DESCRIPTION OF THE GREENEVILLE QUADRANGLE.

By Arthur Keith.

GEOGRAPHY.

GENERAL RELATIONS.

Location.—The Greenieville quadrangle lies chiefly in Tennessee, but comprises also a portion of North Carolina. It is included in the pulled 36° and 36° 30’ and northeast 82° 30’ and 83°, and contains about 965 square miles, divided between Greene, Hamblen, Hawkins, Washington, and Unicoi counties in Tennessee and Madison County in North Carolina.

In its geographical and geological relations this quadrangle forms part of the Appalachian province, which extends from the east to the Mississippi lowlands on the west, and from central Alabama to southern New York. All parts of the region have a common historical record, in its rocks, its geological structure, and its topographic features. Only a part of this history can be read from the map, and only a small area that covered by a single atlas sheet; hence it is necessary to consider the individual area in its relations to the entire province.

Subdivisions of the Appalachian province.—The Appalachian province is composed of three belts, marked physiographic divisions, throughout each of which certain forces have tended to produce similar results in sedimentation, in geological structure, and in topography. These divisions extend the entire length of the province, from northeast to southwest.

The eastern division of the province embraces the Appalachian province, which is made up of many minor ranges and which, under various local names, extends from southern New York to central Alabama. Some of its prominent parts are the South Mountains of Pennsylvania, the Blue Ridge and Catawba Mountain of Maryland and Virginia, the Great Smoky Mountains of western Tennessee and North Carolina, and the Cohutta Mountains of Georgia. Also embraced in the eastern division is the Piedmont Plateau, a vast upland which, as its name implies, lies at the foot of the Appalachian Mountains. It is drained by streams and is lower and less broken than the divisions on either side.

The western division of the province is the Allegheny Mountains, which is bounded on the east by the Allegheny Front and the Cumberland Mountains. The rocks of this division are almost entirely of sedimentary origin, and the surface is very nearly horizontal. The character of the surface, which is dependent on the character and attitude of the rocks, is that of a series of long, broad and parallel ridges and lines of hills separated by smooth open valleys. The rocks of the Allegheny Mountains have been eroded by streams, leaving in relief irregularly rounded knobs and ridges, which bear little resemblance to the original surface. The surface of this great plateau has been completely removed; the erosion is now comparatively low and level, or rolling.

Altitude of the Appalachian province.—The Appalachian province as a whole is a broad, stepped down from an altitude of about 500 feet at the eastern margin of the Blue Ridge Mountains, a system which extends westward to about the same altitude on the Ohio and Mississippi rivers.

Each division of the province shows one or more culminating points. Thus the Appalachian Mountains rise gradually from less than 1000 feet in Pennsylvania to more than 5000 feet in western North Carolina. From this culminating point they decrease to 4000 or 5000 feet in southern Virginia, rise to 4000 feet in central Virginia, and descend to 2000 or 1500 feet on the Maryland and Virginia lines.

The Appalachian Valley shows a uniform increase in altitude from 500 feet or less in Alabama to more than 6700 feet in central Tennessee, and 3500 feet in southern Mississippi.

The Plateau or western division increases in altitude from 500 feet at the eastern edge of the province to 1500 feet in northern Alabama, 2000 feet in central Tennessee, and 3000 feet in southeastern Kentucky. Its height is between 1500 and 2000 feet in West Virginia, and decreases to about 1000 feet in Pennsylvania. From its greatest altitude, along its eastern edge, the Plateau slopes gradually westward, although it is generally separated from the interior lowlands by an abrupt escarpment.

Drainage of the Appalachian province.—The streams of the province are divided into three major systems; one to the Atlantic, in part southeastward into the Gulf, and in part westward toward the Mississippi. All of the major streams flow westward, except a small portion in Pennsylvania and another in Alabama, which flow southward toward the Ohio. The northern portion of the Appalachian or eastern division of the province is drained eastward toward the Atlantic, with the exception of New River. The eastern slopes of the western division all except the eastern slope is drained westward by tributaries of the Tennessee or southward by tributaries of the Ohio.

The position of the streams in the Appalachian Valley is dependent on the geological structure. In general they flow in courses which for long distances the streams that enter Nolichucky River on its south side divide the Great Valley into the northern and southern parts. The deposits are very conspicuous and form practically one plain, which slopes gradually away from the ridges of the mountains and is intersected by streams in all directions. Where it borders the Great Valley it presents a series of long ridges and bluffs rising from 1000 to 1500 feet above the adjoining valley. Thus is seen in greatest contrast the results of erosion of soluble and insoluble formations. The streams fall rapidly from their sources until they emerge upon the valley at elevations varying from 1800 to 1900 feet. Their channels in the Cambrian quartzites and slates, which are strong, rocky, V-shaped gorges at their heads, are cut down to the valley floor following the course of the valley. In the northern portion of the province they are flanked by the rolling ridges and shallow valleys of the Great Valley. In the southern part of the province the Bald Mountains extend eastward to the Atlantic, with the exception of the Ohio. The rainfall is quite uniform, ranging from 40 to 50 inches, and the streams are correspondingly large. The chief tributaries of the river are the French Broad, Holston, and Clinch rivers. The French Broad River is the most important tributary, being 150 miles long and wide at its mouth. The Clinch River is also a large tributary of the Tennessee River, being 150 miles long and wide at its mouth. The Holston River is the smallest of the three, being 50 miles long and wide at its mouth. The river is divided into three parts: the upper part, which is the upper section of the river; the middle part, which is the middle section of the river; and the lower part, which is the lower section of the river. The upper part of the river is characterized by the presence of many small streams and tributaries, which flow into the river from the surrounding mountains and valleys. The middle part of the river is characterized by the presence of many large lakes and reservoirs, which are formed by the impoundment of water from the surrounding streams. The lower part of the river is characterized by the presence of the Tennessee River, which is the longest river in the United States, being 1139 miles long. The river is divided into three sections: the upper section, which is the upper part of the river; the middle section, which is the middle part of the river; and the lower section, which is the lower part of the river.
The granite forms a large and continuous mass that extends southwestward into the Ashville quadrangle and northward through the Roan Mountain and Cranberry quadrangles. The formation consists of granite of varying texture and color and of gneisses that are derived from the granite. It is named from Cranberry, N.C., near which it is typically developed. This member included within the area of the Cranberry granite are small or local beds of meta- granites and pegmatites, which are too small to be shown on the map. These include meta-basalt and meta-limestone. The meta-basalt is generally a medium or fine grained rock, and the meta-limestone is generally a fine to medium grained rock. The meta-basalt is often a light gray or white color. At many places near the contact with the Cranberry granite this rock is altered to a highly altered rock, known as the Cranberry schist. The evidence of this alteration is not found in the eastern area of the Cranberry granite, but it is found in the western part of the quadrangle. The Cranberry schist is a fine to medium grained rock, and it is occasionally found in the eastern area of the Cranberry granite. The evidence of this alteration is not found in the eastern area of the Cranberry granite, but it is found in the western part of the quadrangle. The Cranberry schist is a fine to medium grained rock, and it is occasionally found in the eastern area of the Cranberry granite.
recomposed into quartz, feldspar, and mica. This produced a very granitic rock, or augen granite, in which the large boulders retained their shape better than the finer grains, however, and the fine flakes in the latter are bent and wrapped around the large feldspar particles. These are due to the linear growths of new minerals parallel to lines of motion in the rock. The dark flakes are brought out in the main of the large crystals of biotite and felspar hornblende, and the light colored minerals of augen are in the matrix of the granite.

Another result of the deformation is the series of striated and striped surfaces which are common in this formation, especially in the Chatillo quadrangle. These are due to the frictional surfaces of quartzes and felspars which are also crossed by the fractures. This shows the stress of pressure as extreme as to overcome all the original strength of the rock.

Weathering.—As the formation is attacked by weathering its surface is but slowly reduced. Its siliceous composition is not a great aid to decay, and great bodies in maintaining the altitude of its areas. In the Ashevill, quadrangle, where it is best developed, the sides of the small valleys are reduced than the others.

CUMBERLAND ROCKS.

With the deposition of the Cambrian rocks there comes a great change in the form and direction of the region. The new conglomerate or sandstone is deposited along the northern side of the Alleghany mountain range. The waste of the granite are contained to some extent in the cement of this sandstone. The granite, however, is but slowly broken away, and the weathering is but slowly reduced. The granite is not a good conductor of heat, and the rocks are not subjected to the action of the sun. The water is less abundant and the temperature is not so high as in the Alleghany. The rock is not so hard and the weathering is not so rapid as in the region east of the Alleghany.

CAMERON ROCKS.

The rocks of this formation do not withstand the action of weather as well as the previous formation. The sandstone of this formation is not well cemented and is not as hard as the sandstone of the preceding formation. The rocks are more easily broken and are more likely to be removed by the action of the weather. The rocks of this formation are more easily removed by the action of the water than the rocks of the preceding formation.

SNOWBIRD FORMATION.

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COCHRAN CONGLOMERATE.

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Chattanooga Shale

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The name of the formation is derived from that of Hiwassee River, in Ten­ nessee, where it is first seen. The formation is a sandstone and is the most prominent rock of the region. It is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture. The sandstone is a fine-grained sandstone and is almost uniform in texture.

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Creek Bald. Those which occupy the high points form irregular outcrops in synclines. The others are long, straight stems running nearly across the quadrangle.

Practically all of the formation is composed of quartzites and sandstones. Interbedded with these are a few minor layers of slate and shale, which appear only near the streams where the action of wave-cutting has been at work. It is possible that the amount of slate is greater than it would seem, being covered by the heavy vegetation. The formation is named quartzite of the Mallows, and is probably composed almost entirely of white quartzite which can not be distinguished from many of the older quartzites. There are a few small bands of sub-renal and sandy shales of the same character as the preceding shale formation. These bands are either very fine or medium grained in this quadrangle, and there are practically no variations in its appearance.

Around the end of Meadow Creek Mountain the formation passes upward into the Shady limestone. This is one of the stable rocks of this quadrangle and shows a characteristic conchoidal fracture. In the lower part of the formation the beds are fine grained, and in the upper part they are coarse grained. The whole formation is less than 1000 feet thick in this vicinity. In the area south of the Shady limestone it is seen in large bodies on the northwestern slopes of the Bald Mountains. The name of the formation is taken from Mount Nebo Springs, on Chilhowee Mountain, in the Knoxville quadrangle.

Nearly all of the quartzites and sandstones are light gray or white, and all become white upon weathering. The formation is named quartzite of the Mallows, and is practically indistinguishable from the adjoining quartzites. It is composed of fine-grained, white quartz. In these are included a few minor layers of argillaceous and sandy shale of the same character as the preceding shale formation. The latter does not outcrop in this quadrangle. Near the end of Meadow Creek Mountain the formation passes upward into the Shady limestone. The latter is a fine-grained, white limestone, and is the same or nearly the same as the Shady limestone.

Areas and use.—Three small areas of this formation cross the northwest corner of the quadrangle. All of these areas are near the area, 300 to 400 feet in thickness. In the more slaty portions of the formation the bedding planes and joint planes, chiefly by the action of frost, are usually complete. The soils covering the formation are very thin and sandy and support only the scant growth of timber.

**Shady limestone**

Areas and use.—Two small areas of this formation are found within the quadrangle, both on the southeast side of Lipsey Creek and the northwestern part of the Knoxville quadrangle. It consists of shales and slates, and is practically indistinguishable from the Mallows. In the south it is a mass of gray slate, and in the north it is a mass of shale. In these areas the formation has the appearance of chalcedony and occurs in beds up to 1000 feet thick in this vicinity. In the area south of the Shady limestone it is seen in large bodies on the northwestern slopes of the Bald Mountains. The name of the formation is taken from Mount Nebo Springs, on Chilhowee Mountain, in the Knoxville quadrangle.

**Rome formation**

Areas and use.—Two small areas of this formation are found within the quadrangle, both on the southeast side of Lipsey Creek and the northwestern part of the Knoxville quadrangle. The formation is nearly 1000 feet thick in this vicinity. In the area south of the Shady limestone it is seen in large bodies on the northwestern slopes of the Bald Mountains. The name of the formation is taken from Mount Nebo Springs, on Chilhowee Mountain, in the Knoxville quadrangle.

**SHADY LIMESTONE.**

**Character and thickness.**

Viscous.—The Shady limestone is a very fine-grained limestone, and is practically indistinguishable from the adjoining shales. The rock is white and has the appearance of chalcedony and occurs in beds up to 1000 feet thick in this vicinity. In the area south of the Shady limestone it is seen in large bodies on the northwestern slopes of the Bald Mountains. The name of the formation is taken from Mount Nebo Springs, on Chilhowee Mountain, in the Knoxville quadrangle.

**ROGERSVILLE SHALE.**

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Viscous.—The Rogersville shale is a very fine-grained shale, and is practically indistinguishable from the adjoining shales. The rock is white and has the appearance of chalcedony and occurs in beds up to 1000 feet thick in this vicinity. In the area south of the Shady limestone it is seen in large bodies on the northwestern slopes of the Bald Mountains. The name of the formation is taken from Mount Nebo Springs, on Chilhowee Mountain, in the Knoxville quadrangle.

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limestones at the top of the formation are succeeded by alternating blue and white limestones. These beds are some hundreds of feet thick, and are made up of fine, rounded sand grains embedded in a calcareous cement. These beds are also noteworthy for their presence of chert, which is almost never seen in the Nolichucky district.

**Nolichucky Shale.**

This formation is shown in the same belts as the preceding one and on the Nolichucky plateau, and is the most common of the Cambrian formations. It is named from Nolichucky River, along whose course in the Greeneville district the shale is well exhibited. The formation is composed of calcareous shales and shaly limestones, with beds of massive blue limestones in the upper portion. The included limestones are firm and well cemented, forming a resistant mass, and are slightly argillaceous and yellow, with a greenish tinge. Along the bed north of Greeneville the shale beds are more in thickness above the faults. Throughout the Nolichucky plateaus the formation lies in valleys between the hills and slopes of Knox dolomite and Nolichucky shales.

**Knox Dolomite.**

The Knox dolomite is a formation of great importance. It is composed of a breccia or angular conglomerate of limestone, most of which is very fine grained, and is cemented with calcareous cement. The strata are always high, broad, rounded ridges, protected on their upper surface by the passage of water through the rock, and are therefore subject to washing and drought, but are fertile in the hollows. The Knox dolomite is underlain by the Athens shale, and is separated from it by a fault plane. The Knox dolomite is characterized by its hardness and resistance to weathering, and is therefore usually found in the form oflumps and flakes of argillaceous matter left behind in the hollows. It is composed of blue and black shales, which show little variation from one area to another. The Knox dolomite is underlain by the Athens shale, and is separated from it by a fault plane.

**Athens Shale.**

The Athens shale occupies wide belts in the Holston River and Lick Creek valleys, and numerous narrow strips in the Nolichucky basin. The shale is named from Athens, McMinn County, Tenn., where it is most common. The Athens shale is characterized by its hardness and resistance to weathering, and is therefore usually found in the form of lumps and flakes of argillaceous matter left behind in the hollows. It is composed of black and bluish-black shales, which show little variation from one area to another. The Athens shale is underlain by the Knox dolomite, and is separated from it by a fault plane.

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The Athens shale. Along the southeastern side of Lick Creek Valley, however, the formation is of similar position to the Athens shale. Many thin beds of sandstone of the same character are interbedded with its limbs. These are not of sufficient body or regularity to be shown on the map, but are included in the lower shales.

In the ridge district this formation is more calcareous and sandstone interbedded with calcareous sandy shale. When fresh these are bluish gray in color, but when weathered they become deep brown or red, with the colors being due to the large amount of iron oxide in the rock.

Thickness and relations.—The greatest thickness of the formation is 200 feet, and this measure includes only what is left by erosion in the synclinal folds south of Nolichucky River. In the Lick Creek area it varies in thickness from 5 to 50 feet, including several beds with no definite upper limit. At the time these sandy strata were laid down near shore the ferruginous Moccasin limestones were deposited upon a shallow water level, in a relation similar to that of the Athens shale and Chickamauga limestone. Northeast and Whig, however, as has been above stated, the Athens shale disappears for a short distance and the sandstone is deposited directly upon the Knox dolomite. This relation exists almost everywhere, and its localities are determined in adjacent regions to be due to unconformable deformation after erosion. A few feet of this sandstone lie immediately above the overlying Grinolr shale. Small rounded humus and siltstone of iron ore in some layers is a product of recent weathering and the conglomerates are covered with yellowish-red crusts of iron, soluble to the decomposition of pyroxene and hornblende in the body of the rock.

On account of its fine grain and softness the Clinch sandstone lies in deep valleys or on steep slopes. It is protected from removal by Clinch limestone. Its valleys are cold and narrow and are skidded in at a very small angle. Clinch sandstone ridges. The soils are sandy and well drained, and the valley bottoms are often watered by drainage from underlying strata. In the Appalachian region the topography is nearly flat or very low, which is its characteristic form throughout this region. It is everywhere accompanied by the formation. They are, however, well situated, well drained, and fairly productive.

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The range of the southeasterly dips is from 10° and southern portions, northwesterly dips prevail. southeast through most of the Mountains, although has obliterated all the original textures of the Appalachians. The earliest-known period of com­
process, and the final products of metamorphism toward the southeast, ranging from 30° to 70°, while on
resulted from these changes trend in general north­
and southeast of Greeneville (section D-D). Faults in the region and the sediments were deposited on the southernmost part of the metamorphism which had already become gneissoid or schis­
structure which in most cases the anticlines from which they resulted from are found to have been shored up or along the strike in each direction. The fault is to be seen
were tremendous, but were limited in effect in a relatively narrow zone. Low intensity at any point, but broader in their results, the vertical
folds are of no great length and are not of suf­
readily deciphered. In the igneous and metamor­
the Appalachian Valley scarcely a bed can be found which
extension toward the southwest the basin continues
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toward the northwest. The rocks involved are for the most
dips are practically all toward the southeast, ranging from 30° to 70°, while on
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rarely inclined like those in the igneous rocks. They range from 20° to 60°
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such as iron, zinc, lime, and clay. Through their eroding, of the various other movements of uplift into extensive plains, of precisely the same character as the 1600-foot plain which they are replacing, these are followed down the river valleys they have eroded, and but little from side to side they have not reduced, and they frequently are.

Precious pastures.—While the land stood at one altitude for a long time, most of the rocks were worn away to a nearly level surface. On this surface the great soluble formations of the Valley this second surface are only very slowly weathered. In the harder formations of the Mountain, however, it made less progress than the first, and erosion proceeded only in cutting canyons in the softer surfaces. This second surface is now seen in nearly its original form between the bold front of the Blue Ridge and the Nolichucky Mountains. It is a gently undulating plateau bearing a few small knobs that rise slightly above its level. On its surface are a number of quartzite and sandstone fragments, which are deposited by streams issuing from the mountains. This portion of the ancient plain slope from 1600 to 1800 feet along the foot of the mountains down to 1500 or 1600 feet near the river. Remnants of this plain form the plateau which lies north of Nolichucky River and extends over into the basin of Creek and Holston River. Fragments of the same plateaus and of similar height, of 1600 feet, to be seen in the lower ridges of the Bear Mountains, are the rise of the ridge district northwest of Holston River. In general, there is a slight rise of the plateau remnants toward the northeast. Since its formation, uplift of the land has given the streams greater fall and greater power to wear. They have accordingly cut down into the old plateau till a narrow gorge is left, according to their size and power, and they have produced the present deep, narrow stream valleys, like the canyon of the lower Nolichucky River.

As they are still wearing their channel downward and but little from side to side they have not reached the grade to which the old plain was worn, the amount of elevation was, therefore, much more than the depth of the present streams can probably as much as 500 or 600 feet.

In the valley of Creek, and also at places near the course of Holston River, where rocks become less weathered below it and upper materials are weathered and soft, a third period of erosion has produced small plateaus and terraces that stand at elevations averaging about 1100 feet. As these are followed down the river valleys they broaden and are elevated a little over 1000 feet above sea level, into extensive plateaus, of precisely the same character as the 1600-foot plain which they are replacing. At various other points of uplift which can be traced in adjoining regions no record is to be seen here. Not only any record remains of such movements as depression, although they undoubtedly occurred in this region.

MINERAL RESOURCES.

The rocks of this region are use of in the natural state, as marble, slate, building stones, and read materials, and the materials obtained from them, such as iron, slate, silica, clays, and the throughclusions of the same, are valuable for timber and for crops, and in the grades which they occasion on the market. They are of considerable value.

Marble.—Marble is found in great quantity in the lower Cambrian limestones, the Chickamauga limestone, the Cuevins limestone, and the Granberry, but are utilized for the manufacture of tiles and building materials. The rock is found in the southern part of the region, in beds of quartzite and granite, and along the borders of the Nolichucky and Holston Rivers, the latter of the Tennessee River. The amount of elevation was, therefore, much more than the depth of the present streams can probably as much as 500 or 600 feet.

The latest form in which this portion of the ancient plain slopes from 1600 feet in diameter, most of them being much smaller. Probably the best and the most widely distributed of the residual clay is in the bear soft slaty beds, and when these are followed down the river valleys they have eroded, and but little from side to side they have not reached the grade to which the old plain was worn. When they are broken and their power of resistance reduced, and they frequently are.

Valley.—One of this metal occurs in one place in the quadrangle—2 miles northeast of Bull Branch, in the Sullivan county. It is a rich mass of talc, and consists of 

Weathering and solution. — The weathering and solution of deposits of limonite in the shales of the lower Cambrian. The firmness of the rock is due to its large content of lime, iron oxide or hydrate, and its rich, dark colors are produced by oxides of iron; but when clay is present in the shales the stones are of little importance. The fossiliferous limestone which stands upon the Bays Mountains, the limestone which stands above the Nolichucky, the coal grades are usually heavy, and the fall is frequently concentrated within narrow limits. Along four belts this is particularly the case, those being the Bear Mountain district, the basin of the Holston, and the Clinch rivers, and the Nolichucky continues to be eroded.

Water power.—A great natural resource of this region, and one but little used as yet, is river power. The water supply of the that which lies east of Hayvenus contains for ore banks of ironstone, although in this large area, which is in small quantities is widely distributed through­out this region underlain by the limestone. Near Hayvenus, limestone, which was taken out and seasoned in the old furnace at that place, but operations there were long discontinued. In the extension of this area toward the southwest the bodies of ore become larger. The second area of this formation lies at the head of the Clinch River, the eastern part of it included in this quadrangle.

Clay beds.—These clay beds are of little importance. They vary in thickness from 1 to 6 feet thick, and are widely distributed. They are of little importance. They are not of much value, but they are widely distributed.

Still clay beds.—These clay beds are of little importance. They vary in thickness from 1 to 6 feet thick, and are widely distributed. They are of little importance. They are not of much value, but they are widely distributed.