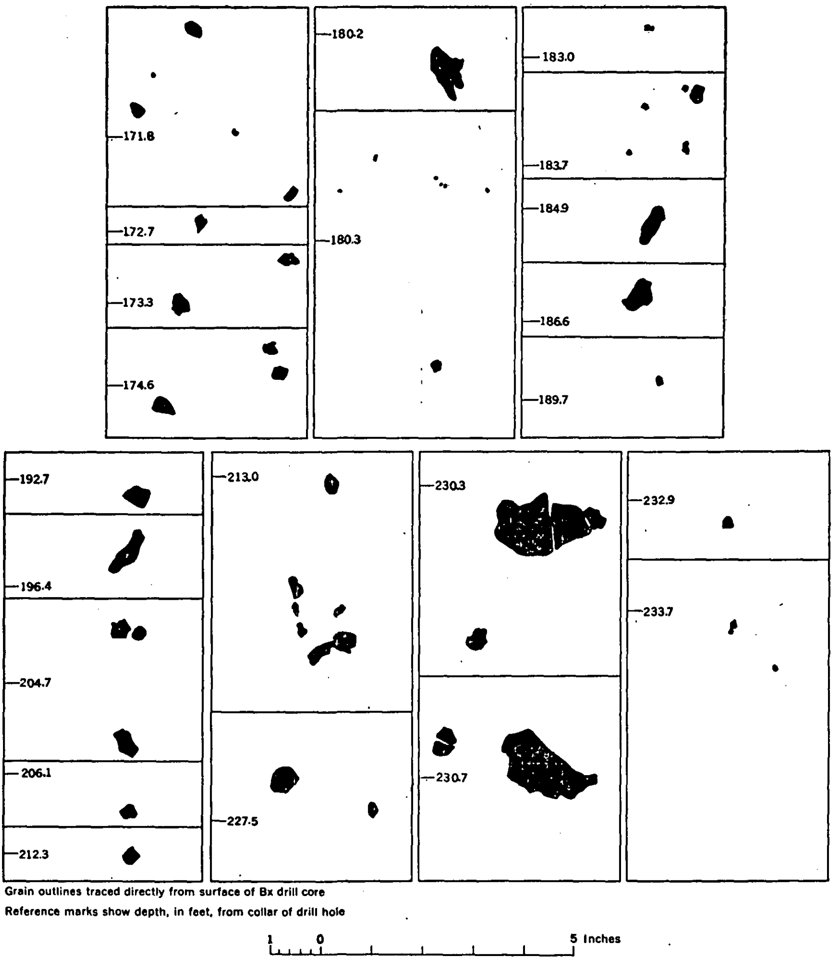


FIGURE 10.—Plan of beryl grains exposed on diamond-drill core from hole HY-4, Hyatt pegmatite, Larimer County, Colo.

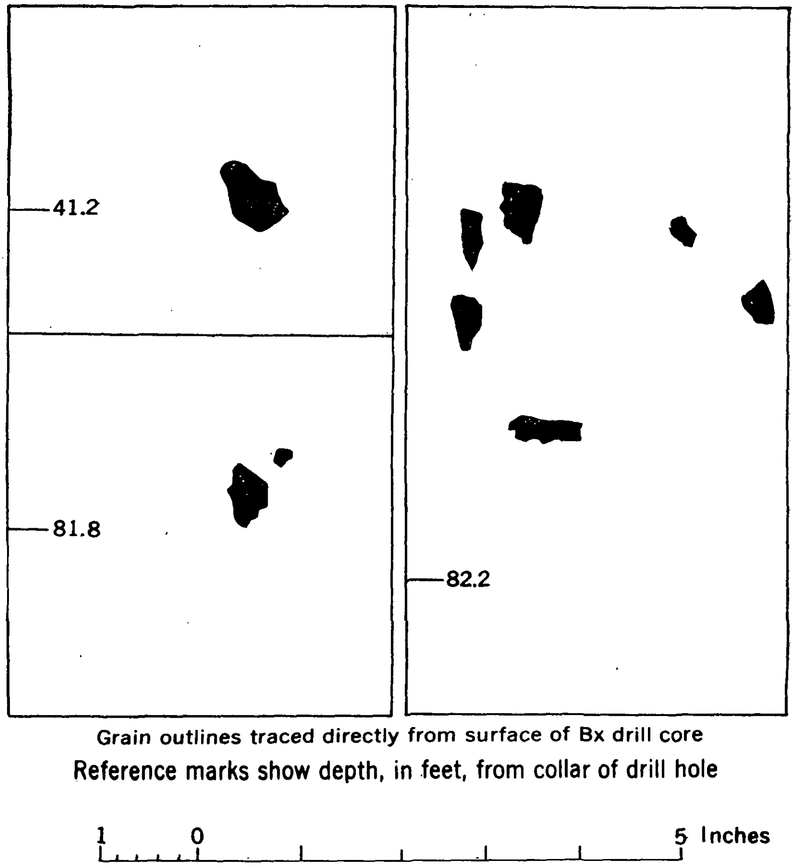


FIGURE 11.—Plan of beryl grains exposed on diamond-drill core from hole HY-5, Hyatt pegmatite, Larimer County, Colo.

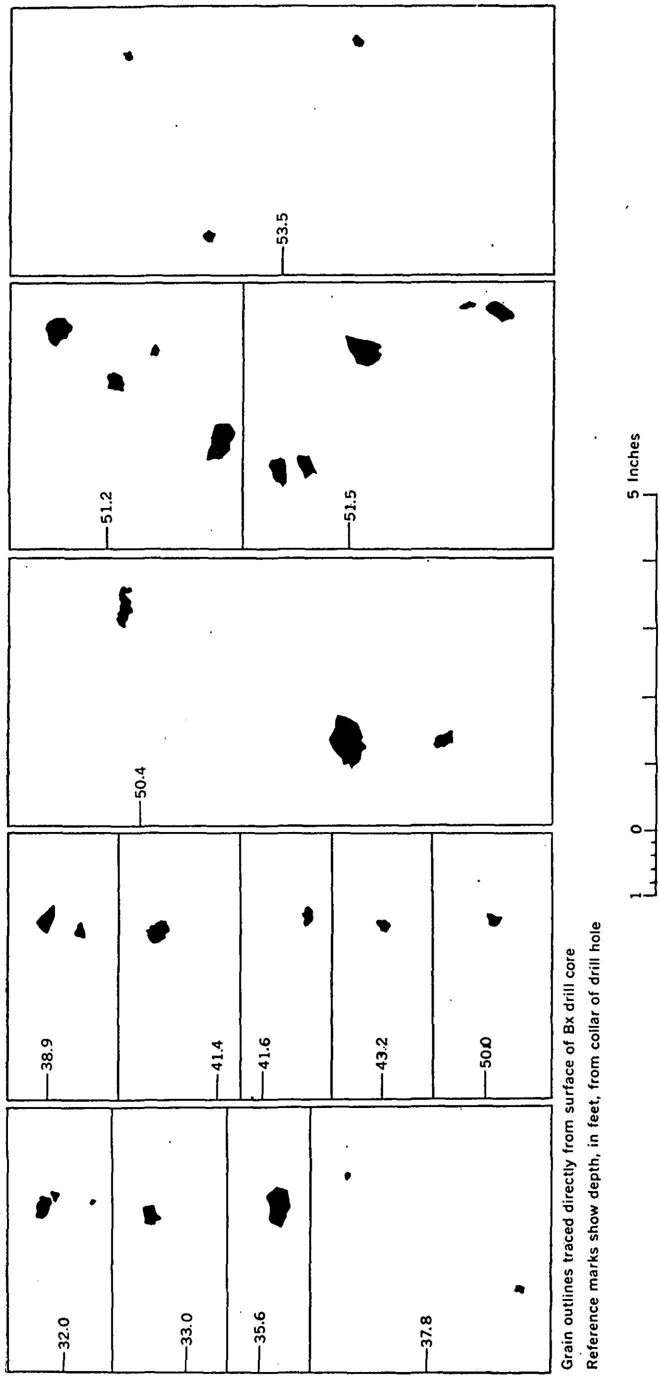


FIGURE 12.—Plan of beryl grains exposed on diamond-drill core from hole HY-6, Hyatt pegmatite, Larimer County, Colo.

according to the system of Cross, Iddings, Pirsson, and Washington (Washington, 1917). The differences between the hypothetical norm and the actual mode are minor: the muscovite present in the rock and not included in the norm is represented by corundum, water, and part of the quartz and magnetite; the hypersthene in the norm (but not in the rock) reflects the presence of a small amount of MgO, and FeO in excess of Fe_2O_3, which are probably incorporated in minute quantities in the feldspars or in the muscovite.

TABLE 15.—*Chemical analysis and norm of plagioclase-perthite-quartz pegmatite, wall zone of Hyatt pegmatite, Crystal Mountain district, Colorado*

[A. M. Sherwood, analyst]

Analysis

	Percent		*Percent*
SiO_2	72.61	TiO_2	0.01
Al_2O_3	15.60	MnO	.04
Na_2O	5.85	BaO	.05
K_2O	3.88	U	.004
Fe_2O_3	.24	H_2O-	.04
FeO	.43	H_2O+	.45
CaO	.35		
MgO	.12	Total	99.714
V_2O_2	.05		

Norm

	Percent		*Percent*
Quartz	22.5	Corundum	1.0
Orthoclase	22.8	Magnetite	.2
Albite	49.8		
Anorthite	1.7	Total	98.8
Hypersthene	.8		

Comparison of the analysis in table 16 with the analyses of the granite, samples C 232 to C 241 of table 13, suggests that there has been little interchange of trace elements between the pegmatite and its wall rock. Manganese, barium, strontium, and chromium are present in similar proportions in the wall zone of the pegmatite and in the adjacent granite; but the other elements, magnesium, lead, calcium, gallium, vanadium, titanium, and bismuth, are higher or lower by at least one unit in the order of magnitude scale.

The lower part of the wall zone consists of about 60 percent plagioclase (albite) and 40 percent quartz with accessory perthite, muscovite, and beryl. Except for the decrease in perthite content, it resembles the upper part of the wall zone, including concentrations of the same types of beryl. The lower wall zone has a maximum thickness of about 40 feet in the keel and narrows upward along both walls to a featheredge. This troughlike body is shown in plate 10.

The outer intermediate zone is made up of perthite (55 percent) and quartz (45 percent). The grains average between 4 and 12 inches in diameter, but some are as much as 3 feet. Minor amounts

TABLE 16.—*Semiquantitative spectrography of plagioclase-perthite-quartz pegmatite, wall zone of Hyatt pegmatite, Crystal Mountain district, Colorado*

[Helen Worthing, spectrographer]

	Elements
Over 10.0	Si
1.0 to 10.0	Al, Na
0.1 to 1.0	K, Fe
0.01 to 0.1	Mn, Ba, Mg, Pb, Ca, Gu, Ca, V
0.001 to 0.01	Sr, B, Ti, Bi, Cr

of fine-grained plagioclase, muscovite, and quartz fill interstices and fractures in the large grains. Assays of drill core from this zone show small amounts of BeO, which probably indicate small grains of beryl in the interstitial filling; no beryl has been observed in the perthite-quartz pegmatite exposed in the drill core or the upper opencut. The zone extends about 130 feet along the hanging-wall side of the deposit and a distance of about 110 feet down the dip. Its width ranges from less than an inch to 7 feet.

The inner intermediate zone of coarse-grained plagioclase-quartz-muscovite pegmatite contains coarse-grained beryl and scrap mica that has been mined intermittently since 1942. This pegmatite consists of 50 percent plagioclase, 40 percent quartz, 7 percent muscovite, and 3 percent beryl and other accessories. The inner intermediate zone pinches and swells, ranging from 2 to 8 feet wide. Several gentle folds plunge at low angles to the southwest (pl. 9) and probably reflect irregularities in the crest of the pegmatite.

Beryl occurs typically in clusters of both large and small crystals. A few small grains are scattered at random in the rock between clusters. Pockets 6 to 12 feet long and extending the full width of the zone have been discovered some 10 to 35 feet apart during mining. There are poorly exposed parts of the pegmatite as much as 70 feet long, in which beryl shoots are not apparent but which have not been prospected to confirm the absence of beryl. The beryl ranges in diameter from 1 inch to 1 foot, although some crystals are as much as 5 feet long. Both anhedral and euhedral beryl are common.

Estimates of rock moved from the inner intermediate zone compared to the tons of beryl produced indicate a beryl content of 2.3 percent recoverable by hand sorting.

The inner intermediate zone also has yielded scrap mica from shoots and streaks of fine- to very coarse-grained muscovite. The streaks are from 1 inch to 5 feet wide and from 1 to 30 feet long. The largest books are as much as 15 inches long and 6 inches thick, but no sheet mica has been obtained from them; the books are heavily ruled and wedged and have "A" structure and many mineral inclusions. The zone is estimated to contain an average of 7 percent muscovite, and perhaps a quarter of it is recoverable by hand sorting. The fine-grained material consists of flakes and books ranging from microscopic to 3 inches in diameter, intimately intergrown with quartz, plagioclase, tourmaline, and beryl, and oriented at random.

The plagioclase of the inner intermediate zone has a medium texture. It is albite with a somewhat platy habit, and there are small patches which become cleavelandite with white curving plates as much as 6 inches in long dimension.

Minor accessory minerals approximately in order of decreasing abundance are tourmaline, microcline, garnet, apatite, lithiophilite-triphylite and other phosphates, bismuthinite and its alteration products, and uraninite and its alteration products. The accessory minerals constitute less than 1 percent of the zone, and no attempt has been made to estimate the abundance of tourmaline, microcline, garnet, and apatite. The rarer minerals exposed during mining operations in 1948 were estimated to be of the following orders of magnitude: phosphates other than apatite 0.00X to 0.0X percent; bismuth compounds 0.008 percent; and uranium-bearing minerals 0.000X percent.

The core of the Hyatt deposit is about 96 percent perthite, 3 percent quartz, and 1 percent of plagioclase, muscovite, tourmaline, and garnet. The perthite is very coarse grained and attains lengths of as much as 10 feet. Quartz occurs in very coarse masses as much as 4 feet in greatest dimension, and as fine-grained inclusions in the perthite, and as interstitial fillings. In addition, plagioclase, muscovite, and tourmaline are included in the perthite and fill the spaces between perthite grains. Beryl has been found along the margins of the core but not in the interior; however, it may be present in the center either as small grains in the interstitial material or as inclusions in the perthite, because small amounts of BeO are found in spectrographic analyses of the drill samples. The miarolitic cavity from the core of the Hyatt deposit contained bertrandite, a rare hydrous beryllium silicate, indicating that a beryllium-bearing mineral was deposited at a late stage in the crystallization of the pegmatite.

The maximum dimensions of the core are 240 feet long, 25 feet wide, and 100 feet in the plane of dip.

EXPLORATION

The Hyatt deposit was explored by six holes drilled from the hanging wall side of the pegmatite (pl. 9). The elevation of the collar, inclination of the hole, and depth drilled are indicated on the map (pl. 9), the drill logs (appendix A, 1–6), the assay plans (figs. 13–17), and the cross sections (pl. 10). For analysis, 58 sludge samples and

RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S 9	48.5 - 52.1	0.011
S 10	52.1 - 55.0	.023
S 11	55.0 - 60.0	.021
S 12	60.0 - 65.0	.026
S 13	65.0 - 67.0	.029
S 14	67.0 - 72.0	.038
S 15	72.0 - 77.0	.043
S 16	77.0 - 80.2	.045
S 17	80.2 - 85.0	.044

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C219	48.2 - 49.0	0.033
C220	50.4 - 53.7	.026
C221	53.7 - 55.0	.010
C222	55.0 - 56.8	Tr.
C223	56.8 - 57.4	.011
C224	57.4 - 60.0	.013
C225	60.0 - 62.0	Tr.
C226	62.0 - 67.0	.029
C227	67.0 - 73.1	.02
C228	73.1 - 76.8	.027
C229	76.8 - 80.2	.013
C230	80.2 - 85.0	.019
C231	85.0 - 90.0	.015

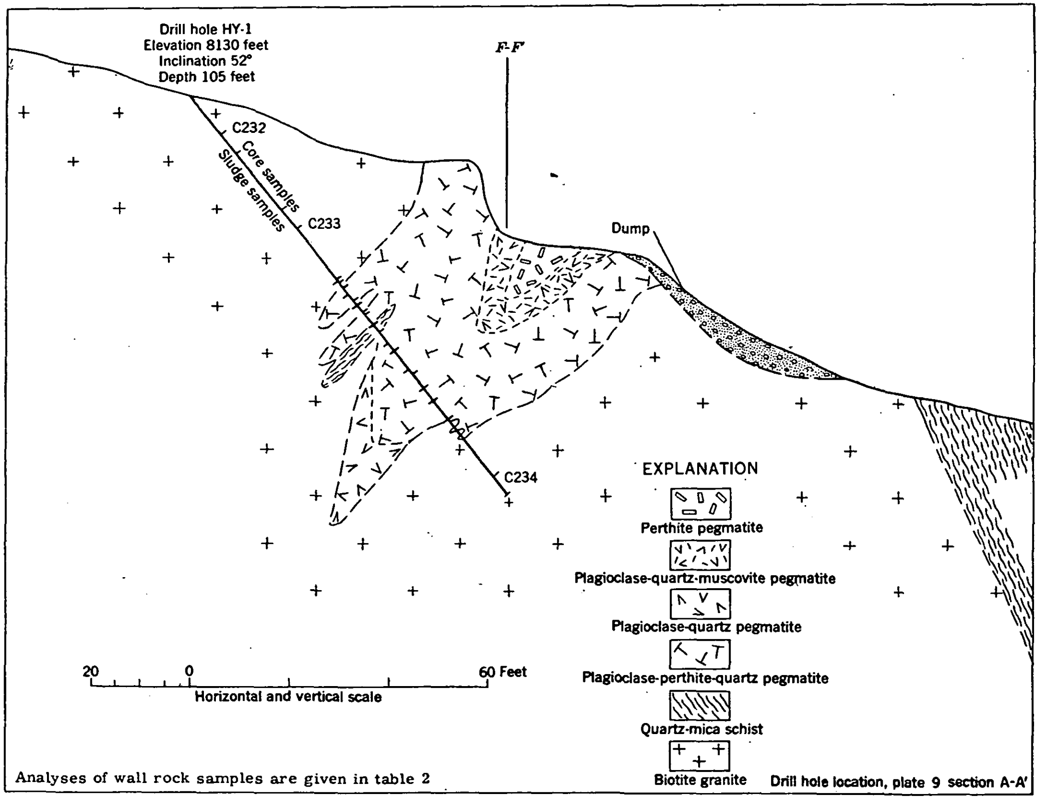


FIGURE 13.—Assay plan of diamond-drill hole HY-1, Hyatt pegmatite, Larimer County, Colo.

DRILL HOLE HY-2
RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S 22	105.0 - 111.6	0.028
S 23	111.6 - 113.6	.016
S 24	113.6 - 117.0	.018
S 25	117.0 - 122.0	.070
S 26	122.0 - 127.0	.048
S 27	127.0 - 132.0	.018
S 28	132.0 - 136.5	.030
S 29	136.5 - 141.0	.063
S 30	141.0 - 146.0	.034
S 31	146.0 - 150.5	.026
S 32	150.5 - 153.0	.060
S 33	153.0 - 158.0	.14
S 34	158.0 - 163.0	.074
S 35	163.0 - 168.0	.050

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C201	104.0 - 104.9	0.008
C202	104.9 - 108.5	.05
C203	108.5 - 112.3	.017
C204	112.3 - 113.3	.023
C205	113.3 - 114.9	Tr.
C206	114.9 - 116.2	.71
C207	116.2 - 122.0	.021
C208	122.0 - 127.0	.019
C209	127.0 - 132.0	.009
C210	132.0 - 136.5	.01
C211	136.5 - 141.0	.05
C212	141.0 - 146.0	.024
C213	146.0 - 150.5	.02
C214	150.5 - 153.0	.04
C215	153.0 - 158.0	.045
C216	158.0 - 163.0	.041
C217	163.0 - 165.6	.039
C218	165.6 - 166.8	.009

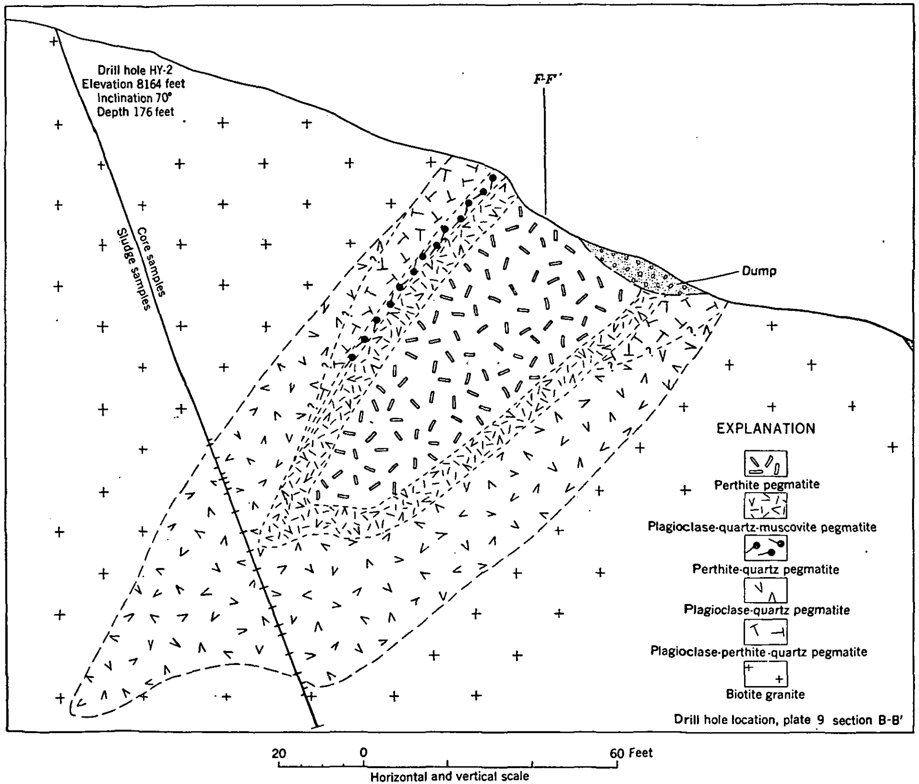


FIGURE 14.—Assay plan of diamond-drill hole HY-2, Hyatt pegmatite, Larimer County, Colo.

DRILL HOLE HY-3

RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S 36	133.0 - 139.0	0.020
S 37	139.0 - 143.5	.017
S 38	143.5 - 147.0	.0069
S 39	147.0 - 152.0	.18
S 40	152.0 - 156.0	.92
S 41	156.0 - 162.0	.22
S 42	162.0 - 167.0	.11
S 43	167.0 - 172.0	.046
S 44	172.0 - 175.0	.045
	No sludge recovered	
S 45	177.5 - 186.0	.064
S 46	186.0 - 189.0	.055
S 47	189.0 - 194.5	.055
S 48	194.0 - 201.0	.074
S 49	201.0 - 208.8	.064

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C174	96.8 - 100.8	0.004
C175	131.8 - 132.5	.004
C176	132.5 - 139.4	.016
C177	139.4 - 144.6	.013
C178	144.6 - 148.2	.001
C179	148.2 - 151.2	.04
C180	151.2 - 153.0	.013
C181	153.0 - 154.9	.96
C182	154.9 - 157.9	.072
C183	157.9 - 159.2	.044
C184	159.2 - 162.5	.037
C185	162.5 - 164.4	.003
C186	164.4 - 167.0	Tr.
C187	167.0 - 172.0	.001
C188	172.0 - 177.5	.001
C189	177.5 - 178.7	.001
C190	178.7 - 183.6	.042
C191	183.6 - 186.9	.009
C192	186.9 - 189.0	.001
C193	189.0 - 194.5	.012
C194	194.5 - 199.3	.03
C195	199.3 - 201.0	.009
C196	201.0 - 202.6	.03
C197	202.6 - 204.4	.016
C198	204.4 - 207.9	.02
C199	207.9 - 209.6	.049
C200	209.6 - 210.6	.008

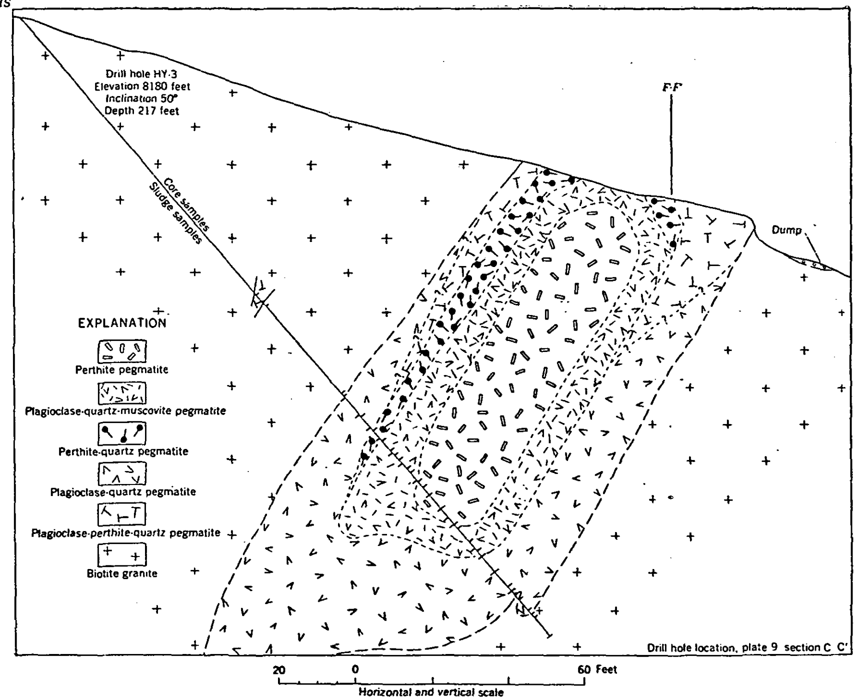


FIGURE 15.—Assay plan of diamond-drill hole HY-3, Hyatt pegmatite, Larimer County, Colo.

DRILL HOLE HY-4

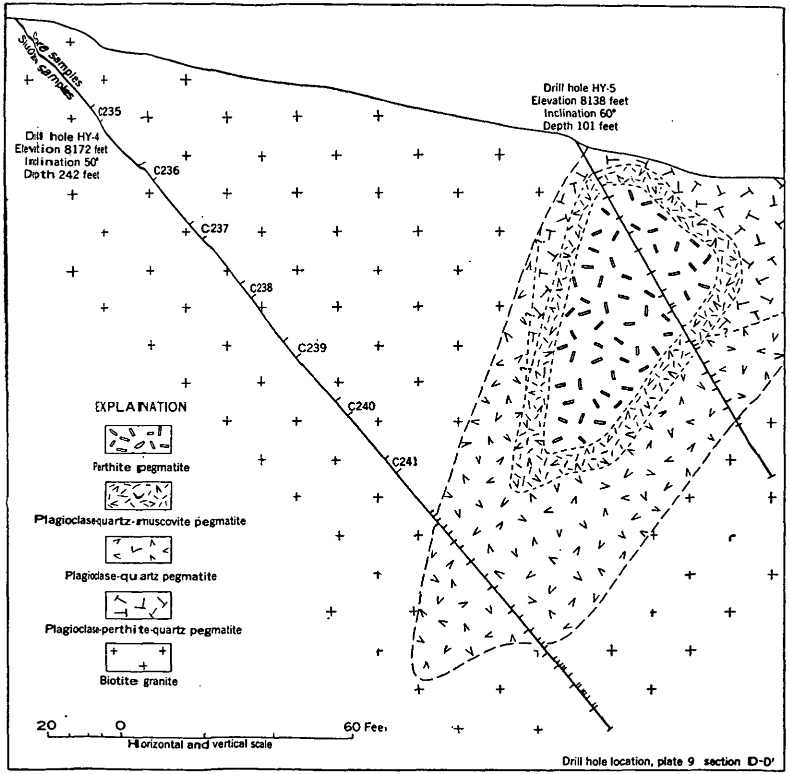
RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S50	172.0 - 178.2	0.015
S51	178.2 - 185.0	.060
S52	185.0 - 193.8	.032
S53	193.8 - 201.5	.035
S54	201.5 - 208.0	.043
S55	208.0 - 216.0	.063
S56	216.0 - 220.3	.014
S57	220.3 - 227.0	.014
S58	227.0 - 235.0	.14

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C145	169.0 - 170.0	0.009
C146	170.0 - 171.6	.006
C147	171.6 - 173.6	.023
C148	173.6 - 176.0	.01
C149	176.0 - 178.2	.007
C150	178.2 - 180.6	.009
C151	180.6 - 185.0	.03
C152	185.0 - 190.2	.029
C153	190.2 - 194.3	.016
C154	194.3 - 201.0	.027
C155	201.0 - 204.3	.007
C156	204.3 - 208.8	.039
C157	208.8 - 212.0	.029
C158	212.0 - 213.4	.04
C159	213.4 - 214.5	.001
C160	214.5 - 218.7	.009
C161	218.7 - 220.0	.01
C162	220.0 - 220.9	.01
C163	220.9 - 221.8	Tr.
C164	221.8 - 222.2	.016
C165	222.2 - 224.4	.01
C166	224.4 - 227.8	.012
C167	227.8 - 228.2	.001
C168	228.2 - 229.7	Tr.
C169	229.7 - 230.3	.005
C170	230.3 - 230.8	.003
C171	230.8 - 231.9	.50
C172	231.9 - 234.3	.015
C173	234.3 - 235.0	.006



DRILL HOLE HY-5

RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S 59	16.0 - 22.5	0.0037
S 60	22.5 - 32.5	.0015
S 61	32.5 - 39.0	.0062
S 62	39.0 - 46.0	.032
S 63	46.0 - 50.5	.019
S 64	50.5 - 59.7	.013
S 65	59.7 - 69.0	.015
S 66	69.0 - 74.0	.0082
S 67	74.0 - 79.6	.034
S 68	79.6 - 85.0	.037

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C124	0.0 - 9.0	0.034
C125	9.0 - 11.0	.0010
C126	11.0 - 13.0	.019
C127	13.0 - 16.4	.00080
C128	16.4 - 22.5	.0022
C129	22.5 - 27.5	.0010
C130	27.5 - 32.5	.0038
C131	32.5 - 39.0	.0019
C132	39.0 - 45.0	.019
C133	45.0 - 49.0	.046
C134	49.0 - 50.0	.0032
C135	50.0 - 55.6	.035
C136	55.6 - 60.0	.01
C137	60.0 - 61.2	.039
C138	61.2 - 62.4	.02
C139	62.4 - 66.5	.016
C140	66.5 - 70.7	.009
C141	70.7 - 72.5	.009
C142	72.5 - 78.2	.05
C143	78.2 - 83.6	.035
C144	83.6 - 85.0	.01

Analyses of wall rock samples are given in table 2

FIGURE 16.—Assay plan of diamond-drill holes HY-4 and HY-5, Hyatt pegmatite, Larimer County, Colo.

RESULTS OF SPECTROGRAPHIC ANALYSIS

SLUDGE SAMPLES

Sample	Depth (feet)	BeO content (percent)
S 69	36.0 - 45.0	0.037
S 70	45.0 - 55.0	043

CORE SAMPLES

Sample	Depth (feet)	BeO content (percent)
C111	29.0 - 30.0	0.0180
C112	30.0 - 34.0	.077
C113	34.0 - 34.4	.034
C114	34.4 - 35.5	.15
C115	35.5 - 39.2	.007
C116	39.2 - 40.5	.0055
C117	40.5 - 43.5	.063
C118	43.5 - 48.2	.12
C119	48.2 - 50.0	.042
C120	50.0 - 50.4	.0089
C121	50.4 - 51.8	.097
C122	51.8 - 54.0	.025
C123	54.0 - 55.0	.0033

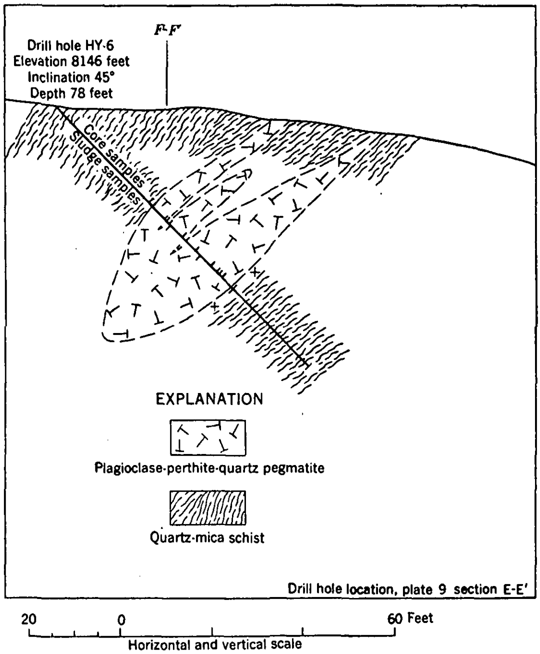


FIGURE 17.—Assay plan of diamond-drill hole HY-6, Hyatt pegmatite, Larimer County, Colo.

121 core samples of pegmatite including the immediately adjacent country rock were taken together with 10 core samples for a spectrographic study of the wall rocks.

MINERAL DEPOSITS

The beryl at the Hyatt pegmatite is present in the wall zones, both upper and lower, and in the inner intermediate zone. The wall zones contain about 0.35 percent beryl, all in grains less than 3 inches in size and averaging less than 1 inch. The drill samples from the inner intermediate zone indicate the rock contains slightly more than 1 percent beryl. Production of beryl from the same zone at the surface indicates a recoverable grade of about 2.3 percent beryl. The zone was sampled by drilling in three places, but only one rich shoot of beryl such as those from which most of the production of beryl has been derived was cut. The drilling, however, does indicate that shoots of beryl are present in the lower parts of the zone and are not restricted to the exposed parts.

The core of the pegmatite contains beryl along its margins. If this beryl is enclosed as fine grains in perthite, it may not be recovered except by milling the perthite.

The Hyatt pegmatite also contains scrap mica and perthite resources. Inclusions and interstitial materials are abundant in the perthite which is not of the best grade. Minor constituents that are of byproduct value are bismuthinite and uraninite.

The dumps at the Hyatt mine are not large but are estimated to contain considerable beryl and potash spar. Potash spar could be recovered by hand sorting, but not much of the beryl could be recovered economically by this method.

The milling of pegmatite to recover beryl and associated minerals of economic value is not within the scope of this report, but it should be pointed out that the fine-grained beryl of the wall zones, the existing dumps, and the residue of future hand-cobbing operations in the inner intermediate zone all constitute accessible mill feed. Milling of the pegmatite would undoubtedly yield higher recoveries of potash spar and mica than those calculated for the resources of recoverable minerals. Milling of the perthite of the core might also improve the grade of the potash spar by reducing the content of interstitial minerals.

BIG BOULDER PROSPECT

The Big Boulder prospect is about 37 miles by road southwest of Fort Collins, Colo., in the SE¼ sec. 36, T. 7 N., R. 72 W., sixth principal meridian. The prospect is reached from the town of Masonville by going west on the Buckhorn Creek road for 21 miles to a bridge and then turning south on an unimproved ranch road to the property (fig. 1). The prospect is on State land and is under the jurisdiction of the Colorado Board of Land Commissioners with offices in the State Capitol, Denver.

The Big Boulder pegmatite was opened in 1936 by Roy Hyatt and H. A. Snider. In 1941 about 600 pounds of beryl was mined and stockpiled by the United Beryllium Ores and Metals Corp., but the mine was idle from 1942 to 1950.

The workings on the property consist of four shallow pits, a small cut, and a 10-foot discovery shaft. A large beryl crystal was mined from the round pit northwest of the discovery shaft (p. 11).

The wartime investigations of the United States Geological Survey included mapping the Big Boulder pegmatite by Hanley and Page on October 2, 1942, and the results of this study are described by Hanley, Heinrich, and Page (1950, p. 92–93). In August 1947 the deposit was remapped by A. J. Lang and the writer.

GEOLOGY

The Big Boulder pegmatite is concordant throughout most of its length in quartz-mica schist which has a northward strike and steep dip. (See pl. 11.) The southern end of the Big Boulder pegmatite is in contact with a perthite-plagioclase-quartz pegmatite, but the structural relations are poorly exposed; a scale of fine-grained muscovite-rich pegmatite which is continuous with the border zone of the east-trending pegmatite (pl. 11) leads the writer to regard the perthite-plagioclase-quartz pegmatite as intrusive into the Big Boulder pegmatite along a plane dipping eastward at an angle of about 25°.

Most of the Big Boulder pegmatite is weathered and eroded to the level of the surrounding terrain, but the north end forms a prominent knob standing about 30 feet above the flat hilltop (pl. 11). A considerable amount of the border zone is exposed on the northern half of the knob indicating that the present exposure closely approximates the original shape of the north end of the pegmatite. In some places where the border zone has been removed, the muscovite books of the wall zone show a preferred orientation, so the position and attitude of the contact can be inferred within a few inches of the border.

The Big Boulder pegmatite is a zoned deposit about 245 feet long and with a maximum width of 80 feet. It strikes N. 10° E., has an over-all dip to the east, and plunges southward—the crest more steeply than the keel (pls. 11 and 12).

The deposit consists of five zones in addition to the border zone: a wall zone of plagioclase-quartz pegmatite, an upper intermediate zone of plagioclase-perthite-quartz pegmatite, a lower intermediate zone of cleavelandite-quartz pegmatite, a hood of perthite-quartz pegmatite, and a core of quartz pegmatite.

The border zone is well developed along most of the exposed contact but rarely exceeds an inch or two in thickness. It is rich in muscovite, and is essentially a muscovite-quartz-plagioclase pegmatite with grains ranging in size from 0.01 to 1 inch. In a few exposures, the schist at the contact with the pegmatite has been converted to granulite, and the border zone is unusually thin or absent.

The wall zone is composed of 55 percent plagioclase and 45 percent quartz with accessory perthite, muscovite, tourmaline, beryl, garnet, and apatite. Although the texture is fine grained, the grains range from 0.01 to 3 inches in length. Anhedral and euhedral beryl crystals average 0.7 inch in length, but some are as much as 2.5 inches long. Muscovite books are more abundant in the outer few inches of the zone than in the inner part and are roughly oriented normal to the contact. The zone has a maximum width of 25 feet and averages about 12 feet wide, but it is absent in some places. It thickens along the keel and toward the south end of the deposit. Although perthite is only an accessory mineral in the zone, it occurs principally in local concentrations rather than uniform disseminations: for example, perthite composes 10 to 25 percent of the material in elongate clots at or close to the contact in several places—along the east contact south of the intruding pegmatite, and at an off-shoot from the west contact west of drill hole BB–3 (pl. 11) and at the west contact in drill hole BB–4. The perthite is, nevertheless, not abundant enough to be classed as an essential mineral in this zone.

The intermediate part of the deposit is essentially an aggregate of albite, perthite, and quartz in two zones. Plagioclase-perthite-quartz pegmatite forms the upper intermediate zone and plagioclase-quartz pegmatite the lower zone. In both intermediate zones the plagioclase has the composition of albite, but in the lower part it has a platy habit and is of the type designated as cleavelandite. The upper intermediate zone is well exposed only in the knob, but the lower intermediate zone is poorly exposed and crops out only in the weathered southern part of the pegmatite.

The upper intermediate zone is composed of plagioclase (50 percent), perthite (30 percent), and quartz (20 percent) with accessory muscovite, tourmaline, beryl, apatite, relict spodumene(?), and uranium minerals. The zone is present in the upper part of the body (pl. 12) and attains a maximum thickness of 50 feet in the northern bulbous part; the average is about 15 feet. The texture is medium grained, but the grains are as much as 8 inches in size. Beryl crystals range in diameter from 0.1 to 4.5 inches and average about 1.5 inches in length. An area 4 feet wide and 25 feet long between the knob and the east contact is composed principally of fine-grained albite, with some perthite and quartz, which weathers more rapidly than the surrounding material and has a different appearance, but grades imperceptibly into material typical of the zone. This unit seems to be an integral part of the zone that crystallized under some locally anomalous conditions. The uraninite and its alteration products and relict spodumene(?) are exposed on the east wall of the discovery shaft along the boundary between the intermediate zone and the hood. The amounts of each are negligible.

The lower intermediate zone of cleavelandite-quartz pegmatite is composed of about 65 percent cleavelandite and 35 percent quartz. Muscovite, perthite, beryl, tourmaline, and garnet are accessory minerals. Two minute plates of tantalite-columbite were found in a core sample. Muscovite occurs as large flakes and books and also as minute scales with low refractive indices indicating the presence of some lithium. The zone forms a troughlike body with a maximum thickness of 25 feet at the south end and tapering upward to a knife edge. The texture is coarse because the common plates of cleavelandite range between 4 and 12 inches in length, though a few in the drill core may be as much as 30 inches long.

The inner edge of the lower intermediate zone contains relict spodumene(?). It is exposed in the eastern end of the northwest-trending trench (pl. 11) and in two places in the drill core of hole BB–5. In all places it is within a few feet of the quartz pegmatite of the core. The relict spodumene(?) is composed of a very fine-grained aggregate of albite and sericite which contains almost 1 percent lithium. Veinlets of fine-grained albite with a few euhedral garnet crystals and some dark phosphatic material cut the cleavelandite-quartz pegmatite.

A hood in the northern part of the Big Boulder pegmatite is composed of 70 percent perthite and 30 percent quartz. It has a maximum thickness of 60 feet (pl. 12). The rock is coarse grained, for the minerals average more than 1 foot in diameter and some perthite grains are as much as 6 feet in diameter. Beryl, muscovite, plagioclase, tourmaline, garnet, alteration products of lithiophilite, and traces of gummite, autunite, and torbernite are present in the hood. A 10.5-ton crystal of beryl was mined from the small pit in this unit northwest of the discovery shaft. In addition to this large crystal, a number of beryl crystals 12 inches in diameter have been found. Some of the quartz in the large shallow pit south of drill hole BB–3 is dark gray and minutely fractured, but it is not believed to be a tectonic breccia. The "breccialike" material is found in masses 1 to 6 feet in diameter that grade outward into typical light-gray to white quartz cut by a few widely spaced joints. The fractures are filled with fine-grained perthite. Streaks of fine-grained muscovite from an inch to a foot wide and 1 to 5 feet long cut the perthite and quartz. Irregular pockets, ½ to 3 feet across, containing garnet as the principal mineral, are scattered through this unit. The garnet is euhedral to anhedral, closely packed, dark colored, and stained with manganese oxides; associated with the garnet are quartz, muscovite, tourmaline, plagioclase, and iron and manganese phosphates.

A fracture filling of perthite-quartz pegmatite extends from the northern part of the hood, across the upper intermediate zone and wall zone to the contact between pegmatite and schist, and possibly into the schist (pl. 11). It is as much as 4 feet wide, has a sinuous trace, and probably dips steeply. The fracture filling can be traced about 4 feet inward from the boundary between the upper intermediate zone and the hood, and there it merges with the perthite-quartz pegmatite of the hood.

The core of the deposit is essentially quartz pegmatite with minor amounts of cleavelandite, muscovite, tourmaline, and garnet. Spectrographic analyses of drill core from this zone reveal the presence of BeO, but no beryl has been recognized. The long axis of the core of the pegmatite plunges 45° S. and is 200 feet long; the maximum width is 35 feet, and the greatest thickness is 100 feet. The size of

295165—55——7

the quartz grains is not known, but continuous masses of quartz 5 feet in length can be seen in the drill core.

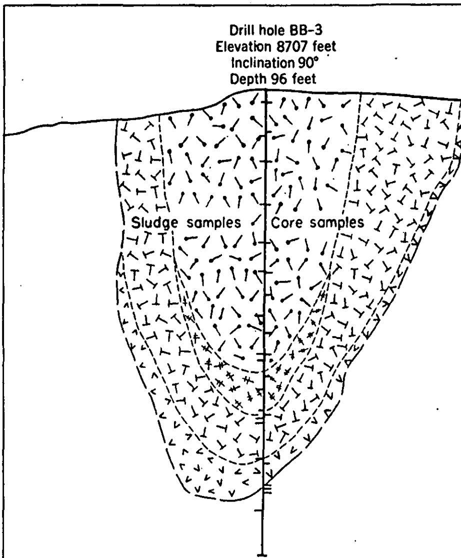
Small grains of tourmaline and muscovite form fillings in steeply dipping fractures that cut all minerals and zonal boundaries of the northern part of the Big Boulder pegmatite (pl. 11). The muscovite-tourmaline fillings are as much as half an inch wide, are discontinuous along the strike, and occur singly or in groups a foot wide and 6 feet long. The long groups of fractures exhibit a "horsetail pattern" of gently curving planes diverging from a central line. Individual fillings rarely exceed 6 inches in length and are generally straight. The horsetail groups are largest and most abundant directly north of drill hole BB-3 and decrease in length and abundance northward and outward to the walls of the deposit. The relations of the fractures to the mineral boundaries of the intermediate and wall zones show the openings formed after these zones had solidified. The muscovite-tourmaline fillings are not found in the hood or core. The fractures could have formed any time between the solidification of the outer zones and the final solidification of the core. These fissures are radially arranged and restricted to the northern quarter of the pegmatite, so it does not seem likely that they were caused by regional deformation. It may be presumed they are contraction or cooling cracks, as suggested by Cameron and others (1949, fig. 52, p. 71), which formed in the northern lobe of the body because it solidified first and lost heat faster than the main mass of the pegmatite. The zoning as shown in plate 12 indicates that the lobe was fully crystallized before the core in the main part of the pegmatite solidified. The presence of tourmaline and muscovite in the core of the pegmatite indicates that material was available at the last stages of crystallization for filling the fractures.

EXPLORATION

The Big Boulder prospect was explored by 5 core holes totaling 682 feet. The elevation of the collar, inclination of the hole, and depth drilled are indicated on the map (pl. 11); the drill logs (tables (appendix A, 7-9); the assay plans (figs. 18-20); and the cross sections (pl. 12). The drilling provided 32 sludge samples, 48 core samples of pegmatite including the immediately adjacent country rock, and 7 core samples for a spectrographic study of the wall rock.

MINERAL DEPOSITS

The Big Boulder prospect averages approximately 0.5 percent beryl; the core is almost barren, but the wall zone contains an amount greater than the average.



RESULTS OF SPECTROGRAPHIC ANALYSIS

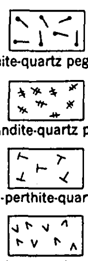
Sludge Samples

Sample	Depth (feet)	BeO Content (percent)
S 71	2.7 - 10.0	0.0030
S 72	10.0 - 15.0	0.026
S 73	15.0 - 24.0	0.0040
S 74	24.0 - 32.0	0.0037
	No sludge recovered	
S 75	37.8 - 47.0	0.0032
S 76	47.0 - 54.8	0.0044
	No sludge recovered	
S 77	56.2 - 62.0	0.010
	No sludge recovered	
S 78	67.2 - 68.0	0.0019
	No sludge recovered	
S 79	68.9 - 76.7	0.012
S 80	76.7 - 86.7	0.0065

Core Samples

Sample	Depth (feet)	BeO Content (percent)
C 97	2.7 - 9.0	0.00085
C 98	9.0 - 15.0	0.0068
C 99	15.0 - 24.0	0.0072
C100	24.0 - 32.0	0.0031
C101	32.8 - 38.0	0.00085
C102	38.0 - 42.7	0.0037
C103	42.7 - 50.6	0.00085
C104	50.6 - 54.8	0.0012
C105	54.8 - 59.2	0.0090
C106	59.2 - 67.2	0.0053
C107	67.2 - 77.0	0.0011
C108	77.0 - 81.8	0.00090
C109	81.8 - 82.4	0.0015
C110	82.4 - 83.2	0.0027

EXPLANATION

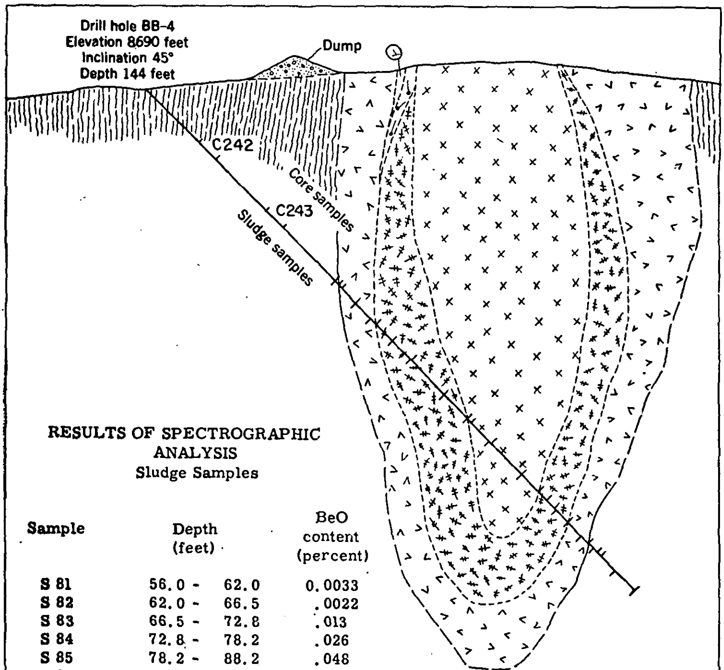


20 0 40 Feet
Horizontal and vertical scale

Drill hole location, plate 11 section B-B'

FIGURE 18.—Assay plan of diamond-drill hole BB-3, Big Boulder prospect, Larimer County, Colo.

The wall zone contains 0.75 percent beryl, each crystal less than 3 inches in maximum length. The lower intermediate zone contains rock with 0.37 percent beryl, in grains less than 5 inches in size. The core and upper intermediate zone have about 0.06 and 0.07 percent beryl, respectively. Beryl is visible in the outcrop of the upper intermediate zone, but neither the drill core nor the outcrop of the core reveal any beryl.



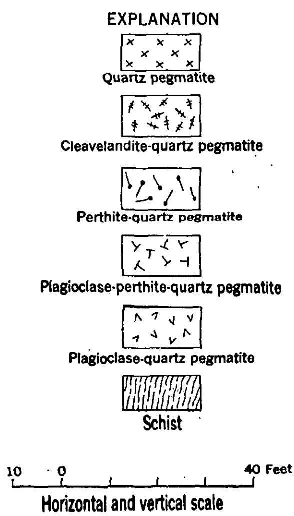
RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 81	56.0 - 62.0	0.0033
S 82	62.0 - 66.5	.0022
S 83	66.5 - 72.8	.013
S 84	72.8 - 78.2	.026
S 85	78.2 - 88.2	.048
S 86	88.2 - 95.0	.044
S 87	95.0 - 101.5	.015
S 88	101.5 - 111.0	.0080
S 89	111.0 - 121.0	.028
S 90	121.0 - 128.6	.044
S 91	128.6 - 132.5	.023
S 92	132.5 - 136.5	.0064

Core Samples

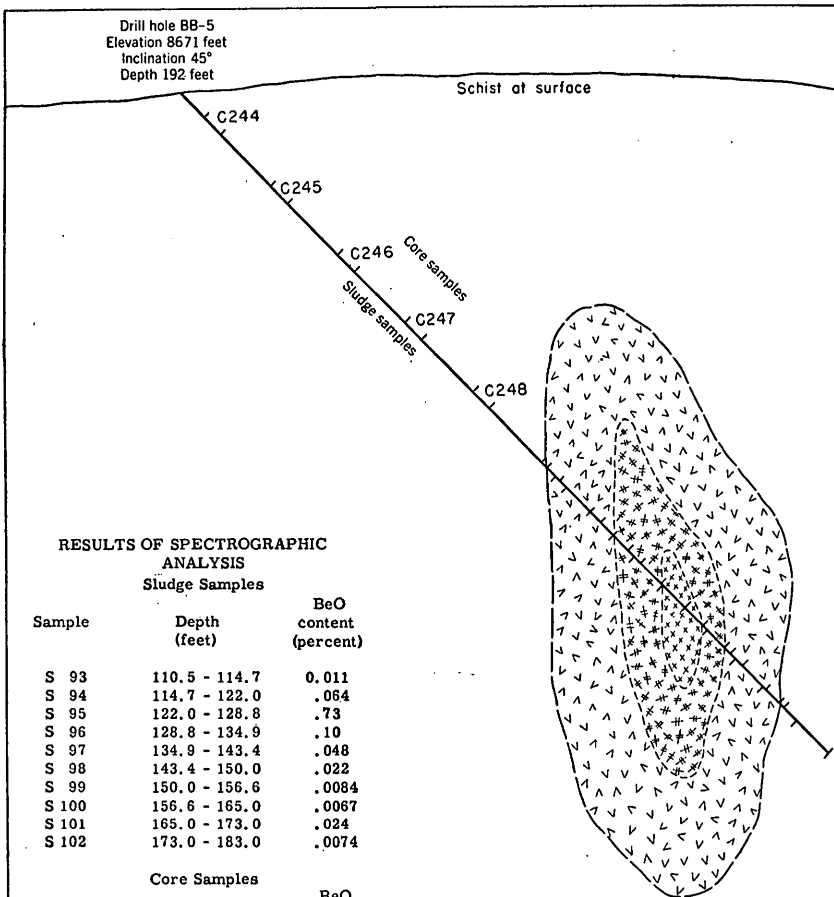
Sample	Depth (feet)	BeO content (percent)
C 79	56.0 - 57.0	0.0027
C 80	57.0 - 58.0	.0017
C 81	58.0 - 62.0	.0023
C 82	62.0 - 68.1	.0014
C 83	68.1 - 72.8	.013
C 84	72.8 - 78.2	.31
C 85	78.2 - 88.2	.039
C 86	88.2 - 95.0	.0033
C 87	95.0 - 96.0	.0034
C 88	96.0 - 102.0	.00075
C 89	102.0 - 111.0	.0021
C 90	111.0 - 116.0	.0033
C 91	116.0 - 118.2	.29
C 92	118.2 - 120.7	.0057
C 93	120.7 - 124.6	.015
C 94	124.6 - 130.8	.0034
C 95	130.8 - 133.0	.0045
C 96	133.0 - 134.1	.0088



Analyses of wall rock samples are given in table 2

Drill hole location, plate 11 section D-D'

FIGURE 19.—Assay plan of diamond-drill hole BB-4, Big Boulder prospect, Larimer County, Colo.



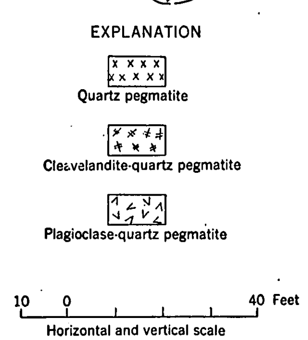
RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 93	110.5 - 114.7	0.011
S 94	114.7 - 122.0	.064
S 95	122.0 - 128.8	.73
S 96	128.8 - 134.9	.10
S 97	134.9 - 143.4	.048
S 98	143.4 - 150.0	.022
S 99	150.0 - 156.6	.0084
S 100	156.6 - 165.0	.0067
S 101	165.0 - 173.0	.024
S 102	173.0 - 183.0	.0074

Core Samples

Sample	Depth (feet)	BeO content (percent)
C 63	107.7 - 109.0	0.0019
C 64	109.0 - 112.8	.0018
C 65	112.8 - 122.0	.026
C 66	122.0 - 125.0	1.2
C 67	125.0 - 128.8	0.90
C 68	128.8 - 133.3	.0046
C 69	133.3 - 136.8	.0042
C 70	136.8 - 143.2	.0016
C 71	143.2 - 150.0	.0035
C 72	150.0 - 155.3	.0020
C 73	155.3 - 161.7	.0021
C 74	161.7 - 163.4	.0024
C 75	163.4 - 167.0	.048
C 76	167.0 - 174.0	.0073
C 77	174.0 - 178.1	.0042
C 78	178.1 - 179.1	.0046



Analyses of wall rock samples are given in table 2

Drill hole location, plate 11 section B-B'

FIGURE 20.—Assay plan of diamond-drill hole BB-5, Big Boulder prospect, Larimer County, Colo.

Only one drill hole cut through the hood of the deposit, and it did not core any beryl crystals (figs. 21, 22). The analyses show 0.04 percent beryl in the drill sample, but the production data show a grade of about 1.68 percent beryl.

No other economic mineral resources are present in the Big Boulder deposit. Muscovite is scarce and of scrap grade; perthite is intimately intergrown with other minerals, and tantalite-columbite is rare and fine grained.

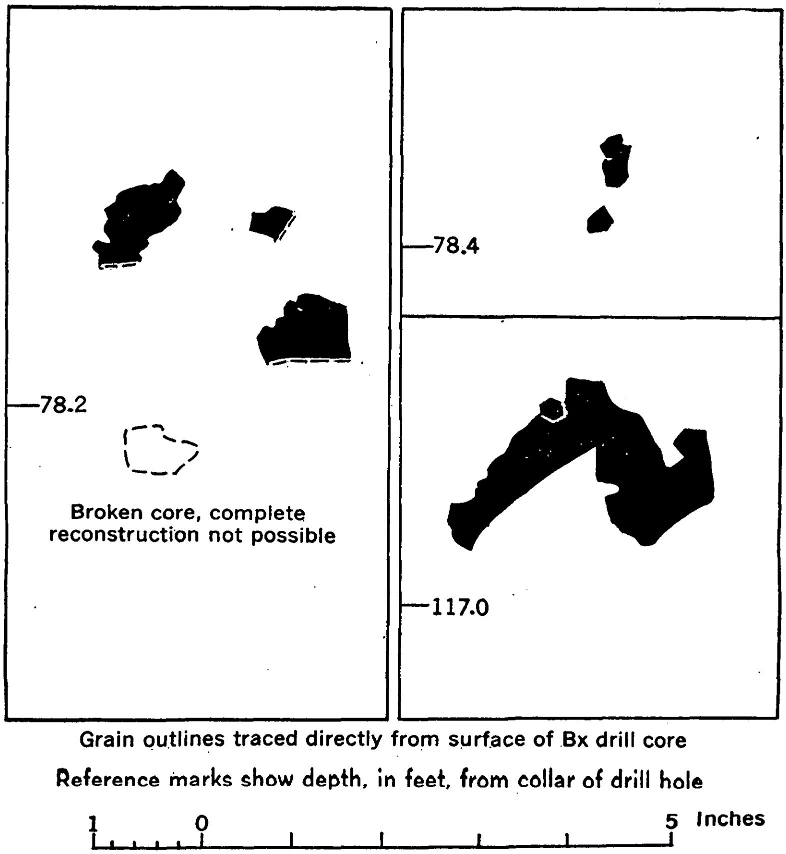


FIGURE 21.—Plan of beryl grains exposed on diamond-drill core from hole BB-4, Big Boulder prospect, Larimer County, Colo.

BUCKHORN MICA MINE

The Buckhorn Mica mine is reached from the town of Masonville by going west on the Buckhorn Creek road for 21 miles to a bridge and turning south on an unimproved ranch road to the property (fig. 2). The Buckhorn Mica mine is in the SW ¼ sec. 29, T. 7 N., R. 71 W., sixth principal meridian.

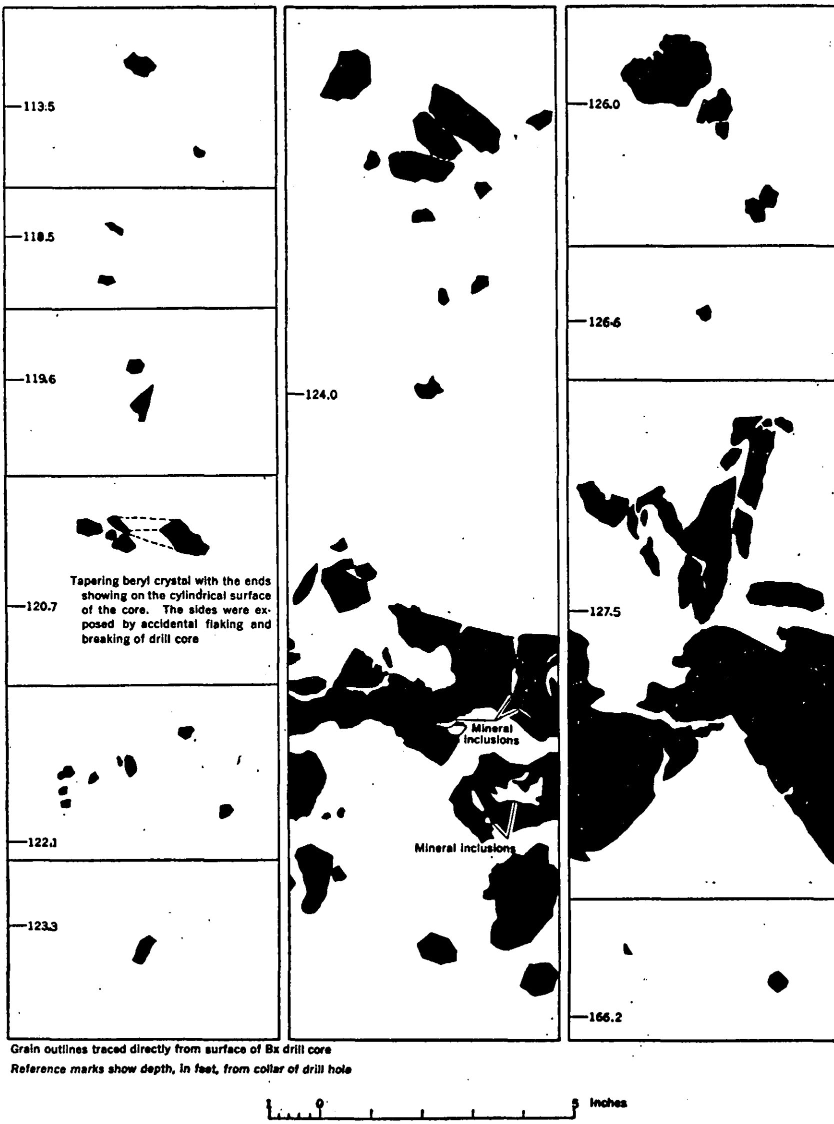


FIGURE 22.—Plan of beryl grains exposed on diamond-drill core from hole BB-5, Big Boulder prospect, Larimer County, Colo.

The mica deposit was discovered in 1884 and was mined for a short period by the Buckhorn Mica Mining & Milling Co. The mine is now owned by Roy Hyatt, who relocated it in 1942 as the Emerald Gem claim. The records of past production are not available, but it is reported that at least 180 tons of ground mica, a few hundred pounds of sheet mica, and 2 or 3 tons of beryl have been produced during different periods of operation. In recent years beryl has been handpicked from the dump, and the amount is estimated at about 1 ton.

The mine has been described by Sterrett (1923, p. 59–60) and by Hanley, Heinrich, and Page (1950, p. 88–90). It was mapped by L. R. Page and J. B. Hanley on September 29 and 30, 1942, and was reexamined by the writer in September 1947. The map by Page and Hanley is reproduced with minor modifications by the writer as plate 13.

The workings consist of three shafts, a series of shallow, more or less interconnected opencuts, and five trenches. The eastern shaft is reported to have been 50 feet deep, and according to Sterrett (1923, p. 59) drifts were made from this shaft, but the underground workings are inaccessible. The observable parts of the caved and backfilled shafts are vertical, and undoubtedly they were sunk in the mica-rich part of the pegmatite. Most of the pegmatite is eroded to the level of the surrounding terrain, but the contacts are well exposed at the east end, and the interior zones can be examined in the larger workings.

GEOLOGY

The Buckhorn Mica pegmatite is a multiple intrusion consisting of the main body 530 feet long, a smaller member at the west end and a poorly exposed member south of the workings in the eastern part of the deposit. The main body and the south member are vertical and concordant in the quartz-mica schist of the area that strikes N. 70° E. The western member is partly concordant as a western extension of the main body and partly discordant, lying in a plane striking N. 50° W., dipping 45° NE. The main body has a maximum width of 32 feet and probably averages about 20 feet in width. The western member has an average width of about 10 feet and reaches a maximum of 16 feet. The full extent of the south member is not known, but it is at least 100 feet long and has a maximum width of 9 feet, probably tapers to a knife edge at both ends, and extends to a depth of 120 feet or more.

The outer part of the main body contains plagioclase, quartz, and perthite, but the perthite is concentrated in the upper and outer parts of the deposit as at the Hyatt and Big Boulder pegmatites. The pegmatite forming the outer part of the deposit can be divided into two zones based on the abundance of perthite: the wall zone exposed at the surface is plagioclase-perthite-quartz pegmatite which grades inward and downward into the outer intermediate zone of plagioclase-quartz pegmatite (pl. 13). The inner intermediate zone is cleavelandite-quartz pegmatite, and the core is cleavelandite-quartz-spodumene(?) pegmatite.

The plagioclase-perthite-quartz pegmatite has a maximum width of 15 feet and extends to a maximum depth of 110 feet below the surface. The average grain size is less than 1 inch, but some grains are as much as 3 inches in long dimension. The texture and appearance of this zone are unusual: the bulk of the material is exceedingly fine grained and encloses coarser grained minerals in streaks and patches elongated roughly parallel to the walls. The matrix has an average grain size of less than 0.3 inch, but the minerals in the streaks are as much as 3 inches in length though the same minerals are common to both parts. The fine-grained matrix is somewhat darker than the common types of fine-grained pegmatite, and the color is irregular giving a blotchy appearance to the rock..

The 70-foot east-trending tongue at the east end of the main body is a zoned fracture filling. The pegmatite was fractured after most of the wall zone had solidified and pegmatite solutions escaped from the unconsolidated interior. The material crystallized to form zones continuous with the rest of the body. This interpretation has been proposed previously by Cameron and others (1949, p. 76). The fracture which breached the wall zone is a conspicuous surface coated with fine-grained green muscovite which separates the wall zone from the intermediate zone on the north side of the large opencut. The wall zone has an average width of about 7 feet in most of the main body but is only 0.2 to 1 foot wide in the fracture filling. The writer concurs with Cameron and his coauthors in explaining the origin of this body and adds the data regarding the thin perthite-bearing wall zone to restrict more closely the relative chronology and eliminate the possibility suggested by Hanley, Heinrich, and Page (1950, p. 89) that the interior zones were formed by a separate injection of magma distinct from the pegmatite forming the wall zone.

The wall zone contains about 0.4 percent beryl according to the drilling data, but only a few crystals, all less than 1 inch in length, are visible in the outcrop. The major beryl content would seem to reside in finely disseminated grains. The proportions of minerals in the fine-grained wall zone are difficult to estimate but appear to be about 55 percent plagioclase, 30 percent perthite, and 15 percent quartz. Muscovite forms less than 1 percent of the wall zone. Other accessory minerals are tourmaline and garnet.

The outer intermediate zone of plagioclase-quartz pegmatite is as much as 10 feet wide but is absent in many places along the outcrop; it extends to the keel of the pegmatite, a maximum depth of 155 feet below the surface. The outer intermediate zone is composed of 65 percent plagioclase and 35 percent quartz in grains ranging from 0.01 to 12 inches in size. Most of the grains, however, range from 1 to 4 inches. Muscovite is abundant in local concentrations: the old workings were sunk on one or more muscovite shoots, but existing exposures do not indicate that muscovite is an essential constituent of the remainder of the zone. Undoubtedly mica-rich pockets and streaks exist in concealed parts of the deposit, but mica probably constitutes less than 5 percent of the total rock. Many muscovite books from the dump are 1 to 8 inches across and as much as 3 inches thick, but all are ruled, wedged, and stained. Perthite in grains 2 to 20 inches across is present in this zone. Tourmaline and purpurite (a hydrous phosphate of iron and manganese) and related phosphatic compounds are minor accessory minerals.

Beryl makes up about 0.5 percent of the outer intermediate zone and occurs in anhedral and euhedral crystals 0.1 to 5 inches in length. Many of the euhedral crystals enclose a large amount of quartz, plagioclase, and muscovite, and some are hardly more than hexagonal rims of beryl around a core of other minerals (see figs. 23–27).

The plagioclase of the outer intermediate zone is albite with an average composition of Ab_{94}. It becomes coarser and somewhat platy

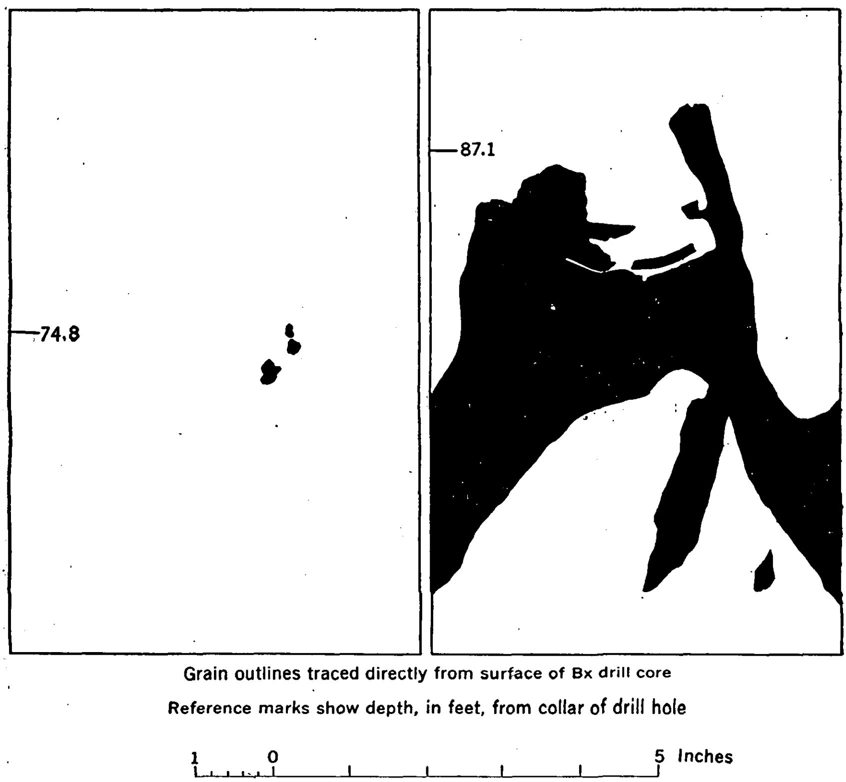


FIGURE 23.—Plan of beryl grains exposed on diamond-drill core from hole BH-1, Buckhorn Mica mine, Larimer County, Colo.

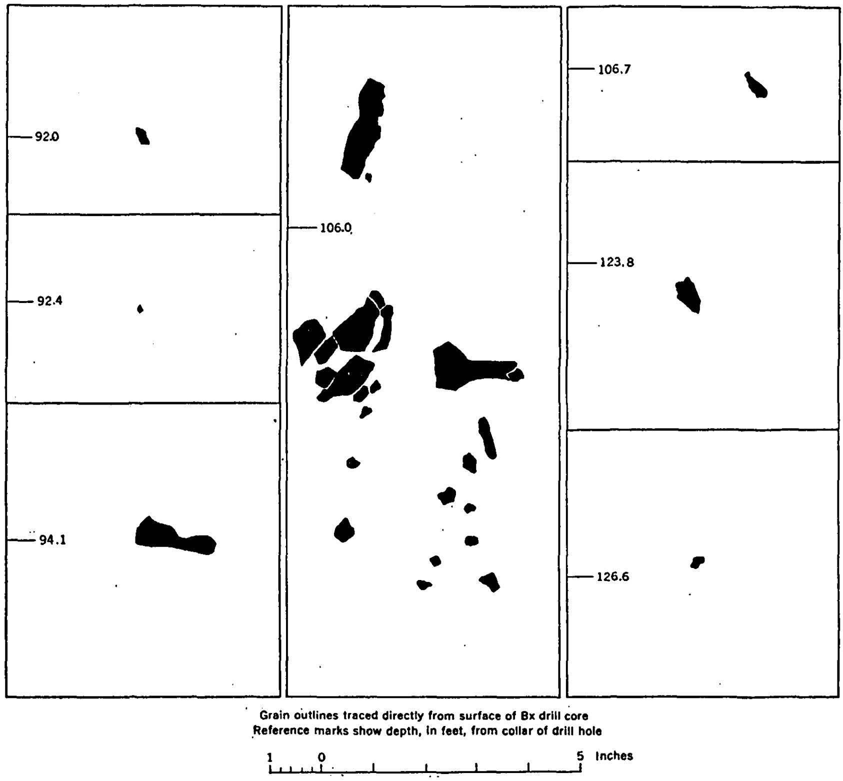


FIGURE 24.—Plan of beryl grains exposed on diamond-drill core from hole BH-2, Buckhorn Mica mine, Larimer County, Colo.

inward toward the inner intermediate zone, and grades gradually into cleavelandite. The boundary between the two intermediate zones is drawn more on average texture and decline of muscovite content than on differences in the essential minerals.

The inner intermediate zone of cleavelandite-quartz pegmatite is exposed for 490 feet on the surface and extends out in the eastern tongue of the main body; it is well exposed in the trench at the east end as well as in the main workings. It has a maximum width of 16 feet and is interpreted to have a maximum depth of 110 feet below the outcrop. The inner intermediate zone contains about 55 percent cleavelandite, 43 percent quartz, and 2 percent accessory minerals. The cleavelandite has an average albite content of Ab_{95} to Ab_{96}, and forms plates as much as 0.3 inch wide and 12 inches long. Muscovite, beryl, columbite-tantalite, and perthite are accessory components. Muscovite forms thin books, 1 to 6 inches in diameter, and minute scales. Columbite-tantalite occurs in plates and blades, 0.01 to 0.6 inch thick and 0.02 to 1 inch long.

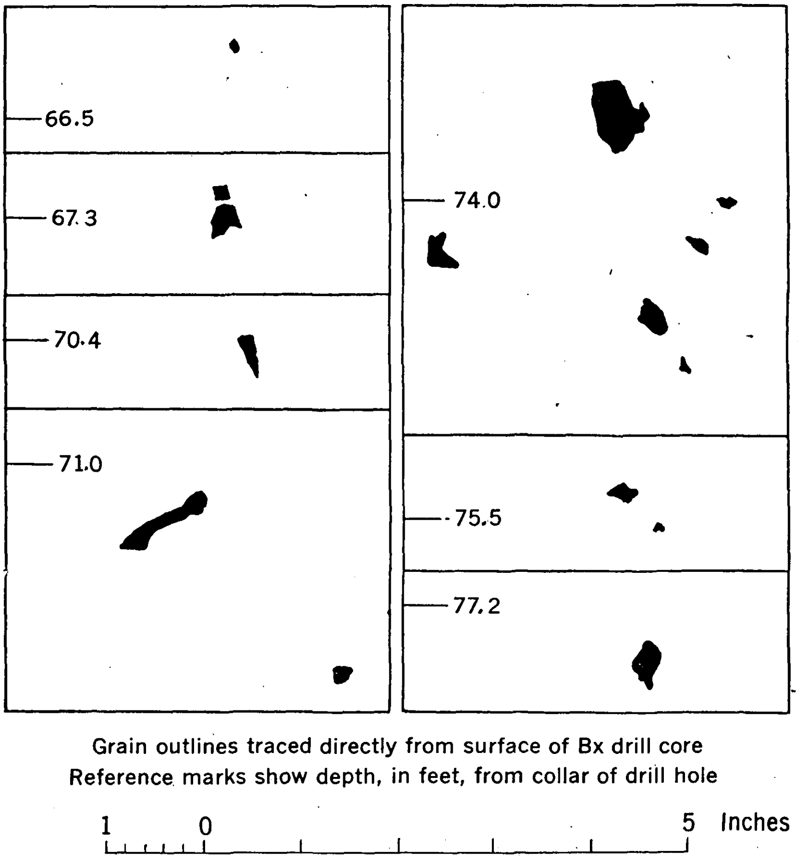


FIGURE 25.—Plan of beryl grains exposed on diamond-drill core from hole BH–3, Buckhorn Mica mine, Larimer County, Colo.

The beryl of the inner intermediate zone is white to pale greenish blue and occurs in grains and crystals 0.1 to 10 inches in length and as much as 6 inches in diameter. Assays of drill samples indicate that the zone contains at least 0.8 percent beryl and locally as much as 2 percent.

The core crops out in the workings for a distance of 85 feet. It has a maximum width of 10 feet and an average width of about 4 feet, tapers downward, and extends about 75 feet below the surface. The core was intersected in drill hole BH–1 but not in the other holes. It is interpreted to have a maximum length of 180 feet in the direction of plunge, that is, 22° S. 68° W.

The core of the main body contains 50 percent cleavelandite, 45 percent quartz, 3 percent relict spodumene(?), and 2 percent accessory minerals. The cleavelandite of the groundmass ranges in composition from Ab_{96} to Ab_{99} and forms plates as much as 20 inches long. Were

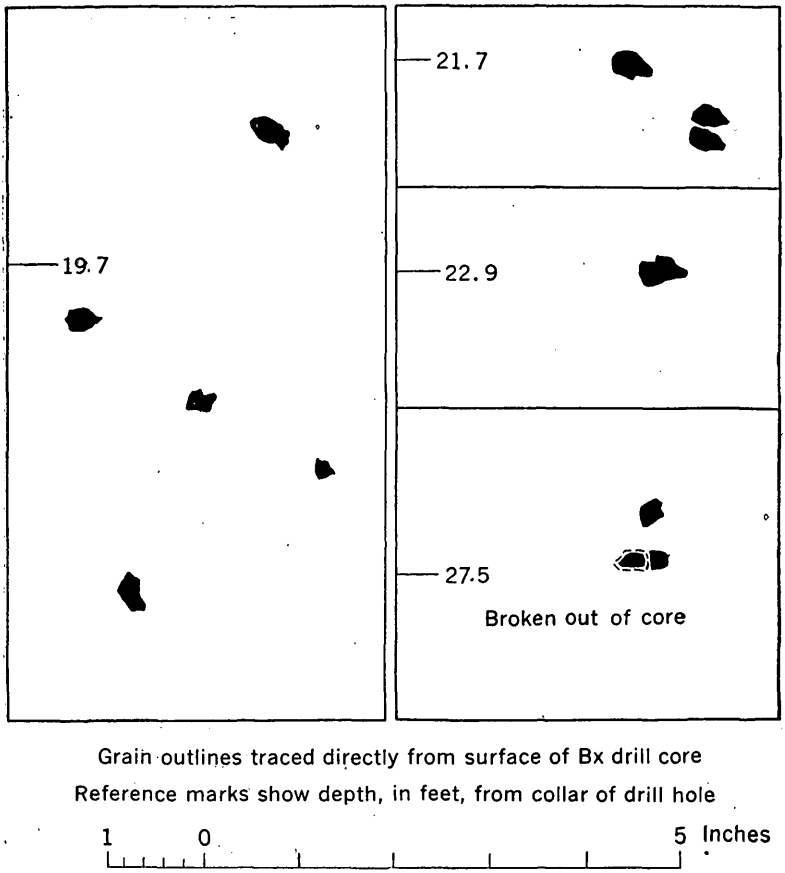


FIGURE 26.—Plan of beryl grains exposed on diamond-drill core from hole BH-4, Buckhorn Mica mine, Larimer County, Colo.

it not for the relict spodumene(?), this zone would differ from the zone surrounding it only in being somewhat coarser grained. The spodumene is replaced by cleavelandite and by lithium-bearing pseudomorphous aggregates of fine-grained albite (Ab_{97}) and sericite. The fine-grained aggregate preserves in many places the lamellar structure of spodumene, but cleavelandite growing inward into the space occupied by the spodumene preserves only the outline of the lath. Some of the relict laths are 3 feet long and 2 to 4 inches thick.

Quartz in the core occurs in larger masses than in the inner intermediate zone, some of the clusters attaining a length of 5 feet. The quartz is cut by streaks and veinlets of fine-grained pale scaly mica. Beryl is an important accessory and in the workings is estimated to constitute 1 percent or more of the zone. The beryl crystals are white to pale blue, are commonly coated with very fine-grained muscovite and albite, and enclose fewer grains of other minerals than

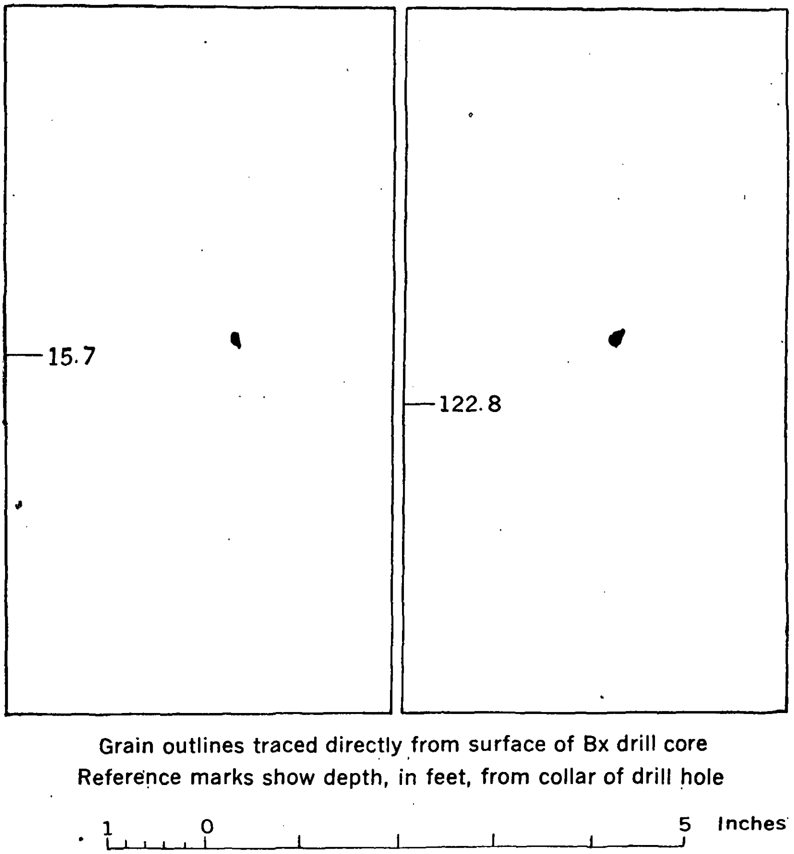


FIGURE 27.—Plan of beryl grains exposed on diamond-drill core from hole BH-5, Buckhorn Mica mine, Larimer County, Colo.

beryl in the surrounding zones. Columbite-tantalite occurs in plates which range from 0.01 to 0.23 inch thick, 0.2 to 3 inches long, and 0.1 to 2 inches wide. One block of rock from the core contains an estimated 11 cubic inches of columbite-tantalite in three clusters of tabular crystals.

The south member of the Buckhorn Mica pegmatite branches off from the main body along the westward extension of the schist parting that is exposed on the south side of the main workings. It is made up of plagioclase-perthite-quartz pegmatite like the wall zone of the main body with which it merges. Like the wall zone of the main body, it is also fine-grained, tan to cream, and mottled. It contains plagioclase (55 percent), perthite (30 percent), and quartz (15 percent). It is known to extend westward to drill hole BH-2 and may connect with the two small pegmatites farther west. Assays indicate a beryl content of about 0.5 percent; but beryl is not readily discernible in the outcrop, so it is probably very fine grained. Muscovite and tourmaline are minor accessory minerals.

The west member branches off from the main body at the end of a schist parting that is exposed in the westernmost pit. Much of the pegmatite in this part of the deposit is concealed, and some of the relations are obscure. The part of the member that trends northeast parallels the main body and is concordant in the schist. The northwest-trending part is in a plane striking N. 50° W., dipping 45° NE. According to the data obtained by drilling, the strike and dip of the discordant branch changes slightly to the northeast. (Compare cross sections in pl. 13.) The concordant part of the west member forms the connecting link between the main body and the discordant part. The northwestward extent of the discordant part may be greater than is shown in the sections (pl. 13), and its northeastward extent in the plane of dip may also be somewhat greater. The intersection of the northeast-dipping plane with the plane of the main body may modify the shape of the keel of the main body; the shape suggested in the sections (pl. 13) assumes that there has been no modification, but the dotted areas are not included in the calculations of reserves.

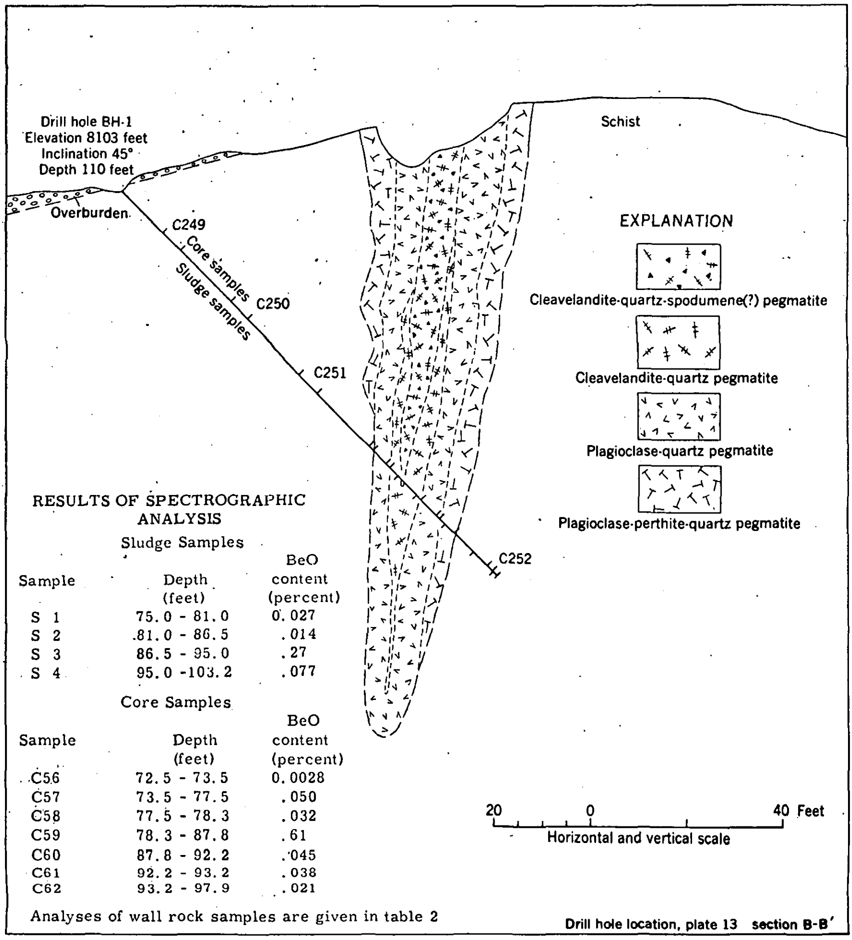
At the surface the west member consists of a perthite-bearing wall zone of plagioclase-quartz pegmatite and a core of cleavelandite-quartz pegmatite. In drill holes BH–4 and BH–5 the wall zone does not contain perthite. In hole BH–3 there are relicts of schistose structure which are interpreted as pegmatitized material at the junction of the west member with the main body.

Drill holes BH–4 and BH–5 pass beneath the main body at such points that the possibility of a westward-plunging crest is eliminated and a narrow limit set on the probable extent of the main body.

The zonal boundaries shown in plate 29 differ in detail from those on the original map by Hanley, Heinrich, and Page (1950, pl. 11). The drilling reveals that the zones are more uniform and symmetrical than the weathered outcrop suggests, and the float has been reexamined and reinterpreted accordingly.

EXPLORATION

The Buckhorn Mica deposit was explored by five holes. The elevation of each collar, the inclination of each hole, and the depths drilled are indicated on the map (pl. 13), the drill logs (appendix A, 10–14), the assay plans (figs. 28–32), and the cross sections (pl. 13). The drilling provided 15 sludge samples, 62 core samples of pegmatite and the immediately adjacent country rock, and 7 core samples for a spectrographic study of the wall rocks.



RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 1	75.0 - 81.0	0.027
S 2	81.0 - 86.5	.014
S 3	86.5 - 95.0	.27
S 4	95.0 - 103.2	.077

Core Samples

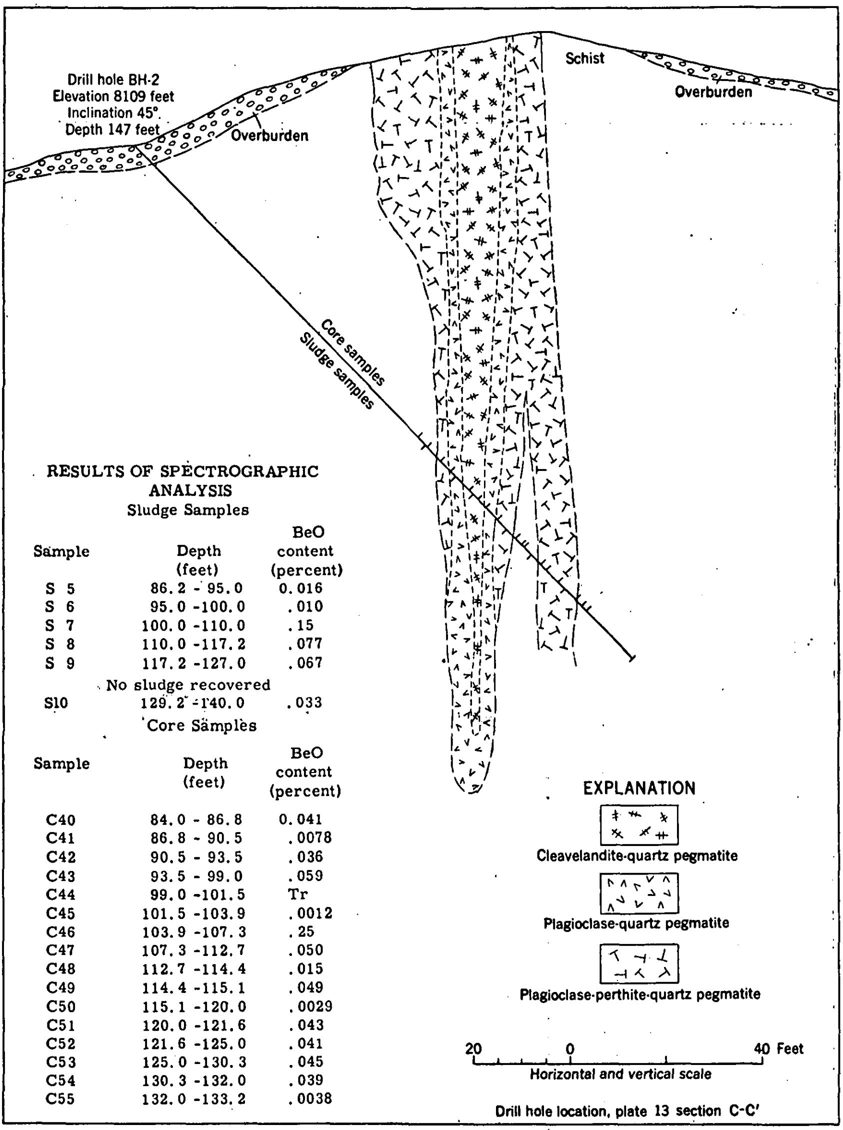
Sample	Depth (feet)	BeO content (percent)
C56	72.5 - 73.5	0.0028
C57	73.5 - 77.5	.050
C58	77.5 - 78.3	.032
C59	78.3 - 87.8	.61
C60	87.8 - 92.2	.045
C61	92.2 - 93.2	.038
C62	93.2 - 97.9	.021

Analyses of wall rock samples are given in table 2

FIGURE 28.—Assay plan of diamond-drill hole BH-1, Buckhorn Mica mine, Larimer County, Colo.

MINERAL DEPOSITS

The most important beryl-bearing zones are the core and inner intermediate zone of the main body. The core is relatively small and is estimated to have the same beryl content as the surrounding zone, so that they are considered as one deposit in the calculations of tonnage and grade. The drilling indicates that beryl-rich pockets are present below the workings, but there is no evidence to assume that they are present in the western part of the deposit. Assays of the drill samples are combined with assays of samples taken at the surface to arrive at estimates of beryl content west of the workings. Samples of the dumps from the main workings confirm the high beryl content indicated by drilling beneath the workings. The beryl content calculated from the drilling data ranges from 0.01 to 1.97 percent and averages 0.86 percent; when combined with other sample data the



RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 5	86.2 - 95.0	0.016
S 6	95.0 -100.0	.010
S 7	100.0 -110.0	.15
S 8	110.0 -117.2	.077
S 9	117.2 -127.0	.067
	No sludge recovered	
S10	129.2 -140.0	.033

Core Samples

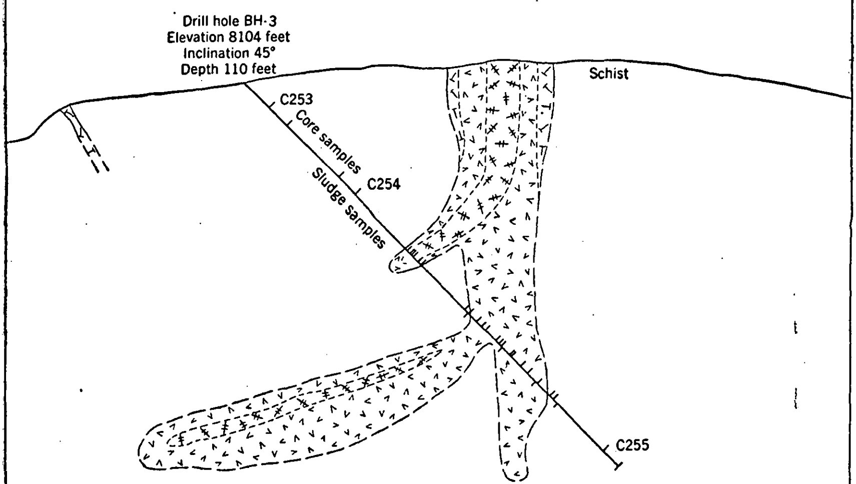
Sample	Depth (feet)	BeO content (percent)
C40	84.0 - 86.8	0.041
C41	86.8 - 90.5	.0078
C42	90.5 - 93.5	.036
C43	93.5 - 99.0	.059
C44	99.0 -101.5	Tr
C45	101.5 -103.9	.0012
C46	103.9 -107.3	.25
C47	107.3 -112.7	.050
C48	112.7 -114.4	.015
C49	114.4 -115.1	.049
C50	115.1 -120.0	.0029
C51	120.0 -121.6	.043
C52	121.6 -125.0	.041
C53	125.0 -130.3	.045
C54	130.3 -132.0	.039
C55	132.0 -133.2	.0038

FIGURE 29.—Assay plan of diamond-drill hole BH-2, Buckhorn Mica mine, Larimer County, Colo.

range is from 0.29 to 1.97 percent and the average is 1.06 percent beryl.

Other resources of the Buckhorn Mica mine are scrap mica and columbite-tantalite.

The columbite-tantalite content of the core and inner intermediate zone has not been tested analytically, but an examination of the workings and dumps suggests that the mineral is present in concentrations of the order of 0.00001 percent.



RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 11	65.0 - 75.0	0.041
S 12	75.0 - 85.0	.048
S 13	85.0 - 91.0	.047

Core Samples

Sample	Depth (feet)	BeO content (percent)
C21	47.5 - 48.4	0.0014
C22	48.4 - 48.9	.0043
C23	48.9 - 50.4	.0011
C24	50.4 - 51.2	.058
C25	51.2 - 51.8	.036
C26	64.0 - 65.2	.0028
C27	65.2 - 67.7	.043
C28	67.7 - 69.1	.066
C29	69.1 - 70.1	.0044
C30	70.1 - 73.4	.062
C31	73.4 - 74.3	.30
C32	74.3 - 74.7	.010
C33	74.7 - 77.3	.054
C34	77.3 - 77.5	.60
C35	77.5 - 80.6	.028
C36	80.6 - 82.6	.038
C37	82.6 - 85.6	.037
C38	85.6 - 89.0	.037
C39	89.0 - 90.0	.0021

EXPLANATION

Cleavelandite-quartz pegmatite

Plagioclase-quartz pegmatite

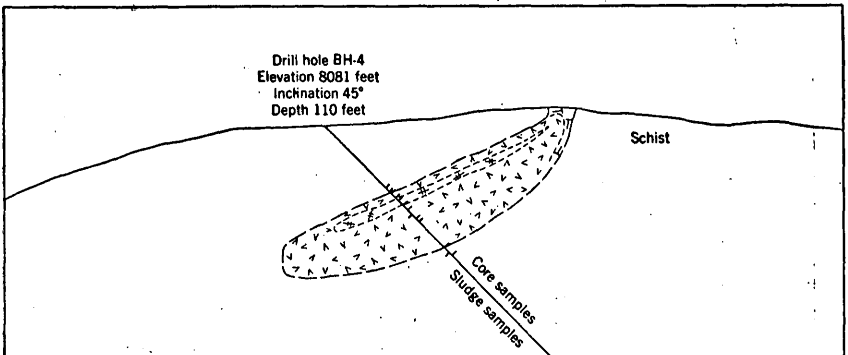
Plagioclase-perthite-quartz pegmatite

20 0 40 Feet
Horizontal and vertical scale

Drill hole location, plate 13 section E-E'

Analyses of wall rock samples are given in table 2.

FIGURE 30.—Assay plan of diamond-drill hole BH-3, Buckhorn Mica mine, Larimer County, Colo.



RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 14	25.8 - 36.3	0.062

Core Samples

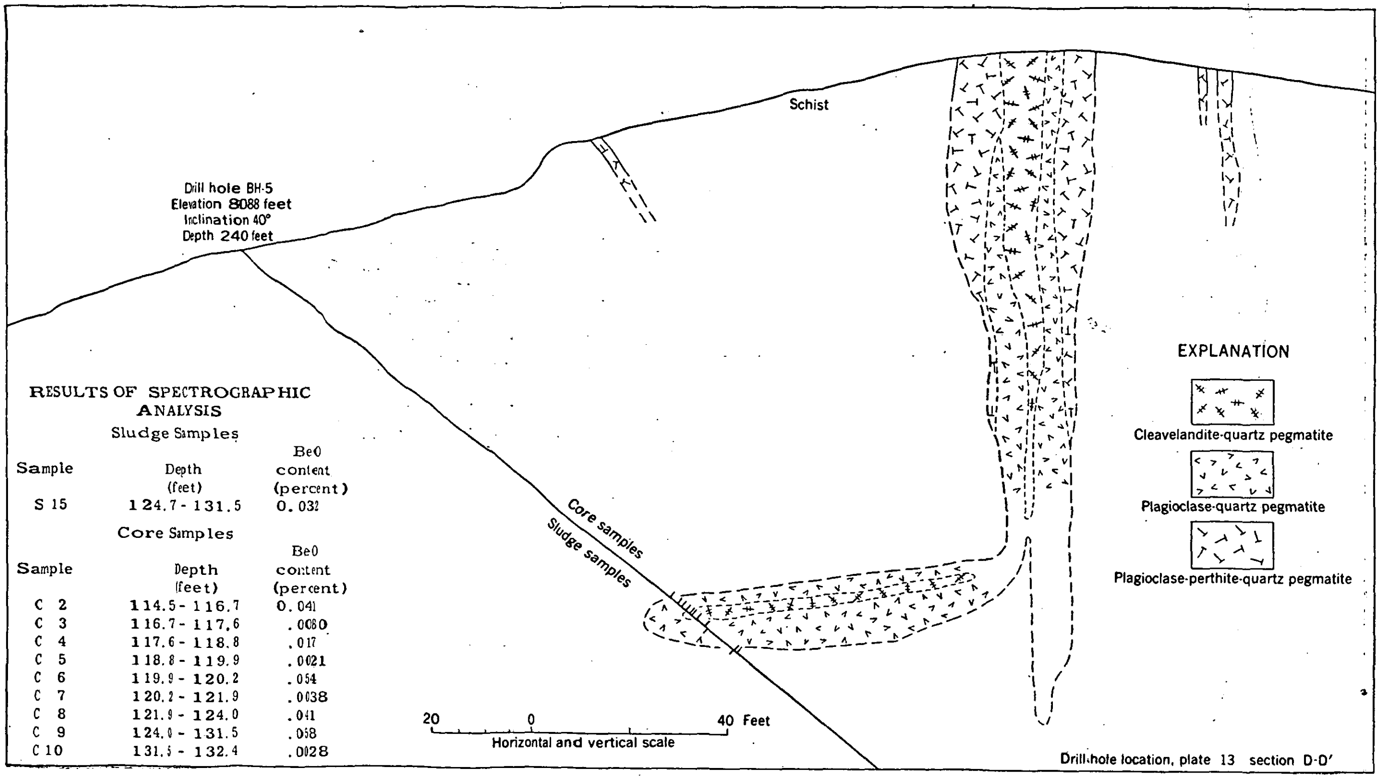
Sample	Depth (feet)	BeO content (percent)
C11	17.8 - 18.8	0.0016
C12	18.8 - 19.3	.23
C13	19.3 - 20.4	.080
C14	20.4 - 21.6	.0024
C15	21.6 - 23.0	.083
C16	23.0 - 24.0	.030
C17	24.0 - 26.5	.052
C18	26.5 - 27.5	.028
C19	27.5 - 35.0	.063
C20	35.0 - 37.0	.0019

FIGURE 31.—Assay plan of diamond-drill hole BH-4, Buckhorn Mica mine, Larimer County, Colo.

The dumps at the Buckhorn Mica mine have been partly reworked and the larger pieces of beryl removed, but they are estimated to contain a few tons of beryl too small to recover by hand sorting.

Perthite grains and crystals might be hand sorted as a byproduct, but the deposit could not be mined for potash feldspar alone.

The relict spodumene(?) contains less than 1 percent lithium and is not a marketable product.



RESULTS OF SPECTROGRAPHIC ANALYSIS

Sludge Samples

Sample	Depth (feet)	BeO content (percent)
S 15	124.7 - 131.5	0.032

Core Samples

Sample	Depth (feet)	BeO content (percent)
C 2	114.5 - 116.7	0.041
C 3	116.7 - 117.6	.0080
C 4	117.6 - 118.8	.017
C 5	118.8 - 119.9	.0021
C 6	119.9 - 120.2	.054
C 7	120.2 - 121.9	.0038
C 8	121.9 - 124.0	.041
C 9	124.0 - 131.5	.058
C 10	131.5 - 132.4	.0028

FIGURE 32.—Assay plan of diamond-drill hole BH-5, Buckhorn Mica mine, Larimer County, Colo.

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APPENDIX A

LOGS OF DRILL HOLES

1.—Drill hole HY-1

Altitude of collar: 8,129.7 feet.
Bearing: S. 24° E.

Inclination: 52°.
Total length: 105 feet.

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 7)*
0–48.2		Biotite granite. Light-gray, medium-grained. Biotite flakes in some parts alined in planes cutting[1] at as much as 32°, indicating flow structure in granite; foliation dips 50° to 85° southward. Many quartz veins 0.01 to 0.2 foot wide, many joints; six pyrite fracture fillings between 19 and 20 feet.	---------
48.2–49.0		Plagioclase-quartz-muscovite pegmatite. Fine-grained. Plagioclase (50 percent), quartz (45 percent), muscovite (5 percent).	---------
49.0–50.4		Biotite granite	---------
50.4–55.0		Pegmatite, mainly plagioclase-quartz. Fine-grained.	
	50.4–53.7	Plagioclase (85 percent), quartz (12 percent), muscovite (3 percent). Muscovite in clots and streaks.	0.0016
	53.7–55.0	Plagioclase (75 percent), quartz (12 percent), perthite (10 percent), muscovite (3 percent).	---------
55.0–56.8		Schist. Granitized, contorted, with many small veins and blebs of quartz.	---------
56.8–57.4		Granite. Foliation prominent, cutting at 40°	---------
57.4–60.0		Plagioclase-perthite-quartz pegmatite. Fine-grained. Plagioclase (50 percent), perthite (25 percent), quartz (20 percent), muscovite (15 percent). Plagioclase and quartz in graphic intergrowth.	.0015
60.0–62.0		Schist. Granitized, and impregnated with pegmatite	---------
	62.0	Pegmatite contact; gradational, cuts at 35° to 40°.	
62.0–85.0		Pegmatite, mainly perthite-plagioclase-quartz. Fine-grained.	
	62.0–67.0	Plagioclase (45 percent), perthite (30 percent), quartz (22 percent), muscovite (3 percent). Cluster of tiny red-brown garnet grains at 65.6 feet.	.0003
	67.0–73.1	Perthite (45 percent), plagioclase (30 percent), quartz (22 percent), muscovite (3 percent).	.0017
	73.1–76.8	Plagioclase (50 percent), perthite (25 percent), quartz (15 percent), muscovite (10 percent).	.0056
	76.8–85.0	Perthite (50 percent), plagioclase (25 percent), quartz (22 percent), muscovite (3 percent). Between 80.2 and 80.6 feet streaks of fine-grained mica cut at 35°.	.0045
	85.0	Pegmatite contact not preserved.	
85.0–90.0		Biotite granite with apatite, and beryl-bearing pegmatite.	
	85.1	Fracture cuts at 57°	.0004
	88.0	Small pegmatite dike cuts at 59°	---------
	89.0	Garnet-bearing pegmatite dike 0.05 foot wide cuts at 33°.	---------
90–105.0		Granite and pegmatitic granite with gradational contacts	---------

2.—Drill hole HY-2

Altitude of collar: 8,163.7 feet.
Bearing: S. 24° E.

Inclination: 70°.
Total length: 176 feet.

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 8)*
0–9		Overburden	---------
9–104.9		Biotite granite. Light-gray, medium-grained, with quartz veins less than 0.2 foot wide and a few stringers of feldspar-rich pegmatite less than 0.1 foot wide. Few joints. Planar features range in cut[1] from 15° to 55°.	---------
	104.9	Contact between granite and pegmatite; quartz-rich, gradational—cut may average about 60°.	

See footnotes at end of table.

2.—*Drill hole HY-2*—Continued

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 8)*
104.9-165.6		Pegmatite, mainly plagioclase-quartz. Fine-grained.	
	104.9-108.5	Plagioclase (60 percent), quartz (29 percent), muscovite (10 percent), tourmaline (1 percent). Muscovite books as much as 0.2 foot in diameter.	0.0057
	108.5-112.3	Plagioclase (65 percent), quartz (32 percent), muscovite (3 percent), tourmaline (X).[2] Graphically intergrown plagioclase and quartz in irregular patches. Tourmaline occurs in muscovite-rich clots.	---------
	112.3-113.3	Quartz (80 percent), plagioclase (12 percent), muscovite (8 percent).	---------
	113.3-114.9	Quartz (99 percent), plagioclase (1 percent)	---------
	114.9-116.2	Quartz (60 percent), cleavelandite (30 percent), muscovite (10 percent).	.0136
	116.2-165.6	Plagioclase (60 percent), quartz (40 percent). Muscovite (X) and tourmaline (X) in streaks and patches. Graphic intergrowths of plagioclase and quartz common. Clot of muscovite and quartz in irregular intergrowth at 124 feet. Clusters of garnet grains common from 164 to 165.6 feet.	.0134
	165.6	Pegmatite contact cuts at 32°.	
165.6-166.8		Granite; with quartz veins and pegmatite patches	---------
166.8-176		Biotite granite. Foliation cuts at 50° to 65°	---------

3.—*Drill hole HY-3*

Altitude of collar: 8,179.5 feet. Inclination: 50°.
Bearing: S. 25° E. Total length: 217 feet.

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 9)*
0-4		Overburden	---------
4-96.8		Biotite granite. Light-gray, medium-grained	---------
	17-18	Biotite flakes alined in two sets of planes. One is parallel to core and the other cuts [1] at 22°; the strike of one set is at 15° to the strike of the other.	
	27	Cluster of pyrite grains.	
	30	Band of quartz and pyrite 0.05 foot wide cuts at 15°.	
	38	Biotite flakes alined in two sets of planes, one parallel to core and one cutting at 35°; planes strike at 35° to each other.	
	47	Quartz pegmatite 1.5 feet wide, cuts at 22°.	
	67	Biotite flakes alined at cut of 40° and at cut of 90°; planes strike at 40° to each other.	
	80	Streak of dark minerals 0.01 foot wide, cuts at 36°.	
	85	Biotite flakes parallel the core.	
	94	Biotite flakes alined in two planes parallel to the core, striking at 20° to each other.	
	96.8	Pegmatite contact cuts at 48°.	
96.8-100.8		Perthite-plagioclase pegmatite. Medium-grained. Perthite (60 percent), plagioclase (38 percent), quartz (2 percent).	---------
	100.8	Biotite-granite contact cuts at 80°.	
100.8-132.5		Biotite granite	---------
	110	Biotite flakes parallel the core.	
	120	Two seams of quartz and pyrite, 0.02 foot wide, cut at 62°.	
	132.5	Pegmatite contact is irregular; minimum cut is 55°, maximum is 80°.	

See footnotes at end of table.

3.—Drill hole HY–3—Continued

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 9)*
132.5–144.6	Pegmatite, mainly plagioclase-quartz-perthite.		
	132.5–139.4	Plagioclase (60 percent), quartz (25 percent), perthite (10 percent), muscovite (5 percent). Fine-grained; graphic textures common. Garnet grains as much as 0.005 foot in diameter and tourmaline grains as much as 0.03 foot long from 132.5 to 133.5 feet.	0.0004
	139.4–144.6	Quartz (90 percent), plagioclase (7 percent), muscovite (3 percent). Plagioclase forms thin interstitial stringers. Tourmaline common between 139.4 and 140.5 feet.	--------
144.6–148.2	Perthite-quartz pegmatite. Quartz with dark-green apatite		--------
148.2–162.5	Pegmatite, mainly quartz-plagioclase-muscovite. Medium-grained.		
	148.2–151.2	Quartz (70 percent), platy plagioclase (20 percent), muscovite (10 percent).	.0299
	151.2–153.0	Quartz (85 percent), platy plagioclase (15 percent), muscovite (X).[2] Muscovite in wedged books as much as 0.3 foot long.	--------
	153.0–154.9	Quartz (65 percent), platy plagioclase (20 percent), muscovite (15 percent). Small areas of dark-gray quartz.	.1836
	154.9–157.9	Plagioclase (65 percent), quartz (35 percent) muscovite (X), tourmaline (X). Graphic intergrowth of plagioclase and quartz.	.0011
	157.9–159.2	Quartz (55 percent), plagioclase (45 percent). Coarser grained than units above and below.	.0037
	159.2–162.5	Plagioclase (50 percent) and quartz (50 percent) in graphic intergrowth.	.0077
162.5–178.7	Pegmatite, mainly perthite. Coarse-grained		--------
	162.5–164.4	Plagioclase (55 percent), quartz (38 percent), muscovite (5 percent), tourmaline (2 percent). Fine, irregular grain and involute banding; white feldspar around pink feldspar, muscovite-rich selvage on feldspar.	
	164.4–178.7	Perthite.	
178.7–189.0	Perthite-plagioclase-quartz pegmatite. Medium-grained.		
	178.7–183.6	Perthite (45 percent), plagioclase (30 percent), quartz (25 percent), muscovite (4 percent), tourmaline (1 percent).	.0162
	183.6–189.0	Perthite (60 percent), plagioclase (20 percent), quartz (15 percent), muscovite (4 percent), tourmaline (1 percent). Clusters of tiny garnet crystals at 187.0 feet.	.0037
189.0–209.6	Plagioclase-quartz pegmatite.		
	189.0–199.3	Plagioclase (70 percent) and quartz (30 percent) in graphic intergrowth.	.0031
	199.3–201.0	Plagioclase (97 percent), quartz (3 percent)	--------
	201.0–202.6	Plagioclase (60 percent) and quartz (40 percent) in graphic intergrowth.	--------
	202.6–204.4	Pegmatitized granite (fine-grained quartz and mica) with plagioclase-quartz pegmatite impregnations and stringers. Contains 1 percent tourmaline. A roll in the footwall.	--------
	204.4–207.9	Plagioclase (96 percent), quartz (4 percent). A very fine-grained aggregate of quartz and muscovite veins the mass, giving a faint marblelike shadowing.	.0005
	207.9–209.6	Plagioclase (85 percent), quartz (15 percent)	.0026
	209.6	Pegmatite contact cuts at 80° to 90°.	
209.6–217	Biotite granite		--------
	209.6–212	Biotite flakes alined almost parallel to core in two planes striking at 40° to each other.	
	212–217	Foliation parallel to core.	

See footnotes at end of table.

4.—Drill hole HY-4

Altitude of collar: 8,171.5 feet.
Bearing: S. 25° E.

Inclination: 50°.
Total length: 242 feet.

Feet		Description	Beryl: area on core surface, in square feet (see fig. 10)
0-10	Overburden		--------
10-170	Biotite granite. Light-gray, medium-grained		--------
	19	Biotite flakes parallel to core.	
	19-21	Closely spaced fractures in granite.	
	21.5	Pegmatite 0.3 foot wide cuts [1] at 46°. Quartz (95 percent), perthite (4 percent), plagioclase (1 percent), tourmaline (X).[3]	
	21-170	Fractures, and quartz veins less than 0.1 foot in width occur at intervals of 0.1 to 1 foot.	
	58.8	Pyrite fracture filling 0.01 foot wide cuts at 90°.	
	61	Chlorite and pyrite fracture filling cuts at 65°.	
	62-63	Feldspar-rich pegmatite. Fine-grained.	
	71.8	Feldspar-rich pegmatite 0.1 foot wide with pyrite and tourmaline; cuts at 69°.	
	78.7	Chlorite and pyrite fracture filling 0.01 foot wide; cuts at 58°.	
	88.2-89.8	Pegmatite 1 foot wide cuts at 72°. Quartz (98 percent), feldspar (2 percent).	
	91.2	Pegmatite 0.15 foot wide cuts at 77°. Feldspar (95 percent), quartz (5 percent), muscovite (X), tourmaline (X).	
	92.8	Pegmatite 0.2 foot wide cuts at 50°. Quartz (80 percent), feldspar (20 percent), apatite (X).	
	97	Biotite flakes alined parallel to core and at 20° to core; planes strike at 40° to each other.	
	103-110	Granite much fractured; pegmatitic parts.	
	112.2	Biotite alinement cuts at 17°.	
	127-130	Fractures parallel the core.	
	140	Biotite alinement cuts at 24° to 34°.	
	140.5-143	Pegmatite. Quartz, feldspar, apatite. Upper contact cuts at 60°, lower contact at 48°.	
	143-149	Massive granite.	
	149	Biotite alinement cuts at 28°.	
	163	Biotite alinement cuts at 18°.	
	170.0	Pegmatite contact cuts at 46.°	
170.0-213.4	Pegmatite, mainly plagioclase-quartz.		
	170.0-171.6	Plagioclase (90 percent), quartz (9 percent), muscovite (1 percent). Tourmaline-rich band 0.1 foot wide at 170.3 feet.	--------
	171.6-173.6	Plagioclase (70 percent), quartz (22 percent), muscovite (8 percent). Muscovite occurs in quartz-rich streaks between 171.6 and 172.3 and between 173.0 and 173.2 feet. Tourmaline-rich band cuts at 65° to 70°.	0.0021
	173.6-176.0	Plagioclase (70 percent), quartz (30 percent), muscovite (X). Tourmaline-rich band 0.05 foot wide cuts at 35°.	.0012
	176.0-178.2	Plagioclase (70 percent), quartz (30 percent), muscovite (X). White plagioclase is somewhat platy and forms graphic intergrowth with quartz.	--------
	178.2-180.6	Platy plagioclase (97 percent), quartz (2 percent), muscovite (1 percent).	.0024
	180.6-190.2	Plagioclase (70 percent), quartz (30 percent), muscovite (X), tourmaline (X). Plagioclase, somewhat platy, in graphic intergrowth with quartz. Cluster of garnet crystals 0.001 foot in diameter at 181.9 feet. Tourmaline grains as much as 0.06 foot long make up 1 percent of the rock from 185.7 to 186.7 feet.	.0033

See footnotes at end of table.

4.—Drill hole HY-4—Continued

Feet		*Description*	*Beryl: area on core surface in square feet (see fig. 10)*
170.0–213.4	Pegmatite, mainly plagioclase-quartz—Continued		
	190.2–194.3	Plagioclase (70 percent), quartz (30 percent), muscovite (X),[2] tourmaline (X). Plagioclase of blocky habit rather than platy. Three garnet crystals—dimensions 0.02 by 0.02 feet, 0.01 by 0.03 feet, and 0.03 by 0.03 feet—at 191.0 feet. Cluster of tiny garnet crystals at 192.0 feet. At 193.0 feet a garnet-rich band cuts[1] at 50°.	0.0010
	194.3–201.0	Plagioclase (60 percent), quartz (30 percent), muscovite (10 percent). Plagioclase platy. Muscovite in masses as much as 0.2 foot long.	.0016
	201.0–204.3	Quartz (98 percent), plagioclase (2 percent), muscovite (X).	---------
	204.3–208.8	Plagioclase (80 percent), quartz (20 percent), muscovite (X), tourmaline (X). Plagioclase granular to blocky.	.0023
	208.8–212.0	Plagioclase (80 percent), quartz (20 percent), in part graphic. Garnet band cuts at 90° at 212.0 feet.	---------
	212.0–213.4	Plagioclase (70 percent), and quartz (30 percent). Scattered clusters of tiny garnet crystals. At 213 feet minute anhedral to euhedral pyrite grains.	.0020
	213.4	Granite contact cuts at 42°.	
213.4–234.3	Granite with small pegmatite bodies.		
	213.4–217.5	Granite with foliation parallel to core	---------
	217.5–218.7	Pegmatitized granite.	
	218.7–220.9	Plagioclase-quartz-perthite pegmatite. Upper contact cuts at 75°, lower cuts at 50°.	---------
	221.8–222.2	Plagioclase-quartz pegmatite cuts at 70°	---------
	224.4–227.8	Perthite-plagioclase-quartz pegmatite. Perthite (60 percent), plagioclase (30 percent), quartz (9 percent), muscovite (1 percent). Muscovite books as much as 0.1 foot across. Upper contact cuts at 25°, lower at 80°.	.0003
	228.2–234.3	Plagioclase-perthite-quarz pegmatite. Plagioclase (55 percent), perthite (30 percent), quartz (15 percent), muscovite (X). At 230.0 feet rock in a 0.6 foot interval contains very fine-grained green mica in greenish-tinted platy plagioclase. Upper contact cuts at 80°, and lower at 64°.	.0022
234.3–242	Biotite granite		---------

5.—Drill hole HY-5

Altitude of collar: 8,138.7 feet. Inclination: 60°.
Bearing: S. 25° E. Total length: 101 feet

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 11)*
0–13	Deeply weathered and partly eroded; core recovery low; contacts approximate.		---------
	0–9	Plagioclase-perthite-quartz pegmatite. Plagioclase (45 percent), perthite (35 percent), quartz (15 percent), muscovite (5 percent).	
	9–11	Quartz.	
	11–13	Plagioclase-quartz-muscovite pegmatite. Fine-grained. Plagioclase (60 percent), quartz (35 percent), muscovite (5 percent). Patches of graphic material.	

See footnotes at end of table.

5.—Drill hole HY-5—Continued

Feet	Description		Beryl: area on core surface in square feet (see fig. 11)
13-55.6	Pegmatite		---------
	13-16	Quartz.	
	16.0-16.4	Quartz (98 percent), plagioclase (2 percent).	
	16.4-27.5	Coarse-grained, pinkish-white perthite.	
	27.5-33.0	Pink perthite.	
	33.0-39.0	Medium-grained quartz (90 percent), with interstitial cleavelandite (8 percent) and muscovite (2 percent).	
	39.0-45.0	Platy plagioclase (75 percent), quartz (23 percent), muscovite (2 percent). Fine-grained. Band of tourmaline 0.2 foot wide at 45.0 feet.	
	45.0-49.0	Graphic, fine-grained intergrowth of plagioclase (75 percent) and quartz (25 percent).	
	49.0-50.0	Plagioclase (50 percent), quartz (30 percent), muscovite (20 percent).	
	50.0-55.6	Perthite (50 percent), plagioclase (25 percent), quartz (15 percent), muscovite (9 percent), tourmaline (1 percent).	
55.6-62.4	Pegmatite, mainly plagioclase-quartz-muscovite		---------
	55.6-60.0	Platy plagioclase (80 percent), quartz (16 percent), perthite (2 percent), muscovite (2 percent).	
	60.0-61.2	Fine-grained aggregate of plagioclase, quartz, and muscovite.	
	61.2-62.4	Dense granular albite.	
62.4-83.6	Plagioclase-quartz pegmatite		---------
	62.4-70.7	Plagioclase (90 percent), quartz (6 percent), muscovite (4 percent), tourmaline (X).[2]	
	70.7-72.5	Fine-grained mica and tourmaline laced through plagioclase (80 percent), quartz (17 percent), muscovite (3 percent).	
	72.5-78.2	Plagioclase (80 percent), quartz (17 percent), muscovite (3 percent).	
	78.2-83.6	Plagioclase (80 percent), quartz (19 percent), muscovite (1 percent).	0.0047
	83.6	Pegmatite contact cuts [1] at 70°.	
83.6-101	Biotite granite with quartz veins and small pegmatites		---------
	83.6-87.0	Quartz veins less than 0.05 foot wide, cut at 10°, 40°, and 50°.	
	93.0	Irregular quartz vein 0.5 foot wide, rich in pyrite.	
	96.0	Pegmatite 0.1 foot wide. Plagioclase (70 percent), quartz (30 percent). Cuts at 65°.	
	97.0	Pegmatite 0.05 foot wide, cuts at 28° in opposite direction to pegmatite at 96.0 feet. Plagioclase (85 percent), quartz (15 percent).	

6.—Drill hole HY-6

Altitude of collar: 8,145.7 feet.
Bearing: S. 24° E.

Inclination: 45°.
Total length: 78 feet.

Feet	Description	Beryl: area on core surface, in square feet (see fig. 12)
0-5	Overburden	--------
5-16	Quartz-mica schist. Dark-gray, fine-grained, fine banding. Cuts [1] at 70° to 90°.	--------
16-16.5	Granite with irregular disconformable contact	--------
16.5-18.9	Quartz	--------
18.9-29.9	Quartz-mica schist. Foliation cuts at 80° to 90°	--------
29.9-30.0	Tourmalinized schist	--------
30.0-34.0	Plagioclase-perthite-quartz pegmatite. Fine-grained. Plagioclase (40 percent), perthite (30 percent), quartz (25 percent), muscovite (5 percent). Upper contact irregular, cut averaging about 70°.	0.0009

See footnotes at end of table.

6.—Drill hole HY-6—Continued

Feet		*Description*	*Beryl: area on core surface in square feet (see fig. 12)*
34.0–34.4	Schist, tourmalinized and silicified		---------
34.4–39.2	Plagioclase-quartz pegmatite		---------
	34.4–35.5	Plagioclase (70 percent), quartz (25 percent), muscovite (5 percent).	
	35.5–39.2	Plagioclase (75 percent), quartz (22 percent), muscovite (3 percent). Fine-grained graphic intergrowth of plagioclase and quartz.	0.0018
39.2–40.5	Tourmaline schist		---------
40.5–54.0	Pegmatite, mainly plagioclase-quartz		---------
	40.5–43.5	Plagioclase (68 percent), quartz (22 percent), perthite (7 percent), muscovite (3 percent). Irregular, fine-grained.	.0009
	43.5–48.2	Graphic intergrowth of plagioclase (80 percent) and quartz (18 percent); muscovite (2 percent).	
	48.2–50.0	Plagioclase (70 percent), quartz (20 percent), perthite (9 percent), muscovite (1 percent). Plagioclase and quartz in graphic intergrowth.	
	50.0–50.4	Perthite with brown dendritic discoloration	.0002
	50.4–51.8	Plagioclase (80 percent), quartz (19 percent), garnet (1 percent). Graphic intergrowth of plagioclase and quartz.	.0036
	51.8–54.0	Plagioclase (80 percent), quartz (20 percent). Graphic.	.0028
	54.0	Contact of pegmatite with granite cuts at 77°.	
54.0–56.3	Biotite granite. Coarse-grained; foliation cuts [1] at 15°		---------
56.3–78	Biotite granite with many quartz veins less than 0.06 foot wide, and feldspar-rich pegmatites 0.2 to 0.3 foot wide at 73, 76.3, and 77 feet. Light-gray aplite dikes at 61 and 70 feet, less than 0.2 foot wide.		---------

7.—Drill hole BB-3

Altitude of collar: 8,707 feet. Inclination: Vertical.
Bearing: Vertical. Total length: 96 feet.

Feet		*Description*	*Beryl: area on core surface, in square feet*
0–2.7	Overburden		---------
2.7–59.2	Pegmatite, mainly perthite-quartz		---------
	2.7–9.0	Coarse-grained perthite with fine-grained interstitial quartz.	
	9.0–15.0	Dark-gray quartz in pebbly brecciallike aggregate with perthite fillings; hematite stains; muscovite (X).[2]	
	15.0–18.0	Quartz in progressively larger fragments with wider perthite fillings, that is, gradation to unit below.	
	18.0–38.0	Coarse-grained perthite with a dozen wedge-shaped blades of light-colored quartz 0.02 foot wide.	
	38.0–42.7	Coarse-grained graphic granite.	
	42.7–47.0	Coarse-grained pink perthite.	
	47.0–48.0	Dark-gray quartz.	
	48.0–59.2	Coarse-grained perthite, a little very fine grained quartz and muscovite. Nodule of iron-manganese phosphate 0.1 foot in diameter at 51.0 feet.	
59.2–67.2	Cleavelandite-quartz pegmatite. Medium-grained. White to cream cleavelandite (65 percent), quartz (30 percent), very fine grained muscovite (3 percent), salmon-colored perthite (2 percent).		---------

See footnotes at end of table.

7.—*Drill hole BB–3*—Continued

Feet		*Description*	*Beryl: area on core surface, in square feet*
67.2–77.0	Plagioclase-perthite-quartz pegmatite. Plagioclase (55 percent), perthite (25 percent), quartz (20 percent), muscovite (X).		--------
	77.0	Band 0.05 foot wide of tiny tourmaline needles; cuts [1] at 70°.	
77.0–82.4	Plagioclase-quartz pegmatite. Fine-grained. Plagioclase (60 percent), quartz (35 percent), perthite (3 percent), muscovite (2 percent).		--------
	82.4	Pegmatite contact cuts at 37°.	
82.4–96.0	Quartz-mica schist. Medium-gray, medium-grained. Cuts at 40°.		
	95–96	Schist contorted; vague foliation cuts at 32°.	

8.—*Drill hole BB–4*

Altitude of collar: 8,690 feet. Inclination: 45°.
Bearing: S. 77° E. Total length: 144 feet

Feet		*Description*	*Beryl: area on core surface in square feet (see fig. 21)*
0–3	Overburden		--------
3–57	Quartz-mica schist		--------
	3–20	Quartz (70 percent), mica (20 percent), feldspar (10 percent). Coarse-grained. Very light-gray quartzose bands alternate with dark-gray to black micaceous bands. Foliation cuts [1] at 35°. Schist gradually becomes lighter and finer grained downward.	
	20–56	Quartz (75 percent), mica (15 percent), feldspar (10 percent). Medium-grained, light-gray, fine banding. Foliation cuts at 25° to 40°.	
	56–57	Dense quartz-mica rock with a few tiny garnet crystals and a feldspar-rich pegmatite 0.05 foot wide sutting at 22°.	
	57	Pegmatite contact, embayed and irregular; average cut about 55°.	
57–68.1	Plagioclase-quartz pegmatite		--------
	57.0–57.4	Clot, with graphic structure, of plagioclase (50 percent), perthite (25 percent), quartz (25 percent).	
	57.4–68.1	Plagioclase (85 percent), quartz (12 percent), perthite (3 percent), muscovite (X).[2] Plagioclase and quartz in graphic intergrowth.	
68.1–96.0	Cleavelandite-quartz pegmatite. Medium-grained.		
	68.1–74.5	Cleavelandite (50 percent), quartz (50 percent).	--------
	74.5–96.0	Cleavelandite (80 percent), quartz (20 percent).	0.0101
96.0–116.0	Pegmatite, mainly quartz. Coarse-grained.		
	96.0–102.0	Quartz (90 percent), cleavelandite (9 percent), tourmaline (1 percent).	
	102.0–106.0	Quartz (96 percent); some massive, grading into breccialike with interstices filled with fine-grained white albite and fine-grained muscovite. A few crystals of garnet and tourmaline.	
	106.0–111.0	Quartz with small blades of white and pink (iron-stained?) cleavelandite, sugary fine-grained albite, muscovite in books as much as 0.1 foot in diameter, and exceedingly fine-grained, pale-green mica.	
	111.0–116.0	Quartz (60 percent), cleavelandite (25 percent), muscovite (10 percent), perthite and microcline (4 percent), garnet (1 percent).	

See footnotes at end of table.

8.—Drill hole BB-4—Continued

Feet		Description	Beryl: area on core surface in square feet (see fig. 21)
116.0–124.6		Cleavelandite-quartz pegmatite. Medium-grained.	
	116.0–121.7	Cleavelandite (60 percent), quartz (40 percent).	0.0708
	121.7–124.6	Cleavelandite and quartz in graphic intergrowth.	---------
124.6–130.8		Plagioclase-quartz pegmatite. Fine-grained. Plagioclase (90 percent), quartz (10 percent), muscovite (X).	---------
	130.8	Schist contact cuts at 70°.	
130.8–144		Quartz-mica schist, some pegmatized	---------
	130.8–131.4	Pegmatized schist. Foliage cuts at 68° to 73°.	
	131.4–133.0	Pegmatite. Fine-grained. Feldspar (85 percent), quartz (15 percent).	
	133.0–134.1	Medium-gray schist. Foliation cuts at 55°.	
	134.1–144	Light-gray schist. Dense; faint banding.	

9.—Drill hole BB-5

Altitude of collar: 8,671 feet.
Bearing: S. 77° E.
Inclination: 45°.
Total length: 192 feet.

Feet		Description	Beryl: area on core surface, in square feet (see fig. 22)
0–6.5		Overburden	---------
6.5–109.0		Quartz-mica schist. Light-gray, medium-grained. Quartz (70 percent), biotite (15 percent), muscovite (10 percent), feldspar (5 percent). Foliation cuts [1] at 35° to 55°; foliation contorted in narrow zones at 12.0, 25.4, and 65 feet. Quartz stringers and blebs at 12.0, 54.0, 65.0, and 93 feet.	
	98–101	Foliation cuts at 60°.	
	109.0	Pegmatite contact, embayed and irregular; cut ranges from 40° to 75°.	
109.0–128.8		Plagioclase-quartz pegmatite.	
	109.0–112.8	Plagioclase (50 percent), quartz (50 percent), pale-green muscovite (X),[2] in minute flakes and in books as much as 0.06 foot in diameter.	0.2619
	112.8–113.0	Muscovite books	---------
	113.0–121.0	Much of quartz and plagioclase is in graphic intergrowth. Irregular 1-inch masses of microcline between 113 and 114.5 feet.	.0101
	122.0–125.0	Large incomplete crystals of beryl	.1245
	123.0–125.0	Tourmaline grains and crystals as much as 0.2 foot in size.	---------
	125–128.8	Plagioclase becomes progressively more platy.	.1273
128.8–143.2		Pegmatite, mainly cleavelandite-quartz	---------
	128.8–133.3	Cleavelandite (90 percent), quartz (10 percent).	
	133.3–136.8	Cleavelandite (95 percent), quartz (5 percent); cut by veinlets of very fine-grained albite, euhedral garnet, dark phosphatic material. Stained by manganese oxides.	
	136.8–142.5	Cleavelandite with manganese oxide dendrites.	
	142.5–143.2	Relict spodumene (?) (90 percent), quartz (6 percent), cleavelandite (4 percent).	
143.2–155.3		Quartz pegmatite. Coarse-grained	---------
	149.0	Stringer of very fine-grained albite with tiny garnet crystal cuts quartz almost parallel to axis of drill core.	
	150.7	Mass of relict spodumene (?) 0.1 foot in diameter.	
	151.7 and 153.0	Stringer of albite and garnet as at 149 feet; patches of very fine-grained green mica.	
155.3–161.7		Cleavelandite-quartz pegmatite. Cleavelandite (50 percent), quartz (40 percent), albite with garnet (10 percent) in patches.	---------

See footnotes at end of table.

9.—*Drill hole BB-5*—Continued

Feet		Description	*Beryl: area on core surface in square feet (see fig. 22)*
161.7–178.1	Plagioclase-quartz pegmatite. Fine-grained.		
	161.7–163.4	Plagioclase (45 percent), quartz (40 percent), muscovite (15 percent).	--------
	163.4–178.1	Plagioclase (50 percent), quartz (50 percent), muscovite (X). Graphic intergrowths common.	0.0007
178.1–179.1	Quartz-mica rock, without foliation. Fine-grained, medium-gray. Joints cut at 50°, crude layering cuts at 70°.		--------
179.1–192.0	Quartz-mica schist. Fine-grained, medium-gray, thinly banded. Quartz (90 percent), mica (10 percent).		--------
	187–192	Slightly contorted schist.	

10.—*Drill hole BH-1*

Altitude of collar: 8,103 feet.
Bearing: S. 21° W.

Inclination: 45°.
Total length: 110 feet.

Feet		Description	*Beryl: area on core surface, in square feet (see fig. 23)*
0–10	Overburden		--------
10–73.5	Quartz-mica schist. Medium-gray, medium-grained		--------
	10.–21.5	Light bands contain as much as 15 percent feldspar. At 18 feet quartz pegmatite 0.9 foot wide cuts [1] at 30°; foliation cuts at 65° above quartz pegmatite but parallels it below. At 21 feet schist is contorted; quartz lenses and pods are common.	
	24.5–30	Foliation cuts at 10° to 25°. At 25.5 feet quartz pegmatite 0.3 foot wide, cuts at 25°.	
	30.–38.5	Foliation and bedding form arc with secondary foliation cutting at 10°. Possible axis of isoclinal fold at 38 feet.	
	38.5–41.5	Schist cuts at 25°–30°.	
	41.5–43.	Quartz pegmatite with trace of feldspar and mica; relict (?) foliation cuts at 40°–55°.	
	56–58.3	Contorted and tourmalinized schist.	
	73.5	Pegmatite contact, irregular; cuts about 50°.	
73.5–78.3	Plagioclase-quartz pegmatite.		
	73.5–77.5	Very fine-grained pink plagioclase (75 percent), quartz (25 percent), muscovite (X).[2] Faint banding cuts at 45°; streaks and patches of fine-grained quartz and muscovite.	0.0005
	77.5–78.3	Plagioclase (45 percent), quartz (35 percent), muscovite (20 percent). Fine-grained.	--------
78.3–87.8	Pegmatite, mainly cleavelandite-quartz.		
	78.3–79.5	Plagioclase (95 percent), muscovite (5 percent). Plagioclase, pale-pink and platy.	.1037
	79.5–87.8	Pale-pink cleavelandite (57 percent), quartz (35 percent), muscovite (8 percent). Medium-grained. Exceedingly fine-grained green mica in cracks and cleavages. Relict spodumene (?) 0.1 foot wide at 82 feet.	--------
87.8–92.2	Plagioclase-quartz pegmatite. Plagioclase (85 percent), quartz (10 percent), perthite (5 percent), muscovite (X). Fine-grained, dirty-tan. Some manganese oxides; banding cuts at 70°.		--------
92.93–93.2	Quartz-mica schist impregnated with pegmatite. Foliation cuts at 60°.		--------
93.2–97.9	Plagioclase-perthite-quartz pegmatite. Pink plagioclase (60 percent), pink perthite (30 percent), quartz (10 percent), muscovite (X). Fine-grained, mottled.		--------
	97.9	Schist contact, embayed; average cut about 70°.	
97.9–110.0	Quartz-mica schist		--------
	99.2–100.5	Schist contorted.	
	100.5–110.0	Cut of foliation decreases from 50° to 25°.	

See footnotes at end of table.

11.—*Drill hole BH-2*

Altitude of collar: 8,109 feet.
Bearing: S. 21° W.

Inclination: 45°.
Total length: 147 feet.

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 24)*
0–5	Overburden		---------
5–90.5	Quartz-mica schist. Medium-gray, fine- to medium-grained		---------
	15–17	Biotite bands cut [1] at 90° and a faint foliation cuts at 45°.	
	17–20	Stringers of quartz cut at 5° to 20°.	
	24.5	Pegmatite 0.8 foot wide cuts at 20° to 40°. Fine-grained. Plagioclase (75 percent), quartz (20 percent), muscovite (5 percent).	
	25.1–29.4	Schist. Medium-gray, fine-grained. Quartz (70 percent), mica (20 percent), feldspar (10 percent). Lenses of quartz and biotite 0.04 foot wide.	
	29.4–47.8	Schist. Medium-gray; light and dark bands 0.005 to 0.01 feet wide; many quartz veinlets and lenses. Quartz (90 percent), mica (10 percent).	
	47.8–53.8	Schist not banded as above.	
	53.8–63.0	Banded schist.	
	63.0–66.0	Contorted schist with quartz stringers and blebs.	
	66.0–83.0	Schist with light and dark bands.	
	83.0–84.0	Quartz blebs in deformed schist.	
	84.0–84.5	Tourmalinized and pegmatitized granulite. Cuts at 30°.	
	84.5–85.9	Plagioclase-quartz-muscovite pegmatite. Fine-grained; stained by manganese oxides; contains schist relicts.	
	85.9–90.0	Schist. Light-gray, fine-grained. Quartz (75 percent), mica (25 percent). At 86.5 feet, plagioclase-quartz pegmatite 0.3 foot wide cuts at 60°.	
	90.0–90.5	Quartz-impregnated schist.	
	90.5	Pegmatite contact cuts at 60°.	
90.5–93.5	Plagioclase-perthite-quartz pegmatite. Fine-grained; pink-mottled. Plagioclase (55 percent), perthite (30 percent), quartz (15 percent), muscovite (X); [2] green mica in fine scales in cracks and cleavages. Relicts of schist cut at 58°.		0.0004
93.5–99.0	Pegmatite, mainly plagioclase-quartz		.0035
	93.5–97.5	Pegmatite is fine grained; plagioclase somewhat platy. Platioclase (85 percent), quartz (13 percent), grains of perthite (2 percent), flakes of muscovite (X).	
	97.5–99.0	Quartz (95 percent), perthite (3 percent), interstitial plagioclase and muscovite (2 percent).	
99.0–103.9	Pegmatite, mainly quartz-cleavelandite		---------
	99.0–100.5	Quartz (99 percent) with many fine fractures filled with cleavelandite (1 percent); very fine-grained green mica (X).	
	100.5–101.5	Quartz (50 percent), cleavelandite (50 percent). Medium-grained.	
	101.5–103.9	Cleavelandite, white and pink.	
103.9–107.3	Plagioclase-quartz pegmatite. Fine-grained. Plagioclase (65 percent), quartz (35 percent), muscovite (X).		.0290
107.3–112.7	Plagioclase-perthite-quartz pegmatite. Fine-grained, tan. Plagioclase (60 percent), perthite (15 percent), quartz (15 percent), muscovite (X). Micaceous streaks look like ghosts of digested schist.		---------
	112.7	Schist contact cuts at 50°.	

See footnotes at end of table.

11.—Drill hole BH-2—Continued

Feet		Description	Beryl: area on core surface, in square feet (see fig. 24)
112.7-120.0	Quartz-mica schist, pegmatitized		---------
	114.5	Plagioclase-perthite-quartz pegmatite 0.7 foot wide, concordant with foliation; cuts at 45°.	
	114.5-118.0	Schist. Medium-grained, light-gray, prominently banded. Light bands are quartz (60 percent), feldspar (40 percent). Dark bands are quartz (70 percent), biotite (25 percent), tourmaline (5 percent).	
	118.0	Fracture cuts at 60°.	
	118.0-120.0	Foliation cuts at 25° to 30°.	
	120.0	Pegmatite contact, discordant with schist above, cuts at 45°.	
120.0-132.0	Perthite-plagioclase-quartz pegmatite. Fine-grained, pink to tan. Perthite (45 percent), plagioclase (35 percent), quartz (20 percent), muscovite (X).		0.0015
	121.6-122.3	Micaceous streaks, parallel to contact, may be schist relicts.	
	130.3-132.0	Tan and mottled, very fine grained.	
	132.0	Pegmatite contact, irregular; average cut about 30°.	
132.0-147.0	Quartz-mica schist. Grades downward from fine-grained and medium-gray to coarse-grained, light-gray, and banded. Cut increases gradually from 20° to 60°.		---------

12.—Drill hole BH-3

Altitude of collar: 8,104 feet.
Bearing: S. 21° W.
Inclination: 45°.
Total length: 110 feet.

Feet		Description	Beryl: area on core surface, in square feet (see fig. 25)
0-5	Overburden		---------
5-47.5	Quartz-mica schist. Medium-grained, light-gray; prominent banding.		---------
	5-12	Foliation cuts [1] at 50° to 60°.	
	12-21	Coarse banding cuts at 60°, and a fine foliation of alined biotite flakes cuts at 30°.	
	21-30	Foliation and banding cut at 55°.	
	30-33.5	Bands are lenticular and anastomosing.	
	33.5	Tourmaline-quartz-biotite schist 0.1 foot wide.	
	33.6-45.5	Banded schist.	
	45.5	Quartz vein 0.2 foot wide with biotite-rich margins.	
	45.5-47.5	Quartz-mica schist. Medium-grained, medium-gray, containing tourmaline (5 percent). Two equally well developed directions of banding cutting at 35° and 50°.	
47.5-51.8	Concealed zoned pegmatite; see table 14. Contact destroyed		---------
	47.5-48.4	Quartz (50 percent), muscovite (30 percent), plagioclase (20 percent). Fine-grained.	
	48.4-48.9	Cleavelandite (90 percent), quartz (10 percent). Dendrites of manganese oxides in cleavelandite. Fine-grained.	
	48.9-50.4	Quartz (98 percent), pale-green lithia-bearing mica (2 percent). Medium-grained.	
	50.4-51.2	Cleavelandite (85 percent), quartz (12 percent); muscovite (3 percent). Fine-grained.	
	51.2-51.8	Quartz (50 percent), plagioclase (30 percent), muscovite (20 percent). Fine-grained. Last 0.3 foot of pegmatite shows preferred mineral orientation normal to contact. Contact cuts at 50°.	

See footnotes at end of table.

12.—Drill hole BH-3—Continued

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 25)*
51.8–65.2		Quartz-mica schist. Fine-grained, dense. Quartz (90 percent), mica (10 percent) predominantly biotite, tourmaline (X).[2] Fine evenly spaced micaceous bands cut[1] at 55° to 60°.	---------
	60.2	Tourmaline-rich band 0.1 foot wide; tourmaline 10 percent.	
	60.3–65.2	Tourmaline-bearing (2 percent) schist.	
	65.2	Pegmatite contact marked by 0.01 foot quartz-enriched schist, cutting at 65°.	
65.2–70.1		Pegmatite, mainly plagioclase-quartz.	
	65.2–65.5	Quartz (50 percent), plagioclase (48 percent), muscovite (2 percent). Border zone with relict foliation parallel to wall rock and contact.	---------
	65.5–66.2	Platy plagioclase (70 percent), quartz (30 percent). Some manganese oxide.	0.0008
	66.2–66.9	Platy plagioclase (95 percent), quartz (5 percent).	---------
	66.9–67.6	Platy plagioclase (70 percent), quartz (20 percent), muscovite (10 percent). Very fine-grained; faint banding cuts at 70° to 90°.	---------
	67.6–69.1	Quartz (50 percent), muscovite (45 percent), plagioclase (5 percent).	---------
	69.1–70.1	Plagioclase (90 percent), quartz (10 percent), muscovite (X). Dense, fine-grained, tan.	---------
70.1–89.0		Pegmatite, mainly plagioclase-quartz.	
	70.1–73.4	Plagioclase (65 percent), quartz (30 percent), muscovite (5 percent). Fine-grained. Micaceous streaks and patches cut core at 55° to 80°, and look like relict schist.	.0033
	73.4–74.3	Platy plagioclase (60 percent), muscovite (40 percent). Medium-grained.	---------
	74.3–74.7	Plagioclase (65 percent), muscovite (30 percent), quartz (5 percent). Fine-grained, with relict schist.	---------
	74.7–77.3	Platy plagioclase (85 percent), quartz (12 percent), muscovite (3 percent). Fine-grained; banding cuts at 45°.	.0004
	77.3–77.5	Muscovite (60 percent), quartz (35 percent), plagioclase (5 percent).	.0006
	77.5–89.0	Plagioclase (80 percent), quartz (17 percent), muscovite (3 percent). Fine-grained, pink; some manganese oxide.	---------
	89.0	Pegmatite contact cuts about 40°	
89.0–110.0		Quartz-mica schist. Fine-grained, light-gray; widely spaced fine banding. Quartz (85 percent), mica (15 percent). Foliation cuts at 35° to 50°.	---------
	97–100	Banding irregular.	
	102.3	Quartz vein 1 foot wide with biotite selvages.	
	103–106	Contorted schist.	

See footnotes at end of table.

13.—Drill hole BH-4

Altitude of collar: 8,081 feet.
Bearing: S 21° W.

Inclination: 45°.
Total length: 110 feet.

Feet		Description	Beryl: area on core surface, in square feet (see fig. 26)
0–5	Overburden		---------
5–18.8	Quartz-mica schist. Fine-grained, medium-gray; fine even banding. Quartz (75 percent), feldspar (15 percent), mica (10 percent). Foliation cuts [1] at 50° to 75°.		---------
	11.3	Drag fold of 0.05-foot amplitude strikes at right angles to maximum dip of foliation, that is, may be horizontal drag fold.	
	18.4–18.8	Tourmalinized schist. Foliation cuts at 55° and 75°.	
	18.8	Pegmatite contact not recovered.	
18.8–20.4	Pegmatite, mainly plagioclase-quartz.		
	18.8–19.5	Plagioclase (80 percent), quartz (15 percent), muscovite (X).[2] Fine-grained, tan; banding cuts roughly at 70°.	---------
	19.5–20.4	Quartz (50 percent), muscovite (30 percent), plagioclase (20 percent).	0.0021
20.4–23.0	Pegmatite, mainly cleavelandite-quartz.		
	20.4–21.6	Cleavelandite (97 percent), muscovite (3 percent). Dark stains.	---------
	21.6–23.0	Cleavelandite (85 percent), quartz (12 percent), muscovite (2 percent).	.0022
23.0–35.0	Pegmatite, mainly plagioclase-quartz.		
	23.0–24.0	Quartz (60 percent), plagioclase (38 percent), muscovite (2 percent).	---------
	24.0–25.8	Fine-grained sugary-white plagioclase (80 percent), quartz (10 percent), muscovite (10 percent).	---------
	25.8–35.0	Tan plagioclase (85 percent), quartz (10 percent), muscovite (5 percent). Fine-grained; irregular grain size. Contorted micaceous streaks between 26.5 and 27.5 feet.	.0010
	35.0	Contact not preserved.	
35–110	Quartz-mica schist		---------
	35–35.5	Black-spotted (biotite and magnetite) schist in silvery (muscovite-rich) schist.	
	35.5–110	Quartz (97 percent), mica (3 percent). Thin widely spaced mica bands in fine-grained dense quartz schist. Between 76 and 77.2 feet, biotite and tourmaline bands, irregular, slightly contorted; small lenses and blebs of quartz. Between 93 and 110 feet banding becomes more irregular, mica more abundant.	

14.—Drill hole BH-5

Altitude of collar: 8,088 feet.
Bearing: S. 20° W.

Inclination: 40°.
Total length: 240 feet.

Feet		Description	Beryl: area on core surface, in square feet (see fig. 27)
0–10	Overburden		---------
10–14	Quartz-mica schist, contorted. Weathered. Contact not recovered		---------
14–16	Plagioclase-quartz-muscovite pegmatite. Fine-grained. Plagioclase (80 percent), quartz (15 percent), muscovite (5 percent). Contact not recovered.		---------
16–114.5	Quartz-mica schist. Fine-grained, light-gray, dense. Quartz (95 percent), mica (5 percent). Foliation cuts [1] at 55°.		---------
	20	Plagioclase-quartz pegmatite 0.15 foot wide.	
	27–28	Two quartz veins 0.05 foot wide cut at 18°.	

See footnotes at end of table.

14.—Drill hole BH–5—Continued

Feet		*Description*	*Beryl: area on core surface, in square feet (see fig. 27)*
	Quartz-mica schist. Fine-grained, light-gray, dense. Quartz (95 percent), mica (5 percent). Foliation cuts [1] at 55°—Continued		
	28–42	Ill-defined banding.	
	42–63	Quartz (90 percent) and mica (10 percent) in fine bands. Dense and fine-grained. Foliation cuts at 40° to 50°.	
	50.5	Perthite-plagioclase-quartz pegmatite 0.05 foot wide cuts at 18°.	
	53	Quartz-muscovite pegmatite 0.05 foot wide cuts at 25°.	
	61	Quartz vein 0.02 foot wide cuts at 18°. Foliation adjacent to its cuts at 45°.	
	63	Quartz vein 0.02 foot wide cuts at 25°.	
	63–64	Contorted schist.	
	64–67	Schist slightly contorted.	
	67–73	Schist much contorted; many irregular patches of quartz.	
	73–80.5	Quartz-mica schist. Medium-gray, medium-grained, evenly banded; bands lenticular. Quartz (80 percent), mica (15 percent), feldspar (5 percent).	
	80.5–89	Schist contorted; many irregular patches of quartz.	
	89–92	Schist evenly banded.	
	92–97	Schist slightly contorted.	
	97–101	Schist evenly banded. Two concordant quartz veins 0.04 and 0.06 foot wide cut at 30°.	
	101–102.9	Contorted schist with quartz blebs.	
	102.9–114.5	Evenly banded schist; cut foliation increases from 45° to 70°.	
	114.5	Pegmatite contact not preserved.	
114.5–118.8	Pegmatite, mainly plagioclase-quartz		---------
	114.5–116.7	Plagioclase (85 percent), quartz (13 percent), muscovite (2 percent). Fine-grained; faint banding normal to core.	
	116.7–117.6	Muscovite (70 percent), quartz (15 percent), plagioclase (15 percent). Fine-grained. Muscovite in books as much as 0.06 foot in diameter. Faint banding cuts at 75°.	
	117.6–118.8	Graphic intergrowth of plagioclase and quartz.	
118.8–121.9	Pegmatite, mainly cleavelandite-quartz		---------
	118.8–119.9	Cleavelandite (95 percent), quartz (5 percent).	
	119.9–120.2	Quartz (65 percent), cleavelandite (30 percent), muscovite (5 percent).	
	120.2–121.9	Cleavelandite (95 percent), quartz (5 percent).	
121.9–131.5	Plagioclase-quartz pegmatite.		
	121.9–124.0	Platy plagioclase (75 percent), quartz (20 percent), muscovite (5 percent). Many minute red-brown garnet grains at 123.6 feet.	0.0001
	124.0–131.5	Plagioclase (85 percent), quartz (12 percent), muscovite (3 percent). Very fine-grained, tan, irregular texture. Clots and streaks of fine-grained, regular-textured white pegmatite composed of quartz (75 percent), plagioclase (20 percent), muscovite (5 percent).	---------
131.5–240	Quartz-mica schist. Fine- to coarse-grained, light- to medium-gray; fine foliation, well-banded, with many narrow zones of crumpling and contortion and small lenses and blebs of quartz. A few feldspar-rich pegmatites less than 0.5 foot in width.		---------

[1] The angle between the axis of the drill core and a planar feature (such as bedding and foliation) is referred to as the cut.

[2] (X) indicates less than 1 percent.

APPENDIX B

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches;
0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture

FELDSPAR-RICH

PLAGIOCLASE-PERTHITE-

51	Schist	None	Concordant	Lenticular	Homogeneous	F
62	Granite	do	Joint-controlled	Tabular	do	F
63	Schist	T	Concordant	Lenticular	do	M
82	Granite	None	Joint-controlled	Tabular	do	F
85	do	do	Concordant in sill.	do	do	F
86	do	do	Joint-controlled	do	do	F
125	do	T	do	do	do	F
131	do	T	do	Tabular, branching.	do	M
148	do	T	do	Tabular	do	F
180	Schist	T	Discordant	Lenticular	Multiple, homogeneous	M
181	do	T	Concordant	do	Homogeneous	M
182	do	T	do	do	do	M
185	do	None	Discordant	Irregular	Multiple, homogeneous	M
190	do	do	do	do	Homogeneous	M
191	do	T	Concordant	Lenticular	do	F
194	do	None	Discordant	do	Multiple, homogeneous	M
203	do	do	do	do	do	M
213	do	do	Concordant	do	Multiple, banded	M
214	do	do	do	do	Homogeneous	M
215	do	do	do	do	Banded	M
224	do	do	do	do	Homogeneous	M
230	do	do	Discordant	do	do	M
234	do	do	Concordant	do	Multiple, homogeneous	M
238	do	do	Discordant	do	Homogeneous	M
247	do	do	do	do	do	M
254	Granite		Joint-controlled	do	do	M
255	do	T	do	do	do	M
308b	do	T	do	Tabular	do	M
330	do	T	Largely concordant in sill.	Lenticular	do	F
331	do	T	Joint-controlled	Tabular	do	M
340	do	T	do	do	do	F
363	do	T	do	do	do	F
365	do	T	do	do	do	M
366	do	T	do	Tabular, branching.	do	F
369	do	T	Discordant	Irregular	do	M
370	do	T	do	do	do	M
384	do	T	Joint-controlled	Tabular, branching.	do	M
386	do	T	do	do	do	F
388	do	T	Irregular	Lenticular	do	F
390	do	None	do	do	do	M
428	Schist	do	Discordant	do	Multiple, homogeneous	F
436	do	do	do	Lenticular	Homogeneous	F
438	do	do	do	Irregular	do	F
446	do	do	do	Lenticular	do	F
452	do	do	do	Tabular?	do	F
453	do	do	do	Irregular	do	F
454	do	do	do	Lenticular	Multiple, homogeneous	F
456	do	do	Concordant	do	do	F
457	do	do	Dominantly concordant.	Branching	do	F
460	do	do	do	Lenticular	do	F
489	do	do	Concordant	do	do	M
500	do	T	do	do	Homogeneous	M
502	do	None	do	Irregular	do	F
503	do	do	Discordant	do	do	M
509	do	do	Concordant	Lenticular	do	M
510	do	do	do	do	do	M

pegmatites

C, coarse, 4-12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES

QUARTZ PEGMATITES

52		40		8		x								
50		40		10		x								
50		40		9		x				x				
52		38		10		x				x				
55		35		10		x								
51		39		10		x								
58		30		12		x		x		x		Beryl	0.08	†0.8
50		39		11		x				x		do	Tr.	†0.6
46		38		16		x				x				
45		30		25		x				x				
45		30		25		x				x				
45		30		25		x				x				
45		35		20		x						Beryl	Tr.	†1.1
45		35		20		x								
45		36		19		x		x		x				
45		35		20		x								
50		33		16		1								
48	0.7	40	2	12	2	x	0.9							
45		35		20		x								
50	.4	32	3	18	2	x	1							
45		35		20		x								
50		30		20		x								
50		40		10		x								
45		35		20		x								
49		35		16		x								
49		35		15			x			1				
49		35		15		x				1				
49		35		15		x				1				
50		42		8		x		x		x		Beryl	.07	0.1-2.4
49		42		9		x				x		do	.1	†0.9
54		37		9		x				x				
51		35		14		x				x		Beryl	Tr.	†0.8
53		38		9		x				x				
55		35		10		x				x				
49		39		12		x				x				
51		41		8		x				x				
49		39		12		x				x				
51		41		8		x				x		Beryl	Tr.	†1.5
50		40		10		x				x				
49		40		10		1								
47		38		14		1		x						
55		30		15		x		x				Beryl	Tr.	†0.6
50		40		10		x						do	Tr.	†0.7
49		39		12		x		x						
72		20		8		x								
58		32		10		x								
50		40		10		x						Beryl	.03	0.1-0.7
48		40		11		1				x				
48		35		16		1								
48		40		12		x				x		Beryl	Tr.	0.1-0.6
46		38		15		1						do	Tr.	0.1-0.5
50		36		14		x		x		x		do	.01	0.2-0.5
50		40		10		x								
50		30		20		x		x		x		Beryl	.07	0.1-1.8
60		20		19		x		x				do	Tr.	0.2-2.4
39		30		30		x						do	Tr.	0.2-2.3

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
					FELDSPAR-RICH	
					PLAGIOCLASE-PERTHITE-	
511	Schist	None	Discordant	Renticular	Homogeneous	M
517	do	do	do	Irregular	Multiple, homogeneous	F
518	do	do	do	do	do	F
519	do	do	do	do	Homogeneous	F
520	do	do	do	do	do	F
521	do	do	do	do	do	M
522	do	do	do	do	do	F
526	do	do	do	do	do	F
535	do	do	Concordant	Lenticular	do	M
536	do	do	do	do	do	M
537	do	do	Discordant	do	do	M
538	do	do	Concordant	do	do	M
539	do	do	do	do	do	M
544	do	do	do	do	do	M
546	do	do	do	do	do	M
547	do	do	do	do	do	M
548	do	do	do	do	do	M
555	do	do	do	do	Multiple, banded	F
557	do	do	Discordant	Irregular	Homogeneous	F
558	do	do	do	Lenticular	do	F
560	do	do	do	do	do	M
563	do	do	do	Irregular	Zoned: Wall	F
					Core	M
564	do	do	do	do	Homogeneous	M
566	do	do	do	Lenticular	Zoned: Wall	F
					Core	M
567	do	do	do	Irregular	Zoned: Wall	M
					Core	C
568	do	do	do	do	Homogeneous	M
572	do	T	Concordant	Lenticular	do	F
573	do	None	do	do	do	M
576	do	do	do	do	do	M
619	do	do	Discordant	Branching	Multiple, homogeneous	F
624	do	do	do	Lenticular	Homogeneous	F
625	do	do	Concordant	do	Multiple, banded	F
626	do	do	do	do	Multiple, homogeneous	F
627	do	do	Discordant	do	do	F
630	do	T	Concordant	Tabular	Multiple, banded	F
633	do	None	do	Lenticular	Homogeneous	F
647	do	do	do	do	Multiple homogeneous	F
654 (Hyatt) [1]	Granite and schist.	T	Discordant and concordant.	do	Zoned:	
					Upper wall	F
					Lower wall	F
					Outer intermediate	C
					Inner intermediate	C
					Core	C
690	Schist	None	Concordant	do	Homogeneous	F
692	do	do	do	do	Multiple homogeneous	F
693	do	do	do	do	Homogeneous	F
695	do	do	do	do	do	F
696	do	do	do	do	do	F
697	do	do	Concordant?	do	do	F
699	do	do	Concordant	do	Multiple homogeneous	F
702	do	do	do	do	Homogeneous	F
703	do	do	do	do	Multiple homogeneous	F

[1] Contains 0.00X to 0.0X percent lithiophillite-triphylite which has an average size of 0.2 inch.

pegmatites—Continued

C, coarse, 4-12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
PEGMATITES—Continued														
QUARTZ PEGMATITES—Continued														
45		24		30		1						Beryl	.07	0.2–1.7
52		36		12		x		x						
53		38		9		x						Beryl	Tr.	0.1–0.4
52		36		12		x				x		do	.7	0.1–0.6
55		34		10		x		1				do	Tr.	0.1–0.6
54		33		12		1						do	.13	0.1–1.0
50		41		9		x		x						
52		36		12		x		x				Beryl	.08	0.1–1.2
45		30		25		x				x		do	.01	0.1–0.8
65		10		24		1		x						
50		30		20		x								
45		35		19		1								
50		29		20		1						Beryl	Tr.	*0.1
59		10		30		1						do	.07	0.1–0.6
50		35		15		x						do	Tr.	0.1–0.4
40		30		30		x				x				
40		30		30		x			x					
52	0.3	38	0.7	10	0.5	x	0.1							
60		30		10		x								
50		25		25		x								
45		30		25		x						Beryl	Tr.	0.1–0.4
60	.1	4	.3	35	.1	1	.1							
50	.4	30	6	19	4	1	.2	x	.1			Beryl	Tr.	†0.9
50	.5	35	3	15	2	x	.1			x		do	Tr.	0.2–1.2
50	.1	30	.4	20	.2	x	.1	x	.1					
17	.6	53	5	30	3	1	.2					Beryl	.07	0.1–0.8
40	.7	30	4	29	3	1	.1	x				do	.31	0.1–2.7
5	.7	65	9	30	6	x	.5					do	.06	0.1–3.0
45		35		20		x						do	.07	0.1–2.4
51		38		11		x		x		x		do	Tr.	*0.2
48		40		12		x		x		x				
48		40		12		x				x				
55		29		16		x						Beryl	Tr.	†0.8
52		33		15		x								
55	.1	35	.3	10	.2	x	.1			x		Beryl	Tr.	†0.4
46		38		15		1						do	Tr.	†0.7
60		32		8		x								
55	.1	34	.3	10	.2	x	.1			1		Beryl	Tr.	†0.4
58		30		12		x				x		do	Tr.	0.1–0.5
45		34		25		1								
50	<1	25	<1	25	<1	x	<1			x	0.01–2	Beryl	.35	*<1
60	<1	x	<1	40	<1	x	<1			x	†2	do	.35	*<1
x	†3	55	†36	45	†36	x	†3					do	Tr.	
50	†12	x	†12	40	†60	7	0.01–15	x	†1	x	†4	do	1.7	0.1–60
												Apatite	X	0.1–0.6
												Bismuthinite	.008	0.1–3
												Uraninite	.000X	0.01–1.5
x	<1	96	†120	3	†48	x	0.01–3	x	<1	x	<1	Beryl	Tr.	
60		29		11		x		x		x				
50		40		10		x		x		x				
48		40		12		x				x				
60		32		8		x				x				
52		36		12		x		x						
52		36		12		x		x						
48		39		12		1						Beryl	Tr.	†0.3
50		40		10		x		x				do	Tr.	†0.6
50		40		10		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture

FELDSPAR-RICH

PLAGIOCLASE-PERTHITE-

Pegmatite (pl. 5)	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
708	Schist	None	Concordant	Lenticular	Multiple homogeneous	F
712	do	do	do	do	Homogeneous	F
715	do	do	Discordant?	Irregular?	do	F
719	do	do	do	do	do	F
847	do	do	Concordant	Lenticular	Multiple homogeneous	F
856	do	T	do	do	do	F
867	do	do	do	do	do	F
874	do	None	Discordant	do	Homogeneous	F
876	do	T	Concordant	do	do	M
877	do	None	do	do	do	F
878	do	do	do	do	do	F
879	do	do	do	do	do	M
894	do	do	Discordant	do	Multiple homogeneous	F
905	do	do	Concordant	do	Homogeneous	F
906	do	do	do	do	do	F
907	do	do	do	do	Multiple homogeneous	F
908	do	do	do	do	do	F
1010	do	do	Discordant	do	Homogeneous	F
1011	do	do	do	do	do	M
1015	do	do	do	Lenticular branching.	do	F
1025	do	do	Concordant	Lenticular	Multiple homogeneous	F
1026	do	do	do	do	do	F
1031	do	do	do	do	Homogeneous	F
1105	do	do	do	do	Multiple homogeneous	F
1109	do	do	Discordant	do	Homogeneous	F
1111	do	T	Concordant	do	Multiple with one zoned member: Wall	F
					Multiple with one zoned member: Core	M
1146	do	None	Discordant	do	Homogeneous	F
1170	do	do	Concordant	Branching lenticular.	Multiple homogeneous	F
1171	do	do	do	Lenticular	Homogeneous	F
1172	do	do	do	do	Multiple homogeneous	F
1174	do	None	Discordant	Irregular branching.	Homogeneous	M
1175	do	do	do	do	do	M
1176	do	do	Concordant	Lenticular	do	M
1177	do	do	do	do	do	F
1179	do	do	do	do	do	F
1203	do	do	do	do	do	F
1204	do	do	do	do	do	M
1205	do	do	Discordant?	Irregular	do	F
1215	do	do	Concordant	Lenticular	Multiple homogeneous	F
1246	Granite	do	Discordant	Lenticular branching.	Homogeneous	F
1248	do	do	do	Irregular	do	M
1274	Schist	do	Concordant	Lenticular	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
PEGMATITES—Continued														
QUARTZ PEGMATITES—Continued														
50		35		15		x						Beryl	Tr.	†0.4
45		35		20		x								
48		40		12		x								
48		33		18		1								
55		35		10		x								
45		38		16		1				x				
53		35		12		x				x				
50		38		12		x				x				
48		37		14		x				1				
55		37		8		x								
55		37		8		x								
55		37		8		x								
50		38		12		x		x						
60		28		12		x								
59		25		15		1				x				
50		37		13		x				x		Beryl	Tr.	0.1–0.4
50		37		13		x				x				
52		38		10		x		x						
52		30		18		x								
52		40		8		x		x						
55		34		12		1								
48		40		12		x				x				
48		30		22		x								
50		34		16		x				x				
52		30		18		x								
45		35		18		1				1	†1.5	Beryl	Tr.	0.1–0.9
55	0.3	20	2	24	1	1	0.1					do	Tr.	0.1–0.5
30	.6	50	5	17	4	1	.2			2	0.1–1.5	do	Tr.	0.1–0.9
44		38		17		x								
62		30		8		x		x		x				
50		38		12		x								
48		40		12		x		x						
59		5		35		1						Beryl	Tr.	†0.9
59		5		35		1								
47		40		12		1				x				
58		32		9		1								
60		28		12		x						Beryl	Tr.	0.1–0.5
54		34		12		x				x				
52		40		8		x		x		x				
50		41		9		x						Beryl	Tr.	†0.7
56		25		18		1								
52		18		28		1		x		x		Beryl Apatite	Tr. Tr.	0.2–2.4 0.1–0.2
49		40		11		x						Beryl	Tr.	†0.5
55		30		15		x		x		x				

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
			FELDSPAR-RICH			
			PERTHITE-PLAGIOCLASE-			
			RATIO OF PERTHITE TO PLAGIOCLASE			
10	Schist	None	Discordant	Lenticular	Homogeneous	F
21	do	do	Concordant	do	do	M
46	do	do	do	Lenticular branching.	do	M
47	Granite	T	Concordant in sill.	Tubular branching.	do	M
48	do	T	Discordant	do	do	M
49	do	T	do	do	do	M
50	Schist	None	Concordant	Lenticular	do	F
53	Granite	T	Concordant in sill.	Tabular	do	M
54	do	T	Discordant	do	do	M
56	do	T	do	do	do	M
57	do	T	do	do	do	M
58	Schist	None	Concordant	Lenticular	do	F
59	Granite	do	Concordant in sill.	Tabular	do	M
60	do	T	Discordant	Irregular	do	M
61	do	T	Joint controlled	Lenticular	do	M
64	do	T	Discordant	Branching	do	M
68	do	None	do	Tabular, branching.	do	F
74	do	do	Concordant in sill, in part.	Branching	do	M
75	Schist	do	Concordant	Lenticular	do	M
80	do	do	do	do	Multiple, homogeneous	F
93	do	do	do	do	Homogeneous	F
101	Schist and granite.	do	Discordant	Tabular	do	F
102	Granite and schist.	do	do	Irregular	do	M
103	Granite	do	Concordant in sill.	Tabular	do	F
104	do	do	Discordant	Irregular	Multiple, homogeneous	F
110	do	T	do	Tabular	Homogeneous	F
112	do	T	do	do	do	F
120	do	None	do	do	do	F
121	do	do	do	do	do	F
122	do	do	do	do	do	M
123	do	T	do	do	Banded	F
137	do	do	do	do	Homogeneous	F
145	do	None	do	do	Banded	M
147	Schist	T	Concordant	Lenticular	Homogeneous	M
149	Granite	None	Discordant	do	do	M
156	do	do	do	do	do	M
160	do	do	do	Irregular	do	M
163	do	do	Concordant in sill.	Tabular	do	F
164	Schist	do	Concordant	Lenticular	do	F
197	do	do	do	do	Multiple, homogeneous	M
207	Granite and schist.	do	do	do	Homogeneous	F
220	Schist	do	do	do	do	F
228	do	do	do	do	do	F
233	do	do	Concordant, in part.	do	Multiple, homogeneous	M
239	do	do	Concordant	do	Homogeneous	M
240	do	do	do	do	do	M
242	do	do	do	do	do	M
243	do	do	Discordant	do	do	M
262	Granite	do	do	Irregular	do	M

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

QUARTZ PEGMATITES

IS ABOUT 1 TO 1

40		45		12		3								
40		45		14		1								
47		43		9		1								
42		45		11		x				1				
45		45		10		x				x				
43		47		9		x				1				
47		43		9		1								
41		49		9		1								
42		46		12		x				x				
45		45		10		x				x				
42		46		12		x								
47		45		8		x								
42		46		12		x				x				
42		47		11		x				x		Beryl	Tr.	0.1–0.4
39		44		16		1								
43		44		12		1				x		Beryl	0.06	0.1–0.9
37		45		17		x		x				do	Tr.	0.3–1.8
42		50		8		x				x				
40		45		14		1								
38		43		18		x		x				Beryl	Tr.	0.2–1.8
46		42		12		x		x				do	Tr.	0.1–0.9
41		49		10		x								
44		48		8		x								
43		48		9		x								
48		44		8		x								
48		50		12		x				x		Beryl	Tr.	0.1–1.8
42		49		9		x				x				
40		51		9		x								
42		49		9		x				x				
49		42		9		x				x		Beryl	Tr.	0.2–0.4
42	0.3	46	0.7	12	0.5	x	0.1			x	0.1			
37		43		19		x				1		do	0.2	0.1–1.8
35		40		23		x				x		Beryl	.03	0.4–1.7
40		48		12		x				x				
40		40		20		x						Beryl	Tr.	†4.2
35		45		19		1						do	Tr.	†.9
39		45		15		1						do	Tr.	0.1–4.0
40		45		14		1								
40		45		15		x								
40		45		14		1								
40		44		16		x								
40		40		20		x								
40		45		15		x						Beryl	Tr.	0.1–0.5
47		40		13		x								
45		40		15		x								
40		45		15		x								
40		40		20		x								
42		38		20		x								
40		40		20		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
			FELDSPAR-RICH			
			PERTHITE-PLAGIOCLASE-QUARTZ			
			RATIO OF PERTHITE TO PLAGIOCLASE			
266	Granite	T	Joint-controlled	Tabular, branching.	Homogeneous	M
268	do	T	do	do	do	M
269	do	None	Discordant	do	do	M
272	do	T	Joint-controlled	Tabular	do	M
273	do	None	do	do	do	M
278	do	do	do	do	do	M
284	do	do	do	do	do	M
292	do	T	Discordant	do	do	F
293	do	T	Joint-controlled	do	do	M
294	do	T	do	do	do	M
296	do	T	do	do	do	M
300	do	T	do	do	do	M
309	Granite and schist.	None	Mainly concordant.	Lenticular	do	M
310	Schist	do	Concordant	do	Multiple, homogeneous	F
311	do	do	do	Irregular	do	F
312	do	do	Mainly concordant.	Irregular, branching.	do	F
313	do	do	Concordant	Lenticular	do	F
319	do	do	do	Lenticular, branching.	do	M
320	do	do	do	Lenticular	Homogeneous	M
321	do	do	do	do	do	F
325	do	do	do	Lenticular, branching.	Multiple, homogeneous	M
333	Granite	T	Joint-controlled	Tabular	Homogeneous	M
342	do	T	do	do	Banded	M
343	do	T	do	Tabular, branching.	Homogeneous	M
345	do	T	do	Tabular	do	M
346	do	T	do	Tabular, branching.	do	M
351	do	T	do	do	do	F
352	do	T	do	Tabular	do	M
353	do	None	do	do	do	M
356	do	T	Discordant	Irregular	do	M
357	do	T	do	do	do	M
358	do	T	do	Tabular	do	M
360	do	None	Joint-controlled	do	do	F
364	do	do	Discordant	do	do	F
367	do	T	do	Tabular, branching.	do	M
385	do	T	do	Tabular	do	M
387	do	None	do	Irregular, branching.	do	C
389	do	do	Concordant in sill.	Tabular	Multiple, homogeneous	F
392	do	do	Discordant	Irregular, branching.	Homogeneous	M
394	do	T	do	Tabular	do	M
407	do	None	Concordant in sill.	do	do	F
419	Schist	do	Discordant	Lenticular	do	F
420	Granite	do	do	Irregular, branching.	do	F
421	do	do	Concordant	Lenticular	do	F
422	do	do	do	do	do	F
445	do	do	do	do	do	F
455	do	do	Concordant?	Lenticular, branching.	do	M

pegmatites—Continued

C, coarse, 4-12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 1 TO 1—Continued

38		43		19		x						Beryl	Tr.	1.7-2.4
40		40		20		x						do	Tr.	†0.8
40		45		15		x								
40		45		15		x				x				
45		42		13		x								
43		48		9		x				x				
40		45		15		x								
49		42		9		x				x		Beryl	Tr.	0.1-0.3
40		45		15		x				x		do	Tr.	0.2-1.2
37		48		15		x				x		do	Tr.	0.4-0.8
40		45		15		x				x				
42		47		11		x				x				
47		45		8		x				x		Beryl	Tr.	0.2-1.3
43		48		9		x								
43		48		9		x								
43		48		9		x				x				
42		48		10		x		x		x				
41		47		12		x				x				
44		48		8		x				x				
44		49		7		x						Beryl	Tr.	0.1
44		45		11		x				x				
42		49		9		x		x		x				
48	0.5	42	3	10	3	x	0.2			x	0.3			
45		45		10		x				x		Beryl	Tr.	0.5-2.4
48		45		7		x				1				
45		48		7		x				x				
41		49		10		x				x		Beryl	0.2	0.1-1.7
42		47		11		x				x				
39		45		16		x				x				
48		42		10		x				x				
40		48		12		x				x		Beryl	1.0	0.2-2.1
48		42		10		x				x				
45		47		8		x				x				
41		47		12		x				x				
42		48		9		x				1				
45		40		15		x				x				
40	.5	43	5	16	4	1	.3			x		Beryl	0.9	0.2-8.4
47		42		11		x				x				
47		42		11		x				x				
40		40		19		1				x		Beryl	0.2	0.7-3.6
38		45		16		x		x						
35		40		24		1						Beryl	Tr.	1 x 1.3
39		45		15		1								
38		42		19		1								
34		40		25		1								
42		47		11		x				x				
40		46		14		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
463	Granite	None	Discordant	Irregular, branching.	Homogeneous	M
464	do	do	do	Irregular	Zoned {Wall / Core	M / C
465	do	do	do	do	Homogeneous	F
466	do	do	Concordant and discordant.	Lenticular	Banded	M
468	do	do	Discordant	do	Multiple, homogeneous	F
471	do	do	Concordant	do	Homogeneous	F
472	do	do	do	do	do	F
474	do	do	Discordant	do	do	F
476	do	do	Concordant	do	Multiple, homogeneous	F
477	do	do	Discordant	do	Homogeneous	F
478	do	do	do	do	do	F
482	do	do	Concordant and discordant.	do	do	F
486	Schist and granite.	do	Discordant	Irregular	do	F
492	Granite	T	Concordant in sill.	Lenticular	Multiple, homogeneous	F
493	do	do	do	do	Homogeneous	M
496	Schist	None	Concordant	do	do	M
504	do	do	Discordant?	do	Banded	F
512	do	do	Concordant	do	Zoned {Wall / Core	F / M
515	do	do	Concordant and discordant.	Irregular	Banded	F
516	do	do	Discordant?	Lenticular	Homogeneous	M
523	do	do	Discordant	Irregular	Multiple, banded	M
527	do	do	do	do	Zoned {Wall / Core (discontinuous).	F / M
528	do	do	Concordant	do	Homogeneous	F
541	do	do	do	Lenticular	do	M
553a	do	do	do	do	Multiple, homogeneous	F
553b	do	do	do	Lenticular?	Homogeneous	F
554	do	do	do	Lenticular	Multiple, homogeneous	F
559	do	do	do	do	Banded	M
561	do	do	Discordant	do	Homogeneous	F
562	do	do	Concordant?	do	Multiple, homogeneous	M
570	Granite	do	Concordant in sill.	do	Homogeneous	M
571	Schist	T	Concordant	do	Zoned {Wall / Core	F / M
578	do	None	do	do	Multiple, homogeneous	F
579	do	do	do	do	do	F
580	do	do	do	do	do	F
585	do	do	do	do	Homogeneous	F
586	do	do	do	do	do	F
587	do	do	do	do	do	F
588	do	do	do	do	Banded	M
591	do	do	do	do	Homogeneous	F
592	do	do	Discordant	do	do	F
601	do	do	do	Tabular	do	F
606	do	do	Discordant?	Lenticular	do	F
610	do	do	Discordant	do	do	F
612	do	do	Concordant?	do	do	F
618	do	do	Concordant	do	do	F
620	do	do	do	do	Multiple, homogeneous	F
623	do	do	Discordant	Branching	do	M

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 1 TO 1—Continued

42		46		12		x								
50	0.5	34	6	16	4	x								
37	.9	52	8	10	7	1				x	†1.3			
38		44		17		x				x		Beryl	Tr.	2.1
40	.4	40	5	19	4	1	0.2					do	Tr.	0.2–0.6
38		43		19		x				x				
39		44		17		x								
40		42		17		x		x						
38		41		20		1				x				
39		44		17		x								
38		45		16		x						Beryl	0.01	0.1–0.7
40		40		20		x								
36		43		21		x				x				
37		40		22		1						Beryl	Tr.	0.1–1.7
43		49		8		x				x				
49		42		9		x				x				
46		40		14		x		x				Beryl	Tr.	0.1–1.3
44	.2	47	.6	9	.5	x								
64	.3	10	2	25	1	1	.1					Beryl	.28	0.1–0.3
31	.6	39	5	29	4	1	.2					do	.05	0.2–0.9
40	.2	48	.5	12	.3	x	.1	x	0.1			do	Tr.	0.2
48		42		10		x		x						
42	.4	50	4	8	3	x	.7	x	.1			Beryl	.06	0.1–0.4
45	.4	35	2	17	1	3	.1					do	.1	0.1–1.2
9	.6	60	5	30	4	1	.3					do	Tr.	0.3–0.9
35		40		25		x						do	Tr.	0.1–0.6
35		39		25		1						do	Tr.	0.5
42		49		9		x								
39		45		15		1								
42		50		8		x		x						
44	.3	46	3	10	3	x	.6							
45		48		7		x								
44		45		9		1								
45		37		17		1				x		Beryl	Tr.	0.1–0.4
50	.2	34	2	15	1	1	.1	x	.1	x	.3	do	Tr.	0.4–1.0
14	.5	50	5	35	4	1	.2	x	.1	x	.9			
41		48		11		x				x				
48		42		10		x				x				
41		48		11		x				x				
38		41		21		x		x		x				
38		41		21		x				x				
39		42		18		1								
37	.4	42	5	20	4	1		.1						
38		44		18		x								
37		44		19		x								
36		43		21		x						Beryl	Tr.	0.2
42		38		20		x		x		x		do	.4	0.2–2.7
37		44		19		x		x		x				
38		43		19		x				x				
45		40		14		1								
41		49		10		x				x				
44		48		8		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
FELDSPAR-RICH						
PERTHITE-PLAGIOCLASE-QUARTZ						
RATIO OF PERTHITE TO PLAGIOCLASE						
628	Schist	None	Concordant	Tabular	Multiple, homogeneous	F
640	do	do	Discordant	Irregular	Homogeneous	F
641	do	do	do	Lenticular	do	F
644	do	do	do	Irregular	Multiple, homogeneous	F
646	do	do	Concordant	Lenticular	do	F
650	do	do	Concordant?	Irregular	do	F
653	do	do	do	Lenticular	do	F
655	do	do	Concordant	do	Homogeneous	F
659	do	do	do	do	do	M
660	do	do	do	do	do	M
661	do	do	do	do	do	F
662	do	do	do	do	do	M
664	do	do	do	do	do	F
665	do	do	do	do	do	F
674	do	do	Discordant?	do	do	F
675	do	do	Concordant and discordant.	do	do	F
676	do	do	Concordant	do	do	M
677	do	do	do	do	do	F
678	do	do	do	do	Banded	F
686	do	do	do	do	Multiple, homogeneous	F
689	do	do	do	do	do	F
700	do	do	Discordant	Irregular	Homogeneous	M
704	do	do	Concordant	Lenticular	do	F
707	do	do	do	do	Multiple, homogeneous	M
709	do	do	do	do	do	F
710	do	do	do	do	Homogeneous	F
716	do	do	Discordant?	do	do	M
717	do	do	do	Irregular?	do	M
718	do	do	do	do	do	M
721	do	do	Concordant	Lenticular	Multiple, homogeneous	F
722	do	do	do	do	do	F
723	do	do	do	do	do	F
724	do	do	do	do	do	F
725	do	do	do	do	do	F
726	do	do	do	do	do	F
728	do	do	do	do	do	F
729	do	do	do	do	do	F
730	do	do	do	do	do	F
731	do	do	do	do	do	F
732	do	do	do	do	do	F
733	do	do	do	do	do	F
735	do	do	do	do	Homogeneous	F
740	do	do	do	do	Multiple, homogeneous	F
761	do	do	do	do	Homogeneous	F
770	do	do	do	do	do	F
780	do	do	do	do	do	M
849	do	do	do	do	Multiple, homogeneous	F
855	do	do	do	do	do	F
857	do	do	do	do	do	M
861	do	do	do	do	do	F
862	do	do	do	do	do	F
863	do	do	do	do	do	F
864	do	do	do	do	do	F
865	do	do	Discordant	do	Homogeneous	F
866	do	do	Concordant	Lenticular, branching.	do	F
873	do	do	Discordant	Irregular	do	M
881	do	do	Concordant	Lenticular	Multiple, homogeneous	F
882	do	do	Discordant	do	Homogeneous	M
883	do	do	Concordant	do	Multiple, homogeneous	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 1 TO 1—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
40		48		12		x				x		Beryl	0.01	0.1–0.6
40		47		12		1								
49		41		9		1						Beryl	.04	0.1–0.8
40		40		20		x								
47		40		12		1								
45		40		14		1				x		Beryl	Tr.	0.1–3.6
42		48		10		x				x		do	Tr.	0.1–0.7
46		40		13		1				x		do	Tr.	0.5
40		43		17		x				x		do	Tr.	0.9
40		44		15		1								
40		44		15		1								
37		45		18		x				x				
37		44		18		1		x		x				
34		45		20		1		x		x				
38		45		17		x								
38		44		18		x		x				Beryl	.06	0.1–1.0
39		38		21		2		x		x		do	.02	0.2–0.6
38		44		18		x		x				do	.06	0.1–1.0
38	0.2	45	1.5	17	1	x	0.1					do	Tr.	0.4
42		50		8		x				x				
52		40		8		x				x				
40		40		20		x								
45		45		10		x						Beryl	Tr.	0.5
40		45		15		x								
45		45		10		x								
45		45		10		x								
40		44		16		x								
40		44		16		x								
40		44		16		x								
40		50		10		x				x				
40		50		10		x		x		x		Beryl	Tr.	0.1–0.5
50		40		10		x				x				
50		40		10		x		x		x				
50		40		10		x				x		Beryl	Tr.	0.4
46		42		12		x				x				
50		40		10		x				x				
50		40		10		x				x				
50		40		10		x				x				
50		40		10		x				x				
50		40		10		x				x				
50		40		10		x				x				
36		45		18		1								
36		45		19		x				x				
34		41		24		x		x		x		Beryl	Tr.	0.2
37		43		19		x				x				
28		31		40		x								
43		36		11		x				x				
36		48		16		x				x		Beryl	Tr.	0.5
40		47		12		1		x		x				
42		47		10		1				x				
42		47		10		1				x		Beryl	Tr.	0.3
42		47		10		1				x				
42		47		10		1				x		Beryl	Tr.	0.4
42		48		9		1								
41		47		11		1				x				
44		39		17		x				x				
42		48		10		x				x				
49		41		10		x								
42		49		9		x				x				

Mineralogy of

Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
					FELDSPAR-RICH	
					PERTHITE-PLAGIOCLASE-QUARTZ	
					RATIO OF PERTHITE TO PLAGIOCLASE	
884	Schist	T	Concordant	Lenticular	Homogeneous	F
886	do	None	do	do	Multiple, homogeneous	F
898	do	do	Discordant	Irregular	do	F
903	do	do	do	Lenticular	do	F
909	do	do	Concordant	do	do	F
911	do	do	do	do	Homogeneous	F
912	do	do	do	Lenticular	do	M
919	do	do	Discordant	do	do	F
941	do	do	Concordant	do	do	M
945	do	do	do	do	Multiple, homogeneous	M
949	do	do	do	do	Homogeneous	M
951	do	do	do	do	do	M
973	do	do	do	do	Multiple, homogeneous	M
976	do	do	do	do	do	M
977	do	do	do	do	do	M
980	do	do	do	do	do	M
988	do	do	Discordant	Lenticular branching.	do	M
990	do	do	Concordant	Lenticular	do	M
997	do	do	do	do	Homogeneous	M
998	do	do	do	do	do	M
999	do	do	do	do	do	M
1000	do	do	do	do	do	M
1002	do	do	do	do	Multiple, homogeneous	M
1003	do	do	do	do	do	M
1005	do	do	do	do	do	M
1008	do	do	do	do	Homogeneous	M
1009	do	do	Discordant	Irregular	do	M
1018	do	do	do	Lenticular	do	M
1019	do	do	do	do	Multiple homogeneous	F
1020	do	do	Discordant?	Irregular?	Homogeneous	F
1022	do	do	Concordant	Lenticular	do	F
1027	do	do	do	do	do	F
1029	do	do	do	do	do	F
1030	do	do	do	do	do	F
1035	do	do	do	do	Multiple homogeneous	F
1041	do	do	do	do	Homogeneous	F
1047	do	do	do	do	do	F
1049	do	do	do	Lenticular, branching.	do	F
1052	do	do	do	Lenticular	do	F
1055	do	do	Discordant	do	do	R
1056	do	do	do	do	do	F
1061	do	do	Concordant	do	do	F
1076	do	do	do	do	do	M
1096	do	do	do	do	do	F
1108	do	do	Discordant	Irregular	do	F
1153	do	do	do	Lenticular, branching.	do	F
1157	do	do	do	Lenticular	do	F
1161	do	do	Concordant	do	do	F
1163	do	do	Discordant	Irregular, branching.	do	F
1181	do	do	Concordant	Lenticular	Multiple homogeneous	F
1194	do	do	Discordant	do	Homogeneous	F
1224	do	do	Concordant	Tabular	do	F
1226	do	do	do	Lenticular	Multiple homogeneous	F
1238	do	do	do	do	do	F
1247	Granite	do	Discordant	Irregular	Homogeneous	M
1260	Schist	do	Concordant	Lenticular	Multiple homogeneous	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 1 TO 1—Continued

39		44		16		x				1				
41		47		12		x				x				
48		42		10		x		x		x				
41		48		11		x				x		Beryl	Tr.	0.2
43		43		14		x				x				
50		41		9		x		x						
35		47		18		x		x		x				
39		45		15		x		x		x		Beryl	Tr.	
29		37		34		x								
37		42		21		x				x				
34		42		24		x				x				
37		43		20		x				x				
37		42		21		x				x				
36		43		21		x				x				
37		44		19		x		x		x		Beryl	Tr.	0.3–0.9
35		44		21		x		x		x				
36		45		19		x				x				
35		45		20		x				x				
41		41		16		2		x		x				
43		40		16		1								
36		46		18		x								
38		45		16		1								
40		44		15		1				x				
36		43		21		x		x		x				
36		45		19		x				x				
45		42		13		x		x		x				
45		47		8		x								
42		46		12		x								
42		46		12		x								
45		43		12		x								
44		45		11		x								
42		44		13		1								
46		38		16		x								
38		40		22		x								
42		45		13		x				x				
36		42		22		x								
37		43		20		x								
37		42		21		x		x				Beryl	Tr.	0.3–3.6
35		43		22		x		x		x				
37		43		20		x		x				Beryl	Tr.	0.3–2.4
38		45		17		1								
37		43		20		x		x		x				
40		43		17		x				x		Beryl	Tr.	0.3–0.9
39		43		18		x		x		x				
42		48		10		x				x				
34		45		21		x				x		Beryl	Tr.	0.7–1.2
36		40		24		x		x				do	0.1	0.1–1.4
38		43		19		x								
42		47		11		x		x		x				
44		44		12		x				x				
39		38		23		x		x		x		Beryl	Tr.	0.2–0.7
38		43		19		x								
38		42		20		x				x				
37		43		20		x				x		Beryl	Tr.	0.3–1.4
44		44		12		x								
36		40		22		x		x		x		Beryl	0.2	0.6–1.3

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches;
0.01 percent. Size columns:

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
1	Schist	None	Discordant?	Tabular	Homogeneous	M
5	do	do	Discordant	Irregular	Multiple banded	M
6	do	do	Concordant	Lenticular	Homogeneous	M
9	do	do	Discordant	do	do	F
11	do	do	do	Irregular	do	M
18	do	do	do	Lenticular	do	M
19	do	do	Concordant	do	Multiple homogeneous	M
22	do	do	do	do	do	F
34	do	do	do	do	Homogeneous	M
35	do	do	do	do	Multiple homogeneous	M
37	do	do	do	do	Multiple banded	F
38	do	do	do	do	Multiple homogeneous	F
40	do	do	do	do	do	M
41	do	do	do	Irregular	Homogeneous	F
42	do	do	do	Lenticular	do	F
45	do	do	do	do	do	M
52	Granite	do	Discordant	Tabular	Homogeneous	M
55	do	T	Concordant	do	do	M
66	do	T	Discordant	do	do	F
67	do	None	do	Lenticular	do	F
69	do	do	Concordant	Tabular	do	F
70	do	do	Discordant	Lenticular	do	F
71	do	do	do	do	do	F
72	do	do	do	Tabular, branching.	do	F
73	do	do	do	Lenticular	Multiple homogeneous	F
76	do	T	Concordant	do	do	M
77	do	None	do	Irregular	do	M
78	do	do	Discordant	Lenticular	Homogeneous	M
79	Schist	do	Concordant	do	do	M
81	Granite	do	Discordant	Tabular	do	F
83	do	do	do	do	do	F
84	do	do	do	do	do	F
87	do	do	Concordant	do	do	M
88	do	do	do	do	do	M
89	do	do	Discordant	do	do	F
90	do	do	do	do	do	F
91	do	do	do	do	do	F
94	Schist	do	do	Irregular	do	F
95	do	do	Concordant	Lenticular	Multiple homogeneous	M
96	do	do	do	do	do	M
100	Schist and granite.	do	Discordant	Tabular	Homogeneous	F
106	Granite	do	Concordant	do	do	M
107	do	do	do	Lenticular	do	F
108	do	do	Discordant	Tabular, branching.	do	F
109	do	do	do	Tabular	do	F
111	do	do	do	do	do	F
113	do	do	do	do	do	F
114	do	do	do	do	do	F
115	do	do	do	do	do	F
116a	do	do	do	do	do	F
116b	do	do	do	do	do	F
117	do	do	do	do	do	F
118	do	do	do	do	do	F
119	do	do	do	do	do	F
124	do	do	do	do	do	M
126	do	do	do	Tabular, branching.	do	M

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2

30		45		24		1								
32	0.4	55	3	13	3	x	0.4							
30		40		28		2								
35		55		10		x								
30		55		15		x								
40		50		10		x								
30		50		20		x						Beryl	Tr.	*0.4
35		55		10		x								
35		55		10		x								
35		55		10		x								
34	.2	55	1	11	.7	x	.1							
32		55		12		x								
35		55		10		x								
37		50		12		1								
37		50		12		1								
40		50		10		x								
40		48		12		x								
32		53		15		x								
33		48		19		x		x		x		Beryl	Tr.	0.2–0.6
36		46		18		x		x		x		do	*0.3	
30		50		20		x		x						
30		49		21		x		x				Beryl	.01	0.2–1.6
30		46		24								do	Tr.	0.2–0.6
31		53		16		x						do	Tr.	0.5–1.2
31		50		19		x								
35		52		12		1				x				
35		50		15		x								
37		55		8		x								
39		53		8		x								
40		50		10		x				x				
40		49		11		x		x		x				
35		54		11		x				x				
40		48		12		x		x		x				
40		48		12		x				x		Beryl	Tr.	0.2
37		54		9		x								
37		54		9		x								
42		50		8		x						Beryl	Tr.	0.1–0.3
33		57		10		x		x				do	Tr.	0.7
34		55		11		x								
34		55		11		x								
34		54		12		x								
33		56		11		x		x		x				
37		55		8		x				x				
41		51		8		x				x				
39		52		9		x				x				
38		53		9		x				x				
40		53		7		x				x		Beryl	.06	0.01–1
36		55		9		x				x				
40		49		11		x				x		Beryl	Tr.	0.2–0.6
41		50		9		x				x				
35		55		15		x				x				
38		51		11		x				x				
40		48		12		x				x				
40		48		12		x				x				
38		49		13		x				x				
50		42		8		x				x		Beryl	Tr.	0.2 x 0.7

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
127	Granite	None	Discordant	Tabular, branching.	Homogeneous	M
128	do	do	do	Tabular	do	M
129	do	do	do	do	do	M
130	do	do	do	do	do	M
132	do	do	do	do	do	M
133	do	do	do	do	do	M
134	do	do	do	do	do	M
140	do	do	do	do	do	M
146	do	do	do	do	Multiple, homogeneous	M
151	do	do	do	Lenticular	Homogeneous	M
152	do	do	do	Tabular	do	M
154	do	do	do	do	do	M
157	do	do	do	do	do	M
158	do	do	do	Lenticular	do	M
159	do	do	do	do	do	M
161	do	do	do	do	do	M
169	Schist	do	Concordant	do	do	F
170	do	do	do	do	Multiple, banded	M
172	do	do	do	do	do	M
173	do	do	do	do	do	M
174	do	do	do	do	do	M
176	do	do	do	do	Multiple, homogeneous	M
178	do	do	do	do	Homogeneous	M
179	do	do	Concordant?	do	do	M
184	do	do	do	do	do	F
186	do	do	Concordant	do	do	F
192	do	do	do	do	do	M
193	do	do	do	do	do	M
195	do	do	do	do	do	M
198	do	do	Concordant?	do	do	M
199	Schist and granite.	do	Discordant	do	Multiple, homogeneous	M
200	Schist	do	do	do	Homogeneous	M
216	do	do	Concordant	do	do	F
217	do	do	do	do	do	M
218	do	do	do	do	do	F
219	do	do	Concordant and discordant.	do	Multiple, homogeneous	F
221	do	do	Concordant	do	Homogeneous	M
226	do	do	do	do	do	M
227	do	do	do	do	do	M
229	do	do	do	do	do	M
231	do	do	do	do	do	M
235	do	do	Discordant	do	do	F
236	do	do	Concordant	do	do	F
241	do	do	do	do	do	F
244	do	do	Discordant	do	do	F
245	do	do	do	do	do	F
246	do	do	do	do	do	F
248	do	do	do	do	Multiple, homogeneous	M
249	do	do	do	do	Homogeneous	F
250	do	do	Concordant	do	do	F
251	do	do	Concordant?	do	do	M
253	do	do	Discordant	do	do	M
256	do	do	do	do	do	F
257	do	do	do	do	do	M
261	Granite	T	do	Lenticular, branching.	do	M
265	do	None	do	Tabular	do	M

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued

Mineralogy

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Plagioclase Percent	Plagioclase Size (in.)	Perthite Percent	Perthite Size (in.)	Quartz Percent	Quartz Size (in.)	Muscovite Percent	Muscovite Size (in.)	Garnet Percent	Garnet Size (in.)	Tourmaline Percent	Tourmaline Size (in.)	Other minerals: Mineral	Other minerals: Percent	Other minerals: Size
36		55		9		x				x				
40		54		6		x				x		Beryl	0.06	0.1–0.9
32		55		13		x						do	.2	0.1–1.1
40		52		8		x								
42		50		8		x						Beryl	.4	0.1–0.7
42		48		10		x								
33		55		12		x				x				
39		50		10		1						Beryl	.15	0.1–2.1
40		50		10		x				x		do	Tr.	
37		45		18		x								
31		55		9		x								
37		50		13		x				x		Beryl	Tr.	
30		55		14		1								
35		45		20		x								
35		45		20		x								
34		50		15		1								
30		55		15		x								
35	0.5	55	2	10	2	x	0.5							
35		50		14		1						Beryl	Tr.	0.2–2.4
35		50		14		1								
35		50		14		1								
30		55		15		x								
35		50		14		1								
32		48		20		x								
30		55		15		x				x				
35		45		20		x								
30		55		15		x								
30		55		15		x								
30		50		20		x								
30		55		14		1								
30		55		14		1								
39		50		10		1		x				Beryl	.1	0.2–1.7
35		45		20		x								
35		55		10		x				x		Beryl	Tr.	0.1–0.3
35		55		10		x								
30		57		13		x								
38		50		12		x								
33		50		17		x								
35		45		20		x								
30		55		15		x						Beryl	Tr.	0.1–0.7
38		50		11		1								
34		43		20		3								
33		47		19		x				x		Beryl	Tr.	
40		49		11		x								
34		50		15		x				x		Beryl	Tr.	0.1–1.2
34		48		18		x								
38		46		16		x		x				Beryl	.02	0.1–1.4
35		50		14		1								
35		44		19		1						Beryl	.18	0.1–0.8
35		46		18		1								
30		50		19		1		x						
30		45		23		2								
30		55		14		1						Beryl	Tr.	0.3 x 0.5
35		52		13		x								
29		45		25		1		x		x		Beryl	Tr.	
30		50		19		1						do	Tr.	.5–1.6

Mineralogy of

Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
FELDSPAR-RICH						
PERTHITE-PLAGIOCLASE-QUARTZ						
RATIO OF PERTHITE TO PLAGIOCLASE						
267	Granite	None	Discordant	Tabular	Homogeneous	M
271	do	do	Joint-controlled	do	do	M
274	do	T	do	do	do	M
280	do	T	do	do	do	M
281	do	None	do	Tabular, branching.	do	M
283	do	T	do	do	do	M
285	do	T	Discordant	Lenticular	do	M
287	do	None	Joint-controlled	Tabular, branching.	do	F
288	do	do	Discordant	Tabular	do	F
289	do	do	do	do	do	F
290	do	do	do	do	do	M
291	do	do	do	do	do	F
295	do	do	do	do	do	M
297	do	do	do	do	do	M
298	do	do	do	Tabular, branching.	do	M
299	do	do	Joint-controlled	do	do	F
301	do	do	do	do	do	M
302	do	do	do	do	do	M
303	do	do	Discordant	do	do	F
304	do	do	Joint-controlled	Tabular	do	M
306	do	do	Discordant	Irregular	do	M
307	do	T	do	Irregular, branching.	do	F
308a	do	T	do	Tabular	do	M
314	Schist	None	Concordant	Lenticular, branching.	Multiple, homogeneous	F
315	do	T	do	Lenticular	do	M
316	do	None	do	do	do	
318	do	T	do	do	Homogeneous	F
322	do	None	do	do	do	F
323	do	do	do	do	do	F
324	do	do	do	do	do	M
326	do	do	do	Lenticular, branching.	Multiple, homogeneous	M
327	do	do	do	Lenticular	do	M
328	do	do	do	do	Homogeneous	F
329	do	do	do	do	do	F
332	Granite	do	Discordant	Tabular, branching.	do	M
334	do	T	do	Tabular	do	F
336	do	None	Concordant in sill.	Lenticular	do	M
337	Schist	do	Concordant?	Irregular	do	M
338	Granite	do	Discordant	Tabular	do	M
339	do	do	do	do	do	F
341	do	do	do	Tabular, branching.	do	F
344	do	do	do	Tabular	do	M
347	do	do	Joint-controlled	Tabular, branching.	do	F
348	do	do	Discordant	Tabular	do	M
349	do	do	do	Tabular, branching.	do	M
350	do	None	do	do	do	M
354	do	do	do	do	do	M
361	do	do	do	Tabular	do	M
368	do	do	do	Irregular, branching.	do	M

pegmatites—Continued

·C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
35		45		20		x						Beryl	Tr.	0. 4–1. 3
40		50		10		x				x				
37		50		13		x				x				
42		50		8		x				x		Beryl	0. 3	0. 1–1. 1
30		55		15		x								
40		50		10		x				x				
35		55		10		x				x				
39		52		9		x				x				
36		50		14		x				x				
36		50		14		x				x				
35		50		15		x				x				
35		59		6		x				x				
38		50		12		x				x				
35		55		10		x				x				
34		58		8		x				x		Beryl	Tr.	0. 2–0. 4
40		50		10		x				x				
39		52		9		x				x		Beryl	.08	0. 1–0. 3
39		52		9		x				x				
37		53		10		x		x		x		Beryl	Tr.	0. 1–0. 2
40		54		6		x				x		do	Tr.	0. 2–0. 6
33		50		17		x				x		do	.1	0. 2–3. 6
42		50		8		x		x		x				
25		35		40		x				1		Beryl	Tr.	0. 2–0. 3
41		50		8		1								
36		53		10		1				x		Bery	Tr.	
36		53		11		x		x						
32		53		14		1		x		x		Beryl	Tr.	0. 2 x 0. 3
40		50		10		x				x				
40		52		8		x				x				
37		50		12		1				x				
40		51		9		x								
38		48		13		1				x				
40		51		9		x		x				Beryl	Tr.	0. 1–0. 4
35		55		10		x		x						
37		55		8		x								
40		49		11		x				x				
38		54		8		x				x		Beryl	Tr.	0. 1–0. 4
35		52		12		x						do	Tr.	0. 2–0. 4
41		51		8		x				x				
41		50		9		x						Beryl	Tr.	0.5 x 0. 3
38		54		8		x				x		do	Tr.	0. 1–0. 3
42		50		8		x				x				
40		53		7		x				x				
41		51		8		x				x				
37		51		12		x				x				
35		50		15		x				x				
36		55		9		x				x				
42		49		9		x				x				
41		48		11		x				x				

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches;
0.01 percent. Size columns:

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
371	Granite	None	Discordant	Tabular, branching.	Homogeneous	M
372	do	do	do	Tabular	do	M
373	do	do	do	Tabular, branching.	do	M
379	do	do	do	do	do	M
380	do	T	do	Tabular	do	M
382	do	None	do	Tabular, branching.	do	F
383	do	do	do	do	do	M
391	do	T	do	Lenticular	Multiple, homogeneous	M
393	do	T	do	Irregular, branching.	Homogeneous	F
395	do	None	do	Tabular	do	F
396	do	do	do	do	do	M
397	do	do	do	do	do	F
400	do	do	do	do	do	F
403	do	do	do	do	do	F
405	do	do	do	do	Zoned{Wall Core	F M
406	do	T	Discordant	Lenticular	Homogeneous	F
408	do	None	Concordant	do	do	F
409	Granite and schist.	do	Discordant	do	do	F
410	Schist	do	Concordant	do	do	F
411	do	do	do	do	do	F
412	do	do	do	do	do	F
413	do	do	do	do	do	F
415	do	ao	do	do	do	F
417	do	do	do	do	do	F
418	do	do	do	do	do	F
423	do	do	Discordant	do	do	F
424	do	do	Concordant	do	Multiple, banded	F
426	do	T	Discordant	Irregular	Banded	F
427	do	None	Concordant	Lenticular	Multiple, banded	F
431	do	do	Discordant	Irregular	Homogeneous	M
433	do	do	do	do	do	M
435	do	do	Concordant?	Lenticular	do	F
437	do	do	Discordant	Irregular	do	F
439	do	do	do	do	do	F
440	do	do	do	do	do	F
441	do	T	do	Lenticular	Zoned{Wall Core	F M
442	do	do	do	Irregular	Zoned{Wall Core	F M
444	do	None	do	Lenticular	Homogeneous	F
447	do	do	do	Irregular	Multiple, homgeneous	F
448	do	do	do	do	do	F
450	do	do	do	Irregular, branching.	do	F
451	do	do	do	Lenticular	do	F
458	do	do	do	Irregular	Banded	F
459	do	do	Concordant	Lenticular	Multiple, homogeneous	F
461	do	do	do	do	Homogeneous	F
462	do	T	do	do	Multiple, homogeneous	F
469	do	T	Discordant?	do	Homogeneous	F
470	do	None	Concordant	do	do	F
473	do	do	Discordant	do	do	M
475	do	do	Discordant?	do	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued: Mineralogy: Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
36		55		9		x				x				
40		50		10		x				x				
40		52		8		x				x				
39		50		11		x				x		Beryl	Tr.	0.5 x 0.7
40		48		11		x				1		do	Tr.	0.7 x 1
34		52		14		x				x				
35		50		15		x				x				
41		49		9		1		x		x		Beryl	Tr.	1.1 x 1.7
38		50		12		x				x				
27		48		25		x				x		Beryl	0.09	0.6–1.2
35		50		15		x				x		do	Tr.	0.3 x 1.1
30		45		25		x						do	.7	0.2–3.5
												Apatite	Tr.	
35		46		18		1				x		Beryl	.04	0.2–1.4
35		47		18		x		x		x		do	Tr.	
31	0.5	43	1	26	0.8	x	60.1	x	60.1	x	0.4	do	.09	0.1–0.6
<1	.6	<1	1	99	5	x	1.3							
36		48		16		x				x				
32		46		22		x				x				
35		47		18		x								
30		50		20		x								
34		44		20		2								
29		50		20		1								
35		44		20		1								
34		50		16		x								
36		49		15		x								
34		47		18		x								
35		46		19		x								
30	.3	50	1	20	1	x	.4					Beryl	.06	0.1–1.2
33	.5	48	1	19	1	x	.2	x	.1		.5	do	.05	0.1–1.6
35	.3	50	.7	15	.6	x	.1	x	.1					
30		52		18		x								
35		49		16		x						Beryl	Tr.	0.2–0.7
35		48		16		1				x				
40		49		11		x						Beryl	Tr.	0.5–2.4
38		52		10		x								
38		48		14		x		x						
58	.5	39	1	11	.6	x	.4			x	.8			
40	.7	51	4	9	1	x	1.5							
42	.3	48	1.2	10	.9	x	.5			x				
36	.6	50	3	14	3	x	1			x	.1	Beryl	Tr.	0.8–1.7
36		52		12		x								
40		50		10		x		x				Beryl	Tr.	
30		52		18		x						do	Tr.	0.1–3.7
38		51		11		x								
37		53		10		x				x				
33	.3	52	.9	15	.6	x	.3							
38		50		12		x				x		Beryl	Tr.	
40		50		10		x								
39		49		12		x				x				
35		45		19		x		x		x				
32		48		19		1								
37		45		17		x						Beryl	Tr.	0.2 x 0.3
32		48		20		x				x		do	Tr.	0.2 x 0.3

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

479	Schist	None	Concordant	Lenticular	Homogeneous	F
480	do	do	do	do	do	F
481	do	do	do	do	do	F
483	do	do	do	do	do	F
484	do	do	do	do	do	F
485	do	do	do	do	do	M
490	Granite	T	do	do	do	F
491	do	T	do	do	do	F
497	Schist	None	do	do	Multiple, homogeneous	F
498	do	do	do	do	do	F
499	do	do	do	do	Homogeneous	M
501	do	do	Discordant	do	do	F
505	do	do	Discordant?	do	Multiple, homogeneous	F
506	do	do	Concordant	do	do	M
507	do	do	do	do	Homogeneous	F
508	do	do	do	do	Multiple, homogeneous	M
513	do	do	do	do	Homogeneous	M
524	do	do	Concordant and discordant.	Irregular	Multiple, banded	F
529	do	do	Concordant	Lenticular	Multiple, homogeneous	M
530	do	do	do	do	do	M
531	do	do	do	do	Homogeneous	F
532	do	do	do	do	do	M
533	do	do	do	do	do	F
534	do	do	do	do	do	F
542	do	do	do	do	Multiple, homogeneous	F
543	do	do	do	do	do	F
549	do	do	do	do	do	M
550	do	do	do	do	do	F
551	do	do	Discordant and condordant.	Irregular	Banded	M
552	do	do	Concordant	do	Multiple, homogeneous	F
565	do	do	Discordant	do	Zoned{Wall Core	F M
569	do	do	Concordant	Lenticular	Homogeneous	M
575	do	do	Discordant	do	do	F
577	do	T	Concordant	do	do	F
581	do	T	do	do	do	M
582	do	T	do	do	do	M
583	do	None	do	do	do	M
589	do	do	do	do	do	F
590	do	do	do	do	Multiple, banded	M
595	do	do	do	do	Homogeneous	F
596	do	do	do	do	Banded	F
597	do	do	do	do	Multiple, banded	F
600	do	do	do	do	Banded	F
604	do	do	Discordant	Tabular	Homogeneous	F
609	do	do	Concordant	Lenticular	do	F
611	do	do	Discordant	do	do	F
614	do	do	Discordant and concordant.	Irregular	Multiple, homogeneous	F
615	do	do	Concordant?	do	do	F
621	do	do	Discordant	Branching	do	F
622	do	do	do	Irregular	do	F
629	do	do	Concordant	Lenticular	do	F
631	do	do	do	do	do	F
632	do	do	do	do	do	F
634	do	do	do	do	Homogeneous	F
635	do	do	do	Branching	Multiple, homogeneous	F
636	do	do	do	Lenticular	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued: Mineralogy: Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
35		45		20		x								
30		45		25		x								
36		46		18		x								
30		49		20		1						Beryl	Tr.	
36		47		16		x				x				
34		48		16		1		x		x		Beryl	Tr.	0.1–1.7
30		45		25		x				x				
30		43		25		2				x				
36		55		9		x								
36		55		9		x								
30		50		20		x		x		x		Beryl	Tr.	0.4–0.5
32		52		16		x				x		do	Tr.	0.2–0.4
41		58		11		x								
38		53		9		x				x		Beryl	Tr.	0.1–0.6
39		46		14		1						do	Tr.	0.4–0.6
33		52		14		1				x				
30		44		25		1						Beryl	Tr.	0.2–0.7
35	0.4	50	0.7	15	0.5	x	0.1							
40		50		10		x						Beryl	Tr.	0.1–0.5
40		50		10		x				x		do	0.03	0.1–0.6
41		50		9		x		x		x		do	Tr.	0.1–0.5
40		48		12		x						do	Tr.	0.1–1.2
36		52		12		x				x		do	Tr.	
40		53		7		x								
30		50		20		x								
36		53		11		x								
35		50		14		1						Beryl	Tr.	
35		50		14		1								
36	.8	55	4	9	2	x	.6							
38		50		12		x								
60	.3	10	.7	30	.5	x	.5					Beryl	.02	0.1–1.2
30	.6	45	4	24	3	1	1							
30		50		20		x		x						
40		48		12		x				x		Beryl	Tr.	0.1–0.8
31		47		20		x				1				
30		48		20		1				1				
30		48		21		1				x				
35		45		19		x				x				
32		47		20		1								
30	.6	48	3	21	3	1	1.2							
29		50		20		x						Beryl	Tr.	0.1–0.4
28	.3	50	.7	21	.3	x	.1	x	0.1			do	Tr.	0.1–0.3
31	.5	49	.9	19	.7	x	.5					do	Tr.	0.2–0.4
29	.5	53	.7	17	.5	x	.3					do	Tr.	0.1–0.6
30		48		21		x						do	Tr.	0.3 x 0.4
33		50		16		x				x				
37		45		17		x		x		x				
36		50		13		1				x		Beryl	Tr.	0.1 x 0.5
41		51		8		x				x				
40		50		10		x								
40		50		10		x								
35		57		8		x				x				
35		57		8		x				x				
35		57		8		x				x				
33		54		12		1				x				
33		55		12		x								
35		57		8		x				x				

295165—55——11

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
FELDSPAR-RICH						
PERTHITE-PLAGIOCLASE-QUARTZ						
RATIO OF PERTHITE TO PLAGIOCLASE						
637	Schist	None	Concordant	Branching	Multiple, homogeneous	F
643	do	do	Discordant	Lenticular	do	M
645	do	do	Discordant and concordant.	Irregular	do	F
648	do	do	Concordant	Branching	Homogeneous	F
649	do	do	Discordant?	Irregular	Multiple, homogeneous	F
652	do	do	Concordant?	Lenticular	Homogeneous	F
656	do	do	Discordant	Irregular	do	C
657	do	do	Discordant and concordant.	do	Multiple, homogeneous	M
658	do	do	Concordant	Branching	Homogeneous	F
666	do	do	do	Lenticular	do	F
669	do	do	do	do	do	M
671	do	do	Discordant	Irregular	do	F
672	do	do	do	Branching	do	M
680	do	do	Concordant and discordant.	Lenticular	Multiple, homogeneous	F
681	do	do	Concordant	do	Homogeneous	F
682	do	do	do	do	do	F
683	do	do	do	do	do	F
685	do	do	do	do	do	F
687	do	do	Discordant	Irregular	do	F
688	do	T	Concordant	Lenticular	Multiple, homogeneous	M
698	do	None	do	do	Homogeneous	F
701	do	do	do	do	do	F
705	do	do	do	do	Multiple, homogeneous	F
706	do	do	do	do	do	M
711	do	do	do	do	do	F
727	do	do	do	do	do	F
734	do	do	do	do	Homogeneous	F
736	do	do	do	do	Multiple, homogeneous	F
737	do	do	do	do	do	F
738	do	do	do	do	do	M
739	do	do	do	do	do	F
741	do	do	do	do	do	F
742	do	do	do	do	do	F
743	do	do	do	do	Homogeneous	F
744	do	do	do	do	Multiple, homogeneous	M
745	do	do	do	do	do	M
746	do	T	do	do	do	M
747	do	None	do	do	do	M
749	do	do	do	do	Homogeneous	F
750	do	do	do	do	Multiple, homogeneous	F
751	do	do	do	Tabular	Homogeneous	F
752	do	do	do	Lenticular	Multiple, homogeneous	F
756	do	do	do	do	do	F
759	do	do	do	do	Homogeneous	F
760	do	do	do	do	Multiple, homogeneous	F
762	do	do	do	Tabular	Homogeneous	F
763	do	do	do	Lenticular	do	F
771	do	do	do	do	do	F
773	do	do	do	do	Zoned {Wall	F
					Core	M
783	do	do	do	do	Multiple, homogeneous	F
786	do	do	do	do	Homogeneous	F
787	do	do	Discordant	do	do	F
788	do	do	Concordant	do	do	F
789	do	do	do	do	Multiple, homogeneous	F
795	do	do	do	do	Multiple, banded	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

38		48		14		x								
32		50		18		x								
38		52		10		x				x		Beryl	Tr.	0.1–2.0
36		51		13		x				x				
38		50		12		x				x		Beryl	0.1	0.1–0.5
41		50		8		1						do	Tr.	
33		50		17		x				x				
39		48		13		x						Beryl	Tr.	
34		47		19		x		x		x				
32		50		18		x								
32		49		16		3		x		x				
33		46		20		x				x				
32		47		20		x		x		x		Beryl	Tr.	0.6 x 0.7
36		47		17		x				x				
30		50		20		x								
30		40		28		2								
30		49		20		1						Beryl	.06	0.2–0.3
33		47		20		x								
35		55		10		x				x				
38		50		12		x		x		x		Beryl	Tr.	
35		50		15		x								
43		55		12		x		x						
40		50		10		x								
32		55		13		x						Beryl	.02	0.2–0.6
41		50		9		x								
33		48		19		x				x				
32		46		22		x				x				
35		48		17		x		x		x				
35		49		16		x		x						
33		47		20		x						Beryl	Tr.	0.6–1.6
31		45		23		1								
35		45		20		x				x				
30		45		24		1		x						
34		46		20		x		x						
32		48		20		x				x				
35		45		20		x				x				
35		45		20		x		x		x		Beryl	Tr.	1.4
34		48		18		x				x		do	Tr.	0.3 x 0.5
32		48		20		x								
30		45		25		x								
33		47		20		x				x				
30		50		20		x				x				
33		47		20		x				x				
30		50		20		x				x				
31		46		23		x				x		Beryl	Tr.	0.5–1.2
30		50		20		x				x				
28		48		24		x		x		x		Beryl	Tr.	0.2–1.5
30		50		20		x				x		do	Tr.	0.2–1.4
30	0.3	51	1	20	0.7	x	0.2			x	0.7			
x	.5	x	1	100	4	x	.5							
35		46		19		x								
30		50		20		x				x				
30		50		20		x				x				
30		50		20		x				x		Beryl	Tr.	0.1–0.2
34		47		20		x		x		x		do	Tr.	0.1–1
30	.2	49	1	21	.6	x	.1	x	.02	x	.5	do	Tr.	0.1–1.4

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches;
0.01 percent. Size columns

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
			FELDSPAR-RICH			
			PERTHITE-PLAGIOCLASE-QUARTZ			
			RATIO OF PERTHITE TO PLAGIOCLASE			
796	Schist	None	Concordant and discordant.	Lenticular	Homogeneous	F
797	do	do	Discordant	do	do	F
798	do	do	Concordant	Tabular	do	F
801	do	do	do	Lenticular	Multiple, homogeneous	F
805	do	do	do	do	Homogeneous	F
806	do	do	do	do	Multiple, homogeneous	F
807	do	do	do	do	do	F
818	do	do	do	do	Homogeneous	F
819	do	do	do	do	Multiple, homogeneous	F
822	do	do	do	do	Homogeneous	F
826	do	do	do	do	do	M
827	do	do	Concordant and discordant.	do	Zoned {Wall Core	M C
829	do	do	Concordant	do	Multiple, homogeneous	F
833	do	do	do	do	Homogeneous	F
836	do	do	do	do	Multiple, homogeneous	F
838	do	do	do	do	Homogeneous	F
840	do	do	do	do	Multiple, homogeneous	F
841	do	do	do	do	Homogeneous	F
843	do	do	do	do	Multiple, homogeneous	F
844	do	do	Concordant and discordent.	do	do	F
845	do	do	Concordant	do	do	F
846	do	do	do	do	do	M
850	do	do	Concordant and discordant.	do	do	F
853	do	do	Concordant	do	do	F
854	do	do	do	do	do	M
858	do	do	do	Branching	do	F
859	do	do	do	Lenticular	Zoned {Wall Core	F M
860	do	do	do	Irregular	Multiple, homogeneous	M
868	do	do	do	Lenticular	Homogeneous	F
869	do	do	do	Irregular	do	F
870	do	do	do	Lenticular	do	F
871	do	do	Discordant	Irregular	do	M
872	do	do	Concordant	Lenticular	do	M
875	do	T	Discordant and concordant.	do	do	M
880	do	None	Concordant	do	Multiple, homogeneous	F
885	do	do	do	do	Homogeneous	F
887	do	do	do	do	Multiple, homogeneous	M
888	do	do	do	do	Homogeneous	F
889	do	do	do	do	do	M
890	do	do	do	do	Multiple, homogeneous	M
892	do	do	Discordant	Lenticular	Homogeneous	F
895	do	do	Concordant	do	Multiple, homogeneous	F
896	do	do	Discordant	do	do	F
897	do	do	Concordant	do	Homogeneous	F
900	do	do	Discordant	Irregular	do	M
904	do	do	Concordant	Lenticular	do	F
914	do	do	do	do	do	F
915	do	do	do	do	Multiple, homogeneous	F
916	do	do	do	do	do	F
917	do	do	do	do	Homogeneous	M
918	do	do	do	do	Multiple, homogeneous	F
920	do	do	do	do	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
29		50		21		x		x		x		Beryl	Tr.	0.3–1.4
33		47		20		x		x		x				
29		50		21		x				x				
30		50		20		x				x				
34		47		19		x				x				
33		50		16		1				x				
34		47		19		x		x		x		Beryl Apatite	Tr. Tr.	0.1–1.2 0.1–0.7
33		48		19		x								
34		48		18		x		x		x				
29		43		24		4								
31		50		17		2				x				
30	0.6	40	3	30	2	x	0.8	x	0.1	x	0.6	Beryl	0.15	0.3–2.4
x	.6	x	1	100	6	x		x	.1	x	1			
35		48		17		x				x				
32		50		18		x								
40		49		11		x				x				
28		49		22		x		x		x				
32		55		12		1								
32		55		12		1								
39		51		10		x								
39		50		11		x								
39		50		11		x								
39		49		12		x				x				
40		48		12		x				x				
40		48		12		x				x		Beryl	Tr.	0.1 x 0.2
38		53		9		x				x				
40		49		10		1				x				
33	.3	50	0.5	12	0.7	5	.3							
x	.5	x	.5	99	3	1	1							
37		50		13		x				x		Beryl	Tr.	0.5 x 0.9
34		55		11		x				x				
36		50		14		x								
38		48		14		x				x				
33		55		12		x								
40		49		11		x								
38		47		14		x				1				
40		50		10		x				x				
40		52		8		x								
40		49		11		x				x				
30		56		14		x								
34		50		16		x								
37		53		10		x								
34		55		11		x						Beryl	Tr.	
38		52		10		x		x		x				
38		52		10		x		x		x				
42		50		8		x				x				
38		52		10		x						Beryl	Tr.	0.7 x 1.2
39		50		11		x		x						
31		47		21		1				x				
30		50		20		x		x		x				
30		53		17		x				x				
33		48		18		1								
32		50		18		x				x				
34		47		19		x				x				

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
921	Schist	None	Concordant	Lenticular	Homogeneous	F
923	do	do	do	do	Multiple, homogeneous	F
929	do	do	do	do	Banded	F
930	do	do	do	do	Multiple, homogeneous	M
931	do	do	do	do	do	F
933	do	do	do	do	do	F
938	do	do	do	do	Homogeneous	F
939	do	do	do	do	Zoned: Wall Zoned: Core	F M
940	do	do	do	do	Homogeneous	F
942	do	do	do	do	do	M
943	do	do	do	do	Multiple, homogeneous	F
944	do	do	do	do	do	F
946	do	do	do	do	Homogeneous	F
948	do	do	do	do	do	F
950	do	do	do	do	do	F
952	do	do	do	Tabular	Multiple, homogeneous	F
954	do	do	do	Lenticular	do	F
955	do	do	do	do	do	F
957	do	do	do	do	do	F
958	do	do	do	do	do	F
959	do	do	do	do	Homogeneous	F
960	do	do	do	do	do	F
961	do	do	do	do	Multiple, homogeneous	F
962	do	do	do	Tabular	Homogeneous	F
963	do	do	do	do	do	F
965	do	do	do	do	do	M
966	do	do	do	Lenticular	do	F
968	do	do	do	do	Multiple, homogeneous	F
969	do	do	do	do	do	F
970	do	do	do	do	do	F
971	do	do	do	do	do	F
972	do	do	do	do	do	F
974	do	do	do	Tabular	Homogeneous	F
978	do	do	do	Lenticular	Multiple, homogeneous	F
979	do	do	do	do	do	F
984	do	do	do	Tabular	Homogeneous	F
985	do	do	do	do	do	F
986	do	do	do	Lenticular	Multiple, homogeneous	F
987	do	do	do	do	Homogeneous	F
989	do	do	do	do	do	F
991	do	do	do	do	do	F
992	do	do	do	do	do	F
993	do	do	do	do	Multiple, homogeneous	F
995	do	do	do	do	Banded	F
996	do	do	do	do	Homogeneous	M
1001	do	do	do	do	Multiple, homogeneous	F
1006	do	do	do	do	Homogeneous	F
1007	do	do	do	do	do	F
1012	do	do	do	do	Multiple banded	F
1016	do	do	Discordant	do	Homogeneous	F
1017	do	do	Concordant	do	Zoned: Wall Zoned: Core	F M
1021	do	do	Discordant	Irregular	Homogeneous	M
1024	do	do	Concordant	Lenticular	do	F
1032	do	do	do	do	do	F
1034	do	do	do	do	Multiple, homogeneous	F
1040	do	do	do	do	Homogeneous	F
1045	do	do	do	Tabular	do	F
1046	do	do	do	Lenticular	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
35		45		19		1				x				
33		47		20		x				x		Beryl	Tr.	0.3 x 0.5
30	0.4	50	0.9	20	0.7	x	0.3			x	0.6			
32		50		18		x				x		Beryl	Tr.	0.2–1.4
35		44		19		2		x						
30		50		20		x								
33		47		20		x				x				
30	.4	45	.7	25	.6	x				x				
Tr.	.6	Tr.	.7	100	3	Tr.								
31		49		20		x		x		x		Beryl	Tr.	0.2–0.5
25		40		35		x				x		do	do	1.2–1.7
32		48		20		x								
31		49		20		x								
31		53		16		x				x				
31		48		21		x								
29		50		21		x				x				
30		50		20		x				x				
32		48		20		x				x				
.30		50		20		x				x				
32		48		20		x								
34		47		19		x								
33		47		20		x				x				
31		48		21		x				x				
31		48		21		x				x		Beryl	Tr.	0.2–1.2
32		48		20		x				x				
32		48		20		x				x				
25		41		32		2						Beryl	Tr.	0.5–1.2
35		45		20		x				x				
33		48		19		x				x				
33		48		19		x				x				
32		48		20		x				x				
36		44		20		x		x		x				
34		48		18		x		x		x				
32		48		20		x		x		x		Beryl	Tr.	0.4–1.8
30		51		19		x				x				
30		50		20		x				x				
31		49		20		x		x		x				
30		50		20		x				x		Beryl	Tr.	0.2–1.7
30		50		20		x				x				
30		50		20		x								
28		51		20		x				x				
32		48		20		x		x		x				
32		48		20		x				x				
32		49		19		x				x				
32	.1	52	.3	16	.3	x	.1							
33		46		20		1								
33		49		18		x				x				
36		47		17		x				x				
36		46		17		1				x				
40	.1	50	.4	10	.3	x	.1							
34		55		11		x				x				
55	.4	34	1	11	1	x	.5					Beryl	Tr.	0.3 x 0.7
25	.6	57	4	18	3	x	1					do	Tr.	1.6 x 1.9
34		48		18		x								
31		51		18		x		x		x				
36		53		11		x								
39		51		10		x				x				
35		50		15		x								
30		49		21		x								
34		47		18		1								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
1048	Schist	None	Discordant	Lenticular	Homogeneous	F
1050	do	do	do	Irregular, branching.	do	M
1051	do	do	do	do	do	F
1062	do	do	Concordant	Tabular	do	F
1067	do	do	do	Lenticular	Multiple, honogeneous	F
1068	do	do	do	Tabular	Zoned {Wall Zoned {Core	M M
1069	do	do	do	Lenticular	Multiple, homogeneous	F
1071	do	do	do	Tabular	Homogeneous	F
1074	do	do	do	Lenticular	do	F
1077	do	do	do	do	Multiple, homogeneous	F
1078	do	do	do	do	Homogeneous	F
1079	do	do	do	do	do	F
1080	do	do	do	do	do	F
1081	do	do	do	do	do	F
1083	do	do	do	do	Multiple, homogeneous	M
1084	do	do	do	do	do	F
1085	do	do	do	do	do	M
1086	do	do	do	do	do	F
1087	do	do	do	do	do	F
1088	do	do	do	do	Homogeneous	F
1091	do	do	do	do	do	F
1092	do	do	do	do	do	F
1093	do	do	do	do	do	F
1094	do	do	do	do	do	F
1095	do	do	do	do	do	F
1098	do	do	do	do	do	F
1102	do	do	do	do	do	F
1104	do	do	do	do	Multiple, homogeneous	F
1107	do	do	Discordant	do	Homogeneous	M
1113	do	do	Concordant	do	do	F
1117	do	do	do	do	do	M
1118	do	do	do	do	do	F
1119	do	do	do	do	do	F
1123	do	do	do	do	Multiple, homogeneous	F
1125	do	do	do	do	do	F
1126	do	do	do	do	Homogeneous	F
1129	do	do	do	do	do	F
1131	do	do	Dsicordant	do	do	M
1133	do	do	Concordant	do	do	F
1134	do	do	do	do	Multiple, homogeneous	F
1135	do	do	do	do	do	F
1138	do	do	do	do	Homogeneous	M
1140	do	do	do	do	Multiple, homogeneous	F
1141	do	do	do	do	do	F
1144	do	do	Discordant	do	Homogeneous	F
1147	do	do	Concordant	Tabular	do	F
1148	do	do	Discordant	Branching	do	F
1150	do	do	Concordant	Lenticular	do	F
1154	do	do	Discordant	do	do	F
1155	do	do	do	do	do	F
1158	do	do	do	do	do	F
1160	do	do	do	do	do	F
1162	do	do	do	do	do	F
1166	do	do	do	Irregular	do	F
1180	do	do	Concordant and discordant.	Irregular, branching.	do	M
1182a	do	do	Concordant	Lenticular	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 3 TO 2—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
34		50		16		x		x				Beryl	Tr.	
35		46		19		x						do	Tr.	0.7–1.4
30		50		20		x		x		x		do	Tr.	1.–2.4
30		50		20		x				x				
30		50		20		x								
30	0.7	49	2	21	2	x	1	x	0.3	x	1.3	Beryl	0.02	0.2–5.4
Tr.	.7	x	2	100	3	Tr.								
28		51		21		x				x				
25		40		35		x		x		x				
35		45		19		1								
31		50		19		x				x				
30		50		20		x				x				
32		52		16		x		x				Beryl	Tr.	0.3–1.2
32		50		17		1								
33		47		20		x		x						
30		50		20		x				x		Beryl	Tr.	0.6 x 0.9
30		50		20		x				x				
35		47		18		x		x		x				
35		47		18		x				x				
30		50		20		x				x				
30		47		23		x								
35		46		18		x						Beryl	Tr.	0.2–0.6
33		49		18		x		x						
31		49		20		x								
28		50		22		x								
34		47		19		x								
34		46		19		1		x						
29		48		22		1								
30		53		17		x				x				
40		48		12		x		x				Beryl	Tr.	0.1–1.4
30		50		20		x		x		x				
34		44		21		1		x						
30		52		18		x				x				
32		51		17		x				x				
34		49		17		x		x		x				
32		50		18		x		x		x				
30		50		20		x				x				
34		45		19		2								
34		45		19		2		x				Beryl	.25	0.1–2.9
30		52		18		x		x		x				
32		48		20		x		x						
34		46		20		x				x				
31		48		21		x		x				Beryl	Tr.	0.2–0.7
34		47		19		x		x		x				
29		50		21		x			x					
33		49		18		x				x		Beryl	Tr.	0.6–2.4
35		45		20		x								
30		50		20		x						Chrysoberyl	Tr.	0.1–0.5
30		50		20		x		x						
34		46		20		x								
31		47		22		x						Chrysoberyl	Tr.	0.1–0.6
32		46		22		x						{Beryl	Tr.	0.2–0.6
												Chrysoberyl	Tr.	0.1–0.5
32		50		18		x						Beryl	.08	0.1–2.5
31		49		20		x		x		x				
36		52		12		x								
35		55		10		x						Beryl	Tr.	
30		56		14		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
FELDSPAR-RICH						
PERTHITE-PLAGIOCLASE-QUARTZ						
RATIO OF PERTHITE TO PLAGIOCLASE						
1182c	Schist	None	Concordant	Tabular	Homogeneous	F
1184	do	do	do	do	do	F
1187	do	T	Discordant	Lenticular	do	F
1190	do	T	do	do	Multiple, homogeneous	F
1191	do	T	do	do	do	F
1193	do	T	do	do	do	F
1195	do	T	do	do	do	F
1196	do	T	Discordant and concordant.	Branching	do	F
1197	do	T	Discordant	do	do	F
1199	do	T	do	Irregular	do	F
1200	do	None	do	Lenticular	do	F
1206	do	do	do	do	do	F
1207	do	do	do	do	do	F
1210	do	do	do	do	do	F
1211	do	do	Concordant	Tabular	Homogeneous	F
1214	do	do	do	Lenticular	Multiple, homogeneous	F
1216	do	do	do	do	Homogeneous	F
1217	do	do	do	do	do	F
1220	do	do	Discordant	do	do	F
1221	do	do	Concordant	do	Multiple, homogeneous	F
1223	do	do	do	do	Homogeneous	F
1227	do	do	do	do	do	F
1228	do	do	do	do	do	F
1230	do	do	Discordant	do	do	F
1231	do	do	do	do	do	F
1232	do	do	Concordant	do	do	F
1236	do	do	do	do	Multiple, homogeneous	F
1237	do	do	do	do	Homogeneous	F
1239	do	do	do	do	do	F
1240	do	do	do	do	Multiple, homogeneous	F
1243	do	do	do	do	do	F
1244	do	do	do	do	Homogeneous	F
1256	Granite	do	Joint-controlled.	Tabular	do	F
1261a	Schist	T	Concordant	Lenticular	do	F
1262	do	None	do	Tabular	do	F
1263	do	do	do	Lenticular	Multiple, homogeneous	F
1264	do	do	do	do	Homogeneous	F
1266	do	do	do	do	do	F
1267	do	do	do	do	Multiple, homogeneous	F
1269	do	do	do	do	Homogeneous	F
1270	do	do	do	Tabular	do	F
1271	do	do	do	Lenticular	do	F
1281	do	do	Discordant	Tabular	do	F
1286	do	do	Concordant	Lenticular	do	F
1297	Granite	do	Discordant	Lenticular, branching.	do	F
RATIO OF PERTHITE TO						
2	Schist	None	Discordant	Irregular	Homogeneous	M
3	do	do	Concordant	Lenticular	Multiple, banded	F
7	do	do	Discordant	Tabular	Homogeneous	M
8	do	do	do	Irregular	Multiple, homogeneous	M
12	do	do	Concordant and discordant.	do	do	F

pegmatites—Continued

C, coarse, 4-12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
PEGMATITES—Continued														
PEGMATITES—Continued														
IS ABOUT 3 TO 2—Continued														
36		44		20		x								
32		49		19		x		x		x				
36		45		19		x		x		x		Beryl	Tr.	0.3-1.4
34		46		20		x				x		do	Tr.	0.3-1.2
32		48		20		x		x		x				
30		50		20		x		x		x		Beryl	Tr.	0.1-2.7
34		47		20		x		x		x				
32		49		19		x		x		x				
34		48		18		x		x		x		Beryl	Tr.	
34		48		18		x		x		x		do	Tr.	0.5-12
33		49		18		x				x				
35		45		20		x						Beryl	Tr.	0.4-1.2
36		46		18		x								
32		50		17		x						Beryl	Tr.	0.2-0.6
38		55		17		x								
42		50		8		x								
32		49		19		x				x				
32		50		18		x		x		x		Beryl	Tr.	1.2-1.9
33		47		20		x				x				
32		48		20		x		x		x		Beryl	Tr.	0.4 x 0.9
31		51		18		x		x		x		do	Tr.	0.2-1.4
36		45		19		x		x		x				
33		49		18		x				x				
34		48		18		x		x		x		Beryl	Tr.	0.7-4.9
32		48		20		x		x		x		do	Tr.	0.1-2.7
34		48		18		x				x		do	Tr.	0.8-2.9
32		48		20		x		x						
32		48		20		x		x						
34		46		20		x				x				
30		47		23		x				x		Beryl	Tr.	0.2-0.5
31		45		24		x				x				
33		47		20		x		x		x		{Beryl	Tr.	0.3-1.3
												{Biotite	Tr.	0.1-0.5
38		50		12		x								
32		48		20		x		x				Beryl	Tr.	0.2-1.2
33		47		20		x		x						
33		46		21		x						Beryl	Tr.	0.3 x 0.7
30		48		22		x				x		do	Tr.	0.4-4.2
32		48		20		x		x		x				
30		44		26		x								
32		51		17		x				x				
31		50		19		x				x				
36		50		14		x								
32		48		20		x				x				
32		48		20		x		x		x				
31		50		19		x		x		x				
PLAGIOCLASE IS ABOUT 2 TO 1														
25		55		19		x								
30	0.2	60	0.4	10	0.3	x	0.2					Beryl	Tr.	0.5 x 1.1
29		65		6		x								
32		60		8		x								
25		50		23		2								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

17	Schist	None	Concordant and discordant.	Irregular	Homogeneous	F
20	do	do	Concordant	Lenticular	do	M
23	do	do	do	do	do	M
24	do	do	do	do	Multiple, homogeneous	M
25	do	do	do	do	do	M
26	do	do	do	do	do	M
27	do	do	do	do	do	M
28	do	do	do	do	do	M
29	do	do	do	do	do	M
30	do	do	do	do	do	M
31	do	do	do	do	do	F
32	do	do	do	do	do	F
33	do	do	do	do	Multiple, banded	F
36	do	do	do	do	do	F
39	do	do	do	do	Homogeneous	M
44	do	do	do	do	do	F
65	Granite and schist.	T	do	Lenticular, branching.	do	F
92	Granite	None	Discordant	Tabular	do	F
97	do	do	Concordant in sill.	Lenticular	do	F
98	do	do	Concordant and discordant.	Lenticular, branching.	do	F
99	do	do	Concordant in still.	Lenticular	do	F
105	do	do	Discordant	Tabular	do	F
135	do	do	do	do	do	M
136	do	do	do	do	do	M
138	do	do	do	Tabular, branching.	do	M
139	do	do	do	Lenticular, branching.	do	M
141	Schist and granite.	do	Concordant	Lenticular	do	F
142	Granite	do	Discordant	do	do	M
143	do	do	do	do	do	M
144	do	do	do	Tabular	do	M
150	do	do	do	do	do	M
153	do	do	do	do	do	M
155	Schist	do	do	do	do	M
162	Granite	do	do	do	do	M
165	Schist	do	Concordant	do	do	F
166	Granite	do	do	do	Multiple, banded	F
171	Schist	do	do	Lenticular	Homogeneous	M
175	do	do	Concordant and discordant.	do	Multiple, homogeneous	M
177	do	do	Concordant	do	do	M
183	do	do	Discordant	Irregular	Banded	F
187	do	do	Concordant	Lenticular	Multiple, homogeneous	F
188	Granite	do	Concordant in sill	do	Homogeneous	F
189	do	do	do	do	do	F
196	Schist	do	Discordant	do	Multiple, homogeneous	M
202	do	do	Concordant	do	do	M
204	do	do	do	do	Homogeneous	M
209	do	do	do	do	Multiple, homogeneous	M
210	do	do	do	do	Multiple, banded	F
211	do	do	do	do	Homogeneous	F
212	do	do	do	do	do	F
232	do	do	do	do	do	M
237	do	do	do	do	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 TO 1—Continued

32		58		10		x								
30		60		10		x								
30		60		10		x						Beryl	Tr.	
30		60		10		x								
30		60		10		x								
30		60		10		x								
30		60		10		x						Beryl	Tr.	0.2–06
30		60		10		x								
30		60		10		x								
30		60		10		x								
30		60		10		x								
30		60		10		x								
30	0.3	60	0.6	10	0.4	x	0.2							
30	.2	60	.6	10	.5	x	.1							
30		55		15		x								
20		65		15		x								
27		53		20		x		x		x		Beryl	Tr.	0.2–1.2
22		68		10		x				x				
25		60		15		x				x				
25		60		15		x				x				
25		60		15		x								
28		60		12		x								
25		65		10		x				x				
20		60		20		x				x				
20		75		5		x								
20		75		5		x								
20		74		6		x								
27		60		13		x								
25		55		20		x								
18		75		7		x						Beryl	Tr.	0.2–0.6
23		60		17		x				x		do	Tr.	0.5–1.1
22		65		13		x				x				
20		60		10		x								
30		60		10		x								
25		65		10		x								
25		60		14		1								
24		60		15		1								
25		60		15		x								
20		60		19		1								
30	.2	60	.4	10	.3	x	.1							
28		60		12		x								
25		55		19		1								
28		60		12		x								
25		55		19		1						Beryl	Tr.	0.2–1.9
30		60		10		x								
25		55		19		1								
30		55		15		x								
32	.4	60	.8	8	.6	x	.2							
21		70		9		x								
21		70		9		x								
25		58		17		x						Beryl	Tr.	0.3–0.5
30		51		19		x				x				

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches;
0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
FELDSPAR-RICH						
PERTHITE-PLAGIOCLASE-QUARTZ						
RATIO OF PERTHITE TO PLAGIOCLASE						
252	Schist	None	Discordant	Lenticular	Multiple, homogeneous	M
258	do	do	do	do	Homogeneous	F
259	do	do	do	do	do	F
263	Granite	T	do	Irregular, branching.	do	M
264	do	None	do	Tabular	do	M
275	do	do	do	Tabular, branching.	do	M
276	do	do	do	do	do	M
277	do	T	do	do	do	M
279	do	do	do	Tabular	do	M
282	do	None	do	Tabular, branching.	do	M
286	do	do	do	Lenticular	do	M
305	do	T	do	Tabular, branching.	do	M
317	Schist	None	Concordant and discordant.	Lenticular, branching.	Homogeneous	F
355	Granite	do	Discordant	Tabular, branching.	do	F
359	do	do	Joint-controlled	do	do	M
362	do	do	Discordant	Tabular	do	M
374	do	do	Joint-controlled	Tabular, branching.	do	M
375	do	T	do	do	do	M
376	do	None	Discordant	do	do	M
377	do	do	do	Tabular	do	M
378	do	do	Joint-controlled	Tabular, branching.	do	M
381	do	do	do	do	do	M
399	do	do	Discordant	do	do	M
401	do	do	Concordant?	Lenticular	do	M
402	do	do	do	do	do	M
414	Schist	do	Concordant	do	do	F
416	do	do	do	do	do	F
425	do	do	do	Tabular	do	M
429	do	do	Discordant	Lenticular	Multiple, banded	F
430	do	do	do	Irregular, branching.	Multiple, homogeneous	F
432	do	do	do	do	do	F
434	do	do	do	Lenticular	do	F
443	do	do	do	do	Zoned {Wall {Core	M C
449	do	do	do	Irregular	Multiple, homogeneous	F
467	do	do	Concordant	Tabular	Homogeneous	F
487	do	T	do	Lenticular	do	F
488	do	T	do	do	do	F
494	do	None	do	do	do	F
514	do	do	do	do	do	F
540	do	do	do	do	do	M
556	do	do	do	do	do	F
574	do	do	do	do	do	M
584	Schist and granite.	T	do	do	do	F
593	Schist	None	do	do	do	F
594	do	do	do	Tabular	do	F
599	do	do	do	Lenticular	do	F
602	do	do	do	Tabular	Banded	F
603	do	do	Discordant	Lenticular	Homogeneous	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent, Tr., less than †, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 TO 1—Continued

29		56		19		1						Beryl	0.05	0.1–2.8
25		60		15		x				x		do	Tr.	0.3–1.3
32		55		15		x				x		do	Tr.	0.3–1.3
25		55		20		x								
25		55		20		x								
18		70		12		x				x				
20		65		15		x				x		Beryl	.05	0.2–1.3
18		70		11		x				1				
15		65		20		x				x		Beryl	.2	0.1–1.9
32		60		8		x				x				
30		58		12		x								
26		55		18		x				1		Beryl	Tr.	0.6–1.2
25		63		12		x								
33		56		11		x								
25		63		12		x				x				
21		46		33		x				x		Beryl	Tr.	0.1 x 0.6
30		55		15		x								
22		62		15		x				1				
25		65		10		x				x				
25		60		15		x				x		Beryl	.1	0.9–4.8
25		63		12		x				x				
27		60		12		1				x				
20		58		22		x				x		Beryl	.15	0.2–5.4
20		50		30		x				x		do	1.7	
15		15		68		2				x		do	.5	
												Apatite	Tr.	
20		60		20		x								
28		56		16		x								
25		55		20		x								
30	0.4	55	0.7	14	0.5	1	0.3	x						
30		53		16		1		x		x				
30		53		16		1		x		x				
29		58		13		x								
5		75		20		x						Beryl	Tr.	2.4 x 3.6
38		50		12		x								
30		62		8		x								
25		50		25		x						Beryl	Tr.	0.1–0.8
30		55		15		x				x				
28		55		16		x		x		1				
35		57		8		x								
15		35		50		x						Beryl	.18	0.1–1.2
27		48		25		x						do	Tr.	0.1–0.4
30		60		10		x								
30		58		12		x		x		x				
19		55		25		x				1		Beryl	Tr.	
24		56		20		x						do	Tr.	0.2–0.8
25		50		25		x								
15		65		20		x								
15	.2	65	.4	20	.4	x	.1					Beryl	Tr.	0.2–0.7
25		50		25		x								

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

Pegmatite (pl. 5)	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
605	Schist	None	Concordant?	Lenticular	Homogeneous	F
607	do	do	Concordant	do	do	F
608	do	do	Concordant?	Banded	do	F
613	do	do	Concordant	Tabular	Homogeneous	F
638	do	do	do	Lenticular	do	F
639	do	do	do	do	do	F
642	do	do	Discordant	do	Zoned{Wall Core	F M
663	do	do	Concordant	do	Homogeneous	F
667	do	do	Concordant	do	do	F
668	do	do	do	do	do	F
670	do	do	do	do	do	M
673	do	T	Discordant and concordant.	Irregular	do	M
684	do	None	Concordant	Lenticular	do	F
691	do	do	do	do	Multiple, homogeneous	F
694	do	do	do	do	do	M
714	do	do	do	do	do	F
748	do	do	do	do	Zoned{Wall Core	F M
753	do	do	do	do	Homogeneous	F
754	do	do	do	do	Multiple homogeneous	F
755	do	do	do	do	do	F
757	do	do	do	do	do	F
758	do	do	do	do	do	F
764	do	do	do	do	Homogeneous	F
765	do	do	do	do	Multiple, homogeneous	F
766	do	do	do	do	Zoned{Wall Core	F M
768	do	do	do	Tabular	Homogeneous	F
769	do	do	do	do	do	F
772	do	do	do	Lenticular	do	F
774	do	do	do	Tabular	Zoned{Wall Core	F M
776	do	do	do	Lenticular	Homogeneous	F
777	do	do	do	do	do	F
778	do	do	do	do	do	F
779	do	do	do	do	Zoned{Wall Core	M M
781	do	T	Concordant?	Lenticular, branching.	Zoned{Wall Core	M M
782	do	None	Concordant	Lenticular	Multiple, homogeneous	F
784	do	do	do	Tabular	Homogeneous	F
785	do	do	do	do	do	F
790	do	do	do	Lenticular	Multiple, homogeneous	F
791	do	do	do	Tabular	Homogeneous	F
792	do	do	do	do	Multiple, homogeneous	F
793	do	do	do	do	do	F
794	do	do	do	Lenticular	Homogeneous	F
799	do	do	do	Tabular	do	F
800	do	do	do	Lenticular	do	F
802	do	do	do	do	do	F
803	do	do	do	do	do	F
804	do	do	do	Tabular	Multiple, homogeneous	F
808	do	do	do	Lenticular	Homogeneous	F
809	do	do	do	do	do	F
810	do	do	do	do	do	M
811	do	do	do	do	do	F
812	do	do	do	do	Multiple, homogeneous	M
813	do	do	do	do	Homogeneous	F

pegmatites—Continued

C, coarse, 4-12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 TO 1—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
26		50		24		x								
26		50		24		x				x				
28	0.4	52	0.7	20	0.5	x	0.2			x	0.3			
30		50		20		x				x				
30		62		8		x								
30		62		8		x								
64	.4	35	1	11	.9	x	.2	x	0.1	x	.5	Beryl	Tr.	0.1-1.2
30	.8	60	3	10	2	x	.4	x	.3	x	1	do	Tr.	0.6-0.6
27		50		22		x								
25		50		25		x								
27		50		23		x								
20		60		18		2								
27		55		17		x		x		1		Beryl	Tr.	
21		50		27		2								
31		60		9		x				x				
32		50		18		x		x		x				
26		65		9		x						Beryl	Tr.	0.1-0.3
27		51		22		x				x		do	Tr.	0.2-1.3
x		x		100		x								
27		53		20		x		x						
22		58		20		x				x				
28		53		19		x		x		x		Beryl	Tr.	0.5-0.7
26		52		22		x		x		x				
26		52		22		x				x				
27		51		22		x				x		Beryl	Tr.	0.2-0.7
27		54		19		x				x				
25	.3	50	.8	25	.6	x	.2			x		Beryl	Tr.	0.1-0.5
x	.5	x	1	100	4	x	.5							
26		56		18		x				x				
23		52		25		x				x				
25		53		22		x				x				
26	.5	52	.7	22	1	x	.1							
x	.5	x	3	100	4	x	.3							
20		60		20		x				x				
22		56		22		x		x		x		Beryl	Tr.	0.2-0.5
27		54		19		x				x				
20	.5	55	2	25	1	x	.1			x		Beryl	0.56	0.2-2.5
x	.7	x	4	100	4	x	.5							
20	.4	60	1	19	1	x	.4			1		Beryl	Tr.	0.5-1.1
x	.6	x	2	100	3	x	.7							
28		51		21		x				x				
20		57		23		x								
26		54		20		x				x				
28		51		21		x				x				
24		48		28		x				x				
25		55		20		x				x				
27		52		21		x				x				
25		53		22		x								
22		58		20		x								
27		53		20		x		x		x				
25		52		23		x				x				
26		52		22		x				x				
28		50		22		x				x				
25		55		20		x				x				
24		60		16		x				x				
22		60		18		x		x		x				
27		55		18		x				x				
24		48		25		3		x		x		Beryl	Tr.	0 2-0.9
15		60		25		x						do	Tr.	0.2-0.6

295165—55——12

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches;
0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
					FELDSPAR-RICH	
					PERTHITE-PLAGIOCLASE-QUARTZ	
					RATIO OF PERTHITE TO PLAGIOCLASE	
814	Schist	None	Concordant	Lenticular	Homogeneous	F
815	do	do	do	do	do	F
816	do	do	Discordant	do	do	F
817	do	do	do	do	do	F
820	do	do	Concordant	do	do	M
821	do	do	do	do	do	F
823	do	do	Discordant	do	do	F
824	do	do	Concordant, in part.	do	do	F
825	do	do	Concordant and discordant.	do	Multiple, homogeneous	F
828	do	do	Concordant	do	Homogeneous	F
830	do	do	Concordant and discordant.	Lenticular, branching.	Multiple, homogeneous	F
831	do	do	Concordant	Lenticular	Homogeneous	F
832	do	do	do	do	do	F
834	do	do	do	do	do	M
835	do	do	Discordant	do	do	M
837	do	do	Concordant	Tabular	do	F
839	do	do	Discordant and concordant.	Lenticular, branching.	do	F
842	do	do	Concordant	Tabular	do	F
848	do	do	do	Lenticular	do	F
891	do	do	do	do	Multiple, homogeneous	M
893	do	do	Discordant	do	Homogeneous	F
910	do	do	Concordant	do	do	F
913	do	do	do	do	Multiple, homogeneous	F
922	do	do	do	do	do	F
924	do	do	do	do	Homogeneous	F
925	do	do	do	do	Multiple, homogeneous	F
926	do	do	do	do	Homogeneous	F
927	do	do	do	do	Multiple, homogeneous	F
928	do	do	do	do	do	F
932	do	do	do	do	do	F
934	do	do	do	do	Homogeneous	F
935	do	do	do	Tabular	do	F
936	do	do	do	Lenticular	do	F
937	do	do	do	Tabular	do	F
947	do	do	do	Lenticular	do	F
953	do	do	do	do	Multiple, homogeneous	F
956	do	do	do	do	do	F
964	do	do	do	do	do	F
967	do	do	do	do	Homogeneous	F
981	do	do	do	do	do	F
982	do	do	do	do	do	F
983	do	do	do	Tabular	do	F
994	do	do	do	do	do	F
1004	do	do	do	Lenticular	Multiple, homogeneous	F
1013	do	do	do	do	Homogeneous	F
1028	do	do	Discordant	Irregular	do	F
1036	do	do	Concordant	Lenticular	Multiple, homogeneous	F
1037	do	do	do	do	Homogeneous	F
1038	do	do	do	do	Multiple, homogeneous	M
1039	do	do	do	do	Zoned {Wall Zoned {Core	F M
1042	do	do	Discordant?	do	Multiple, homogeneous	F
1043	do	do	Concordant	do	Homogeneous	F
1044	do	do	do	Tabular	do	F
1054	do	do	Discordant and concordant.	Irregular branching.	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 TO 1—Continued

20		55		25		x						Bery	Tr.	0.2–1.9
20		58		22		x								
25		55		20		x		x						
25		55		20		x		x						
25		55		20		x				x				
23		55		20		2								
25		58		17		x								
25		55		18		2		x		x		Beryl	0.04	0.1–0.7
20		60		20		x		x		x				
15		65		19		1								
23		50		25		2				x				
25		57		18		x				x				
20		60		20		x		x		x				
23		60		17		x				x				
28		56		16		x		x		x		Beryl	.04	0.1–0.9
27		51		22		x		x		x		do	Tr.	0.1 x 0.1
25		54		21		x				x				
25		55		20		x				x				
28		58		14		x				x				
30		60		10		x								
30		55		15		x								
27		50		23		x				x				
26		52		22		x				x				
26		52		22		x				x				
26		54		20		x				x				
26		54		20		x				x				
28		52		20		x				x				
25		55		20		x		x		x		Beryl	Tr.	
27		50		23		x		x		x		do	Tr.	0.2 x 0.3
26		53		21		x				x				
26		52		22		x				x				
20		57		23		x		x		x				
24		54		21		x				1				
25		55		20		x				x				
27		53		20		x						Beryl	Tr.	0.2–0.4
28		51		21		x		x		x		do	Tr.	0.5–1.2
27		53		20		x				x		do	Tr.	0.5–1.2
26		52		22		x		x		x				
27		53		20		x		x		x				
25		53		22		x		x		x				
28		52		20		x								
25		55		20		x				x		Beryl	Tr.	0.3 x 0.8
27		53		20		x								
20		55		25		x				x				
30		55		15		x								
32		60		8		x						Beryl	Tr.	
30		65		5		x				x				
27		60		13		x								
31		60		9		x				x				
39		50		10		1		x						
10		50		40		x		x				Chrysoberyl.	Tr.	0.05–0.6
22		52		26		x		x		x				
24		50		26		x								
20		53		26		x								
27		54		19		x				x				

Mineralogy of

Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1–4 inches;
0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock		Pegmatite			
	Type and formation	Alteration	Relation to wall rock	Shape	Internal structure	Texture
					FELDSPAR-RICH	
					PERTHITE-PLAGIOCLASE-QUARTZ	
					RATIO OF PERTHITE TO PLAGIOCLASE	
1057	Schist	None	Concordant	Tabular	Homogeneous	F
1058	do	do	do	do	do	F
1060	do	do	do	Lenticular	do	F
1063	do	do	do	do	do	F
1064	do	do	do	do	Multiple, homogeneous	F
1065	do	do	do	do	do	F
1066	do	do	do	do	do	F
1070	do	do	do	do	Homogeneous	F
1072	do	do	do	do	do	F
1073	do	do	do	do	Multiple, homogeneous	M
1075	do	do	do	do	do	F
1089	do	do	do	do	Homogeneous	F
1090	do	do	do	do	do	F
1097	do	do	do	do	do	F
1099	do	do	do	do	do	F
1100	do	do	do	Tabular	do	M
1101	do	do	do	Lenticular	do	F
1103	do	do	do	do	do	F
1106	do	do	do	do	Homogeneous, banded	F
1112	do	do	do	do	Homogeneous	F
1114	do	do	do	do	Multiple, homogeneous	F
1115	do	do	do	do	Homogeneous	F
1116	do	do	do	do	Multiple, homogeneous	F
1120	do	do	do	do	Homogeneous	F
1121	do	do	do	do	Multiple, homogeneous	F
1122	do	do	do	do	do	F
1124	do	do	do	do	do	F
1127	do	do	do	do	do	M
1128	do	do	do	do	Homogeneous	F
1130	do	do	do	do	do	F
1132	do	do	do	do	do	F
1136	do	do	do	do	do	F
1137	do	do	do	do	Multiple, homogeneous	F
1139	do	do	do	do	Homogeneous	F
1142	do	do	do	do	Multiple, homogeneous	F
1143	do	do	do	do	do	F
1149	do	do	do	Tabular	Homogeneous	F
1151	do	do	do	do	do	F
1152	do	do	do	Lenticular	do	F
1156	do	do	do	do	Banded	F
1159	do	do	Discordant	do	Homogeneous	F
1164	do	do	do	Irregular	do	M
1165	do	do	Concordant?	Lenticular, branching.	Multiple, homogeneous	F
1167	do	do	Discordant?	Irregular?	Homogeneous	F
1168	do	do	Discordant	Irregular, branching.	do	M
1169	do	do	Concordant	Lenticular	do	M
1173	do	do	Discordant?	Irregular?	do	F
1178	do	do	Discordant	do	do	M
1182b	do	do	Concordant	Tabular	do	F
1183	do	do	do	do	Multiple, homogeneous	F
1185	do	do	do	Lenticular	do	F
1186	do	do	do	Tabular	Homogeneous	F
1188	do	do	do	do	do	F
1189	do	do	do	Lenticular	do	F
1192	do	do	do	do	Banded	F
1201	do	do	Discordant	Lenticular, branching.	Multiple, homogeneous	F
1202	do	do	Concordant	Lenticular	Homogeneous	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 TO 1—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
26		54		20		x				x				
25		55		20		x				x				
25		55		20		x		x		x				
23		57		20		x				x				
27		55		18		x		x		x				
20		60		20		x				x		Beryl	Tr.	0.2–0.4
20		60		20		x								
27		53		20		x		x		x				
25		55		20		x		x		x				
27		55		18		x				x				
20		60		20		x				x				
28		52		20		x						Beryl	Tr.	0.1 x 0.4
20		60		18		2								
24		53		23		x								
25		55		20		x								
25		55		20		x				x				
24		55		21		x								
25		48		26		1								
30	0.6	58	1	12	0.7	x	0.2							
28		60		12		x				x		Beryl	Tr.	
27		51		22		x				x				
23		60		17		x				x				
20		60		20		x				x				
28		55		17		x		x						
25		58		17		x				x				
25		55		20		x				x				
25		55		20		x				x				
22		57		21		x								
20		58		22		x		x		x			0.14	0.9–2.4
20		60		20		x		x		x				
25		48		25		2				x				
26		54		20		x				x				
25		55		20		x		x		x				
26		52		22		x				x		Beryl	Tr.	0.4 x 0.6
27		52		21		x		x		x		do	Tr.	0.5 x 1.2
25		55		20		x				x				
17		63		20		x				x				
15		65		20		x		x		x		Beryl	Tr.	0.2 x 0.6
20		60		20		x		x		x		do	Tr.	0.5–1.2
22	.6	60	1	18	.8	x	.4							
24		58		18		x								
32		58		10		x		x		x				
29		60		11		x		x						
23		65		12		x								
28		60		12		x								
31		58		11		x						Beryl	Tr.	
32		62		8		x								
31		60		9		x								
20		57		23		x		x		x		Beryl	Tr.	0.2–1.1
28		50		22		x		x		x				
28		52		20		x				x				
28		56		16		x				x				
28		50		22		x				x				
28		52		20		x				x				
23	.6	60	.8	17	.8	x	.5							
28		52		20		x		x		x		Beryl	Tr.	0.4–0.8
28		52		20		x		x		x				

Mineralogy of

[Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture

FELDSPAR-RICH

PERTHITE-PLAGIOCLASE-QUARTZ

RATIO OF PERTHITE TO PLAGIOCLASE

1208	Schist	None	Concordant	Lenticular	Multiple, homogeneous	F
1209	do	do	do	do	do	F
1212	do	do	Discordant	Tabular	Homogeneous	F
1213	do	do	Concordant	Lenticular	do	F
1218	do	do	do	do	Multiple, homogeneous	F
1222	do	do	do	Tabular	Homogeneous	F
1225	do	do	do	Lenticular	Multiple, homogeneous	F
1229	do	do	do	Lenticular, branching.	Homogeneous	F
1233	do	do	do	Lenticular	do	F
1234	do	do	do	do	Multiple, homogeneous	F
1235	do	do	Discordant	do	Homogeneous	F
1241	do	do	Concordant	Tabular	do	F
1242	dc	do	do	do	do	F
1245	do	do	do	Lenticular	Multiple homogeneous	F
1249	do	do	do	do	do	M
1250	do	do	do	do	Hoogeneous	F
1251	do	do	do	do	do	F
1252	Granite	do	Discordant	Branching	do	F
1253	do	do	do	Tabular	do	F
1254	do	do	do	Branching	Multiple homogeneous	M
1255	do	do	do	Lenticular	Homogeneous	M
1257	do	do	do	Tabular	do	M
1258	do	do	do	do	do	F
1259	Schist	do	Concordant	Branching	do	F
1261b	Granite	do	Discordant	do	do	F
1265	Schist	do	Concordant	Tabular	do	F
1268	Granite	do	Discordant	Branching	do	F
1272	Schist	do	Concordant	Lenticular	Multiple homogeneous	F
1273	do	do	do	do	Homogeneous	F
1275	Granite	do	Discordant	Tabular	do	M
1276	do	do	do	Lenticular	do	M
1277	do	do	do	do	do	F
1278	do	do	Joint-controlled	Tabular	do	F
1279	do	do	do	do	do	F
1280	do	do	do	do	Multiple homogeneous	F
1282	Granite and schist.	do	do	do	Homogeneous	F
1283	Schist	do	Concordant	Lenticular	Multiple homogeneous	F
1284	do	do	do	Tabular	Zoned{Wall / Core	F / M
1285	do	do	do	Lenticular	Homogeneous	F
1287	do	do	do	Tabular	do	F
1288	do	do	do	Lenticular	do	F
1289	Granite	do	do	Tabular	do	F
1290	do	do	do	Lenticular	Multiple homogeneous	F
1291	do	do	Joint-controlled	Intricately branching.	do	F
1292	do	do	do	Lenticular	do	F
1293	do	do	do	do	do	F
1294	do	do	do	do	do	F
1295	do	do	Discordant	Branching	Homogeneous	F
1296	do	do	Joint-controlled	Lenticular	do	F
1298	do	do	do	do	do	F
1299	do	do	Discordant	do	Multiple homogeneous	F
1300	do	do	Concordant	Tabular	Homogeneous	F
1301	do	do	do	Lenticular	do	F

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than
†, maximum; *, average]

PEGMATITES—Continued

PEGMATITES—Continued

IS ABOUT 2 to 1—Continued

Pegmatite—Continued														
Mineralogy														
Plagioclase		Perthite		Quartz		Muscovite		Garnet		Tourmaline		Other minerals		
Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (n.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Percent	Size
24		58		18		x								
25		55		20		x								
27		53		20		x		x				Beryl	Tr.	0.1–0.4
												Apatite	Tr.	
17		60		23		x				x				
28		52		20		x				x				
28		52		20		x								
24		53		18		x		x		x		Beryl	Tr.	0.4–0.9
												Biotite	Tr.	
26		50		24		x		x		x				
26		54		20		x		x		x		Beryl	Tr.	0.1–0.2
27		51		22		x				x				
28		51		21		x				x				
28		52		20		x				x				
29		50		21		x				x				
26		52		22		x		x		x				
25		60		15		x								
32		50		18		x								
28		54		18		x		x						
25		54		21		x		x		x				
29		52		19		x						Beryl	Tr.	0.6–1.4
26		56		18		x		x		x		do	Tr.	0.2–0.8
24		55		21		x				x				
27		55		18		x				x		Beryl	Tr.	0.3–0.8
22		58		20		x				x		do	Tr.	0.1–3.4
30		50		20		x		x		x		do	Tr.	0.1–1.2
9		70		21		x						do	Tr.	0.1–0.4
27		55		18		x		x		x				
26		52		22		x						Biotite	Tr.	
30		52		18		x								
25		60		15		x		x		x				
10		65		25		x				x				
20		60		20		x				x		Beryl	Tr.	0.2–1.3
28		50		22		x				x		do	Tr.	0.2–1.5
30		50		20		x				x		do	Tr.	0.1–0.6
15		65		20		x				x		do	Tr.	0.1–1.8
14		67		19		x				x				
25		57		18		x				x				
20		60		20		x				x		Beryl	Tr.	0.2–2.4
10	0.3	60	1	29	0.5	1	0.3							
Tr.	.6	x	1	99	3	Tr.	.3							
19		56		22		3		x				Beryl	Tr.	0.2–3.5
22		58		20		x		x		x				
25		54		21		x				x		Beryl	0.01	0.2–1.0
20		60		20		x				x				
24		56		20		x				x		Beryl	Tr.	0.2–0.8
20		55		25		x		x		x				
15		40		45		x				x				
15		40		45		x				x		Beryl	Tr.	
15		40		45		x				x		do	Tr.	
15		65		20		x				x		do	Tr.	0.6–1.4
15		40		45		x				x		do	Tr.	
25		60		15		x		x		x		do	Tr.	0.4–1.3
15		60		25		x		x		x		do	.02	0.2–2.4
20		60		20		x		x		x		do	Tr.	2.3–4.6
17		44		39		x				x				

Mineralogy of

Alteration column: T, tourmalinized. Texture column: F, fine, less than 1 inch; M, medium, 1-4 inches; 0.01 percent. Size columns:

Pegmatite (pl. 5)	Wall rock: Type and formation	Wall rock: Alteration	Pegmatite: Relation to wall rock	Pegmatite: Shape	Pegmatite: Internal structure	Pegmatite: Texture
QUARTZ-RICH						
13	Schist	None	Concordant	Lenticular	Homogeneous	M
14	do	do	do	do	do	M
15	do	do	Unknown	do	do	M
16	do	do	Concordant	do	do	M
30	do	do	do	do	One member of multiple pegmatite.	M
35	do	do	Discordant	do	do	M
43	do	do	Concordant?	do	Homogeneous	M
167	do	do	Unknown	do	do	M
168	do	do	Discordant	do	do	M
199	do	do	do	do	One member of multiple pegmatite.	M
201	do	do	Discordant?	do	Homogeneous	M
205	do	do	Concordant?	do	do	M
206	do	do	do	do	do	M
208	do	do	Discordant	do	do	C
222	do	do	Discordant?	do	do	M
223	do	do	Concordant	do	do	M
225	do	do	Concordant?	do	do	C
335	Granite	do	Discordant	do	do	C
495	Schist	do	do	do	do	M
525	do	do	do	Irregular	Multiple	M
598	do	do	Concordant	Lenticular	Homogeneous	M
616	do	do	Concordant?	do	do	M
617	do	do	Concordant	do	do	M
651	do	do	Concordant?	do	do	C
679	do	do	Concordant	do	do	M
713	do	do	Concordant?	do	do	C
720	do	do	Discordant?	Irregular	do	C
767	do	do	Concordant	Lenticular	do	M
775	do	do	do	do	do	M
851	do	do	do	do	do	C
852	do	do	do	do	do	M
899	do	do	Concordant?	do	do	M
901	do	do	do	do	do	M
902	do	do	do	do	do	M
975	do	do	Discordant?	Irregular	do	C
1014	do	do	Concordant?	Lenticular	do	M
1023	do	do	do	do	do	M
1033	do	do	Discordant	Irregular	do	C
1053	do	do	do	Oval	do	M
1059	do	do	do	Lenticular	do	M
1082	do	do	Unknown	do	do	M
1110	do	do	Discordant?	Lenticular?	do	C
1145	do	do	Discordant	Lenticular	do	M
1198	do	do	do	do	do	M
1210	do	do	Concordant	do	do	F
TOURMALINE-RICH						
260	Granite	None	Discordant	Lenticular	Homogeneous	M
398	do	do	do	Tabular	do	F
404	do	do	do	Lenticular	do	C

pegmatites—Continued

C, coarse, 4–12 inches. Percent columns: x, less than 1 percent but more than 0.01 percent; Tr., less than †, maximum; *, average]

Plagioclase Percent	Plagioclase Size (in.)	Perthite Percent	Perthite Size (in.)	Quartz Percent	Quartz Size (in.)	Muscovite Percent	Muscovite Size (in.)	Garnet Percent	Garnet Size (in.)	Tourmaline Percent	Tourmaline Size (in.)	Other minerals: Mineral	Other minerals: Percent	Other minerals: Size
PEGMATITES														
x		2		98		x								
x		2		98		x								
0		2		98		0								
0		2		98		0								
0		Tr.		100		Tr.								
3		6		91		x								
0		2		98		Tr.								
0		4		96		Tr.								
x		4		95		x								
x		x		99		x								
Tr.		x		99		x								
Tr.		x		99		Tr.								
Tr.		x		99		Tr.								
x		x		99		x								
x		x		99		x								
x		x		99		x								
x		x		99		x								
Tr.		2		98		x				x				
x		2		98		x								
3		12		85		x								
6		9		85		Tr.								
0		Tr.		100		Tr.								
x		x		99		x								
0		x		99		x								
0		2		98		0				x				
0		x		100		Tr.								
0		x		100		x								
0		5		95		x								
x		3		97		x								
0		x		100		Tr.								
Tr.		x		99		Tr.								
0		x		100		Tr.				x		{Magnetite {Hematite	Tr. Tr.	
(?)		Tr.		100		Tr.								
(?)		Tr.		100		Tr.								
Tr.		x		99		x								
x		(?)		100		Tr.						Biotite	Tr.	
25		20		55		x								
0		x		100		x								
0		(?)		100		Tr.								
0		3		97		Tr.								
0		0		100		0								
Tr.		x		100		Tr.								
17		23		60		x								
0		0		100		0								
0		5		95		x								
PEGMATITES														
Tr.		2		8		Tr.				90				
28		12		x		x		x		60				
0		1		87		Tr.				12				

INDEX

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