DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
J.W. POWELL DIRECTOR

GEOLOGIC ATLAS
OF THE
UNITED STATES

RINGGOLD FOLIO
GEORGIA-TENNESSEE

INDEX MAP

LIST OF SHEETS

DESCRIPTION
TOPOGRAPHY
AREAL GEOLOGY
ECONOMIC GEOLOGY
COLUMNAR SECTIONS
STRUCTURE SECTIONS

LIBRARY EDITION
WASHINGTON, D.C.

ENGRAVED AND PRINTED BY THE U.S. GEOLOGICAL SURVEY
BAILEY J. HINSON, EDITOR OF GEOLOGIC MAPS

1884
The Geologic Survey is making a large topographic map and a large geological map of the United States, which are being used together in the form of a Geologic Atlas. The parts of the atlas are called sections. Each section contains a topographic map and a geological 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 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 advisable to show also the elevation of any part of a hill, ridge, slope or valley, to delineate the horizontal outline or contour of all such areas, and to indicate the 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 shown by a series of dots spaced along the same vertical line, the constant vertical space between each two contours is called the contour interval. Contours are printed black.

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:

[Sketch of a cross-section of a hill with labeled contours]

The sketch represents a valley between two hills. In the foreground is the level of the land, partly covered by a clodded sand-bar. On either side of the valley is a terrace; from that on the right a hill rises gradually with rounded form, whereas from that on the left the ground ascends steeply to a precipice which presents sharp corners. The western slope of the higher hill continues 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 clear the manner in which the contours delineate height, form and slope:

1. A contour indicates approximately a height, above sea level. In this illustration the contour interval is 10 feet; therefore the contours occur at 10, 20, 30, 40, 50 feet, and so on, above sea level. Along the contour at 250 feet are 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 110 feet falls just below the edge of the 120-foot line, whereas the sum of the higher hill is stated to be 670 feet above sea; accordingly the contour at 650 feet surrounds it. In this illustration the numbers 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, and recede into all concavities of ravines and define all prominence.

3. The relations of contour characters to forms of the landscape can be traced in the map and sketch.

*Drainage.*—The water courses are indicated by dark, heavy lines drawn wherever the stream flows the year round, and dotted where the channel is dry a part of the year. Where the lines are continuous the area above the stream, or up land, is a single surface. Where the lines are interrupted by elevations, the surface below underground course is shown by broken blue lines. Marshes and canals are also shown in blue.

**Cultures.**—In the progress of the settlement of any region many natural artificial features, 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, cultures change and gradually come 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.

*Stations.*—The area of the United States (without Alaska) is about 3,920,000 square miles. On a map 240 feet long and 190 feet high the area of the United States would cover 6,000,000 square inches. Each square mile of ground surface would be represented by a corresponding square inch of map surface, if the ground surface were represented by a linear inch on 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 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 is 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 1/63,360.

Three different scales are used on the atlas sheets of the U. S. Geological Survey; the smallest is the scale second to the largest. These correspond approximately to 1/63,360 and 1/2,000,000, or one mile of natural length to one inch of map length. On the scale 1/1,000,000 one square inch of map surface represents and corresponds nearly to one square mile; on the scale of 1/63,360 to about four square miles; and on the scale of 1/2,000,000 to about 40 square miles. At the bottom of each sheet is printed a fraction, as a fraction, and it is further indicated by a "bar scale," a line divided into parts representing miles and yards 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 made up of sheets of convenient size which are bounded by parallels and meridians. Each sheet on the scale of 1/2,000,000 contains one square degree (that is, represents an area one degree in extent in each direction); each sheet on the scale of 1/63,360 contains one-sixteenth of a square degree. These areas correspond nearly to 400, 1800 and 2500 square miles.

The atlas sheets, being only parts of one map of the United States, are laid out without regard to time and space. Strata generally found in the United States contain a large number of fossils, which are found 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: Sedimentary Rocks, Igneous Rocks, Metamorphic Rocks, and Faults. The different kinds found within the area represented by a map are shown by devices printed in color.

Rocks are evenly distributed according to their relative ages, for rocks were formed not all at once, but from age to age in the earth's history. The material composition of the rocks changes very slowly, whereas the character of their deposits 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 sometimes occur under shale; where a flow of lava cooled and was overlaid 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 bordered above and below by different rocks. It is convenient in geology to call such a mass a formation.

*Superglacial rocks.*—These are composed chiefly of clay, sand and gravel, disposed in heaps and irregular blocks, 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 moves from 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 pebbles and hogs and 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, cover a large portion of the glacial deposits. Glacial deposits are those collected by glacial action, including all material that was carried in the ice. The deposits are usually denoted by the name "glacial deposits."

In the distribution of the superficial rocks, the map is shown by colors printed in patterns of dots and circles. 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 distinct types of rocks are used; a pale brown (the underprint) is printed evenly over the whole surface representing the period; a dark tint (the overprint) is used on the patterns representing the period.

Areas of sedimentary rocks are shown on the map by colors printed in patterns of parallel strips. 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 color, 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: Tertiary
- Symbol: Yellow
- Color: Brown
- Pattern: Dots

- Period: Cretaceous
- Symbol: Blue
- Color: Gray
- Pattern: Circles

- Period: Pennsylvanian
- Symbol: Pink
- Color: Red
- Pattern: Squares

- Period: Cambrian
- Symbol: Black
- Color: Green
- Pattern: Lines

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 distinctive periods are used; a pale brown (the underprint) is printed evenly over the entire surface representing the period; a dark tint (the overprint) is used on the patterns representing the period. Formation is further distinguished by 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.

The geologic structures are shown in the map by colors printed in patterns of dots and circles. Sometimes they have cooled from a molten condition. Deep beneath the surface, rocks are often so hot that superheated water, which they contain, forms dikes and sheets. Sometimes they cool, forming dikes and sheets.
GEOGRAPHY.

General relations.—The ringgold atlas sheet is bordered by the parallels of latitude 34° 30′ and 35°, and the meridians of longitude 85° 30′ and 86°. It embraces, therefore, the entire width of the ridge of the south side of the Chattooga range. It is shaped like a figure of eight, and is so represented on the map. The ridge of the Chattooga range, the Rockwood formation reaches the thickness of about 3,000 feet. It can be seen in three parts, and is represented on the map. The lower part consists of thin yellow sandstones, the middle portion of about 400 feet consists of yellow sandstones with some interbedded beds, and the upper portion consists of about 230 feet of yellow sandstones with a middle portion of 3,000 feet thick, and is represented on the map.

The map is a sheet of yellow sandstone with a middle portion of about 230 feet of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

DESCRIPTIVE TEXT.

The ridge of the Chattooga range, the Rockwood formation is composed of yellow sandstone, yellow sandstone, and yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map. The map is a sheet of yellow sandstone with a middle portion of about 230 feet of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

ROCKWOOD FORMATION.

This formation is composed of heavy beds of shale, while the upper portion consists of about 400 feet thick of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

The Rockwood formation is composed of heavy beds of shale, while the upper portion consists of about 400 feet thick of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

The map is a sheet of yellow sandstone with a middle portion of about 230 feet of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

The Rockwood formation is composed of heavy beds of shale, while the upper portion consists of about 400 feet thick of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.

The Rockwood formation is composed of heavy beds of shale, while the upper portion consists of about 400 feet thick of yellow sandstone with a middle portion of 3,000 feet thick, and is represented on the map.
is readily distinguished from that of the Knob dolomite by the great numbers of fossils which it contains. It is often made up of a mass of crinoid stems imbedded in a siltstone matrix. By weathering, the cement remains a porous chert filled with the fossil impressions. In some cases the fossils alone are silicified. The few fossils which are not silicified will not fill 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 escarpment. The upper part of the section the formation covers somewhat larger areas occupying the gentle eastward slopes of the high Rockwood Ridge. A small area of the same formation 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 Banger limestone, but east of Taylor ridge another formation, the Floyd shale, comes in between them. This consists of from 800 to 1,200 feet of variable sediments, for the most part carbonaceous shales, containing bed of coarse white sandstone, and of fine grained, flabby sandstone, and some of lime stone with nodules of chert. The sandstones are almost confined to the synclinal basin east of White oak, Petit Jean, and Ringgold and Parker gaps. In Ammonite valley and the region of John and Born mountains, the formation is much more extensive. It is a thin bed of dark carbonaceous shales, which approach limestones in character in the western part of the sheet. These carbonaceous portions are highly fossiliferous, they are black shales are generally quite barren of organic remains.

Banger limestone—The Banger limestone is 75 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 300 feet thick, and on the eastern side of Lookout Mountain, only two small areas have escaped erosion, through which it doubtless formed a continuous sheet over the whole eastern side of Lookout Mountain, extending to the distance farther eastward. The limestone shows with unmistakable clearness the mode of its formation. It is a mixture composed almost entirely of fragments of crinoids together with the carbonaceous coverings of other sea animals which died and left their remains on the sea bottom.

It is probable that the thinner portion of the Banger 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 greater. Although they may be of the same age, the rocks differ widely in character that they are given distinct names. The Banger limestone is taken from Banger, Alabama, and that of the shale from Floyd county, Georgia.

The presence of the eastern and its absence from the western portion of the sheet, together with the changes already noted in the palæoecologic characteristics of the Rockwood and Chickamagua, 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 Banger limestones, 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 beds of sandstone, siltstone, clay shale, and coal. Its upper limit is at the top of a heavy bed of conglomerate or coarse sandstone from 10 to 21 feet thick, which forms the principal cliff about the edge of Lookout and Pigeon mountains. The formation occurs in but three small areas of the 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 conglomerates. 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, have changed less frequently, and the formations are much more favorably for the accumulation of coal. While the original thickness of the Walden sandstone may have reached 100 feet, it is certain that much of the formation has been removed by erosion. It is confined to the western part of the mountain, and its greatest thickness of 800 feet is found in the narrow belt bounding the eastern 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 perpendicular to the east, so that the constructive process of deposition was stopped and the destructive process of erosion began 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 thrown into many irregular horizons of various angles with the surface. This is the result of compression in a northwest and southeast direction. In the region of White oak, Petit Jean, and Ringgold the compression is usually much less. In addition to the folding, and as a result of the continued action of erosion, it is often cut by horizontal layers, and the structure is in a state of normal convexity, where the strata are horizontal, and in a state of horizontal concavity, where the strata dip to one side. 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.

In Lookout valley the strata dip away from the middle of the valley, both somewhat more steeply toward the west than the east. The same is true in McRae's 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 the strata are broken, as is also vertically, forming the broad plateau of Sand mountain. The axis of the Lookout mountain syncline is at this point roughly at right angles to the western limb passing off the sheet, and the eastern unifying toward the south with the axis of the Pigeon mountain syncline. The eastern limb of the Pigeon mountain syncline, whose western edges form the ridge of Taylor is not a simple trough, like those to the west, but is broken up into isolated basins by short anticlinal. One of the latter is represented in section EE, separating the sheet which forms West Ammonite from the East Town Valley on the south. The ridge 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 north-west of this series of ridges are deeply eroded antecedents, while those on the southeast are synclines, which carry the ridge-forming structures below the general valley level.

**Folds.**—Excepting a small area on the north-eastern boundary of Lookout Mountain, the faults are confined to the region east of Taylor ridge. They are represented on the map by a number of short strike faults, and in the sections by a line whose inclination shows the probable dip of the beds in the places, the arrows indicating the direction in which the beds have been moved on its opposite sides.

The eastern side of the Taylor ridge syncline, except a short distance where it appears as the Dick ridge, is slashed off by a fault which extends for many miles north and south beyond the limits of the map. This fault brings the strata in contact at different places with the overlying formations up to the strain. The eastern limb of the syncline, and the synclinal valley of the sheet, is caused by the fault. The latter is shown in section EE, and it has the peculiarity that the plate 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, management ore, mica, talc, building stone, stone dust, brick clay, and tile clay.

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

The accompanying columnar sections show the variation of the thickness of the coal beds.

The sections are not general, 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 so much 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 Banger to the base of the conglomerate of the thickness of the Lookout sandstone is from 450 to 550 feet. West of Lookout valley this thickness decreases, and the conglomerates above bed of conglomerate has a thickness of five beds of coal, varying in thickness from a few inches to four feet. These beds are worked at several points, and are known as the "coal bed of conglomerate. They appear to thin out toward the east and are usually in a series of localities in Lookout valley. A fault which cuts across the axis of the sheet and moves the bedding surface across the central part of the sheet.

The lower 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 creek the strata dip at a very low angle toward the north and east, and over a considerable area the bed is near the surface that it is extensively mined by removing the few feet of overburden. A narrow strip of Rockwood shale follows the eastern base of Lookout mountain around the head of McRae's cove and the point of Pigeon hill. A very small bed of ore occurs, throughout nearly the whole of this strip, though at some points it is broken up into a number of thin layers, and the thickness of the ore varies from inch to inch. It is worked at various points where proximity to the Chattanooga Southern railroad makes it accessible. The thickness of the coal bed of conglomerate is from five to seven feet, and at some of the places where the coal is exposed the beds have been cut and removed. The bed is usually in a horizontal position, although a number of thin layers may be found in the overburden. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed. The bed is usually in a horizontal position, although a number of thin layers may be found in the broken surface of the bed.
in workable quantities south of the Tennessee-Georgia line.  

Mineral paint.—A subterranean though locally important use of the red hematite is as mineral paint. Only the poorer grades of soft ore, from which the limonite has been thoroughly leached, are employed for this purpose. Considerable quantities are mined in Lookout mountain and ground on the spot. Mills in Chattanooga purchase the ore and ship it from the same locality.  

Limestone.—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 aggregated 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 reduce the iron disseminated through the rocks. When the solution is exposed to air either in the open surface or in cavities under ground, the iron becomes insoluble and is precipitated as the limon yellow substance generally seen about mineral springs. This substance gradually hardens and, where it collects in sufficient quantity, forms a bed of limonite iron ore.  

The general distribution of the sheet, conditions were favorable for this accumulation at certain points in the Carboniferous rocks, generally near the contact with the overlying strata, and the Floyd shale. These 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 mountain 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 is not in quantity in the magnitude of ore.  

Manganese ore.—Oxide of manganese is accumulated under the same conditions and by the same agency as that of iron, but it is much less disseminated than the latter. The deposits at Tunnel Hill are along a fault line at the contact of Knox dolomite with Cambrian shale. The faulting seems in some way to have assisted in the accumulation of the ore, probably by affording an easy passage to the pervading waters, which held the iron and manganese in solution after it was leached from the surrounding rocks. The ore is found in nodules and irregular masses associated with short and red clay which results 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.  

Lignite.—The supply of lignite on the Ringgold sheet, suitable for blast-furnace fuel and for lime, is abundant and convenient of access. The Bangor lignite is used at the Rising Farn Furnace in Johnson creek, on account of its freedom from earthy impurities and its close proximity to the furnace. It contains variable amounts of magnesium carbonates, sometimes as much as 55 per cent.  

The Knox dolomite is quarried extensively at Grayville, near the Tennessee line, and burned for lime. The silicates which this formation contains in large amount is generally segregated in layers of sandstone; these are easily reduced 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.—Some adapted to architectural uses occurs in many places in the formation of the area, but none is quarried except in a small way for local use. A few miles north of the Tennessee line, on the Ringgold sheet, are quarries of dore colored earthy limestones 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 fork are extensively quarried for building stone.  

Soils.—The hard blue Bangor and Chickamauga limestones afford an abundant supply of manure, and thence the sheet of the Knox dolomite and of the Fort Payne formation is an ideal surfacing material. These formations are so close together that the soil in deeper parts of the Knox formation is deeper in depth, but less so where the surfacing material is shallow. The Knox formation is also well adapted as material for roadbeds, even where the soil is shallow, is more uniformly well adapted to deep burnt clay, which is 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 end 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 very silicious clays resulting from the decomposition of the Knox dolomite are probably well adapted for the manufacture of refractory fire brick, and the clays of five clay which are usually associated with the coal may contain materials suited to the same purpose, but they are as yet wholly undeveloped.  

SOILS.  

Soil formation and distribution.—Throughout the region covered by the Ringgold sheet there is a very close relation between the character of the soils and that of the underlying formations. Except in limited areas along the larger streams and on the steeper slopes of the mountains, the soils are developed 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. The soil in the rock, on the other hand, is readily dissolved by water containing carbonic acid, and the clayey or sandy particles which it holds 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 limestones, the cementitious 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. This 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 sedimentary. If the rock is a sandstone or sandy shale the soil is sandy, and 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 physical and agricultural qualities often rest side by side.  

And as the attitude of the strata determines the breadth of outcrop of each formation in any place, it also determines the area of the outcrops. The most productive of these soils are derived from the Bangor and Chickamauga limestone sections; their distribution coincides with the 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 often darkens to a bluish gray. This is its character in West Chickamauga valley where the largest area of the limestone occurs. The rock generally weather more rapidly where they have a steep dip than where they are nearly horizontal, and the same is true of the slopes where the limestone is exposed. The soils are more deeply colored on the narrow belt of limestone close to the Floyd shale than on the broader upper surface of the Knox dolomite. The clay soils derived from the Cambrian shales are somewhat less productive. The Coosa shales and those in the upper part of the Knox dolomite make stiff bluish gray soils which are usually thinner than those covering the limestones, and the clay structure of the rock often appears a few inches below the surface.  

All of these clay soils are well fitted to retain both water and manure, and hence with proper treatment may be brought to a high state of productivity.  

Cherty soils.—Nearly half the area west of the valley is underlain by the Knox dolomite. The soil derived from this formation consists of clay in which the chert is indigenous. The proportion of chert to clay is variable in some places on account of the occasional fragments occur, while in others the residual material is made up almost wholly of chert. Where the chert 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. At the surface where the chert is very large, and the soil is relatively impervious. The soil derived from the Fort Payne shale is deep red, but the areas of the Fort Payne are much smaller and usually occur on steep slopes, so that the soil is relatively impervious.  

Aloireal 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 scales of nicks derived from crystalline rocks which lie far to the east.  

C. WILLARD HAYES.  

Geologist.
### Columnar Sections

#### Generalized Section West of Chattahoochee Valley

<table>
<thead>
<tr>
<th>Formation Name</th>
<th>Columnar Section</th>
<th>Character of Rocks</th>
<th>Character of Topography and Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaked sandstone</td>
<td>Ca</td>
<td>Coarse sandstone and sandy shale with beds of sand and clay.</td>
<td>Flat topped, plateau-like surfaces.</td>
</tr>
<tr>
<td>Lookout sandstone</td>
<td>Cs</td>
<td>Conglomerate and sandstone</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Floyd sandstone</td>
<td>Cf</td>
<td>Sandy limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Fort Payne sandstone</td>
<td>Cb</td>
<td>Shaly limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Chattahoochee black shale</td>
<td>Cr</td>
<td>Heavy bedded shale.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Rockwood formation</td>
<td>Cb</td>
<td>Calcareous and sandy shale with beds of sandstone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Chickamauga limestone</td>
<td>Cb</td>
<td>Blue clayey limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Knox Formation</td>
<td>Cb</td>
<td>Magnesian limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Connessa mudstone</td>
<td>Ca</td>
<td>Blue clayey limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
</tbody>
</table>
| VERTICAL SECTIONS SHOWING POSITION AND THICKNESS OF COAL BENCHES

#### Generalized Section East of Chattahoochee Valley

<table>
<thead>
<tr>
<th>Formation Name</th>
<th>Columnar Section</th>
<th>Character of Rocks</th>
<th>Character of Topography and Soils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lookout sandstone</td>
<td>Ca</td>
<td>Coarse sandstone and sandy shale.</td>
<td>Flat topped, plateau-like surfaces.</td>
</tr>
<tr>
<td>Boulder limestone</td>
<td>Cs</td>
<td>Conglomerate and sandstone</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Floyd sandstone</td>
<td>Cf</td>
<td>Sandy limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Fort Payne sandstone</td>
<td>Cb</td>
<td>Shaly limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Chattahoochee black shale</td>
<td>Cr</td>
<td>Heavy bedded shale.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Rockwood formation</td>
<td>Cb</td>
<td>Calcareous and sandy shale with beds of sandstone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Chickamauga limestone</td>
<td>Cb</td>
<td>Blue clayey limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Knox Formation</td>
<td>Cb</td>
<td>Magnesian limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
<tr>
<td>Connessa mudstone</td>
<td>Ca</td>
<td>Blue clayey limestone.</td>
<td>Uplifts, abrupt changes in terrain.</td>
</tr>
</tbody>
</table>
| VERTICAL SECTIONS SHOWING POSITION AND THICKNESS OF COAL BENCHES

#### VERTICAL SECTIONS SHOWING POSITION AND THICKNESS OF COAL BENCHES

**VERTICAL DISTANCES ARE MEASURED FROM THE TOP OF THE LITIGATION LIMESTONE.**

### Names of Formations

- **Weaked sandstone**
- **Lookout sandstone**
- **Floyd sandstone**
- **Fort Payne sandstone**
- **Chattahoochee black shale**
- **Rockwood formation**
- **Knox Formation**
- **Connessa mudstone**
- **VERTICAL SECTIONS SHOWING POSITION AND THICKNESS OF COAL BENCHES

### Coal Beds

- **Appian chert**
- **Knots**
- **Coal**
- **Shale**

### Names and Symbols Used in this Sheet

- **Ca**: Weaked sandstone
- **Cb**: Lookout sandstone
- **Cc**: Floyd sandstone
- **Cd**: Fort Payne sandstone
- **Ce**: Chattahoochee black shale
- **Ch**: Rockwood formation
- **Ck**: Knox Formation
- **Cm**: Connessa mudstone

### Names of Coal Beds

- **Appian chert**
- **Knots**
- **Coal**
- **Shale**

### Crayla's Outlines of the Geology of Alabama, 1892.

- **Sulphur**
- **Carboniferous**
- **Permian**
- **Triassic**

### C. Willard Hayes

**Geologist**
pour out of cracks and volatiles and flow over the surface as lava. Sometimes they are thrown out of volcanoes as seisms and pyroclasts, and are spread over the surface by wind and water and by the flow of the lava. Later lava flows are interbedded with ash beds.

It is thought that the first rocks of the earth, which is called the Archean period, were igneous. Igneous rocks have intruded among masses beneath the surface and have been thrown out from volcanoes. These periods have been identified with the ages of the earth's development. These rocks occur therefore with sedimentary formations of all periods, and their age 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 rhombi printed in any brilliant color. When the age of a formation is not letters only but a 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.

Igneous rocks are divided into two classes: (1) Altered rocks of crystalline texture. These are rocks which have been so changed by pressure, movement, and chemical action that the mineral particles have rearranged and the rock has assumed a new form. Both sedimentary and igneous rocks may change their character by the growth of crystals and the gradual development of the mineral particles. Marble is limestone which has thus been crystallized. Moraine is one of the common minerals which may thus grow. By this chemical alteration of 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 produced by pressure, high temperatures, and water. When a rock is subjected to these conditions, it is squeezed during movements in the earth's crust, it may divide into many very thin parallel layers, and it is accompanied by changes in the 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 Archean, 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 unaltered.

The crystalline formations are represented on the maps by straight lines and angles, and the hinges of the rock layers are irregularly placed. These are printed in any color and may be darker or lighter than the background. If the rock is not limited to any particular area, the hinges may be arranged in varying patterns.

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 known the letter symbol consists of small letters only.

USES OF THE MAPS.

Topography.—Within the limits of scale the toponymic sheet is an accurate and characteristic delineation of the relief, drainage and colors of the region represented. Viewing the landscape, map in hand, every characteristic feature of the land becomes more distinct.

It may guide the traveler, who can determine in advance or follow continuously on the map his route through the higher and lower lands.

It may serve the inventor or owner who desires to ascertain the position and surroundings of property to be occupied by highway and byways.

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

It provides education for school and homes, and serves all the purposes of a map for local reference.

As geology.—This sheet shows the area 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 in the map the reader should look for that description and the name and description of the formation. If it is not found in any given formation, the reader will be directed to another colored pattern noted, as the areas on the map corresponding in color and pattern may not be traced out.

The legend is also a verbal statement of the geologic history of the district. The formations are arranged in groups according to etiology—igneous or 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 as far as known, the youngest at the top, the most resistant and processes and conditions which make up the history of the district are suggested.

The legend may also describe the formations of or groupings of formations, statements of the occurrence of useful minerals, and qualifications of doubtful condition.

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

Economic geology.—This sheet represents the distribution of useful minerals, the occurrence of arsionic ore, other rocks of economic interest, showing their relations to the features of the surface. All valuable geologic formations which appear on the map are geologically shown in this map also, illustrated by figures and descriptions in the captions and labels.

The broad belt of lower land is traversed by several ridges, which, when they are cut off by the section, are seen to correspond to croutons of sandstone that rise to the surface. The upturned edges of these harder beds form the ridges, and the intermediate valleys follow the contours of lime stone and sandstone slates.

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 where these formations are not inclined but flat, the formations may be indicated by strong colors.

A symbol for mines is introduced in this map, and it is accompanied by 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 geologic.

In any shaft or trench the rocks beneath the surface may be exposed, and in the vertical side of the trench the relations of the different beds may be seen. They are presented by the aid of a diagram representing the relations. The arrangements of rocks in the earth's structure, and sections exhibiting this arrangement is called a structure section.

Mines and tunnels yield some facts of underground structure, and streamers carrying water through rock masses cut sections. By the process of accumulation of the strata, 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.

The figure represents a landscape which is cut off sharply from the foreground by a vertical plane. The landscape exhibits an extended plate on the left, a broad belt of line and troughs, 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 strata and rocks. The kinds of rocks are indicated in the section by appropriate symbols of lines, dots, and dashes. These symbols admit of interpretation as the following are generally used in sections to represent the commoner kinds of rock.

The platou rests 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 bedding 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 formation is a sheet of crystalline schists and igneous rocks. At some period of their history they have been plutonized or pressure and traversed by eruptions of molten rock. 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 sediments and the beginning of deposition of strata of the second group. During this interval the strata 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 unconformable.

The section and landscape in Fig. 2 are hypothetical, but they illustrate only relations which are very frequent. The structure section is related to the maps as the section in the figure is related to the landscape. The profile shows how the strata correspond to the actual relief on the surface of the ground along the section line, and the depth of the minor producing or water-bearing strata which appear in the section may be measured from the surface by using the scale of the map.

Orogenic sections.—This sheet contains a concise description of the rock formations which constitute the local record of geologic history. The map and the words 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, which are shown at the bottom of the sections.

The thicknesses of formations are given under the heading "Thickness in feet," in figures which are the greatest thickness. The average thickness of each formation is shown in the column, which is drawn to a scale—usually 1,000 feet to the inch. The average thickness of the sediments is shown in the column arrangement of the descriptions and of the lithologic symbols in the diagram. The average thickness of the strata is shown at the bottom of the column, the youngest at the top.

The strata are divided into three groups, which correspond with the great periods of geologic history. The first of these is the columnar strata with the great thickness. The columnar strata is shown and also the total thickness of deposits representing any geologic period.

The strata to which events which correspond to uplifts of depression and conjugate interruptions of deposition of sediments may be indicated and geostratigraphic features, soils, or other facts related to it.

J. W. Powell
Director.