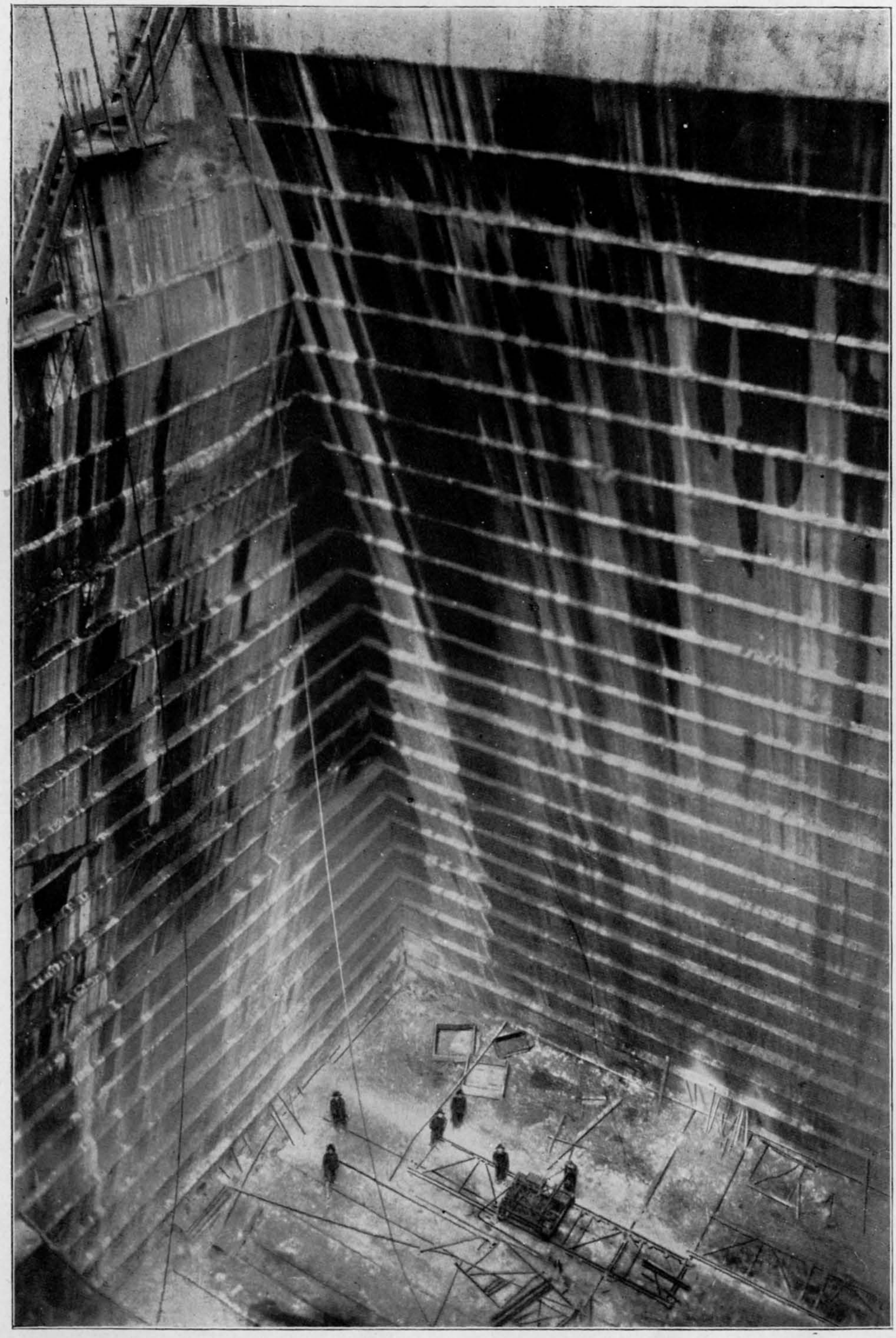

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GEOLOGICAL SURVEY OF GEORGIA

S. W. McCALLIE, State Geologist

BULLETIN No. 23

A PRELIMINARY REPORT

ON THE

MINERAL RESOURCES

OF

GEORGIA

BY

S. W. McCALLIE

State Geologist

ATLANTA, GA.

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Geological Survey of Georgia

in the Year 1910

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LETTER OF TRANSMITTAL

GEOLOGICAL SURVEY OF GEORGIA,

ATLANTA, April 15, 1910.

To His Excellency, JOSEPH M. BROWN, *Governor, and President of the Advisory Board of the Geological Survey of Georgia.*

SIR: I have the honor to submit herewith my preliminary report on the Mineral Resources of Georgia, to be published as Bulletin No. 23, of this Survey.

Very respectfully yours,

S. W. MCCALLIE,

State Geologist.

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PREFATORY NOTE

For some years there has been an ever increasing demand on the State Geological Survey for general information on the State's mineral resources not heretofore supplied in any one of the various publications of the department. To meet this demand this volume has been issued with the hope that it will not only meet the object for which it was published, but also, at the same time, stimulate activity in the development of our mineral resources. It must be borne in mind that this report is by no means intended to be a comprehensive report on the mineral resources of the State, but only a *preliminary report* covering, in a general way, only the principal economic minerals. To those who wish to pursue the different subjects further than here discussed they will find a number of references after each subject, which will be of especial value.

The principal sources of the information found in this report are the various publications of this Survey. These publications, including the reports of Dr. Thos. L. Watson and others, have been made use of freely without any marginal reference to the part abstracted; however, the name of the reports from which the information was largely taken will be found in italics at the close of each subject. In addition, there has been a few articles contributed by Mr. Otto Veatch and Dr. T. Poole Maynard, assistant State Geologists, due credit for which is indicated by marginal references.

The statistical data, as will be seen, are accredited to the U. S. Geological Survey. It should here be added that the statistical information for the year 1908 was the result of the co-operative work of this Survey with the U. S. Geological Survey.

Atlanta, Ga., April 15, 1910.

Mineral Resources of Georgia

PHYSIOGRAPHIC FEATURES OF GEORGIA

Physiographically considered, the State of Georgia is divided into five well marked sub-divisions namely, the Coastal Plain, the Piedmont Plateau, the Appalachian Mountains, the Appalachian Valley and the Cumberland Plateau. Each of these sub-divisions is comparatively well defined: nevertheless, in some instances, the line of separation can not always be sharply drawn. Often, in places, one sub-division blends with another, so that it is frequently impossible to give any definite boundaries. In such cases, the boundaries of the sub-divisions can only be spoken of as occurring within certain limits.

The physiographic sub-divisions of the State, above enumerated, are not peculiar to Georgia alone. They form a part of the main topographic provinces of the Eastern division of the United States, which have been described under the names here given, by Hayes[1] and others. As a whole, these subdivisions may be spoken of as certain well marked land forms, composing belts or zones of variable width extending from New York to Alabama. Each sub-division has its own topographic peculiarities and constitutes a distinct physiographic type. They all have a southwesterly trend, and traverse the various States between the limits just given. The surface configuration of Georgia, as represented by the physiographic sub-divisions above enumerated, are here described in detail.

The Coastal Plain.—The Coastal Plain comprises all that part of Georgia lying south of an irregular line, known as the Fall Line, connecting the cities of Augusta, Milledgeville, Macon and Columbus. The area here included embraces more

1. U. S. Geol. Survey, Nineteenth Ann. Rept., 1897-'98, pp. 9-58.

than half of the entire State. Generally speaking, this subdivision of the State may be spoken of as a nearly level plain, having a gentle slope to the southward. The maximum elevation of the plain occurs along the Fall Line, where, in places, it reaches a height of more than 600 feet above sea-level.

The surface configurations of this area are those common to lands which have recently emerged from the sea. To the northward, there are slight elevations and depressions, conforming in direction to the course of the rivers. As the Fall Line is approached, these surface irregularities become more pronounced; while, to the southward, they gradually decrease in prominence, until they are finally lost in an almost featureless, sandy, pine-clad plain.

Besides the general surface irregularities, here referred to, there are also minor irregularities, which have resulted from local erosion. These surface irregularities, which are most frequently met with in the vicinity of the larger streams, give to the Coastal Plain, in certain sections, an appearance not unlike the more hilly portions of the northern part of the State. Topography of this kind may be seen in Decatur, Thomas and other counties in the western part of the Coastal Plain, as well as in some of the counties lying along the Fall Line.

The streams of the Coastal Plain are numerous, and are usually sluggish. Those rising north of the Fall Line are navigable the greater part of the year for steamboats of considerable size. The larger streams occasionally have, on either side, high bluffs; but, oftener, they traverse low palmetto swamps, or lands having the appearance of a partially filled river-valley, cut by the stream, when the land stood at a higher level. The rivers which flow into the Atlantic enter it by bays or sounds, protected seaward by a chain of low wave-built islands. The land near the coast is low, flat and poorly drained, presenting quite a contrast with parts of the Coastal Plain, at places near the Fall Line.

The Piedmont Plateau.—The Piedmont Plateau is a wide belt, or zone, of elevated land, stretching from the foot of the Appalachian Mountains to the Coastal Plain. Its northern limit is an ill-defined line, extending from the extreme northeastern corner of the State to the Georgia-Alabama line, a few miles southwest of Cedartown. It traverses the State from the northeast to the southwest, with an average width of more than 100 miles, and comprises an area of something like one-third of the total area of the State. This physiographic subdivision consists of an old land form, which has been reduced by erosion to a pene-plain. Along its northern boundary, it has an average elevation of about 1,200 feet above sea-level; while, at its junction with the Coastal Plain, it is reduced to a little less than half of this elevation. It has, therefore, a slope to the southward of about 5 feet per mile, or about twice the slope of the Coastal Plain.

The Piedmont Plateau, when viewed from an elevated point, has the appearance of a level plain, dotted here and there with isolated mountains and hills, such as Stone Mountain, Kennesaw Mountain and Pine Mountain, which rise from 500 to 800 feet above the general level of the Plateau, and which appear to be remnants of an older and somewhat different topography.

The minor inequalities of the surface of the Piedmont Plateau are entirely overlooked, or minimized, by a view from an elevated point. The region, instead of being a level plain, has a broken surface, made up of low, well-rounded hills and ridges, separated by narrow fertile valleys. These minor hills or ridges, which usually have a southwesterly trend, have an elevation varying from 200 to 300 feet above the stream-level.

The streams of the Piedmont Plateau are usually rapid, and are frequently marked by cataracts and water falls. This feature of the streams is especially accentuated along the margin of the Coastal Plain. The river valleys, which are being continually increased in depth by the erosive action of the streams, rarely ever exceed a width of more than a half mile.

The Appalachian Mountains.—This physiographic sub-division is located in the northern part of the State, along the Georgia-North Carolina-Tennessee lines, and extends as far south as Cartersville, the county seat of Bartow county. It has a somewhat triangular form, being limited on the south by the Piedmont Plateau, and on the west by the Appalachian Valley. The western boundary may be said to correspond with what is known as the Cartersville Fault, a great displacement of the strata marking the boundary between the metamorphic and the sedimentary rocks in the northwestern part of the State. This division embraces all, or a part of the following counties:—Rabun, Towns, Lumpkin, Union, Fannin, Murray, Gilmer, Pickens and Bartow. It is one of the smallest of the five topographic sub-divisions of the State; nevertheless, it comprises an area of more than 2,000 square miles.

This sub-division forms the southern terminus of the Appalachian Mountains. It is pre-eminently a mountain region, noted for its picturesque scenery and lofty mountains. The average elevation of the region is less than 2,000 feet; yet, there are numerous mountains within the area, attaining an altitude of more than twice this height. The larger mountains occur in groups or masses without definite arrangement. The higher peaks of these groups usually have precipitous slopes, which, in places, become almost inaccessible. The lesser mountains, and the ridges of the region generally, have a southwesterly trend, corresponding to the general course of the streams. The valleys are narrow, and are traversed by rapid streams, which, in places, form falls many feet in height. Between the main mountains and the ridges, there is a large area of broken country, with hills rising 400 or 500 feet above the general stream level. This portion of the sub-division resembles very closely the more hilly parts of the Piedmont Plateau.

THE APPALACHIAN VALLEY.—The Appalachian Valley may be defined as a low land, lying between the Appalachian Mountains and the Cumberland Plateau. This physiographic subdivision, which traverses the northeastern corner of the State in a southwesterly direction, is about 35 miles wide; and it has an average elevation of about 850 feet above sea-level. Its western boundary is an irregular line, following the eastern escarpments of Pigeon and Lookout mountains.

The region is made up of a number of minor valleys, separated from each other by sharp or well-rounded ridges. The former ridges, as in the case of Taylor's Ridge and Chattoogata Mountain, often attain an altitude of 1,500 feet; while the latter rarely reaches a height of more than 1,200 feet. These ridges all have a northeast-southwest trend, and give to the region a corrugated appearance. The minor valleys are usually narrow, and are traversed by rather sluggish streams which in the northwestern part of the area flow north into the Tennessee River; while those in the other parts of the area flow southward more direct to the Gulf of Mexico.

THE CUMBERLAND PLATEAU.—The Cumberland Plateau occupies the extreme northwestern corner of Georgia, and embraces Pigeon Mountain and portions of Lookout and Sand mountains. This sub-division of the State constitutes the extreme eastern margin of the Cumberland Highlands, traversing Alabama and Tennessee further to the westward. Broadly speaking, the area is an elevated tableland, bisected longitudinally by a deep, narrow valley. That part of the area lying east of the valley constitutes Lookout and Pigeon mountains, and that, to the west, Sand Mountain. These mountains have broad, flat tops, with an average elevation of about 1,800 feet above sea-level. The slopes of the mountains are always precipitous, and are often marked by bold sandstone cliffs, which, in some places, attain a height of 200 feet.

Lookout Mountain, as it enters Georgia from Alabama, forms a broad, flat-top mountain, about 10 miles in width. Some six or eight miles north of the State line, the mountain sends off to the northward a spur, known as Pigeon Mountain. From this point to its northern terminus in the vicinity of Chattanooga, it varies in width from two to four miles. Some of the small streams, which take their rise on Lookout, in their descent to the valley below have cut deep and precipitious chasms in the sandstone bluffs which form the brow of the mountain. Sand Mountain, as represented in Georgia, differs from Lookout Mountain, mainly, in being broader, and in having a more even surface. The valley, above referred to as bisecting the Cumberland Plateau region of Georgia, is the only valley occurring in the physiographic sub-division. It has an average width of about three miles, and is traversed by Lookout Creek, a sluggish stream of considerable size, flowing north into the Tennessee River. The surface of the valley is rolling, but, at the same time, it has a general slope to the northward.

GEOLOGY

Each of the great time divisions of geological history has representatives in the rocks of Georgia. The southern portion of the State, described under Physiographic Features of the State, as the Coastal Plain, is made up of rocks ranging in age from the Cretaceous to the most recent. To the north of this area, comprising both the Piedmont Plateau and the Appalachian Mountain regions, occur the metamorphic, or the crystalline rocks. Still further to the north and west, forming the Appalachian Valley and the Cumberland Plateau, are the unaltered Paleozoics. The line of demarkation, between these three major geologic divisions of the State, is not always sharply drawn. This is especially true of the second and third divisions, where the Crystalline and the unaltered Paleozoic rocks grade into each other, without any sudden or abrupt change. The line, separating the first division, or the recent clastics, from the Crystalline, on the other hand, is more distinct, being marked not only by a very striking unconformity, but also by great change in the lithological character of the rocks.

The sub-divisions of the rocks of the Coastal Plain, in descending order, are given in the following table:

1 Pleistocene
  Columbia Sands
2 Pliocene
  Lafayette
3 Miocene
  Altamaha Grit[1]
  Chattahoochee[2]

1. Recent study of the Altamaha grit seems to indicate that it is probably a phase of the Lafayette and is therefore Pliocene.

2. A classification recently adopted by the U. S. Geological Survey makes the Chattahoochee and the Vicksburg, Oligocene; the Jackson, the Claiborne and the Midway-Sabine, Eocene.

4 Eocene
  Vicksburg-Jackson
  Claiborne
  Midway-Sabine
5 Cretaceous
  Ripley
  Eutaw
  Tuscaloosa or Potomac

PLEISTOCENE

COLUMBIA.—The Pleistocene rocks in Georgia are mainly represented by the Columbia sands, a superficial deposit covering the greater part of the Coastal Plain. The formation consists chiefly of white and yellow sands, rarely showing any distinct lines of stratification. In places it contains water-worn pebbles, a quarter of an inch or more in diameter; but generally it consists of fine-grained sand or loam, which, in the vicinity of the rivers or the coast, may pass into silts.

The Columbia sands sometimes form hills rising 30 feet or more above the general level of the surrounding country. These hills, which are often spoken of as the "Sand Hills," are irregularly distributed throughout the Coastal Plain, from the Fall Line to within a few miles of the Atlantic coast. In certain limited areas, known as the "Red Hills," the Columbia sands are entirely absent, a condition due either to the sands not having been originally deposited, or to their subsequent removal by erosion. The thickness of the formation in Georgia may be said to vary from a maximum of 40 feet to a few inches. Throughout the piney-woods region, where the surface is practically level, the average thickness probably does not exceed two feet.

PLIOCENE

LAFAYETTE.—The Lafayette, whose exact position in the geological time scale is still debated, like the Columbia formation, is a superficial deposit, covering most of the Coastal Plain. The formation consists of orange and vari-colored clays and sands, with local beds of gravel. The basal member of the formation along the Fall Line frequently becomes distinctly pebbly. These water-worn pebbles, which consist largely of quartz derived from the crystalline rocks to the north, occur irregularly distributed throughout the vari-colored sandy clays, but more often they are found in layers or pockets. They also occur in the basal member, at places, with fragments of white clay forming more or less continuous layers. These phases of the lower division of the formation become less pronounced in the southern part of the State, where sandy loam and vari-colored stratified clays predominate.

The upper member of the formation differs from the lower, in being more uniform, both in physical structure and lithological character. Along the Fall Line, at some points, it becomes quite pebbly; however, as a general rule, it is made up almost entirely of massive reddish or motley sandy clays. Frequently, the massive clays of the upper division are hardened into a compact mass, having almost the consistency of sandstone. This indurated layer resists the erosive action of surface waters; and, by being undermined by the washing away of the layers below, it often stands out in high, perpendicular walls. Excellent illustrations of this mode of erosion are frequently met with in the vicinity of streams, which have lowered their channels into the underlying formations.

The thickness of the Lafayette formation is quite variable. At some places, near the northern margin, where it has been protected by the Columbia sands, it attains a maximum thickness of more than 80 feet; at other points, it has been entirely removed by erosion. These eroded areas are quite irregular in outline, and may occur at any point throughout the Coastal Plain. They are more frequently met with, however, in the vicinity of the larger streams; yet, they are not entirely absent from the level piney-woods.

The marine Pliocene, according to Loughridge,[1] occupies a narrow strip of the coast extending from Savannah to St. Mary's. The western boundary of the formation appears never to have been accurately traced. However, it is supposed to be an irregular line corresponding with what Loughridge calls the second terrace, 20 miles or more inland. Deposits, assigned to this formation, have been found as far inland as the western part of Chatham county; near Jesup in Wayne county; and at Burnt Fort in Camden county. The formation is also supposed to underlie Okefenokee Swamp, and to extend as far west along the Georgia-Florida line as the Suwanee River.[2] The lithological character of the formation is varied. It consists mainly of unconsolidated sands, clays and marls. No data are at hand, by which to estimate the thickness of the formation. All of the deep wells along the coast, south of the Savannah River, penetrate the Pliocene beds; but, in only a few cases, have complete samples of the borings been preserved. These samples usually contain but few organic remains, so that it is often practically impossible to determine from them anything definite as to the exact depth to which the beds extend.

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1. U. S. Geol. Surv., Bull. No. 84, p. 84.

2. Recent study seems to indicate that the marine Pliocene is confined to a narrow strip along the Atlantic Coast and does not include or extend as far west as the Okefenokee Swamp.

MIOCENE

The miocene Rocks of Georgia include several sub-divisions, the most important of which are the *Altamaha grit* and the *Chattahoochee formation.*

THE ALTAMAHA GRIT, which was formally supposed by Dr. Eugene A. Smith to be the eastern extension of the Grand Gulf of Mississippi and Alabama, covers a large area. Its northwestern limit coincides with the eastern boundary of the Vicksburg-Jackson, except in Washington and Jefferson counties, where it comes in contact with the Claiborne. It forms a belt, with a maximum width of more than 75 miles, and appears to reach its greatest development along the Oconee River in Laurens and Montgomery counties, where it attains a thickness of something like 200 feet.

The Altamaha grit, as the name suggests, is made up largely of heavy-bedded, indurated sands, with a clay and silica matrix. The particles of sand forming the grit are usually sharp; but, in the same beds, the sharp sand has intermingled with it water-worn pebbles, some of which attain an inch or more in diameter. The lower beds of the formation consist chiefly of clay, which, near the contact of the underlying limestones often become calcareous. Owing to the absence of fossils in the Altamaha grit, its exact position in the geologic time-scale has never been definitely determined. It has been placed by Dall as early Miocene; while Dr. Eugene A. Smith, State Geologist of Alabama, who thinks it is the eastern extension of the Grand Gulf of Mississippi and Alabama, is of the opinion that it is much more recent, probably Pliocene, or even as late as the early Pleistocene.

THE CHATTAHOOCHEE FORMATION, whose limits, so far, have not been defined, seems to be best developed along the Georgia-Florida line in Decatur, Grady and Thomas counties, where it has been examined by Langdon, Vaughan and others. The rocks of this formation, at the railroad bridge over the Chattahoochee River at the New Chattahoochee landing, the type locality, consist of argillaceous and sandy limestone alternating with beds of purer character. In addition to the sub-division of the Miocene, above given, there is still another, known as the Jacksonboro limestone.[1] This sub-division, which has been studied by Lyell, Clarke and Vaughan, appears to be well developed in Screven county, near the confluence of Brier and Beaver Dam creeks. The extent of the formation is unknown; but it is probably confined chiefly to Screven and the adjacent counties.

EOCENE

The Eocene rocks of Georgia may be divided into three sub-divisions; viz., the *Vicksburg-Jackson limestone, the Claiborne* and the *Midway-Sabine.*

THE VICKSBURG-JACKSON LIMESTONE.—This sub-division of the Eocene rocks is well developed in Georgia. With the exception of a small break, of only a few miles, in Washington and Jefferson counties, this limestone forms a continuous belt from the Chattahoochee River, south of Fort Gaines, to the Savannah River, 30 miles south of Augusta. This belt is quite variable in width, due chiefly to the overlapping of the Altamaha grit, which forms its southern boundary. In Dougherty, Terrell and Randolph counties, it attains a width of more than 60 miles. It also reaches a like width along the Ocmulgee River, where the overlying Altamaha grit has been removed by erosion. Besides the main body or belt, of the Vicksburg-Jackson limestone, here noted, there are also iso-

1. The recent studies of Dr. T. Wayland Vaughan show this to be approximately the Tampa horizon.

lated exposures along the streams in Thomas and Brooks counties, near the Georgia-Florida line, and in Crawford county, near the contact of the Crystalline and Cretaceous rocks. The last exposure is interesting, as it shows that the Eocene sea, in which the Vicksburg-Jackson limestone was laid down, extended as far north as the Crystalline rocks. This northern extension of the formation also explains the absence of surface-exposures of the Claiborne, west of the Ocmulgee River.

The Vicksburg-Jackson limestone, as the name suggests, consists chiefly of limestone. It has a maximum thickness of more than 400 feet. The upper member of the formation is made up of hard and soft limestone, with more or less silica, in the form of cherty concretions, which are usually highly fossiliferous. The lower member contains more clay and sand, often in the form of comminuted shells, fragments of corals, and bryozoans, and the disk-like tests of foraminifera. The whole formation, throughout, is highly fossiliferous; and it is noted for its numerous lime-sinks and underground streams.

THE CLAIBORNE.—The second sub-division of the Eocene rocks, which includes the Buhrstone series, occurs along the Chattahoochee River south of Fort Gaines, and also, according to Spencer,[1] along the Flint River south of Montezuma; but it reaches its greatest development between the Ocmulgee and Savannah rivers, where it forms a belt, from 10 to 30 miles in width. This part of the formation, which consists of clays, sands and marls, often indurated and occasionally highly fossiliferous, overlaps, in places, the Cretaceous beds, and comes in immediate contact with the Crystalline rocks. One of these overlaps occurs at Robert's station, a few miles

1. Geol. Surv. of Georgia, First Repot of Progress, 1890-'91, p. 51.

east of Macon, and another, in the vicinity of Grovetown, 17 miles west of Augusta.

The most marked lithological characteristics of the Claiborne, east of the Ocmulgee River, are the heavy beds of sands. These sands, which are usually stained with iron oxide, are frequently indurated, and form, in places, beds of ferruginous sandstone several feet in thickness. An excellent exposure of these sandstones, containing a large number of silicified shells, is to be seen along the Central of Georgia Railroad, near Hollywood station, about ten miles south of Augusta, and at Wren's mill in the northern part of Jefferson county. Other Claiborne rocks, of special interest on account of their containing beautifully preserved fossils, are the heavy-bedded silicified limestone and chert capping Brown's Mountain in Twiggs county, ten miles southeast of Macon. These rocks are also well exposed in a deep ravine two miles south of Griswoldville. Further to the south and west they appear to pass into marls or impure limestones.

The Claiborne clays are usually laminated and porous, partaking of the nature of fuller's earth. Some of the beds are quite fossiliferous, the most abundant fossils being impressions of leaves. Occasionally, beds of these clays are highly lignitic; but such clays are mostly locally developed, and rarely form beds of more than a few feet in thickness. The Claiborne, along the Chattahoochee River, is placed by Langdon at 232 feet, which is probably much less than the maximum thickness attained at points east of the Ocmulgee River.

Midway-Sabine.—This formation, which includes all of the rocks between the Claiborne and the Cretaceous, corresponds to what is often designated as the lower member of the Eocene. It is confined to a narrow belt extending from a point in Macon county east of the Flint River, near Montezuma, to the Chattahoochee River in the vicinity of Fort Gaines. This belt has an average width of about seven miles, but, along the Chattahoochee River, it attains a width of more than twice this distance. Its northern and southern boundaries are usually quite sinuous, owing to the irregular surface erosion and to the overlapping of the Vicksburg-Jackson limestone. The Midway-Sabine rocks consist of impure limestone, clays and sands. These sands are often glauconitic; and, in places, they become cemented by iron oxide into ferruginous sandstones. These sandstones, which frequently contain well preserved casts of gastropods, are well developed near the base of the formation. Some of the best exposures of these ferruginated fossiliferous sandstones occur on the Carter plantation, near Quebec, in the southeast corner of Schley county, and in Stewart county, about six miles northeast of Lumpkin. The clays are usually sandy; but they frequently contain much lime, thus passing into marls. Many of the beds are lignitic, and occasionally contain well preserved plant remains. The limestones are argillaceous, and often highly fossiliferous. In some places in the northern part of Randolph county, these limestones become cavernous, and are traversed by subterranean streams.

The Midway-Sabine rocks are best developed along the Chattahoochee River, where, according to Spencer,[1] they attain a thickness of about 600 feet. East of the Chattahoochee, they appear to decrease in thickness going eastward, and finally disappear, or are buried beneath the Vicksburg-Jackson east of the Flint River.

THE CRETACEOUS

The Cretaceous rocks of Georgia form the northern margin

1. Geol. Surv. of Ga.; Report of Progress, 1890-'91, p. 42.

of the Coastal Plain, where they constitute a belt of variable width extending from the Chattahoochee to the Savannah River. The maximum width of the belt, which occurs along the Chattahoochee, is about 50 miles. Between the Chattahoochee and the Ocmulgee rivers, the width does not average more than 20 miles; while, east of the Ocmulgee, the width is reduced to less than 10 miles.

Langdon, Smith and others recognize three horizons in the Cretaceous rocks along the Chattahoochee River, viz., the *Ripley,* the *Eutaw* and the *Tuscaloosa* or *Potomac.*

THE RIPLEY.—The Ripley, which seems to be confined entirely to that part of the Cretaceous belt between the Chattahoochee and the Ocmulgee rivers, consists of a great thickness of sand, clay and marl, with a few thin beds of soft, impure fossiliferous limestone. The sands often show cross-beddings, and contain more or less glauconite. They are generally incoherent, and are readily washed into deep gullies by surface waters. The clays are mostly impure kaolins, varying from yellow and gray to almost black. The darker clays are often highly lignitic, and contain more or less pyrite, frequently in the form of nodular concretions. The marls are mostly of a dark-gray or greenish color. They often become indurated, forming conspicuous projecting ledges along the banks of the streams. Some of the marl-beds are made up largely of shells, often beautifully preserved. Shark's teeth, fragments of bones and coprolites are also common in the marl-beds.

THE EUTAW AND THE TUSCALOOSA OR POTOMAC.—These two formations differ from the Ripley, mainly in the less frequent occurrence of limestone and marls. They consist chiefly of sands with more or less clay. The clays, which seem to be best developed in the lower division, are well exposed in Taylor county, and also at numerous points between Macon and Augusta. These clays are usually pure kaolin well suited to the manufacture of crockery. They occur as locally developed beds associated with cross-bedded sands. None of these clays[1] or sands are fossil-bearing, east of the Ocmulgee River; and, as a consequence, that part of the Cretaceous was mapped solely on its lithological characteristics. It is quite probable that some of these sands and clays, mapped by the writer as Cretaceous east of Macon, may prove, upon further study, to be Claiborne.

THE CARBONIFEROUS

The Carboniferous rocks reach their greatest development on the Cumberland Plateau. They occur also in the Appalachian Valley region, but only as the lowest members of the series. This system of rocks is calcareous below and siliceous above. The calcareous rocks consist of *Fort Payne chert,* the *Bangor limestone* and the *Floyd shale.* The first two members of this division are made up mainly of limestone; but the Fort Payne chert contains also a large amount of siliceous material in the form of chert. The Floyd shale is usually quite calcareous; and in places, it passes into thin-bedded limestones. The aggregate thickness of the calcareous member of the Carboniferous rocks is more than 2,000 feet.

The upper member of the Carboniferous rocks, which are confined almost entirely to Sand, Pigeon and Lookout mountains, consists of conglomerates, sandstones and shales, with a number of workable seams of coal. This member of the Carboniferous is divided into two divisions; viz., the *Lookout sandstone* and the *Walden sandstone.* The Lookout sandstone has a thickness of about 500 feet, and is made up of

1. Since the above was written fossil leaves have been found by the writer in the clay pit at Carr's Station in Hancock County.

conglomerates, sandstones, and thin-bedded shales and coal. The Walden sandstone is similar to the Lookout sandstone; but it attains a thickness of nearly 1,000 feet. The upper member of the Carboniferous rocks, or what is generally designated as the Coal Measures, differs from the other divisions of the Paleozoic rocks in being almost horizontal.

THE DEVONIAN

This system of the Paleozoic rocks is poorly represented in Georgia. Until recently, the only rocks assigned to the Devonian series in the State was a thin stratum of black shale, with a maximum thickness of only about 40 feet. Hayes recently noted, in the Rome folio of the United States Geological Survey, the occurrence of other rocks which he classifies as Devonian. These recently discovered Devonians occur at various points northwest of Rome. They consist of shale and sandstones, of limited thickness, and are apparently of local distribution.

THE SILURIAN

The Silurian rocks are highly calcareous. With the exception of the uppermost member of the system, they consist almost entirely of limestones. The rocks of this division of the Paleozoic are divided into three series; viz., the *Knox dolomite*, the *Chickamauga limestone*, and the *Rockwood formation.*[1]

THE KNOX DOLOMITE, the oldest of the series, is a cherty, heavy-bedded magnesian limestone, having a maximum thickness of about 5,000 feet. The series forms broad, flat chert ridges, traversing the Appalachian Valley in a northeasterly-southwesterly direction.

1. According to the classification recently adopted by the U. S. Geological Survey the Chickamauga limestone is classified as Ordovician; the Knox dolomite, as Cambro-Ordovician; and the Rockwood formation, as the Silurian

THE CHICKAMAUGA LIMESTONE, the other Calcareous member of the Silurian series, is made up of blue and mottled limestones. In places, some of these beds become shaley; but they always carry a high percentage of lime; and, as a consequence, they are readily soluble by atmospheric waters. The Chickamauga limestone varies from 600 to 1,800 feet in thickness, and is the main valley-forming rock of the Silurian system.

THE ROCKWOOD FORMATION.—The uppermost member of the Silurian rocks, the Rockwood formation, consists of sandstones and shales. These sandstones frequently become heavy-bedded, and form sharp-crested ridges of considerable eminence. The thickness of the formation varies from 600 to 1,500 feet, the maximum thickness being attained in Chattoogata Mountain, a very prominent ridge in the northern-central half of the Appalachian Valley region.

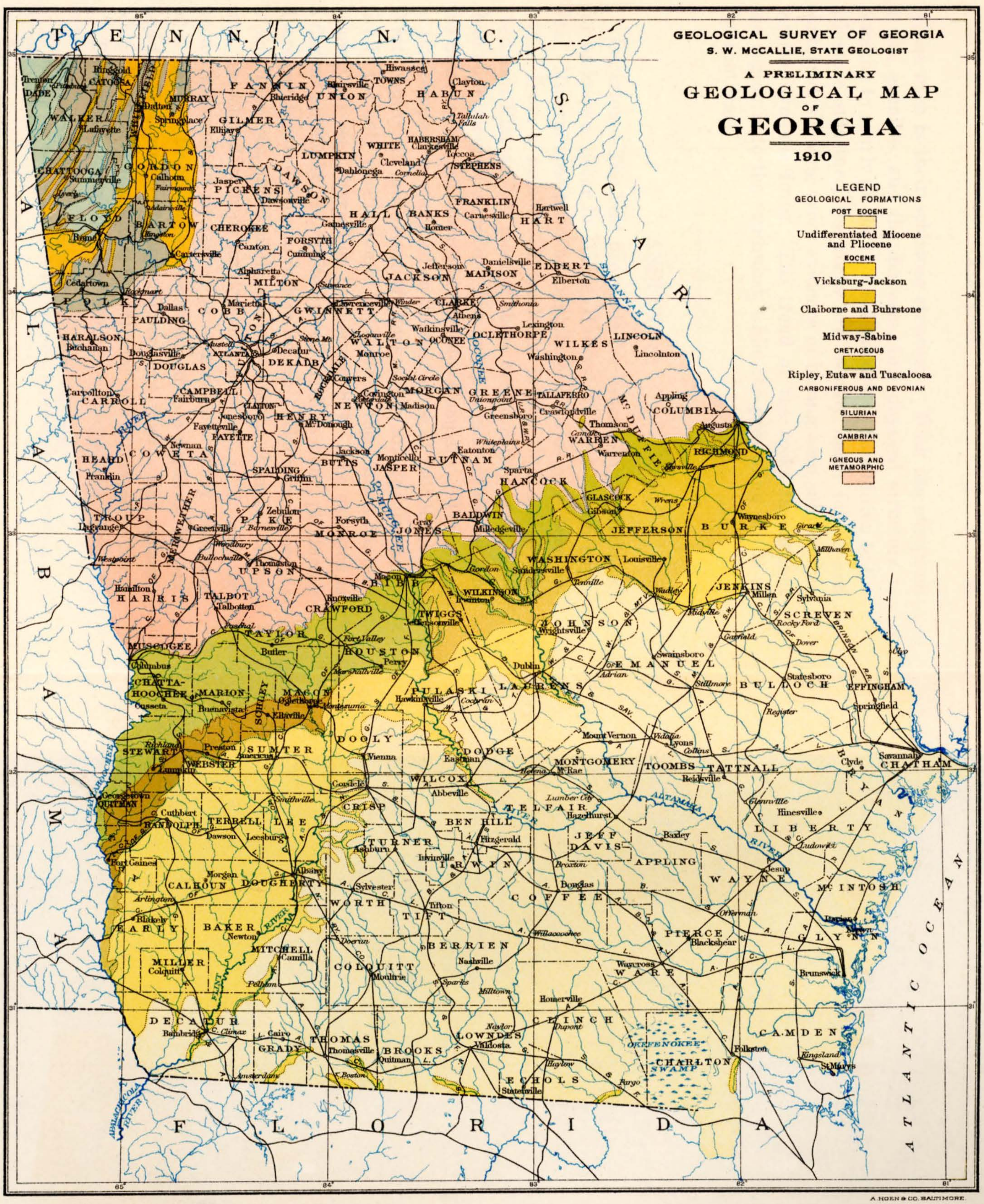
THE CAMBRIAN

The Cambrian rocks are best developed along the eastern side of the Appalachian Valley. They consist of quartzites, shales and limestones. The quartzites are often heavy-bedded, and give rise to some very conspicuous ridges. Mountains and ridges of these quartzites are to be seen in the vicinity of Cartersville, and also along the Georgia-Alabama line west of Etna. The shales are usually calcareous; but, locally, they become siliceous or sandy. They attain a great thickness, and are always valley-forming. Intercalated with the shales, and often forming strata many feet in thickness, occur also beds of blue siliceous limestones. The Cambrian rocks of Georgia all have the appearance of having been deposited in muddy seas near the shore.

THE CRYSTALLINE

The Crystalline rocks of Georgia form a belt, more than 100 miles in width, traversing the northwestern part of the State in a southwesterly direction. They constitute both the Piedmont Plateau and the Appalachian Mountain physiographic sub-divisions. These rocks were formerly regarded as pre-Cambrian; but more recent study seems to indicate that they vary in age from Archean to Triassic. Van Hise, in speaking of the age of the rocks, says: "In our present very imperfect state of knowledge, to call the whole Algonkian or Archean, or even pre-Cambrian, is wholly unwarranted."

These rocks are wholly or partially crystalline. The former includes the granites, the gneisses, the schists, the diorites and the diabases; and the latter, the limestone, the quartzites and the conglomerates. The partially crystalline rocks are found in greatest abundance along the western margin of the area; but they also occur as far to the east as the quartzite ridges of Meriwether, McDuffie and Lincoln counties, those occurring in Meriwether county are known as Pine Mountain, and those in McDuffie and Lincoln counties as Graves Mountain. The most abundant rocks are the gneisses and schists. Intimately associated with and often cutting these rocks as dikes occur the granites and diabases. The granites vary in texture from coarse-grained pegmatite to fine-grained monumental stone. They frequently cover areas of considerable extent, and occasionally form mountains or hills; as, for instance, Stone Mountain, which rises 686 feet above the general level of the surrounding country. These acid intrusives seem to be of different ages; however, they all appear to be much older than the diabases, which always occur in the form of dikes and are probably Triassic in age. One of the most persistent and constant characteristics of the rocks of the Crys-



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talline area is their schistose structure. With the exception of the granites, and the diabases, this physical structure is common to nearly all the rocks of the area. In addition to the schistose structure, the rocks are usually much folded and contorted, showing every evidence of having been subjected to intense dynamic force. The trend of the rocks throughout the region is to the southwest, while the prevailing dip is to the southeast.

ASBESTOS[1]

Location.—The best prospects for asbestos in Georgia, so far as known, occur in White, Habersham, and Rabun counties. Mineral specimens of amphibole asbestos have been obtained from a number of localities in the Blue Ridge ana Piedmont Plateau, but most of these are probably of no more than mineralogical interest. The only producer of asbestos in the State is the Sall Mountain Asbestos Company. The mines of this company are located on the east slope of Sall Mountain, White county, 12 miles west of Clarkesville, and furnish practically the only production of asbestos in the United States.[2] Mining has been carried on here since 1894. The asbestos is a fibrous anthophyllite, white or yellowish in color, producing fibers rarely more than an inch in length. The mineral occurs in small masses, and doubtless represents the chemical alteration, associated with dynamic metamorphism, of a basic igneous intrusion in gneiss. The original discovery consisted of a mass 75 by 50 feet and was mined to a depth of 50 feet, and the rock produced about 90 per cent. fiber. The asbestos which is at present produced is inferior and is classed as No. 2.

Two small occurrences of fibrous anthophyllite, also the

1. Written by Otto Veatch, Asisstant State Geologist.
2. During the last two years there has been a production of asbestos from Vermont and Idaho.

property of the Sall Mountain Company, have been discovered two miles north of Cleveland and about five miles southwest of the Sall Mountain mine. One exposure is about 60 feet wide and 100 feet long; the other occurrence is roughly circular and 20 or 25 feet in diameter. The fiber reaches a length of about ¾ inch; some of the rock has been milled at Sall Mountain and has given fair results.

There are a number of prospects of asbestos on Wolfpit and Mack mountains, six to eight miles northeast of the Sall Mountain mines, mainly on the Martin and Wykle properties. The asbestos seems to be associated with peridotite intrusions and anthophyllite both in masses and in "cross fiber" and "slip fiber" veins is found. The asbestos is closely associated with talc and soapstone. There is some probability of commercial deposits being developed here.

There is an old asbestos mine on the Miller property, two miles northwest of Burton, Rabun county. Asbestos was mined here about 40 years ago and hauled by wagon to Walhalla, South Carolina. The asbestos is the long-fibered, woody variety, and appears in veins both as "cross fiber" and "slip fiber." It appears to have been developed by chemical alteration along cracks in an extensive peridotite intrusion. Analysis of the long fibered, woody variety shows it to be very similar in composition to the anthophyllite at Sall Mountain.

A small amount of asbestos was produced in 1907 by the National Asbestos Company, at Hollywood, near Clarkesville, Habersham county. The asbestos is associated with a small area of peridotite, which has been intruded in a mica-schist. The variety is anthophyllite and occurs both as masses and in small veins in the peridotite. A long-fibered, woody asbestos also occurs. The small quantity of asbestos and the difficulties in milling caused the abandonment of the property.

GEOLOGY.—The asbestos occurrences are confined to the Crystalline area and are associated in most cases with peridotite intrusions. The peridotites are small in area, usually cut gneisses or mica-schists and have a general northeast-southwest trend.

MODE OF OCCURRENCE.—The asbestos occurs as masses of short-fibered anthophyllite and as narrow veins of long-fibered, wood-like asbestos. The fibers of the latter variety are often a foot in length, but are either coarse and brittle, or soft and "rotten," and hence of very little value. At Sall Mountain the rock occurs as small masses, and seems to represent a complete alteration of the original igneous rock. At other localities the asbestos occurs in veins or masses in partially altered peridotite and is associated with more or less talc, chlorite and serpentine.

CHEMICAL AND PHYSICAL PROPERTIES.—There are two varieties of asbestos, the amphibole and the chrysotile. The amphibole varieties are mainly fibrous anthophyllite and fibrous actinolite or tremolite. The chrysotile variety has a short, silky fiber, and can be spun and woven into cloth. This variety has not been developed in the United States, and Canada is the main source of supply. The amphibole asbestos is dull white or gray and produces fibers much longer than those of the chrysotile variety, but the fibers are coarse and usually brittle. Asbestos is an excellent non-conductor of heat, resists the action of ordinary acids and withstands high temperatures without fusion.

The following is a chemical analysis[1] of the anthophyllite of Sall Mountain:

1. Analysis by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.

Loss on ignition	-----
Silica, SiO_2	53.71
Alumina, Al_2O_3	1.89
Ferric oxide, Fe_2O_3	7.14
Lime, CaO	trace
Magnesia, MgO	29.62
Manganese, MnO	.64

USES.—The finer varieties of asbestos are spun into fire-proof cloth. It is a non-conductor of heat and electricity and hence finds a variety of uses for electrical insulation, steam pipe and boiler coverings, etc. It is also used in the manufacture of fire-proof paints and asbestos building material, as lumber, shingles and plaster.

STATISTICS.—The following table taken from Mineral Resources, U. S. Geological Survey, shows the production of asbestos in the United States from 1890 to 1907. The greater part of the output at the present time comes from the Georgia mines.

Year	Quantity (Short tons)	Value	Year	Quantity (Short tons.)	Value
1890	71	$4,560	1900	1,054	$16,310
1891	66	3,960	1901	747	13,498
1892	104	6,416	1902	1,005	16,200
1893	50	2,500	1903	887	16,760
1894	325	4,463	1904	1,480	25,740
1895	795	13,525	1905	3,109	42,975
1896	504	6,100	1906	1,695	28,565
1897	580	6,450	1907	653	11,899
1898	605	10,300	1908	-----	-----
1899	681	11,740	----	-----	-----

REFERENCES ON ASBESTOS

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BARYTES

Location.—As far as known at present, there are only two localities in Georgia where this mineral occurs in commercial quantities. The most noted of these localities and the one which has probably produced the most barytes, is in Bartow county. These deposits, as far as developed, occur on the Cartersville-Emerson public road between the Etowah River and Emerson. The other locality is in the vicinity of Eton, Murray county. There are two different points in the last named district where barytes has been mined in considerable quantities, namely, within the corporate limits of Eton, and about one and a half miles southwest of that town.

Geology.—Both the Bartow and the Murray county barytes occur in rocks belonging to the lower Cambrian series. In the vicinity of Emerson the deposits are associated with the Weisner quartzite and in the Eton district they probably occur in the Beaver limestone or in the residual material derived from that formation.

Mode of Occurrence.—In the Emerson district the barytes occurs in the form of boulders, varying from a few ounces to a ton or more in weight, irregularly distributed through the residual material derived from the Weisner quartzite. This residual material, which consists chiefly of sandy clays and fragments of quartzite, often carries considerable brown iron ore. In fact, the main cut where most of the barytes has been mined was originally worked for iron ore. It has been estimated that fully one-third of the entire residual material mined at these workings is merchantable barytes. The occurrence of the barytes in the Eton district is quite similar to that in the Emerson district, though the residual material here contains considerable chert in the place of quartzite. At one of the pits in the corporate limits of Eton the barytes is to be seen as small veins penetrating the limestone, but at the other workings it seems to occur in irregular pockets and pay streaks in brownish and reddish clays.

PHYSICAL AND CHEMICAL PROPERTIES.—The barytes is usually massive with a granular structure. In color it is generally white, but some of the boulders frequently have a dark bluish tinge, due to some impurity. The individual boulders generally have a thin yellowish stain of iron on the surface when first mined, but the greater part of this coloring matter, which consists chiefly of a coloring of iron stained clay, can be mostly removed by washing. The chemical composition is shown by the following analyses[1] of samples taken from the mines in Murray county:

	I	II
Moisture	.38	.32
Silica, SiO_2	.27	.34
Ferric oxide, Fe_2O_3	.33	.75
Alumina, Al_2O_3	.20	.35
Barytes, $BaSO_4$	98.82	98.24
Total	100.00	100.00

METHODS OF MINING AND PREPARING FOR MARKET.—The method of mining the Georgia barytes ores and preparing them for market, as now in use, is practically the same as that adopted in mining brown iron ores. The mining is done altogether by open pit work. The barytes, together with its accompanying clay and other material, is mined in mass by pick and shovel, loaded on tram cars and carried to the log washer. As the ore passes from the washer it is hand-picked, but not, at present, otherwise treated before it is shipped. The fine ore in some cases is saved by means of jigs operated in connection with the log washer.

USES.—Barytes is largely used as a white pigment, chiefly as a substitute for white lead. It is also used in the manu-

1. Analyses by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.

facture of paper, rubber, oilcloths, paper collars, and barium salts. Other uses which might be mentioned are pottery glazing, sugar refining, and iron enameling.

Barytes mining in Georgia is in its infancy. The mines, both in the Emerson and in the Eton districts have been somewhat irregularly operated for two or three years, but the amount of production is not at hand.

REFERENCES ON BARYTES

1908—Hayes, C. W. and Phalen, W. C. A Commercial Occurrence of Barite near Cartersville, Georgia. U. S. Geol. Surv. Bull. 340-m pp. 3-7, 1908.

1908—Fay, A. H. Barytes. The Mineral Industry, Vol. 17, pp. 72-78, 1908.

BAUXITE

LOCATION.—The bauxite of Georgia occurs in two distinct geological horizons, namely, in the Paleozoic rocks of northwest Georgia and in the Tertiary rocks of south Georgia. The former deposits are limited to six contiguous counties, namely, Walker, Chattooga, Gordon, Bartow, Polk and Floyd, which constitute the middle and south parts of the so-called Paleozoic area. Of these, Bartow and Floyd counties include the vast majority of the ore bodies grouped into fairly well defined districts known as the Hermitage district and the Bobo district. The remaining counties include only one or two deposits each, widely separated, as a rule, from each other.

The Hermitage district is the largest in the Paleozoic area. It includes an area more than 50 square miles, lying between Rome, Kingston and Adairsville, east of the Oostanaula River and north of the Etowah River. It further occupies the contiguous northeastern and northwestern portions, respectively, of Floyd and Bartow counties. As a rule, the deposits are irregularly distributed over the district; but, in some cases, they are sufficiently numerous and near together, to form separate smaller groups, such as the Ridge Valley deposits, etc. The distribution of the ore bodies in this district, as a whole, is a roughly oval-shaped area in outline. The northwestern limits of the area are along a line of contact between the Knox dolomite and the underlying Connasauga shales.

The Cave Spring section, which is included in the Bobo district, has. three distinct deposits grouped along a north-south line, within a half mile of each other, and not more than two miles a little east of south from the town of Cave Spring. These form the most southwesterly known deposits in this part of the State, and are within a comparatively short distance of the Alabama State line. The Bobo district proper consists of a large number of ore banks located between the Southern and the Central of Georgia railroads, about eight miles south of Rome.

The remaining deposits occur in Chattooga, Walker and Gordon counties. The Chattooga county deposits are found in the vicinity of Summerville and Trion Factory, and the Walker county deposits on the Chattanooga Southern Railroad near Chelsea, while the Gordon county deposits are about one mile northeast of Calhoun.

The Tertiary deposits are found in Wilkinson county in Central Georgia, near the northern margin of the Coastal Plain. The main deposit, so far as located, occurs 30 miles east of Macon in the vicinity of McIntyre, and also in the neighborhood of Irwinton, the county seat of Wilkinson county. Further exploration will probably show that these deposits extend into Twiggs, Baldwin and possibly other nearby counties along the northern margin of the Coastal Plain.

CLAY PIT OF THE AMERICAN CLAY CO., TWIGGS COUNTY, GEORGIA.

Geology.—The rocks associated with the bauxite deposits of northwest Georgia range from Cambrian to Silurian in age. They include slates, limestones, shales, sandstones and conglomerates, in considerable variety. These have all suffered considerable metamorphism, and in consequence are much changed, as a rule, in lithologic character and structure. As yet no rocks of igneous origin are known to occur within the area. The bauxite appears to be confined entirely to the Knox dolomite series of rocks, a magnesian limestone formation of the Cambro-Silurian age.

The Knox dolomite is the most uniform and persistent formation in the region; and, in connection with the ore deposits, it forms the most important one of the rock terranes. It lies immediately above the Conasauga shales, and has an estimated thickness of 3,000 to 5,000 feet. It is composed of massively bedded, partially crystalline, gray magnesian limestone. An abundance of included silica, in the form of nodules and layers of chert or flint, is a prevailing characteristic of this dolomite. The soluble carbonates of calcium and magnesium are carried away in solution upon the weathering, leaving the chert and other insoluble portions of the rock, which form a vari-colored siliceous clay with chert fragments as a surface covering. The prevailing depth of this residual material leaves but few exposures of the dolomite visible, except where the streams have cut through into the underlying fresh rock. The rocks of the region represent unquestionable sedimentaries; and, when originally laid down on the sea bottom, they must have preserved a more or less horizontal position. This original position, however, has been profoundly disturbed, as is shown in the tilting and folding of the rocks at steep and varying angles. In this section, as with Appalachian folds in general, the folds show unequal dips on the two sides of the arch and belong to the unsymmetrical type.

They further harmonize with the normal Appalachian type in gentle dips on the southeast sides, and correspondingly steep ones on the northwest. The continued action of the same forces, which produced the folding, resulted in the fracturing and breaking across of the strata in many places—*faulting.*

Two classes of faults have been observed in the region, which show marked differences in many particulars. These are designated by Hayes as minor thrust faults, and major thrust faults. The two apparently bear no close relationship to each other. From field evidence, they were probably formed at different periods of disturbance. The minor thrust faults were likely developed first, and are therefore the older. The two types of faults usually characterize separate or different parts of the area. The distribution of the bauxite seems to have a close connection with the faults.

In Central Georgia, the bauxite, as far as has been observed, lies near the contact of the Cretaceous and Tertiary formations and is always contiguous to white clay beds. It lies in the form of horizontal beds directly upon the clays of the Cretaceous and has been observed as bowlders scattered in the soil, together with fragments of pitted and concretionary clay.

Mode of Occurrence.—In some localities, in the Paleozoic area, the deposits occur in regularly stratified beds; in others, they unquestionably represent alteration or residual deposits, while more commonly they form well-defined pocket deposits entirely distinct from the enclosing residual material. Kaolin, and often also iron ore, is invariably associated with the bauxite.

The following types, based on structure, represent the chief varieties of the ore: Pebble ore, Pisolitic ore, Oolitic ore, Vesicular ore, and Amorphous ore. In the first three varieties, the size of the concretions and the character of the matrix are made the basis of differentiation. In the vesicular and amorphous types of ore, the degree of compactness of matrix and concretions and the relative amounts of the two components are the distinguishing factors. In the pebble ore, the matrix is soft, and is not sufficiently strong to hold the pebbles together, when worked or handled; hence they fall apart like loose gravel, when mined. The pebbles vary greatly in size, but the majority of them, perhaps, measure between three-quarters and one and one-half inches in diameter. They may be simple or complex in structure; perfectly rounded and spherical to irregular in outline; with the nuclei usually powdery and enclosed by hard concentric layers of varying thickness. The pisolitic differs from the pebble type of ore in the size of concretion and the firmness of the matrix. The matrix is usually hard and compact, with the concretions between a quarter and a half inch in diameter, and hard, so that both matrix and concretion break with a conchoidal fracture. The oölitic differs from the pisolitic type by a decrease in size of the concretions. The concretions of this type vary from the size of a pea down to the smallest ore-grain. The vesicular type of ore consists of a compact, dense matrix, from which the concretions have fallen out. In either type of the hard concretionary ore, the concretions, when softer than the matrix, frequently weather upon exposure and fall out, giving a typical vesicular ore on the surface, which grades into the concretionary varieties in the fresh ore underneath. The amorphous ore, as the name implies, consists of the structureless bauxitic clayey matrix, in which concretionary structure is scarcely, if at all, visible. It varies from soft to hard and dense material, closely resembling halloysite.

The Tertiary bauxite deposits, as far as known, always occur in the form of well defined beds. The different types of ore in this region are practically the same as in the Paleozoic area, and therefore require no separate description.

HISTORY.—The first discovery of bauxite in America was in 1887, at a point a few miles northeast of Rome, in Floyd county, Georgia. A few fragments of the unknown mineral were picked up on the Holland lot, two miles north of the Ridge Valley Iron Company's furnace at Hermitage. The intimate association, in this locality, of the bauxite with deposits of limonite, which latter deposits had been worked to some extent, led to the discovery of the mineral, bauxite. The bauxite fragments were highly ferruginous and deep-red in color, and were taken by their discoverer, James Holland, to Edward Nichols, President and Acting Chemist of the Ridge Valley Iron Company, thinking they represented an ore of iron. Mr. Nichols attached no special importance to the find at that time; but, shortly afterwards, he made a chemical analysis of the fragments. Finding the percentage of iron low and that of alumina correspondingly high, as compared with iron ores in general, Mr. Nichols identified the material as the mineral, bauxite. He briefly described the discovery and occurrence of the mineral in the Transactions of the American Institute of Mining Engineers for 1887.

Bauxite mining in the United States had its beginning in Georgia, when, in April, 1888, the deposits of the mineral on the Holland property, lot 61, 23d district of Floyd county, were first opened and worked. The first shipments of the ore were made in May, 1889, to the Pennsylvania Salt Company, at Natrona, Pennsylvania, and to Greenwich Point, near Philadelphia. This lot of ore is said to have been used for the manufacture of both alum and metallic aluminum. In 1889, 728 tons of the ore from Georgia included the total output of bauxite from the United States. Subsequent to the above date, other deposits were opened up in the Paleozoic area, and in a short time bauxite mining became quite active at several localities.

The Tertiary bauxite deposits of Wilkinson county were discovered by Mr. Otto Veatch, Assistant State Geologist, on the Honeycutt property in the spring of 1907, while engaged in the study of the kaolins of that region. Since the discovery of bauxite in that district, only a limited amount of ore has been shipped, but sufficient prospecting has been done to demonstrate that the ore occurs in large quantities.

CHEMICAL PROPERTIES.—The chemical composition of the Georgia bauxites is given in the following table:

ANALYSES OF GEORGIA BAUXITE[1]

Number	H_2O	Al_2O_3	SiO_2	TiO_2	Fe_2O_3
1	32.66	57.18	1.86	6.40	1.90
2	31.70	59.50	2.93	5.40	0.47
3	30.03	54.55	1.54	3.99	9.09
4	31.40	58.55	4.54	2.95	1.40
5	33.06	58.45	3.24	2.65	1.63
6	31.36	57.81	7.41	trace	2.36
7	30.53	62.52	5.36	trace	0.71
8	30.16	55.97	7.56	3.51	1.65
9	31.23	57.50	3.52	6.57	1.40
10	32.20	56.39	3.08	4.13	2.35
11	30.70	62.03	3.66	3.44	0.23
12	30.56	58.96	5.80	5.00	2.90
13	32.40	59.68	2.60	4.32	0.23
14	32.23	59.42	3.50	4.48	none
15	31.86	59.16	4.26	4.80	none
16	30.03	56.75	7.84	3.13	1.86
17	31.23	57.75	5.55	3.56	1.87
18	30.23	56.91	8.33	2.73	1.63
19	31.50	61.98	3.22	0.86	1.18
20	30.66	57.72	5.05	3.51	1.90
21	29.12	57.58	9.38	2.76	0.96
22	26.55	52.92	10.17	2.30	7.66
23	32.97	60.55	2.12	1.96	1.89
24	30.58	60.64	2.30	2.00	1.33
25	32.76	61.52	1.18	2.70	1.70
26	31.03	62.46	4.72	0.23	0.81

The first 20 analyses here given were made in the Pittsburgh Testing Laboratory, Pittsburgh, Pennsylvania, from ores from the Paleozoic area and the remaining analyses by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia, from ores from the Tertiary deposits.

In its purest form, bauxite contains more or less foreign material, either chemically combined or mechanically admixed. Iron sesquioxide, present in variable amounts, ranging from a trace to percentages equal to and occasionally exceeding that of the alumina, is usually present, in part replacing the alumina and in part only as an impurity. So common is iron, as a constituent or impurity, that it serves as a commercial basis for classifying the ore as light-colored or non-ferruginous bauxite, and red-colored or ferruginous bauxite, averaging from 10 to, in extreme cases, 50 per cent. of iron oxide.

Titanium is invariably present, ranging usually from 1 to 10 per cent., when estimated in the form of titanium dioxide. Analyses indicate that this constituent averages higher in the pisolitic ore and is lowest for the structureless bauxitic clays.

Chemical analyses of the purest bauxites invariably show some silica, which varies from a fraction of one per cent. to several per cent., in the purest ore, and from 30 to 35 per cent. in the low grade types of the material—bauxitic clay. The silica is usually present in the form of the hydrated aluminum silicate, clay, which is invariably admixed in varying proportions with the bauxite. It is also present, to some extent, as free silica, as is shown by the microscope.

In addition to these, other common impurities, such as lime, magnesia, phosphoric and carbonic acids, and sometimes the alkalies, soda and potash, amounting to, usually, scarcely more than a trace in each case, are mentioned by various writers. The Georgia bauxite appears generally to be free from these last named impurities.

METHODS OF MINING AND PREPARING THE ORE.—With one exception, the only systematic mining done in the Georgia area is by means of open cuts or pits and shafts. In case the deposit is located on the ridge-slope, a level cut is made, sufficiently wide for a tramway or for barrows, and deep enough to give a good working face on reaching the ore body. This cut usually serves, also, to drain the working. The method of mining on the Watters property, five miles northeast of Rome, consists, in a large degree, of underground work, tunnels and drifts, with some open cuts and shafts. With these exceptions, all the rest of the mining in the bauxite region consists of small pits and prospect holes.

The method of mining in open cuts or pits, such as that recently employed at the Julia and the Maddox mines in the Hermitage district, consists in raising the ore by means of steam hoists or derricks. At the Church bank, in the same district, the ore is raised by means of an inclined cable and cars operated by steam. In the working of shafts, the usual method of hoisting by a hand windlass is practiced; although, in some cases, the steam hoist or derrick doubtless might be employed to some advantage and profit.

As a rule, the ore is easy to mine, because of its comparative softness beneath the surface. It is soft enough, in most cases, to be dug up with the pick although blasting is necessary in some cases. Notwithstanding the readiness with which the ore can be removed from its place, more or less expense is involved in mining on account of its variableness in quality, which makes it necessary to assort the ore. Several grades of ore are found in every deposit, and the various grades are separated in the pit by means of screens and hand picking.

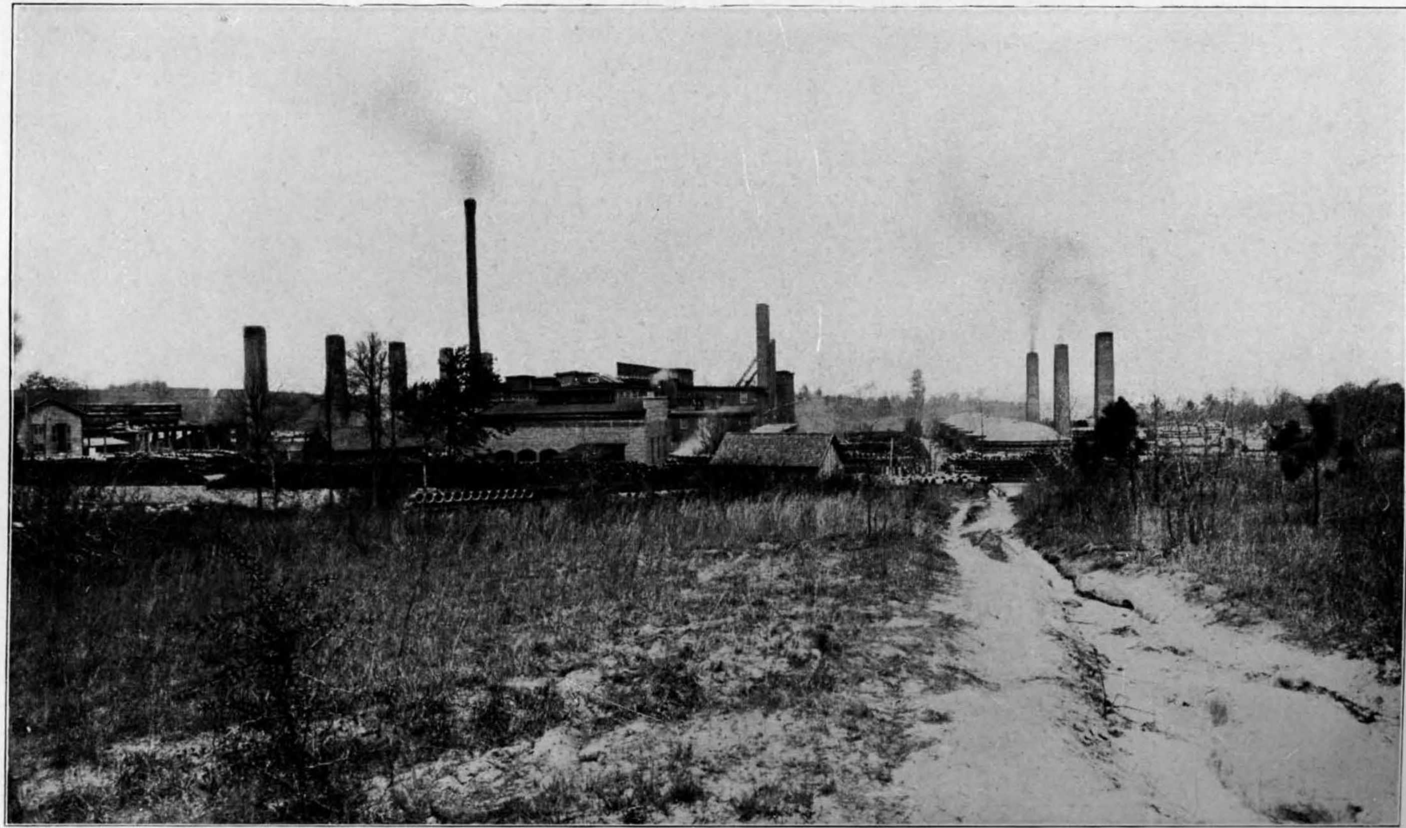
When removed from the pit, the ore contains a large percentage of uncombined water, which, unless expelled or driven off before shipment, makes it a very important item in connection with the high freight rates paid on the ore at present. A large percentage of the ore, however, has been shipped in the past without drying. The moisture is expelled by subjecting the ore to an artificial drying process, which is the one mostly employed; although the natural process of drying under sheds has been practiced to a limited extent. Several forms of artificial dryers have been used.

The most improved form of dryer, the one commonly employed at present, at the largest mines, consists of a large, slightly inclined rotary cylinder, continuous feeder, which was first built and operated by the Southern Bauxite Company at the Warhoop banks in Alabama. The cylinder is maintained at a rather high heat by a fire box at its lower end, and the ore which requires 20 minutes or more to pass through it, is frequently passed through a second time, which practically insures the removal of all the moisture from the bauxite.

Screening is employed before drying in case of the coarse-gravel ore. This removes the greater part of the siliceous clayey matrix and slightly increases the percentage of alumina over that in the unscreened ore. In the case of pebble ore containing a large amount of clay matrix, washing by means of a log washer similar to that used in the treatment of the iron and manganese ores is often employed.

USES.—At present, the bauxite mined in Georgia is used almost exclusively in the manufacture of alum and the aluminum alloys and compounds, and the metal aluminum. More than three-fourths of the ore is consumed, at present, in the manufacture of alum while the remainder is employed in the manufacture of the metal aluminum, its alloys and compounds. These proportions are subject, however, to more or less variation from year to year, dependent upon numerous conditions.

Bauxite is also employed, to some extent, in the manufacture of certain aluminum salts used in the manufacture of baking powders and dyes, as well as in iron and steel castings. In addition to the above named uses, bauxite is used in the



PLANT OF THE GEORGIA VITRIFIED BRICK AND CLAY CO., CAMPANIA, COLUMBIA COUNTY, GEORGIA.

manufacture of fire-brick and an artificial abrasive called alundum.

STATISTICS.—The following statistics, taken from Mineral Resources U. S. Geological Survey, show that with only a few exceptions there has been a gradual increase in the output of the bauxite mines until last year, when there was a great reduction, due mainly to the financial condition of the country and the inactivity of the industry upon which the bauxite trade depends for a market.

Year	Quantity Long tons	Value	Year	Quantity Long tons	Value
1890	1,844	$6,112	1900	20,715	$75,850
1891	3,301	10,728	1901	18,038*	76,300
1892	5,110	16,582	1902	19,000	83,410
1893	2,415	7,750	1903	22,374*	79,651
1894	2,005	6,612	1904	16,909	58,505
1895	3,756	9,690(?)	1905	15,173	64,490
1896	7,313	18,282	1906	25,065	112,792
1897	7,507	18,767	1907	26,456**(?)	129,900(?)
1898	12,943	32,357	1908	10,348*	51,123
1899	19,619	53,952		------	-------

*Including Alabama.
**Including Tennessee.

REFERENCE ON BAUXITE

1887—Nichols, Edward. Aluminum Ore of Floyd County, Georgia. Am. Inst. Mng. Eng. Trans. Vol. 16, pp. 905-906, 1887.

1893—Spencer, J. W. The Paleozoic Group. The Geology of Ten Counties of Northwestern Georgia and Resources. Ga. Geol. Surv., pp. 210-230, 1893.

1895—Hayes, C. W. Bauxite. U. S. Geol. Surv. 16th Ann. Rept., Pt. III, pp. 547-597, 1895.

1901—Watson, Thos. L. The Georgia Bauxite Deposits; Their Chemical Constituents and Genesis. Am. Geol. Vol. 27, pp. 199-225, 8 pls., 1901.

1903—Watson, Thos. L. *Bauxite Deposits of Georgia. Ga. Geol. Surv. Bull. 11, 164 pp., 12 pls., 1 map, 1903.*

1909—Veatch, Otto. *The Bauxite of Wilkinson County, Georgia. Ga. Geol. Surv. Bull. 18, pp. 430-447, 1909.*

CEMENT[1]

LOCALITY.—Both natural and Portland cement are made in Georgia. The natural cement rock has been found, so far, at only two localities in commercial quantity, namely, at Cement, Bartow county, and Rossville, Walker county.

The raw materials for the manufacture of Portland cement are utilized at present only in Polk county in the vicinity of Rockmart. The raw materials, that is, limestone and shale of certain definite chemical composition in close proximity one to the other, are known to occur in Chattooga, Walker and Dade counties and further investigation may show that the limestones and marbles of the Piedmont Plateau and the limestones and marls of the Coastal Plain are also suitable for the manufacture of a Portland cement.

GEOLOGY.—Natural cement is made in Georgia from limestones of two geological formations. The limestones used at the Howard Hydraulic Cement Company and the Georgia Cement and Stone Company are found in the Conasauga formation of Cambrian age, and have been described by Dr. C. W. Hayes of the United States Geological Survey as "being normally composed, at the base, of thin limestones interbedded with shales, then of yellowish or greenish clay shales, and at the top of calcareous shales, grading into blue seamy limestones." The natural cement beds occur near the top of the Conasauga formation at Cement. Natural cement and Hydraulic lime are manufactured by the Chickamauga Cement Company at Rossville. The limestone used here is found in the Chickamauga formation of Silurian[2] age and is exposed over a considerable area. In this vicinity the rocks consist of a blue, thin bedded argillaceous limestone containing some beds of mottled, purple and dove colored limestone, increasing in

1. Written by T. Poole Maynard, Assistant State Geolcgist.
2. See foot note page 30.

earthy impurities toward the east and of considerable thickness.

The raw materials used in the manufacture of Portland cement at the Southern States Portland Cement Company are the Chickamauga limestones of Silurian age and the Rockmart shales, which are the equivalent of the upper portion of the Chickamauga formation, but which are so well defined in this vicinity that they are mapped as a distinct member. These shales immediately overlie the Chickamauga limestones, so that the raw materials used in the manufacture of Portland cement can be obtained from the same quarry. The Chickamauga limestones consist of thin and heavy bedded, high calcium, dark blue, fine grained limestones, interbedded with gray to grayish blue dolomitic limestones. The upper portion of the formation at the property of the Southern States Portland Cement Company consists of dark blue, high calcium lime. However, the formation is usually dolomitic in the upper portion, and the dark blue, high calcium limes occur in more abundance in the lower portion of the formation. No fossils have been found in this vicinity, so that it has been impossible to correlate the individual beds with any degree of certainty.

The shales of the Rockmart formation are of great thickness and the lower portion of the formation has been found to be eminently suitable for the manufacture of Portland cement. The formation consists largely of dark blue to black shales and slates weathering often to olive green and yellow. The lower portion of the formation is remarkably uniform in its lithological character, while the upper portion of the formation is more variable, containing highly ferruginous sandstones, cherty limestones and conglomerates.

Mode of Occurrence.—The natural cement occurs in well defined stratified beds of sedimetary origin on both the properties of the Howard Hydraulic Cement Company and the Georgia Cement and Stone Company. The beds used in the manufacture of the natural cement differ in chemical composition, some of the beds being highly dolomitic while others are extremely argillaceous, but which on mixing give the required chemical composition of a hydraulic cement. The rock used at the Chickamauga Cement Company occurs as thin bedded strata and extends geographically over a considerable area. The limestone used at the Southern States Portland Cement Company occurs as well defined strata which dip at a considerable angle on the eastern portion of the property, so that the limestone can be won by following the strike and plane of the dip. The limestone is considerably folded and on the west side of the fold the beds dip at low angles to the west.

History.—Natural cement was manufactured in Georgia as early as 1851. Three natural cement plants are situated in the Paleozoic area of Northwest Georgia, The Howard Hydraulic Cement Company, at Cement Station, Bartow county; The Georgia Cement and Lime Company, at Linwood, Bartow county, and the Chickamauga Cement Company at Rossville, Walker county.

The Portland cement industry began in Georgia in 1903, when the Southern States Portland Cement Company at Rockmart, was organized by Mr. H. P. Vandeventer, at that time secretary and treasurer of the Georgia Slate Company at Rockmart. The Southern States Portland Cement Company bought the property of the Georgia Slate Company with the intention of quarrying the slate and using the waste material resulting from blasting, splitting, sawing, etc., in the manufacture of Portland cement. Limestones were found in the Chickamauga formation north of the town of Rockmart. The Rockmart shales were found to be of suitable composition at the same locality, so that the idea of using waste slate was abandoned and the plant was located on the property where the raw materials were found in juxtaposition. The Piedmont Portland Cement Company's plant is in process of construction at the present time and the Georgia Portland Cement and Slate Company has recently been organized.

PHYSICAL AND CHEMICAL PROPERTIES.—The natural cement rock of the Chickamauga formation is an argillaceous, thin-bedded dark blue limestone resembling the "cement rock" of the Lehigh district of Pennsylvania in its physical properties. The raw material used at the Howard Hydraulic Lime Company consists of limestones from three beds of the Connasauga formation, each differing in their chemical and physical properties and ranging through an argillaceous siliceous, to a high calcium lime. The limestones of the Chickamauga formation used for making Portland cement in the Rockmart region are dark blue, fine grained, hard, compact limestones and the shales are fine grained semi-crystalline to crystalline, dark blue to black and yellowish green in color.

The following analyses show the character of the constituents which compose the materials used in the manufacture of natural and Portland cement:

NATURAL CEMENT.[1]

	I	II	III
Silica, SiO_2	22.58	19.50	27.68
Alumina, Al_2O_3	7.23	11.60	9.10
Ferric oxide, Fe_2O_3	3.35		2.52
Lime, CaO	48.18	48.86	57.96
Magnesia, MgO	15.00	18.14	2.52
Total	96.22	98.20	99.78

Nos. I and II are from the Howard Hydraulic Lime Company.
No. III is from the Chickamauga Cement Company.

1. Spencer's Paleozoic Group.

PORTLAND CEMENT.[1]

<table>
<tr><th></th><th>I</th><th>II</th><th>III</th><th>IV</th><th>V</th><th>VI</th></tr>
<tr><td>Volatile matter</td><td>42.86</td><td>41.62</td><td>42.64</td><td>7.10</td><td>5.90</td><td>6.60</td></tr>
<tr><td>Silica, SiO^2</td><td>.52</td><td>3.10</td><td>1.24</td><td>57.35</td><td>62.60</td><td>60.10</td></tr>
<tr><td>Alumina, Al_2O_3</td><td>.26</td><td rowspan="2">1.82</td><td rowspan="2">.94</td><td>21.18</td><td rowspan="2">27.30</td><td>22.56</td></tr>
<tr><td>Ferric oxide, Fe_2O_3</td><td>1.00</td><td>3.77</td><td>3.94</td></tr>
<tr><td>Lime, CaO</td><td>53.04</td><td>52.67</td><td>53.90</td><td>4.85</td><td>.66</td><td>1.52</td></tr>
<tr><td>Magnesia, MgO</td><td>2.02</td><td>.90</td><td>1.00</td><td>2.00</td><td>1.29</td><td>.80</td></tr>
<tr><td>Total</td><td>99.70</td><td>100.11</td><td>99.72</td><td>96.25</td><td>97.75</td><td>95.52</td></tr>
</table>

Nos. I, II and III are limestones of the Chickamauga formation.

Nos. IV, V and VI are shales of the Rockmart formation.

USES.—Natural and Portland cements are used for so many different purposes and their uses are so rapidly increasing that only a few of the more important uses can be mentioned. Portland cement has replaced natural cement to a large extent where great strength and soundness are required in mammoth construction work, where the material used must be remarkably uniform. Natural cements are used largely as mortars in construction, while Portland cements are used in heavy masonry, and as a paving material, etc.

STATISTICS.—As there is only one Portland cement plant in operation in Georgia it is impossible to give detailed statistics without revealing the amount produced by a single plant. The following table taken from the Mineral Resources of the U. S. Geological Survey, shows the production of natural cement in Georgia since 1890:

1. Analyses made by C. N. Wiley, Chemist Southern States Portland Cement Company.

Year	Quantity Barrels	Value	Year	Quantity Barrels	Value
1890	40,000	$40,000	1900	28,000	$21,000
1891	40,000	40,000	1901	50,577	40,967
1892	50,393	41,294	1902	55,535	31,444
1893	10,273	9,750	1903	80,620	44,402
1894	9,266	7,094	1904	66,500	37,750
1895	8,050	7,094	1905	89,167	51,040
1896	12,700	9,525	1906	180,500	89,075
1897	18,165	10,899	1907	(a)	------
1898	18,000	13,500	1908	(a)	------
1899	13,000	9,750	----	-----	------

REFERENCES ON CEMENT

1893—Spencer, J. W. The Paleozoic Group. The Geology of Ten Counties of Northwestern Georgia and Resources. Ga. Geol. Surv., pp. 261-271, 1893.

1901—Cummings, Uriah. Natural Cement Rock at Rossville, Georgia. U. S. Geol. Surv. 21st Ann. Rept., pt. 6, pp. 410-411, 1901.

1905—Eckel, Edwin C. Cement Materials and Industry of the United States. U. S. Geol. Surv. Min. Res. pp. 126-131, 336-339, 1905.

CLAYS[1]

KAOLINS AND FIRE CLAYS

LOCATION.—Kaolin and fire-clay occur in all three of the major geological divisions of the State—the Coastal Plain, the Crystalline area, and Paleozoic area.

The clays of the Fall Line belt are confined to the Cretaceous formation, mainly the lower Cretaceous or Tuscaloosa formation, along the northern margin of the Coastal Plain, and occupy a narrow belt extending the entire width of the State from Augusta to Macon and Columbus. The following are localities where the Tuscaloosa strata are well exposed and where the clays are being mined or utilized: Dry Branch, Twiggs county; McIntyre, Wilkinson county; Hephzibah, Richmond county; Carr's Station, on the Georgia Railroad, in Hancock county; Griswoldville, Jones county; Butler, Taylor county; Stephens Pottery, Baldwin county; Lewiston, Gordon, Toomsboro, Chalker, Gibson, Grovetown, Thomson, Byron, and Rich Hill.

Fire-clays also occur in the Tertiary formation of the Coastal Plain. A remarkable bed of pure white clay has been discovered on Sweetwater Creek, near Kelley's Mill, in the northern part of Sumter county. White or slightly stained clays are widely distributed in the northern part of Randolph and the southern part of Stewart counties, and are also exposed in the cuts of the Central of Georgia Railway, between Hatcher and Georgetown, Quitman county.

Residual kaolins occur in the Crystalline area, but have received scarcely any development. Small deposits are widely distributed. Deposits which give promise of being of commercial value occur near Union Point, Dallas, and Jasper.

1. Written by Otto Veatch, Assistant State Geologist.

TRACK ROCK CORUNDUM MINE, TRACK ROCK, UNION COUNTY, GEORGIA.

Bauxite, kaolins and fire-clays occur in the Paleozoic area in Floyd, Bartow, and Chattooga counties. Most of the deposits are near Rome and Cave Spring.

Residual fire-clay, derived from the Knox dolomite, occurs throughout a considerable part of the area underlain by this formation. Clay of this origin is being utilized at Mission Ridge, Walker county.

Flint and plastic clays underlie the coal beds of Dade and Walker counties, but do not possess high refractoriness. An altered Silurian shale, occurring at Aragon, near Rockmart, Polk county, has proved to have some value as a refractory clay.

GEOLOGY.—The kaolins and fire-clays of the State occur in the Cretaceous and Tertiary formations in the Coastal Plain. In the Crystalline area they represent decomposed granite or pegmatite. In the Paleozoic area, the bauxitic clays occur associated with bauxite in the Knox dolomite formation. Residual fire-clays also occur in the Knox dolomite.

MODE OF OCCURRENCE.—The clays of the Cretaceous and Tertiary occur mainly as pockets or small lenticular beds enclosed by sand and sandy clays. The kaolin of the Crystalline area occurs in veins, sheets and pockets retaining the form of the intrusion from which they are derived. The bauxitic clays of the Paleozoic area are asociated with the bauxites, which occur as scattered pocket deposits more or less circular in form. The residual fire-clays from the Knox dolomite also occur in scattered pockets. The fire-clays of the Coal Measures occur as thin layers underlying coal beds.

CHEMICAL PROPERTIES.—The clays of the Tuscaloosa formation are white and stained clays comparatively pure, and closely approach residual kaolins in chemical composition.

Selected samples show as high as 99 per cent. clay substance. The purest clays, kaolins and high grade fire-clays run from 40 to 50 per cent. silica and 34 to 40 per cent. alumina; iron oxide is the chief impurity and varies, in a large number of samples analyzed, from .51 per cent. to 2.11 per cent.; lime and magnesia are entirely absent or occur in only very minute amounts; the percentage of alkalies is always very small—potash usually exceeds soda; titanium dioxide is always present, sometimes as much as 1.5 and 2 per cent., but, as far as the writer was able to ascertain in the laboratory, it produces no noticeable coloring effect, and its fluxing effect is inappreciable; sulphates and organic matter are rarely present.

The kaolins of the Crystalline area contain high percentages of sand, but when washed are very pure and closely approach kaolinite in composition.

Some of the bauxitic clays tested have been found to approach kaolins in chemical composition and may have some value, in limited quantities, for use in the manufacture of the higher grades of pottery. Others showed a higher percentage of aulmina than is found in kaolins, and evidently contained a small percentage of bauxite, $Al_2O(OH)_4$, which contains 73.9 per cent. of alumina, whereas kaolinite, the assumed base of kaolins, contains only 39.8 per cent of alumina.

The residual fire-clays of the Knox dolomite contain a very high percentage of silica in the form of small particles of chert and their refractoriness depends mainly upon the silica content. The percentage of iron and alkalies is low.

The Coal Measure fire-clays and the Rockmart fire-clays are high in silica, contain a high percentage of fluxes and hence have low fusing points for fire-clays.

Physical Properties.—In texture the Fall Line clays are themselves very fine-grained, but they may often contain rather coarse sand grains. Sieve tests on samples of the crude clays showed about 95 per cent. passing a 200 mesh sieve. In hardness the clays vary from very soft to semi-hard, or slightly mealy, to very hard flint clays which can not be scratched with the finger nail. Good samples of the soft and semi-hard clays occur in the mines at Dry Branch and Hephzibah, while the hard clay on the Glover place near Gibson is an example of the flint clay. With the exception of the flint clays, all of the Tuscaloosa clays develop good plasticity, but usually have low air dried strength. In some notable exceptions, however, pure clays were found which showed a maximum air dried strength of 135 pounds per square inch. Most of the clays will show from 10 to 20 or 30 pounds per square inch.

The air shrinkage is usually low, while the fire shrinkage is high and the clays show a strong tendency to crack and check in burning. Leaving out the exceptionally ferruginous clays, the Tuscaloosa clays burn pure white, cream color, or buff, depending upon a number of variable factors. The fusing points of the better clays are high, ranging from cone 30, 3,146° F., to cone 36, 3,362° F.

The bauxitic clays are of various colors, determined by the amount and distribution of iron oxide, white, mottled, pink, yellow and red. The white and pink are freest from impurities, but even the highly colored clays, which contain bauxite, are highly refractory. Some of the white clays show a fair plasticity, but in the greater part of the clays, there is a prevailing lack of plasticity, which is much to their disadvantage. The air dried tensile strength is low, rarely exceeding 15 pounds per square inch. The air shrinkage is usually low, and the fire shrinkage high, and when burned alone, the clays crack badly, especially the bauxitic clays. In point of refractoriness, these clays are excelled by none in the State, and in this property, perhaps, their chief value lies. Some of these clays, tested in a Deville furnace, were unfused at cone 36, 3,362° F. The high percentage of alumina, partly bauxite, will make basic brick, which should make such clays valuable for certain uses. The lean bauxitic clays and the low grade bauxites would perhaps have to be calcined (elimination of the combined water, or water of hydration) before burning. All of the bauxite mines contain white clays. The ore has been worked out of some, but the clays remain as a potential source of wealth.

The residual Knox dolomite clays have poor plasticity and strength, and require a strong clay for a bond. The clay used at Mission Ridge fuses at cone 30, 3,146° F.

The Coal Measure clays have fair plasticity, but their fusing points are too low for them to be of much value for refractory products.

The Rockmart altered shale, above mentioned, has poor plasticity and low strength, and a fusing point at about 3,000° F.

USES.—The kaolins and fire-clays of the Coastal Plain, particularly those of the lower Cretaceous, are suitable for paper filler, white ware pottery, electrical porcelain, sanitary ware, fire-clay products, and terra cotta. Most of the clay mined is shipped to Northern markets. The fire-clays of the Paleozoic area are used mainly for fire brick. The Aragon fire-clay is used in terra cotta and stoneware mixtures. The kaolins of the Crystalline area are undeveloped, but will probably be found suitable for the higher grades of pottery.

BUILDING BRICK, SEWER PIPE, ROOFING TILE, AND OTHER CLAYS

LOCATION.—Clays suitable for use in the manufacture of any of the common clay products are widely distributed. The alluvial clays along the large rivers and the shales afford a good quality of material for common building brick. The clays which have probably been most successfully used are the Pleistocene alluvial clays of the upper part of the Coastal Plain. These clays occur in terraces along the Chattahoochee, Flint, Ocmulgee, Oconee, and Savannah rivers, and are being most successfully used at Columbus, Macon Milledgeville and Augusta. These, in addition to being excellent brick clays, are suitable for sewer pipe, drain tile, and earthenware, and the better quality offers possibilities for roofing tile. Deposits of alluvial clay near Atlanta and at Rome are extensively utilized for common brick. Residual clays are widely distributed over the northern portion of the State, but are mainly of only local value.

A deposit of roofing tile clay is being exploited near Ludowici, Liberty county. The deposit is alluvial in character and is located on Jones Creek, a small tributary of the Altamaha River, and is of Pleistocene age, probably the equivalent of the "second bottom" terrace deposits of the Savannah, Ocmulgee, and Chattahoochee. The clay is 4 to 7 feet in thickness, very fine-grained, has good plasticity and strength and burns to a light red color. Terrace clays along the Ocmulgee, Oconee, and Chattahoochee also offer possibilities for roofing tile.

The plastic white clays of the Fall Line belt, together with certain bluish alluvial clays in the Piedmont Plain, furnish ample material for terra cotta products.

Paving blocks are being manufactured near Harlem, Columbia county, from a mixture of decomposed schist or "shale" and plastic clay, the latter the Claiborne formation.

Residual clays suitable for brick are derived from the Paleozoic formations and the Crystalline rocks. Every county in these areas, or for that matter every district, has clays which may be used for brick, but much of the clay is inferior and hence has no more than a local value.

GEOLOGY.—The clays under this heading have a wide geological range, from pre-Cambrian to Pleistocene and Recent. The Pleistocene alluvial clays, together with the white, plastic clays of the Cretaceous, are of greatest value. The geology of the shales will be discussed below.

MODE OF OCCURRENCE.—The Pleistocene alluvium consists mainly of irregularly stratified, loamy sand and small gravel, with pockets or lenses of plastic and sandy clays. It probably does not exceed 40 feet in thickness at any point, and the clay beds do not exceed 15 or 20 feet in thickness and the average is 6 or 8 feet along the Fall Line. The general section in the clay pits at Columbus, Macon, and Augusta, is in descending order:

1. Loam and sand	1 to 2 feet
2. Yellow or brownish clay, usually with black, iron oxide accretions	....
3. Bluish, stiff, plastic clay	....
4. Fine sand and gravel	....

Some of the clays under this head occur as stratified beds associated with great thicknesses of sand, marl and limestone, for example, the clay beds of the Cretaceous and Tertiary formations of the Coastal Plain. The residual clays occur as a thin surface veneer and are derived from the disintegration and decomposition of the rock formation underlying.

CHEMICAL AND PHYSICAL PROPERTIES.—The alluvial clays are usually sandy and non-calcareous or contain only a small percentage of lime. They have good plasticity, possess high air-dried strength and are red burning.

Residual clays are of such variable character that it is difficult to make a generalized statement concerning their chemical and physical properties. They partake largely of the character of the formation from which they are derived. They usually contain a high percentage of impurities, sand, iron oxide, etc., and are generally red burning.

The properties of the kaolins and fire-clays, which are also, to some extent, used in the manufacture of the more common clay-products, have been previously discussed.

Uses.—The principal clay industry of the State is in the manufacture of common brick. The largest plants are located at Macon, Atlanta, Augusta, and Columbus. There are five large sewer pipe plants and one roofing tile plant. Terra cotta, paving brick and common pottery or earthenware are also manufactured.

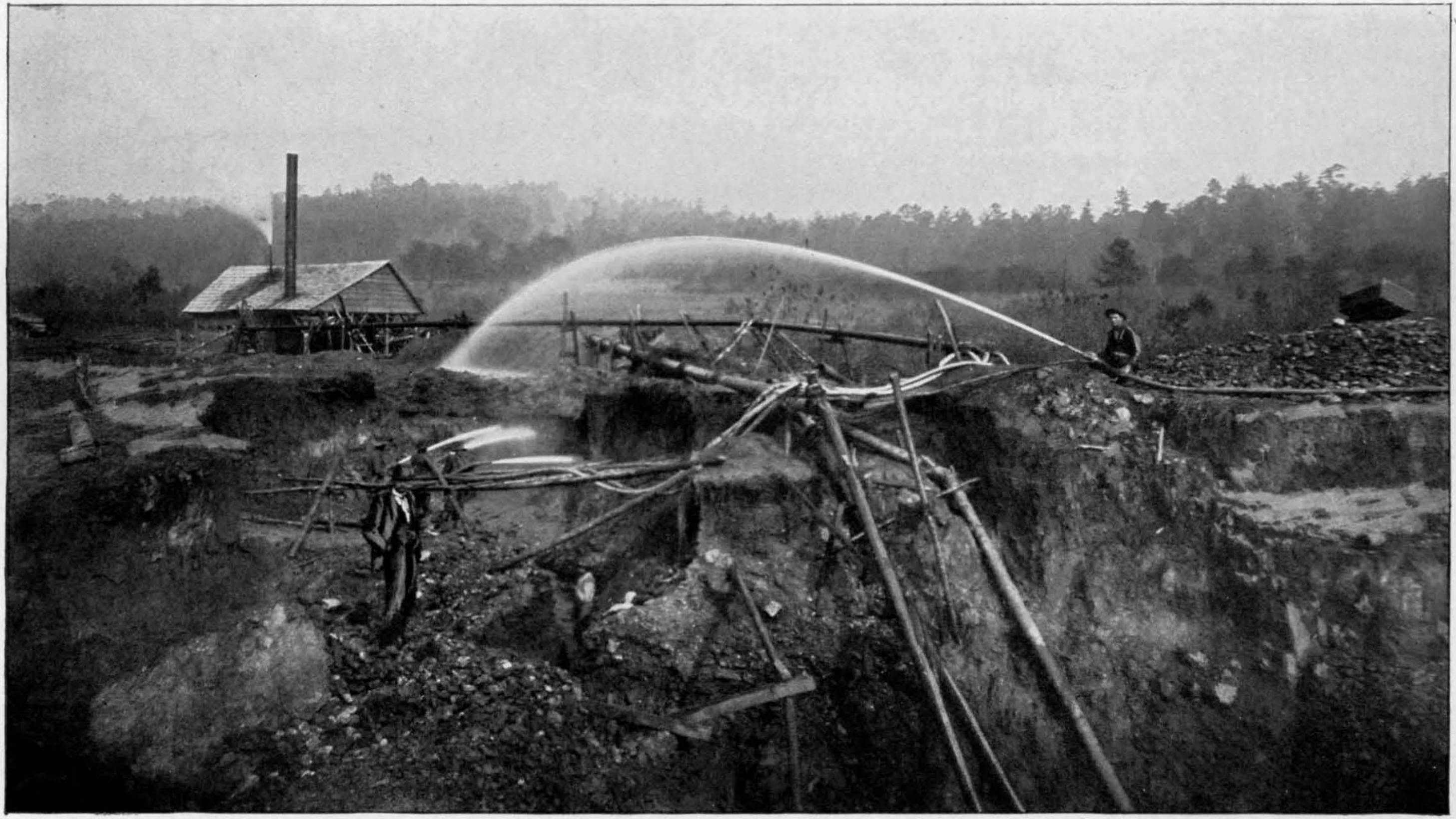
SHALES

Location.—The shales of Georgia, suitable for clay products, are confined to the Paleozoic area, comprising 10 counties in the northwestern part of the State. The principal shales, most suitable for clay products and most accessible, occur in the Floyd, Rockwood, Rockmart, and Connasauga formations, in Floyd, Bartow, Polk, Whitfield, Murray, Walker and Chattooga counties. There are also areas of so-called "shales" in the Piedmont region, though this rock is highly metamorphosed, semi-crystalline and within itself is of little value for clay products. The shales of the Paleozoic area underlie extensive areas and belts and are at many points accessible to railway lines.

Geology and Mode of Occurrence.—The shales range in age from Cambrian to Carboniferous. The "shales" or schists of the Crystalline area are of unknown age, probably Cambrian or pre-Cambrian. They have been greatly folded, faulted and metamorphosed and where undecomposed by weathering agencies are often hard and stony in character. They attain great thickness, the principal shale formations varying from 500 or 600 to 2,000 or 3,000 feet.

Chemical and Physical Properties.—The shales, generally, are deficient in plasticity and have low air-dried strength. The samples tested by this department varied from 20 to 75 pounds per square inch. They have low drying and burning shrinkages, burn to a hard body at low temperatures and have low vitrifying points. With a few exceptions they are high in iron oxide, and are red burning. Their slaking properties are generally poor. They can be dried and burned rapidly. They are generally highly siliceous and in some of the formations they are very sandy and grade into sandstone. Analyses of samples show that they contain only a trace or a very small percentage of lime, though thin beds of limestone occur in them. The shales of the Cambrian and Silurian formations are generally free from carbonaceous matter, those of the Devonian and Carboniferous may be carbonaceous. The quantity of iron sulphide is rarely sufficient to be objectionable.

Uses.—The shales should be found suitable for common brick, and if properly handled will make a superior quality, notwithstanding their low plasticity. There are also localities where they give promise, either alone or mixed with other clays, of being suitable for vitrified brick. They are being utilized at Calhoun for common and pressed brick; at Rockmart and Rome for common brick, and at Blowing Springs and Mission Ridge, Walker county, mixed with other clays, for sewer pipe and building brick, respectively. The



THE YONAH COMPANY'S PLACER MINING PLANT, WHITE COUNTY, GEORGIA.

shales warrant a much further development than they have at present received.

STATISTICS.—The following tables, taken from Mineral Resources, U. S. Geological Survey, give the value of clay products and clays of Georgia from 1905 to 1908 inclusive:

VALUE OF CLAY PRODUCTS OF GEORGIA, 1905 TO 1908.

Product.	1905	1906	1907	1908
Brick				
Common—				
Quantity	275,841,000	303,286,000	318,844,000	248,585,000
Value	$1,444,479	$1,783,988	$1,807,148	$1,335,349
Average per M	$5.24	$5.88	$5.67	$5.37
Vitrified—				
Quantity	(a)	(a)	(a)	(a)
Value	(a)	(a)	(a)	(a)
Average per M	$14.00	$13.99	$12.50	$15.50
Front—				
Quantity	2,667,000	2,094,000	1,625,000	2,929,000
Value	$28,676	$20,747	$16,450	$34,38
Average per M	$10.75	$9.91	$10.12	$11.74
Fancy or ornamental Value	----------	----------	(a)	----------
Fire ---- value	$73,050	$51,310	$82,391	$53,466
Stove lining ---- value	----------	----------	(a)	----------
Draintile ---- value	$13,500	$12,000	$8,050	(a)
Sewer pipe ---- value	$218,000	$221,000	$244,000	$253,664
Architectural terra cotta ---- value	(a)	(a)	(a)	(a)
Fireproofing ---- value	(a)	(a)	(a)	(a)
Tile, not drain ---- value	(a)	(a)	(a)	(a)
Pottery:				
Earthenware and stoneware, ---- value	$21,890	$20,257	$33,885	$10,651
Yellow and Rockingham ware ---- value	----------	$21,890	$33,885	$10,651
Miscellaneous ---- value	$320,151	$291,322	$298,313	$241,096
Total value	$2,119,746	$2,400,624	$2,490,237	$1,928,611
Number of operating firms re orting	95	99	106	108
Rank of State	12	13	13	16

(a) Included in miscellaneous.

VALUE OF CLAY MINED AND SOLD, GEORGIA.

Variety	1905	1906	1907	1908
Kaolin and paper clay:				
Quantity (short tons)	26,216	32,552	28,503	18,230
Value	$ 99,060	$141,765	$126,253	$ 87,540
Fire-clay:				
Quantity (short tons)	2,712	6,070	15,080	13,805
Value	$ 3,307	$ 14,568	$ 14,060	$ 9,005
Stoneware clay:				
Quantity (short tons)	100	(a)	984	666
Value	$ 100	(a)	$ 1,784	$ 2,025
Miscellaneous:				
Value	------	$ 417	$ 5,151	$ 4,433
	$102,467	$156,690	$147,242	$106,028

(a)Included under miscellaneous.

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COAL

LOCATION.—The coal deposits are confined to Lookout, Sand and Pigeon mountains, which are located in the extreme northwestern part of the State in Walker, Chattooga and Dade counties. The deposits of Walker county occur in Pigeon Mountain and along the eastern side of Lookout Mountain. The most valuable coal seams in this county appear to be in the vicinity of the Durham mines. These mines are located on what is known as Round Mountain, a small elevation located near the central axis of Lookout Mountain. Round Mountain, as the name suggests, is a nearly circular mountain having an area of several hundred acres and an elevation of about 300 feet above the surface of Lookout Mountain, on which it is located.

The deposits of Chattooga county are limited to a small area in its extreme northwestern corner along the Georgia-Alabama line. The exposures of coal here, as in Walker county, are near or on the eastern brow of Lookout Mountain at an elevation from 500 to 600 feet above the valley. This county, so far, has produced no coal, but, nevertheless, there are a number of places where promising exposures occur.

The coal area of Dade county exceeds that of any other county in the State. The deposits are confined to the western side of Lookout and the northern portion of Sand Mountain. The main coal mines of this county are on Sand Mountain in the vicinity of Cole City. In addition to these workings, there has also been a limited amount of coal mined near Rising Fawn, in the southwestern part of the county, only a short distance from the Georgia-Alabama line.

The total coal area of Georgia is about 170 square miles.

Geology.—The geology of the coal fields of Georgia is quite simple. The Carboniferous and the underlying strata, which were formerly laid down as horizontal beds of sand, clay, etc., on the sea bottom, have been changed by lateral pressure into a number of huge anticlinal and synclinal folds, having a northeast-southwest trend. One of the most prominent of these folds is the Lookout syncline, forming Lookout Mountain. This fold, which has its northern terminus in Tennessee, traverse the northwestern corner of Georgia, and continues southward into Alabama. The width of the fold, as measured by the limits of Lookout Mountain, varies from one to five miles. Its greatest width is just south of McLamore's Cove, near the Georgia-Alabama line, from which point it gradually decreases in width to the north. With a few local exceptions, the fold is quite symmetrical; that is, the strata from both sides of the mountain dip at about the same angle towards the axis of the fold. At the head of McLamore's Cove, the Lookout syncline sends off to the northeast a small secondary syncline, forming Pigeon Mountain. These folds are separated from each other by the Chattanooga ânticline, which terminates in the head of McLamore's Cove, and extends northeast, along the east side of the mountain, to Chattanooga. East of the Pigeon Mountain syncline, and forming the eastern boundary of the southern extension of the Lookout syncline, is the Chattanooga anticline, which extends for many miles to the northeast.

West of Lookout Mountain, the structure here described is again repeated. To the extreme northwest, is the broad syncline of Sand Mountain, followed by the Lookout Valley anticline, which stops short in Deerhead Cove, thus separating from the main cyncline the Fox Mountain syncline, a counterpart of Pigeon Mountain, which, in turn, is limited on the east by the Wills Valley anticline.

In addition to the large geological structural features, above referred to, there are minor ones which have a very important bearing on the commercial value of the coal seams. These minor features, which are common in all coal fields, are small folds, faults, and irregularities in the thickness of beds.

Associated Rocks.—The coal deposits of Georgia occur in both the Lower and Upper Coal Measures. The Lower Coal Measure consists of what is known as the Lookout sandstone, which is made up of sandstone, conglomerate, shales and coal. The formation varies in thickness In northwest Georgia from 300 to 400 feet. Its upper limit is defined by a heavy bed of conglomerate often seen forming the uppermost cliffs along the margin of Sand and Lookout mountains. The upper beds of the Lookout formation are made up chiefly of sandstone, with thin beds of argillaceous shale, and from 2 to 5 coal seams. The sandstone, in places, is coarse-grained, and it occasionally passes into a conglomerate. It is often cross-bedded, and, at some points, it shows numerous impressions of fossil plants. The shales associated with the sandstone of the upper beds of the Lookout Mountain formation are of a dark or almost black color.

The lower portion of the Lookout Mountain formation consists of red and gray shales, with a few thin beds of sandstone and limestone. The shales, forming the upper part of the lower division of the Lookout formation, are usually quite sandy, while those beds occurring at a lower horizon are distinctly argillaceous. Associated with the latter shales are a few thin beds of limestone. These calcareous beds increase in number as the Bangor limestone below is approached. At some points along the western slope of Lookout Mountain, the sandy shales above referred to contain numerous fossils, the most abundant being bryozoa and fragments of crinoid stems.

The Lookout Mountain sandstone in northwest Georgia forms the surface rock along the margin and the upper slopes of Sand and Pigeon mountains, It caps Rocky and Little Sand mountains east of Taylor's Ridge, and occurs in a small isolated area northeast of Ringgold, near the Georgia-Tennessee line. The total exposed area of the Lookout Mountain formation in northwest Georgia is estimated to be about 170 square miles.

The Upper Coal Measures include a siliceous series of rocks known as the Walden sandstone. It forms the upper member of the sandstone and conglomerates of Lookout, Sand and Pigeon mountains, and is confined entirely to the top of these mountains. The formation, which is made up of sandstone, conglomerate and shale, with from two to seven seams of coal, attains its greatest thickness at Round Mountain in the vicinity of the Durham coal mines. Its approximate thickness at this point has been placed by Hayes at 930 feet.

The sandstones and conglomerates of the Walden formation differ but little from the sandstones and conglomerates of the underlying formation. The shales are also quite similar; but, as a general rule, the Walden shales are more micaceous and sandy; and, at the same time, they are more fossiliferous; especially is this true of the shales associated with the coals.

History.—Prior to 1891, all of the coal mined in Georgia was obtained from Dade county, in the vicinity of Cole City. The first mines operated in this district were opened by Gordon & Russell more than a half century ago, and the coal was hauled by wagon to Shellmound, a distance of about six miles.

It is a difficult matter to obtain any very reliable information as to the aggregate amount of coal taken from the several mines in the Cole City district from the time of their earliest workings to the present. The only trustworthy information, as far as the writer is able to ascertain, is to be found in the Twentieth Annual Report of the United States Geological Survey, and is as follows:

Years	Short Tons	Years	Short Tons
1884	150,000	1888	180,000
1885	150,000	1889	225,934
1886	223,000	1890	225,337
1887	313,715	1891	171,000

Subsequent to the last date here given, the entire coal output for the State is included in one table in the United States report, so that it is practically impossible to say what proportion of each year's production was the output of the Coal City mines. The mines were worked extensively prior to 1884, under the management of ex-Governor Joseph E. Brown and others; but no record of the output is now obtainable.

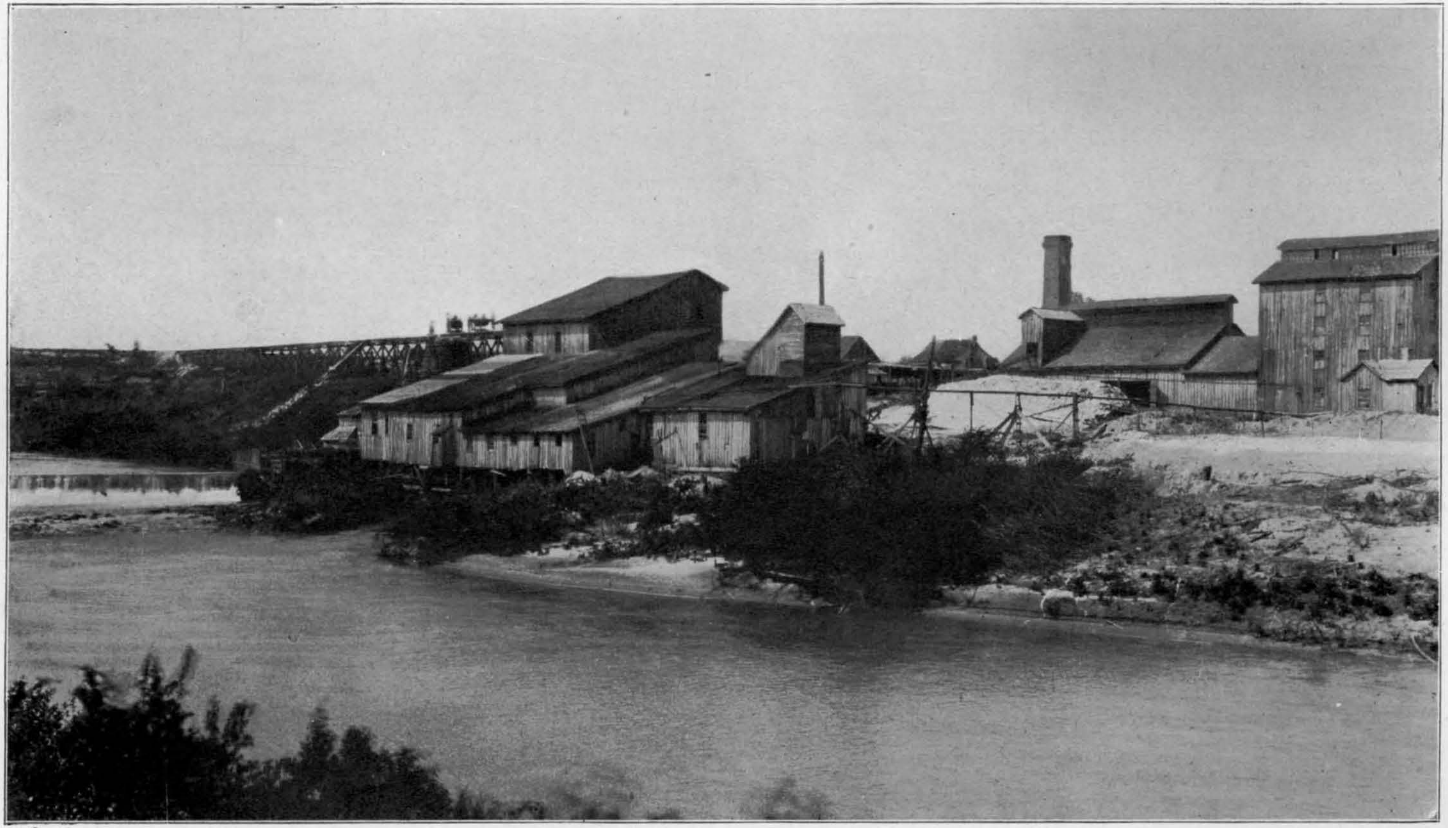
The following table gives the approximate date of opening and the date of closing the coal mines in the vicinity of Cole City:

Name of Mine	When Opened	When Closed
Castle Rock	Not known	1878(?)
Gordon	Not known	1881
Cole City	1881	1891
New South Wales	1882	1885
Elijah	1884	1892
Rattlesnake	1890	1899
Ferndale	1892	1901
Pine Mountain	1898	1898
Raccoon	1901	----

A workable coal seam has long been known to outcrop at the base of Round Mountain. At two or more points, it is said to have been worked to a limited extent prior to the Civil War, when the commercial value of the coal was fully demonstrated by its use in the blacksmith forge. The older excavations at the base of the mountain on the south side, now known as Green's bank, are pointed out as the remains of one of these early workings. Much of the coal used 30 years ago in the blacksmith shops, both on Lookout Mountain and in the adjacent valleys, was obtained from Round Mountain.

Active mining operations might be said to have begun at Round Mountain in 1891, a few months previous to the completion of the Chickamauga and Durham railroad to that point. The first shipments were made in 1892, since which date the mines have been in continuous operation. At the present time the mines in the vicinity of Round Mountain are producing daily about 700 tons, which is used chiefly for steam and coking purposes.

Chemical Properties.—The chemical and heating qualities of the Lookout and Sand mountains coal, made under the direction of Dr. W. H. Emerson, of the Georgia School of Technology, are shown in the following tables:



MILL AND CHLORINATION PLANT, CREIGHTON GOLD MINE, CHEROKEE COUNTY, GEORGIA.

Number	Carbon	Hydrogen	Water	Sulphur	Nitrogen	Ash
1	85.75	4.63	.88	.79	1.44	3.17
2	86.97	4.44	1.06	.62	1.25	2.00
3	79.41	4.60	.93	.88	1.39	9.05
4	85.07	4.48	.77	.88	1.50	3.42
5	84.32	4.72	1.21	.78	1.66	4.20

No.	Calculated Heating Value.	Calori-meter	Differ-ence	Difference Per Cent	Heating Value Per Gram of Combustion	Fixed Carbon, Ash and Moisture free.
1	8,366	8,415	−49	−.6	8,770	79.1
2	8,351	8,409	−58	−.7	8,675	78.4
3	7,821	7,763	+58	+.7	8,624	75.3
4	8,234	8,290	−56	−.7	8,653	78.0
5	8,292	8,211	+81	+1.0	8,680	78.1

1. Lump coal, Durham Mine, Walker County.
2. S. T. Carson's property, Walker County. Vein 120 feet below Durham.
3. S. T. Carson's property, Walker County. Vein 180 feet below Durham.
4. Washed coal, Durham Mine.
5. Unwashed coal, Lookout Coal and Coke Company, Walker County.

The last two columns show that all these coals belong to the same class, the differences not being greater than those that might arise in coal from the same mine from difference of sample, combined with experimental errors. They fall in the lower part of the semi-bituminous class, whose heating value, according to Prof. Wm. Kent, ranges from 8,666 to 8,888 calories, and whose fixed carbon ranges from 75 to 85 per cent.

This class of coals has the maximum heating value, being superior to the anthracites, because of their higher content of hydrogen, and superior to the other bituminous coals, because of their lower content of oxygen. These should be good steam coals and coking coals. Number 1 is very similar to the Pocahontas of Virginia in composition and heating value.

STATISTICS.—The following table taken from Mineral Resources, U. S. Geological Survey, shows the production of coal in Georgia from 1890 to 1908:

Year	Quantity Short Tons	Value	Year	Quantity Short Tons	Value
1890	228,337	$238,315	1900	315,557	$370,022
1891	171,000	256,500	1901	342,825	411,685
1892	215,498	212,761	1902	414,083	589,018
1893	372,740	365,972	1903	416,951	521,459
1894	354,111	299,290	1904	383,191	466,496
1895	260,998	215,863	1905	351,991	453,848
1896	238,546	168,050	1906	332,107	424,004
1897	195,869	140,466	1907	362,401	499,686
1898	244,187	198,169	1908	264,822	364,279
1899	233,111	233,344			

The above statistics show that the coal production in Georgia in 1908 was 27.1 per cent. less than in 1907, and also that the output for 1908 was less than any year since 1899. This decrease in coal production was mainly due to a depression in the iron trade which, in turn, affected the demand for coke.

The number of men employed in the coal mines of Georgia in 1908 were 670, while in 1907 there were 737 men. Previous to April 1909, convict labor was largely employed in the mines, but at present free labor is employed. The average production of coal per man each day during 1908 was only 1.51 tons as against 1.71 tons per man in 1907.

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COPPER

Location.—The most extensive deposits of copper, so far located in the State, are to be found in Fannin, Cherokee and Haralson counties. Those in Fannin county are known as the Mobile Mine and "Lot 20." Both of these mines are located in the extreme northern part of the county only a short distance from the Georgia-Tennessee line and within less than three miles of the famous Ducktown copper mining district. These mines may be said to form the southern extension of the Ducktown deposits. The Cherokee copper deposits have been worked at only one place, namely, the Canton Copper mine, located on the Canton-Marietta public road about one and one-fourth miles south of Canton. The Waldrop Copper mine, in Haralson county, is located about four miles northwest of Draketown, near the Haralson-Polk county line. This mine was originally worked as a copper mine, but later as a pyrites mine. In addition to the deposits here named, copper is also known to occur in Lincoln, Lumpkin, and Fulton counties.

Geology.—The copper deposits all occur in what is known as the Crystalline area. Those in Fannin, Cherokee, and Haralson counties are associated with highly metamorphic sediments, probably lower Cambrian in age, while the deposits in Lumpkin, Fulton, and Lincoln counties occur in older rocks, probably Archaean. The rocks associated with the copper deposits consist chiefly of highly metamorphic schist, gneisses, and conglomerate, all of which are usually much folded and contorted.

MODE OF OCCURRENCE.—The copper ores always occur in veins which are often quite variable, both in width and longitudinal extent. The veins frequently become so variable in width that they may be spoken of as a series of greatly elongated lenses connected by narrow stringers. They have the appearance of having been deposited along crushing or shearing zones and for that reason do not always show well-defined walls. Carl Henrich, in speaking of the copper veins of Fannin county, says:[1] "All of the ore deposits south of the Ocoee River are smaller than the Ducktown ore deposit proper, the ore-bodies being smaller and further apart. They have certainly much less chance of extent, either horizontally or in depth, besides being much smaller, as a rule. I have, although, seen slopes in the Mobile mine 20 and 24 feet wide in places, which had been filled with solid ore." The ore-bodies on "Lot 20" are said to reach a maximum width of 15 feet. The ore-bodies at the Canton and the Waldrop mines are similar to those of Fannin county, but they are generally smaller. In strike and dip, the copper veins always conform to the country rock.

CHARACTER OF THE ORES.—The ores, for convenience of description, may be divided into three zones. The upper or superficial zone extends from the surface to what may be termed the constant water-level and consists mainly of porous, reddish or brownish iron ores, known as gossan. This portion of the ore-body, which often extends to a depth of 80 feet or

1. The Ducktown Ore Deposits, Trans. Am. & Inst. Min. Eng., 1896, Vol. XXV pp. 173-245.

more, contains but little or no copper and is therefore of no commercial value, except as an iron ore. Below the gossan is found the black copper zone, which varies from a few inches to a foot or more in thickness and consists mainly of black copper oxide, green and blue carbonates, and occasionally a small amount of native copper in the form of shreds or thin leaves. The third zone lies below the black copper and consists of the unaltered part of the ore-body. This part of the vein is made up of pyrrhotite and chalcopyrite, together with quartz, zoisite, hornblende, and other accessory minerals. The ore from this zone carries on an average from 2 to 3 per cent. copper, but in some instances it has been known to run much higher.

HISTORY.—Practically all of the copper mining in Georgia was done prior to or shortly after the Civil War and was the direct outgrowth of the discovery of the rich copper deposits in the Ducktown region. It was the prevailing opinion of prospectors at that time that the copper-bearing belt of Tennessee extended southwest through Georgia into Alabama, and as a result of this belief there was much prospecting done in Georgia and in a few instances some very favorable prospects were located. Among these prospects were the mines above mentioned, which for a time produced considerable copper. The only reliable data on the production of copper from these old mines are some notes on "Lot 20." Mining operations appear to have commenced in 1861 and in the following year the lessee, Mr. James Phillips mined and shipped from the property 35.51 tons, valued at $2,451.80. In 1866 the same lessee mined and sold to the Ducktown smelter 246.64 tons, valued at $8,426.87. Subsequent to the last date the property became involved in a protracted law-suit, since which time the mine has ceased to be a producer. The Mobile mine, located in the same vicinity as

"Lot 20," also produced considerable copper in the early sixties, but no reliable record of the production is at hand.

No copper mines are at present operated in the State, though the U. S. Geological Survey, as late as 1906, reported 17,182 pounds of blister copper from the Seminole gold mine in Lincoln county, where a small smelter was operated for a time. This copper was chiefly a by-product obtained from the gold ores of the Seminole mine.

USES.—Copper has various uses. At present nearly 50 per cent. of the copper mined in this country is used in the electrical industries for copper wire and for other purposes. Considerable amount is also used in the manufacture of brass and in castings as well as in sheet copper used for roofing and other purposes. A limited amount of copper is used in coinage. The United States one-cent piece contains 95 per cent. copper, while all silver and gold coins contain 10 per cent copper.

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CORUNDUM

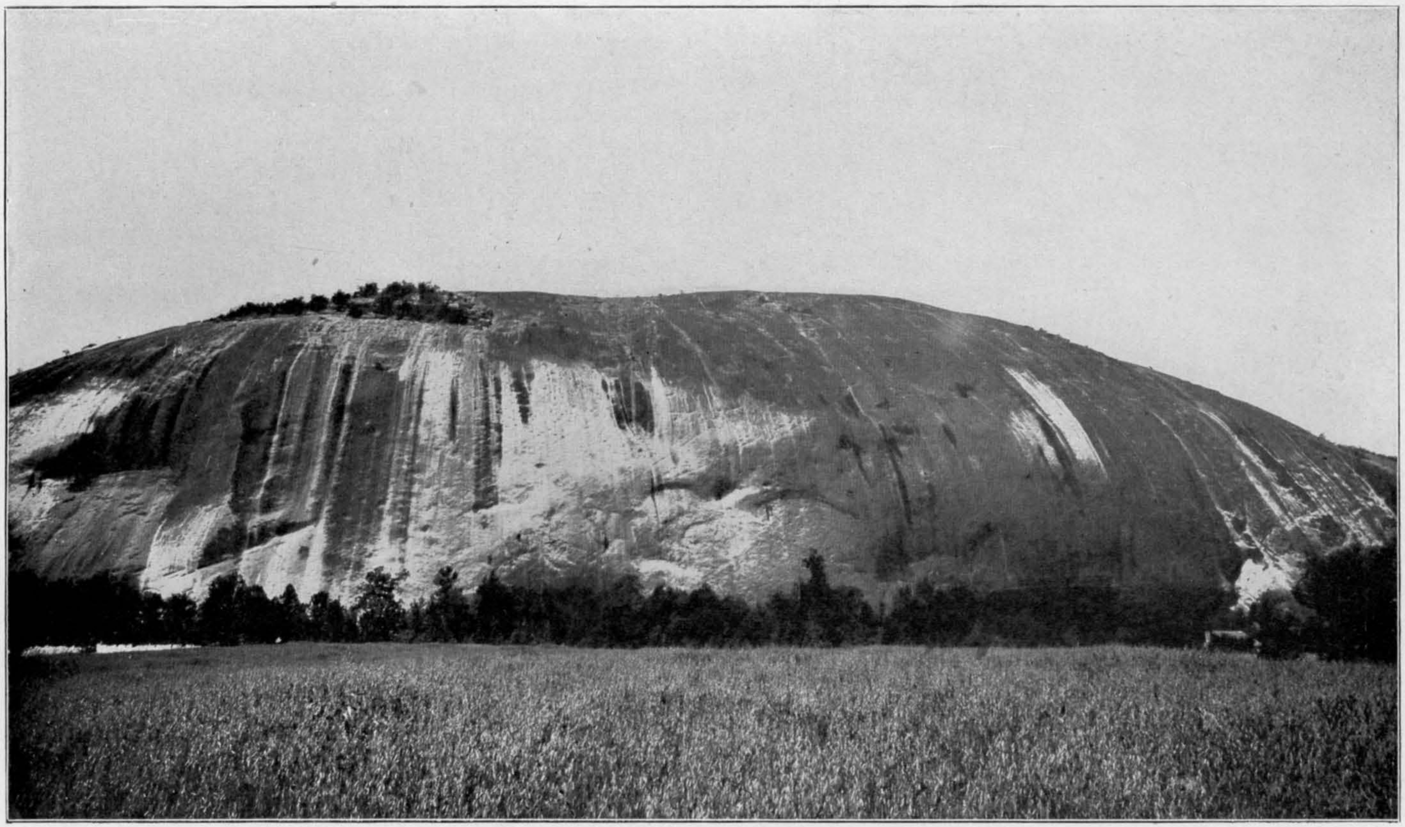
LOCATION.—The corundum deposits of Georgia occur in the Crystalline area, being found in a narrow belt whose width, as it enters Georgia from North Carolina, is limited to the region between the Laurel Creek corundum mine, Rabun county, and Brasstown Creek valley, Towns county. This represents a distance, east and west, of about forty miles. The belt, which is confined chiefly to the Chattahoochee drainage basin, is supposed to narrow down, to the southward, and enters Alabama from Troup county. Corundum is known to occur in the following counties: Rabun, Towns, Union, Lumpkin, Habersham, Hall, Cherokee, Cobb, Forsyth, Paulding, Douglas, Carroll, Heard, Troup and Walton. The chief corundum output has come from the Laurel Creek mine, located in the extreme northeastern part of Rabun county, about 16 miles from Clayton.

Geology.—The corundum deposits in Georgia usually occur in basic magnesian rocks, including chrysolite, anthophylite, serpentinized chrysolites, schistose chlorite and steatite or soapstone. These form igneous intrusions along the lamination lines of the crystalline rocks, the gneisses and schist, showing by existing characteristics that they were distended prior to the final folding of this region, and probably at a time when the beds of these crystalline rocks were made a portion of the continent. The great earth movements that uplifted the area developed lines of weakness and cracks, which were apparently filled by an injection of igneous matter. A portion of the rents thus produced are now filled by the basic magnesian silicates, in which the corundum deposits occur. Earth movements, since, have concealed, in a great measure, the metamorphic influences of this molten material, and have likewise folded some of the peridotite alterations into corresponding relations with the schist and gneiss.

A matter of note is the constant presence of hornblende-gneiss, either on one side or the other of these formations. Such being the case, and since these gneissic-hornblende formations, varying from fifty to three hundred feet and more in width, are continuous for miles across the country, they act as an excellent guide in a search for the corundum-bearing formations. Gneiss or mica-schist seems always to surround the peridotites, or "chrysolite formations," as they are commonly called, the hornblende-gneiss apparently never coming in close contact with the peridotites. The age to which the rocks associated with the corundum deposits of Georgia belong is probably Archæan or pre-Cambrian.

Mode of Occurrence.—The Georgia corundum occurs in veins intersecting the peridotites and their alterations. Sometimes it occurs in the contact bodies, that is, in the gneiss, mica-schist or hornblende-gneiss such an occurrence, however, has not been observed in Georgia. The veins vary in form from those having practically parallel walls, which are usually inclined and descend to unknown depths, to simply lenticular pockets. In width, the veins have been found from one to twelve feet.

The matrix of these veins differs not only in different, but in the same, localities. These four types have been noticed, namely: lime-soda feldspar, with quartz and phlogopite, also with vermiculites instead of phlogopite; lime-soda feldspar with actinolite; a coarse-grained aggregate of lime-soda feldspar and a black hornblende, (margarite is sometimes present in place of the feldspar); a massive vein made up of a light grass-green amphibole, lime-soda feldspar and a little chromite. All these types have their walls of compact, scaly chlorite, which quite frequently contain corundum. The first type is the most common; and, scattered through it, or, as is usually the case of small corundum, in "bunches" or "pockets," occur the various colored varieties of corundum. In such veins, also, immense specimens of massive corundum are found. The second type is apparently rare. In this, only small, irregular pieces of corundum have been found and these usually possess an outer zone of some alteration product of



STONE MOUNTAIN, DEKALB COUNTY, 16 MILES NORTHEAST OF ATLANTA, GEORGIA.

the corundum, usually margarite. The third type is more common than the second but it differs from the first two in its massive, pegmatic character and in its hardness. The feldspar and hornblende are both apparently little altered and are about equally proportionate. Gray, grayish-blue, and slightly pink corundum are evenly distributed through the mass in irregular grains, varying from the size of a pea to several inches in diameter. Margarite has been observed in such veins largely developed. The fourth type is very rare. It is known only at one locality. The rock is made up of fine blades of smaragdite, of a beautiful light grass-green shade, feldspar, and small grains of pink and ruby-red corundum, profusely scattered through the mass.

All varieties of corundum have been found in Georgia, with the exception of emery. The principal variety is the non-transparent variety. A few gems of the variety, sapphire, have been found at the Hog Creek mine, near Hiawassee, Towns county. These were small, prismatic crystals of ruby color, but somewhat cloudy. A few gems of sapphire are said to have been found at the Laurel Creek mine in Rabun county; this report, however, is not authentic.

The corundum of Georgia is usually pink, gray or blue, these colors frequently occurring in the same specimen. Shades of red and light to dark-blue are common. White corundum is rare, and shades of yellow and brown have not been observed.

Georgia corundum is frequently found in crystals; generally in six-sided prisms, and usually without terminations, though sometimes they are terminated by pyramidal faces. More highly modified forms have been found at the Laurel Creek mine. In the main, however, it occurs in small grains or masses. Massive pieces, weighing several hundred pounds, have frequently been taken from the Laurel Creek mine.

History.—The gold washers knew of the presence of corundum in Georgia "early in the forties," but they paid no attention to it. About 1852, Mr. Plant, banker at Macon, Georgia, sent a ruby, a small, red hexagonal prism, to Professor Shepard of Amherst College, which was said to have come from a gold mine in Habersham county. Similar brief mention, by writers of the period of 1870, place the knowledge of its presence in Georgia at an early date in the American history of corundum; yet, there seems to have been no systematic search made for the mineral at this time. About 1870, Mr. William R. McConnell, of Hiawassee, Towns county, an enthusiastic explorer, found a considerable quantity of surface corundum on his estate and, not knowing what is was, he piled it up for later determination. Shortly after, a specimen of this was shown to Rev. C. D. Smith, who immediately recognized it as corundum.

Corundum was first discovered on Laurel Creek in the early seventies by an Englishman, named Thompson. Colonel Jencks followed this discovery by examination, and worked intermittently during 1873 and 1874. Altogether, only a few months' work was put in, and the find seemed so poor that the property was finally abandoned. In 1880, several men, living in the neighborhood, mined it for asbestos. Their mining was much hampered by the frequent occurrence of hard and heavy rocks, which they were forced to remove. The nature of these rocks was unknown to them; consequently they dumped them to one side. This dump was corundum. Dr. H. S. Lucas of Chester, Massachusetts, who already had been for some time actively engaged in corundum prospecting through North Carolina, hearing of these works, visited the locality and at once purchased the property for the Hampden Emery Company of Massachusetts.

Under the able management of Dr. Lucas, corundum veins were exposed, a plant was established, and what had formerly been a poor asbestos mine soon became one of the main sources of supply to the corundum trade of this country. Work was continued from 1880 to 1892 with eminent success. In the latter year, the hillside, under which they were working the most paying vein, caved in, and for a time work was paralyzed. At this time, they had reached a depth of 130 feet, and were working in a vein averaging 8 feet in width. Up to the summer of 1893, work was carried on unsuccessfully at other points, the owners report, while a shaft was being run down through the debris to the main vein. In September of the same year, the mines were closed down. The Track Rock Corundum mine of Union county was also worked to a limited extent about the time the Lucas mine was in operation, but only a limited amount of corundum was ever shipped.

Varieties of Corundum.—Three varieties of corundum are recognized, namely, sapphire, corundum, and emery. The purer kinds of fine colors, transparent and translucent and useful as gems, are known as sapphires the dull colors, not transparent, are called corundum; while the black or grayish black variety intimately mixed with oxide of iron, either magnetite or hematite, is known as emery.

The variety termed "sapphire" includes all those kinds of corundum, which, on account of their purity in color, transparency and translucency, may be used as gems. Under this head, therefore, are grouped many stones which may be divided into two varieties, namely, the ruby and the sapphire. The ruby is pre-eminently the most important of the "precious stones" of the corundum family. Its marvelous beauty, which induced worship from the ancients, has ever awakened an allied feeling in the hearts of Christians. Stones of true "pigeon blood" color are extremely rare and valuable. Burma, Siam and Ceylon are practically the only commercial fields; and, of these, Burma alone has become celebrated for the production of the true color, though occasionally fine gems are found both in Siam and Ceylon. A perfect ruby of one carat weight, or more, has always taken precedence of the diamond in value. Of the two, equally perfect and five carats in weight, the ruby will bring ten times the price of the diamond. The sapphire was ranked by the ancients almost as high, if it was not held in quite as close esteem, as the ruby. To it, as to the ruby, they ascribed wonderful properties, and prized it exaltedly. As with the ruby, commerce knows only of a few localities in which it is found in sufficient abundance to pay for mining. The finest sapphire comes from India.

The variety "corundum" includes all semi-transparent and translucent kinds of corundum not useful as gems; also, all the dull and opaque kinds, except emery. Three types are commonly distinguished in mines, namely, sand corundum, block corundum, and crystal corundum. Sand corundum is a granular corundum, coarse or fine, usually found embedded in a gangue of vermiculites or of decomposed feldspar. In some veins, it occurs free, while in others, alteration or associate minerals, commonly albite, margarite or damourite, wrap it closely, forming a crust, which frequent washing will not remove. The color of sand corundum is usually gray to grayish-blue, although red is common, and all the other colors may be detected. This is much the most productive of corundum found, and, therefore, the most worked. Block Corundum includes the massive corundum with nearly rectangular parting or pseudo-cleavage. The largest specimen of this kind, known to have been found, was taken from the Laurel Creek mine, Rabun county, Georgia, and was said to weigh over 5,000 pounds; other immense blocks have been taken from the same mine, on account of which the mine is frequently called a "block corundum mine." Crystal corundum is quite common, and includes all corundum possessing crystal form. It is present with both the sand and the block corundum, and ranges in size from very minute crystals to those of magnificent proportion. Among the largest crystals ever found were some which were taken from the so-called block corundum veins at Laurel Creek mine during the summer of 1893.

Emery is an intimate mixture of corundum and magnetite or hematite. It is without crystal form, and has the appearance of a fine-grained iron ore, which it was thought to be, for some time. Its hardness is due to the presence of corundum; and this, together with its abundance, makes it very desirable as an abrasive agent. No emery has thus far been found in Georgia.

Physical and Chemical Properties.—The formula for corundum is written Al_2O_3. Sapphire and common corundum are considered essentially pure oxides of aluminum, while emery is an intimate mixture of corundum with an oxide of iron, either magnetite or hematite. The following analysis, by Dr. W. H. Emerson, of the Georgia School of Technology, shows the composition of a specimen of corundum from the Laurel Creek corundum mine:

Alumina, Al_2O_3	95.51
Ferric oxide, Fe_2O_3	0.88
Silica, SiO_2	1.45
Moisture, H_2O	0.74
Total	98.58

Corundum crystals are usually double terminated, six-sided pyramids of six-sided prisms, terminated by the basal plane, and, not infrequently, they are in tabular crystals or six-sided plates. Corundum is extremely brittle, except when compact; then it is tough. A broken surface shows an uneven to conchoidal fracture. The hardness of corundum is 9. The density, as compared with that of water as a standard, assumed to be 1, varies but slightly from 4. The luster of emery is metallic; of the other varieties of corundum, it is adamantine to vitreous.

Uses.—In addition to gem material, corundum has an extensive use in the arts as an abrasive. These abrasives are usually put on the market in the form of corundum or emery wheels, emery paper, or as a powder. The wheels, which also include corundum bricks, whetstones, etc., are quite varied depending upon the use to which they are to be employed. Emery paper, and also pounded corundum, is put on the market in various grades of fineness. Owing to the great hardness of corundum, these papers and powders have an extended use for abrasive and polishing materials. Corundum has also had a limited use in the manufacture of the metal aluminum, as well as in the manufacture of copper and iron alloys. The latter uses of corundum, however, have now been practically replaced by bauxite, a much cheaper mineral.

Statistics.—As previously stated elsewhere in this paper, Georgia has produced no corundum since 1893. From 1880 until 1892, a period of 12 years, Georgia was one of the chief corundum producing States in the Union. In recent years, the corundum mines of Georgia have remained inactive, due chiefly to the low price of corundum and not, as might be supposed, to the exhaustion of the deposits.

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FULLER'S EARTH

Location.—The best deposits of fuller's earth occur in the vicinity of Attapulgus, Decatur county and near Whigham, Grady county. In the former locality the fuller's earth has been worked to a considerable extent by the Lester Clay Company. In addition to these deposits there are also deposits of fuller's earth occuring in Bibb, Twiggs, Columbia and other counties near the Fall Line. The deposits in the vicinity of Pike's Peak, Twiggs county, have been rather extensively worked by the General Reduction Company. These latter deposits are usually associated with the Cretaceous kaolin and fire-clays.

Geology.—The two different deposits of fuller's earth occur in two distinct and separate geological horizons. The deposits found in Decatur and Grady counties are found in the Chattahoochee group which belong to the Oligocene series, while the deposits in Twiggs and the other counties along the Fall Line belong to the Claiborne formation, one of the main divisions of the Eocene rocks.

Mode of Occurrence.—The fuller's earth deposits in the vicinity of Attapulgus occur as irregular beds extending over considerable area. The beds often show distinct lamination and occasionally thin partings of fine white sand. In thickness the beds are variable, but they often attain a thickness of 5 feet or more of the purest variety of the earth. In the Fall Line district the deposits attain a much greater thickness and in places show but litle evidence of stratification. In Twiggs and also in Bibb county it is no uncommon thing for the beds of the fuller's earth clays to attain a thickness of fifty feet or more.

Physical and Chemical Properties.—Fuller's earth is a clay-like material of various colors. The most common color is light cream or brownish gray. It differs from common clay usually in being porus, carrying a high percentage of combined water as compared with the alumina and in having but little or no plasticity. It also has the property of absorbing greases and oils, a property which has long been recognized and made use of in fulling cloth.

The chemical composition of the variety of fuller's earth now being mined in Georgia is shown by the following analysis[1] of a sample taken from the mines of the Lester Clay Company at Attapulgus, Decatur county:

Moisture at 100° C.	8.970
Loss on ignition	10.910
Silica, SiO_2	54.110
Alumina, Al_2O_3	13.028
Ferric oxide, Fe_2O_3	4.080
Manganous oxide, MnO	.110
Lime, CaO	.900
Magnesia, MgO	5.860
Sodium oxide, Na_2O	.183
Potassium oxide, K_2O	.486
Titanium dioxide, TiO_2	1.012
Sulphur, S	.000
Phosphorus pentoxide, P_2O_5	.000
Total	99.649

It will be seen by this analysis that the amount of silica runs very high which is usually one of the characteristics of fuller's earth.

Method of Mining and Preparing for Market.—The method of mining and preparing the fuller's earth for market is quite similar to that adopted in mining and preparing the better varieties of paper and china clays, with the exception, however, the fuller's earths are never washed. The refining process consists of passing the earth through a series of sieves or bolting cloths after it is dried and thoroughly pulverized.

1. Analysis by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.

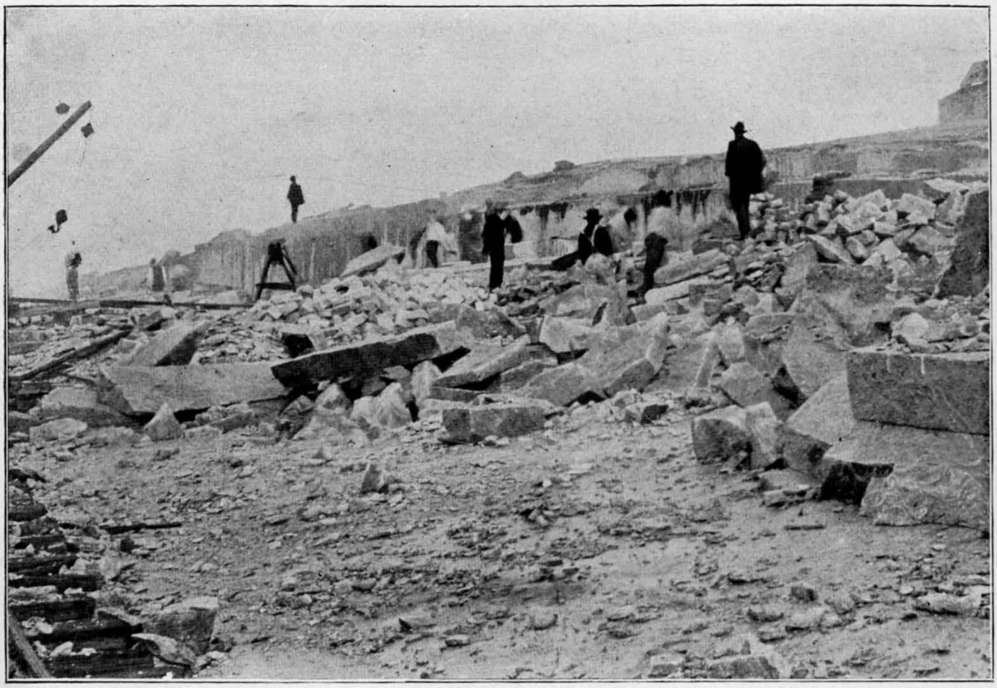

Fig. 2

GRANITE-GNEISS QUARRIES, PINE MOUNTAIN, LITHONIA, GEORGIA. FIG. 2 SHOWS THE QUARRY-FACE AND THE QUARRY BOTTOM AT THE SURFACE OF THE DOMING MASS.

By this method of treatment all of the sand and other coarse foreign material are taken out and it forms a uniform texture before it is put on the market. One of the great troubles in preparing the fuller's earth for the trade is the difficulty of getting it properly dried. The material is quite porous and takes up an unusually large amount of water, so that the cost of drying the earth usually constitutes one of the main items of expense in preparing it for the trade.

Uses.—Fuller's earth, so called on account of it being first used in fulling cloth, is now largely employed in decolorizing and clarifying oils and fats. This peculiar property of this clay-like material is not fully understood, but it is probably due to physical rather than chemical conditions. The method of using these earths in clarifying vegetable oil is usually very simple and consists in first heating the oil in a tank somewhat above the boiling point of water when from 5 to 10 per cent. of earth is added. This mixture is then rapidly stirred for a few minutes when it is filtered, the earth, together with the colored matter, remaining in the filtering cloth, while the clarified oil passes through. Besides the use here given, fuller's earth has also a limited application in the preparation of certain medicines and in the manufacture of soap as well as an absorbent.

Statistics.—The following table, taken from the Mineral Resources of the U. S. Geological Survey, shows the production of fuller's earth in the United States since the beginning of the production in 1895:

Year	Quantity Short Tons	Value	Year	Quantity Short Tons	Value
1895	6,900	$ 41,400	1902	11,492	$ 98,144
1896	9,872	59,360	1903	20,693	190,277
1897	17,113	112,272	1904	29,480	168,500
1898	14,860	106,500	1905	25,178	214,497
1899	12,381	79,644	1906	32,040	265,400
1900	9,698	67,535	1907	32,851	291,773
1901	14,112	96,835	1908	29,714	278,367

The main producers of fuller's earth by States named in the order of their importance are as follows: Florida, Arkansas, Georgia, South Carolina, Massachusetts, Colorado and Texas.

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GOLD

Location.—The gold deposits of Georgia are found in a portion of a broad zone of country stretching from near the center of Alabama northeastward into Maryland and lying principally southeast of the Blue Ridge Mountains. In Georgia, this zone takes in the greater portion of the Piedmont Plateau and a part of the physiographic provinces of the Appalachian mountains. Auriferous areas, in which are found gold-bearing quartz veins and other forms of deposits, occur throughout this region, generally as more or less parallel belts of relatively narrow lateral dimensions, but they are found at some localities as small isolated areas or patches.

In Georgia, the larger portion, by far, of the auriferous areas occur in narrow well-defined belts, and show as bands of varying width running nearly parallel in a northeast and southwest direction. In addition to the belts, a few isolated areas are found in the same section in which the belts occur. All of the deposits are north of the Fall Line, a line formed by the junction of the Piedmont region and the Coastal Plain. In Georgia, this line passes approximately through the cities of Columbus, Macon, Milledgeville and Augusta. The belts parallel in a general way the axis of the Blue Ridge mountains and the larger portion of them lie southeast of this axis. These individual belts are here described.

The Dahlonega belt enters Georgia from Alabama and passes through Haralson and Paulding counties, the northwest corner of Cobb and the southeast corner of Bartow counties, traverses Cherokee county and the extreme northwest corner of Forsyth county and from thence passes through Dawson, Lumpkin, White, Habersham and Rabun counties into Macon county, North Carolina. The Dahlonega belt has a length, in Georgia, of about 150 miles and varies in width at different localities from 2 to 6 miles. The Hall county belt commences in the northern part of Fulton county, runs northeast through Milton, the extreme southeast corner of Forsyth, the northwestern part of Gwinnett, and from thence through Hall, Habersham and Rabun counties into North Carolina. The length of this belt, in Georgia, is about 100 miles. The McDuffie county belt commences in the northeast corner of Warren county, runs northeast through the northern portion of McDuffie, the extreme southeast corner of Wilkes and from thence through Lincoln county to the Savannah River. Its continuation is probably found in South Carolina and in the North Carolina belt. The McDuffie belt is nearer the Coastal Plain than any other known belt, its distance from the Fall Line being about 20 miles. The length of this belt, in Georgia, is about 30 miles with an average width of about 2 miles. The Carroll county belt commences in the western part of Carroll county and, running northeast, passes through a corner of Douglas and thence, traversing a portion of Paulding and Cobb counties, joins the Dahlonega belt at the northern edge of the last named county. As thus outlined, its length is about 50 miles and its greatest width does not probably exceed 2 miles. The Oglethorpe county belt runs northeast through the eastern part of Oglethorpe county. Its length is something like 25 miles and its width is about the same as that of the Carroll county belt. The Madison county belt occurs in Madison and Elbert counties, and extends from a point a few miles northeast of Comer in Madison county to a point about 3 miles northeast of Bowman in Elbert county. Its total length, as far as it has been traced, is only about 10 miles. All of the belts, the locations of which have thus far been described, lie, excepting a small portion of the Dahlonega belt in Rabun county, south or southeast of the crest of the Blue Ride mountains, the most eastern range of the Southern Appalachians. Several belts of minor dimensions are found north of the crest line of the Blue Ridge. The Gumlog belt runs from a point a little south of the Gumlog mine in the northern part of Union county northeast through the northwest corner of Towns county to the Warne mine immediately beyond the State line in North Carolina. Its length, in Georgia, as far as it is known, is about 8 miles. The Coosa Creek belt runs from near the headwaters of Coosa Creek in Union county northeast to a point in the neighborhood of the town of Young Harris in Towns county. Its length is about 15 miles. The Hightower Creek belt runs from near Mountain Scene on the headwaters of Hiawassee River in Towns county northeast to within a few miles of the Georgia-North Carolina line. Its length is about 10 miles.

In addition to the above mentioned well-defined belts, a number of localities are to be noted where gold has been found in isolated areas. The relations, however, of some of these deposits indicate that future prospecting will probably connect a portion of them at least into belts with the usual northeast-southwest trend. The counties in which are to be found the more important deposits of the class just described are Fannin, Gilmer, Lincoln, Hall, Cherokee, Meriwether, Forsyth, Wilkes and Murray. A little gold has also been mined in Hart, Walton, Coweta, Campbell and Newton counties.

GEOLOGY.—The geological formations in which the gold-bearing veins occur are the most ancient in the State, and among the oldest of all the formations of the North American Continent. In Georgia, the rocks of these formations vary in age from Cambrian to Archæan. In the northwestern part of the region, among these ancient rocks, highly altered original sedimentaries are to be found that are usually referred to the Cambrian period. Unaltered, or only slightly altered, intrusive diabases of a later age than Cambrian occur at numerous localities, but their total area is insignificant compared with that of the entire region, when the prevailing rocks are probably Archæan.

A very casual study of the rocks of the Crystalline area will show that the majority of them have been subjected to great shearing stress. Occasionally bodies of granite, probably younger than the neighboring formations, can be found that appear to have been subjected to only a limited amount of pressure, but the major portion of the rocks are gneisses and schists often showing a highly contorted as well as sheared structure. While widespread regional metamorphism is characteristic of the area as a whole, yet, at some points, lines are found along which shearing forces appear to have been especially concentrated.

The auriferous veins were probably formed during the closing period of the last earth crust movement that produced important changes of structure in the rocks. The evidence that their age does not exceed this is found in the fact that the majority of them do not show any large amount of faulting or crushing. All of the veins may not be of the same age and if more definite evidence in regard to age relations was obtainable it might be found that several series of veins are represented in the area. Most geologists who have written on the Southern Appalachian fields arrived at the conclusion that the greater part, at least, of gold deposition antedated Cambrian times.

Some of the gold deposits of Georgia, that occur as isolated areas, are found in rocks that, from their position, can not reasonably be referred to older formations than the Cambrian. The principal vein of the Cohutta gold mine on Cohutta Mountain, in Murray county, occurs in a metamorphosed sediment, probably belonging to the Ocoee.

In North Carolina, ancient volcanics have been found in the region of the gold deposits and referred to Algonkian times, but in studying the rocks associated with the Georgia deposits, nothing indicating an original surface flow has been observed.

Mode of Occurrence.—The three principal types of gold deposits recognized in Georgia are vein deposits, placer deposits and auriferous saprolites or decomposed rock in place.

Several varieties of veins are to be noted. The predominant types are veins conforming in the main to the trend of the inclosing schists and gneisses, which is usually northeast and southwest. These veins pinch and swell both horizontally and vertically causing one of the greatest difficulties attendant on mining this class of deposits. Bodies of ore fifteen or twenty feet in thickness may occur at some points while a short distance away on the same level a small stringer or seam of quartz may be all that represents a vein. These conditions render it difficult to calculate the amount of ore available. At some mines, it has been noted that the pinches and swells occur with a fair degree of regularity, as at the Franklin, or Creighton mine in Cherokee county, where the ore bodies are said to average 60 or 70 feet in linear extent.

In connection with the veins, conforming with the schistosity of the country rock, is a type of deposits which may be designated as gold-bearing zones. These consist, as the name implies, of auriferous zones having in most cases the trend of the formations in which they occur and containing many more or less conformable quartz stringers or lenses of quartz with country rock. They vary from a foot or two to several yards in thickness. Frequently, several more or less parallel zones, ranging from a few to 20 or 30 feet in thickness, occur closely associated, the distribution, as a whole, forming a major zone in some cases several hundred feet in width, the strike of which may, in certain instances, be followed for miles. In these large zones, the paying values, as would be expected, are limited to bands and restricted areas.

In addition to interfoliated veins, others cutting the schistosity of the inclosing rocks at various angles are not uncommon. It is generally believed that these are more uniform and persistent than the other class. Swells and pinches and other irregularities of structure, however, are frequently met with. These non-interfoliated veins are quite common in the McDuffie belt and a number of them have been good producers.

In size, the veins in Georgia, as in other sections of the Southern Appalachian gold fields, vary from a few inches to over twenty feet in thickness. The outcrop of many of the large veins is very noticeable and shows them in some cases holding their width quite uniformly for a number of rods. The most of the largest veins that have been tested show low values, an average in most cases from $6.00 to $15.00 per ton may be considered good. They have not been sufficiently exploited, however, to establish this as a rule.

The placer deposits bear a close relation to the vein deposits, that is, in sections where the veins are most numerous and carry good values the placers have been found to be proportionately important. The auriferous gravel deposits may be classed as both ancient and modern. It is difficult, however, to draw a line between the two classes at many localities. The valleys of the larger streams, where they run with or across the gold belts, are frequently underlain with quite heavy beds of thoroughly water-worn gravel overtopped with sand and clay. In some cases tenaceous blue clay is mixed with the gravels and forms a layer several feet in thickness immediately above the gravel beds. In the lowest parts of the valleys the gravels are usually near the present level of the streams and are to be found thinning out at varying heights along the slopes of the valleys. The different auriferous gravel deposits so far located are associated with present drainage systems and while placer gold can be obtained at some localities as high as thirty or forty feet above the streams, yet the bulk of the gold that has been mined has come from lower levels. These deposits owe their origin to a flooded condition of the streams during a period of subsidence. The changes of level are probably to be referred to the Lafayette or the Columbian period.

Many of the richest placer deposits have been found along the small streams feeding into the larger valleys and in some cases very rich finds have been made in gulches or dry hollows,

THE WHEELER ORE BANK, NEAR EMERSON, BARTOW COUNTY, GEORGIA.

as they are termed, near the smaller streams. These latter deposits grade into the modern deposits previously mentioned as formed by rain-wash and gravitative action.

The saprolite deposits form a rather unique class of gold deposits. The rocks of this section of Georgia are deeply decayed at many localities. The decayed product is found in place, there having been no invasion of the region by glaciers during the period when removal of decomposed rock material by ice erosion was taking place in more northern localities.

In these auriferous bodies of decomposed rock more or less disintegrated quartz veins and many small stringers of quartz are usually present. The gold, generally freed from sulphides, is found both in the quartz and in the rotten rock. In some cases the veins of quartz may be very small, occurring as numerous tiny stringers and seams, and in other cases some individual veins may be of sufficeint size to form workable ore bodies. In the latter case, these larger veins are sometimes mined independently as ordinary vein deposits, as the surrounding saprolite material grades into undecomposed rock below and can no longer be worked by hydraulicking.

Although these deposits are largely worked by washing, and have been described under the heading of placers by several writers, they are not to be confounded with true placer deposits in which the gold has been concentrated by the transporting power of water. In saprolite deposits a certain amount of concentration of gold has taken place by removal of some portions of the rock ingredients in solution while the insoluble or only slightly soluble gold is left behind.

History.—Omitting the traditions of the early Spanish mining, gold, according to White's Statistics of Georgia, was first discovered in the State on Dukes Creek, White county, in 1829. Another account places the first discovery in 1828. The latter discovery is reported to have been made near

Nacoochee, White county, by a negro servant of Major Logan, while on his way from Rutherford, North Carolina, where gold mines had just been opened. The deposits along the Nacoochee River, are said to have attracted the negro's attention and a pan test resulted in the discovery of gold. It is also reported that the first discovery of gold was made on the Calhoun property in Lumpkin county, near Dahlonega. Living witnesses are said to substantiate the last named discovery, but whether or not it antedates the White county discoveries is not known. It seems quite likely that the early discoveries succeeded each other so rapidly that it is now practically impossible to establish the date of priority.

Only a few months after the announcement of the occurrence of gold in North Georgia, hundreds of miners were busily engaged on various streams throughout the section in search of the yellow metal. Governor Gilmer, in a letter dated May 6th, 1830, says: "I am in doubt as to what ought to be done with the gold-diggers. They, with their various attendants, foragers and suppliers, make up between six and ten thousand persons. They occupy the country between the Chestatee and Etowah rivers, near the mountains, gold being found in the greatest quantity, deposited in the small streams which flow into those rivers." It was during this year that the first deposit of gold from Georgia, amounting to $212,000 was made at the U. S. Mint. The most active mining region, at the time, was in Lumpkin county, in the vicinity of Dahlonega. So important had these gold fields become, that the U. S. Government established a branch mint here, in 1838. The mint continued in operation, until 1861, and coined 1,381,-784 pieces, valued at $6,115,569. The total gold production of Georgia to date has been approximately $17,500,000.

The greatest annual output, from the State, occurred in 1843 when the total yield of the various mines, then in operation was $582,782.50. Since the above date, the output has greatly fluctuated from year to year. However, the total yield has gradually decreased, due mainly to the exhaustion of the placer mines, the source from which the greater part of the Georgia gold has been derived.

METHODS OF SAVING THE GOLD.—The methods adopted in saving the gold are variable, depending upon the condition of the ore and the nature of the gold. In vein mining, where the ore has been oxidized and the gold is in a free state, the process adopted is usually amalgamation, but where the gold occurs in sulphurets the barrel chlorination has been chiefly resorted to. The latter method of ore treatment, which has been in operation at the Creighton mine for several years, is here described. The ore, after having been crushed by stamps, passes over the amalgamated plates where about 50 per cent. of the gold is collected, while the remainder is carried off in the sulphides to the concentrators where the greater part of the quartz and other gangue material is removed, leaving concentrates consisting of about 80 per cent. sulphides. The concentrates are carried, in a small car, from the mill to the chlorination plant near by, and are there roasted in a double-hearth reverberatory furnace for 24 hours. This reduces the sulphides to a fraction of 1 per cent., and leaves the gold in such a condition that it can be readily acted upon chemically. From the furnace room, the roasted concentrates are elevated to the third story of the building and are there dumped into a small car, which conveys them to the chlorination barrel. This consists of an oblong iron cask, lined inside with lead, and provided with a charging door, which can be hermetically sealed. It is mounted on an axis and revolves slowly while in use. The motion keeps its contents continually agitated and greatly facilitates the chemical action, which would otherwise be very slow and incomplete. The barrel is charged by placing into it one ton of the roasted concentrates with a sufficient amount of water to render it semi-fluid. To this is added about 12 pounds of chloride of lime and an equivalent amount of sulphuric acid. It is then sealed and revolved on its axis from 4 to 6 hours, when the gold is found to have been acted upon by the nascent chlorine gas, changing it to gold chloride.

The pulpy material is now removed from the barrel to specially prepared filters, where the gold chloride is leached out with water, and the solution is then transferred to storage tanks. From these tanks, the solution passes to the precipitating tanks, where the gold is thrown down by means of ferrous sulphate. The gold precipitate is finally collected, dried, mixed with soda and borax, melted in a crucible and cast into ingots.

The placer and saprolite deposits are chiefly worked by the hydraulic process. The latter deposits, which consist mainly of decomposed rock in place, are mainly worked by sluicing the material through flumes to mills located at some point below the level of the cuts thus formed. A portion of the gold is generally saved by amalgamation in the sluice boxes and the fine portion of the sluiced material is conducted to ore bins behind the batteries of the mills in which it is to be treated. The larger pieces of quartz and partially decomposed rock are removed by grizzlies or some similar contrivance before the current reaches the ore bins, and this material is frequently crushed at the more extensive plants in a separate mill.

In addition to the above methods, a limited amount of work has also been carried on in some of the rivers by means of dredge boats.

STATISTICS.—The production of gold in Georgia for the years 1890 to 1908 inclusive is given in the following table:

Year	Quantity Fine Ounces	Value	Year	Quantity Fine Ounces	Value
1890	-----	$ 100,000	1900	5,644	$ 116,700
1891	3,870	80,000	1901	6,023	124,500
1892	4,583	94,734	1902	4,730	97,000
1893	4,702	97,200	1903	3,000	62,000
1894	4,772	98,652	1904	4,688	96,900
1895	6,192	128,000	1905	4,687	96,900
1896	7,305	151,000	1906	1,149	23,700
1897	7,222	149,300	1907	3,135	64,808
1898	6,221	128,600	1908	2,719	56,207
1899	5,466	113,000			

In 1908 there were 34 gold mines operated in Georgia—22 placers, which include saprolite mining, and 12 deep mines. The number of tons of siliceous ores mined was 6,196, which yielded an average of $7.28 per ton.

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GRANITES AND GNEISSES

Location.—The granites and gneisses of Georgia are confined to what is known as the Piedmont Plateau. This area includes, with the exception of ten northwestern counties, all of that part of the State north of the Fall Line, which line extends from Augusta through Macon to Columbus. Both granites and gneisses are widely distributed throughout this area, but at present the quarrying of these stones is confined to less than a score of counties. The principal centers of the quarrying industry are at Stone Mountain, Lithonia, Elberton, Oglethorpe, Lexington, Sparta, Eatonton, Odessa, and Newnan. In addition to these main quarrying centers, openings of greater or less dimensions have been made in nearly every county of the Crystalline area where a limited amount of stone has been quarried from time to time for local purposes. With the exception of the mica and hornblende schists the granites and gneisses are the prevailing rocks of the Crystalline area, and they may therefore be said to be practically inexhaustible.

Geology.—The Crystalline area is composed of completely holo-crystalline rocks, which afford at present but little evidence of ever having been deposited as sediments. Whatever may have been their origin and structure in the beginning, they have been subjected to so many vicissitudes of profound dynamic metamorphism, mainly through pressure and recrystallization, that proof of sedimentation with a few exceptions is scant. This metamorphism has induced a secondary foliation in the rocks by arranging the mineral constituents along parallel lines, which evidently bear little or no relation to the possible original bedding planes in many of these rocks.

The rocks consist principally of granites, gneisses and schists, cut by a series of younger basic eruptions, principally diabases and diorites. Along the northwestern limits and in other parts of the area, basic ferro-magnesian silicate rocks of igneous origin, containing the corundum deposits, are found crossing the State. Along the eastern, middle northern, and southwestern parts of the area are found belts of quartzite and, in some places, limestone.

Throughout the area the rocks have a prevailing southeast dip approximating 50° and strike from 20° to 30° west of south. Local variations, however, in both dip and strike are wide-spread and marked over the region.

At present, nothing can be said definitely concerning the origin of the schists of the Piedmont region but it is certain that all the granites and gneisses thus far studied are of igneous origin and represent several periods of intrusion, varying from Archæan to Cambrian times.

Mode of Occurrence.—The granite rocks of the State appear for the most part, in large, flat, horizontal masses; as dome-shaped areas of steep and gentle slopes; as large, well rounded boulders scattered over the surface and partially buried in the residual decay; and as ledges exposed along the streams and in ravines, as well as in dikes from one to many feet in width. The outcrops of the flat, horizontal masses vary in extent, from one to fifty or more acres; while the dome-shaped areas contain from fifty to many hundred acres of exposed rock. The best illustrations of the former occur in Hancock, Heard, Meriwether and Pike counties. Stone Mountain in DeKalb county, which rises to an elevation of 686 feet above the surrounding lowland plain, and which has a basal circumference of approximately seven miles, is the most extensive of the dome-shaped masses. Pine, Arabia, Collinsville, McDaniel and Rock-Chapel mountains, belonging to the Lithonia belt of contorted granite-gneiss, may be mentioned as examples of some of the other dome-shaped areas, which vary from 75 to 200 feet in elevation. A scanty granitic soil-covering occurs in places over the larger outcrops. In this, a stunted growth of gnarled cedars, mosses and lichens is usually found. The growth of cedars has become so prevalent over some of the exposures that the outcrops are referred to, locally, as "cedar-rock." In other cases, a few of the flat horizontal masses are known as "flat-rock," on account of the extent and nature of the outcrop. Cedars, mosses and lichens constitute the bulk of vegetation found covering the rock outcrops.

HISTORY.—Among the first granite quarries opened up in the State were those at Stone Mountain. Records show that some rock was quarried from the somewhat disintegrated and decomposed ledges of the ridge as early as 1845 to 1850. The first systematic quarrying, however, was begun in 1869, when the Stone Mountain Granite and Railway Company was chartered by Messrs. John T. Glenn, S. M. Inman and J. A. Alexander, citizens of Atlanta. In 1882, the present owners, the Venable Brothers, of Atlanta, purchased the entire porperty of 2,200 acres, and immediately began developments for extensive quarrying. The annual shipment outside of the State rapidly increased from ten car-loads, under the management of the former company, to twenty thousand car-loads under that of the Venable Brothers.

It was through the efforts of the Venable Brothers, that the development of this property gained for Georgia the high rank and reputation the State now holds among the other granite-producing States in the Union as a granite producer. For some years, DeKalb county, limited exclusively to the output from the Stone Mountain and Lithonia areas, produced all the granite shipped outside of the State; and, in amount of production, it has always ranked first among the numerous granite-producing counties in the State. As early as 1893, the

THE KINSEY ORE BANK, SUGAR HILL, BARTOW COUNTY, GEORGIA.

Stone Mountain quarries were capable of yielding a total capacity of 25,000 paving blocks per day. Two years prior to the last date given, the first quarry, namely, the Coggins Quarry, was opened up in Elbert county, which was followed by the quarries at Lexington, Sparta, and at other points.

CHEMICAL PROPERTIES.—The chemical composition of the Georgia granites and gneisses is shown by the following analyses:

Name of Quarry.	Silica.	Alumina.	Iron Sesqui Oxide	Lime.	Magnesia.	Potash.	Soda.	Ignition.	Total.
Henry Pettus, Wilkes county	74.64	14.00	1.05	1.76	0.37	7.77		0.41	100.00
Stone Mountain	71.66	16.05	0.86	1.07	0.17	4.92	4.66	1.00	100.39
Swift and Etheridge	70.38	16.47	1.17	1.72	0.31	5.62	4.98	0.31	100.96
Diamond Blue Granite Co. (Main opening)	70.30	16.17	1.19	2.61	0.31	4.88	4.72	0.63	100.81
Lexington Blue Gr. Co.	70.03	15.62	1.31	2.45	0.52	5.42	4.82	0.77	100.94
Greenville Granite Co.	69.88	16.42	1.96	1.78	0.36	5.63	4.45	0.39	100.87
Coggins	69.74	16.72	1.45	1.93	0.36	5.33	4.84	0.47	100.84
Carmichael, Campbell county	69.55	16.72	0.99	1.69	0.27	3.94	5.88	0.27	99.31
Diamond Blue Granite Company (Average from minor openings)	69.53	16.46	1.15	2.10	0.85	4.91	5.00	0.91	100.91
Swift and Wilcox, Elbert county	69.45	15.93	1.31	1.91	0.55	5.16	4.33	0.50	99.14
Linch, Putnam county	69.34	17.01	1.74	2.77	0.61	4.54	4.69	0.26	100.96
Tate and Oliver, Elbert county	69.25	16.04	1.72	1.89	0.31	4.94	4.52	0.43	99.10
R. D. Cole, Coweta county	69.08	17.67	1.41	3.27	0.64	3.29	4.56	0.56	100.48
Echols Mill, Oglethorpe county	68.81	17.67	1.13	2.17	0.50	3.90	4.97	0.30	99.45
Sam Hill, Coweta county	68.79	16.48	0.98	1.76	1.30	5.85	4.74	0.38	100.28
Turner, Spalding county	68.76	16.80	0.99	2.72	1.00	3.70	4.82	0.29	99.08
T. B. Tigner, Meriwether county	63.27	19.93	2.82	2.89	0.49	4.85	4.14	0.86	99.25
A. M. Hill	62.52	23.58		3.24	1.55	8.57		0.54	100.00
Georgia Quincy Granite Company	70.90	15.86	1.37	2.15	0.02	4.62	5.05	0.50	100.47
L. N. Calloway, Baldwin county	69.37	16.99	1.99	2.03	0.84	4.54	3.44	0.55	99.75
Crossley, near Lithonia, De Kalb county	76.00	13.11	0.92	1.06	0.27	4.69	3.88	0.31	100.24

Physical Properties.—The following table gives the specific gravity, ratio of absorption, weight per cubic foot, and number of cubic feet contained in one ton (2,000 lbs.)

	Specific Gravity	Ratio of Absorption	Weight per Cubic Foot	Number Cubic Feet Stone in 2,000 lbs.
Lexington Blue Granite Co	2.666	0.092	166.25	12.0
Diamond Blue Granite Co	2.666	0.088	166.62	12.0
Echols Mill	2.657	-----	166.06	12.0
Greenville Granite Co	2.662	0.086	166.37	12.0
Swift & Wilcox Quarry	2.652	0.090	165.75	12.0
Swift & Wilcox Flat Rock	2.645	0.092	165.31	12.0
Tate and Oliver	2.670	0.093	166.87	11.9
Coggins	2.840	0.090	177.50	10.7
Childs	2.665	0.092	166.56	12.0
Stone Mountain	2.686	0.067	167.90	11.9
Odessa	2.642	0.056	165.12	12.1
Snell	2.642	0.075	165.12	12.1
Lithonia	2.686	0.052	167.90	11.9
Flat Rock, Heard county	2.648	------	165.50	12.0

The following table gives the results of crushing tests made at Purdue University, LaFayette, Indiana, on specimens of stone from Stone Mountain and Lithonia:

Locality	CRUSHING TEST. Dimensions	Crushed at Pounds	Crushed at Lbs. per Sq Inch
Lithonia	2.02 in. x 2.04 in. x 2.07 in.	80,000	------
Lithonia	2.02 in. x 2.01 in. x 2.06 in.	61,000	15,024
Lithonia	2.01 in. x 2.01 in. x 2.01 in.	80,000	19,801
Lithonia	2.01 in. x 2.00 in. x 2.00 in.	80,700	------
Lithonia	2.02 in. x 2.08 in. x 2.02 in.	75,700	18,017
Lithonia	2.02 in. x 2.05 in. x 2.02 in.	64,000	15,455
Lithonia	2.06 in. x 2.02 in. x 2.02 in.	78,700	18,913
Lithonia	2.04 in. x 2.04 in. x 2.06 in.	71,700	17,229
Lithonia	2.04 in. x 2.03 in. x 2.03 in.	79,700	19,246
Lithonia	2.04 in. x 2.04 in. x 2.05 in.	79,700	19,151
Lithonia	2.02 in. x 2.02 in. x 2.01 in.	74,700	18,307
Lithonia	2.01 in. x 2.02 in. x 2.04 in.	70,700	17,413
Stone Mountain	2.00 in. x 2.01 in. x 2.02 in.	50,000	12,438
Stone Mountain	1.99 in. x 2.01 in. x 1.99 in.	57,700	14,425
Stone Mountain	2.04 in. x 2.04 in. x 2.05 in.	53,700	12,904
Stone Mountain	2.04 in. x 2.07 in. x 2.05 in.	55,700	13,190
Stone Mountain	2.01 in. x 2.03 in. x 2.02 in.	54,700	13,406
Stone Mountain	2.02 in. x 2.05 in. x 2.01 in.	52,700	12,726

Uses.—The granites and gneisses of Georgia constitute one of the most extensive and important building and monumental stones of the State. They occur in inexhaustible quantities and are profusely distributed throughout the Crystalline area. One of the most interesting and the largest granite masses is that of Stone Mountain, located in DeKalb county, 17 miles northeast of Atlanta. The stone obtained from these quarries is a light-colored muscovite granite possessing remarkable strength and is quite free from all chemical and physical defects. The stone has extensive use as a building material and is also largely employed in street improvement. There is likely no granite in the South more widely known and more generally used than that furnished by the Stone Mountain quarries. It not only has an extensive local use, but much of it is shipped beyond the borders of the State.

Another granite, or more correctly speaking a gneiss, of almost as much economic importance as the Stone Mountain granite, is the Lithonia granite. This stone, which differs chiefly from the Stone Mountain granite in having laminated structure, covers a considerable area in the eastern part of DeKalb and the contiguous parts of Rockdale and Gwinnett counties. The Lithonia quarries are very extensive and furnish large quantities of stone for street improvement as well as for general building purposes. Granites and gneisses, similar to the above, are found in many localities in North Georgia, but only at a few points have they been quarried to any extent.

In addition to the granites and gneisses above mentioned there are other granites which possess qualities that especially fit them for monumental stone. Some of the granites of this character which in the last few years have become quite popular as decorative stone are those obtained from the Elberton. the Oglesby, the Lexington, and the Meriwether quarries.

These monumental granites are fine-grained biotite granites, unusually free from injurious minerals, and admitting of a very brilliant polish. They have but few equals if any superiors in the United States as a monumental stone, and it is only a question of time when the Georgia monumental granite industry will be of very great commercial value to the State.

Besides the uses above enumerated, the Georgia granite and gneisses also have an extended use in paving and curbing as well as in road ballast and concrete work.

STATISTICS.—The following figures taken from Mineral Resources, U. S. Geological Survey, show the value of the Georgia granite product, by years, from 1890 to 1908 inclusive:

Year	Value	Year	Value
1890	$752,481	1900	$380,434
1891	790,000	1901	761,646
1892	700,000	1902	803,778
1893	476,387	1903	672,947
1894	511,804	1904	942,466
1895	508,481	1905	971,207
1896	274,734	1906	792,315
1897	436,000	1907	858,603
1898	339,311	1908	970,832
1899	411,344		

The Tenth Census, in 1880, placed Georgia as the twelfth granite producing State in the Union. The value of the granite product in the State for that year was estimated at $64,480. The next decade, ending 1890, witnessed a remarkable growth in, and development of, the granite industry in the State, revealed in the enormous increase in production. The rapid advancement, made during this period, is shown in the Eleventh Census report for 1890, where Georgia is ranked as sixth among the granite producing States. The valuation of the granite production by States, for 1889, placed Georgia ahead of New Hampshire, which has long been known as the "Granite State." At present, Georgia stands seventh in the rank of the production of granite in this country, being exceeded by Vermont, Massachusetts, Maine, Colorado, Wisconsin, and Maryland.

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GRAPHITE

LOCATION.—Graphite, in limited quantities, is found in a large number of counties in the Piedmont Plain. The most noted occurrences are in Bartow, Cobb, and Pickens counties. It is also known to occur in Cherokee, Douglas, Elbert, Hall, Heard, Madison, Rabun, Habersham, Spalding and other counties. The Bartow county deposits, as so far developed, are in the immediate vicinity of Emerson, where they have been worked more or less continuously for some years. The most promising deposits of Pickens county are probably those in the vicinity of Sharp Top Mountain, about 5 miles west of Jasper.

GEOLOGY.—All of the graphite deposits of the State are associated with highly metamorphic slates, gneisses and schists. In the Emerson district, these rocks are lower Cambrian in age. The graphite in Cherokee and Pickens counties probably also occurs in Cambrian rocks, while the occurrences in the counties further to the east will probably be found to be associated with pre-Cambrian or Archæan rocks.

MODE OF OCCURRENCE.—In most cases, the graphite occurs interbedded with the slates and schists, as in the Emerson district, but it is also met with in irregular veins or as impregnations. A good illustration of the last two modes of occurrence is to be seen in the vicinity of Sharp Top Mountain, Pickens county. Here, it is found chiefly as impregnations in the gneisses, though, at one point, it is to be seen as a well defined vein traversing these rocks. In addition to these occurrences, the graphite is also occasionally met with in the form of small irregular pockets in the schists and gneisses.

HISTORY.—Mining graphite, or more properly speaking, the mining of graphite schist, was begun in the Emerson district by Joseph F. Allison in 1892. About ten years subsequent to this date the American Graphite Company also began mining in the same district. These two plants have practically produced all of the graphite material put upon the market up to the present date. At several localities, notably, in the vicinity of Sharp Top Mountain, Pickens county, there has been considerable prospecting, but none of the prospects have become regular producers.

Physical and Chemical Properties.—Graphite occurs in two forms, namely, the amorphous and the crystalline. The former variety, which is of an earth nature, is by far the most abundant variety met with in Georgia, and is the kind mined in the Emerson district, where it forms from 2 to 4 per cent. of the schist with which it is associated. The crystalline variety, which mostly occurs in the form of scales or flakes, is not so often met with. Nevertheless, good specimens of this variety have been found in Cobb, Pickens, Spalding, and other counties.

A sample of graphite from Cobb county gives the following analysis:

Volatile matter	2.26
Graphite (C)	82.26
Ash	15.48
Total	100.00

Samples of graphite from Spalding county showed over 90 per cent. graphite (carbon).

Uses.—All of the graphite material at present mined in Georgia is used as a filler for commercial fertilizers. Graphite is highly refractory and is therefore largely used in the manufacture of crucibles, which have to withstand intense heat. Graphite is also used in making lead pencils, lubricants, foundry facing, stove polish, electrotyping and in paint.

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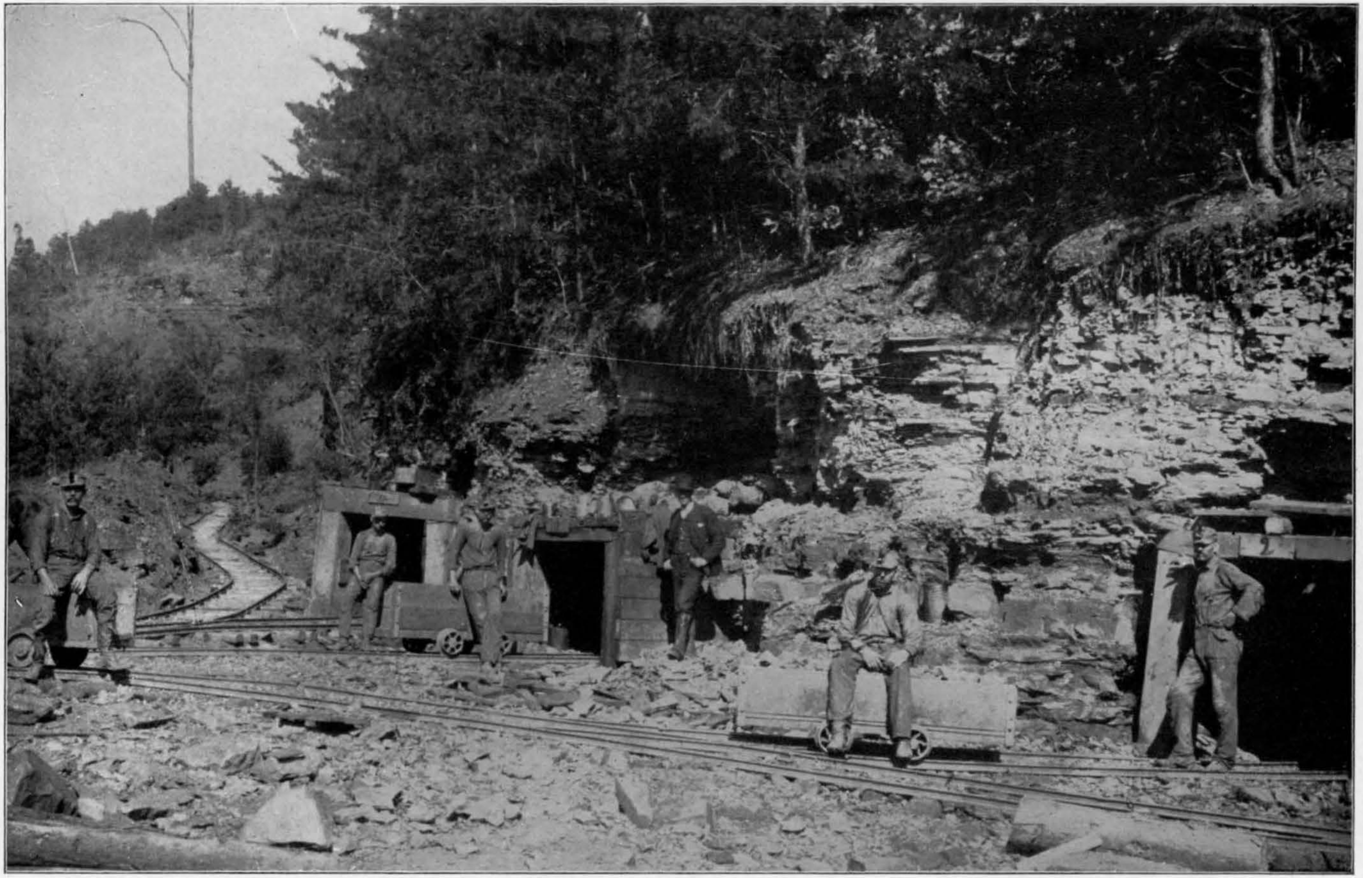
IRON ORES

BROWN IRON ORES

LOCATION.—Brown iron ore is widely distributed throughout the State, but the main deposits of commercial importance appear to be confined to the Appalachian Valley and the Piedmont Plateau. The most extensive deposits of the Appalachian Valley, so far developed, occur in Polk, Bartow, and Floyd counties. The Polk county deposits occur chiefly in the following districts: the Cedartown district, the Fish Creek district, the Wray district, the Esom Hill district, the Etna Valley district, and the Aragon district. Each of these several districts has somewhat indistinct boundaries, however, they are completely separated from each other.

The Bartow county deposits arrange themselves into the following groups, namely, the Eastern district, the Iron Hill district, and the Linwood district. The most important of these three divisions is the Eastern district, which is confined chiefly to the eastern part of the county. The deposits of this district begin about two miles south of Emerson and extend in a northerly direction to Sugar Hill, a distance of about 16 miles. Some of the most important brown iron mines in the State, such as the Sugar Hill mines, are located in this district. The Iron Hill district occurs in the vicinity of Logan post office, 7 miles southwest of Kingston. The brown iron ores of Floyd county occur in the vicinity of Cave Spring and Silver Creek. In addition to these several locali-



A View of the Underground Workings, Kensington Iron and Coal Company's Property, Near Estelle, Walker County, Georgia.

ties, there also occurs in the Appalachian Valley what appears to be valuable deposits in Gordon, Murray and other counties in the northwestern part of the State.

The brown iron ore deposits of the Piedmont Plateau have not been so extensively developed as in the Appalachian Valley, nevertheless, the deposits are widely distributed and will in the future, no doubt, become an important source of brown iron ore. Some of the most promising deposits in this section of the State are to be found in Cherokee, Pickens, Gilmer, Fannin and Meriwether counties.

Geology.—The brown iron ores of the Appalachian Valley are associated chiefly with the Weisner quartzite, the Knox dolomite, and the Chickamauga limestone—rocks of Cambrian and Silurian age. The deposits in Pickens, Gilmer and Fannin counties are associated with the marbles which are supposed to be Cambrian, while other deposits, such as those in Meriwether county, occur with older rocks, probably Archæan.

Mode of Occurrence.—The brown iron ores occur chiefly in the form of pockets, or irregular deposits, in the residual clays. The deposits are quite variable in size. They frequently contain only a few carloads of ore; but, generally, they are far more extensive and often cover a considerable area. Some of the deposits in the Cedartown district have been worked, on a more or less extensive scale, for more than twenty years without exhausting the supply of ore. It is not uncommon to find the deposits extending over five or six acres, but it must be borne in mind that the ore does not occur in equal abundance over the entire area. On the contrary, it is often traversed and intersected by clay "horses," or barren areas, so that when the ore is removed the surface frequently presents the appearance of an old land surface, much dissected by erosion. The depth to which the ore extends seems to be as variable as the superficial extension of the deposits themselves. In some cases they are quite superficial, being only a few feet in thickness; while, in other cases, they appear to extend to great depths. In many places deposits have been worked to a depth of 50 feet or more without reaching the limit. It is not uncommon to find the ore extending below the water-level. In some instances, the deposits on the hill-slope are found to extend into the valley below, where the ore occurs in considerable abundance in the stream beds. The ore, in the individual deposit, is found mostly in the form of bowlders or gravel in the residual clays. The proportion which the ore bears to the entire material mined varies greatly. In some of the most valuable deposits the ore will average, probably, 50 per cent., or more, of the material mined; but, generally, it falls far short of this average.

In addition to the above described form of ore deposits, there are irregular vein deposits. A good illustration of this class of deposit is to be seen at what is known as the Wheeler ore bank, located among the quartzite ridges, about 2½ miles northeast of Emerson. The vein here is quite variable in thickness, and it has been successfully worked along its outcropping for more than a quarter of a mile to the depth, in places, of 40 feet or more. The walling on either side of the vein consists of highly contorted mica-schists, which, in places, have been replaced by brown iron ore. The veins usually conform, in strike and dip, to the country rock; but there is no evidence, whatever, that the ore is a stratified deposit. On the contrary, all the facts go to show that it has resulted from precipitation from chalybeate water circulating in an open fissure.

History.—Probably the first iron furnace put in blast in Georgia was that erected on Stamp Creek in Bartow county about 1840. It is reported that as early as 1853 five blast furnaces were operated at one time in this county. All these furnaces, the remains of which are still to be seen on Stamp Creek and the Etowah River, were small charcoal furnaces with a capacity varying from two to four tons per day. The ore supplying them was obtained from ore banks in their immediate vicinity, or was picked up from the surface of the cultivated fields. The iron industry, thus begun on a small scale in Bartow county, gradually grew in importance until the Civil War. At this time, the furnaces had been greatly enlarged and otherwise improved and the Cooper iron works, located on the Etowa River, were in full operation.

After Sherman's invasion of Georgia, all the furnaces were left in ruins, and no effort was made to rebuild until about 1870, when a few were again put in blast and operated for a short time. About the time the furnaces in Bartow county were shut down, the Cherokee furnace at Cedartown and the Etna furnace in Etna Valley, Polk county went into blast. These were both charcoal furnaces, the former having a capacity of 50 tons and the latter 25 tons per day. Later, two furnaces were put into operation in Floyd county—one at Rome and the other at Hermitage. Each of the above named furnaces were operated, for a time, with considerable energy, but all are now inactive except the Cherokee and the Rome furnaces, which consume daily about 100 tons of ore.

Chemical Properties.—The following analyses[1] of specimens taken from the Ledbetter mine in the Cedartown district show the general composition of the brown iron ores:

1. Analyses made by A. M. Lloyd, Atlanta, Ga.

No.	Fe	P	Insoluble	SiO_2	Mn	Remarks
1	51.89	.824	9.63	------	------	40 feet below surface
2	53.65	.871	5.82	------	------	35 feet below surface
3	50.13	1.583	8.14	------	------	10 feet below surface
4	50.04	1.103	8.11	------	------	6 feet below surface
5	55.45	.567	------	6.82	------	Fine red gravel
6	53.13	.363	7.30	------	------	
7	42.81	1.083	16.47	------	------	6 feet below surface
8	50.62	.637	8.32	------	------	
9	51.72	1.262	------	------	------	
10	52.89	.863	7.98	------	.567	

FOSSIL IRON ORES

Location.—The fossil or Clinton iron ores of Georgia are confined to four counties in the extreme northwestern part of the State. These counties, namely, Dade, Walker, Catoosa, and Chattooga, all of which, with the exception of the last named, are located along the Georgia-Tennessee line only a few miles south of Chattanooga.

The fossil iron ores of Dade county occur in Lookout Valley and Johnson's Crook. The deposits of Lookout Valley are found in two lines of outcroppings extending from the Georgia-Tennessee line to Deerhead Cove, a distance of about 18 miles. The outcroppings on the east side of the valley occur along the minor ridges at the base of Lookout Mountain, while those on the western side occur along the minor ridge at the base of Sand Mountain. The total length of these two almost parallel lines of ore outcroppings, not considering their minor meanderings along the various hollows and hillslopes, is approximately 40 miles. In Johnson's Crook the ores likewise form two main lines of outcroppings similar to those of Lookout Valley. The eastern line of outcroppings, which appears along the base of Lookout Mountain, has a length of about seven miles, while the western line of outcroppings along the base of Fox Mountain, extends only about one-half that distance. Thus it will be seen that the aggregate length of outcroppings of the fossil iron ores in Dade county does not fall far short of 50 miles.

The fossil iron ores of Walker county outcrop along the eastern side of Lookout Mountain from the Georgia-Tennessee line to the head of McLamore Cove. From this point the line of outcroppings turns at an acute angle to the northeast and continues for about 12 miles along the western foothills of Pigeon Mountain. Here it abruptly turns to the southwest and follows the eastern foothills of Pigeon and Lookout mountains, through the western part of Walker and Chattooga counties to the Georgia-Alabama line a short distance south of Menlo. This line of outcroppings, which has a total length of about 70 miles, has but one break in its continuity. This break, which is due to a fault, occurs in the vicinity of Flintstone, only a few miles south of the Georgia-Tennessee line. The length of the break in the outcroppings due to the fault does not exceed three miles and is more than counterbalanced by a second line of outcroppings appearing only a mile or so further to the east.

All along Lookout and Pigeon mountains the ores occur generally along a line of low hills or ridges at the base of the mountains. At some points there occur small narrow valleys between this series of hills and the main mountains. The dip of the ore along this line of outcroppings is usually at a low angle toward the axis of the mountains, but in some cases the dip is at a high angle, and in a few instances the ore beds are entirely overturned, thus giving rise to two lines of outcroppings instead of one. This complicated structure is to be seen at several points in the mines located in the vicinity of High Point.

In addition to the above outcroppings, the fossil iron ores are found also further to the east along Gaylor's and Taylor's ridges and Dirtseller Mountain. Gaylor's Ridge, located in the extreme southwestern corner of Chattooga county, is a typical synclinal ridge, having a maximum elevation of about 700 feet above the adjacent valleys. This ridge extends to the northeast a distance of four or five miles, stopping only a short distance southwest of the southern terminus of Taylor's Ridge. The iron ore of Gaylor's Ridge is confined mainly to its western side, where it is exposed at numerous points.

About six miles north of Gaylor's Ridge and running parallel with it is Dirtseller Mountain. This mountain, like Gaylor's Ridge, is synclinal, extending beyond the Georgia-Tennessee line some miles into Alabama. That portion of Dirtseller Mountain confined to Georgia, in which the fossil ores occur, has a length of only about four miles. The ores occur on both sides of this mountain, outcropping near its summit and dipping at a low angle towards its central axis.

The most eastern outcroppings of the fossil iron ores of importance occur in Taylor's Ridge in the central part of Catoosa and the western part of Walker and Chattooga counties. This ridge, known in Tennessee as White Oak Mountain, intersects the State line a few miles north of Ringgold and extends in a southwesterly direction for more than 50 miles, terminating only a short distance east of the Georgia-Alabama line. Throughout the entire course of the ridge the fossil iron ores are nearly everywhere present, and at several points they have been more or less extensively exploited. This is especially true in Chattooga county a short distance from Summerville, where the ores have been mined almost continuously for some years.

The total length of all of these several different lines of outcroppings aggregate approximately 175 miles.

Geology.—The Rockwood formation, the division of the Silurian in which the fossil iron ores occur, forms the uppermost member of the Silurian rocks. It consists of shales and sandstones with a few thin strata of limestone and one or more beds of fossil iron ore. The sandstones of this formation become well developed in Chattoogata and Horn mountains and also in Taylor's Ridge, but in Dade and the western part of Walker counties shale predominates. The thickness of the formation varies from 600 to 1,500 feet, the greater thickness being confined to that part of the area where the sandstone is best developed.

The structural geology of the region where the fossil iron ores occur is that commonly met with in regions where the strata have been subjected to intense lateral strain, resulting in a series of rather close-pressed, parallel folds and a number of faults of greater or less throw. The folds are more numerous, and at the same time closer pressed along the eastern than the folds along the western margin. This is especially noticeable if a comparison is made between the strata of Sand, Lookout and Pigeon mountains and the strata east of Taylor's Ridge.

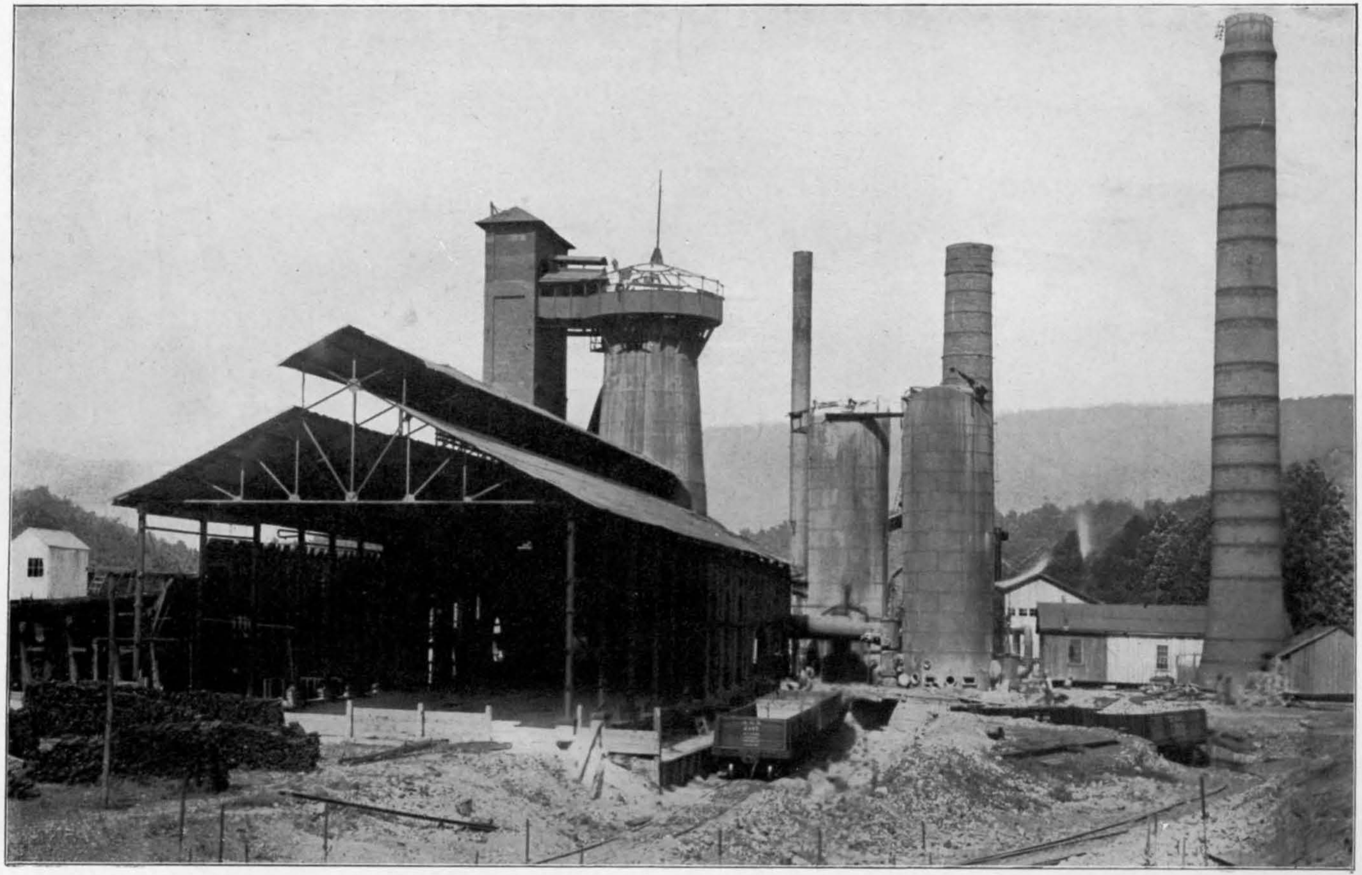
Mode of Occurrence.—The fossil iron ores occur in regular stratified beds varying from a few inches to several feet in thickness. They consist, commercially speaking, of two varieties, namely, the hard ore and the soft ore. The soft ore, which forms the weathered outcrop of the hard ore and which differs from the hard ore mainly in the loss by weathering of calcium carbonate, rarely ever extends more than a short distance beneath the surface.

The physical structure of the soft ore is very variable. It is not always, as the name implies, a soft, friable, earthy, unconsolidated material, but may consist of a very hard, rather closely compacted mass. The latter, when taken from its natural bedding, frequently breaks into prismatic blocks, and is often spoken of by the miners as "block ore." The prismatic structure of these ores is due to a series of joints formed apparently during the folding of the rocks.

The hard ores, or the unweathered part of the ore bed, differ from the soft ore as above stated, chiefly in high percentage of calcium carbonate, and also in being harder and of more compact structure. They occupy a position near the center of the Rockwood formation. The workable beds are rarely more than three in number, more usually they are limited to only one, though at several places two have been successfully worked to a greater or less extent.

Physical and Chemical Properties.—The main mass of the ore consists of iron oxide often in the form of rounded oölitic flaxseed-like particles, or in the form of casts of fossils. The oölitic particles, which have an average diameter of about one-sixteenth of an inch, are usually somewhat flattened, the longer axis being parallel with the bedding of the ore. In some of the beds these particles make up the greater part of the ore, while in other beds they are almost entirely wanting. They are also quite variable in the same bed from place to place, often occurring more or less in patches, or are confined to thin layers. The fossil casts, consisting largely of the fragments of crinoid stems and bryozoans, are present in nearly all of the ore; even the most oölitic beds contain them in greater or less numbers. As a general rule these fossil casts form the larger part of the Georgia ores.

The chemical composition of the fossil ores is shown by the following analyses:



RISING FAWN FURNACE, NEAR RISING FAWN, DADE COUNTY, GEORGIA.

Constituents Determined	I	II
Hygroscopic water	.10	.65
Combined water	2.04	3.57
Ferrous oxide, FeO	2.65	none
Ferric oxide, Fe_2O_3	45.29	81.57
Alumina, Al_2O_3	3.14	5.57
Manganous oxide, MnO	.28	.43
Lime, CaO	21.41	.29
Magnesia, MgO	.44	.42
Silica, SiO^2	7.28	6.55
Sulphur, S	trace	.25
Phosphorus pentoxide, P_2O_5	1.17	.45
Carbon dioxide, CO_2	16.50	none
Total	100.30	99.75

Sample No. 1 in the above analyses is what is known as hard ore and sample No. 2 is what is known as soft ore. These two analyses give a fine average of these two different classes of ores.

METHOD OF MINING.—There are two different methods usually adopted in mining the fossil iron ores, namely, by stripping and by underground work. Stripping, which is generally employed where the amount of overburden does not exceed 15 feet, consists in removing the earth and partially decomposed rock by scrapes and other devices, after which the ore is raised or dug up by means of the pick or crow-bar. This method is nearly always employed in mining the soft ore and is much less expensive than underground mining, unless the overburden is quite heavy. As a general rule, the first mining at nearly all of the workings is by stripping, but as the dip of the ore bed is often at a high angle, this method, within a few rods from the outcropping at most, always gives way to underground work, which is carried on practically in the same way as coal mining.

USES.—The fossil iron ores are used mainly for making iron. There has also been a considerable amount of it ground and used for ocher. Such ochers are largely used in the paint industry and for coloring mortars and cements.

STATISTICS.—The following table shows the production and value of iron ores in Georgia, as given by the Mineral Resources, U. S. Geological Survey, from 1893 to 1908:

Year	Quantity Long tons	Value	Year	Quantity Long tons	Value
1893	176,233	$192,093	1901	213,579	$256,294
1894	174,694	166,228	1902	334,054	464,335
1895	268,823	247,217	1903	443,452	572,052
1896	168,235	144,682	1904	293,802	358,438
1897	204,639	166,704	1905	200,842	296,561
1898	157,994	127,975	1906	411,230	734,780
1899	236,748	235,343	1907	444,114	837,102
1900	315,707	447,127	1908	321,060	540,189

In addition to the two varieties of iron ores above described, there also occur in the various localities in the Crystalline area promising prospects of magnetic iron ores. Among these may be mentioned the deposits in Greene county, near Union Point; the deposits in Lumpkin county, near Dahlonega; and the deposits in Haralson county, near Draketown.

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LIMESTONES[1]

Location.—Limestones are found in the three physiographic provinces of Georgia, namely, the Coastal Plain, the Piedmont Plateau and the Appalachian Valley.

In the Coastal Plain, limestones occur in many counties, but they are of economic importance only at certain localities.

In the Piedmont area the limestones have usually become recrystallized into marbles. They occur as marbles in Fannin, Gilmer, Pickens, and Cherokee counties and in less important areas in Hall and other counties throughout the Piedmont Plateau.

The limestones of the Appalachian Valley region are most abundant and of great economic importance. They occur in Polk, Floyd, Bartow, Chattooga, Gordon, Walker, Dade, Catoosa, Whitfield, and Murray counties.

Geology.—In the Coastal Plain, limestones of the Tertiary age occur in the Chattahoochee group and in the Vicksburg-Jackson, Claiborne and Midway formations. They also occur in the Ripley formation of upper Cretaceous age. The Piedmont region of Georgia contains limestones and marbles which are of Cambrian and pre-Cambrian age.

The Appalachian area affords the greatest abundance of limestone in the State. In this area limestones occur in the following formations, namely, the Connasauga formation,

1. Written by T. Poole Maynard, Assistant State Geologist.

and Beaver limestone of Cambrian age, the Knox dolomite of Cambro-Silurian age, the Chickamauga formation of Silurian age, and the Floyd and Bangor limestones of the lower and upper Carboniferous ages respectively.

Mode of Occurrence.—All of the limestones are of sedimentary origin, in most cases formed from the fossil remains of organisms, while in some cases they may be largely of inorganic origin.

The limestones of the Coastal Plain usually occur as thin bedded argillaceous limestone and marls, consisting often of unconsolidated shells, while those of the Piedmont area occur as stratified layers, the bedding planes of which have generally been obliterated by the pressure to which these rocks have been subjected. The limestones of the Appalachian area are stratified, sometimes semi-crystalline and of many and various colors.

History.—The history of the lime industry in Georgia dates back to the earliest settlers. It has been recognized since very early times that the burning of limestone produced a product which when applied to the soil increased its productive value. Limestones were first used for agricultural purposes and in mortar for building. The lime industry is still in its infancy in Georgia and it has only been in recent years that the true value of limestones has been recognized as among the most important of our economic resources.

Physical and Chemical Properties.—The term limestone is used in a very general sense. It includes those rocks unconsolidated or consolidated which are made up largely of calcium carbonate with varying amounts of silica, alumina and iron oxide, the alkalies, etc. When calcium carbonate is replaced largely by magnesium carbonate it is then known as a dolomite. The physical characteristics will vary from the one extreme of unconsolidated shell marl to the consolidated various colored true limestones through to the crystalline marbles.

The following are analyses[1] of some of the typical limestones from the Paleozoic rocks of Northwest Georgia:

	I	II	III
Lime, CaO	36.76	54.38	53.13
Magnesia, MgO	15.24	.25	.60
Alumina, Al_2O_3 / Ferric oxide, Fe_2O_3	.84	.24	1.42
Sulphur trioxide, SO_3	.00		
Phosphorus pentoxide, P_2O_5	trace	trace	.60
Silica, SiO_2	.91	1.75	1.82
Clay bases	.54	.30	
Moisture	------	------	------
Undetermined	45.71	43.08	42.43
	100.00	100.00	100.00

I. Knox dolomite, Ladd Lime Co., lower strata, Cartersville, Ga.

II. Floyd limestone. This is an average sample of the old Huffaker Lime quarry, Huffaker, Floyd county, Ga.

III. Bangor limestone taken on the property of Mr. J. B. Reeves on the west side of Little Sand Mountain, about 4½ miles north of Crystal Springs, Ga.

Uses.—Probably no other rock is used for such a variety of purposes as limestone. It is used for lime in building, for paving, curbing, flagging, mortar, rubble, riprap, and when crushed it is used for railroad ballast and road building. Limestone is also extensively used for concrete, for furnace flux, for agricultural purposes as a fertilizer, for natural and Portland cements, etc., etc.

Statistics.—The following table taken from Mineral Resources U. S. Geological Survey, gives the value of the production of limestone in Georgia for the years 1907 and 1908:

1. Analyses by Dr. Edgar Everhart, Chemist, Geological Survey of Georgia.

Product.	1907	1908
Rough building	$1,860	$1,518
Dressed building	500	------
Paving	------	1,020
Curbing	200	------
Rubble	245	------
Road making	407	791
Railroad ballast	550	1,900
Concrete	155	2,148
Flux	18,080	996
Lime	70,826	46,780
Other uses	281	------
Total	$93,094	$55,275

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MANGANESE

LOCATION.—The manganese ores occur in two geologically distinct areas in Georgia; one, the Paleozoic group, which includes the ten northwest counties of the State; the other, the Crystalline area, which comprises the Piedmont Plateau and the Appalachian Mountain provinces. The Crystalline area includes that part of the State, exclusive of the ten northwest counties, lying north of an irregular line, known as the Fall Line, which passes near or through the cities of

Columbus, Macon, Milledgeville and Augusta. This line crosses the State in an approximately southwest course, and separates the Crystalline rocks from the Coastal Plain sands, gravels, clays, etc.

A somewhat irregular line, passing south from near Cohutta Springs, in Murray county, to the vicinity of Cartersville, Bartow county, and thence bearing south of west to Esom Hill, Polk county, and continuing west into Alabama, separates the Crystalline area from the Paleozoic group on the northwest. This line is known as the "Cartersville fault." These two provinces, the Paleozoic group and the Crystalline area, compose the north half of the State.

Considerable manganese mining has been done in the Paleozoic group, to which all the commercially important ores of the State chiefly belong. The ores of this area are conveniently grouped into two principal districts, namely, the Cartersville district and the Cave Spring district. These include Bartow, Floyd and Polk counties, with isolated scattered deposits occurring in other counties within the limits of the Paleozoic group.

More or less prospecting work for manganese ores has been done in a number of counties in the Crystalline area. The testwork has been sufficient, in most cases, to indicate that workable deposits of the ore do not exist, although small shipments of the ore have been made from a number of the openings in different counties. The total production of manganese ore from this area will probably not exceed 50 tons.

The localities in which prospecting work has been done for manganese are widely separated and are scattered over various parts of the area, which bear no apparent geological relationship to each other. The deposits are not associated with any particular type of rock; but they occur in association with several widely different mineralogical types.

Geology.—The rocks associated with the manganese deposits in the Paleozoic region range in age from Lower Cambrian to Carboniferous, and they include slate, limestones, shales, sandstones and conglomerates. No igneous rocks are so far known to occur within the limits of the area. The manganese deposits of the area are limited to the residual decay resting on and derived from only three of the formations, namely, the Weisner quartzite, the Beaver limestone, and the Knox dolomite. The region in which these strata occur has been thrown into great northeast-southwest folds from horizontal pressure applied in a northwest-southeast direction. In addition to the folding, continuation of the same comprehensive forces resulted in fracturing and faulting the strata over most of the area. To the northwest of Coosa Valley, the area is one of open folds, and faulting is less conspicuous. Folds of the anticlinal, synclinal and monoclynal types are represented in many examples of northeast-southwest trending ridges, preserved in the harder and more resistant rocks.

With but few exceptions, the rocks associated with the manganese deposits of the Crystalline area include profoundly altered original clastic and igneous masses. Some of the granites and most, if not all the more recent basic dike rocks, retain in the field their original characteristic massive structures.

Many different mineralogical types of rock are represented in this area. Metamorphism has been so complete in many that it is often impossible to say with certainty whether they are derived from original sedimentary or igneous masses. Granites, gneisses, schists, limestones and quartzites, or sandstone, compose the principal rocks. These are cut by numerous intrusions of more recent basic igneous rocks in the form of dikes of diabase, diorite and gabbro, comprising

MANGANESE MILLING PLANT OF THE BLUE RIDGE MINING CO., TWO AND ONE-HALF MILES EAST OF CARTERSVILLE. BARTOW COUNTY, GEORGIA.

the commonest types of the dike rocks. Mica and hornblende-schists are the most widespread of the crystalline schists. The granites and a part of the gneisses are prevailingly mica rocks. The entire Crystalline area is one of great complexity. The rocks are everywhere altered, intricately folded and tilted, and secondary structures have been induced in them. A further result of the intense metamorphism has been the formation of numerous secondary minerals. The structural and age relations of the rocks of the area have not yet been worked out. Most of the rocks are geologically old and belong to different periods of formation; some are pre-Cambrian, while others are of later age.

Mode of Occurrence.—The manganese ores of the Paleozoic area occur imbedded in the heavy mantle of residual clays derived from the decay of the Beaver limestone and Weisner quartzite. The residual decay derived from the Weisner quartzite is composed of light-gray to yellow colored siliceous clay, more or less admixed with angular fragments of the partially decayed quartzite, while that derived from the Beaver limestone consists of a deep-red clay admixed with some chert fragments, and, along and near its eastern contact with the quartzite ridges, additional fragments of the latter rock. Chocolate-brown and black clays, stained with the manganese oxide, are common to the area. The quartzite fragments are frequently in an advanced stage of disintegration, sometimes forming a mass of incoherent white quartz grains easily dug out with the finger. At other times, the quartz fragments readily crumble into sand under the gentlest pressure of the hand. Still, others mingled with the clay have only been slightly discolored and are otherwise apparently as hard and firm as the fresh quartzite. The harder fragments are often cemented by manganese oxide, which forms a distinct manganiferous quartzite breccia.

The ore is distributed through the clay in irregular small pockets, rarely in distinct beds; in the form of veins and stringers penetrating the clay in an irregular manner; and as concretions or nodules of various sizes and shapes, from masses weighing several tons to small disseminated grains scattered through the clay. At times, the ore distribution in the clays conforms, in a general way, to the bedding of the enclosing material; more often, however, this is obscured and the ore bodies are seen penetrating and cutting the clay indiscriminately.

The ore-bearing pockets vary much in number and size, being comparatively close together in some places and some distance apart in others, as much as a hundred feet and more in extreme cases. The pockets vary in size from mere nests to bodies six or more feet thick, and more than thirty feet long. They may, in extreme cases, yield hundreds of tons of the ore, more frequently, however, much less.

In the Crystalline area, the manganese ore is usually massive and often fine granular, mixed or otherwise closely associated with iron and, less often, of the gravel and larger concretionary nodular forms. Of the former occurrence, the locality to the northeast of Cohutta Springs in Murray county, and that of the Draketown district in Haralson and Paulding counties, are the most typical. In the northeast part of Murray county, near the Tennessee line, the manganese exists as small nests or pockets, in extensive beds of iron ore, in quartzites and slates. In its purest form, the manganese is not entirely free from iron, and much of it is a manganiferous iron ore of apparently homogeneous composition. In the Draketown district, in Haralson and Paulding counties, the ore occurs as massive and finely divided manganese oxide in a thinly banded sandstone or quartzite, intercalated with mica-schist. The siliceous rock is heavily charged with small grains and crystals of manganiferous magnetite and separate grains of manganese oxide; and, in places, it is pyritiferous. The manganese is mostly concentrated along the contact between the quartzite and the schist; but it is contained mostly in the quartzite as massive ore carrying, usually, much iron, which, at times, almost totally replaces the manganese.

At other localities in the Crystalline area, manganese is found in massive and nodular forms, and as a black, clayey mixture of finely divided manganese oxide, in the residual clays derived from the decay of hornblende and mica-schists. The mica-schist is often garnetiferous.

History.—Mining manganese ore on a commercial scale appears to have had its beginning immediately after the close of the Civil War. In 1866, Georgia is reported to have produced 550 tons of manganese ore. This ore was from the Cartersville district. One of the first mines operated in this district was the mine on the Dobbins property, which produced, between 1867 and 1885, 5,500 tons of manganese. Subsequent to, and also about the time of the last named date, a number of mines were opened in Bartow, Polk and Floyd counties, so that in the year 1887 Georgia was the second State in the Union in the production of manganese ore, being exceeded only by Virginia. In 1895, Georgia headed the list of manganese producing States in this country, but since the above date the production has been quite variable, due largely to the low price of the ore and to the attention of the miners of the districts being turned to the iron ore deposits which occur in much larger abundance and yield a better profit to the miner.

Chemical Properties.—Only the oxides of manganese occur in Georgia in commercial quantities. Of these, pyrolusite and psilomelane greatly predominate, with some manganite and braunite, and much of the earthy oxide, wad. These cannot always be separated; but they usually occur admixed in varying proportions.

The following analyses of manganese ore from the Cartersville and the Cave Spring districts show the character of the ores:

Manganese	Iron	Silica	Phosphorus	Moisture
41.248	9.100	14.400	0.109	2.000
41.630	1.990	10.820	0.050	4.000
42.856	10.491	7.300	0.139	6.000
44.308	4.595	10.950	0.156	6.000
39.893	10.210	12.720	0.106	6.000
47.080	5.600	low	0.194	------
46.400	-----	5.250	0.277	-----
48.350	-----	2.600	0.122	-----
39.690	5.850	11.860	0.210	-----
41.410	-----	4.500	0.134	-----
40.310	-----	3.760	0.127	------
49.320	-----	3.780	0.208	-----
47.250	-----	5.610	0.198	-----
43.710	-----	7.100	0.236	-----
46.749	1.746	13.050	0.059	------
42.685	1.729	10.000	-----	-----
42.938	5.240	8.009	-----	-----
42.578	1.500	11.950	0.089	-----
42.307	2.400	10.390	0.072	-----
45.189	7.840	7.602	0.035	-----

Physical Properties.—With the exception of the wad, the ore is usually either partially or wholly crystalline, with druses of minute crystals of pyrolusite abundant through the masses, and is of a dark steel-blue color and the nodular type nearly always displays the complete or partial layered or concentric structure characteristic of concretionary masses. Fine gravel and crystalline masses, lump and needle ore compose the bulk of some of the ore bodies. Stalactitic and mamallary structures are often beautifully developed.

METHODS OF MINING AND PREPARING THE ORE.—The method of mining depends largely upon the location of the deposit and its depth below the surface. Open-cut and pit, shaft and tunnel work are employed in mining the manganese ores. The three methods are often used together to advantage in the same place, especially where the ores begin at or near the surface and continue irregularly to some depth below. In such cases, open-cut and pit work is first used; and, from the bottom of the open work, shafts are sunk and drifts are run at different levels from the shafts. Tunneling becomes necessary in most of the steeper slope deposits. In the lower deposits, especially those of the valley bottoms, shafting and tunneling are most advantageously employed. In most of the tunnels and shafts it becomes necessary, from the nature of the clays, to timber the openings in order to prevent caving.

As a general thing, the only treatment of the ore necessary before shipping is to free it from the adhering clay. The larger masses can often be shipped without preparation, as the small quantity of adhering clay is not sufficient to materially lower the quality of the ore. Most of the ore, however, is of such a character that, unless freed from the clay before shipping, it is rendered unmarketable. Crushing and jigging are necessary in the spongy or porous type of ore, the numerous cavities of which are filled with the clay; also, in those ores containing considerable free quartz grains and enclosed fragments of the rock.

In the early history of manganese mining in Georgia, less care was taken to properly cleanse the ore than at present, and much of the ore then shipped contained large quantities of adhering clay and other extraneous material. The principal, and frequently the only treatment was screening. At that time, the washing was done by hand. The form of washer used was a revolving cylinder perforated with holes, fed inside by a constant stream of water. The ore was put into the cylinder through a door; the door was closed and the cylinder revolved by hand until the ore was freed from the clay by running water; the ore was then removed through the same opening. The capacity of such a washer was very limited and it could be used only on a small scale. At present, a form of log-washer, similar to that used for cleaning brown iron ore and ocher, is in use.

USES.—Manganese is used for many purposes; but probably nine-tenths of the ore produced at present is consumed in the manufacture of the alloys of iron and manganese, known as spiegeleisen and ferro-manganese, which, in turn, are used in the manufacture of steel. When in the form of pyrolusite, perhaps its next most important use is in the manufacture of chlorine, as an oxidizer. Smaller quantities of manganese are used for various other industrial purposes, such as the manufacture of manganese-bronze, silver-bronze, bromine and certain paints. It is also used in dyeing, coloring glass, pottery, brick and other wares as well as in making oxygen and in the manufacture of disinfectants.

The Georgia manganese is at present mostly, if not entirely, consumed in the manufacture of steel, in the form of ferro-manganese, and, to a less extent, in bleaching processes. It has been used in some quantity at all the principal steel manufacturing plants in the United States. During the early development, the Georgia ore was largely marketed in England, where it was used for various purposes.

STATISTICS.—The production of manganese ores in Georgia from 1885 to 1908 as given by Mineral Resources U. S. Geological Survey, is shown in the following table:

Year	Quantity Long tons	Value	Year	Quantity Long tons	Value
1885	2,580	$------	1897	3,332	$22,084
1886	6,041	------	1898	6,689	41,571
1887	9,024	------	1899	3,089	23,377
1888	5,568	------	1900	3,447	26,816
1889	5,208	50,143	1901	4,074	24,674
1890	749	4,920	1902	3,500	20,830
1891	3,575	------	1903	500	2,930
1892	826	5,782	1904	-----	-----
1893	724	5,068	1905	150	900
1894	1,277	8,620	1906	-----	-----
1895	3,856	27,416	1907	-----	------
1896	4,085	27,032	1908	-----	------

It will be noticed in the above table that Georgia has produced but little manganese ore since 1904. This is due not, as might be supposed, to the exhausting of the deposits, but largely to the miners' attention being drawn to the mining of iron ore, which has yielded more profitable financial returns.

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MARBLES

LOCATION.—All of the marbles of Georgia, which have so far been worked on a commercial scale, occur along the Louisville & Nashville R. R., in the northern part of the State. They are confined to a narrow belt, about sixty miles long and from one to three miles wide, traversing in a southwesterly direction the counties of Fannin, Gilmer, Pickens and Cherokee. That portion of the counties in which the marbles are found, is usually quite hilly; and, in places, it becomes even mountainous, with peaks reaching an altitude of more than 4,000 feet above sea-level. The average elevation of the region is only about 1,500 feet.

In many instances the marbles form the floor of the narrow valleys; but, more frequently, they are exposed along the adjacent hill-slopes, where they often form bold bluffs from 40 to 50 feet in height. The general trend of the ridges and valleys is northeast and southwest, conforming in direction to the strike of the rocks of the region; however, in some cases, as in the vicinity of Marble Hill, the course of the valleys and ridges may vary considerably from the general northeast and southwest trend. The streams are small but they are always rapid, and often furnish ample power for operating machinery for sawing marbles and for other purposes. The most important streams are Long Swamp, Tolona, and Turniptown creeks. At many places along these streams the valleys in which they flow often become suddenly contracted, thus forming narrow deep gorges, where storage dams for water-powers may be constructed at small cost. In general, the typography of the marble belt may be said to be that commonly met with throughout the Southern Appalachian region, where the streams are rapidly deepening their channels in rocks of variable hardness.

GENERAL VIEW OF THE WORKS OF THE BLUE RIDGE MARBLE CO., NELSON, PICKENS COUNTY, GEORGIA.

GEOLOGY.—The marbles occur near the western margin of what is known as the Metamorphic or Crystalline area of the State. The rocks associated with the marbles are chiefly of sedimentary origin; though there occur in places also rocks of igneous origin. The sedimentary rocks include the clay slates, the mica-schist or mica-slates, the quartzites and conglomerates, and the gneisses, while the igneous rocks are chiefly coarse-grained granites or pegmatites and hornblende rocks.

According to the recent studies of Mr. Arthur Keith of the U. S. Geological Survey, the marbles occur in the upper part of the Cambrian series of rocks, a formation well developed in the metamorphic area of North Georgia. The beds of marble in places attain a maximum thickness of 200 feet or more.

MODE OF OCCURRENCE.—The marble usually occurs along only one line of outcroppings, but at a few places, notably in Pickens county and also in Fannin county, there are two lines of outcrops. It varies in texture from very coarse to very fine grained. The latter variety usually has a laminated structure and carries considerable impurities, such as mica, while the former is almost entirely free from impurities, and also has but few seams or cutters, thus being well suited for building and monumental stone.

HISTORY.—In 1840, Fritz T. Simmons began quarrying marble on a small scale in Longswamp Valley near Tate, Pickens county. This seems to have been the first systematic work done in the State, toward developing the Georgia marbles. Previous to this time, however, the Cherokee Indians, who originally inhabited this section of the country, worked the marble to a limited extent into bowls and various other forms.

The stone worked by Simmons is said to have been obtained from outcroppings and weathered bowlders exposed along the hillside, and was not always of the best quality. The impure and more or less laminated varieties were frequently selected on account of the ease with which they could be worked. At first, all the work required in getting out and polishing the stone, which was then used exclusively for tombstones, was executed by hand. The great amount of manual labor thus spent on the stones, before they were ready for erection in church yards, made them so costly that only the wealthy were able to buy; and, as a result, the demand was so limited that only a few hands were necessary to supply the trade. About two years after Simmons began work he erected a mill with one gang of saws, on the east branch of Longswamp Creek, near Marble Hill postoffice. This was the first mill put up in the county for sawing marble. The mill, as a whole, is said to have been a somewhat primitive affair but the mode of cutting the marble was the same as is now employed in our best mills. A short time after this, another mill was built by Simmons and Hurlick on the west branch of Longswamp Creek, two miles east of Jasper. It was run, though not continuously, for four or five years, when work in both the mill and the quarry located near by was temporarily suspended. Mr. Simmons, who had now associated with him as a partner, Mr. Margum, of Marietta, began work on a more extensive scale at the original quarry, near which the Southern Marble works are now located. The firm continued operations for only a few years; but, during that time, it got out a great many tombstones, many of which can be seen in church yards throughout the surrounding country.

In 1850, Tate, Adkinson & Company opened a quarry in the vicinity of the Georgia Marble Works, and erected two mills on the creek, one above and the other below the quarry.

Each mill had two gangs of saws, which enabled the company to turn out a greater amount of work than any previously organized. Owing to this increased facility for the production of marble, the firm now found it necessary to employ an agent to travel through the counties of North Georgia to solicit orders for tombstones. When a number of these stones, sufficient to make a wagon-load, had been sold, a delivery wagon, drawn by six mules, was started out on the road, to deliver the stones to the respective buyers as it traveled through the country. This mode of transportation, in a mountainous country, where the roads were usually rough and steep, added greatly to the original cost of the stone. Common, plain tombstones, that now bring from ten to twelve dollars per set, then sold at thirty or forty dollars. After continuing operations for only about two years, this firm was succeeded by Rankin, Summy & Hurlick, which was the last company to do any work in the immediate vicinity of the Georgia Marble works, until the present company was organized. In 1854, Summy & Hurlick, who ten years before had opened a quarry two miles east of Jasper, again renewed the work at that place. They erected there a mill with four gangs of saws and continued successful operations for about six years, when the works were abandoned on account of the Civil War. Immediately after the war, the quarry was worked by Robinson, Richardson & Besinger for nearly two years; but it was afterward abandoned, until 1885, when the property fell into the hands of the Perseverance Marble Company, organized by Jas. P. Harrison and others. This company at once made a considerable outlay of money in erecting a steam-mill, opening up new quarries, etc. Steam-drills and all the machinery necessary to carry on a first-class quarry were secured. The works, which now employed a number of hands, continued operations for only about three years, turning out, in the meantime, a great deal of marble, which was used for various purposes.

The Georgia Marble Company was organized in May, 1884, with a capital of $1,500,000. This date marks the beginning of a very important epoch in the history of the development of the marble industry in Pickens county. Previous to this time, Georgia marble was practically unknown to the trade as a building stone, and had only a very local use for tombstones, etc.; but, on account of the superior quality of the marble, and the energy and business-like methods of this and other companies soon organized, it has found its way to all parts of the United States, where it is now used in the construction of some of the most costly buildings. The first work of the Georgia Marble Company, after securing control of nearly seven thousand acres, was to construct and equip a branch railroad from the quarries to the main line of the Marietta and North Georgia Railroad, (now the Atlanta, Knoxville & Northern Division of the Louisville & Nashville R. R.) This gave ready means of transportation to all parts of the country. The mills and quarries were then put in operation at a total cost of nearly $800,000 and have been run continuously ever since with a gradual increasing output.

The Southern Marble Quarries, which are located about four miles east of Tate, were opened in 1885 by Miles & Horne, contractors for the State Capitol of Georgia. The staircase and the tiling, except the border tiles, used in this building, were secured at these works. Since then, the quarries have passed into the hands of the Norcross Brothers, and the facilities for quarrying and working the marble have been greatly increased. New quarries have been opened and mills erected; and great quantities of white marble have been annually shipped to all sections of the country for building monumental work and interior finish.

The Piedmont Marble Company was organized in 1886. The quarries and plant of this company, now owned by the Marble Hill Quarry Company, are located only a short distance from the Southern Marble Company's quarries. The quarries of this company are not at present operated.

The Amicalola Marble Company's quarry, formerly operated by the Atlanta Marble Company, was first opened in 1892, when it was then known as the Herndon quarry. In 1897, the Amicalola Marble Company purchased the property, subsequent to which date, with the exception of the last few months, the quarries have been continuously operated. These quarries are located about one mile south of the Southern Marble Company's quarries.

THE CHEMICAL PROPERTIES of the Georgia marbles are shown by the following analyses[1] of samples of the stone which are now most abundantly put on the market:

CHEMICAL ANALYSES.

Marbles	Calcium oxide	Magnesium oxide	Ferric oxide and alumina	Insoluble siliceous matter	Loss on Ignition	Total
No. 1	54.06	.90	.10	2.12	42.86	100.04
No. 2	32.73	19.37	.35	.73	46.58	99.76
No. 3	55.00	1.12	.15	.35	44.16	100.76
No. 4	31.53	21.30	.24	.10	47.26	100.43
No. 5	31.61	21.06	.78	1.01	46.49	100.95
No. 6	54.41	.75	.32	1.62	43.13	100.23
No. 7	54.67	1.01	.42	.76	43.49	100.35
No. 8	52.77	.82	3.28	1.43	41.85	100.15
No. 9	24.07	17.24	.43	21.76	37.08	100.58
No. 10	30.42	19.86	.91	4.23	Undeter-	------
No 11	31.89	19.64	.74	1.73	mined	------

1. Analyses made by Dr. W. H. Emerson, Professor of Chemistry, Georgia School of Technology.

Physical Properties.—The Georgia marbles vary in texture from fine to coarse grained. The former variety, which varies from uniform white to dark, clouded and flesh colored, has a great strength and low absorption powers, as shown by the following tests:

Crushing Tests

NAME	QUARRY	Compressed Surface in inches.	Pounds.	Actual crushing load in pounds	Compressive strength per square inch in pounds.	Reduced to correspond to pressure per sq. inch on 2 in. cubes, in lbs. per sq. inch.	Specific gravity	Weight per cubic foot in pounds	REMARKS
Kennesaw No. 1	Kennesaw	.99x .99	Bed.	10,000	10,204	12,244	-----	-----	Cracked on edge before bursting
Kennesaw No. 2	Kennesaw	1.00x1.00	Bed.	11,400	11,400	13,680	2.717	169.8	Burst suddenly
Kennesaw No. 3	Kennesaw	1.00x1.00	Bed.	10,672	10,672	12,806	-----	-----	Burst with explosion
Creole No. 1	Georgia	1.00x1.00	Bed.	13,900	13,900	16,680	-----	-----	Burst with explosion
Creole No. 2	Georgia	1.00x1.00	Bed.	13,100	13,100	15,700	2.763	172.6	Burst with explosion
Creole No. 3	Georgia	1.00x1.00	Bed.	13,200	13,200	15,840	-----	-----	
Etowah No. 1	Georgia	1.00x1.00	Bed.	13,200	13,200	15,840	-----	-----	
Etowah No. 2	Georgia	.99x .99	Bed.	12,000	12,244	14,692	2.707	169.1	
Etowah No. 3	Georgia	.99x .98	Bed.	12,300	12,540	15,048	-----	-----	
Southern No. 1	Southern	.99x1.00	Bed.	11,300	11,414	13,696	-----	-----	
Southern No. 2	Southern	.99x1.00	Bed.	10,900	11,010	13,212	2.734	171.8	
Southern No. 3	Southern	.98x1.00	Bed.	10,800	11,020	13,224	-----	-----	

Absorption Tests

NAME	Weight, after drying for 24 hours.	Weight, after remaining in water for 72 hours.	Approximate percentage of absorption.
Kennesaw	45.160 grammes	45.200 grammes	.008 per cent.
Creole	44.320 grammes	44.335 grammes	.004 per cent.
Etowah	42.215 grammes	42.240 grammes	.005 per cent.
Southern, No. 1	46.170 grammes	46.200 grammes	.006 per cent.
Southern, No. 2	44.440 grammes	44.475 grammes	.008 per cent.

Uses.—Georgia marbles are used chiefly for building and monumental purposes and also interior decoration. Prior to 1891, the use of the stone was confined to interior finish and monumental stock, but in that year facilities for handling exterior work were added and the first building undertaken was the Equitable building, Atlanta. The stone has now a wide use for building purposes. Costly buildings, such as State capitols, post-offices, etc., made of Georgia marble are distributed from the Atlantic to the Pacific and from the Canadian to the Mexican boundaries. There is probably no building stone in this country, in recent years, which has gained such a wide-spread use and given such universal satisfaction as the Georgia marble. The growth of the use of the stone has also been equally as phenominal in monumental work. These monuments have not only an extensive sale in the South, but also throughout the North and West. The marble, furthermore, has an extensive use for interior finish and decoration. It is especially well suited for wainscoting, tiling and other interior purposes.

As a building marble, the Georgia stone has but few, if any, equals in the United States. Its purity and great strength, together with its extremely low absorption properties, fit it for all classes of exterior work, and at the same time, even in the most rigid climate, give it a lasting property, surpassed by but few building stones. The dark and flesh color of the stone, which is due principally to the presence of graphite and iron oxide, minerals but little affected by atmospheric or organic agencies, are as unchangeable as the marble itself.

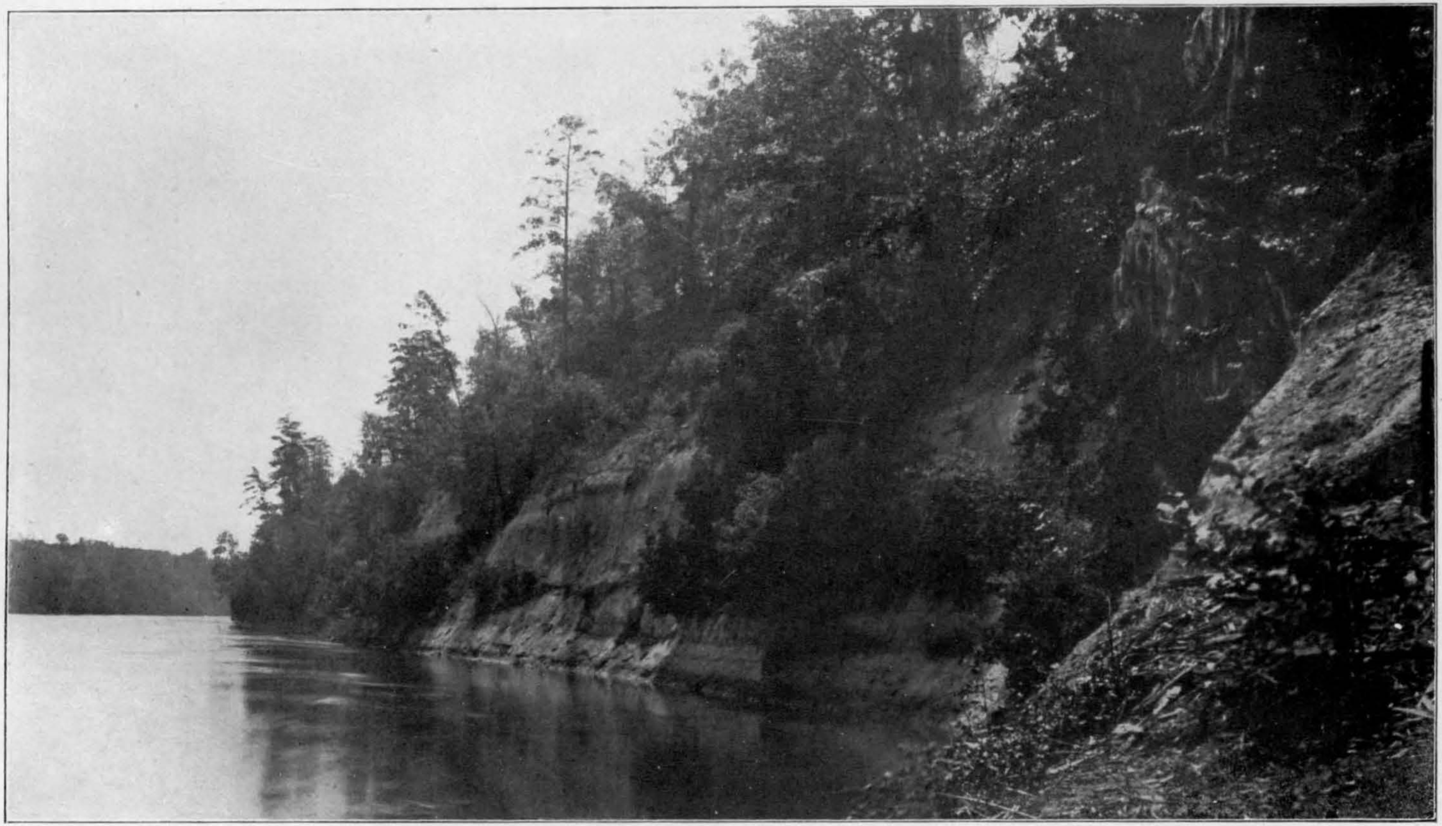
In addition to building, interior finish, and monumental uses, the Georgia marble is also used to a limited extent for fluxing and for the manufacture of carbonic oxide and magnesium sulphate (Epsom salts), and calcium sulphate. For the latter purposes, only the marble is used which runs high in magnesia.

Statistics.—The annual production of Georgia marble in the last 19 years is given in the following table, taken from Mineral Resources U. S. Geological Survey:

Year	Value	Year	Value
1890	$196,250	1900	$631,241
1891	275,000	1901	936.549
1892	280,000	1902	660,517
1893	261,666	1903	565,605
1894	724,385	1904	690,714
1895	689,229	1905	774,550
1896	617,380	1906	919,359
1897	598,076	1907	864,757
1898	656,808	1908	916,281
1899	742,554	----	-------

In addition to the marble above described, there occurs in the Silurian series of rocks in the northwest corner of Whitfield county a narrow belt of dark chocolate and grayish marbles, about one mile east of Red Clay and extends nearly parallel with the Southern Railway for about 10 miles. It is well exposed about one mile east of Varnell's Station on the Eslinger farm, where it was worked to a limited extent several years ago. This marble belongs to the same stratum which traverses the valley of East Tennessee, and which is so extensively worked in the vicinity of Knoxville.

The color of the stone is quite variable. It is generally of a dark chocolate color, variegated with white; but there also occurs, in more or less abundance, a light-gray and a beautiful pink. These various colors are frequently found at the same place, occupying different layers of the same stratum, or they may blend into one another, so that almost any shade of color, from a dark chocolate to a light gray, can be secured. The light gray, which is always the most solid and the most completely crystallized, is generally traversed by dark, irregular lines, that add variety to an otherwise monotonous light-gray surface. The exposures are mostly in the form of bowlders or large disconnected masses, which appear to be due to the surface weathering of thick layers of marble, with a somewhat jointed structure.



Exposure of Miocene Marls and Clays, Porter's Landing, Effingham County, Georgia.

For more complete information on the marbles of Georgia, see Bull. No. 1 revised, published by the Geological Survey of Georgia.

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MARLS

LOCATION.—The marls are confined to the Coastal Plain and they are widely distributed throughout this area. The best exposures of this material are to be found along the Chattahoochee, Flint and the Savannah rivers. Good exposures are also to be seen along the Allapaha River in Echols county and the Big Satilla River in Camden county, as well as along the Altamaha in Wayne county. In addition to these occurrences, more or less extensive beds are frequently met with along the smaller streams throughout the Coastal Plain.

GEOLOGY.—The most extensive and probably the best variety of marls are the so-called glauconitic or greensand marls, which occur in the Cretaceous and Eocene formations. These beds are well exposed along the Chattahoochee River and are also to be seen at various points as far east as Perry in Houston county. Beds of marl likewise occur also in the Oligocene, Miocene and even in the Pliocene formations. They seem to be especially well developed in the Miocene along the Savannah River in Effingham and Screven counties.

MODE OF OCCURRENCE.—The marls through the Coastal Plain always occur in more or less continuous beds associated with the limestones, sands and clays. The greensand marl beds often attain a thickness of many feet and are usually quite uniform throughout. The exposures along stream beds often present quite favorable conditions for cheap mining by means of open cuts. The overburden in many cases attains only a few feet which insures low cost in mining.

PHYSICAL AND CHEMICAL PROPERTIES.—By the term marl, as here used, is meant any calcareous clay or sand which carries a small percentage of plant food, especially phosphoric acid and potash. When the calcareous material is in the form of comminuted shells it is known as shell marl, and when glauconite is present in considerable abundance it is often called greensand marl. These various marls are usually soft, earthy-like material which can be mined with picks and shovels. They are quite variable in color, but more generally they are gray, greenish gray or sometimes almost black.

There is quite a variation in the chemical composition of the Georgia marls as shown by the following analyses[1]:

	I	II
Loss on ignition	32.91	2.54
Lime, CaO	35.54	----
Magnesia, MnO	.10	----
Alumina, Al_2O_3	2.20	----
Ferric oxide, Fe_2O_3	2.72	.71
Titanium dioxide, TiO_2	-----	.05
Sulphur, S	.08	----
Phosphorus pentoxide, P_2O_5	.64	4.55
Silica, SiO_2	25.81	76.18
Total	100.00	100.00

Sample No. 1, in the above table, was obtained from the bank of the Flint

1. Analysis by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.

River at Montezuma, Macon county, and sample No. 2 was obtained from the Savannah River at Porters Landing, Effingham county.

Uses.—Marl is chiefly used as fertilizer. Its value for this purpose depends upon the amount of lime, phosphoric acid and potash present. Dr. Wiley, Chemist of the U. S. Department of Agriculture, in speaking of the marls, says that the chief agricultural constituent of marl is always lime carbonate, which acts in a beneficial way on stiff clay soils and others deficient in lime. In addition to the lime, many marls also carry a considerable amount of phosphoric acid and potash which are important plant foods. The true agricultural value of the marls of South Georgia has never been thoroughly investigated and nothing very definite can be said of their commercial value as a fertilizer. The true value of the deposits can only be definitely determined by practical field tests.

Besides the use of marls for agricultural purposes they have also been found valuable, when composed largely of calcium carbonate, for making Portland cement.

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MICA

Locality.—Mica is widely distributed throughout the Piedmont Plateau. There is scarcely a county in this part of the State which has not one or more prospects. Mica has been worked to a limited extent in Cherokee, Lumpkin, Union, Hall, and Rabun counties. Some of the most promising prospects in Cherokee county are in the vicinity of Holly Springs and Toonigh, and in the Hickory Flats district about 10 miles southeast of Canton. In the last named locality, considerable mica has been mined and put on the market in the last few years. The Lumpkin and Union county deposits, as so far developed, occur near the Lumpkin-Union county line, about 12 miles north of Dahlonega. Much of the mica from this district has been mined by the Pitner Mica Company, which has recently erected and put into operation a plant for grinding mica near Gaddistown, Union county. Mica has been mined in Rabun county at the Kell mica mine, 10 miles east of Clayton, and in Hall county near Gainesville. In addition to these localities, good mica prospects are found in Monroe, Elbert, Habersham, Pickens, Cobb, Gwinnett, as well as in a large number of other counties in the Piedmont Plateau.

GEOLOGY.—Mica is always associated with pegmatite or coarse-grained granites, which occur usually in the form of dikes. These probably differ in age, but they all appear to be much younger than the rocks with which they are associated. It seems most probable that they originated during the volcanic activity, which brought to a close the Paleozoic times. The unsheared and uncrushed condition of the mica-carrying dikes shows that the mountain making forces of the region have been inactive since the intrusion of the dike materials.

MODE OF OCCURRENCE.—Mica occurs both in pegmatite dikes and in veins. The dikes, as well as the veins, are variable in thickness and longitudinal extent, and at the same time the amount of merchantable mica in the different parts of the individual dikes or veins are also quite variable. These conditions are met with in practically all of the mica prospects, and as a result mica mining is always a somewhat hazardous business. The veins differ from the dikes chiefly in being smaller in size and in having a banded structure, due to the arrangement of the mica, feldspar and quartz, the three principal minerals present. In the dikes, on the other hand, the different minerals have no definite order of arrangement. They may occur in bunches or segregations or may even be pretty evenly distributed throughout the dike. Both the dikes and the veins sometimes cut the country rock, the gneisses and schists, but more generally they conform to the schistosity of these enclosing rocks.

Varieties of Mica.—There are a large number of varieties of mica, but only two, namely, muscovite and phlogopite, are used to any extent in the arts. The former variety, which appears to be the only mica of commercial value in Georgia, is a potash mica. This variety may be white, gray, yellow, brown, or green. A reddish brown variety is often designated as "rum" or "ruby" mica. The main features which determine the value of sheet mica is flexibility, transparency, and freedom from foreign minerals, such as iron oxide, together with the size of the individual sheets.

Uses.—Mica has a great variety of uses, but at present the greater part of the production is consumed in the electrical business. Ground mica is largely used in wall paper and roofing as well as a lubricant. Sheet mica also has a limited use for stove doors, lamp chimneys, etc.

Statistics.—The following table taken from the Mineral Resources of the U. S. Geological Survey, gives the amount of mica produced in the United States since 1896 and the value:

Year	Sheet mica		Scrap mica		Total Value
	Quantity	Value	Quantity	Value	
	Pounds		Short tons		
1896	49,156	$65,441	222	$1,750	$67,191
1897	82,676	80,774	740	14,452	95,226
1898	129,520	103,534	3,999	27,564	131,098
1899	108,570	70,587	1,505	50,878	121,465
1900	456,283	92,758	5,497	55,202	147,960
1901	360,060	98,859	2,171	19,719	118,578
1902	373,266	83,843	1,400	35,006	118,849
1903	619,600	118,088	1,659	25,040	143,128
1904	668,358	109,462	1,096	10,854	120,316
1905	924,871	160,732	1,126	17,856	178,588
1906	1,423,100	252,248	1,489	22,742	274,990
1907	1,060,182	349,311	3,025	42,800	392,111

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1907—Sterrett, Douglas B. Mica Deposits of Western North Carolina. N. C. Geol. and Econ. Surv. Econ. Paper 14, pp. 82-107, figs. 5, 1907.

OCHER

LOCATION.—The ocher deposits of Georgia now being worked are located in Bartow county in the vicinity of Cartersville. The belt in which the ocher occurs has an approximate length of about eight miles in a nearly north-south direction. As indicated by natural outcrops and prospect pits, the belt is a very narrow one, not exceeding two miles at the widest point. It has its beginning at a point to the west of Emerson on the John P. Stegall property, about two miles south of the Etowah River, and is easily traced in a northward direction, about one mile east of Cartersville, to a point north and to the west of Rowland Springs. Beyond this point, surface indications disappear and no openings have been made; hence it cannot be traced, although diligent prospecting may possibly reveal a further northward extension of the belt. Less than two miles southeast of the town of Cartersville, the Etowah River cuts directly across the north-south axis of the belt. In cutting across the quartzite ridge at this point, an excellent natural exposure of the ocher beds in place is afforded. Here the ocher has been extensively mined and one of the largest and best equipped plants in the district is located.

GEOLOGY.—The ocher is entirely limited to the Weisner (Cambrian) quartzite, and as stated above, it occurs along a somewhat continuous belt, extending from Emerson on the south side of the Etowah River northward to Rowland Springs, a north-south distance of approximately eight miles. Exposures of the fresh rock indicate that the ocher occupies an extensively shattered zone in the quartzite. It is found in place in the hard and fresh shattered quartzite, and in a similar position in the residual clays derived from the decay of the quartzite. Examples of both occurrences are abundant in the region. The theory, which most satisfactorily explains the formation of these deposits, would probably indicate ocher occurring at considerable depths below the surface which might or might not prove workable. At the river ocher plant, two miles southeast of Cartersville, tunnels have been driven for some distance into the quartzite ridge at or near water level in the river, and the same quality and quantity of the ocher are indicated as at higher levels. Mine openings for ocher elsewhere in the district are usually located at some distance above the drainage level of the surrounding region. No clue therefore as to depth of the ocher or vertical range of the deposits is furnished by any of the workings in the region.

Mode of Occurrence.—So far as mining developments have been made in the area the ocher has nearly equal occurrence in the fresh and in the decayed quartzite. At every point examined its position in the residual clays is in all respects similar to that in the hard and fresh rock, indicating that since its formation some portions of the quartzite have favored decay more than others. With respect then to the character of the enclosing material (rock) the mode of occurrence of the ocher is best described separately under occurrence in the fresh rock and occurrences in the residual decay.

In the fresh rock the ocher forms a series of extremely irregular branching veins, which intersect this shattered quartzite without any apparent system. They frequently expand into bodies of considerable size; and when the ocher is removed, rooms 6 to 10 feet in diameter are sometimes left connected by narrow winding passages. The mining of the ocher has left the point of the ridge completely honeycombed with these irregular passages and rooms.

The contact between the ocher and enclosing quartzite is never sharp and distinct, but always shows a more or less gradual transition from the hard vitreous quartzite to the soft ore which may be easily crushed between the fingers. The quartzite first becomes stained a light yellow and loses its compact, close-grained texture. This phase passes into a second, in which the rock is perceptibly porous, having a rough fracture and a harsh "feel," and containing enough ocher to soil the fingers. In the next phase the ocher preponderates, but is held together by a more or less continuous skeleton of silica, although it can be readily removed with a pick. The final stage in the transition is the soft yellow ocher, filling the veins, which crumbles on drying, and con-

SETTLING VATS AND DRYING SHED OF THE CHEROKEE OCHER AND BARYTES CO., NEAR CARTERSVILLE, BARTOW COUNTY, GEORGIA.

tains only a small proportion of silica in the form of sand grains.

The intermediate zone between the pure ocher and the quartzite is usually a few inches in thickness, although it may be several feet between the extremes, and, on the other hand, sometimes only a fraction of an inch.

In the residual clays the ocher cuts the enclosing clays in a very irregular manner, forming a series of irregular branching deposits which correspond to veins in the fresh rock. The ore bodies narrow and widen, thin and thicken throughout their extent. Irregularity obtains both as to vertical and lateral distribution of the deposits. The contact between the ocher bodies and the surrounding clays is never entirely sharp, but a more or less gradual transition from the clays to the pure ocher is usually shown. The ocher-charged clays at the point of contact lessen considerably in the ocher content a short distance away and is entirely absent in the clays at some distance from the contact. As is the case with the ocher bodies in the fresh rock the transition zone between the clay and the pure ocher is quite variable from a few inches or less to as many feet between the extremes.

History.—The first authentic record of ocher mined in Bartow county, Georgia, dates back to the year 1877, when Mr. E. H. Woodward began mining ocher on a property located near the limits of the town of Cartersville. The crude ocher was hauled in wagons to Cartersville and prepared for market. At this time Mr. Woodward was also engaged in mining manganese on the Dobbins property, six miles northeast of Cartersville.

In the year 1878, Mr. A. P. Silva, who for several years had been engaged in the extensive mining of manganese in the district, mined some ocher on a small scale. In the same year Mr. M. F. Pritchett purchased the ocher interests of Woodward and Silva, and the ocher mined was hauled to Cartersville, where it was washed and dried preparatory to shipping. He used for drying the ocher a brick furnace about 30 feet long and four feet wide with thin sheet iron for the bottom and a fire box located at one end.

Pritchett sold his interest to Maltby and Jones in 1879. Mining was continued on the same properties, but under improved methods. Hauling the crude material to Cartersville was also continued, where it was prepared for market. The only mines worked were located on the Larey property near the wooden bridge across the Etowah River, two and a half miles southeast of Cartersville on the Emerson road.

In 1890 the property was again sold to the Georgia Peruvian Ocher Company, composed of western capitalists. Improved methods in the preparation of the ocher for market were introduced by the company. For the reason that the wagon road was better to Emerson than to Cartersville, the plant was moved to the former place, two miles south of the mines. The first shipment of American ocher to Europe is reported to have been in December, 1890, from the mines of this company near Cartersville, Georgia. The shipment consisted of a consignment of 50 tons to England.

Systematic mining and preparation of the ocher with the use of modern machinery and improved methods, properly dates perhaps from the year 1891, when J. C. Oram of Vermont, and E. P. Earle of New York, both experienced ocher men, became interested in the company. Both of these men had handled ocher for years in the East and it was due to them that the ocher industry became firmly established in Bartow county, Georgia. Up to this time the ocher had been dried with steam in large vats fitted with steam pipes along the bottom of the vats. Mr. Oram first introduced the natural process of air-drying in vats dug in the ground The capacity of the vats was a car-load or more of the ocher when dry. The last two plants established in the district, namely, The Blue Ridge Ocher Company and The American Ocher Company, have not put in equipment for steam drying, but use only the natural or air-drying process.

In 1893, Mr. W. B. Shaffer bought the property adjoining the Larey property, directly at the entrance to the wooden bridge across the Etowah River on the Emerson road, and established the Standard Peruvian Ocher Company. Mr. Garrett Linderman purchased in 1896 the Shaffer plant and property, becoming owner of both the Shaffer and Oram mines and mill and is operating at present as the Georgia Peruvian Ocher Company. All the machinery and other equipment were moved from Emerson to the present site at the bridge and a commodious modern plant installed at the mines for preparing the ocher for market.

In 1898 a second plant, known as the Cherokee Ocher and Barytes Company was installed for the purpose of mining and shipping ocher, by Messrs. Akin and Baxter, one mile east of the Western and Atlantic depot in Cartersville.

In 1899 a third plant, known as the Blue Ridge Ocher Company, was added by Messrs. Hull and Postell, located about two and a half miles east of Cartersville. The last and fourth plant to be established in the district was the American Ocher Company, in 1902, owned by a syndicate in Warrior's Mark, Pennsylvania. The plant is located two and a half miles nearly due east from Cartersville and, like the others, is in all respects an up-to-date plant.

Chemical Properties.—The chemical composition of both the crude and the refined ocher is shown in the following analyses made by the N. P. Pratt Laboratory in Atlanta, Ga.:

Table of Chemical Analyses of the Ocher

	I	II	III	IV	V	VI	VII	VIII
Ferric oxide, Fe_2O_3	72.29	56.29	65.49	54.60	67.37	61.40	67.32	62.79
Alumina, Al_2O_3	5.55	10.15	7.20	6.68	6.85	7.14	5.86	6.94
Ferrous oxide, FeO	0.46	0.39	-----	-----	-----	-----	-----	-----
Manganese dioxide, MnO_2	0.87	0.54	1.80	1.50	2.04	2.00	-----	-----
Silica, SiO_2 (free, sand)	6.65	8.94	7.76	17.42	6.54	11.89	9.14	6.20
Silica, SiO_2 (combined as silicates)	3.98	9.49	6.85	10.08	6.61	5.84	6.35	9.78
H_2O at 105°C	0.55	2.08	0.40	0.48	0.96	0.46	0.78	0.50
H_2O above 105°C	9.22	11.34	10.50	9.24	9.63	9.37	9.60	----
Total	99.57	99.22	100.00	100.00	100.00	98.10	99.05	-----

All of these ochers are refined by washing, except numbers I and II.

PHYSICAL PROPERTIES.—The ocher as it appears in the Cartersville District presents but little diversity of appearance. The principal difference in appearance to be noted is that of color. In this area, the color of the ocher which varies from a dark to a light, bright yellow is conditioned principally, if not entirely, by the amount of clay or argillaceous matter admixed with it, which in turn is dependent upon the character of the rock which the ocher replaces. Where the ocher replaces the pure quartz rock, it is invariably of the light, bright yellow color and it contains comparatively little admixed clay; while the ocher bodies found replacing the interbedded siliceous shales of the Weisner formation contain considerable clay, and the ocher is darker in color and is of inferior grade. On this basis, two grades of the ocher are distinguished: (a) bright yellow and (b) dark yellow containing much clay and of inferior quality.

The bodies of pure ocher consist of a yellow powder of extremely finely divided particles of hydrated ferric oxide, clay-like in character, in which the water content is high and the material soft enough to be spaded up. As the ocher grades from the soft clay-like bodies, through that bound together by a quartz skeleton into the hard and firm quartz rock, the color gradually fades and finally disappears in the absence of the yellow powder from the rock.

Aside from the argillaceous matter or clay, the other impurities, silica and manganese oxide, exercise but little if any effect on the physical appearance of the pure ocher. Silica is constantly present; but it is rarely sufficiently coarse-grained in the purer beds of ocher to impart any perceptible gritty "feel." In the other phases of the ocher the harsh "feel" is apparent from the skeleton of silica binding the ocher powder together. Manganese oxide, usually present only in small trace, gives a slight greenish tint to the refined ocher.

Methods of Mining and Preparing Ocher.—The method of mining consists of tunnels driven into the ridges with shorter drifts or tunnels worked from the main ones at suitable points. By this method a number of levels, one above the other, have been worked on several of the properties, but much more extensively on the Georgia Peruvian Ocher Company. On this property the natural section exposed by the river cutting across the quartzite ridge, has been worked back some distance from the river by blasting. At this point about half of the entire section from top to bottom is of the shattered rock almost entirely replaced by the ocher held together by the hard siliceous skeleton, which can be easily and profitably worked in this way. Timbering is necessary in tunneling as both the clay and the crushed and shattered quartzite are apt to cave in.

None of the ocher is marketed in the crude state. To obtain the merchantable product the only preparation necessary is the separation of the ocher from its mechanically admixed impurities and otherwise preparing it for market by washing, drying, pulverizing and packing.

After the ocher has been mined it is carried on an inclined tramway from the mines to the washer and dumped into a long trough or box filled with running water. A central shaft, armed with iron blades arranged in the shape of a broken helix, revolves lengthwise in the box and violently agitates the ore. The very finely divided particles of ocher remain suspended in and are floated by the water, which escapes through the openings near the top of the box into a race or flume which empties into a series of vats a short distance away where the ocher is allowed to settle. The water is in large part syphoned from the vats by means of rubber hose. After the ocher has settled and as much of the water syphoned off by the hose as possible, further expulsion of the water is by means of evaporation. The ocher is removed from the vats just as soon as it is stiff enough to handle. It is then placed on drying racks under the shed where the drying process is completed. The time required for evaporation sufficient to admit of handling the ocher, after syphoning off the water from the vats to transferring to the racks under the shed, will average about ten days in clear summer weather. It requires from eight to twelve days of similar weather to complete the drying on the racks before removing the ocher to the pulverizer.

Artificial drying is in vats or tanks arranged in series, and in which iron pipes are run at close intervals along the sides and bottoms for steam heating. Drying by this method requires usually not longer than one or two days, when the ocher is ready to be removed to the racks and the drying continued for the usual time, eight to twelve days, before the ocher is dry enough to pulverize. While the time is considerably shortened by the steam drying over the natural evaporation by the sun, the ocher is less desirable than the sun-dried material. The reason for this is that near the pipes the heat is strong enough to partially dehydrate or calcine the ocher, changing its color from yellow to dark red.

After being thoroughly dried on the racks, the ocher is removed to a room where it is pulverized and packed under steam pressure. Packing is in barrels and bags of uniform size. Capacity of the barrels is from 350 to 400 pounds, and that of the bags 210 to 250 pounds.

USES.—The principal use made of the yellow ocher mined in Bartow county, up to the present time, is in the manufacture of linoleums and oil cloths. For this consumption the important markets are in England and Scotland, to which the bulk of the Cartersville product is exported. Some of the ocher is used for a similar purpose in the plants in the United States manufacturing linoleums and oil cloths. It is used to a limited extent in the manufacture of paints.

Until recently the American ochers have been considered inferior to the imported ochers from other countries for the manufacture of paints. Gradually, however, the excellent qualities of the Cartersville ocher for paint purposes are beginning to be recognized and it may be confidently predicted that in the future an increasing demand will be made for this product in paint manufacture. By reason of its high grade character, containing proportionately a smaller amount of impurities and a larger amount of iron oxide than most of the yellow ochers produced in the United States, the Cartersville ocher yields on calcining a rather desirable red pigment, which must eventually make its way into the markets. The Cartersville ocher is further used in a variety of minor ways, the demand for which is very limited.

The principal markets at present for the Georgia product are foreign, and they include points in England, Scotland, Ireland, and to some extent, Germany. It is also shipped for use to many of the larger towns both in the North and in the South.

STATISTICS.—The production of ocher in Georgia from 1890 to 1908 inclusive is shown in the following table taken from Mineral Resources U. S. Geological Survey:

Year	Quantity Short tons	Value	Year	Quantity Short tons	Value
1890	800	$12,800	1900	6,828	$73,172
1891	600	9,000	1901	5,077	49,176
1892	1,748	26,800	1902	3,688	38,423
1893	2,600	39,000	1903	5,212	47,908
1894	1,690	17,840	1904	4,752	44,142
1895	2,105	31,080	1905	4,209	43,481
1896	2,981	28,005	1906	5,550	58,350
1897	2,608	36,600	1907	5,600	57,100
1898	2,858	30,798	1908	6,035	63,851
1899	3,212	39,505	----	-----	------

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PRECIOUS STONES[1]

A large variety of minerals suitable for gems and other ornamental objects and cabinet specimens has been found in the State. No systematic mining for gems, however, has

1. Written by Otto Veatch, Assistant State Geologist.

ARTESIAN WELL, NEAR BRUNSWICK, GLYNN COUNTY, GEORGIA, USED TO IRRIGATE A TRUCK FARM.

been carried on and the finds have been accidental, or incidental to gold, corundum, and other mining. Nearly all of the minerals are found in the Piedmont Plateau and the mountainous section of the northeastern part of the State, but a few, such as opal, chalcedony, jasper and agate, occur in the Coastal Plain.

DIAMONDS.—A number of diamonds has been reported at various times, most of them said to have been found in early placer gold mining. The following is a list of counties in which it is said that diamonds have been found. The list has been compiled from old books[1] and the reports of individuals.

Hall, White, Habersham, Banks, Lumpkin, Dawson, Forsyth, Gwinnett, Cherokee, Clayton, Bartow, Haralson, Carroll, Paulding, Cobb, and Twiggs counties are reported to have furnished one or more stones each. Most of the finds, it must be admitted, lack satisfactory verification, and in some instances one is led to suspect that pure deception has been practiced, and that in still other cases other minerals, as very clear quartz crystals, have been honestly mistaken for diamonds. However, there are a few well authenticated finds, which place the existence of diamond-bearing rock in Georgia not beyond the bounds of a probability.

The first diamond, of which there is any record, is reported to have been found in Hall county, in 1843 by Dr. M. F. Stevenson, while panning for gold. The locality is near Winn's, or Williams' Ferry, and at the mouth of a small branch which enters Muddy Creek at a point about one-half mile from its junction with the Chattahoochee River. The genuineness of the find is not disputed. The locality was vis-

1. The Geology and Mineralogy of Georgia, M. F. Stevenson, 1871.
White's Statistics of Georgia, 1849.
Handbook of Georgia, Thos. P. Janes, Dept. of Agriculture, 1876.
Commonwealth of Georgia, J. T. Henderson, Dept. of Agriculture, 1885.

ited by the writer in January, 1908, and the remains of the old placer workings were found. The branch is only about three-fourths of a mile in length, and a close examination of its drainage basin was conducted. The only rock found is a gray granite which is occasionally cut by thin pegmatite veins and thin quartz veins. The source of the diamond remains obscure.

The report that diamonds have been found in the gravel along Stockeneter Branch at The Glades, 13 miles northeast of Gainesville, should be considered reliable. But here again, there is no clue to their source. The rock within the drainage basin of the branch is granite cut by thin pegmatite veins and quartz veins.

Some credence should be given to the reports of diamonds during the early placer gold mining of White county. Authentic finds[1] are also mentioned in White, Lumpkin, Hall, and Dawson counties, but no localities are given.

It was a popular belief, and is yet so to some extent, that a belt of sandstone and quartz schist, the so-called itacolumite, in Hall, Banks and Habersham counties, would prove to be the source of diamonds, and several were reported to have been found in this rock. These reported finds, however, are open to much doubt. The above belief was based on a resemblance, or fancied resemblance, of this sandstone to the itacolumite of Brazil. It is now thought that the itacolumite of Brazil is not the source of the diamonds found there, but that they originated in clay-schists intruded by pegmatite.[2]

In 1887, a diamond was found on the property of Daniel Light, one and a half miles northwest of Morrow Station, Clayton county. The stone was found at the top of a small hill and near the old house of Daniel Light, and was discov-

1. Commonwealth of Georgia, J. T. Henderson, p. 140.
2. O. C. Farrington, Gems and Gem Minerals, p. 80.

ered in plowing. A shaft was sunk and the soil and disintegrated rock were washed, prospecting for diamonds at this point, but without success. The only rock exposed in this neighborhood is a gray biotite granite which produces a red soil. The genuineness of this find can hardly be disputed, but again the source of the stone is involved in obscurity.

A number of diamonds is reported to have been found on the Nelson property about 11 miles southeast of Macon in Twiggs county. The geological formations here are lower Cretaceous and Eocene sands and clays.

The recent authoritive find[1] of a diamond in Lee county, Alabama, a few miles from Columbus, Georgia, should be mentioned here.

Ruby and Sapphire.—The ruby and sapphire are corundum gems, and while no very fine gem material has yet been discovered in Georgia, there is always the possibility of discoveries, since there are a large number of corundum occurrences in the State. The name ruby is applied to crystals of gem corundum of some shade of red, and sapphire, to all other colors and to the transparent, colorless crystals.

Small rubies have been found at the Hog Creek corundum mine, in Towns county, but their value is impaired from a slight cloudiness. Some of these are on exhibition in the State Museum. A small ruby is also reported to have been found in Habersham county, and sent to Professor Shepard of Amherst College, in 1852, by Mr. Plant of Macon, Georgia.[2] Blocks of corundum showing blue and red colors are not uncommon, and might furnish an ornamental stone of some value.

Occurrences of corundum are known in Rabun, Towns, Union, Habersham, Lumpkin, Hall, Forsyth, Cherokee, Wal-

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1. Mineral Resources of the United States, 1905, p. 731.
2. F. P. King, Corundum Deposits of Ga. Bull. No. 2, Geol. Surv. of Ga., p. 18.

ton, Cobb, Paulding, Douglas, Carroll, Heard, Troup and Upson counties. Beautiful blue specimens have been obtained from the Laurel Creek mine, Rabun county; the Little and Lovegood property, near Monroe, Walton county; and the Prather farm in Paulding county, seven miles southwest of Acworth. Red corundum specimens have been obtained from the McTire property, Paulding county, six miles north of Douglasville; from the Bell Creek and Hog Creek mines in Towns county; near Gainesville, Hall county, and from lot 133, 11th district, Habersham county, beautiful specimens of red corundum coated with pale green margarite.

QUARTZ.—Quartz occurs both crystalline and non-crystalline or crypto-crystalline, and though one of the most common minerals, exhibits a number of forms of value for gems and other ornamental objects.

The clear, transparent crystalline variety is termed rock crystal, and many localities where it occurs in Georgia are known. However, no large crystals, which are of considerable value, anything like the size of those found in California and North Carolina, have yet been obtained. Beautiful specimens are on exhibition in the State Museum, from Rabun, Forsyth, Jones, Wilkes, Franklin and Fulton counties. There are also cut stones from rock crystal from the farm of H. H. Howell, Upson county, and beautiful opalescent quartz, cut *en cabochon,* from the Kell mica mine, Rabun county, and the Dobbins farm, near Griffin, Spalding county.

Amethyst is a violet, or purple, variety of crystalline quartz. Rabun county has furnished some of the finest amethysts obtained in this country, but no systematic search for them has been instituted. Amethystine quartz is very common in the cystalline rocks of the State, but it is only rarely that crystals suitable for cutting into gems are found.

Pretty specimens of rose quartz, showing opalescence have been obtained from the Kell mica mine, Rabun county.

Crystals of smoky quartz have been found which afford fair stones when cut. Specimens have been obtained from the Chapman mica mine, Elbert county, Franklin county, Towns county, and small crystals, showing liquid inclusions, from near Thomaston, and from Talbot county. A smoky quartz crystal given to the State Museum by Prof. L. P. Smith of LaGrange, has been cut into very pretty gems. A rock crystal five and a half inches in length, showing a faint smokiness and a remarkable complex crystalline structure, was found on the J. A. Turpin farm, near Clayton, Rabun county.

A specimen of rutilated quartz was found in the northern part of Cherokee county, but the exact locality is not known. A cluster of quartz crystals from Dr. E. D. Little's farm, near Sheltonville, Forsyth county, showing hematite inclusions; rose-colored specimens, showing parallel crystallization, from Rabun county, and white, opaque crystal groups, from near Statham, Jackson county, are worthy of mention here, since they form fine mineral specimens.

Non-Crystalline Quartz.—The varieties under this head, which are found in the State, are chalcedony, agate and jasper.

Corals which have been replaced by chalcedony occur in upper Oligocene strata in Lowndes, Brooks and Thomas counties, and a number of beautiful specimens have been found. Small specimens of chalcedony containing dendritic markings, "moss agate," have been observed by the writer at the "Rock House" near Cordele, Crisp county, and a bluish-gray agate chalcedony, on the Withlacoochee River in Brooks county, which it is believed would make pretty ornamental objects when polished.

Small masses of agate, red with thin white streaks, from near Roundoak, Jones county, and faint blue agate, with rusty streaks and bluish-gray banding, from the State Farm, Milledgeville, polish well and are suitable for watch charms. There is also in the State Museum pretty polished specimens of a red agate from Fulton county, the gift of Mr. N. P. Pratt, and a black and white banded agate from the National Cemetery at Marietta. An agate, showing straight, parallel bands of red and white is found at Wilmot's ravine, near Thomaston.

Jasper in red, yellow, brownish and black colors occurs, but no quantity of commercial importance has yet been developed. A reddish-brown jasper which polishes well occurs near Roundoak, Jones county; brown jasper is found two miles west of Clarkesville; red jasper along Flint River near Albany; a yellow-brown jasper, one and a half miles south of Elko, Houston county. The stone at the last named locality represents the siliceous replacement of an Oligocene limestone.

OPAL.—No occurrence of precious opal is known. A fire opal has been found near Chalker, Washington county. This occurrence is mentioned by Dana.[1] The opal appears as small masses in quartzite of Eocene age, the so-called "buhrstone" of this region which seems to represent the silicification of a sand which contained calcareous shells, and the opal fills the spaces left by the dissolution of the shells. Opal is observed at a number of localities in the "buhrstone" in the central part of the State but is usually milky or porcelain-like and is probably of no more than scientific interest.

Hyalite, a clear, glassy variety of opal, has been found in thin incrustations in cracks in the peridotite intrusions at the Laurel Creek corundum mine, and at the old Miller asbestos mine, Rabun county. The occurrence of hyalite in

1. System of Mineralogy, 6th edition, 1893, p. 197.

Burke county, mentioned by Dana,[1] is probably at Stony Bluff on the Savannah River, where mammillary incrustations appear in a flint rock of Eocene age.

BERYL.—Beryl is a silicate of alumina and glucina. Emerald, a gem more precious than the diamond, is a rich deep green variety, the color of which is believed to be due to a minute amount of chromium. The common beryl has been found at a number of localities in the State, but is rarely of gem value. A pale blue crystal, from the property of W. T. Smith, Moccasin district, Rabun county, and a pale green crystal from Captain Beck's farm, 8 miles east of Clayton, have sufficient transparency to be of small gem value. Large crystals occur on the Swanson property near LaGrange, but none are of gem value.

GARNET.—Almandine, the common iron-alumina garnet, is widely distributed in mica-schists and other metamorphic rocks in the crystalline area of the State, and in such quantities in places that it has been mined for an abrasive. It is usually in crystals, but sometimes massive, and is a deep red in color. The crystals have nearly always a rusty coating due to alteration from weathering. This variety of garnet is very common in Hall, Lumpkin, Dawson, Cherokee and other counties, appearing often in very large dodecahedral crystals, but, so far as known, has yielded nothing of gem value, although a small mass found near Porter Springs, Lumpkin county, has a rich red color and a few small stones could probably be obtained from it. It is reasonable to predict, however, that careful search would reveal much material that could be used either for gems, or watch jewels.

Essonite, the calcium-aluminum variety, which has a yellowish brown or cinnamon color, has been found in Fannin county, but the exact locality is not known.

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1. System of Mineralogy 6th edition 1893. p. 197.

MOONSTONE.—Moonstone, some form of feldspar, exhibits a beautiful, pale blue opalescence and is prized as a gem stone. Fair gems have been cut from specimens obtained from the Addison Lowe farm near Buford, Forsyth county, and from the Hightower place, 8 miles southwest of Thomaston.

RUTILE.—Rutile is an oxide of titanium, usually black or reddish-brown in color. It crystallizes in the tetragonal system and often occurs in twin crystals and reticulated groups which form natural ornaments. It also exhibits a natural polish, has an adamantine luster and is often cut for gems. Graves Mountain, Lincoln county, furnishes probably the finest crystals of any locality in the world. According to G. F. Kunz,[1] $20,000 worth of crystals have been sold from this locality for cabinet specimens.

ZIRCON.—Zircon, a silicate of zirconia, is a heavy mineral, having an adamantine luster, and when in transparent crystals, produces a gem almost equal to the diamond in luster, but lacks the play of colors. The brownish-red zircons are hyacinths.

Opaque crystals have been found at The Glades mines, Hall county, but not of gem value.

KYANITE.—Kyanite is a silicate of alumina, which occurs in long bladed, bluish crystals, though it may exhibit other colors, and has a hardness of 5-7. It is sometimes cut into gems. Good mineral specimens have been found in Cobb, Habersham, and Upson counties, and are on exhibition in the State Museum.

LAZULITE.—Lazulite is a phosphate of alumina, containing magnesia and ferrous iron. It occurs in fine, pale-blue crys-

1. History of Gems found in North Carolina, N. C. Geol. Surv., Bull. No. 12, 1907, p. 52.

PUBLIC ARTESIAN WELL AT OGLETHORPE, MACON COUNTY, GEORGIA.

tals imbedded in quartzite at Graves Mountain, Lincoln county, and should prove of some value as an ornamental stone.

EPIDOTE—Epidote, a hydrous calcium, aluminum silicate. containing iron, has a very limited use in jewelry. It usually exhibits a yellowish-green color, but is also greenish-black and other shades. Epidote has been found at a number of localities, but nothing of gem value has yet been obtained. Yellowish-green crystals are found at Black Rock Mountain, Rabun county. A fine greenish-black crystal, measuring two and a half by one and a fourth inches, was sent to the Geological Department by Mr. A. Wood of Commerce. The specimen is probably too dark in color, but would otherwise be suitable for gem purposes.

STAUROLITE.—Staurolite, in cruciform crystals, occurs in Fannin and Cherokee counties, and forms natural ornaments, which are sometimes known as fairy stones. No transparent crystals have been found.

FLOURITE.—Flourite is a mineral having the composition, flourine, 48.9 per cent., calcium, 51.1 per cent. It occurs in transparent crystals of a variety of colors, but on account of its softness, 4 in the scale of hardness, has a very limited use in jewelry. Beautiful purple crystals occur in the Knox dolomite formation, near Graysville, Catoosa county.

PEARLS.—A few valuable pearls have been obtained from the shells of mussels in streams in the northwestern part of the State. The pearls obtained from the oyster along the coast lack luster and are of little or no value.

REFERENCES ON PRECIOUS STONES

1849—White, George. Statistics of Georgia, 1849.

1871—Stevenson, M. F. The Geology and Mineralogy of Georgia, 1871.

1876—Janes, Thos. P. Handbook of Georgia, Dept. of Agr. Atlanta, 1876.

1885—Henderson, J. T. Commonwealth of Georgia, Dept. of Agr., Atlanta, p. 140, 1885.

1901—Kunz, Geo. F. U. S. Geol. Surv. Min. Res. for 1888, 1900, 1901.

1903—Farrington, O. C. Gems and Gem Minerals, p. 86, 1903.

PYRITE

LOCATION.—The pyrite deposits of commercial importance appear to be all confined to the Piedmont Plateau. These deposits are met with in a number of counties, the most important localities are in the following counties: Carroll, Haralson, Paulding, Cobb, Cherokee, and Lumpkin. The Carroll county deposits have been worked rather extensively at the Virginia-Carolina Chemical Company's mine about two and a half miles north of Villa Rica and at Reid's Mountain on the Central of Georgia Railway, two miles southeast of Bremen. Both of these mines are now being operated. The Haralson county prospect, known as the Smith-McCandless Pyrite Mine, is situated near the Haralson-Paulding county line, four miles north of Draketown. Another prospect in this county is the Waldrop mine, originally worked as a copper mine, four miles northwest of Draketown. The Cobb county deposits are near Acworth. Considerable pyrite was mined some years ago in Paulding county at the intersection of the Southern and Seaboard railroads, two miles west of Hiram. What appears to be the most extensive and important deposit in Cherokee county is known as the Blake pyrites mine, in the vicinity of the Creighton gold mine, about six miles east of Ball Ground. In the immediate vicinity of the Blake mine, it is reported that the Franklin Pyrites and Power Company has recently opened up an excellent prospect. The main deposit in Lumpkin county occurs on the Chestatee River, six miles northeast of Dahlonega. The commercial value of this deposit has long been known, but its location, 20 miles from the railroad, has, so far, retarded its development.

Geology.—All of the pyrite deposits enumerated in the above localities occur in the Crystalline area associated with gneisses and schists, which are supposed to be of Archæan age. In addition to these, there are also a few other deposits in Fannin and Cherokee counties which are probably lower Cambrian.

Mode of Occurrence.—Pyrite of commercial importance usually occurs in veins. These veins are often very irregular, both in thickness and in horizontal extent. In most instances, the ore bodies may be described as a series of ore chutes united by thin stringers. They appear to be quite similar to the copper veins which they resemble both in structure and size. It is not of uncommon occurrence to find these two classes of ores intermingled in the same veins as at the Waldrop mine.

History.—With the exception of the pyrite mine near Hiram, in Paulding county, all of the pyrites mines in the State have been opened up within the last five or six years. The largest producer up to the present has probably been the Virginia-Carolina Chemical Company's mine, near Villa Rica. Considerable ore has also been produced by the Blake mine as well as the mine at Reid's Mountain in Carroll county.

Character of the Ores.—The ores occur both massive and in a finely granular condition. The latter form of the ore is generally met with in the Blake mine, and the former in the mine near Villa Rica. These ores often occur quite pure and need no further treatment after being taken from the mine. More generally, however, they not only have to be carefully hand-picked, but also crushed and concentrated before put on the market. The most common minerals associated with the pyrite are quartz, mica, copper pyrites, calcite, hornblende, and occasionally galena.

USES.—All of the pyrite mined in this State is used in making sulphuric acid, which, in turn, is used in the manufacture of commercial fertilizers.

STATISTICS.—The production of pyrite for Georgia for the last five years, as shown by the Mineral Resources, U. S. Geological Survey, is here given.

Year	Quantity Tons	Value	Year	Quantity Tons	Value
1904	18,369	$76,101a	1907	28,281	$85,307
1905	19,928	71,863a	1908	20,181	52,180
1906	26,173	78,817a			

(a) Georgia and Alabama.

REFERENCES ON PYRITES

1901—McCallie, S. W. Mineral Resources of Georgia. Int. Ming. Cong. 4th Ses. Pro. pp. 33-42, 1901.

1907—Rutledge, J. J. Pyrites. The Mineral Industry, pp. 839-851, 1907.

ROAD MATERIAL

The road-building materials of Georgia are quite abundant and fairly well distributed throughout the State. In describing these materials, the State will be divided into three divisions, namely, the Paleozoic, the Crystalline, and the Cretaceous-Tertiary areas corresponding to the three great geological divisions of the State.

THE PALEOZOIC AREA

The materials used for road construction in this part of the State, which comprises all or part of the following ten counties, Polk, Floyd, Bartow, Gordon, Murray, Whitfield, Catoosa, Chattooga, Walker, and Dade, consist of limestones, cherts, shales, and sandstones. The limestones of the area are very abundant, and are well suited for macadamizing purposes. They may be separated into three divisions, namely, Knox Dolomite, Chickamauga Limestone, and Bangor or Mountain Limestone.

The Knox Dolomite is the most extensive of the three formations. It attains a thickness, in places, of more than 3,000 feet and occurs in the form of a number of broad and narrow bands, traversing the area in a northeast and southwest direction, giving rise usually to broad, rounded ridges. The formation consists largely of compact, heavy-bedded, light-gray magnesian limestone, sometimes oölitic and always containing a considerable amount of siliceous material in the form of chert, hereafter to be described. The uniform texture and the crystalline structure of the dolomite well suit it for macadamizing purposes. In fact, it would be a difficult matter to find a calcareous deposit better adapted for road material than some of the beds of this formation. The stone is easily quarried, and is readily crushed by the rock-breaker; but it has, at the same time, sufficient toughness to form a durable wearing surface.

The Chickamauga Limestone overlies and is co-extensive with the Knox Dolomite. It occurs in the form of narrow belts, more or less parallel and often valley-forming. The formation is so called from the Chickamauga Valley, where it reaches its greatest development. Its various beds differ considerably, both in physical structure and mineral composition. Much of the Chickamauga limestone weathers into shale having a knotty structure. Such material is often used for road surfacing without being crushed; but its wear, on account of its fragile nature, is usually unsatisfactory. The compact, blue variety of this stone, on the other hand, makes an excellent macadam. It has been extensively used for this purpose, both in Chattanooga and in Chickamauga Park.

THE BANGOR LIMESTONE, which is of Carboniferous age, is a pure dove-colored limestone attaining a thickness of about 900 feet. The formation is well exposed along the flanks of Pigeon and Lookout mountains, where it outcrops beneath the sandstones. The extent of the area covered by this formation is limited mainly to the narrow belts at the base of the above named mountains and, as a consequence, it will probably never become of very great importance in road construction.

THE CHERT DEPOSITS of the Paleozoic area are quite extensive and are widely distributed throughout the area. They occur in two different geological formations, namely, the Knox Dolomite and the Fort Payne Chert, the latter being the lowest member of the Carboniferous formation. The chert of the Knox Dolomite is co-extensive with the dolomite itself, and it is often by far the more important deposit of the two, from a road-building standpoint. It occurs in the dolomite in the form of nodules, and also in beds, frequently several feet in thickness. In the weathering of the dolomite, the chert remains as a residual product, in the form of gray flinty nodules. It has been extensively used for several years for surfacing roads and streets throughout North Georgia. The material is well suited for roads of light travel, but where traffic is heavy it is inferior to limestone. It possesses an excellent binding quality, but, after long drought and much travel, it becomes somewhat dusty.

THE FORT PAYNE CHERT is a siliceous limestone, varying in thickness from 50 to 200 feet. Its lower layers consist largely of heavy beds of chert, resembling very closely the chert of the Knox Dolomite. This formation, like the Mountain Limestone, occurs along the base of Taylor's Ridge and Horn Mountain, further east. The siliceous nature of the formation is well exhibited along the Southern Railway, about one mile south of Sugar Valley station. The chert of the Fort Payne formation is usually distinguished from the Knox Dolomite cherts by its numerous fossils. It is, in places, very fossiliferous, being made up largely of the stems of crinoids, which are cemented together by a siliceous matrix.

In addition to the materials above mentioned, shales, siliceous gravel, and also sandstone occur in the Paleozoic area, but such material is usually inferior for road construction.

The Crystalline Area

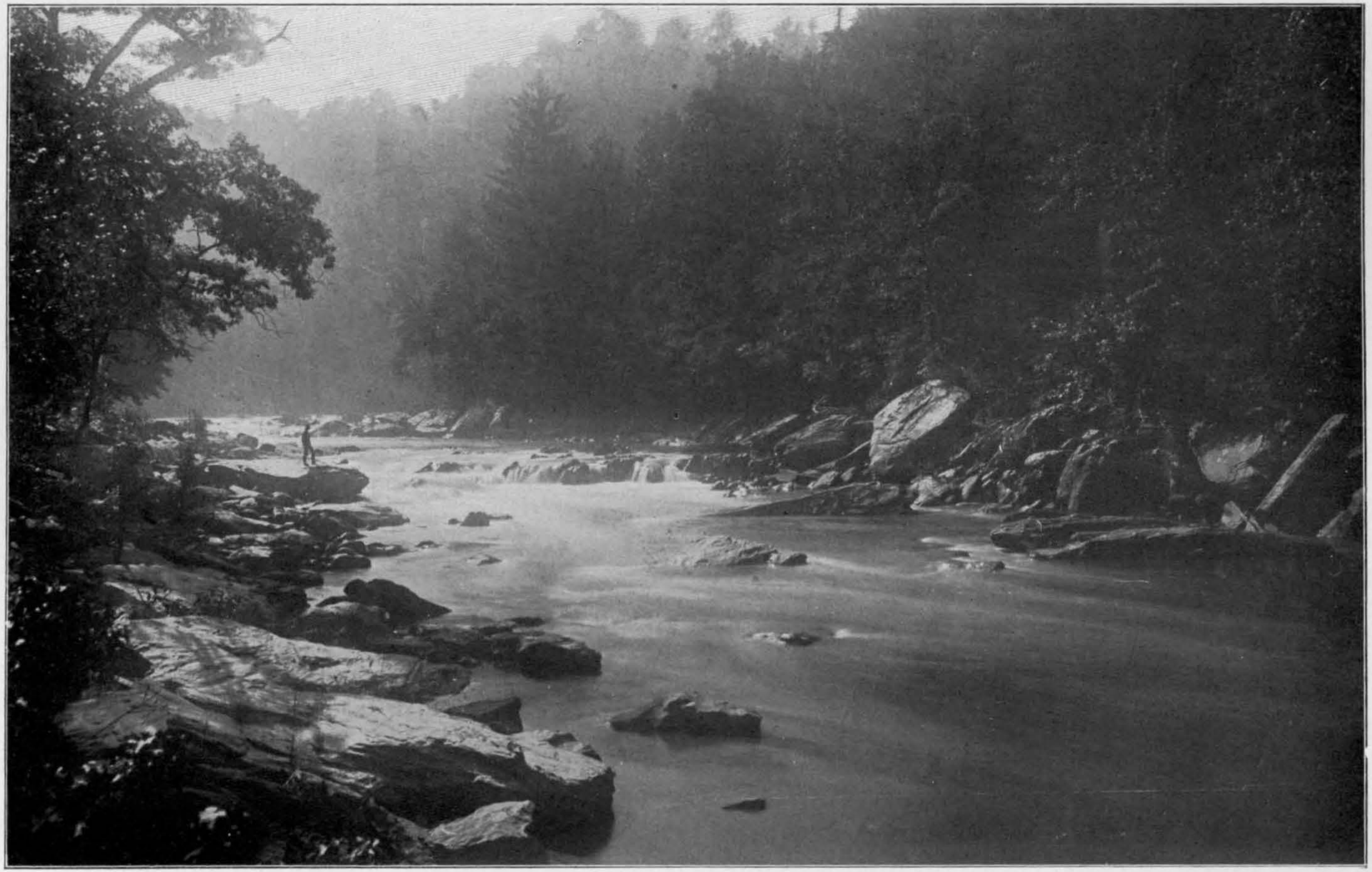
The road building materials of the Crystalline area consist of granite, gneiss, diorite, schists, quartzite, marble, massive quartz, and trap rock.

The Granite is widely distributed throughout the Crystalline area, where it occurs in the form of large intrusive masses in the gneisses and schists. These granite masses often cover hundreds of acres, and occasionally, as in the case of Stone Mountain, form dome-shaped masses rising many feet above the surrounding country. In texture, these granites differ widely. They vary from an exceedingly fine-grained, homogeneous, monumental stone to a very coarse-grained granite or pegmatite. The fine-grained varieties are quite extensively quarried at several localities in the State for building and monumental stone; and also for street paving purposes. The physical tests, which have been made on these granites, show that they have great strength, and are therefore among the best of this class of stone for road material.

Gneiss is far more abundant in the Crystalline area than granite, and, as a general rule, it is much more suitable for road material. The gneisses are divided into two well-known varieties, namely, the true gneiss, made up of quartz, feldspar and mica, and the hornblende gneiss, which contains, in addition to these minerals, hornblende as an essential constituent. Hornblende gneiss is generally superior to the true gneiss for road purposes, on account of its finer texture and greater toughness. It occurs, in places, throughout North Georgia, where it is found in narrow belts underlying the so-called red lands. The true gneiss makes a fair road surfacing material when it is fine-grained and composed largely of quartz. Nevertheless, owing to the small amount of iron present its binding property is always inferior to that of the hornblende gneiss.

Diorite, which is more or less abundant throughout North Georgia, is a green or dark gray rock resembling very closely in general appearance both the hornblende gneiss and the hornblende schist. It occurs mostly in the form of narrow belts or zones, intercalated with the gneisses and schists.

Trap Rock or diabase is very generally distributed throughout the Crystalline area. It occurs always in the form of dikes, which vary in thickness from a few inches to several rods. These dikes which have originated from the filling up of fissures by molten matter forced up from below, have a generally northwest and southeast trend and a nearly vertical dip. The best exposures of dikes are to be seen along the several railroads traversing the Crystalline area. Here, they are frequently exposed in cuts to the depth of 20 feet or more and their relation to the gneisses and schists, together with their mode of weathering, can be easily studied. These rocks are of dark gray or black color, usually fine-grained and quite difficult to break with a hammer. As a



Rapids on the Ocoee River, Near the Georgia-Tennessee Line. The Haziness in the Distance is due to Sulphur Fumes From The Ducktown Smelters.

road surfacing material, this class of rocks has no equal. Its great hardness and its remarkable toughness, together with its excellent binding quality, make it an ideal road-building material. Other rocks of the Crystalline area, but inferior to those mentioned for road material, are hornblende-schist, mica-schist, quartzite, and marble.

THE CRETACEOUS-TERTIARY AREA

The road-building materials of the Cretaceous-Tertiary area are limestone, or flint, and gravel. In the vicinity of the coast, shells also have had a limited use in road surfacing.

THE LIMESTONES of South Georgia outcrop at many points throughout the Coastal Plain. They are exposed most abundantly along the streams in the vicinity of lime-sinks or lakes. They are also occasionally seen in the cuts of the various railroads traversing that part of the State. These limestones are usually soft and of a porous nature; though, occasionally, they become quite compact and are partly crystalline. The softer varieties, in places, consist mainly of fragments of shells and a limited amount of sand cemented together by a calcareous matrix. This class of limestone has been used to a considerable extent for road and street surfacing in South Georgia, where it seems to give satisfaction. The material readily cements into a compact hardened surface, comparatively free from dust. The cheapness with which these soft limestones can be prepared and put in place on the roadbeds, makes them the most valuable material of the Cretaceous-Tertiary area for road surfacing. The hard limestones of South Georgia appear to have but little use, so far, in road constructions. Nevertheless, they are more or less widely distributed, and seem to be fairly well adapted to that purpose.

Buhrstone or flint is quite abundant in Decatur county and also in a number of other counties in South Georgia. It is usually of a porous nature, and has evidently originated from the silicification of the limestone, with which it is frequently associated. These siliceous deposits sometimes occur in more or less continuous layers, often three feet or more in thickness; but, as a general thing, they appear as bowlders or detached masses imbedded in the sands or clays. The buhrstone is quite brittle, and it could hardly be used alone to advantage for road surfacing, but if mixed with the soft limestones, which often are found near by, it would probably make a fair road surface.

Gravel Deposits are quite plentiful along the northern border of the Cretaceous-Tertiary area, where they are often seen in thick beds outcropping beneath the superficial layers of sand. The pebbles are all water-worn, and evidently mark the limit of an old shore line. They are often cemented by ferruginous, sandy clays, and make excellent material for road surfacing. Many exposures of these gravel deposits are to be seen in the vicinity of Augusta, Milledgeville, Macon and Columbus. Besides the road material above mentioned as occurring in the Coastal Plain, there is another very important material for road construction, which should not be overlooked. The material here referred to is a somewhat sandy tough clay, which is nearly everywhere present, just beneath the superficial layer of sand that mantels the entire Coastal Plain. By the use of this clay with a proper mixture of sand a most excellent sand-clay road can be made at a small cost.

REFERENCES ON ROAD MATERIAL

1901—McCallie, S. W. *A Preliminary Report on the Roads and Road-Building Materials of Georgia. Ga. Geol. Surv. Bull. 8, 264 pp., 27 pls., 28 figs., 1901.*

SAND AND GRAVEL

LOCATION.—Sand and gravel are both widely distributed throughout the State. They are especially abundant in the northern part of the Coastal Plain. Excellent deposits of sand are to be seen near Howard on the Central of Georgia Railway in Taylor county; at Junction City in Talbot county; on Bull Creek, three miles east of Columbus in Muscogee county; on the west side of the Flint River at Bainbridge, Decatur county; on the Flint River, just opposite Albany, Dougherty county; on the east bank of Little Ogeechee River, one and a half miles northeast of Lumber City, Telfair county and on the east bank of the Oconee River at Dublin, Laurens county. In addition to these various localities there are numerous other localities throughout the Coastal Plain where more or less extensive deposits of sand and gravel may be found.

In the Piedmont Plateau and the Appalachian Valley the sands and gravels are mostly found along the streams, but, nevertheless, they occur even here in the older formation in some places forming stratified beds of considerable extent, as in the vicinity of Emerson, Bartow county, and on Rocky Face Mountain in Whitfield county. In the latter case the sand is in a form of friable sandstone, but it is easily crushed. A remarkably pure bed of white sand occurs near the base of Sharp Top Mountain, about four miles west of Jasper, Pickens county, and another deposit of similar character may be seen on the Louisville and Nashville Railroad, a few hundred yards north of Turniptown Creek, Gilmer county.

GEOLOGY.—The sands and gravel of the Coastal Plain vary in age from Cretaceous to Pleistocene, but the most important are of Pleistocene age. The sands and gravel of the Piedmont Plateau, with the exception of the stream sand and gravel which are all recent, are probably Cambrian, while those of the Paleozoic area vary from Cambrian to Carboniferous.

MODE OF OCCURRENCE.—The sands of the Coastal Plain attain a thickness of 30 feet or more. Most of them appear to be local thickenings of what is known as the Columbia formation, which mantles the entire Coastal Plain. In the Piedmont Plateau and the Paleozoic area, they occur in regular beds, except those which form in the stream beds which occur mostly as irregular deposits of small lateral extent.

CHEMICAL PROPERTIES.—The sands are often quite pure, as is shown by the following analyses:[1]

	I	II	III	IV	V	VI
Loss on ignition	.22	.33	.56	.30	.52	.08
Ferric oxide, Fe_2O_3	.71	.46	.14	.20	1.43	.50
Titanium dioxide, TiO_2	.09	.13	trace	.09	.11	----
Alumina Al_2O_3, by difference	----	----	----	----	1.02	.05
Undetermined	1.36	.81	1.85	1.27	----	----
Silica, SiO_2	97.62	98.27	97.45	98.14	96.92	99.81
Total	100.00	100.00	100.00	100.00	100.00	99.99

I. Sand from Albany, Dougherty county.
II. Sand from Taylor county.
III. Sand from Lumber City, Telfair county.
IV. Sand from Whitfield county.
V. Sand from Emerson, Bartow county.
VI. Sand from near Jasper, Pickens county.

USES.—Sand has an extensive use for various kinds of structural work. A considerable amount is also used for molding purposes and glass sand, as well as for locomotive purposes, and for furnace sand. Gravel is largely used for tar roofing, road surfacing, etc.

1. Analyses by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.

STATISTICS.—The production of sand and gravel in Georgia since 1903, as shown by the Mineral Resources U. S. Geological Survey, is given in the following table:

Year	Quantity Short tons	Value	Year	Quantity Short tons	Value
1903	4,900	$ 4,410	1906	335,797	$117,816
1904	88,381	38,362	1907	226,290	81,991
1905	85,003	41,253	1908	229,847	80,988

REFERENCES ON SAND AND GRAVEL

1906—Burchard, E. F. Glass Sand, Sand, and Gravel. U. S. Geol. Survey, Min. Res. for 1906, pp. 993-1000.

SERPENTINE

LOCATION.—The only deposit of serpentine, so far worked in Georgia, occurs at the Verde Antique Marble Quarry in Cherokee county, about two miles southwest of Holly Springs. The stone is of igneous origin, and is probably pre-Cambrian in age.

HISTORY.—Prior to the quarrying of stone for interior finish and decorative purposes, the property was worked in a small way for talc, a mineral which originally seemed to have been more or less abundant near the contact of the serpentine with the enclosing schist. The first stone quarried for the trade was taken out some 15 or 18 years ago by the American Marble Company, which at that time owned and operated the large marble mill at Marietta, now known as the Kennesaw Marble Works. The American Marble Company operated the quarry only for a short time, when the property was leased to the Verde Antique Marble Company of Chicago, for a term of fifty years. The last named company, which has now been in possession of the property for several years, and which has operated the quarry at irregular intervals during this period, is at present operating the quarry.

Extent and Mode of Occurrence.—The extent of the deposit is limited to a small area not over 600 feet in length and with a maximum width of not over 150 feet. In shape it is roughly lenticular, being widest near the center and decreasing gradually in width towards both ends. Its form suggests an intrusion which has forced its way upward through the schist, the surrounding country rock. The weathered outcrops, with their rugged and irregular surfaces, form large masses projecting in places 10 feet or more above the general ground level.

Structure and Physical Character.—With the exception of the slight tendency, in places, to schistosity, the stone is distinctly massive, breaking as readily in one direction as another; but, at the same time, the stone is by no means uniform in structure or in mineral composition. One of the most striking physical characters of the serpentine is the veined condition which adds to its beauty. These veins, which are always present, vary in size from a mere microscopic line to a half-inch or so in width, are often so arranged as to form a complete network. In addition to these smaller veins, there are also present large veins frequently four or five inches in width and occasionally several feet in length. The latter are sometimes open, and seriously interfere in quarrying stones of large size, while the former are always closed. The origin of the two systems of veins appears to be entirely different, the larger being due apparently to rock movement and the other to cleavage lines of the original minerals. The vein fillings in the two different systems are also different. In the larger veins, the filling, which is usually of a light color, consists mainly of ferruginous dolomite and talc, while in the smaller veins the filling appears to be mainly a dark greenish serpentine containing numerous granules of magnetite. The main mass of the stone, which fills the meshes between the individual veins, is chiefly pyroxenite with hornblende, which minerals give to the stone a greenish gray color, often splotched with black.

USES.—The stone is used almost exclusively for interior finish and decorations. It is especially adapted for stairways, corridors, mantels and pedestals for statuary. A good example of the pleasing effect of the stone for interior finish may be seen in the entrance of the corridors of the Grant Building and in the smoking room at the Terminal Station, Atlanta. The cost of quarrying, due chiefly to the unsound condition of the stone, makes the Georgia serpentine so expensive that, so far, it has not had a very extensive use. The increase of soundness, however, with the depth, seems to make the future outlook for the stone more promising.

REFERENCES ON SERPENTINE

1907—McCallie, S. W. *A Preliminary Report on the Marbles of Georgia (2nd Edition). Ga. Geol. Survey Bull. 1, pp. 114-117, 1907.*

SLATE[1]

LOCATION.—Slate is found in Georgia in Bartow and Polk counties. The largest area of shale and slate extends from the vicinity of Free Bridge, about three miles south of Cartersville, following somewhat parallel to the great Cartersville fault line in a general southwest direction to about five miles south of Rockmart. This slate belt has its greatest width in the Rockmart region, thinning in both a northeast

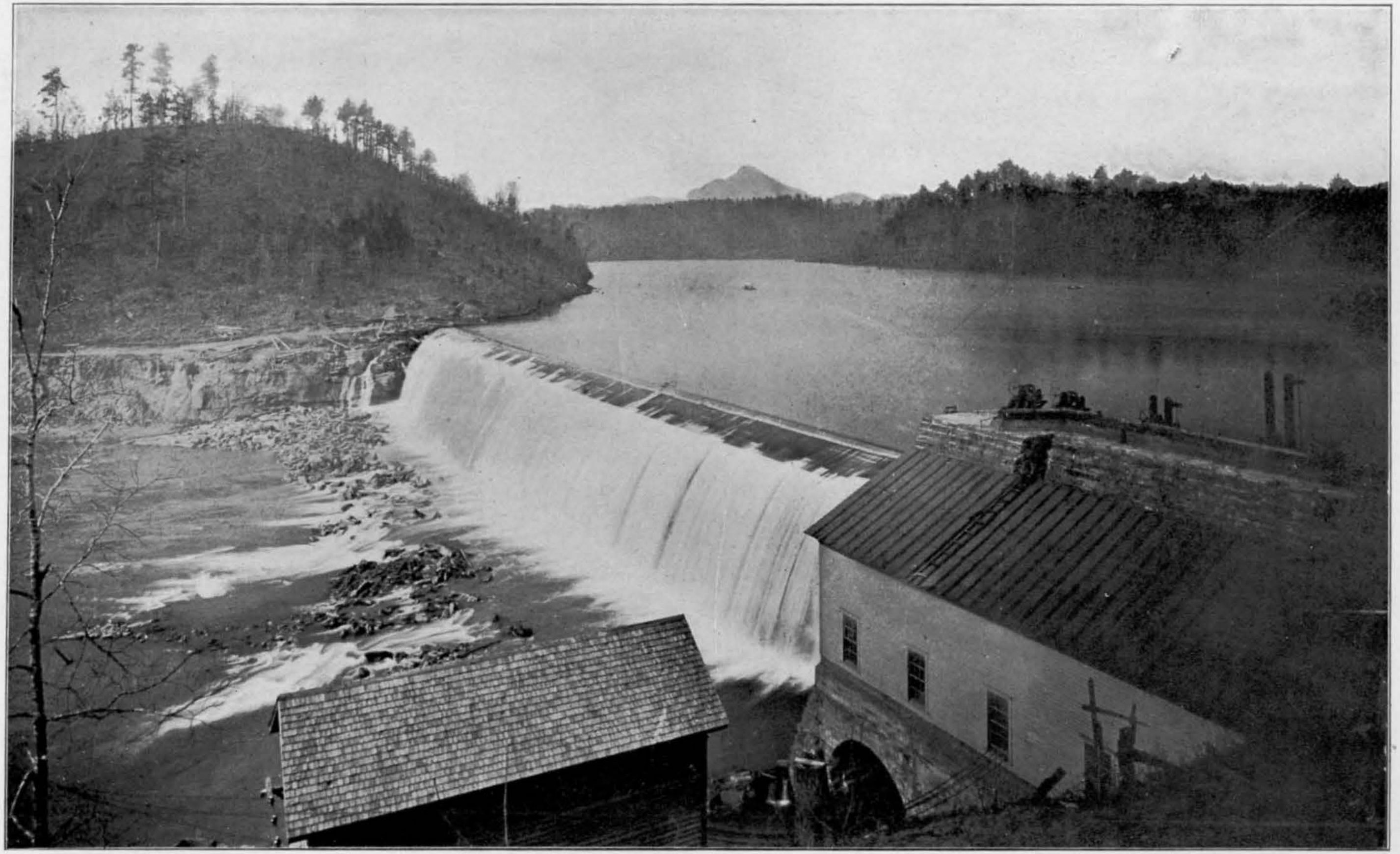
1. Written by T. Poole Maynard, Assistant State Geologist.

and southwest direction. Another belt of slate occurs in the vicinity of Cedartown, Polk county, becoming of more importance southwest of the town.

Geology.—The commercial slates occur in the Rockmart formation of Silurian age. This formation has been correlated by Dr. Hayes of the U. S. Geological Survey with the upper portion of the Chickamauga limestone north of the Coosa Valley. The Rockmart formation consists largely of dark blue to black shales and slates weathering often to olive green and yellow. The lower portion of this formation is remarkably uniform in its lithological character while the upper portion of the formation is more variable, containing highly ferruginous sandstone, cherty limestones and conglomerates.

Mode of Occurrence.—The commercial slate has been found to occur only in the lower portion of the formation. In the vicinity of the Cartersville fault the slate has been so intimately folded that it does not readily split. As the lower half of the formation is more uniform in its lithological character with a good split, the prospector will do well to confine his search to this portion of the formation and some distance from the Cartersville fault.

History.—Slate was quarried at Rockmart previous to 1861 on what is known as the old Dever property. This property was opened by a Frenchman by the name of Blace. It is owned at present by Messrs. Rhodes and Hayden, of Atlanta. Some time later, slate was developed by Col. Seaborn Jones of Rockmart, and in 1893 the quarries were sold to the Georgia Slate Company. Col. Vandeventer of Knoxville, Tennessee, was president of this company. The Georgia Slate Company ceased operating in 1896 and the following year leased the quarries for three years, during which time



DAM, POWER HOUSE AND TRANSMITTER HOUSE OF THE NORTH GEORGIA ELECTRIC CO. AT DUNLAP SHOALS ON THE CHATTAHOOCHEE RIVER, NEAR GAINESVILLE, HALL COUNTY, GEORGIA.

it was successfully operated. In 1901, Mr. H. F. Vandeventer, son of Col. Vandeventer, who was at that time secretary and treasurer of the Georgia Slate Company, found that these slates were eminently suitable, if used with a pure limestone, for the manufacture of Portland cement. He organized the Southern States Portland Cement Company, which company bought the property of the Georgia Slate Company. The Southern States Portland Cement Company has since then confined its attention to the manufacture of Portland cement.

Between 1870 and 1875, the quarry in which the Ellis Davis & Son Slate Company are now operating was opened by Mr. Ellis Davis and Mr. J. W. Davis. In 1897 and 1898 the Slateville quarry was opened by Mr. Wm. Kelley of Atlanta, who leased the property from Mr. Wm. Cornelius, the owner. This quarry is located in the Cedartown slate belt. Inman & Company later leased this quarry. Slate has not been produced here for some years. The Southern Slate Company was organized by its president, Mr. R. P. Sibley, of Rockmart, Georgia, in 1907. This property is on Signal Mountain. Only prospect work has been done and no commercial slate has been produced. In 1907 and 1908, the Black Diamond and Columbia Slate companies, situated about two miles northeast of Rockmart, were organized by Mr. J. W. Stockweather of Knoxville, Tennessee. Commercial slate for roofing was produced here until the fall of 1909. The Rockmart Shale Brick and Slate Company at Rockmart has opened up an extensive quarry and built a plant for sawing and planing, but has never produced any slate for the market.

Physical and Chemical Properties.—The slate is of a dark blue to black color, which is probably due to considerable carbonaceous or graphitic matter. To the unaided eye, it has a fine texture and smooth cleavage, which forms a considerable angle with the original bedding. Some beds of the slate being more calcareous than others effervesce in cold dilute hydrochloric acid. It has little pyrite, is sonorous, and has a good grade of fissility.

The following is an average analysis[1] of Rockmart slate. The sample having been taken from the quarry of Ellis Davis & Son Slate Company, Rockmart, Georgia:

Moisture at 100°C	.46
Loss on ignition	6.34
Soda, Na_2O	1.40
Potash, K_2O	2.63
Lime, CaO	.28
Magnesia, MnO	2.60
Alumina, Al_2O_3	20.80
Ferric oxide, Fe_2O_3	4.93
Manganous oxide, MnO	.10
Silica, SiO_2	59.74
Total	99.96

USES.—Slate is used most extensively for roofing and for many other purposes, namely, burial vaults, platforms, steps, window and door sills, wainscoting, hearths, electrical bases and switchboards, school slates, floor tiles, lavatories, sinks, laundry tubs, mantles, etc.

REFERENCES ON SLATE

1893—Spencer, J. W. The Paleozoic Group. The Geology of Ten Counties of Northwest Georgia and Resources, pp. 35, 275, 1893.

1906—Dale, Nelson T. Slate Deposits and Slate Industry of the United States. U. S. Geol. Surv., Bull. 275, pp. 59-60, 1906.

TALC AND SOAPSTONE[2]

LOCATION.—Talc has been found at a large number of localities in the northern part of the State, but commercial deposits have been developed at only a few places. Soapstone, impure talc, and talcose schist, consisting mainly of talc with other minerals as chlorite, anthophyllite, actinolite,

1. Analysis by Dr. Edgar Everhart, Chemist of the Geological Survey of Georgia.
2. Written by Otto Veatch, Assistant State Geologist.

magnetite and pyrite, is rather widely distributed, but has only a small local value for hearth slabs for fire places and for building stone.

Two companies are at present producing talc, the Cohutta Talc Company and the Georgia Talc Company. The mills of the above companies are located at Chatsworth, Murray county, and the mines are on Fort and Cohutta mountains about three miles distant. Talc has been mined at Fort and Cohutta mountains for a period of about 40 years and in all about 140 pits, tunnels and shafts have been dug in exploration and mining work. The mineral represents an alteration of peridotite which has been intruded in quartzite and quartz schist. The talc occurs on the borders of the intrusions, is mainly massive and in the nature of soapstone, and the beds are reported to vary in thickness from 2 to 30 feet. The peridotite has a northeast-southwest strike and shows a dip of 30° to 45° southeast. The talc is sawed or turned into pencils, and pulverized, mainly for foundry facing. The impurities, or "grit," are magnetite, quartz and pyrite. Small veins of very pure talc, foliated or in plates, appear, but are not in sufficient quantity to be of commercial value. Associated secondary minerals are chlorite, serpentine, asbestos, and magnesite or dolomite, but none of these are of commercial importance.

A considerable amount of prospecting has been done on the Dickey property, one-half mile south of Mineral Bluff, Fannin county. The talc occurs in parallel beds, inclosed by a quartz schist of sedimentary origin. The beds have a thickness of about five feet and have a strong dip to the southeast. The talc is massive and bluish-gray in color. The principal objection to this material for pencils and gas tips is the large amount of "grit," principally pyrite, which it contains.

A small amount of talc has been mined from a deposit three and a half miles south of Blue Ridge, on the Louisville and Nashville Railroad. The workings have caved in and but little information concerning the mode of occurrence can be given. The country rock is an argillaceous schist which contains beds of quartzite and ocher. The talc is massive and white. It may have resulted from the alteration of a thin intercalated layer of dolomite.

A large amount of prospecting work for talc has been carried on about two miles west of Ball Ground. The talc is massive, non-crystalline, and white. It has probably been derived from a dolomitic marble.

A small amount of very pure talc occurs in veins in the serpentinized pyroxene at the quarry of the Verde Antique Marble Company, near Holly Springs, Cherokee county.

Talc is reported to have been mined several years ago at the old Hawes soapstone mine, three miles southwest of Holly Springs. The talc here is both massive and micaceous or foliated and has formed along the borders of a pyroxenite intrusion, leaving a core of partially serpentinized pyroxenite. The igneous intrusion is cutting a mica schist, and has a surface area of about 300 x 75 feet. There is a probability of talc of good quality being found at continued depths along the contact with the schist.

There are a large number of other localities where talc and soapstone have been found. Habersham, Rabun, White, Lumpkin, Cherokee, and Paulding counties furnish most of these localities. A few of the deposits may have some future commercial value, but many of the occurrences are of no more than mineralogical or geological interest.

GEOLOGY.—The talc and soapstone deposits are confined to the Crystalline area of the State, and are associated with peridotite and pyroxenite intrusions and highly metamorphosed sediments, and are of probable Cambrian or pre-Cambrian age.

Mode of Occurrence.—Talc occurs mainly as an alteration product of certain magnesium silicates. Three different sources have been distinguished in Georgia: (1) from the alteration of peridotite intrusions; (2) from the alteration of pyroxenite intrusions; (3) from the alteration of magnesian sediments, dolomite or magnesian shale. The talc associated with the peridotites is derived most probably mainly from the chemical alteration of olivine. It exists in largest quantity along the outer edges of the intrusions, but in a few localities it appears that the whole of a peridotite intrusion has been converted into soapstone or talc schist. The talc associated with the peridotites is usually massive. This type has been found in Murray, White, Rabun, Habersham, and Lumpkin counties. Talc of the second type is found associated with the pyroxenite areas of Cherokee county. Beautiful specimens of apple-green foliated and mica-like talc have been obtained from the Verde Antique quarry near Holly Springs. It also occurs massive and there are small dikes of soapstone which probably represent the complete alteration of pyroxenite. The third class of talc deposits is found in Cherokee and Fannin counties, and has resulted from chemical changes in connection with intense dynamic metamorphism of the original sediments.

Physical and Chemical Properties.—Talc is a white, gray or greenish mineral, and is very soft and has a greasy feel. It is a silicate of magnesia, having the chemical formula, $H_2Mg_3(SiO_3)_4$. It is unattacked by ordinary acids and is resistant to heat. Soapstone is usually considered an impure form of talc. It is massive or schistose and contains, in addition to talc, such minerals as chlorite, actinolite, anthophyllite, magnetite and pyrite. It is soft, however, and easily sawed or cut into desired shapes.

USES.—The principal uses of talc are: pencils for foundry marking, foundry facing, gas tips, paper filler, base for lubricants, fire-proof paints, and toilet powders. Soapstone is used for hearthstones, furnace lining, laundry tubs, etc.

STATISTICS.—The production of talc and soapstone in Georgia has been variable, ranging from about 500 to 6,477 short tons annually with values ranging from $4,000 to $77,213.

REFERENCES ON TALC AND SOAPSTONE

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TRIPOLI

LOCATION.—A light, porous, siliceous stone, locally known as tripoli or rotten stone, occurs in Murray, Whitfield, Chattooga, and other counties in Northwest Georgia. One of the best known deposits in Murray county is on the Tilton property, near Spring Place. There are several localities in Whitfield county where it is known to occur. It has been extensively worked near the Western and Atlantic Railroad on the Hamilton property, a short distance north of the corporate limits of Dalton. Similar works are also to be seen in Chattooga county near Lyerly.

GEOLOGY.—Tripoli, or rotten stone, is a residual product derived from the Knox dolomite. The material appears to be confined to certain beds of this formation where it occurs in the form of irregular beds associated with impure kaolin and chert. In some localities it seems to be in pockets, but more generally it is found in beds showing ill defined lines of stratification. The beds may vary from a few inches to several feet in thickness, but as a general rule the thickest beds carry more or less inferior material, which has to be discarded. Mining is generally carried on by open cuts, but in some places, as at the Hamilton mine, near Dalton, underground mining is resorted to.

CHEMICAL PROPERTIES.—The two following analyses[1] show the chemical composition of some of the Georgia tripoli:

Water, H_2O	2.94	.62
Silica, SiO_2	84.84	92.11
Clay bases	12.22	7.27
Total	100.00	100.00

USES.—Tripoli, or rotten stone, mined in Georgia is said to be used largely in the manufacture of scouring soaps and polishing powders. The material is also employed in the paint industry and as a wood-filler as well as for making filter stone. It is a poor conductor of heat, and has a limited use for safe packing, steam-pipe covering, etc.

Georgia has produced only a limited amount of tripoli and as a result no statistical data are obtainable, either as to the actual amount produced or the value per ton.

REFERENCES ON TRIPOLI

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1. Analyses by Dr. Edgar Everhart, Chemist of the State Geological Survey of Georgia.

APPENDIX

MINERAL WATERS

LOCATION.—Mineral springs of greater or less importance are widely distributed throughout the State. They are specially abundant in the Piedmont Plateau and Appalachian Valley where one or more having a local reputation are met with in nearly every county. These springs are especially abundant in the mountainous region of the Crystalline area where many of them have become sites of prominent summer resorts. Among the springs of this character may be mentioned Warm Springs and White Sulphur Springs of Meriwether county, Bowden Lithia Springs of Douglas county, Indian Springs of Jackson county, White Sulphur Springs of Hall county, White Path Spring of Gilmer county, and Porter Spring of Lumpkin county. Springs of like reputation in the Appalachian Valley are the Catoosa Springs of Catoosa county, Menlo Spring of Chattooga county, and Cohutta Springs of Murray county. In addition to the class of springs here referred to, there are also a large number of springs without accommodation for guests, but the owners of these springs do a more or less extensive business in selling water for table or medicinal purposes. The list of springs selling water, from which reports were received in 1908, are as follows:

Benscott Lithia Springs, Austell, Cobb county.
Bowden Lithia Springs, Lithia Springs, Douglas county.
Catoosa Springs, Catoosa Spring, Catoosa county.
Cox Mineral Spring, Waynesboro, Douglas county.
Daniel Mineral Spring, Union Point, Greene county.
Electric Lithia Spring, Hillman, Taliaferro county.
High Rock Magnesia Spring, near Atlanta, Fulton county.
Major's Spring, Menlo, Chattooga county.
Miller's Spring, Milledgeville, Baldwin county.
Miona Spring, near Oglethorpe, Macon county.
Point Andrew Spring, Macon, Bibb county.

Powder Springs, Powder Springs, Cobb county.
Utoy Spring, near Atlanta, Fulton county.
White Elk Spring, near Macon, Bibb county.
White Oak Mineral Spring, Macon, Bibb county.

STATISTICS.—The following table, taken from Mineral Resources U. S. Geological Survey, gives the quantity and value of mineral waters annually since 1890:

Year	Quantity Gallons	Value	Year	Quantity Gallons	Value
1890	66,000	$18,450	1900	148,500	$28,200
1891	81,500	27,300	1901	284,976	45,521
1892	114,000	30,450	1902	419,100	60,797
1893	86,000	14,600	1903	379,517	65,252
1894	36,000	8,100	1904	305,294	45,744
1895	54,000	10,400	1905	270,249	37,619
1896	167,550	26,855	1906	130,900	14,535
1897	175,500	41,300	1907	246,800	28,120
1898	197,100	39,230	1908	346,198	50,930
1899	128,040	24,770			

It will be noticed in this table that the quantity of water sold in 1908 was 40 per cent. greater than the quantity sold in 1907 and that the value of the water was 81 per cent. greater than in 1907. This increase in value was partly due to an increase in value of the water sold, but mainly to the untiring energy of some of the main producers.

REFERENCES ON MINERAL WATERS

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ARTESIAN WELLS

LOCATION.—The artesian wells of Georgia are practically all confined to the Coastal Plain, which is the only part of the State where the geological conditions are favorable for artesian water supply in large quantities. A considerable number of deep, non-flowing bored wells are also found in the Crystalline and Paleozoic areas, but as a general rule these wells furnish only a limited amount of water and they can not always be relied upon for a continuous supply, as they are often effected by long droughts.

GEOLOGY.—The essential geological conditions for successful flowing artesian wells are as follows: an inclined, porous water-bearing stratum, outcropping at a greater elevation than the surface of the ground at the location of the proposed well; a water-tight continuous bed, both above and below the water-bearing stratum; and a sufficient rainfall to supply the water-bearing stratum at its outcropping with sufficient water for continuous flow. The conditions here enumerated are met with throughout the Coastal Plain of the State.

The most prolific source of artesian water supply in South Georgia is probably the Eocene limestones. This is especially true of the upper member of the series, the Vicksburg-Jackson limestone, which is the source of water supply for a very large number of wells. Scarcely less important, but covering a much less area, is the Cretaceous formation, which supplies the deep wells with water along the Chattahoochee River below Columbus as far south as Fort Gaines. Still other formations that are water carriers of considerable importance, near the coast, are Miocene and Pliocene limestones and sands.

History.—The first successful artesian well sunk in Georgia was put down by the late Col. John P. Fort on his plantation in Dougherty county in 1881, sixteen miles west of Albany. This well was commenced with a very crude outfit in February and after six months of continuous labor and mishaps it was completed at a depth of 550 feet. This well furnished a good flow of water and demonstrated the practicability of obtaining artesian water in South Georgia. Four years after the completion of the above named well, Capt. D. G. Purse put down a successful deep well in Savannah. The successful completion of these two wells in different parts of South Georgia greatly stimulated well boring throughout the entire region, and in a short time the majority of the large towns had constructed deep wells. The total number of deep wells in the Coastal Plain now aggregate several hundred and the number is rapidly increasing.

The Chemical Composition of the Waters.—The most common solids found in the artesian waters of South Georgia are the various carbonates, sulphates, and chlorides of the alkalies and alkaline earths, together with silica, alumina, and iron, while the gases most commonly met with are hydrogen sulphide and carbon dioxide.

The mineral constituents vary from 70 to 1,160 parts per million, the average being above 130 parts per million. The total amount of these constituents present, and the ratio they bear to each other, depend largely upon the character of the water-bearing strata, from which the water is obtained. Thus, water from highly calcareous rocks, such as the Eocene limestone, will carry a higher percentage of mineral matter than waters from the Cretaceous sands. In the one case, the chief mineral constituent is carbonate of lime, and in the other, silica. The water-bearing strata of the Cretaceous rocks are usually sands, and they therefore almost invariably yield soft waters. This is especially true of that part of the formation west of the Flint River, as is shown by the analysis of the water from the lower water-bearing stratum of the Albany well, and also by the analyses of the waters from the deep wells at Montezuma, Fort Gaines and Blakely, all of which probably get their water-supply from the Cretaceous sands.

In contrast with these soft Cretaceous waters, are the almost universally hard Eocene and Miocene waters. These hard waters supply the deep wells of a greater part of the Coastal Plain. They are encountered in the Savannah and Waycross wells at depths varying from 400 to 500 feet, and are the main source of the deep well supply, as far north as Dublin and Hawkinsville. These waters usually carry from 50 to 175 parts per million of calcium carbonate.

The general use of the artesian waters throughout South Georgia has greatly benefited the health of the region. The use of these waters has undoubtedly lessened the prevalence of malarial fever and has otherwise had a beneficial effect on the general health of all the towns and communities where they have been freely used.

Cost of Artesian Wells.—The cost of artesian wells is quite variable, depending upon the character of the formation to be penetrated, the size of the bore-hole, and the depth of the well. One of the greatest difficulties encountered in putting down deep wells in South Georgia is the quick-sands, but by the use of what is known as the "jetting process" of well boring these sands can usually be penetrated at comparatively small cost. It might be stated that, as a general rule, the price by contract for 4 inch wells, including casing, will vary from $1.00 to $2.50 per foot.

USES.—The artesian waters of South Georgia are used largely for domestic and manufacturing purposes. Most of the towns throughout the Coastal Plain are supplied by these waters. In addition to these general uses the waters have a limited use for irrigation purposes and in a few places where there are extremely large flows, they have been utilized for power purposes.

REFERENCES ON ARTESIAN WELLS

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AN INVENTORY OF THE WATER POWERS OF GEORGIA[1]

In the last fourteen years, the Geological Survey of Georgia, in co-operation with the U. S. Geological Survey, has been continuously engaged in collecting data in regard to our streams. While this information is by no means yet complete, sufficient information is now at hand to enable us to calculate with considerable degree of certainty the approximate water power of the State. For convenience of description, the water powers will here be described under the

1. The writer is under obligations to Mr. M. R. Hall, District Manager Water Resources Branch, U. S. Geological Survey, for assistance in collecting data for this paper.

following hydrographic basins: The Savannah basin, the Ogeechee basin, the Altamaha basin, the Apalachicola basin, the Mobile basin, and the Tennessee basin.

THE SAVANNAH DRAINAGE BASIN.—The Savannah drainage basin above Augusta, Georgia, where practically all of the water power is found, comprises an area of 7,300 square miles. The main water powers of this basin, occurring in Georgia, are found on the following streams: The Savannah River (formed by the Tugaloo and the Seneca rivers, 100 miles above Augusta) the Tugaloo River, the Chattooga River, the Tallulah River, the Broad River, the South Broad River, the Hudson Fork, the Middle Broad River, the Beaver Dam Creek. The indicated horsepower of these several rivres is here given.

INDICATED HORSEPOWER OF THE SAVANNAH RIVER DRAINAGE BASIN

Section of River	Minimum horsepower	Minimum horsepower during six high-water months
Savannah River:		
From Augusta to Seneca River	92,890	139,070
Tugaloo River:		
From mouth to mouth of Tallulah River	15,160	22,730
Chattooga River:		
From Tallulah River to West Fork	21,300	31,900
Tallulah River:		
From mouth to head	24,350	37,370
Broad River:		
From mouth to opposite Carnesville	15,632	29,494
South Broad River:		
From mouth to S. A. L. Railroad bridge	1,780	2,460
Hudson Fork:		
From mouth to opposite Homer, Georgia	1,830	2,700
Middle Broad River:		
From mouth to opposite Carnesville	1,270	1,620
Beaver Dam Creek:		
From mouth to opposite Elberton	1,250	1,840
Total	175,462	269,184

The Ogeechee Drainage Basin.—This basin, which is the smallest of the several drainage basins above named, lies almost wholly within the Coastal Plain immediately south and west of the Savannah basin. The drainage area above Millen is 1,900 square miles. The chief stream is the Ogeechee River, formed by the junction of the Williamson Swamp and the Rocky Comfort creeks. The indicated horsepower of the Ogeechee drainage basin is given in the following table:

Indicated Horsepower of the Ogeechee River Drainage Basin

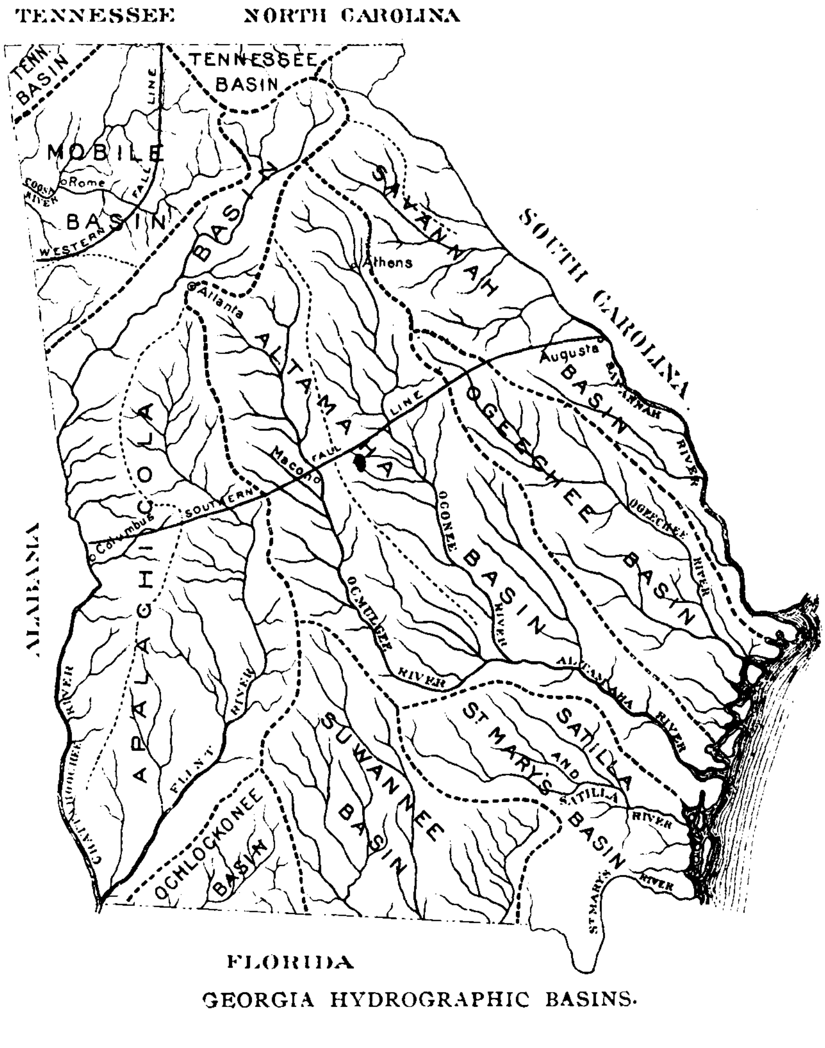
Section of River	Minimum horsepower	Minimum horsepower during six high-water months
Ogeechee River:		
At Millen	3,110	7,770
Cannouchee River:		
At Groveland	785	1,960
Total	3,895	9,730

The Altamaha Drainage Basin.—The Altamaha drainage basin is one of the largest drainage systems of the State. The main streams forming the system, namely, the Oconee and the Ocmulgee rivers, rise in the northern central part of the State and after flowing many miles to the southeast, finally unite in Montgomery county to form the Altamaha, which, in turn, continues to the southeast, entering the Atlantic Ocean at Darien. In addition to the two rivers above named, the more important streams of this basin are the Middle Oconee River, North Oconee River, Mulberry Fork, Apalachee River, South River, Alcovy River, Yellow River, and the Ohoopee River. Practically all of the water power of the streams here mentioned, with the exception of the Ohoopee River, is confined to the Piedmont Plateau north of Macon. The estimated horsepower of these individual streams is as follows:

INDICATED HORSEPOWER OF THE ALTAMAHA RIVER DRAINAGE BASIN

Section of River.	Minimum horsepower	Minimum horsepower during six highwater months.
Oconee River:		
From Milledgeville to junction of Middle and North rivers	17,480	26,510
Middle Oconee River:		
From mouth to head	2,748	4,371
North Oconee River:		
From mouth to opposite Maysville	3,350	5,360
Mulberry Fork:		
From mouth to Mathis' bridge	213	340
Apalachee River:		
From mouth to High Falls bridge	1,768	2,885
Ocmulgee River:		
From Macon to Yellow River	12,640	21,060
South River:		
From Yellow River to Southern Railway bridge	2,887	4,910
Towaliga River:		
From mouth to head of High Shoals	742	1,464
Alcovy River:		
From foot of Newton Factory Shoals to Dabney's bridge	1,031	2,062
Yellow River:		
From mouth to head of Simmons' dam	3,179	6,690
Ohoopee River:		
At Reidsville	1,050	2,620
Total	47,088	78,272

THE APALACHICOLA DRAINAGE BASIN.—The Chattahoochee River is the most important river of this basin. It rises in the high Blue Ridge mountains in the extreme northern part of the State and after flowing to the southwest and south for more than 400 miles finally unites with the Flint River at the Georgia-Florida line to form the Apalachicola River. The drainage area of the Chattahoochee River above Columbus, where the main water power occurs, is 4,900 square miles. Other important streams of the Apalachicola basin are the Flint River, Ichawaynochaway Creek, Muckalee River, Big



GEORGIA HYDROGRAPHIC BASINS.

Potato Creek, and Sweetwater Creek. The estimated available horsepower of these streams is here given.

INDICATED HORSEPOWER OF THE APALACHICOLA RIVER DRAINAGE BASIN

Section of River	Minimum horsepower	Minimum horsepower during six high water months.
Chattahoochee River:		
From Columbus to Santee Creek	118,570	189,190
Flint River:		
From Albany to head of Flat Shoals	45,774	75,950
Ichawaynochaway Creek:		
From mouth to	2,620	4,710
Muckalee River (including Kinchafoonee Creek):		
From mouth to	4,580	7,360
Big Potato Creek:		
From mouth to	1,800	3,240
Sweetwater Creek:		
From mouth to head of Austell Shoals	442	1,100
Total	173,786	281,550

THE MOBILE DRAINAGE BASIN.—This basin, so called because its waters enter the Gulf through the Mobile River, is drained by the Coosa River and its tributaries, the most important of which are the Etowah River, Coosawattee River, Cartecay River, Connasauga River, and Chattooga River. That part of the basin in Georgia includes a large part of northwest Georgia to the north and east of Rome and comprises an area of 4,649 miles. The estimated horsepower of the above named streams are here given.

INDICATED HORSEPOWER OF THE MOBILE DRAINAGE BASIN

Section of River	Minimum horsepower	Minimum horsepower during six highwater months.
Etowah River:		
From mouth to head	26,697	40,039
Chattooga River:		
From above Little River to opposite Summerville	687	1,180
Coosawattee River:		
From mouth to Ellijay	18,900	35,840
Cartecay River:		
From Ellijay to mouth of Pumpkin Creek	4,590	6,880
Connasauga River:		
From Beaverdale to head and on Jack River	6,650	11,865
Total	58,524	95,804

TENNESSEE DRAINAGE BASIN.—Two small detached catchment areas belonging to the Tennessee basin occur in the extreme northern part of the State, one along the Georgia-North Carolina line and the other along the Georgia-Tennessee line. The main streams of the former area are the Ocoee, the Hiawassee and the Nottely rivers, while those of the latter are Chickamauga River, West Chickamauga Creek, and North Chickamauga Creek. The approximate horsepower of these several streams is as follows:

INDICATED HORSEPOWER OF THE TENNESSEE RIVER DRAINAGE BASIN

Section of River	Minimum horsepower	Minimum horsepower during six high water months.
Chickamauga River:		
From mouth to near head	368	736
West Chickamauga Creek:		
From mouth to near head	425	835

Section of River	Minimum horsepower	Minimum horsepower during six high water months.
North Chickamauga Creek:		
From mouth to near head	1,330	2,650
Oconee River and Tributaries	22,536	44,072
Hiwassee River and Tributaries	3,650	6,720
Nottely River	5,586	10,320
Total	33,895	65,333

THE AGGREGATE WATER POWER.—The aggregate horsepower of all the streams above named is here given:

AGGREGATE HORSEPOWER OF THE RIVERS OF GEORGIA

River Basins	Minimum horsepower	Minimum horsepower during six high water months.
Savannah Basin	175,462	269,184
Ogeechee Basin	3,895	9,730,
Altamaha Basin	47,088	78,272
Apalachicola Basin	173,786	281,550
Mobile Basin	57,524	95,804
Tennessee Basin	33,895	65,333
Total	491,650	799,873

In nearly all of the above estimates only 90 per cent. of the actual fall of the streams has been given and the indicated horsepower has been reduced in most cases to 80 per cent., so that the results are thought to be quite conservative and well within the practical working limits. In these estimates, we have made no allowance whatever for storage, which, in many cases, would increase the minimum power from two to three times, nor have we taken into consideration a great number of small streams which would probably aggregate a power approximately equal to the water-power now being utilized by the State.

Omitting for the present these two factors, which would, no doubt, increase the water power more than two-fold, we still have, at the annual lowest known stream stage, an approximate aggregate of 500,000 horsepower. This power, if produced by steam, would require an annual consumption of about 7,000,000 tons of coal, or more than one-half of the coal production of Alabama in 1907. The money value of this power, reckoning a horsepower at $20.00 per annum, is $10,000,000, which is nearly equal to twice the State's annual income from taxes and all other sources.

By the use of storage dams, or by the use of auxiliary steam power for short periods during the dry season, fully 1,000,000 horsepower, at a low estimate, could be utilized. The enormity of this power may be better understood when it is stated that the combined labors of Alabama's coal miners in 1907, consisting of an army of more than 20,000 strong, could not supply the furnaces with coal which would be necessary to produce a steam power equal to Georgia's water power.

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