Mica Deposits of the Southeastern Piedmont

Part 2. Amelia District, Virginia

GEOLOGICAL SURVEY PROFESSIONAL PAPER 248-B

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By RICHARD W. LEMKE, RICHARD H. JAHNS, *and* WALLACE R. GRIFFITTS

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Distribution and structure of pegmatite bodies in the area, their mineralogical characteristics, and the economic possibilities of the mica and other pegmatite minerals

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PART 2. AMELIA DISTRICT, VIRGINIA

By Richard W. Lemke, Richard H. Jahns, and Wallace R. Griffitts

ABSTRACT

During 1943–45 eighty-three mica mines and prospects in the Amelia district of Virginia were examined by the authors as part of the United States Geological Survey's program of evaluating possible sources of strategic minerals.

The Amelia district is, like the rest of the Piedmont, an area of low relief. Most of the district is underlain by mica and hornblende schists and gneisses, which are intruded by granite, gabbro, and diabase. A large body of granite extends southward from Amelia into North Carolina, and smaller bodies occur in other parts of the district. The foliation of the metamorphic rocks strikes northeast and dips moderately to steeply northwest, but it is contorted or folded in places, especially near bodies of intrusive rock. All the rocks are deeply weathered.

Most of the pegmatites in the district are in a northward-trending belt 4 miles wide and 10 miles long. The northern part of the belt is termed the Jefferson-Amelia area; the southern part, the Morefield-Denaro area. The pegmatites in the Jefferson-Amelia area are relatively short lenses that strike east. Those in the Morefield-Denaro area are dikes, much longer than those farther north, that strike northeast. The pegmatites of both areas may be related to the Redoak granite of Laney, and the magma from which the pegmatite bodies crystallized was emplaced along fractures that cross the country-rock foliation. The pegmatites are well zoned, commonly having quartz cores, perthite-rich intermediate zones, and plagioclase-rich wall zones. Like other zoned pegmatites in the Southeastern States, most of the bodies crystallized from the walls inward after the magma was emplaced.

Mica is commercially the most important mineral; in the wall zones, where it may be associated with biotite, it occurs in books that average about 6 in. in diameter. Garnet, beryl, and tourmaline are widespread. The Rutherford and Morefield pegmatites in the Jefferson-Amelia and Morefield-Denaro areas, respectively, contain many accessory minerals, and the Champion pegmatite (Jefferson-Amelia area) contains several minerals in addition to the common ones.

The pegmatites at the Rutherford mine, as well as that at the Morefield mine, have been affected by deuteric or hydrothermal alteration, which resulted in the deposition of new minerals. The feldspar of the Champion pegmatite has been altered, but only moderate amounts of minerals were deposited, partly filling the corrosion openings.

Mica has been mined intermittently since the Civil War, and activity reached a peak during the period 1942–44. The yield of sheet from the crude mica is high, as is the quality of the prepared product. Only a few deposits yield stained mica. From June 1942 to January 1945, a total of 7,156 lb of sheet mica was obtained, 20 percent of which was of no. 1 quality. Although several deposits have been mined out, others have been only partly mined or not mined at all. The mines in the Jefferson-Amelia area have yielded at least two-thirds of the mica produced in the district.

Beryl, columbite-tantalite, and feldspar have been obtained from the Amelia district, and phenakite and topaz may be of commercial value.

INTRODUCTION: FIELD WORK AND ACKNOWLEDGMENTS

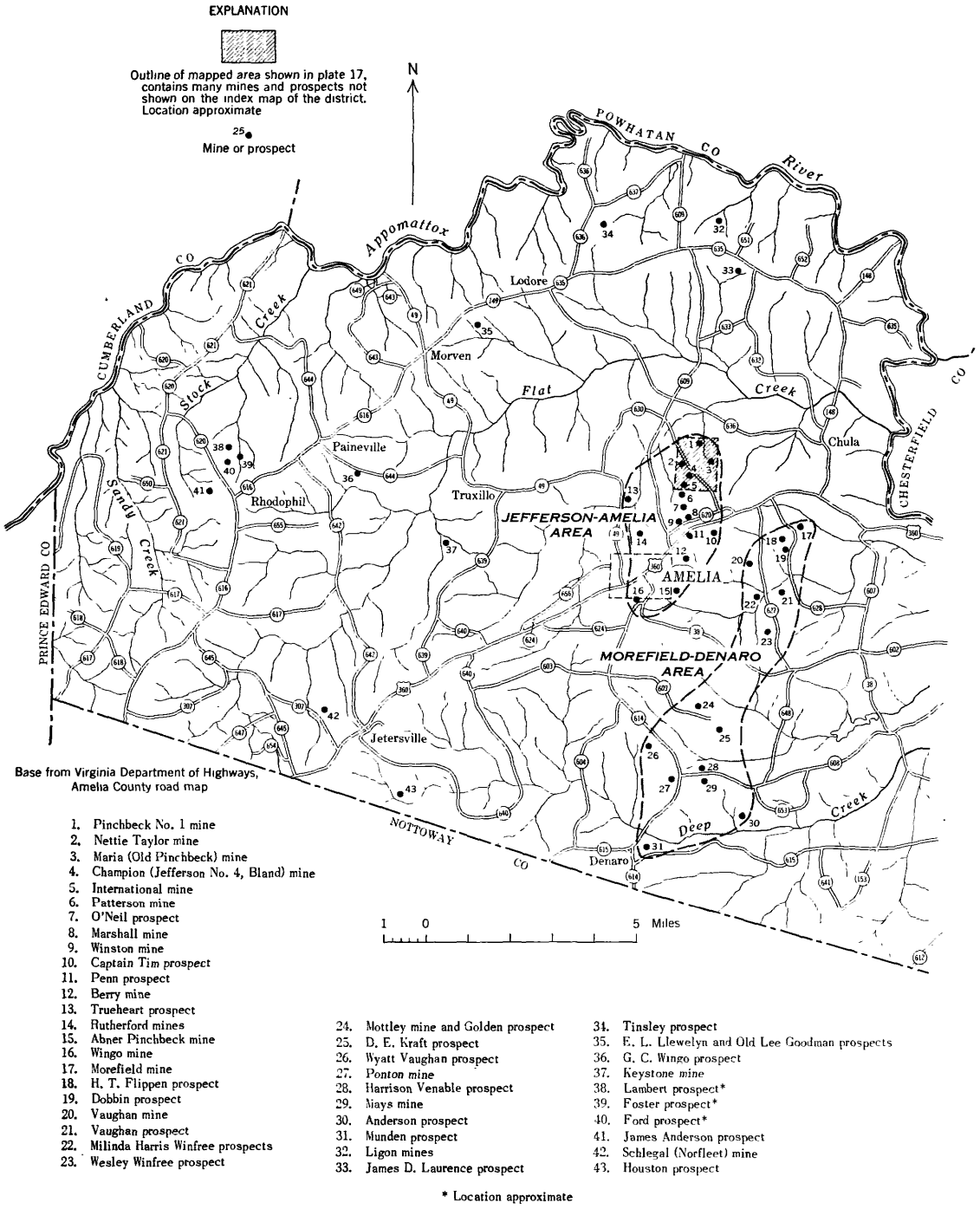
Investigations of mica deposits in the Amelia district were begun by the Geological Survey during the period 1912–15, when D. B. Sterrett examined about 20 deposits and prepared sketch maps of at least 7. The Rutherford and Morefield mines were visited by J. J. Glass and others in 1932, and the mineralogy of these pegmatites was studied in detail during subsequent years. L. R. Page briefly examined several mines and prospects in 1942, chiefly to determine their potentialities as sources of tantalum minerals. A program of systematic and detailed investigations of mica deposits was started by R. W. Lemke in 1943 and was continued intermittently until the fall of 1945 by Lemke, W. R. Griffitts, and R. H. Jahns. Capable field assistance during the earlier stages of the work was provided by J. H. Stillwell, R. L. Smith, Edward Ellingwood III, and Rosewell Miller III. In all, 40 mines and 43 prospects were examined, and 6 of the mines were mapped. Descriptions of 17 other deposits are based chiefly upon reports of Colonial Mica Corporation field engineers and the published record (Pegau, 1932, pp. 50–61; Sterrett, 1923, pp. 308–318). Parts of the Morefield deposit were sampled and systematic mineralogic studies of sample splits were made in the laboratories of the Geological Survey by J. J. Glass. Miss Glass also contributed many helpful mineralogic data.

The United States Bureau of Mines explored four deposits during the summer and fall of 1944. Trenches were excavated at the Morefield mine and two of the McCraw mines, and the Rutherford and Morefield deposits were diamond-drilled. Robert Hickman, engineer in charge of exploration, was uniformly cooperative throughout the investigations. A study of the mica-bearing pegmatites was made by W. R. Brown, of the Virginia Geological Survey, during the

period 1943–45, and this work was correlated with the other investigations to the fullest possible extent. Edgar B. Ward and Charles B. McFee, of the Colonial Mica Corp., gave generously of their time in locating deposits and providing helpful historical and geologic information. D. B. Sterrett, who operated several mines during the wartime period, also furnished much useful information and aided the Survey work in every way. The wholehearted cooperation of other mine owners and operators is acknowledged.

GEOGRAPHY OF THE DISTRICT

The pegmatite district is in Amelia County, near the eastern border of the Piedmont province. It occupies a roughly triangular area of about 150 sq mi (fig. 52), but most of the mica deposits lie within 4 miles of the



1. Pinchbeck No. 1 mine
2. Nettie Taylor mine
3. Maria (Old Pinchbeck) mine
4. Champion (Jefferson No. 4, Bland) mine
5. International mine
6. Patterson mine
7. O'Neil prospect
8. Marshall mine
9. Winston mine
10. Captain Tim prospect
11. Penn prospect
12. Berry mine
13. Trueheart prospect
14. Rutherford mines
15. Abner Pinchbeck mine
16. Wingo mine
17. Morefield mine
18. H. T. Flippen prospect
19. Dobbin prospect
20. Vaughan mine
21. Vaughan prospect
22. Milinda Harris Winfree prospects
23. Wesley Winfree prospect
24. Mottley mine and Golden prospect
25. D. E. Kraft prospect
26. Wyatt Vaughan prospect
27. Ponton mine
28. Harrison Venable prospect
29. Mays mine
30. Anderson prospect
31. Munden prospect
32. Ligon mines
33. James D. Laurence prospect
34. Tinsley prospect
35. E. L. Llewelyn and Old Lee Goodman prospects
36. G. C. Wingo prospect
37. Keystone mine
38. Lambert prospect*
39. Foster prospect*
40. Ford prospect*
41. James Anderson prospect
42. Schlegal (Norfleet) mine
43. Houston prospect

* Location approximate

FIGURE 52.—Index map of the Amelia district, Va., showing the location of the mica deposits.

town of Amelia. The general area is drained by northward- and eastward-flowing tributaries of the Appomattox River, which bounds the county on the north. Much of the country is gently rolling to nearly flat, with a maximum local relief of about 100 ft in some ravine areas. The altitudes around Amelia are near 300 ft.

About half the land is under cultivation, and most of the remainder is wooded. The main route of travel is United States Highway 360, which connects the district with Richmond, 38 miles east-northeast. Virginia Highways 38 and 49 cross the district from southeast to northwest, and a network of paved and graveled secondary roads provides access to many of the mines. Other deposits can be reached over unimproved roads. The towns of Amelia, Jetersville, and Chula are served by the Richmond-Danville line of the Southern Railway.

GEOLOGY OF THE DISTRICT

ROCK FORMATIONS

METAMORPHIC ROCKS

Most of the district is underlain by a complex series of gneisses and schists that are cut by both granitic and gabbroic igneous rocks. The chief metamorphic types are quartz-biotite schist, biotite augen gneiss, garnetiferous mica schist and gneiss, and hornblende schist and gneiss. These are shown on the geologic map of the State as Wissahickon granitized gneiss (Stose, Jonas, and others, 1928). Thinly foliated, dark-colored biotite gneiss and schist, apparently the most widespread types, commonly are interlayered with garnetiferous gneiss and augen gneiss. According to Pegau (1932, p. 17), gneissic phases occur as concordant tabular bodies that range in thickness from less than 1 to 500 ft, with an average of about 20 ft. Most of the biotitic rocks contain white to gray quartz, white feldspar, thin foils of muscovite, and minor hornblende and magnetite.

The biotite augen gneiss, termed quartz monzonite gneiss by Pegau (1932, pp. 20–22), is characterized by almond-shaped pods or "eyes" of feldspar 1½ to 2 in. long. Many consist of plagioclase and minor quartz, and others are single, poorly formed, thickly tabular crystals of plagioclase. The rock is well foliated, and much is distinctly schistose. It consists chiefly of feldspar and quartz, with flakes of biotite and muscovite, and minor garnet, magnetite, graphite, and hornblende. Lenticular masses and thin, irregular stringers of pegmatitic material are abundant. Pegau (1932, p. 22) suggests that the rock was originally a porphyritic biotite-quartz monzonite. As exposed in the district, it may well consist largely of igneous material, but much of it appears to have been derived from sedimentary structures, as bedding and conglomeratic layers are preserved in a few places. The original rock appears to have been impregnated and extensively replaced by feldspar and other minerals.

The garnetiferous rocks are light to medium gray where fresh, but they weather to a dark reddish brown. They are interlayered with the other metamorphic types and commonly grade into them, both along and across the strike. The garnet occurs as individual crystals and granular masses 1/64 to ½ in. in diameter and locally constitutes as much as 15 percent of the rock. It is violet to red and appears to be a member of the almandite-spessartite group.

Most of the hornblendic rocks are dark greenish gray and markedly schistose. Some are dense, fine-grained, and homogeneous, and others are much coarser, less homogeneous, and distinctly layered. All consist of light- to dark-green amphibole crystals, with minor feldspar, quartz, garnet, biotite, epidote, and magnetite. Many of the amphibole needles form flattened clusters or mats parallel with the layering in the rock. A typical specimen from a diamond-drill core near the Morefield pegmatite was examined microscopically by J. J. Glass, who notes the following constituents:

	Percent		Percent
Quartz	40	Apatite	3–5
Brown biotite	30	Orthoclase	2
Dark-green hornblende	20	Zircon	Trace
Sphene	5–7		

Some of the hornblendic rocks may be metamorphosed sills and dikes of intermediate to basic composition, but the origin of most cannot be determined.

A highly pegmatitized garnetiferous gneiss that contains appreciable quantities of flake graphite and minor sillimanite is exposed at several localities about 3¼ miles north-northeast of Amelia. Soapstone occurs 3½ miles northeast of Amelia, where it was mined extensively many years ago. The deposit trends N. 30° W. and appears to be not more than 75 ft thick. Most of the rock is covered by overburden.

IGNEOUS ROCKS

The chief igneous rock in the district is the Redoak granite of Laney (Stose, Jonas, and others, 1928), which forms northward-trending prongs south, southeast, and southwest of Amelia. Most of the rock is a fine- to medium-grained biotite-quartz monzonite, but some porphyritic facies are present. It is distinctly foliated and in places contains abundant partly digested inclusions of hornblende-rich and biotite-rich schists and gneisses. A dark-colored dioritic igneous rock is exposed near several of the mica deposits in the western and southwestern parts of the district.

Pods, thin conformable stringers, and irregular masses of pegmatite occur in the granite and diorite, as well as in all the orthogneisses and metasedimentary rocks. Larger mica-bearing pegmatite pods and dikes also are present. Both pegmatites and the enclosing rocks are transected by diabase dikes of probable Triassic age. They range in thickness from a few inches to at least 10 ft, and most are nearly vertical. Where fresh, the rock is greenish black to black, but it weathers to shades of light brown and light to dark greenish brown and can be easily mistaken for weathered gneiss. Plagioclase, the most abundant mineral, occurs as intergrown laths ½ to 1 mm long. Colorless to brownish-green augite is the chief interstitial mineral.

STRUCTURE

The foliation and layering in the metamorphic rocks generally strike northeast and dip moderately to steeply northwest in the district, but locally the rocks are folded or markedly contorted on a small scale. Zones of crenulation and irregular folding are especially abundant near contacts with the largest pegmatite masses and with the prongs of the Redoak granite of Laney. Among the few broader folds that have been observed are a syncline at the Maria mine and an archlike flexure in the side of the large slumped pit at the Champion mine.

Most of the rocks are deeply weathered, and exposures are poor. Unaltered country rock was exposed only in the lower parts of the Champion, Morefield, Rutherford, and Nettie Taylor mines. The pegmatites themselves are thoroughly weathered near the surface, and complete kaolinization of their plagioclase extends to depths of 70 ft or more in several of the mines.

DISTRIBUTION AND OCCURRENCE OF THE PEGMATITES

Most of the mica-bearing pegmatites in the Amelia district occupy a north-south belt about 4 miles wide and 10 miles long (fig. 52). This belt is divisible geographically and geologically into the Jefferson-Amelia area and the Morefield-Denaro area. The Jefferson-Amelia area is oval in plan and about 2½ miles in maximum width; it extends north-northeastward from Amelia for a distance of about 4 miles. It includes about 50 mines and prospects. The Morefield-Denaro area, which includes at least 18 mines and prospects, is 1 to 3 miles wide and about 9 miles long. It lies east and southeast of Amelia (fig. 52). At least fifteen other deposits are scattered through the part of the district that is north, west, and southwest of Amelia.

Most of the pegmatites in the Jefferson-Amelia and Morefield-Denaro areas are enclosed by micaceous schists and gneisses, chiefly quartz-biotite schist. Layers of hornblendic schists and gneisses have been observed in five mines, as well as in diamond-drill cores from the Rutherford and Morefield deposits. Most wall-rock exposures are so small and the rocks so thoroughly weathered that many amphibole-bearing rocks in the vicinity of the mica deposits may have escaped detection. Distinctly foliated diorite with minor lenses of gneissic granite is said to enclose parts of the Schlegal and Keystone pegmatites, west and west-southwest of Amelia. These rocks may be parts of the complex of the Redoak granite of Laney.

STRUCTURAL FEATURES OF THE PEGMATITES

JEFFERSON-AMELIA AREA

Most of the mica deposits in the Jefferson-Amelia area strike east, or nearly normal to the trend of the pegmatite belt. They are distinctly discordant, dip steeply, and tend to pinch out at depths of 125 ft or less. Most are 5 to 25 ft in maximum thickness, less than 250 ft long, and lenslike or podlike in shape. Several, like the McCraw No. 2 and McCraw No. 3, are forked near one end. The contacts with the wall rock are generally sharp and regular, but some deposits are complicated by major branches (Champion) or abundant small, irregular apophyses (Rutherford No. 2). In the northern part of the area, many deposits are closely spaced in well-defined groups. They are arranged en echelon in plan and possibly in section as well.

Most of the pegmatite bodies are distinctly zoned, with cores of massive quartz. Some of the cores are thick pods, others are thinly tabular, and still others comprise many individual lenses. The wall zones are characteristically rich in medium- to coarse-grained plagioclase, chiefly albite, with interstitial quartz and subordinate mica. Many of the deposits contain irregular and discontinuous intermediate zones of coarse, blocky perthite, some of which encloses graphically intergrown quartz. The wall zones of such deposits commonly contain appreciable quantities of potash feldspar. Other deposits, however, are virtually perthite-free. The border zones are thin and discontinuous and comprise fine- to medium-grained quartz, plagioclase, and abundant biotite and muscovite flakes.

MOREFIELD-DENARO AREA

Most of the pegmatite bodies east and southeast of Amelia differ structurally from those in the Jefferson-Amelia area. They are characteristically long and continuous, and strike lengths of a thousand feet or more are not uncommon. Relatively few bodies are known to taper out downward in existing mine workings, and diamond drilling of the Morefield dike has demonstrated a downward continuity of 200 ft or more. Nearly all the deposits are sharply discordant, and their

walls are remarkably straight and regular. They trend north-northeast to due east, and most trend east-northeast to nearly east. In general the pegmatite bodies appear to have been emplaced in at least two sets of persistent fractures, but a few are complicated by thin apophyses. Many of the branches are sill-like, but others are discordant and extremely irregular.

Nearly all the Morefield-Denaro deposits contain persistent cores of massive quartz with or without minor blocky perthite. Some of these units are very thick. Intermediate zones rich in coarse, blocky perthite are present in several deposits. The wall zones are characteristically rich in plagioclase, with minor interstitial quartz and muscovite. Conspicuous biotite-rich border zones ½ to 5 in. thick occur in most of the deposits.

The outlying deposits range in shape from long, continuous dikes to steeply plunging elongate lenses. Those worked in the Ligon and Keystone mines are pipelike.

MINERALOGICAL FEATURES OF THE PEGMATITES

SIMPLE PEGMATITES

Most of the pegmatites consist chiefly of plagioclase, quartz, and perthite, with subordinate muscovite and biotite, and accessory garnet, beryl, black tourmaline, and apatite. Cassiterite, tantalum minerals, allanite, sulfides, and rare-earth minerals occur in several deposits but in general appear to be very rare.

Milky to glassy and gray quartz ordinarily forms the cores of the pegmatites, and it occurs interstitially in the outer zones as well. Some of the cores contain cavities lined with prismatic crystals of clear to smoky quartz. Others are distinctly granular and sugary and do not appear to be vuggy. Some deposits are transacted by veinlets of light-gray to dark smoky quartz.

Most of the plagioclase ranges in composition from sodic oligoclase to median albite. It is characteristically the dominant constituent of the wall zones, but it also occurs as scattered blocky masses in the perthite-rich intermediate zones of some deposits. Perthite apparently is rare in some pegmatites, but in others it is abundant as large, blocky masses that form irregular but well-defined intermediate zones. Much of the potash feldspar contains graphically intergrown quartz, but many large masses are virtually quartz-free. Well-formed perthite crystals are scattered sparsely through some cores.

Book muscovite is most abundant in the wall zones. Small books and flakes occur with biotite in the border zones of many deposits, and aggregates of small books fill fractures in the cores and intermediate zones of others. Late-stage pale-green to yellow muscovite and sericite are widespread and are particularly abundant along shear planes and cleavage cracks in feldspar crystals. They occur principally as scaly aggregates.

The only abundant accessory minerals are garnet, beryl, and possibly tourmaline. Salmon-colored to deep-red garnet occurs in the border zones and wall zones of most deposits. Black tourmaline also is present in these units, as well as in and along the margins of some of the cores, where it forms rosettelike clusters. Beryl is most abundant along the margins of quartz masses, especially in the pegmatites of the Morefield-Denaro area, and well-formed crystals occur within the cores of some deposits, notably the Champion and Vaughan. Most of the beryl is pale yellowish green to blue green, and few of the crystals contain large quantities of intergrown quartz. Sulfide minerals, tantalum-columbium minerals, apatite, cassiterite, and other accessory species are very rare. Most appear to be late-stage constituents.

The plagioclase and some of the perthite in the near-surface parts of the deposits have been altered to kaolin. Limonite, manganese oxides, and mammillary incrustations of goethite and marcasite also appear to have been formed during the weathering of the pegmatites. A little vermiculite appears to have been developed at the expense of biotite.

PEGMATITES OF COMPLEX MINERALOGY

At least four pegmatites have been markedly affected by deuteric or hydrothermal alteration and are mineralogically very complex. These are the Champion, Rutherford No. 1, and Rutherford No. 2 pegmatites in the Jefferson-Amelia area and the Morefield pegmatite in the Morefield-Denaro area. All four are distinctly zoned, with cores of massive quartz, plagioclase-rich wall zones, and border zones that contain much muscovite and biotite. All but the Champion contain well-developed perthite-rich intermediate zones. The mineralogic complications of corrosion and replacement after consolidation have been superimposed upon these zones, which originally must have been similar to those in most of the other pegmatites in the district.

In the Champion pegmatite, the least complex of the group, extensive corrosion of wall-zone albite was followed by deposition of yellow to green flaky muscovite, thinly tabular sodic albite, thin plates and equant rhombohedra of calcite, sulfide and arsenide minerals, and several other species. Though widespread, these late-stage constituents form a very minor part of the deposit as a whole.

Large parts of the Rutherford No. 1, Rutherford No. 2, and Morefield pegmatites have been extensively albitized. The highly sodic late-stage plagioclase occurs as sugary aggregates and as groups of coarse tabular cleavelandite crystals. Where it is a minor constituent of the pegmatite, its distribution is plainly controlled

by fractures in the host quartz and feldspar, but where albitization is more complete much evidence of structural control has been obliterated. Associated with the cleavelandite and sugary albite are muscovite, zinnwaldite, tantalite-columbite, microlite, beryl, phenakite, topaz, monazite, cassiterite, apatite, sericite, sulfide minerals, and other rarer constituents. Many of these are clearly younger than the adjacent albite crystals. Their relations are discussed in detail in the reports on individual deposits.

ORIGIN OF THE PEGMATITES

The pegmatites might be genetically related to the Redoak granite of Laney, which in general lies south of the district. Most of the granite actually ranges in composition from a quartz diorite to a quartz monzonite, and like the pegmatites it is rich in plagioclase and poor in mafic constituents. Most of the pegmatite bodies appear to have been emplaced along well-defined fractures or groups of closely spaced fractures. The structure of the country rock appears to have had little effect on the distribution and shape of the deposits, although many apophyses conform to the country-rock structure.

The deposits are similar to nearly all the other zoned pegmatites in the Southeastern States in that they appear to have crystallized from the walls inward, with early development of coarse plagioclase and commonly with later crystallization of perthite. Quartz was formed throughout the period of consolidation and was the dominant constituent during the end stages. Much of the book muscovite probably was developed during the early and intermediate stages. Garnet and biotite are early constituents, but beryl was formed during and immediately before crystallization of the cores. Phenomena occurring after consolidation include extensive albitization in three deposits and corrosion of wall-zone plagioclase in a fourth, but no new supplies of magma seem to have been introduced after crystallization had started. Many rare minerals were developed in these four deposits after crystallization of the cores. Some of the evidences of albitization and of the deuteric or hydrothermal origin of some of the rare constituents have already been cited, and the problem is discussed in greater detail in the descriptions of the individual deposits.

ECONOMIC ASPECTS OF THE PEGMATITE MINERALS

MICA

Most of the book mica in the Amelia deposits occurs in the wall zones and is concentrated particularly near their inner margins, along contacts with intermediate zones or cores. Some books are concentrated near the wall-rock contacts. In the Morefield and Rutherford deposits small but thick books occur with albite in the perthite-rich intermediate zones and quartz cores. Their distribution appears to have been governed by fractures in the host rock.

Most of the mica books are 6 in. or less in diameter, but books 12 in. in diameter and 6 in. thick are not uncommon and several as much as 4 ft long, 2 ft wide, and 1½ ft thick have been mined from deposits in the Jefferson-Amelia area. The mica tends to be hard, flat, and free splitting. Its chief defects are clay stains, fractures, and hair cracks. Warping, lockiness, ruling, "A" reeves, and softness are widspread but of minor quantitative significance. Most of the books are clear and brown to brownish olive, but several of the deposits at the western edge of the district contain heavily stained green mica.

The mines in the Jefferson-Amelia area have yielded more than two-thirds of the sheet mica produced in the Amelia district. Several have been well-known sources of exceptionally large, flat sheets. In general the quality of the Amelia mica is very good. The mine-run books from most of the larger mines have yielded 3 to 20 percent trimmed punch and sheet material, with an average of nearly 10 percent.

OTHER MINERALS

Beryl is a common accessory constituent in many of the Morefield-Denaro pegmatite dikes and also occurs in minor quantities elsewhere in the district. It is especially abundant along the margins of quartz cores, and it occurs within the cores of several deposits. Most forms light-green to greenish-blue prismatic crystals ¼ to 18 in. in diameter and 1 in. to 3 ft long. A few exceptionally rich concentrations might be profitably mined on a small scale, but the reserves of such pegmatite appear to be small. The beryl in most deposits probably is economically recoverable as a byproduct only.

Manganotantalite, tantalite, columbite, and microlite are moderately abundant in the Morefield, Rutherford No. 1, and Rutherford No. 2 deposits and are minor constituents of the Champion pegmatite. They are very rare in the deposits that have not been albitized or otherwise modified by late-stage solutions. They occur as crystals and irregular masses, chiefly in cleavelandite-rich parts of the deposits. Few large bodies of pegmatite contain concentrations of tantalum minerals richer than 2 lb per ton. Tantalum-bearing placer and dump materials have been observed at the Morefield and Rutherford mines.

Phenakite, topaz, and possibly cassiterite are of potential economic interest in the Morefield and Rutherford No. 1 and No. 2 deposits, but the total amounts

present appear to be small. Mineral specimens and gem garnet have constituted an economically significant part of the output from the Morefield and Rutherford mines.

Coarse blocky perthite is abundant along or around the quartz cores of several pegmatite bodies, notably the Maria, Buck Pinchbeck No. 1, Pinchbeck No. 1, Rutherford No. 1 and No. 2, Abner Pinchbeck, and Morefield. Several of the deposits have been worked chiefly for feldspar, with mica as a byproduct. Moonstone (translucent albite) has been obtained from the Rutherford mines, and cleavelandite specimens and much gem amazon stone from the Rutherford and Morefield mines.

MINING

HISTORY

Mica mining in Virginia was started shortly after the Civil War, and the Champion mine was one of the first to be opened. The Berry, McCraw, Rutherford, Winston, and Schlegal mines were opened soon after 1873 (Watson, 1909, p. 104). Considerable quantities of stove mica were produced during the period 1885–1900, when at least 12 mines were in operation. Many of those in the Jefferson-Amelia area also were worked between 1910 and 1915 and from 1918 to 1920. The Morefield and Rutherford deposits were worked during the period 1927–33, but most operations in the district between World War I and World War II were intermittent and on a small scale. Stimulated by the high price schedules of World War II, many owners and lessees reopened old mines and developed new deposits. During the period 1942–44 at least 55 deposits were worked, but all were abandoned by June 1945.

MINE WORKINGS AND MINING METHODS

Nearly all deposits in the district were opened by means of trenches, shallow pits, and cuts. Book mica was easily recovered from the soft, kaolinized pegmatites, but much was badly clay-stained. Some mines, like the Rutherford No. 2 and the Morefield, were extended downward or along the strike of the pegmatite bodies by open-cut methods, but the operators of most were forced to sink shafts or drive adits to avoid serious slumping of the soft walls of surface workings. Relatively few of the mines were developed extensively in hard rock, and, even in these, operations were hindered by the caving of weathered and broken ground from older, shallower workings. A heavy flow of water has been a serious problem in almost all operations.

PRODUCTION

Production of sheet and scrap mica from the district is said to have been substantial during the period 1880–1915. The output from the Rutherford, Champion, McCraw, Patterson, and Schlegal mines may well have constituted as much as 700,000 lb of mine-run mica and 45,000 lb of trimmed sheet mica. In contrast, the production of trimmed sheet and punch mica during the wartime period June 1942 to January 1945 was 7,156 lbs. Most was obtained from the Champion mine, and 92 percent of the total comprises the outputs of the Champion, Ligon, Morefield, and Rutherford mines. The quality of the mica was very good, with 20 percent classed as no. 1, 60 percent no. 2, and 20 percent no. 2 inferior. Byproducts included scrap mica, beryl, tantalum minerals, and potash feldspar.

FUTURE OF THE DISTRICT

Mining operations during World War II clearly demonstrated the podlike or lenslike shape of many deposits in the district, particularly those in the Jefferson-Amelia area. Several men reopened old mines at considerable expense, only to find that the deposits were essentially worked out. Other mines, like the Champion, yielded substantial quantities of mica from relatively small unmined parts of the deposits and from pegmatite pillars and "skims" in old workings. Despite the discouraging results of some of the recent mining ventures, it seems likely that reserves of mica-bearing pegmatite might be effectively blocked out by diamond-drill holes aimed at parts of the deposits only short distances beyond or below known old workings. Such pegmatite might then be mined from new shafts sunk in the adjacent country rock.

The deposits of the Morefield-Denaro area have been less extensively explored than those in the Jefferson-Amelia area and hence might well merit additional attention. Most are noteworthy in that they are continuous. Considerable reserves of pegmatite, some of which contains coarse feldspar, mica, and other minerals in potentially economic concentrations, have been blocked out by diamond drilling and trenching in the Morefield deposit.

In all parts of the district there are many pegmatite that have not been opened or have been prospected on a very small scale only. Float fragments of mica and surface blocks of massive quartz attest their presence. Some may contain commercial concentrations of mica or other minerals. Several deposits that might not yield appreciable quantities of sheet mica are rich in blocky microcline and scrap mica. Some in the Jefferson-Amelia area contain substantial tonnages of pegmatite with 10 to 15 percent scrap mica, and several contain many tens to hundreds of tons of coarse potash and soda feldspar. Much of the feldspar is of high quality.

DESCRIPTIONS OF DEPOSITS

JEFFERSON-AMELIA AREA

PINCHBECK NO. 1 MINE

The Pinchbeck No. 1 mine, at the north end of the Jefferson-Amelia area (pl. 2), is essentially a slumped open-cut 130 ft long, 30 ft wide, and 35 ft deep. It is reported to have been opened about 1890 and was in operation in 1906. Kaolin of excellent quality is said to have been obtained from near-surface parts of the deposit. The mine was last worked in 1922, when operations were carried to a depth of 75 ft (Pegau, 1932, p. 56).

The vertical pegmatite dike, which strikes nearly east, is 12 to 18 ft thick in the cut and has a known linear extent of more than 300 ft. A 10 ft core of massive quartz is exposed at the east end of the cut, where it is flanked by a wall zone of medium-grained feldspathic pegmatite (probably rich in plagioclase). The central part of the dike in the west end of the cut consists chiefly of salmon-colored blocky perthite, which probably represents a discontinuous intermediate zone. Beryl and tantalite-columbite have been reported from the deposit.

Books of light brownish-olive flat-A mica, some of which are 12 in. in diameter and several inches thick, occur on both sides of the quartz core. They are badly clay-stained near the surface but otherwise are free splitting and of good quality. Books that yielded sheets as large as 12 by 14 in. are reported, but the average size of the trimmed material probably was about 4 by 6 in. The substantial production of apparently high quality mica from the deposit may warrant further exploration, particularly in that part of the dike that contains the massive quartz core. Some potash feldspar might be obtained as a byproduct from mica operations.

PINCHBECK NO. 2 MINE

The Pinchbeck No. 2 mine, about 900 ft southwest of the No. 1, is an oval pit 30 ft long, 12 ft wide, and 20 ft deep. The exposed pegmatite is a nearly vertical dike 10 ft thick. A thin quartz core in the west end of the pit is flanked by a wall-zone aggregate of fairly fresh perthite masses 6 in. or less in diameter, abundant finer-grained kaolinized plagioclase, and minor quartz. Mica is sparsely distributed throughout the wall zone and is concentrated near its outer margin, The books are green, small, badly contorted, and probably of little value except as scrap.

PINCHBECK NO. 3 MINE

The Pinchbeck No. 3 mine, 100 ft west of the No. 2, is a pit 20 ft long, 15 ft wide, and at least 10 ft deep. Its floor is choked with debris. Pegmatite is not exposed, but the work appears to have been done in the same dike as that in the No. 2 mine. Massive quartz blocks and light brownish-olive mica books as much as 4 in. in diameter may be seen in the dump.

PINCHBECK PROSPECTS

A prospect pit 15 ft in diameter was sunk in pegmatite about 440 ft north of the Pinchbeck No. 3 mine (location 1, pl. 2). None of the pegmatite is exposed, but about 150 lbs of "A" mica is on a nearby dump. A small pit 20 ft to the southwest has yielded mica of good quality, as shown by dump specimens. The material is light brown and free splitting, and some of the largest books should yield 4-by-4-in. sheets. The deposit appears to warrant further prospecting.

A third pit, which is about 860 ft west-northwest of the Pinchbeck No. 3 mine (location 2, pl. 2), was sunk in a small dike that consists mainly of quartz. The mining was done by Buck Pinchbeck for smoky quartz crystals, known locally as "black diamonds." Little mica can be seen.

A small pit (now filled) was dug in what may be the westward extension of the dike mined in the Pinchbeck No. 3 working (location 3, pl. 2), and many small books of mica are present in the dump. Mica books as much as 5 in. in diameter may be seen in the dump from a pit 200 ft to the southwest (location 4, pl. 2). The material is now weathered but appears to have been of fair to good quality.

McCRAW NO. 4 MINE

The McCraw No. 4 mine, which is on the west side of Winterham Road near the north end of the Jefferson-Amelia area, consists of an old pit 20 ft long and 15 ft wide. It has been filled to a level within 15 ft of the surface, but the size of the dump indicates that the workings are not extensive. Exposures of mica schist on the north and south sides of the pit limit the pegmatite dike to a thickness of less than 10 ft. It appears to consist chiefly of kaolinized feldspathic material. Glassy quartz boulders and scrap mica are fairly abundant on the dump. The mica is light brown and is marked by "A" structure. Near-surface books are soft and clay-stained.

About 40 ft to the east-northeast is a small, caved opening (location 5, pl. 2). Small mica books, chiefly of scrap material, are present in the dump.

ABNER MINE

The Abner mine is east of Winterham Road and southwest of the Pinchbeck mines (pl. 2). It was operated prior to August 1914 by the Virginia Mica Producing and Manufacturing Co. The workings comprise an open-cut 80 ft long, about 35 ft wide, and 25

ft deep; a 35-ft shaft that was sunk from the floor of the cut; and inclines that are reported to have been driven both east and west from the ends of the cut.

The country rock is a weathered biotite gneiss whose foliation strikes east to northeast and dips steeply north to northwest. The nearly vertical pegmatite body strikes east and appears to be podlike, with a maximum known thickness of 20 ft in the central part of the cut. It tapers to 6 ft in the east end of the cut and to about 10 ft in the west end. A large core of massive quartz is flanked by a wall zone of kaolinized feldspar and interstitial quartz.

The mica books, which are reported to have been moderately abundant, yielded clear sheets as large as 8 by 10 in. Much of the mineral, however, occurs as rough crystals that are so badly clay-stained that they are suitable for scrap uses only. The mica is light yellowish olive and of the "A" variety. The thickest part of the deposit appears to have been virtually mined out, but clear quartz and some scrap mica might be obtained in future operations.

Abundant scrap mica is present in the dump from a shallow pit 140 ft south of the mine (location 6, pl. 2), but no pegmatite is exposed.

PINE SHAFT MINE

The Pine Shaft mine, which is near Winterham Road and about 400 ft southwest of the Abner mine, was last operated in 1915 by the Virginia Mica Producing and Manufacturing Co. (formerly the Virginia Mica and Mining Co.). The workings comprise an open-cut, a 45-ft shaft, and a drift that extended N. 60° E. at the 40-ft level (Sterrett, 1923, p. 314). All have caved to form a depression 20 ft in diameter. No pegmatite is visible in place, but the dump material consists chiefly of unaltered perthite, kaolinized plagioclase, and yellowish-olive "A" mica.

The pegmatite dike strikes northeast in a highly contorted biotite gneiss whose foliation trends northeast and dips northwest. It is 3 to 10 ft thick and forks at the northeast end of the drift (Sterrett, 1923). Below the 40-ft level the rock is hard and little weathered. The mica is yellowish olive and occurs mainly as large "A" books, some of which are 13 in. in diameter. Ruling and clay and iron stains are serious defects. The proportion of acceptable sheet material that was obtained from the mine-run mica appears to have been small.

NETTIE TAYLOR MINE

The Nettie Taylor mine, which is about 360 ft southwest of the Pine Shaft mine (pl. 2), was last operated in 1943, when D. B. Sterrett deepened an old shaft from 36 to 85 ft and drove a crosscut 10 ft south from its bottom to intersect mica-bearing pegmatite. Two older drifts connected the shaft with a small pit to the east at the 30-ft level (fig. 53). Several tons of scrap mica was recovered during the recent mining, but very little production of sheet material is recorded.

The pegmatite dike is at least 80 ft long. It trends nearly east and dips about 75° S. in mica schist and augen gneiss whose foliation strikes N. 20° E. and dips 25° W. In the vicinity of the shaft the pegmatite is 10 ft thick and consists chiefly of a 5- to 6-ft quartz core and a flanking wall zone of kaolinized feldspar and fine-grained quartz. The keel of the deposit is exposed near the back of the Sterrett crosscut, where it appears to plunge about 15° W. It is broad and rounded in section. The border zone along the keel is a mat of small mica books with minor quartz, and the overlying wall zone is feldspathic.

Mica is exceptionally abundant in the drifts at the 30-ft level, where it occurs in feldspathic pegmatite within 2 ft of the core. The books are as much as 30 in. in diameter, but they are so soft, buckled, clay-stained, and cracked that they yield little material other than scrap. The color is yellowish olive, but some color-zoned books contain brown borders and greenish centers. Cinnamon-brown muscovite is present in and near the easternmost pit. A dark-brown mica that occurs in pegmatite near the shaft weathers like biotite, and in hardness, flexibility, and color it appears to be intermediate between biotite and muscovite. Future operations in the deposit, particularly near and along its keel, might result in the production of substantial quantities of scrap mica and possibly some sheet material as a byproduct.

Two prospect pits that were sunk between the mine and the road to the east (location 7 and 8, pl. 2) appear to have encountered mica of fair quality. Many small books are present in the dumps.

MARIA (OLD PINCHBECK, SMITH) MINE

The Maria mine is 3 miles north-northeast of Amelia and about half a mile north of the McCraw No. 3 mine (pl. 2). It was opened many years ago by one of the Pinchbeck brothers, who mined both mica and feldspar. During 1942 and 1943 it was worked intermittently for feldspar, scrap mica, and quartz by W. W. Howe. The openings include a pit about 40 ft deep and an irregular drift that extends westward from a point about 20 ft below the rim of the pit. Several small pits to the west have exposed an east-west pegmatite body for a strike distance of 300 ft (pl. 3).

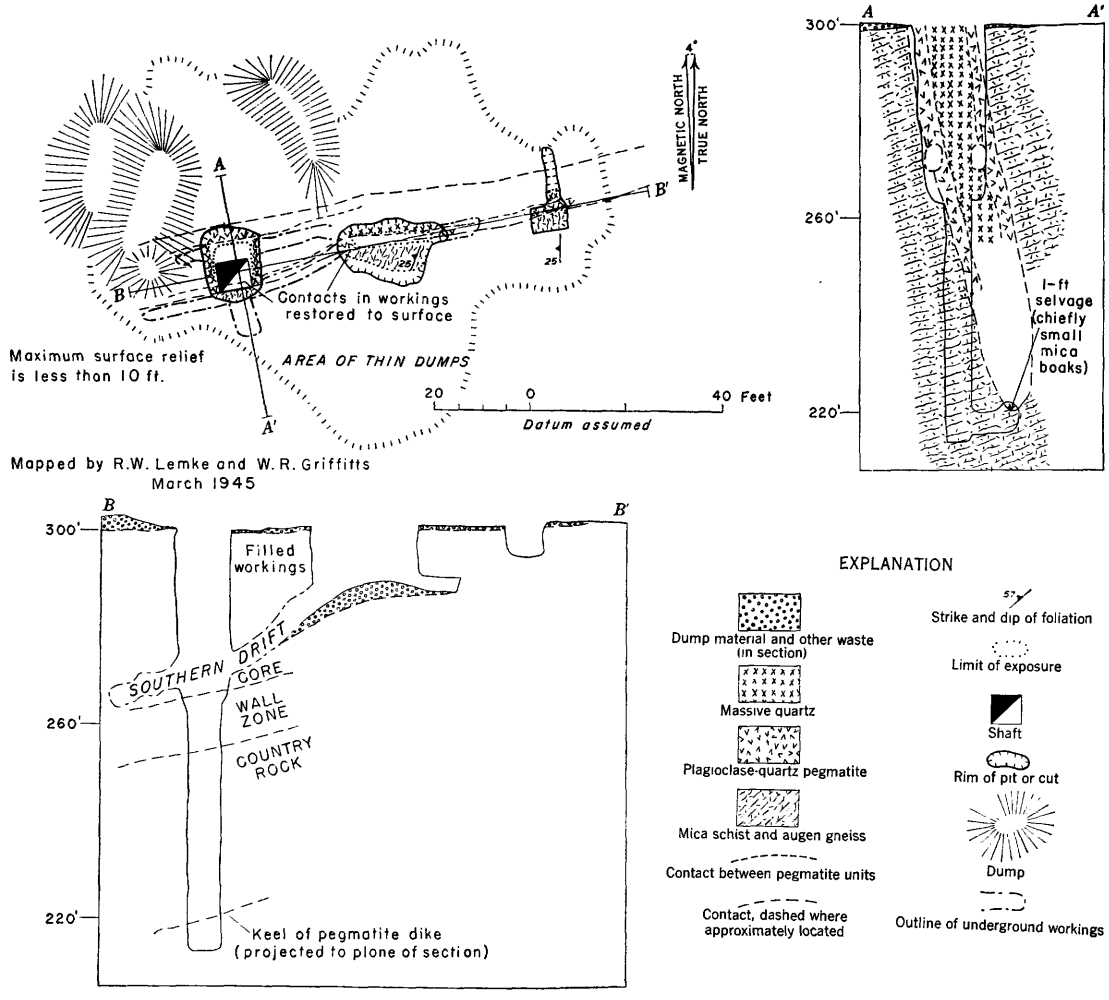


FIGURE 53.—Geologic map and sections of the Nettie Taylor mine, Amelia County, Va.

The country rock is kaolinized biotite gneiss. A 10-ft sill of schistose granite (not indicated on the map) is exposed in the east wall of the cut, and similar rock appears in the north wall of the drift 65 ft from the portal. It is fine- to medium-grained and consists of quartz, kaolinized feldspar, brown muscovite, and possibly garnet and biotite. Quartz plates $\frac{1}{20}$ in. thick and less than 1 in. long are oriented parallel with the contacts.

The pegmatite body is oval in outcrop plan. Its east end may extend beyond the ramp of the cut, and a large pegmatite bulge projects into the northeast corner of the cut. Thus the deposit appears to split eastward, with the space between the two branches occupied by an east-northeastward-plunging fold in country-rock gneiss. The pegmatite body as a whole may plunge very steeply eastward. At the west end of the pit it may be as much as 50 ft thick, but it thins westward and apparently pinches out about 100 ft beyond the pit. Abundant quartz float that occurs about 50 ft farther west may well have been derived from a second pegmatite body of similar shape and composition. On the other hand, it might represent a segment of the main body, if marked pinching and swelling are assumed.

The pegmatite is distinctly zoned. The core, in most places 2 to 10 ft thick, consists of massive quartz with a few scattered blocks of perthite. A long, flat-lying layer of quartz extends northward at the surface (pl. 3) and gives an exaggerated impression of the thickness of the core. The intermediate zone consists of blocky perthite with minor interstitial quartz. Well-faced crystals of feldspar project into the core, and others form spheroidal clusters along the north side of the core (fig. 54). One perthite crystal is at least 10 ft long and 6 ft wide. The intermediate zone thins westward in the drift north of the core and is not present in the short drift to the south.

The wall zone consists of medium-grained plagioclase and interstitial quartz, with scattered mica books and a few blocks of potash feldspar. Nearly all the plagioclase is kaolinized. Biotite flakes are moderately abundant near the walls of the deposit, where they are the

FIGURE 54.—Zonal relations in pegmatite, main pit of the Maria mine, Amelia County, Va. View looking west. *A*, Coarse, blocky perthite; *B*, Massive quartz; *C*, Plagioclase-quartz pegmatite; *D*, biotite gneiss; *E*, slumped material.

principal constituent of an indistinct plagioclase-quartz-biotite border zone. Contacts between pegmatite and wall rock are sharp and fairly regular, and a few gneissic inclusions occur in the pegmatite.

Mica occurs chiefly in rosettelike clusters along the inner margin of the wall zone. Many are 2 ft in diameter and contain books 4 to 10 in. across. Nearer the walls of the deposit the books tend to be smaller and to occur individually. Almost all the mica is of the "A" variety and of value as scrap only. It is light brownish olive to brown and commonly is soft and buckled. The perthite appears to be of good quality, but that exposed in the mine workings is friable as the result of slight weathering. The deposit might be successfully operated for feldspar, with scrap mica and possibly high-grade quartz as byproducts.

JEFFERSON NO. 7 (DERRICK PIT) MINE

The Jefferson No. 7 mine, which lies 420 ft south of the Nettie Taylor mine, is a pit 50 ft long and 20 ft wide. It has been filled to a level within 20 ft of the surface. The old workings were cleaned out by D. B. Sterrett in 1943, but little mica was obtained and operations were abandoned after a short period. The pegmatite dike is 1 to 5 ft thick and very irregular in shape. It strikes N. 80° E. and dips 70° N. in biotite gneiss that is impregnated with much pegmatitic material. The foliation is highly contorted in many places, but at the west end of the pit it trends N. 15° W. and dips 40° W.

A series of quartz pods that are 2 to 3 ft long represents the core of the deposit. These are surrounded by an intermediate zone rich in blocks of perthite as much as 10 in. in diameter. Many have well-developed crystal faces. The wall zone is an aggregate of kaolinized plagioclase and quartz. Nearly all the exposed pegmatite is stained by manganese oxides.

Sheet mica occurs sparingly along the margins of the quartz pods in books as much as 5 in. in diameter. It is flat and light brownish olive, but most is soft, ruled, cracked, and badly clay-stained. Nearly all the books are also stained by manganese oxides. The deposit appears to offer little promise as a source of sheet mica. Abundant small mica books on the dump suggest that some scrap material might be obtained, but the reserves of unmined pegmatite might not be large.

JEFFERSON NO. 6 MINE

The Jefferson No. 6 mine is on the west side of Winterham Road about 580 ft south-southeast of the Nettie Taylor mine. Book mica that yielded 4-by-6-in. trimmed sheets is reported to have been obtained from a pit 30 ft in maximum depth. The opening has since slumped to form a depression 80 ft long, 50 ft wide and 20 ft deep. No pegmatite is exposed, but the deposit is described by Sterrett (1923, p. 312) as a large lenticular mass probably 50 to 60 ft long and 25 ft thick. The wall rock is a decomposed garnetiferous gneiss. Scattered pieces of mica in the dumps are as much as 5 in. in diameter and are of fair to good quality. The material is yellowish olive to light brown, flat, and free splitting.

A prospect pit that was sunk 300 ft southwest of the mine (location 9, pl. 2) appears to have encountered no mica-bearing material, but much quartz float is present in the area. Abundant mica was taken from another pit 350 ft south-southeast of the mine and on the opposite side of the road (location 10, pl. 2). This opening is said to have been 25 ft deep but is now completely filled. Blocks of brownish-olive mica in the dumps are hard and free splitting, and some would yield trimmed sheets as large as 2 by 3 in.

JEFFERSON NO. 5 (FIELDS) MINE

The Jefferson No. 5 mine, which is approximately 1,400 ft east-southeast of the Nettie Taylor mine, comprises a 25-ft shaft and several prospect pits that were dug along the trend of the pegmatite body east of the shaft (locations 11, 12, 13, 14 and 15, pl. 2). It is reported to have been worked about 1912 by Booker Robertson, but no further mining was done until 1943,

when the old shaft was deepened and some additional prospect pits were sunk by D. B. Sterrett and the Champion Mining Corp. No sheet mica was obtained, and the project was abandoned after about 2 months of activity.

The vertical pegmatite dike, which strikes nearly east, consists of a fairly continuous quartz core and surrounding feldspathic material that is thoroughly kaolinized. The core is 3 ft in average thickness. The dike itself is about 10 ft thick and has been exposed for at least 250 ft along its strike. Brownish-olive book mica is fairly abundant in the feldspathic wall zone. The crystals are 4 in. in maximum diameter, and most are soft and badly cracked. Owing to the poor quality and general small size of the books, the deposit offers little promise for future production of sheet mica.

At least three pegmatite dikes may be seen on the ridge about 600 ft north-northwest of the mine workings. They consist chiefly of quartz in masses as much as 20 ft thick. The thin rinds of feldspathic material around these quartz cores were prospected on a small scale many years ago.

CHAMPION (JEFFERSON NO. 4, BLAND) MINE

The Champion mine, which is one of the oldest in the State, is on the west side of Winterham Road, about 1,100 ft south-southeast of the Nettie Taylor mine and 3 miles N. 35° E. of Amelia. It is said to have been operated by a Mr. Skelton shortly after the Civil War, at first by open-cut methods and later by stoping along the north wall of the deposit from a vertical shaft. During subsequent intermittent operations the Skelton shaft was deepened to at least 90 ft, and much mica-bearing pegmatite was stoped out. A second shaft was sunk near the south wall of the deposit by Benz Grindstaff about 1875.

In 1913 and 1914 J. Boyd Bland, of Richmond, deepened the Grindstaff shaft and mined rich mica concentrations in irregular stopes and tunnels. According to Sterrett (1923, pp. 310–311), the shaft was sunk 80 ft vertically and continued with a westerly slope of about 50° for a distance of 50 ft. About 200,000 lb of mica was removed during the Bland operations, and 15,000 lb of sheet material was recovered (Sterrett, 1923, p. 311). Twelve-inch sheets were cut from some of the largest crystals.

D. B. Sterrett leased the mine from Judge Garland Jefferson early in the summer of 1943 and shortly thereafter subleased it to the Champion Mining Co. and became superintendent in charge of operations. An exploratory shaft was sunk on the north side and near the west end of the deposit, but it was abandoned and filled when caving ground was encountered. The main Sterrett shaft was then collared at a point about 20 ft to the west and was sunk in country rock and minor pegmatite to a depth of about 100 ft (pl. 4). Stoping was extended eastward from its bottom, and large quantities of excellent sheet mica were obtained. Most of the mica-bearing rock was worked out, and the mine was abandoned in December 1944.

The pegmatite body, which is discordant, appears to be shaped like a lima bean, with numerous irregularities along its edges. It is nearly vertical, strikes N. 80° E., and has been traced for 120 ft along the strike and 112 ft down the dip. It is about 20 ft in maximum thickness and 5 to 10 ft thick near its edges, which tend to be blunt (pl. 4). The position of the west end of the deposit at and below the 80-ft level is known, but the east end lies beyond the workings from the Skelton shaft at this level (pl. 4). At the surface 2 ft of pegmatite is exposed in a small pit (location 16, pl. 2) 35 ft west of the Sterrett shaft, and the deposit probably extends eastward an appreciable distance beyond the Skelton shaft.

That the pegmatite body is very irregular in detail was demonstrated in the recent mining. A crosscut driven 25 ft southward from the Sterrett shaft at the 43-ft level penetrated 10 ft of pegmatite, but a second crosscut that was driven southeastward at about the 80-ft level encountered the keel of the deposit. The mean plunge of the keel in the vicinity of the shaft is moderately east, but it is complicated by at least three very irregular, westward-extending protuberances. Two of these were worked out during the deepening of the crosscut to the 98-ft level.

After the workings were connected with the stopes from the Skelton and Bland shafts, large quantities of waste were removed through the Sterrett shaft. A broad septum of schist separates the pegmatitic masses exposed in the two older shafts. Evidently the Bland shaft was sunk on an arm of the deposit that extends upward and southward from the main body. This arm may have plunged steeply west. The pegmatite penetrated in the upper part of the Sterrett shaft may be a somewhat similar arm on the north side of the body (section *B–B′*, pl. 4). The distribution of workings in the lower part of the mine is shown in section *A–A′* (pl. 4). The lowest known part of the deposit was mined out to leave a basin of schist about 25 ft long and 10 to 15 ft wide. A 1-ft layer of plagioclase-rich pegmatite dips gently westward from the west side of this basin.

The country rock in the mine area is mica gneiss and schist, with minor interlayered hornblende schist. Augen of feldspar and quartz are locally abundant and appear to be older than the main pegmatite body. Tourmaline and coarse foils of muscovite are locally common near the pegmatite contacts. The country-rock foliation strikes north to northeast and dips very steeply. An anticline about 30 ft across is exposed in

the large caved area east-southeast of the Sterrett shaft.

The deposit is well zoned. The 1- to 5-in. border zone contains medium-grained plagioclase (about Ab_{85}) and abundant scrap mica in books ½ to 1½ in. in diameter. Individual books and clusters of books tend to lie normal to the adjacent wall-rock contacts. The wall zone consists chiefly of white to creamy and greenish albite (Ab_{98}) in blocks 4 to 10 in. in diameter. The massive quartz core is 2 to 9 ft thick and at least 100 ft long and has been traced over a vertical range of nearly 100 ft. Its edges are blunt, like those of the pegmatite body itself.

The pegmatite consists of albite, quartz, and muscovite, with subordinate oligoclase, perthite, and sericite, and minor tourmaline, garnet, beryl, microlite, calcite, arsenopyrite, pyrochlore, scorodite, and allanite. Tantalite-columbite, monazite, zircon, galena, pyrite, and chalcopyrite are rare. Kaolin and marcasite are the principal supergene constituents. Although most of the feldspar in the deposit is sodic albite, median oligoclase is present locally along the walls and perthite occurs sparingly near the core. At the keel of the dike the oligoclase lies against the mica-rich border selvage as gray, semitransparent masses with an intense light-blue chatoyance. The core of the deposit consists almost wholly of gray and smoky quartz. Most is massive, but some large, clear crystals are present. Needles of tourmaline and beryl are locally abundant near the center and margins of the zone, and one cluster of large beryl crystals is said to have been encountered.

Coarse books of muscovite are most abundant in the inner 2 ft of the wall zone, and many are in contact with the quartz of the core. Scattered books also occur in the outer parts of the deposit, especially in the lower workings. Unusually well formed crystals line cavities in very coarse feldspar in the wall zone (fig. 55). Most of the vugs are 1 to 4 in. in maximum dimension, but a 12-in. opening lined with muscovite crystals as much as 4 in. in diameter and 1 in. thick was encountered in 1944 near the keel of the deposit. Some

FIGURE 55.—Muscovite crystals in vugs, Champion pegmatite, Amelia County, Va.

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FIGURE 56.—Corroded albite crystals, Champion pegmatite, Amelia County, Va.

cavity walls are crystal faces of the albite, but others are distinctly corroded. In general the openings are not unlike miarolitic cavities in coarse pegmatitic granites. Small, elongate prisms of quartz, tourmaline, and beryl are present in many of the vugs and in general appear to have been formed after the coarser muscovite but before or at the same time as the massive yellow sericite.

The albite in the outer 1½ ft of the wall zone is somewhat cellular, particularly in the upper mine workings. The openings, which are tabular, are 1/32 to ½ in. in minimum dimension, and some are as much as 5 in. long. Nearly all are parallel with cleavage directions in the coarse feldspar, and many are interconnected to form a striking boxwork structure that gives the crystals a skeletal appearance (fig. 56). Their distribution bears no consistent relation to the crystal faces of the coarse albite, and they appear to have been developed by cleavage-controlled corrosion of the feldspar, in contrast to the vugs that have been described. The walls of individual openings are coated with abundant yellow flakes of muscovite; compact, greasy, yellow masses of sericite; and scattered acicular crystals of tourmaline and beryl. Small, tabular to equant crystals of albite and thin hexagonal plates and equant rhombohedral crystals of calcite occur in some of the cavities. Scorodite, pyrite, galena, and chalcopyrite are rare.

Spessartite is widespread in the wall zone of the pegmatite but was not noted in either the vugs or the corrosion cavities. Octahedral crystals of microlite 1/64 to

1 in. or more in diameter are embedded in creamy to olive-green albite. Pyrochlore, monazite, zircon, and tantalite-columbite also occur in the wall zone, chiefly along or near contacts between quartz and feldspar crystals. The massive quartz and both the fresh and the partly kaolinized feldspar contain irregular fracture fillings and mammillary incrustations of marcasite, which evidently were formed during the weathering of the overlying pegmatite.

The mica content of the deposit was exceptionally high, particularly along the flanks of the core and near the keel. Individual books commonly range from 4 to 14 in. in diameter and from 2 to 10 in. in thickness. Some are distinctly larger, and one 700-lb book was obtained during the recent operations. The mica ranges from light brownish olive to cinnamon brown, and color-zoned books are abundant. In general they contain relatively dark brown bands and thin, pale-greenish rims. Sterrett states that the brown and green books occur together in the deposit. The brown mica is flat, hard, clear, free splitting, and of excellent quality. Some books are ruled, hair-cracked, and warped. In general the green mica is somewhat softer. The mine-run mica recovered during World War II is said to have yielded about 16 percent trimmed sheet material, nearly all of which was classed as no. 1 and no. 2 superior in quality.

Much of the deposit has been mined out. The Sterrett stope is known to extend downward to the keel between the Sterrett and Skelton shafts. A little unmined pegmatite remains at higher levels but is in or near loose, badly broken or caved ground. Most of the Skelton and Bland workings caved during January 1945 to form a large surface depression. Some mica-bearing rock remains in the deeper parts of the deposit east of the Skelton shaft. In a partly caved drift at about the 80-ft level the pegmatite is about 8 ft thick and contains moderate quantities of mica. This drift is now inaccessible, and its eastward extent is not known.

JEFFERSON NO. 3 (CHAMPION NO. 2) MINE

The Jefferson No. 3 mine is west of Winterham Road and about 1,200 ft S. 15° E. of the Champion mine. It was first worked prior to 1912, and extensive mining was done during the period 1913–15 by J. Boyd Bland, of Richmond. Operations during World War II were limited to the digging of a few prospect pits along the inferred eastward extension of the main dike. According to Sterrett (1923, pp. 311–312), the old workings consisted of a shaft about 60 ft deep, 200 to 300 ft of drifts and stopes, and several prospect pits. They were caved by 1915. The Bland workings comprise two shafts about 60 ft deep and 60 ft apart on a line trending northeast, as well as tunnels that were driven from them. One tunnel that connected the northeast shaft with the old shaft was abandoned because of caving ground. A second tunnel, which connected the two new shafts, was driven in part through old workings. Substantial quantities of mica are said to have been obtained during the operations.

The foliation of the country rock, a biotite gneiss that contains much granitic material, strikes northwest and dips southeast. The pegmatite dike strikes nearly east and may dip very steeply south. It contains many inclusions and septa of country rock and may be as much as 75 ft in maximum thickness. Most of the deposit is rather fine grained, almost like a coarse granite, but its central parts are much coarser and contain masses of white quartz several feet thick. All feldspars are thoroughly kaolinized in the deepest workings, which are at least 60 ft beneath the surface. Exposures of pegmatite in 1944 were limited to an eastward trending quartz mass about 10 ft thick that could be seen in two of the pits.

The book mica is segregated around the margins of the quartz masses. Two streaks were encountered (Sterrett, 1923, p. 312). One of these, found in the earlier workings, was reported to have been large; the other, which was mined near the north shaft, was locally large, but most of the books were small. Much of the pegmatite is nearly barren of mica. Small books and flakes are fairly abundant in some of the dumps. The mineral is light brown, flat, and of fair to good quality. The best material obtained during the Bland operations yielded 4-by-6-in. sheets. The mica-bearing pegmatite is reported to pinch out, both to the east and to the west; hence any future development might best be directed to down-dip parts of the deposit below the 60-ft level.

JEFFERSON NO. 2 MINE

The Jefferson No. 2 mine is on the east side of Winterham Road 300 ft due east of the Jefferson No. 3 mine. The oldest workings are several small pits, most of which probably represent caved shafts or drifts. Two other shafts were sunk by D. B. Sterrett early in 1943. From the bottom of the northwest shaft, which was 40 ft deep, a crosscut was driven 25 ft to the southeast, and a branch crosscut was driven 20 ft northeast from a point 12 ft from the shaft. The southeast shaft is about 30 ft deep. No mica-bearing pegmatite was found in any of these workings, and the two shafts were abandoned and filled. A small pit that was sunk northeast of the southeast shaft (location 25, pl. 2) also is partly filled.

A little pegmatite is exposed on the north side of one of the small, partly slumped pits. It consists chiefly of plagioclase, perthite, and quartz. Little mica

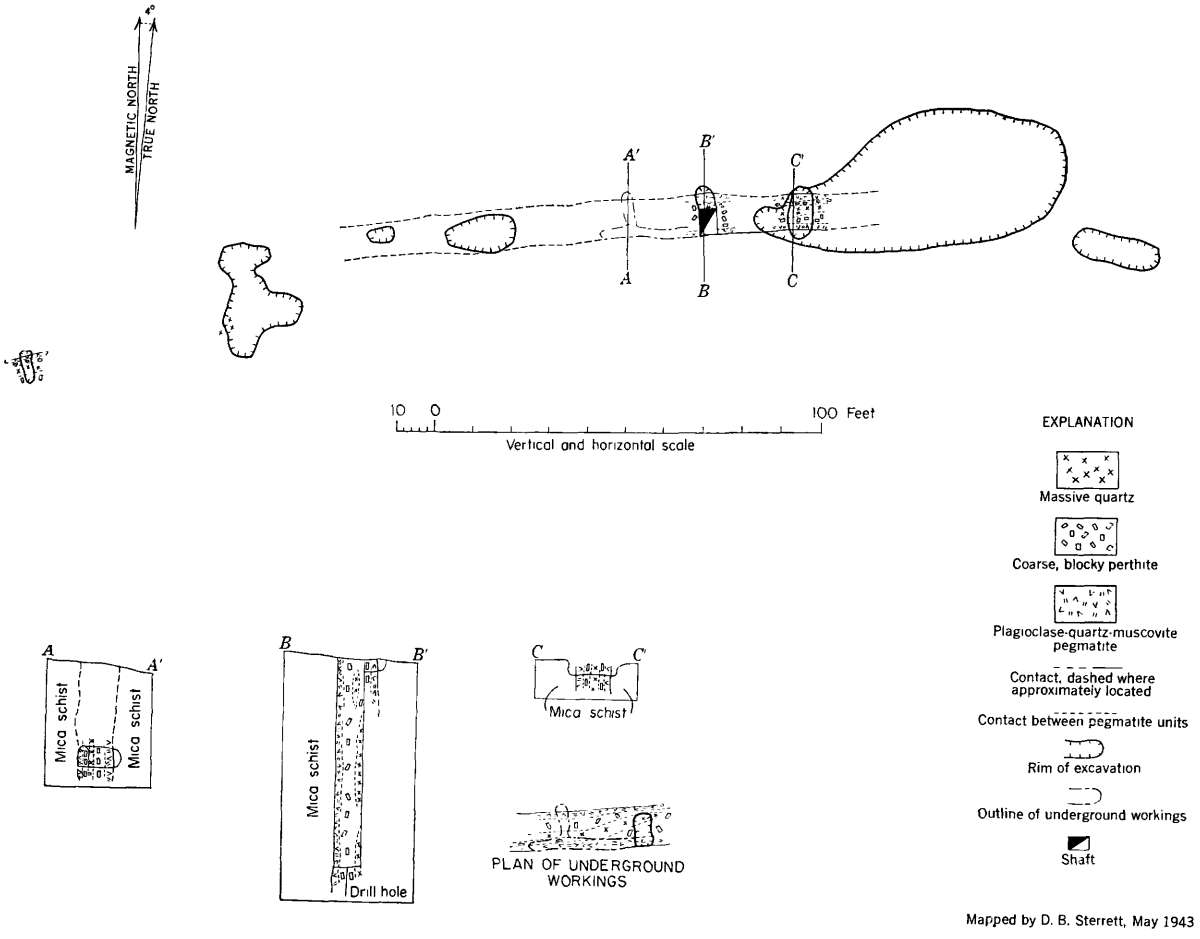

FIGURE 57.—Map plan, and sections of the Jefferson No. 1 mine, Amelia County, Va.

occurs in place, and greenish mica books are very scarce in the dump material.

JEFFERSON NO. 1 MINE

The Jefferson No. 1 mine is 400 ft east of Winterham Road and 2,100 ft southeast of the Champion mine. The old workings comprise several rounded pits along a line that trends nearly due east. Some of these were open-cuts, and others are the surface expressions of caved underground workings. The deposit was last worked for a few months during the summer of 1943 by the Champion Mining Corp. under the direction of D. B. Sterrett. A 58-ft shaft was sunk at the west end of an old cut that is 80 ft long, 30 ft wide, and 17 ft in present depth (fig. 57). A 26-ft drift was driven west from the shaft at the 30-ft level. All the workings are now caved.

The pegmatite body, which is a nearly vertical dike in biotite gneiss, is 9 ft thick in the drift. It contains a 4-ft core of massive quartz with scattered blocks of perthite as much as 4 ft in maximum dimension. The core is flanked by a zone of medium- to coarse-grained perthite with minor quartz. The wall zone consists of quartz and plagioclase. The pegmatite is partly decomposed at the level of the drift, but the material encountered below this level was an extremely soft mass of kaolinized feldspar (probably plagioclase) and abundant scrap mica. A vertical hole drilled from the base of the shaft demonstrated the presence of this soft material to a depth of at least 67 ft. The pegmatite body is also exposed in a small pit west of the main mine workings (location 29, pl. 2), where the quartz core is very thin.

Brown to brownish-olive book mica occurs sparingly along the contact between the wall zone and the perthite-rich intermediate zone. Most is soft and of poor quality. Dump material indicates that the wall-zone pegmatite at the bottom of the shaft contains 15 to 20 percent scrap mica. The mining of such material would require the pumping of a heavy flow of ground water and the handling of extremely soft muck.

JEFFERSON PROSPECTS

Several prospect pits have been excavated in the vicinity of the Jefferson mines. Most are so badly slumped that exposures are poor or lacking. Information concerning them may be summarized as follows:

Pit No. (pl. 2)	Location	Remarks
17	300 ft east of Champion mine	Small books of scrap mica in dump.
18	100 ft south of Champion mine	Apparently no pegmatite encountered.
19	400 ft east-northeast of Jefferson No. 2 mine.	Quartz abundant in dump; little mica present.
20 and 21	300 ft north-northwest of Jefferson No. 2 mine.	No pegmatite in place; scrap mica and quartz in dumps.
22, 23, and 24	On southwest side of Winterham Road between Jefferson No. 2 and No. 3 mines.	Thin pegmatite stringers exposed in biotite gneiss.
26	450 ft west-southwest of Jefferson No. 3 mine.	Underground workings have subsided to form depression 15 ft in diameter and 5 ft deep. Scrap mica and quartz in dump.
27	950 ft southwest of Jefferson No. 3 mine.	No pegmatite exposed in shallow pit 15 ft in diameter; hard, light-brown mica of fair quality in dump.
28	Immediately south-southeast of pit 27.	No pegmatite exposed in opening 12 by 28 ft in plan and 5 ft deep; scrap mica in dump.

McCRAW NO. 3 (OLD PINCHBECK NO. 1) MINE

The McCraw No. 3 mine, which is about 350 ft east-southeast of the Jefferson No. 1 workings, was opened about 1910. After a 30-yr period of idleness, it was reopened and worked by the Champion Mining Corp. for about 2 months. Muck was removed from an open-cut 125 ft long, 40 to 70 ft wide, and 25 to 30 ft deep, and a drift was driven 20 ft east from the end of the cut. Operations were abandoned when a dike of what appears to be altered diabase was encountered in the drift.

The country rock is weathered mica schist and gneiss. In general the foliation strikes northeast and dips northwest, but locally it is much contorted. The nearly vertical pegmatite dike, which strikes east, is 21 ft thick at the west end of the cut and 18 ft at the east end. Several branching stringers that are offshoots from the main body are exposed in the east end of the cut, where the dike itself splits into two main branches. The pegmatite consists chiefly of perthite in the west end of the workings, but in the east end a 4-ft quartz core is present in the southeast branch. It is flanked by blocky perthite. The northeast branch consists chiefly of kaolinized feldspar and quartz.

A mica-rich streak 8 to 12 ft thick is said to have been encountered along the north wall of the deposit during the early mining (Sterrett, 1923, p. 315). Most of this mica was small and of poor quality, but some good brown to brownish-olive sheet material was obtained. Much was color-zoned. The most recent operations resulted in the recovery of little sheet mica, and none of the findings offered much encouragement for further development.

McCRAW NO. 2 (OLD PINCHBECK NO. 3) MINE

The McCraw No. 2 mine, which is 500 ft east of the No. 3, was first worked about 1915. It consists of an open-cut 150 ft long, 30 ft wide, and about 30 ft deep. A little exploration was carried on in 1943 by the Champion Mining Corp., but no extensive mining has been done for many years. The pegmatite occurs in a quartz-biotite gneiss with well-developed foliation that trends N. 40° E. and dips 30° SE. In the west end of the cut the strike of the foliation is N. 80° E. and the dip is vertical.

The main pegmatite body, a nearly vertical dike that strikes N. 85° E., is 6 ft thick in the east end of the cut and thickens to 20 ft at the floor in the west end. At the west end it splits into two prongs, each of which is about 10 ft thick. The junction of the prongs probably plunges west. Both branches appear to be exposed in two pits west and southwest of the main cut, but only thin stringers of pegmatite are exposed in a bulldozer trench that was excavated 75 ft west of the cut by the U. S. Bureau of Mines in 1943. The deposit is well zoned. The core comprises several lenses of massive quartz surrounded by irregular blocks of perthite as much as 6 ft in maximum dimension. The wall zone, which is 1 to 3½ ft thick, consists of kaolinized plagioclase with subordinate quartz and scrap mica. The 1- to 4-in. border zone contains fine-grained mica with a little quartz.

Mica of fair quality occurs sparingly in the pegmatite at the east end of the pit. Some of the books are as much as 6 in. in diameter. The mineral is medium brown to brownish olive, flat, and free splitting. Mica of good quality also was obtained from a small pit east of the large cut and on the opposite side of a stream (location 30, pl. 2). Nearly all the mica in the west part of the deposit is small and of scrap grade, but it may constitute as much as 10 percent of the rock. The portion of the deposit that contains sheet mica appears to have been mined out so far as its near-surface parts are concerned; hence any further exploration should be directed westward down the plunge from the east end of the pit.

McCRAW NO. 1 (PINCHBECK NO. 2) MINE

The McCraw No. 1 mine, 200 ft south of the No. 2, was opened prior to 1924 and presumably was worked for a short period only. No further development work was done until 1943, when some exploratory excavations were made by the Champion Mining Corp. and a bulldozer trench was dug by the United States Bureau of Mines. All three McCraw mines are on the old Smith property, which is now owned by W. A. McCraw. Judge Garland Jefferson controls the mineral rights.

The old opening is a cut 100 ft long, 60 ft wide, and probably about 30 ft deep. The pegmatite dike is reported to have been about 25 ft in maximum thickness near the middle of the cut. Two small drifts that were driven about 30 ft west from the cut in 1943 demonstrated that the deposit tapers out into thin stringers in this direction. No pegmatite was encountered in a

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trench 75 ft west-northwest of the cut. The podlike pegmatite body appears to strike east in quartz-biotite gneiss whose vertical foliation trends N. 50° W.

The pegmatite is poorly exposed in the west end of the cut, where it consists chiefly of kaolinized feldspar, interstitial quartz, and scrap mica. No books with sheet material were noted in the workings, and though large, light brownish-olive books have been found in the dumps, they are scarce. Sterrett (1923), however, reports that some clear brown sheet stock was recovered during the early mining, and feldspar probably was produced as well. The near-surface parts of the deposit appear to have been virtually mined out. No pegmatite is exposed in the pit 100 ft west-southwest of the main open-cut, but the dump contains hard, flat, brown mica.

LINE MINE

The two slumped pits of the Line mine are 400 ft southwest of Winterham Road and about 700 ft west-southwest of the Jefferson No. 1 mine. Both are less than 10 ft deep, but the size of the dumps indicates that some caved underground workings are present. The history of the mine is not known, and no pegmatite is exposed. All the mica in the dumps is small and of scrap grade.

BOOKER MINE

The Brooker mine, which is about 600 ft west of the Line mine, has been idle for many years. The surface expression of its caved workings is a pit about 25 ft in diameter and 12 ft deep. The only exposed part of the deposit is the quartz core, which is 10 ft thick. It strikes nearly east and hence may be a part of the dike that was worked in the Line mine. Abundant quartz float is present between the two mines.

Mica books, some as much as 4 in. in diameter, are abundant in the dumps, and many of the quartz blocks contain impressions of books as much as 10 in. in diameter. The mica is light brown, clear, flat, and free splitting. Some is soft. The mine workings probably were not extensive, and further exploration of the deposit might be warranted.

O'NEIL PROSPECT

Some prospecting was done years ago on the Maggie B. O'Neil property near State Highway 609 and 1.5 miles northeast of Amelia (location 7, fig. 52). Badly broken and ruled mica books are present in the dump from a shallow pit that is 8 by 15 ft in plan. No pegmatite is exposed.

PATTERSON MINE

The Patterson mine is in the bottom of a small valley 2 miles northeast of Amelia (location 6, fig. 52). It has been idle since 1915. The workings consist of a flooded open-cut 100 ft long and 70 ft wide, a 90-ft shaft, and extensive drifts and stopes. The country rock, a quartz-biotite gneiss, contains augen of microcline and minor quartz as much as 2½ in. long. Its foliation and layering strike N. 15° E. and dip steeply east-southeast.

The distribution of the workings indcates that the deposit trends nearly east. It is reported to be thin. The dumps contain medium to very coarse grained plagioclase and perthite, with some quartz and accessory allanite and pinkish-red garnet. The allanite occurs as flattened black crystals. Apatite has been reported. Most of the mica books in the dumps are less than 3 in. in diameter. They are brownish olive, flat, hard, free splitting, and generally of good quality. Substantial quantities of excellent sheet material are said to have been obtained from the deposit.

MARSHALL MINE

The Marshall mine is 1.2 miles northeast of Amelia and about 300 ft north of the Southern Railway tracks (location 8, fig. 52). The opening is an old pit 30 ft in diameter and 12 ft deep. Although its walls are much slumped, the size of the dumps suggests that it never was much deeper. No pegmatite can be seen in the opening, but two nearly parallel dikes trend N. 65° W. in the railroad cut to the southeast. They are 150 ft apart, and the north body may be the one that was mined in the pit.

The dumps contain kaolinized feldspar, blocks of clear to smoky quartz, and mica books as much as 4 in. in diameter. Although soft and split by weathering, the books appear to have been flat and of good quality. A half-inch mass of black cassiterite was found in massive quartz.

WINSTON MINE

The Winston mine, which is 1.3 miles northeast of Amelia, is about 400 ft northwest of the Marshall mine and 150 ft north of the Southern Railway tracks (location 9, fig. 52). The surface openings include two old pits. Pit 1 is 50 ft long, 40 ft wide, and 20 ft deep to water level. Remains of old shaft timbers and large dumps indicate that the underground workings may be extensive. Pit 2, which is 20 ft to the north, is 30 ft long, 20 ft wide, and 12 ft deep.

No pegmatite is exposed, but the deposit probably strikes a few degrees west of north. Blocks of massive quartz and books of mica as much as 5 in. across are present in the dumps. The mica is light brown, flat, hard, and of fairly good quality. Small books are locally abundant. Moderate quantities of sheet mica appear to have been recovered from the deposit.

BERRY MINE

The Berry mine, which is a quarter of a mile N. 35° E. of Amelia (location 12, fig. 52), was worked in 1910 and

1923 to a maximum depth of at least 30 ft. The openings included a large cut and several shafts, but all were filled and the property was later cultivated as farm land. In 1944 John Doelle cleaned out one of the old shafts, but he abandoned operations at a depth of 40 ft in January 1945.

Both the pegmatite and the mica schist country rock are weathered to a depth of at least 40 ft. No pegmatite is exposed, but Sterrett (1923, p. 317) reports that the dike strikes east to east-southeast and that the dumps consisted of gray to bluish-green perthite, mica, columbite, and "chalcedonic quartz." Masses of the quartz contained crystal-lined cavities. Yellowish to brownish-olive flat-A mica is fairly abundant in the deposit. Many of the books are hair-cracked, cupped, and clay-stained. Much sheet material of moderate size and acceptable quality is said to have been recovered in the early operations.

PENN PROSPECT

The Penn prospect is 100 ft east of United States Highway 360, about 500 ft east of the Marshall mine, and 1.2 miles northeast of Amelia (location 11, fig. 52). No pegmatite is exposed in a pit 30 ft long, 15 ft wide, and 8 ft deep, but the dump contains blocks of massive quartz and books of soft, badly fractured mica. Most of the books are less than an inch in diameter, and the largest is about 4 in. All the material is scrap.

TRUEHEART PROSPECT

The Trueheart prospect, which is about 1¾ miles north of Amelia, is on the east side of State Highway 49 near Nibbs Creek (location 13, fig. 52). A shallow pit exposes a 2½-ft pegmatite body with a large quartz core and a thin feldspathic wall zone. Many tiny aquamarine beryl crystals, together with splendent black tourmaline crystals as much as 6 in. long and ¾ in. in diameter, are embedded in the glassy clear quartz of the core. The mica occurs sparingly in small books, few of which are more than 1½ in. in diameter.

RUTHERFORD MINES

The Rutherford mines are 1¼ miles north of Amelia and can be reached from that town over United States Highway 360, State Highway 609, and half a mile of dirt road (location 14, fig. 52). The deposits may have been operated by Indians (Fontaine, 1883), and they are known to have been mined systematically during several periods since 1873. Mica, gem minerals, and mineral specimens have constituted the commercial output. Two of the three mines are well known to mineralogists and geologists as sources of rare minerals.

The original openings were two cuts about 200 ft apart. The no. 1 cut lay on the south slope of a small hill, and the no. 2 cut was in the bottom of a draw near a creek to the southwest (pl. 5). By 1883, shafts nearly 80 ft deep had been sunk from each of the cuts, and large quantities of mica are said to have been obtained. Sterrett (1923, p. 309) notes that in 1912 the no. 1 opening was a pit, 75 ft long and 40 ft wide, that had been formed in part by the caving of old workings. A shaft to the east is said to be 90 ft deep, with a 40-ft drift extending from it in an unknown direction at the 55-ft level. This shaft is now filled, and its location is not accurately known. Most of the work in the no. 2 mine was done prior to 1908, when at least one shaft was sunk to a reported depth of 150 ft and several drifts and irregular stopes were developed. The mine was abandoned in 1912.

The No. 1 mine was worked intermittently by the American Gem and Pearl Co. from 1912 to 1932. During one period 30,000 lb of green perthite, or amazon stone, valued at $60,000 was obtained. In 1912 shaft 1 was sunk to a depth of 90 ft, a drift was extended about 60 ft to the northeast, and a crosscut was driven about 40 ft to the east. An 88-ft shaft was then sunk by H. F. Williams, of the American Gem and Pearl Co., from a point about 50 ft east of shaft 1, and a tunnel was driven northward to connect with the drift from the earlier shaft (pl. 5). The Williams shaft is now caved.

E. J. Tyler, of Asheville, N. C., attempted to reopen the No. 1 mine in May 1943. He began to timber and dewater shaft 1, but when the water level had been reduced to a depth of 85 ft, the north wall collapsed, filling the opening with debris. As the caving was evidently caused by heavy ground in old workings to the north, no attempt was made to resume operations. Tyler then unwatered most of the No. 2 mine, exposing a cut 90 ft long, approximately 40 ft wide, and 75 ft deep. A drift 12 ft wide and 20 ft high extends 25 ft southwest from the end of the cut. Tyler stoped downward in the ground above this drift and ultimately cut through to it, leaving one supporting arch of pegmatite 10 ft thick, 10 ft wide, and 10 ft long. A narrow drift at the 75-ft level extends northeastward from the pit for a distance of 20 ft and then northward for about 10 ft (pl. 5). When the mine was unwatered to the 75-ft level, the collar of a two-compartment shaft became visible at the bottom of the cut. This shaft is reported to be 75 ft deep. After moderate quantities of mica were obtained, chiefly from the southwest end of the cut, much of the overlying ground began to cave, and the mine was abandoned in September 1943. All the workings are now flooded.

The No. 3 mine, which consists essentially of a 25-ft shaft and a connecting drift, is on an east slope about 600 ft west-northwest of the No. 2 cut. The workings were cleaned out in 1943 by Tyler but were abandoned after only a little mica was obtained. The No. 1 and No. 2 deposits were explored by the United States Bureau of Mines during the summer of 1943. Five inclined holes were drilled in the vicinity of the workings (pl. 5).

The country rock consists of interlayered biotite augen gneiss, garnet-biotite gneiss, and hornblende gneiss. In general the foliation strikes northwest and dips gently to moderately northeast. Where exposed in the No. 2 pit the gneissic structure is much folded and otherwise contorted. Feldspar metacrysts are locally abundant, and some appear to have been replaced by waxy, greenish-yellow aggregates of sericite. Similar material fills many joints. Nearly vertical diabase dikes 3 to 4 ft thick were encountered in the drill holes.

The main pegmatite bodies are irregular and markedly discontinuous. They appear to be thick, discordant lenses or pods, from which many branches extend into the country rock. Many of these are concordant, but others are extremely irregular. Each of the mines appears to be in a separate pegmatite body. Little pegmatite is exposed in the vicinity of the No. 1 workings, but the deposit is said to trend northeast through shaft 1 and to dip steeply southeast. It is 6 to 8 ft thick. Two small pits west of the cut expose pegmatite that probably is a separate dike but may be a branch from the main part of the deposit. This smaller body tends toward the workings of the No. 3 mine, and float masses of quartz and feldspar indicate that it is probably continuous in this direction.

The pegmatite body in the No. 2 mine is very irregular between the surface and the 60-ft level, where many apophyses extend into the wall rock (section, pl. 5). At the northeast end of the pit it is 5 to 10 ft thick and its mean dip is about 65° SE. It thins and flattens abruptly at the 60-ft level and beyond that point thickens and dips steeply southeast. The deposit is 8 ft thick at the 62-ft level but thins to 5 ft in the bottom of the pit. In its deeper parts, the smooth and regular walls trend N. 65° E. The dike is 14 ft thick at the portal of the drift in the southwest end of the pit but appears to taper out about 25 ft farther southwest. The bottom of the pit was not completely freed of debris in 1943, but exposures on the nearby walls indicate a thickness of 5 to 8 ft. The lower part of the pegmatite appears to have been emplaced along a major fracture in the metamorphic rocks, but its upper part, in contrast, appears to have been guided in many places by the wall-rock foliation.

The dike in the No. 3 mine strikes nearly due east. It is about 5 ft thick in the drift but is much thicker near the shaft. A 1- to 2-ft quartz core is exposed for the entire length of the drift, and it too thickens near the shaft. The wall-zone pegmatite consists of medium-grained kaolinized feldspar and quartz. Two small pits west of the shaft demonstrate a strike continuity of at least 150 ft.

No large mass of pegmatite was penetrated in diamond-drill holes 1 and 2, which were planned to intersect down-dip parts of the No. 2 deposit beneath the old mine workings (pl. 5). However, many pegmatite stringers, one of which may be as much as 5 ft thick, were penetrated (table 20). Hole 3 was drilled to intersect any southward extension of the deposit at a vertical depth of 130 ft, and hole 4 was intended to intersect any northeastward extension at a vertical depth of 60 ft. Neither penetrated more than thin masses of pegmatite. Hole 5 was drilled about halfway between the No. 1 and No. 2 mines to test for a possible subsurface pegmatite connection between them. This hole penetrated 10 to 12 ft of pegmatitic rock at and below a vertical depth of 106 ft. The pegmatite consists chiefly of plagioclase and quartz, with thin, biotite-rich wall-rock inclusions. It may be the southwestward continuation of the deposit mined in the No. 1 workings.

The drill-hole exploration indicates that the No. 2 deposit probably pinches out at a depth of 200 ft or less and that it likewise is not continuous along the strike far beyond the limits of the mine workings. On the other hand, irregular branches and associated pegmatite stringers probably extend for appreciable distances in many directions. Although the large pegmatite mass penetrated by drill hole 5 may be a continuation of the No. 1 deposit, it lies too far northwest to be readily interpreted as a connection between the No. 1 and No. 2 pegmatites.

Condensed logs of diamond-drill holes in the Rutherford mine area follow.

Condensed logs of diamond-drill holes, Rutherford mine area

[45° angle]

Feet beneath collar	Description of rock
	Hole 1
0–95	Soft, weathered rock; no core.
95–117	Biotite gneiss, with minor hornblende and augen of feldspar and quartz.
117–122	Coarse quartz-feldspar pegmatite.
122–128	Garnetiferous biotite gneiss, with some pyrite and minor pegmatitic stringers.
128–129	Garnetiferous quartz-feldspar pegmatite.
129–181	Biotite gneiss, with local hornblende layers, feldspar augen, and pegmatitic stringers.
181–182	Quartz-feldspar pegmatite, with minor small scales of mica.
182–274	Biotite gneiss, locally garnetiferous, with minor pegmatitic stringers, small feldspar metacrysts, and local hornblendic layers.
274–282	Medium-grained black disbase, with conchoidal fracture.
282–300	Biotite-garnet gneiss, with thin layers of pegmatite.

Condensed logs of diamond-drill holes, Rutherford mine area—Con.

Feet beneath collar	Description of rock
	Hole 2
0–15	Weathered rock; no core.
15–17	Medium- to coarse-grained quartz-feldspar pegmatite.
17–39	Biotite gneiss, with local biotite-rich layers, small masses of garnet, and augen of quartz and feldspar.
39–40	Quartz-feldspar pegmatite, with small crystals of red garnet and half-inch muscovite books.
40–87	Biotite gneiss, with several ½- to 7-in. layers of pegmatite.
87–90	Medium- to coarse-grained quartz-feldspar pegmatite.
90–95	Fine-grained granitic gneiss.
95–101	Chiefly quartz-feldspar pegmatite, with small biotite crystals and several cavities.
101–108	Fine-grained, greenish-black diabase.
108–125	Biotite gneiss, with minor pegmatite stringers.
125–128	Quartz-feldspar pegmatite, with small books of brown mica and pyrite crystals in vugs.
128–300	Biotite gneiss, locally garnetiferous, with quartz and feldspar augen, minor interlayered hornblende gneiss, and abundant ½- to 8-in. layers of quartz-feldspar. Diabase stringer at 148 ft.
	Hole 3
0–25	Soft, weathered rock; no core.
25–27	Quartz-feldspar pegmatite, with some gneissic material.
27–72	Garnetiferous biotite gneiss, with stringers of quartz-feldspar pegmatite.
72–74	Quartz-feldspar pegmatite.
74–80	Biotite gneiss.
80–82	Quartz-feldspar pegmatite.
82–83	Biotite gneiss.
83–84	Quartz-feldspar pegmatite.
84–91	Biotite gneiss, with local tremolite and garnet.
91–92	Quartz-feldspar pegmatite.
92–131	Biotite gneiss, locally garnetiferous, with minor hornblende layers and pegmatitic stringers.
131–134	Quartz-feldspar pegmatite, with some schistose layers.
134–143	Biotite gneiss, with some feldspar augen.
143–146	Fine-grained quartz, with minor feldspar and small scales of biotite.
146–148	Biotite gneiss.
148–151	Feldspar-quartz pegmatite, with very dark brown mica.
151–156	Diabase, pyritic along contact with pegmatite.
156–164	Biotite gneiss, with quartz and feldspar augen and local stringers of pegmatite.
164–165	Quartz-feldspar pegmatite.
165–180	Biotite gneiss, with abundant small lenses of feldspar and quartz.
180–185	Garnetiferous quartz-feldspar pegmatite, with some schistose material.
185–250	Garnetiferous biotite gneiss, with minor layers rich in feldspar and quartz.
	Hole 4
0–60	Soft, weathered rock; no core.
60–67	Biotite gneiss, locally garnetiferous, with minor feldspar and quartz augen.
67–70	Quartz-feldspar pegmatite, with some mica schist and small garnet crystals.
70–200	Biotite gneiss, locally garnetiferous, with interlayered green hornblende gneiss, abundant local pegmatitic stringers, and minor pyrite.
	Hole 5
0–36	Soft, weathered rock; no core.
36–43	Biotite gneiss, with small pegmatitic stringers.
43–47	Interlayered biotite-rich gneiss and quartz-feldspar pegmatite.
47–92	Biotite gneiss, locally garnetiferous, with abundant quartz-feldspar pods and stringers, and minor hornblendic layers.
92–93	Fine-grained black diabase.
93–106	Biotite gneiss, locally garnetiferous, with thin pegmatic stringers.
106–117	Chiefly quartz-plagioclase pegmatite, with wisps of biotite gneiss. Much of the feldspar is chatoyant.
117–122	Interlayered quartz-feldspar pegmatite and biotite-rich gneiss.
122–124	Fine-grained black diabase, with pyrite along fracture planes.
124–134	Biotite gneiss, with minor pegmatitic stringers.
134–137	Quartz-feldspar pegmatite, with small books of dark-brown mica.
137–200	Garnetiferous biotite gneiss, with minor hornblendic layers and abundant pods and stringers of feldspar-quartz pegmatite.

In general the deposits are rich in perthite, quartz, and albite. A quartz core occurs in the No. 3 deposit, and the core in the No. 2 pegmatite consists of large, irregular quartz masses. These are surrounded by an intermediate zone of coarse, blocky perthite. Plagioclase is most abundant in the wall zones of the pegmatite bodies, and the border zones, ¼ to 3 in. wide, consist of small, tightly intergrown books of muscovite, with subordinate biotite, quartz, and plagioclase. According to Glass (1935, pp. 745–746), the presence of the following minerals in the Rutherford deposits has been verified: microcline, albite, quartz, muscovite, microlite, tantalite-columbite, cassiterite, beryl, bertrandite, flourite, garnet, topaz, monazite, tourmaline, allanite, calcite, biotite, apatite, cerussite, chalcopyrite, pyrite, galena, fergusonite, helvite, phenakite, and zircon. Additional, unconfirmed species include anglesite, hatchettolite, ilmenite, leverrierite, pyrochlore, and stibnite.

Two distinct varieties of albite are present. One, the well-crystallized platy form known as cleavelandite, is abundant in the dumps from the No. 1 mine and occurs in the northeast face of the No. 2 pit between the 62-ft level and the floor. Some is glassy and clear, and the remainder ranges from white to pale green or blue. Although much of the cleavelandite occurs as large aggregates and its relation to the adjacent pegmatite minerals cannot be determined, other crystals appear to have been formed along fractures in perthite and quartz. Much of the lower, steeply dipping pegmatite segment in the northeast end of the pit consists of platy albite, locally with small quartz masses that may represent unreplaced centers of fracture-bounded blocks. Some of the reticulate cleavelandite aggregates are as much as 2 ft in diameter, and individual crystal plates are as much as ¾ in. thick and 8 in. long. Rare minerals occur in the angular cavities between the interlocking crystals.

The other variety of albite, which is white to pearly gray, occurs in blocky anhedral masses. Some is characterized by a blue chatoyance along the cleavage faces and in the past has been commonly mistaken for labradorite. It occurs in the No. 1 and No. 2 deposits, chiefly near the walls. Some unweathered masses occur sparingly in the northeast face of the No. 2 pit above the 60-ft level. Much of the kaolinized feldspar in the No. 3 mine workings also may have been this variety of albite.

Green perthite, or amazon stone, is abundant in the No. 1 deposit as blocky masses, some of which are well-developed crystals in quartz. Fragments from the deeper workings are a dark bluish green and commonly contain gem material, whereas those found nearer the surface are partly weathered and bleached. Cream-colored to brownish perthite occurs sparingly in the dumps, and all the potash feldspar exposed in the No. 2 deposit during the last period of operation was yellowish brown. Amazon stone, however, is abundant in the old dumps and presumably was obtained from the deeper workings reached by the two-compartment

shaft. Only the yellow-brown variety is exposed in the No. 3 mine.

Milky, gray, smoky, and clear glassy varieties of quartz are abundant in all three mines. Amethystine and smoky crystals of gem quality have been reported by Fontaine (1883, pp. 330–339) and Pegau (1932, p. 40), but none were observed during the recent mining. Presumably most of those obtained in the past were taken from deeper parts of the workings. Tiny, colorless prismatic crystals of quartz occur in the cavities between cleavelandite plates in the No. 1 and No. 2 deposits.

Most of the coarse book muscovite in the deposits is light to medium brown, clear, flat, free splitting, and relatively free from ruling, fractures, or hair cracks. Books as large as 22 by 24 in. are reported to have been mined before 1912, chiefly from the No. 2 deposit, and books as much as 15 in. in diameter and 6 in. thick were obtained by Tyler in 1943. They yielded nearly 10 percent trimmed sheet material. Most of the large books in the No. 2 deposit occur along the margins of the perthite-rich intermediate zone, and many were obtained in the southwest end of the pit above the level of the drift. The mica high on the northeast face of the main open-cut generally is too small to yield sheet material, and no book mica is exposed in the lower, cleavelandite-rich segment of the deposit.

No sheet mica has been obtained from the No. 1 deposit during recent years, but fragments more than 6 in. in diameter are present in the dumps. Like those in the No. 2 deposit, they are flat, free splitting, and light to medium brown. A few yellowish-green "A" books also are present. Light-brown books as much as 4 in. in diameter are moderately abundant along the margins of the core in the thickest part of the No. 3 dike. They are of fair quality.

Sericite coats some crystal faces, fills cleavage cracks in both cleavelandite and blocky albite, and also is closely associated with fragments of topaz. Most appears to be of hydrothermal origin. Many masses have a compact waxy appearance that resembles some varieties of talc. The sericite and fine-grained flaky muscovite that occur in the cleavelandite are green, pink, yellow, and lilac. Green and yellow-green flakes are most widespread. Aggregates of green sericite are cut in several places by veinlets of lilac-colored flakes.

Biotite occurs sparingly as small flakes and appears to be residual material from partly digested wall-rock inclusions. Microlite probably is most abundant in the No. 1 deposit, where buff to dark olive-green octahedral crystals as much as an inch in diameter are embedded in chatoyant albite. Irregular masses of pale reddish-brown to dark amber-colored microlite occur between plates of cleavelandite. Some of these weigh as much as 8 lb, but most are small. Monazite, which closely resembles the massive microlite in both appearance and occurrence, is said to be present in large masses, but none was found during the most recent operations.

Tantalite-columbite and cassiterite also occur in cavities between cleavelandite crystals. Tantalite-columbite is moderately abundant in the dumps from the No. 1 mine workings, and coarse masses are said to occur in the No. 2 deposit. Most of the coarse material is partly altered, whereas small, flattened, reddish-brown crystals of manganotantalite are wholly fresh, with an adamantine luster. Fergusonite was reported by Fontaine (1883), but none was observed during the recent investigations. Angular masses of glossy black cassiterite as much as 2 in. long are scattered sparingly through the No. 1 mine dumps.

A few small pieces of beryl have been obtained from the No. 2 mine during recent years, but bluish-green to grayish-yellow crystals as much as 4 ft long and 18 in. in diameter are said to have been recovered during the early mining. A few small, yellow crystals occur on plates of cleavelandite from the No. 1 mine (Glass, 1935, p. 747). Bertrandite is present as small, colorless prismatic crystals in the walls of cavities in corroded beryl crystals. Pale-lavender to dark-purple fluorite occurs in the southwest end of the No. 2 mine, and pale-green friable fluorite is closely associated with microlite and other rare minerals in both the No. 1 and No. 2 mines.

Both almandite and spessartite varieties of garnet are present. Red garnet, some of which may be intermediate in composition between almandite and spessartite, occurs along the walls of the deposits, both in pegmatite and in gneiss. Spessartite occurs in blocky albite and cleavelandite. Reddish-brown crystals in the blocky feldspar are as much as 3 in. in diameter and formerly were sought as gem stones. Yellow to reddish and brownish-purple spessartite is intimately mixed with helvite in the platy albite. Helvite also occurs on amazon stone in the No. 2 deposit.

Jet-black crystals of tourmaline are abundant in the old dumps at the No. 2 mine. They range from hair-like prisms to trigonal columns 6 in. in diameter and several feet long. Allanite occurs in perthite-rich pegmatite at the northeast end of the No. 2 mine, chiefly as black, flattened prismatic crystals 6 in. in maximum length. Chalcopyrite and pyrite occur sparingly in the same part of the dike as thin layers or small crystals along the cleavage planes of the perthite.

White to yellowish calcite fills some fractures in cleavelandite, as well as spaces between cleavelandite crystals. Small platy crystals were noted in a few places. Galena occurs in the cavities of cleavelandite aggregates, and some masses weigh as much as 15 lb.

Cerussite occurs rarely as thin, crystalline coatings on the galena. Fractured crystals of phenakite were found by Yeates (1890, p. 325), but none have been recognized at any of the mines since that time. Small fragments of topaz are intermingled with fine-grained muscovite in several places. Zircon occurs sparsely as slender, elongate crystals on cleavelandite masses, and some apatite also occurs on cleavelandite as small, colorless to pale-blue crystals.

Exposures are so incomplete that the genesis of the Rutherford pegmatites can be determined only tentatively and in the most general terms. All three main pegmatite bodies appear to have crystallized from the walls inward. Blocky plagioclase is the dominant feldspar in their outer parts, and coarse perthite is dominant in their inner zones. Quartz probably crystallized throughout the period of pegmatite formation but was especially abundant during the later stages. The core of the No. 3 deposit consists almost wholly of massive quartz, and several large, irregular quartz pods in the other pegmatites are interpreted as discontinuous cores. Small books of mica, generally less than 3 in. in diameter, are scattered through the perthite-rich pegmatite, and moderately large books occur along the margins of this unit in medium- to coarse-grained aggregates of albite, quartz, and subordinate perthite. Few rare minerals appear to have been developed during the consolidation of the pegmatite zones. Well-formed crystals are not common in these primary units, and cavities are rare.

Platy albite appears to have formed at the expense of previously crystallized quartz and feldspar in the No. 1 and No. 2 pegmatites, and much of it is clearly controlled by fractures in the host rock. Most of the rare minerals are associated with the cleavelandite crystals. Tantalite-columbite, cassiterite, microlite, monazite, apatite, topaz, sericite, and other species plainly formed after the cleavelandite. Sericite appears to have been formed through the alteration of feldspars and topaz and probably is later than most of the other minerals. The lilac-colored muscovite, which fills fractures in sericite and fine-grained muscovite aggregates, is still later. Calcite encloses all other minerals present in the spaces between cleavelandite crystals and thus is one of the latest minerals in the deposit. Another very late mineral is quartz, which occurs as smoky crystals and as veinlets that cut all parts of the pegmatites.

The lower part of the No. 1 deposit probably comprises a core of quartz, an intermediate zone of blocky amazon stone, and a wall zone that is rich in cleavelandite. The cleavelandite may have been formed in part by replacement of other pegmatite minerals. In contrast, the branches of the deposit that are exposed near the surface are medium-grained intergrowths of perthite and quartz, in which there is little evidence of hydrothermal alteration. Similarly, the exposed parts of the No. 3 deposit contain no recognizable cleavelandite or other minerals of late-stage origin.

Complete production records for the No. 1 mine are not available, but the amount of mica obtained probably was not large. As in the past, any future production probably will be incidental to operations for gem-quality amazon stone. The heading of the drift from shaft 1 is said to expose considerable quantities of high-grade amazon stone, and the deposit may not be worked out. Heavy ground around most of the irregular old workings is a serious obstacle to reopening the mine.

Book mica that would yield commercial sheet material was exposed during 1943 in the arch at the southwest end of the No. 2 pit. About 2,000 lb of minable mica is thought to be present in this block of ground, and as much as 200 lb of trimmed sheets might be recovered from it. Additional mica-bearing pegmatite probably is present beneath the large drift at the southwest end of the pit, and further reserves might occur near the old shaft at lower levels. The extent of the old, deeper workings is not fully known, however, and the bottom of the cut was not exposed during the recent operations. As in the No. 1 deposit, caved ground would make further mining difficult. Moreover, the results of the diamond drilling suggest that the deposit is bottomed not far beneath the existing workings.

Some book mica is exposed in the No. 3 deposit, but the dike appears to be too thin to contain large reserves. None of the past operations has been successful.

Samples collected by L. R. Page, of the Geological Survey, indicate that dump material in the vicinity of the No. 1 and No. 2 mines may contain as much as 0.2 lb of tantalite-columbite and manganotantalite per ton. About 10,000 cu yd, or 15,000 tons, of such material is estimated to be present, but most of the tantalum minerals occur in fragments and grains so small that they could not be recovered by hand sorting.

ABNER PINCHBECK MINE

An old mine on the Abner Pinchbeck property, 0.5 mile east of Amelia (location 15, fig. 52), was reopened by D. B. Sterrett in 1943. In 1945 the workings comprised a partly filled pit, roughly circular in plan and about 35 ft in diameter, and an older filled pit at its south edge. The size of the dump suggests that the recent pit was less than 25 ft deep. The country rock is a kaolinized feldspathic mica schist in which the foliation strikes N. 70° E. and dips 60° SSW. The vertical pegmatite dike is 1½ to 4 ft thick where exposed in the walls of the pit, but the part that was mined may well have been much thicker. It pinches

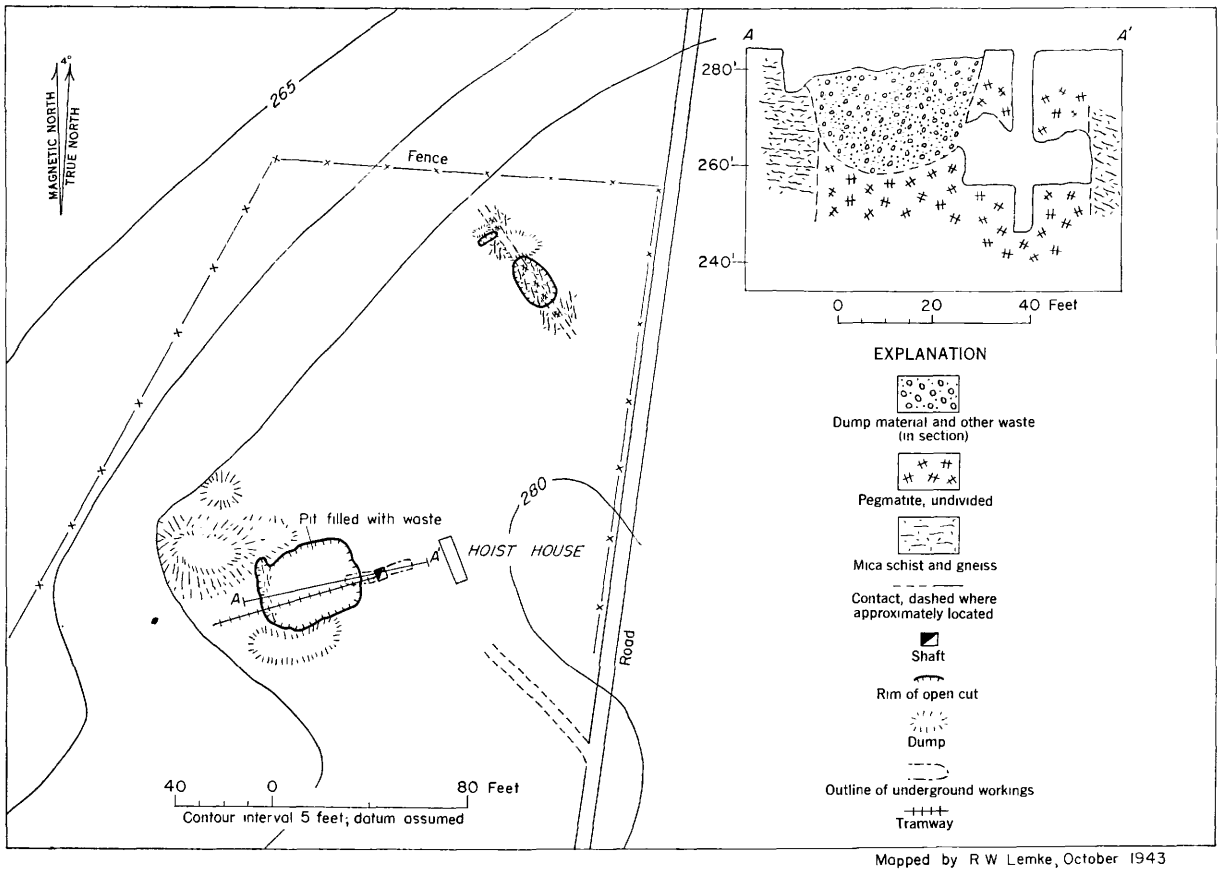

FIGURE 58.—Geologic map and section of the Wingo mine, Amelia County, Va.

and swells in a down-dip direction, and several apophyses extend into the wall rock.

The pegmatite consists of plagioclase, perthite, quartz, muscovite, tourmaline, and beryl. Plagioclase and quartz are the dominant constituents. Mica books and small anhedra of perthite are scattered throughout the deposit. Coarse mica books and pods of quartz as much as 10 in. across are most abundant in the inner parts of the dike, but a few occur near the walls. Large blocks of massive white quartz on the dump indicate a core at least 2 ft thick. Many contain impressions of large mica books and blocks of perthite. Some of the quartz has been brecciated and cemented with later quartz. A mat of ⅛-in. mica flakes forms a discontinuous border zone ¼ in. in maximum thickness.

Tourmaline is locally abundant along the walls of the dike as aggregates of parallel crystals, and a little clear beryl of gem quality is said to have been obtained during the mining operations. Mica constitutes about 15 percent of the pegmatite exposed in the walls of the pit, and 6- to 8-in. books are not uncommon. Some are 3 to 5 in. in diameter and 8 in. thick. They do not contain "A" reeves, but most are cracked and some are bent and ruled. The mica is light yellowish to brownish olive and commonly is clay-stained within a few feet of the surface. No mineral stain is present.

WINGO MINE

The Wingo mine, in the southern part of the town of Amelia (location 16, fig. 52), consists of an open-cut, about 35 ft in diameter and 30 ft in maximum depth, and several underground workings (fig. 58). The history of early mining operations is obscure, but the deposit was last worked during the summer and fall of 1943 by Charles Franchot and H. Engleburt, of the Amelia Minerals Corp. A 43-ft shaft was sunk in pegmatite east of the open-cut, and drifts were driven 10 ft east and 15 ft west at about the 28-ft level. The west drift is said to have been connected with old workings, possibly the bottom of the cut, and the east drift is reported to have reached the wall of the dike. The poor quality of the mica recovered below the 28-ft level led to abandonment of the shaft.

The country rock is quartz-biotite schist and gneiss with distinct foliation that strikes slightly west of north and appears to dip west. It is weathered to a depth of at least 43 ft. Only these foliate rocks are exposed in the trench at the west rim of the open-cut (fig. 58) and in the east heading of the workings from the shaft; hence the pegmatite dike may trend a few degrees west of north. A second, narrow pegmatite body, which strikes north-northwest, is exposed 125 ft northeast of the shaft.

Large fragments of quartz in the dump evidently were taken from the core of the deposit, and the remainder of the pegmatite probably is an aggregate of feldspar and interstitial quartz. The feldspar is only partly kaolinized near the surface, but at the 40-ft level it has been altered to a white clay that forms an "ooze" when wet. Black tourmaline and small crystals of green beryl appear to be closely associated with the quartz core.

Irregular books of brown to light brownish-olive mica are moderately abundant in the feldspathic pegmatite, where they range from 4 to 10 in. in diameter. Some of the sheets are flat, and some are marked by "A" reeves. The books within 30 ft of the surface are relatively hard, free splitting, and of fair to good quality. At deeper levels, however, the mica is soft and buckled and can be processed only as scrap. Tourmaline inclusions are abundant. Additional concentrations of mica along the strike of the deposit might be revealed by further surface exploration.

OTHER DEPOSITS

The following deposits were not examined by the Geological Survey. The description of the International mines is adapted from Sterrett (1923, pp. 316). The description of the Captain Tim prospect was obtained from the Colonial Mica Corporation.

International mines.—The International Mica Co., of Philadelphia, Pa., opened a mica deposit about 400 ft northeast of the Patterson mine and 2¼ miles north-northeast of Amelia (location 5, fig. 52) about 1910 and mined it intermittently for 5 years. The workings are on the north side of a small branch and comprise two slumped open-cuts and a 40-ft shaft, now caved. The country rock is a quartz-biotite gneiss with abundant crystals of rose-pink garnet. Its foliation strikes northwest and dips moderately northeast. The pegmatite body also strikes northwest but dips more steeply northeast. In section it comprises alternating concordant and discordant segments. The pegmatite minerals include plagioclase and quartz, with subordinate perthite and mica. Only small fragments of mica are present in the dumps, but books of good size are said to have been mined. The mineral is clear, light brown, and free splitting.

A second mine was worked by the International Mica Co. west of the Pine Shaft deposit. It was opened in 1915, and small quantities of clear brown mica were obtained. The workings include several slumped pits.

Captain Tim prospect.—Small books of severely ruled mica have been obtained from the Captain Tim prospect, a quarter of a mile east of a small branch stream and about 2 miles northeast of Amelia (location 10, fig. 52). The workings comprise two flooded shafts and irregular appended drifts. The pegmatite body strikes east and contains a core of massive white quartz.

MOREFIELD-DENARO AREA

MOREFIELD MINE

The Morefield mine, one of the best-known pegmatite-mineral localities in the United States, is approximately 4 miles east-northeast of Amelia and can be reached from that town over United States Highway 380 and Butler Road (State Highway 628). It was opened in 1929 by Silas V. Morefield, the owner, who mined by open-cut methods until 1931. The deposit was then leased to W. W. Howe, of the Seaboard Feldspar Co., and was worked about 3 years for green perthite (amazon stone), mica, beryl, and tantalite-columbite. Morefield then resumed operations. The mine was leased to the Minerals Separation Corp. of North America in 1942, later was taken over by the Metals Reserve Company, and finally was returned to Morefield in January 1943.

The main opening is an irregular cut 230 ft long, 10 to 50 ft wide, and 5 to about 25 ft deep (pl. 6). A narrow shaft was sunk in perthite-rich pegmatite from the floor of the cut near the southwest end to a depth of about 45 ft below ground level. Three prospect holes are northeast and east of the cut, and at least six trenches and shallow pits are scattered along the strike of the deposit to the southwest. During 1943 and 1944 Morefield enlarged and deepened the shaft. At the close of the operations, this opening was 16 by 16 ft in cross section at the collar, and its bottom was 60 ft below ground level. The production of mica, feldspar, and other minerals from the mine is summarized in table 1.

TABLE 1.—*Production of mica, feldspar, and other minerals from the Morefield mine, Amelia County, Va.*

Mineral	Pounds	Tons	Approximate value (dollars)
Period 1929–41			
Selected book mica		1–2	$1,000.00
Scrap mica		15–20	250.00
Tantalite-columbite	1,406		1,496.00
Beryl		6	240.00
Feldspar (mostly amazon stone)		450–500	3,300.00
Mineral specimens:			
Zinnwaldite mica		1½	150.00
Topaz		2	200.00
Tantalite-columbite, amazon stone, phenakite, microlite, and others			2,000.00
Total			8,636.00

TABLE 1.—*Production of mica, feldspar, and other minerals from the Moorefield mine, Amelia County, Va.*—Continued

Mineral	Pounds	Tons	Approximate value (dollars)
Period 1943–February 1944			
Trimmed punch and sheet mica	630		$3,775.00
Scrap mica		7	90.00
Beryl	2,500		150.00
Tantalite-columbite	17		46.75
Feldspar		[1] 80	500.00
Total			4,561.75
Grand total			13,197.75

[1] On hand.

The United States Bureau of Mines first explored the deposit during the summer and fall of 1943. The position of the pegmatite body was established by means of four bulldozer trenches southwest of the cut, and its subsurface distribution was determined by means of four inclined diamond-drill holes (pl. 6). A fifth trench was excavated in country rock to the northeast. The southwest trenches, which are 130 to 180 ft long, about 13 ft wide, and 2 to more than 20 ft deep, furnish excellent cross sections of the deposit. A smaller, shallower trench was excavated in pegmatite in the narrowest part of the main pit.

In 1948 the property was leased by the United States Bureau of Mines, and experimental development and mining were carried on during a period of several months. The Morefield shaft was dewatered and deepened to 115 ft. The new shaft segment is 6 by 8 ft in section. Two short drifts at the 45-ft level were enlarged, and several drill holes were fanned out to establish the position of the pegmatite walls. At the 100-ft level a drift was driven at least 75 ft southwestward, mainly along the southeastern wall of the pegmatite. A raise from this drift extended to about the 45-ft level southwest of the Morefield shaft.

The country rock is interlayered biotite gneiss and biotite-hornblende schist. Several zones in which the foliation was crinkled and tightly folded were observed. Nearly vertical diabase dikes cut across the metamorphic rocks and the pegmatite, generally with north to north-northwest trends. One of these is exposed in the main pit, and a much larger dike was encountered in bulldozer trench 5 (pl. 6). All the rocks are thoroughly weathered to depths ranging from 10 to more than 30 ft.

The main pegmatite dike trends N. 45° E. and is remarkably straight throughout its explored length. It is at least 1,100 ft long, and it ranges in thickness at the surface from about 5 ft immediately northeast of the main pit to 30 ft in bulldozer trench 5. It is 14 to more than 18 ft thick in the Morefield shaft. No pegmatite is exposed in trench 1 or in a small pit 30 ft to the southwest, and several shallow auger holes indicate that the deposit tapers to a thickness of about 2 ft between the main open-cut and the trench 1 and pinches out entirely 130 ft east of the cut. On the other hand, it appears to continue southwestward for a considerable distance beyond trench 5.

The dike is sharply discordant and appears to have been emplaced along a persistent fracture, but several branching quartz veins and pegmatite masses are conformable with the wall-rock foliation (sections *B–B′* and *C–C′*, pl. 6). The mean dip of the hanging wall is about 80° NW., but in general the footwall is slightly less steep. A thinning of the dike with depth is indicated in the bulldozer trenches and in diamond-drill holes 2, 3, and 4. The exploratory work done in 1948 demonstrates a rather abrupt downward thinning at the 85- to 88-ft level, where there are many closely spaced, subhorizontal joints. In the lower drift the dike is only 6 to 12 ft thick. Its contacts there have a uniform trend but are very irregular in detail. Diamond-drill hole 1 penetrated two pegmatite masses separated by a few feet of pegmatitic biotite gneiss (pl. 6). The northwestern mass appears to be a downward continuation of the deposit exposed in the open-cut, but it is not clear whether the other is a separate dike, a root-like projection, or an upward branching arm of the main body.

The deposit is irregularly zoned. The relations in the shallower parts of the main workings, which now are covered by slumped masses of overburden, have been briefly but effectively described by Glass (1935, p. 744). She notes "an irregular middle zone of smoky gray quartz, intergrown on its borders with large crystals of beryl and topaz. . . . Blue-green microcline (amazonstone) borders the quartz zone on both sides; albite and muscovite with occasional crystals of garnet form an irregular zone on the wall side of the amazonstone. The narrow, fine-grained selvage bands composed of biotite and quartz occupy the contact between the coarse-grained pegmatite mass and the country rock. . . . "

The core of the deposit is discontinuous. Individual segments range from irregular pods a foot long to platy masses 25 ft thick and several tens of feet long. This innermost unit is best developed in the part of the deposit between bulldozer trenches 2 and 4. In the Morefield shaft it consists of irregular masses 3 to 15 ft in maximum dimension. An intermediate zone that consists mainly of coarse, blocky perthite with subordinate quartz, cleavelandite, albite, and mica is well developed in the northeast part of the deposit but does not appear to be present far southwest of trench 2. Large crystals and crystal aggregates of beryl, topaz, phenakite, and

mica are present locally along the contacts between this unit and the core, as well as within many of the smaller core segments. A few large, well-faced perthite crystals also are scattered through the quartz of the core.

The core and intermediate zone are not present in those lower, thinner parts of the dike that have been most recently explored, nor do such accessory minerals as beryl, topaz, and phenakite appear to occur below the major bulge in the dike. A little tantalite-columbite, however, was found in the lowest drift. At the 100-ft level the central part of the pegmatite consists of coarse-grained graphic granite (perthite and quartz) with subordinate quartz and cleavelandite. This unit may be an outer intermediate zone that flanks the keelward part of the intermediate zone of quartz and euhedral perthite already described.

Medium- to coarse-grained plagioclase-quartz-mica-perthite pegmatite, which is very abundant in trench 5, appears to constitute the wall zone of the deposit. As traced northeastward, it becomes richer in plagioclase, and in the main open-cut it consists chiefly of platy crystals and granular masses of albite. In the thinner part of the dike, beneath the Morefield shaft, the wall zone is 1 to 4 ft thick and consists of moderately coarse, blocky oligoclase-albite with subordinate quartz, muscovite, biotite, and garnet. Here and there is a thin unit of quartz and sugary cleavelandite, ordinarily between the wall zone and the centrally disposed graphic granite unit. The border zone, which ranges in thickness from a knife edge to 11 in. (average about 3 in.), is conspicuous in the main open-cut and shaft. It contains abundant black biotite flakes oriented parallel with the walls, as well as minor fine-grained quartz and small crystals and crystalline aggregates of spessartite.

Mineral species well established as occurring in the deposit (Glass, 1935, pp. 745–746) include microcline, albite, quartz, beryl, biotite, cassiterite, columbite, fluorite, galena, manganotantalite, microlite, monazite, muscovite, phenakite, pyrolusite, spessartite, topaz, tourmaline, triplite, zinnwaldite, and zircon. Other species that have been identified during the recent investigations are allanite, almandite-spessartite, apatite, bertrandite, chalcopyrite, pyrite, and rutile.

Much of the perthite exposed below water level and above a depth of 50 ft in the Morefield shaft is the green amazon-stone variety, but above water level the mineral appears to have been bleached. Blocky, buff-colored perthite also occurs in the inner zones of the deposit and is best exposed along the northwest wall of the shaft. Albite is present as granular masses and as clear and colorless to pale-blue platy crystals about three-quarters of an inch in maximum length. Some of the crystals form interlocking aggregates, and rare minerals occur in the interstices. Albite clearly fills fractures in the quartz and perthite of the inner zones, and much appears to be of replacement origin. The sugary to platy albite in the wall zone may well have replaced plagioclase-quartz-perthite pegmatite similar to that exposed in trench 5, but exposures are so incomplete that few intermediate rock types have been observed. Scattered residual masses of perthite appear in the walls of the main cut and the Morefield shaft.

Nearly all the quartz is milky to smoky. It is abundant as interstitial material in the wall zone but is most prominent as larger masses in the inner units. A little is graphically intergrown with coarse perthite, and a few colorless prismatic crystals were observed in cavities between cleavelandite blades.

Most of the coarse book mica occurs in the inner part of the wall zone, where the concentrations are 6 in. to about 2 ft thick. They flank core segments in some places and the perthite-rich inner intermediate zone in others. Books also are scattered sparsely through the central and outer parts of the wall zone, but very few occur within 18 in. of the walls. Although its distribution is irregular in detail, the mica tends to be concentrated in definite shoots or columns in which the books are oriented in one direction. No consistent plunge could be established for the shoots. The books range in diameter from 4 to 12 in., and most are equant. Parts of some books project into quartz or perthite of the inner zones, with well-developed crystal faces. Their other parts are embedded in albite and generally are markedly corroded by this feldspar.

Much mica also occurs within the inner zones, where it is associated with cleavelandite and appears to have been formed along fractures in quartz and perthite. Most of the crystals are well formed, 1 to 2½ in. in diameter, and 6 to 8 in. long. In the northeastern part of the cut nearly all the mica is zinnwaldite, an iron-lithium species. Its occurrence is similar to that of the fracture-controlled muscovite exposed in the shaft, but the crystals range from 1 to 18 in. in diameter. Glass (1935, p. 759) has described this mineral in detail and has noted the unusually large crystals. They are dark brown, with a bronze luster, and commonly are penetrated by and interlaminated with blades of topaz. Many books intermediate in composition between zinnwaldite and muscovite occur in the deposit, and some grade from muscovite centers to zinnwaldite borders. Appreciable quantities of cesium are present in some of these micas.

In general the Morefield muscovite is light brownish olive to dark brown, and the books are clear, flat, and free splitting. Many are soft and clay-stained, and some contain air bubbles that give them a spongy appearance. Other structural defects are hair cracks, warping, ruling, and minor lockiness. Many books are

tied by inclusions of quartz, fluorite, and garnet. The zinnwaldite is brittle, locky, and unsuited for most electrical uses.

Black biotite occurs in the border zone, as well as in irregular wall-zone concentrations in the southwestern part of the deposit. It resembles lepidomelane and is iron-rich, with 26.72 percent FeO, 2.87 percent Fe_2O_3, and 3.60 percent TiO_2 (Glass, 1935, p. 748).

Beryl occurs chiefly in and near the quartz core. It is white to pale bluish green and ranges from well-terminated prismatic crystals ½ in. in diameter and 4 to 6 in. long to irregular masses weighing as much as 120 lb. It is most abundant in the northeastern part of the deposit, and much is exposed in the open-cut and trench 2. Several large crystals also were obtained from trench 3, and a few masses from the shaft. The mineral appears to be rare in the part of the deposit exposed in trenches 4 and 5. More than half a ton of float beryl was recovered from an area south of the open-cut (pl. 6). Individual fragments weighed as much as 30 lb.

Topaz occurs as anhedral masses and large, poorly formed crystals as much as 44 in. long and 500 lb in weight. The largest crystals are associated with coarse zinnwaldite and are known to occur only in the intermediate zone northeast of the shaft. The smaller masses are associated with quartz and phenakite. They are colorless and transparent to white or yellow and opaque.

Phenakite has been found in trench 2, in the shaft, and in minor quantities elsewhere in the deposit. It is closely associated with beryl, topaz, quartz, zinnwaldite, and perthite and is particularly difficult to distinguish megascopically from much of the topaz. It is colorless to milky white and occurs in crystalline aggregates as much as 5 in. in maximum dimension. Some well-formed transparent crystals ½ to 2 in. long also have been observed.

Tantalite-columbite and manganotantalite are widespread accessory constituents of the wall zone and characteristically are associated with albite. They range from small, thinly tabular crystals that fill crevices in cleavelandite to large, thick, well-formed crystals weighing as much as half a pound. Heart-shaped contact twins and crystal clusters are common. Tantalite-columbite appears to be most abundant in the northeastern part of the deposit, and more was observed in the shaft than in the open-cut. Some crystals of dark-brown to black manganotantalite are associated with quartz, perthite, topaz, and beryl in the inner zones of the dike. Many of the crystals in the thoroughly kaolinized parts of the wall zone have been altered and leached.

Irregular, dull-gray masses of cassiterite occur sparingly in albite-rich parts of the deposit. Most are about an inch long. Octahedral crystals of olive-brown microlite as much as half an inch in diameter also are present in masses of sugary albite and fine-grained cleavelandite. A second type of microlite, which is transparent and pale honey yellow to dark reddish brown, forms irregular crystalline masses and tiny flat crystals in aggregates of coarse cleavelandite. Olive-brown monazite occurs sparsely in albite, chiefly as individual tabular skeletal crystals that enclose crystals of manganotantalite.

Green fluorite, which closely resembles that in the Rutherford deposit, is moderately abundant in the albite-rich pegmatite. It is thermoluminescent, fluorescent, and phosphorescent after exposure to ultraviolet light. Flattened octahedra of colorless to pale-green fluorite occur in some of the muscovite books.

A little dingy yellow, friable bertrandite was found in trench 3, where it formed a partial pseudomorph after beryl. The unaltered part of the crystal extended beneath the water level at the time of examination. Small, imperfect crystals and crystalline aggregates of spessartite are scattered through the biotite-rich border zone, where they are associated with tiny crystals of apatite and zircon. Stains of manganese oxides in the upper parts of the deposit appear to have been derived from masses of altered spessartite and manganotantalite. Radiating clusters of small, bluish-black tourmaline crystals are common in the pit and shaft. Crystalline masses of triplite about an inch in diameter occur locally in albite-rich pegmatite. Some consist of salmon-colored cores and concentric outer layers of brownish-black altered material with an adamantine luster.

The Morefield deposit, like the Rutherford, appears to have developed in at least two clearly recognizable stages. The dike probably crystallized inward from its walls, with formation of a border zone, a medium- to course-grained granitoid wall zone, an intermediate zone rich in graphic granite, an intermediate zone rich in blocky perthite, and a discontinuous quartz core. In this respect it is similar to many of the other pegmatite bodies in the district. Most of the coarse book muscovite in the wall zone, at least a part of the beryl, and possibly some of the tantalite-columbite may well have been formed during the process of consolidation. The second, or later, stage was characterized by the circulation of pegmatitic solutions along fractures, with widespread replacement of quartz, perthite, and probably wall-zone plagioclase by sodic albite. Accompanying the albite were muscovite, zinnwaldite, possibly beryl and topaz, and many rare minerals, including microlite, manganotantalite, mona-

zite, and others. The genetic details are imperfectly known, owing to the lack of continuous exposures and to the thorough weathering of the near-surface parts of the deposit, but most of the replacement evidently was confined to the northeastern part of the dike.

The youngest muscovite books occur in the inner zones and are characteristically elongated normal to the cleavage, in contrast to the more equant books in the wall zone. The zinnwaldite formed even later, and in some books it forms rims around cores of muscovite. Much of the topaz is intergrown with zinnwaldite and may have been formed contemporaneously. Manganotantalite, some tantalite-columbite, cassiterite, triplite, microlite, fluorite, microcline, and muscovite all occur in cavities in reticulate aggregates of cleavelandite crystals; thus they probably are very late stage constituents. Some of the monazite formed around crystals of manganotantalite.

The minerals of current economic interest include perthite, albite, mica, beryl, phenakite, tantalite-columbite, topaz, microlite, and cassiterite. The relative proportions of these constituents in samples collected from the open pit and trenches 2–5 are indicated in table 2.

TABLE 2.—*Mineral composition of samples from open-cut and bulldozer trenches, Morefield deposit, Amelia County, Va.*

[Sampling and preparation by R. W. Lemke; laboratory analyses by J. J. Glass. Figures in parentheses indicate weight in grams]

	Distance from hanging wall (feet)	Weight of final fraction of sample used (grams)	Mineral composition (percent)														
			Bertrandite	Beryl	Phenakite	Columbite-tantalite	Perthite	Albite	Quartz	Topaz	Muscovite	Biotite	Garnet	Monazite	Tourmaline	Zircon	Total
Samples from open-cut (total weight 1,570 lb; each quartered in field to 50 lb):																	
1	0–2	76.4		0	0	Trace	0	74.20	24.60	0.20		0.59 [1]	0.08	0	0.23	0.06	99.96
2	2–4	91.3		Trace	0	0.54	66.10	0	3.50	26.40		3.40 [1]	Trace	0	0	0	99.94
3	4–7	93.8		Trace	Trace	0.06+	37.80	0	52.00	0.27		9.03 [1]	Trace	Trace	0	0	99.16
4	7–9	86.1		0.40	0.002 (calc.)	0.002 (calc.)	66.00	8.66	17.30	6.82		Trace [1]	0.25	0	Trace	Trace	99.18
5	9–11	89.6		0	0.002 (calc.)	0.135	0	77.30	21.80	0.29		Trace [1]	0.06	Trace	0.20	Trace	99.78
Summary, samples 1–5		437.2		Trace	Trace	0.16	34.3 [2]	28.21	26.40	6.20	2.13 (calc.)	2.60 [1]	Trace	Very small trace.	Trace	Trace	100.00
Sample from northeast face of trench 2 at water level (total weight, 1,035 lb; quartered down to 3 lb).		103.0		1.10 [3] (1.13 g)	0.82 [3] (0.85 g)	0.11 (0.12 g)	41.00 (42.26 g)	30.00 (30.90 g)	25.00 (25.75 g)	1.55 (1.60 g)	0.10 (0.11 g)	[4]		0.32 [4] (calc.; 0.33 g)	[4]		100.00 (103.05 g)
Samples from bottom of trench 3 (total weight, 1,240 lb; each sample quartered in field to 50 lb):																	
1	0–4	79.0	0	0	0	Trace	0	42.90	56.50	Trace	0 [5]	0.20	0.04	Trace	0.05	Trace	99.69
2	4–8	94.1	Trace	0	0	Trace	Trace	33.10	66.40	Trace	0.15 [5]	0.09	0.02	0.02	0.02	0	99.80
3	8–14	87.5	0	Trace	0	Trace	Trace	11.40	88.00	0	0.30 [5]	0	0	0.04	0	0	99.74
4	14–18	93.2	0	0	0	0.14	0	33.10	66.50	0	0.05 [5]	0.03	0.04	0.04	0.03	Trace	99.93
5	18–22	80.5	0	0	0	0.11	0	65.90	33.60	0	0.01 [5]	0.09	0.06	Trace	0.01	Trace	99.78
Summary, samples 1–5		434.3	Trace	Trace	0	Trace	Trace	35.30	64.40	Trace	Not det.	Not det.	Trace	Trace	Trace	Trace	99.70
Sample from southwest face of trench 4 (total weight, 325 lb).		72.0		Trace			39.6 (28.6 g)		49.5 (35.8 g)			9.9 (7.2 g)	Trace	Trace		Trace	99.0 (71.6 g)
Sample from southwest face of trench 5 (total weight, 410 lb).		86.8				0.16 (0.14 g)	18.50 (16.03 g)		37.00 (32.06 g)	Trace		44.00 [6] (38.00 g)	Trace	Trace	Trace	Trace	99.66 (86.23 g)

[1] Zinnwaldite (and cesium mica) and biotite.
[2] For samples 2, 3, and 4 percentage of perthite is 53.9.
[3] The BeO content of this sample was determined as follows: It was assumed that the beryl contained 10 percent BeO and the phenakite 45 percent. Given a weight of 1,035 lb for the regional samples and a beryl content of 1.10 percent and a phenakite content of 0.82 for the quartered samples, the total sample would contain 11.4 lb beryl and 8.5 lb phenakite. Therefore the total sample contains

1. 14 lb BeO from beryl
3. 83 lb BeO from phenakite

4. 97 lb total BeO, or .48 percent.

[4] Percentage given for monazite includes biotite and tourmaline.
[5] Trace of lithium.
[6] Sample includes part of a biotite-rich pod and therefore shows a higher biotite content than the pegmatite as a whole.

Additional data were obtained from the diamond-drill cores, as shown on plate 6 and in the following condensed logs of drill holes.

Condensed logs of diamond-drill holes, Morefield mine area

[60° angle]

Feet beneath collar	Description of rock
	Hole 1
0–37	Soft, weathered schist and gneiss; no core.
37–89	Biotite gneiss, locally garnetiferous, with minor biotite-rich layers, hornblendic layers, and local masses of pyrite.
89–90	Salmon-pink to light-green feldspar, with gray quartz and minor biotite.
90–98	Biotite gneiss, locally impregnated with pyrite and white to salmon-pink feldspar.
98–116	Pegmatite, with core recovered as follows: 1.2 ft white to salmon-pink perthite (?), with subordinate smoky quartz, white platy albite (?), and small masses of black tourmaline. 1.0 ft light-green perthite and white platy albite, with minor gray quartz and black tourmaline. 2.4 ft white to salmon-pink feldspar and smoky quartz, with small red garnet crystals. 0.6 ft white feldspar-quartz pegmatite, with abundant biotite. 1.2 ft white to gray feldspar, smoky quartz, small red crystals of garnet, and minor tantalite-columbite. 0.2 ft black biotite, with small specks of white feldspar. 2.7 ft white feldspar, smoky quartz, and thin stringers of biotite.
116–126	Coarse biotite gneiss, with biotite-rich layers; locally rich in pegmatitic quartz and feldspar.
126–138	Chiefly pegmatite rich in platy albite, with some biotite and black tourmaline.
138–150	Feldspathic gneiss, with very abundant black biotite, local small masses of red garnet, and layers of pegmatite.
	Hole 2
0–67	Soft, weathered gneiss; no core.
67–138	Feldspathic biotite gneiss, locally garnetiferous, with many biotite-rich and hornblende-rich layers and thin stringers of pegmatite.
138–156	Biotite gneiss, locally very hornblendic, with abundant pods and stringers of pegmatite.
156–173	Pegmatite, with core recovered as follows: 1.9 ft light-gray to smoky-gray quartz-feldspar pegmatite. 1.0 ft white albite (?). 2.4 ft light-gray quartz-feldspar pegmatite, with small flakes of biotite. 1.4 ft light-gray pegmatite, with platy albite. 0.2 ft albite and green perthite. 2.7 ft albite, light-smoky quartz, and minor green perthite. 5.1 ft light-gray to smoky-gray quartz-feldspar pegmatite.
173–183	Feldspathic biotite gneiss, with local biotite-rich layers.
	Hole 3
0–58	Soft, weathered rock; no core.
58–161	Feldspathic biotite gneiss, locally garnetiferous, with abundant pegmatic stringers, several biotitic and hornblendic layers, and scattered pyrite.
161–180	Pegmatite, with core recovered as follows: 3.5 ft light-gray feldspar-rich pegmatite, with minor quartz. 6.1 ft feldspar-rich pegmatite, with smoky quartz and small crystals of dark-red garnet. 3.0 ft quartz-feldspar pegmatite, with abundant biotite near bottom.
180–188	Biotite gneiss, with many pegmatite stringers and abundant disseminated pegmatitic quartz and feldspar.
	Hole 4
0–63	Soft, weathered gneiss; no core.
63–82	Granitic gneiss, very rich in feldspar.
82–84	Dark-green, medium-grained diabase.
84–92	Feldspar-rich granitic gneiss.
92–116	Feldspathic biotite gneiss, locally garnetiferous.
116–121	Fine-grained, dark greenish-black diabase.
121–128	Feldspathic biotite gneiss, locally garnetiferous.
128–147	Dark greenish-black diabase.
147–149	Light-gray to pale-green pegmatite.
149–156	Feldspathic biotite gneiss, locally garnetiferous.
156–162	Partly altered fine-grained diabase.
162–195	Feldspathic biotite gneiss, locally garnetiferous, with much hornblende and several pegmatite stringers.
195–196	Fine-grained, dark-greenish to black diabase.
196–200	Feldspathic biotite gneiss, with minor garnet and hornblende.
200–202	Fine-grained diabase.
202–245	Feldspathic biotite gneiss.
245–258	Pegmatite, with core recovered as follows: 4.6 ft light-gray to greenish-gray quartz-feldspar pegmatite, with minor reddish garnet, small biotite scales, and beryl (?). 3.2 ft light-gray to greenish-gray quartz-perthite pegmatite. 3.9 ft gray to greenish-gray quartz-perthite pegmatite, much broken and weathered along fracture planes.
258–325	Feldspathic biotite gneiss, locally garnetiferous and hornblendic, with abundant pegmatite stringers.

The main downward extension of the deposit was encountered in hole 1 at a vertical depth of about 80 ft, where it is about 11 ft thick and comprises central units of massive smoky quartz and blocky perthite (chiefly amazon stone) and an outer zone rich in platy albite. The pegmatite contains 3 percent biotite, about 0.4 percent beryl, and minor quantities of tourmaline, garnet, and apatite.

The pegmatite body in hole 2 is about 10 ft thick, and its central part was encountered about 140 ft. beneath the surface. It is somewhat similar to the pegmatite penetrated by hole 1, but albite is the dominant mineral and phenakite and topaz are additional minor constituents. The pegmatite in hole 3 also is 140 ft deep, and its central part consists almost wholly of albite, with minor gray quartz and perthite. The pegmatite is 7 ft thick and 210 ft deep in hole 4, where it is composed of albite, quartz, and perthite, with minor biotite, garnet, beryl, zircon, tourmaline, monazite, rutile, and apatite.

Most of the economically desirable minerals in the dike are concentrated in or along the quartz core or the perthite-rich inner intermediate zone, or in both these units. Thus they occur chiefly in the central and northeast-central parts where the dike is thickest. The mass of unmined pegmatite comprising the two inner zones noted is about 14 ft in average thickness, 60 ft in average depth, and is at least 175 ft long. Although they constitute most of the dike where exposed in trench 2 and in the open pit, the two inner zones are bottomed at levels above the deepest drill hole.

Most of the sheet mica obtained from the deposit has been mined from the pegmatite between the trench in the floor of the main cut and bulldozer trench 2. The books occur in fairly well defined shoots, chiefly along the contact between the wall zone and inner intermediate zone, and are thought to amount to at least several thousand pounds of recoverable mica that would yield 2 to 5 percent sheet material. A fairly large tonnage of scrap mica probably could be obtained as well.

A large fraction of the coarse-grained feldspar is so intermingled with quartz that the recovery of a reasonably pure product by hand cobbing would be very difficult or at least not economically feasible. The feldspar reserves of greatest commercial promise are mainly in the core and inner intermediate zone already described. At least two-thirds of the pegmatite in these two units is feldspar, of which about 60 percent is perthite. The proportion of coarse perthite recoverable by hand sorting probably is about 30 percent, if exposures in the open-cut and the Morefield shaft are representative of the pegmatite. Additional high-grade material undoubtedly is present in other parts of the dike, but no-

where else is it known to be as coarse-grained and as free from intergrown quartz or to constitute such a high proportion of the rock in which it occurs.

Analyses of channel samples suggest that much of the pegmatite between the trench in the open-cut and bulldozer trench 2 may contain 2 to 3 lb of tantalite-columbite per ton. Most of the tantalum minerals occur in the albite-rich wall zone; hence the tenor might be raised to as much as 5 lb per ton by selective mining. A channel sample from trench 5 indicates the occurrence of about 3 lb of tantalite-columbite per ton of pegmatite in that part of the deposit, but so little is known of the mineral distribution that extrapolations beyond the immediate areas of sampling are open to serious error.

An additional reserve of tantalum minerals is present in placer and dump material. Page (unpublished manuscript) estimates that a small placer deposit southeast of the open-cut contains 0.2 lb of such minerals per cu yd and that the old dumps contain 0.25 lb per cu yd.

The richest concentrations of beryl are in core and intermediate-zone pegmatite in the vicinity of the open-cut and trench 2. The erratic distribution of this mineral and the great size range of its crystals make it difficult to estimate reserves. Some beryl also is present farther southwestward in the dike but probably is not concentrated into rich shoots to such an extent.

Channel samples indicate that the richest phenakite concentrations are near the shaft and trench 2. Little of this mineral appears to be present in the southwestern part of the deposit, but some was observed in the core from drill hole 2. Phenakite occurs solely in the core and inner intermediate zone and probably would constitute little more than 0.1 percent of such pegmatite. Megascopic recognition of the mineral is difficult, and little is known concerning its detailed distribution. Despite these uncertainties, a reserve consisting of a few tons of phenakite probably exists and much more may be present. The recovery of this mineral in a mixed beryllium-rich concentrate would necessitate milling.

H. T. FLIPPEN PROSPECT

The H. T. Flippen mica-beryl deposit is on the north side of a small branch stream, 0.3 mile by road west of State Highway 628 and 3.4 airline miles east-northeast of Amelia (location 18, fig. 52). The workings include a shallow filled trench in an open field and a second trench in an adjacent wooded area. The persistent quartz core of the deposit trends N. 10° E. and is exposed for a distance of 400 ft. It appears to be about 5 ft thick. The flanking feldspathic pegmatite contains small muscovite books, biotite flakes less than half an inch in diameter, and crystals of pale-green beryl. Individual masses of beryl weigh as much as 5 lb. The mineral appears to occur along the margins of the core, and some of the crystals project into the quartz. The deposit appears to offer little promise as a source of mica, but additional prospecting to determine the probable reserves of beryl-bearing pegmatite seems warranted by present exposures.

DOBBIN PROSPECT

The Dobbin prospect is 50 ft west of State Highway 628, a few hundred feet southeast of the Flippen prospect, and 0.6 mile south-southwest of the Morefield mine (location 19, fig. 52). The workings include several small pits and a trench 40 ft long and 5 ft deep. The pegmatite dike strikes nearly east in quartz-biotite gneiss, dips 50° N., and can be traced for a distance of about 250 ft. A 5-ft quartz core is exposed along the entire length of the cut and is flanked by kaolinized feldspathic pegmatite that contains minor mica and quartz. Small mica books occur sparingly along the margins of the core. They are clear and dark brown and are badly buckled, wavy, and cracked. Very little sheet mica could be recovered from those that are exposed. Crystals of white beryl as much as 6 in. in diameter also occur along the margins of the massive quartz. The last prospecting was done prior to World War II by the Seaboard and Southern Minerals Co. Additional work is needed to estimate the potentialities of the dike as a beryl deposit.

VAUGHAN MINE

The Vaughan mine is 2½ miles east of Amelia (location 20, fig. 52) and can be reached from that town over United States Highway 360 and State Highway 627. It is west of the State road and on the opposite side of a small creek. The deposit was worked by W. W. Howe in 1942 and by R. E. Kemmerer early in the spring of 1944. The main opening, a pit 30 ft long and 25 ft wide, originally was 40 ft deep but was partly backfilled during the recent driving of a short crosscut at a depth of 8 ft.

The nearly vertical pegmatite dike trends east and is at least 10 ft thick. A quartz core thins from 5 ft at the rim of the cut to 1 ft at the 40-ft level. The wall zone is an aggregate of kaolinized feldspar, book muscovite and biotite, and interstitial quartz. Black tourmaline crystals as much as 8 in. long and 1 in. in diameter occur sparingly with muscovite along the margins of the core. Most of the largest mica books are less than 4 in. across. The mineral is cinnamon brown, flat, free splitting, and in general of good quality. The books near the surface are heavily clay-stained. Although the downward tapering of the quartz core may limit reserves of the chief mica-bearing zone beneath

the cut, additional mica might well be obtained along the strike to the east and west.

VAUGHAN PROSPECT

The Vaughan prospect is 3.3 miles east of Amelia, about midway between State Highways 627 and 628 (location 21, fig. 52). It can be reached from State Highway 627 over 0.9 mile of dirt road and 600 ft of trail that extends to the north. The deposit is owned by Waverley Vaughan and was leased to W. W. Howe in 1943. The main opening is a cut 20 ft long, 12 ft wide, and 5 ft deep.

The pegmatite dike is at least 8 ft thick and strikes N. 50° E. in quartz-biotite gneiss. A 3- to 4-ft quartz core is exposed in the cut, where it is flanked by a kaolinized feldspathic wall zone. Green beryl crystals about 1½ in. in average diameter and as much as 8 in. long are scattered in moderate abundance throughout the core. Mica occurs sparingly as very small books along the margins of the quartz, and the amount of recoverable sheet material from the exposed books is negligible. Although the beryl content of the core appears to be exceptionally high, perhaps more than 3 percent of the rock in the cut, the crystals are scattered and rather small for satisfactory recovery by hand cobbing.

MILINDA HARRIS WINFREE PROSPECTS

The main opening at the Milinda Harris Winfree prospects, a few hundred feet west of State Highway 627 and 3.2 miles east of Amelia (location 22, fig. 52), is an old, partly filled pit 20 ft long and 15 ft wide. No pegmatite is exposed, but abundant mica and quartz float west of the pit suggests the presence of several parallel pegmatite bodies that trend about N. 50° E. Some appear to be continuous for strike distances of 300 ft or more, and one of them probably was mined in the pit. The clay-stained surface mica is in hard, dark-brown, free-splitting books as much as 2 in. in diameter. In general the quality is good.

Float blocks of massive milky-white quartz are abundant in a 100-by-200-ft area 500 ft northeast of the pit. They appear to have been derived from the core of a thick pegmatite body. Kaolinized feldspar is exposed in a shallow pit that was dug along one side of a quartz outcrop, and mica float is abundant near the pit. Beryl is reported to be present in the deposit. Additional surface exploration is needed to determine the potentialities of the pegmatites as sources of mica or beryl.

MOTTLEY MINE

The Mottley mine is between State Highway 603 and Beaverpond Creek, 3½ miles south-southeast of Amelia (location 24, fig. 52). It was opened in 1938 by Abner Pinchbeck, who excavated a cut to a depth of about 20 ft, and was operated in 1943 and 1944 by R. E. Kemmerer for the Amelia-Mottley Syndicate. In 1945 the workings comprised two shafts and the Pinchbeck cut, which is about 30 ft long, 15 ft wide, and 8 ft deep. One shaft is 50 ft west of the cut and 14 ft deep, and the other is 100 ft east of the cut and 42 ft deep.

A mass of quartz trends N. 80° E. between the two shafts and is flanked by kaolinized feldspathic pegmatite. The thickness of the dike is about 20 ft. It appears to dip gently northward in the shallower shaft, but the structure at the bottom of the other shaft is not known with certainty. Little pegmatite was encountered in the lowest 7 ft, and the dike may pinch out or dip to one side of the shaft. Both the pegmatite and the enclosing mica gneiss are thoroughly weathered in all the workings. Light brownish-olive book mica is abundant along the margins of the core. Most is of the flat-A variety and rather soft, and much of that obtained in the east shaft was badly hair-cracked. The proportion of recoverable sheet mica is low.

GOLDEN PROSPECT

A prospect near the Mottley mine was opened by a Mr. Golden in 1943 (location 24, fig. 52). Blocky feldspar is exposed in a small cut, and massive quartz in a shallow pit about 25 ft farther up the gentle hill slope. Dark-brown mica occurs in books as much as 4 in. across, and small quantities of trimmed sheets were recovered during the prospecting.

D. E. KRAFT PROSPECT

The Kraft prospect is near the abandoned county poor farm, 4.2 miles south-southeast of Amelia (location 25, fig. 52). It is owned by D. E. Kraft, of Amelia, and was last worked by W. W. Howe in 1942. A vertical pegmatite dike that strikes nearly east is exposed in two pits. The west pit is 20 ft long, 15 ft wide, and 20 ft deep, and the partly filled east pit is 10 ft in diameter and 18 ft deep. The deposit is 10 ft thick and contains a 4-ft quartz core with a flanking wall zone of kaolinized feldspar, quartz, and mica. Much of the mica is concentrated along the footwall. A few of the books are as much as 4 in. in diameter, but most are much smaller. The mineral is clear and brown but chiefly of scrap grade. It is badly cracked, buckled, ruled, and clay-stained.

WYATT VAUGHAN PROSPECT

The Wyatt Vaughan prospect is southwest of State Highway 614 and 4.1 miles due south of Amelia (location 26, fig. 52). A small pit exposes an eastward-trending pegmatite dike, and mica and quartz float east and west of the pit suggest a strike length of at least 100 ft. All the prospecting was done along one side of a quartz mass of unknown thickness. Book mica is

moderately abundant. It is flat, hard, and in general of good quality. The proportion of trimmed sheets recoverable from the crude mica ranges from 5 to 10 percent. Further exploration of the deposit might be warranted.

HARRISON VENABLE PROSPECT

The Harrison Venable prospect is 4.9 miles S. 15° E. of Amelia, on the north side of State Highway 608 (location 28, fig. 52). A pit 10 ft square and 10 ft deep was sunk by W. W. Howe in 1942. It exposes a nearly vertical 3-ft pegmatite dike that strikes N. 80° E. Float masses of quartz and mica suggest that the dike may be continuous for about 750 ft along the strike. It appears to thicken and perhaps to branch west of the pit. A discontinuous quartz core forms about half the thickness of the pegmatite in the pit. It is surrounded by a wall zone of kaolinized feldspar, interstitial quartz, and moderately abundant mica. The mica books are light brownish olive and about 4 in. in average diameter. They are flat and free splitting, but many are ruled and some are cracked and faintly reeved. Further prospecting might disclose minable concentrations of mica.

PONTON MINE

The Ponton mine is 5 miles S. 8° E. of Amelia, at the junction of State Highways 608 and 614 (location 27, fig. 52). The main opening is a pit 45 ft long, 10 to 20 ft wide, and 15 ft deep. The vertical pegmatite dike trends N. 65° W. in weathered quartz-biotite gneiss with foliation that strikes N. 45° W. and dips 45° SE. A 5-ft quartz core forms the south wall of the cut. On its north side are a 2-ft intermediate zone of blocky perthite and a 3-ft wall zone of kaolinized plagioclase-quartz-mica pegmatite with scattered masses of burr rock 6 to 10 in. in diameter.

Clusters of mica books occur with plagioclase between large perthite crystals in the intermediate zone. They are as much as 5 in. in diameter, and most are flat and unbroken. Some are reeved. Four-by-four-inch trimmed sheets of medium-brown mica are said to have been recovered from the deposit. Further work might well be done on the south side of the quartz core, as well as along the strike on its north side, but any shallow mining would be made difficult by the nearness of the road and by the swampy ground around much of the deposit.

MAYS MINE

The Mays mine, about 500 ft south of the Venable prospect and 5.2 miles S. 15° E. of Amelia (location 29, fig. 52), is on land owned by the George Mays heirs. A little work was done during March 1945 by Ed Carroway, but otherwise the mine has lain idle for many years. One partly filled pit is 25 ft in diameter and 15 ft deep. A more recent, very shallow pit lies to the southwest.

The country rock, a weathered quartz-biotite gneiss, strikes N. 10° E. and dips 30° E. The vertical pegmatite body, which strikes N. 65° E., is 10 ft thick in the main pit but only 1½ ft thick in the other opening. It is distinctly zoned. The discontinuous core comprises tabular quartz masses 8 to 10 in. thick and 4 to 5 ft long. The wall zone is 3 to 4 ft thick and consists of kaolinized feldspar, quartz, and mica. Some masses of granular quartz are 3 to 12 in. in diameter. The ½-in. border zone is composed of fine-grained plagioclase and small mica flakes.

Mica is fairly abundant in the wall zone, where it occurs with plagioclase around the margins of the granular quartz masses. Some of the books are as much as 10 in. in diameter, and many appear to be of moderately good quality. They are light brown, with faint reddish to greenish tinges, and are flat, hard, and free splitting. Many are ruled and cracked, and some are lightly reeved. Clay staining is common. Some books, yellowish olive rather than brown, contain abundant inclusions of hematite. Additional work along the strike and down the dip of the deposit might well disclose appreciable quantities of mica-bearing rock.

OTHER PROSPECTS

The descriptions of three additional deposits were obtained from the Colonial Mica Corp.:

Wesley Winfree prospect.—A mica deposit on the Wesley Winfree property, several hundred feet west of State Highway 627 and 3¼ miles east-southeast of Amelia (location 23, fig. 52), was first prospected about 1902. Bold outcrops of white quartz appear to mark the west end of a thick pegmatite dike that can be traced several hundred yards S. 80° E. Float mica books and quartz blocks are abundant.

Anderson prospect.—The Anderson deposit is on a west slope 0.6 mile southwest of State Highway 653 and 6.3 miles south-southeast of Amelia (location 30, fig. 52). Small books of clay-stained brown mica were obtained from several shallow prospect openings.

Munden prospect.—The Munden prospect is less than half a mile east of Denaro and about 6½ miles south of Amelia (location 31, fig. 52). Sheets of clear brown mica are said to have been recovered from old, shallow prospect openings.

OUTLYING DEPOSITS

LIGON MINES

The Ligon mines are three-fourths mile north of State Highway 635 and 9 miles N. 15° E. of Amelia (location 32, fig. 52). They are said to be owned by

John E. Garnett and were worked by Abner Pinchbeck in 1923, by W. W. Howe in 1942, and by D. B. Sterrett during the fall of 1944. Four deposits have been mined.

The No. 1 mine, 625 ft S. 29° W. of the Garnett residence, is an open-cut 35 ft long, 20 ft wide, and 12 ft deep. It exposes a pegmatite body that is at least 15 ft thick and strikes southeast in quartz-biotite gneiss. A discontinuous quartz core is flanked by medium-grained quartz-kaolinized feldspar pegmatite. Blocky perthite is abundant on the dump and may have been mined from a discontinuous intermediate zone. Mica is moderately abundant along the quartz core. Most of the books are less than 4 in. in diameter and are soft, clay-stained, and badly fractured. Harder and less-stained books may occur in deeper parts of the deposit.

The No. 2 mine, 250 ft N. 29° E. of the No. 1, is a shaft that is nearly circular in cross section and about 20 ft in diameter at the collar. It was deepened to 40 ft in 1944 by D. B. Sterrett, who drove short tunnels to the north and northeast. All the workings were flooded when the deposit was examined in March 1945, and no pegmatite was exposed. According to Sterrett, the pegmatite body is an irregular pipe that does not extend far beyond the shaft in any direction. It contains a quartz core as much as 18 ft thick and a surrounding intermediate zone of unkaolinized blocky perthite. The wall zone is weathered plagioclase-rich pegmatite. Blocks of clear to slightly milky massive quartz, as much as 6 ft across, and smaller blocks of white to salmon-colored perthite are abundant in the dumps. Green beryl crystals 3 in. in maximum diameter are embedded in the quartz. Small books of brown, hard, free-splitting mica also are present. The general quality is good. The pegmatite in the bottom of the shaft is said to contain a little mica.

The No. 3 mine is 310 ft N. 6° E. of the Garnett residence and consists of a cut 30 ft long, 20 ft wide, and 15 ft deep and a caved 10 ft shaft from the cut floor. Little pegmatite is exposed, but the abundant large blocks of massive quartz in the dumps probably were taken from a fairly continuous quartz core. Some contain crystals of yellow beryl half an inch in diameter, and larger crystals are said to have been recovered during the mining. Blocks of hard, unaltered perthite 10 in. in maximum diameter also are abundant and probably were mined from an intermediate zone. Small, soft fragments of mica are severely fractured and clay-stained and contain very little sheet material.

The No. 4 mine, about 1,500 ft N. 12° W. of the house, is a cut 45 ft long, 20 to 30 ft wide, and 20 ft deep. A nearly vertical pegmatite dike strikes N. 75° W. in quartz-biotite gneiss. It may have been as much as 7 ft thick in the cut, but it thins southeastward to 3 ft or less. The rock at the southeast end of the cut is rich in kaolinized feldspar, with minor quartz and small mica. Large fragments of mica are moderately abundant in the dumps. The mineral is flat, hard, and of good quality. No sheet material could be recovered from the books exposed in the southeastern part of the cut, and the rich concentrations of large books appear to have been mined out to the deepest part of the workings.

KEYSTONE MINE

The Keystone mine is on a ridge between Beaverpond Creek and an east branch, 1.8 miles southwest of Truxillo and 4.8 miles N. 80° W. of Amelia (location 37, fig. 52). It was opened in 1907 and was worked for brief periods in 1914 and 1925. The 45-ft shaft was reopened in 1943 by E. J. Tyler, of Asheville, N. C., who found that the deposit had been mined out to its keel. It is an irregular pipelike mass 3 to 8 ft thick and appears to have consisted of a quartz-feldspar wall zone and a massive quartz core. The only exposed pegmatite comprises "skims" of the main mass on the walls of the workings and a few thin branches that extend into the schistose diorite wall rock. The country-rock foliation is vertical and trends N. 15° W. The mica in the deposit was clear, free splitting, and dark brownish olive.

SCHLEGAL (NORFLEET) MINE

The Schlegal deposit is north of State Highway 307 and 1 mile west-northwest of Jetersville (location 42, fig. 52). It was first worked for feldspar between 1880 and 1885 and was abandoned about 1905. A partly flooded cut is 50 ft long, 40 ft wide, and at least 30 ft deep. Two shafts extend from the bottom of the cut, and irregular stopes and drifts are said to have been developed to a depth of 100 ft. The pegmatite dike strikes nearly west in a distinctly foliated diorite with minor layers of gneissic granite. The country-rock foliation strikes N. 15° W. and dips steeply east-northeast.

The deposit is very large in the main part of the mine but is said to pinch to about 10 ft at the northwest end of the cut. Pegmatite is now exposed only in the southwest end of the cut, where it consists chiefly of hard, unaltered, white to salmon-colored perthite and massive quartz. Subordinate constituents are muscovite, plagioclase, and garnet. The mica is brown and appears to be of fair quality, but nearly all the books in the dumps are small. Clear, unusually dark sheets are said to have been obtained during the mining.

Several outcrops of pegmatite are on the Norfleet property in the vicinity of the mine, and one of the pegmatite bodies can be traced for more than a quarter of a mile (Sterrett, 1923, p. 318). Ten- to thirty-foot

thicknesses of pegmatite contain coarse feldspar, pods of quartz, and aggregates of wedge-A mica books. Individual books of flat mica are fairly abundant.

JAMES ANDERSON PROSPECT

The James Anderson prospect is 0.6 mile west of Rodophil and 6.7 miles N. 33° W. of Jetersville (location 41, fig. 52). An open-cut near the James Anderson residence is 40 ft long, 5 to 10 ft wide, and 7 ft deep. It was excavated in 1942 in a nearly vertical pegmatite dike that trends east in quartz-biotite schist. Neither wall of the deposit is exposed. A persistent quartz core is flanked by a zone of coarse salmon-pink perthite with minor quartz. Dark-green to greenish-blue beryl crystals 2 to 10 in. in diameter are fairly abundant along the margins of the quartz. Small books of mica occur sparingly in the feldspathic parts of the dike, especially in plagioclase-rich pegmatite near the walls. The mica is dark yellowish olive, hard, and free splitting, but much is stained with black spots and latticelike intergrowths of iron oxides. Many of the books are marked by "A" structure, and most of the larger ones are badly cracked. Owing to the scarcity and poor quality of the mica, the deposit offers few possibilities except as a source of beryl.

Small fragments of float mica occur along the trend of several other pegmatite bodies in the vicinity of the open-cut.

OTHER PROSPECTS

The descriptions of the following nine deposits were obtained from the Colonial Mica Corporation:

James D. Laurence prospect.—A prospect on the James D. Laurence property, about a quarter of a mile south of State Highway 635 and 7½ miles north-northeast of Amelia (location 33, fig. 52), was worked for a short time in 1942 by W. W. Howe. An inclined shaft had been sunk about 20 years earlier. The pegmatite body strikes N. 75° W. and dips 20° SSW. It contains a quartz core and a wall zone of kaolinized feldspar and interstitial quartz. Mica books as much as 4 in. in diameter occur sparingly along the margins of the core.

Tinsley prospect.—The Tinsley deposit is 0.4 mile east of State Highway 636 and 8½ miles north of Amelia (location 34, fig. 52). Small books of clay-stained mica were obtained many years ago from shallow cuts and trenches.

E. L. Llewelyn prospect.—Small books of dark-brown mica have been obtained from a shallow pit on the E. L. Llewelyn property 0.4 mile southeast of State Highway 149. The prospect is 1.4 miles northeast of Moraven and 7¼ miles northwest of Amelia (location 35, fig. 52). Most of the work was done by the owner during the spring of 1943. The mica is moderately abundant along the margins of a quartz core.

Old Lee Goodman prospect.—The Goodman deposit is near the Llewelyn prospect and State Highway 149. It is owned by L. H. Riggsbee. A pegmatite that strikes N. 5° W. is exposed for a distance of 100 ft. It is 20 ft or more thick and contains abundant small, badly broken books of mica. A few are specked.

G. C. Wingo deposit.—The G. C. Wingo deposit is on the south side of State Highway 644; it is 1.2 miles southeast of Paineville and 7.3 miles west-northwest of Amelia (location 36, fig. 52). Broken, clay-stained fragments of brown mica are scattered around several old slumped prospect openings.

Lambert prospect.—The Lambert deposit is on the side of a small branch, 1¼ miles north of Rodophil and 2.2 miles west of Paineville (location 38, fig. 52). The pegmatite dike contains a quartz core and fringing books of brownish-olive, heavily stained mica.

Foster prospect.—The Foster deposit is on the east side of a small branch 1 mile north of Rodophil (location 39, fig. 52). Clay-stained books of mica are scattered near several old slumped pits and cuts. Most contain black spots and brown latticelike intergrowths of iron oxides.

Ford prospect.—The Ford deposit is about midway between the Foster prospect and State Highway 620 (location 40, fig. 52). Stained books of mica are present in the dumps from shallow cuts and trenches.

Houston prospect.—The Houston deposit is north of Buckskin Creek, three-fourths mile south of State Highway 640 and 1.8 miles south-southeast of Jetersville (location 43, fig. 52). Small, clay-stained books of light-brown mica occur in a pegmatite body with a prominent quartz core.

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