DESCRIPTION OF THE McMINNVILLE SHEET.

GEOGRAPHY.

General relations.—The McMinnville atlas sheet is bounded by the parallels 35° 30′ and 36° and by the meridians 85° 30′ and 86°. The district mapped embraces, therefore, a quarter of a square degree of the earth's surface. Its dimensions are 34.5 miles from north to south and 28 miles from east to west, and it contains about 980 square miles.

The adjacent atlas sheets are the Pikeville on the east and the Sewanee on the south; the country to the north and west has not yet been surveyed. The district lies wholly within the State of Tennessee, embracing all of Warren County and portions of Cannon, De Kalb, White, Van Buren, Grundy, and Coffee counties.

In its geographic and geologic relations this area forms a part of the Appalachian province, which extends from the Atlantic coastal plain on the east to the Mississippi lowlands on the west and from central Alabama to southern New York. All parts of the region thus defined have a common history, recorded in its rocks, its geologic structure, and its topographic features. Only a part of this history can be read from an area so small as that covered by a single atlas sheet; hence it is necessary to consider the individual sheet in its relations to the entire province.

Subdivisions of the Appalachian province.—The Appalachian province may be subdivided into three well-marked physiographic divisions, throughout each of which certain forces have produced similar results in sedimentation, in geologic structure, and in topography. These divisions extend the entire length of the province, from northeast to southwest.

The central division is the Appalachian Valley. It 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 Coosa Valley of Georgia and Alabama and the Great Valley of East Tennessee and Virginia. Throughout the central and northern portions the eastern side only is marked by great valleys—such as the Shenandoah Valley of Virginia, the Cumberland Valley of Maryland and Pennsylvania, and the Lebanon Valley of northeastern Pennsylvania—the western side being a succession of ridges alternating with narrow valleys. This division varies in width from 40 to 125 miles. It is sharply outlined on the southeast by the Appalachian Mountains and on the northwest by the Cumberland Plateau and the Alleghany Mountains. Its rocks are almost wholly sedimentary and in large measure calcareous. The strata, which must originally have been nearly horizontal, now intersect the surface at various angles and in narrow belts. The surface differs with the outcrop of different kinds of rock, so that sharp ridges and narrow valleys of great length follow the narrow belts of hard and soft rock. Owing to the large amount of calcareous rock brought up on the steep folds of this district its surface is more readily worn down by streams and is lower and less broken than the divisions on either side.

The eastern division of the province embraces the Appalachian Mountains, a system 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 Mountain of Pennsylvania, the Blue Ridge and Catoctin Mountain of Maryland and Virginia, the Great Smoky Mountains of Tennessee and North Carolina, and the Cohutta Mountains of Georgia. Many of the rocks of this division are more or less crystalline, being either sediments which have been changed to slates and schists by varying degrees of metamorphism, or igneous rocks, such as granite and diabase, which have solidified from a molten condition.

The western division of the Appalachian province embraces the Cumberland Plateau and the Alleghany Mountains, also extending from New York to Alabama, and the lowlands of Tennessee, Kentucky, and Ohio. Its northwestern boundary is indefinite, but may be regarded as a somewhat arbitrary line coinciding with the Tennessee River from the northeastern corner of Mississippi to its mouth, and thence crossing the States of Indiana and Ohio to western New York. Its eastern boundary is sharply defined along the Appalachian Valley by the Alleghany front and the Cumberland escarpment. The rocks of this division are almost entirely of sedimentary origin and remain very nearly horizontal. The character of the surface, which is dependent on the character and attitude of the rocks, is that of a plateau more or less completely dissected, or, elsewhere, of a lowland. In the southern half of the province the surface of the plateau is sometimes extensive and perfectly flat, but oftener it is much cut by stream channels into large or small, flat-topped hills. In West Virginia and portions of Pennsylvania the plateau is sharply cut by its streams, leaving in relief irregularly rounded knobs and ridges which bear but little resemblance to the original surface. The western portion of the plateau has been completely removed by erosion, and the surface is now comparatively low and level, or rolling.

Altitude of the Appalachian province.—The Appalachian province as a whole is broadly dome-shaped, its surface rising from an altitude of about 500 feet along the eastern margin to the crest of the Appalachian Mountains, and thence descending 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 1,000 feet in Alabama to more than 6,600 feet in western North Carolina. From this culminating point they decrease to 4,000 or 3,000 feet in southern Virginia, rise to 4,000 feet in central Virginia, and descend to 2,000 or 1,500 feet on the Maryland-Pennsylvania line.

The Appalachian Valley shows a uniform increase in altitude from 500 feet or less in Alabama to 900 feet in the vicinity of Chattanooga, 2,000 feet at the Tennessee-Virginia line, and 2,600 or 2,700 feet at its culminating point, on the divide between the New and Tennessee rivers. From this point it descends to 2,200 feet in the valley of New River, 1,500 to 1,000 feet in the James River basin, and 1,000 to 500 feet in the Potomac basin, remaining about the same through Pennsylvania. These figures represent the average elevation of the valley surface, below which the stream channels are sunk from 50 to 250 feet, and above which the valley ridges rise from 500 to 2,000 feet.

The plateau, or western, division increases in altitude from 500 feet at the southern edge of the province to 1,500 feet in northern Alabama, 2,000 feet in central Tennessee, and 3,500 feet in southeastern Kentucky. It is between 3,000 and 4,000 feet in West Virginia, and decreases to about 2,000 feet in Pennsylvania. From its greatest altitude, along the 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 drainage of the province is in part eastward into the Atlantic, in part southward into the Gulf, and in part westward into the Mississippi. All of the western, or plateau, division of the province, except a small portion in Pennsylvania and another in Alabama, is drained by streams flowing westward to the Ohio. The northern portion of the eastern, or Appalachian Mountain, division is drained eastward to the Atlantic, while south of the New River all except the eastern slope is drained westward by tributaries of the Tennessee or southward by tributaries of the Coosa.

The position of the streams in the Appalachian Valley is dependent upon the geologic structure. In general they flow in courses which for long distances are parallel to the sides of the Great Valley, following the lesser valleys along the outcrops of the softer rocks. These longitudinal streams empty into a number of larger, transverse rivers, which cross one or the other of the barriers limiting the valley. In the northern portion of the province they form the Delaware, Susquehanna, Potomac, James, and Roanoke rivers, each of which passes through the Appalachian Mountains in a narrow gap and flows eastward to the sea. In the central portion of the province, in Kentucky and Virginia, these longitudinal streams form the New (or Kanawha) River, which flows westward in a deep, narrow gorge through the Cumberland Plateau into the Ohio River. From New River southward to northern Georgia the Great Valley is drained by tributaries of the Tennessee River, which at Chattanooga leaves the broad valley and, entering a gorge through the plateau, runs westward to the Ohio. South of Chattanooga the streams flow directly to the Gulf of Mexico.

TOPOGRAPHY.

The district mapped on the McMinnville sheet lies wholly within the western division of the Appalachian province, as above defined. The greater part lies in the highland rim of middle Tennessee. The southeastern portion is occupied by the Cumberland Plateau, and the northwestern corner by the extreme eastern edge of the central basin. The western edge of the Cumberland Plateau is extremely irregular. The streams flowing westward on its surface have cut their channels backward so as to form many deep, narrow coves between the irregular remnants of the plateau. The latter are sometimes isolated, forming flat-topped hills or mesas. The slopes from the lower plain up to the plateau are very abrupt, and in many places are in part vertical cliffs. The reason for the abruptness of the slopes is found in the relations of the hard and soft beds forming the plateau. Its summit is capped by several hundred feet of sandstone and conglomerate. Below these beds are 700 or 800 feet of limestone. The latter is removed largely by solution. The overlying hard sandstones are thus undermined and large blocks break off, forming vertical cliffs. In this manner the escarpment which forms the western boundary of the plateau is being pushed back and the extent of the lower plain correspondingly increased. That the sandstone cap and the underlying limestones at one time stretched continuously across the area of the sheet is shown by the small remnant of these rocks forming Short Mountain on its western edge. By reason of its location, away from the larger streams, this remnant has been preserved from erosion.

The surface of the highland rim, which forms the greater portion of the area mapped, has an altitude of about 1,000 feet. The streams flow in narrow channels until they approach the central basin, when, like the streams on the surface of the plateau, they plunge into narrow gorges 400 or 500 feet in depth. The smaller streams have cut these deep channels back but a short distance from the edge of the highland rim, while the larger streams, as Caney Fork of the Cumberland River, have deepened their channels to a much greater distance. The escarpment bounding the highland rim is being pushed back toward the southeast in precisely the same manner as the escarpment bounding the Cumberland Plateau. In the northwestern corner of the area mapped only irregular remnants of its surface remain. While the surface of the Cumberland Plateau is protected by beds of sandstone the surface of the highland rim is protected by beds of chert which intervene between two great masses of limestone. The drainage of the area mapped on this sheet is entirely through tributaries of the Cumberland River.

The foregoing description and an examination of the topographic map show that in this region there are two plains whose surfaces are nearly parallel and are separated by a vertical distance of about 1,000 feet. The lower plain is apparent in the level portions of the highland rim. The upper plain is the general surface of the plateau, and probably also the top of Short Mountain, below which the streams flow in more or less deeply cut channels and above which rise a few isolated hills or mesas.

Areas of these two plains have been recognized over nearly the entire Appalachian province, separated by a varying vertical distance, and their relations throw much light upon the history of the province during the later geologic ages. This region formerly stood much lower than now, so that the present plateau, the higher plain, was near sea-level. The land was worn down by streams flowing upon its surface till it was reduced to a nearly even plain, with only here and there a low hill remaining where the rocks were unusually hard or where they were protected from erosion by their position. Since the surface was not perfectly reduced this is called a *peneplain*, and since it was formed near the lowest possible level of erosion it is called a *baselevel peneplain*. After the surface of the land had become reduced nearly to sea-level this region was elevated about 1,000 feet and at the same time tilted southward. The streams, which had become sluggish, were at once stimulated to renewed activity and began rapidly to sink their channels into the peneplain. Erosion progressed most rapidly upon soft rocks, so that on the western part of this area, where the sandstone capping was thin, and in the Sequatchie anticline, where limestone formed the surface, the streams quickly sunk their channels down nearly to the new baselevel of erosion, and then, by broadening their valleys, began the formation of a new peneplain. The old peneplain was preserved at the higher level, where the hard rocks capped the plateau. After the formation of the second peneplain was well advanced upon areas of soft rocks, the region was again lifted and the streams began cutting their present channels within the last-formed peneplain.

GEOLOGY.

STRATIGRAPHY.

The sedimentary record.—All the rocks appearing at the surface within the limits of the McMinnville atlas sheet are of sedimentary origin; that is, they were deposited by water. They consist of sandstones, shales, and limestones, presenting great variety in composition and appearance. The materials of which they are composed were originally gravel, sand, and mud, derived from the waste of older rocks, or the remains of plants and animals which lived while the strata were being laid down. Thus some of the great beds of limestone were formed largely from the shells of various sea animals, and the beds of coal are the remains of a luxuriant vegetation which probably covered low, swampy shores.

The rocks of this portion of the Appalachian province afford a record of almost uninterrupted sedimentation from early Silurian to late Carboniferous time. Their composition and appearance indicate the nearness to shore and the depth of water in which they were deposited. Sandstones marked by ripples and cross-bedded by currents, and shales cracked by the sun on mud flats, indicate shallow water; while limestones, especially by the fossils they contain, indicate greater or less depth of water and absence of sediment. The character of the adjacent land is also shown by the character of the sediments derived from its waste. Coarse sandstones and conglomerates, such as are found in the Coal Measures, were derived from high land, on which stream grades were steep, or they may have resulted from wave action as the sea encroached upon a sinking coast. Red sandstones and shales, such as make up some of the Cambrian and Silurian formations a few miles to the east, result from the revival of erosion on a land surface long exposed to rock decay and oxidation, and hence covered by a deep residual soil. Limestones, on the other hand, if deposited near the shore, indicate that the land was low and that its streams were too sluggish to carry off coarse sediment, the sea receiving only fine sediment and substances in solution.

The sea in which these sediments were laid down covered most of the Appalachian province and the Mississippi basin. The area of the McMinnville sheet was near its eastern margin, and the materials of which its rocks are composed were therefore derived largely from the land to the eastward. The exact position of the eastern shore-line of this ancient sea is not known, but it probably varied from time to time within rather wide limits.

SILURIAN ROCKS.

The oldest rocks exposed within the limits of the McMinnville sheet belong to the Silurian period. Probably the older Silurian and Cambrian rocks, which are brought to the surface by the steep folds a few miles eastward, extend beneath the whole of this area and far beyond its western limit, but since they have never been brought to light by natural or artificial means nothing is definitely known as to their character.

Chickamauga limestone.—The rocks which form the surface throughout the whole of the Middle Tennessee basin appear in this district only in the northwestern portion, where streams have cut down to them through the overlying formations of the highland rim. This formation, which is the oldest shown on the sheet, consists in the main of massive blue limestones, but contains also thin-bedded limestone and some calcareous shale. The formation is probably 1,000 or more feet in thickness, but only about 200 feet of its upper portion are exposed. The limestone contains many fossils, the most abundant being brachiopods and corals. The formation takes its name from the valley of Chickamauga Creek, shown on the Ringgold and Chattanooga atlas sheets, where it is typically developed.

DEVONIAN ROCKS.

A few miles to the east of this region the Chickamauga limestone is overlain by another Silurian formation, the Rockwood shale. At some point between Sequatchie Valley and the valley of Caney Fork this formation disappears and the Devonian rocks rest directly on the Chickamauga limestone. Whether this break corresponds to a period of erosion during which this region was dry land, or whether, by reason of some peculiar conditions in the sea, no sediments were deposited during late Silurian time, is a question not satisfactorily settled.

Chattanooga black shale.—A thin stratum of shale appears to represent the whole of the deposition which took place in this region during Devonian time. The fossils which it contains indicate that this shale represents only the upper part of the Devonian of other regions, hence the lower Devonian formations are wanting in this region, and probably by reason of the same conditions which account for the absence of the Upper Silurian formations.

The Chattanooga black shale has a remarkably uniform character wherever seen within the area mapped and for a long distance therefrom in all directions. It is about 15 feet in thickness, and consists mainly of highly carbonaceous, nonfissile shale. The upper stratum, usually about 2 feet in thickness, is generally bluish-green, somewhat sandy, and contains a layer of small phosphatic concretions an inch or less in diameter. It seems probable that this upper greenish layer of shale represents an ancient ash-bed, the material having been ejected from a volcano and transported a long distance from its source, partly by winds and afterward by currents, when it had fallen on the surface of the sea which then covered this region.

This formation, on account of its distinctive and striking appearance, has attracted much attention, and has been prospected in many places for coal and various ores, especially silver and copper. Such exploitation, however, has always been attended by failure. Although the black shale contains a large proportion of carbonaceous matter, which burns when it is placed on a hot fire, this proportion is not sufficient to make it a fuel, and no true coal is ever found associated with it. Small concretions of iron pyrites occurring in the shale have given rise to the commonly accepted but wholly erroneous belief that it contains valuable ores.

In some portions of middle Tennessee, southwest of Nashville, the Chattanooga black shale is of commercial importance, since valuable beds of phosphate there occur associated with it. The conditions favorable for the accumulation of these phosphate beds appear to have been quite local, and although, as already stated, the formation carries phosphatic nodules, no bed of sufficient thickness to be commercially valuable exists in the region shown on this sheet.

CARBONIFEROUS ROCKS.

Fort Payne chert.—This formation consists of from 150 to 225 feet of very siliceous limestone. At the base, resting on the Chattanooga black shale, are usually heavy beds of chert with only a small amount of limestone or greenish shale. The proportion of lime increases toward the top of the formation and, gradually replacing the chert, it passes, without abrupt transition, into the Bangor limestone above. The chert of this formation is readily distinguished from that of the Knox dolomite by the great number of fossils which it contains. It is often made up of a mass of crinoid stems embedded in a siliceous cement. On weathering the cement remains as a porous chert filled with fossil impressions. In some cases the fossils alone are silicified, so that they remain in the soil after the solution of the calcareous portion of the rock. As shown on the areal map, this formation comes to the surface over a third or more of the sheet. The beds are nearly horizontal but rise gradually westward, forming a broad belt on the highland rim adjacent to the central basin. On the eastern side of this belt it appears in the deeper stream channels, and on the west it forms the summits of the hills. The rock is rarely seen in place except in the steep sides of ravines, but its outcrops are marked by gray siliceous soil containing more or less abundant chert fragments.

Bangor limestone.—The Bangor limestone consists of 700 to 800 feet of limestone which everywhere forms the lower slopes of the plateau escarpment, the floors of all the coves, and the inner portion of the highland rim. It also occurs in numerous isolated areas on the higher portions of the highland rim, and it forms Short Mountain from its base to a point within 200 feet of its summit. In general it is a massive, blue, crinoidal limestone, although it presents many local variations from this type. Nodules of chert are more or less abundant throughout the formation, though not evenly distributed. Beds of white, porous chert are somewhat abundant in the lower portion of the limestone, and they are usually found embedded in the deep red clays which characterize the outcrops of the formation in the isolated areas above mentioned. In some places, particularly in the upper part of the formation, the limestone contains a very large proportion of argillaceous matter, so that when the calcareous portion of the rock has been removed by solution it appears as a fine, clayey shale, usually gray or green, but sometimes red and purple. It seems that the conditions under which the limestone formed were not everywhere the same, and some localities were furnished with a larger supply of muddy sediment than others near by. Also one or more beds of hard brown sandstone, 15 to 20 feet in thickness, occur in the limestone, from 150 to 280 feet below its top. These beds protect in some measure the underlying limestone, so that in many places a terrace is formed part way down the side of the escarpment. These sandstone beds also cap most of the outlying limestone hills west of the escarpment, which accounts for their level summits.

Lookout sandstone.—The calcareous shales at the top of the Bangor limestone indicate a change in the conditions of sedimentation, shoaling water, and an increase in quantity of sediment. During the deposition of the succeeding formation the sea bottom was lifted, so that the water became shallow over a wide area, while an abundant supply of mud and sand was washed in from the adjoining land. These conditions were unfavorable for the existence animals whose remains are so abundant in the preceding formation, and instead of limestone a great mass of shale and sandstone was deposited. The surface also stood above sea-level at various times, long enough at least for the growth of the luxuriant vegetation which formed the coal beds.

The Lookout sandstone includes from 200 to 350 feet of conglomerate, sandstone, sandy and clayey shale, and coal. Its upper limit, which is fixed somewhat arbitrarily, is taken at the top of a heavy bed of conglomerate usually forming the main cliff in the plateau of escarpments. Frequently a hard, cross-bedded sandstone below the conglomerate, and separated from it by an interval of sandy shale, makes a second cliff, in some places more prominent than that formed by the conglomerate. At Clifty Creek, a few miles east of this district, the formation consists of a single member. The shales and sandstones which ordinarily underlie the conglomerate entirely disappear, and the coarse, pebbly conglomerate rests directly on the Bangor limestone. West of this point the underlying shales reappear, and at Bon Air, on the western side of the plateau, they are nearly 100 feet in thickness and contain two beds of coal. In Martin Point these lower beds increase to 150 or 175 feet in thickness, and in addition to the shale and coal include a heavy stratum of coarse, cross-bedded sandstone. It is not definitely determined whether the lower portion of the formation was deposited continuously over the whole region and then removed by erosion before the conglomerate was laid down, or whether it was never deposited in some places. The latter, however, is more probable. It seems that the sediments which make up this formation were deposited upon a somewhat uneven sea bottom, in broad, shallow troughs extending in a northeast-southwest direction. Thus the limestone at Clifty Creek may have been lifted high enough to suffer erosion while the Lookout shale and coal were being deposited in estuaries and swamps on either side.

The Walden sandstone.—Above the Lookout conglomerate is another series of coal, shale, sandstone, and conglomerate similar to the one just described, but somewhat more uniform in its character and presenting less-abrupt changes. The formation in most places is capable of subdivision into four members. At the base are several hundred feet of shales, in some places approaching a fire-clay in appearance and in others passing through micaceous, sandy shale into thin-bedded sandstones. This member is the most important part of the formation, since it contains the principal coal seam of the region. It decreases in thickness toward the northwest, and on the area of the Pikeville sheet entirely disappears near the western escarpment, where the next member above it rests directly upon the Lookout conglomerate. Above the lower shale is a variable thickness of coarse, white or yellow sandstone, in some places containing a few conglomerate pebbles. This sandstone forms the surface of the plateau over a considerable portion of the area shown on the sheet. Above this middle sandstone are sandy shales, distinguished from those below by the large amount of iron which they contain, giving them usually a rusty-yellow surface. Finally, at the top of the Walden is a heavy, coarse sandstone, generally conglomeritic. The two upper members of the Walden occur chiefly along the eastern side of the Walden and Cumberland plateaus and are not found in the area mapped on this sheet. They also form the broad, rounded hills which were described as rising above the general level of the plateau.

These two formations, the Lookout and Walden sandstones, constitute the productive coal measures of the region. The position and thickness of the various beds of coal will be described under the head of Mineral Resources.

At the close of the Carboniferous period this region was elevated permanently above sea-level, so that the constructive process of deposition was stopped and the destructive process of erosion was begun.

STRUCTURE.

As the materials forming the rocks of this region were deposited upon the sea bottom, they must originally have been disposed in nearly horizontal layers, and throughout the whole of the area of this sheet they retain almost exactly their original horizontal position. They have been elevated many hundred feet since their materials were deposited, and at the same time have been tilted slightly eastward. A few miles to the eastward of this region the beds do not retain anything like their original horizontal position but are inclined at various angles, forming many parallel folds composed of alternating arches and troughs. Besides having been folded the strata along certain lines have been fractured, and the rocks on opposite sides of the fracture have been thrust in different directions.

These features of structure are manifestly due chiefly to compression which acted in a northwest-southeast direction at right angles to the trend of the resulting folds. If the region in which the beds remain unfolded was ever subjected to this compression, as is quite probable, the strata must have been more rigid than those along the ancient shore-line to the east, so that the force was transmitted and its effects accumulated in the present folded zone.

The compression apparently began in early Paleozoic time, and probably continued at intervals until its culmination, shortly after the close of the Carboniferous, when the greater portion of the folding was effected.

In addition to the horizontal force of compression, the province has been subjected to other forces, which have repeatedly elevated and depressed its surface. At least two periods of high land near the sea and two longer periods of low land are indicated by the character of the Paleozoic sediments. And in post-Paleozoic time there have been at least three, and probably more, periods of decided oscillation of the land due to the action of some vertical force. In every case the movements have resulted in warping the surface, and the greatest uplift has occurred nearly along the line of the Great Valley.

Structure section.—The section on the structure sheet represents the strata as they would appear in the sides of a deep trench cut across the country. Their position with reference to the map is on the line at the upper edge of the blank strip. The vertical and horizontal scales are the same, so that the elevations represented in the profile are not exaggerated, but show the actual form and slope of the land. On the scale of the map the section can not represent the minute details of structure; it is therefore somewhat generalized from observations made near the line of the section in a belt a few miles in width.

It is seen from this section that the beds dip very gently toward the southeast. Thus the base of the Fort Payne chert is represented as about at sea-level in the eastern end of the section and nearly 1,000 feet above sea-level at the western end. This corresponds to an average dip of about 30 feet to the mile.

MINERAL RESOURCES.

Coal.—The productive coal-bearing formations, consisting of the Lookout and Walden sandstones, occupy the surface of the Cumberland Plateau. These formations cover but a small part of the McMinnville district, and its area of productive coal is therefore correspondingly small. The area of the Lookout sandstone in this district in which workable coal may be found is about 65 square miles. The Lookout sandstone is much thinner here than a few miles eastward. It decreases from nearly 600 feet at the Sequatchie Valley to 175 feet in this district. As shown on the accompanying vertical sections, it contains two seams of coal, both of which have been worked in a small way at various points. The lower of these seams rests almost directly upon the Bangor limestone. In some cases only a few feet of marl intervene. The thickness of this seam varies considerably, but within the area mapped it was nowhere seen to exceed 24 inches. The upper of the two seams occurs at the base of the cliff, usually formed by a massive Lookout conglomerate. A few feet of shale and thin-bedded sandstone intervene between the coal and the overlying conglomerate. This seam is also quite variable in thickness. On the north side of Martin Point it is from 8 to 10 inches thick, and on the south side from 36 to 48 inches. These two seams probably correspond to the two which are worked at Bon Air, shown on the adjacent Pikeville sheet. The interval between them, however, is much greater here than at Bon Air, and the coal is not so thick. On account of their rapid variation in thickness this coal will probably be mined only for local consumption. It is not a coking coal, but is an excellent steaming and domestic fuel.

In the region to the south and east of the McMinnville district the most important coal seam occurs in the Walden sandstone, a short distance above the Lookout conglomerate. Openings have been made on this Sewanee seam a few miles to the eastward, where it has a thickness probably between 3 and 4 feet. Although the seam has not been opened in the McMinnville district, it probably occupies an area of 20 square miles in the southeastern corner. The Sewanee seam is more uniform in thickness and position than the coals in the Lookout sandstone, so that its commercial importance is much greater, notwithstanding the smaller area.

Iron ore.—Two varieties of iron ore occur in the district, although both are in such small quantities that they probably have little, if any, commercial importance. In the early days, before railroad transportation brought in the cheaper iron from other regions, a small amount of iron was made in forges in the region between Smithville and McMinnville. The ore used was limonite or brown hematite, which occurs in small pockets in the residual material resulting from the decay of the upper portion of the Fort Payne chert.

In other portions of the highland rim, particularly in western-middle Tennessee, these accumulations of limonite attain considerable volume and supply numerous furnaces.

The second variety of iron ore which may be found in this district in commercial quantities is the carbonate or black band ore. At many points in the district mapped on the adjacent Sewanee sheet a bed of this ore occurs at the contact of the Bangor limestone and the Lookout sandstone. In Hubbard Cove, a few miles from the southern limit of the McMinnville sheet, the bed has been opened, and is about $3\frac{1}{2}$ feet thick. Although not observed in the McMinnville district, it is probable that the same bed occurs in corresponding position.

Stone.—Stone adapted to architectural uses is found in nearly every formation shown on the sheet, but has been quarried in only a small way for local use. Somewhat extensive quarries of a pink sandstone occurring in the Lookout have been opened near Sewanee, and the same stone occurs in the southeastern corner of the McMinnville district. Distance from lines of transportation, however, renders this of little present value. Good building stone also occurs in the Bangor limestone along the eastern half of the district mapped, and in the Chickamauga limestone in the northwestern corner.

The hard, blue Bangor and Chickamauga limestones furnish an abundant supply of macadam material, which with but little transportation could be used to make excellent roads in all the valley portion of the district. The residual chert in areas underlain by the Fort Payne is an excellent road material and might be used with advantage in surfacing macadam roads. Unfortunately these abundant materials are as yet wholly unutilized.

Clays.—The residual deposits resulting from the weathering of the Bangor and Chickamauga limestones are red and blue clays, generally well adapted for making brick. This is utilized for supplying local demand near the larger towns. At some points this clay is suitable for pottery and tiling. In the vicinity of Smithville a bed of white clay resulting from the weathering of shales in the upper part of the Fort Payne is used for pottery. Several beds of fire-clay which are associated with the coal probably contain material well adapted for making fire-brick, but they are as yet wholly undeveloped.

SOILS.

Derivation and distribution.—Throughout the region covered by the McMinnville atlas sheet there is a very close relation between the character of the soils and that of the underlying geologic formations. Except in limited areas along the larger streams and on the steepest slopes, the soils are derived directly from the decay and disintegration of the rocks on which they lie. All such sedimentary rocks as occur in this region are changed by surface waters more or less rapidly, the rapidity depending on the character of the cement which holds their particles together. Siliceous cement is nearly insoluble, and rocks in which it is present, such as quartzite and some sandstones, are extremely durable and produce but a scanty soil. Calcareous cement, on the other hand, is readily dissolved by water containing carbonic acid, and the particles which it held together in the rock crumble down and form a deep soil. If the calcareous cement makes up but a small part of the rock, it is often leached out far below the surface, and the rock retains its form but becomes soft and porous; but if, as in limestone, the calcareous material forms the greater part of the rock, the insoluble portions collect on the surface as a mantle of soil, varying in thickness with the character of the limestone, being generally quite thin where the latter is pure, but often very thick where it contains much insoluble matter.

When derived in this way from the disintegration of the underlying rock, soils are called sedentary. If the rock is a sandstone or sandy shale the soil is sandy, and if it is a clay-shale or limestone the resulting soil is clay. As there are abrupt changes in the character of the rocks, sandstones and shales alternating with limestones, so there are abrupt transitions in the character of the soil, and soils differing widely in composition and agricultural qualities often occur side by side. The character of the soils derived from the various geological formations being known, their distribution may be approximately determined from the map showing the areal geology, which thus serves also as a soil map. The only considerable areas in which the boundaries between different varieties of soil do not coincide with the formation boundaries are in the river bottoms and upon the steep slopes, where soils derived from rocks higher up the slope have washed down and mingled with or covered the soil derived from those below. The latter are called overplaced soils, and a special map would be required to show their distribution.

Classification.—The soils of this region may conveniently be classed as (1) sandy soils, derived from the Walden and Lookout sandstones; (2) clay soils, derived from the Bangor and Chickamauga limestones; (3) cherty soils, derived from the Fort Payne chert; (4) alluvial soils, deposited by the larger streams on their flood-plains.

Sandy soils.—The Cumberland Plateau is formed of sandstones and sandy shales, and its soil is a sandy loam. At the surface it is gray, while the subsoil is generally light-yellow, but varies to deep-red. In some places it consists largely of sand, but in others it contains sufficient clay to give the subsoil considerable coherence, so that a cut bank will remain vertical for some years. The depth of soil on the plateau varies from a few inches to ten feet or more, diminishing in proximity to streams, where erosion is most active. A large part of the plateau retains its original forest growth, chiefly of oak, chestnut, and hickory, while pines clothe the steep sides of the stream channels. The practice of burning off the leaves each fall prevents the accumulation of vegetable mold and has delayed a just appreciation of the agricultural possibilities of this region. It has been found well adapted to fruit-raising, particularly for grapes and apples.

Since the sandstones of this region occupy the highest land, the overplaced soils, or those washed down to lower levels, are mostly sandy. They are especially abundant at the foot of the escarpment surrounding the plateaus, where the Bangor limestone and its clay soil are often wholly concealed. The delta deposits formed by streams emerging from gorges cut in the plateaus also give considerable areas of sandy soil, overlying rocks which would themselves produce clay or cherty soils.

Clay soils.—These are derived chiefly from the Bangor and Chickamauga limestones, and their distribution coincides with the outcrops of these formations, as shown on the geologic map. They sometimes have a deep-red color, but where the mantle of residual material covering the rock is thin it is often dark bluish-gray.

The soil in the many coves which penetrate the Cumberland Plateau is derived chiefly from the Bangor limestone. It is a bluish clay with a slight admixture of sand from the rocks capping the plateau, and is exceptionally fertile. It is especially adapted to clover and grain. Considerable areas of red-clay land occur on the highland rim between the foot of the plateau and the inner edge of the Barrens. A deep red-clay soil characterizes also the isolated areas of Bangor limestone in the central and western portions of the district mapped.

Cherty soils.—Outcrops of the Fort Payne occupy something more than a third of the area of the sheet and the chert which makes up so large a portion of this formation determines the character of the residual soil derived from it. The calcareous portion of the rock is removed by solution, leaving the insoluble siliceous constituent as a deep residual mantle upon the surface. The soil derived from the lower part of the formation, where the chert is heavy and abundant, is usually rocky and difficult to cultivate, but rather fertile. That derived from the upper part of the formation is light-gray, very siliceous, and so finely divided that it appears to be almost free from grit and is readily borne by the wind. The subsoil is usually reddish or yellow, and contains considerable clay, with angular chert fragments, which increase in abundance with depth. This gray, siliceous soil characterizes the "barrens" of the highland rim. The land is by no means barren, but has obtained the name by contrast with the seemingly inexhaustible red-clay lands adjacent. With proper cultivation and the use of fertilizers this soil becomes highly productive.

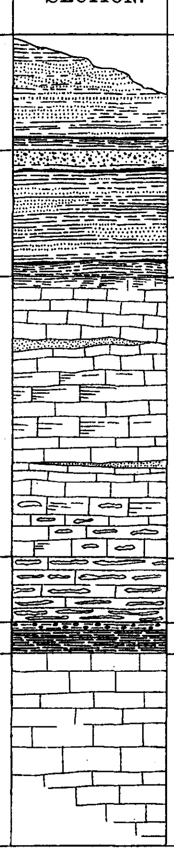
Alluvial soils.—All the streams of this region are more or less rapidly deepening their channels, and hence have very narrow, if any, flood-plains. At the northern edge of the district mapped Caney Fork has cut down nearly to the level of the Cumberland River. It is now widening its valley, and is bordered by narrow strips of alluvial soil for several miles within the district. From the vicinity of Greenbrier bend to the mouth of Collins River the stream flows in a narrow gorge and has no flood-plain. Farther up, on Caney Fork and its tributaries, where the streams flow on the highland rim, they are again bordered by strips of alluvial soil. This is a sandy-clay loam, and owes its fertility largely to the vegetable matter which it contains.

CHARLES WILLARD HAYES,
Geologist.

January, 1896.

COLUMNAR SECTIONS

GENERALIZED SECTION FOR THE McMINNVILLE SHEET.
SCALE: 500 FEET = 1 INCH.



Period.	Formation Name.	Symbol.	Columnar Section.	Thickness in Feet.	Character of Rocks.	Character of Topography and Soils.
CARBONIFEROUS	Walden sandstone.	Cw		250+	Coarse sandstone and sandy shale with beds of coal and fire-clay.	Broad, level plateaus, intersected by narrow, rocky gorges. Gray, yellow, or red sandy loam.
CARBONIFEROUS	Lookout sandstone.	Cl		200–350	Conglomerate. Sandstone and shale with beds of coal and fire-clay.	Cliffs of plateau escarpments.
CARBONIFEROUS	Bangor limestone.	Cb		700–800	Shaly limestone. Massive, blue, crinoidal limestone with some shaly beds and thin lenses of coarse sandstone. Blue limestone with nodular chert.	Steep slopes forming the lower part of plateau escarpments. Black clay-soil. Level plain west of the plateau. Red soil, slightly cherty.
CARBONIFEROUS	Fort Payne chert.	Cp		150–225	Cherty limestone and heavy beds of chert.	White, siliceous soil. Barrens of the highland rim.
DEV.	Chattanooga black shale.	Dc		10–30	Carbonaceous shale.	Steep sides and level bottoms of valleys below the highland rim.
SILURIAN	Chickamauga limestone.	Sc		200+	Blue, flaggy limestone with some mottled, earthy beds.	

VERTICAL SECTIONS; SHOWING THE POSITION AND THICKNESS OF COAL BEDS.
SCALE: 250 FEET = 1 INCH.
VERTICAL DISTANCES ARE MEASURED FROM THE TOP OF LOOKOUT CONGLOMERATE.

Formation.	Section on the North Side of Martin Point, 6 Miles Southeast of McMinnville.	Section on the South Side of Martin Point, 7 Miles Southeast of McMinnville.
Walden Sandstone. (Cw)		
Lookout Sandstone. (Cl)	Coarse, heavy sandstone. Coal....................8″–10″ Cross-bedded sandstone. Coal..................18″–24″	Coarse, heavy sandstone. Shale. Coal..................36″–48″ Coal.
Bangor Limestone. (Cb)	Limestone and sandy shale. Purple and green, calcareous shale and limestone.	Limestone.