PEGMATITES OF EIGHT MILE PARK, FREMONT COUNTY, COLORADO

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(Continued from p. 448, Vol. 33, Nos. 7–8)

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MINERALOGY

General Features

On the basis of occurrence the pegmatite minerals may be divided into three groups:

1. The common rock-forming minerals, which constitute the bulk of the material of the zones.
2. The rarer minerals which occur chiefly in the secondary units.
3. The products of supergene alteration.

The mineralogy of the zones and of undifferentiated pegmatites is simple and is characterized by strong development of primary rock-forming minerals: quartz, microcline, muscovite, and biotite. Other subordinate constituents are oligoclase, garnet, schorl, magnetite, and chlorite.

The rarer constituents are restricted to the secondary units, wherein the dominant minerals are sodic plagioclase, quartz, and muscovite. Other important minerals are tourmaline, garnet, apatite, beryl, lepidolite, triplite, and chalcocite. Other, still rarer, constituents also may be present. Vugs are very rare, and, if present at all, are small. In the School Section pegmatite 1- to 6-inch vugs containing minute cleavelandite and sericite crystals were observed. Vugs with very small quartz crystals were found on the Mica Lode dumps. A few 1- to 1½-inch vugs were noted in the Van Buskirk deposit.

Calcite, kaolinite, limonite, and manganese oxide are the chief products of weathering.

The complete list of mineral species found in the pegmatites is given in Table 5.

Table 5. List of Minerals of the Pegmatite Bodies

Quartz	Apatite	Malachite
Microcline	Triplite	Azurite
Andesine	Fremontite	Chrysocolla
Oligoclase	Cerussite(?)	Beyerite
Albite	Columbite	Bismutite
Muscovite	Torbernite(?)	Limonite
Biotite	Magnetite	Manganese oxide
Chlorite	Hematite	Calcite
Lepidolite	Chalcocite	Kaolinite
Garnet	Native silver	Chalcedony
Beryl	Native bismuth(?)	
Tourmaline	Covellite	

Description of Minerals

Quartz

Quartz occurs in all zones and in secondary units as well. Fine-grained granitic intergrowths with microcline are characteristic of wall zones, and subgraphic to graphic intergrowths with microcline, and intergrowths with small muscovite flakes occur in intermediate zones. Quartz-muscovite aggregates also form border zones. Massive white quartz in pods as much as 30 feet long occurs in cores. In secondary units quartz forms a granular intergrowth with plagioclase; occurs in veinlets with albite, muscovite, and less commonly biotite; and less commonly is intergrown in a subgraphic pattern with either garnet or black tourmaline.

The color ranges from clear to milky white to light gray. In a few deposits limonite colors the mineral many shades of red and brown. In the McMullin Lease No. 2 pegmatite the core quartz is banded by alternating milky and clear layers about one inch thick. In many deposits post-crystallization fracturing has shattered the quartz. In the Mica Lode tiny flattened quartz crystals have formed along such fractures. On the dumps from this quarry were found several specimens with small vugs containing $\frac{1}{8}$-inch quartz crystals coated by manganese oxide.

Microcline

The chief feldspar is perthitic microcline which occurs intergrown with quartz in wall zones, as euhedral phenocrysts and irregular masses with graphically intergrown quartz in intermediate zones, and as 6-inch to 6-foot, quartz-free crystals in cores.

The color ranges from pink to dark red. The reddish color is characteristic for the area, not only for microcline in pegmatites but in Pikes Peak granite and aplite as well. That part of the red color was formed after crystallization is shown by borders of darker color along minute fractures. Microcline associated with abundant biotite is generally somewhat darker in color. Mottled white and pink microcline occurs locally in the Meyers Quarry pegmatite. In the Rim pegmatite phenocrysts of red microcline with intergrown quartz are set in a matrix containing white microcline. Coarse white microcline also occurs in a small pegmatite pod on the Meyers Quarry property, but in general the white color is atypical. Specimens of brown and gray microcline were noted in the Van Buskirk deposit.

Microcline is altered to sericite, kaolinite, or calcite. Replacement commonly proceeds outward from along perthite lamellae and cleavage traces.

In addition to the usual cleavages, some of the microcline at the Meyers Quarry has an unusual "cross ripple," which consists of minute grooves roughly parallel to the perthitic structure. These grooves may represent slickensides. A similar structure, formed by minute, sharply defined ridges, occurs in the microcline of graphic granite in the Van Buskirk pegmatite.

Graphic Granite

Sub-graphic and graphic intergrowths of quartz and microcline are common in intermediate zones and locally in wall zones. All gradations from irregular granular to well-defined graphic textures are present. At the Van Buskirk deposit this gradation is well illustrated by the following varieties:

1. Granular intergrowth of quartz and microcline; neither mineral is host.
2. Irregular blebs and pods of quartz in dominant microcline. The microcline host is not a single crystal and the quartz units may lie across the feldspar grain boundaries.
3. Irregular tabular quartz bodies, with lateral projections and apophyses, generally in a single host crystal of microcline.
4. Typical graphic individuals of quartz in single crystals of microcline; i.e., ideally developed graphic granite.
5. Minute, parallel lenses of quartz set in a rough en echelon pattern in single microcline crystals.

Landes (1935, p. 330) states his belief in a hydrothermal replacement origin of graphic granite. The writer favors the theory of simultaneous crystallization to explain the formation of these variable intergrowths. This also is supported by the phenocrysts of sub-graphic to graphic granite in a matrix of typically granular quartz and microcline. The origin of such a combination is difficult to explain by replacement of microcline by quartz, for only the phenocrysts are graphic in texture.

Plagioclase

Four varieties of plagioclase occur in the pegmatites. The most calcic, andesine, is restricted to several interior pegmatites that transect xenoliths of gabbro in Pikes Peak granite. The plagioclase of the other interior pegmatites is invariably white oligoclase.

The three generations of plagioclase that occur in secondary units are, from oldest to youngest:

1. Fine- to medium-grained plagioclase which ranges in composition from oligoclase to albite. The color is generally light red or pink but may be white, light gray, or grayish lilac.
2. Fine-grained, sugary, white albite.
3. White to light red cleavelandite, which occurs associated with small vugs, in large radiating masses, and in bands marked by comb structure.

Type 1 occurs in a granitic intergrowth with quartz and forms the bulk of the feldspar in replacement units. The unusual gray variety corrodes altered triplite, and the color may result from the breakdown of the phosphate. This plagioclase is veined by black tourmaline.

White sugary albite (Type 2) replaces pink plagioclase (Type 1), microcline, quartz, beryl, apatite, and tourmaline, and is cut by garnet veinlets. Thin films of fine-grained albite also coat fracture surfaces in the shattered quartz of the Mica Lode core.

In the Meyers Quarry pegmatite, cleavelandite (Type 3) occurs only in association with lepidolite and corrodes earlier pink plagioclase (Type 1), quartz, and beryl. In the School Section deposit cleavelandite, commonly coated by bright green sericite, is arranged in rosette structure marginal to small vugs. Minute crystals project into cavities. Here cleavelandite also replaces black tourmaline.

Muscovite

Primary muscovite is found in all zones except the core. With quartz it forms fine-grained border zones, where it may occur as a selvage of small books normal to the walls. In wall zones it occurs with microcline and quartz, and in intermediate zones it is intergrown with quartz in sub-parallel plumose aggregates of $\frac{1}{2}$- to $1\frac{1}{2}$-inch flakes. The origin of these dendritic growths is obscure. There is little evidence to indicate that the muscovite is much later than the quartz.

The large blades and books of muscovite and the masses of tightly interlocking flakes ("ball" mica) form fracture-controlled units or irregular replacement bodies. These bodies commonly occur along the footwall sides or in the footwall parts of core pods. In the Mica Lode, replacement of the footwall half of the core has been intense and irregular. Here muscovite occurs as follows:

1. Veins of fracture filling. These are thin and contain flattened garnet crystals and muscovite flakes parallel with the walls.
2. Tabular and pod-like masses that have the original fracture as in (1) but are distinguished by extremely coarse blades of muscovite arranged in comb or rosette structure, generally on the hanging-wall side of the fractures. Some of the wedge-shaped blades are as much as two feet long. These bodies are very abundant and may be 20 feet long and 10 feet wide.
3. Irregular masses and pods of "ball" mica with subordinate intergrown plagioclase (Type 1). Some of these pods may be rimmed by a border of bladed mica. Masses 25×30 feet in section, containing 60–90% muscovite have been mined. The individual flakes vary from 1/16 to 1 inch across.

Very little muscovite occurs in well-formed, flat books. The large blades are wedge-shaped, minutely fractured, and marked by heavy fishtail structure. In a few places incipient replacement around small core pods in the Meyers Quarry has led to the development of minor plagioclase and scattered flat muscovite books as much as 6 inches across. Some of these have A-structure and others are broken by reeves. Many contain heavy central inclusions of magnetite films. Similar books with similar defects occur locally around core pods in the School Section pegmatite.

The color varies from gray green to silvery green to bright green. Staining by red iron oxide and black manganese oxide is common in the aggregates of wedge blades.

Muscovite also occurs in long narrow strips intergrown with biotite. This intergrowth, called "tanglefoot," consists of a central strip of biotite and borders of muscovite. The laths are as much as six feet long, eight inches wide, and one inch thick. They are common in the wall zone of the School Section pegmatite, where they tend to be normal to the hanging-wall contact. They are certainly among the last components to crystallize, for they cut sharply across the fabric of the zone. Muscovite rimmed by lepidolite is found in the replacement units in the west end of the Meyers Quarry. The cleavage is uninterrupted by the transition, and contacts between the two are sharp.

Table 6. Variations in γ Indices of the Muscovites

Occurrence	Color	Range in γ	Mean γ
1. Primary muscovite of the zones	Gray green to bright green	1.602–1.612	1.605
2. Bladed muscovite and "ball" mica in secondary units	Light silvery green	1.602–1.604	1.603
3. Muscovite associated with the cleavelandite-lepidolite replacement phase	Colorless	1.594–1.600	1.597
4. Sericite	Yellow, green, gray	1.580–1.590	1.585

Fine-grained, flaky, fibrous, or massive sericite is common. The color is yellow to bright green. It is one of the latest minerals to form and replaces microcline, beryl, tourmaline, cleavelandite, and fremontite.

Table 6 shows the variation in color and γ indices of refraction of the muscovites with respect to their paragenetic position. The younger muscovites have slightly lower indices.

Biotite

Biotite is widely distributed in wall zones as small books and flakes and as large blades of "tanglefoot." Locally it becomes very abundant, especially in the marginal pegmatites. At the Border Feldspar No. 1 deposit biotite occurs abundantly with quartz and red oligoclase in late veins that cut across the core. Blades as much as 6 feet long and $1\frac{1}{2}$ feet across lie parallel with the walls of the veins and appear to have formed along fractures in the quartz and plagioclase. Biotite also occurs in the Magnusson pegmatite in a dendritic intergrowth. The central axis of the branch is 10 feet long with regular offshoots 2 feet long at 65-degree angles. Much biotite has been altered to gray-green chlorite.

Chlorite

Primary chlorite occurs only in a few pegmatites of the injection gneiss, where it forms ½-inch, fibrous aggregates. Secondary chlorite formed by the supergene alteration of biotite is especially abundant in the School Section pegmatite.

Lepidolite

Lepidolite was found only in the core-margin replacement units of the Meyers Quarry pegmatite. A single specimen of lepidolite replacing beryl was obtained from the No. 4 Cut dumps, but all the rest of the mineral was found in the replacement pods near the western end of the deposit. Associated with it are beryl, garnet, abundant cleavelandite, muscovite, black, red, and green tourmaline, and rarely, fremontite and columbite. Three varieties were noted:

1. Flaky, fine-grained, deep purple lepidolite.
2. Pale lilac rims of lepidolite bordering muscovite books.
3. Large flat books of very pale lilac lepidolite.

The fine-grained type, which is most abundant, commonly is associated with rubellite. It replaces quartz and cleavelandite, and in association with quartz cuts across plagioclase (Type 1) in thin veinlets. It appears to corrode fremontite slightly. A little dark purple lepidolite also occurs in quartz in curved, 2×1-inch plates marked by closely spaced reeves.

The narrow rims of pale lepidolite around 1- to 3-inch muscovite books are not common. The books of very pale lepidolite, which occur with the older green tourmaline, appear to have formed somewhat later than the fine-grained darker lepidolite. The γ indices of refraction of the three types are as follows:

Fine-grained	*Rims*	*Pale books*
1.561–1.566	1.564	1.577–1.588

Garnet

Light-brown to clove-brown garnet is locally abundant in a few pegmatites. Although scattered crystals occur in wall zones and intermediate zones, the bulk of the mineral is found in the secondary units within or at the margin of cores.

Well-formed crystals, ½ inch to 1 inch in diameter, are the rule, but small patches of a subgraphic intergrowth of garnet and quartz also occur.

There may be two generations of garnet. The earlier (?) is dark-brown spessarite, which is associated with black tourmaline, muscovite, and red oligoclase (Type 1). Cleavelandite (Type 3) strongly corrodes aggregates of this variety. The second (?) generation is reddish brown in color and occurs in finely granular aggregates and veinlets that transect and replace large crystals of gray-green apatite and white sugary albite (Type 2). Masses of spessartite as much as six feet across have been reported from the Mica Lode pegmatite. A large pod of intergrown garnet and chalcocite occurs in blocky microcline of the core, and irregular veinlets of spessartite cut across margins of quartz pods in the Mica Lode core. Much of the garnet alters readily to manganese oxide; some of it is replaced by light green sericite.

Beryl

Scattered crystals of beryl are widespread in secondary units, but local strong concentrations also occur there. An irregular mass of plagioclase-muscovite-beryl rock replaces part of the footwall side of the Mica Lode core. A similar but smaller unit occurs along the margin of the core pod in the No. 4 Cut at the Meyers Quarry. Scattered crystals occur in many other deposits.

The most common color is a pale blue-green, but deep blue, pale blue, light green, and lemon yellow also occur. Specimens of white to pale orange beryl were found on the Mica Lode dumps, and light red beryl was obtained at the Border Feldspar No. 2 deposit. Much of the beryl associated with triplite at the Mica Lode is stained black by manganese oxide from the altered phosphate. The texture of the mineral varies from chalky to glassy; small parts of a few crystals are of gem quality.

Many crystals show zoning, which may be expressed in one of three ways:

1. A core of beryl that contains numerous minute inclusions of muscovite separated from an outer inclusion-free zone by a film of muscovite or feldspar. The two zones are the same color.
2. A core of albite and quartz bordered by an unaltered outer shell of beryl (Fig. 12).
3. A deep-red core and an outer white shell: found only at the border Feldspar No. 2 pegmatite.

The crystals are commonly sheathed by small muscovite flakes or by fine needles of black tourmaline. Veinlets of quartz and tourmaline transect them normal to the length. Some crystals have cores and "inclusions" of quartz and albite (Type 2) ("shell" beryl) (Fig. 12).

Both tapering and non-tapering crystals may have such features. Shaub (1937, p. 1051) believes that the "beryl-albite intergrowths . . . are shown to be of such a nature that an origin through the processes of replacement is most unlikely, while on the other hand their relationship and other features clearly indicates (sic) a comtemporaneous (sic) crystallization."

This origin seems untenable for several reasons: (1) Beryl in the Eight Mile Park pegmatites is restricted to secondary pegmatite units and is

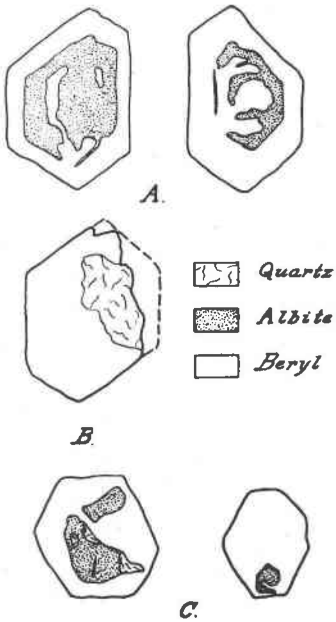

FIG. 12

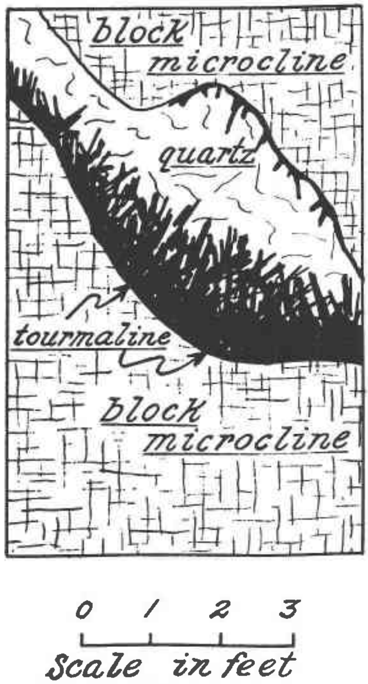

FIG. 13

FIG. 12. Cross sections of "shell" beryl crystals, School Section deposit.

FIG. 13. Preferential replacement of quartz by tourmaline, core of Border Feldspar No. 2 pegmatite.

itself of hydrothermal origin. (2) Much of the albite (Type 2) is clearly later than the tourmaline, which veins and coats the beryl crystals. (3) Moreover, the beryl crystals show considerable variation in their refractive indices from core to margin and also from the small end to the large end of tapered crystals. This indicates a zonal variation in their alkali content. (4) The intergrown quartz and albite commonly occur in cores or platy masses whose sides are parallel with prism faces of the beryl (Fig. 12). In fact, Shaub (p. 1046) notes this crystallographic control of the beryl on the albite and states, "The beryl at the large ends consists of plate- or blade-like masses usually having their sides parallel to the first or second order prisms. In addition, other forms as pyramids and pinacoid were noted."[1] The writer believes these data offer strong support for origin of the intergrowths through the replacement of selected zones within beryl by albite and quartz. Analogies in other minerals are common, as for example, the zonal replacement of plagioclase by sericite; tourmaline by quartz, damourite, or cookeite (Frondel, 1935A, p. 856); pyrite by chalcocite and pyromorphite by galena (Schouten, 1934); plagioclase by epidote (Grimsley, 1894), and actinolite by talc (Phillips and Hess, 1936).

Many beryl crystals are very soft and crumbly. Microscopic examination reveals that they have been replaced by sericite.[2] The altered crystals also may be heavily stained by limonite and veined by manganese dendrites.

Some of the beryl crystals are markedly tapering, a structure characteristic of beryl from many pegmatites in south-central Colorado. Both zoned and unzoned crystals taper. The tapering crystals are commonly oriented nearly normal to the contact between unreplaced core rock and secondary muscovite-plagioclase pegmatite, with the larger end at the core side. These relations were observed for tapered crystals in the No. 4 Cut of the Meyers Quarry, at the Mica Lode, at the School Section deposit, and at the Suzana No. 3 pit. Beryl crystals normal to the contact between cores and adjoining pegmatite are shown by Johnston (1945, p. 1034) and by de Almeida et al. (1944).

The beryl associated with the lepidolite-cleavelandite type of mineralization differs somewhat from that found in the muscovite-plagioclase replacement units in its lemon-yellow color, porcelanoid texture, lack of taper and zoning, and freedom from alteration.

The ω indices of refraction of the green and blue beryls range from 1.576 to 1.587, with a mean of 1.581. The orange to white variety found on the Mica Lode dump has $\omega = 1.595$ and appears to be high in the alkali elements.

Tourmaline

The tourmaline is of two types, the common schorl, and the brightly colored varieties. Schorl occurs as a minor constituent of wall and intermediate zones, but is concentrated in core-margin replacement pods that are rich in muscovite and red plagioclase (Type 1). In the marginal pegmatites, fine-grained tourmaline occurs in narrow crosscutting veinlets.

[1] See also Johnston (1945, p. 1033).

[2] Checked by *x*-ray powder photograph.

Abundant black tourmaline has been found in the School Section pegmatite where it forms suns as much as four feet in diameter. Individual crystals may reach three inches in diameter and eight inches in length. In some the prismatic striations are bent.

Tourmaline prefers to replace quartz, if possible. This selectivity is particularly well illustrated in the Border Feldspar No. 2 open cut where individual quartz pods within the core have been strongly replaced by tourmaline, and the surrounding blocky microcline is completely free of the mineral (Fig. 13). This phenomenon also occurs in the School Section deposit. Similar relations, on a smaller scale, were observed in the Suzana No. 1 body, where quartz in a fine-grained, subgraphic intergrowth of quartz and microcline has been replaced selectively by black tourmaline. Tourmaline crystals formed in quartz commonly are well developed, with sharply-defined faces, whereas those which replace microcline are flattened, irregular, dull, and tend to occur not as single crystals but in matted clusters and narrow veinlets.

At the School Section quarry black tourmaline replaces quartz and microcline and appears to be contemporaneous with garnet. It is older than a little of the red plagioclase (Type 1), cleavelandite (Type 3), and a second generation of quartz. Quartz and plagioclase (Type 1) veinlets normal to the length are common. Many crystals have been offset along these filled fractures. Around the sides of small vugs black tourmaline is intensely replaced by cleavelandite, which is coated by bright yellow-green sericite.

Some crystals contain a poorly defined zonal structure with a core speckled by abundant small muscovite flakes and an outer muscovite-free layer (incipient selective replacement?). Other crystals are completely coated by fine-grained muscovite. "Shell" tourmaline crystals at the Colfelco No. 12 prospect have central parts selectively replaced by quartz and muscovite.

The colored tourmalines occur only in the cleavelandite-lepidolite replacement units in the western part of the Meyers Quarry pegmatite. The red, light green, and blue-black varieties occur as single-color crystals, but most of the crystals are color zoned with the following combinations:

	Core	*Border*
1.	Blue-black	Dark green
2.	Dark green	Pink
3.	Dark green	Light green
4.	Light green	Yellow
5.	Red	Yellow
6.	Light green	Red

From these relationships the sequence of types, from oldest to youngest, is: (1) blue-black, (2) dark green, (3) light green, (4) pink, (5) red, and (6) yellow.

The colored tourmalines are veined by quartz and albite and may have the outer zone partly replaced by albite. They are closely associated with lepidolite: the green variety with flat books of pale lilac lepidolite, and the rubellite with masses of fine-grained purple lepidolite. Two crystals of green tourmaline may form a V with pale lepidolite between the arms. A few green crystals occur in radiating groups. Minute rubellite crystals form coatings on fremontite crystals.

Apatite

Apatite is unusually abundant in the core-margin replacement units of the School Section pegmatite, where it forms blocky crystals as much as eight inches across. The color varies from a dull gray-green to an iridescent dark purple. The mineral is veined by white sugary albite (Type 2) and by garnet. Veinlets of albite may be so numerous as to form a replacement breccia of the larger crystals. Fine-grained blue apatite occurs sparingly in the Van Buskirk, Suzana No. 4, and the Meyers Quarry pegmatites. At the last it replaces quartz and microcline.

An unusual dark brown apatite was found on the Mica Lode dumps. It resembles triplite with which it is closely associated. Under the microscope the mineral is seen to contain very abundant dark brown to black inclusions. Identification was confirmed by *x*-ray powder photograph. Like the associated triplite, the mineral is corroded by gray albite and muscovite. Possibly it formed by the supergene alteration of triplite by calcium carbonate waters. Associated are crusts of limonite and manganese oxide.

Triplite

Triplite was found only in the Mica Lode and School Section pegmatitites. In both bodies it is associated closely with beryl-muscovite mineralization. The occurrence and crystallography have been described in detail (Wolfe and Heinrich, 1947).

The mineral occurs chiefly in gray albite and small flakes of light colored muscovite, which may sheath the masses. Less commonly both minerals corrode and vein triplite. In the School Section pegmatite fine-grained black tourmaline replaces triplite.

Fremontite

Fremontite was first described by Schaller (1911, 1912) from Eight

Mile Park under the name of natramblygonite. This was later withdrawn because of certain etymological objections (Schaller, 1914, 1916). The mineral also has been reported from Jeclov, near Jihlava, Moravia, in Czechoslovakia (Sekanina, 1933).

The description of this rare species follows:

Triclinic, with two cleavages, the better parallel to {001}, the other parallel to {100}; occurs in cleavable masses or crystals with rough faces; forms noted are *c*{001}, *b*{010}, *a*{100}, *z*{1$\bar{2}$0}, *e*{0$\bar{2}$1}, and *h*{$\bar{1}$01}; the angles agree with the corresponding angles on amblygonite; under the microscope two directions of polysynthetic twinning appear; $H=5.5$; $G=3.01$–3.06; color grayish to white; translucent to opaque; luster vitreous to greasy but approaches chalky upon weathering; optically positive; X nearly normal to {001}; $\alpha=1.594$, $\beta=1.603$; $\gamma=1.615$; 2V is large; before the blowpipe easily fusible with slight intumescence to an opaque white enamel.

Formula—$(Na, Li)AlPO_4(OH, F)$

Analysis (by Schaller):

P_2O_5 =	44.35
Al_2O_3 =	33.59
Li_2O =	3.21
Na_2O =	11.23
K_2O =	0.14
H_2O =	4.78
F =	5.63
	102.93
$O=F_2$ =	2.37
	100.56

The type crystals and masses examined by Schaller are now part of the Holden collection at Harvard University and were restudied by the writer. The crystals are coated by thin films of yellow sericite and transected by quartz veinlets normal to the *c* axis. Small blebs of rubellite also form a coating and corrode the crystals. Lepidolite corrodes and replaces fremontite. The crystals are rough and did not form in vugs but were surrounded on all sides by pegmatite.

Several small fragments of fremontite were collected from the western part of the Meyers Quarry pegmatite. The mineral is restricted in its occurrence to the core margin replacement pods of cleavelandite-lepidoite rock, and it was found only at the easternmost of these.

A cerussite pseudomorph after fremontite has been reported by Frondel (1935B) from near Canon City. The association with quartz, lepidolite, and pink feldspar indicates that the specimen probably was obtained from the Meyers Quarry pegmatite. An attempt to locate the specimen (*Amer. Mus.* 18064) for further study was unsuccessful.

Columbite

Although columbite is a relatively common mineral in many pegmatites of south-central Colorado, it is rare in the pegmatites of Eight Mile Park. Headden (1905) has described the mineral from this locality and reports that it occurs in masses as heavy as 600 pounds, associated with red, green, and black tourmaline. This association clearly indicates that his material was found in the cleavelandite-lepidolite rock in the western part of the Meyers Quarry pegmatite. The analysis by Headden follows:

$$
\begin{aligned}
Cb_2O_5 &= 56.48 \\
Ta_2O_5 &= 22.12 \\
WO_3 &= 0.45 \\
SnO_2 &= 0.11 \qquad\qquad G = 5.6608 \\
FeO &= 8.07 \\
MnO &= 12.45 \\
IgO &= 0.15 \\
&\overline{99.83}
\end{aligned}
$$

Small specimens of columbite were found at the Meyers Quarry, Mica Lode, and School Section quarry. Sterrett (1923) in his description of the Mica Lode (Mica Hill) states (p. 56), "In small openings lower down rough crystals of beryl from an inch to a foot in diameter and columbite in masses weighing 2 or 3 pounds were found." At the School Section quarry a $\frac{3}{4}$-inch crystal was found in the eastern part of the Shipley Cut where it occurs in the plagioclase-muscovite replacement pod and is associated with beryl, triplite, and abundant black tourmaline.

Torbernite (?)

Associated with the rubellite, lepidolite, and fremontite of the Meyers Quarry are exceedingly minute flakes of a grass green uranium mineral, probably torbernite. The flakes tend to occur along contacts between rubellite or fremontite crystals and quartz-lepidolite matrix.

Magnetite

Magnetite is a very abundant constituent of pegmatites in the injection gneiss. Exterior pegmatites near the injection gneiss contacts also contain it, but interior marginal and other exterior pegmatites carry it but rarely. In some exterior pegmatites it occurs only in thin films, included in muscovite.

An unusual magnetite-bearing pegmatite occurs in the SW. $\frac{1}{4}$, NE. $\frac{1}{4}$, Sec. 22 overlooking Overshot Gulch (Fig. 2), on the McMullin Lease. The deposit is a sill which strikes N. 62° E. and dips 85° NW. It is very poorly zoned with medium-grained margins of red microcline and quartz and a slightly coarser core of the same minerals. Biotite occurs sparingly. Magnetite, which is very abundant, occurs in "streaks" and clusters of crystals throughout most of the mass. The crystals range in size from $\frac{1}{4}$ inch to $2\frac{1}{2}$ inches. Most of them are faced, partly by rounded, striated octahedral faces and partly by flat, well-formed octahedral faces. The mineral appears to be primary in origin and probably crystallized early.

The crystals weather out and are concentrated in the debris below the outcrop. Somewhat similar pegmatites have been described by Ball (Spurr, Garrey, and Ball, 1908, p. 61), who states, "Magnetite is a widely distributed constituent, and in some places forms over one-third of the pegmatite mass, which in consequence becomes a lean iron ore. Magnetite occurs in crystals which solidified prior to the other constituents of the pegmatite or in irregular aggregates which solidified practically at the same time as quartz and orthoclase. The crystals, which are octahedrons or octahedrons modified by the faces of the cube, reach a maximum diameter of 4 inches, and some of the aggregates are 6 inches across."

Hematite

Hematite occurs as an alteration of the magnetite crystals and of the magnetite inclusions in muscovite. Coatings of specular hematite occur along fractures in massive quartz in the Suzana No. 3 pegmatite. Veinlets of fine-grained hematite are common in many pegmatites in injection gneiss.

Chalcocite

Chalcocite intergrown with spessartite garnet was found in a 6-foot pod in the Mica Lode quarry, and other large masses have been mined in the past.[1] The pod is rimmed by coarse blades of muscovite. The mineral is steely blue in color and transects and replaces microcline and associated muscovite. In polished section there appear minute, bronze-colored inclusions that may be native bismuth. The pod and the surrounding muscovite and microcline are heavily stained by manganese oxide from the decomposed garnet and by malachite from the altered chalcocite.

Chalcocite also occurs at the School Section deposit. Associated with it are minute patches of secondary covellite and copper carbonates. Only a few 1-inch pods of the material were found in a matrix of plagioclase and muscovite.

[1] Personal communication from Mr. Robert Shipley.

Native Silver

A polished section of the School Section chalcocite disclosed extremely minute blebs of a soft white mineral in grains too small to identify by etch test methods. Professor L. C. Graton kindly instructed the writer in the use of the microdrill (Harcourt, 1937) by means of which the tiny grains were drilled out. The powder was then collected in a capillary tube. An x-ray powder photograph of the material gave the correct lines and spacings for native silver. The native silver, native bismuth (?), chalcocite, and bismuth carbonates may be secondary minerals formed by the decomposition of a primary copper-bismuth-silver sulfosalt.

Malachite, Azurite, and Chrysocolla

Malachite is the chief alteration production of chalcocite both at the School Section quarry and at the Mica Lode. A little malachite also stains feldspar in the Main Cut of the Meyers Quarry. Azurite occurs sparingly at the School Section associated with minor chrysocolla and is locally abundant in the Mica Lode core where it forms thick crusts with malachite on dark red microcline.

Bismutite

Bismutite occurs as a secondary mineral at the Meyers Quarry' Mica Lode, Border Feldspar No. 1, and School Section pegmatites. Commonly it occurs as thin light green to gray crusts in fractured quartz. At the School Section and Mica Lode deposits an intergrowth of bismutite and beyerite forms 2-inch earthy pods. Bismutite is a common accessory mineral of many pegmatites in south-central Colorado and northern New Mexico (Heinrich, 1946).

Beyerite

The rare calcium-bismuth carbonate, beyerite, was found at the School Section deposit closely intergrown with bismutite, and at the Mica Lode quarry in relatively pure masses. The detailed mineralogy has been described (Heinrich, 1947).

Limonite and Manganese Oxide

Limonite and manganese oxide, which form by the weathering of triplite, commonly stain the surrounding minerals, microcline, quartz, plagioclase, beryl, and muscovite. Manganese oxide also results from the decomposition of spessartite garnet and stains the associated microcline and muscovite.

Kaolinite

Kaolinite forms as an alteration production of microcline and plagioclase. Less commonly it also replaces beryl, as in the Mica Lode and Meyers Quarry pegmatite. The color varies from olive-green, to gray, to light red.

Calcite and Chalcedony

Botryoidal crusts of earthy, cream colored calcite are very common in pegmatite at the very crest of the School Section hill. It replaces microcline along fractures and cleavage planes. Although no limestone remnants now cap the hill, it seems clear that there has been relatively little erosion of the knob since the cover of sediments was stripped away, and the secondary calcite probably was derived from Morrison limestone.

Veinlets of gray chalcedony occur in the Colfelco No. 12 pegmatite, which lies near the Morrison contact. Similar veinlets occur in pegmatites of the injection gneiss along the Morrison contact near the south edge of the area. Because of the close association with the sedimentary rocks, it appears likely that the silica was derived from them and deposited in fractures in the pegmatite bodies which these rocks formerly covered.

DESCRIPTIONS OF SELECTED DEPOSITS

History

One of the earliest references to mica deposits in Fremont County is found in Williams (1883), but the deposits of Eight Mile Park are not specifically mentioned. Holmes (1899) lists seven mica deposits in Colorado, but none in Fremont County.

It is reported that the first mining in Eight Mile Park was done by a Mr. Boyle of Canon City, probably shortly before 1900.[1] According to Sterrett (1923), the deposits have been prospected or worked at different times, but mica mining in Fremont County was most active from about 1904 to 1907. During this period the United States Mica Co., of Chicago, Ill., operated the mines of the Micanite region, and the Canon City Mica Mining & Mills Co. operated the Mica Hill (Mica Lode) mine. The United States Mica Co. had an elaborate trimming plant and a dry grinding mill near the mines. The Canon City Mining & Mills Co. had a dry grinding mill and an experimental plant in Canon City to develop uses for the product. None of the mines was in operation in 1908 and 1913.

[1] Personal communication from Mr. J. E. Meyers.

In 1928 Mr. J. E. Meyers of Canon City located a claim on the Mica Lode and operated it alone for a year and then with a partner, Mr. B. O. Halstead. Mr. Meyers sold his half interest in 1930, and shortly thereafter the property came under the control of the Western Feldspar Company (now Magnusson and Sons) of Denver. In 1939, after several years of litigation, the deposit was acquired by the Colorado Feldspar Company of Canon City (a subsidiary of the Consolidated Feldspar Corporation of Trenton, N. J.). It has been leased for many years to Robert Shipley of Canon City who constructed a small crushing and screening plant for mica separation.

The Meyers Quarry pegmatite (also known as Meyers-Halstead Quarry) was prospected in 1929 by Mr. Meyers and was operated intermittently until 1945 by the Colorado Feldspar Company. Seven claims, belonging to the company, cover the outcrop of the pegmatite belt along the schist-granite contact from the sedimentary hogbacks as far west as the Mica Lode. Since 1945 several contractors have mined the deposit for short periods.

The land on which the School Section pegmatite crops out is the property of the State of Colorado. It was leased first to Mr. Shipley, who began work in 1929 and continued until 1931. From 1931 to 1935 it was operated by the Western Feldspar Company, after which it lay idle for nearly four years. In 1939 the Colorado Feldspar Company reopened operations which were continued until 1945. A picking belt, constructed in 1944, was used for about a year. In 1945 and 1946 J. E. Meyers worked the deposit.

The Suzana Nos. 1, 3, 4, and 5 pegmatites were prospected by the Colorado Feldspar Company between 1940 and 1943. In 1945 the company explored the enormous Colfelco deposit in order to outline pegmatite reserves for the feldspar flotation mill that it constructed at Gorgemore and placed into operation in late 1947.

Smaller deposits operated and prospected by Mr. Meyers include the Meyers-McMullin, Ring, and Lorain. Magnusson and Sons have prospected the Van Buskirk, Magnusson, and Magnusson Crosscuts deposits. The two Border Feldspar deposits have been worked by Mr. Shipley. Most of the small cuts and pits in the western extension of the School Section pegmatite were made by Mr. Cal Dell of Canon City.

It is estimated that from 1928 to 1946 there have been produced from the district 235,000 tons of feldspar, 30,000 tons of muscovite (chiefly grinding mica), and about 40 tons of beryl.

Marginal Pegmatites

Colfelco

The Colfelco pegmatite, by far the largest in the district, occupies much of the northern half of Sec. 20 and continues westward into Sec. 19, where it is covered by Mesozoic sediments. The sheet-like deposit, which is one mile long and $\frac{1}{4}$ mile wide, trends N. 65° E. and probably has a general element of dip to the southeast. Its sheet-like nature is clearly shown by isolated patches of overlying granite and exposures of granite in footwall "windows." Locally it may be as much as 200 feet thick. In size it compares favorably with a pegmatite in the Georgetown Quadrangle, south of Duck Lake (Spurr, Garrey, and Ball, 1908), which is 1.7 miles long and 0.6 mile in width.

Like most of the marginal pegmatites it is very poorly differentiated, but several distinct rock types can be recognized:

1. The most common contains abundant euhedral graphic granite phenocrysts, 2 inches to 2 feet on edge, in a fine-grained matrix of microcline, quartz, and biotite. Locally muscovite supplants biotite. The phenocrysts comprise 10–80% of the rock.
2. The matrix of type 1 without the blocky graphic granite.
3. A rock composed chiefly of graphic granite (rare).
4. Near some core masses Type 1 grades into a two phase pegmatite composed of quartz-muscovite and quartz-microcline rock.
5. A border phase of fine-grained quartz, microcline, sericite, and magnetite.
6. Rare core pods as much as 50×20 feet in plan, composed of predominant quartz and subordinate microcline in crystals 4 feet or less on edge. In general quartz-free microcline is very rare in the deposit.
7. Along the footwall side of one of the larger core pods near the southwest corner of the mass plagioclase pegmatite has been developed. It contains abundant 6-inch masses of garnet and 3-inch books of muscovite.

Diabase dikes cut the sheet in several places. This relationship is particularly well shown on the south wall of the Gorge where the floor of the pegmatite body is clearly exposed.

The deposit has been prospected by means of a dozen small pits that constitute the recent assessment work by the Colorado Feldspar Company. Most of the outcrop is covered by 22 claims staked by the company who is quarrying the deposit as a source of feldspar-rich pegmatite for its flotation mill at Gorgemore. It is estimated that this deposit contains a minimum of 400,000,000 cubic feet or 32,000,000 tons of pegmatite.

School Section

The School Section pegmatite is the most extensively mined marginal pegmatite. It also appears to be the only marginal pegmatite that has been markedly affected by hydrothermal replacement. The deposit, which is in the southeast corner of Sec. 16, has been mined from two large open cuts (the Meyers and Shipley Cuts), and from ten smaller cuts and pits (Fig. 14). The northwest-trending Meyers Cut is 300 feet long, 75 to 135 feet wide and 50 feet deep. A bench, 15 feet below the rim has been made at the west end. The Shipley Cut, which trends northeast, is 320 feet long, as much as 160 feet wide, and 25 feet deep. A level, 10 feet below the cut floor, was begun from the southeast.

The pegmatite, which trends N. 73° W., is an irregular sheet-like body that splits northwestward into several flat-lying arms. The exposed length is about ½ mile, the maximum width is 500 feet, and the maximum thickness appears to be about 75 feet. In the southeast the general dip is 5–20° SW. but northwestward the dip changes to 10°–15° NE. The sheet-like form of the deposit is well shown by the granite exposed in several footwall "windows" (Fig. 14, Section B-B′) and by the gently dipping hanging-wall contact exposed on the northeast side of the Meyers Cut (Fig. 14, Projection A-A′). Moreover, the shallow gulch northwest of the Meyers Cut has cut through the upper part of the deposit.

Sixteen core pods were mapped, but it is probable that several more have been mined out completely. The pods, which range in length from several feet to nearly 200 feet, are flat-lying shallow masses that parallel the general pegmatite structure. The larger ones contain important concentrations of blocky feldspar, but many of the smaller are composed only of massive quartz.

Underlying, or less commonly partly surrounding, most of the core pods are replacement units of quartz-sodic plagioclase pegmatite in which garnet, muscovite, beryl, black tourmaline, cleavelandite, apatite, and sericite occur in varying quantities. Rarer constituents are columbite, triplite, chalcocite, beyerite, and bismutite. Rosette cleavelandite, black tourmaline, and apatite are especially abundant near the northeast entrance of the Shipley Cut. Triplite is also common there and likewise at the mouth of the Meyers Cut. No concentrations of beryl were noted, but scattered crystals, many of which have cores selectively replaced by albite and quartz, are widespread in these units.

The intermediate-zone rock is typically of two phases: (1) graphic granite and (2) quartz-muscovite pegmatite. Locally graphic granite predominates, and northwest of the Meyers Cut biotite in small flakes and in "tanglefoot" laths becomes an important constituent. In the Meyers Cut many of these laths tend to be normal to the hanging-wall contact. Where biotite is abundant, microcline is dark red. Secondary calcite is common near the crest of the knob.

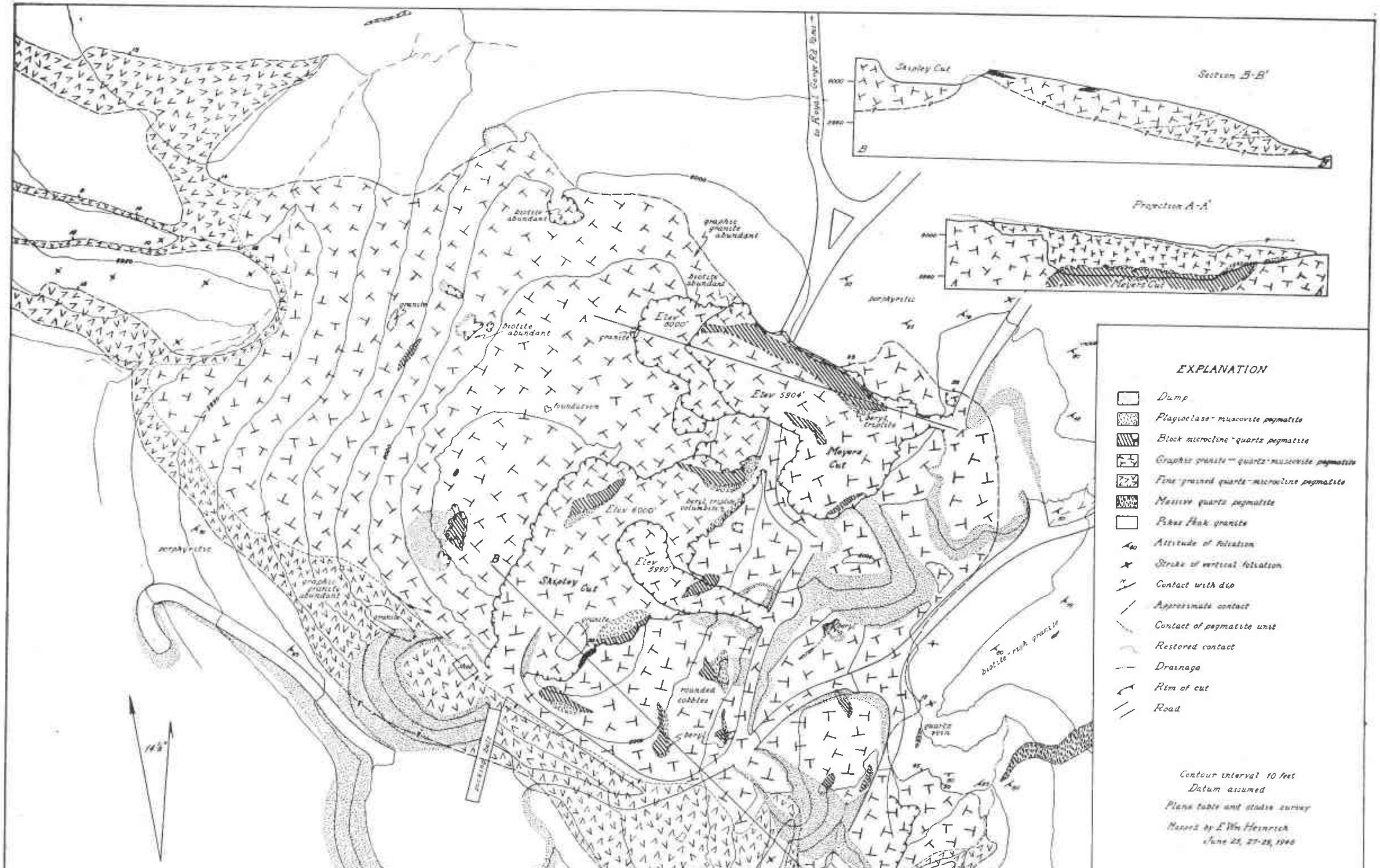

Fig. 14. School Section pegmatite.

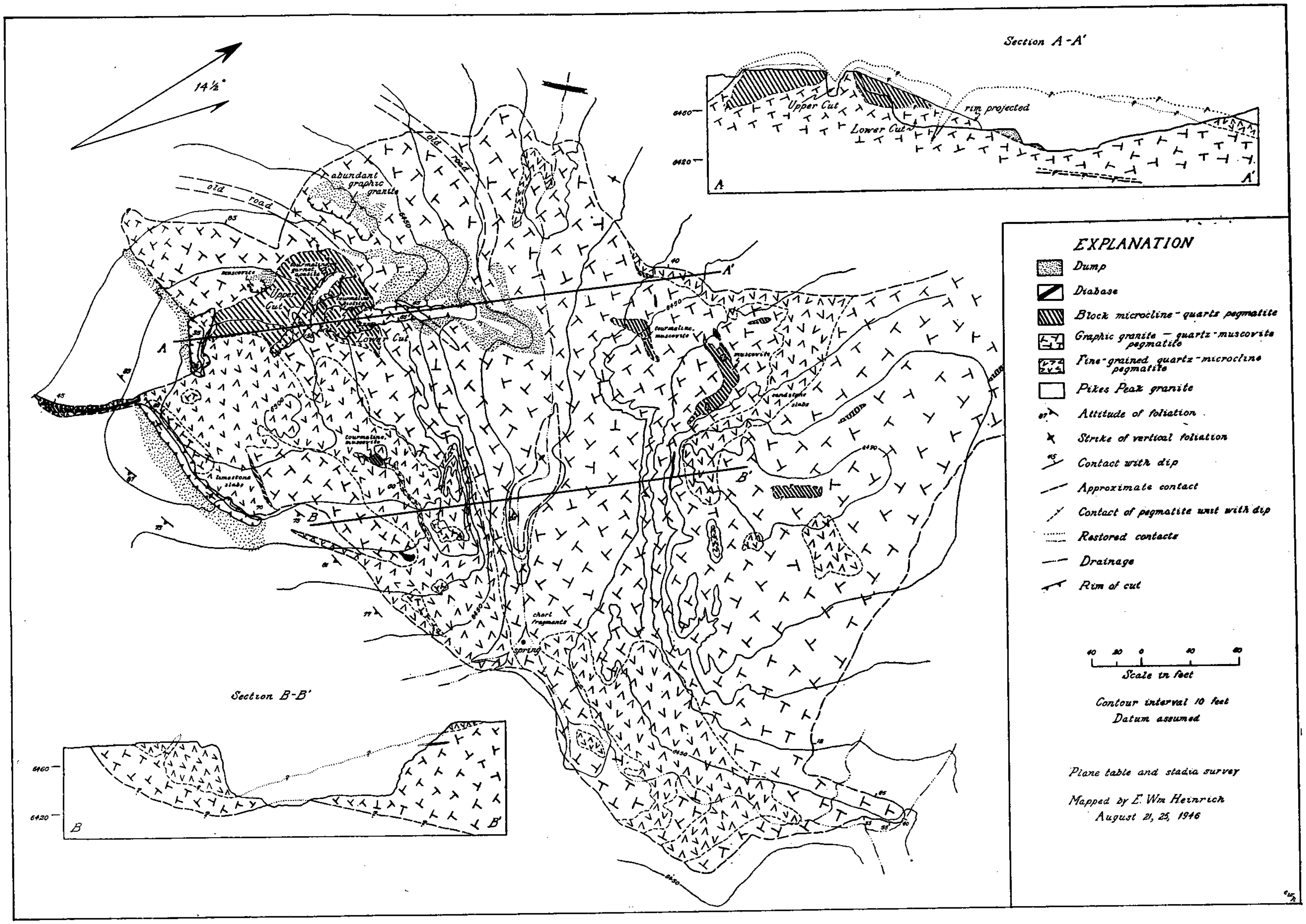

FIG. 15 Van Buskirk pegmatite.

The wall zone, which remains only on the footwall side, probably has been stripped from the hanging wall. It contains graphic granite phenocrysts in a groundmass of fine-grained quartz, microcline, and muscovite. The phenocrysts range in size from 6 inches to 3 feet, and are more resistant to weathering than the matrix. The zone crops out as a ledge with a knobby, irregular surface. Biotite occurs locally. In some parts of the zone phenocrysts are absent and the rock is a fine- to medium-grained quartz-microcline intergrowth.

Although much feldspar has been secured in the past, mining has always been difficult owing to the discontinuous nature of the core pods. Mineable quantities of feldspar are exposed on the northeast side of the Meyers Cut, but many of the other large concentrations appear to be exhausted. The pegmatite has yielded 25,000 tons of feldspar, 200 tons of grinding mica, and several tons of beryl.

Van Buskirk

The Van Buskirk body, which is in the NE ¼, SE. ¼, Sec. 15 is perhaps the type example of the marginal pegmatites. Only a few small pits have been made in the northern part of the deposit, but the southern third has been explored by means of 2 long cuts, 3 trenches, and a pit (Fig. 15). A gulch cuts across the general north trend of the body to reveal the footwall granite (Fig. 15, Section B-B′). Several roof pendants of granite are exposed in the two main cuts (Fig. 15, Section A-A′).

Three flat-lying pegmatite units are present. Along the hanging wall and footwall are discontinuous zones of fine-grained quartz and microcline with muscovite or biotite or both. The chief rock type is composed of phenocrysts of graphic granite in a fine-grained quartz-microcline groundmass, which grades into rock composed of graphic granite and quartz-muscovite intergrowth. The nearly horizontal core pods, which are generally small, consist of massive quartz and blocky microcline. Commonly they are bordered by scattered crystals of black tourmaline or muscovite. The largest core unit, which is exposed in the southwest corner of the deposit, has been mined from the two main cuts. It is rich in coarse microcline but contains in addition much biotite in blades 4 feet long and 6 inches wide. Along the footwall side is a concentration of red sodic plagioclase in which occur small patches of fine-grained muscovite, abundant black tourmaline, and a little blue apatite.

Exterior Pegmatites

Lorain

One of the most unusual deposits in the area is the Lorain pegmatite in the northern part of Sec. 29. The dike, which ranges in thickness from 5

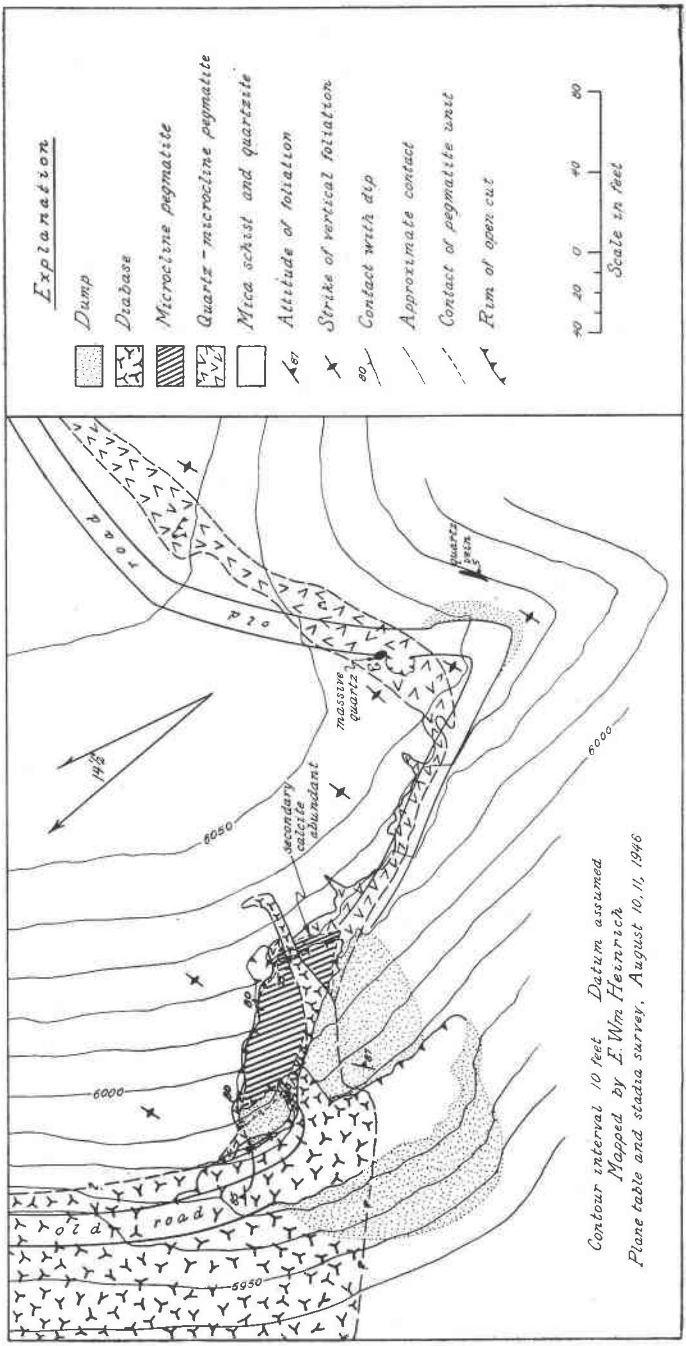

FIG. 16. Lorain pegmatite.

to 35 feet, is L-shaped in plan (Fig. 16). The eastern part, a vertical sill along the metamorphic foliation, strikes N. 80° E., but the crosscutting western arm strikes N. 25° W. and dips 80° NE. The western arm is 250 feet long, and the eastern branch continues for nearly ¼ mile. Near the northwestern end a large dike of diabase cuts sharply across the pegmatite.

The thicker western part has been mined from an open cut, 60 feet long, 30 feet wide, and as much as 45 feet deep, which marks the former site of a thick microcline core. Very little quartz was present. The microcline is transected by quartz-plagioclase veinlets on a very minute scale and is replaced by sericite. The core is flanked by thin zones of medium-grained microcline rock with uncommon 1-inch quartz blebs and traces of sericite and garnet. Southeast and east of the cut the dike consists of a fine- to medium-grained aggregate of quartz, microcline, graphic granite and a little muscovite and biotite. A small pod of massive white quartz occurs near the pit in the bend of the dike. Calcite derived from the weathered diabase coats pegmatite in the cut.

Border Feldspar No. 1

The Border Feldspar No. 1 pegmatite, which lies in the SW. ¼, NW. ¼, Sec. 22, has been mined from a quarry, 100 feet long and 50 feet wide. The floor level is 35 feet below the rim, and a bench lies 8 feet above the floor. The pegmatite body is extremely irregular in shape with numerous roof pendants of schist and many flat rolls in the hanging-wall. In section the body approaches that of a saucer (Fig. 17, Section A-A′). It has a maximum thickness of 50 feet.

The flat-lying, highly shattered core of dark red microcline and subordinate quartz is 10 to 30 feet thick. Fracture-filling biotite in parallel blades 6 feet long, 1½ feet wide, and 4 to 5 inches thick, cuts across the core minerals. Red sodic plagioclase occurs between the blades. In addition 6-inch flat-lying veins of quartz and parallel biotite books transect the core. A moderate amount of feldspar remains to be mined from the core but the dark red color and the abundant biotite considerably reduce its value. Fine-grained plagioclase-quartz pegmatite with minor beryl, garnet, black tourmaline, sericite, and bismutite lies along the footwall side of the core, replacing the medium-grained quartz-microcline-graphic granite rock of the wall zones. Coarse muscovite is uncommon in the deposit.

The country rock is a fine-grained quartz-biotite-garnet schist, one of the few examples of garnet-bearing rocks in the area. The foliation strikes N. 65° E. and dips 75° NW. and the lineation formed by alignment of garnet crystals on the planes of schistosity plunges 60° NE.

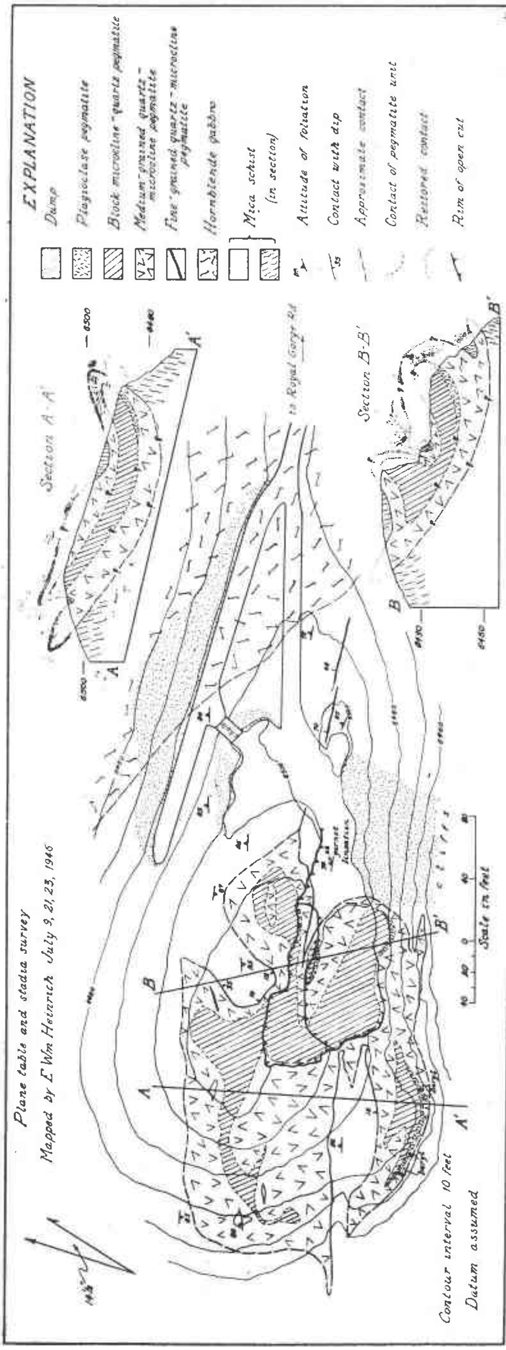

FIG. 17. Border Feldspar No. 1 pegmatite.

Magnusson Crosscut

The Magnusson crosscut is on the south side of the west end of Rattlesnake Ridge in the SW. ¼, SE. ¼, Sec. 14. It is the only pegmatite in the area developed by underground methods. The crosscut, which is 80 feet long, is opened by a 45-foot entry cut (Fig. 18). The pegmatite body, which is 60 feet thick, strikes N. 78° W. and dips 65–80° SW. On the footwall side the foliation of the muscovite schist strikes on the average N. 70° E. and dipps 44–58° NW., but on the hanging-wall the structure strikes east-west and dips 35° S. Thus the pegmatite appears to have been emplaced along the crest of an anticlinal fold or along a fault.

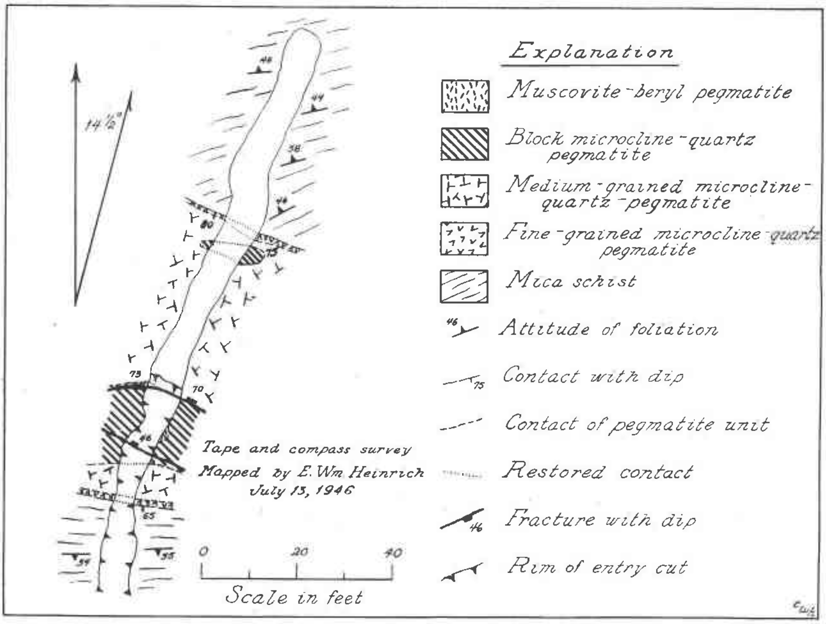

FIG. 18. Magnusson Crosscut pegmatite.

Along both contacts is a thin zone of fine-grained quartz and microcline. The intermediate zone is a medium-grained aggregate of quartz and microcline with abundant graphic granite. The core, which is 15 feet thick, lies near the hanging wall and consists of blocky microcline and coarse quartz partly replaced by plagioclase, "ball" mica, and beryl. On the east side of the entry cut is exposed a beryl crystal 2 feet in diameter and 3½ feet long. Both the core and the replacement pegmatite are cut by several fractures that trend parallel with the core and dip moderately to steeply northwest.

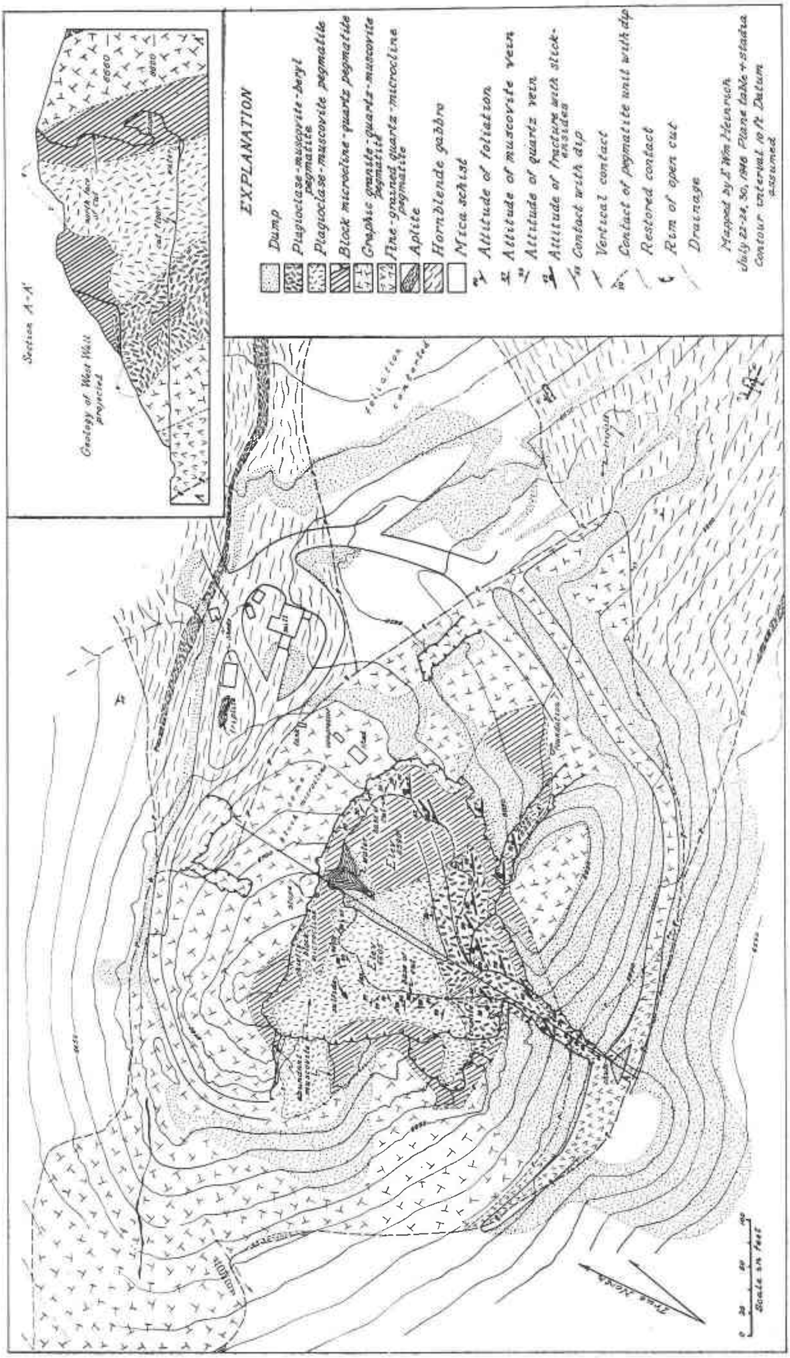

FIG. 19. Eastern part of Mica Lode pegmatite.

Mica Lode

The Mica Lode pegmatite, which is in the NE. $\frac{1}{4}$, SW. $\frac{1}{4}$, Sec. 14, is a lens-like sill, about 1300 feet long and as much as 450 feet wide, that strikes and dips moderately to steeply northeastward. Although the contacts are somewhat obscured by dumps, the offshoots that are so typical of the Meyers Quarry body appear to be largely absent in this deposit. Schist and gabbro alternate along the walls.

The deposit has been mined from an open cut which is 200×280 feet in plan and as much as 150 feet deep at the north face. An irregular stope, 35 feet long and 35 feet high, has been driven into the north face at floor level. Several small benches have been developed at levels 15, 35, and 85 feet above the floor. Two long and narrow entryways lead into the quarry. The one from the east is no longer used and has been left hanging 40 feet above the floor. In addition to the main quarry, four prospect trenches have been dug.

Border zones were not observed, and wall zones are poorly developed and poorly exposed. The stronger development of wall zone rock is on the footwall side. It consists of fine-grained quartz and microcline, with a little muscovite. A few veinlets of muscovite cut across the aggregate. The intermediate zones are very similar in mineralogy and texture to those of the Meyers Quarry pegmatite (see below) and likewise constitute the single largest unit of the deposit.

The core is a single central unit, 400 feet long and as much as 230 feet thick, that dips steeply to the northwest. It is composed of massive pods of white quartz as much as 30 feet long and crystals of red microcline six feet or less on edge. Quartz is somewhat more abundant near the footwall side where a prominent shear zone that trends N. 14–60° E. and dips 43–80° NW., has shattered the rock. The north face of the quarry, which lies near the hanging-wall side of the core, is unusually rich in microcline of very good quality.

Much of the footwall and central parts of the core has been replaced by plagioclase-muscovite pegmatite. This replacement unit is Y-shaped in section with an unreplaced mass of core rock lying between the two arms (Fig. 19, Section A-A′). On the basis of mineralogy two subdivisions are recognized: the southern part, which contains beryl and triplite in addition to the usual muscovite and plagioclase, and the larger northern part which is beryl-free and richer in coarse muscovite.

Muscovite is strongly developed and occurs in spectacular veins and fracture-controlled replacement bodies, 2 to 6 feet thick, and 6 to 20 feet long. The 1- to 3-foot wedge blades are arranged in rosette and comb structures. In addition, abundant masses of "ball" mica, as much as 25 ×30 feet in section, also have been found. The rest of the unit consists of

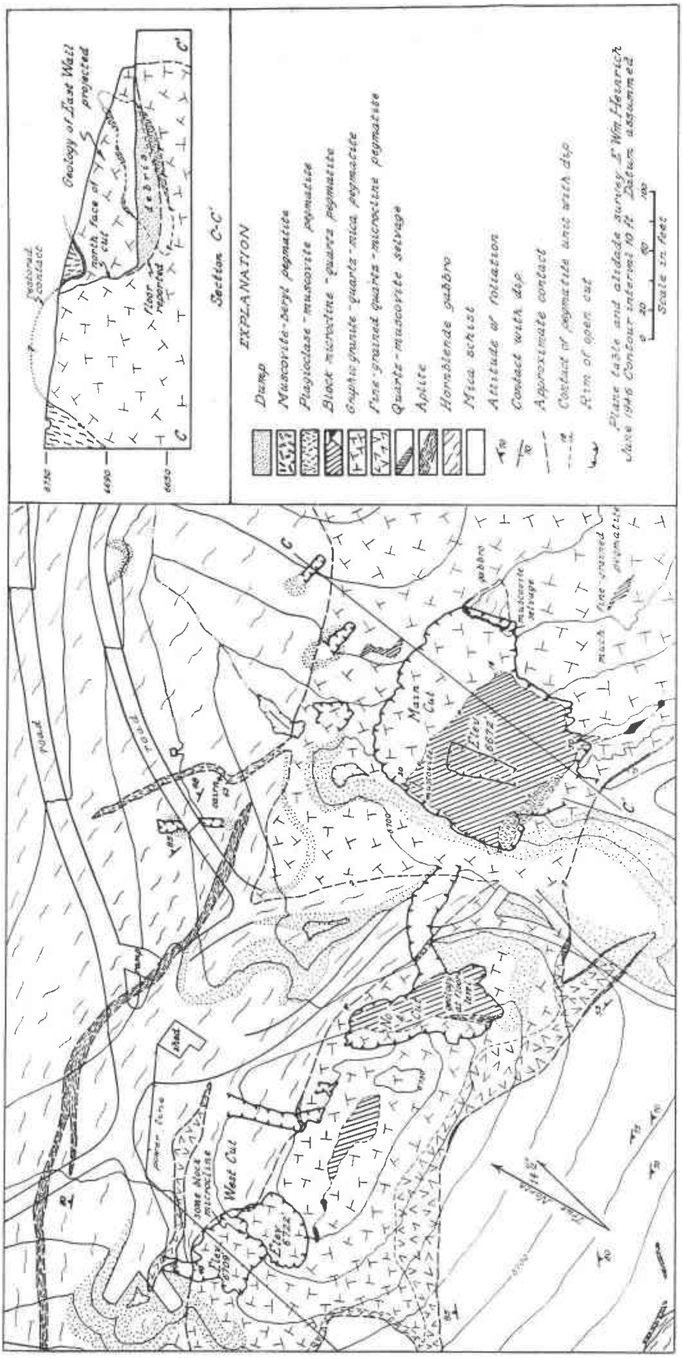

FIG. 20. Central part of Meyers Quarry pegmatite.

interstitial red sodic plagioclase and quartz, unreplaced remnants of coarse microcline and massive quartz, veinlets of garnet, late veinlets of quartz and albite, rare pods of chalcocite, and garnet.

The fractures that controlled the replacement are abundant. Many are curving and irregular in attitude. Northwest strikes and northeast strikes are almost equally abundant, but dips are more common to the northeast and northwest. Dips to the south are rare. Minor minerals in the beryl-bearing rock are schorl, triplite, apatite, and columbite. Muscovite is less abundant in this lower replacement unit.

The shearing along the southeastern side of the cut probably came close to the end of the period of hydrothermal mineralization, for beryl crystals and muscovite books are also fractured and broken. Some of the fracture planes are coated by white albite and by small flattened quartz crystals. In the small cut in the western nose of the pegmatite a shear zone, similar in strike but dipping 60° SE., fractures medium-grained quartz-microcline pegmatite.

The Mica Lode is the only deposit in the district in which there remain moderate to large reserves of quartz-free feldspar and mica. It is estimated that 175,000 tons of feldspar, 30,000 tons of grinding mica and 30 tons of beryl were obtained from the deposit between 1928 and 1946.

Meyers Quarry

The Meyers Quarry pegmatite is about ½ mile long and as much as 300 feet thick. The main workings, which are in the NW. ¼, SE. ¼, Sec. 14, include three large open cuts, 15 smaller cuts and trenches, and about a dozen small pits. The Main Cut, the largest, is 100×150 feet in plan and 50 feet deep at the face. The No. 4 Cut to the west, which is 100×50 feet in plan and 55 feet deep, is opened by a deep curving entrance way (Fig. 21). Part of the southwest face is overhanging. The West Cut, 100 feet long and 50 feet wide, contains a bench 20 feet below the rim and the floor 13 feet lower.

The pegmatite is very irregular in shape; it pinches and swells and sends off irregular branches and long apophyses (Fig. 20). The general trend, which is N. 75° E., is parallel with the strike of the country rock structure. It dips on the average moderately to steeply northwest. On the northwest side the wall rock is hornblende gabbro, but on the southeast the chief rock is mica schist. The intrusion appears to have been guided by the contact between the two.

The pegmatite is well differentiated. An incompletely developed 1- to 2-foot border zone consists chiefly of ¼- to ½-inch muscovite flakes in a gray quartz matrix. Microcline is generally absent. In a few places, as around the roof pendant of gabbro exposed in the northeast corner of the

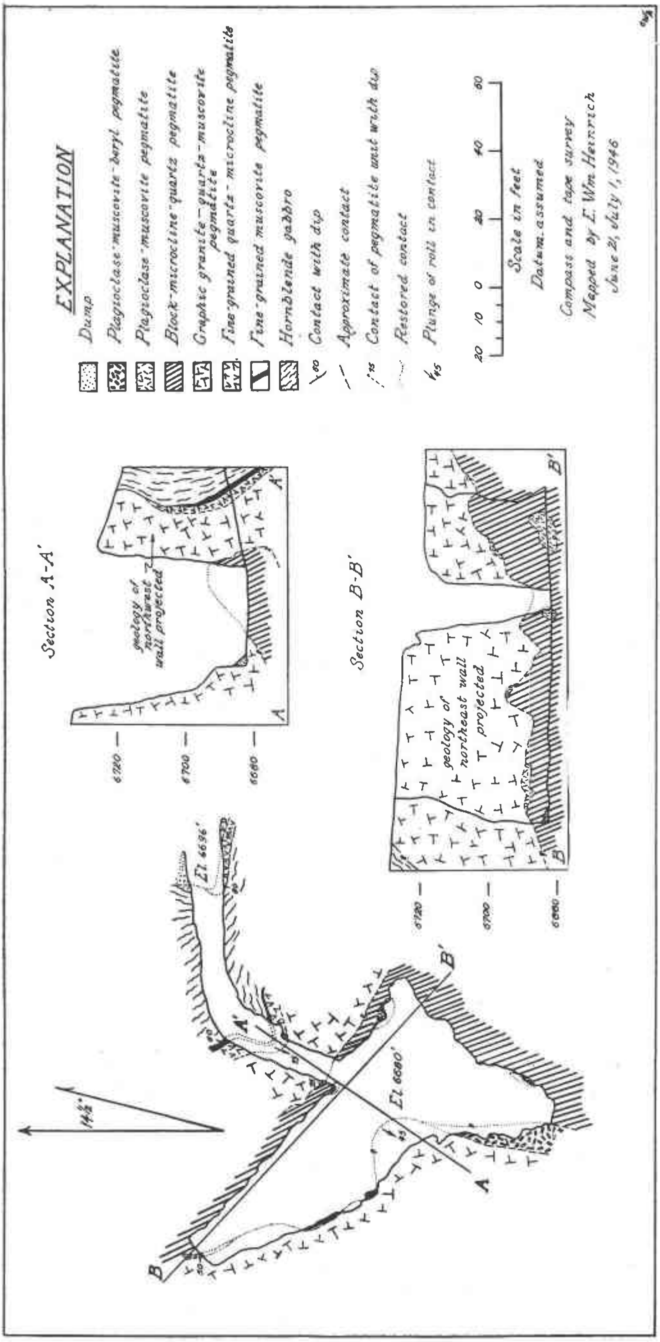

FIG. 21. No. 4 Cut, Meyers Quarry pegmatite.

Main Cut (Fig. 20), there is a thin selvage of muscovite books, $\frac{1}{2}$ to $1\frac{1}{2}$ inches in size, which tend to be normal to the contact.

The wall zone is generally discontinuous and somewhat more strongly developed along the footwall side. The rather uniformly fine-grained rock consists of quartz, microcline, and muscovite. Locally occur streaks and lenticular patches of somewhat coarser quartz and microcline as much as one foot wide and five feet long, parallel with the walls. The zone, which weathers to a pebbly surface, is resistant to erosion, and where well developed tends to crop out as a rib, four to five feet above the flanking schist and intermediate-zone pegmatite. The contact with the intermediate zone is not always easy to define, and commonly a gradation exists.

The intermediate zone, which forms the largest part of the body, is characterized by two petrologic phases: (1) a subgraphic to graphic microcline-quartz rock and (2) a quartz-muscovite rock. Locally graphic granite ("corduroy spar") becomes dominant and may grade into small masses of quartz-free microcline ("embryonic" cores). Other variations include a few scattered blocks of quartz-free microcline generally less than a foot on edge, small clusters of muscovite books four to five inches wide, a few crystals of black tourmaline and garnet, and uncommon blades of "tanglefoot."

The core, which is not a single continuous unit but a number of isolated pods of varying size, contains only massive quartz and crystals of microcline as much as four feet on edge. The largest of these core pods has been mined in the Main Cut and reportedly was unusually rich in microcline. It is a tabular lens whose hanging-wall contact dips 15–20° north and whose footwall dips 50° northward but flattens with depth. According to Mr. Meyers the lens was mined out downward and to the north. Below it lies pegmatite rich in "ball" mica and plagioclase, a footwall replacement unit. Part of this unit is exposed on the walls of the cut.

Another large core pod, somewhat more irregular in shape, was quarried in the No. 4 Cut (Fig. 21). Much good quality microcline remains on the southeast side of this cut, but overhanging walls would make its removal hazardous. Along the west side of the core is a large mass of "ball" mica and sodic plagioclase that dips beneath the core. On the core side of this unit, tapering beryl crystals, as much as 12 inches long and five inches across, are abundant. They tend to lie normal to the contact between the two rock types, with the larger end embedded in the core.

On the crest of the ridge between the No. 4 and the West Cuts another core pod crops out, but it has not been prospected, although some coarse microcline is exposed. A number of smaller core pods occur both east and west of the three main openings. Those to the east are quartz-rich, and those in the western part are very small but are important because they overlie and have localized cleavelandite-lepidolite pegmatite (Fig. 22).

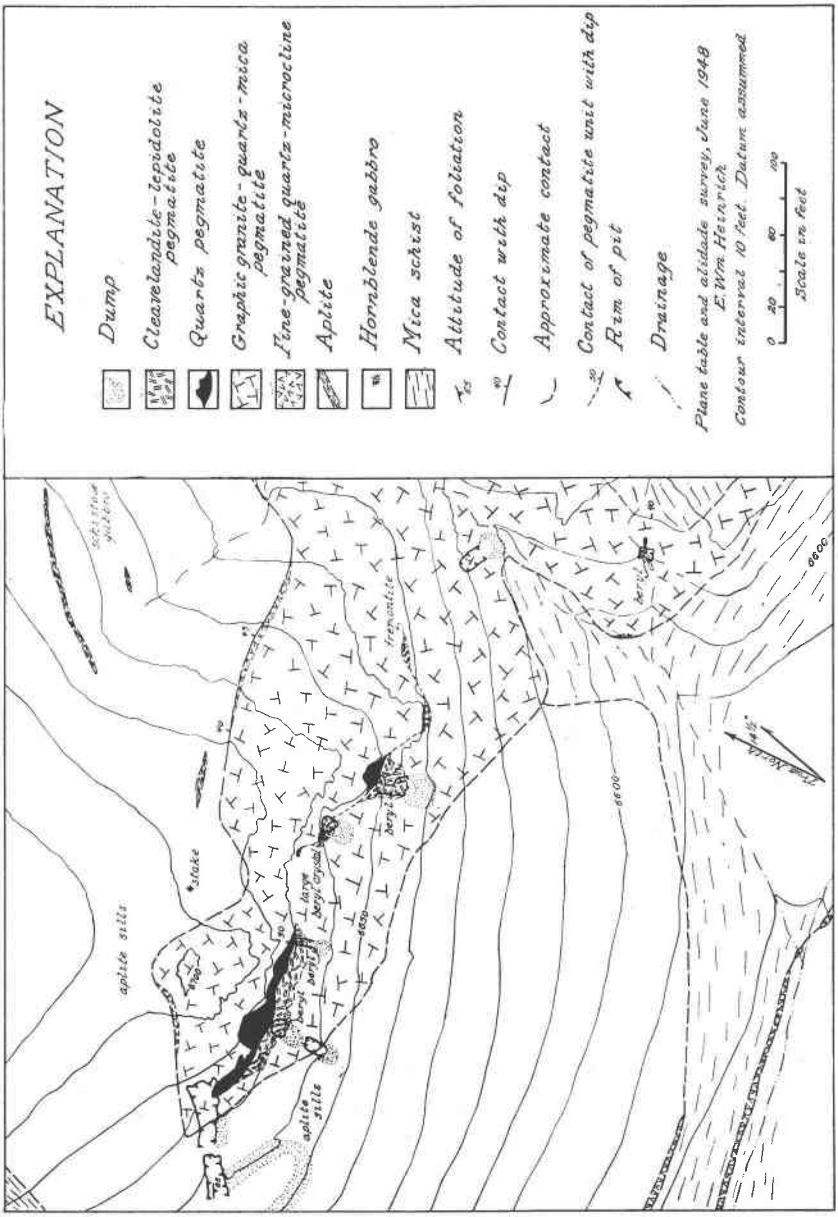

FIG. 22. Western part of Meyers Quarry pegmatite.

These pods dip moderately northwestward in conformity to the general pegmatite dip.

The footwall core-margin units in the Main and No. 4 Cuts consist chiefly of red oligoclase and muscovite. The latter mineral occurs most abundantly in unoriented flaky aggregates ("ball" mica), but tabular bodies of large wedge-shaped blades in comb structure are also common, especially directly along the core contacts. Locally within the cores, microcline has been replaced by small irregular masses of "ball" mica. Plagioclase-muscovite pegmatite is not confined to the footwall sides of cores but is developed only slightly along the hanging-wall contacts. Other minerals found in the units include: in the Main Cut, black tourmaline, garnet, and bismutite; in the No. 4 Cut, apatite, columbite (on dump), tourmaline, and garnet.

Lepidolite-cleavelandite pegmatite is restricted to the footwall margins of the small cores in the western part of the pegmatite. Pale pink to white cleavelandite, the chief mineral, occurs in curved bands and radiating clusters. Most of the lepidolite is in fine-grained flaky aggregates intergrown with quartz and albite. Locally garnet is very abundant, as are black tourmaline, muscovite, and beryl. Beryl occurs in crystals as much as $1\frac{1}{2}$ feet in diameter. Rarer constituents are the colored tourmalines and fremontite. Columbite and cerussite are reported. The replacement unit localized along the schist contact in the gulch (Fig. 22) is distinctly banded with layers of cleavelandite and of quartz and lepidolite.

CONCLUSIONS

The pegmatites are related in position, mineralogy, age, and origin to the batholith of Pikes Peak granite. They are granitic in composition, and red microcline is characteristic of both granite and pegmatite. The pegmatites are younger than the granite and the associated alplite dikes, but are older than the diabase dikes. Both aplites and pegmatites appear to have been intruded relatively shortly after the crystallization of the Pikes Peak magma. It is believed that they are late differentiates of this magma.

The pegmatites occur as three different types: interior, marginal, and exterior. Each type has its own characteristic shape, attitude, and internal structure. Interior and marginal pegmatites are generally lacking in hydrothermal mineralization, which reaches a peak in the larger exterior pegmatites.

The internal structural elements of the pegmatites are divisible into two groups: zones and secondary units. Zones, which formed first, resulted from the crystallization of the pegmatite magma in successive stages inward from the contacts. Slower cooling and consequent coarser texture attended the formation of the inner zones. The development of the larger crystals also may have been aided by a concentration of volatiles in the central parts of the bodies. Closed system conditions appear to have prevailed during this stage.

Superimposed on this zonal structure are secondary units of several

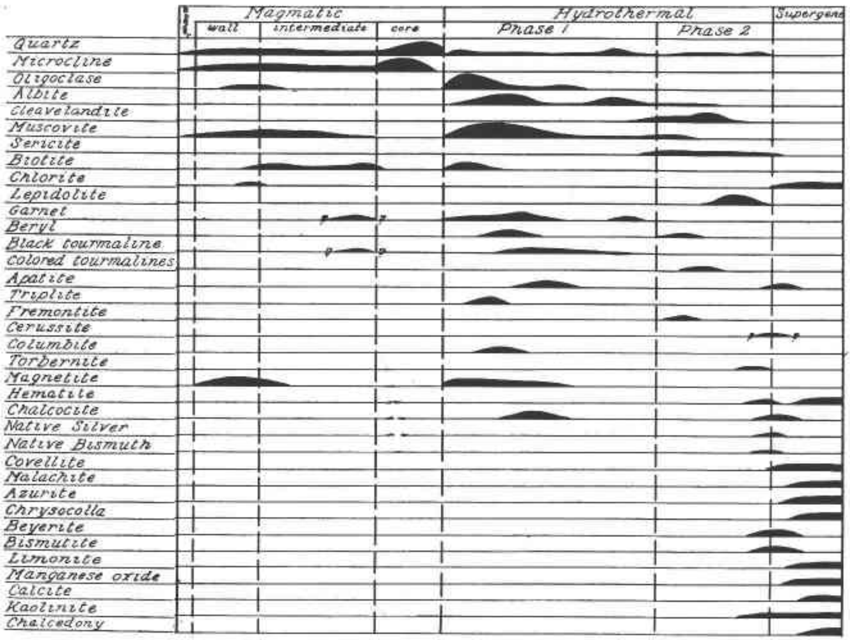

FIG. 23. Paragenesis of the pegmatite minerals.

types: fracture-filled veins, and fracture-controlled and zone contact-controlled replacement bodies. These units transect the zonal structure, cutting one or more zones and replacing parts of a single zone or of several zones. In many cases the guiding fissures can still be discerned; in others only a vague suggestion of fracture control remains. Replacement along the footwall contacts of cores is particularly extensive. Secondary structural units are believed to have formed by the replacement of crystallized zonal pegmatite by material carried by hydrothermal solutions. These solutions may represent further additions to the pegmatite from the original magmatic source (open system conditions) or they may be merely the offspring of the pegmatite magma itself, accumulated as residual, volatile-rich material during the development of the zones. The total amount of pegmatite formed by hydrothermal processes is very small, of the order of 1% of the total volume of pegmatite exposed in the district.

Two distinct hydrothermal phases are present. The earlier is characterized by abundant muscovite and red plagioclase (oligoclase-albite), and by less abundant garnet and black tourmaline. In its more intense aspects apatite, triplite, and beryl are common. Phase 2, which apparently is later, is almost entirely restricted to the western part of the Meyers Quarry pegmatite. It characteristically contains lepidolite, cleavelandite, and the colored tourmalines. Black tourmaline, garnet, and muscovite, which are more typical of the older phase, are corroded and partly replaced. The paragenetic sequence of the minerals is shown diagrammatically in Figure 23.

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