Pegmatites in the Blue Ridge of North Carolina are important sources of sheet and scrap mica, feldspar, kaolin, and quartz. Small amounts of beryl, columbite-tantalite, monazite, sammakite, and uranium minerals also have been produced. The mica-bearing pegmatites occur in mica and hornblende gneiss and schist throughout the Blue Ridge province but are concentrated in the Spruce Pine and Franklin-Sylva districts.

The Blue Ridge is geologically complex; the rocks are mainly poly metamorphic orthogneisses and paragneisses and schists that are part of a large thrust sheet that has moved at least 30 miles to the northwest in the northern part of the area. This thrust sheet is bounded on the east by the Brevard fault zone and on the west by the Unaka Mountain belt which consists of metamorphosed and nonmetamorphosed late Precambrian and Cambrian sedimentary rocks in various complex folds and thrust faulted blocks.

During an early Precambrian metamorphic period a thick sequence of sedimentary and volcanic rocks was altered to gneiss and schist. Parts of the sequence were migmatized to layered granite gneiss and intruded by masses of granite and granodiorite. In the early or middle Paleozoic a second period of regional metamorphism resulted in the widespread intrusion of pegmatite associated in some areas with large masses of finer grained granodiorite. The pegmatites are in areas where the metamorphic intensity in the second period of metamorphism reached at least the kyanite-muscovite andalusite zone of the amphibolite facies. Some deformation of the pegmatites occurred after crystallization, and later faulting in the pegmatites is probably related to a late Paleozoic deformation that culminated in widespread thrust faulting.

The pegmatites have a simple mineralogy and structure and range in composition from granite to granodiorite. The principal minerals are oligoclase, perthitic microcline, quartz, and muscovite. Biotite and garnet are the main accessory minerals, but a wide variety of other minerals has been found in minor amounts.

Two-thirds of the pegmatite bodies are tabular, a quarter of them are lenticular, and the remainder are of irregular shape. About half the bodies are discordant with the foliation of the enclosing country rock. Simple mining has been reported in about 40 percent of the deposits but may have been overlooked in some others. The most common type of zoned pegmatite has a plagioclase-muscovite-quartz wall zone and a quartz or quartz-perthite core. A few deposits have perthite intermediate zones or cores. More than half the deposits are deeply weathered, and for many of those the pegmatite is incompletely known.

Sheet mica generally is scattered throughout unzoned deposits or is concentrated in wall zones. In some deposits, mica is concentrated in shoots within a zone. The size and quality of the mica vary widely between districts, within districts, and even within a single deposit. About 20 percent of the deposits contain some stained mica, about 15 percent contain mica with mineral intergrowths, and about 30 percent contain mica that has been deformed after crystallization.

Descriptive data are available on 1,350 mines and prospects. About 100 mines have an individual production greater than 10,000 pounds of sheet mica, but more than half of the deposits have produced less than 800 pounds each. Total production of sheet mica for the region is unknown. Production in recent years has been 25-50 percent of the total weight and 45-85 percent of the value of United States production. About half of the scrap mica and half or more of the feldspar produced in the country have come from the Blue Ridge area.

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and others, 1946). The following men mapped in one or more of the principal districts in the Blue Ridge for others as part of the Survey's strategic minerals investigations (Kesler and Olson, 1942; Olson, 1944; Olson 1952), study of the feldspar deposits in the Bryson City district (Cameron, 1951), and examination of the pegmatites of the Cashiers and Zirconia districts (Olson, 1952). These studies were also done in cooperation with the North Carolina Department of Conservation and Development.

From 1945 to 1953, emphasis was placed on aerial geologic mapping in the Spruce Pine district (Parker, 1952; Kulp and Brobest, 1956; Brobest, 1962), study of the feldspar deposits in the Bryson City district (Cameron, 1951), and examination of the pegmatites of the Cashiers and Zirconia districts (Olson, 1952). These studies were also done in cooperation with the North Carolina Department of Conservation and Development.

Each district has been used in preparing this report. No maps of individual deposits are available, but many of the important deposits are available either in reports by geologists from the U.S. Geological Survey and of mining engineers from the U.S. Bureau of Mines. The field examinations for the Geological Survey were made by D. H. Amos (1939-45), S. A. Bergman (1955-55), E. B. Boudette (1957), A. R. Laurence (1956-57), R. L. McDowell (1951-55), and E. L. Boudette (1957). These studies were also done in cooperation with the North Carolina Department of Conservation and Development. From 1939 to 1945 the work was done in cooperation with the Bureau of Mines.

The Blue Ridge province is bounded on the southeast by the Piedmont province (fig. 1) and on the northern side by the Valley and Ridge province. The borders of the Blue Ridge are clearly defined in most places at the base of an abrupt slope, but, locally, the transition is too gradual to fix the boundary accurately.

In North Carolina the term "Blue Ridge" in its toposynthetic sense is applied only to the main divide which lies near the southeastern edge of the province. The steep slopes of the Piedmont to this divide is termed the "Blue Ridge front." The high linear mountain ridges along the northeastern edge of the province are called the Unaka Mountains. The mountain groups, ranges, and peaks between the Blue Ridge front and the Unakas generally lack a systematic orientation. The major valley bottoms are broad, but the slopes steepen rapidly along smaller streams. Slopes of 30°-45° are common in the headwater areas. Slopes inclined less than 10° form a minor part of the area.

Much of the Blue Ridge province in North Carolina is drained by tributaries of the Tennessee and New River basins, both of which flow into the Ohio River. The major rivers draining eastward to the Atlantic coast along the Blue Ridge front. The area has a humid climate, and surface and ground water are generally abundant. The mountains are heavily wooded. Rock exposures are generally limited to a few steep slopes, streambanks, and roadcuts. The depth of weathered rock ranges from a few feet to more than 100 feet.

**GEOLOGY**

The Blue Ridge province in North Carolina contains old sedimentary and igneous rocks that have a complex metamorphic and structural history. The area was mapped in reconnaissance by Arthur Keith and his associates from 1928 to 1935, The latter half from 1936 to 1940, and the early work generally lacks a systematic orientation. The major valley bottoms are broad, but the slopes steepen rapidly along smaller streams. Slopes of 30°-45° are common in the headwater areas. Slopes inclined less than 10° form a minor part of the area.

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Bryant, 1964), the Great Smoky Mountains (Hamilton, 1961; Hadley and Goldsmith, 1961; King, 1964; Neuman and others, 1960; King, 1965; Spruce Pine City area (Cameron, 1951). On plate 1 the geology of the Blue Ridge has been generalized from Keith's folio maps and the more recent mapping.

The Blue Ridge geologic province, which does not coincide exactly with the physiographic province, has been divided into three major geologic belts by King (1955, 1956): A narrow Brevard belt on the east, a wide Blue Ridge belt in the center, and the Unaka belt on the west. These belts differ in rock type, grade of metamorphism, and structure. More than half of the province is formed by the Blue Ridge belt, which contains a basement complex of older Precambrian micaceous gneiss and schist, hornblende gneiss and schist, migmatic, and granitic gneisses, and locally extensive areas of Precambrian metasedimentary rocks. Interspersed into these rocks are small stocks and dikes of younger Precambrian and Paleozoic granite, granodiorite, pegmatite, and ultramafic rocks. The presence of younger Precambrian and Cretaceous metasedimentary rocks, granitic gneisses, and migmatic schists has been generalized from Keith's folio maps and interpreted it to be a downfolded mass of sediments and associated intrusive bodies of gabbro or diorite.

LOWER PRECAMBRIAN BASALT COMPLEX

Most of the Blue Ridge belt is composed of a thick sequence of interlayered mica gneiss and schist and hornblende gneisses and schists. The mica-rich rocks comprise Keith's Carolina Gneiss, and the hornblende-rich rocks, his Roan Gneiss. Keith (1904, p. 2) described the Carolina Gneiss (of former usage) as "an immense series of interlayered mica-schists, mica gneiss, hornblende gneiss, and fine-grained granitoid layers." The Roan Gneiss (of former usage) he described as "a great series of beds of hornblende gneiss, hornblende-schist, and diorite, with some interbedded mica-schists and mica gneiss" (Keith, 1904, p. 3). Recent workers in the Spruce Pine district, however, did not use Keith's terminology; instead, they mapped areas of predominately mica schist, mica gneiss, or hornblende gneiss (Olson, 1944; Parker, 1952; Bryant, 1962, p. 3). The older gneiss types are not shown separately on plate 1. The mica-rich rocks are the more abundant of the two groups, and mica gneiss is probably more abundant than mica schist. The gneiss and schist are interlayered and grade from one to another. Both are light to dark gray and fine- to medium-grained. Field relations indicate that the gneisses are probably metamorphosed intrusive bodies of gabbro or diorite.

LAYEDER ERTIC GNEISS

The area shown as layered gneissic granites on the geologic map (pl 1) includes most of what Keith mapped as "Cranberry Granite" and also the small area that he mapped as "Henderson Granite" northeast of Old Fort (Keith, 1905b). In the Cranberry, Keith (1904, p. 3-4) included granitic varieties of texture and color, schists and gneisses derived from granite, and small bodies of metasediments, metabasite, metagabbro, pegmatite, quartz-diorite, and mica and hornblende gneisses similar to the Carolina and Roan Gneisses of former usage. According to Bryant (1962, p. D13), the Cranberry in the type area consists of masses of gray layered and nonlayered gneissic granites and layers of green to black amphibolite, hornblende gneisses, and epidote-biotite schist. He redefined the unit as the Cranberry Gneisses because of the prevalence of gneissic structure and the heterogeneous composition (Bryant, 1962, p. D13). Hamilton (1960) found massive uniform granite, layered granite, quartz monzonite and gneiss, and gneissic quartzite, metagabbro, in an area of northeastern Tennessee mapped as Cranberry by Keith. According to Hamilton (1960, p. 13), at least some of Keith's metagabbro layers are mylonite. Oriel (1950, p. 32) found many diverse rock types in areas of Keith's Cranberry Granite near Hot Springs, N.C., and in other areas this unit probably includes many types of metamorphic rock.

The geologic and stratigraphic relations of the layered gneissic granites to other rocks in the Blue Ridge are not clear. Keith thought the Cranberry was younger than the gneisses of the Carolina and Roan belts, but recent workers in the Spruce Pine area have interpreted the Cranberry as interlayered with the mica and hornblende gneisses in a transition zone and consider the Cranberry to be the oldest unit of a thick sedimentary sequence that has been metamorphosed and granitized (Brobst, 1955, p. 581; Eckelmann and Kulp, 1956). Bryant (1962, p. D14) also recognized a mixed zone between Cranberry Gneiss and the mica and hornblende gneisses and suggested that the transitional rocks are a migmatic zone and the Cranberry a more granitized part of that zone. Because of structural complications, it is uncertain whether or not the Cranberry Gneiss lies stratigraphically below the mica and hornblende gneisses (Bryant, 1962, p. D14).
Gratiate and Nonlayered Granitic Gneiss

Large masses of lower Precambrian nonlayered granitic gneiss and gneisitic granite are found within layered gneisses along the southern Blue Ridge belt and as isolated areas in the Grandfather Mountain window and in the southeastern part of the Great Smoky Mountains. The layered gneissic granite unit also contains smaller bodies of nonlayered gneisites not mapped by Keith and too small to show on plate 1. The larger bodies of nonlayered gneisites in the layered gneisses were mapped by Keith as Beech Granite in the Cranberry and Roan Mountain quadrangles (Keith, 1903, 1905a). Recent work by Bryant (1962, p. D15) indicates that "the Beech Granite is a coarse-grained inequigranular white to light-pink, cataclastic granite." According to Bryant, a similar nonlayered granite gneiss occurs in elongate masses and irregular bodies along the edge of the Blue Ridge belt northwest of Asheville. Keith (1904, p. 4) described this granite gneiss as the Wilson Creek Gneiss. The Wilson Creek Gneiss is a fine-grained equigranular to markedly inequigranular rock that ranges in composition from granite to granodiorite (Keith, 1903, p. 10). Included in this gneiss are thin layers of mica gneiss, hornblende gneiss, and mafic rocks. Keith (1903, p. 3) mapped the granite as a massive granitic rock, but its genetic relationship to the hornblende gneiss of his Roan Gneiss is not clear. Keith (1905, p. 28-34) describes 15 other kinds of ultramafic rocks of the Ocoee Series in the Ocoee and nearby areas. None of these formations contains pegmatite.

GRANITE AND NONLAYERED GRANITIC GNEISS

The Wilson Creek Gneiss has an average composition of 40% quartz, 28% microcline, and 26% albite; the maximum grain size is 4 inches (Bryant, 1962, p. D6). According to Bryant (1962, p. D19), the Wilson Creek Gneiss formed as a massive granite rock, but its genetic relationship to the granite gneisses is not clear. Keith (1904, 1905a) describes a fine-grained granite gneiss that is a massive granitic rock, but its genetic relationship to the granite gneisses is not clear. According to Keith, the Max Patch Granite intrudes the layered granite gneisses of the Blue Ridge belt (Keith, 1903, p. 4). Keith described the gneiss as a light-gray to red mica-granite that is a fine-grained equigranular to markedly inequigranular rock that ranges in composition from granite to granodiorite (Keith, 1903, p. 10). Keith (1905, p. B13—B24) mapped as biotite flaser and augen gneisses that have a composition of quartz monzonite and granobiotite. Small layers of mica gneiss, hornblende gneiss, and mafic gneiss are common. A few leucosomes and fine-grained bodies of sheared pegmatite ranging in width from several inches to several feet occur in the gneissic granite in the Dooly area (Hadley and Goldsmith, 1963, p. B20). The principal minerals are pink potassium feldspar, subordinate plagioclase and quartz, and biotite and garnet.

UPPER PRECAMBRIAN ROCKS

The term Bakersville Gabbro was first used by Keith (1905). It is a massive ultramafic rock composed of plagioclase, hornblende, and minor feldspar. Keith (1905) noted that this rock is a fine-grained equigranular porphyritic, metagabbro. Labradorite, microcline perthite, and opaque minerals are present in the less metamorphosed parts, and hornblende, garnet, calcic amphibole, and plagioclase are present in the more metasomatized parts. Keith and Pederson (1958) describe similar metagabbro from near Bakersville as part of a large dike swarm.

The Bakersville Gabbro intrudes both the layered gneissic granite and the interlayered mica-hornblende gneiss. The gabbro is younger than the early plutonic metamorphosed rocks but older than the late regional metamorphism (Kulp and Poldervaart, 1956, p. 399). A few bodies of metagabbro were also mapped by Keith (1904) near Alexander and Slocumville in Ben- n Donne County. The pegmatite is believed to be related to the hornblende gneiss of Keith (1903) and older than the Bakersville Gabbro which he considered unmetamorphosed. These bodies of metagabbro are not shown on plate 1.

OCEAN SERIES

Metasedimentary rocks of the Oceania Series of late(?), probably Cambrian age make up most of the Great Smoky Mountains and also occur in small downfolded areas in the Blue Ridge belt (King, 1955, p. 360). Because detailed information is lacking, the smallest downfolded areas of Oceania or equivalent rocks are not shown separately in the complex. The massif gabbro intrudes the gneissic gneisses that are described as biotite gneisses and augen gneisses that have a composition of quartz monzonite and granobiotite. Small layers of mica gneiss, hornblende gneiss, and mafic gneiss are common. A few leucosomes and fine-grained bodies of sheared pegmatite ranging in width from several inches to several feet occur in the gneissic granite in the Dooly area (Hadley and Goldsmith, 1963, p. B20). The principal minerals are pink potassium feldspar, subordinate plagioclase and quartz, and biotite and garnet.

UPPER PRECAMBRIAN ROCKS

The term Bakersville Gabbro was first used by Keith (1905) for rock units in the center of the layered gneissic granite unit. Keith (1905) noted that this rock is a fine-grained equigranular porphyritic, metagabbro. Labradorite, microcline perthite, and opaque minerals are present in the less metamorphosed parts, and hornblende, garnet, calcic amphibole, and plagioclase are present in the more metasomatized parts. Keith and Pederson (1958) describe similar metagabbro from near Bakersville as part of a large dike swarm.

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rocks that contain various proportions of olivine, pyroxene, and amphibole, and several types of rock formed by secondary alteration. Contacts between ultramafic rock and the enclosing gneiss and schist are relatively sharp and generally roughly concordant (Pratt and Lewis, 1905, p. 29; Hadley, 1949, p. 113). The outer edges of most ultramafic rocks are altered and sheared, and even the fresh dunite in the larger masses is generally granulated. Where cut by joints and faults, the dunite is altered to chlorite, talc, sericite, andesine, or serpentine. Many of the ultramafic deposits are only a few feet or few tens of feet wide and a few hundred feet long; but one of the largest masses is 2,000 feet wide and 8,000 feet long and covers an area of 300 acres on Buck Creek in Clay County. This deposit consists chiefly of dunite (90 percent), but includes troctolite (8 percent) and corundum (Hadley, 1949). Another extensive deposit forms a ringlike structure 6 miles long and 3.5 miles wide around the eastern Great Smoky Mountains to be younger than the gneisses that they intrude, but, they are also deformed (Cameron, 1951, p. 9; Miller, 1953, p. 1137). The principal rock types there are dunite, websterite, and enstatite pyroxenite. The age of the ultramafic rocks is not well established, but it is probably early Paleozoic. The ultramafic rocks are younger than the gneisses that they intrude, but, they are also deformed (Cameron, 1951, p. 9; Miller, 1953, p. 1134; Hadley and Goldsmith, 1963, p. B74). None of these intrusions is dated accurately, but at least some of them are probably Paleozoic. Age determinations reported for minerals from several pegmatites and the Whiteside Granite range from 170 to 708 million years (table 1), but these dates may reflect the final metamorphism and not the time of original crystallization. The Whiteside Granite was named by Keith (1907b, p. 4) from exposures on Whiteside Mountain in Jackson County. Similar dome-shaped masses of granite mixed with gneiss occur in adjacent parts of Macon and Transylvania Counties (pl. 1). The areas that Keith mapped as Whiteside contain numerous sills, dikes, and irregular mass of granite interlayered with and cutting mica gneiss. Gneiss in contact with granite generally contains much added feldspar and quartz, and has been described as migmatite (Olsen, 1938). The granite itself probably has a range in composition: Heinrich (1953, p. 75) describes it as a tonalite-granodiorite, and Griffitts and Overstreet (1952, p. 787) is composed of potassium feldspar, plagioclase, quartz, muscovite, and biotite in various proportions (Olsen, 1952). Lead-alpha determinations on monazite and zircon from the Whiteside range from 358 to 708 million years (table 1) and are not definitive. The age of the Whiteside Granite is too old for Pb to be useful in determining its age.
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**Note:** The table continues with similar entries for different locations and minerals. The entries include geological determinations and references. The text mentions various geological formations and locations, such as the Blue Ridge of North Carolina and Tennessee, and references various studies and authors for the data presented.
Muscovite is present rather than the biotite or hornblende. Accessory minerals include biotite, garnet, apatite, allanite, epidote, thulite, pyrite, and pyrrhotite. Grain size ranges from 1 to 1 inch and averages more than ¼ inch. Locally, large crystals of perthite may be 1 foot or more in length. Much of the rock is sufficiently coarse grained to be called a fine-grained pegmatite (Olson, 1944, p. 22; Parker, 1923, p. 9), and all gradations between coarse-grained light-colored granodiorite and pegmatite occur (Bryant, 1962, p. D18).

The granodiorite is intrusive into the mica and hornblende gneiss units as small iliks, dikes, and irregular masses in several areas of Avery, Mitchell, and Yancey Counties (pl. 1). The largest mass is near Spruce Pine and is at least 4,000 feet wide and 2 miles long (Brobst, 1962, p. A10) whilst the smaller bodies are present in all the granodiorite bodies, especially near the margins. Parts of the larger bodies are massive, but most have a crude foliation or layered structure produced by parallel mica flakes and streaks of quartz, feldspar, and garnet. The foliation is generally parallel with the regional trends of the gneiss and schist.

**Pegmatite**

Mica-bearing pegmatites occur throughout the eastern half of the Blue Ridge province in North Carolina (fig. 1 and pl. 1), but they are concentrated in the Spruce Pine and Franklin-Sylva Districts. Pegmatites are restricted in general to the mica and hornblende gneiss units of the basement complex and, locally, to areas of the mica gneiss where such rocks have been regionally metamorphosed to at least the kyanite-muscovite subfacies of the amphibolite facies. Some also occur in granite and granodiorite. The region probably contains many more pegmatite bodies than are shown on plate 1, but these bodies are apt to be small or mica poor.

The pegmatites throughout the region are generally similar, but there are minor differences within and between districts. The pegmatites are variable in texture. Muscovite, kinds and amounts of accessory minerals, and degree of conformity to the structure of the wall rock. More detailed descriptions of the characteristics of the pegmatites in each district are given in the sections on the individual districts.

In the Blue Ridge as a whole, the mica-bearing pegmatites are predominantly discordant and commonly show a tabular shape (65 percent), lenticular (25 percent), or irregular (10 percent). They range in size from thin seams a few inches thick to large masses several hundred feet thick and more than 1,000 feet long. About half of the deposits in the Blue Ridge are concordant pegmatites, the remaining half are discordant. The texture is generally simple throughout the area; plagioclase, quartz, and biotite are the principal minerals. Biotite and garnet are common accessory minerals, and apatite, beryl, pyrite, and tourmaline are less common. Other accessory minerals are sparse but Sterrett (1923, p. 171) listed 65 different minerals associated with the pegmatites. The Spruce Pine district may have a greater variety of accessory minerals than the other districts.

The occurrence and origin of some of the accessory minerals are described by Hall (1933; 1934), Ross (1937), and Heinrich (1960).

Grain size throughout the area ranges from fine (less than 1 in.) to very coarse (more than 1 ft) in many individual deposits. Perthite crystals are commonly 1 foot long across a ¼ inch and less, whilst inclusions are more than 1 foot across. Muscovite crystals are generally less than 1 foot across, but some are larger than 3 feet across. Plagioclase crystals are generally less than 1 foot across, and quartz grains are generally less than 1 inch. Other minerals are generally in masses or crystals that are at most a few inches across.

The internal structure of the Blue Ridge pegmatites is simple. Many have a simple distribution of minerals throughout, but some zoning of minerals and texture has been reported in about 40 percent of the deposits and zoning may be present in most. The most common zone is a thin, fine to coarse-grained pegmatite, a wall zone of fine- to coarse-grained feldspar, quartz, and muscovite, and a quartz or quartz-perthite core. Intermediate zones with blocky plagioclase or perthite are found in a few deposits.

Poorly zoned deposits contain muscovite scattered throughout the wall rock or may contain mica-rich shoots. These pegmatites are often well foliated and contain a mica-rich core. Most of these pegmatites are discordant and are commonly found in wall zones or along the margins of the core in intermediate zones. Many such deposits have mica-rich shoots, commonly in lenses or rolls in the pegmatite-wallrock contact. Such shoots generally plunge parallel to the plane of minor structures in the wallrock.

Most deposits that have been mined at a profit contain mica-rich zones or mica-rich shoots. All parts of the pegmatite rock may not be equally rich; the mica-rich rock may be only along the hanging-wall side of the pegmatite or, rarely, along the footwall side.

All the mica-bearing pegmatites in the Blue Ridge are discordant and are not related to a single source. The pegmatites are similar in composition and probably in age. They occur in similar structural relationships in a variety of wallrock types. The composition of the wall rock has only minor influence on composition of pegmatite: pegmatites in metamorphic rocks—especially hornblende gneisses—have somewhat more iron and magnesium than those in granodiorite. Pegmatites in granodiorite (Olson, 1944, p. 36). The same sequence of mineral zones in all zoned deposits and the general increase in grain size from the walls inward in both zoned and unzoned deposits are typical of granitic pegmatites in general (Cameron and others, 1949) and are a part of the evidence for magmatic crystallization.

The pegmatites in each district can be classified into two groups: (1) those in which the pegmatites crystallized was clearly intruded into the country rock to form both the concordant and the discordant bodies. The discordant bodies occupy fractures, joints, or faults, and a slight alteration and country rock along foliation planes beyond the ends of some concordant bodies mark possible channelways for the movement of magma. Some of these foliation planes probably are later than muscovite, and in many pegmatites the bulk of the interior consists of plagioclase-muscovite or quartz-muscovite rock. In some deposits the larger part of the mica crystallized first in the fine-grained selvage or border zone. Larger book mica continued to grow and formed a nearly pure perthite core or intermediate zone. Quarts ordinarily continued to form until last and is the core in most zoned deposits. Most of the late fractures fillings consist mainly of quartz. The pegmatites in the Blue Ridge are in general discordant and are commonly found in wall zones or along the margins of the core in intermediate zones. Many such deposits have mica-rich shoots, commonly in lenses or rolls in the pegmatite-wallrock contact. Such shoots generally plunge parallel to the plane of minor structures in the wallrock. Most deposits that have been mined at a profit contain mica-rich zones or mica-rich shoots. All parts of the pegmatite rock may not be equally rich; the mica-rich rock may be only along the hanging-wall side of the pegmatite or, rarely, along the footwall side.

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The pegmatites may well have formed by local melting of constituents of the metamorphic rocks at still greater depth. Their crystallization, however, was also under deep-seated conditions, for mica-bearing pegmatites are abundant in the layered gneiss gneisses where it was metamorphosed only to the biotite-albite grade near the Grandfather Mountain area (Bryan, 1959, p. D21-D29), the muscovite-chlorite or biotite-chlorite grade along the Watauga River (Hamilton, 1960, p. 24), or to similar low grades in parts of the eastern United States (Hayden and Goldsmith, 1963, p. B104-B106).

Possibly the larger intrusives of the Spruce Pine and Cashiers districts were also the result of local melting and migration of small masses of granitic magma in an area of high-grade regional metamorphism, and owe their size to greater heat and pressure that gave rise to the larger masses of mica-bearing pegmatites associated with them. It is evident from the crystallization of the blocky perthite that granite (Olson and others, 1946, p. 13). Possibly the larger intrusives of the Spruce Pine and Cashiers districts were also the result of local melting and migration of small masses of granitic magma in an area of high-grade regional metamorphism, and owe their size to greater heat and pressure that gave rise to the larger masses of mica-bearing pegmatites associated with them. It is evident from the crystallization of the blocky perthite that granite (Olson and others, 1946, p. 13).
is apparently controlled partly by structural attitude and partly by wallrock lithology. Simple tabular pegmatites are generally not so strongly deformed as contorted S-shaped ones. Pegmatites enclosed by thick masses of coarse mica schist are less deformed than those enclosed by gently deformed mica schists. Pegmatite bodies along the margin of the Spruce Pine district, especially those near the contact between interlayered mica and hornblende gneisss with layered granitic gneiss, are more intensely sheared than pegmatites near the center of the district. Similar cataclastic structures are common in the pegmatites in the other districts of the Blue Ridge province, but have not been studied in detail. In general, however, deformed mica books are more abundant in pegmatites throughout the Blue Ridge than they are in similar pegmatites in the Piedmont province (Jahn and others, 1952–53, p. 50).

The age of the deformation is not well known. Some deformation may have occurred during the formation of the pegmatites; some is clearly related to local faulting; however, much of it may be related to the period of regional deformation that followed the main period of regional metamorphism as outlined by Hadley (1905, p. B107). The larger Greenbrier fault mapped in parts of the Great Smoky Mountains is earlier than the main Precambrian regional metamorphism (Hadley and Goldsmith, 1963, p. B90), but its relation to the structures and the pegmatites in the Blue Ridge belt is not known.

**Blue Ridge thrust sheet**

The recent mapping of the Grandfather Mountain window (Bryant, 1962; Bryant and Reed, 1962; Bryant, 1965; Reed, 1964 a, b; Reed and Bryant, 1984) indicates that the basement complex in the Spruce Pine district west of the window is part of an overthrust mass that has moved to the northwest at least 30 miles (48 kilometers). No large structural break is known or apparent from Keith’s reconnaissance mapping of the basement complex between the Spruce Pine and the Franklin-Sylva districts (Keith, 1904, 1905b, 1907b), and it is quite probable that all the basement complex in the Blue Ridge north of the Brevard belt is part of a large thrust sheet. The amount of movement of this thrust sheet may not be the same everywhere along it, and it is not known which, if any, of the thrust faults shown along the western edge of the Blue Ridge is the principal fault along which movement took place. Depth to the fault below most of the Blue Ridge is unknown. In the area between the Grandfather Mountain window and the Mountain City window, Bryant and Reed (1962, p. 167) estimate a depth of 5,000 feet, and they suggest a depth of 10,000 feet or more in the Spruce Pine district. The major thrust movement is inferred to be late Paleozoic (Bryant and Reed, 1962, p. 167). If so, it is younger than the mica pegmatites, and part of the deformation of the pegmatites may be related to this period of faulting.

**Metamorphism**

The basement complex in the Blue Ridge has been metamorphosed several times, and the effects of older periods of metamorphism are partly obscured by later overprinting. The following metamorphic and structural events, however, are recorded in the Blue Ridge belt: (1) a plutonic episode in Precambrian time about 1,000-1,100 million years ago; (2) a period of folding and faulting in the early Paleozoic; (3) a second period of dynamothermal metamorphism reaching a thermal maximum in the middle to late Paleozoic in the eastern Tennessee area. A late Paleozoic deformation accompanied by fewer thermal effects, probably in mid-Paleozoic time; and (5) a late Paleozoic deformation that culminated in large scale thrust faulting. Details of the metamorphic history of the basement complex in northeastern Tennessee are described by Hamilton (1960), in the Franklin-Sylva district by Bryant (1965), and in the eastern Great Smoky Mountains by Hadley and Goldsmith (1963, p. B107). The Precambrian metamorphic history of the Spruce Pine district has been mapped by Kulp and Fielder (1960), and a chronology of the major metamorphic events of the Blue Ridge is given by Hamilton and Eckelmann (1959) and Kulp and Eckelmann (1964).

The oldest metamorphism recognized is a plutonic episode of Precambrian age during which a thick sequence of sedimentary rocks was metamorphosed to gneiss and schist (Bryant, 1962, p. D26; Hadley and Goldsmith, 1963, p. B23). Along the northwestern edge and in the deeper parts of the section these rocks were retrograded at this time where the grade of the new metamorphic environment was less than that of the Precambrian plutonic metamorphism (Hamiltion, 1960, p. 22; Hadley and Goldsmith, 1963, p. B107). A second period of dynamothermal metamorphism then took place, probably during the early or middle Paleozoic. In the Great Smoky region, sedimentary rocks of the Ocoee Series were metamorphosed to the chloride grade in the west and to higher grades in the southeast. Along the western edge of the Blue Ridge belt the basement rocks were retrograded at this time where the grade of the new metamorphic environment was less than that of the Precambrian plutonic metamorphism. One discordant date that range from 170 to 420 million years. Because all the pegmatites contain evidence of
followed the thrusting and preceded the emplacement of fault constitutes a later metamorphic episode that may be related to the late Paleozoic deformation. 

Biotite (black), and phlogopite (amber). All have a biotite-albite grade seems to be related to the period of deformation that culminated in the late Paleozoic. Deformation of the Blue Ridge probably is related to the late Paleozoic thrust faulting, the age of this low-rank metamorphism is not fully established. Some of the observed effects may be related to a late stage of the main Paleozoic and some may be related to the period of thrusting. Deformation of the pegmatites in the Blue Ridge probably is related to this late deformation and may be the metamorphic episode of 350 million years ago, recognized by Kulp and Edeburn (1964). Little metamorphism accompanied the later major period of deformation that culminated in the late Paleozoic faulting and formation of the Blue Ridge thrust sheet. In the Great Smoky area, faulting during the late Paleozoic is characterized by unrecrystallized gneiss and no obvious metamorphism (Hedley and Goldsmith, 1963, p. 235). A similar lack of recrystallization is noted along faults and mylonite of this age in northeast Tennessee (Hamilton, 1960, p. 29). In the Grandfather Mountain area, some recrystallization to phlogopite near or in the pegmatite districts also give discordant K/Ar and Rb/Sr ages that range from 330 to 450 million years. 

The principal mica minerals are muscovite (white), biotite (black), and phlogopite (amber). All have a perfect basal cleavage and form crystals that can be split into thin sheets having various degrees of transparency, to toughness, and cleavage. The micas are common minerals, but only muscovite is of commercial importance in North Carolina. 

Two types of mica are sold: sheet mica, which must be relatively flat, free from defects, and be large enough so that it can be cut into specified sizes; and scrap mica, which is all mica that does not meet sheet mica specifications and is generally ground to a powder. Small sheets of muscovite of poorer quality that can be punched or trimmed into disks 1 inch or larger in diameter are classified as punch mica and are included in the general term "sheet mica." Sheet muscovite is an important insulating material in the electronic and electrical industries. Built-up mica made from very thin sheets and reconstituted mica made from scrap can be substituted for larger sheet mica for some uses (Skow, 1962, p. 11). Scrap mica is used in the roofing, wall paper, rubber, paint, and other industries. 

Sheet mica is commonly mined from the large crystals or books scattered throughout unzoned pegmatite deposits. The manner in which the crystals are obtained by mining and the care and skill of preparation are also important factors affecting the value. 

About 20 percent of the deposits in the Blue Ridge contain reddish-brown (ruby) muscovite, 24 percent contain brown (rum), and 34 percent green; the remainder contains an intergrowth of two parallel, crossed sets of muscovite crystals or books. Some books are lines, striations, or shallow corrugations that lie in the basal surfaces of the mica crystals. Where two sets of ruling are present, the mica is said to have "A" structure. "Herringbone" structure is common in the Blue Ridge. 

Micas that contain mineral inclusions or impurities are called "locked." Locked mica contains reddish-brown or brown muscovite that is free of mineral inclusions or impurities. The recovery of good sheet mica from the crude block mica varies with the type and quality of the mica and the standards of mining, preparation, and classification used by the individual miner. No standards are available, but estimates of recovery of good trimmed mica from crude mica range from 2 to 5 percent for the average mica and are as much as 10 percent from good quality mica in a few mines. 

Prices of sheet mica depend on the size and quality of the sheet. In 1963 they ranged from 7 cents a pound for sheets 1/16 inches by 1/16 inches to 88 cents a pound for sheets 8 inches by 8 inches. During World War II the Government support prices for all sheets 1/16 inches by 1/16 inches ranged from $1.10 to $8 a pound. For sheets 1/8 inches by 1/8 inches from $15 to $17.70 a pound for sheets 1-2 square inches of ruby mica classified as good or better. Sheets 3-6 square inches brought $40 a pound, and sheets 6-12 square inches ranged from $20 to $70 a pound. Similar sized sheets of stained mica ranged from $8 to $14.80. Nonrusty variety weighs from 300 to 3,500 pounds per cubic foot. The size is usually determined by the number of square inches of a block of mica.
the great range of quality, the expense of mining, and the large amount of hand labor needed for preparation limit the periods of high prices. Since the end of the Government purchasing program in June 1962, little sheet mica has been mined in North Carolina. Revenue that could be calculated from the data available for no development work has pre-
ceded mining, and no mica-bearing rock is blocked out. An appraisal of the probable amount of mica remaining in the pegmatites, based on the abundance of pegmatite bodies at depth is almost certain to be virtually the same as at the surface, indicates that at least as much mica remains as has been mined. The finding and mining of this mica will depend largely on such economic factors as domestic market and prices, which influence the amount of prospecting.

During the last period of Government mica buying, 1952-62, most of the larger producing mines were those that had been big producers in the past, and many were worked out or left in a condition that will make further mining difficult. The rate of new discoveries has been small during both World War II and the 1950’s, even though exploration was encouraged by the Federal Government through financial assistance. Deposits exposed at the surface have generally been prospected, and the difficulty and cost of finding unexplored de-

5. Determination of the mineralogy and zoning of the pegmatite is important. Sheet mica generally occurs in oligoclase- and quartz-rich rock and not in perthite-rich rock. A perthite-rich pegmatite, however, may have a wall zone of plagioclase-quadra-

Mica is generally more abundant near sharp bends or rolls in the wallrock or along the crests of pipe-like or tonguelike bodies. Mica may also be concentrated along the hanging wall or the under-

2. Pegmatite mining has been greatly sheared or faulted, to the fission of the rockwall are apt to be plunged parallel to the plunge of minor structures in the wallrock. Alongate mica concentrations, generally called shears or sheets, may also tend to plunge parallel to the plunge of the pegmatite. A repetition of structural features may have produced addi-
tional shears or extensions of known deposits down plunges.

3. The shape of the pegmatite body may influence the location of mica concentrations. In pegmatites

1. Large mica-bearing pegmatites tend to occur in groups; in the Spruce Pine district, for example, several large deposits are clustered together in the Bandana area. It is therefore logical to look for additional pegmatite deposits near large mica producing areas. Careful geologic mapping will help establish in many places a pattern in the localization of large deposits, for some seem to occur on euhedral or in a belt like a string of beads, and others are related to the zips of folds in the coun-

town. The presence of quartz float may indicate a zoned pegmatite. A lack of evidence for zoning in surface exposures, however, does not necessarily mean that the deposit is not zoned at depth. Diamond drilling may aid in determining the presence, size, and location of different zones. By demonstrating the continuation of pegmatite along the trend of a persistent shoot, such drilling can indirectly indicate size of mica deposits.

7. Pegmatites that have been greatly sheared or faulted contain deformed mica. If the deformed mica

that pinch and swell, mica may be more abundant either near the constrictions or in the swells. Mica is generally more abundant near sharp bends or rolls in the wallrocks along the crests of pipe-like or tonguelike bodies. Mica may also be concentrated along the hanging wall or the under-

4. The size of the pegmatite body is also an important factor. Unzoned pegmatites 3-10 feet thick and 100-200 feet long have been mined successfully by recent methods. Mica mined in such pegmatites generally contains mica sparsely scattered throughout an unzoned body more than 20 feet thick, so much barren rock has to be removed that mining for mica alone is unlikely to be profitable. In zoned deposits, mining can be restricted to the mica-

6. The quality of mica at the surface may indicate the presence of pegmatite or of pegmatite zones but will supply little direct in-

the margin of a quartz core tends to be reeved or side of a wallrock inclusion. Mica along the footwall is generally more abundant than along the hanging wall. Mica along the hanging wall rather than along the footwall. Mica along the footwall is generally more abundant than along the hanging wall.

Mica is used in a variety of applications:

7. Some pegmatite deposits contain only scrap mica, and a large amount of scrap is produced during the mining, trimming, and fabricating of sheet mica. Most scrap mica, however, is produced from weathered granodiorite bodies and as a byproduct from the mining of feldspar and kaolin. From 1943 to 1962 North Caro-

Sheet mica' deposits contain only scrap mica, and a large amount of scrap is produced during the mining, trimming, and fabricating of sheet mica. Most scrap mica, however, is produced from weathered granodiorite bodies and as a byproduct from the mining of feldspar and kaolin. From 1943 to 1962 North Caro-

Feldspar mining in North Carolina began in Mitchell County in 1911 (Watte, 1913, p. 100) and in a few years became an important industry. For many years the State has produced half or more of the feldspar produced in the United States, and since 1953 the State production has averaged about 250,000 tons annually. Until recently, much of the feldspar was perthite and oligoclase hand cobbled from large crystals in zoned pegmatites. Since 1951 finer grained pegmatite and granodiorite have been mined in bulk, and a mix-

The Spruce Pine district is the principal source of feldspar recovered by flotation methods. In 1962 six operators produced feldspar in this manner from nine mines in Mitchell County, and two operators produced feldspar from scoria and scoria pigments in Yancey County (Beck and others, 1963, p. 790, 793). Some hand-cobbled feldspar was produced in Mitchell, Swain, and Yancey Counties.

The average price of crude feldspar was $19.31 per long ton in 1962 and $19.51 in 1960 (de Polo and Tucker, 1963, p. 537). The average price of ground feldspar was $12.71 per short ton in 1962 and $13.40 in 1960. From 1956 to 1960 almost 45 percent of the feldspar produced in the United States was sold in the United States and used in glass, 32 percent in pottery, 5 percent in enamels, and 8 percent in other ceramic uses, scouring soaps, and abrasives. There is little use of feldspar as a source of potassium, but there is also an increase in the use of lower grade and finer grained materials recovered through milling and flotation. Reserves of feldspar in granodiorite with a grain size of 30 feet of the surface deposit are estimated by Brobst (1962, p. A15) to be in excess of 200 million tons.

KAOLIN

Modern mining of kaolin for high-quality ceramic products started at Webster in Jackson County
Total production of kaolin from the Blue Ridge is not known, but annual production from 1921 to 1940 ranged from 1,000 to 15,000 short tons and averaged 18,000 short tons. The amount of washed kaolin available in four groups of deposits near Spruce Pine was estimated by Parker (1946, p. 26-41) to range from 3 to 7 million tons. Kunz (1907) estimated reserves of crude kaolin in Avery, Mitchell, and Yancey counties at 51 million tons from which about 45 million tons of finished kaolin might be recovered.

PEGMATITE DISTRICTS

The mica-bearing pegmatites of the Blue Ridge are grouped into districts for convenience in describing them in this report. The mines and prospects in each district are listed alphabetically in table 4, starting at the north with the Jefferson-Boone district. The locations of the mines are shown on plates 2-4. The table and figures do not include the mica mines of the Cashiers district described by Olson (1922), nor the feldspar deposits of the Bryson City district described by Cameron (1951).

BERYL

Beryl is so rare a constituent of Blue Ridge pegmatites that no regular production of beryllium ore is possible. A total of a few tons of beryl may have been recovered from pegmatites mined for mica in the Spruce Pine district, but no accurate production figures are available. About $6,000. Total production for the district is unknown, but it probably does not exceed 50,000 pounds of sheet muscovite. A few of the mines have been worked for beryl as a byproduct.

Because of the pegmatites of the Wilkes district are generally weathered and poorly exposed, few of the deposits have been mapped in detail. In general, the pegmatite bodies seem to be tabular or lens-shaped. Most are less than 5 feet thick, but a few are 25 feet or more thick. Some of them are as much as 200 feet long. More than half are probably concordant to the foliation of the country rock. This is a result of the thinning of the pegmatite during this same period with the aid of DMEA loans. None of the mines were being worked in April 1962, and many of the older mines are difficult to find. The total production of the district from 1867 to 1962 is estimated to be more than 200,000 pounds of sheet and punch but probably less than 300,000 pounds. There are no detailed production records before 1941 for this district. A few of the old mines have produced more than 10,000 pounds of full-trimmed sheet mica. Although none of the deposit is known to be mined out, many of the workable areas are in such poor condition that mining could be resumed only with difficulty.

The pegmatites in the Jefferson-Boone district are chiefly tabular or lensicircular. About two-thirds are discordant to the foliation of the country rock. They range in thickness from 1 to 70 feet and average less than 10 feet. In length they range from less than 100 feet to nearly 80,000 feet. The last to be developed were those in the Wilkes district. The deposits have been mined for mica and feldspar in North Carolina. Mica was mined by the Indians in prehistoric times; traces

in 1888, but the Cherokee's evidences of mined clay and sold it to English traders as early as the 17th century (1890, p. 462; Watts, 1922, p. 10). In 1767, Josiah Wedgwood sent T. Griffiths to get clay from the Cherokee's Cove near the Little Tennessee River about 5 miles northwest of present-day Cherokee. Griffiths also cleared out an old clay pit, mined about 12 tons of clay, and transported about 13 tons to Charleston, S.C., for shipment to England (Griffiths, 1929). Discovery of good quality clay in Craven County in 1768 stopped further mining in North Carolina.

The Webster deposits were the main center of production in North Carolina for about 30 years, but clay mines were opened in Mitchell County in 1904, in Macon County in 1905, and in Swain County shortly after that. The last to be developed were those in Avery County, in the Black Mountains. The kaolin deposits in Jackson, Macon, and Swain counties were exhausted in the early 1920's, and the only deposits that were being worked in 1923, were those of the Harris Clay Co. in Avery County.

The kaolin deposits in the Blue Ridge are residual deposits formed by the weathering of feldspar in pegmatitic and granodiorite. Most of the pegmatitic deposits are described by Watts (1913), Ries and others (1922), Bayley (1925) and had large deposits in granodiorite. Most of the pegmatitic deposits were those of the Harris Clay Co. in Avery County (pl. 2)."
Simonds, 1896). The prospect was abandoned, but the
prospecting work was begun at the mine by the firm of
Heep and Clapp of Knoxville, Tenn. Shortly there-
after the Ray mine was opened in Yancey County by
G. D. Ray (Sterrett, 1933, p. 168), and within a few
years there were more than a score of active mines,
many of which were operated by Heep and Clapp.
Some information is available concerning 714 mines
and prospects in the Spruce Pine district (table 4),
and probably there are as many more prospects and
small mines about which little is known. Production
data for the district are poor for the period before World War I.
Koster and Olson (1942) gave incomplete production
records for 130 mines for the period 1917-40, and rec-
ords were kept by the Colonial Mica Corp. for the pro-
duction from 708 mines and prospects for the period
June 1940 through 1963. Only 10 percent of the mines had a
significant production during the period 1913 through 1962.
Most mines operated for sheet mica only, however,
were closed in June 1962 when the Government buying
program ended.
Within the Spruce Pine district there are 67 mines
that have a recorded individual production greater than
10,000 pounds. One hundred mines have an individ-
ual production greater than 500 pounds but less than
10,000 pounds of sheet mica. Most of the produc-
tion of the district has come from a few very large
mines, as shown in table 2.
During the period 1951-62 the Spruce Pine district
was actively explored, and much of this exploration
was aided by the Defense Minerals Exploration
Administration. A total of 322 applications for aid
were received on 299 different pegmatite bodies. Of the
147 contracts granted, 22 were in Avery County, 80 in
Mitchell County, 12 in Yancey County, and 15 in
Spruce Pine district, but only a small fraction contain
minable deposits of sheet mica. The known pegmatites
are distributed unevenly throughout much of the
district (Brochet, 1962, pl. 1), and there are some areas
containing few, if any, pegmatites, such as the
Knotz area of the Averitt-Mitchell County line.
The pegmatites range from small pods and thin seams
to large masses hundreds of feet thick and thousands
of feet long. Some of the largest bodies are mined for
feldspar and a few for both feldspar and mica. Large
deposits range from only for sheet mica to
600 pounds but less than 10,000 pounds of sheet mica. Most of the produc-
tion of the district has come from a few very large
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<table>
<thead>
<tr>
<th>Year</th>
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<td>1941-70</td>
<td>20 largest mines</td>
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<tr>
<td>1941-70</td>
<td>10 largest mines</td>
<td>456,456</td>
</tr>
<tr>
<td>1941-70</td>
<td>Over 200 other mines and prospects</td>
<td>1,206,000</td>
</tr>
<tr>
<td>1941-70</td>
<td>Total</td>
<td>2,555,000</td>
</tr>
</tbody>
</table>

The internal structure of Spruce Pine pegmatites is
relatively simple (Cameron and others, 1949, p. 62-64).
Nearby 75 percent of the deposits have no apparent
internal zoning of contrasting mineral composition or
texture. The 25 percent that are zoned, two-thirds
have a zone of feldspar, quartz, and mica and a core
of massive quartz. The remainder have perthite-
plagioclase, quartz, perthite-plagioclase, quartz, or
core. About 20 percent of the zoned bodies have no
primary intermediate zones of various proportions
of feldspar and quartz. A few pegmatites have small
replacement units of fine-grained plagioclase replacing
muscovite and quartz.

The pegmatite districts of the Blue Ridge in North Carolina

<table>
<thead>
<tr>
<th>Year</th>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1941-70</td>
<td>20 largest mines</td>
<td>2,482,068</td>
</tr>
<tr>
<td>1941-70</td>
<td>10 largest mines</td>
<td>456,456</td>
</tr>
<tr>
<td>1941-70</td>
<td>Over 200 other mines and prospects</td>
<td>1,206,000</td>
</tr>
<tr>
<td>1941-70</td>
<td>Total</td>
<td>2,555,000</td>
</tr>
</tbody>
</table>

The pegmatites contain about 25 percent quartz as a small-
to-medium-sized grains mixed with feldspar, as graphic intergrowths in feldspar, or as large, sparse crystals.

Muscovite is widespread and abundant in many of the pegmatites. Practically all of it is perthite, and much of it has a graphic texture. The muscovite is white to light-green or pink. Grain size is medium to very coarse. Most of the muscovite is in intermediate zones or core.

Muscovite is present in all the pegmatites. It ranges from the fine-grained scaly form called sericitic to large bodies several feet across. Total muscovite content may be as much as 15 percent in the granodiorite and peg-
matite (Brochet, 1962, p. A10), but sheet muscovite probably forms from 2 percent to no more than 8 percent of one deposit. More muscovite is an alternative product other than residual solutions during crystalization or from metamorphic effects of subsequent deformation.

The birefringence and size of the sheet-mica crystals vary widely in different parts of the district. Color ranges from light reddish brown (ruby) through light green (white) to light brownish green, light green, and brownish green. Some sheets are mottled by irregular color variations, and some have alternating color bands generally hexagonal or rhombohedron in plan. Reddish-brown mica is found in 22 percent of the deposits, brown in 20
The pegmatites in the Buncombe district are similar to those in adjacent areas. Most of the deposits are weathered, tabular (65 percent) or lenticular (27 percent) bodies in mica gneiss or schist. Three deposits are in hornblende gneiss and three cut dunite. Nearly three-quarters of the deposits are less than 10 feet thick, and only 5 percent are greater than 20 feet thick. About 60 percent are concordant to the foliation of the country rock. One-deposits are discordant. The largest single producer is the Woodlawn mine in Haywood County, well outside the center of the district. This mine was opened in 1867 and was one of the first mines worked in North Carolina in modern times. As in the districts to the northeast, several of the large deposits were originally worked by long tunnels. Although a few of them have been mined to depths of several hundred feet, nearly all the deposits are worked to depths ranging from 10 to 100 feet. More than half of the deposits are tabular, about 20 percent are lenticular, and 22 percent are irregularly shaped. About 80 percent are discordant bodies. The wallrock is mica gneiss (92 percent), interlayered mica and hornblende gneiss (5 percent), and hornblende gneiss (2 percent). Numerous thin dikes and sills of different materials are present. The pegmatite minerals are generally green or greenish brown. Reddish-brown mica is present in at least two of the deposits. The quality of the sheet mica is poor and the quantity is small. Much of the mica is stained.

**Woodlawn District**

The Woodlawn district lies between the Spruce Pine and Franklin-Sylva districts of north central North Carolina. Although a few of the structures are discordant, most are concordant with the foliation of the country rock. The deposits are concordant to the foliation of the country rock and range from 200 to 800 feet thick. Most of the deposits are concordant to the foliation of the country rock and range from 200 to 800 feet thick. Most of the deposits are concordant to the foliation of the country rock and range from 200 to 800 feet thick.
26 percent, or plagioclase-perthite-quartz-muscovite in 20 percent. About 10 percent of the deposits have one or more intermediate zones of plagioclase-perthite-quartz, perthite-quartz, or perthite. A thin border zone of feldspar-quartz-mica or quartz-mica pegmatite is present in some of the deposits. Late-stage fracture fillings or replacement units are rare. A few deposits contain cores that are sheared and have thin strips of biotite along fractures. Some deposits have veinlets of quartz, quartz-muscovite, or plagioclase-muscovite that cut outer zones. Perlitic is partly altered to plagioclase and muscovite along shear zones.

The principal minerals are quartz, oligoclase, perthitic microcline, and muscovite. The chief accessory minerals are biotite and garnet. Pyrite, pyrrhotite, and arsenopyrite are present in a few deposits, and allanite, anhedral, beryl, clinozoisite, epidote, biotite, kyanite, and tourmaline are reported from less than 2 percent of the deposits.

Table 4—Summary description of mica mines and deposits.

<table>
<thead>
<tr>
<th>Mine or prospect</th>
<th>Source of information</th>
<th>Principal periods worked</th>
<th>Workings (measurements, in feet)</th>
<th>Description of mica</th>
<th>Production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beaver Creek mine</td>
<td>CMC, USBR</td>
<td>1910, WWII</td>
<td>Shaft 60, edit</td>
<td>Medium sheet</td>
<td>do</td>
</tr>
<tr>
<td>Back Mountain mine</td>
<td>USGS, CMC</td>
<td>1913, 1930, WWII</td>
<td>Shaft 60, drift 10; shaft 20</td>
<td>Biotite, white, hard, clear, ruled</td>
<td>do</td>
</tr>
<tr>
<td>Conner prospect</td>
<td>CMC</td>
<td>1913, 1930, WWII</td>
<td>Shaft 50, edit</td>
<td>Biotite, brown, hard, crooked, crystal</td>
<td>Small sheet</td>
</tr>
<tr>
<td>Coss Don mine</td>
<td>USGS, CMC</td>
<td>1910, WWII</td>
<td>Shaft 50, edit</td>
<td>Biotite, hard, clear, crooked, crystal</td>
<td>Small sheet</td>
</tr>
<tr>
<td>Dugway (Darty) mine</td>
<td>CMC</td>
<td>1892, WWII</td>
<td>Pit 20 long, 15 deep</td>
<td>Biotite, white, hard, clear</td>
<td>Small sheet</td>
</tr>
<tr>
<td>Dugway (Houck) mine</td>
<td>CMC</td>
<td>1910, WWII</td>
<td>Cut 20, small sheet</td>
<td>Biotite, hard, clear, ruled</td>
<td>Small sheet</td>
</tr>
<tr>
<td>Dugway (Tecumseh) mine</td>
<td>CMC</td>
<td>1910, 1930, WWII</td>
<td>Shaft 50, edit</td>
<td>Biotite, hard, clear, crystal</td>
<td>Small sheet</td>
</tr>
<tr>
<td>Dugway (Tecumseh) mine</td>
<td>CMC</td>
<td>1910, 1930, WWII</td>
<td>Shaft 50, edit</td>
<td>Biotite, hard, clear, ruled</td>
<td>Small sheet</td>
</tr>
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<td>1910, 1930, WWII</td>
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</tbody>
</table>

Table 5—Pegmatite districts.

<table>
<thead>
<tr>
<th>Shape</th>
<th>Size (ft)</th>
<th>Attitude</th>
<th>Relation to wall structure</th>
<th>Wallcrack</th>
<th>Extent of weathering</th>
<th>Rockburden (external structure, texture, and mineralogy of pegmatite)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tabular</td>
<td>&lt;4-5 T</td>
<td>Vertical</td>
<td>Interpreted as being the same as the Halleckite gneiss</td>
<td>Unweathered</td>
<td>P-Q-2 pegmatite</td>
<td>Do</td>
</tr>
<tr>
<td>Tabular</td>
<td>&gt;60 D</td>
<td>Vertical</td>
<td>Interpreted as being the same as the Halleckite gneiss</td>
<td>Unweathered</td>
<td>P-Q-2 pegmatite</td>
<td>Do</td>
</tr>
<tr>
<td>Tabular</td>
<td>&lt;4-5 T</td>
<td>Vertical</td>
<td>Interpreted as being the same as the Halleckite gneiss</td>
<td>Unweathered</td>
<td>P-Q-2 pegmatite</td>
<td>Do</td>
</tr>
<tr>
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<td>&gt;60 D</td>
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