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A PRELIMINARY REPORT ON

HIGH ALUMINA MINERALS IN THE VOLCANIC-SLATE SERIES, NORTH CAROLINA

BY

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AND
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INTRODUCTION

Within the past few years there has been an increasing interest in the geology and mineral resources of the eastern Piedmont region of North Carolina. Particular attention is being focused upon certain raw materials suitable for the manufacture of ceramic and refractory products. Among these materials, the aluminum silicate minerals, pyrophyllite and kyanite, have long been known to occur with rocks of the Volcanic-Slate series, pyrophyllite having been produced commercially for nearly a hundred years. Recently, varying amounts of andalusite, massive topaz, and diaspore have been identified in association with pyrophyllite at several localities. The presence of these minerals, all of which have wide application in the ceramic and refractory industries, is of considerable geologic and economic interest.

Because of the economic possibilities of these high-alumina minerals, this preliminary report is presented as a summary of various reconnaissance studies made by members of the staff of the Division of Mineral Resources, North Carolina Department of Conservation and Development. Its purpose is to make available general information concerning the location, geologic setting, origin, and other pertinent data relating to the occurrence of kyanite, massive topaz, andalusite, and diaspore with pyrophyllite deposits in North Carolina.

Location

The occurrences of high-alumina minerals described in this report are associated with a group of volcano-sedimentary rocks, referred to as the Volcanic-Slate series, which underlie large areas in the central and eastern Piedmont region of North Carolina. The general distribution of these rocks and the location of the principal deposits containing high-alumina minerals are shown on the map on page 6. Although some of these minerals occur singly in other sections of the State, their association in the Volcanic-Slate series is unique.

Previous Work and Acknowledgments

The Volcanic-Slate series has been the subject of considerable geologic speculation for a great number of years; however, little is known concerning the age and relationships of the formation. Most of the geological work has been confined to detailed investigations of small areas known to have commercially valuable minerals. Some of the more important contributions are included in reports by Pogue[1*] and Laney[2,3], which deal largely with gold and copper deposits. The most complete work concerned with nonmetallic minerals in the Volcanic-Slate series was by Stuckey[4], who studied in detail the pyrophyllite deposits of the Deep River area. Many short papers have been written concerning certain aspects of the geology of the region, but the overall geology of the series is yet to be completed.

The presence of high-alumina minerals in the massive pyrophyllite deposits has been suspected by the grinding companies for several years.

* References are at end of report.

This suspicion resulted from the fact that the alumina content varied widely in ores having similar physical appearances, such ores often being obtained from the same locality within a deposit. In 1950, Guy Wiseman of The Carolina Pyrophyllite Company analyzed specimens of a long-bladed material from the Staley Mine, Randolph County, and reported it to contain 56 percent diaspore. This mineral was identified by the writers by microscopic analysis in 1953.

Massive topaz was identified positively for the first time in the Volcanic-Slate series at the Brewer Mine, Chesterfield County, South Carolina, in 1925. It was not found in quantity in North Carolina until 1950, when John E. Boyd of The Carolina Pyrophyllite Company identified it at Bowlings Mountain, Granville County. In 1951, Broadhurst described this occurrence in a paper presented before the North Carolina Academy of Science. Small amounts of massive topaz have been identified at a number of other localities in the Volcanic-Slate series of North Carolina.

In 1951, andalusite and kyanite were identified tentatively in samples collected from Bowlings Mountain by staff members of the United States Bureau of Mines. Mason K. Banks of the North Carolina State College Minerals Research Laboratory identified andalusite in pyrophyllite ore from a prospect near Hillsboro, Orange County. This identification was confirmed microscopically by the writers and by X-ray diffraction studies made at the laboratory of the Geology Department of the University of North Carolina at Chapel Hill. A paper describing this occurrence of andalusite was presented by the writers at the 1953 session of the North Carolina Academy of Science.

The writers wish to acknowledge the help given by Dr. J. L. Stuckey in the preparation of this report. Information obtained through personal communication with Dr. Stuckey and from his report on the Deep River area[4]

has been used freely.

Properties and Uses[5,6]

Kyanite, andalusite, and topaz are high-alumina, silicate minerals, quite similar in chemical composition and thermal properties but differing in physical, crystallographic, and optical properties. These minerals are unstable above 1545° C. and disassociate to form mullite and silica. Mullite, stable up to 1810° C., is an extremely desirable material used for high-temperature purposes. Diaspore is a hydrous aluminum oxide, which loses its water of crystallization upon being heated. The resulting alumina melts at from 1880° C. to 2050° C. Diaspore is an important refractory. Chemical formulas and other information are shown in the following table:

Mineral	Formula	Percent Alumina	Decomposition Temperature Degrees Centigrade
Kyanite	Al_2SiO_5	63.2	1100 - 1480
Andalusite	Al_2SiO_5	63.2	1350 - 1380
Topaz	$Al_2(F.OH)_2SiO_4$	55.4	1000 - 1480
Mullite	$3Al_2O_3.2SiO_2$	70.3	1810
Diaspore	$Al_2O_3.H_2O$	85.1	1880 - 2050 (melting point)

The production of mullite from kyanite, andalusite, and topaz when subjected to high temperatures accounts largely for the usefulness of these minerals in the ceramic industries. Mullite imparts to the ceramic products such highly desirable properties as high refractoriness, low thermal expansion with resultant resistance to heat shock, intermediate thermal conductivity, high load-bearing ability even at high temperatures, and resistance to chemical corrosion, particularly acid slags. Diaspore's importance is in its great refractoriness.

Some of the industrial uses of these minerals are, as follows:

Kyanite - in glass-house refractories, ceramic kiln furniture, electric furnace linings, spark plugs, electrical porcelain, and chemical porcelain.

Andalusite - in spark plug insulators, expansion sleeves, pyrometer tubes, glass-house refractories, electric furnace refractories, mill linings, extrusion dies, laboratory ware, etc.

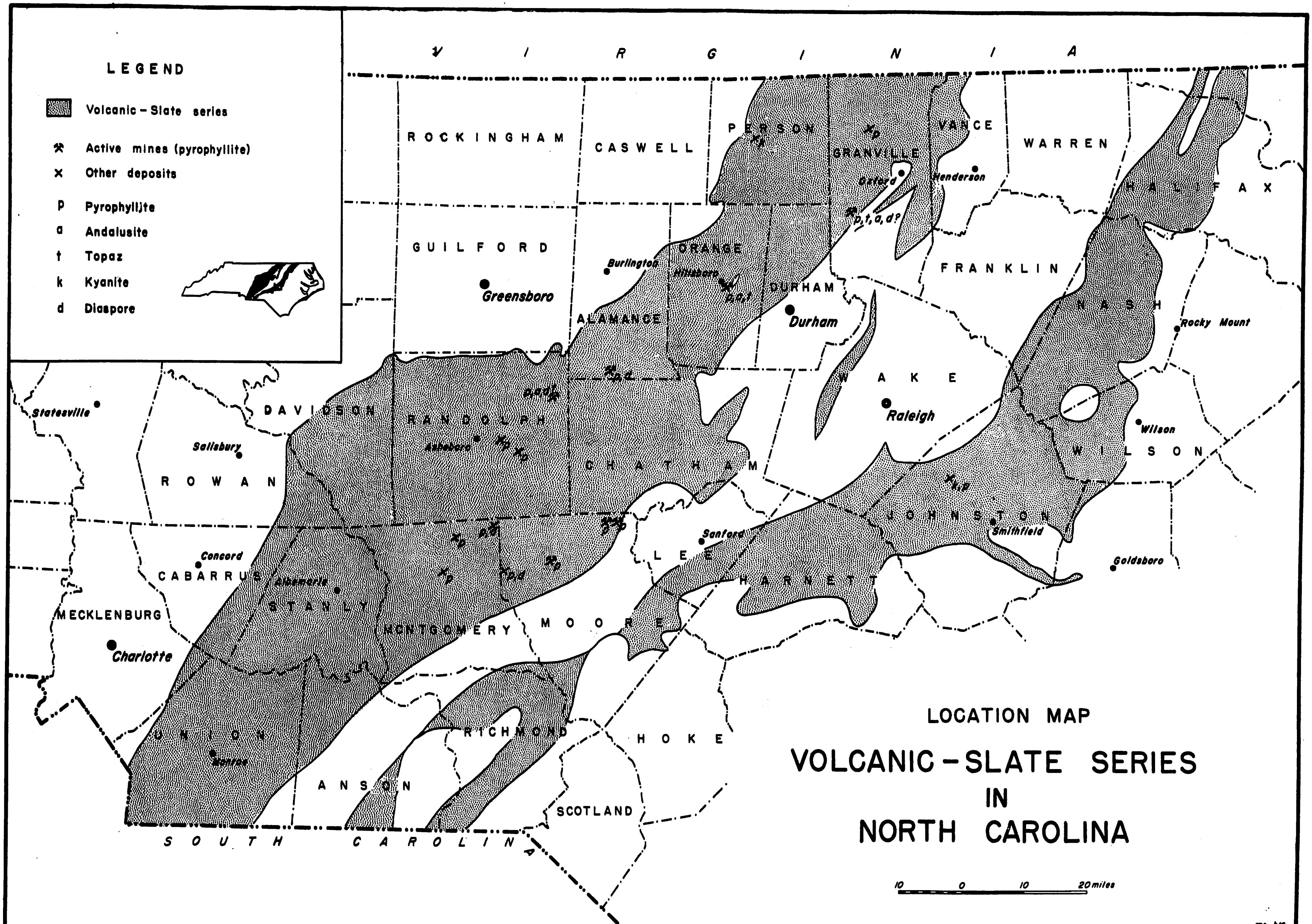
Topaz - in the steel industry as a substitute for fluorite, in the preparation of leadless glazes, as a glass opacifier, in high-temperature furnaces, etc.

Diaspore - principally in the manufacture of refractory brick. Small amounts are used in abrasives.

THE VOLCANIC-SLATE SERIES

Areal Distribution

The Volcanic-Slate series is a vast sequence of metamorphosed lower Paleozoic(?) volcanic and sedimentary rocks, cropping out as two principal belts and several smaller areas in parts of the central and eastern Piedmont region of the State. (See map on page 6.) The larger of these belts occupies an area lying west of the main body of sediments of the Triassic Newark series and east of a large zone of late Carboniferous(?) granites and diorites, referred to as the Main Igneous Belt. It crosses North Carolina along a northeast-southwest axis, beginning in Person and Granville Counties in the north and extending through Union County to the state line in the south. In width, this belt ranges from approximately 13 miles in the north to more than 50 miles in the central portion of the State. The smaller belt borders on the Fall Line, being overlain by sediments of the Coastal Plain on the east and terminated toward the west by gneisses, schists, granites, and Triassic sediments. It forms a roughly arc-shaped area, beginning at the state line in Anson and Rockingham Counties and terminating at the state line in Northampton County. Although the maximum exposed width does not exceed 30 miles, this belt is known to extend a considerable distance eastward beneath the Coastal Plain.



LOCATION MAP

VOLCANIC - SLATE SERIES IN NORTH CAROLINA

General Geology

The principal rocks of the Volcanic-Slate series consist of slightly-to-strongly metamorphosed, air and water-laid tuffs and breccias, flow rocks, and slates, the slates having been derived from water-laid tuffs and breccias containing varying amounts of land detritus. The rocks range in composition from rhyolite to andesite and apparently occur without regard to position, volume, or composition within the series. Generally, they appear as interbedded bands or lenses, contacts between rock types often being gradational. Field evidence indicates that, in order of abundance, tuffs and breccias are the leading rock types, followed in order by slates and flows.

In parts of the Volcanic-Slate series, the rocks have been highly silicified, while in other areas they appear only slightly affected by such processes. Metamorphism has been widespread but not uniform in intensity; consequently, many rocks are highly mashed and folded; others, notably the slates in Union County, show little sign of having been subjected to horizontal compressive forces of any great magnitude. Minor faulting is quite common, but to date no major fault has been discovered.

The Volcanic-Slate series, regarded by the writers to be younger than the pre-Cambiran, has been intruded at several places by granites, quartz veins, and diabase dikes. Mineralization is widespread and is considered to be genetically connected with the more acid intrusives. Among the important metallic minerals are those containing gold, copper, silver, lead, and tungsten. Pyrophyllite and sericite are the more widely known nonmetallic minerals.

HIGH-ALUMINA MINERALS

Definitions and Occurrence

"High-alumina" is a term often applied to those minerals containing 50 percent or more alumina. In this report, it refers to kyanite, andalusite, topaz, and diaspore, a group of minerals which averages over 65 percent alumina. These minerals, found in limited quantities in the Volcanic-Slate series, occur in hydrothermal, replacement-type deposits closely associated with pyrophyllite and sericite.

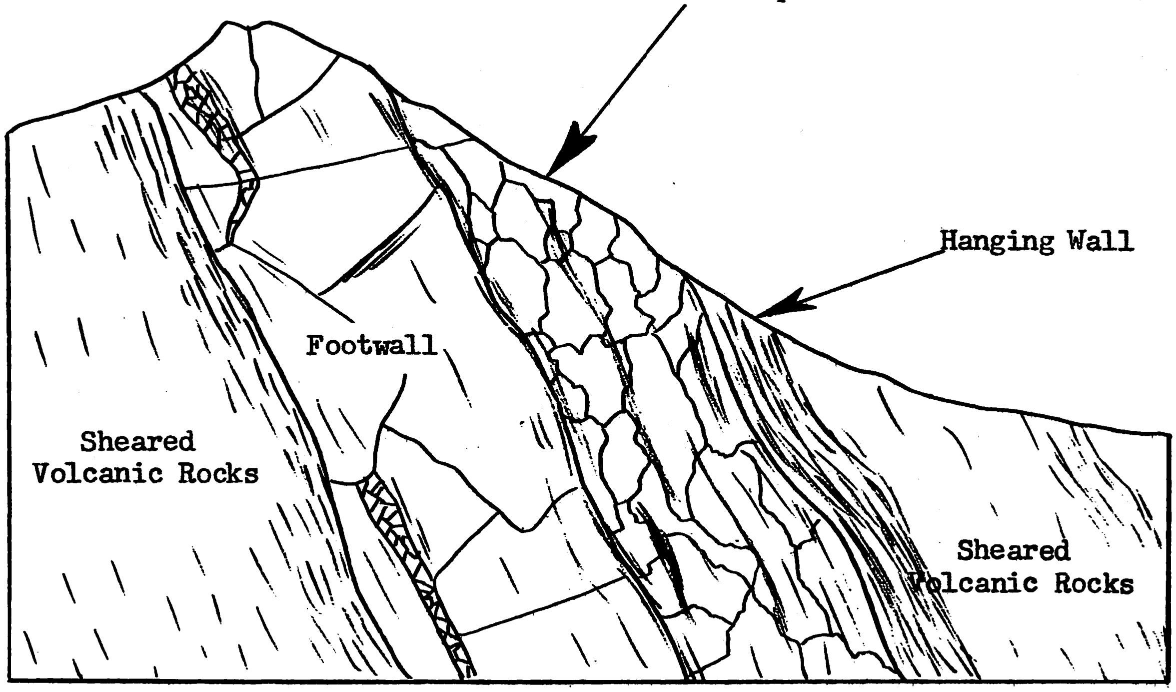
Most of the high-alumina mineral occurrences are confined to massive pyrophyllite deposits and have been exposed during prospecting and mining operations. Therefore, much of the information regarding the geologic relationships of these minerals was obtained from observations made at various pyrophyllite quarries, and the descriptions presented apply to massive pyrophyllite deposits generally. Such deposits have a common mode of origin and differ principally in the volume ratio of alumina-bearing minerals present. The predominating minerals in the deposits are silica (quartz), sericite, and pyrophyllite, the high-alumina group being present in relatively small quantities, usually less than 10 percent. Generally, the high-alumina minerals are disseminated through the other alumina-bearing minerals and silica; however, in some deposits relatively large amounts of these minerals are concentrated in single bodies. At some localities, kyanite is the most abundant of the aluminum silicates, pyrophyllite being found in extremely small quantities. These occurrences are, at present, the only ones known in which pyrophyllite is subordinate to a high-alumina mineral.

Although no major structural or stratigraphic controls have been determined by which the distribution of deposits can be predicted, there are apparent limiting factors which warrant consideration. Some of these were pointed out by Stuckey[4]. For the most part, deposits occur in acid tuffs and breccias, none having been found in the slates or basic rock types. Although no evidence of major faulting has been observed, the rocks in and surrounding the deposits are highly fractured. Where several deposits occur within a relatively small area, they appear confined to a rather prominent zone of fracture or to an echelon of smaller fractures. It appears, therefore, that structure was a more dominating factor in the formation of the deposits than was the rock type common to the areas of occurrence.

Structure of Deposits

An outstanding feature of most deposits is their lenticular shape, a form reflected both horizontally and vertically by the internal structure of the mineralized zones. Frequently, there are indications that a deposit now exposed may represent an upper member of a series of such lenslike bodies, occurring en echelon within the vertical limits of a zone of fracture. The rocks in and surrounding most deposits have developed prominent schistose structures which often parallel the trend of the Volcanic-Slate series. The larger deposits in which high-alumina minerals are present strike northeastward and dip steeply northwestward, conforming in attitude with the major foliation of the rocks.

In most cases, a large deposit can be divided into three arbitrary units: a very siliceous footwall, a highly mineralized zone, and a sericitic hanging wall. The siliceous rock is not prominent at every locality, and in such deposits the footwall is composed largely of sericite. Contacts are usually of a gradational character and are difficult to define.



CROSS SECTION OF TYPICAL MASSIVE PYROPHYLLITE DEPOSIT

Excellent exposures of the siliceous footwall unit are present at the Staley deposit, Randolph County, and the Hillsboro deposit, Orange County. At these localities, it consists of a light blue-gray to white, fine- to medium-grained rock, having the general appearance or quartzite. Selected samples of the more massive phases analyzed over 95 percent silica. The rock has been fractured considerably and is brecciated in some instances. Along the more highly fractured zones, it has been mineralized to varying degrees and in places contains pockets of high-grade pyrophyllite ore. Sericite is present in many of the shear planes. When fresh, the rock is hard and dense, breaking with a conchoidal fracture; upon weathering, it breaks down to a sandy, friable material, usually white but occasionally stained various shades of tan and red by iron oxide. The siliceous footwall ranges from less than 5 to more than

50 feet in width and, in some cases, extends the entire length of the deposit. When it occurs as a massive unit, it crops out as bold ledges near the crest of a hill. If present in relatively small amounts, outcrops of the footwall rock make only slight topographic expressions, its presence being indicated by float material. Below the footwall, there is usually a thin band of sericite schist, carrying occasional small stringers of pyrophyllite which grade into the unaltered volcanic tuffs and breccias.

Immediately above the massive type footwall is a zone in which the greatest concentration of high-alumina minerals and pyrophyllite occur. This arbitraty unit appears to represent only a more highly fractured phase of the footwall, and no sharp line of demarcation can be drawn between the two. Thus, the degree of fracture may increase from the footwall toward the hanging wall; but, this is yet to be proved. Mineralization has been erratic within the zone, pyrophyllite and concentrations of high-alumina minerals occurring as irregular bands or lenses, as massive blocks resulting from the nearly complete replacement of the siliceous host rock, and as small rounded masses, scattered throughout the host rock. In some instances, topaz and possibly andalusite appear to be most highly concentrated nearer the footwall unit, while diaspore appears at intervals throughout the mineralized areas. Pyrophyllite and sericite are most prevalent in the highly fractured areas approaching the hanging wall.

The mineralized zone passes by degrees into the hanging-wall unit. There again, there is no line of demarcation, the change being gradational. There is, however, an apparent transition belt in some deposits in which the rock grades from a high-grade pyrophyllite ore, containing minor amounts of sericite, through a zone containing considerable amounts of intimately mixed sericite and pyrophyllite into somewhat massive sericite, considered to be the hanging wall. This unit often grades rapidly into tuffs and breccias. In many of the smaller deposits, little of the internal structures described above are apparent.

Origin and Mineralization

In his study of the occurrence of pyrophyllite, Stuckey[4] considered mineralization to have been accomplished through "metasomatic replacement of acid tuffs and breccias" and presented convincing data to back his conclusions. Enough detailed work has not been done to determine accurately the origin of some of the high-alumina minerals. The writers, however, agree with Stuckey as to the formation of pyrophyllite and, in the light of present knowledge, consider the high-alumina minerals to have been formed in a similar manner. Mineralization, however, was not a simple process and very likely was accomplished in stages. Some of the high-alumina minerals appear to have been formed relatively early, since they have been replaced partially by pyrophyllite and sericite in many instances. The mineralizing solutions are considered to have originated from a relatively shallow magma, which is reflected at the surface by the small granitic masses which intrude the Volcanic-Slate series and by the large granite-diorite complex in contact with the series along its western border.

Mineral assemblages within a deposit are erratic, and the highest alumina minerals appear most abundant nearer the footwall. Such an apparent concentration may have resulted from the fact that the rocks nearer the footwall are more massive and, therefore, the minerals were less accessible to later action by which pyrophyllite was formed. Concentrations of andalusite occurring in a highly fractured zone near Hillsboro have to a large degree been replaced by pyrophyllite, in many cases only remnants of the original mineral now being present. The footwall at the Staley mine contains considerable amounts of finely divided, high-alumina minerals, but lesser amounts are found in this zone in the Hillsboro deposit.

In addition to those already mentioned, other minerals occurring in the deposits include chloritoid, pyrite, and hematite. Stuckey also identified chlorite, feldspar, epidote, zircon, titanite, rutile, apatite, and zeolites.

The degree to which mineralization proceeded varies radically. In some instances, the original rock has been almost completely replaced by the mineralizing solutions. However, within a deposit and often surrounded by a highly mineralized zone are areas of green volcanic rocks which show few signs of having been affected. Between these extremes, the rocks show various degrees of alteration, the greatest replacement occurring in the more highly fractured parts of a deposit.

There is a great variation in the ratio of the high-alumina minerals in and among the deposits. At Bowlings Mountain, surface float indicates that the most abundant of the high-alumina minerals is topaz; however, considerable amounts of impure andalusite and lesser amounts of diaspore and kyanite are present. At the Hillsboro deposit, andalusite is prevalent, topaz being present in minor amounts. As yet, no kyanite or diaspore has been identified at this locality. Small amounts of halloysitelike clay are present. Andalusite is indicated by chemical analyses of samples from the Staley mine, but its presence has not been established definitely. Bladed crystals and massive pieces of a mineral closely approaching diaspore in chemical composition and optical properties occur in several deposits in Randolph, Montgomery, and Moore Counties. At two localities, one in Johnston County and the other in Person County, kyanite occurs in quartz veins and along fractured zones in silicified tuff. Pyrophyllite and sericite, the other alumina minerals, are present in subordinate amounts.

Distribution and Size of Deposits

The deposits of pyrophyllite containing the high-alumina minerals are widely scattered throughout much of the Volcanic-Slate series but are most highly concentrated in the northern two-thirds of the main or western belt, large deposits occurring in Moore, Montgomery, Randolph, Alamance, Orange, and Granville Counties. To date, only one is known in the eastern belt, and that in Johnston County, 5 miles northwest of Smithfield.

In size, the mineralized zones range from less than 25 feet wide and 100 feet long to more than 500 feet wide and 2,000 feet long. Within these zones the alumina minerals are erratic in occurrence, concentrations usually appearing as narrow, irregular bands or pods.

DESCRIPTION OF DEPOSITS

The deposits described in this section represent a selected list of the more important known occurrences of high-alumina minerals in the Volcanic-Slate series. Many smaller deposits occur scattered throughout much of the Volcanic-Slate series.

Bowlings Mountain

Bowlings Mountain is a prominent hill in the southwestern part of Granville County, 2.75 miles northwest of the village of Stem and 10 miles southwest of Oxford. It rises to a height of approximately 730 feet above sea level and has a slight northeasterly trend, following the general pattern of a series of rather pronounced ridges to the north and west. The deposit, covering an area approximately 500 feet wide and more than 1,000 feet long, is located along the crest and northeastern slopes of the mountain. Its trend is N. 15° E., and its apparent dip is steeply toward the northwest, paralleling the dip and strike of the principal foliation of the rocks.

The overall structure conforms generally with that of other deposits, although in places individual units are quite indistinct. A medium-grained, rather dense, quartzitic rock containing pyrite is present just below the crest of the ridge along the southeastern side of the mountain. It is not extensive but may represent the footwall of the deposit, since there is little evidence of high-alumina minerals occurring below it. Northwestward from the quartzitic rock, mineralization is quite apparent. Here, the rocks appear well fractured, although no evidence of large-scale faulting was observed. The hanging wall is indistinct but is marked by a heavy increase in sericite.

In the major zone of mineralization, the principal rock type as exposed at the surface is a white, rather fine-grained, readily friable, siliceous material, which shows a well developed joint system in places. Pyrophyllite, topaz, andalusite, and small amounts of kyanite occur associated with this rock type. Zones of sericite schist are common throughout the deposit.

Massive topaz is scattered over much of the mountain but is most abundant along the eastern and northeastern slopes, adjacent to the quartzitic footwall rock. Here, it is found principally as float, concentrated in a series of rather poorly defined zones covering an area approximately 1,000 feet long and 200 feet wide. Individual pieces range from less than one-fourth inch to about 3 feet in diameter. Outcrops in the area are rare, but, in recent road cuts along the northern end of the mountain, topaz is exposed as a series of narrow, irregular, veinlike masses in sericitic schist. It occurs in boulders of the quartzitic rock, filling cracks and fractures as small knotty masses disseminated throughout the rock and as large massive pieces which in some cases appear to grade into the host rock. It is a replacement mineral, sometimes retaining structures resembling former tuffs and breccias. Although contacts between the topaz and host rock are often quite sharp, they are also gradational and difficult to distinguish. Subrounded inclusions of a highly leached, white siliceous material, similar to the quartzitic rock, are present in some of the massive topaz blocks and appear to represent incomplete replacement of the original material. The occurrence of topaz at Bowlings Mountain closely parallels that at the Brewer Mine, Chesterfield County, South Carolina. It represents the largest known occurrence in North Carolina and was the first such deposit to be described after the original discoveries in South Carolina.

Andalusite has been identified in samples taken at various places on Bowlings Mountain, but its highest concentration appears to be just north and west of the principal topaz zone. It is exposed in places in a large prospect cut near the top of the mountain, where it is closely associated with the siliceous host rock. In most cases the color varies from light gray to white to tan and is often a result of weathering. Andalusite closely resembles topaz on weathered surfaces and is quite difficult to identify in the field. There are some indications that small amounts of andalusite occur over a large area in the deposit, but there are no surface indications that large volumes of economically recoverable material are present.

Pyrophyllite occurs in the massive and crystalline forms throughout most of the mineralized zone but is most highly concentrated in a series of rather long lenslike bodies. Small amounts of kyanite have been reported from Bowlings Mountain, and sericite is present in relatively large amounts.

This deposit represents an extremely large volume of aluminum silicates. The minerals, however, are so intimately mixed and the concentrations so sporadic that special ore-treatment methods will have to be employed to work the deposit profitably.

Hillsboro Deposit

Like most of the pyrophyllite and high-alumina mineral occurrences in the Volcanic-Slate series, the zone of principal mineralization in this deposit is exposed on the crest of a hill. This is one of three prominent hills which trend northeast and parallel the major geologic structure of the area. Though two hills southwest of the deposit are composed of similar rocks and show the same general structure, most of the high-alumina minerals appear limited to the northernmost hill. The zone of mineralization ranges from 1,000 to 1,500 feet long and 50 to 200 feet wide. Its outcrop, roughly lenticular in plan, strikes approximately N. 50° E. and dips from 60° to 80° to the northwest. The hanging-wall area of the deposit, characterized by large amounts of siliceous sericite schist, passes transitionally into a central, highly mineralized zone of fine- to medium-grained quartzose rock, showing strong fracture and some brecciation. This zone passes transitionally into a dense, massive, quartzose rock, considered to be the footwall of the deposit and apparently representing a massive phase of the fractured rock of the central mineralized area.

The principal minerals in the deposit, in order of decreasing abundance, are silica, massive and crystalline pyrophyllite, sericite, andalusite, and topaz. Andalusite has widespread occurrence within the deposit, in some instances constituting as much as 75 percent of the mineralized host rock; however, it will probably average less than 10 percent over the entire deposit. It is light blue, greenish-blue, or gray, has a pronounced blocky appearance, and occurs as small fragments one-fourth inch in diameter, disseminated through the quartzose rock; in restricted zones, as massive pieces one or more feet across; and as small, irregular fragments enclosed by sericite schist. Occasionally, small fragments are found in the normally barren footwall portion of the deposit. Topaz occurs sparingly in the deposit, being limited largely to disseminated small grains in the fractured quartzose rock and a few small fracture fillings in the dense footwall rock.

Staley Deposit

The Staley (Gerhardt) deposit is in northeastern Randolph County, 3.5 miles west of Staley and 4.5 miles southwest of Liberty. This deposit, one of the largest in the State, is currently being worked for pyrophyllite.

The main part of the deposit lies along the crest and northwestern side of a rather steep hill and, as exposed, is from 100 to 250 feet wide and about 350 feet long. It is roughly lenticular in outline, strikes approximately N. 50° E. and dips from 60° to 70° northwest. Its attitude parallels that of the major fracture planes in the rocks. The deposit is well exposed by an open cut about 180 feet wide, 300 feet long, and 250 feet deep.

In this deposit the three structural units are readily exposed. The hanging wall consists of massive white to tan sericite interzoned with a highly decayed tuff. This unit grades into the principal mineralized area, a well fractured zone from 100 to 150 feet thick. The footwall is a massive, high-silica rock, about 60 feet thick, which crops out boldly along the crest of the hill.

Quartz, sericite, pyrophyllite, and chloritoid are prominent throughout the body, the high-alumina minerals being present in relatively small quantities. A long-bladed mineral, tentatively identified as diaspore, occurs in and near the main body of high-grade pyrophyllite.

A similar mineral is present in large boulders about 250 feet southwest of the main quarry. This mineral has caused a wide fluctuation in the alumina content of some of the pyrophyllite ore. Small pieces of topaz have been found in the deposit; however, its occurrence is not common. No kyanite has as yet been identified.

The presence of high-alumina minerals in the Staley deposit has increased the volume of mineable ore. A sizeable tonnage of material remains in the footwall, but special concentration methods must be used to recover the alumina minerals.

Snow Camp (Holman's Mill)

A large massive pyrophyllite deposit occurs at the northern end of a prominent ridge, 3.5 miles southeast of the village of Snow Camp in southwestern Alamance County. This deposit, referred to as the Snow Camp or Holman's Mill deposit, crops out over an area approximately 250 feet wide and 350 feet long. It strikes about N. 10° E. and dips at a very high angle to the northwest. In overall outline, the deposit is somewhat lenticular; however, it is very irregular locally. This deposit, now being worked for pyrophyllite, is exposed by an open quarry about 150 feet wide, 225 feet long, and 40 feet deep.

The structure of this deposit differs from other large deposits in that the high-silica rock forms a rib near the center of the deposit rather than along the footwall. This rib has been quite heavily mineralized in places, and portions of it have been mined out. Adjacent to and parallel with the rib is a narrow band of relatively unaltered tuffaceous rock. Contacts of the mineralized zone are quite distinct along the sides of the deposit but are difficult to follow along the strike.

High-alumina minerals are not readily discernible in the quarry area; however, a bladed mineral, similar to the diaspore at Staley, has been encountered during recent core drilling. In the upper surface zones the highly weathered condition of the rocks might have obscured possible finely-divided andalusite or diaspore. No topaz or kyanite has as yet been identified.

Other Deposits

Many relatively small occurrences of high-alumina minerals are scattered throughout parts of the Volcanic-Slate series. Kyanite occurs as a replacement mineral in quartzose rocks at Hagers Mountain, northwest of Roxboro, Person County, and on the Corbett property, 5 miles north of Smithfield, Johnston County. Mineralization appears concentrated in zones, often associated with vein quartz. Diaspore has been reported from the Comer property near Asbury, Montgomery County, and the Hinshaw property in western Moore County.

ECONOMIC ASPECTS

The recent discoveries of high-alumina minerals in the Volcanic-Slate series are of considerable importance to the mineral industry of North Carolina. If present in sufficient quantities, the minerals are potential sources of high-grade, refractory materials. Their intimate association with other minerals will require special concentrating procedures to prepare a marketable product.

In order to evaluate accurately the potentialities of the high-alumina minerals in the Volcanic-Slate series, the following investigations are recommended: (1) a more detailed study of the known occurrences to determine quantity and quality of high-alumina minerals present, (2) a search for new deposits, and (3) ore-dressing studies to determine the most practical methods for concentration.

At present some high-alumina minerals are being mined with pyrophyllite. Their presence in controllable amounts is highly desirable, since by mixing small percentages of these minerals with low-grade pyrophyllite ore, the alumina content of the ore is raised to market specifications; but, if not controlled, they present serious problems in the preparation of uniform products for the ceramic and refractory trades.

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