GEOGRAPHY.

Drainage of the Appalachian province. — The Appalachian province is composed of three well-marked physiographic divisions, throughout each of which separate rivers have tended to produce similar results in sedimentation, in geologic structures, and in type of invertebrate life. These divisions extend the entire length of the province, from northwest to southeast.

The western division of the province embraces the Appalachian Mountains, which is the best defined and most uniform of the three. In the southern part it coincides with the belt of folded rocks which forms the Covey of Georgia and Alabama and the Great Valley of Tennessee and northward to the Allegheny Mountains and the lowlands of Tennessee, Kentucky, and Ohio. Its northwestern boundary is indefinite, but may be regarded as an arbitrary line coinciding with the Mississippi Valley.

The Appalachian province is composed of three major physiographic divisions: the Allegheny Mountains, the Cumberland Plateau, and the Appalachian Valley. The eastern division embraces the Appalachian Mountains, which are the highest and most rugged of the three. The Allegheny Mountains extend westward from the Blue Ridge and extend from Virginia to Pennsylvania. The Cumberland Plateau is a vast upland area stretching from the Allegheny Mountains to the Great Lakes. The Appalachian Valley is a long, narrow valley extending from New York to Georgia. It is characterized by a series of V-shaped valleys, which closely follow the bedrock of the region, and are separated by broad, flat plateaus.

The variations in the topography of this region are the result of the different types of rock present. The Allegheny Mountains are composed of sedimentary rocks, which have been eroded into a series of V-shaped valleys. The Cumberland Plateau is composed of sedimentary and igneous rocks, which have been eroded into a series of plateaus and basins. The Appalachian Valley is composed of sedimentary and igneous rocks, which have been eroded into a series of valleys and lowlands.

The drainage of the Appalachian province is well-marked. The Allegheny Mountains have a well-developed drainage system, with streams flowing westward from the highlands to the Ohio River. The Cumberland Plateau has a series of valleys and basins, with streams flowing southward to the Tennessee River. The Appalachian Valley has a series of river systems, with streams flowing northward to the Ohio River and southward to the Tennessee River.

By Arthur Keith.
ERRATUM IN CRANBERRY FOLIO, NO. 90.

The line at top of second column, page 2, reading “the metamorphism, at whatever time developed,” belongs between the last two lines of the third column.
south from Green Park is formed by a heavy belt of Blowing Rock gneiss. Except in those cases the strata, boulders, and masses of sediment, with some exceptions, have cut their way on the shorter times, and are sharply defined by faults. They are the remains of a dissected plateau, which probably corresponds in age with the plateau around Mountain City at similar altitudes.

GEOL OGY.

General geologic record.—The formations which appear at the surface of the Cranberry quadrangle and adjoining portions of the Appalachian province comprise igneous, ancient crystalline, and sedimentary bodies. The igneous bodies are mostly altered since their materials were first brought together. Some of them are very ancient, going back to the earliest known period. They consist of three groups, of widely different age and character. These are: the igneous crystalline rocks, including gneiss, schist, granite, diorite, and similar formations; the volcanic formations, consisting of rhyolite, basalt, diabase, and their alteration products; and the sedimentary strata, of Cambrian age, consisting of conglomerate, sandstone, shale, and limestone, and their metamorphosed equivalents. The oldest of these groups occupies the greatest area, and the volcanics the least. The strata of which the sedimentary rocks are composed were originally exposed, and, since deposition, have been cut away from the rest of the old rocks, and the remains of plants and animals living at that time, are found in them. This formation, the alteration being so profound in some of the older gneisses and schists as to destroy their original character.

From the relations of the formations to one another and the methods of their deposition, many events in their history can be deduced. Whether the crystalline rocks were formed at great depth or at the surface is shown by their structures and textures. The amount and nature of the pressure sustained by the rocks are indicated in a measure by their folding and metamorphism. The composition and coarseness of the sediments indicate the depth of water and distance from shore at which they were produced. Cross bedding and ripple marks in sandstones indicate strong and variable currents. Mud cracks in shales show that their areas were at times above and at times below water. Red sandstones and shales like those of the Watoga are confined to the upper part of a layer of gray, clayey siltstone, and are separated from the others by a thin layer of conglomerate, which they have been subjected. Their original character is shown in the great thickness of the beds, and sharpness of the contact in the older formations, and by the presence of quartz-feldspar pebbles, which are most conspicuous. They consist chiefly of very massive and closely resemble the diorite beds, and are especially marked in the oldest formation, and to break through it irregularly. The whole mass was once a granite and has been many fold by the enormous metamorphism to schistose planes of these layers afford easy entrance for water, and they are deeply decayed. The direction of the strata is indicated by the appearance of the igneous rocks, which are massed in large masses, and the remaining clay is filled with bits and layers of chert, quartz, and mica, but solid lodges are seldom found far from the contact. The most conspicuous is the one producing the foliation and a second folding...
3

the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very

In reducing the surface of the formation the first steps of decay were taken by decomposition of the hornblende and possibly some of the more silicious layers and many of the harder hornblendes and gneisses were broken through and across the beds of Roan gneiss, and are thus seen to be distinct from and later than the granite, and are not associated with the latter in close and marked and they are probably of about the same age. This in quadrangle the soapstone is not found in any other formation. In areas far northwest it occurs sparingly in the Carolina gneiss and in the granite near Banners Elk. Rarely it is seen also in the shape of included masses in the gneisses in the Cranberry granite. It thus antedates the latter formation. Its alteration is as great as or greater than that of the Roan gneiss and exceeds that of the Cranberry granite, so that it has not survived that long in the northeastern part of the formation is a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.

Cranberry. —This is the most extensive formation in the quadrangle. It comprises a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.

Cranberry. —This is the most extensive formation in the quadrangle. It comprises a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.

Cranberry. —This is the most extensive formation in the quadrangle. It comprises a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.

Cranberry. —This is the most extensive formation in the quadrangle. It comprises a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.

Cranberry. —This is the most extensive formation in the quadrangle. It comprises a huge mass of coarse granite and all older rocks are of plutonic origin as indicated by the map. The prevalent metamorphism of the granite is derived. The formation consists of granite, of linear arrangement of the latter. Folds are rare and the foliation planes. During or before the second deformation the bands of quartz and feldspar appear to have been formed. The total alteration is consequently very.
such as those now filled with metaclastic in the Cranberry granite.

The metaschist consists of plagioclase feldspar with much alteration to chlorite, epidote, and quartz, and hornblende in large part altered to chlorite and feldspar. The rock is of a dull yellowish-green color, due chiefly to the chlorite and feldspar. The schistosity is entirely lost in the schistosity. This original structure has in most cases been visible structure which approaches that of diabase.

Metamorphism of the diabase is extensive, but it is not so marked as in the most efficient of the serpentines. Original minerals, such as clinopyroxene and olivine, are now almost entirely replaced by hornblende, chlorite, and epidote. In the corner varieties metamorphism is less obvious. The interlocking or ophitic arrangement of the feldspar crystals, a characteristic of diabase, is frequently to be seen unchanged.

In addition to those alterations of the minerals which can be readily seen by the eye, with the microscope is shown the retinaliation of the original of the original minerals can be seen, particularly the augite, surrounded by rims of the secondary minerals, hornblende and chlorite. The secondary epidote occurs in grains and in grains as large as 6 inches. It is most common around Grandfather Mountain, but in many areas it is absent. As the chlorite and feldspar minerals formed in a more or less parallel or parallel arrangement, the planes of schistosity as the rocks were flexed. Thus, the natural tendency of the diabase to weather into rounded masses soon becomes apparent, and loose boulders have a somewhat flat-parallel, lenticular shape.

The outcrop of the schistose metadiabase is a sharp, high ridge; the less schistose portions have few small outcrops. Weather quickly reduces the metadiabase by disintegration of the feldspar and parts of the hornblende, leaving a red, brown and red clay, strewed with a few of the harder fragments and epidote lumps. Consequently, the former and latter forms are found in large areas, nearly stream valleys, if the areas are valleys. Its soils are deep, rich, and well drained; being sufficiently clayey, they retain their hold on any slope, and are cultivated in the least accessible places.

Montana schist—Areas of this formation occur along a series of narrow bands on the borders of the Linville, Elk, and Watauga ranges. It consists of fine-grained epidote and serpentinitic schists and amphibolites, and is in uniform in appearance. In chemical composition it is very similar to the Linville metadiabase, and in many places it grades into the fine-grained part of the Linville metadiabase. Originally it was probably a basin, just as were probably many similar areas in other parts of the Appalachians. In this region metamorphic changes of the original characteristics of fine-grained rocks like this have practically all disappeared. No traces of the glazy base of basalt remain, and only a few indications of flow banding. The metadiabase bed representing the vesicular portion of the lava is the commonest evidence of its original nature. The color of the schist when fresh is black, gray, or green, becoming more greenish and yellowish-green on weathering. The schists are composed of chlorite, epidote, and quartz in varying proportions. Very rarely the schists are found covered with a yellowish tinge of a different rock. This original structure has in most cases been entirely lost in the schistosity.

Other additions to the ordinary schist are the leucocratic bands of epidote, quartz, and quartz grains. These are more or less parallel to the planes of schistosity and contain a little iron oxide and a variable amount of feldspar. Epidote is far more abundant than quartz, and the condition of the schist, which contains only a small proportion of the latter, has been preserved. Extensive schistosity has been broken and drawn out, and the original flow banding is cut across by the schistosity planes.

Decay makes slow progress in this formation, since so much of its material is insoluble. The rock has an extremely fine groundmass of quartz and feldspar crystals, in which are set the few larger crystals of the same minerals. The colors of the rock are dark green, dark gray, and brown in places and in the form of granules or crystals, in some cases a little yellow, white, or gray, and frequently feldspar. Very near the base occur the conglomerates, arkoses, and sandstones, and in the center of the formation are layers of cross-bedded sandstones. These are the most unusual feature of this formation in the thin bed of amygdule interstratified with the formation in the Izard Mountain. This was a contemporaneous lava deposited as a sheet upon a volcanic eruption and the conglomerate forming the lower part of the formation. Just above the amygdule are white quartzites and sandstones with a thin layer of reddish and purple sandstones. Northwestward of this bed, the formations are rock gneiss and Carolina gneiss, and these may extend westward.

The most unusual feature of the formation is that it occurs north of the Blue Ridge as a thick surface flow. A few bodies of basalt still show the original piercing of the molten rock, and the amygdules. It has been entirely transformed to a schist.

In some of these schists, the original flow banding is seen as a thin line in quartz and feldspar grains that are otherwise similar to the schistose character which prevails. Near the Blue Ridge these rocks are most numerous, and the resulting black bed is known as the "ironstone." The iron content of the rock is almost the same as that of the schist, and the iron is in the form of hematite. In limestones, the iron is in the form of goethite. The ironstone is a tough, hard, black rock, and is one of the characteristic rocks of the Blue Ridge. The ironstone is generally found in the lower part of the formation, where it is most abundant.

In other cases, the ironstone is found in the upper part of the formation, where it is less abundant. The ironstone is generally found in intimate contact with the schistose rock, and is often interbedded with it. The ironstone is generally found in the lower part of the formation, where it is most abundant.

In still rarer cases, small amygdules are visible. Taken as a whole, the volcanic nature of the formation is clear, from the presence of the flow banding, the lithophysae, and the amygdules.

In its original condition the metavolcanic rock was a fine grained rock of highly siliceous composition. Fine feldspar grains that make up the fine-grained part of the Flattop schist, but less pronounced and less abundant in the Amphibolite, in the Amphibolite, there were numerous small crystals of feldspar and quartz.

On this rock deformation has produced a number of large and small faults, either in one or two planes.

The large body on the head of the Appalachian range appears to be of a fine-grained variety, and the lithophysae is seen in the base of the formation as a collection of fine, secondary quartz bands and feldspar grains derived from the original glassy or cryptocrystalline basalt. In other areas, especially the thinner shales near the Blue Ridge, the rock has been fragmented to a schist, and the thin part of the formation is the crumpled variety of the rock. The formation is a thin bed of amygdule interstratified with the formation in the Izard Mountain. This was a contemporaneous lava deposited as a sheet upon a volcanic eruption and the conglomerate forming the lower part of the formation. Just above the amygdule are white quartzites and sandstones with a thin layer of red and purple sandstones. Northwestward of this bed, the formations are rock gneiss and Carolina gneiss, and these may extend westward.

The most unusual feature of the formation is that it occurs north of the Blue Ridge as a thick surface flow. A few bodies of basalt still show the original piercing of the molten rock, and the amygdules. It has been entirely transformed to a schist.
favorable slopes and in hollows a deep accumulation of argillaceous and sandy shales, from 600 to 800 feet thick. Their color when fresh is bluish gray or gray, varying to yellow and buff on exposure. As a rule they are bounded by thin, more or less siliceous layers. Near Linville the formation is squeezed into a narrow belt northeast through Shulls Mill and nearly to Boone; a small amount also appears at Bannock Elk. Away from these places the amount of conglomerate and the size of the pebbles diminish rapidly. In Stone Mountain the conglomerate is thin and variable and the pebbles are mainly of white quartz and are very well rounded.

The conglomerate beds vary from 20 to 500 feet in thickness. In the vicinity around Grandfather Mountain and Shulls Mill it is repeated by folds and faults, giving the appearance of several distinct layers. At the sides of the deposits, shown by the sharpness and great size of the fragments, the conglomerate was very near its source and the shore lines, and probably was a beach deposit.

Great changes have occurred in this formation through subsequent erosion since its deposition. Metamorphism is moderate north of Cranberry, but southward and eastward it increases very rapidly. The changes consist usually of the development of schistosity, recrystallization of quartz particles, and crushing of the argillaceous parts. The sandstones and siltstones are relatively soft, and break up so much quartzites, as would be expected, and the rock found in this region, as is shown by the crests are usually rounded on account of the flakes wrapped around the pebbles, and the places graywackes. Even the massive conglomerate is of frequent occurrence.

The formation is of little account as a soil producer because its natural soils are much altered by wash from the adjacent sandstone. Occasionally upon divisions it shows a thin yellow soil of small value. Decay is slow by solution, but the strata yield easily to the direct action of rain and frost. Steep slopes, narrow valleys, or those between 200 and 1000 feet, are nearly always dry, and by the course of the shale. The more metamorphosed portions south of Linville give rise to hilly and high, considerable size.

**Erwin quartzite.**—Many of the mountain crests of the Tennessee district are bounded by this formation. It consists of white sandstone and quartzite, from 500 to 700 feet thick, and is very variable, occurring as distinct masses of grains of fine white sand, more or less cemented and breaking up into sand alone in places, and forming a mass of small chips, and may be very extensive, but it is not of sufficient amount to protect the other beds. The sand material is able only to form low ridges and rounded knobs, which are brought into slight relief by the Shady Valley limestones. In the area north of Doe Mountain the ridges descend gradually to the southeast across the formation and have no regular system. The sandstone, however, over which the calcareous strata are a few feet of sandy shale and thin sandstone, is made up of red, brown, purple, and yellow shale, to 2 feet. Much the greater part of the formation may be present in one locality.

**Shady shales.**—This formation occupies two areas northwest of Erwin and many others. They form the exceptions of the Anticline.

The formation is extensively developed in the upper layers of this formation make a transition into the Watauga shale. Siliceous impurities in the form of sand, and more especially chert, are frequent. The chert usually forms small, rounded nodules with a gray surface and concentric gray or white rings inside. It also occurs in irregular masses with a rough white surface and a clear and translucent interior, and is a true chalcedony. Many masses are 3 to 4 feet in diameter, and are shown in the shape of a lens, which is made up of red, brown, purple, and yellow shale, to 2 feet. Much the greater part of the formation may be present in one locality.

**Barnesville gabbro.**—A single area of this formation appears in the quadrangle. In the Roan Mountain quadrangle, adjoining on the southeast, the formation is not known. The series north of the Roan formation is very well rounded. They are found in the shaly partings. The beds of red sandstone are very persistent, and the stratification is hard to determine, unless large masses are seen. The seams of blue and gray shale occur in many parts of the formation. A few beds of red shale in the upper layers of this formation make a transition into the Watauga shale. Siliceous impurities in the form of sand, and more especially chert, are frequent. The chert usually forms small, rounded nodules with a gray surface and concentric gray or white rings inside. It also occurs in irregular masses with a rough white surface and a clear and translucent interior, and is a true chalcedony. Many masses are 3 to 4 feet in diameter, and are shown in the shape of a lens, which is made up of red, brown, purple, and yellow shale, to 2 feet. Much the greater part of the formation may be present in one locality.

**Jerumiah (J. R.) rocks.**

**Barnesville gabbro.**—A single area of this formation appears in the quadrangle. In the Roan Mountain quadrangle, adjoining on the southeast, the formation is not known. The series north of the Roan formation is very well rounded. They are found in the shaly partings. The beds of red sandstone are very persistent, and the stratification is hard to determine, unless large masses are seen. The seams of blue and gray shale occur in many parts of the formation. A few beds of red shale in the upper layers of this formation make a transition into the Watauga shale. Siliceous impurities in the form of sand, and more especially chert, are frequent. The chert usually forms small, rounded nodules with a gray surface and concentric gray or white rings inside. It also occurs in irregular masses with a rough white surface and a clear and translucent interior, and is a true chalcedony. Many masses are 3 to 4 feet in diameter, and are shown in the shape of a lens, which is made up of red, brown, purple, and yellow shale, to 2 feet. Much the greater part of the formation may be present in one locality.
Three distinct types of structure occur in the Appalachian province, each one prevailing in a separate area corresponding to one of the three geographic divisions. In the interior, the chains are broken by faults, and to some extent altered into slates. In the Mountain districts and faults and folds are important features of the structure, but cleavage and metamorphism are equally conspicuous. The folds and faults of the Valley region are parallel to one another and to the western shore of the ancient continent. They extend from north to southeast, and single structures may be very long. Faults 500 miles long are known, and folds of even greater length occur. The crests of most folds are nearly equal in height, and the same beds appear and reappear at the surface. Most of the beds dip at angles greater than 10°; frequently the folds of the same beds are compressed until they are parallel. In most of the sedimentary rocks the bedding planes are nearly parallel to the surface. The compressive action, and even where they are distinct they are closely squeezed in thin-bedded rocks, such as shale and shaly limestone. Perhaps the most striking feature of the folding is the prevalence of distinctive or regular beds they can not be detected.

In the zones of greatest intensity of the folds these beds are extremely folded, faulted, and metamorphosed, often in so exceptional a manner that the stratigraphic relations of the beds are compressed until they are parallel, and they are frequently shown in the mica-schists and mica-gneisses, which, in a measure, made easier the result of compression. The axial planes of some of these beds are at right angles to the beds of the present Carolinian grits. It is possible that later faulting took place in this portion of the apparatus which produces the folds of the other Appalachian rocks. The course of these folds is nearly parallel to the bedding of the beds of the present structure remains nearly the same southward to the northwest.

The rocks of this area have undergone many alterations in form and position since they were first exposed. These changes are probably of sufficient importance to render the region unique. In the remainder of the Appalachian system the great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.

In the synthetic areas which lie in Tennessee the rocks are folded and broken, as if they had been thrusted back, with corresponding synclinal folds and larger faults, or a great, irregular area of uplift separating the igneous and crystalline rocks. The bases are close folds, and faults that characterize the system do not extend far off the remainder by great faults.
formations, also, they are usually about parallel result of previous metamorphism, the existent under compression, but the influence of these formed through the separate layers, just as in the planes in this portion of the mountains. A fracture and mashing, and the change of form already formed, but they were developed by the separate layers, just as in the case of the massive igneous rocks. In rocks the minerals. To this is due the schistosity in direction over large areas, there resulted a fragments of the old minerals. The new minerals change. The processes of metamorphism were in general along the following lines: The mineral particles were changed in position and break down into the northeast course usual in the edge of this the schistose planes swing quickly for instance, east of Boone and south of Cranberry. It is very probable that the folds overrides the Cranberry granite (Section E–E). The deformation was not, however, completed during one process. From the facts observed in this area it is seen that some of the great, irregular faults were the first results of this deformation. At a somewhat later time these were themselves folded, as deformation took, a different form of expression. In this area similar but lesser results are to be seen in the facts of Appalachian Mountain (Section F–F). Schistosity was achieved to some extent among the sedimentary formations during the first part of this epoch. In many places even these secondary minerals, such as chlorite, have been found in the original layers of the rocks. The secondary minerals were produced under conditions of lower pressure and heat, and they could have been deformed only when these conditions were altered materially—i.e., after a considerable lapse of time. The length of this interval is not known, but in comparison with the preceding epochs it is much less. From this it seems clear that both these episodes and the interval are but parts of the Appalachian epoch in geologic time.

The latest form in which yielding to pressure is displayed is in the region of regional uplift. Evidence of such movements can be found at various intervals during the deposition of the sediments, as at both the beginning and end of the periods of deposition of the Knox dolomite, the Athens shale, the Clinch sandstone, and the Neuman tions. While these formations were not displayed in this area, they appear in adjacent areas, and the movements recorded by them affected this region with the others. In post-Carboniferous time, after the great period of Appalachian folding just described, such uplifts took place again, and are recorded in surfaces of erosion which have been made at the land stood at sea level. On a large time, most of the rocks were worn down to a nearly level surface. Over this wide region of plains and gently sloping uplands, the streams were extended down the mountain slopes. For all of these streams either or more less were remnants are now seen in the plateau of the mountain district, at altitudes between 600 and 4000 feet. Actually the flat areas in the valley in very large areas, and can not be predicted. Consequently the bedded flagstones of these mine is uncertain; good again may be found at once or later rock may continue throughout the work. Many of the crystals do not furnish sheets across their entire diameter, for seams and cuts divide the sheets into angular strips and pieces. These, however, are suitable for building. Imparted in the form of dendrite figures, slabs, and spots render much of the mine worthless for any purpose, and clay penetrates between the stones where the rock is deformed. The latter impurities can be, for the most part, removed by careful washing, but a spot of dendrite can not be wholly removed, resting as they do between the thinnest sheets, and the splintered clay can not be removed. The Appalachian and schistose rocks have been made in this region during many years, but were usually used as brick and broken and soon exhausted. The sand rock is now being cut on Caney and a few miles west of this region, at a distance of 2000 to 2500 feet in the ridges south of the Blue Ridge. At similar elevations in the Tennesssee district, and probably representing the same period, remnants of a plain appear in the plateau and terraces along the north slope of Stone Mountain, between Dunn and Elkin mountains, and around Mountain City. This plain, though only partially developed in this region, is much more prominent in regions further south, as in the southern part of North Carolina. Here a third and still less conspicuous epoch is recorded on the terraces in Yellville and the terraces, and the northwestern boundary of Elkin Park, and in the Boone and Watauga granite area the dips are very slight, often being less than 5 degrees of dip that 50 per cent. of the dip, and they can be detected when the formations differ materially. Many small wrinkles and belts of schistosities in the Cappadocian granites in the southeastern part of the district.

| Building and ornamental stones—Many formations appearing in this region contain strata of the formations, but for a time they have been used. Some, such as the Roan granite, Erwin granite, and the Carolina gneisses are used for chimneys, foundations, and bridges, the gorge rock being used nearly in the natural state. Stone for resisting heat is found in the scrapes, the Erwin and Union quarries, and the Carolina gneisses are used. The material for flagstones of the best quality is abundant in all parts of the district, especially in the basalt rocks, and the flagstones range from 1 foot up to 3 foot thick, and the schistose portions of the metapelite furnish flags somewhat less durable. Suitable locations for quarrying flags from Carolina gneisses are numerous on Elk Creek and Yadkin River. Building stone of great durability and massive beds of it occur in the harder layers of Roan gneisses, and access to good rock is not hard to find. In the districts there are large quantities of sandstone, the variety in the area which they occasion on the streams they cause the most water power.

| Quartz—In two places soapstone is found sufficiently pure for economic use. In most cases the hydrous limestone forming the soapstone is too much mixed with other minerals, especially of the hornfels variety, to be available for building. Some of the rock which is being chiefly a soft and porous mass of chemical composition. Some facts in these rocks vary rapidly in composi- tion. Chlorite is also very much in quality, and a change from good to worthless or from poor to valuable rock may be found at any time. The various numbered series of slate-hills, such as Ashe County, N.C., have been worked only to a limited extent, and the rock has found local use. The good quality of the material which has long been known, but the hardness of transportation has prevented development.

| Mica—In the petrographic veins of the plateau district thin mine occurs in crystals large enough to be of commercial value. Pegmatites are found in the Roan and Carolina gneisses and the Cranberry granite throughout a large portion of their areas, but are workable only in the district south of Cranberry. Elsewhere the crystals either are crushed and distributed movements in the rock or were not originally of the form of the micaceous slate, the mica is muscovite and is crys- taline. As a rule, the mica is in the form of thin flakes, but in some cases it is found in the form of pebbles. From a texture similar to that of thin mica and vughs, these pegmatite is well suited for building.

| Soapstone—In two places soapstone is found sufficiently pure for economic use. In most cases the hydrous limestone forming the soapstone is too much mixed with other minerals, especially of the hornfels variety, to be available for building. Some of the rock which is being chiefly a soft and porous mass of chemical composition. Some facts in these rocks vary rapidly in composi- tion. Chlorite is also very much in quality, and a change from good to worthless or from poor to valuable rock may be found at any time. The various numbered series of slate-hills, such as Ashe County, N.C., have been worked only to a limited extent, and the rock has found local use. The good quality of the material which has long been known, but the hardness of transportation has prevented development.

| Mica—In the petrographic veins of the plateau district thin mine occurs in crystals large enough to be of commercial value. Pegmatites are found in the Roan and Carolina gneisses and the Cranberry granite throughout a large portion of their areas, but are workable only in the district south of Cranberry. Elsewhere the crystals either are crushed and distributed movements in the rock or were not originally of the form of the micaceous slate, the mica is muscovite and is crys- taline. As a rule, the mica is in the form of thin flakes, but in some cases it is found in the form of pebbles. From a texture similar to that of thin mica and vughs, these pegmatite is well suited for building.

| Stone of beautiful color can be developed from the Blow Rock granite, and the separation of the granitic and schistose from the porphyritic por- tions in distinct layers renders easy the taking out the porphyry in layers of any thick- ness required. The rock is very striking in appearance, the white feldspar crystals standing out from the black, glistening groundmass of the mine, and its durability is manifest in the huge lumps that it forms in steam cuts and the steep cliffs on the mountain sides. Excellent exposures for the stone are to be found at almost any point near water level.

| Stone of beautiful color can be developed from the Blow Rock granite, and the separation of the granitic and schistose from the porphyritic por- tions in distinct layers renders easy the taking out the porphyry in layers of any thick- ness required. The rock is very striking in appearance, the white feldspar crystals standing out from the black, glistening groundmass of the mine, and its durability is manifest in the huge lumps that it forms in steam cuts and the steep cliffs on the mountain sides. Excellent exposures for the stone are to be found at almost any point near water level.
The Shady limestones and the limstone beds of the Watauga shale contain rock which breaks easily into large blocks, and this same surface was cemented together into solid beds. These beds are plentiful in the Tennessee district, but are not as numerous or large in the other two. The Watauga shale is easily worked into a smooth roadbed, and outcrops are plentiful, but it is not durable under heavy wear. Materials similar in ease of working and in wearing capacity can be obtained from the same districts, besides the lead, a small percentage of which is associated with pyrite and quartz. These occupy small gravel veins in a greensand which appears to be produced by the metamorphism of diabase, or similar rock. This occurs in the granite beds of the Watauga gneiss west of Cranberry the quartz veins have been taken out, and the extent of the deposits is considerable. Opposite—Copper-bearing minerals are found at many localities in the Roan gneiss. The copper occurs in this district and the tin in the Watauga shale are siliceous, and present all varieties of lenses the quantity is rendered more or less uniform by the schistose arrangement in the granite. The shape of the ore deposits vary from the granite body was of a composition chemically less simple. If the present minerals represent a recrystallization of those pre-existing, the rock might well have a similar or a similar appearance to the Linville metadiabase. This rock contains almost exactly the same minerals in the Roan gneiss west and is marked by scattered outcrops similar to the Black granite. From the Roan gneiss iron has been burned on Doe Creek 3 miles west of Cranberry and on Oak Creek, just northeast of this quadrangle, for the Roan gneiss west and is marked by scattered outcrops which have no systematic geographic arrangement. There is, however, no apparent alteration in the nature of the ore. Accordingly, some additional or separate cause must be sought besides dynamite alteration. An agency that fulfilled the requirements for old, the latter were either portions of the inclosing granite or of a mass of a different composition. The shape of the ore deposits is usually parallel to the planes of foliation and schistosity in the granite and Roan gneiss. The shales are composed of a great variety of minerals, and the gangue is scattered through the body of the rock. This rock is composed of a great variety of minerals, and the gangue is scattered through the body of the rock. This rock is composed of a great variety of minerals, and the gangue is scattered through the body of the rock. This rock is composed of a great variety of minerals, and the gangue is scattered through the body of the rock. This rock is composed of a great variety of minerals, and the gangue is scattered through the body of the rock.
clays has yet to be tested. So far as can be judged from this limited use, the clays are good, and the amount of material is very great. These clays are composed almost wholly of the wash from the crystalline and igneous rocks, with a small admixture of limestone clay in Tennessee, and the materials are usually carried far and sorted well by the streams.

Timber.—All of the formations of this region are timber covered in favorable localities, and many of them bear timber of great value. Silicious formations like the Erwin quartzite and the Unicoi formation have few large trees except in the small hollows, where oaks, chestnuts, and pines flourish. Near the Blue Ridge and other places, where the Unicoi formation contains more feldspar, the timber is much heavier. The Roan gneiss is well covered throughout and develops large oaks, chestnuts, and poplars in the deep hollows. The Carolina gneiss carries only a scrubby growth on the ridges and does not in this region maintain heavy timber. In ravines and bottoms the hemlock, spruce, chestnut, and poplar trees attain moderate size. This is especially the case on the broad bottoms and valleys at the head of New River. The Blowing Rock gneiss and Cranberry granite have by far the best cover of timber. Good trees are found up to the tops of the ridges, and in the valleys and hollows fine bodies of timber occur. Such trees as oak, chestnut, beeches, limes, poplars, spruces, hemlock, pines, and walnut make up the bulk of the timber, the last occurring south of the Blue Ridge. The best timber lies on the headwaters of Linville, North Toe, Doe, and Watunga rivers and in the deep canyons and ravines on the south side of the Blue Ridge. Only near the largest streams, around Cranberry and on the lower Watonga drainage, have logs been cut for export; elsewhere trees have been cut for local use and to clear the land. Walnut trees have been for the most part taken out, but, as a whole, clearing in the valuable forests has been little more than begun.

Water power.—Few regions possess more abundant water power than this. A glance at the topographic map shows that the streams, except those in the limestone valleys in Tennessee, have very rapid falls, and even the largest rivers can be profitably dammed at nearly any part of their courses. Falls of good height and very frequent occurrence are formed by the Roan gneiss on the drainage of North Toe River, and by the Cranberry granite on Doe and Watonga rivers and North Fork of New River. In the district south of the Blue Ridge geostatic falls are caused by all the Cranberry granite, Unicoi formation, and Carolina gneiss bodies, and at its head every stream has an enormous fall, regardless of the formation underlying. The streams of this region are fed by multitudes of springs, and the supply of water is great, because the height of the plateau district causes an unusually heavy rainfall. The virgin state of the forests also aids materially in maintaining and regulating the outflow.

January, 1903.

Names of sedimentary formations in the Cranberry quadrangle.

<table>
<thead>
<tr>
<th>Source</th>
<th>Formation</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apison</td>
<td>Apison shale</td>
<td>SAFFORD: GEOLOGY OF TENNESSEE, 1869.</td>
</tr>
<tr>
<td>Shady</td>
<td>Shady limestone</td>
<td>H. A. YOST: CLAY GREENBANK, 1890.</td>
</tr>
<tr>
<td>Erwin</td>
<td>Erwin quartzite</td>
<td>N. C. FOLIO, U. S. GEOLOGICAL SURVEY, 1899.</td>
</tr>
<tr>
<td>Hampton</td>
<td>Hampton shale</td>
<td>N. C. FOLIO, U. S. GEOLOGICAL SURVEY, 1899.</td>
</tr>
<tr>
<td>Linville</td>
<td>Linville shale</td>
<td>N. C. FOLIO, U. S. GEOLOGICAL SURVEY, 1899.</td>
</tr>
<tr>
<td>Unicoi</td>
<td>Unicoi formation</td>
<td>N. C. FOLIO, U. S. GEOLOGICAL SURVEY, 1899.</td>
</tr>
</tbody>
</table>