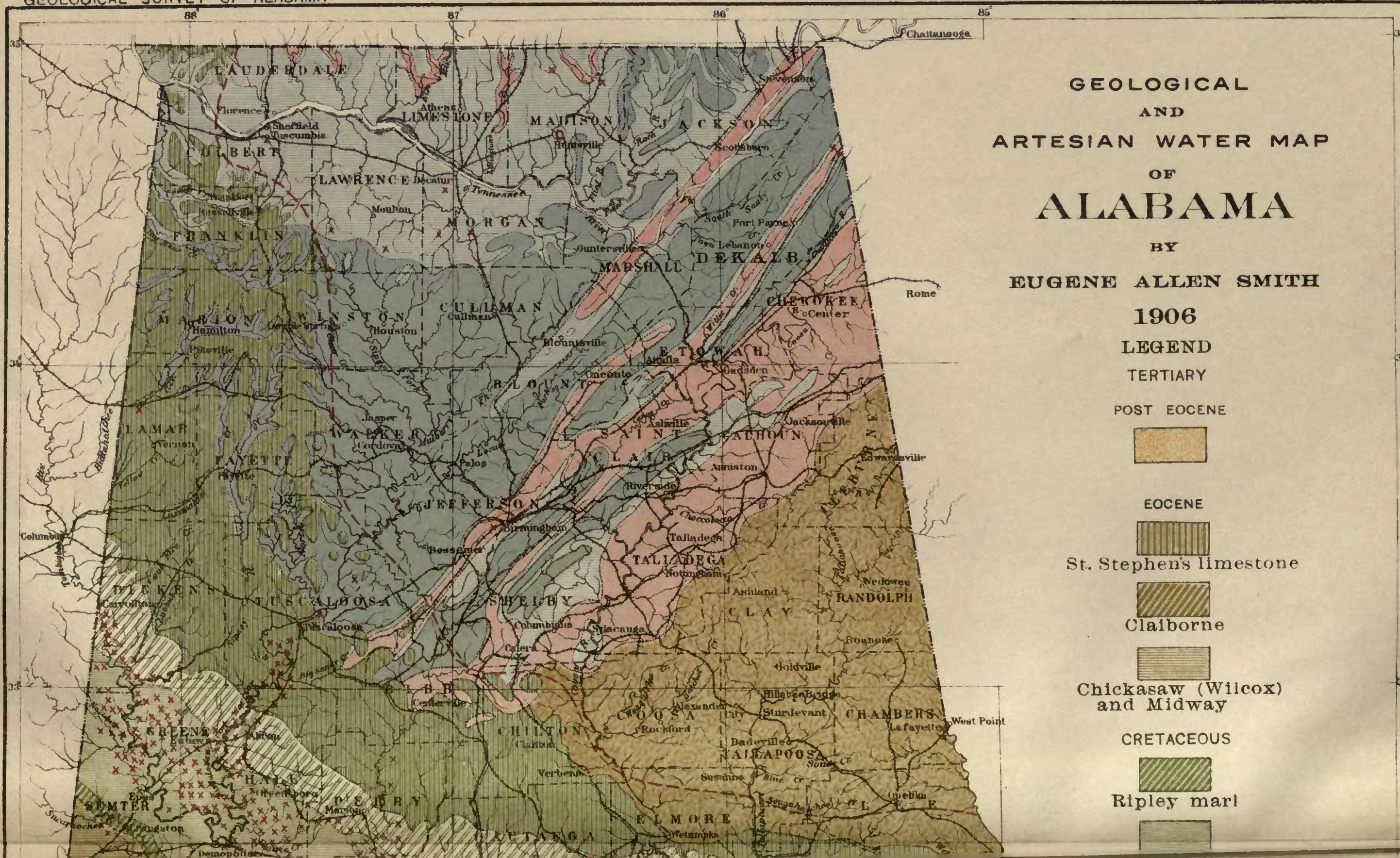
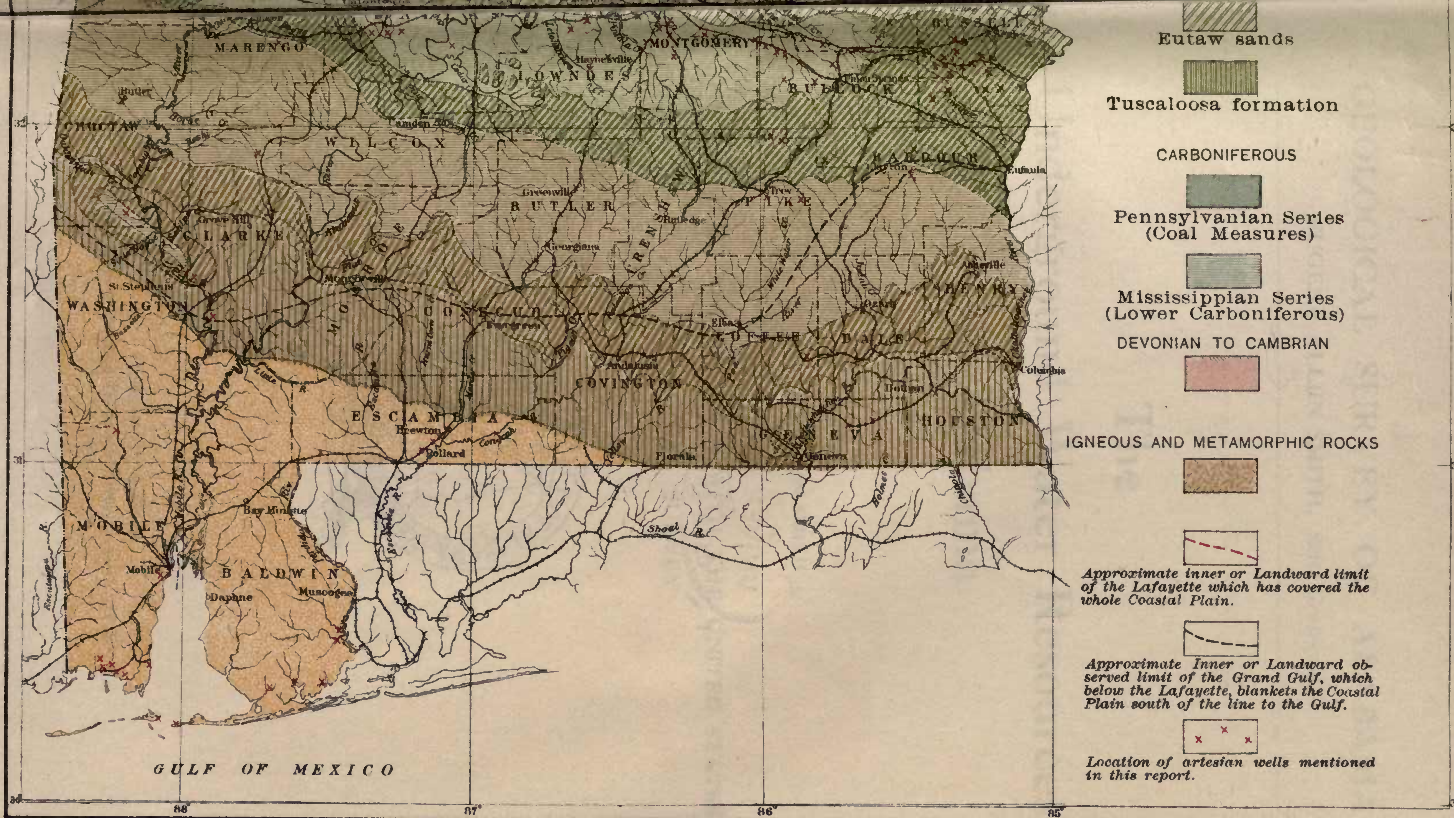

GEOLOGICAL
AND
ARTESIAN WATER MAP
OF
ALABAMA
BY
EUGENE ALLEN SMITH
1906
LEGEND
TERTIARY
POST EOCENE
EOCENE
St. Stephen's limestone
Claiborne
Chickasaw (Wilcox) and Midway
CRETACEOUS
Ripley marl
LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
LAWRENCE
MORGAN
MARSHALL
DEKALB
FRANKLIN
MARION
WINSTON
CULLMAN
CHEROKEE
ETOWAH
BLOUNT
LAMAR
FAYETTE
WALKER
SAINT CLAIR
CALHOUN
JEFFERSON
TALLADEGA
CLAY
RANDOLPH
PICKENS
TUSCALOOSA
SHELBY
GREENE
BIBB
CHILTON
COOSA
TALLAPOOSA
CHAMBERS
HALE
PERRY
SUMTER
ELMORE
Chattanooga
Rome
West Point
Columbus
Florence
Sheffield
Tuscumbia
Athens
Huntsville
Scottsboro
Decatur
Birmingham
Bessemer
Tuscaloosa
Gadsden
Anniston
Talladega
Jasper
Cullman
Wetumpka
Demopolis



Eutaw sands
Tuscaloosa formation
CARBONIFEROUS
Pennsylvanian Series (Coal Measures)
Mississippian Series (Lower Carboniferous)
DEVONIAN TO CAMBRIAN
IGNEOUS AND METAMORPHIC ROCKS
Approximate inner or Landward limit of the Lafayette which has covered the whole Coastal Plain.
Approximate Inner or Landward observed limit of the Grand Gulf, which below the Lafayette, blankets the Coastal Plain south of the line to the Gulf.
Location of artesian wells mentioned in this report.
MARENGO
MONTGOMERY
LOWNDES
BULLOCK
CHOCTAW
WILCOX
BARBOUR
BUTLER
PIKE
CLARKE
HENRY
WASHINGTON
CONECUH
COFFEE
DALE
COVINGTON
ESCAMBIA
HOUSTON
GENEVA
MOBILE
BALDWIN
GULF OF MEXICO
Hayneville
Union Springs
Camden
Eufaula
Greenville
Rutledge
Georgiana
Troy
Abbeville
St. Stephens
Monroeville
Evergreen
Elba
Ozark
Andalusia
Columbia
Dothan
Brewton
Pollard
Florala
Geneva
Bay Minette
Mobile
Daphne
Muscogee
Shoal R.
Holmes
32°
31°
30°
88°
87°
86°
85°
A. HOEN & CO. BALTIMORE.

GEOLOGICAL SURVEY OF ALABAMA

EUGENE ALLEN SMITH, *State Geologist*

[Monograph no. 6]

The
Underground Water Resources of Alabama

By

EUGENE ALLEN SMITH

PREPARED IN CO-OPERATION WITH THE UNITED STATES GEOLOGICAL SURVEY

Montgomery, Alabama

The Brown Printing Company, State Printers and Binders

1907

PREFATORY LETTER.

To his Excellency,
B. B. COMER,
Governor of Alabama,

Sir:—Since 1898 the Geological Survey of Alabama in co-operation with the United States Geological Survey, has been engaged in the systematic investigation of the Water Resources of the State.

Most of the well records contained in the present report were published by the United States Geological Survey, in Water Supply and Irrigation Paper No. 102, "Contributions to the Hydrology of the Eastern United States, by M. L. Fuller, 1903-4." A year later a Summary of the Underground Water Conditions in Alabama, with a sketch map showing approximately the artesian water systems of the State, was prepared by the present writer for Water Supply and Irrigation Paper No. 114 of the National Survey, "Underground Water Conditions of the Eastern United States, by M. L. Fuller, 1904."

The manuscript of this report, in approximately its present form, was submitted in July 1905 to the Director of the United States Geological Survey. In that office it was edited, to its material improvement, and with the expectation of early publication; but owing to the congestion of work at the Government Printing Office, the prospect of immediate publication by the National Survey seemed to be so remote that the manuscript was returned for publication by the Alabama Survey.

During this interval a considerable amount of new material had accumulated, which has been incorporated in the report, together with additional sections in the discussion of the Chemistry and Classification of the Alabama Waters.

I trust that the report now submitted to the people of Alabama may be of service to many, and that in due time it may be followed by a more comprehensive account of the Underground Water Resources of the State, and especially of the medicinal waters.

Most of the records of wells and springs herein mentioned were collected by Dr. B. F. Lovelace, then with the University of Alabama; some, by Mr. James A. Anderson of Alabama Survey; the rest by correspondence from the office of the United States Geological Survey. The analyses, with the few exceptions duly credited, were made in the laboratory of the Alabama Survey by Mr. R. S. Hodges, Chemist to the Survey.

Very respectfully,

EUGENE A. SMITH,
State Geologist.

University of Alabama, March 25, 1907.

TABLE OF CONTENTS.

CHAPTER I.

CHAPTER II.

CHAPTER III.

CHAPTER IV.

ILLUSTRATIONS.

FULL PAGE PLATES.

FIGURES IN TEXT.

UNDERGROUND WATER RESOURCES OF ALABAMA.

CHAPTER I.

PHYSICAL GEOGRAPHY, GEOLOGY, AND CLIMATE.

PHYSICAL GEOGRAPHY AND NATURAL DIVISIONS.

Geographic position.—Alabama is situated between the eighty-fifth and eighty-ninth meridians of west longitude and mainly between the thirty-first and thirty-fifth parallels of north latitude. The total area thus included is, according to the latest estimates, 52,251 square miles, of which 51,540 square miles constitute the land surface.

Surface Configuration and Grand Divisions.—Apart from the minor inequalities and the relatively small area of the Talladega Mountains, the surface of the State may be considered as an eroded or dissected plain, whose mean elevation above sea level is not much less than 600 feet. To the north and east the surface rises above this elevation and to the south and west it sinks below it. A curving line drawn from the northwest corner of the State through Tuscaloosa and Montgomery to Columbus, Georgia, would mark approximately the southern boundary of the area whose altitude is above 600 feet. This elevated land is the Southwestern terminus of the great Appalachian region, and forms the *Appalachian Division* of this report.

The line along which the highest altitudes occur—i. e., the axis of elevation of this area—runs in a northeast-southwest direction nearly along the northern boundaries of Coosa, Clay, and Cleburne counties. The altitude increases toward the northeast, and as a consequence the general slope of the surface is away from this elevated area toward the northwest, west, southwest, south, and southeast. The mountains of the State all rise 1200 to 1600 feet above the highland, or 2000 to 2400 feet above sea level. The rest of the State, whose general altitude is less than 600 feet, constitutes the *Coastal Plain Division.* The surface of this area slopes, approximately one foot to the mile, south and west toward the Gulf of Mexico and the Mississippi Valley. The elevation decreases from about 600 feet where it touches the Appalachian division to 200 to 300 feet in the highlands overlooking the Gulf in the two coast counties. Into the materials of this gently sloping plain the rivers and other streams have sunk their channels, leaving between them the remnants of the original mass which constitute the hills of this section of the State.

Another point of difference between the two great divisions, readily seen by an inspection of the map, is the prevailing northeast-southwest direction of the minor subdivisions of the Appalachian area and the approximately east-west trend of such subdivisions in the Coastal Plain area. Some other important differences between the two sections will be discussed below.

River systems.—In general terms, two factors have been mainly instrumental in determining the direction of the drainage systems of Alabama. These are, first, the slopes toward the northwest and southeast away from the Appalachian axis of elevation, and second, the more general slope of the surface of the State, taken as a whole, southwestward toward the Mississippi Valley. The latter factor has greatly outweighed the former in fixing the direction of the watercourses, the result being that the whole drainage system of the State has a general southwesterly direction, with the single exception of the Tennessee River.

In the southeastern half of the Appalachian area, while the natural fall is to the southeast and south, most of the streams, especially the minor ones, are also influenced by the northeast-southwest trend of the valleys and ridges and make their way toward the Coastal Plain in a zigzag course, alternating between southeast and southwest. In the northwestern half of the Appalachian area, the two branches of Black Warrior River follow in general the troughs or basins of the Warrior coal field, which pitch toward the southwest, while the Tennessee, entering the State near its northeastern corner, follows a limestone valley southwestward to Guntersville, and then turns northwestward down the slope from the axis of the Appalachian highlands.

In the central part of the Appalachian area the dependence of minor ridges and valleys on the geologic structure is most clearly seen. They all have a northeast-southwest trend, parallel to the strike of the outcropping edges of the folded strata. The valleys are cut into the limestones and other easily eroded rocks, while the harder rocks form the ridges.

In the Coastal Plain area the main or trunk streams have southerly or southwesterly courses, determined by the general slope of the surface; while their minor tributaries together with attendant ridges and valleys, are controlled in location and direction by the geologic structure and by the character of the materials of the geological formations.

Throughout the Coastal Plain the constituent beds of sand, clay, limestone, and marl, have a dip in the same general direction as the surface of the country, but at a more rapid rate—on an average about 35 or 40 feet to the mile. While the main (consequent) streams have cut across the edges of these slightly inclined beds, the smaller streams run roughly parallel to them. The result is that the landward or in-facing slopes of the minor stream valleys are abrupt, while the slopes facing gulfward are very gentle, often hardly to be distinguished from horizontal. Thus, while the adjustment of the smaller streams of the Coastal Plain to the geologic structure is not so striking, it is in places quite as complete as in the Appalachian area.

Mountains and table-lands.—As has been intimated above, the mountainous region of the State is confined to the Appalachian division, the two halves of which (divided by a northeast-southwest line) show important differences. In the southeastern half the strata have been greatly folded and plicated and in part metamorphosed, and are always much indurated. As a consequence the mountains of this section, illustrated by the Talladega Mountain range, the most elevated in the State, are often sharp-crested and serrated, but always with uneven summits. In the northwestern half the strata are in wide, open waves or folds, and the mountains, exemplified by the Cumberland Plateau, are merel ythe remnants of an elevated tableland, with steep slopes toward the bordering valleys. Between the principal members of this mountain system are great valleys which are carved in the main from limestones interstratified with harder and more durable beds of sandstone and chert. These harder beds form northeast-southwest minor ridges which flute the great valley areas.

There are no mountains properly so called in the Coastal Plain. The hills, like those of the Cumberland Plateau, are merely remnants carved from the original mass.

Sub-Divisions.—The sub-divisions of the Appalachian area, based on the topographic and geologic features, are: (1) The Talladega Mountains and Ashland Plateau, of igneous and metamorphic rocks; (2) the Appalachian valleys of Paleozoic rocks below the Coal Measures, (Pennsylvanian); (3) the coal fields of the Pennsylvanian Series; and (4) the Tennessee Valley, of the Mississippian Series, (Lower Carboniferous.)

The Coastal Plain has two great basal systems, the Cretaceous and Tertiary, and two blanket formations, the Grand Gulf and Lafayette. The Coastal Plain is best adapted to general agriculture and is noted for its extensive forest growths.

In both these great divisions of the State the topographic and other distinctive characters of the minor subdivisions are so intimately dependent on the geologic structure that it is desirable to discuss these features in connection with the geologic formations.

GEOLOGY.

The subjoined table shows the chronological sequence of the geologic formations represented in Alabama, and the geologic map (Pl. I.) shows their surface distribution. It may be added that the existence of certain late Tertiary marine formations in the lower counties of the State has been revealed by deep borings, while their outcrops have not as yet been observed at the surface, a circumstance that is partly explained by the presence in that section of two superficial formations, the Grand Gulf and the Lafayette, beneath which these marine deposits lie in places deeply buried.

GEOLOGIC FORMATIONS OF ALABAMA.

- Quaternary.
  - Soils
  - First bottom deposits and recent alluvium
  - Second bottom deposits
  - Columbia sands
  - Lafayette
- Tertiary
  - Pliocene
    - Grand Gulf
    - Pascagoula
  - Miocene—Chattahoochee (Alum Bluff, Oak Grove, etc.)
  - Eocene
    - St. Stephens limestone
    - Claiborne
      - Gosport greensand
      - Lisbon beds
      - Tallahatta buhrstone
    - Chickasaw Or Wilcox (Lignitic)
      - Hatchetigbee
      - Bashi (Woods Bluff.)
      - Tuscahoma (Bells Landing.)
      - Nanafalia (Coal Bluff)
    - Midway
      - Naheola (Matthews Landing.)
      - Sucarnochee clay
      - Clayton limestone
- Cretaceous
  - Ripley marl
  - Selma chalk
  - Eutaw sand
  - Tuscaloosa formation
- Carboniferous
  - Pennsylvanian Series (Coal measures)
  - Mississippian Series (Lower Carboniferous)
    - Bangor limestone } Contemporaneous.
    - Oxmoor formation } Contemporaneous.
    - Tuscumbia limestone } Ft. Payne chert
    - Lauderdale chert } Ft. Payne chert
- Devonian—Chattanooga black shale
- Silurian—Red Mountain formation (Clinton)
- Ordovician
  - Pelham limestone (Trenton)
  - Knox Dolomite
- Cambrian
  - Coosa shale
  - Montevallo formation
  - Aldrich limestone
  - Weisner sandstone
- Metamorphic and Igneous rocks
  - Talladega slates — Metamorphic Paleozoic strata; Pennsylvanian in part
  - Ashland mica schists — Metamorphic sediments of undetermined age, probably Paleozoic
  - Igneous rocks — Granites, diorites, gneisses, etc., of several ages (pre-Cambrian and Paleozoic)

Appalachian Division.

The main characteristics of the Appalachian area have already been sketched. Its four subdivisions will now be taken up more in detail, especially as regards the topography and geologic structure, the discussion of the relation of these to the circulation of the underground waters being left to another chapter.

Talladega Mountains and Ashland Plateau, (igneous and metamorphic rocks.)—These two sections correspond with the Blue Ridge and the Piedmont plateau of Georgia and the States to the northeast. They make up the southeastern half of the Appalachian division, embracing part or all of Cleburne, Talladega, Clay, Coosa, Chilton, Elmore, Tallapoosa, Randolph, Chambers, Lee, and Macon counties. The rocks are all more or less crystalline in texture and fall into two general classes: (1) massive or dike rocks of igneous origin, such as granite, diorite, and diabase; and (2) metamorphic or schistose rocks. The latter class is likewise divided into two divisions according to origin: (a) those derived from igneous rocks, such as the gneisses, the hornblende schists, the Hillabee green schists, etc., (b) and those derived from sediments, such as the feebly crystalline phyllites of the Talladega Mountains, which are now known to be, at least in part, of the age of the Pennsylvanian series, (Coal Measures); the more fully crystalline mica-schists of the Ashland Plateau; and the quartzites and crystalline marbles and dolomites.

The planes of schistosity of these rocks, which may or may not coincide with original bedding planes, have in Alabama an almost universal dip to the southeast, giving a general northeast-southwest direction to all those topographic features which are due to the differential weathering of their outcropping edges.

The Talladega Mountains, form the northwestern part of this subdivision. They are high, generally sharp-crested ridges with narrow, often gorgelike valleys between. These mountains have an altitude of 2400 feet above sea level and are the highest peaks in the State. From this elevated land the country falls off rapidly on the west toward the great Coosa Valley, and on the east to the Ashland Plateau. The latter has an average elevation above the sea of 1000 feet. The plain-like character of this plateau is evidently the result of erosion—"base-leveling"—and is not due to the horizontal position of the rocks, as is the case with the Cumberland Plateau, presently to be described. The surface of the Ashland Plateau is made up of beveled-off edges of the steeply dipping schists, and the present topographic features are due to the subsequent elevation of this baseleveled plain and the dissection of its mass by the watercourses.

The recent discovery of Carboniferous fossils on the eastern flank of the Talladega Mountain range where it merges into the Ashland Plateau, is evidence that some, at least, of these metamorphic rocks are of Paleozoic age. The southeastern half of the Plateau is in part made up of gneisses and mica-schists which are apparently older than the schists above mentioned. This may be due, however, simply to a greater degree of alteration. Dikes of granite, diorite, gabbro, and other types of rock generally considered to be of unquestioned igneous origin are sometimes intruded between the schists, and frequently across them.

In the western part of the Ashland Plateau these dikes intersect the Paleozoic schists and are, therefore, of Paleozoic or later age. In the eastern part, the dikes are intruded into schists of possible pre-Cambrian age. A kind of metamorphosed trap rock or greenstone of peculiar character has been traced in an irregular line of outcrop from Chilton County, Alabama, into Georgia. This has been called the Hillabee Schist. It has been observed in Alabama only along the eastern base of the Talladega Mountain range, generally separating the slates of the Talladega Mountains from the mica-schists of the Ashland Plateau.

Appalachian Valleys (*Paleozoic formations below the Pennsylvanian*).—The wide valley with prevailing calcareous soils lying between the Talladega Mountains on the east and Lookout Mountain and the Coosa coal field on the west has received the name of Coosa Valley, from the river which drains it. It is the continuation and terminus of the Valley of East Tennessee and the Great Valley of Virginia. Cahaba Valley lies between the Coosa and Cahaba coal fields; Wills Valley occupies the country between Lookout and Raccoon mountains. Both of these valleys merge into the Coosa Valley between the end of Lookout Mountain and the Cahaba coal field. Between the Warrior and Cahaba coal fields are Shades and Jones valleys, the latter at its north end branching into Coosa Valley on the one hand and Murphrees Valley on the other. Farther west, lying between Raccoon Mountain on the east and the Cumberland Plateau on the west, is Browns or Blount Springs Valley, the prolongation in Alabama of the Sequatchee Valley of Tennessee. In structure all these valleys are anticlinal—that is, they have been eroded out of the crests of the long, narrow folds into which the strata have been bent by the compressing force acting from the southeast. With the exception of Murphrees Valley, these folds were lapped over toward the northwest and so have their steeper slopes on that side, while the gentle slope is toward the southeast. In Murphrees Valley the reverse is the case, the steeper slope being on the southeast side. The erosion to which these arches have been subjected has removed their crests, leaving only the remnants of the upbent strata to show by their position the original structure.

In the Coosa Valley the structure is more complex. It is not a single anticlinal fold, but rather a series of folds, closely compressed, overlapping toward the northwest, and complicated by faulting and over-riding of the broken parts. Most of the present strata are the remnants of these folds. They have in consequence a very general dip toward the southeast. In the other valleys the structure is more simple, since there is but a single arch, which is nearly always, broken or faulted on the northwest side, (on the southeast side in Murphrees Valley.)

The steep dips above alluded to are always on the faulted side. By reason of the faulting, some of the strata are cut out and do not appear as they should in a normal anticline.

The geologic formations occurring in these valleys range from the lowest Cambrian up to the Pennsylvanian series, the latter, however, affecting the valley making only in the sense that it makes the summits of the bordering mountains. The most prominent of these formations is the Knox dolomite, a massive calcareous rock which generally occupies the central portions of the valleys. There are also other important limestones and calcareous shales, of Cambrian age, which form the floors of parts of these valleys, especially of the Coosa. All these limestones are interbedded with sandstones and chert, which stand out as subordinate ridges that diversify all the valleys. The Coosa Valley is thus a great trough, 30 miles wide, fluted with scores of parallel smaller valleys and ridges. The other valleys mentioned are of similar nature, but have less of these minor features.

The Weisner sandstone occurs, so far as the writer has observed, in the Coosa Valley region only. It is a veritable mountain-making formation, appearing most prominently in the range that extends from Alpine Mountain, near Coosa River, northeastward by Talladega, Oxford, and Anniston and on part Jacksonville into Georgia. The sandstones of the Red Mountain (Clinton) formation, as well as those of Mississippian series (Lower Carboniferous,) in the southwestern part of the Coosa Valley, form a number of well-defined ridges. The siliceous or cherty parts of two of the limestone formations—the Knox dolomite and the Lauderdale make prominent flint ridges in all the valleys; the Lauderdale also caps the Red Mountain (Clinton) ridges of the smaller valleys. A great body of calcareous shales and shaly limestones, appears in the "Flatwoods" of the Coosa Valley, extending from the Georgia line on both sides of the river down to Gadsden and thence farther southwestward toward the north end of the Cahaba coal field. These are the Coosa and Montevallo shales of Cambrian age.

The Pelham (Trenton) and Bangor limestones are of less importance in the valley making, though each is found in the subordinate troughs of the greater valleys. Shades Valley, which has been formed mainly out of the Bangor limestone, lies between Red Mountain, east of Birmingham, and Shades Mountain, the western escarpment of the Cahaba coal field, and forms a very important topographic feature of that section.

These great valley regions are of extreme importance to Alabama from the fact that they contain the iron ores, bauxites, limestones, shales and clays, all of which have played a prominent part in the development of the State.

Coal fields (Pennsylvanian series.)—The coal fields are four in number—the Coosa, Cahaba, Lookout Mountain, and Warrior. They are separated from one another by long, narrow anticlinal valleys above described. Structurally they are troughs or synclines between these anticlines. In a general way it may be remarked that the synclinal troughs were much wider than the anticlinal ridges, and that, away from the immediate vicinity of these uplifts, the strata of the coal fields are far less disturbed than are those of the adjacent valleys, retaining in general their original nearly horizontal position. By reference to the geological map it will be noticed that the expanse of nearly horizontal strata of the coal becomes gradually wider and wider to the west and that the upward-bent wrinkles of the valleys are correspondingly narrower and farther apart. In the Coosa and Cahaba fields the syncline is unsymmetrical. Its axis lies close to its southeastern edge, in consequence of which the strata on the western side of the synclinal axis, embracing the greater part of the field, have a gentle southeasterly dip. On the eastern side they are sharply upturned, at times vertical, and give to these fields the appearance of being monoclines. Cross folds of minor character divide both these fields into several smaller basins. Lookout Mountain is a shallow synclinal trough well elevated above the valleys on each side of it. The same may be said of Raccoon Mountain, which forms the northern and northeastern parts of the Warrior field. Raccoon Mountain is capped by the Pennsylvanian rocks and presents steep escarpments to the bordering valleys. That part of these fields in which the flat-topped summits of the highlands are capped with Pennsylvanian rocks, has been called the "plateau region." Across Tennessee River, in the northeast corner of the State, these plateaus are known as the spurs of the Cumberlands. In the southwestern part of the Warrior field, however, the strata of the Pennsylvanian series are found at levels ranging from that of the general drainage to far below it. This part of the field has been called the "basin region." It is evident that in the plateau region only the lower strata of the Pennsylvanian series are present, while in the basin region we may have, and in its southwest end do have, the entire thickness of these rocks. The principal coal-mining districts are thus to be found in the western or southwestern parts of these fields, especially in the Warrior and Cahaba, and less conspicuously in the Coosa. The Lookout field is wholly in the plateau region.

Valley of the Tennessee, (Mississippian series).—The area included under this head is naturally divisible into two parts, the first including the region east of Huntsville, bordered by the Cumberland mountains on the one side and Sand Mountain on the other. The second part embraces the valley west of Huntsville to the Mississippi State line.

From the northeast corner of the State down to Guntersville, the river is confined to a long narrow trough, known in Tennessee as the Sequatchee Valley, and in Alabama as Browns or Big Spring Valley. Below Guntersville the river flows in a northwest direction along a narrow, often gorge-like valley through the Cumberland Plateau to about the Meridian of Huntsville. It here emerges into the broad and open valley which is usually referred to as the Valley of the Tennessee.

The geologic formations of this lower stretch of the river are the Bangor (Chester) limestone with its interstratified sandstones, lying in general south of the river, while the country to the north is made by the siliceous limestones of the Tuscumbia (St. Louis), the Lauderdale, and other members of the Mississippian series below the Bangor. These strata, while almost horizontal, have yet a perceptible dip to the south. The river crosses them nearly at a right angle to the dip, giving a Coastal Plain type of topography. The river itself occupies a broad trough in the Tuscumbia limestones, while on both sides are erosion ridges, with steep northward-facing slopes and gentle structural slopes on the south. North of the river these ridges are formed by the siliceous parts of the limestones. On the south the principal east-west ridge, known as Little Mountain, owes its existence to one of the intercalated sandstones in the Bangor limestone. Moulton Valley lies between Little Mountain and Raccoon Mountain. The Tennessee Valley, like the Coosa Valley, is a complex trough fluted with narrow parallel ridges and subordinate valleys. Back from the river the red residual soils form some of the finest farming lands in the State. The cherty portions of the limestone from which these soils are derived remain as low rocky knolls which support a fine growth of oaks. The houses of the planters are usually located on these knolls. In the more broken part of the valley, between the immediate lowlands of the river and the northern boundary of the State, the large proportion of siliceous matter in the limestones makes the soils in general inferior to those of the river plain.

Coastal Plain Division.

The two fundamental systems of the Coastal Plain are the Cretaceous and Tertiary. They consist of interstratified beds of sand, clay, limestone, and marls, with their admixtures. These beds have an average dip toward the Mississippi embayment and the Gulf of Mexico, ranging from 30 to 40 feet to the mile. The surface of the Coastal Plain as a whole falls away in the same direction, but at a much less rapid rate—about 1 foot to the mile—so that in going southward from the Appalachian area we pass in succession over the beveled edges of these formations from the oldest to the newest. Each of these formations, with the exception of some of the Miocene and Pliocene, occupies the surface in a belt proportional in width to its thickness and running approximately east and west across the State.

After the close of Tertiary time there was deposited a blanket formation which is of great importance in the Coastal Plain. It is known as the Lafayette formation, and is a mantle of reddish and light-colored loams and sands, with frequent beds of waterworn pebbles in the lower parts. It has an average thickness of 25 to 30 feet and formerly covered the entire area of the Coastal Plain. It rests unconformably on the older formations following the topography in general very closely, though in many large areas it has been in great part removed by erosion. As a consequence this formation makes perhaps four-fifths of the cultivated soils of the whole plain, and its significance in relation to the underground waters, which appear in springs and shallow wells, cannot well be overestimated.

The characteristics of the several divisions of the Cretaceous, Tertiary, and Quaternary systems will here be reviewed in a general way, many details being left for consideration in connection with their relations to the underground water supply.

The combined thickness of the Cretaceous formations in Alabama has been estimated to be about 2500 feet; that of the Tertiary formations classed as Eocene in the table, about 1800 feet. The thickness of the post-Eocene strata can not yet be stated with much certainty, though in some deep borings at Mobile, Miocene shells found at a depth of over 1500 feet.

CRETACEOUS.

The Cretaceous system in Alabama includes four formations which are, in ascending order:

(1) *The Tuscaloosa,* a formation of freshwater origin, made up in the main of sands and clays in many alternations.

(2) *The Eutaw,* a formation of marine origin, composed of sands and clays more or less calcareous, but nowhere showing beds of hard limestone.

(3) *The Selma Chalk,* likewise of marine origin, a great calcareous formation of the nature of chalk, with varying admixtures of clay and other impurities.

(4) *The Ripley,* also a marine formation in which the calcareous constituents generally predominate, but in parts containing sandy or clayey beds.

None of these formations greatly affects the topography or has marked lithologic characters except the Selma chalk. This underlies a belt entering the State from Mississippi and extending eastward with an average width of 20 to 25 miles, to a short distance beyond Montgomery, where its distinctive characters are lost or merged into those of the "blue-marl region," to be more particularly treated later. The somewhat uniform composition of the Selma chalk has caused it to be more deeply and evenly wasted by erosion and solution than the more sandy formations north and south of it. As a consequence, its outcrop is in the shape of a trough, with a gently undulating, almost unbroken surface except where remnants of the once continuous Lafayette mantle have protected the underlying limestone from erosion and have thus formed knobs and ridges capped with its loams and pebbles.

In this belt, more than in any other of the Coastal Plain, the soils show their residuary character. They are, as a rule, highly calcareous clays and, where much mixed with organic matters, of black color. Throughout this section are areas originally destitute of trees and hence known as "prairies". From the agricultural point of view, the Selma chalk or black belt is the most highly favored part of the State and, apart from the cities, holds the densest population.

The Eutaw and Tuscaloosa formations outcropping north of the prairie or Selma chalk belt, show no marked topographic features. The relatively broken and uneven topography of the Tuscaloosa area results largely from the preponderance of loose or slightly indurated sands with subordinate beds of plastic clay in the formation. The general absence of lime and phosphate from the strata causes comparatively poor soils. The most important features of some parts of this territory are, or rather were, the grand forests of long-leaf pine, now practically exhausted. The surface of the Eutaw belt is generally smoother than that of the Tuscaloosa, and the calcareous character of many of the sandy and clayey beds insures greater fertility.

The Ripley formation, south of the Selma area, has many features in common with the Eutaw, and while prevalently sandy, it yet contains a very considerable proportion of limestone and calcareous clays.

As has been intimated above, the Selma chalk seems to give out a short distance east of Montgomery, and the whole marine Cretaceous section takes on a very uniform lithologic character, being composed in the main of a bluish sandy marl in which scales and flakes of mica are numerous. The lower beds of the blue marl might perhaps be discriminated from the rest by the presence of certain fossils of the Eutaw horizon. In the eastern part of the State, however, the three marine Cretaceous formations, so clearly distinct in the western part, are represented by a series of beds of rather uniform lithologic character, though perhaps sufficiently distinct in their fossils.

TERTIARY.

EOCENE.

In the western half of the State, in the vicinity of Alabama and Tombigbee rivers, the succession and thickness of the strata from the base of the Tertiary up to the top of the St. Stephens limestone, have been ascertained with a considerable degree of accuracy. Eastward to the Chattahoochee, less work has been done, but the formations have been fairly well studied and their succession and thickness along the Chattahoochee are also very well established, chiefly by the work of Mr. D. W. Langdon. These strata, which are usually classed as Eocene, have a thickness of about 1800 feet and present the following characteristics:

MIDWAY GROUP.

Clayton limestone.—At the base of the Tertiary is found an impure limestone, thin and inconspicuous in western Alabama, but thickening to the east until on Chattahoochee River it includes fully 200 feet of alternating calcareous sands and limestones. This formation is called the Clayton limestone.

Sucarnochee clay.—Next above the Clayton there is, along Tombigbee River, a series of black or dark-brown clays at least 100 feet thick. This formation is also well exposed at Black Bluff on Tombigbee, and on Sucarnochee River, and has been called Sucarnochee. At Black Bluff and sparingly at a few other points these clays are fossiliferous. While nearly devoid of lime in the Tombigbee drainage, except in the lowermost strata, the clays become more and more calcareous to the east, and in Wilcox county, east of Alabama River, they form the basis of some fine black prairie lands. The formation east of Wilcox County has not been traced.

Naheola formation (Matthews Landing.)—Next above the Sucarnochee clays is the Naheola formation, embracing 150 feet or more of gray sandy clays, with some beds of dark sandy glauconitic clay contaaining marine fossils near the base. To the east this formation appears to die out and it is not found exposed on Chattahoochee River.

CHICKASAW (WILCOX) GROUP.

Between the top of the Sucarnochee clay and the base of the Tallahatta buhrstone lies a group which Dr. Hilgard, in his report on the Geology of Mississippi, called the Lignitic.

The term LaGrange was used by Dr. Safford of Tennessee, to include a portion of the beds originally termed Lignitic by Hilgard. LaGrange is a locality name and would doubtless have stood but for the fact that Safford included in it the Lafayette (Orange Sand), and a portion of the Cretaceous. The name Lignitic being also deemed inadmissible, because descriptive, the term Chickasaw, from the Chickasaw Bluffs near Memphis, was proposed by Dr. Hilgard and Prof. Dall as a substitute, to include the beds grouped by Hilgard under the term Lignitic, excluding what he termed the Flatwoods belt. In this sense the name was duly accepted by the geologists and has been used by Prof. Dall and others since 1895. Some objection seems to have arisen to this name also, and in a recently published report, by Messrs. Eckel, Crider and Johnson, on the Underground Water Resources of Mississippi* the term Wilcox, from Wilcox County, Alabama, where these beds are characteristically developed, is substituted for Chickasaw, and embraces the Nanafalia, the Tuscahoma, the Bashi, and the Hatchetigbee formations. In the present Report the accepted term Chickasaw is retained for this group with the alternative of Wilcox in case the objection to the former name proves to be well founded.

This is the most massive of these divisions, having a thickness which is probably not less than 900 feet. It also presents a great variety in lithologic character and in fossil contents. In the most general terms the Chickasaw or Wilcox strata are cross-bedded sands, thin-bedded or laminated sands, laminated clays, and clayey sands, with beds of lignite and lignitic matter which merely colors the sands and clays. With these are found interbedded at several horizons strata containing marine and estuarine fossils. The fossil-bearing beds form the basis for the separation of this group into four formations, given in some detail below.

Nanafalia formation (*Coal Bluff.*)—The Nanafalia overlies the Naheola, and maintains a tolerably uniform thickness of about 200 feet entirely across the State. These beds are mostly sandy, but contain great numbers of the shells of a small oyster, *Gryphoea thirsae.* Near Alabama River and for a short distance to the east, a gray siliceous clay with a tendency to indurate into a tolerably firm rock resembling very closely some of the strata of the Tallahatta buhrstone of the Claiborne group, presently to be described, is a characteristic feature of the whole section. At the base of the oyster-shell beds there are, at certain localities, other fossiliferous beds containing a great variety of forms.

At the bottom of the Nanafalia formation there is a bed of lignite, 5 to 7 feet thick, which may be traced across the country from Tombigbee River into Pike County, where it is well exposed near Glenwood station, not far from Troy.

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*Water Supply Paper, No. 159, U. S. Geological Survey.

The Nanafalia sands will be considered again in another chapter in connection with the underground water supply of some parts of the State.

Tuscahoma formation (*Bells Landing.*)—These beds are about 140 feet thick and consist mainly of gray and yellow cross-bedded sands and sandy clays, generally poor in fossils except at one horizon, which is typically exposed at the localities from which the two names above have been taken.

Bashi formation (*Woods Bluff*).—Above the Tuscahoma is the Bashi which averages perhaps 80 feet in thickness. It is composed of the sands and sandy clays common in the Tertiary. It is distinguished by a characteristic bed of highly fossiliferous greensand with associated beds of lignite immediately below it. By these features the Bashi may be easily identified across the width of the State.—The best exposure of the fossiliferous green sands of this formation is at Woods Bluff on Tombigbee river.

Hatchetigbee formation.—The uppermost formation of the Wilcox group is composed of beds of brown, purple, and gray laminated sandy clays and cross-bedded sands abounding in characteristic fossils. It is about 175 feet thick in the vicinity of Tombigbee River, but it thins to the east, though otherwise maintaining its distinctive character. These beds have been named Hatchetigbee, from a bluff on Tombigbee River. They will be referred to again in the discussion of the underground waters.

CLAIBORNE GROUP.

Between the Chickasaw group and the base of the St. Stephens limestone lie the strata of the Claiborne group easily divisible in Alabama, into three formations, the lower being the Tallahatta Buhrstone, the middle being the Lisbon formation and the upper, the Gosport Greensand.

Tallahatta buhrstone.—In the western part of the State the most prominent rocks of this formation are aluminous sandstones or siliceous claystones. They vary slightly in composition, but are always poor in fossils except the microscopic siliceous shells of marine diatoms and radiolaria. To the east the percentage of clay decreases, the rocks become more calcareous, and the fossils are more abundant, and in place of the silicified shell casts of the Tombigbee and Alabama drainage basins are extensive beds of shells, mostly oyster shells. The thickness of the buhrstone varies from 400 feet in the western part of the State to 200 feet in the eastern part. In the western part of Alabama and still more in Mississippi, beds of fossiliferous green sand are abundant in both the Tallahatta and in the Lisbon strata of the Claiborne. The decay of the greensands has in many places given rise to the accumulation of deposits of brown iron ore which may some day have a commercial value. The Tallahatta Buhrstone as here defined is the equivalent of the *Siliceous Claiborne* of Hilgard.

The Lisbon Formation.—Between the Buhrstone and the base of the Gosport greensand are the Lisbon beds consisting of about 115 feet of calcareous clayey sands and sandy clays generally fossiliferous.

The lower half of these beds contains a great number and variety of well preserved shells; in the upper half the shells of *ostrea sellaeformis* and several species of *pecten* greatly preponderate over other forms. The most characteristic exposures in Alabama of these beds, which are the equivalents of Hilgard's *Calcareous Claiborne,* are at the Claiborne and Lisbon Bluffs on the Alabama river.

The Gosport Greensand.—This division, which, so far as yet known, does not appear in any other of the Gulf States, embraces the strata of the Claiborne group lying between the top of the Lisbon, and the base of the St. Stephens. The beds are in general highly glauconitic sands about thirty feet in thickness at the Claiborne and Gosport bluffs and include the fossiliferous greensands which have made the name Claiborne famous, and which have furnished the greater part of the Claiborne fossils described and figured by Conrad and Lea. While this division, as above mentioned, is not known in Mississippi, Louisiana or Texas, yet its importance in Alabama, from the historical point of view and because of the great number and variety and beautiful state of preservation of its fossils, is such as to compel mention and a distinct name. This member of the Claiborne group has been observed at a number of localities in Monroe, Clarke, Choctaw and Washington counties. The name is from Gosport a landing on the Alabama river a few miles below the Claiborne Bluff.

St. Stephens limestone.—Above the Claiborne, and constituting the uppermost member of the Eocene in Alabama, is the St. Stephens limestone, equivalent in part to the Vicksburg limestone and in part to the Jackson limestone of Mississippi. In Alabama these two formations blend so completely that it has been impossible to draw clearly the line of demarkation between them, and the St. Stephens is therefore intended to include the Alabama representatives of both. Immediately overlying the Claiborne fossiliferous sands, at many points in Clarke, Choctaw, and Washington counties, is an argillaceous limestone closely resembling the Selma chalk and like it giving rise to rich black limy soils. The fossils of this bed show that it is probably of Jackson age, but the great mass of the St. Stephens formation, between 200 and 300 feet thick, consists of a limestone of a considerable degree of purity in which the ever present fossil is a nummulitic shell, *Orbitoides lyelli.* Other shells also abound, but this is characteristic. This limestone shows many variations, being in some cases hard, almost crystalline, capable of a high polish, of a pleasing variety of color, and hence probably well adapted for ornamental construction. Commonly, however, the rock is soft and easily cut with a saw, axe, or plane when fresh from the quarry, and it is much used in the construction of chimneys and pillars to houses. On this account it is well known from Texas to Florida as the "chimney rock." In the southeastern part of the State and in Georgia this limestone has frequently become silicified, and great masses of it appear to have all of the lime replaced by silica. The bones, particularly the vertebræ, of an extinct whale, *Zeuglodon,* are in some localities abundant in the lower (Jackson) division.

Topographic features of the Eocene.—In general it may be said that the part of the State in which the Eocene strata occur is a gently sloping plain into which the streams have sunk their valleys, leaving between them remnants of the original mass as hills. Two or three formations of the groups impress themselves on the soils and the topography more forcibly than the others. The first of these is the great bed of black clays of the Sucarnochee horizon, underlying a belt of country known west of Alabama River as the "Flatwoods" or "Post Oaks." East of this river these clays are strongly calcareous and give rise to black prairie soils. The Flatwoods proper constitute a sort of trough 5 or 6 miles wide, badly drained and little cultivated, with a heavy growth of small post-oaks and short-leaf pine. During wet weather the Flatwoods have all the characteristics of a swamp. Along the northern border of this belt the clays are often highly calcareous, and the transition from the limy Cretaceous formations to the tough plastic clays of the genuine Flatwoods is very gradual.

The next member of topographic importance is the Nanafalia especially in that part of the State west of the drainage area of Alabama River. In this section there is a considerable thickness of indurated clayey sands—sandstones, in fact—overlying the oyster-shell bed. This gives rise to a very broken and hilly country, as shown in the Grampian Hills of Wilcox County. In the eastern part of the State there are many "sinks" and big springs in the Nanafalia territory.

Farther south the outcrop of the Tallahatta buhrstone, especially in the western half of the State, makes veritable mountains, often rising with steep northwardfacing slopes 200 feet or more above the adjacent lowlands. In Clarke and Choctaw counties, and in still greater degree in Mississippi, these buhrstone mountains, with their rocky slopes, remind one of the Appalachian region.

In the eastern counties the Clayton limestone acquires exceptional thickness, 200 feet or more, and shows the characteristics of limestone terranes such as caves, lime sinks, and "big springs." The St. Stephens limestone also gives rise to broken country with characteristic caves and other features. Along the northern edge of this (St. Stephens) outcrop the strong, limy, black soils formed by the clayey limestone resemble the black prairie soils of the Selma chalk, but the topography of the country offers strong contrast—in the chalk, softly undulating, almost level lands; in the lower St, Stephens, exceedingly broken and deeply eroded lands, justifying the name "lime hills."

As has been indicated above, the trunk streams of the Alabama Coastal Plain flow across the outcropping strata, while their tributaries flow in general parallel to the strike of these outcrops. In the gradual sinking of the beds of these tributary streams the characteristic Coastal Plain topography is developed; the infacing slopes of the hills are precipitous, while the gulfward slopes are gentle. The streams have their place generally at the base of the steep infacing slopes.

MIOCENE.

CHATTAHOOCHEE SERIES.

In 1889 Mr. D. W. Langdon of the Alabama Geological Survey, discovered on Chattahoochee River a new series of marine calcareous formations of Miocene age, overlying the Vicksburg limestone. This series he called the Chattahoochee from the town and landing of that name.

With the exception of some sandy clays on Conecuh River, which hold a few poorly preserved fossils of the Chattahoochee horizon, none of these beds has up to the present time been found to outcrop in Alabama, for the reason that the section of the state in which these outcrops would normally occur is covered with a thick mantle of two superficial formations, the Grand Gulf and the Lafayette. In addition to this that portion of the region contiguous to Mobile river in which we should expect to find the outcrops, is of the nature of a delta with low alluvial banks. It is safe, however, to say that these Chattahoochee formations underlie the southern part of the State beneath the superficial deposits mentioned, for deep borings in Mobile and Baldwin counties have demonstrated their existence at depths between 800 and 1550 feet, by means of the shells characteristic of the several horizons brought up by the drills.

PLIOCENE.

PASCAGOULA.

In 1889, Mr. L. C. Johnson, also of the Alabama Survey, discovered on Chickasawhay river in Mississippi a few miles above its confluence with Leaf river to form the Pascagoula, a highly fossiliferous marine or estuary deposit to which he gave the name Pascagoula. This bed has as yet been seen in outcrop only at the type locality and, according to Mr. Dall, at Shell Bluff on the Pascagoula river*. At the type locality it underlies strata of the Grand Gulf formation. Most of the shells of this bed are of a new species, (*Rangia Johnsoni*) ; but along with these are numerous shells of *Ostrea Virginica,* by Mr. Dall's determination. As this latter species is not known to occur in strata older than Pliocene, the Pascagoula is placed in this formation in our classification.

In the artesian wells at Mobile shells characteristic of the Pascagoula horizon are brought up from depths of about 700 feet. We may therefore be reasonably certain that this formation, like the Chattahoochee, underlies the lower part of the State though its outcrop for reasons given, has not yet been discovered.

GRAND GULF FORMATION.

This name was given in Mississippi to a series of sands and clays of varying character and varying degree of induration, overlying directly and unconformably the Vicksburg limestone, and, together with the next overlying Lafayette beds, forming the surface of the Coastal Plain of that state down to within ten miles of the Gulf of Mexico. More specifically the strata are thin-bedded and massive clays of colors varying from white through shades of red and brown to black, interstratified with sands, the latter in many places indurated to form sandstones, with aluminous or siliceous cement. Occasionally these rocks are even quartzitic, as at the type locality and in a number of places in Georgia and Alabama, but as a rule they are only slightly coherent. The clays also in part are indurated into mudstones, and in part are more or less plastic. The presence of lignitic matters and of gypsum is also locally characteristic of the clays, many of which are quite meager because of intermixture with fine grained sand. In Alabama the prevailing materials are massive clays of reddish to brown colors or mottled gray to red and laminated clays interbedded with sands varying in coherence from loose sands to firm sandstones and aluminous or siliceous cement. The aluminous sandstones pass by insensible

*This may be the same as the type locality, which is also called Shell Bluff. E. A. S.

gradations into meager clays which are themselves often indurated into mudstones as compact as some of the sandstones.

While the induration of the sands is common in Mississippi along the border of the river valley from Grand Gulf down to the Louisiana line, and thence eastward beyond Brandon, it is by no means confined to those bounds as some are disposed to believe. In Georgia in all parts of the Altamaha Grit region, occasional occurrences of the exceedingly hard, sometimes quartzitic, sandstones are known down to within a few miles of the Atlantic coast. It may be here remarked that the excessive silicification, often resulting in the complete obliteration of the original texture of the rock, as is the case in one of the sandstone ledges at the type Grand Gulf locality, is by no means confined to that locality nor, indeed to the rocks of the Grand Gulf formation, for in the southeastern parts of Alabama and southwestern of Georgia adjacent, much of the Vicksburg limestone has been so completely petrified by silica that not a trace of lime remains, and many of the masses of Miocene corals so common in Southwestern Georgia are completely silicified, being interiorly a mass of amorphous silica devoid of all trace of organic structure. These remarks are made in connection with a proposition to restrict the name Grand Gulf to the quartzitic sandstone occurring at the type locality.

While the inner or landward border of the Grand Gulf mantle is in contact with the Vicksburg limestone in Mississippi and with the St. Stephens in western Alabama, from Covington county in the latter state eastward it is found lapping successively over the older Tertiary formations, and about Clayton and Eufaula and in adjacent parts of Georgia, even over the Ripley beds of the Cretaceous. On the map accompanying this report only this landward margin of the formation is attempted to be shown. Below or southward of this line its strata cover *partially* the outcrops of the upper Cretaceous and older Tertiary beds, while those of the newer Tertiary, Chattahoochee and Pascagoula, with the exception of the exposure on the Conecuh river above mentioned, seem to be *completely* hidden by it and the closely associated Lafayette. Along the Chattahoochee river south of the Alabama line, however, the whole series of these newer Tertiary beds (possibly excepting the Pascagoula,) is clearly exposed, with the Grand Gulf and Lafayette beds overlying them. In Alabama as yet we have only the evidence afforded by the deep borings in Mobile and Baldwin counties, to prove that below the surface occupied by the Grand Gulf and Lafayette beds, all the Miocene and Pliocene marine Tertiary formations above mentioned are reached at depths between 200 and 1550 feet. All the facts derived from observations in Mississippi, Alabama, Georgia, and Florida seem to show that the Grand Gulf formation cannot be older than upper Pliocene, since it overlies often by an interval of many feet, the Pascagoula shell bed with *Ostrea Virginica*. In these states no formation older than the Lafayette is known to overlie it.

It is impossible to give with certainty the thickness of the Grand Gulf strata. The dip in some parts of its territory seems to be no greater than the general slope of the land surface; in this respect it resembles the Lafayette. In Mobile and Baldwin counties the thickness above sea-level is at least 150 feet, and in the borings mentioned a greater but undetermined thickness is found. The absence of fossils, except plant remains and a few fresh water unios, makes the fixing of the exact age of the formation difficult; in this also it resembles the Lafayette.

In the lower counties of the State the Grand Gulf is one of the most important formations in relation to underground waters, and more detailed mention of it will be made later.

QUATERNARY.

LAFAYETTE FORMATION.

The surface distribution of this great mantle formation, or rather its landward limit, will be seen by the map. In general it consists of a red sandy loam, usually devoid of stratification in the upper part, with cross-bedded sands and irregular beds of water-worn pebbles in the lower part.

The thickness does not often exceed 25 feet, and it follows the contours of the surface very closely, being a veritable blanket, sometimes completely washed away, but varying very little in thickness whether on the high level interstream plateaus or along the slopes which break away from them.

It overlies with uncomfortable contact every formation in Alabama from the oldest up to the Grand Gulf inclusive.

Since all the high table lands, remnants of the plain into which the streams have worn their valleys, are covered by the red loam of this formation its importance as a soil former is obvious. In yet another particular its importance cannot be overestimated, namely, in its relations to the underground waters. Its loam and pebble beds are storage reservoirs of countless springs and shallow wells over the entire Coastal Plain. Other details will be given in connection with the discussion of the underground water distribution.

LATER FORMATIONS.

The later formations, Columbia, Second Bottom deposits, First Bottom and other recent alluvial deposits, and soils, may be here passed over with mere mention, and with the remark that no sure identification of the Columbia has been made in Alabama, though some gray and white sands frequently seen overlying the Lafayette are probably of this age.

CLIMATE OF ALABAMA.

BY MR. FRANK P. CHAFFEE,

Section Director, U. S. Weather Bureau, Montgomery, Ala.

(By permission from an article prepared for the Climatological Department of Agriculture.)

General Features.

In the preparation of this climatic summary, reference has been made to the reports of the Smithsonian Institution and of the United States Signal Service, now the Weather Bureau; to Bulletin No. 18 of the Agricultural Experiment Station at Auburn, Ala.; and to the reports of the various voluntary observers in Alabama co-operating with the Weather Bureau.

In its distance from the equator, elevation above sea level, configuration of its mountain chains, proximity to the sea, and prevailing winds, Alabama is favorably situated for a temperate and comparatively uniform climate. In the extreme southwestern portion, washed by the water of the Gulf of Mexico, the climate approaches the subtropical, while the climate in the highlands of the northeast is similar to that of regions of less elevation much farther north. Extremes of temperature are rare. Over the southern half of the States the heat of the summer is tempered by the prevailing winds from the Gulf, and in the more northern counties the elevation secures immunity from excessively high temperature. Freezing temperatures do not often continue longer than 24 to 48 hours. Snow rarely falls, except in the northern counties, where it occurs on an average of about twice each winter and seldom remains on the ground for more than 48 hours. The rivers do not freeze. With the exception of the country along the Gulf Coast, where the precipitation is heavy, the rainfall is well distributed. The growing season is so long that often two and sometimes three minor crops are raised on the same ground in one year.

Temperature.

The average temperature of the entire State is 63 degrees; for the southern portion, 66 degrees; middle portion, 64 degrees; northern portion, 60 degrees. Highest average, 67 degrees, in Baldwin and Mobile counties; lowest average, 60 degrees, in Dekalb County. The average by seasons is as follows: Winter, 46 degrees; spring, 63 degrees; summer, 79 degrees; autumn, 63 degrees. The average summer maximum is 90 degrees and the average winter minimum 35 degrees. The absolute maximum, 109 degrees, occurred at Lock No. 4 (Lincoln), Talladega County, July 7, 1902; the absolute minimum, 17 degrees below zero at Valley Head, Dekalb County, February 13, 1899. Average number of days per year with temperature above 90 degrees, 62; average number of days per year with temperature below 32 degrees, 35. The temperature seldom falls below zero, the above extremely low reading being recorded during the severe cold wave of February 12-13, 1899, which gave the coldest weather ever recorded or remembered in this section.*

Killing Frost.—The average dates of last killing frost in spring are as follows: northern district, April 6th; middle district, March 23rd; southern district, March 9th; for the state, March 2rd. Average dates of first killing frost in autumn:

*Since preparing this article a temperature of 18° below zero occurred at Valley Head, Dekalb County, February 14, 1905. F. P. C.

northern district, October 20th; middle district, November 5th; southern district, November 17th; for the state, November 4th. This gives average growing seasons as follows; northern district, 197 days; middle district, 227 days; southern district, 253 days; for the state, 226 days. The latest killing frost known, May 2nd, 1897, at Oneonta, Blount Co.; with this exception, the latest on record, was April 30th, at Valley Head, Dekalb County. The earliest killing frost of which there is official record was October 2nd, at Decatur, Morgan County, but the voluntary observer at Oneonta reports that there is a record of killing frost having occurred at that place, September 4th, 1866. Over the middle counties, the last killing frost, as a rule, occurs during the first half of April, and where the last frost is recorded in March, the records show its formation during the early part of April was prevented by cloudy weather or fresh to brisk winds. The first killing frost usually occurs over the middle counties during the last half of October. When the first frost occurred in November, the records show that at the same time during the last half of October the temperature was low enough for frost, the formation of which was prevented by conditions mentioned above.

The distribution of the temperature is shown by the subjoined chart.

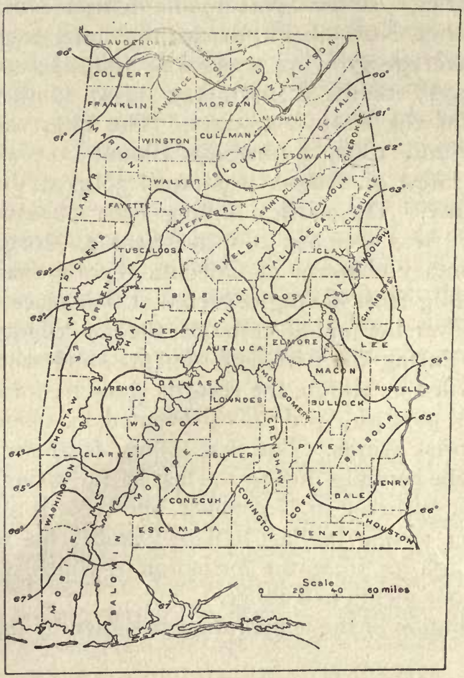

Fig. 1.—Map showing mean annual temperatures (Fahrenheit) in Alabama.

PRECIPITATION.

Annual precipitation for the State as a whole, 52 inches; for northern district, 52 inches; middle district, 51 inches; southern district, 55 inches. The distribution of precipitation is shown by the accompanying chart. The greatest annual average—from 62 to 63 inches—is in the southwestern counties, bordering on the Gulf of Mexico. Another region of heavy precipitation is found over the mountainous (north-central and north-eastern) portions, where it ranges from 47 to 54 inches per annum. The region of least precipitation is near the center of the State, where the annual average is about 46 inches. The precipitation is practically all rain. Snow occurs on an average twice each winter in the northern half of the State and about once a winter in the southern counties; it varies from very light in the southern district to moderately heavy (about 8 to 14 inches) in the north-central and northern counties. It is not common for a winter to pass without snow enough to cover the ground in any portion of the State. The precipitation is well distributed throughout the growing season, especially in the middle and most important agricultural counties, and the autumns are, as a rule, favorable for the maturing and gathering of the staple crops.

Fog.—Dense fog seldom occurs, and then generally in the winter or spring months, and is mostly confined to the coast district.

Hail.—This occurs occasionally during the spring and summer months, though really destructive hailstorms are rare in this section.

Thunderstorms.—These occur in some portions of the State during every month of the year, being most frequent during the summer months. The most severe thunderstorms occur along the Gulf coast, and in the west-central counties.

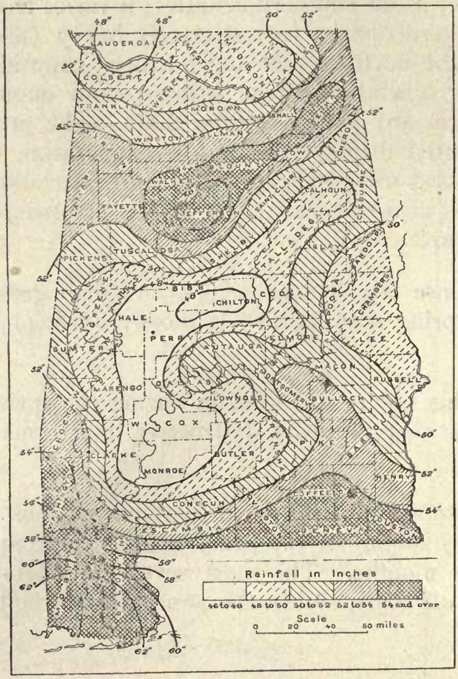

Fig. 2.—Map showing average annual precipitation in inches for Alabama.

Winds.

The prevailing direction for the year is south; for winter, north; spring, south; for summer, south; for autumn, north. Average hourly velocity, (computed from records at Mobile and Montgomery only), 7 miles. The highest velocity ever recorded, was 72 miles from southeast at Mobile October 2nd, 1893. Winds of 40 miles per hour or more have occurred as follows: Mobile (record from 1885 to 1893 inclusive) 23 times, or on an average or a little more than once a year. Montgomery, (record from 1875 to 1903 inclusive), 12 times, or an average of about once in three years.

During the passage of general storms over and to the north of this region, destructive wind storms or tornadoes have occurred as follows: Year of greatest frequency, 1884, with 19 storms; average yearly frequency 1.6 storms; year in past twenty-three with no report of storms, none; month of greatest frequency, March; day of greatest frequency, January 11th; hours of greatest frequency, 6 to 8 p. m.; months without such storms, July, August, September, and October; prevailing direction of storm movement, southwest to northeast; region of greatest frequency, north central portion.

CHAPTER II.

A. GENERAL DISCUSSION OF UNDERGROUND WATERS.

SOURCE OF CIRCULATING WATERS.

The ocean, which covers three-fourths of the surface of the earth is the chief source from which is derived the water which circulates through the atmosphere, and upon and through the lands, and the great reservoir into which most of these waters finally return.*

By evaporation from its surface, moisture is taken up into the atmosphere to be condensed and to fall as rain or snow either directly back into the ocean, or upon the land surface and from it back into the universal reservoir by several ways more particularly to be mentioned below. In this passage, the water may be temporarily locked up and withdrawn from circulation in the tissues of organic beings, animal and vegetable, and in minerals, but eventually practically all joins again the great cycle.

As has been shown in a previous chapter, the amount of this rainfall for the state of Alabama, averages about 52 inches per annum.

DISPOSITION OF THE WATER FALLING UPON THE LAND SURFACE.

The water falling upon the surface of the land is disposed of in the following ways: (1) A part is restored directly to the atmosphere by evaporation from the surface without previous absorption, (2) a part runs directly into the streams without being first absorbed by the soil, and (3) a part soaks downward into the ground where it is retained for a longer or shorter period.

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*Different views are held as to the origin of Underground waters, for while it is generally conceded that the rainfall is the chief source, some believe that the original constituent water of the igneous rocks is the source of certain highly carbonated springs. Others think that the sea water included in marine sediments at the time of their accumulation is the source of some saline waters.

(1) *Evaporation before absorption.*—During and immediately following precipitation in the form of rain, the atmosphere is commonly nearly or quite saturated with vapor, and the evaporation which takes place before the rain is absorbed by the ground is very small, the amount being practically negligible as compared with that absorbed by the soil and later evaporated from its surface or through its vegetation. The evaporation from the streams in a region like Alabama, though considerable in the aggregate, is also small as compared to that from the general land surface after absorption, probably not averaging more than 1 or 2, possibly 3 per cent. at the outside, of the whole amount evaporated. In broad general computations, the entire evaporation proceeding the absorption of the water by the soil may be neglected without introducing any material error.

(2) *Direct runoff of Flood flow.*—This portion of the rainfall makes its way by open channels into the streams and thence finally back into the ocean, in its progress carving and sculpturing the land surface into irregularities which constitute scenery, and producing the infinite variety of topography which we everywhere see. It moves the loose rock waste down the slopes and into the streams where, reinforced by seepage waters, it carries the waste, often after many interruptions, finally into the sea, and spreads it upon the sea bottom in layers of sorted materials, the basis of a new series of rock formations, which may be added to the dry land by the uplifting of this sea bottom. Held back temporarily in its descent by more resistant rock ledges, it develops power which may be utilized by man; in other parts, where unobstructed, it is available as a means of transport; when occasion demands it may be stored up by artificial means and used for power, for irrigation, and for other purposes.

Few observations have been made as to the amount of water which thus passes from the land without being first absorbed, but this is known to be very small when any large district is considered. In a sandy soil only 3 or 4 per cent of the rainfall may be thus returned. On the other hand Prof. Prestwich*, for a region showing an ordinary succession of permeable

*Geology, Vol. I, p. 155. This assumption is probably considerably too large.

strata, assumes that 1-3 of the total rainfall is removed by direct runoff. In certain limited glacial areas, where the rocks are nearly or quite free from soil, this percentage of direct runoff may be much greater than this amount. In the Coastal Plain region of Alabama perhaps one fourth of the soil is clayey and would have a runoff as high as that indicated by Prof. Prestwich, but the remaining three-fourths are sandy and should possess a direct runoff of less than 5 per cent. It is believed that the direct runoff in the area of the consolidated rocks in the northeastern portion of the state will not average more than 15 or 20 per cent of the rainfall.

(3) *Absorption.*—Neglecting the small amount of evaporation taking place before absorption and deducting 15 per cent of the total rainfall to cover the direct surface runoff, we have a total of approximately 85 per cent. of the rainfall absorbed by the soil.

This absorbed water plays an important part in the disintegration of rocks and their conversion into soil. It takes up the soluble matters encountered in its passage through the rocks and soil, transporting a part of them in solution to the sea, depositing a part in the interstices of loose sediments cementing them into rocks, concentrating and depositing another part in veins or beds or other available forms in which they may be turned to the use of man. It maintains and regulates the supply of moisture in the soil, without which all vegetable life would be impossible. It saturates the soil below certain depths, affording thus the sources of our springs and wells; and by its slow but constant movement through the ground it feeds the streams as they flow towards the sea.

A large amount of it is returned to the atmosphere by evaporation either directly from the surface and through the tissues of growing plants, or from the streams after the surplus of the ground water has joined them by seepage. In Alabama the evaporation, owing to the limited area exposed in proportion to the length of the drainage systems and to the humidity of the climate, is not especially high. Determinations made in the years 1900-1903 of the runoff of the Alabama river, showed that 27 of the 54 inches of rainfall were returned by the stream to the sea, most of the remaining 27, or nearly 50 per cent. of the rainfall, having been lost by evaporation.

Over the broad area of the Mississippi basin the average evaporation is much greater. According to Messrs. Humphreys and Abbott* only 25 per cent. of the total rainfall of this basin is discharged into the Gulf of Mexico. Nearly 75 per cent. must, therefore, have been lost by evaporation.

Final Runoff.—One per cent. or less of the water remaining after evaporation† may be taken up in chemical combination by the rocks; the rest representing about 35 per cent. of the total rainfall, joins the permanent underground water body occupying the pores of crevices within the rocks and other materials below the water table. These materials in the course of time, where conditions have been favorable to the absorption, have become filled to saturation, so that at the present time practically all of the ground water not lost through evaporation finds its way by seepage into the streams, constituting at least two-thirds of what is ordinarily spoken of as the *final run-off*, the other third being contributed by the surface run-off or flood flow.

It is in high degree probable, however, that the direct surface run-off in Alabama covers less than 15 per cent. of the rainfall, and that the proportion of the final run-off contributed by underground seepage is correspondingly greater than above given.

AMOUNT OF WATER AVAILABLE TO ARTESIAN WELLS.

It is computed that one inch annual rainfall amounts to 17,-378,743 gallons per square mile; 52 inches, which is the average rainfall for the State of Alabama, being thus equivalent to 903,-694,636 gallons to the same area. Since the area of the State, according to the Twelfth Census, is 52,250 square miles, the total rainfall per annum for the State amounts to 47,218,044,-731,000 gallons.

As we have seen above, approximately 85 per cent. of this rainfall is absorbed by the ground. This amount is equivalent to a daily supply of 109,959,830,195 gallons for the whole area, or 2,104,494 gallons daily per square mile.

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*Report on the Mississippi River, p. 132.

†C. R. Van Hise, Treatise on Metamorphism, Monograph, 47; U. S. Geol. Surv., p. 156.

The largest flow measured by the writer in Alabama is that of the great well near Roberts in Escambia county, which yields 5,000,000 gallons daily. The average daily rainfall would supply 21,992 such flows, or nearly 90,000 such as that of the Pickens well yielding 850 gallons per minute, provided all the water entering the soil were available to wells.

If we exclude the 50 per cent. returned to the atmosphere through evaporation of the 85 per cent. of the rainfall absorbed by the ground, there would still remain 35 per cent. theoretically available; but as a matter of fact the clays and other of the finer soils may contain a large amount of water and yet because of their compactness give up a little of it to wells penetrating them. For this reason the amount of available water may fall far short of the maximum above given.

These rough estimates given, even with the limitations mentioned, will suffice to show that the rainfall is adequate to supply as many artesian wells as are likely to be sunk within the limits of the State supposing them to be evenly distributed over the area.

As a matter of fact, however, the wells are at present, and probably always will be, more or less concentrated in groups which may lead to an excessive draining on the resources of certain districts.

It may be remarked that the water which soaks into the ground, passes directly downward into the artesian reservoir rather than laterally toward the stream channels, and that an excessive drain on account of artesian wells would show itself first of all in the general lowering of the water table, with consequent diminution of the supply of water in shallow wells and springs, and in the lessening of the run-off of the streams.

We may therefore be safe in saying that so long as the shallow wells and springs continue to yield, and so long as the streams continue to flow, our artesian supply may be counted on.

DEPTH OF PENETRATION.

The downward penetration of water under the influence of gravity takes place through cracks and fissures or through pores of the rocks, and its lower limit will be reached when these openings no longer exist. The depth at which all pores are closed has been estimated to be about six miles. Experience, however, shows that ground waters do not actively circulate to any such depth, being confined in fact largely to the upper 2,000 feet of the crust where they occur mainly in sedimentary rocks. In crystalline rocks the depth to which the water pentrates in economic amounts is usually much less, few wells obtaining supplies at depths of more than 500 feet.

DISTRIBUTION AND MOVEMENTS OF UNDERGROUND WATERS.

Underground water, like that which circulates in the ocean and in the atmosphere, is in constant motion as observation shows. The chief cause of this motion is gravity. Capillary action and thermal changes are effective also, but in comparatively limited degree.

The distribution of the ground water and the direction and other peculiarities of its movements are in so great measure determined and controlled by the physical structure and arrangement of the materials through which it circulates, and by the surface topography, that a consideration in some detail of these modifying causes becomes necessary.

Modifications of Groundwater Movements due to Physical Structure.

POROSITY.

All the materials, whether loose or consolidated, composing what is commonly called the curst of the earth, are in varying degree capable of absorbing water through the pores or open spaces separating the particles. The degree of porosity is determined by the size and shape of the particles and their closeness of approximation. If the particles are of somewhat uniform size and shape, and rounded, the porosity will vary between 25 and 45 per cent. according to the closeness of the packing. In material composed of grains of varying size and shape, the porosity is considerably less.

Thus the *residual materials* resulting from the weathering of crystalline rocks and consisting of grains varying perhaps from a quarter of an inch in diameter down to the finest clay, would absorb much less water than if the grains were of uniform size, whether like the larger grains or the smaller. Nevertheless, because of the looseness of such materials the porosity may be as high as 30 per cent. or more of the volume.

In *sedimentary deposits* (mechanical), the materials are more or less completely sorted according to the weight of the individual particles, and hence the different beds of this kind are likely to be composed of grains of approximately uniform size, and in the unconsolidated condition may possess a porosity amounting to 20 to 50 per cent. of their volume.

The *calcareous sediments* formed by the precipitation of carbonate of lime by organic agencies may be in the form of limestones or of a calcareous ooze or mud, originally as open and porous as the mechanical sediments above considered, but more liable to have the pores filled by secondary deposition of carbonate of lime, and to become compacted limestones, which are at times the most impermeable of rocks. Under certain conditions, however, in the form of chalk or chalky marls, these beds may retain their porosity. In the change from limestone to dolomite the rock becomes open-textured because of shrinkage in volume, and the permeability of all rocks may be increased by the formation of cracks and fissures from any cause.

On the other hand the porosity of loose and open-textured sediments may be diminished by pressure, and by secondary filling of the pore spaces. So while all the rocks exposed at the surface of the earth or lying within a few miles depth from the surface, possess a greater or less degree of porosity, this porosity diminishes with the depth from the surface and is practically *nil* long before the extreme depth of five or six miles is reached, at which theoretically the existence of open spaces becomes impossible.

Amount of water absorbed by porous rocks.—The porous beds above referred to, in a region of adequate rainfall, below the water table will be saturated with water to a very considerable depth, and the amount of water thus absorbed is very great, as will be apparent when we consider that over 90 per cent. of the surface of the earth is occupied by such beds. In general the compact rocks show rarely over 15 per cent. of pore space, but one hundred feet thickness of rocks of this degree of porosity, when saturated with water would hold an amount equivalent to an underground lake of water 15 feet deep. In one hundred feet thickness of loams and clays and chalks similarly saturated, the amount would be correspondingly greater.

In the following table are given the amounts of water which a cubic foot of some common materials will absorb.*

Comparative Absorptive Capacity of Different Materials.

Material	Water absorbed per cubic foot	Material	Water absorbed per cubic foot.
	Quarts.		Quarts.
Sand	10	Dolomite	1 to 10
Potsdam sandstone	2 to 6	Chalk	8
Triassic sandstone	4	Granite	1/100 to ¼
Trenton Limestone	¼ to 1¼		

Incomplete Saturation:—It is generally assumed as above stated, that below the water table and down to the limit of meteoric circulation, the pores of all the strata are filled to saturation with water. But recent studies of well records and samples have shown that this is far from being true.† "Few of the crystalline rocks, for instance, hold anything like their full capacity of water. Many mines in both sedimentary and crystalline rocks are dry and dusty even when far below the water level, open and porous sandstones which contain no water at all have been recognized in deep wells, while clays underlying the ground water are often incoherent and powdery. Estimates of the ground-water in the earth have varied many hundred per cent. because of the different initial assumptions made in the computations."

Lost Water.—This phenomenon also is referred to in the article above quoted. "Many of the lower sandstones of southwestern Pennsylvania and elsewhere, although open and porous, are found by the drill to be destitute of water. That they are beyond the ordinary limit of meteoric circulation will be admitted, but as marine formations, they must have been saturated at the time of their deposition, and as they have never

*M. L. Fuller Water Supply Paper No. 114, U. S. Geol. Surv., p. 23.
†M. L. Fuller, Economic Geology, Vol. I, page 565.

down to the present time been above sea or drainage level the water should, in the absence of any known means of escape still be present. This, as has been indicated, is not the case. The problem of what has become of this water is one of the more fascinating ones left for future solution."

PERMEABILITY.

Marked differences exist in the rate of movement of water through permeable rocks. Falling upon sand water is quickly absorbed and transmitted through the relatively large pores to the permanent groundwater below, and a small proportion only is lost by evaporation or direct surface runoff. In the case of clays the water penetrates the capillary pores very slowly. The pores in the upper layers soon become filled and much water is lost by direct runoff and by evaporation because of the slowness with which it penetrates the underlying layers. Thus, while clay possesses high absorptive capacity it holds water with wonderful tenacity, and offers the greatest resistance to any movements through its pores.

For these reasons clays are classed with the impervious materials, and in most of the artesian systems of Alabama, serve as the water-tight confining beds to the water-bearing sandstones and other open-textured rocks. Of course, with sufficient time the water taken up by the clay will be transmitted, but this movement is so slow that for our present purposes it may be ignored.

Other fine grained materials exhibit similar qualities and Professor Prestwich* has shown that some chalks, with the same absorptive capacity as certain sandstones, transmit water 600 times slower.

Cause and rate of movement of underground waters.— Gravity is the chief cause of the movements of underground waters as it is for the movements of water in the surface streams. In both cases the flow is from a higher to a lower level. The rate of movement, according to Schlichter,† de-

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*Geology, Chemical, Physical, and Stratigraphic, Vol. I, page 159.

†The Motions of Underground Waters; Water Supply Paper No. 67, U. S. Geological Survey, p. 17.

pends (1) on the size of the pores, (2) on the degree of porosity, (3) on the pressure, and (4) on the temperature.

Velocity.—According to this author the *velocity* of the groundwater flow is the rate (measured as so many feet a day, or a year, etc.,) at which the water advances through the porous medium, irrespective of the amount of water thus advancing. For materials of various grades the following results have been obtained:

Velocity of Groundwater through Materials of different Grades, having a Pressure Gradient or Slope of 10 *Feet to the Mile.*

Material.	Miles per year.	Ft. per year.
Fine sand ______0.2 mm. diameter	0.010	52.8
Medium sand ___0.4 mm. diameter	0.041	216.0
Coarse sand ____0.8 mm. diameter	0.16	845.0
Fine gravel _____ 2 mm. diameter	1.02	5,386.0

The velocity for any other gradient can easily be calculated from the above. Thus, for a gradient of 100 feet to the mile, the velocity will be ten times that given in the table.

Flow or Discharge.—The amount of water (measured in cubic feet per minute) passing through a given cross section, is called the *flow* or *discharge,* and for the same materials and same degree of porosity and same gradient as in the preceding table, this flow is shown in the following table:

Flow of Groundwater in Materials of different Grades, through a Bed of Vertical Cross section 200 *by* 1000 *Feet, sloping* 10 *Feet to the Mile.*

	Cubic ft. per minute.
Fine sand ________________________________	5.5
Medium sand ______________________________	22.0
Coarse sand _______________________________	87.0
Fine gravel ________________________________	546.0

When the results of experiments on loose unconsolidated materials are compared with the actually measured rate of flow through the rocks for long distances, great discrepancies appear; for it is found that the flow through rocks is many times more rapid than the calculated and observed movements through porous sands. Concerning this Professor King* says: "It appears clear therefore, ... that the movements of water across long distances must take place in considerable measure through passage ways larger than those which depend upon the pore space fixed by the diameters of the grains which constitute the beds themselves."

There is no doubt but that the rate of flow of water through the superficial layers of rocks is increased by the existence of cracks and fissures due to the contraction and expansion from changes of temperature, to frost, crustal movements, etc., but it must be borne in mind on the other hand that at considerable depths below the surface these cracks and fissures are likely to be closed by the creep of the rock, and by the deposition of mineral matters from the circulating waters, so that after all we may conceive of the transmission of water through the rocks, and especially through deep seated rocks, as being mainly through the pores of the rocks themselves.

We have heretofore taken no account of another factor which is bound to affect the rate of flow, viz., hydrostatic pressure. On this point Prof. W. H. Norton† says, "rocks which transmit but feebly at the surface yield water at far greater ratios under strong pressure of artesian head. Since one pound of pressure to the square inch is required to support each 2.31 feet of water, in a flowing artesian well 1,155 feet deep in which the water rises to the surface from the bottom of the well, the water must exert at the base of the boring a pressure of 500 pounds to the square inch. The effect of such pressures . . . . . . must be to augment greatly the horizontal transmission of water. The effect of even a moderate increase of pressure is seen in mechanical filters, and the rapid rise in percolation accompanying the use of such pressure is set forth in certain experiments made by Isaac Roberts.‡ The stone through whose pores the water was forced is stated to have been to 10 1-2 inches thick, and of "average coarseness."

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*Nineteenth Annual, U. S. Geol. Survey, Part II, page 249.

†Artesian wells of Iowa, Iowa Geological Survey, Vol. VI, page 165.

‡De Rance, Water Supply of England Wales, p. 19.

Relation of Percolation to Pressure.

Pressures.	Percolation.
10 pounds to square inch	4 ½ Imperial gallons.
20 pounds to square inch	7 ½ Imperial gallons.
46 pounds to square inch	19 Imperial gallons.

The temperature of the water is also an important factor in determining the rate of flow, the movement being noticeably greater for high temperatures than for low ones, as shown in the following table.*

Relative Flow of Water at various Temperatures through Soil. (Standard Temperature is 50 Degrees F.)

Temperature Degrees F.	Relative flow.	Temperature Degrees F.	Relative flow.	Temperature Degrees F.	Relative flow.
32	0.74	55	1.08	80	1.51
35	0.78	60	1.16	85	1.62
40	0.85	65	1.25	90	1.70
45	0.92	70	1.34	95	1.80
50	1.00	75	1.42	100	1.90

MODIFICATIONS OF GROUNDWATER MOVEMENT DUE TO TOPOGRAPHY.

The running streams found in the caverns and subterranean channels of limestone formations, and in less degree in the cracks and fissures of other rocks, while sometimes of large size and of local importance, form but an insignificant part of that great body of water circulating through sands, and other porous strata, with which we are here chiefly concerned and which is here termed "ground water."

GROUNDWATER DIVISIONS.

In the discussion of underground waters three divisions have been recognized: (1) The unsaturated zone, (2) The surface zones of flow, and (3) The deep zones of flow.

*Schlichter Water Supply Paper, No. 67 U. S. Geol. Survey, p. 24.

The unsaturated zone extends from the surface of the ground down to the upper surface of the groundwater body—"the water-table." In this zone the saturation of the strata is prevented partly by the downward percolation of the water into the permanently saturated layers and partly by its being brought back to the surface by capillarity and the roots of plants and there evaporated.

The surface zone of flow extends from the level of the water table down to the first impervious stratum of considerable extent. The deeper zones of flow are those which lie below the first impervious stratum, and of these there may be several in the same region.

In the discussion of artesian systems we shall be chiefly concerned with the deeper zones of flow, while most of the other problems of the water supply pertain to the surface zone.

Surface Zone of Flow.

FORM OF THE GROUNDWATER TABLE.

The upper surface of the groundwater body, or the water table, shows a general agreement with the surface configuration of the land. Where the surface is horizontal over any broad area the water table likewise tends to be horizontal, its distance below the top of the ground depending partly on the rainfall and partly upon the depth from which moisture can be raised to the surface and evaporated. Where the land is sloping the water table slopes in a similar direction but usually at a less angle. Again where the surface is hilly there are corresponding but less marked undulations in the water table, the latter being practically at the level of the streams in the valleys, while under the crests of the hills it is considerably below the surface, the distance depending upon the amount of rainfall and the angle of slope towards the valley. These relations are very well shown in the accompanying diagram taken from Schlichter.

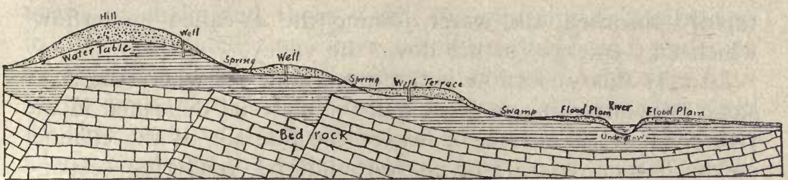

Fig. 3. Ideal section across a river valley, showing the position of the groundwater and the undulations of the water table with reference to the surface of the ground and bed rock.

Ordinarily the surface of the water table is above the level of the streams, and it will easily be seen how streams are constantly fed by seepage from the higher lands on each side, and how valleys not occupied by streams may be kept wet by the slow rise of water from below as it is forced up by hydrostatic pressure. This will be illustrated by the subjoined figure.*

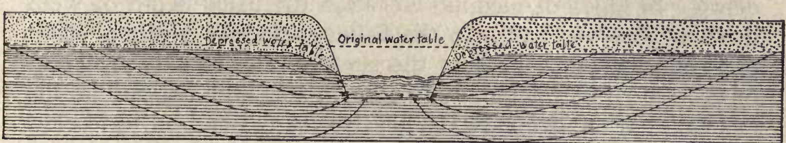

Fig. 4. Diagramatic section illustrating seepage and the growth of streams. Lines with arrows are lines of flow.

This figure will also show that the very general belief that underground waters are fed from rivers and lakes, is true only in very exceptional cases and under peculiar circumstances, for the hydrostatic pressure forcing the water from the highlands into the stream will in most cases exceed the pressure in the opposite direction.

Where, however, shallow soil is spread out over limestones cut by fissures and cracks, it may happen that the groundwater level cannot be maintained above the ordinary level of some of the surface streams. Similar conditions may exist in certain porous sandstones or other fissured rocks which are deeply underdrained. Again, in the arid region streams flowing out upon dry plains over channels of coarse materials, are often

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*Schlichter Movements of Underground Water. Water Supply Paper No. 67, U. S. Geological Survey, p. 13.

rapidly absorbed, the water joining the so-called 'underflow' which may emerge further down the valley.

Usually this underflow is not important, yet where the river slope (downstream) is great and the material deposited in the river channel is coarse, or where the fine silt of the channel covers deeper deposits of coarser material, rendering seepage into the channel difficult and underground passage downstream easy, the underflow may be relatively large, but the velocity of the underflow is always, according to Schlichter, very small and the total amount is commonly greatly exaggerated.

The depth of the water table, as we have seen, is greatly influenced by topography, but in regions of abundant rainfall and comparatively little evaporation, as in the eastern United States, the permanent groundwater level is seldom very far below the surface even in the uplands. In most parts of the Alabama highlands wells do not require to be more than 100 feet deep, and water is usually obtained at a much less depth. In lands of medium elevation the usual depth of wells is from 30 to 40 feet. In the valleys and low grounds water is often obtained very near the surface, and usually at depths of from 10 to 15 feet. It is only in the arid regions of the country that the groundwater level is many hundred feet below the surface.

Modifications of Groundwater Movement due to Stratification.

Deep Zones of Flow.

The materials of sedimentary formations are more or less perfectly sorted according to size, and the strata of different kinds constituting a cycle of deposition, normally succeed each other in a definite order, which is, pebbles and coarse sands below, followed in ascending order by finer sands, and these in turn by clays. To these inorganic matters must be added, as the last term of the series, the organic sediments, chalk and limestone.

Of the sediments above named the sandstones or sands usually constitute the porous, permeable beds, and the shales or clays, the impervious ones. The limestones in general may be classed as impervious, but some of the chalks, and especially those limestones, which are made up of loosely cemented fragments of shells and those which by exposure to weathering in the unsaturated zone, have become fissured and traversed by caverns and other open passage ways, may be in very high degree permeable, and thus water-bearers. Of this nature are the loose textured, shelly limestones of the Claiborne formation which constitute the water-bearing stratum of so many artesian wells in Georgia, Alabama, and Mississippi. In still another way limestone may become open-textured, viz., in its alteration into dolomite, with attendant diminution in volume, and development of cracks and interstices.

In any considerable thickness of stratified deposits representing a number of cycles of deposition as above outlined, there will almost certainly be found beds of porous materials well fitted for quickly absorbing water and for transmitting it by percolation, enclosed between beds which are relatively impervious. And since these beds are nearly always inclined at some angle to the horizon they furnish the conditions for storing, and maintaining a circulation of water far below the zone of surface flow in one or more systems or zones of deeper flow as defined above.

The distinguishing features of the deeper zones of flow have been so clearly presented by Prof. Schlichter in the work so often referred to above, that we can not do better than quote his words.

"The pervious and water-bearing sandstones and limestones beneath the surface zone of flow constitute what we have called the deeper zones of flow. There may be several of these deeper zones or they may be absent altogether. When present, they may be distinguished from the surface zone of flow by the following characteristics:

(1) The surface zone of flow has a free, unconfined upper boundary (the water table) and an impervious lower boundary. The deep zone of flow has an impervious upper boundary as well as an impervious lower boundary.

(2) The unit of the upper zone of flow is the drainage area or river valley. The unit of the deep zone of flow is regional and geologic and not dependent upon surface contours. However, it must not be forgotten that the deeper geologic structure is frequently the principal determining factor controlling the surface drainage, so that the deep zones of flow do not commonly run counter to the direction of the surface flow.

(3) The surface zone of flow is dependent upon the local rainfall of the immediate region. The deeper zones of flow receive their waters from distant areas.

(4) The surface zone of flow is in part above the level of surface drainage channels, while the deeper zones are entirely below the local drainage level.

(5) There is commonly a difference in the chemical composition of the waters from the two zones. It is difficult in our present state of knowledge to make valuable generalizations. The waters of the surface zone are usually less mineralized than those of deep strata, but in arid regions this general rule is frequently reversed. The carbonates are the predominant salts of the surface waters. The deeper waters are usually characterized by rather high amounts of dissolved chlorides. Waters of the surface zone contain dissolved oxygen gas, which is almost entirely absent from the deep waters."*

RECOVERY OF UNDERGROUND WATERS.

Water is returned to the surface mainly by two general ways: (1) By springs, and (2) by wells.

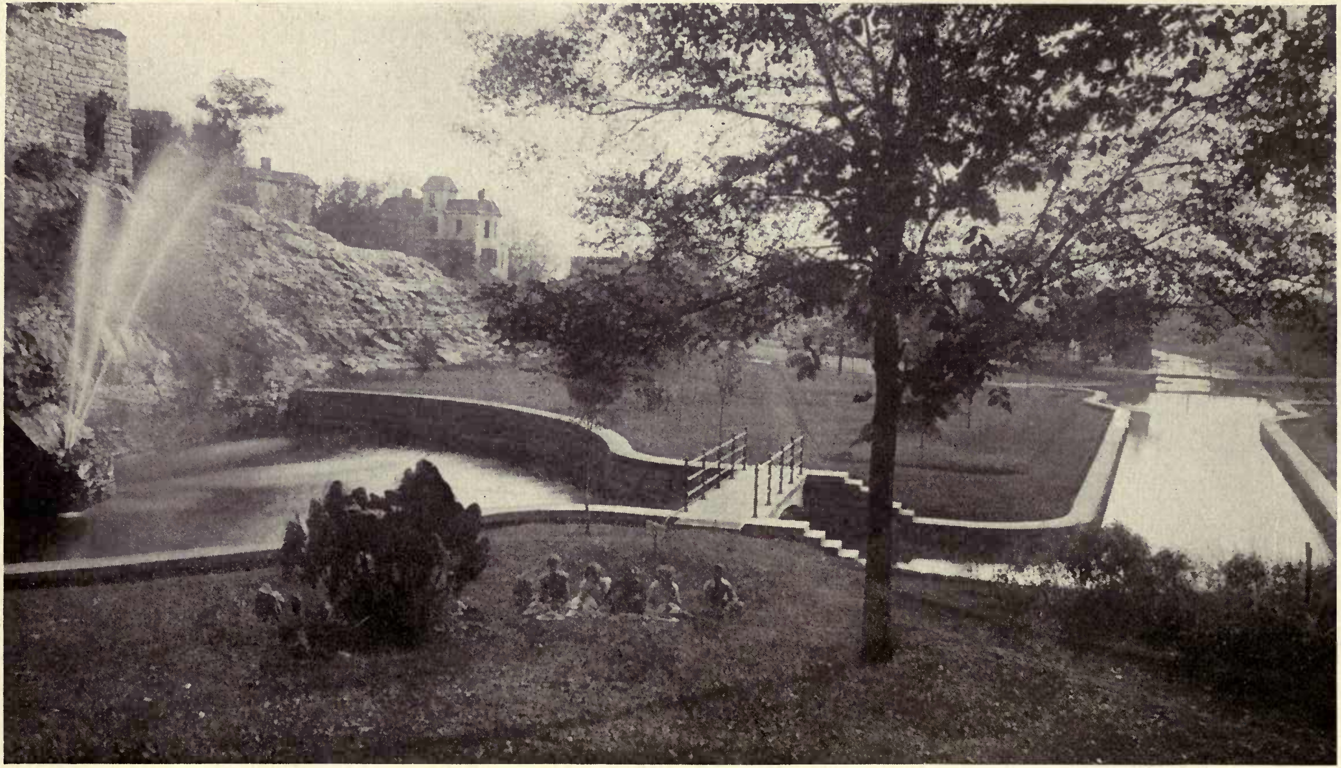
WATERS NEAR THE SURFACE.

Springs.—It has already been pointed out how in a region of uneven surface the rain-fall soaking into the ground will raise the level of the groundwater in the uplands until the head is sufficient to cause lateral movement towards the low ground, where it will rejoin the surface water by general seepage or seepage springs along the sides of the valleys, or pass into lakes and running streams and even into the sea if the distance is not too great. Where the emergence of the water is concentrated in a small area we have what is known as a spring. Such springs most commonly emerge just above an impervious bed. (Fig. 5)† or from between two impervious beds. (Fig. 6.)†

Fig. 5. Hillside spring from unconfined water bed without head.

*The Motions of Underground Waters, page 53.

†M. L. Fuller. Water Supply Paper, No. 145. U. S. Geol. Survey: page 47.



BIG SPRING IN HUNTSVILLE, MADISON COUNTY.

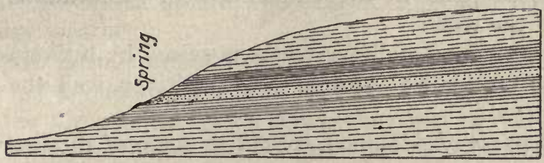


Fig. 6. Hillside spring from confined water bed under more or less head.

In limestone regions they generally emerge from solution passages in a mass of uniform rock. These are often of considerable size, and are commonly known in Alabama as "big" or "limestone" springs. One of the best known springs of this character in the State is that at Huntsville, (See Plate II). The water emerging from the subcarboniferous limestone at this point forms a stream of considerable size. The Knox Dolomite, another extensive calcareous formation in Alabama, affords hundreds of similar big springs. In the Coastal Plain region, especially in Barbour and Henry Counties, the Clayton and Nanafalia limestones, and further south the St. Stephens limestone of the Tertiary, are also characterized by similar springs.

Open wells.—To supplement these natural modes of recovery of underground waters, recourse has been had from the earliest times to artificial contrivances, the most important and most commonly used of these being the ordinary open well. An excavation is made in water-bearing sands to some depth below the water table. A lowering of the water table around the well at once follows by reason of the converging flow of the underground waters into the well. If the water is not drawn from the well the level of the water table will be restored after a time and stand at the same height in and near the well as father away. If the water be removed in any considerable quantity, the level of the water in the well will remain below that of the general water surface outside, the depression depending on the quantity of the water removed.

Driven wells.—The *driven well* is merely a modification of the open well, made by driving a pipe with open end, or better with closed point at the end and with perforations above it to admit the water.

From the open well the water is raised by bucket, or pump, or other mechanical means. For a driven well the pump is mostly used.

In all parts of Alabama, except in some of the limestone regions and the Post Oak Flatwoods, (and even in these in places), water may always be obtained by sinking wells to depths varying from a few feet to one hundred or more, generally less than fifty feet. In residual accumulations, (i. e. those resulting from the decomposition of the rocks), such as are common in the area of the crystalline rocks, and in the Coal Measures, and in some limestone regions where these surface matters are more or less clayey and localized in extent, the supply is likely to be uncertain, and the wells to go dry or to diminish greatly in summer. But where the surface materials are of such wide distribution and of such favorable composition as are afforded by the Lafayette beds that have been spread so generally over the whole Coastal Plain Region of Alabama, the supply seems to be never-failing under present climatal conditions.

It is not an uncommon circumstance in some parts of the Coastal Plain Region, that of two closely contiguous wells the water of the one may be good while that of the other may be unfit for use by reason of excess of organic matter and iron salts. The one penetrates into a buried slough or other deposit of organic matters, while the other does not. This is shown by the accompanying figure taken from Water Supply Paper No. 145, U. S. G. S. page 112.

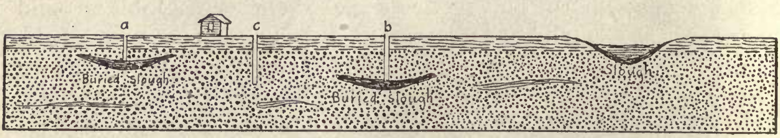


Fig. 7. Diagram showing buried sloughs. Wells at a and b would furnish water containing iron and organic matter. The well at c would furnish comparatively pure water. (After Purdue.)

Inasmuch as the lowering of the groundwater level in the uplands by drainage into the lowlands, goes on very slowly, the time of low water in the wells rarely coincides with the season of dry weather.

The hillside springs are subject to like conditions or limitations, they go dry in many places in the Coal Measures and region of the Crystalline rocks, while they are never-failing in parts of the Coastal Plain where the materials of the Lafayette form the surface.

Deep-seated Waters.

It has been shown above how alternations of the permeable and impervious strata of the sedimentary formations afford the conditions for deep seated flow of underground waters. From these deeper zones of flow as from the surface zone, the water may also be recovered through the agency of gravity supplemented by natural or artificial return ways.

Deep Springs (*Fissure springs.*)—The groundwater in gently dipping porous beds enclosed between impervious ones, may in the course of its downward percolation to considerable depths, meet with joints or fissures in the impervious overlying bed and thus escape to the surface, sometimes at considerable distance from the place at which it entered the ground, as is shown in the accompanying figure.

Figure 8. Fissure spring.

The waters of springs of this kind having been long in contact with the strata are likely to be highly charged with mineral matters that have been taken into solution on the way. Deep springs are usually distinguished from surface springs by a greater constancy of flow, by relative uniformity of summer and winter tenperatures, and by freedom from contamination.

Artesian wells.—In this paper the term "artesian" is used for any well sunk into a deep zone of flow where the water is found under hydrostatic pressure, so that it will rise in a well above the impervious confining strata. As thus defined artesian wells may be divided into flowing and non-flowing. This, however, is a non-essential distinction, since of two wells sunk into the same water-bearing stratum one may flow while the other on somewhat higher ground may not. From such wells the deep seated waters are recovered either by natural flow or by pumping at the surface.

B. ARTESIAN WELLS.

Artesian wells are governed by certain laws and present certain definite features, a discussion of which will be found in the following paragraphs.

ESSENTIAL CONDITIONS.

In his treatise entitled, The Requisite and Qualifying Conditions of Artesian Wells, *Prof. Chamberlin enumerates the following seven prerequisites:

I. A pervious stratum to permit the entrance and the passage of the water.
II. A water tight bed below to prevent the escape of the water downward.
III. A like impervious bed above to prevent escape upward, for the water, being under pressure from the fountain head, would otherwise find relief in that direction.
IV. An inclination of these beds, so that the edge at which the waters enter will be higher than the surface at the well.
V. A suitable exposure of the edge of the porous stratum, so that it may take in a sufficient supply of water.
VI. An adequate rainfall to furnish this supply.
VII. An absence of any escape for the water at a lower level than the surface at the well.

These have commonly been accepted as essential to artesian flows, but recent investigations† indicate that artesian flows may take place where the first four of these conditions,

*Fifth Annual Report. U. S. Geol. Survey, 1885, pp. 131-173.

†M. L. Fuller. Artesian Flows from Unconfined Sandy Strata; Engineering News, Vol. 52, pp. 329-330.

supposedly indispensable, are absent. The following figure representing a typical East and West section across the bays on the north shore of Long Island, illustrates one such case, where, notwithstanding the permeability of the sands, wells penetrating below the water table at the base of the bluffs obtain flowing water.

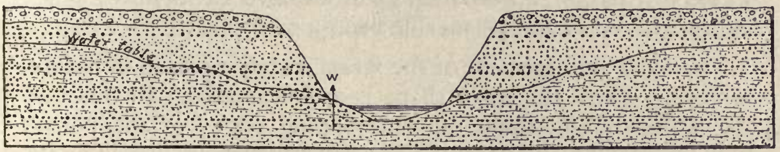


Fig. 9. Section showing conditions furnishing flows from unconfined sandy strata. (After Fuller.)

Slight difference in the degree of porosity of the sands may account for the phenomena, or the horizontal arrangement of the grains, even in uniform sand, may so oppose the passage of the water that it will pass upward through the well with greater ease than through the sand of the nature described, and a flow will result.

In the region of the metamorphic and igneous rocks also, artesian wells are obtained where some of these "essentials" appear to be wanting.

In fact, adequate rainfall, suitable outcrop of the porous bed, and absence of leakage being assumed, it is probable that the one essential pre-requisite of an artesian flow is a sufficient difference in the level of the water table in closely adjacent regions.

In the great majority of cases, however, with which we in Alabama are concerned, the conditions governing the artesian problems are practically those discussed by Prof. Chamberlin, and a statement of some of the most important of these conditions will help to a proper undertaking of much that follows.

Artesian system.—A series consisting of a porous or permeable bed enclosed between two impervious ones, all having a moderate dip or incline somewhat greater than the general slope of the surface, constitutes an artesian system. Water falling as rain upon the outcropping edge of the permeable bed will be absorbed by it, and by the force of gravity will percolate through it in the only direction possible, i. e. down the dip, general diffusion being prevented by the under-and over-lying impervious beds. Carried thus between impervious sheets to a lower level than the outcrop, the water will accumulate under hydrostatic pressure, and if the overlying retaining bed be pierced by an opening, natural or artificial, the water will ascend, approximately to the level of its head, which is the outcrop of the permeable bed.

The ideal arrangement of the strata, rarely realized in nature, is that in which the basin shape is approximated. In this case the water falling upon the outcropping edges of the porous beds, gradually sinks from every side toward the center of the basin. This case is illustrated by Fig. 10 below.

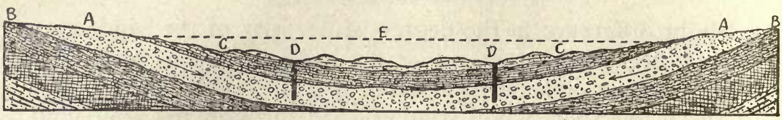


Fig. 10. Ideal Artesian Basin.

A far more common arrangement and one prevalent in the Alabama Coastal Plain is that where the strata all dip in one direction and the general slope of the land surface is in the same direction but at a less rapid rate. In such a system the character of the well, whether flowing or not, will depend upon the local inequalities of the surface.

These conditions are illustrated in the following figure.

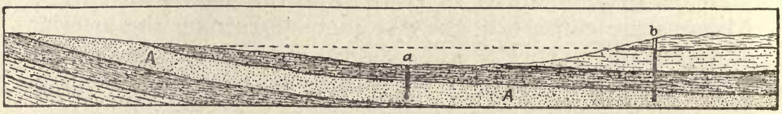


Fig. 11. Diagrammatic representation of a single artesian system, showing the influence of relative altitude in determining whether or not the well will flow. A is the porous water-bearing bed enclosed between impermeable ones. The well at a will flow, that at b on higher ground will not.

If the general slope of the land surface were in the opposite direction from the dip of the strata, a flowing artesian well would be an impossibility except under peculiar local conditions.

The diagram below, Fig. 12, for which we are indebted to Mr. M. L. Fuller* illustrates a case which has come under his observation, where the water flows at a higher level than the outcrop of the water-bearing bed of the region, being fed, however, in part through a joint or fault from a higher lying source.

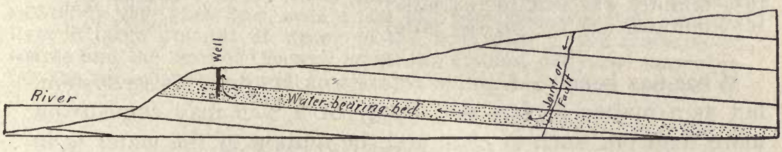


Fig. 12. Underground conditions in Thompsonville well. (Conn.)

A very gentle dip of the strata is most favorable, for if the dip be great not only will the outcrop of the porous bed be narrow and its intake capacity thus reduced, but the water will very quickly be conducted to depths which it would be impracticable to reach by borings. A dip of one per cent. will carry a stratum down 52.8 feet in a mile; a dip of ten per cent. will carry it down 528 feet in a mile; while a dip of 45 degrees will carry the bed down one mile in a mile. These relations and the rapid narrowing of the area of outcrop with increase of the angle of the dip will be made clear by the accompanying diagram in which A, B and C, represent the relative widths of the outcrop of three strata of equal thickness but of different inclinations; A at 5 degrees, B at 10 degrees, and C at 25 degrees from the horizon.

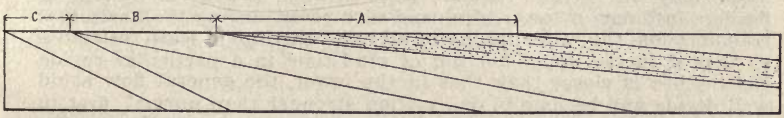


Fig. 13. Illustrating the influence of the dip of the strata on the width of the outcrop.

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*Water Supply Paper No. 110, U. S. Geol. Survey, p. 102.

The following figures will further illustrate these points:

A bed of 1000 feet thickness inclined at different angles will have a surface outcrop varying as shown in the table below.

Angle of Dip.	Width of outcrop.
45 degrees	1414 feet.
20 degrees	2924 feet.
10 degrees	5780 feet.
5 degrees	11495 feet.
30 minutes	114547 feet.
26 minutes (40 feet to the mile)	132275 feet.
19½ minutes (30 feet to the mile)	176367 feet.
16½ minutes (25 feet to the mile)	208333 feet.

What has been said above refers to a single artesian system, but as a matter of fact the supply of a well may come from more than one such system, and the motion of the water is in consequence far more complicated than above indicated. On this point Mr. King* writes as follows:

"It would appear that all fissures of all rocks must participate in the horizontal movements of ground water to a considerable extent if they lie below the plane of saturation and are in any way connected with a water-bearing stratum. Where two sandstone (porous) horizons are separated by rock formations possessing jointed structure developed in a marked degree it may be that these joints and fissures participate in no inconsiderable extent in the horizontal transmission of the water."

"It may also be true that such beds separating two sandstone formations will serve to make the water in both beds available to wells which penetrate only the upper horizon, the water reaching the well not directly but by rising in a general way at many places or along numerous lines and networks of fissures and over wide areas, in such a manner as to keep the upper sandstone more nearly filled with water and thus maintain the pressure in the rock about the well at a materially higher point than would otherwise exist, especially in such cases as the wells of the city water works where continuous pumping is maintained."

"It may even be true that water from an upper horizon of sandstone may, in certain regions, pass through a general system of fissures into one of lower level, and *vice versa,* during the horizontal transmission, the water taking in all cases the line of least resistance so that if in the upper horizon of sandstone in a particular region the texture is closer than that in the lower, the general flow could well divide and become in one section stronger than normal, first in the lower horizon and then in the upper horizon, according as the textures of the two rocks vary in coarseness."

"It would appear that the more rational view to take of the movement of underground water is that it is one more or less continuous

*Nineteenth Annual Report, U. S. G. S. Part II, page 249.

body receiving accessions at many high levels and discharging its water at many lower levels, but that the water in reaching its lower levels may not all of the way follow continuously one particular geological horizon.'

"It is of course true that the maximum flow must be concentrated in the sandstone horizons, but it seems also necessary to suppose that even here there may be joints, fissures, or other waterways which materially assist in the transmission of the water."

"In the case of wells sunk in rock the flow of water into them may be very much more rapid than that of the general flow of the water through the formation into which the well is sunk, because when the water is taken out, either by pumping or by natural discharge, a local effective head is developed, much greater than the general effective head, and as the water approaches the well from all sides, a relatively very slow flow, even a few feet back from the well, will deliver a large amount of water to the well, and if the material is coarse and the bore of the well small the amount delivered may even tax the capacity of the well to deliver the water which is brought to it."

MODIFYING CONDITIONS.

In a single artesian system of the Alabama Coastal Plain, of limited extent and fairly uniform in the composition and structure of its strata, the conditions will be about as represented in the diagram given above, Fig. 11.

In the very nature of things, however, these sediments will not be in continuous and unbroken sheets under the whole expanse of the Coastal Plain. They will be intersected by streams and will vary in the character of the materials and their thickness and order of succession from place to place, so that wells, which from their position should have nearly identical logs or records, do often show very great differences. Some of the complications thus brought about may be briefly noted.

Effects of erosion.—If the water-bearing stratum be intersected by a ravine or stream valley at right angles to its dip, the effect on wells on the two sides of the ravine may be very different as the following diagram will show.

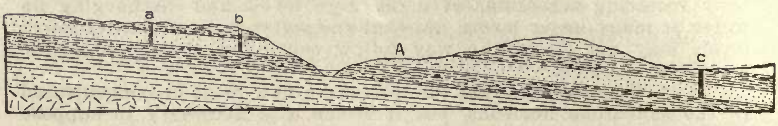

Fig. 14.—Section showing the effect of erosion. A is the porous water-bearing bed between two impervious ones. The well *a* will flow provided the distance from the ravine be considerable and the leakage from the water-bearing bed into the ravine not too great, but the well *b* will probably not flow because of this leakage into the adpjacent ravine.

The well at *c* might not yield water if the exposure of the water-bearing bed was limited to the side of the ravine and therefore of small area, but if the bed outcrops over considerable area of the valley floor as shown in the figure, a flow would probably be obtained.

Variations in the Water-bearing stratum.—In two principal ways the water-bearing stratum may change so as materially to affect the artesian prospects. It may thin down in the direction of the dip until the confining impervious beds come together. Above this point a well may be successful, below it not. Again, the porous bed may become gradually finer and finer in texture, or it may be gradually replaced by silt or clay, and thus the transmission of the water may be clogged or prevented.

Conditions like these are common enough in the Coastal Plain region and from the very nature of the mode of accumulation of off-shore sediments, are normal, for the coarser materials deposited near the shore are succeeded by finer textured sands and by silts and clays as the distance from the shore increases. The two figures below will illustrate these conditions.

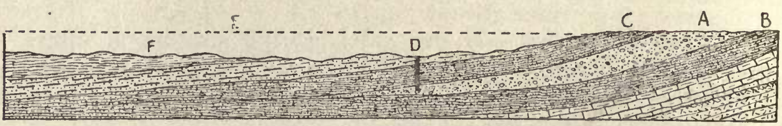

Fig. 15. Section illustrating the thinning out of a porous water-bearing bed, A, enclosed between impervious beds B and C thus furnishing the necessary conditions for an artesian fountain at D, but to the left of D the conditions for such fountain would be absent. (After Chamberlin.)

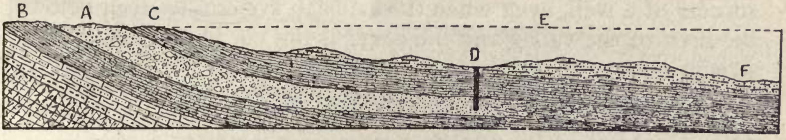

Fig. 16. Section illustrating the transition of a porous water-bearing bed A, into a close textured impervious one. Being enclosed between two impervious beds B and C, it furnishes the conditions for an artesian fountain at D, but not for one to the right of D where the porous bed is replaced by an impervious one. (After Chamberlin.)

Variations in the confining impervious beds.—These beds may vary in texture from place to place, or they may be cracked and fissured in such a way as ta permit leakage sufficient to modify very materially the artesian conditions. Defects in the confining bed *below* may allow leakage into a lower porous bed which outcrops at a lower level, thus reducing the effective head of the upper water-bearer. The character of the confining bed *above* is even more important than that of the underlying one, for the water being under pressure will be forced through it unless it be comparatively water-tight or else very thick, and thus the amount of water available to the well will be diminished possibly to the extent of preventing a flow altogether.

The efficiency of the cover increases with its thickness as may be easily understood, and a relatively porous cover may under certain circumstances not only serve as a confining bed but may even increase the yield of water. This will be the case when the surface of the country between the fountain head and the well is high so that the general level of the water table is *above* the outcrop of the porous water-bearing bed.

The downward pressure of this groundwater will not only prevent the upward escape of the artesian water but may even add to its volume.

On the other hand, if the country between fountain head and well is low and the cover on that account comparatively thin, there will be some leakage unless this cover is exceptionally impervious.

In this way the occurrence of a river valley between the fountain head and the well may seriously lessen the probabilities of success of a well, even when the artesian system lies well below the floor of the valley and the cover is not cut by the bed of the stream.

Other modifying conditions.—In a region like the Coastal Plain of Alabama, which includes a number of artesian systems, other complications arise from irregularities in the extent and in the order and distribution of the various strata. The following figures, taken or adapted from Darton,* are introduced to illustrate a few of the cases commonly encountered.

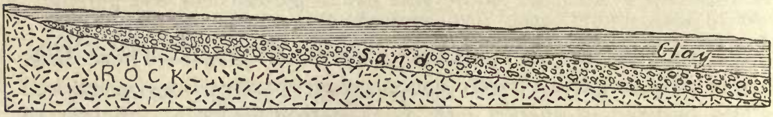

Fig. 17 Illustrates the case where an impervious bed overlaps completely the intake area of the porous bed, thus greatly diminishing or cutting off its water supply. This porous bed may be, at other points along its outcrop, bared of this impervious overlap and thus be water-bearing.

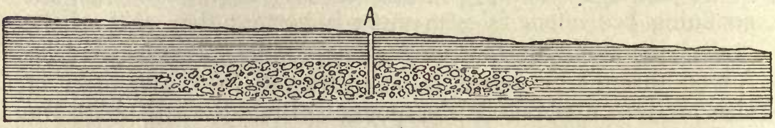

Fig 18 Represents the occurrence of a gravel bed completely enclosed in clays so that no water can accumulate in it, and a well at A although finding favorable materials for water would obtain none.

Fig 19 Shows the case where gravelly bedy of ancient streams or the beaches of ancient lakes have become buried under the later accumulations of impervious materials and rest on the same. Two of these lines of gravel, which may be narrow and sinuous but which may extend for miles, are here shown in cross section. Unlike the case represented in the preceding figure, the gravels are not completely enclosed in clays, but in other parts of their courses are bared of the impervious cover and have thus become water-bearing. Wells at AA which go down into the ancient channels would be successful, while those at B and B wholly in the impervious material would not.

*Bulletin No. 138. U. S. Geological Survey.

In Fig. 20 the conditions would appear to be favorable for water at A in the gravels between the upper clay beds, but the water does not accumulate, for it is free to flow over the edge of the clay into lower gravels, where it would be found in a deep well, as at B.

ARRANGEMENT OF THE STRATA IN THE ALABAMA COASTAL PLAIN.

The most favorable disposition of the strata actually existing in Alabama, as has been said above, is found in the Coastal Plain region, which is underlain by the sediments of the Cretaceous and Tertiary formations, consisting of beds of sand, clay, and limestone, and others of intermediate character in many alternations. These lie in great sheets thinning out landward and increasing in thickness toward the Gulf, thus making a great flat wedge resting on the Gulfward sloping floor of the older rocks.*

The ground surface in the Coastal Plain sinks from an altitude of about 600 feet near the landward margin to the level of the sea in the two coast counties though there are places in Baldwin County where the land has an altitude of fifty feet or more on the very border of Perdido Bay, and high land, 100 feet and more in altitude, exists in both Mobile and Baldwin a few miles from the Gulf.

The strata themselves have also a general dip or incline toward the Gulf, but at a more rapid rate than that of the land surface, this dip being from 25 to 40 feet to the mile, and averaging perhaps 30 feet. The conditions are thus afforded for

*Very few of the artesian borings in Alabama have gone down to this floor, except in the immediate vicinity of the surface outcrops of the older formations. The borings at Tuskegee have penetrated the granitic rocks underlying that section; and at Tuscaloosa, borings within a distance of one or two miles south of the last appearance of the rocks of the Coal Measures in the bed of the river at the bridge, have reached these rocks and penetrated them to considerable depths; but beyond that distance none has gone through the strata of the Cretaceous which here overlie the Coal Measures.

many artesian systems. The low relief of the country makes impossible, however, the great hydrostatic pressure observed in the mountainous regions.

All this may be made clear by the accompanying diagram, taken with slight modification from Darton's Report on Artesian Well Prospects in the Atlantic Coastal Plain,* to which paper I am indebted for many valuable suggestions.

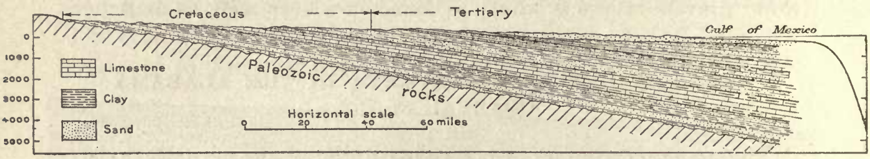

Fig. 21. Section from north to south across the Alabama Coastal Plain illustrating its artesian conditions.

DECLINE OR FAILURE OF ARTESIAN WELLS.

The causes of decline in the flow of artesian wells and their detection, have been fully discussed in the article of Prof. Chamberlin, which those interested in the subject should consult. In this report we can make only brief mention of some of the most obvious of these.

Increase of leakage is responsible for most of this trouble, and is likely to occur when the well is not piped its whole depth and especially when the boring is through limestone, the capillary passages and cracks in which may be gradually enlarged by solution, thus allowing the water to escape.

Iron rusts quickly, especially if there are corrosive ingredients in the water, and the piping thus rendered defective may cause much loss from leakage.

Closure of the bore.—Soft and plastic beds like those of clay and shale, and loose ones like those of sand where the pressure is great, may yield and tend to close the bore. Or the water-bearing rock in the immediate vicinity of the well may become clogged by the deposition of fine silt in its pores, or by some form of organic life, or by a deposit of iron.

Decline from exhaustion.—If there is but a limited accumulation of water in the distant elevated edge of the porous bed

*Bulletin No. 138, U. S. Geol. Survey, p. 18.

and it is not promptly renewed from the surface, the well may gradually draw it off. A decreasing flow from this cause will fluctuate with the rainfall and will renew itself with returning wet seasons. But too heavy drafts on the capacity of the water-bearing stratum by increase in the number of wells will be sure to cause a gradual failure of the artesian basin, for while the water supply is constantly renewed it may easily happen that the drains upon the basin may be greater than the supply. Of all causes of decline this is probably the most common. The obvious remedy would be the attaching of spigots or the reduction of the outlets, by which too great waste would be prevented.

CHARACTER OF THE WATER.

Temperature.—It is a fact derived from observation that below the depth at which the daily and yearly fluctuations of temperature are felt, the temperature of the earth increases with the depth at a rate which varies with the different materials encountered, but which may be put at an average of one degree of Fahrenheit for every fifty feet of descent. In our latitude the depth of the *level of invariable temperature* as it has been called, is roughly speaking about 100 feet. Below this, the increase of heat with the descent should be felt. Waters coming from great depths would thus be expected to have a higher temperature than those which have a more superficial origin, and many tests of temperature have shown this to be the case. The first attempt to prove this by the records of Alabama artesian wells, was made by Dr. Alexander Winchell in 1856, while he was in charge of a school near Eutaw. The results of Dr. Winchell's tests were published by him in the Proceedings of the American Association for the Advancement of Science, for the year 1856. The temperatures given vary from 64 degrees to 77.5 degrees, and the depths of the wells from 90 to 728 feet. The mean annual temperature of that part of the state (temperature of the invariable stratum) is not far from 64 degrees.

After rejecting a number of observations which were obviously erroneous, the average shown by the records was an increase of 1 degree for every 44.96 feet.

It is obvious that artesian wells do not afford the best means for establishing this rate of increase, for the reason that in them the water almost always comes from several horizons and thus the temperature of the flow is likely to be lower than that of the deepest source. Still, it is very evident that the temperature of the water increases with the depth of the well, though the rate of this increase cannot be established by observations of the temperature, except in such cases where it is certain that the water comes from only one horizon.

Mineral Ingredients.—Water which has long remained in contact with the strata of the earth will have taken into solution a portion of the ingredients of those strata, and the proportion of dissolved ingredients will be greater in proportion to the length of time of such contact and the temperature there prevailing. Waters which come from the greatest depths are therefore on both accounts likely to be more fully saturated with soluble matters than those which come from shallow depths only. We have seen above that the movements of groundwaters at considerable depths must be exceedingly slow giving them more time to effect solution. But on the other hand there is a great difference in the amount of soluble matter which different strata contain, and it might easily happen that the water from a well of moderate depth would come from a bed with a large proportion of soluble salts, while one from a greater depth might derive its water from a stratum of nearly pure sand containing a minimum of such salts. It is thus probable that the dissolved salts of an artesian water are far more dependent upon the character of the water-bearing beds than upon the depth and temperature. As the flow continues, the water which formed the original reservoir with a maximum of dissolved salts, would gradually be drawn off and its place would be taken by water which had not so long been in contact with the rocks. A slight dimunition of the proportion of dissolved salts might therefore in time be perceptible if the flow were very generous.

Inasmuch as most of the strata of the Coastal Plain of Alabama are marine sediments, it would naturally be inferred that the soluble materials enclosed in them and thus given up to the circulating waters. would be such as were originally held in solution in the sea water. The chief one of these is common salt or chloride of sodium, and along with it are smaller quantities of the chlorides and sulphates of potassium, magnesium, and calcium. In some of the artesian waters the carbonates predominate, such as carbonates of sodium, calcium, magnesium, and potassium. These waters are, in some cases at least, derived from fresh water sediments.

In the next Chapter are given many analyses of the waters from the different parts of the state and from the different geological formations, which will partially illustrate this subject.

CHAPTER III.

DETAILED DESCRIPTION OF THE UNDERGROUND WATERS OF ALABAMA.

APPALACHIAN DIVISION.

TALLADEGA MOUNTAINS AND ASHLAND PLATEAU. (IGNEOUS AND METAMORPHIC ROCKS.)

SURFACE FEATURES.

In the geological sketch above it has been shown that the rocks underlying the Appalachian division of the State are more or less crystalline in texture, and below a moderate depth usuallly very densely compacted and practically impervious. Near the surface they are often much fractured and fissured, but the crevices offer very limited and uncertain channels for the transmission of ground water. Most of these rocks display at the surface division planes of schistosity, dipping generally toward the southeast, but open passages along these lines are likewise superficial, so that at best in the original rocks the conditions are wanting, or at least very unfavorable, for the storage or transmission of ground water.

SHALLOW WATERS.

By the action of atmospheric agencies the rocks throughout this area are more or less completely covered by a mantle of clayey sand, the result of their decay. In favorable locations, where this residual matter is not disturbed by rains, it is possible to trace the progress of the decay from the structureless clays through rotten slates down to the unaltered crystallime rock. In some places the decay penetrates to great depths, 100 feet or more. Very frequently the residual matter has been removed from the place of its origin, having slid down slopes and accumulated in lowlying lands, leaving the comparatively fresh rock bare at the summits and along the exposed cliffs. The surface mantle thus provided, being a mixture of clayey matter with fragments of quartz and other undecomposed minerals, is sufficiently porous to absorb and transmit with readiness water falling upon it. The moisture is thus diffused generally throughout the mass, descending until held in check by the nearly impervious undecomposed rock below. The ground water can therefore be utilized by means of ordinary shallow wells and springs, but on account of the discontinuous character of the surface accumulations the supply of water is in places somewhat limited and liable to failure in seasons of drought.

A good many bored wells have been sunk in this residual material especially in Chilton county, about Thorsby, by Mr. I. E. Sarber. These wells get water at depths varying from 60 to 100 feet, in a clean yellow sand underlying a hard yellow or blue clay, and resting on the solid granitic rock of the country. Into this rock the borings have pentrated as much as 60 feet without any yield of water. There is generally some rise of water in the wells, the usual stand being from 30 to 70 feet below the surface.

MINERAL WATERS.

The Hillabee schist is the source of a number of mineral springs, the most important of which are Chandler's, Chambers', and Jenkins', all situated on the eastern flank of the Talladega Mountain range. A sample of the water from Chandler's Spring has been analyzed by Mr. Hodges, with the following results:

Analysis of water from Chandler's spring.

	Parts per million.
Potassium (K)	3.3
Sodium (Na)	7.5
Magnesium (Mg)	10 3
Calcium (Ca)	37.7
Iron (Fe)	4.3
Alumina (Al_2O_3)	4.4
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	9.5
Carbonic acid (HCO_3)	186.0
Silica	55.1
	319.8

This is an alkaline-saline water which, from the relatively large amounts of iron and the sulphates of potassium and magnesium, should possess some medicinal quality.

The water from Chambers Springs, a few miles distant from Chandlers and derived from the same source,—the Hillabee Schist—has somewhat similar though not identical composition, as may be seen from the following analysis by Mr. Hodges.

Analysis of water Chamber's Spring. "Sulphur Spring."

	Parts per million.
Potassium (K)	.3
Sodium (Na)	5.5
Magnesium (Mg)	19.2
Calcium (Ca)	39.0
Iron and Alumina (Fe_2O_3,Al_2O_3)	3.3
Chlorine (Cl)	3.0
Sulphuric acid (SO_4)	5.4
Carbonic acid (HCO_3)	217.8
Silica (SiO_2)	56.7
	350.2

ARTESIAN PROSPECTS.

In the surface beds of residual soils and other products of decomposition the conditions are unfavorable to the success of artesian borings, since these beds are not continuous over large areas and are lacking in alternations of pervious and impervious strata with gentle inclination. In the underlying solid rocks the conditions for artesian water can not be said to be much more favorable, for while these rocks attain, especially near the surface, some degree of permeability by reason of the joints and fissures by which they are traversed, these channels are not likely to be continuous for any great distance nor to be present at any great depth; moreover, their position can not be determined beforehand and there is no certainty about striking them. Almost any boring into these rocks will directly fill with water, but only under favorable local conditions is the amount likely to be sufficient to meet very large demands.

The manner in which the joints may serve as waterways for artesian supply is illustrated by the accompanying figure after M. L. Fuller.*

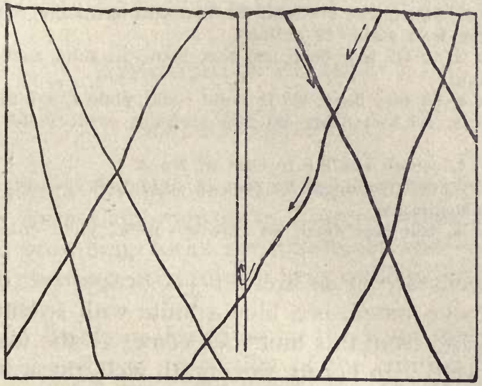

Fig. 22. Well in jointed rock.

The figure will also show how it is possible for polluted water to pass along these joints into the well.

On general principles then, the area of the igneous and metamorphic rocks may be considered as unfavorable for artesian water prospects, and experience in many States bears this out. On the other hand by increasing the number of borings within a limited space, it is often possible to obtain an adequate supply. This has been demonstrated at Lanett in Chambers county. Recent studies have also thrown some light on the artesian conditions of the crystalline rocks, and Mr. Fuller† expresses the opinion that it is possible by means of careful examination to determine in advance the probabilities of the success of a well within a margin of anly a few per cent. of error.

The number of well records from this section of the Appalachian Division, is at present quite small, but the use of the drill is steadily increasing.

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*Water Supply Paper No. 114, U. S. Geol. Survey, page 28.

†Economic Geology, Vol. I. page 567.

LANETT WELLS.

In 1897 and '98 eight wells were bored for the Lanett Bleachery and Dye Works at Lanett in Chambers County. The first well as 93 feet deep through soil and loose rock only. It yielded thirty-six gallons per minute.

Well No. 2 was bored 248 feet, 113 feet through solid rock which is of granite. This well yields 29 gallons.

Well No. 3, is 467 feet deep, 390 feet being in solid rock; yield 62 gallons per minute.

Well No. 4, 703 feet deep, 610 in solid rock; yield 62 gallons per minute.

Well No. 5, 460 feet deep, 390 feet through rock; yield 17 gallons per minute.

Well No. 6, record similar to that of No. 5.

Well No. 7, 690 feet deep, 500 feet in solid rock. Original yield about 90 gallons per minute.

Well No. 8, 1064 feet deep, 984 through rock; yield only 30 gallons.

These wells are in an area of 350 or 450 feet radius. The rock, as above stated, is a blue granite with seams or veins of flint rock, and from this flint rock comes all the water obtained from the wells. In boring the eighth well, the water from the two nearest wells was reduced, from which it has been inferred that the group of wells takes up practically all the water available within the area. The piping down to solid rock was all six inches in diameter. The water is considered very pure. It contains a trace of magnesia, and, with the exception of the water from the surface well, appears to be free from lime. Information concerning these wells is furnished by Mr. L. Lanier, President of the Lanett Cotton Mills.

ALEXANDER CITY WELLS.

Well No. 1, depth, 525 feet; depth to water, 250 feet; diameter, 10 inches; depth of casing 60 feet, to rock; height of water, 17 feet; wields, 45 gallons per minute; after lowering the sand to 100 feet there was no further change by pumping; use, for fire purposes only; method of pumping, air compressor; total solids, 415.94 parts per million; volatile and organic matter, 112.98 parts per million; temporary hardness 46.22 parts per million; permanent hardness, 179.76 parts per million; mineral constituents, chlorine, lime, and magnesia relatively abundant, sulphuric acid, iron, and alumina in small amount.

Well No. 2, depth, 350 feet; depth to water, 250 feet; diameter, 10 inches; depth of casing 60 feet, to rock; yield, 60 gallons per minute; height of water, 17 feet; stand has not been lowered by pumping below 100 feet; total solids, 461.7 parts per million; volatile and organic matter, 51.3 parts per million; temporary hardness, 47.93 parts per million; permanent hardness, 172.89 parts per million; mineral constituents, chlorine, lime, and magnesia relatively abundant, sulphuric acid, iron, and alumina in small amount.

The composition of the water from the two wells appeared to be substantially the same.

AUBURN, LEE COUNTY.

A well was bored at Auburn in 1899 by M. L. Fullan, the details of which will be found in the description of Lee County in the Coastal Plain division below.

APPALACHIAN VALLEYS.

SURFACE FEATURES.

The geological formations occurring in the Appalachian valleys range from Cambrian up to Lower Carboniferous inclusive. The prevailing rocks are limestones and dolomites, but along with them are subordinate beds of shale, sandstone, and conglomerate.

The great limestone formation is the Knox dolomite, which occupies a very large proportion of the entire area. Of less importance are the Trenton and Tuscumbia (Lower Carboniferous) limestones, which usually outcrop only along the margins of the valleys or the bases of the bordering hills.

In the lower part of the Cambrian occur the most important bodies of shale, which underlie large areas in the Coosa Valley and smaller ones in the central parts of the lesser valleys. Other bodies of shale inclosing beds of sandstone, occur among the strata of Clinton (Red Mountain) ridges. Still other shales make a large part of the area of the Lower Carboniferous along the western border of the Coosa Valley.

The sandstones are fairly well distributed among the various formations, but the greatest bodies, including conglomerates, are found in the Coosa Valley, where they rise into veritable mountains. The sandstones of the Clinton (Red Mountain) ridges and of the Lower Carboniferous formations may under certain conditions be of importance in connection with artesian prospects, which are considered below.

SHALLOW WATERS.

While the rocks of this subdivision are not as a rule characterized by any serviceable degree of porosity, as will be seen later, yet they are all covered more or less completely by soils and other residual matters resulting from their decay and weathering, and these surface accumulations are fairly well adapted to the absorption and storage of the rainfall, so that springs and open wells are common throughout this area except where it is too thoroughly underdrained by cavernous limestones. As is the case, however, with all residual accumulations, these surface beds are not commonly in continuous bodies of great extent and thus their water supply is more or less closely dependent on local rainfall.

Of much greater importance in this connection are the great limestone springs, or "big springs," especially of the Knox dolomite and in less degree of the Tuscumbia (Lower Carboniferous) limestones. Both these limestones, in some parts, are highly siliceous or cherty, and like all limestones are traversed near the surface by fissures, channels, and caverns, formed or enlarged by the solvent action of the circulating waters, which also, dissolving the purer parts of the limestone, leave behind the chert in great open masses of the highest degree of permeability. In consequence of these conditions much of the rainfall in these terranes finds it way sooner or later into these subterranean channels forming streams which emerge as "big springs."

It need hardly be said that wells or borings may sometimes happen to be sunk on one of these underground streams, from which large supplies of water may be obtained by pumping, though in the nature of things the water is not likely to rise in the wells, having free outlet through the underground channel. In Birmingham, and probably in many other places, such streams have been utilized by air-lift appliances.

It would be hardly possible to enumerate all the great limestone springs of this section, but the following are well known; In the Coosa Valley, the springs about Piedmont, Alexandria, Jacksonville, Coldwater Spring near Anniston, Oxford, Talladega town, Kelley's above Talladega, Fayetteville, Montevallo, etc.; in the lesser valleys, Village Springs, Springville, Hawkins, Elyton, Bessemer, or Jonesboro, Bucksville, Tannehill, Roup's, Guntersville.

MINERAL WATERS.

The mineral waters of the Appalachian valleys show a great variety in their composition on account of the variety of materials making up the formations in which they are found. The most prolific sources of these mineral waters are, perhaps, the ferruginous, calcareous shales of the Cambrian, and the black bituminous shales of the Devonian and Lower Carboniferous; and the most common mineral waters from these formations are sulphur and chalybeate waters, usually more or less closely associated, making classification rather difficult.

Sulphur and Chalybeate Waters.

JONES SPRINGS.

Seven miles southwest of Gadsden on the Ashville road, in the N. E. quarter, N. E. quarter, Section 1, Township 13, Range 5 E., is a white sulphur spring on the place of Mr. Jones. The spring flows daily from 800 to 1000 gallons and the water is very agreeable to the taste. On the same land there is a large spring coming out of the limestone formation.

ST. CLAIR SPRINGS.

Farther southwest in Section 3, Township 15, Range 2 E., are the St. Clair Sulphur Springs. The waters come from the limestones overlying thin-bedded calcerous shales of the "Flatwoods." They are pleasant to the taste and not too strongly impregnated with sulphur. Ample accommodations are provided for visitors.

There are six springs along a brook running a little east of north. The first five in order of occurrence from the south, are (1) Black Sulphur, (2) Sulphur, (3) Freestone, (4) White Sulphur, and (5) Red Sulphur. No. 6, a short distance west of No. 5 is known as Lithia Spring. Nos. 1 and 2 are considerably stronger in sulphur than either No. 4 or No. 5, but in other respects are similar. All the sulphur waters contain lithium and traces of barium and strontium. No lithium could be detected in No. 6, which is also free from barium and strontium. The temperatures of the waters were, No. 4, 66.5°; No. 5, 63.5°; and No. 6,60.5°, the temperature of the air at the same time being 73.8°.

Analysis of water from springs No. 4, 5 and 6, St. Clair.

	Parts per million. No. 4	No. 5	No. 6
Potassium (K)	1.2	1.8	.6
Sodium (Na)	8.3	23.6	3.5
Lithium (Li)	trace.	stg. trace.	none
Magnesium (Mg)	16.4	14.8	17.3
Calcium (Ca)	36.9	31.8	37.5
Barium (Ba)	trace.	trace.	
Strontium (Sr)	trace.	trace.	
Iron and alumina (Fe_2O_3, Al_2O_3)	2.2	2.2	1.3
Chlorine (Cl)	4.9	11.5	4.1
Sulphuric acid (SO_4)			4.8
Carbonic acid (HCO_3)	209.1	170.0	161.2
Sulphuretted hydrogen (H_2S)	.3	8.2	
Silica (SiO_2)	13.3	16.9	18.4
	292.6	280.8	248.7

No. 4 "White sulphur."
No. 5 "Red Sulphur."
No. 6 "Lithia."

TALLADEGA SPRINGS.

Both sulphur and chalybeate waters are found at Talladega Springs, Plate III, but their origin is difficult to determine with certainty, since the springs arise from the limestones at the foot of mountains of the Weisner quartzite (Cambrian). Inasmuch as these mountains are mostly in contact with much younger strata on the north by reason of faulting, it is probable that the springs have their origin in the Devonian or Lower Carboniferous black shales, both of which appear in the near vicinity, though the rock from which the water issues seems to be the Pelham limestone. There are many conveniences for visitors here and the waters are well known.

Below is an analysis of this water by Prof. W. C. Stubbs taken from Bulletin 32, U. S. G. S. 1886 but recomputed to ionic form and parts per million by Mr. Hodges.

Determinations by Mr. Hodges of the sulphuretted hydrogen of this water in 1904 and 1905 gave only about 19 parts per million.

TALLADEGA SPRINGS, TALLADEGA COUNTY.

SHELBY SPRINGS, SHELBY COUNTY.

Analysis of water from Talladega Springs.

	Parts per million.
Potassium (K)	77.4
Sodium (Na)	127.7
Magnesium (Mg)	4.6
Calcium (Ca)	115.3
Alumina (Al_2O_3)	24.8
Iron (Fe)	trace
Chlorine (Cl)	55.5
Sulphuric acid (SO_4)	131.7
Carbonic acid (HCO_3)	368.0
Sulphuretted hydrogen (H_2S)	539.2
Silica (SiO_2)	42.5
	1486.7

SHELBY SPRINGS.

Shelby Springs, in Section 14, Township 21, Range 1 W., (Plate IV) comprising two sulphur springs with white deposits, a chalybeate spring, and a magnesium spring, come from the black shale of the Subcarboniferous, which here underlies so much territory. In the near vicinity is a large limestone spring.

The composition of one of the sulphur waters of Shelby Springs, viz., that from a spring near the pavilion shown in Plate IV, is given in the following analysis by Mr. Hodges.

Analysis of water from Shelby Springs, "White Sulphur."

	Parts per million.
Potassium (K)	1.2
Sodium (Na)	7.3
Magnesium (Mg)	7.9
Calcium (Ca)	47.8
Iron and Alumina (Fe_2O_3,Al_2O_3)	1.3
Chlorine (Cl)	2.4
Sulphuric acid (SO_4)	9.6
Carbonic acid (HCO_3)	80.1
Sulphuretted hydrogen (H_2S)	.8
Silica (SiO_2)	36.4
	194.8

HAWKINS WELL.—LEEDS MINERAL WATER.

This well is near the line of the Southern Railway, in Jefferson County a mile or two east of Leeds, (Plate V). The well is near the boundary of St. Clair County, and is an ordinary open well about 50 feet deep. The composition of the water is shown in the accompanying analysis, by Mr. Hodges.

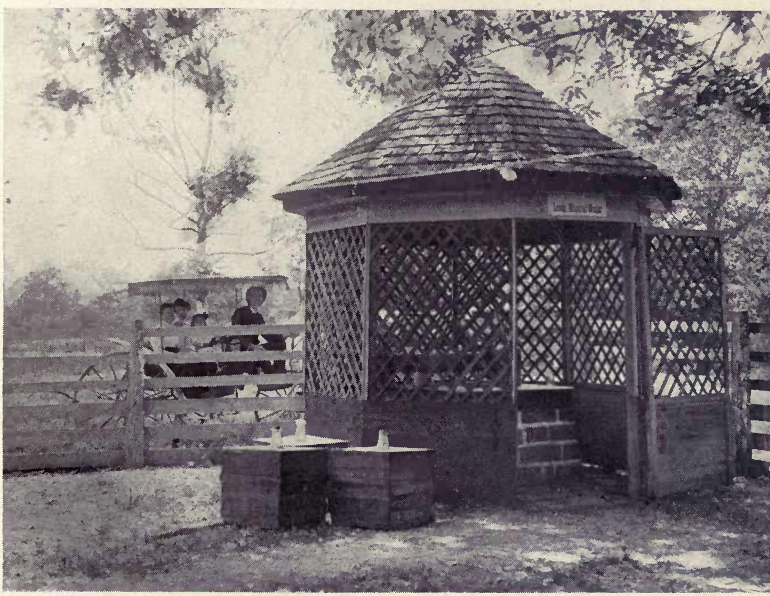
Analysis of Leeds Mineral Water; Hawkins Well.

	Parts per million.
Potassium (K)	6.7
Sodium (Na)	20.5
Magnesium (Mg)	.9
Calcium (Ca)	2.5
Iron (Fe)	2.1
Aluminum (Al)	4.6
Chlorine (Cl)	20.5
Sulphuric acid (SO_4)	35.2
Carbonic acid (HCO_3)	34.5
Silica (SiO_2)	19.9
	147.4

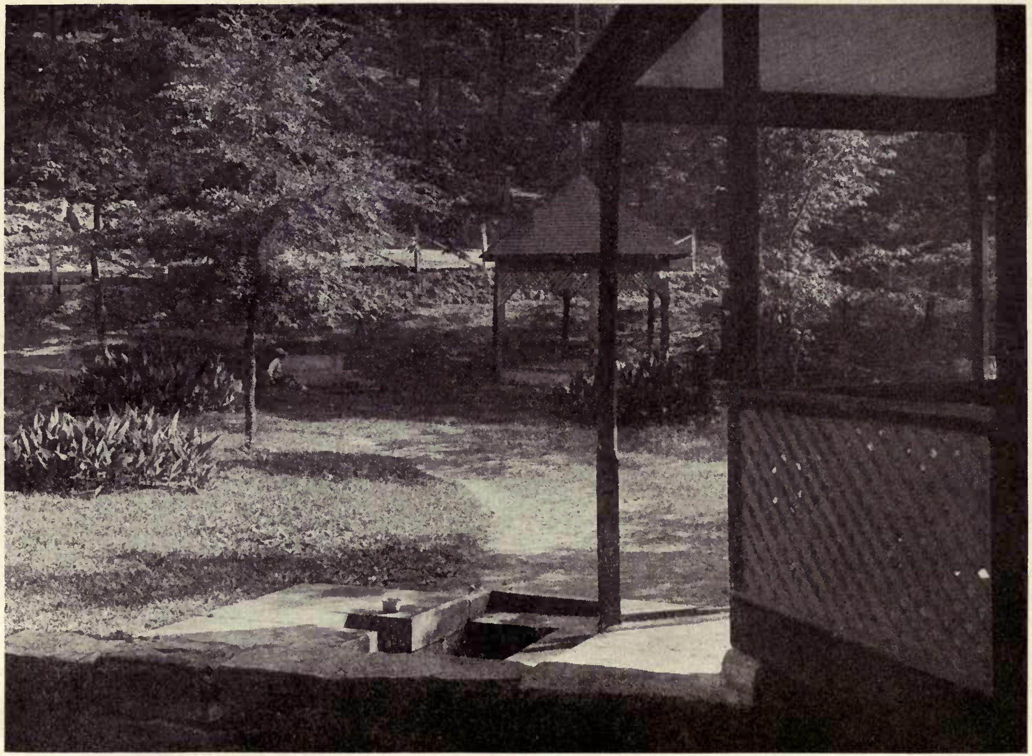
The well is in Subcarboniferous starta at the eastern foot of Little Oak Mountain, in the Cahaba Valley. This water is bottled and has an extensive sale in the State.

ALABAMA WHITE SULPHUR SPRINGS.

These springs are in the southwest corner of Section 10, Township 4, Range 10 E., in Wills Valley, Dekalb County. The surface rocks at the springs are the cherty limestones of the Subcarboniferous, but the underlying Devonian shale is undoubtedly the source of the sulphur water. This black shale is rich in iron pryrites and its decomposition produces the sulphur. There are here five springs (Plate VI), three of which are more or less impregnated with sulphur, though none of them very strongly.



HAWKINS WELL. (LEEDS MINERAL WATER), JEFFERSON COUNTY.



ALABAMA WHITE SULPHUR SPRINGS, DEKALB COUNTY.

Mr. Hodges has analyzed the waters from two of the springs, viz, the White Sulphur and the Freestone, with the results given below:

Analyses of water from Alabama White Sulphur Springs.

	Parts per million. No. 1	No. 2
Potassium (K)	3.2	trace.
Sodium (Na)	15.7	1.8
Lithium (Li)	trace.	
Magnesium (Mg)	55.8	5.3
Calcium (Ca)	118.3	74.6
Iron (Fe)	.7	.6
Alumina (Al_2O_3)	1.3	2.1
Chlorine (Cl)	4.2	1.4
Sulphuric acid (SO_4)	304.2	10.5
Carbonic acid (HCO_3)	294.5	246.2
Sulphuretted hydrogen (H_2S)	8.1	
Silica (SiO_2)	25.8	11.0
	831.8	353.5

No. 1 "White sulphur."
No. 2 "Freestone."

The Plate (VI) shows the White Sulphur Spring, No. 1, in the foreground, and the Freestone Spring, No. 2, in the background.

BLOUNT SPRINGS AND VICINITY.

The most noted sulphur springs in the State are the Blount Springs, situated near the end of Sequatchee (Browns) Valley, in the southwest quarter of Section 6, Township 13, Range 2 W.

The plate, No. VII, shows the pavilion at Blount and the positions of the several springs mentioned below; while the diagram, figure 23, will make these positions more definite, and will serve for their better identification.

The little marble basins in front of the pavilion mark the places of most of the springs.

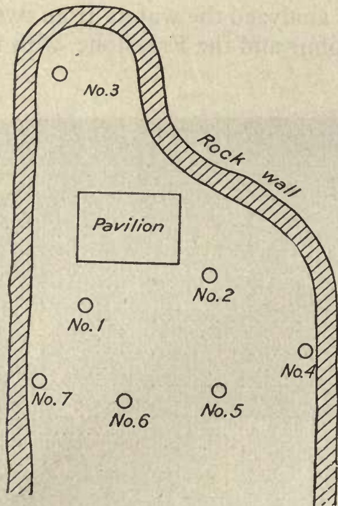


Fig. 23. Diagram of Blount Springs.

Quantitative analyses of the water of three of these springs have been made by Mr. Hodges, and qualitative examinations of three others, with the results given below.

Analyses of Blount Springs Sulphur Waters.

	Parts per million.		
	No. 1	No. 2	No. 3
Potassium (K)	14.2	13.8	11.8
Sodium (Na)	234.3	232.0	217.8
Lithium (Li)	1.2	*	*
Magnesium (Mg)	24.3	24.9	23.1
Calcium (Ca)	51.4	53.2	50.6
Barium (Ba)	4.6	*	*
Strontium (Sr)	2.4	*	*
Iron (Fe)	.8	1.0	.8
Alumina (Al_2O_3)	1 5	1.5	1.3
Chlorine (Cl)	325.1	320.1	297.3
Bromine (Br)	1.9	*	*
Iodine (I)	trace.	trace.	trace.
Sulphuric Acid (SO_4)	trace.	trace.	trace.
Carbonic acid (HCO_3)	279.1	276.2	257.3
Sulphuretted hydrogen (H_2S)	56.5	54.2	53.1
Silica (SiO_2)	26.5	19.7	16.6
	1023.8	996.6	928.9

*Present but not determined.

BLOUNT SPRINGS, BLOUNT COUNTY.

A qualitative test of springs No. 5 and 6 showed them to be very similar to No. 1. A qualitative examination of spring No. 4 gives of solid dissolved matter 555.75 parts per million. The water is non-sulphuretted and contains some sulphates; lithium is also present.

The temperature was found to be practically the same in all these springs, 63.5° F., the temperature of the air at the same time being 82° F. With the exception of No. 4 they were all strongly sulphuretted. They furnish an abundant supply of water for drinking and baths, No. 1, the largest, having a flow of about 3 gallons per minute.

The presence of some constituents in relatively large quantities, not commonly found in Alabama mineral waters, makes these springs noteworthy. They contain more sulphuretted hydrogen and lithium than any other water in the State of whichh a record is available, the presence of the latter being easily detected with the spectroscope in the water as taken from the spring, without any concentration. Salts of barium and strontium are also present.

Cold Spring.—This is a good type of the "Big" springs so characteristic of the Lower Carboniferous rocks, and would not properly be considered as a mineral spring. It is about one mile south of Blount Springs Hotel near the bank of Randolph Creek. The flow of water is very large. The temperature is 59°, the temperature of the air at the same time being 79°.

The analysis given below show its principal ingredient to be carbonate of lime. It is free from sulphuretted hydrogen and any large amount of sodium chloride, which are so plentiful in the Blount Springs water proper.

Analysis of water from "Cold Spring," near Blount Springs.

	Parts per million.
Potassium (K)	1.3
Sodium (Na)	7.2
Magnesium (Mg)	4.4
Calcium (Ca)	58.7
Iron and Alumina (Fe_2O_3, Al_2O_3)	1.7
Chlorine (Cl)	9.9
Sulphuric acid (SO_4)	8.9
Carbonic acid (HCO_3)	194.8
Silica (SiO_2)	14.8
	301.9

Glenwood Spring.—Of somewhat similar nature is a water from the Oxmoor sandstone ridge, near Blount Springs, on the property of Mr. G. D. Fitzhugh. This spring is in the N. W. quarter, N. E. quarter, Section 6, Township 13, Range 2 W., and is called Glenwood Spring.

Analysis of water from Glenwood Spring, near Blount Springs.

	Parts per million.
Potassium (K)	1.0
Sodium (Na)	4.5
Magnesium (Mg)	2.1
Calcium (Ca)	28.1
Iron and alumina (Fe_2O_3,Al_2O_3)	1.1
Chlorine (Cl)	5.3
Sulphuric acid (SO_4)	8.4
Carbonic acid (HCO_3)	91.8
Silica (SiO_2)	12.2
	154.5

Harrell's Well.—The following analysis by Mr. Hodges of the water from a well 90 feet deep on the property of Mr. W. F. Harrell, one mile north of Blount Springs, shows it to be a chalybeate water, and it is reputed to have valuable medicinal character.

Analysis of water from Harrell's well, near Blount Springs.

	Parts per million.
Potassium (K)	1.0
Sodium (Na)	6.6
Magnesium (Mg)	7.4
Calcium (Ca)	53.9
Iron and alumina (Fe_2O_3,Al_2O_3)	12.4
Chlorine (Cl)	15.7
Sulphuric acid (SO_4)	19.3
Carbonic acid (HCO_3)	167.7
Silica (SiO_2	14.7
	298.2

BORDEN-WHEELER SPRINGS.

This much visited resort is on the Seaboard Air Line R. R., in Cleburne County, (Plate VIII.)

The accompanying analysis of the water, by Mr. Hodges, will show its character.

BORDEN-WHEELER SPRINGS, CLEBURNE COUNTY.

Analysis of water from Borden-Wheeler Springs.

	Parts per million.
Potassium (K)	.9
Sodium (Na)	4.0
Magnesium (Mg)	6.7
Calcium (Ca)	36.3
Iron (Fe)	1.6
Alumina (Al_2O_3)	.3
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	22.9
Carbonic acid (HCO_3)	131.6
Silica (SiO_2)	19.9
	225.9

OTHER SPRINGS.

The Devonian black shales give rise to numerous sulphur and chalybeate springs in Calhoun County and elsewhere. The sulphur springs in the N. W. quater, S. W. quarter, Section 30, Township 15, Range 6, E., in Calhoun County, occur in black shales interstratified with seams of resinous-looking brown and grayish sandstones. The water is pleasant to the taste, being not too strongly impregnated with sulphur. In the S. W. quarter, N. W. quarter, Section 30, Township 16, Range 4 E., in St. Clair County, a group of sulphur and chalybeate springs occur in the same black shales. A chalybeate spring from the Subcarboniferous shale is recorded in the S. E. quarter, N. W. quarter, Section 1, Township 15, Range 6 E., also in Calhoun County.

Of chalybeate springs there is no lack in the other formations in this section; thus in the Weisner (Cambrian) sandstones are the Chocco Springs, near Talladega, in the southeast corner of Section 17, Township 18, Range 5 E., comprising two chalybeate and several freestone springs; also another fine and well-known chalybeate spring in the northeast corner of Section 2, Township 15, Range 9 E., in Calhoun County. Chalybeate waters are also abundant in the strata just under the bluff of the lower conglomerate of the Coal Measures capping Lookout and Raccoon mountains. These are noticed under "Coal Measures."

INGRAM WELL.

The Devonian black shale of Calhoun County yields another water of rather interesting composition from the Ingram well, 28 feet deep, in the E. half, S. W. quarter, Section 26, Township 14, Range 6 E., one and one-half miles east of Ohatchee. (Plate IX A.) The analysis below is by Dr. J. W. Mallett.*

Analysis of Ingram lithia water from well near Ohatchee.

	Parts per million.
Sodium (Na)	6.37
Potassium (K)	1.58
Lithium (Li)	.06
Manganese (Mn)	.11
Calcium (Ca)	44.21
Strontium (Sr)	.16
Ammonium (NH_4)	.20
Zinc (Zn)	.29
Iron (Fe)	.70
Maganese (Mn)	.11
Copper (Cu)	.06
Aluminum (Al)	.27
Sulphuric acid (SO_4)	17.13
Chlorine (Cl)	5.68
Carbonic acid (HCO_3)	147.72
Nitric acid (NO_3)	.13
Silica (SiO_2)	39.68
Fluorine (F)	trace.
	268.82

*Expressed by analyst in grains per gallon and hypothetical combinations; recomputed to ionic form and parts per million at U. S. Geological Survey.

SALINE WATERS.

LANDERS WELL AND GARY SPRINGS.

Besides chalybeate waters, the variegated shales of the Cambrian yield strongly saline waters of medicinal quality, as may be seen from the following analyses of water from the well of Mr. A. M. Landers, of Jacksonville, and from the Gary Springs, near Centerville, both analyses of Mr. Hodges.

A. INGRAM WELL, NEAR OHATCHEE, CALHOUN COUNTY.

B. GATE CITY WELL, JEFFERSON COUNTY.

Analysis of water from A. M. Landers's well, Jacksonville.

	Parts per million.
Sodium (Na)	41.3
Magnesium (Mg)	122.9
Calcium (Ca)	276.3
Iron and Alumina (Fe_2O_3,Al_2O_3)	3.4
Chlorine (Cl)	.7
Sulphuric acid (SO_4(	1071.5
Carbonic acid (HCO_3)	206.6
Silica (SiO_2)	35.4
	1758.1

Analysis of water from Gary Springs, near Centerville.

	Parts per million.
Potassium (K)	2.7
Sodium (Na)	4.3
Magnesium (Mg)	85.6
Calcium (Ca)	456.1
Iron and Alumina (Fe_2O_3,Al_2O_3)	8.9
Chlorine (Cl)	3.3
Sulphuric acid (SO_4)	1337.4
Carbonic acid HCO_3)	126.8
Carbon dioxide (CO_2)	47.7
Silica (SiO_2)	18.3
	2091.1

Free carbonic acid, 242 cc. per liter.

The calcareous shales of the "Flatwoods" of Coosa River above Gadsden yield also mineral water of very decided character, as may be seen from the following analysis, by Mr. Hodges.

BALL FLAT WELL.

Analysis of water from John B. Smith's well, Ball Flat.

	Parts per million.
Potassium (K)	5.9
Sodium (Na)	112.1
Magnesium (Mg)	96.3
Calcium (Ca)	393.6
Iron and alumina (Fe_2O_3,Al_2O_3O)	3.5
Chlorine (Cl)	127.6
Sulphuric acid (SO_4)	1302.5
Carbonic acid (HCO_3)	120.3
Silica (SiO_2)	20.0
	2181.8

ARTESIAN PROSPECTS.

All the older rocks which have lain below a thick covering of younger formations for a long time, even though originally porous, have had their porosity greatly diminshed by the filling of the pores with silt or clay, or more commonly, in the deeper zones, of flow, by the deposition of mineral matter. Limestones are, in their original condition, in most cases among the most compact and least porous of rocks; shales, while possessing a high degree of porosity, are yet almost impermeable by reason of the small size of the pores and the great friction encountered by the water in passing through; sandstones have originally the greatest degree of permeability, by virtue of the comparatively large size of the individual grains, and consequently of the pores between them. The sandstones of the Appalachian valleys, having remained long deeply buried, have lost a part of their porosity as above explained, so that in general all the rocks underlying this area must be considered as poorly adapted to the absorption and transmission of water.

On the other hand, the limestones may be open textured from several causes. Near the surface, as above shown, they may be jointed and fissured and these openings may be enlarged by solution in circulating waters; in the alteration of limestone into dolomite there is a diminution in the volume of the rock and a consequent development of shrinkage cracks; where siliceous or cherty limestones have been exposed at the surface for a long time the lime may be leached out and the chert left as an exceedingly open and porous mass through which the waters may pass without obstruction. Some of the sandstones still possess a reasonable degree of porosity. The shales are always good covers and underlying beds for the porous strata, and in many places the alternations of pervious and impervious beds at a gentle inclination fulfil some of the requisites of an artesian system, so that under favorable local conditions artesian water may be found in much of this area. These favorable conditions may be offset, however, in several ways. The fissures are likely to be narrowed or even closed at considerable depths, and they are rarely continuous for any great distance; the same may be said of the openness of texture produced by other causes. Moreover, the geologic structure may give rise to still other opposing conditions. As already stated, the rocks in all these valleys have been bent upward into anticlinal arches which are often lapped over to one side; or several folds may be compressed together, and there may be further complications by faulting. These disturbances are more in the eastern part of this area than farther west. As a consequence the strata, even when other conditions are favorable, may stand at too steep an inclination to be well adapted to artesian borings, for the water in the porous bed would be carried beyond available depths too quickly.

The horizons which have yielded artesian water, so far as the collected records go, are the lower Cambrian limestones and sandstones about Anniston and the Lower Carboniferous strata of Red Mountain, near Birmingham.

The Weisner sandstone is a great mountain-making formation running with occasional breaks from the Georgia line southwestward by Piedmont, Jacksonville, Anniston, and Talladega to the Kahatchee Hills near Talladega Springs. The foothills of this ridge are covered with a thick layer of residual deposits resting on the other Cambrian formations.

ANNISTON.

Several borings have been made at Anniston with the results given below. These borings pass through the residual matter near the surface and the limestones into a sandstone in which the water is obtained. This may be the Weisner sandstone, but reliable identifications have not been made.

Well No. 1, Charcoal Furnace; diameter, 8 inches; depth, 260 feet; water rises within 4 feet of the surface; capacity not determined, but seems to have been several gallons per minute; well was abandoned because of the loss of tools.

Well No. 2, Charcoal Furnace; drilled in 1886 by Charles Morgan; diameter, 6 5-8 inches; depth, 558 feet; water at 550 feet, rising to within 4 feet of the surface. The boring struck decomposed Cambrian limestone at 32 feet, in which it continued all the way, except for 8 feet of porous sandstone at the bottom. The well is located about 40 feet from No. 1, on ground about 30 feet lower than the waterworks well. The limestone is thicker at the furnaces. While drilling in the limestone the water level in No. 1 was affected, but on completion the limestone was cased off. A pump delivering a solid 5-inch stream did not diminish the supply after a twenty-four hour test.

Coke Furnace well; drilled in 1899; diameter, 10 inches; depth, 480 feet; height of water, 80 feet. The well was begun at the bottom of a shaft which was sunk 126 feet through yellow clay, 10 feet through shale, and 344 feet into limestone. The flow of water into the shaft from the well was determined by measurement to vary from 1,200 to 1,900 gallons per minute. When drawing 1,800 gallons per minute the pumps held the level constantly at 5 feet below the bottom of the shaft.

City water-works well, diameter, 8 inches; depth, 310 feet; depth to water, 280 to 310 feet; water rises to within 30 feet of the surface; capacity under pump, 1,000 gallons per minute without lowering; quality, good; temperature 60 degrees. The well is supposed to be entirely in Cambrian rocks. It was started at the bottom of a shaft 120 feet deep. From the surface the materials were: Soil, a few inches; yellow clay, 4 feet; coarse gravel, 36 feet; limestone, somewhat decomposed and interspersed with numerous seams and jointed masses, 240 feet; flint, 2 inches; sandstone, at first coarse grained, but becoming gradually porous, 30 feet.

In the upper part of the Lower Carboniferous beds, equivalent in general to the Bangor (Chester or Mountain) limestone division of geologists, are some thick bodies of shales and sandstone which have received the name Oxmoor, from their great development at the village of that name in Shades Valley. The same strata reappear prominently east of the Coosa coal field and between that field and the great Coosa Valley. Some of these sandstones are quite opentextured and free from lime, and thus well fitted for the absorption and transmission of water. In many places they have a gentle slope to the southeast, and being inclosed between shales form good artesian reservoirs.

GATE CITY.

Records have been collected of artesian wells in these strata at only one place, viz, the eastern slope of Red Mountain near Gate City, Birmingham, yet on general principles there should be reasonable expectation of success in borings at other points in Shades Valley, as well as in the region between the Coosa coal field and Coosa Valley.

Borings made by Mr. DeBardeleben in Shades Valley south and southwest of Birmingham, in prospecting for the Red Mountain ore seam, have recently fully realized this expectation.

The Gate City wells are in the S. E. quarter, N. W. quarter, Section 26, Township 17, Range 2 W., in Shades Valley, at the base of the Red Mountain ridge. Here were formerly two large limestone springs about 30 feet apart. Four wells have been bored within a radius of 100 feet of these springs; two of them are 10 inches in diameter, the other two 6 inches. The water in all the wells stands at about the height of the two springs mentioned, and overflows or stands a few feet below the surface according to the elevation of the mouth of the well. The borings are 25,85,103, and 344 feet deep respectively. The sinking of these wells has diminished the flow of one of the springs, but the other does not seem to be affected. One of these wells is shown in Plate IX. B.

In the N. W. quarter of the S. E. quarter of Section 26, Township 17, Range 2 W., and a short distance southeast of the springs and wells just mentioned are other springs. The water from one of these—E, T. Cox's—has been analyzed by Mr. Hodges with the following results.

Analysis of water from E. T. Cox's spring, Shades Valley.

	Parts per million.
Potassium (K)	.8
Sodium (Na)	8.2
Magnesium (Mg)	5.6
Calcium (Ca)	22.8
Iron and Alumina (Fe_2O_3,Al_2O_3)	3.2
Chlorine (Cl)	3.3
Sulphuric acid (So_4)	6.6
Carbonic tcid (HCO_3)	106.6
Silica (SiO_2)	43.3
	200.4

The sandstones of the Clinton (Upper Silurian) formation might locally furnish an artesian supply, but as they are generally calcareous they probably have low porosity. Their position, however, between impervious shales, is favorable.

In the lesser valleys and the two Red Mountain ridges (east and west) the great preponderance of limestones and calcareous shales among the strata and above all their high angle of dip are unfavorable for artesian prospects, though, as above mentioned favorable for "big springs."

COAL MEASURES (CARBONIFEROUS ROCKS)

The strata of the Coal Measures consist in the main of the sandstones, conglomerates, and shales; the coal seams form a very small percentage of the entire thickness and there are a few thin beds of impure limestone.

SHALLOW WATERS.

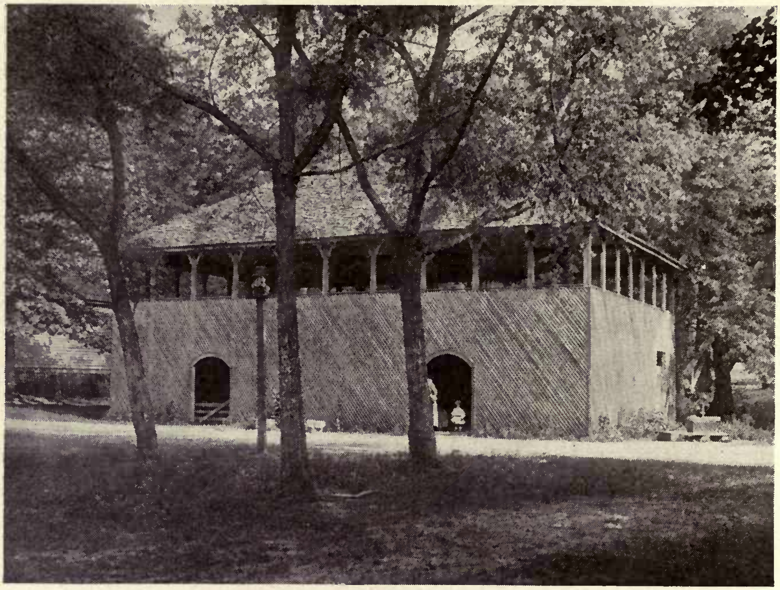
In consequence of weathering these rocks are covered with a mantle of residual material—sands, clays, and loams of varying thickness according to the locality; though in some places this mantle has been entirely removed by erosion leaving bare rocks at the surface. Springs and open wells are everywhere sources of water for domestic use, but on account of the non-continuity of these surface beds and their variable thickness the supply is intimately dependent on occasional conditions, and is prone to diminish or fail in times of long-continued drought. These springs escape usually just above a bed of shale or a coal seam. The latter is an especially effectual hindrance to downward percolation, and in consequence wet, fern-covered benches along the hillsides and in the ravine heads are considered good guides in prospecting for coal.

The sandstone strata near the base of these measures are generally good collectors and storers of surface waters, especially near the cliffs and escarpments overlooking the valleys. The springs at Mentone, on Lookout Mountain; on Monte Sano, near Huntsville; and on Shades Mountain, near Oxmoor, are instances. The waters from Towne's spring and the De Soto Springs on Shades Mountain have been found by analysis (see below) to be alkaline-carbonate waters, with, however, no excessive amount of dissolved mineral matter.

Toward their southwestern limit the Coal Measures are covered in part by later formations—the Tuscaloosa and Lafayette—and as these consist in the main of unconsolidated sands and pebbles, the surface-water supply dependent upon them is much more reliable and usually never failing.

MINERAL WATERS.

While the Coal Measures are prolific in mineral waters, mainly sulphur and chalybeate, there are comparatively few places



A. COOK SPRINGS, ST. CLAIR COUNTY.

B. MENTONE SPRING, DEKALB COUNTY.

where they have been utilized and where accommodations have been provided for visitors.

COOK SPRINGS.

These springs, (Plate X. A), located on the Seaboard Air Line, in the Coosa coal field, are well situated and improved. There are several springs of different kinds, among them a chalybeate and a sulphur spring. With the exception of these two which have respectively 269.8 and 274.1 parts per million, the waters contain comparatively little dissolved mineral waters, as may be seen by the subjoined analyses by Mr. Hodge:

Analyses of water from Cook Springs.

	Parts per million.			
	No. 1	No. 2	No. 3	No. 4
Sodium (Na)	30.2	6.9	11.0	3.7
Potassium (K)	2.6	1.5	3.7	.9
Magnesium (Mg)	4.1	1.3	2.6	1.0
Calcium (Ca)	22.6	10.0	117.2	2.8
Iron and alumina (Fe_2O_3,Al_2O_3)	22.6	4.0	10.8	.8
Chlorine (Cl)	5.3	5.3	3.5	3.5
Sulphuric acid (SO_4)	5.3	7.9	2.1	2.1
Bicarbonic acid (HCO_3)	157.1	38.3	74.1	14.9
Sulphuretted hydrogen (H_2S)	.4			
Silica (SiO_2)	43.8	19.5	44.8	10.8
Total	274.1	94.7	269.8	40.5

No. 1 "Sulphur spring."
No. 2 "Lithia or Magnesia."
No. 3 "Chalybeate."
No. 4 "Lithia."

SPRINGS ON SHADES MOUNTAIN.

At and near the summits of the high plateaus of the Coal Measures, adjacent to and overlooking the valleys, are many fine springs, chiefly chalybeate, though frequently alkaline-carbonate like the Cook Springs just mentioned. Of this kind two springs on Shades Mountain, near Oxmoor, Jefferson County, of which analyses by Mr. Hodges are given below:

Analysis of water from DeSoto Spring No. 1, near Oxmoor.

	Parts per million.
Potassium (K)	.6
Sodium (Na)	7.3
Magnesium (Mg)	3.2
Calcium (Ca)	34.1
Iron and Alumina (Fe_2O_3,Al_2O_3)	5.1
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	1.9
Carbonic acid (HCO_3)	129.4
Silica (SiO_2)	36.9
	220.2

In the same vicinity is another spring, on the property of Mr. John Townes, of Birmingham:

Analysis of water from Towne's spring, near Oxmoor.

	Parts per million.
Potassium (K)	2.3
Sodium (Na)	15.8
Magnesium (Mg)	3.9
Calcium (Ca)	21.0
Iron and Alumina (Fe_2O_3,Al_2O_3)	3.6
Chlorine (Cl)	5.3
Sulphuric acid (SO_4)	.5
Carbonic acid (HCO_3)	118.4
Silica (SiO_2)	31.1
	201.9

Another well-known spring close by is the Hale Spring. As a matter of fact springs of the finest chalybeate water are numerous, and one might say characteristic, in the basal conglomerates and other strata of the Coal Measures wherever these appear in cliffs overlooking the valley.

SPRINGS ON LOOKOUT MOUNTAIN.

In the syncline of Lookout Mountain, along the banks of Black Creek, are two well-known chalybeate springs. The first is near the end of the mountain, close to Alabama City on the Hollingsworth property, in the N. W. quarter, N. W. quarter, Section 32, Township 11, Range 6 E., and is known simply as the Chalybeate Spring. It flows in a small stream, strongly impregnated with iron, from beneath the sandstone or conglomerate which makes the falls of Black Creek. This water has been favorably known for many years. No improvements have been made. Higher up the Valley, in Section 3, Township 10, Range 7 E., are the Lay Springs, where several bold streams of strong chalybeate water flow from beneath a conglomerate, probably overlying the one which makes the falls below.

At the lower end of Lookout Mountain, between Gadsden and Attalla, in the N. E. quarter, S. E. quarter, Section 31, Township 11, Range 6 E., is a sulphur spring of which it is difficult to tell whether it comes from the strata of the Coal Measures or from those of the Cambrian, since the two are there brought together by faulting.

On the western side of Lookout Mountain numerous sulphur and chalybeate springs issue from beneath the capping conglomerate of the mountain. One such spring is east of Cordell station, on the Alabama Great Southern Railroad.

MENTONE SPRINGS.

The following analysis by Mr. Hodges is of water from a spring at Mentone, in Section 28, Township 5, Range 10 E., (Plate X, B), owned by the Loring Springs Hotel Company.

Analysis of water from springs at Mentone.

	Parts per million.
Potassium (K)	1.3
Sodium (Na)	2.6
Magnesium (Mg)	3.0
Calcium (Ca)	4.5
Iron (Fe)	6.6
Alumina (Al_2O_3)	2.3
Chlorine (Cl)	.8
Sulphuric acid (SO_4)	15.4
Carbonic acid (HCO_3)	33.2
Silica (SiO_2)	10.8
	80.5

OTHER SPRINGS.

On the west side of Wills Valley, in the N. W. quarter, Section 25, Township 6, Range 8 E., under the cliffs of Raccoon Mountain, a chalybeate spring flows from flagstones lying between conglomerates. At the head of Bristow Cove, in Murphree Valley, two similar springs are recorded, one from above and one from below the lower conglomerate.

Across Raccoon Mountain and the Tennessee Valley, among the spurs of the Cumberlands in Jackson and Madison Counties, many such springs come from the measures just below the conglomerates, as on Keel Mountain at Dr. Blair's residence in Section 30, Township 4, Range 3 E., and farther south in Township 5, Range 2 and 3, around the cliffs of the mountain. On Raccoon Mountain, also in Jackson County, near Fern Cliff Postoffice, a chalybeate spring arises from above the Cliff seam of coal. In Blount County, on the west side of the valley of Blount Springs, in the N. E. quarter, Section 10, Township 12, Range 2 W., and again on the east side of the same valley in the N. E. quarter, Section 19, Township 13, Range 2 W., are locally well-known chalybeate springs arising from the strata near the base of Coal Measures, like those above mentioned.

In Winston County in a low place near Brown Creek in Section 3, Township 11, Range 9 W., is the Blue Spring of Dr. Kaiser, a sulphur spring of fine quality. In the so-called rock houses of Winston and Marion counties chalybeate springs are numerous and characteristic.

In Tuscaloosa County in the N. E. quarter, Section 8, Township 18, Range 9 W., in Wyndham Springs. This is a sulphur spring of pleasant taste and reputed medicinal quality. Nearby, in the northeast corner of Section 34, Township 17, Range 9 W., is Hagler's, a strong chalybeate spring flowing from flagstones. In the N. E. quarter of Section 16, Township 18, Range 10 W., is a spring which is rather saline and from which some salt was made during the civil war.

Comment has already been made on the common occurrence of chalybeate and other springs in the wet heads of the little ravines in all parts of the basin region of the Warrior coal field, where they are shed by underlying impervious seams of coal and are thus good guides to the prospector for coal. Very few of these springs have been improved.

ARTESIAN PROSPECTS.

The sandstones and conglomerates are the permeable beds, and as they are interstratified with shales and generally lie in nearly horizontal position or with but moderate dip, they afford in these respects the requisite conditions for artesian systems. In the smaller fields, the Coosa and Cahaba, as has been stated, the strata dip toward the southeast over the entire width of the fields, with the exception of a narrow belt along the eastern borders, where they stand nearly vertical in the eastern limb of the unsymmetrical synclines. In the southwestern part of the Cahaba field the stratigraphic relations are more complicated, but even there these conditions prevail over much territory. In the Lookout Mountain and Warrior fields the strata form shallow synclines, which as a whole, have a pitch to the southwest. The success of artesian borings in these areas therefore, would seem to depend chiefly on the permeability of the sandstones and conglomerates. So far as the porosity of these rocks is concerned the case is similar to that of older rocks generally which have lain long buried beneath other strata—the pore space is likely to be diminished by deposition of mineral matter from the underground waters. Like all massive rocks, these are traversed by joints and fissures which afford passageways for the underground waters, but such passageways are uncertain and unreliable. On these accounts it is generally not possible to forecast with any degree of certainty the result of artesian borings. Flowing wells of large volume are, however, hardly to be expected.

ETOWAH COUNTY.

In this connection may be mentioned several interesting instances of successful wells near the end of Lookout Mountain, where the prospects, on general principles, would appear to be unfavorable. At Alabama City a well 6 inches in diameter was bored about six years ago in the vertical rocks of the great fault which cuts off Lookout Mountain on the south. These rocks are the sandstones and shales of the lower Coal Measures. The well is 165 feet deep and is cased to the bottom. The well mouth is about 60 feet above the railroad track at the station, and the water stands at 30 feet. A pump delivering 12 gallons per minute has raised from this well 10,000 gallons without any diminution in the amount discharged, but whether the stand in the well was lowered could not be told.

At the southeastern angle of the mountain rim overlooking Gadsden, at the residence of Messrs. T. S. Kyle and E. T. Schuler and the hotel, wells have been sunk into the sandstones or conglomerates which make the highest points of the mountain here and are 500 feet or more above the court-house. Mr. Kyle's well is within 200 feet of the edge of the escarpment, and though only 60 feet deep it furnishes an abundant supply of water, which is raised by a hot-air pump. Mr. Schuler's well is in a similar position and 50 feet deep, furnishes an abundant supply, but perhaps not so much as the preceding. At the hotel also there was no difficulty in getting a good water supply in these sandstones. In all cases the water rises in the wells, but does not overflow. The wells are sunk in the outcrop of the intaking rocks.

On the N. C. and St. L. R. R. at Carlisle, on Sand Mountain, a fine stream of good water comes from a boring made in search of coal. Depth about 175 feet. No details obtained.

CAHABA FIELD.

ST. CLAIR COUNTY.

At Davis Station, on the Seaboard Air Line, there is a flowing well, 3 1-2 inches in diameter and 244 feet deep, that yields about 25 gallons per minute. The well is in Section 7, Township 16, Range 2 E., on the eastern side of the railroad, and is between the outcrops of the Wadsworth and Mammoth coal mines.

WARRIOR FIELD.

WALKER COUNTY.

At Oakman, Walker County, a well was bored in August, 1899, during a long-continued dry spell. The depth was 58 1-2 feet; the boring was through sandstone, in which the water was obtained. The water rises two feet above the surface and the flow is about two gallons per minute; the temperature is 63°F.

At Jasper J. B. Carrington drilled two wells. No. 1 in Court House Square, went to the depth of 350 feet, but a good flow was obtained at 152 feet in a white sandstone. The water rose 17 feet above the surface and continued to flow till the second well was drilled, when the stand went down to 15 feet. No. 2

well, 6 inches in diameter, was drilled at the coke ovens, getting a good flow at 182 feet below the surface, which was here about 25 feet lower than the surface in the court-house yard. The water rose 22 feet above the surface and is sufficient in quantity to supply water for 300 coke ovens. A pump with 6-inch suction pipe could be worked steadily on this well for fifteen hours, and then after a rest of five or six hours could be run another fifteen hours.

At Stovall's gin, between the two wells above mentioned, a shallow well was dug in which, at the depth of 15 feet, water was struck which rose to the surface and flowed off as a spring.

CULLMAN COUNTY.

At Cullman, the county seat, a number of wells were bored during the eighties, of which the following records have been furnished by Mr. Max Schmitt, of that town. There has been no diminution in the supply of any of these wells since the first tests.

RECORD OF WELLS AT CULLMAN.

No.	Location.	Depth Feet.	Water level Feet.	Yield.
1.		1320	80	Abundant; level not lowered by steam pump.
2.	City well	715	80	Level not lowered by large air compressor.
3.	Frank Ardt's place of business	96	63	Supply unlimited.
4.	Cullman Cotton Oil Co.'s plant	100	30	
5.	A. Dreher & Co.'s furniture factory	108	80	Supply unlimited.
6.	C. Arnold & Son's factory	143	40	Supply limited.
6a.	30 feet from No. 6	100	40	Supply limited.
7.	J. H. Carter's place of business	270	20	Supply unlimited.
8.	George H. Parker's residence	101	46	Supply limited.
9.	Paul Mohr's residence	110	42	Supply good.
10.	William Blevin's residence	78	48	Supply plentiful.
11.	St. Bernard College	150	101	Inexhaustible.
12.	St. Bernard College	209	130	Supply unlimited.

MARION COUNTY.

At the Brilliant coal mines of the Aldrich Coal Mining Company two wells have been bored by J. O. Heflin, as follows:

Well No. 1, bored in August, 1902; diameter, 8 inches; depth, 401 feet: yields, 250 gallons per minute for four hours; well has been in daily use day and night for three years; temperature, 54°.

The composition of the water from this well is shown in the following analysis by Mr. J. C. Long.*

Analysis of water from well No. 1, Brilliant.

	Parts per million.
Sodium (Na)	2.69
Magnesium (Mg)	17.03
Calcium (Ca)	52.11
Chlorine (Cl)	4.16
Sulphuric acid (SO_4)	14.00
Carbonic acid (HCO_3)	111.34
Iron and alumina (Fe_2O_3,Al_2O_3)	2.57
Silica (SiO_2)	13.96
Undetermined	36.29
	254.15

Well No. 2, bored in December, 1904; diameter, 10 inches; depth, 375 feet; has yielded 1000 gallons per minute for four hours; not yet in regular use.

The water in both these wells stands just at the surface of the ground, with slight overflow.

JEFFERSON COUNTY.

Borings for water supply were made in the summer of 1900 at Pratt City by Messrs. Canfield & Irwin, of St. Louis.

Well No. 1, on the ridge between the old No. 1 slope and the creek, and on the edge of the fault; depth, 354 feet; cased 50 feet; 323 feet of 4-inch discharge, and 308 1-2 feet of 1 1-3-inch air pipe; stand during dry weather,—76 1-4 feet, falling on pumping to —80 or —85 feet; yield, 200 gallons per minute; water soft and pleasant to the taste. The boring passed through alternating strata of sandstone and slate of varying degree of hardness, and a 4-foot seam of coal at 320 feet.

Well No. 2, 100 yards west of No. 1; depth 405 feet; has not been satisfactory and is now seldom used.

*Expressed by analyst in grains per gallon and hypothetical combinations; recomputed in ionic form and parts per million at U. S. Geological Survey.

Two other wells may be noted in this vicinity. In the N. E. quarter, N. E. quarter, Section 20, Township 17, Range 3, W. the Pratt Company has a well in which a flow was obtained at 65 feet, but lost at 500 feet. The well was plugged at 85 feet and has since maintained a slight flow. In the S. E. quarter N. E. quarter of the same section Mr. W. A. Brown, of Elyton, has a well 200 feet deep, which has a good flow.

In section 26, Township 18, Range 8 west one mile above the mouth of Indian creek, a boring was made to the depth of 640 feet prospecting for coal. From this boring comes overflowing water which fills an inch pipe. Along with the water is also inflammable gas.

FAYETTE COUNTY.

Only one artesion record is available from Fayette County. A well was bored in 1900 by W. F. Little at the court house, Fayette. Depth, between 500 and 600 feet. Between 200 and 300 feet a seam of coal 4 feet thick was struck. No water was obtained.

TUSCALOOSA COUNTY.

In the city of Tuscaloosa and a few miles above, at Holt, on the banks of the river, artesian wells have been bored into the sandstones and rocks of the Coal Measures with success, while at Kellerman, about 20 miles northeast, a boring to the depth of 1000 1-2 feet failed to get water.

At the hosiery mills in the suburbs of Tuscaloosa, is the well of Rosenau Brothers, drilled by Heflin Brothers in 1903. Its depth is 520 feet; diameter, 6 inches; water obtained at 325 feet rises to within 14 feet of the surface; used in the mills; good drinking water; analysis is below. Record: Soil, 0 to 20 feet; quicksand and gravel, 30 to 115 feet; thence to bottom of the boring alternations of sandstones and slates of the Coal Measures, reported by the drillers to be limestones and cherts. At another boring, however, for Mr. B. Friedman, at the site of his proposed furnace only a few miles distant, a drilling to the depth of 1000 feet showed no limestone or chert, but only sandstones, slates, and coal.

The analysis of the hosiery mill water, by Mr. Hodges, is as follows:

Analysis of water from Hosiery-mill well, Tuscaloosa.

	Parts per million.
Potassium (K)	5.9
Sodium (Na)	403.7
Lithium (Li)	trace.
Magnesium (Mg)	14.9
Calcium (Ca)	70.0
Iron (Fe)	.5
Chlorine (Cl)	703.0
Sulphuric acid (SO_4)	2.2
Carbonic acid (HCO_3)	152.1
Silica (SiO_2)	17.3
	1369.6

The water from the hosiery-mill well is much used by the people of Tuscaloosa and is reputed to have decided medicinal qualities.

The well at Kellerman, on the property of the Central Coal and Iron Company, also bored by Heflin Brothers in 1903, to a depth of 1000 1-2 feet into the strata of the Coal Measures consisting of sandstones, shales, and four seams of coal, did not get water in any useful quantity. This may be, in part at least, due to the altitude, which is 500 to 600 feet above tide.

The other well mentioned above, at the Friedman furnace site near Tuscaloosa, passed through similar strata to a depth of 1010 feet. No record is made of the water in this well, which was, however, bored for the purpose of prospecting for the underlying coal. It is quite probable that it would yield water, as the altitude of the mouth of the well is not much above that of the hosiery mill.

Tuscaloosa City well. In the summer of 1905 a boring was made by the city near the Court House to the depth of 1511 feet, Mr. Heflin being the contractor. Diameter of well, 8 inches. Depth to solid rock about 90 feet. The casing went down into the rock ten or fifteen feet. No reliable record of the strata passed through is available, but the measures below the surface covering of sand and clay as shown elsewhere in the vicinity in other borings are the usual succession of sandstones shales, conglomerates, etc. of the Coal Measures. The water rises in the well to--65 feet and is by estimate lowered by pumping to--150 feet, and the estimated yield is 15,000 gallons a day.

Three miles up the river from Tuscaloosa, at the furnace of the Central Coal and Iron Company, five wells were drilled in 1903 by Heflin Brothers. No. 1 well was 544 feet deep; No. 5, 200 feet deep; and Nos. 2, 3, and 4 were of intermediate depths. No. 1 yields 50 gallons per minute; No. 2, 85 gallons; No. 3, 150 gallons; No. 5, about 200 gallons. Measurements were made by testing one well at a time. Water was found about 60 feet below the surface. No advantage was secured by lowering the water in the wells below 70 feet, and when this was done water could be heard running into the well. The water-bearing sand rock is about 89 feet above sea level. No decrease was observed in No. 2 after No. 5 was bored, and it is not known what, if any, effect Nos. 3 and 4 have on No. 5. The water is used for drinking purposes alone, as it carries too much salt to be used in the boilers, which are supplied from the river.

The water from well No. 1, which is on the hill near the Semet-Solvay ovens and which is much deeper than the others, is quite similar to that from No. 5, as may be seen by the analysis below:

Both analysis by Mr. H. Buel,* Chemist of the Central Iron Company.

Analyses of water from wells at Holt.

	Parts per million. No. 1	No.5
Sodium (Na)	152.63	177.93
Potassium (K)	8.17	12.74
Magnesium (Mg)	31.12	28.11
Calcium (Ca)	84.00	80.97
Chlorine (Cl)	449.25	474.49
Sulphuric acid (SO_4)	5.43	5.55
Carbonic acid (HCO_3)	24.09	26.69
Iron and alumina (Fe_2O_3,Al_2O_3)	13.69	13.01
Silica (SiO_2)	75.52	86.80
Organic matter	103.90	106.47
Hydrogen sulphide (H_2S)	1.54	....
	947.80	1012.76

*Expressed by analyst in grains per gallon and hypothetical combinations. Recomputed to ionic form and parts per million at U. S Geological Survey.

VALLEY OF THE TENNESSEE.

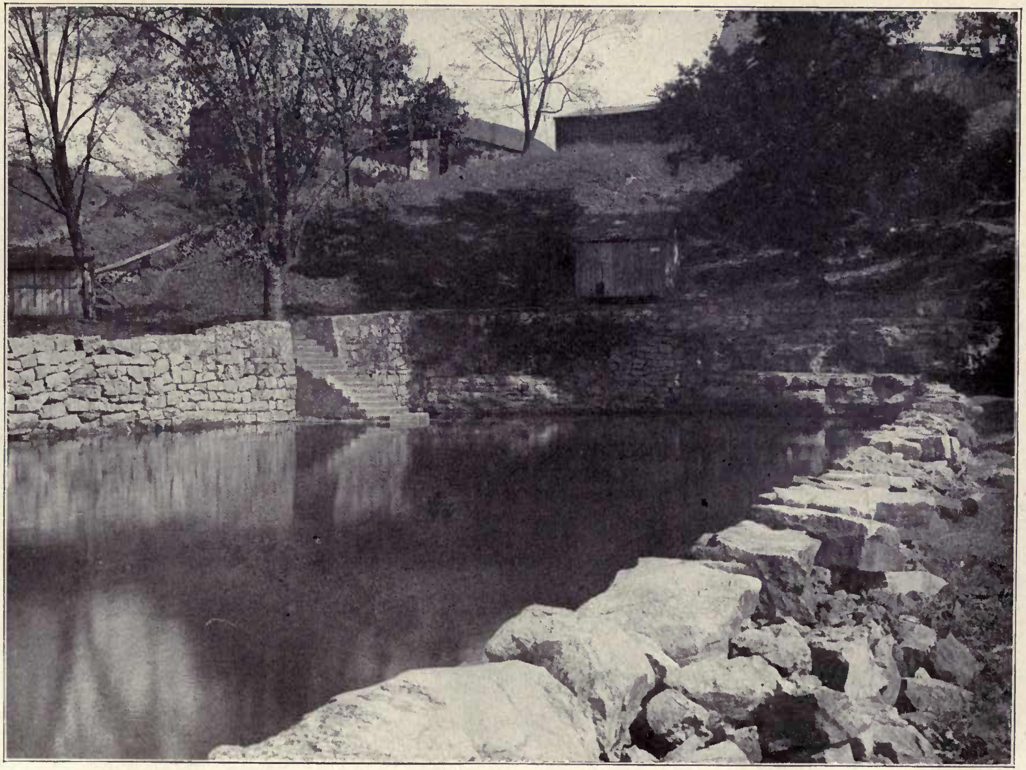
SURFACE FEATURES.

In the geologic sketch it has been shown that the Tennessee Valley in Alabama is of two fold character. The stretch from the northeast corner of the State down to Guntersville belongs to the Appalachian valleys already considered, and only that part of the State in which the river has a westerly course is to be included in the present division. As stated, the strata are mainly lower Carboniferous limestones, with their intercalated sandstones near the top of the series. The lower sandstones of the Coal Measures cap the limestone east of Huntsville, but areas where this is the case would belong rather to the preceding division.

SHALLOW WATERS.

In the Tennessee Valley proper, therefore, the strata have a gentle dip toward the south, and, except at the western edge of the region, the rocks are covered by residual matter resulting from their decay. This covering consists of clays and loams, with numerous angular fragments of chert—the broken-up remnants of the chert layers with which the limestone are so generally interbedded. Good supplies of surface water from springs and open wells are to be looked for except where the soil is too thoroughly underdrained into the caverns and channels of the omnipresent limestones; but the water which finds its way into these caverns emerges again as "big springs," of which those at Huntsville (Plate II.) and Tuscumbia (Plate XI) are the most famous examples. From the nature of the materials with which they come in contact in their underground passage, these waters are generally more or less highly charged with carbonate of lime and carbonate of magnesia.

The area north of the river, extending from the Tennessee line southward for about 15 miles, underlain by the more siliceous limestones, has more abundant surface or hillside springs, while the red lands in the immediate valley of the river, as well as those South of Little Mountain in Moulton Valley, are rather characterized by lime sinks, caves, and big springs. The depth of the surface soils, however, in both divisions insures a fairly abundant supply of underground water.



BIG SPRING, TUSCUMBIA, COLBERT COUNTY.

MINERAL WATERS.

Chalybeate Springs.

These are perhaps the most numerous of the mineral waters of this as well as of other sections. They are common at the base of the capping sandstones of the spurs of the Cumberlands east of the Huntsville meridian, and especially where a coal seam underlies.

In the upper or Chester or Bangor limestone division of the Subcarboniferous one or two thick beds of sandstone are intercalated between the limestones, and at the contacts of the two rocks mineral springs are often seen, the most numerous of these being the chalybeate, though sulphur springs also occur. Examples of these are the Ligon Springs, in the northwest corner of Township 6, Range 11 W.; and the Franklin Springs, in Section 16, of the same township and range. According to Professor Toumey's analysis of the water of the Ligon Springs, it contains free carbonic acid, sodium chloride, sulphate of iron, and a trace of sulphate of magnesium.

In the immediate vicinity of this spring is another containing chloride and sulphate of iron and free carbonic acid. At the Franklin Springs, besides the sulphur springs for which the place is noted, there is a chalybeate spring which, according to Professor Toumey, contains in addition to the iron only a little lime.

At the base of the Bangor limestone, where it is contact with the St. Louis limestone, is another horizon of the chalybeate waters, which break out in many places at the foot of Little Mountain.

Lastly, in the lowermost of the Subcarboniferous limestones which immediately overlie the Devonian black shale, chalybeate waters spring up in connection with sulphur waters but sometimes alone. Of this class is the Pettusville Spring, in the S. E. quarter Section 10, Township 1, Range 4 W.

Sulphur Springs.

While the chalybeate springs are more numerous the sulphur springs are generally more valued as places of resort for health and pleasure seekers. The most important of these springs in the Tennessee Valley, as elsewhere in the Appalachian division, have their origin in the Devonian black shale, because of the organic matter and pyrite nodules which it contains; and it is easy to understand why chalybeate springs are often found associated with sulphur waters, from this source. The exposures of the black shale in this area are mostly confined to Elk River, Limestone Creek, and the headwaters of Flint River, all in the extreme northern part of the State.

The Moore Spring, 12 miles north of Athens, on Maple Creek, a tributary of Elk River, according to Professor Toumey had a temperature of 68 degrees, while the atmospheric temperature was 71.6 degrees. The water contains, besides the sulphur, free carbonic acid, carbonate of lime, sodium chloride, and traces of carbonates of iron and potassium.

The Wooley Springs, in the S. W. quarter Section 39, Township 1, Range 3 W., once much visited but now practically abandoned, include a chalybeate and an alum spring in addition to the white sulphur spring.

The Johnson well, near Meridianville, in Section 26, Township 2, Range 1 W., is one of the best known springs in this section. It also embraces, in addition to the sulphur springs, an alum spring. This spring is on a tributary of Flint River and appears to rise from the lower Subcarboniferous limestones and not from the black shale.

Another sulphur spring, on Barren Fork of Flint River, in the S. W. quarter Section 26, Township 1, Range 1 E., is associated with a chalybeate spring.

At New Market, in the S. W. quarter, N. W. quarter Section 33, Township 1, Range 2 E., a well was bored for oil to a depth of 1000 feet or more. In this well sulphur water was struck at a depth of 118 feet and again at 700 feet. The water rises above the surface and is used by the inhabitants of the town.

Stewart's well, near Florence, was examined by Professor Tuomey, and found to contain, in addition to the sulphur, free carbonic acid, sodium chloride, and sodium carbonate, with traces of magnesium carbonate and alumina.

Another horizon of sulphur waters is that mentioned above for chalybeate waters, viz, the contact of the intercalated sandstone beds and the limestone in the upper Subcarboniferous or Bangor group. At Franklin Springs, in Section 16, Town-

BAILEY SPRINGS, LAUDERDALE COUNTY.

ship 6, Range 11 W., already mentioned under "Chalybeate springs," is a sulphur spring. Again, at the base of Little Mountain sulphur and chalybeate waters are seen near Town Creek station, on the Southern Railroad.

Farther east, in Morgan County, in the southeast corner of Section 19, Township 6, Range 1 W., are the Valhermoso Springs, two sulphur and one chalybeate, similarly situated geologically at or near the contact of the sandstones with the limestones.

Alkaline-saline Springs.

In Lauderdale County, near the banks of Shoal Creek, are many springs which have attained some reputation. The best known of these is Bailey Springs, (Plate XII) consisting of a group of springs with water of varying quality. A sample of the water from a spring recently improved by Dr. H. A. Moody, below those shown in plate, has been analyzed by Mr. R. S. Hodges, with the result below:

Analysis of water from Moody's Spring at Bailey Springs.

	Parts per million.
Potassium (K)	1.4
Sodium (Na)	2.4
Magnesium (Mg)	2.6
Calcium (Ca)	16.0
Iron and alumina (Fe_2O_3, Al_2O_3)	1.6
Chlorine (Cl)	5.3
Sulphuric acid (SO_4)	3.8
Carbonic acid (HCO_3)	57.0
Silica (SiO_2)	8.1
	98.2

Other springs here are called chalybeate and iron springs and are reputed to have special curative qualities. The grounds at Bailey's are well kept and the accommodation is ample for a large number of guests. Much of the patronage from a distance comes from Memphis and other points to the west in Mississippi.

The small house or pavilion in the foreground of Plate XII is over the "Rock Spring."

Professor Tuomey mentions several other springs in the same general region, viz., Todd's, Lee's, Langford's, Witherspoon's, etc., but none of these, so far as the writer is aware, is now fitted up for the accommodation of visitors.

Acid Springs.

At center Grove, in Morgan county, W. E. Forman has a well with strongly saline water of acid reaction and peculiar composition, as may be seen from the subjoined analysis by Mr. Hodges:

Analysis of water from W. E. Forman's well, Center Grove.

	Parts per million.
Potassium (K)	trace.
Sodium (Na)	trace.
Magnesium (Mg)	28.2
Calcium (Ca)	23.8
Manganese (Mn)	26.6
Iron (Fe)	7.1
Aluminum (Al)	7.9
Chlorine (Cl)	trace.
Sulphuric acid (SO_4)	276.0
Carbonic acid (HCO_3)	trace.
Silica (SiO_2)	50.0
	419.6

The large portion of manganese sulphate is exceptional among the waters thus far examined, and the presence of the sulphates, especially of magnesium, make it also a strongly alterative water.

Tar Springs.

An account of the mineral springs of the Tennessee Valley would be incomplete without some mention of the tar springs which occur in connection with the upper Subcarboniferous or Bangor limestones of Moulton Valley. The westernmost of these is reported in Section 27, Township 5, Range 15 W., near the State line of Mississippi; but the best known are the Capps Creek tar springs, in the lower part of Lawrence County, in the S. W. quarter Section 6, Township 8, Range 6 W., once much visited by the afflicted, who drank tar water or took pills of the somewhat indurated tarry matter.

On Town Creek, in the N. E. quarter Section 16, Township 5, Range 9 W., and again in the N. E. quarter Section 33, same township and range, an din the N. W. quarter Section Township 6, Range 9 W., are tar springs, at all or most of which borings have been sunk for oil.

In all this region the wells mentioned often yield sulphur, chalybeate, and saline waters, and some of them overflow, as will b emore particularly noted in the next section.

ARTESIAN PROSPECTS.

From the general account of the geologic structure above given, the outlook for artesian waters might be expected to be fairly good, and the few wells that have been bored or of which records have been obtained, bear out this expectation. As has been intimated, the limestones are generally inferior water bearers. Their capacity in this respect depends largely on the existence of fissures and joints and on other secondary characters which cannot be recognized at the surface. The almost universal presence of chert in these limestones is a favorable circumstance down to certain depths, for the leaching out of the calcareous parts by circulating waters leaves the chert as an exceedingly open and porous residue.

Beds of open-textured sandstone also lie intercalated between the limestones prevailing in the territory south of the river, or rather south of the range known as Little Mountain, in Moulton Valley. Many borings have been made in this territory in search of petroleum and many also probably for water, with reasonable success, though flowing wells are comparatively rare.

NEW MARKET.

Very few records are available of borings north of the river —only those of the New Market well in the S. W. quarter N. W. quarter Section 33, Township 1, Range 2 E. and of two wells at Hazel Green, near Huntsville, all of which were bored for oil.

The record of the New Market well is as follows:

Record of New Market Well.

	Feet.
Soil	8
Cherty rocks	25
Limestone and chert	30
Black shale	18
Gray sandstone	2
Limestone and shales	965

In this well the Subcarboniferous group is represented by the first three of the series, the Devonian by black shale and sandstone and the Silurian by limestones with shale parting. The well was bored in 1890, with diamond drill; diameter, 2 inches; permanent fresh water was struck at 22 feet and sulphur water at 118 and 700 feet. No salt water or gas was found. The sulphur water from both depths mentioned flows above the surface and is used by the inhabitants of the town.

HAZEL GREEN.

Of the wells on Overton farm, near Hazel Green the following records were obtained.

Well No. 3, first water struck at 60 feet; yield, 40 gallons per minute; stand,—20 feet; temperature, 52 degrees. At 187 feet a black sulphur water was struck, and at 217 feet a strong salt water. No water was obtained below 271 feet, to which depth the casing extends. The mouth of the well is 667 feet above tide.

Well No. 4, depth, 310 feet; first water at 32 feet, in rock; water does not flow, but stands at ground level except when gas is turned in, when it is blown about three feet above the surface; yield, 150 gallons per minute, without any perceptible lowering of the stand; temperature, 56 degrees. In this well neither sulphur nor salt water was struck and no water was found below 147 1-2 feet. The mouth of the well is 603 feet above tide.

These wells were bored for oil and gas. The quantity of the latter from well No. 4 is sufficient to run a 25 horse power boiler.

SOUTH OF TENNESSEE RIVER.

South of the river the borings are very numerous.

Curtis well, about 6 miles southeast of Decatur; bored about seventy-five years ago; depth, 341 feet; flow, about 10 gallons per minute, which has been constant in quantity since the well was drilled; water slightly impregnated with sulphuretted hydrogen gas.

Judge H. B. Tompkin's well.—About 2 miles east of Sheffield recently bored; depth, 190 feet; 50 feet through soft surface earth. 25 feet through chert, and the rest through dark flint; water rises about 48 feet in the well and is raised to the surface by windmill pump;—supply plentiful.

L. W. Deprez's well, at Russellville; depth, 60 feet; the water rose about 38 feet in the well.

E. M. Harris's well, 4 miles southeast of Russellville; depth, about 100 feet; water rose to within 15 feet of the surface.

The numerous borings, some of them to the depth of more than 1700 feet, which have been made in search of oil and natural gas have in most cases yielded salt water. As has been mentioned above these wells are most common in the country about Moulton and Russellville, since it is here that the tar springs abound, and these have been selected as the most promising places for borings. The Goyer wells, in Section 29, Township 7, Range 6 W. are perhaps the best known. The well at Hartsell, 1730 feet deep, found fresh water at 30 feet, sulphur at 160 feet, brackish water at 352 feet, and salt water at 1730 feet. A salt well in the southeast corner of Section 10, Township 7, Range 5 W. has a depth not accurately ascertained but propably less than 200 feet. The water overflows, as it does also in some of the wells in Moulton Valley. However, the writer knows of no well in this region which has been sunk for water, oil being the thing sought. While little account has been taken of the water obtained in these borings it is probable that all of them have a supply sufficient for ordinary purposes, if the quality be suitable, but in only a few of them does the water rise above the surface.

COASTAL PLAIN DIVISION.

General Account.

The general topographic and geologic features of the Coastal Plain, which embraces about three-fifths of the area of the State, have been sketched above in Chapter II; but since most of the artesian wells of the State (more than 95 per cent. of those recorded in this report) are in this territory, it is desirable that the stratigraphic relations of the formations be presented somewhat more in detail.

For shallow waters this division, like the Appalachian, is dependent in part on the residual materials provided by the decay of the underlying stratified rocks; but in addition to these a thin coating, 25 or 30 feet in thickness, of loam, sand, and pebbles—the Lafayette formation post-Tertiary age—has been spread unconformably upon the Cretaceous and Tertiary strata over the entire Coastal Plain; and where these deposits have not been carried away by erosion they, of course, determine the surface-water conditions in much greater degree than do the residual soils of the Cretaceous and Tertiary.

In the southern part of the State, as indicated by the map, (Pl. 1.) another formation, in many respects similar to the Lafayette but older, covers great areas of the St. Stephens and post-Eocene formations down to the borders of the sea. This is the Grand Gulf formation, which will be treated in detail later.

The artesian systems of the Coastal Plain are provided by the strata of the Cretaceous and Tertiary formations. The general stratigraphic relations of these formations are shown in fig. 21, p. 62.

In the great area embraced by the Coastal Plain, uniformity in the artesian conditions of the same formation in different parts is not to be looked for nor does it exist. In consequence, it will be expedient to give the notes on wells, etc., under several heads, those in which the conditions are approximately similar being grouped together. It will also be expedient to discuss the subject by counties, following in general a geographical order. It should be understood, however, that in the very nature of things this dual arrangement can not be followed absolutely, for the conditions are not identical in any two counties.

The wells which derive their water supply from the Cretaceous strata fall naturally into two groups, which, in geographical distribution, coincide approximately with the drainage areas of Tombigbee and Alabama rivers on the west and that of the Chattahoochee on the east. The Cretaceous well records by counties will be given in these two groups, preceded by such additional details of the stratification as may be necessary for the fuller understanding of the artesian conditions.

The Tertiary wells are few in number as compared with the Cretaceous. They will constitute a third group and their description by counties will also be proceeded by such additional explanatory details of stratification as can be obtained.

The geographical distribution of the wells of the Coastal Plain is shown, at least approximately, on the geologic map (Pl. I.) The marks indicate the locations of groups of wells rather than of individual wells, it being manifestly impossible on a small scale map to mark each of the 1414 wells of which records have been obtained.

From this map it will be apparent that most of the wells are on the outcrop of the Selma chalk (prairie region). These get their water supply mainly from the Eutaw sands, but some of the deeper borings, especially those near the northern border of the chalk, penetrate into the still lower Tuscaloosa strata, also water bearing.

The wells on the Eutaw outcrop get their water in part from the Eutaw and in part from the Tuscaloosa, according to depth, while those located on the Tuscaloosa formation begin and end in it.

South of the chalk are some wells, both in the Cretaceous and in the Tertiary, which derive their water supply from the uppermost Cretaceous (Ripley, or Blue Marl) strata. This is especially the case in the eastern counties—Pike, Bullock, Barbour, and Russell.

The following figures will show perhaps more clearly than does the map the concentration of the wells in Cretaceous strata. Of the whole number (1414) of which accounts are given herein, 1.220, or a little over 86 per cent. are in the Cretaceous, while only 136, or not quite 10 per cent., are in the

Tertiary, the remaining 4 per cent. being in the older formations of the Appalachian division.

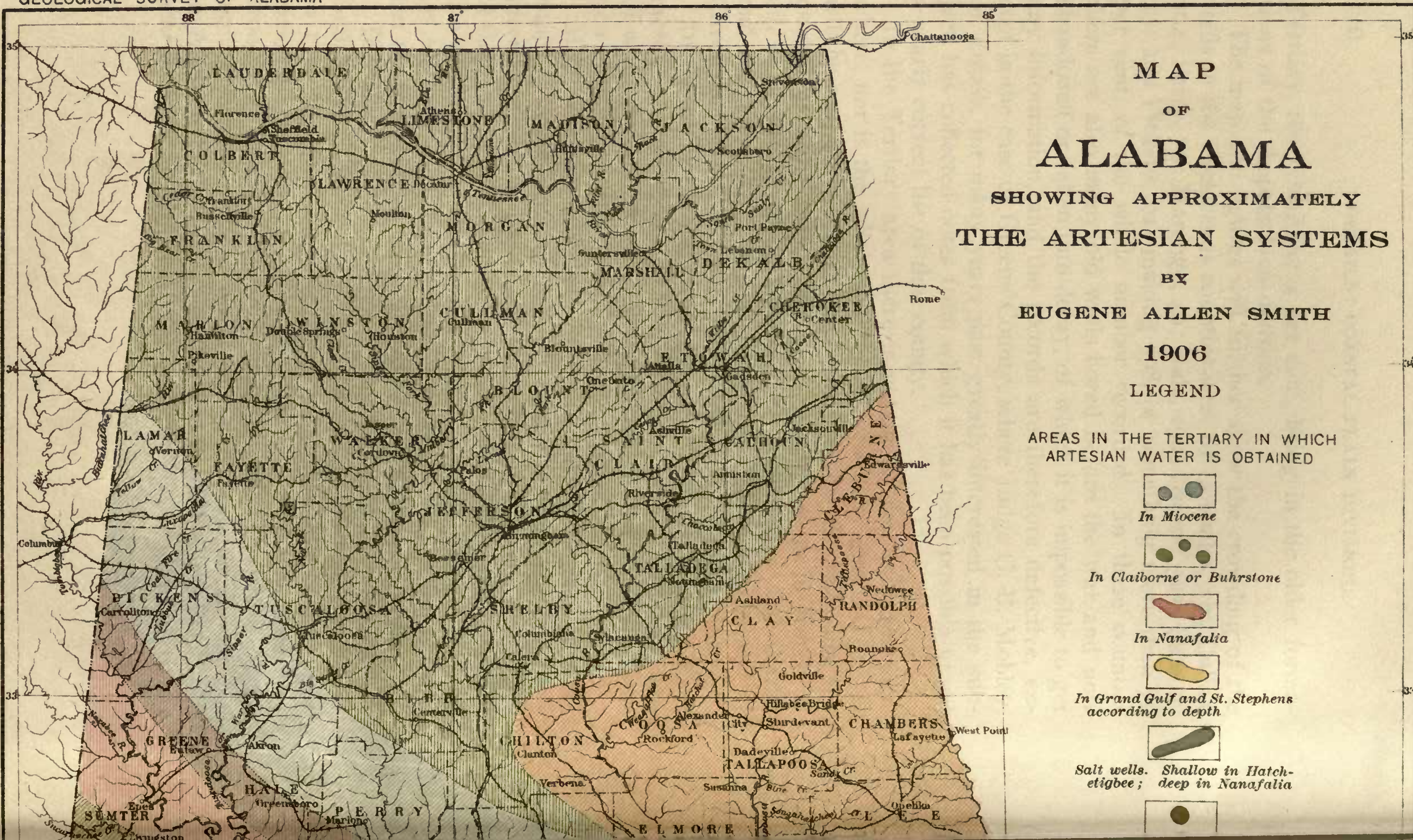
The map and figures will further show the crowding of the wells in the Cretaceous counties west of Lowndes, viz, Dallas, 202; Perry, 79; Marengo, 49; Hale, 192; Greene, 323; Sumter, 59; and Pickens, 94; making 998, or something more than 70 per cent. of the whole number recorded. In these counties there are also many old wells bored before the war and now abandoned or fallen into decay, of which it is impossible to get any information, and the records are therefore defective, except in the case of Greene County, where Judge G. B. Mobley, of Eutaw, for many years past greatly interested in the subject, has collected notes from which it has been possible to get a nearly correct list of that county.

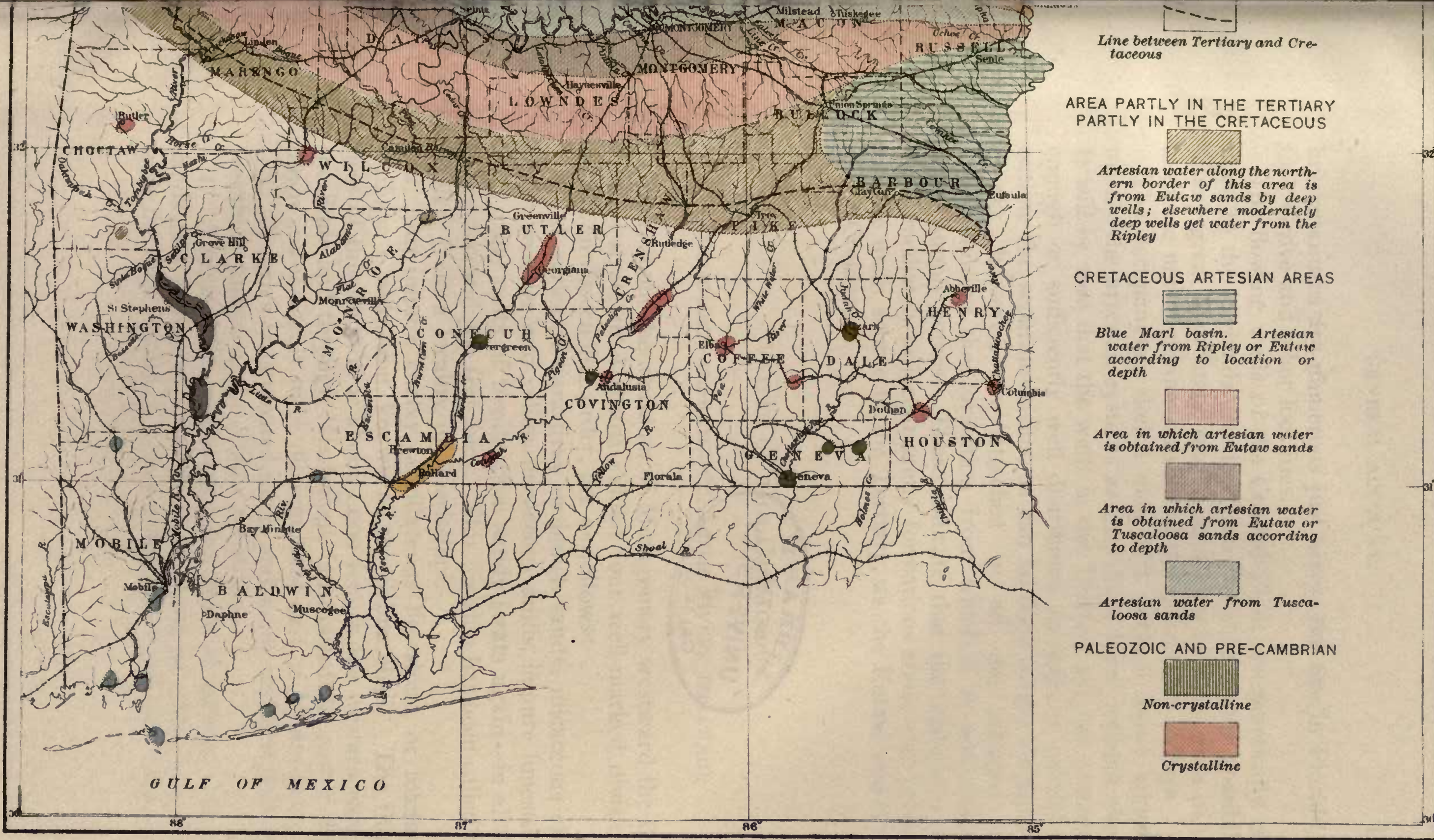
In the Tertiary area there is no similar concentration anywhere, nor is the whole number of wells very great—136. It will be seen that most of the borings follow the railroads, the exceptions being mainly the wells recently sunk in search of oil, e. g., in the salt-wells region of Washington and Clarke and the lower parts of Mobile and Baldwin counties, and at Citronelle, Mobile County, and Roberts, Escambia County.

In the salt-wells region referred to, as in parts of the Cretaceous prairie region, there are many old wells sunk years ago of which no records are now obtainable, indeed, the very location of many of them can not be ascertained.

Most of the artesian wells in the Tertiary section obtain their supply from the great sandy Nanafalia formation and its adjacent Tuscahoma above, and Naheola below. A few, like those at Geneva, get water in the Claiborne or Buhrstone. At Brewton the shallow wells, less than 100 feet in depth, probably do not go deeper than the Grand Gulf, which there forms the surface; but the deep borings get water in the St. Stephens strata.

The deep wells in Mobile and Baldwin counties, starting in Grand Gulf strata at the surface, bring up from depths of 700 to 1550 feet, shells characteristic of the Miocene formations exposed along the banks of the Chattahoochee river and first brought into notice by D. W. Langdon, of the Alabama Geological Survey. The outcrop of these Miocene formations in Alabama has as yet been observed at only one point, i. e., near Roberts, Escambia County, on the banks of Conecuh river,


MAP
OF
ALABAMA
SHOWING APPROXIMATELY
THE ARTESIAN SYSTEMS
BY
EUGENE ALLEN SMITH
1906
LEGEND
AREAS IN THE TERTIARY IN WHICH ARTESIAN WATER IS OBTAINED
In Miocene
In Claiborne or Buhrstone
In Nanafalia
In Grand Gulf and St. Stephens according to depth
Salt wells. Shallow in Hatchetigbee; deep in Nanafalia
LAUDERDALE
LIMESTONE
MADISON
JACKSON
COLBERT
LAWRENCE
MORGAN
FRANKLIN
MARSHALL
DEKALB
CHEROKEE
MARION
WINSTON
CULLMAN
ETOWAH
BLOUNT
LAMAR
FAYETTE
WALKER
SAINT CLAIR
CALHOUN
CLEBURNE
JEFFERSON
TALLADEGA
RANDOLPH
CLAY
PICKENS
TUSCALOOSA
SHELBY
COOSA
CHAMBERS
CHILTON
TALLAPOOSA
GREENE
HALE
PERRY
SUMTER
ELMORE
Chattanooga
Rome
Florence
Sheffield
Athens
Huntsville
Scottsboro
Decatur
Moulton
Russellville
Guntersville
Port Payne
Cullman
Hamilton
Double Springs
Houston
Blountsville
Pikeville
Attalla
Gadsden
Oneonta
Ashville
Jacksonville
Vernon
Fayette
Jasper
Cordova
Anniston
Edwardsville
Columbus
Birmingham
Talladega
Bessemer
Wedowee
Carrollton
Ashland
Tuscaloosa
Columbiana
Sylacauga
Roanoke
Goldville
Centreville
Hillabee Bridge
Alexander City
Rockford
West Point
Eutaw
Akron
Clanton
Dadeville
Lafayette
Verbena
Greensboro
Marion
Susanna
Opelika
Livingston
Epes
Chattahoochee R.
Tennessee R.
Sipsey R.
Tombigbee R.
Luxapalila
Buttahatchee
Coosa R.
Tallapoosa R.
88°
87°
86°
85°
35°
34°
33°



Line between Tertiary and Cretaceous
AREA PARTLY IN THE TERTIARY PARTLY IN THE CRETACEOUS
Artesian water along the northern border of this area is from Eutaw sands by deep wells; elsewhere moderately deep wells get water from the Ripley
CRETACEOUS ARTESIAN AREAS
Blue Marl basin. Artesian water from Ripley or Eutaw according to location or depth
Area in which artesian water is obtained from Eutaw sands
Area in which artesian water is obtained from Eutaw or Tuscaloosa sands according to depth
Artesian water from Tuscaloosa sands
PALEOZOIC AND PRE-CAMBRIAN
Non-crystalline
Crystalline
GULF OF MEXICO
MARENGO
CHOCTAW
WILCOX
LOWNDES
MONTGOMERY
BULLOCK
RUSSELL
BARBOUR
PIKE
BUTLER
CRENSHAW
CLARKE
WASHINGTON
MONROE
CONECUH
COVINGTON
COFFEE
DALE
HENRY
HOUSTON
GENEVA
ESCAMBIA
MOBILE
BALDWIN
Butler
St Stephens
Grove Hill
Monroeville
Evergreen
Greenville
Georgiana
Rutledge
Andalusia
Elba
Dothan
Abbeville
Columbia
Eufaula
Clayton
Union Springs
Hayneville
Montgomery
Milstead
Tuskegee
Linden
Brewton
Flomaton
Florala
Geneva
Bay Minette
Mobile
Daphne
Muscogee
88°
87°
86°
85°
32°
31°
A. HOEN & CO. BALTIMORE.

but exposures are numerous just across the line in Florida, at Oak Grove and other localities.

The flowing wells of the Coastal Plain are practically confined to the lowlands, the low relief precluding the possibility of any great hydrostatic head. As a consequence, wells of this kind are not numerous outside of the great river valleys.

The accopanying sketch map (Pl. XIII.) shows approximately the artesian systems as they have been outlined above. It will be seen that the wells in the Tertiary are not numerous enough or sufficiently well distributed to make it possible to outline the separate basins, as can be done in the Cretaceous. Marks, however, are attached to all the artesian well areas showing the formation from which it is probable the water supply comes. These indicate that the Nanafalia and the immediately adjacent sandy formations above and below it are the main source in the Tertiary, as the Eutaw stands are in the Cretaceous.

Waters of the Cretaceous.

TOMBIGBEE-ALABAMA-CONECUH RIVERS DRAINAGE.

From about the meridian of Montgomery westward the Cretaceous strata in Alabama exhibit four well-marked divisions, which, in descending order, are as follows:

1. A series of dark-gray or bluish sandy, micaceous clays which weather into yellow micaceous sands, impure limestones with many casts of fossils, then sandy strata again—in all between 200 and 300 feet thick. This division has been called the Ripley, from a locality in Mississippi.

2. An impure chalky, argillaceous limestone, or tolerably uniform composition, known as the Selma chalk. The thickness of this division is about 1,000 feet in the western part of the State and through Mississippi, but toward the east it thins down and is hardly to be distinguished east of Montgomery.

3. A series of laminated sands and sandy clays, at least 300 feet thick, known as the Eutaw formation.

4. A great series, at least 100 feet thick, of variously colored sands and laminated massive clays, some of which are filled with the impressions of leaves, often in a good state of preser-

vation. To this series, which is, in part at least, equivalent to the Potomac formation of the Atlantic coast, the name Tuscaloosa formation has been given.

The Selma chalk, or "rotten limestone," as it was once called, is deficient in surface waters except during wet seasons, and it is because of this and the fact that the best farming lands of the State—the black prairie lands—are derived from it that so large a proportion of the artesian wells are to be found located on this chalk. Especially is this true of the earlier wells, which were almost without exception in the prairie region. Recently, however, deep wells have been sunk in other Cretaceous strata which are not lacking in surface water.

In the western part of this drainage area the water-bearing formations are the Tuscaloosa and the Eutaw, which are prevailingly sands and clays in many alternations. The Ripley calcareous sands are also utilized to some slight extent in the western part, but they become more and more important in this respect to the east, as will be seen below.

In the Tuscaloosa formation the borings have been comparatively few, and a general statement of the water horizons can not be made with certainty. At the summit of the formation there is usually a body of purple or red clay of considerable thickness through which the boring must go before water is reached. Mr. John I Hawk, of Selma, who has had much experience in this business, says that when he strikes the "pink kaolin" he usually stops, as he is not likely to get water for at least 100 feet. In the lower part of the formation the borings have been more numerous, especially in Tuscaloosa County, where the records show that after a depth of 20 to 30 feet of loose materials, the borings go through 100 to 200 feet of what is called "blue rock," below which as a rule a supply of water is obtained.

As regards the Eutaw sands the case is different, for by far the greater proportion of the artesian wells in Alabama derive their water from this horizon. Mr. John I. Hawk has furnished the following notes. Most of the wells bored by him have been in the Selma chalk area, this being the "blue rock" of the well borers, but not the blue rock above mentioned in the Tuscaloosa formation. Mr. Hawk says:

"Once through the blue rock, we strike a sand rock varying from 1 to 3 feet in thickness, and next, small beds of black and white sand with a green coloring in it (green sand) and interspersed with green soapstone (laminated clay.) The first water is in these strata of sand, and it comes up according to the elevation; in very low places it will overflow, but it never makes a strong stream.

"From 75 to 100 feet below the sand rock mentioned, we encounter a very hard rock (I think a white lime rock), varying in thickness in different sections from 2 inches to 2 feet; once through this rock we get the second stream of water in much the same kind of strata, and this water will rise about 12 feet higher than the first stream.

"About 75 to 100 feet below the hard cover rock just mentioned, we have what we call white soapstone, from 10 to 40 feet in thickness; then a stratum of sand whiter and coarser than any of the preceding, interspersed with green soapstone and the same green coloring in the sand. This bed is from 40 to 75 feet thick and from it comes our third water, which rises about 10 feet higher than the second.

"Immediately below this is a bed of green soapstone, from 50 to 90 feet thick, followed by a marl from 20 to 50 feet thick, and beneath the marl we have a very coarse sand interspersed with sandrock and soapstone, from 20 to 40 feet in thickness. In this we get our fourth stream, which rises from 30 to 40 feet higher than first stream and is very strong.

"Below this the pink kaolin begins, there being about 400 feet or a little more between the blue rock and the pink formation. I have bored into this pink formation from 40 to 100 feet, but have never gone through it, nor increased the supply of water any by boring beyond the coarse white sand."

In the eastern part of the area under consideration the drainage is divided between Alabama and Conecuh rivers in Pike and Bullock counties, and the artesian characters in these two counties are transitional, having many points of resemblance to those of the Chattahoochee area in Russell and Barbour counties.

DISCUSSION BY COUNTIES.

LAMAR COUNTY.

The surface formation in this county is the Tuscaloosa, with a capping of Lafayette sands and pebbles where erosion has not been too great. Underlying these two formations and exposed along the valleys of some of the streams in the northeastern part of the county are the sandstones and shales of the Coal Measures.

SHALLOW WATERS.

The sands and pebble beds and laminated clays of the Tuscaloosa and Lafayette formations afford here, as elsewhere, ample supplies of good surface water in springs and open wells, and as a consequence few deep wells have been needed.

Artesian Prospects.

The sands and clays of the Tuscaloosa, in many alternations and with moderate and uniform westerly or southwesterly dip, furnish the requisite conditions for artesian systems, as is provided by the few wells that have been bored in the county and by those in the adjoining county in Mississippi, Monroe.

SULLIGENT.

Thus far records have been obtained only of wells at Sulligent, where three were bored in 1900 by W. F. Little, of West Point, Miss. No record could be secured of the strata passed through in these borings.

Town well, depth, 206 feet; 3-inch iron casing at the bottom; when first drilled flowed 74 gallons per minute; In less than two years the casing was corroded and the well clogged so that the present yield (1904) is only 18 gallons; water rises to 28 feet and still flows.

Ogden well, 250 yards south of the town well and about the same depth; is filled in and does not flow at present.

Stone well, 250 yards east of the town well and about the same depth; still flows (1904).

FAYETTE COUNTY.

The stratigraphic conditions in Fayette County are practically the same as those above given for Lamar County, except that the surface formations (Tuscaloosa and Lafayette) the not present in quite so great thickness and the Coal Measures appear in the valleys of most of the larger streams. What has been said concerning the surface waters and artesian prospects of Lamar will apply equally to Fayette County.

The only artesian well in the County of which a record is available is at the court-house, Fayette, and was bored by W. F. Little in 1900. Its depth is between 500 and 600 feet. At 200-250 feet a seam of coal 4 feet thick was struck. The well was through rock and was abandoned without getting any notable supply of water.

This particular well, while starting in the Tuscaloosa formation, soon reaches the Coal Measures, and has been mentioned under that head (p. 97). But further west in this county, the Tuscaloosa formation affords conditions similar to those reported above under Lamar County, and artesian borings should succeed if proper localities are selected. The wells would, however, be shallow, since the rocks of the Coal Measures are nowhere very far below the surface in Fayette County.

TUSCALOOSA COUNTY.

Surface Features.

Except in a narrow strip in the southeast corner of this county, where Subcarboniferous, Silurian, and Cambrian beds are exposed in the anticline of Roups Valley, the Coal Measures should on general principles, underlie the entire county, but as a matter of fact these strata are not revealed either in outcrop or by borings southwest of a northwest-southeast diagonal passing through the city of Tuscaloosa. Northeast of this line the sands and clays of the Tuscaloosa formation and the red loam and pebbles of the Lafayette form the surface, with the older strata outcropping in the low grounds of the streams. Only the two younger formations are known in the southwestern half of the county, except along Black Warrior River, where the Second Bottom and other recent deposits occur. An account has already been given (p. 97-99) of the surface and artesian waters of the Paleozoic half of the county, and this section is concerned only with the Cretaceous half.

Shallow Waters.

In the sands of the Cretaceous and especially in the loam and pebble beds of the overlying Lafayette a practically never failing supply of good water is recovered in open wells and springs. The former are rarely as deep as 100 feet, and the finest springs of pure water flow from beneath the Lafayette mantle. It would be impracticable to mention localities of the springs, since they occur almost everywhere that the contact of the Lafayette with an older formation is exposed in a ravine or bluff. The water, as a rule, is remarkably pure, with a small content of solid matter, and the same may be said of the waters of the open wells when they are sunk in Lafayette materials only. Inasmuch as the Lafayette lies upon the eroded, uneven surface of the Tuscaloosa, the latter formation is often penetrated in wells, and when lignitic clays are struck in such cases the water frequently has a brackish taste.

The springs which flow from beneath the Lafayette gravel on the grounds of the University of Alabama may be taken as fairly representative of the class. Analysis of the water from one of these springs, made by Mr. Hodges, shows the following composition:

Analysis of water from spring at University of Alabama.

	Parts per million.
Potassium (K)	.9
Sodium (Na)	1.8
Magnesium (Mg)	1.6
Calcium (Ca)	4.9
Iron and Alumina (Fe_2O_3,Al_2O_3)	.7
Chlorine (Cl)	1.9
Sulphuric acid (SO_4)	5.3
Carbonic acid (HCO_3)	20.2
Silica (SiO_2)	6.6
	43.9

In some cases, while the total amount of mineral matter in these waters may be quite small, yet the relatively large proportion of some of the constituents may give to the water a decidedly mineral or medicinal quality. This may illustrated by the following analysis by Mr. Hodges:

Analysis of water from Ozment Spring.

	Parts per million.
Magnesium (Mg)	1.4
Calcium (Ca)	2.3
Iron and Alumina (Fe_2O_3,Al_2O_3)	2.0
Chlorine (Cl)	trace
Sulphuric acid (SO_4)	5.4
Carbonic acid (HCO_3)	6.9
Silica (SiO_2)	17.9
	35.9

Here the proportions of Magnesium sulphate and of iron to the whole amount of solid matter are relatively very large, and apparently justify the claim that this is a mineral water.

Prof. J. H. Foster, of Tuscaloosa, has furnished the following notes concerning two "blowing wells" in the lower part of the county:

The first of these wells is on the old E. R. King place, now owned by Mr. J. C. Mize, in Fosters settlement, about 12 miles south of west of the city. The well is a bored well, 8 inches in diameter and 90 feet deep, with a circular plank curbing extending about 3 feet above the ground. A hinged lid of board, about 10 inches wide and 12 inches long, fits over the top of the curbing. On the approach of a storm or of change from fair weather to foul, a strong current of air comes from the well sufficient to lift the free end of the lid 3 inches, this lifting of the lid occurring at longer or shorter intervals according to the magnitude of the barometric change. Sometimes the lid will be raised and dropped with great rapidity making a rattling noise that can be heard at a distance. From the depths of the well come sounds as of a cauldron of water furiously boiling. Under ordinary conditions the water stands about 3 feet deep in the well, but on the approach of storms, when the water is disturbed as above described, the bucket frequently comes up only half full. These disturbances in the well usually occur from twenty-four to forty-eight hours before a predicted storm. On the premises of Mr. J. N. Robertson in Hickman, about 3 miles west of Fosters is another well which exhibits similar phenomena.

Artesian Prospects.

Northeast of the city of Tuscaloosa the Cretaceous beds occur in detached masses occupying summits only, and hence are not serviceable for artesian systems. In the southwestern part of the county, however, they are continuous, and because of their composition (alternating clays and sands) and of their moderate and uniform dip, the conditions are in every way favorable to artesian wells. The fact that good surface water can so easily be had from the Lafayette beds in every part of the county has made recourse to artesian wells unnecessary, except in the Second Bottom lands of the river. Here are the earliest artesian wells, and indeed the only ones, except those near Tuscaloosa which have been sunk into the strata of the Coal

Measures, as already described (p. 97-99). To those who are compelled to live in the lowlands along the river, artesian water should prove a boon in diminishing the sickness which seems to follow the use of surface water in the river bottoms. The use of artesian water at the three locks next below Tuscaloosa is said to have effected a very great improvement in the health of the workmen.

All the artesian wells in the Coastal Plain part of this county begin and end in the Tuscaloosa formation.

Until about the year 1900 the only artesian well in the county was that at Willifords Landing, on the river, mentioned below, but it has since been found that good artesian wells may be had in all the lowlands between Saunder's and Foster's ferries and thence on both sides of the river to the lower border of the county. Probably the impetus to this artesion boring was given by the action of the United States engineers in sinking wells at the lock sites below the county line. Gradually borings have been made farther and farther north, as success was achieved.

TUSCALOOSA AND VICINITY.

The following records show the present status of the subject:

S. F. Alston's well, in the N. E. quarter N. E. quarter Section 15, Township 22, Range 11 W.; bored in 1902 by Martin & Morrison; depth, 268 feet (Alston), 234 feet (Morrison); original volume, 75 to 100 gallons; ran thus six months until Mr. Foster's well (see next record), a half mile away, was bored, when it fell off gradually to its present volume, 3 gallons; temperature 66 degrees; water rose 16 feet above the surface and overflowed with small force;

Record of S. F. Alston's well, Tuscaloosa.

	Feet.
Clay, etc.	0 — 6
Dark sand	6 — 05
Blue rock	50 — 236
Sand, water bearing	236 — 268

First overflow from 236 feet; 3—inch casing down to blue rock.

J. Manly Foster's wells: No. 1. in the S. E. quarter N. E. quarter Section 15, Township 22, Range 11 W., half a mile from the Alston well; bored in 1902 by W. V. Morrison; depth, 234 feet; 3-inch casing; flowed strong stream for six weeks, then fell off suddenly to present volume of 2 1-2 gallons; temperature, 66 degrees; a good drinking water; noticeable improvement in the health of those using it.

Record of J. Manly Foster's well No. 1, Tuscaloosa.

	Feet.
Sand and gravel	0 — 30
Blue rock	30 — 80
Sand and water with occasional streaks of blue rock	80 — 234

No. 2 and 3, bored by Wyndham in the fall of 1904 on Mr. Foster's place in Section 22, Township 22, Range 11 W.; depth, about 250 feet; both wells flow good streams from 1 1-4-inch pipe. Nos. 4, 5, and 6, bored for Mr. Foster by Wyndham in the spring of 1905, in Sections 13 and 14, Township 22, Range 11 W.; depth, 250-270 feet; all three furnish good flow from 1 1-4-inch pipe.

Well of Will Murphy (colored), in the E. half N. W. quarter of Section 13, Township 22, Range 11 W.; bored in March ,1905, by Wyndham; depth, about 280 feet; weak stream.

Friedman & Loveman's well, in the N. E. quarter Section 24, Township 22, Range 11 W.; bored by W. V. Morrison in 1902; depth 320 feet; first overflow at 300 feet; 3-inch casing; original volume estimated at 4 gallons, which gradually increased to present volume, 24 gallons; temperature, 66 degrees.

Record of Friedman & Loveman's well.

	Feet.
Soil and clay	0 — 30
Blue rock	30 — 150
Sand, with thin layers of hard rock	150 — 300
Hard rock	300 — 320

A peculiar circumstance is related by Mr. Morrison concerning this well; the water first rose to —5 feet. Three barrels of water were then poured into the pipe, when the water began to flow and has since continued to flow without interruption.

Henry A. Jones's wells, bored by Martin and Morrison in 1902: No. 1, on Slade place, in the S. E. quarter S. W. quarter Section 20, Township 22, Range 10 W.; depth, 160 feet; principal supply of water at 150 feet;

stopped in hard rock; water stands at —7 feet and pump is used. No. 2, about 100 yards from No. 1; record practically the same.

Quarles well, at Foster's Ferry bridge; bored by Morrison in 1902; depth, 306 feet; 3-inch casing; overflow at 260 feet, weak; since the first few days the flow has remained constant at 6 gallons per minute; temperature, 67 degrees.

Record of Quarles well, Foster's Ferry.

	Feet.
Soil and clay	0 — 30
Blue rock	30 — 150
Sand and water with an occasional strata of blue rock	150 — 306

RIGHT BANK OF RIVER.

Below the above localities, on the right bank of the river, there are several wells lately bored, records of which have been secured.

Henry A. Jones's wells, in Sections 5-6, Township 24, Range 53; four wells bored by W. V. Morrison in 1902, not more than half a mile apart, all flowing, and about the same depth, 166 feet (Morrison); No. 1, 3-inch casing; flows 70 gallons per minute; temperature, 66 1-2 degrees. No. 2, 3-inch casing; first overflow at 103 feet; flows, 90 to 100 gallons per minute; temperature 66 degrees. No. 3, 4 1-2-inch casing; first overflow at 136 feet; present flow, 1 1-2 gallons per minute; temperature 64 degrees. No. 4, 3-inch casing; first overflow at 136 feet; present volume (estimated), 60 gallons per minute; temperature, 65 1-2 degrees.

Guy Foster's well, in Section 7 or 8, Township 24, Range 5 E.; bored by Morrison in 1902; depth, 170 feet; equally strong flow at 162 feet; first overflow at 130 feet; present volume, 30 gallons per minute; temperature, 66 degrees. Mr. Foster thinks that heavy rains 50 miles north are followed in three days by an increased volume; otherwise the flow is constant. Mr. Morrison thinks that all the wells in this neighborhood would rise 20 feet above the surface.

Well of Charles Verner and Henry King, in fraction A, Section 13, Township 24, Range 4 E.; bored by Morrison in 1902; 3-inch casing; depth, 200 feet; first overflow at 164 feet, somewhat weaker than at 200 feet; practically constant volume, 30 gallons per minute; temperature, 67 degrees.

Record of Verner and King well, near Tuscaloosa.

	Feet.
Soil, clay	0 — 30
Blue rock	30 — 150
Sand with occasional thin strata of blue rock	150 — 200

Henry King's well, 1 mile northwest of the old well at King's Ferry; bored by W. M. Martin in 1904; depth, 198 feet; 57 feet of 3-inch casing; estimated flow, 40 gallons per minute.

HULLS.

Y. T. Auxford's wells, Hulls station, in Section 17, Township 24, Range 5 E.; bored by Morrison: No. 1, depth, 234 feet; overflowed at 210 feet; 3-inch casing; constant volume, 30 gallons per minute; temperature, 67 degrees.

Record of Auxford well No. 1, Hulls.

	Feet.
Soil and clay	0 — 43
Blue rock	43 — 210
Sand and water	210 — 234

The water from this well has been analyzed by Mr. Hodges, with results as shown below:

Analysis of water from Auxford well No. 1, Hulls.

	Parts per million.
Potassium (K)	2.4
Sodium (Na)	4.9
Magnesium (Mg)	8.4
Calcium (Ca)	36.3
Iron and Alumina (Fe_2O_3,Al_2O_3)	2.5
Chlorine (Cl)	7.0
Sulphuric acid (SO_4)	5.1
Carbonic acid (HCO_3)	148.9
Silica (SiO_2)	17.8
	233.3

No. 2, 1 mile southwest of Hulls; depth 234 feet; overflow at 200 feet: rises 4 feet above the surface; temperature, 66 degrees; volume approximately constant. No. 3, three-fourth mile southwest of Hulls; depth, 290 feet; 3-inch casing; overflow at 260 feet; constant volume, 1 gallon; temperature 66 degrees.

Record of Auxford well No. 3, Hulls.

	Feet.
Soil, clay	0 — 30
Pink sandstone	30 — 200
Sand, with thin layers of blue rock	200 — 290

WILLIFORDS.

On the right bank of the river, below Thomas Allen's and almost on the lower border of the county, is the oldest artesian well in the county, at Willifords Landing, Plate XIV. This well is on the second terrace of the river and is said to be 400 feet deep. The water overflows in a stream about an inch in diameter, and is quite free from dissolved mineral matter. No record can now be obtained of this well, which was bored more than fifty years ago.

Analysis of the water by Mr. Hodges shows the following composition:

Analysis of water from well at Williford's Landing.

	Parts per million.
Potassium (K)	11.6
Sodium (Na)	17.4
Magnesium (Mg)	5.3
Calcium (Ca)	23.4
Iron and Alumina (Fe_2O_3,Al_2O_3)	2.5
Chlorine (Cl)	17.4
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	130.0
Silica (SiO_2)	13.1
	220.7

BIBB COUNTY.

Some details concerning the surface and mineral waters of Bibb County have been given above (p. 83) in the section on the Coosa Valley Region, Appalachian valleys. The southern and southwestern parts of the county are occupied by the Tuscaloosa sands and clays with their capping of Lafayette, and the underground water conditions are entirely similar to those in the corresponding parts of Tuscaloosa County. No well records from Bibb are available, but it may be asserted that the artesian prospects in the lower parts of the county are favorable. As in some other counties, the abundance and good quality of the surface water afforded by the open wells and springs have rendered recourse to artesian borings unnecessary.

ARTESIAN WELL AT WILLIFORDS, TUSCALOOSA COUNTY.

CHILTON COUNTY.

In this county the general geological conditions are quite similar to those in Bibb County, and there should be no difficulty in obtaining artesian water in the southwestern part, where the surface is occupied by the Tuscaloosa formation with its Lafayette capping. As shallow wells, however, generally furnish ample supplies of good water, artesian borings have not been made in many places, and there are few records.*

PICKENS COUNTY.

Surface Features.

The underlying Cretaceous formations of Pickens County are the Tuscaloosa, the Eutaw, and the Selma chalk. The Tuscaloosa occupies the northeastern and the Eutaw the southwestern half of that part of the county lying east of Tombigbee River, while the Selma chalk occupies the small area west of the river, together with a few scattering tracts along the river on the eastern side.

In the Tuscaloosa-Eutaw territory east of the river the county is somewhat broken because of the incoherent character of the sands and clays which make up these formations. Where the watercourses are not too close together, however, the divides between them are level plateaus with the Lafayette red-loam soils, underlain by pebbles, which once capped the Cretaceous over the entire area.

Shallow Waters.

In the relatively small area west of the river, which is occupied by the Selma chalk, the Lafayette mantle is in great part wanting and the soils are composed of the residual matter from the decomposition of the limestone. In this section open wells and surface springs are not to be counted on, because of the underlying chalk, but in the rest of the county the surface materials afford conditions for a fairly adequate supply of water

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*See, however, notice of bored wells near Thorsby—under Appalachian Division—Talladega Mountain section, p. 67.

for springs and wells, though these are liable to be much reduced or to go dry in the summer. On Coal Fire Creek are many chalybeate springs and on Lubbub Creek near Reform is a noted bold spring which is much visited for health and recreation. Near the mouth of Lubbub Creek and in the old town of Vienna also are bold springs of pure, cold water.

ARTESIAN PROSPECTS.

In the Tuscaloosa and Eutaw formations underlying Pickens County the alternations of sands and clays and their uniform gentle (southwestward) dip afford favorable conditions for artesian systems, borings for water are usually successful. The oldest of these artesian borings were made in the prairie or chalk region, or along its eastern border, but recently a few wells have been put down in the territory of the older Cretaceous formations, notwithstanding the fact that here a good water supply can generally be had from shallow wells and springs.

Wells in the Eutaw Formation.

A number of artesian wells have been bored within the territory of the Eutaw, chiefly in the vicinity of Bridgeville, on Lubbub Creek, along Sipsey River, and near Ringos Bluff and Pickensville. Prof. Alexander Winchell has given an account of some of these wells in an article in the Proceedings of the American Association for the Advancement of Science, 1856. The average depth of the wells mentioned in this article is 180 feet, which would reach the base of the Eutaw or the top of the Tuscaloosa as water-bearing sands. As these wells were mostly bored before the war, it is impossible at this time to get any records of the strata passed through and but few of the depth of the borings. Notes have been collected of as many as could be heard of, and the temperatures together with the volume of water afforded by those visited, are given below.

The wells near the contact of the Eutaw with the Selma chalk would have an estimated depth of 300 feet, more or less, to the "fourth water" of the borers, while those near the contact of the Eutaw with the Tuscaloosa should be shallower in proportion to the nearness to the latter. Near this line, however, it is probable that water is obtained from the underlying Tuscaloosa sands.

SIPSEY RIVER.

Well on old Doctor Hinton Place, 7 or 8 miles northeast of Vienna; old well; flow (estimated), 5 gallons per minute; temperature, 65 degrees.

Sipsey Mill well, 8 miles northeast of Vienna; owned by John Childs; flow (estimated), 30 gallons per minute; temperature, 65 degrees.

Wells on Sam Wilder place; No. 1, 9 miles northeast of Vienna; flows 4 feet above surface; yield, 33 gallons per minute; temperature, 65 degrees. No. 2, one quarter mile northeast of old Sipsey Mill and 8 1-2 miles northeast of Vienna; flows 3 feet above surface; yield, 20 gallons per minute; temperature, 65 degrees.

LUBBUB CREEK.

From the territory near the mouth of Lubbub Creek and for some distance upstream, and in the low ground of Tombigbee River up to Ringos Bluff, the following are reported:

Old Bridgeville well, on Lubbub Creek, 5 1-2 miles from Vienna; flows 1 foot above surface, decreasing; i. e. wooden pipe decayed; estimated yield, 25 gallons per minute; temperature, 66 degrees.

ALICEVILLE AND VICINITY.

At Aliceville, north of Bridgeville, a well now owned by John Cochrane, has lately been bored by Mr. McGracken; first water at 125 feet; stand —19 feet; second water at 180 feet; stand —16 feet. The record down to the depth of 309 feet is as follows:

Record of Cochrane well, Aliceville.

	Feet.
Soil and loose materials	0 — 56
Blue rock	56 — 125
Sand, water	125 — 130
Blue rock	130 — 175
Hard sand	175 — 200
Blue rock	200 — 240
Sand, water	240 — 250
Blue rock	250 — 285
Sand	285 — 288
Blue rock	288 — 305
White clay and black sand	305 — 309

Wells on Mrs. M. E. Mayhew's place, originally Cunningham place; 1 1-2 miles southwest of Aliceville; flows 2 feet above surface; yield, 8 gallons per minute; temperature, 66 degrees.

Aaron Harris's well, 2 miles southwest of Aliceville; flows 4 feet above surface; yield, 60 gallons per minute; temperature, 66 degrees.

Well on McCaa place, 3 miles southwest of Aliceville; estimated flow, 50 gallons per minute, decreasing, in decay.

Well on Spruille place, owned by L. E. McKinstry, 4 miles southwest of Aliceville; in decay, flow not estimated; temperature, 66 degrees.

Well on McKinney place, owned by Mrs. L. E. McKinstry, 4 1-2 miles southwest of Aliceville; flows 3 feet above surface; estimated yield, 10 gallons per minute; temperature, 66 degrees.

Well on Mrs. E. A. McCaa's place, 5 miles southwest of Aliceville; flows 1 foot above surface; estimated yield 10 gallons per minute; temperature, 66 degrees.

Well on Billy McCaa place, owned by Gardiner & Somerville; flows 2 feet above surface; estimated yield 25 to 30 gallons per minute; temperature, 66 degrees.

NEAR TOMBIGBEE RIVER.

Gardiner & Somerville well, Newport Landing, Tombigbee River; flows 4 feet above surface; temperature, 67 degrees.

Well on Nolen place, 4 or 5 miles northeast of Vienna; flow 12 gallons per minute; temperature, 66 degrees.

Well on Dr. Carpenter's place, 4 or 5 miles northeast of Vienna; old well; flow 8 gallons per minute, temperature, 66 degrees.

Well on Dr. Carpenter's place at ferry; old well; yield, 4 gallons per minute; temperature, 66 degrees.

Old well near Baptist Church, 5 miles northeast of Vienna; yield, 1 1-2 gallons per minute; temperature, 65 1-2 degrees.

Well on Bonner place, owned by Mr. Hagaman, 5 1-2 miles north of Vienna; bored about 1885; flows 1 foot above surface; yield 5 gallons per minute; temperature, 65 degrees.

Well on Gibson place, owned by Mrs. Chapman, 6 miles north of Vienna; estimated flow, 5 gallons per minute; temperature, 65 1-2 degrees.

Well on Mayhew place, owned by E. Stewart, 7 miles north of Vienna; yield 65 gallons per minute; temperature, 64 1-2 degrees.

Wells on Gardiner place, 7 1-2 miles north of Vienna: No 1, deepened in 1860 to 285 feet; first water at 225 feet, overflowing; second water at 285 feet, rises 25 feet above surface; estimated volume, 100 to 200 gallons per minute; temperature, 65 degrees. There are two other large wells at this place which were once used to run a mill: No. 2 has an estimated flow of 125 gallons per minute; No. 3, is 300 feet deep.

G. T. Heard's wells: No. 1, in the N. E. quarter of N. W. quarter Section 20, Township 22, Range 16 W.; flows 3 feet above surface; yield, 30 gallons per minute; temperature 66 degrees. No. 2, 8 miles west of Aliceville and 1 1-2 miles southeast of Ringos Bluff, in fractional S. E. quarter Section 14, Township 22, Range 17 W.; on the old Stapp place; estimated flow, 50 gallons per minute, decreasing, in decay; temperature, 66 degrees.

Well on Caraway place, 9 miles west of Aliceville; flows 4 feet above surface; estimated yield, 60 gallons per minute; temperature, 67 degrees.

Bradford well, owned by Abe Gray, 8 miles east of Ringos Bluff; flows good strong stream; no details obtained.

At Ringos Bluff there are 5 old wells, of which some records of 4 follow: No. 1, at warehouse at bluff; flows 2 feet above surface; yield, 12 gallons per minute; temperature, 66 degrees. No. 2, 30 yards from No. 1; estimated flow 40 gallons per minute, decreasing, piping in decay;

temperature, 66 degrees. No. 3, 100 yards from No. 1; old wooden piping decayed to ground, forming a kind of spring; estimated yield 5 gallons a minute; temperature, 65 degrees. No. 4, 200 yards east of No. 1; flows 2 feet above surface; estimated yield, 4 gallons per minute; temperature, 65 degrees.

PICKENSVILLE AND VICINITY.

Henry Ball's wells: No 1, 5 miles a little west of south of Pickensville, in Section 12, Township 22, Range 17 W.; no details; flows 2 feet above surface; yield, 6 gallons per minute; temperature, 65 1-2 degrees.

Mrs. E. G. Hood's well, 3 miles south of Pickensville; flows 3 feet above surface; estimated yield, 7 gallons per minute; temperature, 65 degrees.

W. R. Rogers's well, 3 miles south of Pickensville, near Jackson Ferry; new well, bored by Talley & Cunningham in 1902; depth, 236 feet; 3-inch casing, 64 feet; flows 2 feet above surface; yield 5 gallons per minute; temperature, 63 degrees.

Record of W. R. Rogers' well.

	Feet.
Sand, gravel, etc.	0 — 36
Blue rock	36 — 42
Blue mud	42 — 236

Mrs. W. A. Peterson's well, 2 miles west of south of Pickensville; old well; flows 2 feet above surface; yield, 25 gallons per minute; temperature, 65 degrees.

Well on old Walker place, three quarters of a mile south of Pickensville; yield, 5 gallons per minute; temperature, 66 degrees.

W. R. Rogers's wells (old): No. 1, half a mile west of Pickensville; yield, 75 gallons per minute; temperature, 65 degrees. No. 2, three quarters of a mile west of Pickensville; flow, 25 gallons per minute, wooden pipe in decay; temperature, 64 1-2 degrees. No. 3, three quarters of a mile west of Pickensville; flow (estimated), 50 gallons per minute; temperature, 64 1-2 degrees.

J. F. Wilkins's wells (old): No. 1, 1 1-4 miles east of Pickensville, on Bonner's Mill road on Big Creek; No. 2, 5 miles west of north of Pickensville; both flowing; no details.

H. L. Stone's well, on Nance place, 2 1-2 miles northeast of Pickensville, a quarter of a mile east of house; old well; no record.

J. E. Stewart's wells: No. 1, old well, 2 1-2 miles north of Pickensville; flowing. No. 2, new well, 2 1-2 miles northwest of Pickensville; bored by Talley & Cunningham; depth, 260 feet; 3-inch casing, 22 feet; flows 2 1-2 feet above surface; yield, 8 gallons per minute; somewhat stronger than the new well of W. R. Rogers above mentioned.

Well on Lee place, in Lees Bend, 6 miles northwest of Pickensville; owned by J. E. Stewart, 1 mile northwest of his well No. 2 above mentioned; flowing: not visited.

Wells in the Selma Chalk.

VIENNA AND VICINITY.

The "rotten limestone" or Selma chalk makes the surface only in that part of the county west of the Tombigbee, with the exception of a small tract near the mouth of Sipsey River, about the town of Vienna. Most of the wells in this section, as in the territory of the Eutaw formation, were bored many years ago, before the civil war, and the records have been lost. In the article above referred to Professor Winchell, on the authority of Mr. James Strait, a well borer, formerly of Greene County, gives the depths of the artesian wells at and near Vienna as from 350 to 400 feet. This depth would reach the "fourth water" of Mr. Hawk (see p. 113), and it is probable that the majority of the flowing wells of the prairie region are supplied by these strata near the base of the Eutaw formation.

The following partial records of some of the wells have been obtained:

W. B. Peebles wells, in the S. E. quarter S. W. quarter Section 34, Township 24, Range 2 W.: No. 1, depth, about 350 feet; flow, 3 gallons per minute; temperature, 66 degrees. No. 2, yield, 1 1-2 gallons per minute; temperature, 66 degrees. No. 3, old well; flows 2 gallons per minute; temperature, 66 degrees. No. 4, bored about 1885; depth about 380 feet; flow, 3 gallons per minute; temperature, 67 degrees

Mrs. Sallie Turnipseed's well, locality same as above; old well, in Vienna; no record.

Well on old Wyndham place, one mile northeast of Vienna, owned by W. B. Peebles; flow, 30 gallons per minute; temperature, 67 degrees.

Gold Dust farm well, 1 or 2 miles northeast of Vienna, owned by Mr. Hagaman, of Vienna; flow, (estimated), 5 gallons per minute, piping in decay, so that it forms a kind of spring.

Well on Wilder place; 1 or 2 miles northeast of Vienna; old well; flows 5 gallons per minute; temperature, 66 degrees.

Well on Ferguson place, near Vienna; old well; flow, half a gallon per minute; temperature, 66 degrees.

Well on Cherry place, near Vienna; old well; flow, 2 gallons per minute; temperature, 66 degrees.

Well on Manning place, near Vienna, owned by Mr. Hagaman; flow, 1 1-2 gallons per minute; temperature, 66 degrees.

Well on Wilder place, owned by W. B. Peebles; piping in decay, no record.

Wells on Richardson place, 2 or 3 miles northeast of Vienna, owned by Mr. Hagaman; bored long before the war by Mr. Garrow, to furnish water for a mill; all close together: No. 1, flows from a 6-inch pipe at the level of the ground; estimated flow, 50 to 75 gallons per minute; temperature, 66 degrees. No. 2, estimated flow, 10 to 15 gallons per minute; temperature 66 1-2 degrees. No. 3, water flows from a 6-inch pipe at the bottom of a gulch, 10 feet below the surface; estimated flow, 50 to 75 gallons per minute. No. 4, water flows from an 8-inch pipe (cypress log), in gulch 8 feet below surface of ground; estimated flow, 75 to 100 gallons per minute; temperature 66 degrees. No. 5, flows at surface; estimated yield, 6 gallons per minute; temperature, 66 degrees.

Wells on Barnes place, 2 or 3 miles northeast of Vienna, owned by Peebles & Hagaman. One well flows 3 feet above the surface; estimated yield, 30 gallons per minute; temperature, 66 degrees. Two other wells on this place have about the same flow and temperature.

Hagaman wells, in the S. W. quarter of N. E. quarter Section 27, Township 24, Range 2 W.: No. 1 flows 12 gallons per minute; temperature 66 degrees. No. 2, flows 1 gallon per minute; temperature, 66 degrees.

STONE AND VICINITY.

West of Tombigbee river, at Stone and vicinity and farther west, there are many old wells of which the records are not now obtainable, but concerning which a few notes may be presented, and several new wells have been bored which supply additional needed information.

Public well, Stone, old well; water formerly overflowed but now stands at —2 feet; estimated volume, 3 or 4 gallons per minute; temperature, 68 degrees.

Dr. B. T. Jones's well, 200 yards east of post-office in Stone; new well, bored by C. T. White in 1902; depth 400 feet; 3 1-2-inch casing, 22 feet; 2-inch casing, 300 feet; first water at 150 feet; second water at 200 feet; third water at 400 feet; water rises 4 feet above surface; yields, 2 1-2 gallons per minute; temperature, 67 degrees. The record is as follows: Soil, clay, etc., 0 — 22 feet; blue rock, 22 — 100 feet; sand and gravel, with occasional rock, 100 to 400 feet.

Dr. T. H. G. Cook's well, Stone; new well; bored in 1902 by C. T. White; depth, 650 feet; 2-inch casing, 600 feet; first water at 250 feet, stand —7 feet; second water at 300 feet, stand —7 feet; third water at 560 feet, rising to surface; excavated 3 feet to get overflow.

Walter Wyndham's wells, a half mile west of Stone: No. 1, flows 1 1-2 gallons per minute; temperature, 67 degrees. No. 2, formerly overflowed; stand now —10 feet; has been sounded to the depth of 300 feet.

R. C. Long's well, three quarters mile east of Stone, at ferry; flows 3 feet above surface; yield, 1 1-2 gallons per minute; temperature, 67 degrees.

J. B. Somerville's well, 1 1-2 miles east of Stone; new well; bored by White in 1902; depth, 500 feet; 4-inch and 2-inch casing to bottom; first water at 400 feet; formerly overflowed, but water stands now just at surface. On the same place are several old wells, most of them no longer flowing: No. 1, 150 yards south of house; overflows in the winter only. No. 2, formerly overflowed; water stands now at —4 feet. No. 3, one mile east of house; flows 4 feet above surface, a good stream.

On the Winston Jones and Goldsby places, 3 miles west of Stone, are several old flowing wells.

SHERMAN,* DANCY AND VICINITY.

In the lower edge of Pickens County, about Sherman and Dancy are several wells of which the following records are available:

T. Moore's well, 1 mile south of Sherman, in Section 14, Township 23, Range 3 W.; old well; bored about 1870 by Joe Ladd (colored); depth, 600 feet; diameter, 4 inches; flow, 6 1-2 gallons per minute; temperature, 72 degrees.

Will Oliver's well, 1 mile west of Sherman; old well; flow, 1 1-2 gallons per minute; temperature, 70°.

Well of Mrs. Adams, 2 miles west of Sherman; bored about 1870 by Mr. Ladd; depth, 602 feet; flow, 30 gallons per minute; temperature, 72 1-2°.

W. E. Whittens well, 3 miles west of Sherman; bored by Bicksler in 1900 or 1901; depth, 725 feet; temperature, 71°.

Wells of Mrs. Peter Wier, Sr., 3 miles west of Sherman; three old wells, bored about 1860. One of these yields 2 1-2 gallons per minute, temperature, 71°. The other two are now in decay.

Well on King place, 3 3-4 miles west of Sherman; very old, and with very small stream; no record.

T. A. Baker's wells, Dancy; No. 1, bored by White in 1899; depth, 700 feet; not flowing; first water at 450 feet; second water, at 600 feet, stand -8 feet; third water at 700 feet, stand -22 feet. Record: Soil, 0-15 feet; blue rock, 15-280 feet; quicksand, 280-320 feet; sand and thin rock, 320-600 feet. No. 2, bored by Ladd; depth, 450 feet; water stands at -10 feet; steam pumping for twenty-four hours does not lower level. No. 3, abandoned; record same as No. 2.

J. H. McDonald's well, 2 1-2 miles north of Dancy; bored by White in June, 1903; depth, 350 feet; diameter, 3 1-2 inches; water stands at -90 feet; pumped. The ground level here is estimated to be 75 feet above Dancy. Record: Soil, 0-20 feet; blue rock, 20-300 feet; sand and rock, 300-350 feet.

W. D. King's well, 2 miles west of Dancy; bored by Bicksler in 1901; depth, 903 feet; cased 797 feet; first overflow at 903 feet; 3 1-2 gallons per minute; stand -20 feet. Record: Soil 0-21 feet; blue rock, 21-361 feet; sand and rock, 361-800 feet; hard rock, 800-903 feet.

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*Sherman is near the line of Pickens County but is in reality in Sumter county. The Moore, Oliver and Weir wells are in Sumter county; the others mentioned are in Pickens.

SUMTER COUNTY.

SURFACE FEATURES.

The dividing line between the Cretaceous and Tertiary beds in Sumter County passes in a northwest-southeast direction through Livingston, the county seat. The Cretaceous strata are for the most part Selma chalk, with a narrow belt of the Ripley formation along the southern border. Southwest of the Cretaceous beds are the Tertiary strata of the Midway and Black Bluff, or Sucarnochee (post-oak Flatwoods) formations, extending as far as York station, beyond which the other beds of the lower Tertiary make the surface of the county to its southwestern limit.

Topographically, that part of the county occupied by the Cretaceous strata is in general gently rolling rather than hilly; but through Sumterville and on to a little west of Epes runs a prominent ridge which owes its existence to a slight difference in the quality of the limestone rock. The town of Sumterville is situated on this ridge, and from its summit one may overlook the country from Tombigbee River on the one side to the Mississippi line and beyond on the other. This ridge and the depression of the Flatwoods are the two most pronounced topographic features of the county. Another prominent ridge, based on what is commonly known as "horse-bone rock", passes northwestward through Warsaw and Sherman, in the extreme northern part of the county. Between this ridge and that on which Sumterville stands the limestone is quite pure and uniform in quality, and makes the most fertile and attractive of the farming lands. In this belt are found most of the artesian wells of the county, since the Sumterville ridge is in general too high for flowing wells, and south and west of it the wells would as a rule be too deep for economy.

SHALLOW WATERS.

Springs in the Selma Chalk.

NEAR EPES.

As may be inferred there is a general scarcity of surface springs in the chalk region of Sumter County, but there is one never failing spring in the southeast corner of the S. W. quarter S. E. quarter, Section 6, Township 19, Range 1W.; about 7 miles northeast of Livingston, 3 miles southeast of Epes, and 2 miles from Tombigbee River, on the plantation of Mr. Harden L. Jones, of Livingston. The water oozes from a fissure in the chalk rock, here slightly fossiliferous, and collects in a shallow pool. As it was thought to have medicinal properties, it has been analyzed by Mr. Hodges, with the result given below:

Analysis of water from H. L. Jones's spring, near Epes.

	Parts per million.
Potassium (K)	14.6
Sodium (Na)	374.2
Magnesium (Mg)	277.7
Calcium (Ca)	617.7
Iron (Fe)	trace
Chlorine (Cl)	665.5
Sulphuric acid (SO_4)	2089.0
Carbonic acid (HCO_3)	453.8
Silica (SiO_2)	14.5
	4507.0

Springs in the Tertiary Formations.

In the Tertiary formations of Sumter County there is generally no lack of fairly good surface waters, except in the belt of post-oak Flatwoods, underlain by the black Sucarnochee clays which weather to a reddish color. This whole belt is only slightly elevated above the general drainage plain, and is comparatively level, as the name indicates. After rains the water stands in all the slight depressions, or runs off into streams, and very little of it soaks into the clay. As a consequence, no supply of surface waters for wells can be depended on. Cisterns dug into the solid clay and filled with rain water from the house tops supply domestic needs, and shallow ponds are utilized for cattle.

In some parts of this region shallow wells find a meagre supply of water in the clay, but it is apt to be highly impregnated with salts of various kinds and is unsuitable for drinking except by those accustomed to it.

YORK AND VICINITY.

On the plantation of Mr. W. A. Altman, about 1 1-2 miles south of York on the Butler road is a well the water of which is used by the negroes on the place, who claim to be fond of it, though they say they cannot drink much of it because of its weakening effect, due no doubt to the Epsom salts with which it is strongly impregnated. An analysis of this water by Mr. Hodges shows the following composition:

Analysis of water from Altman well, near York.

	Parts per million.
Potassium (K)	37.3
Sodium (Na)	705.1
Magnesium (Mg)	726.1
Calcium (Ca)	501.3
Iron and alumina (Fe_2O_3, Al_2O_3)	16.9
Chlorine (Cl)	461.2
Sulphuric acid (SO_4)	4636.2
Carbonic acid (HCO_3)	404.5
Silica (SiO_2)	75.8
	7564.4

Two, and perhaps more, wells in York have water somewhat similar in composition, though not so strongly saturated, as may be seen from the analysis given below:

Analysis of water from C. B. Mill's well, York.

	Parts per million.
Potassium (K)	61.9
Sodium (Na)	359.8
Lithium (Li)	trace
Magnesium (Mg)	542.4
Calcium (Ca)	530.3
Iron and alumina (Fe_2O_3, Al_2O_3)	17.0
Chlorine (Cl)	460.8
Sulphuric acid (SO_4)	3553.4
Carbonic acid (HCO_3)	80.3
Silica (SiO_2)	55.0
	5660.9

Analysis of water from Dr. R. H. Hale's well, York.

	Parts per million.
Potassium (K)	14.1
Sodium (Na)	379.1
Magnesium (Mg)	258.6
Calcium (Ca)	315.3
Iron (Fe)	86.6
Chlorine (Cl)	354.5
Sulphuric acid (SO_4)	2283.3
Silica (SiO_2)	92.4
	3783.9

At Curl station on the Southern Railway, a short distance east of York, a well has been sunk in the Flatwoods clays, and the water has a composition similar to the above, as may be seen from Mr. Hodges's analysis:

Analysis of water from B. Hightower's well, Curl station.

	Parts per million.
Potassium (K)	22.5
Sodium (Na)	540.2
Lithium (Li)	trace
Magnesium (Mg)	383.8
Calcium (Ca)	607.2
Iron and alumina (Fe_2O_3, Al_2O_3)	18.2
Chlorine (Cl)	761.1
Sulphuric acid (SO_4)	3085.0
Carbonic acid (HCO_3)	14.0
Silica (SiO_2)	42.9
	5474.9

The waters of the flatwoods will be referred to again under Marengo County.

The Cretaceous and Tertiary formations in Sumter and other counties of the Coastal Plain are mantled by pebbles and red loam of the Lafayette formation, and where erosion has removed least from the surface, as on the divides, the lands are almost level and are capped by this red loam with the pebbles below it. In these table-lands there is an ample supply of the best freestone water, gathered and stored in the sands and pebble beds. Wherever these conditions prevail no borings for artesian waters have generally been made. In the territory of the Selma chalk the remnants of the red loam and pebble beds are generally small and insufficient to provide a durable water supply. In the sandier parts of the Cretaceous (Ripley) and in the greater part of the territory south of the Flatwoods the Lafayette mantle remains in good part intact, and the water supply is correspondingly adequate for open wells and springs.

ARTESIAN PROSPECTS.

The records presented below show fairly well the artesian conditions in Sumter County. They are given in the approximate order of their geographic and geologic relations; the wells in Warsaw and vicinity being in the northern part of the county and nearest the base of the Selma chalk, and the others following progressively southward and westward and being on successively later strata*

The deep wells all derive their water from the Eutaw sands.

WARSAW AND VICINITY.

Town well No. 1, located in street; bored in 1848 by Peter Burns; depth, 400 (?) feet, diameter, 4 inches; first overflow at 300 feet; well originally flowed a 2-inch stream; on sounding the well in 1893 Peter Clements found it to be only 300 feet deep; present flow, 1 1-2 gallons per minute.

Town well No. 2, in street, 150 yards northwest of No. 1; bored by Peter Burns in 1849; depth, 450 feet; diameter, 4 inches; first flowing water from 300 feet; yield two-thirds gallons per minute; stands 1 foot below the surface.

J. W. Gentry's well, bored by C. T. White in 1900; depth, 560 feet; casing, 26 feet of 3-inch pipe; first water at 300 feet, rose 10 feet above the surface; second water at 560 feet, rose 40 feet above the surface; original flow (estimated), 250 gallons per minute; present flow, 5 1-2 gallons per minute; temperature, 71°.

Mrs. J. W. Bell's well, near Warsaw, in Section 33, Township 23, Range 2 W.; bored in 1851 by Peter Burns; depth, 400 feet; original flow, 1 1-2 inch stream from depth of 300 feet; present volume, 1 gallon per minute; temperature, 68°.

Well on old N. A. Rogers place, in Section 33, Township 23, Range 2 W., near Warsaw; bored by Peter Burns in 1850; depth, 450 feet; flow, from 300 feet; now in decay.

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*Some of the wells in the vicinity of Sherman are in Sumter County, though described under Pickens County. Sherman is very close to the county line, but in Sumter.

Well on Rogers estate, near Warsaw; bored by Simon & Ladd in 1897; depth, 300 feet; diameter, 4 inches; first flow at 250 feet; volume, 1 1-2 gallons per minute; temperature, 68°.

Well on Weston place, near Warsaw (?); depth, 396 feet; flows one-third of a gallon per minute; temperature, 69°.

Well on J. J. Little's estate, one-half mile north of Warsaw; bored between 1850-1860 by John Horn; 1 1-2 inch stream originally, but now yields one-quarter of a gallon per minute; temperature, 70°.

William Willis's well, 1 1-2 miles north of Warsaw; bored about 1850 by John Horn; no record.

J. J. Little's well, on Washington place, 4 miles north of Warsaw; no data obtainable.

Wiley Barnes's well, 2 1-2 miles north of Warsaw; bored in 1847; originally gave a 2-inch stream.

Robert Oliver's well, 4 miles north of Warsaw; new well; flow, 5 gallons per minute; temperature, 70°.

Wells on Andrew Lyon's place, 4 1-2 miles north of Warsaw; No. 1, bored in 1855 (?); water stands at -60 feet. No. 2, 40 feet lower than No. 1; flows, 10 gallons per minute; temperature, 69°.

J. P. Rogers's well, one half mile northwest of Warsaw; bored in 1847 by Peter Burns; originally gave a 1 1-2 inch stream, but was abandoned thirty years ago.

Well on Nan Stone place, 1 1-2 miles northwest of Warsaw; bored about 1845; original stream, 1 1-2 inch; present volume, one-half gallon per minute; temperature, 69°.

William Peebles's well, 2 miles northeast of Warsaw; bored in 1845 by John Horn; originally gave 2 1-2 to 3 inch stream.

Well on old Bell place, 3 miles northwest of Warsaw; water stands at -18 feet.

C. J. Brockway's well, 4 miles northwest of Warsaw; bored by Ladd in 1898; flow, 2 gallons per minute; temperature, 72°.

J. P. Rogers's well, one-fourth mile west of Warsaw, in Section 33, Township 23, Range 2, W.; bored by C. T. White, in 1901; depth, 300 feet; cased to rock with 3-inch casing; first water at 220 feet, rising 10 feet above surface; original volume, 6 gallons per minute; temperature 69°. Record; Sand, 0-26 feet; blue rock, 26-220 feet; sand and water, 220-300 feet.

F. M. Grove's well, one-half mile west of post office at Warsaw, in Section 33, Township 23, Range 2 W.; bored by C. T. White in 1901; depth, 460 feet; casing, 20 feet of 3 1-2 inch pipe; first water at 250 feet, rose to -10 feet; second water at 300 feet, rose to -10 feet; third water at 400 feet, overflowing; fourth water at 460 feet, flows; yield, 1 gallon per minute; temperature, 70°; water found beneath a thin, solidified layer.

Well of Oliver & Oliver, 8 miles west of Warsaw; small stream.

Well on Mac Roger's place, 5 miles southwest of Warsaw; old well; flows 1 1-4 gallons per minute; temperature, 69°.

J. H. Pinson's wells, 7 miles southwest of Warsaw, in Section 9; Township 22, Range 3 W.; No. 1 bored by J. W. Patterson in 1902; depth, 702 feet; casing, 250 feet of 2-inch pipe, 4-inch casing at top; supply, from the third water horizon, will rise to 40 feet above surface; flow, 2 gallons per minute; temperature, 71°. No. 2, bored about 1855; flows, one-third of a gallon per minute; temperature, 68°.

J. W. Patterson's well, 7 miles southwest of Warsaw, in Section 23, Township 22, Range 3 W.; bored by C. T. White, in 1901; depth, 700 feet; casing, 3 1-2 inch to rock; 250 feet of 2-inch pipe; first water at 460 feet, rose to -30 feet; second water at 500 feet, rose to -30 feet; third water at 700 feet, rose to 6 feet above surface; estimated flow, 1 to 2 gallons per minute.

Record of Patterson well, 7 miles southwest of Warsaw.

	Feet.
Soil	0 — 20
Blue rock	20 — 200
Hard, dry sand	200 — 300
Blue rock	300 — 460
Sand	460 — 500
Soapstone	500 — 700

Well on Taylor place, 2 miles south of Warsaw in Section 9, Township 22, Range 2 W.; bored about 1855 by John Horn; depth, 400 feet; cased below rock with iron pipe; good stream until 1902, when it was stopped by entrance of sand.

GAINESVILLE AND VICINITY.

Some distance down the river, about Gainesville, artesian wells are numerous, many of them dating back to before the civil war. In general the first water in the vicinity of Gainesville is much more salty than the second. The following are the records:

John Rogers's well, Gainesville; depth, 630 feet; principal water supply at 630 feet; water rises to 20 feet above surface; quality good; well starts in the "rotten limestone" and obtains its supply from the Eutaw formation; blue rock is reached at 27 feet from the surface and is 383 feet thick.

Old mill well, Gainesville; owned by the town; bored about 1850; depth, 600 feet; formerly overflowed, but is now pumped; yield, 1 1-2 gallons per minute; temperature, 69°.

R. H. Long's well, near Gainesville, in Section 2, Township 21, Range 2 W., bored by C. T. White in 1900; depth, 626 feet, rose to 25 feet above the surface; estimated flow, 10 gallons per minute; no decrease. Record: Gravel and sand, 0-43 feet; blue rock, 43-375 feet; sand and water, 375-475 feet; "soapstone," 475-626 feet.

John A. Rogers's well, near Gainesville in Section 7, Township 21, Range 2 W.; bored by C. T. White in 1900; depth, 630 feet; casing, 300 feet of 2-inch pipe; first water, at 375 feet, rose to -24 feet; second water, at 630 feet, rose to 20 feet above the surface; flow, 5 gallons per minute; volume constant; temperature, 73°. Record: Soil, 0-20 feet; blue rock, 20-375 feet; sand and water, 375-475 feet; "soapstone," 475-630 feet.

Mrs. Ben Moy's well, 4 miles north of Gainesville; old well; flow very weak, decreasing, in decay.

Mrs. Mooring's well, 5 miles north of Gainesville; bored by Joe Ladd (colored) in 1875 (?); flow, 1 gallon per minute; temperature, 71°; 4 inch casing to blue rock.

Well on Sallie Rogers's place, 6 miles north of Gainesville; bored by C. T. White in 1899; depth, 500 feet; casing, 30 feet of 3 inch pipe; estimated original volume 15 gallons; flow now 1 1-3 gallons per minute; temperature, 71°; first water, at 350 feet, rose just to surface; second water, at 450 feet, rose to 30 feet above the surface. Record: Soil, 0-20 feet; blue rock, 20-350 feet.

Mrs. L. A. Landford's old well, 2 miles northwest of Gainesville; flows one-eighth of a gallon per minute, at 4 feet above the surface; temperature, 69°.

L. A. Knight's well, 6 miles northwest of Gainesville; bored by Howard Horn in 1855 (?) ;flows 1 1-4 gallons per minute; considerable leakage; temperature, 69°.

Well on Marsh place, 7 1-2 miles northwest of Gainesville; old well, yielding 1 1-2 gallons per minute; temperature, 70°.

Long & Patterson wells, in Section 4, Township 21, Range 2 W.: No. 1, 1 1-2 miles west of Gainesville; bored by C. T. White in 1900; water stands at -1 foot; depth, 700 feet; casing, 250 feet of 2-inch pipe; temperature, 69°; first water, at 475 feet, rose to -40 feet; second water, at 700 feet, rose to -15 feet. Record: Blue rock, 0-475 feet; sand and water, 475-515 feet; successive strata of blue rock and clay, 515-700 feet. No. 2, 1 3-4 miles west of Gainesville; bored by C. T. White in 1900; depth, 700 feet; casing, 250 feet of 2-inch pipe; estimated to be 12 feet lower than No. 1; original flow, about 6 gallons per minute; present flow, 2 gallons per minute; temperature, 74°. No. 3, 1 1-2 miles west of Gainesville; bored by J. W. Patterson in 1902; depth, 676 feet; water rising to 30 feet above the surface at 676 feet; flow, stopped by accident; water now stands at -15 feet.

Well of William Wier (colored), 4 miles southwest of Gainesville; bored by C. T. White in 1900; depth, 700 feet; casing, 200 feet of 2-inch pipe; first water, at 500 feet, rose to -5 feet; second water, at 700 feet, rose to 20 feet above the surface (?); original volume estimated at 15 gallons per minute; present volume, 1 gallon per minute; temperature, 71°. Record: Soil, 0-20 feet; blue rock, 20-500 feet; sand and water, 500-550 feet; soapstone, 550-700 feet.

Sam T. Jones's wells: No. 1, on Wyndham place, 3 1-2 miles south of Gainesville; flows, one-quarter of a gallon per minute, formerly much stronger; temperature, 71°. No. 2, 2 1-2 miles south of Gainesville; bored by C. T. White in 1901; depth, 700 feet; original flow, 12 gallons per minute; present flow, about one-half gallon per minute; temperature, 70°; first water, at 400 feet, rose to -20 feet; second water, at 475 feet, rose to -20 feet; third water, at 700 feet, rose to 17 feet above the surface. Record: Soil, 0-20 feet; blue rock, 200-400 feet; sand, 400-450 fet; clay, 450-475 feet; sand and water, 475-700 feet. No. 3, one-half mile south of Gainesville; bored by J. Ladd to 360 feet, and finished to 700 feet by C. T. White in 1901; water formerly flowed, but now stands at -1 foot; casing 20 feet of 5-inch pipe; a flow of water, rising to -20 feet, was encountered at 432 feet. Record from 360 feet: Sand and water, 360-400 feet; successive strata of sand and soapstone, 400-700 feet.

T. L. Smith's well, 2 miles south of Gainesville; bored by C. T. White in 1901; depth, 735 feet, casing, 320 feet of 3 1-2 and 2-inch pipe; original flow, 1 or 2 gallons per minute. Record: Soil, 0-20 feet; blue rock, 20-400; penetrated four strata of sand.

Well of Tom Minneice (colored), 3 1-2 miles south of Gainesville in Section 18, Township 21, Range 1 W.; bored by C. T. White in 1900; depth, 600 feet; casing 300 feet; original volume (estimated), 25 gallons per minute; present volume, 12 gallons per minute; first water at 300 feet, rose to 10 feet above the surface; second water, at 600 feet, rose to 25 feet above the surface; temperature, 71°. Record: Soil (clay), 0-34 feet; blue rock, 34-276 feet; sand and water; 276-600 feet.

R. H. Long's well, 2 1-2 miles southeast of Gainesville, in Section 13, Township 21, Range 2 W.; bored by C. T. White in 1900; depth, 600 feet; casing 250 feet of 2-inch pipe; first water at 350 feet, rose to -20 feet; second water, at 600 feet, rose to 20 feet above the surface; original flow, 15 gallons per minute; present flow, 3 gallons per minute; temperature, 72°. Record: Soil, 0-20 feet; blue rock, 20-350 feet; sand, 350-400 feet; soapstone, 400-600 feet.

Well on Senator Morgan place, 4 miles southeast of Gainesville, in Section 18, Township 21, Range 1 W.; deepened from 350 to 550 feet by C. T. White; flow, 3 3-4 gallons per minute at 4 feet above the surface; no decrease since well was deepened; temperature, 71°.

J. A. Rogers's old wells on Swilley place: No. 1, 5 miles southeast of Gainesville, in Section 20, Township 21, Range 1 W.; water formerly flowed, but now stands at -8 feet. No. 2, 6 1-2 miles southeast of Gainesville, in Section 22, Township 21, Range 1, W.; flow, 7 gallons per minute at 3 feet above the surface; temperature, 69°.

EPES AND VICINITY.

Well of Epes Cotton Oil Company, at Epes, on the right bank of the Tombigbee, on Jones Bluff, the site of old Fort Constitution; bored in 1899 by J. I. Hawk. The altitude of Epes is 125 feet and it stands on the white chalk rock. Depth of well, 737 feet; record as follows:

Record of Epes well.

	Feet.	in.
Blue rock	442	0
Reddish muddy substance	65	0
Greenish sand, with water	103	0
Stone	0	8
Rusty, hard pan	70	
Stone	0	3
White sand	42	0

At first a small stream ran out at the surface; on lowering the boring, a rather better stream was obtained, but it is still weak, less than a gallon a minute; surface about the well has been lowered in order to get better overflow. An analysis of this water was furnished by Mr. W. B. Harkness,* who also furnished the record of the well:

Partial analysis of water from Epes well.

	Parts per million.
Total solids in solution	3605.25
Volatile and organic	60.24
Chlorine (Cl)	1927.13
Iron and alumina (Fe_2O_3, Al_2O_3)	3.94
Silica (SiO_2)	11.81
Magnesium (Mg)	14.95
Calcium (Ca)	45.17
Sulphuric acid ,SO_4)	Trace
Sodium (Na), present in large amount but not determined	
Carbonic acid, present but not determined.	
Potassium (K)	Trace

Mrs. A. M. Tart's well, 3 miles southeast of Epes; bored by Murray about 1852; depth, 930 feet; cased 400 feet; flowing water between 800 and 900 feet; yield, 28 gallons per minute; temperature, 79°.

W. A. C. Jones' well, 1 1-4 miles southwest of Mrs. Tart's well above mentioned, but about 150 feet higher on a hard limestone ridge. Bored by E. L. Machamer, 1906. Depth, about 1,000 feet. Water rises to within 100 feet of surface, pumped by windmill. Casing at bottom 150 feet 2-inch pipe, and on this 160 feet of 2 1-2 inch pipe.

*Expressed by analyst in grains per gallon; recomputed to parts per million at U. S. Geological Survey.

Record of W. A. C. Jones' well.

	Feet.
Brownish soft top soil	0 to 20
Blue rotten lime rock	20 — 72
White soft lime rock	72 — 495
Tough white rock	495 — 571
Blue lime rock	571 — 767
Hard white sand rock	767 — 773
Greensand with water	773 — 778
Fine sand rock with thin layers of hard rock and water which rose to within 128 feet of top	778 — 834
Very hard blue flint rock	834 — 836
Greenish sand with water	836 — 870
Soft, dark and muddy earth alternating with beds of hard rock and sand, water bearing	870 — 992

T. V. White's well, 3 1-2 miles northwest of Epes, in Section 11, Township 20, Range 2 W.; bored by C. T. White in 1901; depth, 700 feet; original flow, 3 gallons per minute; temperature, 72°; first water at 500 feet; rose to -3 feet; second water, at 550 feet, rose to -15 feet; third water, at 700 feet; flows; casing, 320 feet. Record: Blue rock, 0-500 feet; sand with water, 500-540 feet; clay, 540-550 feet; sand with water, 550-570 feet; pink soapstone, 570-700 feet.

Louis Brown's well, 5 miles northwest of Epes, in Section 9, Township 20, Range 2 W.; bored by C. T. White in 1901; depth, 735 feet; water level, -15 feet; first water, at 600 feet, rose to -40 feet; second water, at 650 feet, rose to -40 feet; third water, at 735 feet, rose to -15 feet; temperature 72°. Blue rock, 600 feet thick; otherwise, record is similar to that of T. V. White's well.

SUMTERVILLE AND VICINITY.

The elevation of the ridge on which Sumterville stands is too great for flowing water, but by artesian borings water could certainly be obtained sufficiently near the surface to be raised by pumps. At present the water supply is obtained from cisterns. At the base of the ridge, with proper selection of locality, flowing water might be obtained, but the boring would be deep, as is shown by the records at Epes and Livingston.

LIVINGSTON AND VICINITY.

On the upper strata of the chalk formation and the overlying Ripley stands Livingston, the county seat of Sumter County. Here a well has been bored which exhibits the full thickness of the chalk. The record is as follows: Soil and surface sands, 20 feet; Selma chalk, or blue rock, 930 feet; Eutaw sands to bottom of well (1062 feet), 112 feet. The first water was reached immediately below the blue rock, at 966 feet, affording a small stream which rose to the surface; at 1005 feet a larger stream was obtained in coarse green sand, and deeper drilling discovered no other water. The flow is quite feeble, the water barely reaching the surface, which has been lowered about the mouth of the well for convenience in collecting the water.

Analysis of water from well at Livingston.

*Analyst, Dr. R. E. Webb.**

	Parts per million.
Sodium (Na)	1996.65
Magnesium (Mg)	14.65
Calcium (Ca)	48.58
Iron (Fe)	2.19
Chlorine (Cl)	3123.18
Bromine (Br)	13.16
Carbonic acid (HCO_3)	127.45
Strontium (Sr)	Trace
Silica (SiO_2)	19.50
	5335.36

	Cc. per liter.
Free carbonic acid in solution	92.97
Carbonic acid in combination	40.36
Total carbonic acid	133.33

A considerable quantity of inflammable gas comes with the water. This water is considered beneficial to the health.

*Expressed by analyst in grains per gallon, and hypothetical combinations; recomputed to ionic form and parts per million at U. S. Geological Survey.

Allison Lumber Company's well, about 11 miles south of Livingston, and 3 miles south of Bellamy station, on the Southern Railway, in Section 13, Township 17, Range 2 W.; bored in 1903; depth, 1010 feet. Record: Soil and clay, 0-20 feet; black clay (Sucarnochee or Flatwoods clay), 20-160 feet; white lime rock, 160-1000 feet; below this quicksand and water which overflows and yields about 3 gallons per minute. From the record it will be seen that the mouth of the well is on the Flatwoods clay (Tertiary), and that the boring, like that at Livingston, passes through the whole chalk formation into the Eutaw sand. The water from this well has been analyzed by Mr. Hodges, and has the following composition:

Analysis of water from Allison Lumber Company's well, near Bellamy.

	Parts per million.
Potassium (K)	13.2
Sodium (Na)	540.2
Magnesium (Mg)	43.1
Calcium (Ca)	139.6
Iron and alumina (Fe_2O_3, Al_2O_3)	5.2
Chlorine (Cl)	4538.0
Sulphuric acid (SO_4)	.3
Carbonic acid (HCO_3)	784.5
Silica (SiO_2)	50.8
	8573.7

Another well was bored by the same company at their logging camp, 3 miles farther south. The record was about the same as that given above, except that both the black clay and the lime rock were thicker, the total depth of the well being 1240 feet. The water rises to within 5 feet of the surface; on lowering the surface below that depth a small flow, less than half a gallon per minute, is obtained. It was thought that there was some leakage at the contact of the black clay with the lime rock at about 200 feet depth, since the water rose with great force to that height. Both wells are cased for 40 feet, with an 8-inch hole below the casing. The water in the well at the logging camp is not so salty nor so highly impregnated with other minerals as that in the other well.

Sumter Lumber Company's wells: No. 1, 4 miles southwest of Livingston, in the Flatwoods; bored by F. H. Braswell; depth, 1260 feet; no details. No. 2, 5 miles west of Livingston, also in the Flatwoods; said to be the only well drilled in Sumter County west of Livingston; bored by F. H. Braswell in 1902; never finishedl

GREENE COUNTY.

Surface Features.

The Tuscaloosa formation underlies a small area, about one township in extent, in the northeast corner of Greene County; the rest of the county is underlain by beds of the Eutaw and Selma chalk in belts of nearly equal width from northeast to southwest. Over all the older rocks was spread the Lafayette mantle of pebbles and red loam, remnants of which are still to be seen in the high plateaus between the watercourses, where the country has been least affected by erosion. These high, level lands, 400 to 500 feet above tide, are excellent farming tracts. The soils are slightly less fertile than those of the prairies, but their level surface, their responsiveness to fertilizers, and the abundant supply of the best freestone water, stored up in the pebbles and sands and easily reached by wells less than 100 feet deep or appearing as hillside springs, more than compensate for the slight difference in original fertility. In the prairies these remnants of the Lafayette mantle are not so common as in other sections, but here and there they form conspicuous features of the landscape, as for instance in the "Fork" between Black Warrior and Tombigbee rivers, where they appear as isolated conical hills upon which many oldtime mansions are located. The smaller hills of this sort strongly resemble Indian mounds, and several of them may be seen from Burton Hill From the contact of the limestone with the overlying Lafayette sands and pebble beds, fine springs of freestone water gush out wherever the area of the hill is large enough to afford an adequate collecting ground. The settlement of Burton Hill is supplied in this way.

The Lafayette is also very generally found on the third terrace of the two rivers at an altitude of from 80 to 100 feet above the "second bottom," or lowlands. Here also, as on the high plateaus, these materials are found in flat lands which are upward of 3 miles wide. The writer has been unable to discover any difference in structure and arrangement between the red loam and pebbles of this formation occurring on the high divides and those on the river terraces 200 feet below.

From Knoxville to Eutaw the strata of the Eutaw formation are crossed in succession from base to top. The lower beds are yellow and reddish cross-bedded sands, with thin streaks and flakes of gray clay separating the sand layers. Above these, dark-gray laminated clays alternating with yellowish sands become more prominent, and near Eutaw, forming the uppermost strata of the formation are cross-bedded greensands. From the character of these materials it will be easily understood that the topography of the Eutaw terranes is very much broken, with steep rounded hills and deep gullies. The soils resulting from the decomposition of the Eutaw beds are usually sandy, but there is generally a mixture of lime with the sand by which they are easily distinguishable from the sandy soils of the Lafayette even when the two, as is often the case, are found in juxtaposition.

At the town of Eutaw begin the beds of "rotten limestone" or Selma chalk, which underlie all the rest of the county westward to Tombigbee River.

In the Tuscaloosa and Eutaw territory the sandy beds of these formations, as well as of the overlying Lafayette, are, as usual, a guarantee of an adequate supply of good freestone water, and in this part of the county, artesian wells are not very numerous. Of the wells in the list furnished by Judge G. B. Mobley, of Eutaw (see below), only those around Clinton, at Lock 5 (now Lock 8) at Springfield, in north Eutaw, and about Finch's Ferry, are located in the territory of the Eutaw formation. To these, however, may be added the wells in the city of Eutaw itself, which is situated at the contact of the Eutaw with the "rotten limestone," all these wells except those at the lock in the river bottom, are close to the line of contact.

From the data given below it will be seen that only a few borings, in the extreme northeast corner of the county, are in the area of the Tuscaloosa formation. These and most of those just enumerated, including the deeper borings in the city of Eutaw, penetrate into the Tuscaloosa strata. With these few exceptions the wells of Greene County derive their waters from the Eutaw sands.

Artesian Records.

In the region occupied by the "rotten limestone," or Selma chalk the usual absence of shallow waters may be noted, and a correspondingly large number of artesian wells. The great majority of these wells are located in the northeastern half of the belt of limestone, within 10 or 12 miles of the line of junction with the Eutaw, probably because the depth to water there averages perhaps not more than 500 to 600 feet. In the southwestern half of the limestone belt the depth to water increases to 1000 feet and more, as shown in the Livingston well across the Tombigbee in Sumter County.

JUDGE MOBLEY'S LIST.

Other details concerning these old wells, collected by JudgeG. B. Mobley, are given in tabular form below:

Wells in Greene County.

Township.	Range.	Section.	Part of Sec.	Plantation as shown on Snedecor's map of Greene County (1856.)	Present owner or estate.	Remarks.
19	3 E.	5	NW¼ SW¼	J. C. Pickens	M. Bailey's heirs	Strong freestone.
19	2 E.	12	Fraction	Sorsby place		Near river.
19	2 E.	14	NW¼	M. R. Brassfield place	D. S. Brassfield heirs	At landing, near river, strong
19	2 E.	24	NE¼	J. G. Rowe estate		Near road.
19	2 E.	25	Near center	J. C. Cole estate	Cole heirs	On road.
20	3 E.	21		Buchemans Island		
20	3 E.	31	SE¼ NE¼	Jacob Holbrook	C. E. Latimer	
20	3 E.	30	SE¼ NE¼	I. C. Snedecor	Blackman place	Strong.
20	3 E.	32	NE¼ NE½	Lovit Hines estate	Hines heirs	
20	2 E.	1	NW¼ NE¼	M. Fowler	Dollarhide Company	On McAlpine's ferry road.
20	2 E.	1	NW¼NW¼	J. A. Watson	M. H. Murphy	Very bold stream.
20	2 E.	3	Near center	S McAlpine	T. W. Roberts	New well in same section.
20	2 E.	4	NW¼ nr cntr.	James Willis	William Scears	
20	2 E.	5	NW¼	J. R. Blocker	Julia W. Byrd	
20	2 E.	5	NW¼ SE¼	James A. Watson	T. W. Roberts	Depth, 400 ft.; v'ry c'ld; salty.
20	2 E.	9	NW¼	James A. Watson	Bernard Harwood	
20	2 E.	16	NW¼ NE¼	D. C. Williams	John Gray	
20	2 E.	21	E½ SW¼	J. R. Blocker	E. T. O'Connor	
20	2 E.	27	SE¼	J. R. Blocker	E. T. O'Connor	

20	2	E.	27	W½ SW¼	J. L. Walton	Mrs. J. L. Webb	
20	2	E.	28	SW¼	J. L. Walton	Mrs. J. L. Webb	
20	2	E.	32		W. A. Glover	W. N. Glover	
20	2	E.	33	NE¼ NE¼	J. R. Blocker	John Blocker	
20	1	E.	4	NW¼ NW¼	George Hays	M. T. Sumner	
20	1	E.	8	SE¼	I. B. Smaw	William Smaw	
20	1	E.	17	NW¼	I. B. Smaw	William Smaw	
20	1	E.	25	SW¼	J. I. Thornton	H. I. Thornton estate	New well.
20	1	E.	36	NE¼	J. I. Thornton	Syd Moore	Not flowing.
20	1	E.	36	NW¼	James I. Thornton	Syd Moore	Strong, new.
21	3	E.	7	NE¼	J. T. Creswell	B. Harwood, et al.	Eutaw landing, strong.
21	2	E.	2	NW¼ NW¼	J. T. Creswell	Roberta McQueen	Near road.
21	2	E.	3	NE¼ NE¼	J. T. Creswell	D. Kyle's heirs	
21	2	E.	3	NE¼ NW¼	J. T. Creswell	D. Kyle's heirs	Stopped up.
21	2	E.	3	SE¼	J. B. Clark	H. M. Clark	
21	2	E.	4	NE¼ SE¼	Asa White	T. W. Roberts	
21	2	E.	4	W½ NW¼	D. B. Meacham	Wm. Scears	Not flowing.
21	2	E.	7	NW¼ NW¼	J. F. Cross	J. J. Dew	
21	2	E.	8	NE¼	J M. Jones	J. W. Jones estate	Sulphur well.
21	2	E.	11	SE¼	W. Pettigrew	J. G. Harris	
21	2	E.	14	NE¼ SW¼	Jos. Pickens	J. G. Harris, agent	Two wells.
21	2	E.	15	NE¼	V. M. Randloph	J. G. Harris, agent	
21	2	E.	17	NW¼	J. J. Winston	J. W. Jones's heirs	
21	2	E.	18	NE¼	J. J. Winston	J. W. Jones's heirs	
21	2	E.	20	SE¼	P. Lightfoot	G. H. Dunlap	
21	2	E.	21	SW¼ NW¼	A. Clement	National Bank	On road.
21	2	E.	22	W½ NE¼	J. T. Creswell	A. W. Howard	Near Choctaw Bluff.
21	2	E.	24	NE¼ NE¼	Jos. Pickens		Lock 4 (7).
21	2	E.	27	SE¼, fraction	William McAlpine	T. W. Roberts	West of river, Steph'ns Bluff.
21	2	E.	28	W½ NW¼	A. Clement	J. P. Harry	
21	2	E.	29	SW¼	Phil. Lightfoot	G. H. Dunlap	Three wells.
21	2	E.	29		Phil. Lightfoot	G. H. Dunlap	Windmill.
21	2	E.	30	NW¼	Phil. Lightfoot	G. H. Dunlap	
21	2	E.	33	E½ NE¼	James Wills	T. W. Roberts	Old well; new well in SE¼.

JUDGE MOBLEY'S LIST—*Continued.*

Township.	Range.	Section.	Part of Sec.	Plantation as shown on Snedecor's map of Greene County (1856.)	Present owner or estate.	Remarks.
21	2 E.	33	NW¼	J. W. Hall	J. W. Clement	
21	1 E.	1	NE¼	J. R. Dunlap	Burt Dunlap	
21	1 E.	1	E½ NE¼	S. P. Steele	A. W. Howard	Not flowing.
21	1 E.	1	W½ NW¼	C. D. Graham	Graham place	
21	1 E.	2	E½ NE¼	C. D. Graham	Graham place	Strong.
21	1 E.	3	SE¼ SE¼	T. S. Cook	Mary Alexander	
21	1 E.	4	NW¼	J. C. Bizzell	Mary Bizzell's heirs	
21	1 E.	6	SE¼	J. T. Brown	W. T. Brown's heirs	About 28 wells in 1 acre.
21	1 E.	7	NW¼	A. S. Steele	J. F. Cross	
21	1 E.	8	SE¼ SE¼	Hayes-Hairston	M. T. Sumner	
21	1 E.	9	NE¼	Barney Cox	Syd Moore	
21	1 E.	11	SE¼	L. M. Minor	J. J. Dew	
21	1 E.	12	NE¼	C. D. Graham	E. C. Selden	Three wells.
21	1 E.	12	NW¼	C. D. Graham	E. C. Selden	
21	1 E.	14	SE¼	George Hayes	J. J. Dew	Willow pond well.
21	1 E.	14	NE¼	B. Cox	Syd Moore	
21	1 E.	15	W½ NE¼	Tobias Cook	Charles Cook	
21	1 E.	22		Hayesville Land Company		Hairston; 2 wells; no flows.
21	1 E.	18	SW¼ SW¼	S. R. Cook	Lizzie Dunlap	Three wells.
21	1 E.	30	W½ NE¼	George Hayes estate	W. F. Thetford	Not flowing.
21	1 E.	33	NW¼ NE¼	George Hayes estate	Mrs. R. Hatter	
21	1 W.	1	NE¼	T. T. Chiles		

21	1 W.	2	E½ NW¼	H. T. Croft	J. J. Dew	
21	1 W.	3	W½ SW¼	A. Jolly	Jolly heirs	
21	1 W.	4		A. Jolly	Jolly heirs	
21	1 W.	5	SW¼	N. Goree		
21	1 W.	11	SE¼	W. R. Hatter	J. R. Taylor	
21	1 W.	12	NW¼ NE¼	A. S. Steele	J. F. Cross	
21	1 W.	12	SE¼	Mary Bizzell	Mary Bizzell's heirs	
21	1 W.	14	NW¼ NW¼	Trussell's Ferry		
22	3 E.	10		Zac McGehee	Samuel Spencer	Lock 5 (8).
22	3 E.	31	SW¼ NW¼	J. C. Johnson	M. L. Kirksey	Just below Finch's ferry.
22	2 E.	14	SE¼	Springfield	Mollie Smith	
22	2 E.	27	E½ SW¼	Jordan well	William Scears	
22	2 E.	30	NE¼ NW¼	D. P. Bestor	J. O. Banks	Two wells.
22	2 E.	31	SW¼	E. R. Steele	Jos. Cramer	
22	2 E.	36	SE¼ NE¼	J. C. Johnson	M. L. Kirksey	Finch's ferry.
22	2 E.	36	NE¼ NE¼	J. C. Johnson	M. L. Kirksey	Dump well.
22	1 E.	3	W½ W½	Town of Clinton		About 28 wells.
22	1 E.	4	E½ E½	Town of Clinton		
22	1 E.	6	SW¼	McAfee & Gregory	Samuel Norwood	
22	1 E.	7	W½ NE¼	Eph J. Butler	Dew estate	Two wells.
22	1 E.	11	SW¼	J. P. & W. H. Pippin	A. M. Pippin estate	
22	1 E.	14	N½	J. P. & W. H. Pippin	A. M. Pippin estate	Two wells.
22	1 E.	15	E½ E½	Abner McMillan	A. McMillan's heirs	Two wells.
22	1 E.		line bet. 7 & 18	Eph. J. Butler	Dew estate	Several wells.
22	1 E.	20	NW¼ NW¼	Willis Crenshaw	Brown & Hagaman	
22	1 E.	22	Center	Theo. Thomas	H. B. Thomas	
22	1 E.	26	SW¼	Wiley Coleman	J. O. Banks	
22	1 E.	27	N½ SE¼	N. P. Pippin	Clarence Pippin	
22	1 E.	28	SE¼ SE¼	Rebecca Hall	J. F. Cross	
22	1 E.	29	E½ NE¼	Solomon Hitt	Mrs. Brinley	
22	1 E.	30	E½ SW¼	T. T. Chiles	Brown & Hagaman	
22	1 E.	33	N½	Barney Cox	G. Braune estate	
22	1 E.	32	SE¼ SE¼	J. C. Bizzell	Bizzell heirs	
22	1 E.	36	SE¼ SW¼	S. P. Steele	Alice McDowell	

JUDGE MOBLEY'S LIST—*Continued.*

Township.	Range.	Section.	Part of Sec.	Plantation as shown on Snedecor's map of Greene County (1856.)	Present owner or estate.	Remarks.
22	1 W.	4	SW¼	John Swilley		
22	1 W.	6	W½ NE¼	Robert Craig	S. W. John	
22	1 W.	8	NW¼ SW¼	Anne Smith	John Rogers	
22	1 W.	9	W½ NW¼	M. Campbell	John Rogers	
22	1 W.	10	NW¼ NW¼	Nat Cameron	M. Cameron	
22	1 W.	10	NW¼ SW¼	William Cameron	Wm. Cameron's heirs	
22	1 W.	12	NE¼ SE¼	William Rainey	John Leavell	
22	1 W.	12	SE¼	Mary Rainey	John Leavell	
22	1 W.	13	SE¼ NE¼	P. P. Parham		
22	1 W.	15	W½ NE¼	M. H. Pearson	A. Jolly's heirs	
22	1 W.	17	SE¼ SW¼	W. R. T. Smith		
22	1 W.	17	W½ NW¼	A. Norwood	H. Montgomery	
22	1 W.	17	E½ SW¼	A. Norwood	Powers place	
22	1 W.	19	NW¼ NE¼	D. R. Wright		
22	1 W.	27	NE¼	Simeon Maxwell	D. Dew estate	
22	1 W.	28	SE¼	Josiah Collins	N. Cameron	
22	1 W.	28	SW¼ SW¼	E. Rogers		
22	1 W.	31	NW¼ SE¼	J. M. Hitt	D. H. Williams	
22	1 W.	32	NE¼ NE¼	I. F. Pearson		
22	1 W.	33	W½ SW¼	A. Jolly	A. Jolly's heirs	
22	1 W.	33	W½ NW¼	Rogers		
22	1 W.	36		James Crawford	A. W. Gray	

22	2 W.	25	Fraction	John C. Whitsett		
22	2 W.	25	SE fraction	John C. Whitsett		Smith's Ferry.
23	1 W.	7	SW¼	H. G. Jones	T. K. Jones	
23	1 W.	8	SW¼	H. G. Jones	T. K. Jones	
23	1 W.	10	SE¼ SE¼	L. Williams	L. Williams	700 feet; does not flow.
23	1 W.	16	SW¼	Henry Jones	T. K. Jones	
23	1 W.	18	Center	G. W. Hill	J. W. Cook	
23	1 W.	18	NE¼ NE¼	G. W. Hill	Z. McGowan heirs	
23	1 W.	20	NE¼	T. deGraffenreid	D. Norwood	
23	1 W.	23	NW¼	J. B. Thompson	J. B. Thompson's heirs	
23	1 W.	26	SW¼	F. M. Childers	R. Abram	
23	1 W.	29	SE¼	J. F. deGraffenreid	M. A. Hales	
23	1 W.	29	SW¼	Simeon Carpenter	J. W. Cook	
23	1 W.	30	E½ SW¼	P. Coleman	J. Lockart estate	
23	1 W.	31	E½ NE¼	John Strait	S. W. Strait	
23	1 W.	32	SW¼	Simeon Carpenter	W. H. Sanders	
23	1 W.	33	SE¼ NE¼	J. D. Duncan	A. M. Duncan	
23	1 W.	34	SW¼ NW¼	J. W. D. Thomas	A. M. Duncan	
23	1 W.	34	SE¼	A. Norwood Mill	John Leavell	
23	1 W.	32	SW¼	Carpenter place	William Hales	
23	2 W.	2	NW¼ fraction	W. P. Posey		Mouth of Sipsey River.
23	2 W.	1	W½ SE¼	I. Rutledge	A. Horton	
23	2 W.	11	NE¼	G. W. Hill	J. W. Cook	
23	2 W.	12	SE¼	H. G. Jones (12)	T. K. Jones	

The following records may be given of wells not included in the above list and of some in the list of which further details are available. They are named in order from north to south.

SIPSEY.

Well on Mose Horton's place, opposite Sipsey Mill well in Pickens County; depth, not recorded; water flows at 4 feet above the surface; yield, 15 gallons per minute; temperature, 65°.

(LOCK 6 NOW LOCK 9) BLACK WARRIOR RIVER.

A. P. Patton's well; bored by Kinniard in 1891; depth reported, 300 feet; casing, 3-inch; original flow, 20 gallons per minute; volume later fell off to a little over a gallon per minute; temperature, 63°.

STEELE BLUFF.

Well of Judge A. P. Smith, of Eutaw; bored by Morrison & Morrison in 1902; depth, 400 feet; casing, 3-inch; flows at 25 feet above the surface; volume constant; cased to 360 feet; weak flow of water from 330 feet; yield, 22 gallons per minute; temperature, 69°. Record: Clay, sand, 0-30 feet; pink soapstone, 30-250 feet; sand and water, 250-400 feet.

Well of Jeff Patton, of Knoxville, on Tombigbee River, one-half mile above Steeles Bluff, in the SW. 1-4, Section 12, Township 23, Range 3 E.; bored by Kinniard & Sample in 1901; depth, 360 feet; casing, 3-inch; first flowing water at 200 feet; flowed originally 50 gallons per minute, but had ceased before November, 1901. Record: Sand and gravel, 0-130 feet; soapstone, 130-170 feet; blue rock, 170-200 feet; sand and blue rock with water, 200-260 feet. This well has since caved in and is lost.

CLINTON AND VICINITY.*

About the town of Clinton there are 28 wells, varying in depth from 250 to 350 feet. Most of the streams are bold and constant, the waters being very pure, with traces of salt and soda. Three of these wells are used to supply the boilers of the steam ginneries and grist mills, but the others are used solely for ordinary domestic purposes.

EUTAW AND VICINITY AND SOUTHWARD.

The water of most of the wells about Eutaw is rather strongly impregnated with salt. Some of the old wells at Finch's Ferry, mnetioned in Judge Mobley's list (p. 146), were used for making salt during the civil war.

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*See also Mobley list, page 146.

The following analyses by Mr. Hodges will still better illustrate the character of these waters.

Analyses of waters from wells near Eutaw.

	Parts per million.			
	No. 1	No. 2	No. 3	No. 4
Potassium (K)	5.2	9.8	7.6	23.4
Sodium (Na)	221.8	193.0	430.0	1750.0
Magnesium (Mg)	.5	5.3	3.0	29.6
Calcium (Ca)	7.0	24.7	14.0	175.6
Iron & alumina (Fe_2O_3, Al_2O_3)	2.1	1.9	2.7	5.7
Chlorine (Cl)	232.7	220.7	515.0	2986.1
Sulphuric acid (SO_4)	.6	.9	1.2	3.2
Carbonic acid (HCO_3)	217.6	246.7	319.7	173.7
Silica (SiO_2)	11.2	7.2	8.6	8.7
	698.7	710.2	1301.8	5156.0

No. 1.* From Crassdale plantation of J. O. Banks, Jr., near Eutaw, N. W. quarter N. W. quarter Section 30, Township 22, Range 2 E. Bored in 1854. See Pl. XV. A.

No. 2.* From Little Egypt well, Crassdale Plantation of J. O. Banks, Jr., N. W. quarter N. W. quarter of Section 25, Township 22, Range 1 E. Bored by Ladd in 1899.

No. 3. From city waterworks, Eutaw.

No. 4.* From dump well, on Alabama Great Southern Railroad, between Eutaw and Finch's Ferry.

A record of the boring for the well at the court-house in Eutaw, in 1853, taken from Professor Winchell's article,* is as follows:

Record of Court House well, Eutaw.

John W. Elliott, Superintendent of Work.

	Feet.
Soil and red clay	15
Sand and soft, light-colored, mottled clay	45
White sand and water	3
Blue shale and yellowish clay, alternating	200
Yellowish clay, inclining to red	100

*Winchell, Dr. A., Proc. Am. Assoc. Adv. Sci., Vol. 10, 1856, p. 95.

*See also Mobley list, page 146.

Red, caving soil, crumbling like rotten brick	100
Sand (water), brown, white, and greenish	20
Red and yellowish clay	100
Dark-brown sand	50
Coarse reddish sand with gravel and scales of mica	80
Reddish "soapstone" like a bed of clay	
	743

This record might be interpreted as follows: Soil and surface materials, 15 feet; Eutaw beds, 378 feet; Tuscaloosa beds, 350 feet. In this well water, rising within a few feet of the surface, was found at less than 100 feet.

The last well sunk in the public square at Eutaw penetrated the red Tuscaloosa clays at the depth of 445 feet, the thickness of the clay being 40 feet. Below this, at about 480 feet, came a quicksand, 36 feet thick, down to the next indurated bed below. As soon as the quicksand was struck the water overflowed for an hour, but sank when the sand was agitated, to its present stand of -16 feet.

Well at Alabama Great Southern Railroad depot; altitude, 185 feet; drilled in 1886; depth, 400 feet; water salty; overflowed at first, but has ceased to do so. This well, starting in the Eutaw, penetrates the purple clays of the Tuscaloosa at the depth of about 400 feet.

McClure Lumber Company's well, near the dump well No. 4 in table above, p. ——, in the W. half N. E. quarter Section 36, Township 22, Range 2 E; now (July, 1905) boring.

Mr. J. G. Harris's well, in the N. E. quarter Section 4, Township 21, Range 2 E., south of the depot in Eutaw; depth, 80 feet.

Judge T. W. Roberts's well,* 1 mile south of Eutaw, in the N. E. quarter S. E. quarter Section 4, Township 21, Range 2E; diameter at bottom, 1 1-2 inches; depth, 239 feet; first water reported at 52 1-2 feet; water supply at bottom; flows at surface; carries some salt; starts in Selma chalk and probably gets water in the Eutaw sands. Record: Clay and sand to lime rock, 11 feet; rotten lime rock (water at bottom), 39 feet; blue lime rock, 150 feet; sand, 10 feet; dark soapstone, 16 feet; sand, 3 feet; soapstone, 6 feet; hard rock, 2 feet; sand to water, 2 feet.

Well on Clarke place (owned by Ed. and Henry Kinney) in the N. W. quarter N. E. quarter Section 9, Township 21, Range 2, 1 1-2 miles south of Eutaw, 500 yards from well of Judge T. W. Roberts; bored by Gus. Sample in May, 1905; depth, 520 feet; 3-inch casing; flows small stream; pump used; blue marl encountered at 16 feet, continuing for 500 feet.

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*See also Mobley list, page 146.

Well on Crenshaw place, formerly F. L. Constantine's, in the S. E. quarter S. E. quarter Section 9, Township 21, Range 2 E., about 2 miles south of Eutaw; bored for Eugene Anderson in May, 1905, by Gus. Sample; depth, 140 feet; 2 1-2-inch casing; first water, at 35 feet, rose to surface; overflowing water at 60 feet and bold (2 1-2-inch) stream at 105 feet.

Well on J. W. Hall place, owned by Marion James (colored), in Section 15, Township 21, Range 2 E., about 3 miles south of Eutaw; bored in 1904; depth, 300 feet; 3-inch casing; flows a fine stream.

Wells on Clements place,* about 4 1-2 miles south of Eutaw, in the N. W. quarter Section 21, Township 21, Range 2 E. (old wells): No. 1, on Eutaw and Forkland road; yield, 2 gallons per minute; temperature, 71°, water salty. No. 2, one-half mile east of road; deptn, 200 feet; twenty-five years ago gave a strong stream, but has gradually weakened; present overflow 9 feet lower than formerly; yield, 1 2-3 gallons per minute; temperature, 71°; water salty. No. 3, 100 yards from house; flow exceedingly small.

Wells on Judge T. W. Coleman's place (formerly Jos. W. Hall's): No. 1, in the S. W. quarter N. W. quarter Section 33, Township 21, Range 2 E., 6 miles south of Eutaw; bored in the fall of 1904 by Gus. Sample; depth, 485 feet; flows 1 1-2-inch stream. No. 2, in the W. 1-2 N. E. quarter same section; completed in June, 1905.

Judge T. W. Robert's well, in the S. E. quarter section 33, Township 21, Range 2 E., about 6 miles south of Eutaw; bored in the spring of 1905 by Gus. Sample; depth, about 450 feet; flows a strong stream. An old well with a very weak flow, on the same place is mentioned above in the Mobley list (p. 146.)

Well of Dollarhide Company, in the W. half N. W. quarter Section 2, Township 20, Range 2, E., on top of hill half a mile west of the old well in section 1 (see Mobley list), which is in the swamp; bored in November 1904, by Gus. Sample; depth, about 500 feet. This well is about 75 feet higher than the old well, but flows a stronger stream.

Judge T. W. Roberts's well,† 7 miles south of Eutaw, in Section 3, Township 20, Range 2 E.; bored by Kinniard & Sample in 1901; depth, 405 feet; casing, 4 1-2-inch; water at 300 feet, salty; yield, 10 gallons per minute at surface; temperature, 70°. An old well near by this.

Wells on Swilley place, 9 miles south of Eutaw, owned by E. W. Degrauenreid, of Greensboro: No. 1, at the house, in the S. E. quarter N. W. quarter Section 7, Township 20, Range 2 E.; bored by Morrison in 1898; depth, 495 feet; casing, 3-inch; yield, 2 gallons per minute; temperature, 71°; flow obtained from 400 feet; water very salty; used for domestic purposes and stock. Record: Clay, 0-10 feet; blue rock, 10-250 feet; sand, with thin strata of blue rock and water, 250-495 feet. No. 2, 1 mile northeast of the house, in the S. E. quarter N. W. quarter Section 7, Township 20, Range 2 E.; reported by Morrison in 1898; depth, 450 feet; casing, 3-inch; yield, 1 gallon per minute; temperature, 71°; flow from 400 feet; water salty. Record: Clay, 0-10 feet; blue rock, 10-300 feet; hard rock, 300-306 feet; sand, with water, 306-450feet.

S. L. Creswell's wells, 10 miles southwest of Eutaw, in Section 17, Township 20, Range 2 E.: No. 1, depth, 456 feet; temperature, 72°. No. 2, in field at Creswell's plantation; depth, 440 feet; temperature, 71°. No. 3, one-half mile north of No. 1,; depth, 550 feet; temperature, 72°.

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*See also Mobley list, page 146.

†See also Mobley list, page 146.

C. C. Dunlap's well, in center of Section 17, Township 20, Range 2 E.; recently bored; depth, over 400 feet; good flow.

Capt. James Webb's well, 11 miles south of Eutaw, in Section 20, Township 20, Range 2 E.; bored by Kinniard & Sample; depth, 560 feet; casing, 4-inch; first flowing water at 540 feet; well flowed a year and then partly caved in, after which the pump had to be used. Record: Soil, 0-6 feet; blue rock, 6-540 feet: sand, 540-560 feet.

Old wells renewed—On the Thornton place, in the N. E. quarter Section 25, Township 20, Range 1 E., an old well has been rediscovered which now yields a plentiful supply of salty but palatable water.

On the E. C. Seldon place, in Section 12, Township 21, Range 1 E., an old well was exposed by the formation of a gully. The well was found plugged up, but when opened the water stood 6 or 8 feet below the surface. It is near the house and is now used for domestic purposes. It is supposed to have been bored about 1840. No one in the vicinity remembered anything about it.

In the northern edge of Eutaw, about ten years ago, a freshet exposed an old well that was bored about 1845 by Colonel Pickens. This well now gives a good supply of fine drinking water.

In the vicinity of Eutaw are several old bored wells that have been converted into serviceable open wells by cutting off the old wooden casing after it has begun to decay, and digging around it to a sufficient depth.

The well on the Jones place, in the N. E. quarter Section 8, Township 21, Range 2 E., has the reputation of yielding a fine sulphur water.

HAIRSTON.

About 2 1-2 miles east of Hairston is a well, owner unknown, that is reported to be 530 feet deep. Blue rock, 170 feet thick; water rises to 2 1-2 feet above the ground; yield, 4 gallons per minute.

BOLIGEE AND VICINITY.

Well of Moses Kay (colored), 4 miles north of Boligee; bored by Mr. Ladd in 1899; depth, 142 feet; casing, 3-inch; pure water, 2 gallons per minute, from bottom; flows 3 feet above the surface; temperature, 66°; limestone occurs at 40 feet.

Well of Alec. Alexander (colored); bored by Mr. Ladd in 1899; depth, 350 feet; water, which rises to 5 feet above the surface, was obtained at 320 feet.

E. F. Bouchelle's well, Boligee; bored in 1899 by Mr. Ladd; depth, 500 feet; first flowing water at 300 feet; water rises to 22 feet above the ground; flow originally 60 gallons, but June 20, 1899, was 40 gallons per minute; somewhat salty; temperature, 70°; closed against sand at the bottom; starts in Selma chalk; water supply from Eutaw sand.

H. T. Bouchelle's well, in the S. E. quarter Section 31, Township 21, Range 1E.; bored by J. I. Hawk, in 1898; depth, 450 feet; 3-inch casing; closed against sand; flowed over pipe at 10 feet above the ground; estimated original volume, 10 gallons per minute; first flowing water at 350 feet; somewhat salty. Record: Soil, 0-20 feet; blue rock, 20-220 feet; sand, with occasional thin layers of rock, with water, 220-450 feet.

Dr. Hatter's well, depth, 250 feet; flow small; starts in Selma chalk and obtains its water from Eutaw sands.

Mrs. Perry's well, 100 yards south of station; bored by Mr. Ladd in 1894; flows 3 feet above surface; yield, 1 3-4 gallons per minute from a depth of 250 feet; water carries salt and sulphur; temperature, 68°.

BURTON HILL.

Dr. Perrin's well, in the S. W. quarter Section 13, Township 20, Range 1 E.; not flowing; depth, 544 feet; temperature, 70°.

Bullock well, in the N. E. quarter Section 14, Township 20, Range 1 E.; flows small stream.

ERIE AND VICINITY.

Well of Caleb Blackman (colored), 2 1- miles southwest of Erie, bored by Morrison in 1888; depth, 320 feet; casing, 4-inch; water from 290 feet, flowing 10 gallons per minute to a height of 5 feet above the ground; temperature, 67°. Record: Sand and gravel, 0-30 feet; blue rock, 30-300 feet; sand, water, blue rock, etc., 300-330 feet.

Well of Deb Marks (colored), 3 miles southwest of Erie, in Section 30, Township 20, Range 3 E.; bored by Morrison in 1898; depth, 330 feet; casing, 3-inch; water from 300 feet, flowing 4 1-2 gallons per minute; temperature, 68°. Record: Sand and gravel, 0-30 feet; blue rock, 30-300 feet; sand with water, 300-330 feet.

FORKLAND AND VICINITY.

Miss C. A. Lewis's well, in the N. W. quarter N. W. quarter Section 3, Township 19, Range 2 E.; bored in 1901 by J. I. Hawk; water soft, not salty; originally the well gave a strong flow, but an accident in inserting the casing greatly reduced it; present flow, 1 1-2 gallons per minute; temperature, 72°.

E. S. Latimer's well, in the S. E. quarter S. W. quarter Section 4, Township 19, Range 2 E.; bored by J. I. Hawk in 1901; flows 9 gallons per minute; temperature, 74°; water salty but soft and gives no crust in boilers; volume constant; water rises to 18 feet above the ground; cased throughout, except in the limestone; water used for domestic purposes.

Williamson Glover's well, Forkland; depth, 445 feet; temperature, 72°.

D. S. Brassfield's well, at Landing, in the N. W. quarter Section 14, Township 19, Range 2 E.; depth, 575 feet; blue rock 350 feet thick; water rises to 3 feet above the ground; yield, 20 gallons per minute.

W. B. Baltzell's well, 5 miles west of Forkland, in the W. half N. W. quarter Section 11, Township 19, Range 1 E.; bored by Hawk in 1891; flow, 8 gallons per minute; temperature, 72°.

Emma R. Hillman's well, on the Robert Taylor place, in the W.half N. W. quarter Section 17, Township 19, Range 1 E.; flows a bold stream; water slightly salty but palatable.

Wells on Cole place,* in Section 25, Township 19, Range 2 E.; 4 1-2 miles north of Demopolis, on the Erie road (old wells): No. 1, flow, 1 gallon per minute; temperature, 70°. Three others within a radius of 1 mile; all flow about the same stream.

HALE COUNTY.

SURFACE FEATURES.

The surface of Hale County is divided somewhat evenly between strata of the Tuscaloosa formation in the northeast, the Eutaw in the center, and the Selma chalk in the southwest. Over all these rocks were spread the pebbles and red loam of the Lafayette; but this mantle has been in great part removed by erosion from the area of the chalk, though present over most of the other two divisions. Where the county is least dissected by erosion, especially on the wide divides between the streams, the surface is quite level, with a soil of red loam underlain by pebbles, the two together being from 20 to 25 feet thick. Along the slopes from this plateau, the underlying formations are exposed. Wherever the Lafayette pebbles and loam are present, and very generally in the two prevailingly sandy formations, Tuscaloosa and Eutaw, there is seldom any lack of good water to be had from ordinary wells and from springs.

Among the many fine springs of this county a few may be mentioned. The best known of all are the Green Springs, in the S. W. quarter Section 23, Township 22, Range 4 E., near the celebrated school of Prof. Henry Tutwiler, about one-quarter of a mile from Fivemile creek. Here are several bold springs of the finest chalybeate water. Farther down the creek, 4 or 5 miles from Green Springs, are the Linkumdoddy Springs (chalybeate and sulphur), also well known.

ARTESIAN WELLS.

In the region, occupied by the Selma chalk, the surface waters as usual, are not sufficient for the needs of the people, and recourse is had to artesian wells. A few of these wells are located in the Tuscaloosa area and get their water supply from its sands; and others located near the eastern edge of the Eutaw outcrop also penetrate the water-bearing sands of the Tuscaloosa. Of this character are the wells at Moundville, Powers, Cypress Switch, and Stewarts, on the Alabama Great Southern Railroad. Others located on the Eutaw outcrop, especially those nearest to the chalk territory, are sunk altogether into Eutaw materials and there obtain their water supply.

Most of the wells along the line of the Southern Railway between Akron and Selma are thus situated, e. g., Akron, Evans, Greenwood, (Wedgworth), Sawyerville, and Greensboro. But the great majority of the wells, especially in the western and southern parts of the county, are located on the Selma chalk outcrop, though the borings pass through that formation and get their water supply from the underlying Eutaw sands.

The following records of the artesian wells in Hale County are given as nearly as possible in their geographic order, from north to south.

MOUNDVILLE AND VICINITY.

Thos. B. Allen's well, near the lower line of Tuscaloosa County, 3 miles west of Moundville, on the left bank of Black Warrior River; bored about 1903; depth, 275 feet; first 50 feet, down to a soft rock, cased with 3-inch pipe, the rest to bottom with 1 1-4-inch pipe; first overflow at 234 feet; water rises above the surface, making a noise like an engine pumping; yield, 24 gallons per minute; temperature, 63°. The water is piped over house, kitchen, dairy, and garden. An analysis by Mr. Hodges is as follows:

Analysis of water from Thos. B. Allen's well, near Moundville.

	Parts per million.
Potassium (K)	11.8
Sodium (Na)	295.6
Magnesium (Mg)	20.7
Calcium (Ca)	109.8
Iron and alumina (Fe_2O_3, Al_2O_3)	1.7
Chlorine (Cl)	649.6
Sulphuric acid (SO_4)	.6
Carbonic acid (HCO_3)	115.6
Silica (SiO_2)	15.9
	1221.3

J. A. Elliott & Son's well, bored by Morrison in 1899; depth, 600 feet; water at 450 feet, rose to -1 foot and pumping was necessary for five minutes; on stopping the pumping the well began to flow and has since continued; yield, 1 gallon per minute; temperature, 67°. Well is in Tuscaloosa formation. Record: Soil and clay, 0-50 feet; sand rock, 50-54 feet; pink soapstone, 54-300 feet; hard rock, 300-310 feet; sand, with water and occasional strata of hard rock, 310-600 feet. The composition of this water as shown by the analysis of Mr. Hodges, is as follows:

Analysis of water from J. A. Elliott & Son's well, Moundville.

	Parts per million.
Potassium (K)	3.3
Sodium (Na)	2.9
Magnesium (Mg)	5.5
Calcium (Ca)	23.8
Iron and alumina (Fe_2O_3, Al_2O_3)	2.0
Chlorine (Cl)	4.2
Sulphuric acid (SO_4)	4.3
Carbonic acid (HCO_3)	100.0
Silica (SiO_2)	19.2
	165.9

R. L. Griffin's well, bored by W. H. Martin in 1903; depth, 480 feet; casing, 70 feet of 3-inch, 360 feet of 1 1-4-inch; water at 375 feet, rose to -1 foot; at 480 feet, rose to 16 feet above the ground; present yield 10 gallons per minute; temperature, 67°; water used in several houses. Record: Clay, 0-70 feet; blue rock, 70-375 feet.

W. P. Phifer's well, in the S. W. quarter Section 1, Township 23, Range 4; bored in August, 1903, by W. H. Martin; depth, 490 feet; cased 63 feet with 3-inch casing, 400 feet with 1 1-4-inch inner casing; flow, 12 gallons per minute.

POWERS STATION AND VICINITY.

John Findlay's well, Powers; bored by W. V. Morrison; depth, 406 feet; casing, 3-inch; flow at 330 feet; yield, 7 1-2 gallons per minute, volume constant; water rises to 25 feet above the ground; temperature, 68°. Record: Soil and clay, 0-500 feet; blue rock, 50-250 feet; sand and water, with thin strata of rock, 250-406 feet.

Wells at Lock 6 (now Lock 9), on Black Warrior River near Powers, in fraction D, Section 5, Township 23, Range 4; bored by Morrison in 1900, for Christie, Lowe & Heyworth, contractors: No. 1, depth, 316 feet; 3-inch casing; original volume, 30 gallons; water rose to 34 feet above the ground; weak overflow at 296 feet; temperature, 65°. Record: Sand and gravel, 0-50 feet; soapstone, 50-200 feet; water, sand, occasional thin strata of rock, 200-316 feet. No. 2, is a 1 1-2-inch pipe inside of well No. 1; depth, 336 feet; volume said to be variable; flow, 6 gallons per minute; temperature, 65°.

CYPRESS SWITCH.

Strudwick Brothers' well, bored by W. J. Kinnaird in 1900; depth, 320 feet; diameter, 2 inches; water at 300 feet, rising to 20 feet above the ground; temperature, 67°.

STEWARTS AND VICINITY.

C. D. Cummings's wells: No. 1, at house; bored by Morrison in 1897; depth, 605 feet; diameter, 3 inches; water at 600 feet, rising to 35 feet above the ground; flow, (30 feet above the ground), 6 gallons per minute; volume constant; temperature, 66°; water hard (salt and sulphur), Record:

Soil and clay, 0-30 feet; pink soapstone, 30-600 feet. No. 2, 250 yards north of house; bored by Morrison in 1900; depth, 400 feet; diameter, 3 inches; water at 350 feet, rising to 30 feet above the ground; decidedly mineral (chalybeate), with odor of hydrogen sulphide; record same as in No. 1. No. 3, 300 yards north of house; bored by Morrison in 1897; depth, 363 feet; diameter, 3 inches; water at 300 feet, rising to 30 feet above the ground; flow, 2 gallons per minute; volume, constant; temperature, 67°; water hard and decidedly mineral (chalybeate); record same as in No. 1.

W. H. Martin's well, about 2 1-2 miles east of Stewarts; bored by Martin & Morrison; depth, 550 feet; diameter, 3 inches; water stands at -39 feet; level constant. Record: Soil and clay, 0-30 feet; sand and gravel, 30-400 feet; rock, 400-402 feet; black mud, 402-412 feet; rock, 412-413 feet; successive strata of rock and black or red mud, 413-550 feet.

Wells at Lock 5 (now Lock 8), between Stewarts and Akron; No. 1, drilled in 1899; diameter, 3 inches; depth, 166 feet; flow, 60 gallons per minute; quality good; well entirely in Tuscaloosa beds. No. 2, (owner unknown), reported to be 600 feet deep, the water standing at 8 feet above the ground.

All the wells above given are located on and derive their water from the Tuscaloosa strata.

AKRON AND VICINITY.

W. B. Inge's well, at tne hotel, Akron; depth, 140 feet; water level varies from -6 feet in dry weather to 0 above the ground in wet weather; formerly overflowed a foot or more above the surface; yield, 7 gallons per minute; temperature, 68°. This well is located on the Eutaw sands, but gets waater from the underlying Tuscaloosa beds.

Well of the Alabama Great Southern Railroad, northeast of depot at Akron. This well was bored about the year 1904 or 1905; no record available.

Wells of Waller, Lichtman, and Murphy Land and Development Company.

In 1905 seven wells were bored by this company on their property at Akron. Depths varying from 146 to 305 feet or more. Records have been obtained of only one of these wells in which three water-bearing sands were penetrated at depths of 146 feet, 200 feet, and 305 feet. It being thought that there was marked difference in the quality of these three flows, each was cased off, so that it is separately delivered at the mouth of the well, and designated No. 1, No. 2, and No. 3 respectively. Casing, 3-inch down to No. 1, 146 feet; inside of this 2-inch casing down to flow No. 2, 200 feet; and inside the 2-inch casing 305 feet of 1 1-4-inch casing to the lowest water, 305 feet. Record; Soil, clay and gravel, 0-83 feet; blue soapstone, 83-116 feet, waterbearing sands ,116-146 feet, (yielding water No. 1); strata not recorded, 146-190 feet; blue soapstone 190-200 feet; below this soapstone good flow, (No. 2); strata not recorded, 200-250 feet; pink soapstone or kaolin, 250-305, below which (No. 3,) a fine stream flowing about 12 feet above the ground through the well tools.

The waters from No. 1 and No. 2 have been analyzed by Mr. Hodges with results given below. No. 1 and No. 2 come from Eutaw sands; No. 3 from the Tuscaloosa sands.

Analysis of waters from Waller, Lichtman, and Murphy Land Co. well, Akron.

	Parts per million.	
Potassium (K)	4.3	3.0
Sodium (Na)	8.1	6.6
Lithium (Li)	Trace	Trace
Magnesium (Mg)	.3	.3
Calcium (Ca)	7.0	8.2
Iron (Fe)	13.6	10.0
Alumina (Al_2O_3)	1.8	1.6
Chlorine (Cl)	3.1	4.1
Sulphuric acid (SO_2)	5.2	5.8
Carbonic acid (HCO_3)	68.6	56.2
Silica (SiO_2)	17.7	19.6
	141.4	115.1

From the analysis it will be seen that this is one of the strongest chalybeate waters as yet tested in the state.

Well at house of W. E. Wedgworth, 1 mile south of Akron, in the N. W. quarter N. E. quarter Section 19, Township 22, Range 4 E.; bored by Sample in 1902; depth, 400 feet; diameter, 3 inches; water stands at -15 feet; level constant under domestic use; temperature, 66°.

O. V. Crabtree & Co's. well, 3 miles west of Akron, on Alabama Great Southern Railroad; bored by Kinnaird & Sample in 1900; depth, 300 feet; casing 3-inch; flowing water at 220 feet, rising to 8 feet above the ground. Record: Soil and gravel, 0-50 feet; blue rock, 50-220 feet; sand with water, 220-300 feet.

Judge Coleman's wells, near Akron, and between Akron and Finch's Ferry: No. 1, 1 mile north of the Crabtree well above described; bored by Martin in 1904; depth, 324 feet; estimated yield, 25-30 gallons per minute; contains iron and salt; temperature, 67°. No. 2, 75 yards from No. 1; record same in all particulars. No. 3, on the Bartee place, 1 1-4 miles west of the two preceding; bored in 1903; depth, 354 feet; casing, 39 feet, 3-inch; estimated flow, 50 gallons per minute. No. 4, 2 miles east of Finch's Ferry; bored in 1903; depth, 278 feet; casing, 39 feet, 3-inch; estimated flow, 12 gallons per minute. No. 5, 1 1-2 miles southeast of Akron; bored in 1904; depth, 600 feet; water level, -13 feet. This well is half a mile east of the Southern Railway track, and the surface at the mouth of the well is estimated to be 15 feet higher than the track.

EVANS STATION AND VICINITY.

B. S. Evans's wells, Evans station: No. 1, 200 yards from house, in the N. E. quarter Section 36, Township 22, Range 3 E.; bored by W. J. Kinnaird in 1901; depth, 200 feet; flowing water at 180 feet, rising to 8 feet above the ground; yield, 30 gallons per minute, constant; temperature, 68°. No. 2, at house; bored by Morrison; depth, 633 feet; 4-inch casing above 40 feet; water level -3 feet; used for domestic purposes. Record: Sand and clay, 0-40 feet; blue rock, 40-300 feet; sand, 300-350 feet; soapstone, 350-633 feet.

W. M. Wedgworth's wells, on McGee place, three-fourths of a mile east of Evans station; bored in 1904 by Martin & Wyndham: No. 1, depth, 400 feet water level, -1 foot. No. 2, 100 yards north of No. 1; depth, 300 feet; water level, -12 feet.

W. M. Sample's wells: No. 1, at Evans station; bored by Kinnaird & Sample in 1902; depth, 180 feet, casing, 3-inch; flowing water at 160 feet; rising to 4 feet above the ground; yield, 18 gallons per minute; slightly diminished since first bored; temperature, 68°. Record: Soil and clay, 0-40 feet; blue rock, 40-160 feet; sand with water, 160-180 feet. No. 2, one-fourth of a mile west of Evans station; bored by Kinniard & Sample; depth, 180 feet; casing, 3-inch; flowing water at 160 feet; original volume, 10 gallons per minute, decreased slightly; temperature, 68°. Record: Soil and clay, 0-70 feet; blue rock, 70-160 feet; sand with water, 160-180 feet. No. 3, one-half mile west of Evans station; bored by Kinniard & Sample; depth, 160 feet; casing, 3-inch; flowing water at 140 feet; original volume, 30 gallons per minute; present volume, 18 gallons per minute; temperature, 67°. Record: Soil and clay, 0-70 feet; blue rock, 70-140 feet; sand with water, 140-160 feet. No. 4, three-fourths of a mile west of Evans station; bored by Kinniard & Sample; depth, 200 feet; casing, 3-inch; flowing water at 160 feet; volume, 30 gallons per minute (estimated); temperature, 68°. Record: Soil and clay, 0-50 feet; blue rock, 50-120 feet; (?), 120-160 feet; sand, with water, 160-200 feet.

C. D. Cummings's well, three-fourths of a mile west of Evans station; bored by Sample & Morrison in 1902 (?); depth, 160 feet; casing, 3-inch; water rises to 4 feet above the ground; yield, 3 1-2 gallons per minute; temperature, 68°. Record: Sand and gravel, 0-60 feet; blue rock, 60-155 feet; coal, 155-156 1-2 feet; sand, with water, 156 1-2-160 feet.

C. H. Wedgworth's well, about 1 1-4 miles west of Evans station, in the S. W. quarter S. E. quarter Section 34, Township 22, Range 3 E.; bored by Kinnaird & Sample in 1901; depth, 210 feet; casing, 3-inch; water at 160 feet, rising to 4 feet above the bround; volume, 24 gallons per minute; temperature, 67°. Record: Sand and gravel, 0-40 feet; blue rock, 40-160 feet; sand, with water, 160-210 feet.

WEDGWORTH, (GREENWOOD, MAYS STATION.)

These are all the same locality. The railroad station is Mays; the postoffice was Greenwood until very recently, when the name was changed to Wedgworth.

W. M. Wedgworth's well, in the S. W. quarter N. W. quarter Section 11, Township 21, Range 3 E.; bored by Sample & Morrison in 1899 or 1900; depth, 200 feet; casing, 4 1-2-inch; flowing water at 140 feet, rising to 10 feet above the ground; volume constant; decided improvement in the health of users; yield, 18 gallons per minute; temperature, 68°. Record: Sand and gravel, 0-30 feet; blue rock, 30-140 feet; sand and water, 140-150 feet; blue rock, 150-190 feet; sand and water, 190-200 feet. The analysis of this water, by Mr. Hodges, shows the following composition:

Analysis of water from W. M. Wedgworth's well, near Wedgworth.

	Parts per million.
Potassium (K)	7.6
Sodium (Na)	24.6
Magnesium (Mg)	2.2
Calcium (Ca)	11.9
Iron and alumina (Fe_2O_3, Al_2O_3)	2.6
Chlorine (Cl)	10.5
Sulphuric acid (SO_4)	5.1
Carbonic acid (HCO_3)	88.4
Silica (SiO_2)	17.2
	170.1

Well at Wedgworth's store, on the railroad; bored in 1904 by Kinnaird & Sample; depth, 235 feet; 40 feet of 3-inch casing; first flowing water at 175 feet; second flow, good stream, at 200 feet; third water at 235 feet, rising to 15 feet above the ground.

Miss K. C. May's well, 3 miles north of east of Wedgworth; bored by Kinnaird & Sample in 1902; depth, 200 feet; diameter, 3 inches; flowing water at 160 feet; estimated volume, 65 gallons per minute; flow constant; temperature, 67°. Record: Soil, etc., 0-40 feet; blue rock, 40-160 feet; sand, with water, 160-200 feet.

W. E. Wedgworth's wells: No. 1, 1 mile east of Wedgworth, in the N. E. quarter N. W. quarter Section 1, Township 21, Range 3 E.; bored by Sample in 1902; depth, 210 feet; casing, 3-inch; flowing water at 170 feet, rising to 5 feet above the ground; yield, 18 gallons per minute; temperature, 67°. Record: Soil and clay, 0-40 feet; blue rock, 40-170 feet; sand, with water, 170-210 feet. No. 2, about 1 1-4 miles east of Wedgworth, on the old Wedgworth place; water rises to 4 feet above the ground; yield, 35 gallons per minute; temperature, 67°; other data similar to No. 1.

Wells on Allen Wilson place: No. 1, one-half mile west of Wedgworth; flow, 2 1-2 gallons per minute; temperature, 68°. No. 2, 1 1-2 miles west of Station; flow, 4 1-2 gallons per minute; temperature, 67°.

Governor Seay's well, 3 miles southwest of Wedgworth, on the road to Lock 4 (7); drilled about 1897; depth, 198 feet; casing, 30 feet, 6-inch; water rises to 3 feet above the ground; yield, 15 gallons per minute; temperature, 66°.

E. W. Degraffenreid's well, 4 or 5 miles southwest of Wedgworth; yield, 2 1-4 gallons per minute; temperature, 68°; an old well, but still flowing.

E. L. Kimbrough's wells, 3 to 5 miles southwest of Wedgworth; No. 1 ("camp well"), one-fourth of a mile east of Lock 4 (7), in pasture; bored by Morrison; depth, 160 feet; diameter, 3 inches; flowing water at 140 feet, rising to 4 feet above the ground; yield, 40 gallons per minute; flow, constant; temperature, 67°. Record: Soil and clay, 0-53 feet; blue rock, 53-130 feet; sand and water, 130-140 feet; hard white rock, 140-160 feet. No. 2 ("new-ground well"), in swamp 1 1-4 miles east of Lock 4 (7); originally bored by hand and afterwards (1898) deepened by Morrison to 160 feet; casing, 30 feet, 6-inch; estimated original flow at 3 feet above the ground; 35 gallons per minute; present flow, 12 gallons per minute; temperature, 67°. No. 3, ("upland-pasture well"), bored by Morrison in 1898; depth, 160 feet; casing, 4 1-2-inch; flowing water at 140 feet; estimated original yield, 20 gallons per minute; present yield, 17 gallons per minute; temperature, 68°. No. 4 ("river-field well"), bored by J. I.

Hawk in 1896; depth, 185 feet; flowing water at 175 feet; yield, 12 gallons per minute; temperature, 68°. Record: Clay and soil, 0-10 feet; quicksand, 10-40 feet; blue rock, 40-185 feet. No. 5 ("house-lot well"), bored by J. I. Hawk in 1898; depth, 272 feet; first water at 175 feet; flowing water at 240 feet; estimated original yield, 18 gallons per minute; present yield, 3 gallons per minute; temperature, 68°. Record: Sand, clay, and gravel, 0-25 feet; blue rock, 25-175 feet; remainder unrecorded. No. 6 ("mill well"), bored by J. I. Hawk; yield, 17 gallons per minute; temperature, 68°.

Wells of Madison Jones, Jr., No. 1, at Mays station (Wedgworth Postoffice); bored by J. I. Hawk in 1899; depth, 216 feet; casing, 6-inch; flow, 60 gallons per minute; volume constant; temperature, 69°; well is entirely within the Eutaw sands. Record: Clay, 0-12 feet; blue rock, 12-170 feet; sand and water, with thin strata of blue rock, 170-216 feet. No. 2, in pasture opposite the house, half a mile south of the station; bored 170 feet by hand, and completed by J. I. Hawk in 1899; depth, 285 feet (256 feet according to Mr. Jones); casing, 5-inch; flows 22 gallons per minute; volume constant; temperature, 69°. The water from this well shows the following composition in the analysis by Mr. Hodges:

Analysis of water from well of Madison Jones, Jr., near Mays Station.

	Parts per million.
Potassium (K)	3.9
Sodium (Na)	51.8
Magnesium (Mg)	2.6
Calcium (Ca)	12.3
Iron and alumina (Fe_2O_3, Al_2O_3)	2.5
Chlorine (Cl)	38.4
Sulphuric acid (SO_4)	5.0
Carbonic acid (HCO_3)	121.2
Silica (SiO_2)	27.8
	265.5

LOCK 4 (NOW 7.)

Well No. 1, in the S. W. quarter of Section 18, Township 21, Range 3 E.; bored by Morrison in 1900; depth, 280 feet; casing, 40 feet, 3-inch; first flowing water at 200 feet; estimated original yield, 35 gallons per minute; present yield, 18 gallons per minute; temperature, 6o°; water rises to 24 feet above the ground. Record: Sand and gravel, 0-50 feet; blue rock, 50-160 feet; sand with water alternating with thin strata (10-12 feet(of blue rock, 160-180 feet. Well No. 2, on west bank of river; bored by N. A. Yuille; covered by water in times of flood; data not obtainable.

The analysis of the water from well No. 1, by Mr. Hodges, is as follows:

Analysis of water from well No. 1, *at Lock* 4 (*now Lock* 7.)

	Parts per million.
Potassium (K)	4.5
Sodium (Na)	444.8
Magnesium (Mg)	2.7
Calcium (Ca)	14.9
Iron and alumina (Fe_2O_3, Al_2O_3)	1.6
Chlorine (Cl)	481.9
Sulphuric acid (SO_4)	.4
Carbonic acid (HCO_3)	413.6
Silica (SiO_2)	13.2
	1377.6

SAWYERVILLE AND VICINITY.

E. L. Kimbrough has two deep wells at Sawyerville, bored by J. I. Hawk.

Jack Monette's wells, 3 miles west of Sawyerville: No. 1, at mill; bored by Sample & Morrison in 1897; depth, 640 feet; diameter, 3 inches; water stands at -8 feet; level constant. Record: Sand, 0-10 feet; blue rock, 10-450 feet; sand and water, with thin strata of blue rock, 450-600 feet; pink soapstone, 600-640 feet. No. 2, at house; bored by Sample in 1901; depth, 440 feet; flowing water from bottom; yield, 17 gallons per minute; volume constant; temperature, 70°. No. 3, at mill; bored by Sample; depth, 440 feet; diameter, 3 inches; water stands at constant height of -10 feet. No. 4, at mill; bored by Smith; depth, 435 feet; diameter, 3 inches; water stands at constant height of -10 feet. No. 5, one-fourth of a mile east of Lock 3 (now Lock 6); bored by Smith; depth, 360 feet; casing, 1 1-2-inch; flows about 4 gallons per minute; temperature, 69°. No. 6, one-half mile northeast of Lock 3 (now Lock 6); drilled by Smith; data lacking. Mr. Monette has also three overflowing wells at old Erie, of which records were not obtained.

T. J. Yancey's well, 3 miles nearly south of Sawyerville, in Section 13, Township 20, Range 3 E.; bored by Kinnaird & Sample in 1902; depth, 315 feet; casing, 30 feet, 3-inch; first overflow at 280 feet, weak; water rises to 5 feet above the ground; yield 15 gallons per minute; temperature, 67°. Record: Sand and gravel, 0-30 feet; blue rock, 30-280 feet; sand and water, 280-315 feet.

ERIE.

Well at Lock 3 (now Lock 6), Black Warrior River, Erie Landing, in the N. W. quarter Section 16, Township 20, Range 3 E.; bored by Kinnaird & Sample in 1903; depth, 520 feet; casing, 20 feet, 3-inch; first water at 300 feet, stood at -35 feet; second water, at 400 feet, stood at -8 feet; at 400 feet the water flowed over for two days; yield, 3 gallons per minute; temperature, 68° Record: Lime rock, 0-20 feet; blue rock, 20-300 feet; alternating sand and blue rock, 300-400 feet; pink soapstone, 400-500 feet. The last is probably Tuscaloosa formation, the first 400 feet being Eutaw sands and rock.

GREENSBORO AND VICINITY.

The city of Greensboro has several 4-inch wells about 432 feet deep, situated in a depression about 48 feet below the level of the court-house. The water stands at -30 feet, and the aggregate yield of the wells by air lift is 110 gallons per minute. Mr. C. E. Waller states that in the borings ten water-bearing strata were passed, indurated ledges about 10 feet apart being above and below the water-bearing sands. The formation throughout is Eutaw. The composition of the water from the city supply is as follows, the analysis being by Mr. Hodges:

Analysis of water from wells of Greensboro city waterworks.

	Parts per million.
Potassium (K)	5.1
Sodium (Na)	24.9
Magnesium (Mg)	13.1
Calcium (Ca)	21.8
Iron and alumina (Fe_2O_3, Al_2O_3)	5.3
Chlorine (Cl)	60.4
Sulphuric acid (SO_4)	4.8
Carbonic acid (HCO_3)	95.6
Silica (SiO_2)	4.6
	235.6

Mr. William Withers states that borings have been made in this basin to depths of from 75 to 1,600 feet. The shallow wells furnish an ample domestic supply, while those from 500 to 800 feet deep give abundant water for industrial, manufacturing, and irrigatiuon purposes.

J. M. P. Otts's well, Greensboro, in the S. W. quarter S. E. quarter Section 17, Township 20, Range 5 E.; bored by Morrison in 1903; depth, 157 feet; casing, 36 feet, 3-inch; water stands at -7 feet. Record: Soil, 0-23 feet; blue rock, 23-55 feet; sand and water, 55-115 feet; blue rock, 115-157 feet.

Blount & Ward's well, bored by Morrison in 1902; depth, 500 feet; casing, 3-inch; water stands at -13 feet; well has never been used. Record: Clay, 0-30 feet; blue rock, 30-300 feet; sand and thin strata of blue rock, 300-425 feet; pink soapstone, 425-500 feet.

Cotton Oil Company's well, 300 yards from Blount & Ward well; bored by Morrison in 1902; depth, 500 feet; casing, 30 feet, 6-inch; water stands at -13 feet; reported to carry much sulphur; used in boilers at mill; gives no crust; supply reported inexhaustible. Record: Clay, 0-30 feet; blue rock, 30-300 feet; sand, with occasional strata of blue rock, 10 inches to 3 feet thick, 300-500 feet.

Lee Otts's well, on Jenkins place, about 2 1-2 miles southwest of Greensboro, in the N. W. quarter Section 30, Township 20, Range 5 E.; bored by Morrison in 1903; depth, 600 feet; casing, 3-inch; water stand at -7 feet; well abandoned. Record: Sand, 0-22 feet; blue rock, 22-400 feet; pink soapstone, 400-600 feet. Water is from a stratum of sand in the blue rock.

In the lower part of the county, west and southwest of Greensboro, in the prairie region, are to be found many of the old-time rich plantations. This region, as has been shown, is deficient in shallow-water supply. From the beginning recourse has been had to artesian borings, and new wells are constantly being put down as necessity arises. The following records will show how these borings are concentrated about the older settlements and plantations.

Cheney Borden's well, 6 miles west of Greensboro; bored by Kinnaird & Sample in 1901; depth, 400 feet; diameter, 3 inches; water stands at -40 feet; used two months and abandoned.

MILLWOOD AND VICINITY.

Wiley Tunstall's wells: No. 1, in the S. E. quarter Section 35, Township 20, Range 3 E., at Millwood, 300 yards northwest of the house, across pond; bored by Kinnaird & Sample in 1901; depth, 330 feet; casing, 6-inch; flowing water obtained at 300 feet; original yield (estimated), 40 gallons per minute; present yield, 30 gallons per minute, flowing 3 feet above surface; temperature, 66°. Record: Soil, 0-40 feet; blue rock; 40-300 feet; sand and water, 300-330 feet. No. 2, 400 yards north of house; bored by Kinnaird & Sample to 300 feet in 1901 and deepened to 500 feet in 1902; depth, 500 feet; casing, 6-inch; flow in 1902, 75 gallons per minute; temperature, 68°; reported to have mineral properties. Record: Soil, 0-40 feet; blue rock, 40-240 feet; sand, water, etc., 240-500 feet. No. 3, 70 yards northwest of mill house; bored by Kinnaird & Sample in 1902; depth, 500 feet; casing, 4 1-2 inch; flowing water at 260 feet, rising to 2 feet above the ground; yield, 75 gallons per minute; temperature, 68°. Record. Soil, 0-50 feet; blue rock, 50-260 feet; sand and water, with thin strata of blue rock, 260-500 feet. No. 4, 80 yards west of house; bored by Kinnaird & Sample in 1902; depth, 500 feet; casing, 4 1-2-inch; first flowing water at 260 feet; present yield, at 2 feet above the ground, 75 gallons per minute; temperature, 68° Record: Soil, 0-50 feet; blue rock, 50-260 feet; sand and water, with thin strata of blue rock, 260-500 feet. No. 5, in the S. E. quarter N. W. quarter Section 33, Township 20, Range 4 E., on Jeffrey place (pasture well); bored by Kinnaird & Sample in 1902; depth unknown; diameter 3 inches; present yield, 9 gallons per minute; temperature, 69°. No. 6, in the S. W. quarter S. E. quarter Section 29, Township 20, Range 4 E., on Jeffrey place, near George Taylor's store, 3 miles east of Millwood; bored by Kinnaird & Sample in 1902; depth, 360 feet; casing, 3-inch; flowing water at 300 feet, rising to 2 feet above the ground; estimated original volume, 6 gallons per minute; present volume, 3 gallons per minute (much leakage); temperature, 70°. No. 7, at Grindle Pond, 2 miles north of Millwood, in Section 23, Township 20, Range 3 E.; bored by Kinnaird & Sample in 1902; depth, 200 feet; casing, 3-inch; flowing water at 120 feet; present yield, 38 gallons per minute at 2 feet above the ground; temperature, 66°.

A. Well on Crassdale Plantation, (J. O. Banks), near Eutaw, Green County.

B. Pickens Well, near Greensboro, Hale County.

Wells Nos. 1 to 4 of Colonel Tunstall at Millwood Landing, above described, have been recently bored to take the place of old wells which formerly supplied water for a mill. Some of the old wells are still in use, but are not included in the above notes. One large well on the river bank has lately been destroyed by the caving of the bank. Reports of the depths of the ante-bellum wells are generally exaggerated, as is shown by recent borings in the same localities.

Pickens well, about 2 miles southeast of Millwood, in the N. W. quarter N. E. quarter Section 6, Township 20, Range 4 E., on the old Samuel Pickens place; one of the largest wells in the State; diameter of casing, 7 1-4 inches; water rises in a solid stream 9 inches above the top of the pipe; estimated flow, 850 gallons per minute; temperature, 72°. In the immediate vicinity of this well are four or five others of varying capacity, some of them extremely bold, others weak. No reliable records are obtainable, but it is reported that the wells have depths varying from 450 to 850 feet, the former figure being probably nearer correct. Pl. XV. B. shows the Pickens well in its present state.

M. H. Murphy's wells: No. 1, 1 1-2 miles east of big Pickens well, in Section 5, Township 19, Range 4; bored by J. I. Hawk in 1903; depth, 502 feet; casing, 2-inch; flow, 11 gallons per minute; temperature, 70° No. 2, (old well, cleaned out by Hawk), in the N. E. quarter S. E. quarter Section 8, Township 19, Range 4; depth, 497 feet; casing, 2-inch.

Well at Lock 2 (5), in the S. W. quarter Section 25, Township 19, Range 3 E.; drilled in 1903; depth, 400 feet; casing, 3-inch; weak overflow from depth of 300 feet; estimated yield, 30 gallons per minute; temperature, 67°. Record: Soil and clay, 0-20 feet; blue rock, 20-280 feet; sand with water, 280-400 feet.

CEDARVILLE AND VICINITY.

A. C. Jones's well, Cedarville, in the S. E. quarter Section 15, Township 19, Range 4; old well, not flowing.

Kelly Brothers' well, Cedarville, in the S. W. quarter S. W. quarter Section 15, Township 19, Range 4; bored by Ben Rainey about 1873; depth, about 275 feet; flow 4 gallons per minute; supply constant, water rises to 3 feet above the ground; temperature, 68°.

Tom Ruffin's wells: No. 1, on O'Donnell place, 1 mile northwest of Cedarville; flow, 8 gallons per minute; temperature, 67°; old well. No. 2, 200 yards north of No. 1; in decay, but still flows. No. 3, 1 1-4 miles northwest of Cedarville, in Section 16, Township 19, Range 4; flow, 5 gallons per minute; water rises to 4 feet above the ground; temperature, 67°. No. 4, 1 1-2 miles northwest of Cedarville, in Section 16, Township 19, Range 4; no record. These wells are located about 2 miles southeast of the big Pickens well. No. 5, Cedarville, in the N. W. quarter N. W. quarter, Section 32, Township 19, Range 4; flows 2 gallons per minute; temperature, 68°.

A. B. Gewin's well, Cedarville, in the N. E. quarter N. E. quarter Section 32, Township 19, Range 4; does not overflow; windmill used; old well.

Sledge & Leonard's well, Cedarville, in the N. W. quarter N. E. quarter Section 22, Township 19, Range 4; does not flow; pump used; water stands at -5 feet; temperature, 67°

Sander's mill well, Cedarville, in the N. W. quarter N. E. quarter Section 22, Township 19, Range 4; water rises to 2 feet above the ground; flow, 2 1-2 gallons per minute.

Peyton Agnew's well, 1 mile west of Cedarville, in the N. W. quarter N. E. quarter Section 21, Township 19, Range 4; old well; flow, 1 gallon per minute; temperature, 67°.

Kelly Brothers' well, 1 1-2 miles southwest of Cedarville, in Section 28, Township 19 Range 4; bored in 1902; depth, 175 feet; flow, 2 gallons per minute; temperature, 65°.

WHITSITT AND VICINITY.

Wells on Egypt place: No. 1, 1 1-2 miles west of Whitsitt, in the S. E. quarter S. E. quarter Section 13, Township 19, Range 4; flowing; in decay; temperature, 66°. No. 2, 2 1-2 miles west of Whitsitt, in the S. E. quarter S. E. quarter Section 13, Township 19, Range 4; estimated flow, 10 gallons per minute; temperature, 66°. No. 3, 2 1-4 miles west of Whitsitt, in the S. E. quarter S. E. quarter, Section 13, Township 19, Range 4; flow, 15 gallons per minute; temperature, 67°. No. 4, 2 1-4 miles west of Whitsitt, in the N. E. quarter N. E. quarter Section 24, Township 19, Range 4; bored by Ben Rainey in 1902; depth, 125 feet; flow, 1 1-2 gallons per minute; temperature, 67°; no further data obtainable. No. 5, 2 miles west of Whitsitt, in the N. E. quarter S. E. quarter Section 13, Township 19, Range 4; flow, 1 1-2 gallons per minute; temperature, 66°. These are all old wells.

Wells on Knight place: No. 1, 3 1-2 miles south of Greensboro, near center of Section 7, Township 19, Range 5; flow, 6 gallons per minute; water level, 3 feet above the ground; temperature, 67° No. 2, in the S. E. quarter S. W. quarter Section 7, Township 19, Range 5; flow, 4 gallons per minute; temperature, 67 1-2°. No. 3, inthe S. E. quarter S. W. quarter Section 7, Township 19, Range 5; temperature, 66 1-2°; flows, but in decay. No. 4, in the S. E. quarter N. E. quarter Section 18, Township 19, Range 5; flow, 4 gallons per minute; water level, 3 feet above the ground; temperature, 67°. No. 5, no record. These are old wells.

Wells on Peck place: No. 1, in the N. W. quarter S. W. quarter Section 5, Township 19, Range 5; flow, 20 gallons per minute at 4 feet above the ground; temperature, 66°. No. 2 near center of Section 5, Township 19, Range 5; flow, 5 gallons per minute; temperature, 66°. Both old wells.

George Erwin's wells (old): No. 1, one-half mile west of Whitsitt, in the N. W. quarter S. E. quarter Section 20, Township 19, Range 5; flow, 1 gallon per minute; temperature, 71°. No. 2, one-half mile north of west of Whitsitt, in the N. E. quarter S. E. quarter Section 20, Township 19, Range 5; does not flow. No. 3, one mile north of west from Whitsitt, in the N. W. quarter N. W. quarter Section 20, Township 19, Range 5; flow, 3 gallons per minute; temperature, 66°.

Wells on Mrs. Tunstall's place: No. 1, one-half mile east of Whitsitt, in the S. E. quarter S.W. quarter Section 21, Township 19, Range 5;

flow, one-quarter gallon per minute; temperature, 67 1-2°. No. 2, 1 mile north of No. 1, in the N. E. quarter N. W. quarter Section 21, Township 19, Range 5; flows one-quarter gallon per minute. Both old wells.

Mrs. C. L. Karnegie's well, at Whitsitt, in the S. W. quarter S. W. quarter Section 21, Township 19, Range 5; old well; no longer flows.

Well on Karnegie place, 1 1-2 miles south of Whitsitt; owned by Mr. White, of Newberne; flow, two-thirds of a gallon per minute; temperature, 66°.

Wells on "Long Farm" place, near center of Section 29, Township 19; Range 5: No. 1, 1 mile southwest of Whitsitt; in decay; water stands at surface. No. 2, in decay. Both old wells.

Wells on Harris Tinker place: No. 1, 1 mile south of Whitsitt, in the N. W. quarter S. W. quarter Section 28, Township 19, Range 5; flow, one-half gallon per minute; temperature, 67°. No. 2, 1 mile south of Whitsitt, in the N. W. quarter S. W. quarter Section 28, Township 19, Range 5; flow, one-half gallon per minute. No. 3, in the S. E. quarter N. W. quarter Section 28, Township 19, Range 5; well now in decay. No. 4, N. W. quarter S. W. quarter Section 28, Township 19, Range 5; in decay. No. 5, N. W. quarter S. W. quarter Section 28, Township 19, Range 5; flow, one-fifth of a gallon per minute; temperature, 67°. All these are old wells.

Wells on Mrs. Mattie Croom's place, in Section 22, Township 19, Range 5; two old wells that flow about two-thirds of a gallon per minute; temperature, 67°.

Wells on Mauldin place: No. 1, 1 1-2 miles southeast of Whitsitt, in Section 27, Township 19, Range 5; flow, one-third of a gallon per minute; temperature, 67°. No. 2, 1 1-2 miles south of Whitsitt, in the N. W. quarter N. W. quarter Section 33, Township 19, Range 5; flow, one-half gallon per minute; temperature, 66°. Both old wells.

NEWBERNE AND VICINITY.

Well on Irvin plantation, 2 1-2 miles northeast of Newberne; bored by J. I. Hawk in 1899; depth, 300 feet; water stands at -27 feet; quality good. No blue rock encountered; well starts in the Selma chalk; water supply from Eutaw sands.

M. S. Heron's wells: No. 1, one-half mile northwest of Newberne, in the N. W. quarter S. W. quarter Section 24, Township 19, Range 5; bored by Hawk in 1900; depth, 300 feet; casing, 4-inch; water stands at -35 feet; temperature, 67°. No. 2, 1 mile northwest of Newberne; bored in 1896; in the S. E. quarter Section 14, Township 19, Range 5; depth, 350 feet; does not flow.

R. L. Bennett's wells: No. 1, near Newberne, in the N. E. quarter S. W. quarter Section 24, Township 19, Range 5; bored by Andrew Clark in 1878; depth, 425 feet; cased 250 feet with 5-inch casing; first water, at 105 feet, stood at -40 feet; second water at 165 feet, stood at ? feet; third water, at 225 feet, stood at -16 feet; fourth water, at 350 feet, stood at -30 feet. No. 2, three-quarters of a mile west of Newberne, in the N. W. quarter Section 24, Township 19, Range 5; bored by Andrew Clark in 1878; depth, 50 feet; flows 1-inch stream.

A. E. Walker's well, Newberne, in the N. E. quarter N. W. quarter Section 25, Township 19, Range 5; bored by Hawk in 1903; depth, 300 feet.

F. S. Morrisette's well, Newberne, in the S. E. quarter N. W. quarter Section 25, Township 19; Range 5; bored by Hawk in 1903; depth, 300 feet.

Well on F. S. Morrisette plantation, where P. Morrisette lives; bored by Hawk in August, 1903; depth, 400 feet; casing, 20 feet 4-inch; first water at 300 feet, rose 2 feet above surface; second water, at 400 feet, rises 10 feet above surface; depth to principal water supply, 400 feet; original flow, 10 gallons per minute; depth to blue rock, 18 feet; thickness of blue rock, 250 feet.

Well of Farmers' Gin and Warehouse Company, bored by Hawk; depth, 485 feet; flow, 3 gallons per minute; starts in Selma chalk; water in Eutaw sands.

W. H. Landers's well, in the S. E. quarter S. W. quarter Section 24, Townsend 19, Range 5; bored by Hawk in 1903; depth, 300 feet; casing, 20 feet, 3-inch; first water, at 165 feet, stood at -42 feet; second water, at 300 feet, at -30 feet. Record same as J. H. Turpin's well below.

Dr. J. Huggins reports that he has a well that does not overflow; water stands at -23 feet; impregnated with iron, sulphur, and lime. He also reports the "Duffin saline well," in Newberne, formerly owned by his father, now the property of S. Hardenbergh. This is an old well; the water was much used before the war, being thought good for indigestion. The analysis, by Mr. Hodges, is as follows:

Analysis of water from S. Hardenbergh's well, Newberne.

	Parts per million.
Potassium (K)	24.8
Sodium (Na)	266.0
Magnesium (Mg)	39.6
Calcium (Ca)	589.2
Iron and alumina (Fe_2O_3, Al_2O_3)	12.2
Chlorine (Cl)	720.1
Sulphuric acid (SO_4)	760.4
Carbonic acid (HCO_3)	528.6
Silica (SiO_2)	43.4
	2984.3

Dr. Huggins says there are four very large flowing wells near Newberne which yield about 250 gallons per minute. He estimates about 200 artesian wells about Newberne, most of them yielding from 1 to 20 gallons per minute.

J. J. Hogue's well, Newberne, 400 yards southwest of post-office, in the N. W. quarter S. W. quarter Section 25, Township 19, Range 5; bored by Hawk in 1900; depth, 300 feet. Record same as that of J. H. Turpin,s well.

J. H. Turpin's well, 1 mile from Newburne, in the S. W. quarter Section 25, Township 19, Range 5; bored by Hawk in 1901; depth, 350 feet; casing, 20 feet, 4-inch; first water at 110 feet; second water at 320 feet; overflows; original flow, 16 gallons per minute; temperature, 67°.

Record of J. H. Turpin's well, 1 mile from Newberne.

	Feet.
Clay	0 — 20
Blue rock	20 — 95
Sand and soapstone	95 — 105
Hard rock	105 — 107
Soapstone	107 — 167
Hard rock	167 — 169
Soapstone	169 — 250
Sand and soapstone	250 — 300
Soapstone	300 — 350

Andrew J. Moore's wells: No. 1, at residence, near Newberne; bored by Hawk in 1903;depth, 500 feet; cased with 2- and 4-inch pipe; water stands at -20 feet; first water at 250 feet; second water at 340 feet; third water at 420 feet; fourth water at 500 feet; thickness of blue rock, 175 feet; depth to blue rock, 20 feet. No. 2, in lot, 2 1-2 miles south of Newberne; bored by Hawk in 1900; depth, 5C0 feet; flow, 6 gallons per minute; blue rock was encountered at 12 feet and continued to 137 feet; well starts in Selma chalk; water supply from Eutaw sands. No. 3, bored by Hawk in 1903.

D. L. Moore's wells, bored by J. I. Hawk: No. 1, depth 300 feet; flow, 28 gallons per minute. No. 2, depth, 410 feet; flow 35 gallons per minute.

Pollard Brothers' well, bored by J. I. Hawk in 1903; depth, probably 300 feet or more; water stands at -18 feet; blue rock at 22 feet, 80 feet thick.

W. R. Tubbs's well, bored by J. I. Hawk in 1900; depth, 300 feet; water stands at -28 feet; blue rock at 20 feet, 85 feet thick.

R. A. White's well, bored by J. I. Hawk in 1900; depth, 300 feet; water stands at -22 feet; blue rock at 20 feet, 85 feet thick.

R. A. White & Co.'s well, at store, one-quarter of a mile north of depot, Newberne; bored by Hawk in June, 1903; depth, 300 feet; casing, 2υ feet, 4-inch; first water at 165 feet, rising to -40 feet; second water at 285 feet, rising to -30 feet; depth to principal water supply, 285 feet; pump used; depth to blue rock, 19 feet; thickness of blue rock, 85 feet.

Well at Newberne (owner unknown), reported depth, 475 feet; water rises to 4 feet above the ground; flows 30 gallons per minute; blue rock 8υ feet thick.

W. P. Nelson's well. 2 1-2 miles southwest of Newberne; bored by Hawk; depth, 500 feet; flow, 8 gallons per minute; blue rock at 20 feet, 200 feet thick.

Carter Washington's well, in lot, 4 miles southwest of Newberne; bored by Hawk in August, 1903; depth, 400 feet; casing 20 feet, 4-inch; first water at 300 feet, rising to -2 feet; second water at 400 feet, rising to 5 feet above the ground; depth to principal supply, 400 feet; flow 6 gallons per minute; depth to blue rock, 16 feet; thickness of blue rock, 240 feet.

Ned Pickens's well, 4 1-2 miles southwest of Newberne; bored in October, 1900, by J. I. Hawk; depth, 300 feet; diameter, 4 inches; first water, at 200 feet, flowed 2 feet above surface; second water, at 300 feet, flowed 12 feet above surface; depth to principal water supply, 260 feet; original flow, 15 gallons per minute; depth to blue rock, 16 feet.

SUNSHINE.

Well (owner unknown), reported to have been bored by J. I. Hawk to a depth of 300 feet; flow, 12 gallons per minute; blue rock at 18 feet, thickness 185 feet.

LANEVILLE AND VICINITY.

I. F. Lewis's well, 2 miles southwest of Laneville; bored by Hawk in June, 1901; depth, 710 feet; casing, 375 feet, 2-inch and 4-inch; first water, at 350 feet, rose to -18 feet; depth to principal water supply, 690 feet; overflows; depth to blue rock, 16 feet; thickness of blue rock, 325 feet.

Garber Brothers' (new) wells: No. 1, 1 mile south of Laneville; flow, 4 gallons per minute; rises to 2 feet above the ground; temperature, 74°. No. 2, located one-half mile north of No. 1; flows one-half gallon per minute; rises to 2 feet above the ground; temperature, 73°. No. 3, flows 10 gallons per minute; stands at surface; temperature, 66°. No. 4, 1 mile west of No. 3; flow, 8 gallons per minute; rises to 2 feet above the ground; temperature, 66°.

Well on Rugh place, 3 miles northwest of Laneville, owned by W. B. Inge, of Greensboro; bored by Hawk in July, 1901; depth, 400 feet; casing 18 feet, 4-inch; first water at 250 feet, rising 2 feet above surface; second water at 390 feet, rising 12 feet above surface; depth to principal water supply, 390 feet; original flow, 15 gallons per minute; depth to blue rock, 16 feet; thickness of blue rock, 200 feet.

Wells on Hermitage place, 4 miles north of Laneville, owned by Lewis; 4 old wells.

Wells on "Bleak House place," owned by Mrs. Ivey Lewis estate: No. 1, near center of Section 12, Township 18, Range 4; flow, 1 1-2 gallons per minute; rises to 2 feet above ground; temperature, 68°. No. 2, in the N. W. quarter S. W. quarter Section 7, Township 18, Range 5; flow, 4 gallons per minute; rises to 3 feet above the ground; temperature, 69°. No. 3, in the N. E. quarter S. E. quarter Section 12, Township 18, Range 4; flow, 3 gallons per minute; rises to 3 feet above the ground; temperature, 69°. No. 4, in the S. E. quarter Section 12, Township 18, Range 4; flow, 4 gallons per minute; rises to 5 feet above the ground; temperature, 67° No. 5, in the S. W. quarter S. E. quarter Section 12, Township 18, Range 4; flows weak stream. These are all old wells.

GALLION AND VICINITY.

Wells on "Oak Grove place," 3 or 4 miles northeast of Gallion, owned by Ivey F. Lewis, formerly owned by C. W. Collins: No. 1, in the N. E. quarter Section 15, Township 18, Range 4; depth, 200 feet; casing, 3-inch; flow, 1 gallon per minute; water rises to 4 feet above the ground; temperature, 68°. No. 2, in the S. E. quarter Section 11, Township 18, Range 4; flow, 5 gallons per minute; temperature, 69°. No. 3, S. E. quarter Section 11, Township 18, Range 4; no record. No. 4, N. E. quarter Section 15, Township 18, Range 4; depth, 700 feet; casing, 3-inch; flow, one-quarter of a gallon per minute; water rises to 5 feet above ground; temperature, 70°. No. 5, in the N. E. quarter, Section 15, Township 18, Range 4; depth 900 feet; casing, 3-inch; flow, 1 gallon per minute; water rises to 5 feet above the ground; temperature, 70°. No. 6, in the S. W. quarter Section 10, Township 18, Range 4; flow, one-half of a gallon per minute; water rises to 3 feet above the ground; temperature, 68°. No 7, in the N. W. quarter Section 14, Township 18; Range 4; flow, 1 gallon per minute; temperature, 70°. No. 8, in the S. E. quarter Section 10, Township 18, Range 4; flow, 2 gallons per minute; temperature, 70°.

Well on "Simon Tract place," owned by Mrs. Dr. Browder, in Section 9, Township 18, Range 4; flow, one-third gallon per minute; temperature, 68°.

Mrs. Collins's wells (old), in the S. W. quarter N. E. quarter Section 17, Township 18, Range 4: No. 1, flow, 40 gallons per minute; water rises to 8 feet above the ground, temperature, 72°. Two other wells, one-quarter and one-half mile North of No. 1, flowing 1 or 2 gallons per minute.

C. W. Collins's well, in the N. E. quarter S. E. quarter Section 17, Township 18, Range 4; old well; flow, one-half gallon per minute; water rises to 3 feet above the ground; temperature, 68 1-2°.

Mrs. Julian Collins's well, 2 miles northeast of Gallion, in the S. W. quarter Section 19, Township 18, Range 4; old well; flows good stream.

C. W. Collins's wells, 1 1-2 to 2 miles northeast of Gallion (old wells): No 1, at house, in the S. W. quarter S. W. quarter Section 27, Township 18, Range 4; depth, 1200 feet; formerly flowed; water now stands at -8 feet. No. 2, at house; bored in 1891; depth, 1500 feet; overflow from about 750 feet; thickness of lime rock, 250 feet; at 1250 feet encountered red stratum. No. 3, 3 miles northeast from Gallion, in Section 22, Township 18, Range 4; depth, 600 or 700 feet; flow, 5 gallons per minute; temperature, 72°; thickness of lime rock, 250 feet. No. 4, 3 miles northeast of Gallion, in Section 23, Township 18, Range 4; depth, 600 or 700 feet; flow, 7 1-2 gallons per minute; water rises to 4 feet above the surface; temperature, 71°. No. 5, in Section 15, Township 18, Range 4; depth, 600 or 700 feet; flow, 2 gallons per minute; temperature, 69°.

B. M. Allen's wells, 3 miles east of Gallion; two old wells, no longer flowing. Mr. Allen has recently had other wells bored of which records have not been obtained.

Wells on Dunlap place: No. 1, 1 1-2 miles north of Prairieville; flow, 20 gallons per minute. No. 2, 1 mile southwest of No. 1; flow, 2 gallons per minute.

FAUNSDALE AND VICINITY.

Well on Madden place, 3 miles north of Faunsdale, owned by Garber Brothers; flow, 1 gallon per minute; temperature, 69°.

Wells on Drake place: No. 1, 3 miles north of Faunsdale; flow one-quarter gallon per minute; rises to 2 feet above ground; temperature, 69°. No. 2, one-quarter mile southwest of No. 1; flow, one-half gallon per minute; rises to 2 feet above ground. No. 3, one-quarter mile southwest of No. 1; flow, 1 gallon per minute; water stands at surface. No. 4, 200 yards east of No. 1; flow, 30 gallons per minute; temperature, 75°; recently cleaned.

Wells on Croom place, owned by J. H. Minge (old wells): No. 1, 3 miles north of Faunsdale; flow, 1 1-3 gallons per minute; rises to 4 feet above the ground; temperature, 70°. No. 2, one-quarter mile east of No. 1; flow, one-quarter gallon per minute; rises to 2 feet abovetheground; temperature, 70°. No. 3, 1 mile south of No. 1; 1 gallon per minute; rises to 3 feet above the ground; temperature, 69°.

Well of Mr. London, of Birmingham, 6 miles south of Newberne, and about same distance north of Faunsdale; bored by Kinnaird & Sample in 1902; depth, 500 feet; 3-inch casing; overflowing water obtained at a depth of 500 feet after three days; flow, 5 gallons per minute; temperature, 68°. Record: Soil 0-8 feet; blue rock with occasional strata of sand, 8-500 feet.

PERRY COUNTY.

SHALLOW WATERS.

On account of its great extent from north to south, Perry County embraces within its borders all four of the Cretaceous formations and exhibits in consequence much variety in its topography and soils. The northeastern part down nearly to the latitude of Marion is underlain by the Tuscaloosa formation, cross-bedded sands of many colors, with strata of massive or joint clay of mottled red, purple, brown, and gray colors. In all this section the country is somewhat hilly, and the surface soils, being formed either by the sandy strata of the Tuscaloosa or the equally sandy beds of the overlying Lafayette, are well suited for absorbing and transmitting the waters which fall upon them. Generally, therefore, in this section there is no dearth of water to be had from wells and hillside springs. Many of the wells, however, have a tendency to go partially dry in the winter season.

The Eutaw formation, composed of sands and laminated clays, makes a narrow belt between the Tuscaloosa and the Selma chalk. Very nearly the same conditions of topography and soils prevail here as in the Tuscaloosa area, and open wells and springs are numerous.

In the limestone territory, on the other hand, shallow waters are deficient and deep wells correspondingly more numerous.

Some of the springs in the Tuscaloosa and Eutaw terranes are well known, and a few of them may be mentioned: The Popular Spring, near the old town of Hamburg, 5 miles south of Marion, is a cold spring boiling up through the sands; half a mile southeast of this is a similar spring, the Norman; 8 miles southeast of Marion, on the Fikes place, 1 mile from the bridge, is a spring, small but constant in all seasons, temperature, 66°; 12 miles a little east of south of Marion, is the Haynesworth Spring of chalybeate water; 13 miles west of Marion is Dr. W. T. Downey's sulphur spring; 11 miles west of Marion on R. M. Foster's place, are several springs; in the corporate limits of Marion is the Magnesia Spring, on the Perkins place; 3 1-2 miles east of Marion on the road to Sprott, are the Clinton Springs which comprise several springs of sulphur and iron waters; 4 1-2 miles due east of Marion are the Burroughs' Springs, of mineral quality, some of them chalybeate; half a mile due north of Burroughs are several chalybeate springs; 5 miles east of Marion in sec. 26, T. 20, R. 8, is C. W. Ford's spring, strong of iron and formerly much used by Marion people.

Artesian Waters.

The Tuscaloosa and Eutaw sands are in this county, as elsewhere, the water-bearing sands of the artesian wells. Notwithstanding the fact that the territory of these formations is fairly well supplied supplied with shallow wells, the records show also a number of artesian wells here.

WELLS IN THE TUSCALOOSA FORMATION.

The six wells recorded below are located on the outcrop of the Tuscaloosa in the northern and northeastern parts of the county, and obtain water from that formation.

Well on Hornbuckle place, owned by H. A. Peters, near LeVert, in the S. E. quarter N. E. Quarter Section 34, Township 21, Range 8; flow, 12 gallons per minute; water rises to 5 feet above the ground; 6-inch casing; temperature, 65°. This well was bored over 40 years ago, about the same time as the Sprott well No. 3. There were a number of these old wells in the vicinity, but all have stopped flowing except these two.

T. M. Wallace's well, 8 miles northeast of Marion, in the N. W. quarter Section 14 or N. E. quarter Section 15, Township 20, Range 8; bored by a negro in 1898; depth, 250 feet; cased to bottom with 5, 4, and 3 1-2 inch casing; first overflow at 100 feet; second overflow at 150 feet, bold stream; present flow, one-half gallon per minute; temperature, 65 1-2°. No hard rock, but principally sand, with one or two strata of blue rock. Partly bituminized logs were encountered between 50 and 100 feet.

Lovelace well, 6 miles a little north of east of Marion; old well; formerly overflowed; water now rises just to the surface; used as a kind of cistern.

Sprott wells: No. 1, at house, in the N. W. quarter N. W. quarter Section 31, Township 20, Range 9; bored by hand in 1886; depth, 150 feet; cased to bottom with 4 and 6 inch casing; temperature, 66°. At 150 feet water rose 2 feet above surface; on penetrating a thin stratum of rock at this depth, the water rushed up with great violence, flowing 60 gallons per minute. Record: Sand, 0-30 feet; Tuscaloosa formation, 30-150 feet; then a few inches of hard rock. No. 2, at quarter, 1 mile south of No. 1, in the N. W. quarter N. W. quarter Section 6, Township 19, Range

9 E.; bored by hand in 1895; depth, 150 feet; cased to bottom with 4 and 6 inch pipe; flow, 1 gallon per minute; temperature, 66°. Record: Sand, 0-30 feet; Tuscaloosa formation, 30-150 feet. No. 3, on Wallace place, 3 miles nearly south of No. 1, in the S. W. quarter Section 1, Township 19, Range 8; very old well; depth, 150 feet; flow, 12 gallons per minute, originally much stronger; recently cased to bottom with 4-inch casing; temperature, 65°. Record: Sand, 0-30 feet; Tuscaloosa formation, 30-150 feet.

WELLS IN THE EUTAW FORMATION.

On the Eutaw outcrop as on the Tuscaloosa, bored wells are not so numerous as in the region of the Selma chalk, but a few wells are recorded about Marion and to the southeast near Radfordville and Felix.

MARION AND VICINITY.

Town well, Marion, in the E. half Section 12, Township 19, Range 7; bored in 1898; depth, 650 feet; 6-inch casing; water stands at -150 feet.

Well at old Ike Underwood place, 6 miles southwest of Marion, in the N. W. quarter Section 28, Township 19, Range 7; flow, 2 gallons per minute; temperature, 66°.

Well on Ed. Craig place; old well; flows very weak stream.

Peyton Tutwiler's wells (old): No. 1, in the S. W. quarter Section 16 or 17, Township 19, Range 7; 5 miles west of Marion; flow, 1 gallon per minute; temperature, 66°. No. 2, one-half mile west of No. 1; estimated flow, 10 gallons per minute; temperature, 66°. Nos. 3 and 4 are in decay.

OLD HAMBURG.

In and around the town of old Hamburg, close to the contact of the Eutaw with the chalk formation, but on the former, are many old wells yielding bold streams of fine drinking water. As the town has gone down, many of these old wells have fallen into disuse.

RADFORDVILLE.

J. S. Alexander's wells, near Radfordville: No. 1, in Section 32, Township 19, Range 9; diameter, 8 inches; flows 18 gallons per minute; water rises to 4 feet above the ground; temperature, 66°; tastes strong of iron. No. 2, in the N. E. quarter N. E. quarter Section 6, Township 18, Range 9; bored about 1859; depth 250 feet; 8-inch casing; original flow, 35 gallons per minute at 4 feet above the ground; present flow, 50 or 60 gallons per minute at surface; temperature, 66°; tastes strong of iron.

W. B. Alexander's wells, near Radfordville: No. 1, one-half mile east from J. S. Alexander's well No. 1; depth, 250 to 300 feet; 8-inch casing; estimated flow, 50 gallons per minute, in decay; temperature, 67°; tastes strong of iron. No. 2, bored by an old negro in 1897; depth, 150 feet; casing 50 feet, 4-inch; first water at 150 feet; flow, 20 gallons per minute; water rises to 4 feet above the ground.

FELIX AND VICINITY.

Walter Smith's well, near Felix; bored by W. Suttle in 1903; depth, 210 feet, 4-inch casing; first water at 210 feet; flow, 12 gallons per minute; water rises to 4 feet above the ground; temperature, 66°.

Wells on Suttle & Jones plantation, near Felix: No. 1, at Mr. Suttle's house, in the northeast corner of the N. E. quarter S. W. quarter Section 16, Township 18, Range 9; bored in December 1902, by Mr. Suttle; depth, 220 feet; casing, 40 feet, 4-inch; first water at 100 feet, overflowed; third water at 220 feet, flow, 12 gallons per minute; temperature, 67°. Record: Clay, 0-16 feet; gravel, 16-18 feet; clay, 18-35 feet; blue rock, 35-100 feet; successive layers of white and black sand and some sand rock, 100-220 feet. Water tastes very strong of iron. No. 2, 200 yards north of No. 1, at gin, in the S. E. quarter N. W. quarter Section 16, Township 18, Range 9; bored in 1898 by Pat Gilmore; depth, 198 feet; casing, 32 feet, 4-inch; flow, 8 gallons per minute; temperature, 67°. No. 3, 2 miles west of north of No. 1, at fork of roads near Edwards place, in the N. W. quarter N. E. quarter Section 8, Township 18, Range 9; bored by Suttle in 1897; depth, 96 feet; casing, 4-inch; record same as No. 1. No. 4, 2 miles west of north from No. 1, in the N. W. quarter N. W. quarter Section 8, Township 18, Range 9; bored by Suttle in 1903; depth, 180 feet; casing, 30 feet, 4-inch; first water at 100 feet; second water at 180 feet; both overflowed; yield, 9 gallons per minute; temperature, 66°. No. 5. 2 1-2 miles northwest of No. 1, in the center of the N. E. quarter Section 7, Township 18, Range 9; bored by Suttle in 1903; depth, 186 feet; casing, 35 feet, 4-inch; first water at 100 feet; second water at 186 feet; both overflowed; estimated yield, 11 gallons per minute; temperature, 66°; record same as No. 1. No. 6, 1 mile west of north of No. 1, at Goshen place, in the center of the S. E. quarter Section 8, Township 18, Range 9; in every particular about the same as No. 1. No. 7, 2 miles west of north of No. 1; old well at W. S. Suttle's residence, Edwards place, in the N. E. quarter N. W. quarter Section 8, Township 18, Range 9; bored about 1852; depth, 225 feet; diameter 6 inches; estimated flow, 25 gallons per minute; temperature, 66°. Nos. 8 to 14, all within 3 miles of Felix, are old wells bored about 1850; casing, 4 and 6 inch; some are rather weak now, but all were formerly good strong wells:

No. 8, on Vaughn place, in the N. W. quarter N. W. quarter Section 9, Township 18, Range 9;

No. 9, on Vanderslice place, in the N. W. quarter N. W. quarter Section 21, Township 18, Range 9;

No. 10, on Vanderslice place, in the S. E. quarter N. E. quarter Section 20, Township 18, Range 9;

No. 11, on Swift place, in the S. E. quarter S. E. quarter Section 28. Township 18, Range 9;

No. 12, on Cooper place, in the N. W. quarter S. E. quarter Section 35, Township 18, Range 9;

Nos. 13 and 14, on Davis place, in the N. W. quarter N. E. quarter, Section 2, Township 17, Range 9.

WELLS IN THE SELMA CHALK.

Most of the bored wells are naturally found in the relatively small area of the Selma chalk in the southwestern part of the county. These wells get their supply generally from the Eutaw sands, the depth to which increases southward and southwestward.

UNIONTOWN AND VICINITY.

The deepest of the wells on the Selma chalk is at Uniontown, which is also the southerlymost point from which wells are recorded in Perry County. The altitude of Uniontown is 286 feet, and the water stands at -120 feet. Depth of well (reported by the mayor in 1898), 1195 feet; diameter, 8 inches; water comes from the second horizon at 870 feet; raised by air-lift; volume, 300 gallons per minute; supply seems inexhaustible; temperature, 79°; the quality of the water, good, only 178.0 parts per million of dissolved solids; supply ample for the present needs of the town.

J. C. Welch's well, reported in 1898; depth, 895 feet; 8-inch casing to bottom; water stands at -125 feet; temperature, about 68°.

G. D. Stollenwerck's well, 3 1-2 miles north of Uniontown; bored by Hawk in September, 1903; depth, 590 feet; casing, 275 feet, 2 and 4 inch; first water at 400 feet; second water, at 540 feet, stands at -60 feet; depth to principal supply, 550 feet; pump used; depth to blue rock, 20 feet; thickness of blue rock, 350 feet.

G. B. Johnston's well, 10 miles south of Uniontown; bored by J. I. Hawk in 1904; depth, 875 feet; diameter, 4 and 3 inches; depth to principal supply, 855 feet; water stands at -40 feet; yield, 10 gallons per minute with pump; water stratum at 175 feet.

SCOTTS STATION.

Howze Scott's wells, Scotts Station; 5 old, nonflowing wells; water stands at from 3 to 30 feet from surface, as it does in all the wells in this vicinity; age of wells not known; depth generally supposed to be from 85 to 300 feet.

A. B. Gewin's well, Scotts Station, 300 yards northwest of station; depth, 62 feet; casing, 18 feet, 4-inch.

W. A. Thigpen's well, 3 miles south of Scotts Station; bored by a negro in 1896; depth, 100 feet; casing, 18 feet, 4-inch.

SOUTHWARD FROM MARION.

Wells on Billingsley place: No. 1, in the N. half of N. half Section 5, Township 18, Range 7, 7 miles southwest of Marion; in decay, flow decreasing. No. 2, in the N. half Section 5, Township 18, Range 7; estimated flow, 1 gallon per minute; temperature, 66°. Nos. 3, 4 and 5 are decreasing in flow; no other data.

J. C. Tidmore's wells: No. 1, 8 miles south of Marion, on Lee place, in Section 28, Township 18, Range 8 E.; depth, 135 feet; bored with 4-inch auger. Record: Soil, 0-20 feet; blue rock at 22 feet. No. 2, one-quarter mile from No. 1, yields water of a dark color, not drinkable. No. 3, 1 mile from No. 1, in the same hollow, yields water similar to No. 2, but not so bad. The character of the water from well No. 1 above is shown by the following analysis, by Mr. Hodges:

Analysis of water from Tidmore well No. 1, 8 miles south of Marion.

	Parts per million.
Potassium (K)	11.3
Sodium (Na)	177.6
Magnesium (Mg)	85.2
Calcium (Ca)	857.6
Iron and Alumina (Fe_2O_3,Al_2O_3)	16.8
Chlorine (Cl)	661.1
Sulphuric acid (SO_4)	1448.5
Carbonic acid (HCO_3)	546.5
Silica (SiO_2)	54.4
	3859.0

HAMBURG STATION AND VICINITY.

J. T. Fitzgerald's wells (old), on plantation at Hamburg station: No. 1, 1 mile southwest of Hamburg, in the S. E. quarter Section 19, Township 18, Range 8; flow, three-quarter gallons per minute; temperature, 66°. No. 2, 1 1-2 miles west of Hamburg, in the N. W. quarter S. E. quater Section 19, Township 18, Range 8; flow, 1 1-2 gallons per minute; water rises to 2 feet above the ground; temperature, 66°. No. 3, 2 miles southwest of Hamburg, in the N. W. quarter Section 30, Township 18, Range 8; flow, 1 gallon per minute; temperature, 66°. No. 4, 2 miles southwest of Hamburg, in the N. W. quarter Section 30, Township 18, Range 8; flow, 2 gallons per minute; temperature, 66°. Nos. 5 and 6 are in decay and decreasing in flow.

J. S. Blackman's well, 2 1-2 miles southwest of Hamburg, in the W. half N. W. quarter Section 30, Township 18, Range 8; flow, 2 gallons per minute; temperature, 66°.

R. B. Wallace's wells (old): No. 1, 2 miles southwest of Hamburg, in the S. W. quarter Section 29, Township 18, Range 8; flow, one-quarter gallon per minute; temperature, 66°. No. 2, 2 1-2 miles southwest of Hamburg; flow, 3 gallons per minute; water rises to 2 feet above the ground; temperature, 65°. No. 3, no longer flows; water stands at -40 feet; pump used.

Wells of Jones & Stewart, of Marion: No. 1, 3 miles west of south of Hamburg, in Section 31, Township 18, Range 8; water stands at -5 feet. No. 2, one-fourth mile north of No. 1; does not flow; water stands at -5 feet. No. 3, one-half mile west of No. 1, flow, 1 1-2 gallons per minute; temperature, 66°. No. 4, 1 1-4 miles west of No. 1; flow, 1 gallon per minute; temperature, 66°. No. 5, 1 1-4 miles west of No. 1; flow, 2 gallons per minute; temperature, 66°. These are all old wells.

B. Tubbs and R. Tubbs each has an old, nonflowing well, 10 miles south of Marion. No information obtainable.

Judge Shivers's well, on Tarrant place, 11 miles south of Marion; nonflowing.

Well of Mrs. McCarroll, of Marion, 4 miles southwest of Hamburg, in the N. W. quarter Section 5, Township 17, Range 8; flow, 5 gallons per minute; temperature, 67°.

MARION JUNCTION AND VICINITY.

Many of the wells in this vicinity, north and northeast of Marion Junction, are close to the county line, and there is occasionally some uncertainty as to whether they should be credited to Dallas or Perry County. Where the locations are given above in Township 17, Range 9, it would seem that they should come under Dallas, though the best information obtainable credits them to Perry. It is therefore quite probable that the records of localities by the land numbers may be at fault.

Mrs. Chisholm's well, 5 miles northeast of Marion Junction, in the S. E. quarter N. E. quarter Section 6, Township 17, Range 9, 150 yards from County line; flow, 1 gallon per minute; temperature, 69°; old well.

Gordon Chisholm's well, 4 miles northeast of Marion Junction, at mill, in the N. E. quarter N. W. quarter Section 5, Township 17, Range 9; old well; estimated flow, 12 gallons per minute; water rises to 3 feet above the ground; temperature, 68 1-2°.

Johnny Chisholm's wells: No. 1, 4 miles northeast of Marion Junction, adjoining Gordon Chisholm's place on the west; old well; flow, one-half gallon per minute; water rises to 1 foot above the ground; temperature, 68°. No. 2, one-quarter mile east of No. 1; new well; bored by Patrick Gilmore in 1898; depth, 70 feet; flow, constant, 1 1-2 gallons per minute; temperature, 66°. This well is located about 2 miles from the limestone belt. Record: Blue rock, 0-69 feet; hard rock, water, 69-70 feet.

Brown well, 150 yards from county line, one-quarter mile east of Mrs. Chisholm's well; flow, one-quarter gallon per minute; temperature, 66°; old well.

Sallie White's wells (old): No. 1, 5 1-2 miles northeast of Marion Junction, just beyond the bridge; estimated flow, 5 gallons per minute; water rises to 2 feet above the ground. No. 2, one-quarter mile east of No. 1, on south side of road from Marion Junction to Selma; flows 10 gallons per minute; temperature, 67°.

Well of W. J. & E. T. Gilmer, 3 1-2 miles Northeast of Marion Junction, 100 yards from county line; new well; bored by a negro in 1902; depth, 143 feet; water stands at -12 feet; stopped at first water. Record: Prairie soil; 0-15 feet; lime rock, 15-130 feet; sand rock, 130-131 feet; sand, 131-143 feet. Broke tool in second sand rock at 143 feet.

MARENGO COUNTY.

SURFACE FEATURES.

The surface rocks in a narrow strip in the northern part of Marengo County are the upper members of the "rotten limestone," or Selma chalk. These rocks have the usual character, except that the limestone is at the top more mixed with clay than is generally the case and abounds in fossils, mainly

Exogyra and *Gryphaea*. Next below the fossiliferous stratum comes a very pure whitish limestone, which is now utilized at Demopolis in the manufacture of Portland cement. This bed of pure limestone extends across the county by Van Dorn, Gallion, and Faunsdale to Uniontown and beyond. The strata of the Ripley formation outcrop in a belt just south of the Selma chalk. These beds are, in their disintegrated form at least, prevalently sandy, but below the zone of weathering they consist of sandy limestones or highly calcareous sandstones The sands which lie at the surface over all this Ripley belt might be supposed to indicate that this formation would be a good water bearer, but such is not the case, at least so far as artesian waters are concerned, for in the Flatwoods belt adjoining the Ripley on the south, artesian borings have not generally resulted in overflowing wells. The surface sands give rise to fairly good wells, and springs are found along the edges of the ravines and washes, the water in both cases being usually rather strongly impregnated with lime.

Although the Selma chalk outcrops only in the upper part of Marengo County, it is within this area that most of the artesian wells are found. These have a great thickness of the chalk to penetrate before reaching the water-bearing sands of the Eutaw and they are consequently deep.

Artesian Records.

DEMOPOLIS AND VICINITY.

At Demopolis, on Tombigbee River, artesian wells supply the town water works. The records of these borings are given below, together with those of other wells in and around the city.

City well, Demopolis, in the S. E. quarter Section 24, Township 18, Range 2; bored by Jackson in 1885; depth, 775 feet; flow, 50 gallons per minute.

City waterworks wells, Demopolis, in the S. E. quarter Section 24, Township 18, Range 2; No. 1, bored by Mr. Lipscomb in 1898; depth, 765 feet; diameter, 3 inches; water rises to 20 feet above the ground; original flow, 15 gallons per minute; present flow, 6 gallons per minute; temperature, 73°. No. 2, depth, 735 feet; diameter, 4 inches; water rises to 12 feet above the surface; flow, 30 gallons per minute.

New city wells, Demopolis, in the S. E. quarter Section 24, Township 18, Range 2; two wells, 50 feet apart; bored by J. I. Hawk in 1902; depth, 900 feet; first flow at 800 feet; yield, about 150 gallons per minute. Record: Lime rock, 0-500 feet; sand, 500-900 feet; at about 700 feet in one well, a thin rock, very hard, not found in the other well. A sample of this water has been analyzed by Mr. Hodges, with the following results:

Analysis of water from wells of the Demopolis waterworks.

	Parts per million.
Sodium (Na)	255.8
Magnesium (Mg)	1.1
Calcium (Ca)	3.7
Iron and alumina (Fe_2O_3,Al_2O_3)	4.0
Chlorine (Cl)	40.6
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	624.0
Silica (SiO_2)	22.1
	951.3

Leder Oil Company's well, Demopolis, on eastern edge of town, in the S. W. quarter Section 24, Township 18, Range 2; bored by Hawk in May, 1902; depth, 765 feet; casing 325 feet, 4-inch and 2-inch; first water at 550 feet, stand -10 feet; second water at 650 feet, stand -2 feet; third water at 750 feet, stand 10 feet above the ground; depth to principal supply, 750 feet; original flow, 12 gallon per minute; depth to blue rock, 8 feet; thickness of blue rock, 500 feet.

Demopolis Cooperage Company's wells, on eastern edge of town, in the S. W. quarter Section 24, Township 18, Range 2; bored in June, 1902, by Hawk, depth, 750 feet; casing 325 feet, 2 1-2-inch and 4-inch; first water at 525 feet, stand -2 feet; second water at 625 feet, stand 8 feet above the ground; third water at 735 feet, stand 20 feet above the ground; depth to principal supply, 735 feet; flow, 35 gallons per minute; depth to blue rock, 38 feet; thickness of blue rock, 485 feet.

Demopolis Ice and Cold Storage Company's well, in the S. E. quarter Section 24, Township 18, Range 2; bored by Lipscomb in 1901; depth, 835 feet; casing, 300 feet, 4-inch, 535 feet 3-inch; first water at 525 feet; second water at 625 feet, flowing 6 gallons per minute; third water at 835 feet, flowing 60 gallons per minute; present flow (estimated), 35 gallons per minute. Record: Lime rock, 0-525 feet; sand, 525-575 feet; sand rock, 575-576 feet; sand, with occasional thin rock, 576-835 feet.

Well on George A. Kli place, Demopolis, in the S. E. quarter Section 19, Township 18, Range 2; flows 1 1-2 gallons per minute; temperature, 82°.

John C. Webb's wells, Demopolis, in the S. W. quarter Section 24, Township 18, Range 2: No. 1, at Compress; bored by Stevens; estimated flow, 25 gallons per minute; temperature, 75°. No. 2, bored by Stevens; flow, 25 gallons per minute; temperature, 75°.

John C. Webb's wells, near Demopolis: No. 1, on Sharp place, 3 1-2 miles northeast of Demopolis; bored by Hawk in November, 1901; depth, 661 feet; casing 350 feet, 2-inch and 4-inch; first water at 490 feet, stand -12 feet; second water at 550 feet, stand -4 feet; third water at 650 feet, stand 4 feet above the ground; depth to principal supply, 650 feet; original flow, 5 gallons per minute; depth to blue rock, 16 feet; thickness of blue rock, 430 feet. No. 2, on Baumgarten place, 4 miles southeast of Demopolis; bored by Hawk in January, 1902; depth, 755 feet; casing 350 feet, 2-inch and 4-inch; first water at 600 feet; -10 feet; second water 675 feet, stand, -4 feet; third water at 750 feet, stand 8 feet above the ground; depth to principal supply, 750 feet; original flow, 10 gallons per minute; depth to blue rock, 14 feet; thickness of blue rock, 540 feet. No. 3, on Sledge place, 4 3-4 miles south of Demopolis; bored by Hawk in July, 1902; depth, 1040 feet; casing, 300 feet, 3-inch and 4-inch; first water at

825 feet, stand —80 feet; second water at 950 feet, stand -70 feet; depth to principal supply, 950 feet; does not flow; pump used; depth to blue rock, 16 feet; thickness of blue rock, 750 feet.

Jesse Whitfield's wells, on Gaineswood place: No. 1, one-quarter mile south of Demopolis, in the N. E. quarter Section 25, Township 18, Range 2; flow decreasing so that it forms a kind of spring. No. 2, 1 mile south of No. 1, in the N. E. quarter Section 36, Township 18, Range 2; old well; no longer flows.

Gaineswood well, near Demopolis, one-half mile south of ice factory; in the N. E. quarter Section 25, Township 18, Range 2; bored about 1864; when the ice-factory well was bored this well ceased to flow.

Alabama Portland Cement Company's well, at Spocari, near Demopolis, in the S. E. quarter Section 19, Township 18, Range 3; bored by Stevens in 1900; depth, about 750 feet; flow, 100 gallons per minute; water rose to 20 feet above the ground; first water, at 475 feet, barely overflowed; principal supply from 750 feet. Record: Lime rock, 0-450 feet; sand and thin sand rock, 450-750 feet.

R. P. Knox's well, Demopolis; bored by Hawk in 1904; depth, 911 feet; flows.

Bessie Minge Manufacturing Company's well, Demopolis, in Section 26, Township 18, Range 2; bored by Fred Braswell; depth, over 700 feet; 400 feet through the lime rock; flow, 20 gallons per minute; temperature, 75°.

Black Warrior Lumber Company's well, Demopolis; bored by Hawk in 1904; depth, 760 feet; flows.

—. P. Allen's well, 3 miles south of Demopolis, N. E. quarter S. W. quarter Section 1, Township 17, Range, 2; bored by Stephens in 1895; depth, 1175 feet; casing, 1030 feet, 2-inch; estimated flow, 8 gallons per minute; water rises to 9 feet above the ground; overflow at 1030 and 1175 feet. Record: Lime rock, 0-650 feet; sand with occasional rock, 650-1030 feet; gravel, 1030-1040 feet; pink soapstone, 1040-1175 feet.

D. H. Britton's well, in the N. half S. W. quarter Section 20, Township 17, Range 4; old well; no record available.

Well at Van Dorn station, 3 or 4 miles east of Demopolis; flows good stream.

GALLION AND VICINITY.

Wells on Windsor place, owned by Thornton Tayloe, 2 miles southeast of Gallion, in the S. half Section 9, Township 17, Range 4, E.; four old wells: No. 1, flow, 2 gallons per minute; temperature, 74°. The four wells are in a radius of 1 mile; two of them no longer flow, and the fourth well flows about 2 gallons per minute.

Well on Ross place, 6 miles south of Gallion, in the S. W. quarter Section 34, Township 17, Range 4, E.; flow, one-half gallon per minute; water rises to 3 feet above the ground.. temperature, 69°.

FAUNSDALE AND VICINITY.

John Minge's well, on Body place, 5 miles southwest of Faunsdale; bored in 1903 by A. J. Dallings; no record since completion; first water, at 420 feet, stood at -6 feet. Record: Soil, 0-12 feet; blue rock, 12-420 feet; sand, 420-500 feet.

Well on Palmetto place, 3 or 4 miles southwest of Faunsdale; owned by Alex Archer; estimated flow, 4 gallons per minute; water rises to 4 feet above the ground; temperature, 74°.

Wells on Smaw place, 3 1-2 miles north of west of Faunsdale; three old wells; all flow from one-quarter to 1 gallon per minute; temperature, 69°.

Well on Gholson place, 2 1-2 miles north of west of Faunsdale; depth, 300-500 feet; flows half-inch stream.

Minge Wilkins's wells (old), 2 miles north of west of Faunsdale; bored about 1845: No. 1, depth, 360 feet; diameter, 3-inches; flow one-tenth of a gallon per minute. No. 2, three-fourths mile west of No. 1; depth, 400 feet; flow, one-tenth of a gallon per minute.

Wells on Selden place, 1 1-2 miles north of Faunsdale; two old bored wells, not flowing at present.

C. D. Walker's wells, one-half mile northeast of Faunsdale; three old wells, one of them barely flowing at surface, the other two having stopped; depth supposed to be about 450 feet.

Mims Walker's wells, Faunsdale; five wells; depths, 450, 450, 560, 650. and 830 feet; start in the Selma chalk and obtain water from the Eutaw sands; four of them overflow with small streams; yield of one is 15 to 20 gallons per minute; others can not be exhausted by deep-well pump; from the 830-foot well a windmill fills a 5,000- gallon tank in 12 hours with no decrease in volume.

Well about 3 1-2 miles north of Faunsdale, reported to be 700 feet deep; yield, 8 gallons per minute; water rises to 2 1-2 feet above the ground; blue rock at a depth of 230 feet.

Faunsdale Oil Mill well, bored by A. J. Dallings in 1901; depth, 700 feet; diameter, 6 inches; water stands at -45 feet; air-lift used; level varies with amount pumped. Record: Blue rock, 0-400 feet; sand, 400-550 feet; flint rock, 550-551 feet; sand, 551-625 feet; hard rock, 625-626 feet; sand, 626-700 feet.

J. C. Brown's well, Faunsdale; bored by a negro in 1899; depth, 560 feet; first water at 540 feet, stand -70 feet, level lowered by pumping; second water at 550 feet, stands at -84 feet. Record: Marl, 0-540 feet; at 540 feet a thin stratum of sand, then 18 inches of flint rock, and greensand at bottom of boring.

NEAR OLD SPRING HILL.

Mrs. Charles Allen's well, 2 1-2 miles east of Old Spring Hill; depth, 1400 feet; at 900 feet water stood at -30 feet; at 1400 feet water stood at -12 feet.

DAYTON.

About Dayton are several wells which date from ante-bellum days and of which no records are now obtainable; but they have, according to the best available information, all gone through the limestone into the underlying Eutaw sands.

LINDEN.

At Linden, which is on the extreme southern border of the Cretaceous, a well has been put down through the whole thickness of the Ripley formation and the "rotten limestone." As Linden is located near the lowlands of the Chickasabogue, the full thickness of the Ripley sands is not here present, as the record of the well will show. The well is in the court-house yard, and the record of the borings, as furnished by Prof. L. G. Biggers, is as follows:

Record of Court House well, Linden.

	Feet.
Clay	0--7
Soft Limestone	7--34
Quicksand	34--58
Blue sand	58--68
Quicksand with mica	68-118
Pure white sand	118--168
Blue sand	168--188
Hard bluestone	188--190
Soft shale or clay	193--322
Light-colored limestone, like that at Demopolis	322--501
Limestone, slaty and darker than the preceding	501--901
Similar rock, but harder and ending below in a hard crust	901-1041

At 1040 feet, a hard shell of stone was pierced, below which came a fine-grained, water-bearing sand. Below this, at 1115 feet, a limestone (or clay), very hard, to bottom of well; but the boring went down to 1200 feet, through soft limestone (?) and white and gray clay; there was also some quicksand below the bed rock at 1115 feet. The stream rises about 18 inches above the surface of the court-house yard, but the flow is very weak, only about 18 or 20 gallons to the hour; temperature of the water is 73°, and the taste saline. It is said that a pump throwing 1 1-2-inch stream and worked continuously for seven or eight hours did not lower the water in the pipe below 16 feet. If this is the case, the obvious means of increasing the flow would be to pipe off the water at this depth, and there is enough slope to accomplish this without trouble.*

*Since the above was written this has been done, and a good flow is obtained at the present mouth of the well, 20 feet, more or less, below the level of the court-house yard.

The Linden well and that at Livingston, Sumter County, are similarly located as to geologic formations; both pierce the Ripley and the whole thickness of the Selma chalk, though this is not quite so evident here as at Livingston. In both places the stream is weak and the water saline.

The writer's interpretation of the record above is that the line between the Ripley and the Selma Chalk will fall somewhere within the soft shale or clay, 132 feet thick, between 190 and 322 feet; and that the strata below that to 1115 feet are the chalk formation, and the rest Eutaw, though, as has been said above, this is not very apparent.

The character of the water from the Linden public well is shown by the accompanying analysis by Mr. Hodges:

Aanalysis of water from court-house well, Linden.

	Parts per million.
Potassium (K)	trace
Sodium (Na)	550.0
Magnesium (Mg)	1.6
Calcium (Ca)	7.2
Iron and Alumina (Fe_2O_3, Al_2O_3)	5.0
Chlorine (Cl)	445.1
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	719.2
Silica (SiO_2)	17.8
	1745.9

Southern Cotton Company well, Linden, in the S. E. quarter N. E. quarter Section 5, Township 15, Range 3; bored by S. W. Ingram in 1902; depth, 550 feet; casing, 80 feet, 6-inch; first water at 500 feet; second water, at 550 feet, stood at -18 feet; yield, 25 gallons per minute for a week, lowering level to -33 feet.

Judge S. P. Prowell's well at Linden, about 200 yards north of depot. Depth 1100 feet; diameter 6 inches; casing to bottom. Present flow about one half gallon per minute at 6 feet elevation above the surface; original flow 2 gallons per minute. Taste and effect decidedly those of epsom salts. Record, sand about 100 feet, then lime rock to depth not given.

FLATWOODS OR POST OAKS.

South of Linden is the belt of Flatwoods or Post Oaks, as the lands have been called. The surface of this belt is occupied by the clays of the lowermost Tertiary. Near their contact with the Ripley the clays are strongly limed by the washings from that formation and make a sort of black prairie country of great fertility. The main body of the Flatwoods, however, away from this contact, contains comparatively little lime. The surface is a trough between the sandy calcareous hills of the Ripley, on the one side, and the high Tertiary hills capped with the red loam and pebbles of the Lafayette, on the other. On account of the dearth of water during the summer and the excess of it during the winter, and spring, cultivation of the Flatwoods land is out of the question, except locally where a remnant of sand of an overlying formation has escaped removal by denudation. For water the few inhabitants, mostly negroes, depend on cisterns dug into the clay and filled from the house-tops. Another drawback to cultivation of the Flatwoods is the defective drainage, but this might be overcome if the water problem were solved.

The following notes concerning the artesian borings in the Flatwoods of Marengo County have been furnished by Mr. C. B. Wooten, of Consul. These examples will serve to show that good water may be obtained in the Flatwoods by deep borings.

In the vicinity of Whitehall, 15 miles east of Linden, in 1857 and 1858, seven wells were bored in or near the plantation of Colonel Watts, in the midst of the Flatwoods or Post Oak belt. These wells ranged in depth from 350 to 800 feet; the first water struck in any of the borings was at 320 feet, and it rose to within 40 or 50 feet of the surface; water was sulphurous and chalybeate. Colonel Watt's place was 2 miles south of the Linden and Cahaba road, 6 miles from McKinley, and 2 miles from Thomaston.

Mr. Wooten, in 1858, had a well bored to the depth of 320 feet, getting splendid water which rose to within 60 feet of the surface.

Since the completion of the Louisville and Nashville railroad to Myrtlewood, several deep wells have been sunk within the territory of the Flatwoods. These borings, however, do not seem to have obtained any water from the Ripley sands, but have gone through the Selma chalk into the Eutaw sands, like the well at Linden. Through the courtesy of Mr. J. R. Nevers we are enabled to give some account of a deep well at Cates. in Section 10, Township 15, Range 2 east.

Well at Cates: Depth 1140 feet; diameter 3 inches; cased with 3-inch casing to depth not given; depth to water 1120 feet; overflowing 25 gallons per minute. No decrease since the beginning in 1906. The water is salty and is used only for drinking purposes. It is said to be of about the same character as the water from the Livingston well in Greene county.

Record: Clay 0- 12 feet; black soapstone (Sucarnochee clay) with a little sand but no water, 12- 162 feet; limestone (Selma chalk) with occasional hard ledges, 162 - 1000 feet; hard rock, 1000 - 1080 feet; water bearing sands, 1080 - 1140 feet. No water was obtained until the depth of 1080 feet had been reached; the water bearing sands are 60 feet in thickness and the strainer of the well rests on the next rock below the sands. The well yields a good deal of gas at all times. The water rises to an elevation of 40 feet above the surafce.

LOWER PART OF THE COUNTY.

The lower part of Marengo County is underlain by sands and clays of the Tertiary formations, which in most places still have the capping of the red loam and pebbles of the Lafayette. Surface waters are therefore generally ample in quantity and excellent in quality, so that artesian borings are hardly needed. In these sections, however, where clays predominate in the surface outcrops, it would in many cases be much to the advantage of the citizens to get better water than can be had from shallow wells and springs. In such places there should be no trouble in obtaining artesian water, as is shown by the boring at Butler, Choctaw County, where the strata are similar to those in Marengo County.

DALLAS COUNTY.

General Conditions.

Within the limits of Dallas County all four divisions of the Cretaceous outcrop are at the surface and determine the soils, the topography, and the water conditions. The two lower divisions (Tuscaloosa and Eutaw) appear only in a narrow strip in the northeast corner of the county, between Oakmulgee and Mulberry creeks, in Townships 18 and 19. In the greater part of this section the red loam and pebble beds of the Lafayette overlie the strata of the older formations and determine the soils and water conditions. Surface wells and springs yielding the best freestone water are not lacking in this section, and while no artesian wells are recorded there be no difficulty in getting artesian water within reasonable depths from either the Tuscaloosa or Eutaw sands.

North of Alabama River, about the city of Selma,, is a wide terrace, 75 to 100 feet above river level, on which the red loam and pebbles of the Lafayette formation overlie the calcareous beds of the Selma chalk. The immediate surface about Selma and for a number of miles up and down the river is formed by sands, probably of a later formation than the Lafayette (Columbia or Ozark sands). Beyond this terrace the chalk forms the surface, as a rule, to the north, west, and southwest of Selma.

In all this section down to a northwest-southeast line running approximately parallel to Chilatchee creek and 3 miles distant from it, water must necessarily come from artesian borings, except where the Lafayette and Columbia sands overlie the chalk and afford the usual abundance of freestone water from wells and springs.

In crossing the county from Rehobeth, Wilcox County, by way of Crumptonia, Orrville, and Marion Junction, one sees very little of the chalky limestone except near the crossing of Boguechitto Creek, the surface being formed mainly by the Lafayette and Columbia sands and loams. Near Marion Junction the chalk begins. The reason for this seems to be that this road follows generally the lowlands of Boguechitto Creek and its tributaries, where erosion has been more than usually effective. The sands and loams of this mantle appear to be of the same nature as the terrace sands near Selma. Not many artesian wells are found along this road, but the surface wells seem to afford sufficient water to meet the demand. From 3 or 4 miles south of Marion Junction to the northern and western boundaries of the county, the chalk occupies the surface. At Marion Junction (altitude(204 feet) the wells do not overflow, and windmills are used for raising the water. The depth of wells here is reported to be only 250 feet.

A belt 8 or 10 miles wide in the lower part of Dallas County, is underlain by the strata of the Ripley formation, in which, so far as the writer's information goes, no bored wells have been sunk. Much of the surface, however, throughout this belt is formed by the Lafayette sands and loams, in which surface wells afford a sufficient supply of water.

East of Alabama River the conditions are about the same as those above described for the area underlain by the chalk and the Ripley. The divides in this part of the county, in the territory of both these formations, are often high, level plains, with a surface of red loam underlain by pebbles (Lafayette). Richmond, Carlowville, and Pleasant Hill are upon such high plateaus. The lowlands have strong calcareous soils (Selma chalk and Ripley), entirely different from the sandy loams of the plateaus.

ARTESIAN RECORDS.

The details below of the bored wells of Dallas County, will illustrate its artesian conditions.

CAHABA.

The old town of Cahaba was probably one of the first places where artesian borings were made in Dallas County. One of these, "the great well," is said to yield 1200 gallons of water per minute, which if true, would make it probably the largest in the State except the Roberts well in Escambia County. The great well on the Pickens place, in Hale County, yields now only about 850 gallons per minute, and it, also, has the reputation of being the largest in the State. It is probable that the flow in both these wells has much diminished since they were first bored, by reason of leakage and the stopping or partial stopping of the pipe by stones and other obstructions. The record of the Cahaba well, as published by Professor Winchell.* (furnished to him by Mr. Campbell, who bored it), is as follows:

*Proc. Am. Assoc. Adv. Sc. 1856, section on Geology, p. 99.

Record of the "great well," Cahaba.

	Feet.	Inches.
Loam, red clay, sand, and pebbles	32	10
First "rotten limestone"	330	10
First sandstone (a concrete of sand and shells)	0	6
Gray sand, with water	3	0
Second sandstone	1	3
Gray sand	2	5
Sticky sand and clay	2	9
Sand and "rotten limestone" (?) (clay)	7	9
Sticky sand and clay	19	9
Greensand	1	6
Gray sand, with water	129	10
Third sandstone	0	11
Gray sand, with water and streaks of "rotten limestone	51	—
Bluish sand, with two streaks of reddish sand	32	—
Bluish-gray and laminated clay	27	6
Dark-gray sand, with water	26	—
Bluish-gray sand and clay, with water	59	8
	736	6

The interpretation which might be given to this record is:

Hypothetical record of "great well," Cahaba.

	Feet.
Sands, loams, and pebbles of the Lafayette	32.83
Selma chalk	380.83
Eutaw sands	227.66
Tuscaloosa sands and clays	145.16
	740.59

This might possibly serve to indicate that borings into the Tuscaloosa formation in other places would yield a greater flow of water than those that go merely into the Eutaw sands. The general impression among the well borers is that when they reach the pink kaolin or soapstone, as it is often called, no increase in the supply will be obtained for at least 100 or 200 feet. Allowance must, of course, always be made for variations in the thickness of the beds of massive clay occurring in the Tuscaloosa formation, since they are sometimes 200 feet or more thick. It would probably be worth while in many cases to continue the borings through these clays when a sufficient supply of water has not been found above them.

From Dr. Winchell's paper above cited some additional records are taken of the old artesian wells about Selma and Cahaba, before details of the more recent borings are given. Besides the "great well," he mentions the court-house well (depth, 555 feet; temperature, 75°), and the well at Bell's Hotel (depth, 400 feet; temperature, 74°), both in the town of Cahaba, where there are at least 15 old wells flowing 10 to 30 gallons per minute and varying in temperature from 74° to 76°. Dr. Winchell also records a well on the opposite side of the river, near Cahaba, on the plantation of E. P. Watts, bored by Crow & Read (depth, 275 feet; flow, 20 gallons per minute); and two wells on the plantation of Freeman King, 5 miles below Cahaba, also on the opposite side of the river, each 560 feet deep and yielding 250 gallons per minute.

Selma and Vicinity.

Dr. Winchell gives records of 11 wells in Selma, as follows:

Record of wells in Selma.

Location.	Depth.	Yield.	Borer.
	Feet.	Gallons per minute.	
Junction of Main and Water Sts....	470		Mr. Crow.
Main street, north of No. 1..........	380	100	Mr. Crow.
Main street, north of No. 2..........	334	40	Mr. Crow.
Residence of Abner Jones............	280	12	Mr. Crow.
Residence of J. Lapsley	330	25	Mr. Crow.
Foundry	409	230	Mr. Campbell.
Machine shop	360	300(?)	Mr. Crow.
Mr Hall's	340	100	Mr. Crow.
Russell & Berry brickyard	350	300	Mr. Crow.
Harrison's brickyard	360	300	Mr. Crow.
Blevins & Edwards's	Not given	Not given	

Cawthon Cotton Mills well, Selma; bored in 1899 by J. I. Hawk; flows 115 gallons per minute; depth to blue rock, 30 feet; thickness of blue rock, 250 feet; well starts in "rotten limestone" and water supply is from Eutaw sands.

City waterworks wells, Selma; six wells ranging in depth from 425 to 500 feet, all of which overflow or are pumped into reservoir; bored in 1888; temperature, 63°. Four 5-inch and 6-inch wells, with depths of from 500 to 700 feet, are located at main station; water rises 3 feet above the surface, but is pumped for distribution by the air-lift process; total flow from four wells, 38,000 gallons per hour. The following analysis by Mr. Hodges shows the composition of the water of the city supply at Selma:

Analysis of water from city waterworks wells, Selma.

	Parts per million.
Potassium (K)	5.4
Sodium (Na)	12.0
Magnesium (Mg)	2.3
Calcium (Ca)	19.3
Iron and alumina (Fe_2O_3, Al_2O_3	1.0
Chlorine (Cl)	6.8
Sulphuric acid (SO_4)	9.6
Carbonic acid (HCO_3)	86.5
Silica (SiO_2)	33.0
	175.9

City waterworks well, No. 4, Selma; bored by John Bicksler in 1903; cased to bottom with 6-inch, 8-inch and 11-inch casing depth, 655 feet; estimated flow, 300 gallons per minute; boring stopped in fourth water.

Record of city waterworks well No. 4, Selma.

	Feet.
Clay	0 — 14
Sand and gravel	14 — 18
Blue rock	18 — 34
Hard rock	34 — 35
Blue rock	35 — 165
Greensand	165 — 180
Hard rock	180 — 182
Sand and water (rising to —9 feet)	182 — 272
Marl	272 — 290
Sand and gravel	290 — 302
Red marl	302 — 310
Soapstone	310 — 427
Hard rock	427 — 532
Red Marl	532 — 572
Sand and gravel	572 — 655

Well at the council chamber, Selma; depth, 620 feet; gives good flow; starts in the "rotten limestone" and obtains water from the Tuscaloosa; altitude, 121 feet; temperature, 62°.

C. C. Ferrill's well, 1 mile from court-house, Selma; bored in 1884 by Peyton Hatch; depth, 487 feet; flow, 110 gallons per minute; temperature, 68°; starts in the "rotten limestone" and obtains water from the Eutaw sands or Tuscaloosa formation; depth to blue rock, 125 feet; altitude, 121 feet.

Analysis of water from C. C. Ferrill's well, Selma.
(Analyst, R. S. Hodges.)

	Parts per million.
Potassium (K)	6.5
Sodium (Na)	6.9
Magnesium (Mg)	1.8
Calcium (Ca)	21.3
Iron and alumina (Fe_2O_3, Al_2O_3)	1.8
Chlorine (Cl)	3.4
Sulphuric acid (SO_4)	6.4
Carbonic acid (HCO_3)	88.2
Silica (SiO_2)	18.6
	154.9

E. Gilman's well, Selma; bored in 1899 by J. I. Hawk; depth, 643 feet; flows 85 gallons per minute; 4-inch casing to blue rock, balance 2 1-2-inch; water carries some iron; altitude, 121 feet.

Record of E. Gilman's well, Selma.

Soil	0 — 28
Blue rock	28 — 90
Sand and sand rock	90 — 100
Sand, sandrock, and layers of soapstone	100 — 480
White clay	480 — 520
Pink kaolin	520 — 600
Sand, gravel, some red clay	600 — 643

H. A. Harralson's well, Selma; bored in 1875; depth, 780 feet; diameter, 4 inches; flow small and charged with iron; starts in "rotten limestone" and obtains water from the Tuscaloosa formation.

Hestell Cotton Mill well, Selma; bored by Patrick Gilman; depth, 465 feet; yield, 80 gallons per minute; starts in "rotten limestone" and obtains water from Eutaw sands and Tuscaloosa formation; altitude, 121 feet.

McGill well, corner of Broad street, near union depot, Selma; flows 12 gallons per minute from 2-inch pipe; temperature, 68°; altitude, 121 feet.

Well at People's Oil Mills, Selma; bored in 1900; started in the "rotten limestone" and obtained water in Tuscaloosa beds; altitude, 121 feet. Record unknown.

Race track well, Selma; stated to be 3 inches in diameter and to yield 150 gallons per minute; temperature, 68°; water charged with iron; starts in "rotten limestone" and obtains water from the Eutaw sands or Tuscaloosa beds.

J. L. Schweizer's well, at residence, two blocks northwest of Southern Railway passenger depot, Selma; bored by Hawk in December, 1900; depth, 450 feet, casing, 400 feet; 2 1-2-inch and 4-inch; first water at 100 feet, stand —10 feet; second water at 210 feet, stand —2 feet; third water at 320 feet, stand 3 feet above the surface; fourth water at 450 feet, stand 5 feet above the surface; depth to principal supply, 450 feet; flow, 20 gallons per minute; depth to blue rock, 30 feet; thickness of blue rock, 65 feet.

J. M. Baker's well, at residence, 1410 Selma street, Selma; bored by Hawk in February, 1901; depth, 665 feet; casing, 2-inch, 3-inch and 4-inch; first water at 100 feet, stand —20 feet; second water at 210 feet, stand —12 feet; third water at 320 feet, stand —7 feet; fourth water at 465 feet, stand —2 feet; depth to principal water supply, 650 feet; flow, 150 gallons per minute; depth to blue rock, 35 feet; thickness of blue rock, 65 feet.

Knox Academy well, corner of North and Mabry streets, Selma; bored by Hawk in November, 1902; depth, 615 feet; casing, 615 feet, 2 1-2-inch and 4-inch; first water at 100 feet, stand —20 feet; second water at 210 feet, stand —12 feet; third water at 325 feet, stand —4 feet; fourth water at 450 feet, stand —4 feet; depth to principal water supply, 610 feet; original flow, 96 gallons per minute; depth to blue rock, 31 feet; thickness of blue rock, 75 feet.

There are perhaps as many as 100 smaller wells in the city of Selma in which the water stands near the surface and is

A. WELL IN ELKDALE PARK, SELMA, DALLAS COUNTY.

B. OLD ROAD SHOWING GRAND GULF STRATA CAPPED WITH LAFAYETTE NEAR GAINESTOWN FERRY, CLARKE COUNTY.

raised by pumps; but no reliable records could be obtained of these.

Buckley Cotton Oil Mill well, Selma; bored by John Bicksler in 1892; depth, 500 feet; first water, at 69 feet, stood at —8 feet; second water, at 170 feet, stood at surface; third water, at 186 feet, overflowed; fourth water, at 500 feet; overflowed; yield, 300 gallons per minute.

Record of Buckley Cotton Oil Mill well, Selma.

	Feet.
Sand	0 — 20
Gravel	20 — 28
Soapstone	28 — 32
Shell	32 — 34
Sand	34 — 38
Lime rock	38 — 41
Sand	41 — 67
Hard rock	67 — 69
Sand and water (rising to —8)	69 — 88
Soapstone	88 — 98
Soft sandstone	98 — 170
Sand and gravel (overflow)	170 — 173
Hard rock	173 — 176
Coal	176 — 177
Sandstone	177 — 180
Marl	180 — 186
Sand (overflow)	186 — 190
Soapstone	190 — 196
Sandstone	196 — 230
Red sand	230 — 242
Sand	242 — 280
Rock	280 — 288
Sand and gravel (water increasing)	288 — 500

Well at Elkdale Park, Selma, (Plate XVI. A.) in the N. E. quarter Section 24, Township 17, Range 10; bored by John Bicksler in 1902; depth 656 feet; first water at 165 feet, stood at —7 feet; second water, at 375 feet, overflowed; third water, at 600 feet, flows 300 gallons per minute; temperature, 72°. Mr. Bicksler thinks that the flow has increased to 400 gallons in two years.

Record of well at Elkdale Park, Selma.

	Feet.
Clay	0 — 18
(?)	18 — 34
Soapstone	34 — 55
Greensand	55 — 83
Blue rock	83 — 165
Sand (water rising to —7 feet)	165 — 170
Soapstone	170 — 195
Blue marl	195 — 202
Marl	202 — 375
Gravel and sand (overflow)	375 — 384
Rock	384 — 386
Sand	386 — 395
Red marl	395 — 420
(?)	420 — 600
Sand and water	600 — 656

Andrew Gill, of Selma, is authority for the following: On his place two blocks west of the ice factory, is a well bored in 1885, which ordinarily flowed 10 to 15 gallons per minute, but when the ice-factory well was bored the flow was weakened. A pump is used in the ice-factory well and when this is in operation the Gill well ceases flowing entirely. The same is true of two other wells in the vicinity, one owned by Mr. Schweizer and another by Eugene Robbins. Mr. Schweizer's well is 4 years old, Robbin's well 18 years, and the ice-factory well 18 years. Several years ago Proctor & Gamble bored a well at the cotton-oil mill. At about 450 feet they got an overflow which caused the three wells mentioned above to stop, also C. C. Ferrill's well, 250 yards southwest of the oil mill, and a well at the Hestell Cotton Mills, one-quarter of a mile west of the oil-mill well. The wells all stopped entirely until Proctor & Gamble cased against the 450-foot water, when they began to flow again. When Colonel Abbott had the Elkdale Park well bored, in 1902, several wells in the vicinity were shut off and they have never flowed since that time.

Well at Summerfield Oil Mills, Selma; bored in 1899; depth, 465 feet; diameter, 6 inches; flow, 100 gallons per minute; cased to blue rock; starts in "rotten limestone" and obtains water from the Eutaw sands or from the Tuscaloosa formation; altitude, 121 feet.

Well on Welch plantation, 3 miles northwest of Selma; bored in 1899 by J. I. Hawk; flow, 18 gallons per minute; depth, 424 feet. Blue rock from 18 to 138 feet, balance sand and soapstone.

Well at Durands Bend, about 6 miles northwest of Benton; in a dilapidated condition and forms a kind of spring; flow was probably 10 or 15 gallons per minute; temperature, 70°.

Andrew Gill's well, 7 miles west of Selma; bored in 1899 to a depth of 365 feet; yield by natural flow, 30 gallons per minute; starts in "rotten limestone" and obtains water from the Eutaw sands.

Well owned by Mrs. L. R. Jones, of Selma, 3 miles southwest of Selma, in the N. W. quarter N. E. quarter Section 34, Township 17, Range 10; estimated flow, 30 gallons per minute.

Well owned by Mrs. Carroll, of Montevallo, 3 miles west of Selma, in the S. W. quarter S. W. quarter Section 26, Township 17, Range 10; flow, 2 gallons per minute; reported to have had much stronger flow until a well was bored one-half mile east.

Wells on Hunter place: No: 1, 5 miles southwest of Selma, in the N. W. quarter N. E. quarter Section 8, Township 16, Range 10; 200 yards east of the Southern Railway; flow, 5 gallons per minute; temperature, 68°. No. 2, 1 mile north of No. 1, in the N. W. quarter Section 4, Township 16; Range 10; flow, 5 gallons per minute; temperature, 68°.

Well on Sanders place, 4 1-2 miles north of Cahaba, 5 miles southwest of Selma, in the N. E. quarter S. W. quarter Section 8, Township 16, Range 10; flow, 2 gallons per minute; water rises 1 foot above the ground; temperature, 70°.

ALONG THE LOUISVSLLE AND NASHVILLE RAILROAD.

Well at crossing of Cahaba River; depth, 590 feet; diameter, 6 inches; water rises 22 feet above the surface; yield, 80 gallons per minute; temperature, 70°; reported in 1899.

Well at Salt Marsh ("Sugar Bottom"), 1 mile east of Beloit, on Southern Railway, in fraction B, N. E. quarter Section 14, Township 16, Range 9; flow, 20 gallons per minute; water rises 5 feet above the ground; temperature, [illegible].

Two other wells are recorded on the line of this railroad, but without sufficient notes of exact locality: No. 1, depth, 487 feet; diameter, 6 inches; water rises 28 feet above the surface; flow, 110 gallons per minute; temperature, 68°. No. 2, depth, 600 feet; diameter, 6 inches; flow, 80 gallons per minute; water rises 16 feet above the ground; temperature, 72°.

ORRVILLE AND VICINITY.

Town well, Orrville; bored by a negro in 1900; depth, 635 feet; water stands at —17 feet; first water at 404 feet; second water at 635 feet, stands at —17 feet. Record: Soil, 0-50 feet; blue rock, 50-401 feet; sand rock, with water-worn pebbles, 401-404 feet. Steam pump used and water was not lowered.

Ellis & Dunaway's well, Orrville, 300 yards north of town well, in the N. W. quarter Section 2, Township 15, Range 8; bored by John Bicksler in 1902; depth, 1088 feet; first water at 545 feet; second water, at 730 feet, rose 1 foot above the surface; third water not given; fourth water, at 1088 feet, stood at —11 feet. 100,000 gallons per day have been pumped from the well and the level not lowered.

Well on J. F. Milhous place, 3 miles west of Orrville, on south side of Louisville and Nashville Railway, in the S. E. quarter Section 32, Township 16, Range 8; flow, 6 gallons per minute; water rises 2 feet above the surface; temperature, 73°.

MARTIN'S STATION AND VICINITY, LOUISVILLE & NASHVILLE RAILROAD.

Louisville and Nashville Railroad well, Martins Station, in the N. W. quarter S. E. quarter Section 31, Township 16, Range 8; bored by Bicksler in 1900; depth, 755 feet; water rises 27 1-2 feet above surface, and keeps railroad tank full; temperature, 76 1-2°.

A. J. Martin's wells: No. 1, three-fourths mile northwest of Martins Station, in Section 31, Township 16, Range 8; flow, 1 1-2 gallons per minute; water rises 3 feet above the surface; temperature, 75°. No. 2, 1 mile west of Eleanor, in the N. W. quarter N. W. quarter Section 36, Township 16, Range 7; flow, 1 gallon per minute; water ris s 3 feet above the surface; temperature, 74°.

Craig Smith's well, 4 1-2 miles west of Martins Station; old well, in decay.

E. B. Martin's wells: No. 1, 1 1-2 miles southwest of Martins Station, in the S. E. quarter N. E. quarter Section 1, Township 15, Range 7; an old flowing well; flow, 5 gallons per minute; water rises 4 feet above the ground; temperature, 74°. No. 2, one-fourth mile southwest of Martins Station, in the S. E. quarter S. W. quarter Section 31, Township 16, Range 8; very weak stream; pump used; temperature, 70°.

Phil Milhous's old wells: No. 1, 3 miles southwest of Martins Station, in the N. W. quarter N. E. quarter Sec. 2, Township 15, Range 7; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 77°. No. 2, one-half mile northwest of No. 1, near center of Sec. 35, Township 16, Range 7; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 75°. No. 3, flows a very weak stream, no particulars.

Mrs. F. M. Hunter's well, 1 1-2 miles south of Martins Station, in Section 7, Township 15, Range 18; old flowing well; yield, 6 gallons per minute.

Well on Wilson place (owned by A. J. Martin) 1 mile north of Martins Station, in the N. W. quarter S. E. quarter Section 30, Township 16, Range 8; flow, 3 1-2 gallons per minute; water rises 5 feet above the surface; temperature, 71 1-2°.

Dr. J. P. Furniss's old well, 2 miles southwest of Martins Station, in the N. E. quarter Section 11, Township 15, Range 7; flow, 5 gallons per minute.

NEAR LINES OF SOUTHERN RAILWAY.

Wells on Elijah Bell place: No. 1, 1 1-4 miles south of Brown's Station, in the S. E. quarter N. W. quarter Section 27, Township 17, Range 7; flow, one-eighth gallon per minute; water rises 4 feet above surface; temperature, 69°. No. 2, one-half mile southeast of No. 1, in the N. W. quarter S. E. quarter Section 27, Township 17, Range 7; flows; no record.

A. C. Davidson's well, 1 mile west of Brows Station, in the N. E. quarter N. W. quarter Section 21, Township 17, Range 7; flow used for boiler in sawmill; could not be measured.

Well on Clark place, near Browns Station, in the N. W. quarter Section 34, Township 17, Range 7: old well; flow, 3 gallons per minute; water rises 3 feet above the ground; temperature, 70 1-2°.

Wells on Nelson place: No. 1, 2 miles southwest of Browns Station, in the N. E. quarter Section 29, Township 17, Range 7; flow, 2 gallons per minute; water rises 2 feet above the ground; temperature, 70°. No. 2, one-fourth mile west of No. 1; flow, one-half gallon per minute; water rises 3 feet above the surface; temperature, 69°. No. 3, one-fourth mile west of No. 1; flow, one-half gallon per minute; water rises 4 feet above the surface; temperature, 69°. No. 4, one-fourth mile east of No. 1; flow, 3 gallons per minute.

Wells on Turner Bell place, 4 miles southeast of Browns Station: No. 1, in the S. E. quarter S .W. quarter Section 2, Township 16, Range 7; flow, 1 gallon per minute; water rises 4 feet above ground; temperature, 69° No. 2, in the S. W. quarter S. W. quarter Section 2, Township 16. Range 7; flow, 1 gallon per minute; water rises 3 feet above the surface; temperature, 70°.

The following wells near Brown's Station were inaccessible, and no records are available. On the Buck Bell place, in the S. E. quarter S. E. quarter Section 3, Township 16, Range 7;

the Parnell place, in the S. E. quarter N. E. quarter Section 35, Township 17, Range 7;

the Bland place, in the S. E. quarter Section 26, Township 17, Range 7:

the A. C. Coats place, in the N. W. quarter Section 26, Township 17, Range 7.

Kendrick Brothers' wells, Massilon: No. 1, at Massilon, in the S. E. quarter N. W. quarter Section 20, Township 17, Range 8; bored by Peyton Hatch; depth, 280 feet; casing, 45 feet, 4-inch; water stands at —36 feet; windmill used; first water at 280 feet. No. 2, at Massilon, in the

S. E. quarter N. W. quarter Section 20, Township 17, Range 8; bored in 1901 by Tom Reid; depth, 280 feet; casing, 35 feet, 4-inch; water stands at —45 feet; probably stopped on rock just above second water. No. 3. 300 yards east of No. 1; old well; depth, 280(?) feet; water stands at —22 feet. No. 4, 700 yards east of No. 1; old well; depth 280(?) feet; water stands at —24 feet. No. 5, 1 1-4 miles east of No. 1, in the S. W. quarter N. E. quarter Section 21, Township 17, Range 8; bored by Tom Reid in 1898; depth, 285 feet; water stands at —45 feet. No. 6, 2 1-2 miles southeast of No. 1, in the S. W. quarter Section 27, Township 17, Range 8; old flowing well; no record. No. 7, in the N. W. quarter N. W. quarter Section 20, Township 17, Range 8; bored in 1901 by Tom Reid; depth, 280 feet; water stands at —45 feet. No. 8, 1 1-2 miles northwest of No. 1; old flowing well; no record. No. 9, 1 3-4 miles northwest from No. 1; old flowing well; no record.

Wells on Jones estate, 1 1-2 miles southwest of Massilon; 4 old wells, now in decay; pumps used.

W. H. Kendrick's wells, 3 miles southwest of Massilon: No. 1, in the S. E. quarter N. W. quarter Section 31, Township 17, Range 8, on top of hill; water stands at —32 feet. No. 2, in the S. W. quarter N. W. quarter Section 31, Township 17, Range 8, at foot of hill, 100 yards northwest of No. 1 and 35 feet lower; flows very weak stream. No. 3, S. E. quarter N. W. quarter Section 31, Township 17, Range 8, 150 yards east of No. 1; water stands at —20 feet.

Well on S. W. John's place, 1 mile west of Massilon, in the N. E. quarter N. W. quarter Section 19, Township 17, Range 8; old well; flowing 5 gallons per minute; temperature, 74°

C. O. Jones's well, near Massilon, in the S. W. quarter N. W. quarter Section 30, Township 17, Range 8; flow, 1 gallon per minute; water rises to 1 foot above the ground; temperature 70°.

Wells on Mrs. King's place, near Massilon: No. 1, 1 1-4 miles west of Massilon, in the S. W. quarter N. W. quarter Section 19, Township 17. Range 8; flow, 1 1-2 gallons per minute; water rises 5 feet above surface; temperature, 72°. No. 2, 2 miles west of Massilon, in the N. W. quarter N. W. quarter Section 25, Township 17, Range 7; flow, 1 gallon per minute; water rises 3 feet above the ground; temperature, 69°. No. 3, three-fourths mile west of No. 1, in the S. W. quarter N. W. quarter Section 30, Township 17, Range 8; flow, 1 gallon per minute; water rises 2 feet above the surface; temperature, 69°. No. 4, at house, in the S. W. quarter S. W. quarter Section 19, Township 17, Range 8; flow, 1 gallon per minute; temperature, 69°. No. 5, at house, in the S. W. quarter N. W. quarter Section 19, Township 17, Range 8; flow, 1 galon per minute.

Mrs. E. W. Fort's well, 1 mile north of Marion Junction, in the N. E. quarter Section 14, Township 17, Range 8; depth, 900 feet; water stands at —5 feet.

Mitchell well, owned by H. P. Randall, in the S. E. quarter S. E. quarter Section 22, Township 17, Range 8; estimated flow, 2 gallons per minute; temperature, 71°.

Well on Harrell place, 2 1-2 miles southwest from Marion Junction; in the N. W. quarter Section 27, Township 17, Range 8; owned by Kendrick Brothers, of Massilon; flow, 1-2 gallon per minute; temperature, 68°. This well is located somewhat lower than the Mitchell well.

Pegues well, 3 miles south of west of Marion Junction, in the S. E. quarter S. E. quarter Section 29, Township 17, Range 8; flow has decreased and water stands at surface.

Rascoe well, 3 1-2 miles southwest of Marion Junction, in Section 28, Township 17, Range 8; owned by M. F. Smith, of Marion Junction; flow 1 gallon per minute; water rises 2 feet above surface; temperature, 69°.

Well on Overstreet place, 4 miles southwest from Marion Junction, in Section 33, Township 17, Range 8; old well; flow ,2 gallons per minute; water rises 2 feet above ground; temperature, 70°.

Wells on Ullman place, owned by Mudhall Smith: No. 1, 4 1-2 miles southwest of Marion Junction; flow, 2 gallons per minute; water rises 2 feet above surface; temperature, 70°. No. 2, on old mill site, one-half mile east of No. 1, south of railroad; flow, 1 gallon per minute; water rises 2 feet above surface; temperature, 69°. No. 3, no record; does not flow. All old wells.

Will Moore's old wells: No. 1, 4 miles west of south of Marion Junction; flow, 4 gallons per minute; water rises 3 feet above surface; temperature, 68° . No. 2, one-fourth miles east of No. 1; flow, 1 gallon per minute; water rises 2 feet above surface; temperature, 69°. Nos. 3 and 4; no record.

Dave Taylor's well, 5 1-2 miles south of Marion Junction; no record.

Henry Stubbs's well, 5 miles southeast of Marion Junction, in Section 33, Township 17, Range 9; bored in 1898 by Pat Gilmer; depth, 260 feet; water stands at —7 1-2 feet. Record: Soil, 0-8 feet; blue rock, 8-240 feet; rock, 240-242 feet; sand, 242-260 feet. Stopped in first water.

Well on Crenshaw place, 5 miles south of Marion Junction, owned by Dr. Jones, of Selma; bored in 1904 by Gus. Somers; no record.

Eulow well, 4 miles southwest of Marion Junction, in the N. E. quarter N. W. quarter Section 3, Township 16, Range 8; owned by J. W. Wallace, of Birmingham; flow, 1 gallon per minute; water rises 2 feet above the surface; temperature, 68°.

Well on Woodruff place, 3 miles southwest of Marion Junction, Section 34, Township 17, Range 8; owned by Mrs. S. E. Woodruff of Selma; old well; flow, 2 gallons per minute; water rises 3 feet above surface; temperature, 68°.

Well on Bean place, 2 miles west of south of Marion Junction, in the S. W. quarter Section 26, Township 17, Range 8; owned by Dr. A. W. Jones, of Selma; flow, 2 gallons per minute; water rises 2 feet above ground; temperature, 69°.

Well of Tom Harrell (colored), 2 miles southwest of Marion Junction, in the N. E. quarter Section 27, Township 17, Range 8; flow, 1 gallon per minute; water rises 3 feet above ground; temperature, 68 1-2°.

Mrs. L. G. Fort's well, at station, Marion Junction; bored about 1890; depth, 250 feet; diameter, 3 inches; water stands at —40 feet; pump used.

The other wells at Marion Junction having the same record as Mrs. Fort's, are those of H. P. Randall, M. F. Smith, S. A. Brice, Dr. J. M. McDonald, C. E. Fort, J. B. Moore, Mrs. M. F. Fort, P. B. Harrell, and Pat Gilmore

Sam Bryce's wells: No. 1, 3 miles northeast of Marion Junction, on north side of Marion Junction and Selma road, in the S. E. quarter S. E. quarter Section 7, Township 17, Range 9; old well; flow, 1 gallon per minute; temperature, 69°. No. 2, in the N. E. quarter N. E. quarter Section 7, Township 17, Range 9; old well; flow, 3 gallons per minute; water rises 3 feet above surface; temperature, 68 1-2°.

Pennell wells, both old; No. 1 does not flow; No. 2 flows 3 gallons per minute; temperature, 70°.

Reuben Tubbs's well, on Harrell place, 3 1-2 miles northeast of Marion Junction, in the N. E. quarter N. W. quarter Section 17, Township 17, Range 9; bored in 1860; depth, 250(?) feet; flow, 3 1-2 gallons per minute; water rises 3 feet above ground; temperature, 69 1-2°.

W. A. Cochrane's well, one-fourth mile east of J. Chisholm's well No. 2; old well; flow, one-half gallon per minute; water rises 3 feet above surface; temperature, 66°.

In addition to the above there are in this neighborhood (north and northeast of Marion Junction) several wells which do not flow, on places belonging to S. H. White, on the Ward tract, and on the McCreary place. It may be remarked here that some of the wells credited to Perry County may be in Dallas, as they are close to the County line.

Wells on Johnson place: No. 1, 1 3-4 miles southeast of Harrell's, in the S. E. quarter S. E. quarter Section 20, Township 17, Range 9; owned by J. W. Wallace of Birmingham; flow, 8 gallons per minute; water rises 3 feet above the ground; temperature, 69°. No. 2, 300 yards east of No. 1, estimated flow, 2 gallons per minute; temperature, 67°.

Well on Moore place, 4 miles southeast of Harrell's in the N. W. quarter S. E. quarter Section 28, Township 17, Range 9; owned by E. L. Moore, of Marion Junction; old well; estimated flow, 15 gallons per minute; water rises 10 feet above the surface; temperature, 69 1-2°.

Well on Wade place (W. A. Cochrane estate), 3 miles southeast of Harrell's, in the S. W. quarter S. E. quarter Section 29, Township 17, Range 9; in a ravine 8 feet deep; old well; flow, 3 gallons per minute; temperature, 66 1-2°.

Wells on Gill place: No. 1, 5 miles southeast of Harrell's, in the S. E. half S. E. quarter Section 3, Township 16, Range 9; flow, 1 gallon per minute; water rises 3 feet above the surface; temperature 68°. No. 2, 50 yards north of No. 1, and on hillside 30 feet higher; flow, 1 gallon per minute; temperature, 68°. No. 3, in the S. E. quarter N. E. quarter Section 10, Township 16, Range 9; flow, 5 gallons per minute; water rises 2 feet above the surface, 70°. All old wells.

Well on Phil Milhous place, 1 mile a little east of south from Gill well No. 1, in the N. W. quarter N. W. quarter Section 11, Township 16, Range 9; old well; estimated flow, 10 gallons per minute; water rises 6 feet above the surface; temperature, 68°.

Town well, Eleanor, S. W. quarter S. W. quarter Section 19, Township 16, Range 8; bored by A. A. Simms in 1895; depth, 510 feet; casing, 3 1-2-inch; first water at 510 feet overflowed 1 1-2 feet above surface; original flow, 1 gallon per minute, 1 foot above surface; no longer flows.

P. Walter Milhous's wells: No. 1, three-fourths mile west of Eleanor, in the S. half N. W. quarter Section 24, Township 16, Range 7; bored in 1870; depth, 610 feet; diameter, 4 inches; flow, one-sixth gallon per minute; water rises 3 feet above the ground; temperature, 70 1-2°. No. 2, 1 1-4 miles northwest of Eleanor, in the N. W. quarter N. E. quarter Section 24, Township 16, Range 7; bored about 1880; depth, 450 feet; diameter 4 inches; flow, one-half gallon per minute; water rises 3 feet above surface; temperature, 70°. No. 2 well is about 25 feet higher than No. 1.

J. N. Walker's well, one-fourth mile east of Eleanor, in the S. E. quarter S. W. quarter Section 19, Township 16, Range 8; old well; depth, 525 feet; casing, 4-inch; flow, 1 gallon per minute; water rises 1 foot above surface; temperature, 69°.

Well on Josh Hurt place in the N. W. quarter N. E. quarter Section 5, Township 16, Range 8; flow, one-fourth gallon per minute; temperature, 72°.

Wells on Chambers place: No. 1, in the S. E. quarter N. W. quarter Section 8, Township 16, Range 8; flow, 4 gallons per minute; temperature, 70°. Nos. 2 and 3 are near No. 1 and ceased flowing a number of years ago. All are old wells.

Well on King place, S. E. quarter S. W. quarter Section 18, Township 16, Range 7; owned by Mr. Potter; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 73°.

Well on Roscoe place; old well: flows very weak stream, no record available. Well on Hempshaw place, 1 1-2 miles west of Boguechitto; flow 2 gallons per minute; water rises 4 feet above ground; temperature, 71°.

Wells on Moss Grove place, 4 miles west of Boguechitto; owned by Col. S. W. John. No. 1, flows, 1 gallon per minute; temperature, 70 1-2°. No. 2, three-fourths mile west of No. 1; bored by Mr. Potter in 1883; depth, 1000 feet; casing, 4-inch; flow, 10 gallons per minute; first water at 520 feet, stand —18 feet; second water at 740 feet, stand —11 feet; third water at 1000 feet, stand 8 feet above surface.

Record of well No. 2, on Moss Grove Place, near Bougechitto.

	Feet.
Soil	0 — 22
Blue rock	22 — 518
Rock	518 — 520
Sand and water	520 — 739
Hard rock	739 — 740
Sand	740 — 799
Sand rock	799 — 1000

No. 3, 1 mile west of No. 1; flow, one half gallon per minute; water rises 2 feet above the ground; temperature, 71°. No. 4, 1 1-4 mile northwest of No. 1; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 71°. No. 5 and 6 are decreasing in flow, in decay.

Dr. E. B. Moseley's wells: No. 1, one-fourth mile west of Boguechitto, in the S. E. quarter S. E. quarter Section 7, Township 16, Range 8; old well; no longer flows. No. 2, 150 yards west of No. 1, in the S. E. quarter S. E. quarter Section 7, Township 16, Range 8; bored about 1845; flow. 1 gallon per minute; water rises 4 feet above ground; temperature, 71°. No. 3, one-fourth mile east of No. 1, in the N. E. quarter N. W. quarter Section 17, Township 16, Range 8; bored by a negro in 1893; depth, 740 feet; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 71°.

Well on William Moore place, 2 1-2 miles northeast of Boguechitto; old well; no longer flows.

Well on Strong Johnson place, 1 1-2 miles northeast of Boguechitto; old well; no longer flows.

Well on Wilson place, 2 miles west of Boguechitto; flow, 2 gallons per minute; water rises 4 feet above surface; temperature, 71°.

Well on Carmichael place, Elias Gray present owner, 3 miles west of Boguechitto; old well; flow, 1 gallon per minute; water rises 3 feet above ground; temperature, 71°.

W. N. Carson's well, on Old's place, 1 1-2 miles south of Boguechitto; in the W. half N. W. quarter Section 20, Township 16, Range 8; flow, 8 gallons per minute; water rises 3 feet above surface; temperature, 70°.

E. M. Overstreet's well, 1 1-2 miles north of Boguechitto, in the E. half N. E. quarter Section 5, Township 16, Range 8; flow, 2 gallons per minute; water rises 3 feet above surface; temperature, 70°.

W. N. Carson's well, 3 miles southeast of Boguechitto; in the N. E. half N. E. half Section 28, Township 16, Range 8; bored about 1894 by negroes; depth, 420 feet; casing, 4-inch; flow, 1 gallon per minute; water rises 2 feet above surface, temperature, 69°. Record: Clay, 0-30 feet; blue rock, 30-400 feet.

Mrs. Rainey's well, 1 1-2 miles east of Boguechitto, in the S. E. quarter S. E. quarter Section 16, Township 16, Range 8; flow, one-half gallon per minute; water rises 2 feet above surface; temperature, 70°.

Bill Hatch's well, three-fourths mile southeast of Boguechitto, in the S. E. quarter S. W. quarter Section 17, Township 16, Range 8; flow, 4 gallons per minute; water rises 3 feet above surface; temperature, 70°.

George Washington's well, one-half mile west of south of Boguechitto, in the N. W. quarter S. E. quarter Section 18, Township 16, Range 8; bored in 1882; depth, over 400 feet; diameter, 4 inches; flow, 3 gallons per minute; water rises 3 feet above the surface; temperature, 71 1-2°.

John Moore's well, three-fourth mile south of Boguechitto, in the N. W. quarter N. W. quarter Section 17, Township 16, Range 8; depth, 475 feet; diameter, 4 inches; flow, 3 gallons per minute; water rises 3 feet above surface; temperature, 70°.

Well on Adam Edwards place, one-half mile south of Boguechitto, in the N. E. quarter S. E. quarter Section 18, Township 16, Range 8; bored in 1879; depth, 475 feet; diameter, 4 inches; flow, 3 gallons per minute; water rises 3 feet above surface; temperature, 70°. Record: Clay, 0-14; blue rock, 14-470 feet; sand rock, 470-476 feet; overflows at 476 feet.

Well on Sydney Edwards place, three-fourths mile north of east of Boguechitto, in the S. W. quarter Section 9, Township 16, Range 8; flow, 2 gallons per minute; water rises 3 feet above ground; temperature, 69°.

Wells on Dedman place, 1 mile north of Boguechitto: No. 1, in the E. half N. E. quarter Section 5, Township 16, Range 7; flow, one-third gallon per minute; water rises 4 feet above surface; temperature, 70°. Nos. 2 and 3 no longer flow.

Andrew Ridgeway's well, on Harvey Hurt place, in the N. E. quarter N. W. quarter Section 5, Township 16, Range 7; water barely flows. On this place are two other wells; both old and no longer flowing.

Wash Smith's well, Boguechitto, in the S. E. quarter S. W. quarter Section 6, Township 16, Range 8; flow, 2 gallons per minute; water rises 4 feet above surface; temperature, 72°.

Ebo Smith's well, three-fourths mile northwest of Boguechitto, in the S. E. quarter N. W. quarter Section 7, Township 16, Range 8; flow, one-fourth gallon per minute; water rises 1 foot above well mouth; temperature, 69°.

EAST OF ALABAMA RIVER.

Well on Watts place, 4 miles west of Sardis; owned by John Stanfield; flow, 15 gallons per minute; water rises to 4 feet above surface; temperature, 72°.

Well on Duke place, 4 1-2 miles west of Sardis; owned by W. W. Burns of Selma; flow, 2 gallons per minute; water rises to 4 feet above surface; temperature, 72°.

Well on Stevenson place, 5 1-2 miles southwest of Sardis; owned by W. J. Stevenson of Berlin; flow, 1 gallon per minute; water rises to 12 feet above surface; temperature, 74°.

Wells on Reese place: No. 1, at Kings Landing, in the N. E. quarter S. E. quarter Section 20, Township 15, Range 10; estimated flow, 75 gallons per minute; water rises to 7 feet above the surface; temperature, 76°. No. 2, in the N. W. quarter N. E. quarter Section 29, Township 15, Range 10; estimated flow, 30 gallons per minute; water rises to 15 above the ground; temperature, 77°.

Well on Middle place, 3 miles west of Kings Landing, in the N. E. quarter S. E. quarter Section 23, Township 15, Range 9; owned by Mrs. M. E. Reese, of Berlin; flow, 12 gallons per minute; temperature, 76 1-2°.

Well on Wood place, 3 1-2 miles southwest of Kings Landing, in the S. E. quarter N. E. quarter Section 27, Township 15, range 9; flow, 30 gallons per minute; water rises to 5 feet above the surface; temperature, 76 1-2°.

Well on Molette place, 3 1-2 miles southwest of Kings Landing, in the N. W. quarter N. E. quarter Section 1, Township 14, Range 9; flow, 10 gallons per minute; water rises to 3 feet above surface; temperature, 77 1-2°.

Well on Milhous place, 2 1-2 miles southwest of Kings Landing, in the S. W. quarter N. E. quarter Section 36, Township 15, Range 9; flow, 10 gallons per minute; water rises to 3 feet above the ground; temperature, 77°.

Well on Creek place, 2 1-2 miles southeast of Kings Landing; Section 33, Township 15, Range 10; flow, 40 gallons per minute; water rises to 6 feet above the ground; temperature, 77°.

LOWNDES COUNTY.

Surface Features.

The geological structure of Lowndes County is quite similar to that of Dallas County on the one side and Montgomery County on the other, and the conditions of water supply are practically the same. Very few well records, however, have been obtained from Lowndes County.

The outcropping Cretaceous rocks are the Selma chalk in the northern part of the County and the Ripley formation in the southern. Both of these are mantled by the pebbles and red loam of the Lafayette. The interstream areas are high, flat table-lands, covered by the Lafayette deposits, where the best of the freestone water is obtainable from shallow wells and hillside springs.

Throughout the northern half of the county the conditions for artesian wells should be favorable, but in the southern half the borings would necessarily be very deep, since they would have to pierce the entire thickness of the Selma chalk.

The Ripley beds form a belt 5 or 6 miles wide along the southern border of the county. They are composed of calcareous sands interstratified with limestone ledges. This arrangement of the strata produces, in the process of denudation, a very uneven and rugged country. In other counties very few wells have been bored in territory formed by the Ripley beds, and the writer knows of none in Lowndes County.

Artesian Records.

The following are the records for the entire county.

SCOTT HILL.

W. D. McCurdy's well, 4 miles west of Lowndesboro, on a high hill; bored by Bicksler in 1903; water stands at —140 feet; boring ends probably in Tuscaloosa beds.

Record of W. D. McCurdy's well, Scott Hill.

	Feet.
Clay	0 — 40
Blue rock	40 — 475
Hard rock	475 — 477
Sand	477 — 525
Blue marl	525 — 575
Rock	575 — 578
Soft sandstone	578 — 625
Quicksand	625 — 680
Blue clay	680 — 700

LOWNDESBORO STATION.

C. M. Smith's well bored by A. Ockenden in 1899; depth, 700 feet; cased to bottom with 2-inch, 3-inch, 4-inch casing; water stands at —23 feet; 4000 gallons have been pumped out in a day without lowering the level; does not flow; first water at 150 feet, stand —75 feet, salty; second water at 450 feet, stand —75 feet; third water at 700 feet, stand —23 feet; boring probably ends in Tuscaloosa beds.

Record of C. M. Smith's well, Lowndesboro Station.

	Feet.
Clay and gravel	0 — 15
Blue rock	15 — 150
Sand	150 — 155
Clay	155 — 450
Sand	450 — 455
Clay and sand	455 — 700

CORRIE.

T. J. Hairston's well, in Section 17 or 18, Township 14, Range 16 E; bored by Ingraham; depth, 562 feet; water stands at —80 feet; raised by Marsh steam pump, delivering 2 1-2 gallons per minute; it is thought that a larger pump would not exhaust or lower the water; water has a decided taste, thought to be of soda.

HAYNEVILLE.

One well 800 feet deep; water stands at —80 feet; raised by steam pump.

MONTGOMERY COUNTY.

Surface Features.

Montgomery County lies altogether within the limits of the Cretaceous beds. The Eutaw division, consisting of yellowish and reddish cross-bedded sands with clay partings, is well exposed in the railroad cuts and along the river bank at Montgomery, and occupies that part of the county east of the city lying between Alabama River on the north and the line of the Central of Georgia Railway on the south. In the lower townships of the county the strata of the Ripley occupy the surface, while all the intermediate area is underlain by the Selma chalk.

Shallow Waters.

In the Eutaw and Ripley territories the sandy strata serve as water-bearers, and in all three divisions the overlying Lafayette sands, pebbles, and loams still remain in places on the divides, making level plateaus about 400 feet above tide level. In the Lafayette areas an abundant supply of good water is obtained from wells and springs. As is the case elsewhere, the Selma chalk, or "rotten limestone," is unfavorable to the existence of good surface waters and consequently the greatest number of artesian wells are found in the area of its outcrop.

While the strata of the Tuscaloosa formation do not appear at the surface within the limits of Montgomery County, they outcrop in the bordering counties of Autauga and Elmore, and undoubtedly underlie the Eutaw sands south of Alabama River.

Artesian Records.

The southern limit of the Selma chalk area in Montgomery County is marked by an infacing escarpment, or a range of hills with steep and abrupt northward slopes, but gentle slopes toward the south. This escarpment marks also the line between lands on the north depending for water supply on artesian wells, and those on the south in which the sands hold sufficient water to supply all ordinary needs.

No record of any artesian borings south of this line has been found, and in this respect Montgomery County agrees with all the other counties similarly situated geologically.

Of the wells whose records are given below, the following are located on the Eutaw sands and get water either from these or from the underlying Tuscaloosa materials: Well on place formerly owned by M. E. Pratt, at Pratt Ferry; most of the wells in the city of Montgomery; wells on Martin Baldwin place and Paul Le Grand place, north of Montgomery.

The well records from the city of Montgomery have been most carefully kept and give the most information, and they are given first.

MONTGOMERY.

Within the memory of many now living the old wells in Exchange square and on Commerce street yielded overflowing streams; but the recent sinking of so many large wells within the city limits has so lowered the water table that neither of these now flows and the same is probably true of all the older small wells. Of the older wells of the city waterworks, the following was bored by William D. Chapin:

Record of Chapin well of City Waterworks, Montgomery.

	Feet.
Clay	30
Sand and gravel	60
Sand rock, full of hard nodules	6
Black clay that flakes off like slate on exposure to the air and turns gray	4
So-called marl with streak of clay	80
Sand with water, but not a running sand; more like a very soft sandstone	20
Marl and clay	100
Sand with water, like second above	15
Marl and clay	80
Coarse sandstone, some water, very soft	25
Hard sandstone, large flow of water, rises about 25 feet above the surface	2
Clay and marl, with a hard streak of lime rock at bottom	90
Lignite	3
Marl in loose pieces, like stones on seashore	60
Clay	5
Very hard lime rock	2
Coarse white sand, with streaks of hard sandstone; large flow of water, say 200 gallons per minute, rises about 40 feet above surface	51
	633

Below this to the bottom of the boring was marl. The marl in this boring is probably a fossiliferous sand with streaks or partings of clay. While the boring undoubtedly reaches the strata of the Tuscaloosa formation, it is impossible from the record to say where the transition from the Eutaw sands to the Tuscaloosa occurs. It is probably somewhere between 250 and 300 feet.

The books of the city waterworks contain much information concerning artesian conditions in Montgomery. Previous to 1899 there were six wells in use, the Cook, Parker's West, South, Northwest, Southwest, and Southeast wells, all bored by the Cook Well Company, of Chicago, Ill. Twelve new wells were sunk in 1899. These wells do not flow and airlift is necessary. It is estimated that the daily capacity, when all are connected, is 5,000,000 gallons. The average temperature is 68°. The record of the Cook and Parker's West wells and some details of the four other older wells are given below.

Old Cook well, depth, 837 feet; started with 12-inch casing; flowed 191,998 gallons in twenty-four hours when well was first started.

Record of Cook well, Montgomery.

	Feet.
White clay	0 — 16
White sand	16 — 18
Blue marl	18 — 26
Coarse gravel; washing water would not fill well; had to use sand pump	26 — 55
Coarse gravel	55 — 85
Blue marl; stopped the 10-inch casing, as it would not drive; substituted 8-inch casing; struck fine gravel and sand	85 — 139
Blue marl; water stood at —10 feet, sand rock at 145 feet 18 inches; no headway drilling, used rotary process	139 — 145
Thin blue clay	148 — 170
Fine white sand	170 — 188
Blue clay	188 — 225
Light yellow sand	225 — 240
Red clay	240 — 255
Blue clay and sand	255 — 258
Red clay	258 — 280
Yellow sand	280 — 288
Blue clay	288 — 297
Sand and clay	297 — 312
Clay	312 — 320
Red and blue clay; water flowed 8 feet above surface	320 — 345
Clay	345 — 365
Coarse water-bearing sand	365 — 373
Lignite in sand, with 1 1-2-inch rock	373 — 380
Sand rock and sand, cavity 6 feet	380 — 388
Water-bearing sands	388 — 402
Fine sands	402 — 410
Sand, with ledges of sand rock	410 — 421
Clay and sand; some water	421 — 450
Finer sand, with a little clay	450 — 480
Fine sand; some red, mixed with clay	480 — 507
Black clay	507 — 530
Sand	530 — 540
Black clay, with traces of sand	540 — 585
Sand and clay	585 — 610
Very fine, water-bearing sand; temperature, 70°	610 — 650
Blue clay, with some yellow	650 — 720
Blue and red clay	720 — 837
	837

Record of Parker's West well, Montgomery.

	Feet.
Sand and gravel	0 — 89
Clay	89 — 109
Clay and sand	109 — 129
Fine and coarse sand	129 — 178
Sand and blue marl	178 — 185
Clay and sand	185 — 225
Red clay and sand	225 — 330
Sand; hole, caved 40 feet; water overflowed a little	330 — 395
Sand	395 — 471
Black clay	471 — 507
Black clay; with some sand; good stream	507 — 530
Black clay	530 — 546
Sand	546 — 580
Blue clay	580 — 585
Sand, with very little clay; water to surface at 600 feet	585 — 621
White sand	621 — 652
Stiff clay	652 — 662
White sand	662 — 706
Red sand; some clay	706 — 714
White sand	714 — 785
Reddish sand	785 — 795
White sand	795 — 837
Sand and clay	837 — 876
White sand	876 — 880
White sand and clay	880 — 888
White sand and beds of clay and sand	888 — 895
Hard sand rock, some white, alternating with softer rock	895 — 1091

Water rises 200 feet. Salt water at 1091 feet, in reddish clay. Stopped drilling at this point. Cased off at 712 feet, using water found at that point. Water from this well pumped into Cook well.

South well, depth, 650 feet.

Northwest well, depth, 457 feet; 340 feet 8-inch casing, 67 feet 6-inch casing, 50 feet 6-inch strainer; flow, 92 gallons per minute.

Southwest well, depth, 448 feet; 338 feet 8-inch casing, 60 feet 6-inch casing, 50 feet 6-inch strainer; flow, 60 gallons per minute.

Southeast well, depth, 645 feet.

A number of tests have been made by means of airlift to determine the capacity of the different wells. These have varied somewhat at different times. The following are probably typical:

Capacity of wells at Montgomery, as shown by air-lift tests.

Well.	Gallons per minute.	Gallons per 24 hours.
Northeast well	285	410,400
Southwest well	212	304,280
Cook well	225	324,000
Parker well	239	344,160
	961	1,383,840

In 1899 12 new wells were bored for the waterworks company, with the record given below.

Record of new waterworks wells, Montgomery.

	Feet.
Top soil	0 — 15
Clay	15 — 95
Marl	95 — 225
Water-bearing sands	225 — 228
Reddish clay with pebbles; small ledge of sandstone	228 — 450
Black clay; water	450 — 650

At 650 feet the water stood at —20 feet; at 450 feet, —35 feet; and at 250 feet. —50 feet. As has been said above, on account of the many wells sunk in Montgomery the water now stands much lower than formerly.

In the records given the red clays of the Tuscaloosa formation appear to have been reached at depths of 225 to 250 feet, which is about what one would anticipate from the horizon of the mouth of the wells, which is about 100 feet below the top of the Eutaw sands.

Other records of wells in Montgomery are as follows:

Well at Exchange Hotel, bored for D. P. West, proprietor; depth, 650 feet; casing, 2-inch and 4-inch; water stands at —45 feet; temperature, 66°; good drinking water, but not fit for boilers.

*Analysis of water from well at Exchange Hotel, Montgomery.**

	Parts per million.
Sodium (Na)	78.70
Potassium (K)	16.21
Magnesium (Mg)	.38
Calcium (Ca)	4.32
Chlorine (Cl)	7.66
Sulphuric acid (SO_4)	1.50
Carbonic acid (HCO_3)	144.13
Iron (Fe)	Trace.
Silica (SiO_2)	11.81
	264.71

Montgomery Brewery wells: No. 1, depth, 550 feet; temperature, 68°; sand and a little water at 90 feet; cased off and lowered to 480 feet, passing through blue clay and sand; some water, supply insufficient; lowered to 550 feet, reaching good water with a flow 6 feet above the surface. No. 2, depth, 700 feet; passed through sand and blue clay, with ledges of rock 2 feet thick; cased to 550 feet; supply inexhaustible; stands now at —17 feet, on account of stream being turned into well No. 1.

Montgomery Ice and Storage Company's well, bored by Tillison in 1903; depth, 163 feet; casing, 6-inch; first water at 35 feet, stand —35 feet; second water at 140 feet, stand —27 feet; 100 gallons per minute pumped from this well constantly. Record: Clay, 0-30 feet; sand, 30-38 feet; gravel, 38-50 feet; sand and water, 50-94 feet; soapstone with sand, 94-140 feet; sand, gravel and water, 140-160 feet. The well of the Union Slaughterhouse, 600 yards east of this well, encountered no gravel.

*Expressed by analyst in grains per gallon and hypothetical combinations; recomputed in ionic form and parts per million at U. S. Geological Survey.

Union Slaughterhouse well, bored by Tillison in 1898; depth, 163 feet, first water at 20 feet, stand —20 feet; second water at 140 feet, stand —28 feet. Record: Clay, 0-20 feet; sand, 20-110 feet; soapstone, 110-140 feet; sand and water, 140-163 feet.

NORTH AND WEST OF MONTGOMERY.

The three wells next following are also on the Eutaw sands:

Well on old Jesse Cox place, afterwards owned by M. E. Pratt, at Pratt's Ferry, 10 miles west of Montgomery; bored by Wm. D. Chapin; overflows.

Record of well on old Jesse Cox place, Pratts Ferry.

	Feet.
Clay	0 — 20
Sand and gravel	20 — 30
Marl	30 — 35
Tough black clay	35 — 65
Marl	65 — 265
Sand, with streaks of sandstone, water-bearing	265 — 320

The material called marl in the above record is the same as that which makes the lower part of the bluff at the ferry on the opposite side of the river; it consists of cross-bedded calcareous sands with a few fossils and is interstratified with tough laminated black clays. This is called marl at Prattville and elsewhere. All the strata penetrated by this boring belong to the Eutaw formation.

Well on Martin Baldwin place, 7 miles north of Montgomery, in the S. W. quarter Section 8, Township 17, Range 18; bored by M. S. Gilmer in 1898; flow, 3 gallons per minute; water rises to 2 feet above the surface; temperature, 67°.

Well on Paul Le Grand place, 4 1-2 miles north of Montgomery; bored by Sarber in 1904; depth, 423 feet; casing, 2-inch.

First water at	115 feet,	stand —45 feet;
Second water at	200 feet,	stand —23 feet;
Third water at	300 feet,	stand —15 feet;
Fourth water		stand —15 feet:

Record: Clay, 0-20 feet; clay and compact dry sand, 20-115 feet; (?) 115-200 feet ; sand and water, 200-210 feet; clay and compact sand. 210-300 feet; sand and clay, 300-423 feet.

SOUTH AND EAST OF MONTGOMERY.

South of the line of contact of the Eutaw and Selma chalk outcrops, artesian water is obtained from the sands of the Eutaw at varying depths. Comparatively few of these wells yield flowing water, and it is reported by Mr. F. J. Tillison, who during the last twenty-five years has bored at least a hundred wells in the county, mainly in the northern half, that only five are overflowing wells. These are the following:

Well at Abraham Church, 4 miles south of Montgomery, in the S. E. quarter Section 36, Township 16, Range 17; diameter, 4 inches; flow, one-fourth gallon per minute; water rises to 1 foot above surface; temperature, 69°.

Griel Brothers' well, on Forbes place, 5 miles south of Montgomery, in the N. E. quarter Section 1, Township 15, Range 17; depth, 86 feet; water stands at surface.

Silas Tyson's wells, 4 miles west of south of Montgomery, in the S. E. quarter Section 35, Township 16, Range 17: No. 1, in field; depth, 60 feet; flows; temperature, 66°. No. 2, in pasture; water stands at 2 feet above surface; makes a kind of cistern.

W. E. Pierce's well, 4 1-2 miles west of south of Montgomery, in Section 2, Township 15, Range 17; depth, 65 feet; flow, 2 1-2 gallons per minute; water rises to 3 feet above surface; temperature, 66°.

The other records from Montgomery County are given as nearly as practicable in order from west to east.

Well at Stone's on the Western Railway of Alabama, 7 or 8 miles west of Montgomery; new well; flow, about one-eighth gallon per minute; temperature, 72°; no other record obtained.

A. H. Clark's wells, Hope Hull: No. 1, at house one-half mile east of postoffice; bored by Tillison in 1894; depth, 265 feet; casing, 4-inch; first water at 250 feet, stand —75 feet. Record: Clay, 0-20 feet; marl, 20-250 feet; sand and water, 250-265 feet. Five other wells; records not available.

Well of Atlantic Coast Line railroad, Sprague Junction; bored by Tillison in 1892; depth, 738 feet; casing, 4-inch; first water, at 645 feet, stands at —75 feet; tastes strong of soda. Record: Sand and clay, 0-16 feet; marl, 16-645 feet; sand and water, with occasional rock, 645-738.

Another well at Sprague Junction is reported to be 400 feet deep, with 8-inch and 6-inch casing; water stands at —75 feet; no record obtained.

In connection with the record of the railway well at Sprague Junction given above. Mr. Tillison reports that Conover bored another 20 feet away from the first, going down 1100 feet, casing to 900; but the water rose no higher than —75 feet. It could not be used in the boilers.

Mr. Tillison reports further that in Montgomery county the first, third and fourth waters of Mr. Hawk, as explained on page 113, all rise to the same height. As a rule Mr. Tillison does not case below the marl, which may be the explanation of this circumstance.

Dr. J. M. Galloway's well, 1 mile northeast of Snowdoun; bored by Tillison in 1891; depth. 527 feet; diameter, 4 inches; water stands at —80 feet; first water at 510 feet. Record: Clay, 0-20 feet; marl, 20-360 feet; sand and water, 360-380 feet.

Amos Jones's well, 16 miles from Montgomery (6 miles east of south); bored by Tillison in 1879; depth, 527 feet; water stands at —80 feet; first water, at 510 feet, stood at —80 feet. Record: Clay, 0-20 feet; marl, 20-510 feet; sand and water, 510-527 feet.

According to F. J. Tillison a well at Barachias is 200 feet deep and the water stands at —16 feet, and the same authority states that a well at Myrtle is 250 feet deep, with the water standing at —20 feet.

P. H. Hammack's well, Pike Road; bored by Tillison in 1895; depth, 352 feet; casing, 4-inch; first water, at 340 feet, stands at —95 feet. Record: Sand, 0-20 feet; marl, 20-340 feet; sand and water, 340-352 feet.

W. H. Lawson's well, near Mitchell Station, but in Montgomery County; bored by Y. T. Radford in 1899; depth, 680 feet; casing, 4-inch; first water at 630 feet, stand —50 feet. Record: Soil, 0-20 feet; marl, 20-630 feet; hard rock, 630-631 feet; sand, 631-680 feet.

AUTAUGA COUNTY.

Shallow Waters.

The Tuscaloosa formation underlies the northern half of Autauga County and the sands and clays of the Eutaw the southern half. Over these rocks is spread the surface mantle of loam and pebbles of the Lafayette formation. The conditions are therefore favorable for a never failing supply of freestone water from springs and open wells throughout the entire county, and for artesian wells especially in the lower half, within the Eutaw territory.

Artesian Prospects.

Because of the abundance of springs, and the fact that good water can be obtained almost everywhere in the county by wells of moderate depths, it has been only within the last two years that attempts have been made to get artesian water, and the records of artesian wells are as yet confined to the lowlands of Autauga and Swift Creeks, at Prattville and Autaugaville. The stratigraphic conditions, however, are favorable in other parts of the county underlain by the Tuscaloosa beds.

PRATTVILLE.

The first attempts to get artesian water were made in Prattville in the summer of 1904, Mr. Ira E. Sarber, of Thorsby, being the contractor.

Prattville is situated in the valley of Autauga Creek, the elevation being considerably less than 100 feet above high-water level in Alabama River, 4 miles away. It is stated that in 1894, on a place owned by Dr. Robert Davis, in Prattville, a well was driven about 30 feet deep, in which the water rose about 10 feet above the surface, and that it is still flowing, but rises only about 3 feet above the surface. About the same time Mr. M. D. Fisher bored a well 100 feet deep, in which the water stood at the surface until the spring of 1904, when it rose 3 feet above the surface, and has flowed ever since.

Since the spring of 1904 a great number of wells have been bored and the number is constantly increasing. As the records will show, water is commonly obtained at a depth of 100 feet, more or less, when the mouth of the well is approximately at the level of the Prattville streets. In cases where the depth is greater, it is generally because the elevation of the well is higher, as at Mrs. Pratt's and at Mr. Daniel Pratt's.

The sands first penetrated, to the depth of 20 to 30 feet, are the comparatively recent sands of the Autauga Creek bottom, on which the greater part of Prattville stands. The marl referred to in the records consists of alternations of calcareous sand and gray clays; some of the strata contain shells by which the formation is easily identified as Eutaw.

Public well, at bridge; bored by I. E. Sarber, in July, 1904; depth, 99 feet; casing, 64 feet, 2-inch; flow, (Sarber) 20 gallons per minute; water rose in 1-inch pipe to 24 feet above surface; measured flow October 20, 1904, from spigot, 12 gallons per minute.

L. L. Chapman's well; bored by Sarber in 1904; flow, 20 gallons per minute; at first, much sand; measured flow October 29, 1904, 30 gallons per minute; casing, 4-inch, 50 feet; temperature, 66°. Record: Sand, 0-28 feet; marl (Eutaw), 28-79 feet; water sands, 79 feet to bottom, about 100 feet.

E. I. Smith's well, bored by Sarber in 1904; depth, about 100 feet; log similar to others in town; measured flow October 29, 1904, 25 gallons per minute. This well and Chapman's were the largest in town, until the well at the Baptist church was bored.

Academy yard well, bored by Sarber in 1904; surface about on same level as at Dr. Rice's and Mr. Graham's; casing, 70 feet, 2-inch; flow (Sarber), 20 gallons per minute; water rises in 1-inch pipe to 13 feet above the surface; measured flow October 29, 1904, from 1-inch pipe, 12 gallons per minute; temperature, 65°. Record: Sands, 25-30 feet; marl, 30-90 feet; water-bearing sands, 90-99 feet. The following analysis was made by Mr. Hodges:

Analysis of water from Academy well, Prattville.

	Parts per million.
Potassium (K)	1.2
Sodium (Na)	1.3
Magnesium (Mg)	.4
Calcium (Ca)	.6
Iron (Fe)	.2
Alumina (Al_2O_3)	.3
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	.5
Carbonic acid (HCO_3)	5.6
Silica (SiO_2)	15.6
	27.4

Sanitary Analysis.

	Parts per million.
Nitrogen as	
Free ammonia	0.01
Albuminoid ammonia	None.
Nitrates	.02
Nitrites	None.
Chlorine	1.7
Total residue	19.
Loss on ignition	7.4

W. M. Fisher's well, bored by Sarber in 1904; depth, about 90 to 95 feet; flow, 6 to 8 gallons per minute; log similar to others.

Dr. Clarence Rice's well, bored in July, 1904, by Sarber; casing, 70 feet, 2-inch; first water at 55 feet, rising to —7 feet; second water, first overflow, at 100 feet; flow at first, 8 gallons per minute, increasing in three or four weeks to 20 gallons; water rises in 1 1-2-inch pipe to 16 feet above surface. Record: Sands, 0-30 feet; marl, 30-55 feet; water-bearing sands, 55-62 feet; marl, 62-100 feet; water-bearing sands, 100-115 feet.

Malcolm Graham's well, bored in July, 1904, by Sarber; record same as that of Dr. Rice's well but depth is 123 feet. The surface here is 20 to 25 feet higher than at the bridge. Flow (Sarber), 15 gallons per minute; measured flow October 29, 1904, from one-half inch pipe, about 5 gallons per minute.

J. C. Burns's well, bored in July, 1904, by Sarber; casing, 60 feet, 2-inch water rose in 1-inch pipe to 20 feet above surface; flow, 20 gallons per minute, decreasing after six months to 14 gallons; measured flow October 29, 1904, 12 gallons per minute. Record: Sand, 0-23 feet; marl, 23-28 feet; sand, 28-37 feet; marl, 37-80 feet; water sands, with streaks of marl, 80-94 feet.

G. Cook Spigener's well, bored by Sarber in 1904; depth, about 86 feet; flow, 2 1-2 to 3 gallons per minute.

Thomas Fay's well, bored by Sarber in 1904; water rose to 30 feet above surface; flow, about 10 gallons per minute; temperature, 65°.

Mr. Anthony's well, bored in November, 1904; flow, 1 gallon per minute.

Daniel Pratt's well, bored in November 1904; flow 50 gallons per minute at first, decreasing to 12 gallons in three months and to 6 or 8 gallons in six months. Another well was bored later in the same yard. Record of No. 1: Sand, 0-30 feet; marl, 30-80 feet; coarse white sand (first water rising to —2 feet), 80-86 feet; marl, 86-108 feet; sands like those in town wells (second water rising to 2 feet above surface), 108-116 feet; marl, 116-120 feet; coarse sand and pebbles (third water, rising to 7 feet above surface), 120-126 feet; (?), 126-198 1-2 feet.

Mrs. Julia A. Pratt's well, bored by Sarber in September, 1904; casing 100-160 feet, 2-inch; first water below 100 feet, flowing 2 1-2 gallons per minute, cased off; second water at 180 feet; flow at first, 11 gallons per minute; decreasing after one week to 5 1-2 gallons, probably stopped by pebble. Record: Sands, 0-40 feet; marl, 40-140 feet; sand, 140-147 feet; marl, 147-180 feet; water-bearing sands, 180-198 feet.

The following is a partial list of wells bored in Prattville and vicinity since the fall of 1904. It is almost impossible to keep up with the borings.

Wells bored in Prattville and vicinity since 1904.

Bored by J. S. Catts, 1904-1906.

Diameter, 2 inches.

No.	For whom drilled.	Depth feet.	Casing feet.	Yield in gal. per M.	Stand.
1	Jack Smith	110	60	4-5	Overflows.
2	Will Anderson	103	62	4-6	Overflows.
3	Mrs. Montgomery	176	120	lost	Struck cavity.
4	Buford McKeithen	325	250	4-	(Pump) 150 feet.
5	Thornton place, (Thomas)	137	68	6-8	Overflows.
6	Campbells place, (Thomas)	147	60	6-10	Overflows.
7	Sim Fair place, (Thomas)	135	100	3-4	Overflows.
8	Bulger place, (Thomas)	142	87	5-8	Overflows.
9	Ice Factory, (Thomas)	152	102	25-30	Overflows.
10	On Washington road, (Thomas)	158	110	20-30	Overflows.
11	Ben Durden	139	100	8-10	Overflows.
12	(1) Paradise, (Cotton mills)	146	100	3-4	Overflows.
13	(2) Paradise, (Cotton mills)	150	116	15-20	Overflows.
14	(3) Paradise, (Cotton mills)	112	96	4-5	Overflows.
15	(4) Paradise, (Cotton mills)	139	94	3-5	Overflows.
16	Daniel Pratt	160	110	10-12	Overflows.
17	Continental Gin Factory	157	100	6-8	Overflows.
18	Mrs. Dora Barnes yard	139	108	6-8	Overflows.
19	Dr. Rice	178	.....	lost	Broke rod.
20	Dr. Rice	193	160	20-30	Overflows.
21	Mrs. Pratt	138	120	10-12	Overflows.
22	Bob Golden	120	98	10-12	Overflows.
23	Ed. Golden	100	65	10-12	Overflows.
24	Mrs. Smith	165	140	20-30	Overflows.
25	Baptist church	165	142	100-	Overflows.
26	Bob Wards, (Thomas)	138	88	4-6	Overflows.
27	Methodist parsonage	124	86	4-6	Overflows.
28	J. W. Young	276	220		No stream.
29	William Graham	167	140	lost	Broke pump.
30	William Graham	196	160	4-	—100 foot Pump.
31	Wade Hunt	198	163	5-6	Overflows.
32	Baptist parsonage	196	182	4-6	Overflows.
33	Mrs. McCrary	131	88	4-6	Overflows.

Mr. Catts gives as the average record of the wells drilled by him the following: Sand and a hard pan composed of very fine white sand, very hard, 20 feet; yellow or red clay or marl, with some fine beds of ochre, red and yellow, and a great deal of ising glass, 80-100 feet.

The best streams are found in very coarse sand and gravel, which is forced out by the pressure of the water. From well No. 25 of the above list over a car load of sand came up. Only one well strong in lime, viz., No. 4. The water generally becomes clear in 2 to 10 hours. No rock struck in any of these borings, but some gravel in all.

From other sources the following notes are obtained:

L. Q. Nelson's well, Chestnut street crossing of Louisville and Nashville railroad.

Well near Mobile and Ohio railroad.

Well in lot between W. F. Wilkinson's and Dan Smith's.

Alf Wadworth's well several miles south of Prattville, on the old Daniel Pratt plantation; depth, 311 feet.

Maj. M. M. Smith's well 3 miles southwest of Prattville; not flowing; stand of water, —12 feet.

John Wadsworth's well, bored by Shackelford in 1905; depth, 475 feet; casing, 254 feet, 2-inch, 445 feet 1 1-4-inch. Record: Red clay, 0-19 feet; gravel, 19-41 feet; sand rock 18 inches thick at 83 feet; fine-grained sand, with water, 104-107 feet, and 144-154 feet; rock 8 inches thick at 260 feet; water, 290-296 feet; coarse yellow sand, with water, rising to surface. 435-440 feet; marl, chalk, and red and yellow ocher, 440-474 feet; at bottom of boring, 475 feet, water rising above the surface and flowing 15 gallons per minute.

AUTAUGAVILLE.

Jim Nunn's well, 1 mile from Autaugaville; bored by Radford in 1898; depth, 200 feet; casing, 4-inch; first water at 180 feet. stand —100 feet; much gravel.

ELMORE COUNTY.

Surface Features.

The northern part of Elmore County, as far south as Wetumpka and Tallassee, is underlain by the metamorphic gneisses and mica schists; southward from that latitude to Tallapoosa River, which separates Elmore from Montgomery County, the strata are Cretaceous, ranging from the Tuscaloosa to the lower measures of the Selma chalk. In the southern part of the county, below Wetumpka and east of Coosa River, and in all that part lying west of the Coosa and its continuation in the Alabama, the older rocks are covered with with the Lafayette mantle of pebbles and red loam. Discontinuous remnants of this mantle are also to be found in places on the east side of the Coosa. lapping far up over the metamorphic rocks.

Shallow Waters.

Where the Lafayette mantle is absent the residual soils and other materials from the crystalline rocks constitute the water reservoir and the supply from springs and wells is not always satisfactory, though generally adequate. On the other hand, wherever the Lafayette loam and pebble beds cover the surface the best freestone water is abundant. West of Alabama and Coosa rivers to the borders of Autauga County and beyond, relatively low lands of unusually level surface extend from opposite Montgomery practically to the line of Chilton County. In all this territory the Lafayette materials form the surface, and on each side of these lowlands, which are followed by the Louisville and Nashville Railroad, flat-topped hills capped with the same materials rise to elevations of 100 feet or more above the railroad. On closer examination of these hills the sands and clays of the Tuscaloosa formation may usually be discovered underneath the Lafayette beds. As in other counties, the plateaus capped by the Lafayette beds form the finest farming lands of the region.

On the borders of the lowlands mentioned is the town of Robinson Springs, so called from the fine springs which emerge from below the Lafayette pebble beds at their contact with the less pervious Tuscaloosa clays. This water is similar to that of all the Lafayette springs, an analysis of one of which, the University Spring, is given under Tuscaloosa County. (p. 116).

South of Wetumpka, in the N. E. quarter Section 18, Township 18, Range 19 E., is the Harrowgate Sulphur Spring, once a famous place of resort, but now entirely abandoned. This spring is in the low grounds of a small stream running into the Coosa, and it is difficult to determine the bed from which it comes though it is probably one of the lower Cretaceous formations. Sands have washed over the site of the springs and the buildings have been allowed to fall into decay.

Artesian Conditions.

In the territory of the crystalline schists the conditions are, as a rule, unfavorable for artesian waters, though deep borings will almost anywhere fill with water to within pumping distance of the surface, and in many cases with a fairly good supply.

In the area west of Alabama and Coosa rivers and south of Wetumpka on the east side of the Coosa, the prospects for artesian wells are more favorable because of the underlying Cretaceous (Tuscaloosa) beds. As yet few artesian borings have been made. The available records are given below.

PRATTVILLE JUNCTION.

Well in S. E. quarter N. E. quarter Section 10, Township 17, Range 17; bored by Sarber in 1904; depth, 184 feet; flows at surface; water stands

4 feet above surface; first water, at 176 feet, stood at —20 inches. Record: Soil, 1-10 feet; gravel, 10-40 feet; clay, compact sand, 40-176 feet; sand and water, 176-184 feet.

GRANDVIEW.

Ray Rushton's well, bored by Sarber in 1904; depth, 183 feet; first water at 65 feet, stand —65 feet; second water at 173 feet, stand —150 feet. Record: Clay, 0-20 feet; clay and compact sand, 20-173 feet; sand and water, 173-183 feet. At a depth of 90 feet a stratum of dry, compact sand was encountered.

STATE FARM.

Well at State farm, 8 miles northeast of Montgomery, in the N. E. quarter S. W. quarter Section 2, Township 17, Range 18; bored by Gilmer & Caylor in 1893; depth, 420 feet; cased to bottom, 4-inch and 6-inch.

First water at 120 feet, stand —20 feet;
Second water at 150 feet, stand —16 feet;
Third water at 175 feet, stand —6 feet;
Fourth water at 200 feet, slight overflow;
Fifth water at 250 feet, stand, 16 feet above the surface;
Sixth water at 400 feet, stand 4 feet above surface; flow, 24 gallons per minute. Record: Sand and gravel, 0-30 feet; alternate strata of sand and gravel and red clay, 30-400 feet; sand and water, 400-420 feet.

MACON COUNTY

Surface Features.

Macon County displays a number of geologic formations in its structure, the metamorphic rocks, occupying the northern township (18), being overlapped in succession to the south by the Tuscaloosa, Eutaw, and Selma chalk, in fairly parallel belts. In the southern townships the somewhat irregular bodies of the chalk are overlain by the sands, clays, and shell beds of the Ripley, over all of which lies the Lafayette capping of red loam and pebbles. The Lafayette formation, as usual, affords an abundance of good water from springs and shallow wells, and the same is true of the Tuscaloosa and to a certain degree of the Eutaw. This will explain in some measure the absence of artesian borings in these sections.

Artesian Prospects.

As far south as Tuskegee the cretaceous beds seem to be rather thin and unfavorable for artesian waters, as is shown by the uniformly unsuccessful borings at the Tuskegee waterworks, which go into the underlying gneiss. Most of the successful borings, obtaining water in the Eutaw sands, are in the region of the chalk, along the Seaboard Air Line, but in no case has overflowing water been obtained.

With the exception of those at Tuskegee and Warriorstand, all the records obtained are of wells along the line of the railroad in the lower part of the county.

TUSKEGEE.

City waterworks wells (nine); bored by Moore and McCreary; depths range from 125 to 180 feet. They supply but little water and none of them are now used except in very dry seasons, the principal supply coming from a number of springs at the foot of a hill just north of the city. Two or three of the wells were only 30 to 40 feet deep and overflowed 1 or 2 gallons per minute.

WARRIORSTAND.

Well bored by O. B. Radford; depth, 450 feet; no water in sand.

CHESSON.

J. L. Robert's well, bored by O. B. Radford in 1899; depth, 350 feet; first water at 325 feet; water stands at —9 feet; steam pump used; pumps 10 gallons per minute.

HARDAWAY.

A. B. Chesson's well, one-half mile southwest of station; bored by O. B. Radford in 1904; depth, 325 feet; casing, 4-inch; first water at 300 feet; water stands at —72 feet.

Town Well, bored by J. N. Ingram in 1898; depth, 300 feet; casing, 4 1-2-inch; first water, at 173 feet, stood at —17 feet; second water, at 300 feet, stood at —20 feet.

DOWNS AND VICINITY

W. S. Harris's well, bored by J. N. Ingram in 1902; depth, 356 feet; casing, 4 1-2-inch; first water at 325 feet.

Will Harris's well, one-fourth mile from station; bored by O. B. Radford in 1899; depth, 325 feet; first water, at 300 feet, stood at —20 feet.

James Adams's well, 3 miles north of Downs; bored by O. B. Radford; depth, 118 feet; water stands at —25 feet; first water at 118 feet.

D. Adams's well, 4 miles north of Downs, one-half mile east of Adams well; bored by O. B. Radford in 1900; depth, 350 feet; casing, 4-inch; first water at 340 feet, stands at —50 feet.

FORT DAVIS.

Mrs. Wilson's well, bored by O. B. Radford in 1900; depth, 450 feet; casing, 4-inch; first water, at 425 feet, stood at —50 feet.

Hart Russell's well, 7 miles from Fort Davis; bored by O. B. Radford in 1898; depth, 218 feet; first water, at 190 feet, stood at —40 feet.

E. P. Bledsoe's well, Armstrong, 3 miles east of Fort Davis; bored by J. W. Radford in 1897; depth, 450 feet; first water, at 425 feet, stood at —55 feet; steam pump used; pumps 10 gallons per minute.

ROBA.

Clay Crosby's well, bored by Y. T. Radford in 1899; depth, 475 feet; casing, 4-inch; first water, at 450 feet, stands at —60 feet; steam pump used; pumps 10 gallons per minute.

LEE COUNTY.

SURFACE FEATURES.

The surface of Lee County is occupied by the outcrops of the crystalline schists and their decomposition products, with the exception of a narrow belt at the southern border where the sands and clays of the Tuscaloosa overlap the crystalline rocks. In the southern half of the county the red loam and pebbles of the Lafayette overlie the older rocks and afford the usual conditions for good water from springs and wells.

ARTESIAN PROSPECTS.

The only artesian records in Lee County are from Auburn, in the crystalline area, and from Girard, opposite Columbus, Ga., in the lower belt, from which it will be seen that the artesian prospects are, as a rule, not favorable.

AUBURN.

Alabama Polytechnic Institute well, bored by M. F. Fullan in 1899; depth, 106 feet; casing, 2-inch; water stood at surface; estimated yield, 3 gallons per minute with air-lift. Record: Orange sand, 0-10 feet; micaceous granite, 10-40 feet; gneissoid granite, 40-45 feet; gneissoid granite with comparatively small amount of mica (good water-bearing stratum), 45-47 feet; compact gneiss, 47-56 feet; coarse-grained granite, small amount of mica, quartz predominating in coarse crystals (good water-bearing stratum), 56-60 feet; gneissoid granite, more compact than preceding forms and containing iron coloration, 60-106 feet.

GIRARD.

E. Hill & Co.'s well, bored by J. W. Radford from a depth of 200 feet; total depth, 420 feet; casing, 4 1-2-inch and 6-inch; first water, at 360 feet, stood at —250 feet. Record: Clay and sand, 200-360 feet; sand and water, 360-390 feet; hard rock, 390-420 feet. This well, beginning in the Tuscaloosa beds overlying the gneiss, goes down into the latter at 390 feet, but the water is obtained from the Tuscaloosa.

PIKE COUNTY.

Artesian Prospects.

An east-west line through Pike County just north of Troy would separate the Cretaceous beds on the north from the Tertiary on the south. In the former only the uppermost formation of the Cretaceous, the Ripley, appears at the surface, and in this territory are found practically all the wells whose records have been obtained. In all cases it is probable that the water is reached in the strata of the Ripley, or "blue marl," as it is called. The oldest wells in the county are those about Orion, and most of the newer ones are in the same vicinity. In parts of this section thick beds of sand, of Lafayette and later age, overlie the Cretaceous beds and furnish an ample supply of shallow waters, which is probably the cause of the dearth of artesian wells.

ORION AND VICINITY.

T. B. Harmon's well, on Gordon place, 2 miles northeast of Orion, in the S. W. quarter S. W. quarter Section 29, Township 12, Range 21; flow, 1 1-2 gallons per minute; water rises to 1 foot above surface; temperature 67°.

Wells on Silver place: No. 1, 2 1-2 miles north of east of Orion, in the S. E. quarter N. E. quarter Section 32, Township 12, Range 21; estimated flow, 15 to 20 gallons per minute; water rises to 1 foot above floor; temperature, 66 1-2°. No. 2, 3 miles nearly south of Orion, in the N. E. quarter Section 4, Township 11, Range 21; inaccessible; in decay, flow decreasing, probably 1 gallon per minute.

Well on Oak Grove place, owned by Fox Henderson, 1 mile east of Orion, near center of Section 6, Township 11, Range 21; flow, 1 gallon per minute; water rises to 1 foot above surface; temperature, 68°.

Well on Jackson place, 4 miles southeast of Orion, in the S. E. quarter Section 8, Township 11, Range 21; depth, 332 feet; flow, 40 gallons per minute; water rises to 4 feet above the ground; temperature, 69°.

The wells above mentioned were all put down in 1858 by a well borer named Ledbetter.

Judge W. R. White's well, 3 1-4 miles east of Orion; bored by J. A. Sessions in 1903; depth, 287 feet; diameter, 2 inches; first water at 230 feet; second water, at 270 feet, rose to —6 feet.

LOGTON.

Booker Lawson's wells: No. 1, 1 1-2 miles west of Logton; bored by J. A. Sessions in 1903; depth, 263 feet; first water, at 247 feet, stands at —23 feet. No. 2, bored by J. W. Radford in 1901; depth, 304 feet; casing 4-inch; first water, at 161 feet, stand —30 feet; second water, at 263 feet. stand —72 feet. Record: Clay, 0-10 feet; marl, 10-161 feet; sand and water. 161-187 feet; marl, 187-263 feet; sand and water followed by marl, 263-304 feet. Mr. Radford did not case against the first water. He had a similar experience one-half mile south of the above location, the second water not rising as high as the first. Chunnennugga Ridge is only about 6 miles north of Logton and probably 100 feet higher. This ridge is the probable source of the first water at Logton, and this may account for the exceptional fact that the first water rises 42 feet higher than the second water.

LINWOOD.

Troy Oil and Chemical's Company's well; bored by J. A. Sessions in 1903; depth, 80 feet; casing, 4-inch; first water, at 64 feet, stands at —23 feet; pumps 20,000 gallons per day.

L. W. Williams's well, 2 1-2 miles east of Linwood; bored by J. A. Sessions in 1903; depth, 130 feet; casing, 4-inch; first water, at 120 feet, stands at —83 feet. Record: Sand, 0-4 feet; (?), 4-14 feet; marl, 14-120 feet; sand and water, 120-130 feet.

Only one attempt at an artesian well in the Tertiary area of Pike County, viz, at Troy, the county seat. This well is on a moderately high ridge similar to Chunnennugga Ridge in Bullock County. The lower part of Pike County is, in general well watered, the materials of the Tertiary formations, like those of the overlying Lafayette, being suited to the absorption and storage of the rainfall. The Clayton member of the Tertiary does not differ widely in its materials from the Ripley underlying it, so that it is not easy to draw the line between Cretaceous and Tertiary in the Troy record.

The Nanafalia sands occupy the surface in the lower townships of the county, and there should be no difficulty in getting artesian waters from them.

TROY.

Public well, bored at the expense of the city; elevation, 581 feet; depth. 2,632 feet; flow of about 75 gallons per minute obtained at depth of 450 feet, but lost when the well was lowered; well finally abandoned after boring cost about $26.000.

The following record was made by the borer, Mr. Conover, and left at the Troy Normal College together with a drawing of the well.

Record of public well, Troy.

	Feet.
Clay	0 — 12
Yellow sand	12 — 120
Shell rock	120 — 126
Green marl	126 — 186
Shell rock	186 — 190
Quicksand	190 — 308
Compact sand	308 — 753
Quicksand	753 .. 792
Compact sand	792 — 798
Coarse white sand and water	798 — 914
Blue sand	914 — 954
Blue marl	954 — 1598
Compact sand	1598 — 1606
Green marl	1606 — 1614
Shell rock and coral	1614 — 1622
Compact sand	1622 — 1642
Blue marl	1642 — 1762
Coarse sand	1762 — 1770
Coal (lignite)	1770 — 1770 ½
Green marl and sand	1770 ½ — 1780 ½
Compact sand; coal (lignite) 2 inches	1780 ½ — 1784 ½
Coal (lignite)	1784 ½ — 1785 ½
Blue marl	1785 ½ — 2585 ½
Compact sand	2585 ½ — 2605 ½
Gray marl	2605 ½ — 2632 ½

At this depth the boring should almost reach the crystalline rocks after passing through the entire thickness of the Cretaceous formations. The uncertainty as to what is meant by the word marl makes it impossible to determine accurately the formation in which the boring stopped.

BULLOCK COUNTY.

Surface Features.

The most marked topographic feature of Bullock County is the Chunnennugga Ridge, which makes the divide between the waters flowing northward into the Alabama and those flowing southward into Chattahoochee, Pea, and Conecuh rivers. Like all such ridges (called "*cuestas*" by geographers) in the Coastal Plain, Chunnennugga Ridge has a steep infacing (northward) slope and a very gentle, in places hardly perceptible slope in the other direction. In most parts of the county the northern edge of this ridge marks approximately the line of contact between the Selma chalk and the sandier strata of the Ripley.

Artesian Prospects.

In the northern or limestone half of the county artesian wells are the main source of water, which is derived from borings varying in depth with the location. The record given below of the Gray well at Mitchell Station (altitude 252 feet), on the Central of Georgia Railway, is interpreted as indicating that the boring goes through the Selma chalk and into the Eutaw sands below. The designations marl, rotten stone, etc., in this record are not easy to interpret, but the location of Mitchell station is such as to make the thickness of the chalk there about 200 feet or less.

MITCHELL STATION.

Eli Gray's well, bored by Frank Tillotson; depth, 394 feet; casing enlarged from 3 1-2-inch to 6-inch on account of sand; cased to marl. Record: Top soil, 0-18 feet; marl, 18-268 feet; limestone, 268-269; rotten stone, 269-319 feet; marl, 319-394 feet.

Frank Rutland's well, bored by Y. T. Radford in 1899; depth, 380 feet; casing, 4-inch; first water, at 350 feet, stood at —20 feet.

FITZPATRICK.

Atlantic Compress Company's well, bored by Y. T. Radford in 1903; depth, 450 feet; casing, 4-inch; first water at 400 feet; water stands at —20 feet; steam pump gives 20 gallons per minute.

THOMPSON STATION.

Dallas Patterson's well, bored by O. B. Radford in 1897; depth, 540 feet; casing, 4-inch; first water, at 520 feet, stood at —39 feet.

NORTH OF CHUNNENNUGGA RIDGE.

Other records of borings in the limestone country north of Chunnennugga Ridge are as follows:

Bob Gholson's well, 2 1-2 miles southwest of Fitzpatrick; bored by J. W. Radford in 1900; depth, 535 feet; casing, 4-inch; first water, at 500 feet, stands at —45 feet.

A. V. Barnett's well, High Log post-office, 5 miles southwest of Fitzpatrick; bored by Y. T. Radford in 1898; depth, 700 feet; casing, 4-inch; first water, at 680 feet, stood at —60 feet; pumps 10 gallons per minute.

SHOPTON, AND VICINITY.

Gus Edwards's well, bored by J. W. Radford in 1901; depth, 1050 feet; casing, 4-inch; first water, at 1000 feet, stands at —150 feet; yield, 10 gallons per minute with steam pump.

George Edwards's well, 2 miles east of Shopton; bored by Sessions in 1901; depth, 988 feet; casing, 4-inch; first water, at 988 feet, stood at —200 feet.

BUGHALL.

E. C. Dawson's well, bored by O. B. Bradword in 1898; depth, 1000 feet; casing, 4-inch; stopped in marl; no water.

UNION SPRINGS AND VICINITY.

Singleton & Linton's well, 4 miles northwest of Union Springs; bored by J. W. Radford in 1899; depth, 666 feet; casing, 4-inch; first water at 560 feet; second water at 636 feet; third water, at 655 feet, stands at —122 feet. Record: Soil and clay, 0-45 feet; marl, 45-560 feet; sand and water, 560-620 feet; flint rock, 620-636 feet; sand and water, 636-641 feet; flint rock, 641-655 feet; sand and water, 655-666 feet.

A. E. Singleton's well, 3 1-2 miles west of Union Springs; bored by J. W. Radford in 1900; depth, 650 feet; casing, 4-inch; first water, at 600 feet, stood at —125 feet.

S. P. Rainer's well, 1 mile west of Union Springs; bored by Y. T. Radford in 1899; depth, 815 feet; casing, 4-inch; first water, at 775 feet, stood at —160 feet.

Well of J. H. Rainer, Jr., 3 1-2 miles north of Union Springs; bored by Y. T. Radford in 1901; depth, 610 feet; casing, 4-inch; first water, at 590 feet, stood at —120 feet.

Union Springs is on the summit of Cunnennugga Ridge, which, as before stated, is on the contact of the Selma chalk with the Ripley sands and clays. The altitude of the ridge here is between 485 and 515 feet, and borings for water are necessarily deep, and with no prospect of flow. The wells which supply the city show that the water stands at —238.5 feet, from which depth it is pumped by air lift. The record is as follows:

City waterworks wells, Union Springs; altitude, 519 feet; two wells, same record for both; bored by D. A. Caylor, and record furnished by him; commenced in 1894, completed in 1895; depth, 848 1-2 feet; cased to the bottom with 8-inch casing; rests on very hard impenetrable rock; water stands at 238 1-2 feet; pumps 140 gallons per minute; temperature, 68°.

Record of city waterworks wells, Union Springs.

	Feet.
Top soil	0 — 16
Marl, with seams of light-gray rock, varying in thickness from 2 to 12 inches occurring every 25 feet	16 — 848 ½

Analysis of water from city waterworks wells. Union Springs.

(*Analyst, R. S. Hodges.*)

	Parts per million.
Potassium (K)	6.6
Sodium (Na)	61.4
Magnesium (Mg)	.2
Calcium (Ca)	2.5
Iron and alumina (Fe_2O_3 Al_2O_3)	.7
Chlorine (Cl)	9.4
Sulphuric acid (SO_4)	31.8
Carbonic acid (HCO_3)	124.8
Silica (SiO_2)	15.1
	252.5

EAST OF UNION SPRINGS.

Eastward from Union Springs the Ridge loses its distinctive character, passing gradually into the high dividing line between the Alabama and Chattahoochee drainages. The two records which follow come from this high land. The waters from the wells in this section, in both Macon and Bullock counties, are said to have a strong odor of sulphur.

Atlantic Compress Company's well, Suspension; bored by Y. T. Radford in 1903; depth, 700 feet; casing, 4-inch; first water, at 700 feet, stood at —140 feet. This well caved, but another a short distance away gave 4 1-2 gallons per minute with pump.

J. Bank's well, Guerrytown; bored by O. B. Radford in 1904; depth, 600 feet; casing, 4-inch; first water, at 560 feet, stood at —7 feet. As soon as pump is used, water falls to —100 feet.

SOUTH OF UNION SPRINGS.

South of Union Springs deep beds of sand, either of Lafayette or more recent formation, overlie the Ripley strata, the characteristic red loam and pebble beds of the Lafayette, however, appearing in many localities. This part of the county is consequently well supplied with shallow waters and deep borings are rare. Only the two following records could be obtained:

J. C. Graham's well, Inverness; bored by Y. T. Radford in 1902; depth, 925 feet; casing, 4-inch; no water. Record: Quicksand, 0-10 feet; marl, 10-300 feet; sand, dry, 300-315 feet; marl, 315-925 feet; stopped in marl.

W. S. Deason's well, near Eric; bored by Sessions in 1903; depth, 106 feet; diameter, 4 inches; first water, at 106 feet, stands at -45 feet.

CHATTAHOOCHEE RIVER DRAINAGE. "BLUE MARL" REGION.

STRATIGRAPHIC CHARACTERS.

East of Macon County the three upper divisions of the Cretaceous, so easily distinguished to the west, can not be made out with any definiteness. The succession and character of the strata along Chattahoochee River are somewhat as follows:

First. A great series of bluish micaceous and clayey sands, with indurated ledges, all more or less fossiliferous; and massive bluish clays, sometimes with lignitic matter, along Chattahoochee River for a distance of 35 or 40 miles, corresponding to a thickness of 1000 feet or more. These beds, or at least the upper half of them, contain shells characteristic of the Ripley formation.

Second. A series of cross-bedded sands, with clay partings, the latter, when thick, containing many fragments of lignitized stems and leaves and occasionally large logs, also lignitized; dark-colored micaceous sands with indurated ledges in which are fossil oysters; nearly black, somewhat sandy clays and clayey sands, with many fossils, mainly in the form of casts. These beds have a thickness of about 400 feet along the river. The fossils of this series, so far as they have any distinctive characters, seem to be closely related to the species occurring in the upper part of the Eutaw sands.

Third. The cross-bedded sands mottled clays, gray clays, and other characteristic materials of the Tuscaloosa formation, extending from Broken Arrow Bend, 8 miles below the city up to Columbus, Ga., and perhaps farther. This formation seems to be much thinner in the eastern part of the State than farther west.

It will be seen that the Selma chalk as a distinct division, recognizable by its physical characters and its fossils, has given out, strata with Eutaw fossils being directly overlain by strata with fossils characteristic of the Ripley, into which the chalk has apparently merged. In Russell and Barbour counties the Ripley beds, which occupy a large proportion of the surface have the general designation of "blue marl."

Along the upper border of Russell County the Tuscaloosa beds are exposed about Columbus, Ga., and Girard and on the river bluffs from Columbus down to Broken Arrow Bend, where the dark-gray calcareous sands with fossils of the lowermost Eutaw are encountered. The other strata of the Eutaw, consisting of clayey sands, laminated dark-gray clays, and yellow and white sands, are exposed along the river bluffs from Broken Arrow Bend to the mouth of Ihagee Creek.

From Ihagee Creek down to Otho, below Eufaula, the river banks show the succession of the Cretaceous beds, which are extremely uniform in lithologic character and which contain throughout the characteristic fossils of the Ripley group, often in the finest state of preservation and of such fresh appearance as to suggest, at least, that they are of Tertiary age. These beds, known throughout this part of the State as "blue marl", consist of bluish or gray calcareous effervescent sands, generally containing either shell fragments or entire shells, scales of mica, grains of glauconite, bits of lignitic matter, etc. The sands show variations in the proportion of clay, mica, and lignitic matter, and also in the color, which shades out to yellow where much weathered and merges into brown where the proportion of iron is considerable and the material is not too much exposed and dried out. Some shade of blue or dark gray is in the main, characteristic of the whole series below the level of ground water, and this justifies the name of blue marl, if the word marl be used to designate beds of almost any material containing shells or fragments of shells. The bluish sandy beds alternate at frequent intervals with indurated ledges of similar materials compacted into rather hard rocks by a calcareous cement. Such ledges usually contain large numbers of the shells of the various oysters characteristic of the Cretaceous, such as *Exogyra, Gryphaea, Anomia, Ostrea* in several species.

From this account it would seem that the Eutaw and Ripley beds in this section afford fairly good conditions for artesian water and the records which have been obtained appear to indicate that both formations do yield such water; flowing wells are, however, rare.

Russell and Barbour are the two typical "blue-marl" counties, but many of the characteristics of this region are observed in the Cretaceous formations of Pike County and of the southern part of Bullock County, and the artesian conditions of these sections are practically the same as those described in Russell and Barbour.

COUNTY DETAILS.

RUSSELL COUNTY.

Surface Features.

The topography of Russell County does not offer any very marked peculiarities. As usual, many of the high divides are capped with the Lafayette mantle of red loam and pebbles, making level plains in which an abundance of good water can always be had from wells and springs. In the blue marl region, where the Cretaceous beds are not covered by this mantle of Lafayette, water may generally be had in wells varying in depth from 30 feet in the lowlands to 50 or 60 feet in the uplands. If it is not obtained at that depth, it will not be found by penetrating into the blue marl. Some of these wells go dry in summer, and especially was this the case in 1897.

The records given below are instructive. It is to be remarked that the water in these borings stands at a higher level than is generally the case. In most of the State the water does not overflow when the altitude of the well is much above 225 feet, and not always at lower elevations. At Hurtsboro, with an altitude of 346 feet, the water stands within a few feet of the surface (8 or less), as it does also at Hatchechubbee, with an altitude of 311 feet.

Artesian Records.

KAOLIN STATION.

Two wells, bored by the City of Columbus, Ga., one mile south of the City, near Kaolin Station on Central of Georgia railway.

No. 1 drilled by L. B. Clay, of Bartow, Ga., Depth 286 feet diameter not known; water rises 12 to 15 feet above the ground. Record—Clay, etc., 0-5 feet; sand and gravel, 5-33 feet; decomposed sand rock, gravel and chalk, 33-53 feet; hard chalk, marl and soft rock, 53-113 feet; water bearing strata, 113-116 feet; marl, 116-146 feet; water bearing strata, 146-153 feet; marl and rock, 153-173 feet; artesian water strata, 173-185 feet; red clay, blue marl and soft sand rock, 185-235 feet; hard rock, 235-238 feet; water sand, or honey comb water bearing rock, 238-245 feet; flint rock, very hard, 245-246 feet; alternating thin layers of marl rock and water bearing strata, 246-281 feet; granite rock, very hard 281-286 feet.

No. 2. Drilled by Perry Andrews of Atlanta, Ga., Depth about 280 feet; diameter 12 inches; estimated flow 5,000 gallons a day without pumping, estimated yield by air lift 120,000 gallons a day. Water rises 12 to 15 feet above the surface

In both these wells the underlying granite was reached and the boring discontinued at about 280 feet depth.

HURTSBORO AND VICINITY.

Public well, Hurtsboro; altitude, 346 feet; bored in 1898 by Morrison and Wicker; top soil, 15 feet; sand and marl, 110 feet; two ledges of shell rock in the marl, 2 feet; compact sand and shell rock every 3 or 4 feet down to 400 feet; water-bearing sand with some red clay at bottom; total depth, 530 reet; casing, 50 feet, 4-inch; water stands at -9 feet; temperature 68°.

W. H. Bank's well, Hurtsboro; depth, 526 feet; water stands at -8 feet; temperature, 66°. Record: Top to blue marl, 68 feet; marl, 125-200 feet thick, with about 20 ledges of shell rock, very hard; compact white sand between the ledges of shell rock; hard red clay under the marl; then water-bearing sand.

J. P. Crawford's well, Hurtsboro; bored in 1898; depth, 302 feet; casing, 102 feet, 2½-inch; water stands at -2½ feet; pump easily exhausts flow; flows freely after five minutes; water colors vessels.

Record of J. P. Crawford's well, Hurtsboro.

	Feet.
Lime rock	0 — 12
Shell rock	12 — 13½
Gray and red sands	13½ — 85
Marl	85 — 107
Gray flint rock	107 — 108
Hard marl	108 — 138
Rock	138 — 139
Marl	139 — 185
Rock	185 — 187
Marl	187 — 200
Gray sand	200 — 215
Hard rock (water rose to -4½ feet)	215 — 217
Sand and mica	217 — 243½
Rock	243½ — 244
Compact sand	244 — 246
Sand and mica	246 — 263
Sand and lignite	263 — 278
Water-bearing sands	278 — 302

Eton Tucker's well, Hurtsboro, one-fourth mile northeast of Crawford well; bored by Mr. Tucker in 1902; depth, 560 feet; water stands at -24 feet; record same as other Hurtsboro wells.

HATCHECHUBBEE AND VICINITY.

C. E. Ingram's well, Hatchechubbee; altitude, 311 feet; depth, 400 feet; water stands at surface; casing, 20 feet, 3-inch.

Record of C. E. Ingram's well, Hatchechubbee.

	Feet.
Top Soil	0 — 20
Marl	20 — 100
Coarse sand, with shell rock	100 — 140
Hard greenish marl	140 — 200
Sand and shell rock	200 — 300
Pink marl	300 — 350
Red clay (bottom sand)	350 — 400

The wells of L. C. Cooper, F. P. Haddock, J. M. DeLacy, and A. B. Walker, in Hatchechubbee, were all put down at the same time; all are close together and the records are the same as that of the Ingram well.

McMicken well, 3 miles south of Hatchechubbee; bored by W. M. Morrison in 1898; water stands at -50 feet; casing, 20 feet, 3-inch; top to marl, 12 feet; marl 130 feet thick; thin ledge of shell rock.

Jim Perry's well, 8 miles south of Hatchechubbee; record same as that of McMicken well.

SEALE AND VICINITY.

Court-house well, Seale; bored in 1898 by Wicker & Morrison; depth, 170 feet; water stands at -30 feet; casing, 120 feet, 3-inch; 90 feet through clay, coarse gravel, and coarse sand with small black grains; this sand alternates with shell rock from 6 inches to 2 feet in thickness; log at 40 feet.

J. S. Brannon's well. 2½ miles north of Seale; depth, 400 feet; water rises to -75 efet; casing, entire depth, 4-inch.

OSWICHEE.

W. J. McLendon's well, near Chattahoochee River; depth, 465 feet. Record: Sand and clay, 20 feet; marl with shell, 65 feet; beds of sand and marl, 15 to 25 feet thick, alternating, to 380 feet; hard rock, 2 feet; sand to 445 feet. Water at this point flowed 12 gallons per minute, but has decreased to 4 gallons. Well lowered 20 feet into sand to hard rock.

Analysis of water from W J. McLendon's well, Oswichee.

(Analyst, R. S. Hodges.)

	Parts per million.
Potassium (K)	1.8
Sodium (Na)	23.9
Magnesium (Mg)	.7
Calcium (Ca)	11.5
Iron and alumina (Fe_2O_3, Al_2O_3)	2.0
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	6.4
Carbonic acid (HCO_3)	93.5
Silica (SiO_2)	36.8
	178.3

Of the wells described above, those at Oswichee and Seale undoubtedly go into the Eutaw formation, since these two places are close to the contact of the two formations. The wells at Hatchechubbee also penetrate into the Eutaw, but the two south of Hatchechubbee barely reach it. The deepest of the Hurtsboro wells may go down to the Eutaw, but the shallower ones hardly do so.

The wells along the Seabord Air Line, described below, are farther from the contact of the Eutaw and Ripley, and as they are relatively shallow they do not pass out of the Ripley sands or marls.

RUTHERFORD AND VICINITY.

R. P. Tallman's well, Rutherford, 10 miles southeast of Hurtsboro; bored by W. E. Wicker in April, 1898; depth, 164 feet; casing, 22 feet, 3-inch; flow, 18 gallons per minute; piped into residence; temperature, 68°. Record: Top to marl, 22 feet; marl with ledges of shell rock, 100 feet. Later information is that the water here has ceased to flow and that other wells in the vicinity of Rutherford and Hurtsboro either no longer flow or have much weaker streams than when first bored.

H. M. Rutherford's well, Rutherford; depth, 135 feet; casing, 20 feet, 3-inch; flowed 6 gallons per minute for two years, stands now at surface; temperature, 68°. Record: Top soil, 18 feet; marl, about 100 feet; balance sand and water.

Mr. W. M. Morrison bored two more wells for Mr. Rutherford in 1901 and furnishes the following details: No. 1, at residence; depth, about 180 feet; water stands at -1 foot. Record: Clay and sand, 20 feet; blue marl, 130 feet; hard shell rock, 6 inches; water-bearing sand, 30-40 feet; hard blue rock, 4 feet; sand to bottom. No. 2, at store, near railroad; same depth and record as No. 1; flow, 1½ gallons per minute.

G. L. Hardin's wells, Rutherford: No. 1, "brick-yard well," three-fourths mile south of Rutherford; bored by Mr. Hardin in 1902; depth, 105 feet; casing, 3-inch; first water, at 90 feet, stood at 6 feet above the surface; flow, weak; present flow, 3 gallons per minute; water rises to 3 feet above the surface; temperature, 66°. Record: Soil, 0-15 feet, at 60 feet, 18 inches of soft shell rock; sand, 90-105 feet. No. 2, "ginnery well," one-half mile east of Rutherford; bored by Mr. Hardin in 1899; depth, 140 feet; casing, 3-inch; first water, at 120 feet, stood at 18 feet above the surface; flow, 3 gallons per minute; temperature, 66°. No. 3, three-fourths mile west of Rutherford; bored by Mr. Hardin in 1901; depth, 130 feet; casing, 3-inch; first water at 115 feet, stood at 1 foot above the surface; flow 2 gallons per minute; temperature, 66°. Record same as others.

N. W. E. Long's well, 1 mile northeast of Rutherford; depth, 120 feet; water stood at -4 feet; increased to small flow; gravel, marl, and sand.

Well on Hatcher plantation, 1½ miles northwest of Rutherford; depth, 160 feet; flow, 5 gallons per minute; cased to marl with 3-inch casing.

T. L. McDonald's well, 2 miles northwest of Rutherford; bored by G. L. Hardin in 1900; depth, 260 feet; first water stands at -60 feet.

Well on plantation of S. T. Margaret, 2 miles south of Rutherford; bored by W. M. Morrison in 1901; flow, 1 gallon per minute. Record: Clay and sand, 15 feet; blue marl to 130 feet; gray sand and water to 175 feet.

Gus Battle's well, 2 miles south of Rutherford, on high red hill; bored by W. L. Morrison in 1901; water stands at -40 feet. Record: Clay and sand, 70 feet; blue marl to 210 feet; water-bearing sand, 30 feet.

Upshaw Brothers' well, 3½ miles southeast of Rutherford; bored by Geo. Thompson in 1901; depth, 150 feet (?); flow, 3 gallons per minute; water rises to 2 feet above the surface; temperature, 67°.

Mr. Thompson also bored two wells at Persons Crossing, 3 or 4 miles east of Rutherford, about which no reliable information could be obtained. One is owned by J. W. Upshaw and the other by T. L. Mitchell.

PITTSBORO AND VICINITY.

Well at store of J. W. Upshaw, near Hooks Station, 8 miles west of Pittsboro; bored by Wicker in 1898; depth, 325 feet; water used is from strata at 122 feet; water rises to -35 feet; unlimited supply; colors vessels; casing, 20 feet, 3-inch. Record: Top soil, 0-20 feet; marl with ledges of shell rock, 20-120 feet; sand and water, 120-122 feet; marl, 122-325 feet.

Well on L. C. Lamb's plantation, 8 miles west of Pittsboro; bored in May, 1898; depth, 129 feet; casing, 24 feet, 3-inch; flow, 10 gallons per minute; temperature, 67°; colors vessels. Record: Top soil, 0-20 feet; marl, 20-128 feet; shell rock, sand underneath, 128-129 feet.

Well at R. B. Adams's plantation, 3½ miles northwest of Pittsboro; bored by Wicker in 1898; casing, 20 feet 4-inch; water rises to -50 feet; very hard; pumps free, supply inexhaustible. Record: Top to marl, 18 feet; water and sand; 97 feet; does not go below the marl.

Well at L. C. Lamb's residence, 3½ miles northwest of Pittsboro; bored by Wicker in 1898; casing, 20 feet, 4-inch. Record: Top to marl, 18 feet; bored to 97 feet to sand and water, marl underneath.

Public well, Pittsboro; bored by W. E. Wicker in 1898; casing, 26 feet, 3-inch; flow, three-fourths gallons per minute; temperature, 72°; tastes of sulphur and colors vessels with iron; stated to be good for stomach troubles. Record: Surface to marl, 24 feet; marl, with two layers of hard shell rock, 193 feet; quicksand, 2 feet, with hard rock at bottom. The analysis of the water from this well by Mr. Hodges, is as follows:

Analysis of water from public well, Pittsboro.

	Parts per million.
Potassium (K)	1.5
Sodium (Na)	59.1
Magnesium (Mg)	.8
Calcium (Ca)	9.0
Iron and alumina (Fe_2O_3, Al_2O_3)	.9
Chlorine (Cl)	61.3
Sulphuric acid (SO_4)	1.6
Carbonic acid (HCO_3)	82.6
Silica (SiO_2)	41.0
	257.8

Well at J. W. Caldwell's gin, Pittsboro; depth, 445 feet; casing, 26 feet, 3-inch; original flow, one-half gallon per minute; present flow, 1 quart per minute; temperature, 72°; colors vessels.

Record of J. W. Caldwell's well, Pittsboro.

	Feet.
Top soil	0 — 18
Marl	18 — 78
Shell rock	78 — 78½
Marl, sand and water (1 gallon in 8 minutes)	78½ — 225
Marl, sand and water (½ gallon per minute)	225 — 265
Marl (hard rock at bottom)	265 — 445

F. P. Pitts's well, at residence, Pittsboro; depth, 217 feet; temperature, 68°.

Record of F. P. Pitt's well. Pittsboro.

	Feet.
Top Soil	0 — 20
Marl	20 — 60
Soft shell rock	60 — 61
Marl	61 — 75
Sand	75 — 80
Hart flint rock	80 — 82
Marl (water and sand, 1 quart in 12 minutes)	82 — 165
Marl	165 — 185
Marl (flow increased to 32 gallons per minute, drill lost)	185 — 217

GLENVILLE AND VICINITY.

Comer-Bishop Company's well, on Cowikee Creek, near Glenville; bored by Morrison in 1899; depth, 514 feet; water stands at -9 feet. Record: Clay, 0-8 feet; coarse gravel, 8-18 feet; marl, shell rock, 4 inches thick, 18-294 feet; water-bearing sands, 294-514 feet.

Wells on on Capt. E. C. Perry's plantation, near Glenville: No. 1, depth, 164½ feet; casing, 22 feet, 3-inch; water rises to 25 feet above the surface; flow, 100 gallons per minute; temperature, 67°.

Record of E. C. Perry's well, No. 1, near Glenville.

	Feet.
Top soil	0 — 15
Quicksand	15 — 17
Marl	17 — 160
Shell rock	160 — 160½
Water-bearing sands	160½ — 164½

Analysis of water from E. C. Perry's well No. 1, near Glenville.

(*Analyst, R. S. Hodges.*)

	Parts per million.
Potassium (K)	8.6
Sodium (Na)	87.2
Magnesium (Mg)	1.5
Calcium (Ca)	36.5
Iron and alumina (Fe_2O_3, Al_2O_3)	1.8
Chlorine (Cl)	73.5
Sulphuric acid (SO_4)	175.9
Carbonic acid (HCO_3)	12.8
Silica (SiO_2)	19.4
	417.2

No. 2, one-half mile from No. 1; bored by Geo. Thompson in 1899; depth, 175 feet; flow, 60 gallons per minute; temperature, 67°. Record same as No. 1.

Wells on Hatcher's plantation, on Chattahoochee River; 4 or 5 flowing wells are reported here, but no records were obtainable.

BARBOUR COUNTY.

Surface Features.

The area of Barbour County is about equally divided between the Ripley division of the Cretaceous on the north and the lower divisions of the Tertiary on the south.

Some details have already been given under Russell County, of the Ripley strata as exhibited in the eastern counties of this section. These beds consist in the main of bluish or grayish sands, with scales of mica, grains of greensand, and very generally fragments and decomposed masses of marine shells.

The presence of calcareous material in the sands has caused the name marl to be applied to them and to the formation as a whole throughout this part of the State. Besides the sandy marl, thick beds of somewhat massive clay are not uncommon in some parts of the county, where they form the basis of a certain class of soils known as the "hog wallow" prairie.

South of the latitude of Clayton the Tertiary strata lap over those of the Cretaceous and determine in great measure the character of the soils and of the topography. The contact of Cretaceous and Tertiary in many parts of this county is marked by a well-defined ridge similar to the Chunnennugga Ridge of Bullock County, though differing in the geologic formations involved.

In its upper part this ridge, which may be called the Clayton Ridge, is made by the Clayton limestone, with a double capping consisting of beds of the Grand Gulf massive and laminated clays and sands, and the usual red loam, sands, and pebble beds of the Lafayette.

The northward-facing slope of Clayton Ridge is steep and well marked, while the southward slope, being structural, is gentle and scarcely to be distinguished from a level plain. On the summit of the ridge is the town of Clayton, to the north of which lie the calcareous lands of the "blue marl" region, while to the south the surface is generally sandy, partly from the materials afforded by the Tertiary strata and partly from the overlying Grand Gulf and Lafayette deposits.

The presence beneath the surface of limestone of the Clayton and Nanafalia horizon is shown for many miles south of its outcrop by the bold springs of blue limestone water which break out in places in the lower part of the county. The best known of these is the Blue Spring, a place of resort for people from all parts of the county. This spring breaks out in the bottom of Choctawhatchee River and occupies a nearly circular area about 25 feet in diameter. The water is clear and blue like that of the Big Springs of Florida, but of considerably lower temperature.

In both Cretaceous and Tertiary terranes the divides are often high, level plains capped with the materials of the Lafayette. As a matter of course surface waters in such regions are abundant and of good quality. In the Tertiary formations also there seems to be no lack of water supply from ordinary wells and springs.

In the northern half of the county, on the other hand, where the Lafayette sands are not present and the water must be obtained from the blue marl strata, the supply is deficient and artesian borings are necessary.

Artesian Prospects.

The few available records of the bored wells of Barbour show that the borings have not gone deeper than the Ripley strata, except possibly in the case of the Eufaula Oil and Gin Company's well which may have reached the Eutaw sands. It may be remarked again in this connection that along Chattahoochee River below Columbus, the whole Cretaceous series above the Tuscaloosa, shows a great uniformity of material, so that it is not easy to distinguish between the Eutaw and the Ripley where there are no fossils available.

EUFAULA AND VICINITY.

At Eufaula the altitude of the well from which the city supply is derived is 110 feet below that of the railroad track at the depot, or 90 feet above mean tide; that of the Oil and Gin Company's well is about the same as that of the depot-200 feet above tide; and that of the well at Moulthrop's brick yard is probably intermediate between the two. At the two lower wells the water overflows, but not at the other. In all these the supply seems to be inadequate.

City Water Company's well, Eufaula, under the bluff on the west bank of Chattahoochee River, 110 feet below the city; casing, 4-inch; flow, 5 3-4 gallons per minute; hydraulic ram used; temperature, 68°. Boring is in marl to water-bearing sands at 400 feet; several layers of soft rock; hard rock below the water-bearing sand.

Eufaula Oil and Gin Company's well, Eufaula; bored in 1895; depth, 950 feet; water at first stood at -26 feet; now stands at -50 feet; cased at 300 feet, 4-inch and 6-inch; supply insufficient; well abandoned.

Record of Eufaula Oil and Gin Company's well, Eufaula.

	Feet.
Top soil and sand	0 — 30
Marl	30 — 380
Soft sandstone	380 — 381
Cavity with a little water	381 — 389
Marl, water below in very fine sand	389 — 950

Well at Moulthrop's brick yard, 1 mile southeast of Eufaula; bored in April, 1900, by Eugene Thompson; depth, 350 feet; casing, 20 feet, 4-inch; flow, 5 gallons per minute. Record: Top soil, 0-20; marl water, 20-350. The water bearing bed in this well is a sharp gray sand of fine grain, used by engineers for grinding valves. The boring went 15 feet deeper than this sand and struck a hard rock which was not pierced. The marl contains a great many shells, and in it at intervals of about 30 feet occur indurated crusts. The following analysis of the water from this well was made by the Pratt Laboratory, of Atlanta, Ga.

*Analysis of water from Moulthrop's well, Eufaula.**

	Parts per million.
Sodium (Na)	136.92
Potassium (K)	3.05
Calcium (Ca)	3.49
Magnesium (Mg)	.79
Chlorine (Cl)	13.68
Sulphuric acid (SO_4)	5.25
Carbonic acid (CO_3)	172.83
Iron and alumina (Fe_2O_3, Al_2O_3)	1.88
Silica (SiO_2)	15.92
Organic and volatile matter	33.02
	386.83

*Expressed by analyst in grains per gallon and hpothetical combinations; recomputed to ionic form and parts per million at U. S. Geological Survey.

Comer-Bishop Company's well, on Jennings Fryer place, 6 miles north of Clayton; bored by W. L. Morrison; record furnished by him; depth, 277 feet; water stands at —80 feet. Record: Top soil, 0-30 feet; marl, 30-120 feet; sand with layers of very hard rock, from 4 inches to 4 feet thick, 120-277 feet. The analysis of this water, by Mr. Hodges, is as follows:

Analysis of water from Comer-Bishop Company's well, near Clayton.

	Parts per million.
Potassium (K)	3.3
Sodium (Na)	77.8
Magnesium (Mg)	4.3
Calcium (Ca)	14.9
Iron and alumina (Fe_2O_3, Al_2O_3)	7.0
Chlorine (Cl)	17.5
Sulphuric acid (SO_4)	27.6
Carbonic acid (HCO_3)	212.7
Silica (SiO_2)	28.1
	393.2

HARRIS AND VICINITY.

B. B. Comer's well, Harris; bored by W. L. Morrison in 1899; record furnished by him; depth, 780 1-2 feet.

Record of B. B. Comer's well, Harris.

	Feet.
Clay	0 — 4
Coarse sand	4 — 20
Blue marl	20 — 120
Shell rock	120 — 120½
Sand	120½ — 130
Soft rock	130 — 133
White sand with plenty of water containing white sediment; not good; cased off	133 — 153
Soft shell rock and hard marly sand	153 — 220
Blue marl	220 — 550
Hard blue sand	550 — 600
Marly sand and shell rock alternating; no more water	600 — 780

C. H. Bishop's well, Harris; bored in September 1899, by W. L. Morrison; record furnished by him; depth, 183 feet; water rises to —10 feet; pump put down to 120 feet; yield, 6 gallons per minute by pump.

Record of C. H. Bishop's well, Harris.

	Feet.
Clay and sand	0 — 13
Marl	13 — 103
Hard shell rock	103 — 105
Marl	105 — 110
Shell rock	110 — 112
Water-bearing sands	112 — 115
Shell rock and marl alternating	115 — 140
Compact marl	140 — 183

The analysis by Mr. Hodges shows this water to have the following composition:

Analysis of water from C. H. Bishop's well, Harris.

	Parts per million.
Potassium (K)	3.8
Sodium (Na)	85.3
Magnesium (Mg)	5.1
Calcium (Ca)	9.3
Iron and alumina (Fe_2O_3, Al_2O_3)	5.3
Chlorine (Cl)	17.5
Sulphuric acid (SO_4)	31.6
Carbonic acid (HCO_3)	211.6
Silica (SiO_2)	18.9
	388.4

B. B. Comer's wells, all bored by D. A. Sylvester: No. 1, at Harris Station, 150 yards from depot; depth, 62 feet; casing, 3-inch, to marl; first water, at 55 feet, stands at 9 feet above the surface; original flow, 7 gallons per minute at 2 feet above the surface; present flow, one-eighth gallon per minute. Record: Soil. 0-16 feet; marl, 16-55 feet; sand, 55-62 feet; thin shell rock at 52 feet. No. 2, 75 yards west of Harris Station, on higher ground than No. 1; bored in 1904; depth, 110 feet; casing, 3-inch to marl; first water at 107 feet, stood at -14 feet. Record: Soil, 0-17 feet; marl, 17-107 feet; sand, 107-110 feet. No. 3, 300 yards north of west of Harris Station; bored in 1904; depth, 108 feet; casing, 3-inch; first water, at 100 feet, stood at surface; second water, at 106 feet; original flow, one-half gallon per minute; present flow, one-sixth gallon per minute; temperature, 68°. Record: Sand, 10-17 feet; marl, 17-100 feet; sand, 100-103 feet; rock, 103-106 feet; sand, 106-108 feet. No. 4, 1 mile south of Harris Station; bored in 1904; depth, 139 feet; casing, 3-inch; first water at 134 feet; original flow, 3½ gallons per minute; present flow, 3 gallons per minute; temperature, 66°. No. 5, 4 miles southwest of Harris Station; bored in 1904; depth, 201 feet; casing, 3-inch; first water, at 197 feet; rose to 3 feet above the surface; original flow, 3 gallons per minute; present flow, 2½ gallons per minute; strong of sulphur; temperature, 68°. No. 6, 150 yards west of No. 5; bored in 1904; depth, 184 feet; first water at 180 feet, rose to 3 feet above the surface; original flow, 2 1-2 gallons per minute; present flow, 1½ gallons per minute; thin shell rock at 90 and 135 feet; strong of sulphur; temperature, 67½°. No. 7, 5 miles southwest of Harris Station; bored in 1904; casing, 3-inch; first water at 164 feet; rose to 3 feet above the surface; flow, 6 gallons per minute. No. 8, 3 miles southeast of Harris Station; bored in 1904; depth, 218 feet; first water at 208 feet; second water, at 215 feet, stood at -9½ feet. Record: Sand and clay, 0-37 feet; marl with much sand, 37-42 feet; hard rock, 42-43 feet; marl with sand, 43-215 feet; so much sand mixed with the marl that the well had to be cased to the bottom. No. 9, 4 miles west of north of Cowikee; bored in 1902; depth, 165 feet; first water at 158 feet; second water, at 160 feet; rose to 2 feet above the surface; original flow, 2 gallons per minute; present flow, 1½ gallons per minute; temperature, 69°. No. 10, three-fourths mile northeast of No. 9; bored in 1904; depth, 198 feet (?); record unreliable. No. 11, one-half mile west of No. 9; bored in 1902; depth, 330 feet; first water, at 326 feet; stands at -22 feet; tastes of alum. No. 12, one-half mile northwest of No. 11; bored in 1902; depth, 370 feet; first water at 355 feet; second water, at 363 feet, stands at -26 feet. No. 13, 1 mile west of No. 9; bored in 1904; depth, 170 feet; first water, at 164 feet, rose to 4 feet above the surface; original flow, 3½ gallons per minute; present flow, 3 gallons per minute; temperatur, 67°. No. 14, on Cody place, 300 yards east of No. 10; bored in 1904; depth, 171 feet; record same as No. 10. No. 15, 2½ miles northeast of Cowikee; bored in 1902; depth, 270 feet; first water, at 166 feet; flow, 2 gallons per minute; temperature, 69°. No. 16, 4 miles east of Cowikee; bored in 1902; 3 wells here on Richardson place; same record as No. 15; flow, 4 gallons per minute; temperature, 69°. No. 17, located 7 miles north of east of Cowikee; bored in 1902; depth, 280 feet; first water, at 274 feet; stood at -19 feet.

Well at Spring Hill, Cowikee; depth, 600 feet; water stands at -18 feet.

CLAYTON.

City well, bored by Y. T. Radford in 1903; depth, 560 feet; cased to bottom, 4-inch, 6-inch, 8-inch, and 12-inch; first water, at 520 feet; stood at -252 feet. Record: Clay, 0-50 feet; sand, 50-80 feet; yellow clay, 80-120 feet; quicksand 120-220 feet; rock and marl, 220-520 feet; sand and water, 520-560 feet.

The character of the water from this well is shown by the analysis below, made by Mr. Hodges:

Analysis of water from city well, Clayton.

	Parts per million.
Potassium (K)	4.6
Sodium (Na)	69.4
Magnesium (Mg)	2.9
Calcium (Ca)	19.6
Iron and alumina (Fe_2O_3, Al_2O_3)	6.5
Chlorine (Cl)	21.2
Sulphuric acid (SO_4)	25.7
Carbonic acid (HCO_3)	195.5
Silica (SiO_2)	26.8
	372.1

Waters of the Tertiary.

GENERAL STATEMENT.

As has been stated, (p. 110), the number of artesian wells in the Tertiary area is as yet comparatively small, and the data are not at hand for defining the artesian horizons with the precision that is possible in the case of some parts of the Cretaceous. A general account of the character and succession of the Tertiary strata has been presented in Chapter I (pp. 4-25). To this account is here added a more extended consideration of these beds in their relations to underground waters, especially artesian.

The Clayton limestone, at the base of the Tertiary, seems nowhere to be of importance as an artesian horizon, but in the eastern counties its occurrence is of such magnitude as to give rise to underground, cavern-conducted streams and their attendant "big springs."

The great body of Sucarnochee clays, next above the Clayton, is also wholly unsuited to the absorption and storage of the rainfall. They underlie, in Alabama and Mississippi, the "Flatwods," or "Post Oaks," in which the soils are generally tough and intractable, badly drained, and thus difficult of cultivation. All this region is deficient in good water, and very much of it is waste land.

Between these Flatwoods clays and the base of the Claiborne, is a great thickness—750 feet or more—of sands and clays and sandy clays, interspersed with beds of lignite and deposits of marine shells. These constitute the Chickasaw (Wilcox) division of the Tertiary, or Lignitic, as it was formerly called, throughout which the conditions are more or less favorable to artesian systems; for, while most of the strata are sandy, yet interspersed throughout their entire thickness are beds of clay and of indurated calcareous sands, so disposed as to confine the waters which may have permeated and filled the more sandy strata. Bored wells at the proper altitudes throughout this whole territory should, therefore, yield water from depths varying locally.

It has been found by experience that in the Chickasaw or Lignitic division the Nanafalia sands, together with the adjacent parts of the Naheola below and the Tuscahoma above, form a good artesian reservoir.* At the top of this division the Woods Bluff and Hatchetigbee sandy clays with indurated layers constitute another artesian horizon, which is drawn upon by a number of wells.

The Claiborne formation, with its three members, Gosport, Lisbon and Buhrstone, aggregating, 400 to 450 feet in thickness, consists of sands, interstratified in the lower (Buhrstone) member with beds of clay, often indurated into rock, and in the upper member with indurated ledges of calcareous sands. The whole formation is therefore well adapted, both in materials and structure, to serve as an artesian water horizon. Many wells in Georgia and Mississippi and a few in Alabama derive their waters from this reservoir.

The St. Stephens limestone, being calcareous throughout, would on general principles be regarded as unfavorable for artesian waters; but the limestone varies widely in character, from an open, porous rock to a very compact limestone capable of taking a fine polish; and experience has shown that it furnishes the water supply of a number of artesian wells.

The marine Tertiary beds of Miocene and later age do not appear at the surface to any great extent anywhere in Alabama, being covered by the Grand Gulf and Lafayette beds; but the wells in Mobile and Baldwin counties have amply demonstrated the fact that they are fine water reservoirs, though the water is often impregnated with salt.

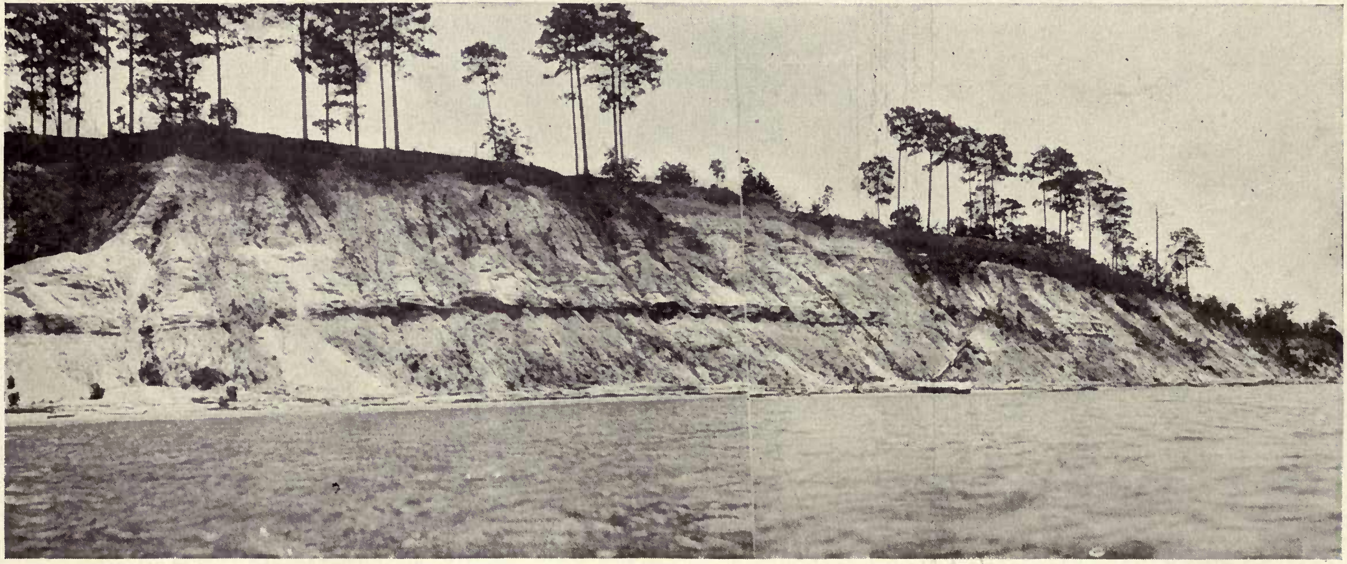
Throughout the entire region underlain by the above-mentioned strata the prevalence of sands in the residual soils, as well as in the later Lafayette and Grand Gulf, which cover so much of the territory, has generally insured an abundance of good water, breaking out along hillsides as springs or within easy reach in shallow wells, and thus the necessity has not been felt for seeking water by artesian borings.

This review of the Tertiary formations in Alabama leads to the conclusion that artesian water should be obtained from almost any horizon above the Sucarnochee clays. It will be

*In the map of the Artesian Systems (Plate XIII), the water horizon designated as Nanafalia, is meant to include also adjacent parts of the Naheola and Tuscahoma.

A. BLUE POND—NEAR DIXIE, COVINGTON COUNTY.

B. PAVILION OF SULPHUR WELL, NEAR JACKSON, CLARKE COUNTY.



RED BLUFF ON MOBILE BAY NEAR MONTROSE, BALDWIN COUNTY. GRAND GULF STRATA CAPPED WITH LAFAYETTE.

seen further that there is in the Tertiary terranes no area in which the water conditions are dominated by a limestone of great thickness, like the Selma chalk of the Cretaceous. As a consequence there is no belt across the State within the limits of the Tertiary that can be compared with the chalk area in regard to the number of artesian wells and the conditions which make them almost a necessity. The nearest approach thereto is in the Flatwoods, or Post Oaks, underlain by the Sucarnochee clays; and here the parallel extends mainly to the dearth of shallow waters in both sections. In the one case the strata are limestones of various kinds; in the other they are clays; in both the shallow waters are in excess in the winter months and almost entirely absent during the dry season; in both water for domestic use is stored in cisterns excavated in the country rock, limestone or clay.

The fact that the limestone soils of the Cretaceous are among the most productive in the State, has been the cause of the early settling of the Cretaceous region and the early recourse to artesian borings to supply human needs. In the Flatwoods, on the other hand, the native fertility of the soil has not been so immediately apparent, for the country is badly drained and difficult of cultivation and hence not much improved; but the farmers are beginning to appreciate the potential value of these lands, and deep borings are being made in increasing numbers to supply the greatest deficiency of the region-good water.

The typical Flatwods in Alabama are in Sumter and Marengo counties, the underlying black clays becoming gradually more calcareous toward the east, so that across Alabama River in Wilcox County, the tough, intractable Flatwoods clays are replaced by highly calcareous clays which weather into fine, black prairie soils. The water-bearing strata for artesian wells of moderate depth in the Flatwoods, as well as in the Wilcox County prairie lands, are the Ripley beds, which on the outcrop are hardly more than loose sands. the lime having been leached out of them; below water level, however, they may be compact calcareous sandstones, comparatively impermeable.

In several counties in northeastern Mississippi, where the same conditions prevail, wells bored in the Flatwoods reach water at reasonable depths, the water rising not to the surface, but within pumping distance. In Sumter County, Ala., also, there are several old wells in the Flatwoods with the water standing within 100 feet of the surface; in Marengo County several wells 350 to 800 feet deep have been put down in the Flatwods region and the water stands in them within 40 to 60 feet of the surface. During the past twelve months deep wells in the Flatwods have been sunk through the Selma chalk and obtained water from the underlying Eutaw sands. In one instance, viz., at Cates in Marengo county, overflowing water, 25 gallons per minute, was reached at 1120 feet depth. It seems therefore in the highest degree probable that artesian water may be obtained in almost any part of the Flatwoods, at depths varying from 300 to 1100 or 1200 feet. The shallower wells have not as yet yielded overflowing water, but those which penetrate into the Eutaw sands are likely to get it.

With an abundance of good water for domestic purposes, the Flatwoods, heretofore allowed to lie uncultivated, would become desirable farming lands in places where proper drainage is practicable.

In the area underlain by the St. Stephens limestone there is, as a rule, no actual need of artesian borings for a water supply. In Washington, Choctaw, and Clarke counties, however, by reason of the Hatchetigbee anticlinal uplift, this formation lies at the surface through a belt of considerable width. In this belt the presence of black limy soils and the dearth of surface waters present similar conditions to those in the territory of the Selma chalk, and here also artesian wells are numerous. This is especially the case in Clarke and Wayne counties, Mississippi, at the west end of this anticline, where it is crossed by the Mobile and Ohio Railroad, the towns of Shubuta, Waynesboro, and Winchester being supplied by artesian wells going down into the underlying Claiborne beds. In Alabama there are few artesian wells in this belt, partly at least for the reason that it is not crossed by a railroad line and has few towns of considerable size.

South of the outcrop of the St. Stephens limestone, except in a few places, the only formations appearing at the surface are the Grand Gulf, the Lafayette, and the later sands of the bottom lands and parts of the coast, the shallow waters being found almost exclusively in the two first named. The Lafayette will be referred to in connection with shallow waters in almost

BLUFF OF GRAND GULF STRATA, OVERLAIN BY LAFAYETTE, PERDIDO BAY. NEAR SOLDIER CREEK, BALDWIN COUNTY.

PERDIDO BAY FROM BLUFF, NEAR LILLIAN, BALDWIN COUNTY.

every county in the Tertiary division of the Coastal Plain, and further description of it here is unnecessary; but because of the preponderating influence of the Grand Gulf in some of the lower counties—Washington, Mobile, Baldwin, Escambia, and Covington—a fuller account of it and of the late Tertiary formations hidden underneath it will be presented at this point. This account will be made clearer by Plates XVI to XXII referred to below, which show the variations in the formation due to geographic distribution. Plate XVI, B, illustrates the relations of the strata north of Alabama River at Gainestown, Clarke County. Here the Grand Gulf overlies the St. Stephens limestone, which may be seen in all the low bluffs a short distance back from the river bottom. The Grand Gulf, which consists of sands with intercalated beds of clay, is in its turn overlain by a capping of Lafayette red loam and pebbles. None of the St. Stephens is shown in the view, but it outcrops a few hundred yards distant from this locality. In those parts of the Grand Gulf terrane, where the limestone is near the surface, lime-sinks and consequent deep ponds are common and characteristic. The view of Blue Pond, in Covington county, near Dixie P. O. Plate XVII, A, shows a rather exceptional type of these limesink ponds, in that its formation has been of such recent date that the banks are not yet rounded up by weathering but remain nearly vertical. It gives, however, the plainest evidence of its origin. Usually the sinks are not so sharply defined because of the wearing down and filling in around the edges, and the lakes or ponds take on the characteristics of the lakes so numerous in Florida. These occur where the limestone is not very deep below the surface and is covered by the Grand Gulf and Lafayette materials. Only one of this class of pond is known in Alabama and that is McDade's Pond near Florala, close to the Florida-Alabama line in Covington county, and shown in Plate XXIII.

To the south the St. Stephens limestone sinks deeper and deeper below the surface and its influence on the topography gradually dies out. Other later Tertiary (Miocene) marine beds, many feet in thickness, come in above the limestone as it sinks. These later beds are exposed at comparatively few places, but their presence is amply demonstrated by all the deep borings in Mobile, Baldwin, and Escambia counties, at Oak Grove, Fla., and along Chattahoochee River.

Above these marine beds, apparently with nearly if not quite horizontal stratification, lie the two great surface formations of the Coastal Plain—the Grand Gulf and the Lafayette—practically unchanged in materials and stratification down to the very borders of the bays on the Gulf of Mexico. High bluffs of Grand Gulf material capped with the Lafayette, overlook these bays at many points where deep borings reveal the presence of Miocene shell beds 700 to 1500 feet or more below. At Montrose, on Mobile Bay, between Daphne and Point Clear, there is a fine exposure of the two formations, as shown in Plate XVIII. The capping of Lafayette red loam and pebbles is clearly distinguishable from the main mass of the bluff, which is made by the sands and laminated clays of the Grand Gulf. The unconformity between the two formations is also very clearly shown in this view where the indurated layer in the Grand Gulf, many feet below the Lafayette at the left of the view, is in contact with it at the extreme right, the Lafayette following the contour of the surface while the Grand Gulf is nearly horizontal in stratification. So far as can be seen the materials here are similar to those at Gainestown Ferry.

Similar unconformities may be seen at many points in Alabama and Mississippi, for the Lafayette seems to have been spread over the surface of the country after it had attained approximately its present relief. On Perdido Bay, from Lillian to Soldier Creek Post office, and probably at many other points not visited by the writer, these same formations make high bluffs coming down to the water's edge. (Plates XIX and XX). The character and arrangement of the materials of the two formations along Perdido Bay are not essentially different from what may be seen at Montrose.

A few words may be said in regard to the surface features of these highlands, which, as is shown in the views just referred to, extend down to salt water. South of the belt in which the underlying St. Stephens causes the lime-sinks and ponds, the general surface down to the Gulf is that of a plateau, the high, flat lands being well adapted for farming and grazing, but now devoted practically to two industries—timber and turpentine. The monotony of these high, flat lands is, however, everywhere interrupted by shallow depressions or sinks, few of them exceeding 4 or 5 feet in depth. Water may collect in these depressions, forming ponds a few yards to 40 or 50 yards in di-

GUM POND, FLATWOODS (GRAND GULF). BALDWIN COUNTY.

PINE MEADOW OR SAVANNAH, BETWEEN SWIFT AND LILLIAN, BALDWIN COUNTY.

ameter, around which a shrubby growth of gums may spring up (Pl. XXI.) Other depressions, in many cases larger than the ponds, may be void of shrubby undergrowth or of standing water, and thus give rise to savannahs or pine meadows, as shown in Plate XXII. The latter term is often applied to lower lying lands timbered with longleaf and Cuban pine. The savannahs grade into more undulating lands which with their growth of high grass and bright flowers and absence of disfiguring undergrowth give the impression of being well kept parks. Through these parks one may drive for miles in almost any direction without need of road or path. In the savannahs the growth of pine is stunted; in the park lands it is better, but not of the best.

There is some doubt as to the cause of these depressions, which are characteristic in Florida, Georgia, Alabama, Mississippi, and presumably in the other Gulf States. They seem, however, to be due to inequalities in the surface of the underlying Grand Gulf clays, since there are generally no underlying limestones or other soluble materials near enough to the surface to cause the formation of so many small depressions of limited extent within, say, an acre of territory.

The above account will, it is thought, better than any other description, show the absolute dependence of the shallow-water conditions in the lower counties on the two late formations which have so much in common, both being spread, with no appreciable prevailing dip, over the beveled edges of the southward-dipping St. Stephens and later Tertiary formations.

The artesian conditions in this territory are fixed by the underlying Tertiary formations above mentioned. That they are generally favorable is demonstrated by the success of borings in Escambia and Mobile counties, very few having been made in the other counties where similar conditions prevail.

DISCUSSION BY COUNTIES.

HENRY COUNTY.

SURFACE FEATURES.

The older Tertiary formations which underlie the territory of Henry County include the Nanafalia sands and the Hatchetigbee and Claiborne, all of which in other places are good artesian reservoirs. Over the greater part of the county there are, in addition to the above, two more recent formations, the Grand Gulf and the Lafayette, in the materials of which is stored a generous supply of surface water to be drawn on by springs and shallow wells. There is no lack, therefore, of good freestone waters in most parts of the county. With proper selection of altitude, there should be no trouble in getting artesian water from the deeper beds.

ARTESIAN RECORD.

The record of only one deep well in Henry County has been obtained—the town well at Abbeville; bored by Van Vleet in 1904; depth, 401 feet; water stands at —172 feet; pump yields 60 gallons per minute for seven hours. The formation at the surface is the Buhrstone and the boring penetrates probably into Tuscahoma or Nanafalia sands.

HOUSTON COUNTY.

SURFACE FEATURES.

The surface of new county of Houston is covered in many parts by the red sandy loams and pebble beds of the Lafayette. Below these are the sands and stratified clays of the Grand Gulf, and under them the white St. Stephens limestone. The last-named formation underlies the entire area of the county except some small tracts in the extreme northern part and along Chattahoochee River about Columbia.

Owing to the character of the two surface formations the water supply from wells and springs is in general good in quality and adequate in quantity.

ARTESIAN RECORDS.

Deep wells are recorded from two points only—Columbia and Dothan.

COLUMBIA.

Columbia is situated on the terrace of Chattahoochee River in the Claiborne formation.

Well bored by Harrington about 1890 or 1891; depth, 485 feet; casing, 8-inch and 6-inch, to bottom; water rose to -8 feet, and an excavation of 14 feet was made around the well to obtain a flow; yield, 50 gallons per minute; considered very fine water; analysis shows magnesia. Record: Marl near the top about 150 feet thick; hard shell rock at frequent intervals below to the bottom; probably in Nanafalia sands.

DOTHAN.

City Water Company's wells: No. 1, bored by C. A. Ray, of Providence. R. I., in 1896; depth, 625 feet; water stands at -150 feet; yield with air life, 200 gallons per minute; water excellent; casing, 8-inch to about 300 feet; remainder 6-inch; flow has increased; present yield, 250 gallons per minute; temperature, 72°. No. 2, bored 5 feet from No. 1; depth unknown; no water obtained.

Town well, in Section 24, Township 3, Range 26; bored by S. S. Chandler in 1903; depth, 645 feet; casing, 425 feet 8-inch; 210 feet 6-inch; first water at 360 feet, stood at -75 feet; second water, at 600 feet, stands at -130 feet; air-life gives 250 gallons per minute; level lowered to -150 feet.

Record of town well, Dothan.

	Feet.
Clay	0 — 20
Sand	20 — 177
Sand rock	177 — 239
Dry sand	239 — 247
Sand rock	247 — 267
Dry sand	267 — 344
Sand rock	344 — 395
Sand	395 — 511
Sand rock	511 — 517
Sand and water	517 — 640

Ice Company's well, bored by Frank Sutter in 1904; depth, 622 feet; casing, 0-200 feet, 8-inch; 200-495 feet 6-inch; first water, at 400 (?) feet, stood at -60 feet, small supply; second water, at 622 feet, stands at -70 feet; pumping level, -150 feet; yield, 50 gallons per minute. Record: Clay, 0-100 feet; coarse gravel, 100-102 feet; sand, 102-210 feet; sand with layers of soft rock from 1 inch to 6 feet in thickness, 210-575 feet; dry sand, 575-600 feet; clay, 600-622 feet; sand at 622 feet.

Dothan is on the St. Stephens formation and these borings probably go down into the Nanafalia sands.

GENEVA COUNTY.

Surface Features.

Geneva County lies practically wholly within the territory of the St. Stephens limestone, but the Tertiary rocks, instead of dipping uniformly southward, lie in undulations which bring the strata of the Claiborne to the surface along the banks of Pea River, even as far as the town of Geneva, near the southern border of the county. For this reason it is not easy to determine the horizon to which the bored wells penetrate.

Over the older Tertiary rocks lie, as usual in this part of the State, the Grand Gulf sands and stratified clays in variable thickness, and upon these, where not removed by erosion, the Lafayette red sandy loams and pebble beds. These two later formations afford favorable conditions for abundant supplies of good surface water from wells and springs. At Coffee Springs there are several magnificent springs boiling up through the sands and running off in a brook of good size.

Artesian Records.

The artesian wells of Geneva County do not flow, probably because of the lack of head due to the irregularities in the dip of the Tertiary strata. The supply, however, seems to be ample, the water in most of them being in all probability obtained from the strata of the Buhrstone. But few records have been collected since the boring of deep wells, except at the town of Geneva, began only on the completion of the branch of the Central of Georgia railway through the county a few years ago.

The wells at Hartford and Slocomb begin in the St. Stephens and reach the base of the Claiborne or the upper part of the Buhrstone.

GENEVA.

Public well, bored by W. L. Morrison in 1900; water, at 307 feet, rose to -14 feet, the supply appearing inexhaustible; but through some dissatisfaction the city council insisted on boring deeper, with the resul that the casing was broken, the flow lost, and the well finally abandoned. Record: Coarse white and yellow sand, 0-30 feet; yellow marl, 30-42 feet; bluish sand, 42-80 feet; buhrstone, (?) soft in middle, 80-84 feet; blue sand, 84-94 feet; shell rock, 94-96 feet; sand and coral rock alternating, 96-338 feet. The bottom of the boring was probably in the Buhrstone or the underlying Hatchetigbee.

Town well, bored by S. S. Chandler in 1903; depth, 261 feet; casing, 108 feet 10-inch, 148 feet 8-inch; first water, at 129 feet, stood at -10 feet; second water, at 216 feet, stood at -12 feet; air lift used; yield (estimated), 60 gallons per minute. Record: Sand, 0-108 feet; lime rock (probably Claiborne), 108-129 feet; gravel, first water, 129-133 feet; marl, 133-183 feet; lime rock (probably Claiborne), 183-250 feet; sand, second water, 250-261 feet.

Besides these, several shallow artesian wells have been sunk in Geneva, a typical one supplying the railroad tank near the river. The boring goes down 80 feet below the level of the track, getting water from below the first rocky or limestone ledge, with a stand of —12 or —15 feet. A well several feet in diameter is sunk to this point and bricked up. A pump delivering between 4000 and 5000 gallons per hour holds the level of the water at a constant point, which represents the capacity of the well. The water is quite pure and soft and free from taste of any kind.

HARTFORD.

Town well, bored by W. C. Van Vleet in 1904; depth, 314 feet; first water at 200 feet; second water, at 314 feet, stands at -18 feet; estimated yield, 100 gallons per minute for three days; pumping level, -25 feet.

SLOCOMB.

Morris Lumber Company's well, bored in 1901 by the mill hands; depth, 280 feet; casing, 160 feet, 6-inch; water stands at -28 feet; pump delivers 50 gallons per minute.

DALE COUNTY.

Artesian Prospects.

Dale County shows a great range in the Tertiary formations, which extend from the Nanafalia to the St. Stephens limestone, all of them covered, in places at least, by the two later formations so often mentioned, the Grand Gulf and the Lafayette. There are correspondingly great possibilities in its water resources, both surface and artesian. As yet, however, artesian boring has been done only at Ozark the county seat, which is on the outcrop of the Woods Bluff marl. At the depth of 710 feet the boring must be near the base of the Tertiary, if not in the underlying Ripley.

OZARK.

Town well, altitude about 8 feet below that of the Railroad track; bored by W. E. Hughes, of Specialty Well Drilling Company, Atlanta, Ga., in 1902; depth, 710 feet; first water at 250 (?) feet; second water at 710 feet; capacity of well by air lift, 200 gallons per minute. Record: Red clay, 0-40 feet; marl, 40-500 feet; sand, marl and shell rock (probably the shell bed of the Nanafalia), 500-525 feet; 525-710 feet not recorded, or at least the record not obtained; boring probably ends in the Clayton. An analysis of the water from this well has been made by Mr. Hodges, as follows:

Analysis of water from town well, Ozark.

	Parts per million.
Potassium (K)	2.9
Sodium (Na)	6.1
Magnesium (Mg)	7.7
Calcium (Ca)	47.7
Iron and alumina (Fe_2O_3, Al_2O_3)	1.4
Chlorine (Cl)	3.5
Sulphuric acid (SO_4)	8.8
Carbonic acid (HCO_3)	132.9
Silica (SiO_2)	45.3
	256.3

COFFEE COUNTY.

Surface Features.

The underlying older Tertiary formations of Coffee County range from the Nanafalia member of the Lignitic in the north to the St. Stephens limestone in the extreme south. Over all these are found locally remnants of the Lafayette sands, loams, and pebbles.

Artesian Prospects.

Artesian borings have been made, so far as information has been obtained, only at Elba, Brockton, and Enterprise. The well bored in 1904 at Elba gets water in the Nanafalia sands, as shown by the shells brought up with the borings. The Enterprise well probably goes no deeper than the Hatchetigbee sands underlying the Burstone. The shallower wells at Elba, 160 to 185 feet deep, hardly go deeper than the Hatchetigbee or Woods Bluff horizon, or perhaps into the upper part of the Tuscahoma sands, the town itself being on Hatchetigbee strata.

ELBA AND VICINITY.

The most instructive of the wells at Elba is that at the railroad depot, bored by S. S. Chandler in 1904; depth, reached in the latter part of July, 293 feet; diameter, 12 inches, reduced to 10. Record: Surface sands, 0-16 feet; marl or laminated grayish blue clays, 16-265 feet; water-bearing sands with shells of *Gryphaea thirsae*, 265-293 feet. These shells show that the horizon is the Nanafalia.

Public well, bored at the Elba court-house in 1899 by W. L. Morrison; flow, 2½ gallons per minute at a depth of 150 feet; water now stands just at the surface; temperature, 68°. Record: Yellow clay, 2 feet; coarse yellow sand, 16 feet; blue compact marl, 42 feet; hard lignitic material, 40 feet; blue marl, 30 feet; sand and lignite to the bottom at 150 feet. Other deep wells have been sunk by the same driller in this locality.

Well 4 miles west of Elba, on an elevation about 112 feet above the town; bored by W. L. Morrison in 1899; water rises to -40 feet, an unlimited supply being obtained by the use of pumps; tastes of alum. Record: Red clay, 0-8 feet; coarse yellow sand, 8-30 feet; hard black rock, 30-35 feet; coarse yellow sand, 35-70 feet; shell rock, 70-72 feet; marl, 72-250 feet; hard rock and sand, 250-312 feet. Water supply probably from Nanafalia sands or lower Tuscahoma.

Several other wells were bored in 1899 and 1900 by Morrison, in and around Elba. All have about the same record; some are or were flowing; in others the water stands at the level of the ground, or slightly below. Every new well lessens the flow of the others. Among these wells are those of the county jail; N. W. Wright; William Rushing; John Rushing; (in this well a log was encountered at a depth of 40 feet); Judge S. M. Rushing (this well yields 3 gallons per minute); W. M. Rushing; D. C. Collins; King & Simmons; Allen King; public school; W. B. Perdue; Mr. Lightner; Raynor livery stable; Mrs. S. E. Beard; John Farriss; T. J. Ham; William Ham; J. N. Ham; J. T. Law; Dr. Bradley; Dr. Boyd; Dr. Blue; Mrs. Ada Rushing; county poor house; Fayette Prescott; Aaron Head; W. M. Tucker; G. W. Gunter.

BROCKTON.

Well 1 mile south of Brockton, at Henderson & Boyd's saw mill; bored by Mr. Van Vleet.. water stands at -150 feet; supply probably from the Nanafalia sands.

ENTERPRISE.

Town well, bored by Frank Sutter in 1903; depth, 398 feet; casing, 6-inch; first water, at 132 feet, stood at -132 feet; second water, at 370 feet, stood at -127 feet; yield, 400 gallons per minute with air lift; level lowered 12 feet. Record: Clay, 0-60 feet; soft lime rock, 60-68 feet; shell rock, 68-98 feet; shell rock 98-104 feet; black mud, 104-130 feet; flint rock, 130-132 feet; sand, 132-140 feet; marl, 140-230 feet; mud, 230-265 feet; rock, 265-266 feet; marl, 266-370 feet; sand and water, 370-398 feet. The following analysis of the water has been made by the Southern Cotton Oil Company, Savannah, Ga.*

Analysis of water from town well, Enterprise.

	Parts per million.
Sodium (Na)	17.21
Magnesium (Mg)	.74
Calcium (Ca)	35.17
Chlorine (Cl)	15.02
Sulphuric acid (SO_4)	40.15
Carbonic acid (CO_3)	39.12
Iron and alumina (Fe_2O_3), Al_2O_3)	8.90
Silica (SiO_2)	19.50
Volatile matter	33.87
	205.25

COVINGTON COUNTY.

SURFACE FEATURES.

The older Tertiary formations in Covington county range from the Nanafalia member of the Lignitic up to the St. Stephens limestone. Unconformably overlying the St. Stephens, Claiborne, and Buhrstone are the sands and stratified clays of the Grand Gulf, capped in turn by the red loam and pebbles of the Lafayette where denudation has not removed them. Like all the counties of this latitude, Covington is well watered, and artesian wells are few in number and of a recent date.

SHALLOW WATERS.

While the character of the shallow waters is in great measure determined by the loose materials of the Grand Gulf and La-

*Expressed by analyst in grains per gallon and in hypothetical combinations; recomputed in ionic form and parts per million at U. S. Geological Survey.

McDADE'S POND, FLORALA, COVINGTON COUNTY.

fayette, yet in the lower parts of Covington and adjoining counties, and in still greater measure in Florida, these waters are modified by the underlying St. Stephens limestone, and big limestone springs running off in veritable creeks are not uncommon. Akin to these are the lime sinks, ponds, and lakes of this section. Near the western limit of Covington County, in Section 6, Township 2, Range 14, is Blue Pond, with nearly perpendicular sides as if it had recently fallen in. The name characterizes the water, which is of beautiful blue color. The pond is hardly more than 100 yards in diameter and the water is about 10 feet below the general surface of the ground. Pl. XVII, A, shows this curious pond. At Florala in the lower part of the county close to the Florida line is McDade's pond shown in Plate XXIII. This is also of limesink origin but on larger scale and of greater antiquity, and illustrates a type of pond or lake exceedingly characteristic of many parts of Florida, but, so far as known, unique in Alabama.

ARTESIAN PROSPECTS.

The deepest of the artesian wells in Covington County is that bored for the cotton-oil mill at Andalusia, which probably goes down into the Nanafalia sands or perhaps into the Naheola. All of the wells are located geologically on the upper Claiborne strata, very near the contact with the Buhrstone. They are all likewise on or near the lines of the Louisville and Nashville and Central of Georgia railroads.

ANDALUSIA AND VICINITY.

Town well, 40 yards from Central of Georgia Railway station, in the N. W. quarter, N. W. quarter, Section 20, Township 4, Range 16; bored by Frank Sutter in 1904; casing, 8-inch and 6-inch; well was not tested up to the time this record was obtained; probably reaches the Tuscahoma or Nanafalia sands.

Record of town well, Andalusia.

	Feet.
Sand and clay	0 — 113
Sand rock	113 — 114
Sand	114 — 122
Sand rock	122 — 123
Black mud	123 — 130
Sand rock	130 — 133
Shale	133 — 141
Sand rock	141 — 142
Clay	142 — 168
Sand (at 186 feet 3 inches of rock)	168 — 186
Clay	186 — 190
Sand	190 — 207
Shaly clay and sand	207 — 273
Rock	273 — 274
Gritty mud	274 — 313
Gritty mud, with frequent layers of rock	313 — 380
Blue marl	380 — 480

Southern Cotton Oil Company's well, Audalusia, one-fourth mile east of station in the N. W. quarter, N. W. quarter, Section 20, Township 4, Range 16; bored by Frank Sutter in 1902; depth, 1130 feet; water stands at -110 feet; casing 430 feet, 4½-inch; air lift gives 45 gallons per minute. the following analysis is by the chemist of the Southern Cotton Oil Company:*

Analysis of water from Southern Cotton Oil Company's well, Andalusia.

	Parts per million.
Sodium (Na)	63.84
Magnesium (Mg)	1.04
Calcium (Ca)	1.23
Chlorine (Cl)	12.00
Sulphuric acid (SO_4.	7.52
Carbonic acid (HCO_3)	72.65
Iron (Fe)	.47
Silica (SiO_2)	20.52
	179.27

RIVER FALLS AND SANFORD.

The three following wells probably get their water from the lower strata of the Buhrstone or from the immediately underly-

*Expressed by analyst in grains per gallon and hypothetical combinations; recomputed to ionic form and parts per million at U. S. Geological Survey.

ing Hatchetigbee sands, which are frequently dark colored from lignitic matter.

Horse Shoe Lumber Company's well, River Falls; bored by W. M. Morrison in 1901; depth, 230 feet; yield, 3 1-4 gallons per minute. Record: Clay, 8 feet; coarse sand, 12 feet; yellow marl, 30 feet; alternating blue marl and thin layers of rock to 200 feet; buhrstone, 8 inches; water-bearing sands and lignite, 30 feet.

Henderson Lumber Company's well, Sanford; bored by W. M. Morrison in 1901; depth, 386 feet; casing, 3-inch; water stands at -70 feet. Record: Clay, 0-12 feet; white sand, 12-30 feet; hard red and yellow clay, 30-80 feet; alternating layers of sand, blue marl and rock, 80-175 feet; blue marl, 175-275 feet; water-bearing sand and lignite, 275-295 feet; porous limestone, 295-350 feet; water bearing sand and rock, 350-386 feet.

W. W. Vorn's well, Sanford; bored by W. M. Morrison in 1901; casing 4½ inch; water stands at -70 feet. Record: Hard red and yellow clay, 0-75 feet; yellow sand and soft rock, 75-90 feet; blue marl, 90-200 feet; shell rock, 200-202 feet; water-bearing sand, 202-235 feet.

CRENSHAW COUNTY.

Surface Features.

The two northernmost townships in Crenshaw County are underlain by the Cretaceous formations, the rest of it by the Tertiary formations up to the top of the Lignitic. In the northern part of township 10, adjoining Montgomery County, the Selma chalk is the surface formation, and in this vicinity wells would have to go through the whole thickness of the chalk to reach the Eutaw sands. A prominent ridge, the entension of the Chunnennugga Ridge of Bullock County (see p. 226), marks the line between the chalk and the Ripley in the lower part of township 10.

Artesian Prospects.

In the area underlain by the Ripley, embracing most of township 9, artesian prospects are favorable, but no records of wells have been obtained. In the adjoining county, Pike, in the same formation are several wells about Orion. In the Clayton beds, which form the base of the Tertiary, wells usually have to go very deep and are frequently unsuccessful. The only records obtained are from townships 6 and 7, in the lower part of the county. It is probable that the wells about Brantley and Theba get water from the Nanafalia sands and that at Searight, from a higher horizon, possibly the Tuscahoma. Flowing wells are rare among those as yet bored.

THEBA.

Bently Lumbers Company's wells: No. 1, in the S. E. quarter Section 25, Township 7, Range 17; bored by mill hands in 1904; depth, 225 feet; casing, 20 feet, 6-inch; first water at 177 feet; second water, at 225 feet, rose to 14 feet above the surface; presnt flow, 17 gallons pr minute; temperature, 68°. Record: Sand and clay, 0-18 feet; blue marl, 18-80 feet; sand rock, 80-81 feet; black marl, 81-90 feet; alternating layers of sand and rock, 6 inches thick, 90-200 feet; clay, 200-203 feet; rock, 203-204 feet; sand and water, 204-225 feet. No. 2, 75 yards from No. 1; bored by mill hands in 1903; depth, 177 feet; casing, 20 feet, 4-inch; flow, 1 gallon per minute; temperature, 68°. Record same as No. 1.

BRANTLEY AND VICINITY.

Town well, Brantley, in the N. W. quarter Section 16, Township 7, Range 18; bored by C. C. Brinson in 1899; depth, 366 feet; casing, 20 feet, 4-inch; water stands at -22 feet; pump gives 20 gallons per minute for four hours. The character of the water from this well is shown by the following analysis by Mr. Hodges:

Analysis of water from town well, Brantley.

	Parts per million.
Potassium (K)	1.3
Sodium (Na)	4.1
Magnesium (Mg)	5.6
Calcium (Ca)	45.6
Iron and alumina (Fe_2O_3, Al_2O_3)	9.9
Chlorine (Cl)	1.7
Sulphuric acid (SO_4)	10.1
Carbonic acid (HCO_3)	157.5
Silica (SiO_2)	35.5
	271.3

L. C. Cooper's well, Brantley, in the N. W. quarter Section 16, Township 7, Range 18; bored by George Thompson in 1899; depth, 170 feet; water stands at -25 feet.

Southern Cotton Oil Company's well, Brantley, in the N. W. quarter Section 16, Township 7, Range 18; bored by S. W. Ingram in 1902; depth, 155 feet; water stands at -18 feet.

J. T. Cooper's well, at mill one-fourth mile east of Brantley, in the N. E. quarter Section 16, Township 7, Range 18; bored by George Thompson in 1899; depth, 260 feet; casing, 20 feet, 4-inch; water stands at -22 feet; pump gives 50 gallons per minute.

SEAWRIGHT.

Southern Cotton Oil Company's well, in the N. E. quarter Section 19, Township 6, Range 17; bored by S. W. Ingram; depth, 276 feet; casing, 20 feet, 4-inch; first water small stream; second water, at 276 feet, stands at -12 feet; force pump gives 27 gallons per minute.

BUTLER COUNTY.

Surface Features.

With the exception of a small area in the northeast corner, Butler County is underlain by Tertiary strata, embracing all the lower divisions up to the Buhrstone. In the territory of the Ripley and Clayton calcareous beds are prevalent and the topography in general is much broken because of the numerous indurated ledges of calcareous material among the sandier beds. To the south about Greenville and for several miles on either side, is a great extent of red sands or loams, which resemble those of the Lafayette but probably consist of residual matter from the Tertiary beds.

These Tertiary formations range from the Midway up to the Claiborne, and in their outcrops present the usual monotonous character. Overlying all, where not removed by denudation, are the red loam and pebble beds of the Lafayette. In many localities these surface beds are extremely sandy, especially on the watersheds. An example of this condition may be noted along the Montgomery road between Greenville and Sandy Ridge.

Mineral Waters.

ROPER'S WELL.

One of the most widely known mineral waters of Alabama, sold under the name of "Wilkinson's Matchless Mineral Water," is obtained from Roper's well, 3 miles east of Greenville, and a well subsequently sunk near it. The latter well is about 40 feet deep and 15 feet in diameter. The section shown in the sides of the well consists of 9 1-2 feet of sandy clay, 6 3-4 feet of sand and mottled clay, and below this the "black earth," which continues to the bottom of the well. This black earth is the source of the "mineral." It is a dark colored sandy clay containing organic matter and iron pyrites, with considerable greensand in small grains irregularly disseminated through it. The reaction of the oxidation products of the pyrites on the clay and its contained vegetable matter yields the sulphuric acid, the alum, and the other sulphates which characterize the water, as shown by the analysis.

The water fresh from the well is colorless, the iron being in the ferrous condition, but on standing it gradually becomes yellowish red from further oxidation of the iron.

As the source of the mineral matter is superficial and local, the strength of the water varies with the rainfall, being much less during the rainy season. Analyses may therefore differ very widely in regard to the amount of mineral matter to the gallon. An analysis made by Dr. Metz, of New Orleans, shows 1244.45 grains; a sample of the bottled water furnished by the proprietor of the well, and said to have been collected six years ago, contains 1333.8 grains; the water in a 16-quart bottle on sale June 1, 1905, contains 458.45 grains; while the sample direct from the well collected by Mr. Hodges for analysis after several months of rainy weather, contains 213.9 grains. In putting up the water for the market it is the endeavor of the proprietor to make it as nearly as possible of uniform strength. When too concentrated it is diluted with fresh water; when too dilute leachings from hoppers of the pyritous earth are added.

Mr. Hodges's analysis is given below; also, for the sake of comparison, an analysis made by J. B. Little and the writer about twenty years ago, from a sample collected by Mr. Little, and one made by Dr. Metz, of New Orleans. These analyses sufficiently illustrate the variations in the concentration, as well as in the relative proportions of the different ingredients, which takes place in the course of time and by reason of seasonal changes.

Analyses of "Matchless Mineral Water" from Roper's well, near Greenville.

(Parts per million.)	I	II	III
Potassium (K)	7.6	15.8	33.0
Sodium (Na)	57.6	51.9	76.9
Magnesium (Mg)	78.0	235.1	278.0
Calcium (Ca)	322.4	300.8	373.4
Iron (Fe, ferrous)	90.5	1085.0	1358.8
Iron (Fe, ferric)	204.1	1038.4	4013.7
Aluminum (Al)	132.8	33.2	69.8
Chlorine (Cl)	78.3	42.3	53.2
Sulphuric acid (SO_4)	2493.3	6434.8	15130.3
Sulphuric acid (H_2SO_4). free)	19.9	30.7	
Silica (SiO_2)	131.2	86.4	103.7
	3615.7	9354.4	21490.8

I Analysis by Robert S. Hodges, 1905.
II Analysis by J. B. Little and Dr. E. A. Smith, about 1885.*
III Analysis by Dr. Metz, of New Orleans, 1893.*

*Originally expressed by analysts in grains per gallon and in form of radicals; recomputed in ionic form and parts per million by R. S. Hodges.

BUTLER SPRINGS.

Near the western border of the county, just south of Redicks Creek are the Butler Springs, formerly much visited, but now nearly abandoned, though a few families come every year with camping outfits and drink the water. Its character is shown by the following analysis by Mr. Hodges:

Analysis of water from Butler Springs.

	Parts per million.
Potassium (K)	1.8
Sodium (Na)	9.3
Magnesium (Mg)	1.0
Calcium (Ca)	5.3
Iron and alumina (Fe_2O_3, Al_2O_3)	2.9
Chlorine (Cl)	7.0
Sulphuric acid (SO_4)	13.1
Carbonic acid (HCO_3)	16.5
Silica (SiO_2)	19.6
	76.5

ARTESIAN PROSPECTS.

All the artesian wells in Butler are to be found along the line of the Louisville and Nashville railroad, and most of them have been bored to supply the needs of saw mills. In some cases where the timber supply has been exhausted the mills have been moved and the wells have fallen into decay.

GREENVILLE.

City waterworks wells at the foot of the hill east of town, 60 feet or more below the level of the railroad track, which is 444 feet; bored in 1892 by the American Pipe Manufacturing Company; depth, 400 feet; water supply obtained between 186 and 217 feet; below 217 feet the strata were blue to black clays, alternating with harder strata, probably of the Ripley formation; mouth of the well is on the Naheola sands; water stands at -50 feet; pump delivering 90 gallons per minute does not lower the stand more than one foot. According to the analysis of Mr. Barnum, chemist to the company, the solid matter in solution in this water, consist in the main of the carbonate and sulphate of magnesium and chloride of sodium.

Ice-factory well, in the N. E. quarter N. E. quarter Section 24, Township 10, Range 14; depth, 107 feet; casing, 84 feet, 8-inch; water stands at -13 feet; force pump gives 75 gallons per minute; boring probably does not go through the Naheola.

Southern Cotton Oil Company's well, in the S E. quarter S. W. quarter Section 14, Township 10, Range 14; bored by Morgan, of Birmingham, in 1902; depth, 105 feet; casing, 8-inch to bottom; water stands at -53 feet; estimated yield with steam pump, 150 gallons per minute; ends probably in the Naheola.

FOREST.

W. M. Flowers's wells: No. 1, at saw mill, in the S. E. quarter Section 8, Township 9, Range 14; bored by M. S. Gilmer, in 1892; depth, 195 feet; casing, 5-inch; water stands at -20 feet; first water at 195 feet; pump yields 50 gallons per minute. No. 2, 350 yards south of No. 1; bored by M. S. Gilmer in 1895; depth, 390 feet; water stands at -20 feet; estimated yield with pump, 50 gallons per minute. These wells are located on the Nanafalia outcrop and get water probably from the Naheola sands.

BOLLING.

W. J. Flowers Lumber Company's wells; bored fifteen years ago and in use about ten years; now abandoned on account of removal of the mill; altitude, 308 feet; depth of No 1, 1010 feet; of No. 2, 230 feet; water stands at -10 feet; yield, about 75 gallons per minute each, to pump. The water was used for steam and domestic purposes, but was not well adapted to the former, as it produced a scale in the boilers. As no increase in the volume of water was noticed below the depth of 230 feet, the second well stopped there, going down probably into the Naheola sands, while the deeper well may have gone to the base of the Tertiary or into the Ripley.

CHAPMAN.

The following wells are located near the contact of the Tuscahoma and Nanafalia, and obtain water in all probability from the sands of the latter.

W. T. Smith Lumber Company's well, bored in 1904 by M. Canfield; depth, 186 feet; flow, 150 gallons per minute.

Louisville and Nashville Railroad well, bored in 1904 by M. Canfield; depth, 175 feet; flow, 150 gallons per minute.

DUNHAM.

Dunham Lumber Company's well, depth, 382 feet; probably obtaining water in the Nanafalia sands or the immediately underlying Naheola; elevation, 221 feet; water rises to 3 feet above the surface; original flow, 18 gallons per minute; flow in 1904, about 5 gallons per minute; temperture, 73°. The record given by Mr. B. B. McKenzie is as follows: Sand and clay, 13 feet; marl, 160 feet; rock, 2 feet, below which a weak stream was struck, rising above the mouth of the well, but as the quantity was insufficient the boring was continued; at 380 feet a stratum of hard rock was encountered, 2 feet thick, and below it a fine stream of water, rising, as stated, 3 feet above the surface. The formation at the surface is Woods Bluff, and the water supply is from the Nanafalia.

CONECUH COUNTY.

SURFACE FEATURES.

The older Tertiary formations underlying Conecuh County range from the Buhrstone up to the St. Stephens limestone, with small tracts of still older beds in the extreme north. There is thus a considerable degree of diversity in the topography. Overlying the Tertiary beds mentioned, in the southern third of the county, is a mantle of the Grand Gulf sands and stratified clays, and over everything the red loam and pebbles of the Lafayette. These two later formations provide as usual, an abundance of pure freestone water from shallow wells and springs. On the high interstream plateaus, where the Lafayette mantle is comparatively undisturbed, the wells are of moderate depth, often less than 50 feet, and along hillsides between these plateaus and the stream valleys springs break out everywhere above the first comparatively impervious layer beneath the mantle of sand and pebbles.

Artesian Prospects.

While very few deep wells have been reported from this county, there is no reason why borings should not be successful, since the Claiborne beds and parts of the St. Stephens limestone are well known to be good artesian reservoirs. Only one well record has been obtained.

EVERGREEN.

Town well, in the W. half N. E. quarter Section 3, Township 5, Range 11; bored by Porter and McDonald in 1903; depth, 168 feet; casing, 6-inch, to bottom; water stands at -30 feet; estimated yield by pumping, 115 gallons per minute; water is pumped into standpipe, from which it is distributed through the town. Boring begins in strata of the St. Stephens, overlain by Grand Gulf and Lafayette; water probably obtained from the Claiborne sands below the limestone.

ESCAMBIA COUNTY.

Surface Features.

The surface throughout Escambia County is occupied chiefly by two formations, the Lafayette and Grand Gulf, whose sands, loams, clays, and pebble beds have at one time covered all the underlying Tertiary rocks. The Lafayette, here as elsewhere, is a mantle averaging 20 to 25 feet in thickness, and the Grand Gulf sands and stratified clays are also of the nature of a covering formation beneath the Lafayette. The underlying Tertiary formations next below the Grand Gulf are the St. Stephens or white limestone in the northern part of the county, and the sands and clays of the lower Miocene in the southern part.

The Lafayette and Grand Gulf have been so much eroded that they are not now everywhere present, though generally so on the higher and more level tracts; along the slopes and in the lowlands they are frequently absent and the Tertiary sands and limestones are exposed at the surface.

The conditions are favorable for shallow waters and a good supply may be had almost anywhere in the county from wells 60 feet or less in depth; springs also are not rare.

Artesian Prospects.

Deep borings for artesian water have as yet been confined to the vicinity of the Louisville and Nashville Railroad, mainly at Brewton, Harrington, Flomaton, and Atmore, but flowing wells should be obtained by moderately deep borings elsewhere in the country where the altitude is not too great.

BREWTON AND VICINITY.

Most of the artesian wells in the county are at Brewton and in its immediate vicinity. Mr. W. J. Malone, who has drilled very many of these wells, has furnished the following general record of the conditions there:

The shallowest of the flowing wells are only 40 feet deep; the deepest nearly 400 feet. The record in general is as follows: surface, sand, gravel, etc., 20 feet; bluish clay, 20 feet; just below this in the sands is the first water. The flow from the shallow wells is large at first, but falls off rapidly; the water is strongly chalybeate.

The sands below the blue marl or clay above noted are 15 to 20 feet thick, and are followed by 6 feet of white sticky mud; then the second water at a depth of 65 feet, more or less. The flow of this is stronger than that of the first, but the water is likewise chalybeate.

The white sticky mud continues 6 feet more, making 12 feet in all; then sand for 5 feet, and a third flow of water at a depth of about 75 feet. This water is also chalybeate and the flow is a little better than the second.

Below this are about 100 feet of loose white nonpacking sand, then an indurated bed of yellowish limestone 25 to 35 feet thick, below which, at a depth of about 200 feet, is another good flow of water. This is described as magnesian (lime) water, and is quite different from the water obtained above it.

Below the yellowish limestone are 33 feet of sand, 33 feet of blue mud like the first mentioned, 2 feet of very hard dark-blue slaty rock, 60 feet of blue clay in egg-shaped lumps, then lime rock down as far as the borings have penetrated. In this rock the drill will sometimes drop suddenly 2 or 3 feet, as if cavities existed in the rock. When the blue mud is encountered, gas nearly always comes up. In the lime rock water is obtained in places where the rock is of open texture, or porous.

As before stated, borings have gone into this limestone to a depth of about 400 feet from the surface, but the rock has not been passed through. The water from this horizon is decidedly limy, or "magnesian."

Mr. Malone states that the volume of water from the shallow wells varies with the height of the water in Murder Creek, on the terrace of which the town is located, at about 85 feet above tide. The shallow wells probably do not go below the Grand Gulf beds.

Among list of the shallow wells bored by Mr. Malone to depths of 65 to 80 feet are those of E. Downing (3 wells), J. A. McGowan (2 wells), Jet McGowan, Mrs. Spear, P. B. Sowell (2 wells), A. McGowan (2 wells), M. McCall, W. A. Harrold, (2 wells), Brewton Gun Club, Phifer's bakery, Peters Lumber Company (3 wells), and M. S. Lovelace (2 wells). These flow from 2 to 5 gallons per minute, and are generally cased for 65 feet with 1 1-4-inch pipe. The record is practically the same for all, as follows: Sands and soil, 0-35 feet; blue marl, 35-45 feet; white sand, 45-65 feet; clay and marl, 65 feet to bottom.

Besides these there are about 80 other wells of the same kind in and about Brewton with similar records. Among them are the Parker well, 68 feet deep; the canning factory well, 75 feet deep, with a good flow and water less strongly chalybeate than the others from this depth; Allsup's well, 75 feet deep; 2 wells at the ice factory, 42 and 44 feet deep, respectively, with strongly chalybeate water. The old McMillan well, bored many years ago, has ceased to flow. The water was strongly chalybeate.

The following wells get water from about 175 feet depth: Dr. W. H. Malone's, 200 feet deep, but water comes from the 175-foot level, as the well is on higher ground; Arends Hotel, 130 feet deep; Cedar Creek Mill, 178 feet; Dr. Tarrant's, 175 feet. These go into the St. Stephens limestone, and all the deeper wells are from the same formation. The well at the power house has a 2-inch pipe bringing the water from the bottom, 393 feet, and an outside 4-inch pipe bringing it from the 175-foot level.

The three following records are of wells recently bored in Brewton.

Wiley Downing's well, one-half mile from ralroad station; bored by David Carpenter in 1904; depth, 509 feet; casing, 3-inch and 2-inch; stood at -21 feet; second water, at 315 feet, overflowed; third water, at 360 feet; rises 31 feet above the surface; flow, 15 gallons per mniute at 2 feet above the surface; water is piped throughout the house and flows a strong stream on second floor.

Record of Wiley Downing's well, Brewton.

	Feet.
Sand	0 — 12
Clay	12 — 72
Sand	72 — 180
White lime rock	180 — 216
Black soft mud (between 290 and 300 feet shell embedded in mud)	216 — 300
Lime rock	300 — 302
Soft white marl	302 — 315
Rock	315 — 316
White soft marl	316 — 328
Alternating layers of soft marl 10 or 12 feet thick and hard rock 3 to 6 inches thick	328 — 509

E. Downing's well, one-half mile northeast of station; bored by David Carpenter in 1904; depth, 360 feet; casing, 3-inch and 2-inch; water rises 34 feet above the surface; flow, 5 gallons per minute. Record same as preceding.

Cedar Creek Mill Company's well, in the S. E. quarter Section 28, Township 2, Range 10; bored by Henry Hammons in 1904; depth, 178 feet; casing, 1½ inch; first water at 50 feet, flowing; second water, at 155 feet, flowing one gallon per minute; third water, at 177 feet, flowing 2 gallons per minute. Record: Sand and gravel, 0-25 ieet; red clay, 25-30 feet; gravel, 30-33 feet; joint clay, 33-45 feet; white marl, 45-55 feet; quicksand, 55-141 feet; sand and lime rock, 141-178 feet.

HERRINGTON AND VICINITY.

J. A. Jernigan's well, Herrington, in the N. W. quarter N. W. quarter Section 14, Township 1, Range 9; bored in 1895 by negroes; depth, 117 feet; casing, 1½ inch to bottom flow, 1 gallon per minute.

Well at Keego, 1 mile northeast of Herrington, near Louisville and Nashville track; bored by negroes in 1902; depth, 135 feet; casing, 1 1-4 inch, to bottom; original flow, 10 gallons per minute; present flow, 1 gallon per minute; temperature, 69°.

POLLARD.

The town of Pollard is on the terrace of Conecuh River, 25 or 30 feet above the bottom lands and perhaps 50 feet above low-water level. Many of the wells bored here reach depths of 80 to 100 feet, usually less than 90, and are probably altogether in Grand Gulf strata. They all yield flowing water and in most cases good streams, the best of them filling a 1 1-2 inch pipe. Most of the borings have been made by Charlie Sowell, a negro, who gives the following general record: Red clay, 0-20 feet; white sand, 20-30 feet; white plastic clay, 30-40 feet; blue sand, 40-55 feet; blue sticky marl, 55-65 feet; at about 70-75 feet is usually a streak of black mud, in which the water is commonly found; this black mud is just above a blue clay.

Well at Martin Lindsey Hotel, depth, 97 feet; flow, 6 gallons per minute; water rises to 7 feet above the surface; temperature, 69°.

W. A. Findley's well; bored about 1890; depth, 68 feet, (?); casing, 2-inch; water rises to 2 feet above the surface; estimated flow, 25 gallons per minute; temperature, 69°.

Lindsey Lumber Company's well; bored by Charlie Sowell; depth, 64 feet; flow, 7 gallons per minute, water rises to 4 feet above the surface.

W. T. Mayo's well, 75 yards south of station; depth, 97 feet; casing, 1½ inch; flow, 3 gallons per minute; water rises to 3 feet above the surface; temperature, 69°.

C. L. Wiggin's well; bored in 1900; depth, 85 feet; flow, 3 gallons per minute; water rises to 6 feet above the surface; temperature, 69°; supply falls off in dry weather.

Mat Manning's well; depth, 90 feet (?); flow, 3 gallons per minute; water rises to 6 feet above the surface; temperature, 69°.

B. F. Pringle's well; bored by Charlie Sowell; depth, 104 feet; estimated flow, 10 galolns per minute; water rises to 4 feet above the surface; temperature, 69°.

I. K. Stubb's well, 400 yards west of station; flow, 3 or 4 gallons per minute; water rises to 4 feet above the surface; temperature, 69°.

M. Lindsey's well; flow, 1 gallon per minute; water rises to 3 feet above the surface; temperature, 69°.

Well at N. N. Martin's turpentine still, one-fourth mile from station; bored by Charlie Sowell; depth, 75 or 80 feet; casing, 2-inch; flow, 25 gallons per minute; water rises to 8 feet above the surface; temperature, 68½°.

J. L. Jernighan's well, one-fourth mile west of station; bored by Mr. Jernighan; depth, 73 feet; casing, 1½ inch; flow, 25 gallons per minute; water rises to 3 feet above the surface; temperature, 69°.

Other wells in Pollard are on Dr. Ford's place; on the Hammock or McMillan place, where the stream fills a 1½ inch pipe, the temperature of the water being 68°; and at the Bonita Hotel.

WEST OF POLLARD.

To the west of Pollard there are few wells and they appear to be deeper. At Flomaton, the elevation of which is not greatly different from that of Pollard, there is only one well, viz, that in Mr. G. A. Ivey's yard. This well was sunk by driving a 1 1-2-inch pipe with open end down 311 feet, and pumping out the sand and other materials at intervals through a smaller pipe. The water at present (1905) rises 8 or 10 feet above the surface, but Mr. Ivey states that when the three fourths-inch pipe was in it rose more than 50 feet above the surface. The material pumped out was chiefly white sand. At 211 feet the first water, a powerful stream, was reached, but the sand caved in and clogged the pipe, and it was not obtained again. Mr. Ivey reports that from near the bottom of the well was brought up what he thought to be a petrified oak leaf, about 3 inches long and narrow like the leaf of the willow oak; he also got at this depth "pieces of charcoal." This statement leads to the inference that the boring penetrated the Coal Bluff lignite bed, which should be at about this depth here. He also reports that at old Erie (between Pollard and Flomaton) there is or was a flowing well, in which, at a depth of 80 feet, a "cypress" log was found.

A sample of the water from Mr. Ivey's well has been analyzed by Mr. Hodges, with the result given below.

Analysis of water from G. A. Ivey's well, Flomaton.

	Parts per million.
Potassium (K)	2.3
Sodium (Na)	9.2
Magnesium (Mg)	3.7
Calcium (Ca)	8.5
Iron (Fe)	3.8
Alumina (Al_2O_3)	2.3
Chlorine (Cl)	2.8
Sulphuric acid (SO_4)	9.4
Carbonic acid (HCO_3)	64.1
Silica (SiO_2)	15.2
	121.3

The water has a slight taste of sulphur and stains glasses with the deposited iron.

Further west, at Atmore, in the W. half N. W. quarter Section 29, Township 1, Range 6, a well was bored by W. M. Carney in 1902, but no water was obtained and no record is available.

ROBERTS.

The deepest boring made in Escambia County, is a well bored for oil on the banks of Conecuh River 6 miles above Roberts. Unfortunately samples of the materials penetrated at different depths could not be obtained except in a few instances. At a depth of 100 feet the St. Stephens limestone was struck, and the boring was still in the same rock at the depth of 190 feet. Claiborne shells were brought up in abundance before the drill had gone 700 feet. As nearly as can be determined the boring must have gone to the base of the Tertiary, if not into the Ripley beds.

A great volume of water was struck at less than 700 feet. It was estimated that, when half shut off, this flow was 3000 gallons per minute, and much greater before being reduced.

The boring was done by M. Canfield in 1902-3. The Grand Gulf sands are at the surface, and the lower part of the river bluff is formed by the calcareous sands of Miocene age, while the top of the St. Stephens limestone is not far below the water level in the river, since it shows in the banks a few miles upstream. The water which pours out of this well is beautifully clear and blue, such as is seen in limestone springs, and is decided limy.

The record as given by Mr. Canfield is as follows:

Record of well at Roberts.

	Feet.
Sand	0 — 22
Blue marl	22 — 37
Fine white sand	37 — 39
Gumbo	39 — 60
Lime rock and shell	60 — 61½
Gumbo	61½ — 90
Layers of shell rock and blue clay, 1 or 2 inches thick..	90 — 90
Blue clay, 1 foot; white shell rock, 2½ feet; blue clay, shell rock, 5 feet; very hard flint rock, 6 in., soft lime rock, 2 feet; blue clay, 2 feet	100 — 113
Lime rock	113 — 120
Hard lime rock, 18 inches; soft lime rock, 2½ ft.; hard lime rock, 2 feet	120 — 126
Lime rock; small slow at about 150 feet	126 — 234
Lime and sand shale (water)	234 — 248
Sand rock	248 — 317
Lime and sand (water)	317 — 337
Hard sand rock (water)	337 — 347
Black muck, green clay, lignite, trace of oil; strong flow of water (3,000 gallons per minute) *	347 — 353
Lime rock, lignite, oily sand	353 — 363
Shale	363 — 365
Sandy shell rock	365 — 375
Shell rock	375 — 388

*The water from 350 feet came up through a 12-inch pipe 22 feet above the ground, then 8 feet through a 4-inch pipe, in all 30 feet. From the top of this pipe a 4-inch stream was projected 35 feet into the air, 65 feet above the ground surface.

Sandy shale	388	— 401
Soft, honeycombed lime rock	401	— 413
Gumbo (sea sediment)	413	— 416
Hard shell rock	416	— 427
Soft sand rock, lignite	427	— 441
Lignite	441	— 446
Sand	446	— 466
Soft lime rock, becoming harder	466	— 480
Honeycombed lime rock (water)	480	— 490
Hard lime rock	490	— 505
Blue marl	505	— 506
Lime rock	506	— 522
Soft lime	522	— 524
Sand, strong flow of water, nearly as great as that at 350 feet	524	— 526
Lime rock, sandy at times	526	— 588
Sandy shale	588	— 600
Lime rock, part shells	600	— 629
Blue sand shale	629	— 639
Lime rock	639	— 653
Sand and shale; at 675 feet good flow of water	653	— 698
Lime rock; thin stratum of coal in last 30 feet	698	— 748
Shell rock (cap rock)	748	— 758
Sand rock, much mica	758	— 764
Shell rock	764	— 773
Hard slate	773	— 813
Shell and lime rock	813	— 821
Sand	821	— 831
Shell and sand	831	— 911
Pyrite	911	— 912
Blue marl	912	— 923
Gumbo, some shell	923	— 958
Chalk	958	— 960
Gumbo	960	— 968
Soft sand rock	968	— 988
Sand rock	988	— 992
Pyrite	992	— 999
Gumbo, streaks of shale	999	— 1148
Dark clay	1148	— 1154
Hard lime rock,shells	1154	— 1158
Clay, like lime	1158	— 1159
Lime, shells, sand rock	1159	— 1164
Gumbo, some gas	1164	— 1214
Porous lime rock	1214	— 1220
Shale	1220	— 1240
Soft, porous black rock, oil sand	1240	— 1245
Dark shale	1245	— 1290
Dark-green sand	1290	— 1305
Soft rock	1305	— 1310
Dark shale	1310	— 1320
Gumbo with shell	1320	— 1337
Soft sand rock	1337	— 1350
Dark shale	1350	— 1355
Shells, lime rock	1355	— 1360
Dark shale	1360	— 1375
Soft sand rock	1375	— 1380
Dark shale	1380	— 1390
White clay	1390	— 1400
Soft sand rock, black specks	1400	— 1410
Sandy shale, black specks	1410	— 1422
Dark shale	1422	— 1439
Pyrites, shells, sand and rock mixed together, salt water, flow 150 gallons per minutes	1439	— 1484
Dark shale, hard hard streaks and some shells	1484	— 1522
Dark clay or gumbo	1522	— 1550
Hard flinty rock	1550	— 1553
Gumbo shale, some shells	1553	— 1640

At this depth the formation should be lower Nanafalia or Naheola. At 1300 feet a petrified sea-crab shell was found.

At 1600 feet, salt water about 200 gallons per minute.

MONROE COUNTY.

Surface Features.

The older Tertiary formations of Monroe County range from the Nanafalia sands and marls in the north to the St. Stephens limestone in the south, with the capping formations of the Grand Gulf over the limestone and the Lafayette over all, where not removed by denudation. This gives the usual Coastal Plain variety in the shallow water conditions. Where these are dependent on the two capping formations, the quality and quantity of the water are generally all that can be desired. In many places, where these mantles have been removed the underlying, older Tertiary materials influence the shallow-water supply both in quality and quantity.

Mineral Waters.

AWIN AND VICINITY.

Near Awin in Wilcox county but across the line in the northeastern part of Monroe county, there is an area in the Nanafalia terrane in which are many fine springs. The waters from five of these have been analyzed by Mr. Hodges for Messrs. J. M. Williams and S. L. Crooks, with results shown in following table.

Analyses of water from springs in Monroe County near Awin, Wilcox county.

	Parts per million.				
	No. 1	No. 2	No. 3	No. 4	No. 5
Potassium (K)	1.9	1.1	1.2	1.3	.8
Sodium (Na)	9.2	7.7	7.5	8.2	7.0
Magnesium (Mg)	1.2	4.1	3.9	3.2	4.3
Calcium (Ca)	13.7	59.6	54.1	36.0	17.2
Iron and alumina (Fe_2O_3, Al_2O_3)	2.8	7.3	1.9	3.0	4.8
Chlorine (Cl)	3.5	6.6	5.3	5.3	3.7
Sulphuric acid (SO_4)	10.2	52.1	38.2	23.3	7.5
Carbonic acid (HCO_3)	55.7	146.4	148.2	114.1	77.7
Silica (SiO_2)	29.6	49.5	43.8	53.9	31.1
	127.8	334.4	303.1	248.3	154.1

Analysis of No. 1 was made for Mr. J. M. Williams of Awin in 1903, the others were made in 1906 for Mr. S. L. Crook and others who intended to improve the property with a view to making it a health resort. The odor of sulphuretted hydrogen was noticed when the water No. 5 was examined, but no attempt was made to determine the amount since to be of any value such determination would have to be made at the spring.

TUNNEL SPRINGS.

At about the site of old Kempsville, near the station of Tunnel Springs, on the Louisville and Nashville Railroad, in the S. W. quarter S. E. quarter Section 14, Township 8, Range 8, are two springs which have lately attracted attention. They issue from a high hill of the Buhrstone rock, and are only about 15 feet apart. The composition of the dissolved mineral matter is similar in the two waters, but with slight differences, as the following analyses by Mr. Hodges will show:

Analyses of water from Tunnel Springs.

	Parts per million.	
	No. 1	No. 2
Potassium (K)	1.9	1.0
Sodium (Na)	6.9	4.8
Magnesium (Mg)	37.4	23.0
Calcium (Ca)	88.4	65.0
Iron (Fe)	44.6	
Iron and alumina (Fe_2O_3, Al_2O_3)		42.6
Aluminum (Al)	32.2	
Chlorine (Cl)	trace	trace
Sulphuric acid (SO_4)	618.0	336.0
Carbonic acid (HCO_3)	7.1	
Silica (SiO_2)	34.5	39.4
	871.0	511.8

With this composition these springs should have very decided medical qualities, but as yet there are no improvements or accommodations for visitors.

ARTESIAN PROSPECTS.

The Tuscahoma and Nanafalia sands are usually water bearing and favorable to the success of artesian borings, and in the northern part of the county there should be no difficulty in getting artesian water from them. In the southern part the Claiborne and St. Stephens formations may usually be counted on to yield artesian water. Only two records of deep borings have been obtained from Monroe County.

NADAWAH.

Shoal Creek Lumber Company's well, in the N. W. quarter N. E. quarter Section 28, Township 10, Range 9; bored by New Orleans parties; water stands at -3 feet.

Record of Shoal Creek Lumber Company's well, Nadawah.

	Feet.
Soil	0 — 8
Rock	8 — 12
Soapstone	12 — 30
Rock	30 — 34
Soapstone	34 — 48
Rock	48 — 51
Soapstone	51 — 59
Rock	59 — 61
Sand and shell	61 — 64
Rock	64 — 69
Soapstone	69 — 78
Rock	78 — 80
Sand and shell	80 — 90
Rock	90 — 96
Sand and shell	96 — 120
White sand. with water	120 — 137
Shell	137 — 156
Quicksand	156 — 160
Clay	160 — 168
Soapstone	168 — 207
Rock	207 — 209
Soapstone	209 — 259
Muck	259 — 327
Black clay	327 — 490
Shell rock, 4 inches thick	— 490
(?)	490 — 516
Rock	516 — 532
Black clay	532 — 551
Rock	551 — 557
Muck	557 — 676
Rock, 8 inches thick	— 676
Drab clay	676 — 716
Rock	716 — 717
Drab clay	717 — 718
Rock	718 — 720
Black clay	720 — 744
(?)	744 — 751
Rock, 18 inches thick	751 — 752
Drab clay	752 — 781
Rock	781 — 784

This record does not give much information as to the strata penetrated, but from the depth of the well and its position the borings must go into the Ripley sands of the Cretaceous, Nadawah being on the outcrop of the Nanafalia.

MAROS.

In the lower part of the county at Maros, Mr. J. A. Joullian has recently (1906) bored a well for Mr. J. M. Blacksher to the depth of 600 feet.

While this boring was a failure as regards artesian water, it gives some definite information about the underlying formations. The record according to Mr. Joullian is as follows:

Record of J. M. Blacksher's well at Maros.

	Feet.
Red clay, gravel and sand	0 — 300
Hard blue clay or shale	300 — 400
Sand	400 — 420
Dark brown clay without fossils	420 — 460
Same material more granular in structure	460 — 480
Same material with small shells of miocene age	480 — 500
Hard blue shale or clay	500 — 540
Rock	540 — 545
Blue clay	545 — 585
Soft blue clay or gumbo	585 — 600
Hard white limestone rock, bottom of boring	600 — 604

On account of the hardness of the rock at the depth of 600 feet and because the upper part of the boring was not cased and getting into bad shape, the drilling was stopped, and another larger well of 10 inch diameter, was begun with the intention of going down to 1500 or 2000 feet depth. At this time (Jan. 1907), the boring is down 200 feet in the red clay and gravel.

The shells which were brought up from 480 to 500 feet have been identified as being of Chipola age, and the white limestone is probably either the Chattahoochee limestone of Langdon, or the top of the St. Stephens.

It is rather remarkable that no water-bearing sands were penetrated in the 600 feet of this boring.

WILCOX COUNTY.

SURFACE FEATURES.

In Wilcox County the older underlying formations are the Ripley in the northwestern part and the lower Tertiary formations up to the Woods Bluff and Hatchetigbee in the southern. These older formations are covered discontinuously by remnants of the Lafayette capping of red sandy loams and pebbles. In most parts of the county an abundance of good water is stored in the superficial deposits and is recoverable from springs and wells. Some of the springs are considered to have medicinal qualities, and analyses of the water from two of them in the lower part of the county are here presented.

Mineral Waters.

CALEDONIA.

At Caledonia on the land of Mr. W. H. McGraw a well about 30 feet deep sunk in materials of the Nanafalia formation yields a water with very strong mineral properties, as may be seen in the subjoined analysis by Mr. Hodges.

Analysis of water from well of W. H. McGraw, Caledonia.

	Parts per million.
Potassium (K)	14.6
Sodium (Na)	150.6
Magnesium (Mg)	189.0
Calcium (Ca)	649.8
Iron and alumina (Fe_2O_3, Al_2O_3)	2.6
Chlorine (Cl)	310.8
Sulphuric acid (SO_4	1712.0
Carbonic acid (HCO_3)	686.5
Silica (SiO_2)	45.2
	3761.1

A spring at the foot of a hill close by has also strong astringent and acid taste. The mineral quality of these waters depends undoubtedly on the presence of iron pyrites in the strata.

SCHUSTER.

On the property of G. W. Stuart at Schuster are numerous springs boiling up through the sands on land lying between swamp and hills covered with piny woods. The water analyzed (by Mr. Hodges) has an exceptionally small amount of dissolved mineral matter, but the relative proportions of the ingredients, i. e., the preponderance of the salts of sodium and magnesium, may account for the medicinal qualities.

Analysis of water from Stuarts Spring, Schuster.

	Parts per million.
Potassium (K)	1.1
Sodium (Na)	8.1
Magnesium (Mg)	.7
Calcium (Ca)	.8
Iron and alumina (Fe_2O_3, Al_2O_3)	1.3
Chlorine (Cl)	3.5
Sulphuric acid (SO_4)	3.4
Carbonic acid (HCO_3)	18.7
Silica (SiO_2)	11.4
	49.0

AWIN.

On J. M. Williams's land, on the line between Wilcox and Monroe counties, in the N. W. quarter N. W. quarter Section 22, Township 10, Range 11, are 12 springs, one of them freestone water, the others mineral. That these springs are in the region of the Nanafalia formation is shown by the occurrence of rock composed of shells of the characteristic oyster of this horizon. As all of the springs from which the waters have been analyzed are just south of the county line and in Monroe, these analyses will be found under Monroe county.

OTHER SPRINGS.

Between Consul, on the Louisville and Nashville Railroad, and Gastonburg, on the Southern Railway is Boiling Springs, so-called from the fact that a fine freestone spring boils up through the sands.

Several sulphur springs occur at various points in the county. Of these mention may be made of one at Annemanie; one at Pine Hill, on the Southern Railway; Tait's spring at Blacks Bluff, on Alabama River, and one on Judge J. T. Beck's place near Camden.

About Gastonburg and Roberta, in the Cretaceous terranes, are small, flat-topped hills capped with sandy strata of the later formation (Lafayette). On these hills water is readily obtained from shallow wells; while in the lower lands near by, lacking this capping of sands, there is often a scarcity of water. The case is somewhat similar to that of the Forkland country in Greene County noticed above. (p. 144.)

Artesian Prospects.

The only deep wells in Wilcox County, records of which have been obtained, are those about Pine Hill and Catherine, on the Southern Railway; but there seems to be no good reason why such wells should not be successful in other parts of the county, especially in the region where the Nanafalia sands are available. The success of the boring at Nadawah, just over the line in Monroe County, is indicative of what may be expected in the lower part of Wilcox County.

PINE HILL.

Well of Vredenburg Saw Mill Co., at Pine Hill, in Section 29, Township 12, Range 5 East. Bored by J. H. Wood, of Bristol, Tenn., in 1905. Depth, 404 feet; cased to bottom. Flows 3 gallons per minute.

Altitude of Pine Hill station, 110 feet.

CATHERINE AND VICINITY.

The records about Catherine are as follows:

Mr. J. S. Robins reports that within 6 miles of Catherine there are three wells on his place and his father's old place adjoining on the north, all of them about 120 feet deep. At 120 feet quicksand is found and the water rises to about -20 feet. In each case a 4-foot well was dug down to water, and buckets are used. The wells are thus little better than surface wells, as the water in them is almost entirely sepage water except in the dry season. Other surface wells in this vicinity go dry, but these furnish water the entire year.

On the Kirksey place, 4 miles north of west of Catherine is an old well, reported to be 300 feet deep, in which water stood at -60 feet; a 4-foot well was dug around it to the water and buckets were used. This is a watering place for a large area in dry seasons.

On Mr. J. R. Pharr's place, in Catherine, is a dug well 90 to 100 feet deep, having 6 or 8 feet of water in the bottom. It is definitely stated by several of the older citizens that in the bottom of this well is a bored well of considerable depth; one report giving it as 800 feet, another as 400 feet.

Mr. M. A. Boynton, of Catherine, reports several very old wells flowing small streams on the north side of Chilatchee Creek, a few miles north and northeast of Rehobeth and Alberta.

Mr. Dave Vaughn has a 4-foot well 1 mile southwest of Catherine, 15 feet deep, in the bottom of which is a hole 6 inches in diameter of unknown dpth. When the water is dipped out and the well cleaned the water rises rapidly and finally stands at -15 feet in dry weather, when no seepage water enters. Mr. Vaughn reports several such wells in the vicinity.

All of the above wells probably do not penetrate deeper than the Ripley formation, which prevails at the surface.

CLARKE COUNTY.

SURFACE FEATURES.

The underlying Tertiary strata of Clarke County range from from the Tuscahoma or Bells Landing group up to and including the St. Stephens limestone, but owing to an uplift of the Hatchetigbee anticline, the Jackson anticline, and perhaps other disturbances of the strata, there are complications in the geologic structure which make its study of exceeding interest and which will have to be taken into account in calculating the probabilities of success in artesian borings.

The open, sandy nature of most of these formations and the fact that remnants of the great mantle of Lafayette loam and pebbles are common on all the great divides insure an abundance of good freestone water from springs and open wells in nearly every part of the county.

MINERAL WATERS.

As in the adjoining county of Choctaw, the Hatchetigbee sands and clays are the source of many springs of mineral water, especially sulphur and chalybeate, and along the lower border of the Hatchetigbee uplift, of tolerably strong brines. While many "salt oozes" spring from the outcrops of Hatchetigbee materials, most of the brines are derived from bored wells, and hence they will be considered in connection with the artesian prospects.

TALLAHATTA SPRINGS.

In Section 26, Township 11, Range 2 E., are the well-known Tallahatta Sulphur Springs, in the lowlands of Tallahatta Creek, at the northern base of the Buhrstone hills. These springs are very little improved, and the visitors are mainly from the immediate vicinity.

LOWER SALT WORKS SULPHUR SPRING.

This is a fine spring coming like the Tallahatta, from the Hatchetigbee clays at the base of a ridge of Buhrstone rocks. The water is of a decidedly saline taste, but very palatable.

Other sulphur springs occur with the salt waters of the Hatchetigbee horizon, but they are not improved or visited except by the people living near by.

Artesian Prospects.

The water-bearers among the Clarke County strata are the Hatchetigbee and the lower Claiborne formations, though water may also generally be found in the underlying Tuscahoma sands. The strata in Clarke County do not have a uniform southerly dip, but are thrown into waves by the Hatchetigbee anticline. This uplift extends diagonally through the southern part of the county, but its effects are seen throughout the county, especially in the fact that by it the St. Stephens limestone is kept as the surface formation, overlain, of course, by the Lafayette, over two-thirds of the entire area. This means that the formations in this area lie nearly flat, or rather in a basin, since the Hatchetigbee sands and clays, after disappearing below the surface above Grove Hill, reappear in the vicinity of Tombigbee River at Jackson and at other points as far south as Oven Bluff. These reappearances of the older beds so far south, though in the prolongation of the Hatchetigbee anticline, are due to another anticline, the Jackson. The bearing of these facts on the artesian prospects will be evident.

OLD SALT WELLS.

Deep borings for water for domestic and similar uses have not, so far as information is available, been attempted in Clarke County; but many years ago, before or during the civil war, on many of the outcrops of the Hatchetigbee strata, especially along the southern border of the Hatchetigbee anticline, and at the lower end of the Jackson anticline the occurrence of salt springs or oozes in the low grounds of Tombigbee River, both in Washington and Clarke counties, led to the boring of wells for a more ample supply of brine for salt making, and there are scores of these old wells in both counties, bored to depths varying from a few feet to 400 feet as a maximum. All of them overflow, being located as a rule in the palmetto flats of the creeks such as Stave, Jackson, and Salt creeks, usually near their mouths but occasionally 2 miles or more from the river. Some of the salt wells are merely excavations around the salt oozes, filled to the brim with the brine. During the war these places were centers of salt production for the State and for the Confederacy, the men engaged in the manufacture being exempted from military duty. The principal production was at the Upper, Middle, and Lower Salt Works, the first being in T. 7, Range 1 E., the second in Township 6, Range 2 E., and the last in Township 5, Range 2 E., not far from Oven Bluff. The Upper Salt Works, and the lower works, near Oven Bluff, have been patented to the State of Alabama, under the names "salt reserve lands."

A small amount of natural gas comes with the salt water from these wells in most cases, and at some of them especially where the brines are weak, there is a good deal of sulphuretted hydrogen.

In the low grounds of Bassetts Creek, south of Jackson, is a bored well, 105 to 110 feet in depth (presumably altogether in the Hatchetigbee formation), which yields a good stream of sulphur water, rather strongly impregnated with salt. This is one of the most agreeable to the taste of any of the sulphur waters of the State, and it has recently been piped a few hundred yards from the well up to a pavilion at the railroad station in the northwest corner of the S. W. quarter N. E. quarter Section 9, Township 6, Range 2, where it comes up through a marble vase provided for it. (Pl. XVII, B.) The composition is shown by Mr. Hodges' analysis below:

Analysis of water from well on Bassetts Creek, near Jackson.

	Parts per million.
Lithium (Li)	trace
Potassium (K)	8.2
Sodium (Na)	960.3
Magnesium (Mg)	16.0
Calcium (Ca)	54.0
Iron and alumina (Fe_2O_3, Al_2O_3)	2.6
Chlorine (Cl)	1466.5
Sulphuric acid (SO_4)	6.4
Sulphuretted hydrogen (H_2S)	*
Carbonic acid (HCO_3)	267.1
Silica (SiO_2)	17.8
	2798.9

*Present not determined.

The bored well which furnishes this water is very near the center of Section 9, Township 6, Range 2, and a few yards southwest of it is another well, the Saint well, which yields a sulphur water with less salt than the Jackson well. In the northwest quarter of this section, about 100 yards west of the pavilion, or vase of the sulphur well, is another bored well yielding a chalybeate water, like the others somewhat impregnated with sulphur. A fourth well is in the low grounds of the creek, about a mile west of the wells here described. In all these wells the water overflows.

About 5 miles above Jackson, at Glendon station, on the Southern Railway, there is a flowing well bored eight or ten years ago by Mr. Welch, then in charge of the sawmills at that place.

Two miles beyond Glendon, at Walker Springs, there are three old wells sunk before the war. One of these, south of the railroad, is near the site of the old hotel and constitutes the springs from which the place is named. The other two are nearer the railroad. A fourth well was sunk by Mr. Savage about ten years ago at his store near the railroad. All these wells overflow.

RECENT BORINGS.

The discovery of oil at Beaumont, Tex., a few years ago led to the search for oil in many parts of the South and the brine and gas wells of Clarke and Washington counties naturally attracted attention with the result that drilling was soon begun in all the old salt-works regions. A few of the records of these borings are here given through the courtesy of Messrs. S. A. Hobson and W. R. Osborne, In many cases the records were not accurately kept, and only scanty notes, mainly of the depth of the borings and the depths at which water was encountered, are now obtainable

Well at Beckham's Landing, near McGrew Shoals; bored in 1903-4; depth, 2600 feet,

Bolen well, in the northeast corner of the S. E. quarter S. E. quarter Section 17, Township 7, Range 1, E.; bored under the direction of S. A. Hobson in 1902-3.

Record of Bolen well.

Material.	Thickness. Feet.	Depth. Feet.
Lafayette loam with gravel at bottom	20	20
Dark-blue and greenish marl and sandy clays, with occasional pyrite nodules	40	60
Ledge of rock (strong gas flow just below this)	1	61
Indurated sand rock (more gas and undetermined volume of salt water)	3	64
Dark marls with pyrite nodules interspersed (more gas and film of oil))	40	104
Quicksand, with lignitic streaks near bottom	25	129
Dark marls and clays, occasionally slightly sandy	100	229
Light-colored, slightly indurated sand rock	10	239
Dark gummy clays or marls, exuding a black, molasses like odorless fluid, which fluoresces in certain lights	90	329
Alternations of dark gummy shales, sand clays, and clayey sands, with occasional pyrite nodules (gummy shales aggregating 90 per cent. of the mass)	377	706
Hard, almost quartz-like sand rock	4	710
Loose sands, dark-colored gray grains, full of fish remains (strong stream of salt water —about 6 per cent. solution—with gas that burns steady flame 15 inches high from mouth of 6-inch pipe)	30	740

At 740 feet the Bolen well was discontinued, owing to inability of the contractor to complete his contract The strata of the Buhrstone occupy the surface at the mouth of the well, with the St. Stephens limestone on the elevations near by. At 740 feet the boring would probably reach the Manafalia sands.

A sample of the brine from an old well close to the Bolen well has been analyzed by Mr. Hodges. This brine was used during the civil war in the manufacture of salt, and may be taken as a fair representative of that class of water.

Analysis of water from old salt well near Bolen well.

	Parts per million.
Postassium (K)	144.0
Sodium (Na)	11472.0
Magnesium (Mg)	122.4
Calcium (Ca)	246.8
Iron and alumina (Fe_2O_3, Al_2O_3)	5.2
Chlorine (Cl)	18520.0
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	26.1
Silica (SiO_2)	8.2
	30544 7

Edgar well, on Bumpus land, in the N. W. quarter S. W. quarter Section 26, Township 7, Range 1 E.; drilled by W. R. Osborne, of Metuchen, N. J., for the Edgar Oil Company in 1903-4.

The following record was furnished by Mr. Osborne:

Record of Edgar well.

Material.	Thickness. Feet.	Depth. Feet.
Sand	10	10
Limestone	4	14
Mud	3	17
White chimney rock (St. Stephens limestone)	83	100
Yellow sand, dry	10	110
Blue sandy clay	5	115
White limestone	50	165
Sand	20	185
Shells	5	190
Black clay	25	215
Black sand	10	225
Gray sand and shells	50	275
Buhrstone	47	322
Clay with mica	2	324
Sand and shells (slight show of oil)	28	352
Bluish sand	28	370
Buhrstone and shale	32	402
Coarse water-sand	55	457
Green clay and stone	47	504
Green clay and stone, showing oil and gas	24	528
Gumbo	37	565
Gray and black sand	5	570
Light-colored gumbo, turning dark	132	702
Black sand and shell, with gas and oil	2	704
Black gumbo	1	705
Gray sand and clays, with gas	120	825
Gumbo	80	905
Sand, with water and gas	25	930
Blue gumbo	30	960
Sand and gas	15	975
Blue gumbo	5	980
White clay	2	982
Very black sand	1	983
Gumbo	52	1035
Sand	20	1055
Gumbo	47	1102
Black sand and gas	6	1108
Light-colored clay	52	1160
Gumbo (stopped on rock)	41	1201

This boring beginning at the St. Stephens limestone, which is passed at 165 feet, probably goes into the Naheola beds.

Bush well, on State Salt Reserve lands, (Upper Salt Works) half a mile northwest of the Edgar well, in the center of Section 27, Township 7, Range 1 E.; bored by George O. and W. R. Osborne for T. G. Bush & Co., in 1902; record not obtained.

Salt Mountain well, in the southwest corner of the N. W. quarter S. W. quarter, Section 34, Township 6, Range 2 E.; bored in 1904-5 under the direction of S. A. Hobson.

Record of Salt Mountain well.

Material.	Thickness. Feet.	Depth. Feet.
Surface soil and clayey sand	7	7
Bluish clay	10	17
Fossiliferous limestone ledge	½	17½
Gravel (strong stream of salt water, some gas)	2	19½
Dark-greenish, unctious-feeling, acid-tasting substance containing occasional fossil shells or prints, weathering white on exposure to air	2	21½
Gravel and clear sand	49	70½
Indurated dark-grayish sand rock	4	74½
Dark-gray sand, partially indurated, with occasional very hard ledges	50	124½
Dark gummy shale, exuding odorless, molasses-like scum; very compact formation as a whole, but with thin streak of gravel and sand; nodules of pyrite interspersed throughout	215	339½
Indurated ledge of sand rock	1½	341
Gummy shale similar to that 215 feet	100	441
Very hard conglomerate; sand, gravel, pyrites and ocasional shell fragments	5	446
Gummy shales with many pyrite nodules and occasional shale "pots" which cave under water pressure	75	521
Mixture of clay, gravel, and shells, capped with indurated ledge	12	533
Gummy clays, with occasional alternations of siliceous shale and pyrite nodules	196	729
Compact shale ledge	1½	730½
Sand, almost hard enough to make self-sustaining walls	77½	808
Very hard ledge, semi-crystalline sand rock	1	809
Partially indurated sand	92	901
Peculiar dark sandy shale, somewhat shot shaped when wet but rather amorphous when dry, pouring out of hole in volumes as drilling progressed	20	921

At this depth the boring beginning near the top of the Hatchetigbee would probably be down into the Nanafalia or the Naheola.

CHOCTAW COUNTY.

SURFACE FEATURES.

The strata of the entire Tertiary series, from the Sucarnochee up to the St. Stephens limestone, are involved in the structure of Choctaw County; and in addition to this, in the southern part of the county an anticlinal uplift brings up the Hatchetigbee clays in the midst of the St. Stephens territory. Remnants of the Lafayete sands, loams, and pebbles are found capping some of the divides and forming as usual level plateaus. Under these conditions there is no lack of good water from springs and open wells.

MINERAL SPRINGS.

Waters of medicinal quality are furnished by a number of formations in this county—the Claiborne, Hatchetigbee, Woods Bluff, Tuscahoma, Nanafalia, and Naheola—practically the whole series occurring in the county. A rather full list of these springs is here presented through the courtesy of Mr. O. C. Ulmer, of Butler.

Springs of the Claiborne formation.

THORNTON SPRINGS.

On Surveyors Creek, in the S. E. quarter N. E. quarter Section 24, Township 11, Range 3 W., there are two or three strong sulphur springs which were thought by some to be equal to the Bladon Springs. Before the war this was a noted resort; it is now practically disused.

MINERAL EXTRACTS.

In this connection it may be proper to notice certain mineral extracts which have been put on the market and have had considerable sale because of their medicinal value. One of the first of these to come into notice was the "Extract of acid Iron earth." This was made from the dark-colored, carbonaceous, sandy, pyritous clays of the Claiborne formation near Bladon Springs, by drying the clay under shelter for some time, during which, by the oxidation of the pyrite and the action of the decomposing vegetable matter, sulphates of iron, alumina, and other bases, were formed, impregnating the earthy matter. The leachings of this, with as nearly as possible uniform concentration, were put up into bottles and placed on the market.

In the vicinity of Fail, in the same county, a similar "Mineral extract" has been made from pyritous, carbonaceous clays of the Claiborne formation.

Of late the "Extract of acid Iron earth," evaporated to dryness and the solid residue pressed into tablets, has been sold under the name of Natona.

Springs of the Buhrstone and Hatchetigbee formations.

The Hatchetigbee anticline brings to the surface, in the southern part of Choctaw county, a narrow strip of Hatchetigbee clays surrounded by the materials of the Buhrstone, all having a northwest-southeast trend. In this area in Choctaw and the adjoining parts of Washington County are mineral springs, gas springs, and salt well almost innumerable. Only a few of the best known can be mentioned.

BLADON SPRINGS.

The most important of the springs of the Hatchetigbee are the Bladon Springs, embracing a number of springs which yield different kinds of water—sulphur, soda, vichy, etc. The chief of these is the Bladon Spring, of sulphur water, in the extreme northeast corner, of the S. E. quarter Section 20, Township 9, Range 2 W. A few yards away, in the southeast corner of the northeast quarter of the section, is the vichy spring, close to the line between sections 20 and 21; the grounds of the springs include parts of both sections.

No recent analyses of the waters from these springs are available, but the following, made many years ago, are taken from Crook's "Mineral Waters of the United States and their Therapeutic Uses," page 86, and are presented in their original form.

Analyses of Waters from Springs at Bladon Springs, Choctaw County.

One U. S. Gallon contains; Solids.	Vichy Springs R. L. & W. P. Riddell.	Branch Spring R. L. & W. P. Riddell.	Sulphur Spring R. L. & W. P. Riddell.	Old Spring R. P. Brumby.
Sodium carbonate	46.33	41.21	34.93	32.89
Magnesium carbonate	0.29	0.61	0.65	1.36
Calcium carbonate	0.87	2.14	2.42	2.75
Iron carbonate	0.49	0.23	0.76	0.62
Calcium sulphate	2.25	2.79	2.96	....
Iron sulphate	....	....	....	0.24
Sodium chloride	....	....	....	7.69
Strontia	....	....	....	0.32
Silica	....	....	....	2.10
Organic matter	2.26	1.90	1.25	....
Crenic acid	....	....	....	0.75
Hypocrenic acid	....	....	....	0.60
Total	52.49	48.88	42.97	48.72
Gases	Cubic inches.	Cubic inches.	Cubic inches.	Cubic inches.
Carbonic acid	65.44	59.20	52.88	32.56
Sulphuretted hydrogen	....	....	0.56	....
Chlorine	1.84	1.84	1.84	....
Total	67.28	61.04	55.28	32.56

While these analyses as thus stated, do not accord altogether with modern views, they possess a certain historic interest and show very clearly the character of the waters as being alkaline carbonated with predominance of sodium; one containing also sulphuretted hydrogen.

Plate XXIV shows the Hotel and the pavilion over the sulphur springs at Bladon.

Between Bladon and Cullom, in the S. E. quarter of Section 20, Township 9, Range 2 W., a strong chalybeate spring issues from below a bluff of Hatechetigbee clays. South of the stores and post-office at Bladon there was formerly an alum spring and close by an alum well, both being now disused and filled up.

About one mile from Bladon, in the northwest corner of Section 29, Township 8, Range 2 West, are the Cullom springs with similar variety of waters. Plate XXV shows the Hotel at Cullom Springs.

A. Hotel at Bladon Springs, Choctaw County.

B. Pavilion of Sulphur Spring, Bladon Springs, Choctaw County.

Bladon was a noted resort before the war for the people of Mobile and New Orleans. At present, although both Bladon and Cullom are well fitted for the accommodation of guests, the number of visitors is relatively small because of the irregularity in the running of the boats and the distance from railroad lines.

SPRINGS ALONG TURKEY CREEK.

In other parts of the Hatchetigbee outcrop, and in the surrounding Buhrstone northwest of Bladon and particularly along the several branches of Turkey Creek, mineral springs, gas seeps, and sucks or licks are numerous and characteristic. Carbonate of soda seems to be a very constant ingredient of the waters, whether sulphur and other mineral ingredients are present or not. Where these soda springs come up in the creek flats, a crust is sometimes formed which is firm enough to walk on; but fissures and cracks soon develop, the crust breaks up, and a black or dark-colored mud, of the consistency of mush, oozes out. These places are devoid of vegetation and during dry weather become covered by an efflorescence of carbonate of soda, according to general belief, though no analysis has as yet been made of it. This deposit is extremely attractive to cattle and deer and thus gives rise to the common name "licks," or "sucks." It is often necessary to fence in the licks to prevent loss of cattle by miring down in the semi-liquid mud.

Dansby Springs, in the N. E. quarter Section 6, Township 9, Range 2 W., is a collection of iron, sulphur, and soda springs and sucks. At Zeb Taylor's in Section 14, Township 9, Range 3 W., is a strong sulphur spring; and at Zack Rogers's, in Section 34, Township 9, Range 3 W., is a strong chalbeate spring, near Conner's Natona bed above referred to (p. 291). All these are on Turkey Creek and along the axis of the Hatchetigbee anticline.

OTHER SPRINGS.

Further north, in its regular place, the Hatchetigbee is again the source of mineral springs, of which the following may be noted:

Chapman Springs, in the southeast corner of the S. W. quarter Section 36, Township 13, Range 3 W., about 3 miles southwest of Butler; strongly chalybeate water; no improvements.

Walker Spring, in the S. W. quarter N. E. quarter Section 25, Township 13, Range 3 W., 1¼ miles southwest of Butler; fine chalybeate spring; no improvements.

Another spring, in the S. E. quarter N. W. quarter Section 14, Township 13, Range 3 W., is not now used.

Springs of the Woods Bluff formation.

BUTLER AND VICINITY.

In the valley of Wahalock Creek, near Butler, are several fine springs of sulphur and chalybeate waters, locally well known, but without accommodations for guests.

Scarlock Springs, in the S. W. quarter Section 2, Township 12, Range 2 W.; chalpbeate water, a bold stream.

Jackson Mineral Spring, in the N. W. quarter S. E. quarter Section 4, Township 13, Range 2 W.; white sulphur; a strong flow.

Chalybeate Spring, in the S. W. Section 3, Township 12, Range 2 W., near the bridge over Wahalock Creek; has strong taste also of sulphur.

Spangenburg Iron Spring, in the city of Butler; also issues from the Hatchetigbee.

At Pushmataha, a few hundred yards north of the negro church, there is a bold chalybeate spring in the edge of a branch. The water rises in the "gum" about 2 feet above the general surface.

Springs of the Tuscahoma formation.

Eureka or Sharon Springs in Section 33, Township 15, Range 3 W.; white sulphur.

Springs of the Nanafalia formation.

Rutledge Spring, in Section 15, Township 15, Range 3 W.;

On the J. A. Watters place, half a mile below Gays Landing, on the Choctaw County side, a great volume of blue water rushes out in the edge of the river and the clear stream can

HOTEL AT CULLOM SPRINGS NEAR BLADON SPRINGS, CHOCTAW COUNTY.

be traced for a long distance sharply defined against the generally turbid river water. This stream issues from the Nanafalia marl beds which there form the banks of the river.

Springs of the Naheola formation.

Ashford Springs, in the E. half S. W. quarter Section 15, Township 15, Range 2 W.; once celebrated resort for the wealthy planters of Sumter and Choctaw counties; now in decay, with nothing to mark the former importance of the place except the marble basin of the spring. One of the springs here is a white sulphur, one a sulphur-chalybeate and one a vichy.

ARTESIAN PROSPECTS.

While the number of artesian wells in Choctaw County may be counted on the fingers of one hand, success should follow deep borings in almost every part of the county. This is rendered practically certain by the experience in the adjoining county in Mississippi, where there are many artesian wells obtaining their water in the Hatchetigbee sands and the lower Claiborne beds.

CULLOM SPRINGS.

The most instructive boring made in Choctaw County is at Cullom Springs, near Bladon. This was started in 1884 and finished in 1885 by Captain Trowbridge who was seeking petroleum. The surface rocks are probably the uppermost strata of the Hatchetigbee. The boring penetrated the underlying Tertiary beds and the Ripley and, as the record is interpreted, about 125 feet into the Selma chalk. While it is impossible to identify with certainty the beds penetrated by this boring, yet there are several points which seem to be pretty well determined. Thus in the lower part of the boring the black or dark-blue clays of the Sucarnochee seem to be unmistakably shown as well as the clayey sands with shells of the Ripley and the 125 feet of uniform blue rock of the Selma chalk at the base.

The whole depth of the boring is 1345 feet and the record obtained from Captain Trowbridge is as follows:

Record of Cullom Springs boring.

Material.	Thickness. Feet.	Depth. Feet.
Loose surface materials, varying slightly in color and texture	80	80
Alternations of blue and sandy marl (clay), with indurated blue ledge 5 feet thick at base	81	161
Soft clayey marl	23	184
Greensand, with shells, 3 feet, followed by 22 feet alternating hard and soft beds, the latter fossiliferous and water bearing	25	209
Marls or blue clays	46	255
Brown and blue marls (clays) in many alternations (lignitic?)	21	276
Blue marls or clays, with 2 feet of greensand at base	61	337
Lignite, 5 feet, followed by 19 feet of brown, tough marl (clay)	24	361
Blue sandy marl, with many varieties of shells; Venericardia planicosta recognized	23	384
Blue sandy marl (clay)	58	442
Brown marl (clay), 5 feet, with 32 feet blue marl below	37	479
Greensand marl, 9 feet, followed by 37 feet of blue marl (clay); at 500 feet water was struck, which flowed 10 feet above the surface	46	525
Brown clay marl, 19 feet, followed by 15 feet of blue clay with greensand, containing shells	34	559
Brown marl, resembling soapstone; contains shells; stream of water near bottom which flowed 30 feet above surface	50	609
Gray sandy marl, with shells	15	624
Gray sandy marl, with shells; more clayey than preceding	64	688
Very tough blue marl (clay), at base of which is a thin layer of white sand and then a thin layer of greensand	71	759
Brown marl (clay), 5 feet, followed by alternating beds of clay and sand, mostly sand (first salt water)	20	779
Alternations of gray and brown sand, with marl (clay)	26	805
Tough blue marl (big vein of salt water)	13	818
Sand and clay alternating	14	832
A kind of white limestone (?) containing mica, passing below into 3 feet of blue sandy marl, containing shells	28	860
Blue marl (Clay), 14 feet, followed by 14 feet of blue marl and sand, numerous shells	28	888
Marl 12 feet, with streaks of sand, followed by brown sand and marl, 12 feet	24	912
Greenish rock, chalky above. hard below	11	923
Sandstone, 4 feet, followed by 25 feet of white, blue, and gray quicksand (strong stream of salt water)	29	952
Marls or clays, mostly grayish or light brown, with several ledges of extremely hard rock, e. g, one 2 feet thick at 966 feet, one 1 foot thick at 971 feet, one 3 inches thick at 978 feet, one 1 foot thick at 1000 feet	137	1089
Tough black clay, 2 feet, followed by 99 feet of dark blue clay, some of it quite hard and firm, some very soft and sticky	101	1190
Snuff-colored clay, soft and sticky	13	1203
Gray sand and shells, 12 feet, followed by 5 feet of soft sandy clay	17	1220
Hard ledge, 4 inches thick at top, below which are about 125 feet of moderately hard grayish or blue rock, with scarcely any change in color or texture, to bottom of boring; no shells observed; "Rotten limestone"	125	1345

The following additional notes regarding this well may be of interest: At 80 feet water was struck, but it did not overflow. At 200 feet there was a bold stream of mineral (vichy) water, which overflowed. At 400 feet another strong stream of mineral water, like the preceding. At 1,000 feet a stream

SALT WELL AT CULLOM SPRINGS, CHOCTAW COUNTY.

of salt water with inflammable gas was struck. The present flow combines the streams at 200, 400, and 1,000 feet. The water is decidedly salty, and has a temperature of 83°. The gas collects in bubbles or in a foam on the surface of the water in the tank into which the stream flows. A lighted match touched to this foam ignites the gas, which burns over the surface of the water for some minutes, unless extinguished by accidental splash. The gas may also be ignited at the spout. where it burns with a flame 6 or 8 inches high. The estimated flow is 10 to 15 gallons per minute. Plate XXVI shows the house enclosing this well and through the open door the stream may be discerned. The quality of the water is shown in the accompanying analysis, by Mr. Hodges:

Analysis of Cullom Springs water.

	Parts per million.
Potassium (K)	21.0
Sodium (Na)	4043.0
Magnesium (Mg)	35.3
Calcium (Ca)	74.9
Iron and alumina (Fe_2O_3, Al_2O_3)	3.8
Chlorine (Cl)	6098.9
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	457.5
Silica (SiO_2)	9.9
	10744.3

BUTLER.

Well in court-house yard, depth, 600 feet; water stands at -30 feet; temperature, 77°. No record obtainable. Butler is on the Woods Bluff formation, and at the depth of 600 feet the boring is probably in the Naheola sands, or possibly no deeper than the Nanafalia.

WASHINGTON COUNTY.

Surface Features.

In the northeast corner of Washington County, by reason of the anticlinal uplift already mentioned under Choctaw County, the Tertiary strata down to the Hatchetigbee are brought to the surface. In the rest of the county the only

Eocene formation occurring at the surface is the St. Stephens limestone. Over the greater part of the territory of the latter is spread a later formation, the Grand Gulf, which, together with the Lafayette, is responsible for the soils and much of the topography, and in still greater degree for the shallow waters. Where the loams and sands of the Lafayette are the surface materials there is always an abundant supply of the very best water in springs and open wells. Where the limestone is the surface formation the water conditions are not so favorable, but it must be remarked that in most of the St. Stephens area the two capping formations are present.

Mineral Springs.

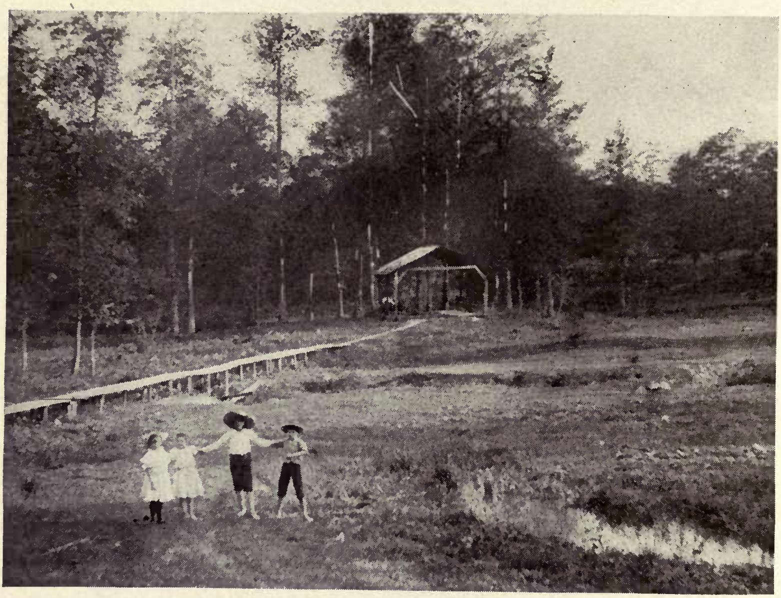
Springs in the Hatchetigbee formation.

The outcrop of Hatchetigbee clays and sands, with their inclosing Buhrstone strata, caused by the anticlinal uplift, is the source of numerous mineral springs in Washington county, as it is in Choctaw County adjoining.

The salt springs or oozes will be more particularly described below in connection with the artesian borings made in search of brine for salt manufacture. The other mineral springs of the Hatchetigbee anticline comprise sulphur, soda, and iron waters, in most of which there is more or less natural gas.

In the palmetto flats of an affluent of Santa Bogue Creek, in the N. W. quarter N. E. quarter Section 9, Township 8, Range 2 W., is Sanderson's spring, at which there has been a slight effort at improvement by providing a box. The water here has a soft, alkaline taste, with a suspicion of sulphur. In the sloughs or abandoned channels of the creek near by are many other similar springs, not at all improved but of a decided mineral character. In all of them bubbles of natural gas are constantly rising. Higher up the creek, at John Long's place in the S. W. quarter Section 6, Township 8, Range 2 W., there is a mineral spring similar to the vichy spring at Cullom, said to contain carbonate of soda and some sulphur.

Farther down, near Santa Bogue, is Salt Pond, formerly a beaver pond, receiving the streams from several salt wells in the vicinity. The dam has been cut and the pond drained away, and the place is now of the nature of a suck or lick, a



A. Mound Spring at Healing Springs, Washington County.

B. Creek Spring at Healing Springs, Washington County spot bare of vegetation, an acre or two in extent, and covered in dry weather, according to popular belief, by an efflorescence of carbonate of soda. In the midst of this area there seems to be an ooze of soft or semiliquid mud of black or dark color, over which at times a crust forms that is firm enough to bear the weight of a man, but trembles under foot. Cracks and fissures gradually develop in this crust and it breaks up, letting out the black mud. Cattle and deer are fond of the soda salt that accumulates on the surface of these sucks and it is necessary to fence them in, as the cattle mire down in them.

As in Choctaw County, carbonate of soda seems to be a characteristic ingredient of the mineral waters of the Hatchetigbee anticline, whether or not sulphur and iron are also present.

Springs of the Grand Gulf formation.

The Grand Gulf formation in most of the region of its occurrence, both in Mississippi and Alabama, is the source of numerous mineral springs, especially of such as are charged with the salts of magnesium and with iron. The percentage of these dissolved salts is often small, however, as may be seen from the analyses given below.

HEALING SPRINGS.

In the northwestern part of the county, near the inland margin of the Grand Gulf formation, are the Healing Springs, on a branch of Santa Bogue Creek. The springs, 17 in number, occur in the low grounds and marshy spots along the stream. The water is under a slight hydrostatic pressure which causes it to rise a few feet above the general level of the stream when confined by boxing or by pipes. The water is remarkably clear and pleasant to the taste; it contains a small proportion of dissolved solids, but these are in combinations which probably give them their therapeutic value. The analyses of the water from four of the springs, by Mr. Hodges, will show clearly the nature of the water. The situation of the springs, in the midst of a forest of yellow pine, is a distinct advantage to the seeker for health.

Analyses of Healing Springs waters.

	Parts per million.			
	No. 1	No. 2	No. 3	No. 4
Potassium (K)	1.6	1.5	1.9	1.9
Sodium (Na)	2.2	2.6	3.4	2.3
Magnesium (Mg)	1.9	2.0	1.9	1.4
Calcium (Ca)	8.5	9.2	8.1	5.2
Iron and alumina (Fe_2O_3, Al_2O_3)	4.9	4.9	5.5	4.1
Chlorine (Cl)	3.5	3.5	3.5	3.5
Sulphuric acid (SO_4)	11.5	8.9	9.8	9.6
Carbonic acid (HCO_3)	23.3	31.7	29.3	13.8
Silica (SiO_2)	28.8	27.1	29.1	26.6
	86.2	91.4	92.5	68.4

No. 1. Mound Spring.
No. 2. Creek Spring.
No. 3. Scholes Spring.
No. 4. McCartney Spring.

Artesian Prospects.

OLD SALT WELLS.

Within the area of the St. Stephens limestone, and especially along the southern border of the Hatchetigbee auticline, a very large number of borings have been made, most of them before the civil war, for the purpose of obtaining brine for the manufacture of salt. These salt wells are most abundant in Washington County in the palmetto flats bordering Salt Creek and the tributaries of Tauler Creek, generally within a mile from Tombigbee River and in a strip extending nearly parallel with its course from a mile or two above old St. Stephens nearly to Frankville. The wells have been bored to depths varying from 150 to 400 feet, and in one instance the depth has been given as 800 feet, in the case of a well at the Morgan Salt Works. At the Bucksnort Salt Works, near Peevy's Landing, according to Mr. Coleman, the deepest well was 370 feet and the majority of them about 250 feet. At about 100 feet salt water was usually struck, but the brine was weaker than that obtained at a greater depth.

In many places the salt water has been obtained by inclosing a space 8 or 10 feet square by driving down piling of 2-inch boards, and then digging out the dirt from the interior, when the salt water would gradually fill the shafts. The dug wells were, of course, located on the spots where the salt water oozed from the ground. The brine from the dug wells is reported to be relatively weak.

A story vouched for by a number of witnesses is to the effect that during the boring of one of the wells on Salt Creek there was a great explosion or "blow-out" of gas, which tore up the casing and made a noise which was heard for miles. With the explosion came a great rush of gas which caught fire from a camp near by and striking back to the well set fire to the derrick, consuming lt.

All the wells on the Washington County side of the Tombigbee seem to be located on the strata of the Claiborne formation (upper or lower), and to penetrate into the Hatchetigbee beds, except of course the shallow dug wells, which do not go deeper than 25 or 30 feet. The hills bordering all the salt flats seen by the writer were of the St. Stephens limestone, and rocks of the nature of the radiolarian clay stones so characteristic of the lower Claiborne or Buhrstone were noticed in many instances close to the well, with apparently hardly space enough for the upper Claiborne strata to come between them and the white limestone. About the Bucksnort Works, near Peevy's Landing, however, the upper Claiborne beds are well exhibited along the road leading down to the river.

Most of the salt wells of this county and of Clarke County, on the opposite side of the river, yield a small amount of natural gas with the brine, and many of the weaker brines are also strongly charged with sulphuretted hydrogen. These circumstances have led recently to the boring of a number of deep wells in this section in search of petroleum. Several of these borings were made along the reef of rock which forms the McGrew Shoals, above St. Stephens. It is stated that many years ago, when a blast was made in this reef to clear the shoals for navigation, oil came out of the rock upon the surface of the water in the river and was ignited and burned there for some time. This statement was made in a newspaper at the time of the occurrence. Several recent borings have been made on both sides of the river in this vicinity.

ST. STEPHENS.

Concerning the borings of the Washington County side, a few notes have been obtained from Mr. B. D. Turner and from Mr. James Keoughan, the contractor:

St. Stephen's Oil Company's well, in Section 27, Township 7, Range 1 W., in the northwest corner of the old Spanish grant known as the John McGrew tract, about 1,600 feet from the oil landing on Tombigbee River, above St. Stephens; bored in 1902; depth, 2006 feet; casing, 700 feet, 8-inch. No accurate log of this boring was kept and the following notes are from memory. At the depth of 250 feet, salt water and gas (Turner), below which was a very hard layer of "Buhr-stone" rock 5 feet thick. Below this to 1,250 feet, alternations of hard ledges and sands with salt water and inflammable gas. At 730 feet a heavy flow of fresh water in white sand (Keoughan). A heavy flow of salt water and gas was noted by Captain Keoughan between 750 and 800 feet. At 1,250 feet, according to Mr. Turner, the fluid from the boring changed from lead color to black, probably because of a bed of lignitic matter. Below this to the bottom of the well were 750 feet of dark-blue sand and blue shale.

The St. Stephens limestone lies on the hills about this well, which is in one of the palmetto flats bordering a small stream emptying into the river close by. The mouth of the well appears thus to be in the Claiborne strata close below the base of the St. Stephens. The salt water at the depth of nearly 800 feet would appear to be from strata below the Hatchetigbee which has generally been considered the main reservoir of the salt waters, and certainly is for many of them. The bottom of this boring is probably in the Cretaceous limestone.

MOBILE COUNTY.

Surface Features.

The geologic formations which show at the surface in Mobile County are the Grand Gulf and Lafayette, with the later, comparatively recent lowland formations or bottom lands of the rivers and creeks.

The St. Stephens limestone passes below the Grand Gulf formation in the upper part of Washington County and is not see at all in Mobile County. The existence, however, of marine Miocene strata far below the surface in the latitude of the city of Mobile is proved by the shells brought up from the deep wells bored in several parts of the city, which will be referred to later. None of the borings as yet recorded has gone down into the St. Stephens limestone.

The most prominent topographic feature of Mobile County in some respects is the Citronelle-Springhill ridge, the watershed between Mobile and Dog rivers. This ridge, with constantly diminishing altitude, extends down to within 2 or 3 miles of the Gulf. At Citronelle its altitude at the railroad station is 333 feet, while elevations on both side of the road are as much as 30 feet higher; at Springhill, 6 miles west of Mobile, it is 216 feet; and at St. Elmo station, on the Louisville and Nashville Railroad, it is 130 feet in a cut of 30 feet, making the land surface 160 feet above tide.

The width of the ridge varies as the headwaters of the several branches of the two drainage systems approach or recede from the central line of the divide, being in some palces a mere "backbone," in others a plateau a mile or two in width. From this divide there is a gentle descent into the broad "second bottoms" of Mobile River on one side and of Dog River on the other.

Away from the level lands capped with the Lafayette loam and pebbles, the clayey sands of the Grand Gulf are everywhere the surface strata except in the near vicinity of the coast and streams. Wherever this is the case in Mobile, Washington, Baldwin, and Escambia counties, and probably elsewhere, the generally level surface is marked by numerous shallow depressions which are filled with water in wet seasons, becoming ponds or marshes, or, where not too wet, meadows or savannahs.

Where the Lafayette is the surface formation an abundance of the best freestone water is obtained from open wells or from springs which break out along the hillsides at the contact of the Lafayette with the underlying Grand Gulf beds. Most of the streams flowing away from the Citronelle ridge have their headwaters in such springs or oozes from the Lafayette sands. Some of these springs are celebrated, such as that at the Jesuit college at Springhill; others are less well known, but quite as fine. On account of the pure water and fresh air, Springhill is much visited by the citizens of Mobile, many of whom have their residences there.

MINERAL WATERS.

CITRONELLE.

In the territory of the Grand Gulf formation, i. e., in the lower-lying lands from which the Lafayette capping has been removed by erosion, the water conditions are rather unfavorable, for while an abundant supply can usually be obtained by boring through the superficial layers into the underlying clays, yet it is often charged with mineral matter and objectionable to the taste. Frequently these waters break through the surface layers forming bold springs, often mineral springs. Of such character is the Cherokee or Wedgeworth Spring, 2 or 3 miles east of Citronelle, but many feet below the level of the ridge. This is a strong chalybeate and sulphur water, as is shown in the analysis by Mr. Hodges, given below:

Analysis of water from Cherokee Spring, 3 miles east of Citronelle.

	Parts per million.
Potassium (K)	.9
Sodium (Na)	4.0
Magnesium (Mg)	1.1
Calcium (Ca)	3.0
Iron (Fe)	12.6
Alumina (Al_2O_3)	.8
Chlorine (Cl)	3.5
Sulphuric acid (SO_4)	2.1
Carbonic acid (HCO_3)	45.6
Silica (SiO_2)	17.9
	91.5

SPRINGS NEAR THE COAST.

In the flat lands near the coast there are many mineral springs and some of the wells in the same section, both shallow and artesian, yield similar water.

Bromberg's springs.—Near Bayou Labatre, on the land of F. G. Bromberg, of Mobile, are several springs of clear, cool water, some of them almost on the banks of the bayou. The following analysis, by Mr. Hodges, is of the water from one of these springs:

Analysis of water from Bromberg's spring No. 1, near Bayou Labatre.

	Parts per million
Potassium (K)	1.7
Sodium (Na)	3.7
Magnesium (Mg)	.9
Calcium (Ca)	.6
Iron (Fe)	2.3
Chlorine (Cl)	12.7
Sulphuric acid (SO_4)	1.4
Silica (SiO_2)	6.4
	29.7

It is rarely that an analysis shows so small proportion of dissolved solids.. From this point of view the water would be called remarkably pure, and its color and taste bear out this inference.

Another of these spring waters has been analyzed by the National Brewers' Academy and Consulting Bureau of New York,* as follows:

Analysis of water from Bromberg's spring No. 2, near Bayou Labatre.

	Parts per million.
Sodium (Na)	5.10
Potassium (K)	.32
Magnesium (Mg)	1.25
Calcium (Ca)	1.15
Chlorine (Cl)	9.27
Sulphuric acid (SO_4)	2.18
Carbonic acid (HCO_3)	15.08
Iron (Fe)	.88
Lithium (Li)	.13
Organic carbon	.48
Silica (SiO_2)	6.08
	41.92

The analyses show these two waters to differ very materially. In the first the salts are chlorides only, with the exception of a small amount of sulphate of iron; in the second the salts are chlorides, sulphates, and carbonates. In both, on the other hand, the salts of magnesium and iron and common salt predominate.

*Expressed by analyst in grains per gallon and hypothetical combinations; recomputed to ionic form and parts per million at U. S. Geological Survey.

Grand Bay.—Of somewhat similar character to the water from Bromberg's spring No. 2 is that from a shallow well in the northwest corner of the S. half N. E. quarter Section 6, Township 7, Range 3W., on land belonging to John W. Bright, of Grand Bay. This is a well bored with an auger, 24 feet deep, curbed with plank and admitting a bucket 6 inches in diameter; it yields 50 gallons, and after an interval of 12 hours the water is up to the original stand. On account of its taste and the fact that it stained vessels in which it stood, it was thought to have medicinal value. It is a strong chalybeate water, as the following analysis by Mr. Hodges shows:

Analysis of water from John W. Bright's well, Grand Bay.

	Parts per million.
Potassium (K)	2.4
Sodium (Na)	26.5
Magnesium (Mg)	.2
Calcium (Ca)	4.1
Iron and alumina (Fe_2O_3, Al_2O_3)	24.4
Chlorine (Cl)	28.3
Sulphuric acid (SO_4)	1.4
Carbonic acid (HCO_3)	42.1
Silica (SiO_2)	35.0
	164.4

SPRINGS ABOUT MOBILE BAY.

Along the Mobile terrace and in other low grounds about Mobile Bay a plentiful supply of water can commonly be obtained by driving tubes down to depths of 75 feet or more, but the character of the water varies with the locality. On the river front, according to Mr. N. K. Ludlow, extremely salty water was obtained at a depth of 40 feet, while at 75 feet in the same locality the water was free from salt and good for all uses. At the light-house and also immediately opposite the city of Mobile a pipe driven to the depth of 150 feet yielded only clear salt water. At the light-house the water rose in the tube to within 18 inches of the top: The strata passed through were, first, a river-mud deposit, then a hard blue clay, with sand below it; at 150 feet a hard rock was encountered and through which it was impossible to drive the tube. Mr. Ludlow is of the opinion, based on his personal experience, that it is impossible by any ordinary hand or steam pump to exhaust the water from a driven well properly put down in this section.

These waters probably all come from the comparatively recent deposits overlying the Lafayette and Grand Gulf along the terraces of streams and the Gulf or Bay.

Artesian Prospects.

Experience of recent years has shown that artesian water can be had in most parts of the county where the elevation is not too great. These later borings have demonstrated the fact, heretofore unknown, that a great thickness of marine Tertiary deposits, of Miocene and later age, underlies the lower half and in all probability the whole of the county. The borings also demonstrate the fact, which can easily be verified by any one who will drive a few miles around the city of Mobile, that the deposits which have for many years been recognized by the geologists of the Gulf coast as Grand Gulf overlie all these later Tertiary beds, even down to the waters of the Gulf of Mexico. In Baldwin County this evidence is even more convincingly presented in the easily recognized Grand Gulf exposures in high bluffs overlooking the waters of Mobile and Perdido bays.

In many of these waters the proportion of salt is high, but in others it is not so great as to unfit them for ordinary uses.

MOBILE AND VICINITY.

Well at Mobile Brewery, Corner of Water and Adams streets, 500 yards from river front; depth, 800 feet; bored by Elder Hydraulic Boring Company in December, 1894. This was one of the first of the artesian wells in this county. After passing through a deposit of the "second bottom" or terrace formation, including probably the Lafayette, the boring goes through beds which can be identified only with the Grand Gulf, into shell-bearing strata which are shown by well-preserved fossils to be of late Tertiary age. Record furnished by Dr. Charles Mohr.

Record of Mobile Brewery well.

	Depth. (feet)
Coarse, sharp-edged sand, with siliceous pebbles and fragments of oyster shells	90
Fine sand	100
Coarse gravel of siliceous pebbles and coarse sand, with lignitized coniferous wood	130
Muddy sand; water highly charged with bluish-green argillaceous matter	300
As above, more compact, sandy particles somewhat finer and plastic	450
Of the same muddy nature, compactness increasing	490
Arenaceous sediment in the blue still finer, more plastic; di..cult boring	580
Sediment still more plastic, very fine, soft and velvety	625
Material remains unchanged	660
Stratum of indurated clay, with some coarse sand, abounding in small bivalves; small flow of water	700

After penetrating the clay about 30 feet a heavy stream of water was struck, with a discharge estimated at not less than 300 gallons per minute, under heavy pressure, bringing up pebbles of large size, indurated clay nodules. The material resembles the shingle of a beach. Also an abundance of coarse black sand (with magnetic iron ore). Two days later the flow of water had increased to 500 gallons per minute, and was about clear of sand.

Well of the Mobile Electric Lighting Company, bore in 1906. Depth, 650 feet; diameter, 8 inches; flows a large volume of water of brownish color and slightly brackish taste, accompanied by a little inflammable gas.

Well at the oil mill, 3 miles north of Mobile; depth, about 800 feet: record similar to that of the Brewery well, so far as can be ascertained. The water from this well is salty and accompanied by a considerable amount of marsh gas. The following analysis of the water was made by James Boyce, chief chemist of the American Cotton Oil Company.*

Analysis of water from Cotton Oil Mill Company's well, 3 miles north of Mobile.

	Parts per million.
Sodium (Na)	1135.52
Potassium (K)	15.74
Magnesium (Mg)	7.40
Calcium (Ca)	15.10
Chlorine (Cl)	1440.44
Carbonic acid (CO_3)	281.30
Silica (SiO_2)	19.20
Organic matter	178.30
	3,093.00

*Expressed by analyst in grains per gallon and hypothetical combinations: recomputed in ionic form and parts per million at U. S. Geological Survey.

Wells of Blacksher Lumber Company, at Magazine, three miles north of Mobile at the mouth of Chickasabogue creek. Bored by J. A. Joullian in 1906.

No. 1. Depth, 250 feet; diameter, 3-inches; flow 75 gallons per minute. The water being intended for boiler use was analy ed and found to contain considerable quantities of the sulphates of sodium and potassium and practically no iron. It is highly prized both for drinking and for use in the boilers. No. 2. Depth, 420 feet; diameter, 3-inches. First water at 250 feet; second at 390 feet, from which depth the water is taken.

Flow and quality of the water similar to that of No. 1, except that the water has a slightly brackish taste, and is accompanied by a small amount of inflammable gas. Record; white sand and red clay, 0-100 feet; blue clay, 100-250 feet, at which depth the first water was obtained in sand. Below the depth of 250 feet the record is not given, but at 420 feet a bed of black or dark clay was entered from which some fragments of shells broken by the drill, were obtained.

Mobile Oil Company's wells, at the Bascomb race track, a few miles from the court-house near Mobile; bored by J. A. Joullian in 1902; two wells close together; records practically identical.

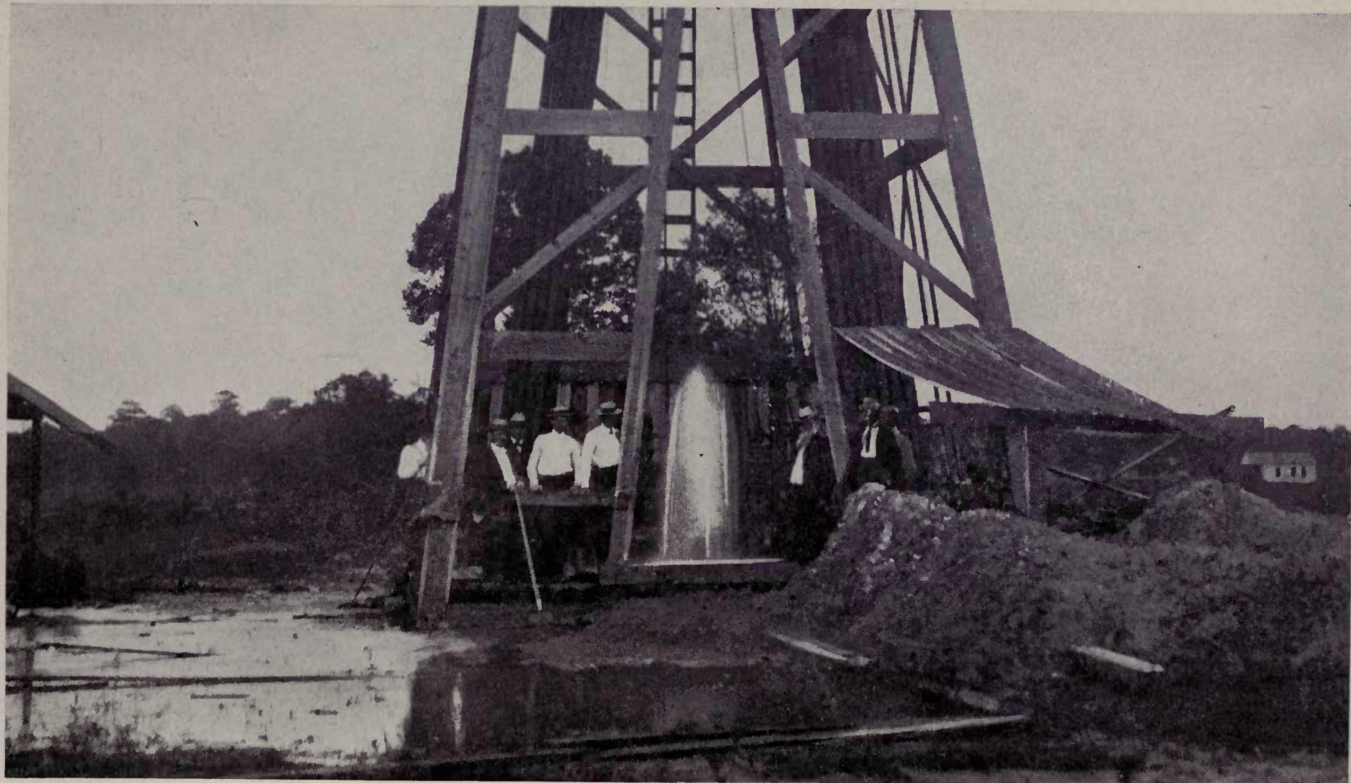
Record of Mobile Oil Company's well No. 1, near Mobile.

Material.	Thickness. Feet.	Depth. Feet.
Upper soil	15	15
Blue clay	10	25
Lignite	2	27
Blue clay and sand	75	102
Coarse white sand	15	117
Gravel	35	152
Stiff blue clay	22	174
Blue sand	6	180
Blue shale and fragments of shells	22	202
Blue clay	52	254
Sand	5	259
Blue clay	15	274
Coarse white sand	46	320
Blue shale and shells	20	340
Blue shale	35	375
Sandstone	3	378
Gravel	1	379
Gumbo	15	394
Blue sand	10	404
Blue shale	5	409
Sandy blue clay	45	454
Blue clay	23	477
Sand	15	492
Blue shale	29	521
Sand	10	531
Blue shale	40	571
Gravel	5	576
Blue shale	50	626
Blue shale with shells	2	628
Blue clay	20	648
Sand	22	670
Blue shale and lignite	2	672
Blue shale and rotten shells	20	692
Sand, shelly	20	712
Shale	19	731

Gumbo	20	751
Shale, shells	20	771
Shale and small shells	9	780
Blue clay	30	810
White sand	5	815
Gumbo	25	840
Sand, salt water, and gas	59	899
Gravel	47	946
Gray clay	21	967
Blue clay	17	984
Shale and shells	23	1,007
Sand	23	1,030
Blue clay	29	1,059
Blue shale	11	1,070
Blue clay	22	1,092
Conglomerate, pebbles	2	1,094
Hard blue shale	16	1,110
Sand rock	2	1,112
Gumbo	36	1,148
Sand rock	5	1,153
Gumbo	3	1,156
Sand rock	8	1,164
Gumbo	5	1,169
Sand rock and some gas	4	1,173
Blue clay and lignite	23	1,196
Hard rock	4	1,200
Gumbo	12	1,212
Rock	2	1,214
Gumbo and lignite	10	1,224
Rock	7	1,231
Fine sand	5	1,236
Rock	2	1,238
Blue clay and shells	8	1,246
Gumbo	12	1,258
Shale	25	1,283
Rock	2	1,285
Gumbo	23	1,308
Shale	45	1,353
Gumbo	85	1,438
Limestone, blue	2	1,440
Shale	1	1,441
Limestone	2	1,443
Shale	4	1,447
Shale	2	1,449
Limestone	1	1,450
Shale	2	1,452
Lime rock	7	1,459
Sand and shells; gas and saltwater	60	1,519
Limestone	7	1,529

Shells were brought up from various depths in this well. At about 700 feet the shells indicate the Pliocene; between 1500 and 1550 feet were shells characteristic of the Oak Grove (Fla.) horizon, which is Miocene.

Well No. 2 (Plate XXVIII) went deeper, pentrating into the Chattahoochee limestone, though not reaching the Vicksburg (St. Stephens.) In this well also, at the depth of 1,250 feet, the shells encountered were those characteristic of the Chipola beds of Florida. Thus there is here a section of the Pliocene and the whole of the Miocene of the Gulf coast. These beds are very sparingly exposed at the surface in Alabama; the only locality thus far noted being in Escambia County; but



BASCOMB WELL NO. 2. (SALT WATER AND INFLAMMABLE GAS). NEAR MOBILE, MOBILE COUNTY.

they are well shown on the Chattahoochee River in Florida, and on the Chickasawhay in Mississippi, where, however, they are only the uppermost of the series which has been identified as Pliocene.

Great quantities of salt water and inflammable gas come up from both these wells. The following notes on well No. 1 are furnished by Mr. Joullian, who superintended the work.

The well has a flow of 2,500 barrels (of 42 gallons) in twenty-four hours. The water is a 3 per cent. salt solution, with a temperature of 86°. The well also yields about 200,000 cubic feet of gas in twenty-four hours. It was the intention to pipe this gas to the city, but it has not been done. As the water spouts up 7 or 8 feet above the end of the 4-inch pipe which forms the casing it is a foam of gas and water which can be ignited, when it burns until accidentally splashed out by the water falling back.

ALABAMA PORT.

At Alabama Port, near the southeast end of the mainland, below Mobile, a well has been bored by the company owning the property. From this well also shells have been brought up which identify the formations as in the other wells above noticed. The water from this well has been analyzed by Mr. Hodges, with the result shown below:

Analysis of water from well at Alabama Port.

	Parts per million.
Potassium (K)	trace
Sodium (Na)	120.2
Magnesium (Mg)	trace
Calcium (Ca)	2.6
Iron and alumina (Fe_2O_3, Al_2O_3)	1.1
Chlorine (Cl)	113.7
Sulphuric acid (SO_4)	1.0
Carbonic acid (HCO_3)	129.1
Silica (SiO_2)	33.5
	401.2

No accurate record was kept of this boring, but the following notes are furnished by Mr. L. M. Tisdale: Flowing water, 7 gallons per minute, was struck at 80 feet, the small flow being due to a defective strainer. The present well is cut off at 377 feet, below which to the bottom (900 feet) hard ledges were encountered at intervals in the generally loose and unconsolidated materials.

Another well is now (1905) in progress in the same locality.

FORT GAINES.

At Fort Gaines, at the east end of Dauphin Island, across the channel from Fort Morgan, a well has recently been bored by the United States Government. It was completed November 12, 1903; diameter, 6 inches; depth, 919 feet.

Record of Government well, Fort Gaines.

Material	Thickness. Feet.	Depth. Feet.
White sand	10	10
Black sand	60	70
Blue sand	6	76
White sand	95	171
Blue clay	20	191
White sand	41	232
Blue sand, very fine	45	277
Blue clay	35	312
Blue sand	30	342
Blue clay	10	352
Limestone (2 feet)	2	354
Gray sand; salt water	55	409
Sandstone, very hard	5	414
Gravel	5	419
Gumbo clay	30	449
Gray sand	110	559
Blue clay	60	619
Gray sand	50	669
Gravel	10	679
Blue clay	145	824
Water-bearing sand (strainer landed in this)	95	919

The water from this well has been analyzed by Mr. Hodges, with the result given below:

Analysis of water from Government well, Fort Gaines.

	Parts per million.
Potassium (K)	4.1
Sodium (Na)	125.7
Magnesium (Mg)	1.4
Calcium (Ca)	6.1
Iron and alumina (Fe_2O_3, Al_2O_3)	1.6
Chlorine (Cl)	192.9
Sulphuric acid (SO_4)	2.0
Carbonic acid (HCO_3)	29.1
Silica (SiO_2)	53.9
	416.8

ARTESIAN WELL, OYSTER CANNING ESTABLISHMENT, NEAR BAYOU LA BATRE, MOBILE COUNTY.

WELLS ON PORTERSVILLE BAY SHORE.

The following six records are available of wells bored along the Bay shore from the mouth of Bayou Labatre to a point a little east of the mouth of Bayou Coden. Those nearest Bayou Labatre were bored several years ago, the others in 1906.

Oyster Canning Establishment well, at mouth of Bayou Labatre. Only meagre records can be obtained of this well which was bored a number of years ago. It is 580 feet deep, passing through sands and clays. The first water was reached at 500 feet, but the yield was small and the water rose only to the top of the tube. The boring was then continued for 40 feet, when the drill dropped suddenly 20 feet as if in a cave. Water was struck again at the depth of 580 feet, rising 15 feet above the surface, filling an elevated tank directly from the pipe. From the tank it is conducted by wooden troughs supported on trestles to the factory, one-fourth mile or more distant. Plate XXIX shows this arrangement.

The water from this well is quite different in composition from that of the Fort Gaines well, but similar to, though less salty than that of the Alabama Port well, as may be seen from the accompanying analysis by Mr. Hodges:

Analysis of water from Bayou Labatre Cannery well.

	Parts per million.
Potassium (K)	3.7
Sodium (Na)	54.5
Magnesium (Mg)	1.1
Calcium (Ca)	3.5
Iron and alumina (Fe_2O_3, Al_2O_3)	1.8
Chlorine (Cl)	42.5
Sulphuric acid (SO_4)	4.0
Carbonic acid (HCO_3)	87.9
Silica (SiO_2)	48.7
	247.7

Another well of which no records have been obtained has been bored near the railroad track a few rods north of the Oyster Cannery well above described.

Barret's well near Sans Souci Beach. Depth, 518 feet; diameter, 2 inches; flow, 50 gallons per minute. The water unlike that of the Mobile wells is clear and without color; contains sulphate of sodium and a little iron and sulphuretted hydrogen.

The Graham well at the mouth of Bayou Coden. Depth, 520 feet; diameter, 3 inches; flow, 100 gallons per minute, a full strong stream, under considerable pressure. The water has a slightly stronger taste of sulphate of sodium than the preceding.

Well at Coden station where the railroad crosses Bayou Coden. Depth, about 520 feet, good flow, record similar to that of the other wells along the beach.

The Ralston well on the beach a short distance east of the Mouth of Bayou Coden and the Graham well. Depth, 520 feet; diameter, 3 inches flow 60 gallons per minute; water of the same quality as that of the Barret well.

Record of the Portersville Bay wells above described; Soil and mottled clay, 0-15 feet; Blue clay, 15-48 feet; sands yielding abundance of water, not overflowing, 48-68; Blue clays alternating at intervals with sands, all devoid of shells or other organic remains so far as could be seen, 68-520 feet.

CITRONELLE.

On the high plateau dividing the waters of the Alabama from those of Dog River, near Citronelle borings were made in 1902 in search of oil, under the auspices of the Mobile Oil Company. Two wells were sunk not far apart. The second well went to the depth of 1,960 feet or more. A few notes in regard to this well have been obtained from Mr. Knott, who did the drilling. From the surface down to 900 feet the material appeared to be sand and shale (clay ?) ; at 900 feet a blue marl was encountered, and at that depth Mr. Knott found a little showing of oil; from 900 to 1,960 feet there were alternations of rock and shale and streaks of dry sand; between 500 and 600 feet there was plenty of water, but it was not tested as to whether or not it would overflow. No water was found below 650 feet.

As has been stated above, the surface materials of the Citronelle plateau are the red loam, sand, and pebbles of the Lafayette, beneath which is an undetermined thickness of sands and clays of the Grand Gulf formation, at least 300 feet, to judge from the fact that the same formation is at the surface on the river banks 300 feet lower, in the same latitude.

BALDWIN COUNTY.

SURFACE FEATURES.

So far as observation has yet gone, nothing older than the Grand Gulf shows at the surface in Baldwin County, which extends 72 miles north and south. Over the Grand Gulf lies the mantle of Lafayette loams, sands, and pebbles on most of the higher, least-eroded divides; not indeed in a continuous sheet, but in patches which are remnants of such a sheet. In topographic character the county varies from hilly and dissected in the northern half to high-level plateaus in the southern half. These high flat lands extend to the shores of Mobile and Perdido bays, (Plates XVIII, XIX, and XX). The elevation of the land between Mobile Bay and Perdido River south of the main line of the Louisville and Nashville Railroad is on an average not less than 200 feet.

The flat lands above mentioned are characterized by the occurrence at frequent intervals of shallow depressions, which, according to the season, are shallow ponds, marshes, or savannahs. (Plate XXII). The larger and more permanently wet depressions are the well-known "gum ponds," so called from the fringe of black gum trees with they are bordered. (Plate XXI). The gently undulating surface thus produced, with its timber of long-leaf pine, its lack of shrubbery undergrowth, and its carpet of grass, resembles a well-kept park.

Shallow Waters.

Water is easily obtained in nearly all parts of the county—from springs where the inequalities of the surface are sufficient to expose the Grand Gulf beds below the Lafayette, and elsewhere from open wells which vary in depth from a few feet to 90 feet. In the northern half of the county the conditions are like those so often described in the other counties. In the southern half the flatness of the country causes a relative scarcity of springs. Below the Lafayette the stratified sands and clays of the Grand Gulf afford storage reservoirs, and bottoms for the open wells. At Daphne, opposite Mobile, the wells are 40 to 45 feet deep, passing first through the Lafayette loams, then into Grand Gulf sands to water, which is always just above streaks of pipe clay. At Randall's store, on the hill above Daphne, the wells are 100 feet deep, the extra depth being in the sands and loams above the stratified clay. On the high flats 3 or 4 miles from Daphne the wells again are shallower, 40 feet or more, passing through the Lafayette and the sandier beds of the Grand Gulf to a bottom of clay. At Montrose, south of Daphne, the wells are 90 feet deep only 200 to 300 yards back of the high bluff on which the settlement stands. This bluff is a part of the high land of the county, extending down to the bay without any intervening low grounds. It is well shown in Plate XVIII.

Mineral Waters.

The mineral waters in Baldwin County are in the main salty. They are to be had from shallow and driven wells sunk on the sand spits and low islands. All the bored wells on Blakely Island are reported by Mr. J. D. Webb as yielding salty water. Shallow wells on the spit between the lagoon and the Gulf yield salt water from which salt was manufactured during the war. It is said to be more salty than the water of the Gulf. Some of these salt wells are in the N. E. quarter Section 12, Township 9 S., Range 3 E., on the eastern side of Bay St. John. Others are in the N. W. quarter Section 7, Township 9 S., Range 4 E. It is worthy of remark that similar shallow wells on the mainland and quite as near to the salt water of the lagoons and bays frequently yield pure water, some of it exceptionally so. This may be seen in the analyses of the water from the Bromberg springs, and from the Bayou Labatre Cannery well, in Mobile County. Good drinking water is also to be had from shallow wells on the landward margin of Perdido Bay in Baldwin County.

Artesian Prospects.

Except in a few deep wells recently bored the artesian conditions of Baldwin County depend on the strata of the Grand Gulf formation alone. Near Soldier creek Post-office, in Section 16, Township 8 S., Range 6 E., on Perdido Bay, in Mr. Randolph's driven well, 45 feet deep, the water rises very nearly to the surface. At Millview, on the Florida side of the bay, in a well 55 feet deep, the water rises 5 or 6 feet above the surface. Up Wolf Bay, near Swift Post-office, overflowing water is obtained at a depth of 110 feet. Near Perdido River at Lane's Ferry two flowing wells were noted and one at Gateswood, not far from Seminole. Of these no particulars were obtained. On the Florida side of the river such wells are more numerous than on the Alabama side.

In the matter of deep wells there is comparatively little to record. In the southern part of the county, in the center of Section 22, Township 8 S., Range 4 E., Major Fitzhugh has recently bored for oil to a depth of of more than 1500 feet; record not obtained. It is of interest to note that Miocene shells were encountered in this well, as in the Mobile wells, at depths of 730 feet and lower.

SUPPLEMENTARY NOTES.

ADDITIONS.

Several analyses overlooked at the time or available since the printing of that part of the Report to which they belong, are here added.

Appalachian Valleys.

Cahaba River Water.—The following analysis by Mr. Hodges, of water from Cahaba River at DeShazo's Mill, below Leeds in Jefferson county, is given as showing the average character of the water supply of the City of Birmingham. This belongs to the bicarbonated alkaline calcic class of waters which includes the majority of the potable waters investigated by us.

Analysis of water from Cahaba River, below Leeds, Jefferson County.

	Parts per million.
Potassium (K)	3.6
Sodium (Na)	3.8
Magnesium (Mg)	8.0
Calcium (Ca)	40.7
Iron and alumina (Fe_2O_3, Al_2O_3)	3.2
Chlorine (Cl)	3.5
Sulphuric acid (SO_4)	1.7
Carbonic acid (HCO_3)	162.2
Silica (SiO_2)	46.1
	272.8

Valley of the Tennessee.

Sanaqua Mineral Water, Huntsville, Madison County—In the vicinity of Huntsville, several rather shallow bored wells have recently been sunk into the limestones of the Subcarboniferous formation. One of these is reported 3 miles northwest of Huntsville of which no record is available. Another about 4 miles southwest of the city, was bored in 1905 by Judge S. Morgan Stewart. Depth 160 feet; 40 feet through the surface soil and 120 feet into the limestone. The water stands at -110 feet and is brought to the surface by a pump, the tubes of which are very quickly corroded. Because of its very decided mineral qualities this water has been put on the market as the Sanaqua Mineral Water. Its composition is shown by the following analysis made by Dr. B. B. Ross, State Chemist, the analysis being originally expressed in grains per gallon and hypothetical combinations, but recomputed in ionic form and parts per million by Mr. R. S. Hodges.

Analysis of Sanaqua Mineral Water, Huntsville, Madison County.

	Parts per million.
Potassium (K)	22.5
Sodium (Na)	2634.7
Magnesium (Mg)	187.4
Calcium (Ca)	410.7
Ferrous oxide (FeO)	8.4
Alumina (Al_2O_3)	10.8
Chlorine (Cl)	1365.3
Sulphuric acid (SO_4)	5393.0
Carbonic acid (HCO_3)	trace
Sulphuretted hydrogen (H_2S)	69.0
Silica (SiO_2)	16.3
	10118.1

As the analysis shows this is a strong saline water of the sulphated sulphuretted class, containing also a high percentage of sodium chloride and of salts of iron. In these characters it resembles the waters of the Flatwoods of Sumter county as exhibited in the analyses of the waters of the Altman, Mills, and Hightower wells.

Coastal Plain Division; Cretacious.

HALE COUNTY.

Spring of T. G. Moore; two miles from Greensboro in the S. W. quarter of the S. W. quarter of Section 7, Township 20, Range 5 E. This may be taken as a fairly representative spring of the kind mentioned on page 158 as coming from the Lafayette formation. The water from this spring has been analyzed by Mr. Hodges with the following results:

Analysis of water from T. G. Moore's Spring, near Greensboro, Hale County.

	Parts per million.
Potassium (K)	.6
Sodium (Na)	4.3
Magnesium (Mg)	.6
Calcium (Ca)	1.2
Iron (Fe)	.3
Alumina (Al_2O_3)	2.3
Chlorine (Cl)	2.9
Sulphuric acid (SO_4)	.6
Carbonic acid (HCO_3)	13.8
Silica (SiO_2)	11.4
	38.0

It belongs to the class of alkaline bicarbonated waters which includes many potable waters as well as waters of reputed medicinal virtue.

Artesian well at Lock 5, *now Lock* 8, *Black Warrior River.*—On page 161 reference is made to two wells at this Lock, between Stewarts and Akron.

The water from well No. 1 has been analyzed by Mr. Hodges with the results given below.

Analysis of water from well No. 1, Lock 8, Black Warrior River.

	Parts per million.
Potassium (K)	8.3
Sodium (Na)	1057.4
Magnesium (Mg)	15.2
Calcium (Ca)	87.2
Iron (Fe)	2.8
Chlorine (Cl)	1330.1
Sulphuric acid (SO_4)	trace
Carbonic acid (HCO_3)	865.1
Silica (SiO_2)	15.8
	3381.9

This is a strong alkaline saline muriated water with relatively high percentage of iron. The almost entire absence of sulphates is to be remarked.

Well at Evans Station.—The water from one of the earlier artesian wells at Evans station in Hale county has been analyzed by Mr. Hodges; probably one of the E. S. Evans wells mentioned on page 162. It is a good type of the alkaline saline sulphated class and as such is here given, although more heavily charged with dissolved salts than the majority of the waters of this class, excepting the sulphur waters.

Analysis of water from well at Evans Station, Hale county.

	Parts per million.
Potassium (K)	3.0
Sodium (Na)	106.3
Magnesium (Mg)	33.2
Calcium (Ca)	84.2
Iron and alumina (Fe_2O_3, Al_2O_3)	1.9
Chlorine (Cl)	21.0
Sulphuric acid (SO_4)	274.0
Carbonic acid (HCO_3)	323.4
Silica (SiO_2)	44.6
	891.6

COASTAL PLAIN DIVISON; TERTIARY.

SUMTER COUNTY.

Well of Dr. J. A. Beavers, one mile east of Cuba.—Drilled by Dr. J. A. Beavers in May 1905 in his yard to supply water for domestic use. Previous to this time malarial fevers had been prevalent in his family but since the well was sunk no case of sickness has occurred and Dr. Beavers ascribes this to the use of the water, which is raised by means of a hand pump. This pipe is 1 1-4 inch in diameter.

The analysis by Mr. Hodges shows this water to belong to the class of alkaline saline water with predominant sulphates but with a good percentage of chlorides, and relatively high content of iron. Waters of this class even when only slightly charged with these mineral matters are often considered to have medicinal value, as for instance the waters of the Healing Springs in Washington county, Butler Springs in Butler, Mentone Springs in DeKalb, Hawkin's well supplying the Leeds Mineral water in Jefferson county, mentioned in this report.

Analysis of water from Dr. J. A. Beavers' well, Sumter county.

	Parts per million.
Potassium (K)	.6
Sodium (Na)	4.7
Magnesium (Mg)	1.9
Calcium (Ca)	3.6
Iron and alumina (Fe_2O_3, Al_2O_3)	1.8
Chlorine (Cl)	6.6
Sulphuric acid (SO_4)	8.4
Carbonic acid (HCO_3)	14.1
Silica (SiO_2)	9.5
	51.2

CORRECTIONS.

Several errors have escaped the proof reader, as is inevitable. The following are perhaps of enough importance to be pointed out and corrected:

On page 79 the summation of the analysis of the Cold Spring water should be 301.7, instead of 301.9.

On page 80 the summation of analysis of water from Harrell's well should be 298.7, instead of 298.2.

The analyses on page 89 of the waters from Cook springs, No. 1 "Sulphur spring" and No. 3, "Chalybeate" are here reprinted as they should be, as the best way to make the corrections.

Analyses of water from Cook Springs.

	Parts per million.	
	No. 1.	No. 2.
Sodium (Na)	30.2	11.0
Potassium (K)	2.6	3.7
Magnesium (Mg)	4.1	2.6
Calcium (Ca)	22.6	11.7
Iron & alumina (Fe_2O_3, Al_2O_3)	2.8	10.8
Chlorine (Cl)	5.3	3.5
Sulphuric acid (SO_4)	5.3	2.1
Bicarbonic acid (HCO_3)	157.1	74.1
Sulphuretted Hydrogen (H_2S)	.4	
Silica (SiO_2)	43.8	44.8
	274.2	164.3

Corresponding changes should be made in the figures in the descriptive paragraph preceding the analyses.

On page 99. The summation of Analysis No. 1 should be 949.34 instead of 947.80.

On page 133 in the heading of the analysis—C. B. Mill's should be C. P. Mills'.

On page 142 the summation of Dr. Webb's analysis should be 5345.36 instead of 5335.36.

On page 143 the figures showing the proportion of Sodium in the water of Allison well should be 2999.0 instead of 540.2—and the analysis correctly stated should be

Analysis of water from Allison Lumber Company's well, near Bellamy.

	Parts per million.
Potassium (K)	13.2
Sodium (Na)	2999.0
Magnesium (Mg)	43.1
Calcium (Ca)	139.6
Iron & Alumina (Fe_2O_3, Al_2O_3)	5.2
Chlorine (Cl)	4538.0
Sulphuric Acid (SO_4)	.3
Carbonic Acid (HCO_3)	784.5
Silica (SiO_2)	50.8
	8573.7

On page 160 the figure for Silica in the analysis should be 19.9 instead of 19.2.

On page 162 the summation of the first analysis of the Akron water should be 129.7 instead of 141.4, and that of the second, 115.4 instead of 115.1.

On page 258—the summation of the analysis should be 209.68 instead of 205.25.

On page 276 the summation of analysis No. 3 should be 304.1 instead of 303.1.

CHAPTER IV.

THE CHEMISTRY AND CLASSIFICATION OF ALABAMA WATERS.

CHEMISTRY.

We have seen that all underground waters have their source in the rainfall. Before reaching the earth the rainwater is practically free from solid mineral matter, but is more or less charged with oxygen and carbon dioxide, which give to it some solvent power. At the surface its solvent powers are still further increased by the solution of certain compounds resulting from the decomposition of organic matter, and locally, from the oxidation of metallic sulphides (chiefly iron pyrites). Aided by these it speedily becomes charged with mineral matter in its downward percolation through permeable strata.

All natural waters are therefore mineral waters, though this term has now come to include only those natural waters to which their mineral contents impart a decided taste or a decided medicinal quality.

Let us first follow the course of the meteoric water, charged as it is with oxygen carbon dioxide, and organic matter, in its downward progress through the strata. The sedimentary rocks which furnish to the infiltrating waters their mineral contents may for convenience be placed in two groups, namely: (1) those composed of the products of the decomposition more or less complete, of the crystalline rocks, and (2) those consisting essentially of limestone and dolomite.

The materials of the first group are, the insoluble residual matters, (mainly quartz sand and clay, usually ferruginous), resulting from complete decomposition; the undecomposed but still decomposable fragments of the constituent (especially feldspathic) minerals of these rocks; and the soluble products (mainly alkaline carbonates and silicates) of this decomposition, permeating and saturating the two preceding.

These soluble products and the gradual decomposition of the feldspathic fragments by the carbonated waters furnish a continuous supply of the alkalies to the water. The carbonate of potassium, as is well known, in contact with clayey sediments, very quickly passes into insoluble compounds; the carbonates of calcium and magnesium in this class of sediments although soluble, are present in very small quantities; while the sand and clays are almost entirely insoluble. The carbonated water which has passed through sediments of this nature would therefore, contain notable quantities of sodium with smaller amounts of calcium and magnesium.

In its circulation through the strata the carbonated meteoric water comes also in contact with the second class of sediments composed of limestones and dolomites, from which it takes up notable amounts of calcium and magnesium in the form of bicarbonates or as simple carbonates; and such water would therefore be characterized by a predominance of calcium and magnesium ions, although waters coming from limestones always contain more or less sodium.

In their underground circulation an intermingling of waters of these two varieties would naturally give rise to those intermediate classes containing carbonates both of alkalies (K and Na), and of alkaline earths (Ca and Mg.)

We have also seen that the great majority of our stratified rocks are marine sediments, and therefore must necessarily have the pore spaces which constitute no inconsiderable portion of their volume, filled with the waters of the ancient seas in which the sediments were deposited. This will be the case especially where these rocks lie below the level of the sea and have not been uplifted or broken so as to allow their bitter waters to be replaced by fresh infiltrating waters. It may be remarked here also, that clayey and calcareous sediments preserve their saline solutions far better than do the porous sandstones, as may be seen by comparison of the analyses of the water derived from strata of various kinds.* And furthermore, as at present, so in the past, there have been interior basins without outlet, and portions of the sea isolated from the main body in which by complete evaporation, gypsum, salt, and the more soluble salts of the mother liquor have become incorporated in the sediments in solid form. Circulating waters after taking in solution these neutral salts from the above mentioned marine sediments, embrace on the one hand the brines, characterized

*T. S. Hunt, Chemical and Geological Essays, page 104.

by the preponderance of chlorides and the practical absence of sulphates, and on the other hand, the sulphated waters characterized by the predominance of sulphates and the relatively small amount of chlorides. Sulphated saline waters of this origin are, however, in our experience, rare. The more prolific source of the sulphated waters is the action of the sulphuric acid and sulphates of iron and aluminum, generated by the oxidation of pyrites, upon salt-bearing calcareous and magnesian sediments. Beds of carbonaceous clay with gypsum and iron pyrites are especially favorable to the production of such water as is shown by its abundance in the "Flatwoods" belt of the Tertiary. Often waters of this later class contain free sulphuric acid, there being all gradations between strongly acid waters nad those in which the free acid has been neutralized by the alkaline and earthy constituents of the enclosing sediments. Those waters produced through the agency of the oxidation products of pyrites must necessarily be of superficial and local character, and, so far as we have examined them, come from springs and shallow wells, varying in composition with the saturation of the acids and in concentration with the variations in rainfall.

It goes almost without saying that a water deriving its mineral constituents from any one of the above mentioned sources alone will rarely be met with, for in the underground circulation there must inevitably be a more or less thorough mingling of the waters enriched from all the sources referred to.

The agency of decaying organic matter, such as is found in the black shales of the Paleozoic formations, in the mineralization of water is shown in those varieties popularlly designated as "chalybeate" and "sulphur" water. Small proportions of iron ore are present in almost every variety of water, but it is only to those in which a notable amount (8 parts per million*) of iron is present and which therefore have characteris-

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*In the case of waters containing only a small amount of mineral matters, iron in much smaller proportion than 8 parts per million may impart a chalybeate character to it. The analyses given in this report seem to show that when the proportion of iron to the total amount of dissolved solids in the water is as high as 1 to 75, the water is chalybeate.

Thus, the water of the Ivey well at Flomaton contains only 3.8 parts per million of iron, yet it is very decidedly chalybeate, but the total solids in this water amount to only 121.3 parts per million. The water of Chandler's spring containing 319.8 total solids and 4.3 iron, is also chalybeate. The water of the Mentone spring is strongly chalybeate with 6.6 parts per million of iron and 80.5 parts per million total solids.

tic medicinal proprieties, that the name "chalybeate" is commonly applied. In the sediments free from organic matter the iron exists in the ferric or highly oxidized condition which is insoluble in meteoric waters, but by the action of decomposing organic matter this oxide is reduced to the ferrous, which is easily soluble in carbonated waters. On exposure to the air the escape of the carbon dioxide is followed by the oxidation of the iron back to the ferric or insoluble condition, and its consequent deposition as hydrated ferric oxide in the run-off of the spring.

"Sulphur" waters are characterized by the presence of sulphuretted hydrogen in such quantity as to give a distinct character to the water. The origin, at least of all the Alabama waters of this nature, may be traced to the reducing action of decomposing organic mater upon sulphates. In very many cases this reaction may be very intimately associated with oxidation of the metallic sulphides, principally iron pyrites. This oxidation gives rise to the sulphate of iron and by subsequent reactions to the sulphates of magnesium, calcium, etc. When the decaying organic matter is present in sufficient amount these sulphates may be reduced to sulphides which may be taken directly into solution or by reaction with alkaline waters may form hydrogen sulphide. Brines containing small amounts of sulphates are liable to contain traces of sulphuretted hydrogen if organic matter be present.

CLASSIFICATION.

A systematic arrangement is the first requisite in a study of mineral waters. Any classification, while to a certain extent arbitrary, must be broad enough to include any mineral water which may hereafter be analyzed and must also be in line with modern research. Many classifications have been proposed, but the one brought out by Messrs. Haywod and Smith in a recent government publication* is the most satisfactory since it is based entirely upon the chemical composition of the water, the subdivisions being determined by the predominance of one or more of the ingredients. The classes are defined not upon

*Haywood and Smith, "Mineral Water of the United States," Bull. 91, Bureau of Chemistry, U. S. Department of Agriculture.

the basis of the combinations of the ions* present, as most writers have done, but upon the basis of the ions themselves, no chemical methods being known by which in solutions the relative amounts of acid and basic ions entering into combination with each other to form salts can be determined.

In the first place, all waters are characterized by their temperature and are divided into two great groups: Thermal and non-thermal, waters having a temperature above 70°F., being considered as thermal. These two groups are treated precisely alike so far as their solid constituents are concerned. Each contains four main classes: alkaline, alkaline-saline, saline, and acid, each of which may be further characterized by its predominant acid constituent as carbonated or bicarbonated, borated, or silicated for the alkaline class; sulphated, muriated or nitrated for the alkaline-saline and saline classes; and as sulphated or muriated for the acid class.

If any basic element is prominent in the water this fact may be indicated by prefixing its name, (sodic, lithic, potassic, calcic, magnesic, ferruginous, or aluminic) to the regular class name.

If any basic or acid constituent is prominent therapeutically but not chemically, this fact may be indicated by adding or affixing its name (arsenic, bromic, iodic, boric, siliceous, ferruginous, etc.) to the regular class name.

Lastly, any water belonging to any subdivision of either of the four classes, may be characterized by the presence of gaseous constituents, as carbon dioxated, sulphuretted, carburetted, etc.

This classification, as to group, class, and subclass, is shown in the table below, any class being capable of additional characterization by naming its prominent acid or basic constituent, as above indicated.

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*According to the modern theories of electrolytic dissociation an ion is an electrically charged simple atom or group of atoms forming in itself a complete individual, i. e. acting as a chemical unit. To illustrate; common salt—sodium chloride—consists of an atom of sodium (Na) combined with an atom of chlorine (Cl). In solution the ions of common salt would be Na for the basic element and Cl for the acid. In calcium sulphate, a combination of calcium with sulphuric acid, the ions are Ca for the calcium base, and SO_4 for the acid group.

SCHEME OF CLASSIFICATION.

Group.	Class.	Subclass.
Thermal or Nonthermal.	I. Alkaline	Carbonated or bicarbonated. Borated. Silicated.
	II. Alkaline-saline	Muriated. Sulphated. Nitrated.
	III. Saline	Muriated. Sulphated. Nitrated.
	IV. Acid	Muriated. Sulphated.

Alkaline waters.—Alkaline waters are defined as those giving an alkaline reaction* and containing carbonic or bicarbonic acid ions in predominating quantities, and those giving an alkaline reaction and containing boric or silicic acid ions in predominating quantities, where it can be proved that the alkalinity is due to the presence of borates or silicates.

Saline waters.—Saline waters are those which have an alkaline or neutral reaction and contain sulphuric, hydrochloric, or nitric acid ions in predominating quantities.

Alkaline-saline waters.—Alkaline-saline waters lie between the alkaline and saline classes. They have an alkaline reaction and contain acid ions from both these classes in approximately equal amounts.

Acid waters.—Acid waters are those which have an acid reaction, and contain either sulphuric or muriatic acid ions in predominating quantities.

ALKALINE WATERS.

TABLES I AND II.

Of the alkaline waters as defined above our present investigations are concerned with the carbonated only, divisible into two groups, one in which calcium is the predominating basic

*When acid or alkaline reactions are mentioned in these definitions, methyl orange is supposed to be used as indicator. (Haywood and Smith.)

constituent, and the other in which sodium is predominant. In only one of the alkaline waters analyzed did the water fall outside of these two groups. The water referred to is that from the mineral spring at Citronelle, Mobile County, in which iron predominates over all other basic constituents. In the examination of these analyses (Tables I. and II.) it will be seen that in both groups the amount of mineral matter present is relatively small, seldom exceeding 300 parts per million. To this, however, the water from the Demopolis City wells, with 951.3 parts per million of solid matters, mainly sodium carbonate, is a very notable exception.

These waters are all good for domestic purposes, many of them constituting the water supply of our cities, and it is probable that when more analyses shall have been made, this suitability of the alkaline waters for city supplies will be still more clearly shown.

Table I includes those alkaline bicarbonated waters in which calcium is the predominant basic constituent, and of these we have 37 analyses, which we place in three groups; (1) the normal calcic bicarbonated alkaline waters; (2) those in which the proportion of magnesium is exceptionally high, and (3) those in which iron is a characteristic or predominant constituent.

Of the normal waters of group 1, we have 26 analyses, 18 of which are of spring waters, 1 of a shallow well, 1 of a river furnishing a city supply, and 6 of deep wells. Ten of the spring waters, and the shallow (Ingram) well water, are considered medicinal waters. The Cold Spring at Blount Springs and the Freestone spring at the Alabama White Sulphur Springs may be taken as typical limestone spring waters, which issue so abundantly from the subcarboniferous limestones and from the Knox Dolomite. The Cahaba river water also gets its character from the limestones over which the river flows in the upper part of its course.

Of the 6 deep well waters, three, viz., those from C. C. Ferrill's and the City wells at Selma, and from the well at Williford's Landing, contain relatively high percentages of the chloride and sulphate of sodium, which brings them into close relation with the waters included in Table II.

In group 2 of Table I, we have placed those bicarbonated alkaline waters which are characterized by relatively high proportion of the salts of magnesium. It is of interest to note that of the six analyses here included, five are of "mineral" springs, and one of a deep well in the Coal Measures. All the mineral springs are places of resort. While in all these magnesic waters the bicarbonates predominate, yet the saline constituents, chlorides and sulphates, are also relatively abundant.

Of the chalybeate waters of group 3, one is from a spring, one from a shallow well, and three from deep wells. In this connection it is to be remarked that the magnesic mineral spring waters of the preceding group 2, are also strongly chalybeate.

In Table II, which includes those bicarbonated alkaline waters in which sodium is the predominating constituent, there are 17 analyses. Of these, 13 are of waters from deep wells coming from or through limestone formations, the other 4 are from springs, three of which are classed as mineral (medicinal) springs. One of these, the Cherokee spring at Citronelle, is remarkable from the fact that the iron predominates over all the other basic ingredients of the water. Nearly intermediate between this class and the preceding are the two deep well waters above alluded to, from Selma and from Williford's (Table I.) which might with almost equal propriety be put in Table II. With the exception of the Exchange Hotel and Demopolis waters, the high percentage of sodium in the deep well waters derived from limestone formations, appears to be due in part to the common salt and sodium sulphate which those formations, as marine sediments, normally contain. With increase in the relative proportion of sodium salts these waters grade into the alkaline-saline muriated, and saline muriated waters which may be considered the typical deep well waters.

It will be seen by reference to the other tables that about half of the "mineral" waters of which we have analyses, are included in the bicarbonated alkaline classes, and of these a very large proportion, four-fifths or more, contain calcium as the predominating constituent.

It is to be remarked that either of these groups of alkaline waters may become chalybeate through the intervention of decaying organic matters, such as are found in the black shales of the Paleozoic formations.

The same black shales, in conjunction with the oxidation products of iron pyrites,a mineral of frequent, almost universal occurrence in such shales, are the source of many of the sulphuretted waters of this section. The Cook springs in the Coal Measures and the two St. Clair Sulphur springs in the Cambrian Flatwoods owe their existence to black pyritous shales.

Chalybeate waters are more commonly spring waters than deep well waters. The only strongly chalybeate well waters in this class are those from the Akron and Brantley wells. The other chalybeate waters come from springs in the crystalline rocks, (Chandler's and Chambers'); in the Subcarboniferous or Mississippian series, (Harrell's); in the Coal Measures or Pennsylvanian series (Cooks); and in the Grand Gulf, (Citronelle.)

With the exception of Harrell's (shallow well), these are places of resort.

ALKALINE-SALINE WATERS.

TABLE III.

As the name indicates, these waters are intermediate between the alkaline and saline classes and contain approximately equal portions of the carbonates which are characteristic of the alkaline class and of the chlorides and sulphates predominant in the saline class. They are further subdivided into two groups, muriated and sulphated, according to the preponderance of the chlorides or sulphates which they have derived from the strata through which they have passed.

In this class the mineral contents are generally much higher than in the alkaline class, and since marine sediments which make up the bulk of our stratified rocks are richer in chlorides, mainly common salt, than in sulphates, the muriated waters hold a larger proportion of mineral matters than do the sulphated. This may be seen by inspection of the table. The small amount of sulphates in the muriated waters is also worthy of notice.

In the muriated group of alkaline-saline waters we have 16 analyses available; 10 from deep wells, 1 from a shallow well, and 5 from "mineral" springs. Eight of the deep wells, viz., those in Hale, Greene, and Marengo counties, and the Pittsboro well derive their waters from the Eutaw sands, while the

Bayou Labatre and Alabama Port wells of Mobile county find their water in Miocene or some later Tertiary strata. The three sulphur waters of Blount Springs owe their content of sulphur to the oxidation of pyrite and the reducing action of organic matter in the Devonian black shale. The Blount waters are generally considered to be the strongest sulphur waters in the State, a claim which is borne out, so far as the analyses presented in the tables accompanying this paper are concerned.* Only one of the waters of this group is notably chalybeate, viz., that from a shallow well of J. W. Bright in Mobile county.

Of the sulphated group there are 11 analyses available, of which 7 are of spring waters; 2 of shallow wells, (Hawkins and Beavers); and 2 of deep wells, that at Enterprise deriving its water probably from the Nanafalia formation, and that at Evans Station, from the Eutaw sands. Only one of this group is a chalybeate water, the Mentone on Lookout Mountain, (Coal Measures.)

In both groups of this class, the gradual increase of the chlorides and sulphates present, marks a gradual transition into the saline class.

SALINE WATERS.

Table IV.

Under this heading are included two very distinct groups, both as regards origin and composition. The one group is characterized by the predominance of chlorine ions, the other by the predominance of sulphuric acid ions. Both groups contain variable but relatively small quantities of carbonic acid ions as a result of intermingling with waters of other classes.

The muriated waters of this class contain as their chief constituent, common salt, with or without the chlorides of potassium, magnesium, or calcium. Sulphates are practically absent (as in the muriated group of the alkaline-saline class), and this, in connection with the presence of calcium and magnesium salts (chlorides) in relatively large proportion, is considered to be characteristic of ancient brines as distinguished from the

*The large figure for the sulphuretted hydrogen, (539.2 parts per million) in the analysis of Talladega Springs water, given in Table IV, is evidently a mistake, since a recent determination made at the spring by Mr. Hodges, gave only 19 parts per million.

waters of modern seas. Their composition points thus to their derivation from the brines and mother liquors of ancient seas, or from the salts of these ancient seas left in solid form upon evaporation of isolated basins.

Of these muriated waters we have 13 analyses; all, with the exception of a spring situated on the coast in Mobile county, from deep wells deriving their supply from a great variety of geological formations. The two wells at Holt and the Hosiery Mill well at Tuscaloosa derive their water from the strata of the Coal Measures; the Allen well, the Eutaw Dump well, the Livingston and the Allison wells, from the Tuscaloosa and Eutaw sands of the Cretaceous; the Clarke county salt well, from the middle Eocene; the Jackson well and the Cullom Springs well, from the lower Eocene, although the drilling in the latter well went down into the Cretaceous; the Fort Gaines well and the Mobile Oil Mill well, from the Miocene or some later Tertiary formation.

Some of these waters are used for domestic purposes, others are too salty for constant use, while the water from the Clarke county brine well has been used in the manufacture of salt.

The waters from the Hosiery Mill well in Tuscaloosa and from the Livingston well are considered to have medicinal value. The same is true also of the sulphur well at Jackson in Clarke county, which yields the only sulphuretted water of this class of which we have an analysis. This is primarily a saline water containing a small amount of sulphates, from the reduction of which by the organic matters in the water, the sulphuretted hydrogen has originated. To the taste this is one of the most pleasant of the mineral waters of the State.

Of the sulphated waters of the saline class we have 12 analyses; 2 of springs, 7 of shallow wells, and 3 of deep wells.

The sulphated saline waters are of two-fold origin; first, those formed by the solution of the sulphates existing in the strata as deposits of sulphate of sodium, potassium, magnesium or calcium. The calcium sulphate (gypsum) is always present, and it may be that the other sulphates have been formed by the decomposition of the gypsum by solutions containing the alkaline and magnesian salts.* Second, those formed by the action of the sulphuric acid or the acid sulphates upon alkaline solutions or upon calcareous or magnesian rocks. The sulphated saline waters thus produced through the agency of the oxidation products of pyrites must necessarily be of superficial and local character. These waters, with two exceptions, Hightowers and Sanaqua†, contain notable amounts of carbonates, as a result of mixtures with alkaline waters. The sulphated salines fall naturally into three classes according as sodium, calcium, or magnesium is the predominating basic constituent, and in the greater number of the waters of this group analyzed calcium predominates. Several waters of the sulphated saline class contain notable amounts of iron and might be called chalybeate.

ACID WATERS.

TABLE V.

The acid waters of Alabama are due to reactions in which the oxidation products of metallic sulphides, mainly iron pyrites, take an essential part. By this oxidation there is produced first the sulphate of iron (possibly free sulphuric acid), and, by further reactions of this with aluminous, calcareous and magnesian rocks, and alkaline solutions, the other sulphates. So long as there is an excess of free acid or of the acid sulphates of iron and aluminum, the waters will be acid, but by progressive saturation of the acid with the various bases mentioned, there will be a gradual formation of neutral sulphates

*The fact that these waters, with the exception of Perry's, Hardenbergh's and Sanaqua come from springs or shallow wells is full of significance. The water standing in these wells has time to take in from the surrounding clays, into which the wells have mostly been sunk, all the soluble salts within its reach, such as sulphates of magnesium, sodium, and calcium, bituminous matters, and if pyrites be present, the products of its oxidation and their alterations. The Hightower, Mills, and Altman wells, are in the black clays of the Flatwoods, while the conditions about the Gary and Jones springs and the Tidmore, McGraw, and Landers wells are quite similar, though the geological formations are different.

†The Sanaqua water might probably better be classed with the acid waters since carbonates are practically absent. In the very high percentage of chlorides, however, it differs from the other acid waters which we have analyzed.

and thus a gradation into the sulphated division of the saline waters. These waters, as well as those of the sulphated saline class of similar origin, are of superficial and local character. These acid waters are, of course, highly medicinal and therefore of much interest. The first from a shallow well of Mr. W. E. Forman, is remarkable for the large amount of manganese sulphate which it holds. The two free acid waters, Dr. Hale's and the Matchless Mineral Water of Greenville, are of special interest. If we compare Dr. Hale's with the other three waters of the same (Flatwoods) formation, viz., Hightower's Mills', and Altman's, of the saline class, several important relations will appear. The Hale water being strongly acid contains, of course, no carbonates, the Hightower water similarly has practically no carbonates, but also no free acid—the neutralization being complete and as yet no accession of carbonates from contact with alkaline waters. The other two waters, Mills' and Altman's, exhibit the further alteration of such a water as the Hightower after neutralization of the acid, through gradual accession of carbonates by intermingling with ordinary calcareous alkaline waters. All three, Hightower, Mills, and Altman, seem to betray their derivation from a water of the Hale type by their high content of iron diminishing as the alteration progresses.

The other acid water, from the Roper well near Greenville, "Matchless Mineral Water," has much reputation as a medicinal water, which it well deserves. I give in addition to Mr. Hodges' analysis of the water from a sample taken after a long wet season, one by myself and Mr. J. B. Little made many years ago, and one by Dr. Metz of New Orleans, to show not only the difference in the concentration, but also in the composition of the water at different times. One analysis shows 3,615.7 parts per million, another 9,354.4 parts per million, over twice as much, and the other 21,490.8 parts per million nearly six times as much. In the dilute water (Hodges' analysis) the amounts of chlorine, sodium, potassium, calcium, aluminum, and silica are relatively much greater than in the more concentrated waters of the other two analyses. On the other hand the iron and sulphuric acid ions in the concentrated waters are present in relatively much larger proportion than in the dilute.

GENERALIZATIONS.

From a study of the composition of the waters of Alabama as indicated by the analyses given in this report, I think we may be justified in drawing a few general conclusions, realizing fully, however, that entirely reliable generalizations cannot be made from a small number of analyses. For the present also, we shall consider only the deep wells, leaving the shallow wells and springs for a later occasion.

In the three tables which follow we have brought together the analyses of the deep well waters which, as nearly as we can decide it, come from the same geological formation. The class to which each water belongs is shown by the Roman numerals. The geographical distribution of the wells has also been kept in mind in the arrangement of the analyses in the tables, and the depths of the wells are given in most cases. In a few instances the figures indicate the depth from which the water supply comes rather than the actual depth of the boring.

WATERS FROM THE TUSCALOOSA STRATA.

TABLE VI.

In Table VI are 13 analyses of waters derived from the Tuscaloosa formation. With the single exception of T. B. Allen's, they are of the alkaline bicarbonated class, with relatively small amounts of mineral matters and therefore all eminently fit for drinking and domestic uses; the exception is a strongly saline water due to the presence of a large amount of salt.

The waters from the McLendon well, the Union Springs Water Works, the Prattville Academy, and the Exchange Hotel, all from East Alabama, and the Demopolis well in Western Alabama, belong to the subclass in which the sodium predominates over the calcium, and this predominance is due to the presence of bicarbonate of sodium rather than to common salt, sodium chloride. The waters from the Elliott and the Auxford wells near the Tombigbee river in Hale and Tuscaloosa counties, are clearly of the subclass of alkaline waters in which the calcium predominates. The waters from the two Akron wells might be put in either class, since the proportions of sodium and calcium are approximately equal. The two Selma waters, and that from Williford's Landing are, in a way, intermediate between the two subclasses, for while the calcium predominates in each, the amount of sodium is quite high, and the large proportion of chlorine, especially in the Williford water, seems to show that this is due in part at least to common salt.

From the analyses above presented it appears that from the meridian of Montgomery eastward, as a rule, these waters are characterized by predominance of sodium salts, chiefly sodium bi-carbonate. To the westward of the Montgomery meridian the subclass with predominant calcium salts (bicarbonate), is more frequently represented, not however, to the exclusion of the sodium subclass, as may be seen in the analyses of the Demopolis and Akron waters. Furthermore the proportion of common salt seems to be greater in the waters west of Montgomery than in those to the east. But the great excess of salt in the water from T. B. Allen's well is remarkable, considering its source in the Tuscaloosa sands.

By way of a partial explanation of the facts brought out, it may be stated that the Tuscaloosa formation, being in the main if not altogether of fresh water origin, would naturally contain only a small amount of common salt in its strata. And since the materials of this formation in east Alabama were probably furnished by the disintegration products of the igneous and metamorphic rocks, while in west Alabama they were provided by the sedimentary strata of the Coal Measures and other Paleozoic (marine) formations, the prevalence of the sodic subclass in the eastern section and of the calcic subclass, especially when notable amount of common salt is present, in the other section, may be accounted for.

WATERS FROM THE EUTAW SANDS

TABLE VII.

In Table VII are assembled the analyses of waters from the Eutaw sands. Of the 16 analyses here included, practically all belong to the saline and alkaline-saline classes, mainly the latter. The two which are assigned to the bicarbonated class with predominance of sodium, viz. Wedgworth's and Madison Jones', contain so much salt, as indicated by the relatively high chlorine content, that they might almost be included in the alkaline-saline class. While all these waters contain large amounts of common salt and are therefore to be classed as muriated, yet three of them, viz., those from the Perry well in Russell county, and from the Evans and Hardenberg wells in Hale county, contain so much sulphate of lime as to bring them into the sulphated division. In every other case the amount of sulphates is exceedingly small, sometimes dwindling to a mere trace or to practical absence. They all contain notable amounts of carbonates.

These facts find their explanation in the circumstance that the Eutaw sands are marine sediments and contain the salts of the ancient seas in which they were deposited. While the carbonates are chiefly carbonates of lime and magnesia leached from the limestones interstratified with the Eutaw sands, yet in the majority of cases the alkaline (potassium and sodium) carbonates are also present in these waters.

WATERS FROM UPPER CRETACEOUS AND TERTIARY STRATA.

Table VIII.

In Table VIII we have five analyses of deep well waters derived from the Upper Cretaceous or Blue Marl strata of east Alabama, and 11 of waters derived from several horizons of the Tertiary.

Blue Marl Waters.

The five analyses under this head belong to the Alkaline bicarbonated class with predominance of sodium salts, and are all, with the exception of the Andalusia well, from wells in Barbour county. By referring to the first four analyses of Table VI, which are also of waters from East Alabama wells, it will be seen that they belong to the same class of sodic alkaline bicarbonated water, although derived from a different formation—the Tuscaloosa.

The waters of the Clayton City supply, and from the Comer-Bishop and C. H. Bishop wells, are practically identical in composition and come from approximately the same horizon. In these the sulphates are slightly in excess of the chlorides, as is the case also with the water of the Union Springs City supply given in Table VI. In the other two, Andalusia and Moulthrop's, the chlorides predominate slightly, but in all five the carbonates (mainly of sodium) are considerably in excess of other salts combined. A somewhat similar relation is characteristic also of the four waters of the Tuscaloosa formation (Table VI) above referred to.

It would seem reasonable to offer the same explanation of the predominance of the alkaline (sodium) carbonates in the Blue Marl waters as was suggested for the Tuscaloosa-derived waters of these eastern counties, viz., the formation of the sediments from the decomposition products of the near-by igneous and metamorphic rocks. The relatively larger proportion of chlorides and sulphates in the Blue Marl as compared with the Tuscaloosa waters, accords with the marine origin of the Blue Marl strata.

Tertiary Waters.

The 11 analyses of waters from Tertiary strata are arranged in geographical order from the coast regions of Mobile county northward and eastward. The Mobile county wells and the Ivey well at Flomaton derive their supply from the middle or upper Tertiary strata, (Miocene or Pliocene). The Mobile county wells all yield salt water, (muriated alkaline-saline and saline.) The water of the Ivey well is sodic Alkaline bicarbonated with enough iron to make it decidedly chalybeate. The water from the town well at Brantley in Crenshaw county, is quite similar, but in it the calcium predominates; it also is strongly chalybeate.

Of the three salt wells, the two in Clarke county, viz., the Brine well and the Jackson sulphur well, probably get the salt water from the Hatchetigbee formation; in the Cullom Springs well in Choctaw county, while the boring went down well into the Cretaceous, the main stream of salt water is from a depth of about 800 feet and therefore probably from the Nanafalia formation or the next underlying Naheola.

All the salt wells and salt oozes of Washington and Clarke counties seem to be in some way connected with the Hatchetigbee and Jackson anticlinal uplifts, and while in many places along the flanks of these anticlinals, especially along the southern flank of the Hatchetigbee, the salt water comes to the surface in oozes or springs, or is brought to the surface by borings ranging in depth from a few feet to 300 or 400, it may be that its real source is in deeper lying strata, and that its occurrence at the surface and at shallow depths may be due to artesion conditions in the inclined strata of the uplifts and the existence of cracks or the locally porous nature of the overlying confining strata. The town well at Enterprise probably draws upon the Nanafalia sands for its supply, and in its relatively small amount of dissolved solids, the sulphates are slightly predominant over the carbonates. The deep borings of the Ozark City water works will probably reach the lower strata of the Tertiary. For a deep well this water is of rather exceptional character, being a normal calcic alkaline bicarbonated water, and more like a spring or shallow well water than a deep well water. This composition and the relatively small amount of dissolved solids insures its suitability for a city supply.

We have as yet too few analyses of waters from the Tertiary deep wells to justify any serious attempt at a geological or geographical classification.

From this comparison of the analyses of the bored well waters derived from the three Cretaceous formations we are led to the following conclusions; (1) The strata of the Tuscaloosa and of the Blue Marl or Ripley formations yield waters of the alkaline class, which includes the waters best suited for domestic use. The waters from the Tuscaloosa as a rule, do not hold more than 200 to 250 parts per million of solids, while those from the Blue Marl hold in general between 350 and 400 parts.

In all the Blue Marl waters, and in those from the Tuscaloosa east of Montgomery, the sodium predominates over the calcium, while in the Tuscaloosa waters westward from Montgomery, as a rule, the calcium is predominant. The larger proportion of total solids in the Blue Marl waters seems to be due to a relatively larger proportion of the sulphates and chlorides, the proportion of carbonates in these and the Tuscaloosa waters being approximately the same.

(2) The waters from the Eutaw sands are more highly charged with mineral matters than those from the other two formations, the total solids ranging on an average from 400 to 5000 parts per million.

Of the dissolved mineral matters, common salt (sodium chloride) is usually the most important and characteristic, although in two of the analyses the sulphates are in excess. Because of this high percentage of salt most of these waters fall into the alkaline-saline and saline classes. Even in the two waters in which the carbonates predominate the proportion of salt is notable. While by reason of the large amount of dissolved solids which they contain, the waters from the Eutaw sands are not so well suited for domestic purposes as those from the other formations, yet they are very extensively so used in the "prairie" or "Black belt", where the surface waters are deficient. By far the greater part of the bored wells of which we have records are in this prairie belt and derive their supply from the underlying Eutaw sands.

The following extracts with accompanying sketch map, taken from the Report of the Alabama Coastal Plain, pages 306 and 307, may possibly throw some light upon the relations of the Cretaceous formations which have been instrumental in causing these differences in the waters from the different formations and from the geographically different parts of the same formation. It must be borne in mind that the Tuscaloosa formation is of fresh water origin while the others are, prevalently at least, marine.

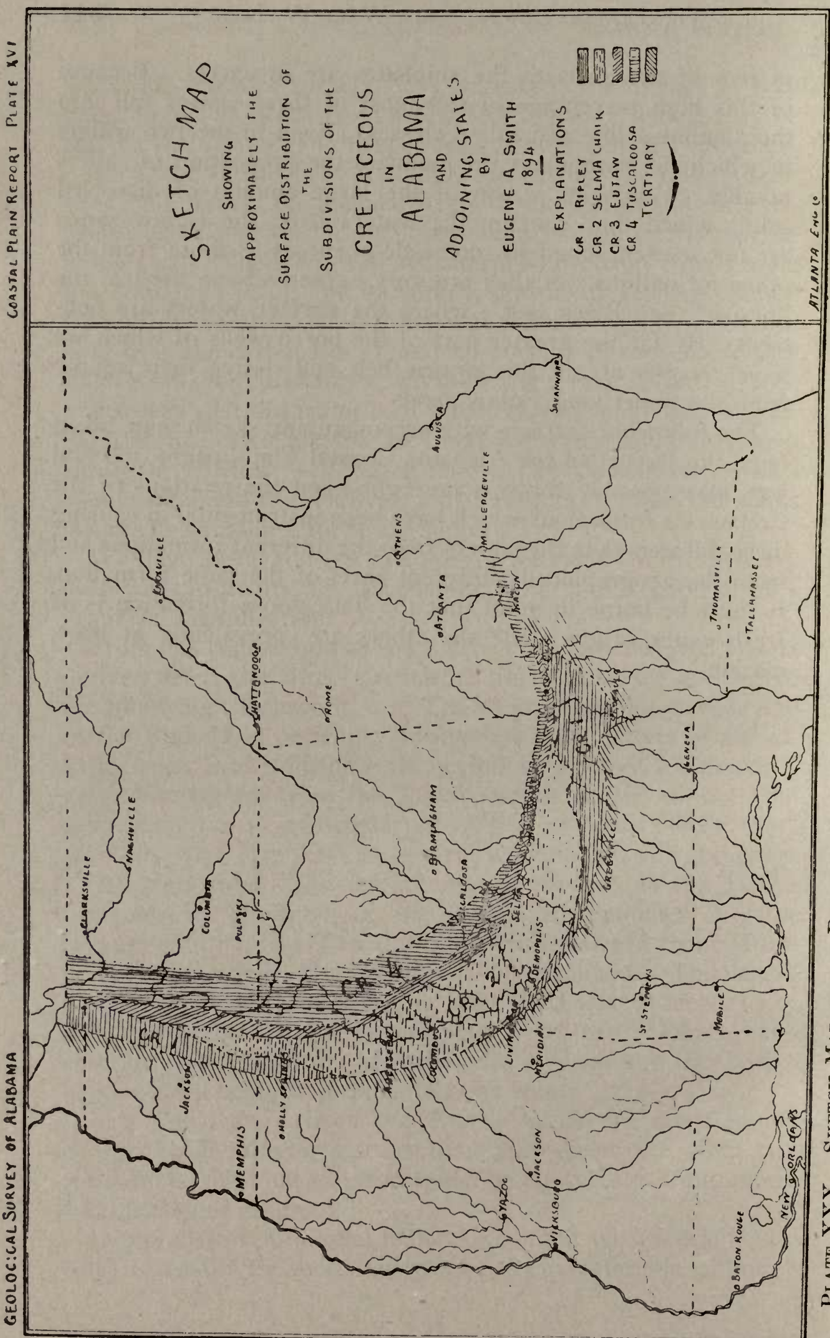

PLATE XXX. SKETCH MAP OF THE DISTRIBUTION OF THE CRETACEOUS FORMATIONS IN ALABAMA AND ADJOINING STATES.

"An examination of the distribution of the Cretaceous formations in the adjoining states will make the condition of things in Alabama more easily understood, and for this purpose the accompanying sketch map has been prepared, Plate XVI. Of all the Cretaceous formations the Tuscaloosa is the most widely distributed. It continues eastward along the foot hills of the Appalachians to Maryland and beyond. The other divisions have not been traced eastward beyond the western part of Georgia. The map will show how in the upper half of Tennessee the whole Cretaceous, above the Tuscaloosa, is represented by littoral or offshore deposits, chiefly sandy, in which there are a few fossils of Eutaw species in the eastern or lower part, and of Ripley species in the western. In the eastern part of Alabama we have a similar state of things, for along the Chattahoochee River the lower parts of these sandy strata hold Eutaw species and the rest Ripley species, all the strata being of littoral or off-shore character. Below the central line in Tennessee the chalky beds of the Rotten Limestone wedge in between these two sandy series and gradually narrow down or crowd out the upper or Ripley portion of them, so there is a good stretch of county in northeastern Mississippi where the chalky strata represent the entire series above the Eutaw sands, and border upon the Tertiary formations, in direct contradistinction to what we have seen in northern Tennessee and eastern Alabama, where beds of the Ripley aspect represent the entire series above the Eutaw. In Sumter county, Alabama, or perhaps in the immediately adjacent parts of Mississippi, the Ripley beds set in again as a margin of the chalk area, at first narrow, but widening out towards the east, until beyond Macon county, Alabama, it represents the whole upper series as above stated. From this we may also infer a good deal concerning the conditions which prevailed during the deposition of these Cretaceous beds, for we see that in the central part of this area, extending from Macon county, Alabama, around to the central part of Tennessee, deep or open sea prevailed during the greater part of the upper Cretaceous times, while contemporaneously, in the eastern part of Alabama and the northern part of Tennessee shallow water or offshores deposits were accumulating."

CONCLUDING REMARKS.

An extended discussion of mineral waters from the point of view of their therapeutic, or curative action upon the human system, would be foreign to the intent of this report, which is to give a general account of the underground waters of Alabama. It is hoped, however, that the mineral waters with which our State of Alabama abounds, may be considered later in a special report, after fuller investigations and more numerous analyses.

A few words may nevertheless be appropriate here concerning the chemical relations of potable and mineral waters, and sanitary and unsanitary waters, and concerning the limitations of a chemical analysis in discriminating betwen them.

The characteristics of a good drinking water have been defined as follows: (1) It should be clear and limpid. (2) It should be colorless. (3) It should be odorless, especially free from sulphuretted hydrogen or putrefactive animal matter. (4) It should be cool. (5) It should have an agreeable taste: neither flat, nor salty, nor sweetish. (6) It should be free from disease germs. (7) It should be free from all other substances mineral or organic, injurious to the human system; especially from dissolved organic matter of animal origin. (8) While a certain amount of saline matter is necessary to give the water a good taste, the total amount of dissolved solids should not as a rule exceed 500 or 600 parts per million, including not more than 30 or 40 parts per million of chlorine. A certain amount of gases, consisting of carbon dioxide and air (oxygen and nitrogen), is also essential to give life to the water and to save it from flatness.

The first five of these are physical characters, determined by the appearance, or the smell or the taste, and not by a chemical analysis. The sixth and seventh are the characters that distinguish a sanitary from an unsanitary water, and these are determined either by microscopic examination or by a "sanitary" chemical analysis, which is quite a different thing from the ordinary mineral analysis. It is therefore only the eighth characteristic which falls in the domain of the usual analytical methods.

Sanitary Analysis.—No fact has been more clearly demonstrated than that diseases may be disseminated by water, and it is equally certain in some cases, and probable in all, that these diseases are due to microscopic organisms which flourish best in solutions of organic matter of animal origin, hence the common belief that waters contaminated by decaying animal matters or refuse are most dangerous to health. The microscopic organisms above referred to may be detected by examination with microscope by a competent observer. A number of specific disease germs, such as the germ of typhoid fever, are well known, and when these are detected in the water there can be no question of its unsanitary character. Such examinations, however, belong to the bacteriologist and not to the chemist.

The nitrogenous animal matters which sustain the life of these disease germs, in the process of their decomposition in waters, yield "albuminoid" ammonia, (or ammonia from organic nitrogen,) and this by further decomposition yields in succession nitrous and nitric acids which combine with bases present to form nitrites and nitrates respectively.

The presence, therefore, of certain minimum amounts of albuminoid ammonia (as distinguished from free ammonia or ammonia salts), and of nitrites and nitrates may lead to well grounded conclusions as to the amount of decomposing (polluting) organic matter and the stage of the decomposition. If only the nitrates are present the inference is that the water, if previously contaminated by decaying animal matters, has again become pure through their removal by complete decomposition. But waters holding a notable amount of organic ammonia or of nitrites or of both, would still contain the material upon which disease germs thrive, and would therefore be dangerous to health.

All natural waters contain some chlorine, but when the amount in a potable water exceeds 50 parts per million, the suspicion is that this excess is due to the pollution of the water by sewage or animal excretions. An inspection of the analyses given in the tables above, will show that the waters from many of our deep wells, where there can be no question of contamination, contain much more than 50 parts per million of chlorine, so that in considering the amount of chlorine as an indication of contamination, the source of the water as well as the normal chlorine content of the waters of the particular district, must be taken into account. In itself, therefore, the amount of chlorine in a water is no evidence of contamination.

In similar manner the presence of albuminoid ammonia and of nitrites in excess of an accepted limit, while it may throw suspicion upon the water as to its sanitary character is by no means a certain evidence thereof. In fact it is doubtful if any purely chemical examination of a water can *always* be relied upon to establish its sanitary or unsanitary character. Of course, where these suspicious matters are present in large excess, or where even normally harmless constituents are present in quantities like 1,000 or more parts per million, the chemical analysis might be conclusive; as would be the case also if among the mineral constituents of the water there were found any actively poisonous compounds.

While there are many who are firm in the belief that the character of a water may be centainly determined by the "sanitary analysis" above referred to, some of the most experienced investigators of the subject have been forced to the opposite conclusion. In a paper on "The Futility of a Sanitary water analysis as a test of potability"* Mr. Marshall O. Leighton of the United States Geological Survey, contends, and we think proves by citation of many analyses, that "the sanitary analysis offers nothing by which one may positively distinguish between a dangerous and a wholesome water." Dr. William M. Drown one of the most eminent of the students of sanitary problems, in speaking of the sanitary analysis, is quoted as saying:† "My long experience in this line of work has impressed me with many doubts concerning its value."

Analysis of Mineral Waters—When we undertake by a chemical analysis to determine the mineral or medicinal character of a water we are confronted with difficulties that in some cases appear to be insuperable. When the analysis reveals the presence in the water of very notable amounts of Epsom or Glauber salts, of sulphuretted hydrogen, or iron, or of other active medicinal compounds, there is no difficulty in pronouncing upon its mineral character or in forming an opinion as to the constituents to which the medicinal virtue is due.

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*Reprint from Biological Studies by the Pupils of William Thompson Sedgwick, Boston 1906, page 36 and following.

†Reprint above quoted, page 48.

On the other hand there are many springs which have rightly acquired great reputation for the curative properties of their waters, which upon chemical analysis are found to be not so highly mineralized as the majority of potable waters, and to contain nothing by which their medicinal character can be accounted for. Judged by the chemical analysis many of these waters would be pronounced exceptionally pure waters of the alkaline bicarbonated or alkaline saline class, often with less than 100 parts per million of dissolved mineral matters.

Many analyses of mineral waters are thus a distinct disappointment to the proprietors of the springs and to the doctors, who naturally, in view of the well established curative character of the waters, expect the analysis to reveal the presence in large amount of some substance of unequivocal therapeutic value.

These analyses are also sometimes a source of embarrassment to the chemist, as may be inferred from the following extract from a letter just received at this office:

"——————, March 6, 1907.

Dear Sir:—I spent one day this week with ------------ at ------------. He has what he thinks is a very fine mineral spring there. He had the water analyzed once, by Mr. R. S. Hodges, I believe. He is not quite satisfied with the analysis, however, as the doctors say the water produces a greater effect than is indicated in the analysis."

The water in question contains less than 50 parts per million of mineral matters, consisting mainly of the carbonate, chloride and sulphate of sodium. The proportion of iron is relatively large but the calcium and magnesium are in smaller amounts. The inference would be that the curative effects of the water were due to the presence of the iron salts and the sulphate of sodium, but the small amount of mineral matters of any kind seems to be the stumbling block.

In this connection I cannot perhaps do better than quote some of the statements of a distinguished student of the Mineral Waters of the United States.* "A number of the waters included, and of importance commercially, would be consid-

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*A. C. Peale. Fourteenth Annual Report of the Director of the U. S. Geological Survey, page 57.

ered indifferent when viewed in the light of their chemical composition, but it must be remembered that some very pure waters have an undoubted therapeutical effect, and that chemical analysis, which is absolutely reliable only in its estimation of basic salts and acids, will not always explain the medicinal effect of a water, and that small quantities of some constituents are often more effective as remedial agents than others that are present in larger quantities." It might be well also to bear in mind that a given amount of a medicinal substance taken into the system along with a large amount of water, may be quite as effective as the same amount taken in more concentrated form; in other words, that the *actual amount* in parts per million of the ingredients of a mineral water (i. e. its concentration), is of less importance than the *relative proportions* of these ingredients.

In the light of recent discoveries, it seems highly probable that the curative effect of some mineral waters of this kind may be due to the presence of radium or of some radio-active substance, which the ordinary chemical analysis does not reveal.

While the ordinary limit of the amount of total solids in a potable water is put at 500 to 600 parts per million, it will be easily understod that if the sulphate of sodium, or magnesium, or other active medicinal salts, make any considerable proportion of these total solids, it would unfit the water for constant use. Conversely, some waters with a far greater amount of total solids than 600 parts per million, may be used for drinking purposes if certain substances, notably common salt and alkaline carbonates, constitute the major part of these solids.

Many mineral waters of repute are among the purest of potable waters, and some, even if they contain substances of active therapeutical value, may be tolerated by the human system and, if the dilution is sufficiently great, may serve as a potable waters.

Concerning, however, the use of such strong medicinal waters as those described under our sulphated saline class, some comment may not be amiss, and in this connection the words of Dr. E. W. Hilgard, in that too little known and appreciated, but best of all State Reports, the "Agriculture and Geology of Mississippi," (p. 286) are quoted: "It cannot be too strongly urged upon the inhabitants of these regions * * * * * * * that the *habitual* use of mineral water proper of *any* kind, is no more rational than would be the use of any other medicine, with persons in a normal state of health. It is often said that mineral waters are "Nature's own remedy," which may be true enough, provided there is something *to be remedied*. The Epsom salt, Glauber's salt, etc., contained in these waters, are no less purgative, debilitating, and therefore injurious to persons in good health, than the same articles are when derived from the druggist's vials.'

TABLES OF ANALYSES

OF

ALABAMA WATERS

TABLE I. CALCIC ALKALINE BI-CARBONATED WATERS.

Normal.

Constituent. / Locality.	University spring, Tuscaloosa county.	Scholes spring, No. 3, Healing Springs, Washington Co.	Creek Spring, No. 2, Healing Springs, Washington Co.	Lithia or magnesia spr., Cook spr., No. 2, St. Clair Co.	Crook spring No. 1, Monroe county.	Moody's spr., Bailey Spr's. Lauderdale county.	Crook spring No. 5, Monroe county.	Selma water works, Dallas county.	Towne's spr., near Oxmoor, Jefferson county.	C. C. Ferrill, deep well, Selma, Dallas county.	E. T. Cox's spring, Jefferson county.	Williford's landing, deep well, Tuscaloosa Co.	Elliott & Sons., deep well, Moundville, Hale county.	Glenwood spr., Blount Spr., Blount county.	DeSoto spr., near Oxmoor, Jefferson county.	Crook spring No. 4, Monroe county.	Borden-Wheeler spring, Cleburne county.	Y. T. Auxford, deep well, Hulls', Tuscaloosa, county.	Cahaba River, at DeShazo's Mill, Jefferson county.
Lithium (Li)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Potassium (K)	.9	1.9	1.5	1.5	1.9	1.4	.8	5.4	2.3	6.5	.8	11.6	3.3	1.0	.6	1.3	.9	2.4	3.6
Sodium (Na)	1.8	3.4	2.6	6.9	9.2	2.4	7.0	12.0	15.8	6.9	8.2	17.4	2.9	4.5	7.3	8.2	4.0	4.9	3.8
Magnesium (Mg)	1.6	1.9	2.0	1.3	1.2	2.6	4.3	2.3	3.9	1.8	5.6	5.3	5.5	2.1	3.2	3.2	6.7	8.4	8.0
Calcium (Ca)	4.9	8.1	9.2	10.0	13.7	16.0	17.2	19.3	21.0	21.3	22.8	23.4	23.8	28.1	34.1	36.0	36.3	36.3	40.7
Strontium (Sr)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Barium (Ba)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Iron (Fe)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	1.6	----	----
Alumina (Al_2O_3)	----	----	----	----	----	----	----	----	----		----	----	----	----	----	----	.3	----	----
Iron Oxide (Fe_2O_3) and alumina (Al_2O_3)	.7	5.5	4.9	4.0	2.8	1.6	4.8	1.0	3.6	1.8	3.2	2.5	2.0	1.1	5.1	3.0	----	2.5	3.2
Chlorine (Cl)	1.9	3.5	3.5	5.3	3.5	5.3	3.7	6.8	5.3	3.4	3.3	17.4	4.2	5.3	1.7	5.3	1.7	7.0	3.5
Sulphuric acid (SO_4)	5.3	9.8	8.9	7.9	10.2	3.8	7.5	9.6	.5	6.4	6.6	*	4.3	8.4	1.9	23.3	22.9	5.1	1.7
Bi-Carbonic acid (HCO_3)	20.2	29.3	31.7	38.3	55.7	57.0	77.7	86.5	118.4	88.2	106.6	130.0	100.0	91.8	129.4	114.1	131.6	148.9	162.2
Silica (SiO_2)	6.6	29.1	27.1	19.5	29.6	8.1	31.1	33.0	31.1	18.6	43.3	13.1	19.9	12.2	36.9	53.9	19.9	17.8	46.1
Sulphur (S)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Hydrogen sulphide (H_2S)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
	43.9	92.5	91.4	94.7	127.8	98.2	154.1	175.9	201.9	154.9	200.4	220.7	165.9	154.5	220.2	248.3	225.9	233.3	272.8

* Trace.

TABLE I. CALCIC ALKALINE BI-CARBONATED WATERS.—*Continued.*

Locality.	Normal—*Continued.*							Magnesic.						Chalybeate.				
Constituent.	Ingram Lithia water shallow well, Ohatchee, Calhoun Co.	City water works, deep well, Ozark, Dale county.	White sulphur spr., Shelby Springs, Shelby county.	Crock spring No. 3, Monroe county.	Cold spring, Blount Springs, Blount county.	Crook spring No. 2, Monroe county.	Freestone spr., Ala. White Sulphur Spr's., DeKalb Co.	Red sulphur spr. No. 5, St. Clair Springs, St. Clair Co.	White sulphur spr. No. 4, St. Clair Springs, St. Clair Co.	Lithia spring No. 6, St. Clair Springs, St. Clair Co.	Chandler's spring, Talladega county.	Chamber's spring, Talladega county.	Well No. 1, Brilliant Mine. deep well. Marion county.	Land Co.'s well No. 1, deep well, Akron, Hale county.	Land Co., well No. 2, deep well, Akron, Hale county.	Chalybeate spring, Cook spr. No. 3, St. Clair county.	Town well, deep well, Brantley, Crenshaw county.	W. F. Harrell, shallow well, Blount Springs, Blount Co.
Lithium (Li)	.1	----	----	----	----	----	----	*	*	----	----	----	----	----	----	----	----	----
Potassium (K)	1.6	2.9	1.2	1.2	1.3	1.1	----	1.8	1.2	.6	3.3	.3	----	4.3	3.0	3.7	1.3	1.0
Sodium (Na)	6.4	6.1	7.3	7.5	7.2	7.7	1.8	23.6	8.3	3.5	7.5	5.5	2.7	8.1	6.6	11.0	4.1	6.6
Magnesium (Mg)	----	7.7	7.9	3.9	4.4	4.1	5.3	14.8	16.4	17.3	10.3	19.2	17.0	.3	.3	2.6	5.6	7.4
Calcium (Ca)	44.2	47.7	47.8	54.1	58.7	59.6	74.6	31.8	36.9	37.5	37.7	39.0	52.1	7.0	8.2	11.7	45.6	53.9
Strontium (Sr)	----	----	----	----	----	----	----	*	*	----	----	----	----	----	----	----	----	----
Barium (Ba)	----	----	----	----	----	----	----	*	*	----	----	----	----	----	----	----	----	----
Iron (Fe)	.7	----	----	----	----	----	.6	----	----	----	4.3	----	----	13.6	10.0	----	----	----
Alumina (Al_2O_3)	.3	----	----	----	----	----	2.1	----	----	----	4.4	----	----	1.8	1.6	----	----	----
Iron Oxide (Fe_2O_3) and alumina (Al_2O_3)	----	1.4	1.3	1.9	1.7	7.3	----	2.2	2.2	1.3	----	3.3	2.6	----	----	10.8	9.9	12.4
Chlorine (Cl)	5.7	3.5	2.4	5.3	9.9	6.6	1.4	11.5	4.9	4.1	1.7	3.0	4.2	3.1	4.1	3.5	1.7	15.7
Sulphuric acid (SO_4)	17.1	8.8	9.6	38.2	8.9	52.1	10.5	----	----	4.8	9.5	5.4	14.0	5.2	5.8	2.1	10.1	19.3
Bi-Carbonic acid (HCO_3)	147.7	132.9	80.1	148.2	194.8	146.4	246.2	170.0	209.1	161.2	186.0	217.8	111.3	68.6	56.2	74.1	157.5	167.7
Silica (SiO_2)	39.7	45.3	36.4	43.8	14.8	49.5	11.0	16.9	13.3	18.4	55.1	56.7	14.0	17.7	19.6	44.8	35.5	14.7
Sulphur (S)	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----	----
Hydrogen sulphide (H_2S)	----	----	.8	----	----	----	----	8.2	.3	----	----	----	----	----	----	----	----	----
	263.5	256.3	194.8	304.1	301.7	334.4	353.5	280.8	292.6	248 7	319.8	350.2	217.9	129.7	115.1	164.3	271.3	298.2

* Trace.

TABLE II. SODIC ALKALINE BI-CARBONATED WATERS.

Constituent.	Normal.															Chalybeate.
Locality.	Academy well, Prattville, Autauga county.	"Lithia" spr. (No. 4), Cook Springs St. Clair county.	T. G. Moore's spring, Greensboro, Hale county.	G. A. Ivey's well, Flomaton, Escambia county.	W. J. McLendon, Oswichee, Russell county.	W. M. Wedgworth, Wedgworth, Hale county.	Sulphur spring, (No. 1), Cook Springs.	Madison Jones, Jr., Wedgworth, Hale county.	Water works, Union Springs, Bullock county.	So. Cot. Oil Company, Andalusia, Covington county.	Water works, Clayton, Barbour county.	Comer-Bishop Co., Harris, Barbour county.	Exchange Hotel, Montgomery, Montgomery county.	C. H. Bishop, Harris, Barbour county.	Moulthrop's, Eufaula, Barbour county.	City water works, Demopolis, Marengo county.	Cherokee mineral spring, Citronelle, Mobile county.
Potassium (K)	1.2	.9	.6	2.3	1.8	7.6	2.6	3.9	6.6	----	4.6	3.3	16.2	3.8	3.1	----	.9
Sodium (Na)	1.3	3.7	4.3	9.2	23.9	24.6	30.2	51.8	61.4	63.8	69.4	77.8	78.7	85.3	136.9	255.8	4.0
Magnesium (Mg)	.4	1.0	.6	3.7	.7	2.2	4.1	2.6	.2	1.0	2.9	4.3	.4	5.1	.8	1.1	1.1
Calcium (Ca)	.6	2.8	1.2	8.5	11.5	11.9	22.6	12.3	2.5	1.2	19.5	14.9	4.3	9.3	3.5	3.7	3.0
Iron (Fe)	.2	----	.3	3.8	----	----	----	----	----	.5	----	----	*	----	----	----	12.6
Alumina (Al_2O_3)	.3	----	2.3	2.3	----	----	----	----	----	----	----	----	----	----	----	----	.8
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	----	.8	----	----	2.0	2.6	2.8	2.5	.7	----	6.5	7.0	----	5.3	1.9	4.0	----
Chlorine (Cl)	1.7	3.5	2.9	2.8	1.7	10.5	5.3	38.4	9.4	12.0	21.2	17.5	7.7	17.5	13.7	40.6	3.5
Sulphuric acid (SO_4)	.5	2.1	.6	9.4	6.4	5.1	5.3	5.0	31.8	7.5	25.7	27.6	1.5	31.6	5.3	*	2.1
Bi-Carbonic acid (HCO_3)	5.6	14.9	13.8	64.1	93.5	88.4	157.1	121.2	124.8	72.7	195.5	212.7	144.1	211.6	172.8	624.0	45.6
Silica (SiO_2)	15.6	10.8	11.4	15.2	36.8	17.2	43.8	27.8	15.1	20.5	26.8	28.1	11.8	18.9	15.9	22.1	17.9
Hydrogen sulphide (H_2S)	----	----	----	----	----	----	.4	----	----	----	----	----	----	----	----	----	----
	27.4	40.5	38.0	121.3	178.3	170.1	274.2	265.5	252.5	179.2	372.1	393.2	264.7	388.4	353.9	951.3	9.15

* Trace; percentage not determined.

TABLE III. ALKALINE-SALINE WATERS.

a. muriated.

Constituent. / Locality.	F. W. Bromberg spr. No. 2., Bayou Labatre, Mobile Co.	Stuart's spring, Schuster, Wilcox county.	City water works, Greensboro, Hale county.	John W. Bright, Grand Bay, Mobile county.	Canning factory, Bayou Labatre, Mobile county.	Public well, Pittsboro, Russell county.	Alabama Port, Mobile county.	J. O. Banks, "Little Egypt" well, Eutaw, Greene Co.	J. O. Banks, "Crassdale" well, Eutaw, Hale county.	"White Sulphur" spr. No. 3, Blount Springs, Blount Co.	"Arsenic" spr. No. 2, Blount Springs, Blount county.	"Red Sulphur" spr. No. 1, Blount Springs, Blount Co.	City water works, Eutaw, Greene county.	Lock 4 (7), Hale county.	City well, Linden, Marengo county.	Lock 5 (8) well, Hale county.
Lithium (Li)	.1	----	----	----	----	----	----	----	----	*	*	1.2	----	----	----	----
Potassium (K)	.3	1.1	5.1	2.4	3.7	1.5	*	9.8	5.2	11.8	13.8	14.2	7.6	4.5	*	8.3
Sodium (Na)	5.1	8.1	24.9	26.5	54.5	59.1	120.2	193.0	221.8	217.0	230.0	234.3	430.0	444.8	550.0	1057.4
Magnesium (Mg)	1.2	.7	13.1	.2	1.1	.8	*	5.3	.5	23.1	24.9	24.3	3.0	2.7	1.6	15.2
Calcium (Ca)	1.1	.8	21.8	4.1	3.5	9.0	2.6	24.7	7.0	50.6	53.2	51.4	14.0	14.9	7.2	87.2
Strontium (Sr)	----	----	----	----	----	----	----	----	----	*	*	4.6	----	----	----	----
Barium (Ba)	----	----	----	----	----	----	----	----	----	*	*	2.4	----	----	----	----
Iron (Fe)	.9	----	----	----	----	----	----	----	----	.8	1.0	.8	----	----	----	2.8
Alumina (Al_2O_3)	----	----	----	----	----	----	----	----	----	1.3	1.5	1.5	----	----	----	----
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	----	1.3	5.3	24.4	1.8	.9	1.1	1.9	2.1	----	----	----	2.7	1.6	5.0	----
Chlorine (Cl)	9.3	3.5	60.4	28.3	42.5	61.3	113.7	220.7	232.7	297.3	320.1	325.1	515.0	481.9	445.1	1330.1
Bromine (Br)	----	----	----	----	----	----	----	----	----	*	*	1.9	----	----	----	----
Iodine (I)	----	----	----	----	----	----	----	----	----	*	*	*	----	----	----	----
Sulphuric acid (SO_4)	2.2	3.4	4.8	1.4	4.0	1.6	1.0	.9	.6	----	----	----	1.2	.4	*	*
Bi-Carbonic acid (HCO_3)	15.1	18.7	95.6	42.1	87.9	82.6	129.1	246.7	217.6	257.3	276.2	279.1	319.7	413.6	719.2	865.1
Silica (SiO_2)	6.1	11.4	4.6	35.0	48.7	41.0	33.5	7.2	11.2	16.6	19.7	26.5	8.6	13.2	17.8	15.8
Hydrogen sulphide (H_2S)	----	----	----	----	----	----	----	----	----	53.1	54.2	56.5	----	----	----	----
	41.4	49.0	235.6	164.4	247.7	257.8	401.2	710.2	698.7	928.9	996.6	1023.8	1301.8	1377.6	1745.9	3381.9

* Present, but percentage not determined.

TABLE III. ALKALINE--SALINE WATERS.—*Continued.*

b. sulphated.

Constituent. / Locality.	Ozment's spring, Tuscaloosa, Tuscaloosa county.	Dr. J. A. Beavers' well, Cuba, Sumter county.	"McCartney" spring No. 4, Healing Spr., Wash. Co.	Butler springs, Butler county.	Chalybeate spring, Mentone DeKalb county.	"Mound" spring, No. 1, Healing Springs, Washington Co.	Hawkins' well, Leeds, Jefferson county.	Town well, Enterprise, Coffee county.	White sulphur spr. No. 1, Ala. White Sul. spr's. DeKalb Co.	Evans' well, Evans' Station, Hale county.	Sulphur spring, Talladega Sps., Talladega county.
Lithium (Li)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Potassium (K)	-----	.6	1.9	1.8	1.3	1.6	6.7	-----	3.2	3.0	77.4
Sodium (Na)	*	4.7	2.3	9.3	2.6	2.2	20.5	17.2	15.7	106.3	127.7
Magnesium (Mg)	1.4	1.9	1.4	1.0	3.0	1.9	.9	.7	55.8	33.2	4.6
Calcium (Ca)	2.3	3.6	5.2	5.3	4.5	8.5	2.5	35.2	118.3	84.2	115.3
Iron (Fe)	-----	-----	-----	-----	6.6	-----	2.1	-----	.7	-----	*
Alumina (Al_2O_3)	-----	-----	-----	-----	2.3	-----	4.6	-----	1.3	-----	24.8
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	2.0	1.8	4.1	2.9	-----	4.9	-----	9.0	-----	1.9	-----
Chlorine (Cl)	*	6.6	3.5	7.0	.8	3.5	20.5	15.0	4.2	21.0	55.5
Sulphuric acid (SO_4)	5.4	8.4	9.6	13.1	15.4	11.5	35.2	40.2	304.2	274.0	131.7
Bi-Carbonic acid (HCO_3)	6.9	14.1	13.8	16.5	33.2	23.3	34.5	39.1	294.5	323.4	368.0
Silica (SiO_2)	17.9	9.5	26.6	19.6	10.8	28.8	19.9	19.5	25.8	44.6	42.5
Hydrogen sulphide (H_2S)	-----	-----	-----	-----	-----	-----	-----	-----	8.1	-----	539.2
	35.6	51.2	68.4	76.5	80.5	86.2	147.4	175.9	831.8	891.6	1486.7

* Present, but percentage not determined.

TABLE IV. SALINE WATERS.

a. muriated.

Constituent. / Locality.	F. W. Bromberg spr. No. 1. Bayou Labatre, Mobile Co.	Government well, Ft. Gaines, Mobile county.	Central C. & I. Co. well No. 1 Holt, Tuscaloosa county.	Central C. & I. Co. well No 2, Holt, Tuscaloosa county.	Thos. B. Allen, Moundville, Hale county.	Hosiery mill well, Tuscaloosa Tuscaloosa county.	Cotton Oil Co.'s well, near Mobile, Mobile county.	Sulphur well, Jackson, Clarke county.	Dump well, Eutaw, Greene county.	Livingston well, Livingston, Sumter county.	Allison Lumber Co., Bellamy, Sumter county.	Deep well, Cullom Springs, Choctaw county.	Old brine well, N. W. of Jackson, Clarke county.
Potassium (K)	1.7	4.1	8.2	12.7	11.8	5.9	15.7	8.2	23.4	------	13.2	21.0	144.0
Sodium (Na)	3.7	125.7	152.6	177.9	295.6	443.7	1135.5	960.3	1750.0	2999.7	1999.0	4043.0	11472.0
Magnesium (Mg)	.9	1.4	31.1	28.1	20.7	14.9	7.4	16.0	29.6	14.6	43.1	35.3	122.4
Calcium (Ca)	.6	6.1	84.0	81.0	109.8	70.0	15.1	54.0	175.6	48.6	139.6	74.9	246.8
Iron (Fe)	2.3	------	------	------	------	.5	------	------	------	2.2	------	------	------
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	------	1.6	13.7	13.0	1.7	------	------	2.6	5.7	------	5.2	3.8	5.2
Chlorine (Cl)	12.7	192.9	449.3	474.5	649.6	703.0	1440.5	1466.5	2986.1	3123.2	4538.0	6098.9	18520.0
Bromine (Br)	------	------	------	------	------	------	------	------	------	13.2	------	------	------
Sulphuric acid (SO_4)	1.4	2.0	5.4	5.6	.6	2.2	------	6.4	3.2	------	.3	*	*
Bi-Carbonic acid (HCO_3)	------	29.1	24.1	26.7	116.6	152.1	281.3	267.1	173.7	127.5	784.5	457.5	26.1
Silica (SiO_2)	6.4	53.9	75.5	86.8	15.9	17.3	19.2	17.8	8.7	19.5	50.8	9.9	8.2
Hydrogen sulphide (H_2S)	------	------	1.5	------	------	------	------	*	------	------	------	------	------
	29.7	416.8	844.4	906.3	1221.3	1369.6	2914.7	2978.9	5156.0	5365.5	8573.7	10744.3	30544.7

* Present, but percentage not determined.

TABLE IV. SALINE WATERS.—*Continued.*

b. sulphated.

Constituent. / Locality.	E. C. Perry well No. 1, near Glenville, Russell county.	S. Hardenbergh well, Newbern, Hale county.	A. M. Landers well, Jacksonville, Calhoun county.	John B. Smith well, Ball Flat Cherokee county.	Gary spring, Centerville, Bibb county.	J. C. Tidmore well, Hamburg Perry county.	W. H. McGraw, shallow well, Caledonia, Wilcox county.	Harden L. Jones spring, near Epes, Sumter county.	B. Hightower well, Curl Station, Sumter county.	C. P. Mills well, York, Sumter county.	W. A. Altman well, York, Sumter county.	Sanaqua mineral water well, Huntsville, Madison county.
Potassium (K)	8.6	24.8	------	5.9	2.7	11.3	14.6	14.6	22.5	61.9	37.3	22.5
Sodium (Na)	87.2	266.0	41.3	112.1	4.3	177.6	150.6	374.2	540.0	359.8	705.1	2634.7
Magnesium (Mg)	1.5	39.6	122.9	96.3	85.6	85.2	189.0	277.7	383.8	542.4	726.1	187.4
Calcium (Ca)	36.5	589.2	276.3	393.6	456.1	857.6	649.8	617.7	607.2	530.3	501.3	410.7
Iron (Fe)	------	------	------	------	------	------	------	------	------	------	------	8.4
Alumina (Al_2O_3)	------	------	------	------	------	------	------	------	------	------	------	10.8
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	1.8	12.2	3.4	3.5	8.9	16.8	2 6	*	18.2	17.0	16.9	------
Chlorine (Cl)	73.5	720.1	.7	127.6	3.3	661.8	310.8	665.5	761.1	460.8	461.2	1365.3
Bromine (Br)	------	------	------	------	------	------	------	------	------	------	------	------
Sulphuric acid (SO_4)	175.9	760.4	1017.5	1302.5	1337.4	1448.5	1712.0	2089.0	3085.0	3553.4	4636.2	5393.0
Bi-Carbonic acid (HCO_3)	12.8	528.6	206.6	120.3	126.8	546.5	686.5	453.8	14.0	80.3	404.5	*
Carbonic acid, free, (CO_2)	------	------	------	------	47.7	------	------	------	------	------	------	------
Silica (SiO_2)	19.4	43.4	35.4	20.0	18.3	54.4	45.2	14.5	42.9	55.0	75.8	16.3
Hydrogen sulphide (H_2S)	------	------	------	------	------	------	------	------	------	------	------	69.0
	417.2	2984.3	1758.1	2181.1	2091.1	3859.0	3761.1	4507.0	5474.9	5660.9	7564.4	10118.1

* Trace; percentage not determined.

TABLE V. ACID WATERS.

b. sulphated.

Constituent. / Locality.	W. E. Forman, Center Grove, Morgan county.	Spring No. 2, Tunnel Springs, Monroe county.	Spring No. 1, Tunnel Springs, Monroe county.	Dr. R. H. Hale, York, Sumter county.	Roper's well, Hodges, analyst, Greenville, Butler Co.	Roper's well, Smith & Little, analysts, G'nville, Butler Co.	Roper's well, Metz, analyst, Greenville, Butler county.
Potassium (K)	*	1.0	1.9	14.1	7.6	15.8	33.0
Sodium (Na)	*	4.8	6.9	379.1	57.6	51.9	76.9
Magnesium (Mg)	28.2	23.0	37.4	258.6	78.0	235.1	278.0
Calcium (Ca)	23.8	65.0	88.4	315.3	322.4	300.8	373.4
Manganese (Mn)	26.6	------	------	------	------	------	------
Iron (Fe-ferrous)	------	------	------	------	90.5	1085.0	1358.8
Iron (Fe-ferric)	7.1	------	44.6	86.6	204.1	1038.4	4013.7
Aluminum (Al)	7.9	------	32.2	------	132.8	33.2	69.8
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	------	42.6	------	------	------	------	------
Chlorine (Cl)	*	*	------	354.5	78.3	42.3	53.2
Sulphuric acid (SO_4)	276.0	336.0	618.0	2283.3	2493.3	6434.8	15130.3
Sulphuric acid-free (H_2SO_4)	------	------	------	------	19.9	30.7	------
Bi-Carbonic acid (HCO_3)	------	------	7.1	------	------	------	------
Silica (SiO_2)	50.0	35.4	34.5	92.4	131,2	86.4	103.7
	619.6	511.8	871.0	3783.9	3615.7	9354.4	21490.8

* Trace; percentage not determined.

TABLE VI. WATERS DERIVED TUSCALOOSA STRATA.

CLASS.	II	II	II	II	I	I	II	II	I	I	I	I	1 Va
Constituent. / Locality.	W. J. McLendon's well, Oswichee, Russell county.	City water works well, Union Springs, Bullock county.	Academy well, Prattville, Autauga county.	Exchange Hotel well, Montgomery, Montgomery Co.	C. C. Ferrill's well, Selma, Dallas county.	City water works wells, Selma, Dallas county.	City water works wells, Demopolis, Marengo county.	Waller Land Co. well No. 1, Akron, Hale county.	Waller Land Co., well No. 2, Akron, Hale Co.	Williford s Landing well, Tuscaloosa county.	J. A. Elliott's well, Moundville, Hale county.	Y. T. Auxford's well, Hulls, Tuscaloosa county.	T. B. Allen's well, near Moundville, Hale Co.
Potassium (K)	1.8	6.6	1.2	16.2	6.5	5.4	------	4.3	3.0	11.6	3.3	2.4	11.8
Sodium (Na)	23.9	61.4	1.3	78.7	6.9	12.0	255.8	8.1	6.6	17.4	2.9	4.9	295.6
Magnesium (Mg)	.7	.2	.4	.4	1.8	2.3	1.1	.3	.3	5.3	5.5	8.4	20.7
Calcium (Ca)	11.5	2.5	.6	4.3	21.3	19.3	3.7	7.0	8.2	23.4	23.8	36.3	109.8
Iron (Fe)	------	------	.2	*	------	------	------	13.6	10.0	------	------	------	------
Alumina (Al_2O_3)	------	------	.3	------	------	------	------	1.8	1.6	------	------	------	------
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	2.0	.7	------	------	1.8	1.0	4.0	------	------	2.5	2.0	2.5	1.7
Chlorine (Cl)	1.7	9.4	1.7	7.7	3.4	6.8	40.6	3.1	4.1	17.4	4.2	7.0	649.6
Sulphuric acid (SO_4)	6.4	31.8	.5	1.5	6.4	9.6	*	5.2	5.8	*	4.3	5.1	.6
Carbonic acid (HCO_3)	93.5	124.8	5.6	144.1	88.2	86.5	624.0	68.6	56.2	130.0	100.0	148.9	115.6
Silica (SiO_2)	36.8	15.1	15.6	11.8	18.6	33.0	22.1	17.7	19.6	13.1	19.9	17.8	15.9
	178.3	252.5	27.4	264.7	154.9	175.9	951.3	129 7	115.1	220.7	165.9	233.3	1221.3
Depth of well (feet)	465	848	100	650	487	500	900	146	200	400	600	234	275

* Trace; percentage not determined.

TABLE VII. WATERS DERIVED FROM EUTAW SANDS.

CLASS.	IIIa	IVb	IIIa	IIIb	II	II	IIIa	IIIa	IIIa	IVa	IIIa	IIIa	IVb	IVa	IVa	IIIa
Constituent. / Locality.	Public well, Pittsboro, Russell county.	E. C. Perry's well, No. 1, near Glenville, Russell Co.	Government well, Lock 8, Hale county.	Evans well Evans Station, Hale county.	W. M. Wedgworth's well, Wedgworth, Hale county.	Madison Jones Jr., well, Wedgworth, Hale county.	Little Egypt well, J. O. Banks, Eutaw, Greene Co.	Crassdale well, J. O. Banks, Eutaw, Greene county.	City water works well, Eutaw, Greene county.	Dump well, Eutaw, Greene county.	City water works well, Greensboro, Hale county.	Government well, Lock 7, near Erie, Hale county.	S. Hardenbergh's well, Newbern, Hale county.	Public well, Livingston, Sumter county.	Allison Lumber Co.'s well, Bellamy, Sumter county.	Public well, Linden, Marengo county.
Potassium (K)	1.5	8.6	8.3	3.0	7.6	3.9	9.8	5.2	7.6	23.4	5.1	4.5	24.8	-----	13.2	*
Sodium (Na)	59.1	87.2	1057.4	106.3	24.6	51.8	193.0	221.8	430.0	1750.0	24.9	444.8	266.0	1996.7	2999.0	550.0
Magnesium (Mg)	.8	1.5	15.2	33.2	2.2	2.6	5.3	.5	3.0	29.6	13.1	2.7	39.6	14.6	43.1	1.6
Calcium (Ca)	9.0	36.8	87.2	84.2	11.9	12.3	24.7	7.0	14.0	175.6	21.8	14.9	589.2	48.6	139.6	7.2
Iron (Fe)	-----	-----	2.8	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	2.2	-----	-----
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	.9	1.8	-----	1.9	2.6	2.5	1.9	2.1	2.7	5.7	5.3	1.6	12.2	-----	5.2	5.0
Chlorine (Cl)	61.3	73.5	1330.1	21.0	10.5	38.4	220.7	232.7	515.0	2986.1	60.4	481.9	720.1	3123.2	4538.0	445.1
Bromine (Br)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	13.2	-----	-----
Sulphuric acid (SO_4)	1.6	175.9	*	274.0	5.1	5.0	.9	.6	1.2	3.2	4.8	.4	760.4	-----	.3	*
Carbonic acid (HCO_3)	82.6	12.8	865.1	323.4	88.4	121.2	246.7	217.6	319.7	173.7	95.6	413.6	528.6	127.5	784.5	719.2
Silica (SiO_2)	41.0	19.4	15.8	44.6	17.2	27.8	7.2	11.2	8.6	8.7	4.6	13.2	43.4	19.5	50.8	17.8
	257.8	417.2	3381.9	891.6	170.1	265.5	710.2	698.7	1301.8	5156.0	235.6	1377.6	2984.3	5345.5	8573.7	1745.9
Depth of well (feet)	220	164	166	200	200	216	-----	---	500	-----	432	280	300	1005	1000	1040

* Trace; percentage not determined.

TABLE VIII. WATERS FROM UPPER CRETACEOUS (BLUE MARL), AND TERTIARY STRATA.

	Cretaceous. Blue Marl.					Tertiary. Miocene or pliocene.					Hatchetigbee.		Nanafalia.			Clayton.
CLASS.	II	II	II	II	II	IIIa	IIIa	IVa	IVa	II	IVa	IVa	IVa	I	IIIb	II
Constituent. / Locality.	Cotton Oil Co.'s well, Andalusia, Covington county.	City water works well, Clayton, Barbour county.	Comer-Bishop Co.'s well, near Clayton, Barbour Co.	C. H. Bishop's well, Harris, Barbour county.	Moulthrop's well, Eufaula, Barbour county.	Canning factory well, Bayou Labatre, Mobile county.	Alabama Port well, Mobile county.	Government well, Ft. Gaines, Mobile county.	Cotton Oil Co.'s well, near Mobile, Mobile county.	G. A. Ivey's well, Flomaton, Escambia county.	Old salt well, Clarke Co.	Sulphur well, Jackson, Clarke county.	Deep well, Cullom Springs, Choctaw county.	Town well, Brantley, Crenshaw county.	Town well, Enterprise, Coffee county.	City water works, Ozark, Dale county.
Potassium (K)	----	4.6	3.3	3.8	3.1	3.7	*	4.1	15.7	2.3	144.0	8.2	21.0	1.3	------	2.9
Sodium (Na)	63.8	69.4	77.8	85.3	136.9	54.5	120.2	125.7	1135.5	9.2	11472.0	960.3	4043.0	4.1	17.2	6.1
Magnesium (Mg)	1.0	2.9	4.3	5.1	.8	1.1	*	1.4	7.4	3.7	122.4	16.0	35.3	5.6	.7	7.7
Calcium (Ca)	1.2	19.5	14.9	9.3	3.5	3.5	2.6	6.1	15.1	8.5	246.8	54.0	74.9	45.6	35.2	47.7
Iron (Fe)	.5	-----	-----	-----	-----	-----	-----	----	----	3.8	------	------	------	------	------	------
Alumina (Al_2O_3)	----	-----	-----	-----	-----	-----	-----	----	----	2.3	------	------	------	------	------	------
Iron oxide (Fe_2O_3) and alumina (Al_2O_3)	----	6.5	7.0	5.3	1.9	1.8	1.1	1.6	-----	----	5.2	2.6	3.8	9.9	9.0	1.4
Chlorine (Cl)	12.0	21.2	17.5	17.5	13.7	42.5	113.7	192.9	1440.5	2.8	18520.0	1466.5	6098.9	1.7	15.0	3.5
Sulphuric acid (SO_4)	7.5	25.7	27.6	31.6	5.3	4.0	1.0	2.0	-----	9.4	*	6.4	*	10.1	40.2	8.8
Carbonic acid (HCO_3)	72.7	195.5	212.7	211.6	172.8	87.9	129.1	29.1	281.3	64.1	26.1	267.1	457.5	157.5	39.1	132.9
Silica (SiO_2)	20.5	26.8	28.1	18.9	15.9	48.7	33.5	53.9	19.2	15.2	8.2	17.8	9.9	35.5	19.5	45.3
Hydrogen sulphide (H_2S)	----	-----	-----	-----	-----	-----	-----	-----	-----	------	------	*	------	------	------	------
	179.2	372.1	393.2	388.4	353.9	247.7	401.2	416.8	2914.7	121.3	30544.7	2798.9	10744.3	271.3	175.9	256.3
Depth of well (feet)	1130	560	277	183	350	580	900	919	800	377	------	110	800	366	398	710

* Present, but percentage not determined.

INDEX.

a—analysis given. r—record given.

a—analysis given. r—record given.

a—analysis given. r—record given.

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