DEPARTMENT OF THE INTERIOR

UNITED STATES GEOLOGICAL SURVEY

J.W. POWELL DIRECTOR

GEOLOGIC ATLAS

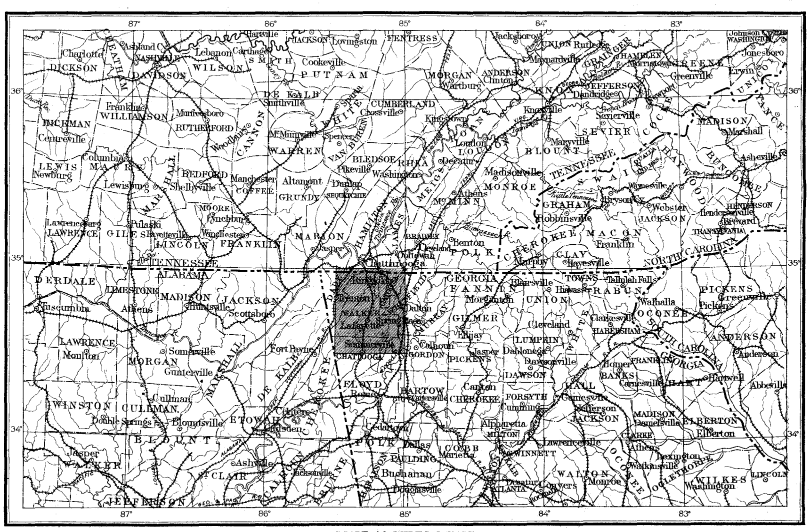
OF THE

UNITED STATES

RINGGOLD FOLIO

GEORGIA-TENNESSEE

INDEX MAP



SCALE: 40 MILES = 1 INCH

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FOLIO 2 | FIELD EDITION | RINGGOLD

'INGTON, D. C.

ENGRAVED AN' 'ED BY THE U.S. 'OLO' SURVEY

BAILEY WILLIS, EDIT' 'EOLOGIC MAPS S. J. KÜBEL, ' ENGRAVER

EXPLANATION.

The Geological Survey is making a large topographic map and a large geologic map of the United States, which are being issued together in the form of a Geologic Atlas. The parts of the atlas are called folios. Each folio contains a topographic map and a geologic map of a small section of country, and is accompanied by explanatory and descriptive texts. The complete atlas will comprise several thousand folios.

THE TOPOGRAPHIC MAP.

The features represented on the topographic map are of three distinct kinds: (1) inequalities of surface, called *relief*, as plains, prairies, valleys, hills and mountains; (2) distribution of water, called *drainage*, as streams, ponds, lakes, swamps and canals; (3) the works of man, called *culture*, as roads, railroads, boundaries, villages and cities.

Relief.—All elevations are measured from mean sea level. The heights of many points are accurately determined and those which are most important are stated on the map by numbers printed in brown. It is desirable to show also the elevation of any part of a hill, ridge, slope or valley; to delineate the horizontal outline or contour of all slopes; and to indicate their degree of steepness. This is done by lines of constant elevation above mean sea level, which are drawn at regular vertical intervals. The lines are called *contours* and the constant vertical space between each two contours is called the *contour interval*. Contours are printed in brown.

The manner in which contours express the three conditions of relief (elevation, horizontal form and degree of slope) is shown in the following sketch and corresponding contour map:

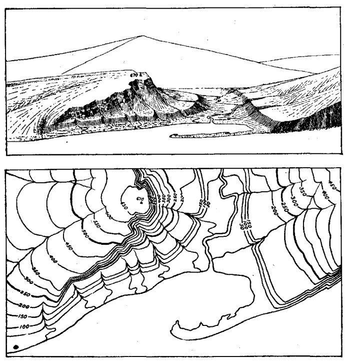

Fig. 1. The upper figure represents a sketch of a river valley, with terraces, and of a high hill encircled by a cliff. These features appear in the map beneath, the slopes and forms of the surface being shown by contours.

The sketch represents a valley between two hills. In the foreground is the sea with a bay which is partly closed by a hooked sand-bar. On either side of the valley is a terrace; from that on the right a hill rises gradually with rounded forms, whereas from that on the left the ground ascends steeply to a precipice which presents sharp corners. The western slope of the higher hill contrasts with the eastern by its gentle descent. In the map each of these features is indicated, directly beneath its position in the sketch, by contours. The following explanation may make clearer the manner in which contours delineate height, form and slope:

1. A contour indicates approximately a height above sea level. In this illustration the contour interval is 50 feet; therefore the contours occur at 50, 100, 150, 200 feet, and so on, above sea level. Along the contour at 250 feet lie all points of the surface 250 feet above sea; and so on with any other contour. In the space between any two contours occur all elevations above the lower and below the higher contour. Thus the contour at 150 feet falls just below the edge of the terrace, while that at 200 feet lies above the terrace; therefore all points on the terrace are shown to be more than 150 but less than 200 feet above sea. The summit of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration nearly all the contours are numbered. Where this is not possible, certain contours are made heavy and are numbered; the heights of others may then be ascertained by counting up or down from a numbered contour.

2. Contours define the horizontal forms of slopes. Since contours are continuous horizontal lines conforming to the surface of the ground, they wind smoothly about smooth surfaces, recede into all reentrant angles of ravines and define all prominences. The relations of contour characters to forms of the landscape can be traced in the map and sketch.

3. Contours show the approximate grade of any slope. The vertical space between two contours is the same, whether they lie along a cliff or on a gentle slope; but to rise a given height on a gentle slope one must go farther than on a steep slope. Therefore contours are far apart on the gentle slopes and near together on steep ones.

For a flat or gently undulating country a small contour interval is chosen; for a steep or mountainous country a large contour interval is necessary. The smallest contour interval used on the atlas sheets of the Geological Survey is 5 feet. This is used for districts like the Mississippi delta and the Dismal Swamp region. In mapping great mountain masses like those in Colorado, on a scale of $\frac{1}{250,000}$ the contour interval may be 250 feet. For intermediate relief other contour intervals of 10, 20, 25, 50, and 100 feet are used.

Drainage.—The water courses are indicated by blue lines, which are drawn unbroken where the stream flows the year round, and dotted where the channel is dry a part of the year. Where the stream sinks and reappears at the surface, the supposed underground course is shown by a broken blue line. Marshes and canals are also shown in blue.

Culture.—In the progress of the settlement of any region men establish many artificial features. These, such as roads, railroads and towns, together with names of natural and artificial details and boundaries of towns, counties and states, are printed in black.

As a region develops, culture changes and gradually comes to disagree with the map; hence the representation of culture needs to be revised from time to time. Each sheet bears on its margin the dates of survey and of revision.

Scales.—The area of the United States (without Alaska) is about 3,025,000 square miles. On a map 240 feet long and 180 feet high the area of the United States would cover 3,025,000 square inches. Each square mile of ground surface would be represented by a corresponding square inch of map surface, and one linear mile on the ground would be represented by a linear inch on the map. This relation between distance in nature and corresponding distance on the map is called the scale of the map. In this special case it is "one mile to an inch." A map of the United States half as long and half as high would have a scale half as great; its scale would be "two miles to an inch," or four square miles to a square inch. Scale is also often expressed as a fraction, of which the numerator is a length on the map and the denominator the corresponding length in nature expressed in the same unit. Thus, as there are 63,360 inches in a mile, the scale "one mile to one inch" is expressed by $\frac{1}{63,360}$.

Three different scales are used on the atlas sheets of the U. S. Geological Survey; the smallest is $\frac{1}{250,000}$, the second $\frac{1}{125,000}$, and the largest $\frac{1}{62,500}$. These correspond approximately to four miles two miles, and one mile of natural length to one inch of map length. On the scale $\frac{1}{62,500}$ one square inch of map surface represents and corresponds nearly to one square mile; on the scale of $\frac{1}{125,000}$, to about four square miles; and on the scale of $\frac{1}{250,000}$, to about sixteen square miles. At the bottom of each atlas sheet the scale is expressed as a fraction, and it is further indicated by a "bar scale," a line divided into parts representing miles and parts of miles.

Atlas sheets.—A map of the United States on the smallest scale used by the Geological Survey would be 60 feet long and 45 feet high. If drawn on one of the larger scales it would be either two times or four times as long and high. To make it possible to use such a map it is divided into atlas sheets of convenient size which are bounded by parallels and meridians. Each sheet on the scale of $\frac{1}{250,000}$ contains one square degree (that is, represents an area one degree in extent in each direction); each sheet on the scale of $\frac{1}{125,000}$ contains one-quarter of a square degree; each sheet on the scale of $\frac{1}{62,500}$ contains one-sixteenth of a square degree. These areas correspond nearly to 4000, 1000 and 250 square miles.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to the boundary lines of the states, counties or townships. For convenience of reference and to suggest the district represented each sheet is given the name of some well known town or natural feature within its limits. At the sides and corners of each sheet the names of adjacent sheets are printed.

THE GEOLOGIC MAP.

A geologic map represents the distribution of rocks, and is based on a topographic map,—that is, to the topographic representation the geologic representation is added.

Rocks are of many kinds in origin, but they may be classed in four great groups: Superficial Rocks, Sedimentary Rocks, Igneous Rocks and Altered Rocks. The different kinds found within the area represented by a map are shown by devices printed in colors.

Rocks are further distinguished according to their relative ages, for rocks were not formed all at one time, but from age to age in the earth's history. The materials composing them likewise vary with locality, for the conditions of their deposition at different times and places have not been alike, and accordingly the rocks show many variations. Where beds of sand were buried beneath beds of mud, sandstone may now occur under shale; where a flow of lava cooled and was overflowed by another bed of lava, the two may be distinguished. Each of these masses is limited in extent to the area over which it was deposited, and is bounded above and below by different rocks. It is convenient in geology to call such a mass a *formation*.

(1) *Superficial rocks.*—These are composed chiefly of clay, sand and gravel, disposed in heaps and irregular beds, usually unconsolidated.

Within a recent period of the earth's history, a thick and extensive ice sheet covered the northern portion of the United States and part of British America, as one now covers Greenland. The ice gathered slowly, moved forward and retreated as glaciers do with changes of climate, and after a long and varied existence melted away. The ice left peculiar heaps and ridges of gravel; it spread layers of sand and clay, and the water flowing from it distributed sediments of various kinds far and wide. These deposits from ice and flood, together with those made by water and winds on the land and shore after the glacier had melted, and those made by similar agencies where the ice sheet did not extend, are the superficial formations. This period of the earth's history, from the beginning of the glacial epoch to the present, is called the Pleistocene period.

The distribution of the superficial rocks is shown on the map by colors printed in patterns of dots and circles.

(2) *Sedimentary rocks.*—These are conglomerate, sandstone, shale and limestone, which have been deposited beneath seas or other large bodies of water and have usually become hard.

If North America were gradually to sink a thousand feet the sea would flow over the Atlantic coast and the Mississippi and Ohio valleys from the Gulf of Mexico to the Great Lakes. The Appalachian mountains would become an archipelago in the ocean, whose shore would traverse Wisconsin, Iowa, Kansas and Texas. More extensive changes than this have repeatedly occurred in the past. The shores of the North American continent have changed from age to age, and the sea has at times covered much that is now dry land. The earth's surface is not fixed, as it seems to be; it very slowly rises or sinks over wide expanses; and as it rises or subsides the shore lines of the oceans are changed.

The bottom of the sea is made of gravel, sand and mud, which are sorted and spread. As these sediments gather they bury others already deposited and the latter harden into layers of conglomerate, sandstone, shale or limestone. When the sea bottom is raised to dry land these rocks are exposed, and then we may learn from them many facts concerning the geography of the past.

As sedimentary strata accumulate the younger beds rest on those that are older and the relative ages of the deposits may be discovered by observing their relative positions. In any series of undisturbed beds the younger bed is above the older.

Strata generally contain the remains of plants and animals which lived in the sea or were washed from the land into lakes or seas. By studying these remains or fossils it has been found that the species of each epoch of the earth's history have to a great extent differed from those of other epochs. Rocks that contain the remains of life are called *fossiliferous*. Only the simpler forms of life are found in the oldest fossiliferous rocks. From time to time more complex forms of life developed and, as the simpler ones lived on in modified forms, the kinds of living creatures on the earth multiplied. But during each epoch there lived peculiar forms, which did not exist in earlier times and have not existed since; these are *characteristic types*, and they define the age of any bed of rock in which they are found.

Beds of rock do not always occur in the positions in which they were formed. When they have been disturbed it is often difficult to determine their relative ages from their positions; then fossils are a guide to show which of two or more formations is the oldest. When two formations are remote one from the other and it is impossible to observe their relative positions, the characteristic fossil types found in them may determine which one was formed first. Fossil remains found in the rocks of different states, of different countries and of different continents afford the most important means for combining local histories into a general earth history.

Areas of sedimentary rocks are shown on the map by colors printed in patterns of parallel straight lines. To show the relative age of strata on the map, the history of the sedimentary rocks is divided into nine periods, to each of which a color is assigned. Each period is further distinguished by a letter-symbol, so that the areas may be known when the colors, on account of fading, color blindness or other cause, cannot be recognized. The names of the periods in proper order (from new to old), with the color and symbol assigned to each, are given below:

PERIOD.	SYMBOL.	COLOR—PRINTED IN PATTERNS OF PARALLEL LINES.
Neocene (youngest)	N	Yellowish buff.
Eocene	E	Olive-brown.
Cretaceous	K	Olive-green.
Juratrias	J	Gray-blue-green.
Carboniferous	C	Gray-blue.
Devonian	D	Gray-blue-purple.
Silurian	S	Gray-red-purple.
Cambrian	Є	Brown-red.
Algonkian (oldest)	A	Orange-brown.

In any district several periods may be represented, and the representation of each may include one or many formations. To distinguish the sedimentary formations of any one period from those of another, the patterns for the formations of each period are printed in the appropriate period-color; and the formations of any one period are distinguished from one another by different patterns. Two tints of the period-color are used: a pale tint (the underprint) is printed evenly over the whole surface representing the period; a dark tint (the overprint) brings out the different patterns representing formations. Each formation is furthermore given a letter-symbol, which is printed on the map with the capital letter-symbol of the period. In the case of a sedimentary formation of uncertain age the pattern is printed on white ground in the color of the period to which the formation is supposed to belong, the letter-symbol of the period being omitted.

(3) *Igneous rocks.*—These are crystalline rocks, which have cooled from a molten condition.

Deep beneath the surface, rocks are often so hot as to melt and flow into crevices, where they congeal, forming dikes and sheets. Sometimes they pour out of cracks and volcanoes and flow over the surface as lava. Sometimes they are thrown from volcanoes as ashes and pumice, and are spread over the surface by winds and streams. Often lava flows are interbedded with ash beds.

It is thought that the first rocks of the earth, which formed during what is called the Archean period, were igneous. Igneous rocks have intruded among masses beneath the surface and have been thrown out from volcanoes at all periods of the earth's development. These rocks occur therefore with sedimentary formations of all periods, and their ages can sometimes be determined by the ages of the sediments with which they are associated.

Igneous formations are represented on the geologic maps by patterns of triangles or rhombs printed in any brilliant color. When the age of a formation is not known the letter-symbol consists of small letters which suggest the name of the rocks; when the age is known the letter-symbol has the initial letter of the appropriate period prefixed to it.

(4) *Altered rocks of crystalline texture.*—These are rocks which have been so changed by pressure, movement and chemical action that the mineral particles have recrystallized.

Both sedimentary and igneous rocks may change their character by the growth of crystals and the gradual development of new minerals from the original particles. Marble is limestone which has thus been crystallized. Mica is one of the common minerals which may thus grow. By this chemical alteration sedimentary rocks become crystalline, and igneous rocks change their composition to a greater or less extent. The process is called *metamorphism* and the resulting rocks are said to be metamorphic. Metamorphism is promoted by pressure, high temperature and water. When a mass of rock, under these conditions, is squeezed during movements in the earth's crust, it may divide into many very thin parallel layers. When sedimentary rocks are formed in thin layers by deposition they are called *shales;* but when rocks of any class are found in thin layers that are due to pressure they are called *slates.* When the cause of the thin layers of metamorphic rocks is not known, or is not simple, the rocks are called *schists,* a term which applies to both shaly and slaty structures.

Rocks of any period of the earth's history, from the Neocene back to the Algonkian, may be more or less altered, but the younger formations have generally escaped marked metamorphism, and the oldest sediments known remain in some localities essentially unchanged.

Metamorphic crystalline formations are represented on the maps by patterns consisting of short dashes irregularly placed. These are printed in any color and may be darker or lighter than the background. If the rock is a schist the dashes or hachures may be arranged in wavy parallel lines.

If the formation is of known age the letter-symbol of the formation is preceded by the capital letter-symbol of the proper period. If the age of the formation is unknown the letter-symbol consists of small letters only.

USES OF THE MAPS.

Topography.—Within the limits of scale the topographic sheet is an accurate and characteristic delineation of the relief, drainage and culture of the region represented. Viewing the landscape, map in hand, every characteristic feature of sufficient magnitude should be recognizable.

It may guide the traveler, who can determine in advance or follow continuously on the map his route along strange highways and byways.

It may serve the investor or owner who desires to ascertain the position and surroundings of property to be bought or sold.

It may save the engineer preliminary surveys in locating roads, railways and irrigation ditches.

It provides educational material for schools and homes, and serves all the purposes of a map for local reference.

Areal geology.—This sheet shows the areas occupied by the various rocks of the district. On the margin is a *legend,* which is the key to the map. To ascertain the meaning of any particular colored pattern on the map the reader should look for that color and pattern in the legend, where he will find the name and description of the formation. If it is desired to find any given formation, its name should be sought in the legend and its colored pattern noted, when the areas on the map corresponding in color and pattern may be traced out.

The legend is also a partial statement of the geologic history of the district. The formations are arranged in groups according to origin—superficial, sedimentary, igneous or crystalline; thus the processes by which the rocks were formed and the changes they have undergone are indicated. Within these groups the formations are placed in the order of age so far as known, the youngest at the top; thus the succession of processes and conditions which make up the history of the district is suggested.

The legend may also contain descriptions of formations or of groups of formations, statements of the occurrence of useful minerals, and qualifications of doubtful conclusions.

The sheet presents the facts of historical geology in strong colors with marked distinctions, and is adapted to use as a wall map as well as to closer study.

Economic geology.—This sheet represents the distribution of useful minerals, the occurrence of artesian water, or other facts of economic interest, showing their relations to the features of topography and to the geologic formations. All the geologic formations which appear on the map of areal geology are shown in this map also, but the distinctions between the colored patterns are less striking. The areal geology, thus printed, affords a subdued background upon which the areas of productive formations may be emphasized by strong colors.

A symbol for mines is introduced in this map, and it is accompanied at each occurrence by the name of the mineral mined or the stone quarried.

Structure sections.—This sheet exhibits the relations existing beneath the surface among the formations whose distribution on the surface is represented in the map of areal geology.

In any shaft or trench the rocks beneath the surface may be exposed, and in the vertical side of the trench the relations of different beds may be seen. A natural or artificial cutting which exhibits those relations is called a *section,* and the same name is applied to a diagram representing the relations. The arrangement of rocks in the earth is the earth's *structure,* and a section exhibiting this arrangement is called a *structure section.*

Mines and tunnels yield some facts of underground structure, and streams carving canyons through rock masses cut sections. But the geologist is not limited to these opportunities of direct observation. Knowing the manner of the formation of rocks, and having traced out the relations among beds on the surface, he can infer their relative positions after they pass beneath the surface. Thus it is possible to draw sections which represent the structure of the earth to a considerable depth and to construct a diagram exhibiting what would be seen in the side of a trench many miles long and several thousand feet deep. This is illustrated in the following figure:

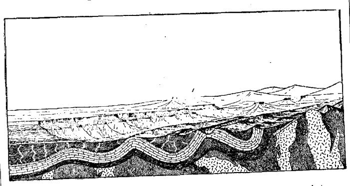

Fig. 2. Showing a vertical section in the front of the picture, with a landscape above.

The figure represents a landscape which is cut off sharply in the foreground by a vertical plane. The landscape exhibits an extended plateau on the left, a broad belt of lower land receding toward the right, and mountain peaks in the extreme right of the foreground as well as in the distance. The vertical plane cutting a section shows the underground relations of the rocks. The kinds of rock are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of much variation, but the following are generally used in sections to represent the commoner kinds of rock:

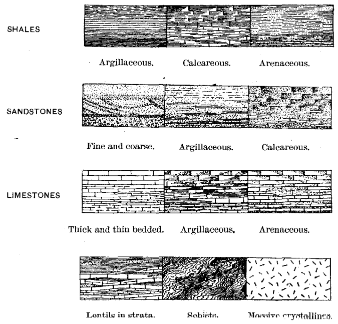

Fig. 3. Symbols used to represent different kinds of rocks.

The plateau in Fig. 2 presents toward the lower land an escarpment which is made up of cliffs and steep slopes. These elements of the plateau front correspond to horizontal beds of sandstone and sandy shale shown in the section at the extreme left, the sandstones forming the cliffs, the shales constituting the slopes.

The broad belt of lower land is traversed by several ridges, which, where they are cut off by the section, are seen to correspond to outcrops of sandstone that rise to the surface. The upturned edges of these harder beds form the ridges, and the intermediate valleys follow the outcrops of limestone and calcareous shales.

Where the edges of the strata appear at the surface their thicknesses can be measured and the angles at which they dip below the surface can be observed. Thus their positions underground can be inferred.

When strata which are thus inclined are traced underground in mining or by inference, it is frequently observed that they form troughs or arches, such as the section shows. But these sandstones, shales and limestones were deposited beneath the sea in nearly flat sheets. Where they are now bent they must, therefore, have been folded by a force of compression. The fact that strata are thus bent is taken as proof that a force exists which has from time to time caused the earth's surface to wrinkle along certain zones.

The mountain peaks on the right of the sketch are shown in the section to be composed of schists which are traversed by masses of igneous rock. The schists are much contorted and cut up by the intruded dikes. Their thickness cannot be measured; their arrangement underground cannot be inferred. Hence that portion of the section which shows the structure of the schists and igneous rocks beneath the surface delineates what may be true, but is not known by observation.

Structure sections afford a means of graphic statement of certain events of geologic history which are recorded in the relations of groups of formations. In Fig. 2 there are three groups of formations, which are distinguished by their subterranean relations.

The first of these, seen at the left of the section, is the group of sandstones and shales, which lie in a horizontal position. These sedimentary strata, which accumulated beneath water, are in themselves evidence that a sea once extended over their expanse. They are now high above the sea, forming a plateau, and their change of elevation shows that that portion of the earth's mass on which they rest swelled upward from a lower to a higher level. The strata of this group are parallel, a relation which is called *conformable.*

The second group of formations consists of strata which form arches and troughs. These strata were continuous, but the crests of the arches have been removed by degradation. The beds, like those of the first group, being parallel, are conformable.

The horizontal strata of the plateau rest upon the upturned, eroded edges of the beds of the second group on the left of the section. The overlying deposits are, from their position, evidently younger than the underlying formations, and the bending and degradation of the older strata must have occurred between the deposition of the older beds and the accumulation of the younger. When younger strata thus rest upon an eroded surface of older strata or upon their upturned and eroded edges, the relation between the two is *unconformable,* and their surface of contact is an *unconformity.*

The third group of formations consist of crystalline schists and igneous rocks. At some period of their history the schists have been plicated by pressure and traversed by eruptions of molten rock. But this pressure and intrusion of igneous rocks have not affected the overlying strata of the second group. Thus it is evident that an interval of considerable duration elapsed between the formation of the schists and the beginning of deposition of strata of the second group. During this interval the schists suffered metamorphism and were the scene of eruptive activity. The contact between the second and third groups, marking an interval between two periods of rock formation, is an unconformity.

The section and landscape in Fig. 2 are hypothetical, but they illustrate only relations which actually occur. The sections in the Structure Section sheet are related to the maps as the section in the figure is related to the landscape. The profiles of the surface in the section correspond to the actual slopes of the ground along the section line, and the depth of any mineral-producing or water-bearing stratum which appears in the section may be measured from the surface by using the scale of the map.

Columnar sections.—This sheet contains a concise description of the rock formations which constitute the local record of geologic history. The diagrams and verbal statements form a summary of the facts relating to the characters of the rocks, to the thicknesses of sedimentary formations and to the order of accumulation of successive deposits.

The characters of the rocks are described under the corresponding heading, and they are indicated in the columnar diagrams by appropriate symbols, such as are used in the structure sections.

The thicknesses of formations are given under the heading "Thickness in feet," in figures which state the least and greatest thicknesses. The average thickness of each formation is shown in the column, which is drawn to a scale,—usually 1,000 feet to 1 inch. The order of accumulation of the sediments is shown in the columnar arrangement of the descriptions and of the lithologic symbols in the diagram. The oldest formation is placed at the bottom of the column, the youngest at the top. The strata are drawn in a horizontal position, as they were deposited, and igneous rocks or other formations which are associated with any particular stratum are indicated in their proper relations.

The strata are divided into groups, which correspond with the great periods of geologic history. Thus the ages of the rocks are shown and also the total thickness of deposits representing any geologic period.

The intervals of time which correspond to events of uplift and degradation and constitute interruptions of deposition of sediments may be indicated graphically or by the word "unconformity," printed in the columnar section.

Each formation shown in the columnar section is accompanied, not only by the description of its character, but by its name, its letter-symbol as used in the maps and their legends, and a concise account of the topographic features, soils, or other facts related to it.

J. W. POWELL,
Director.

RINGGOLD ATLAS SHEET.

DESCRIPTIVE TEXT.

GEOGRAPHY.

General relations.—The Ringgold atlas sheet is bounded by the parallels of latitude 34° 30′ and 35°, and the meridians of longitude 85° and 85° 30′. It embraces, therefore, a quarter of a square degree of the earth's surface. Its dimensions are 34.5 miles from north to south and 28.3 miles from east to west, and it contains 980 square miles. The adjacent atlas sheets are Chattanooga on the north, Dalton on the east, Rome on the south, and Stevenson on the west. The Ringgold sheet lies mainly within the State of Georgia, but a narrow strip about a mile in width along its northern edge lies in Tennessee. It embraces portions of Dade, Catoosa, Walker, Whitfield, Chattooga, Floyd and Gordon counties in Georgia, and portions of Madison, Hamilton and James counties in Tennessee.

Topography.—The country embraced within the atlas sheet is marked by three distinct types of topography. These are determined both by differences in the character of the underlying rocks, and by geologic structure or the relation of the strata to the surface. The three types of surface are (1) plateaus, (2) sharp ridges, (3) undulating or level valleys.

The plateaus are confined to the western third of the sheet. They include Lookout and Pigeon mountains and a small portion of Sand mountain. Pigeon mountain is simply a spur of Lookout, separated from it at its northern point by McLamore cove, but merging with it toward the south. The plateaus have an altitude of about 2,000 feet above sea level, though numerous points about the edge rise from one to four hundred feet higher. The surface is generally level or rolling with a slight inclination from the edges toward the center, giving the mountains the form of shallow troughs. They are usually bounded by abrupt escarpments rising from 1,000 to 1,200 feet above the surrounding valleys. The drainage of the plateau is influenced by the inclination of the strata, which dip slightly from the escarpments toward the axes of the mountains. In the shallow troughs thus formed along the axes the streams flow for considerable distances before breaking through notches in the rim and descending by falls and rapids to the outer valley. Thus Little river, which rises on Lookout mountain opposite Johnson crook, flows toward the southwest for thirty-eight miles before leaving the summit of the plateau. Its channel becomes a deep rocky gorge a few miles before emerging upon the valley, though in its upper course it is but little below the general level of the plateau.

The second type of surface is confined to the eastern third of the sheet. The sharp ridges by which it is characterized are, like the plateaus to the west, produced by hard sandstones which offer much greater resistance to erosion than the rocks above and below. The difference between the plateaus on the west and the ridges on the east is due to the dip of the hard strata, which in the plateaus are nearly horizontal, while in the ridges they are steeply inclined.

The westernmost of these is Taylor ridge, which extends entirely across the sheet and continues northward as White Oak mountain. It preserves throughout the sheet an elevation of about 1,400 feet above sea level, or 500 to 600 feet above the valley. Its western face is steep and uniform, while its eastern face has a much gentler and less even slope. The next prominent ridge to the east is John mountain, which terminates abruptly nine miles from the southern edge of the sheet. Its trend is parallel to that of Taylor ridge, and its altitude is somewhat greater, as the Rockwood sandstones, which form the ridges, increase in thickness toward the east. Along the eastern edge of the sheet are Horn, Mill Creek, Chattoogata, and Rocky Face mountains, a series of short overlapping ridges, each terminating abruptly a few miles further toward the north than the one next westward.

Between Lookout mountain and Taylor ridge is a broad valley forming a belt of comparatively low land across the sheet. About the center of the sheet is the divide between the branches of Chickamauga creek, which flow northward into the Tennessee, and the Chattooga river, which flows south toward the Gulf. The divide is not a sharp line at which the waters part, but is a considerable area on which they flow indifferently in either direction. This has an elevation of only about 250 feet above the Tennessee at Chattanooga; hence, if the valley were lowered that amount the waters of the Tennessee would flow directly south to the Gulf instead of northwest to the Ohio river.

This low land between Lookout mountain and Taylor ridge is a part of the great Appalachian valley which extends from Pennsylvania to central Alabama. It is underlain by rocks which are more easily eroded than the hard sandstones of the adjoining highlands. They are mostly calcareous shales and limestones, which are removed largely by solution. The beds containing a large proportion of insoluble matter form low rounded hills and ridges, but these seldom rise more than 200 or 300 feet above the general level of the valley. East of Taylor ridge is a belt of low land similar to the one occupying the center of the sheet, but somewhat narrower and having its surface more broken by subordinate ridges. Its waters flow partly north to the Tennessee and partly south directly to the Gulf.

STRATIGRAPHY.

All the rocks appearing at the surface within the limits of the Ringgold atlas sheet are of sedimentary origin, that is, they were deposited by water. The materials of which they were composed were mud, sand and pebbles, derived from some older rocks, or the remains of plants and animals which lived while the strata were being laid down. 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 covered low swampy shores.

CAMBRIAN ROCKS.

Apison shale.—The oldest rocks exposed within the limits of the sheet consist of slightly sandy or clayey shales. Their most striking peculiarity is the brilliant coloring which they display in sharply contrasted bands of red, purple, green and yellow. The thickness of these shales is not known, since they are always limited on one side by a fault, but at least 1,000 feet are exposed at some localities on the sheet. The name of the formation is taken from Apison, Tennessee, in the southeastern part of the Chattanooga sheet.

Rome formation.—Next above the Apison shale are the sandstones and shales of the Rome formation. They are probably between 3,000 and 4,000 feet in thickness, but on account of the folding and crumpling which the strata have suffered it is impossible to obtain accurate measurements. The lower portion of the formation, from 1,500 to 2,000 feet thick, is composed of alternating layers of sandstone and shale. Passing upward, the proportion of shale gradually increases so that toward the top only a few thin siliceous beds occur which can scarcely be called sandstone. The shales are usually brown or dark olive-green, while the sandstone beds are reddish, brown or purple, with occasional thin layers of white quartzite. The sandstone beds show ripple marks and other signs of having been deposited in shallow water, but the water was evidently growing deeper during their deposition and the succeeding formation contains limestone and calcareous shales, which must have been formed on a comparatively deep sea bottom and remote from any high land that could yield coarse sediments.

Connasauga shale.—This formation is composed at the base of thin limestones interbedded with shales, in the middle of yellow or greenish clay shales, and at the top of blue seamy limestone or calcareous shales. Some of the thin beds of limestone, especially those near the lower part of the formation, have a peculiar oolitic structure, being made up of rounded or flattened grains about a tenth of an inch in diameter. This oolitic limestone is sometimes absent. The boundary between the Rome and Connasauga then becomes very indefinite and their separation difficult. The same is true when the upper part of the Rome also contains beds of limestone, as is the case in the central part of this sheet. The thickness of the Connasauga shale probably varies between 1,500 and 2,500 feet, but, on account of the great contortions which the beds have suffered, the same uncertainty attaches to their measurement as in the case of the two older formations. The formation takes its name from the Connasauga valley, in Georgia, on the Dalton sheet.

The Cambrian rocks come to the surface in a narrow strip of nearly uniform width, which extends through the center of the sheet, forming Chattooga and Peavine valleys. Another similar strip occupies the eastern part of the Chattooga valley, terminating a few miles from the southern edge of the sheet. In these Cambrian areas west of Taylor ridge only the Connasauga is exposed, or if the upper portion of the Rome comes to the surface it is so calcareous as to be indistinguishable from the overlying formation.

East of Taylor ridge is a somewhat broader area of Cambrian rocks. It is bounded by a fault on its western side, and against this fault strips of the oldest rocks appear. These are followed by the later formations in successive parallel bands toward the east. On the extreme eastern edge of the sheet, in its southeastern corner, are Cambrian rocks, which are also bounded on the west by a fault with some peculiar features to be described later.

Of the Cambrian formations only the Rome sandstones make ridges, all the others giving rise to low, level valleys.

SILURIAN ROCKS.

Knox dolomite.—The lowest division of the Silurian, the Knox dolomite, consists of from 3,000 to 3,500 feet of massively bedded and somewhat crystalline magnesian limestone. This limestone, or more properly dolomite, contains a large amount of silica in the form of nodules and layers of chert or flint. Upon weathering, that part of the rock which consists of the carbonates of lime and magnesia is dissolved, leaving behind the chert, usually imbedded in red clay. This residual material covers the surface to great depths and the dolomite itself is seldom seen except in the channels of the larger streams. The Knox dolomite forms a broad area east of Lookout mountain extending southward to a narrow point in McLamore cove. It also forms a strip on either side of the Cambrian rocks of Chattooga and Peavine valleys. Its outcrops are marked by the characteristic rounded chert hills, which rise between 300 and 400 feet above the general level of the valley in Missionary ridge and Chickamauga hills. The formation also occurs in a number of less regular strips between Taylor ridge and Chattoogata mountain, in some of which the chert forms well marked ridges.

Chickamauga limestone.—This formation shows a decided change in character between its exposures on the western and the eastern sides of the sheet. In Lookout valley it is a hard, blue, flaggy limestone, about 1,000 feet thick, and highly fossiliferous. In the narrow strip along the eastern side of Lookout mountain, and in the broader area of West Chickamauga valley, from which the formation takes its name, it is mainly a blue limestone, but it contains some beds of mottled, purple and dove-colored limestone. In the belt along the western side of Chattoogata mountain, the formation shows a still further increase in thickness and in the proportion of earthy impurity which the limestone carries. It consists of about 1,800 feet of purple or dove-colored earthy limestone with some blue fossiliferous beds and others which weather to yellow shales.

Rockwood formation.—This upper division of the Silurian varies widely in character and thickness within the limits of the sheet. On the western edge of the sheet in Lookout valley and Johnson crook, it consists of about 600 feet of calcareous shales with some blue limestone interbedded. East of Lookout mountain it is somewhat thicker and contains no limestone, but some beds of rather sandy shales. In White Oak mountain it is from 1,100 to 1,300 feet thick, and consists largely of hard, reddish brown sandstones, with sandy shales above and below. On the eastern edge of the sheet, in the ridges of the Chattoogata range, the Rockwood formation reaches the thickness of about 1,500 feet. It is here capable of subdivision into three parts, and is so represented on the map. The lower portion consists of thin purple sandstones interbedded with yellow sandy shales. The middle portion of about 400 feet consists of heavy sandstone with a few interbedded shales. One bed of coarse sandstone and conglomerate, from 50 to 75 feet thick, forms the sharp crest of the ridges. The upper portion of the formation is composed of yellow shales and coarse porous sandstone which probably contained a considerable amount of calcareous matter.

The formation is named from Rockwood, Tennessee, on the Kingston atlas sheet. It is of great practical importance on account of the red fossil iron ore generally associated with it. The ore, however, is not always present, and on this sheet it is confined to the portions of the formation which are found west of Taylor ridge.

DEVONIAN ROCKS.

Chattanooga black shale.—Overlying the Rockwood formation, except in the extreme eastern part of the sheet, is a thin stratum of shale which appears to represent the whole of the deposition which took place in this region during the Devonian period. This formation, called the Chattanooga black shale, has a remarkably uniform character wherever seen within the limits of the sheet and for a long distance on either side, north and south. In the western part of the sheet it is about 35 feet thick, in Taylor ridge 11 feet, and it is wanting in the ridges of the Chattoogata range. Whether the shale was originally deposited over the whole of this region and then eroded before the succeeding formation was laid down, or was never deposited in the eastern portion, is a question not yet satisfactorily answered. The upper portion of the shale, three or four feet in thickness, is usually dark gray in color and often carries a layer of round concretions about an inch in diameter. The remainder of the formation is jet black from an abundance of carbonaceous matter, and when freshly broken it emits a strong odor like petroleum.

This shale, on account of its distinctive and striking appearance, has attracted much attention from miners, 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, since the shale contains nothing of present economic importance. Although it contains a large proportion of carbonaceous matter which burns when it is placed in a hot fire, the amount is not sufficient to constitute a fuel, and no true coal is ever found associated with the shale. Small concretions of iron pyrites, which it often carries, have given rise to the commonly accepted, but wholly erroneous, belief that the shale contains valuable ores. The formation is of economic importance only as a starting point in prospecting for the red fossil iron ore which occurs below it at a uniform depth, over considerable areas.

CARBONIFEROUS ROCKS.

Fort Payne chert.—This formation consists of from 75 to 200 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 calcareous shale. In the western part of the sheet the lime increases toward the top of the formation and gradually replacing the chert it passes without an abrupt transition into the Bangor limestone above. It is there about 200 feet thick. In Taylor ridge and eastward the lower part of the formation is composed of heavy beds of chert, while the upper part contains coarse cherty sandstones which become porous by the solution of the calcareous matter they originally contained. The chert of this formation is readily distinguished from that of the Knox dolomite by the great numbers of fossils which it contains. It is often made up of a mass of crinoid stems imbedded in a siliceous cement; on weathering, the cement remains a porous chert filled with the fossil impressions. In some cases the fossils alone are silicified so that they remain in the soil after the solution of the calcareous cement. The formation occurs in a narrow strip on each side of Lookout valley and along the eastern side of Lookout and Pigeon mountains, usually forming, with the Rockwood shale, a narrow ridge parallel to the mountain escarpments. In the eastern part of the sheet the formation covers somewhat larger areas, occupying the gentle eastward slopes of the high Rockwood ridges. The formation name is taken from Fort Payne, Alabama, on the Fort Payne sheet.

Floyd shale.—As before stated, the chert, on the western portion of the sheet, passes upward directly into the Bangor limestone, but east of Taylor ridge another formation, the Floyd shale, comes in between them. This consists of from 850 to 1,350 feet of variable sediments, for the most part carbonaceous shales, containing local beds of coarse white sandstone, and of fine grained, flaggy sandstone, and some of blue limestone with nodules of chert. The sandstones are mostly confined to the synclinal basin east of White Oak mountain, between Ringgold and Parker gaps. In Armuchee valley and in the regions east of John and Horn mountains the formation is made up of black carbonaceous shales, which approach limestones in character in the western part of the area. These calcareous portions are highly fossiliferous, though the black shales are generally quite barren of organic remains.

Bangor limestone.—The Bangor limestone is 750 feet thick in the western part of the sheet, where it forms the lower portion of the mountain slopes. East of Taylor ridge it is about 500 feet thick, and only two small areas have escaped erosion, though it doubtless formed a continuous sheet over the whole of this region, and may have extended some distance farther eastward. The limestone shows with unmistakable clearness the mode of its formation. It is often composed almost entirely of fragments of crinoids together with the calcareous coverings of other sea animals which died and left their remains on the sea bottom.

It is probable that the lower portion of the Bangor limestone on the western part of the sheet and the Floyd shale on the eastern part were deposited at the same time, the former in a comparatively deep sea and the latter near the shore where the supply of mud and sand was abundant. Although they may be of the same age, the rocks differ so widely in character that they are given distinct formation names. The name of the limestone is taken from Bangor, Alabama, and that of the shale from Floyd county, Georgia.

The presence of the Floyd shale on the eastern and its absence from the western portion of the sheet, together with the changes already noted in the lithologic character of the Rockwood and Chickamauga, indicate that during their deposition the land, from which the sediments were derived, was toward the southeast while the deep sea was toward the northwest.

Lookout sandstone.—At the close of the period occupied by the deposition of the Bangor limestone there was an uplift of the sea bottom, 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. 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 450 to 550 feet of conglomerate, thin bedded sandstone, sand and clay shales, and coal. Its upper limit is at the top of a heavy bed of conglomerate or coarse sandstone from 25 to 75 feet in thickness, which forms the principal cliff about the edge of Lookout and Pigeon mountains. The formation occurs in but three small areas east of Taylor ridge and apparently has a thickness of only about 200 feet, though the upper part may have been removed by erosion.

Walden sandstone.—The Walden sandstone includes all the rocks lying above the Lookout conglomerate. Its sandstones, shales and coal beds were deposited under conditions very similar to those which prevailed during the deposition of the preceding formation. The conditions, however, changed less frequently and were somewhat more favorable for the accumulation of coal. What the original thickness of the Walden sandstone may have been can not now be determined, but it is certain that much of the formation has been removed by erosion. It is confined to the western part of the sheet, and its greatest thickness of 930 feet is found in the deeper portions of the Lookout mountain syncline.

These two formations, the Lookout and Walden sandstones, constitute the productive coal measures. 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.

Definition of terms.—As the materials forming the rocks of this region were deposited upon the sea bottom, they must originally have been in nearly horizontal layers. At present, however, the beds are not usually horizontal, but are inclined at various angles with the surface. This is the result of compression in a northwest and southeast direction, by which they have been bent into a series of arches and troughs. In describing these folded strata the term *syncline* is applied to the downward bending troughs and *anticline* to the upward bending arches. A synclinal axis is a line which runs lengthwise of the synclinal trough, at every point occupying its lowest part, and toward which the rocks dip on either side. An anticlinal axis is a line which occupies at every point the highest portion of the anticlinal arch, and away from which the rocks dip on either side. These axes may be horizontal or inclined. Their departure from the horizontal is called the pitch of the axis and is usually but a few degrees. In addition to the folding, and as a result of the continued action of the same forces which produced it, the strata along certain lines have been fractured, and the rocks have been thrust in different directions on opposite sides of the fracture: this is termed a *fault.*

Structure sections.—The six sections on the structure sheet represent 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. These sections represent the structure, as it is inferred from the position of strata observed at the surface. On the scale of the map they cannot represent the minute details of structure; they are therefore somewhat generalized from the dips observed in a belt a few miles in width along the line of the section.

Anticlinal and synclinal folds.—It will be seen from the sections that the strata form a series of nearly parallel folds which trend about N. 15° E. In the western part of the sheet the folds are open and the beds generally dip at low angles, though in a few cases they approach the vertical. East of Taylor ridge they are often vertical or overturned, and in many places their normal relations are disturbed by faults. Thus, from the western to the eastern sides of the sheet, there is a progressive increase in the degree of disturbance which the rocks have suffered.

There is an intimate connection between the structure and the present topography. The surface has been fashioned by the streams which flow upon it, and the action of the streams has been controlled by the position of the hard and soft layers of rock. The valleys in general are upon anticlinal arches, and the mountains are formed by synclinal troughs. This result has been brought about by the more rapid erosion of the hard beds at the tops of the arches than in the bottoms of the troughs. The streams must originally have flowed in the synclines, but they have gradually transferred their channels to the axes of the anticlines and the original relation of high and low land has been reversed.

In Lookout valley the strata dip away from the middle at low angles, though somewhat more steeply toward the west than the east. The same is true in McLamore cove, and also in the broad valley extending through the center of the sheet where the difference in dip on opposite sides of the axis is much greater. A short distance west of Lookout valley the rocks become practically horizontal, forming the broad plateau of Sand mountain. The axis of the Lookout mountain syncline forks at the head of Johnson crook, the western limb passing off the sheet, and the eastern uniting toward the south with the axis of the Pigeon mountain syncline. The syncline whose western edge forms Taylor ridge is not a simple trough, like those to the west, but is broken up into isolated basins by a number of transverse anticlines. One of the latter is represented in section EE, separating the basin which forms West Armuchee valley from Dirt Town valley on the south. The ridges from John mountain to Rocky Face are formed by a number of overlapping synclines whose axes pitch rapidly toward the south. The valleys on the northwest of this series of ridges are deeply eroded anticlines, while those on the southeast are synclines, which carry the ridge-forming stratum below the general valley level.

Faults.—Excepting a small area on the north edge of the sheet, just east of Lookout mountain, the faults are confined to the region east of Taylor ridge. They are represented on the map by a heavy solid or broken line, and in the sections by a line whose inclination shows the probable dip of the fault plane, the arrows indicating the direction in which the strata have been moved on its opposite sides.

The eastern side of the Taylor ridge syncline, except for a short distance where it appears as Dick ridge, is sheared off by a fault which extends for many miles north and south beyond the limits of the sheet. This fault brings the oldest rocks of the region in contact at different places with all the overlying formations up to the Bangor limestone. Several faults of lesser importance occur north and east of Tunnel Hill, and one of even greater extent follows the eastern side of Chattoogata mountain and crosses the southeastern corner of the sheet. The latter is shown in section EE, and it has the peculiarity that the plane on which the older rocks were thrust over from the east was nearly horizontal and has been folded with the underlying strata.

MINERAL RESOURCES.

The mineral resources of the Ringgold sheet consist of *coal, iron ore, mineral paint, manganese ore, limestone, building stone, road stone, brick clay,* and *tile clay.*

Coal.—The productive coal-bearing formations are the Lookout and Walden sandstones, which have already been described. They occupy, on this sheet, the surface of Lookout and Pigeon mountains and a small portion of Sand mountain, a total area of 116 square miles.

The accompanying columnar sections show the position and thickness of the various coal beds. The sections are not generalized, but each represents the actual measurements made at a single locality. It will be seen that the beds vary considerably, in number, position and thickness, from one part of the field to another, though it is probable that in some of the sections by no means all of the beds are shown. The datum from which their position is measured up or down in the section is the top of the conglomerate. It is not always possible to determine this plane exactly, so that some uncertainty is thus introduced into the correlation of coal beds in different parts of the field.

The vertical distance from the top of the Bangor limestone to the top of the conglomerate—that is, the thickness of the Lookout sandstone—is from 450 to 550 feet. West of Lookout valley this division of the coal measures contains from three to five beds of coal, varying in thickness from a few inches to four feet. These beds are worked at Cole city and Castle rock, just west of the Ringgold sheet. They appear to thin out toward the east and only one is definitely located in Lookout mountain, though several thin beds probably exist below the conglomerate. This is shown in the section at the head of Johnson crook where its thickness, which may be only local, is five feet. On the western side of Lookout mountain, a few miles south, two beds, both of which have been worked, occur at about the same position as the one represented in the section.

In Sand mountain several beds of coal occur within less than 300 feet above the conglomerate, one of which is worked at the Ætna mines, ten miles west of Chattanooga. These beds are also represented in the southern portion of Lookout mountain, but, so far as known, they do not occur on the Ringgold sheet. At 540 and 615 feet above the conglomerate are beds of coal which are worked at the Durham mines on Lookout mountain. They very nearly correspond in position with the coal which is worked farther north in the Walden, at the Dayton and Rockwood mines. They lie in the center of the Lookout mountain syncline, and have been protected from erosion by the rim of heavy conglomerate which surrounds the basin. This rim has been cut through at McCallie gap and the higher rocks have been removed from the northern part of the basin by Rock creek and Long branch, so that only the southern portion contains coal.

In the broader portion of the syncline, where Pigeon and Lookout mountains unite, it is altogether probable that workable coal will be found either in the beds worked in the northern basin or in those nearer the conglomerate which are mined farther south at Fort Payne and Gadsden.

Iron ore.—Two varieties of iron ore, which differ widely in appearance and in their mode of occurrence, are found on the Ringgold sheet. They are the hematite, or red fossil ore, and the limonite, or brown ore. The former is limited to the western and the latter to the eastern part of the sheet.

Hematite.—The red fossil ore is associated with rocks of the Rockwood formation and is very similar to the ore occurring at the same horizon in such widely separated localities as Wisconsin, New York, and Alabama. It is a regularly stratified bed, retaining a constant thickness and definite relation to other strata of the formation over considerable areas. Like other rock strata, however, it is not absolutely constant, so that, while the map indicates closely the areas within which the ore may occur, careful examination is required at any particular locality to determine whether its quantity and quality are such as to make it commercially valuable.

The proportion of iron in the ore usually decreases with the distance below the surface, and at considerable depths it becomes simply a more or less ferruginous limestone. The decrease downward in the proportion of iron is due to the fact that near the surface the lime has been largely removed by percolating surface waters, leaving behind the insoluble iron oxide as the soft ore. The presence of lime in the ore is not objectionable, except as it renders mining more difficult, for it removes the necessity of adding limestone as a flux in the furnace. The soft ore is very easy to mine, and considerable quantities are frequently obtained by trenching along the outcrop even when the bed is not of sufficient thickness to make deep mining profitable at present.

The upper part of the Rockwood formation, which carries the ore, occurs in a narrow strip on either side of Lookout valley, the strata dipping gently away from the middle of the valley. In Johnson crook the strata dip at a very low angle toward the north and east, and over a considerable area the ore bed is so near the surface that it is extensively mined by removing the few feet of overlying rock. A narrow strip of Rockwood shale follows the eastern base of Lookout mountain around the head of McLamore cove and the point of Pigeon mountain. A workable bed of ore occurs throughout nearly the whole of this strip, though at some points it is broken up into a number of thin beds by shale partings, so that it cannot be mined economically. It is worked at various points where proximity to the Chattanooga Southern railroad affords easy transportation.

The Rockwood formation in the eastern part of the sheet consists largely of hard brown sandstones and sandy shales, and the conditions which prevailed during their deposition were apparently not favorable to the formation of iron ore. On the same belt some miles toward the north there is a heavy bed of ore in the upper part of the formation, which decreases in thickness toward the south. In White Oak mountain it probably does not occur in workable quantities south of the Tennessee-Georgia line.

Mineral paint.—A subordinate though locally important use of the red hematite is as mineral paint. Only the purer grades of soft ore, from which the lime has been thoroughly leached, are employed for this purpose. Considerable quantities are mined in Lookout valley and ground on the spot. Mills in Chattanooga are also supplied from the same locality.

Limonite.—The limonite ore does not occur in this region as a regularly stratified bed, but in irregular surface deposits. Hence the limits within which it may occur cannot be indicated with the same certainty as in the case of red ore. These deposits, however, are found to be associated with certain groups of strata, so that in a general way their position may be indicated. Although iron oxide is very widely distributed throughout the rocks and soil, it is only when it becomes segregated in large quantities and in a comparatively pure condition that it is commercially valuable as an ore. The agency by which the segregation is effected is the percolating surface water, which contains small quantities of weak acids derived from the atmosphere and decaying vegetation. These acids dissolve the iron disseminated through the rocks. When the solution is exposed to air either at the surface or in cavities under ground, the iron becomes insoluble and is precipitated as the slimy yellowish substance generally seen about mineral springs. This substance gradually hardens and, where it collects in sufficient quantity, forms a bed of limonite iron ore.

In the southeastern portion of the sheet, conditions were favorable for this accumulation at certain points in the Carboniferous rocks, generally near the contact between the Fort Payne chert and the Floyd shale. Three areas are indicated on the map in which extensive deposits of limonite are known to occur, but these probably do not include all such deposits. The area west of Sugar valley has been extensively worked and the ore deposits have been generally exhausted. Three small areas in the vicinity of Tunnel Hill are indicated as containing deposits of limonite, but in these the iron ore is subordinate in importance to the manganese ore.

Manganese ore.—Oxide of manganese is accumulated under the same conditions and by the same agency as is oxide of iron, but it is much less widely distributed than the latter. The deposits at Tunnel Hill are along a fault line at the contact of Knox dolomite with Cambrian shales. The faulting seems in some way to have assisted in the accumulation of the ore, probably by affording an easy passage to the percolating waters, which held the iron and manganese in solution after it was leached out of the surrounding rocks. The ore is found in nodules and irregular masses associated with chert and red clay which result from the decomposition of the Knox dolomite, and which are always specially abundant in the vicinity of faults. The ore has been mined somewhat extensively at Tunnel Hill.

Limestone.—The supply of limestone on the Ringgold sheet, suitable for blast-furnace flux and for lime, is abundant and convenient of access. The Bangor limestone is used at the Rising Fawn furnace in Johnson crook, on account of its freedom from earthy impurities and its close proximity to the furnace. It contains variable amounts of magnesium carbonate, sometimes as much as 35 per cent.

The Knox dolomite is quarried extensively at Graysville, near the Tennessee line, and burned for lime. The silica which this formation contains in large amount is generally segregated in layers of chert; these are easily removed in quarrying, and the layers of limestone produce an exceptionally high grade of lime.

It is probable that some of the earthy Chickamauga limestones may be suitable for the manufacture of hydraulic cement, but no analyses are available on which to base definite statements as to their value.

Building stone.—Stone adapted to architectural uses occurs in nearly every formation within the area, but none is quarried except in a small way for local use. A few miles north of the Tennessee line, on the Chattanooga sheet, are quarries of dove-colored earthy limestone at the base of the Chickamauga, and beds of the same character are widely distributed over the central and eastern part of the Ringgold sheet. The red and purple earthy limestones and sandstones in the valley west of Rocky Face would seem particularly adapted for the trimmings employed in brick buildings. Sandstones suitable for foundations occur in White Oak mountain and the ridges to the east, and also in Lookout and Pigeon mountains. These have as yet been quarried only for local use.

Road material.—The hard blue Bangor and Chickamauga limestones afford an abundant supply of macadam, and the residual chert of the Knox dolomite and of the Fort Payne formation is an ideal surfacing material. These formations are so widely distributed over the sheet that but little transportation would be required to build excellent roads, but unfortunately, except in the vicinity of Chattanooga, the abundant road material is as yet wholly unutilized.

Clays.—The residual deposits resulting from the weathering of the Bangor and Chickamauga limestones are red or blue clays, which are generally well adapted for making brick. They are also suitable for the manufacture of drain tile, and considerable quantities have been obtained for that purpose from Blowing Springs, near the southern edge of the sheet, and from a point about four miles south of Lafayette, where the clay is obtained from calcareous Cambrian shales. Some of the highly siliceous clays resulting from the decomposition of the Knox dolomite are probably well adapted for the manufacture of refractory fire brick, and the beds of fire clay which are usually associated with the coal may contain materials suited to the same purpose, but they are as yet wholly undeveloped.

SOILS.

Derivation and distribution.—Throughout the region covered by the Ringgold atlas sheet there is a very close relation between the character of the soils and that of the underlying geological formations. Except in limited areas along the larger streams and on the steepest slopes of the mountains, the soils are derived directly from the decay and disintegration of the rocks on which they lie. All sedimentary rocks such as occur in this region are changed to soil by surface water. This process goes on more or less rapidly, according to the character of the cement which holds the particles together. Siliceous cement is nearly insoluble and rocks in which it is present, such as quartzite and some sandstones, are extremely durable. They produce but a scanty soil. Calcareous cement, on the other hand, is readily dissolved by water containing carbonic acid, and the clayey or sandy particles which it held together crumble down, forming an abundant soil. If the calcareous cement makes up but a small part of the stone it is often leached below the surface; the rock then becomes soft and porous while retaining its form; 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. The soil is generally quite thin where the limestone 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 clayey shale or limestone the soil is clay. As there are abrupt changes from bed to bed of sandstone, shale and limestone, 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. And as the attitude of the stratum determines the breadth of outcrop of each formation in any place, it also determines the area of the corresponding soil. Where a stratum is nearly horizontal, as the the Chickamauga limestone of West Chickamauga valley, the corresponding soil covers a broad area, but where one outcrops in a nearly vertical position, as the same formation does just east of Pigeon mountain, the resulting soil occupies only a narrow strip.

If the character of the soils derived from the various geological formations be 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 upon the steep slopes where soils derived from rocks higher up the slope have washed down and mingled with or covered the soils derived from those below. These 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, some parts of the Floyd shale, the Rockwood formation east of Chattooga river, and the Rome sandstone. (2) Clay soils; derived from the Bangor and Chickamauga limestones, the Rockwood formation west of Chattooga valley, the upper part of the Floyd, and the Connasauga and Apison shales. (3) Cherty soils; derived from the Fort Payne chert and the Knox dolomite. (4) Alluvial soils; deposited by the larger streams upon their flood plains.

Sandy soils.—Lookout and Pigeon plateaus are formed by sandstones and sandy shales, and their 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 more often it contains sufficient clay to make the subsoil so coherent that a cut bank will remain vertical for some years. The depth of soil on the plateau varies from a few inches to a dozen or more feet, depending chiefly on the proximity to streams and the consequent activity of erosion. A large part of the plateau retains its original forest growth, generally 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. The Rockwood formation east of Chattooga river is made up of sandstones and sandy shales, and the extensive areas of its outcrops have sandy soils. They are agriculturally less important than the plateaus, since the strata are steeply inclined so that they produce ridges, and some beds of hard sandstone break up into blocks, which cover most of the surface. Some calcareous sandstones near the top of the formation produce the small areas of deep fertile soil which are found on most of the high ridges in the eastern portion of the sheet. Two strips of the Rome sandstone east of Taylor ridge yield sandy soil, and the surface is so rocky as to be scarcely tillable.

Since the sandstones of this region occupy the highest land, the overplaced soils, or those washed down to lower levels, are mostly sandy. These sandy soils are especially abundant at the foot of the escarpment surrounding the plateau, where the Bangor limestone and its clay soil are often wholly concealed.

Clay soils.—The valleys of this region are due to the presence of narrow belts of soluble limestone or easily eroded shale, and they are therefore always occupied by clay soils, except immediately along the larger streams. The most productive of these soils are derived from the Bangor and Chickamauga limestones, and their distribution coincides with the outcrops of those formations as shown on the geologic map. They have generally a deep red color, but where the mantle of residual material covering the rock is thin it is often dark bluish gray. This is its character in West Chickamauga valley where the largest area of the limestone occurs. The rocks generally weather more rapidly where they have a steep dip than where they are nearly horizontal. Hence the soil is deeper and more highly colored on the narrow belt of limestone east of Pigeon mountain than on the broader belt of the same rocks in Chickamauga valley. The clay soils derived from the Cambrian shales are somewhat less productive. The Connasauga shales and those in the upper part of the Rome formation make stiff bluish gray soils which are usually thinner than those covering the limestones, the shaly structure of the rock often appearing a few inches below the surface.

All of these clay soils are well fitted to retain fertilizers, and hence with proper treatment may be brought to a high state of productiveness.

Cherty soils.—Nearly half the area west of the plateau is underlain by the Knox dolomite. The soil derived from this formation consists of clay in which the chert is imbedded. The proportion of chert to clay is variable; in some places only occasional fragments occur, while in others the residual material is made up almost wholly of chert. Where the clay predominates the soil is deep red, but it becomes lighter with the increase in amount of chert, and in extreme cases is light gray or white. Even where the proportion of chert is very large this is a strong productive soil, especially adapted to fruit raising. The soil derived from the Fort Payne chert is similar to that from the Knox dolomite, but the areas of the Fort Payne are much smaller and usually occur on steep slopes, so that its soil is relatively unimportant.

Alluvial soils.—These are confined to small areas along the Chickamauga, Chattooga, and Oostanaula rivers. Although these streams flow in broad valleys they are rapidly cutting narrow channels below the general level of these valleys, and their flood plains, the bottom lands, are nowhere extensive. Most of the streams flow between high banks above which they rarely rise. Along the Oostanaula the soil is a rich sandy loam containing a considerable proportion of fine scales of mica derived from crystalline rocks which lie far to the east.

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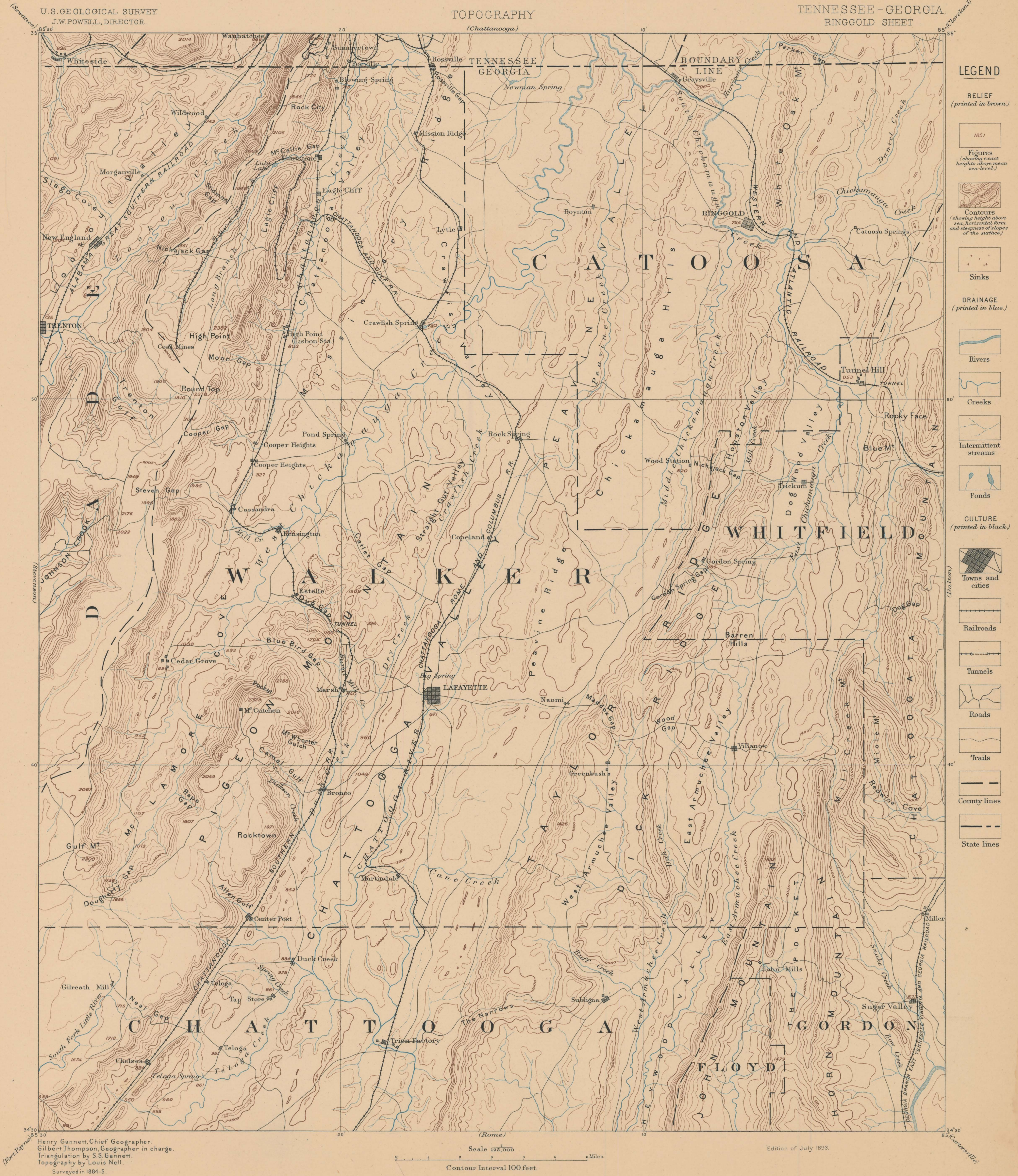
U.S. GEOLOGICAL SURVEY.
J.W. POWELL, DIRECTOR.

TOPOGRAPHY

TENNESSEE – GEORGIA
RINGGOLD SHEET



Henry Gannett, Chief Geographer.
Gilbert Thompson, Geographer in charge.
Triangulation by S.S. Gannett.
Topography by Louis Nell.
Surveyed in 1884-5.

Scale $\frac{1}{125,000}$

0 1 2 3 4 5 6 Miles

Contour Interval 100 feet

Edition of July 1893.

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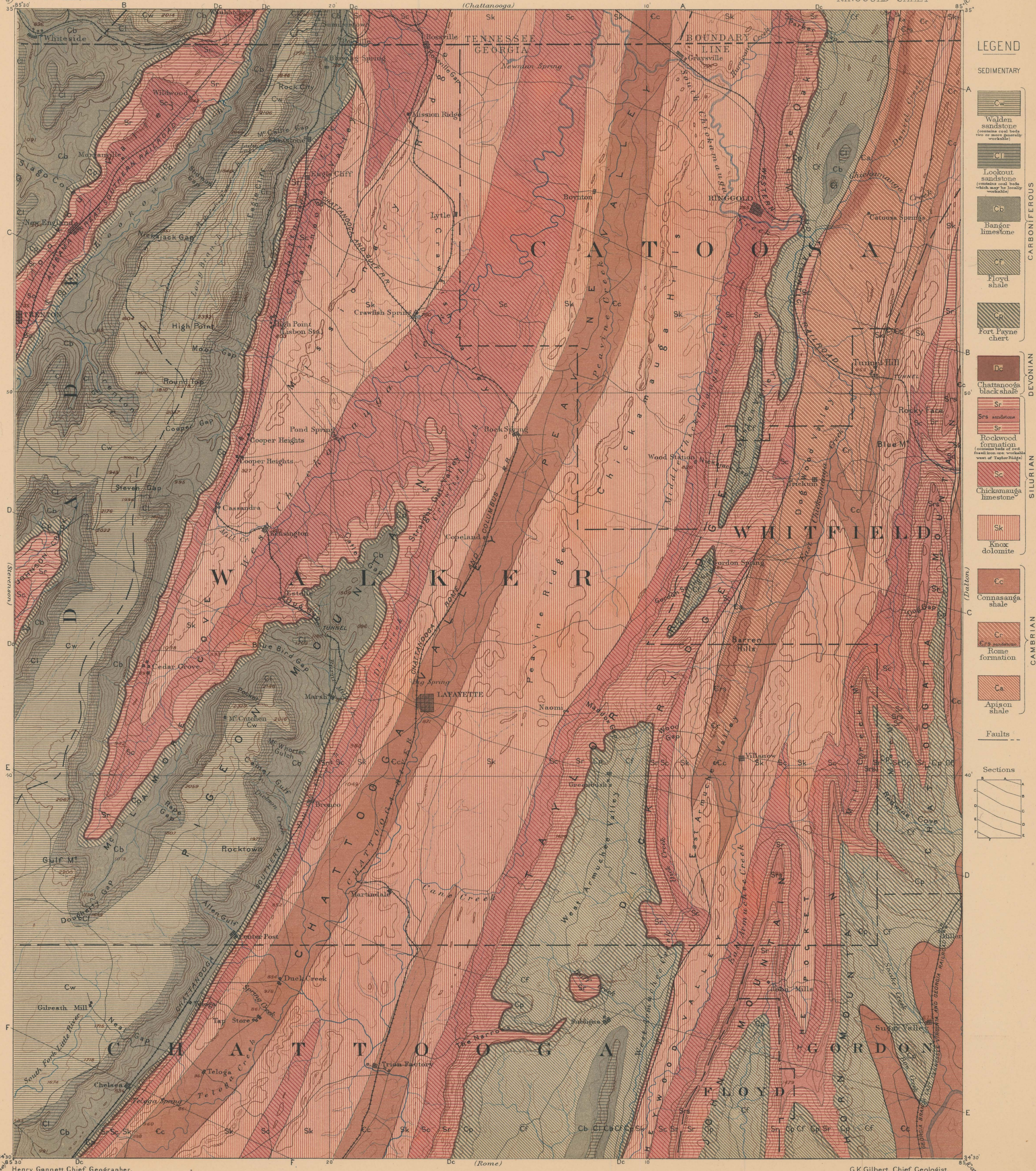
AREAL GEOLOGY

TENNESSEE-GEORGIA
RINGGOLD SHEET



Henry Gannett, Chief Geographer.
Gilbert Thompson, Geographer in charge.
Triangulation by S.S. Gannett.
Topography by Louis Nell.
Surveyed in 1884-5.

Scale $\frac{1}{125,000}$

Contour Interval 100 feet
Edition of July 1893.

G.K. Gilbert, Chief Geologist.
Bailey Willis, Geologist in Charge.
Geology by C. Willard Hayes.
Surveyed in 1888-9.

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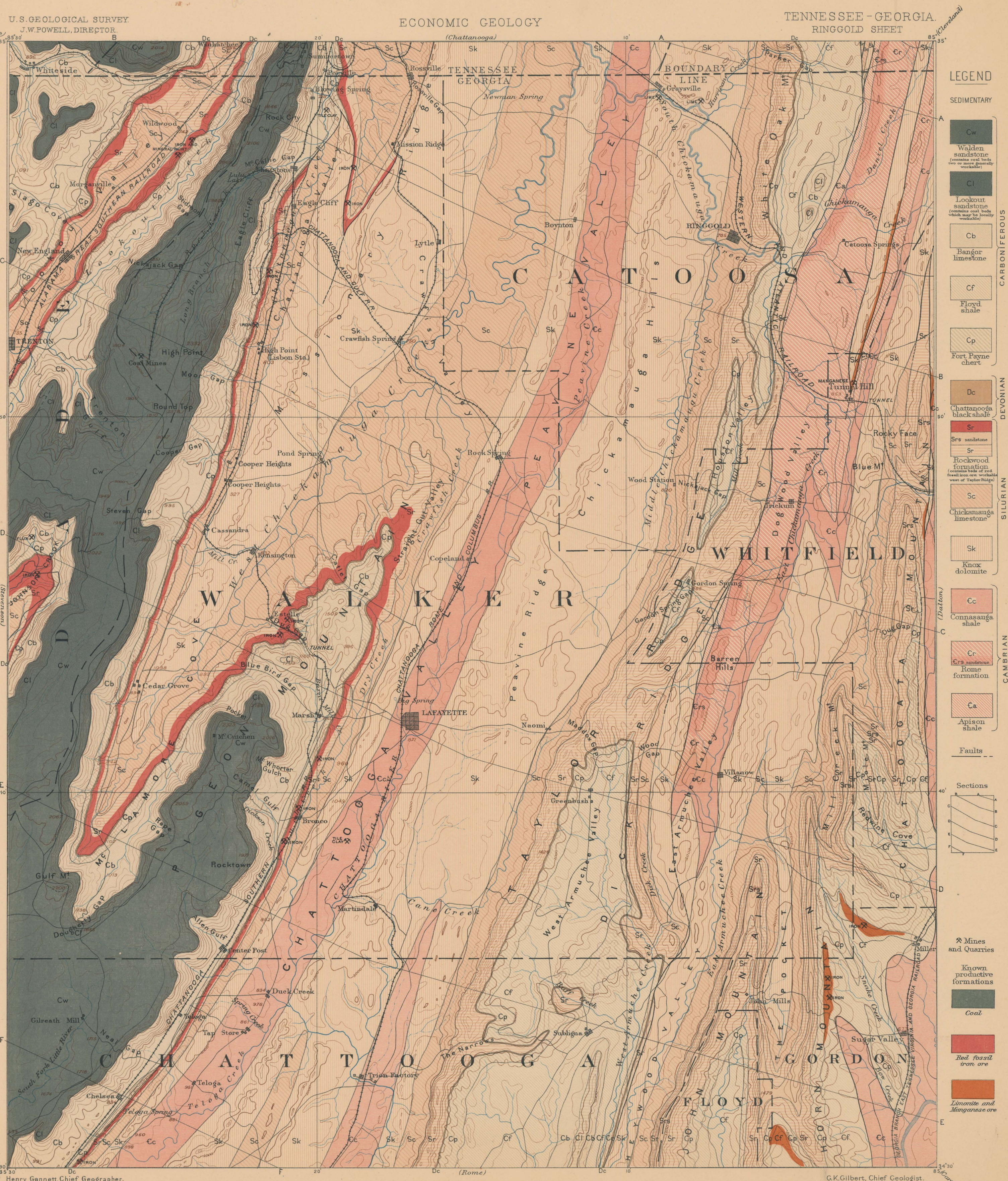
ECONOMIC GEOLOGY

TENNESSEE - GEORGIA.
RINGGOLD SHEET



Henry Gannett, Chief Geographer.
Gilbert Thompson, Geographer in charge.
Triangulation by S.S. Gannett.
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COLUMNAR SECTIONS

TENNESSEE - GEORGIA.
RINGGOLD SHEET

GENERALIZED SECTION WEST OF CHATTOOGA VALLEY.

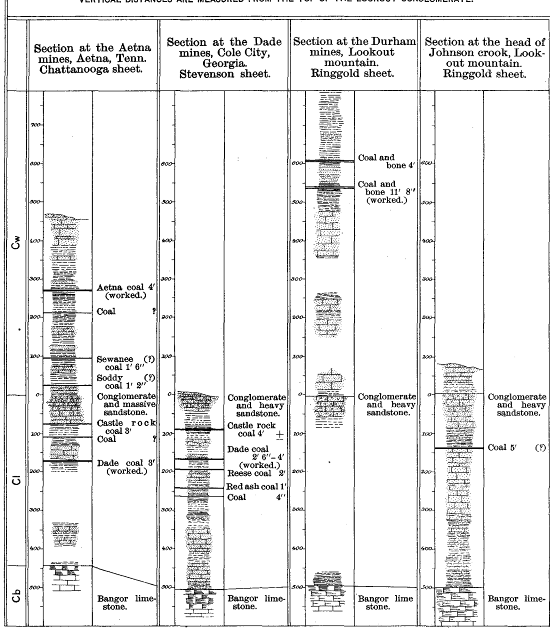
SCALE 1000 FEET = 1 INCH.

Period.	Formation Names.	Formation Symbols.	Columnar Section.	Thickness in Feet.	Character of Rocks.	Character of Topography and Soils.
CARBONIFEROUS	Walden sandstone.	Cw		930	Coarse sandstone and sandy shale with beds of coal and fire clay.	Flat topped, plateau-like mountains. Gray, yellow or red sandy loam.
CARBONIFEROUS	Lookout sandstone.	Cl		450— —550	Conglomerate. Sandstone and sandy shale with beds of coal.	Cliffs; abrupt plateau escarpments. Scanty soil, rocky and sandy.
CARBONIFEROUS	Bangor limestone.	Cb		700— —750	Shaly limestone. Massive, blue, crinoidal limestone. Shaly limestone.	Steep mountain slopes and valleys. Black clay soil with more or less sand from rocks above. Narrow valleys. Red clay soil with sand and chert from adjacent slopes.
CARBONIFEROUS	Fort Payne chert.	Cp		175—200	Heavy bedded chert.	Sharp, narrow ridges parallel to plateau escarpments. Sandy clay soil with abundant fragments of chert.
DEV.	Chattanooga black shale.	Dc		25—35	Carbonaceous shale.	
SILURIAN	Rockwood formation.	Sr		600— —800	Calcareous and sandy shale with beds of fossil iron ore.	
SILURIAN	Chickamauga limestone.	Sc		1000— —1300	Blue flaggy limestone.	Level valleys; shallow residual deposits of red or blue clay. Scanty blue clay soil where the limestones are nearly horizontal, and deeper red clay where they are steeply inclined.
SILURIAN	Knox dolomite.	Sk		3000— —3500	Magnesian limestone; white, gray, or light blue; generally granular and massively bedded; containing nodules and layers of chert.	Low ridges and irregular rounded hills; deep residual deposits of red clay and chert. Red clay soil with a few fragments of chert grading into white or gray soil, composed almost entirely of chert.
CAMBRIAN	Connasauga shale.	Ꞓc		1500— —2500	Blue seamy limestone. Greenish clay shale. Thin beds of oolitic limestone.	Level or rolling valleys. Stiff yellow or bluish gray clay soil.

VERTICAL SECTIONS SHOWING THE POSITION AND THICKNESS OF COAL BEDS.

SCALE 250 FEET = 1 INCH.

VERTICAL DISTANCES ARE MEASURED FROM THE TOP OF THE LOOKOUT CONGLOMERATE.



GENERALIZED SECTION EAST OF CHATTOOGA VALLEY.

SCALE 1000 FEET = 1 INCH.

Period.	Formation Names.	Formation Symbols.	Columnar Section.	Thickness in Feet.	Character of Rocks.	Character of Topography and Soils.
CARBONIFEROUS	Lookout sandstone.	Cl		200	Conglomerate, sandstone and sandy shale.	Level topped mesas. Gray, yellow or red sandy loam.
CARBONIFEROUS	Bangor limestone.	Cb		500	Massive, blue, crinoidal limestone.	Steep mesa slopes. Red clay soil with more or less sand from rocks above.
CARBONIFEROUS	Floyd shale.	Cf		850— —1350	Carbonaceous shale with beds of blue crinoidal limestone and shaly sandstone. Coarse sandstone. Sandy shale.	Valleys with low rounded hills. Sandy clay soil. Steep ridges and hills. Rocky, sandy soil.
CARBONIFEROUS	Fort Payne chert.	Cp		75—150	Calc. sandstone & chert beds.	Knobs parallel with Rockwood ridges; sandy soil with fragments of chert.
DEV.	Chattanooga black shale.	Dc		0—11	Carbonaceous shale.	
SILURIAN	[Rockwood sandstone.] Rockwood formation.	Sr [Srs] Sr		1100— —1600	Greenish sandy shales and coarse porous sandstone. White or brown sandstone or conglomerate. Red and yellow sandstone and sandy shale.	Small areas of deep red sandy loam. Prominent ridges with uniform elevation and slope. Rocky, sandy soil.
SILURIAN	Chickamauga limestone.	Sc		1100— —1800	Earthy limestones; mottled, purple and gray. Blue flaggy limestone.	Level valleys; shallow residual deposits of red or blue clay. Scanty blue clay soil where the limestone beds have low dips, and deeper red clay where they are steeply inclined.
SILURIAN	Knox dolomite.	Sk		3000— —3500	Magnesian limestone; white, gray or light blue; generally granular and massively bedded; containing nodules and layers of chert.	Low ridges and irregular rounded hills; deep residual deposits of red clay and chert. Red clay soil with a few fragments of chert, grading into white or gray soil, composed almost entirely of chert.
CAMBRIAN	Connasauga shale.	Ꞓc		1500— —2500	Blue seamy limestone interbedded with clay shales. Olive green or brown clay shales. Thin beds of blue limestone, generally oolitic, interbedded with clay shales.	Level or rolling valleys. Stiff yellow or bluish gray clay soil.
CAMBRIAN	Rome formation. [Rome sandstone.]	Ꞓr [Ꞓrs]		3000— —4000	Greenish or brown shales with thin siliceous layers. Purple, brown and white sandstones interbedded with sandy shales.	Valleys with low ridges. Thin sandy clay soil. Comby ridges. Rocky, sandy soil.
CAMBRIAN	Apison shale.	Ꞓa		1000+	Sandy or clay shales in brightly colored alternating bands.	Narrow, rolling valleys. Stiff clay soil.

NAMES OF FORMATIONS.

	Names and symbols used in this sheet.		Smith: Geology of the valley region adjacent to the Cahaba coal field, Alabama, 1890.	Smith: Outline of the Geology of Alabama, 1878.	Safford: Geology of Tennessee, 1869.
Carboniferous	Cw Cl	Walden sandstone. Lookout sandstone.	Coal measures.	Upper coal measures. Lower coal measures. Millstone grit; conglom.	Coal measures.
Carboniferous	Cb Cf Cp	Bangor limestone. Floyd shale. Fort Payne chert.	Bangor limestone. Oxmoor shale. Fort Payne chert.	Upper sub-carboniferous or mountain limestone. Lower sub-carbonifer's.	Mountain limestone. Siliceous group.
Dev.	Dc	Chattanooga black shale.	Black shale.	Genesee or Black shale.	Black shale.
Silurian	Sr	Rockwood formation.	Red mountain or Clinton.	Clinton or Dyestone.	Dyestone group: White-oak mountain sandst.
Silurian	Sc Sk	Chickamauga limestone. Knox dolomite.	Trenton or Pelham limestone. Knox dolomite.	Trenton, Chazy or Maclurea. Quebec or Knox dolom.	Trenton, Lebanon or Maclurea limestone. Knox dolomite.
Camb.	Ꞓc Ꞓr Ꞓrs Ꞓa	Connasauga shale. Rome formation. Rome sandstone. Apison shale.	Choccolocco or Montevallo shales.	Knox shales. Calciferous or Knox s. s.	Knox shale. Knox sandstone.

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