Geology of the Quartz Creek Pegmatite District Gunnison County Colorado

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GEOLOGY OF THE QUARTZ CREEK PEGMATITE DISTRICT, GUNNISON COUNTY, COLORADO

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ABSTRACT

The Quartz Creek pegmatite district includes an area of about 29 square miles in the vicinity of Quartz Creek in Gunnison County, Colo. This area contains 1,803 pegmatites that are intruded into pre-Cambrian rocks.

The rocks exposed in the district range in age from pre-Cambrian to Recent. The oldest pre-Cambrian rocks are chiefly quartzites interbedded with a few arkoses and conglomerates. These rocks are surrounded by more abundant hornblende gneiss and tonalite. A small body of hornblende-biotite tonalite and two thin layers of dacitic pillow lava are present. The hornblende gneiss and tonalite have the same composition and differ only in texture. The older material (hornblende gneiss) has a well-marked lineation, whereas the younger (tonalite) is equigranular. Subsequently, a large body of quartz monzonite was intruded along the northern boundary of the mapped area. Later, coarse-grained granite was intruded in the southern part of the area. Dikes of fine-grained granite cut the coarse-grained variety. The last stage of igneous activity in the pre-Cambrian is marked by a large number of pegmatitic intrusions.

The pre-Cambrian rocks were tilted and eroded, and the flat-lying Morrison formation of Jurassic age deposited on the irregular surface. This formation is conformably overlain by the Dakota sandstone of Cretaceous age. Faulting produced a vertical offset of 410 feet in the Mesozoic sediments along the only large fault in the area. At the end of the Mesozoic era there was another interval of erosion. Tertiary(?) tuff is exposed in three small, scattered areas in the southern part of the district. It overlies both the Dakota sandstone and pre-Cambrian formations. Glacial till occurs along the edges of Quartz Creek and Wood Gulch. Quaternary alluvium fills valley bottoms.

Although the composition of the country rock has little effect on the shape of the pegmatites, the foliation imposed on this rock has a localizing effect and generally controls the ultimate shape of pegmatites. Zoned and related internal structures are not well developed in the pegmatites of this region. Many of the pegmatities are homogeneous and those that are zoned usually contain a large wall zone and small discontinuous cores. In addition to the more common homogeneous and zoned pegmatites, 7 percent of the pegmatites show a layered structure of textual and mineralogical units not repeated on the opposite side of the pegmatite. Other internal structural units include pegmatites which vary in composition along strike, multiple or "line-rock pegmatites," and fracture fillings.

The mineralogy of the pegmatites is described in detail. Specific attention was given to most of the 27 observed minerals. A study of indices of refraction of 439 specimens of plagioclase showed that the variation from zone to zone and layer to layer is minor and that there is no systematic variation in the district. No correlation could be found between the refractive index of plagioclase in the pegmatites and the type of country rock, or the presence of various accessory minerals.

Median index of refraction determinations on 95 specimens of muscovite showed no constant variation from wall zone to core or from layer to layer. Optical properties of curved muscovite are identical with those of the flat variety.

The higher index of refraction was determined for 183 beryl specimens. Beryl in pegmatites containing only a wall zone and a core showed no difference between zones; but in pegmatites that have intermediate zones, the indices of refraction of the beryl indicated an increase in the alkali content inward from the contact. Beryl occurs with almost all the pegmatite minerals and is not restricted in its mineral associations.

Tourmaline, with the exception of the black variety, is associated with lepidolite. Dark-green and blue tourmaline is found in the outer zones of pegmatites containing lepidolite, and the pink and light-green varieties are found in direct contact with lepidolite.

Lepidolite occurs as aggregates of small flakes, as flat plates, and as curved plates; the three varieties are optically identical. The lighter colored varieties have higher indices of refraction and contain less lithia than the darker varieties.

The following minerals are described in detail: perthite, quartz, martite, biotite, garnet, columbite-tantalite, monazite, microlite, topaz, gahnite, allanite, and an unidentified mineral.

Lack of alteration in the wall rocks adjacent to the pegmatites is interpreted as indicating that the original pegmatitic fluid did not have an excess of materials such as B, OH^-, and P needed to form alteration minerals. Because of their low concentration, the above materials were available only in the pegmatitic fluid during its crystallization. Pegmatites that contain the rare minerals, such as beryl, tourmaline, curved muscovite, biotite, magnetite, monazite, columbite-tantalite, cleavelandite, topaz, lepidolite, and microlite, show a grouping in clusters within the district.

Beryl-bearing pegmatites occur most abundantly in hornblende gneiss and are only rarely found in either granite or quartz monzonite.

The types of minerals that form in a pegmatite appear to be determined by the character of the fluid segregated from the original magma and by the spacing and length of the period during which it segregated. The distribution of the rarer pegmatite minerals in different groups is related to their origin, and they are found in pegmatites derived by later segregation. The pegmatites formed from the earlier stages of the segregation contain minerals commonly found in granites.

Inferred reserves of the district are estimated for beryl, scrap mica, feldspar to be expected from both hand-cobbing and milling, lepidolite, columbite-tantalite, topaz, monazite, and

microlite. No sheet mica was found. As reserves are small and transportation costs are high, substantial production of low-priced feldspar and scrap mica will depend on the adoption of economical milling techniques for recovering the large quantities of feldspar available. Beryl is irregularly distributed, and its recovery as a byproduct will depend on the establishment of a stable market for feldspar and scrap mica. Lepidolite reserves are small and of low grade.

INTRODUCTION

Prior to World War II the Quartz Creek pegmatite district was well known for its fine specimens of colored tourmaline, topaz, microlite, and books of lepidolite. During and after World War II small quantities of beryl, lepidolite, and tantalum minerals were produced from the district.

LOCATION AND SURFACE FEATURES

The Quartz Creek pegmatite district is on the western slope of the Sawatch Range in Tps. 49 and 50 N., R. 3 E., New Mexico principal meridian, Gunnison County, Colo. (fig. 1). It covers about 29 square miles in the vicinity of Quartz Creek. State Highway 162 follows Quartz Creek through the district and joins United States Highway 50, 2 miles south of the southern boundary of the mapped area. A road branching from State Highway 162 crosses the southeastern corner of the area and connects with United States Highway 50, 1 mile west of Doyleville. Unimproved roads follow several of the valleys, and a mine-access road, made during World War II, connects State Highway 162 with the Brown Derby mine. The nearest railroad shipping point, Parlin, is on a narrow-gage line of the Denver and Rio Grande Western Railroad, which connects with standard-gage lines of that railroad at Salida to the east and Montrose to the west.

The slopes are moderately steep, and the surface has a maximum relief of 2,200 feet. The highest point in the district is near the northern boundary and has

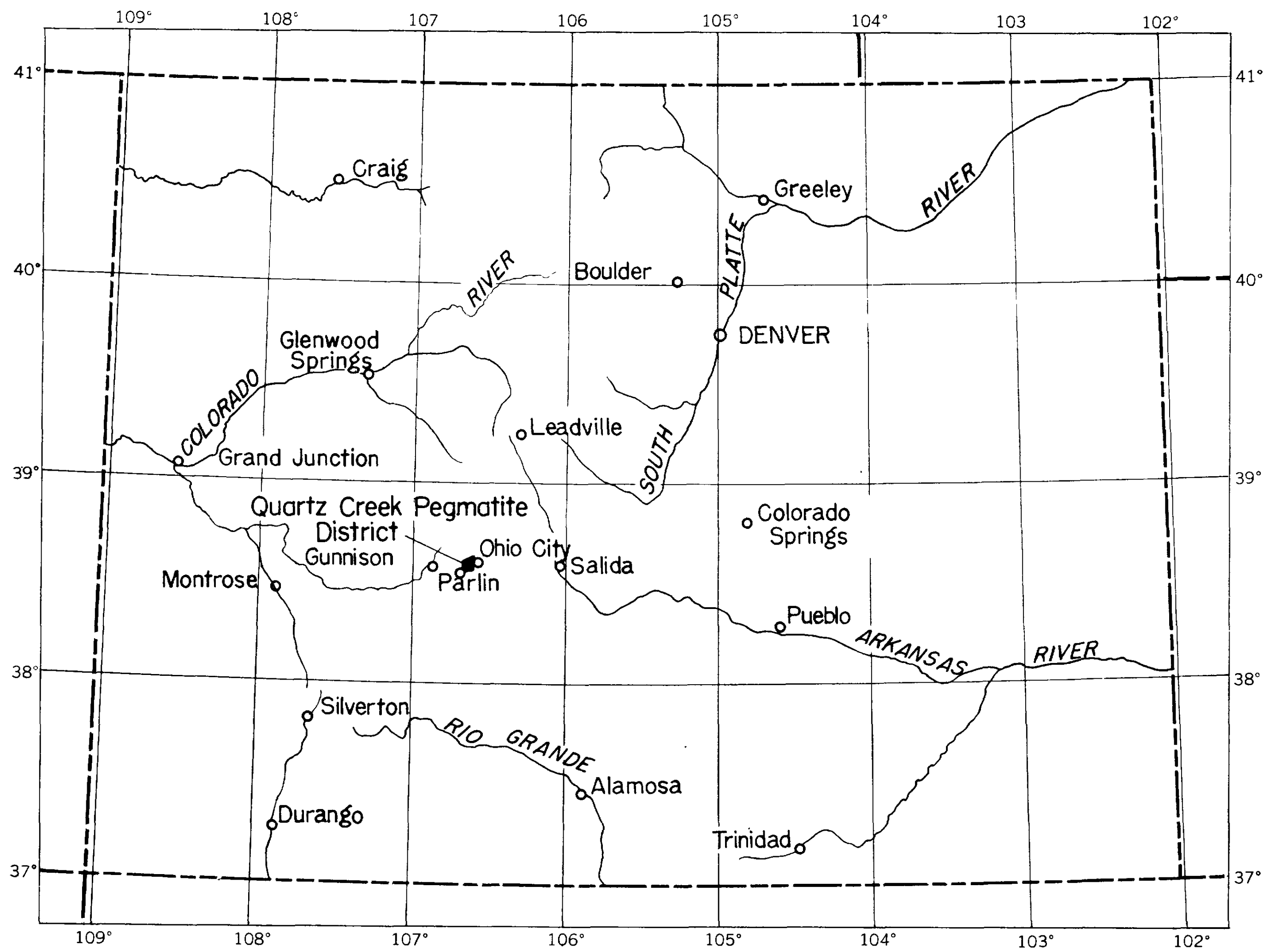

FIGURE 1.—Index map of the Quartz Creek pegmatite district, Colo

an altitude of 10,238 feet. Quartz Creek, the principal drainage of the area, flows through a flat cultivated valley that ranges from a quarter to half a mile in width. The hills rising from Quartz Creek generally are sage covered, and the north-facing slopes of the higher hills are covered with aspen or spruce and pine. Quartz and Alder Creeks are the only permanent streams in the district, but water flows in Willow Creek and through Wood Gulch during the spring and early summer.

PRODUCTION

The recorded production of pegmatite minerals from the Quartz Creek district is 51 tons of beryl, 283 tons of lepidolite, 140 tons of scrap mica, 5,000 pounds of tantalum and columbium minerals, and 15 pounds of monazite.

From September 1943 to the spring of 1945 the Brown Derby property was leased by the Hayden Mining Co. Prior to February 1945, 3,155.67 pounds of beryl (J. B. Hanley, oral communication) were sold to the Metals Reserve Company and 283 tons of lepidolite to the Corning Glass Co. In addition, 4,000 pounds of microlite concentrate containing 52 percent microlite was stockpiled at the mill and later sold. Though the final production figures are not available, they are not greatly in excess of these figures as mining was stopped in the spring of 1945.

The White Spar No. 1 and No. 2 pegmatites, which are 0.8 mile north of the Brown Derby mine, for a short time during World War II were mined by the Colorado Feldspar Co. The production of lepidolite and feldspar is not known but was small.

There was no mining in the district from 1945 to 1947. Mr. Rod Fields located the Bucky claim on the east side of Willow Creek and started to mine beryl in the spring of 1948. Mr. Fields produced 17 tons of beryl and in November 1948 sold the property to Beryllium Mining Co., Inc., which has produced, to May 1950, 32.0 tons of beryl, 139.6 tons of scrap mica, 1,020 pounds of columbite-tantalite, 15 pounds of monazite, and 13 pounds of a mineral resembling samarskite. The last two minerals were sold to Ward's Natural Science Establishment, Inc.

PREVIOUS WORK

Early papers on the pegmatites of the Quartz Creek district have been concerned chiefly with the mineralogy of the Brown Derby pegmatites (Eckel, 1933, p. 239–245; Landes, 1935, p. 333; Eckel and Lovering, 1935, p. 77–79). A map showing the regional geology of the Gold Brick district, on a scale of 1.5 inches equal 1 mile, was published by Crawford and Worcester (1916). The southwestern corner of their map, an area roughly 3.3 by 2 miles, overlaps the northern part of the present area mapped. No pegmatites are shown on their map, and the area now known to contain them is designated "granite." The area around Tomichi Dome, several miles to the east of the Quartz Creek district, has been described by Stark and Behre (1936, p. 101–110).

Between September 1942 and December 1944 the U. S. Geological Survey had several field parties mapping in Colorado, under E. W. Heinrich in 1942, and under John B. Hanley in 1942–44 (Hanley, Heinrich, and Page, 1950, p. 63–80). In the Quartz Creek district these parties mapped in detail—on scales ranging from 1:240 to 1:600—the Opportunity No. 1 claim, the Brown Derby No. 1 claim, the Brown Derby Ridge pegmatites, the Brown Derby No. 5, the White Spar No. 1, the White Spar No. 2, and the Bazooka pegmatites. In all, 25 pegmatites were mapped with plane table and telescopic alidade. Several other pegmatites were visited and described.

FIELD WORK AND ACKNOWLEDGMENTS

The investigations carried out by the U. S. Geological Survey in the Quartz Creek pegmatite district during World War II were concerned primarily with pegmatites from which feldspar, muscovite, and minerals containing beryllium, tantalum, lithium, and the rare earths were produced. Such pegmatites are in the minority, and time did not permit detailed study of the associated, more numerous, unproductive pegmatites, or of the broader relations of pegmatites to the regional geology. This study, started in 1948, was made not only to provide an economic appraisal of individual deposits but also to determine the regional relationships of pegmatites and country rock.

The field work for this report was started on July 10, 1948. M. H. Staatz and P. T. Flawn began mapping on the east side of Quartz Creek and A. F. Trites and F. L. Klinger on the west side. Field work was recessed September 7, 1948. It was resumed on June 12, 1949, and completed December 10, 1949. The writers were assisted for 3 months during 1949 by F. L. Klinger and for 2 months by J. D. Vogel. Mapping was done by pace and by Brunton compass; the Pitkin quadrangle topographic map enlarged to a scale of 1:12,000 was used as a base (pl. 1). Individual pace and compass maps also were made of each pegmatite on scales ranging from 1:480 to 1:2,400, depending upon the size of the pegmatite. Petrographic work was done during the spring of 1950.

The percentage of all minerals except beryl was visually estimated for each unit and is presented in table 20. Where a significant amount of beryl was present in a pegmatite unit, its percentage was determined by a modified large-scale Rosiwal method, by which a measured area of the unit, at least 1,000 times larger than its average grain size, was compared with the total measured area of beryl exposed in the unit.

Index determinations were made in white light, using carefully checked oils, and were corrected for variance in temperature. In some cases, results were repeatedly checked, and it is believed that the index determinations for all minerals with indices below 1.700 have an accuracy of ± 0.001. Indices above 1.700 have an accuracy of ± 0.005. Specific gravities of monazite and columbite-tantalite were determined by Jolly balance. All specific gravity readings were made at least twice, and it is probable that the accuracy of the results is about ± 0.3.

L. R. Page, of the Geological Survey, was the immediate supervisor of this project. McClelland Dings and Charles Robinson, also of the Survey, spent a day in the field helping in the stratigraphic study of the Dakota and the Morrison formations. Two days were spent with N. L. Bowen, J. F. Schairer, O. F. Tuttle, and M. L. Keith, of the Geophysical Laboratory, in reviewing some of the geochemical problems of pegmatites. C. H. Behre, Jr., of Columbia University spent 3 days in the field with the authors, and gave many valuable suggestions. Laboratory work was aided by helpful advice from John W. Adams.

The writers are glad to acknowledge the wholehearted cooperation and hospitality of the people of the district. Particular thanks are due to Mr. Charles Wemlinger, of the Beryllium Mining Co.; Mr. Rod Fields, of the Bucky mine; and Mr. Jesse Fields, of the Beryl and Rare Minerals lode.

This investigation was made in part on behalf of the Division of Raw Materials of the United States Atomic Energy Commission.

GENERAL GEOLOGY

The rock units mapped in the Quartz Creek pegmatite district range in age from pre-Cambrian to Recent (pl. 1). The age of the Brown Derby No. 1 pegmatite, as determined from uranium-bearing microlite collected by Eckel and Lovering (1935, p. 79), is 760 million years. The oldest pre-Cambrian rocks consist of metasedimentary rocks, predominantly quartzites, surrounded by younger and more abundant hornblende tonalite and hornblende gneiss (a metatonalite). Included in this series are two small bands of dacitic pillow lava and one of hornblende-biotite tonalite. A coarse-grained porphyritic granite, similar in appearance to the Pikes Peak granite (Eckel, 1933, p. 240) intrudes the earlier pre-Cambrian rocks in the south-central part of the district and a large quartz monzonite intrusive body occurs in the extreme northern part. The hornblende gneiss, granite, and quartz monzonite are in turn intruded by many fine-grained pink granite dikes and by a large number of pegmatites.

An angular unconformity separates the pre-Cambrian rocks from the flat-lying Jurassic Morrison formation and the Cretaceous Dakota sandstone which crop out along the east and west sides of the area.

Flat-lying Tertiary(?) tuff is exposed in three scattered patches overlying unconformably both the Dakota sandstone and pre-Cambrian rocks. Small areas of glacial till border Quartz Creek and Wood Gulch, and Quaternary alluvium fills many of the valley bottoms.

In general, the pre-Cambrian rocks dip steeply and have a northwesterly trend, which is shown by the bedding of the metasedimentary rocks and the trend of the dacitic pillow lava. The pegmatites have a general northeast trend across all the earlier structures.

Only three faults with displacements of more than 20 feet were found in the area. The largest of these trends northwest and separates the Dakota and Morrison formations from the pre-Cambrian in the southwestern corner of the district. Two other faults, cut by this large fault, separate a block of Dakota sandstone from the pre-Cambrian and Morrison formations.

PRE-CAMBRIAN ROCKS

QUARTZITE

Pre-Cambrian quartzite, interbedded partly with arkosic quartzite and conglomerate (pl. 1), is best exposed on the slopes of Wood Gulch in four areas. Two parallel bodies of arkosic quartzite, each about half a mile long, crop out along the headwaters of Tollgate Gulch, a tributary of Quartz Creek, which is northwest of Wood Gulch. Narrow outcrops, a few tens or hundreds of feet long, are found at widely scattered localities on the northern side of Quartz Creek. These rocks have been highly metamorphosed and are part of a much larger area of sedimentary rocks, separated by intrusive tonalite and hornblende gneiss.

The pre-Cambrian quartzites generally are dark gray but in places are white and brown. The original sediments ranged in size from silt to gravel, but most were fine grained. Some of the quartzites are now slightly schistose. The northernmost unit of the metasedimentary rocks in Wood Gulch is a conglomerate containing pebbles that range in diameter from 0.1 to 2 inches. Some of the pebbles are elongated; the ratio of width to length ranging from 1:4 to 1:5. Feldspar (orthoclase, microcline, and plagioclase) is present throughout the unit, but the proportion varies widely. The rocks along Wood Gulch are commonly quartzites with only a few percent of feldspar, but those on the north side of Quartz Creek contained 20 percent or more of feldspar. The amount of the dominant dark mineral, biotite, ranges from a trace to about 15 percent. Muscovite is common in amounts of one percent or less. In rocks rich in feldspar, epidote is prominent and may comprise more than 50 percent of the rock. One specimen contains hornblende and clinozoisite as well as biotite. Apatite, zircon, and magnetite are common accessories.

Quartz-mica schists, composed chiefly of quartz, biotite, feldspar, and muscovite, are found in a few scattered outcrops in the northern part of the area. Locally, these schists contain well-developed porphyroblasts of quartz and magnetite.

At different exposures the formation ranges in thickness from a few feet to a maximum of about 600 feet.

The quartzites are the oldest rocks in the district and are surrounded by younger hornblende gneiss, tonalite, and granite. One xenolith of conglomerate was found in the granite.

DACITE

Dacitic pillow lava crops out in two northwesterly-trending bands south of Quartz Creek; one on the northwestern slope of Wood Gulch in sec. 11, T. 50 N., R 3 E. and the other about 900 feet northwest of the Brown Derby mine.

The pillow lava is yellow green to dark green, depending on the proportion of epidote. It is a fine-grained, dense, vesicular rock. Some vesicles contain well-developed crystals of epidote and quartz; a few are completely filled with fine-grained quartz. Large ellipsoids or pillows (fig. 2), several feet long and about one foot wide, are common. Under the microscope the unaltered rock is seen to consist of green prismatic hornblende (50 percent), quartz (30 percent), and andesine (20 percent). Epidote may be present almost to the exclusion of other minerals and is veined by calcite.

The band of pillow lava on the northwestern slope of Wood Gulch is 140 feet thick and is conformable with the enclosing pre-Cambrian quartzite and conglomerate. This pillow lava was extruded under water over a sand and was covered by later sediments. A second band of pillow lava, 6,450 feet to the northwest, is enclosed in hornblende gneiss. The two areas of pillow lava (pl. 1) are almost alined on strike and are probably remnants of the same layer. Both bands of pillow lava are younger than the pre-Cambrian quartzites to the northeast and older than the quartzites to the southwest.

HORNBLENDE-BIOTITE TONALITE

One small body of hornblende-biotite tonalite is exposed in section 11 on the northwestern slope of Wood Gulch. It is approximately 900 feet long and 110 feet wide and is bounded on the north by pre-Cambrian quartzite and on the south by hornblende gneiss. It is approximately 80 feet southwest of a band of pillow lava; the long axes of the outcrops of the hornblende-biotite tonalite and of the pillow lava are parallel.

The biotite tonalite is dark gray with prominent black hornblende crystals, 0.05 inch in diameter, in a

FIGURE 2.—Pillow lava showing ellipsoidal pillows on northwest side of Wood Gulch.

black, speckled, fine-grained matrix. Plagioclase phenocrysts, the same size as the hornblende crystals, contain small included grains of biotite, epidote, and hornblende. Dark minerals make up about 50 percent of the rock. Hornblende, the chief dark mineral, constitutes 25 percent of the rock and commonly forms ragged prismatic grains; but locally it occurs as small included grains in the plagioclase and quartz. Biotite constitutes 22 percent of the rock and occurs with hornblende as aggregates and in the plagioclase as a myriad of randomly oriented fine grains. Epidote (3 percent) and magnetite (<1 percent) are the other dark minerals. Andesine (40 percent) forms large crystals clouded with many fine crystals of biotite, hornblende, and epidote. Quartz (10 percent) is interstitial to the andesine.

The hornblende-biotite tonalite occurs near the southwest edge of the pre-Cambrian quartzite and has a trend parallel to the strike of the bedding in the quartzite. It is similar in composition to the pillow lava, but it is not vesicular and contains much less epidote and no calcite. It is also much coarser grained. The similarity in trend and composition suggests that the hornblende-biotite tonalite and the pillow lava were derived from the same magma.

HORNBLENDE GNEISS AND TONALITE

The hornblende gneiss and the tonalite grade together—sometimes in the same outcrop—and because the difference in the two rocks is one of structure, the hornblende gneiss and the tonalite were mapped separately only along the northwestern slope of Wood Gulch, where fine-grained hornblende gneiss is very schistose and is cut by the coarser, equigranular hornblende tonalite (fig. 3). These two rocks are evidently of different ages, the tonalite having been intruded after the older rock had been metamorphosed considerably. The intrusive hornblende tonalite bodies in Wood Gulch have a northwesterly trend, parallel to that of the pre-Cambrian quartzites.

FIGURE 3.—Tonalite outcrop on northwest side of Wood Gulch.

The foliation of the hornblende gneiss south of Quartz Creek has a north to northwesterly strike and dips steeply in either direction. North of Quartz Creek the strike ranges between north-northwest and north-northeast, except adjacent to the quartz monzonite where the foliation parallels the contact.

The hornblende gneiss and tonalite have the widest distribution of any rock type and occupy the central part of the Quartz Creek district. These mafic rocks extend beyond the area mapped for a considerable distance to the northeast, where they have been described by Crawford (1916, p. 27–28). They are the host rocks for a very large number of pegmatites, and many fine-grained granite dikes.

The hornblende gneiss and tonalite range in texture from fine to coarse grained; the maximum grain size is about 0.20 inch. Textures or structures commonly found are: (1) Prominent, well-banded gneissic structure, (2) intersertal texture, (3) porphyritic texture, and (4) equigranular texture. Exposures of this rock are, in general, poor, and even where well exposed the textural changes are so great that in most places separation into mappable units was not feasible. Both rocks are dark gray to greenish black where fresh, and weather to colors whose extremes are greenish gray and reddish brown. The hornblende content ranges from 20 to 80 percent, but most of the rock contains from 50 to 75 percent hornblende. Some facies are unusually rich in hornblende, and the rock may then grade into a hornblendite or perknite.

The minerals in the hornblende gneiss and tonalite are essentially the same, but the proportions of each vary widely. Hornblende, biotite, and feldspar are the only minerals that can be identified megascopically. In places much of the hornblende has altered to biotite. Andesine is the dominant light-colored constituent, but quartz and microcline are present locally. The accessory minerals are apatite, zircon, sphene, magnetite, epidote, chlorite, and sericite.

Much of the hornblende is present as distinct, dark-green euhedral crystals, but part is present as frayed, ragged, pale-green grains. In one place it is altered to chlorite. Biotite is not found in some areas, but in others it is abundant. It forms as much as 60 percent of the rock, commonly is unaltered, and occurs in brown prismatic crystals. Andesine (An_{30}–An_{44}) is poorly twinned and commonly is clouded with fine kaolin and sericite. The andesine crystallized after the hornblende in most places and fills the spaces between the hornblende crystals; in a few places the opposite is true. In most specimens quartz is present, constituting a maximum of 7 percent of the rock and occurs as small clear grains with sutured borders. The grains are interstitial to the andesine; rarely they are micrographically intergrown. Because of the presence of a small amount of quartz, the rock is called a tonalite rather than a diorite (Crawford, 1916, p. 27–28). Microcline is present in a few places, but in most of the rock examined it is absent. A trace to several percent of apatite and zircon are almost universally present as euhedral crystals associated with biotite. Epidote and sphene are found locally, usually where the hornblende is pale green and has been considerably altered. Magnetite occurs in irregular grains and is not common. Augite was noted in one specimen.

QUARTZ MONZONITE

Quartz monzonite crops out along the northern boundary of the Quartz Creek district. Pegmatites, similar in size and shape to those in hornblende gneiss, are relatively large and regular near the outer edge of the intrusive. Farther within the mass the pegmatites are only a few inches thick and are very irregular in shape.

The quartz monzonite is a light- to dark-gray porphyritic rock that ranges in composition from quartz monzonite to granodiorite. Poor exposures make it difficult to map the variations of this rock in the field.

Mafic minerals (12 to 22 percent) form clots and streaks composed of biotite, hornblende, zircon, sphene, magnetite, and apatite. Hornblende (trace to 15 percent), the dominant dark mineral, generally has been frayed and altered to biotite. Biotite (7 to 14 percent) occurs in small brown unaltered flakes and in clots or aggregates that appear megascopically to be large crystals. Apatite and magnetite (1 to 2 percent) commonly occur with biotite. Zircon, in trace quantities, is universally present as small crystals. Wedge-shaped crystals of brown sphene locally make up as much as 5 percent of the rock. The leucocratic minerals are quartz, andesine, and microcline. Both andesine and microcline are in large phenocrysts and in smaller grains in the groundmass. The feldspar content ranges from about 12 to 45 percent microcline and from about 30 to 65 percent andesine. The plagioclase has a composition of An_{31}–An_{35}. Microcline shows crosshatch twinning in most places. No quartz is observed megascopically, but in thin section small clear grains, interstitial to the feldspars, make up 4 to 15 percent of the rock. The quartz exhibits strain shadows and in many places has sutured borders.

The quartz monzonite was intruded into the hornblende gneiss and, in turn, was cut by pegmatites. It is thus intermediate in age between pegmatite and hornblende gneiss. The age of the quartz monzonite in relation to the coarse- to fine-grained granite is not definitely known, because the two rocks are not in contact. The following evidence, however, suggests that the quartz monzonite is older: (1) In many regions the differentiation of a batholith results in the early formation of more mafic rocks; and subsequently, rocks of intermediate and granitic composition are formed; in the Quartz Creek district the quartz monzonite is intermediate in composition between the granite and the earlier hornblende tonalite and might, therefore, be interpreted as intermediate in age as well; (2) the gneissic texture in the hornblende gneiss is parallel to the contact with the quartz monzonite (pl. 1); this implies that the quartz monzonite was intruded during metamorphism, whereas the coarse-grained granite cuts across foliation in many places; and (3) the pegmatites that cut the granite and quartz monzonite have a composition more similar to the granite and appear to have been derived from it rather than from the quartz monzonite.

COARSE-GRAINED GRANITE

A large band of coarse-grained granite (pl. 1) trends north-northwest across the district from the northeastern corner of section 22 to the northern border of section 33. This granite forms the prominent mountains on the southeast side of Quartz Creek. Another band of massive granite crops out a mile to the west and extends about a mile north of the southern boundary of the area mapped. These two granite masses converge several miles south of the Quartz Creek pegmatite district to form a large V-shaped intrusion. In addition to the two large granite plutons, many small bodies that range in area of exposure from a few feet square to areas measuring 2,000 by 800 feet, are scattered throughout the hornblende gneiss and tonalite terrain. The area of most abundant small scattered granite intrusives is west of the main granite mass and trends north-northwest.

FIGURE 4.—Coarse-grained granite along the divide between Wood Gulch and Quartz Creek.

The granite is a pink porphyritic rock (figs. 4, 5) that forms well-rounded outcrops. The phenocrysts are crystals of pink microcline, 0.50 to 0.75 inch long, and of grains of clear quartz, 0.25 to 0.50 inch long. In thin section the microcline phenocrysts show many small included crystals of diversely oriented microcline, quartz, biotite, and albite. The quartz phenocrysts are composed of several grains, commonly with sutured borders. The coarse-grained groundmass consists of microcline, quartz, biotite, albite, magnetite, apatite, and zircon. Some specimens also contain sericite, epidote, and chlorite. The average composition of this rock is estimated to be microcline (71 percent), quartz

(20 percent), biotite (8 percent), albite (1 percent), and less than 1 percent of magnetite, apatite, and zircon, and trace quantities of epidote, sericite, and chlorite. Apatite and zircon are most abundant as small included crystals in larger crystals of biotite. Epidote commonly occurs near biotite, and chlorite is derived from biotite.

There are two less common varieties of the coarse-grained granite. Granite gneiss occurs in a few isolated masses near the western edge of the district and is characterized by the parallel arrangement of elongate quartz and biotite crystals, granulation, slickensiding, and recrystallization of quartz. Much of the biotite has been altered, and only small wisps and discolored areas remain. The gneiss is believed to be a normal granite that has been metamorphosed by shearing.

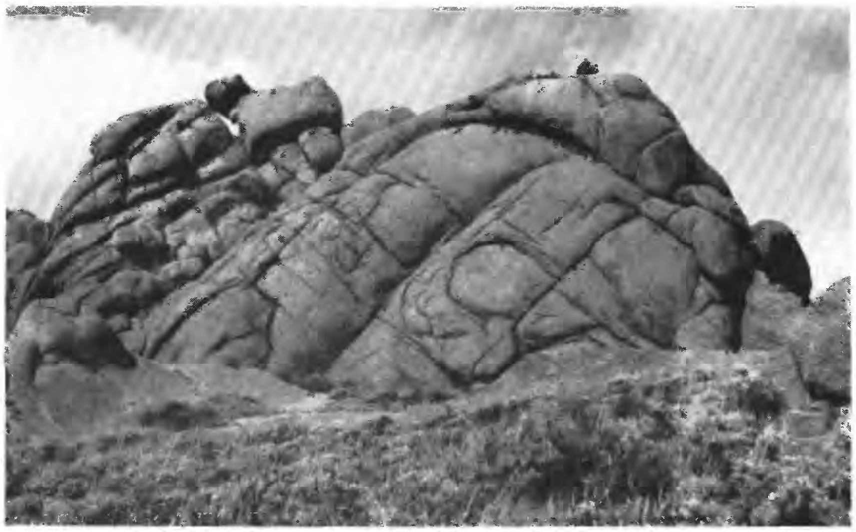

FIGURE 5.—Coarse-grained granite with two sets of joints at right angles.

A red granite occurs in small patches within the two main granite masses. It has no large phenocrysts, has many small vugs, contains only a few percent of quartz and a trace of biotite, and has a high proportion of albite.

The granite is younger than the hornblende gneiss, tonalite, and pre-Cambrian quartzites because it cuts these rocks or contains partly assimilated inclusions of them. On Indian Head, a large granite mass jutting out into the valley of Quartz Creek (pl. 1, sec. 4) contains numerous partly assimilated fragments having large microcline porphyroblasts. The granite is in turn cut by dikes of fine-grained granite and by pegmatite. Its relation to the quartz monzonite is not clear, but the quartz monzonite is probably older than the granite.

FINE-GRAINED GRANITE DIKES AND PEGMATITES

Pegmatite and fine-grained granite (pl. 1) are found together in many places and cut both hornblende gneiss and the coarse-grained granite. The fine-grained granite dikes are cut by the pegmatites wherever found in contact. The pegmatites are found throughout the district, except in the central parts of the two main granite masses. The fine-grained granite is much more restricted in distribution and occurs in dikes in a north-northwesterly trending zone west of the largest granite intrusion. The same zone contains many small intrusive bodies of coarse-grained granite. A few fine-grained granite dikes are found in hornblende gneiss 200 feet from the northeast edge of the largest granite body.

The structure in the earlier pre-Cambrian rocks is followed in part by the granite dikes on the north side of Quartz Creek, which have a general trend of from N. 0°–20° W. (pl. 1). South of Quartz Creek the dikes generally have a northeasterly trend but range from N. 20° W. to N. 50° E.

The pegmatites form both long narrow dikelike bodies and irregular masses. Except in sec. 33, the dikes trend from N. 15° to 60° E., and cut across the earlier structure. In the vicinity of the southeast corner of sec. 33, T. 50 N., R. 3 E., the pegmatites have an average trend of N. 35° W. The pegmatites are described in detail in a succeeding part of this report.

The fine-grained granite is pink and has a grain size of about 0.015 inch. The dikes range in width from a few inches to 180 feet and in length from a few feet to 2,700 feet. The contacts with the surrounding rock are sharp, and the granite forms prominent outcrops. The rock is made up almost entirely of leucocratic microcline, quartz, and plagioclase. Microcline (20 to 60 percent) has crosshatch twinning. Clear quartz (15 to 40 percent) forms irregular grains, many with sutured borders, and is interstitial to plagioclase and microcline. The plagioclase (20 to 40 percent) is albite (An_4) and occurs as crystals coated with kaolin and as inclusions in microcline crystals. Biotite is the dominant dark mineral, ranging from a trace to about 5 percent; the average is less than 1 percent. Ragged grains of muscovite, commonly included in large feldspar grains, make up as much as a few percent of the rock in places. A few euhedral crystals of apatite and irregular-shaped grains of magnetite are present in some specimens. This rock, because of its granitic texture, is designated a granite rather than an aplite.

The fine-grained granite is related in age to the coarse-grained granite and probably was derived from the same magma, but at a later date. This age relationship is indicated by their areal distribution. The small coarse-grained granite bodies and the fine-grained granite dikes crop out in the same north-northwesterly trending band west of the main granite mass, and the fine-grained granite dikes also occur in a narrow zone along the northern contact of the largest granite mass. Both rocks are of the same mineral composition, but the fine-grained granite is commonly richer in plagioclase and poorer in microcline and may represent a more sodic fraction of the magma.

JURASSIC ROCKS, MORRISON FORMATION

The Morrison formation unconformably overlies the pre-Cambrian rocks and is conformably overlain by the Dakota sandstone along the western and eastern edges of the Quartz Creek district. The Morrison formation is covered in more than 90 percent of the area, and the outcrops are commonly of the more resistant sandstone lenses.

This formation is composed of a basal and an upper sandstone that are separated by varicolored shale. The basal sandstone rests on the pre-Cambrian and closely resembles the Dakota sandstone in appearance. It is white to tan and weathers buff to yellowish brown. The quartz grains are subrounded, and a few beds are quartzitic. The middle unit of the formation rarely is exposed. It is composed of green, brown, and reddish shales with a few thin limestone and sandstone beds. Above the shales is a white fine-grained sandstone flecked with iron oxide. This rock is prominently crossbedded and usually is friable; the individual quartz grains are well rounded. This sandstone is conformable with the basal pebble conglomerate of the Dakota sandstone.

At no place in the area is a complete section of the Morrison formation exposed, but a thickness of 355 feet was measured along the west side of Alder Creek, in sec. 36, T. 50 N., R. 2 E., from the top of the underlying pre-Cambrian (as determined by float) to the base of the Dakota formation. The thickness of the Morrison formation was also measured by McClelland Dings (oral communication, 1949) in the southwestern corner of the adjacent Garfield quadrangle. His measurements, made under equally difficult conditions, with the exact position of the upper and lower limits inferred, indicate the thickness of the Morrison to be between 315 and 375 feet.

No fossils were found, and the identification of the Morrison formation in the Quartz Creek district is based on its lithologic similarity to this formation in nearby areas.

CRETACEOUS ROCKS, DAKOTA SANDSTONE

The Dakota sandstone is well exposed in a series of cliffs that border Alder Creek (pl. 1). In figure 6, it is shown capping the Morrison formation along the western border of the district; it also crops out east of the mapped area.

FIGURE 6.—Cliff of Dakota sandstone.

The Dakota is made up of a basal pebble conglomerate and an overlying sandstone. The conglomerate is composed of subrounded to rounded pebbles averaging 0.25 inch in diameter. The pebbles are for the most part quartz, with subordinate amounts of black chert and red jasper. In part, the conglomerate is arkosic though much of the feldspar has altered to clay. The upper part of this unit is quite friable and commonly crossbedded, whereas the lower part locally is cemented with chalcedony and is very resistant.

The upper unit of the formation is composed almost entirely of sandstone, but the uppermost part contains thin beds of fine-grained black to gray fissile shale a few inches to 1.5 feet thick. This sandstone is composed dominantly of subrounded grains of quartz, and subordinately, of orthoclase. The rock ranges from a true arkose with about 25 percent feldspar to an almost pure quartz sandstone. The cliff-forming units are well-cemented sandstones, but much of the formation is soft and friable. Locally it has been indurated to quartzite. The sandstone is white to gray and weathers buff or yellowish brown. One bed in the upper part is marked by radiating 1-inch spheroids of limonite pseudomorphous after pyrite.

The Dakota sandstone is not completely exposed in the area mapped, and the upper surface has been eroded. The maximum thickness obtained from the six sections measured is 183 feet; the basal conglomerate is 33 feet thick.

The only fossils that were found in this formation are a poorly preserved gastropod of unidentifiable genus and a few fragmentary casts of plant stems.

TERTIARY(?) ROCKS, TUFF

A white tuff is well exposed on the south side of Quartz Creek, in the southeast corner of the Quartz Creek district (sec. 8), where it forms a small cliff above the Dakota sandstone. At two smaller areas of outcrop, in sec. 16 on the south side of Wood Gulch and in sec. 5 on the north side of Quartz Creek, the tuff overlies pre-Cambrian rocks.

The tuff is a porous, white flaggy rock occurring in layers 1 to 2 inches thick. The layering dips from 4 to 23 degrees northeast. A few subrounded fragments of darker volcanic rock (fig. 7) are enclosed in an aphanitic matrix containing phenocrysts, about one thirty-second of an inch long, of plagioclase and biotite. The orientation of the biotite, in general, is parallel to the layering.

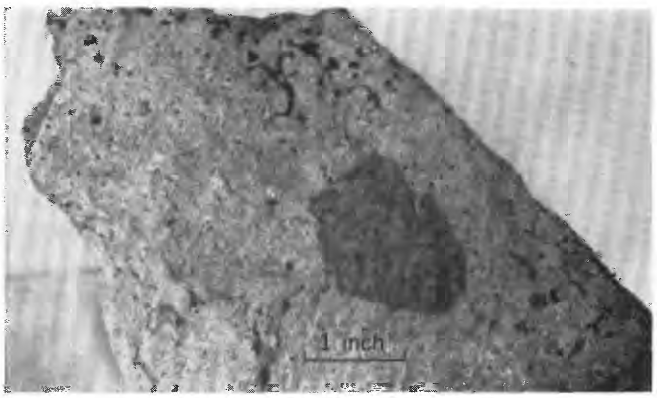

FIGURE 7.—Tuff with large volcanic fragment.

In thin section, the tuff has a clastic texture and shows many scattered phenocrysts in a brown cryptocrystalline groundmass. The phenocrysts comprise about 35 percent of the rock. Andesine-labradorite (more than 30 percent), commonly occurring as angular fragments or rarely as euhedral crystals, is the most common phenocryst. Some of the plagioclase crystals show zoning. Biotite (3 percent) is the chief dark mineral and occurs in long prismatic crystals. Next in abundance is black anhedral magnetite (1 percent). Other minerals in approximate order of abundance are: hornblende, quartz, scapolite, sphene, apatite, and zircon.

The tuff outcrops are erosional remnants, a few tens of feet thick, of a thicker and more extensive tuff bed. The tuff that overlies the Dakota sandstone along the east side of Quartz Creek has a minimum thickness of 83 feet. The tuff is shown to be younger than the faulting which brought pre-Cambrian rocks against the Dakota sandstone, because the tuff crosses the fault line with no apparent displacement. It is overlain along Wood Gulch by glacial till, presumably of Pleistocene age. The tuff, therefore, has been tentatively designated as Tertiary(?).

QUATERNARY DEPOSITS

GLACIAL TILL

Pleistocene(?) glacial till overlies the other formations along both sides of Quartz Creek and Wood Gulch and fills the broad valley of Quartz Creek, where it is covered by a foot or less of soil. On the south side of Quartz Creek the till is quite thin, and pegmatite outcrops protrude through it. The till was deposited over areas having considerable differences in altitude. The highest position is on the north side of Quartz Creek at 8,700 feet; on the south side the altitude is 8,250 feet. The till deposits on the north side are part of the lateral moraine, whereas those on the south side are till ridges in the valley moraine. The till near the mouth of Wood Gulch appears as thin irregular patches, which seem to be remnants of a broad valley moraine.

The till is composed of clay, fine sand, pebbles, and boulders as much as 3 feet in diameter. The boulders are a heterogeneous mixture of several rock types and differ from place to place. On the south side of Quartz Creek and along Wood Gulch, hornblende gneiss and tonalite are the dominant rock types in the till and in places form more than 80 percent of it. Near the mouth of Alder Creek on the north side of Quartz Creek, the boulders in the till consist of sandstones of the Dakota and the Morrison formations (30 percent), pegmatite (30 percent), fine-grained granite (20 percent), ryholite porphyry (10 percent), and hornblende gneiss (10 percent). Other identifiable boulders include chert, pre-Cambrian quartzite, Sawatch quartzite, epidote rock, quartz monzonite, basalt, massive quartz, and andesite.

ALLUVIUM

Recent alluvium forms a narrow strip in the bottom of most of the valleys in the Quartz Creek district. Along Quartz Creek this strip is ⅛ to ¾ mile wide and extends northeastward across the entire district. The alluvium is dominantly fine silt, 4 to 8 inches thick, and overlies glacial deposits along most of Quartz Creek.

STRUCTURAL GEOLOGY

The structure of the older pre-Cambrian rocks of the Quartz Creek district has a general northwest trend, which is cut by stocks and batholiths of younger pre-Cambrian granite and quartz monzonite. Mesozoic and later rocks are flat lying and are cut by several faults in the southern part of the district.

The general trend of the pre-Cambrian metasedimentary rocks is northwest, with a steep dip southwest. The foliation of the pre-Cambrian hornblende gneiss strikes northwest, north, or northeast and dips steeply. On the southeast side of Quartz Creek and along the western edge of the district the foliation trends northeast and dips from 70° SE. through vertical to 59° NW. Around the edge of the quartz monzonite intrusion, the foliation parallels the contact and dips steeply from it. In the northern part of the district, the foliation strikes northeast and dips from steeply southwest to vertical.

The large granite mass dips steeply to the northeast along its northeastern side. On the west, however, the contact was not exposed, but the innumerable small stocks along this side (pl. 1) suggest that the granite underlies the schist at shallow depth. The contact of the quartz monzonite was not exposed, but the strike of the foliation of the hornblende gneiss is parallel to that of the contact, and it is probable that the dip is also parallel.

Most of the pegmatites trend northeast along joints and cut across the foliation of the older rocks. Groups of parallel lenticular pegmatites with this trend are common (fig. 8).

Faults are difficult to recognize in the pre-Cambrian rocks except where pegmatites have been cut and offset. The displacement observed ranges from a few inches to 4 feet. Drag folds and local disruptions in the foliation also may have been the result of unrecognized faulting.

FIGURE 8.—Outcrops of pegmatites showing regional trend.

Two sheared and mineralized fractures were mapped in the hornblende gneiss. The larger of these is south of Quartz Creek, 250 feet east of the Buckhorn pegmatite (no. 659). The second shear zone is in the northwestern part of the area mapped, where the southern part of pegmatite 1199 has been displaced about 3 feet to the west.

In the Mesozoic sedimentary rocks, faults are more readily recognized. A major fault separates Dakota sandstone from hornblende gneiss in the southwestern part of the district (pl. 1) and trends N. 20°–42° W. A vertical displacement of 410 feet was measured on the west side of Alder Creek, the southern block having moved downward with respect to the northern block. On the west side of Alder Creek the Dakota sandstone has been sharply upturned by drag of the beds at the fault. In the southwestern part of the district, along State Highway 162, a small segment of Dakota sandstone has been downfaulted between the large fault and two smaller ones to the level of the highway and folded into a gentle anticline (fig. 9).

FIGURE 9.—Anticline in center of picture is a downfaulted block of Dakota sandstone.

PEGMATITES

SIZE AND SHAPE OF PEGMATITES

The pegmatites of the Quartz Creek district range in size from bodies a few inches wide and a few feet long to bodies such as the Black Wonder pegmatite, 12,600 feet in length and 6,700 feet in maximum width. Most of the pegmatites range from 100 to 400 feet in length, but 37 bodies are more than 1,000 feet long. The two largest pegmatites are the Bucky, 4,000 feet in length by 2,600 feet in maximum width, and the Black Wonder; both are very irregular and have many small branches. The small pegmatites are more common in the granite and quartz monzonite.

On the basis of shape, the pegmatites in the Quartz Creek district can be classified as: (1) Lenticular, (2) lenticular-branching, (3) oval, and (4) irregular. Examples of each are shown in figures 10 to 17, including both the extreme variations and the average shape in each type. Each of these examples represents many more pegmatites of similar shape. The lenticular pegmatites are 2.3 times more common than the irregular pegmatites—the second most abundant type. The general order of frequency is 1 oval pegmatite to 2.3 lenticular-branching pegmatites, 2.8 irregular pegmatites, and 6.6 lenticular pegmatites.

Comparison of pegmatite shapes in this district with shapes in the Black Hills (Page and others, 1953) and in other pegmatite districts has shown that shape of a granitic pegmatite is controlled primarily by the type and competency of country rock, although the amount of intruded material also influences the shape of the pegmatite if that amount is large.

FIGURE 10.—Small branching pegmatite cutting fine-grained granite.

The pegmatites in the Quartz Creek district for the most part are intruded into granite, quartz monzonite, hornblende gneiss, and tonalite. The hornblende gneiss and tonalite have similar compositions, but the hornblende gneiss is foliated, and the tonalite is more massive. Both rocks are competent, and the pegmatites tend to follow fractures and joints that cut the poorly to well-developed foliation in the hornblende gneiss. Though the pegmatites intruded into hornblende gneiss are usually well exposed, the adjacent gneiss is rarely seen. Wherever the foliation of the hornblende gneiss was exposed adjacent to the pegmatite, the angle between the foliation plane and the side of the pegmatite was measured; the results are plotted in figure 18 on a bar graph. This graph indicates that there is no constant angle at which the pegmatites cut the foliation of the country rock, though it is most commonly an angle of less than 60 degrees. The irregularity of the pegmatites and their many changes in direction point to the emplacement of the pegmatites along irregular fractures and joints. The hornblende gneiss and tonalite are too poorly exposed to allow measurement of any over-all joint systems. The largest body of coarse-grained granite is well exposed, and 638 joints were measured in it (fig. 19). In local areas of several

FIGURE 11.—Large branching pegmatite (no. 250) cutting hornblende gneiss.

hundred square feet, such as A, B, and C on plate 1, where from 50 to 60 joints are exposed, these are related to 2 or 3 well-developed sets of joints. Over the entire granite body, however, 638 joints show a random orientation. The main granite body is cut by pegmatites only in its northwestern end, where the lenticular and lenticular-branching pegmatites trend N. 45° W. In the hornblende gneiss and tonalite the pegmatites trend from N. 0°–45° E. (pl. 1). The trend of the lenticular pegmatites in the mafic rocks is very uniform over the whole district. This points to a districtwide joint system in the hornblende gneiss and tonalite, whereas the joint systems in the granite vary from one locality to the next. A probable explanation of this peculiar feature is that the joint system in the more mafic rocks antedates the intrusion of the granite and that the jointing in the granite was caused by local stresses at the time of the intrusion.

In comparing the various types of country rock with the shapes of pegmatites, it was found that in competent rocks, lenticular-branching pegmatites and, to a lesser extent, irregular pegmatites are more common than in competent rocks. The type of country rock has little to do with the shape of the pegmatite, provided the rocks being compared are of equal competency. Table 1 shows the frequency of occurrence of each shape compared to the oval shape in each of the three most common types of country rock, hornblende gneiss and tonalite, coarse-grained granite, and quartz monzonite.

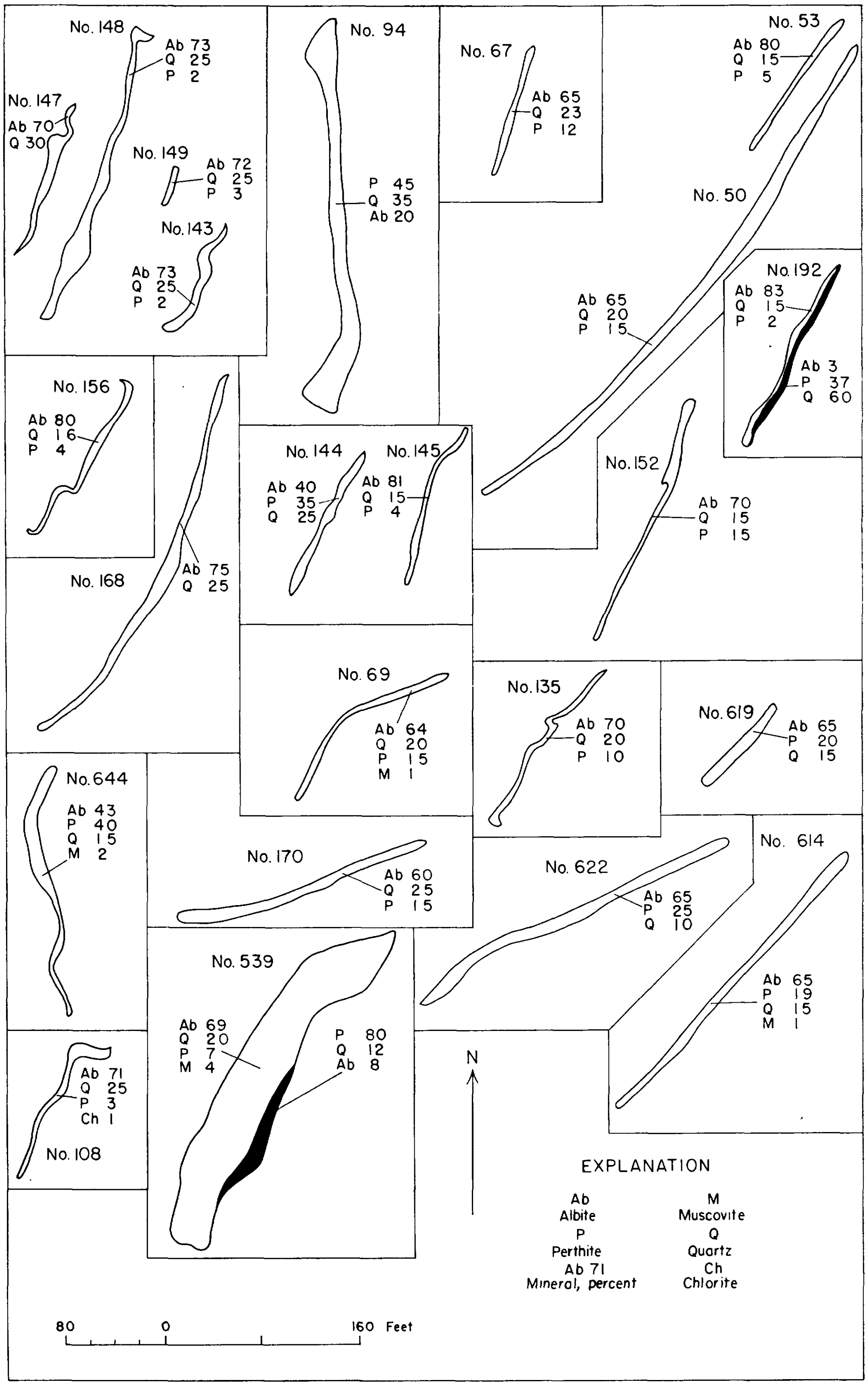

FIGURE 12.—Types of lenticular pegmatites, Quartz Creek pegmatite district

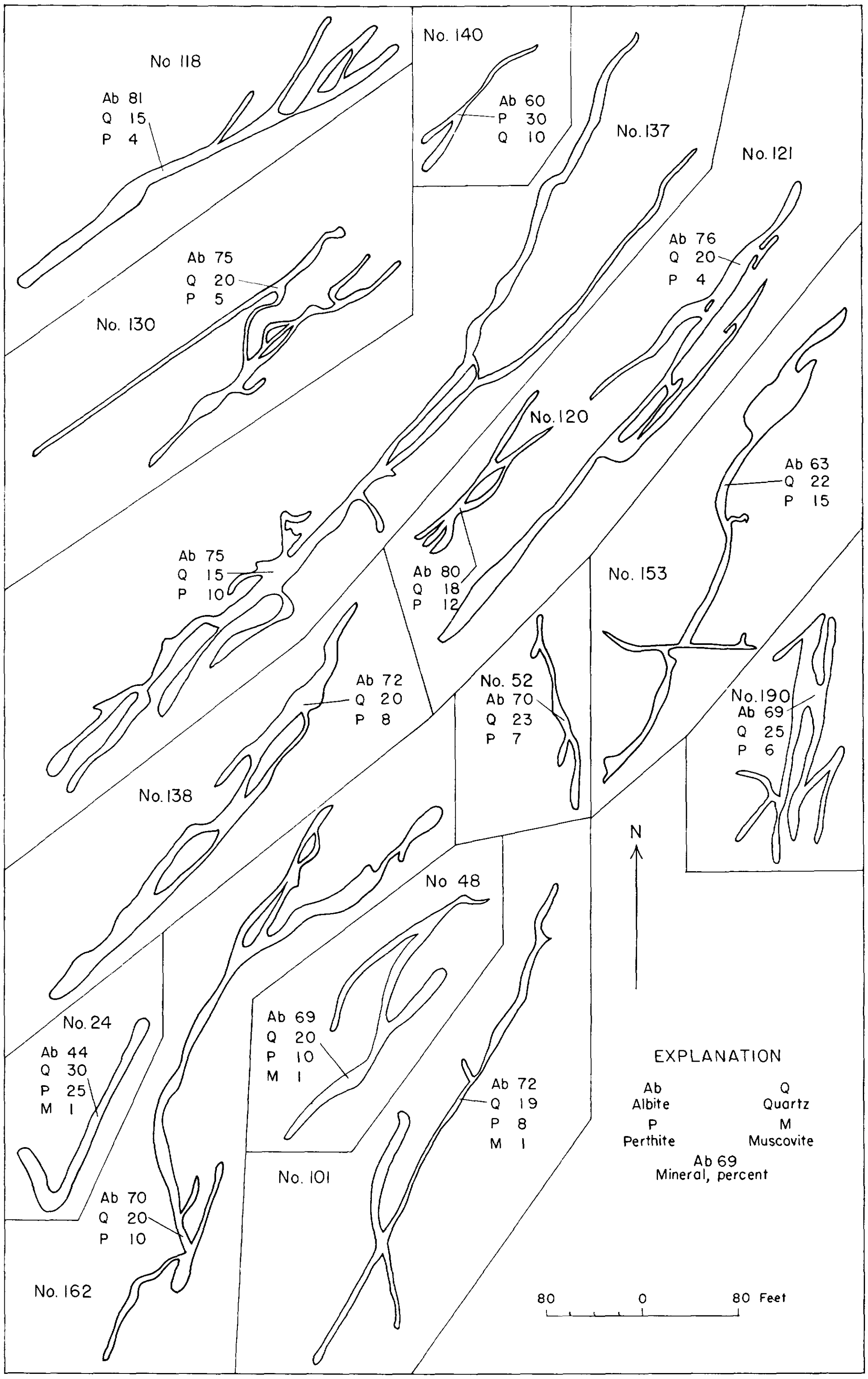

FIGURE 13.—Types of lenticular and branching pegmatites, Quartz Creek pegmatite district.

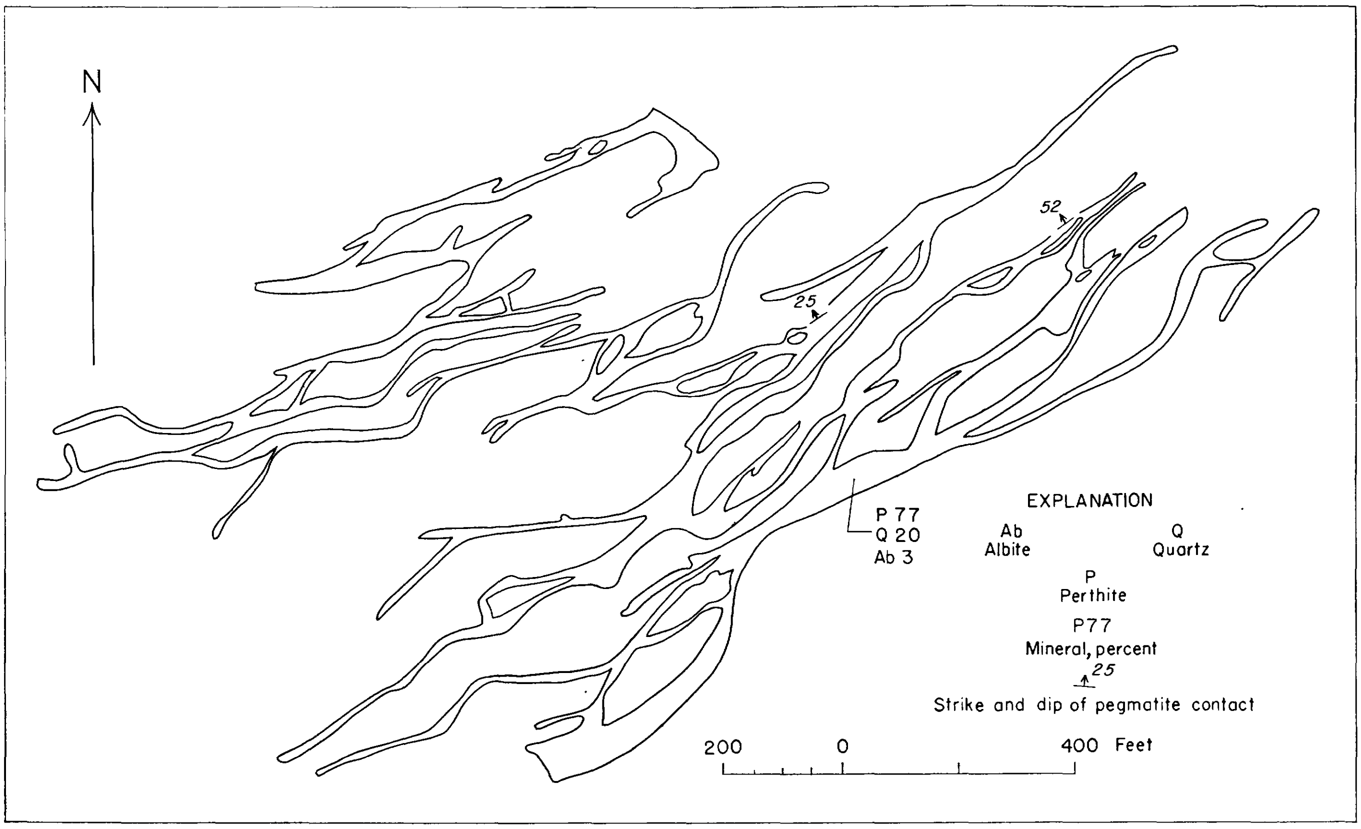

FIGURE 14.—Shape of pegmatite 1294, Quartz Creek pegmatite district.

All pegmatites that cut more than one rock type are omitted (fig. 17). Except for the larger number of irregular pegmatites in the quartz monzonite the ratios are remarkably similar. The higher ratio of irregular pegmatites in the quartz monzonite probably can be correlated there with the greater number of large pegmatites in this area. This is discussed in more detail in a succeeding paragraph. The country rocks differ greatly in their mineralogy, texture, and chemical composition, and yet the shapes of the pegmatites show little variation. The rocks of this district have one important characteristic in common: they are all tight, brittle, and of equal competence. However, the effect on the shape of the pegmatites where the host rock possesses even minor foliation is very striking. Table 2 shows the frequency of occurrence of the different shapes as a ratio related to the oval shape in hornblende gneiss and tonalite.

TABLE 1.—*Ratio of pegmatite shapes to the oval-type shape in different kinds of country rock, Quartz Creek pegmatite district.*

Rock type	Pegmatite shapes			
	Lenticular	Lenticular-branching	Irregular	Oval
Hornblende gneiss and tonalite	5. 8	2. 6	2. 4	1. 0
Coarse-grained granite	6. 2	2. 6	3. 8	1. 0
Quartz monzonite	6. 4	2. 0	6. 0	1. 0

TABLE 2.—*Ratio of pegmatite shapes to the oval-type shape in hornblende gneiss and tonalite, Quartz Creek pegmatite district.*

Rock type [1]	Pegmatite shapes			
	Lenticular	Lenticular-branching	Irregular	Oval
Hornblende gneiss	8. 7	2. 0	2. 8	1. 0
Hornblende tonalite	12. 0	9. 2	2. 2	1. 0

[1] Gradational rock types, such as those rocks which showed a slight foliation, are not included in this table.

Foliation has a profound effect in simplifying the shapes of the pegmatites by decreasing the number of branching types; the lenticular-branching type is 4.6 times more common in the hornblende tonalite than in the hornblende gneiss.

Pegmatites in incompetent rocks, such as mica schist, are, in general, concordant with the foliation and were emplaced by shouldering apart the country rock. Pegmatites of this type are most commonly lenticular, but other common forms are troughlike, arcuate, and teardrop. Lenticular-branching pegmatites are extremely rare. The schistosity of the wall

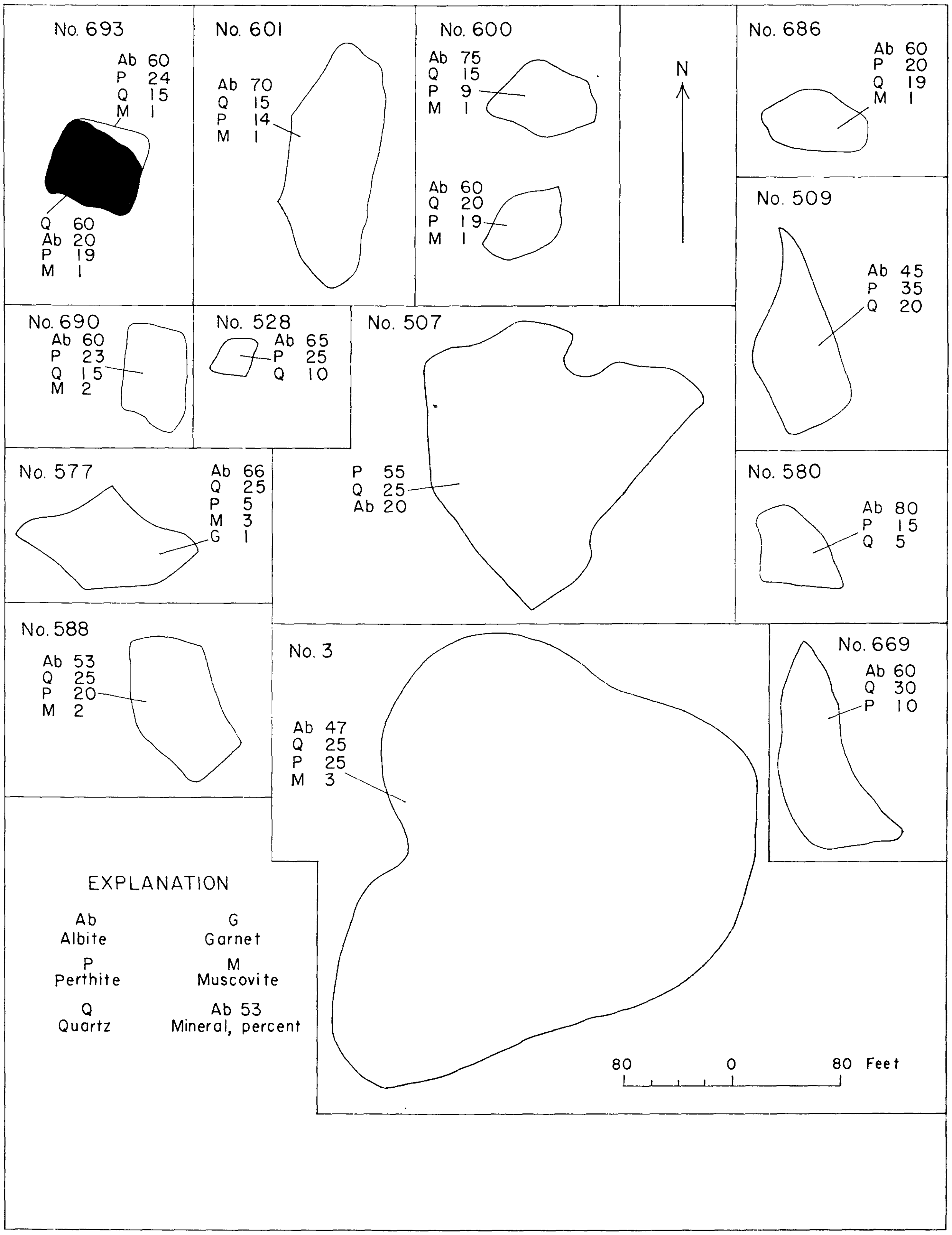

FIGURE 15.—Types of oval pegmatites, Quartz Creek pegmatite district.

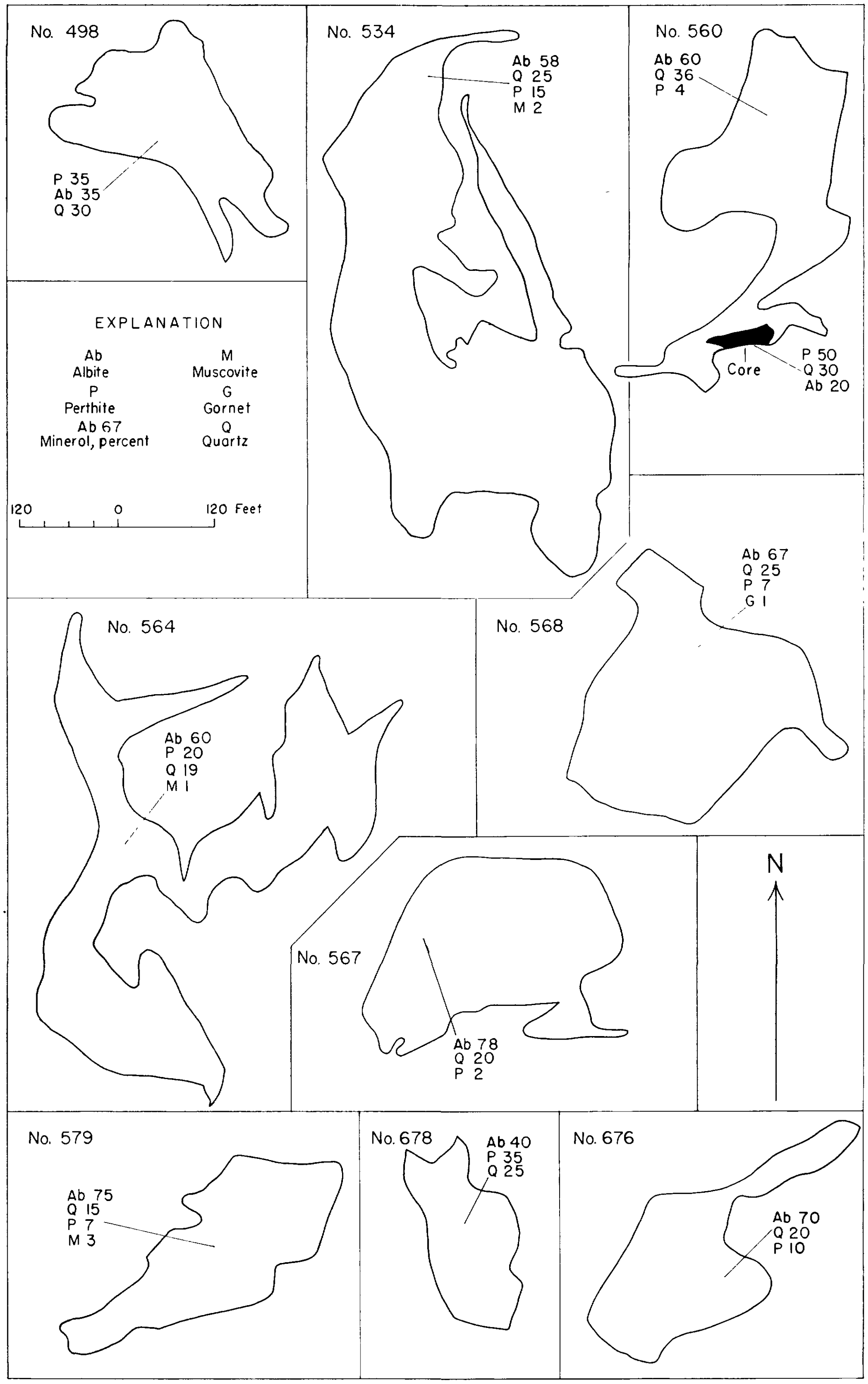

FIGURE 16.—Types of irregular pegmatites, Quartz Creek pegmatite district.

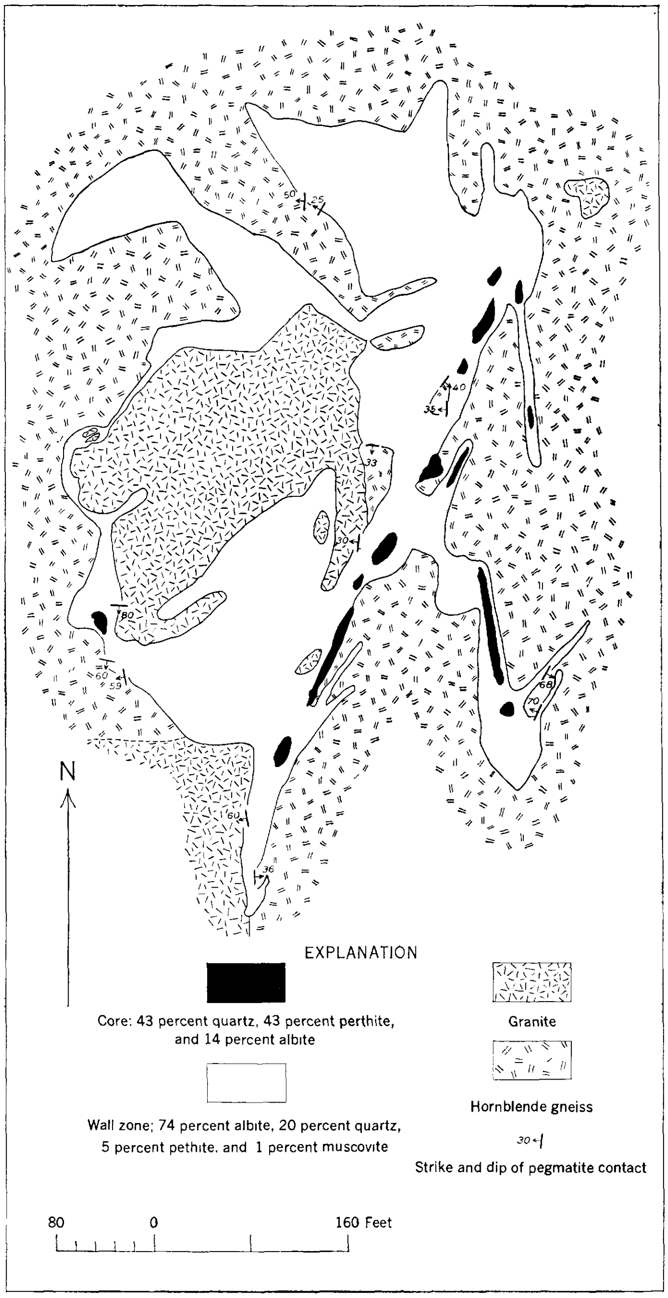

FIGURE 17.—Pegmatite 297, Quartz Creek pegmatite district.

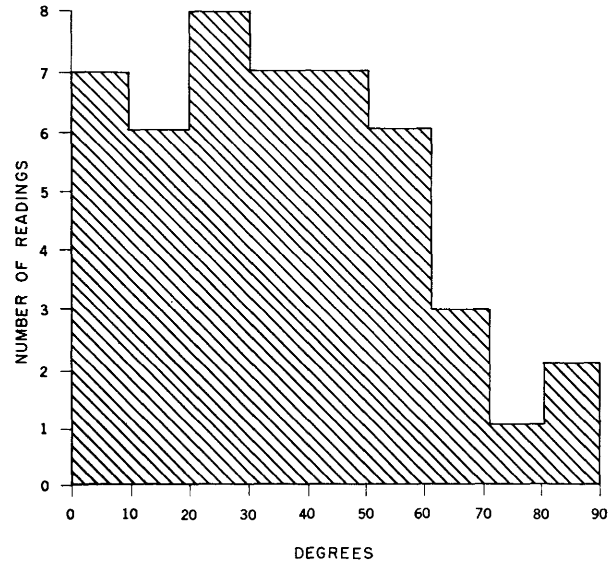

FIGURE 18.—Bar graph showing angle between pegmatite contacts and foliation of country rock.

rock is commonly conformable around the entire pegmatite.

The second factor influencing the shape of pegmatites is in the quantity of material introduced. With the intrusion of large quantities of pegmatitic material, the control of the country rock structures on the shape is usually obscured; and the body becomes an irregular stocklike mass. Indications of initial directional control that fractures had on large pegmatites, such as the Black Wonder, Bucky, or Buckhorn, were obliterated by the large quantity of material and is found only in the small stringers that extend outward from the main mass.

The competence of the country rock makes a great difference when predicting pegmatite shapes and attitudes underground for ore reserve calculations. Shapes in incompetent rocks may be projected with some confidence, whereas pegmatite shapes in competent rocks, such as those in the Quartz Creek district, can be predicted only if the attitudes of the controlling fractures are known.

INTERNAL STRUCTURE

The recognition of distinct lithologic and structural units within pegmatites dates back many years. Hunt (1871, p. 182–186), who noted a remarkable banded arrangement "formed by successive deposits of mineral matter" at Brunswick, Topsham, and Newry, Maine, appears to have been the first American geologist to recognize a regular internal structure in pegmatites. Many early authors of 25 to 40 years ago referred to segregations, veins, layers, bands, and streaks. An excellent historical review of these early writings is given by Cameron, Jahns, McNair, and Page (1949, p. 10–13). Until about 1940 most of the work on pegmatites was carried out by mineralogists and geologists who emphasized the mineralogy and theories of genesis of pegmatites and put little emphasis on their structure. See, for example: Fraser (1930, p. 349–364); Hess (1925, p. 289–298; 1933, p. 447–462); Landes (1923, p. 519–530, 537–558; 1925, p. 355–411; 1932, p. 211; 1933, p. 33–56, 95–103; 1935, p. 319–333); and Schaller (1925, p. 269–279; 1927, p. 59–63; 1933, p. 144–151).

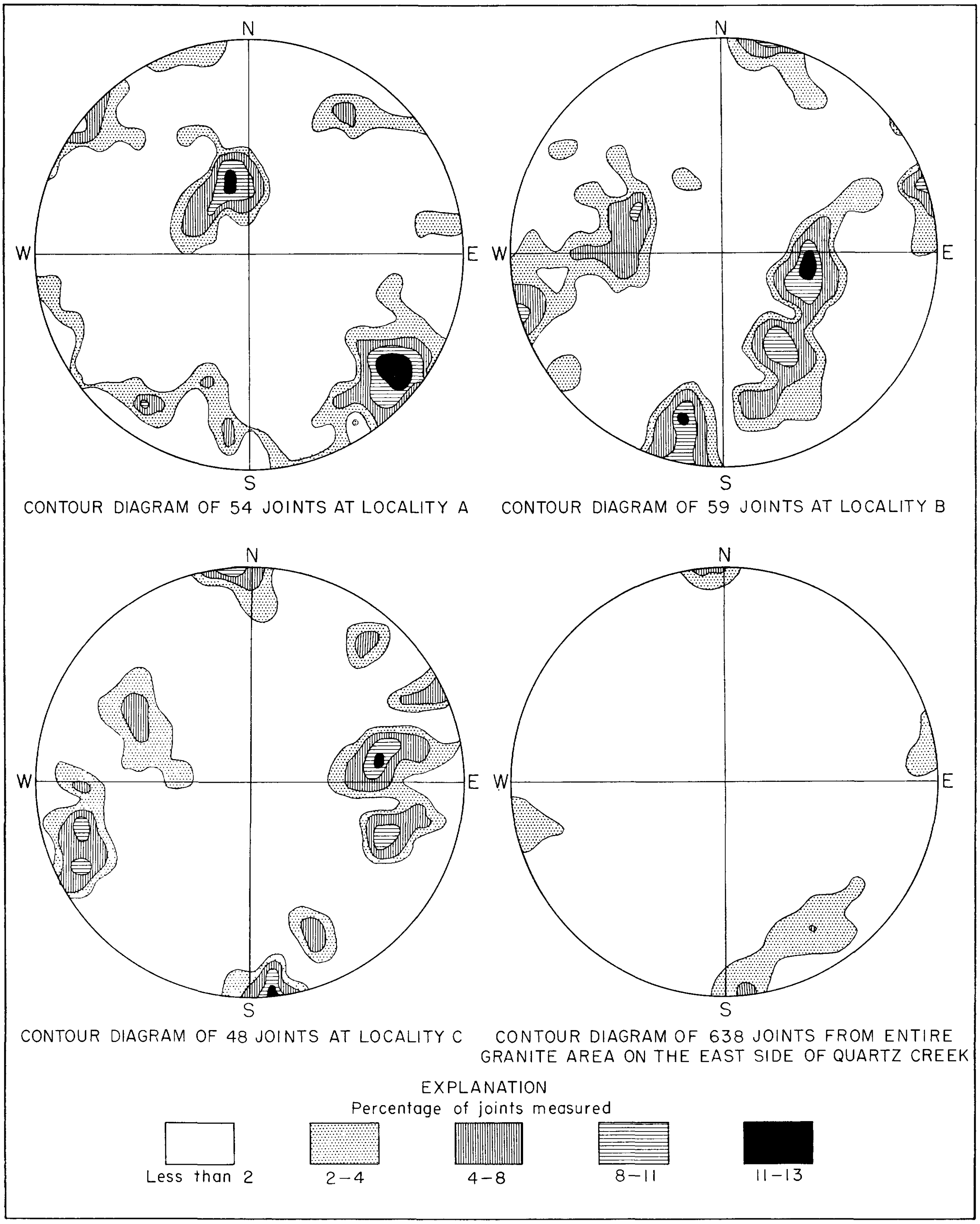

FIGURE 19.—Contour diagram of attitude of joints in granite; localities A, B and C are shown on plate 1.

After 1940, because of the wartime need for pegmatite minerals, the U. S. Geological Survey made many studies of the internal mineralogic and structural units in pegmatites. As the economical concentrations of valuable minerals in pegmatites tend to be concentrated in rock units distinct from the adjacent barren units, detailed mapping and interpretation of various pegmatite units have proved to be of much aid in exploration, development work, and mining (Smith and Page, 1941, p. 295–630; Olson, 1942, p. 363–403; Bannerman, 1943, p. 1–22; Cameron, Larrabee, McNair, Page, and Shainin, 1945, p. 369–393; Johnston, 1945, p. 1015–1070; Jahns, 1946, 293 p.; Cameron, Jahns, McNair, and Page, 1949, 115 p.; Hanley, Heinrich, and Page, 1950, 124 p.). Drilling on the basis of structural interpretation of the internal units has given excellent results (Page, 1950, p. 12–34).

The internal units of pegmatites have been classified as (1) zones, (2) fracture fillings, and (3) replacement bodies (Cameron, Larrabee, McNair, and Stewart, 1944, p. 89; Jahns, 1946, p. 39–51; Heinrich, 1948, p. 436–442; Cameron, Jahns, McNair, and Page, 1949, p. 13–97). Many of the pegmatites of the Quartz Creek district differ from those in other pegmatite areas in that, in addition to these three units, they may contain an internal structure designated as banding in this paper.

ZONES

The zones of a pegmatite in ideal development are concentric shells about an innermost zone or core (fig. 20); in many places they are incomplete, however, forming only along one end or in one part of the pegmatite. Zonal structure is formed during the primary consolidation of the pegmatitic magma and may be cut by fracture fillings and replacement bodies. Zones have been classified (Jahns, 1946, p. 42; Cameron, Jahns, McNair, and Page, 1949, p. 20) as: (1) border zones, (2) wall zones, (3) intermediate zones, and (4) cores.

Border zones are fine-grained selvages that in most pegmatites are a few inches or less in thickness. Most are of little significance in the mining or quarrying of pegmatites and hence in the industry are not distinguished from the adjoining wall zones that are more coarsely granular and much thicker. Although wall zones actually are the second zones from the margins of pegmatite bodies, they are designated as such in recognition of terminology firmly established in the pegmatite mining industry. The innermost zone or core occurs at or near the center of the pegmatite either as an elongate lens or a series of disconnected segments. Any zone between the core and the wall zone is an intermediate zone. Any number of intermediate zones can exist, but few pegmatites contain more than three. If the core is not exposed at any one level, the innermost exposed zone may be identified erroneously as a core.

BANDING

Banding is the name given to the layered structures forming pegmatite units that differ in mineralogy, texture, or both and tend to have a nonconcentric arrangement within pegmatite bodies. Banding in a pegmatite may divide the body either across or along the strike. Several distinct types of banding are recognized in the Quartz Creek district.

Banding parallel to strike.—Pegmatites in which banding is parallel to the strike and dip of the body are called layered pegmatites (fig. 21). The distinct bands or layers are mappable units of definite mineralogy or texture and are not repeated. The layered pegmatites commonly consist of several tabular units whose contacts are approximately parallel to the hanging-wall and footwall sides of the pegmatite. These layers differ from zones in that there is no repetition of units on the other side of the pegmatite. Pegmatites composed of two layers are by far the most common type in this district. These units commonly extend the entire length of the pegmatite and are from 1 to 30 feet thick. This type of banding is confined to narrow lenticular and lenticular-branching pegmatites or to a narrow lenticular part of irregular pegmatites. It is not found in thick parts of irregular pegmatites or oval pegmatites. The distinct upper and lower units in many of these layered pegmatites can be distinguished in only certain parts of the body and merge along strike into a single unit. Where two layers merge, or telescope, the unit formed has the bulk composition of the two combined layers and a texture intermediate between that of the upper and lower layers. In pegmatite 548, for example, an upper layer, consisting of perthite (50 percent), quartz (33 percent), albite (15 percent), and muscovite (2 percent), and a lower layer, consisting of albite (74 percent), quartz (20 percent), perthite (3 percent), and muscovite (3 percent), become progressively less distinct to the south and finally merge into a single unit, consisting of albite (63 percent), quartz (20 percent), perthite (15 percent), and muscovite (2 percent).

Banding across strike.—Some pegmatites are banded across the strike into two or more mappable units differing in mineralogy, texture, or both (fig. 22). These are designated as pegmatites showing variation in composition along strike. Banding across strike results in two or more pegmatite units that have their contact at an angle to, rather than parallel to, the strike of the pegmatite. Units in such pegmatites occupy the full width of the body and are from 20 to several hun-

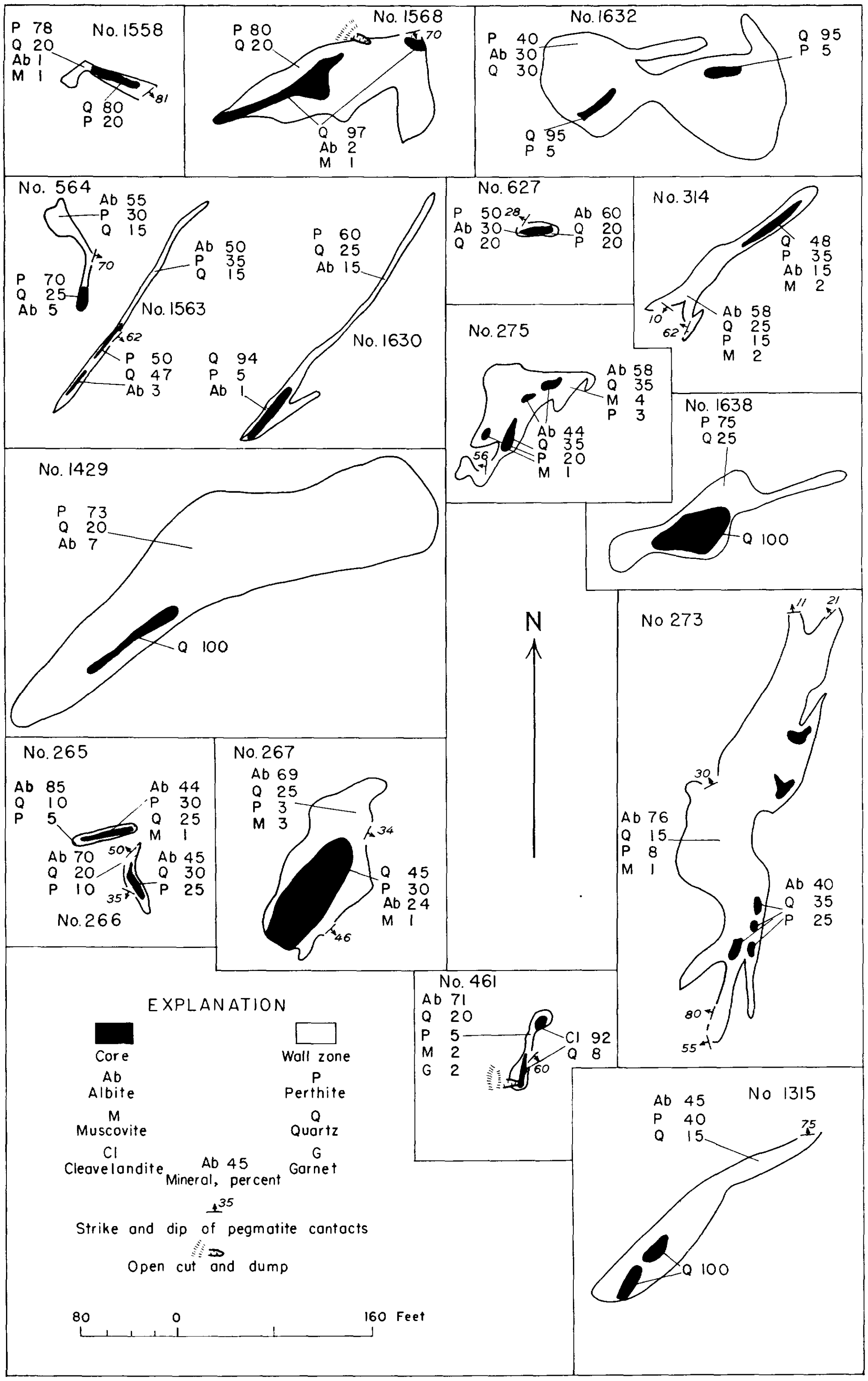

FIGURE 20.—Zoned pegmatites, Quartz Creek pegmatite district.

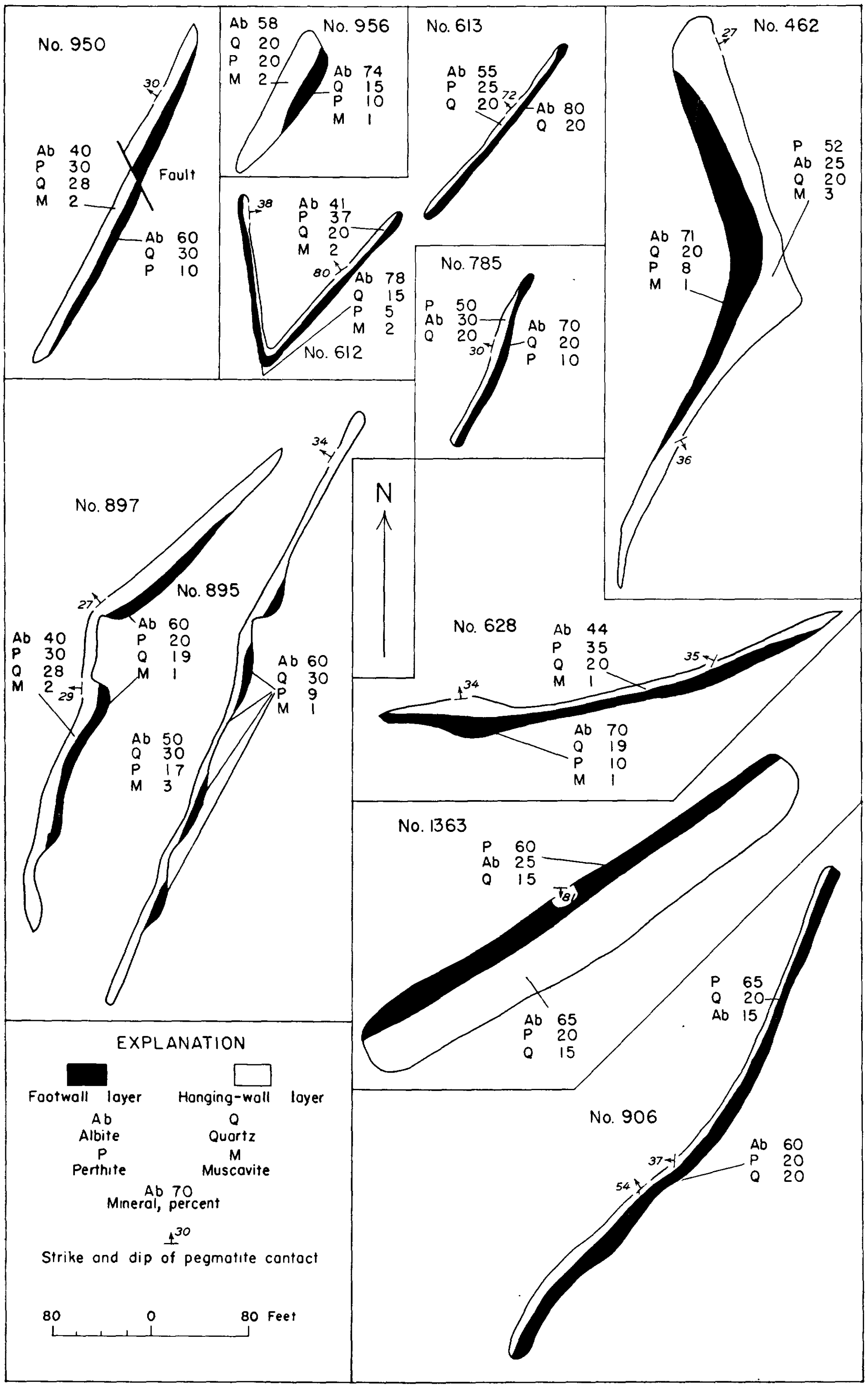

FIGURE 21.—Layered pegmatites, Quartz Creek pegmatite district.

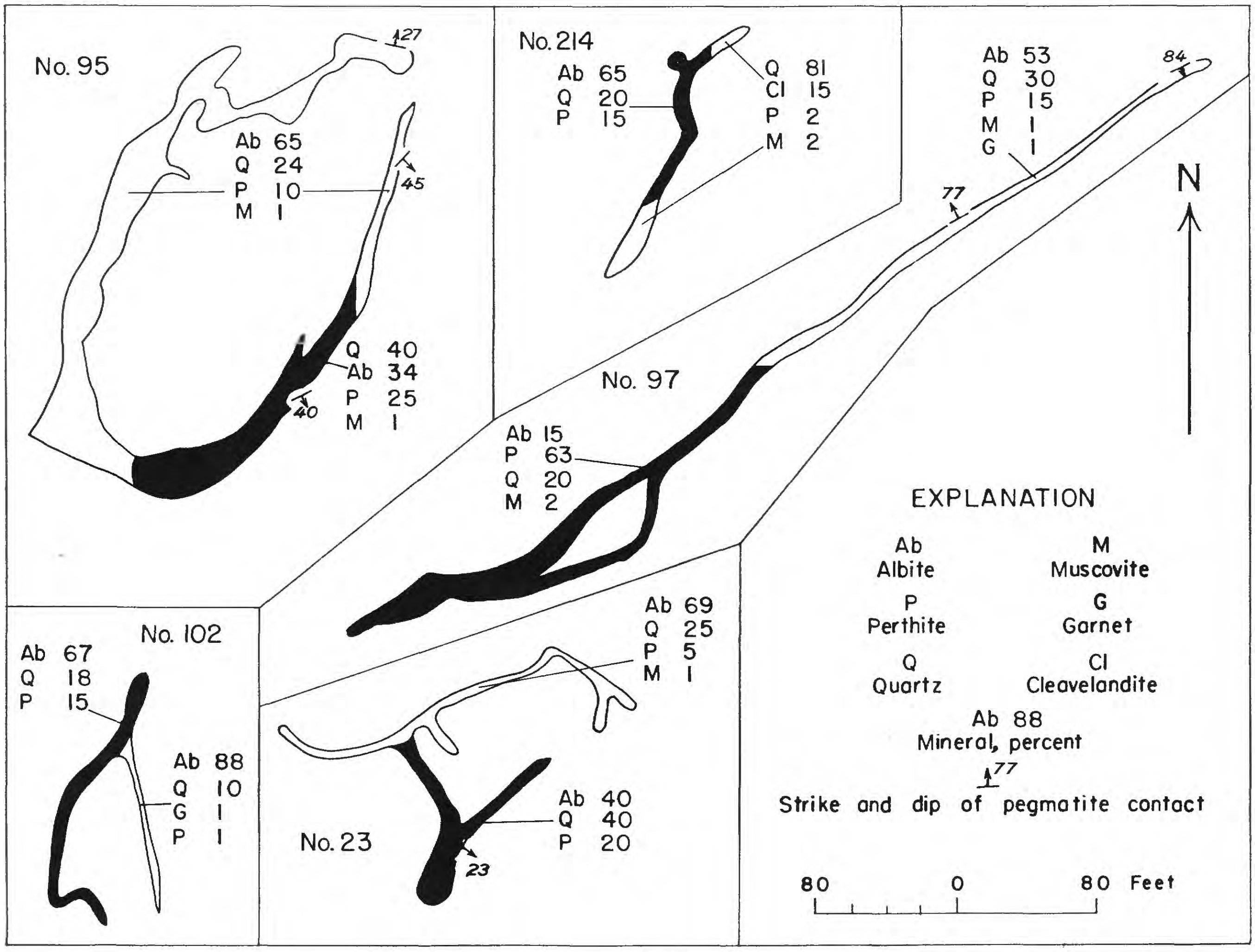

FIGURE 22.—Pegmatites showing variation in composition along strike, Quartz Creek pegmatite district.

dred feet across parallel to the strike of the pegmatite body. The units have the shape of whatever part of the pegmatite they occupy; thus, one unit may occupy the short, thin, lenticular part and another the long, irregular, bulbous part of a pegmatite. Banding across strike has been found only in lenticular and lenticular-branching pegmatites and all such bodies contain either 2 or 3 bands (fig. 22).

Multiple banding.—Some pegmatites in the Quartz Creek district are composed of innumerable very thin bands that differ in texture, mineralogy, or both. The bands are rarely mappable on ordinary scales. This type of banded rock has been described as "line rock" in the Pala district, Calif. (Schaller, 1925. p. 273). Line rock in the Quartz Creek district is characterized by the repetition of bands of minerals from 0.01 inch to 0.4 foot thick; the average thickness is less than 0.5 inch. The banding in most places, as in pegmatite 670, is parallel to the strike of the body, but in a few places it cuts across the strike. Line rock is found commonly as patches in a small part of the pegmatite. No pegmatite, with the exception of pegmatite 670, contains more than 15 percent of line rock, and most of them contain less than 1 percent. Line-rock-bearing pegmatites, therefore, are not classified separately.

Line rock is most common in albite-rich pegmatites where obvious banding is caused by layers of garnet and muscovite as much as a quarter of an inch thick (Figs. 23, 24). Layers of fine-grained albite-quartz pegmatite are interspersed with coarser layers of perthite-quartz-albite pegmatite (½ to about 4 inches thick). The layers of perthite-quartz-albite pegmatite are lenticular and usually pinch out within short distances. Other layers may occur above or below to form an echelon pattern. Rarely the albite-quartz pegmatite forms the lenticular units in line rock. The banding may end abruptly against large crystals or an aggregate of minerals (fig. 25). Line rock is most common adjacent to the walls of the pegmatite, especially on the footwall side. In several places thin

FIGURE 23.—"Line rock" in the lower part of pegmatite 670. Fine dark layers are small garnets.

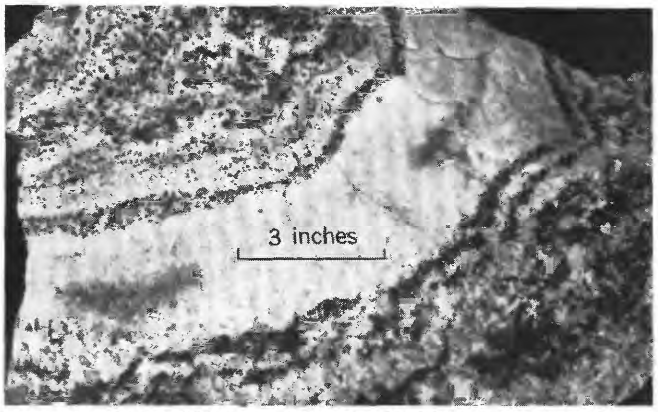

FIGURE 24.—"Line rock" from pegmatite 461. Black layers are garnet and muscovite; white layers are mainly albite with a little quartz.

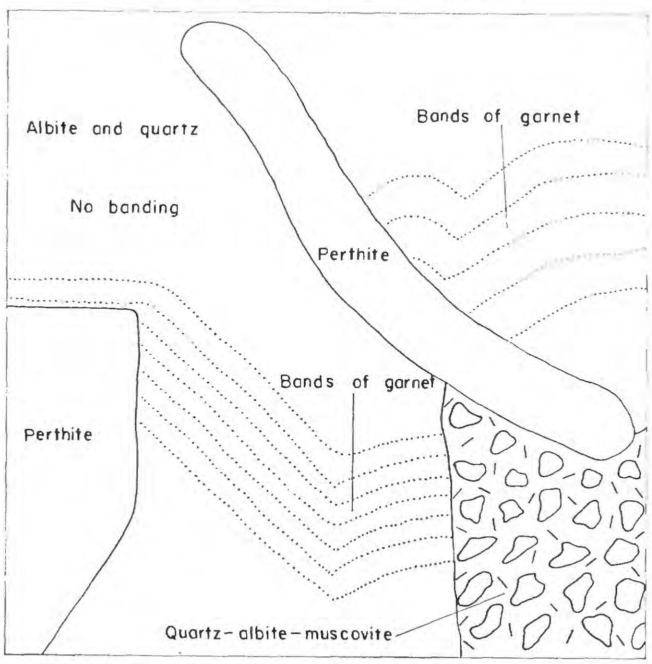

FIGURE 25.—Relation of banding to crystals or to nonbanded mineral aggregates, pegmatite 70.

layers of garnet and albite were noted terminating abruptly against euhedral perthite crystals. The perthite is veined by albite along fractures and was either entirely crystallized or, at least, partly crystallized before all the albite formed. Thus, the perthite is not a later mineral which cut the layering but rather a buttress against which the layering stopped. The arrangement of garnets and micas in bands suggests at least local movement of the pegmatite magma with rapid minor changes in composition so that first one mineral would be crystallizing and then another. Thus, a row of garnets might be formed in an area of movement up to a projecting perthite crystal, which would either deflect the current or cause deposition of a row up to its side and another along its top. This row on top might be swept from its more exposed position where narrowing of the channel caused the current to be swifter, or it might be incorporated into the perthite upon further growth. In this case the evidence is against replacement, because the banding is regular, the early perthite shows no corrosion by the later garnet and albite, and the incorporation of garnet in some perthite crystals points to simultaneous growth. The alternating lenses of perthite-quartz-albite pegmatite in fine-grained albite-quartz pegmatite suggests zoned multiple pegmatites such as might be formed by crystallization from lenses of trapped liquid.

Line rock is common in many pegmatites in other areas: the Crystal Mountain district, Colo. (W. R. Thurston, oral communication), the Middletown district, Conn., the Pala district, Calif. (Schaller, 1925, p. 272–273), the Eight Mile Park district, Colo. (Heinrich, 1948, p. 448), and the Bridger Mountains district, Wyo. (McLaughlin, 1940, p. 62–63).

FRACTURE FILLINGS

Fracture fillings are tabular bodies that extend from inner units into outer units of the pegmatite. In places they connect directly with the core.

Fracture-filling units are common in pegmatites of the Quartz Creek district but are usually small; many are only a few feet in length. Most of these units are only a minor part of a pegmatite, though there may be several in a single pegmatite. Discontinuous core segments and fracture fillings are difficult to distinguish in some irregular pegmatites.

Most of the fracture fillings are coarse grained and consist predominantly of perthite-quartz pegmatite or of quartz pegmatite. In pegmatite 1096 a fracture filling of massive quartz extends from the core across the wall zone.

REPLACEMENT UNITS

No mappable replacement units were found in the pegmatities of the Quartz Creek area, although there are several places where small areas were replaced along fractures. Replacement units form by the replacement of preexisting consolidated pegmatite with later material. The interaction of two minerals or of a mineral with the rest-solution during the process of crystallization is not considered as replacement in this paper. The embayment of one mineral by another and the filling of small fractures have been given as criteria of replacement, but these textures also can be formed if an early-formed mineral is corroded by the rest-solution and subsequently coated by a later mineral.

The criteria used to distinguish a replacement body are, therefore, the presence of relict textures or structures of the preexisting rock that indicate essentially complete consolidation prior to replacement. Where a pegmatite is not zoned or where no preexisting textures

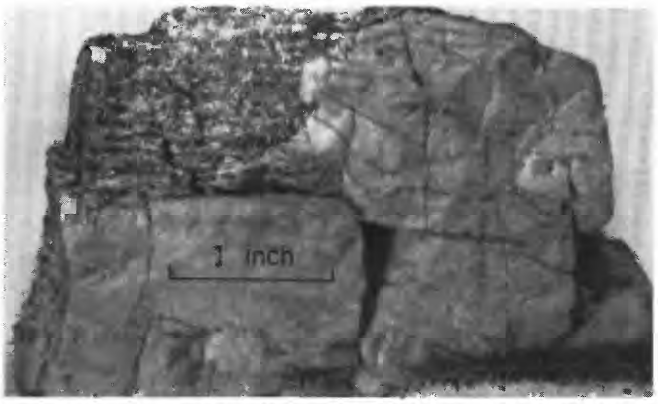

FIGURE 26.—Replacement of perthite by fine-grained muscovite (black). Note the unreplaced albite lamellae (white) of the perthitic structure in muscovite.

or structures remain, it may be very difficult to recognize a replacement body.

The interaction of one mineral on another during the crystallization process is more pronounced in pegmatites than in other igneous rocks because of the large grain size of the crystals which magnifies the embaying of one mineral by another. Thus, a crystal of one mineral may be partly or completely grown before the equilibrium in the solution will permit a second mineral to start crystallizing. The new crystal may form around the first crystal or grow out from it or, in the new equilibrium, the first mineral may be soluble and may be replaced by the second. Evidence of this sort does not prove or disprove the presence of a replacement unit. An excellent example of muscovite selectively replacing perthite and leaving narrow albite stringers of the perthite intergrowth unreplaced is illustrated in figure 26. The pegmatite was essentially homogeneous and shows no evidence of a separate replacement body.

TYPES OF PEGMATITES

Pegmatites may be divided into homogeneous and heterogeneous pegmatites. The homogeneous pegmatites are simple aggregates of feldspar, quartz, and accessory minerals that cannot be divided into contrasting units on the basis of mineralogy and texture. These pegmatites form the great bulk of pegmatites in many regions, such as the Quartz Creek district, Colo., Black Hills region, S. Dak., Spruce Pine district, N. C., (D. A. Brobst, oral communication) and the Crystal Mountain district, Colo. (W. R. Thurston, oral communication). Homogeneous pegmatites commonly form relatively small dikes and rarely contain minable concentrations of economic minerals. Because they lack the economic and rarer minerals, they have received little attention in the past by mineralogists and geologists. Most of the pegmatite literature is devoted to descriptions of pegmatites containing the rarer minerals. Recently, however, the U. S. Geological Survey has undertaken regional mapping of pegmatite districts in other parts of Colorado and in South Dakota, North Carolina, and Connecticut. These districts are all similar, and these studies should result in obtaining a broad knowledge of the character and distribution of all types of pegmatites. This work may yield the much-needed data required to understand the relationships of homogeneous and heterogeneous pegmatites.

Heterogeneous pegmatites are those that can be divided into different rock units on the basis of either mineralogy or texture or both.

HOMOGENEOUS PEGMATITES

Homogeneous or one-unit pegmatites form the great bulk of the pegmatites in the Quartz Creek district. Of more than 1,800 pegmatites, 78 percent are homogeneous or "unzoned." Homogeneous pegmatites occur as lenticular, lenticular-branching, oval, and irregular bodies. Only a few of the larger irregular pegmatites are zoned; they contain one or more discontinuous cores. Examples of homogeneous pegmatites are shown in figures 12 to 16. The dominant minerals are plagioclase, quartz, and perthite. Most of the pegmatites contain as much as 2 percent of one or more of the following minerals: Muscovite, garnet, biotite, and magnetite. Beryl and tourmaline are present in some pegmatites but constitute only a small fraction of 1 percent.

HETEROGENEOUS PEGMATITES

Zoned pegmatites.—Zoned pegmatites form roughly 14 percent of the pegmatites in the area (figs. 17 and 20); most have only a core, a wall zone, and a narrow border zone. Most of the border zones in the Quartz

Creek district are only a fraction of an inch thick and are cooling selvages. Because of their thinness they were mapped with the wall zones.

The mineralogy and texture of the wall zone usually resembles the homogeneous pegmatites in the immediate vicinity. The core, except where the wall zone is predominantly graphic granite, is commonly coarser grained and contains more perthite or quartz, or both, than the surrounding wall zone. Cores consisting only of massive quartz are very common (fig. 27) in the northwestern part of the district. Cores of perthite-quartz pegmatite also are common. Fourteen pegmatites have cores of cleavelandite-quartz or cleavelandite-lepidolite-quartz pegmatite. They include the Bazooka, White Spar No. 2, and the Brown Derby No. 2 and No. 3 pegmatites, which have been described previously by Hanley, Heinrich, and Page (1950, p. 66–68, 71–74, 77–80). Not all the lepidolite-bearing and cleavelandite-bearing pegmatites are zoned pegmatites; these minerals are also found in small homogeneous pegmatites, layered pegmatites, and pegmatites that vary in composition along their length. The cores in small pegmatites may form a large proportion of the pegmatite (no. 267, fig. 20), but in large pegmatites they usually make up 1 percent or less of the total rock (fig. 17). Pegmatites having an intermediate zone as well as a core and a wall zone are rare. Only 7 pegmatites in the Quartz Creek district contain intermediate zones. In 5 pegmatites this zone consists of muscovite-albite pegmatite surrounding one or more small discontinuous cores.

FIGURE 27.—A thin zoned pegmatite with an albite-quartz wall zone and a quartz core.

The Quartz Creek district has few well-zoned pegmatites. Those which are zoned commonly consist of only a wall zone and a core. The core units are usually irregularly distributed, discontinuous segments, and constitute only a small part of the pegmatite. Judging from the sizes and distribution of the core segments, only a small proportion of pegmatitic liquid remained after consolidation of the wall zone. This crystallized in scattered areas as core segments.

Layered pegmatites.—Layered pegmatites make up approximately 7 percent of all pegmatites in the Quartz Creek district. Layering is most common in the thin dikelike lenticular and lenticular-branching types of pegmatites. Layering is not common in large irregular pegmatites, although a few of the thinner irregular bodies are layered.

Most of the layered pegmatites contain a perthite-rich hanging-wall unit and an albite-rich footwall unit (fig. 21). As an example, pegmatite 685 (pl. 1), on the north side of Wood Gulch, has a hanging-wall unit visually estimated to contain albite (30 percent), quartz (20 percent), perthite (48 percent), and muscovite (2 percent) and a footwall unit of albite (65 percent), quartz (15 percent), perthite (19 percent), and muscovite (1 percent). In a few pegmatites the hanging-wall unit has more albite than perthite, but the hanging-wall unit always contains more perthite than the footwall unit. Pegmatite 1363 (fig. 21 and pl. 1) is the only body that contains a higher proportion of perthite in what is believed to be the footwall unit; this pegmatite, however, is nearly vertical (81°). The texture of the hanging-wall unit is coarser than that of the footwall unit, because perthite tends to form larger crystals than albite. Perthite forms in crystals from 0.5 to 3 inches in diameter, and albite forms in crystals from 0.06 to 0.25 inch in diameter. In the albite-rich units the quartz crystals are about the same size as those of albite, but in the perthite-rich units they are nearly as large as the perthite crystals. The above relationship would seem to suggest an immiscibility between potassium-rich and sodium-rich fluids, but the contact between two immiscible layers would be horizontal and that of these dikes is between 25° and 81°.

Layered pegmatites with a perthite-rich hanging-wall layer and an albite-rich footwall layer have been described by Schaller (1925, p. 271–274) in the Pala district, Calif.

The concentration of perthite as hoods in the upper part of zoned pegmatites is common in pegmatites in many districts. Examples are the Keys No. 1 pegmatite, Orange, N. H.; the W. T. Foster No. 1 pegmatite, Shelby, N. C.; the Palermo No. 1, Grafton County, N. H.; the Strickland-Cramer pegmatite, Portland, Conn.; and the Beecher Lode, Dyke Lode, Etta, Dan Patch, Hugo, and Bob Ingersoll Dike Nos. 1 and 2 of the Black Hills, S. Dak. (Cameron, Jahns, McNair, and Page, 1950, p. 44–45, 48). The perthite-rich hanging-wall layers in pegmatites of the Quartz Creek district appear to be the extreme development of perthite-rich hoods in thin lenticular bodies. Two of the lepidolite-bearing pegmatites, pegmatite 306 (Opportunity No. 4 claim) and pegmatite 452 (the Brown Derby No. 1) are layered. Pegmatite 306 consists of an upper albite-quartz-perthite unit and a lower cleavelandite-quartz-lepidolite unit. The Brown Derby No. 1 pegmatite contains at least eight different units. Not all these are present throughout the pegmatite: some form lenticular pods. The Brown Derby is described by Hanley (Hanley, Heinrich, and Page, 1950, p. 69–71) as having a border zone, a wall zone, a possible intermediate zone, and a compound core made up of three different units. The Brown Derby has more mappable units than any other pegmatite in the region. Many of these layers are found in only certain parts of the dike and merge along strike with other units. The central part of the unit has an albite-quartz wall zone on both hanging-wall and footwall sides, but to the north the wall zone on the hanging-wall side disappears, and the pegmatite becomes a layered pegmatite. Other layered pegmatites probably are incompletely developed zoned pegmatites.

The layered pegmatites are most abundant (1) along the ridge just south of Quartz Creek in the southwestern corner of the district, (2) in the vicinity of the Brown Derby mine, and (3) along the western side of Big Gulch. Layered pegmatites are sparsely distributed among other types of pegmatites in the first two areas but are the dominant type in the third area. The layered type is almost absent in other areas.

The distribution of the layered pegmatites suggests that their development is controlled by a particular set of conditions. The country rock in these areas is hornblende gneiss, as in many areas that are void of layered pegmatites. The conditions under which these bodies cooled and crystallized probably controlled their formation. The original composition of the pegmatite liquid, especially concentration of the fugitive constituents, may have been important but probably was not the controlling factor, because there are different mineral assemblages in layered pegmatites, and because many unlayered pegmatites are identical to layered ones in mineralogy. The possibility of the layers being formed by replacement of preexisting pegmatite rather than by difference in crystallization history has been considered, but most of the perthite is in well-formed crystals, surrounded by later albite and quartz. The crystals are only slightly embayed and are not cut by veinlets of other minerals. The facts that the perthite layer, with only one possible exception, is on top, that the contact between the two layers is gradational, and that the layers may telescope gradually into a homogeneous unit do not seem to fit the picture of irregular replacement.

Pegmatites showing variation in composition along strike.—About 1 percent of the pegmatites have more than one unit, where the mineral composition of the unit changes along the length rather than across the pegmatite (fig. 22). In some lenticular-branching pegmatites, each branch has a different mineral assemblage. In lenticular pegmatites one end may be of one mineral composition and the opposite end of another, or the center of the pegmatite may be of one mineral composition and the ends of a different mineral composition. In a few pegmatites one part may contain a core in addition to the layers across the pegmatite.

The dominant variation is the change from a unit rich in perthite to one in which perthite is less abundant or even absent; however, parts of some of the branching cleavelandite- and lepidolite-bearing pegmatites on the Opportunity No. 1 claim (nos. 209, 213, 214, 215, and 216) have similar units.

Pegmatites showing variation in composition along strike are lenticular and lenticular-branching pegmatites and, in part, may represent multiple injections of pegmatite fluid.

Multiple pegmatites.—Multiple pegmatites are formed by multiple intrusions so that the walls of the pegmatite formed by the second injection are tangent to that of the first. Thus, the various units have strikes which trend within a few degrees of one another. Branching and irregular pegmatite bodies may be the result of multiple intrusion of two or more pegmatite fluids into the same spot. In general, many adjacent pegmatites are often of similar composition and texture. It may be difficult, therefore, to distinguish between a branching and a multiple pegmatite. There are in the Quartz Creek district two pegmatites that have been formed by two separate injections of pegmatitic fluids. Pegmatite 251 is a lenticular-branching body with a wall zone and a thin core in each branch (fig. 28). The two branches join near the north end, and instead of the cores joining, as cores do in a normal branching pegmatite, there are two parallel cores at the junction, showing that it is a multiple pegmatite formed at slightly different times by two separate injections. Pegmatite 216 on the Opportunity No. 1 claim is a north-trending albite-quartz-perthite pegmatite, which is cut by a northeasterly-trending body of perthite-quartz and cleavelandite-quartz pegmatite (fig. 28). Though this pegmatite resembles a multiple pegmatite in that it is formed of two separate injections, walls of the two pegmatites are crosscutting rather than tangent.

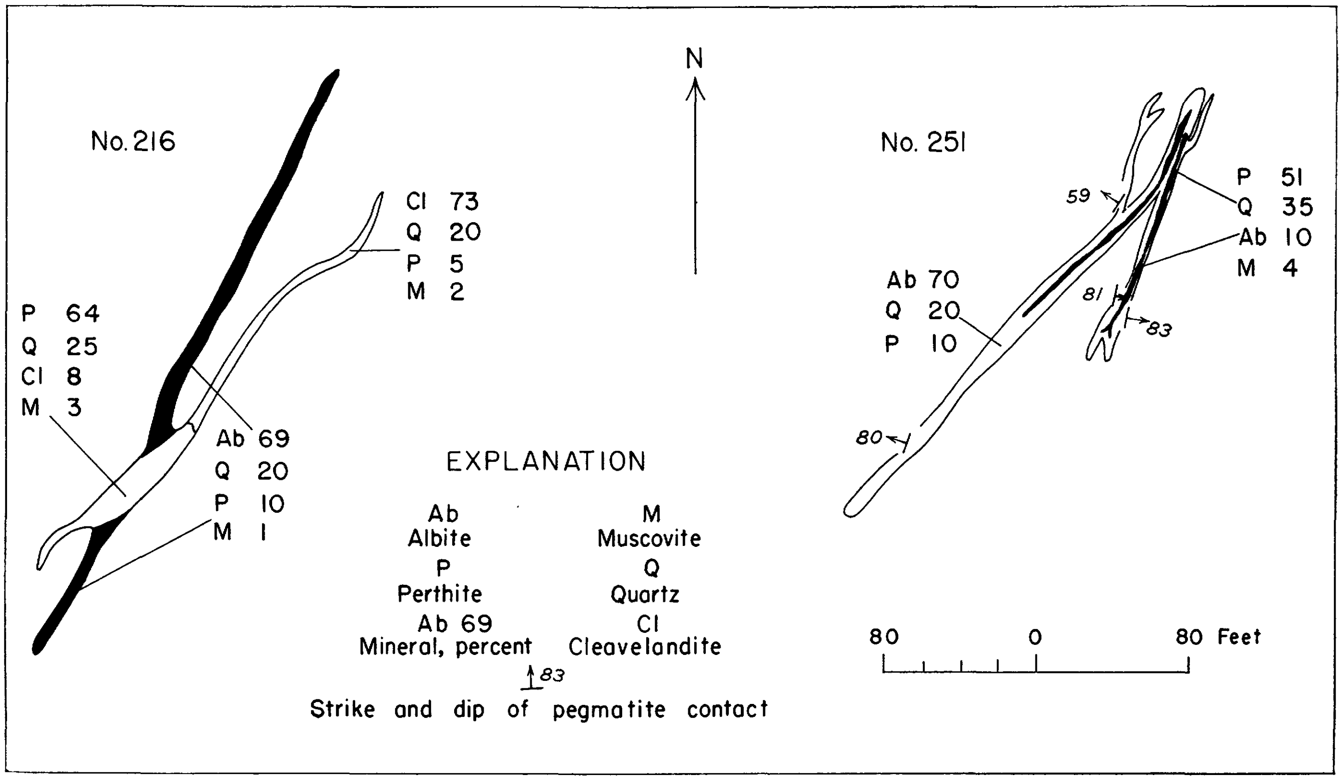

FIGURE 28.—Multiple pegmatites, Quartz Creek pegmatite district.

MINERALOGY

A total of 27 minerals has been found in the pegmatites of the Quartz Creek district. Perthite, plagioclase, and quartz are the essential minerals and form om fr95 to more than 99 percent of most pegmatites. Only a very few pegmatites have units rich in muscovite; this mineral cannot be considered an essential mineral of the pegmatites of this district. The common accessory minerals are considered to be those found in more than 10 percent of the pegmatites. These minerals, in order of their frequency, are: muscovite, garnet, biotite, magnetite, and beryl. The quantity of these minerals in any particular pegmatite is small; muscovite commonly ranges from 0.5 to 3 percent; garnet, from 0.5 to 1 percent; biotite and magnetite, less than 1 percent; and beryl, a few small crystals.

The other 19 minerals are found in less than 3 percent of the pegmatites of the district and are considered rare accessory minerals. They also commonly amount to only a small fraction of 1 percent of any pegmatite. Table 3 lists all accessory minerals, the number of pegmatites which contain these minerals and the percent of the total pegmatites in which they are found.

The pegmatite minerals are described in detail with special attention to variations in composition as determined by differences in refractive index. Plagioclase and beryl show variations in indices corresponding to changes in their alkali content, and similarly the refractive index of muscovite can be related to its ferric iron content. Determinations of the refractive indices of these three minerals from various layers of layered

TABLE 3.—*Occurrence of accessory minerals in 1,803 pegmatites of Quartz Creek district*

Mineral	Number of pegmatites in which mineral was observed	Percent of pegmatites in which mineral was observed
Muscovite	1, 058	57. 9
Garnet	965	52. 9
Magnetite or martite	422	23. 1
Biotite	357	19. 6
Beryl	232	12. 7
Tourmaline	48	2. 6
Columbite-tantalite	29	1. 6
Monazite	23	1. 3
Lepidolite	17	. 9
Microlite	13	. 7
Chlorite	9	. 5
Topaz	8	. 4
Gahnite	8	. 4
Samarskite	7	. 4
Epidote	3	. 2
Apatite	3	. 2
Fluorite	2	. 1
Spodumene	1	. 06
Amblygonite	1	. 06
Allanite	1	. 06
Lithiophilite-triphylite	1	. 06
Betafite	1	. 06
Chrysocolla	1	. 06
Unknown	1	. 06

pegmatites and from poorly zoned pegmatites showed no appreciable variations.

Slight differences in the composition of beryl and albite from the well-zoned pegmatites were indicated by differences in refractive index. The variations showed that the alkali content of beryl and the albite content of plagioclase increase inwardly from the wall zone of the pegmatites.

The indices of plagioclase, muscovite, and beryl in pegmatites from different types of country rock were found. If these pegmatites were formed from the country rock with the help of some submagmatic metamorphic metasomatic processes, as suggested by Ramberg (1949, p. 50–51), then the differences in the country rock should be reflected in the alkali content of the plagioclase and beryl and the ferric iron content of the muscovite. No relationship between the indices and type of country rock is apparent.

Detailed results of the work on indices is given under each mineral.

PLAGIOCLASE

Plagioclase occurs in all pegmatites of the Quartz Creek district and is the dominant mineral in most. It may form as much as 90 percent of all types of structural or mineralogic units. The plagioclase occurs in fine-grained sugary aggregates of equigranular grains and in coarse platy crystals (cleavelandite). Cleavelandite has been found in 28 pegmatites in this district. Where used in this report, the term "plagioclase" refers only to the typical granular form, and the term "cleavelandite" refers to the platy form. Plagioclase commonly is abundant in (1) homogeneous pegmatites, (2) wall zones of zoned pegmatites, and (3) footwall layers of layered pegmatites. These units may contain more than 98 percent plagioclase and quartz. Cleavelandite, on the other hand, is restricted for the most part to central parts of the pegmatites.

The plagioclase ranges in size from less than 0.003 to about 1.5 inches across; the average size is about 0.12 inch. Crystal shape usually is not discernible, but the cleavage surfaces commonly are curved or warped. Twinning is visible only in the large crystals. Plagioclase is found in graphic intergrowth with quartz in a few places. Most of the plagioclase is white, but cream, brownish, and pinkish shades are common. The plagioclase locally resembles perthite in color but can usually be distinguished by its warped surfaces, twinning lamellae, lack of perthitic structure, and occurrence in fine aggregates.

Cleavelandite is found in thin plates 0.03 to 0.06 inch thick and 0.5 to 4 inches in maximum dimension. The average plate is approximately 2 inches long, 1.5 inches wide, and 0.04 inch thick. The crystals are white and semitransparent. The surface of the crystal is wavy, and twin lamellae can be seen along the edges.

The lower index (N_α) of the (010) cleavage flakes was determined in white light on 17 specimens of cleavelandite and on 439 specimens of other types of plagioclase from the Quartz Creek district. The cleavelandite is a sodic albite, its lower index ranging in value from 1.528 ($Ab_{97}An_3$) to 1.530 ($Ab_{95}An_5$), with an average of 1.529 ($Ab_{96}An_4$). The other plagioclase specimens vary in composition from sodic albite to calcic oligoclase; the lower index ranging in value from 1.527 ($Ab_{99}An_1$) to 1.541 ($Ab_{74}An_{26}$), with an average of 1.532 ($Ab_{93}An_7$). Table 4 gives the results of these determinations, the type of country rock, and the type of pegmatite or pegmatite unit from which each specimen was taken.

The lower refractive index of plagioclase was determined for all internal units in each beryl-bearing pegmatite and for a selected number of pegmatites in each type of country rock. The refractive indices of the plagioclase in pegmatites with the hornblende gneiss and tonalite wall rocks average 1.530, and those in the quartz monzonite average 1.538. Refractive index of plagioclase in pegmatites from the hornblende gneiss near quartz monzonite is in the same range as those in the quartz monzonite. The lower refractive index of plagioclase in pegmatites in the hornblende gneiss decreases from the quartz monzonite area southward; the difference appears to be controlled by the regional distribution rather than composition of the country rock.

In zoned pegmatites of the Black Hills (Page, and others, 1953) and other districts (Cameron, and others, 1949, p. 99), a systematic variation in the plagioclase has been noted from zone to zone, the anorthite content decreasing toward the core. Most pegmatites in the Quartz Creek district do not have well-developed zones but, when zoned, show a rather large wall zone with scattered core segments. Table 5 shows that, of the 19 pegmatites considered, there is not much change in the indices in 17 pegmatites that are composed of only wall zone and core; 8 showed no change of index, 5 decreased slightly in index (0.001 to 0.002) from wall zone to core, while 4 increased in index (0.001 to 0.006). In 2 well-segregated pegmatites with intermediate zones there is a decrease in refractive index of 0.005 towards the core, indicating a decrease in anorthite content, which is in accord with previous work. In a well-segregated pegmatite the plagioclase probably will tend to show a systematic decrease of the anorthite content toward the center; but when the zoning is poor, the plagioclase will either have the same composition or have erratically distributed values.

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TABLE 4.—*The range in values of the lower refractive index ($N\alpha$) of cleavelandite and other types of plagioclase in all pegmatite units in the Quartz Creek district and its relation to different types of country rock*

Country rock and type of pegmatite or pegmatite unit	Number of determinations of the lower refractive index ($N\alpha$) in the indicated values for—																	
	Cleavelandite			Other plagioclase														
	1.528	1.529	1.530	1.527	1.528	1.529	1.530	1.531	1.532	1.533	1.534	1.535	1.536	1.537	1.538	1.539	1.540	1.541
Hornblende gneiss and tonalite:																		
Homogeneous pegmatite					16	41	39	11	11	8	6	8	4	10	5	2		1
Zoned pegmatites:																		
Wall zone					2	25	11	9			2	2						
Intermediate zone(s)		1			1		1	1										
Core		6	2		2	5	5	1							1			
Layered pegmatites:																		
Lower layer						6	3	1				1						
Median layer						1	1											
Upper layer					1	7	5											
Pegmatites which change in composition along strike			1	1	2		1	1			1	1	1					
Fracture filling							1											
Granite and hornblende gneiss or tonalite:																		
Homogeneous pegmatites			1	2	3	10	9	6	1						1			
Zoned pegmatites:																		
Wall zone			1			2	2	2	1		1							
Core		1			1	1	2	3										
Layered pegmatites:																		
Lower layer						2	1	2				1						
Median layer(s)						1												
Upper layer						2	2	1		1		1				1		
Pegmatites which change in composition along strike	1	2			1	1	3	1										
Fine- and coarse-grained granite:																		
Homogeneous pegmatites						6	9	9	5	10	1	1						
Zoned pegmatites:																		
Wall zone						1	1											
Core			1			1		1										
Quartz monzonite:																		
Homogeneous pegmatite											1		4	7	19	12	5	
Zoned pegmatites:																		
Wall zones														3	2		1	
Intermediate zone(s)									2			1						
Layered pegmatite:																		
Lower layer															1			
Upper layer															1			
Country rock unknown:																		
Homogeneous pegmatite							1		1									

A comparison was also made between the lower refractive index of plagioclase from the hanging-wall layer and the footwall layer of layered pegmatites (table 6). As the hanging-wall layer is relatively rich in perthite and the footwall layer relatively poor, it was thought that this change in the alkali content might be reflected in the ratio of sodium to calcium in the plagioclase. Of the 11 pegmatites investigated, 6 showed no variation in index, and 5 showed an increase of 0.001 to 0.002 in index from the hanging-wall layer to the footwall layer. As the limit of accuracy of the index determinations, which were made by oil immersion, is approximately 0.001±, the results show a negligible change. The concentration of perthite, and thus, the potassium content in the upper layer, seems to have little effect on the ratio of sodium to calcium in plagioclase.

TABLE 5.—*Lower refractive index (N_α) of plagioclase in zoned pegmatites of Quartz Creek pegmatite district.*

Pegmatite (pl. 2)	N_α of plagioclase in wall zone	N_α of plagioclase in intermediate zone	N_α of plagioclase in core
174	1.529		1.528
279	1.531		1.529
289	1.529		1.530
451	1.529		1.529
453	1.529		1.529
454	1.529		1.529
455	1.529		1.529
456	1.529		1.529
535	1.535	1.529	
536	1.528		1.528
674	1.531		1.530
847	1.533		1.539
989	1.530		1.529
1002	1.531		1.530
1028	1.529		1.531
1044	1.529		1.530
1202	1.530		1.530
1402	1.537	1.532	
1666	1.529		1.529

A comparison of the refractive indices of plagioclase in beryl-bearing and non-beryl-bearing pegmatites (table 11) shows that both have a wide range and that the non-beryl-bearing pegmatites have more calcic plagioclase.

Cleavelandite occurs in crystals generally many times larger than the more common form of plagioclase, has a flat platy crystal habit, as compared with the more equant plagioclase crystals, and is invariably white or bluish white, whereas plagioclase is white, yellow, green or pink. These two varieties probably did not form under identical chemical and physical conditions. Cleavelandite occurs in 20 pegmatites in the Quartz Creek district and has been noted in homogeneous, zoned, and layered pegmatites and pegmatites which vary in composition along the strike. In zoned pegmatites it is found in the intermediate zone in 3 places and in the core in 16. The tendency for cleavelandite to form in the central part of pegmatites has been noted in other parts of Colorado (Hanley and others, 1950, p. 7) and in other districts in the United States (Cameron and others, 1949, p. 58).

TABLE 6.—*Lower refractive index (N_{α}) of plagioclase in layered pegmatites, Quartz Creek pegmatite district.*

Pegmatite (pl. 2)	N_{α} of plagioclase in hanging-wall layer	N_{α} of plagioclase in footwall layer
270	1. 528	1. 530
432	1. 529	1. 530
433	1. 530	1. 530
435	1. 529	1. 529
462	1. 529	1. 529
548	1. 529	1. 529
778	1. 535	1. 535
1004	1. 529	1. 529
1043	1. 530	1. 531
1105	1. 530	1. 531
1172	1. 529	1. 531

Cleavelandite has distinctive mineral associations. In the Quartz Creek district it is associated with quartz, lepidolite, microlite, beryl, topaz, columbite-tantalite, perthite, muscovite, garnet, and tourmaline. Many of these minerals are normally found with cleavelandite though the reverse is not always true. Cleavelandite is associated with lepidolite in 14 of the 17 lepidolite-bearing pegmatites, with topaz in all 8 topaz-bearing pegmatites and with microlite in 12 of the 13 microlite-bearing pegmatites. The association of cleavelandite with lithium minerals and some of the rare accessory minerals has been noted in other districts. In the Tin Mountain pegmatite, Custer County, S. Dak., cleavelandite occurs in the core associated with spodumene, lithium mica, beryl, amblygonite, cassiterite, columbite-tantalite, apatite, microlite, and pollucite. In the Harding mine near Dixon, N. Mex. (J. W. Adams, oral communication), cleavelandite in fracture fillings is associated with purple muscovite, microlite, and spodumene. In the Rutherford and Morefield pegmatites near Amelia, Va. (Glass, 1935, p. 761–763), cleavelandite is associated with cassiterite, manganotantalite, microlite, and zircon. The regional distribution of cleavelandite-bearing pegmatites (pl. 6) shows that, with the exception of two bodies, all the deposits containing cleavelandite also contain lepidolite or are adjacent to pegmatites containing lepidolite. Among the possibilities suggested are those that some of the elements common to lepidolite and its associated minerals may be responsible for the formation of platy cleavelandite, or temperature and pressure conditions during which its associated minerals are deposited are the same as those for cleavelandite. The elements that might promote the growth of cleavelandite are lithium (in lepidolite, zinnwaldite, amblygonite, and spodumene), rubidium or cesium (in lepidolite, muscovite, tourmaline, beryl, and pollucite), and fluorine (in lepidolite, fluorite, and topaz). The role of fluorine is difficult to evaluate because it may be present as an essential constituent, as in fluorite, topaz, or lepidolite, or it may occur undetected as a minor constituent in other minerals such as muscovite by substituting for the OH^{-} radical. Spectrographic analyses should be made of both cleavelandite and other albite from a number of pegmatites to determine whether small quantities of lithium, fluorine, or other elements are present in one type of plagioclase and not in another.

PERTHITE

All the potassium feldspar examined in pegmatites of the Quartz Creek district was white, cream, or pink microcline-perthite; no orthoclase or microcline free of veinlike laminations of albite was noted. The albite laminae are thin, roughly parallel, and white.

Several types of perthite were noted in the few thin sections that were studied. In the most common form, albite occurred in veinlets cutting the microcline at various angles. This type of perthite was called vein perthite by Andersen (1928, p. 116–207).

A second type showed thin films of albite, generally perpendicular to the (010) plane of the microcline. This type of perthite Andersen called film perthite.

Andersen regards vein perthite as formed by the opening of contraction cracks, recrystallization of microcline, and replacement. It should be noted that Andersen states that the circulating solutions that did the replacing were derived from the same pegmatitic magma from which the initial crystallization of the feldspar took place. Thus, he implies that the replacement was a part of a reaction between the already crystallized material and the rest-solutions, rather than a replacement by outside solutions. Film perthite is regarded by Andersen to be a product of exsolution.

Perthite occurs in most pegmatites, and in some it is the predominant mineral. It is absent from some sodic-rich units, but forms as much as 93 percent of perthite cores. Sodic-rich pegmatites commonly contain less than 15 percent perthite; other pegmatites are in a large part graphic granite. Generally the perthite-rich pegmatites are most abundant in the northwest part of the district.

All pegmatite units contain perthite, but it is most abundant as graphic granite in homogeneous pegmatites or in wall zones of zoned pegmatites and as blocky perthite in cores of quartz-perthite pegmatite. The hanging-wall unit of layered pegmatites is commonly rich in perthite.

The perthite is in crystals ¼ inch to 8 feet in maximum dimension. The crystals are largest in the cores, where they average 1.5 feet. Perthite crystals in the wall zone or in layered and homogeneous pegmatites are from 2 to 3 inches in size. In fine-grained plagioclase-rich pegmatites, the perthite crystals are smaller than in pegmatites where perthite is the dominant mineral. Graphic granite crystals are from 6 inches to 4 feet in length and average about 80 percent perthite and 20 percent quartz. About a ton of graphic granite was crushed, quartered, and analyzed.[1] This analysis (table 7) indicates that the soda is almost entirely in the albite laminae of the perthite. The list of normative minerals (Washington, 1917, p. 1162–1165), calculated from this analysis, verifies the fact that there is little present other than quartz and feldspar and that the microcline molecule is 4.5 times as abundant as that of plagioclase.

Perthite forms blocky equidimensional crystals that are surrounded and veined by an aggregate of quartz, albite, and muscovite. In most places perthite is the first essential mineral to crystallize, but rarely it appears to be later than some or all the associated minerals.

TABLE 7.—*Chemical analysis of graphic granite from the Bucky mine, Quartz Creek district, Colo.*

[G. A. Parker, analyst]

Oxide	Percent
SiO_2	71.56
Al_2O_3	14.82
K_2O	10.97
Na_2O	1.69
CaO	0.08
Fe_2O_3	0.01
MgO	Tr.
Cr_2O_3	None
	99.13

QUARTZ

Quartz is estimated to comprise 15 to 30 percent of all pegmatites in the district; the average amount is about 20 percent in homogeneous pegmatites, nonlepidolite-bearing layered pegmatites, and wall zones of zoned pegmatites. Although the ratio of perthite to plagioclase varies widely in these types of rock, the quartz content is nearly everywhere 15 to 20 percent. Many cores and fracture fillings are made up solely of milky quartz, whereas other cores and fracture fillings are mixtures of blocky perthite and quartz. The quartz in fracture fillings, intermediate zones, and cores is 10 to 100 percent of the unit.

The quartz is generally white to gray, although smoky varieties are found in a few pegmatites, commonly as small ellipsoids ranging from 1 to 10 millimeters in length. The smoky varieties are usually associated with radioactive minerals—for example, with microlite in pegmatites 215, 216, and 452 and with allanite in pegmatite 847. Small patches of smoky quartz have been found without visible radioactive minerals.

Quartz in most places fills interstices and forms veins in perthite crystals, indicating that it crystallized after the perthite. Rarely, however, the reverse is true. The quartz associated with blocky perthite is in crystals 2 to 18 inches in size and is commonly slightly finer grained than perthite. In graphic granite, the quartz forms crude cuniform rods 0.03- to 0.25-inch thick and as much as 1.5 feet long.

Albite is interstitial to quartz and in places appears to vein it. This relationship indicates that albite crystallized last, but in many places the mutual intergrowths suggest a contemporaneous age. Where quartz occurs solely with albite, it forms crystals 0.03 to 0.5 inch in diameter; as the proportion of perthite increases in the unit, the size generally increases. Muscovite and quartz in many places are intergrown and appear to have crystallized almost simultaneously.

MUSCOVITE

Muscovite is found in about 60 percent of the pegmatites in the Quartz Creek district. On the east side of Quartz Creek it occurs in 85 percent of the pegmatites. On the west side the iron content of the pegmatites is higher; considerable magnetite is present; and biotite occurs in place of part of the muscovite. Muscovite is found in all types of internal units in the pegmatites and generally forms 0.5 to 3 percent of the rock; rare small pegmatites contain as much as 10 percent.

The muscovite is clear and colorless to green, and individual sheets show black mineral staining. The larger pieces have reeves and "A" structure. Most of the muscovite, however, is about 0.25 inch in diameter and commonly is intergrown with quartz. In only two pegmatites, the Buckhorn (no. 659) and the Bucky (no. 1574), are muscovite books more than 3 inches in size; books 1 foot in size occur in the Bucky pegmatite.

The muscovite occurs in both flat and curved forms. The flat variety is common in most rocks; the curved variety is found in 23 pegmatites, all on the northwestern

[1] Analysis obtained through the courtesy of C. A. Wemlinger, vice-president in charge of operations, Beryllium Mining Co., Inc.

slope of Wood Gulch, where it occurs in a series of concentric shells 0.12 to 0.5 inch thick.

The composition of muscovite is expressed in three constituent molecules (Winchell, 1947, p. 268; Volk, 1939, p. 255–266), the end members of a triangular composition diagram, and the composition of any sample of muscovite can be expressed in terms of these three end members. The end members are potassium muscovite, $K_2Al_2(Al_2Si_3O_{10})_2(OH)_4$; phengite, $K_2H_2(Fe,Mg)_2(Al_2Si_3O_{10})_2(OH)_4$; and ferric iron muscovite, $K_2Fe_2(Al_2Si_3O_{10})_2(OH)_4$. The refractive indices of muscovite increase with the proportion of the ferric iron muscovite in the mineral. The total amount of iron can not be ascertained from the indices alone, however, as the iron may also be in the ferrous form in the phengite member. Specimens containing phengite and the potassium muscovite member have the same indices for equal amounts of the ferric iron muscovite. Information obtainable from refractive index determinations on the chemical composition of muscovite is, therefore, less useful than similar data on plagioclase and beryl. Volk (1939, p. 257–259) made 22 chemical analyses and obtained the optical data on muscovite from various pegmatites scattered throughout the world. These analyses are in an area on the diagram midway between potassium muscovite, phengite, and up to 38 percent ferric iron muscovite. The median refractive index (N_β) was determined on 95 specimens of muscovite from the Quartz Creek district and ranged from N_β=1.585 to 1.606 (table 8), indicating up to 28 percent of the ferric iron muscovite molecule. It was thought originally that a variation in the refractive indices, and thus in ferric iron content, might be found between units or layers. Table 9 shows the median refractive indices (N_β) of muscovite from the wall zone and core of seven zoned pegmatites. There is a small variation in the refractive indices but the variation is not constant, either in direction or amount. The median refractive indices of muscovite in layered pegmatites (table 10) show a small but unsystematic variation between the hanging-wall and the footwall layers. A comparison of median refractive indices of muscovite from pegmatites in several types of country rock was also made. The lack of sufficient samples from pegmatites in the granite and quartz monzonite made this work inconclusive, but the variations are in the same range as those from pegmatites in the hornblende gneiss or tonalite. Comparison was also made between the muscovite in various beryl-bearing and nonberyl-bearing units. The refractive indices of the muscovite in the beryl-bearing units were in the same range as those in the nonberyl-bearing units. In short, no markedly regular change can be recognized, insofar as refractive index may be used as a criterion, in the composition of muscovites from the different zones of the pegmatites, nor in those from different layers, nor in those that are found in pegmatites in different kinds of country rock.

TABLE 8.—*Number and distribution of median refractive indices (N_β) found in flat and curved muscovite*

Median index (N_β)	Number of specimens	
	Flat muscovite	Curved muscovite
1.585	1	1
1.586	1	0
1.587	1	0
1.588	0	0
1.589	0	2
1.590	0	1
1.591	0	0
1.592	4	2
1.593	1	0
1.594	7	0
1.595	4	2
1.596	4	0
1.597	12	1
1.598	7	0
1.599	4	3
1.600	7	0
1.601	8	1
1.602	5	1
1.603	6	1
1.604	1	0
1.605	5	1
1.606	1	0

TABLE 9.—*Median refractive index (N_β) of muscovite from zoned pegmatites*

Pegmatite	N_β of muscovite in wall zone	N_β of muscovite in core
174	--------	1. 592
208	1. 599	[1] 1. 578
213	1. 592	1. 599
245	1. 596	1. 594
266	1. 597	1. 595
288	1. 595	1. 597
321	1. 594	--------

[1] Zinnwaldite.

It was thought that the curved muscovite in the Quartz Creek district might also be a lithium mica, but median indices (N_β) determined for 16 specimens of curved muscovite show the same range of index and approximately the same distribution as the flat muscovite (table 8). Furthermore, the angle $2V$ of the curved mica (40 degrees) is much too high for a lithium mica. In making refractive index determinations on muscovite, however, several lithium micas were found. These micas are colorless, flat, and associated with cleavelandite. Their median index ranges in value from 1.560 to 1.578, which is below that of the muscovite series. These specimens are in the zinnwaldite range of the lepidolite series. There is no definite method to distinguish white lithium mica from muscovite in the hand specimen, but the lithium micas are more brittle, and the presence of cleavelandite should lead one to consider the possibility that lithium micas may be present. A simple test to distinguish the two involves the use of a blowpipe: lithium mica can, but muscovite can not be fused.

TABLE 10.—*Median refractive index (N_β) of muscovite in layered pegmatites*

Pegmatite	N_β of muscovite in hanging wall	N_β of muscovite in footwall
913	1. 597	--------
927	1. 604	1. 600
937	1. 597	--------
944	1. 601	1. 601
953	1. 599	1. 602
954	1. 605	1. 603
958	1. 606	1. 598
959	1. 605	1. 605
963	1. 605	1. 603
969	1. 605	1. 602
975	1. 598	1. 601
997	1. 603	1. 598
1132	1. 601	1. 601
1172	1. 595	1. 594

GARNET

Approximately 55 percent of the pegmatites of the Quartz Creek district contain minor quantities of garnet. It is commonly in crystals less than 0.03 inch in diameter and may easily be overlooked. Garnet ranges in size from less than 0.01 inch to 1 inch in diameter, but crystals of more than 0.15 inch are rare. This mineral occurs in all the pegmatite units but has a decided preference for the fine-grained plagioclase-rich parts, such as those found in the footwall units of layered pegmatites, the wall zones of zoned pegmatites, and homogeneous pegmatites. It is found in crystals 0.20 inch and larger in the coarser-grained cores, but in most cores it is absent. Though garnet is widely distributed throughout the district, it constitutes only a trace to less than 1 percent of most pegmatites; in a few of the smaller ones it makes up as much as 1 percent of the rock. Garnet is erratically distributed, and some parts of a pegmatite may contain several percent while others contain none. In the Bucky pegmatite, (no. 1574) rock exposed in two pits contains several percent of garnet, whereas in the same unit in other pits the mineral is absent. Brown garnet is conspicuous in "line rock," forming long thin bands which contrast with the white plagioclase-rich bands.

The garnet occurs singly or in clusters as light-brown, reddish-brown, and black euhedral crystals. Some crystals are black because of manganese staining on their surfaces; others are black throughout. The garnet in many pegmatites is clear reddish brown with no manganese staining. One of the larger crystals is an intergrowth of garnet and quartz.

The garnet group may be divided into six members: almandite ($Fe_3Al_2Si_3O_{12}$), spessartite ($Mn_3Al_2Si_3O_{12}$), pyrope ($Mg_3Al_2Si_3O_{12}$), grossularite ($Ca_3Al_2Si_3O_{12}$), andradite ($Ca_3Fe_2Si_3O_{12}$), and uvarovite ($Ca_3Cr_2Si_3O_{12}$). Ford (1915, p. 33–49), Fleischer (1937, p. 751–759), and Wright (1938, p. 436–449) have shown that garnet specimens do not correspond usually to any simple chemical type but contain two or more end members in solid solution.

It was shown first by Ford (1915, p. 33–49) that the index of refraction and the specific gravity of a garnet depend in a simple and direct way on the chemical composition. He calculated the index of refraction and the specific gravity of 23 garnets from their chemical composition. These values agreed within less than 2 percent with those determined by direct measurement. The reverse process is not so simple, as a single determination of refractive index or specific gravity may correspond to several combinations of end members. It would be possible from a series composed of three different molecules to have a number of different combinations with the same index of refraction. The problem is somewhat simplified because all garnets are in one of two groups: the aluminum-bearing garnets (almandite, spessartite, and pyrope) and the calcium-bearing garnets (grossularite, andradite, and uvarovite). These two groups, as shown diagrammatically by Winchell (1947, p. 175), are miscible with each other in only limited amounts. Wright (1938, p. 439, 446) compiled 35 analyses of garnets from pegmatites and 18 from granites which he converted into weight percent of the 5 common members of the garnet group, namely: almandite, spessartite, pyrope, grossularite, and andradite. His conclusions from studies of garnet from pegmatites and other types of rock are: (1) There is a remarkable constancy of one variety of garnet in each rock type, and (2) spessartite and almandite constitute 85 to 90 percent of the garnet molecules in pegmatites and granites. Thus, if one of the major constituents is known, the other can be estimated within a limit of error of 5 to 15 percent. Winchell (1947, p. 179–181) has compiled data by Ford and others into several diagrams from which, if the garnet group is known, and the specific gravity and index of refraction have been determined, a general composition in terms of the garnet molecules can be derived.

Indices of refraction were determined on garnet from 15 widely scattered pegmatites in the Quartz Creek district. Specific gravity was not determined, but all specimens were qualitatively tested and found to contain manganese. All the indices of refraction are between 1.810 and 1.820, many specimens having refractive indices about 1.815. The indices of refraction show small variations, but, in general, the garnet of this region is remarkably constant in index and composition. The proportion of almandite and spessartite can be roughly evaluated by neglecting the small percent pointed out by Wright to be taken up by the other garnet molecules and assuming that the mineral to be made up only of spessartite and almandite. In this case the garnet would range in composition from 67 percent spessartite, 33 percent almandite (N=1.810) to 33 percent spessartite, 67 percent almandite (N=1.820). Most of the proportions would be nearer to 50 percent spessartite and 50 percent almandite (N=1.815).

In this district garnet is associated with all the common and almost all the rare pegmatite minerals; however, it has a tendency to occur more abundantly with fine-grained plagioclase.

MAGNETITE AND MARTITE

Magnetite, commonly altered to martite, is widespread in minor quantities and is found in approximately 20 percent of the pegmatites. Most pegmatites contain only a few scattered crystals, but several of the smaller pegmatites have about 1 percent.

Magnetite and martite are dull to steely black and rarely form well-developed octahedra. Almost all specimens, however, have the good octahedral (111) parting that easily distinguishes this mineral from columbite-tantalite. The mineral ranges in size from grains of less than 0.10 inch to round masses as much as 3 inches in diameter.

Magnetite and martite are found as accessory minerals in the feldspathic pegmatites but are not found in any of the lepidolite-bearing units. Magnetite occurs in both the perthite-rich and the albite-rich pegmatites and is one of the few accessory minerals associated with graphic granite. The distribution of magnetite and martite is usually erratic; a few small areas in the pegmatite may contain 1 or 2 percent and the rest of the pegmatite only a trace. These two minerals are associated commonly with perthite, albite, quartz, and biotite, and in a few places with garnet. Few beryl-bearing pegmatites contain either magnetite or martite; the two minerals are nowhere adjacent to each other. Muscovite is nowhere associated closely with the magnetite although they may both be in the same pegmatite, whereas biotite is closely associated with magnetite or martite.

The association of magnetite with biotite but not with muscovite is easily explained. Those parts of the pegmatite with sufficient iron to form magnetite also had sufficient iron to form biotite; those parts free of iron would contain muscovite in place of biotite.

BIOTITE

Biotite is found in almost 20 percent of the pegmatites on the west side of Quartz Creek but is found in only 6 percent of the pegmatites on the east side. In most pegmatites biotite forms considerably less than 1 percent of the rock; in a few of the smaller pegmatites it forms several percent.

Biotite is dark to greenish black and occurs in blades from a fraction of an inch to 8 inches in maximum diameter; in most pegmatites the flakes are 0.25 to 0.5 inch. The larger books usually occur in small areas and may be either restricted to core segments or to small patches in the otherwise uniform homogeneous pegmatite or the wall zone of a zoned pegmatite.

The median refractive index (N_β) of seven specimens ranges from 1.636 to 1.671. Not only do the refractive indices vary from specimen to specimen but also in different parts of the same book. Much of the biotite is partly altered to chlorite and the variation in refractive index depends on the extent to which the biotite has been altered. These median refractive indices indicate that the biotite approximates siderophyllite (Winchell, 1947, p. 273) in composition and is high-iron rather than high magnesium biotite.

Biotite was found in part of the lepidolite-bearing pegmatites, but it is not in the same units as lepidolite. It is common in both perthite- and albite-rich pegmatite and is one of the few accessory minerals in graphic granite. Biotite is commonly associated with magnetite or martite; muscovite is found only in the magnetite-free part of these pegmatites.

BERYL

Beryl is found in 232 pegmatites in the Quartz Creek district and is widely distributed; yet in most pegmatites there are only a few small crystals. Beryl is found in all types of pegmatites and pegmatite units: homogeneous pegmatites; core, intermediate, and wall zones of zoned pegmatites; various layers of layered pegmatites; and units of pegmatites that differ in composition along the strike.

Beryl may be brown, white, gray, greenish white, pale green, greenish gray, or pale blue green. White, brown, and greenish white are the most common colors. Beryl of such colors is difficult to distinguish from feldspar in many exposures. The beryl crystals range from 0.006 inch to 2 feet in diameter. In fine-grained albite-rich pegmatites beryl crystals are 0.10 to 0.25 inch in diameter, but larger crystals occur in the more coarsely grained intermediate zones and cores. Although a higher percent of beryl was found in the albite-rich units than in the units rich in perthite, only the latter contained beryl in grains large enough to be hand cobbed. The average beryl crystal is approximately twice the size of the common form of albite and about half the size of the associated perthite grains.

Beryl occurs as subhedral to euhedral hexagonal crystals; tapered crystals are rare except at the Bucky pegmatite [2] (no. 1574). Intergrowths of beryl with feldspar, quartz, tourmaline, or other minerals are common in some regions, such as northeastern Brazil (Johnston, 1945, p. 1032–1034), New Hampshire, Connecticut (Shaub, 1937, p. 1045–1051), and the Eight-Mile Park district, Colo. (Heinrich, 1948, p. 557–558), but in the Quartz Creek district only one mixed crystal was found. It was intergrown with garnet and quartz near the center of the crystal and with albite near the outer edges.

Beryl may contain as much as the theoretical maximum of 14.0 percent BeO. In most beryl, however, substitutions involving Cs_2O, Li_2O, Na_2O and Al_2O_3 decrease the BeO content so that it commonly ranges from 11 to 13 percent.[3] Winchell (1947, p. 213), Adams (1953, p. 117), and Schaller [4] have shown that the decrease in BeO content is accompanied by an increase in the refractive indices and have compiled charts showing the alkali and BeO content for any particular refractive index. According to Schaller's chart, the refractive index of the slow ray (N_ω) of beryl containing 14 percent BeO is 1.566, whereas the refractive index of beryl containing 10 percent BeO is 1.600.

The refractive index of the slow ray (N_ω), determined for 183 beryl specimens from various units, ranges from 1.573 to 1.585 and averages 1.578. These determinations are compiled in table 11 together with the determinations of the minimum refractive index on cleavage plates of the associated plagioclase. The table is divided according to country rock types and subdivided according to the type of pegmatite and internal structure. This table shows that the refractive index of beryl, and therefore the composition, varies irregularly in the different types of pegmatites and internal units. There appears to be no correlation between type of country rock and the refractive index of

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

[3] Schaller, W. T., Unpublished chart.

[4] Schaller, W. T., op. cit.

TABLE 11.—*The number of refractive-index determinations of plagioclase and beryl, their relation to different types of country rock and types of pegmatites or units.*

Country rock and type of unit	Number of determinations for indices given											
	Lower refractive index on cleavage plates of plagioclase					Higher refractive index on cleavage plates of beryl							
	1.528	1.529	1.530	1.531	Other values	1.575	1.576	1.577	1.578	1.579	1.580	1.581	Other values
Hornblende gneiss and tonalite:													
Homogeneous pegmatites	13	16	21	6	1.532(5) 1.533(3) 1.534(1)	4	7	10	17	13	2	3	1.573(1) 1.582(2) 1.583(1) 1.585(1)
Zoned pegmatites:													
Wall zone	1	18	6	2	1.534(1)		3	3	1	1	1		
Intermediate zone(s)	1	1	1	1						1	1		
Core	1	7	3	1		3	2	4	7	4	2		1.582(2)
Layered pegmatites:													
Lower layer		5	3	1				1		1			
Median layer(s)		1							1				
Upper layer	1	6	5	1		1	2	3	2	1			
Pegmatites which change composition along strike	2	1	3	1	1.527(1)					2			
Fracture filling			1		1.534(1)		2						
Granite and hornblende gneiss and tonalite:													
Homogeneous pegmatite	3	8	9	6	1.527(2) 1.532(1)	2	2	4	6	3	4	2	1.574(1) 1.584(1) 1.585(1)
Zoned pegmatites:													
Wall zone		2	2	1									
Intermediate zone(s)		1			1.533(1)		1				1	1	
Core	1	2	2	3	1.539(1)	1	2		3	3	2		
Layered pegmatite:													
Lower layer		2	2	2	1.535(1)		1	1					
Upper layer		3	1	1	1.535(1)			1	1				
Pegmatites which change composition along strike	2	3	2	1				2	2		1		1.574(1)
Fine- and coarse-grained granite: homogeneous pegmatite		3	1	1			1				1	1	1.583(2) 1.584(1)
Quartz monzonite:													
Zoned pegmatites:													
Wall zone					1.537(1)						1		
Core					1.532(1) 1.535(1)				1				
Country rock unknown: homogeneous pegmatites			1		1.532(1)	1	1						

beryl. Only 2 specimens of beryl were obtained from pegmatites in the quartz monzonite and 6 from pegmatites in fine- and coarse-grained granite.

It has been noted in pegmatites of the Black Hills (Page, and others, 1953) and other districts (Cameron, and others, 1949, p. 99) that there is a systematic increase in the alkali content of beryl from the wall zone inward toward the core. Similar data on beryl from zoned pegmatites from the Quartz Creek district is rather meager because a large part of the beryl found was from a single zone of a zoned pegmatite. The refractive indices of beryl from different units of zoned pegmatites are compiled in table 12 together with the minimum refractive index of adjacent plagioclase for comparison. Most pegmatites have only small cores, and zoning is poorly developed. A difference of 0.001 in indices is all that is noted from wall zone to core of the more simply zoned pegmatites. The refractive indices of the slow ray ($N\omega$) of beryl from three pegmatites that contain beryl in an intermediate zone as well as in either a core or a wall zone differ as much as 0.003 between the intermediate zone and either the core or wall zone. This increase inward in alkali content is in accord with the findings of previous workers.

TABLE 12.—*Refractive indices of plagioclase and beryl from beryl-bearing units of zoned pegmatites*

Pegmatite	Wall zone		Intermediate zone		Core	
	N_α of plagioclase	N_ω of beryl	N_α of plagioclase	N_ω of beryl	N_α of plagioclase	N_ω of beryl
174	1. 529	------	--------	------	1. 528	1. 580
250	1. 530	1. 580	--------	------	--------	1. 579
279	1. 531	1. 576	--------	------	1. 529	--------
289	1. 529	------	--------	------	1. 530	1. 578
436	1. 529	1. 578	--------	------	--------	1. 577
454	1. 529	------	--------	------	1. 529	--------
455	1. 529	------	--------	------	1. 529	1. 578
535	1. 534	1. 577	1. 529	1. 580	--------	--------
847	1. 533	------	--------	1. 576	1. 539	1. 579
989	1. 530	------	--------	------	1. 529	1. 580
1002	1. 531	------	--------	------	1. 530	1. 578
1025	1. 529	------	--------	------	1. 531	1. 578
1044	1. 529	------	--------	------	1. 530	1. 575
1202	1. 530	------	--------	------	1. 530	1. 578
1402	{------ 1. 537	------ ------	(1) 1.532 (2) 1.535}	1. 578	--------	--------
1574	{------ ------	------ ------	(1) 1.528 (2) 1.530}	1. 579	1. 528	1. 582

Refractive indices of beryl and plagioclase from layered pegmatites have not been published. Table 13 gives the refractive indices of these two minerals in 12 two-layered pegmatites, which contain an upper perthite-rich layer and a lower albite-rich layer. Most of the beryl is found in the coarser grained upper layer. In two pegmatites beryl occurs in both layers but there is no important difference in value of the refractive index between units.

Beryl is associated with plagioclase, quartz, perthite, muscovite, garnet, lepidolite, tourmaline, topaz, microlite, tantalite, monazite, gahnite, and biotite. Beryl is not associated with any particular pegmatite mineral to the exclusion of others. It has not, however, been found in graphic granite pegmatite. Beryl usually occurs in clusters or groups of crystals. In pegmatite 279, 35 crystals of beryl were found in an area about 2 feet square. This was the only beryl noted, although this branching pegmatite exceeds 720 feet in length. Many other pegmatites have a similarly sporadic distribution of beryl.

TABLE 13.—*Refractive indices of plagioclase and beryl from beryl-bearing layered pegmatites*

Pegmatite	Lower layer		Upper layer	
	N_α of plagioclase	N_ω of beryl	N_α of plagioclase	N_ω of beryl
270	1. 530	--------	1. 528	--------
417	1. 529	1. 577	1. 530	1. 577
432	1. 530	--------	1. 529	1. 576
433	1. 530	--------	1. 530	1. 577
435	1. 529	--------	1. 529	1. 575
462	1. 529	--------	1. 529	1. 578
548	1. 529	--------	1. 529	1. 576
778	1. 535	--------	1. 535	--------
985	1. 530	1. 578	1. 530	1. 577
1004	1. 529	--------	1. 529	--------
1105	1. 530	1. 579	1. 531	--------
1172	1. 531	--------	1. 529	--------

TOURMALINE

Tourmaline is relatively rare in the Quartz Creek district and has been found in only 48 of the 1,803 pegmatites studied. It is common in most pegmatites, in many pegmatites areas, but the Quartz Creek district is notable because of its paucity of tourmaline and the low boron content of its pegmatites. Except in the lithium-bearing pegmatites, only a few tourmaline crystals occur in each pegmatite. Some units in the lithium-bearing pegmatites contain as much as 3 percent tourmaline.

The colors are black, dark green, blue, light green, and pink. The green, blue, and pink varieties are found only in the lepidolite-bearing pegmatites; the black variety occurs in both lepidolite- and nonlepidolite-bearing pegmatites. Of the 48 tourmaline-bearing pegmatites, 38 contain only the black variety. It occurs in subhedral to anhedral crystals; commonly the $m(10\bar{1}0)$ and $a(11\bar{2}0)$ prism faces are the only faces developed. In many places it is in small pods of coarse-grained quartz or quartz-perthite pegmatite in an otherwise homogeneous body. Black tourmaline has been found associated with quartz, perthite, albite, cleavelandite, muscovite, beryl, garnet, biotite, monazite, columbite-tantalite, and gahnite but not with lepidolite and topaz.

The black tourmaline was found only in zones completely free of lepidolite; in many zones it is restricted to the extreme hanging wall or footwall part. Dark-green tourmaline was found either in zones containing lepidolite or in adjacent zones. It is common in the outer part of lepidolite-bearing units and the inner part of the adjacent unit. It is nowhere in contact with lepidolite but occurs in the cleavelandite-quartz part of the zones. Pink and pale-green varieties of tourmaline occur adjacent to lepidolite in lepidolite-bearing units. These two varieties of tourmaline commonly occur together; the pink variety is more abundant. In the Brown Derby No. 1 pegmatite (no. 452) these varieties sometimes occur in single crystals which have a pink core and a light-green rim and are known as "watermelon" tourmaline. The dark-blue variety of tourmaline is not present as individual crystals but forms massive wavy bands in lepidolite-bearing pegmatites, where it occurs in part with the black tourmaline and in part with the dark-green tourmaline. There is commonly a thin band of small garnets in the center of the blue bands. Figure 29, a sketch of part of pegmatite 453, shows the relation of various colored tourmalines to the pegmatite units.

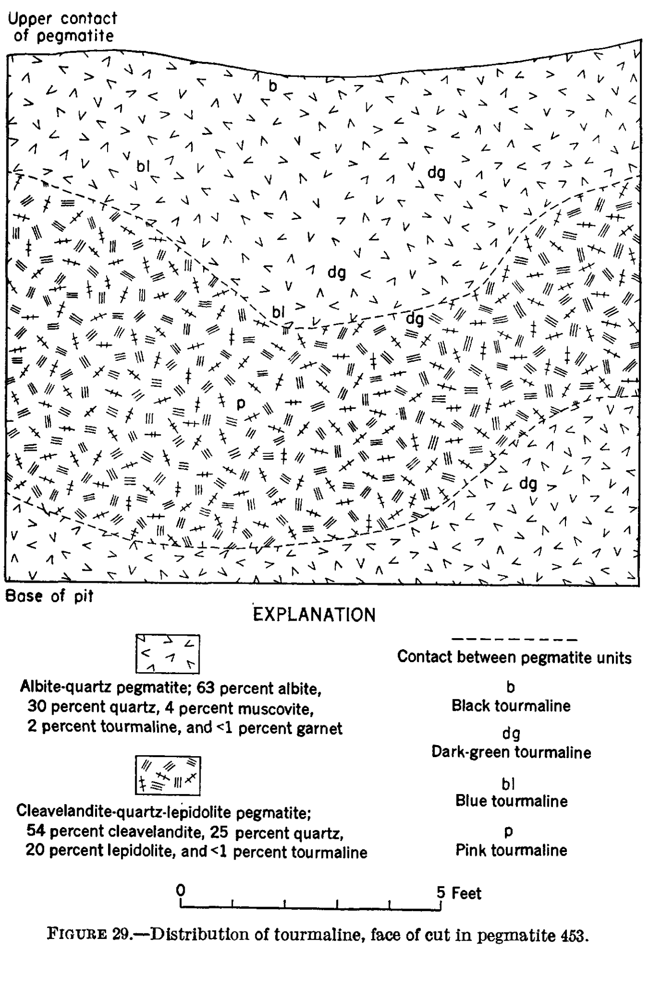

FIGURE 29.—Distribution of tourmaline, face of cut in pegmatite 453.

Not only the color, but also the indices of refraction differ. Table 14 gives the higher refractive index (N_ω) of 19 tourmaline specimens; 11 are of black tourmaline and range in value from 1.652 to 1.664. The 2 specimens with the smallest refractive indices are from the outer edges of lithium-bearing pegmatites. The 3 dark-green tourmaline specimens have refractive indices of 1.646 or 1.647—all lower values than the indices of black tourmaline. The black variety grades into the dark-green variety, and is to be expected that, if enough determinations of indices were made, a gradational series would be found in which the green varieties would have the lower refractive indices. Two pink tourmaline specimens from different pegmatites have refractive indices (N_ω) of 1.643 and 1.637. Both a pale-green tourmaline and a pink tourmaline from adjacent areas in pegmatite 452 have a refractive index of 1.637 for the slow ray (N_ω); the pink core and the pale-green rim of a "watermelon" tourmaline have a refractive index of 1.634 for the slow ray N_ω. The pale-green and pink varieties appear to vary in composition, but variation can not be correlated with color. The different colors may be caused by the presence of a minor element that does not affect the refractive index, by oxidation or reduction of an element in different states of oxidation, or by a slight rearrangement of the molecular structure of tourmaline. The sequence from black tourmaline in the outer parts of lepidolite-bearing pegmatites to pale-green and pink tourmaline in the inner can be correlated with a progressive change in refractive indices, but the pale-green and pink crystals which grew together in the same environment without detectable differences in index can not be thus correlated.

TABLE 14.—*Higher refractive index (N_ω) of tourmaline, Quartz Creek pegmatite district*

Pegmatite	Name	Color	N_ω
205		Black	1.657
215	Opportunity No. 1	Black	1.652
231		Black	1.657
251		Black	1.657
306	Opportunity No. 4	Black	1.655
311		Black	1.663
1238		Black	1.657
1238		Black	1.659
1278		Black	1.655
1322		Black	1.665
1607		Black	1.664
215	Opportunity No. 1	Dark green	1.646
306	Opportunity No. 4	Dark green	1.647
306	do	Dark green	1.646
306	do	Pink	1.643
452	Brown Derby No. 1	Pink	1.637
452	do	Pale green	1.637
452	do	(Pale-green rim) (Pink center)	1.634

Early work has shown that change in color in tourmaline commonly varies with the density of the crystals (D'Achiardi, A., 1872), axial ratio *a:c* (D'Achiardi, G., 1896), and refractive indices. More recent spectrographic work (Warren, 1935, p. 531–536) demonstrates that color also varies with chemical composition. Difficulties of determining the elements which are the particular color determinant are presented by the large number of elements that are present in minor amounts in tourmaline. Tourmaline acts as a scavenger and takes into its structure small quantities of a great variety of elements. Shainin[5] had spectrographic analyses made of the minor base elements in four tourmaline specimens (table 15). These analyses show that the greatest amount of manganese (0.5) occurs in a pink specimen. All four specimens contain manganese, but the other pink specimen contains no more manganese than the green or the blue specimens.

TABLE 15.—*Spectographic determination of percent of minor elements in tourmaline from Maine*[1]

Color	Mn	Ti	Ga	Sn	Pb	Zn
Deep blue	0.2	0.01	0.02	0.01	<0.001	0.5
Green	.2	.005	.02	.05	.02	.1
Pink	.5	<.001	.02	.01	-------	.2
Deep pink	.2	<.001	.01	.05	.05	.02

[1] Analysis made in the Investigations Section of the Geochemistry and Petrology Branch of the U. S. Geological Survey for Vincent Shainin. Janet Fletcher, analyst.

Many elements appear to have little or no effect on the color of tourmaline, as they are present in some colored tourmalines and absent in others. Other elements may effect a change in color only when found in association with some other element.

In résumé, all tourmalines in the Quartz Creek district other than the black variety are in the lepidolite-bearing pegmatites. There is a gradual color change from black through blue and dark green to pink and light green, paralleled by a change in refractive indices as the lepidolite-bearing parts of the pegmatite are approached. Increase in the concentration of a group of alkalies, such as lithia, cesia, and probably others in conjunction with decrease in iron and manganese, parallel the changes to lighter colors of the tourmaline. When much iron is in the structure, it may darken the mineral to back or dark green, but the development of the lighter shades requires the presence of lithia and other alkalies. The various shades of green and blue are probably caused by the presence of several other elements.

COLUMBITE-TANTALITE

Columbite-tantalite has been found in 29 pegmatites of the Quartz Creek district. It occurs in homogeneous pegmatites; in wall zone, intermediate zone, and core of zoned pegmatites; in layered pegmatites; and in parts of pegmatites that show variation along strike. The pegmatites bearing columbite-tantalite are distributed throughout the district. Columbite-tantalite is found in only a few crystals in most pegmatite units, except in pegmatites 1234 and 452 (Brown Derby No. 1). In the latter pegmatite it makes up 1.4 percent of the rock in a small unit about 20 feet long and 1 foot wide.

In the Quartz Creek district columbite-tantalite is black with a dull to lustrous surface. It has a black to brown streak. The tabular crystals range in thickness from that of a sheet of paper to 1 inch and in length from a fraction of an inch to 4 inches. The crystals are usually subhedral to euhedral, the brachypinacoid, *b* (010), forming the tabular faces present in most specimens. Other faces which were noted on some of the columbite-tantalite crystals are *a* (100), *d* (110), *g* (130), *k* (011), and *u* (111).

The columbite-tantalite, (Fe, Mn) (Cb, Ta)$_2$O$_6$, series is one of complete gradation between iron and manganese and between niobium and tantalum. Members of the series are divided on a basis of purely arbitrary standards, the terms columbite and tantalite being applied according to content of niobium or tantalum. A secondary division is made by naming the mineral ferrocolumbite or ferrotantalite if the ratio of iron to manganese is greater than 3:1, and manganocolumbite or manganotantalite if the ratio of manganese to iron is in excess of 3:1. The specific gravity, streak (De Almeida, and others, 1944, p. 218), and probably certain other physical properties change with the increase in niobium or tantalum content. Because chemical analysis of these two elements is expensive, the approximate composition is obtained by specific gravity determinations, and reference to charts that relate the specific gravity to the niobium-tantalum ratio. The ratio of iron to manganese has only a minor effect on the change in specific gravity and is ignored in this method. Table 16 gives the specific gravity of eight specimens from the Quartz Creek district as determined on a Jolly balance. These specimens range from an almost pure manganocolumbite (specific gravity 5.0 and 5.1) to a niobium-rich tantalite (specific gravity 6.7). As only the latter specimen falls in the tantalite field, this district appears to be one, therefore, that contains columbite almost to the exclusion of tantalite. Hanley (1950, p. 71) gives the specific gravity of a piece of columbite-tantalite from pegmatite 452 (Brown Derby No. 1 claim) as 5.61 and the chemical composition as 72 percent Cb_2O_5 and 6 percent Ta_2O_5.

The specimen on which the chemical work was done was collected by Eckel (1933, p. 244) and was from a pegmatite unit of a different type from that of the

[5] Shainin, V. E., Unpublished analyses of tourmaline from Newry-Rumford area, Maine, 1947.

Hanley specimen. Because the niobium-tantalum ratio commonly varies from zone to zone, as seems evident from specimens collected by Eckel and by Hanley, there is a discrepancy between the composition obtained from the specific gravity and that given by Eckel.

TABLE 16.—*Specific gravity measurements of columbite-tantalite samples*

Pegmatite	Internal unit	Specific gravity
205	Core	6. 1
205	do	6. 3
245	do	5. 7
452	Layer	5. 8
1234	Wall zone	5. 0
1234	do	5. 1
1557	Core	6. 7
1574	Intermediate zone	6. 0

Columbite-tantalite is found in direct contact with the following minerals in one or more pegmatites: Quartz, albite, perthite, beryl, muscovite, monazite, biotite, tourmaline, and gahnite. It also has been found in the same zones, but not in direct contact with garnet, topaz, microlite, martite, and lepidolite. Though columbite-tantalite is associated with almost all the pegmatite minerals, there are three associations which are most common in the Quartz Creek district: (1) With massive quartz, (2) with cleavelandite or cleavelandite and quartz, and (3) with feldspar (either perthite or plagioclase) and monazite. Its association with monazite is not pure chance as it can be seen that 9 of the 24 monazite-bearing pegmatites, or 37 percent, contain columbite-tantalite (pl. 5).

MONAZITE

Monazite (Ce, La, Nd, Pr) PO_4 is found in 24, or approximately 1.5 percent, of the pegmatites. It occurs in homogeneous pegmatites; in the cores, pods, and intermediate zones of zoned pegmatites; and in layered pegmatites. In 3 pegmatites, namely the Brown Derby No. 1 (no. 452), the Black Wonder (no. 847), and the Bucky (no. 1574), monazite is found in more than a half-dozen crystals. A unit 20 feet long and 1 foot wide at the Brown Derby No. 1, pegmatite 452, contains approximately 2.2 percent monazite. Of two localities in the Black Wonder pegmatite (no. 847), one is worthy of special attention in that it contains 0.05 percent monazite in an intermediate zone of plagioclase-muscovite-quartz pegmatite surrounding a quartz pod. This intermediate zone is about 4 feet thick, and the quartz pod is approximately 15 feet long and 6 feet wide. In the Bucky pegmatite (no. 1574) the monazite is found sporadically in the mica zone around the quartz core.

Monazite occurs as euhedral dark-red to clove-brown crystals that range in size from 0.25 inch long, 0.15 inch wide, and 0.03 inch thick to 2 inches long, 1.2 inches wide, and 0.5 inch thick. Most of the larger specimens come from the Brown Derby No. 1. Crystal forms identified include the *a*(100), *m*(110), *n*(120), $v(\bar{1}11)$, *r*(111), $x(\bar{1}01)$, *c*(001), and *h*(305) faces. The crystals are usually flattened parallel to the *a*(100) face, and some of them are also twinned parallel to this face.

The specific gravity of the monazite ranges in value from 5.0 to 5.6, as determined by the Jolly balance.

Optically, the monazite is colorless to yellow, with high birefringence. The lower index of refraction, (N_α), ranges from 1.78 to 1.80, in value, averaging about 1.79. Table 17 shows that the specific gravity and lower index (N_α) do not vary with a consistent relationship.

In the Quartz Creek district monazite is associated with quartz, albite, perthite, muscovite, columbite-tantalite, gahnite, biotite, and garnet; however, it is found usually in a feldspar-rich part of the pegmatite. Of the 24 pegmatites containing monazite, 9 also contain columbite-tantalite.

TABLE 17.—*Lower index of refraction* (N_α) *and the specific gravity of monazite*

Pegmatite	Internal unit	Index of refraction (N_α)	Specific gravity
452	Pod	1. 80	5. 3
290	do	1. 79	5. 1
847	do	1. 78	5. 1
847	Intermediate zone	1. 78	5. 6
997	Footwall layer	1. 79	5. 3

LEPIDOLITE

Lepidolite is found in 17 pegmatites; it occurs in homogeneous pegmatites, in core and intermediate zones of zoned pegmatites, in interior layers of layered pegmatites, and in parts of pegmatites which show variation in composition along strike. Thus, no particular type of pegmatite seems to be favored. In the very small number of zoned pegmatites, it appears to be most common in the central parts.

The lepidolite is white, lilac, or various shades of purple; lilac to purple varieties are most common. It has three forms: (1) Fine-grained aggregates with individual sheets less than 0.25 inch in diameter, (2) large platy books 2 to 10 inches in diameter, and (3) curved concentric books, 0.5 to 2 inches across (Fig. 30). The large platy lepidolite is found in only 5 of the 17 pegmatites that form a group between the Brown Derby No. 1 dike (no. 452) and the Brown Derby No. 5 dike (no. 535), a maximum distance of 2,200 feet. Only 3 pegmatites on the Brown Derby No. 1 claim (nos. 452, 454, and 457) have curved

FIGURE 30.—Lepidolite, from left to right: fine-grained aggregate, curved plates, and large plates.

lepidolite. Both plate and curved lepidolite are either purple or lilac. An analysis is reported by Stevens (1938, p. 615) on large plates of pale-purple lepidolite from Ohio City. The sample probably came from either dikes 452, 453, or 454 (Brown Derby No. 1 claim), as these dikes were the only ones containing lepidolite in large plates that had been developed at the time. The analysis follows:

Li_2O	5.05	MnO	2.78
SiO_2	49.58	TiO_2	.06
Al_2O_3	23.87	H_2O-	.51
K_2O	10.14	H_2O+	1.22
Na_2O	.57	F	7.49
CaO	None		
Rb_2O	1.62	Total	103.19
Cs_2O	.09	Less O=F	3.15
FeO	[1] .21		
MgO	None	Difference	100.04

[1] Total iron reported as FeO.

The formula for this lepidolite as determined from the analysis is $K_4Li_7Al_5 \cdot Al_2Si_{15}O_{40}(F,OH)_8$. Hanley (1950, p. 72) reports that the physical and optical properties of all the lepidolite from the Brown Derby claim (pegmatites 452, 453, and 454) are similar, and the only chemical difference is that the manganese content of the large plates is slightly higher. Winchell (1947, p. 370) in a triangular diagram shows that the median index of the lepidolite group of mica increased from the polylithionite, $K_2Li_4Si_2(AlSi_3O_{10})_2(OH,F)_4$, and lepidolite, $K_2Li_3Al_3(AlSi_3O_{10})_2(OH,F)_4$, end members to the protolithionite end member, $K_2LiFe_4Al(AlSi_3O_{10})_2(OH, F)_4$. This increase of refractive index is, in general, parallel to an increase of iron and a decrease of lithium and can be used to determine the approximate Li_2O content. The median index (N_β) of 14 lepidolite specimens from six different pegmatites ranges in value from 1.555 to 1.578 (table 18). Six specimens are white, or white with just a tinge of lilac, and these specimens have the highest indices (N_β= 1.560, 1.564, 1.564, 1.565, 1.575, and 1.578). The two specimens with N_β 1.575 and 1.578 give a qualitative test for iron, and fall in the range of zinnwaldite rather than true lepidolite. The other four lepidolite specimens with high refractive indices are probably between lepidolite and zinnwaldite in composition. Three specimens of book lepidolite have median indices of 1.557, 1.559, and 1.562, and one specimen of curved lepidolite had a median index of 1.560. These values average only a little higher than the purple lepidolite occurring in fine-grained aggregates and show that the chemical composition of the different forms varies only to a minor extent. The shape and size of lepidolite give no clue as to its chemical composition or optical properties. The best guide noted is color, the paler and the whiter forms having higher refractive indices and containing less lithia.

TABLE 18.—*Median refractive index (N_β) and description of lepidolite from Quartz Creek pegmatite district*

Pegmatite	Name	N_β	Description
208		1.578	White (1/4- to 1/8-inch sheets).
215	Opportunity No. 1	1.565	White with lilac tinges. elongate (3/4-inch) blades in a radial aggregate.
306	Opportunity No. 4	1.557	Lilac (1/4- to 1/2-inch sheets).
306	do	1.558	Purple, fine-grained aggregates (1/32-inch sheets).
306	do	1.564	White with lilac tinge (1/4-inch sheets).
452	Brown Derby No. 1	1.557	Purple, fine-grained aggregates (1/16-inch sheets).
452	do	1.555	Purple, fine-grained aggregates (1/8- to 1/4-inch sheets).
452	do	1.559	Lilac, book lepidolite (6-inch sheets).
452	do	1.560	Purple, curved lepidolite (1- to 2-inch curved books).
461		1.562	Purple, book lepidolite (2-inch sheets).
535	Brown Derby No. 5	1.560	Silvery-white blades (1/4- to 1/2-inch sheets).
535	do	1.564	White, fine-grained aggregate (1/16-inch sheets).
535	do	1.557	Lilac book lepidolite (5-inch sheets).
637		1.575	White (in aggregate with 1/8- to 1/4-inch sheets).

Lepidolite is found in amounts that range from a trace to 95 percent by volume of a pegmatite unit. Only the Brown Derby No. 1 (no. 452) has units that contain lepidolite in excess of 10 percent of the rock; in the White Spar No. 2 (no. 602) lepidolite makes up 6 to 10 percent of the rock, and all others contain smaller proportions. The units that contain lepidolite are commonly lens-shaped and small; several are less than 15 feet long. The Brown Derby No. 1 pegmatite (no. 452) contains by far the largest lepidolite body. This unit is 319 feet long.

Lepidolite is associated with the following minerals: Cleavelandite, other albite, quartz, muscovite, perthite, topaz, beryl, microlite, pink and green tourmaline, columbite-tantalite, and apatite. Cleavelandite, the form of albite usually found with lepidolite, is its most common associate. In two small pods the lithia mica is white and probably is zinnwaldite. Topaz, microlite, and colored tourmaline characterize the lepidolite units and are rarely found outside of them.

Lepidolite in many places occurs in compact aggregates with cleavelandite or quartz; these minerals appear to have crystallized simultaneously. In other places lepidolite veins cut cleavelandite, quartz, and perthite. Topaz commonly is surrounded by a rim of lepidolite that may be in part a product of reaction with the remaining liquid. Lepidolite appears to have been deposited late in the course of crystallization because in zoned pegmatites it is confined to the core where it is in part contemporaneous with the quartz and cleavelandite, and in part of later age.

PYROCHLORE-MICROLITE

Pyrochlore-microlite is found in 14 pegmatites, all on the east side of Quartz Creek. It is not found in homogeneous pegmatites, in wall zone of zoned pegmatites, or in the hanging-wall layer of layered pegmatites; but it is found in the intermediate zone and cores of zoned pegmatites, in the interior and the lower layer of layered pegmatites, and in units of pegmatites that change in composition along strike. The most favorable place is the core of zoned pegmatites. Pyrochlore-microlite commonly is found in a few scattered crystals only, except in pegmatite 217 (Opportunity No. 1 claim) and pegmatite 452 (Brown Derby No. 1). In pegmatite 217 it occurs in concentrations of 10 or 12 crystals in cleavelandite and quartz, whereas pegmatite 452 contains 0.35 percent of microlite (Hanley, and others, 1950, p. 73) in a central lepidolite unit.

Pyrochlore-microlite is light yellow, light greenish yellow, olive green, light brown, or dark brown. The crystals are from 0.01 to 0.4 inch in diameter. In massive fine-grained lepidolite the crystals are anhedral, but in quartz and cleavelandite they are euhedral with well-developed to distorted octahedra, *o*(111), and modified dodecahedra, *d*(110).

Pyrochlore is essentially $NaCaCb_2O_6F$, and microlite is essentially $(Na, Ca)_2Ta_2O_6(O, OH, F)$. The two species form an isomorphous series in which the columbium-rich members are called pyrochlore and the tantalum-rich members microlite. Besides the elements given in the above formulas, oxides of some of the following elements may comprise several percent of the mineral: K, Mg, Fe, Mn, Sb, Ce, La, Dy, Er, Y, Th, Zr, U, Ti, Sn, and W.

Considerable work has been done on microlite from the Brown Derby No. 1 (pegmatite 452), especially during World War II, when it was mined together with lepidolite. An analysis of microlite from this pegmatite by J. G. Fairchild, as previously reported (Eckel and Lovering, 1935, p. 78–79), follows:

Ta_2O_5	68.47	P_2O_5	None
Nb_2O_5	4.45	CaO	9.19
TiO_2	.10	MgO	.04
SnO_2	.95	PbO	.40
UO_2	1.69	Na_2O	2.94
UO_3	2.40	K_2O	.25
ThO_2+ rare earths	None	F	1.51
Al_2O_3	.10	Cl	None
Fe_2O_3	1.91	Insol.+SiO_2	.92
MnO	.11	H_2O	2.84
ZnO	None		
CuO	.04	Total	98.41
Bi_2O_3	.07	Less O=F	.64
As_2O_5	Trace(?)		
BeO	None	Difference	97.77

The specific gravity of this material is 5.604, and its index of refraction, as determined by J. J. Glass of the Geological Survey, is close to 1.93. The analyses indicate that the mineral is microlite having a high ratio of tantalum to niobium. As would be suspected from the uranium content, this mineral is highly radioactive and can be detected easily with a Geiger-Mueller counter.

The material from the Brown Derby No. 1 pegmatite (no. 452) is dark brown to light brown. An olive-green specimen from the Brown Derby No. 5 pegmatite (no. 535) was analyzed spectrographically, and it was found that the tantalum was more abundant than the columbium. This specimen is thus also on the microlite side of the series. It gave a positive test with the Geiger-Mueller counter, but not as strong as that given by the dark-brown variety.

One light-greenish-yellow specimen from pegmatite 461 gives no reaction to the Geiger-Mueller counter. The dark color of the pyrochlore-microlite may be caused by the radioactivity of the uranium, as are the brown halos surrounding the dark pyrochlore-microlite in the lepidolite.

Similar observations were made by J. W. Adams (oral communication) at the Harding mine near Dixon, N. Mex., where he found that light microlite was not radioactive but dark microlite was.

Pyrochlore-microlite is associated in the Quartz Creek district with cleavelandite, lepidolite, quartz, and muscovite. The two types of occurrence are: (1) With massive fine-grained lepidolite, and (2) with cleavelandite and smoky quartz. In 8 pegmatites it is in lepidolite and in 6 in cleavelandite and quartz. In most places, if pyrochlore-microlite is with lepidolite, cleavelandite is present in minor amounts; where pyrochlore-microlite occurs in cleavelandite, lepidolite is a minor constituent. Lepidolite is present in 12 of the 14 pyrochlore-microlite-bearing units, and cleavelandite in 13. The association of pyrochlore-microlite with either lepidolite, cleavelandite, or both is common in pegmatites in other areas. It is found with lepidolite and cleavelandite at the Bob Ingersoll mine, Pennington County, S. Dak.; with cleavelandite and lepidolite at the Tin Mountain mine, Custer County, S. Dak.; with cleavelandite and lithium mica in the Harding mine, near Dixon, N. Mex. (J. W. Adams, oral communication); with cleavelandite at the Rutherford and Morefield mines, near Amelia, Va. (Glass, 1935, p. 753); and with lepidolite and albite (type not defined) from a pegmatite at Topsham, Maine (Palache and Gonyer, 1940, p. 412).

TOPAZ

Topaz is relatively rare in pegmatites and is entirely lacking in many districts. The Quartz Creek district contains eight topaz-bearing pegmatites, less than one-half of 1 percent of all pegmatites mapped.

The topaz is milky white, though the exteriors of some crystals have a greenish stain. The crystals are subhedral to euhedral, and most are long and tapering. They are usually 4 to 8 inches in diameter and a foot or two in length, but specimens have been found which are 12 inches in diameter and 4 feet in length. The prism faces *m*(110) and the pyramid faces *i*(223) are the best developed. The basal pinacoid *c*(001) was noted on a few specimens, and probably with continued study other faces could be found. Basal cleavage is well developed on most specimens. The lower index of refraction (N_α) was determined to range from 1.616 to 1.618 (table 19) on 4 topaz specimens from 3 different pegmatites. Winchell (1947, p. 199) and Pardee, Glass, and Stevens (1937, p. 1063–1064) have shown that the indices of topaz increase with the increase of water content and decrease of the fluorine content. The topaz in the Quartz Creek district has a uniform water and fluorine content; and by interpolation from a table given by Winchell (1947, p. 199), it was calculated that the topaz contains between 17.0 and 18.5 percent fluorine and 0.9 to 1.5 percent water.

TABLE 19.—*Lower refractive index (N_α) of topaz from the Quartz Creek district*

Pegmatite	Name	N_α
215	Opportunity No. 1	1.616
452	Brown Derby No. 1	1.617
452	do	1.618
1574	Bucky	1.616

In the Quartz Creek district topaz is found only in lepidolite-bearing pegmatites and is directly associated with the following minerals in one or more pegmatites: Lepidolite, cleavelandite, quartz, muscovite, beryl, perthite, and tourmaline. It is always found with the first three minerals. Purple lepidolite commonly forms a coating around topaz. The association of topaz with lepidolite would be expected, as fluorine is part of the chemical composition of both minerals. Stevens (1938, p. 615) analyzed 17 different lepidolite specimens and found that the fluorine content ranges from 4.09 to 9.19 percent, the average being 7.03 percent. On the Opportunity No. 1 claim, pegmatite 215, some of the topaz has a pale-green thin micaceous coating of polylithionite. This specimen of polylithionite is biaxial negative and has $N_\beta=1.558$ and $N_\gamma=1.565$. Both polylithionite and lepidolite seem to form as a product of reaction between the early-formed topaz crystals and the residual fluid; they corrode the surface of the topaz crystals in some places. Though less than 0.5 percent of the pegmatites of the Quartz Creek district contain topaz, almost 50 percent of the lepidolite-bearing pegmatites have topaz.

GAHNITE

Gahnite, the zinc spinel, is a rare mineral found in only eight pegmatites. It occurs in homogeneous pegmatites, in intermediate zones and cores of zoned pegmatites, and in layered pegmatites.

Gahnite is greenish black to dark green and occurs in anhedral masses. The crystals are from 0.03 to 0.75 inch in diameter. The mineral is green, isotropic, and has an index of refraction of 1.81 ± 0.005.

Gahnite does not appear to have any favored mineral association. In pegmatite 1540 it is found with massive quartz and muscovite; in pegmatite 1574, with albite, quartz, muscovite, and beryl; and in pegmatite 452, with albite, columbite-tantalite, monazite, tourmaline, garnet, biotite, and quartz. The pegmatites containing this mineral are widely distributed, and its presence depends upon the availability of zinc in the pegmatitic fluid.

Gahnite is rare or absent in most pegmatite districts but has been reported from the Tims Hill deposit in Connecticut (Faye, 1922, p. 9).

ALLANITE

Allanite is rare in the Quartz Creek district. In the Black Wonder (no. 847) it occurs in several pods, each a few feet thick and about 10 feet long. This pegmatite is over 6,700 feet wide and 12,600 feet long, and the pods represent only a minute part of the total volume of the pegmatite. The pods consist of quartz (about 90 percent) and albite. A few scattered crystals of allanite occur in smoky quartz.

The allanite is present as prismatic crystals up to 2 inches long, with a square cross section as much as 0.5 inch across. The mineral is black, has a shiny lustre, and is ringed by an unidentified reddish-brown decomposition product. At least three different substances are observed under the microscope. One is isotropic, reddish brown, and has a refractive index a little less than 1.62; the second is anistropic and colorless; and the third is isotropic and grayish green. These observations are in agreement with those of Hitchens who describes the allanite from Fitchburg, Mass. (Hitchens, 1935, p. 18).

UNIDENTIFIED MINERAL

An unidentified, shiny, greenish-black mineral, believed to be a new species, was found at the Bucky pegmatite (no. 1574). This mineral occurs in scattered pockets in the mica zone. A total of 17 pounds was collected during the mining operation. This mineral is associated with muscovite, altered feldspars, quartz, monazite, and columbite-tantalite. It appears to be most closely associated with and in places intergrown with columbite-tantalite.

The mineral has a conchoidal fracture and superficially resembles samarskite, fergusonite, or euxenite. A powder X-ray pattern was compared with the standard patterns of known minerals in the files of the Geological Survey and Columbia University with negative results. A spectrographic analysis by A. T. Meyers, of the Geological Survey indicates with the order of magnitude of concentration, the following components:

Component	*Concentration*	*Component*	*Concentration*
Nb_2O_5	X0.0	Y_2O_3	.X
Ta_2O_5	X.0	SnO_2	.X
U_3O_8	X.0	La_2O_3	Traces
ThO_2	.X	TiO_2	.X
MnO	.X	PbO	.X
Fe_2O_3	.X	Sb_2O_3	.0X
CaO	.X	MgO	Trace
ZrO_2	.X		

Looked for but not found: Na, Bi, W, and P.

A determination of equivalent uranium made by measuring the radiation from uranium and thorium, gave a value of 11 to 12 percent which would show that the X.0 given for U_3O_8 would be nearly 10 percent. Like many other radioactive columbo-tantalates the unknown is metamict.[6]

In thin section, this mineral is pale yellow, isotropic, and has an index of refraction of 1.80 ± 0.05.

It has a specific gravity of 3.8, and some of it contains small cavities lined with a fine-grained yellow material.

OTHER MINERALS

Chlorite occurs in 9 small pegmatites in the Quartz Creek district. It comprises several percent of these pegmatites. The grains range in size from 0.03 to 0.06 inch. Chlorite is found in fine-grained albite-rich pegmatites and is in part an alteration product of biotite.

Samarskite, or a similar mineral such as euxenite, is present in 7 pegmatites. It has refractive indices above 1.83; when in feldspar, it is surrounded by a reddish halo. This mineral is commonly associated with smoky quartz and is strongly radioactive. Only 1 or 2 crystals of it, 0.03 to 0.5 inch long, have been found in each pegmatite.

Epidote is noted in 3 pegmatites as fine-green veinlets and was introduced into the pegmatite after its solidification.

Light-blue apatite, as crystals 0.25 to 0.5 inch across, was found in 3 pegmatites. In most pegmatite districts apatite is common, but in the Quartz Creek district it is rare.

Light purple fluorite is found in 2 pegmatites as grains about 0.06 inch in size. It is extremely rare.

Spodumene and amblygonite occur only in the Bazooka pegmatite (no. 424) in a circular core unit 20 feet in diameter. White lathlike crystals of spodumene are found on the small dump. No amblygonite was found by the writers, but it was observed by Hanley (1950, p. 66–68).

Phosphates of the lithiophillite-triphylite series and their alteration products are found in the Bucky pegmatite (no. 1574). Two crystals were noted in the mica zone and one crystal in perthite-quartz pegmatite adjacent to a subsidiary core segment, approximately 2,500 feet to the southeast.

Betafite is reported by Hanley (1950, p. 71) associated with monazite, gahnite, and columbite-tantalite in the Brown Derby No. 1 pegmatite (no. 452). It was not observed by the writers and is probably very rare.

ALTERATION OF WALL ROCKS

The alteration of wall rock by the introduction of pegmatitic materials is common in many districts. Jahns (1946, p. 52–54) describes impregnation of quartzite and mica schists in the Petaca district by pegmatite fluids that formed muscovite, microcline, and plagioclase to such an extent that the contact between some of the pegmatites and the country rock is gradational. The formation of muscovite and tourmaline in the country rock adjacent to the pegmatites in New England has been briefly mentioned (Cameron, and others, 1953). Numerous pegmatites in the Black Hills of South Dakota show abundant alteration at the wall rock-pegmatite contact (Page, and others, 1953). Thus, along the margins of the Helen Beryl pegmatite in Custer County are patches of granulite a few inches to 6 feet thick. The granulite differs in composition from place to place and consists of quartz (30 to 70 percent), muscovite (5 to 30 percent), biotite (2 to 15

[6] Metamict n., An originally crystalline substance that has become amorphous. The energy for this change of state is generally agreed to arise from alpha particle bombardment.

percent), and minor quantities of tourmaline and apatite. The Elkhorn pegmatite, also in Custer County, has intensely tourmalinized the quartz-mica schist on the hanging-wall side of the pegmatite.

In the Quartz Creek district, however, there has been practically no alteration of the country rock adjacent to the pegmatite. The only noticeable alteration is of hornblende gneiss, which appears slightly more friable adjacent to the contact. The three main types of country rock, hornblende gneiss and tonalite, granite, and quartz monzonite, are equally free of alteration.

Alteration of country rock might not be expected in the granite and quartz monzonite, as both rocks contain essentially the same minerals as the pegmatites. On the other hand, the hornblende gneiss and tonalite are markedly different in chemical composition from the pegmatites. Similar hornblende rocks in other districts have been intensely altered. In describing the Petaca district, Jahns (1946, p. 54) states, "Where amphibole schist lies against pegmatite, as in the Green Peak deposit, it has been converted to a dense aggregate of biotite flakes." McLaughlin (1940, p. 53), discussing the pegmatites of the Bridger Mountains, Wyo., says that all the older pegmatite dikes are accompanied by alteration on the hanging-wall side of the dike, where the percentage of hornblende in the original hornblende schist was greatly reduced and quartz became the predominant mineral.

The type of country rock may affect the kind or amount of alteration, but it does not seem to be the only controlling factor. Apparently composition of the original pegmatite fluid caused the difference between the pegmatites of the Quartz Creek district and those of many other districts that have widespread alteration along pegmatite contacts. In all parts of the world tourmaline, apatite, and muscovite are among the most widespread minerals in the zone of alteration. In fact, both tourmaline and apatite are among the commoner minerals in most pegmatite districts and may occur in almost every pegmatite; yet in the Quartz Creek district tourmaline is a constituent (and a comparatively minor one) of only 48 of 1,803 pegmatites, while apatite is found in but 3. Tourmaline is the only boron mineral found; phosphorus occurs in 3 pegmatites as apatite, in 1 pegmatite as lithiophillite-triphylite, in another as amblygonite, and in 23 pegmatites as monazite. These facts indicate that the original pegmatite magma contained little B, P, and OH^-, and possibly other volatiles.

Insufficient concentration of the elements needed to form alteration minerals seems responsible for the lack of alteration in the Quartz Creek district though such elements were available in the pegmatite fluids in sufficient amounts to form rare minerals.

DISTRIBUTION OF MINERALS

Some pegmatite districts are important as sources of lepidolite, sheet mica, columbite-tantalite, beryl, or other pegmatite minerals. The granitic pegmatites of most districts consist essentially of perthite, plagioclase, quartz, and muscovite, but not all pegmatite districts have the same assemblage of minor minerals. It is this assemblage of minor minerals and variants of common minerals, such as curved muscovite and colored tourmaline, that indicate the differences in the overall composition in the original source magmas, as well as the original pressure-temperature relationship, of each district.

Not only do the less common minerals vary from district to district, but from pegmatite to pegmatite. During World War II the United States Geological Survey studied pegmatites from which critically needed materials were produced, and these pegmatites were simply classified according to minerals of economic interest. It was recognized by many investigators that a certain type of mineral occurred in certain groups of pegmatites; for example, the lithium-bearing pegmatites were not distributed haphazardly throughout a given district but appeared in clusters or groups. This distribution of mineralogically similar pegmatites is illustrated in the Black Hills of South Dakota, where such well-known lithium producing pegmatites as the Etta, Peerless, Hugo, and Edison occur in one small region, and the Helen Beryl, Helen Beryl No. 2, and Tin Mountain in another.

The areal mapping on which this report is based afforded an excellent opportunity to study the distribution of minerals in a medium-sized pegmatite district. A series of maps (pls. 2 to 6) shows the distribution throughout the Quartz Creek district of beryl, tourmaline, curved muscovite, biotite, magnetite, monazite, columbite-tantalite, cleavelandite, topaz, lepidolite, and microlite. Some minerals—such as flat muscovite and garnet—are too widely distributed to be significant, whereas others—such as chlorite, amblygonite, and spodumene—are too rare to be of use statistically. Two facts are emphasized by these maps: (1) The relation of distribution of certain minerals to all the pegmatites in the district, and (2) the constant association of two or more minerals. The associated minerals are grouped on the same figure.

Each pegmatite that contains at least one crystal of a particular mineral is indicated on the map as a bearer of that mineral. This scheme of representation has a serious defect, because large pegmatites erroneously appear to have a greater quantity of the mineral than do the smaller pegmatites. For example, the Black Wonder pegmatite (12,600 feet long by 6,700 feet wide), contains only a few crystals of beryl in two small pockets, yet it appears on the map to be a large beryl-bearing area.

Plate 2 shows 232 beryl-bearing pegmatites in 5 main groups and a few scattered pegmatites in the north-central part of the area.

Plate 3 shows the location of the groups of pegmatites bearing tourmaline and curved muscovite. It is significant that these relatively rare minerals are concentrated in their distribution in relation to the hundreds of pegmatites mapped.

Magnetite and biotite are found in 422 and 357 pegmatites, respectively. These two minerals are present in almost every pegmatite in the northern part of the area (pl. 4), yet known in the southern part only in a few small clusters of pegmatites.

Plate 5 shows the distribution of columbite-tantalite-bearing and monazite-bearing pegmatites. Only 1 or 2 crystals of this group of minerals were formed in each pegmatite.

Plate 6 shows the grouping of lepidolite-, cleavelandite-, topaz-, and microlite-bearing pegmatites. The intimate association of the 4 minerals is evident. These minerals are abundant in 4 main groups of pegmatites.

RELATIONSHIP OF THE PEGMATITES TO THE COUNTRY ROCK

REGIONAL RELATIONSHIP

The two acid plutons in the Quartz Creek district and the pegmatites might have had a common parent magma. A study of the areal distribution of the pegmatites related to these igneous bodies did not establish conclusively the genetic relationships between the pegmatites and the plutons.

If the pegmatites and the plutons were derived from a common magma, the regional pattern would be expected to show a concentration of the pegmatites along the outer edges of the plutons and in the adjacent country rock. In the Quartz Creek district the pegmatites are found on the margins of both granite and quartz monzonite bodies, as well as in the adjacent country rock.

A logical explanation for the concentration of pegmatites along the outer margins of the intrusions is that the granite and quartz monzonite are more dense and less fractured and thus should have afforded less easy passage to the pegmatite solutions than did the adjacent hornblende gneiss. Thus the only zones of weakness in the plutons available to pegmatite intrusions were the fractures formed during cooling that are common along the edges of these intrusive bodies. The observed pattern of pegmatite distribution in relation to the plutons does not preclude the possibility that the pegmatites were derived from the original magma of either of these two rock types.

RELATIONSHIP OF BERYL-BEARING PEGMATITES

Beryl-bearing pegmatites are much more common in certain types of country rock than in others. The ratios of beryl-bearing pegmatites to non-beryl-bearing pegmatites in various types of country rock are: 1:6.4 in hornblende gneiss and tonalite, 1:20 in granite, and 1:189 in quartz monzonite. These figures show a wide range and suggest that the concentration of beryl in pegmatites is influenced by the country rock, hornblende gneiss being more favorable than granite and quartz monzonite.

An attempt is made to explain the differences between the ratio in granite and that in hornblende gneiss of beryl-bearing pegmatites to non-beryl-bearing pegmatites. It was thought that the granite might have absorbed BeO from the pegmatite fluid, thus raising the BeO concentration in the granite and lowering it in the pegmatite. Bulk samples were taken from a graphic granite-rich pegmatite (no. 512) and the adjoining coarse-grained granite. The pegmatite sample consisted of perthite (62 percent), quartz (20 percent), albite (15 percent), and muscovite (3 percent). A little more than half of this rock was graphic granite. The granite was visually estimated to contain microcline (67 percent), albite (20 percent), quartz (8 percent), and biotite (5 percent). The pegmatite contained a trace of BeO, and the granite contained an amount less than was detectable spectrographically (under 0.0001 percent). The granite shows no enrichment of the BeO where adjacent to the pegmatite. On the other hand, the pegmatite contains very little BeO, and thus any enrichment of the granite would be small.

For comparative purposes, bulk samples were taken also of the footwall layer of the Brown Derby No. 1 pegmatite (no. 452) and of the hornblende gneiss within 8 inches of the contact. The pegmatite was estimated to consist of albite (89 percent), quartz (10 percent), tourmaline (1 to 2 percent), muscovite (less than 1 percent), and garnet (trace). The analyses showed that this pegmatite contains 0.030 percent BeO, and the hornblende gneiss a trace. Though the hornblende gneiss contains only a trace of BeO, this is more than is present in the granite. The results are inconclusive owing to the small amounts of BeO in the samples, but it is probable that some explanation other than absorption of BeO by the country rock accounts for the beryl-bearing pegmatites favoring certain rock types.

The possibility that the BeO in the pegmatite was derived from the country rock was not investigated. Samples of hornblende gneiss and granite at a greater distance from the pegmatite are needed to check the average BeO content of each country rock type.

ORIGIN

The problem of the origin of granitic pegmatites is complex and involves not only the origin and separation of their constituents from the original magma but also their crystallization. Granitic pegmatites in many areas appear to be related areally to large bodies of intrusive rock. Most of these intrusive rocks crystallized from magmas of silicic composition, and, thus, granitic pegmatites are commonly associated with the more silicic igneous rocks, such as granites. Goranson (1931, p. 481) has shown that certain natural rhyolitic glasses may contain 8 to 10 percent water. The amount of water released in the later stages by slow crystallization of such a magma would be very large. In addition, volatile elements such as F, Cl, B, and P, would be concentrated. The alkalies, Na, K, Li, Cs, and Rb, also tend to be concentrated during the later stages of crystallization.

Granitic pegmatites have some of the properties of granites and some, of various types of veins. They appear to be an intermediate type and have been compared with both igneous rocks and veins by various writers. Beryl, a typical pegmatite mineral, is found also in granites and quartz veins—a fact which suggests a continuous gradation between these rock types. Beryl, for example, is found in the granites on Mount Antero, Colo. (Adams, J. W., 1953), and in the Sheeprock Mountains, Utah; and beryl-quartz veins are found in the Victorio Mountains (Holser, 1953); on Mount Antero—California vein (Adams, 1953); in Arizona—Boreana vein (Hobbs, 1944, p. 254); and at Kazakhstan, U. S. S. R. (Sinegub, 1943, p. 129–157).

Most of the pegmatites in the Quartz Creek district are simple pegmatites composed of minerals typical of granites—perthite, quartz, plagioclase, muscovite, and garnet. The unusual "distinctive" minerals of pegmatites rarely are found. Such minerals as cleavelandite, lepidolite, topaz, microlite, gahnite, and columbite-tantalite occur in less than 2 percent of the pegmatites in the district. The predominant mineralogical difference between pegmatites in many districts and their associated granites is that the pegmatites are somewhat higher in muscovite content, indicating a higher water content of the original fluid. In the Quartz Creek district, however, muscovite is a relatively minor mineral, a fact suggesting that the original magma was deficient in water. The few pegmatites that have minerals containing other volatile elements are probably the result of a later stage of segregation and crystallization.

More than 90 percent of the pegmatites in the Quartz Creek district have an average grain size of less than 1 inch and in texture may even resemble fine- to coarse-grained granite. In the northern part of the area many of the pegmatites in texture resemble typical granitic rocks; they have even been mapped by Crawford and Worcester (1916, pl. 2) as granite. The lepidolite-bearing Brown Derby pegmatites, on the other hand, are much coarser textured and contain many minerals distinctive of pegmatites that have been described by Landes (1935, p. 333) as showing "abundant evidence of hydrothermal replacement." The outer parts of these pegmatites, however, are similar in composition and texture to the great majority of the simple pegmatites in the district.

The pegmatites of every district have some distinctive characteristics, and these usually are caused by the presence of certain minerals. For example, the pegmatites of the Black Hills are, in general, rich in tourmaline, muscovite, and apatite and other phosphate minerals. Very little topaz and lepidolite are found in this large district. These minerals show that the original magma was comparatively rich in P, B, OH^-, and poor in F. The pegmatites of the Quartz Creek district, on the other hand, differ from those in the South Dakota district and many others in that they are relatively lean in muscovite, biotite, tourmaline, and phosphate minerals and are relatively rich in topaz, lepidolite, and columbite-tantalite. These minerals indicate that the original magma of the Quartz Creek district pegmatites was lean in OH^-, B, and P and comparatively rich in F, Ta, and Cb. In the entire Quartz Creek district, only three pegmatites contain enough muscovite to be considered sources of scrap mica; the content is commonly 0.5 to 3 percent. Biotite content is less than 1 percent. The lack of these two minerals in most pegmatites indicates that the pegmatites of this area contain relatively little OH^-. Tourmaline is found in only 48 pegmatites, and the content is only a fraction of 1 percent. The dominant phosphorus mineral is monazite, which is present only as a few small crystals in 24 pegmatites. Other phosphate minerals, apatite, amblygonite, and lithiophillite-triphylite, found in only 1 to 3 pegmatites, are exceedingly rare. Fluorine is a constituent of topaz in 8 pegmatites, lepidolite in 17 pegmatites, microlite in 14 pegmatites, and fluorite in 2 pegmatites. Niobium and tantalum are present in columbite-tantalite in 29 pegmatites; in microlite in 14 pegmatites, and in samarskite(?) in 7 pegmatites, and in an unidentified mineral in 1 pegmatite.

Within a particular district considerable variation is shown in the areal distribution of pegmatite minerals. As previously indicated, pegmatites with certain of the rare elements occur in definitely circumscribed areas or groups. Perhaps pegmatite fluids escaped from a particular part of the chamber of the parent granitic magma and moved in a certain restricted direction, dividing into separate units before final emplacement; this could account for the strikingly localized distribution of certain pegmatite minerals in one area. The distribution of these minerals in different groups is related to their origin. As the parent granite magma cooled, it may be assumed the pegmatite fluids were segregated in different parts of the magma and escaped from various parts at different times. The pegmatite fluid that is driven from the parent chamber earliest contains less volatile material, probably is under less vapor pressure, and forms the greater number of all pegmatites—those that most closely resemble other granitic rocks. The minerals found in any pegmatite depend on the original composition of the material segregated in a pocket and on the stage of crystallization at which it was segregated. The more highly volatile constituents are in the pegmatite fluids formed at a later stage and form a few rare pegmatites. Many minerals are almost always found in close association with certain other minerals because they contain either common ions that make their association imperative or elements that are concentrated at the same stage in crystallization. Such minerals with common ions include: lepidolite, topaz, and microlite—all of which contain F^-; and lepidolite and lighter colored tourmaline both of which contain Li^+. Minerals which owe their association to elements segregated at approximately the same stage are columbite-tantalite and monazite. In places where these two minerals are not associated, it probably is due to a lack of elements to form one or the other mineral.

The more common minerals are segregated continuously or recurrently during the differentiation of the parent granite. In pegmatites containing the rarer elements, minerals such as plagioclase, perthite, quartz, and muscovite are still the predominant minerals. The rarer elements, such as Li, Cs, Rb, F, Cl, Nb, and Ta, probably are in the more soluble part of the pegmatite material and certainly are among the last to crystallize.

The heterogeneous pegmatites show various types of internal structure. Three principal explanations of the origin of this structure have been advanced.

One explanation is that this type of structure is formed by fractional crystallization of the pegmatitic fluid in place. Reaction between crystals and rest-solution is incomplete, and succe sive layers of contrasting composition are deposited. Formation of internal structures by this method requires that nothing be added and that the pegmatite be essentially o' the same composition as the magma from which it formed. This explanation has been favored by Brogger (1880, p. 215–235), Kemp (1924, p. 708), Shaub (1940, p. 673–688), Johnston (1945, p. 1015–1070), and Cameron, Jahns, McNair, and Page (1949, p. 97–106).

A second explanation is that such internal structure is formed in an open system by successive deposition of material along the walls by hydrothermal solutions. The composition of the solutions changes progressively so that successive layers of contrasting composition are formed. Various modifications of this explanation have been given by Hunt (1871, p. 82–89, 182–191), and Quirke and Kremers (1943, p. 571–580).

A third explanation is that the development is in two stages: a magmatic stage in which the pegmatitic fluid is injected and crystallizes to form massive pegmatite that has essentially the composition of a potash-rich granite and a hydrothermal stage during which solutions passing through the pegmatite cause it to be partly or completely replaced. This hypothesis is an adaptation of some of the theories of Hess (1925, p. 289–298), Schaller (1925, p. 269–279), Landes (1933, p. 33–56, 95–103), Gevers (1937, p. 331–377), and Derry (1931, p. 454–475).

Any hypothesis advanced to explain the origin of the internal structure must be in accord with all the known features of heterogeneous pegmatites. Many of the characteristics of heterogeneous pegmatites, such as gradational or abrupt contacts between successive layers or zones of contrasting composition, could be formed by each of the above mentioned modes of origin. Furthermore, it is not clear from the textural relations alone whether the first magmatic part of the pegmatite has been replaced by later hydrothermal solutions or whether the earlier crystallized minerals were corroded by residual magmatic solutions as the chemical environment, pressure, and temperature changed. Therefore, the evidence in support of the origin of the internal structure of pegmatites must be a composite of the mineralogical, structural, and textural features.

The Quartz Creek district has few well-zoned pegmatites and does not present the wealth of structural, textural, and mineralogical data that are available in many regions. Some of the outstanding features noted in heterogeneous pegmatites of the Quartz Creek district that must be considered in determining origin of structural units are:

1. Poorly zoned pegmatites made up of a large wall zone and one or more core segments show, between the wall zone and core, no consistent change in the anorthite content of the plagioclase, alkali content of the beryl, or the ferric iron content of the muscovite.

2. Pegmatites containing an intermediate zone in

addition to a wall zone and core show, from wall zone inward, a decrease in the anorthite content of plagioclase and an increase in the alkali content of beryl—variations comparable to similar changes reported from other districts.

3. Tourmaline in zoned, lepidolite-bearing pegmatites becomes gradually lighter colored from the outer edge of the wall zone toward the core. The color change is paralleled by a decrease in index of refraction which may be correlated with chemical composition.

4. Most of the layered pegmatites are composed of a perthite-rich hanging-wall and an albite-rich footwall layer.

5. A few heterogeneous pegmatites contain lepidolite, topaz, columbite-tantalite, and microlite in structural units adjacent to other units that do not contain these rare minerals.

6. The textures of the pegmatite units range from fine- to extremely coarse-grained, and adjacent units commonly have markedly different textures.

7. The fracture-filling units found in some pegmatites extend from the quartz core across, or cut, the surrounding wall zone.

Some of these features can be explained by several hypotheses, but the writers believe that they are most readily explained by a hypothesis involving fractional crystallization of a magma in an essentially closed system. The relationship of fracture-filling units to wall zones indicates that wall zones formed before the cores. This age sequence, in conjunction with the structural relations of the core and wall zones, is particularly difficult to explain by the other hypotheses. If these zones were formed by successive replacement of preexisting massive pegmatite, they would show the reverse of this age sequence, because the contact of pegmatite and wall rock is a more likely place for penetration by replacing solutions than the gradational contact between the internal structural units.

Assuming that pegmatite development proceeds with falling temperature, plagioclase of relatively high anorthite content should form first and become more sodic later. Beryl with a low alkali content should form early. This sequence was noted in the few better zoned pegmatites having an appreciable change in mineral composition that indicated a decrease in temperature as deposition proceeded toward the center of the pegmatite. Layered and poorly zoned pegmatites show little change.

The gradual increase in some zoned lepidolite-bearing pegmatites of the lithium content of tourmalines toward the center, as well as an increase in lepidolite, denotes a gradual increase of lithium content and certain other elements, such as cesium, rubidium, and fluorine. This gradual change of pegmatitic fluid can be explained either by fractional crystallization or by deposition of material along open channels provided that the channelway was through the center of the pegmatite.

Most of the minerals in granitic pegmatites are the same as those found in granites. A similar origin might be expected for such similar rocks.

The age relations between the layers are not apparent in layered pegmatites, especially for the more common type, which has a perthite-rich hanging-wall grading into an albite-rich footwall. The presence of the perthite-rich layer always on the hanging-wall side of the pegmatite is difficult to explain if one assumes that this unit formed by deposition of material along throughgoing channels or by successive replacement of massive pegmatite.

The problem of origin of the internal structure of the Quartz Creek pegmatites is far from being solved, but the evidence presented suggests an origin by fractional crystallization in place.

RESERVES

Reserves of pegmatite minerals are difficult to estimate, because normal sampling procedures can not be used. Grade can be obtained by relating the areas of industrial minerals exposed on a pegmatite surface to the total exposed area. The percent of mineral exposed may be converted to a weight percent of mineral by making proper corrections for specific gravity.

The tonnage of rock containing an industrial mineral can be calculated from a detailed map of the internal structure of the pegmatite.

Reserve calculations have been made for all the industrial minerals in pegmatites of the Quartz Creek district. Mining operations in the past were based on production of lepidolite, scrap muscovite, and beryl. Reserves of potash feldspar might sustain mining operations, if transportation were less expensive.

The total reserves of clean, hand-cobbable feldspar are estimated to be 795,600 tons of potash feldspar and 9,740 tons of soda feldspar. These feldspar reserves are all in pegmatite units containing more than 25 percent feldspar, in grains greater than 12 inches in length. The minimum size of a unit included in these calculations was 200 feet long and 40 feet wide.

In addition, considerable feldspar is recoverable by milling. Most of this feldspar is in the form of graphic granite. A number of these pegmatites would pose considerable transportation difficulties because they are several miles over mountainous terrain from the nearest road. A total of 251,300,000 tons of milling-grade feldspar is calculated for 40 pegmatives. This is an average of 6,028,000 tons per pegmatite. The largest reserves are in the Black Wonder pegmatite (no. 847).

No sheet mica and very little scrap mica are found in the Quartz Creek district. Scrap muscovite reserves are estimated to be 13,500 tons, of which 1,400 tons are recoverable by hand cobbing. The scrap mica obtained is a byproduct of the mining of beryl-bearing pegmatites. Only three pegmatites (the Bucky, the Buckhorn, and the Beryl and Rare Minerals Lode) contain either enough muscovite or muscovite in large enough pieces to be considered recoverable as a by-product of beryl mining. The muscovite reserves of these three pegmatites are calculated to be 1,400 tons.

The total beryl reserve estimated for the Quartz Creek district is about 350 tons. One pegmatite was estimated to contain 160 tons of beryl; another, 75 tons; and a third, 40 tons. Thirty-eight of the pegmatites contain less than 10 tons of beryl. Of the total 350 tons of beryl, probably 325 tons are hand cobbable.

Some of the pegmatites that have beryl reserves also contain lepidolite, microlite, topaz, columbite-tantalite, and monazite. The lepidolite reserves of the entire area amount to 3,560 tons. One pegmatite was estimated to contain 1,600 tons of lepidolite. Only four lepidolite deposits have individual reserves exceeding 100 tons. For the district as a whole, reserves are 900 tons of topaz, 900 pounds of microlite, 4,000 pounds of columbite-tantalite, and 400 pounds of monazite. The reserves of the last three minerals, because they occur in such small widely distributed quantities, are very difficult to calculate

PROSPECTING FOR BERYL

Of the 1,803 pegmatites found in the Quartz Creek district, 232 contain some beryl. In most of these pegmatites only 1 or 2 crystals of beryl 0.10 to 0.25 inch in diameter, were noted. Of the 232 pegmatites, 42 have more than 2 square inches of beryl exposed, and of these, only a very few could be considered as possible sources of appreciable beryl production.

It is very difficult to find pegmatites that contain beryl in sufficient quantities to be of commercial value. The beryl in this district is commonly white and resembles feldspar or quartz. It is usually overlooked by prospectors. Favorable beryl-bearing zones are covered by overburden in many places, and diligent prospectors in these favorable areas might find worthwhile deposits.

Several broad statements can be made concerning the favorable and unfavorable areas in which to look for beryl in pegmatites of the Quartz Creek district. Granite and quartz monzonite are, apparently, definitely unfavorable as host rock for beryl pegmatites. Only three pegmatites in granite were found to contain beryl; none of the exposures contained as much as 2 square inches of beryl. Only one pegmatite in quartz monzonite contained beryl. All pegmatites in the Quartz Creek district that contained as much as 2 square inches of beryl had hornblende gneiss wall rocks. The hornblende gneiss is exposed in a large area favorable for detailed prospecting.

Although detailed studies indicate that beryl is most common in albite-rich pegmatites, no beryl has been recovered commercially from those pegmatites because they are almost invariably too fine grained. The beryl in them ranges in grain size from 0.06 to 0.5 inch. In perthite-rich pegmatites, beryl is less common, but most grains of beryl present are large enough to be hand cobbed. The small grain size of the beryl-bearing, albite-rich pegmatites precludes economic recovery of beryl under present technological conditions; deposits of this type, therefore, cannot be expected to be of immediate concern to the prospector. Ultimately, however, they may be treated by flotation and, if found in sufficient quantities, may become economically important enough to warrant the erection of a mill.

Some pegmatites have both albite-rich and perthite-rich parts. The perthite-rich parts may be a source of beryl at the present time, but the albite-rich parts, though equally rich in beryl, are at present too fine grained to mine. The beryl in pegmatites containing cleavelandite is coarse grained and may be recovered by hand methods; consequently cleavelandite-bearing pegmatites should be prospected carefully.

Graphic-granite pegmatites, one of the most common types of perthite-rich pegmatites in the district, do not contain beryl and should be avoided in searching for beryl deposits. Beryl favors massive perthite-quartz pegmatite units or perthite-muscovite-rich units, though the very irregular distribution of beryl may cause one part of a unit to be completely barren of beryl although in other parts it may be abundant. Lepidolite is considered one of the more favorable indicators of beryl in prospecting, because much beryl is found in lepidolite-bearing pegmatites.

In general, the Quartz Creek district is not a favorable district in which to prospect for beryl, because the good mica and feldspar deposits are of small size and production of beryl in the past has been a by-product of mining of one or the other of these minerals. There are no sheet mica deposits in the district; the scrap mica deposits are not large; feldspar in large quantities must be recovered by milling of graphic granite; and deposits of feldspar that can be hand cobbed are small. The small size of the deposits of these minerals, in conjunction with the high cost of transportation, almost precludes profitable mining operations in this district at 1951 prices. Only a small amount of feldspar has been sold by local producers, and the high cost of transportation and the small size of the perthite units in this district do not encourage the production of feldspar.

DESCRIPTIONS OF INDIVIDUAL DEPOSITS

A detailed description is given below of some of the economically more interesting pegmatites. Only pegmatites which have been producers in the past or may be potential producers in the future will be described.

OPPORTUNITY NO. 1 CLAIM (PEGMATITE 215)

The Opportunity No. 1 claim is in the NE¼ sec. 17, T. 49 N., R. 3 E. This prospect is claimed by Earl A. Serry and is south of the Doyleville road on the eastern slope of a north-trending ridge. The claim includes more than 10 pegmatites, but the main workings are on the largest one, no. 215. This pegmatite is exposed by 5 small cuts, the largest of which is 37 feet long, 10 feet wide, and 10 feet deep; the other 4 are each about 8 feet long, 4 feet wide, and 5 feet deep. No minerals have been produced from this prospect.

The pegmatite is a lenticular-branching pegmatite 730 feet in maximum length and 40 feet in maximum width. Much of the pegmatite, however, has a thickness of less than 5 feet. It dips 45° to 80° SE. and cuts both fine-grained granite and hornblende gneiss.

The pegmatite is divided into four units along the strike of the body (fig. 31). Albite-quartz-perthite pegmatite forms a unit in the stringers extending from the northeast, the southwest, and the central part of the pegmatite. This unit has an average grain size of 0.25 inch and is estimated to consist of albite (65 percent), quartz (20 percent), perthite (15 percent), muscovite (less than 1 percent); it contained one small, 0.25 inch, pale-green beryl crystal. Near the south end of the pegmatite, the body widens considerably at the junction of a small northward-trending branch with the main body of the pegmatite. This wide area is made up of several units. The western side is a unit of quartz-albite pegmatite that has an average grain size of 3 to 4 inches and is estimated to contain quartz (75 percent), albite (20 percent), muscovite (3 percent), perthite (2 percent), and tourmaline (less than 1 percent). The eastern side of this bulge area is dominantly perthite-cleavelandite-quartz pegmatite, has an average grain size of about 2 to 3 inches, and is estimated to consist of pink perthite (60 percent), white cleavelandite (20 percent), quartz (20 percent), muscovite (less than 1 percent), black tourmaline (less than 1 percent), and garnet (trace). The perthite occurs in crystals as much as 12 inches long. The central part of this bulge, and the rest of the pegmatite to the north, is cleavelandite-quartz pegmatite. This pegmatite has an average grain size of 1.5 inches and is estimated to consist of white cleavelandite (69 percent), quartz (20 percent), perthite (8 percent), muscovite (2 percent), black and dark-green tourmaline (1 percent), lepidolite (less than 1 percent), topaz (less than 0.5 percent), beryl (0.1 percent), garnet (trace), microlite (trace), columbite-tantalite (trace), and monazite (trace). Concentrations of lepidolite are present locally. In one 3-foot area lepidolite constitutes as much as 5 percent of the rock. It occurs as fine-grained aggregates and in larger plates 0.25 to 1 inch in diameter. The topaz is milky

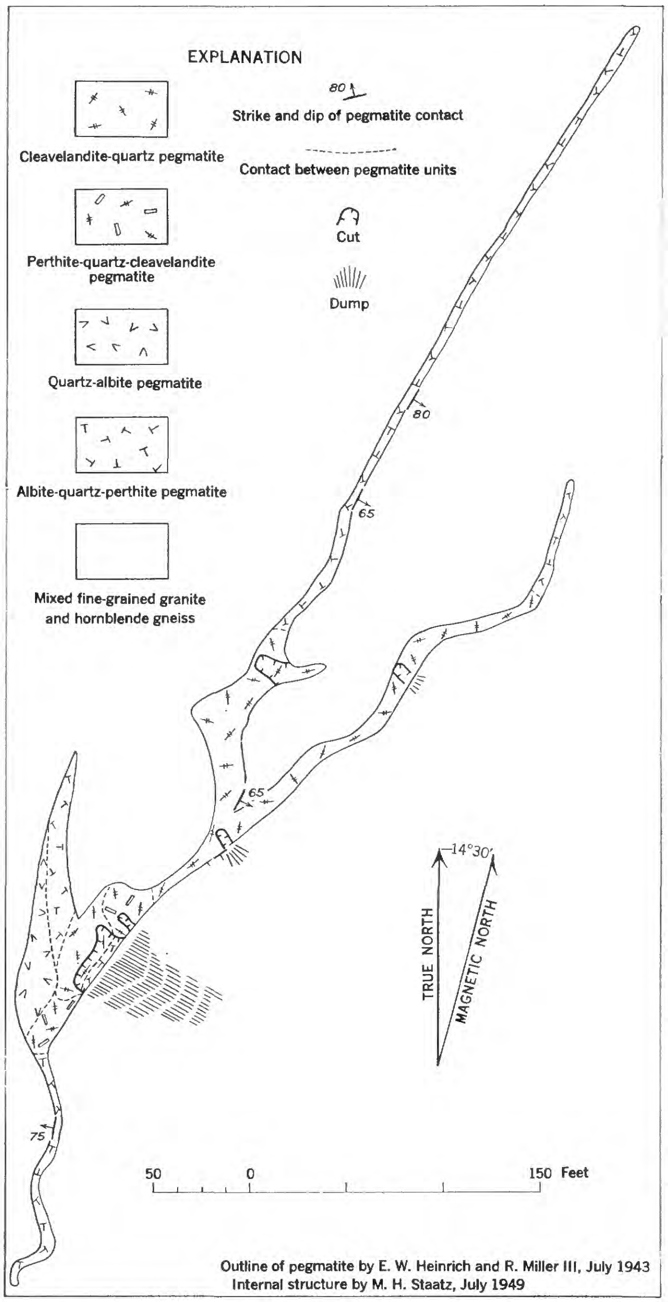

FIGURE 31.—Geologic map, Opportunity No. 1 (no. 215) pegmatite.

white, has a good cleavage, and commonly occurs with white beryl. Beryl and topaz have an irregular distribution. In the southern part of this unit microlite, associated with smoky quartz and platy cleavelandite, is found as clusters of distorted octahedra, as much as 0.25 inch in diameter, modified by dodecahedra. Probably the microlite content of this small part of the pegmatite is a few pounds per ton. Columbite-tantalite is less common than the microlite; and only a few small crystals, the largest an inch across, were found. Four crystals of monazite associated with columbite-tantalite were noted.

PEGMATITE 417

Pegmatite 417 (pl. 1) is on the western side of the western branch of Wood Gulch, near the western limit of sec. 2, T. 49 N., R. 3 E. It is a few feet above the canyon bottom and can be reached by the secondary road running up Wood Gulch. It is opened by one small pit 18 feet long, 4 feet wide, and 4 feet deep at its western face.

The pegmatite is irregular and is approximately 370 feet long and 105 feet in maximum width. Part of the irregularity is the result of its exposure on a dip slope. The pit, which is near the center of the pegmatite, cuts completely through the body, and at this point the pegmatite is 6 feet thick. The pegmatite intrudes hornblende gneiss and has a wall zone and a core. The wall zone is the greater part of the body and has an average grain size of 0.12 inch. It consists of albite (55 percent), quartz (35 percent), perthite (5 percent), and muscovite (5 percent); one 0.75-inch crystal of beryl was noted. The core has an average grain size of 3 inches; it consists of perthite (45 percent), albite (42 percent), quartz (8 percent), muscovite (5 percent), and beryl (0.2 percent); one small piece of samarskite was noted. The beryl forms pale-green euhedral crystals that range in size from 0.25 inch by 0.25 inch to 2 inches by 4 inches. A grain count of 101 square feet of the core contained 0.2 percent beryl in 33 crystals.

BROWN DERBY DIKE NO. 1 (PEGMATITE 452)

The Brown Derby Dike No. 1 is the easternmost of the Brown Derby group of dikes, in sec. 3, T. 49 N., R. 3 E. This dike is a few hundred feet below the crest of a long ridge at 9,300 feet on the east side of Quartz Creek. An access road, built by the Federal Government from Colorado State Highway 162 to the workings, is approximately 2 miles long.

The pegmatite has been described by J. B. Hanley (1950, p. 68–71). Since this mapping was finished (December 1944), the high-grade pod-shaped concentration of lepidolite in the lepidolite-quartz-cleavelandite core has been completely mined out (fig. 32). Furthermore, in the lepidolite-quartz-cleavelandite core in tunnel 2, the working face has been extended 30 feet to the east for a width of 20 feet. This additional work was completed by the Hayden Mining Company before it ceased mining in 1945.

In May and June 1950, the United States Bureau of Mines drilled two core holes. Diamond-drill hole 1 (pl. 7) is inclined 60 degrees, has a bearing of N. 77° W., and was drilled from the dump of dike 1. The hole has a length of 208.5 feet and cuts dikes 2 and 3. Diamond-drill hole 2 was drilled from the hillside above tunnel 3 and cut dikes 1, 2, and 3. The bearing of the hole is N. 88° W., and the inclination is a minus 65 degrees.

FIGURE 32.—Mouth of stope of the Brown Derby No. 1 pegmatite (no. 452) showing contact of pegmatite with hornblende gneiss.

The Brown Derby No. 1 dike is a lenticular and branching pegmatite, with two branches at its southern end. It is exposed for a total length of 913 feet.

The west branch is exposed in a series of six prospect pits. It is made up of a wall zone of albite-quartz pegmatite and a core of albite-quartz-biotite pegmatite.

The albite-quartz pegmatite forms nearly all the west branch of the dike. It has a grain size of 4 to 6 inches and is estimated to contain quartz (52 percent), cleavelandite (45 percent), muscovite (3 percent), and less than 1 percent of garnet, tourmaline, and lepidolite.

The albite-quartz-biotite pegmatite of the core is exposed in pit 11 and is 20 feet long by 1.5 feet wide. The grain size of the core ranges from 0.12 to 0.25 inch. The unit contains albite (86 percent); quartz (5 percent); biotite (4 percent); monazite (2.2 percent); columbite-tantalite (1.4 percent); gahnite, the zinc spinel (1 percent); less than 1 percent of garnet and tourmaline; and trace quantites of fluorite and betafite. Monazite forms well-developed euhedral crystals, 0.25 to 1.5 inches in diameter, and the columbite-tantalite forms tabular crystals, 0.25 to 1 inch across.

The main part of the pegmatite is composed of six different units, identified from hanging wall to footwall as follows: Perthite-albite-quartz pegmatite (hanging-wall layer), hanging-wall quartz pod, curved-lepidolite layer, lepidolite-microlite pod, quartz-cleavelandite-lepidolite-topaz layer, and albite pegmatite (footwall layer).

The perthite-albite-quartz pegmatite makes up the entire width of the northern part of the dike and the eastern branch of the southern part of the dike. Elsewhere in the lepidolite-bearing part of the dike, it occurs as the hanging-wall layer, with the exception of the vicinity of the inclined shaft where it is missing. At this point the quartz pod takes the place of the perthite-albite-quartz pegmatite. This pegmatite has an average thickness of about 8 feet. In the lepidolite-bearing part of the pegmatite it does not exceed 4 feet. The grain size of the unit is about 12 inches, and the composition is estimated to be perthite (40 percent), albite (30 percent), quartz (20 percent), muscovite (10 percent), beryl (0.1 percent), and trace of tourmaline. Beryl crystals range from 0.25 to 2 inches in diameter.

The hanging-wall quartz pod is approximately 84 feet long and 2 feet thick. Its grain size is 24 inches, and the constituents are estimated as quartz (70 percent), cleavelandite (25 percent), and lepidolite (5 percent). The lepidolite occurs in sheets from 3 to 4 inches across.

The curved-lepidolite layer is 190 feet long and averages 2 feet in thickness. This unit forms the back of the extension of tunnel 2 and much of the back of the stoped area in the inclined shaft. The grain size of the curved lepidolite layer is 4 to 5 inches, and the composition is cleavelandite (44 percent), quartz (40 percent), curved lepidolite (15 percent), topaz (1 percent), less than one percent muscovite and tourmaline, and a trace of apatite. The curved lepidolite ranges from 0.25 to 2 inches across, and the topaz ranges from 4 to 8 inches across.

Two principal lepidolite-microlite pods are known. In addition, smaller pods have been exposed in pits and trenches. The largest pod was mined in the inclined shaft, and the other was discovered underground and mined by tunnel 2. The pod at the inclined shaft was approximately 60 feet long with a maximum width of 8 feet. It was mined from the inclined shaft for a total length of about 170 feet down the dip. The pod exposed in tunnel 2 is approximately 30 feet wide by 6½ feet thick and is present in the face of the tunnel. The mined length is approximately 40 feet. The average grain size of the unit is 1 inch, and the average composition is cleavelandite (43 percent), lepidolite (40 percent), quartz (15 percent), topaz (2 percent), microlite (0.35 percent), and a trace of beryl. The lepidolite is in crystals 0.03 to 0.12 inch across and is irregularly distributed within the pods. Microlite crystals range from less than 0.01 inch to 0.25 inch in diameter and are in shoots within the pods. This unit in tunnel 2 is extremely low in microlite and has also a low lepidolite content. The pod has been nearly mined out in the incline; the remainder shown in the bottom is pinching to the southeast.

The quartz-cleavelandite-lepidolite-topaz layer is the footwall part of the lepidolite-bearing units of the pegmatite. It is exposed on the surface for a distance of 319 feet and has an average thickness of 2 feet. The unit has an average grain size of 4 to 6 inches and consists of quartz (55 percent), cleavelandite (25 percent), lepidolite (10 percent), topaz (10 percent), less than 1 percent muscovite, and less than 0.1 percent beryl. Lepidolite is in flat books ranging from 1 to 7 inches across and topaz crystals are as much as 42 inches long. Beryl is in crystals ranging from 1 to 4 inches in diameter.

The albite pegmatite (footwall layer) has an average thickness of 1.5 feet. It occurs discontinuously along the lepidolite-bearing part of the pegmatite. It has a grain size of 0.25 inch and composition estimated to be albite (90 percent), quartz (8 percent), tourmaline (2 percent), less than 1 percent garnet, and a trace of biotite.

BROWN DERBY NO. 5 (PEGMATITE 535)

The Brown Derby No. 5 (pegmatite 535) (pl. 1) is in a small gulch on the west side of the Brown Derby ridge at an elevation of 8,900 feet. It is in the south-central part of sec. 34, T. 50 N., R. 3 E.

This claim is reached by a short spur road from the main Brown Derby road and is owned by Mrs. Marie Disberger. The workings consist of two small opencuts and an adit. The larger cut has a main part, 32 feet long, 15 feet wide, and 18 feet deep at the eastern face. The southern branch of this cut is 12 feet long, 6 feet wide, and 6 feet deep at the northeast face. An adit, approximately 10 feet long, was driven from the eastern end of this cut. A second shallow cut, 10 feet long and 8 feet wide, is northeast of the main cut.

This pegmatite was originally mapped by J. B. Hanley and Roswell Miller III, on September 3, 1943, with plane table and telescopic alidade. The description of the internal structure of the pegmatite was revised by the writers in September 1949 (fig. 33).

The Brown Derby No. 5 pegmatite intrudes greenish-black hornblende tonalite. The pegmatite is irregular in shape, being 210 feet long and 50 feet wide (maximum). It consists of three zones—wall zone, intermediate zone, and core. The wall zone is 2.5 feet thick where exposed in the large opencut, has a range in grain size of from 0.12 to 0.25 inch, and consists of albite (61 percent), quartz (25 percent), perthite (10 percent),

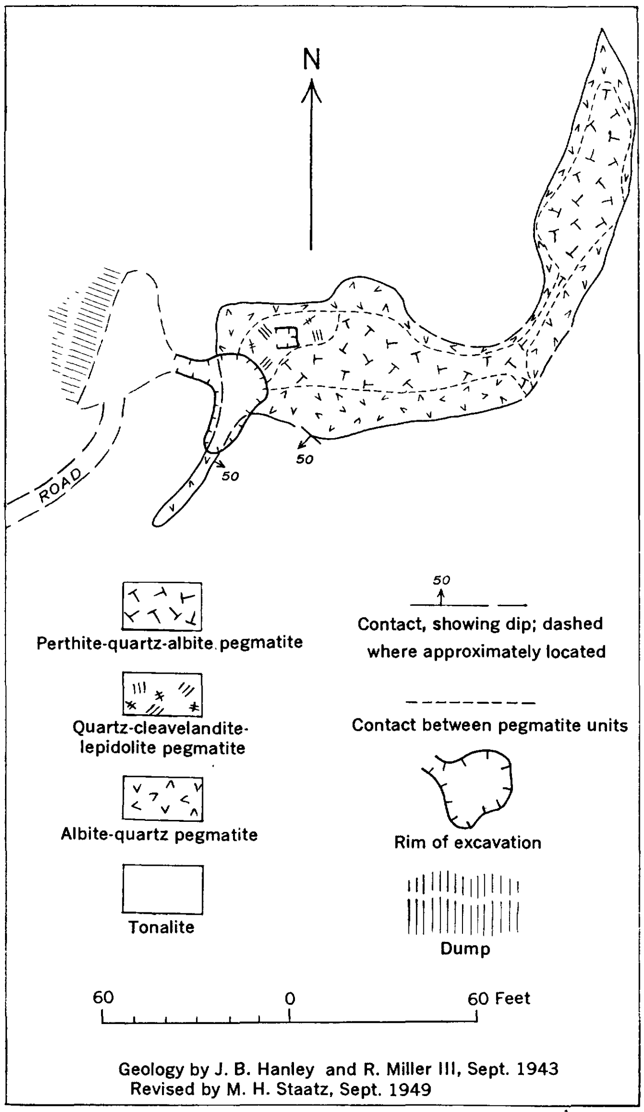

FIGURE 33.—Geologic map, Brown Derby No. 5 (no. 535) pegmatite.

muscovite (4 percent), black to greenish-black tourmaline (less than 1 percent), lepidolite (trace), garnet (trace), and beryl (less than 0.1 percent). One exposed area of the wall zone, about 3 feet square, contains 17 beryl crystals ranging in size from 0.5 by 0.5 inch to 1 by 1.3 inches. This unusually rich area averaged 1.13 percent beryl in blue-green euhedral crystals, but contained only three crystals that could be hand cobbed.

In the southeastern part of the pegmatite, within the wall zone is a small intermediate zone, approximately 50 feet long and 14 feet wide. It has an average grain size of 4 inches and consists of quartz (55 percent), white cleavelandite (35 percent), lepidolite (5 percent), white massive perthite (4 percent), muscovite (1 percent), beryl (0.1 percent), topaz (less than 1 percent), garnet (less than 1 percent), greenish-black tourmaline (less than 1 percent), apatite (trace), microlite (trace), and columbite-tantalite (trace). Lepidolite occurs both as fine-grained aggregates and as large flat sheets up to 6 inches in diameter. The workings are on this zone, and mining was directed toward the recovery of the fine-grained lepidolite; most of the large sheets were thrown out on the dump. The beryl is in blue-green euhedral crystals from 0.5 to 3.5 inches in diameter The beryl content increases in the northern part of the zone and appears richest in the small northern pit. In this upper pit beryl count made on an area 4 feet by 5 feet indicated 0.43 percent beryl by volume. About 15 pounds of beryl was also found lying on the dump from this pit. The topaz is milky white and forms euhedral crystals, 4 to 6 inches long, adjacent to the lepidolite. The garnet forms crystals as much as 1.5 inches in diameter, and commonly is surrounded by coronas of muscovite. It is most common near the contact with the underlying wall zone. The apatite is in widely scattered, light-blue crystals 0.5 inch in diameter. Microlite was not seen in place but was found on the dump in distorted octahedra, 0.12 to 0.25 inch in diameter. The olive-green microlite is faintly radioactive and is found between plates of cleavelandite. One crystal of columbite-tantalite, 0.06 by 0.75 inch, was found between plates of cleavelandite.

The core at its southeastern end has a gradational contact with the intermediate zone. The grains of the core average 6 inches in diameter. The core consists of white massive quartz (40 percent), white perthite (39 percent), albite (20 percent), muscovite (1 percent), lepidolite (trace), blue-green beryl (only 1 crystal, 4 by 6 inches), and columbite-tantalite (2 thin pieces, 0.5 by 0.06 inch).

PEGMATITE 537

Pegmatite 537 (pl. 1) is on a small ridge in the SE¼ sec. 34, T. 50 N., R. 3 E. It is penetrated by one small adit approximately 4 feet wide and 6 feet long. This working is several hundred feet above and 600 feet to the northeast of the Brown Derby mine road.

Pegmatite 537 is an irregular dumbbell-shaped body (fig. 34), 530 feet long and 84 feet in maximum width. The pegmatite intrudes hornblende gneiss. It has a fine-grained wall zone and three small discontinuous core segments. The wall zone makes up more than 90 percent of the pegmatite, with an average grain size of 0.25 inch. It consists of albite (60 percent), quartz (25 percent), perthite (10 percent), muscovite (5 percent), and garnet (less than 1 percent).

The northern and southern core segments of this pegmatite have an average grain size of 6 inches and consist of perthite (66 percent), quartz (20 percent), albite (10 percent), and muscovite (4 percent). Grains of perthite range in diameter from 3 to 12 inches. Beryl is found only in the northern core segment. A

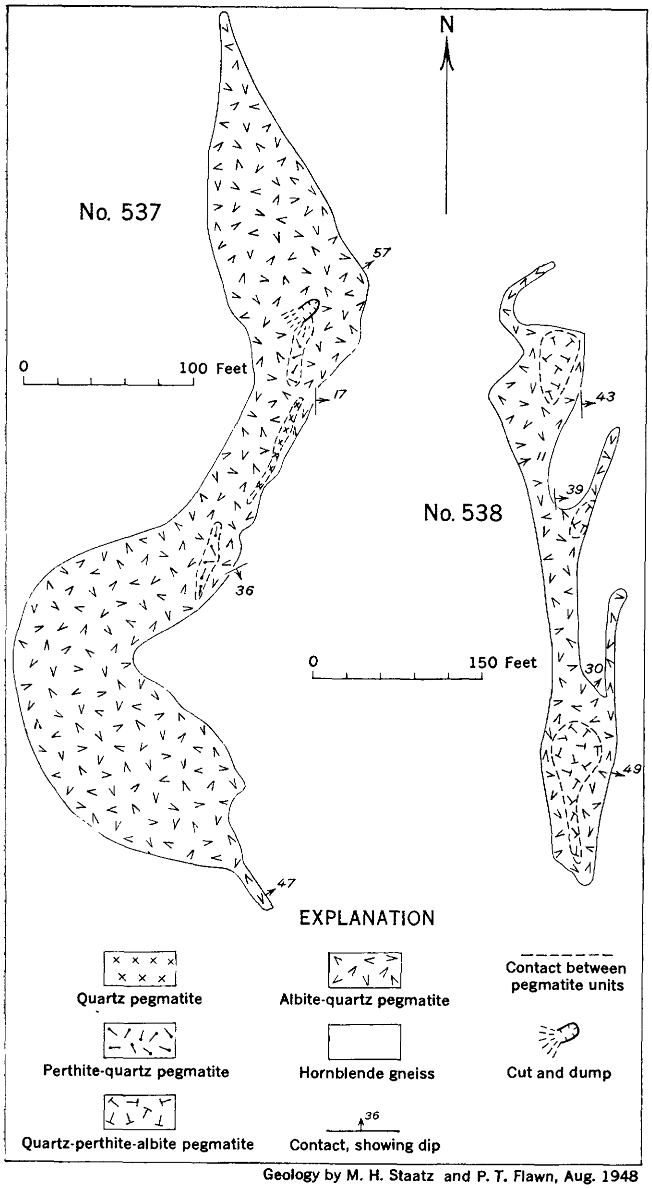

FIGURE 34.—Geologic map of pegmatites 537 and 538.

grain count on the sides of the small adit in this core showed 0.31 percent beryl. The beryl observed consisted of 22 pale-green euhedral crystals ranging in size from 0.25 by 0.12 inch to 2.5 by 4 inches. The core segment containing beryl is 52 feet long and 10 feet wide. The central core segment is 3 to 5 feet wide, has an average grain diameter of 6 inches, and contains quartz (85 percent), perthite (10 percent), albite (5 percent), and muscovite (less than 1 percent). No beryl was noted in this pod.

PEGMATITE 538

Pegmatite 538 (pl. 1) caps the top of a small ridge in the SE¼ sec. 34, T. 50 N., R. 3 E. One small cut, 6 feet square and 1 foot deep, exposes the southern end of this pegmatite. This cut is approximately 650 feet northeast of the Brown Derby road and several hundred feet above it. Pegmatite 538 is an elongate lenticular-branching pegmatite, approximately 550 feet long and 60 feet in maximum width (fig. 34). The pegmatite intrudes hornblende gneiss and consists of wall zone and three small discontinuous core segments located in the thicker parts of the pegmatite. The wall zone comprises more than 60 percent of the pegmatite, has an average grain size of 0.25 inch, and consists of albite (57 percent), quartz (25 percent), perthite (10 percent), and muscovite (8 percent). The core segments have an average grain size of 4 inches and consist of quartz (50 percent), perthite (32 percent), albite (15 percent), and muscovite (3 percent). Perthite occurs in crystals of 6 to 8 inches in diameter. Pale-green beryl was noted only in the southernmost core segment, where it was estimated from several beryl counts, to make up 0.95 percent of the rock. The beryl crystals range in size from 0.12 by 0.12 inch to 6 by 6 inches. The southern pod is 128 feet long and has a maximum width of 35 feet.

PEGMATITE 560

Pegmatite 560 (pl. 1), on which no claim had been located, is at the foot of the mountains on the east side of Quartz Creek in the west-central part of sec. 34, T. 50 N., R. 3 E. This pegmatite is 1,500 feet south of State Highway 162 and lies directly beyond a meadow. It is extremely irregular (fig. 35) and has a length of 430 feet and a maximum width of 200 feet. It cuts across the contact of the granite and the hornblende gneiss. This pegmatite consists of a narrow wall zone, a large core, and a small pod near the south end. The grains of the wall zone average 0.12 inch in diameter. This zone consists of albite (60 percent), quartz (36 percent), perthite (4 percent), muscovite (less than 1 percent), and garnet (trace). The core comprises the greater part of the pegmatite and has an average grain size of 4 inches. It consists of perthite (50 percent), quartz (30 percent), albite (20 percent), and muscovite (trace). A lenticular pod, 78 by 18 feet, is found on the south end of the pegmatite. This pod has an average grain size of 1 to 2 feet and contains perthite (75 percent), quartz (20 percent), albite (5 percent), and beryl (0.45 percent). The beryl is pale green and ranges in size from 1 by 2 inches to 4 by 8 inches. This pod contains the only beryl noted in the pegmatite.

BERYL AND RARE MINERALS LODE (PEGMATITE 590)

The Beryl and Rare Minerals Lode (no. 590, pl. 1) is a small lenticular pegmatite on the north-facing slope of Tollgate Gulch, in the SE¼ sec. 34, T. 50 N., R. 3 E.

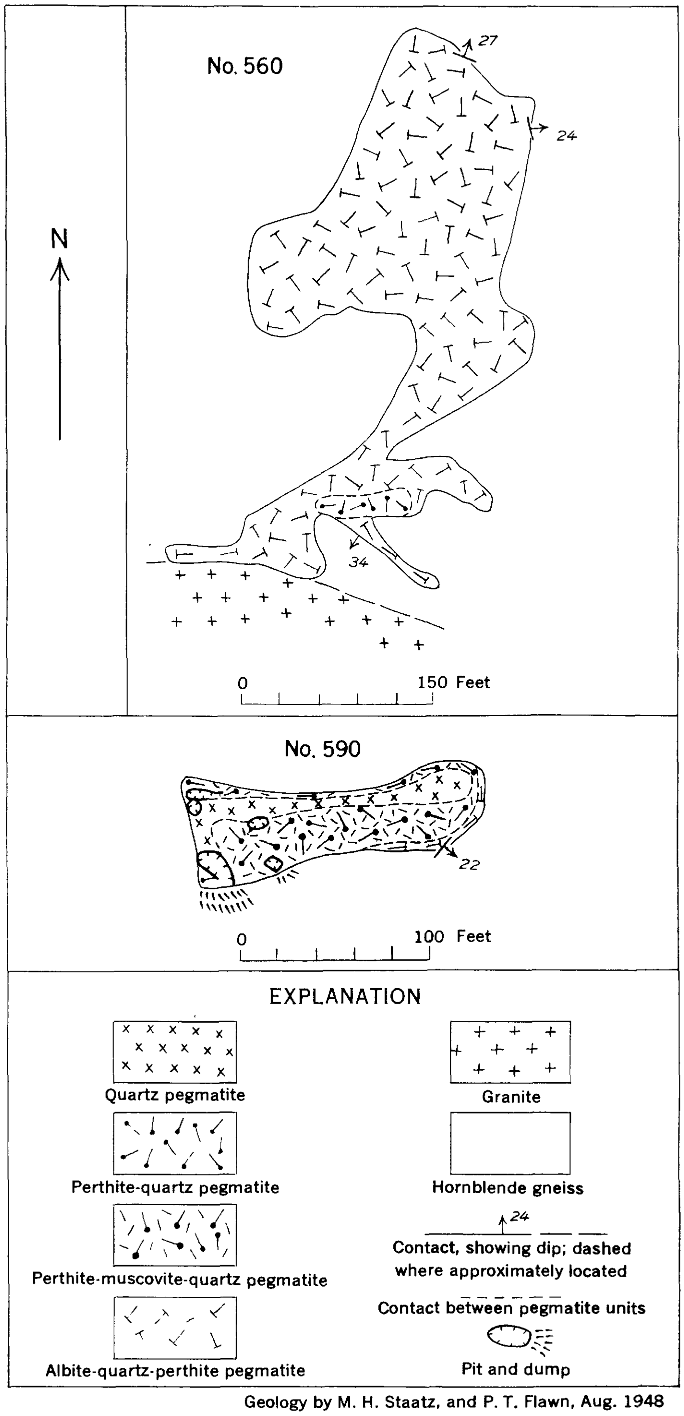

FIGURE 35.—Geologic maps of pegmatites 560 and Beryl and Rare Minerals lode (no. 590).

This lenticular pegmatite is 154 feet long and 55 feet wide and dips gently to the south at an angle of from 5 to 10 degrees (fig. 35).

The property is about a quarter of a mile south of a small private road in the bottom of Tollgate Gulch and is reached by a narrow path winding up the hillside.

The claim on this pegmatite was located by Jesse Fields on November 27, 1949. Mr. Fields has opened at least six small pits; the smallest is a few feet square and 1 foot deep and the largest 22 feet long, 10 feet wide, and 2 feet deep. These pits are on local concentrations of beryl and thus expose the richest parts of the beryl-bearing pegmatite. To 1950 Mr. Fields has recovered approximately 480 pounds of beryl, 2 pounds of columbite-tantalite, and approximately 800 pounds of muscovite. The Beryl and Rare Minerals pegmatite intrudes hornblende gneiss and may be divided into three zones: wall zone, intermediate zone, and core. The top of the pegmatite has been eroded, exposing the flatlying central units. The wall zone is thin and irregular and is exposed in only a few places along the edge of the pegmatite. It has an average grain size of 0.25 inch and consists of albite (55 percent), perthite (20 percent), quartz (25 percent), and muscovite (less than 1 percent).

The intermediate zone is well exposed by the workings. It has an average grain size of approximately 3 feet and is estimated to consist of perthite (50 percent), muscovite (30 percent), quartz (20 percent), albite (less than 1 percent), beryl (0.1 percent), columbite-tantalite (less than 0.05 percent), traces of gahnite and an unidentified mineral resembling the samarskite-fergusonite-euxenite group of minerals. The perthite occurs in crystals from 1 to 5 feet in diameter. Muscovite is abundant in the outer part of this zone and occurs in books as much as 8 inches across. It is reeved, soft, and heavily stained and is all scrap mica. It closely resembles the mica at the Bucky and Buckhorn properties. Beryl ranges from 0.5 to 8 inches in diameter and is white. From the amount of beryl recovered and the size of the workings, the percentage of beryl obtained in the pits is estimated to be 0.4 percent. Because the pits were in the beryl-rich parts of the pegmatite and because many parts of this zone are completely barren of beryl, the overall content in this zone is approximately 0.1 percent. Columbite-tantalite was found intergrown with perthite in one pit. These crystals are from 0.01 to 0.12 inch thick and as much as 2 inches across, but no columbite-tantalite is exposed in the rest of the pegmatite. Gahnite is intergrown with fine muscovite in one small area. This mineral crystallizes as dark-green octahedra 0.01 inch in diameter. Within the intermediate zone is a core made up entirely of quartz that extends the length of the pegmatite.

WHITE SPAR NO. 2 (PEGMATITE 604)

The White Spar No. 2 pegmatite is in sec. 35, T. 50 N., R. 3 E. It is on the north side of Tollgate Gulch, 0.9 mile from State Highway 162, and is reached by a mine road that follows the gulch. The pegmatite is now being mined for lepidolite by the Consolidated Feldspar Co. It was located in August 1942 and is owned by the Colorado Feldspar Co.

The pegmatite was examined and mapped with plane table and telescopic alidade by E. W. Heinrich and Roswell Miller III, on July 28, 1943 (Hanley, Heinrich, and Page, 1950, p. 77–80).

Two prospect pits have been made in the pegmatite, one, about 40 feet long and 10 feet wide, at the north end of the dike and one, approximately 60 feet long and 25 feet wide, at the south end.

The pegmatite is about 260 feet long and ranges in width from 6 feet near the center to nearly 50 feet at the north end. The trend is north, but the southern contact of the pegmatite strikes N. 15° W. and dips 70° NE. The pegmatite cuts hornblende gneiss, in which the foliation strikes N. 25° W. and dips from 70° to 80° NE. The pegmatite consists of a core of fine-grained albite-quartz-perthite-lepidolite pegmatite surrounded by a discontinuous wall zone of albite-perthite-quartz-muscovite pegmatite. The wall zone is discontinuous along the pegmatite and has a maximum width of 5 feet. Its grain size averages 0.25 inch, and the composition is estimated to be 45 percent albite, 30 percent perthite, 20 percent quartz, 5 percent muscovite, and less than 1 percent lepidolite. The lepidolite has an average grain size of 0.12 inch but occurs in books as much as 1 inch across. The core ranges from 6 to 32 feet in width. It has a finer texture than the wall zone, with grains averaging 0.02 inch in size. It contains 45 percent plagioclase, 35 percent quartz, 10 percent perthite, 10 percent lepidolite, less than 1 percent garnet, and traces of beryl, microlite, fluorite, and chrysocolla. The lepidolite has an average grain size of 0.03 inch and occurs in lenses and stringers up to 4 inches wide. The lepidolite exposed in the northern pit is banded with coarser grained albite and quartz.

A grab sample of the core taken by Heinrich (Hanley, Heinrich, and Page, 1950, p. 80) from the southern pit and analyzed spectrographically by the Geological Survey contained 0.7 percent Li_2O, or about 17 percent lepidolite, 0.05 percent BeO, and no Cb or Ta.

WHITE SPAR NO. 1 (PEGMATITE 636)

The White Spar No. 1 pegmatite is in sec. 35, T. 50 N., R. 3 E. It is on the north side of Tollgate Gulch and is connected to State Highway 162 by a mine road 0.7 mile long. A claim was located on this pegmatite in 1942 by the Colorado Feldspar Co. E. W. Heinrich and Roswell Miller III of the Survey examined and mapped this property with plane table and telescopic alidade on July 29, 1942 (Hanley, Heinrich, and Page, 1950, p. 77–80).

The mine workings consist of five prospect pits, the largest of which is 50 feet long and has a maximum width of 25 feet.

The pegmatite crops out on the summit and on the south-facing slope of a narrow ridge paralleling and separating Tollgate Gulch from a gulch to the north. The pegmatite is intruded into hornblende gneiss, but none of the contacts are exposed.

The pegmatite trends N. 20° E. and dips from 30° to 35° SE. It has a length of 200 feet and a maximum width of 85 feet.

Four zones are well developed within the pegmatite. A wall zone of fine-grained albite-perthite-quartz-muscovite pegmatite completely surrounds an intermediate zone of fine-grained cleavelandite-quartz-perthite-lepidolite pegmatite and cores of lepidolite-quartz pegmatite and quartz pegmatite. The wall zone is 9 feet thick on the hanging-wall side and 33 feet on the footwall side (Hanley, Heinrich, and Page, 1950, p. 77) and has an average grain size of 2 inches. The composition is estimated to be 45 percent albite, 32 percent perthite, 20 percent quartz, and 3 percent muscovite. Perthite is in crystals as much as 24 inches long and 15 inches wide, and muscovite in books that average 1.5 inches across and 1 inch thick.

The cleavelandite-quartz-perthite-lepidolite intermediate zone, on the western and southern edges of the quartz core, is 90 feet long and ranges in width from 1 to 18 feet. The grain size is 1 inch, and the zone is estimated to contain 55 percent cleavelandite, 25 percent quartz, 15 percent perthite, 5 percent lepidolite, 0.01 percent beryl, 0.003 percent topaz, and 0.0003 percent columbite-tantalite, and a trace of microlite. Perthite crystals average 12 inches in length and 8 inches in width. The lepidolite occurs in books 3 inches across and 0.5 inch thick. The beryl is yellow to pale blue green and occurs in crystals from 0.5 to 1.75 inches in diameter. Topaz crystals are small, ranging in size from 0.06 to 1 inch. The columbite-tantalite crystals are as much as 0.4 inch long and 0.25 inch wide.

The pegmatite cores are of two types: white, massive, quartz pegmatite and lepidolite-quartz-microlite pegmatite. The quartz pegmatite occurs as 1 large irregular mass, 80 feet long and 3 to 13 feet wide, and as 7 smaller lenses.

The core of the lepidolite-quartz pegmatite is on the west side of the quartz pegmatite, between the core and the intermediate zone of cleavelandite-quartz-perthite-lepidolite pegmatite. This core is 20 feet long and from 1 to 8 feet wide, has a grain size of 0.03 inch, and contains approximately 90 percent lepidolite, 10 percent quartz, and 0.1 percent microlite.

BUCKHORN (PEGMATITE 659)

The Buckhorn (pegmatite 659, pl. 1) caps the top of a ridge on the north side of Tollgate Gulch in the SE¼ sec. 27, T. 50 N., R. 3 E. It is irregular (fig. 36), having a maximum length of 1,750 feet and a maximum width of 1,360 feet. It is exposed at altitudes between 8,900 and 9,400 feet above sea level and 350 to 850 feet above Tollgate Gulch. The nearest road is State Highway 162, 0.4 mile to the west.

At least 3 claims have been located on this pegmatite. Claim notices show 2 of these to be: the Buckhorn, on the northwestern part of the pegmatite, and the Feldspar claim, in the northeastern part of the pegmatite, both located by Bert and Florence Tucker. On the Buckhorn claim there are several small trenches, the largest 30 feet long, 5 feet wide, and 8 feet deep, and the smallest 4 feet long, 3 feet wide, and 2 feet deep. The Feldspar claim has a trench 15 feet long, 3 feet wide, and 2 feet deep. Several hundred feet to the east of the Feldspar claim is an unnamed claim which has a small shaft, 4 feet square and 8 feet deep, and several hundred feet farther east a trench 15 feet long and 3 feet wide. No mining has been done on these claims.

The Buckhorn pegmatite (fig. 36) intrudes hornblende gneiss and tonalite. The greater part of this pegmatite has only one zone, but it contains several small disconnected core segments in its upper part along the ridge. Around one of these cores is a small intermediate zone. The small cuts in the Buckhorn claim are made on this intermediate zone. The wall zone, which forms more than 90 percent of the pegmatite, has an average grain size of 0.25 to 0.5 inch. It is esti-

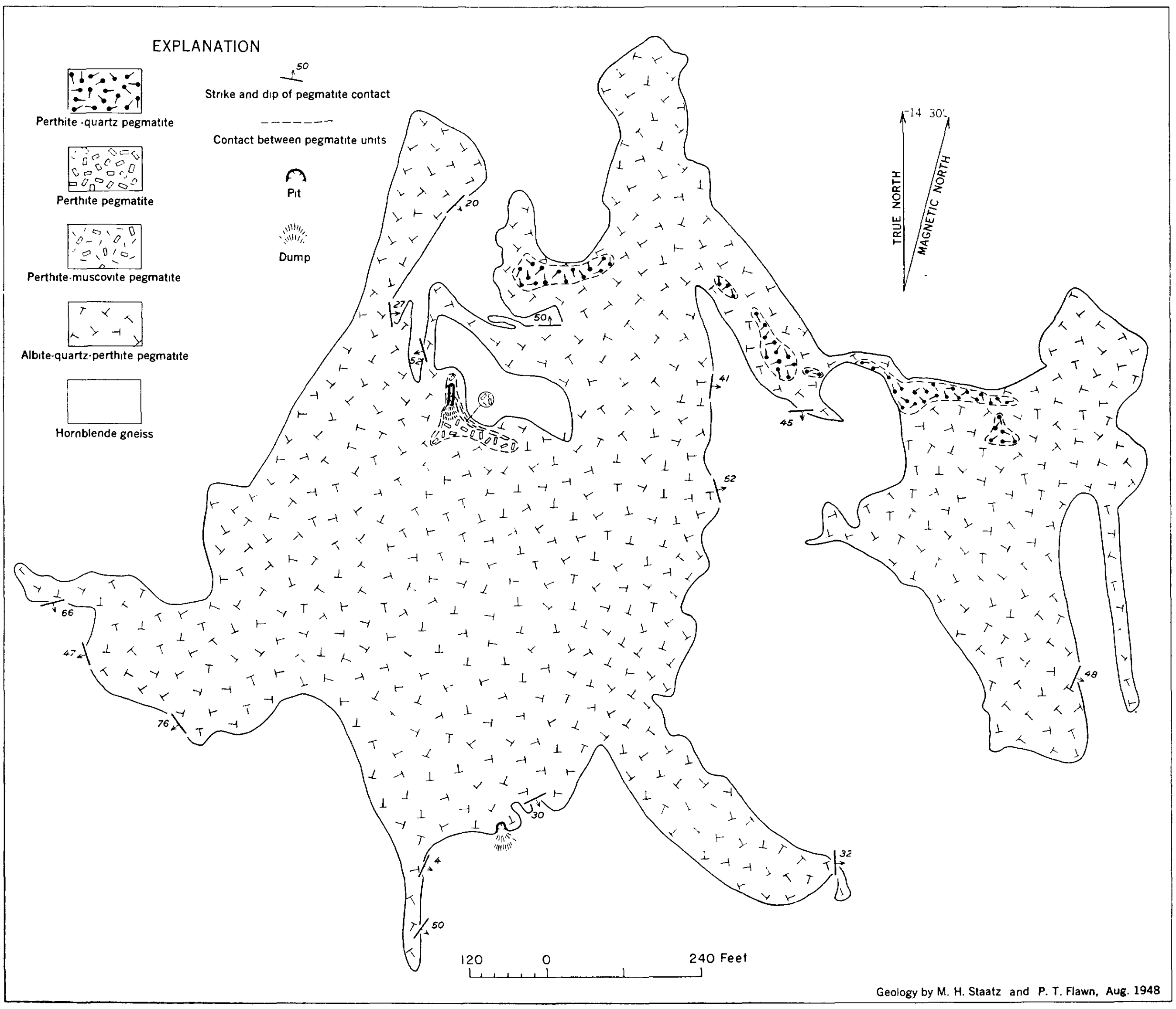

FIGURE 36.—Geologic map, Buckhorn (no. 659) pegmatite.

mated to contain albite (59 percent), quartz (20 percent), white to pink perthite (20 percent), fine-grained gray-green muscovite (1 percent), garnet (trace), and biotite (trace). Though most of these minerals are fine grained, the perthite occurs in crystals 1 to 3 inches in diameter.

The intermediate zone is 1.5 to 2 feet thick. It has an average grain diameter of approximately 1 foot and consists of perthite (50 percent), muscovite (40 percent), and quartz (10 percent). A few greenish crystals of beryl, approximately 1 inch in diameter, were noted. Three or four crystals of columbite-tantalite and monazite, about 0.5 inch long, were found adjacent to the core in a feldspar-rich part of this zone. The muscovite in the intermediate zone occurs in books as large as 10 by 18 inches. It is greenish gray and has a strongly developed "A" structure. It closely resembles the scrap mica from the Bucky mine, which is prized as a grinding mica. The intermediate zone is about 150 feet long and diminishes in mica content to the south. The amount of scrap mica available, therefore, is small.

The core segment within the intermediate zone is south of the other core segments and differs considerably from them in composition and texture. This core has an average grain diameter of 2 feet and consists of perthite (91 percent), quartz (7 percent), muscovite (1 percent), and beryl (0.7 percent). The beryl is pale green and ranges in size from 0.2 by 0.7 inch to 3.2 by 5.5 inches.

The other cores are exposed along the top of an east-west trending ridge and are only 10 to 20 feet thick. They may be the eroded remnants of a once much larger and continuous core. The average grain size of the minerals in these core segments is 8 to 12 inches; and though they vary in the percentage of minerals, they are estimated to contain perthite (53 percent), quartz (45 percent), albite (1 percent), and muscovite (1 percent).

The small shaft to the east of the Feldspar claim was sunk in a quartz-rich part of this pegmatite. It yielded approximately 75 pounds of beryl. These beryl crystals are 1 to 2 inches across, white, and closely resemble quartz. This appears to be a beryl-rich pocket, and others might be found on further exploration. The amount of beryl is not likely to be large, as the core segments are extremely thin. A limited amount of feldspar could be obtained from these core segments, but the low price of feldspar and high transportation costs make the economic feasibility of working it questionable.

BLACK WONDER (PEGMATITE 847)

The Black Wonder pegmatite is the largest pegmatite in the district, covering parts of secs. 20, 21, 22, 27, 28, 29, 32, and 33, T. 50 N., R. 3 E. It is 12,600 feet long and has a maximum width of 6,700 feet. The northeast end is less than 200 feet from Willow Creek, and the southwest end is at Big Gulch. A road from Big Gulch to the State Highway 162 traverses the pegmatite for 1.5 miles. Much of the eastern edge is within a quarter of a mile of the highway. The western part of the pegmatite forms the southern extension of a prominent north-trending ridge. This ridge rises to the north, and the highest point on the pegmatite is over 9,700 feet. The southern and eastern edges of the pegmatite are at an altitude of slightly above 8,500 feet.

The Black Wonder is extremely irregular, as it consists of a large number of intersecting dikes of uneven spacing and size.

Most of the pegmatite intrudes hornblende gneiss, but part of it cuts coarse-grained granite at the southeast and pre-Cambrian sedimentary rocks in a small area at the northeast.

The pegmatite has aroused little mining interest. Two claims, the Black Wonder and the Beryl, have been filed on different parts of the pegmatite. The Black Wonder prospect, in the eastern part of sec. 29, was located in May 1948 on a magnetite-rich area in the pegmatite and consists of one small pit. The Beryl claim, located in June 1948 by Bert Tucker, is in sec. 27 and the workings consist of three pits on a beryl-bearing unit and a fourth on a monazite-bearing unit.

The pegmatite consists of a thick wall zone enclosing small widely scattered cores and cut by occasional fracture fillings. Only a few of the cores have an intermediate zone between them and the wall zone. The wall zone, constituting over 95 percent of the pegmatite, varies in texture and composition. In the southern and western parts of the pegmatite, it is a graphic granite unit, grading to the north and northeast into a unit with only a few crystals of graphic granite in a matrix of albite and quartz. The wall zone at the south and west end has an average grain size of 3 inches and is estimated to contain 60 percent perthite, 24 percent albite, 15 percent quartz, 1 percent martite, less than 1 percent biotite, and a trace of garnet. Graphic granite crystals, as much as 5 feet across, constitute 50 percent of this part of the wall zone. Small local concentrations of martite are common, such as the one upon which the Black Wonder claim was made. Martite comprises 10 percent of the wall zone at the prospect pit and to the northeast for 50 feet, in crystals as much as 4 inches across. The wall zone to the north and east has an average grain size of 1.5 inches and is estimated to contain 55 percent albite, 30 percent perthite, 15 percent quartz, less than 1 percent garnet, and a trace of martite. Graphic granite constitutes less than 10 percent of this part of the wall zone in crystals less than 6 inches across.

At the Beryl claim, two different types of intermediate zone surround quartz cores. One intermediate zone contains monazite and columbite-tantalite; and the other, beryl crystals. The beryl-containing intermediate zone occupies the space between two small quartz pegmatite cores, 7 feet apart; the larger core is 25 feet long and 10 feet wide. Two prospect pits—the larger 9 feet long by 6 feet wide—are on the east side of the larger quartz pegmatite core. Another pit, 15 feet long and 4 feet wide, is on the east side of the smaller quartz pegmatite core. The intermediate zone is not exposed completely around the larger core but lies east of it, surrounding the smaller one. This zone has a maximum size of 30 feet long and 15 feet wide. The grain size averages 2 inches, and the zone is estimated to contain 79 percent albite, 10 percent quartz, 5 percent perthite, 5 percent muscovite, 1 percent garnet, and 0.2 percent beryl. The muscovite occurs in books from 0.25 to 5 inches across. Garnet crystals range in size from 0.25 to 2 inches. Beryl, in semitransparent yellowish-green crystals from 0.5 to 1.25 inches in diameter, is concentrated along the eastern edge of the larger quartz pegmatite core.

The monazite-bearing intermediate zone is approximately 400 feet northeast from the beryl-bearing zone and is exposed by a prospect pit 4 feet long and 3 feet wide, on the east side of a quartz pegmatite core. The core is 15 feet long, 6 feet wide and is 2 feet thick at its edge in the pit. This intermediate zone is estimated to be 15 feet long and 4 feet wide. Its grain size is 6 inches, and the composition is estimated to be 55 percent albite, 30 percent muscovite, 15 percent quartz, and traces of monazite and columbite-tantalite. Books of muscovite are as much as 8 inches across, and crystals of monazite average 0.75 inch long by 0.12 inch wide. The columbite-tantalite crystals average 0.12 by 0.06 inch.

The cores are nearly all small, can be measured in tens of feet in length, and are less than 10 feet wide. They range in composition from 100 percent quartz to 10 percent quartz and 90 percent perthite. In the northeast part of the pegmatite, books of muscovite form as much as 30 percent of the cores in crystals as much as 5 inches across. In some of the cores the quartz is smoky, suggesting the presence of radioactive minerals. Several small crystals of allanite were found in one core.

In various places the wall zone is cut by fracture fillings of white quartz. These fracture fillings range from a fraction of an inch to 6 inches in width.

TRIO NO. 1 (PEGMATITE 1402)

The Trio No. 1 pegmatite is on the ridge west of Willow Creek at an altitude of 10,000 feet, in secs. 16 and 21, T. 50 N., R. 3 E. The nearest road is along Willow Creek, 1 mile northeast of the claim. This road joins State Highway 162, 2.5 miles to the southeast. The claim was located on May 2, 1949 by Bert Tucker, George Tucker, and A. T. Pearson. Discovery workings consist of four small prospect pits, the largest of which is 13 feet long, 10 feet wide, and 4 feet deep.

The pegmatite is 644 feet long and has a maximum width of 152 feet. It is irregular in shape and is intruded into quartz monzonite. The pegmatite is made up of 4 zones: a thick wall zone constituting over 90 percent of the pegmatite, 2 small intermediate zones, and several small discontinuous cores. The wall zone has an average grain size of 0.75 inch and is made up of albite (45 percent), perthite (40 percent), quartz (15 percent), biotite (less than 1 percent), and martite (less than 1 percent). The intermediate zones are of two types: a quartz-albite-perthite pegmatite and a quartz-albite-muscovite pegmatite, both found around one core. The quartz-albite-perthite pegmatite intermediate zone, 20 feet long by 15 feet wide, is east of the quartz-albite-muscovite pegmatite intermediate zone and separates it from the wall zone. This quartz-albite-perthite pegmatite has an average grain size of 6 inches and is estimated to contain quartz (35 percent), albite (34 percent), perthite (30 percent), garnet (0.5 percent), and biotite (0.5 percent). Six beryl crystals from this zone were found on the stockpile, ranging from 1 to 8 inches in diameter and from 1 to 6 inches in length. The quartz-albite-muscovite pegmatite is 3.5 feet thick and surrounds the core of quartz pegmatite. This zone has an average grain size of 1 inch and is made up of quartz (60 percent), albite (25 percent), muscovite (15 percent), and garnet (less than 1 percent). Muscovite crystals average 1 inch across and 1.5 inches thick.

Cores of quartz pegmatite occur in several places and are as much as 15 feet long by 12 feet wide. The core on which the workings are located is 20 feet long by 5 feet wide and consists entirely of quartz.

BUCKY (PEGMATITE 1574)

GENERAL FEATURES

The Bucky pegmatite is an irregular pegmatite on the ridge between Willow and Illinois Creeks. Numerous claims are located on this pegmatite in the E½ sec. 22, T. 50 N., R. 3 E. The Bucky claim, on which the main workings are found, is on the northern end of the pegmatite and covers a quartz pod 100 feet long and 60 feet wide. This claim was originally owned by Mr.

Rod Fields, who has driven several small adits along the southern side of the pod and from it has produced approximately 17 tons of beryl, 100 pounds of columbite-tantalite, 25 pounds of an unidentified mineral resembling samarskite, and 15 pounds of monazite. The scrap mica was at first discarded, but approximately 20 tons were stockpiled in September 1948. In the fall of 1948, Mr. Fields sold the property to the Beryllium Mining Co., Inc., which has produced from open pits excavated by blasting and bulldozing. A road was constructed to the mine workings, approximately 400 feet above the valley bottom, by the Beryllium Mining Co., Inc. In May 1950 a small mill for separating the scrap mica was built beside the mine road. Prior to May 15, 1950, the Beryllium Mining Co., Inc., had produced 32 tons of beryl, 139.6 tons of scrap mica, 1,020 pounds of columbite-tantalite, 15 pounds of monazite, and 13 pounds of a mineral resembling samarskite.

The beryl was sold to several buyers in Colorado, and part was trucked to Longmont, and part was sold on the property. In 1950 the scrap mica was being shipped to Western Nonmetallics in Pueblo, Colo. No columbite-tantalite had been sold, and the small production of monazite and the mineral resembling samarskite had been purchased by Ward's Natural Science Establishment for resale as mineral specimens.

The Bucky mine workings were mapped in September 1948, with plane table and telescopic alidade. This map (pl. 8) covered an area extending from the northern contact of the pegmatite with the schist to a point 180 feet south of the main quartz pod. A beryl count was made in the mine workings. In November 1949, this map was revised to show the new workings. The outline of the whole pegmatite was mapped (pl. 1) in September 1949.

GEOLOGY

The Bucky pegmatite has been intruded chiefly into hornblende gneiss, but it also cuts several small bands of quartzite. The pegmatite is extremely irregular and contains many small inclusions or pendants of country rock. The main bulk of the pegmatite is made up of a fine-grained discontinuous wall zone and an intermediate zone of coarse-grained graphic granite. Within this are scattered 36 cores of quartz pegmatite, in several segments, each at least 10 feet long. Some of the core segments are surrounded by as many as three intermediate zones. The "core segments" have a peripheral arrangement (insert map, pl. 8), and some may be fracture fillings rather than true core segments.

The discontinuous wall zone may be absent in some parts and several hundred feet thick in others. It has an average grain size of 0.25 inch and consists of albite (60 percent), perthite (20 percent), quartz (16 percent), muscovite (4 percent), and a trace of garnet.

Inside the wall zone is a thick intermediate zone. This is made up chiefly of graphic granite aggregates that range in diameter from 2 inches to 1 foot and average about 5 inches. Besides graphic granite, this pegmatite unit contains 3 to 4 percent of cream-colored perthite, 1 percent of white quartz crystals, 3 percent of fine-grained cream-colored albite, and less than 1 percent of biotite. The biotite occurs in thin, 6-inch blades, localized in small areas in this rock. The albite is difficult to distinguish from the perthite but is most abundant along the contacts of the quartz-albite perthite pegmatite; it has a low index of refraction (N_α) of 1.530 ± 0.002. The estimated bulk composition of this rock is perthite (77 percent), quartz (20 percent), albite (3 percent), and biotite (1 percent).

The most common type of pegmatite adjacent to and surrounding the quartz pods is a quartz-albite pegmatite. Some of these pods have no other intermediate zones separating them from the graphic granite pegmatite, while others, as previously stated, have as many as three. The quartz-albite intermediate zone has an average grain size of 0.5 inch and usually contains equidimensional quartz grains surrounded by albite. The estimated composition of this rock is quartz (55 percent), albite (40 percent), perthite (3 percent), muscovite (1 percent), and garnet (1 percent). The albite is cream colored and commonly is interstitial to the quartz crystals. It has a lower index of refraction (N_α) of 1.532 ± 0.002. The perthite is most common near the perthite-quartz pegmatite zone where it occurs as graphic granite; it also occurs near the muscovite-feldspar-quartz-beryl zone as cream-colored crystals about 4 inches across. The muscovite is in light-colored irregular books 0.25 to 0.75 inch long. It occurs in local aggregates, comprising as much as 10 percent of the rock. Adjacent to the core of the Bucky mine, the feldspar is considerably kaolinized.

Muscovite-feldspar-quartz-beryl pegmatite predominates around the large Bucky core segment (pl. 8) but is also well developed around at least two other core segments and may be present to a minor extent around several more. The zone weathers easily and is usually concealed by quartz float. It is well exposed along the southern and eastern side of the Bucky claim, where mine faces are more than 20 feet high. This zone extends around three-fourths of the Bucky core segment but pinches out in the northwest quarter and is from 1 to 10 feet thick. The muscovite-feldspar-quartz-beryl pegmatite zone has a grain size which ranges in diameter from 3 inches to over 8 feet and averages about 2 feet. It has an estimated composition of muscovite (40 percent), feldspar (31 percent), quartz (20 percent), beryl (8.9 percent), columbite-tantalite (0.11 percent), an unidentified mineral resembling samarskite (0.003 percent), monazite (0.003 percent), topaz (less than 1 percent), gahnite (less than 1 percent), phosphates (trace), and lepidolite (trace). Muscovite makes up from 10 to 80 percent of the rock and is found in books as much as 1 foot across; the average is 6 inches. The books are heavily lined, have irregular surfaces, contain minute crooked fractures, and have a prominent "A" structure. Both red and black mineral staining is common. This is scrap mica and is quite soft, a property that makes it an excellent grinding mica. The feldspar occurs chiefly as cream-colored massive perthite and as cream-colored fine-grained albite. The albite is commonest in heavy muscovite concentrations and has a minimum index of refraction (N_{α}) of 1.531 ± 0.002. Because of the heavy kaolinization of both feldspars, the relative proportions of perthite to albite could not be readily determined. Quartz occurs as large white crystals several feet in diameter. Beryl is found in large white to pale-green euhedral crystals. A total of 64 beryl crystals was noted in 344.5 square feet of muscovite-feldspar-quartz-beryl pegmatite measured along the mine walls. The basal area of the crystals ranged in size from 0.007 to 5.0 square feet and averaged 0.70 square feet. Beryl is more common and occurs in larger crystals in the perthite-quartz-rich part than in the muscovite-rich part. A beryl count, made in Mr. Fields' early workings, which follow a beryl-rich concentration, gave an average of 13 percent beryl. Most of the zone worked since that time contained much less beryl. A second pocket, opened in April 1950, yielded approximately 9 tons of beryl, before June of the same year. The beryl in this, as in all zones, is again concentrated in pockets separated by almost barren rock. The beryl has a maximum index of refraction ($N\omega$) of 1.578 ± 0.002, which corresponds to approximately 13.2 percent BeO. A small part of the beryl has been kaolinized. The columbite-tantalite, monazite, and an unidentified mineral resembling samarskite usually occur together in erratically distributed pockets. They were found in some of the early workings adjacent to the core segment. Columbite-tantalite occurs in black tabular crystals as much as 6 inches across. Monazite occurs in reddish-brown euhedral crystals 0.25 to 1 inch long, and the adjacent feldspar is frequently stained red. The unidentified mineral resembling samarskite has been found in masses as much as 5 inches across. It is dark greenish black, has conchoidal fracture, a greasy luster, and no apparent crystal form. This mineral is metamict and its X-ray pattern does not agree with that of samarskite, fergusonite, euxenite, allanite, or uraninite. A more complete discussion of this mineral is given in the section on mineralogy.

Topaz has been reported from the Bucky core segment, but it occurs in greater abundance around a small pod on the southwestern part of the pegmatite. Topaz in crystals 1 to 4 inches across may constitute as much as 1 percent of this zone. Lepidolite in very fine-grained aggregates has been found adjacent to the topaz but is quite rare.

Lithiophillite-triphylite occurs in a few crystals adjacent to the Bucky core segment and in another small pod in the extreme northeastern end of the pegmatite.

In addition to the muscovite-feldspar-beryl pegmatite, a coarse-grained perthite pegmatite envelopes the Bucky core segment. This rock has an average grain diameter of 6 feet and is estimated to consist of 93 percent of cream-colored perthite, 7 percent of quartz, and less than 1 percent of albite and muscovite. The perthite is slightly kaolinized. About 30 tons of cream-colored perthite has been stockpiled at the mine, but no sale had been made as of June 1950.

Quartz-core segments are found scattered throughout the pegmatite and range in dimensions from a few feet long and less than 1 foot wide to 100 feet long and 80 feet wide (the core on which the Bucky claim is located). The quartz pegmatite is made up entirely of pure white massive quartz. As this rock is resistant to erosion, it forms prominent knobs, and joint blocks commonly cover the adjoining pegmatite.

A unit believed to be a fracture filling is found in two places along the outer edge of the pegmatite. This has an average grain diameter of 3 feet and is estimated to consist of 50 percent quartz and 50 percent perthite.

LITERATURE CITED

Adams, J. W., 1953, Beryllium deposits of the Mount Antero region, Chaffee County, Colorado: U. S. Geol. Survey Bull. 982–D.

Andersen, Olaf, 1928, The genesis of some types of feldspar from granite pegmatites: Norsk geol. tidsskr., v. 10, p. 116–207.

Bannerman, H. M., 1943, Structural and economic features of some New Hampshire pegmatites: N. H. State Plan. Devel. Comm., Min. Res. Survey, Concord, p. 1–22.

Brogger, W. C., 1880, Die Mineralien der Syenit pegmatit gange Sudnorwegischen Augit-und Nephelin syenite: Zeitschr. Krystallographie u. Mineralogie, Band 16, p. 215–235.

Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R., 1949, Internal structure of granitic pegmatites: Econ. Geology Mon. 2, 115 p.

Cameron, E. N., Larabee, D. M., McNair, A. H., Page, J. J., and Shainin, V. E., 1945, Structure and economic characteristics of New England mica deposits: Econ. Geology, v. 40, p. 369–393.

Cameron, E. N., Larabee, D. M., McNair, A. H., and Stewart, G. W., 1944, Characteristics of some New England mica-bearing pegmatites [abs.]: Econ. Geology, v. 39, p. 89.

Cameron, E. N., Larabee, D. M., Page, J. J., Stewart, G. W., and Shainin, V. E., 1953, Pegmatite investigations in Maine, New Hampshire, and Connecticut, 1942–1945: U. S. Geol. Survey Prof. Paper 255. [1954]

Crawford, R. D., and Worcester, P. G., 1916, Geology and ore deposits of the Gold Brick district, Colorado: Colo. Geol. Survey Bull. 10, 116 p.

D'Achiardi, A., 1872, Mineralogia della Toscana, Pisa.

D'Achiardi, G., 1896, Le tourmaline del graniteo elbano: Atti della soc. Toscana di Sci. Nat. Mem. 15.

De Almeida, S. C., Johnston, W. D., Leonardos, O. H., and Scorza, E. P., 1944, The beryl-tantalite-cassiterite pegmatites of Paraiba and Rio Grande do Norte, Northeastern Brazil: Econ. Geology, v. 39, p. 206–223.

Derry, D. R., 1931, The genetic relationships of pegmatites, aplites, and tin veins: Geol. Mag., v. 68, p. 454–475.

Eckel, E. B., 1933, A new lepidolite deposit in Colorado: Am. Ceramic Soc. Jour., v. 16, p. 239–245.

Eckel, E. B., and Lovering, T. S., 1935, Work of Eckel, Lovering, and Fairchild—Microlite from Ohio City, Colo.: Report of the Committee on the Measurement of Geologic Time, Nat'l. Research Council, p. 77–79.

Fleischer, Michael, 1937, The relation between chemical composition and physical properties in the garnet group: Am. Mineralogist, v. 22, p. 751–759.

Ford, W. E., 1915, A study of relationships existing between the chemical, optical and other physical properties of the members of the garnet group: Am. Jour. Sci., 4th ser., p. 33–49.

Faye, W. G., 1922, Mineral localities in the vicinity of Middletown, Conn.: Am. Mineralogist, v. 7, p. 4–12.

Fraser, H. J., 1930, Paragenesis of the Newry pegmatite, Maine: Am. Mineralogist, v. 15, p. 349–364.

Gevers, T. W., 1937, Phases of mineralization in Namaqualand pegmatites [1936]: Geol. Soc. South Africa Trans. and Proc., p. 331–377.

Glass, J. J., 1935, The pegmatite minerals from near Amelia, Va.: Am. Mineralogist, v. 20, p. 741–768.

Goranson, R. W., 1931, The solubility of water in granitic magmas: Am. Jour. Sci., 5th ser., v. 22, p. 481–502.

Hanley, J. B., Heinrich, E. W., and Page, L. R., 1950, Pegmatite investigations in Colorado, Wyoming, and Utah, 1942–1944: U. S. Geol. Survey Prof. Paper 227, 124 p.

Heinrich, E. W., 1948, Pegmatites of Eight Mile Park, Fremont County, Colorado: Am. Mineralogist, v. 33, p. 420–448, 550–587.

Hess, F. L., 1925, The natural history of pegmatites: Eng. and Min. Jour.-Press, v. 120, p. 289–298.

——— 1933, Pegmatites: Econ. Geology, v. 28, p. 447–462.

Hitchens, C. S., 1935, The pegmatites of Fitchburg, Mass.: Am. Mineralogist, v. 20, p. 1–24.

Hobbs, S. W., 1944, Tungsten deposits in the Boreana district and the Aquarius Range, Mohave County, Ariz.: U. S. Geol. Survey Bull. 940–I, p. 247–264.

Holser, W. T., 1953, Beryllium minerals in the Victorio Mountains, Luna County, N. Mex., Am. Mineralogist, v. 38, p. 599–611.

Hunt, T. S., 1871, Notes on granitic rocks: Am. Jour. Sci., 3d ser., v. 1, p. 82–89, 182–191.

Jahns, R. H., 1946, Mica deposits of the Petaca district, Rio Arriba County, N. Mex.: N. Mex. Bur. Mines Bull. 25, 294 p.

Johnston, W. D., Jr., 1945, Beryl-tantalite pegmatites of northeastern Brazil: Geol. Soc. America Bull., v. 56, p. 1015–1070.

Kemp, J. F., 1924, The pegmatites: Econ. Geology, v. 19, p. 697–723.

Landes, K. K., 1923, Sequence of mineralization in Keystone, S. Dak. pegmatites: Am. Mineralogist, v. 13, p. 519–530, 537–558.

——— 1925, Paragenesis of the granitic pegmatites of central Maine: Am. Mineralogist, v. 10, p. 355–411.

——— 1932, Criteria of age relations of minerals: Econ. Geology, v. 27, p. 211.

——— 1933, Origin and classification of pegmatites: Am. Mineralogist, v. 18, p. 33–56, 95–103.

——— 1935, Colorado pegmatites: Am. Mineralogist, v. 20, p. 319–333.

McLaughlin, T. G., 1940, Pegmatite dikes of the Bridger Mountains, Wyo.: Am. Mineralogist, v. 25, p. 46–68.

Olson, J. C., 1942, Mica-bearing pegmatites of New Hampshire: U. S. Geol. Survey Bull. 931–P, p. 363–403.

Page, L. R., 1950, Uranium in pegmatites: Econ. Geology, v. 45, p. 12–34.

Page, L. R., and others, 1953, Pegmatite investigations 1942–1945, Black Hills, S. Dak.: U. S. Geol. Survey Prof. Paper 247, 228 p.

Palache, Charles, and Gonyer, F. A., 1940, Microlite and stibiotantalite from Topsham, Maine: Am. Mineralogist, v. 25, p. 411–417.

Pardee, J. T., 1937, Glass, J. J., and Stevens, R. E., 1937, Massive low-fluorine topaz from the Brewer mine, South Carolina: Am. Mineralogist, v. 22, p. 1058–1064.

Quirke, T. T., and Kremers, H. E., 1943, Pegmatite crystallization: Am. Mineralogist, v. 28, p. 571–580.

Ramberg, Hans, 1949, The facies classification of rocks: A clue to the origin of quartzo-feldspathic massifs and veins: Jour. Geology, v. 57, p. 18–54.

Schaller, W. T., 1925, The genesis of lithium pegmatities: Am. Jour. Sci., 5th ser., v. 10, p. 269–279.

——— 1927, Mineral replacement in pegmatites: Am. Mineralogist, v. 12, p. 59–63.

——— 1933, Pegmatites: Ore deposits of the Western States, Am. Inst. Min. Met. Eng., p. 144–151, New York.

Shaub, B. M., 1937, Contemporaneous crystallization of beryl and albite vs. replacement: Am. Mineralogist, v. 22, p. 1045–1051.

——— 1940, The origin of some pegmatites in the town of Newry, Maine: Am. Mineralogist, v. 25, p. 673–688.

Sinegub, E. S., 1943, Berill: Nemetallicheskoye iskopayeme SSSR, Moscow-Leningrad, v. 2, p. 129–157.

Smith, W. C., and Page, L. R., 1941, Tin-bearing pegmatites of the Tinton district, Lawrence County, S. Dak.: U. S. Geol. Survey Bull. 922–T, p. 595–630.

Stark, J. T., and Behre, C. H., Jr., 1936, Tomichi dome flow: Geol. Soc. America Bull., v. 47, p. 101–110.

Stevens, R. E., 1938, New analyses of lepidolite and their interpretation: Am. Mineralogist, v. 23, p. 607–628.

Volk, G. W., 1939, Optical and chemical studies of muscovite: Am. Mineralogist, v. 24, p. 255–266.

Warren, T. W., 1935, Spectrographic analysis of tourmalines with correlation of color and composition: Am. Mineralogist, v. 20, p. 531–536.

Washington, H. S., 1917, Chemical analyses of igneous rocks: U. S. Geol. Survey Prof. Paper 99, 1201 p.

Winchell, A. N., 1947, Elements of optical mineralogy: pt. 2, 459 p., John Wiley and Sons, New York.

Wright, W. I., 1938, The composition and occurrence of garnets: Am. Mineralogist, v. 23, p. 436–449.

CHARACTERISTICS OF THE PEGMATITES (TABLE 20)

TABLE 20.—*Mineralogy of pegmatites*

[Relation to wall rock: Ne, not exposed; C, cross-cutting; Cf, conformable; Shape: L, lenticular; LB, lenticular-branching; Ir, irregular; Ov, oval; Percent: a check mark (√) indicates that mineral is present but was not measured in percent]

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1	Tonalite		Ne	L	1 unit	¾	45		35				25		<1						
2	do		Ne	L	do	2–3	15		49				35		1						
3	do		Ne	Ov	do	¼–½	47		25				25		3		<1				
4	do		Ne	L	do	¾–1	53	1/16	15				30	12	1		1	⅛	Biotite Gahnite Beryl	Trace do 4 crystals	1/32 ⅛–3
5	Tonalite and coarse-grained granite.	None	C	Lb	do	¼	54		20				25		1		<1				
6	Granite	do		L	do	⅛–¼	65		15				20		<1		Tr.				
7	Tonalite and granite.		Ne	Lb	do	⅛–¼	58		20				20		2		<1				
8	Biotite gneiss and granite.	None	Cf	Lb	do	¼	60		20				20		<1		Tr.				
9	Tonalite and granite.	do	C	L	do	¼–½	62		18				20		<1		<1				
10	Unknown			L	do	1/16	69		10				20		Tr.		<1				
11	Tonalite	None	C	Lb	do	¼	60		20				20		<1		<1				
12	Tonalite, coarse-grained granite, fine-grained granite.	do	C	Lb	do	¼–½	44		35				20		<1		<1				
13	Coarse-grained granite.			L	do	⅛–¼	65		15				20		<1		Tr.				
14	Tonalite		C	L	do	⅛–¼	65		15				20		<1		<1		Tourmaline	Trace	
15	Fine-grained granite.			L	do	1	30		35				35		2		<1				
16	Tonalite		Ne	L	do	½–¾	50		15				35		<1		<1				
17	Unknown		Ne	Lb	do	½–¾	55	⅛	25	4–6			20	4–6	<1		<1				
18	Tonalite and coarse-grained granite.	None	C	Lb	do	3–4	15	⅛	59	8–10			25	8–10	1	3–4	<1				
19	Tonalite		Ne	L	do	4	25		50				25				Tr.				
20	do	None	C	Ir	do	⅛	72		7				20		<1		<1				
21	do		Ne	L	do	½	55		25				20		<1		<1		Beryl Columbite-tantalite.	1 crystal 3 crystals	¼
22	do		C	L	Wall zone	¼	59		15				25		1		<1		Beryl	1 crystal	4
					Core	6–8	10		5				85		<1						
23	do		C	Lb	Southern branch.	1–2	40		20				40		<1		Tr.				
					Northern branch wall zone.	¼	69		5				25		1		<1				
					North branch core.	6	10		53				35		2	1–4	<1		Beryl Monazite Columbite-tantalite.	13 crystals 3 crystals 5 crystals	1–1½ ½ ¾
24	do		Ne	L	1 unit	1	44		25				30		1		<1		Beryl	1 crystal	½
25	do		C	Lb	Main unit	¼–½	45		30				25		<1		<1				
					Fracture-filling 15 inches long.	6–8			10				90								
23	Coarse-grained granite.			L	1 unit	⅛–¼	60		20				20		<1		Tr.				
27	do			Lb	do	⅛–¼	72		7				20		1		Tr.				
28	do	None		Lb	do	1/16	70		10				20		Tr.		Tr.		Magnetite	Trace	
29	do			Lb	do	⅛	80		5				15		<1		Tr.				
30	do	None		Lb	do	⅛	80		5				15		<1		<1				
31	do			L	do	⅛	59		15				25		1		<1				
32	do			L	do	⅛	73		7				20		<1		Tr.				
33	Coarse- and fine-grained granite.			Lb	do	¼	44		25				30		1		Tr.				
34	Coarse-grained granite.	None		Lb	do	⅛–¼	64		15				20		1		Tr.				
35	do	do		Lb	do	⅛–¼	60		20				20		<1		Tr.				
36	do		Ne	Lb	do	⅛–¼	54		25				20		1		Tr.				
37	do		Ne	L	do	⅛–¼	60		20				20		<1		Tr.				
38	do		Ne	L	do	⅛	77		3				20		<1		Tr.				
39	do		Ne	L	do	⅛	69		5				22		4		Tr.				

40	do			Lb	do	<1/16	79		5				15		1		Tr.				
41	Hornblende gneiss		Ne	Lb	do	⅛	71		8				20		1		Tr				
42	do		Ne	Ir	do	1/16–⅛	74		10				15		1		1				
43	Coarse-grained granite.	None		Ir	do	⅛–¼	48		30				20		2		1				
44	do			L	do	⅛	74		5				20		1		1				
45	Hornblende gneiss		Ne	L	do	¼	65		15				19		1						
46	do		C	Lb	do	⅛	74		5				20		1		1				
47	Hornblende gneiss and granite.		C	Lb	do	⅛–¼	65		15				20		<1		Tr.				
48	Hornblende gneiss		C	Lb	do	⅛–¼	69		10				20		1		<1				
49	do		C	Lb	do	1/16–⅛	64		10				25		1		<1				
50	do		Ne	L	do	¼	65		15				20		<1		Tr.				
51	do		Ne	Ir	do	¼	65		15				20		Tr.		Tr.				
52	Tonalite		C	Lb	do	⅛–¼	70		7				23		Tr.						
53	Hornblende gneiss			L	do	1/32	80		5				15		Tr.		<1				
54	do		Ne	L	do	¼	55		20				25		<1		<1				
55	Tonalite		C	Ir	North end	¼	59		20				20		1		Tr.				
					South end	1–2	27		27				45		<1				Beryl	1 crystal	1½
56	do		Ne	L	1 unit	⅛	75		5				20		<1		<1				
57	Hornblende gneiss		Ne	L	Wall zone	⅛–¼	70		15				15		Tr.		Tr.				
					Cores	1	25		35				40		<1						
58	Tonalite		Ne	L	1 unit	1/16–⅛	77		3				20		Tr.		Tr.				
59	do		Ne	L	do	⅛	80		5				15				Tr.				
60	do		Ne	Ir	do	⅛	71		8				20		1		1				
61	do		Ne	L	do	1–2	35		30				35		1						
62	do		Ne	L	Wall zone	⅛	70		15				15		1		1				
					Core	10 12	5		10				85		1						
63	do		C	Lb	1 unit	1	54		20				25		1		Tr.				
64	do	None	C	Lb	Wall zone, west branch.	⅛–¼	69		15				15		1		<1				
					Core, west branch.	6	15		43				40		2				Columbite-tantalite.	3 crystals	1½
																			Monazite		
					East branch	⅛–¼	60		25				20		<1		<1		Tourmaline	Trace	
65	do		Ne	Lb	1 unit	⅛	69		10				20		1		<1				
66	do		Ne	L	do	½–1	45		10				45		<1		Tr.				
67	Coarse-grained granite.		Ne	L	do	¼	65		12				23		<1		<1				
68	Tonalite		Ne	L	do	½–1	50		25				25		<1		Tr.		Beryl	2 crystals	
69	do		C	L	do	⅛–¼	64		15				20		1		<1				
70	do		C	Lb	do	⅛	72		8				20		<1		Tr.				
71	Tonalite and coarse-grained granite.	None	C	L	do	¼–½	50		25				25		<1		Tr.				
72	do	do	C	Lb	do	⅛–¼	65		15				20		<1		<1				
73	Tonalite		Ne	L	do	⅛–¼	55		20				25		<1		Tr.				
74	do		C	Lb	do	⅛–¼	65		15				20		1		<1				
75	do		Ne	L	do	⅛–¼	55		20				25		<1		<1				
76	do		Ne	L	do	⅛–¼	60		20				20		Tr.		<1				
77	do		Ne	L	do	¼	60		25				15		Tr.		<1				
78	do		Ne	L	do	1	40		25				35		Tr.		Tr.		Beryl	2 crystals	¼
79	do		Ne	L	do	¼	59		15				25		1		Tr.				
80	do		C	Lb	do	¼	60		20				20		<1		Tr.		Beryl	do	⅛
81	Tonalite and fine-grained granite.		C	Lb	do	¼	62		15		5	([1])	22		1		<1		do	1 crystal	⅛
82	do	None	C	L	do	⅛–¼	75		5				20		<1		Tr.				
83	do	do	C	L	Wall zone	⅛–¼	71		3				25		1		Tr.				
					Core	(?)	1		1				98								
84	Tonalite		Ne	L	1 unit	¾–1	45		25				30		Tr.		Tr.		Beryl	2 crystals	⅛
85	Tonalite and fine-grained granite.			L	do	<1/16	62		3		5	([1])	35						Tourmaline	1	
86	do		C	Lb	do	¼	55		20				25		<1		Tr.		Beryl	2 crystals	
87	Tonalite	None	C	Ir	do	½–¾	50		25				25		Tr.		Tr.				
88	Hornblende gneiss			Lb	Northern end	¼	65		10				25		<1		Tr.		Beryl	1 crystal	¼
					Southern end	1/16	93		Tr.				7						Epidote	Trace	
89	do		Ne	Lb	1 unit	⅛	70		10				20		<1		Tr.				
90	Coarse-grained granite.		Ne	L	do	⅛	76		4				20		<1		Tr.				
91	do		Ne	Ir	do	⅛	73		2				25		<1		Tr.				
92	do		Ne	L	do	½–¾	60		20	3–7			20	¼–2	<1		Tr.				
93	Tonalite		Ne	L	do	1/64	68		1				30		1		Tr.	⅛			
94	Hornblende gneiss and fine-grained granite.	None		L	do	2	20		45				35		Tr.						
95	Tonalite and coarse-grained granite.		C	L	Northern end	¼	65		10				24		1						
					Southern part	1	34		40				25	1–6	1						
96	Tonalite	None	C	Lb	Wall zone, northeast part.	4	28		50		60–70	12–24	20		2						
					Wall zone, southwest part.	¼	66		12		2–3	6	20		2						
					Cores	8	10		41				45		4	½–2					
97	Tonalite and fine-grained granite.	do	C	Lb	Wall zone, southwest end.	6–8	15		65		80	4–12	20		2		Tr.				
					Wall zone, northeast end.	¼–½	53		15				30		1		1				
					Cores	6–8	5		40				54		1						

[1] Graphic albite.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
							Mineralogy														
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
98	Coarse-grained granite.	None		L	Wall zone	1/8	77		5				15		3		Tr.		Biotite	<1	
					Core	8	[2] 20		10				68		2						
99	do	do		L	Wall zone	1/4	62		20				18		<1						
					Core	6	[2] 1		30				69		<1		Tr.		Biotite	Trace	
100	Tonalite and coarse-grained granite.	do	Cf	L	1 unit	1/8	79		1				20				Tr.				
101	do	do	C	Lb	do	1/8-1/4	72		8				19		1		Tr.		Magnetite	1 crystal	
102	do			Lb	West branch	1/4-1/2	67		15				18		<1		Tr.		Beryl	2 crystals	1/4
					East branch	1/32	88		1				10				1-2				
103	Tonalite			L	1 unit	1/4	67		15				18		<1		<1				
104	do			L	do	1/16-1/32	74		1				25				Tr.	1/8			
105	Tonalite and coarse-grained granite.		C	Lb	Northeast and southwest branches	1/16-1/32	74		1				25				Tr.	1/8-1/4			
					Northward-trending branch	1/2	60		20				20		Tr.		Tr.		Beryl	4 crystals	1/2
106	Tonalite		C	Lb	1 unit	1/4	72		8				20		<1		Tr.		Beryl	2 crystals	1/8-1/2
107	do			Lb	do	1/8	67		8				25		Tr.				Magnetite	1 crystal	
108	do			L	do	1/1 -1/8	71		3				25		Tr.				Chlorite	2	
109	do			L	do	1/4	70		10				20		<1		Tr.				
110	do		Ne	Lb	do	1/8	71		4				25		<1		Tr.		Tourmaline	Trace	
111	do		Ne	L	do	1/8-1/4	70		5				25		<1		Tr.				
112	Hornblende gneiss		Ne	Lb	do	1/8-1/4	75		5				20		<1		<1		Beryl	13 crystals	1/8-1/4
113	Hornblende gneiss and coarse-grained granite.		Ne	Lb	do	1/8-1/4	74		8				18		<1		Tr.				
114	Hornblende gneiss		Ne	L	do	1/8-1/4	70		10				20		<1		<1		Beryl	2 crystals	1/8
115	Hornblende gneiss and granite.		Ne	Lb	do	1/8	73		5				22		<1		Tr.				
116	Hornblende gneiss			Ir	do	1/8-1/4	65		15				20		<1		Tr.		Beryl	2 crystals	1/4-3/4
117	Tonalite and granite.		Ne	L	do	1/4-1/2	65		15				20		<1		Tr.		do	3 crystals	1/8-1/4
118	Coarse-grained granite.	None		Lb	do	1/16	81		4				15		<1		Tr.				
119	do		Ne	Lb	do	1/8-1/4	67		8				25		Tr.		Tr.				
120	Tonalite		C	Lb	do	1/32-1/16	80		2				18		Tr.		Tr.				
121	do		C	Lb	do	1/16-1/8	76		4				20		Tr.		Tr.		Beryl	5 crystals	1/8-1/2
122	Not exposed		Ne	Ir	do	1/8-1/4	65		15		5		20		<1		Tr.				
123	do		Ne	Ir	do	1/8-1/4	62		18				20		<1		<1				
124	Fine-grained granite.		Ne	Lb	do	1/8-1/4	70		10		2		20		<1		Tr.				
125	Tonalite			L	do	1/8	75		5				20		Tr.		Tr.		Beryl	1 crystal	5/8
126	do		Ne		do	1/8-1/4	75		10				15		Tr.		Tr.		do	do	1/8
127	Hornblende gneiss		Ne		do	1/8-1/4	70		10				20		<1		Tr.				
128	do		Ne		do	1/8-1/4	73		7				20		<1		Tr.		Beryl	2 crystals	1/8
129	Tonalite		C	Lb	do	1/8	76		4				20		Tr.		Tr.		do	1 crystal	1/8
130	do		C	Lb	do	1/8-1/4	75		5				20		<1		Tr.		do	3 crystals	1/8
131	do		C	Lb	do	1/4	65		8				27		Tr.		Tr.		do	2 crystals	1/8
132	do		C	Lb	do	1/8	77		5				18		<1		Tr.		do	do	3/4
133	Hornblende gneiss		Ne	Lb	do	1/4-1/2	56		4				40		<1		Tr.		do	do	1/4
134	do		Ne	Ir	do	1/8-1/4	73		2				25		<1		Tr.		do	do	1/4
135	do		Ne	L	do	1/8-1/4	70		10				20		<1		Tr.		do	1 crystal	1/8
136	Tonalite	None		Ir	do	1/2-3/4	70		8				22		<1		Tr.		do	11 crystals	1/4-1 1/2
137	Hornblende gneiss			Lb	do	1/4	75		10				15		<1		Tr.		do	4 crystals	1/4
138	Hornblende gneiss and granite.	None		Lb	do	1/8	72		8				20		<1		Tr.				
139	Hornblende gneiss	do		L	do	1/4	65		15				20		<1		Tr.		Tourmaline	Trace	
																			Beryl	1 crystal	1/2
140	Coarse-grained granite.	do		Lb	do	1/2-3/4	60		30				10		<1		Tr.				
141	Tonalite and granite.	do	C	Lb	do	1/4	72		10				18				Tr.				
142	Tonalite			L	do	1/4	72		3				25				Tr.				
143	do			Ir	do	1/8	73		2				25		Tr.		Tr.		Beryl	1 crystal	3/16
144	Hornblende gneiss		Ne	L	do	1/4	40		35				20								

145	do		Ne	L	do	1/16-1/8	81		4				15				Tr.				
146		None	C	Lb	do	1/2	55		25				20		<1		Tr.				
147	Tonalite	do		L	do	1/4	70		Tr.				30						Beryl	3 crystals	1/8-1/4
148	do	do		L	do	1/8-1/4	73		2				25		<1		Tr.		do	1 crystal	1/8
149	do			L	do	1/8	72		3				25				Tr.				
150	Tonalite and coarse-grained granite.	None		Lb	do	1/8-1/4	65		15				20		Tr.		<1		Beryl	2 crystals	1/4
151	do			L	do	1/4	70		15				15								
152	Coarse-grained granite.		Ne	L	do	1/8	70		15				15				Tr.				
153	Coarse-grained granite and hornblende gneiss.	None	C	Lb	do	1/4-1/2	63		15				22		<1		Tr.				
154	Ne		Ne	Ir	1 unit	1/8	73		7				20		<1		Tr.				
155	Hornblende gneiss and coarse-grained granite.		Ne	L	do	1/8	72		8				20		Tr.						
156	do		Ne	L	do	1/16-1/8	80		4				16		Tr.				{Biotite {Martite	Trace do	
157	Tonalite		Ne	L	do	1/8	70		10				20		Tr.		Tr.				
158	Hornblende gneiss			L	do	1/2	55		20				25		Tr.		Tr.				
159	do		Ne	L	do	1/2	55		20				25				Tr.				
160	Coarse-grained granite.			L	do	1/16-1/8	80		5				15		Tr.		Tr.		Martite	3 crystals	
161	do	None		Lb	do	1/8	75		5				20		Tr.		<1				
162	Tonalite and coarse-grained granite.	do		Lb	do	1/8-1/4	70		10				20		Tr.		<1		Beryl	8 crystals	1/8-1/4
163	do		C	Lb	do	1/4-1/2	65		20				15				<1		{Beryl {Biotite {Martite	1 crystal Trace do	1/8
164	Coarse-grained granite.		Ne	Lb	do	1/8-1/4	60		25				15		Tr.		Tr.				
165	Tonalite and coarse-grained granite.	None		L	do	1/8-1/4	70		10				20		<1						
166	do	do		L	do	1/8-1/4	65		15				20		<1						
167	Tonalite		Ne	Ir	do	1/4-1/2	60		20				20				Tr.				
168	Hornblende gneiss and granite.	None		L	do	1/32-1/16	75		<1				25								
169	Coarse-grained granite.	do		Lb	do	1/4-1/2	63		25				12		<1		<1				
170	Tonalite and granite.	do		L	do	1/4	60		15				25		<1		Tr.				
171	Hornblende gneiss		Ne	Lb	do	1/8	65		20				15				<1				
172	do		Ne	L	do	1/8-1/4	65		12				23				Tr.		{Beryl {Martite	3 crystals 1 crystal	1/8-1/4
173	do		Ne	L	do	1/8	73		7				20		Tr.		Tr.		Beryl	5 crystals	1/8-1/4
174	Hornblende gneiss and granite.	None		Lb	{Wall zone {Core	1/8-1/4 1-2	70 20		10 40				20 40		Tr.		Tr.		{Martite {Beryl	Trace 1 crystal	1/16
175	Coarse-grained granite.	do		Lb	{Wall zone {Core	1/4	65		15				20 100		Tr.						
176	Tonalite and coarse-grained granite.	} do		L	{Wall zone {Core	1/16-1/8 6	83 10		2 20				15 70		Tr.						
177	Tonalite and granite.		Ne	L	1 unit	1/8-1/4	65		15				20				<1				
178	Coarse-grained granite.	None		L	do	1/8	75		5				20				Tr.		Martite	Trace	
179	Tonalite		Ne	L	do	1/8	73		7				20				Tr.		Magnetite	do	
180	do			Lb	do	1/2	45		25				30				Tr.				
181	Tonalite and granite.	None	C	Lb	do	1/4	72		20				8		Tr.		Tr.		Magnetite	Trace	
182	do	do	C	L	do	1/16	66		25				8		Tr.		<1				
183	do	do	C	L	do	1/16-1/8	70		5				20		Tr.		<1				
184	do		Ne	L	do	1/8	70		20				10				Tr.		Beryl	2 crystals	1/16
185	do	None	C	L	do	1/2	65		25				15		Tr.		Tr.				
186	do	do	C	Lb	do	1/4	71		20				8		1		Tr.		{Martite {Beryl	Trace 1 crystal	1/8
187	do	do		L	do	1/4-1/2	50		32				18		1		<1				
188	do	do	C	Lb	do	1/8-1/4	73		22				5				Tr.		{Magnetite {Beryl	Trace 2 crystals	1/8
189	do	do	C	Lb	do	1/4-1/2	45		30				25				Tr.				
190	Tonalite	do	C	Lb	do	1/16-1/8	69		6				25						Beryl	2 crystals	1/8
191	do		C	Lb	do	1/16	75		5				20				Tr.				
192	Tonalite and granite.	None		L	{Wall zone {Core	1/32 6	83 3		2 37				15 60								
193	Tonalite	do		Lb	1 unit	1/16	76		4				20				<1		Magnetite	Trace	
194	do	do		L	do	1/16	78		2				20				Tr.		do	do	
195	Tonalite and granite.		Ne	Lb	do	1	33		45				22		<1		<1				
196	do			Lb	do	1/4	70		10				20		Tr.		Tr.		Beryl	2 crystals	1/16-3/4

[2] Cleavelandite.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase Percent	Plagioclase Size (in.)	Perthite Percent	Perthite Size (in.)	Graphic granite Percent	Graphic granite Size (in.)	Quartz Percent	Quartz Size (in.)	Muscovite Percent	Muscovite Size (in.)	Garnet Percent	Garnet Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
197	Tonalite	None		L	1 unit	⅛	7		8				25		<1				Beryl	5 crystals	¼
198	do		Ne	L	do	¼–½	50		35				15		<1				do	1 crystal	¼
199	Fine-grained granite.			Ov	do	½–¾	66		4				30		<1						
200	do			Ir	Wall zone	⅛	80		10				10		<1						
					Core	6	15		43				42		<1						
201	do			L	1 unit	⅛–¼	77		8				15		<1		Tr.		Beryl	1 crystal	½
202	Hornblende gneiss and fine-grained granite.	None		Ir	do	½–¾	74		5				20		1						
203	Fine-grained granite.			Ir	do	¾	58		20				20		2						
204	do		Ne	L	do	½	45		35				20		<1		Tr.				
205	Hornblende gneiss	None		Ir	Wall zone	⅛	77		3				20		<1		Tr.		1 Gahnite	1 crystal	
					Core	4–5	20		30				50		1				Columbite-tantalite.	2 crystals	
206	do		Ne	L	1 unit	¾	44		25				30		1						
207	Tonalite		Ne	L	do	¼	59		7				30		4		Tr.				
208	Fine-grained granite.		Ne	L	Wall zone	¼	62		5				30		3						
					Core	3	[2]39		15				45		1						
209 (Opportunity Dike No. 10).	Fine-grained granite and hornblende gneiss.		C	Lb	Northern branches.	⅛–¼	60		20				20		Tr.						
					Main southern body.	2	[2]70		10				20		<1						
210 (Opportunity Dike No. 9).	do		Ne	L	1 unit	1	[2]58		20				20		2						
211 (Opportunity Dike No. 7).	do		Ne	L	do	⅛	78		7				15		Tr.		Tr.				
212 (Opportunity Dike No. 6).	do		Ne	L	do	⅛–¼	74		5				20		Tr.		Tr.		Tourmaline	1	
213 (Opportunity Dike No. 5).	do		Ne	L	Wall zone	1	[2]70		12				18		<1				Tourmaline	<1	
					Core	6	[2]20		40				40		<1				Beryl	Several crystals	(3)
214 (Opportunity Dike No. 4)	do		Ne	L	North and south ends.	3–5	[2]15		2				81		2						
					Central section	¾	65		15				20		<1				Tourmaline	Trace	
					Small stringers, albite-quartz-perthite pegmatite.	¼	65		15				20		<1				Beryl	1 crystal	¼
215 (Opportunity Dike No. 3).	do		Ne	Lb	Central part, cleavelandite-quartz pegmatite.	1	[2]69		8				20		2		Tr.	(4)	Lepidolite	<1	¼–1
																			Topaz	<0.5	(5)
																			Monazite	2 crystals	1
																			Columbite-tantalite.	5 crystals	½
																			Microlite	<1	1/32–¼
																			Beryl	20 crystals	¾–1½
																			Tourmaline	<1	¼–1
					South-central unit, perthite-cleavelandite-quartz pegmatite.	2–3	[2]20		60	8			20		<1		Tr.				
					Pod, quartz-albite pegmatite.	3–4	20		2				75		3				Tourmaline	<1	
216 (Opportunity Dike No. 1).	do		Ne	Lb	North-trending branches.	⅛–¼	72		10				18		<1						
					Northeast branch.	1½	[2]73		5				20		2		<1		Microlite	2 crystals	⅛
					Central and southwestern branch.	4	[2]8		64	12–36			25		3	½–¾			Beryl	5 crystals	¼–4
																			do	3 crystals	1–3

217 (Opportunity Dike No. 1).	Fine-grained granite.		Ne,	Ov	1 unit	4-8	5		10				84		1				Tourmaline	<1	
218 (Opportunity Dike No. 8).	Fine-grained granite and hornblende gneiss.		Ne	L	do	2	[2] 55		30				15		<1				Tourmaline	Trace	
219	Coarse-grained granite.	None		Ir	do	⅛	75						20						Biotite Chlorite.	<1 5	
220	do			L	do	¼	75		3				20						Chlorite	2	
221	Fine-grained granite.		Ne	L	do	¼	65		15				20		<1		Tr.				
222	Covered		Ne	Lb	do	⅛-¼	56		5				35						Chlorite	4	
223	Fine grained gneissic granite.	None	Cf	Lb	do	¼	55		25				20		<1		Tr.		Beryl	1 crystal	¼
224	do	do	Cf	L	do	¼	77		3				20				Tr.				
225	Fine-grained granite.		Ne	L	do	⅛	72		8				20				Tr.		Magnetite Tourmaline	Trace Trace	
226	Fine-grained granite and hornbende gneiss.			L	do	⅛	65		15				20		Tr.		Tr.		Beryl Tourmaline Magnetite	5 crystals Trace Trace	(4)
227	Fine-grained granite and hornblende gneiss.	do	Cf	L	do	¼	70		10				20		Tr.		Tr.		Biotite	Trace	
228	do		Ne	L	do	⅛-¼	70		10				20				Tr.				
229	Fine-grained granite and tonalite.		Ne	Lb	do	⅛	77		8				15		<1		Tr.		Martite Tourmaline	Trace do	
230	Tonalite			Lb	Wall zone	¼	70		10				20		Tr.		<1		Beryl	6 crystals	(4)
					Core	4-6	10		30				60		1		<1				
231	Tonalite and granite.		Ne	L	Wall zone	⅛-¼	80		5				15		<1		<1		do	3 crystals	
					Core	6	10		40				49		1						
232	Tonalite			Ov	1 unit	⅛	74		3				22		<1		1	<1/16-½			
233	Fine-grained granite.		Ne	L	do	⅛-¼	70		10				20		<1		Tr.		Beryl	1 crystal	¼
234	Hornblende gneiss		Ne	L	do	¼	69		5				25		1		Tr.				
235	Fine-grained granite.		Ne	L	do	¼	60		15				25		Tr.						
236	Fine and coarse-grained granite.	None	Cf	L	do	¼	65		15				20		Tr.				Biotite	Trace	
237	Fine-grained granite.	do		Lb	do	¼	60		20				20		<1		Tr.		Beryl	2 crystals	⅜
238	do	do		L	do	½-¾	54		20				25		1		Tr.		Tourmaline Beryl	Trace 3 crystals	¼
239	Hornblende gneiss		Ne	Ov	do	⅛-¼	70		10				20		Tr.		Tr.		Beryl	1 crystal	¼
240	do		Ne	L	do	¼	70		15				15		Tr.		Tr.		Beryl	do	½
241	Gneissic granite		Ne	Ov	do	½-¾	41		40				18		<1		Tr.		Tourmaline	Trace	
242	Fine-grained granite.	None		Ov	do	½	50		30				20		1		Tr.				
243	do	do	C	Lb	do	¼	70		10				20				Tr.		Martite	Trace	
244	do	do		L	do	¼	65		10				25		<1		Tr.		Beryl	4 crystals	⅛-¼
245	Hornblende gneiss, tonalite and granite.	do	C	Ir	North half, wall zone.	8	57		20		25	24-36	20		3		Tr.		do	1 crystal	(6)
					South half, wall zone.	⅛	85		3				12		<1		Tr.		Beryl Columbite-tantalite.	2 crystals 3 crystals	½ ¼
					Core pods	1-2	49		20				30		1						
246	Hornblende gneiss	do	C	Ir	Wall zone	¾	65		8				25		2						
					Core pods	2½	25		35				40		<1		Tr.				
247	do			Ir	1 unit	½	84		4		5		12		<1						
248	do			L	do	¾	64		8				25		3		Tr.				
249	do		C	Lb	do	1½	53		20		20		25		2		Tr.				
250 (Opportunity 2A and 3A).	do	None	C	Lb	Wall zone	4	33	¼-½	40	2-36	10-15	12-36	25	¼-½	2	¼-½	Tr.		Beryl Monazite Biotite	1 crystal 1 crystal <1	2½ ⅛
					Core pods	6-8	5		30				65		<1				Beryl	1 crystal	(7)
					Wall zone	¼-½	70		10				20		<1		Tr.		Beryl	2 crystals	¼-1
251	do		Ne	Lb	Core	8	10		51				35		4				Beryl Monazite Tourmaline Columbite-tantalite.	4 crystals 5 crystals Trace 2 crystals	⅛-1½ (8) 1/32-¼
252	Tonalite		Ne	Lb	1 unit	⅛-¼	80		5				15		<1		Tr.		Biotite	Trace	
253	do		Ne	Lb	do	⅛-¼	75		10				15		<1		Tr.				
254	Hornblende gneiss		Ne	L	do	¼	70		15				15		<1		Tr.				
255	Tonalite		Ne	Lb	do	¼	57		8				35		<1		Tr.				
256	Hornblende gneiss		Ne	L	do	¼	60		15				25		<1		Tr.				
257	do		Ne	L	do	⅛-¼	76		4				20		<1		Tr.				
258	do		Ne	Lb	do	¼	69		10				20		1		Tr.				
259	do		Ne	Ir	do	¼	53		22				25		Tr.		Tr.		Beryl	14 crystals 1 crystal	⅛-½ ¾
260	Hornblende gneiss and fine-grained granite.		Ne	L	do	¼	55		20				25		<1						
261	Fine-grained granite.		Ne	L	do	¼	55		25				20		<1						

[2] Cleavelandite. [3] Up to 3. [4] Up to ½. [5] Up to 36. [6] ¾ by 2. [7] 6 by 10. [8] Up to 1.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
262	Hornblende gneiss		Ne	L	1 unit	1/8–1/4	73		15				12		<1		Tr.				
263	Fine-grained granite.			Ir	do	1/2	50		30				20		<1						
264	do			L	do	1/4	72		8				20		<1						
265	Hornblende gneiss		Ne	L	Wall zone	1/16–1/8	85		5				10		<1		<1				
					Core	1	44		30				25		1						
266	Fine-grained granite.		Ne	L	Wall zone	1/4	70		10				20		<1		Tr.				
					Core	1–2	45		25				30		<1				Columbite-tantalite	1 crystal	
267	Hornblende gneiss		Ne	Ov	Wall zone	1/8–1/4	69		3				25		3		Tr.				
					Core	3–4	24		30				45		1						
268	Hornblende gneiss and fine-grained granite		Ne	L	1 unit	1/4	67		3				30		<1						
269	Fine-grained granite		Ne	L	do	1/4	61		4				35		<1						
270	Hornblende gneiss	None		Ir	Hanging-wall layer.	3/4–1	44		25				30		1						
					Middle layer	6	25		30				45		<1	1–2			Beryl	1 crystal	(9)
					Footwall layer	1/16	81		3				15		1		<1				
271	Tonalite	do		L	1 unit	3/4	40		35				25		<1		Tr.				
272	Hornblende gneiss	do		Ir	do	1/8	80		5				15		<1		<1				
273	do	do		Ir	Wall zone	1/8	76		8				15		1		Tr.				
					Core pods	2	40		25				35		<1						
274	do		C	Lb	Hanging-wall layer.	3/4	45	1/8–1/4	30	1–4			25		<1		Tr.		Martite	Trace	1/2
					Footwall layer	1/16	81		3				15		1		<1				
					Core	2	25		40				35		<1						
275	do			Ir	Wall zone	1/8–1/4	58		3				35		4						
					Core pods	2	44		20				35		1						
276	do	None		Lb	1 unit	1/4	74		5				20		1						
277	Hornblende gneiss and granite	do	C	Ir	Wall zone	1/8–1/4	71		8				20		1						
					Core	2	30		54				15		1						
278	do	do		L	1 unit	1/4	64		7				27		2		Tr.				
279	Hornblende gneiss			Lb	Wall zone	1/4	65		15				20		<1		Tr.		Biotite	Trace	
																			Beryl	35 crystals	1/8–3/8
					Core	3	30	1/8–1/4	30				39		1	1/4–3/4	<1		Gahnite	Trace	1/64
																			Samarskite(?)	1 crystal	1/2
280	do			L	1 unit	1/8	73		12				15		<1		Tr.		Martite	Trace	
281	do			L	do	1/8	75		10				15		Tr.		Tr.		Beryl	3 crystals	1/8–1/4
282	do			Lb	do	1/4	65		20				15		Tr.		Tr.		Biotite	Trace	
283	do		Ne	L	do	1/2–3/4	60		15	3–6			25		<1		<1		Beryl	1 crystal	1/4
284	Fine-grained granite	None		L	do	1/8	70		8				22				Tr.				
285	do	do	Cf	L	do	1/8	70		15				15				<1				
286	do			L	do	1/2	55		25				20		<1		Tr.				
287	Hornblende gneiss			Lb	do	1/4	75		15				10		Tr.		Tr.				
288	do		Ne	L	Wall zone	1/4	63		3				30		4		<1		Tourmaline	1 crystal	
					Core	3	[2] 60		>1				40		<1				Beryl	3 crystals	1
289	do		Ne	L	Wall zone	1/2	42		25	2–3			30		3		Tr.		Tourmaline	1 crystal	
					Core	1 1/2	[2] 60		5				35		<1				Beryl	do	2
																			Columbite-tantalite	do	
																			Tourmaline	do	
290	Hornblende gneiss and granite.	None		Lb	Hanging-wall layer	1/8	79		2				15		4		Tr.		Biotite	Trace	
					Center layer	4–6	20		50				30		<1		Tr.		Beryl	1 crystal	
																			Tourmaline	Trace	
					Footwall layer	3/4	37		42				20		1		Tr.		Biotite	do	
																			Columbite-tantalite	1 crystal	
																			Monazite	do	
291	Fine-grained granite.		C	L	1 unit	1/2	55		20				25		<1		Tr.				
292	Tonalite		C	Lb	Hanging-wall layer.	3/4	54		25				20		1						
					Footwall layer	1/16	86		3				10		1						

293	do			Ov	Wall zone	⅛	78		2				20		<1	[2]					
					Core	3	15		42				42		1						
294	Hornblende gneiss			Ir	1 unit	⅛	66		3				30		1						
295	do	None		Ir	do	¼	70		10				20		<1		Tr.				
296	do		Ne	L	North and south ends	4	25		43				30		2						
					Center unit	1/16	83						15		2		<1				
297	Hornblende gneiss and granite	None	C	Ir	Wall zone	½	74		5				20		1						
					Core	6–8	14		43				43		<1						
298	Hornblende gneiss		Ne	L	One unit	½	65		10				25		Tr.						
299	Covered		Ne	Lb	do	¾	65		20				25		<1				Beryl	8 crystals	1/16–¼
300	Hornblende gneiss		Ne	Lb	do	¾	53		22	3-6			25		<1		Tr.		Beryl	do	¼
																			Martite	Trace	⅛–1
301	do		Ne	Ir	do	¼	66		3				30		1		<1		Beryl	2 crystals	½
302	do		Ne	Lb	Wall zone	½	70		10				20		<1		Tr.		Beryl	do	½–1
					Core	1½	15		40				45		<1						
303	do		Ne	L	1 unit	⅛	80		8				12		<1		<1				
304	do		Ne	Ov	do	½	54		20				25		1		<1				
305	Hornblende gneiss and fine-grained granite.	None		Ir	Wall zone	⅛	80		5		1		15		1		<1		Beryl	3 crystals	1/16
					Core				√				√						Chlorite	Trace	
306 (Opportunity No. 4).	Hornblende gneiss		Ne	L	East layer	¼	65		10	3			22		3		Tr.		Tourmaline	<1	
					West layer	1½	[2] 79	1–3					15		1				Tourmaline	<1	
																			Microlite	2 crystals	1/10
																			Lepidolite	4–5	1/16–½
307 (Opportunity No. 4).	do		Ne	Ir	1 unit	½	47		30		5–10		20		3		<1		Tourmaline	Trace	
308	do		Ne	L	Wall zone	½	59		15		10–20		25		1		Tr.		Beryl	1 crystal	
					Core	3			√				√								
309	do		Ne	Ir	Hanging-wall layer.	¼	64		20				15		1		<1				
					Footwall layer	4–6	5		75		>50		20		<1						
310	do		Ne	Ir	1 unit	¼	35		45		5–10		20		1						
311	do		Ne	L	do	¾	44		35		30		20		1		<1		Beryl	2 crystals	¼
																			Tourmaline	Trace	
312	do		Ne	Ir	do	2–3	25		54		75		20		1		Tr.		Tourmaline	Trace	
313	Granite gneiss		Ne	Ov	do		15		64		75		20		1						
314	Hornblende gneiss and granite gneiss.		Ne	L	do	1	38		40		50		20		2						
315	Tonalite and granite.	None	C	Lb	do	½–¾	75		5				20		<1						
316	Tonalite	do	C	Ir	Wall zone	¼	66		5				25				4				
					Core	8	10		25		5		64		1	2			Beryl	1 crystal	¾
317	do		Ne	Lb	Wall zone	¼–½	58		15				25		2		Tr.				
					Core	4	15		35				48		2						
318	do		Ne	L	1 unit	¼	69		1				30		<1						
319	Hornblende gneiss		Ne	L	do	¾	44		30				20		6						
320	do		Ne	Lb	do	½	61		1				35		3						
321	Tonalite	None	Cf	L	Wall zone	⅛	70						30								
					Intermediate zone.	½	84		2				10		4						
					Core								100								
322	Hornblende gneiss		Ne	L	1 unit	¼–½	62		10				25		3						
323	Tonalite	None	C	Ov	Wall zone	½–¾	69		10				20		1						
					Core	2	40						59		1						
324	do	do	C	Ir	1 unit	¼	68		10				20		2						
325	do	do	C	Ir	do	⅛–¼	84		10	1			5	¼–½	1–2	½	<1		Beryl	1 crystal	
326	do		Ne	Ov	do	1	40		40				20		<1						
327	do		Ne	Ov	do	½	52		30	6			18		<1						
328	do		Ne	L	do	⅛	80		5	2			15								
329	do		Ne	Lb	do	¼	54		30	6			15		1		<1				
330	Tonalite and fine-grained granite.		Ne	Lb	do	¼	60		19				20		1		Tr.		Beryl	3 crystals	½
																			Biotite	Trace	
																			Magnetite	2 crystals	
331	Tonalite		Ne	L	do	¾	45		35				25		<1						
332	Fine-grained granite.			Lb	do	½	35		40				25		Tr.		Tr.				
333	Tonalite		Ne	L	do	¼–½	50		30				20		<1		<1		Magnetite	<1	
334	Hornblende gneiss and granite.	None	C	Ir	do	1/16	73		7				20		Tr.		Tr.		do	Trace	
335	Hornblende gneiss		Ne	L	do	⅛	75		10				15				Tr.				
336	do		Ne	L	do	¼	55		25				20		<1		Tr.		Beryl	1 crystal	⅛
337	Hornblende gneiss and granite.	None	C	L	do	¼	60		25				15		<1		<1				
338	Tonalite		Ne	Lb	do	¼–½	55		20				25		<1		Tr.		Beryl	2 crystals	¼
339	do		Ne	Lb	do	¼–½	55		25				20		<1		Tr.		Epidote	Trace	
340	do		Ne	L	Wall zone	¼	67		10				20		3		<1				
					Core	4	10		5				84				1				
341	do		C	Lb	1 unit	⅛–¼	63		15				22				<1				
342	do		Ne	L	do	⅛–¼	70		10				20		<1		Tr.		Beryl	2 crystals	¼
343	do		Ne	L	do	1/16	78		2				20				Tr.				

[2] Cleavelandite. [9] 1 by 5.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
344	Tonalite and granite.		Ne	L	1 unit	⅛–¼	55		25				20		Tr.		Tr.				
345	do	None	C	Lb	do	⅛–¼	65		15				20		<1		Tr.				
346	do	do		L	do	⅛–¼	65		15				20		<1		Tr.				
347	Tonalite		Ne	Lb	do	¼	60		20				20		Tr.		Tr.		Beryl	2 crystals 1 crystal	1/16 ¼
348	do		Ne	Lb	do	¼–½	50		25				25				Tr.				
349	do		Ne	L	do	½	40		25				35				Tr.				
350	Tonalite and granite.		Ne	L	do	⅛–¼	65		15				20		Tr.		Tr.		Magnetite	<1	
351	Granite			L	do	⅛	65		15				20		Tr.		Tr.		Biotite Magnetite	Trace do	
352	Tonalite and granite.	None		Lb	do	⅛–¼	55		30				15		Tr.		Tr.		do	<1	
353	do	do	C	L	do	¼	55		25				20		<1		Tr.		Biotite	Trace	
354	do	do	C	Lb	do	⅛	70		15				15		Tr.		Tr.		do	do	
355	do	do	C	Lb	do	½–¾	58		25				15		2		Tr.				
356	do		Ne	Lb	do	¼	65		15				20		Tr.		Tr.		Biotite Magnetite Beryl	Trace do 3 crystals	 ⅛–¼
357	Tonalite		Ne	Ir	Wall zone	1/64	85						15								
					Core	(?)			<1				100								
358	Hornblende gneiss		Ne	L	1 unit	¼	60		20				20		Tr.		Tr.		Beryl	10 crystals	½–¾
359	do		Ne	L	do	¼	60		20				20		<1		Tr.		Beryl Columbite-tantalite.	4 crystals 1 crystal	1 <¼
360	Coarse-grained granite.	None		Ir	do	¾	45		40				15		Tr.		Tr.		Biotite Beryl	Trace 1 crystal	 ½
361	Tonalite		Ne	Lb	do	½–¾	45		30				25		<1		Tr.				
362	do		Ne	L	do	¼	65		15				20		<1		Tr.				
363	do		Ne	Lb	do	½	55		25				20		<1		Tr.		Beryl	4 crystals	½
364	do		Ne	L	do	¼–½	50		25				25		<1		Tr.		do	10 crystals	⅛–¼
365	do		Ne	L	do	¼	60		20				20		<1		Tr.		do	1 crystal	¼
366	do		Ne	Lb	do	⅛–¼	72		8				20		<1		<1		do	6 crystals	⅛–1
367	do		Ne	Lb	do	¼–½	53		25				20		2		Tr.		do	1 crystal	¼
368	do		Ne	Lb	do	⅛	72		3				25		Tr.		Tr.				
369	do		Ne	L	do	¼	65		15				20		Tr.		Tr.				
370	do		Ne	L	do	⅛–¼	69		10				20		1		Tr.				
371	do		Ne	L	do	⅛–¼	64		15				20		1		<1				
372	do		Ne	L	do	⅛–¼	67		12				20		1		Tr.				
373	do		Ne	L	do	¼–½	54		25				20		1		<1				
374	do		Ne	L	do	⅛	70		5				25		Tr.						
375	do		Ne	Lb	do	⅛–¼	70		10				20		<1		Tr.				
376	do		Ne	L	do	¼	50		30				20		<1		Tr.				
377	do		Ne	L	do	⅛–¼	70		10				20		<1		Tr.		Beryl	1 crystal	¼
378	do		Ne	L	do	¼	59		20				20		<1		1		do	9 crystals	¼
379	Tonalite and fine-grained granite.		Ne	L	do	⅛	73		5				22		<1		<1		do	1 crystal	1/16
380	Tonalite		Ne	Lb	do	¼	68		12				20				Tr.				
381	do		Ne	L	do	¼	65		15				20		Tr.		Tr.				
382	do		Ne	Lb	do	⅛–¼	70		10				20		<1		<1		Beryl	4 crystals	¾
383	do		Ne	Lb	do	⅛–¼	65		15				20		<1		<1		Martite	Trace	
384	do		Ne	Lb	do	¼–½	60		20				20		<1		<1		Beryl	1 crystal	½
385	do		Ne	L	do	6–8	7		53		33		40		Tr.				Biotite Columbite-tantalite.	Trace 2 crystals	 ½
386	do		Ne	L	do	⅛	72		8				20		<1		Tr.				
387	Coarse-grained granite.	None		L	do	¼	60		25				15				<1				
388	do	do		L	do	⅛	75		10				15				<1				
389	Tonalite	do	C	Lb	do	⅛	73		7				20		Tr.						
390	Tonalite and granite.	do		L	do	⅛–¼	70		10				20		<1		<1		Beryl	1 crystal	¼
391	Tonalite	do	C	Lb	Wall zone	<1/64	75						25		Tr.						
					Core	4–8	15						85						Tourmaline	Trace	
392	Covered		Ne	Lb	1 unit	1–2	40		40				20		<1		Tr.				
393	do		Ne	Ov	do	1	40		35				25		<1						

394	do		Ne	Ir	do	¼	63		7				25		5		Tr.				
395	do		Ne	L	do	⅛–¼	57		15				25		3						
396	do		Ne	Lb	do	1–2	49		40				10		1						
397	do		Ne	L	do	⅛–¼	70		5				25		Tr.		Tr.				
398	do		Ne	L	do	1–2	38		45		20		15		2						
399	do		Ne	Ir	do	1–2	50		30				20		<1		Tr.		Biotite	<1	
400	do		Ne	L	do	¾	50		30				20		<1		Tr.				
401	do		Ne	Ir.	do	⅛–¼	70		10				20						Biotite Magnetite	Trace do	
402	do		Ne	L	do	¾	40		45				15		Tr.		Tr.				
403	do		Ne	L	do	¾	50		35				15		<1		Tr.				
404	do		Ne	L	do	¾	45		30				25		<1		Tr.				
405	Tonalite	None	Ne	Lb	do	¾	55		15				30								
406	do		Ne	L		½	47		30	6			20		3						
407	Hornblende gneiss		Ne	L	do	¾	50		20	4			30		<1						
408	do		Ne	Lb	do	½	60		10				30		<1						
409	do		Ne	L	do	⅜	70						30		<1						
410	do		Ne	L	Wall zone	⅛	85						15								
					Core	4–5			15	4			85		<1						
411	Quartzite		Ne	L	Wall zone	¼	85						15		<1						
					Core	6	30		39	4–10			30		1						
412	Hornblende gneiss		Ne	L	1 unit	3	53	⅛	35	10			10		2						
413	do		Ne	L	Wall zone	⅛	72		5				15		8				Beryl	0.3	
					Core	6	15		44				40		<1				Beryl	<0.05	
414	do		Ne	L	1 unit	½	44		20				35		1						
415	do		Ne	L	do	1	57		8	3			35				<1				
416	do		Ne	L	do	⅜	55		35				10		<1		Tr.		Beryl	4 crystals	¾
417	do		Ne	Ir	Wall zone	⅛	55		5				35		5				do	1 crystal	¾
					Core	3	42		45	4–6			8		5				do	0.2	⅛–2
418	do		Ne	L	1 unit	¼	61		15				20		4				do	1 crystal	¼
419	do		Ne	Lb	do	½	75		15				10		<1		Tr.				
420	do		Ne	L	do	⅜	75		10				15				Tr.		Beryl	2 crystals	¼
421 (Ben-Kauf No. 4).	do		Ne	L	do	½	44		20				35		1						
422 (Ben-Kauf No. 1.)	Tonalite		Ne	Lb	Hanging-wall layer.	3	22		35				35		8						
					Central unit	½	[2] 81		15				2						Lepidolite Microlite Apatite	2 0.01 1 crystal	 ¼
					Footwall layer	¼	50		2				40		8						
423	Hornblende gneiss		Ne	L	1 unit	½	49		35				15		1						
424 (Bazooka)	Tonalite		Ne	L	Wall zone	½	[2] 82						10						Lepidolite	8	
					Core	1–2	[2] 15						85								
					do	4	[2] 20						60						Microlite Lepidolite Spodumeme Amblygonite	1 crystal 2 12 6	
425	Hornblende gneiss		Ne	L	1 unit	¼	60		15				25						Beryl	3 crystals	¾
426	do		Ne	L	do	⅜	54	⅛	10	4			35		1						
427	do		Ne	L	do	1	30		40				30								
428	do		Ne	L	do	1	30		40				30		<1				Beryl	2 crystals	½
429	do		Ne	L	do	½	70		15	8			15		<1						
430	do		Ne	Ov	do	½	55	<⅛	20	2			25		Tr.						
431	do		Ne	Lb	Hanging-wall layer.	4	30		45				25		<1				Beryl	<0.05	1
					Footwall layer	¼–½	65		20				15		Tr.						
432	do		Ne	L	Border zone	⅛	92		5				3						Beryl	0.1	¼–¾
					Hanging-wall layer.	2	46		30				20		4		Tr.		do	0.05	¼–¾
					Footwall layer	¼	62	⅛	2				35		1				do	1 crystal	
433	do	None	Cf	L	Hanging-wall layer.	½	44		20	4			35		1		Tr.		do	<0.05	1½
					Footwall layer	⅛	64						35		1						
434	do		Ne	L	1 unit	¼	54		8				35		3	¼			Beryl	1 crystal	6
435	do		Ne	L	Hanging-wall layer.	1	40		35				15		2				do	4 crystals	
					Footwall layer	⅛	65						35		<1						
436	do		Ne	L	Wall zone	¼	65	⅛	5	3			30		<1						
					Core	4	5		80				15		<1				Beryl	1 crystal	1
437	do		Ne	L	1 unit	¼	46	⅛	20	8			32		2				do	do	½
438	do		Ne	L	do	¼	55	⅛	15	6			30		<1				do	do	¾
439	do		Ne	L	do	¼	55		15				30		<1				Beryl	2 crystals	¼
440	do		Ne	Ov	Hanging-wall layer	3	25		40	12			25		10				do	do	
					Footwall layer	¼	52		15				26		7				Apatite	Trace	
441	do		Ne	Ir	Wall zone	¼	65		30	1			5		Tr.						
					Core	8–12	2		8				90								
442	do		Ne	L	1 unit	⅛	45		15				35		5						
443	do		Ne	L	do	⅛	38		35				25		2						
444	do		Ne	L	do	¼	50	⅛	15				35								
445	do		Ne	L	do	8	35	⅛	5				60	1							
446	do		Ne	L	do	¼	53	⅛	7	2			40	1	<1		Tr.				
447	do		Ne	L	do	¼	40		35				25		<1						
448	do		Ne	L	do	¼	58		2				40								
449	do		Ne	Ir	do	1	40	⅛					57	2	2		Tr.		Tourmaline		1
450	do		Ne	L	do	1	34	¼					65	1	1						

[2] Cleavelandite.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
451	Hornblende gneiss		Ne	L	1 unit	1	40		40	4	5–10		20								
					West branch wall zone, quartz-cleavelandite pegmatite.	4–6	[2]45						52		3		<1		Tourmaline	<1	
																			Curved lepidolite	<1	
					West branch core, albite-monazite-columbite pegmatite.	1/8–1/4	86	1/8–1/4					5	1/8			<1		Tourmaline	<1	1/4–1/2
																			Gahnite	1	1/16
																			Biotite	4	1/16
																			Monazite	2.2	1/4–1 1/2
																			Columbite-tantalite.	1.4	1/4–2
																			Fluorite	Trace	
																			Betafite	Trace	
					Hanging-wall layer, perthite-albite-quartz pegmatite.	12	30		40				20		10				Tourmaline	Trace	(10)
																			Beryl	0.1	2 by 2.
452 (Brown Derby No. 1).	do	None	C	Lb	Hanging-wall quartz pod.	24	[2]25						70						Lepidolite	5	3–4
					Curved-lepidolite layer.	4–5	[2]44						40		<1				Curved lepidolite	15	1/4–2
																			Topaz	1	4–8
																			Apatite	5 crystals	1/4
					Lepidolite-microlite pegmatite layer.	1	[2]43						15						Lepidolite	40	<32–<8
																			Microlite	0.35	1/64–1/4
																			Topaz	2	4–6
																			Beryl	1 crystal	1/2
					Quartz-cleavelandite-lepidolite-topaz layer.	4–6	[2]25	1/2–3					55	1–10	1	1/2–1 1/2			Tourmaline	<1	
																			Lepidolite	10	1–7
																			Topaz	10	(11)
																			Beryl	<0.1	1–4
					Footwall layer, albite pegmatite.	1/4	90						8		Tr.		<1		Biotite	Trace	
																			Tourmaline	2	
453 (Brown Derby No. 2).	do	do	C	L	Wall zone	1/4–1/2	62						30		7		<1		Biotite	1	
					Core	1	[2]53						40				<1		Topaz	<1	
454 (Brown Derby) No. 3).	do	do	C	Lb	North end	12–24	10		74	12–24	75		15		1				Topaz	1.1	4–8
																			Microlite	1 crystal	
																			Lepidolite	5	
																			Tourmaline	1	
					South end, wall zone.	1/2–3/4	37		2				55	1–2	4	1–3	<1		Biotite	2	
																			Beryl	2 crystals	1/2
																			Tourmaline	<1	
																			Topaz	<1	
																			Microlite	Trace	
																			Columbite-tantalite.	1 crystal	
					South end core	5–6	[2]47		1				38		4		<1		Beryl	4 crystals	1–3
																			Lepidolite	7	
																			Tourmaline	3	
455 (Brown Derby Dike No. 4).	Hornblende gneiss and biotite schist.	do	C	L	Southern and northern ends.	1/8	82		10				8		<1		<1				
					Southern part core.	24–36	10		80				10		Tr.				Beryl	3 crystals	3–12
					Central section	24–36			5				95								
456 (Brown Derby Dike No. 5).	Hornblende gneiss		Ne	L	Wall zone	1/2	65		20				15		<1		<1		Microlite	1 crystal	1/4
					Core	8	[2]56						45		1						

457 (Brown Derby Dike No. 6).	do		Ne	Lb	Wall zone	¼	72		5				20				<1		Tourmaline Beryl Curved lepidolite.	<1 1 crystal 3	 ¼
					Core	3	[2] 64		5				30		5		<1		Curved lepidolite.	1	
458 (Brown Derby Dike No. 7).	do		Ne	L	Hanging-wall layer.	6	10		70	(12)			20		4				Beryl	1 crystal	2
					Footwall layer	¼	68		10				20		2		<1				
459 (Brown Derby Dike No. 8).	Hornblende gneiss and biotite schist.	None	C	Lb	Wall zone	3	42		35	4–12	2		20		3		<1		Gahnite Beryl	Trace 4 crystals	 ¼–7
					Pod	4	[2] 67						20		1				Topaz Lepidolite	10 2	
460 (Brown Derby Dike No. 9).	Biotite schist	do	C	L	1 unit	2	45		44	(13)			10		1						
461 (Brown Derby Dike No. 10).	Biotite schist and hornblende gneiss.	do	C	Lb	do	3	44		35	(14)			20		1		Tr.		Beryl Tourmaline	8 crystals Trace	½–3
462	Hornblende gneiss	do	Cf	L	Wall zone	⅛–¼	71		5				20		2		2	1/16	Biotite Tourmaline	<1 <1	 ¼–½
					Core	3	[2] 92						8		<1		<1		Lepidolite Microlite Tourmaline	<1 5 crystals <1	1/16–3 ⅛–¼
463	do		Ne	L	Hanging-wall layer.	3	25		52				20		3		<1		Beryl	1 crystal	¼
					Footwall layer	¼	71		8				20		1		<1				
464	do		Ne	L	Wall zone	¼–½	45		10				40		5						
					Core	2	10		55				25		5				Biotite	<1	
465	do		Ne	L	Wall zone	¼	70		15	(3)			15		<1				do	Trace	
					Core	12	5		20				75								
466	do		Ne	L	1 unit	½	65		20				15								
467	do	None		L	Hanging-wall layer.	4	30		40				30		<1		Tr.				
					Footwall layer	¼	65		15				20								
					Fracture filling								100								
468	Coarse-grained granite.	do		L	Wall zone	¾–1	3		77		30		20								
					Core	3–4			60				40		<1						
469	do	do		L	1 unit	¾–1	3		72				25		Tr.		Tr.		Biotite	Trace	
470	do			L	do	1–2	5		75				20		<1						
471	do			Lb	do	¼–½	25		49		10–15		25		1						
472	do	None		Lb	do	2–3	4		69		30		25		2		Tr.				
473	do			L	do	¾	30		44		25		25		1		Tr.				
474	do	None		Lb	do	¾	3		77		30		20		<1		Tr.				
475	do	do		L	do	1–2	1		78		20		20		1						
476	do	do		Lb	do	1½	2		78		30		20		Tr.		Tr.		Biotite	Trace	
477	do	do		Lb	do	¼–½	50		25				25		<1		Tr.		Beryl Magnetite	21 crystals <1	⅛–½
478	do	do		L	do	3–4	1		73		90		25		1						
479	do			Lb	do	1	2		77		50		20		1		Tr.				
480	do			L	do	1–2	5		75		70		20				Tr.		Magnetite	Trace	
481	do			L	do	1-2	2		78		60		20		<1		Tr.				
482	do			L	do	1–2	1		79		75		20		<1						
483	do			L	do	½–¾	15		65		30		20		Tr.				Beryl Biotite	1 crystal Trace	¼
484	do	None		L	Wall zone	1–2	2		78		90	4	20	⅛					Magnetite	do	
					Core	3			30				70								
485	do	do		L	Main unit	3–4	5		75		85		20						Biotite	Trace	
					Fracture filling	6			√				√								
486	do	do		Lb	Main unit	3-4	5		75		85		20		Tr.		Tr.		Biotite	Trace	
					Fracture filling	6	Tr.		5				95				Tr.		do	do	
487	do			Ov	1 unit	3–4	10		70		70		20								
488	do			L	Main unit	3–4	15		70		80		15		Tr.		Tr.		Tourmaline	Trace	
					Fracture filling	6			√				√								
489	do	None		Lb	1 unit	4	3		82		90		15				Tr.		Magnetite Biotite	Trace do	
490	do			L	do	2–3	3		77		90		20						Magnetite	do	
491	do			L	do	3	2		78		95		20				Tr.		do	do	
492	do			Lb	Main unit	3–4	1		79		95		20						do	<1	
					Fracture filling	5–6			35				65								
493	do	None		Lb	1 unit	4–5	Tr.		80		95		20				Tr.		Magnetite	Trace	
494	do	do		Lb	do	4	3		77		95		20				Tr.		Biotite Magnetite	do do	
495	do			Lb	do	1	5		75		80		20				<1		Biotite	do	
496	do	None		Lb	do	3–4	15		55		√		30								
497	do	do		Ir	do	3	10		65		√		25				Tr.				
498	do	do		Ir	Main unit	1–2	35		35		√		30								
					Fracture filling	(?)							100								
499	do			L	1 unit	5	23		47		√		30		Tr.						
500	do			Lb	do	2	30		45		√		25		Tr.						
501	do			L	do	5	8		50		√		30		2						
502	do			L	Wall zone	¼	10		60		√		30				Tr.				
					Core	(?)				(14)			100								

[2] Cleavelandite. [3] Up to 3. [10] ½ by ¼. [11] Up to 7 across by 42 long. [12] Up to 18. [13] Up to 6. [14] Up to 12.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
503	Coarse-grained granite.			Lb	1 unit	6	7		65				25		3	¾					
504	do			Ov	Main unit	2	30		40	([3])			25		5						
					Fracture filling	(?)							100								
505	do			Ir	Main unit	2	30		45	4	40		25								
					Fracture filling	(?)							100								
506	do	None		Lb	1 unit	4	15		55		85		30		Tr.		Tr.				
507	do	do		Ov	Main unit	2	20		55		80		25		<1						
					Fracture filling	(?)							100								
508	do	do		Ir	Main unit	1-2	20		60				20		Tr.						
					Fracture filling	(?)							100								
509	do	do		Ir	Main unit	½	40		30		√		30								
					Fracture filling	(?)							100		<1		Tr.				
510	do		Ne	L	Main unit	¼	70		5				25								
					Fracture filling	(?)							100								
511	do	None		L	Main unit	½-1	30		40		√		30								
					Fracture filling	6			10				90								
512	do	do		Ir	1 unit	½	30		39		50		30		1						
513	do		Ne	Ir	do	¼	33		35		50	½	30		2						
514	Hornblende gneiss and granite.		Ne	L	do	4	15		50		85		35								
515	Hornblende gneiss		Ne	Ir	do	4	15		50		85		35								
516	Hornblende gneiss and granite.		Ne	L	do	2	34		35		√		30		1						
517	Hornblende gneiss		Ne	Ir	Main unit	2-3	45		25				30		<1						
					Fracture filling	(?)							100								
518	do		Ne	Ir	1 unit	1-2	20		50		40		30								
519	do		Ne	L	do	¼	55		15				30						Biotite	Trace	
520	do		Ne	Ir	Wall zone	¼	50		20		√		30		Tr.		Tr.				
					Core	6			10				90								
521	do		Ne	L	1 unit	¼	65		5				30								
522	do		Ne	L	do	⅜	80						20								
523	do		Ne	Lb	do	2	50		30	([15])	√		20								
524	do		Ne	L	Wall zone	¾	10		65		√		25								
					Core		√						√								
525	do		Ne	L	1 unit	¼	57		25				18								
526	Dacite	None		L	do	¼	55		20	([15])			25		<1						
527	do	do		L	do	1-1½	20		50				30								
528	Hornblende gneiss		Ne	Ov	do	¼	65		25	¾			10				<1				
529	do		Ne	L	do	4			√		85		√								
530	Hornblende gneiss and granite.		Ne	Lb	Main unit	1-2	20		45				35								
					Fracture filling	(?)							100								
531	Coarse-grained granite.		Ne	Ir	1 unit	1	25		40				35								
532	do		Ne	L	Main unit	¼	50		25	([15])			25				Tr.				
					Fracture filling	(?)							100								
533	Dacite	None		L	Wall zone	¼	53		25	([19])			20		2	¾					
					Core	(?)							100								
534	Hornblende gneiss	do		Ir	Wall zone	⅛-¼	58		15				25		2						
					Core	4-12	7		62				30		1				Beryl	1 crystal	4
					Fracture filling	6	7		62				30		1						
535 (Brown Derby No. 5).	Tonalite	do		Ir	Wall zone	⅛-¼	61		10				25		4		Tr.		Tourmaline	<1	
																			Lepidolite	Trace	
																			Beryl	<.05	0.6-1.1
					Intermediate zone.	4	[2] 35		4				55		1		<1		Apatite	Trace	½
																			Columbite-tantalite.	1 crystal	1/64-¾
																			Tourmaline	<1	
																			Microlite	13 crystals	⅛-¼
																			Lepidolite	5	
																			Topaz	<1	4-6
																			Beryl	<0.1	½-3½
					Core	6	20		39				40		1				Columbite-tantalite.	2 crystals	1/16-1½
																			Lepidolite	Trace	
																			Beryl	1 crystal	([16])

536	Hornblende gneiss	do		Ir	Wall zone	¼–½	45		10	([15])			40		5						
					Core	24–36	10	¼	55				25		5				Biotite	5	8
					Fracture filling				25				75								
537	do		Ne	Ir	Wall zone	¼	58		5				35		2				Beryl	0.3	¼–3
					Core	8–10	10		65				20		5						
538	do		Ne	Ir	Wall zone	¼	57		10	([13])			25		8						
					Core	4	15		32				50		3	¼			Beryl	0.5	1/64–6
539	do		Ne	L	Hanging wall layer.	6	8		80				12								
					Footwall layer	⅛	69		7				20		4						
540	do		Ne	L	1 unit	¼	62	⅛	15	([17])			20	⅛	3	¼					
541	do	None		L	Wall zone	¼	60		10				25		5		<1				
					Core	6	5		25				70						Beryl	Several pieces	¾
542	do		Ne	Ir	Wall zone	¼	60		30				10		<1						
					Core	6	53		5				92		<1						
543	do		Ne	Ir	Wall zone	½	55		10				30		5				Beryl	1 crystal	1½
					Core	(?)							100								
544	do		Ne	L	1 unit	⅛	68		10				20		2						
545	do		Ne	L	Wall zone	⅛–¼	69		10				20		1		<1				
					Core	1	20		48				30		2						
546	do		Ne	L	Wall zone	¼	55		25				20		<1						
					Core	5	5		3				92		<1				Biotite	Trace	
547	do		Ne	L	1 unit	6	25		30				43		2						
548	do	None	C	Lb	Hanging-wall layer.	10	15		50				33		2				Beryl	3 crystals	3–4
					Footwall layer	⅛	74		3				20		3						
					Consolidated	¼–½	63		15				20		2						
549	do			L	Wall zone	¼	58		15				25		2						
					Core	8	10		20				66		4						
550	do		Ne	Ir	1 unit	¼	53	⅛	20				25		2				Monazite	1 crystal	¾
551	do		Ne	L	do	½	54		25	([13])			20		1				Beryl	4 crystals	½
552	do		Ne	L	do	⅛	60		10				30		<1						
553	do		Ne	L	Wall zone	⅛	70		15				14		1						
					Core	(?)															
554	do		Ne	L	1 unit	½–¾	50	⅛	25	([18])			25		<1						
555	do		Ne	L	Hanging-wall layer.	4	25		60				15		<1		Tr.				
					Footwall layer	⅛	70		15				15								
556	do			Ir	Main unit	¼	70		15	2			15								
					Fracture filling	2	20		55	([17])			25								
557	do			L	Wall zone	¼–½	49		20	([17])			30		1						
					Core	8	10		60				30								
558	do		Ne	Lb	Main unit	⅛–¼	59		20	([17])			20		1		Tr.				
					Fracture filling	6–12	5		64				30		1						
559	do		Ne	L	Main unit	¼	65	⅛	6	([19])			25		4	¼					
					Fracture filling	4															
560	Hornblende gneiss and granite	None		Ir	Wall zone	⅛	60		4				36		<1		Tr.				
					Main core	4	20	⅛	50				30		Tr.						
					Small pod	12–24	5		75				20						Beryl	0.45	1½–5
561	Hornblende gneiss			L	North end	¼	60		20				20								
					South end	1	30		45				25		Tr.		Tr.				
562	Course-grained granite.		Ne	Ir	Wall zone	⅛	93		1				6		<1						
					Core	1	20		35	([18])			45		<1		Tr.				
563	Hornblende gneiss			L	1 unit	¾	45		40	([3])			15								
564	do		Ne	Ir	Main unit	¼	60		20	([18])			19		1		Tr.				
					Fracture filling				50				50								
					do								100								
565	do		Ne	Lb	Wall zone	⅛	70		5				25		Tr.		Tr.				
					Core	5	35		35				30								
566	do		Ne	Ir	Main unit	¼	50		20				30								
					Fracture filling								100								
567	do	None		Ir	Wall zone	⅛	78		2				20		Tr.						
					Pod								100								
568	do	do		Ir	Main unit	⅛	67		7	½–4			25		<1						
					Fracture filling	2–8			50				50								
569	do		Ne	Ov	1 unit	⅛	50		20				30		Tr.						
570	do	None		L	do	⅛	67		8	([13])			25		<1		Tr.				
571	do		Ne	Ir	do	⅛–¼	73		5				20		1		1				
572	do		Ne	Ir	Wall zone	¼	65		10				25		<1		<1				
					Core	12			9				90		1						
573	do	None		Ir	Main unit	¼	64		15				20		1		Tr.				
					Fracture filling				50				50								
574	do	do		Ir	Main unit	⅛–¼	54		15				30		1		<1				
					Fracture filling				50				50								
					do	(?)							100								
575	do		Ne	L	Wall zone	⅛	60		15				25		<1						
					Core								100								
576	do		Ne	Ov	Wall zone	⅛	73		2				25		Tr.		<1				
					Core	5–6	20		45				35		<1						
577	do		Ne	Ov	Main unit	⅛–¼	66		5				25		3		1				
					Fracture filling				50				50								
					do	(?)							100								
578	do		Ne	L	1 unit	⅛–¼	61		1				35		3		Tr.				

[2] Cleavelandite [3] Up to 3. [13] Up to 6. [15] Up to 2. [16] 4 by 6. [17] Up to 5. [18] Up to 8. [19] Up to 4.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
579	Hornblende gneiss		Ne	Ir	Main unit	1/8	75		7				15		3		Tr.				
					Fracture filling								100								
580	do		Ne	Ov	1 unit	1/8	80		15				5		<1		Tr.				
581	do		Ne	Ir	do	1/8-1/4	63		8				27		2		Tr.				
582	do		Ne	Ov	Wall zone	1/8	70		10				20		Tr.		<1				
					Core	8			10				90								
583	do		Ne	L	1 unit	1/2	40	1/8	30	4-6			30		<1		Tr.				
584	do		Ne	Ir	do	3/4	37		25				35		3		Tr.				
585	do		Ne	L	do	1/2	30		39	(19)			30		1						
586	do		Ne	L	do	3/4	25		45				30		<1						
587	do		Ne	Ir	do	1	49	1/8	20	2-6			30	2-6	1		Tr.				
588	do		Ne	L	do	1/4	53		20	(17)			25		2						
589	do		Ne	L	do	1/4	32		35	1-2			30		3				Beryl	Several crystals	1/4-3/4
590 (Beryl and Rare Minerals Lode).	do		Ne	L	Wall zone	1/4	55		20				25		<1						
					Intermediate zone.	36	<1		50	12-60			20		30	(18)	<1		Beryl Columbite-tantalite. Gahnite Unknown	0.2 <0.05 Trace do	1/2-8 1/4-2 <1/32 1/4
					Core	(?)							100								
591	do		Ne	Ov	1 unit	1/8	60		19				20		1						
592	do		Ne	Lb	Wall zone	1/8	45		20	1/2			30	1/8	5	1/8-1/2					
					Core	2			70				30								
593	do		Ne	L	1 unit	1/4-1/2	28		30				40		2						
594	Tonalite	None		L	do	1/2	56		18				25		1		<1				
595	do	do		L	Hanging-wall layer.	1-2	40		37				20		3		<1				
					Footwall layer	1/8-1/4	84		1				15		<1						
596	Hornblende gneiss		Ne	Ir	1 unit	1/4	30		39	(13)			25		1						
597	do		Ne	Ov	do	1/2	25		39	(13)			35		1						
598	Quartzite	None	C	L	do	1/2-1	39		38				20		3		Tr.		Beryl	1 crystal	3/16
599	Hornblende gneiss			Lb	do	1/4	44		30				25		1		Tr.				
600	do		Ne	Ov	do	1/8	75		9				15		1						
601	do		Ne	Ov	do	1/16	70		14				15		1						
602	do		Ne	L	Wall zone	1/8	64	1/16	20	2			15		1	1/8					
					Core pod	1/2	30		50	3-4			20		<1	1			Beryl Tourmaline	1 crystal Trace	1
603	do		Ne	Ov	1 unit	1/32	79		5				15		1						
604 (White Spar No. 1).	do	None	C	Ir	Wall zone	1	45		32	18			20		3	1 1/2					
					Intermediate zone.	2	[2] 50		15	10			25						Lepidolite Topaz Beryl Columbite-tantalite. Microlite	5 <1 0.1 Trace do	2 (17)
					Core	4			40	24			60								
					Small pod	1/32							10						Microlite Lepidolite	0.1 90	1/32
605	Tonalite		Ne	L	1 unit	1/4	54		25	30			18		1	1/8			Lepidolite	2	
606	Hornblende gneiss	None	C	L	do	1/8	70		15	3			15		<1	1/2					
607	Tonalite		Ne	Lb	Main unit	1/32	75		9	3/4			15		1	1/16					
					Fracture filling	1/8	50		23	4			25						Lepidolite	2	1/8
608	do		Ne	L	1 unit	1/16	70		14	4			15		1	1/16					
609	Hornblende gneiss		Ne	Lb	do	1/32	70		9	3			20		1	1/16					
610	do	None	C	L	do	1/4	42		38	2			20		<1	1/32					
611	do		Ne	L	do	1/2	40		40	8			20		<1	1/8					
612	do	None	C	Lb	Hanging-wall layer.	1/4	41		37	4			20		2	1/8					
					Footwall layer	1/32	78		5	1			15		2	1/16					
613	do		Ne	L	Hanging-wall layer.	1/8	55		25	2			20		<1	1/16					
					Footwall layer	1/32	80						20		<1	1/32					
614	Biotite schist	None	C	L	1 unit	1/8	65		19	3 1/2			15		1	1/16					
615	Hornblende gneiss	do	Cf	L	do	1/8	70		15	2 1/2			15		<1	1/8					
616	do		Ne	Ir	Hanging-wall layer.	1/4	50		30	4			20		<1						
					Footwall layer	1/32	75		10	5			15		<1	1/16	Tr.				

617	do		Ne	L	Hanging-wall layer.	½	30		60	5			10		<1	1/16					
					Footwall layer	1/16	64		20	4			15		1	1/16	Tr.				
618	do	None	C	Ir	Hanging-wall layer.	½	54		25	5			20		1	1/16	Tr.				
					Footwall layer	1/16	74		10	3			15		1	1/16					
619	do		Ne	L	1 unit	⅛	65		20	4			15								
620	do		Ne	L	do	⅛	70		15	1			15		<1	1/16					
621	do		Ne	L	do	¼	60		25	3			15		<1	1/16					
622	do		Ne	L	do	⅜	65		25	2			10		<1	1/16					
623	do		Ne	L	do	¼	40		40	2			20		<1	⅛					
624	do	None		Ir	do	1/16	60		15	2			24		1	1/32					
625	do	do		L	do	1/16	65		9	2–5			25		1	1/16					
626	do		C	L	do	1/16	70		15	3–9			15		<1	1/16					
627	do		C	L	Wall zone	1/16	60		20	1–2			20		<1	1/16					
					Core	¼	30		50	2–4			20		<1						
628	do		C	L	Hanging-wall layer.	1	44		35	4–7			20		1	¼					
					Footwall layer	1/32	70		10	1–2			19		1	1/16					
629	do		Ne	L	1 unit	¼	50		29	2–4			20		1	⅛					
630	do	None	C	L	do	¼	64		20	3–6			15		1	1/16					
631	do		Ne	L	do	1/16	69		15	3–6			15		1	1/16	Tr.				
632	do		Ne	L	do	¼	45		35	2–4			20		<1	1/16					
633	do		Ne	L	do	1/32	65		20				14		1		Tr.				
634	do		Ne	L	do	1/64	65		20				13		2						
635	Tonalite		Ne	L	do	1/16	60		19				20		1						
636 (White Spar No. 2).	Hornblende gneiss	None	C	L	Wall zone	¼	45		30	1½–2½			20		5				Lepidolite	<1	⅛
					Core	1/32	45		10	4–6			35				<1		Fluorite	Trace	
																			Microlite	<0.01	1/32
																			Beryl	2 crystals	⅝
																			Chrysacolla	Trace	
																			Lepidolite	10	<1/32
637	do	do		L	Wall zone	¼	40		38				20		2		Tr.				
					Core pod	1	[2] 20		35	8–12			40		5				Lepidolite	Trace	
																			Columbite-tantalite.	1 crystal	
					Fracture-filling	¼	[2] 50		5	4–10			30		15				Beryl	do	2
																			Microlite	.01	⅛
																			Lepidolite	Trace	
628	do		Ne	L	Hanging wall layer.	¼	30		5				50		15						
					Central layer	3	70						30								
					Footwall layer	⅛	64		5				30		1						
639	do		Ne	L	Wall zone	¼	59		20	3–4			20		0.5	½					
					Core pod	1	10		20	8–15			67		3						
640	do		Ne	L	1 unit	⅛	50		30	4–7			19		1	½					
641	do		Ne	Ir	do	1/16	65		14	3–6			20		1	⅛					
642	do	None		Ir	do	1/16	55		23				20		2		Tr.				
643	Hornblende gneiss and biotite schist.	do	C	Ir	Wall zone	⅜	72		7				20		1		Tr.				
					Core pod	¼	20		55				15		4		1		Beryl	2 crystals	½
					do	¼	19		60				20		1						
644	Hornblende gneiss		Ne	L	1 unit	¼	43		40	10–12			15		2	½	Tr.				
645	do	None	Ir	Ir	Wall zone	3/16	55		24	1–1½			20		1		0.5				
					Core	3	19		40	2–3			40		1	2					
					Small pods	1			18	2–3			80		2	3–4					
646	do		Ne	L	Wall zone	⅛	49		20	1–2			30		1						
					Core pod	1	8		50	(20)			40		2	1					
647	do		Ne	L	Wall zone	1/64	75		13	4–7			10		2	¼			Tourmaline	Trace	
					Core pod	3	5		80	9–14			10		5	1					
648	do		Ne	Ir	1 unit	1/16	75		8	5–7			15	2		¼	Tr.				
649	Hornblende gneiss mica schist, and quartzite.		Ne	L	Wall zone	1/32	54		10				35		1	⅛	Tr.				
					Core pod	1	30		47	6–8			20		3	½–¾					
650	Hornblende gneiss		Ne	Ir	1 unit	⅛	69		10	4–6			20		1	⅛					
651	do		Ne	Ir	do	⅜	69		10	2½–3			20		1	⅛					
652	do		Ne	L	Hanging wall layer.	⅛	40		20	12–14			40								
					Footwall layer	1/16	70		9	2–3			20		1	⅛	Tr.				
653	do	None		Lb	1 unit	1/16	60		20	5–9			20		0.5	(21)	Tr.				
654	do		Ne	Ov	do	1/16	60		10	3–5½			29		1	1/16	Tr.				
655	do	None		Ir	Wall zone	¼	45		35	8–12			19		1	(15)					
					Core	2	10		52				35		3	1–1½	0.5				(3)
656	do			L	1 unit	1/16	60		18	2–4			20		2	⅛					
657	do	None		Ir	Wall zone	1/16	31		40	4–10			25		4	⅜					
					Core pod	⅛	65		15				20								
658	do	do		L	1 unit	1/16	50		19	3–4			30		1						
					Wall zone	¼–½	59		20	1–3			20		1		Tr.		Biotite	Trace	
659 (Buckhorn and Feldspar lodes).	Hornblende gneiss and tonalite.	do	C	Ir	Intermediate zone.	12			50				10		40	4–12			Beryl	Several crystals	
																			Columbite-tantalite.	do	¼
																			Monazite	do	¼
					Core, Buckhorn claim.	24			91				7		1	1			Beryl	0.7	½–4
					Core pods on ridge.	8–12	1		53				45		1	½–2			do	0.5	½–2

[2] Cleavelandite. [3] Up to 3. [13] Up to 6. [15] Up to 2. [17] Up to 5. [18] Up to 8. [19] Up to 4. [20] Up to 10. [21] Up to ¼.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
660	Hornblende gneiss		Ne	L	Wall zone	1/16	70		9				20		1	1/8					
					Core pods	2	30		40	3–6			30								
661	do			Ir	Wall zone	1/8	70		10	2–4			18		2	1/8					
					Intermediate zone.	1/2	20		49				20		10				Beryl	0.8	1/2–2 1/2
					Core	1			40				50		10						
662	do		Ne	Ov	1 unit	1/8	78		4	(13)			15		3		<1				
663	do		Ne	Ir	Wall zone	1/4	53		20				25		2						
					Core	6	10		65				25								
664	do		Ne	Ir	Wall zone	1/4	70		8	(19)			20		2		Tr.				
					Core	1 1/2	30	1/4–1/2	30				40		<1						
665	do		Ne	Ov	1 unit	1/8	87		2	(19)			10	(19)	<1		1				
666	do		Ne	Ov	Wall zone	1/8	76		2				25		2		<1				
					Core	4	25		35				40								
667	do		Ne	L	Wall zone	1/8	80		5				15		Tr.		<1				
					Core	(?)			10				90								
668	do		Ne	Lb	Main unit	1/8–1/4	72		8				20		<1		Tr.				
					Fracture filling	2–3	15		15				70		<1						
669	do		Ne	Ir	1 unit	1/4–1/2	60		10				30		<1						
670	do	None	Ne	Ir	do	1/4	60		15	1–4			25		<1		Tr.				
671	do		Ne	Ir	Main unit	1/2	56		19				25		1		Tr.				
					Fracture filling	(?)			50				50								
					do	(?)							100								
672	do		Ne	L	1 unit	1/8	71		8				20		1		Tr.				
673	do		Ne	L	do	1/4	40		25				35		<1						
674	do			Ir	Wall zone	1/8	65		10				25		<1		<1				
					Core	4	15		45				35		5	(3)			Columbite-tantalite.	Trace	
675	do		Ne	Ov	Main unit	1/8–1/4	70		15	(18)			15		<1		Tr.				
					Fracture filling	6			50				50								
676	do			Ir	Main unit	1/8	70		10				20		<1		<1				
					Fracture filling	4	3						95		2						
677	do		Ne	Ov	Main unit	1/8–1/4	60		15	(15)			25		<1				Biotite	Trace	
					Fracture filling	(?)							100								
678	do		Ne	Ir	Main unit	1 1/2	40	1/4	35	3–4			25	3–4	1		Tr.				
					Fracture filling	(?)							100								
					do	6–8	15		55				30								
679	do			Lb	Wall zone	1/8	72		12				15		1		Tr.				
					Core	4–8	15		40				45		<1						
680	do		C	Ir	Main unit	1/8	74		5				20		1		<1				
					Fracture filling	(?)							100								
681	do			Ir	1 unit	1/16	70		9				20		1		Tr.				
682	do		C	Ir	Wall zone	1/32	70		14	3–5			15		1	1/4	Tr.				
					Core pod	3/4	15		54	6–10			30		1	1/2					
683	do		Ne	L	1 unit	1/16	70		9	4–5			20		1	1/32					
684	do	None	Cf	Ir	Hanging-wall layer.	1	45		38				15		2						
					Footwall layer	1/32	75		14				15		1		Tr.				
685	do			L	Hanging-wall layer.	1/2	30		48	4–6			20		2	1/2					
					Footwall layer	1/32	65		19	2–3			15		1	1/8	Tr.				
686	do		Ne	Ov	1 unit	1/4	60		20	5–7			19		1	1 1/2	Tr.				
687	do		Ne	L	do	1/4	50		39				10		1						
688	do		Ne	Ir	do	1/32	70		14	• 2–4			15		1	3/4					
689	do		Ne	Ov	Hanging-wall layer.	1/2	30		55	6–12			15		<1	1/2					
					Footwall layer	1/16	45		33	2–3			20		2	1/2					
690	do		Ne	Ov	1 unit	1/32	60		23	5–7			15		2	1/4					
691	do		Ne	Ov	do	1/4	65		20	3–4			13		2	1/2					
692	do		Ne	Ov	do	1/4	40		40				19		1						
693	do				Wall zone	1/16	60		24				15		1						
					Core	1/2	20		19				60		1						
694	do			Ir	1 unit	1/64	74		10				15		1						
695	do		Ne	L	do	1/4	50		30				20								
696	do		Ne	L	do	1/8	60		20				20								
697	do		Ne	Ir	do	1/8	30		54				15		1						
698	do		Ne	Ir	do	1/16	60		19.5				20		0.5						

699	do		Ne	Ir	do	⅛	50		30		30	8	20		Tr.		Tr.	1/16	Biotite	Trace	⅛
700	do		Ne	Ir	do	¼	55		30		50	5	15						Magnetite	Trace	1/16
																			Biotite	do	1/16
701	do		Ne	Ir	do	1	20		50			10	30				Tr.	1/16	Biotite	Trace	¼
702	do		Ne	L	do	2	35		50		40	10	15				Tr.	1/32	Magnetite	do	1/16
703	do		Ne	Ov	do	¼	50		30				20				Tr.		Biotite	Trace	
704	do		Ne	Ir	do	⅛	50		35		30		15								
705	do		Ne	L	do	1/16	65		15				20						Biotite	Trace	
706	do		Ne	L	do	⅜	40		30				30								
707	do		Ne	Ov	do	1/16	70		5				25								
708	do		Ne	L	do	2	10		65		80		25								
709	do		Ne	L	do	2	10		65		80		25								
710	do		Ne	L	do	1	30		40				30								
711	do		Ne	L	do	3	10		70		80		20								
712	do		Ne	Ov	do	3	10		60		(√)		30								
713	do		Ne	Ir	do	3	10		60				30								
714	do		Ne	L	do	3	10		60		80		30								
715	do		Ne	Ir	Wall zone	2	10		60				30								
					Intermediate zone.								50		50	¾					
					Core								100								
716	do		Ne	L	1 unit	3	10		70				20				Tr.				
717	do		Ne	L	do	2	10		70				20								
718	do		Ne	L	do	3			70		80		20								
719	do		Ne	Ov	do	½	70		10	8			30				Tr.				
720	do		Ne	L	do	¼	70		10				20								
721	do		Ne	Ov	do	1	10		60				30				Tr.				
722	do		Ne	L	do	⅛	70		10				20								
723	Hornblende gneiss and coarse-grained granite.		Ne	L	do	¼	50		30				20				Tr.		Biotite	Trace	
724	Hornblende gneiss		Ne	L	do	¼	60		10				30								
725	do		Ne	L	do	¼	50		20				30								
726	do		Ne	L	do	¼	50		30				20								
727	do		Ne	L	do	¼	60		10				30								
728	do		Ne	Lb	Wall zone	1	10		65		75		25								
					Intermediate zone.	¼	[2] 67						30		3	2			Beryl	1 crystal	⅜
					Core	½			80				20								
729	do		Ne	L	Wall zone	¼	70		10				20								
					Intermediate zone.	2			40				60								
					Core	4			20				80								
730	do		Ne	L	1 unit	1/16	60		10				30						Biotite	Trace	
731	do		Ne	L	do	⅛	30		50		(√)		20								
732	do		Ne	Ov	do	1/32	80		15				5								
733	do		Ne	L	do	2	20		60		60		20								
734	do		Ne	L	do	1/16	60		10				30								
735	do		Ne	Lb	do	2	10		70		50		20								
736	do		Ne	Lb	do	¼	70		10				20								
737	do		Ne	L	do	1	10		70		50		20								
738	do		Ne	L	do	2	10		70		60		20								
739	do		Ne	Lb	Wall zone	¼	60		20				20								
					Core	½			80				20								
740	do		Ne	Lb	Wall zone	¼	30		50				20				Tr.				
					Intermediate zone.	4			70				30								
					Core								100								
741	Hornblende gneiss and granite.	None		L	Southwest dike	¼	80						20								
					1 unit	1/32	70						30						Biotite	Trace	
742	Hornblende gneiss		Ne	Ov	do	1	10		60				30				Tr.				
743	do		Ne	L	do	2	10		70		60		20								
744	do		Ne	Lb	Wall zone	1/16	70		10				20								
					Intermediate zone.	1/16	35						60		5	2					
					Core	¼	30		50				20								
745	do		Ne	Ov	1 unit	2	10		70		70		20								
746	Granite		Ne	L	do	2	10		70		70		20								
747	Hornblende gneiss		Ne	L	Wall zone	⅛	30		50				20								
					Intermediate zone.	⅜	20						70		10	1¼					
					Core								100								
748	do		Ne	L	Wall zone	⅛	70		10				20								
					Intermediate zone.	⅜	50						45		5	1½					
					Core								100								
749	do		Ne	L	1 unit	2	10		70		60		20								
750	do		Ne	L	Wall zone	⅛	70		2	5			28								
					Intermediate zone.	⅜	50						45		5	1½					
					Core								100								
751	do		Ne	L	1 unit	⅛	30		50				20								

[2] Cleavelandite. [3] Up to 3. [13] Up to 6. [15] Up to 2. [18] Up to 8. [19] Up to 4.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
752	Hornblende gneiss		Ne	L	Wall zone	2	10		70		70		20								
					Intermediate zone.	3/8	10						75		15	1					
					Core								100								
753	do		Ne	L	1 unit	1/8	60		10				30				Tr.				
754	do		Ne	L	do	1/8	40		20				30				Tr.				
755	do		Ne	L	do	1/16	50		10				40								
756	do		Ne	L	do	1/16	65		15	5			20								
757	do		Ne	L	do	1/8	60		15				25								
758	do		Ne	L	do	3/8	10		60				30								
759	do		Ne	L	do	1/32	60		10				30				Tr.				
760	do		Ne	L	do	1/32	60		25				15				Tr.				
761	do		Ne	L	do	1/4	70		10				20								
762	do		Ne	L	do	1/8	60		10				30								
763	do		Ne	L	do	1/4	70		10				20				Tr.				
764	do		Ne	L	do	1/32	70		5				25				Tr.				
765	do		Ne	L	do	1/32	70		5				25				Tr.				
766	do		Ne	Ov	do	1/4	70		10				20								
767	do		Ne	L	do	1/4	20		50		60		30								
768	do		Ne	Ov	do	3/8	10		70				20								
769	do		Ne	Ov	do	1/8	35		35				30						Biotite	Trace	
770	do		Ne	L	do	1/8	30		40		50		30						do	<1	
771	do		Ne	L	do	1/4	30		50		50		20								
772	do		Ne	Ov	do	1/4	40		20		10		20								
773	do		Ne	L	do	1/8	50		20		15		30						Biotite	Trace	
774	Coarse-grained granite.	None		Lb	Wall zone	3	25		60		50	8	15						Magnetite Biotite	do do	 1/4
					Core	4			49.5	12			50						Biotite	0.5	4
775	do	do		L	1 unit	1	50		30	3	10	5	20				Tr.	1/16	Biotite Martite	Trace do	1/4 1/2
776	do	do		L	do	1	10		69.5		√		20				Tr.		Biotite	0.5	1/32
777	do	do		L	do	1	50		30		40		20				Tr.		Biotite Magnetite	Trace do	
778	Coarse-grained granite and hornblende gneiss.	do		Ir	Hanging-wall layer.	18	10		70		70	24	29						Biotite	1	
					Footwall layer	2	70	1/2	10	1	5		17		Tr.	1/8	Tr.	2	do	3	2
					Core	12			60				40						Martite Biotite Beryl	Trace do do	2 3
779	Hornblende gneiss		Ne	L	1 unit	5	50		15		35	8	35				1				
780	do		Ne	L	Hanging-wall layer.	5	10		60	3	70	8	30						Biotite Martite	Trace >1	
					Footwall layer	1	70		5		10	3	25						Biotite	Trace	
781	do		Ne	L	Wall zone	1½	5		65	3	75	5	30		Tr.				Martite	>1	
					Core	10			10				89		1	2					
782	do		Ne	Ir	Wall zone	3/4	4.5		60	3	75	5	35				Tr.		Martite	0.5	
					Core	9			19				80		1	1					
783	Coarse-grained granite and hornblende gneiss.	None	C	Ir	Wall zone	1	30		50		60		20				Tr.		Biotite Martite	Trace do	
					Core	3			65				30		5				Beryl	2 crystals	2½
784	Hornblende gneiss		Ne	L	1 unit	1	25		55		70		20				Tr.		Martite	Trace	
785	do		Ne	L	do	1/16	40		35	3	40		25				Tr.				
786	do		Ne	Lb	do	1	10		70		60		20								
787	do		Ne	L	do	2	10		65		80		25				Tr.				
788	do		Ne	L	do	3	10		75				15								
789	do		Ne	L	do	3	10		75				15								
790	do		Ne	Lb	do	3	10		65		80		25		Tr.		Tr.				
791	do		Ne	Ov	do	2	10		65		.80		25								
792	Granite			L	do	1/2	60		20		20	6	20						Biotite	Trace	
793	do			L	do	1	10		65		80		25								
794	do			L	do	1/2	50		30		40	6	20						Biotite	Trace	
795	do			L	do	1/2	35		45		40		20								
796	do			L	do	1	20		55		60		25								
797	do			Lb	do	1	10		70		60	6	20								
798	do			L	do	2	10		70		60		20								
799	do			L	do	2	10		60		50		30								

800	do			L	do	2	10		60		50		30								
801	do			L	do	1½	15		60		50		25				Tr.				
802	do			L	do	¼	40		40		30		20								
803	do			L	do	1/16	30		50		40		20								
804	do	None		Lb	do	¼	30		55		45		15								
805	do	do		L	do	¼	20		60		50		20				Tr.				
806	do	do		L	do	1	10		70		60		20						Biotite	Trace	
807	do			L	do	2	10		65		55		25								
808	do			Lb	do	1	10		65		55		25						Magnetite	Trace	
809	do			Lb	do	2	10		75		65		15								
810	do			Ov	do	½	15		60		50		25								
811	do			L	do	¼	10		60		50		30								
812	do	None		Lb	do	½	20		55		45		25								
813	do			L	do	¼	20		60		50		20						Biotite	Trace	
814	do	None		Lb	do	¼	15		65		55		20								
815	do			L	do	1/16	35		40				25				Tr.				
816	do			L	do	⅛	50		25				25								
817	do			Ir	do	⅛	30		45	7	10		25				Tr.				
818	do			Ov	do	½	30		50		40		20				Tr.				
819	do			L	do	1	10		70		60		20				Tr.		Biotite	Trace	
820	do			L	do	1	10		70		60		20				Tr.		do	do	
821	do			L	do	¼	25		55				20								
822	do			Ov	do	1/32	50		30				20								
823	do			Ir	do	¼	45		35	1	25	7	20								
824	do			Ov	do	2	10		60		50		30								
825	do	None		L	do	1	10		65		55		25								
826	do	do		L	Wall zone	¼	30	1/16	50	2	40	6	20		<1				Monazite	Trace	½
					Core	3	10	1	55	2		12	20		15	½					
827	do	do		L	1 unit	½	35	¼	45	5	20	5	20		<1	⅛	Tr.		Monazite	Trace	¼
828	do	do		L	do	¼	50		30		20	6	20						do	do	¼
829	do	do		Ir	do	¼	50		30	5	20	8	20				Tr.		Biotite	do	
830	do	do		L	do	½	25		55		10		20								
831	do	do		L	do	¾	35	1/16	45	3		8	20		Tr.		Tr.				
832	do	do		Ov	do	¾	10		65	2	40	6	25				Tr.		Biotite Magnetite	Trace do	
833	do			Ov	do	1/16	60		24	5			15		1	2					
834	do	None		Lb	do	½	30		55		40		15		Tr.		Tr.		Biotite	Trace	
835	do	do		Lb	do	½	30		50	4	40	4	20				Tr.		do	do	
836	do	do		Lb	do	¼	50		30				20				Tr.				
837	do			Ir	do	¼	20		65		55	16	15								
838	do	None		L	do	⅛	45		40		30	8	15								
839	do	do		Lb	do	⅛	65		20		10	10	15								
840	do			L	do	2	10		70		60	6	20								
841	do			Ov	do	⅛	65		20	1			15		Tr.				Martite	Trace	
842	do			Ov	do	¼	65		15				20		Tr.						
843	do			Ov	do	⅛	35		50		40		15						Biotite	Trace	
844	do			Ir	do	⅛	70		15	2			15								
845	Covered with glacial till.			Ir	do	2	30		44				20		0.5	1	0.5	1/32			
846	do			Ir	do	1	33.5		45		35	8	20		0.5	¾	1	1/16			
847 (Black Wonder).	Hornblende gneiss, coarse-grained granite, and quartzite.	None	C	Ir	Wall zone, south and west parts.	3	24		60		50	8	15				Tr.		Martite Biotite	1 >1	
					Wall zone, north and east parts.	1½	50		30		(21)	6	15				<1		Martite	Trace	
					Intermediate zone.	2	79		5				10		5	¼–5	1	¼–2	Beryl	0.2	½–1¼
					Intermediate zone.	6	55						15		30	(18)			Monazite Columbite-tantalite.	17 crystals 3 crystals	¾ ⅛
					Core								100								
					do				(√)				(√)								
					do				(√)				(√)						Allanite	Trace	¼
848	Hornblende gneiss		Ne	L	1 unit	2	55		25				20						Magnetite	do	
849	do		Ne	L	do	1	49		30		20		20								
850	do		Ne	Ir	do	2	25		54		40		20				1				
851	do		Ne	Lb	do	1	35		45		35		20				<1				
852	do		Ne	L	do	¾	35		45	7	35	6	20				Tr.		Biotite Magnetite	Trace do	
853	do		Ne	L	do	1	35		45	3	35	6	20				Tr.	1/32			
854	do		Ne	Ov	do	¾	40		45		35		15				<1		Biotite	Trace	
855	do		C	Ir	do	3	15		65		55		20						Magnetite	do	
856	do		Ne	Ir	Wall zone	¾	10		70	2	60	5	20		Tr.				do	do	
					Core	5			50	6			50								
857	do		Ne	Ov	1 unit	3	20		60	3	55	6	20						Magnetite	Trace	1/16
858	Hornblende gneiss and granite.	None		L	do	3	35	1/16	40	3	30	8	25						do	do	1/16
859	Hornblende gneiss		Ne	L	do	2	35		45	3	25	6	20				Tr.	½			
860	do		Ne	Ir	do	1	30		50	8	45	3	20				Tr.		Biotite Magnetite	Trace do	
861	do		Ne	Ov	do	½	70		10		5		20								
862	do		Ne	L	do	¼	60		20				20								
863	do		Ne	L	do	1/16	70		10				20								
864	do		Ne	L	do	½	50		30		20		20								
865	do		Ne	L	do	½	20		50		40		30								
866	do		Ne	L	do	½	50		30		20		20								

[18] Up to 8. [21] Less than 10.

TABLE 2.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
867	Hornblende gneiss		Ne	L	1 unit	¼	60		20				20						Magnetite	Trace	
868	do		Ne	L	do	⅛	60		10				30				Tr.				
869	do		Ne	L	do	1/16	70		5				25				Tr.				
870	do		Ne	Ov	do	1/16	60		20				20								
871	do		Ne	Ov	do	¼	65		15		10		20				Tr.				
872	do		Ne	Lb	do	1/16	70		10		V		20								
873	do		Ne	L	do	¼	55		20		10		25								
874	do		Ne	L	do	1	30		50		40		20				Tr.				
875	do		Ne	L	do	½	50		30		20		20				Tr.				
876	do		Ne	L	do	½	40		40		30		20				Tr.		Biotite	Trace	
877	do		Ne	L	do	¼	60		20		10		20				Tr.				
878	do		Ne	L	do	⅛	50		30		20		20				Tr.		Biotite	Trace	
879	Hornblende gneiss and granite.	None	Ne	L	do	½	50		30		20		20				Tr.				
880	Hornblende gneiss		Ne	L	do	½	40		40		30		20								
881	do		Ne	L	do	⅛	60		10				30								
882	do		Ne	L	do	⅛	40		30				30						Biotite	Trace	
883	do		Ne	Ov	do	⅛	50		20		10		30								
884	do		Ne	L	do	⅛	60		10				30						Biotite	Trace	
885	do		Ne	L	do	⅛	50		20		10		30		Tr.						
886	do		Ne	L	do	⅛	50		20		10		30		Tr.						
887	do		Ne	L	do	⅛	60		20		10		20								
888	do		Ne	L	do	⅛	50		20		10		30		Tr.						
889	do		Ne	L	do	½	30		50		40		20								
890	do		Ne	L	do	⅛	50		20		10		30								
891	do		Ne	L	do	⅛	50		20		10		30								
892	do		Ne	L	do	½	30		50		40		20								
893	do		Ne	Ov	do	⅛	50		20		10		30								
894	do		Ne	L	do	⅜	40		28				30		2						
895	do		Ne	L	Hanging-wall layer.	¼	50		17				30		3						
					Footwall layer	1/32	60		20				19		1						
896	do		Ne	L	Hanging-wall layer.	¼	55		25				20		Tr.						
					Footwall layer	1/32	75		5				20		Tr.						
897	do		Ne	L	Hanging-wall layer.	¼	40		30				28		2						
					Footwall layer	1/32	60		20				19		1						
898	do		Ne	L	1 unit	½	35		45	3			20		<1						
899	do		C	L	do	1	30		50	3			20		Tr.	¼					
900	do		Ne	L	Hanging-wall layer.	¾	40		40	2			19.5		0.5	¼					
					Footwall layer	⅜	70		10	¾			19.5		0.5	¼					
901	do		Ne	L	Hanging-wall layer	1	20		64.5	2			15		0.5						
					Footwall layer	¼	50		40	½			10		<1						
902	do		Ne	L	1 unit	¾	48		30	3			20		2	¼	Tr.				
903	Hornblende gneiss and granite.		Ne	L	do	¾	35		50	3			15		<1						
904	do	None	C	L	do	½	30		50	¾			20								
905	do		Ne	L	Hanging-wall layer.	1	25		55	4			19.5		0.5	⅛					
					Footwall layer	¼	50		30	1½			20		Tr.						
					Core								100						Beryl	Trace	¼–¾
906	Hornblende gneiss		Ne	L	Hanging-wall layer.	1½	15		65	3			20		Tr.	¼	Tr.				
					Footwall layer	¼	60		20	2			20		Tr.	1/16	Tr.				
907	Hornblende gneiss and granite.	None	Ne	L	1 unit	¼	30		60	½			10								
908	Hornblende gneiss		Ne	L	Wall zone	¾	20		65	4			15		<1						
					Intermediate zone.	⅜	25		40	¾			28.5		5	⅜	Tr.		Beryl	1.5	1/16–1
					Core				40				60								
909	Hornblende gneiss and granite.	None		L	1 unit	¾	20		50	1			30		Tr.	¼					

910	Coarse-grained granite.	do		L	Hanging-wall layer.	¾	5		80	2	10	3	15						Biotite; Magnetite	Trace; do	
					Footwall layer	¼	55		35	½			10		<1		Tr.				
911	Hornblende gneiss		Ne	L	Hanging-wall layer.	¾	15		69.5	2	3	3	15		0.5						
					Footwall layer	¼	45		40	½			15		Tr.						
912	do		Ne	L	1 unit	¾	25		60	2			15		<1		Tr.				
913	do		Ne	L	Hanging-wall layer.	¾	15	1/64	65	2			20		Tr.	1/16					
					Footwall layer	⅛	75		5	1			20		Tr.	1/32	Tr.				
914	do		Ne	L	1 unit	½	55		25	1			20		Tr.	⅛					
915	do		Ne	L	do	½	30		50	1½			20		<1						
916	do		Ne	L	Hanging-wall layer.	¼	30		39	3			30		1	½					
					Footwall layer	1/64	60		10				30				Tr.				
917	do		Ne	L	Hanging-wall layer.	¼	26		40				30		3				Biotite	1	
					Footwall layer	1/32	50		20				30				Tr.				
918	do		Ne	L	Hanging-wall layer.	¼	50		20				20		10	1					
					Footwall layer	½	10		60	3			30		Tr.				Biotite	Trace	
919	do		Ne	L	1 unit	¼	28		40	2			30		2	1					
920	do		Ne	L	Wall zone	1/64	70		10				20				Tr.				
					Intermediate zone.	¼	45		20				30		5	1					
					Core	1	5		59				34		1						
921	do		Ne	L	Hanging-wall layer.	¼	8		70	3	V		20		2						
					Footwall layer	1/32	60		20				20				Tr.				
922	do		Ne	L	Hanging-wall layer.	⅛	50						40		10	½	Tr.				
					Footwall layer	1/32	70		20				10								
923	do		Ne	L	Hanging-wall layer.	¼	48		20	4			20		2	1					
					Footwall layer	¼	55		14				30		1						
924	do		Ne	L	Hanging-wall layer.	⅛	8		60	3			30		2						
					Footwall layer	1/32	19		40				40		1						
925	do		Ne	L	Hanging-wall layer.	⅛	30		50				20		1						
					Intermediate zone.	¾	15						60		25	½					
					Core	1			80	5			20								
					Footwall layer	1/32	60		20				20								
926	do		Ne	L	1 unit	⅛	65		10				24		1	½	Tr.		Monazite	1 crystal	½
927	Hornblende gneiss and coarse-grained granite.		Ne	Ir	Hanging-wall layer.	½	10		65	1			15		<1		Tr.				
					Footwall layer	⅛	80		5	½			15				<1		Biotite	Trace	
928	Hornblende gneiss		Ne	L	1 unit	¼	40		30	2			38		2	½					
929	do		Ne	L	Hanging-wall layer.	¼	15		50	4			30		5	½					
					Footwall layer	1/64	60		14				25		1						
930	do		Ne	L	Hanging-wall layer.	¼	30		10				50		10	1					
					Footwall layer	1/32	75						25				Tr.				
931	do		Ne	Lb	Hanging-wall layer.	¼	30		40				20		10	1			Monazite	1 crystal	¼
					Footwall layer	1/32	60		10				29.5		0.5		Tr.				
932	do		Ne	L	Hanging-wall layer.	¼	30		50				17		3	½	Tr.				
					Footwall layer	⅛	60		15				24		1						
933	do		Ne	L	Hanging-wall layer.	⅛	10		60	3			29		1						
					Footwall layer	1/64	60						40				Tr.				
934	do		Ne	L	Hanging-wall layer.	¼	30		40	4			28		2	1					
					Footwall layer	1/64	60		10				28		2						
935	do		Ne	L	Hanging-wall layer.	⅛	30		40	3			25		5	1¼					
					Footwall layer	1/64	60						40				Tr.				
936	Fine-grained granite and hornblende gneiss.	None		Lb	1 unit	¼	63		20	4			15		2	¼	Tr.	1/16	Beryl	1 crystal	¼
937	Granite	do		L	Hanging-wall layer.	1½	20	1/32	65	3			15		0.1	½					
					Footwall layer	½	65	1/64	15	1			20		Tr.						
938	Hornblende gneiss		Ne	L	1 unit	½	25		65	2	2	5	10		<1						
939	do		Ne	L	Hanging-wall layer.	¾	40		38	2	10	.4	20		2	½	Tr.				
					Footwall layer	½	67	1/64	15	2	5	1	15		Tr.	1/32	3				
940	do		Ne	L	1 unit	½	25		60	2½			14		1						
941	Granite and hornblende gneiss.	None		L	do	1	15		55		5	5	30		Tr.		Tr.				
942	do	do		L	do	¾	10		65	3			25								
943	Gneissic granite	do	C	L	do	½	30	1/32	50	2			18		2	¼					

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
944	Granite and hornblende gneiss.		Ne	L	Hanging-wall layer.	3/4	20		15	4			15		15	1/8	Tr.				
					Footwall layer	1/4	50	1/32	10	2			20	1/4	20	1/4	0.1				
945	do	None		L	Hanging-wall layer.	1½	15	1/32	60	3			15		10	1/2					
					Footwall layer	1/8	50		10				20								
946	Hornblende gneiss		Ne	Lb	Hanging-wall layer.	3/4	30		20	2½			50		Tr.						
					Footwall layer	1/2	50		40				10		<1		Tr.				
947	Granite	None		L	Hanging-wall layer.	3/4	30		50	2			20		Tr.						
					Footwall layer	1/2	60	1/32	20	1			20								
948	Hornblende gneiss		Ne	L	Hanging-wall layer.	1/4	55		15				28		2						
					Footwall layer	1/16	60		10				30		Tr.						
949	do		Ne	L	Hanging-wall layer.	1/16	35		35				28		2						
					Footwall layer	1/32	60		9				30		1						
950	do		Ne	L	Hanging-wall layer.	1/4	40		30				28		2						
					Footwall layer	1/32	60		9				30		1		Tr.				
951	do		Ne	L	Hanging-wall layer.	1/8	40		40				17		3						
					Footwall layer	1/64	70		9				20		1		Tr.				
952	do		Ne	L	Hanging-wall layer.	3/8	40		39				20		1						
					Footwall layer	1/32	60		19				20		1						
953	Hornblende gneiss		Ne	L	Hanging-wall layer.	3/8	45		25				28		2						
					Footwall layer	1/64	60		5				34		1		Tr.				
954	do		Ne	L	Hanging-wall layer.	1/8	40		40				17		3						
					Footwall layer	1/64	70		9				20		1		Tr.				
955	do		Ne	L	Hanging-wall layer.	1/16	63		20				15		2						
					Footwall layer	1/32	70		10				19		1						
956	do		Ne	L	Hanging-wall layer.	1/4	58		20				20		2						
					Footwall layer	1/32	74		9				15		1						
957	do		Ne	L	Hanging-wall layer.	1/4	50		30				19		1						
					Footwall layer	1/32	70						30								
958	Hornblende gneiss and granite.		Ne	L	Hanging-wall layer.	1/2	20		65	2½			15								
					Footwall layer	1/2	45		40	1			15				Tr.		Biotite	Trace	
959	Hornblende gneiss.		Ne	L	Hanging-wall layer.	1	30	1/8	50	4			20		<1	1/4					
					Footwall layer	1/4	70	1/32	10	1			20		Tr.						
960	do		Ne	L	1 unit	3/4	45		40	2			15		<1						
961	do		Ne	L	do	1/2	55	1/16	25	3			19.5		0.5	1/4					
962	do	None	C	L	do	1	30		50	4			19		1	1/2					
963	do		Ne	L	Hanging-wall layer.	1/4	48		20				30		2				Monazite	1 crystal	1/4
					Footwall layer	1/32	70		4				25		1						
964	do		Ne	L	1 unit	1/16	50		20				30								
965	Coarse-grained granite and hornblende gneiss.	None		Lb	do	1/8	50		20		V		30								
966	Hornblende gneiss		Ne	L	do	1/4	20		60		50		20								
967	do		Ne	L	do	1/4	30		50		40		20								
968	do		Ne	Ov	do	1/32	60		10				29				1				
969	do		Ne	L	Hanging-wall layer.	1/4	10		60		2		28								
					Footwall layer	1/4	40		27				30		3						
970	do		Ne	L	1 unit	1/64	80						20								

971	do		Ne	L	Hanging-wall layer.	¼	10		60				30								
					Footwall layer	1/64	60		5				30		5						
972	do		Ne	L	Hanging-wall layer.	1/16	10		60				28		2						
					Footwall layer	1/16	55		10				25		10						
973	do		Ne	L	Wall zone	1/64	70		9				20		1						
					Core	¼	60		8				30		2						
974	do		Ne	L	1 uniy	1/32	60		13				25		2						
975	do		Ne	L	Hanging-wall layer.	½	50		19				30		1	2					
					Footwall layer	1/64	80						20								
976	do		Ne	L	1 unit	1/64	75						25								
977	do		Ne	L	do	1/16	75						20		5						
978	do		Ne		Hanging-wall layer.	1/64	10		60				30								
					Footwall layer	1/16	50		20				22		3						
979	do		Ne	L	Hanging-wall layer.	⅜	10		65				24		1						
					Footwall layer	¼	50		15				30		5						
980	do		Ne	L	Hanging-wall layer.	½			70				28		2						
					Footwall layer	1/64	70		2				25		3						
981	do		Ne	L	Hanging-wall layer.	⅛	10		60				30								
					Footwall layer	1/64	60		6				30		4						
982	do		Ne	L	Hanging-wall layer.	½	5		70				24		1						
					Footwall layer	1/64	70						28		2						
983	do		Ne	L	Hanging-wall layer.	⅜	20		60				18		2						
					Footwall layer	1/32	70		4				25		1						
984	do		Ne	Lb	Hanging-wall layer.	¼	10		60				27		3						
					Footwall layer	¼	30		10				45		15						
985	Hornblende gneiss and fine-grained granite		Ne	Lb	Hanging-wall layer	1	20		50	5			20		10	¾	Tr.	1/64	Beryl	1 crystal	½
					Footwall layer	½	49.2		30	5			15		5	1/16	0.5	1/64	Beryl; Monazite	0.3; 3 crystals	1/16–½; ¼–½
986	do		Ne	L	1 unit	2	15		50	12	(√)	5	19.5		15	¾	.5	1/32			
987	do		Ne	Lb	Hanging-wall layer	¾	35		40	4			15		10	¼	Tr.	1/16			
					Footwall layer	¼	64		15	2			15		5	⅛	1	1/64			
988	do		Ne	Lb	Hanging-wall layer	2	20		50	5			20		10	¾	Tr.	1/64			
					Footwall layer	1/16	60		15	1			15		10	1/16	Tr.	1/64			
989	do		Ne	Lb	Wall zone	1/64	75		10	1			15		Tr.	⅛	<1	1/128			
					Core	¼	40		29	4			20		1	1			Beryl	2 crystals	¼–⅜
990	do		Ne	L	One unit	⅛	45		35	2			20		Tr.	¼					
991	Hornblende gneiss		Ne	L	do	⅜	54		30	4			15		1	1/16	<1	1/128			
992	Hornblende gneiss and fine-grained granite.	None	Ne	Lb	Hanging wall layer	¼	40		30	2			20		10	¼					
					Footwall layer	1/32	73		10	1			15		2	1/32	Tr.	1/128			
993	do	do	Ne	L	One unit	⅛	64		20	1½			15		1	1/16	Tr.	1/64			
994	Hornblende gneiss		Ne	L	do	¼	65		20	3			15		Tr.	⅛	<1	1/128			
995	do		Ne	L	do	⅜	45		40	3			15		Tr.	⅛			Beryl	3 crystals	¼–½
996	do		Ne	L	do	¼	35		45	3			15		Tr.	⅛	<1	1/128			
997	do		Ne	L	Hanging-wall layer	¾	20		45	5	5	3	25		10	½					
					Footwall layer	¼	75		15				10		<1				Monazite	1 crystal	¼
998	Fine-grained granite and hornblende gneiss.	None		L	One unit	⅛	55		25	2			20		Tr.	1/32			Beryl	4 crystals	¼–1
999	Hornblende gneiss		Ne	Lb	do	⅛–¼	55		25				20		<1		Tr.		do	1 crystal	¼
1000	Fine-grained granite and hornblende gneiss.	None		L	Wall zone	⅛	63		20		10	5	15		2	1/16	<1	1/128			
					Core	1	20		50	4			20		10	⅜	Tr.	1/32			
1001	do		Ne	L	One unit	½	35		45	3			20		Tr.	¼	Tr.	1/64	Beryl	1 crystal	1
1002	Hornblende gneiss		Ne	L	Wall zone	1/64	78		5				15		Tr.	⅛	2	1/64	Beryl	3 crystals	1/32–⅛
					Core	½	29		50				20		1	¼	Tr.	1/32	Columbite-tantalite	1 crystal	1/16
1003	Granite and hornblende gneiss.	None		L	Hanging-wall layer	¾	20		55	2			25		<1				Beryl	do	¼
					Footwall layer	⅛	50		35	1			15		<1						
1004	Granite and hornblende gneiss.	do	C	L	Hanging-wall layer	¾	30		45	2			20		5	¼					
					Footwall layer	¼	68		10	1			20		2	⅛	<1				
	do	do	C	L	Core	2			30				70				<1		Beryl	5 crystals	1/16–¾
1005	Granite and hornblende gneiss.	do		Lb	One unit	⅛–¼	65		15				20		<1		Tr.		do	1 crystal	¼
1006	Hornblende gneiss		Ne	Lb	do	⅛	58		20	2			20		2	⅛			do	9 crystals	1/32–¼
1007	do		Ne	L	do	⅛–¼	54		20				25		1		Tr.				

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
							Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1008	Hornblende gneiss and fine-grained granite.		Ne	Lb	1 unit	1/8-1/4	55		15				30		<1		Tr.				
1009	do	None		L	do	1/4-1/2	47		33				20		Tr.		Tr.		Beryl	2 crystals	1/4-1/2
1010	do		Ne	Lb	do	3/16	55		30	2			15		Tr.	1/16			do	6 crystals	1/16-1/4
1011	Hornblende gneiss, fine-grained granite, and coarse-grained granite.	None		Lb	do	1/4	45		35				20		<1		Tr.		do	1 crystal	1/4
1012	Hornblende gneiss and fine-grained granite.		Ne	L	do	1/4	50		30				20		<1		Tr.		do	2 crystals	1/4
1013	Hornblende gneiss and coarse-grained granite.	None		Lb	do	1/4	50		29				20		1		Tr.				
1014	Hornblende gneiss, fine-grained granite, and coarse-grained granite.	do	Ne	L	do	1/8-1/4	55		25				20		<1		Tr.		Beryl	2 crystals	3/4
1015	do	do	Ne	L	do	1/8-1/4	60		20				20		<1		Tr.		do	5 crystals	1/4-1/2
1016	Hornblende gneiss		Ne	L	do	3/16	53		25	3			20		2	1/8	Tr.	1/128	do	1 crystal	1/8
1017	do		Ne	Lb	do	1/8	57.5		20	2			20		2	1/8	0.5	1/64			
	do		Ne	L	do	1/8	45		30	3			20		5	1/4	0.1	1/16			
1018 1019	Hornblende gneiss and fine-grained granite.		Ne	Lb	do	1/8	42		30	2	20	3	15		8	1/8	Tr.	1/64			
1020	do	None	Ne	L	do	1/4	30		40	3	30	3	20		10						
1021	do		Ne	L	do	1/8	50		25	3	10		20		5	1/8	Tr.	1/32			
1022	Hornblende gneiss		Ne	L	{Wall zone	1/16	50	1/32	20				28		2				Biotite	Trace	
					{Core	2	10		49	3			30		1						
1023	do		Ne	L	{Wall zone	1/8	60		19				20		1						
					{Core	1 1/2-3			50	3			50								
1024	do		Ne	L	{Wall zone	1/2	40		28				30		2						
					{Core	3/4-2 1/2	20		55	2 1/2			25								
1025	do		Ne	L	{Wall zone	1/8	55		10				30		5						
					{Core	1/8	30		37				30		3						
1026	Fine-grained granite and hornblende gneiss.	None		L	{Wall zone	3/8	45		25	5	15		20		10	3/8	Tr.	1/32			
					{Core	2			20				80								
1027	do	do		L	{Wall zone	1/16	60		20	3			15		5	1/2	Tr.	1/16			
					{Core	4	10		35				45		10	3/4			Beryl	2 crystals	1/4-3/8
1028	Hornblende gneiss, fine-grained granite and coarse-grained granite.	do		Lb	{Wall zone	1/8	63		10	1			15		5	1/8	2	1/64			
					{Core	2	15		30	4			50		5	1			Beryl	1 crystal	3/8
1029	Hornblende gneiss and fine-grained granite.	do		Lb	1 unit	1/2	40		30	4			20		10	1/2	Tr.	1/16			
1030	do	do		Lb	do	3/4	35		35	5			20		10	1/2	Tr.	1/16			
1031	do		Ne	L	do	1/8	49		30	3			20		Tr.	1/16	1	1/64	Beryl	1 crystal	3/16
1032	do		Ne	L	do	1/4	53		25	4			20		2	1/2	Tr.	1/16	do	do	3/16
1033	Hornblende gneiss		Ne	L	do	3/8	49		25	4			20		5	1/4	1	1/64	do	2 crystals	1/16-1/8
1034	do		Ne	Lb	do	3/16	39.5		30	3			20		10	1/4	0.5	1/64	do	1 crystal	3/16
1035	Hornblende gneiss and fine-grained granite.		Ne	L	do	1/16	61		20	3			15		2	1/8	2	1/64	Columbite-tantalite.	do	3/8
1036	do		Ne	L	do	1/4	43.5		25				20		10	1/2	0.5	1/128	{Cleavelandite Biotite Columbite-tantalite. Beryl	1 Trace 1 crystal 2 crystals	 3/8 1/8 1/16-1/8
1037	do		Ne	L	do	3/8	34.5		35				20		10	1/8	0.5	1/128			

1038	Hornblende gneiss, fine-grained granite, and coarse-grained granite.	None		Lb	do	1/2	40		30	3			20		10	3/4	Tr.	1/16			
1039	Hornblende gneiss and fine-grained granite.		Ne	L	do	1/8	60		15	3			20		5	1/4	Tr.	1/128	Beryl Biotite	1 crystal Trace	3/8 1/4
1040	Hornblende gneiss, fine-grained granite, and coarse-grained granite.	None		Lb	Hanging-wall layer.	1/4	40		40	4			15		5	1/4	Tr.	1/16			
					Footwall layer	1/32	78		5	1/2			15		Tr.	1/16	2	1/128	Beryl	1 crystal	3/8
1041	Hornblende gneiss and fine-grained granite.	do		Lb	1 unit	3/8	42		35	4			20		3	1/8	Tr.	1/64	Biotite Chlorite Beryl	Trace do 4 crystals	1/4 1/8 1/16–1/2
1042	do	do		Lb	do	1/8	58.5		20	3			20		1	3/16	0.5	1/64	Beryl	7 crystals	1/32–1/4
1043	do		Ne	L	Hanging-wall layer.	1/8	49.5		35				15		0.5	1/8	Tr.	1/64	Biotite Beryl	Trace 0.6	1/4 1/16–3/8
					Footwall layer	1/128	85						15				<1		Beryl	1 crystal	1/8
1044	Hornblende gneiss		Ne	Lb	Wall zone	1/64	78		5	1/4			15				2				
					Core	3/8	40		35	3	5		15		10	1/2	Tr.	1/32	Beryl Biotite	3 crystals Trace	1/8–3/16 1/4
1045	do		Ne	L	1 unit	1/16	58		20	1			15		5	1/8	2	1/128	Beryl	3 crystals	3/8–1/2
1046	Hornblende gneiss and fine-grained granite.		Ne	L	do	1/16	62		15	3			20		3	1/4	<1	1/32	do	do	1/16–3/32
1047	Hornblende gneiss		Ne	Lb	do	1/4	49		30	4			20		1	3/16	Tr.	1/32	do	2 crystals	1/8–1/4
1048	Hornblende gneiss and fine-grained granite.	None		L	do	1/16	57		20	4			20		3	1/8	Tr.	1/32	do	1 crystal	1/8
1049	Hornblende gneiss		Ne	L	do	1/16	56		20	3			20		4	1/8	Tr.	1/32	Columbite-tantalite.	do	3/16
1050	do		Ne	L	do	1/8	49.5		30	3			20		0.5	1/2	<1	1/32	Biotite	Trace	1/8
1051	do		Ne	L	do	1/8	45		35	2			15		5	1/8	<1	1/64			
1052	Hornblende gneiss and fine-grained granite.	None		Lb	do	1/4	45		30	4			20		5	1/8	<1	1/16	Beryl	1 crystal	1/4
1053	Fine-grained granite.	do		L	do	1/8	49.5		30	3			20		0.5	1/16	Tr.	1/64	Beryl Biotite	5 crystals Trace	3/32–3/16 1/64
1054	Hornblende gneiss		Ne	L	do	1/4	43		30	3			20		7	3/16	Tr.	1/32	Biotite	do	1/4
1055	do		Ne	L	do	1/8	55		20	3			20		5	1/4	<1	1/64			
1056	do		Ne	L	do	1/4	45		30				25		<1						
1057	Hornblende gneiss, fine-grained granite, and quartzite.	None		Lb	do	1/4–1/2	30		44				25		1		Tr.				
1058	Fine-grained granite.	do		Lb	do	1/4	49		30				20		1		Tr.				
1059	Hornblende gneiss and quartzite.	do		Lb	do	1/4–1/2	43		37				20		<1		Tr.				
1060	Hornblende gneiss		Ne	Lb	do	1/8–1/4	60		15				25		Tr.		<1				
1061	do		Ne	L	do	1/8–1/4	55		25				20		<1		Tr.				
1062	do		Ne	L	do	1/4	45		35				20		<1		Tr.		Magnetite	Trace	
1063	do		Ne	L	do	1/2	30		50				20		<1		Tr.		Biotite	do	
1064	Hornblende gneiss, fine-grained granite, and quartzite.	None		L	do	1/4	49		25				25		1		Tr.		Beryl Columbite-tantalite.	1 crystal do	7/8 1/4
1065	Hornblende gneiss		Ne	Lb	do	1/4–1/2	45		35				20		<1		Tr.		Beryl	1 crystal	1 1/4
1066	Hornblende gneiss and fine-grained granite.	None		Lb	do	1/2	42		37				20		1		Tr.				
1067	Hornblende gneiss, fine-grained granite and quartzite.	do		L	do	1/8–1/4	60		20				20		<1		Tr.				
1068	Hornblende gneiss		Ne	Lb	Wall zone	1/8–1/4	51		25				20		4		<1		Beryl	17 crystals	1/8–5/8
					Core	3	1		40				58		1				Beryl Columbite-tantalite.	3 crystals 1 crystal	
1069	Hornblende gneiss and fine-grained granite.	None		L	1 unit	1/4–1/2	42		37				20		1		<1		Beryl	4 crystals	3/16–5/8
1070	Hornblende gneiss		Ne	Ir	do	1/8–1/4	69		10				20		1		<1		Beryl	5 crystals	1/16–3/4
1071	do		Ne	L	Wall zone	1/2	40		35				25		<1		<1		do	23 crystals	1/8–1/2
					Core	6	1		38				60		1				Biotite	Trace	
1072	do		Ne	L	1 unit	1/2–3/4	35		40				25		<1		Tr.		Beryl	26 crystals	1/16–1/2
1073	Hornblende gneiss and fine-grained granite.	None		L	do	1/4–1/2	44		35				20		1		Tr.				
1074	Hornblende gneiss		Ne	Lb	do	3/4	35		45				20		Tr.		Tr.		Biotite	Trace	
1075	Hornblende gneiss and coarse-grained granite.	None		Lb	do	1/4	45		34				20		1		<1		Beryl	3 crystals	3/16

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1076	Hornblende gneiss and fine-grained granite.		Ne	L	Wall zone	½	30		50				20		Tr.		Tr.		Biotite Martite	Trace do	
					Core	1	10		50				40						Beryl Biotite	2 crystals Trace	1/16–½
1077	Hornblende gneiss		Ne	Lb	Wall zone	¼–½	45		35				20		<1		Tr.				
					Core	5	<1		7				93								
1078	do		Ne	Lb	1 unit	⅛–¼	50		30				20		<1		Tr.				
1079	do		Ne	L	do	¼	45		30				25		<1		Tr.				
1080	Hornblende gneiss and fine-grained granite.	None		Lb	do	⅛–¼	55		25				20		<1		Tr.				
1081	do	do		L	do	⅛	54		25				20		1		<1		Beryl Martite	1 crystal Trace	⅛
1082	do	do		L	do	¼–½	49		30				20		1		<1		Martite	Trace	
1083	do	do		L	do	¼	60		20				20		<1		<1		Beryl	6 crystals	⅛–⅜
1084	do	do		L	do	⅛–¼	59		20				20		1		<1		do	5 crystals	⅛–¼
1085	Hornblende gneiss		Ne	L	do	½–¾	43		30				25		2		Tr.		do	3 crystals	3/16–¾
1086	do		Ne	Lb	do	⅛–¼	49		30				20		1		Tr.		do	1 crystal	3/16
1087	do		Ne	L	do	⅛–¼	60		20				20		<1		Tr.				
1088	Hornblende gneiss and fine-grained granite.	None		L	do	¼	44		35				20		1		<1		Biotite Beryl	Trace 3 crystals	3/16
1089	Hornblende gneiss		Ne	L	do	⅛–¼	49		30				20		1		<1				
1090	do		Ne	L	do	¼	55		25				20		<1		<1		Biotite	Trace	
1091	do		Ne	L	do	½	39		40				20		1		Tr.		Beryl	1 crystal	¼
1092	do		Ne	L	Wall zone	⅛–¼	55		25				20		<1		<1		do	do	¼
					Core	4–5	1		25				74		<1						
1093	do		Ne	L	1 unit	4½	40		35				25		<1		Tr.		Beryl	2 crystals	¼
1094	do		Ne	L	do	¼–½	35		40				25		<1		Tr.		do	4 crystals	⅛–½
1095	do		Ne	L	do	¼	45		30				25		<1		Tr.		do	2 crystals	⅛
1096	do		Ne	L	Wall zone	½	35		45				20		<1		Tr.				
					Core	4	1		25				74				Tr.				
1097	do		Ne	L	1 unit	¾	15		65		15		20		<1		Tr.				
1098	do		Ne	L	do	¼	44		35				20		1		Tr.				
1099	do		Ne	L	do	½–¾	40		39				20		1		Tr.				
1100	do		Ne	Lb	do	¼	44		30				25		1		Tr.		Beryl	2 crystals	¼
1101	do		Ne	L	do	¼	45		30				25		<1		Tr.		Epidote	Trace	
1102	do		Ne	L	do	¼	49		30				20		1		Tr.		Beryl	1 crystal	3/16
1103	do		Ne	Lb	do	¼	44		35				20		1						
1104	do		Ne	L	do	⅛	46.5		30				20		3		0.5				
1105	do		Ne	L	Hanging-wall layer.	¾	30		45	4			15		10	¾	Tr.	1/64			
					Footwall layer	1/16	67.5		15	2			15		2	¼	0.5	1/128	Beryl	1 crystal	1/16
1106	do		Ne	L	1 unit	¼	49		35	3			15		1	⅛	Tr.	1/64			
1107	Fine-grained granite and hornblende gneiss	None		L	Hanging-wall layer.	¼	50		30	3			15		5	⅛	Tr.	1/16			
					Footwall layer	1/32	72		10	½			15		1	1/16	2	1/64			
1108	do	do		Lb	1 unit	⅛	44.5		30	2			20		5	¼	0.5	1/128			
1109	do	do		Lb	do	1/16	73		10	1			15		2	¼					
1110	do	do		L	do	1/16	68		15				15		2						
1111	do	do		Lb	do	⅛	45		30	2			20		5	½					
1112	Hornblende gneiss		Ne	Lb	do	⅛	50		25	1	15	4	15		2	⅛					
1113	Hornblende gneiss and fine-grained granite.	None		L	do	½	39		45	3			15		1	¼	Tr.	1/64			
1114	do	do		Lb	do	1/32	74		10	¾			15		1	1/16	<1	1/64			
1115	do	do		L	do	1/16	72		10				15		3	⅛					
1116	do	do		L	Hanging-wall layer.	⅜	20		60	¾			15		5	¼					
					Footwall layer	1/64	84						15		1	1/64					
1117	Hornblende gneiss		Ne	L	Hanging-wall layer	½	15		40	1½			40		5	⅛					
					Footwall layer	1/64	85						15		Tr.	1/64	<1	1/64			
1118	Hornblende gneiss and fine-grained granite.	None		Lb	1 unit	1/16	78		5				15		2	⅛	Tr.	1/64			

1119	Hornblende gneiss		Ne	L	Hanging-wall layer	3/8	8		60	3/4			25		7	1/4					
					Footwall layer	1/32	83						15		2	1/64					
1120	do		Ne	Ov	1 unit	3/8	39		45	1			15		1	1/4	<1	1/8			
1121	do		Ne	Lb	do	3/8	59		20	1½			20		1	1/4					
1122	do		Ne	L	Hanging-wall layer.	1/8	20		60				19		1						
					Footwall layer	1/16	40		28				30		2						
1123	do		Ne	L	Hanging-wall layer	1/4	60		10				27		3						
					Footwall layer	1/64	75		5				18		2						
1124	do		Ne	L	1 unit	1/32	45		24	4			30		1						
1125	do		Ne	L	Hanging-wall layer	1/4	17		50				30		3	3/4					
					Footwall layer	1/64	60		19				20		1						
1126	do		Ne	L	Hanging-wall layer	1/2	15		50				30		5	1					
					Footwall layer	1/32	60		8				30		2						
1127	do		Ne	L	1 unit	3/8	30		30				30		10						
1128	do		Ne	L	do	1/16	70		4				25		1						
1129	do		Ne	L	Hanging-wall layer.	1/8	10		60				27		3						
					Footwall layer	1/32	60						38		2						
1130	do		Ne	L	Hanging-wall layer	1/4	30		50				28		2						
					Footwall layer	1/32	70		4				25		1						
1131	do		Ne	I	Hanging-wall layer	1/8	10		60				27		3						
					Footwall layer	1/32	70		4				25		1						
1132	do		Ne	L	Hanging-wall layer	1/4	10		50				40		<1						
					Footwall layer	1/32	60		10				25		5						
1133	do		Ne	L	Wall zone	1/64	80						20								
					Core	1/32	30		20				49		1						
1134	do		Ne	Ov	1 unit	1/16	60		10				30								
1135	do		Ne	L	do	1/8	50		20				30		Tr.						
1136	do		Ne	L	do	1/8	44.5		30	5			15		0.5	1/8	<1	1/64			
1137	Hornblende gneiss and fine-grained granite.	None	Ne	Ir	1 unit	1/4	48		30				20		2	1/4					
1138	do	do	Ne	L	do	1/8	60			5			20				Tr.	1/64	Biotite	Trace	1/4
1139	Hornblende gneiss		Ne	Ir	do	1/16	75		10	3			15								
1140	do		Ne	Ir	do	1/4	58		25	4			15		2	3/8					
1141	do		Ne	Ov	do	1/4	75		10	2			15								
1142	do		Ne	L	do	1/2	50		35	2			15								
1143	do		Ne	Ov	do	1½	45		35		15	8	20								
1144	do		Ne	Ir	do	1/4	75		10	2			15		5	1/4					
1145	do		Ne	Lb	do	1/4	50		25		15	6	15		10	1/4					
1146	do		Ne	L	do	1/8	50		20	3	10	5	20		10	1/4					
1147	do		Ne	Lb	do	1/4	56		25		15	6	15		3	1/8	1	1/128			
1148	do		Ne	Lb	Wall zone	1/8	58.5		25	2			15		1	1/8	0.5	1/64			
					Core	3/4	10		5	1/2			30		55	1					
1149	do		Ne	L	1 unit	1/16	72		10	2			15		3	1/4					
1150	do		Ne	L	Wall zone	1/8	40		30	3			20		10	1/4					
					Core	4	10		30	6			55		5	1			Beryl	2 crystals	1½–3¼
1151	Coarse-grained granite and hornblende gneiss.	None		L	1 unit	1/8	45		35	3			15		5	1/4	Tr.	1/128			
1152	do	do		L	Hanging-wall layer.	1/8	40		40	3			15		5	1/4					
					Footwall layer	1/64			84				15				1	1/128			
1153	Hornblende gneiss		Ne	Lb	Hanging-wall layer.	1/8	40		40	1			15		5	3/8	Tr.	1/128			
					Footwall layer	1/64	84						15				1	1/128			
1154	Fine-grained granite and hornblende gneiss.	None		L	Hanging-wall layer.	1/8	40		43.5	1½			15		1	1/2	0.5	1/128			
					Footwall layer	1/64	80		5	1/2			15				Tr.	1/128			
1155	Hornblende gneiss		Ne	Lb	Hanging-wall layer.	3/8	25		45	2			20		10	3/4					
					Footwall layer	1/64	79		5	1/4			15				1	1/128			
1156	do		Ne	L	Hanging-wall layer.	1/16	48.5		35	2	25	5	15		1	1/4	0.5	1/128			
					Footwall layer	1/64	84						15				1	1/128			
1157	do		Ne	Lb	1 unit	1/2	15		50		40	5	20		15	1/4	<1	1/32			
1158	do		Ne	L	do	1/4	55		20	2			25								
1159	do		Ne	L	do	1/8	65		15	3			20		Tr.	1/16					
1160	do		Ne	Lb	do	1/8	59		25	3			15		1	1/8	Tr.	1/8			
1161	do		Ne	L	do	1/4	65		10	4			25								
1162	do		Ne	L	do	3/8	60		10	1½			30								
1163	do		Ne	L	do	1/8	70		15	1			15				Tr.	1/64			
1164	do		Ne	Lb	Hanging-wall layer.	1/2	30		50	1			20		5	1/4					
					Footwall layer	1/64	75		10	3/4			15		Tr.	1/32	Tr.	1/128			
1165	do		Ne	L	Wall zone	1/16	60		20	2			15		5	1/16					
					Core	3	15		38				45		2	1					

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1166	Hornblende gneiss and granite.	None	Ne	L	1 unit	1/8	62		20	2			15		3	1/4	Tr.	1/128			
1167	Fine-grained granite and hornblende gneiss.	do		L	do	1/8	50		25	3			20		5	1/4					
1168	do	do		L	do	1/16	69		10	1			20		1	1/16					
1169	do	do		Lb	Wall zone	1/4	53		25	1	15	5	20		2	1/8					
					Core	3			10	4			80		10	3/4					
1170	Hornblende gneiss		Ne	Lb	1 unit	1/8	50		20	3			20		10	1/4					
1171	Hornblende gneiss and fine-grained granite.	None		L	do	1/2	30		50	8			15		5	3/8	<1	1/64			
1172	do	do		Lb	Hanging-wall layer.	1/4	35		40	5			15		10	1/4	<1	1/64			
					Footwall layer	1/64	75						15		10	1/64	Tr.				
					Core	3			45	5			45		10	3/4			Beryl	1 crystal	1
1173	Hornblende gneiss		Ne	L	1 unit	1/8	69.5		15	2			15		0.5	1/4	<1	1/32			
1174	do		Ne	Lb	Wall zone	1/8	60		20				20		<1		Tr.				
					Core	2	7		50				43		<1				Beryl	8 crystals	1/4-1
1175	do		Ne	L	1 unit	1/4-1/2	54		25				20		1		Tr.				
1176	do		Ne	L	do	1/4-1/2	44		35				20		1						
1177	do		Ne	Ir	Wall zone	1/2	53		25				20		2		<1				
					Core	8	1		30				66		3						
1178	do		Ne	Ir	Wall zone	1/2	35		41				20		4		<1				
					Core	1	<1		15				85		<1						
1179	do		Ne	Ir	1 unit	1/2	40		40		10		19		1		<1				
					Fracture filling	3	2		58				40		<1				Beryl	8 crystals	1/4-1/2
1180	do		Ne	L	1 unit	1/8-1/4	49		20				30		1		<1				
1181	Hornblende gneiss and fine-grained granite.	None		Lb	do	1/8-1/4	45		33				20		2		Tr.				
1182	Hornblende gneiss		Ne	Lb	Wall zone	1/8-1/4	40		40				20		<1				Beryl	2 crystals	1-6
					Core	6-8	2		5				93								
1183	do		Ne	Ir	1 unit	3/4	25		45				30				<1				
1184	do		Ne	Lb	do	1/4	43		35				20		2		Tr.				
1185	Hornblende gneiss and fine-grained granite.	None	Ne	Lb	do	1/4	43		25		Tr.		20		2		Tr.				
1186	Hornblende gneiss		Ne	L	do	1/4-1/2	15		57				25		3		<1				
1187	do		Ne	L	Wall zone	1/2	10		68		5		20		2		<1				
					Core	6-8			15				85								
1188	Hornblende gneiss and fine-grained granite.	None		Ir	Wall zone	1/16	62		20				15		3		1				
					Intermediate zone.	1/8	30		25				25		20		Tr.				
					Core								100								
1189	Hornblende gneiss		Ne	L	Wall zone	1/4-1/2	44		35				20		1		<1				
					Core	4-5	<1		40				60		<1				Beryl	1 crystal	3/4
1190	Coarse-grained granite and hornblende gneiss.	None		L	1 unit	1/2	30		50				20		<1		Tr.				
1191	Hornblende gneiss		Ne	Lb	do	1/2	42		37				20		1		Tr.				
1192	do		Ne	Lb	do	1/2	35		44				20		1		Tr.		Beryl	22 crystals	1/8-1/2
1193	Hornblende gneiss fine-grained granite, and coarse-grained granite.	None		Lb	Wall zone	3/8	50		20	5			20		10	1/2	Tr.	1/64			
					Intermediate zone.	1	15		25	5	10		35						Hematite	Trace	
					Core	8			20				80						Beryl	3 crystals	1-1½
1194	Hornblende gneiss		Ne	L	1 unit	3/16	48		30				20		2		Tr.		do	2 crystals	1/32-1/16
1195	do		Ne	L	do	1/8	47		30	3			20		3	1/8	Tr.	1/32			
1196	do		Ne	L	Wall zone	1/8	59.5		20	3			20		0.5	1/8	Tr.	1/64			
					Core	8			60	8			40								
1197	Hornblende gneiss and fine-grained granite.	None		L	Wall zone	1/8	60		25	2			15		Tr.	1/16	Tr.	1/64	Biotite	Trace	1/2
					Core	8			40	8			60		Tr.	1/4					
1198	do	do		L	Wall zone	1/8	59		20	2			20		0.5	1/4	0.5	1/32			
					Core	3	10		50	5			35		5	1/2	Tr.	1/32			

1199	do	do		Lb	Wall zone	1/2	48		30	5			20		2	1/4	<1	1/32			
					Intermediate zone.	1	40		10	5			30		20	2	Tr.	1/32			
					Core	8			10	8			90								
1200	do	do		Lb	1 unit	1/4	62		15	1			20		3	1/8	Tr.	1/32			
1201	Hornblende gneiss		Ne	Ir	do	3/8	39		40	4			20		1	1/4	<1	1/64	Beryl Biotite	1 crystal Trace	1/2 1/4
1202	do		Ne	L	Wall zone	1/4	50		30	1½			20		Tr.	1/4	Tr.	1/64	Biotite	do	1/4
					Core	5	5		35				60		Tr.				Beryl	4 crystals	5/16–1/2
1203	do		Ne	L	1 unit	1/4	40		35	1			25		Tr.	1/4	Tr.	1/64			
1204	do		Ne	L	do	1/16	56.5		20	3			20		3	1/8	0.5	1/64	Magnetite	Trace	1/4
1205	do		Ne	L	do	1/16	55		20	3/4			20		5	1/8	<1				
1206	do		Ne	Lb	Wall zone	1/4	50		25	3			20		5	1/8	<1	1/64			
					Intermediate zone.	1/4	48		10	5			20		20	1	2	1/4			
					Core	8			40				60								
1207	do		Ne	L	1 unit	3/16	40		30	5			20		10	1/4	<1	1/64			
1208	Hornblende gneiss and fine-grained granite.	None		L	Wall zone	1/8	44.5		30	5			20		5	1/8	0.5	1/32			
					Intermediate zone.	3/4	25		10	3			35		30	1					
					Core	8	20		40	8			35		5	1/4					
1209	Hornblende gneiss		Ne	L	Wall zone	1/8	45		25	3			20		10	1/4	Tr.	1/32			
					Core								100								
1210	do		Ne	Lb	1 unit	1/4	53		25	4			20		2	1/4	Tr.	1/16			
1211	do		Ne	L	Wall zone	1/4–1/2	15		59				25		1		<1				
					Core	6–8	2		30				68		<1						
1212	do		Ne	L	Wall zone	1/2	30		40	5			20		10	1/2	Tr.	1/32			
					Core								100								
1213	Hornblende gneiss and fine-grained granite.	None		L	1 unit	1/4	60		25		15	5	15						Biotite	Trace	1/4
1214	Hornblende gneiss		Ne	L	do	3/8	45		40		20		15						Chlorite	do	1/4
1215	do		Ne	L	do	3/8	40		35	4			25						Magnetite	do	1/16
1216	Hornblende gneiss and granite.		Ne	L	do	3/8	45		30		3		24.5				0.5	1/64	Magnetite Hematite	do do	
1217	Hornblende gneiss		Ne	L	Wall zone	1/16	75						25								
					Core	1/2	45		30	3			25						Magnetite	Trace	1/16
1218	do		Ne	L	1 unit	1/4	40		40		10		20						Martite	do	
1219	do		Ne	L	Wall zone	1/2	15		60		10		25						Martite Biotite	<1 Trace	
					Core				2				98								
1220	do		Ne	Lb	1 unit	2–3	15		65				20						Magnetite	Trace	
1221	do		Ne	L	do	1/4–1/2	35		40				25		<1				Martite	do	
1222	Quartz monzonite	None		Lb	do	1/8	60		20				20		Tr.		Tr.		Magnetite	Trace	
1223	do			Lb	do	1/4	40		40				20				<1		do	<1	
1224	do			Lb	do	1/4	55		25				20		Tr.		Tr.		do	Trace	
1225	do			L	do	3/4	20		55		10		25				Tr.		Martite Biotite	do do	
1226	do	None		Lb	Wall zone	3/4–1	10		70		15		20				Tr.		Martite	do	
					Core								100						Biotite	do	
1227	do			L	1 unit	3/4	25		50		20		25						Martite	do	
1228	do			Lb	do	1/2–3/4	25		55				20				Tr.		do Biotite	do do	
1229	Quartz monzonite and hornblende gneiss	None		Lb	do	1/4–1/2	20		55				25				<1		Magnetite	<1	
1230	Quartz monzonite			Lb	do	3/4	50		25				25						Magnetite Biotite	<1 Trace	
1231	do	None		Ir	do	1/4–1/2	35		45				20		<1		Tr.		Biotite Magnetite	do do	
1232	Hornblende gneiss		Ne	Lb	do	1/8–1/4	50		30				20				Tr.		Magnetite Biotite	do do	
1233	Quartz monzonite			L	do	1/4–1/2	30		55				15		<1		<1		Martite	<1	
1234	do	None		Ir	Wall zone	1/2	15		60				25				<1		Martite Columbite-tantalite.	<1 10 crystals	
					Core								100								
1235	do	do		Ir	1 unit	1/4	20		55				25						Martite	<1	
1236	Hornblende gneiss		Ne	L	do	1/8	60		15				25				<1		Magnetite Biotite	Trace <1	
1237	do		Ne	L	do	1/32	88		5	1/2			15						Biotite	2	1/16
1238	do		Ne	Ir	Wall zone	1/32	80		5	1			15						Biotite	Trace	1/64
					Core	6	10		30				60		Tr.	1/16	Tr.	3/8	Beryl Samarskite Tourmaline	3 crystals 2 crystals Trace	3/4–1½ 1/8 1½
1239	do		Ne	Ir	1 unit	1/64	78		5	5			15						Biotite	2	1/64
1240	do		Ne	Ir	do	1/32	75		10				15						Biotite Columbite-tantalite	<1 1 crystal	1/32 1/8
1241	do		Ne	L	do	1/2	30		55		35	3	15						Biotite Tourmaline	<1 Trace	1/32 1/8
1242	do		Ne	Ir	Wall zone	1/32	50		30				20						Biotite	Trace	1/16
					C re	3	60												Samarskite	1 crystal	1/8
1243	do		Ne	Ir	Wall zone	1/16	75		5				20						Tourmaline	Trace	
					Core								100						Biotite	Trace	

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1244	Hornblende gneiss		Ne	Lb	South end	1/2	60		20	3			20				Tr.	1/64	Magnetite	Trace	1/4
					North end	1/64	84						15						Biotite	1	1/61
					Core	2 1/2	60						40								
1245	do		Ne	L	1 unit	1/64	84						15						Biotite	1	1/32
1246	do		Ne	L	do	1/8	70		15		5	3	15				<1	1/64			
1247	do		Ne	Ir	do	1/16	80		5	1			15						Biotite	<1	1/8
																			Martite	Trace	1/16
1248	do		Ne	Ir	Wall zone	1/8	65		20		10	8	15				<1	1/16	Biotite	do	1/2
					Core								100		Tr.	1/64					
1249	do		Ne	L	1 unit	1/4	70		15	6			15		Tr.	1/4	Tr.	1/64			
1250	do		Ne	L	do	1/16	75		15		5	5	10		Tr.	1/16	<1	1/64			
1251	do		Ne	L	do	1/16	80		5	1/2			15				<1	1/64	Biotite	<1	1/32
1252	do		Ne	L	do	1/32	75		10	3			15				<1	1/64			
1253	do		Ne	L	Wall zone	1/16	75		10		5	3	15				Tr.	1/16			
					Intermediate zone.	1	30		50	3			20		Tr.	1/8			Biotite	Trace	1/2
					Core				25				75						do	do	2
1254	Coarse-grained granite and hornblende gneiss	None		L	1 unit	1/16	75		10	2			15						do	<1	1/32
																			Magnetite	Trace	1/32
1255	Hornblende gneiss		Ne	L	do	1/8	55		30	3			15		Tr.	1/16	Tr.	1/64			
1256	do		Ne	L	do	1/4	55		30		20	5	15				<1	1/64	Martite	<1	1/64
1257	Coarse-grained granite and hornblende gneiss	None		Ov	do	1/8	65		20		10	5	15		Tr.	1/16			Biotite	Trace	1/16
1258	do	do		Ir	do	1/16	70		15	1			15		Tr.	1/16	<1	1/64			
1259	do	do		Ir	do	1/8	55		30		20	5	15		1	1/8	Tr.	1/64			
1260	do	do		Lb	do	1/16	70		15	3			15				<1	1/32			
1261	do	do		Ir	do	1/8	65		20		10	5	15		Tr.	1/8	Tr.	1/32			
1262	Hornblende gneiss		Ne	L	Wall zone	1/8	70		15	1			15		Tr.	1/32	<1	1/64			
					Core	1 1/2	75		5	2			20		Tr.	1/16	Tr.	1/32			
1263	do		Ne	L	1 unit	1/8	70		10	1 1/2			20				<1	1/64			
1264	do		Ne	Lb	do	1/8	50		30	3			20				<1	1/16			
1265	do		Ne	L	do	1/8	50		30	5	5		20				<1	1/64	Biotite	Trace	3/8
1266	Fine-grained granite and hornblende gneiss.	None		L	do	1/8	62		20	2			15		3	1/4	Tr.	1/128			
1267	Coarse-grained granite and hornblente gneiss.	do		L	Wall zone	3	33		50		30	3	15		2	1/4					
					Intermediate zone.	1 1/2	30		20	8			30		20	3	Tr.	1/16			
					Core	3			15				85								
1268	Hornblende gneiss		Ne	Ir	1 unit	1/4	45		40		30	5	15						Biotite	<1	1/4
																			Magnetite	Trace	1/8
1269	Hornblende gneiss and granite.	None	C	Ir	do	1/8	60		15	3			25				<1	1/32	Magnetite	<1	1/8
1270	Hornblende gneiss		Ne	L	do	1/4	35		50				15		<1		<1				
1271	do		Ne	Ir	do	3/4	49		30				20		<1		Tr.				
1272	do		Ne	L	do	1/4	63		15				20		2		<1				
1273	do		Ne	Lb	do	3/4	49		30				20		1		Tr.				
1274	do		Ne	Lb	do	1/4–1/2	58		20				20		2		<1		Martite	Trace	
																			Tourmaline	do	
1275	do		Ne	Lb	do	1/8–1/4	65		15				20		<1		<1				
1276	do		Ne	L	do	1/8–1/4	65		15				20		<1		<1				
1277	do		Ne	L	do	1/4	54		25				20		<1		<1		Martite	<1	
																			Biotite	Trace	
																			Tourmaline	do	
1278	do		Ne	Lb	do	1/4	45		35				20		Tr.		Tr.		Martite	<1	
																			Tourmaline	Trace	
1279	Hornblende gneiss and fine-grained granite.	None		L	do	1/8–1/4	90		5				5						Biotite	<1	
1280	Hornblende gneiss and quartz monzonite.	do		L	do	1/4–1/2	40		35				25		<1		Tr.				
1281	do	do		Ir	do	1/2–3/4	35		40				25				Tr.		Martite	<1	
1282	do	do		L	do	1/2	15		65		5		20				Tr.		Biotite	<1	
																			Magnetite	<1	

1283	do	do		Ir	do	¼	35		45		5		20		Tr.		Tr.		Magnetite	Trace	
1284	Hornblende gneiss		Ne	L	do	12–24	20		60		70		20						Biotite Magnetite	do <1	
1285	Hornblende gneiss and quartz monzonite.	None.		Lb	Wall zone	8–12	30		50		60		20				Tr.		Samarskite (?) Biotite Magnetite	Trace <1 <1	
					Core	6	1		15				84		<1		Tr.		Biotite Magnetite	Trace do	
1286	do	do		Lb	Northeast branch.	4–6	15		65		80		20						Magnetite Biotite	<1 <1	
					Southwest branch, wall zone.	¼–½	45		35				20		<1		<1		Magnetite Biotite	Trace do	
					Southwest branch, core.	12–24	1		30				69								
1287	Quartz monzonite	do		Lb	1 unit	½–¾	45		35				20		Tr.		<1		Biotite	<1	
1288	do	do		L	do	¼	20		55				25						Biotite Martite	<1 <1	
1289	do	do		Lb	do	½	15		65				20						Biotite Martite	<1 Trace	
1290	do	do		L	do	¼	30		45				25				Tr.		Biotite Martite	do do	
1291	do	do		L	do	⅛–¼	38		42				20				Tr.		Biotite Magnetite	do do	
1292	Hornblende gneiss		Ne	L	do	⅜	49.5		30		85		20		Tr.		0.5		Biotite	do	
1293	do		Ne	L	do	⅜	60		25		40		15		Tr.		Tr.		do	do	
1294	do		Ne	L	do	3/16	59		21		20		20				Tr.		Magnetite	do	
1295	do		Ne	Lb	do	3/16	53		25				20		2		Tr.				
1296	do		Ne	L	do	¼	52.5		25				20		2		0.5				
1297	do		Ne	L	do	⅛	48.5		30				20		1		0.5		Martite Biotite	Trace do	
1298	do		Ne	Lb	do	⅜	54.5		30		Tr.		15		0.5		Tr.				
1299	Quartz monzonite			Ir	do	1	40		45		35	12	15						Magnetite Biotite	<1 Trace	1/16 ¼
1300	do			L	do	½	55		25		15	5	20				<1	1/32	Biotite	do	¼
1301	do	None		Ov	do	2	65		15		5	8	20						Biotite Magnetite	do do	¼ 1/32
1302	do	do		Ir	do	1	55		25		15	8	20						Magnetite Biotite	do do	½ 1/16
1303	do	do		L	do	½	55		25	3			20						Magnetite Biotite	do do	½ ¼
1304	do			L	do	¼	60		20	3			20						Magnetite Biotite	do do	¼ 1/16
1305	do			L	do	1	50		30		20	12	20						Biotite	do	1/32
1306	do			L	do	¼	65		20		10	8	15						Magnetite	do	1/16
1307	do	None		L	do	1/16	75		10	4			15						do	<1	1/16
1308	do			Lb	do	½	40		35	3	5		15						Magnetite Biotite	<1 Trace	1/16 ½
1309	do			L	do	1	35		50	3			15						Magnetite	<1	⅛
1310	do	None		Ir	do	½	20		62				15						Magnetite Biotite	<1 3	1/16 1/16
1311	do	do		Ov	do	¾	45		35	4			20						Magnetite Biotite	<1 Trace	1/16 ⅛
1312	do	do		Lb	do	2	50		35		25	8	15						Magnetite Biotite	do do	¼ ¼
1313	do	do		Ov	do	3	32		50		40	12	15						Biotite Magnetite	3 Trace	⅛ ⅛
1314	do			Ir	Wall zone	3	40		45		35	12	15						Magnetite	do	1/16
					Core								100						Biotite	do	⅛
1315	do			L	Wall zone	3	45		40		30		14.5						do	.5	1
					Core								100								
1316	do	None		Ir	1 unit	4	60		35		25	10	15						Biotite	<1	2
1317	do	do		Ir	do	3	60		25		10	8	15						Martite Biotite	<1 <1	¼ 2
1318	do			Ov	do	4	55		30		20	8	15						Biotite Chlorite	Trace do	1/16
1319	do	None		Ir	Eastern part	5	20		40	6			30		10	1	<1				
					Western part	6	60		25		15	8	15						Biotite	Trace	½
1320	do			Lb	1 unit	4	50		30		20	10	19						Magnetite Biotite	.5 .5	½ 1
1321	do			L	do	2	60		25		10	8	15						Magnetite Biotite	Trace do	½ ½
1322	Hornblende gneiss and quartz monzonite.	None		Ir	Wall zone	2	55		30		20	8	15						Biotite Magnetite	do do	 ½
					Core	2	25		40				35		10	4	Tr.	¼	Beryl	5 crystals	½–¾
					do								100						Tourmaline	Trace	2
1323	Hornblende gneiss		Ne	L	Wall zone	3	43		40		30		15						Biotite Magnetite Chlorite	1 1 Trace	
					Core								100						Beryl	3 crystals	2½–8
1324	do		Ne	L	1 unit	4	60		35		25		15						Biotite Magnetite	Trace do	
1325	do		Ne	L	do	3	65		20		10		15						Magnetite	do	
1326	do		Ne	L	do	2	65		20		2		15						Biotite	do	½
1327	do		Ne	L	do	5	47		30		20		20		Tr.	1/16	3	⅜	Martite	<1	1
1328	do		Ne	Lb	do	2	59.5		18	4	10	6	20				2		Magnetite	.5	

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
							Mineralogy														
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1329	Hornblende gneiss		Ne	L	1 unit	6	43		35		25	10	20				Tr.	¼	Magnetitte	2	½
1330	do		Ne	Ir	do	1	64.5		20		10	12	15				0.5	⅛	Biotite	Trace	¼
1331	do		Ne	Ir	do	1	59.5		20	5	2		15				5	¼	Magnetite	.5	½
1332	do		Ne	Ir	do	3	60		25				15						do	Trace	
1333	do		Ne	Ir	Hanging-wall layer.	5	40		45				15								
					Footwall layer	¼	79		5				15						Biotite	1	⅛
1334	do		Ne	L	1 unit	4	60		25		15		15				Tr.		Magnetite	Trace	
1335	do		Ne	Ov	do	2	44		40		30		15				Tr.	⅛	do	1	⅛
1336	do		Ne	L	do	2	53		30		15		15				Tr.	1/16	do	2	¼
1337	do		Ne	Lb	do	1	60		25		15		15						do	Trace	
1338	do		Ne	L	do	2	50		20				30				<1		do	do	
1339	do		Ne	Ir	do	¼	45		35		25		20				Tr.				
1340	do		Ne	Lb	do	3	45		40		30		15						Magnetite	Trace	
1341	do		Ne	L	Hanging-wall layer.	¾	35		45		10		20				Tr.		Biotite	do	
					Footwall layer	¼	25		20				55				Tr.		do	do	
1342	do		Ne	Lb	1 unit	2	50		30		10	8	20				<1	1/32	Magnetite	do	1/16
1343	do		Ne	L	do	2	50		30		20		20						Biotite	do	
																			Magnetite	do	
1344	do		Ne	Ir	do	1	65		20				15						Magnetite	do	
1345	do		Ne	L	do	4	30		50		5		20				Tr.		Biotite	do	
1346	do		Ne	L	do	2	50		30		10		20						Magnetite	do	
1347	do		Ne	Ir	do	3	55		30		20	8	15						Biotite	do	½
																			Magnetite	<1	½
1348	do		Ne	Ov	do	4	60		25		15	12	15						Magnetite	<1	1
1349	do		Ne	L	do	1	20		45		20	8	35		Tr.		Tr.		do	Trace	
1350	do		Ne	Ir	do	2	75		10				15				Tr.		do	do	
1351	do		Ne	L	do	4	45		40		20	8	15				Tr.	⅛			
1352	do		Ne	Ir	do	4	64		20		5	6	15						Magnetite	1	½
1353	do	None	C	L	do	2	60		20		2		20						do	Trace	1/16
																			Biotite	do	1¼
1354	do		Ne	L	do	4	70		15		5	8	15				Tr.	¾	Magnetite	do	¼
1355	do		Ne	Ir	Wall zone	4	50		35		25	10	15				<1		Biotite	<1	
					Core								100						Magnetite	<1	
					do								100								
1356	do		Ne	Ir	1 unit	4	43		40		30	12	15						Biotite	2	1
1357	Hornblende gneiss and quartz monzonite.		C	Ir	do	2	60		25		15		15						Magnetite	<1	1/16
																			Biotite	Trace	⅛
1358	Hornblende gneiss		C	Ir	do	1½	75		10	5	1	8	15				<1	1/32	Magnetite	do	⅛
1359	do		C	L	do	1½	55		25		1	4	20						do	<1	¼
1360	do		Ne	Ov	do	1½	75		10	4	2		15						Magnetite	Trace	¼
																			Biotite	do	⅜
1361	do	None	C	L	do	1½	55		20		1		25				Tr.		Magnetite	do	⅛
																			Epidote	do	
1362	Quartz monzonite	do	C	L	do	3	45		35		10	6	20				Tr.	1/64	Magnetite	do	¼
1363	Hornblende gneiss		Ne	L	Hanging-wall layer.	2	65		20		10	12	15						Biotite	do	1½
					Footwall layer	3	25		60				15						Magnetite	do	
																			Biotite	do	
1364	do		Ne	?	1 unit	1	74.5		10				15						Biotite	0.5	
																			Magnetite	Trace	
1365	do		Ne	Ov	do	5	55		35		25	8	15						Magnetite	do	1/32
1366	do		Ne	Ov	do	1¼	55		30		20	8	15						Biotite	do	1/32
1367	do		C	Ir	do	2	65		20		5	12	15						Magnetite	do	1/32
																			Biotite	do	¼
1368	Quartz monzonite	None		L	do	2	40		45		25	10	15						Magnetite	<1	1/16
																			Biotite	Trace	⅜
1369	do	do		L	Wall zone	3	60		25		10	12	14.5						Biotite	0.5	⅛
																			Magnetite	Trace	⅛
					Core								100								
1370	do	do		Lb	1 unit	1	70		15		5		15						Magnetite	Trace	1/32
																			Biotite	do	1/32
1371	do			L	do	2	55		30		20	12	15				Tr.	¼	Magnetite	do	¼
																			Biotite	do	¼
1372	do	None		L	do	2	45		25		15	8	15				Tr.	¼	Magnetite	do	¼
																			Biotite	do	¼

1373	do			L	do	1	65		20		5	5	15						Magnetite	do	¼
																			Biotite	do	1/16
																			Chlorite	do	
1374	do			L	do	1	55		23		2		20				2	1/16	Magnetite	do	½
1375	do	None		L	do	1½	65		20		5		15				Tr.	⅛	do	do	¼
1376	do	do		Lb	Wall zone	2½	30		50		30	12	20				Tr.	2	Biotite	<1	½
					Core								100								
1377	do	do		Ir	1 unit	¾	75		10		5		15						Magnetite	Trace	⅛
																			Biotite	do	⅜
1378	do	do		Ov	do	1½	65		20		10	8	15				Tr.	1/64	Biotite	do	¼
																			Magnetite	do	1/16
1379	do	do		L	do	1½	65		20		5		15						Magnetite	do	1/32
1380	do			L	do	⅜	69		15				15				1	1/16			
1381	do			L	do	1	70		15		5		15				Tr.	1/16	Martite	<1	⅛
1382	do			Lb	do	1½	60		25	7	5		15				Tr.	1/32	Biotite	Trace	½
																			Magnetite	do	¼
1383	do	None		Ir	do	2	60		25	3	20	8	15						Biotite	do	¼
																			Martite	<1	1/16
1384	do	do		L	do	1	70		15		2		15						Magnetite	Trace	1/16
1385	do			L	do	2	70	5	15		5		15						do	do	1/32
1386	do	None		L	do	2½	20		55		30		25						Martite	do	¼
1387	do	do		L	do	2½	20		55		10		25						do	do	⅜
1388	do			Ir	do	1	65		20		10	12	15						Martite	do	¼
																			Biotite	do	½
1389	do	None		Ir	do	¾	75		10		3	5	15						Biotite	do	⅛
																			Magnetite	do	1/32
1390	do			Ir	Wallzone	2½	45		35		20	12	20						Biotite	do	2
																			Magnetite	do	½
					Core								100								
1391	do			L	1 unit	½	70		15		1		15						Magnetite	Trace	1/16
1392	do			Lb	do	½	55		30		5		15						do	<1	¼
1393	do			L	do	1½	30		55	5	30		15						Magnetite	<1	⅜
																			Biotite	Trace	1/16
1394	do			L	do	3	30		50		40	12	20						Biolite	<1	1/32
																			Magnetite	Trace	1/32
1395	do			L	do	¾	60		25		5		15						Magnetite	<1	⅛
1396	do	None		Lb	Wall zone	3	60		25		12		15						Magnetite	<1	⅛
																			Biotite	Trace	⅛
					Core								100								
1397	do	do		Ir	Wall zone	2	50		30		20	15	20						Magnetite	<1	½
																			Biotite	Trace	¼
					Core								100								
1398	do	do		Ov	1 unit	1/32	10		72				15						do	3	1/32
1399	do	do		Ir	do	1/32	20		65				15						Magnetite	<1	1/16
																			Biotite	Trace	1/16
1400	do	do		Ir	do	¾	70		15		10	12	15						Magnetite	do	1/32
1401	do	do		Ir	do	⅛	75		10				15						do	do	1/16
1402 (Trio No. 1).	do	Ir		do	Wall zone	¼	50		25	1	10	12	15						Biotite	do	1/16
																			Magnetite	do	⅛
					Intermediate zone.	6	34	2	30	18			35				0.5	½	Tourmaline	do	2
																			Biotite	0.05	½
																			Beryl	6 crystals	½–8
					do	1	25	3					60		15	1	<1	½			
					Core								100								
1403	do	do		Lb	1 unit	¼	55		25				20						Magnetite	Trace	1/16
1404	do			Ir	Wall zone	1/32	60		20				20						do	<1	1/16
					Core	½	45		40				15						do	Trace	⅛
1405	do			Ir	1 unit	½	45		15	2			40						do	do	1/16
																			Biotite	do	1/32
1406	do			Ov	Wall zone	1/64	79		5				15						do	1	1/64
					Core	¼	55		30				15		Tr.	1/64			do	Trace	⅛
1407	do	None		Lb	Wall zone	1/32	79.5		5				15						do	0.5	
					Core	¼	55		30	2			15		Tr.				do	Trace	
1408	do	do		Ir	1 unit	⅜	65		15				20						Magnetite	<1	1/16
1409	do			Ir	do	½	55		30	1			15						Biotite	Trace	1/16
																			Magnetite	<1	¼
1410	dp	None		L	do	⅛	70		15	2			15						Biotite	<1	⅛
1411	do	do		L	do	½	65		15	2			20						Biotite	<1	⅛
																			Magnetite	Trace	⅛
1412	do	do		Ir	do	2	30		50		40	8	20						Biotite	do	¼
1413	do	do		L	do	¾	35		50		40	5	15						Magnetite	do	¼
1414 (Snowshoe).	do	do		Ir	Wall zone	3	30		50		40		20						Magnetite	<1	¼
																			Biotite	Trace	½
					Core								100								
1415	do	do		Ir	1 unit	3	30		50		40	8	20						Magnetite	Trace	⅛
																			Biotite	do	½
1416	do	do		L	do	1	55		15		5		30						Magnetite	do	1/16
1417	do	do		Ir	do	½	30		20	3			50						do	do	1/16
1418	do	do		Ir	do	¼	10		65				25						Martite	do	
																			Biotite	do	
1419	do	do		L	Wall zone	¾	35		45		5		20						Martite	do	
					Core								100							do	
1420	do	do		Ir	1 unit	¼	20		55		15		25						Biotite		
																			Magnetite	<1	1½
1421	do	do		L	do	½	30		20		20		50						Martite	<1	
1422	do			L	do	1	25		55		25		20						do	Trace	

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
1423	Quartz monzonite	None		L	Wall zone	2-3	30		50		70		20						Mastite		
					Core	8			40				60						do	<1	
1424	do			Ir	Wall zone	2-3	15		60		50		25						Magnetite Biotite	<1 Trace	
					Core								100								
1425	do			L	1 unit	3/4	30		50				20						Martite	<1	
1426	do			Ir	Wall zone	3/4	15		70		10		15						do	<1	
					Core								100								
1427	do	None		Ir	1 unit	3/4	35		40		15		25						Martite Biotite	<1 Trace	
1428	Quartz monzonite and hornblende gneiss.	do	C	Lb	Wall zone	1	15		65		40		20				Tr.		Magnetite	<1	
					Core								100								
1429	Hornblende gneiss		Ne	L	Wall zone	2	35		45		70		20				Tr.		Martite	<1	
					Core								100								
1430	Hornblende gneiss and quartz monzonite.	None		Ir	Wall zone	1/4	70		5				15						Magnetite	Trace	1/16
					Core	24			20				80								
1431	Quartz monzonite			L	1 unit	1/16	70		10	1/4			20						Biotite	Trace	1/64
1432	do	None		Ir	do	1/16	70		15		10	12	15						do	do	1/4
1433	do	do		Lb	Main branch	2½	45		40		30	12	15						Magnetite Biotite	<1 <1	1/8 1
					North branch	1/16	85						15								
1434	do			L	1 unit	3/8	70		15	2			15						Magnetite Biotite	<1 Trace	 1/16
1435	do			L	do	1/4	65		20		5	3	15						do Magnetite	do <1	1/64 1/8
1436	do	None		Lb	do	1/2	55		30		20	5	15						Biotite Magnetite	<1 Trace	1/2 1/4
1437	do			Ir	do	1/2	65		20				15						Biotite Magnetite	do do	1/4 1/64
1438	Hornblende gneiss		Ne	Ir	do	1½	50		35		25	12	15						do	do	1/4
1439	do		Ne	Ir	do	1/8	65		20		10	5	15						do Biotite	<1 Trace	1/32 1
1440	do		Ne	Ir	do	1/8	70		15		5	3	15				<1	1/64			
1441	do		Ne	L	do	1/4	70		15		5	5	15						Magnetite	Trace	1/8
1442	do		Ne	Lb	do	3/4	55		30		20	10	15				Tr.	1/8	Magnetite	Trace	1/8
1443	do		Ne	L	do	1/8	65		20		5		15						do	do	1/16
1444	Quartz monzonite			Lb	Wall zone	4	25		55				20						Magnetite Biotite	do do	1 1/4
					Core	12			10				90						Biotite	do	3
1445	Hornblende gneiss		Ne	Ir	1 unit	1/8	70		15	2			15				<1	1/64	Magnetite Biotite	<1 Trace	1/4 1/4
1446	do		Ne	L	do	3/8	55		30				15						Magnetite	do	1/8
1447	do		Ne	L	do	1/2	50		35		5	8	15				<1	1/128	Biotite	do	1/16
1448	do		Ne	Ir	do	1/16	68		15		5		15						do	2	1/2
1449	do		Ne	L	do	1/16	75		10	1/2			15				Tr.	1/64	do	Trace	1/16
1450	Quartz monzonite			L	do	1/4	65		20				15						Magnetite Biotite	do do	1/4 1/4
1451	Hornblende gneiss	None	Ne	Ir	do	1/8	75		10	1			15						Biotite Magnetite	do do	1/16 3/8
1452	do	do	Ne	L	do	1/8	45		40		10	8	15						Magnetite	do	1/8
1453	Quartz monzonite	do		Ir	do	2	65		20				15						do	do	1/8
1454	do			L	Wall zone	3	40		35		25		25						Magnetite Biotite	do do	1/4 1/2
					Core	12			10				90								
1455	Hornblende gneiss		Ne	Ir	1 unit	4	53		30		20	8	15						Biotite Magnitite	2 Trace	1/16 1/32
1456	Quartz monzonite	None		L	Wall zone	1/4	74		10				15						Biotite Magnetite	1 Trace	1/8 1/8
					Core	2	25		55	5			20		Tr.						
1457	do	do		L	1 unit	1/2	75		10	2			15						Magnetite Biotite	Trace do	1/8 1/16
1458	do	do		L	do	1	60		20	5			20						Magnetite Biotite	do do	1/16 1/32
1459	Hornblende gneiss		Ne	Lb	do	3	65		20	10	8		15						Magnetite	do	1/16

1460	Quartz monzonite			L	Wall zone	8	25		40	20	12		35						Biotite	do	¾
																			Magnetite	do	¾
					Core	12			40				60						Biotite	do	3
1461	Hornblende gneiss		Ne	Ir	1 unit	1½	60		25		15	8	15						Biotite	do	¼
																			Magnetite	do	1/16
1462	do		Ne	Ir	do	2	55		30		20	12	15						Biotite	do	⅛
																			Magnetite	do	1/16
1463	do		Ne	Ir	do	3	50		35		25	12	15				Tr.	1/32	Biotite	do	1/16
1464	do		Ne	L	do	4	30		55		45	12	15						Biotite	do	1/16
																			Magnetite	do	1/32
1465	do		Ne	Ov	do	2	55		25				20						Magnetite	do	⅛
																			Biotite	do	⅛
1466	do		Ne	L	do	3½	35		50		40	18	15						Magnetite	do	¼
																			Biotite	do	⅛
1467	do		Ne	Ir	do	2	65		20		10	12	15						Magnetite	do	1/32
																			Biotite	do	¼
1468	do		Ne	Ir	do	2½	42		40.5		30	12	15						Biotite	2	¼
																			Magnetite	0.5	1/32
1469	do		Ne	L	do	1½	55		30		20	3	15						do	Trace	1/32
1470	do		Ne	Ir	do	2	55		30		20	8	15		Tr.	⅛			Magnetite	do	½
																			Biotite	do	⅛
1471	do		Ne	Ov	do	1	65		20		10	5	15						do	do	1/32
1472	do		Ne	L	do	½	70		15		5	5	15				Tr.	1/32	Magnetite	do	1/32
1473	do		Ne	Ov	do	1½	45		40		30	8	15				Tr.	1/32	Magnitite	do	1/32
																			Biotite	do	1/32
1474	do		Ne	Ir	do	2½	55		30				15						Biotite	do	1/16
																			Magnetite	do	1/32
1475	do		Ne	L	do	1	42.5		40		30	6	15						Biotite	2	
																			Magnetite	0.5	¼
1476	do		Ne	L	do	2	45		40				15		Tr.	1/32	Tr.	3/16	Magnetite	Trace	¼
1477	do	None	C	L	do	2½	45		40		30	8	15				Tr.	1/16	do	do	¼
1478	do	do	C	Lb	do	1	50		30	3			20				Tr.	1/32	Biotite	do	⅛
																			Magnetite	do	1/16
1479	do		Ne	L	do	1	60		25		15	8	15				Tr.	1/64			
1480	do		Ne	Lb	do	¾	70		15	4			15				Tr.	1/64	Biotite	Trace	⅛
1481	do		Ne	L	do	½	60		25		2		15				Tr.	1/64	do	do	¼
1482	do		Ne	L	do	¾	60		25	3			15				Tr.	1/64	Magnetite	do	1/64
1483	do		Ne	L	do	1	49.5		30		5		20				0.5	1/32	Magnetite	do	⅛
																			Biotite	do	⅛
1484	do		Ne	L	do	2	63.5		20		10	8	15						Magnetite	1	1/16
																			Biotite	0.5	½
1485	do		Ne	L	do	1	49.5		30		20	12	15						Biotite	5	¼
																			Magnetite	0.5	⅛
1486	do		Ne	L	do	2½	36		45		35	12	15						Biotite	3	¼
																			Magnetite	1	1/16
1487	do		Ne	L	do	2	47		35		25	8	15						Biotite	3	1/16
1488	do		Ne	L	do	1	65		20		10	8	14						Biotite	1	1/16
																			Magnetite	Trace	⅛
1489	do		Ne	L	Wall zone	2½	44		35				20				Tr.	¼	Biotite	1	¼
					Core	6			80				20								
1490	do		Ne	Ov	1 unit	1	60		25		20	5	15				Tr.	1/64	Biotite	Trace	⅛
1491	do		Ne	L	do	¾	40		35		10		25						Magnetite	<1	
1492	do		Ne	L	do	1½	65		15		5		20		Tr.						
1493	do		Ne	Lb	do	3	45		35	4	25	8	20				Tr.	1/16	Biotite	<1	2
																			Magnetite	Trace	1/32
1494	do		Ne	L	do	3	48.5		30		20	10	20		1	¼	Tr.		Magnetite	0.5	½
1495	do		Ne	Ir	Hanging-wall layer.	4	25		45	8	5		30		Tr.	¼	Tr.	1/16	do	Trace	1/32
					Footwall layer	2	55		30		10	8	15				Tr.	1/16	do	do	1/32
																			Biotite	do	½
1496	do		Ne	Lb	1 unit	½	35		45		10		20		Tr.		Tr.				
1497	do		Ne	L	Wall zone	¾	55		20		3	10	20		5						
					Intermediate zone.	2			20				60		20	3					
					Core								100								
1498	do		Ne	Lb	Wall zone	1	55		30		20		15						Magnetite	Trace	
					Core								100						Biotite	do	
1499	do		Ne	L	Wall zone	½	45		20				35		Tr.						
					Core	8			50				50								
1500	do		Ne	Lb	1 unit	¾	50		30				20		Tr.				Magnetite	Trace	
																			Biotite	do	
1501	do		Ne	Ir	Hanging-wall layer.	3	30		60		20		10						Magnetite	do	
					Footwall layer	¼	50		20				30						do	do	
1502	do		Ne	L	1 unit	2	55		25		15		20	2	Tr.				do	do	
1503	do		Ne	L	do	4	35		50		40		15		Tr.	¼	Tr.				
1504	do		Ne	L	do	2	10		60		60		30		Tr.				Magnetite	Trace	
1505	do		Ne	L	do	1	50		30		40		20		Tr.				do	do	
1506	do		Ne	L	Hanging-wall layer.	3	20		50				30						do	do	
					Footwall layer	½	50		30				20						do	do	
1507	do		Ne	L	Wall zone	1½	55		30		20	8	15				Tr.		Biotite	do	¼
					Core	4			40				60								
1508	do		Ne	Ir	Hanging-wall layer.	5	20		50		20		30		Tr.		Tr.		Magnetite	<1	
					Footwall layer	¼	40		30				30		Tr.				do	Trace	

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
1509	Hornblende gneiss		Ne	Ir	1 unit	2	37		46				15		2		Tr.				
1510	do		Ne	L	do	½	58		25				15		2						
1511	do		Ne	L	do	2	45		35		25		20		<1	¼	Tr.	1/32			
1512	do		Ne	L	do	1	65		20		15	10	15		<1	2					
1513	do		Ne	L	do	1½	55		25		20	5	20		<1	¼	Tr.		Biotite	Trace	½
1514	do		Ne	L	do	3	40		45	10	35	24	15				Tr.	1/16	Magnetite	do	1
1515	do		Ne	L	do	1	35		40		30	12	25		Tr.	⅛	<1		do	do	1/32
1516	do		Ne	Ov	Wall zone	¾	55		30	5	20	8	15				Tr.		do	do	
					Core								100								
1517	do		Ne	L	1 unit	4			10				90						Monazite	1 crystal	½
1518	do		Ne	Ir	Wall zone	¾	55		30				15								
					Core								100						Monazite	do	⅜
1519	do		Ne	L	1 unit	2	60		20				20		<1		Tr.				
1520	do		Ne	L	do	¾	55		25		15	3	20		<1	1			Biotite	<1	¼
1521	do		Ne	L	do	1½	45		35	5	5	5	20				Tr.				
1522	do		Ne	L	do	1	40		25		15		24						Biotite	1	
1523	do		Ne	Ir	Wall zone	1½	50		30		20	12	20						Magnetite	Trace	1
					Core								100						Biotite	do	2
1524	do		Ne	L	1 unit	¾	65		20		15		15				<1				
1525	do		Ne	L	do	¼	60		20				20		<1		Tr.		Biotite	Trace	
1526	do		Ne	L	do	¾	65		20	3	5	8	15				<1	1/32	do	do	1/16
1527	do		Ne	Lb	do	¾	65		15		5	8	20				Tr.	1/64	Biotite	do	⅛
																			Magnetite	do	1/16
1528	do		Ne	Ir	do	1½	50		35		25		15				Tr.	1/64	Biotite	do	1/16
1529	do		Ne	Ir	do	1½	50		30		20	8	20				Tr.	1/64	do	do	⅛
1530	do		Ne	L	do	½	65		20				15				Tr.	1/64	do	do	1/16
1531	do		Ne	L	do	1½	55		30		20	8	15				Tr.	1/64	do	do	⅛
1532	do		Ne	L	do	⅜	49		35		25	5	15				1	⅛			
1533	do		Ne	L	do	⅛	70		15				15				<1	1/16	Magnetite	Trace	⅛
																			Biotite	do	⅛
1534 (the Trio Beryl Knob).	do		Ne	Ir	Wall zone	½	50		35		30	10	15				<1	1/16	Biotite	Trace	⅛
																			Magnetite	do	¼
					Intermediate zone.	3	20		50				10		20	2					
					Core	36			20				80								
					Intermediate zone.	¾	50		33.5				15		Tr.	¼	Tr.	¼	Biotite	1	¼
																			Magnetite	Trace	⅛
					Core	10			50				30		10	½					
1535	do		Ne	Lb	Wall zone	¼	60		25	5	Tr.		15						Magnetite	Trace	⅛
					Core	2			4				95		1	¼					
1536	do		Ne	L	1 unit	¼	65		20	5	2		15				<1	1/16	Biotite	Trace	⅛
1537	do		Ne	Lb	Wall zone	⅜	50		35		5		15				<1	⅛			
					Core	3			10				89		1	½					
1538	do		Ne	Lb	1 unit	1	53		20				25		2						
1539	Covered by alluvium		Ne	Ir	Hanging wall zone.	3	20		65	18	40	12	15		<1	¼	<1	1/16			
					Footwall layer	1/64	80		5				15		Tr.	⅛					
					Core	4			40				60								
1540	Hornblende gneiss		C	Ir	Wall zone	2	45		33		25	18	20		2	¼					
					Core	15			30	18			60		10	8			Gahnite	<1	1½
1541	do	None	C	Ir	1 unit	¾	45		30	2			20		5	⅛	Tr.				
1542	do	do	C	Ir	Wall zone	1/16–⅛	83		2				15		<1		Tr.				
					Core	8–12	7		55				37		1						
1543	do	do	C	L	Wall zone	⅛	65		15		Tr.		20		<1		Tr.				
					Core	6–8	4		35				60		1		Tr.				
1544	do		Ne	Ir	Wall zone	3–4	29		50		60		20		1		Tr.				
					Core	3–4	8		55				37		1						
1545	do		Ne	L	1 unit	¼	64		15		10		20		1		<1				
1546	do		Ne	L	do	½	35		55				10		<1		Tr.				
1547	do		Ne	L	do	4	20		35				45								
1548	do		Ne	L	do	½–1	30		49		45		20		1		Tr.				
1549	do		Ne	L	do	⅛–¼	59		20		10		20		1		<1				
1550			Ne	Ir	do	¼–½	50		15				35		<1		Tr.				
1551	Hornblende gneiss		Ne	Ir	North part	8	25		63				10		2	⅛	<1				
					South part	½	50		30	4			15		5		<1				
					Core				65	12			25		10	1					
1552	do		Ne	L	Wall zone	½	75		5	1			20				Tr.				
					Core								100								

1553	do		Ne	Ir	1 unit	¼	69.5	¼	5	½			20		5	⅛	0.5	1/32			
1554	do		Ne	L	do	½	44		35				20		1		Tr.				
1555	do		Ne	Ir	do	1-2	20		64	75			15		1		<1				
1556	do		Ne	Ir	do	½-¾	35		44		15		20		1		Tr.				
1557	do	None		Ir	Wall zone	½	30		49		10		20		1		Tr.		Biotite	Trace	
					Core	8	1		8				91		<1				Columbite-tantalite.	1 crystal	½
1558	do		Ne	L	Wall zone	2-3	1		78		90		20		1						
					Core	8	<1		20				80		<1				Columbite-tantalite.	1 crystal	¼
1559	do		Ne	Lb	1 unit	2-3	10		75		75		15		<1		Tr.				
1560 (Flood No. 1 and No. 2).	do		Ne	Ir	1 unit	½-1	30		49		5		20		1		Tr.				
					Fracture filling	8	(√)		(√)				(√)		(√)				Beryl	1 crystal	2
1561	do		Ne	L	1 unit	1	20		55		5		20		5		Tr.				
1562	do		Ne	Ir	do	1	10		66		5		20		4		Tr.				
1563	do	None	C	L	Wall zone	½-¾	50		35				15		<1		<1				
					Core	6-8	3		50				47								
1564	do		Ne	L	Wall zone	¼	55		30				15		<1		Tr.		Biotite	Trace	
					Core	6	5		70				25		<1		1		Magnetite	<1	
1565	do		Ne	L	1 unit	1-2	15		65		35		20		<1		Tr.				
1566	do		Ne	Ir	1 unit	¼-½	49		30		5		20		1		<1				
					Fracture filling		(√)		(√)				(√)		(√)						
1567	do		Ne	Ir	1 unit	¾-1	15		64		20		20		1		Tr.		Martite	Trace	
																			Biotite	do	
1568	do		Ne	Ir	Wall zone	3-4	<1		80		85		20		<1						
					Core	8	2						98		<1						
1569	do		Ne	Ir	1 unit	¼-½	15		63		10		20		2						
1570	do		Ne	Ir	Wall zone	¼-½	20		59		5		20		1		<1				
					Core		1		4				93		2						
1571	do		Ne	L	1 unit	⅛	72		7				20		1		<1				
1572	do		Ne	L	do	½	69		3	2			20		7	⅛	1	1/32			
1573	do		Ne	Lb	Wall zone	½-¾	10		60				30		<1						
					Core	8	8		17				75						Beryl	1 crystal	1
					Wall zone	¼	60		20				16		4		Tr.				
					Graphic granite intermediate zone.	5	3		77				20						Biotite	<1	6
					Quartz albite intermediate zone.	½	40		3	1-4			56		1	¼-¾	<1				
1574 (Bucky, Goldie, South-Slope).	Hornblende gneiss and quartzite.	None	C	Ir	Muscovite-feldspar-quartz-beryl intermediate zone.	8	5		26				20		40		6		Gahnite	<1	⅛-1
																			Beryl	8.9	8
																			Columbite-tantalite.	0.11	½-6
																			Monazite	0.003	¼-¾
																			Unknown	0.003	½-4
																			Phosphates	Trace	3
																			Lepidolite	do	1/64-⅛
																			Topaz	<1	1-3
					Perthite intermediate zone.	60	<1		93	60			7		<1				Beryl	<1	
					Core pods								100						Beryl	<1	
					Fracture filling	36			50				50								
1575	Hornblende gneiss		Ne	Ov	1 unit	4			2				98								
1576 (Camp Robber).	do		Ne	Ov	Wall zone	1	15		60		15		25				Tr.				
					Core								100								
1577	do		Ne	Ir	1 unit	1-1½	35		45		20		20		<1		Tr.				
1578	do		Ne	Ir	do	¾	35		49		20		15		1		Tr.				
1579	do		Ne	Ir	do	1-2	15		65		80		20				Tr.		Martite	1 crystal	
1580	do		Ne	Ir	do	2-3	15		70		80		15		<1		Tr.				
1581	do		Ne	Ir	do	2	35		50		50		15		<1		Tr.				
1582	do		Ne	Ir	do	½	40		40		5		20		<1		Tr.				
1583	do		Ne	L	do	¼	30		45				25		<1		<1				
1584	do		Ne	L	do	½-¾	25		55		35		20		<1		<1				
1585	do		Ne	Ir	do	¼-½	5		75		75		20		<1		Tr.				
1586	do		Ne	Ir	do	¾-1	30		53		10		25		2		Tr.				
1587	do		Ne	L	do	3-4	15		65		70		20		<1						
1588	do		Ne	L	do	1	40		40		20		20		<1		Tr.				
1589	Hornblende gneiss and quartzite			Ir	do	¼-½	21		59		5		20		1		<1		Magnetite	Trace	
1590 (Windy Knob).	Hornblende gneiss		Ne	Ir	Wall zone	¼	65		20				15				<1		do	do	
					Intermediate	6	15		69	18			10		3	1½	3	½			
					Core								100								
1591	do		Ne	L	Wall Zone	½	70		15	15			15		<1		Tr.				
					Core	4	10		60				29		1		Tr.				
1592	do	None		Lb	1 unit	½	50		30	5			20				<1	1/16	Magnetite	Trace	⅛
1593	do		Ne	Ov	do	½	40		40		10		2		<1		Tr.				
1594	do		Ne	L	do	½-¾	35		45		15		20		Tr.		Tr.				
1595	do			Ir	Wall zone	1	25		55		65		20		<1		Tr.		Martite	Trace	
					Core								100								
1596	do		Ne	L	1 unit	8	25		54		30		20		1		Tr.		Martite	Trace	
1597	do		Ne	L	do	⅛	65		15				20				<1				
1598	do	None		L	do	⅛	25		55				20		Tr.		<1				
1599	do	do	C	L	do	1/16	70		15				15				<1				
1500	do		Ne	Ir	do	1½	45		40		30		15						Magnetite	Trace	1/32
1601	do		Ne	L	do	¼	75		10		5	8	15						do	do	⅛

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock		Pegmatite																		
	Type	Alteration	Relation to wall rock	Shape	Internal structure	Texture (in.)	Mineralogy														
							Plagioclase		Perthite		Graphic granite		Quartz		Muscovite		Garnet		Other minerals		
							Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Percent	Size (in.)	Mineral	Amount or percent	Size (in.)
1602	Hornblende gneiss		Ne	Lb	1 unit	1/8	70		15		5	3	15						Magnetite	Trace	1/16
1603	do		Ne	L	do	1/8	58		25				15				2	1/32			
1604	do		Ne	L	do	1/8	75		10				15				<1	1/16			
1605	do	None	C	L	do	1/8	55		30		5		15				<1	1/64			
1606	do		Ne	L	do	1/8	50		30				20				<1	1/16			
1607	do		Ne	L	do	1/2	35		50				15				<1	1/32			
1608	do		Ne	L	do	1/8	75		10				15				Tr.	1/32			
1609	do		Ne	L	do	3/4	15		25				60		Tr.		<1		Biotite	Trace	
1610	do		Ne	Ir	Wall zone	4-6	35		55		50		20		<1		<1		do	do	
					Core pods	(?)							100								
1611	do		Ne	L	Wall zone	3-4	20		50		40		30		Tr.						
					Core	(?)			3				97								
1612	do		Ne	Lb	Wall zone	2-3	20		55				25		<1				Martite	Trace	
					Core	(?)			1				99								
1613	Hornblende gneiss and quartzite		Ne	Lb	1 unit	3-4	30		45		30		25		Tr.		Tr.				
1614	do		Ne	L	do	1-2	50		30		5		20		Tr.		Tr.				
1615	Quartzite		Ne	L	do	1-2	40		40		5		20		<1		Tr.				
1616	Hornblende gneiss		Ne	L	do	1/4	50		25				25				<1		Magnetite	<1	
1617	do		Ne	Ir	do	3/4	20		60		15		20				Tr.		Biotite	Trace	
																			Magnetite	do	
1618	Quartz-biotite-schist	None	C	Ir	do	2-3	20		55		55		25				Tr.		Martite	<1	
1619	Hornblende gneiss and quartz-biotite schist		Ne	Ir	do	4-6	15		60		55		25						Martite	Trace	
																			Biotite	do	
1620	Covered		Ne	L	do	1/4-1/2	50		30				20				<1		Biotite	Trace	
																			Martite	do	
1621	Hornblende gneiss		Ne	L	do	1/4-1/2	45		35				20				<1	(22)	Biotite	<1	
1622	do		Ne	L	do	1/4-1/2	35		45				20				Tr.		Biotite	<1	
																			Tourmaline	Trace	
1623	do		Ne	Lb	do	1	15		50				35				<1		Biotite	do	
1624	do		Ne	Ir	do	2	1		33				65		1		<1		do	do	
1625	do		Ne	L	do	1-2	15		60				25				<1				
1626	do		C	L	do	3/4	30		45				25		<1		<1		Biotite	Trace	
1627	do	None		Ir	do	1 1/2	55		7				35		3				Lepidolite	do	
1628	do		Ne	L	do	1/4-1/2	35		45				20		Tr.		<1				
1629	do		Ne	Lb	Wall zone	1/2	40		40				20		Tr.				Biotite	Trace	
					Core	12			10				90		<1				Magnetite	do	
1630	do	None		Lb	Wall zone	1/4	20		55				25		<1		<1		Magnetite	do	
					Core	3-6	1		5				94				Tr.		Monazite	1 crystal	
1631	Tonalite	do		Lb	Wall zone	1/4	25		50				25				<1				
					Core	3-4	<1		7				93								
1632	do	do		Ir	Wall zone	1/8	30		40				30				Tr.		Biotite	Trace	
					Core	3			5		1		95						Martite	do	
1633	do	do		Ir	1 unit	1/2-3/4	25		50				25				Tr.		Biotite	do	
1634	Hornblende gneiss		Ne	L	Wall zone	3-4	15		65		40		20								
					Core	(?)			Tr.				100		Tr.						
1635	do		Ne	Ov	1 unit	1/4	25		50				25				Tr.		Biotite	Trace	
																			Martite	do	
1636	do		Ne	L	do	1/8	35		44				20						Biotite	1	
																			Martite	<1	
1637	do		Ne	L	do	1/2	15		60				25						Biotite	<1	
																			Martite	<1	
1638	Covered		Ne	Ir	Wall zone	2	20		55		60		25						Biotite	Trace	
					Core	(?)							100						Martite	do	
1639	Hornblende gneiss	None		L	1 unit	1/2	40		35				25		<1		<1		Biotite	do	
1640	do	do		L	do	1	40		30				30		<1		<1				
1641	do	do		L	do	3/4	15		65				20		<1		<1				
1642	do		Ne	Ir	Wall zone	1/2-3/4	35		40		5		25				<1				(15)
					Core	(?)							100						Biotite	<1	
1643	Hornblende gneiss and quartzite.		Ne	Ir	1 unit	1/2	20		55				25		Tr.		<1		Biotite	Trace	
1644	Hornblende gneiss		Ne	L	do	1/4	20		55				25		Tr.		<1		Biotite	<1	
1645	do		Ne	L	do	1/8-1/4	35		35				30				<1		do	<1	
1646	do		C	L	do	1-2	15		50				35				<1		do	<1	

1647	do		C	Lb	do	¼–½	35		40				25		Tr.		<1		Biotite Magnetite	Trace do	
1648	Hornblende gneiss and quartzite.	None		Lb	do	¼–½	30		35				35		Tr.		<1		Biotite	do	
1649	Hornblende gneiss		Ne	L	do	¼–½	15		55				30				<1		do	do	
1650	do		Ne	L	do	½	40		40				20				Tr.		do	do	
1651	do		Ne	Ir	do	¼	35		40				25				Tr.		do	do	
1652	do		Ne	Lb	do	½	30		50		5		20				Tr.		do	do	
1653	do		Ne	L	do	2–3	20		65		10		15						Magnetite	<1	
1654	do		Ne	L	do	<⅛	19		55				25						Biotite	1	
1655	do		Ne	Lb	do	⅛–¼	40		39				20						do	1	
1656	do		Ne	Lb	Wall zone	6–8	25		55		50		20		<1				do	<1	
					Core								100								
1657	do		Ne	Ir	1 unit	1	20		55		30		25						Biotite Martite	<1 <1	
1658	do		Ne	Ov	do	1–2	10		70		10		20						Biotite Magnetite	<1 <1	
1659	do	None		Lb	Wall zone	1–2	30		45		30		25						Biotite Martite	<1 <1	
					Core	12			15				85								
1660	do		Ne	Ir	1 unit	2–3	15		60		75		25						Biotite Martite	<1 <1	
1661	Quartz monzonite	None		Ir	Wall zone	4	10		70				20						Biotite Magnetite	<1 <1	
					Core	(?)							100								
1662	do	do		Ir	1 unit	2–3	40		40		15		20						Biotite Magnetite	<1 <1	
1663	do	do		Ir	do	1	20		25				55						Biotite	Trace	
1664	do			L	do	¼	30		50				20						Biotite Martite	<1 <1	
1665	do			Ir	do	⅛	20		55				25						Biotite Martite	<1 <1	
1666	Hornblende gneiss	None		Ir	Wall zone	½	20		50		15		30						Biotite Martite	<1 <1	
					Core	(?)							100						Beryl	1 crystal	
1667	Quartz monzonite			Ir	1 unit	⅛	10		55				35						Biotite Martite	<1 Trace	
1668	do			Lb	do	1/16	72		2				25						Biotite	1	
1669	do	None		Ir	do	¾–1	2		78		5		20						Biotite Magnetite	Trace <1	
1670	do			L	do	4–6	20		80		85		20						Magnetite	Trace	
1671	Hornblende gneiss		Ne	L	do	⅛	55		20				25						Biotite Martite	<1 <1	
1672	do		Ne	L	do	2–3	30		45		25		25						Martite	Trace	
1673	do		Ne	Ir	do	⅛–¼	50		25				25				Tr.		Magnetite	do	
1674	do		Ne	Lb	do	¼	30		40				30		<1		<1				
1675	do	None		Ir	do	½	5		70				25				<1		Biotite	Trace	
1676	do	do	C	Ir	do	⅛–¼	60		15				25				Tr.		do	<1	
1677	do		Ne	Ir	do	⅛–¼	35		40				25				Tr.		Biotite Magnetite	<1 Trace	
1678	do		Ne	L	do	⅛	64		10				25						Magnetite Biotite	1 <1	
1679			Ne	L	do	⅛–¼	65		15				25						Biotite	Trace	
1680	Hornblende gneiss		Ne	L	do	¼	50		30				20						Magnetite	do	
1681	do		Ne	Ir	do	¼	35		40				25						Magnetite Biotite	<1 <1	
1682	Quartz monzonite	None		Ir	do	¾	20		55				25						Magnetite	<1	
1683	Hornblende gneiss		Ne	Ir	do	⅛	60		15				25						Biotite Magnetite	<1 Trace	
1684	do		Ne	Ir	do	½–¾	15		55				30		Tr.		<1		Biotite	<1	
1685	do		Ne	L	do	¼–½	3		61				35		<1		1				
1686	do		Ne	L	do	¼–½	10		60				30				<1		Biotite	<1	
1687	do		Ne	L	do	½	10		55				35				<1		do	<1	
1688	do		Ne	L	do	¼–½	7		63				30				<1				
1689	do		Ne	L	do	¼–½	5		60				35				<1				
1690 (Lazy Day)	do		Ne	L	do	¼	40		35				25		<1		<1		Biotite	Trace	
1691	do		Ne	L	do	¼–½	20		55				25				<1		do	do	
1692	do		Ne	Ir	do	¼	12		63				25				<1		do	<1	
1693	Hornblende gneiss and quartz monzonite		Ne	Lb	do	¼–½	45		35		15		20								
1694	Hornblende gneiss		Ne	L	do	1½	10		70		65		20								
1695	Hornblende gneiss and quartz monzonite		Ne	L	do	1	15		65		40	4	20						Magnetite	Trace	
1696	do	None		Lb	West part	¼	60		15	2	<5		25		Tr.				Biotite	Trace	
					East part	1½	20		60		30		20						Magnetite	<1	
1697	Hornblende gneiss		Ne	Lb	1 unit	1	10		70		70		20								
1698	do		Ne	L	do	2	10		70		80		20								
1699	Quartz monzonite			L	do	1	15		65		70		20						Magnetite	Trace	
1700	do			L	do	2	5		75		85		20						do	do	
1701	Quartz monzonite and hornblende gneiss		Ne	Lb	do	1–2	10		70		70		20								
1702	do		Ne	L	do	1	10		70		85		20						Magnetite	Trace	

[15] Up to 2. [22] Up to ¼.

TABLE 20.—*Mineralogy of pegmatites*—Continued

Number and name of pegmatite (Pl. 1)	Wall rock: Type	Wall rock: Alteration	Pegmatite: Relation to wall rock	Shape	Internal structure	Texture (in.)	Plagioclase: Percent	Plagioclase: Size (in.)	Perthite: Percent	Perthite: Size (in.)	Graphic granite: Percent	Graphic granite: Size (in.)	Quartz: Percent	Quartz: Size (in.)	Muscovite: Percent	Muscovite: Size (in.)	Garnet: Percent	Garnet: Size (in.)	Other minerals: Mineral	Other minerals: Amount or percent	Other minerals: Size (in.)
1703	Hornblende gneiss		Ne	Lb	1 unit	2	15		65		70	(18)	20						Biotite	Trace	
1704	do		Ne	L	do	2	20		55		50	(20)	25								
1705	do		Ne	L	do	½-1	45		35		25		20								
1706	Hornblende gneiss and quartz monzonite		Ne	L	do	1½	30		50		60		20						Magnetite	Trace	
1707	Hornblende gneiss		Ne	Lb	do	¼	60		25	(15)	1		15						Biotite Magnetite	do <1	 ½
1708	do		Ne	Ir	do	¼-½	45		30	(3)	5		25						Magnetite	Trace	
1709	do		Ne	L	do	½-1	50		30	(2)	10		20						Biotite Magnetite	do <1	¼ ½
1710	do		Ne	L	do	¼-½	60		20		10		20				Tr.		Magnetite	Trace	
1711	do		Ne	L	do	1	35		45		40		25						do	do	
1712	do		Ne	Ir	do	½-1	40		40		20		20						Biotite Magnetite	do do	
1713	do		Ne	Lb	do	¼	50		30				20		Tr.		Tr.		Biotite Martite	do do	
1714	do		Ne	Lb	do	½	45		35		5	6-10	20				Tr.		Martite	do	
1715	do		Ne	L	do	¼	60	1/16-⅛	20	½-2			20				Tr.				
1716	do		Ne	L	do	¼	60		20	½-1			20				Tr.				
1717	do		Ne	Lb	do	1	35	⅛	45	1-3	20		20	⅛-¼					Magnetite	<1	¼
1718	do		Ne	Lb	do	1	50		30	½-3	30		20						do	<1	<½
1719	do		Ne	Ir	do	¼	60	⅛	20	½-1½			20	¼-1							
1720	Hornblende gneiss and quartz monzonite.	None		Ir	Northeast and southwest ends.	1	1		79		10		20				Tr.		Martite	<1	½
					Central part	¼-½	35		45				20				<1				
1721	Quartz monzonite	do		L	1 unit	½-1	20	1/16-⅛	60	½-3	30	1-3	20	⅛-¼	Tr.	⅛	Tr.	⅛	Magnetite Biotite	<1 Trace	¼-½ 1
1722	Hornblende gneiss and quartz monzonite.	do		Lb	do	2	30		50		20		20				Tr.		Biotite Magnetite	do <1	 ¾
1723	do			Lb	do	2	5		75		40		20				<1		Biotite Martite	Trace <1	
1724	Hornblende gneiss		Ne	L	do	3	30		50		30		20				Tr.	1/32	Magnetite	Trace	⅛
1725	do		Ne	L	do	¾	60		25		10	6	15						do	do	1/32
1726	do		Ne	L	do	¼	50		30	3			20				<1	1/16	do	<1	1/32-¼
1727	do		Ne	L	do	¾	35		45		10	5	20				Tr.	1/16			
1728	do		Ne	Ir	do	4	30		50		60	10	20						Biotite Magnetite	Trace do	1/16 ⅛
1729	Hornblende gneiss and quartz monzonite.		Ne	L	do	½	45		35	3			20						Magnetite	do	1/32
1730	do		Ne	L	do	3	30		55		40	6	15						Biotite Magnetite	do do	⅛ 1/32
1731	Hornblende gneiss		Ne	L	do	¼	49.5		30	3			20				0.5	1/16	Biotite Magnetite	do do	¼ 1/32
1732	Hornblende gneiss and quartz monzonite.		Ne	L	do	½	65	⅛	20		20	4	15						Biotite	do	⅛
1733	do		Ne	Lb	do	¼	45		35		20	4	20						Magnetite	do	1/16
1734	do		Ne	Lb	do	6	10		70		85		20		Tr.				Biotite Martite Samarskite(?)	<1 <1 3 crystals	
1735	Hornblende gneiss		Ne	Lb	do	½	55	1/32	30	4			15						Magnetite	Trace	1/16
1736	Hornblende gneiss and quartz monzonite.		Ne	L	do	2	30		50	4	30	6	20						Martite	do	⅛
1737	do		Ne	L	do	1	50		30	3	15	4	20				<1	1/64	do	do	1/32
1738	do		Ne	Lb	do	2	40		34.5		40	8	25				0.5	⅛	Magnetite	do	1/32-2

1739	Quartz monzonite			L	do	½	30		50		50		20						Magnetite Biotite	do do	1/64 ¼
1740	Quartz monzonite and hornblende gneiss.		Ne	L	do	2	50		35		50	8	15						Biotite Magnetite	do do	1/16–¼ 1/16
1741	Quartz monzonite			L	do	3	30		50		65	8	20						Magnetite	do	1/32
1742	do			L	do	1½	35		50		35	5	15								
1743	do	None		Ir	do	2	40		45		30	5	15						Biotite	Trace	¼
1744	do			L	do	2	40		50		40	4	10						Magnetite Biotite	do do	⅛ ⅛
1745	do			L	do	½	60		25		20	5	15						Magnetite	do	1/16–1
1746	do			L	do	¾	50		30		30	5	20						do	do	1/16
1747	do			L	do	5	25		65		70	8	15								
1748	do			L	do	1	55		35	4	15	5	20				<1	1/64	Magnetite	Trace	1/16
1749	do			L	do	2	30		55		40	8	15						do	do	1/16
1750	do			L	do	1	35		45		20	8	20				Tr.	1/16	Magnetite Biotite	do do	1/32 1/32
1751	do			L	do	4	20		60		60	8	20						Magnetite	do	1/16
1752	do			Lb	do	½	55		30	2			15						do	do	¼
1753	do			L	do	4	25		50		50	10	25						do	do	1/32
1754	do			L	do	1	55		35	4	15	5	20				<1	1/64	do	do	1/16
1755	do			L	do	2	30		50		50	5	20						do	do	⅛
1756	do			L	do	4	25		60		60	6	15						Biotite Magnetite	do do	⅛ 3/16
1757	do			Lb	do	5	30		55		50	8	15				Tr.	1/64	Biotite Magnetite	do do	1/32 1/32
1758	do			L	do	4	30		55		50	10	15				Tr.	1/32	Magnetite	<1	1/32
1759	do			Ir	do	3	20		65		70	8	15						do	Trace	⅛
1760	Quartz monzonite and hornblende gneiss.		Ne	L	do	1½	20		65		60		15						do	do	¼
1761	Quartz monzonite			Lb	do	3	45		40		40	8	15						do	Trace	1/16
1762	do			L	do	2	45		40		20	6	15				Tr.	1/32	Magnetite Biotite	do do	1/16 1/32
1763	do			L	do	2	25		60		20	5	15				Tr.	1/32	Magnetite	do	1/16
1764	do			L	do	3	30		55		50	8	15						do	do	⅛
1765	do			L	do	2	30		55		40	5	15						do	do	1/32–½
1766	do			L	do	1	45		40		10	5	15						do	do	1/16
1767	do			L	do	3	20		65		60	12	15						do	do	1/16–1
1768	do			Lb	do	3	15		65		60	8	20						do	do	1/16
1769	do			L	do	2	30		55		50	8	15						do	do	1/16
1770	do			Lb	do	2	30		55		50	5	15						do	do	1/32
1771	do			Ir	do	½	40		35		5		25						Martite	<1	
1772	do	None		Ir	do	3	35		50		60	8	15						Magnetite	Trace	1/32
1773	do			Lb	do	½	40		40		10		20						Martite	<1	
1774	do			L	do	3	10		75		70		15						Magnetite	Trace	⅛
1775	do			L	do	¼	55		30	3	10	4	15						Biotite Magnetite	do do	1/16 ⅛
1776	do			L	do	2	25		55		30	6	20						Magnetite Biotite	do do	3/16 ⅛
1777	do			L	do	4	35		50		40	5	15						Magnetite	do	⅜
1778	do			L	do	1	50		30		20	5	20						do	do	1/32
1779	do			L	do	5	20		65		70	8	15						do	do	¼
1780	do			Lb	do	1	30		55		20		15						do	<1	¼
1781	do			L	do	½	25		60	3			15						do	Trace	⅛
1782	do			L	do	2	25		50		10	5	25						do	do	¼
1783	do			L	do	3	40		40		40	8	20						do	do	⅛
1784	do			L	do	¼	70		15	3			15						do	do	3/16–½
1785	do			L	do	3	30		50		40	8	20						Biotite Magnetite	do do	⅜ 1/16
1786	do			L	do	5	30		40		30		30						Magnetite	<1	⅛–2
1787	do			Lb	do	2–3	10		70		80		20						Martite	<1	
1788	do			L	do	1–2	30		50		45		20						Magnetite	<1	
1789	do			L	do	1–2	20		55		40		25						do	<1	
1790	do			Lb	do	⅛–¼	55		25				20				<1		Martite	Trace	
1791	do			L	do	⅛–¼	70		10				20				<1				
1792	do			L	do	½	45		35		20		20				Tr.		Martite	<1	
1793	do			L	do	¾	35		40		2		25				<1		do	Trace	
1794	do			Lb	do	½	50		25		1		25				Tr.		do	<1	
1795	do			L	do	¾	35		45		Tr.		20				Tr.		do	Trace	
1796	do			Lb	do	¼	50		30		2		20				Tr.		Magnetite	do	
1797	do			L	do	1	15		64		60		20						do	1	
1798	do			Lb	do	2	25		55		30		20				<1		Biotite Martite	Trace <1	
1799	Hornblende gneiss	None	C	L	do	½–¾	30		40				30		Tr.						
1800	Quartz monzonite	do		Ir	do	¾	25		55		5		20						Biotite Martite	Trace <1	⅛–1½
1801	Hornblende gneiss	do		Ir	do	⅛–¼	63		8				27		2		Tr.				
1802	do			Lb	do	⅛–¼	70		9				20		1		Tr.				
1803	do			Lb	do	1	63		20				15		2						

[3] Up to 3. [15] Up to 2. [18] Up to 8. [20] Up to 10.

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