COMMONWEALTH OF VIRGINIA

DEPARTMENT OF CONSERVATION
AND ECONOMIC DEVELOPMENT

DIVISION OF MINERAL RESOURCES

MICA AND FELDSPAR DEPOSITS OF VIRGINIA

WILLIAM RANDALL BROWN

MINERAL RESOURCES REPORT 3

VIRGINIA DIVISION OF MINERAL RESOURCES

James L. Calver
Commissioner of Mineral Resources and State Geologist

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Commonwealth of Virginia
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Richmond
1962

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MICA AND FELDSPAR DEPOSITS OF VIRGINIA

By Wm. Randall Brown

ABSTRACT

Mica and feldspar have been produced commercially from pegmatites in Bedford, Amelia, Henry, Prince Edward, Charlotte, Pittsylvania, Cumberland, and Powhatan counties of Virginia. Mica, but as yet no feldspar, has also been produced from pegmatites in Franklin, Hanover, Goochland, Louisa, and Spotsylvania counties. By-product minerals, and locally the main mineral, of pegmatite mining include kaolin, quartz, beryl, columbite-tantalite, and gem and specimen minerals. Feldspar, in addition to extraction from pegmatites, has been recovered in considerable quantity from alaskite-syenite deposits in northwestern Bedford County; and aplite, with the same uses as feldspar, has been and is being quarried on a sizable scale in Nelson and Amherst counties.

Feldspar mining, carried on mainly in Bedford County, has been a fairly large and relatively stable industry in the State since about 1923. Aplite has been quarried on an increasing scale in Nelson County since 1938. Both feldspar and aplite are used mainly in the glass industry; feldspar, in addition, is used in the manufacture of pottery, enamel, scouring powders and soaps, abrasives and as a binder in abrasive wheels, artificial teeth, poultry grit, roofing, stucco, and welding rod coatings. Bluish-green "amazonstone" feldspar, mined in Amelia County, is used as a gem stone.

Mica mining tends to be erratic and sporadic except during times of war, when the mineral's strategic qualities and this country's shortage have spurred it into intensive and feverish activity. A very large part of the total high quality mica recovered in Virginia has been produced, first, in the early years of discovery, about 1867 to 1885; and, second, during and immediately following the years of World Wars I and II. The year of greatest production was 1919, when 189,147 pounds brought $36,818; the year of greatest value of sheet mica sales was 1944, when 15,682 pounds brought $93,269. Data concerning the over 200 pegmatite deposits in Virginia, incorporated in this report, were gathered, for the most part, during World War II, when more mines and prospects were

open and accessible than at any other time in history. The production of non-strategic stained ("electric") sheet mica and scrap mica has not been subject to war-time stimulus, and such mica was mined almost continuously in Franklin County from 1912 to 1946.

Mica has a unique combination of properties, including flexibility, elasticity, resistance to heat and chemicals, cleavage which permits splitting into exceedingly thin sheets, high dielectric strength, and high resistance to the passage of electric current, which make it almost ideally suited for use as an insulating material in nearly all types of electrical and much electronic apparatus. High quality mica is indispensable in types of motors and generators, airplane spark plugs, radio tubes, transformers, and radio condensers. Mica unfit for use in sheet form is finely ground and is used extensively in the manufacture of roll roofing, wall paper, joint cement, plastics, rubber, paint, and less extensively in numerous other products.

Pegmatites, from which all of the mica and most of the feldspar in the State are produced, are unusually coarsely, and generally irregularly, crystallized bodies of igneous rock minerals, chiefly feldspar, quartz, and mica. The minerals in most commercial bodies tend to be more or less segregated into zones, a factor which greatly aids in exploration and exploitation of the deposits. Sheet mica is recovered mainly from wall zones, whereas feldspar is taken chiefly from coarser inner (intermediate) zones; quartz comprises the core of most bodies.

The alaskite-syenite deposits of Bedford County, which are quite different from the pegmatitic feldspar deposits, are granitoid rocks which appear to belong to the ancient crystalline complex of the Blue Ridge structural province. This association and certain other features suggest a kinship with the aplite (anorthosite) mass of Nelson and Amherst counties.

The outlook for continued large production of feldspar in the State appears to be very good, especially in view of the probable use of flotation and other methods of extraction which can make formerly unworkable deposits economic. High quality mica is still available at many mines in the State, but sizable production is not to be expected until unusually high prices again prevail. Numerous deposits, especially in Amelia and Franklin counties, however, appear presently to offer the possibility of economic operations for scrap and electric sheet mica.

INTRODUCTION

GENERAL STATEMENT

Mica and feldspar, along with lesser amounts of beryl, kaolin, quartz, columbite-tantalite, and gem minerals, for many years have been produced in Virginia. Sheet mica, a strategic material, is essential in many types of electrical apparatus and the United States' production is inadequate to supply its needs. For this reason, mica production was greatly stimulated during World War II, and nearly every known deposit in the State was mined or explored and some new deposits were found. This gave unprecedented opportunity to study, not only the mica deposits of the State, but also deposits of feldspar and other associated minerals. The new data gathered in this study, along with a summary of what was formerly known, are presented in this report. Information is also included on properties, uses, occurrence, prospecting, mining, and marketing of mica and feldspar.

FIELD WORK AND ACKNOWLEDGEMENTS

Field work occupied approximately 20 months between June 1942 and August 1945; some areas were revisited in 1946, 1947, and 1960. Much of this time was spent in cooperative studies with Colonial Mica Corporation, an agency of the Federal Government. Technological data have been taken from reports by the U. S. Bureau of Mines, U. S. Geological Survey, Tariff Commission, and publications by the American Institute of Mining and Metallurgical Engineers.

The writer is especially indebted to A. A. Pegau of the Virginia Division of Mineral Resources; Edgar B. Ward, Field Engineer of Colonial Mica Corporation; and Douglas B. Sterrett, formerly of the U. S. Geological Survey and, during World War II, a mine operator in Amelia County, each of whom gave valuable information, advice, and assistance in the field and during preparation of the report. Other members of the Colonial Mica Corporation staff were helpful, particularly W. J. Alexander, B. C. Burgess, and R. T. Dent. Plane-table maps of several mines were made with the assistance of R. O. Bloomer of St. Lawrence University. Mine operators and land owners throughout producing areas of the State were most cooperative and helpful and freely supplied information. Some data on aplites were supplied by E. O. Gooch, formerly of the Virginia Division of Mineral Resources.

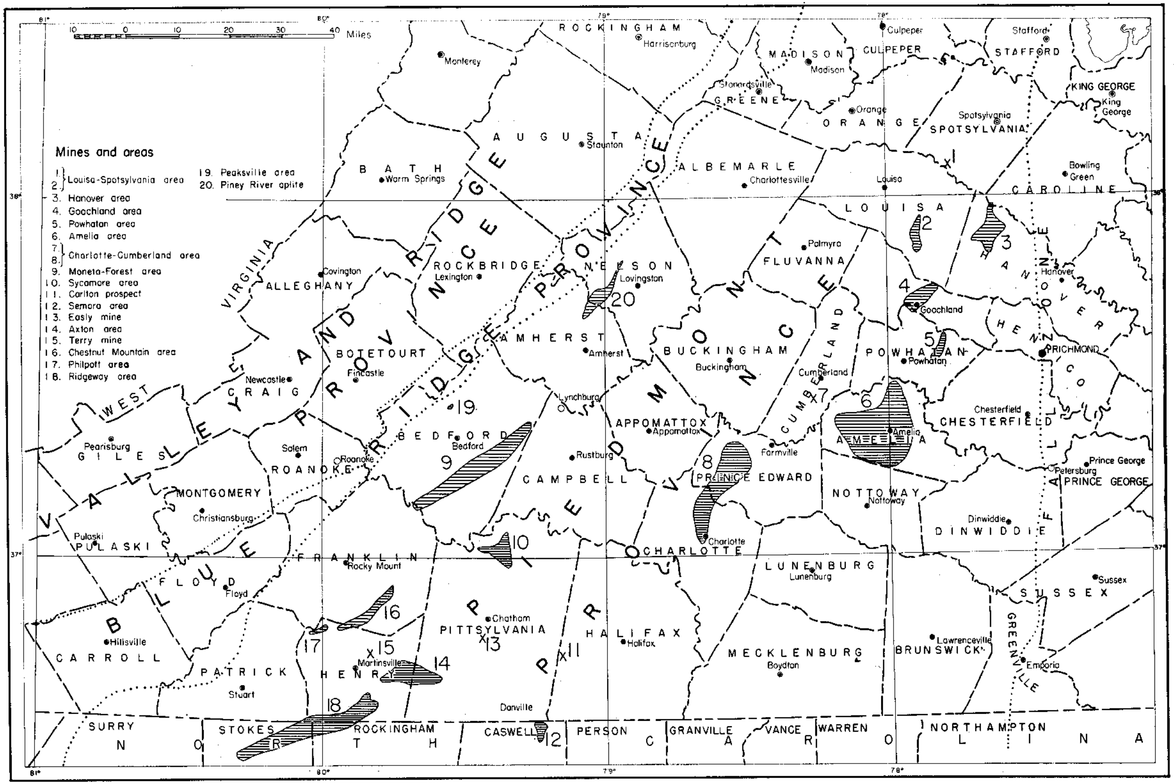


Figure 1. Index map showing location of the known mica and feldspar deposits of Virginia.

Special thanks are due Arthur Bevan, former State Geologist, for suggesting and directing the study, and for encouragement and valuable advice. The writer is grateful to R. S. Edmundson of the University of Virginia for editorial assistance and to B. N. Cooper of Virginia Polytechnic Institute for editorial assistance and some drafting. Finally, the writer is indebted to James L. Calver, Commissioner of Mineral Resources and State Geologist of Virginia, for assistance of various kinds and for making publication possible.

LOCATION AND GENERAL FEATURES OF DEPOSITS

The known deposits of commercial mica and feldspar in Virginia occur only in the Piedmont physiographic province (Figure 1). This province, lying between the Coastal Plain on the east and the Blue Ridge on the west, is underlain for the most part by igneous and metamorphic rocks and is geologically quite complex. All mica and most feldspar produced in the State have been gotten from pegmatites; some feldspar has been recovered from syenite, alaskite, and aplite (anorthosite).

Pegmatite deposits occur chiefly within two broad belts: an eastern, or Amelia-Spotsylvania belt; and a western, or Martinsville-Lynchburg belt. For descriptive purposes, the eastern belt may be considered to consist essentially of the Amelia, Powhatan, Goochland, Hanover, and Louisa-Spotsylvania areas; and the western belt considered to consist essentially of the Ridgeway, Axton, Philpott, Chestnut Mountain, Sycamore, Bedford, and Peaksville areas. A subordinate belt or isolated area extends through Charlotte, Prince Edward, and Cumberland counties. A few more or less isolated deposits also occur outside of these areas. Aplite, with the same uses as pegmatitic feldspar, is produced from anorthosite in northeastern Amherst and southwestern Nelson counties.

Some high-quality sheet mica has been mined in each pegmatite area of the State, but most of the clear sheet has come from the Amelia and Ridgeway areas and from a few mines in Hanover, Goochland, and Powhatan counties. Large quantities of scrap and black-stained sheet, or "electric", mica have been mined in the Chestnut Mountain area and smaller quantities in the Ridgeway and other areas. The Bedford area, although relatively minor in the production of mica, has been the predominant source of feldspar in the State. Large quantities of feldspar have also come from the Peaksville area, and lesser quantities from the Amelia, Ridgeway, Charlotte-Cumberland, Axton, and Sycamore areas. Beryl, columbite-tantalite, phenakite, and monazite have been produced as by-products of mica and feldspar mining in Amelia County; and beryl has been sold from one mine in Powhatan County. Amazonstone and other gem stones have been produced in the Amelia area, and small quantities of quartz have been sold from the Bedford area.

HISTORY OF MICA MINING

The history of the mica industry in Virginia has been outlined by Watson (1907, p. 279-284; 1909, p. 101-105; 1911, p. 94-95) and Pegau (1932, p. 7-8). It is chiefly a story of intermittent operation, periodically stimulated by a rise in prices, the discovery of a rich deposit, or a combination of these factors.

The first important period of mica mining in Virginia began in 1867 and lasted until about 1885. The first mines opened were near Hewlett in Hanover County. In 1873, more important operations were begun on the Jefferson property near Amelia in Amelia County, to be followed soon by the opening of the Berry, Winston, and Pinchbeck mines, near Amelia, and the Schlegal mine, near Jetersville. The opening of the Rutherford mines was of special interest, not only because of the quantity and size of the mica uncovered, but because of the unusual minerals found in the deposit. During this same period, beginning about 1880, the Irwin and other mines in Goochland County were opened.

From 1885 to 1900, little mica was mined in Virginia. There was a slight increase in production between 1900 and 1903, followed by another lull lasting until 1907, when mines near Ridgeway in Henry County were opened. These operations near Ridgeway underwent a setback the following year when the plant of the Pittsburgh Mica Company was destroyed by fire, and mica production in Virginia slumped again, not to be revived until 1914, when a second important period of activity began as a result of wartime prices.

During World War I and for a short time thereafter, many old mines in different parts of the State were reopened, and the Ridgeway, Axton, and Chestnut Mountain areas came into prominence. In 1918, the production of sheet mica reached its greatest value for this period, when 78,500 pounds brought $46,200. In each of the next two years, this quantity was more than doubled, with 189,147 pounds of sheet mica produced in 1919 and 179,339 pounds in 1920, but the total value for these two years was only $59,007 (Table 1). Under lowered prices, production dropped off sharply in 1921, but was revived somewhat during the three years following. From 1930 until World War II, mining activity was confined largely to the Chestnut Mountain area, where

Table 1.—Production of Mica in Virginia, 1908–1958 (Pegau, 1932, p. 104; Mineral Resources of the United States, 1908–1931; Minerals Yearbook, 1932–1959)

YEARS	SHEET MICA		SCRAP MICA		TOTAL VALUE
	Pounds	Value	Short Tons	Value	
1908-09	21,260	....	121	....	$11,946
1910	....	....	....	....	....
1911–1913	4,585	$ 4,578	47	$ 712	5,290
1914	27,672	22,358	153	2,295	24,653
1915	10,808	9,590	63	828	10,418
1916	39,978	18,251	182	2,703	20,954
1917	68,558	22,831	253	2,709	25,540
1918–19	267,647	79,018	982	12,091	91,109
1920–21	186,161	26,943	*	45,317	72,260
1922	43,449	6,577	296	9,718	16,295
1923–24	98,752	10,778	649	12,302	23,080
1925–26	....	....	600	15,600	15,600
1927–28	31,202	11,385	93	2,405	13,790
1929–30	*	*	*	*	17,905**
1931	6,554	601	371	4,044	4,645
1932-37	*	*	*	*	*
1938	*	*	2,174	22,758	22,758
1939–42	*	*	*	*	*
1943	5,829	15,863	1,499	31,529	47,392
1944	15,082	57,906	1,700	38,294	96,200
1945	2,983	2,395	376	7,720	10,115
1946–55	*	*	*	*	*
1956	396	5,814	....	....	5,814
1957	529	6,401	....	....	6,401
1958	147	2,193	....	....	2,193
1959	108	1,212	....	....	1,212

*Statistics cannot be disclosed.
**Estimated.

operations for scrap and electric sheet were rather continuously carried on.

Renewed interest in Virginia mica deposits was shown in 1939, but little sheet mica was mined until 1942. In June 1942, Colonial Mica Corporation, a government agency, was set up to stimulate domestic mica production and to buy strategic mica. By the middle of 1943, largely through the activities of this corporation, mining activity had reached a new peak in the Amelia area and strategic mica was being produced in Hanover, Henry, and Goochland counties. By the summer of 1944, the pace of mining had slackened in Amelia County, and stopped altogether in Hanover, but was continuing in Goochland and had reached an all-time high in Henry and Powhatan counties. This year the total value of sheet mica sold considerably exceeded that for any previous year, although the total poundage did not approach that for the years 1916 to 1924 (Table 1). Early in 1945, most mines in the State had been closed because of lower prices and restricted buying schedules. There was a slight renewal of interest in 1952 with the initiation of a Government purchasing program, but production has been largely or entirely restricted to Powhatan County where Ed Martin in 1952, Clinton Dolphin and W. D. Baltzley in 1953, and the Piedmont Mining Company, Inc., and J. E. Wilson in 1954, reported production of small quantities of sheet mica.

HISTORY OF FELDSPAR MINING

(Watson, 1907, p. 276; 1909, p. 106-107; 1913, p. 32; Pegau, 1932, p. 9-10; Mineral Resources of the United States, 1907-1931; Minerals Yearbook, 1932-1957)

In the early stages of feldspar mining in Virginia, during the latter part of the last and the early part of the present century, feldspar was produced chiefly as an adjunct to mica mining, and many or most feldspar deposits were found in the search for mica. Since about 1923, however, when company mining of the large deposits in Bedford County began getting under way, production in the State has been continuous and, for the most part, only incidentally related to the mica industry. The size and constancy of this production is distinctly in contrast to the generally small, discontinuous, and sporadic production which has characterized the mica industry for all save the war years part of this period (Tables 1 and 2).

Table 2.—Production of Crude Feldspar in Virginia, 1929-1958 (Mineral Resources of the United States, 1929-1931; Minerals Yearbook, 1932-1958)

Years	Short Tons	Value	Years	Short Tons	Value
1929	6,677	$ 38,628	1941	*	*
1930	6,760	38,048	1942	24,298	$140,304
1931	9,331	48,545	1943	20,550	122,957
1932	6,759	31,990	1944	24,010	147,106
1933	13,459	52,758	1945	29,089	178,664
1934	12,140	64,529	1946	32,960	204,588
1935	14,810	81,474	1947	41,820	261,741
1936	20,459	114,807	1948	34,770	231,607
1937	22,175	125,396	1949	33,936	234,442
1938	9,766	52,037	1950	26,879	188,153
1939	18,544	100,299	1951	30,979	232,099
1940	21,705	116,531	1952–1958	*	*

*Statistics cannot be disclosed.

Most of the early mining of feldspar was in Amelia County, but Watson (1909, p. 106) states that in 1907, single quarries were in operation near Amelia in Amelia County, near Prospect in Prince Edward County, and near Bells in Bedford County. During the years 1908, 1911, and 1912, only the quarry in Prince Edward County was in production (Watson, 1909, p. 106; 1913, p. 32); but in 1914, the reported production from one mine (presumably the same) in Prince Edward County was larger in quantity than that from any other state (Katz, 1916, p. 454). During the years 1915 and 1916, there was small production from Amelia, Henry, Pittsylvania, and Bedford counties; but there was no reported production for the years 1917 to 1922.

In 1923, a quarry was worked near Moneta, Bedford County, by the Moneta Mineral and Mining Company; and another was worked near Axton, Henry County, by the Vicama Mica Company. During the next year or so, the Seaboard Feldspar Company of Baltimore took over the quarry near Moneta, also a quarry opened by R. Q. Young of Moneta; and the Axton quarry was abandoned. It is said that the production from these mines near Moneta was chiefly high-grade potash feldspar. During the years 1927-1929, the General Minerals Corporation of Virginia produced gem feldspar from near Winterham Station, Amelia County. In 1929, production was reported by the Seaboard Feldspar Company and the Virginia Feldspar Company from Bedford County and by the Mica Products Corporation of Norfolk from near Axton, Henry County. This year, too, the Seaboard Feldspar Company grinding mill at Brookneal, Campbell County, went into production.

Except for dips in 1932 and 1934, production increased each year up to 1938, when low prices brought on chiefly by large relatively cheap western production caused some curtailment. In 1934, Virginia ranked third behind North Carolina and Maine in feldspar production. In 1938, the Virginia Feldspar Company built a grinding mill in Bedford; and Dominion Minerals, Inc., of Washington, D. C. reported first production of aplite from Amherst County near Piney River. In 1940, the Seaboard Feldspar Company mill at Brookneal was destroyed by fire; the next year a new mill was constructed in Bedford under the name of the parent company, Clinchfield Sand and Feldspar Corp., and the Virginia Feldspar Company mill at Bedford was taken over by Carolina Mineral Company of Erwin, Tennessee. In 1942, the Carolina Mineral Company became the second producer of aplite from the Piney River vicinity, Nelson County; and in 1959, Buffalo Mines, Inc. became the third.

Feldspar production in the State dropped somewhat in 1943, then rose steadily until in 1947 it reached its peak of 41,820 tons, worth

$261,741. This peak was attained chiefly through the development and very active operation of the Peaksville mines in Bedford County. Since 1947, production has been less, but has remained at a high level, coming almost entirely from the Peaksville area and the Forest vicinity of Bedford County, a small quantity coming from Pittsylvania County in 1952. During the same period, the production of aplite, entirely from two operations in the Piney River vicinity, has been constant and sizable, but it has fluctuated somewhat from year to year.

OUTLOOK

Although synthetic mica and other substitutes for natural mica in a number of its less exacting uses have been developed, there are, as yet, no adequate substitutes for it in its more exacting uses (Skow, 1959) and until these are available, the demand for strategic-quality sheet mica will remain high. It is only in time of war or under special Government purchasing schedules, however, that high-quality domestic mica can compete with the closely hand-prepared and hand-classed mica from foreign sources. Should conditions such as existed during World War II again arise, considerable high-quality sheet mica could certainly be produced in Virginia, but the quantity would be less than during past crises, as it was far less during World War II than during World War I (Table I).

The outlook for stained, or electric, sheet mica is possibly better than for clear sheet, in that deposits of stained mica have not been so thoroughly exploited as have those of clear; in addition, in recent years the prices paid for electric sheet have been higher in relation to those paid for clear mica than in the past. Appreciable quantities of electric mica almost certainly remain in parts of most pegmatite areas of the State, particularly the Chestnut Mountain, Ridgeway, Axton, and Jetersville part of the Amelia area.

Of the forms in which mica is sold, scrap mica is probably the most likely to be produced in large quantity in Virginia in the future. The demand for ground mica has risen almost constantly through the years, even during times when production of other mineral commodities declined. Deposits of easily worked, deeply kaolinized pegmatite rich in small mica are abundant in many parts of the Virginia Piedmont, particularly in the Amelia, Chestnut Mountain, Axton, and parts of the Ridgeway area.

As regards feldspar, it is unlikely that many more large, coarse pegmatitic bodies rich in potash feldspar, such as have supported most operations in the past, will be discovered in the State; and much of the potash feldspar in known deposits has been exhausted. It does appear, however, that the Blue Ridge and the extreme western Piedmont should be explored for more bodies of the Peaksville type. In spite of intensive exploration and mining in the Bedford area, large tonnages, particularly of soda feldspar, certainly remain. This is also true of the Peaksville area; and several mines in the Amelia and Ridgeway areas, and possibly in Prince Edward County, could probably support feldspar operations, particularly if by-product mica is recovered.

Although pegmatitic feldspar appears to be available in quantity, its production must meet competition from nepheline syenite, aplite, and feldspar separated from alaskites and granites by the flotation process. In order to meet this competition, producers in this State will almost certainly have to adopt flotation, electrostatic processes, or other methods of separation which eliminate costly hand methods and make feasible the recovery of by-products like mica and garnet. In addition, the adoption of the flotation method should bring into the realm of economic workability many deposits of granitic and syenitic rocks and fine-grained pegmatites never remotely economic under older methods of separation.

PREVIOUS GEOLOGIC WORK

Since the seventies or early eighties, when the Rutherford mines in Amelia County were opened, numerous articles have been written on pegmatite minerals of Virginia, particularly those found near Amelia (see Pegau, 1932, p. 112-116). In 1883, Fontaine described the mineralogy of the Rutherford mines; and in 1907, Watson briefly described mines in the Amelia and Jetersville districts. Bastin (1911, p. 971-975), in a report on the mining of quartz and feldspar in the United States, described mines in Amelia, Bedford, and Prince Edward counties. Sterrett (1913, p. 1045-1048) described the occurrence of amazonstone in Amelia County; a year later he (Sterrett, 1914, p. 65-125) gave the first detailed descriptions of mica mines in Henry, Pittsylvania, Franklin, and Bedford counties; and in 1923, he (Sterrett, 1923, p. 307-330) wrote the most detailed account of mica deposits of Virginia yet prepared. Pegau's comprehensive report on the pegmatite deposits of Virginia, in which something of the geology and history of operation of most of the known deposits of the state is included, was published in 1932. In 1935, Glass described in detail the mineralogy of the Rutherford and Morefield pegmatites near Amelia. Cameron, Jahns, McNair, and Page (1949), in a large paper on the internal structure of granitic pegmatites, included mention of a number of Virginia deposits and a map of the Champion pegmatite near Amelia. Jahns, Griffitts, and Heinrich (1952); Lemke, Jahns, and Griffitts (1952); and Griffitts, Jahns, and Lemke (1952), in a professional paper of the U. S. Geological Survey, discussed in detail the pegmatites of the Southeastern Piedmont and described and mapped many deposits in Virginia.

SOURCE ROCKS OF MICA AND FELDSPAR

GENERAL STATEMENT

Feldspar is the most abundant mineral in the earth's crust. It is an essential mineral in most igneous rocks, many metamorphics, and a few sediments. Mica, also a common mineral in the rocks of the earth, is a prominent accessory in many granitic rocks, an essential mineral in most phyllites, schists, and gneisses, and is generally abundant in soils and sediments derived from these rocks. In most of their common occurrences, however, feldspar and mica are too fine-grained and intimately intermixed with other minerals to be commercial. Rocks which have yielded commercial quantities of these minerals are listed below and will be discussed separately.

Mica	*Feldspar*
Pegmatites	Pegmatites
Phyllites and schists	Nepheline syenite
Clays derived from granitic rocks	Anorthosite ("aplite")
	Alaskite granite
	Dune sands

PEGMATITES

GENERAL FEATURES

Pegmatites are injected* plutonic bodies of unusually coarsely and, commonly, irregularly crystallized rock of apparent igneous or igneo-aqueous origin. Crystals of muscovite mica of sheet size, found only in pegmatite, are part of this coarse crystallization. Coarse crystallization of other minerals, like feldspar and beryl, also helps make their extraction economically feasible. Most pegmatites, and all of those from which feldspar and sheet muscovite are recovered, are mineralogically similar to granite in that they consist chiefly of alkali feldspar, quartz, and mica. Garnet, tourmaline, and beryl are common in many, and rare and unusual minerals of lithium, fluorine, chlorine, boron, tantalum, columbium, tin, tungsten, phosphorus, uranium, and other elements occur in some complex pegmatites.

*Injected bodies, of Daly's (1933, p. 75) broad three-fold classification, are those which come to occupy their chambers through more or less restricted channels connecting the chamber with a deeper reservoir or source. Dikes and sills are the most common forms.

ORIGIN OF PEGMATITES

Pegmatites occur exclusively in areas of igneous and metamorphic rocks and are themselves products of igneous and/or metamorphic processes. General opinion is that they are the offspring of large bodies of deep-seated silicic magma with a certain necessary content of volatiles such as water vapor, lithium, fluorine, chlorine, etc. In late stages of solidification of this magma, these volatiles become rather highly concentrated before all of the elements which make rock minerals have been utilized in crystallization. High vapor pressures, probably aided by earth movement and dilatant effects of fissuring (Mead, 1925), cause some of these volatiles to escape or be drawn from the partially solidified magmatic mass. In their escape, they carry with them in solution the yet unused elements like silicon, aluminum, potassium, sodium, calcium, etc., which go into rock minerals. When these solutions of volatiles and rock-mineral elements have moved to places of proper temperature and pressure, rock minerals like feldspar, quartz, and mica begin to crystallize. The presence of abundant volatile elements, however, depresses their freezing points and, partly by catalytic action, promotes the growth of large crystals; certain elements among the volatiles, too, sometimes join in to produce rare and unusual minerals.

In view of the possibility that some large granitic bodies (or considerable portions of such bodies), with which pegmatites are commonly associated, never went through a magmatic stage (Gilluly et al., 1948), one must consider the possibility, pointed out by Schaller (1933, p. 151), that pegmatites "represent the 'sweat', or the most easily liquified portions that have been squeezed out of various kinds of rocks by orogenic processes."

OCCURRENCE AND FORM

Granitic pegmatites occur in regions characterized by metamorphic rocks and sizable granitic masses. The granitic rocks are generally considered to be parental to the pegmatites, and the names *interior*, *marginal*, and *exterior* have been applied to the pegmatites according to whether they are in the central part of the granitic masses, in their peripheral portions, or outside in the bordering metamorphics, respectively (Gevers, 1936; Heinrich, 1953). Watson (1906, p. 536-539) describes interior and marginal pegmatites as being abundant in the Richmond-Fredericksburg area and states that some are of large size. These are of simple mineralogy without rare or unusual minerals, contain more potash feldspar than plagioclase, and in part occupy fault breaks of small displacement. To the writer's knowledge, however, none has been worked commercially—the mica- feldspar- and rare mineral-pegmatites of importance in Virginia being largely exterior pegmatites. A great many have no obvious relationship to any specific granitic mass.

Most pegmatites are tabular to strongly lenticular sills or dikes, with tapering, blunt, or branching extremities; pods and phacoliths also occur as do oval, chimney-like, and completely irregular forms. Apophyses are common to all. Shape in any particular case has been determined chiefly by the nature of the invaded rock, existing structures and pressures, and the viscosity of the pegmatitic fluid.

The intrusion of many bodies in Virginia, particularly in the areas of the western Piedmont (exclusive of the Chestnut Mountain area), has been essentially parallel to foliation of enclosing mica schists and gneisses. In these areas, flat lenses and lenticular sheets, frequently with one blunt end but commonly tapering at both ends, are the most common forms. In the Chestnut Mountain area and in areas of the eastern Piedmont of Virginia, where most pegmatites are discordant to foliation, control by cross fractures is suggested by the usual simple exterior form of the bodies and by their similar attitudes. Although some highly irregular bodies occur, most are thinly to thickly lenticular and have near vertical dip and a general eastward strike across the prevailingly northeastward-trending foliation. Controlling fractures were probably faults of small displacement; jointing appears an unlikely type of control for any but very small bodies. In the Chestnut Mountain area, one well-developed joint set closely parallels strike and dip of numerous pegmatites; but the joints cut the pegmatite, and nowhere do they appear to carry pegmatite mineralization. Although these joints could not have influenced pegmatite intrusion, they may have been formed by forces similar to those which created openings which did control intrusion.

SIZE

Pegmatites in Virginia range in size from stringers a fraction of an inch thick and a foot or so long to dikes like that at the Big Hicks (Wheatley) mine near Moneta, which in places is 160 feet wide, is over 700 feet long, and is continuous to depths below 155 feet. Bodies mined for mica have a thickness of about 2 to 40 feet and an average of possibly 10 feet; most are less than 250 feet long, but a few, like the Morefield dike near Amelia, are over 1,000 feet long. The Morefield dike has been shown by diamond drill to extend beyond a depth of 200 feet; other mica pegmatites have pinched out at from 10 to 30 feet. Pegmatites mined for feldspar, on the average, are appreciably larger then those worked for mica. Thicknesses in the Moneta-Forest area, from which a preponderant part of this State's feldspar production has come, range from 15 to 160 feet and have an average of about 50 feet.

MINERALOGY

A total of 82 different minerals have been reported from Virginia pegmatites (Jahns, Griffitts, and Heinrich, 1952, p. 30-32). Kyanite, to the writer's knowledge unreported but occurring at the Saunders No. 2 mine in Hanover County, raises the number to 83.

Most of the pegmatites are of simple mineralogy and consist chiefly of sodic plagioclase and potash feldspar, quartz, and muscovite. Plagioclase, from albite to oligoclase, is the dominant feldspar in mica-rich pegmatites; coarse perthitic microcline, the chief potash feldspar of pegmatites, approaches and locally exceeds plagioclase in abundance in pegmatites worked for feldspar such as some of those in the Bedford area. Weathering has commonly kaolinized plagioclase to depths of from 10 to 200 feet; microcline is considerably more resistant and is often fresh at the surface at places where plagioclase is deeply weathered. Quartz is abundant in all granitic pegmatites, both as granular intergrowths with other minerals and as massive cores. Muscovite is plentiful, though not necessarily commercial, in most Virginia pegmatites except some which appear to be related to the older granitic plutons of the Blue Ridge structural province.

The most common accessory minerals are biotite, garnet, and black tourmaline. Biotite is particularly plentiful in some plagioclase-rich wall zones where, in part, it occurs as fracture fillings and replacements about fractures. In zones of deep kaolinization most biotite has been altered to vermiculite. Intergrowths of biotite and muscovite and inclusions of crystals of one mica within books of the other occur. Garnets in shades of light red to tan, ranging from spessartite to almandite in composition (Jahns, Griffitts, and Heinrich, 1952, p. 36), are abundant in the border and wall zones of many pegmatites.

Beryl has been found in pegmatites of Charlotte, Caroline, Franklin, Henry, and Bedford counties and has been produced commercially from those in Amelia and Powhatan counties. Uraninite, autunite, and uranophane have been reported from the Ridgeway area (Jahns, Griffitts, and Heinrich, 1952, p. 30-32). The largest number of mineral species have come from three dikes in Amelia and one in Powhatan County which, in addition to the common pegmatite minerals, have produced many rare and unusual minerals including columbite, manganotantalite, cassiterite, phenacite, topaz, fluorite, monazite, zinnwaldite, and helvite (Glass, 1935).

PEGMATITE UNITS

Many simple pegmatites, except for thin border zones of different texture or structure, are essentially uniform throughout; but pegmatites of complex mineralogy and practically all of those which yield commercial mica, feldspar, and beryl display more or less systematic changes in lithology or mineralogy from the walls inward. Each portion of these non-uniform pegmatite bodies, different from other portions, is called a *pegmatite unit.* Although pegmatite units have been observed and described by numerous workers through the years, their great economic importance and genetic significance have been emphasized only since extensive detailed study of pegmatites was begun in the early years of World War II. Since that time the results of many excellent detailed studies have been published (Smith and Page, 1941; Olson, 1942; Bannerman, 1943; Cameron, Larrabee, McNair, Page, Shainin, and Stewart, 1945; Johnston, 1945; Jahns, 1946; Cameron, Jahns, McNair, and Page, 1949; Jahns, Griffitts, and Heinrich, 1952; et al.). Most workers recognize the three fundamental types of units defined by Cameron, Jahns, McNair, and Page (1949, p. 14) as follows (Fig. 2):

"1. *Fracture fillings* are units, generally tabular, that fill fractures in previously consolidated pegmatite.

"2. *Replacement bodies* are units formed primarily by replacement of pre-existing pegmatite, with or without obvious structural control.

"3. *Zones* are successive shells, complete or incomplete, that reflect to varying degrees the shape or structure of the pegmatite body. Where ideally developed they are concentric about an innermost zone or core. Some concentric units, however, are not zones but belong in the categories above."

The size of individual units ranges from mere scales or veinlets to the major part of some large pegmatite bodies. In some cases, units merge one into another without distinct line of demarcation; in others, contacts are sharp. Grain size classification (in terms of maximum crystal dimension) used by the U. S. Geological Survey for pegmatite textures, and used in this report, are as follows: (Jahns, Griffitts, and Heinrich, 1952, p. 17)

	General grain size in inches
Fine	Less than 1.
Medium	1 to 4.
Coarse	4 to 12.
Very coarse	Greater than 12.

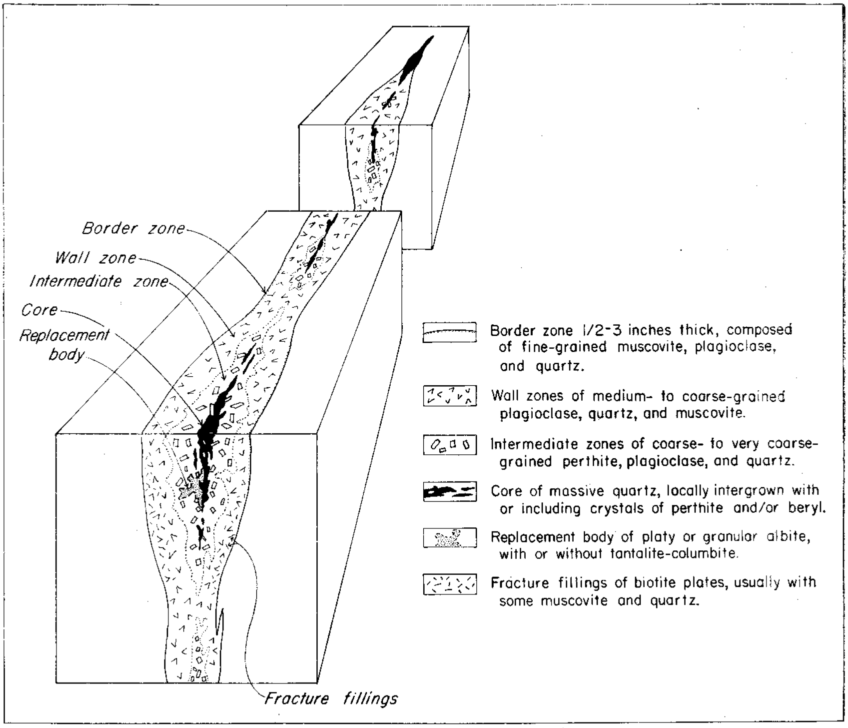


Figure 2. Block diagram showing idealized relations between the most common types of zones, fracture fillings, and replacement bodies in Virginia pegmatites.

ZONES

Zones, defined above and illustrated in Fig. 2, constitute the most important type of pegmatite unit because commercial accumulations of valuable minerals are largely limited to multizoned pegmatites (pegmatites with more than two zones). In addition, exploration for and extraction of valuable minerals are aided by the fact that specific minerals tend to be localized within certain zones.

Ideally, zones have a concentric and symmetrical arrangement within the pegmatite body; commonly, however, symmetry is impaired by differences in thickness of zones on opposite sides of a body, the discontinuous nature of some zones, and the occasional occurrence of a zone on only one side. Inner zones tend to be much more irregular and less continuous than those nearer the walls and may occur only in thicker parts of bodies.

Zones are named according to: (1) position within the pegmatite body, and (2) mineralogy and texture. On the first basis, Cameron, Jahns, McNair, and Page (1949, p. 20) propose the names:

1. Border zone (the outermost zone).
2. Wall zone.
3. Intermediate zone (single or multiple).
4. Core (the innermost zone).

Pegmatites with only two zones consist of border zone and core; those with three zones consist of border zone, wall zone, and core. Intermediate zones, defined as lying between wall zone and core, can occur only in pegmatites with four or more zones. Because of the frequent discontinuous or patchy nature of intermediate zones and cores, it is necessary that a considerable cross-sectional portion of any body be visible before zones can be named with certainty. For example, in early stages of excavation of a deposit the first zone within the border zone might appear to be a core but in later development be found to be a wall zone; likewise, what seems to be a core in a 3-zone pegmatite might later be found to be an intermediate zone in a 4-zone pegmatite.

Zoned pegmatites typically become coarser grained from the walls inward. Quartz occurs throughout, reaching its peak development in massive quartz cores. If potash feldspar is an important constituent in a body, it is generally most abundant and in largest crystals in intermediate zones, and plagioclase, richest in the outer zones, diminishes inward. Zonation typical of many Virginia pegmatites, as well as many in other regions, is outlined below and diagrammed in Fig. 2. Additional zones may be recognized in places, but these are mostly minor mineralogical or textural modifications of the types listed.

Border zones, ½ to 3 inches thick, consisting of fine-grained quartz and plagioclase feldspar, with or without fine-grained muscovite.

Wall zones, commonly making up 50-85 per cent of the pegmatite body, consisting of medium- to coarse-grained plagioclase and quartz, usually with some muscovite and, commonly, some potash feldspar. The best shoots of sheet muscovite generally occur in this zone.

An *intermediate* (*core-margin*) *zone* of (1) coarse to very coarse, blocky perthitic potash feldspar and interstitial quartz, with or without plagioclase, muscovite, and/or biotite, or (2) quartz, plagioclase, and greenish "A" muscovite. Combinations of the two are fairly common, usually with (1) forming the *inner intermediate zone* and number (2) the *outer intermediate zone*. Beryl, where present, is usually in intermediate zones.

Cores of massive "bull" quartz, locally but infrequently including crystals of beryl or microcline.

Intermediate zones rich in coarse perthitic potash feldspar (perthite) are well developed in most pegmatites worked for feldspar but are generally poorly developed or absent in those worked for mica; some of the better mica-pegmatites in the State are almost or completely lacking in potash feldspar.

Theories as to the origin of zones are several and have been comprehensively summarized by Cameron, Jahns, McNair, and Page (1949, p. 97-105). These writers, armed with compelling evidence, "adopt, as a working hypothesis, the concept that zones have developed from the walls inward, essentially by fractional crystallization and incomplete reaction in a restricted system".

FRACTURE FILLINGS

Parts of some pegmatites have undergone post-consolidation fracturing and the fractures filled with mica, quartz, and/or feldspar; locally other minerals occur. In places, fractures cut all zones; elsewhere they are confined to outer zones, which suggests that only these outer parts of the body were consolidated at the time of fracturing. Many small fillings and all of the larger fillings (generally not over a few inches to a foot or so thick) consist mostly of quartz, locally with some microcline, and frequently extend outward from quartz cores. In the Bedford and Chestnut Mountain areas of Virginia, however, by far the most widespread type of fracture fillings are scales and blades of biotite and muscovite, from an inch or so to a maximum of several feet long, occupying abundant cracks in random but definite fracture pattern, chiefly in wall zones, but locally extending into intermediate zones and cores. Replacement has obviously occurred about some of the fractures. None of the mica is fit for sheet use and, in places, particularly the Chestnut Mountain area, the biotite is extensively altered to vermiculite. These fractures are confined to the pegmatite, and do not extend into the wall rock as do some other types. This suggests shrinkage within the pegmatite as the cause of the cracking.

REPLACEMENT BODIES

The effects of replacement of pre-existing pegmatite by later minerals are very common in pegmatites and much has been written concerning them. These effects range from local and minor, as in nearly all pegmatites of relatively simple mineralogy including most mica pegmatites and those mined for feldspar, to so extensive that they determine the prevailing characteristics of some complex pegmatites, particularly those rich in high-soda albite, lithium, tin, or tantalum and columbium (Schaller, 1925; Derry, 1931; Hess, 1933; Landes, 1933; Gevers, 1936, et al.).

Cameron, Jahns, McNair, and Page (1949, p. 84-85) emphasize the importance of distinguishing (1) corrosion, veining, and replacement of early crystals which have become unstable in the presence of remaining fluids in partially consolidated portions of the pegmatite mass, from (2) replacement of completely consolidated portions of the pegmatite body by fluids from yet unconsolidated parts of the mass or from altogether outside sources. They call the first "reaction replacement" and restrict the name "replacement body" to the second. Understandably, the two are frequently difficult or impossible to distinguish with certainty, especially where compositions, textures, and small relations have been obscured by kaolinization, as they have in many Virginia pegmatites.

Much of the small scale corrosion and partial replacement of perthite by plagioclase (other than the granular or platy, high-soda type), common in Virginia pegmatites, particularly in the Moneta-Bedford area, is probably reaction replacement. A possible example of extensive replacement of this type was observed on the 110-foot level of the Big Hicks (Wheatley) mine near Moneta (Fig. 14).

Among the simplest replacement bodies are enlargements about fracture fillings, which are obviously post-consolidation. Most or all replacements by granular or platy (cleavelandite) albite more sodic than about An_5 may be post-consolidation (see Schaller, 1925, p. 279); replacement albite which can be traced into fracture fillings in quartz cores, seen in some pegmatites in the Bedford area, is also certainly late albite.

Replacement bodies of large size appear to be rare in Virginia pegmatites. Those in the Morefield (Fig. 3) and two Rutherford dikes near Amelia, however, are extensive and have created much interest because of the rare and unusual minerals which they contain (Glass, 1935). A very similar complex pegmatite occurs at the Herbb No. 2 mine in Powhatan County, but this is more strongly kaolinized, has been less thoroughly explored, and has not yielded such a great variety of minerals. In the lower levels of the Champion mine of the Amelia area coarse albite (An_9) of the wall zone and along the keel of the pegmatite has been rather extensively corroded and replaced by platy albite (An_5)

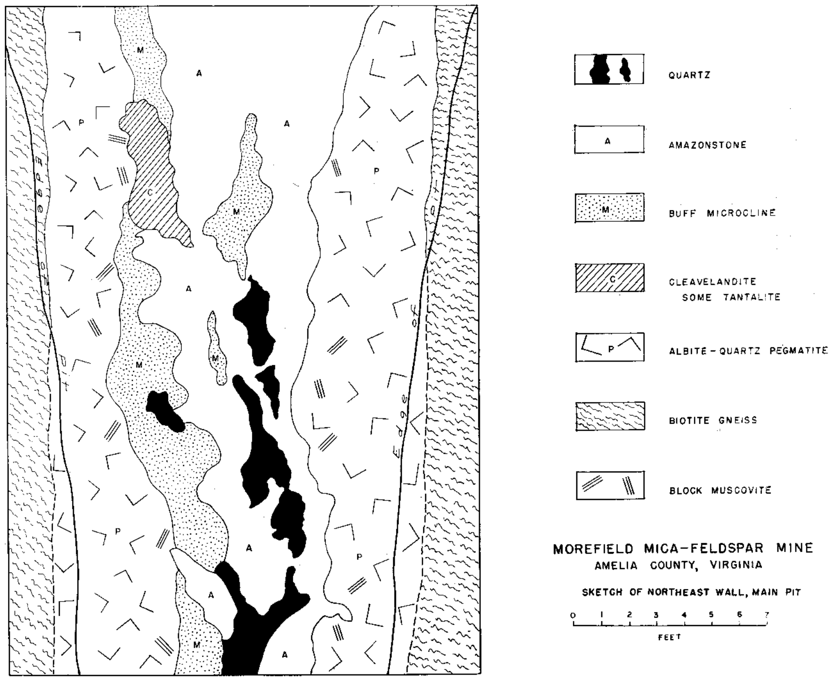


Figure 3. Sketch showing relations between mineralogic units in pegmatite as exposed in the wall of the main pit, Morefield mine, Amelia County.

and small greenish muscovite. In the R. E. Nance mine near Moneta replacement of light gray microcline by white platy albite (An_{16}) and some associated quartz and small muscovite has been widespread.

OCCURRENCE OF MICA IN PEGMATITES

In this report, minable concentrations of mica are termed *shoots.* Most of the richer shoots and those containing the best mica occur in pegmatites rich in plagioclase and low in potash feldspar. In some thin pegmatite bodies and in some simple pegmatites where mica occurs more or less from wall to wall, much or all of the body may constitute the mica shoot; in thicker, zoned pegmatites mica shoots generally show some definite relation to the zonation. Types of deposits found in Virginia are discussed under the following headings, listed in approximate order of importance: wall-zone deposits, pods and thin lenses, disseminated deposits, intermediate-zone deposits, and fracture fillings and replacements.

WALL-ZONE DEPOSITS

Shoots in plagioclase-quartz-muscovite wall zones constitute the most important occurrence of block mica in the southeastern states (Jahns, Griffitts, Heinrich, 1952, pp. 57, 60). There is no rule as to where within wall zones the mica will be most abundant. In some, as in the Saunders No. 2 mine of Hanover County, it is concentrated toward the walls; in others, as in the Champion mine near Amelia, the mica is largest and most abundant in the inner part of the wall zone adjacent to the quartz core; in still others it occurs fairly uniformly throughout the thickness of the wall zones. At the Champion and Nettie Taylor mines of the Amelia area and the Price mine in Henry County rich shoots occur along the trough-like keel of the pegmatite. It is also common for rich concentrations to occur at irregularities, horses, and constrictions in wall zones. Shoots may occur in wall zones of one or both sides of a pegmatite; but, if both, that on one side is generally richer than that on the other, although color and quality of the mica is nearly always the same. Shoots along both walls are more common in steeply- than in gently-dipping bodies but are not confined to those of steep dip. In gently-dipping bodies with shoots along only one wall, there seems to be no rule as to which wall the shoots follow. In the Harry Knight mine in Rockingham County, North Carolina, the strongest shoot is along the footwall, whereas in the Joe Hawkins mine in the same area, a single excellent shoot extends along the hanging wall. Wall zone shoots vary from narrow and quite irregular to broad and blanket-like; few are completely coextensive with the wall zones in which they occur.

PODS AND THIN LENSES

Sizable mica of good quality is abundant in some short pod-like as well as relatively longer thin lenses of pegmatite. Some of these are unzoned, others have a crude zonation to which the mica shows a general localization. Mica in the former may be classed as disseminated and that in the latter classed according to zonal relationship (Jahns, Griffitts, and Heinrich, 1952, p. 57). Because of the small thickness of these bodies, however, shoots in the unzoned bodies are not truly disseminated, and localization in zoned bodies is of slight commercial significance compared to over-all size and shape of the bodies. For these reasons, small bodies of these types are here given a separate classification.

Many pods and thin lenses of pegmatite exhibit obvious structural control. Good examples are found at the Monteiro-Amber Queen mine in Goochland County where discordant attitudes of foliation in schists which enclose the bodies strongly suggest emplacement along faults. At the DeShazo mine in the Ridgeway area thin irregular lenses and stringers of pegmatite, locally rich in mica, appear to occur as fillings and replacements along fractures in aplite. At the Coleman No. 1 mine, also in the Ridgeway area, markedly lenticular masses of pegmatite, 2 to 3 feet thick and composed chiefly of plagioclase and quartz with some coarse centrally-placed microcline and abundant high quality mica, occur as concordant bulges within the strong primary foliation of the enclosing, genetically related aplite (Pl. 20).

DISSEMINATED DEPOSITS

In this report, the name disseminated deposit is applied only to those unzoned or poorly zoned pegmatites which are more than about 2 feet thick and in which mica is distributed more or less at random throughout. In Virginia, block mica is rarely of this occurrence, but in some deeply kaolinized pegmatites, notably in the Chestnut Mountain area, small mica is so abundantly disseminated and so easily extracted that it can be recovered commercially for grinding.

INTERMEDIATE-ZONE DEPOSITS

In many pegmatites, the only intermediate zone is a "core-margin" concentration of greenish "A" muscovite with variable amounts of sodic plagioclase and quartz, with or without perthite, fringing a core of massive quartz or quartz and perthite. Similar concentrations also occur as outer-intermediate zones fringing quartz-perthite inner-intermediate zones or detached segments of these zones. Lean concentrations of the latter type occur at the Morefield mine of Amelia County and the Herbb No. 2 mine of Powhatan County. Core-margin shoots are more numerous and much more important than the outer-intermediate zone concentrations because of their general larger yield of mica and, often, the larger size of the crystals. Some core-margin shoots contain very large crystals, as at the Ridgeway and Tom Smith mines in the Ridgeway area; but the crystals from such shoots, although generally clear, tend to be reevy and wedged. The latter is true even in pegmatites with wall-zone shoots of flat mica.

FRACTURE FILLINGS AND REPLACEMENTS

These are of slight importance in Virginia. Small crystals and thin scaly plates of muscovite with biotite and quartz, with or without high-soda albite, are abundant as fillings and replacements along fractures in outer zones of many pegmatites in the Bedford and Chestnut Mountain areas but are useless except possibly as scrap. Thicker books of poor-quality mica with and in replacement cleavelandite at the Herbb No. 2 and Morefield mines of Powhatan and Amelia counties, respectively, may be replacement muscovite, but they may also represent unreplaced material from an intermediate zone.

FELDSPAR IN PEGMATITES

Pegmatites have long been the chief source of commercial feldspar, although certain finer-grained rocks rich in feldspar or feldspar and nepheline have become quite important. In general, the best spar pegmatites are large, coarse- to very coarse-grained, and contain considerable potash feldspar. In most uses, other than in the glass industry, a high potash-soda ratio is required, and in No. 1 grade feldspar it must be at least 2:1. Potash feldspar in zoned pegmatites is generally in the form of blocky perthite concentrated in intermediate zones. Because of the desirability of potash spar, its usual coarse crystallization, and its resistance to kaolinization compared to soda spar, most spar operations in the Virginia Piedmont have been started in croppings of potash spar of the inner parts of pegmatite bodies. With depletion of these inner zones, mining has been extended to the coarser parts of the adjoining soda spar-rich wall zones. With deeper mining it has frequently been noted that the potash-soda ratio decreased with depth. In some bodies, the intermediate perthitic zones pinch out downward against quartz cores, showing that their over-all shape is hood-like (Fig. 2).

Coarse- to very coarse-grained material has been required in most pegmatite spar operations because of the hand picking and cobbing methods used for removing unwanted minerals. With the use of froth flotation, a separatory process coming into wide usage, grain size loses its significance; also much wall-zone material in the Bedford area, unusable because of much fracture-fill biotite, could become commercial under the flotation process (Pl. 3A).

In that potash feldspar is usually an important constituent in most good spar pegmatites but tends to be sparse or lacking in mica pegmatites, spar pegmatites seldom yield much mica and vice versa. Also, many mica pegmatites are much too small for commercial feldspar production, probably averaging not more than 10 feet in thickness, whereas pegmatites mined for feldspar are generally not less than about 20 feet thick. There have been instances, however, where production of mica helped sustain feldspar operations and the other way around, and certainly there are more deposits in the State, particularly in the Amelia and Ridgeway areas, where operations of this type may be carried on in the future.

PHYLLITES AND SCHISTS

Very small mica is sufficiently abundant in some phyllites and schists to be commercially recoverable. These rocks are usually easily crushed, and after crushing, the mica can be separated by tabling and other means of concentration. The resulting product is comparable in many ways to the dry-ground product derived from scrap mica (Wierum, 1938, p. 113).

CLAYS

Variable amounts of small mica are found in certain white china clays formed by weathering of feldspars in granitic rocks, and the recovery of such mica has become a useful industry in North Carolina. The mica was an original constituent in the granite along with the feldspar but has been more resistant to decomposition. The removal of the mica makes the clay more desirable, and the mica recovered more than pays for the separation (Wierum, 1938, p. 112).

ALASKITE AND SYENITE

Alaskite is essentially a granite with little or no dark mineral, and syenite is like a granite with less than 10 per cent quartz. Alaskites which vary in texture from the fineness of granite to the coarseness of pegmatite and which consist, in order of abundance, of oligoclase, quartz, microcline, and muscovite are being utilized in western North Carolina for their feldspar and mica content (Burgess, 1949, p. 347; de Polo and Tucker, 1958, p. 478). Since World War II, several deposits of granitoid rock ranging in composition from potassic to sodic alaskite and syenite have been quarried near Peaksville in Bedford County, Virginia, and the ground product sold for the same uses as pegmatite feldspar. These rocks appear to be related to the Coles pegmatite of the same area and to belong to the Precambrian Pedlar complex (Bloomer and Werner, 1955, p. 582) of the Blue Ridge structural province. This relationship would appear to point up the region of outcrop of the Pedlar, which is nearly coextensive with the Blue Ridge structural province of Virginia (Geologic Map of Virginia, 1928), as a region to be prospected for more bodies similar to these near Peaksville.

NEPHELINE SYENITE

Nepheline syenite is a megascopically crystalline quartz-free rock composed essentially of alkali feldspar and nepheline (a silicate of alumina, soda, and potash). The feldspars are usually albite, microcline, and orthoclase but anorthoclase occurs in some varieties. Feldspathoidal minerals other than nepheline, along with such minerals as apatite, fluorite, sphene, zircon, calcite, and iron-bearing minerals like hornblende and lepidomelane, are commonly present. Where the rock is low in iron-bearing minerals and most of those present can be removed by high intensity magnetic separators, its medium low silica and high alumina and alkali content make it well suited as a substitute for feldspar in the glass and certain ceramic industries (Burgess, 1949, p. 368; Deeth, 1957).

Nepheline syenites are relatively rare rocks but do occur in numerous parts of the world, notably in Canada, Russia, India, and Norway, and in Arkansas, New Jersey, and Wisconsin of this country. The only commercial producers are Canada and Russia, but it is very probable that use of this rock will increase and spread. In 1957, this country's imports of nepheline syenite from Canada amounted to 166,989 tons valued at $2,505,248 (de Polo and Tucker, 1958, p. 484).

Several nepheline syenites (phonolite, in part) occur in northern Augusta County, Virginia (Watson, 1913). Their occurrence in this limestone region is in good agreement with that of most other nepheline syenites of the world. This occurrence, along with the presence of associated diabases, suggests that they owe their origin to desilication of basaltic magma by reaction with limestone, as hypothesized by Daly (1933, p. 497) and Shand (1943, p. 359-360).

Table 3—Chemical analyses of nepheline syenite from two Augusta County dikes compared with a typical analysis of Canadian nepheline syenite after 2 percent Fe_2O_3 has been removed by magnetic separation.

	Augusta Co., Virginia (Watson, 1913, p. 316-317)		Finished product nepheline syenite, Blue Moutain, Canada (Deeth, 1957, p. 1243)
	North dike	South dike	
SiO_2	54.77%	53.57%	60.4%
Al_2O_3	21.41	22.46	23.6
Fe_2O_3	2.46	1.01	0.08
FeO	0.68	0.92	
MgO	0.18	0.37	0.1
CaO	0.47	1.49	0.7
Na_2O	9.53	10.22	9.8
K_2O	4.97	5.14	4.6
Loss on ignition	4.78	3.40	0.7

In Table 3 above, chemical analyses of stone from two Augusta County dikes are shown in comparison with a typical analysis of Canadian nepheline syenite *after about 2 percent* Fe_2O_3 *has been removed by magnetic separation.*

These analyses are remarkably similar, particularly when the 2 per cent Fe_2O_3 is added back into that of the Canadian product. Unfortunately, the exact size of the Virginia dikes is unknown, but R. W. Johnson, Jr. (personal communication) of the U. S. Geological Survey states that at least one is over a mile long. In view of possible commercial use, it would appear that these dikes deserve a closer study.

APLITE

A high-feldspar rock is produced by three grinding plants near Piney River, Virginia, and sold under the name "aplite", for use in the glass industry (Fig. 1). The rock is the same as that called pegmatite by Merrill (1902, p. 351), syenite by Watson and Taber (1913, p. 68-90), and Roseland anorthosite by Ross (1941, p. 3-5). It occupies a belt about 16 miles long by a maximum of 2½ miles wide in northeastern Amherst and southwestern Nelson counties (Watson and Taber, 1913, fig. 3). The rock is composed chiefly of antiperthitic plagioclase, mostly andesine but in places as sodic as albite, along with variable amounts of accessory quartz, apatite, clinozoisite, titanite, biotite, actinolite, rutile, and ilmenite (Ross, 1941, p. 4).

VALUABLE PEGMATITE MINERALS

MICA

WORLD SOURCES

India has long been the world's largest producer of sheet mica, and the United States is almost completely dependent upon India for film mica and muscovite splittings. Other important producers are the United States, Brazil, Canada, Norway, Argentina, Southern Rhodesia, Tanganyika, and Madagascar. Over half the world's supply of scrap mica is produced in the United States; important but much smaller amounts come from India and Union of South Africa. In 1957, North Carolina accounted for 84 per cent of this country's sheet mica production; other producers, in order of importance, included New Hampshire, Maine, Georgia, South Dakota, South Carolina, New Mexico, Idaho, and Virginia (Skow and Tucker, 1958).

PROPERTIES OF MICA

The term "mica" is used as a group name for seven distinct mineral species of true micas, all of which show similarities in chemical composition, crystal structure, and physical properties. These seven species with their theoretical chemical formulas or general composition are as follows (Dana, 1932, p. 658):

Muscovite (white mica)	$H_2KAl_3(SiO_4)_3$
Phlogopite (brown or amber mica)	$H_2KMg_3Al(SiO_4)_3$
Biotite (black mica)	$H_2K(Mg,Fe)_3(Al,Fe)(SiO_4)_3$
Lepidolite	$(OH,F)_2KLiAl_2Si_3O_{10}$
Paragonite	$H_2NaAl_3(SiO_4)_3$
Zinnwaldite	Lithium-iron mica
Lepidomelane	High iron micas

All members of the mica group crystallize in the monoclinic system, but are nearly hexagonal or orthorhombic in symmetry. They commonly develop the same crystal forms and occur not infrequently as intergrowths, those of muscovite and biotite being especially common.

The outstanding physical property of the micas is the perfectly developed basal cleavage which permits crystals to be split into numberless, very thin, tough, and more or less elastic plates or sheets. A study of the internal structure of mica by means of X-ray has shown that this remarkable cleavage results from a sheet-like arrangement of groups of atoms within the crystal. These groups of atoms (SiO_4 tetrahedra) are further arranged in hexagonal rings within the sheets, and this apparently gives rise to the frequent pseudohexagonal, or six-sided, shape taken by the mica crystals (Pl. 1A).

The members of the mica group are also characterized by secondary cleavages, or partings, which develop in nature or may be developed artificially by striking or pressing a thin basal plate with a dull-pointed instrument. These provide a ready means of crystallographic orientation for plates which lack crystal faces. When the plate is struck, a six-rayed star composed of three cracks intersecting at angles of 60 degrees tends to develop. Two lines in this "percussion figure" are nearly parallel to the prism faces, while the third line, which is generally the most strongly developed, is parallel to the clinopinacoid. If the cleavage plate is strongly pressed, rather than struck, a series of lines, constituting a "pressure figure", tend to develop at right angles to those of the percussion figure. In muscovite, the line parallel to the *b* axis is generally developed most prominently.

At present, only four members of the mica group are of commercial importance. Ordinary muscovite, biotite, and phlogopite, are useful because of their physical properties, whereas lepidolite is an ore of lithium. The vanadium muscovite, roscoelite, serves as an ore of vanadium. In Virginia, only muscovite has been found in commercial quantities.

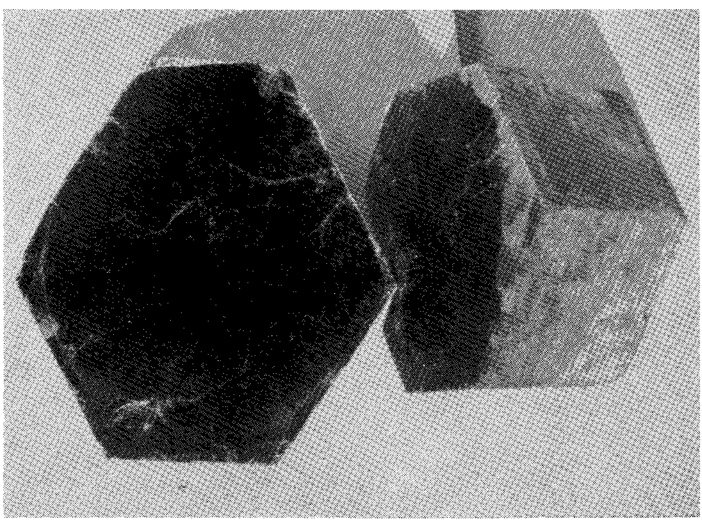
MUSCOVITE

Muscovite, variously referred to as white mica, potash mica, isinglass, or simply as mica, is the most common and commercially the most important member of the mica group. Since the physical properties of muscovite are of prime importance in determining its usefulness and since these properties are subject to considerable variation and cannot be changed or improved by refining or alloying, the properties of muscovite will be considered in some detail, with special emphasis on those most affecting its utilization. For an exhaustive discussion of properties, see Jahns and Lancaster (1950).

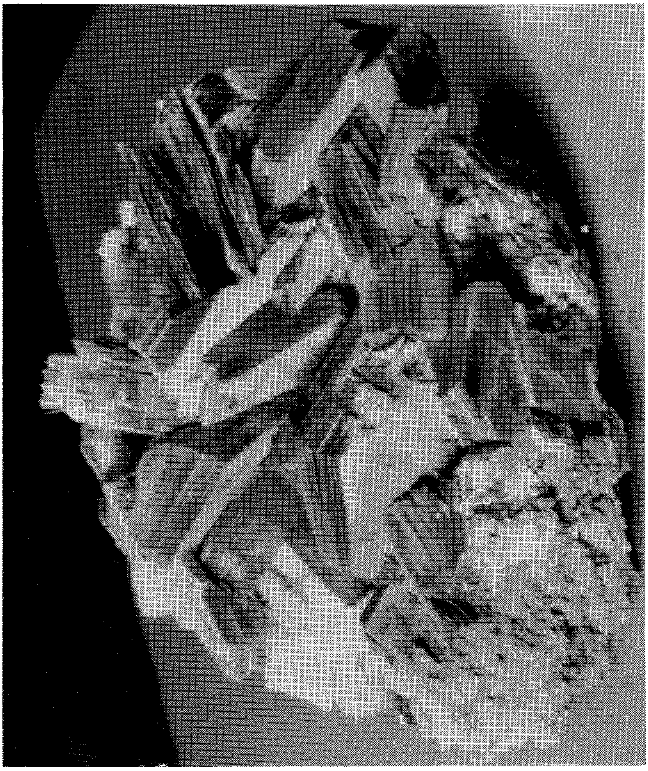
FORM

Muscovite occurs in tabular book- or scale-like crystals ranging in size from microscopic flakes to blocks measuring yards across and weighing hundreds of pounds. Such very large crystals are extremely rare; and the very small, though abundant, are important only as sources of scrap mica. The intermediate to large crystals, from 2 to 8

Plate 1

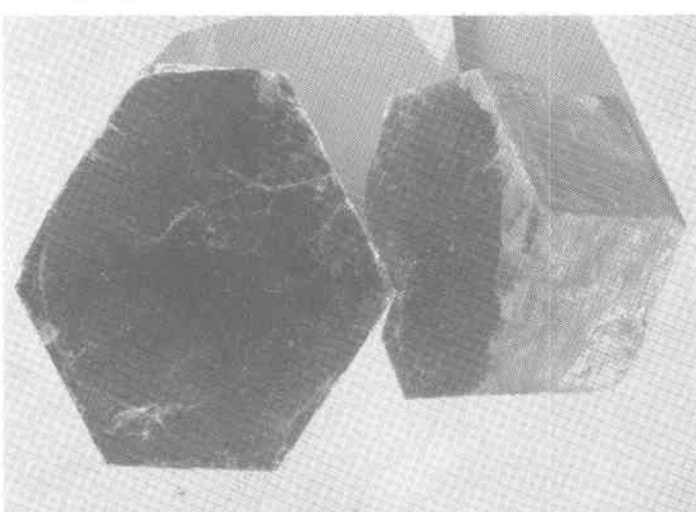


A. Six-sided mica crystals from the Saunders No. 2 mine, Hanover County. x2/5

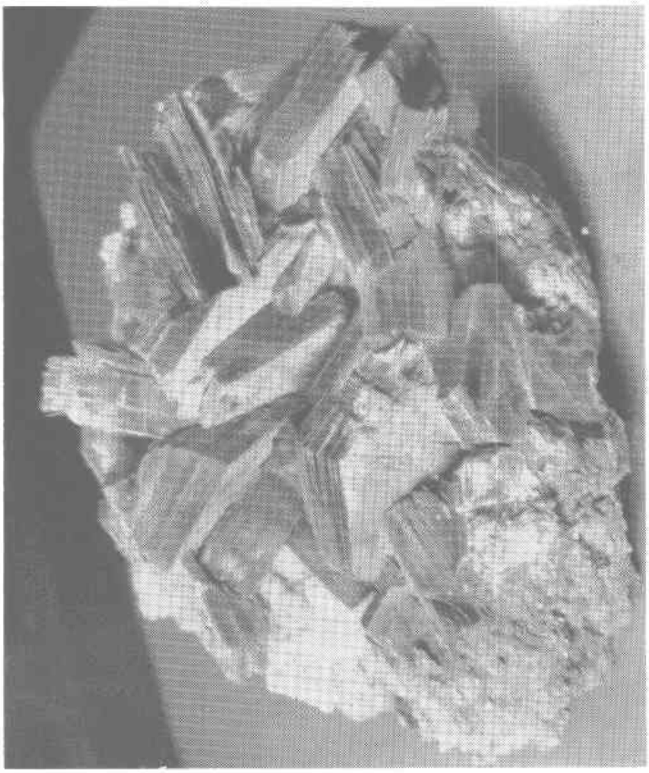


B. Cluster of mica crystals found lining a cavity at the Champion mine, Amelia County. x2/5

Plate 1

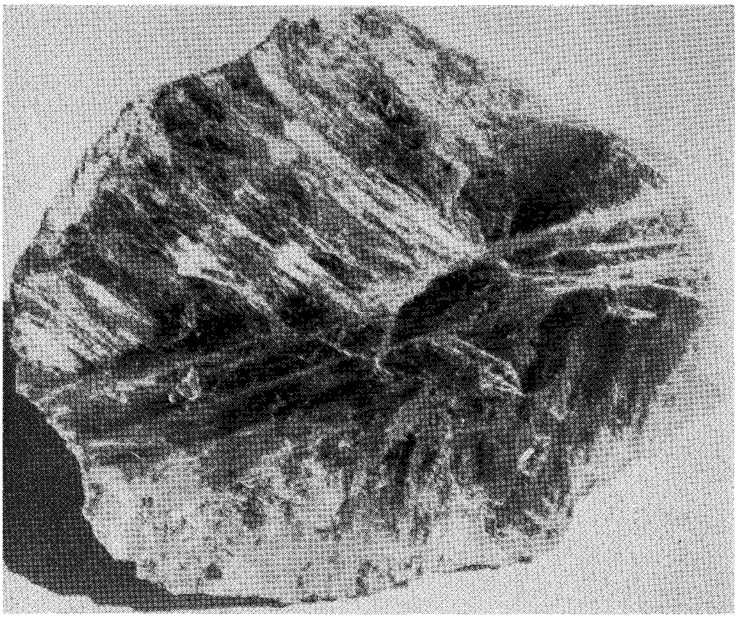


A. Six-sided mica crystals from the Saunders No. 2 mine, Hanover County. x2/5

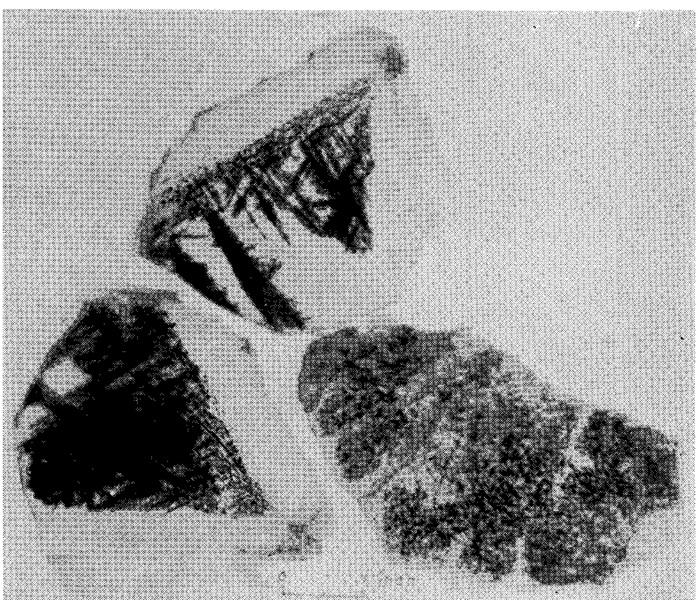


B. Cluster of mica crystals found lining a cavity at the Champion mine, Amelia County. x2/5

Plate 2

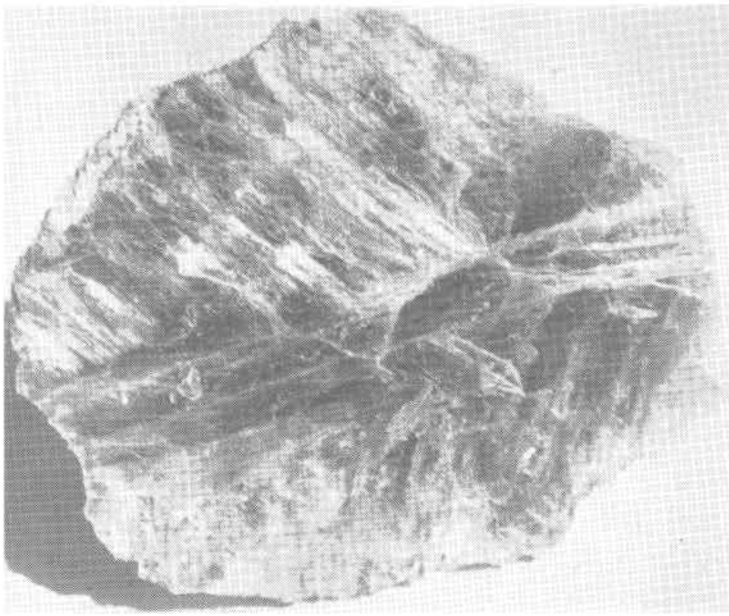


A. Herringbone mica from the Broomfield mine, Pittsylvania County. Three sets of reeves are developed. x1/2.

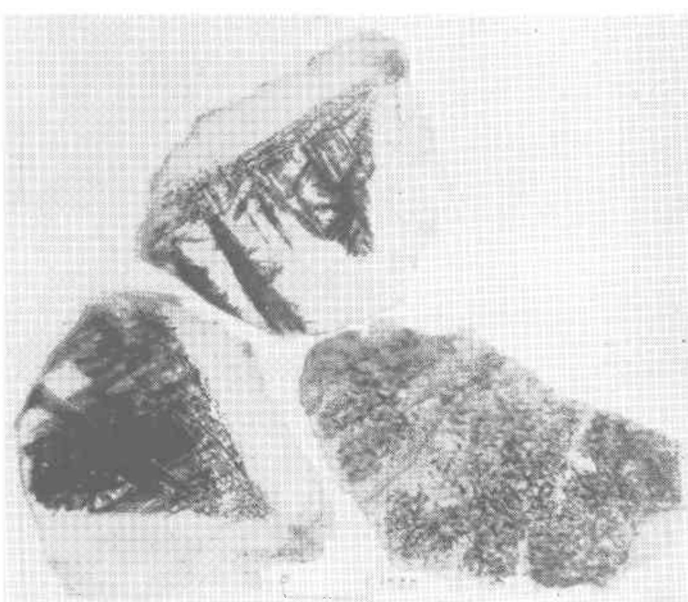


B. Black-stained ("electric") mica from the Chestnut Mountain area, Franklin County. Stain and inclusions are hematite.

Plate 2



A. Herringbone mica from the Broomfield mine, Pittsylvania County. Three sets of reeves are developed. x1/2.



B. Black-stained ("electric") mica from the Chestnut Mountain area, Franklin County. Stain and inclusions are hematite.

inches across, are the most important commercially because it is from these sizes that most sheet mica is derived. The most valuable crystals are those which yield the largest and most perfect sheets.

The quality of individual crystals, called "books" or "blocks" by miners, is subject to wide variation depending upon conditions during and since their formation. The more perfect books, probably products of slow growth, yield flat plates free from cracks, stains, inclusions, waves, and "reeves". The term "reeve" refers to ridge and line-like imperfections in the plates which prevent free splitting.

A common imperfection is a combination of two series of reeves intersecting at an angle of about 60 degrees to form a V, or an A without a cross bar. Mica with this structure is called "A" mica. Although the "A" blocks generally occur singly, each "A" actually makes up only one-sixth of a complete crystal (Kesler and Olson, 1942, p. 14). A combination of one and a half "A" units, unequally developed, produces a feather, fishbone, or herringbone structure (Pl.2A). The structure of "A" crystals in which the reeves are largely confined to the marginal portions, is referred to as flat "A". Blocks of "A" mica tend to be thick at the wide end of the "A" and thin toward the apex, giving, when pronounced, what is called "wedge" mica. Material with wedge and herringbone structure can be used only for scrap mica.

CLEAVAGE

The most prominent feature of muscovite is its more or less perfect cleavage, or tendency to split into flat plates, parallel to the basal pinacoid of the crystal. The perfection to which this cleavage is developed largely determines the value of a block of mica. For the most exacting uses the cleavage plates must separate cleanly and completely into very flat sheets, each of which must be of uniform thickness. Waves, ripples, reeves, and wedged areas are undesirable and must be trimmed from the flat areas to be classed as "sheet" quality. Mica in which the cleavage plates separate incompletely and with difficulty is called "tanglesheet", "gummy", or "locky" mica.

Secondary cleavages or partings along the lines of the pressure figure cut across the basal plates, in places, to form strips or triangles called "ribbon" or "ruled" mica. "Ruling" obviously reduces the value of the mica because it reduces the size of sheets a crystal will yield, and badly ruled mica can be used only for scrap mica.

DISTORTION

Faulting, slumpage, and other earth movements affecting the mica-bearing body subsequent to the formation of the mica crystals may break and distort the crystals. Common results are ruling, bending, and fracturing of the mica. Ruling has been discussed under cleavage. Bent crystals will not yield flat sheets and bending is usually accompanied by fracturing. Crystals may be irregularly broken throughout, or cleavage plates may be crossed by fine, irregular, almost imperceptible "hair cracks" which prevent the separation of complete sheets.

The fact that the most deformed mica found in Virginia occurs in kaolinized pegmatites suggests that processes accompanying and following the change from feldspar to minerals of the kaolin group produce breakage in mica. Where breakage has resulted from these processes, undeformed or less deformed mica might be expected below the zone of kaolinization.

Possibly the breakage from kaolinization processes may locally be secondary to breakage by faulting, and kaolinization itself may be due in part to faulting. In pegmatites injected along faults or shears, renewed movements following consolidation could deform the mica and fracture the feldspars, later giving access to kaolinizing solutions. In pegmatites so affected, the mica would be deformed at depths below, as well as above, the zone of kaolinization.

Definite post-mica faults are found in some deposits. At the Abner Cox No. 1 prospect in Henry County, Virginia, and the Jack Hole mine in Stokes County, North Carolina, mica crystals near faults are sheared and ground into small flakes. Those not along faults in the same workings are perfectly sound.

COLOR

Very thin sheets of muscovite are generally transparent and appear colorless, but sheets one-sixteenth of an inch or more in thickness commonly show shades of brown, yellow, green, or pink. Jahns and Lancaster (1950, p. 48), after extensive studies, concluded that colors in mica can be grouped into seven main categories, as follows:

Main color categories	*General terms of the trade*
Pinkish buff and drab Cinnamon brown	Ruby
Brown Brownish olive	Rum
Yellowish olive Yellowish green Green	Green

Other terms are used locally in the trade, such as "white" for very light shades and "water-colored" for brownish olive to smoky-olive colors. The "black-stained" refers to mica which is streaked or spotted with iron oxide and not to inherent color in the mica. Uneven distributions of color within single sheets, often zoned along crystallographic lines, are common.

"Green" mica has generally been considered less desirable than "ruby" and "rum"; but Jahns and Lancaster (1950, p. 105), in summarizing results of their extensive tests as well as tests of various others, state

> ". . . the results of the present investigations show that there is no intrinsic difference, quality for quality, between clear ruby and clear non-ruby micas from the Southeastern States. Clear green, yellowish-olive, and brownish-olive micas, selected by visual means, should prove just as satisfactory for condenser use as clear buff and light-brown micas, and several manufacturers have indeed found this to be the case."

Much green mica, however, does contain damaging mineral stain, and it is generally softer than ruby and rum micas. Dark-colored micas appear to have as good electrical properties as the lighter colored; but they are undesirable where transparency is required, and they may take more work to prepare since one must split them into thinner sheets to detect imperfections.

STAINS, INTERGROWTH, AND INCLUSIONS

Muscovite commonly contains impurities in the form of intergrown or included mineral or vegetable matter which may appreciably affect its preparation, value, and usefulness. Types of impurities may be classed as follows (Jahns and Lancaster, 1950, p. 12):

Primary impurities (formed during or soon after crystallization of the mica):

- Air stain
- Mottling and inorganic "vegetable stain"
- Mineral stain (intergrowths and inclusions)

Secondary impurities (introduced into the mica by weathering or ground water):

- Air creep
- Clay, iron, and manganese stains
- Organic vegetable stain

Primary staining, being closely related to the formation of the mica, is unrelated to the present land surface and may increase, decrease, or remain unchanged with depth. Of the primary stains, air stain, mottling, and "vegetable stain" are the least important. Air stains are inclusions of gas in the form of tiny bubbles, either scattered or in swarms, and flattened pockets. Mottling and inorganic "vegetable stain" are greenish, yellowish, and brownish discolorations produced by inclusions of minute scales and finely divided aggregates of chlorite, biotite, or material rich in ferrous iron (Jahns and Lancaster, 1950, p. 12). Particular types include curdy "bursts", brown "cigarette burns", and brown and green "frog eyes".

Mineral stain, the most serious of the primary impurities, consists chiefly of extremely thin, oriented, black to brown inclusions of iron oxide between the mica laminae; and thicker, usually more or less flattened, crystals of minerals like quartz, garnet, apatite, albite, tourmaline, and beryl extending through variable thicknesses of mica laminae. Intergrowths of biotite with muscovite, the two in structural continuity, also occur. Iron oxides are much the most common of the mineral inclusions and are mostly in the form of hematite, although magnetite is not uncommon (Frondel and Ashby, 1937; Jahns and Lancaster, 1950, p. 13). Iron-stained mica varies from lightly "specked" or "spotted" to heavily stained varieties referred to as "black", "black-stained", or "electric" mica. Hematite occurs in transluscent brown to smoky, skeletal, dendritic, and lattice-like splotches, laths, and irregular growths with hexagonal symmetry (Pl. 2B). Opaque hematite crystals, ranging from brownish black to reddish brown, are rare. Magnetite, in equant hexagonal and lath- to needle-like crystals, is commonly opaque but may be transparent with lavender to gray coloration. Opaque crystals are lustrous iron-black. These film-like inclusions of hematite and magnetite, unless they are restricted to certain parts of mica books, generally cannot be removed. Thicker, so-called "stony" or "sandy", inclusions of quartz, garnet, etc., however, usually can, and must, be removed in the sheeting process, and the surrounding area trimmed away. An interesting feature of some stained mica is a bright red or green coloration like that from a film of oil on water, produced, according to Frondel and Ashby (1937, p. 114), by interference from a mica film above inclusions.

Secondary impurities include chiefly earthy minerals, constituting "clay stain", yellowish-red to brown "iron stain", black "manganese stain", and green organic vegetable stain which have been introduced by weathering and ground-water processes. In places, plant rootlets also separate mica laminae, as does air creep, which is air which has penetrated books from their edges, either in nature or as a result of rough handling or trimming with shears or a dull knife. These secondary inclusions can greatly reduce the value of near-surface mica in that they must be sheeted or trimmed out of all sheet stock.

ELECTRICAL PROPERTIES

In that most sheet mica is used in electrical apparatus, electrical properties of mica such as electrical conductivity, dielectric strength, and power factor are of utmost importance. Conductivity relates to the resistance of a substance to the passage of an electric current; dielectric strength refers to the ability of the substance to maintain this resistance without breakdown or puncture when subjected to high voltages. Mica has high resistance to the passage of electric current and, as Wierum (1938, p. 9 and 13) points out, although there are more perfect insulators (have higher specific resistance), there is none which has as high a dielectric strength and is at the same time thin, flexible, infusible, and impervious to water. Iron oxide stains increase conductivity, so only clear mica can be used where the best insulation is required. Dielectric weakness may be caused by imperfections like pinholes and hair cracks, but breakdown or rupture is seldom caused by conducting impurities (Jahns and Lancaster, 1950, p. 23).

The power factor of mica is the percentage loss of electrical energy in a condenser in which mica is the dielectric. Good condenser mica should have a power factor of less than 0.04 per cent, or a Q value (the reciprocal of the power factor) of at least 2,500 (Jahns and Lancaster, 1950, p. 16). The results of numerous measurements of power factor in micas have been published by Horton (1935, p. 41-46), Kesler and Olson (1942, p. 18-30), Jahns and Lancaster (1950, p. 104), and others.

ELASTICITY AND TENACITY

Muscovite, when free from flaws, is flexible in that it can be bent sharply without breaking. It is also highly elastic in that thin sheets tend to return to their original condition when the bending force is released, even though the bending may have been extreme. The finest quality sheet mica of the type used in airplane spark plugs, called cigarette mica, is so flexible that it can be rolled around a rod about 1/8 inch in diameter without cracking or buckling (Wierum, 1938, p. 19). Elasticity is important where mica is used for diaphragms in acoustic apparatus, for bridges and supports in radio tubes, and in all other uses requiring resonance and resistance to shock.

Muscovite is sectile in that it can be severed smoothly or punched into coherent pieces. This property permits it to be trimmed for market and cut into the various patterns required in industry.

SPECIFIC GRAVITY AND HARDNESS

The specific gravity of muscovite varies from 2.76 to 3.0. A block occupying one cubic foot would weigh from about 172 to 187 pounds, slightly more than a cubic foot of granite.

Muscovite has a hardness of 2 to 2.5 according to the Moh scale. Although color is not always indicative of hardness, generally the darker varieties of muscovite, and phlogopite, are harder than the light-colored varieties. The hard varieties usually can be sheeted more easily and cleanly than the soft, but they tend to be less flexible and are, therefore, less desirable for some uses.

REACTION TO HEAT

Muscovite is a good insulator against heat, is constant in volume over a wide range of temperatures, and for all practical purposes may be considered to be infusible. It may be heated to 400° C. without change, but at this temperature it begins to lose minute quantities of water of crystallization. With continued heating, the mica swells, becomes brittle, and loses its transparency (Horton, 1935, p. 6 and 8). Phlogopite will withstand higher temperatures than muscovite, and is virtually unaffected up to 800° C.

CHEMICAL STABILITY

Muscovite is chemically stable and is not decomposed by acids (unlike phlogopite which is completely decomposed by sulphuric acid). It is not affected by oil and is impervious to, and does not attract or absorb water. It is virtually unaffected by chemical weathering, although the agents of weathering may cause the cleavage laminae to separate.

USES OF MICA

Mica has been used widely and for a variety of purposes, but by far its most important use has been in the electrical and electronic industries where its unusual properties of thinness, flexibility, resistance to heat, shock, electricity, water, oil, and acids; its high dielectric strength and low power factor make it almost ideally suited for use as an insulating material. Its usefulness in the electrical field has been greatly increased by the invention of built-up mica, a plate- or board-like material which is made in various sizes and thicknesses by glueing together large numbers of relatively small, very thin sheets of mica known as "splittings". Built-up mica is used chiefly in commutator segments and V-rings for motors and generators, high temperature and high voltage armatures, high voltage transformers, electric flatirons, and insulating washers. According to Skow and Tucker (1958, p. 850), reconstituted mica, a sheet material "formed by paper-making procedures from specially delaminated natural mica scrap, can substitute for built-up mica in many applications". Mica used in sheet form without building up, referred to as "pattern", "block", or "film" mica, is stamped or punched by machine into a wide variety of shapes and sizes and used chiefly in electronic tubes, capacitors, high temperature and high voltage armatures, and airplane motor spark plugs.

Mica unfit for use in sheet form is classed as scrap and is used exclusively in ground form. Although the use of sheet mica has diminished somewhat in recent years, the demand for ground mica has tended to increase. This is in spite of decreased use of wet-ground mica in wallpaper, formerly its chief application. Today, most scrap mica is dry-ground for use in roofing, joint cement, plastics, and welding rods. Wet-ground mica is used mainly in paint and rubber. Other uses of ground mica include oil well drilling muds, molded electric insulation, house insulation, Christmas tree snow, and lubricants.

PROSPECTING AND MINING FOR MICA

In Virginia, crystalline rocks of the types which contain commercial mica may be expected only in the Blue Ridge and Piedmont provinces. Pegmatites, the only source of commercial sheet mica, occur in both of these provinces, but commercial mica-bearing pegmatites are known only in the Piedmont province.

Pegmatite is usually easily identified by its coarse texture and characteristic light-colored mineral assemblage of feldspar, quartz, and mica. Under the conditions of deep chemical weathering which prevail in the Piedmont, much or all of the feldspar at and near the surface is commonly altered to white clay (kaolin); in places only large glistening flakes of residual mica and random masses of quartz remain to suggest the presence of an underlying body of pegmatite. Most book mica occurs in plagioclase-rich pegmatites, and plagioclase is much more susceptible to kaolinization than is potash feldspar. In the search for mica, therefore, thorough kaolinization may be considered favorable, in that it usually shows the former presence of much plagioclase. Masses of massive quartz with kaolin and mica are also favorable because they indicate some zoning in the pegmatite.

The size, quantity, and quality of mica found at the surface, either in solid rock or in the soil, generally indicate the commercial possibilities of the unworked deposit. None of these factors, except quality as affected by clay staining, can be counted upon to improve with depth. Below the zone of weathering clay staining disappears and the mica becomes harder and more compact; but it cannot be expected that such primary imperfections as reeves and primary stains will disappear. In prospecting for sheet mica, it is seldom worth while to consider a deposit unless the exposed mica is fairly abundant, of generally good quality, and yields sheets that measure several inches across. Large, deeply kaolinized deposits containing abundant small mica of any quality, however, may be good scrap mica prospects. It is also well to remember that mica may not be as abundant underground as it is in the soil where it has been concentrated by the weathering away of associated, less resistant feldspars.

In the evaluation of a mica prospect, the size and extent of the pegmatite body must also be considered. Mica is often more highly concentrated in small than in large bodies, but larger bodies may offer greater possibilities of ultimate production. Generally those bodies which have the greatest lateral extent also have the greatest vertical dimensions; also, longer bodies offer greater possibilities of multiple shoots.

Cross-trenching may provide information helpful in the evaluation of a deposit but, because of the irregular nature of many mica shoots, its usefulness is limited. The usual procedure in exploration is to open a small pit, shaft, or tunnel at the place where mica is found in greatest abundance on the surface. Core and churn drilling may be useful in determining the depth to which a body of pegmatite extends, the depth to which it is weathered, and the location of new bodies. However, although mica may be locally abundant within the pegmatite, because of its usual irregular distribution, there is no assurance that it will be encountered by the drill.

Abandoned mines which have been good producers often produce well when reopened. This is true because, with the narrow margin of profit under which most mica mines are operated in normal times, they are often abandoned for reasons other than the exhaustion of the deposit. Specific reasons for abandonment may be a drop in prices, a machine breakdown, or the inability of the operator either to finance necessary exploratory work or to purchase needed equipment.

Before reopening a mine, every effort should be made to get information concerning former operations. The reason for stoppage is important; and a knowledge of the underground workings, if any, will help direct the new work. Old shafts should generally be avoided if the underground workings have been extensive. Where such information is lacking, much dependence must be placed upon a study of the old dumps, which will yield information about the quality of the mica, the character of the pegmatite and enclosing rock, and the extent of the operation.

The mica-mining industry in this country consists chiefly of small-scale operations. Certain deposits could be worked more extensively, but it is extremely difficult or impossible to determine beforehand how much investment is warranted in any particular case. Rarely is it possible to block out reserves and probable returns ahead of mining since the distribution of mica in most dikes is too irregular and the size and quality of mica too variable. "Large Capital" is not attracted to enterprises which have these uncertainties and are not accompanied by possibilities of considerable profit (Wierum, 1938, p. 43-46).

On the other hand, the small operator can, with a small outlay of capital, begin an operation. If reasonably successful, the mica sales produce a profit and allow for an expansion of the mine; and if not, the operations are soon abandoned. Such operations have been common in Virginia and serve to explain, in part, the intermittent nature of mica mining. A few better-financed operations have been carried out on a larger scale and in a fairly regular manner. During World War II, systematic mining was encouraged by high prices and by the availability of government supplied equipment.

Mining methods employed depend chiefly upon the nature of the deposit, the terrain, the experience of the operator, and the equipment available. Most deposits are worked first by open-pit methods. Where the walls are solid and the pegmatite body is wide and stands vertically, pit operations may be extended to a depth of from 50 to 70 feet. In inclined bodies and in those with soft decomposed wall rocks, most pits are quit at more shallow depths and mining continued from shafts or inclines down the dip of the pegmatite. It is also common practice where weathering is deep and the dike is inclined to offset from the outcrop of the dike in the direction of dip and there sink a shaft which will encounter the hanging wall of the dike at some level below the zone of weathering.

As in other mining, drifts are generally run at various levels from the shafts and inclines and the mica-bearing portion of the dike stoped out between levels. Both drifts and stopes are very irregular because they generally follow closely the course of the mica shoots. Exploratory drifts, and crosscuts are sometimes extended to locate new shoots. Pegmatites which crop out on steep hillsides are mined to an advantage by tunnels or inclines rather than by pits and shafts.

In most operations the amount of machinery is kept to a minimum. Hoisting in shallow openings is often done by hand windlass, whereas in deeper and more progressive operations, mica and muck are removed by metal bucket, floating-boom derrick, and gasoline hoist. Headframes are seldom used. In a few places mine cars on rails are used for transporting muck; in small incline mines, drag buckets are commonly used. Steam hoists and pumps are little used at present, although they were rather widely employed in the past. During World War II, when the government, through Colonial Mica Corporation, was leasing mine equipment at low rates, the mines in Virginia were far better equipped than before. Numerous mines were supplied with air compressors, gasoline hoists, gasoline and compressed air pumps, air hammers, and many other items.

Timbering is an important consideration in many mica mines in Virginia because of the deep weathering which characterizes most areas. In many places, shafts must be closely cribbed to depths of from 30 to 50 feet; and, within these depths, the ceilings and walls of drifts and tunnels must be carefully supported. Where kaolinization extends below the water level, flowage in the pegmatite often makes timbering so difficult that continued downward excavation is not practical. In the Chestnut Mountain area, most mines are but lightly timbered even though the dikes are thoroughly kaolinized to the depth of present workings. This is possible partly because the water table is deep, and partly because most mines are operated for only a short period and then quickly abandoned.

Proper blasting in mica mines requires experience and skill. If a shot is too large or is improperly placed, valuable mica may be damaged. An experienced driller, after striking a book of mica, changes the position of his hole. The attempt is always made to place the holes and charge them in such a way that the mica-bearing pegmatite is "pulled" down without destructive shattering. After a shot, the mica is at once segregated to prevent its being injured in the processes of mucking.

PROCESSING AND MARKETING

GENERAL STATEMENT

Mica comes from the mine in a diversity of sizes and shapes and may show great variations in quality. Before it can be manufactured into finished products it must be sorted, split (rifted), and trimmed. This preliminary work may be done by the miner, some firm specializing in this work, or by the manufacturing company. The methods employed depend upon the original condition of the mica and the demand of the manufacturer.

Although attempts at standardization have been, and are being made, differences still exist between terms applied to the forms in which mica is sold according to the district in which it is produced and according to whether it is domestic or imported stock. *Mine-run* or *run-of-the-mine* mica is the rough, unsorted bulk production from a mine. For mica which has undergone some sorting and/or preparation, the U. S. Bureau of Mines (Skow and Tucker, 1958) recognizes the two major categories: *sheet mica*, which includes blocks, films, and splittings (and may or may not include "punch" mica); and *scrap mica*. The term "sheet mica" in its broadest sense, therefore, includes all mica used in sheet form, and the term "scrap" includes all mica used in ground form. The American Society for Testing Materials (1958, p. 1115-1116) makes the following definitions:

> *Blocks.*—Mica of the thickness of 0.007 inch minimum, full-trimmed, unless otherwise designated.
>
> *Films.*—Knife-dressed mica of specified quality, split to any range of specified thickness between 0.0008 to 0.0040 inch.
>
> *Thins.*—Knife-dressed mica, 0.002 inch to less than 0.007 inch in thickness.
>
> *Splittings.*—Laminae split from blocks and thins and furnished as book-form or book-pack and loose-pack.

In this country, the better mica crystals from the mine which have been sorted for rifting are called "book" or "block" mica; but, in view of the above usage, the term "block" might well be abandoned in favor of "book" mica. The general terms "sheet" or "pattern" mica are often used as essentially analogous with block mica as defined above but not necessarily full-trimmed.

Splittings, which are cemented together to make built-up mica, average about 3 square inches in area and are generally less than 0.001 inch in thickness. Practically all of the splittings consumed throughout the world come from India and Madagascar, where they are split by hand.

SHEET MICA

Preparation for market.—Mica, which comes from the mine in the form of rough thick crystals, is cleaned of dirt and cobbed free of adhering rock. During this process, those crystals which obviously will not yield sheet mica, either because of small size or imperfections, are laid aside as scrap.

The better crystals, or books, are taken to a rifting and trimming, or "sheeting", house, where they are split into sheets which can be readily cut, usually 1/16 of an inch or less in thickness. Splitting is generally done with a knife about 3 inches long having a V point. "Tight" books must sometimes be rapped on the edges before they can be split. It is the sheeter's responsibility to get the most usable mica in the largest size possible from each book. Furthermore, the sheeter must be experienced so that he can improve his product as much as possible by splitting the sheets in such a way that inclusions and imperfect layers are removed.

After the mica has been rifted, imperfect areas and rough edges are trimmed off by one of several methods. In the roughest trim, called "thumb-trim", the more defective areas are simply broken away with the fingers. Until recent wartime demands for high-quality small mica arose, this was generally the only trim given to "punch" mica. Practically all sheet mica, is given a closer trim, either by sickle, shears, or knife. Sickle-trimmed mica is characterized by very irregular outlines and strongly beveled edges. Mica cut by shears has straight unbeveled edges. Most of the mica in this country is trimmed by knife and is generally trimmed less closely than in other countries. However, during World War II and in recent stockpiling programs, the Government has encouraged close trimming and has bought much mica with "full" and "half" trim. *Full-trimmed mica* is rifted mica trimmed on all sides with all cracks, reeves, and cross-grains removed; *half-trimmed mica* is rifted mica trimmed on two sides, with at least two-thirds of the pieces trimmed on two adjacent sides, the balance of the pieces trimmed on the two parallel long sides, and with no cracks extending into the area by which the piece is graded (Amer. Soc. for Testing Materials, 1958, p. 1115).

Knife trimming is done with a sharp knife several inches long and either straight or curved, the latter being used chiefly for trimming small mica. Each cut is made with the knife held at an angle to the plane of the sheets. This facilitates cutting and imparts a beveled edge to the mica, a most desirable feature if the sheets are to be split further. The stroke of the knife is generally toward the person doing the trimming and is usually against a chest pad if the mica being trimmed is medium or large, or against a wooden hook attached to a table if the mica is small.

Grading as to size.—Sheet mica is sold according to quality and size (grade), the better qualities and the larger sizes demanding the higher price. The size grade of any piece of mica is determined by the size of the largest rectangle fulfilling all the requirements of quality that can be cut from it. Table 2 shows the usual size groups under which domestic mica is sold and their relation to the standard Indian grades:

Table 4.—Domestic and ASTM grade sizes of muscovite sheet mica (films and block). [Adapted from Jahns, Griffitts, and Heinrich (1952, p. 62) and the American Society for Testing Materials (1958, p. 1117 and Fig. 1)].

Domestic grades (Approx. corresponding size)	Usable area in single rectangle (square inches)	Minimum dimension on one side (inches)	ASTM grade sizes (Indian grades)
Small punch	1 to 1½	¾	No. 6
Punch	1½ to 2¼		
Circle	2¼ to 3	⅞	No. 5½
1½- x 2-inch	3 to 4	1	No. 5
2- x 2-inch	4 to 6		
2- x 3-inch	6 to 10	1½	No. 4
3- x 3-inch	10 to 12	2	No. 3
3- x 4-inch	12 to 15		
3- by 5-inch	15 to 24	2	No. 2
4- by 6-inch	24 to 36	3	No. 1
	36 to 48	3½	A-1 (Special)
6- x 8-inch	48 to 60	4	E Special
8- x 8-inch	60 to 80	4	EE Special
8- x 10-inch	80 to 100	4	OEE Special
Larger than 8- x 10-inch	Over 100	4	OOEE Special

Classification as to quality.—Sheet mica is classified chiefly according to visual properties and, recently and to a lesser extent, by electrical properties. Quality classification is a costly hand operation and, as a result, the detailed classification used for Indian mica has not generally been applied to domestic mica. Micas free from primary iron-oxide stains have been called "clear" and those containing such stains classed as "black-stained", or "electric". The designations No. 1, No. 2, and No. 3 have also been used in North Carolina and Virginia. In general, it is considered that No. 1 mica must be hard and free of mineral and vegetable inclusions and cracks, but may contain slight air inclusions and be slightly wavy. No. 2 is about the same except that it may contain some vegetable inclusions. No. 2 inferior, a class recognized by Colonial Mica Corporation, is the same as No. 2 except that it may contain considerable clay and vegetable stains and minor mineral inclusions and may be more wavy and softer. No. 3 contains more mineral inclusions than No. 2 inferior and more or less corresponds to the designations "black-stained" and "electric".

From time to time, since 1932, the American Society for Testing Materials has set up and revised quality classifications for mica, based chiefly upon Indian standards. Descriptions of visual quality designations accepted in 1957 follow (American Society for Testing Materials, 1958, p. 1121):

V-1, Clear.—Hard, of uniform color, nearly flat, free from all stains, foreign inclusions, cracks, and other similar defects.

V-2, Clear and Slightly Stained.—Hard, of uniform color, nearly flat and may contain slight crystallographic discoloration, and very slight air inclusions in not more than one-fourth of the usable area.

V-3, Fair Stained.—Hard, of uniform color, may contain slight waves, slight crystallographic discoloration, and slight air inclusions in not more than one-half of the usable area.

V-4, Good Stained.—Hard, of uniform color, may contain medium waves, slight crystallographic discoloration, and medium air inclusions in not more than two-thirds of the usable area.

V-5, Stained A Quality.—Hard, may contain medium air inclusions, uniformly distributed in the usable area, slight green vegetable stains, and medium waves.

V-6, Stained B Quality.—Hard, may contain heavy air inclusions and heavy waves, medium green vegetable stains, slight black and red dots (mineral), and clay stains.

V-7, Heavy Stained.—Hard, and may contain heavy air inclusions and waves, slight light black and red dots (mineral), medium cloudy stains, clay stains and green stains (vegetable). Soft, buckles, ridges, and sand blast acceptable if specified.

V-7a, Densely Stained.—Hard and soft. May contain heavy waves and air inclusions, cloudy stains, light black and red dots (mineral), medium black and red stains (mineral), buckles, and ridges. Also green stains (vegetable type), clay stains, herringbones, and sand blast.

V-8, Black Dotted.—Hard, may contain medium waves, heavy air inclusions, cloudy stains, light black and red dots (mineral), and green stains (vegetable).

V-9, Black Spotted.—Hard, may contain medium waves, heavy air inclusions, cloudy stains, light black and red dots (mineral), green stains (vegetable type), and sand blast, medium black stains, (mineral), slight red stains (mineral), and clay stains.

V-10a, Densely Black and Red Stained.—Hard, and may contain heavy waves, air inclusions, cloudy stains, light black and red dots (mineral), red stains (mineral), black and red stains (mineral), green stains (vegetable type), and sand blast, very dense black and red stains (mineral), and slight clay stains. Soft if specified.

Prices.—Prices paid for mica vary greatly according to the size, quality, and preparation of the mica and to the demand. The effects of the first three can be seen in the tables below. Table 5 shows prices offered by mica fabricators in 1961 (and but little changed during the

Table 5.—Prices for various grades of clear sheet mica, February, 1961 (Engineering and Mining Journal Metal and Mineral Markets)

Grade (size)	Price per pound	Grade (size)	Price per pound
Punch	\$0.07 to \$0.12	3- x 4-inch	\$2.00 to \$2.60
1½-x 2-inch	.70 to 1.10	3- x 5-inch	2.60 to 3.00
2- x 2-inch	1.10 to 1.60	4- x 6-inch	2.75 to 4.00
2- x 3-inch	1.60 to 2.10	6- x 8-inch	4.00 to 8.00
3- x 3-inch	1.80 to 2.30		

Table 6.—Prices for domestically produced muscovite mica purchased by the Government, 1958, by grade and quality (Skow, Gwinn, and Tucker, 1958, p. 775). [Grade and quality designations are ASTM]

	PRICE PER POUND				
	FULL-TRIMMED			HALF-TRIMMED	
	Good Stained or better	Stained	Heavy Stained	Stained	Heavy Stained
Block and film mica:					
Ruby:					
No. 3 and larger......	$70.00	$31.90	$14.80	$12.00	$8.00
No. 4 and No. 5......	40.00	18.25	6.85	5.00	4.00
No. 5½ and No. 6....	17.70	7.55	4.00	3.00	2.00
Nonruby:					
No. 3 and larger......	70.00	25.55	11.85	9.60	6.40
No. 4 and No. 5......	40.00	14.60	5.45	4.00	3.20
No. 5½ and No. 6....	17.70	6.55	4.00	2.40	1.60

Hand-cobbed mica:	*Per short ton*
Ruby..	$600
Nonruby..	540

past several years) for roughly-trimmed clear domestic sheet micas. Prices for stained, or "electric", mica were approximately 10 to 20 percent below those for clear mica. During World War II and in a stock-piling program of recent postwar years, the Government has paid considerably higher prices for better-prepared, high-quality domestic mica (Table 6).

SCRAP MICA

Mica unfit for use in sheet form, called "scrap" mica, is recovered as a necessary by-product of the mining and preparation of sheet mica; it is also recovered from some pegmatite mines operated exclusively for scrap mica, from mica-rich phyllites and schists, and as a by-product of the kaolin industry. "Shop", or "bench", and "factory" scrap are generally cleaner and whiter than "mine" scrap and that recovered from metamorphic rocks and clay and, therefore, usually command a somewhat higher price. Another source of scrap, and one which has not been utilized to its fullest in Virginia, is in old mine dumps.

For use, scrap mica is more or less finely reduced by wet- or dry-grinding processes. The wet-ground product has a higher sheen and luster and mixes more smoothly with liquids but is more expensive to produce. In 1958, about 85 percent of all ground mica was dry ground

(Skow, 1959, p. 142). Wet grinding is usually done in chaser mills consisting of circular steel tanks about 10 feet in diameter, in which heavy wooden rollers revolve. Dry grinding is chiefly by high-speed hammer mill, although rod mills and other types of pulverizers have been used.

Engineering and Mining Journal markets quotations, February, 1961, were as follows: Scrap mica, $20 to $30 per ton; wet-ground mica, very fine, $140 to $155 per ton; bulk sales, dry-ground mica, $30 to $55 per ton.

FELDSPAR

GENERAL STATEMENT

Feldspar is a group name for a number of mineral species which are aluminum silicates of potassium, sodium, calcium, and rarely barium that have similar crystallization and physical properties. The potassium species, orthoclase and microcline, have the same formula ($KAlSi_3O_8$), but differ in that orthoclase is monoclinic in crystallization whereas microcline is triclinic. The most usual potash feldspar in pegmatites is microcline. The soda-lime, or plagioclase, feldspars comprise six triclinic species that grade from pure albite ($NaAlSi_3O_8$) to pure anorthite ($CaAl_2Si_2O_8$). The potash feldspars and plagioclase of 100 to 70 percent albite (An_0 to An_{30}), known as silicic or alkali feldspars, comprise the important feldspars of commerce. The theoretical compositions of the chief feldspar species are shown in Table 7 (Burgess, 1949, p. 346).

Feldspars in nature never have the composition of these theoretical molecules because the potash feldspars always contain some soda and the sodic plagioclases contain small amounts of potash; neither do the absolutely pure albite or anorthite molecules occur. In addition to these

Table 7.—Composition and Properties of Principal Feldspars.

Constituent	Orthoclase ($KAlSi_3O_8$)	Microcline ($KAlSi_3O_8$)	Albite ($NaAlSi_3O_8$)	Anorthite ($CaAl_2Si_2O_8$)
Chemical Composition, Theoretical Percentage				
SiO_2	64.7	64.7	68.7	43.2
Al_2O_3	18.4	18.4	19.5	36.7
CaO				20.1
K_2O	16.9	16.9		
Na_2O			11.8	

molecular solid solutions there are various mineral intergrowths and mixtures with feldspar which make its pure separation very difficult. All commercial pegmatitic potash feldspars contain plagioclase in the intergrowth known as *perthite*, and many of them are intergrown in a ratio of about 3:1 with quartz in graphic granite, or "corduroy" spar.

Feldspars are most commonly white, yellowish, pale-brownish, pink, gray, or green. They have vitreous to pearly luster, a colorless streak, and cleavage well developed in two directions at or near 90 degrees. Fresh feldspar has a hardness of 6 and cannot be scratched with a knife. Specific gravities range from 2.5 to 2.9. Under chemical weathering the feldspars alter to a white clay known as kaolin.

Feldspars make up about 60 percent of the earth's crust, but they have been produced commercially only from pegmatites, syenite, alaskite, aplite (anorthosite), granite, and dune sands. In pegmatites, they occur as crystalline masses that range from a fraction of an inch to several feet thick, intergrown with variable proportions of quartz, muscovite, tourmaline, garnet, and other minerals.

In 1957, the United States produced 53 percent of the Free World output of feldspar; and West Germany, France, Italy, Norway, Sweden, and Japan furnished most of the remainder. In this country, the chief producing states were North Carolina, California, Colorado, South Dakota, New Hampshire, Virginia, Maine, Connecticut, Georgia, Arizona, and Tennessee (de Polo and Tucker, 1958, p. 477-482).

USES

In 1957, the glass industry consumed 52 percent of the ground feldspar sold in the United States; the pottery industry, 26 percent; and the enamel industry, 4 percent (de Polo and Tucker, 1958, p. 480). Smaller quantities of feldspar are also used in scouring powders and soaps, abrasives, artificial teeth, abrasive wheels (as a binder), poultry grit, roofing, stucco, and welding rod coatings. Bluish green microcline, called "amazonstone" or "amazonite", has been mined on a moderate scale in Amelia County for use as a gem stone.

MARKET GRADES

Most feldspar consumers buy material already ground and sized, but some manufacturers buy crude feldspar and grind it to their own specifications. Small operators also often sell crude spar to larger producers and grinders. *Crude spar*, which is not everywhere closely or uniformly classified, is usually classed according to purity and somewhat as to whether it is chiefly potash or soda feldspar. No. 1 spar, according to Metcalf (1941, p. 2-4), is the selected grade from any particular district and may contain from little or no free quartz to as much as 10 to 15 percent, depending upon the district. No. 2 spar should not contain over 25 percent free quartz, and No. 3 not over 30 percent. Nos. 1 and 2 should be sufficiently free from iron-bearing substances to burn to a clear white color. Grades of crude spar separated upon a chemical basis are given by Burgess (1949, p. 357) as follows:

Grades of Crude Feldspar Recognized for Royalty

No. 1 feldspar shall have not more than 68 pct silica content, not more than 0.10 pct iron as Fe_2O_3, and a potash-soda ratio of at least 2:1.

No. 2 feldspar shall have not more than 72 pct silica content and not more than 0.10 pct iron as Fe_2O_3.

No. 3 feldspar shall be any other analysis of feldspar suitable for milling but not within the specifications of No. 1 or No. 2 grades.

Dental spar is carefully hand-sorted crude potash feldspar in crystals free from all visible impurities. Potash feldspar of even greater purity can be separated by flotation. Crude feldspar for use in cleansers and scouring soaps should be free from quartz grit but may contain more muscovite than can be tolerated in ceramic feldspar.

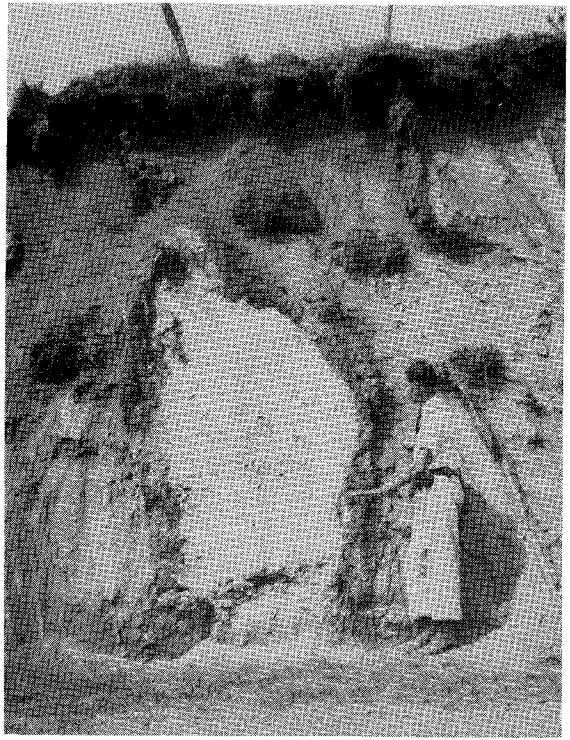
Ground spar is classified chiefly according to fineness of grinding, chemical composition, and use (see Burgess, 1949, p. 360-364, and National Bureau of Standards, 1930). Glass spar, used in glassmaking chiefly for its alumina content, may be either soda or potash feldspar, the former, according to theoretical composition, containing a somewhat higher percentage of alumina than the latter. No. 2 glass spar must contain at least 17 percent alumina, not over 0.1 percent ferric iron, and at least 11.5 percent total alkalies. In No. 1 glass spar the free quartz content cannot exceed 6 percent. Pottery spars have a rather wide range in composition, although high-potash feldspar is usually preferred. Glaze spar is high-soda and contains 4 percent or more Na_2O (Metcalf, 1941, p. 3-4).

PROSPECTING AND MINING FOR FELDSPAR

In Virginia, feldspar has been produced chiefly from pegmatite and to a lesser extent from alaskite, syenite, and aplite (anorthosite). These are found only in the Piedmont and Blue Ridge provinces, and the only known potential source outside of these provinces is nepheline syenite in the Valley and Ridge province.

All source rocks for feldspar in the State tend to be prominent in the field because of abundant white or nearly white feldspar, or its

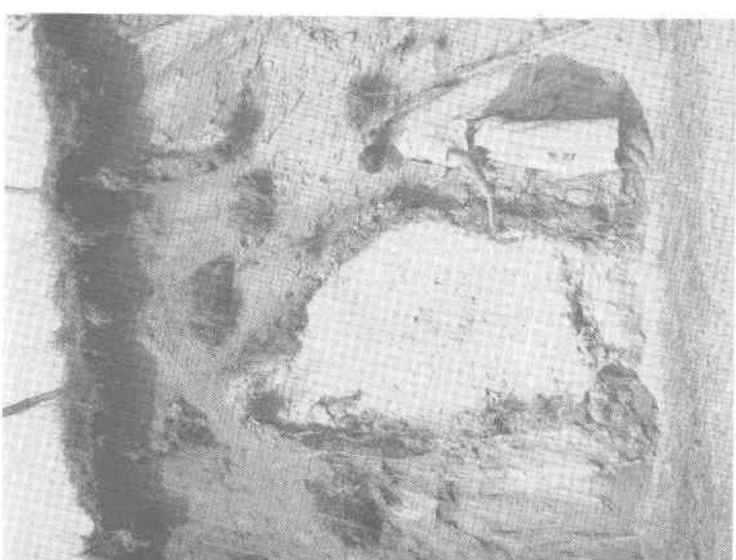
Plate 3



A. Lens of partly kaolinized pegmatite in biotite gneiss 7 miles southeast of Bedford, Bedford County.

B. Pegmatite at the Harry Knight mine, Ridgeway area. Mica, M, occurs most abundantly near the footwall.

Plate 3

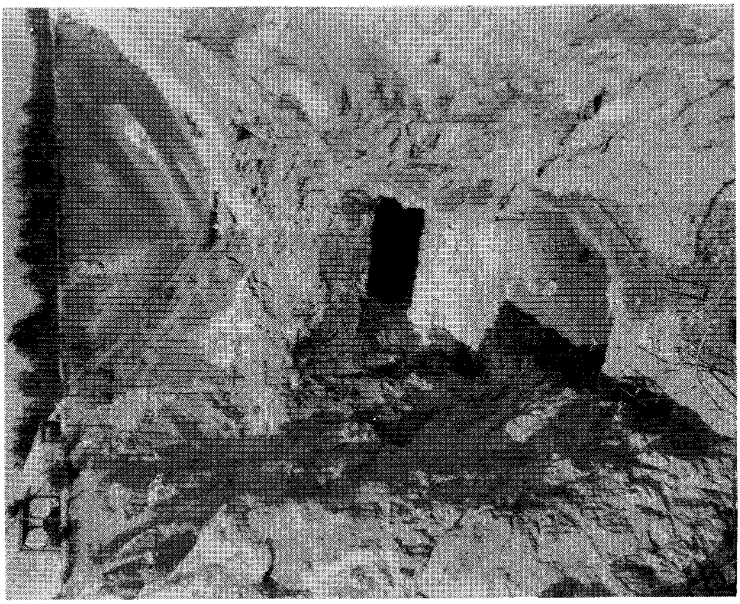


A. Lens of partly kaolinized pegmatite in biotite gneiss 7 miles southeast of Bedford, Bedford County.

B. Pegmatite at the Harry Knight mine, Ridgeway area. Mica, M, occurs most abundantly near the footwall.

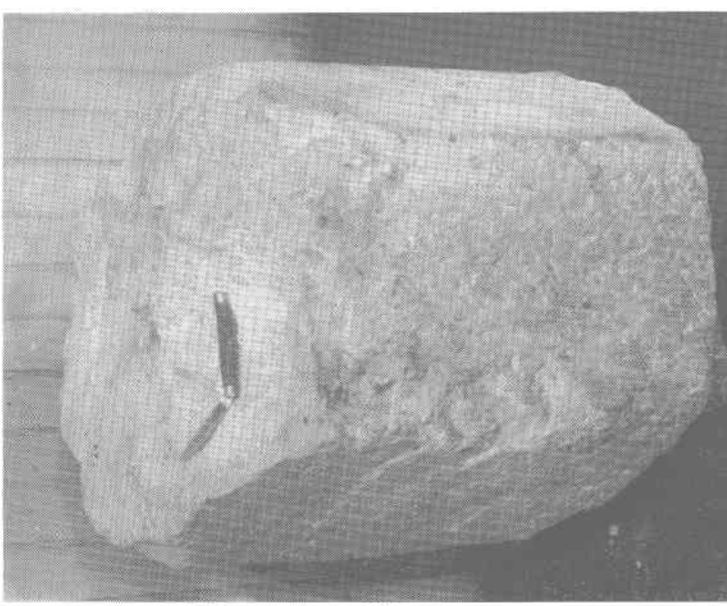
Plate 4

A. Beryl crystal from Herbb No. 2 mine, Powhatan County.

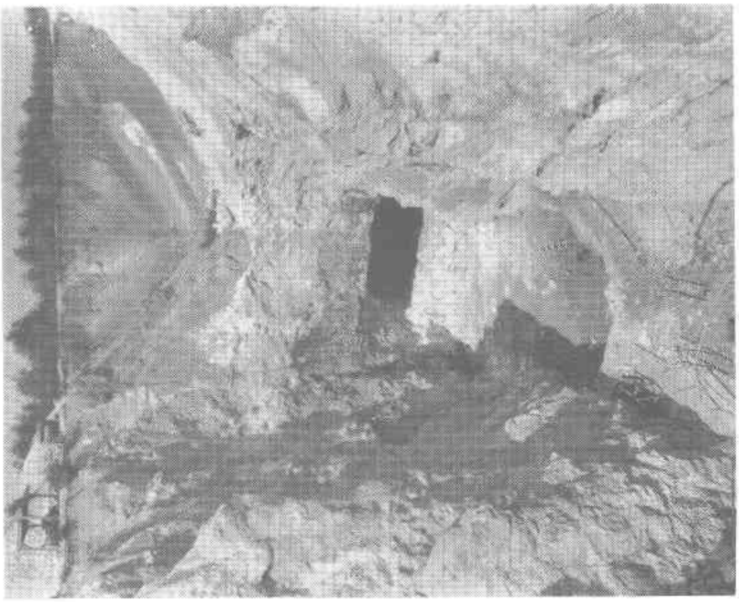


B. Pit and tunnel entry at the Big Hicks (Wheatley) feldspar mine, Bedford County. View looking northeast (1943).

Plate 4

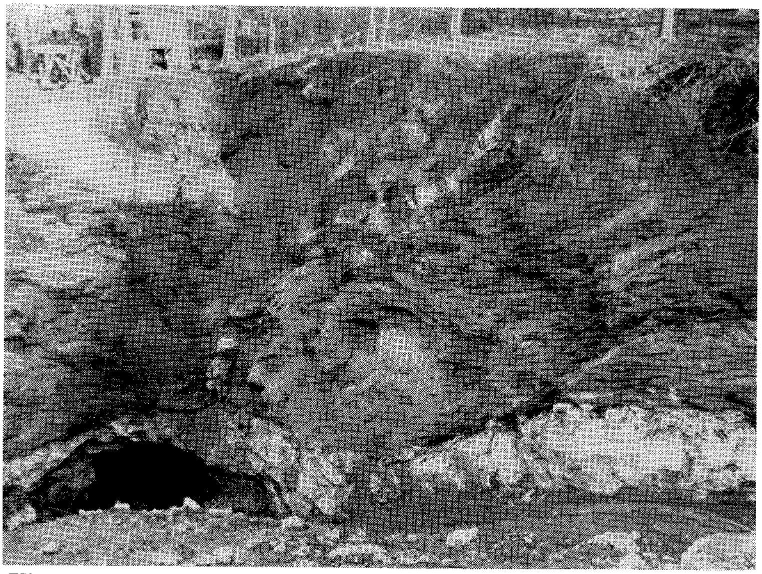


A. Beryl crystal from Herbb No. 2 mine, Powhatan County.

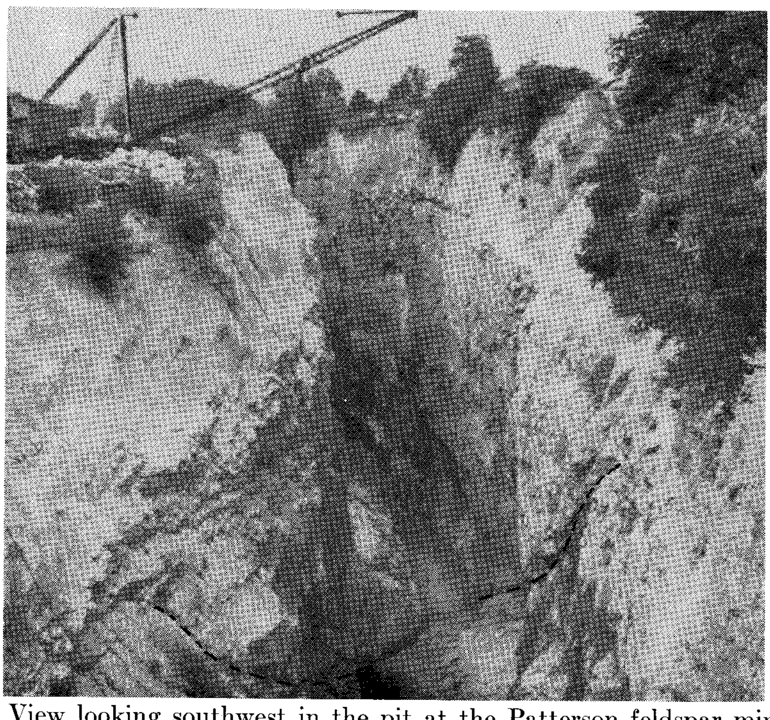


B. Pit and tunnel entry at the Big Hicks (Wheatley) feldspar mine, Bedford County. View looking northeast (1943).

Plate 5



A. View looking northeast in the pit at the Harry Knight mine, Ridgeway area. The light-colored mica-bearing pegmatite extends across the lower part of the picture.



B. View looking southwest in the pit at the Patterson feldspar mine, Bedford County. The pegmatite is about 50 feet thick. Dashes show position of a minor fault cutting the pegmatite (1947).

Plate 5

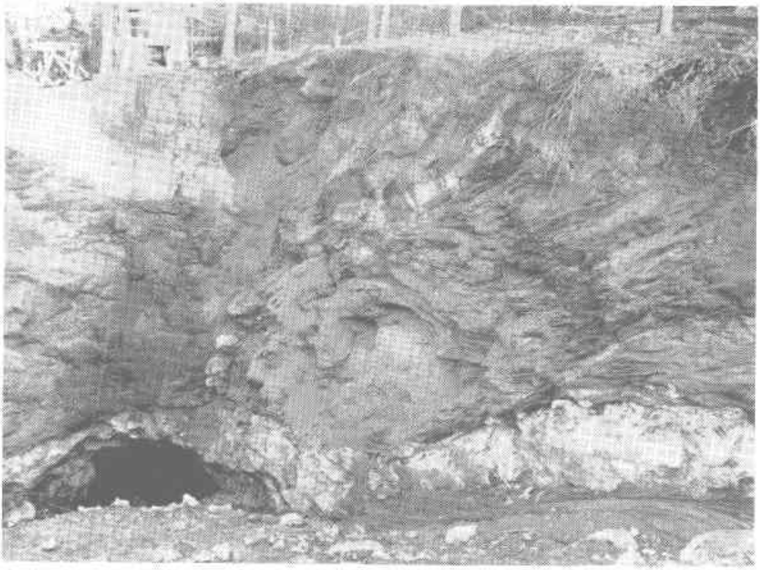


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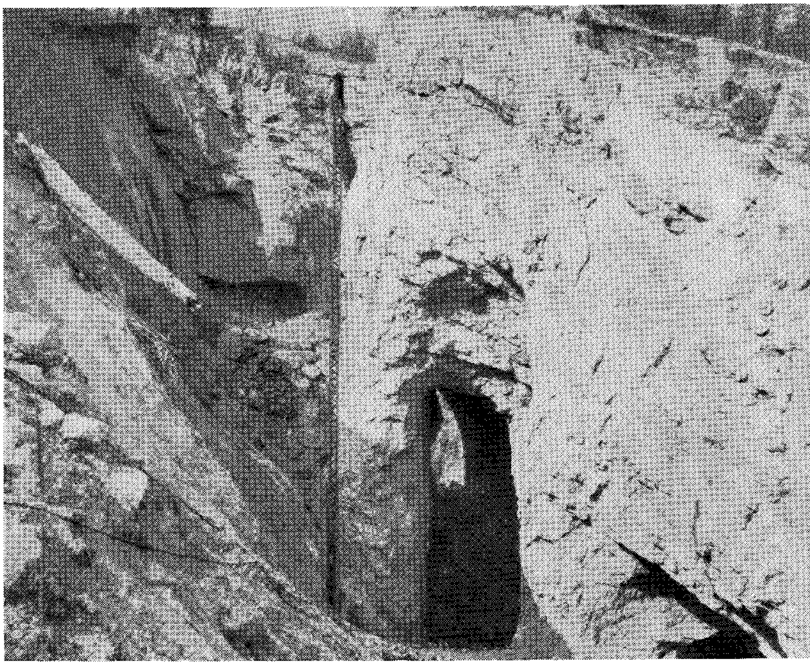
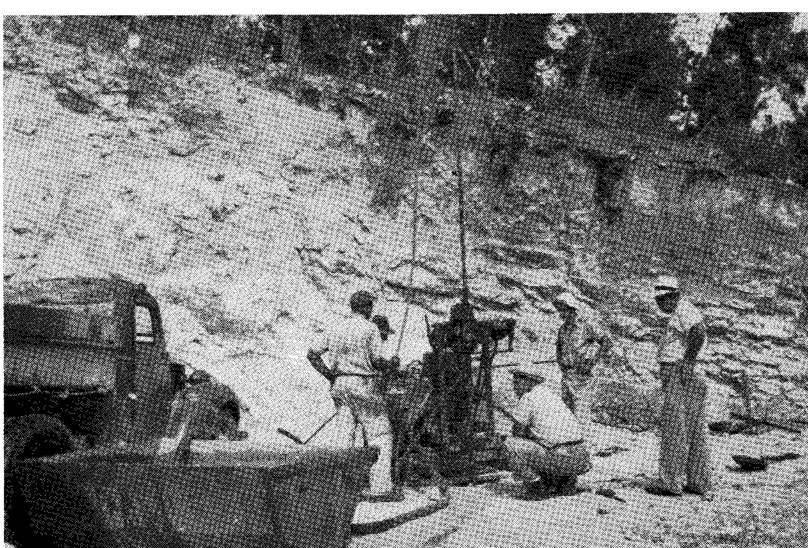
Plate 6

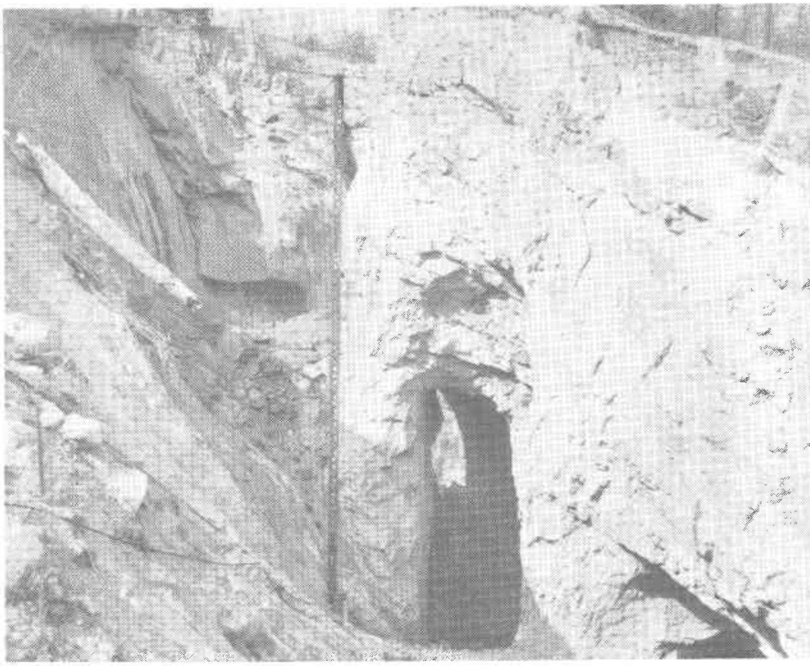


A. Coles feldspar mine, Bedford County (1960).

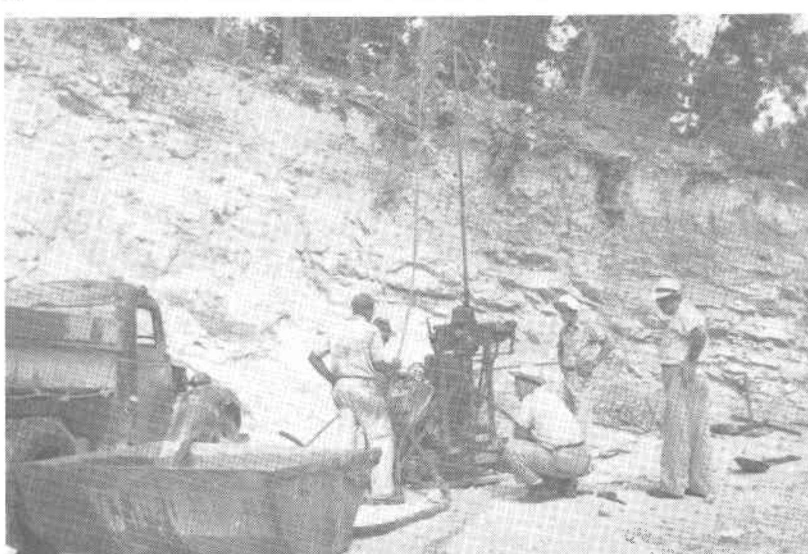


B. Exploratory diamond drilling at the Coles mine, Bedford County (1947).

Plate 6



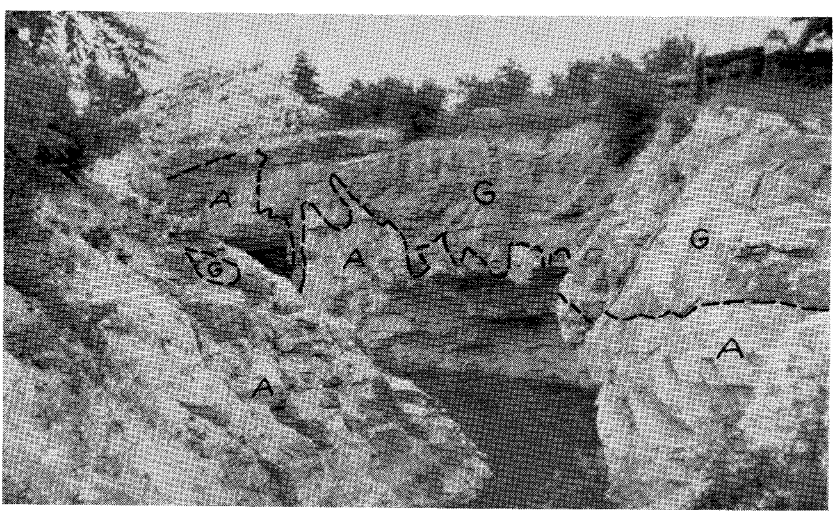
A. Coles feldspar mine, Bedford County (1960).



B. Exploratory diamond drilling at the Coles mine, Bedford County (1947).

Plate 7

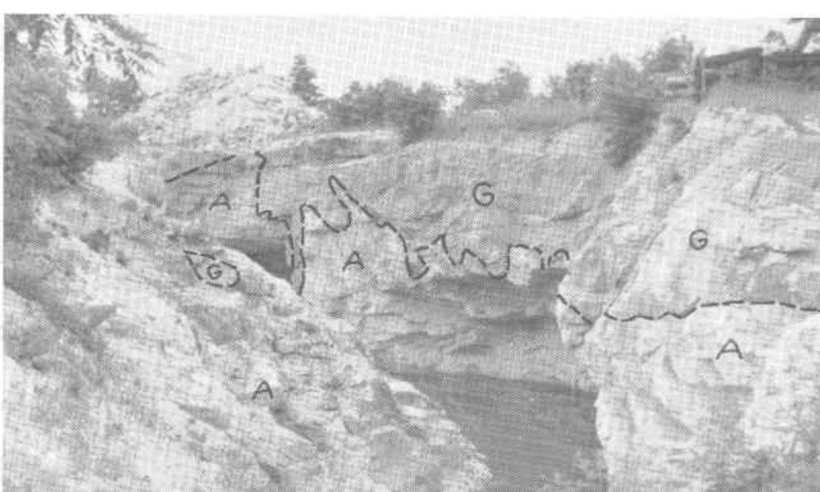
A. Peaksville alaskite-syenite mine, Bedford County (1947).



B. Peaksville alaskite-syenite mine, showing contact between light-colored alaskite-syenite, (A), and gray granite, (G).

Plate 7

A. Peaksville alaskite-syenite mine, Bedford County (1947).



B. Peaksville alaskite-syenite mine, showing contact between light-colored alaskite-syenite, (A), and gray granite, (G).

weathering product kaolin, and quartz; mica also characterizes most. Pegmatite, consisting predominantly of these minerals, may be particularly conspicuous because of its coarse crystallization. Pegmatites mined for feldspar are usually considerably larger, coarser grained, and richer in potash feldspar than are mica pegmatites. Bodies which are thoroughly kaolinized at the surface, although they may make mica mines, are generally poor prospects for feldspar because they are usually low in potash feldspar and kaolinization is apt to be deep.

Preliminary work is usually by shallow pits and trenches, bulldozer, or portable air compressor and pneumatic drill. Fresh rock must be drilled and blasted. Mining is almost entirely by open pit, although limited underground workings are sometimes extended laterally from pit operations (Pl. 4B).

PREPARATION FOR MARKET

In 1958, about 80 percent of the feldspar produced in the North Carolina-Tennessee-Georgia region and close to 60 percent of the total feldspar produced in the United States was separated by froth flotation (de Polo, 1959). The great advantages of the flotation process are that most or all of the feldspar-bearing rock can be mined, purer products and greater flexibility in products can be had, and the costly hand separation methods, almost universally used in the past, are avoided. In addition, many rocks which could not possibly have been worked by older methods have become commercial; even many previously hand-picked waste piles can be reworked. The recovery of by-product mica, garnet, and quartz is also much greater. Flowsheets of feldspar plants with flotation are given by Burgess (1949, p. 359) and Lutjen (1953).

In recent years, advantages similar to those of flotation have been obtained by the Spar Mica Corp., Limited, of Montreal, through use of electrostatic methods of separation (Diamond, 1957).

Where mining is not for flotation or electrostatic treatment, the crude feldspar must be cobbed with hammers to rid it of quartz, mica, garnet, tourmaline, and other minerals before it is marketed. For most purposes, quartz is not as objectionable as most other minerals and is regarded chiefly as a diluent affecting only the grade of the feldspar. Virtually all other minerals, however, must be removed from all grades of feldspar. Potash feldspar is also usually separated from soda feldspar and the hard spar from the soft, or semi-kaolinized, spar. At the mill, the spar is hand-picked and then ground in conical, cylindrical, or tube mills to 20 mesh, 100 mesh, 200 mesh, or special meshes (Burgess, 1949, p. 360 and 367). The finer sizes are required for pottery and glaze whereas the coarser sizes are used chiefly in glassmaking. Iron-bearing minerals like biotite, garnet, and tourmaline and metallic iron from the crushing equipment are removed by magnetic separators.

PRICES

The average price paid for crude domestic feldspar sold in the United States in 1957 was $8.89 per ton, and that for the period 1948-1957 was $7.81 per ton. Ground feldspar in 1957 sold at the average price of $11.75 per ton, and in the period 1948-1957 sold at the average price of $13.98 per ton (de Polo and Tucker, 1958, p. 478). Engineering and Mining Journal markets quotations for ground feldspar, February 1959, were as follows: Potash or soda feldspar, 200 mesh, ceramic grade, $18.50 to $22.50 per bulk ton; glass feldspar, white, 20 mesh, $10.00 to $12.50 per ton. In 1958, however, increased use of nepheline syenite and the importation of large quantities of foreign pottery had caused a drop in the price of glass-grade feldspar in the North Carolina area to $9.80 per ton (de Polo, 1959).

KAOLIN

Small quantities of kaolin, a soft, white to yellowish clay formed as a weathering product of feldspar, have been sold from a few Virginia pegmatites. It occurs in virtually all pegmatites in the State, and in some plagioclase-rich bodies it is the chief constituent down to depths of from 20 to over 100 feet. Most deposits, however, are too small or contain too much intermixed quartz and mica or iron-bearing mineral like garnet and tourmaline to be commercial at existing prices.

Most domestic kaolin comes from Georgia, South Carolina, North Carolina, Pennsylvania, Florida, Alabama, California, and Utah. In 1957, the kaolin consumed in this country was distributed as follows: paper 54 percent; rubber 14 percent; refractories 12 percent; pottery 4 percent; and the remaining 16 percent in cement, floor and wall tile, fertilizers, chemicals, insecticides, paint filler or extender, and linoleum. The average value of domestic kaolin sold or used in 1957 was $16.30 per short ton. (Gunsallus and Brett, 1958, p. 364-365).

QUARTZ

Massive bodies of nearly pure quartz from a foot or so to over 15 feet thick occur as cores in many pegmatites. Such quartz when crushed is useful in ceramics and in abrasives like sandpaper, and some has been sold as a by-product of feldspar mining in the Bedford area of Virginia. Because of relatively low value (about $5.00 per short ton in 1957) and the difficulty and expense of crushing, however, it is generally not economic to recover.

BERYL

Beryl of proper color, clarity, and structural perfection is a valuable gem stone and it is also the chief ore mineral of the metal beryllium. Gem varieties of beryl include golden beryl, aquamarine, morganite, and emerald. Only the first two have been reported from Virginia. Most of the beryllium produced is alloyed, in small amounts, with copper to which it imparts high strength and resistance to fatigue, corrosion, heat, and wear. This alloy is used in diaphragms, pump impellers, fuel injectors, nonsparking tools, and in springs in meters, instruments, electrical motors, switches, and relays. Beryllium is also alloyed with aluminum, nickel, and steel. The oxide is used in certain ceramics, crucibles, and high-temperature electrical and thermal insulators. Beryllium metal has found use in nuclear reactors and has potential use in missiles (Eilertsen, 1958, p. 258-259).

Beryl most typically occurs in pale green, blue-green, greenish-blue, or white, elongate, six-sided crystals (Pl. 4A). Less commonly it is yellow or pink, and it may be anhedral. It has a vitreous luster, imperfect basal cleavage, a hardness of 7.5 to 8, and a specific gravity of 2.63 to 2.8. Although the ideal formula is $Be_3Al_2(SiO_3)_6$, as much as 5 percent of the theoretical maximum of 14 percent BeO may be replaced by alkalies. Nearly all of the beryl produced from the southeastern Piedmont, however, has had a BeO content of 12 percent or better (Jahns, Griffitts, Heinrich, 1952, p. 77). In 1957, journal quotations on domestic beryl of 10 to 12 percent BeO were $46 to $48 per short ton unit BeO (each unit being 20 pounds of contained BeO) (Eilertsen, 1958, p. 259-260).

Most beryl occurs as subhedral to euhedral crystals in inner zones of pegmatites, most frequently fringing, but locally included, in quartz cores. Crystals also occur in intermediate zones and, rarely, as late growths in cavities. Small quantities of massive beryl occur in the wall zones of some pegmatites.

Although in 1957 the United States used 65 percent of the world's supply of beryl, it produced less than 5 percent of the total. The chief producing countries are Brazil, Mozambique, Argentina, and Belgian Congo. Most domestic production comes from South Dakota, Colorado, New Mexico, and New Hampshire (Eilertsen, 1958, p. 261).

Some beryl has been sold as a by-product to mica mining in Amelia and Powhatan counties, Virginia, and has been reported from most other pegmatite areas of the State. Occurrences with mica or feldspar are described elsewhere in this report. Occurrences not described here are on the Lily B. Vaughan property 2½ miles slightly south of east of Amelia; on the Waverley Vaughan and adjoining E. W. O'Neal properties three-fourths of a mile east-northeast of the Vaughan mica mine; on the Truehart property 1¾ miles north by west of Amelia; and on the Jenkins property near Rodophil 9 miles west of Amelia (Brown, 1945).

COLUMBITE-TANTALITE

The columbite-tantalite series includes all gradations from the pure columbite molecule, $(Fe,Mn)Cb_2O_6$, to the pure tantalite molecule, $(Fe,Mn)Ta_2O_6$. Members of this series which are nearest these end members in composition are the most desirable ores. In mangano-tantalite, manganese has taken the place of most of the iron. Properties vary somewhat according to composition. The mineral is generally in black to reddish brown, short prismatic or thin tabular orthorhombic crystals with submetallic, dull to brilliant luster. These give a dark red to black streak and have distinct to poor cleavage, a hardness of 6, and a specific gravity of 5.3 to 7.3 (Dana, 1932, p. 695-697).

Columbium (niobium) is used in the manufacture of stabilized stainless steels, as well as in high-temperature alloys employed in gas turbines, jet engines, guided missiles, high-speed cutting tools, and various nuclear engineering applications. Tantalum is consumed chiefly in the electronics industry, particularly for use in capacitors and as anode and grid materials in high-temperature, high-voltage transmitting tubes and in rectifiers. Tantalum, because of its resistance to body acids and its compatibility with body tissues, is also used in surgical repairs. Prices for domestic columbite-tantalite ore in 1958 were influenced by Government purchase schedules which included bonuses, premiums, and penalties. Most purchases, however, were at $3.40 per pound of contained combined pentoxides for material estimated to contain 50 percent of such oxides in random ratios (Barton, 1958, p. 405-406; 1959).

Nigeria, Belgian Congo, Brazil, Norway, Malaya, and the United States lead the world in production of columbite-tantalite ores. Most of this country's production comes from placer deposits in Idaho; some pegmatitic production comes from Arizona, South Dakota, New Mexico, and Colorado (Barton, 1958, p. 404).

Small quantities of manganotantalite have been produced and columbite and slightly radioactive microlite ($Ca_2Ta_2O_7$) have been identified from the Morefield and Rutherford mines in Amelia County. These minerals are still present in small quantity in the dumps at these mines and have been panned from nearby creeks. Manganotantalite also occurs at the Herbb No. 2 mine in Powhatan County; and Jahns, Griffitts, and Heinrich (1952, p. 35) report the occurrence of columbite-tantalite in pegmatites in Bedford County. In the Amelia and Powhatan County occurrences, the columbite-tantalite minerals are closely associated with cleavelandite and sugary albite.

GEM AND SPECIMEN MATERIALS

A number of gem and specimen minerals have been recovered from Virginia pegmatites, most of them from the famous Rutherford and Morefield dikes near Amelia, which have supplied specimens to museums about the world. The greatest volume of gem material has been amazonstone, a deep bluish-green variety of microcline, which has sustained operations at the Rutherford mines on several occasions. It also occurs in some quantity at the Morefield mine and the Herbb No. 2 mine in Powhatan County. Hyacinth spessartite (garnet), moonstone (clear opalescent feldspar), and beryl also have been recovered at the Rutherford mines (Pegau, 1932, p. 11). Gem or near gem aquamarine beryl has been found at the Truehart prospect, Champion and Morefield mines; and clear bluish-green beryl has been recovered at the James Anderson prospect, all in Amelia County. Golden beryl has been found at the Williams prospect in Henry County. Opalescent plagioclase occurs at several mines in Amelia and Hanover counties, and Sterrett (1923, p. 317) reports finding at the Berry No. 1 mine in Amelia County chalcedonic quartz suitable for cutting into a semi-precious stone.

Beautiful cellular masses of white to bluish white, reticulated cleavelandite crystals with crystals of rare and unusual minerals like microlite, bertrandite, cassiterite, and manganotantalite in the interspaces were recovered in quantity at the Rutherford No. 2 mine. Although much of this material is today preserved in many museums, abundant beautiful specimens lay for years in the mine dumps, only to be marred by weathering or thoughtlessly destroyed by undiscerning collectors. The largest recorded zinnwaldite crystal (Glass, 1935, p. 760), a doubly-terminated topaz crystal measuring 7¾ x 8½ x 11½ inches, and a 5-inch phenakite crystal were found at the Morefield mine of the Amelia area.

ECONOMIC GEOLOGY OF INDIVIDUAL AREAS

AMELIA AREA

GENERAL STATEMENT

The Amelia area lies almost wholly within, and includes all but the southeastern part of Amelia County (Pl. 8). It is about 18 miles long in a northwesterly direction and 16 miles wide. Most parts of the area are easily accessible because of numerous paved and graveled secondary roads. It is crossed centrally in a northeasterly direction by U. S. Highway 360 and by the Richmond-Danville line of the Southern Railway.

The land surface is gently rolling to nearly flat. Altitudes range from about 200 feet at Appomattox River, near the northeastern limit of the area, to about 500 feet near Rodophil, in the western part. The entire area is drained by northward to eastward flowing tributaries to Appomattox River, which forms its approximate northern boundary. The water table is generally from 30 to 40 feet deep in divide areas but close to the surface near streams. As a rule, the volume of water encountered in mines is not excessive.

All rocks at the surface show the effects of strong weathering, and pegmatites rich in plagioclase are generally deeply kaolinized. The dike at the Nettie Taylor mine is thoroughly kaolinized to its lower limit of 87 feet, but the dike at the Champion mine a few hundred yards away is kaolinized only to a depth of 45 to 50 feet. Kaolinization aids excavation above the water table, but it may make mining impossible, or in the least uneconomic, below because of the tendency for wet kaolin to flow into openings. In addition, much mica in the zone of intense kaolinization is bent, ruled, and cracked and contains undesirable clay stain. With an efficient separatory plant, however, some of the larger kaolinized bodies in the Amelia area might be worked profitably above the water level for scrap mica.

ROCK TYPES

The predominant rock types in the Amelia area are medium- to dark-gray, medium-grained quartz-biotite gneiss and feldspathic schist, determined by Pegau (1932, p. 20-22) to be of quartz monzonitic composition. Locally, these contain white albite-oligoclase augen and segregations or injections of pegmatitic material. More or less concordant garnetiferous and hornblendic facies are common. Dark green to nearly black, fine- to coarse-grained, even-granular to porphyroblastic hornblende gneisses and schists of dioritic composition also occur in the area. Foliation throughout most of the area generally strikes northeast and dips gently to steeply northwest, although local variations and contortions are common, particularly near large pegmatitic instrusives. A northwesterly-trending body of soapstone, perhaps 75 feet wide, occurs half a mile southwest of the Morefield mine, 3½ miles east-northeast of Amelia. It was quarried many years ago. Relatively narrow, but commonly long, north- to northwesterly-trending diabase dikes of probable Triassic age occur here and there throughout the area.

PEGMATITES

Pegmatites are common throughout the Amelia area and are especially abundant in an oval-shaped sub-area about 4½ miles long by 2 miles wide, elongated northward from just south of Amelia to the vicinity of the Pinchbeck No. 1 mine near Nibbs Creek. Pegmatites are also concentrated, though less thickly, in another sub-area 9 miles long, extending from near the Morefield mine 4 miles east-northeast of Amelia to Denaro 6 miles south of Amelia. Lemke, Jahns, and Griffitts (1952, p. 104-107) refer to the first as the Jefferson-Amelia area and the second as the Morefield-Denaro area and note that pegmatites in the two differ structurally.

About 25 mines and a large number of prospects have been opened in the Jefferson-Amelia sub-area. Most of the pegmatites are relatively short and thick, stand nearly vertical, and strike N. 60-80° E. across the prevailing north to northeast trend of the enclosing rocks. Thicknesses range from a foot or so to 40 feet but average about 12 feet in deposits worked. The longer bodies do not appear to extend beyond about 200 to 300 feet, and some of the more deeply explored have pinched out at at fairly shallow depths. The Nettie Taylor dike terminated rather abruptly at 87 feet, the Champion at about 115 feet, and drill holes failed to encounter the Rutherford No. 2 dike at depths of about 140 feet.

By far the most interesting and important of the 18 or so pegmatites which have been prospected or worked in the Morefield-Denaro sub-area is that at the Morefield mine. This remarkable complex pegmatite strikes N. 45° E., dips steeply southeastward, has a maximum thickness of 30 feet, is almost straight over its known extent in excess of 1,000 feet, and has been shown by drill hole to extend to a depth greater than 200 feet. The long tabular nature of this pegmatite is in decided contrast to the short lenticular form so typical of most bodies in the Jefferson-Amelia sub-area. Other pegmatites in this vicinity are from 4 to 15 feet thick, and some appear also to be long tabular; but exploration has hardly been sufficiently extensive to prove that this form is typical of the whole sub-area.

Most pegmatites in the Morefield-Denaro sub-area, like those in the Jefferson-Amelia, dip nearly vertical, strike slightly north of east, and are sharply discordant with the foliation of enclosing rocks. Also, in both sub-areas the dikes are arranged roughly en echelon. In spite of differences in form, these similarities in strike, dip, areal pattern, and relation to enclosing rocks strongly suggest that the openings into which the pegmatites were emplaced were formed by the same or similar regional forces. Probably they were injected or drawn by dilatation into tensional breaks produced by regional torsion or shearing couple.

Pegmatites in the more outlying portions of the Amelia area are less consistent in attitude than those in the areas of greatest concentration, but most also dip steeply and strike northeastward. A few strike northwest, and the Ligon and Keystone dikes appear to be chimney-like.

Most pegmatites of the Amelia area are mineralogically simple, but at least four are complex. The simple pegmatites are typically coarse to very coarse-grained and consist essentially of feldspar, quartz, and mica with more or less accessory garnet, tourmaline, and beryl. Most have thin border zones; prominent deeply kaolinized plagioclase-quartz-muscovite wall zones; inconspicuous to thick intermediate zones of quartz and blocky perthite; and lenticular, long tabular, or segmented cores of massive quartz. The plagioclase of wall zones is sodic oligoclase to middle albite. Garnet and tourmaline are common in border and wall zones of the pegmatites and in adjoining wall rocks. The complex Morefield and two Rutherford pegmatites are characterized by large intermediate zones of coarse perthitic microcline and by extensive replacement units composed chiefly of cleavelandite and sugary albite. Much of the microcline is the variety amazonstone; and many rare and unusual minerals like manganotantolite, cassiterite, microlite, topaz, spessartite, and monazite occur with the replacement albite. Replacement has been widespread in at least the lower part of the Champion pegmatite, where albite of the wall zone is corroded and replaced by cleavelandite and tiny green muscovite crystals.

ECONOMIC MINERALS

Commercial products from the pegmatites of the Amelia area include, in approximate order of importance: muscovite mica, gem amazonstone, feldspar, beryl, manganotantalite, columbite, gem spessartite, and various specimen minerals. Mica is generally most abundant in pegmatites which contain little or no perthite and occurs chiefly in wall zones, commonly near their inner margins. Most mica from the area is of good quality, being clear, hard, flat, and of light brown to brownish olive (light rum) color. In some deposits, large green "A" mica books fringe quartz cores. Some stained and specked mica is found in places in the western part of the area.

Amazonstone, the blue-green variety of microcline, occurs in intermediate zones of the Morefield and Rutherford Nos .1 and 2 dikes and has sustained operations at the Rutherford No. 1 through several periods of mining. Moderate quantities of potash feldspar have been mined or could be recovered from the Morefield, Rutherford Nos. 1 and 2, Pinchbeck No. 1, McGraw No. 3, Maria (Howe), Schlegal, Ligon No. 1, James Anderson, and possibly other deposits in the area.

Large beryl crystals have been recovered from the Rutherford Nos. 1 and 2, Morefield, and Champion mines and smaller crystals found at the McGraw No. 3, Ligon, James Anderson, Truehart, Vaughan, Flippen, Dobbin, and other deposits. The quantities found, however, are such that the mineral can be recovered only as a by-product of other mining.

Manganotantalite, tantalite, columbite, and microlite are fairly plentiful in the Rutherford and Morefield pegmatites and occur in nearby creek placers. Like beryl, however, they can be recovered only as by-product minerals. Gem and specimen minerals are largely restricted to complex pegmatites like those at the Rutherford and Morefield mines.

PRINCIPLE MINES AND PROSPECTS

JEFFERSON PROPERTY

The old J. G. Jefferson property, about two miles northeast of Amelia, occupies the central part of the main producing belt in the Amelia area. Most of the mines are near the eastern side of the property, not far from Road 630 (Winterham Road). Although the presence of mica was reported earlier, it was not until about 1873 that mining was begun here by a Mr. Champion. Subsequently, numerous operators mined and prospected the property. Between January 1943 and December 1944, extensive exploratory work and considerable mining was done by D. B. Sterrett.

Jefferson No. 1 mine.—The Jefferson No. 1 mine is about 100 yards east of Road 630 and 1.6 miles, by road, north of U. S. Highway 360 (Pl. 8, No. 15). Old workings consisted chiefly of several prospect pits and a partially filled open cut now 80 feet long, 35 feet wide, and 18 feet deep. In the spring of 1943, the Champion Mining Corp., under the direction of D. B. Sterrett, opened several new trenches which revealed a vertical, east-trending pegmatite dike over 300 feet long and 10 feet wide. A 52-foot shaft was then sunk just west of the old open cut, and a 26-foot drift driven along the south wall of the dike at the 26-foot level. At 16 feet from the shaft a crosscut was made from this drift to the north wall of the dike. These workings revealed a vertical core of broken quartz, 1 to 4 feet wide, which is coextensive with the exposed portions of the dike. This is flanked by a discontinuous intermediate zone of coarse perthite. Plagioclase of the wall zone is so thoroughly kaolinized that the shaft had to be abandoned at a depth of 52 feet, and a 9-foot steel drill showed that the feldspar is decomposed to a depth of at least 61 feet.

Abundant, clear, light rum-colored mica was found along both walls but most of it was badly bent, broken, and hair-cracked. The larger crystals measured as much as 18 x 12 x 12 inches but only a few yielded trimmed sheets larger than 2 x 2 inches. From $200 to $300 worth of scrap and sheet mica was sold by the Champion Mining Corp.

Jefferson Nos. 2 and 3 mines.—The Jefferson No. 2 and No. 3 mines are on opposite sides of Road 630 about 800 feet west-northwest of Jefferson No. 1 mine (Pl. 8, Nos. 16, 17). The No. 2 mine is 300 feet east of the No. 3. Both mines are reported to have been worked by Champion and others before 1900, and the No. 3 mine was worked by J. Boyd Bland in 1913-14. In the winter of 1943, D. B. Sterrett did exploratory work at both mines.

The old workings at Mine No. 2 consisted of five or more pits and shafts and at least one tunnel that extended westward under the road. It is reported by Henry Booker, who worked in the mine, that some large mica was left in this tunnel. Sterrett sank two 40-foot shafts near the old openings; and from the northernmost shaft, drove a 20-foot drift S.5°W. at the 39-foot level. Only a small quantity of mica was recovered.

Sterrett (1923, p. 311-312), concerning Mine No. 3, states:

". . . The old workings consisted of a shaft about 60 feet deep, 200 to 300 feet of drifts and stopes, and several prospect pits. The old workings have caved badly or have been filled with muck and mud and could not be examined. New work by Mr. Bland consisted of two shafts about 60 feet deep and 60 feet apart on a line running from northeast to southwest, and tunnels driven from them . . . One tunnel was driven from the northeast shaft to the old shaft and abandoned because of caving ground. Another tunnel was cut between the two new shafts around the east side of the old shaft. This cut into old workings that had been partly filled with washes of muck and mud. An old tunnel to the east, now filled, is reported to have been driven 200 feet . . .

". . . The pegmatite cuts the bedding of the gneiss, but the exposures were not plentiful enough to permit a determination of its strike and dip. Apparently it elongated eastward, but it is at least 60 feet thick and probably as much as 75 feet thick from north to south. It contains horses of gneiss. The formations are thoroughly decomposed to the depth of the lowest working, 60 feet . . . The mica occurs in streaks and is segregated around the masses of quartz. Two streaks of mica were encountered. One of these, found in the earlier workings, was reported to be rich; the other, near the north shaft, was rich in places, but most of the mica was in small crystals. Much of the pegmatite is nearly barren of mica. The best mica obtained during the last work yielded sheets 4 by 6 inches and of the same good quality as that from Mine No. 1."

Archer prospect.—The Archer prospect is 560 feet S.65°W. of the Jefferson No. 3 mine (Pl. 8, No. 26). There was a shaft at this place, but it is now caved and there are no records of activity or production. Clear mica is fairly abundant in the dump.

Champion (Jefferson No. 4, Bland) mine.—The Champion mine is on the west side of Road 630, 1100 feet north of the Jefferson No. 3 mine, and 1.9 miles by road north of U. S. Highway 360 (Pl. 8, No. 18). It is reported to have been opened by Champion about 1873 and is probably the Jefferson mine mentioned by Watson (1907, p. 280) as the first mine opened in the Amelia area. There are no records of operations between 1873 and 1895 but mining is reported to have been carried on from time to time by Shields and probably others. About 1895 Benz Grindstaff worked the mine for Dr. Skelton; and later, about 1904, worked it for himself. In 1913, Brook Sewell reopened the mine, but shortly thereafter J. Boyd Bland of Richmond, took over its operation. Altogether, Sewell and Bland worked the mine for 18 months, producing about 200,000 pounds of mica, of which 15,000 pounds was sold as sheet (Sterrett, 1923, p. 311). Bland* states that his work consisted chiefly of cleaning out the old shafts and drifts and extending the stopes. He used the Grindstaff shaft for entrance.

In the spring of 1943, D. B. Sterrett, acting for the Champion Mining Corporation of Philadelphia, began exploratory work at the Champion mine. Several trenches were cut in the vicinity of the old works and two exploratory shafts about 25 feet deep and 10 feet apart were sunk 40 feet northwest of the caved opening to the Grindstaff shaft (See Pl. 9). Four to five feet of pegmatite, containing small sheets of mica, was encountered crossing the central part of the southwestern

*Personal communication.

shaft and the southern corner of the northeastern shaft. Both shafts were abandoned because of slumpage toward old workings.

In July 1943, a new shaft was begun in a thin vertical wedge of pegmatite 60 feet west-northwest of the Grindstaff shaft. This pegmatite pinched out at a depth of about 25 feet, but another body of pegmatite, about 10 feet thick and possibly connected with the one in the shaft, was encountered 6 feet from the shaft in a south-southeastward drift at the 43-foot level. Neither of these bodies of pegmatite was very rich in sheet-size mica.

At a depth of 100 feet another drift was driven 9 feet southeastward where it broke into an old stope. This stope, about 65 feet long, 40 feet or more high, and about 15 feet wide, was elongated east-west with the strike of the pegmatite and connected near the eastern end with the Grindstaff and older Skelton shafts. Skidpoles extended from the bottom of the Grindstaff shaft to a sump 20 feet to the northwest. This sump, at a depth of 110 feet from the surface, represented the deepest work in the mine. Additional work included a subsidiary stope about 10 feet high in the ceiling of the big stope, and a drift of unknown length extended eastward from the bottom of the Skelton shaft.

Tapering ends of the pegmatite had been left in the west end of the big stope and at the Skelton shaft at the east end. The Grindstaff shaft was only partly in pegmatite. Mica-rich pegmatite had been left in places along the walls and ceiling of the big stope and about the old sump.

Sterrett did some unproductive work at the west end of the big stope, scaled some pegmatite from the walls and ceiling, opened the Skelton shaft to the surface, and cleaned out and deepened the old sump. In the bottom of the sump the pegmatite was found to level out abruptly and to plunge northwestward. When a 6-foot exploratory drill hole in the gneiss floor at the 98-foot level, 22 feet southeast of the Sterrett shaft, encountered only about one foot of pegmatite, it was assumed that the main body of pegmatite did not continue far. Richly clustered block mica and mica burr about the sump also suggest that the sump is near the keel of the body. Diamond drilling below the level of the sump was considered, but further expenditure was discouraged by findings elsewhere in the mine and by market conditions. The mine was abandoned on December 15, 1944, and on the following New Year's Eve the workings caved in, leaving a hole at the surface 90 feet long, 45 feet wide, and 25 feet deep (Pl. 9).

The pegmatite body at this mine is in the form of an irregular lens about 80 feet long, 20 feet in maximum width, and extending to a depth of approximately 110 feet. It strikes N.78°E.; dips from 60°N. near its base to vertical in the Skelton shaft; and, except near its extremities, cuts across the foliation of the enclosing gneiss.

Zonation in the pegmatite is distinct, but wall zones and quartz core greatly predominate over other units. A border zone up to several inches in thickness, consisting of plagioclase (Ab_{85}) and small yellowish muscovite or (in parts of the lower workings) of a mat of fine closely-massed muscovite, is locally present. Intermediate-zone perthite adjacent to the quartz core is quite sparse or absent. The wall zone, which comprises most of the pegmatite and from which all sheet mica has been produced, is composed chiefly of medium- to coarse-grained, cream to white or greenish-gray albite (about Ab_{95}), small to large book muscovite, and variable quartz. The grain size of the feldspar increases strongly from the walls inward. In places in the outer part of the wall zone quartz and albite show coarse graphic intergrowth; in the central part of this zone much of the albite is in coarse subhedral to euhedral crystals. Book muscovite was recovered throughout the wall zone, but the richest shoots in the part of the pegmatite worked by Sterrett were within the inner few feet of this zone near and against the quartz core and in the basal part of the wall zone along the keel of the pegmatite. In the latter position, about the old sump, book muscovite was very richly clustered. The core zone of the pegmatite, from 2 to 10 feet thick, is dominantly milky to clear glassy quartz.

Multifaced crystals of albite from 4 to 15 inches long are abundant in parts of the wall zone. Some, of composition Ab_{85}, are partly transparent; others, of composition Ab_{95}, display a beautiful blue opalescence. Numerous crystals, especially near the quartz core, show discoloration along cleavage directions so that they appear zoned; or, in extreme cases, they have been etched and corroded so that only skeletal frameworks remain. Within these frameworks, scales of sericite, minute plates of white mica, tiny clear crystals of quartz, cubes of pyrite, and elongated crystals of tourmaline and beryl have been deposited. Some of these late minerals also occur in cracks in the quartz core.

Cavities which appear more like vugs or miarolitic cavities than like corrosional openings are common in lower parts of the pegmatite. These are lined with multifaced crystals of muscovite and albite, and are mostly only a few inches across. One, 12 inches across and lined with muscovite crystals 2 to 4 inches wide, however, was encountered near the keel of the pegmatite (Pl. 1B).

Biotite and tourmaline occur in places near the walls of the pegmatite. Tiny pale blue crystals of beryl were found enclosed in quartz of the core; and a number of pale blue-green crystals (One 12 by 13 inches thick and 4 feet long) were found on the south side of this core. Parts of the latter were clear and approached gem aquamarine in quality. A tantalite crystal ¾ inch across and a small allanite crystal were also found by Sterrett. Marcasite, one of the latest minerals, was observed between mica plates and in fractures in albite and quartz.

The pegmatite is enclosed in a migmatic rock composed of bands of medium- to dark-gray biotite and hornblende gneiss alternating with bands of white to buff pegmatitic material with local garnet prophyroblasts and augen of waxy white plagioclase. On the north side of the pegmatite foliation strikes N.40°-75°W. and dips 10°-15°SW.; on the south side it strikes N.30°E., and dips 10°SE.

Mica from this mine is of excellent quality, being clear, flat, and only slightly ruled and broken. Most is of light rum color, although in some parts of the dike it is pale green. Color zoning along crystallographic lines is common. Mica books in the main shoots in the wall zone are generally from about 3 to 10 inches in diameter, but one block recovered by Sterrett was 2 feet in diameter and 8 inches thick. During 1944, the Champion Mining Corporation sold, in addition to 20 tons of scrap mica, about 4700 pounds of strategic sheet mica valued at nearly $32,000.

Jefferson No. 5 (Fields) prospect.—The Jefferson No. 5 prospect is on the Clarence Fields property 300 yards N.60°E. of the Champion No. 1 mine (Pl. 8, No. 19). At this place, in the spring of 1944, D. B. Sterrett opened about a dozen shallow pits and trenches within a distance of 200 feet along a vertical pegmatite dike striking about N.84°E. This dike, ranging from 2 to 8 feet in width, carries a persistent core of quartz as much as 4 feet thick. Fairly good mica crystals were found in some of the trenches and, although surface-stained mica was uncovered in abundance at the west end of exploration, little mica was recovered from a 25-foot shaft sunk at this end In all, about a ton of scrap mica was recovered from these operations.

Jefferson No. 6 mine.—The Jefferson No. 6 mine is on the west side of Road 630 about 500 feet north of the Champion mine (Pl. 8, No. 20). No recent work has been done here and in 1943, all that could be seen of the old partly filled workings was an open cut 65 feet long, 35 feet wide, and 15 feet deep. The dike is apparently lens-like with the longest dimension extending east-west, but the only pegmatite visible was an 18 inch streak at the east end of the cut. Mica, potash feldspar, kaolin, and translucent white and smoky quartz were plentiful in the dump. The mica, in rough crystals as much as 7 inches across, was clear, white to pale rum-colored, flat to flat "A", clean-splitting, and in part ruled.

Jefferson No. 7 mine.—The Jefferson No. 7 mine is about 100 yards west of the Jefferson No. 6 mine and 800 feet northwest of the Champion mine (Pl. 8, No. 21). In 1943, D. B. Sterrett cleaned out and enlarged old workings to form a pit 50 feet long, 20 feet wide, and 30 feet deep at the east end. Short tunnels were run from the northeast corner of the pit. The pegmatite exposed is about 10 feet wide, strikes N.65°E., dips irregularly northwestward, and is prevailingly discordant to the foliation of the enclosing migmatic biotite gneiss which strikes from northeast to northwest and dips northward. At the east end of the pit the pegmatite branches irregularly into the gneiss. Zonation is evident in the pegmatite at the west end of the pit, with kaolinized plagioclase adjacent to the walls and coarse buff microcline of the intermediate zone enclosing irregular quartz core segments. Mica was found chiefly in the kaolin near the walls and adjacent to quartz core segments.

When the pit was first opened, mica was abundant near the surface, and one block measuring 12 by 10 by 6 inches was recovered. Although this mica was free from primary stain, it was badly clay stained, ruled, and bent. It was hoped that these defects would lessen with depth, but as the pit was deepened mica became so scarce that the operation was abandoned. A total of $200 to $300 worth of sheet mica was sold.

Jefferson No. 8 prospect.—The Jefferson No. 8 prospect is on the north side of a farm road about a quarter of a mile west of Jefferson No. 6 mine (Pl. 8, No. 22). Five shallow pits, the largest of which is 35 feet long and 15 feet wide, have been opened here within a distance of 220 feet along an east-west line. An opening, now partly caved and filled with water, at the east end of the largest pit appears to have been a shaft. A 4-foot width of pegmatite is exposed in the westernmost pit and clear, flat, medium-sized books and sheets of mica are rather abundant in the dumps. There are no records of production.

Nettie Taylor (Jefferson No. 9) mine.—The Nettie Taylor mine is about 50 yards southwest of Road 630 and about 200 yards northwest of Jefferson No. 6 mine (Pl. 8, No. 23). The old workings consisted of a 10 by 10 foot shaft, 25 feet deep; a 15 by 25 foot pit, 15 feet deep; and several short tunnels. The shaft and pit, 15 feet apart, were connected by an irregular tunnel. A dike, consisting of a 4- to 7½-foot core of fractured quartz bordered on either side by from 1 to 2 feet of kaolinized pegmatite, was exposed in the shaft. Large fractured books of clear greenish rum-colored mica were abundant in the kaolinized pegmatite on the south side of the core and rather plentiful in that on the north side. The dike strikes N.66°E., dips about 80°SE., and is sharply discordant to the foliation of the enclosing migmatic biotite schist and augen gneiss which strikes about N.20°E., and dips 25°NW. Reddish-purple garnets and some graphite occur in these wall rocks.

When, in 1943, D. B. Sterrett, acting for Mica Associates of Philadelphia, began operating this mine it was discovered that, although good-sized mica was abundant, much of it was badly bent and fractured. For this reason, the Colonial Mica Corporation gave financial assistance for the purpose of sinking the shaft below the zone of kaolinization, to determine the depth of kaolinization and the character of the mica below this zone. As the shaft was deepened, water was encountered at a depth of about 30 feet, and at a depth of 55 feet the shaft passed from the southward-dipping dike into the footwall. At 93 feet a sump was made, and from the 87-foot level a cross-cut was driven 9 feet southward to where it encountered closely bunched mica along the trough-like keel of the pegmatite which terminated at this point. At the keel, which plunged about 15°W., the pegmatite was still thoroughly kaolinized and the mica was bent and fractured.

Jefferson No. 10 prospect.—In 1944, the old Jefferson No. 10 prospect, about 80 yards southwest of Road 630 and 200 yards northwest of the Nettie Taylor mine, consisted of several trenches and an old water-filled pit about 25 feet in diameter. No pegmatite was exposed, but translucent, waxy-white quartz with black tourmaline inclusions was abundant in the dump, and small No. 1 quality mica was present in minor amount.

MCCRAW PROPERTY

The mines and prospects on the W. A. McCraw property, lying, in general, north, east, and southeast of the Jefferson property, except for the Stevens prospect, are on the east side of Road 630 about 3 miles northeast of Amelia Station. The Stevens prospect is near the McCraw homeplace on the west side of Road 630 and north of the Jefferson property. Much of the present McCraw property is a part of the old Pinchbeck property described by Sterrett (1923, p. 314-315) and the A. T. Smith property described by Pegau (1932, p. 56).

McCraw No. 1 mine.—The McCraw No. 1 mine (Smith No. 78 of Pegau; Pinchbeck No. 2 of Sterrett) is 1000 feet northeast of Road 630, about 1½ miles by road north of U. S. Highway 360, and 2.7

miles N.30°E. of Amelia Station (Pl. 8, No. 12). Old workings consisted of an open pit 100 feet long, 60 feet wide, and over 25 feet deep. In 1943, the Champion Mining Corporation, under the direction of D. B. Sterrett, drove two exploratory tunnels westward from the bottom of the pit. One tunnel extended 25 feet due west and was T-shaped, the other 15 feet northwest and was Y-shaped. About 15 feet of east-trending kaolinized pegmatite was exposed at the tunnel entries, but in the tunnels this body was shown to divide into two tapering tongues. Mica, mostly small and badly broken, was fairly abundant in the pegmatite. Pegau (1932, p. 57) reports books yielding trimmed sheets 8 by 10 inches, but Sterrett recovered little or no large mica and sold only 6 to 8 pounds of sheet mica.

McCraw No. 2 mine.—The McCraw No. 2 mine (Smith No. 79 of Pegau; Pinchbeck No. 3 of Sterrett) is 160 feet north of the McCraw No. 1 mine (Pl. 8, No. 13). It consists of a partly filled open pit 170 feet long, 30 feet wide, and 20 feet deep, with a drift extended westward from the bottom. In 1943, D. B. Sterrett trenched both ends of the pit and cleaned out some small openings to the west. A pegmatite body, 6 feet thick at the east end of the pit and 20 feet thick at the west end, with vertical dip and N.75°E. strike was exposed. Only small lenses and stringers were encountered in the openings to the west. The main pegmatite body consists of an irregular quartzose core; a discontinuous intermediate zone of perthite; wall zones of kaolinized plagioclase, small quartz, and abundant small mica; and a local thin border zone of fine muscovite and quartz.

Sterrett's exploratory work yielded little sheet mica, but it did uncover, at the east end of the pit, one 50-pound block which trimmed 8 pounds of sheet. Considering the abundance of small mica in the deposit, however, it is possible that it might support a small scrap operation.

McCraw No. 3 mine.—The McCraw No. 3 mine (Pinchbeck No. 1 of Sterrett) is near the head of a small valley about 500 feet west of the McCraw No. 1 mine and 375 feet S.75°E. of the Jefferson No. 1 mine (Pl. 8, No. 14). It is probably the Pinchbeck mine described by Watson (1907, p. 283) as being the only mine operating in Amelia County in 1906, and also the "Pinchbeck quarry" as being located on the "largest dike" in the property.

Watson states that the mine was first worked about 1888, and that in 1906 it had a depth of 28 feet; also that feldspar, kaolin, and mica (some of which trimmed 12 by 14 inches) were sold from the mine.

Bastin described the dike as being 35 feet wide in the west end of the pit, with finer textured, more thoroughly kaolinized feldspar and more abundant mica near the walls, and massive quartz and coarse cream-colored potash feldspar, some in pure masses 4 feet across, near the middle of the dike.

When examined in 1943, the old pit, approximately 100 feet long and 65 feet wide, was partly filled with water. Later exploratory work by the Champion Mining Corporation under the direction of D. B. Sterrett included several trenches and a tunnel. One trench across the west end of the old pit exposed a body of pegmatite 20 feet thick, with vertical dip and east strike, cutting discordantly the foliation of the enclosing migmatic biotite gneiss which strikes northeast and dips northwest. A nearly vertical shoot of small mica could be seen near the south wall of the pegmatite.

Trenching at the east end of the pit exposed two irregular east-trending branches of pegmatite, the northernmost of which is 6 feet thick and is composed chiefly of kaolin and pinkish blocky perthite. The other branch, separated from the first by 20 feet of gneiss, is 18 feet thick and contains a 3- to 4-foot core of quartz flanked, in part, by perthite. Books of smoky to brownish-olive mica, some of which measured 7 by 13 by 4 inches, but many of which were ruled, cracked, and bent, were found adjacent to the quartz core on its south side. Some good quality potash feldspar was removed from both of the easterly branches of pegmatite.

When a diabase dike was encountered cross-cutting the pegmatite just east of the east end of the pit, work was shifted to a 30-foot incline, with about 40 degree pitch, extended eastward from the west end of the pit. Although a considerable width of pegmatite with shoots of mica along both walls was exposed in this incline, caving walls forced the work to be abandoned.

The alignment and similar strike of pegmatite in the McCraw mines No. 2 and No. 3 suggest that both are on the same body, but trenches cut in the intervening area by the Champion Mining Corporation failed to show continuity.

Pineshaft mine.—The Pineshaft mine is on part of the old Pinchbeck property now owned by W. R. McCraw, 1¼ miles northwest of the McCraw No. 3 mine, 185 feet northeast of Road 630, and about 350 feet northeast of the Nettie Taylor mine (Pl. 8, No. 9).

No recent work has been done at this place, but Sterrett (1923, p. 314), who visited the mine when it was being operated by the Virginia

Mica Producing and Manufacturing Company in 1915, described the workings as follows:

> "There was a small open cut, a shaft 45 feet deep on the northeast side of the cut, and a 25-foot drift run N. 60°E. from the 40-foot level. The country rock is much folded biotite gneiss having a general northeast strike and northwest dip. The pegmatite also strikes northeast. The tunnel cuts slantwise across the pegmatite, which forks at the northeast end. The pegmatite is 3 to 10 feet thick and has been decomposed to a depth of nearly 40 feet, below which weathering has affected it but little and the potash feldspar is fresh. The pegmatite exposed in the workings is rich in crystals of mica, some of which are more than 18 inches across. Much of the mica is the A variety, or ruled, and some is rather badly stained with limonite from surface weathering."

Abner mine.—The Abner mine is 330 feet northeast of the Pine-shaft mine (Pl. 8, No. 10). According to Sterrett (1923, p. 313), when the Virginia Mica Producing and Mining Company (formerly the Virginia Mica and Mining Company) abandoned work here prior to August 1914, workings consisted of an open cut 80 feet long, 30 feet wide, and 25 to 35 feet deep with inclines at both ends and a 35-foot shaft in the bottom. The cut and the inclines extended east-west along the strike of the pegmatite. In 1944, the shaft was full of water and the inclines caved, making a surface opening about 130 feet long. The dike, which is lens-shaped, probably has a maximum thickness of about 20 feet near the middle of the pit, but it tapers to about 6 and 10 feet in the east and west ends, respectively. Quartz core segments were exposed in both ends of the pit and good-sized books of mica were visible adjacent to those in the east end.

According to Sterrett (1923, p. 313), a fairly large quantity of mica was mined, but it contained a large proportion of rough crystals good only for scrap. Some clear sheets measuring 8 by 10 inches were trimmed from the best crystals.

Stevens prospect.—The Stevens prospect is on the McCraw home-place, about 300 feet west of Road 630, and 1100 feet N.80°W. of the Abner mine (Pl. 8, No. 8). Local residents state that it was opened about 1915; but no recent work has been done and little could be learned about the deposit. Old workings include three shallow pits within a distance of 50 feet along a N.75°E. line, and a fourth hole about 150 feet to the west. Small, clear, flat, light rum-colored mica occurs rather abundantly in the dump along with white and smoky quartz, albite tourmaline, and graphic granite.

RUTHERFORD PROPERTY

The Rutherford mines, half a mile west of Road 609 and 1¼ miles north of Amelia (Pl. 8, Nos. 38, 39, 40), have long been famous because of the rare and unusual minerals which they have produced. The earliest and latest operations were for mica, but most mining has been for gem amazonstone. The No. 1 mine is southwest of the farmhouse on the side of a low hill; the No. 2 mine is in a valley beside a small stream 100 yards southwest of the No. 1; and the No. 3 mine, which to date has been insignificant in mineral production compared to the other two, is 250 yards west of the No. 1 mine (Pl. 10).

Fontaine (1883) says that the deposits were worked in prehistoric times, probably by Indians. The earliest recorded mining was by Dr. Samuel B. Henry a year or so before Fontaine's report of 1883; the next was in 1894. According to Sterrett (1923, p. 308) and Spurgeon Bartlett,* mine foreman, the No. 1 mine was worked, chiefly for amazonstone, by the American Gem and Pearl Company of New York from about 1908 to 1910. There appears to have been no further work, except the reworking of old dumps, until 1931 when T. Arthur Smith of Washington, D. C. reopened the No. 1 mine, primarily for the recovery of gem-quality amazonstone. From about 1932 the mines again lay idle until May 1943 when E. J. Tyler of Asheville, North Carolina, acting under the name of Rutherford Minerals Corporation, drained and briefly worked the No. 2 mine, did some exploratory work at the No. 3 mine, and made an unsuccessful attempt to reopen the No. 1 mine. Also in 1943, the U. S. Bureau of Mines put down five exploratory diamond drill holes on the property. In 1958, W. D. Baltzley again drained the No. 2 pit and worked the deposit for mica until the fall of 1959, at which time he began open-pitting the No. 1 deposit with power shovel.

Country rock, like that throughout most of the Amelia vicinity, is prevailingly biotite gneiss with garnetiferous and hornblendic facies, feldspathic augen, and numerous pegmatitic stringers. Foliation generally strikes northeastward and dips moderately northwestward; although, locally, as at the No. 2 mine, it is strongly contorted. The larger pegmatites are markedly lenticular, strike northeastward, and dip steeply southeastward across the foliation of enclosing rocks. Each of the three mines appears to be on a separate dike.

Workings at the No. 1 mine were begun as a pit 70 feet long. After this had been deepened with the steep southeast dip of the dike until the wallrock overhang became dangerous, a shaft, called the No. 1 shaft, was sunk on the southeast, or hanging wall, side of the dike about 20 feet from the pit (Pl. 10). At the 55-foot level a cross-cut to the dike was made and a 40-foot drift extended northeastward along the dike.

*Personal communication.

Stoping was carried above this drift almost to the bottom of the pit. The shaft was then deepened to 90 feet, where it encountered the dike, and a 50-foot drift extended northeastward along the dike. Overhand stoping was carried above this drift until drill holes intersected earlier workings above. This is said to have been the extent of the workings when the American Gem and Pearl Company began its operations in 1908 or 1909.

The American Gem and Pearl Company sank a new shaft, called Williams or No. 2 shaft, 50 feet east of the No. 1 shaft. At the 88-foot level a cross-cut was driven from the shaft about 40 feet northwestward to the old drift from the No. 1 shaft, where a winze 35 to 40 feet deep was sunk on the dike. From the bottom of the winze an inclined cut was made upward to the bottom of the No. 1 shaft and stoping of unknown extent done.

In 1931, T. Arthur Smith reopened the No. 1 mine and produced gem-quality amazonstone for approximately one year. At the time this operation was abandoned, the No. 1 shaft was at least 100 feet deep and some workings extended to a depth of about 165 feet. In May 1943, E. J. Tyler began draining and reconditioning the No. 1 shaft. As dewatering progressed, slumpage occurred in the old pit to the north and in the Williams shaft. When the water had been lowered to the 70-foot level in the No. 1 shaft, the north wall began to collapse and the project was abandoned.

The No. 2 mine was opened and operated by Dr. Samuel B. Henry in the early 1880's and reopened and mined for a period about 1900 and perhaps again about 1912 by concerns unknown to the writer. It apparently lay idle from this time until June 1943, when E. J. Tyler drained the old pit. When drained, this pit was found to be 150 feet long, 50 feet wide at the surface, tapering to 5 to 12 feet wide in the bottom, and 75 feet deep (Pl. 10). The south wall was slightly overhanging because of the southward dip of the dike. An L-shaped tunnel 20 feet long extended eastward from the bottom of the pit at the east end, and there was a stope 25 feet long at the west end. In the bottom of the pit, 20 feet from the east end, there was also a partly filled two-compartment shaft reported to be 75 feet deep. Tyler recovered some mica from the east end and from a surface opening into the stope at the west end, but the amount was not sufficient to counter-balance the cost of heavy pumping, and the operation was soon abandoned.

Little pegmatite is exposed at the surface at the No. 1 mine but the original pit, which must have more or less followed the dike, is elongated in a N.65°E. direction. Spurgeon Bartlett, who was foreman at the mine on two occasions, however, says that in the workings the dike was from 6 to 15 feet thick with an average of 8 feet, had a strike of N.45°E. and a dip of about 70°SE.

The ends of the dike at the No. 2 mine, but practically none of its medial portion, were exposed when the pit was drained by Tyler in 1943; but the shape of the pit showed a prevailing strike of N.56°E., a dip of about 70°SE., and a thickness at the 60-foot level of from 5 to 8 feet. At the east end of the pit at about the 50-foot level, the dike could be seen to divide into two branches; below this bifurcation much of the visible part of the dike was composed of coarse cleavelandite (Pl. 10). The main branch of pegmatite, from 4 to 7 feet thick, bent somewhat northward from the trend of the dike in the pit and dipped only about 62°SE. It was composed chiefly of coarse buff perthite, smoky quartz, and muscovite, with minor white albite near the walls. Some of the latter showed a blue chatoyance. Crystals of perthite a foot or more in diameter occurred near the footwall and in sparse medial masses. Some quartz core segments were also present. A mica shoot, containing books 8 inches or more across, was visible in the central and hanging wall parts of this main branch of pegmatite. Small deep red garnets, associated with quartz and mica, were observed locally. At the west end of the pit, the dike was 8 to 10 feet thick near the surface, narrowed to 18 inches at the 50-foot level, then broadened to 8 or 9 feet in the bottom of the pit. The pegmatite exposed in this part of the pit was composed chiefly of albite and quartz with some book mica scattered irregularly throughout the central part of the dike.

The 5 diamond-drill holes put down by the U. S. Bureau of Mines in 1943 were intended to test the lateral extensions and vertical extent of the No. 2 deposit, and the possibility of a subsurface connection between the No. 1 and No. 2 deposits. Lemke, Jahns, and Griffitts (1952, p. 122) summarize conclusions from this drilling as follows:

"The drill-hole exploration indicates that the No. 2 deposit probably pinches out at a depth of 200 feet 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 [about half way between the No. 1 and No. 2 deposits] 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."

The large pegmatite mass encountered in hole 5, mentioned above, is described as being 10 to 12 feet thick at and below a vertical depth of

106 feet and to be chiefly quartz-plagioclase pegmatite, with wisps of biotite gneiss (Lemke, Jahns, and Griffitts, 1952, p. 122-123).

The mineral assemblages at the Nos. 1 and 2 mines have long attracted the attention of geologists and collectors, and have been described by a number of writers including: Fontaine (1883), Watson (1907), Bastin (1911), Sterrett (1913, 1923), Pegau (1932), Glass (1935), and Lemke, Jahns, and Griffitts (1952). Glass (1935, p. 745-746) lists 27 well established mineral species as follows: albite, allanite, almandite, apatite, bertrandite, beryl, calcite, cassiterite, cerussite, chalcopyrite, columbite, fergusonite, fluorite, galena, helvite, manganotantalite, microcline, microlite, monazite, muscovite, phenacite, pyrite, quartz, spessartite, topaz, tourmaline, and zircon. Most of the specimens described by Glass came from the No. 1 mine, which was being operated at the time of her visit in 1932; but in most older reports the writers neglected to designate from which mine the minerals described were recovered.

The arrangement of minerals within the main parts of the pegmatite bodies has not been described, but some intermineral relations are evident in specimens from the dumps and in parts of the pegmatite at the No. 2 mine exposed during Tyler's operation in 1943. Miners who worked in the No. 1 mine report that amazonstone was taken from the central part of the dike and that mica was left along the sides in places. This suggests well-developed microcline-rich intermediate zones, and wall zones of book mica. Glass's (1935, p. 747) statement that at the time of her visit the new dump from the No. 1 mine consisted largely of cleavelandite and that "the angular cavities between the network of interlocking platy crystals contain the rarer minerals" would seem to indicate the presence of large replacement bodies at the No. 1 mine.

Old records as well as old dumps indicate that mineralogy, zonation, and replacement at the No. 2 mine were similar to those at the No. 1. Fontaine (1883) speaks of much cellular albite with many open cavities found at the No. 2 mine and states that amazonstone, beryl, fluorite, columbite, and spessartite garnet were more abundant here than at the No. 1 mine. He reports beryl crystals 3 to 4 feet long and as much as 18 inches thick and states that almost all of the beryl recovered came from the No. 2 mine.

Mica from the No. 1 and No. 2 mines is of excellent quality, being light rum-colored, clear, flat, hard, and but moderately ruled. Watson (1907, p. 282) reports the recovery of books which trimmed 22 by 24 inches but does not state from which Rutherford mine they came. Tyler in 1943 recovered books from the No. 2 mine as much as 15 inches across and 6 inches thick. There are no records of the commercial recovery of crude feldspar from any of the Rutherford mines.

The pegmatite at the Rutherford No. 3 mine, 250 yards S.80°W. of the No. 1 mine and 90 feet west of Mica Mine Brook, lacks the unusual mineralogy characteristic of the pegmatites at the other mines and has never been an important source of mica or feldspar. Old workings consisted of a pit 15 feet wide and deep from which a drift extended 35 feet westward to connect with the bottom of a 25-foot shaft. The area to the west has been cross-trenched for a distance of about 60 yards. In 1943, Tyler reopened and enlarged these old workings, exposing in the pit a dike of pegmatite 2-5 feet thick, striking N.80°E. and dipping steeply. Toward the shaft, the dike becomes thicker. The pegmatite is largely kaolinized, contains a rathei continuous one- to two-foot quartz core, and is fairly rich in broken, clay-stained mica. Some pegmatite and small mica occur in the trenches west of the main openings.

OTHER MICA- AND FELDSPAR-PRODUCING PROPERTIES

Maria (old Pinchbeck, Howe) mine.—The Maria mine is on the old Abner W. Pinchbeck property 3 miles northeast of Amelia and 2300 feet northeast of the Champion mine (Pl. 8, No. 25). Old workings consisted chiefly of 2 shallow shafts about 30 feet apart connected by an irregular tunnel at about the 20-foot level. Along the dike to the west there were, in addition, 8 shallow exploratory pits within a distance of about 100 yards.

The mine was reopened in 1942 by W. W. Howe of the Seaboard and Southern Minerals, Inc. In 1944, new workings consisted of a pit about 35 feet in width and depth at the site of the old western shaft, and a cut 15 feet deep and 115 feet long. Scrap mica and coarse, cream-colored potash feldspar were being recovered in fair quantities.

The pegmatite body exposed in the main opening is about 25 feet thick, stands nearly vertical, and strikes N.82°E. It is distinctly zoned, with a core of massive quartz 2 to 12 feet thick, irregular and discontinuous intermediate zones of coarse perthite, and wall zones of muscovite, quartz, and kaolinized plagioclase. Some blocky perthite is included in the quartz core. Pale green, lightly specked "A" mica is locally abundant in the inner part of the wall zone near quartz or perthite. Although some large books were recovered, the pronounced "A" structure made it suitable only for scrap.

W. T. Pinchbeck No. 1 mine.—This mine is 100 yards south of Nibbs Creek, a third of a mile northeast of Road 630, and 3.3 miles N.15°E. of

Amelia (Pl. 8, No. 6). It was last operated in 1922 by the Richmond Mica Company.

Workings consist of a pit 160 feet long, 30 feet wide, and 31 feet deep. In this is exposed a nearly vertical dike of pegmatite 15 feet thick, striking N.83°W. A core of massive quartz 8 to 12 feet thick, bordered by partly kaolinized plagioclase pegmatite, is present in the central and eastern parts of the pit. Buff-colored perthite, perhaps part of a hood-like intermediate zone, makes up most of the exposure near the west end of the pit and is sparingly present adjacent to and on the north side of the quartz in the central part of the pit. A considerable quantity of large mica suitable for stove windows is reported to have been recovered from the pegmatite on both sides of the quartz core, and one block measuring 13 by 15 by 7 inches was observed in place on the south side of the quartz. Some cleavelandite is present in the pegmatite, and Pegau (1932, p. 56) reported finding manganotantalite in strike with the dike.

Wall rock is biotite gneiss containing numerous stringers of pegmatite. Its foliation, although having a strike similar to that of the pegmatite, dips about 40°NW. and is, thus, transected by the nearly vertical pegmatite.

There is no evidence that mica in this deposit has been exhausted. It is of excellent quality, being rum-colored, clear, flat and flat "A", and clean splitting. Potash feldspar has also been mined in some quantity and a considerable tonnage may still be available.

W. T. Pinchbeck No. 2 prospect.—The W. T. Pinchbeck No. 2 prospect includes two shallow pits about 500 feet southeast of the Pinchbeck farmhouse and 800 feet southwest of the No. 1 mine (Pl. 8, No. 7). These pits, which are about 20 feet long and 15 feet deep, are 100 feet apart on a N.80°E. line. No pegmatite is exposed in the western pit; but small, clear, generally flat mica is fairly plentiful in the small dump. A body of pegmatite 8 feet thick, striking N.70°E. and dipping 65°SE., is exposed in the eastern pit. This consists chiefly of coarse, blocky, partly kaolinized perthite adjacent to a quartz core 1 to 6 inches thick. A 1- to 2-inch border zone, rich in small biotite and muscovite is also present. Thin streaks of small, green, contorted mica extend downward through the pegmatite on either side of the quartz core.

Line prospect.—The Line prospect, consisting of a partly filled shaft, is 50 yards southwest of Henry Booker's house, west of Road 630 and 2½ miles north-northeast of Amelia (Pl. 8, No. 28). No pegmatite is exposed, but medium to small, clear, light rum-colored, flat, ruled mica is abundant in the dump.

About 200 yards south of the Booker prospect there is another old pit, 60 feet long and 10 feet deep, in which is exposed a body of pegmatite composed dominantly of massive quartz (Pl. 8, No. 29). A small amount of mica is present in the dump.

Booker prospect.—The Booker prospect is about 200 yards west of the Line prospect (Pl. 8, No. 27). The old working, consisting of a roughly circular pit about 35 feet in diameter and 12 feet deep, was overgrown with vegetation when examined in 1943. A body of massive white quartz 4 feet thick was exposed in the west side of the pit, and both quartz and mica could be traced on the surface eastward for at least 150 feet from the prospect. Medium to small, light rum-colored mica of good quality was plentiful in the dump.

John Patterson mine.—The John Patterson mine is in a valley about three-fourths of a mile north of U. S. Highway 360 and 2 miles N.25°E. of Amelia (Pl. 8, No. 31). Sterrett (1923, p. 315) states that workings were reported to include a shaft 90 feet deep, but in 1943 all that could be seen was a water-filled pit about 90 feet long and 50 feet wide. Much fresh, coarse pegmatite, consisting chiefly of white plagioclase and potash feldspar, white quartz, and muscovite, is present in the dump. Some of the feldspar is in crystals a foot or more thick. The small amount of mica observed in the dumps was light rum-colored, flat and flat "A", hard, and clear. Some ruled crystals measured 2 by 7 inches. Accessory allanite (Sterrett, 1923, p. 315) and apatite (Pegau, 1932, p. 59) have been reported, also from the dumps. No wall rock is exposed in the immediate vicinity of the mine, but biotite-quartz gneiss, locally containing augen of microcline and stringers of pegmatite, is exposed in the stream a short distance to the west.

Two old prospects have been opened about a quarter of a mile south of the John Patterson mine (Pl. 8, Nos. 32 and 33). The easternmost (No. 33) consists of several shallow pits within an area of approximately 25 square feet. Quartz is abundant in the dump and clear, light-rum, flat, ruled mica, some in sheets 4 inches square, is fairly plentiful. The other prospect, about 100 yards N.80°W. of the first, also consists of several shallow closely-spaced pits. Mica of good quality, some in rough books measuring 5 by 7 inches, is abundant in the small dump.

P. A. Patterson prospect.—The P. A. Patterson prospect (Pl. 8, No. 30), consisting of a pit 50 feet long and 10 to 12 feet deep, is about a quarter of a mile northwest of the John Patterson mine. A 4- to 6-foot vein of quartz, striking east, is exposed in the pit, but no pegmatite was observed. Small mica of good quality is fairly plentiful in the dump.

Marshall (Winston) mines.—The Marshall mines are on the west side of Road 629 near U. S. Highway 360 and the Southern Railway about 1¼ miles northeast of Amelia (Pl. 8, No. 34).

The workings nearest Road 629 consist of two pits, one 35 feet and the other 50 feet long. The easternmost pit is 10 feet deep to water, the other 10 feet deep to fill. No pegmatite is exposed in either pit, but kaolin in the dump suggests that this was a soft-rock mine. Flat ruled mica of No. 1 quality, some in sheets 4 inches square, is abundant in the dump at the eastern pit, but is less plentiful in that at the western pit. White massive quartz also occurs in the dumps.

Several other old pits have been opened 100 yards north of State Road 629 and about 150 yards west of the above locality. The largest working is circular in outline, 30 feet across, and 15 feet deep; partly kaolinized pegmatite is exposed on the north side. White and smoky quartz and clear, light-rum, ruled mica of small to medium size are abundant in the dumps.

Berry No. 1 mine.—The Berry No. 1 mine is on the southeast side of the Southern Railway three-fourths of a mile northeast of Amelia (Pl. 8, No. 35).

Watson (1907, p. 280, 282) lists this mine as one of the principal mica producers of the early days, but states that in 1906 no work had been done for many years. According to Sterrett (1923, p. 317), the mine in 1912 consisted of ". . . a pit 35 feet across and 15 feet deep to water, with a cribbed shaft 12 feet square in the bottom . . . The pegmatite appears to have an east to an east by south strike." He also reports that the dump contained bluish-green microcline (amazonstone), a small crystal of columbite, and a block of chalcedonic quartz, 15 inches thick, suitable for cutting into a semi-precious stone.

For many years prior to the writer's visit to the place in 1943, the old openings had been filled and the surface graded. A few sheets of mica, apparently of good quality, and small fragments of microcline and quartz were found scattered over the surface.

Berry No. 2 mine.—The Berry No. 2 mine is on the R. P. Penn property, half a mile southeast of U. S. Highway 360, and about a mile northeast of Amelia (Pl. 8, No. 36).

It is reported that Richardson opened the mine about 1910. Old workings consisted of a pit, 45 feet long by 25 feet wide, with two cribbed shafts in the bottom. In 1944, John A. Doelle cleaned out and deepened the western shaft. At a depth of 28 feet below the surface, however, he was forced to abandon the operation because of inability to control wet fill which flowed through the cribbing.

Soft mica-bearing pegmatite formed the floor of the shaft and massive quartz bordered the north wall. The percentage of mica recovery from the pegmatite was relatively high, and some books measured 10 inches across. This mica was pale green, of flat structure, and, in part, bent and cracked.

Berry No. 3 (Penn) prospect.—The Berry No. 3 prospect is on the property of R. P. Penn about 140 feet south of U. S. Highway 360 and 1¼ miles northeast of Amelia (Pl. 8, No. 37).

The old partly filled pit is 23 feet long, 12 feet wide, and 5 feet deep. D. B. Sterrett trenched the sides of the pit, exposing a 1-foot vein of quartz in the east side. Sheets of mica, measuring 5 by 6 inches, and mica "burr" were observed on both sides of this vein and in the dump. The mica is generally flat, clean-splitting, ruled in part, and commonly clay-stained, though free from primary stain.

Will Jones (Corson) prospect.—The Will Jones (Corson) prospect is 1⅛ miles northwest of Amelia and 175 yards south of the junction of Courthouse Branch and Mica Mine Brook (Pl. 8, No. 41). Workings included a shallow U-shaped cut and a pit 12 feet in diameter and 15 feet deep to fill. Two streaks of pegmatite, the largest about 18 inches thick, are exposed in the pit. Clear flat "A" mica in sheets up to 3 inches square were observed in the dump.

Abner Pinchbeck prospect.—The Abner Pinchbeck prospect, consisting of a pit about 20 feet square and 10 feet deep to fill, is half a mile east of Amelia (Pl. 8, No. 44). A 4-foot core of massive quartz marked with impressions of laıge feldspar and mica crystals, is exposed in south wall of the pit; and streaks of kaolinized pegmatite, from 2 to 4 feet wide, are exposed in the north, southeast, and southwest walls. The pegmatite, except for offshoots and stringers, is discordant with the foliation of the enclosing biotite gneiss. Clear greenish rum-colored mica, some in 5- to 8-inch books, is fairly abundant in the pegmatite, but much of it is bent and ruled.

A. B. Wingo mine.—The A. B. Wingo mine is near the southern corporate limits of Amelia about two-tenths of a mile northeast of the intersection of State Highway 38 and Road 614 (Pl. 8, No. 43).

Old workings consisted of an oval pit 50 feet long and a shallow pit 15 feet in diameter. In 1943, the Amelia Minerals Corporation crosscut the east and west ends of the larger pit and sank a shaft to a depth of about 38 feet. The shaft was started on a 4½-foot dike of pegmatite in the east cross-cut about 10 feet east of the pit. At a depth of 20 feet, drifts were run east and west from the shaft. Six feet east of the shaft the pegmatite was found to pinch out and at a point 12 feet west of the shaft old workings were intersected. Water was encountered at a depth of about 22 feet, and from this point downward the miners found it very difficult to retain the soft plastic pegmatite walls.

The pegmatite dike exposed in the working is about vertical and has a strike close to east. It is thoroughly kaolinized and contains a 1½-foot core of quartz on the south side of which large blocks of ruled and bent, pale green mica were found in abundance. Tourmaline inclusions are common in mica of the lower levels. From $500 to $600 worth of sheet mica and several tons of scrap were sold before the shaft was abandoned. Several pounds of beryl were also found during the operation.

Trenching at the shallow pit 135 feet northeast of the larger main pit exposed massive quartz and several feet of pegmatite containing some small mica. This pegmatite strikes N.45°W. and dips 25°SW. A few small beryl crystals were also found at this pit.

Morefield mine.—The Morefield mine, on the S. V. Morefield property about 3½ miles N.70°E. of Amelia (Pl. 8, No. 45), ranks with the Rutherford mines as a producer of rare and unusual minerals. Like these mines, it has produced, not only a great number of specimen minerals, but also many minerals of commercial importance. Among the latter are included mica, feldspar, gem amazonstone, beryl, phenacite, and minerals of the tantalite-columbite series. (See Lemke, Jahns, and Griffitts, 1952, Table 1, p. 127-128).

The mine was opened by S. V. Morefield in 1929; worked by the Seaboard Feldspar Company in the early 1930's; and again by Morefield, although intermittently, until about 1940. Some exploratory work was done at the Morefield mine by the Seaboard and Southern Minerals, Incorporated, in 1941. The next year it was leased to the Minerals Separation Corporation of North America, but remained idle until the United States Bureau of Mines, acting for Metals Reserve Corporation, did exploratory work in 1943. In January 1944, Morefield resumed intermittent operation of the mine. For several months in 1948 the United States Bureau of Mines carried on experimental development and mining on the property.

The mine, when taken over by Metals Reserve Corporation, consisted chiefly of an open pit 230 feet long, from 8 to 60 feet wide, and about 25 feet deep. There were also a filled shaft, about 45 feet deep below ground level, near the west end of the pit and several prospect pits along the strike of the pegmatite body (Pl. 11). To prove the extent of the deposit, the United States Bureau of Mines cross-cut the dike with a bulldozer in five places and put down four diamond drill holes. They also scraped and washed a considerable area of placer material in the creek flat immediately south of the mine.

In 1944, Morefield enlarged the shaft and deepened it to about 60 feet below ground level, and started drifts along the north wall at about the 45-foot level. In 1948, the United States Bureau of Mines further deepened the shaft to 115 feet, enlarged the drifts at the 45-foot level, drove a drift 75 feet southwestward from the shaft at the 100-foot level, and raised to about the 45-foot level from this southwestward drift (Lemke, Jahns, and Griffitts, 1952, p. 128).

Exploratory work by the United States Bureau of Mines showed the pegmatite body at the Morefield mine to have unusual regularity and extent. It was proved at the surface for a distance of over 1,000 feet along the strike, and vertically to a depth greater than 200 feet; its inferred dimensions are considerably greater (Lemke, Jahns, and Griffitts, 1952, Pl. 6). The body varies in thickness from 5-16 feet in the pit to 30 feet in bulldozer trench No. 5, 720 feet west of the pit; drill holes show that it tapers downward. It strikes about N.47°E. and is nearly straight. A plot of diamond drill holes by Lemke, Jahns, and Griffitts (1952, Pl. 6), in which the holes are assumed to be perfectly straight, indicates a very steep northwestward dip only a few degrees from the vertical.

The eastern part of the pegmatite body, for a distance of about 300 feet, is mineralogically complex. Westward the body at the surface becomes relatively simple and is composed chiefly of partly kaolinized albite, buff-colored perthite, small muscovite and biotite, and stringers and masses of glassy quartz. In addition to these minerals, Glass (1935, Table 1) lists the following well-established species from the complex portion of the dike: beryl, cassiterite, columbite, fluorite, galena, manganotantalite, microlite, monazite, phenacite, pyrolusite, spessartite, topaz, tourmaline, triplite, zinnwaldite, and zircon. Additional species identified in more recent investigations include: allanite, almandite-spessartite, apatite, bertrandite, chalcopyrite, pyrite, and rutile (Lemke, Jahns, and Griffitts, 1952, p. 129).

The mineralogy of the complex portion of the pegmatite is similar to that of the Nos. 1 and 2 bodies on the Rutherford property, the chief differences, according to Glass, being in the presence of a considerable quantity of phenacite and in the abundance of large crystals of topaz and zinnwaldite at the Morefield mine. Zonation is irregular but quite distinct. That at the main opening has been described by Glass (1935, p. 744) as follows:

> "The minerals of the Morefield dike show a symmetrical zonal arrangement, with an irregular middle zone of smoky quartz, intergrown on its borders with large crystals of beryl and topaz. The 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, and are probably reaction zones with the country rock."

Recent workings at the mine expose to advantage this zonal arrangement (Fig. 3). Medial quartz is not everywhere present; and locally, amazonstone of the intermediate zone gives way to buff perthitic microcline, into which it is gradational. Both varieties of potash feldspar are older than quartz of the core, since they include veinlets from it. Crystals and masses of topaz, phenacite, and beryl occur with perthite near or within quartz of the core. Morefield reported one topaz crystal 44 inches long weighing 500 pounds (Glass, 1935, p. 758); some small crystals showed double terminations. Phenacite, in colorless to milky white crystals and masses as much as 4 inches long, is commonly difficult to distinguish from topaz. The mineral is considerably higher in beryllium content than beryl and, when sold with beryl, tends to raise appreciably the percentage of beryllium oxide (BeO). Beryl, some in crystals several feet in length, is fairly plentiful in the main mine workings and in the first trench to the west. About 500 pounds of placer beryl was also recovered by the United States Bureau of Mines from the stream flat south of the pit. It is reported that about 7 tons of beryl were sold from the mine prior to 1944.

Cleavelandite albite appears to have been generally or everywhere of late origin in that it fills crevices in or replaces the more common minerals with which it is associated. Numerous less common minerals, including yellow beryl, calcite, cassiterite, manganotantalite, microlite, monazite, tantalite-columbite, and zircon, are closely associated with and occur within interspaces between cleavelandite plates. (See Glass, 1935, Table 6). Tantalite-columbite also occurs, but in lesser quantities, in buff perthite. Lemke, Jahns, and Griffitts (1952, Table 1) report a production between the years 1929 and 1944 of 1,423 pounds of this mineral, valued at $1,542.75.

Book muscovite, locally in crystals 10 to 12 inches across and 3 to 7 inches thick, occurs mainly in the inner part of the albite-quartz-perthite-mica wall zones and is most abundant in that on the northwest side. It is generally light rum-colored, clear, and flat; some has a tendency to be "gummy", or not split cleanly. During the period 1943-1944, approximately 7 tons of scrap mica, valued at $90.00 and 630 pounds of trimmed punch and sheet mica, valued at $3,775.00, were sold from the mine (Lemke, Jahns, and Griffitts, 1952, Table 1).

Wallrock is mostly dark gray biotite-hornblende gneiss. Its foliation, which dips in various directions at from 10° to 45°, is sharply transected by the main pegmatite body; numerous apophyses, however, are concordant. In many places, foliation on both sides of the dike is toward the dike (Pl. 11). This suggests injection at these places of pegmatite material from above; also that the present body is only the lower portion of a formerly much larger body.

Dobbin (Thraves) prospect.—The Dobbin (Thraves) prospect is on the southwest side of Road 628, about three-fourths of a mile south of the Morefield mine, and 3¾ miles east of Amelia (Pl. 8, No. 48). It consists of an old irregular shallow pit 45 feet long, and a 12-foot cross-trench. Massive quartz from 3 to 7 feet thick, bordered by a foot or two of partly kaolinized pegmatite, is exposed in the pit, and heavy quartz float can be traced on the surface for about 200 feet to the west. The dike strikes N.70°E., dips about 65°NW., and cuts the foliation of the enclosing gneiss discordantly. Pale greenish-blue beryl crystals as much as 1½ inches thick and 7 inches long occur fairly plentifully in massive quartz. Mica, in broken books as much as 4 inches across, occurs adjacent to the quartz core on its footwall side. It is clear and rum-colored, but generally is too badly cracked to yield sheets.

Beryl crystals, measuring 4 by 7 inches, have been found back of the H. T. Flippen farmhouse two-tenths of a mile west of the Dobbin prospect (Pl. 8, No. 47). Beryl has been reported also from the "Hog Lot" prospect on the southern part of the S. V. Morefield property about 500 yards north of the Dobbin prospect (Pl. 8, No. 46).

Vaughan mine.—The Vaughan mine is on the property of Waverley Vaughan west of Road 627, a quarter of a mile south of Smacks Creek, and 2½ miles S.78°E. of Amelia (Pl. 8, No. 51). In 1941, at the site of old workings, W. W. Howe of Seaboard and Southern Minerals, Incorporated, opened a pit 85 feet long, 20 feet wide, and 12 feet deep and sank a shaft to a depth of 25 feet in the bottom. In 1944, the mine was leased by R. E. Kemerer, who extended short tunnels from the south side of the pit and started an incline on this side about 50 feet east of the shaft. In April 1944, this incline, all in pegmatite, pitched 25 degrees S.54°W., and was 35 feet long.

A dike of kaolinized pegmatite, striking N.75°E., and dipping 80°SE., was exposed in the shaft. It was approximately 15 feet thick and contained a 2 to 5-foot core of quartz; eastward in the vicinity of the incline it appeared to widen to 25 or 30 feet.

Rum-colored clear mica in books as much as 8 to 10 inches across was fairly abundant, especially on the hanging-wall side of the quartz, but so much of it was ruled and bent that the yield of sheet sizes was small. Biotite and black tourmaline were commonly associated with the muscovite mica.

Winfree prospect.—The Winfree prospect is a quarter of a mile west of Road 627, 0.9 mile south of the Vaughan mine, and 3 miles east-southeast of Amelia (Pl. 8, No. 53). About 2 feet of kaolinized pegmatite with a 1-foot quartz core is exposed in the southwest end of an old pit 20 feet long by 15 feet deep. Black-stained mica in ruled and cracked books from 2 to 4 inches across is scattered about the pit.

DeKraft prospect.—The DeKraft prospect is near the abandoned county poor farm on the south side of Road 603 and 3.3 miles south of Amelia (Pl. 8, No. 56). The workings made by Seaboard and Southern Minerals, Incorporated, in 1942 consist of a small irregular pit 18 feet deep, a shallow cross-cutting trench, and a shaft 15 feet deep. The dike exposed at the surface is from 8 to 10 feet thick, is thoroughly kaolinized, and strikes generally east. In the shaft, which is about 50 feet east of the pit, it splits into two branches; one extending north and the other south, possibly along a joint plane. Clear light-green mica, in small books, is abundant; but, because most of it is ruled and bent, the recovery of sheet and punch mica has been small.

Mottley mine.—This mine is on the R. W. Mottley property about one-eighth of a mile east of an abrupt bend in Road 603 and 3 miles south of Amelia (Pl. 8, No. 54). The earliest recorded work at this place was by Abner Pinchbeck, who in 1938 opened a shallow pit 27 feet long by 15 feet wide. In 1943, R. E. Kemerer of the Amelia-Mottley Syndicate began sinking a shaft 75 feet northeast of this pit but abandoned it at a depth of 44 feet when the untimbered walls began to cave. Early the next year a new shaft was started 50 feet west of the pit but it was abandoned at a depth of 14 feet.

Massive quartz and kaolinized pegmatite were exposed in all of the openings. The dike strikes about N.62°E. and dips 70°-80°NW. Its complete thickness was not determined because only one wall was exposed, but it is in excess of 12 feet. Lit-par-lit injection was well displayed along the south wall of the eastern shaft.

Clear light rum-colored mica of medium size was plentiful near the quartz core and along the south wall, but most of it was ruled, cracked, and bent. The operation was abandoned because of mining difficulties and the low yield of sheet mica.

Golden prospect.—The Golden prospect is on the W. C. Golden property half a mile southwest of the Mottley mine and 700 feet northeast of Butler Creek (Pl. 8, No. 55). Prospecting in June 1944 included two small pits 4 feet deep and about 50 feet apart. Pegmatite in a nearly vertical dike 4½ feet wide is exposed in the eastern pit and can be traced for about 100 feet further east by float mica. The main dike is discordant to the foliation of enclosing mica schist, but numerous apophyses intrude the schist concordantly. The pegmatite is dominantly a mixture of coarse quartz, cream-colored perthite, and muscovite. Clear, light rum-colored mica in books up to 6 or 7 inches across is plentiful but is commonly ruled and bent. Some was cut and sold in 1944.

Ponton prospect.—The Ponton prospect is about 60 yards southwest of the store at Ponton and about 5 miles by road south of Amelia (Pl. 8, No. 57). This prospect, consisting of a pit 40 feet long, 15 feet wide, and 15 feet deep, was worked for two short periods between 1925 and 1932. It is reported that these operations were abandoned because of a lack of pumping equipment.

The pit was opened in largely kaolinized pegmatite on the north side of a large core of massive quartz striking N.65°W. and dipping about 80°SW. A plagioclase-rich wall zone about 2 feet thick and an intermediate zone containing blocky perthite, 3 feet thick, are evident in the pegmatite. Books of clear, ruled, flat, rum-colored mica as much as 5 inches in diameter occur fairly plentifully with kaolinized plagioclase of the intermediate zone near the quartz core. Exploration on the south side of the quartz might reveal similar mica-bearing pegmatite.

Venable prospect.—The Venable prospect is 60 feet north of Road 608, half a mile east of the Ponton prospect, and 4.7 miles south of Amelia (Pl. 8, No. 58). A vertical dike of pegmatite 3 feet thick and striking about N.65°E., is exposed in a small pit 10 feet deep. Clear, flat, ruled and bent mica in books as much as 7 inches across are plentiful in the central part of the dike and near a 10-inch quartz core segment. Quartz and mica are also abundant on the surface, particularly in vicinity of the state road, for as much as 385 feet west of the pit. It appears that further exploration at this place would be warranted.

Mays prospect.—The Mays prospect, consisting of a circular pit 20 feet across and 12 feet deep to fill, is on the George Mays property about 150 yards south of the Venable prospect (Pl. 8, No. 59). A dike of kaolinized pegmatite, 8 feet thick, striking about east, and nearly vertical, is exposed in the east side of the pit. It cuts discordantly the migmatic biotite gneiss wall rock, the foliation of which strikes N.40°E. and dips 25°SE. Clear ruby-colored, flat mica in books as much as 8 inches across is sparsely distributed near a small quartz core segment. Some is ruled and bent. Accessory tourmaline and biotite occur.

David Anderson prospect.—The David Anderson prospect is 1.7 miles S.52°E. of Ponton Store and 6 miles south of Amelia (Pl. 8, No. 60). In 1943, Sterrett sank a shallow shaft at a place where abundant small clear mica had been discovered in a posthole, but the project was abandoned when it was found that the mica became less abundant downward.

Munden prospect.—This prospect is on the S. C. Munden property about four-tenths of a mile northeast of the intersection of Roads 614 and 615 and 6 miles south of Amelia (Pl. 8, No. 61). Two small openings 150 feet apart were opened at this place about 1920. The easternmost and largest working, now largely filled, is said to have been a shaft 25 to 35 feet deep. Kaolin, microcline, mica, and small pieces of quartz occur on the dump. The mica, some of which measures 4 by 2½ inches, is white to light rum-colored, clear, and generally flat. Some is crinkled and ruled.

Ligon mines.—The four Ligon pit mines are on the west side of Road 651 about 2½ miles southeast of Giles Mill and 9 miles N. 16°E. of Amelia. Abner Pinchbeck is said to have worked the mines about 1923; some work was done by W. W. Howe of Seaboard and Southern Minerals, Inc., during 1941-42; and the No. 2 mine was worked by D. B. Sterrett and Joel Watkins in 1944. The mines, at least in Colonial Mica Corporation designation, are numbered from south to north, the southernmost being No. 1 and the northernmost being No. 4 (Pl. 8, Nos. 1, 2, 3, 4).

The No. 1 mine is on a gently sloping hillside about 630 feet S. 29°W. of the Ligon farmhouse. The pit, when abandoned by Seaboard and Southern Minerals, Inc., in 1943, was 40 feet long, 20 feet wide, and 15 feet deep and was in water. An irregularly branching body of kaolinized pegmatite, with a maximum width of about 15 feet, was exposed in the south, east, and west walls. Clear, flat mica in books measuring as much as 5 by 8 inches was fairly plentiful but much of it was soft, clay-stained, and badly ruled.

The No. 2 mine is on the northeast side of a creek 370 feet S.29°W. of the Ligon farmhouse. It was reopened by Sterrett and Watkins in the summer of 1944 but was abandoned in November of this year, not because of depletion of the deposit, but because of uncertain conditions in the mica market. Workings when abandoned consisted of a roughly circular pit 27 feet across and 40 feet deep, with short drifts to the north and west from the bottom. The pegmatite body has a maximum thickness of about 25 feet and is highly irregular but generally chimney-like in shape, with numerous apophyses extending into the enclosing tourmalinized schist and gneiss wall rocks. Large quartz core segments, one 18 feet across, and coarse blocky perthite in crystals as much as 4 feet long comprise most of that part of the body exposed in the central and southwestern parts of the pit; plagioclase, quartz, and muscovite make up most of that in the northern part of the pit. This zonation suggests an extension of the body to the southwest. Flat, greenish, rum-colored mica, much of it ruled and bent, was recovered from various parts of the plagioclase pegmatite and was most abundant in one of the northern apophyses. Broken books as much as 3 feet across were encountered.

No. 3 pit, 35 feet long, 18 feet wide, and 8 feet deep to water, is about 100 yards north of the Ligon farmhouse. Small bodies of kaolinized pegmatite are exposed in the south, west and north sides of the pit, and mica and quartz can be traced on the surface 75 feet north of the pit. Small clear mica is fairly abundant along a narrow quartz core exposed in the south wall of the pit; small, pale green beryl crystals occur sparingly in the quartz. Blocky perthite, probably from an intermediate zone, is present in the dump.

No. 4 pit is on the east side of a small stream about 400 yards northwest of the No. 3. This pit, about 40 feet long, 15 feet wide, and 18 feet deep, is on a nearly vertical pegmatite dike that strikes in an easterly direction. At the surface the dike is 4 feet wide, but near the bottom of the pit it has pinched to only a thin streak. Clear light rum-colored mica of small to medium size is fairly plentiful near the lower extremity of the pegmatite.

J. D. Lawrence prospect.—The J. D. Lawrence prospect is 25 yards south of Road 635, 1⅜ miles south of the Ligon property, and 7½ miles north-northeast of Amelia (Pl. 8, No. 5). It was first opened about 1935 and was reopened by the Seaboard and Southern Minerals, Incorporated, in 1942. A nearly vertical, largely kaolinized pegmatite dike, about 15 feet wide and with N.80°E. strike, is exposed in an incline 16 feet deep. Small, clear, pale green mica, of flat and flat "A" structure, is fairly abundant near a 4-6 foot thick quartz core.

Keystone mine.—The Keystone mine is about half a mile west of Road 639, 4½ miles west of Amelia, and 3.2 miles by road north of U. S.

Highway 360 (Pl. 8, No. 64). It was called the "Keystone Mica Company mine" by Sterrett (1923, p. 317), who states that it was worked first in 1907 and again in 1914, after a period of idleness. Farley, who is reported to have first opened the mine, states that it was later reopened and worked about 1926 by the Keystone Mica and Monazite Company. In August 1943, E. J. Tyler of Asheville, North Carolina cleaned out the old workings but abandoned the operation when little mica or pegmatite were found.

Workings consist of a shaft 48 feet deep and a short eastward drift from the bottom. The pegmatite body, which was probably chimney-like, appears to have been completely worked out except for a portion 4 to 5 feet wide along the northeast wall and several irregular tapering stringers in the face of the drift. The visible pegmatite is fresh and hard and includes a very irregular core of light-gray quartz. Small- to medium-size books of smoky rum-colored, clear, flat "A", mica are abundant adjacent to the quartz. The dark-gray biotite-gneiss wall rock strikes N.20°W. and dips 70°NE.

A few feet of pegmatite is exposed in an old shallow prospect pit about 115 feet southeast of the shaft, but it contains little mica. Prospecting has been done also at a locality about a quarter of a mile northwest of the Keystone mine and at several places within a distance of a mile southwest of the mine. The mica found in most of these prospects is small and stained.

Schlegal (Norfleet) mine.—The Schlegal (Norfleet) mine is on the K. P. Norfleet property 100 yards northeast of Road 658, about 1 mile west of Jetersville, and 1.1 miles by road north of U. S. Highway 360 (Pl. 8, No. 63). Watson (1907, p. 283) states that it was opened about 1882 and last worked about 1901. There is no record of more recent operation. Sterrett (1923, p. 318) reports that the workings consisted of two shafts and an open pit 18 feet deep and 60 feet long. According to Watson, one shaft was worked to a depth of 100 feet and had several drifts run from it.

The geology of the deposit is described by Watson (1907, p. 283) as follows: "The country rock comprises a gneiss of granite composition and a sheared, thinly schistose diorite. As measured at the top of the open work, the pegmatite dike containing the mica will not exceed 30 feet in width. The openings are apparently made in a curved or bent portion of the dike the two parts of which strike N.70°W. and S.20°W. The pegmatite cuts across the foliation of the country rock which at the openings strikes nearly north and south."

Watson also states that quartz, feldspar, and mica were marketed from the mine; and that a mill for grinding and crushing feldspar for use in pottery was operated at the mine. The mica, some of which yielded 8 by 12 inch trimmed sheets, was dark amber colored.

In 1943, all workings were largely filled with water and/or debris. A mass of coarse pegmatite 8 feet thick, consisting chiefly of quartz and hard pale pink perthite, was exposed on the west side of a cribbed shaft in the bottom of the pit. Mica in the dump is of good quality but is not abundant. The deposit may still contain commercial quantities of feldspar.

Houston prospect.—The Houston prospect is on the W. Z. Nester property about 2 miles east of Jetersville (Pl. 8, No. 62). Old workings consist of a shaft now filled with water and a pit 15 feet long and 8 feet deep. A vertical pegmatite dike, 6 feet thick and striking N.10°-20°E., is exposed in the north end of the pit. No mica of commercial size was seen in the pegmatite or in the dump.

James Anderson prospect.—The James Anderson prospect is 1.1 miles by road northwest of Rodophil and 6½ miles northwest of Jetersville (Pl. 8, No. 70). In 1942, Seaboard and Southern Minerals, Incorporated, dug a pit here 60 feet long, 23 feet wide, and 12 feet deep on an easterly striking body of pegmatite. This body is about 23 feet thick in the west end of the pit but thins to the east. It is composed chiefly of coarse, cream-colored perthitic microcline, kaolin, dark smoky-gray to light-gray quartz, and muscovite. Pale, bluish-green, translucent beryl in irregular masses and crystals measuring as much as 7 by 6 by 5 inches are common. Green mica in "A" and flat crystals up to 7 by 8 inches across are fairly plentiful near quartz bodies, but much of this is lightly stained and specked.

Ford and Lambert prospects.—Two small pits have been dug on the Ford property, about half a mile northeast of the James Anderson property, and one small pit opened on the Lambert property, about three-fourths of a mile north of the Ford prospect (Pl. 8, Nos. 71, 72). Pink potash feldspar, massive quartz, and some mica occur in the small dumps at the Ford prospects. Both flat and "A" mica are present, but most of the sheets, some measuring 7 by 4 inches, are lightly to heavily stained. The small Lambert pit, located along a body of massive quartz, contains abundant small stained mica.

Foster prospect.—The Foster prospect is about a quarter of a mile northeast of the Ford prospect and 1¼ miles north of Rodophil (Pl. 8, No. 73). About 300 yards S.80°W. of the Foster farmhouse, at a place said to have been prospected before World War I and again about 1940, two small pits, 3 and 8 feet deep, have been opened beside a nearly vertical quartz mass. This mass, 5 feet thick and striking N.70°E., is bordered by a foot or so of perthite-rich pegmatite containing plentiful flat and "A" books of mica. The "A" books are mostly clear and some measure 5 to 7 inches across; most of the flat books are black stained.

G. C. Wingo prospects.—Several small prospects have been opened on the G. C. Wingo property 1¼ miles southeast of Paineville and about 6 miles north of Jetersville (Pl. 8, No. 69). The largest pit, 40 feet long and 5 feet deep to fill, about 150 yards S.70°E. of the farmhouse, contains gray glassy quartz and mica of subsheet size. A smaller pit on a highly quartzose pegmatite dike about 280 yards southwest of the large pit contains small, clear, tangle-sheet mica in some abundance.

Buddy Jones and Eggleston prospects.—The Buddy Jones and Eggleston prospects are on opposite sides of Road 642, north of Little Creek, and 4 miles by road north of Jetersville (Pl. 8, Nos. 67, 68). The Jones pit, 30 feet long and 5 feet deep to fill, on the west side of Road 642, is on a mass of pegmatite at least 20 feet wide, composed chiefly of coarse potash feldspar with lesser amounts of soda feldspar, bluish-gray quartz, and pale-green mica. The mica is clear, but generally small and of poor structure.

The Eggleston workings on the east side of the road, consisting of a circular pit and a shallow pit elongated in a northeasterly direction, are slumped and overgrown. Small clear and specked mica occur sparingly in the dumps.

POWHATAN AREA

GENERAL STATEMENT

The mica deposits of greatest commerical importance in Powhatan County occur within an area, about 3 miles long by half a mile wide, which extends from just north of Flat Rock northeastward to the vicinity of a tributary to Dutoy Creek (Fig. 4). Prospects for mica have also been opened in vicinity of James River several miles north of this area. To the writer's knowledge, no feldspar has been produced in commercial quantity in Powhatan County.

The Powhatan area is similar to the Amelia area with respect to geology, topography, and weathering. The most widespread country rock is a dark-gray migmatic biotite gneiss, similar in appearance and composition to that in the Amelia area. This is commonly weathered to a deep-red, banded, micaceous clay. Large bodies of pegmatite generally have the form of relatively short thick lenses that cut across the foliation of the enclosing rocks. Most bodies consist chiefly of plagioclase-quartz-muscovite pegmatite which forms wall zones about thin discontinuous perthite-rich intermediate zones and large cores or core segments of massive quartz. In most deposits, the plagioclase has been kaolinized to the depth of working. One complex pegmatite, that at the Herbb No. 2 mine, is very similar in its major mineralogic features to those at the famous Rutherford and Morefield mines in the Amelia area. Mica is abundant in certain of the deposits and some rather large crystals have been recovered. It is generally clear, rum-colored, and of flat structure; but ruling and cracking are common defects in mica from shallow workings.

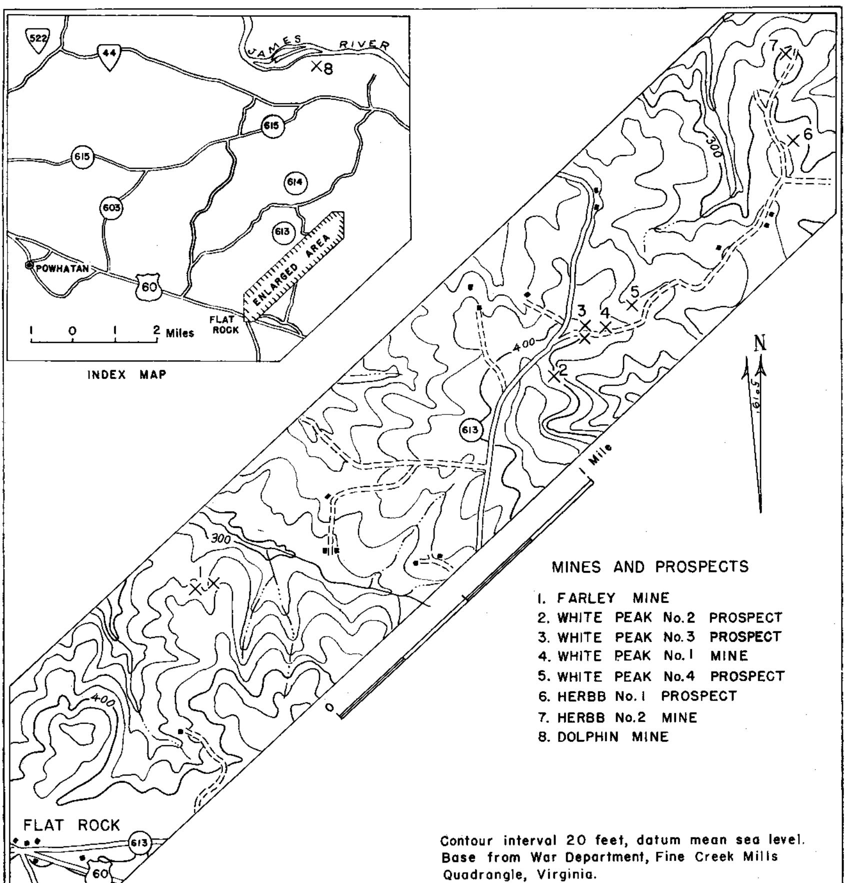


Figure 4. Location of mines and prospects in the Powhatan area.

WHITE PEAK MINES AND PROSPECTS

The White Peak workings, consisting of one mine and three prospects, are on the James M. Purcell property, formerly the Judge T. M. Miller property, on the east side of Road 613 about 2.8 miles by road north of U. S. Highway 60 and 7 miles east of Powhatan (Fig. 4, Nos. 2, 3, 4, 5). The deposits on this property were worked first by Wells and Miller of Richmond about 1895, then by J. G. Strader in 1905, and next by Atkinson about 20 years later. In 1942, one of the deposits was prospected by W. W. Howe of Seaboard and Southern Minerals, Incorporated, of Chula, Virginia, and New York. During the winter and spring of 1944, the Virginia Manganese Corporation of Richmond operated the No. 1 mine and prospected the other deposits. From July until September 1944, the No. 1 mine was worked by Jacob Van Doren of Richmond.

White Peak No. 1 mine.—The White Peak No. 1 mine is about 250 yards east of Road 613 and 2¼ miles N.48°E. of Flat Rock (Fig. 4, No. 4; and Pl. 12). The earliest workings consisted of a small pit about 8 feet deep and a shaft 18 feet or more in depth. In 1944, the Virginia Manganese Corporation began their operation by deepening this initial pit to 17 feet and lengthening it to 25 feet to include the old shaft. They then excavated westward by tunnel and opencut for a distance of 95 feet along the south wall of the dike and drove two tunnels to the north wall from the bottom of the initial pit. They also cross-cut the dike in three places with backhoe power shovel. The place of deepest work by this corporation was about 50 feet west of the initial pit, where the dike was opencut to a depth of 36 feet. Water was encountered at a depth of about 33 feet, and below this level work was discouraged by the plastic condition of the pegmatite.

When Van Doren took over the operation, he enlarged the cut along the south side of the dike and opened a new cut along the north side. The next work included a tunnel along the north wall of the dike at the 15-foot level northwest of the initial pit, a 20-foot shaft (extending 53 feet below ground level) from the bottom of the south cut at a place about 70 feet west of this pit, and two drifts, one extending 42 feet westward and the other 12 feet eastward from the bottom of this shaft (Pl. 12). Mica was very plentiful in these underground workings.

The workings show the pegmatite body to be an asymmetrical nearly vertical lens, with an average strike of N.85°E., an over-all length of at least 220 feet, and a maximum width of about 30 feet. The fact that the pegmatite in an exploratory shaft near the eastern end of the body pinches out at a depth of 19 feet but is persistant to a depth of at least 53 feet in workings near the central part of the dike suggests that the body plunges westward.

The main body of pegmatite is discordant to the foliation of the enclosing migmatized biotite gneiss, although numerous stringers and offshoots penetrate along the folia. The strike of this gneiss varies from northeast to northwest, and the dip, which is generally to the south, varies from about 12 to 45 degrees.

The pegmatite includes a large irregular core of light-gray, massive quartz having a maximum thickness of 12 feet, that extends throughout the length of the dike. Partly kaolinized perthite with inclusions of biotite occurs in places within and adjacent to the quartz. The remainder of the body consists predominantly of wall zone kaolin (from plagioclase), muscovite, and small quartz. Feldspar generally becomes coarser from the walls inward, and some crystals, near quartz are from 4 to 6 feet long. Graphic granite is common in the inner parts of the body.

Mica has been recovered chiefly from the outer part of the wall zones. The richest shoot, also the first worked, was from 1 to 4 feet thick and extended from the surface near the southeastern edge of the dike westward along the south wall for about 65 feet, where it appeared to join a rich vertical shoot which extended downward to a depth of at least 53 feet. Another shoot, 2 to 10 feet thick and of undetermined vertical extent, was found along the north wall in the eastern part of the dike. Block mica was very abundant in the thickest part of this shoot.

Some of the mica recovered from this mine has been large. One block, 4½ feet long, 2½ feet wide, and from 6 to 12 inches thick, weighing about 900 pounds, was found near the south wall, 12 feet west of the No. 1 trench, and 10 feet below the surface.

Mica from this deposit is dark amber-, or rum-colored, of flat structure, and free from primary stain. Much of it is rather badly ruled and cracked, but these defects are counter-balanced, in part, by the size and abundance of the mica.

White Peak No. 2 prospect.—The White Peak No. 2 prospect is on a gently sloping hillside about a quarter of a mile S.55°W. of the No. 1 mine (Fig. 4, No. 2; and Pl. 12). Five small holes less than 15 feet deep, spaced along a pegmatite dike within a distance of 130 feet, were dug at this place during one of the earlier periods of exploration. In 1944, the Virginia Manganese Corporation cross-cut the dike in 4 places with power shovel, then deepened one of the central cuts to 19 feet and ran several short drifts from the bottom.

The pegmatite strikes N.67°E., dips about 75°NW., is over 150 feet long, and has a maximum exposed thickness of 16 feet and an average thickness of about 11 feet. It is generally discordant with the foliation of the enclosing mica gneiss which strikes about N.60°E., and dips 30°-35°SE.

Although most of the feldspar has been kaolinized to the depth of working, the original texture of the pegmatite appears to have been very coarse. Central irregular masses of quartz and recognizable perthite, about which flat dark rum-colored mica is locally fairly abundant, occur here and there. Although little mica was recovered during the last operation, it is thought that workable shoots may yet be found.

White Peak No. 3 prospect.—The White Peak No. 3 prospect (Miller mine of Pegau, 1932, p. 60) is about 150 yards west of the White Peak No. 1 mine and 100 yards east of Road 613 (Fig. 4, No. 3; and Pl. 12). In 1944, the Virginia Manganese Corporation cut seven trenches at this place with the purpose of exploring and delineating a deeply kaolinized pegmatite dike which had been partly exposed in several old shallow pits.

Trenching showed the dike to be shaped somewhat like a spoon viewed from the side, with the bowl, which is to the north, having a maximum thickness of about 40 feet, and the handle an average thickness of about 10 feet. The total length of the dike is not known, but old workings show it to be over 350 feet. The dike bends from a strike of N.10°W. and a steep southwest dip in its northern part to a strike of from N.2°W. to N.13°E. and a nearly vertical dip in its southern part. It is everywhere discordant to the foliation of the mica gneiss wall rock.

The widest part of the dike contains a core of massive quartz, about 11 feet thick, which is intergrown on the borders with crystals of muscovite and biotite. The occurrence of biotite, some in crystals 5 inches across and 9 inches thick, is a prominent feature of the pegmatite throughout its length. Block muscovite mica similar to that at the White Peak No. 1 mine also occurs in many places along the west wall of the dike.

White Peak No. 4 prospect.—The White Peak No. 4 prospect is about 560 feet N.26°E. of the White Peak No. 1 mine (Fig. 4, No. 5; and Pl. 12). In 1944, the Virginia Manganese Corporation cleaned out a small pit from 10 to 15 feet deep which had been dug at this place many years before, and dug two cross-cutting trenches. A dike 10 feet thick, striking N.63°E. and dipping 67°-79°NW., was exposed in the pit but was not encountered in a trench about 100 feet to the northeast. It is only a few feet thick in a trench 45 feet southwest of the pit. Clear, rum-colored mica of medium size is fairly abundant in the pit but much of it is ruled and cracked.

HERBB MINES

Herbb No. 1 mine.—In 1944, the Herbb No. 1 mine, 3½ miles northeast of Flat Rock and 0.7 mile northeast of the White Peak No. 1 mine (Fig. 4, No. 6) was explored by Carl Fleming of Colonial Homes, Inc., of Richmond. Five deep trenches and a pit 100 feet long, 50 feet wide, and 17 feet deep were opened near several old shallow pits. Three deeply kaolinized lenticular dikes of pegmatite, striking northeastward and varying in thickness from about 2 to 12 feet, were exposed in the workings. Clear, light rum-colored mica of flat structure, some in sheets 10 inches across, was abundant in the old dumps; but only a small quantity was found in the new openings.

Herbb No. 2 mine.—The pegmatite deposit at the Herbb No. 2 mine, one-eighth mile N.14°E. of the Herbb No. 1 (Fig. 4, No. 7), was explored and briefly worked in 1944 by Carl Fleming of Colonial Homes, Inc., of Richmond. Trenches across and along the body were cut; and a pit, 130 feet long, 40 feet wide, and 15 feet deep, was opened near old prospect pits.

The pegmatite body strikes N.20°E., dips steeply eastward, and is from 5 to 40 feet thick and at least 240 feet long (Pl. 13). It is generally discordant with the foliation of the enclosing feldspathic biotite gneiss and schist except near the northern limits of its exposure, where it is approximately concordant. Also near its north end, the walls converge beneath the pegmatite in a manner which suggests that here the keel of the body is shallow and that, therefore, plunge is to the south.

In prevailing mineralogy, this pegmatite is very similar to the famous Rutherford and Morefield pegmatites near Amelia. The large numbers and varieties of minerals recovered from these Amelia bodies have not been found; but as yet this body is incompletely explored and possibly it has been more deeply eroded. Irregular core segments of massive quartz as much as 5 feet thick are prominent throughout most of the central part of the body. These are bordered by intermediate zones rich in blue-green and buff to pink perthite locally containing large beryl crystals. Kaolinized wall-zone pegmatite which appears to have been rich in plagioclase is present in thicknesses of a foot or so in a few places. Much wall-zone pegmatite, as well as large parts of the intermediate zones, have been replaced by sugary-textured and platy cleavelandite albite, locally containing scattered crystals of tantalite-columbite. Muscovite and weathered spessartite garnets also occur in cleavelandite near quartz and perthite masses. Euhedral crystals of biotite occur here and there.

Muscovite is neither abundant nor of particularly good quality. It is generally clear, yellowish-green to rum-colored, of flat A structure, and commonly soft, bent, and broken. Fleming recovered about half a ton of beryl, including several large crystals, from near massive quartz in the central part of the main pit. One broken crystal was about 5 feet long and 27 inches thick. A part of another, presently on display in the Division of Mineral Resources Building at Charlottesville, measures 14 by 17 by 20 inches and weighs about 300 pounds (Pl. 4A). Feldspar has not been produced from the mine but potash spar may be present in commercial quantity.

OTHER MINES AND PROSPECTS

Farley mine.—The Farley mine is on a small ridge 1½ miles S.60°W. of the White Peak No. 1 mine and 0.9 mile N.33°E. of Flat Rock (Fig. 4, No. 1). In 1944, old workings, which consisted of about a dozen pits and trenches arranged in broad V-pattern, one side of the V being 130 feet long and extending N.25°W., the other 110 feet long and extending N.35°E., were caved and partly filled with debris. It is reported that one of the larger pits originally opened into a shaft about 140 feet deep. A northwesterly-trending core of massive quartz 4 to 5 feet thick is exposed in the largest pit and in smaller pits as much as 100 feet to the southeast. Clear, flat, ruled, rum-colored mica of medium size is rather abundant in the large dumps. Massive quartz, biotite, plagioclase feldspar, and clear, ruled, muscovite mica also occur in the dumps adjacent to several prospect pits 160 feet northeast of the largest pit.

Dolphin mine.—The Dolphin mine is on the Clinton Dolphin property 0.7 mile south of James River and 1.7 miles N.68°E. of Fine Creek Miles (Fig. 4, No. 8). The workings, when examined in December 1944, consisted of two pits about 15 feet long by 20 feet deep, 18 feet apart, and a 25-foot inclined tunnel which extended N.5°E. from the southern pit to a point slightly under the floor of the northern pit.

An irregular pegmatite dike, striking about N.12°E. and from 2½ to 5 feet thick, is exposed in both pits and the tunnel. In the northern pit it is nearly vertical, whereas in the southern pit it dips about 45°S.E. The pegmatite is highly quartzose and contains both plagioclase and microcline feldspar and massive quartz. Much of the microcline is fresh, whereas most of the plagioclase is kaolinized to the depth of working. Small mica is abundant throughout the pegmatite and book mica is plentiful along the west wall and along what appears to be the keel of the dike exposed in the tunnel. Books as much as 2 feet across occur but are commonly so ruled and broken and marred by clay staining that trimmed sheets no larger than 3 by 4 inches are recovered. The mica is generally clear, rum-colored, and of flat structure. A small quantity of strategic sheet was sold in 1944.

GOOCHLAND AREA

GENERAL STATEMENT

The Goochland area (Fig. 5) includes a belt about six miles wide and seven miles long, extending northeastward from James River across the narrow waist of Goochland County into the southeastern and southwestern corners of Louisa and Hanover counties, respectively. The largest settlement is Goochland Court House. Paved highways Numbers 250, 6, and 522 cross the area and, along its southern border, it is served by the Chesapeake and Ohio Railway.

In the northeastern and central parts of the Goochland area the land surface is gently rolling; in the southwestern part, where streams have cut more deeply into the upland surface as they approach the somewhat entrenched James River, the topography is more rugged. Altitudes vary from less than 150 feet at James River to slightly over 350 feet at Perkinsville and average about 300 feet. The larger streams in the area, chief of which are Beaverdam and Court House creeks, drain in a southernly direction to James River.

Weathering throughout most of the area has been deep. Plagioclase in pegmatites has been kaolinized to depths of from 20 to 50 feet or more; fresh microcline, on the other hand, is found near the surface. The water table in divide areas generally lies at a depth of from 30 to 40 feet.

Feldspathic biotite gneiss similar to that in the Amelia area is the predominant rock type. According to Pegau (1932, p. 62) this is of quartz monzonitic composition; Carl Brown (1937, Pl. 2), on the other hand, calls the prevailing rock type "Wissahickon biotite gneiss injected by granite and pegmatite". The northeastern part of the pegmatite-bearing district is within area mapped by Brown as State Farm biotite-oligoclase gneiss of igneous origin. Both the State Farm and the so-called "Wissahickon" gneisses appear to be intruded by hornblende gneiss, metapyroxenite, and metaperidotite (Pegau, 1932, p. 62; Brown, 1937, p. 15).

Pegmatites are generally smaller and less abundant than in the Amelia area. According to Pegau (1932, p. 62) they range from a few inches to 10 feet in thickness, and generally strike about N.40°W. across the foliation of the enclosing rocks. Most have been deeply kaolinized and were, thus, probably originally composed chiefly of plagioclase feldspar.

PRINCIPAL MINES AND PROSPECTS

A total of about 12 mines and prospects have been worked for mica in this area. No feldspar has been produced. The first mines were opened about 1880, but the greatest activity took place during and immediately following World War I. Only the Amber Queen and Monteiro mines were opened during the World War II period of activity.

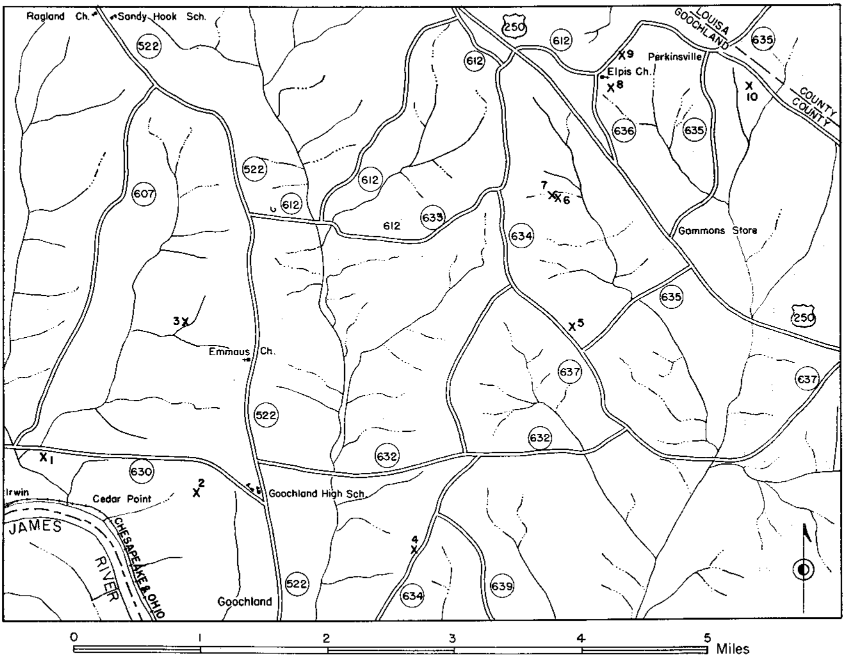


Figure 5. Location of mines and prospects in the Goochland area.

Mines and Prospects

1. Irwin mine
2. Reed prospect
3. Salter prospect
4. Bradshaw prospect
5. Turner prospect
6. Amber Queen mine
7. Monteiro mine
8. Owen prospect
9. Owen prospect
10. Nicholas prospect

Amber Queen mine.—The Amber Queen mine is half a mile southwest of U. S. Highway 250 and 3.8 miles N.36°E. of Goochland (Fig. 5, No. 6). The mine property, which consists of one acre out of the old Monteiro tract, was owned in 1943-44 by W. H. Thomas of Micaville, North Carolina, and R. M. McCormick of Fishersville, Virginia.

The mine is said to have been opened by G. W. Wiltchane about 1880. Between 1916 and 1918 it was worked briefly by E. M. Gathright of Goochland; then by J. E. Burleson of Spruce Pine, North Carolina; and, after a period of inactivity, again by Gathright. No further work was done until about 1941, when W. H. Thomas cleaned out and retimbered Gathright's old shaft to a depth of 30 feet. After another period of idleness, the mine was opened again by Thomas in December 1943, and operated for about four months. In 1944 only the most recent openings were accessible.

Gathright's first work is said to have consisted of a shallow pit, possibly 100 feet across, and several shallow exploratory shafts. When Burleson took over the mine, he drove an incline to the west, probably from the northernmost cone-like pit (see Pl. 14), and opened a fairly large stope on a rich pocket of mica 15 to 20 feet below the surface. The walls of this stope were unsupported and soon collapsed. During this operation, Burleson is reported to have recovered 40,000 to 45,000 pounds of block and mill mica. Gathright, in his second operation, sank a shaft about 25 feet northeast of Burleson's incline and extended a drift northwestward along a pegmatite body to near the property line.

In 1943, Thomas sank a shaft 30 feet northwest of the Gathright shaft and drifted 30 feet northwestward at the 56-foot level and 12 feet southeastward at the 70-foot level. Old drifts from the Gathright shaft were encountered at the 35- and 45-foot levels. The schist wall rock was still weathered and soft at the 70-foot level.

The pegmatite body in the Thomas workings is 1 to 3 feet thick, strikes N.37°W., and dips steeply to the southwest. It is sharply discordant with the foliation of the enclosing mica schist and gneiss, and divergent dips on opposite sides of the body suggest emplacement along a fault. The feldspar in the pegmatite, which has been almost completely kaolinized to depths of 40 to 45 feet and to a lesser extent below, appears to have been predominantly plagioclase.

Clear, amber-colored mica of flat structure and medium size was found to be abundant along the northeast wall of the dike, but much of it was badly ruled, bent, and hair cracked.

Monteiro mine.—The Monteiro mine, consisting of several trenches and two shafts with various connected underground workings, is on the C. F. Monteiro property within a distance of 100 feet northwest of the Amber Queen mine, 3.8 miles N.36°E. of Goochland (Fig. 5, No. 7). First work at this place is said to have been done by J. H. Simpson about 1900. There is no record of other work until January 1944, when Carl Fleming of Colonial Homes, Inc., of Richmond, began trenching and sank a 24-foot exploratory shaft 65 feet N.75°W. of the Thomas shaft of the Amber Queen mine. When little pegmatite was encountered in this shaft, a second shaft was sunk 55 feet to the northeast. In September 1944, this second shaft was 60 feet deep; drifts had been extended northwestward a distance of 8 feet at the 23-foot level, 41 feet at the 38-foot level, and 29 feet at the 56-foot level; and most of the pegmatite had been stoped out between the 14- and 60-foot levels as far as the property line on the southeast side of the shaft. (See Pl. 14).

The pegmatite body in the Monteiro workings is bowed somewhat northeastward, striking N.38-55°W.; dips from vertical near the surface to 70°N.E. in the lower workings; and is from 1 to 3 feet thick in most places. It pinches out in the main Fleming shaft at a depth of 45 feet, but reappears in the same plane a few feet below and in the drifts to the northwest (Pl. 14). The pegmatite sharply transects the foliation of the enclosing feldspathic biotite gneiss and schist, and differences in attitude of foliation on opposite sides of the bodies strongly suggests emplacement along a fault. It is probable that the main pegmatite mined on both the Amber Queen and Monteiro properties followed the same fault fissure, or zone, and the pinch-outs in the lower Monteiro workings are at places where the walls were in tight contact.

The pegmatite is largely kaolinized to a depth of about 20 feet; but below this level, where it is fairly fresh, it is of medium-coarse texture and is composed chiefly of plagioclase, fine quartz, and muscovite. Book mica, of the same general quality as that from the Amber Queen mine, although probably less deformed, was recovered chiefly from a rich shoot along the northeast wall. Some of the larger books were 15 inches across and weighed 70 pounds. Griffitts, Jahns, and Lemke (1953, p. 177) state: "Analysis of mining data for a period of several months in 1944 indicates that the main Monteiro pegmatite body yielded 4.5 percent mine-run mica. The proportion of recovered trimmed punch and sheet material in the books amounted to 6 percent. Such substantial recoveries of high-quality material suggest that exploration for other pegmatite lenses might yield a satisfactory return." Exploration should be to the northwest and southeast in the direction of the fault breaks which seem to have controlled intrusion of the pegmatite.

Irwin mine.—The Irwin mine is on the south side of State Highway 6, half a mile north-northeast of Irwin, and 2¼ miles N.60°W. of Goochland (Fig. 5, No. 1). When examined in 1943, the old workings, consisting of two pits and a shaft, were badly caved and overgrown. The larger pit, about 80 feet south of State Highway 6, was 60 feet long, 50 feet wide, and 20 feet deep to fill. A shaft in its northwestern end is reported by Sterrett (1923, p. 321) to have been 50 feet deep, whereas Brown (1937, p. 36) states that it was 90 feet deep. The smaller opening, a few yards northeast of the larger pit, was 15 feet long, 20 feet wide, and 18 feet deep to fill.

Pegmatite, except for small offshoots and stringers which penetrate the mica gneiss wall rock, is not exposed. Clear, light rum-colored, flat and generally free-splitting mica with some ruling is fairly abundant in the dump. The largest crystals observed measured 6 by 4 inches.

Reed prospect.—The Reed prospect is on the property of Mrs. E. P. Reed about 400 yards south of State Highway 6, and one mile northwest of Goochland (Fig. 5, No. 2). It has not been worked since about 1900. In 1943, all that could be seen was a pit 140 feet long in a N.45°W. direction, 25 feet wide, and 18 feet deep to fill. No pegmatite was exposed. Some small mica of good quality was present in the dump.

Salter prospect.—The Salter prospect is beside a small stream on the L. T. Salter property, on the south side of State Highway 522, about 2¼ miles N.18°W. of Goochland (Fig. 5, No. 3). The old pit, when examined in 1943, was 60 feet across and 6 feet deep to fill. Brown (1937, p. 36) states that it was originally about 20 feet deep. Sub-sheet size mica, some of good quality, was found in the dump.

Bradshaw prospect.—The Bradshaw prospect, consisting of a small pit 8 feet deep beside Road 634, 2 miles by road northeast of Maidens (Fig. 5, No. 4), was opened about 1925. Scattered flakes and a few small books of clear mica occur in the dump.

Nicholas prospect.—The Nicholas prospect is 5½ miles northeast of Goochland and half a mile south-by-southeast of Perkinsville (Fig. 5, No. 10). Pegau (1932, p. 65) reports that a pit, 20 feet long and 22 feet deep, was dug here in 1916; but in 1943 this was largely filled with debris and covered by vegetation. Mica on the dumps is light rum-colored and generally flat and free from primary stain. Some sheets are said to have trimmed 5 by 6 inches. The dike is about 5 feet wide and can be traced for 150 yards in a N.20°-30°E. direction.

Owen prospects.—Two small pits have been opened on the John Owen property 1¼ miles west of Perkinsville (Fig. 5, Nos. 8 and 9). One is 1,300 feet northeast of Epis Church, the other is 800 feet southeast of this church. Pegmatite is exposed in each, but sheet-size mica is scarce or absent.

Swann prospect.—The Swann prospect about half a mile west of Goochland consists of several small openings on small pegmatite bodies. None, as yet, has shown commercial possibilities.

HANOVER AREA

GENERAL STATEMENT

Mining for mica in Virginia is thought to have started in 1867 on the old Saunders property near Hewlett, Hanover County. Other deposits have since been opened in nearby parts of Hanover and Caroline counties, but none comparable in size to those on the Saunders property have been found (Fig. 6).

Pegmatite bodies in this area are common but do not appear to be abundant, and few are large. They generally trend in an easterly direction, cutting across the foliation of the enclosing rocks which generally strikes northeastward and dips toward the northwest. The most widespread country rock is a garnetiferous biotite gneiss.

PRINCIPAL MINES AND PROSPECTS

SAUNDERS PROPERTY

Mica has been mined in at least five places on the old Saunders property between Little River and State Highway 51 about 2 miles south of Hewlett (Fig. 6, Nos. 1-5). Nos. 1 and 2 mines are on that part of the property owned in 1943 by O. W. Harris, and Nos. 3, 4, and 5 are on that part owned by J. K. Poteat.

Watson (1909, p. 104) states that this property was first mined from 1867 to 1870 by Barr, Johnson and Company of Erie, Pennsylvania, which in this period produced 60,000 pounds of clipped stove mica, a quantity so great that it flooded the then limited market. After a change of ownership, mining was resumed for a few months in 1883. Following another period of idleness, the property was purchased in 1907 by A. Ford of Washington, D. C., who installed equipment and did exploratory work resulting in a recovery of 1,000 pounds of excellent quality rough mica. It is said that some of this mica measured 18 by 33 inches. There is no record of further activity until about 1930 when the

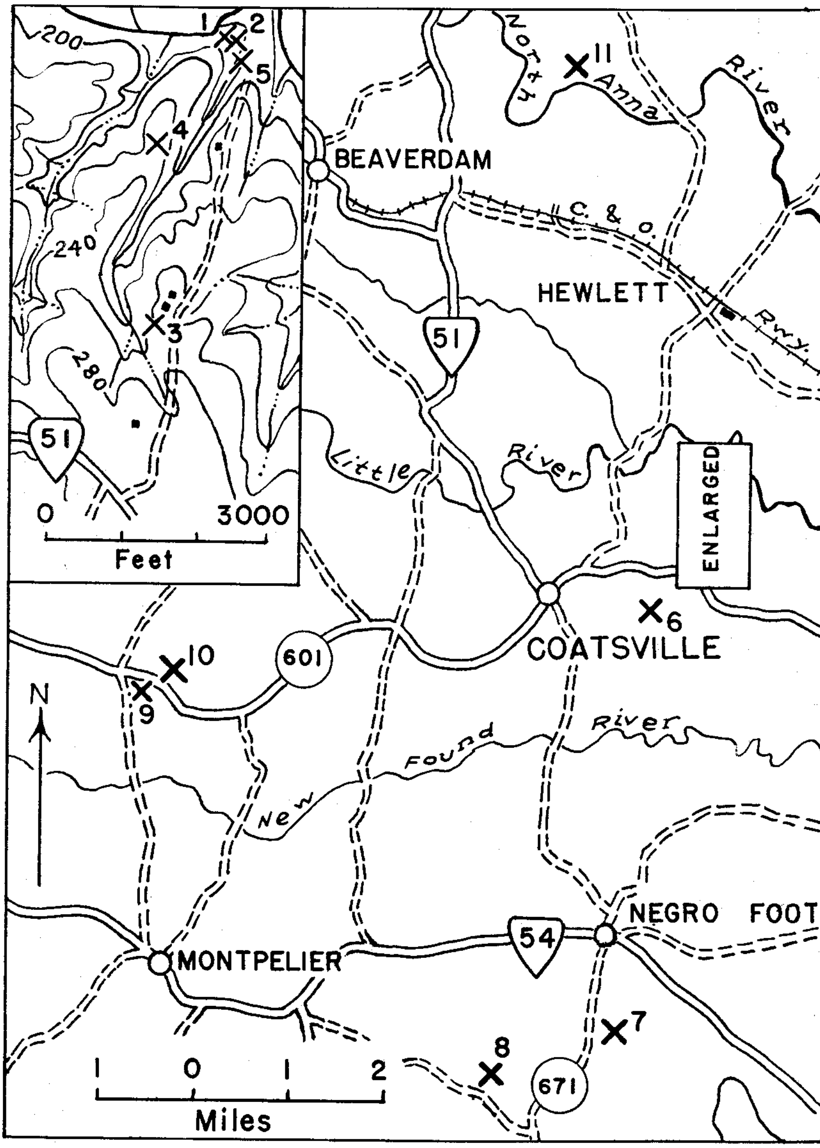


Figure 6. Location of mines and prospects in the Hanover area.

1. Saunders No. 1 mine
2. Saunders No. 2 mine
3. Saunders No. 3 mine
4. Saunders No. 4 prospect
5. Saunders No. 5 prospect
6. Nolan prospects
7. Langford prospect
8. Stanley prospect
9. Harris prospect
10. Southworth prospect
11. Last Mile mine

No. 2 mine was worked for a short time by the Hartford Talc Company of Maryland. In 1943, the No. 2 mine was reopened and worked by the Virginia Manganese Corporation of Richmond, Virginia.

Saunders No. 1 mine.—The Saunders No. 1 mine is near the north end of the old Saunders property about 200 feet southeast of a northward bend in Little River (Fig. 6, No. 1). It was probably the first mine opened in this area and almost certainly one of the largest producers. Old workings consisted of a pit 120 feet long, 35 feet wide, and 35 feet deep at the southeastern end (Sterrett, 1923, p. 321). In 1943, this was partly filled and the pegmatite body was not exposed, but it probably strikes N.70°E. with the elongation of the pit (Pl. 15). The foliation of the enclosing garnetiferous biotite gneiss strikes N.30°E., and dips 40°NW.

The large dump contains massive white and smoky quartz, kaolin, muscovite, and white translucent, partly opalescent, plagioclase. Several tons of scrap mica piled near the east end of the pit, presumably beside an old trimming house, was sold in 1943 by Mr. Poteat. This mica was greenish rum-colored, of flat or flat-A structure, ruled in part, and generally free from primary stain.

Saunders No. 2 mine.—The Saunders No. 2 mine is on the west side of a small tributary to Little River, about 90 feet southeast of the Saunders No. 1 mine (Fig. 6, No. 2). It is the only mine on the property which has been worked to any extent in recent years.

Old workings consisted of a pit 100 feet long, 12 feet wide, and 40 feet in maximum depth. During the summer of 1943, the eastern end of this pit was widened and deepened to 57 feet by the Virginia Manganese Corporation of Richmond (Pl. 15). When this work was begun, trouble from water was expected because of the shallow ground-water level near the mine, but flow into the pit was slight even at the maximum depth of working.

The pegmatite body is nearly vertical, strikes N.74°E., and cuts sharply across the foliation of the enclosing garnet-biotite gneiss. Before it was removed in mining, the body averaged 11 feet in thickness throughout the eastern part of the pit, but near the middle of the pit it tapered abruptly to only 2½ feet, and at the west end of the pit it divided into stringers. In the deeper parts of the pit, inclusions of gneiss, which had been encountered here and there at higher levels, became more numerous, and at a depth of 57 feet the massive part of the body gave way to branching apophyses.

Those portions of the pegmatite which were visible during the operations of 1943 consisted essentially of a quartz core from a few inches to 3½ feet thick, plagioclase-quartz-muscovite wall zone, and a thin border zone of fine plagioclase, quartz, muscovite, and, locally, kyanite. No potash feldspar was observed. Plagioclase of the wall zone, determined to be oligoclase (An_{17}), became distinctly coarser inward from the walls; some euhedral crystals abutted against and were locally enclosed in quartz of the core. Patches of highly quartzose mica "burr", also locally including small euhedral crystals of plagioclase, were common within the wall zone. Garnets occurred sparingly. Translucent pale- to deep-blue crystals of kyanite as much as 3 inches long were abundant in the lowermost parts of the pegmatite adjacent to kyanite-bearing gneiss wall rock.

Book mica occurred throughout most of the dike but was largest and most abundant near the walls, especially the south wall. Everywhere, books of all sizes showed a marked tendency to occur in thick well-defined six-sided crystals (Pl. 1A). One measured 12 by 16 by 8 inches and weighed 217 pounds. The mica is clear, smoky rum-colored, flat, free-splitting, and of excellent quality. It is reported that the Virginia Manganese Corporation recovered 34 tons of mine run mica during its 6 months operation and that this yielded 2 to 3 percent trimmed sheets. Mining was abandoned when it appeared that the narrow extensions of the pegmatite body could not be profitably worked.

Saunders No. 3 mine.—The Saunders No. 3 mine is about three-fourths of a mile S.15°W. of the Saunders No. 1 and a quarter of a mile north of the Poteat home (Fig. 6, No. 3). The old open cut, 150 feet long and about 30 feet deep, is elongated in an easterly direction, probably coinciding with the strike of the pegmatite body. About 1942, Mr. Poteat drained this cut and sank a 20-foot shaft at the east end. A large body of quartz bordered by kaolin and some plagioclase was exposed, but commercial quantities of mica were not observed. It is reported, however, that good quality mica was recovered from earlier operations.

Saunders No. 4 prospect.—The Saunders No. 4 prospect, half a mile north of the Saunders No. 3 mine (Fig. 6, No. 4), is a shallow pit 70 feet long, cut in an easterly direction across the crest of a low ridge. Abundant white massive quartz and some potash feldspar and small clear ruled mica occur in the dump. It is reported that little mica has been produced from this place.

Saunders No. 5 prospect.—This prospect, 310 feet S.10°W. of the Saunders No. 2 mine (Fig. 6, No. 5; and Pl. 15), consists of a shallow U-shaped cut 30 feet across and several prospect pits dug in the bottom by the Virginia Manganese Corporation in 1943. A body of kaolinized pegmatite 5 feet thick, striking N.55-80°W. and dipping 20°NE., is exposed in the more recent pits. It appears probable that the greater part of the body was removed during early operations. Small to medium-sized mica is fairly abundant in the dump and occurs sparingly in the pegmatite near small quartz masses. It is similar in color and quality to that at the Saunders No. 2 mine, but it may be more ruled and bent.

OTHER MINES AND PROSPECTS

Nolan prospects.—The Nolan prospects are on the Churchill Nolan property on the southwest side of State Highway 51 about one mile southwest of the Saunders mines (Fig. 6, No. 6). The largest opening, consisting of a shallow trench 100 feet long extending N.70°E. into the base of a low hill, is about 300 yards west-southwest of the Nolan farmhouse. Other smaller openings were noted about 40 feet northeast of the main trench and at a locality about 100 yards west of the farmhouse.

In 1943, the Virginia Manganese Corporation cross-cut the east end of the main trench, exposing 1 foot of pegmatite and some aplite. The nearby dump contains a small amount of potash feldspar, abundant kaolin, massive white quartz, and flake mica. Some clear, greenish rum-colored, flat, clean splitting, mica in books from 3 to 7 inches across is also present.

Langford mine.—The Langford mine is on the Langford, or "Rose Hill" farm, 1.3 miles by road south of Negro Foot (Fig. 6, No. 7). In 1943, the old oval-shaped pit, about 35 feet long, was partly filled with water so that the depth could not be determined, but the size of the dump suggests that it is deep.

A dike of kaolinized pegmatite 5 feet wide at the surface, broadening to 10 feet at a depth of 8 feet, was well exposed in the western end and along the southern side of the pit. Several books of "A" mica, some 10 inches across, could be seen in place adjacent to an irregular quartz core. Much massive white quartz and a few sheets and books of heavily reeved and broken mica occur in the dump along with an occasional flat smoky, rum-colored sheet.

Southworth prospect.—The Southworth prospect is on the H. L. Southworth property about 70 yards northeast of Road 631 and half a mile east of Beazeley Store (Fig. 6, No. 10). Prospecting has been done also at several other localities in the general vicinity of Beazeley Store, but mica has not been recovered in commercial size or quantity. The Southworth prospect, consisting of a pit 25 feet long and 18 feet deep, is on a small pegmatite dike composed chiefly of massive quartz. Mica is abundant, but most is of a bad "A" structure. It is reported, however, that a few ruled books of good quality mica 2 feet across have been recovered.

Stanley prospect.—Several shallow pits have been opened on a body of mica-bearing pegmatite on the T. E. Stanley property about 2 miles southeast of Stanley Corner and 2 miles southwest of Negro Foot (Fig. 6, No. 8), but no mica of commercial size has been uncovered.

Last Mile mine.—This mine is on the Lawrence Beazeley farm in Caroline County about 7 miles southwest of Ladysmith (Fig. 6, No. 11). It was opened in 1942 as a bulldozer trench 55 feet long, 20 feet wide, and about 7 feet deep. The next spring W. E. Baltzley and David Sternberg sank two shafts, 20 and 25 feet deep, in the floor of the trench. A nearly vertical body of pegmatite, 10 feet thick near the middle of the pit but tapering almost to nothing near the ends of the pit, striking N.55°W., was exposed. The foliation of the deeply weathered garnet-biotite gneiss wall rock strikes northeast and dips northwestward.

Stained, bent, hair-cracked, rum-colored mica occurs in some abundance in the kaolinized wall-zone pegmatite; and clear pale-green mica is locally plentiful near a 2- to 3-foot quartz core and local masses of intermediate-zone perthite. It is reported that about 600 pounds of mica, some of good quality, was taken from the western shaft. Several crystals of beryl, one weighing about 15 pounds, were also recovered.

LOUISA-SPOTSYLVANIA AREA

GENERAL STATEMENT

Mica has been mined and prospected at several localities near Apple Grove about 8 miles south of Mineral in Louisa County and at one locality near North Anna River in Spotsylvania County (Figs. 1 and 7). Pegmatites are fairly abundant near Apple Grove, though most so far uncovered have been relatively small. These are generally concordant with the foliation of enclosing rocks, which commonly strikes northeast and dips southeast. Mica in most of the bodies is stained. Production has been small.

MINES AND PROSPECTS

Childress mine.—The Childress mine is in Louisa County about 200 yards southeast of U. S. Highway 33 and 3 miles N.40°E. of Apple Grove (Fig. 7). Workings, probably made during World War I, consist of an oval-shaped pit 50 feet long by 12 feet deep, a shaft about 21 feet deep, and several long trenches. In 1942, the shaft was partly caved and filled

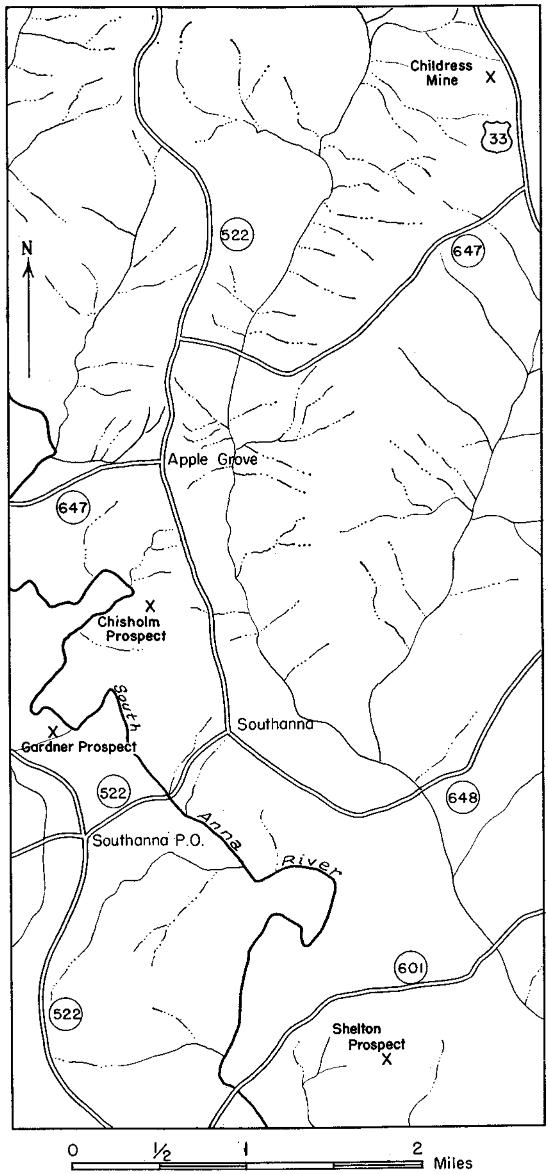


Figure 7. Location of mines and prospects in the Louisa area.

with water. A body of quartz, 5 to 8 feet wide, is exposed on the surface for about 100 feet S.25°W. from the shaft. It is reported that the best mica was found beneath this quartz body, which pinched out at slight depth. Mica in the dump is pale-green, quite soft, of flat "A" structure, and free from primary stain. Sheets 6 to 8 inches across are common.

Gardner prospect.—A body of pegmatite 5 feet thick, striking northeastward, has been exposed in several small pits on the George I. Gardner property near South Anna River 1½ miles S.25°W. of Apple Grove (Fig. 7). Mica is fairly abundant but most of it is black-stained.

Chisholm prospect.—The Chisholm prospect, consisting of two small pits, is on the L. T. Chisholm property about half a mile south of Apple Grove (Fig. 7). A body of mica-bearing pegmatite, about 15 feet thick, is exposed here and there on the surface for about 300 yards. It is generally concordant with the foliation of the enclosing biotite gneiss which strikes N.35°E., and dips 70°SE. Mica, associated with potash feldspar and smoky quartz, is fairly abundant, but most of it is of "A" structure, and carries primary stain.

Shelton prospect.—A vertical body of pegmatite about 2 feet thick, striking N.20°W., is exposed in a shallow prospect pit 20 feet long on the W. H. Shelton property about 3½ miles southeast of Apple Grove (Fig. 7). It can be traced on the surface for about 700 feet. Small books of clear, rum-colored, free-splitting mica occur fairly plentifully in the pegmatite about a thin quartz core.

Edenton mine.—The Edenton mine, on property owned by L. W. Edenton of Brokenburg, is in Spotsylvania County 8½ airline miles northeast of Mineral, a mile northeast of North Anna River, and half a mile east of Road 613 (Fig. 1, No. 1). At the time of the writer's visit in 1943, no work had been done since the mine was opened by R. M. Lloyd about 1900. Development consisted of a 50-foot shaft and a 120-foot drainage tunnel from the 25-foot level, extending northwestward into a long trench. Kaolinized pegmatite in a body 6 feet thick, striking N.60°E. and dipping 60°NW., is exposed in the partly caved shaft. Some clear, light rum-colored, flat and flat-"A" mica of medium size is visible in place near the mouth of the shaft. Much fresh quartz-mica "burr" and some hard perthite and gneiss wall rock occur in the dump; mica is not abundant.

A northeastward-trending tunnel 25 feet long and a shallow pit also have been opened at a place about 350 yards southwest of the above workings. A body of pegmatite 4 to 5 feet thick, striking N.75°E. and dipping 60°NW., approximately parallel with the foliation of the enclosing wall rock, is exposed in the pit. Only narrow stringers are exposed at the mouth of the tunnel. "Burr" rock and blocky perthite are piled about the pit. Small clear, flat mica occurs sparsely.

CHARLOTTE-CUMBERLAND AREA

GENERAL STATEMENT

Pegmatites occur in a number of places within a general belt, 4 to 10 miles wide and approximately 40 miles long, which extends from a mile or so south of Charlotte Court House, Charlotte County, northeastward through the central part of Prince Edward County to the vicinity of Cumberland in Cumberland County. Mining and prospecting have been limited largely to the southern half of this belt, i.e., between Charlotte C. H. and Prospect (Fig. 8). Operations in the vicinity of Prospect have been chiefly for feldspar, and Watson (1913, p. 32) states that during the years 1911 and 1912 the entire production of feldspar in the state was from one mine near Prospect. Although there has been no production in recent years, the area probably still should be considered a potential source of potash feldspar. Outside of the Prospect vicinity, most operations have been for mica but, except in the vicinity of Charlotte C. H., most of that recovered has been of poor quality, being generally green, black stained, and reevy.

Topographically the Charlotte-Cumberland area is a broad gently rolling upland with altitudes ranging from about 315 feet to 750 feet. Jonas (1932, Pl. 2) has mapped the prevailing rock types as "Columbia granodiorite and Columbia granite injection in hornblende gneiss". Deep weathering, typical of the central Piedmont, prevails.

The pegmatites are mineralogically simple but most are zoned. Typically, they have cores of massive quartz, more or less prominent perthite-rich intermediate zones, and kaolinized plagioclase-quartz-muscovite wall zones.

MINES AND PROSPECTS

Henry Moore mine.—This mine, consisting of a pit 25 feet long by 15 feet deep, is on the west side of Road 645 about 2 miles by road southwest of Charlotte Court House (Fig. 8, No. 1). A body of pegmatite 3 feet thick, trending east and dipping 50°S., is exposed in the pit and can be traced on the surface 100 yards to the east. During Moore's operation in 1941-42, good quality ruby-colored mica, some in sheets which trimmed 3 by 5 inches, was recovered in moderate quantity from

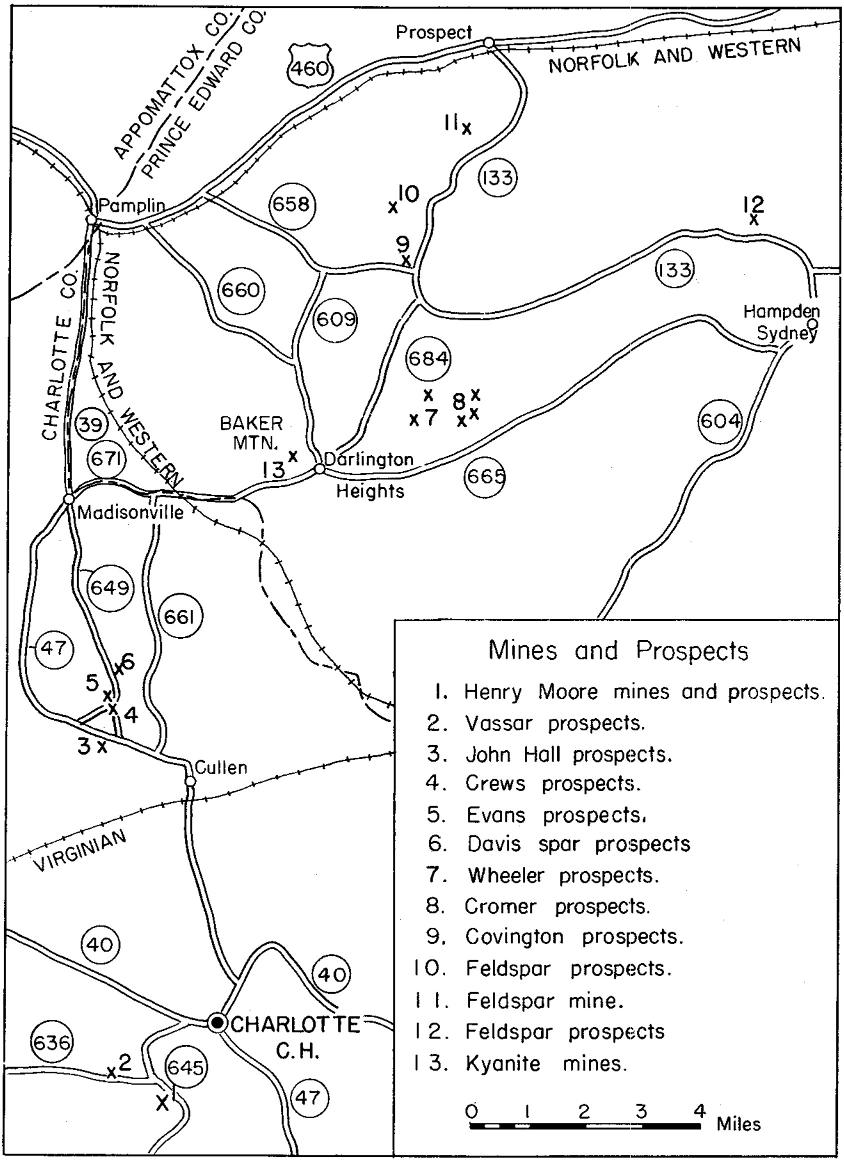


Figure 8. Location of mines and prospects in the Charlotte-Cumberland area.

kaolinized pegmatite flanking a 1- to 2-foot quartz core. It was most abundant on the hanging wall side.

Vassar mine.—In 1942, mica-bearing pegmatite was encountered in a shallow well being dug on the John Vasser property on the north side of Road 636 about a mile north-northwest of the Henry Moore mine and a mile southwest of Charlotte Court House (Fig. 8, No. 2). In 1943, short drifts had been extended from the 18-foot level along the N.12°E. strike of the steeply-dipping body, exposing a 4-foot thickness of pegmatite on the west side of a large core of massive quartz. Slightly reeved greenish-rum mica, some with light mineral stain, was being recovered from kaolinized plagioclase pegmatite adjacent to the quartz core and to perthite masses of a discontinuous intermediate zone. It is said that about $200 worth of strategic mica was sold.

John Hall prospect.—In 1943, C. T. Crews, of Cullen, sank a 27-foot shaft and opened a pit 15 feet long and deep on the John Hall property on the south side of Virginia Highway 47, one mile by road west-northwest of Cullen (Fig. 8, No. 3). A year later, these openings had been filled and no pegmatite was visible, but it is said that a body 7 to 8 feet thick, striking northeastward and dipping to the southeast, was exposed in the pit, and that a considerable quantity of green, black-stained, flat mica of medium size was recovered.

Crews prospect.—The Crews prospect, consisting of two small pits, is near the intersection of Roads 649 and 689 about 0.9 mile northwest of Cullen (Fig. 8, Nos. 4 and 5). One pit is near the C. T. Crews farmhouse on the south side of Road 649; the other pit, also dug by Crews, is on the Evans property just across Road 649 and about 100 yards northeast of the Crews property. A small body of pegmatite composed chiefly of coarse pink potash feldspar, containing small black-stained mica, was uncovered on the Crews property, whereas on the Evans property only a little mica and several crystals of bluish-green beryl, some as much as 1 by 7 inches, were found.

Davis prospect.—The Davis prospect is a slumped and overgrown pit about 70 feet long on the Irving Davis property about a quarter of a mile north of the Crews prospect (Fig. 8, No. 6). Pegau (1932, p. 94) states that the pegmatite dike, striking N.60°E., and dipping 45°NW., is 10 feet wide. Good quality light-pink potash feldspar occurs abundantly in the dump, along with some small mica of poor quality.

Cromer and Wheeler prospects.—The Cromer and Wheeler prospects. opened in 1944 by W. H. Venable, are on the north side of Road 665 about 7 miles by road west of Hampden-Sydney (Fig. 8, Nos. 7 and 8).

A body of pegmatite about 13 feet thick, striking east and dipping 70°N., is exposed in one pit about 75 feet southeast of the Cromer farmhouse. It is composed chiefly of kaolin, pink potash feldspar, and irregular masses of quartz. Pale green mica in books as much as 5 inches across occurs fairly abundantly near some of the quartz. This is mostly flat and clear, but some is lightly specked. Pegmatite containing good quality potash feldspar, but little mica, is also exposed in a trench 150 feet west of this pit and in several trenches in the woods from 100 to 200 feet west of the house.

Pink potash feldspar and small green specked "A" mica also occur in other openings about 300 yards north of the house.

Several shallow openings on the adjoining Wheeler property, about a quarter of a mile northeast of the Wheeler farmhouse, show abundant pink potash feldspar and minor amounts of green specked "A" mica. Clear "A" mica also was plowed up in a field about 200 feet northeast of the Wheeler farmhouse, but in 1944 no exploratory openings had been made.

Covington prospect.—In 1944, W. H. Venable opened a number of trenches and small pits on the A. W. Covington property just northwest of the intersection of Roads 658 and 133, 7½ miles by road west of Hampden-Sydney. These openings exposed a zoned body of pegmatite 13 feet thick, striking N.30°W., and dipping from vertical to 70°SW. Pale green "A" mica, some in books 8 inches across, occurs abundantly in plagioclase pegmatite adjacent to a 3-foot core of massive quartz and about masses of intermediate-zone perthitic microcline. Most of it is black stained. Small black-stained "A" mica is also fairly abundant in a body of pegmatite 7 feet thick with a 3-foot core of quartz, exposed in a trench 130 yards southeast of the above openings.

Meinhard prospects.—There are numerous injections of pegmatitic material in hornblende gneiss on the C. R. Meinhard property a short distance northeast of Road 639, about 8½ miles south-southwest of Cumberland (Fig. 1, No. 7). Pink potash feldspar and some small green mica of poor structure have been exposed in several small pits dug by Mr. Meinhard in 1942. The likelihood of commercial mica does not appear to be good, but further exploration for feldspar in this vicinity may be warranted.

RIDGEWAY AREA

GENERAL STATEMENT

The Ridgeway area, about 30 miles long and from 3 to 5 miles wide, extends from the vicinity of Smith River 3 miles northeast of Ridgeway, Henry County, Virginia, southwestward to near Dan River about 4 miles southwest of Lawsonville, Stokes County, North Carolina (Fig. 1, No. 18, and Pl. 16). An outlying deposit, probably related to this area, has been described by Sterrett (1923, p. 271-273). The known pegmatite deposits are most closely spaced in the northeastern half of the Ridgeway area, that is in that part which lies in Virginia and near the State Line in North Carolina. These deposits have been worked almost exclusively for mica, although some feldspar has been marketed from a few, including those at the Ridgeway, Eanes, and Garrett mines in Virginia.

U. S. Highway 220 and the Roanoke and Winston-Salem line of the Norfolk and Western Railway extend north-south through the eastern part of the area, and numerous clay and gravel roads give ready access from these to neighboring districts and the western part of the area.

The Ridgeway area occupies a rather thoroughly dissected portion of the Piedmont upland. Parts of the old relatively flat upland surface are preserved in the higher interstream areas, but most hilltops are rounded. Slopes adjacent to streams are moderate to steep, and some streams have entrenched meanders. Relief is moderate, with elevations ranging from about 650 feet at Smith River in the northeastern part of the area to slightly over 1,000 feet near the North Carolina line. A divide near the State Line separates northeasterly drainage to Smith River from southwesterly dıainage to Mayo River. The southwestern part of the area is drained by Dan and Mayo rivers and their tributaries.

Ground water is encountered at depths of from a few feet in low areas to 80 feet on some of the higher divides, but the average is about 35 to 40 feet. Weathering is not so deep as in the eastern Piedmont, but pegmatites rich in plagioclase are commonly kaolinized to or somewhat below the water table. Potash feldspar is usually fairly fresh at or near the surface.

ROCK TYPES

Quartz-mica schist, commonly containing garnets and some biotite, is the most widespread metasedimentary rock in the area. Biotite gneiss is fairly widespread near granitic intrusives in the central part of the area, also east of Price and in the extreme western part of the area.

Foliation in these rocks strikes prevailingly northeastward in the northeastern part of the area but more eastward in the western two thirds of the area, with a northward bow in strike directions near the Stokes-Rockingham counties line, North Carolina (Pl. 16). Dips, except between Ridgeway and Price and in northwestern Rockingham County, North Carolina, are predominantly to the north and northwest. Between Ridgeway and Price dips are variable, but are mostly from northeast to southeast; in northwestern Rockingham County they are dominantly northeastward. It is noteworthy that the pegmatite belt as a whole follows the regional trend and major undulations of the foliation.

Sill-like bodies of hornblende gneiss and "metagabbro", from a few inches to 100 feet or more thick, are common in the northeastern part of the area and increase in prominence northward to the vicinity of Martinsville. These have usually been interpreted to be altered basic intrusives or volcanics, and some may be products of metasomatism. An ultramafic body of "metapyroxenite" occurs a quarter of a mile west of the town limits of Ridgeway. The age of the metasediments is unknown, but the presence of hornblendic bodies in them suggests that they are pre-Ocoee (King, 1955, p. 360-361) and pre-Candler formation (Brown, 1958, p. 30 and Fig. 2).

Sills and dikes of pegmatite and aplitic granite (granite to quartz diorite in composition) are common throughout the area, and there is a body of light gray granite several miles wide between Sandy Ridge, North Carolina, and the Virginia line. Eastward from this body, aplitic granite and mica schists and gneisses are interlayered as migmatite. The gradual change from where granite makes up most of the rock to where schist is predominant can be observed to advantage along the Price-Sandy Ridge road, beginning near the Stokes-Rockingham counties line and going about 3 miles eastward to near the Tom Smith mine. The granite north of Sandy Ridge presumably is part of the Leatherwood granite of Pegau (1932), with which the pegmatites of this region are thought to be genetically related. The youngest igneous rocks of the area are dikes of diabase, of probable Triassic age, which locally intrude all younger rocks, and which generally trend north to northwestward across regional structures.

PEGMATITES

Pegmatites are abundant in the Ridgeway area, especially in its northeastern portion. Many are well exposed in cuts along U. S. Highway 220 and the Norfolk and Western Railway between Sheffield Hill, just north of Ridgeway, Virginia, and Price, North Carolina. Most bodies in this area, unlike those in areas of the eastern Piedmont and in the Chestnut Mountain area to the north, are approximately concordant with foliation of enclosing rocks. Throughout most of the area, therefore, they usually strike northeastward and dip toward the northwest. In the small part of the area in North Carolina just east of the Stokes-Rockingham counties line where rock foliation dips northeastward, the pegmatite bodies also dip northeastward. In vicinity of the Garrett and Eanes mines, about 2 miles southwest of Ridgeway, where foliation dips in various directions, a number of bodies dip southeastward (Pl. 16).

The pegmatites range in thickness from an inch or so to 50 feet or more; most of those mined are between 4 and 10 feet thick. Bodies in rocks with strong foliation tend to be more regular in form than those in rocks like metagabbro and granite, in which foliation is weak. According to Sterrett (1923, p. 324), the body at the Ridgeway mine increases in width from 4 to 30 feet within a horizontal distance of 20 feet, and from 1 to 30 feet within a vertical distance of 50 feet. Some pinch out at shallow depths, like the one at the John Price mine which appears to terminate at a depth of 30 feet; others extend considerable distances down the dip, like that at the Joe Hawkins mine in North Carolina which has been worked down the dip for a distance of over 525 feet.

Pegmatites in this area are generally of finer grain size, are less distinctly zoned, and contain less potash feldspar than is usual in most other areas in Virginia. Discontinuous quartz cores are common; but they are frequently irregular, and roughly parallel masses of quartz separated by plagioclase-quartz-muscovite pegmatite are not unusual. The remainer of most bodies is predominantly plagioclase-quartz-muscovite wall zone. Blocks and discontinuous masses of intermediate zone perthite occur in numerous bodies. Border zones, consisting of finer-grained mixtures of the same minerals which comprise the wall zones, are mostly thin, discontinuous, and inconspicuous. Biotite, spessartite garnet, tourmaline, and beryl occur here and there but are less frequent than in many areas. Griffitts, Jahns, and Lemke (1953, p. 162) have reported uraninite, autunite, uranophane (?), other secondary uranium minerals, and allanite (?) at the Harry Knight mine.

Book mica occurs chiefly in plagioclase-quartz-muscovite wall zones, either more or less disseminated throughout or roughly concentrated in shoots, usually along one or the other of the walls; in places it is clustered about quartz core masses. Much of it, especially in the eastern and northeastern parts of the area, is greenish rum colored (yellowish to brownish olive); some is rum colored (yellowish brown); very little is ruby colored (pinkish). A few deposits yield only clear mica, but most contain some lightly specked mica from which a fair proportion of clear may be rifted. Some moderately to heavily stained mica occurs in southwestern Henry County, Virginia, and nearby parts of northwestern Rockingham County, North Carolina; it is uncommon elsewhere.

Most of the small amount of feldspar produced in the Ridgeway area has been intermediate-zone perthite. This is usually coarse and blocky and is fresh at or near the land surface, but it rarely comprises large parts of the pegmatites of this area. Plagioclase, on the other hand, is the chief constituent of most bodies, but it is generally of only medium grain size—and thus difficult to extract—and is commonly deeply kaolinized. With the growing use of flotation in feldspar separation, some of the low-iron granitic masses in this region may be more likely sources of feldspar than the relatively small pegmatites.

PRINCIPAL MINES AND PROSPECTS—RIDGEWAY AREA, VIRGINIA

Ridgeway mines.—The deposits at the Ridgeway mines, on the west side of U. S. Highway 220 a quarter of a mile N.10°W. of Ridgeway Station (Pl. 16, Nos. 8 and 9), were prospected near the beginning of this century by Captain McCray, of Ridgeway, who later interested persons in Pittsburgh, Pennsylvania, to form the Pittsburgh Mica Company. This company did the first extensive mining on the property. When Sterrett (1923, p. 323-326) visited the mines in 1913, the main mine was being operated by the Ridgeway Mica Company, which had developed as an outgrowth of the earlier company after a period of idleness. During World War I the mines were operated by the Chestnut Mountain Mica Company. The next activity seems to have been in 1940-41, when Gus B. Grindstaff and C. P. Simms reopened and made an unprofitable attempt to work the main mine. In 1942, the Meyer and Brown Corporation of New York bought the property and spent several months in exploration and in reopening and working of the main mine, but this venture also was unsuccessful and the operation was abandoned in January 1943.

When the property was visited in October 1942, the main (northern or No. 1) mine consisted essentially of a pit 85 feet long by 40 feet wide; an incline about 300 feet long, extending in a S. 25°W. direction from the bottom of the pit to a depth of perhaps 120 feet below the surface; and 2 shafts, 15 feet apart and on opposite walls of the pegmatite, sunk to the incline 50 and 60 feet from the pit (Pl. 17). Stoping had been done to a height of as much as 30 feet above the floor of the incline and for variable distances on either side to follow bulges in the pegmatite body. Where worked, this body strikes approximately N.25°E., dips from 75°NW. at the surface to about 60°NW. in the lower workings, and is essentially parallel to the foliation of the enclosing metagabbro gneiss. Sterrett (1923, p. 324) states that it varies from 1 to 30 feet in thickness, with an average of about 15 feet, and that it has been shown by prospect pits to extend 250 feet southwest of the mine. He also records that most of the mica recovered was taken from a shoot which plunged from 35° to 40° S.25°W. in the body of pegmatite.

The main mine was a large producer of mica during the earlier operations, and some of the mica was quite large. Books over 2 feet across, one weighing 776 pounds, have been reported; and a part of a crystal measuring 18 by 20 inches and weighing 42 pounds was presented to the United States National Museum by the Ridgeway Mica Company (Sterrett, 1923, p. 325; Pegau, 1932, p. 71). Mica from this mine is generally light smoky to greenish rum colored, of flat "A" structure, and free from mineral stain; a small percentage is lightly specked.

The southern, or No. 2 workings, consisting of two shafts 20 and 22 feet deep in the bottom of a shallow pit, and various older workings of unknown extent, are 380 feet S.15°E. of the main mine. In 1943, the Meyer and Brown Corporation sank a new 20-foot shaft 40 feet northwest of the old shafts. A small amount of mica was recovered, and it is said that the pegmatite appeared fairly promising at the time work was abandoned. The dump from this new shaft contains plagioclase and potash feldspar, smoky quartz, sericite, garnet, and clear and lightly specked greenish rum-colored mica.

Mica of good size and quality was encountered in fair abundance in two shallow pits about 100 yards west of the main mine. Aplite and mica-bearing pegmatite also are exposed in a number of places along U. S. Highway 220 just east of the Ridgeway mines, but the pegmatite bodies appear to be small and non-persistent.

Carpenter prospect.—This prospect, consisting of a pit 15 feet deep, is on the W. M. Carpenter property on the east side of U. S. Highway 220, 125 yards east-southeast of the Ridgeway mine (Pl. 16, No. 10). A very irregular mass of pegmatite about 15 feet thick, containing masses and septa of schist, is exposed. The feldspar in the pegmatite is chiefly plagioclase, but a few blocks of perthite occur near a 2-foot quartz core segment. Small books of clear to lightly-specked, ruled, flat mica occur sparsely near the quartz core and the schist inclusions.

Fine-grained pegmatite has been exposed in shallow openings on the Barns property about 60 feet south of the Carpenter prospect, but no appreciable mica has been recovered.

Cole Compton prospect.—The Cole Compton prospect, consisting of some old workings and a 16-foot exploratory shaft dug by E. C. Burton in 1943, is about 130 yards northeast of the Ridgeway mine (Pl. 16, No. 6). The pegmatite body is 4 feet thick, strikes N.60°E., and dips 60°NW. A mica shoot with a steep northwestward plunge was encountered in the shaft and several hundred pounds of mica were recovered. This mica, some of which was 9 inches across, was greenish rum-colored, generally flat or flat "A", commonly ruled, and mostly clear, although some was lightly specked.

Sheffield mine.—The Sheffield mine, sometimes called "Fontaine", is 100 yards northwest of Road 687, a quarter of a mile northeast of U. S. Highway 220, and 1.1 miles northeast of the town limits of Ridgeway (Pl. 16, No. 4). It was worked by Captain McCray before World War I, reopened by the Keystone Mica Company in 1943, and briefly prospected by J. H. Martin and W. E. Land in 1944.

Old workings consisted of an open pit 50 feet long, 15 feet wide, and 18 feet deep; and two shafts about 25 feet deep just west and southwest of the pit. Recent work consisted chiefly of cleaning out the pit and deepening the west shaft to a depth of 30 feet.

A body of pegmatite 3 to 5 feet thick, striking N.45°E. and dipping 70°NW., is well exposed in the pit. It is composed chiefly of coarse plagioclase feldspar, cut by irregular veinlets of smoky to clear glassy quartz; some sheet mica occurs along the footwall. Another body of pegmatite, 10 feet thick and reported to have yielded some good mica, is exposed in the walls of the west shaft. Both bodies are largely concordant with the foliation in the enclosing hornblende gneiss.

When the mine was visited in 1943 and 1944, little mica was visible in the exposed pegmatite, but it was fairly abundant in the dumps. What appeared to be a promising mica shoot was exposed by Martin and Land 25 feet northeast of the pit, but it was explored only a few feet below the surface. Sterrett (1923, p. 326) records a report that Captain McCray recovered $1,500 worth of mica from his early operation of the mine. Mica from this mine is greenish to smoky rum-colored, flat and flat "A", and of medium size, but much of it is lightly to heavily specked.

Another old opening about 18 feet deep to fill is a quarter of a mile southwest of the Sheffield mine near the intersection of Road 687 and U. S. Highway 220 (Pl. 16, No. 5). Mica in the dump is mostly small and finely specked with iron oxide. Pegmatite containing small clear and specked mica is exposed in several places along U. S. Highway 220 immediately to the south.

Paul Compton prospect.—The Paul Compton prospect is one-tenth of a mile northwest of the Norfolk and Western Railway 1½ miles N.30°E. of Ridgeway Station (Pl. 16, No. 3).

Workings, made many years ago, consist of a shaft, estimated to be about 30 feet deep, and a shallow pit. In 1944, no pegmatite was visible, but perthite, "A" muscovite, and massive white quartz were seen in the dump. The mica, some in books 5 inches across, was fairly plentiful but was largely stained and specked with iron oxides.

Abner Cox mine and prospect.—The Abner Cox mine is about 100 yards southwest of Road 641, half a mile west-northwest of Egglestone Ford, and 3 miles northeast of Ridgeway (Pl. 16, No. 2). Workings, made by J. D. Whitlow in 1943, consist of an inclined pit 20 feet deep and several exploratory trenches. A body of sheared pegmatite and aplite, 4 feet thick, striking N.75°E., and dipping 45°NW., is exposed between walls of weathered metagabbro. A small thrust fault cuts the body near the incline entrance. Clear greenish mica is fairly plentiful, but most of that recovered has been so badly sheared and bent that it was good only for scrap. It is possible that better quality mica might be found beyond the zone of faulting.

The Abner Cox prospect is about 200 yards northeast of the Abner Cox mine and 70 yards northeast of Road 641 (Pl. 16, No. 1). Lightly-stained to clear "A" mica, some in books a foot across, is fairly plentiful in a body of pegmatite 5 feet thick and striking N.70°E., which has been exposed in several trenches.

J. L. Cox prospect.—A shallow pit 18 feet in diameter, said to have been opened by Whitehearst and Captain McCray about 1900, is on the John Letcher Cox property, just northwest of a tributary to Turkeycock Creek, 150 yards east of Road 633, and 4½ miles slightly north of east of Ridgeway Station (Pl. 16, No. 16). In 1944, nothing was visible in the pit, but the dump contained a considerable quantity of fresh pegmatite and some small, flat, clear to lightly-specked, ruby-colored mica.

Hundley prospect.—This prospect is 0.2 mile southeast of Road 636 and 2 miles slightly north of east of Ridgeway Station (Pl. 16, No. 15). In 1941, J. E. Hundley and Sanford Roberts dug several small shallow pits and ran a tunnel for about 30 feet in a S.45°W. direction from the largest pit. A body of pegmatite 5 feet thick, composed chiefly of coarse blocky potash feldspar, light-gray quartz lenses, kaolin, and muscovite was exposed. It strikes N.30°E. and dips 40°NW. Small clear and specked mica is fairly abundant along the footwall of the body near the quartz masses. It is reported that one book a foot across and weighing 50 pounds was recovered.

Shropshire prospect.—This prospect is on the R. H. Shropshire property within the corporate limits of Ridgeway about 250 yards east of the railway station (Pl. 16, No. 12). Workings consist of six holes, none deeper than 12 feet, opened by Captain McCray about 1900 or by H. A. Knight during World War I; and a 10-foot shaft sunk by J. H. Martin and W. E. Land in 1944. Some pegmatite and mica are exposed in each pit and appear as float on the surface as far as U. S. Highway 220, 350 feet to the west. The mica is pale green, clear, and generally free from reeve; but Knight states that, although it was found in rich pockets, most of it was too soft to sheet. The deposits might be worked commercially for scrap.

Jones prospect.—This prospect, consisting or three old pits, is on the George O. Jones property about 130 yards northeast of the high school in Ridgeway (Pl. 16, No. 13). The largest pit is about 40 feet long and 20 feet deep with a 10-foot tunnel driven N.60°W. from the bottom. It is elongated N.75°E., and pegmatite float occurs on the surface for a distance of 250 feet in this direction from the pit. The exposed pegmatite is largely kaolinized but does contain quartz and some fairly fresh perthite. Green to greenish rum-colored mica in ruled books as much as 7 inches across is fairly abundant in the dump but is only sparsely visible in the exposed pegmatite.

Eanes No. 1 mine.—This mine is on the H. L. Eanes property, 500 feet S.25°W. of the farmhouse, 1½ miles southwest of Ridgeway, and half a mile by farm road south of U. S. Highway 220 (Pl. 16, No. 28). Mining was begun by Mr. Eanes in 1943 and, at the time work was abandoned the following spring, a pit 65 feet long and 35 feet deep had been opened (Pl. 18). An irregular body of partly kaolinized pegmatite about 15 feet thick, striking N.50°E. and dipping 65°SE., was exposed. It contained lenticular inclusions of aplitic granite and was only in part concordant with the foliation of the enclosing feldspathic schist. Mica was abundant in a narrow shoot with a 35 degree plunge in a S.10°E. direction. At the height of production, Eanes recovered from 300 to 500 pounds of clear to lightly specked mica per day, from which the sheet recovery averaged 4.5 percent.

Eanes No. 2 (Grindstaff) mine.—This mine is on the H. L. Eanes property 450 feet south of the Eanes No. 1 mine, about 1½ miles southwest of Ridgeway (Pl. 16, No. 29; and Pl. 18). It was worked many years ago by Gus Grindstaff, who is said to have recovered a considerable quantity of mica from a 30-foot shaft with a 15-foot drift extending eastward from the bottom. In 1943, Martin opened a pit 25 feet deep just south of the Grinstaff work but encountered only a narrow lens of pegmatite which yielded but 300 pounds of mica. The following year H. L. Eanes cleaned out and enlarged Grindstaff's workings into one very irregular pit which joined the Martin pit on the south. Also in 1944, Albert Knight sunk a 27-foot shaft 25 feet east of the Eanes workings but it failed to encounter appreciable pegmatite.

Several lenticular bodies of more or less unzoned pegmatite, from 2 to 6 feet thick, were encountered in the mining. These dip in various directions from east to southwest and are largely, although not entirely, concordant with the foliation of the enclosing mica schist and interlayered hornblende gneiss. A thrust fault with about 3-foot displacement cuts the pegmatite in the central part of the main pit. Good quality pinkish to rum-colored, flat, generally clear mica occurred scattered throughout most of the pegmatites and locally was concentrated in rich pockets. In spite of the relatively small size of the pegmatites, the mica yield was considerable. More bodies similar to those mined probably occur in the vicinity.

Fields feldspar mine.—This mine, on the H. L. Eanes property 700 feet southwest of the Eanes No. 2 mine, about 1½ miles southwest of Ridgeway (Pl. 16, No. 30; and Pl. 18), was worked in 1931-32 by the Clinchfield Sand and Feldspar Corporation of Baltimore. A carload of potash feldspar and some mica were produced from a pit 35 feet long and 12 feet deep, in which is exposed a body of pegmatite at least 20 feet thick, striking northeast and dipping 60°SE. Pink and white perthite occur adjacent to a 3-foot quartz core and as irregular masses enclosed in kaolinized plagioclase of the wall zone. Mica does not appear to be abundant.

Garrett No. 1 feldspar mine.—This mine, on the Albert Knight property (part of the old Garrett estate) 180 feet south of the Eanes No. 2 mine and about 1½ miles southwest of Ridgeway (Pl. 16, No. 27; and Pl. 18), consists of a shallow pit 37 feet long by 17 feet wide which connects at the north end with a northeasterly-trending stope 30 feet deep, 15 feet high, and about 60 feet long. A body of pegmatite over 20 feet thick, striking northeast, and dipping 80°SE., is exposed. It is composed chiefly of very coarse blocky white perthitic microcline with interstitial partly kaolinized plagioclase. Mining was primarily for feldspar, but there are no records of production. Small, lightly-specked to clear mica occurs in the dump but does not appear to be abundant in the mine.

Garrett No. 2 mine.—A number of years ago, a shaft reported to be 40 feet deep was sunk 65 feet south-southwest of the Garrett No. 1 mine (Pl. 18). The nearby dump contains white perthitic potash feldspar and small clear to lightly specked mica.

Garrett No. 3 prospect.—This prospect, consisting of a pit 15 feet wide and deep, is on the Albert Knight property 240 feet southeast of the Garrett No. 1 mine, about 1½ miles southwest of Ridgeway (Pl.18). When it was cleaned out by the owner in 1944, a body of kaolinized pegmatite 4 feet thick, striking N.67°E. and dipping from vertical to 80°SE. was exposed. Some small poor quality mica occurred adjacent to a tapering quartz core.

Garrett No. 4 mine.—This mine, worked by Fields and others about the time of World War I, is on the Albert Knight property a mile east of the Eanes No. 1 mine ¾ mile southeast of U. S. Highway 220, and 1¼ miles south-southwest of Ridgeway (Pl. 16, No. 24). The largest opening is a 40-foot shaft inclined 60°NW. down the dip of a body of pegmatite 10 feet thick. Potash feldspar is plentiful in the dump but mica appears to be scarce. Four shallow pits, aligned N.35°E., 75 feet southeast of the shaft have exposed a kaolinized pegmatite body with a 2-3 foot quartz core, about which lightly to heavily black-stained "A" mica is fairly plentiful. It is reported that some flat mica which trimmed 2 by 3 inches was recovered.

Garrett Nos. 5 and 6 prospects.—Six shallow holes, here designated the Garrett No. 5 prospect, have been opened on the northeast side of a lumber road, on the Albert Knight property, a quarter of a mile west-southwest of the Garrett No. 4 mine (Pl. 16, No. 25). Small, clear to black-stained, flat and "A" mica occurs sparsely in association with a massive quartz body as much as 100 feet thick, about which there is a minor amount of perthite. A small quantity of black-specked mica has also been recovered from several prospect pits, here designated the Garrett No. 6 prospect, an eighth of a mile south of the No. 5 prospect (Pl. 16, No. 26).

Garrett-Penn feldspar mine.—This mine is on the Albert Knight property, 300 feet N.55°W. of the old Penn farmhouse, half a mile southeast of U. S. Highway 220, and a mile south-southwest of the town limits of Ridgeway (Pl. 16, No. 23). Old workings consist of approximately 10 shallow pits from 5 to 25 feet long, opened within a distance of 250 feet along a body of pegmatite about 20 feet thick. This body strikes N.40°E. and dips 60°NW. in conformity with the foliation of the enclosing coarse quartz-mica schist. The pegmatite is composed chiefly of potash feldspar, but it also contains some plagioclase, quartz, and small, flat, rum-colored, generally black-specked mica.

Oliver prospects.—Several shallow pits and exploratory shafts were opened a number of years ago in vicinity of Matrimony Creek, about ¾ mile southwest, south, and southeast of the Eanes No. 1 mine, and 1¾ miles southwest of the town limits of Ridgeway (Pl. 16, Nos. 31, 32, 33, and 34). In 1943, there had been no recent work and only a small amount of clear light rum-colored mica was visible in the dumps.

Pace mines and prospects.—About a dozen openings for mica have been made on the Pace property on the west side of Road 726, 0.3 mile west of U. S. Highway 220, and half a mile west of the town limits of Ridgeway (Pl. 16, No. 18). First woık is said to have been by a Mr. Doyle in 1918. In 1943, the Keystone Mica Company of Stoneville, North Carolina, reopened an old pit (here called No. 1 pit) 20 feet deep, about 200 feet south of the Pace farmhouse. A 15-foot incline was extended from the bottom of the pit northwestward down the dip of the pegmatite, and from the end of this a drift was driven 15 feet northeastward. Work was abandoned by this company when the west wall began to cave. In April 1944, mining at this pit was resumed by F. H. Lamb, F. M. Dodson, and D. D. McCall of the Walnut Cove Mica Company, who lengthened the incline to 19 feet and the northeast drift to 34 feet.

These operations at the No. 1 pit exposed a body of pegmatite with an average thickness of about 3 feet, a N.75°E. strike, and a dip of 45°NW., largely enclosed in hornblende metagabbro. The body pinched and swelled irregularly and appeared to pinch out entirely near the end of the northeast drift. Core segments of quartz as much as a foot thick were present in places; the remainder of the body was largely plagioclase-quartz-muscovite pegmatite. Book mica occurred chiefly near the walls of the body and was especially abundant in the local rolls and swells. Mica from this mine is generally clear, flat to flat "A" with good crystal faces, and from light rum- to ruby-colored. Some of the larger books measured 8 by 10 inches.

Two pegmatitic masses, enclosed in aplitic granite and containing some mica, are visible in an old shaft, 20 feet deep to fill, 30 feet north of the No. 1 pit. A second pit, 200 feet east of the Pace farmhouse, was cleaned out and briefly worked by the Walnut Cove Mica Company in 1944. A thin body of pegmatite, lying between hornblende metagabbro and gneissic aplite, striking about N.17°W. and dipping 37°NE., was exposed. Some mica similar to that at the No. 1 pit was recovered, but the operation was abandoned when the pegmatite appeared to pinch out in a short drift from the north end of the pit at a depth of 27 feet.

Lovelace (Doyle) mine and prospects.—The Lovelace mine and prospects are on the John Doyle property a mile west-southwest of Ridgeway (Pl. 16, No. 19). The mine, which is a quarter of a mile northeast of Road 688, was opened in 1916 by Gus Grindstaff and Dewey Kallam, who sank 3 shafts from 25 to 40 feet deep, about 30 feet apart along a N.25°E. line. Grindstaff states that $5,000 worth of mica was sold from the mine in 1916, and that the greatest quantity of mica was recovered from the northeasternmost shaft, which was 40 feet deep.

Mining was resumed in the early 'twenties by Kallam and Blevins, who changed the operation to an open pit. In 1943, this pit was 95 feet long, 50 feet wide, and 25 feet deep to fill. The main body of pegmatite was not visible; but a 2-foot thickness of pegmatite, enclosed in hornblende metagabbro, striking N.35°E., and dipping 80°NW., was exposed along the north side of the pit. Little mica could be seen in place, but that in the dump was of small sheet size, flat, and clear to lightly specked.

Some mica similar to that at the Lovelace mine has been found in narrow lenses of pegmatite exposed in several shallow pits dug within a distance of 120 feet northeast of the mine. Some prospecting also has been done in vicinity of Road 688 southwest of the mine, but most of the mica recovered has been lightly to heavily specked with primary stain.

Carter Prospect.—A crooked shaft 15 feet deep has been sunk on the T. W. Carter property a quarter of a mile south of the Lovelace mine and a mile southwest of Ridgeway (Pl. 16, No. 20). A body of pegmatite 2 feet thick, striking N.30°E. and dipping 65°NW., enclosed concordantly in very coarse quartz-mica schist, is exposed. Heavily specked "A" mica is abundant along the footwall adjacent to an 8-inch quartz core.

In 1943, A. W. Newberry cut two exploratory trenches 130 feet and 90 feet long at a place 300 yards southeast of the above shaft, exposing several small unproductive lenses of pegmatite. Some small books of mostly clear mica were uncovered, but they were reevy and difficult to split.

DeShazo mine.—The DeShazo mine is half a mile northwest of U. S. Highway 220 and 1½ miles southwest of the corporate limits of Ridgeway (Pl. 16, No. 21). It was mined for mica by Gus B. Grindstaff and Dewey Kallam during World War I; by C. R. McIver of Greensboro, North Carolina, during 1943 and the early part of 1944; and by R. M. Griffiths of Pottsville, Pennsylvania, during the fall of 1944 and in 1945.

At the time McIver began mining, there were several dozen shallow openings, including several shafts from 15 to 40 feet deep, within an area about 400 feet long from east to west and 360 feet wide (Pl. 19).

McIver's work consisted chiefly of two pits 70 and 115 feet long; a 60-foot incline plunging 16 degrees in a N.40°E. direction from the north end of the southernmost pit, with various associated cross-cuts and stopes near its end and a 25-foot shaft in the northern pit near an old "Dogwood" opening made earlier by E. C. Burton. Griffiths drove another incline 60 feet long, nearly parallel with, but at a flatter angle and below, the McIver incline. This intersected the McIver workings at a horizontal distance of 30 feet from the McIver adit. Griffiths next cut two pits, 50 and 70 feet long and about 20 feet deep, near the crest of the hill 120 feet northwest of the northern McIver workings near some recent openings by A. G. Owen and W. S. Harless. He also drove a 32-foot tunnel northward into the hill 70 feet northwest of the northern McIver pit, but this failed to encounter pegmatite.

The geology in vicinity of the DeShazo deposits is complex. The main openings have been made largely in foliated aplitic granite and the numerous pegmatitic fracture fillings and replacements which it contains. This body of granite is elongated irregularly northeastward, is about 125 feet wide, and is bounded in part on the southeast side by mica schist and gneiss and on the northwest side by hornblende metagabbro. Masses of the metagabbro also intertongue with the granite at each end and locally form septa within that part of the granite which has been mined. This so-called metagabbro, like many similar hornblendic rocks occurring in peripheral areas about large granitic masses, may be genetically related to the granite.

The pegmatitic masses, which contain the book mica, generally trend somewhat across the foliation in the enclosing granite and are quite irregular and unpredictable. Most strike northeastward and dip to the southeast, except in vicinity of the northwesternmost openings where they dip to the northwest. The pegmatitic solutions appear to have gained access along fractures, about which they have replaced granite in varying degree, so that the walls of the pegmatite are not at all sharp. In McIver's northern pit, a thin pegmatite body, rich in mica, more or less follows the granite-schist contact. In places, books of muscovite occur almost completely within granite, but there is always some pegmatitic plagioclase (oligoclase near albite) and quartz associated with it. All of the pegmatite bodies uncovered have been only from a few inches to several feet thick, but the thicker bodies commonly have quartz cores and intermediate zones rich in perthite.

Although the pegmatite bodies are small, they are locally numerous and generally contain appreciable small- to medium-size good quality book mica. This is smoky rum-colored, fairly hard, flat, and largely free from mineral speck. The largest books recovered by McIver were over a foot across, but the average trim was about 2 by 2 inches. McIver sold approximately $5000 worth of mica during his first year of operation.

Price mine.—This mine is on the John Price property, a mile south-southwest of the DeShazo mine, 0.6 mile by Road 689 north of U. S. Highway 220, and 2 miles southwest of the corporate limits of Ridgeway (Pl. 16, No. 22). Mining was begun in 1943 by E. C. Burton at the southernmost of a series of 8 old prospect pits aligned about N.55°E. along the southeast brow of a hill. Burton sank a shaft to a depth of 30 feet, then drove a 51-foot incline in a N.42°E. direction from the bottom.

The shaft intersected the hanging wall of a body of pegmatite 8-10 feet thick, striking N.45°E. and dipping 50°SE., which fingered out into schist near the bottom of the shaft. The incline was driven along the keel of the pegmatite which has a northward plunge of about 18 degrees at this place. The pegmatite is essentially a coarse aggregate of white plagioclase, buff microcline, quartz, and muscovite; little zonation is evident in the parts exposed. Two narrow shoots of mica extended down through the pegmatite in the shaft, but mica was most abundantly recovered from along the keel of the body. This mica is smoky rum-colored, hard, flat, and mostly clear; a small percentage is specked. Books from 5 to 8 inches across were common, and one book recovered measured 9 by 14 by 4 inches and weighed 50 pounds.

Coleman mines and prospects.—Two mines and several prospects have been opened on the Sam T. Coleman property immediately north of the Virginia-North Carolina line, 2.4 miles west of U. S. Highway 220, and 5½ miles west-southwest of Ridgeway (Pl. 16, Nos. 42, 43, 44).

The No. 1 mine is on a north-trending ridge about 200 yards south of the Coleman home (Pl. 20). First mining was in 1917-18 by Dewey Kallam, J. B. Grindstaff, and Gus B. Grindstaff, who sank several shafts, the deepest possibly to 50 feet, and made a pit 80 feet long by 35 feet wide. Two shafts were within the area of the pit; and a third, 41 feet deep with a 35-foot southeastward drift from the bottom, is 20 feet north of the pit. Gus Grindstaff states that little mica was recovered from the latter operation and that the most mica was taken from the easternmost and deepest shaft. Some mica-bearing pegmatite, striking northwestward and dipping 60° to 70°NE. more or less concordantly with the enclosing biotite gneiss, is exposed in the northwest and southeast ends of the pit.

In January 1944, E. J. Tyler, of Asheville, North Carolina, sank a 56-foot shaft (steeply inclined to 28 feet and vertical below) in the east corner of the pit. Lenticular bodies of pegmatite about 2 feet thick, striking approximately N.70°W. and dipping 45°NE., were encountered at depths of 30 and 54 feet in the shaft. A curving, combined drift and stope with average inclination of about 13 degrees was then started eastward following the lowermost body (See Pl. 20). This body pinched out 50 feet from the shaft, but other similar lenses and pods of pegmatite were encountered beneath the first, and the drift was extended a total distance of 65 feet. Some lenses were enclosed more or less concordantly in biotite gneiss; others were closely associated with, and locally enclosed in, banded aplite. Book mica occurred from wall to wall in most lenses and was particularly abundant in some of the small thick pods in aplite. Some of the thicker lenses contained cores of blocky buff-colored perthite.

Mica from the No. 1 mine is smoky rum- to greenish rum-colored, hard, generally flat, and clear to lightly specked. A large quantity of trimmed punch and 2 by 3 to 6 by 8 inch sheet was sold during Tyler's operation, which was terminated in July 1944.

The Coleman No. 2 mine is on the east side of a small stream about 300 yards northeast of the No. 1 mine. It was first worked during World War I by Gus B. Grindstaff and Dewey Kallam, who sank a 25-foot shaft 60 feet east of the stream and ran 40- and 140-foot drainage tunnels to the west and northwest from the bottom. A considerable quantity of mica is said to have been produced. In the spring of 1943, the Keystone Mica Company of Stoneville, North Carolina, sank a 20-foot shaft just east of the old caved shaft and recovered a small quantity of mica. In the fall of the same year, E. J. Tyler deepened this shaft to 25 feet, ran a 15-foot drift southward from the 20-foot level, then opened the whole into a pit 40 feet long by 25 feet wide and deep.

Tyler's work at the No. 2 mine exposed several bodies of pegmatite, from a few inches to 3 feet thick, for the most part striking about N.70° W. and dipping 50° to 55°NE., enclosed in partly decomposed aplite. Some of these were rich in book mica similar to that at the No. 1 mine; others were barren. When the operation was abandoned, some mica was still visible in a narrow zone near the west end of the pit about 10 feet from the surface.

Two bodies of pegmatite, one 2 feet and the other 10 inches thick, striking N.40°W. and dipping northeastward, are exposed in several shallow prospect pits which were opened a number of years ago about a quarter of a mile west of the Coleman home. Mica is fairly abundant in the dumps, but most of it is specked and badly bent and broken.

Ernest Penn prospect.—In 1943, C. P. Robertson of Stoneville, North Carolina, did exploratory work on the Ernest Penn property just north of the Virginia-North Carolina line, 3.2 miles slightly north of west of Price, North Carolina (Pl. 16, No. 53). He cleaned out an old pit to a depth of 10 feet and drove a tunnel 35 feet N.40°W. along the strike of a body of pegmatite with a 57°NE. dip and a thickness in excess of 4 feet. Where exposed, this body is composed chiefly of perthite, kaolin, and muscovite. Although fairly abundant, the mica is mostly of "A" structure and is from lightly to heavily specked.

L. J. Smith prospect.—This prospect, consisting of several shallow pits, is on the L. J. Smith property just north of the Virginia-North Carolina line and 1¾ miles N.68°W. of Price, North Carolina (Pl. 16, No. 41). A body of pegmatite 1½ feet thick, striking N.65°E. and dipping 30°SE., is exposed in one pit 12 feet deep. From clear to heavily-stained, smoky green, flat mica is fairly abundant in the dump, and some is visible in place. About 50 feet east of this pit, blocky perthite occurs prominently in a second pit reported to have been opened for feldspar about 1910.

Watkins prospect.—This prospect, just north of the Virginia-North Carolina line, 0.3 mile southwest of Watkins School, and a mile west-northwest of Price, North Carolina, was worked by the Chestnut Mountain Mica Company in 1919 (Pl. 16, No. 39). Two shafts were sunk, the deepest to 25 feet. Mica is said to have been found in some abundance and in large books, but much of it was badly ruled and broken. That in the dumps is stained and specked.

Phillips mine.—This mine, consisting of about a dozen shallow pits from 5 to 50 feet long, some on each side of a gravel road, is just north of the Virginia-North Carolina line 2 miles slightly west of south of Ridgeway (Pl. 16, No. 36). A body of pegmatite from 5 to 25 feet thick and over 100 yards long, striking N.65°E., is exposed. Massive quartz in a core 4 feet thick and pale pink potash feldspar of the intermediate zone are prominent in the medial and southwestern openings; the feldspar, probably plagioclase, at the northeastern openings is largely kaolinized. Badly wedged "A" mica, finely dusted with iron oxides, is locally abundant in the wall zones and adjacent to quartz of the core. It is reported that Gus Grindstaff and E. C. Burton worked the mine for the Richmond Mica Company before World War I and shipped from 12 to 14 tons of scrap mica.

Remsen prospect.—A small quantity of green, generally clear flat "A" mica, some in books 5 inches across, was found in an excavation for a cellar on the C. O. and N. C. Remsen property a third of a mile northwest of the Phillips mine and 1¾ miles south-southwest of Ridgeway (Pl. 16, No. 35).

Mullens prospect.—The Mullens deposit is in the extreme northwestern part of the main Ridgeway belt about half a mile north of the Virginia-North Carolina line, 4¾ miles south of Spencer, and 8 miles west-northwest of Ridgeway (Pl. 16, No. 54). It was worked as an open pit, 50 feet long, 25 feet wide, and 10 feet deep, by E. G. Adams of Martinsville in 1934. An irregularly branching body of pegmatite with a maximum width of about 25 feet, striking N.70°E. and dipping steeply to the northwest, is exposed in this pit and can be traced on the surface eastward for 60 yards. Mica, some in books measuring 12 by 14 inches, is abundant in parts of this body. Although it is pale- to deep-green, soft, and commonly badly reeved and black stained, a small quantity of strategic grade was recovered by E. C. Burton in 1944.

Williams prospect.—The Williams prospect, several miles outside of the Ridgeway area proper, is 0.3 mile south of U. S. Highway 58 and 3 miles southwest of Martinsville. Workings consist of 4 small pits within a distance of 200 feet, opened by K. E. Williams in 1943-44, in which are exposed several small lenses of pegmatite, containing a moderate amount of small, specked mica, and some beryl. The latter is in small, well-formed, white to golden crystals, some of which are reported to be of gem grade.

PRINCIPAL MINES AND PROSPECTS—RIDGEWAY AREA, N. C.

The locations of mines and prospects in the North Carolina portion of the Ridgeway area are shown on Plate 16. The more important of these are briefly described here because of their geologic and economic relations to those in the Virginia portion of the area. For more detailed accounts of these, and for descriptions of the less important deposits, see Griffitts, Jahns, and Lemke, 1953.

Tom Smith mine.—This mine, consisting of 5 shafts, numerous pits, and various underground workings along the strike of a mica-bearing pegmatite for a distance of nearly 700 feet, is on the south side of the Price-Sandy Ridge Road about 3 miles S.80°W. of Price, Rockingham County, North Carolina (Pl. 16, No. 51, and Pl. 21). It was worked by Richard Fortner for J. C. Burleson during World War I, with a reported recovery of 168,000 pounds of mica. In 1942, it was reopened by the Keystone Mica Company of Stoneville, North Carolina, who worked it intermittently into the summer of the following year, recovering about 80,000 pounds of mica. In January 1944, Benjamin D. Smith, the owner, started a new operation which lasted about 6 months. Following this, J. E. Bird of Thomasville and Oscar Lackey of High Point spent several months making two large open pits with the use of heavy earth-moving equipment, but they recovered relatively little mica. These pits, one of which is over 500 feet long, 90 feet wide, and about 35 feet deep, largely obscured most of the earlier workings. Both the outline of these pits and earlier openings are shown on Plate 21.

The pegmatite body at the Tom Smith mine strikes N.64°W., dips from 35° to 67°NE., and is generally concordant with the foliation of the enclosing complex of mica, hornblende, and granitic gneisses. It dips most steeply in the eastern part of its exposure and, at least locally, steepens with depth. It varies in thickness from 8 feet in some western openings to about 25 feet in eastern openings and has a length in excess of 600 feet. Mineral zonation is not prominent in the pegmatite. The feldspar, which was predominantly plagioclase, has been almost completely kaolinized even in the deepest workings. Thin cores and parallel lenses of quartz, generally less than one foot thick but attaining a thickness of 3 feet in at least one place, are common. Pale green, generally clear "A" mica is locally extremely abundant, especially near quartz masses and along the footwall of the body. So much of this is soft, ruled, wedged, or locky that the percentage yield of mica has been low. Appreciable sheet mica, however, has been rifted from the flat "A" books, some of which are quite large. A block recovered in 1942 measured 2 feet square, weighed several hundred pounds, and yielded 14 by 16 inch trimmed sheets.

Two large north-trending diabase dikes, from 7 to 22 feet thick, along with several smaller sill- and dike-like bodies, cut the pegmatite body. The Keystone No. 1 shaft, which was intended to intersect this body down dip, failed to encounter any pegmatite because it was inadvertently sunk in one of these nearly vertical decomposed bodies of diabase. Crystals of mica adjacent to this diabase had been bleached and robbed of their properties of elasticity and easy splitting.

Harry Knight mine.—The Harry Knight mine, one of the largest producers of mica in the Ridgeway area, is 0.7 mile northwest of the Tom Smith mine, 3.6 miles due west of Price, North Carolina, and 7 miles west-southwest of Ridgeway (Pl. 16, No. 52). It was opened by H. A. Knight, Jr., of High Point in January 1943, and in May 1945 workings consisted essentially of a wedge-shaped pit 100 feet long and 35 feet deep, an air shaft, and a roughly radial pattern of inclines and drifts which fanned out approximately 100 feet down-dip from the pit (Pls. 22 and 5A).

The pegmatite body is a gently undulating sill from 1 to 12 feet thick, striking from N.20°W. near the surface to about N.35°W. in the lower workings, and dipping approximately 25°NE. The average thickness within the workings is 5 to 6 feet. The body is prevailingly concordant with the foliation of the chloritic hornblende gneiss country rock, which is altered to coarse biotite gneiss adjacent to the pegmatite.

The pegmatite is imperfectly zoned and consists largely of plagioclase (An_5)-quartz-muscovite wall zone, enclosing fairly continuous core segments of massive quartz from a few inches to several feet thick. Perthite is present in minor amount in much of the wall zone and occurs as large blocky crystals in thicker and deeper parts of the pegmatite about quartz cores and associated with highly quartzose portions of the pegmatite. Garnets are also abundant in parts of the quartzose pegmatite; and Griffitts, Jahns, and Lemke (1953, p. 162) have reported the presence of uraninite, autunite, uranophane (?), other secondary uranium minerals, and allanite (?).

Mica is very abundant in a shoot from 1 to 2 feet thick which follows the footwall of the body and appears to plunge eastward across its northeast dip (Pl. 3B). This shoot has a pitch length of over 160 feet and a breadth of from 40 to 100 feet. A poorer mica shoot follows the hanging wall of the body, and some books occur near quartz cores. The mica is smoky rum-colored, hard, flat, and free-splitting; about half of that recovered has been lightly to heavily stained or specked with iron oxide. Mica in the hanging wall shoot contains more stain than that in the footwall shoot, and stain seems to increase somewhat toward the borders of each shoot. The mica tends to be large, 10-inch books being very common, and some books being as much as 22 inches across.

Rosa Evans mine.—This mine, 2.1 miles airline S.60°W. of Price, North Carolina, and 6 miles southwest of Ridgeway (Pl. 16, No. 49), was first worked during or before World War I. It was leased in 1942 by the Keystone Mica Company of Stoneville, North Carolina, and was worked intermittently for about a year under the direction of C. P. Robertson. It was taken over and worked throughout 1944 by H. A. Knight, Jr., of High Point.

Workings consist of two pits, 55 and 90 feet long and about 30 feet deep, and a dozen or more other small pits and shallow shafts within an area 200 feet long by 160 feet wide on a northeast-facing hillside. The pegmatite body, which has been encountered in nearly all of the openings, is from 6 to over 25 feet thick, strikes approximately N.55°W., and dips northeastward at a somewhat steeper angle than the 18° slope of the hill. The pegmatite body, which is composed chiefly of plagioclase, quartz, and muscovite, shows no distinct zonation except that parts of it are coarsest and contain buff-colored perthite near the hanging wall. Small- to medium-size book mica is locally abundant in pockets and shoots, some of which are near the hanging wall, but others of which appear to have no particular localization within the body. The mica is pale greenish rum-colored and free from black iron oxide, but it commonly contains curdy green primary vegetable stain and is wavy. Production during World War II was moderate and the sheet recovery was rather high, but little of the recovery was No. 1 quality.

Joe Hawkins mine.—This mine, one of the largest producers of mica in the Ridgeway area, is in northeastern Stokes County, 2.2 miles west-southwest of Sandy Ridge, North Carolina (Pl. 16, No. 59). It is said to have been opened about 1890 by Joe Hawkins. It was next worked by the Empire Mica Company of New York in 1903, and by Sam Blaylock of Celo, N. C., during World War I. The Sandy Ridge Mica and Mining Company of Washington, D. C., then operated it from August 1942 until February 1944, recovering a large quantity of high quality mica. In September 1944 the mine was reopened by Louis Aldridge, W. S. Flynt, and Ira Goins.

In December 1944, workings consisted essentially of a pit 170 feet long, 40 feet in maximum width, and 40 feet deep to fill; and a 365-foot incline (280 feet long from the adit) with associated lateral stopes and short tunnels. This incline extends N.30°W., following the dip of the pegmatite body,which varies from 40° near the surface to 16° near the end of the incline. The Sandy Ridge Mica and Mining Co. drove a 50-foot exploratory drift southwestward from the incline 155 feet from the adit, but this drift curved irregularly up-dip and did not follow the hanging wall of the pegmatite where another shoot of mica might be most expected. This company abandoned operations when the pegmatite appeared to pinch out near the end of the incline; but when Aldridge, Flynt, and Goins reopened the mine it was found that the pegmatite steepened rather abruptly at this place and the incline had been driven over the pegmatite.

The pegmatite body is from 2 to 10 feet thick in the incline, strikes N.60°E. and dips from 40° to 16°NW. Its lateral extensions are incompletely explored, but the thinning of the body to the northeast and down-dip make it appear that the workings are near its northeastern edge. The body is largely concordant, but locally discordant, with the foliation of the enclosing gneissic granite and migmatic biotite gneiss. The body is imperfectly zoned, with quartz core segments from a few inches to several feet thick, intermediate zones rich in buff-colored perthite adjacent to or occupying the position of the core, and wall zones of plagioclase-quartz-muscovite pegmatite. Deep red garnets are common. Book mica was taken mainly from a very rich shoot which followed the northeast edge of the pegmatite body, chiefly along the hanging wall. According to Scott Thomas, mine foreman, this shoot ranged in vertical thickness from a few inches to 6 feet and had an average width of about 15 feet. It is possible that other parallel shoots lie southwest of existing workings.

Mica from this mine is smoky to pinkish rum-colored and generally flat and clear. The percentage yield of sheet mica was high, and many books recovered were large enough to trim 6 by 8 inches.

Ruby King (*J. C. Hawkins*) *mine.*—This mine is on the Jonah C. Hawkins property 700 feet east of the Joe Hawkins mine and 2.1 miles west-southwest of Sandy Ridge, North Carolina (Pl. 16, No 58). It is said to have been worked about 1920 and was reopened in 1944 by C. P. Robertson and E. C. Burton. In December 1944, the main workings were an old shaft 25 feet deep, a pit 47 feet long and 27 feet deep, and a 72-foot incline driven in a N.15°E. direction, all connected by a room-and-pillar-like network of drifts and stopes. These drifts and stopes were on two levels, one along the hanging wall and the other on the footwall of the pegmatite body, and were separated in many places by a massive quartz core from 1 to 6 feet thick. Coarse masses of perthite occur in places adjacent to this quartz. In the central part of the workings, the pegmatite body strikes N.30°E. and dips 16°NW., but its west edge is turned up, giving it a trough-shape. It is generally, although not everywhere, concordant with the foliation of the feldspathic biotite gneiss wall rock. Greenish "A" mica with low sheet yield occurs on both sides of the quartz core and is especially abundant on the under side. Flat ruby- to rum-colored mica of excellent quality occurs less abundantly along the footwall of the pegmatite and to some extent along the hanging wall. The production of strategic sheet mica during the period of World War II was large.

Jack Hole (*Hole*) *mine.*—The Jack Hole mine, another large producer of sheet mica during the World War II period, is on the steep north valley wall above Big Creek about a quarter of a mile west of its junction with Dan River and 6 miles by Road 89 from Danbury, Stokes County, North Carolina (Pl. 16, No. 63). It is said to have been opened about 1901 and was reopened in June 1943 by the Sandy Ridge Mica and Mining Company of Washington, D. C. Sterrett (1923, p. 263-265) describes two deposits about a third of a mile apart; the one worked in 1943-44 appears to be the one which he refers to as the "other outcrop", rather than the "principal deposit". In January 1944, mica was being recovered from a combination incline and stope, 65 feet long, 20 feet high, inclined 25° northwestward into the hill. Several other openings, including a short incline, had been made at about the same level on the hillside, exposing a body of pegmatite over 200 feet long, striking nearly east and dipping 30° to 40°N. more or less concordantly with the foliation of the enclosing coarse quartz-mica schist. This body is 25 feet thick at the incline but tapers in both directions along the strike. The feldspar, which includes both perthite and plagioclase, is largely unkaolinized. Plates of quartz an inch or so thick extend through the pegmatite parallel with the walls. Several small faults cut the pegmatite within the incline and to the east of the adit. Book mica, some in crystals a foot across, occurs here and there through much of the pegmatite and is localized above and below a schist horse on the east side of the incline. The mica is light greenish rum-colored, of flat "A" structure, and commonly considerably ruled and bent.

AXTON AREA

GENERAL STATEMENT

Pegmatites occur here and there throughout eastern Henry and southwestern Pittsylvania counties and are localized in a rather well-defined area about 12 miles long from east to west and 5 miles wide in the general vicinity of Axton, Henry County (Fig. 1, No. 14; and Fig. 9). U. S. Highway 58 from Martinsville extends through the southwestern part of the area, and paved Road 647 extends northward from Axton; access to most other parts of the area can be gained by clay and gravel roads.

This area is characterized by the mature, rather strongly rolling topography which typifies much of the dissected western Piedmont province of Virginia. The topography is somewhat more subdued and the weathering generally deeper than in the Ridgeway area to the southwest. Elevations range from about 600 feet near Sandy River in the eastern part of the area to 1029 feet at Axton.

The rocks of this area are similar to those in the Ridgeway area, but poor outcrops make accurate comparisons difficult. The chief rock types are quartz-mica schists and gneisses, aplitic granite, and hornblende "metagabbro". Diabase dikes are common and chlorite-actinolite metapyroxenite occurs near Soapstone 4 miles east of Axton.

Pegmatites are numerous in the more common rocks and have various attitudes. Those in the western and northern parts of the area

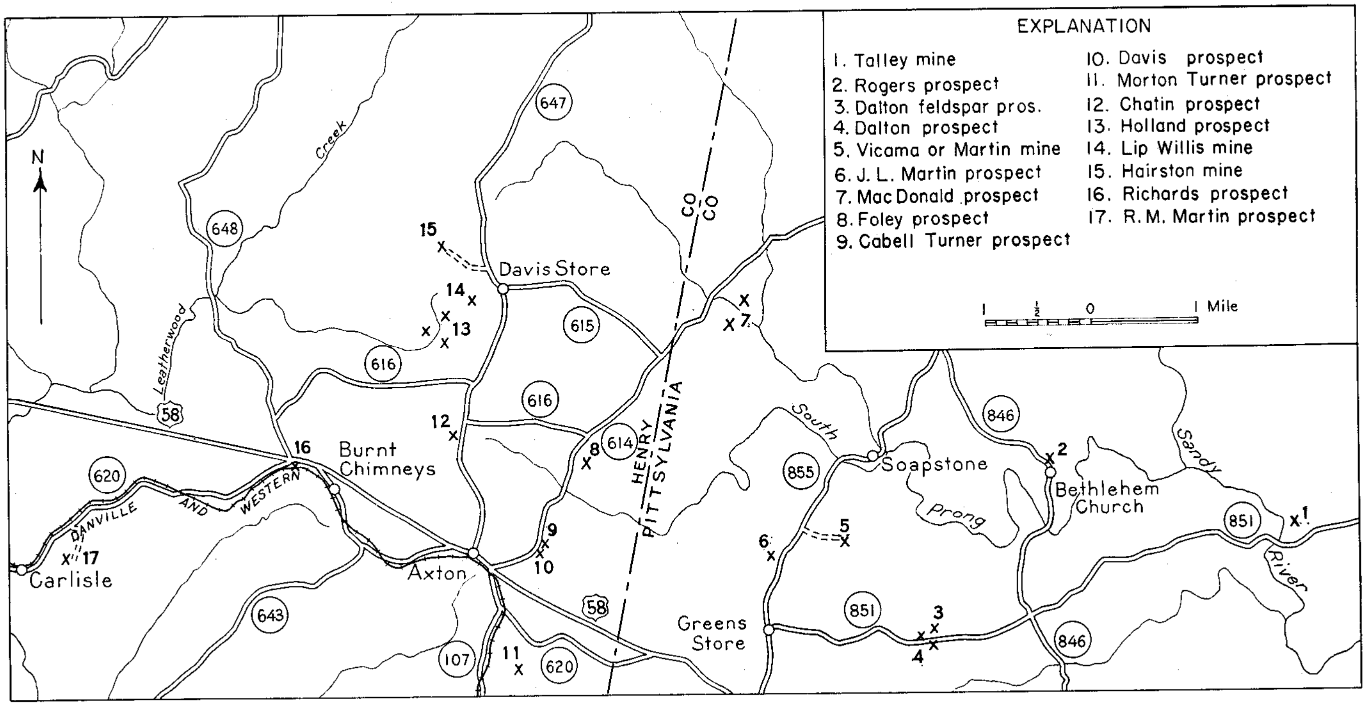


Figure 9. Location of mines and prospects in the Axton area.

generally strike northeastward and those in the southeastern part tend to strike northwestward. Many are more or less concordant with the foliation of the enclosing rocks; others are discordant. Heavy slumpage in old pits and general poor exposure make accurate determinations of size difficult, but some bodies are over 40 feet thick and several hundred feet long. The chief minerals are the common ones of pegmatites elsewhere, feldspar, quartz, and muscovite. Tourmaline, garnet, and biotite occur as accessories; and beryl has been reported from the Hairston mine (Sterrett, 1923, p. 328). Many bodies have sizeable cores of massive quartz, and some have large intermediate zones rich in blocky perthite. Muscovite in sheet sizes is abundant in some, occurring chiefly in the kaolinized plagioclase-quartz-muscovite wall zone portions, but much of it contains iron oxide stain. A moderate amount of feldspar has been recovered from some of the bodies with large perthitic units.

The area was widely prospected and mined for mica in the early 'twenties, but later activity has been largely confined to small-scale feldspar mining. At the time the deposits were examined during the years 1942-1944, there was practically no activity.

MINES AND PROSPECTS

Vicama (Martin) mine.—This mine is in Pittsylvania County, on the west side of Georgia Branch, a mile northeast of Greens Store, and 3½ miles due east of Axton (Fig. 9, No. 5). It is said to have been opened by Edd Martin and Arthur Harper shortly before World War I and worked by the Vicama Mica Company about 1922; it was later worked by Mica Products Corporation and by Edd Martin.

Workings, consisting of about 16 shafts from 15 to 50 feet deep, a dozen pits of various sizes, and fairly extensive underground workings, are largely within an area 200 yards long by 50 yards wide, extending northwestward from a small westward tributary to Georgia Branch along a low ridge. The pegmatite body, which is from 15 to 30 feet thick, strikes N.35-40°W., and dips 10°NE., crops out at the southern base and along the southwestern side of the ridge; it is about 40 feet beneath the surface on the northeast side of the ridge. Pits and inclines have been opened along the outcrop and the shafts sunk to the northeast. A second body of pegmatite, beneath and parallel with the first, was encountered in some of the shafts. Both bodies are generally concordant with foliation in the enclosing biotite and hornblende gneisses. In 1943, many of the unsupported large flat stopes in the gently-dipping pegmatite had collapsed, and the underground workings were generally inaccessible.

A core of massive quartz as much as 3 feet thick is present in many parts of the pegmatite body and, in places, parallel masses of quartz occur. Perthite, generally adjacent to massive quartz, is prominent in places, especially in some southeastern openings. Plagioclase is largely kaolinized near the surface but is fairly fresh in the deeper workings. Well-formed garnet crystals, some 3½ inches in diameter, are locally abundant. Mica is said to have been found in large pockets, but most of it is lightly to heavily specked, and is of "A" structure. According to Pegau (1932, p. 77), 20 carloads of scrap mica, 15 tons of punch and sheet mica, and 3 carloads of feldspar were sold from the mine in the early 'twenties.

Hairston mine.—This mine is on the property of R. M. Martin in Henry County, 0.4 mile west of Road 647, and 3 miles north of Axton (Fig. 9, No. 15). It was worked between 1918 and 1920 by H. C. Fields and has been worked intermittently by the owner since 1932. Earlier mining was primarily for mica, but more recent operations have been largely for potash feldspar.

Workings consist of about a dozen shafts and pits from 5 to 35 feet deep, some of which are connected by tunnels, within an aıea about 500 feet long by 100 feet wide. When the deposit was examined in 1943, exposures were very poor, but it appeared that the deposit consisted essentially either of one very irregular body or several small bodies. Visible masses of pegmatite generally trend N.20-40°E. and dip from vertical to 80°SE. in more or less concoıdance with the foliation of the mica schist wall rock. Some small discordant masses exposed in the largest pit, however, follow obvious fault breaks. Black tourmaline in long slender crystals is locally abundant in both the pegmatite and adjoining wall rock and commonly forms rosettes in books of mica. Beryl has been reported by Sterrett (1923, p. 328), and Martin states that a few pounds have been sold. Biotite is another common accessory.

Light green "A" mica is rather abundant, but most of it is specked or stained, and many books contain mineral inclusions. Flat mica of good size is said to have been recovered from some of the now caved northeastern openings.

Lip Willis mine.—This mine is on the R. L. Brown property half a mile southeast of the Hairston mine and 2½ miles north of Axton (Fig. 9, No. 14). It was worked for mica by H. C. Fields of Martinsville between 1920 and 1923.

The pegmatite body strikes N.77°E., dips nearly vertical or steeply to the southeast, and consists essentially of a core of massive quartz from 2 to 6 feet thick bordered by thin kaolinized plagioclase-quartz-muscovite wall zones. Six shallow pits 5 to 25 feet long, connected in part by tunnels, have been opened along the northwest side of the quartz core, and 3 shafts 20 to 40 feet deep have been sunk on the southeast side, exposing the body for a distance of about 125 feet. Book mica and imprints of books as much as 8 inches across occur in and along the quartz in fair abundance. This mica is partly flat and partly of "A" structure, light greenish, and mostly black stained.

Holland prospects.—The Holland prospects, described here as Nos. 1, 2, and 3, are on the R. J. Holland property about half a mile west of Road 647 and 2 miles north of Axton (Fig. 9, No. 13). At the No. 1 prospect, which consists of a small pit 10 feet deep to fill on a low ridge a quarter of a mile S.60°W. of the Lip Willis mine, finely specked mica in books as much as 4 inches across is fairly abundant in the dumps. The No. 2 prospect, consisting of two shafts aligned in a N.65°W. direction, possibly 20 feet deep with short connecting tunnels, is on the slopes of a low hill about a quarter of a mile southwest of the No. 1 prospect. Mica in the dumps is bright-green, has heavily stained borders, and is commonly ruled and bent. At the No. 3 prospect, along a lumber road two-tenths of a mile southeast of the No. 2 prospect, some books of heavily specked "A" mica have been recovered from a small shallow pit.

Chatin prospect.—The Chatin prospect, on the J. N. Holland property near Road 647 and 1½ miles by road north of Axton (Fig. 9, No. 12), is a partially filled pit 10 to 15 feet deep, about which are scattered pieces of feldspar, quartz, and mostly clear, but sub-sheet size, mica.

Richards (Dishwater) prospect.—The Richards (Dishwater) prospect is about 150 yards west of the Moral Hill Baptist Church and 1½ miles west-northwest of Axton (Fig. 9, No. 16). Mica, including one book 6 by 4 by 4 inches, was first uncovered here by dishwater thrown from the porch of the Burnt Chimney farmhouse. In June 1944, A. G. Owen and W. S. Harlass started a shaft at this place but abandoned it at a depth of 11 feet when only a little small specked mica was found. The mica occurs in thin pegmatite streaks in aplitic granite, striking about N.63°W. and dipping 35°NE.

R. M. Martin prospect.—A pit 10 feet deep has been opened on the R. M. Martin property a quarter of a mile southeast of the old Martinsville-Danville Road, half a mile east of Carlisle, and 3.8 miles due west of Axton (Fig. 9, No. 17). Some scrap mica and several tons of feldspar have been recovered from a gently-dipping body of pegmatite 4 feet thick.

Morton Turner prospect.—Small, black-specked mica was found in some abundance in a shallow pit 50 feet southeast of the Morton Turner farmhouse a mile south-southeast of Axton (Fig. 9, No. 11). In 1943 the pit had been filled.

Cabell Turner prospect.—A considerable quantity of mica is said to have been recovered by a Mr. Adkins about 1910 from 6 openings along the crest of a low hill on the Cabell Turner property about half a mile east-northeast of Axton (Fig. 9, No. 9). These openings, which in their slumped condition in 1943 appeared to be mainly pits about 15 feet deep, are aligned N.25°E., presumably with the strike of a pegmatite body. Small, clear to lightly specked, greenish mica is fairly abundant in the dumps.

Wynn (Jim Davis) prospect.—Several small pits have been opened on both sides of a small stream on the George T. Wynn property, several hundred feet southwest of the Cabell Turner prospect and half a mile east of Axton (Fig. 9, No. 10). Small, cracked, reevy, specked mica, good only for scrap, is abundant in the dump at the main pit north of the stream; perthitic microcline and glassy quartz are also present. Similar mica is also abundant at places 200 feet to the west and 370 feet to the southwest.

Foley prospect.—Four shallow pits, now largely filled and overgrown, have been opened on the Ruben Davis property about 250 yards east of Road 614 and 1.5 miles by road northeast of Axton (Fig. 9, No. 8). Greenish rum-colored, cracked, bent, specked mica is abundant in the small dumps; and a number of books, including some 8 inches across, are visible in the northernmost pit. The trend of the pegmatite, very little of which is visible, is northeastward.

MacDonald prospect.—The MacDonald prospect, owned in 1943 by Ida Watkins, is on the east side of Road 614 near Tanyard River and 3½ miles northeast of Axton (Fig. 9, No. 7). The main opening is a slumped pit 20 feet long and 6 feet or more deep. Greenish rum-colored, flat "A" mica of small sheet size is scarce in this pit but fairly abundant in the dump. Possibly 50 per cent of it is clear, whereas the remainder is lightly specked and streaked.

J. L. Martin prospect.—The J. L. Martin prospect is about 250 yards west of Road 855, 0.7 mile north of Greens Store, and 2.6 miles east of Axton (Fig. 9, No. 6). Concerning this prospect, Pegau (1932, p. 77) states: "It was operated by the Vicama Mica Company in 1922. It is reported that 25 tons of mica was taken from an open cut 20 feet long and 25 feet deep. The dike is about 10 feet wide and strikes

N.50°W. It consists of a medial band of quartz 3 feet wide, flanked by kaolin intermixed with quartz and mica. Mica commonly occurs next to the quartz." In 1943, the old opening was filled to a depth of 12 feet and little pegmatite was exposed. Mica was not especially abundant in the dump and that seen ranged from clear and flat to heavily specked and strongly reeved.

Dalton prospect.—The Dalton prospects are on both sides of Road 851, 1.6 miles east by road from Greens Store and 4½ miles east of Axton (Fig. 9, Nos. 3 and 4). The workings include several small pits and shafts located along an irregular northwesterly line for a distance of about 1000 feet. The largest opening near the northwest end of the area prospected is said to have consisted of a shallow shaft with a 30-foot drift extending southeastward from the 15-foot level. Mica in the nearby dump is soft, crinkled, and heavily stained. Locally in other parts of the area prospected small, clear to heavily specked mica is fairly abundant.

About 250 feet northwest of the Dalton farmhouse, pink perthitic microcline, some in graphic intergrowth with quartz, is sufficiently abundant and widespread to suggest the possibility of commercial feldspar.

Talley mine.—This mine is on the Lucy Giles Talley property, 200 yards east of Sandy River, a quarter of a mile north of Road 851, and 7.5 miles east of Axton (Fig. 9, No. 1). Workings, made by the Vicama Mica Company in the early 1920's, include two shafts, the deepest 40 to 60 feet deep, several short tunnels, and a small open cut. The pegmatite body is about 4 feet thick, strikes N.65°W., dips 60°SW., and consists of a quartz core 1 to 3 feet thick bordered by kaolinized wall zones. According to Pegau (1932, p. 77), the deposit is reported to have yielded 3 carloads of mica, mostly scrap. Sheets of lightly to heavily black specked, light rum-colored mica, some 4 inches across, are abundant in the dump.

Rogers prospect.—The Rogers prospect, last worked by E. C. Burton of Martinsville, is about 200 yards northeast of Bethlehem Church and 5½ miles slightly north of east of Axton (Fig. 9, No. 2). The old workings included two shallow pits about 40 feet long and several prospect holes, aligned in a N.55°E. direction. All were slumped in 1943. Small, light rum-colored, ruled, heavily specked mica was fairly abundant in the dumps.

Easly mine.—The old George Easly mine, owned in 1943 by Solomon Easly, is well outside of the Axton area proper, being in Pittsylvania County 18 miles northeast of Axton and 3¼ miles S.25°W. of Chatham (Fig. 1, No. 13).

According to Sterrett (1923, p. 329), this deposit was worked first between 1900 and 1905 and again about 1910. Development consisted of a shallow pit which opened into a sloping tunnel that extended about 25 feet southward to an airhole shaft, thence 25 feet in a S.55°E. direction to the bottom of a 40-foot shaft. Further tunnelling was done from this deeper shaft. When the mine was visited in 1943, the tunnels were inaccessible and the 40-foot shaft was filled to within 25 feet of the surface.

The foliation of the mica gneiss wall rock exposed in the pit is contorted but strikes generally east and dips about 40°S. The gneiss contains black tourmaline needles near its contact with the pegmatite. Sterrett states that the pegmatite body is over 8 feet thick, and that it is about normal granitic pegmatite without large segregations of massive quartz. The body appears to strike northward and dip 35-45° to the east. Feldspar in the pegmatite is partly kaolinized.

Light green ruled books of mica, some 5 inches across and varying from clear to heavily stained and from flat to wedged "A", are fairly abundant in the dump. Books 14 inches in diameter are said to have been recovered.

Terry mine.—This mine is on the east brow of Nantes Mountain in Henry County several miles northwest of the Axton area proper, 100 yards east of Road 659, 1.4 miles north of Virginia Highway 57, and 3½ miles northeast of Martinsville (Fig. 1, No. 15). Development has been chiefly by E. G. Adams of Martinsville, and both mica and feldspar have been produced.

In June 1945, workings consisted of an L-shaped pit 40 feet long opening into a 15-foot tunnel driven northwestward into the sloping hillside of Nantes Mountain. The pegmatite body is 19 to 25 feet thick, strikes N.35°E. and dips about 50°NW. It is irregularly zoned. Several masses of massive quartz 2 to 10 feet thick, associated with and locally including large sheets of biotite and very coarse blocks of pink perthite, occur in interior parts of the body but are not everywhere in the central part. Portions of the inner part of the body are also plagioclase-perthite-quartz-muscovite pegmatite. The wall zones are largely finer grained plagioclase-quartz-muscovite pegmatite. Much of the plagioclase is kaolinized but the perthite is relatively fresh. A considerable quantity of scrap mica was recovered from a very rich shoot 1½ to 2 feet thick in plagioclase pegmatite adjacent to and on the footwall side of the largest quartz mass. Radial masses of "A" books with apices pointing inward also occur here and there in plagioclase-rich pegmatite. Most of the mica from the mine is black stained and of poor structure, but sales of potash feldspar and scrap mica have made mining profitable. Some electric sheet mica has been sold.

PHILPOTT AREA

Several mines and prospects for mica have been opened in a poorly defined area about 7 miles long by a mile or so wide, extending east-northeastward through Philpott in the northwest corner of Henry County (Fig. 1, No. 17; and Fig. 10). Both clear and stained mica, along with a small amount of potash feldspar have been produced. The area is one of mature dissection and relatively rugged topography. Elevations range from about 800 feet at Smith River to slightly over 1200 feet on the higher hilltops. The chief rock types are garnetiferous, and locally staurolitic, mica schists and gneisses, hornblende gneiss, and light gray Leatherwood granite. Phyllite, pebbly quartzite, soapstone, and metapyroxenite occur in vicinity of Henry about 2 miles north of the main part of the area. Pegmatites are fairly plentiful but few are large. Most strike northwest and dip northeast; some are prevailingly concordant with the foliation of the wall rocks, others are markedly discordant. The bodies generally have cores of massive quartz, perthite-rich intermediate zones, plagioclase-rich wall zones, and thin discontinuous border zones.

MINES AND PROSPECTS

Greer and Merriman mines.—These mines, on adjacent properties and on the same pegmatite body, are half a mile north of Virginia Highway 57, two miles southwest of Philpott, and 2.4 miles N.68°W. of Bassett (Fig. 10). The deposit was first worked about 1935 by Allen Moore. In 1942, that portion of the deposit on the Booker Greer property (Greer mine) was leased by Edd Martin, of Axton, and E. C. Burton, of Ridgeway, who worked it intermittently into 1945. In June 1944, E. J. Tyler, of Asheville, N. C., opened a pit 18 feet wide and 15 feet deep at the site of some old prospect trenches on the adjoining Merriman property to the south.

In June 1945, development at the Greer mine included three shaft-like openings about 18 feet apart and 5 to 15 feet deep along the hanging wall (east wall) of the body. The two southernmost were connected by a partly caved drift which led into a southward-plunging incline beyond the southernmost opening. In addition, Martin had driven a 30-foot incline into the footwall side of the body opposite the northernmost opening.

The pegmatite body is 20 to 30 feet thick, over 200 feet long, strikes N.20°W., dips 57-75°NE., and is largely concordant with the foliation of the enclosing staurolite-kyanite-mica schist. Zonation is well developed. No large quartz core was exposed in the workings of the Greer mine, but a 2-foot thickness was encountered in Tyler's pit on the Merriman property. Most of the pegmatite at the Greer mine is composed of intermediate zone white to buff perthite with interstitial and graphically intergrown quartz. This is bordered by largely kaolinized plagioclase-quartz-muscovite wall zones from one to four feet thick; a 3-inch fine-grained quartz-muscovite border zone is evident in places on the hanging wall. Along the footwall in the Martin incline, albite (An_3) and abundant fine pale green muscovite fill fractures in and locally replace perthite.

Book mica is very abundant in a shoot about 3 feet thick along the hanging wall in the Greer mine; it is much less abundant on the footwall and in the openings on the Merriman property. This mica is generally clear, but some is stained and specked. The clear material is almost free from color. Tourmaline inclusions are common, and ruling is widespread. The sheet recovery is low, but some strategic sheet was sold by Martin and Burton. Although this has not been a feldspar mine, the large perthite-rich intermediate zones suggest that it could be a commercial source of potash feldspar.

Morrison mine.—The Morrison mine is on the C. R. Morrison property on the south side of Road 674 about 1½ miles northeast of

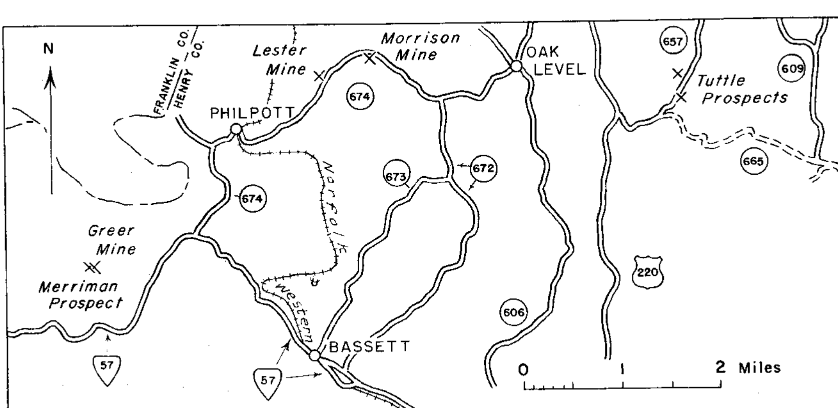


Figure 10. Location of mines and prospects in the Philpott area.

Philpott and 3 miles north of Bassett (Fig. 10). It is thought to have been worked first by E. G. Adams of Martinsville about 1935 and next by Pat Thomas in 1939. It was reopened by Edd Martin and E. C. Burton in the fall of 1943, but this partnership was soon dissolved, and Martin alone continued to operate the mine until June 1944.

Early work consisted chiefly of a steeply inclined shaft about 90 feet deep, with a short northwestward drift from about the 35-foot level, and two test pits 60 and 100 feet east of the shaft. Martin deepened the shaft, robbed the sides, and extended a 43-foot drift southeastward from about the 35-foot level and a 59-foot drift northwestward from the 20-foot level. Overhand stoping from the southeast drift was carried to within 10 feet of the surface. Muck from both drifts was dumped into the shaft, filling it to within 21 feet of the surface.

All workings generally follow the hanging wall of the pegmatite body which strikes N.50°W. and dips 70°NE. The complete width of the body is not exposed but it is in excess of 8 feet; the length of the body is shown by float to be over 200 feet. An exceedingly rich mica shoot occurs in kaolinized pegmatite along the hanging wall throughout most of the workings. This shoot is separated from the quartz-mica schist wall, which the pegmatite cuts discordantly, by a 2- to 3-inch border zone of quartz and small green mica. Small quartz masses and some perthite occur in the inner part of the body.

The mica is generally clear, white, soft, and small, although some 8 to 10-inch books were recovered. It is reported that Martin recovered from 30 to 35 tons of mine-run mica from his small operation and, although a high proportion of it was badly ruled and cracked, his sale of strategic sheet was large.

Lester mine.—This mine is on the G. P. Lester property 80 feet west of Road 674, half a mile S.65°W. of the Morrison mine, and 1¼ miles by road northeast of Philpott (Fig. 10). It is said to have been opened by E. G. Adams about 1937.

Workings consist of three closely spaced pits, 20, 26, and 40 feet long and from 10 to 15 feet deep. When examined in 1942, the pegmatite body was poorly exposed. It strikes N.65°W., dips 70°NE., is thoroughly kaolinized, and appears to be about 15 feet thick. Large quartz core segments up to 5 feet thick are prominent in parts of the dike. Small mica is fairly plentiful in the dumps and rough books 8 inches across were seen in place adjacent to quartz. This mica is generally clear, white, and of flat structure, but much of it is ruled, and black tourmaline inclusions occur in some books.

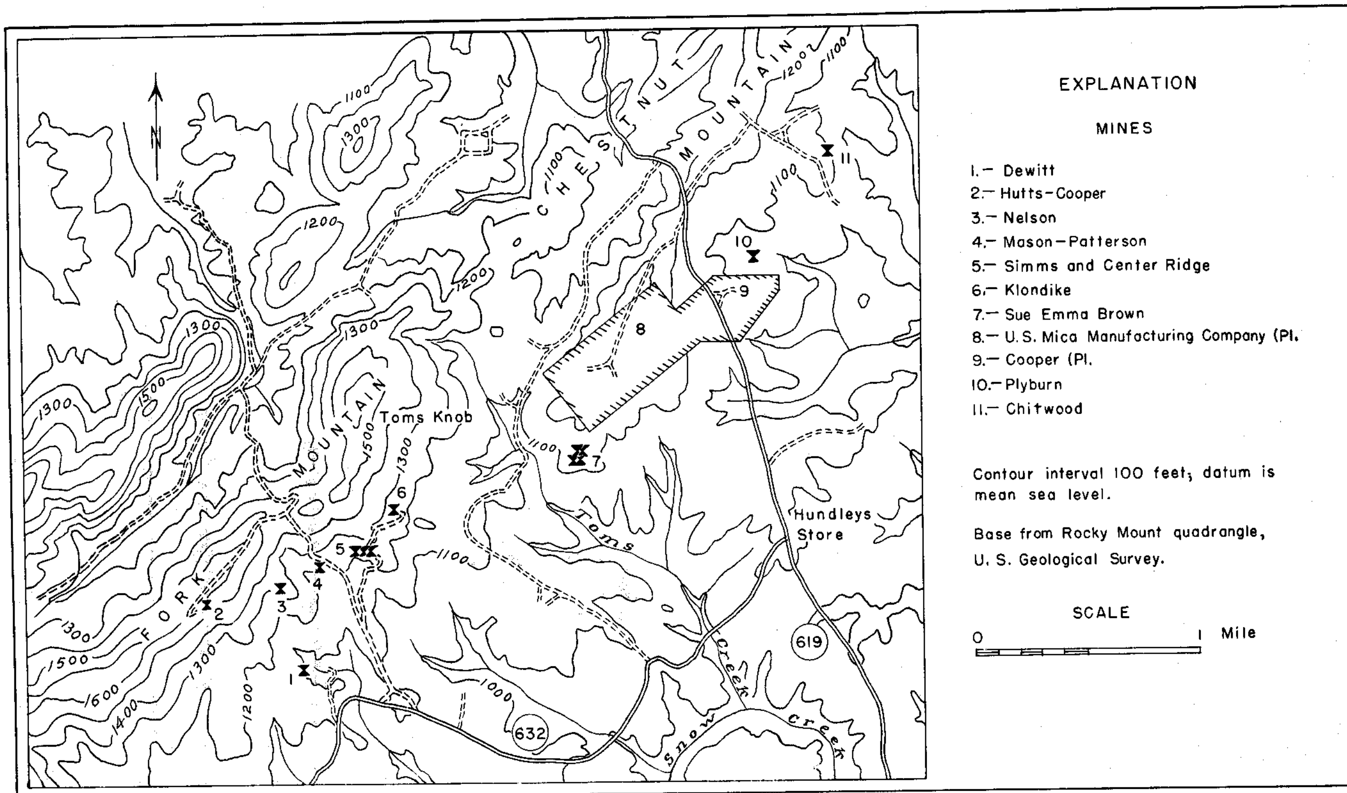


Figure 11. Location of mines and prospects in the Chestnut Mountain area, Franklin County.

Tuttle prospects.—The Tuttle prospects, consisting of two small pits, are on the Charlie Tuttle property near Bowles Mill, 0.6 mile east of U. S. Highway 220, and 7½ miles north-northwest of Martinsville (Fig. 10).

The southern pit, 9 feet long and 4 feet deep, is on the southwest side of Road 657 and half a mile north of Bowles Mill. A body of kaolinized pegmatite over 6 feet thick, striking northwestward across the foliation of the mica schist wall rock, is exposed. Both clear and lightly stained and specked mica, some in books 5 inches across, is abundant adjacent to a 3-foot quartz core.

The northern pit, 4 feet in diameter and 5 feet deep, is 0.6 mile by road north of the southern pit and 200 yards west of Road 657. The pegmatite body exposed in this cut is over 3 feet thick, strikes N.65°W., dips 65°SW., and is parallel with the foliation of the enclosing mica schist. The pegmatite is largely kaolinized and contains abundant small mica near a mass of quartz along the footwall. All of the mica examined was heavily black-stained and much of it was badly ruled and bent.

CHESTNUT MOUNTAIN AREA

GENERAL FEATURES

Pegmatite deposits occur here and there in southeastern Franklin County but are rather abundantly localized in an area about 4 miles long by less than a mile wide, extending northeastward along the southeast flanks of Fork and Chestnut Mountains from a place about 3 miles southwest of Road 619 to near Heaton Branch, a mile northeast of Road 619 (Fig. 1, No. 16; and Fig. 11). The area is readily accessible from Rocky Mount, 11 miles to the northwest, by paved Road 619, and from Martinsville, a similar distance to the south, by Virginia Highway 108 and Road 619.

The Chestnut Mountain area is situated high up on the flanks, and in part upon outlying knobs, of Fork and Chestnut Mountains, which rise fairly abruptly as monadnocks above the dissected Piedmont surface. The topography is rugged and slopes are steep. Elevations range from about 1000 feet on the lower slopes to 1690 feet at the crest of Fork Mountain. Drainage is southeastward to Snow Creek. The water table generally lies between 40 and 60 feet below the surface; but in mines of the U. S. Mica Manufacturing Co., high on the mountain, water was seldom encountered at depths less than 100 feet. Most of the area is under second growth forest cover.

Mining has been almost entirely for scrap mica and electric sheet mica; no feldspar has been produced. The first important mining in the area was by the Chestnut Mountain Mica Company before World War I. This company remained active until about 1920 and, during part of this period, maintained a sheeting house at Chestnut Mountain and a sheeting house and a manufacturing plant at Rocky Mount. J. T. Mullaney then organized the Clinchfield Mica Corporation which operated until about 1924; from 1924 until 1929, mining was carried on by the Central Mica Corporation of Rocky Mount. The main properties were then leased by H. C. Fields, of Martinsville, who worked the deposits until 1934, at which time the U. S. Mica Manufacturing Company put in a modern separatory plant and took over operations on the south side of the Rocky Mount Highway (Road 619). This company mined continuously, except for seasonal shutdowns, until 1944. Mining was continued on the north side of Road 619 as late as 1943 by a subsidiary of Asheville Mica Company, of North Carolina, and into 1945 by the Nelson Mica Company of Rocky Mount.

ROCK TYPES

The prevailing rock type is quartz-muscovite schist; garnetiferous, staurolitic, and chloritoid-bearing facies are very common; and biotite and hornblende gneisses occur locally. Foliation generally strikes northeast and dips 30° to 70°SE., but variations are common, especially near discordant pegmatite intrusives.

These schists and gneisses form rather good mine walls where fresh and dry; but, because of the deep weathering which prevails throughout most of the area, careful timbering is required in most underground workings. Many pit operations are also made hazardous by the tendency of prominent joints in combination with schistosity to promote large slumps, particularly where schistosity dips into the pit.

PEGMATITES

Pegmatites are abundant in the main area of concentration, and some are large. That at the Cooper mine attains a thickness of 40 feet and is over 900 feet long. Elsewhere, bodies from 2 to 75 feet thick have been mined, but the average of those worked is about 10 feet. Few operations have been abandoned because of bottoming of the pegmatite, but deep kaolinization has almost completely prevented mining below the water table. It is said that the Old Chestnut Mountain Mine was worked to a depth of 160 feet.

Considering the area as a whole, the strike and dip of pegmatite bodies is quite variable; but within limited parts of the area attitudes tend to be similar. In the southwestern part of the area, most bodies are largely concordant with the foliation of the enclosing rocks which strikes northeast and dips steeply southeastward. In the northeastern two-thirds of the area, most bodies are discordant and strike N.60°W. to east and dip steeply northward. Most of the longer bodies show considerable variations in strike, and locally change from a northward to a southward dip. The walls of many bodies are very irregular, in places partly because of replacement of the wall rock, and apophyses are frequently numerous.

The area is characterized by a rather well-developed system of joints, one set of which are approximately parallel with many of the discordant pegmatites. These joints are younger than the pegmatite and thus could not have affected its intrusion, but the pegmatite may have been injected into openings which were produced by forces similar to those which produced the joints.

Feldspar in the pegmatites is almost completely kaolinized in all workings and appears to have been predominantly plagioclase; however, the blocky nature of some kaolin and its graphic intergrowth with quartz seem to show that perthite was present in places. Cloudy to smoky quartz occurs in all pegmatites as "burr" intergrowth with mica, interstitial veinlets and masses, and/or large cores and core segments. Black tourmaline and weathered garnets are common accessories, and beryl occurs in a few bodies, chiefly as small crystals in or near quartz cores. Biotite, largely altered to vermiculite and commonly intergrown with and enclosed by later muscovite and quartz, occurs abundantly as fracture fillings and replacements about fractures in the wall zones of some bodies.

Mica is abundant in most bodies but it is virtually all black-stained or specked and a high proportion of it is too small or badly deformed for use other than as scrap. Considerable quantities of electric sheet were produced in the earlier years of mining but more recent mining has been almost entirely for scrap mica. In most bodies the mica is more or less disseminated from wall to wall, but some is concentrated in shoots, usually along the walls or near quartz cores. In these concentrations the mica locally comprises 40 to 80 per cent of the pegmatite, but the average yield from most dikes taken as a whole is reported to be 12 to 25 per cent. The deeply kaolinized pegmatite is easily mined and explosives are seldom necessary except where large masses of quartz are to be removed. The usual practice is to mine the entire pegmatite and pass it through screens and rollers to separate the mica; only large books are removed by hand.

PRINCIPAL MINES AND PROSPECTS

U. S. MICA MANUFACTURING COMPANY MINES

A large number of mines have been opened within a district about a mile long by half a mile wide lying between Road 619 and the headwaters of Toms Branch to the southwest (Fig. 11, Nos. 7, 8 and 9). Most of the mines are on the southern and eastern slopes of a small knob which lies just south of the southwest end of Chestnut Mountain. Various parts of the district are owned by Sigurd Olsen, Central Mica Corporation, Tom Dudley, Daniel Goode, Eames, and Sue Emma Brown.

Mining was started in this district before World War I and was carried on almost continuously until late in 1944. The longest continuous and most extensive mining was carried on by the U. S. Mica Manufacturing Company, of Forest Park, Illinois, between 1934 and 1944. During part of 1944, operations were continued by Security Development Company of Chicago. In the spring of 1945, the mining and separatory equipment of the U. S. Mica Manufacturing Company had been bought by the Nelson Mica Company of Rocky Mount.

About 30 shaft and pit mines, the deepest said to be 135 to 160 feet deep, and a large number of prospect holes have been opened. Most of the large pits are slumped and in 1945 underground workings in all but the newer mines were largely inaccessible. The location and general nature of most of the openings are shown on Plates 23A and 23B. Historical data included in the descriptions to follow were obtained largely from Gus B. Grindstaff, Mine Foreman for Nelson Mica Company.

Mule Hole mine.—The Mule Hole mine, so named because of two mules which were killed in a slide here, is on a south-sloping hillside 240 feet southeast of Road 619 and 3.4 miles by road north-northwest of Virginia Highway 108 (Pl. 23B). In 1943 it had been idle for some time and visible workings consisted of a partly slumped pit 250 feet long and 55 feet deep from the high north side, elongated N.75°W. with the strike of the pegmatite. A 15-foot thickness of kaolinized pegmatite with much quartz-mica "burr" was visible in the west end of the pit. First work at the place was done by the Chestnut Mountain Mica Company which sank 2 shafts about 50 feet deep. The present pit was opened by the Central Mica Corporation about 1926, but the operation is said to have been unsuccessful because of early collapse of the north wall.

No. 3 mine.—The No. 3 mine is adjacent to and on the southeast side of the old highway about 400 feet northwest of the Mule Hole mine (Pl. 23B). It consists of several shafts with connecting drifts, the deepest shaft being about 35 feet deep. Last work was done by the U. S. Mica Manufacturing Company about 1941. It is reported that excellent stained sheet mica, some in ribbons 4 by 14 inches, was recovered near the surface, but at greater depth, little but small broken mica was found. A body of kaolinized pegmatite over 20 feet thick, striking N.80°E., is exposed in the workings.

Water Hole mine.—The Water Hole mine, along a small stream about 350 feet southwest of the Mule Hole mine (Pl. 23B), was worked about 1940 by the U. S. Mica Manufacturing Company. The workings, now largely filled with water, consisted chiefly of a pit 120 feet long and 35 to 40 feet deep, and several drifts. A 20-foot thickness of kaolinized pegmatite with massive quartz is exposed in the west end. There are no records of production.

Brooks mine.—The Brooks mine, which was worked chiefly by the U. S. Mica Manufacturing Company, is 320 feet west-southwest of the Water Hole mine and 240 feet north of the U. S. Mica Manufacturing Company separatory plant (Pl. 23A). The workings, consisting mainly of two pits 115 and 80 feet long and several shafts, all connected by drifts, are aligned in a N.80°W. direction. Mining at the eastern pit is reported to have extended to a depth of 75 to 80 feet. Masses of kaolinized pegmatite 12 to 20 feet thick, and a small decomposed diabase dike are exposed in the western pit.

Chimney mine.—This mine, consisting essentially of 2 shafts 35 feet apart and underground workings extending to a depth of about 60 feet, is 540 feet northwest of the U. S. Mica Manufacturing Company separatory plant (Pl. 23A). Pegmatite, in a body 4 feet thick, striking N.75°W. and dipping 55°NE., is said to have been stoped out almost completely between the shafts to the depth of working. The unusually regular walls of this body suggest emplacement along a fault. It is said that mica, ranging from clear to lightly specked, was found in abundance at this mine and that some of the best sheet of the district was produced.

Eames No. 2 mine.—This mine, partly on the Eames' and partly on the Central Mica Company property, is at the crest of the main ridge 380 feet west of the Chimney mine and 950 feet west-northwest of the U. S. Mica Manufacturing Company separatory plant (Pl. 23A). Workings, made chiefly by the U. S. Mica Manufacturing Company, consist of a roughly circular pit 60 feet in diameter and 30 feet deep to fill, and one or more inclines to the east. Two parallel bodies of pegmatite, the upper 4 to 5 feet thick and the lower 3 feet thick, striking N.5°E. and dipping 35°SE., are exposed in the eastern part of the pit. The upper body has a 3-foot core of massive quartz. A large quantity of scrap mica is reported to have been recovered from this mine.

Plant No. 1 mine.—This mine, consisting of 3 shafts and several small elliptical pits, all connected by drifts and stopes, is immediately west of the U. S. Mica Manufacturing Company separatory plant (Pl. 23A). The westernmost shaft is 330 feet west of the plant, the easternmost is 60 feet west of the plant, and underground workings are said to extend beneath the plant. In 1942, the shaft nearest the plant, called the "Plant" shaft, was being used for entrance and hoisting. This was 100 feet deep on a 68 degree incline to the north-northeast, and drifts 50 to 200 feet long had been driven in both directions along the pegmatite body at vertical intervals of 20 feet.

The pegmatite body strikes from N.60°W. to N.80°E., dips 65-75°N., is over 380 feet long, and is from 5 to 11 feet thick in the workings. As elsewhere in the area, the feldspar is thoroughly kaolinized to and probably somewhat below the deepest workings. A persistent quartz core from a few inches to 2 feet thick extends throughout the exposed parts of the body. In places adjacent to this, the outlines of coarse blocky feldspar and graphic granite are visible in kaolin, suggesting that there was an intermediate zone rich in perthite. Small- to medium-sized mica occurs abundantly disseminated throughout most of the pegmatite and locally is concentrated in shoots near the walls and adjacent to the quartz core. Most of this is bent, ruled, and black stained.

Plant No. 2 mine.—This mine is on another kaolinized pegmatite body which is nearly parallel with and lies 100 to 160 feet south of the body at the Plant No. 1 mine (Pl. 23A). It was worked by the U. S. Mica Manufacturing Company during 1942-43. Development included three inclined shafts, the deepest going to about 80 feet, several small pits, and extensive connecting drifts and stopes. The pegmatite body strikes N.70-80°W., dips 67-75°NE., is over 400 feet long, and has an average width of 5 to 6 feet. A core of massive quartz from a few inches to 3 feet thick extends through most of the exposed portions of the body. The recovery of scrap mica was large.

Old Chestnut Mountain (*Cook and Custer*) *mine.*—This mine is on the northeast brow of the main knob on the property worked by the U. S. Mica Manufacturing Company, 300 yards west-southwest of the separatory plant (Pl. 23A). It is probably one of the oldest and deepest mines in the area. The Chestnut Mountain Mica Company is said to have worked it to a depth of 124 feet and the U. S. Mica Manufacturing Company is reported to have deepened it to 150 to 160 feet. In 1945, the workings, which include several pits from 40 to 80 feet long and five shafts, were badly caved and little could be determined about the deposit. The pegmatite body is quite irregular near its west end but trends generally east, dips 66-75° northward, and is locally at least 20 feet thick. In part it contains a core of massive quartz 3 to 5 feet thick.

Hickory mine.—This mine, consisting of two relatively shallow shafts 30 feet apart with connecting drifts, is 250 feet southwest of the Old Chestnut Mountain mine and 1100 feet west-southwest of the separatory plant (Pl. 23A). The pegmatite body is about 3 feet thick, strikes N.65°W., dips 65°NE., and contains a small quartz core. A considerable quantity of good electric sheet mica is said to have been produced from the mine. Openings also have been made on two similar, nearly parallel, bodies 45 and 115 feet to the northeast.

No. 29 mine.—The No. 29 mine is about one-third of a mile southwest of the U. S. Mica Manufacturing Company separatory plant (Pl. 23A). It was worked chiefly by the Chestnut Mountain Mica Company and is reported to have been a good producer. Workings include a pit 105 feet long and 25 feet deep to fill, a 15-foot shaft 40 feet to the east, and various drifts and stopes from the bottom of each. The pegmatite body exposed in the pit is about 12 feet thick, strikes N.78°W., and dips about 62°NE., cutting across the foliation of the enclosing chloritoid-quartz-mica schist, which strikes N.60-65°E., and dips 55-67°SE. Quartz core segments several feet thick are included in parts of the dike.

Dudley mine.—The Dudley mine, 115 feet southwest of the No. 29 mine (Pl. 23A), has been worked by both the Chestnut Mountain Mica Company and the U. S. Mica Manufacturing Company. The recovery of scrap mica is said to have been large. Workings consist chiefly of a pit 150 feet long, 15 to 40 feet wide, and 35 feet deep to fill, and two inclines extending southeastward from the east end of the pit. The pegmatite body strikes N.60°W., dips northeast, and appears to range from 12 to 30 feet in thickness. It is discordant to the foliation of the chloritoid schist wall rock, has irregular walls, and locally includes large horses of schist.

Sue Emma mine.—The Sue Emma mine is 450 feet S.75°W. of the Dudley mine and a mile N.68°W. of Hundley's Store (Pl. 23A). It is reported to have been opened by J. E. Burleson about 1914 and worked briefly in 1942 by the U. S. Mica Manufacturing Company. Workings consist of an oval pit 25 feet long by about 20 feet deep, and a shallow, steeply inclined shaft with connecting drift. A nearly vertical body of pegmatite about 12 feet thick and striking N.70°E. is exposed in the pit.

Crystals of beryl, some over an inch thick and 5 inches long, occur in a 3- to 4-foot quartz core.

Several shallow shafts and prospect pits have also been opened between the Sue Emma mine and Toms Creek about half a mile to the southwest, but production from this locality has been relatively small.

COOPER PROPERTY

The G. K. Cooper property comprises a district about a quarter of a mile square on the northeast side of Road 619 immediately opposite the U. S. Mica Manufacturing Company mines and a mile north-northwest of Hundley's Store (Fig. 11, No. 9, and Pl. 23B). From 1936 until 1943 the mines on the Cooper property were operated by a subsidiary of Asheville Mica Company, originally called the Franklin Mica Corporation and later the Lincoln Mica Company. Mining by these companies was underground and by pit. In 1943 the Nelson Mica Company of Rocky Mount bought Lincoln Mica Company's equipment, including a scrap mica separatory plant, and began open-pit mining with a bulldozer, a method found to be quite successful in the larger bodies of kaolinized pegmatite. To handle increased mine output, a new plant was built in the spring of 1945 near the crossing of Road 619 and Chestnut Creek on the northwest side of Chestnut Mountain

Cooper mine.—This, the largest mine on the G. K. Cooper property, is 200 feet north of the Nelson Mica Co. separatory plant, 300 feet northeast of Road 619, and 1.2 miles north-northwest of Hundley's Store (Pl. 23B). In 1945 the main opening was a pit 580 feet long, 20 to 60 feet wide, and 20 to 41 feet deep. Earlier workings at the site of this pit included a 60-foot shaft and associated underground workings. A 50-foot shaft and 2 inclines with connecting drifts and stopes had also been opened on the same body of pegmatite within 200 feet of the east end of the main pit; and a pit 100 feet long had been opened on another body of pegmatite, or the faulted end of the same pegmatite, just west of the main pit.

The main body of pegmatite is over 900 feet long and varies in width from a maximum of 40 feet near its western end to only 6 feet at its easternmost exposure. It is nearly vertical and strikes N.83°W. in the main pit, but it bends to a N.75°E. strike and a steep southeast dip near its eastern end. The body is discordant to the foliation of the enclosing iron-stained quartz-mica schist. Post-pegmatite faults occur near the west end of the main pit and may have displaced the west end of the body northward. Remnants of a massive quartz core occur in parts of the main pit. No unkaolinized feldspar was observed by the writer, but the blocky nature of some kaolin near the core and its graphic intergrowth with quartz suggest the former presence of perthite-rich intermediate zones. Quartz-mica "burr" is common in various parts of the body; and fracture zones with fillings and adjacent replacements of biotite, quartz, and muscovite are abundant in parts of the wall zones. Small- to medium-sized, ruled and broken, stained and specked mica is abundant throughout much of the pegmatite, especially that of the wall zones. The production of scrap mica from the mine has been large.

Grindstaff mine.—This mine, opened by Gus B. Grindstaff many years ago, is 50 feet southeast of the main pit of the Cooper mine (Pl. 23B). First development consisted of a nearly circular pit 90 feet in greatest dimension and 40 feet deep; later the Franklin Mica Company extended this pit 120 feet to the west and drove inclines and stopes to the east. In 1943, the Lincoln Mica Company sank a shaft 25 feet east of the main pit and crosscut northward beneath old workings to the pegmatite

The major part of the pegmatite body strikes about N.80°W. and dips steeply to the southeast, but in its eastern part it splits into numerous branches which extend in various directions. For the most part, it is discordant with the foliation in the mica schist wall rock, but some branches are concordant. The body has a maximum thickness in excess of 30 feet. The feldspar is completely kaolinized in the workings and little zonation is evident. Biotite fracture fillings, now altered to vermiculite, are abundant in the outer parts of the body. Muscovite is abundantly disseminated through much of the pegmatite and large quantities of scrap mica and appreciable electric sheet have been recovered.

Indian mine.—This mine, consisting of an oval pit 75 feet long with a 50- to 60-foot caved shaft in the middle, is 45 feet northeast of the Grindstaff mine (Pl. 23B). The deposit is thought to have been worked first in prehistoric times, but chief mining was done by the Franklin Mica Company. The pegmatite body strikes generally east-northeast and dips steeply southeastward, but it is very irregular and has numerous apophyses. Production of stained scrap mica from the mine is said to have been good.

Fields mine.—The Fields mine, consisting of a pit 140 feet long and about 30 feet deep, is 415 feet south of the Cooper mine and 115 feet northeast of Road 619 (Pl. 23B). It was worked most extensively by H. C. Fields of Martinsville, probably in the early 'thirties. The kaolinized pegmatite body exposed in the pit cuts discordantly the foliation of the quartz-mica schist wall rock, is 8 to 15 feet thick, strikes N.85°W., and is nearly vertical. The western half of the exposed body contains a medial zone of quartz-mica "burr" four feet thick, associated with which are abundant crystals of tourmaline, some as much as five inches thick and 14 inches long. A considerable quantity of electric sheet mica, some in large sizes, was produced from the mine along with much scrap mica.

Almon mine.—This mine, opened by S. Almon of the Franklin Mica Corp., is 40 feet northwest of the Fields mine (Pl. 23B). Almon's work consisted of two shallow inclines; but, in 1944, the Nelson Mica Company changed the development to a pit 155 feet long, 20 feet wide, and 8 to 14 feet deep. This work exposed a kaolinized pegmatite dike 4 to 5 feet thick, striking N.75°W. and dipping 45°NE., from which a moderate amount of stained scrap mica was recovered.

Allen Moore mine.—The Allen Moore mine is 300 feet northwest of the Fields mine and about 20 feet northeast of Road 619 (Pl. 23B). It was opened many years ago by Allen Moore and later worked by the Chestnut Mountain Mica Company. Development consists of two shafts 25 to 35 feet deep with connecting drifts and stopes. The pegmatite body exposed in the shafts is 3 to 5 feet thick, strikes N.85°W., and dips 73° NNE. There are no records of production.

MASON–PATTERSON PROPERTY

The Mason-Patterson property, consisting of 351 acres, is on the southeastern slopes of Fork Mountain about three-quarters of a mile north of Road 632 and 2 miles airline southwest of Road 619. Four mines have been opened on this property within a distance of 700 yards along a general northeast line. These are, from southwest to northeast: the Mason-Patterson, Simms, Center Ridge, and Klondike mines (Fig. 11, Nos. 4, 5, and 6).

Mason-Patterson mine.—This mine is on the southwest side of an old mountain road three-fourths of a mile north of Road 632 and 3 miles by road southwest of Hundley's Store (Fig. 11, No. 4). In 1943, it was under lease to A. L. Nelson, of Rocky Mount, but had not been worked for a year or two. Workings include two pits 60 feet apart with various tunnels and drifts extended from the bottom. The westernmost pit is 110 feet long, 70 feet wide, and about 40 feet deep; the other is 70 feet long and 15 feet deep.

The pegmatite body is over 250 feet long and varies in thickness from 50 feet in the western pit to 10 feet in the eastern opening. It strikes N.60°E. and dips 50-60°SE. in approximate concordance with the foliation of the enclosing iron-stained quartz-mica schist. A core of massive quartz which is only 1½ feet thick in the thickest (western) part of the body broadens to 8 feet in the eastern pit. Relatively small, colorless mica is abundantly disseminated through most of the kaolinized pegmatite. It is said that production of scrap mica has been large, but little sheet mica has been produced because of the small size of the mica and the common ruling and reeve imperfections.

Simms mine.—This mine is about 275 yards northeast of the Mason-Patterson mine and 1.9 miles airline due west of the intersection of Roads 632 and 619 (Fig. 11, No. 5). It was worked intermittently between 1935 and 1941 by C. P. Simms; in 1943 it was under lease to A. L. Nelson of Rocky Mount. Workings consist of a roughly circular pit 40 feet across and 25 feet deep, a 20-foot trench extending to the southeast, and several short tunnels driven eastward and northward from the east side of the pit.

Several masses of kaolinized pegmatite, separated by schist and fingering upward into and locally cutting irregularly across the folia of the enclosing garnet-chlorite-quartz-muscovite schist, are exposed in the pit. These masses strike about N.20-25°E. and dip 45°SE. Mica is fairly abundant in shoots parallel with the foliation in the nearby wall rock but most of it is small and black-specked. It is reported that 40 pounds of pale blue beryl, some in crystals 1½ inches thick, was recovered by Simms.

Center Ridge mine.—This mine, 120 feet east of the Simms mine (Fig. 11, No. 5), consists of a pit 28 feet long, 14 feet wide, and 13 feet deep to fill with two inclined drifts 10 and 30 feet long extending eastward from the east end. Two bodies of kaolinized pegmatite 1½ to 3 feet thick, striking N.10°E. and dipping 57°SE. in concordance with the foliation of the coarse mica schist wall rock, are exposed in the north wall of the pit. The easternmost body overlies a small hornblende gneiss sill. An appreciably thicker body with numerous upward projecting apophyses is exposed in the south wall. Small mica is fairly abundant in the pegmatite; and it is reported that a moderate amount of sheet mica, 10 to 50 per cent of which was clear, was sold from the mine.

Another small pit, with two steep inclines from the bottom reaching to depths of 15 and 18 feet, was opened in 1943 by the Nelson Mica Company 100 feet east of the Center Ridge mine. A downward-tapering body of pegmatite 1½ to 3 feet thick with a 50-55°SE. dip was exposed. Mica, ranging from faintly stained to quite clear, white, and soft, is fairly abundant both in the pegmatite and the adjacent altered schist. A small quantity of similar mica was also recovered from a shallow shaft 150 feet southeast of the Center Ridge mine.

Klondike mine.—This mine, on the property of Lena W. Vines of Roanoke, is on a small ridge about 380 yards northeast of the Center

Ridge mine and 1.8 miles N.86°W. of the intersection of Roads 632 and 619 (Fig. 11, No. 6). It was worked by S. Almon of Rocky Mount in 1940, and in 1943 the Nelson Mica Company was making preparations to renew operations. The main opening is a shallow pit 75 feet long, in which are exposed 3 bodies of pegmatite a foot or so thick and one body 8 to 10 feet thick. This largest body, in the west end of the pit, is irregular in shape and only approximately concordant with the foliation of the enclosing chloritoid-quartz-mica schist which strikes N.75°E. and dips 40-65°SE. It consists of a broken core of massive quartz 3-4 feet thick bordered on each side by about 2 feet of mica-rich kaolinized pegmatite. Many of the mica books are of good size, some measuring 7 by 10 inches; but much of the mica is of poor structure and it is all black-stained. Tourmaline is a common accessory, and crystals and irregular masses of pale blue beryl occur sparingly.

OTHER MINE PROPERTIES

Hutts-Cooper mine.—This mine is just east of the crest of the southeast ridge of Fork Mountain, 1.2 miles by dirt mountain road west-southwest of the Mason-Patterson mine, and 2.7 miles airline S.85°W. of the intersection of Roads 632 and 619 (Fig. 11, No. 2). It was opened by the U. S. Mica Manufacturing Company in 1942; and in 1943 workings consisted of a nearly circular pit 60 feet in diameter and 30 feet deep with several tunnels, none over 12 feet long, extending into the walls. The walls of the pegmatite body were not exposed, but it appeared to be at least 75 feet thick. The pegmatite is of medium-coarse texture, is thoroughly kaolinized, and includes core segments of massive quartz several feet thick. Tourmaline occurs as an accessory mineral. Small, black-specked, ruled and bent mica is abundant throughout most of the exposed pegmatite, and the yield of scrap mica to rock is reported to be about 1 to 4. The mine has yielded little sheet mica, but the recovery of scrap has been large.

DeWitt mine.—This mine, consisting of a pit and a shaft opened by the U. S. Mica Manufacturing Company in 1940, is 800 yards S.15°W. of the Mason-Patterson mine and 2.2 miles west-southwest of the intersection of Roads 632 and 619 (Fig. 11, No. 1). In 1943, the nearly circular pit, 45 feet in diameter, was partly filled, but it is said to be 30 feet deep; the shaft, 15 feet southeast of the pit, is 35 to 40 feet deep.

A southeastward-dipping body of pegmatite 2 to 6 feet thick is exposed in the southeast end of the pit and in the shaft. The main body of pegmatite, exposed in the northwestern part of the pit, is 8 to 10 feet thick, strikes N.35-40°E., dips 45°SE., and is thoroughly kaolinized.

Mica is abundant in irregular, closely matted masses throughout much of this main body, and it is reported that in places the yield of mine run mica was as high as 80 per cent. This mica is dominantly black-stained, ruled reevy, and contorted but it is said that 300 to 600 pounds of electric sheet and punch was sold from the mine in 1940. It is probable that considerable quantities of mica can yet be recovered from extensions of this pegmatite body along the strike in both directions from the pit.

Nelson mine.—This mine is 600 yards north of the DeWitt mine and 350 yards S.65°W. of the Mason-Patterson mine (Fig. 11, No. 3). In 1943, shortly after it was opened by the Nelson Mica Company, two shallow pits had been dug in decomposed pegmatite on opposite sides of a 30-foot quartz core. Small, ruled, lightly specked to clear, white mica was abundantly disseminated throughout the pegmatite in both pits. It is said that when the deposit was more extensively developed later in 1943, considerable quantities of white scrap mica were produced.

Chitwood mine.—This mine is on the C. E. Plybon property on the southeast flank of Chestnut Mountain 0.8 mile east of the mountain crest where crossed by Road 619 (Fig. 11, No. 11). It was worked during the 'thirties, and some prospecting and cleaning out of old openings was done by S. Almon of Rocky Mount in 1942. The main workings are two inclined shafts about 100 feet apart, sunk down the dip of the pegmatite body. The easternmost shaft is reported to be 80 feet deep with a 35-foot drift to the southwest and a 15-foot drift to the northeast; the other shaft is 30 feet deep.

The pegmatite body is 1½ to 7 feet thick, at least 150 yards long, strikes N.55-60°E., dips 55-80°SE., and is thoroughly kaolinized to the depth of working. Clear hard flat mica, some in sizes which would trim 3 by 4 inches, is abundant in the dumps and is said to have been found to be fairly plentiful in the mine.

SEMORA AREA

Mica and feldspar have been mined on a small scale in a belt about 20 miles long, 10 miles east of Danville, extending from the vicinity of Semora, Caswell County, North Carolina, to near Vernon Hill in southwestern Halifax County, Virginia (Fig. 1, Nos. 11 and 12). The greatest activity has been several miles west of Semora and near Milton, North Carolina; some prospecting has been done in southwestern Halifax County, Virginia, just over the state line to the north, and near the north end of the area.

The common country rock is coarse-grained granite, characterized by coarse, pink to red microcline; areas of migmatic schist and gneiss are also common. Pegmatites occur both in the granite and in the schists and gneisses. These are also generally characterized by pink microcline perthite, but pale blue quartz and yellowish to white plagioclase are also usually present. Muscovite mica occurs sparingly in most bodies, and some rich pockets have been found. Most of it, however, is of poor quality, being lightly to heavily stained and commonly of poor structure. The area is probably a more likely source for feldspar than for mica.

The only deposit in the Virginia portion of the area which to the writer's knowledge was prospected during the war years is on the L. E. Carlton property several miles southwest of Vernon Hill, 0.9 mile east-southeast of Ingram, Halifax County (Fig. 1, No. 11). A small pit dug by Mr. Carlton in 1944 exposed a hard irregular body of pegmatite 3 feet thick, striking northeastward and dipping to the southeast. The body is partly discordant to the foliation of the enclosing migmatic chlorite-biotite gneiss. The pegmatite is composed chiefly of coarse perthite with interstitial quartz and sparse muscovite. The mica, some in books 6 inches across, is flat, green, contains green primary vegetable stain, and is difficult to sheet.

SYCAMORE AREA

GENERAL FEATURES

Pegmatite has been mined in several places within an area of about 25 square miles in the general vicinity of Gretna, Bright, and Sycamore in north-central Pittsylvania County (Fig. 1, No. 10; and Fig. 12). The deposits have been worked chiefly for mica, but some feldspar has been produced in the northern part of the area.

Topographically the area is more or less typical of the dissected western Piedmont upland. Divide areas tend to be rather level or gently rounded whereas the descents to streams are fairly abrupt. Elevations range from about 700 to 1100 feet. The Southern Railway and U. S. Highway 29 cross the area from north to south, and good secondary roads extend to most parts of the area. The most widespread rock type is garnetiferous quartz-mica schist; mica gneiss, micaceous quartzite, hornblende gneiss, and diabase occur locally. Marble crops out to the north and west and may extend into the pegmatite area.

Pegmatites are fairly numerous in parts of the area but are not abundant. The largest are 40 to 50 feet thick and a few hundred feet

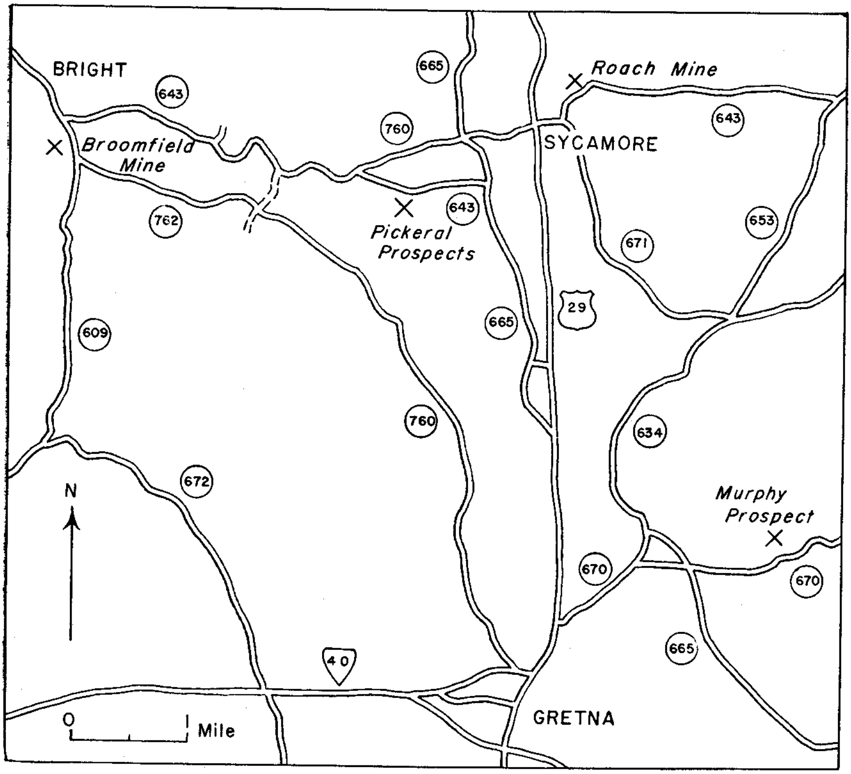


Figure 12. Location of mines and prospects in the Sycamore area.

long. Most are more or less concordant with the foliation of the enclosing schists, which generally strikes northeast and dips southeast, but some are discordant and strike northwest. Kaolinization of feldspars in many bodies has been complete or nearly complete to or somewhat below the water table.

MINES AND PROSPECTS

Broomfield mine.—This mine is on the G. W. Broomfield property 4 miles west of Sycamore and half a mile south of Bright (Fig. 12). Pegau (1932, p. 80-81) states that in 1928 there were 7 prospect pits from 5 to 25 feet deep within a distance of a quarter of a mile along an approximate N.80°W. trend. One of these pits 150 yards north of the farmhouse road and 200 yards west of Road 609 was enlarged and worked by Shirley Simms about 1937. In 1943, this pit was 100 feet long, 25 feet wide, and 15 to 20 feet deep to fill. The pegmatite body exposed in this pit is at least 25 feet thick, strikes N.80°E., dips about

50°SE., and is thoroughly kaolinized throughout the visible workings. Some of the kaolin appears to have been derived from coarse perthite. Pegmatite exposed in the road 200 yards to the northeast may be a continuation of this body.

Mica, in bunches and masses in kaolin associated with veinlets of waxy quartz, was abundant in the northwest and northeast walls of the pit; and a number of weathered books were visible in a gully 50 feet northeast of the pit. The largest books were over a foot across, but all of the mica observed was soft, bent or broken, and heavily clay stained. It is largely free of primary stain, and good quality mica might be obtained at greater depth. Simms is said to have sold some sheet mica.

Pickeral prospects.—Several prospect pits have been opened on the M. W. Pickeral property on the south side of Road 643 and 1.5 miles southwest by road from Sycamore (Fig. 12). The largest pit, a quarter of a mile east-southeast of the farmhouse, is 25 feet long and 18 feet deep. It is in thoroughly kaolinized pegmatite on the north side of a massive quartz core several feet thick. The body trends approximately east. Specked to heavily-stained, ruled, flat and "A" mica, some in books 8 inches wide, is fairly abundantly disseminated through the pegmatite.

Another small pit, 100 yards southeast of the farmhouse, has exposed a body of pegmatite 6 feet thick, striking northeastward. Mica similar to that at the larger pit is abundantly clustered about the rounded base of a quartz core 2 feet thick.

Whitehead (Roach) mine.—This mine is on the Ruth and D. H. Whitehead property about 200 yards north of Road 643 and half a mile northeast of Sycamore (Fig. 12). It has been operated intermittently over a period of many years by Robert Roach, who is said to have recovered considerable quantities of electric-grade sheet mica. The main opening is a pit 100 feet long, 15 feet wide, and 20 feet deep, elongated N.65°W. approximately along the strike of a body of kaolinized pegmatite about 15 feet thick. Small generally flat black-stained mica is fairly abundantly disseminated through the pegmatite and is especially plentiful near the walls. Some has "A" structure. The largest books observed measured 3 by 4 inches, but it is reported that some which yielded 14 by 14-inch trimmed sheets have been recovered.

Murphy prospect.—Several narrow bodies of mica-bearing pegmatite are exposed on the F. L. Murphy property on the north side of Road 670 about 2 miles northeast of Gretna and 4 miles south-southeast of Sycamore (Fig. 12). The best exposures are along a farm road north of the farmhouse and in a creek to the southwest. One body 10 feet thick and possibly 300 feet long, striking about N.35°E., contains abundant mica partly in and adjacent to a 1½-foot massive quartz core. This mica is generally free of primary stain, but much of it has "A" wedge, or, herringbone structure. The largest books seen were 4 inches wide.

Farmer feldspar mine.—Feldspar has been mined on the G. E. Farmer and Lonnie Dalton properties just west of U. S. Highway 29 and south of Road 641, 0.8 mile north of Motley and 3.2 miles north-northeast of Sycamore. Several pits, one said to be 40 feet deep, have been opened on a pegmatite body from 20 to 50 feet thick which strikes about N.60°E. and is several hundred yards long. The pegmatite is chiefly coarse microcline perthite with moderate plagioclase and quartz. Mica is not abundant, and that present is small. According to Pegau (1932, p. 81), two carloads of feldspar were shipped from the deposit for use in scouring soap.

MONETA-FOREST AREA

GENERAL STATEMENT

The Moneta-Forest area, wholly within Bedford County and from 3 to 5 miles wide and 28 miles long, extends from near the Campbell County line northeast of Forest southwestward to Staunton River, 4 miles southwest of Moneta (Fig. 1, No. 9; and Pl. 24). Some prospecting also has been done in the extension of this area into the northeastern part of Franklin County. The main part of the area is crossed by the Norfolk and Western Railway and U. S. Highway 460 at Forest and by the Virginian Railway and Virginia Highway 122 at Moneta. Other parts of the area can be reached by Virginia Highways 43, 24, 297, and 127, and by numerous secondary blacktop and clay roads.

The area is one of moderate relief with altitudes that vary from about 600 feet near Ivy Creek in the northeastern part of the area to 1144 feet at Stone Mountain 4 miles southeast of Moneta. Drainage is chiefly to Staunton and Otter rivers and Goose Creek, which flow southeastward across the area. Drainage in the extreme northeastern part of the area is by tributaries to James River.

Ground water is seldom encountered at depths of less than 40 feet except in low areas near streams, where pumping may become necessary at 15 to 20 feet unless the enclosing rocks are unusually compact. The flow of water is generally not excessive. The Patterson feldspar mine, which is over 700 feet long and about 175 feet deep, yielded from 65,000 to 100,000 gallons per day, depending upon the season.

Rock weathering has been less deep in most parts of this area than in areas of the central and eastern Virginia Piedmont, and kaolinization in pegmatites has been less extreme. The latter is due partly to the usual higher proportion of relatively resistant potash feldspar in pegmatites of this area. In many places, potash feldspar is relatively fresh at or near the surface; plagioclase (soda) feldspar is commonly partially to completely kaolinized to depths of from a few feet to over 30 feet.

GEOLOGIC SETTING

The geology of the Moneta-Forest area is extremely complex and even certain fundamental relations are obscure. The rocks of the area, with the exception of the pegmatites and rare Triassic diabase intrusives, are all metasedimentary or metaigneous and are probably of Precambrian age. The pegmatite deposits are localized within a belt of biotite and hornblende gneisses, named Moneta gneiss by Pegau (1932, p. 22-26), which lies between broad outcrop areas of Lynchburg gneiss on the southeast and Lovingston (or "Marshall" in the terminology of Bloomer and Werner, 1955) quartz monzonitic gneiss on the northwest. Brown (1958, p. 12-18) interprets the Moneta to be unconformable beneath the Lynchburg and older than Lovingston granitization; Diggs (1955, p. 18-19), on the other hand, describes the relations between the Lynchburg, Moneta, and Lovingston gneisses as gradational and conformable. Diggs (1955, Geologic Map and Fig. 3) also has mapped areas of Lynchburg formation as synclinal infolds within Moneta gneiss. Pegmatites of the area occur near these apparent infolds of Lynchburg formation but they appear to occur largely or completely within the feldspathic biotite-quartz and hornblendic gneisses of the Moneta complex.

PEGMATITES

Pegmatites are plentifully, but quite unevenly, distributed throughout the length of the Moneta-Forest area. Most of the known bodies are near streams or roads along which they make prominent outcrop. It is possible that many potentially commercial bodies lie beneath uplands away from roads, obscured by deep soils and vegetation. Pegmatite bodies in this area tend to be larger, coarser, less deeply kaolinized, and more persistent along the strike than bodies in other areas of the state. Most also contain a higher ratio of potash feldspar to plagioclase and less muscovite mica. Bodies which have been mined for feldspar, which includes practically all of the commercial bodies in the area, range in thickness from about 10 to 160 feet and average perhaps 50 feet. The body at the Big Hicks (Wheatley) and Young mines near Moneta attains a thickness of 160 feet and appears to be along a trend of pegmatites over a mile long. Most bodies are more or less concordant with the foliation of the enclosing gneisses, which has a prevailing northeast strike and very steep southeast dip. Many bodies plunge northeastward, but the large Patterson and Mitchell bodies plunge southwestward.

The mineral zonation which characterizes nearly all commercial bodies is similar to that observed in a great many pegmatites elsewhere. Cores of massive quartz, in places including coarse crystals of perthite, are common. Intermediate zones composed chiefly of very coarse perthite with interstitial quartz and mica are frequently large. Crystals of perthite as much as 14 feet long were encountered in intermediate zones at the Big Hicks mine. Coarse plagioclase-quartz-muscovite wall zones, generally containing more or less perthite, also make up prominent parts of most bodies; and thin discontinuous border zones of quartz, muscovite, and plagioclase are locally present.

Biotite is plentiful in many pegmatites, especially in some wall zones where it occurs associated with quartz and muscovite as fracture fillings and, to some extent, as a replacement about fractures. Pink to brownish red garnets are also very abundant in many bodies; and beryl, tourmaline, pyrrhotite, chalcopyrite, and pyrite occur in some.

MINING AND PRODUCTION

The Moneta-Forest area was first prospected for mica; but, since 1907 when first feldspar production was reported from a quarry near Bells, mining has been almost exclusively for feldspar. With the beginning of large-scale company quarrying near Moneta by the Moneta Mineral and Mining Company in 1923, this area began supplying most of the feldspar produced in Virginia. Of the 461,876 tons reported production between the years 1929-1952 (Table 2), a preponderant part came from the Moneta-Forest area, and much of the remainder came from the Peaksville area, also in Bedford County.

After the quarry near Moneta had been worked by the Moneta Mining and Milling Company for a year or so, the operation was taken over by the Seaboard Feldspar Company of Baltimore. In 1929, this company built a grinding mill at Brookneal, Campbell County, which it operated until it was destroyed by fire in 1940, supplying it with feldspar from numerous mines in the Moneta-Forest area. Within a year, a new mill was built in Bedford by the Clinchfield Sand and Feldspar Corporation of Baltimore, which also had been operating in the State since the late 'twenties. Another company, the Virginia Feldspar Company, was also active in the area for the period 1929 to 1947, and in 1938 built a grinding mill at Bedford. In 1941, the Carolina Mineral Company of Irwin, Tennessee, bought this mill, and in 1947 it bought the Virginia Feldspar Company's large Patterson mine. Its mill and operations in the area were abandoned in 1951.

MINES AND PROSPECTS

Walton (Everett) mine.—This mine on the F. H. T. Walton property, is on the southwest side of a tributary to Elk Creek 1.8 miles S.60°W. of Forest (Pl. 24, No. 2). It was probably opened during the 'twenties and was worked in 1941 by the Clinchfield Sand and Feldspar Corporation under the direction of Wilbur Nance, and was reopened in 1944 by the Carolina Mineral Company.

In 1945, workings consisted of a pit 165 feet long, 25 to 35 feet wide, and 22 feet deep to water, with a tunnel driven northeastward from the bottom. The pegmatite body is 20 feet thick, and strikes N.40°E. and dips 70°SE. in general concordance with the foliation in the enclosing hornblende gneiss. It is distinctly zoned, with a core of massive quartz as much as 3 feet thick; an irregular and discontinuous intermediate zone of very coarse blocky pink to flesh-colored perthite with interstitial quartz, albite, and muscovite; and a coarse-grained plagioclase-perthite-quartz-muscovite wall zone. Some muscovite in the wall zone is thin and friable and appears to fill fractures; small, green, lightly specked, flat muscovite also occurs in a shoot within plagioclase on the footwall side of the core. Production from the mine has been chiefly feldspar, an appreciable portion of which has been of the potash variety; but a small quantity of strategic mica was sold in 1944, and Pegau (1932, p. 90) reports that during its early operation several carloads of kaolin were shipped for use in pottery.

Schwerin mine.—This mine is on the south side of a small creek 1800 feet slightly west of south of the Schwerin farmhouse and 1.3 miles S.60°W. of Forest Station (Pl. 24, No. 27). It was worked almost continuously from 1952 to 1954 by the Clinchfield Sand and Feldspar Corp. and is reported to have been a good mine. In April 1960, little could be seen except a water-filled pit about 160 feet long and 50 feet wide, elongated northeastward.

Willie Walker prospect.—A pit 40 feet long and 15 feet deep, and one or two smaller holes were opened about 1935 on the Amandus N. Walker property half a mile west-southwest of Forest Station (Pl. 24, No. 1). In 1942, two bodies of pegmatite, one 8 and the other 4 feet thick, standing nearly vertical and striking about N.65°E., were exposed in the main pit. These appear to converge to form a single body 16 feet thick in a smaller pit to the northeast. The exposed pegmatite is largely kaolinized and little hard feldspar is exposed in the pit, but it is possible that appreciable commercial feldspar may be found beneath the zone of kaolinization.

Poindexter mine.—This mine, on the northwest side of Road 622, 1.5 miles S.50°W. of Forest (Pl. 24, No. 3), was worked for feldspar by Carolina Mineral Company in 1944. In 1945, the abandoned workings included two shallow pits about 70 feet long, aligned N.40°E. with the strike of the pegmatite. Two bodies of irregular, rather fresh pegmatite, 12 and 18 feet thick and with nearly vertical dip, were exposed, separated by a 5-foot thickness of biotite-hornblende gneiss and walled by the same rock. A thin body of massive quartz forms the eastern wall to the northwestern body, and scattered masses of coarse blocky perthite occur medially within it. A larger and more continuous zone of blocky perthite occurs in the central part of the larger southeastern body. Approximately a third of the visible pegmatite consists of potash feldspar; one determination of plagioclase showed a composition of An_{16}. Much fracture-fill biotite, largely altered to vermiculite, occurs in the outer parts of each body. The tonnage of feldspar produced from the mine was not large.

Jack White mine.—This old feldspar mine is adjacent to and on the northwest side of Road 622, immediately northeast of and on the same pegmatite body with the Poindexter mine (Pl. 24, No. 28). Workings, opened many years ago by Clinchfield Sand and Feldspar Corp., consist of a slumped pit about 300 feet long by a maximum of 30 feet deep. The pegmatite body is 35 feet thick, strikes N.37°E., dips about 75°SE., and is distinctly but irregularly zoned. It has a discontinuous core of massive quartz 2 feet thick, which is bordered on the west side by a very irregular intermediate zone several feet thick composed chiefly of blocky perthite and associated graphic granite. The greatest part of the exposed body is partially kaolinized plagioclase-quartz-muscovite wall-zoned pegmatite. Ruled and cracked, clear, light rum-coloıed book mica occurs sparingly along the west wall.

Jordan-Braxton mine.—This mine, 0.2 mile southeast of Road 622 and 2 miles southwest of Forest (Pl. 24, No. 4), was being worked in 1942 but was idle when revisited in 1943. The workings, consisting of two pits about 100 yards apart, appear to be on the same pegmatite body. The northeastern pit is 50 feet long and 10 feet deep; the more recently worked southwestern pit is 156 feet long, 25 feet wide, and 30 feet deep. The pegmatite body, which strikes N.25°E. and dips 80°SE., is 8 feet thick in the northwestern pit and from 5 to 30 feet thick in the southwestern pit. It is composed chiefly of white plagioclase with moderate amounts of small quartz and muscovite; some gray perthite occurs in the interior parts of the body near small quartz core segments. Small books of ruled, clear, light rum "A" mica occur in places near the core. Garnet and biotite are common accessory minerals. It is said that appreciable feldspar for use in porcelain and glass, and some quartz were sold from the mine.

Sunny Knoll mine.—This mine is on the Crow Harris property 270 feet S.50°E. of an abrupt bend in Road 622, one mile west of the Jordan-Braxton mine, and 3.2 miles S.60°W. of Forest (Pl. 24, No. 5). The main opening, made about 1941-42, is an oval pit 80 by 100 feet across and 30 feet deep with two 100-foot inclined cuts on the southwest side for access by truck. The main body of pegmatite is about 30 feet thick, strikes N.60°E., and dips 70°SE. It is composed chiefly of plagioclase feldspar, with moderate quartz and some scattered masses of perthite. Zonation is not particularly distinct. Fracture-fill biotite, partly altered to vermiculite, is abundant near the hanging wall. Muscovite is scarce throughout most of the body, but one pocket containing flat free-splitting books as much as 14 inches across, but rather heavily specked with red and black iron oxides, was encountered.

Big Harris (Nance) mine.—This large feldspar mine is on the Crow Harris property on the south side of a tributary to Elk Creek, 1100 yards southwest of the Sunny Knoll mine, and 3.2 miles S.48°W. of Forest (Pl. 24, No. 6). It was worked to a depth of about 100 feet by the Clinchfield Sand and Feldspar Corporation before this company quit its operation in 1940. In 1943, the Carolina Mineral Company reopened the mine, first removing from the northwest side of the pegmatite body a considerable quantity of feldspar which had been obscured by a thin wall of schist, then cutting a bench 70 feet long and 25 feet deep at the south end of the old water-filled pit. In May 1945, the old pit had been drained and enlarged to 200 feet in length, 100 feet in width, and 140 feet in depth, with a 40-foot overhung heading to the southwest in the bottom. When the pit was abandoned in 1950, it was about 200 feet deep.

The pegmatite body has a maximum thickness in excess of 100 feet, is over 300 feet long, and strikes N.56°E. and dips about 80°SE. in general concordance with the foliation in the feldspathic biotite gneiss wall rock. It is irregularly zoned, with a massive quartz core as much as 5 feet thick extending fairly continuously through the upper part of the exposed body; an intermediate zone rich in blocky gray perthite making up about two-thirds of the thickness of the body in its upper portion but tapering and tonguing out downward; and a medium to coarse plagioclase-quartz-muscovite wall zone, developed chiefly on the hanging wall (southeast) side and increasing in width with depth. Fracture-fill biotite is present in places near the walls. Small books of light rum-colored, flat, clear to lightly-specked muscovite mica, some of which are ruled and difficult to split, occur rather sparingly in the wall zones. Carolina Mineral Co. sold a small quantity of strategic mica in 1944. Early production from the mine consisted chiefly of potash feldspar but, as with many other mines in the area, the percentage of soda feldspar produced increased as the mining became deeper. The total tonnage of feldspar produced has been very large.

Wells mine.—Feldspar and a small amount of mica have been mined on the L. W. Wells property between Roads 704 and 643, 2.8 miles N.60°W. of New London Academy, and 4.3 miles southwest of Forest (Pl. 24, No. 7). The chief opening is a pit 60 feet long and 20 feet deep, cut into the brow of an east-trending ridge. Three small bodies of pegmatite, possibly all branches of the same body, are exposed. These bodies, the largest of which is about 10 feet thick, strike nearly east and dip 80°N. to vertical across the foliation of the enclosing coarse mica gneiss which strikes N.60°E. and dips 80°SE. The exposed pegmatite is composed chiefly of partly kaolinized plagioclase with moderate quartz and muscovite. Books of mica, some measuring 6 by 10 inches, are fairly abundant near massive quartz core masses in pegmatite along the west and north walls of the pit. This mica is light rum-colored, generally flat, and largely free from primary stain; but ruling and bending are common and the mid-portions of some books are specked and locky or reevy.

Egypt (Bells) mines.—Five mines and dozens of prospects have been opened 7 to 8 miles southwest of Forest in the "Bells" or "Egypt" vicinity between Virginia Highway 297 and a large eastward bend in Big Otter River slightly over a mile to the southwest (Pl. 24, Nos. 8-12). Most mining, which has been almost entirely for feldspar, has been done by the Clinchfield Sand and Feldspar Corp. which began exploratory work in the vicinity as early as 1928 (Pegau, 1932, p. 87). Mining nearest the highway was carried on between 1935 and 1942 by Clyde Smith.

When these mines were visited in 1942, Smith had opened 3 pits within 600 feet of Virginia Highway 297, exposing two essentially parallel bodies of pegmatite 18 to 25 feet thick and 18 to 50 feet thick, striking N.60°E. and dipping steeply southeastward. The pegmatite in the largest pit, which was 140 feet long and 25 feet deep, yielded appreciable feldspar, a rather high proportion of which was of the potash variety.

The Callahan mine, on the southeast side of a farm road 0.4 mile southwest of the Smith mine, consisted of several pits, the largest being

120 feet long and 20 feet wide and deep. The pegmatite being mined was finer grained than most in the area and had the appearance of having been crushed.

The Boyer mine, 1800 feet southwest of the Callahan mine, was an L-shaped pit 140 feet long and about 50 feet deep. The pegmatite contains both potash and soda feldspar and appreciable book mica. Some of this mica is rum- to ruby-colored, clear, flat, and free splitting; other books are badly reeved, ruled, and black-specked. A small quantity of mica was also found in prospects about 100 yards south of the main Boyer pit.

The Old River (Goggins Ford) mine and the Seaboard (Newman) mine are two pits, 160 feet long and 80 feet deep, and 200 feet long and 60 feet deep, respectively, on the northeast side of Big Otter River about 1800 feet west-southwest of the Boyer mine. Pegau (1932, p. 88) reports the shipment from these mines (or this vicinity) of 2 carloads of feldspar in 1928 and several carloads in 1931.

Creasy mine.—This, the "Otter Hill" prospect of Pegau (1932, p. 89-90) and the "American Asbestos Company's mine" of Sterrett (1923, p. 318-319), is 100 feet northwest of Falling Creek a quarter of a mile southwest of its juncture with Big Otter River, 6.3 miles south of Goode, and 9 miles S.43°W. of Forest (Pl. 24, No. 13).

According to Sterrett (1923, p. 318-310), "The deposit was worked by open cut 40 feet long, and 20 feet in greatest depth, and a shaft, now filled with water, reported to be 30 feet deep, in the end of the cut. The open cut was driven northwestward into a hillside about 30 feet above a creek. A hoist was arranged over the shaft, and a tram extends from it to the shop and storehouse, about 40 feet to the northwest . . .

"The country rock is hornblende schist or schistose diorite badly weathered to a reddish-brown earth. The pegmatite is approximately comformable with the enclosing schist, striking N.30°E. and having a nearly vertical dip. Where exposed in the open cut it is nearly 20 feet thick. The east half is highly feldspathic and the west half contains more quartz and is richer in mica . . . Opaque reddish garnets are abundant, and some flattened garnet crystals are enclosed between the sheets of mica. Much of the mica has the A structure but would yield good sheets from the part between the A lines. Crystals of mica 8 or 10 inches across were seen in the shop, where several tons of rough mica is stored."

In 1942, the old workings were badly caved and overgrown. Little feldspar was visible, but abundant "A" mica associated with a 15-foot core of massive quartz was exposed in the northwest end of the pit.

Patterson (Johnson) mine.—This very large mine is on the Waldo and Stanoke Johnson property, on the northwest side of a creek, 100 yards southwest of the juncture of Roads 715 and 714, a mile north of Otter Hill, and 6 miles southeast of Bedford (Pl. 24, No. 14). It was opened in 1931 by R. H. and H. T. Patterson who operated it under the name of the Virginia Feldspar Company until January 1947, when the mine was sold to Carolina Mineral Company. It was abandoned in 1951, and in 1960 the pit was full of water. Reported production of feldspar prior to 1947 was in excess of 200,000 tons.

Workings consist of a pit 780 feet long, 40 to 80 feet wide, and 175 feet deep (Pl. 5B). The pegmatite body has a relatively uniform thickness of about 50 feet throughout the length of the pit but pinches rather abruptly to 20 feet at the southwest end. It is gently curved with convex side to the north, strikes N.40-60°E., is nearly vertical, and apparently plunges southwestward. A minor fault, striking N.87°E. and dipping 37°SSE., cuts the body in the east-central part of its exposure and appears to be partly responsible for its curvature (Pl. 5B). Wall rock adjacent to the pegmatite is a weakly foliated, medium- to coarse-grained, feldspathic gneiss of the Moneta complex.

The pegmatite is composed essentially of medium to coarse plagioclase-quartz-biotite-muscovite wall zones 5 to 10 feet thick, and a very coarse perthite-plagioclase-quartz inner zone as much as 50 feet thick. Large core masses of quartz were not observed by the writer but were possibly present at higher levels. Mining has been largely confined to the very coarse inner zone, much of the finer-grained wall zone pegmatite being left along the sides of the pit. Biotite of the wall zone is mostly small and appears to fill fractures. At deeper levels of mining, the production of soda feldspar from the inner zone exceeded that of potash feldspar, but the reverse is said to have been true at higher levels. Crystals of both types of feldspar are very coarse, generally ranging from one to 6 feet in length. In part they have crystallized together, but some perthite encloses and is interstitial to plagioclase of composition (An_{20}.) Small crystals of beryl occur very sparingly associated with perthite and quartz. Pink garnets are quite abundant in various parts of the pegmatite. Late albite locally replaces perthite in inner parts of the body; and rare hydrothermal fracture fillings of pyrrhotite, chalcopyrite, and pyrite have been noted.

Muscovite is not generally abundant, but in 1944 several tons of mine run mica, which yielded a small quantity of strategic sheet, was recovered from two small shoots in very coarse pegmatite near the east end of the pit.

Mitchell mine.—This mine is on the John E. Mitchell property, across the creek and several hundred feet southeast of the Patterson mine (Pl. 24, No. 15). It was opened in 1928 by the Clinchfield Sand and Feldspar Corp., and worked a number of years; it was reopened in 1949 by Carolina Mineral Company and worked about a year. Clinchfield again worked the mine from 1955 to 1957, then allowed it to remain idle until 1959 when its operation was renewed. In April 1960, workings consisted of a pit 440 feet long, from 20 to 50 feet wide, and 150 feet deep in the southwest end.

The exposed pegmatite body is 30 to 50 feet thick, strikes N.36°E., dips 90-80°SE., and appears to plunge southwestward. Wall-zone pegmatite, 5 to 10 feet thick, left along the sides of the pit is chiefly medium-grained plagioclase, quartz, and muscovite, cut by numerous large blades of fracture-filling biotite; blocks of light gray perthite and fractured crystals of pink garnet are locally present; flat but ruled, rum-colored muscovite occurs sparsely. Large perthite-plagioclase-quartz intermediate zones are present and have been the object of most of the mining. The perthite is in beautiful light gray blocks as much as 5 feet long. No core was observed but 3-foot masses of white massive quartz lie in the dump. Wall rock is feldspathic biotite gneiss of the Moneta complex. The mine has been a good producer of both No. 1 and No. 2 feldspar.

Wade mine.—This mine is on the west bank of a small north-flowing tributary to Falling Creek, approximately 300 yards north of Road 725, and 7 miles S.30°E. of Bedford (Pl. 24, No. 16). It is said to have been worked last by George Witt about 1940. A body of kaolinized pegmatite 20 feet thick, striking N.45°E. and dipping 60°SE., is exposed in a shallow pit 60 feet long. It is generally concordant with the arkosic quartzite wall rock. Rum-colored, clear to lightly specked mica occurs sparingly near small quartz plates and with biotite as late fracture fillings. In 1943, about 100 pounds of bent and broken mica, some in books measuring 7 by 11 inches, was piled near the pit.

Overstreet mine.—This mine is on the H. E. Crouch property, 0.4 mile by farm road west of Road 732, 1.7 miles north-northeast of Hadens Bridge, and 6 miles N.82°E. of Moneta (Pl. 24, No. 19). It was opened and operated for mica many years ago by the American Asbestos Company and was reopened in November 1943 by the Clinchfield Sand and Feldspar Corporation which worked it until February 1944.

Old workings included two or three shafts 25 to 30 feet deep within a distance of 60 feet, aligned in a N.30°E. direction along the strike of a nearly vertical body of pegmatite. Clinchfield Sand and Feldspar Corp. opened a pit 40 feet long, 25 feet wide, and 35 feet deep at the site of the eastern shafts. The pegmatite body is over 25 feet thick and is essentially concordant with the foliation in the mica gneiss wall on the southeast side; the west wall is not exposed in the main part of the pit, but gneiss cuts abruptly across the strike of the pegmatite at its northeast end. The pegmatite is largely decomposed to the depth of working, but the blocky outlines of former large crystals of feldspar are visible in the kaolin. Flat greenish rum-colored mica, much of which was ruled and bent, was locally very abundant in a quartz-rich zone near the southeast wall but was scarce elsewhere in the explored parts of the body. Clinchfield recovered about 5 tons of mica from this zone within a depth of 20 feet of the surface. The largest books measured 9 by 14 inches and trimmed 3 by 5 inches. The operation was abandoned when this rich pocket appeared to be exhausted.

A shallow pit 40 feet long also has been opened just southwest of a farm road 0.3 mile northeast of the Overstreet mine, exposing a partly kaolinized body of pegmatite 12 feet thick, striking N.25°E. and dipping 70°NW. Small, clear to black-stained, smoky green mica occurs sparingly.

Thurman mine.—This mine is on the north side of a westerly-flowing creek, a quarter of a mile southwest of the intersection of Roads 731 and 732, and 6.3 miles N.78°E. of Moneta (Pl. 24, No. 17). It was worked by Seaboard Feldspar Co., and later by a Mr. Gregory of Bedford about 1941. Workings include a pit 110 feet long and 25 feet deep, in which is exposed a body of pegmatite with an outcrop width of at least 50 feet, striking northeastward and apparently dipping at a rather low angle. The visible pegmatite is fine to medium grained and somewhat quartzose. Any core or intermediate zone originally present has been removed in mining. Small, ruled, lightly specked, smoky olive mica occurs sparingly.

Nance mine.—This large feldspar mine, consisting of a pit 160 feet long, 85 to 95 feet wide, and 95 feet deep with overhung stopes in each end, is on the R. E Nance property on the south side of the Virginian Railway, 1.6 miles slightly north of east of Moneta (Pl. 24, No. 21; and Fig. 13). It was opened about 1939, was being operated by Morgan Nance in 1945, and was abandoned about 1950.

The pegmatite body strikes N.40°E., dips approximately 65°SE., and is 50 feet thick at the surface but tapers to about 25 feet near the bottom of the pit. It is generally concordant with the foliation in the contorted Moneta biotite and hornblende gneiss wall rock but locally

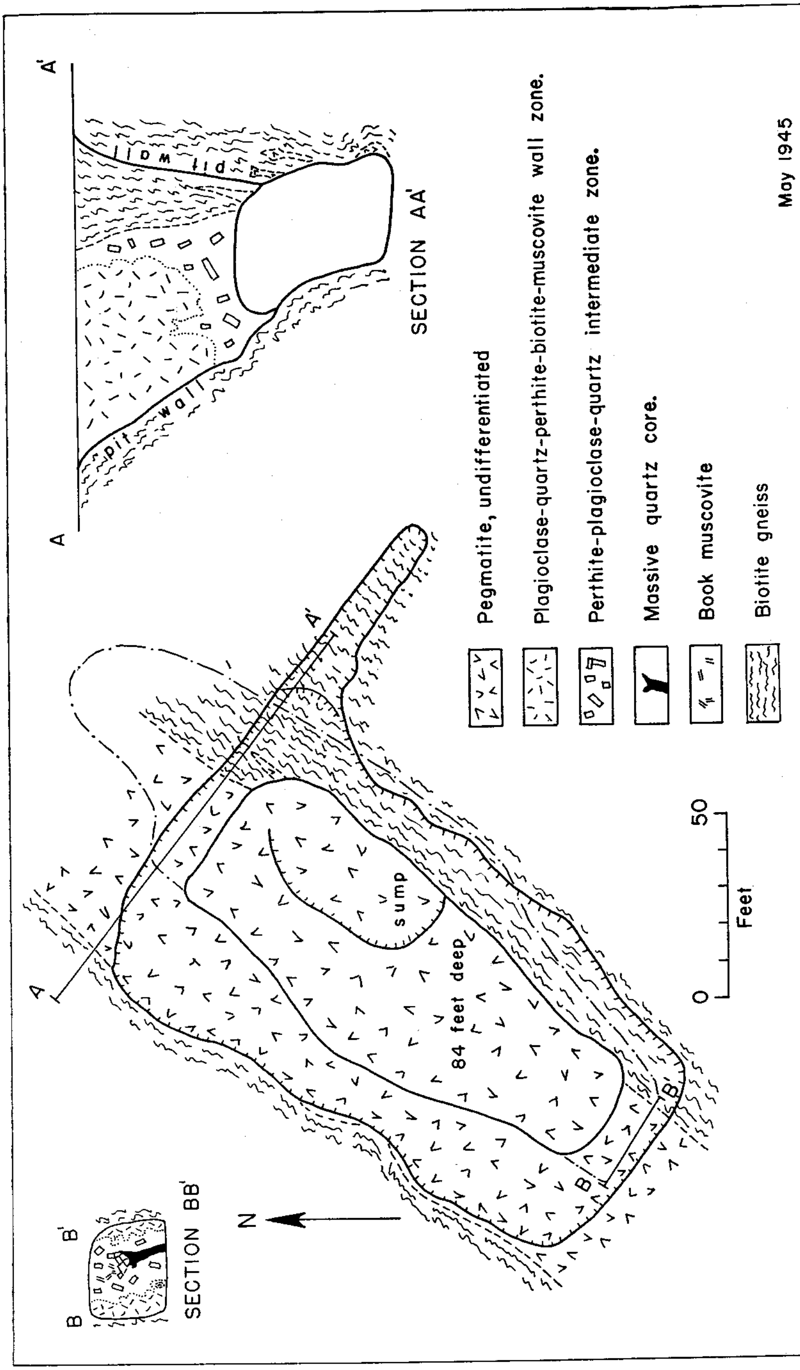


Figure 13. Geologic sketch map and sections of the Nance feldspar mine, 1.6 miles east of Moneta, Bedford County.

bulges into and intertongues with it, especially on the southeast side. Mineral zonation is quite distinct and fairly regular at the southwest end of the pit but is much less regular at the northeast end (Fig. 13). At the southwest end, the body has a discontinuous core of massive quartz several feet thick, which abuts against and locally includes coarse blocky masses of gray perthite. This is bordered by intermediate zones of very coarse perthite-plagioclase-quartz-muscovite pegmatite, which are bordered in turn by wall zones of medium- to course-grained plagioclase-quartz-perthite-muscovite pegmatite. At the northeast end of the pit, typical wall-zone pegmatite is largely lacking along the southeast wall and in the lower levels, but it makes up most of the upper part of the body. Biotite, with some muscovite and quartz, is very abundant as fracture fillings and minor replacements about fractures in the wall-zone pegmatite. Late plagioclase (An_{16}), in the form of fracture fillings in quartz and perthite and as replacements in perthite is quite prominent in considerable parts of the intermediate zones.

Large quantities of potash and soda feldspar have been produced from the mine. Book mica is not generally abundant but occurs as local segregations in the central part of the pegmatite body and along the hanging wall. It is rum-colored and mostly clear, but much of it is cracked and reevy. A small quantity of strategic sheet mica was sold in 1944.

Morgan mine.—This mine is 350 feet north of the Virginian Railway, 500 feet north of the Nance mine, and 1.6 miles N.80°E. of Moneta (Pl. 24, No. 20). Workings, made before 1942, include a main pit 125 feet long, 50 feet wide, and 30 feet deep; and a smaller pit 200 feet to the west 125 feet long and 18 feet deep. The pegmatite body in the main pit is very irregular in shape but attains a thickness of about 35 feet, strikes generally N.80°E., dips 60 to 80°NW., and is largely concordant with foliation in the enclosing mica gneiss. The feldspar, which appears to have been chiefly coarse plagioclase, is almost completely kaolinized to the depth of working. The body contains a core of massive quartz as much as two feet thick, but quartz is not particularly abundant elsewhere in the pegmatite Small, clear to lightly specked, light rum-colored book mica occurs sparsely along the walls. Pegmatite in the smaller pit is similar to that in the main pit.

Young mine.—The Young mine is a quarter of a mile northeast of Road 608 and 0.8 mile S.15°E. of Moneta (Pl. 24, No. 25). It was opened about 1923 by a Mr. Young and was being worked by the Seaboard Feldspar Company in 1931 (Pegau, 1932, p. 86). After a number of years of idleness, mining was resumed at the middle pit by Morgan Nance of Moneta in 1944.

Workings consist essentially of 3 pits about 150 feet apart, each apparently on a separate body of pegmatite. In 1945, the middle and largest pit was 200 feet long, 75 feet wide, and 70 feet deep at the northeast end. The pegmatite body in this pit is 40 feet thick, strikes N. 60°E., dips 70°SE., and is walled by hornblende gneiss. It thins downward to the southwest in a manner which suggests that it may plunge northeastward. The body shows mineral zonation similar to that in many other bodies in the area. It has a core of massive quartz several feet thick with included and intergrown blocks of gray perthite; intermediate zones rich in very coarse perthite with interstitial and graphically intergrown quartz; wall zones of medium- to coarse-grained plagioclase, quartz, muscovite, and some perthite; and a very thin discontinuous plagioclase-quartz-muscovite border zone. A considerable quantity of both No. 1 and No. 2 spar have been produced from this middle pit, and it is reported that some mica was sold during early operations. Generally clear dark rum-colored book mica occurs rather

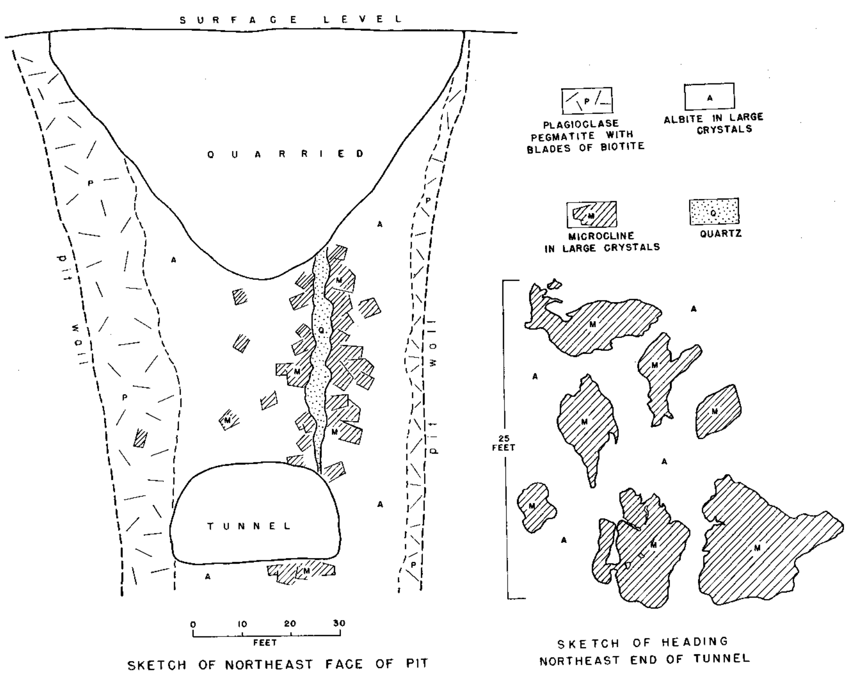


Figure 14. Sketch of the northeast end of the Big Hicks (Wheatley) feldspar pit a mile southeast of Moneta, Bedford County.

sparingly in parts of the wall zones but it is mostly small and difficult to sheet.

The pits to the northwest and southeast of the main pit, said to be 50 and 30 feet deep respectively, were considerably slumped in 1944; but the pegmatite bodies in each appeared to have attitudes similar to that of the body in the main pit. Pegau (1932, p. 86) states that 3 bodies about 15 feet thick were exposed in the northwestern pit.

Big Hicks (Wheatley) mine.—This large mine is half a mile by mine road west of Road 654 and a mile S.65°E. of Moneta (Pl. 24, No. 23). It is 0.9 mile N.65°E. of the Young mine, and aerial photographs show so good an alignment of pits and pegmatite masses between them that they appear to be on the same undulatory pegmatite body, or at least along the same structural trend. The mine was opened in 1923 by the Moneta Mineral and Mining Company and was worked by the Seaboard Feldspar Company from a short time thereafter until about 1941, and by the Clinchfield Sand and Feldspar Corp. from 1941 until 1951. When closed, workings consisted of a pit 600 feet long, 30 to 125 feet wide, and 155 feet in greatest depth, with a large horizontal stope driven over 200 feet northeastward from the bottom at the northeast end (Pl. 4B).

The pegmatite body has a maximum thickness of about 160 feet at the surface but is only approximately 65 feet thick in the bottom of the pit toward the northeast end. It strikes N.60°E. and is nearly vertical except in its thinner lower portions where it dips steeply to the southeast. The body is quite distinctly but irregularly zoned (Fig. 14). A 3- to 5-foot quartz core, in part intergrown with and locally including large subhedral to euhedral crystals of light gray perthite, extends through the pegmatite in the southeast-central part of the pit; smaller masses of massive quartz occur in the southwestern part of the pit. An intermediate zone as much as 20 feet thick, composed mainly of giant perthite crystals, some 5 to 14 feet long, and numerous very large crystals of plagioclase, lies on the southeast side of the quartz core; a similar zone from 20 to 40 feet thick containing less perthite occurs on the northwest side. Wall zones of deeply kaolinized medium-grained plagioclase with some perthite, quartz, and muscovite, containing abundant fracture-filling plates of biotite, are present on both sides of the body and attain a thickness of about 35 feet on the northwest side. Striking replacement of large perthite crystals by plagioclase was evident in the heading of the northeasterly stope (Fig. 14). Pink thulite occurs with this plagioclase. Small muscovite is plentiful in the wall zones, but book mica is very scarce and little or none has been

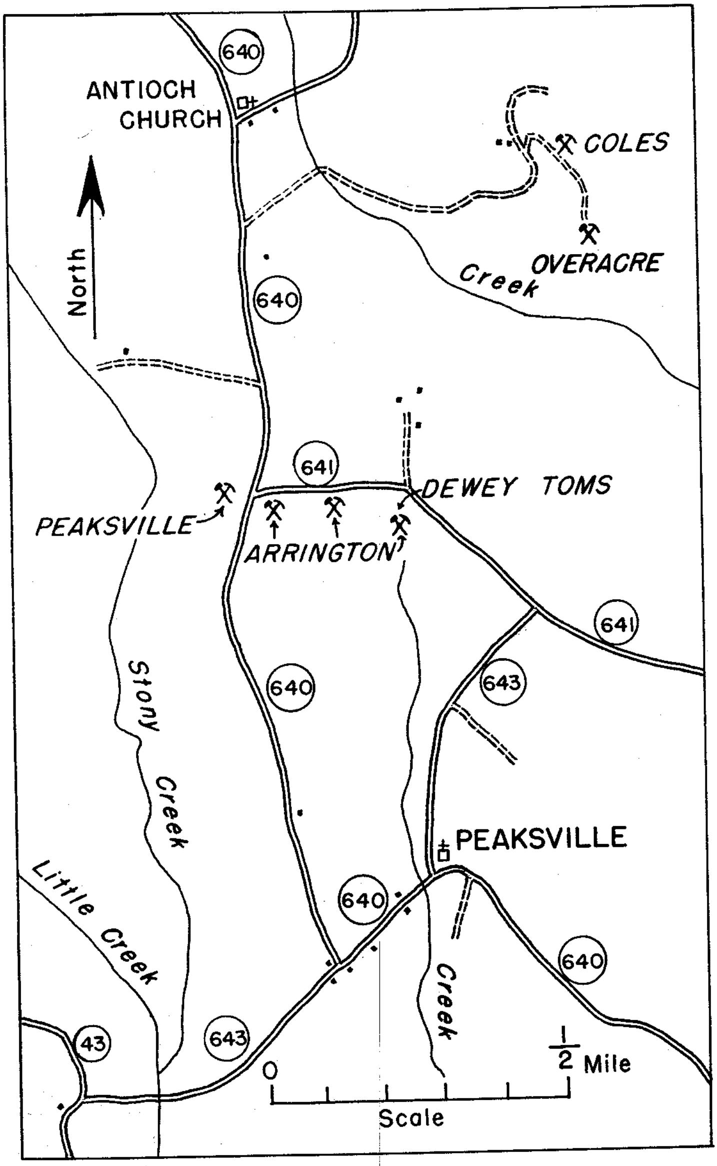


Figure 15. Location of mines in the Peaksville feldspar area.

sold. Large quantities of both potash and plagioclase feldspar have been produced, the total tonnage being in the order of 75,000 tons.

Hicks mine.—This, the largest of several openings between and along the same structural trend as the Young and Wheatley mines, is half a mile southwest of the Wheatley mine and 0.8 mile southeast of Moneta (Pl. 24, No. 24). In 1943, a body of pegmatite about 50 feet thick, with N.60°E. strike and steep southeast dip, was exposed in a pit 170 feet long, shaped like an angular cucumber. It is said to have been worked by Morgan Nance, but there are no records of production.

Minnie Martin mine.—This mica mine is near the juncture of Roads 655 and 654, about 100 yards north of Martin's store, and 2.8 miles almost due south of Moneta (Pl. 24, No. 26). When visited in 1943 it had not been worked for several years. Development consists of a pit 140 feet long by 20 feet wide and deep on a body of pegmatite 12 to 15 feet thick, with a N.50°E. strike and a 65°SE. dip. The pegmatite appears to have been composed chiefly of plagioclase, now largely kaolinized to the depth of working, with minor perthite, quartz, and muscovite. Light green, generally flat, free-splitting, clear to heavily specked mica, some in large broken books, is locally fairly abundant near a 2-foot quartz core and along the footwall of the body. It is reported that several tons of scrap mica and some clear and specked sheet mica have been produced.

PEAKSVILLE AREA

GENERAL FEATURES

Feldspar has been mined in considerable quantity from one large pegmatite body and from several bodies of syenite and alaskite granite which occur within an area about a mile long in a northeasterly direction and less than half a mile wide, in Bedford County 0.6 mile north-northwest of Peaksville and 5 miles slightly west of north of Bedford. The area can be reached by going north from the Bedford city limits 4½ miles by Virginia Highway 43, thence half a mile east by Road 643, and 0.8 mile north by Road 640 (Fig. 15). It is in the immediate foothills of the Blue Ridge, and topography varies from rolling to mountainous. Elevations in vicinity of the mines average about 1060 feet.

The feldspar deposits lie wholly within the Precambrian granitic core rocks of the Blue Ridge structural province and, in this and in some other respects, they more closely resemble the anorthosite ("aplite") deposits of Nelson and Amherst counties thirty miles to

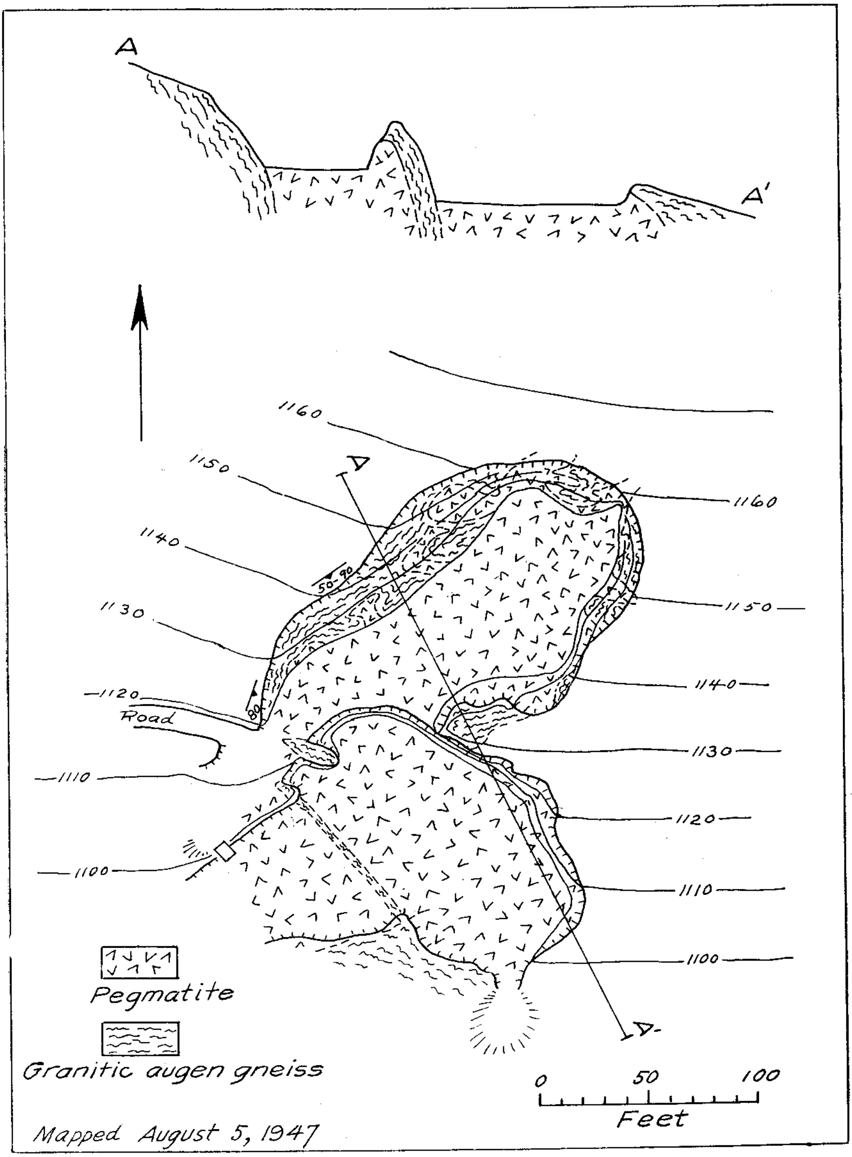


Figure 16. Sketch map of the Coles feldspar mine, 1.3 miles north of Peaksville, Bedford County.

the north than they do other feldspar deposits of the state. Like the anorthosite, they are almost devoid of visible mica and lack the mineralogic zoning typical of most commercial pegmatites. In addition, blue quartz, apatite, and titanium minerals are common associated accessories; and granulation and small-scale shearing, possibly suggesting accumulation by crystal sorting, are widespread.

Although some of the feldspar-rich rocks of the Peaksville area are of medium pegmatitic texture (have average grain size of 1 to 4 inches in diameter), as at the Coles and Overacre mines, and most others are of medium granitic texture (have average grain size of 1 to 5 mm. in diameter), mineralogic similarities within the rocks, and similar relations to enclosing rocks suggest that rocks of both textures are genetically related.

PEGMATITES

Coles mine.—Several bodies, which in their mineralogy and coarse grain appear to be true pegmatites, are known in the area, but only that on the Reuben Coles property, 1.3 miles north of Peaksville (Fig. 15), has been mined on a large scale. Open pit mining was begun in 1945 by J. W. Nance under contract with Clinchfield Sand and Feldspar Corp. When the operation was well under way, production of feldspar averaged about 1500 tons per month, and by April 1960, when the operation appeared to be nearing an end, total production had been in excess of 200,000 tons. Wilbur Nance states that the Coles has been one of the best mines in Bedford County.

The general form of the pegmatite body and of the workings in 1947 are shown in Figure 16. In April 1960, these workings had been enlarged to the south-southwest to give the pit a total length of about 540 feet, and deepened down the steep southeastward dip of the body to a maximum of about 200 feet (Pl. 6A). The deeper workings to the southeast had approximately a 40-foot overhang which was supported by two massive pillars; access to the deeper workings was through a 200-foot tunnel from the south (Pl. 6B).

The pegmatite body is quite irregular in shape but strikes about N.20°E., dips 50-55°SE., and from the workings appears to plunge southward. Its thickness is from 40 to 80 feet through most of the workings but it appears to pinch out in the lowermost workings. Numerous apophyses extend into the gray granite and augen gneiss walls, and inclusions of wall rock in the pegmatite are common. The pegmatite is composed predominantly of pale pink microcline perthite containing plates, masses, and veinlets of gray to bluish-gray quartz.

Table 8.—Modes of rocks at mines in the Peaksville area, Bedford County. Determined by point count in thin sections of typical specimens.

	Peaksville mine				Arrington mine		Dewey Toms mine	Coles mine
	Pink syenite	White alaskite	Gray granodiorite wall	Gray granite wall	White alaskite	White alaskite	Light gray alaskite	Gray granite wall
Quartz	2	34	31	43	24	42	43	45
Orthoclase	20	5	1	3	14	27	6	16
Microcline	43	54	24	27	42	17	26	17
Plagioclase	35	6	34	14	20	14	18	15
Biotite	..	1	6	3	..	x	x	6
Muscovite	..	..	2	3	x	x	7	1
Clinozoisite	..	x	1	6	x	x	x	x
Epidote	..	x	x	x	..	x	..	x
Allanite (?)	..	..	x	x	..	..	..	x
Sphene	..	..	x	x	x	..	..	..
Ilmenite	..	..	..	..	x	x	..	x
Leucoxene	x	..	..	..	..	..	..	..
Chlorite	..	..	x	x	..	..	x	..
Zircon	..	..	..	..	..	..	..	..
Apatite	x	x	..	..	..	..	..	..
Fluorite	x	x	x	x	x	x	x	x

Table 9.—Chemical analyses of a mill sample of feldspar from the Coles mine and of rock specimens from the Peaksville mine. (Courtesy of Clinchfield Sand and Feldspar Corp. of Baltimore).

		Peaksville (grab samples)	
	Coles (Mill Sample)	Pink Syenite	White Alaskite
SiO_2	68.7	67.9	69.2
Al_2O_3	17.3	18.2	17.4
Fe_2O_3	0.09	0.09	0.09
CaO	0.2	0.2	0.6
K_2O	10.8	7.6	0.7
Na_2O	2.9	5.8	11.3
Ignition loss	.2	.4	.5
	100.19	100.19	99.79

Late purple fluorite forms veinlets and encrustations; mica is absent, and there is no zonation.

Overacre mine.—In the spring of 1960, a body of pegmatitic rock similar to that at the Coles mine was discovered about 1000 feet S.17°E. of the Coles mine (Fig. 15). Partly kaolinized surface material analyzed 13 percent potash and no soda. In April 1960, a pit 150 feet long, 100 feet wide, and 25 feet deep had been opened and several 100-foot exploratory drill holes sunk. The visible pegmatite approached the dimensions of the pit and bottom was not reached in the drill holes. The body appears to be even more irregular than that at the Coles mine, and included masses of light gray granite wall rock are numerous.

SYENITES AND ALASKITES

Medium-grained granitoid rocks ranging in composition from sodic syenite to alaskite granite (including monzonite and quartz monzonite) have been quarried for their feldspar content in at least four places a short distance east and west of the juncture of Roads 640 and 641, about 0.6 mile north-northwest of Peaksville (Fig. 15). The geologic relations in each deposit are so similar that one description will suffice for all.

The commercial granitoid bodies are very irregular in shape but show a tendency to trend eastward and dip moderately to steeply southward. All are light-colored, ranging from white and pale pink to light gray, and are enclosed in medium- to dark-gray, medium-grained granite to granodiorite. Contacts are gradational, the zone of gradation generally being not over a fraction of an inch to an inch or so thick, and are extremely irregular, with much intertonguing of the light- and dark-colored phases (Pl. 7B).

Microscopic study shows that the commercial light-colored rocks consist predominantly of medium-grained hypidiomorphic mixtures of potash feldspar, albite, and quartz (Table 8). Feldspar is the chief mineral and, in some, potash feldspar, mainly microcline, predominates over albite; in others the reverse is true. The quartz content ranges from about 2 to 45 percent, being lowest in the pink material. All show more or less fracturing and granulation, especially about grain borders, and both quartz and feldspar show strong undulatory extinction. Minute quantities of fine-grained biotite, muscovite, epidote, clinozoisite, apatite, ilmenite, and sphene have been introduced along fractures, replacing earlier minerals in part. In places, albite has undergone recrystallization. The non-commercial medium- to dark-gray rocks have essentially the same mineralogy as the light-colored commercial rocks which they enclose, but they contain much larger quantities of introduced biotite, muscovite, etc. Both the commercial and the non-commercial rocks locally contain even later fracture fillings of megascopic pyrite and purple fluorite. By far the most desirable material is the low-quartz pink syenite.

Peaksville mine.—This, the largest syenite-alaskite mine in the area and the first to be opened, is immediately west of Road 640 opposite where it is joined by Road 641 from the east (Fig. 15). It was first worked by Wilbur Nance and H. T. Patterson, Jr. in 1928. In 1960, it was owned by International Minerals and Chemical Corp. and had been worked on an average of about 4 months per year since 1945 by Clinchfield Sand and Feldspar Corp. under lease. The general form of the alaskite-syenite body and the nature of the main workings in 1947 are shown in Fig. 17 and Plates 7A and 7B. In 1960, the main pit had been

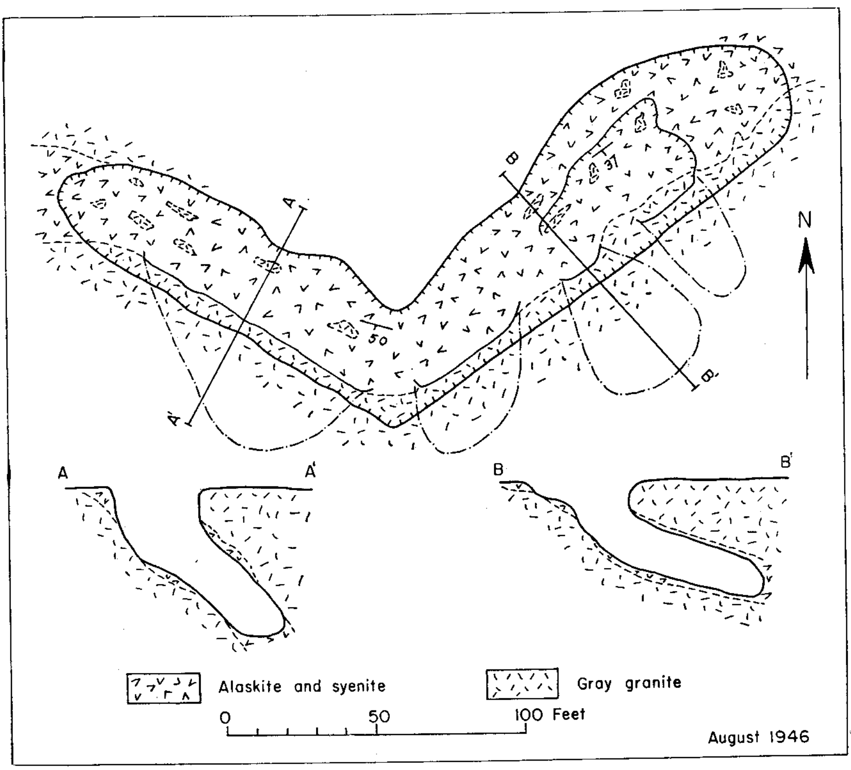


Figure 17. Sketch map of the main pit at the Peaksville alaskite-syenite mine, 0.7 mile north-northwest of Peaksville, Bedford County.

widened to a maximum of about 100 feet and the underground workings enlarged and deepened to perhaps 60 feet below the surface.

The syenite-alaskite body is 25 to 40 feet thick, trends irregularly eastward, and dips 37 to 80° southward. Both white and pink varieties of the rock are present, the pink being most prominent toward the top of the body. Small coarse pegmatite-like zones occur rarely, and quartz veins and fluorite veinlets are common. Modes from thin sections are given in Table 8.

Dewey Toms-Arrington mines.—Several pits have been opened along and on both sides of the old county road, now just south of the present Road 641, within half a mile east of the Peaksville mine (Fig. 15). In 1947, the O. G. Arrington property on the south side of the old road was being mined by Carolina Mineral Co., and the Dewey Toms property on the north side was being mined by Clinchfield Sand and Feldspar Corp. The largest and easternmost pit, 150 feet long, 90 feet wide, and 40 feet deep, had been opened directly across the old road and was being operated by both companies. The rock being quarried was a predominantly white to light gray alaskite similar to that at the Peaksville mine but high in quartz (Table 8). The walls had not been exposed, but numerous very irregular patches and masses of dark gray granite were included within the light-colored alaskite. Similar light- and dark-colored phases were exposed in the several other smaller pits to the west.

SELECTED BIBLIOGRAPHY

American Society for Testing Materials, 1958 Book of ASTM Standards, Pt. 9, Philadelphia, Pa.

Anderson, Olaf, 1931, Discussion of certain phases of the genesis of pegmatites: Norsk Geol. Tidsskrift, B. 12, p. 1-56.

Bannerman, H. M., 1943, Structural and economic features of some New Hampshire pegmatites: New Hampshire State Planning and Devel. Comm., Min. Res. Survey, Pt. 7, 22 p.

Barton, W. R., 1958, Columbium and tantalum: U. S. Bur. Mines, Minerals Yearbook, 1957, vol. 1, p. 403-416.

Bastin, E. S., 1911, Quartz and feldspar: U. S. Geol. Survey, Mineral Resources of the United States, 1910, Pt. 2, p. 963-975.

Bloomer, R. O., and Werner, H. J., 1955, Geology of the Blue Ridge region in central Virginia; Geol. Soc. America Bull., vol. 66, p. 579-606.

Brown, W. R., 1945, Some recent beryl finds in Virginia; Rocks and Minerals, vol. 20, p. 264-265.

————————, 1953, Structural framework and mineral resources of the Virginia Piedmont; Ky. Geol. Survey Spec. Pub. no. 1, p. 88-111; Va. Div. Geol. Reprint no. 16.

————————, 1958, Geology and mineral resources of the Lynchburg quadrangle, Virginia; Virginia Div. of Mineral Resources, Bull. 74, 99 p.

Burgess, B. C., 1949, Feldspar *in* Industrial minerals and rocks, 2nd ed.; New York, Amer. Inst. Min. and Met. Eng., p. 345-373.

Cameron, E. N., Jahns, R. H., McNair, A. H., and Page, L. R., 1949, Internal structure of granitic pegmatites; Econ. Geology Publ. Co., Urbana, Ill., Monograph 2, 115 p.

Cameron, E. N., Larrabee, D. M., McNair, A. H., Page, J. J., Shainin, V. E., and Stewart, G. W., 1945, Structural and economic characteristics of New England mica deposits: Econ. Geol., vol. 40, p. 369-393.

Daly, R. A., 1933, Igneous rocks and the depths of the earth: New York, McGraw-Hill Book Co., Inc., 598 p.

Dana, E. S., 1932, A textbook of mineralogy; New York, John Wiley & Sons, Inc., 851 p.

Deeth, H. R., 1957, Nepheline syenite at Blue Mountain; Min. Eng., vol. 9, no. 11, p. 1241-1244.

———— and Koenig, C. J., 1949, Recent developments in mining, processing, and application of nepheline syenite from Blue Mountain, Ontario; Amer. Inst. Mining and Met. Engrs., Trans., vol. 181, p. 424-431.

de Polo, Taber, 1959, Feldspar; Eng. Min. Jour., vol. 160, no. 2, p. 143.

———— and Tucker, G. E., 1958, Feldspar, nepheline syenite, and aplite; U. S. Bur. Mines, Minerals Yearbook, 1957, vol. 1, p. 477-486.

————, 1959, Feldspar, nepheline syenite, and aplite; U. S. Bur. Mines, Minerals Yearbook, 1958, vol. 1, p. 427-435.

Derry, D. R., 1931, Genetic ıelationships of pegmatites, aplites, and tin veins; Geol. Mag., vol. 68, p. 454-475.

———— and Phipps, C. V. G., 1957, Nepheline syenite deposit, Blue Mountain, Ontario; Sixth Commonwealth Mining and Metallurgical Congress, Industrial Mins. Div. Canadian Inst. Min. and Met., p. 190-195.

Diamond, G. S., 1957, Electrostatic separation of feldspar and other non-metallic minerals; Canadian Mining and Metallurgical Bull. (Montreal), vol. 60, no. 547, Nov. 1957, p. 669-673.

Diggs, W. E., 1955, Geology of the Otter River area, Bedford County, Virginia; Va. Polytechnic Institute, Bull., vol. 48, no. 9, 23 p.

Eilertsen, D. E., 1958, Beryllium; U. S. Bur. Mines, Minerals Yearbook, 1957, vol. 1, p. 257-263.

————, 1959, Beryllium; U. S. Bur. Mines, Minerals Yearbook, 1958, vol. 1, p. 229-235.

Engineering and Mining Journal Metal and Mineral Markets (for dates stated), New York.

Fontaine, W. M., 1883, Notes on the occurrence of certain minerals in Amelia County, Virginia; Amer. Jour. Sci., 3rd series, vol. 25, p. 330-339.

Frondel, Clifford, and Ashby, G. E., 1937, Oriented inclusions of magnetite and hematite in muscovite; Amer. Min., vol. 22, p. 104-121.

Geologic map of Virginia, Va. Geol. Survey, 1928.

Gevers, T. W., 1936, Phases in mineralization in Namaqualand pegmatites; Trans. Geol. Soc. South Africa, vol. 39, p. 331-378.

Gilluly, James, et al., 1948, Origin of granite; Geol. Soc. America, Mem. 28, 139 p.

Glass, J. J., 1935, The pegmatite minerals from near Amelia, Virginia; Amer. Min., vol. 20, p. 741-768.

Griffitts, W. R., Jahns, R. H., Lemke, R. W., 1953, Mica deposits of the southeastern Piedmont, Pt. 3, Ridgeway-Sandy Ridge district, Virginia and North Carolina, and Pt. 4, Outlying deposits in Virginia; U. S. Geol. Survey Prof. Paper 248-C, p. 141-202.

Gunsallus, B. L., and Brett, Betty A., 1958, Clays; U. S. Bureau Mines, Minerals Yearbook, 1957, vol. 1, p. 363-387.

Heinrich, E. W., 1953, Zoning in pegmatite districts; Amer. Min., vol. 38, p. 68-87.

Hess, F. L., 1933, The pegmatites of the western states, *in* Ore deposits of the western states (Lindgren Volume); Amer. Inst. Min. Met. Eng., p. 526-536.

Hewitt, D. F., 1957, Nepheline syenite *in* The geology of Canadian industrial mineral deposits; Sixth Commonwealth Mining and Metallurgical Congress, Industrial Mins. Div. Canadian Inst. Min. and Met., p. 186-190.

Horton, F. W., 1935, Mica; U. S. Bur. Mines Inf. Circ. 6822, 57 p.

Jahns, R. H., 1946, Mica deposits of the Petaca district, Rio Arriba County, N. Mex.; New Mex. School Mines, State Bur. Mines and Min. Res., Bull. 25.

————————, 1953, The genesis of pegmatites, II Quantitative analysis of lithium-baring pegmatite, Mora County, New Mexico; Amer. Min., vol. 38, p. 1078-1112.

————————, 1955, The study of pegmatites; Econ. Geol., Fiftieth Anniversary Volume, Pt. II, p. 1025-1130.

———————, Griffitts, W. R., Heinrich, E. W., 1952, Mica deposits of the southeastern Piedmont, Pt. 1, General features: U. S. Geol. Survey Prof. Paper 248-A, p. 1-102.

———————, and Lancaster, F. W., 1950, Physical characteristics of commercial sheet muscovite in the southeastern United States; U. S. Geol. Survey Prof. Paper 225, 110 p.

Johnston, W. D., Jr., 1945, Beryl-tantalite pegmatites of northeastern Brazil; Geol. Soc. America Bull., vol. 56, p. 1017-1068.

Jonas, A. I., 1932, Geology of the kyanite belt of Virginia, *in* Kyanite in Virginia; Va. Geol. Survey Bull. 38, p. 1-38.

Katz, F. J., 1916, Feldspar; U. S. Geol. Survey, Mineral Resources of the U. S., 1914, p. 449-454.

Kesler, T. L., and Olson, J. C., 1942, Muscovite in the Spruce Pine district, North Carolina; U. S. Geol. Survey Bull. 936-A, 38 p.

King, P. B., 1955, A geologic section across the southern Appalachians, *in* Guides to Southeastern Geology; Geol. Soc. America, p. 332-373.

Landes, K. K., 1925, The paragenesis of the granite pegmatites of central Maine; Amer. Min., vol. 10, p. 355-411.

———————, 1933, Origin and classification of pegmatites; Amer. Min., vol. 18, p. 33-56, 95-103.

Lemke, R. W., Jahns, R. H., Griffitts, W. R., 1952, Mica deposits of the southeastern Piedmont, Pt. 2, Amelia district, Virginia; U. S. Geol. Survey Prof. Paper 248-B, p. 103-139.

Lutjen, G. P., 1953, Kona plant features flexibility in feldspar flotation; Eng. and Min. Jour., vol. 154, no. 5, p. 92-95.

Marble, J. P., 1935, Age of allanite from Amherst County, Virginia; Amer. Jour. Sci., 5th sèr., vol. 30, p. 349-352.

Mead, W. J., 1925, The geologic role of dilatancy; Jour. Geol., vol. 33, p. 685-698.

Merrill, G. P., 1902, Rutile mining in Virginia; Eng. and Min. Jour., vol. 78, p. 351.

Metcalf, R. W., 1941, Marketing feldspar; U. S. Bur. Mines Inf. Circ. 7184.

——————, Calver, J. L., and Feitler, S. A., 1959, The mineral industry of Virginia; U. S. Bur. Mines, Minerals Yearbook, 1958, vol. 3, p. 973-994.

Mineral Resources of the United States; 1882-1931; U. S. Geol. Survey, 1882-1923; U. S Bur. Mines, 1924-1931.

Minerals Yearbook, 1932-1958; U. S. Bur. Mines.

National Bureau of Standards, 1930, Feldspar, commercial standard CS 23-30. Recommended method for chemical and screen analysis.

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

Pegau, A. A., 1932, Pegmatite deposits of Virginia; Va. Geol. Survey Bull. 33, 123 p.

Ramberg, Hans, 1952, The Origin of metamorphic and metasomatic rocks; Chicago, Univ. of Chicago Press, 317 p.

Ross, C. S., 1941, Occurrence and origin of the titanium deposits of Nelson and Amherst counties, Virginia; U. S. Geol. Survey Prof. Paper 198, 59 p.

Schaller, W. T., 1925, Genesis of lithium pegmatites; Amer. Jour. Sci., 5th ser., vol. 10, p. 269-279.

——————, 1933, Pegmatites *in* Ore deposits of the western states; Amer. Inst. Min. and Met. Engrs., New York, p. 144-151.

Shand, S. J., 1943, Eruptive rocks; London, Thomas Murby & Co., 444 p.

Skow, M. L., 1959, Mica Engineering and Mining Journal, vol. 160, no. 2, p. 142.

——————, Gwinn, G. R., and Tucker, G. E., 1959, Mica; U. S. Bur. Mines, Minerals Yearbook 1958, vol. 1, p. 767-786.

—————— and Tucker, G. E., 1958, Mica; U. S. Bur. Mines, Minerals Yearbook, 1957, vol. 1, p. 841-866.

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

Sterrett, D. B., 1913, Gems and precious stones; U. S. Geol. Survey, Mineral Resources of the United States, 1912, Pt. 2, p. 1023-1060.

————, 1914, Some deposits of mica in the United States; U. S. Geol. Survey Bull. 580, p. 65-125.

————, 1923, Mica deposits of the United States; U. S. Geol. Survey Bull. 740, 342 p.

Tyler, P. M., 1950, Economic importance of pegmatites; U. S. Bur. Mines Inf. Circular 7550, 57 p.

Watson, T. L., 1906, Lithological characters of Virginia granites; Geol. Soc. America Bull., vol. 17, p. 523-540.

————, 1907, Mineral resources of Virginia; Virginia-Jamestown Exposition Commission, Lynchburg, Va., 618 p.

————, 1909, Annual report on the mineral production of Virginia during the calendar year 1908; Virginia Geol. Survey Bull. 1A, 141 p

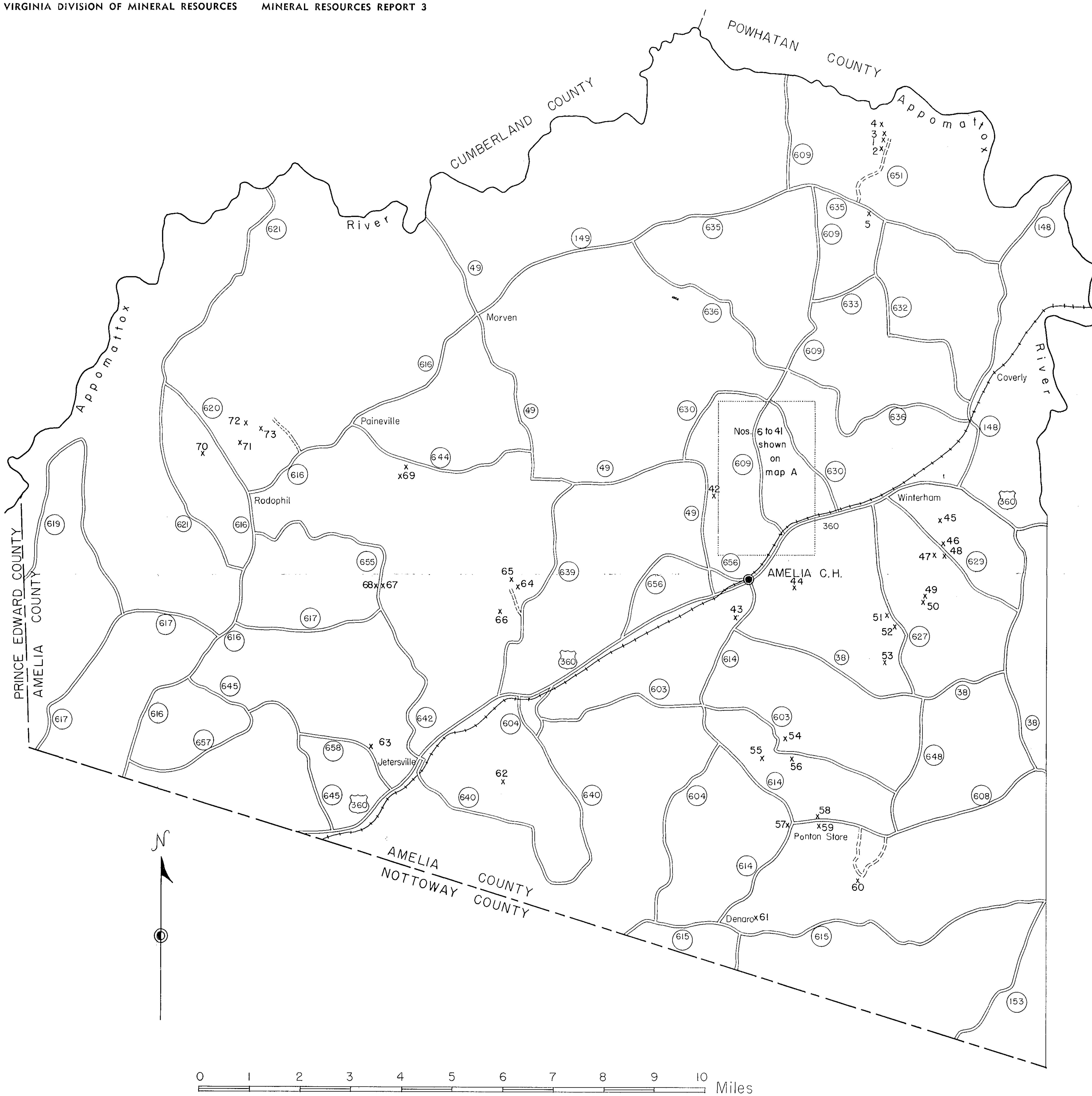
————, 1911, Biennial report on the mineral production of Virginia during the calendar years 1909 and 1910; Virginia Geol. Survey Bull. 6, 123 p.

————, 1913, Biennial report on the mineral production of Virginia during the calendar years 1911 and 1912; Virginia Geol. Survey Bull. 8, 76 p.

———— and Cline, J. H., 1913; Petrology of a series of igneous dikes in central western Virginia; Geol. Soc. Amer. Bull., vol. 24, p. 301-334.

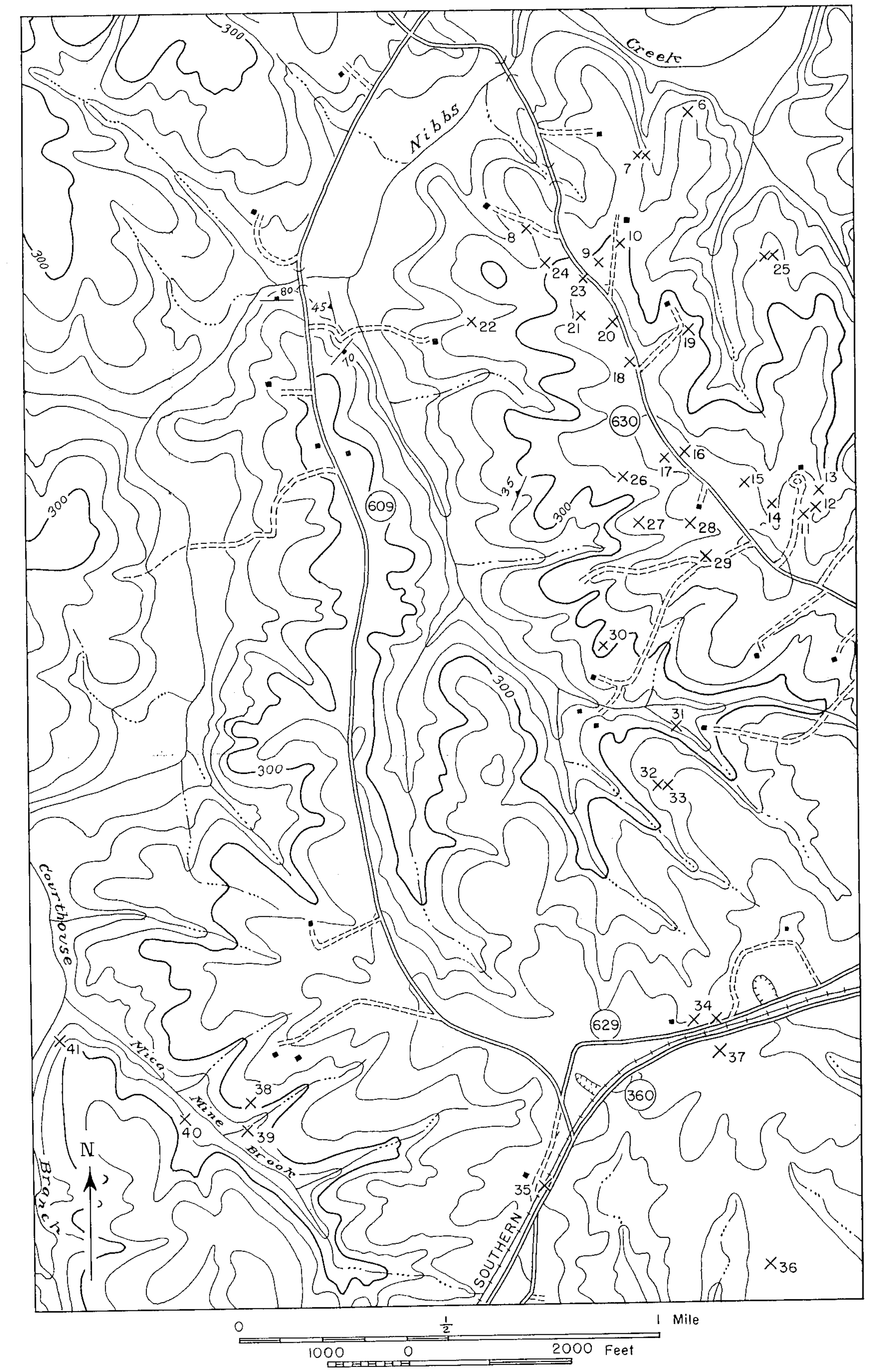
———— and Taber, Stephen, 1913, Geology of the titanium and apatite deposits of Virginia; Virginia Geol. Survey Bull. III-A, 308 p.

Wierum, H. F., and others, 1938, The mica industry, U. S. Tariff Comm. Rept. 130, 2nd ser., p. 11-26.

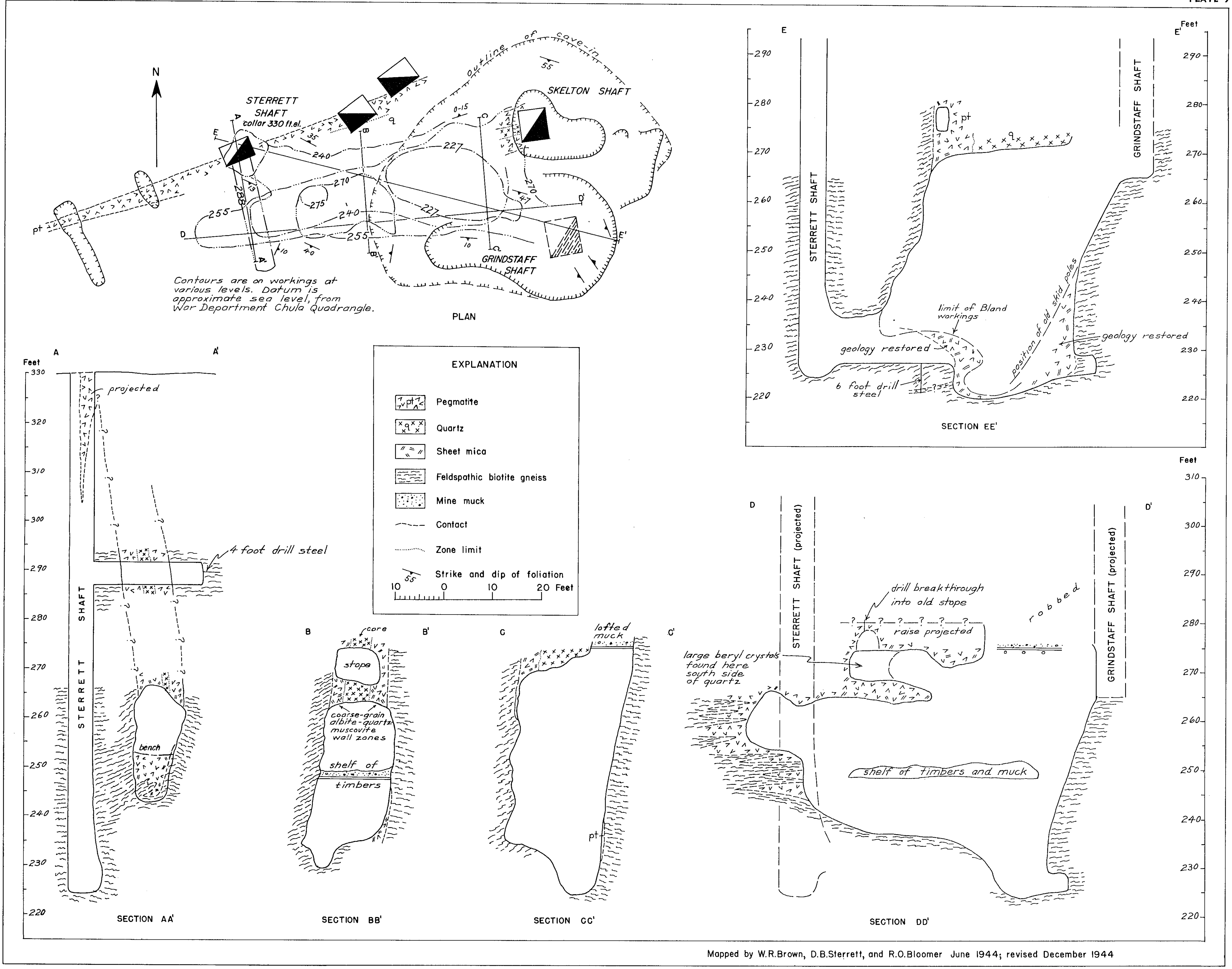


Mines and Prospects

1. Ligon No. 1 prospect
2. Ligon No. 2 prospect
3. Ligon No. 3 prospect
4. Ligon No. 4 prospect
5. Lawrence prospect
6. W. T. Pinchbeck No. 1 mine
7. W. T. Pinchbeck No. 2 prospect
8. Stevens prospect
9. Pineshaft mine
10. Abner mine
11. McCraw prospect
12. McCraw No. 1 mine
13. McCraw No. 2 mine
14. McCraw No. 3 mine
15. Jefferson No. 1 mine
16. Jefferson No. 2 mine
17. Jefferson No. 3 mine
18. Champion (Jefferson No. 4) mine
19. Fields (Jefferson No. 5) mine
20. Jefferson No. 6 mine
21. Jefferson No. 7 mine
22. Jefferson No. 8 prospect.
23. Nettie Taylor (Jefferson No. 9) prospect
24. Jefferson No. 10 prospect
25. Howe mine
26. Archer prospect
27. Granason prospect
28. Booker prospect
29. Prospect
30. P. A. Patterson prospect
31. John Patterson mine
32. Prospect No. 37 of Pegau
33. Prospect No. 38 of Pegau
34. Marshall mines
35. Berry No. 1 mine
36. Berry No. 2 mine
37. Berry No. 3 prospect
38. Rutherford No. 1 mine
39. Rutherford No. 2 mine
40. Rutherford No. 3 mine
41. Will Jones (Corson) prospect
42. Truehart beryl prospect
43. A. B. Wingo mine
44. Abner Pinchbeck prospect
45. Morefield mine
46. Morefield "Hog lot" prospect
47. Flippen beryl prospect
48. Dobbin prospect
49. O'neil beryl prospect
50. Waverley Vaughan beryl prospect
51. Waverley Vaughan mine
52. Lily B. Vaughan beryl prospect
53. Winfree prospect
54. Mottley prospect
55. Golden prospect
56. DeKraft prospect
57. Ponton prospect
58. Venable prospect
59. Mays prospect
60. David Anderson prospect
61. Munden prospect
62. Houston prospects
63. Schlegal mine
64. Keystone mine
65. Prospects
66. Prospects
67. Eggleston prospect
68. Buddy Jones prospect
69. G. C. Wingo prospects
70. James Anderson prospect
71. Ford prospects
72. Lambert prospect
73. Foster prospect

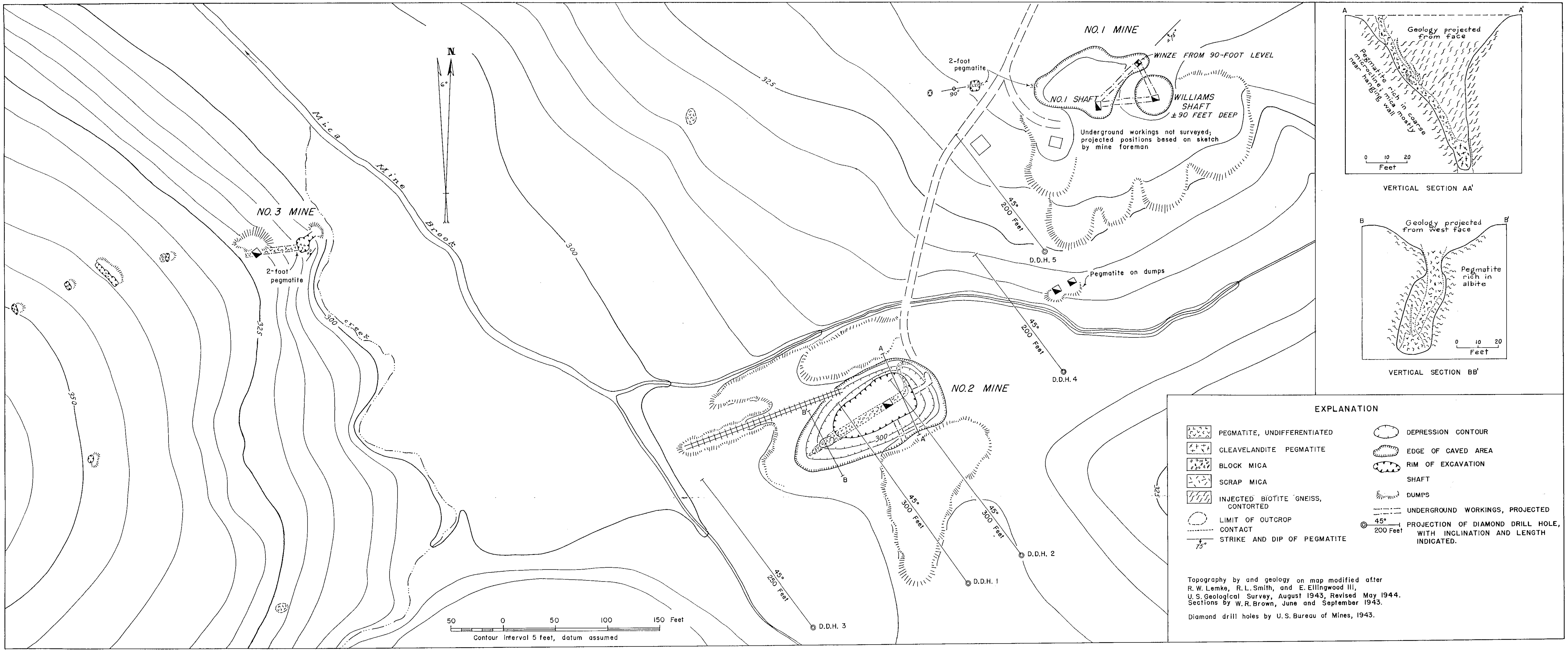


MAP SHOWING LOCATION OF MICA MINES AND PROSPECTS IN THE AMELIA AREA, AMELIA COUNTY, VIRGINIA.

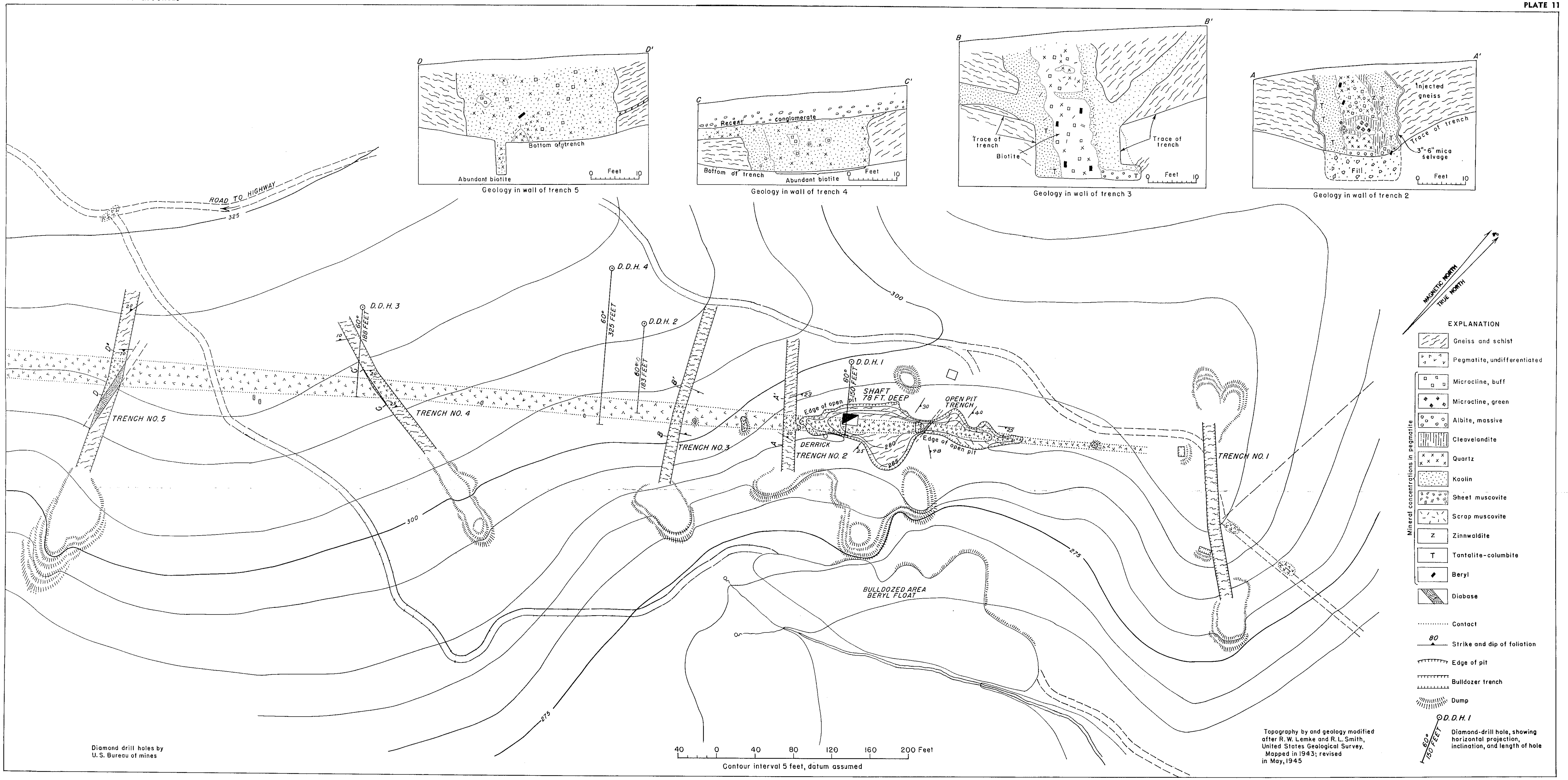


Mapped by W.R.Brown, D.B.Sterrett, and R.O.Bloomer June 1944; revised December 1944

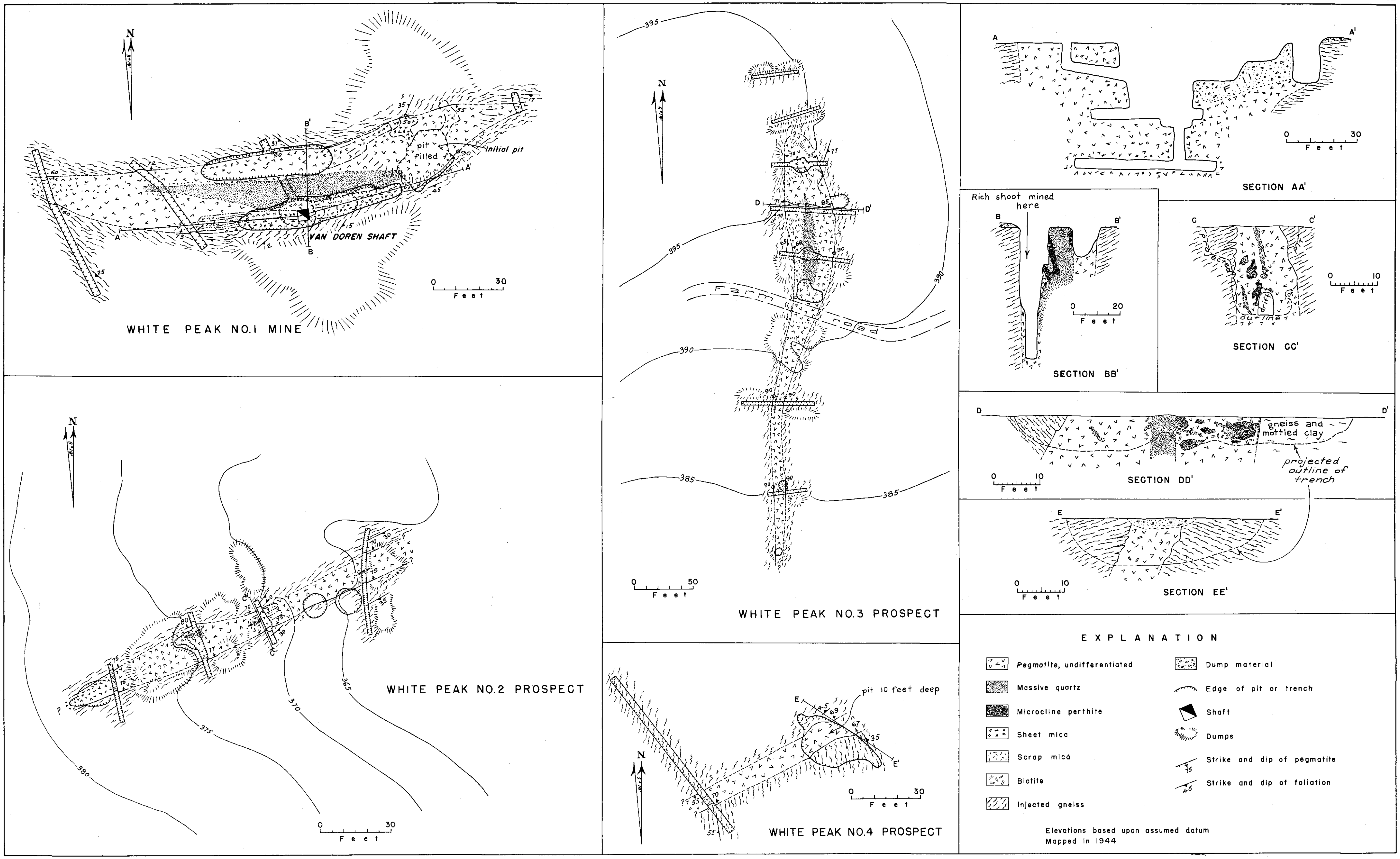
GEOLOGIC MAP AND SECTIONS OF THE CHAMPION MICA MINE, AMELIA COUNTY, VIRGINIA.



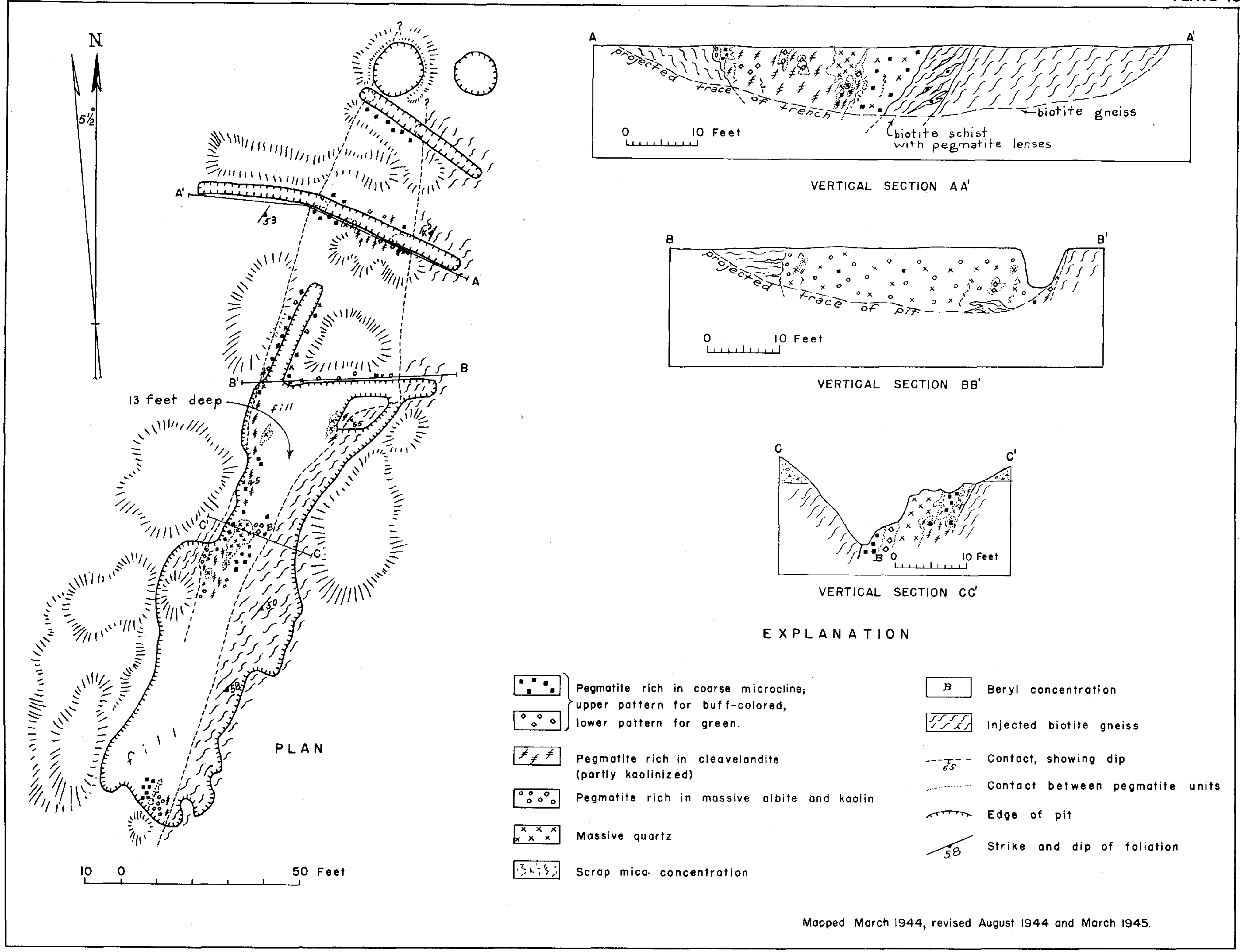
GEOLOGIC MAP AND SECTIONS OF THE RUTHERFORD MICA-FELDSPAR MINES, AMELIA COUNTY, VIRGINIA.



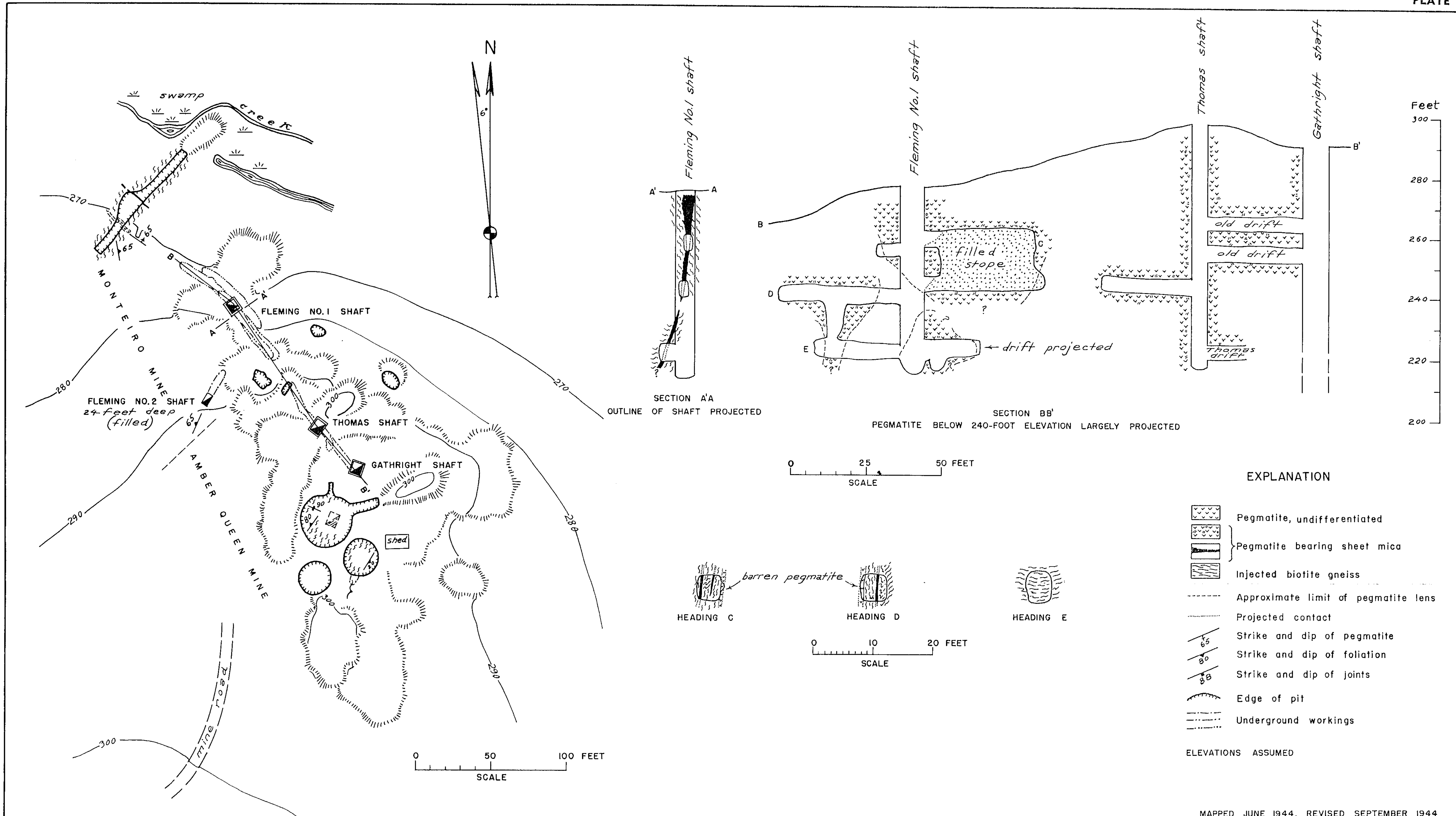
GEOLOGIC MAP AND SECTIONS OF THE MOREFIELD MICA-FELDSPAR MINE, AMELIA COUNTY, VIRGINIA.



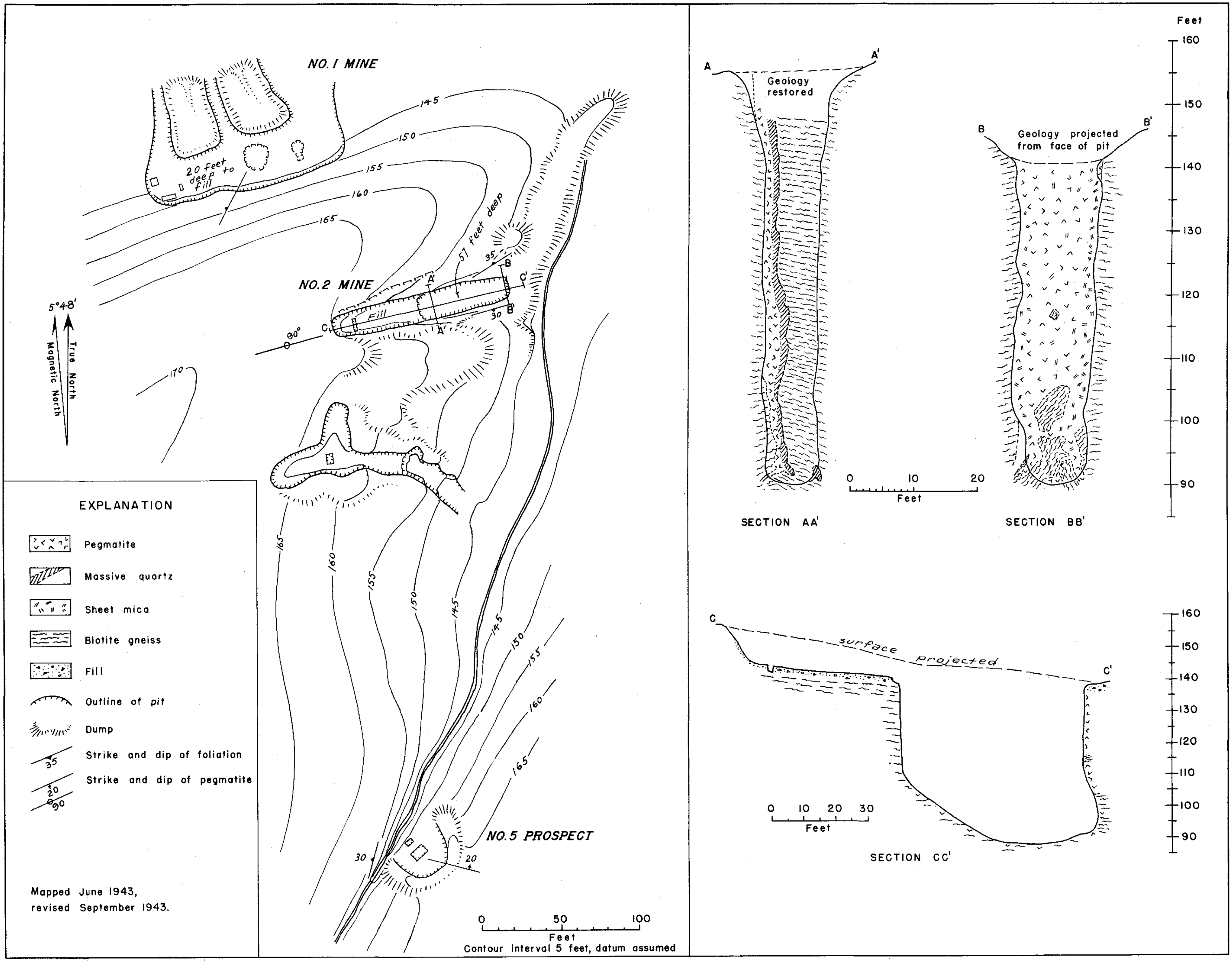
GEOLOGIC MAP AND SECTIONS OF THE WHITE PEAK MICA MINE AND PROSPECTS, POWHATAN COUNTY, VIRGINIA.



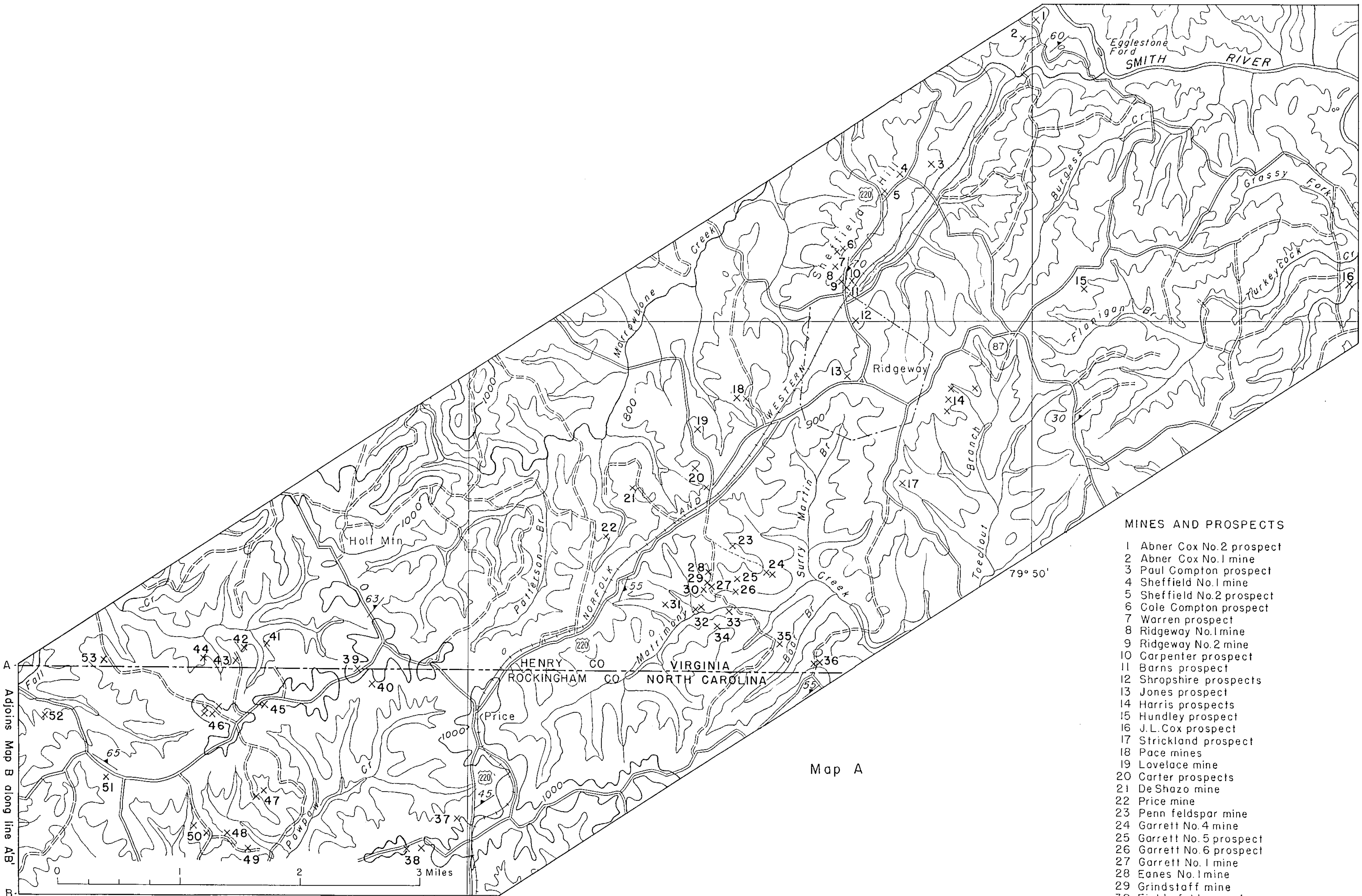
GEOLOGIC MAP AND SECTIONS OF THE HERBB No. 2 MICA-FELDSPAR MINE, POWHATAN COUNTY, VIRGINIA.

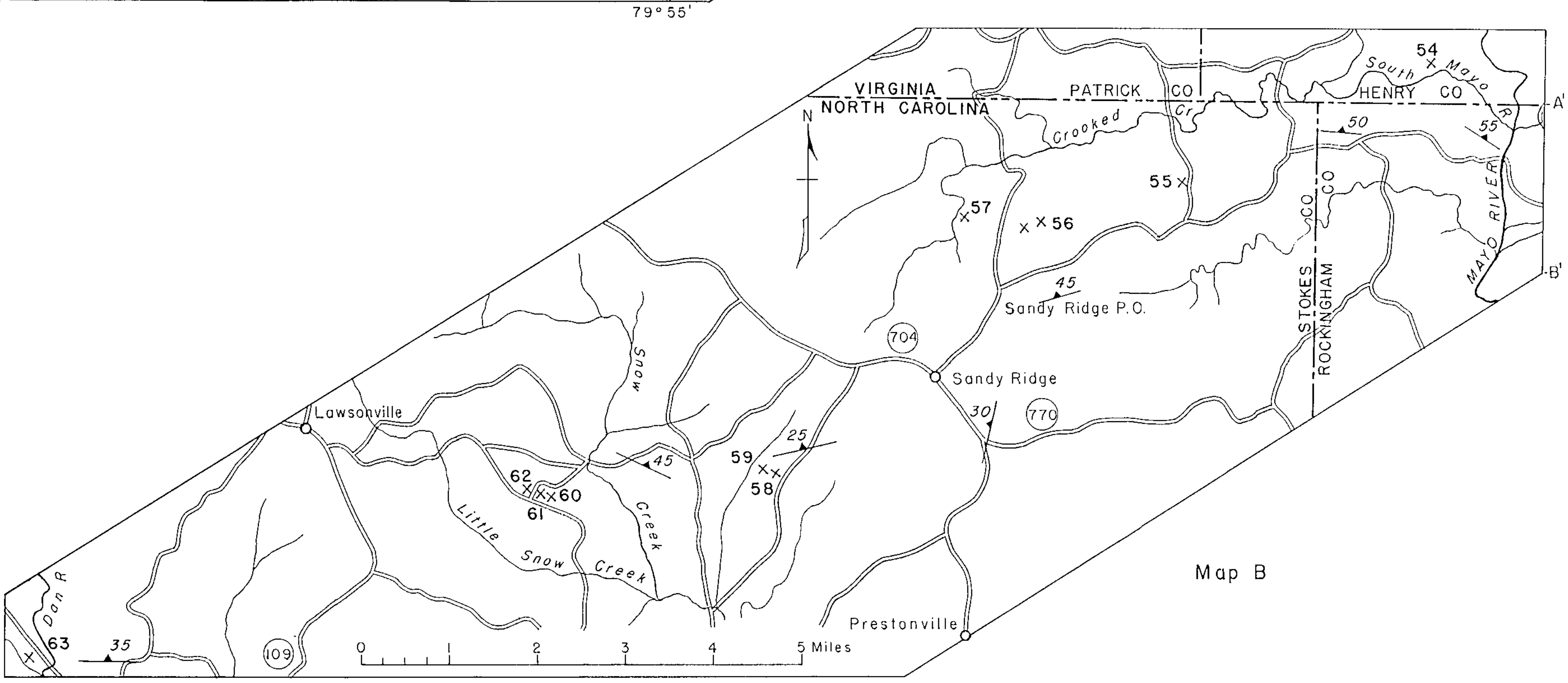


GEOLOGIC MAP AND SECTIONS OF THE MONTEIRO-AMBER QUEEN MICA MINE, GOOCHLAND COUNTY, VIRGINIA.



GEOLOGIC MAP AND SECTIONS OF THE SAUNDERS No. 1 AND No. 2 MINES AND No. 5 MICA PROSPECT, HANOVER COUNTY, VIRGINIA.



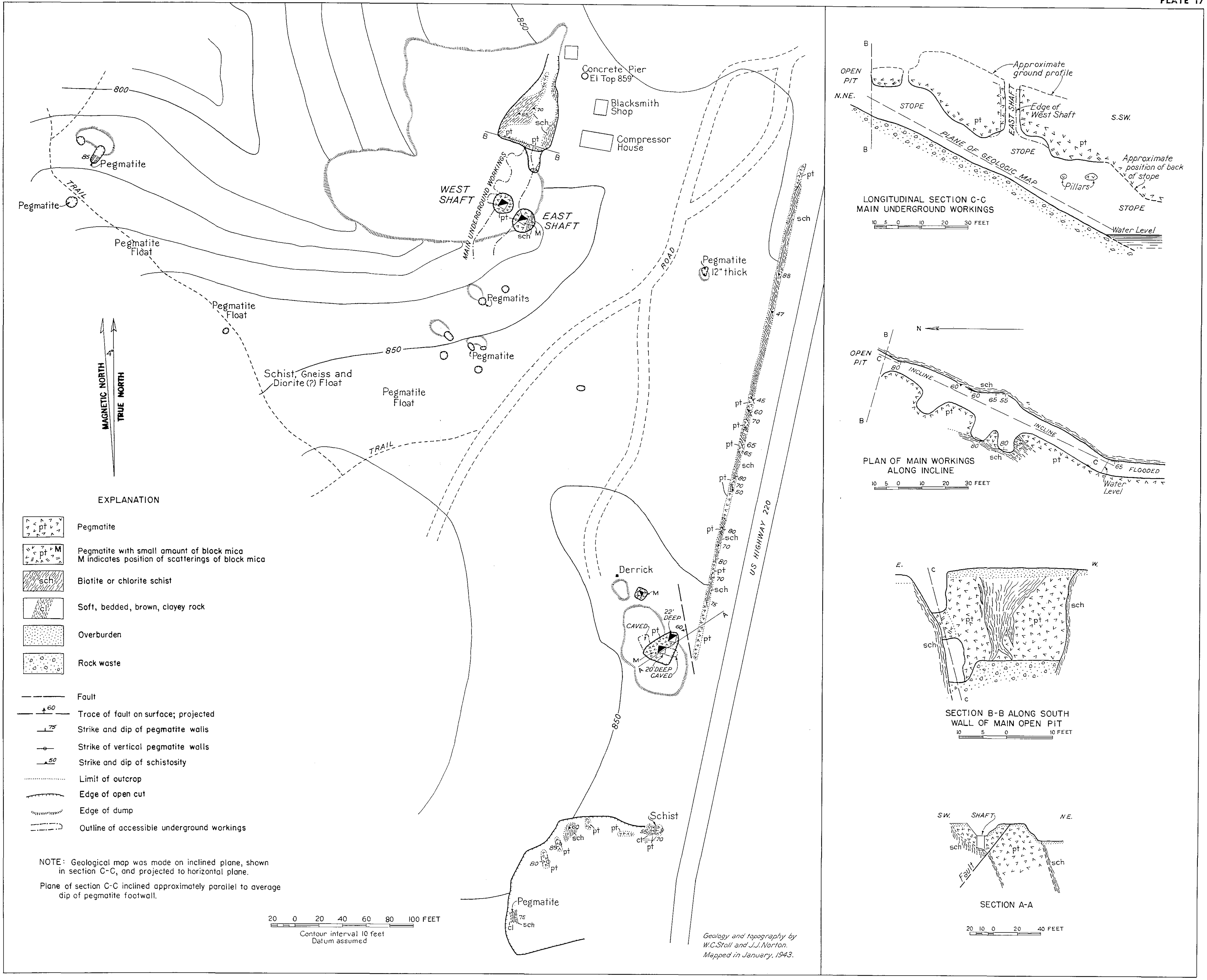


MINES AND PROSPECTS

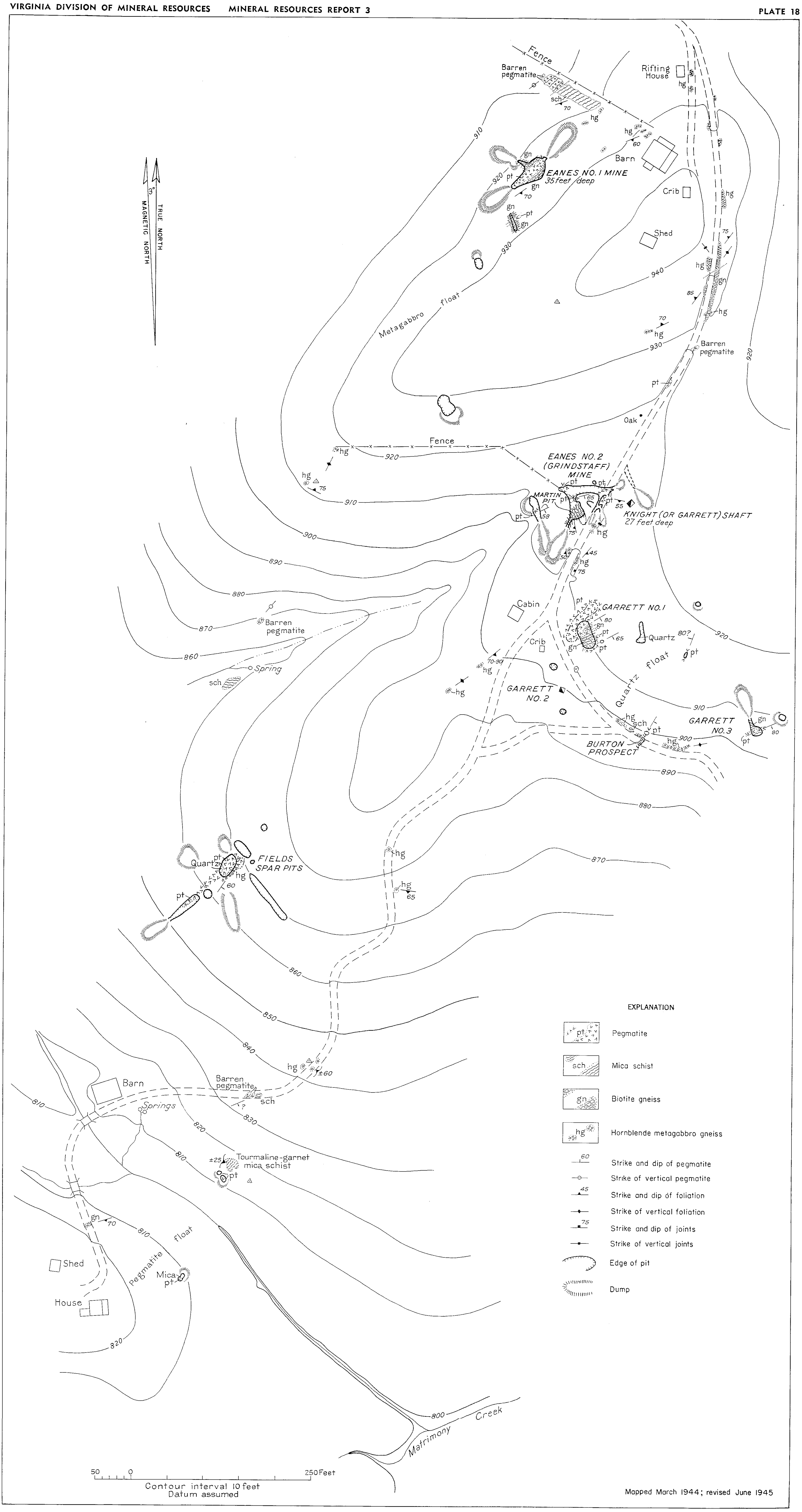
1 Abner Cox No. 2 prospect
2 Abner Cox No. 1 mine
3 Paul Compton prospect
4 Sheffield No. 1 mine
5 Sheffield No. 2 prospect
6 Cole Compton prospect
7 Warren prospect
8 Ridgeway No. 1 mine
9 Ridgeway No. 2 mine
10 Carpenter prospect
11 Barns prospect
12 Shropshire prospects
13 Jones prospect
14 Harris prospects
15 Hundley prospect
16 J. L. Cox prospect
17 Strickland prospect
18 Pace mines
19 Lovelace mine
20 Carter prospects
21 DeShazo mine
22 Price mine
23 Penn feldspar mine
24 Garrett No. 4 mine
25 Garrett No. 5 prospect
26 Garrett No. 6 prospect
27 Garrett No. 1 mine
28 Eanes No. 1 mine
29 Grindstaff mine
30 Fields feldspar mine
31 Oliver prospect No. 1
32 Oliver prospect No. 2
33 Mill (Oliver) prospect
34 Oliver prospect No. 3
35 Remsen prospect
36 Phillips mine
37 Tyler Holland mine
38 Byrd Holland mine
39 Watkins prospect
40 Clifton mine
41 L. J. Smith prospects
42 Coleman No. 2 mine
43 Coleman No. 1 mine
44 Coleman No. 3 prospect
45 Earnest Smith prospect No. 1
46 Earnest Smith prospect No. 2
47 Long Tom mines
48 Long Tom prospect
49 Rosa Evans mine
50 Cox prospects
51 Tom Smith mine
52 Harry Knight mine
53 Earnest Penn prospect
54 Mullens prospects
55 Brown mine
56 Wilkins prospects
57 Ottis Shelton prospect
58 Ruby King mine
59 Joe Hawkins mine
60 Moorefield mine
61 Cruise prospect
62 G. R. Shelton mine
63 Jack Hole mine

45 — Strike and dip of foliation

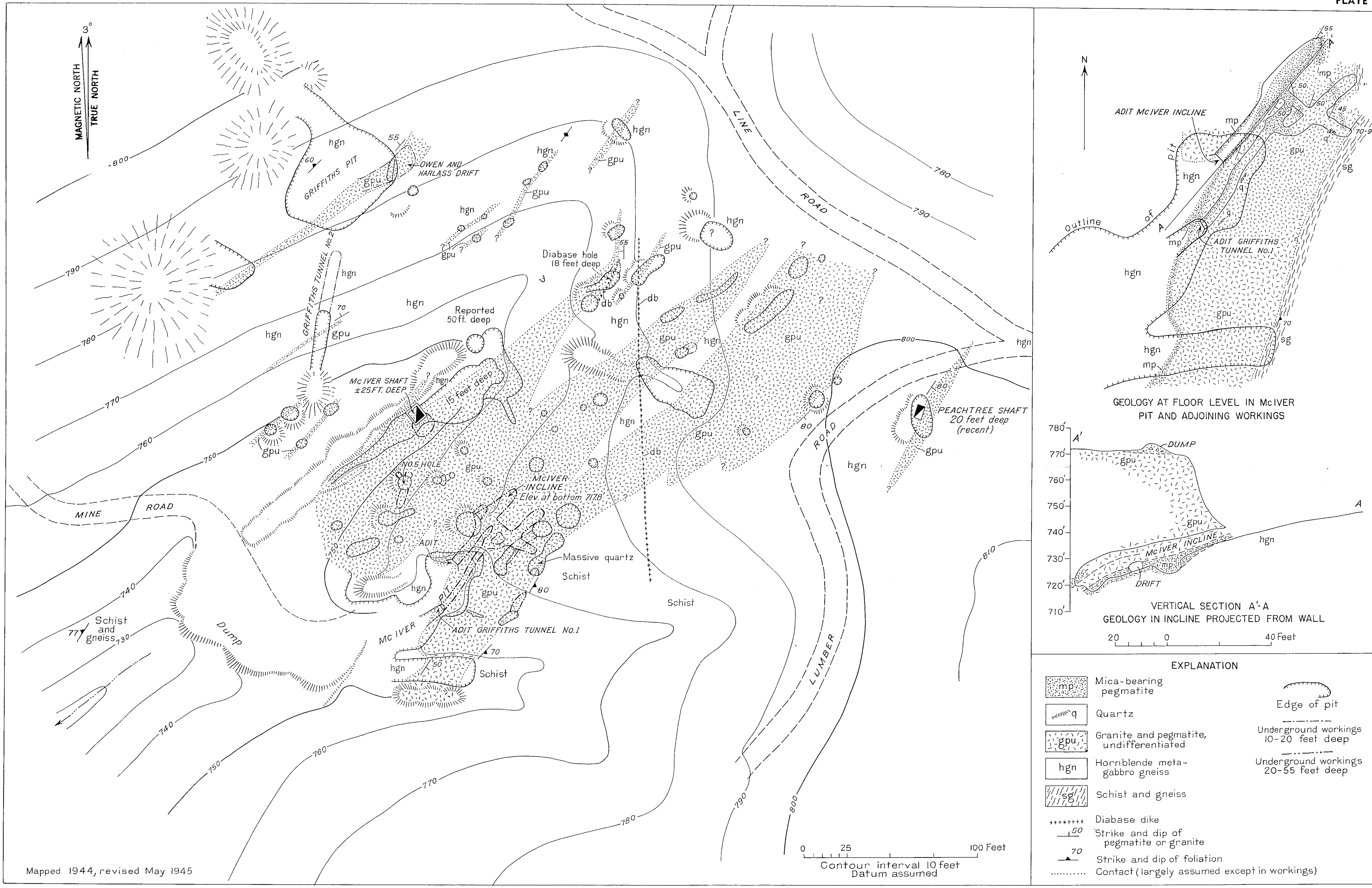
MAPS SHOWING LOCATION OF MICA MINES AND PROSPECTS IN THE RIDGEWAY AREA, HENRY COUNTY, VIRGINIA; AND ROCKINGHAM AND STOKES COUNTIES, NORTH CAROLINA.



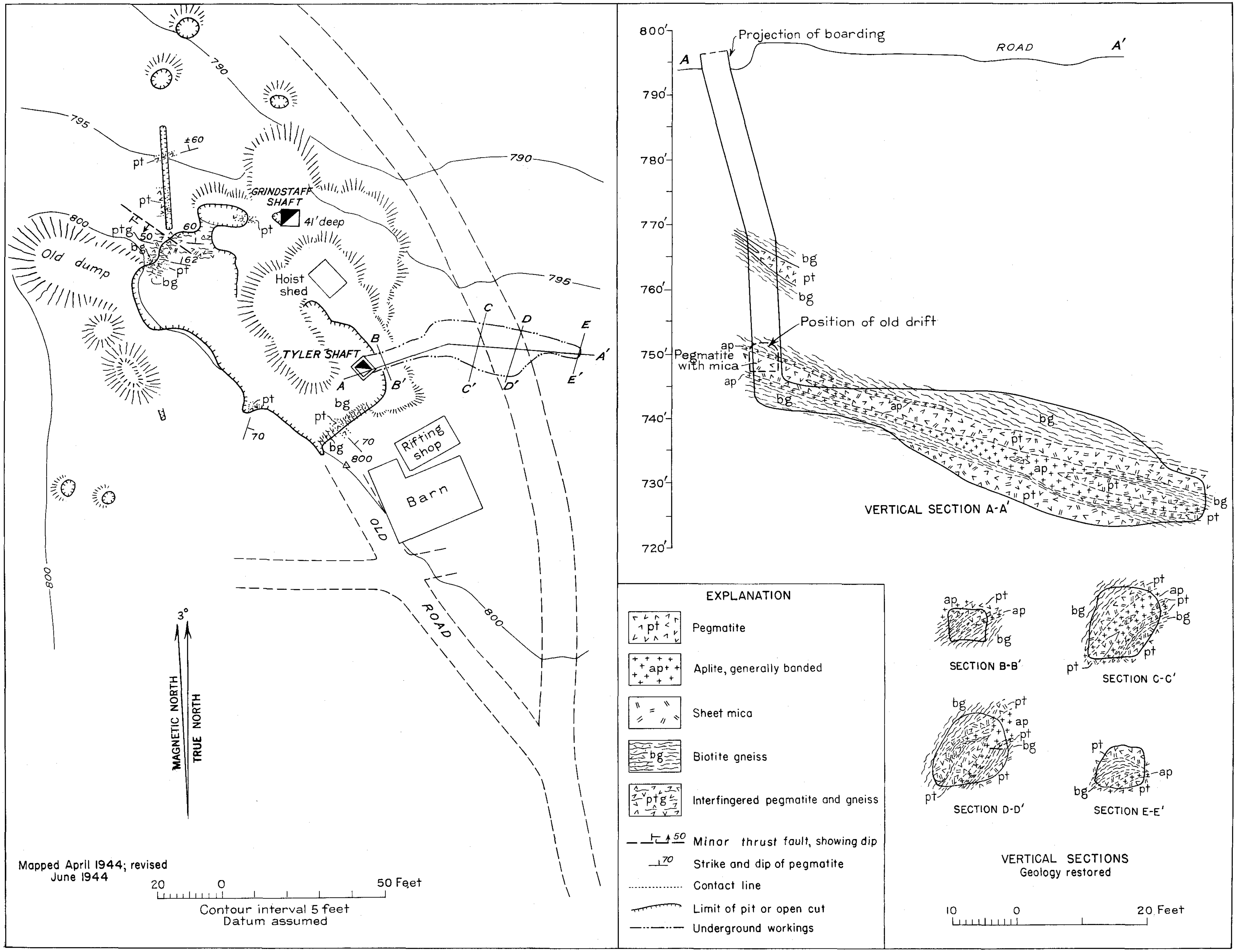
GEOLOGIC MAP AND SECTIONS OF THE RIDGEWAY MICA MINES, HENRY COUNTY, VIRGINIA.



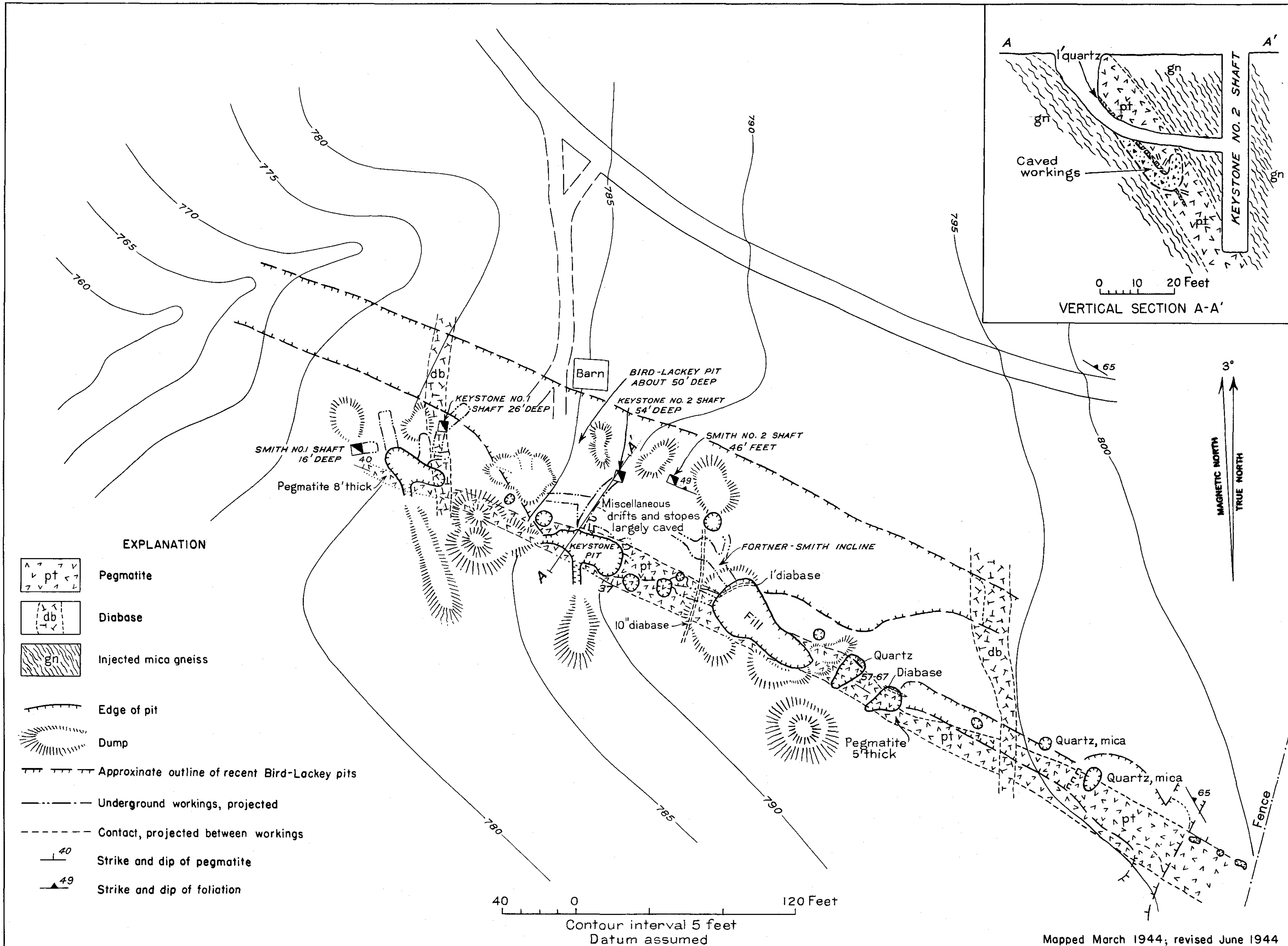
GEOLOGIC MAP OF THE CHIEF PRODUCING PORTION OF THE EANES AND ALBERT KNIGHT MICA PROPERTIES, HENRY COUNTY, VIRGINIA.



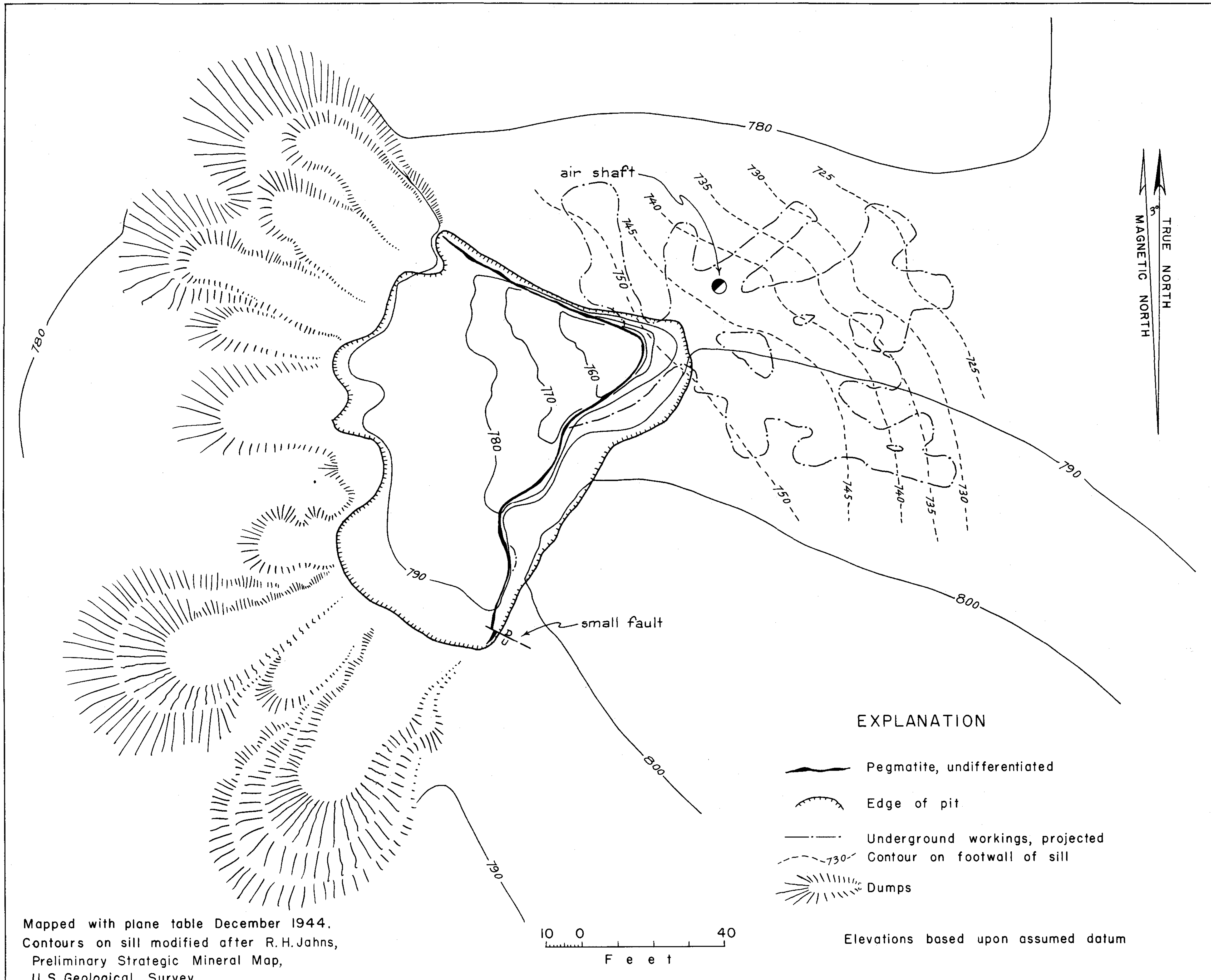
GEOLOGIC MAP AND SECTIONS OF THE DESHAZO MICA MINE, HENRY COUNTY, VIRGINIA.



GEOLOGIC MAP AND SECTIONS OF THE COLEMAN No. 1 MINE, HENRY COUNTY, VIRGINIA.



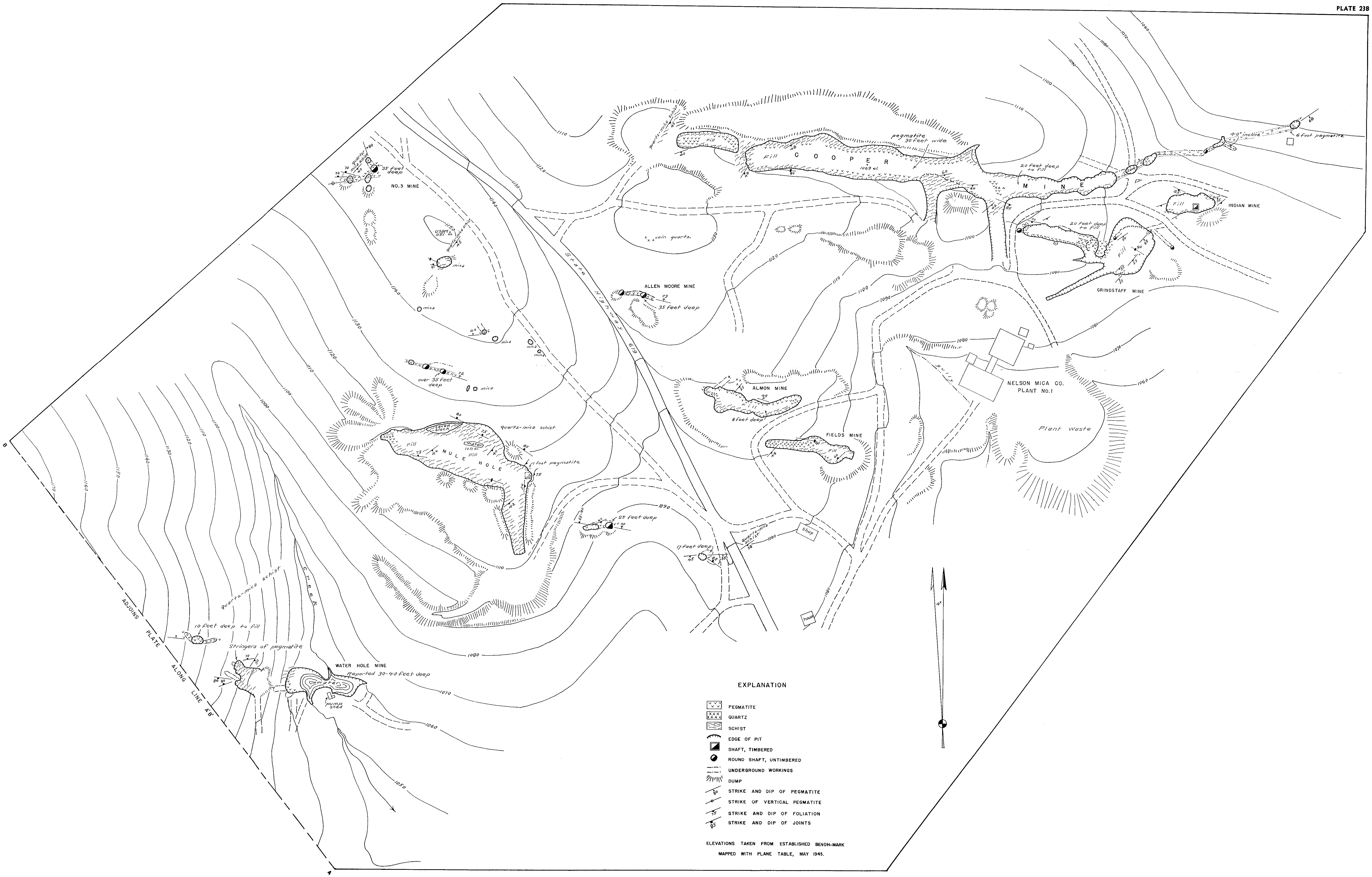
GEOLOGIC MAP AND SECTION OF THE TOM SMITH MICA MINE, ROCKINGHAM COUNTY, NORTH CAROLINA.



GEOLOGIC MAP OF THE HARRY KNIGHT MICA MINE, ROCKINGHAM COUNTY, NORTH CAROLINA.

GEOLOGIC MAP OF A PORTION OF THE CHESTNUT MOUNTAIN MICA AREA, FRANKLIN COUNTY, VIRGINIA.

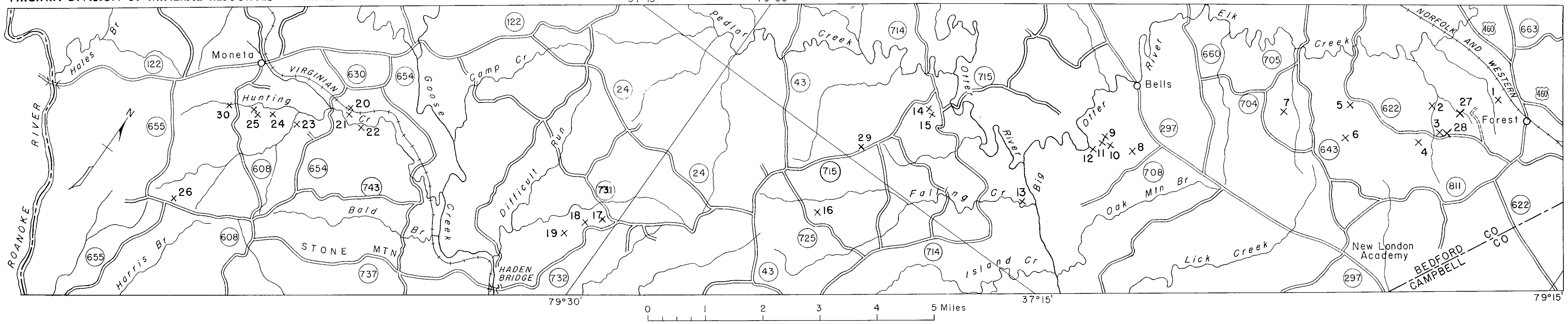
50 0 50 100 150
SCALE IN FEET



GEOLOGIC MAP OF A PORTION OF THE CHESTNUT MOUNTAIN MICA AREA, FRANKLIN COUNTY, VIRGINIA.

50 0 50 100 150

SCALE IN FEET



LIST OF MINES AND PROSPECTS

1 Willie Walker spar prospect
2 Walton (Everett) spar mine
3 Poindexter spar mine
4 Jordan-Braxton spar mine
5 Sunnyknoll spar mine
6 Big Harris spar mine
7 Wells spar mine
8 Smith spar mines and prospect
9 Seaboard spar mine
10 Callahan spar mine
11 Boyer spar mine
12 Old River Hole spar mine
13 Creasy mica mine
14 Patterson spar mine
15 Mitchell spar mine
16 Wade mica-spar prospect
17 Thurman spar mine
18 Overstreet spar prospect
19 Overstreet mica mine
20 Morgan spar mine
21 R.E. Nance spar mine
22 R.E. Nance spar prospect
23 Wheatly spar mine (Big Hicks)
24 Hicks spar mine
25 Young spar mines
26 Minnie Martin mica mine
27 Schwerin spar mine
28 Jack White spar mine
29 Hatcher spar prospect
30 Nichols spar mine

MAP SHOWING LOCATION OF FELDSPAR AND MICA MINES IN THE MONETA-FOREST AREA, BEDFORD COUNTY.