DESCRIPTION OF THE BESSEMER AND VANDIVER QUADRANGLES

By Charles Buttus

INTRODUCTION

LOCATION AND EXTENT OF THE AREA

The Bessemer and Vandiver quadrangles, which are called in this folio the Bessemer-Vandiver area, are in Jefferson and Shelby counties in the north-central part of Alabama. (See fig. 1.) The area is bounded by parallels 32° 15' and 33° 15' north latitude and by meridians 86° 30' and 87° west longitude. It covers one-eighth of a square degree and has an area of 495 square miles. The area was surveyed in cooperation with the Geological Survey of Alabama.

THE APPALACHIAN HIGHLANDS

DESCRIPTION OF THE BESSEMER AND VANDIVER

The Appalachian Highlands are the interior low plateau which are included in the Interior Plateau by the United States Geological Survey but which in the opinion of some, including the writer, should be included in the Appalachian Highlands.

The boundary between the Piedmont and Blue Ridge provinces is the east foot of the Blue Ridge and the east of the high but irregular eastern escarp of the mountains of western North Carolina and northern Georgia which form the southern extensions of the Blue Ridge. The boundary between the Blue Ridge and Appalachian Valley provinces is the west foot of the Blue Ridge of Virginia and of the high mountains of eastern Tennessee and which extend into northwestern Georgia to the point where it intersects the boundary between the Piedmont and Blue Ridge provinces, about 15 miles southeast of Dalton. The Blue Ridge province thus terminates in northwestern Georgia. Thence southward the Piedmont and Appalachian Valley provinces are continuous, the indefinite boundary between them running southward through the Blue Ridge province and the Appalachian Plateau province. The boundary between the Appalachian Valley and the Appalachian Plateaus is, in Pennsylvania, the escarpment known as the Allegheny Front or Allegheny Mountain; in southeastern Virginia and through Tennessee, the Cumberland or Allegheny escarpment or Cumberland Mountain; and in Alabama, the eastern escarpment of Lookout Mountain and the eastern boundary of the Warrior coal field. The western boundary of the Appalachian Plateaus is, in Tennessee, about midway between Knoxville and Nashville, where the Benjamin escarpment, 800 to 1,000 feet high, separates the Cumberland Plateaus from the Blue Ridge. Northward the boundary, though not sharply defined, is extended through central Ohio to the vicinity of Cleveland.

Piedmont Province

The Piedmont province is a rolling upland 1,000 feet above sea level at the east foot of the Blue Ridge and 500 feet or less above sea level at the west foot of the Blue Ridge, and 800 to 2,000 feet high, separating the Cumberland Plateaus from the Blue Ridge. The boundary of this province is defined by the ridges, which are generally 800 to 1,000 feet high, and by the escarpments which separate them from the adjacent provinces.

The rocks and structural conditions that characterize the Blue Ridge province are not fully understood. The rocks are of varied type, including limestones, dolomites, conglomerates, sandstones, and shales, which have been greatly disturbed by folding and faulting, as herein described.

BLUE RIDGE PROVINCE

The Blue Ridge province is one of mature topography. The streams are generally well incised into the surface, and the landscape is characterized by low ridges and narrow valleys. The altitude of the higher summits in Virginia is 3,000 to 5,000 feet, and in western North Carolina, Mount Mitchell, 6,671 feet high, is the highest point east of Mississippi River. Throughout its extent this province is characterized by the prevalence of old, well-defined, and extensive structures.

The Blue Ridge province is divided into two natural subdivisions named the Blue Ridge and the Appalachian Plateaus. The Blue Ridge province is characterized by the prevalence of old, well-defined, and extensive structures. The Appalachian Plateaus province is characterized by the prevalence of young, low-relief structures.

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TOPOGRAPHY OF THE AREA

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RELIEF

The altitude of the area ranges from 240 feet above sea level on the south margin of the Bessemer quadrangle near Birmingham to 1,620 feet on Signal Mountain in the Northern Valley quadrangle. Throughout most of the area the relief ranges from 100 to 300 feet. The relief is usually greater, however, near Birmingham, where the summit of Red Mountain is 400 feet above the level of Jones Valley, and in the vicinity of Ossomoro, where the escarpment of Shades Mountain rises.

COHABO RANGES

The Cohabo Ranges extend across the entire length of the Bessemer-Vandiver area. They are characterized by the prevalence of old, well-defined, and extensive structures. The streams are generally well incised into the surface, and the landscape is characterized by low ridges and narrow valleys. The altitude of the higher summits in Virginia is 3,000 to 5,000 feet, and in western North Carolina, Mount Mitchell, 6,671 feet high, is the highest point east of Mississippi River. Throughout its extent this province is characterized by the prevalence of old, well-defined, and extensive structures.

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abruptly to a height of 500 feet above Shades Valley. The
The linear type is characterized by parallel ridges and valleys
features which may be designated the linear and diffuse types.
Distinguishes the Cahaba Ridges.
Especially noteworthy examples of the ridges are Oak, Double
conglomerate. The valleys are wide and flat. (See PI. I.)
the character and attitude of the strata, as is well exhibited
the structure-section map of the Bessemer
The total fall of Cahaba River in the quadrangles in a dis-
mer for considerable distances into the surrounding country.
Excellent metaled roads radiate from Birmingham and Besse-
mer for considerable distances into the surrounding country.
In this region there are five dolomite formations which in
The equivalency of the Rome and "Montevallo" was not sat-
Helen, consists, so far as observed, of several hundred feet of limestone.
In view of the uncertainty as to the age and relations of those rocks, it is believed to be most expedient not
to assign any definite age to them.

**Descriptive Geology**

The rocks of the quadrangles are all of sedimentary origin
and range in age from Cambrian to Carboniferous; all the
Pleistocene systems but the Devonian are well represented.

The maximum thickness of rocks exposed is about 20,000 feet.
These rocks were originally deposited on the bottom of bodies
of water in a nearly horizontal attitude. In small parts of the
strata this attitude has been fairly well preserved, but in
general recent usage.

The geology of this region has been described and mapped
in section B-B' on the structure-section map of the Bessemer
The two types of topography are the result of differences in

The Bessemer and Vandiver quadrangles lie in the Black
Warrior, Cahaba, and Coosa drainage basins. About 70 square
miles in the northwest corner of the Bessemer
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**Rome Formation**

None and east limb. The name Rome Formation, from Rome,
was introduced by Hayes in 1857. The name "Chocca-
locco or Montevallo shales" was introduced by E. A. Smith, at
about the same time, for rocks in central Alabama now known
to be the Copper Ridge dolomite.

The red shale of these areas is almost certainly of Rome or
Montevallo age. It is generally the strata have been folded and faulted until their
original relations have been destroyed. In addition to

Outside of the industrial district just described the popula-
tions of these streams are very considerable. The red shale is much
underlain by the Shady ("Beaver") limestone, which prob-
ably for considerable distances into the surrounding country.

In view of the uncertainty as to the age and relations of those rocks, it is believed to be most expedient not
to assign any definite age to them.

The raw materials of iron making—iron ore, coal, and lime-
stone—are abundant in this region, for much more than 12,000,000 tons of iron ore, 17,806,000 tons of coal and
slate, are known to be in the Bessemer quadrangle.
from which the following forms have been identified by C. D. Walcott except the *Olenella*, which was identified by the

<table>
<thead>
<tr>
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<th>Species</th>
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<tr>
<td><em>Olenella</em></td>
<td><em>Atata</em></td>
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<tr>
<td><em>Olenella</em></td>
<td><em>Smithia</em></td>
</tr>
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*Olenella* (Potter) *Atata* Walcott.  
*Olenella* (Potter) *Smithia* Walcott.  
*Olenella* (Potter) *Olenella* Walcott.  
*Olenella* (Potter) *Olenella* Walcott.

The fossils in this list, except the *Olenella*, were obtained from two localities, one a quarter of a mile north of Helena and the other a mile south of Helena, from a bed that seems to be about 500 feet below the top of the Rome. In the vicinity of Montevallo, about 500 feet below the top of the Rome as delimited in that locality, *Olenella* (Smithia) is abundant. Of the fossils in the list *Olenella* (Potter) *Atata*, *Olenella* (Potter) *Smithia*, and *Olenella* (Potter) *Olenella* are known only from the Rome of Cahaba Valley. The *Olenella* (Potter) *Olenella* is recorded by Walcott from Lower, Middle, and Upper Ordovician strata, the greater number of occurrences are Middle Cambrian.

On the basis of continuity and lability as well as on other meager fossil evidence, the Rome formation has been correlated with the upper part at least of the Wenang Formation of Virginia, and the lower part of the Wenang Formation of Pennsylvania. However, fossils collected from the Russell formation in the summer of 1926, three considerable units upon the supposed equivalence of the Rome and Russell formations.

**Conasauga ("Coca") limestone**

**Noce.**—The name Conasauga, from Conasauga River, in northwestern Georgia, was introduced by Hayes in December 1890, and appeared in print in February, 1891. The name *Coca*, from Coos Valley, was introduced by Smith in January, 1890, for the rock. There is no known connection with the name of the Rome formation, the name Conasauga is used in this folio.

**Distribution.**—The Conasauga limestone underlies most of the width of Opossum Valley from Bessemer to Westley. It is bounded on the west side by a fault along which it is in contact with the Paleozoic. It crops out extensively in Jones Valley, occupying a belt about a mile wide the whole length of the valley, opposite the street-car barn. In Birmingham Valley, it must thin out somewhere underneath the Cahaba coal field in Alabama carries Middle Cambrian fossils of Tennessee from two localities, one a quarter of a mile north of Helena and the other 4 miles south of Helena, from a bed that seems to be about 500 feet below the top of the Rome. In the vicinity of Montevallo, about 500 feet below the top of the Rome as delimited in that locality, *Olenella* (Smithia) is abundant. Of the fossils in the list *Olenella* (Potter) *Atata*, *Olenella* (Potter) *Smithia*, and *Olenella* (Potter) *Olenella* are known only from the Rome of Cahaba Valley. The *Olenella* (Potter) *Olenella* is recorded by Walcott from Lower, Middle, and Upper Ordovician strata, the greater number of occurrences are Middle Cambrian.

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The species of trilobites listed are now regarded by both Walcott and Ulrich as Leptaspis *williardi* and *L. levis* of Upper Cambrian age, but according to Walcott one of the branches goes down into the Middle and Lower Cambrian. It is agreed, however, that at least one part of the Conasauga which carries these fossils is of Upper Cambrian age. No exclusively Middle Cambrian fossils are yet known from the Conasauga of Birmingham Valley. But the Conasauga limestone of the areas northeast of the Cahaba coal field in Alabama carries Middle Cambrian fossils and may be all Middle Cambrian. Through the fossils the Conasauga has been correlated with the Rutledge limestones, Raggedy shales, Marysville limestones, and Nollechake shales of Tennessee, those of southeastern Tennessee and southwestern Virginia, and the Warrior limestones of Pennsylvania. This correlation, however, is correct only for the Conasauga of the State of Alabama as a whole. The Conasauga limestone of Birmingham Valley, as far as known, is more nearly equivalent to the Nollechake shales and perhaps the Marysville limestones also.

**Cambrian or Ordovician System**

**Subdivision.** Pending a decision as to the adoption of Ulrich's proposed *Cambrian* system, five formations are recognized by the United States Geological Survey as of either Cambrian or Ordovician age. They are, in ascending order, the Brierfield, Ketona, Rome, Brierfield, and *Opdolite* formations. Through the fossils the Conasauga has been correlated with the Rutledge limestones, Raggedy shales, Marysville limestones, and Nollechake shales of Tennessee, those of southeastern Tennessee and southwestern Virginia, and the Warrior limestones of Pennsylvania. This correlation, however, is correct only for the Conasauga of the State of Alabama as a whole. The Conasauga limestone of Birmingham Valley, as far as known, is more nearly equivalent to the Nollechake shales and perhaps the Marysville limestones also.

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 Pleasant Ridge, northwest of Bessemer. It crops out in the Salem Hills, in Flint Ridge, along the west base of Mount Morgan, and in New Hope Mountain. It is almost certainly present under the coal fields and under all that part of the Bessemer-Vandiver area east of New Hope Mountain.

Character.—As the Copper Ridge dolomite is not well exposed, owing to the steepness of the region, but knowledge of its real character can be gained through direct observation. Here and there an isolated exposure of dolomite appears in a wide expanse of territory, the surface of which is very unevenly covered with red, tawny, or gray soil, full of clumps and heaps of chert, which are also strewn abundantly over the surface. Fortunately, however, exposures on Alligator Creek, nearly 30 miles to the southeast of the Bessemer quadrangle, have revealed the real nature of the Copper Ridge and Chepultepec dolomites. A section of these dolomites on Alligator Creek is followed upward in regular sequence by an almost complete section of the Springville and Newala limestones along Little Cahaba River half a mile east of Alligator Creek and within the Montevallo quadrangle. A compilation of the two sections is given below.

Section along Alligator Creek and Little Cahaba River in secs. 6 and 17, T. 16 N., R. 5 E.

<table>
<thead>
<tr>
<th>Layer</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Ketona dolomite:</td>
<td>Non-lithic, light gray, very finely crystaline, yields abundant heavy chert.</td>
</tr>
<tr>
<td>2.</td>
<td>Limestone, light gray, non-lithic, little exposed:</td>
<td>Similar to Ketona dolomite but less cherty.</td>
</tr>
<tr>
<td>3.</td>
<td>Limestone, light gray, very finely crystaline:</td>
<td>Yields abundant heavy chert.</td>
</tr>
<tr>
<td>5.</td>
<td>Chert:</td>
<td>Yields abundant heavy chert.</td>
</tr>
</tbody>
</table>
| 11. | Limestone, calcareous: | Limestones, as noted by Washburne through microscopic examination to be crystalline quartz. It is very dense and angular, sometimes angular to subangular, very little of it being nearly or wholly chalky, like much of the chert of the other cherty formations of the region. A typical specimen is shown in Plate III. The prevailing colors are white, yellowish, and pink. Topographically the Copper Ridge dolomite generally express the present ridge, on account of the present minor valleys of chert which have accumulated on the surface. Flint Ridge and the Salem Hills, in Birmingharn Valley, and New Hope Mountain, in the Montevallo quadrangle, are examples of the Chaptulae.

Character.—The thickness of the Copper Ridge in the Alligator Creek section is 1,750 feet, which may be assumed as the thickness throughout the Bessemer Valley area. Age and correlation.—No fossils have been found in the Copper Ridge dolomite in either the Bessemer or the VanZandt quadrangle. A number of fossils have been observed in the Montevallo-Columbus region in the south, and a few fragments of gastropods in the stone collected in the southeastern part of the Montevallo quadrangle. A collection obtained half a mile west of Chicksellville in the Birmingham quadrangle, 16 miles south of Birminham, and still further northwest, are the best that have been obtained from the Copper Ridge in the Appalachians region. Of the Copper Ridge fossils are as a rule exceedingly rare in the Copper Ridge, and these are found almost without exception only edifices of the described as the thickness of the Bessemer-Vandiver area.

Character.—The thickness throughout the Bessemer-Vandiver area. It is almost certainly present under the coal fields and under all that part of the Bessemer-Vandiver area east of New Hope Mountain.
lies at a number of points between Keyston and Calera. (See table of analyses, p. 21.)

**Thickness.**—The thickness of the Newala in Cahaba Valley is 900 to 1,000 feet thick, but in the southeastern part of the Vandiver quadrangle it may be as much as 1,000 feet thick, being known at the base of the Knox dolomite, which is underlain by the Odenville limestone. In the southeastern part of the Vandiver quadrangle it is said to be 4,000 feet thick.

**Age and correlation.**—Newala limestone is probably of late Beekmantown age. It is identified with the upper division of the Beekmantown limestone in New York, where it is of late Beekmantown age. On the other hand, the Newala limestone in Cahaba Valley is of late Beekmantown age, as shown in the following paragraphs.

**Distribution.**—In Alabama the Odenville is probably of late Beekmantown age, as shown in the following paragraphs. In the Odenville quadrangle it is probably of late Beekmantown age, as shown in the following paragraphs.

The Odenville is best exposed in the Odenville area, to the south of the Beekmantown of the Cretaceous period, at Odenville, where it is of late Beekmantown age. In the Odenville quadrangle it is probably of late Beekmantown age, as shown in the following paragraphs.

**Name and definition.**—The Odenville is a common fossiliferous limestone, which is well exposed in the Odenville area, to the south of the Beekmantown of the Cretaceous period, at Odenville, where it is of late Beekmantown age. In the Odenville quadrangle it is probably of late Beekmantown age, as shown in the following paragraphs.

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**Age and correlation.**—The Odenville is probably of late Beekmantown age, as shown in the following paragraphs. It is identified with the late Beekmantown of New York, which is of late Beekmantown age, as shown in the following paragraphs.

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to be confined to the part of the Chazy group now known as the Crown Point limestone. This evidence seems sufficient ground for the correlation of the Lenoir with the middle Chazy. It is also possible that the Pierre and Rienzi limestones of the Stony River group of New York, and possibly the Hazelton and the Rockaway groups of the northern part of Coho Valley. The true extent of this unconformity at the base of the Little Oak limestone.

Luconia Valley

The Little Oak limestone is prominent along the west escarpment of Little Oak Ridge from Pelham to the north margin of the Vandalia quadrangle. Immediately north of Pelham its outcrop is repeated by faults, so that there are three long, narrow areas of it. The best exposure is on the point of a prominent synclinal spur 1/4 mile southwest of Newhope church, just on the west side of the Vandalia quadrangle. It is also well exposed in the Atlanta, Birmingham, and Atlantic Railway cut and adjacent thereto just east of Pelham. The limestone is profusely exposed and apparently of full thickness in the high knolls south of Pineville Creek, half a mile southeast of Pelham, and on outcrops southward from Pelham by loss of beds from the top, so that at the northern margin of the Montevallo quadrangle, to the south, only the bottom 100 feet on an elevated area of volcanic ash or tuff about 1 mile southeast of Sullivan, it widges out, the Frogs Mountain sandstones, overlapped on the north, being in contact with the Athens shales. Evidently the Little Oak in the area just outlined was boiled over by erosion in the long interval that preceded the deposition of the Frogs Mountain sandstones. In the Page Spring anticlinal area, in the northeastern part of the Vandalia quadrangle, chalk with Orthoceras fossils, and the Flagstaff sandstone, mingled with chert with Mississippian fossils (Palaeoniscus), indicate the presence of limestone regarded as probably Little Oak.

Character. The Little Oak limestone is composed of dark fossiliferous micaceous limestone. The chert occur as irregular plates or nodules, arranged in definite layers. A very characteristic feature is the pattern taken by the earthy impurities on the exposed surface of the limestone beds being covered by a network of gray earthy rinds or an inch or two wide, inclining in their deposed mudstones. Such blue limestone with an expanse of which are the size of the hand. (See PI. XVI.) This character is especially prominent at the top of the limestone, just below the Fort Payne chert, from Pelham northwest for 3 miles or more.

Along the west side of the Fort Payne chert ridge south of Pelham and into the Montevallo quadrangle the lower part of the Little Oak is partly made up of highly argillaceous layers, which tend to break up into shaly slabs on weathering. It is also probably also includes layers of shale. Some of the argillaceous limestone is included with the chert. The character of the lower part of the Little Oak suggests continuous deposition from the Athens, but as the Tiffloc sandstone of Tuscaloosa is overlain by the Little Oak limestone, this material is probably nothing but the Athens and the Little Oak limestone is, not represented in the region, the appearance is deceptive.

Thickness. The thickness of the Little Oak limestone probably does not exceed 400 feet, which it appears to reach in the center of the Vandalia quadrangle. At Pelham its thickness is not over 250 feet. Age and correlation. The Little Oak limestone has yielded a considerable number of fossils, and the general character of the fauna is indicated by the subjoined list.

The basal part of the formation is, locally, very fossiliferous, and the fauna occurs in chert, which is derived perhaps from highly argillaceous or siliceous layers of limestone. The following fossils have been identified:

- *Inoceramus sp.*
- *Rhaeticoceras sp.*
- *Orthoceras sp.*
- *Bryozoa sp.*
- *Chonetes sp.*
- *Trilobites sp.*
- *Palaeoniscus sp.*

The fauna of the Little Oak limestone is unique and as yet has yielded but little information beyond the fact that it is probably of Late Devonian age. It is only for this reason has it failed to reveal a single species that is certainly identical with any described form. The *Orthoceras* and *Rhaeticoceras* nomen near *P. plicata* closely resemble the *Chonetes* of the *Chonetes* and *Rhaeticoceras* nomen near *P. plicata*.
Lingulas as much as 1 inch long and half an inch broad. It is exposed at the intersection of Fourteenth Street and Fourth Avenue, South Birmingham, and near State No. 1 mine, Bessemer. At this place 50 feet is exposed, and the bed is probably at least 100 feet thick; below it is the Attalla conglomerate, which is about 50 feet of purple sandstone and shale, in places a little above it, with intercalated beds of limestone and of sandstone, and a little below, a bed of iron ore. It is exposed at the intersection of Fourteenth Street and Fourteenth Avenue; near West End, in a conspicuous little knoll about 500 feet at the intersection of Fourteenth Street and Fourteenth Avenue; near West End, in a conspicuous little knoll about 500 feet; and in the Stones River and Black River parts of the Chickamauga of this region.

The Attalla conglomerate, according to McColl, is of Mississippi age.

In Birmingham Valley there is a great stratigraphic gap between the Chickamauga and the overlying Red Mountain formation, and in Cahaba Valley between the Little Oak limestone and the overlying Frog Mountain sandstones. In Birmingham the whole rock section is 3 miles southeast of Bessemer. The Trenton part of the Chickamauga in the Bessemer quadrangle therefore corresponds to only the base of the Trenton shallows. The whole rock section of these ages occurs, their aggregate thickness is 5,000 feet.
Red Mountain. As shown by bore holes, the formation unconformity between the Little Oak limestone and the Frog Cahaba coal field eastward to the great Helena fault. This softer. Most of it is only slightly or not at all fossiliferous. Section of Red Mountain formation and CMckamauga limestone on Pentamerus oblongus.

Sandstone, yellow, coarse, friable (Frog Mountain sandstone. There are small outliers of the formation which contains fossils. The sandstone in the Medina part (below the Big seam) is medium fine grained, brownish, soft, porous, and friable or mealy. One bed (Hickory Nut ore seam), however, carries abundant Pentamerus oblongus.

The amount of limestone is insignificant. More is shown in the Woodward shaft than is known elsewhere. The iron-ore beds are made up largely of fragments of fossil Bryozoan and bryozoan, replaced and cemented by iron oxide and mingled with sand and small quartz pebbles. The amount of limestone is insignificant. It is not plentiful enough close above the Ida seam at that place to have been observed. The amount of limestone is insignificant. It is not plentiful enough close above the Ida seam at that place to have been observed. The iron ore media is No. 3 of the section at the Sloss No. 1 mine at Bessemer.

The section of Red Mountain formation in the Bessemer-Vandiver area, showing the iron-ore seams.

The section of Red Mountain formation and Chickamauga limestone in bore holes of Woodward shaft, 2 miles southwest of Bessemer.
the most common species and such of the rarer forms as are valuable facies of it which is found in the underlying Eockwood of Tennessee. Occurrence in Alabama is of special interest because it adds material to the Clinton limestone member or that of the somewhat older R Reynolds" horizon of the Clinton in Alabama, beginning with the Big ore seam, mainly identified by Ulrich, are listed below:

- *Leptaena rhomboidalis* Wilckens.
- *Bucanella trilobata* (Conrad).
- *Brassfield of southern Ohio. In other words, there are no rocks in Calhoun Valley that represent the time necessary for the deposition of these 50,000 feet of rocks in Pennsylvania.

**SYSTEMATIC VIEW**

The Devonian system is represented in this part of Alabama by the Frog Mountain sandstones (which here is of Oriskany and Onondaga age, as exploited beyond) and perhaps by the Chattanooga shale, which is of either upper Devonian or early Carboniferous age.

**FROG MOUNTAIN STONE**

Frogs —The Frog Mountain sandstone was so named by Hayes, from Frog Mountain, 1 mile east of Odenville, and 14 miles northeast of Leeds in the Line Mountain quadrangle. In the Cut out of Frog Mountain, a sandstone 1 foot thick and carries layers of rock like that of the Red Mountain. As the beds regarded as of Hamilton age. The 6 inches of sandstone carrying the fauna of the first horizon is from a very small quartzite and soft chalky mass. Locally it contains very small quartz pebbles. In Clear Branch Gap it is a hard quartzite. The Frog Mountain sandstone ranges from a quarter to two inches thick in this area. The sandstone is from 6 inches to 20 feet thick in this area.

The Frogs Mountain sandstone is widely used in the construction of the Calhoun Valley. In Kentucky, the Bearing formation of Calhoun, and the Blackwood strata of Tennessee, Biplonodon cyanus is extremely common, as can be seen in the lower part of the Red Mountain sandstone, in beds regarded as of Hamilton age. The 6 inches of sandstone carrying the fauna of the first horizon is from a very small quartzite and soft chalky mass. Locally it contains very small quartz pebbles. In Clear Branch Gap it is a hard quartzite. The Frog Mountain sandstone ranges from a quarter to two inches thick in this area. The sandstone is from 6 inches to 20 feet thick in this area.

**DISTRIBUTION**

The Frogs Mountain sandstone is known in this area only along the crest of Little Oak Mountain, in the Van Valkenburgh ridge, and in the Red Mountain. It is proven to be that of Hamilton age. It is exposed in this area only along the Little Oak Mountain, in the Van Valkenburgh ridge, and in the Red Mountain. It is proven to be that of Hamilton age. It is exposed in this area only along the Little Oak Mountain, in the Van Valkenburgh ridge, and in the Red Mountain. It is proven to be that of Hamilton age.

**ADDITIONAL RESOURCES**

The Frogs Mountain sandstone: 1. It is a common sandstone from both the Caledonian and Devonian of Ohio, the former of Oriskany and the latter of Hamilton and Marcellus age. Chattanoogae is a common formation in the Dolomites limestone only and thus known elsewhere only in the Line Mountain quadrangle. The *Troglospides* species is a common formation in the Dolomites limestone only and thus known elsewhere only in the Line Mountain quadrangle. The *Troglospides* species is a common formation in the Dolomites limestone only and thus known elsewhere only in the Line Mountain quadrangle. The *Troglospides* species is a common formation in the Dolomites limestone only and thus known elsewhere only in the Line Mountain quadrangle.

The Frogs Mountain sandstone appears on the map of Spangler's quadrangle was collected a piece of very fine grained alluvial rock like some of that in No. 5 of the above section, carrying an undiagnostic under the Caledonian era. Oddly, a large species of Onycha, *Stropheodonta corrugata* Conr., was collected 6 to 8 feet below the Chattanooga shale: *Troglospides sericans*, *Troglospides sericans*, *Troglospides sericans*, *Troglospides sericans*, and *Troglospides sericans*. About 3 miles further northward, at Clinch Gap, sandstone is from 6 inches to 20 feet thick in this area. The sandstone is from 6 inches to 20 feet thick in this area. The sandstone is from 6 inches to 20 feet thick in this area. The sandstone is from 6 inches to 20 feet thick in this area.

The Frogs Mountain sandstone is known in this area only along the Little Oak Mountain, in the Van Valkenburgh ridge, and in the Red Mountain. It is proven to be that of Hamilton age. It is exposed in this area only along the Little Oak Mountain, in the Van Valkenburgh ridge, and in the Red Mountain. It is proven to be that of Hamilton age.

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Ragland section exposed is as follows:

A collection of free specimens of silicified fossils has been obtained from sandstone, and a few incomplete specimens of silicified corals occur in sandstone. It may be as much as 50 feet thick and so far is conflicting. The corals alone suggest only Onondaga, but from Frog Mountain, the type locality of the Frog Mountain sandstone at the Ragland section, south of Ragland Creek, just south of Ragland, where the Devonian is exposed, fossils probably includes beds ranging in age from the later part of the Ordovician to the early part of the Carboniferous epoch.

UNCONFORMITY AT TOP OF FROG MOUNTAIN SANDSTONE

There is a stratigraphic break between the Frog Mountain sandstone and the underly­ing Chattanooga shale, the extent of which is in doubt, owing to the uncertainty as to the age of the Chattanooga. If the Chattanooga is of Genesee age, as it is classified in the earlier reports, the unconformity in this area represents no more than the Maurelian, Hamilton, and Fossiliferous formations; if it represents only the Upper Devonian the unconformity is correspondingly greater; and if the Chattanooga is probable Mississippian, as held by some, the break represents a considerable part of the Middle Devonian and all of the Upper Devonian, or about 6,000 feet of rocks not present in the section. (See section on p. 9.)

DEVIL'S VORTEX OR CARBONIFEROUS SYSTEM

CHATTANOOGA SHALE

The Chattanooga shale was named by Hay 16 from Chattanooga, Tenn. In this region it overlies the Frog Mountain sandstone, or, where the Red Mountain formation is immediately succeeded by the Fort Payne shales. Character and distribution. — The Chattanooga is a black fossiliferous shale, the black color being due to the presence of carbonaceous matter. The shale is thin, in red beds, with red layers or flints, or brecchia or greenish where it has weathered down a slope. In a cut on the Louisville & Nashville Railroad in Red River County, Twenty-Fourth Street, crossing just southwest of Birmingham, the Chattanooga consists of 4 inches of greenish shale above and 12 inches of dark clay below.17 Similar beds represent the shale through the southeastern portion of the Bessemer quadrangle. The Chattanooga is here, in thin beds, present along Red River, appearing wherever it is exposed. In Clear Branch Gap only a black shaly bed at the top of the Frog Mountain represents the formation. It has not been observed in Cherokee Valley south of La Grange, 3 miles north of the Van deventer quadrangle.

Thickness. — In the Bessemer-Vanderbilt area the Chattanooga is nowhere known to be more than 2 feet thick and is probably only a few inches thick in most of the area.

Age and correlation. — The Chattanooga shale includes all the sediments preserved in this region that were deposited in the time between the Frog Mountain epoch and the Fort Payne epoch. Within this time a maximum of about 9,000 feet of Middle and Upper Devonian and lower Mississippian rocks accumulated in central Pennsylvania. Whether the Chattanooga was deposited in the Devonian or Mississippian part of this long period has not been determined to the satisfaction of all geologists, owing to the lack of decisive evidence. It has generally been classified as Devonian, but Ulrich and others believe it to be Mississippian. Ulrich has obtained from it, at Chattanooga, Lopha solici and Oberhagenia americana, and from the crinoidal beds in Alabama, some of the richest and most complete collections of Silurian fossils. The writer has obtained Trematodus subtruncatus from beds below the middle of the Chattanooga shale at Bloom Springs. All of this, associated with Lopha solici, occurs in the black slates in Illinoia and Indiana, which is also believed to fall within the limits of the Ohio shale. The Ohio shale is classified as Devonian or Carboniferous by the U. S. Geological Survey, but it is believed by Ulrich to be of Mississippian age, except a small thickness at the bottom, which is regarded as Devonian. The Chattanooga is Devonian in the northeastern parts of Ohio, and at other places, particularly north of Huntington, Ala., a large number of species of conodonts characteristic of the mid-Cambrian and lower part of the Middle Devonian. These conodonts are regarded by Ulrich as decisive evidence of the Mississippian age of the Chattanoo­ga shale in Alabama and western Tennessee. Liuopal cox, however, regards the Chattanooga as of the late Devonian or early Mississippian age. These conodonts are regarded by Liuopal as decisive evidence of the Mississippian age of the Chattanooga shale. Its base is identified as the basal Devonian, and the break between the Chattanooga and the Ohio shale is also considered as such. In this region it overlies the Frog Mountain sandstone, and the earliest beds are Mississippian age. The chalky beds in southern Illinois are also Mississippian in age. The Chattanooga is generally considered as the base of the Upper Devonian, or about 6,000 feet of rocks not present in the section. (See section on p. 9.)

southwestward thinning is effected by the loss of Devonian beds from the bottom, so that only the top part, of Mississippian age, can be seen in the localities that have been examined. The localities where the Fort Payne chert, the Warsaw limestone, the Hartselle sandstone (as restricted), the Bangor limestone (as restricted), chert, the Warsaw limestone, the Gasper formation, the Hartselle sandstone, and the Bethel sandstone, amounting to a thickness of 700 feet.

CHARNOFF SYSTEM

The Mississippian series in this area includes the Fort Payne chert, the Warsaw limestone, the Gasper formation, the Hartsville sandstone (as restricted), the Bangor limestone (as restricted), or the flood shale, which is the equivalent of the last three, and at least the lower part of the Parkwood formation.

The type region of the Mississippian series in the Mississippian and Upper Ordovician, all of the Middle and Upper Ordovician, all of the Devonian and Silurian, and the lower part of the Mississippian series of the Carboniferous system.

CARBONIFEROUS SYSTEM

The Mississippian series in this area includes the Fort Payne chert, the Warsaw limestone, the Gasper formation, the Hartsville sandstone (as restricted), the Bangor limestone (as restricted), or the flood shale, which is the equivalent of the last three, and at least the lower part of the Parkwood formation.

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sandstone and corresponding to the Gasper formation is called Hartselle sandstone. A basal sheet or tongue of the Floyd shale, being regarded as a basal sheet or tongue of the sandstone and corresponding to the Gasper formation is called latitude of Bessemer, where the Hartselle sandstone thins out the Birmingham quadrangle, to the north, where it was Leesdale. As here redefined the formation occupies the stratigraphic position of the Hardinsburg sandstone of the Mississippian age and correlation.

**HARTSELL SANDSTONE (RESTRICTED)**

**NAME.**—The Hartselle formation as redefined and restricted is named from Bangle, in the Birmingham quadrangle, near which it is typically developed and fully exposed. It includes the limestone under the underlying Hartselle sandstone and the overlying Pennsylvanian sandstone, as at Hartselle, where the Hartselle sandstone is included in the Bangor. Above the shale is a sandstone as much as 5 feet thick. The best exposures of these beds are on the sand and gravel deposits of Bessemer and the vicinity of Bessemer. In the region farther north where the reasonable expectation is that it has a larger content of clayey matter, which it would have acquired near the area of its lateral passage to the Floyd shale facies described below.

In the vicinity of Bessemer the clay or dark shale that has a maximum thickness of about 30 feet and lies directly above the Hartselle sandstone is included in the Banger. Above the shale is a sandstone as much as 5 feet thick. The best exposures of these beds are on the sand and gravel deposits of Bessemer and the vicinity of Bessemer. In the region farther north where the reasonable expectation is that it has a larger content of clayey matter, which it would have acquired near the area of its lateral passage to the Floyd shale facies described below.

**NAME.**—The Floyd shale was introduced by Hayes for a thin mass of rock typically developed in Floyd County, Ga., composed predominantly of green, dark, and black shales but including considerable limestone and some sandstone.

In Shadwell the Banger limestone is here restricted passes laterally into that of the Floyd, and this shale the name Floyd is applied, although it is not strictly equivalent to the typical Floyd, which includes older beds than the Banger. In Shadwell the Floyd also extends up to the sandstone that makes Little Shadwell Mountain, which is taken as the base of the Parkwood formation, and in the northern part of Shadwell Valley an upper tongue of Floyd shale overlies the Banger limestone.

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### Section of Floyd shale in bore hole near Woodward shoal 3/4 mile southwest of Dunnavant, Ala.

<table>
<thead>
<tr>
<th>Bed</th>
<th>Name</th>
<th>Thickness</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>clay shale</td>
<td>Dunnavant</td>
<td>0.5</td>
<td>vertical</td>
</tr>
<tr>
<td>shale</td>
<td>Limestone</td>
<td>2.5</td>
<td>horizontal</td>
</tr>
<tr>
<td>sandstone</td>
<td>Fort Payne</td>
<td>0.2</td>
<td>horizontal</td>
</tr>
<tr>
<td>limestone</td>
<td>Limestone</td>
<td>2.0</td>
<td>horizontal</td>
</tr>
<tr>
<td>shale</td>
<td>Shale</td>
<td>1.0</td>
<td>vertical</td>
</tr>
</tbody>
</table>

**The absence of the Bangor limestone and Hartscle sandstone as distinct units in this locality is demonstrated by this section.**

**Thickness.**—The best determination of the thickness of the Floyd is afforded by the Woodward shoal, where the thickness penetrates 500 feet. As the shaft sinks about 500 feet below the top of the Floyd, the total thickness is about 1,045 feet. In a boring on Shades Creek, 2½ miles southwest of Oxmoor, the total thickness is about 1,000 feet.

**Owing to extreme crumpling in the area in Coosa Valley, in the Vaniverd quadrangle, no reliable estimate of thickness can be made. It may not exceed 1,100 or 1,200 feet, although only crumpling is its formation is highly inclined and its outcrop is 7 miles wide.**

**Relation of the Floyd shale and Bangor limestone.**—At Trussville, the Bangor limestone is from 20 to 30 feet thick and is nowhere more than 100 feet thick. In a bore hole just east of the Plantersfield-Beamsville valley it breaks down into nodules, and a little beyond coarsely crystalline fossiliferous limestone 5 feet thick at the edges it breaks down into nodules, and a little beyond coarsely crystalline fossiliferous limestone 5 feet thick.

**The tongues of Floyd shale overlying the Bangor limestone in Shades Valley was called Pennington in the Birmingham folio.**

**The occurrence of Canocephalus in this region is interesting.**

**The Parkwood formation was named from the town of Parkwood, in the Bessemer quadrangle, which is located on the formation. It includes the 1,500 to 2,000 feet of gray shale and sandstone lying above the base of the sandstone that makes Little Shade Mountain and Bald Ridge half a mile west of Oxmoor and below the Brown coal bed, which is taken as the base of the Parkwood formation. (See section 3, fig. 4.)

**The plants are of interest in that fossil plants are rare in the Mississippian and Pennsylvanian of the central United States.** They exhibit, too, a curious mixture of forms generally accredited to the Devonian, Mississippian, and Pennsylvanian (the *Asterocrinia* and the *Lepadina*).

**PARKWOOD FORMATION**

**Note.**—The Parkwood formation was named from the town of Parkwood, in the Bessemer quadrangle, which is located on the formation. It includes the 1,500 to 2,000 feet of gray shale and sandstone lying above the base of the sandstone that makes Little Shade Mountain and Bald Ridge half a mile west of Oxmoor and below the Brown coal bed, which is taken as the base of the Parkwood formation. (See section 3, fig. 4.)

**Distribution.**—The formation crops out in this quadrangle only on the west side of the Cahaba and Coosa coal beds, where it dips eastward beneath the younger rocks. It crops out along both sides of the Vaniver-Peavine creek valley; and, dipping westward, it is exposed for a short distance along the east side of the Coosa coal bed in the southern part of the Vaniver quadrangle. Along most of the east side of the Coosa coal bed the Parkwood is absent, but the best outcrops of the Parkwood are in the vicinity of Oxmoor, where it is nearly all exposed, and along the Southern railway west of Genery. Near (Huntsville)....

**Charcole.**—The Parkwood formation in this quadrangle is composed of gray shale and sandstone that bear a close resemblance to the Parkwood rocks, which overlie the Parkwood. The sandstone generally makes thick beds, the maximum being 100 feet thick, but it is not limited, and most of it is probably more or less feldspathic. Much of it is somewhat feldsparose and weather to a rusty color. No sub-"
Pottsville formation occupies three separate areas—the Warrior field, in the northwest corner of the Bessemer quadrangle; the Cahaba field, which lies diagonally across the southern part of the county; and the Coosa field, in the two quadrangles, and the Coosa field, which extends directly across to the Yancey quadrangle. 

Shales.—The Pottsville rocks are made up of sandstone and shale containing coal beds. The sandstone consists almost entirely of quartz grains and of mica shreds wholly of quartz grains, though it contains a little mica and of the sandstone contains enough feldspar to be markedly silicified. In addition to the feldspars the shale contains a large proportion of very fine quartz grains and of mica shreds in about equal proportion, together with small amounts of the other minerals that occur in the sandstone. Carbon and iron oxides are present in both shale and sandstone as coloring matter. The shale of the Pottsville range from a pure slate to a sandy material; the clay is excellent for building brick, especially pressed brick, and the sandy material for vitrified brick for paving and other purposes.

Although most of the rocks are probably of fresh-water origin, yet the presence of some fossil forms in certain beds at the bottom of the formation shows that these beds were deposited in the sea.

Is the most distinctive and valuable constituent of the formation is in and is described under the heading “Economic geology.” The names and vertical succession of the coal beds are shown in the columnar-section sheet and in Figure 5.

The lower part of the formation includes thick and resistant beds of sandstone or conglomerate that persist throughout all its exposed areas and occur in prominent ridge situations, such as Mount St. Moritz in the Warrior field, Shade Mountain in the Cahaba field, and Logan Mountain in the Coosa field. These beds are commonly called “Millstone grit.” Owing to their stratigraphic significance and topographic prominence several of these beds have been named and mapped as members of the Pottsville formation.

The part of the formation above that contains these basal sandstone members is a heterogeneous repetition of shale and sandstone beds, in which some of the shale beds are as much as 300 feet thick. Nearly all the workable coal beds occur in this upper part—that is above the “Millstone grit.” The coal-generating area of the Warrior field is generally associated with these beds, and sandstone and shale beds, in which some of the shale beds are as much as 300 feet thick. Nearly all the workable coal beds occur in this upper part—that is above the “Millstone grit.”

The other coal fields of Alabama, the nearly the uppermost coal bed of the Pottsville in this area, is more strongly developed than in the Cahaba field. In the Coosa field the Pine sandstone, like the Shades sandstone, is thick bedded at the base but finer grained and more flaggy at the top and is 250 feet thick.

Doubt Oak Mountain. The Shades sandstone is thick bedded, rather coarse, and generally somewhat conglomeratic in the lower part, where the pebbles of white quartz are small and nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg, and in their upper parts they are nearly the size of a pigeon’s egg.
The still higher part of the coal measures of the Warrior field falls in the middle Pot­ts­ville, no upper Pottsville being present, in that field. In the top of the lower Pottsville. The still higher part of the val­lom and higher coal beds, the boundary between the middle and upper Pottsville lying over the Holms or Yoh-­ni­ coal.

**CAHAVA FIELD**

**Coosa Field**

**War­ri­er Field**

**COSA FIELD**

**Bessemer Field**

**WARRIOR FIELD**

**WALTON FIELD**

**RICKER FIELD**

**Bessemer-Vandiver**

**Brook­wood-Middlefield**

**Mary Lee-Tidmore**

**Tid­more-­WARRIOR FIELD**

**Cobb-Nickel plate**

**Jefferson-Curry**

"Geologic history."

The alluvium consists of fine gravel and silt that has been laid down by the following streams as they have overflowed their banks. It is confined to the streams, and those strips with few exceptions are narrow. Its total area is only a few square miles, and usually not more than a few feet.

**STRUCTURE**

The term structure is here used to indicate the attitude or "lay" of the strata, which are in reality extensive sheets of rock, piled one upon another. The terms used in describing structural features are given on the inside of the cover page of this folio.

**METH­O­DS OF REPRESENTING STRUCTURE**

The structure of the Bessemer-Vandiver area is shown by structure sections and by structure contours. A structure section shows the lay of the strata as it would appear in a deep trench cut across the region at right angles to the general strike of the rocks. Structure contours show the structure by lines resembling those that represent surface contours, drawn on the map through points at which the surface of a bed taken as the reference stratum lies at a given distance above or below sea level. As for example a line passing through all points on the top of the Pratt coal bed 500 feet above sea level, another through all points 100 feet above sea level, and so on. In the Bessemer-Vandiver district the structure is represented by contours only in the small area of the Warrior coal field, in the northeast corner of the Bessemer quadrangle.

The details of structure are shown on the map by strike and dip symbols, by the lines that represent the position of the faults and axes of the folds, and by the structure sections. A few comments on general and special features follow.

**GENERAL FEATURES**

The general structure of this district is that characteristic of the Appalachian Valley province from Canada to Alabama. The originally horizontal strata have been folded as a result of lateral compression, so that now the major features of the structure are comparable to a succession of great waves that cross the quadrangle in a north-south direction, the crests of the waves corresponding to the great anticlines, such as the Bir­ming­ham anticline, and the troughs of the wave to the great syn­clines, such as the Cahava and Coosa coal fields. However, as the crests of the great anticlines have been eroded off, the undulating structure can be visualized only when the arches are restored in imagination. These major structural features are themselves affected by minor ant­ci­lines and syn­clines, which are walled and masked. Great overthrust faults form the eastern boundary of the synclinal troughs occupied by the coal fields.

From the Birmingham anticline the rocks dip southeastward into the Cahava trough. The Red Mountain formation, which creeps out at 1,000 feet above sea level on the crest of Red Mountain, descends to 1,200 feet or more below sea level in the Acton basin. The general southeastward dip is interrupted by minor folds like the Tacon and Dol­ley Ridge anticlines and the bounding Birmingham and Little Valley syn­clines. Along the southeast margin of the Cahava field the synclines become—the Carys­ba, Hol­ms, An­ton, and Little Cahava basins. Between the Little Cahava and Acton basins there is an area of complicated folding which has not been fully worked out, though in general character is indicated by the mapping and by structure section C-C' of the Vandiver quadrangle.

In the same manner the rocks on the southeast limb of another anticline dip from Cahava Valley southeastward into the Coosa trough but are interrupted by minor folds like the Vandiver anticline and the other minor folds mapped. The Vandiver anticline separates the Yellow­ro­of basin from the main area of the Coosa coal field. The Yellow­ro­of basin is a syn­clinal shaped syn­cline with the east side faulted out but with both ends part­ly preserved. From the east side of the Coosa field the rocks seem to dip, westward in general to the Col­urn­­bia syn­cline, which crosses the southeast corner of the Vandiver quadrangle. The former existence of an anticline near the Coosa field is indicated. The surface rocks east of the Coosa field are minutely crumpled, as noted in the description near the Coosa field is indicated. The surface rocks east of the Coosa field are minutely crumpled, as noted in the description.

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**METAMORPHISM**

Notwithstanding the great movement, with attendant friction and crushing near the fault planes there has been but slight metamorphism of the rocks. The Mon­ter­v­al­lo coal bed, which has been mined up to the fault, is said to show no change that would indicate any difference from its ordinary chemical composition.

As already described, the Floyd shales are very minutely crumpled, and the bed everywhere dips steeply. They have also been fractured minutely, and the fractures have been filled with quartz, which forms veins, mostly a quarter to half an inch thick.

**GEOLOGIC HISTORY**

In the earliest time of which there is record in the sedimentary rocks of the Appalachian Highlands, perhaps a hundred million years ago, along the site of the Appalachian Valley lay a strait between still more ancient lands on the east and on the west. This strait was on the eastern border a great area, extending in the region of the present Great Lakes, that was slowly but intermittently subsiding during all of Paleozoic time. The Appalachian shield widened into the Appalachian Gulf. The filling up of this sub­tend­ing earth basin by sediments derived from the bordering lands constitutes the period of this history which properly begins with the Pala­zoic era. The vast lapse of time which had preceded the deposition of these sediments is recorded in the rocks of the Blue Ridge and Piedmont provinces. These rocks, which extend beneath the Appalachian Valley and Appalachian Piedmont, are the foundation upon which the Paleozoic rocks rest.

**PALEO­COGHO EDA**

**CAMERON PER­IOD**

From the bordering land areas great quantities of mud were discharged into the Appalachian Strait by the rivers of Talladega time (Algonquin and Paleozoic). At times coarse sand mixed with small quartz pebbles was deposited and forms the few thin beds of quartzite in the Talladega slate. There was also a short period of limonite deposition, when the Swear limestone member was laid down. Fine clayey material greatly predominated, however, which indicates that the material was derived from land of low relief or was deposited in water distant from shore so that only the fine sediment was transported to it.

As most of the Talladega rocks were originally finely struc­ted clay they were evidently deposited in water, seeming under conditions favorable to Cambrian type of life. Except for the rare occurrence of unknown algae in the Swear limonite, however, no organic remains have ever been discovered in them or in their equivalent in Georgia and Ten­nes­see and it is believed that the Talladega strata were deposited during most of the time of its existence. In this lack of life the lower two-thirds of the Talladega rocks second with known pre-Cambrian rocks elsewhere in other structural features.

**15**
In the succeeding Weisner epoch much coarse sand with fine gravel was deposited in alternation with fine material like that of the Talladega. The Weisner epoch was certainly Carboniferous, for Lower Cambrian fossils occur, though rarely, in the Weisner formation.

The Weisner epoch was succeeded by that in which the Shady limestone was laid down. This indicates a great change in geographic or meteorologic conditions, for obviously none of these limestones can be deposited except in water free from earthy sediment. A few forms of life are known to have existed in the sea of the Appalachian region in Shady time but so far as known life was scarce.

The deposition of earthy sediment was resumed in the succeeding Rome epoch, and a notable feature of the deposits then formed is the red shale, which denotes perhaps an accumulation of soil stained red by iron oxide on a tributary land during an arid time in which the Shady limestone was laid down, the lack of water for the transportation of sediment being the cause of the deep sea of Shady time. At rare intervals the limestones was invaded by streams of tributaries bringing deposits of whose remnants are now entombed in the deposits laid down during the time of their invasion.

In the Conasauga epoch, which followed the Rome epoch, the conditions again favored the formation of limestones in Alabama. The land bridge was submerged, for limestones or sandstones of Conasauga (Upper Carboniferous) age is widely distributed over the Middle West, where the older Cambrian rocks are absent, so that the Upper Carboniferous rocks rest upon pre-Cambrian crystalline or metamorphic rocks. Life flourished throughout the Conasauga epoch. There were many species of trilobites and a great abundance of individual shells. Brachiopods were also plentiful but of few species. Probably in Conasauga was a persistent body of water known as the Chickamauga basin, which existed between Cahaba and Birmingham valleys, for, as shown under the heading "Descriptive geology," the Conasauga is already the eastern margin of the Cahaba basin, which was probably not deposited there because of an island in that part of the Conasauga sea. This Cahaba basin marks an area in which there was a decided tendency to uplift, technically called a positive area, as shown below, and this tendency is denoted by the peculiar distribution of the Ordovician limestones in the two valleys as noted under the heading "Steigings" (p. 1) and hereinafter mentioned.

CUMBERLAND OR OROPHYSIC PERIOD

The period succeeding the deposition of the Conasauga limestone and ending with the deposition of the dolomite was one of the most notable periods for the deposition of dolomites in the history of the earth. After the Conasauga limestone was laid down Birmingham Valley and Cahaba Valley were elevated above sea level, and the resulting erosion produced the unconformity described on page 1. After the deposition of the Brierfield dolomite in the Monticello region there followed a reemergence, including that of the Cahaba barrier, except south of Bessemer (p. 3), and the Kootenai dolomite was laid down in both Birmingham and Cahaba Valleys. It was followed over all the southern Appalachian region and so remained while the great area of the Copper Ridge dolomite was deposited. In Alabama, southeastern Georgia, and probably southern Tennessee this subsidence continued during Chepultepec time, but in the Birmingham Valley north uplifts precluded the deposition of the Chepultepec and Tuscumbia limestones.

The seas of this dolomite period were nearly devoid of living organisms that possessed parts capable of fossilization except in Chepultepec time, when some forms, principally gastropods, were common but not abundant. It is the common belief that dolomite is not deposited as dolomite but that limestone is first deposited and subsequently changed into dolomite by the substitution of magnesium for part of its calcium. So far as known at present limestone at present is being precipitated from solution in water by organic agencies such as molluscs, corals, and limestone plants, among which bacteria play a noteworthy part. As the dolomites of this period are nearly destitute of fossil shells and other parts of organisms, which would have been preserved, it is certain that the limestones from which the dolomites have been derived were not deposited by shell-bearing animals or corals. It seems probable, however, that the plants, bacteria, and other organisms were the principal agents, and that, being perishable, they have left no remains. The great mass of limestones may have been converted into compact dolomite contemporaneously with its deposition in sea water charged with magnesium salts.

OCEANOBRIC PERIOD

The Ordovician period was one of notable oscillation in the Appalachian Valley province, leading to repeated emergence and submergence of certain areas and corresponding gaps in the sedimentary sequence and causing a patchy distribution of the rocks of different ages in some areas as described under the heading "Steigings." The theory of oscillations as affecting the distribution of formations in Birmingham and Cahaba valleys is illustrated in Figure 6.

In Chickamauga time the waters of the region abounded in brachiopods, bryozoans, gastropods, and other marine forms, whose fossilized remains now fill the Chickamauga limestone and are present abundantly in the Little Oak and Little Oak limestones.

The distinct forms of Birmingham and Cahaba valleys during Ordovician time developed through the complete separation of the two areas by the Cahaba barrier. In Chickamauga time the Ordovician period was volcanic eruptions that occurred from late Chazy to early Tren­ton time. The sites of the volcanoes are unknown, but the last known time was so limited that the erupted rock dust was distributed, probably by the winds, over an area extending from Alabama to southern Ohio. Thus originated the bed of volcanic ash in the upper part of the Chickamauga limestones, described on page 7. The rarity of volcanic action in the Ordovician period in eastern North America is in strong contrast with conditions just across the Atlantic, where, in Wales and western England, volcanoes were active throughout Ordovician time and yielded volcanic rocks of large proportions which the Ordovician rocks, the ash beds or tuffs aggregating several thousand feet in thickness.

SILURIAN PERIOD

Great oscillation continued throughout the Silurian period. The elevation of the Cahaba Valley area above sea level prevented the deposition or removal of any Silurian deposits that may have been laid down in that region. Birmingham Valley and the site of the Cahaba coal field, on the other hand, were submerged at the beginning of the period and so remained while the Red Mountain formation was laid down. After about 100 feet of shale and sandstone had accumulated the Ordovician sea first occupied the lowlands and valleys, in which were formed the Attalla conglomerate (p. 7), and above this was laid down the remainder of the Silurian beds. The sea was probably uplifted and eroded and a pothole was formed that terminated the Big seam of ore that had been formed through the decay of a vast thickness of dolomites and limestones, just such as now covers large areas in the Birmingham region. The rivers that drained this area and emptied into the Silurian lagoon bore supplies of iron compounds in solution, just like modern rivers. Through the constant evaporation of the waters of the lagoon and the constant addition of the iron-bearing solutions the iron became concentrated and was deposited in the complexes, in time replacing part of the lime carbonate of the skeletal remains. Thus the Big seam was first formed, and on removal subside was buried beneath the subsequent sandstone and shale. By a repetition of the same conditions the Upper Silurian beds were formed. In the Ida area of Alabama an area of subaerial erosion or subaerial weathering was probably uplifted and eroded and a pothole was formed that penetrated the Big seam (p. 8). This pothole was filled during the time when the Attalla conglomerates lived in the region, for coals of Pennsacola origin occur in the material that filled the pothole. Of the Chazy spires, which lasted during the remainder of the Silurian period and extended in Alabama except in the extreme northwest corner of the State, where rocks of this age are believed to be present but not exposed.

DEVONIAN PERIOD

The gap in the record at the end of the Silurian period covers also the early part of the Devonian period. Then the region was again submerged, the submergence beginning in Oraukiny time and continuing into Ordovician time. A few characteristic Ordovician animals made their way into the southern part of the region and a few Ordovician forms invaded the Cahaba Valley belt. The remainder of the Devonian period, an immensely long time, is, however, blank in this region, except in so far as the Chattanooga shale, regarded by the writer as more probably of Mississippian age, may constitute a meager record that is not susceptible of certain interpretation. The region is possible interruptions is so great and the subject so speculative that limits of space preclude further discussion here. Evidence is accumulating, however, that the Devonian sea persisted into Hamilton time in a considerable area at least in parts of St. Clair and Calhoun counties lying to the northeast of the Chattanooga shale.

CARBONIFEROUS PERIOD

The events of the early part of Carboniferous time (Kinderhook epoch) are not recorded in the Birmingham district unless in the Chattanooga shale, and the succeeding Fern Glen
and Burlington arees are represented only in the lower beds of the Fort Payne group. The region was entirely submerged, however, during Kaskaskia (Fort Payne) and Waseca time but was raised again to sea level during all or parts of St. Louis and Ste. Genevieve time and the early part of the succeeding Cherokee time. Then it was submerged and so continued during the rest of Chester time, and, except in the northern part of the Bessemer quadrangle, where the Ranger limestone was deposited, presumably on the surface, which was at that time so near the sea. This condition of the sea lasted until the deposition of the first coal bed, the Pittsburgh, on the Red Gap fault, which produced the earthquake in the Birmingham district. Almost no records of them exist in the Birmingham district.

It will be dimly perceived perhaps from this brief history that the present is only a stage in the unending evolution of the earth and its inhabitants and is genetically connected with a remote past as well as with an equally remote future. The beginning of this mighty train of events we can not know, and its end we can not foresee.

**ECONOMIC GEOLOGY**

The mineral resources of the Bessemer-Vandiver area consist of coal, iron, dolomite and limestone, shale and clay, road metal, chalk, building stones, lime and cement materials, soil, and water. The areas most gossanized by violent earthquakes are the product of the coals, iron ore, and dolomite, for these are the raw materials of iron-making, the principal industry of the region. A necessary condition for the profitable operation of the iron-making industry in Alabama is the proximity of the deposits of coking coal, iron ore, and dolomite or limestone in one place. Red Mountain forms the western edge of the ore-bearing area. The Mary Lee coal group probably crops out in the Bessemer-Vandiver area. The Mary Lee coal group probably crops out in the Bessemer-Vandiver area.

**Bessemer quadrangle**

The Bessemer quadrangle includes in the northwest corner a small part of the Warrior coal field. The coals of the Warrior field are more or less distinctively separated into groups, which were named by McCalley, in ascending order, the Black Creek coal group, including the Black Creek, Jefferson, and Lick Creek coals; the Mary Lee coal group, probably consisting of the Mary Lee and Newton coal groups; the Pratt coal group, including the Gwin beds; and the Brookwood coal group, including the Carter, Millers, and Brookwood coals. The beds of the last two groups do not occur in the Bessemer-Vandiver area.

**MART LEE COAL GROUP**

The Black Creek coal group does not crop out in the Bessemer-Vandiver area.

**BROOKWOOD AND CARTER COAL GROUPS**

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**HIDALGO COUNTY COAL GROUP**

The Mary Lee coal group probably crops out in the Bessemer-Vandiver area.

**UNITED STATES GEOLOGICAL SURVEY**

The Mary Lee coal group probably crops out in the Bessemer-Vandiver area.
made up of thin layers a few inches thick separated by shale bands as much as 5 feet thick. Boreings that penetrate the Mary Lee group in this territory show that the different beds of the group can be recognized but are greatly split up and that workable benches occur only in the Jagger and Blue Creek beds. The same split-up condition that characterizes the beds of the Mary Lee group throughout the eastern part and probably through the whole Warrior field persists in stronger development in this part of the field. The comparatively thin layers of clay or shale in the Mary Lee bed elsewhere are represented in this territory by layers of shale as much as 5 feet thick, which separate the thin layers of coal so widely that the bed is workable. A section obtained 1 mile northeast of Doamples is an example. (See fig. 6, section 1.) In the Bessemer quadrangle the Jagger and Blue Creek beds are in better condition than the Mary Lee, each having a workable bench 3 feet 6 inches thick with which are associated thinner layers that are separated by a greater or less thickness of clay or shale. 

PRATT COAL GROUP

The Pratt coal group crops out from Wylam to a place 2 miles southwest of Dolomite, where its outcrop is cut by the Opponsum Valley fault. As the other beds of the group are deeply covered by rock wails, some of them are known on the outcrop except the Pratt, and that only as far as it has been opened in mines. They dip steeply to the northwest along their outcrops.

Gillespie and Curry coal beds. — Borings show that a number of thin layers of coal occur through a wide zone that may be broadly correlated with the Gillespie bed. Still higher there are a number of benches that correspond in a general way to the Curry bed. One of these benches, 230 feet below the Pratt coal, is 3 feet 6 inches thick.

Amorcia (Double) and Nickel Plate (Corvallis) coal beds. — The Amorcia bed, or at least its main bench, is 125 feet below the Pratt bed at the top of the Pratt group. This bed has been exposed in Wylam and Ensley, and sections measured at these places are published in the Birmingham folks (p. 18). In the Bessemer quadrangle, as revealed by borings, there are a number of layers separated by shale that may be assigned to this general horizon but not to the Pratt, and that only as far as it has been opened in mines. They dip steeply to the northwest along their outcrops.

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Squirl. In extension north of Teco is not certainly known, but it appears to break up into a number of thin beds, which may be so arranged as the thin worthless beds designated by the geologists of the Tennessee Coal, Iron & Railroad Co. The Big Dollar coal, or at least a number of thin beds, in its probable horizon is mapped with a broken line. It is not known to be of value in the Bessemer quadrangle.

**Coal beds in and about coal fields**

The Pump coal bed was examined only at creek level just west of the water tank half a mile south of Teco, where the bed has the section shown in section 5 of Figure 10. According to Squire, there is another bed only a small distance below this. The two beds correspond to beds above the Big Bone in the Montevallo quadrangles, called Young and Jones by the prospectors of the Tennessee Coal, Iron & Railroad Co., who traced those beds northward to the vicinity of the water tank above mentioned. In the Montevallo quadrangle, at a locality 5 miles north of the base of the Bessemer quartzite, these beds are about 40 feet apart and 3½ to 3½ feet thick with partings.

**YOUNGBLOOD (BLACK SHALE, COKE) COAL BED**

At the Falliston mine the Buck bed contains 2 feet 5 inches to 3 feet of clear coal. (See fig. 11, section 6.) The chemical character of the coal is shown in analysis 3744 (p. 20). The bed probably persists north of this locality and is probably one of a number of apparently thin beds which are present in the Altoa basin and which show in the road southeast of Bains Bridge. In the Little Cahaba basin a bed exposed on Coal Branch in the central part of sec. 15, T. 15 S., R. 1 W. (see fig. 11, section 7) is in the base of the Buck, and this view is corroborated by the existence of another bed a short distance north of the Coal Branch. This is the Coal Branch coal bed (black shale) bed. (See fig. 11, section 1.)

At points one-fourth of a mile distant on either side of the locality the bed, although the same, the bed, through it differs somewhat from its composition in that locality, still has a clear thickness of 27 inches on the south side and 26 inches on the north side.

**THOMPSON (LOWER) COAL BED**

The Youngblood seems to be a valuable bed along the whole length of its outcrop. In a cut on the Louisville & Nashville Railroad half a mile north of the roadway of the Youngblood (black shale) bed. (See fig. 11, section 1.)

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**HELENA COAL BED**

North of Buck Creek the bed is believed to be a lignite bed along the whole length of its outcrop. In a cut on the Louisville & Nashville Railroad half a mile north of the roadway of the Youngblood (black shale) bed. (See fig. 11, section 1.)

In the vicinity of the Buck Creek, a bed is known to be of coal containing a large amount of lignite, and that the bed shows a better thickness at some places in the Altoa basin, and which show in the road southeast of Bains Bridge. In the Little Cahaba basin a bed exposed on Coal Branch in the central part of sec. 15, T. 15 S., R. 1 W. (see fig. 11, section 7) is in the base of the Buck, and this view is corroborated by the existence of another bed a short distance north of the Coal Branch. This is the Coal Branch coal bed (black shale) bed. (See fig. 11, section 1.)

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The coal beds of the Cahaba and Coosa fields are generally inclined at angles exceeding 20°. In some places the beds are joined table of analyses by the United States Bureau of Mines.

The chemical composition of the coal is shown by the sub-ultimate constituents of coal or lignite with the same degree of accuracy as the ultimate constituents. Therefore, in the proximate analyses the moisture, volatile matter, fixed carbon, and ash are given in percentages of the moisture in the coals and in the ultimate analyses the ash, sulphur, hydrogen, carbon, nitrogen, and oxygen are given in atomic percentages. The determination of the calorific value of individual units is not reliable, and hence the British thermal units are given to the nearest ton.

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occur there is no great change in the character of the ore, for as we proceed from the same varies between an average of 35 per cent of metallic iron in this particular mine.

The ore in the upper bench of the Big seam, which is not known, contains about the same percentage of metallic iron as that in the upper bench, but owing to the larger percentage of silica and alumina and the smaller percentage of calcium carbonate it can not be profitably smelted at the present prices of iron. However, this ore can be treated as to eliminate much of the useless matter and to increase the percentage of metallic iron in the residue. This treatment is technically called beneficiation. In the future, as the deposits of higher-grade ore become exhausted and the ore in the lower-grade ore, of which there is an enormous quantity in the Birmingham district, can probably be utilized. Much of this ore may be permanently lost, however, through the settling of the roof of the present mines in the upper bench of the Big seam, which will make mining the lower bench impossible or as costly as to be prohibitive.

MINING CONDITIONS

The ore bed and inclining rocks dip southwestward under Shade Valley at angles of 10° to 20°. Locally the dip is greater than 20°, but over most of the area of the Big seam it is less than 20°. In a few mines, as Spangle Hill, Woodward, and Foster No. 1, faults have been encountered ranging in dip from 10° to 14 to 20° feet through the level of the ore. In a number of the mines the considerable irregularities of dip produce structural rolls. Exposure in Shades Valley also discloses local irregularities, such as vertical or overturned beds. Divided faults, such as those in the mines, are known, and probably there are others. There is a fault just east of Greece Gap and another on the east side of the area of the Fort Payne chart in the vicinity of Mount Morga.

The beds inclining the ore make a strong roof and floor to the mine, and this feature, combined with the thickness of the ore and the generally nodular dip, are favorable to mining. The water supply is adequate and near at hand. The mines are easily accessible by railroad, and transportation is cheaply provided.

The sillar and street method of mining is followed. Most of the workings are along bedding planes, with some workings along strike headings driven to right and left on the level.

DEPOSITS

Twenty-six slope mines are now operating in the part of Red Mountain between Spinks Gap and Birmingham. The deepest slope in 1897 was 2,301 feet long and is probably 5,000 feet or longer by this time (1926). Probably four-fifths of the Red Mountain ore is mined in the Birmingham district, amounting to 6,412,507 tons in 1925,19 comes from these mines. Detailed information on the mines and their products is given elsewhere.15

LIMESTONE AND DOLomite

The Chickamauga and Newala limestones and the Ketona dolomite afford the best rock for line, flux, cement, and other uses. The Conasauga limestone would afford rock suitable for cement.

Calcium carbonate limestone.—The Chickamauga limestones crop out in a narrow strip at the west foot of Red Mountain, under which it dips at angles of 10° to 20°. Much rock is accessible, however, free from cover of higher formations. Probably it does not differ much materially from the rock at Gate City, in the Birmingham quadrangle. Analyses of samples from an old quarry half a mile north of Gate City show a composition of about 90 to 95 per cent calcium carbonate; 2 to 6 per cent silica, and 1 to 5 per cent iron oxides. The rock is nonmagnesian and suitable for cement. It is not so well adapted for line and flux, however, as other rock in the district and is not likely to be in such demand for such use.

Ketona dolomite.—The Newala limestone is extensively exploited in Calhoun Valley for lime burning. The Keystone and quartz limestones and dolomite are in the area. Part of the Newala limestone, comprising probably a thickness of 900 to 900 feet, is, with the exception of a few local beds of dolomite which are called sandstone by the quarrymen, a very pure calcium carbonate. The quantity of this rock is practically inexhaustible.

The following table gives analyses of the Newala limestone and the sandstone made from it. The Keystone quarry is in the Bessemer quadrangle; the other quarry is in the same belt of limestone in the Montevallo quadrangle. The analyses are all given because the variations shown doubtless exist also in the Bessemer-Vandiver area. They represent the extremes as well as the general average composition with sufficient accuracy for all practical purposes. The samples were collected and the analyses made by Robert S. Hodges, chemist of the Alabama Geological Survey.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Description</th>
<th>Analysis (vol. %)</th>
<th>Specific gravity</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Newala limestone</td>
<td>71.10 15.00 11.00</td>
<td>2.67</td>
</tr>
<tr>
<td>2</td>
<td>Newala limestone</td>
<td>72.00 15.00 11.00</td>
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<tr>
<td>3</td>
<td>Newala limestone</td>
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<td>2.69</td>
</tr>
<tr>
<td>4</td>
<td>Newala limestone</td>
<td>74.00 15.00 11.00</td>
<td>2.70</td>
</tr>
<tr>
<td>5</td>
<td>Newala limestone</td>
<td>75.00 15.00 11.00</td>
<td>2.71</td>
</tr>
</tbody>
</table>

The Bessemer-Vandiver district has a variety of soils. The Chickamauga and Newala limestones and the Ketona dolomite afford the best rock for line, flux, cement, and other uses. The Conasauga limestone would afford rock suitable for cement.

C L A Y  A N D S H A L E

The limestones and dolomites of the region are generally overlain by a layer of residual clay that is in places as much as 6 feet thick. This clay has been rather extensively utilized for common brick in the vicinity of Birmingham. In 1925 about 2 per cent of the output of Bessemer lime worked at the Bessemer plant was utilized at the Bessemer Brick Works, 1 mile west of Bessemer. Shale suitable for making brick is present in enormous quantities in the Floyd, Parkwood, and Pettisville formations. Both the Pettisville and Parkwood shales are utilized in the Birmingham region for common, pressed, paving, and chemical brick of most excellent quality.

ROAD METAL

The limestones and dolomites already described will afford caliche clays and suitable material for road making both for foundations and surfaces. The dolomite of the coal measures and other beds will yield abundant material for foundation work. The charts of the region, especially the Bessemer chart, is an ideal material for surfaces on roads. The characterizations of the Floyd Parish which especially facilitates its use for this purpose is its minutely fractured condition, at least near its outcrop. It can be dug or blasted from its beds to considerable depths and comes out in a condition to go on the road with little or no further preparation. About 2 miles west of Bessemer chart is taken out in this way to a depth of about 100 feet. The comparatively brittle nature of the Floyd Parkwood chart allows it to pulverize and become firmly compacted into a hard, smooth mass. The formation will probably yield clay practically ready for the use as soon as it is put upon the outcrop, and the supply easily accessible to transportation along the east flank of Red Mountain and in West End Mountain is inexhaustible.

Clay from the Copper Ridge dolomite has been used to some extent for road dressing. It is taken from the bank adjacent to the road, where the fine portions of the sandstone clay mixed with clay have accumulated at the base of slopes. A considerable quantity of this material has been taken from a pit half a miles north-west of Mobile Junction, Bessemer.

BUILDING STONE

Abundant sandstone for rough masonry occurs in the Pettis­ville formation, Parkwood formation, Harville sandstones, and Red Mountain formation. A little brown sandstone has been taken from the Red Mountain formation in the vicinity of Gote City for superstructural work. However, very little stone of a quality suitable for such work can be obtained. In fact, the use of cement has practically supplanted that of stone for all kinds of course masonry, and there is practically no commercial demand for such rock as this region possesses.

SOILS

The Bessemer-Vandiver district has a variety of soils. The alu­na sandstone of the Pettisville formation yields a soil that ranges from a sandy to a clay loam, depending on whether sandstone or shale predominates in the underlying rocks, from the distinguished which of the soil is derived. Those types of soil are blended and modified by adumbral with other as a result of the over of the soil from the slopes. The soils are from 8 to 10 inches thick and are underlain by about 3 feet of sandy clay subsoil that contains fragments of rock. The soils them­selves contain a considerable percentage of rock fragments, but as a rule the fragments are fine and constitute no obstacle to cultivation. The soil is of moderate fertility.

This analysis is insufficient to determine the general char­acter of the Pettisville limestone. The rock analyzed is suitable for flux or for lime for most purposes. The Conasauga is utilized on a large scale for cement manufacture at Brays, a few miles northeast of Birmingham.

Quarrying conditions.—Except the Chickamaugas, which crop out on the walls of the canyon, the limestone and dolomite formations crop out on the level valley floors and dip generally at high angles, necessitating open-pit quarrying below the level of the surface. Consequently continual pumping and the hoisting of the rock to a considerable height. Successful operations, therefore, demand a rather expensive equipment.

LIME AND CEMENT

The raw materials of lime and cement abound but are not much utilized. The Nevallas, Lenoir, and Chickamaugas limestones are suitable for both lime and cement; the Lenoir is utilized by the large cement mill at Leeds, in the Birmingham quadrangle. The Chickamaugas supplies the line works at Chepa­lapo, 30 miles north of Birmingham, and the Newala supplies the limestone for the Keystone lime works and also for several other large lime works in Calhoun Valley south of Keystone. (See analyses in second column.)

The cement plant at Leeds obtains its shale from the Floyd Parkwood, which is utilized as a filler for cement for its inclusion in the Portland cement. Probably much of the shale in the Pettisville formation is suitable for cement.
The valleys underlaid by limestone and dolomite have some of the best soil. The soil which overlies the Keetuk dolomite is a red clayey loam of great thickness and of high natural fertility. The areas of Copper Ridge dolomite and of Fort Payne shale have a soil composed of stony loam which is comparatively unfertile on the hills and ridges but is productive in the valleys and low-lying flat lands among the hills, where it has accumulated by transportation from the higher ground. On the slopes and hills the soil is generally a white clay loam full of chunks of chert and boulders, which are an impediment to cultivation, but in the lower grounds the fragments of chert, though plentiful, are finer and less troublesome. The areas of Conasauga limestone have a reddish, yellowish, or black clay loam of good fertility. Locally these areas are low-laying, poorly drained, and unfit for tillage.

The alluvium along the streams is the best soil of the region, but it is of small extent.

**WATER RESOURCES**

*Surface water.*—The average annual precipitation in northeastern Alabama is 45 to 54 inches. This precipitation is enough to maintain a good water supply, except on the ridges and hills, which have a rapid run-off. The valleys and low-lying flat lands among the hills, where it has accumulated by transportation from the higher ground, are well-watered, but it is of small extent.

*Ground water.*—There are a good many large springs in the limestone areas. Hawk Spring north of Bessemer, which has a flow of 2,700,000 gallons daily, is one of the largest. This indicates a considerable underground circulation in the limestone. Springs are less common and smaller in the belts of shale and sandstone, as Shadow Valley and the Cahaba coal field. Here, however, the natural supply of water for domestic use can be obtained in wells generally not over 50 feet deep.

*Surface water.*—Three miles, 100 to 150 feet deep, drilled in the Conasauga limestone at Bladellings's brewery, in Birmingham, yield 250 gallons of water a minute each and have never shown any sign of exhaustion. Probably this limestone and the other limestones that crop out in the valley will yield abundant water, which, however, have to be pumped. The streams in the Cahaba coal field and along the Deannavent syncline is ideal for artesian wells. The Shadow and Pine sandstones, which should be good water carriers, crop out along the high ridges and underlie the alluvium at moderate depths on the flanks or near the axes of the synclines. It seems almost certain that strong flowing wells could be obtained by drilling to the sandstone beds on Patux Creek near Little Valley Mountain in the Bassmoer quadrangle or anywhere along the valley bottom between Okt and Double Oak mountains from Big Narrows to Deannavent. The structural conditions are displayed in structure sections $A$- and $B$- for both the Bessemer and Vanderblue quadrangles.

*Potable and domestic water.*—Potable water is supplied by many springs and by the streams fed by such springs, and permanent supplies of potable water for farms are obtainable almost everywhere from wells less than 50 feet deep. The chemical character of this water varies according to the nature of the underlying rock formations. The range in quality and composition of this water is shown in the accompanying table of analyses. The water from the limestones formations is of course hard water; that from the areas of Floyd shale varies according to the location of the well, some being high in hardness and some low. The analyses of the water of the Allinder and adjoining wells, Nos. 15 to 16, show the highest hardness. The differences are probably due to the presence or absence of limestone layers in the vicinity of the wells. Nearly all the samples from the Pottsville areas are of low hardness; they are freestone waters.

*No notable mineral water is known or reported from the Bessemer-Vanderblue area.*

Approximate analyses of waters of the Birmingham district, Ala.

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Sodium</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Total hardness</th>
<th>Chlorides</th>
<th>Temperature of water, $^\circ$ F</th>
<th>Acidity</th>
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</thead>
<tbody>
<tr>
<td>Jan. 17, 1913</td>
<td>18,19. Shades Creek at road crossing between Bessemer and Helena. Floyd shale.</td>
<td>10</td>
<td>15</td>
<td>22</td>
<td>47</td>
<td>46</td>
<td>101</td>
<td>160</td>
</tr>
<tr>
<td>Nov. 14, 1912</td>
<td>18,19. Shades Creek at road crossing between Bessemer and Helena. Floyd shale.</td>
<td>22</td>
<td>15</td>
<td>22</td>
<td>47</td>
<td>46</td>
<td>101</td>
<td>160</td>
</tr>
<tr>
<td>Jan. 17, 1913</td>
<td>20. Well of St. Paul's Episcopal Church, Bessemer. Fort Payne shale.</td>
<td>30</td>
<td>45</td>
<td>22</td>
<td>77</td>
<td>89</td>
<td>115</td>
<td>220</td>
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</table>

**WATER POWER**

*Stream flow.*—No regular gaging stations have been maintained, but the following miscellaneous discharge measurements have been made on streams in the Bessemer and Vanderblue quadrangles. These measurements and the data in the accompanying table compiled from records at gaging stations on streams adjacent to the area give an indication of the flow that may be expected.

Approximate analyses of waters of the Birmingham district, Ala.

<table>
<thead>
<tr>
<th>Date</th>
<th>Source</th>
<th>Sodium</th>
<th>Potassium</th>
<th>Calcium</th>
<th>Total hardness</th>
<th>Chlorides</th>
<th>Temperature of water, $^\circ$ F</th>
<th>Acidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 17, 1913</td>
<td>18,19. Shades Creek at road crossing between Bessemer and Helena. Floyd shale.</td>
<td>10</td>
<td>15</td>
<td>22</td>
<td>47</td>
<td>46</td>
<td>101</td>
<td>160</td>
</tr>
<tr>
<td>Nov. 14, 1912</td>
<td>18,19. Shades Creek at road crossing between Bessemer and Helena. Floyd shale.</td>
<td>22</td>
<td>15</td>
<td>22</td>
<td>47</td>
<td>46</td>
<td>101</td>
<td>160</td>
</tr>
</tbody>
</table>

**Potential horsepower.*—Cahaba River and the larger creeks are capable of developing considerable power for gristmills, sawmills, small electric plants, and other uses. Cahaba River in the vicinity of Blount, about 10 miles southeast of Bessemer, would yield 500 net horsepower with a 46-foot dam and an 80 per cent turbine at ordinary low water.

In this district the flow of Cahaba River is of course smaller and the potential power correspondingly less, though still considerable. A number of gristmills and sawmills utilizing 10 to 40 horsepower have been operated on different streams. Paper Creek at Helena supplies power for running a small electric plant for lighting the town. These plants, however, have been developed but an insignificant part of the possible water power of the region. Similar small plants could doubtless be built on Cahaba River, Shadow Creek, Valley Creek, and other streams.

December, 1925.