Georgia
State Division of Conservation

DEPARTMENT OF MINES, MINING AND GEOLOGY

Garland Peyton, Director

THE GEOLOGICAL SURVEY
Bulletin Number 54

GEOLOGY AND MINERAL RESOURCES OF THE PALEOZOIC AREA IN NORTHWEST GEORGIA

By

Charles Butts
Geologist, U. S. G. S. (Retired)

and

Benjamin Gildersleeve
Geologist,
TVA

Published in Cooperation with the Tennessee Valley Authority

ATLANTA

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LETTER OF TRANSMITTAL

Department of Mines, Mining and Geology

Atlanta, November 8, 1947

To His Excellency, M. E. Thompson, Acting Governor

Commissioner Ex-Officio, State Division of Conservation

Sir:

I have the honor to submit herewith Georgia Geological Survey Bulletin No. 54, "Geology and Mineral Resources of the Paleozoic Area in Northwest Georgia," by Charles Butts and Benjamin Gildersleeve. The publication of this bulletin at this time fills an urgent and long-felt need for an up-to-date treatise upon the geology and mineral resources in one of Georgia's most active commercial mining areas.

The report contains a manuscript on the geology and stratigraphy, a companion manuscript on the economic minerals of the area, a mineral map and a geologic map, both of which are on a scale large enough to be of practical use. It is believed that this report will be received with universal approval and utilization by both geologists and industrialists.

One unusual economic feature is the inclusion in the bulletin of complete chemical analyses made on representative samples of all the limestone in northwest Georgia. This will enable the industrialist to determine beforehand the approximate location of the type of limestone for which he may have need in his manufacturing process. Another unusual feature of the report is the publication for the first time in a Georgia Geological Survey bulletin of a representative group of fossil plates and pictures.

The manner of preparing and publishing this report is another example of the value of cooperation between a federal and a state agency. The Department of Mines, Mining and Geology did not have available the personnel or the facilities for doing the field work and preparing the bulletin and the maps alone. Due to a working agreement which has existed between this department and the Tennessee Valley Authority. we were able to obtain the cooperation of the Minerals Research Section of the Commerce Department of the Tennessee Valley Authority. This cooperation included the revision of existing geologic manuscripts and maps, the preparation of the economic section of the report, the preparation of illustrations and fossil plates, and the publishing of the two large-scale maps referred to above. Without this cooperation, it would have been utterly impracticable for this department to have undertaken such a ramified project alone.

It is our belief that the publication of this excellent report at this time will serve to stimulate increased activity leading toward a more proper development and utilization of the mineral resources of northwest Georgia.

Very respectfully yours,

Garland Peyton,

Director.

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PREFACE

In 1937 the late Dr. Charles Butts, formerly of the U. S. Geological Survey (retired 1933), revised the geologic mapping and described the Paleozoic strata of northwest Georgia for the Georgia Department of Mines, Mining and Geology. This work resulted in several important changes in the interpretation of the geology of the area; for example, recognition of the Mississippian age of the Rockmart slate previously regarded as a facies of the Stones River group (Ordovician). These changes were incorporated in the latest (1939) edition of the State Geologic Map which was published without an explanatory text.

The Minerals Section of the Commerce Department, Tennessee Valley Authority and the Georgia Department of Mines, Mining and Geology have been engaged for a number of years in cooperative studies of mineral deposits in northern Georgia. Detailed field surveys of the mineral resources in the ten northwest counties were made by J. L. Calver, K. H. Teague, and S. D. Broadhurst under the direction of B. Gildersleeve, staff geologists of the Tennessee Valley Authority. These surveys (November 1945-June 1946) were directed toward an appraisal of the possibilities for increasing more effectively the economical utilization and industrial development of the mineral resources of this area.

The 1939 State Geologic Map was inadequate as a base for detailed mineral resource studies (because of its scale—approximately 1 inch to 8 miles— and lack of important culture features). Since the maps available to Dr. Butts in 1937, and the ones he used in preparing his geologic map, were a miscellany of planimetric sheets, soil and quadrangle maps, it was decided, therefore, to use as field survey sheets photo indexes obtained from the United States Department of Agriculture, Agricultural Adjustment Administration. These photo indexes (made from aerial surveys in 1938, 1942 and 1943) for eight counties had a scale of 1 inch to 1 mile, and a scale of 1 inch to 1/2 mile for the two remaining counties in the area. In addition to indicating the locations of mineral deposits, mines, quarries and prospects on the field sheets, formational contacts (as determined by Dr. Butts) are noted also. Therefore, the geologic map (originally published as a part of the 1939 edition of the

State Geologic Map) has been reissued with revisions. These revisions, discussed with Dr. Butts and approved by him, are based on the additional information obtained in this survey of the mineral resources. Other changes were necessitated by the transfer of formational contacts to a new and more accurate base map.

This report, as the title indicates, combines in a single volume the geologic map, and complementary text prepared by Dr. Butts with a review of the mineral resources of northwest Georgia.

Benjamin Gildersleeve.

GEOLOGY OF THE PALEOZOIC AREA IN NORTHWEST GEORGIA

By Charles Butts

INTRODUCTION

Location and Extent

The Paleozoic rocks of Georgia are in that part of the eastern United States known as the Appalachian Valley.* As shown on the geologic map, the Paleozoic rocks of Georgia underlie all of Dade, Catoosa, Walker, Whitfield, Chattooga, and Floyd counties, and most of Murray, Gordon, Bartow, and Polk counties, a roughly quadrangular area of about 3000 square miles in the northwest corner of the State. This area is bounded on the east and south by the outcrop or trace of a great overthrust fault plane on which more ancient rocks are thrust over the Paleozoic rocks, which probably extend eastward and southward beneath the older rocks an unknown and undeterminable distance. The outcrop of the fault trace is near the west base of the high escarpment of the Cohutta Mountains north of the latitude of Chatsworth and at the west and north base of the same escarpment, but with less relief south of that latitude to south of Cartersville, and thence southwest to the Alabama State line near the southwest corner of Polk County. The fault is located easily by the abrupt change from the stratified Paleozoic rocks to the flaky, greenish schist of the overthrust mass.

The survey on which this description is based was made in the period March to July 1937, in which the writer had the efficient assistance of Dr. G. W. Crickmay.

Previous Work

The pioneer work on the Paleozoic of Georgia seems to have been that of C. W. Hayes of the U. S. Geological Survey. The results of his work have been published in the following papers and reports:

*For full description of the physical geography of the State see *Physical Geography of Georgia,* Georgia Geol. Survey Bull. 42, 1925.

Hayes, C. W., *The overthrust faults of the southern Appalachians,* Geol. Soc. America Bull. 2, 1891. (This bulletin contains a geologic map which shows that Hayes had, at that date, laid down the outlines of the Paleozoic geology of the State that have been followed in all subsequent publications.)

——— *Report on the geology of northeastern Alabama and adjacent portions of Georgia and Tennessee,* Alabama Geol. Survey Bull. 4, 1892.

——— U. S. Geol. Survey, Geol. Atlas, Ringgold folio (no. 2), 1894.

——— *Geology of a portion of the Coosa Valley in Georgia and Alabama,* Geol. Soc. America Bull. 5, 1894.

——— *On the Devonian (Oriskany) in the southern Appalachians,* Am. Jour. Sci., 3d ser., vol. 47, pp. 237-238, 1894. (Contains note on the Carboniferous in Georgia.)

——— U. S. Geol. Survey, Geol. Atlas, Stephenson folio (no. 19), 1895.

——— *Notes on the geology of the Cartersville quadrangle,* Science, new ser., vol. 1, 1895.

——— *Bauxite,* U. S. Geol. Survey 16th Ann. Rept., pt. 3, pp. 547-597, 1895.

——— *The geological relations of the southern bauxite deposits,* Am. Inst. Min. Eng., Trans., vol. 24, pp. 243-254, 861, map, 1895.

——— *The physiography of the United States: The Southern Appalachians,* pp. 305-336, 1896.

——— U. S. Geol. Survey, Geol. Atlas, Rome folio (no. 78), 1902.

Besides the areas described in the published reports, Hayes mapped the Cartersville, Dalton, and Tallapoosa quadrangles covering the rest of the Paleozoic area, but the maps were not published, although the manuscript maps have been available to geologists for many years.

Hayes, C. W. and Campbell, M. R., *The geomorphology of the southern Appalachians,* Nat. Geog. Soc., vol. 6, pp. 63-127, 1895; also Nat. Geog. Soc. Mon. 1, no. 1, pp. 305-336, map, 1895.

The geology of the entire Paleozoic area was described and mapped by J. W. Spencer, State Geologist:

Spencer, J. W., *The Paleozoic group: the geology of ten counties of northwestern Georgia,* Georgia Geol. Survey, 1893. (The name Oostanaula series was introduced in this report.)

Other bulletins of the Georgia Geological Survey contain excellent accounts of the Valley geology and are accompanied by adequate maps showing the geology according to the state of knowledge existing at the time of their preparation. The more important of these bulletins are cited below:

McCallie, S. W., *Preliminary report on the coal deposits of Georgia,* Georgia Geol. Survey Bull. 12, 1904.

——— *Report on the fossil iron ores of Georgia,* Georgia Geol. Survey Bull. 17, 1908.

Maynard, T. P., *Limestones and cement materials of north Georgia,* Georgia Geol. Survey Bull. 27, 1912.

Shearer, H. K., *Report on the slate deposits of Georgia,* Georgia Geol. Survey Bull. 34, 1912. (The name Cartersville formation was introduced in this bulletin.)

Smith, R. W., *Shales and brick clays of Georgia,* Georgia Geol. Survey Bull. 45, 1931.

In preparation for the map and description, the area was traversed as completely as the allotted time permitted. Hayes' geologic boundaries and identification of formations were verified or rectified as observed facts seemed to warrant. Some of his larger units, such as the Chickamauga limestone, were resolved into smaller units to bring the stratigraphy into harmony with the more detailed knowledge of the geology of the Valley that has been gained through the observations of Ulrich, Keith, Campbell, and Butts in other parts of the Valley or in the time since the work of Hayes was done. These changes constitute the author's main contribution to the knowledge of the geology of the area.

PHYSIOGRAPHY

The Appalachian Valley is a relatively narrow belt of country extending from Canada to northern Alabama which is at a somewhat lower altitude than the country on either side. On the southeast, it is bounded by the Blue Ridge Mountains of Virginia, the mountains of eastern Tennessee, and the Cohutta Mountains of Georgia. On the northwest, it is bounded by the

Fig. 1. Knox dolomite topography, looking northeast from a point about three miles southwest of Chickamauga, Walker County.

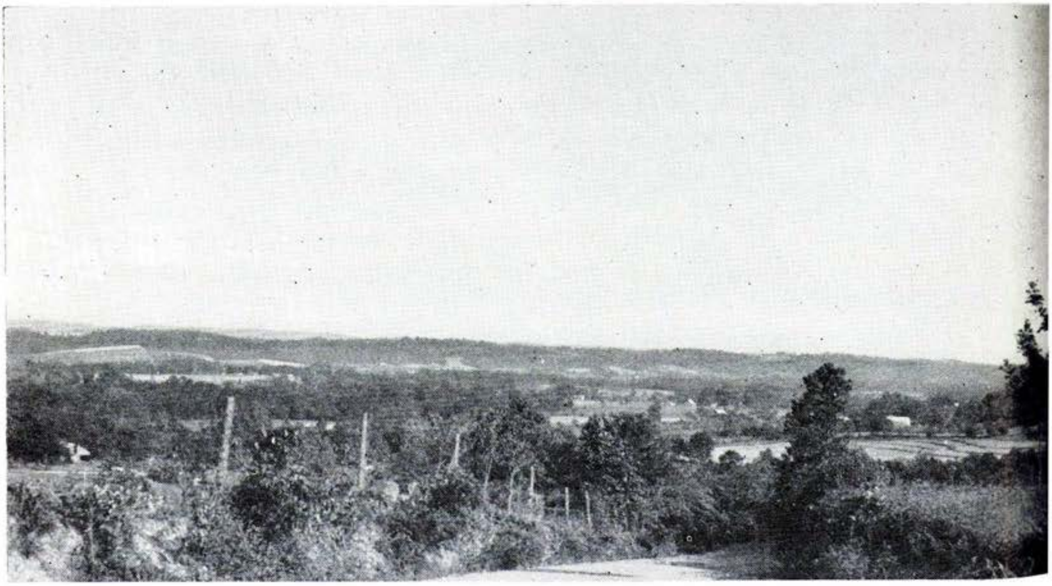


Fig. 2. Looking southeast over Peavine Valley from a point on Boynton Ridge, one mile northwest of Boynton to Peavine Ridge on the outcrop of the Conasauga formation and representative of all such valleys in northwest Georgia.

eastern escarpment of the Appalachian Plateau—known as the Alleghany front in Pennsylvania, and the Cumberland escarpment in Tennessee—and is delineated somewhat indefinitely by Lookout and Sand Mountains in Georgia and Alabama. The Appalachian Plateau roughly coincides with the Appalachian coal fields of the eastern United States. On account of the occurrence of high ridges in the Appalachian Valley, especially within its northwest half, it is commonly called the Appalachian Valley and Ridges. A complex of such ridges—White Oak Mountain, Taylor Ridge, John Mountain, Horn Mountain, Chattooga Mountain, Rocky Mountain, Sand Mountain, Simms Mountain, Lavender Mountain, and Gaylor Ridge—extends northeast through the middle part of the Valley of Georgia. These have been designated the Armuchee Ridges. Except for these ridges, the Valley is a nearly flat surface or a peneplain between Cohutta and Lookout Mountains. (See the profiles of the structure sections on the margin of the geologic map.) The flat surface is the northward extension of the Coosa Valley of Alabama and probably represents the Harrisburg peneplain of the northern part of the Appalachian Valley in Pennsylvania and Virginia.

Geologically, the Appalachian Valley is distinguished by folded and faulted stratified rocks: limestone, dolomite, shale, and sandstone; the Blue Ridge is largely, and the high land on the southeast of the Blue Ridge is entirely, occupied by crystalline rocks: schist, gneiss, and granite; the Appalachian plateau is occupied by relatively undisturbed, nearly flat-lying stratified rocks: shale, sandstone, and coal beds.

STRATIGRAPHY

The rocks of the Valley originated as mechanical sediments, silt, sand, gravel, or as solutions, mainly of lime or magnesium carbonates for the limestone and dolomite; all of which were carried by running water from the Piedmont upland on the southeast into the Paleozoic sea and there spread out as horizontal sheets covering many thousands of square miles of the sea bottom. These sheets succeeded each other upward until their thickness amounted to many thousand feet. Naturally, the sheets at the bottom were older than those above. In the course of a very long time the loose sediments were consolidated by the great pressure resulting from the weight of their great thickness and by processes of cementation, which need not be described here, into the existing solid rocks—shale, sandstone, and limestone. On the basis of the history of their deposition and for the convenience of study and descriptions, the entire thickness of the rocks has been divided into systems, and these are further subdivided into formations and members which are the ultimate stratigraphic units. The succession, thickness, and names of the succeeding systems and formations are shown in the columnar section on the margin of the accompanying geologic map.

Cambrian System

WEISNER QUARTZITE

The Weisner quartzite takes its name from Weisner Mountains, Cherokee County, Alabama. The formation is composed of a thick succession of beds of hard quartzitic sandstone and conglomerate, alternating with beds of shale. The shale seems to predominate in amount, but the beds of sandstone are enough in number and so hard and resistant to erosion as to give rise to high and conspicuous ridges which are in some areas, as in Indian Mountain in southwest Polk County and in the adjacent Cherokee County, Alabama, separated by valleys eroded in the shale belts. The result is an elevated and rugged topography as exemplified in Indian Mountain and Little Pine Log Mountain north of Cartersville. Unfortunately, owing to lack of continuous exposures of undisturbed rocks, no detailed sections showing the actual composition of the formation in Georgia have been made. The impression is given that the individual sandstone beds are generally not more than a hundred feet thick.

The Weisner occupies a small area in western Polk County which is the extension of the Indian Mountain area from Alabama into Georgia. Its other area is the high ridges next east of Cartersville which are continued northward in Little Pine Log Mountain and in several knobs northeast of that mountain to Pine Log Creek about on the line between Bartow and Cherokee counties, where the Weisner passes beneath the overthrust mass of older rocks. The Weisner is best exposed along the road from Rock Run railroad station, Alabama, to Esom Hill, Georgia, and at Sugar Hill at the east base of Little Pine Log Mountain 12 miles northeast of Cartersville. Its topographic expression is best displayed in Indian Mountain where the high ridges upon the beds of sandstone alternate with valleys eroded upon the shale between the beds of sandstone. No accurate determination of the thickness of the Weisner in Georgia has or can be made. In Columbiana Mountain, Shelby County, Alabama, where the formation is similar in composition to that in Georgia, it is 1,700 feet thick.

Henry McCalley estimates the thickness in Choccolocco Mountains, which are continuous with Indian Mountain, as 2,500 feet. Hayes, in the Rome folio, estimated the possible thickness as 5,000 to 10,000 feet in Indian Mountain, but with the qualification that the estimate was uncertain due to possible repetition of the beds by faults and folds. Little Pine Log Mountain, about one mile wide, is apparently occupied by the Weisner with high dip. Allowing for repetition by minor folds as shown in exposures at Sugar Hill, the thickness could be reasonably estimated at 2,500 feet. The thickness is given as 2000 feet in the columnar section, and this is believed to be conservative.

The Weisner continues southwest from Indian Mountain through Choccolocco, Ladiga, and Alpine Mountains to Columbiana Mountain which is a detached area east of Columbiana, Alabama. In Georgia it continues northward, beyond the head of Pine Log Creek beneath the overthrust mass on the boundary fault and reappears from beneath the mass in the valley of Ocoee River in Tennessee, about four miles north of the State line. Here it forms Bean Mountain. Farther northeast in Tennessee, it is represented in Chilhowie Mountain.

SHADY DOLOMITE

The Shady dolomite is named from Shady Valley, 14 miles east of Bristol, Tennessee. In Columbiana Mountain, Alabama, and at places in Tennessee and Virginia, the superposition of the Shady upon the Weisner or its equivalent can be seen, but this contact was nowhere seen in Georgia and apparently is nowhere exposed in the State.

The Shady, so far as observed in Georgia, is a bluish-gray, medium coarsely-crystalline dolomite, the same as in Alabama, Tennessee, and Virginia. Observations of fresh rock in natural exposures were obtained in only a few places. Most exposures, and they also are few and small, were in the bottom of barite or manganese pits. In the barite pits great quantities of iron-stained, siliceous material, some of which includes fossils and lumps of barite, occur. This material, together with the clay in which it is imbedded, is derived from siliceous and argillaceous dolomite through the process of weathering and indicates the presence of such beds in the Shady. Through weathering, the lime and magnesium carbonates have been leached out of such rock, and only the insoluble constituents, sand and clay, remain, and these have accumulated to thicknesses of 50 to 100 feet and bury the normal dolomite which has been uncovered here and there in the barite pits. As the barite occurs only in the Shady, the distribution of the pits show the distribution of the Shady, and upon such evidence the mapping of this formation is based.

As shown on the map, the Shady crops out in three loops between Cartersville and Allatoona and in a narrow area extending from Cartersville north to the great overthrust just north of Pine Log Creek, near the northeast corner of Bartow County. A small area of Shady is mapped three miles northeast of Rydal. In Polk County, Shady dolomite occurs along the Southern Railroad in the vicinity of Etna, extending from the State line northeastward for a distance of about four miles.

There is a small natural exposure of the Shady on the west bank of the Etowah River, just below the dam two miles southeast of Cartersville, another east of the river one mile west of Emerson, and another just north of the Louisville and Nashville Railroad at the sharp bend one-half mile east of the river and two miles east of Cartersville. Exposures in the barite pits occur in the Paga pits, and other pits south of the Paga pits, three miles southeast of Cartersville, and in a manganese pit south of but near Spring Creek, 1-1/2 miles south of White.

The Shady east of Cartersville is fossiliferous, the fossils occurring in the residual iron-stained material and, rarely, in the barite nodules. Provisional identifications have been made by C. E. Resser. The most common and significant fossils are several species of *Archeocyathus,* a genus somewhat similar in appearance to horn corals, a large species of *Hyolithes,* cf. *H.*

princeps, Kutorgina cingulata, and trilobites, *Rimouskia* cf. *R. typica,* and *Wanneria.*

The *Archeocyathus* and *Kutorgina* are Lower Cambrian genera common in the Shady dolomite at Austinville, Virginia, and in rocks of corresponding age as far north as Quebec, Labrador, and Newfoundland. *Rimouskia* is known elsewhere only in the vicinity of Bic on the St. Lawrence River, 160 miles northeast of Quebec, Canada. These occurrences show the extension of rock of Shady age into those regions. Southwest of the region described in this report the Shady occurs along the northwest base of Choccolocco Mountain, the southeast base of Alpine Mountain, and southeast base of Columbiana Mountain, all in Alabama.

ROME FORMATION

The Rome takes its name from Rome, Georgia, near which the formation is largely exposed. It next overlies the Shady dolomite throughout the length of the Valley from Alabama to Pennsylvania. The contact is exposed in only a few places and nowhere in Georgia.

The Rome is almost fully composed of sandstone and shale, but in places there are thin layers of limestone. Limestone is of rare occurrence, however, and it makes an insignificant proportion of the Rome. The sandstone is fine-grained and green or red. Some of it is apparently slightly calcareous and, upon leaching of the calcareous cement, the green sandstone becomes a rusty brown color and of somewhat porous texture. Much of the shale is gray, pinkish, or yellowish as weathered but probably is normally greenish. Beds of red shale or lumpy, red mudrock occur, and these together with the red sandstone are the most distinctive features of the Rome in the belt passing through Rome and extending from Cave Springs northward as far as Resaca. The most northern occurrence of such red rock observed in this belt is one mile west of Resaca, north of which red rocks are scarce or absent. None occur along the Dalton-Chatsworth road, where the Rome is almost continuously exposed as far east as Coahulla Creek. Here the Rome is composed mainly of yellowish shale with thin layers of green sandstone. So far as exposures permit observation, this type of the Rome prevails in the Rome-Dalton belt northward from the latitude of Resaca to Tennessee. In the Tunnel Hill belt, however, passing three miles east of Ringgold, the red color of the shale and sandstone is prevalent. Two miles north of Georgia in Tennessee, in the vicinity of Apison, a thick body of intensely red mudrock occurs in this belt. This is the typical Apison shale of Hayes which he considered to be a separate formation underlying the Rome. However, it seems more probable that the Apison is only a facies of the lower part of the Rome. It thus appears that the bright red colors in the Rome in Georgia occur only west of the meridian of Resaca. In the most eastern belts of the Rome next west of Cohutta Mountains, only pinkish shale and a rather rough gray shale more or less dark-stained, as with manganese oxide, occur. Along the southeast margin of the belt, passing through Cartersville and northward, is considerable purplish shale which shows in weathered road cuts. Shale of identical character occurs at Talladega, Ala., in an analogous position with respect to the overthrust rocks on the southeast. This purplish color on the southeast may be regarded as replacing the red color farther west. The beds marked by this purplish shale which, however, makes up only a small proportion of the entire formation here, are probably the beds designated as the Cartersville formation by some authors. The beds in question are believed to be only a southeastern facies of the Rome. However, an exception is the occurrence of a good body of quartzitic sandstone which makes a conspicuous ridge three miles long, Camp Ground Ridge, between Chatsworth and Eton and west of the deep reentrant of Holly Creek Valley into Cohutta Mountains. This has been called the Rome sandstone. Considerable thin-bedded, gray sandstone interbedded with gray shale occurs also in the belt northwest of Cartersville and east of Cassville, where its outcrop makes four conspicuous ridges well shown on the topographic map of the Stilesboro quadrangle. There may be four different sections containing much sandstone or only one section repeated by folds or faults. A ridge-making sandstone crosses Pettit Creek at the reservoir dam three miles southwest of White.

The Rome crops out in three belts, the most western of which extends from Villanow northeast via Tunnel Hill to Tennessee, the middle extends clear across the Paleozoic area from Cave Springs to Tennessee via Resaca and Dalton, and the southeastern extends from Cartersville to east of Crandall, where it passes beneath the overthrust rocks of Cohutta Mountain. The middle belt is divided at the north by a syncline of Conasauga formation and Knox dolomite. The southeast belt is also split by a syncline of Conasauga terminating on the south a couple of miles southeast of Pine Log.

The best displays of the Rome are west of Cave Springs, various places in the city of Rome, especially along the Etowah River; one mile west of Resaca; in the vicinity of Tunnel Hill, especially along the road going west from State Highway 3, one-half mile northwest of Tunnel Hill; at Catoosa Springs, five miles north of Tunnel Hill; along U. S. Highway 76, beginning about one-half mile east of Dalton and extending two miles east nearly to Coahulla Creek; and along the road northwest of Oakman and southwest of the Coosawattee River.

Owing to uncertainty as to limits and to probable repetitions caused by folding and faulting, no accurate measurement of the Rome is possible. Hayes estimated the thickness at 750 to 5,000 feet, the latter figure including the Apison shale. The larger figure seems not unreasonable from the lack of definite evidence of repetition in such well-exposed sections as that east of Dalton and that west of Oakman.

The Rome in Georgia has yielded but few fossils so far as certainly known, but through its lithology and lateral continuity it is known to be the same as the Rome in Alabama, Tennessee, and Virginia. In those states, *Olenellus, Wanneria,* and other fossils of accepted Lower Cambrian age occur and prove the Lower Cambrian age of the Rome. The only fossil collected in the course of the field examination for this report, in beds confidently referred to the Rome, is *Solenopleurella virginica* Resser, which was named from a specimen found in an exposure of the Rome three miles southwest of Buchanan, Virginia. In Georgia, this fossil was found in a clay derived through decay from a calcareous rock. The locality, discovered by Geoffrey Crickmay, is in the road going up to Johnson Mountain, 1½ miles east of Bolivar and one mile north of Pine Log Creek. The fossiliferous bed is immediately beneath the overthrust fault at the base of Cohutta Mountain.

CONASAUGA FORMATION

The Conasauga was named by C. W. Hayes from the Conasauga River, Georgia. The formation is composed mainly of shale which weathers to a pale yellowish-gray or pinkish color. The unweathered rock is greenish. In its western belts the weathered shale is fissile, soft, and fragile. In the eastern-most belt, as at the west base of Cohutta Mountains, the weathered shale is commonly pinkish and firmer. Interbedded in the shale is much blue limestone, exposures of which are common throughout all the Conasauga belts. The presence of the limestone, and the absence of red shale or sandstone are two criteria upon which the boundaries between the Rome and Conasauga are approximately determined. As a general rule, if red rock is present, the formation is Rome; if limestone is present, the formation is Conasauga.

The largest area of Conasauga is both north and south of the Coosa River, in Floyd County southwest of Rome. A belt on which Lafayette is located crosses the northwest part of the state from Graysville to Menlo. A shorter belt lies along the Chattooga River, and, as an anticline, pitches beneath the surface north of Trion. East of a line drawn through Rome and Dalton the outcrop of the Conasauga makes a complicated pattern of anastomosing belts of outcrop controlled by the geologic structure.

The shale of the formation is exposed to view at many places in every belt of outcrop and can be seen on any road crossing the outcrop. The limestone is commonly exposed in more limited areas than the shale. The valley followed by the Louisville and Nashville Railroad from south of Ramhurst to Fairmount is located on a belt mainly or largely underlain by limestone which is exposed at many places. On Sallacoa Creek, one mile south of Fairmount, is a large quarry in this limestone. The width of this belt is at least a mile, for limestone is exposed at intervals at least a mile west of both Oakman and Ranger. A bed or beds of limestone are exposed in the reentrant of Holly Creek, indicating a belt one-half mile wide, containing limestone, that crosses the valley just east of Hassler Mill. Limestone 100 feet thick is exposed in the valley of Pine Log Creek in Bartow County just south of the boundary between Bartow and Gordon counties. Thin-bedded limestone interbedded with shale is exposed through a distance of three-fourths of a mile on U. S. Highway 41 in Peavine Valley, two miles southwest of Graysville, and a very thick, massive limestone is exposed in an abandoned quarry just northwest of Graysville. Another good exposure is at the old cement factory one mile northwest of Kingston. The limestone here has a good many nodules of black chert. A good thickness of limestone is exposed near a church three miles northwest of Vans Valley, Floyd County. Limestone is conspicuously exposed in the fields northwest of the highway going north from Trion, Chattooga County, and there is an especially good exposure of banded limestone in Broomtown Valley one mile east of Menlo. Another large exposure is in the Floyd County quarry just east of the Coosa River three miles southwest of Rome. Here the limestone is thin-bedded to laminated, overturned, intensely shattered, and recemented by calcite. It seems to be 100 to 200 feet thick. Hayes identified this limestone as Shady (Beaver), but it is clearly Conasauga. Probably this same limestone is extensively exposed on Pettit Creek four miles north of Cartersville and, dipping at a low angle, for about a mile along Nancy Creek opposite Rogers, three miles northwest of Cartersville.

The statement concerning the thickness of the Rome (p. 13) applies equally to the Conasauga. Hayes estimated the thickness at 1,500 to 4,000 feet, and that seems about as satisfactory an estimate as can be made under the conditions.

The Conasauga is fossiliferous, and some collections were made in the course of the field work and have been identified by Resser. A list follows:

Acrocephalops tutus (Walcott)
Alokistocare americanum (Walcott)
Alokistocarella arcuosa Resser
Coosella ? sp.
Coosia sp. cf. *C. calanus* (Walcott)
Elrathia georgiensis Resser
Kootenia romensis Resser
Menomonia sp.
Obolus willsi (Walcott)
Olenoides georgiensis Resser

Most of these fossils are referred to the Middle Cambrian, but the *Coosella*?, *Coosia* and *Menomonia* are of Upper Cambrian age, and the beds having them are referred to the Nolichucky horizon of the Conasauga. It is of interest that these youngest and Nolichucky species occur nearest the great boundary fault at the foot of Cohutta Mountain. The *Coosella*? and *Coosia* were collected from a limestone near Hassler Mill only a few hundred feet below the overthrust fault, while the *Menomonia* was collected at a point on the highway about 1½ miles northwest of Ramhurst from beds that are also not far below the overthrust. They are useful in proving the Conasauga age of the easternmost Cambrian shale and limestone in Georgia.

Cambrian and Ordovician (U. S. Geological Survey) or Ozarkian and Canadian (of E. O. Ulrich)

KNOX DOLOMITE

This name is used here for a map unit that corresponds nearly to the Knox dolomite of the type region, Knox County, Tennessee. The difference is that the Newala limestone which in Georgia overlies the Knox of the region is included in the typical Knox. The Knox of Georgia includes rocks that in Alabama, Tennessee, and Virginia have been separated into the following formations named in ascending order: Copper Ridge dolomite, Chepultepec dolomite or limestone, and Longview or Nittany dolomite. While these units have been recognized in Georgia, the conditions of exposure and scarcity of fossils make their accurate separation impossible without much more detailed investigation than the time available for the field work for the present report permitted.

So far as exposed, the Knox is prevailingly a thick-bedded, gray dolomite which yields on weathering a great amount of gray chert which is universally distributed over the surface as boulders and chunks of smaller size. Such chert marks the outcrop of the Knox even where there are no exposures of the underlying strata of the formation. In an exposure at the dam on the Chattooga River at Trion, there is much limestone interbedded with dolomite.

The largest area of Knox is between Rome and Cartersville where the width of the area is approximately 22 miles. Assuming the mapping to be correct, its least width is in the vicinity of

Byrd on the boundary between Polk and Floyd counties. The whole area is in a shallow syncline pitching to the south and rising northward. On the north it is divided by an anticline of Conasauga shale extending from Calhoun to Kingston. It is also split by a number of minor faults south of Rome which bring up several fingers of Conasauga. There are four synclinal areas west of Crandall and an area on the southeast flank of an anticline east and south of Ringgold and Tunnel Hill, breaking up into synclinal and anticlinal fingers south of Villanow. A very wide belt extends across the State, passing east of Lafayette. It is divided into three belts by anticlines of older and synclines of younger rocks on the southwest in Chattooga County. The most western belt is that occupied by Missionary Ridge west of Chickamauga and Chattanooga National Military Park. This area is anticlinal.

Exposures of the dolomite are very rare. One of the most extensive is along Chickamauga Creek just southeast of Graysville. Another good exposure is at the quarry at Ladds at the southeast end of Quarry Mountain, two miles southwest of Cartersville. Smaller exposures are along the Etowah River at the bridge, three-fourths of a mile southeast of Euharlee; in the big bend two miles west of Kingston, and along the highway east of Lindale and also east of Silver Creek, four to five miles south of Rome. Exposures are still more rare in the northwestern belts, including Missionary Ridge, but the presence of the underlying dolomite is revealed by the abundant chert on the surface.

No reliable measurement of the thickness of the Knox in Georgia is possible. In Cahaba Valley, Alabama, the Longview is 500 feet thick; the Chepultepec 1,000 feet, and the Copper Ridge 2,000 feet, making 3,500 feet in all. (See p. 16 for names.) Hayes estimated the thickness in the Rome quadrangle at 4,000 to 5,000 feet. It is believed that 3,500 feet is a conservative estimate for Georgia.

The occurrence of Chepultepec fossils at several localities proves the presence of the Chepultepec dolomite as a constituent of the Knox of the region. *Sinuopea* was found 1½ miles northwest of Euharlee well within the Knox area. Another species of *Sinuopea* was found on East Armuchee Creek, five miles south of Subligna. *Chepultepecia* and *Sinuopea* were collected two miles southwest of Kensington. The best display of the Chepultepec is at the intersection of Tyler Street with U. S. Highway 41 in the north part of Dalton and on the railroad at the curve just south of the town. At these points, cavernous chert, typical of the Chepultepec, carries many fossils, among which is its main guide fossil, *Helicotoma uniangulata,* also *Ophileta subalata,* and *Sinuopea* cf. *S. suturata.* A small collection of poorly preserved gastropods in cavernous chert made by Kesler on the top of Sprouls Knob west of Cartersville shows the presence of the Chepultepec. *Lecanospira,* the diagnostic fossil of the Longview dolomite of Alabama and of the Nittany dolomite of Pennsylvania and the Roubidoux formation of Missouri, was found in the Knox of the main area 1½ miles northwest of Taylorsville, Bartow County, and at several points west of Trion and Summerville. These occurrences prove the presence of the Longview in the Knox of Georgia. The occurrence of a soft, chalky chert in the soil southwest of Euharlee is believed to mark the outcrop of the Longview in that region. The Knox of Georgia then includes the Longview at the top and the Chepultepec next below. Whatever Knox there is below the Chepultepec and down to the Conasauga is Copper Ridge. The Longview is named from Longview in Cahaba Valley, Shelby County, Alabama; the Chepultepec from the village of that name in Murfrees Valley, Blount County, Alabama; and the Copper Ridge from a prominent and persistent ridge in Tennessee northwest of Morristown. The Copper Ridge and Chepultepec are included by Ulrich in his Ozarkian System, and the Longview dolomite and the Newala limestone, next to be described, are included in his Canadian System. The present usage of the U. S. Geological Survey is to assign the Copper Ridge to the Cambrian and the Chepultepec to the Ordovician, and to include it, together with the Longview and Newala, in the Beekmantown group which by the Survey is classed as Lower Ordovician, or the lowest and oldest division of the Ordovician System.

Ordovician System

"CHICKAMAUGA LIMESTONE"

For general information the following statement is made here. The name Chickamauga has been in general use since about 1890. It was introduced by C. W. Hayes from West

Chickamauga Valley south of Chattanooga. In its type area the Chickamauga includes a number of stratigraphic units elsewhere recognized. They are named in descending order and grouped into map units on the accompanying geologic map as follows:

Chickamauga limestone	Maysville formation Trenton limestone Lowville limestone	Map symbol, Oml
	Lebanon limestone Lenoir (Ridley) limestone Mosheim limestone Murfreesboro limestone	Map symbol, Osr
	Newala limestone	Map symbol, On

NEWALA LIMESTONE

The Newala limestone was named from Newala station on the Southern Railroad west of Calera, Alabama. The Newala of Georgia is the basal member of the typical Chickamauga limestone which was named by Hayes from Chickamauga Creek along which it crops out for a distance. It is a rather thick-bedded, pure, blue limestone, and it holds this character throughout all its areas of outcrop in Georgia. The formation is massive, thick, or moderately thick-bedded. Blue-gray, finely crystalline, and some compact dove layers (vaughanite) occur. In places on weathered outcrops, nodules, stringers, and thin partings of black chert occur, the latter giving some of the layers a straticulate structure.

The Newala crops out and is exposed in a line of hills west of Euharlee Creek north of Aragon and is believed to underlie a considerable area of low, flat ground extending northeast of Stilesboro, although exposures of limestone float were seen at only a few places. It crops out at Cedartown and Fish and is believed to be present in the valleys extending south to the boundary fault, although but few exposures were seen along those valleys. There is a continuous outcrop along both sides of Missionary Ridge, which converge to a point near Cedar Grove, Walker County. The western outcrop is cut off by a fault two miles south of the State line, the eastern outcrop extends several miles north of the State line into Tennessee where it rounds, passing eastward, the point of a pitching syncline, and thence the Newala extends south into Georgia for a distance of about nine miles along the east side of Chickamauga Creek. South of this point the formation was not detected and seems to thin out entirely. Fort Oglethorpe is located on the eastern outcrop. A small triangular, synclinal wedge enters the State from Tennessee west of Rossville. This wedge expands northward in the city of Chattanooga where the Newala underlies the National Cemetery. Another narrow outcrop of the Newala extends south into Georgia west of White Oak Mountain and is exposed on Hurricane Creek a thousand feet above its mouth in East Chickamauga Creek. Another outcrop extends south in Murray County east of the Conasauga River to Spring Place. From the distribution of outcrops, it appears that the Newala is absent in a wide belt between Lookout (Pigeon) Mountain and Ringgold on the one hand, and Cedartown and the Conasauga River west of Chatsworth and Tennga on the other hand. This condition is the same as that in Birmingham Valley, Alabama, where the Newala is likewise absent. From this circumstance the inference can be drawn that that belt was, through oscillation, elevated above the sea in Newala time and hence received no deposits. The maximum uplift seems to have been near Dalton where rocks regarded as of Lowville age rest upon the Chepultepec dolomite.

The best exposures of the Newala are along the highway southwest of Chickamauga to Pond Spring; in the quarry of the Southern States Cement Company about one mile north of Rockmart; and at Davitte 1½ miles northeast of Aragon. There is a good exposure at Cedar Grove, Walker County; another just west of the north-south highway one mile east of the southeast corner of Chickamauga and Chattanooga National Military Park; another one mile east of Fashion, and a better one 1½ miles west of Eton, both in Murray County.

No direct measurement of the thickness of the Newala was made. From the height of the hills north of Aragon, some of which are 200 feet high and capped with Rockmart shale, from the low dip of the limestone, and from the fact that the Knox cannot be very deep below the base of the hills, it is judged that the thickness of the Newala does not exceed 300 feet. Two hundred and fifty feet, as shown in the columnar section, is believed to be a conservative estimate.

The Newala is sparingly fossiliferous. Species of the gastropods, *Hormotoma* cf. *H. artemesia, Hormotoma*? sp. *Coelocaulus* cf. *C. lineata, Helicotoma*? sp., *Maclurites affinis*?, coiled cephalopods like *Tarphyceras* or *Eurystomites,* and *Gonotelus (Goniurus)* cf. *G. elongatus* Raymond have been noted. The most significant for correlation, however, is *Ceratopea,* the operculum of a gastropod which so far as known occurs only in limestone of upper Beekmantown age—as the Cotter and Powell limestones in Arkansas, the Newala limestone of Alabama, the upper Beekmantown of Tennessee and Virginia, and the Bellefonte limestone of central Pennsylvania. The age and stratigraphic position of the Newala is thus fully established. *Ceratopea* is rather abundant a mile or so south of Chickamauga where as many as 40 specimens were counted on the surface of a limestone boulder. It was collected a third of a mile north-

Fig. 3. Newala limestone with overlying Rockmart shale, one mile northeast of Aragon, Polk County.

east of Kensington and was noted on a head branch of Cedar Creek 1½ miles southeast of Esom Hill, Polk County, and again 1½ miles west of Eton, Murray County. The occurrence southeast of Esom Hill is only about one-fourth mile north of the boundary fault at the base of the Talladega slate, and that west of Eton where numbers of specimens occur is in the very top of the Newala and within a few feet below the Athens shale. As will be seen after reading the succeeding description, there is a considerable hiatus here.

The Newala is utilized for cement manufacture by the Southern States Portland Cement Company a mile north of Rockmart and has been used at Davitte, 1½ miles northeast of Aragon. In Cahaba Valley, Alabama, it is extensively burned for lime. Probably it is suitable for such uses in most of its areas in Georgia.

HIATUS

No sandstone corresponding to the St. Peter sandstone of the Mississippi Valley occurs in Georgia. The stratigraphic horizon of the St. Peter, together with certain underlying limestone formations, constituting with the St. Peter the Buffalo River group, is believed to be below the Murfreesboro limestone. If that is the actual position there is a hiatus in Georgia due to the absence of the Buffalo River group.

STONES RIVER GROUP

Next above the Newala in Georgia is the Stones River group named from the Stones River in middle Tennessee. It comprises the following formations in ascending order: Murfreesboro limestone, Mosheim limestone, Lenoir (Ridley) limestone, and the Lebanon limestone as described below.

Murfreesboro Limestone

The Murfreesboro limestone is named from Murfreesboro in the central basin of Tennessee southeast of Nashville. The formation varies in its character in different belts of outcrop. In McLemore Cove, as shown on Chickamauga Creek northeast of Kensington, it is, so far as exposed, composed of dove-colored or blue, compact or crystalline, fossiliferous limestone. In places in this region a peculiar, black, ropy chert ramifies through the limestone. In the eastern belts, as the first belt west of Lafayette and the belt west and north of Ringgold, a considerable proportion of the formation is red or red-mottled limestone interbedded with the blue or dove beds. These mottled beds are also fossiliferous, containing bryozoa and minute ostracods. In McLemore Cove and Chattanooga Valley and to the east of Chickamauga Park and west and north of Ringgold the Murfreesboro limestone immediately succeeds the Newala limestone. South of Chickamauga Park to Broomtown Valley west of Berryton the Murfreesboro rests upon the Knox dolomite with an intervening hiatus resulting from the absence not only of the Buffalo River group but also of the Newala limestone.

The general distribution of the Murfreesboro has been suggested by the preceding description and is also shown on the map. Attention may be called to the fact that the Murfreesboro as well as the formations grouped under the symbol Osr apparently thin out entirely about east of Summerville, and all of them are also absent beneath the Rockmart shale at Cedartown, Rockmart and vicinity. Nor are any of the formations of the Osr group proper present east of White Oak Mountain or of its southern extension as marked by Taylor Ridge east of Summerville and by Gaylor Ridge south of Holland.

Probably the best exposures of the blue limestone facies of the Murfreesboro, which are only partial, are just east of Pond Spring; on Chickamauga Creek at the bridge on the road from Lafayette through Catlett Gap to Pond Spring; and in Chickamauga Park on U. S. Highway 27 one-half mile south of the Georgia Monument. Here there is also some of the red-mottled and gray-mottled limestone at the bottom resting upon the compact, dove limestone of the Newala. The red-mottled limestone is well exposed along the road west from Lafayette and just west of Dry Creek. It is also exposed along the northwest base of Boynton Ridge in the road, U. S. Highway 27, one-half mile north of Rock Spring; three-fourths of a mile east of Blue Spring church in the woods south of the east-west highway; and at Burning Bush school and one-half mile north thereof and one mile east of the southeast corner of Chickamauga Park; and still farther north on the east-west highway to Graysville about four miles north of Ringgold, and midway between Hurricane Creek and the north-south highway north of Ringgold. The blue limestone of the Murfreesboro is also exposed along the north-south road three to four miles north of Ringgold. The fossiliferous red and mottled as well as the blue limestone is exposed in a large quarry 2½ miles due east of the Wilcox Tunnel through Missionary Ridge in the eastern environs of Chattanooga, Tennessee, and 5½ miles north of the State line.

The Murfreesboro is moderately fossiliferous. The following forms have been recognized: *Tetradium* cf. *T. racemosum, Dianulites, Nicholsonella, Coeloclema, Mesotrypa, Mimella, Multicostella, Strophomena* cf. *S. incurvata, Helicotoma tennesseensis, Lophospira bicincta, Raphistomina* cf. *R. modesta, Orthoceras* sp. *Gonioceras* sp. *Calliops (Pterygometopus)* sp., *Leperditella inflata, L. Mundula, Leperditia* cf. *L. pinguis.* A number of these fossils such as *Nicholsonella pulchra, Strophomena incurvata,* and *Helicotoma tennesseensis,* occur in the Murfreesboro at its type locality, Murfreesboro, Tennessee, or in the thin Pierce limestone next above the Murfreesboro. So, the correlation of this limestone in Georgia with the Murfreesboro is beyond a reasonable doubt. Practically all these fossils make their first appearance in the Murfreesboro. None of these genera are known in the Buffalo River group which circumstance is in confirmation of the belief that the Buffalo River group is older than the Murfreesboro and is not represented in Tennessee or Georgia, hence the hiatus at the base of the Murfreesboro.

Mosheim Limestone

The Mosheim was named from Mosheim, Tennessee, seven miles west of Greeneville. It is a dove, compact limestone very characteristic and very persistent at its horizon through the whole length of the Appalachian Valley from Alabama to Maryland. On weathered exposures it is light gray or bluish and commonly is coated with a thin, white, chalky crust. It has a conchoidal fracture and a glassy texture and is strikingly distinct from the enclosing limestone, and usually there is no difficulty in recognizing it. Chemically it is a pure calcium carbonate.

The Mosheim varies from a few feet to 100 feet in thickness, but the smaller thickness prevails.

Owing to its small thickness it is not extensively exposed in Georgia. There is a good exposure near the road from Lafayette to Pond Spring a few hundred feet southeast of the bridge over Chickamauga Creek; one in Chickamauga Park just east of the road one-half mile south of the Georgia Monument; and one just east of U. S. Highway 27 a few hundred feet south of the intersection with the road west of Chickamauga. It was not noted anywhere to the east of Chickamauga Park or of Pigeon Mountain. If present, it is probably thin and rarely exposed. No fossils were seen in the Mosheim in Georgia, but at Mosheim, Tennessee, the type locality; one-half mile east of Odenville, Alabama; and at scattered points in Virginia, large gastropods, notably large species of *Lophospira.* are the most common fossils.

Lenoir (Ridley) Limestone

Throughout the Appalachian Valley the Mosheim limestone is everywhere succeeded by the Lenoir limestone which was so named from Lenoir City, Tennessee, 22 miles southwest of Knoxville. In the Nashville basin and Sequatchie Valley, Tennessee, the Lenoir is represented by the Ridley limestone, and perhaps Ridley should be used for the formations in Georgia.

So far as can be seen in Georgia, the Lenoir is a dark gray, medium coarsely crystalline limestone, possibly 100 feet thick. In places it yields much rather large, somewhat cavernous or scraggy, and blocky, black, fossiliferous chert.

The Lenoir has about the same distribution as the Mosheim except for a narrow strip north of Dalton and just east of Cohutta, which enters Georgia from Tennessee, where the Mosheim was not exposed, although there is room for it in an unexposed space between the Lenoir and the Knox.

There is a good exposure of the Lenoir near a local quarry in Chickamauga Park 500 feet east of U. S. Highway 27 and just south of Viniard Field. The blocky, fossiliferous chert occurs on an east-west road intersecting the main road one mile northeast of Pond Spring. The chert is abundant in a field north of the road, just east of a small creek and midway between the main road and Old Bethel Church. The Lenoir can be seen about 1,000 feet southeast of West Chickamauga Creek along the road to Lafayette through Catlett Gap, and a few hundred feet northwest of the intersection of the road going southwest to Davis Cross Roads. Another good exposure where *Maclurites magnus* occurs is one-half mile north of the State line and just east of Tennessee Highway 60 about 15 miles north of Dalton.

A few diagnostic fossils were obtained from the Lenoir such as *Rafinesquina* cf. *R. minnesotensis, Protorhyncha ridleyana, Maclurites magnus* and *Leperditia fabulites pinguis*. The *Protorhyncha* and *Leperditia* show the approximate equivalence of the Lenoir with the Ridley limestone of middle Tennessee and Sequatchie Valley, Tennessee. and the *Maclurites* indicates its equivalence with the Lenoir limestone of the Appalachian Valley generally and with the middle Chazy Crown Point limestone of the Lake Champlain region of New York and Vermont.

Lebanon Limestone

This formation was named from Lebanon, Wilson County, Tennessee. In that region it was long known as the Glade limestone, because of the cedar glades that flourished on its outcrop.

The Lebanon is very largely composed of very thin-bedded limestone intercalated in gray, shelly limestone, all more or less argillaceous, the thin layers of limestone being splotched, even on fresh breaks; with yellowish spots where the clayey matter is most plentiful. The thin layers of limestone are largely composed of fossil shells and stems of bryozoa. Such layers seem to prevade the entire thickness of the Lebanon. On weathering and erosion these layers break down into small slabs which strew the surface of the ground, and such ground seems to be especially favorable to the growth of cedars, thus giving rise to the cedar glades that are common on the outcrop of the Lebanon.

As with the other formations so far described, no direct measurements of the thickness of the Lebanon can be made. The best estimate is based on the exposure on U. S. Highway 27, just northwest of Chickamauga Creek, where the width of outcrop is about 1,200 feet and the dip 10 degrees, which yields a thickness of 200 feet.

The Lebanon crops out along both sides of McLemore Cove along the outside margin of the Stones River (Osr) belt north about to Tennessee, where its outcrop rounds the Pigeon Mountain syncline, and thence continues south beyond Rock Spring an undetermined distance. It is present also along the west flank of White Oak Mountain north of Ringgold, but its limits have not been determined. It probably extends along the west side of the Stones River belt (see p. 23) south of Ringgold, but how far is not known.

The Lebanon can best be seen along the road from Lafayette to Pond Spring via Catlett Gap. It is abundantly displayed by exposures of the beds in place and by its slabby debris through a distance of about one-half mile beginning about 1,000 feet south of the bridge over West Chickamauga Creek. Another excellent display is along the cross road for a considerable distance beginning about one-half mile west of Old Bethel Church and continuing west for a half mile. Possibly the best exposure of all is on U. S. Highway 27 immediately northwest of West Chickamauga Creek where it is exposed *in situ* in road cuts. Here it is very fossiliferous, and good collections can be made from the material removed from the cuts and dumped along the roadside.

The Lebanon limestone is highly fossiliferous. Some of the more common or significant forms are the following: *Camarocladia implicatum* Bassler, *Arthroclema striatum, Escharapora ramosa, Mesotrypa* sp., *Stictoporella* sp., *Glyptorthis bellarugosa, Hesperorthis* aff. *H. tricenaria, Mimella* sp., *Multicostella* sp., *Pionodema* aff. *P. subaequata, Rafinesquina* aff. *R. minnesotensis, Sowerbyella lebanonensis* Bassler, *Valcourea deflecta, Illaenus* sp., *Leperditia fabulites pinguis*. The *Camarocladia, Escharapora, Hesperorthis, Pionodema, Sowerbyella, Valcourea,* and *Leperditia* very definitely correlate the Lebanon of Georgia with the Lebanon of middle Tennessee and Sequatchie Valley.

BLOUNT GROUP

Succeeding the Stones River group is the Blount group made up in Georgia of the following formations in ascending order: Holston marble, Athens shale, Tellico formation, and Ottosee (Sevier) shale.

Holston Marble

The Holston marble is a coarsely crystalline fragmental limestone, more or less reddish in color. The widely used Tennessee marble is an example. Here, as throughout Tennessee as well shown in the Knoxville region where the Holston is extensively exploited for marble, the Holston immediately succeeds the Lenoir limestone. There is no known formation between the Holston and Lenoir anywhere.

The Holston occurs in only one narrow belt extending into Georgia from Tennessee just east of State Highway 71 to within six miles north of Dalton. This outcrop is marked by a dense dark red soil, and probably for that fact was identified as the Tellico formation by Hayes on the folio on the Cleveland quadrangle just north of Tennessee in this region.

The Holston can be seen on the side and crest of a low ridge just west of State Highway 71 or Tennessee Highway 60, and one-half mile north of the State line. The Lenoir with *Maclurites magnus* immediately underlies the Holston here.

The thickness of the Holston seems to be 50 to 100 feet. It probably has little value as a marble in Georgia.

Athens Shale

The Athens shale was named from Athens, McMinn County, Tennessee. In Georgia the Athens is a gray, sandy shale which includes some thin beds of shaly sandstone and beds of coarse sandstone.

The Athens is present only in the northeastern part of the Paleozoic area where it occupies a wedge-shaped area which enters Georgia from Tennessee just east of Tennga and extends south to a fault which crosses its outcrop and cuts it off in a point about two miles southwest of Eton. Its outcrop here is marked by a conspicuous ridge known as Sumac Ridge which is made by the sandstone members of the Athens. The Athens is very fully exposed on the road west from Eton in the space of 1½ to 2 miles west of the village; on the road to the west two miles north of Eton; and on the road crossing its outcrop 2½ miles south of Tennga.

On the basis of the width of outcrop and an average southeast dip of 30 degrees, the thickness of the Athens is 3,500 feet. Hayes gives 2,500 feet for the Cleveland quadrangle, Tennessee, which nearly joins the Georgia area on the north of Tennga.

No fossils were found in the Athens of Georgia, possibly because of lack of time for adequate search, so fossil evidence of the Athens age of these rocks is lacking. Nevertheless, both Hayes and Ulrich have identified the rocks of this belt to the north in Tennessee, as in the vicinity of Benton, as Athens. So, according to the best evidence, the identification is correct. In similar rock in the vicinity of Sevierville southeast of Knoxville, Tennessee, and farther north, east of Bristol, and southwest in Alabama, graptolites occur which show that the Athens is of about the same age as the Normanskill shale of the Albany District, New York. In places in Virginia the Athens occurs close above the Holston marble from which it is separated by a thin formation known as the Whitesburg limestone, which, in places in Alabama also, immediately underlies the Athens.

Tellico Formation

The Tellico formation in this area is predominantly a coarse grained, ferruginous sandstone with some shale and, in places, a conglomerate at the base.

The Tellico occurs in a single narrow belt along the extreme northeastern edge of the Paleozoic area, extending southwestward a distance of about eight miles from the Tennessee-Georgia line to within four miles north of Eton, Murray County.

Ottosee (Sevier) Shale

In the narrow belt north of Dalton with the Holston marble as already described, the Holston is overlain by a soft, yellowish, slightly fossiliferous shale. Perhaps 100 feet is exposed. This answers to the character of much of the Sevier or Ottosee shale farther north in Tennessee and is tentatively referred to that formation. If it is Sevier, the Athens shale and the Tellico sandstone which normally intervene between the Holston and Sevier are absent from the section in the narrow belt referred to here. No Ottosee or Sevier was recognized elsewhere in Georgia.

LOWVILLE-MOCCASIN LIMESTONE

The Lowville limestone was named from Lowville, Lewis County, New York. The Moccasin limestone was named from Big Moccasin Creek, Scott County, Virginia. The Moccasin and Lowville are facies of the same general formation, the Lowville facies being bluish or dove-colored limestone and the Moccasin facies being predominantly red.

The formation occupies a strip on the margin of the belts, designated on the map by the symbol Oml, next to the Stones River belt (Osr) or to the Knox dolomite. In a complete sequence, as in McLemore Cove, the Lowville-Moccasin succeeds the Lebanon limestone. No formation is anywhere known to intervene between the two. In the region south of Tunnel Hill, marked by the town of Villanow, and south of Taylor Ridge, north of Holland and west of Lavender, the Newala limestone and the Stones River group appear to be absent, and the Lowville-Moccasin rests upon the Knox dolomite with an obvious hiatus between them.

The limestone facies of the Lowville-Moccasin is a bluish or dove, rather thin-bedded limestone without any red color or considerable argillaceous content. This facies is present in McLemore Cove, in Chattanooga Valley, and on the west slope of White Oak Mountain north of Ringgold. The Moccasin facies of the formation is composed largely and, in the eastern belts, apparently mainly of red argillaceous, calcareous rock that weathers to a red mudrock. This facies appears on the west in the synclinal area west of Summerville where much red shale or mudrock occurs. This red rock apparently composes most of the formation along the northwest slope of Taylor Ridge as shown on the road, U. S. Highway 27. Occasional small exposures of reddish, crumbly, limy beds occur within the areas of red mudrock. Farther east as in the belt between Rocky Face Mountain and Tunnel Hill, the red mudrock is at its maximum thickness. There are occasional layers of sandstone and at other levels layers of limestone, especially in the lower part of the red mass as just south of U. S. Highway 41 and just west of Mill Creek a couple of thousand feet east of Rocky Face village. Along the road south of Rocky Face for several miles the red mudrock is exposed at many places close above the Knox dolomite. If the red rock here is correctly identified as Lowville-Moccasin there is here a great hiatus between it and the Knox due to the absence of the Stones River and Blount groups and the Newala limestone.

The best exhibit of the limestone or truly Lowville facies of the formation is along the road between Lafayette and Pond Spring about midway between Catlett Gap and West Chickamauga Creek. The Moccasin facies is best displayed in the road, U. S. Highway 27, on the northwest slope of Taylor Ridge and along the road, U. S. Highway 41, between Rocky Face Mountain and Rocky Face village.

The limestone facies of the Lowville is fairly fossiliferous, and fossiliferous limestone beds occur interbedded with the red mudrock of the Moccasin facies.

A few of the fossils collected from both facies are *Tetradium cellulosum, Rhinidictya nicholsoni,* and other *bryozoa, Zygospira recurvirostris, Pionodema subaequata, Rafinesquina minnesotensis, Strophomena* sp., *Hebertella*?, *Camarotoechia* cf. *C. plena*? (as shown in Geology of Alabama, plate 31, figure 1), *Helicotoma verticalis, Raphistomina lapicida, Lophospira perangulata, Lophospira* large sp., *Hormotoma gracilis, Actinoceras bigsbyi, Bathyurus johnstoni, Pterygometopus, Leperditella sulcata, Leperditia fabulites.* Some of these species as *Tetradium cellulosum, Pionodema subaequata, Bathyurus johnstoni,* and *Leperditia fabulites* are fairly diagnostic of the Lowville.

The red rock of the Moccasin occurs along the southeast side of the Valley as far north as Roanoke, Virginia. It occurs in Bays Mountain southeast of Knoxville, Tennessee, and was there named the Bays sandstone. It extends southwest into Alabama where it occurs along the north flank of Colvin Mountain, Cherokee County. In Alabama the red rocks contain a *Camarotoechia*, the same or similar to the species of the preceding list which was collected at Dalton, Georgia. In Georgia the Moccasin facies of the formation makes up the main body of the rock which, in the belts east of Lafayette and Summerville, in the Rome and Ringgold folios, was mapped by Hayes as Chickamauga limestone.

TRENTON LIMESTONE

The Trenton limestone, one of the most noted formations in the eastern United States, was named from Trenton Falls, Herkimer County, New York. In Georgia no formations have been noted corresponding to the thin Watertown and Amsterdam limestones which, in New York, lie between the Lowville and Trenton.

The Trenton is prevailingly a relatively thin-bedded to shelly, bluish-gray, coarsely crystalline, highly fossiliferous limestone. It is largely made up of fragments of fossils. There are some argillaceous layers, but these make up but a small proportion of the formation. The thickness of the Trenton appears to be about 150 feet.

The limestone (Oml) in Lookout Valley northwest of Lookout Mountain is all Trenton. The Trenton crops out in a continuous strip on both sides of McLemore Cove. It was not seen, however, along the northwest slope of Taylor Ridge east of Trion and southward to the Coosa River. So far as known, it is everywhere absent east of the wide belt of "Knox" next east of Lafayette and Chickamauga Park.

The Trenton can best be seen in Lookout Valley where only the Trenton crops out and is extensively exposed. It is also considerably exposed to view on the highway from Lafayette to Pond Spring about one-half mile west of Catlett Gap through Pigeon Mountain. This is an excellent exposure with *Rhynchotrema increbescens* fairly plentiful at Haysville on the west side of Chattanooga Valley seven miles south of the State line at St. Elmo.

The Trenton is highly fossiliferous. The following few species have been noted: *Tetradium columnare, Columnaria alveolata, Constellaria emaciata, C. teres, Eridotrypa briareus,* several other bryozoans, *Herbertella frankfortensis, Platystrophia praecursor, Rafinesquina alternata, Rhynchotrema increbescens, Cyrtodonta grandis*?. These are common fossils of the Trenton of middle Kentucky and Tennessee and of southwest Virginia.

MAYSVILLE FORMATION

The Maysville was named from Maysville on the Ohio River, Mason County, Kentucky. In a full sequence, as at Cincinnati, Ohio, the Maysville is separated from the Trenton by the Fulton and Eden shales. In Georgia, so far as known, the Fulton and Eden are absent and, where the Maysville is present, the Trenton also is absent, and the Maysville succeeds the Moccasin.

The Maysville in Georgia, as exposed, is soft, tawny, clayey, siliceous rock probably derived from an argillaceous, calcareous rock through the leaching of the calcareous matter in the process of weathering. Indurated, hard rock occurs in fresh exposures.

The Maysville has been recognized only on the northwest slope of Taylor Ridge on U. S. Highway 27, and on the road east from Trion through the Narrows Gap on Taylor Ridge, and in McDaniel Gap through White Oak Mountain which is the northward continuation of Taylor Ridge. McDaniel Gap is one mile south of Ooltewah, Tennessee, and 10 miles north of Ringgold. There is then a strip of Maysville extending for 20 miles and probably more along the northwest face of Taylor Ridge-White Oak Mountain which has no known connection with the Maysville elsewhere. The nearest locality at which the Maysville is definitely known is Cumberland Gap, Virginia-Tennessee. Doubtless the Maysville extends southwest along the Cumberland escarpment a considerable distance from Cumberland Gap into Tennessee, but it is absent at Chattanooga and must thin out between Cumberland Gap and Chattanooga.

The Maysville is known to be such from the presence of the following fossils: *Herbertella sinuata, Platystrophia* sp.?, *Zygospira modesta, Plectorthis plicatella, Orthorhynchula linneyi, Byssonychia radiata, Cymatonota pholadis, Pterinea demissa, Lophospira bowdeni. Orthorhynchula linneyi,* which was found on the road east of Trion on the northwest face of Taylor Ridge, is one of the most persistent and widely distributed Maysville fossils and is present along the Appalachian Valley from Georgia to central Pennsylvania. It is also associated throughout with abundant pelecypods, among which are the species listed.

Silurian System

SEQUATCHIE FORMATION

The Sequatchie formation was named from Sequatchie Valley, Tennessee. It is separated from the Maysville by a slight hiatus due to the absence of the McMillan formation which in southwestern Ohio lies between the Maysville and the Richmond formation of which the Sequatchie is a modified equivalent.

Ulrich proposes that the Sequatchie and its approximate equivalent, the Richmond formation of southwestern Ohio and southeastern Indiana, be classified as Silurian, but other geologists, perhaps a majority, still believe it should be classed as Ordovician. There are arguments on both sides.

The Sequatchie formation is composed of shale and sandstone, more or less of which in their unweathered condition are somewhat calcareous. A few beds of rather thick to massively bedded limestone occur. In some sections there are thin layers of fine quartz conglomerate or grit. At other places thick to massive beds of very fine-grained, rusty, fossiliferous sandstone occur. In places the layers are rather thick and compact and distinctly reddish. The reddish layers are commonly near the contact with the Trenton, and serve for the differentiation and recognition of the two formations. This red color is a distinctive feature of the Sequatchie formation.

The Sequatchie is known to be present wherever its horizon crops out as far east as the northwest slope of White Oak Mountain, and its southward continuation, Taylor Ridge. It has not been observed, however, in the ridges carrying the Red Mountain formation east and south of Tunnel Hill to and including Lavender Mountain. It may be present in those areas, however, although unobserved.

The Sequatchie is well-exposed on the Tennessee, Alabama, and Georgia Railroad just west of Estelle. Other good exposures are in cuts along U. S. Highway 11 between Chattanooga and Wildwood; along the road up Wauhatchie Branch where the massive limestone is exposed one-half mile west of U. S. Highway 11; on U. S. Highway 27 on the northwest side of Taylor Ridge at and just below the summit of McWhite Gap; and, also on Taylor Ridge, on the road northeast of Trion just west of the Narrows at the summit. Here the massive, rusty sandstone of the formation is best exposed. On U. S. Highway 11 one-fourth mile northeast of Wildwood, the contact of the Sequatchie and the underlying Trenton is exposed and also the thick limy, reddish beds in the lower part and the still higher thin-bedded and shaly upper part of the Sequatchie are completely exposed.

The thickness of the Sequatchie seems to be about 250 feet.

The following fossils were collected from the Sequatchie: *Rhombotrypa quadrata, Dalmanella meeki, Leptaena richmondensis, Platystrophia ponderosa, Refinesquina* sp., *Rhynchotrema capax, Sowerbyella* sp., *Byssonychia radiata, Modiolopsis concentrica.* The *Rhombotrypa, Leptaena,* and *Rhynchotrema* are distinctive Richmond forms of the Cincinnati region of southwestern Ohio and southeastern Indiana and indicate the Richmond age of the Sequatchie. Northward, the typical Sequatchie occurs at Cumberland Gap, Virginia-Tennessee, and farther north the formation is represented by the red, nonmarine Juniata formation in Virginia and Pennsylvania, and by the Queenston shale in New York and Canada.

RED MOUNTAIN FORMATION

The Red Mountain formation was named from Red Mountain just east of Birmingham and Bessemer, Alabama. As the formation is of the same character in Georgia as in Alabama, the use of the name has been extended into Georgia. The Red Mountain is the same as the Rockwood formation, except that the Rockwood included the Sequatchie and on Taylor Ridge probably included the Maysville.

The Red Mountain is almost entirely composed of sandstone and shale. The sandstone is generally in thin layers interbedded with shale, but in the basal part strata of thick-bedded sandstone as much as 50 feet thick occur. The sandstone is usually fine-grained and gray, but many layers of ferruginous, rusty sandstone occur. In Lookout Valley and westward the upper part of the formation is largely a finely fissile, greenish shale. In the lower half of the formation are thin beds of limestone, some coarse-grained and bluish gray, and some more or less ferruginous and mottled red. Thin, more or less lenticular and nonpersistent beds of fossil and "oolitic" iron ore (hematite) occur.

The Red Mountain formation, owing to its thick and hard beds of sandstone, makes conspicuous ridges. White Oak Mountain and its southward continuation, Taylor Ridge east of Summerville, are examples. Rocky Face Mountain is another example where the thick ledge, white sandstone capping its top, is a striking object in the landscape, both looking west from U. S. Highway 41 northwest of Dalton and looking east from the road east of Rocky Face village. This sandstone is known as the White Oak Mountain sandstone. Other prominent ridges make up a complex in the region around Villanow. They end south of Villanow in John and Horn Mountain. Lavender Mountain and Mount Alto (Horseleg Mountain) southwest of Rome are other examples.

The Red Mountain formation crops out along both sides of McLemore Cove and along the southeast base of Pigeon Mountain. It occurs on both sides of Lookout Valley and extends north into Johnsons Crook east of Rising Fawn. It is best developed and most conspicuously displayed on the summit and upper southeast slopes of White Oak Mountain and Taylor Ridge and on Rocky Face Mountain.

The best exposure of the Red Mountain formation is in the road cuts on U. S. Highway 27 on the southeast slope of Taylor Ridge in the space between 1¼ miles and three-fourths of a mile northwest of Gore. There are excellent exposures along U. S. Highway 11 southwest of Chattanooga and in a cut on the Nashville, Chattanooga and St. Louis Railroad, 1¼ miles north of Wildwood, where the railroad runs for a distance in Georgia just south of the State line. Another good exposure is along the Central of Georgia Railroad at the south end of Lavender Mountain west of Lavender, and another in McDaniel Gap through White Oak Mountain, 10 miles north of Ringgold. Still another good exposure is along U. S. Highway 41 in the bend of Chickamauga Creek, one mile east of Ringgold.

The thickness of the Red Mountain formation varies from about 150 feet west of Lookout Valley to about 500 feet in White Oak Mountain and Taylor Ridge.

The Red Mountain formation is moderately fossiliferous. The fossils are divided into two groups which are quite separate from each other and correspond to two quite distinct divisions or formations.

In the lower division the following forms have been collected: scalloped crinoid stem plates, *Helopora fragilis*, *Camarotoechia* cf. *C. neglecta* Foerste, *Dolerorthis flabellites, Dalmanella edgewoodensis, Leptaena* sp., *Hebertella daytonensis, Platymerella manniensis, Platystrophia reversata, Sowerbyella transversalis* var. *prolongata, Hermotoma subulata, Phacops pulchellus.*

The fossils of the above list show that the lower part of the Red Mountain is approximately of the age of the Brassfield limestone of Ohio and Indiana. The Brassfield is partially equivalent to the Albion sandstone, upper or White Medina of New York, and of the Tuscarora quartzite of Pennsylvania, and the Clinch sandstone of Virginia and Tennessee.

In the upper division the following fossils have been collected: *Monograptus clintonensis, Anoplotheca hemispherica, Atrypa reticularis* (Silurian form), *Chonetes novascoticus, Pentamerus "oblongus", Rhipidomella hybrida, Stropheodonta convexa, Encrinurus* cf. *E. ornatus, Gyronema* cf. *Poleumita transversa* Prouty, *Calymene "niagarensis", Zygobolbina conradi.* These are all well-known and persistent Clinton fossils and prove the Clinton age of the upper part of the Red Mountain. In Lavender Mountain, Taylor Ridge, and White Oak Mountain a bed of yellowish clayey rock (tripoli), with *Pentamerus "oblongus"* and *Anoplotheca hemispherica,* two of the distinctly Clinton fossils, occur and are quite widespread, apparently below the middle of the Red Mountain, and it indicates that the boundary between the Clinton and Brassfield is somewhat below the middle of the Red Mountain. West of Lookout Valley the Clinton is apparently much thinner than the Brassfield.

In Alabama the Red Mountain carries the fossil ore of the Birmingham district. In Georgia fossil ore also occurs in the Red Mountain in beds that rarely reach a thickness of three feet. The quality is about the same as that of the Birmingham ores. The ore reserves are considerable, but the relative thinness of the beds and the structural conditions make mining so expensive that, under present conditions in the iron mining industry, it would probably be impossible for mining in Georgia to compete in the iron ore markets of the country. The iron ores of northwestern Georgia have been fully described by S. W. McCallie, former State Geologist, in Bulletin 17 of the Georgia Geological Survey, published in 1908.

Devonian System

ARMUCHEE CHERT

The Armuchee chert is named from the town of Armuchee at the northeast end of Lavender Mountain. The Armuchee succeeds the Clinton. No strata of upper Niagara age—Rochester shale, and Lockport dolomite, nor of Cayuga age—McKenzie limestone, Wills Creek formations, Tonoloway limestone, nor of Lower Devonian age—Helderberg limestone, nor of Oriskany sandstone are present, so that there is a hiatus of considerable magnitude between the Clinton and Armuchee.

The Armuchee is generally a gray chert, but in Mount Alto (Horseleg Mountain), on the west side near the north end, it includes beds of calcareous, fossiliferous sandstone which weather to a friable condition and brown color from the iron oxide present. At the south end of Lavender Mountain is about 50 feet of chert overlain by 15 to 20 feet of sandstone. It is uncertain whether this sandstone belongs with the Armuchee, but a similar sandstone in Frog Mountain, Alabama, and named the Frog Mountain sandstone, seems to be of Onondaga age, the same as the Armuchee, and for that reason it is, at present, thought that the sandstone in question can best be included in the Armuchee.

The Armuchee seems to be present at most places where its horizon crops out, but it was not seen on the east side of White Oak Mountain. Although generally present on its outcrop, it is too thin to be shown separately on the map of the present scale, so it is grouped with the overlying black Chattanooga shale, and the two are shown on the map by a black dash line. At the north end of Mount Alto and on Turkey Mountain two miles northeast of Armuchee, the Armuchee covers an area of sufficient size, so that it can be shown on the map by a distinctive color and pattern.

The best exhibits of the Armuchee are at the north end of Mount Alto, two miles southwest of Rome where it is exposed along the road on the west side below the college; at the north end of Lavender Mountain; on Turkey Mountain; and on U. S. Highway 27, three-fourths of a mile northwest of Gore.

The following fossils have been collected from the Armuchee: *Favosites* cf. *F. shriveri*, *Cladopora* cf. *C. labrosa*, *Pleurodictyuon* sp., Cyathaphyloid coral, *Anoplia nucleata*, *Eodevonaria arcuata*, *Meristella rostellata*?, *Orthotetes pandora*, *Pentagonia* cf. *P. uniangulata*, *Spirifer divaricatus*, *Spirifer duodenarius*, *Spirifer macrothyris*?, *Rhipodomella* cf. *R. vanuxemi*. Most of these fossils are of common occurrence in the Onondaga limestone northward to New York, and westward to the Falls of the Ohio at Louisville, Kentucky. The *Eodevonaria*, *Pentagonia*, and three species of *Spirifer* are especially characteristic of the Onondaga, and the Onondaga age of the Armuchee seems well assured.

CHATTANOOGA SHALE

The Chattanooga shale was named from the city of Chattanooga. It is a densely black, highly fissile or slaty shale. Generally, there is in the upper part of the Chattanooga a layer of greenish clay one to two feet thick, full of black nodules an inch

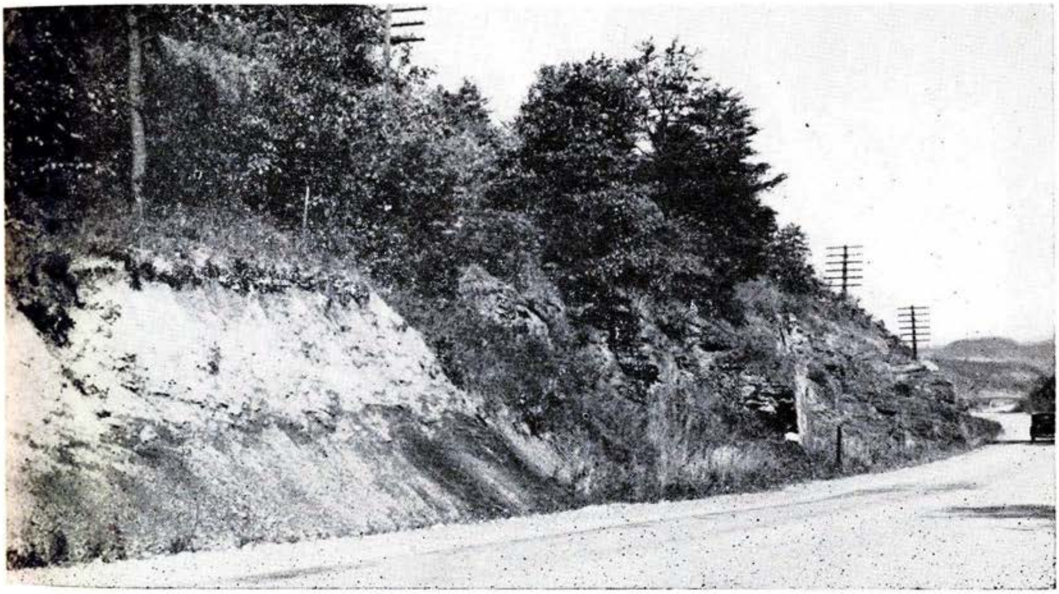


Fig. 4. Southeast slope of Taylor Ridge, ¾ mile northwest of Gore, Chattooga County. View looking northeast. Left—Armuchee chert, probably halloysite horizon. Center—Chattanooga shale, poorly exposed. Right—Fort Payne chert.

or so in diameter. These are supposed to be phosphatic, as they are elsewhere. This clay is supposed to be the same as the Maury Green shale in middle Tennessee.

The Chattanooga is universally present wherever its horizon crops out on the surface, and it is thus a reliable horizon marker and datum plane from which to identify and measure the formations above and below. Its outcrop is shown on the geologic map by a thin dash, black line. It everywhere marks the base of the Mississippian (Carboniferous) formation from Alabama and Georgia north to southern Virginia.

Some of the best places to see the Chattanooga are the following: on Armuchee Creek just below the mill dam just west of Crystal Springs, Floyd County; in a highway cut just north of the Tennessee, Alabama, and Georgia Railroad, and 1,000 feet north of the State line, and just southeast of St. Elmo, Tennessee; just south of the State line at the same locality; in the gap through Shinbone Ridge on the road west from Lafayette; on U. S. Highway 11 at the underpass beneath the Southern Railway southwest of Chattanooga; and on the road at the north end of Mount Alto on the west slope about one mile south of West Rome.

The thickness of the Chattanooga varies from a few feet up to 30 feet. One of the thickest developments appears to be in Shinbone Ridge west of Lafayette.

The Chattanooga is but slightly fossiliferous. A few small specimens of Lingula occur here and there, and the linguloid forms *Barroisella* and *Lingulipora* have been collected in Alabama. Conodonts, minute, serrate fossils, supposed to be teeth of some small fishlike animal without bony skeleton that could be preserved, occur. From the similarity or identity of some of these conodonts with species from the Mississippian Sunbury shale of Ohio and other regions, Ulrich has concluded that the Chattanooga is Mississippian. From the apparent stratigraphic continuity of the Chattanooga with Upper Devonian formations in southwest Virginia, the writer believes that the Chattanooga is Upper Devonian.

Mississippian System

The Mississippian System in Georgia is composed of two diverse facies of rocks of equivalent age. In Lookout and Pigeon Mountains the Mississippian is composed of limestone and chert except for the Pennington shale at the very top. This, excluding the Fort Payne chert at the bottom, has been called the Bangor limestone in former accounts of the geology of Georgia, as in the Ringgold and Rome folios. East of White Oak Mountain, Taylor Ridge, and Gaylor Ridge the Mississippian is prevailingly a shale with intercalated beds of limestone. This facies is named the Floyd shale from Floyd County, where it is fully developed and was first recognized as a distinct facies and regarded as a distinct formation. In Rocky Mountain north of Lavender and in the west side of Little Sand Mountain east of Gore, the name Bangor limestone was used, but the Bangor of those areas corresponds to only a small part of the Bangor of Lookout and Pigeon Mountains.

The name Bangor limestone was taken from Bangor, Alabama, 32 miles north of Birmingham. Here the Bangor succeeds the Hartselle sandstone. So the type of the Bangor could only be limestone above the Hartselle sandstone. Elsewhere in Alabama and in Georgia where the Hartselle is thin or absent the name was also applied to lower limestone, that is to limestone below the horizon of the Hartselle sandstone. As this lower limestone has been divided and the sub-divisions given other names, Bangor was no longer applicable in the broader sense, and in 1926 the application was restricted to the limestone above the Hartselle sandstone, extending up to the Pennington shale. In Georgia, the name, as has hitherto been used, "Bangor limestone" includes the following Mississippian units as exposed in the section at the north end of Lookout Mountain, named in descending order:

Pennsylvanian system
  Pottsville formation
    Walden formation
    Lookout sandstone (rim rock)
Mississippian system
  "Bangor" limestone
    Pennington shale
    Bangor limestone (restricted)
    Hartselle sandstone
    Golconda limestone
    Gasper limestone
    Ste. Genevieve limestone
    St. Louis limestone
    Hiatus, Warsaw limestone absent
  Fort Payne chert
Devonian system
  Chattanooga shale

Since it is impracticable at present to map the "Bangor" formations separately, the limestone is here described as Mississippian limestone undivided or "Bangor limestone" in quotation marks to indicate the former use of the name in the broad sense. On the geologic map the Fort Payne chert is included in the "Bangor" and Floyd areas. It occupies everywhere the margin of the areas and lies next to the Chattanooga shale.

FORT PAYNE CHERT

The name Fort Payne is taken from Fort Payne, DeKalb County, Alabama. In Georgia, it is composed of stratified chert and of a dark, compact, calcareous shale or argillaceous limestone with probably a small content of limy material. The chert is dense, brittle, gray, and evenly bedded, although the bedding faces are irregularly furrowed, giving an uneven contact. The individual layers of chert are generally six inches to one foot thick, but they vary to thinner and to somewhat thicker layers. The shale is massively bedded and of a dark gray color. The relations of the chert and shale seem to be variable. The word "seems" is used because no completely exposed section immediately above the Chattanooga shale, including both kinds of rock were seen. On the west slope of Mount Alto one mile south of West Rome the Chattanooga shale is immediately overlain by about 50 feet of chert; the chert is overlain by a considerable thickness of the shale mentioned above, and this shale apparently is overlain by another bed of chert. In a railroad cut just west of Lavender, Floyd County, a good thickness of the shale is exposed, and the shale is overlain by chert. Below the shale is an unexposed space extending down to the Armuchee. There is in this space plenty of room for the Chattanooga and a lower bed of chert. On the Southern Railway just east of the crossing of the Central of Georgia Railroad, the shale is overlain by a considerable thickness of thin-bedded chert, and the same is true at the big quarry in the shale on the Southern Railway about one mile due north of Rome. On the north-south road east of White Oak Mountain, $1\frac{1}{4}$ miles due east of Ringgold and about one-half mile north of U. S. Highway 41, the shale lies directly upon the Chattanooga black shale and is overlain by the chert which shows along U. S. Highway 41 just east of the intersections of the roads, and the Chattanooga shale also shows at the intersection not far below the chert. The shale member of the Fort Payne is, therefore, not very thick—not over 50 feet, one would judge. From its manifest interbedding with the chert, this shale is regarded as a member of the Fort Payne and is

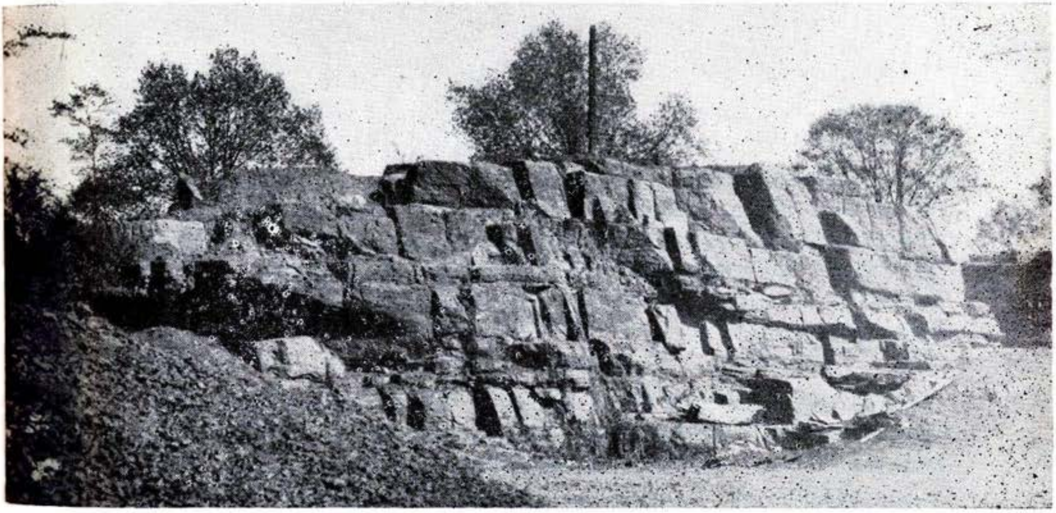


Fig. 5. Dark thick-bedded calcareous shale in quarry at crossing of Southern Railway over U. S. Hy. 27 in the northern part of Rome, Floyd County. This is regarded as a facies of the lower part of the Fort Payne chert formation and is provisionally called the Lavender member.

here named the Lavender shale member from its good exposure in the railroad cut just west of Lavender station.

The Fort Payne is persistent throughout the entire Paleozoic area east to the east base of White Oak Mountain and Taylor Ridge. It is exposed at many places, and the chert can best be seen near the underpass of U. S. Highway 11 beneath the Southern Railway southwest of Chattanooga and at the west foot of Lookout Mountain a short distance northeast of the underpass. It is fully exposed in a highway cut in the gap of Shinbone Ridge west of Lafayette. Another good exposure is on U. S. Highway 27 about one-half mile east of Crystal Springs, Floyd County. Here is the most fossiliferous locality seen. The best exposure, about one-half mile long, is on the east slope of Taylor Ridge and U. S. Highway 27 one-half mile or so west of Gore where the full thickness, all solid chert, has been cut to a clean face in road making. The contact of the chert with the Chattanooga shale can be seen at most of these places, but one of the best exposures of this sequence is at the mill dam at Crystal Springs. The best exposures of the Lavender shale member are at the type locality on the railroad one-third of a mile west of Lavender station, and in a large quarry in the shale at the underpass of U. S. Highway 27 beneath the Southern Railway, about one mile north of Rome.

Neither the chert nor the Lavender member is highly fossiliferous, as a general thing, but, from a few more fossiliferous places, the following fossils have been collected: from the chert proper—*Hadrophyllum ovale, Zaphrentis* cf. *Z. cliffordana, Z. compressa,* large crinoid stems, one-half inch or more in diameter, *Athyris lamellosa, Chonetes shumardanus, Linoproductus ovatus, Dictyoclostus (Productus)* cf. *D. crawfordsvillensis, D.* cf. *D. inflatus, D.* cf. *D. viminalis, Spirifer, leidyi* type, *Spirifer rostellatus.*

From the Lavender shale member the following fossils have been tentatively identified: *Dictyonema* sp., *Cystodictya linearis, Hemitrypa* near *H. nodosa, Fenestrellina burlingtonensis, Fenestralina* near *funicula, F. multispinosa, F. regalis, F.* near *F. rudis, Brachythyris subcardiformis?, Cleiothyridina glenparkensis, Dictyoclostus (Productus) burlingtonensis, Phaethonides spinosus.* All these fossils, both from the chert and the Lavender member, are forms that occur in the Keokuk or Burlington limestone of the Mississippi Valley or in the New Providence shale of Burlington age, or in chert of Keokuk age in Kentucky. Some of them, especially those from the chert, occur in the Fort Payne chert of Alabama or Kentucky. Notable is the *Hadrophyllum* which was described from specimens collected from the Fort Payne chert near Nobob, Barren County, Kentucky, the only other known locality. The four species of *Fenestrellina* occur in the New Providence of Kentucky, or in the Keokuk, or Burlington of Iowa. The large crinoid stem plates are common in the Fort Payne of Alabama and Kentucky and have not been found at any other horizon. The evidence is sufficient to establish the equivalence of the Fort Payne with the Burlington and Keokuk of the standard Mississippian section of the Mississippi Valley.

"BANGOR" LIMESTONE

As already explained, this name is used here in a quotational sense. The "Bangor" is confined to the slopes of Lookout Mountain and of Pigeon Mountain, the eastern offshoot of Lookout Mountain. The entire "Bangor" is said to be extremely well developed and exposed on the north end of Pigeon Mountain.

The "Bangor" can best be described by describing the section at the north end of Lookout Mountain which probably persists throughout the Lookout and Pigeon Mountains region. At the base no evidence of the Warsaw limestone has been found so that the St. Louis is believed to rest directly upon the Fort Payne.

St. Louis Limestone

The St. Louis is a thick-bedded, dark, fine-grained, cherty limestone about 100 feet thick. It is exposed along U. S. Highway 11 on the lower western slope down to the beginning at the bend of the road to a west direction. West of the exposure of the St. Louis there is an unexposed space of a few hundred feet along the road down to the Fort Payne, some part of which is well exposed in a road cut. The St. Louis is fully exposed on the Nashville, Chattanooga and St. Louis Railroad for 850 feet east of the overhead crossing of the Southern Railway. The slightly irregular contact with the overlying Ste. Genevieve limestone is also well exposed here. Neither here nor elsewhere has the contact of the St. Louis upon the Fort Payne been observed in Georgia. The St. Louis is marked in Georgia, as well as westward to the Mississippi Valley, by two species of massive corals, *Lithostrotionella castelnaui* (*"Lithostrotion canadensis"*) and *Lithostrotion proliferum.* These occur in the section just described. They have been noted also at the head of Cherokee Branch and west of Cherokee Ridge four miles northeast of Ringgold, and especially fine examples have been collected by a local collector living in the vicinity of Rising Fawn.

Ste. Genevieve Limestone

Next above the St. Louis is the Ste. Genevieve limestone named from Ste. Genevieve, Missouri. It is easily distinguished from the St. Louis by its oolitic and noncherty character. It can be affirmed with certainty that the St. Louis is everywhere nonoolitic with perhaps rare and local exceptions. The basal bed of the Ste. Genevieve at the north end of Lookout Mountain is a massive-bedded, gray, oolite limestone separated from the underlying, dark, fine-grained, highly cherty St. Louis by an irregular contact. The contact is very plain, both on the Nashville, Chattanooga and St. Louis Railroad and on the highway about halfway down the western slope from the summit on U. S. Highway 11 and at the north end of Lookout Mountain. Its thickness here is about 90 feet.

The Ste. Genevieve in contrast with the St. Louis is gray to bluish gray, rather thick-bedded and coarsely crystalline, on the whole, and probably in Georgia as elsewhere is a highly pure calcium carbonate. It is well exposed not only on the highway as said above, but also for the entire distance along the cut of the Nashville, Chattanooga, and St. Louis Railroad at the north end of Lookout Mountain.

The Ste. Genevieve is also identified by the presence of its guide fossil, *Platycrinus penicillus (huntsvillae),* which was noted at the north end of Lookout Mountain and at points farther east where it occurs in limestone in the lower part of the Floyd shale. This fossil is of constant occurrence at this horizon west to Illinois and Missouri and north as far as Bluefield, West Virginia.

Gasper Limestone

The Ste. Genevieve is succeeded above by another formation, the Gasper limestone, of very similar lithologic character which would hardly be separated from the Ste. Genevieve but for the fact that in western Kentucky and southern Illinois the two are separated by the Bethel sandstone which reaches a thickness of 100 feet. This sandstone does not extend eastward beyond Christian County, Kentucky, but the Ste. Genevieve below and the Gasper above have been traced continuously across the entire length of Kentucky and into southwestern Virginia. The Gasper is a thick-bedded, gray, rather coarsely crystalline, noncherty limestone about 100 feet thick at the north end of Lookout Mountain. It is fully exposed in the upper 100 feet of the Nashville, Chattanooga, and St. Louis Railroad cut at the north end of the mountain and along U. S. Highway 11 on the upper part of the west slope, the top of the formation coinciding approximately with the road level across the summit.

It happens that a genus of crinoids, *Talarocrinus,* is confined to the Gasper east of central Kentucky. This fossil can be identified by its various separate parts such as the circular basal disk or by one of the two semicircular plates of the disk, or by the U-shaped radial plates. These have been observed in the formation at the north end of Lookout Mountain. Another characteristic Gasper fossil, *Campophyllum gasperense,* also occurs. It is a fact worth noting that several specimens of *Lithostrotionella,* cf. *L. castelnaui ("Lithostrotion canadensis"),* were found in the Gasper on the east base of Pigeon Mountain one mile west of Cedar Grove, and also in the Floyd at the north end of Cherokee Ridge six miles northeast of Ringgold. (See also p. 51).

There is an excellent exposure of the massively bedded Gasper on the road to Lookout Mountain in Johnsons Crook three miles northeast of Rising Fawn. Here *Talarocrinus, Pentremites pyriformis, P. godoni,* and *Agassizocrinus ovalis,* all Gasper fossils, were noted.

Golconda Limestone

Next above the Gasper are about 20 feet of shale and interbedded, thin, platy limestones carrying a very characteristic crinoid, *Pterotocrinus capitalis,* and an associated compound coral which is probably the form referred to by James Safford in the Geology of Tennessee as *Palastraea carbonaria.* The

Pterotocrinus is known elsewhere only in southern Illinois where it occurs in the Golconda limestone named from Golconda, Hardin County, Illinois. This bed is, therefore, regarded as representing the Golconda. It is well-exposed for a considerable distance along the highway just above the highway level at the summit of the road.

Hartselle Sandstone

Just above the Golconda horizon and coming down about to the level of U. S. Highway 11 in the axis of the Lookout Mountain syncline are 5 to 10 feet of sandstone or sandy limestone that weathers to sandstone. This is believed to represent the Hartselle sandstone of Alabama which lies at the base of the Bangor limestone as restricted.

Bangor Limestone (restricted)

Above the Hartselle horizon is thick-bedded, bluish gray, coarsely crystalline limestone extending up on the mountain side to the Pennington shale. It is approximately 500 feet thick. This is the Bangor limestone as redefined and restricted in Special Report No. 14 of the Alabama Geological Survey, published in 1926. This makes up more than one-half of the thickness of limestone cropping out on the slopes of Lookout Mountain. At a point in Paris Hollow on Pope Creek 1½ miles west of Hooker some highly fossiliferous, shaly beds occur in the Bangor. Here the following fossils were collected: *Pentremites cherokeus, P. spicatus, Archimedes communis, A. meekanus, A. swallovanus, Fenestrellina cestriensis, F. serrulata, F. tenax, Prismopora serrulata, Septopora subquadrans, Polypora cestriensis, Composita subquadrata, Spiriferina transversa.* Several of these fossils as *Pentremites spicatus, Archimedes communis,* and especially *Prismopora serrulata,* are reliable markers for the Glen Dean limestone of Kentucky and Illinois, and for the lower part of the Bangor limestone at Bangor, Alabama. There is no doubt that the Glen Dean is represented in the lower part of the Bangor. Just how much of the standard Mississippian section of the Mississippi Valley is represented in the upper part of the Bangor is unknown.

Pennington Shale

Above the Bangor restricted but included in the "Bangor" of former reports and extending up to the basal Pennsylvanian ("Lookout") sandstone, is the Pennington shale named from Pennington Gap, Virginia. The Pennington is predominantly shale, largely yellowish as weathered, but including beds of red shale which is its distinguishing characteristic. Thin sandstones and limestones occur as minor constituents. The Pennington is further distinguished by the presence of marine fossils, bryozoans and brachiopods, which do not occur commonly in the overlying Pennsylvanian (Coal Measures) rocks which are predominantly nonmarine deposits. The thickness of the Pennington in Georgia is 100 to 200 feet.

The Pennington is a persistent bed around the rim of Lookout Mountain below the very conspicuous sandstone cliff or rim rock. It can be seen on the incline railway at the north end of the mountain, on the road to the Durham mines from Cenchat in Chattanooga Valley; on the road to Daughertys Gap at the south end of McLemore Cove; on the road on the west escarpment in Johnsons Crook; and on the road up the mountain side directly east of Fort Payne, Alabama. The Pennington type of rock persists at the same horizon throughout northern Alabama, in Tennessee and Kentucky west of the Cumberland Plateau, and in southwest Virginia. It is not claimed that the Pennington of Georgia corresponds exactly to all of the Pennington in other regions.

At the north end of Lookout Mountain the level of the Tennessee River is about 550 feet above the sea. The St. Louis limestone is apparently all below river level there, or say that the bottom of the St. Louis is at an altitude of 500 feet. The base of the Pennsylvania is placed at the altitude of 1,500 feet. As the strata are nearly horizontal here, this gives a total thickness of approximately 1,000 feet for the "Bangor" at the north end of Lookout Mountain. The total thickness of the different members of the "Bangor" here as estimated, taking 150 feet for the thickness of the Pennington, is 950 feet.

FLOYD SHALE

The Floyd shale was named from Floyd County, Georgia. It is predominantly a gray to black, fissile shale, but it includes beds of limestone like those of the "Bangor", and at one place a rather thick bed of sandstone. Some of the beds of limestone have been mapped as "Bangor," but in such places the amount of limestone falls so far short of the real "Bangor" that it seems best to regard such beds as members of the Floyd in which they are all included in this report.

The Floyd occurs only east of White Oak Mountain and Taylor Ridge where it occupies several large and more or less detached areas. On the north is a long area east of Ringgold. South, there are two small synclinal areas in western Whitfield County. Farther south are the principal areas marked by Gore and Armuchee. A long, irregular strip runs from the Armuchee area north nearly to the latitude of Dalton.

The Floyd areas are generally eroded to flat surfaces in which there are few exposures of the underlying rocks. The best exhibition of the shale is in the pits for the brick works at West Rome. Scattered, small exposures occur generally throughout the different areas, and it seems unnecessary to point them out. The best exhibition of the sandstone in the Floyd is at the south end of Rocky Mountain in Texas Valley, 10 miles northwest of Rome. Here the sandstone is so prominent that it was mapped in the Rome folio and named the Oxmoor sandstone. The limestone is well shown on the west side of Little Sand Mountain, on the western shoulder, five miles south of Subligna; at Orsman in Texas Valley; in a road cut just northwest of Huffaker, five miles northwest of Rome; and at the airport three miles northwest of Rome. Probably the best display of limestone in the Floyd areas is at the north end of Cherokee Ridge just south of the State line and about 1½ miles southeast of Parker Gap, Tennessee. This is in the belt of Floyd that crosses the State line five miles east of Graysville. It is to be noted that this locality is in the line of N. 40°E. strike (which prevails in the Appalachian Valley), from Pigeon Mountain in which the "Bangor" facies of the Mississippian is present. This is a manifestation of the fact, to be noted in many other cases, that the original strike of deposition diagonals the present trend of the folded belts, which trend controls the areal distribution of the outcrops of the formations.

The thickness of the Floyd cannot be exactly determined, but it is estimated to be at least 1,500 feet.

At various localities fossils have been obtained from the Floyd sufficient to prove its equivalence with the "Bangor." The lowest horizon is the St. Louis limestone in which *Lithostrotionella castelnaui* (*"Lithostrotion canadensis"*) occurs and has been collected on the divide between Cherokee Creek and an unnamed northward flowing stream just west of Cherokee Ridge and four miles northeast of Ringgold. At the base of Cherokee Ridge, one-half mile farther north, *Cystelasma quinqueseptatum,* a diagnostic Ste. Genevieve fossil is fairly abundant. A couple hundred feet west of the Nashville, Chattanooga, and St. Louis Railroad and 2¾ miles southeast of Ringgold, oolitic limestone with bases and stem plates of *Platycrinus penicillus* are exposed. This is, of course, Ste. Genevieve and is the easternmost known occurrence of the formation and its guide fossils seen in the Appalachian Valley. The fossils are still there in the rock for anyone to see that may be interested.

At the north end of Cherokee Ridge and just south of the State line 1¼ miles southeast of Parker Gap, Tennessee, the Gasper limestone is highly fossiliferous, such Gasper fossils as *Campophyllum gasperense, Pentremites godoni* Ulrich, *P. planus, P. pyriformis, Agassizocrinus ovalis, Girtyella indianensis,* and other common Chester fossils occurring here. Here also is one of the rare occurrences of a coral scarcely, if at all, distinguishable from *Lithostrotionella castelnaui* (*"Lithostrotion canadensis"*). This locality; also a locality at the base of Pigeon Mountain, a mile or so west of Cedar Grove; and a locality two miles south of Greenbush, Walker County, or three miles northwest of Subligna, Chattooga County are all in the Gasper. Insofar as known, or at least reported, these are the only occurrences east of the Mississippi Valley of this *Lithostrotionella* above the St. Louis limestone.

Localities where the Gasper *Pentremites* are abundant are at and a few hundred feet west of old Shackelton about 1½ miles south of Gore, Chattooga County. In the airport three miles northwest of Rome a limestone crops out which carries *Talarocrinus*. Now this genus is unknown east of central Kentucky in any other formation than the Gasper limestone.

Near Huffaker, five miles northwest of Rome, in an old quarry three miles north of Rome, and at a point one-half mile southeast of Gore *Fenestrellina cestriensis, F. flexuosa, Orthotetes kaskaskiensis, Diaphragmus elegans, Productus inflatus, Spirifer increbescens, Composita subquadrata* occur. These seem on the whole to indicate a higher horizon than the Gasper.

The lists given could be extended to include several other common Chester fossils, but the fossils cited are sufficient to establish the Chester age of the Floyd shale and to show its equivalence with the "Bangor" limestone, excluding of course the Fort Payne chert.

ROCKMART SLATE

The Rockmart slate was named from Rockmart, Polk County. This formation succeeds the Newala limestone with an erosional unconformity between, as can be seen in an extensive stripping excavation at the quarry at Davitte, about one mile northeast of Aragon, Polk County.

The Rockmart is predominantly a clay rock which includes thin beds of sandstone and at one horizon a thick stratum of thinly bedded, slightly fossiliferous chert about 80 feet thick. This bed is exposed in a road metal pit by the roadside a mile north of Walthrall, Polk County. Stray beds of argillaceous limestone and of limestone conglomerate are reported, but none such were seen by the writer.

Usually the slate as weathered is a gray or pink color but normally is dark colored as can be seen in the quarry at Davitte. Just south of Rockmart is a thick body of densely black, cleaved slate that has been utilized to some extent as a roofing slate. Well-developed, slaty cleavage prevails in considerable areas as just south of Rockmart and two miles southeast of Taylorsville. Along the boundary fault in southern Polk County it has been so cleaved and altered that there is difficulty in distinguishing it from the schists of the overthrust mass.

Except for a small outlier in Bartow County north of Taylorsville, the Rockmart occurs only in Polk County, where there are four separate areas of varying size, the largest being an area one mile east and northeast of Rockmart and another one mile south of Cedartown. The range of Newala hills or knobs north of Aragon are likely to be capped with a thin residual layer of

Rockmart. On the small knob in the northeast corner of Polk County the Rockmart is about 50 feet thick with shale below and a few feet of sandstone on the top of the knob.

Good exposures of the Rockmart can be seen at so many places that it is hardly necessary to enumerate them.

The thickness of the Rockmart cannot be determined without extensive field work, if even with that. The bedding is most everywhere steeply inclined and cut by slaty cleavage. No certainly recognizable beds or horizons have as yet been detected that would serve as datum planes for measurement. Various estimates have been made ranging from 1,200 to 3,000 feet. In the writer's judgment 3,000 feet is not excessive; it may be much thicker.

The Rockmart has hitherto been regarded as a facies of the Stones River group and correlated with the "Chickamauga" of ancient usage. Reasons why this correlation cannot be accepted are given below. In the first place, the chert in the midst of the Rockmart one mile north of Walthrall, Polk County, carries crinoid fragments, among which is an occasional elliptical stem plate of *Platycrinus*. This genus of crinoids occurs only in the Carboniferous and is especially abundant in the lower Carboniferous or Mississippian as in the Burlington chert at Burlington, Iowa. A single fragment of a *Spirifer* was found in this chert on the top of the ridge made by the outcrop of the chert at that point. *Spirifer* is unknown in the Ordovician ("Chickamauga") and is scarce in the Silurian. It is abundant in the Devonian and Carboniferous. It seems certain that the chert in question is not older than Devonian, and the occurrence of *Platycrinus* seems to establish its age as Carboniferous and most probably Mississippian. The presence of Carboniferous here was recognized by Hayes who showed areas of Carboniferous in this region on an unpublished map of the Tallapoosa quadrangle. It has been assumed and stated that the "Carboniferous" overlies the Rockmart, presumably on the theory that it occupied the center of a synclinal area. As a matter of fact, however, the fossiliferous chert north of Walthrall is nearly vertical, is interbedded with shale and sandstone of the Rockmart type, and is evidently a constituent of the same. It is the author's hypothesis that the Rockmart is Mississippian and a correlative facies of the Floyd shale. This broad statement may be qualified by the admission that the black slate at Rockmart may be referred to the Athens shale. But, it must be remembered that the Floyd is also very black in places and that the Chattanooga shale is also very black, so that the color and other lithologic characters cannot be taken as proof that the black slate is Athens. There are still other considerations. In Alabama, as two miles north of Wilsonville, Shelby County, the Floyd shale is nearly in contact with the Newala limestone, being possibly separated therefrom by a small thickness of chert carrying *Spirifer*, which may represent the Fort Payne chert. Near Calcis, Shelby County, fossiliferous Mississippian is in contact with the Newala. At Erin, 10 miles southeast of Talladega, Carboniferous occurs apparently infolded in pre-Cambrian Talladega slate. In and near the grounds of Fort McClellan a few miles north of Anniston, a great thickness of shale, regarded as Mississippian, seems to overlie in places at least the Conasauga shale, as shown on the geologic map of Alabama, 1926 edition. Fort McClellan is only 30 miles southwest of the nearest Rockmart area south of Cedartown, Georgia, and is in strike therewith. In a preliminary map of the Fort Payne quadrangle, Hayes showed a large area of Floyd overlying and in contact with the Conasauga shale. The point of all this is that the Mississippian is transgressive southeastward, so that in these southeastern belts of the Valley, the Mississippian, represented mainly by the Floyd shale, rests on older and older rocks the farther southeast the locality.

These facts as respects Alabama were observed, and conclusions reached in 1923-1926, before the writer had ever seen the Georgia Rockmart. The interpretation of the Rockmart as Mississippian (Floyd) is in complete harmony with the situation in Alabama. (See the geologic map of Alabama accompanying special Report No. 14, 1926).

Pennsylvanian System

POTTSVILLE FORMATION

The Pennsylvania System or, according to the usage of the U. S. Geological Survey, the Pennsylvanian series of the Carboniferous System, is named from western Pennsylvania where it was earliest brought to attention by extensive coal mining.

The Pottsville formation, or, often put in the form of the Pottsville group, was named from Pottsville in the anthracite coal field of eastern Pennsylvania.

The Pottsville is composed entirely of thick sandstone, conglomerate, and shale beds. Its distinctive characteristic everywhere is its many beds of coal of which there are a few in Georgia. At the base of the Pottsville is a thick and persistent sandstone resting upon the Pennington shale. This sandstone was named the Lookout sandstone by Hayes from its conspicuous display as the rim rock at the top of Lookout Mountain. The Lookout is a coarse, thick-bedded, conglomeratic sandstone, 150 feet or so thick. It is said to include a coal bed or two. It corresponds to the Sewanee conglomerate of Walden Ridge and of the Cumberland Plateau in Tennessee. It is supposed that the sandstone of Rocky and Little Sand Mountain between Subligna and Lavender is "Lookout." Below what appears to be the equivalent of the "Lookout" in the northwest corner of the State, in the vicinity of the abandoned Cole City, is about 300 feet of shale and sandstone with two workable coal beds. This body of rock seems to correspond to the Gizzard formation of the east escarpment of the Cumberland Plateau west of Pikeville, Bledsoe County, Tennessee.

The "Lookout" sandstone is overlain along the central part of Lookout Mountain and in the northwest corner of Georgia by a considerable thickness of rocks composed of sandstone and shale with much more shale than in the "Lookout." This overlying formation was named the Walden sandstone by Hayes from Walden Ridge to the north in Tennessee. Besides the shale the "Walden" is distinguished from the "Lookout" by workable beds of coal in Lookout Mountain. The coal mines at Durham occur in this part of the Pottsville.

The main body of Pottsville rocks occupies the central axis on the summit of Lookout Mountain. Outlying areas are in the northwest corner of the State west of Lookout Valley and in Rocky and Little Sand Mountain already mentioned.

The "Lookout" sandstone, the cliff-maker of Lookout Mountain, is about 150 to 200 feet thick. The "Walden" is estimated by Hayes at the Durham mines to be 930 feet thick, which seems rather excessive. Assuming that the above estimates are nearly correct, and assuming further that the approximately 300 feet of coal measures in the northwest corner of the State are below the horizon of the "Lookout" and not present in Lookout Mountain, the total thickness of the Pottsville in Georgia is 1,430 feet, or 1,500 feet in round numbers.

According to the best knowledge, the Pottsville of Georgia is of lower Pottsville age and falls within the limits of the Lee conglomerate of Tennessee and Virginia and corresponds approximately to the lower part of the Pottsville of the anthracite coal fields of Pennsylvania which carry the Lykens Nos. 4 and 5 and the Lykens Valley coals.

The coal resources of Georgia have been satisfactorily described by S. W. McCallie, in the following publication: *The Coal Deposits of Georgia,* 1904, The coal resources are evidently rather small as compared with those of the neighboring states, but still they are considerable.

STRUCTURE

General Statement

By structure, as used here, is meant the attitude of the strata beneath the surface. The Paleozoic rocks of Georgia partake of the structure characteristic of the rocks of the Appalachian Valley generally. The originally horizontal strata have been thrown into waves or folds, anticlines or synclines, and broken and displaced by great faults. These folds and faults extend for miles along the direction of the Valley. The general nature of the structure is shown in the profile sections on the margin of the geologic map. The great deformation of the horizontal strata has been produced by enormous lateral pressure exerted from the direction of the Atlantic Ocean. Comparable structure could be produced by pressure against one edge of a pile of thin sheets of wax, the opposite edge being fixed and immovable. As a result of this manner of formation the fault planes generally dip toward the southeast (right on the structure sections). The strata on the southeast of the faults have been shoved upward and forward (toward the northwest). Such faults are called overthrust faults in distinction from vertical or slightly inclined faults where the displacement has in general been downward, or, as a result of tilting of the fault block, downward on one side and upward on the other.

Details of Structure

Boundary fault—The exposed Paleozoic rocks are bounded on the east and south by a great overthrust fault of low declination to the southeast. The semicrystalline schists which presumably underlie the Paleozoic rocks have been thrust upward and forward so that they now overlie the Paleozoics along their margin as shown conclusively in the valley of Holly Creek in the vicinity of Hassler Mill, Murray County. Here the crystalline rocks occupy the steep valley walls and clearly overlie fossiliferous Upper Cambrian limestone, which, dipping southeastward at a high angle, crosses the valley in a northeast direction and extends on either side beneath the schists which crop out on the slopes 100 to 200 feet above the limestone at the base of the slope. The overthrust is also well shown near the head of Pine Log Creek in eastern Bartow County, and a mile southeast of Esom Hill, Polk County, where the Newala limestone with *Ceratopea* is exposed within a few hundred feet of the schist. Judging from the low, southeast dip of the fault plane on the bluffs above Holly Creek, the northwest movement of the overthrust mass may have been several miles. Possibly the Paleozoic rocks extend southeast beneath the thrust a considerable distance. It is significant that the Upper Cambrian rocks adjacent to the fault dip southeastward beneath it. Indeed, it is conceivable that the overthrust rocks once extended northwest to a line in continuance with the outcrop of the fault in Alabama, which line in Georgia may have extended northeast from Esom Hill to Tennessee. On this assumption, the rocks of the overthrust mass have been eroded from the area between Cartersville and such a line. This is purely speculative.

Anticline—An anticline occupied by the Rome formation extends from Chatsworth south to the vicinity of Cass Station, Bartow County. Within this anticlinal belt in southern Murray County is apparently a narrow syncline of Conasauga shale.

Minor faults—Just west of Chatsworth and Crandall are two minor faults, one bringing the Rome over the Conasauga, and the other (on the west) bringing the Knox into contact with the Athens shale and the Newala limestone.

Syncline—An essentially synclinal belt extends from just west of Tennga on the north to the boundary fault and the crystalline rocks in the vicinity of Rockmart and Cedartown on the south. On the north the belt is narrow because the eastern limb of the syncline is faulted off, but southward the syncline broadens and is marked by the wide expanse of Knox between Cartersville and Rome. The syncline is bordered on both sides by Conasauga shale, and an anticlinal tongue of Conasauga extends south into the middle of the Knox from Calhoun nearly to Kingston.

Anticline—An anticline bringing up the Rome formation extends from Tennessee to Rome. On the north the anticline is bifurcated, and between its two arms, between Tennga and Cohutta, is a syncline carrying Conasauga and Knox. Southward the anticline extends to and beyond Rome.

Minor faults—To the east of Lindale and Cave Springs are a number of small, parallel faults bringing the Conasauga up into contact with the Knox, forming several alternating, narrow fingers or slivers of each.

Syncline and fault—From south of Dalton another synclinal belt, slightly faulted east of Cohutta, extends to Tennessee. The deepest part of the syncline holds Holston and Lenoir limestones against which, on the east, the Knox is faulted. This syncline bordered on the west by the Rome fault extends to Alabama along the Coosa River, where it is spread out by immensely contorted or corrugated minor structures into a triangular area occupied by the Conasauga shale, which is six miles wide at the Alabama line.

Rome fault—The Rome fault, described by Hayes in the Rome folio (see introduction), extends north from Rome to Tennessee and west from Rome to Alabama. It is a flat overthrust carrying the Conasauga shale, synclinal remnants of which have escaped erosion and lie as tongues or projections upon the Floyd along a belt extending north from west of Lindale to Hill City in northwestern Bartow County. The broad area of Conasauga southwest of Rome which extends a long distance into Alabama is also a part of the overthrust mass as conclusively shown by the strike of the younger formations into this mass, beneath which they extend along an east-west line for the distance of 16 miles west of Rome. At the north end of the fault in Georgia the displacement is apparently less, for it there seems to be confined to the Knox. A little farther south, the Conasauga is thrust upon the Red Mountain formation east of Tunnel Hill and west of Dalton. The overthrust mass clearly passes over Mount Alto (Horseleg Mountain) as shown by the narrow area of Conasauga lying upon the Floyd shale just northwest of the Mountain. A glance at the geologic map is sufficient to suggest the probability that the overthrust mass once extended northwest over the Armuchee ridges to a line extending possibly from Attalla, Alabama, to the vicinity of Ringgold, Georgia. After the overthrusting on a relatively flat plane, folding of both the younger rocks beneath the overthrust as well as those of the overthrust sheet took place. Then erosion removed both the overthrust rocks, and much of the younger rocks beneath the thrust plane, except that the overthrust Conasauga shale lying in the syncline escaped removal. The way the synclinal lobes of the Conasauga extend toward the synclines between the ridges in northeastern Floyd and western Gordon counties, as well as the lobes between Rome and Lavender Mountains is thus explained.

Faults north of Tunnel Hill—Two small faults north of Tunnel Hill enclose a narrow strip of Knox between Rome on either side. This Knox appears to be in a down-dropped block into the Rome formation.

Fault between Ringgold and Tunnel Hill—This fault extends to the south end of Johns Mountain near Crystal Springs 10 miles north of Rome. Northeast and east of Ringgold a wide belt of Rome is raised into contact with the Floyd shale. The displacement decreases southward, and the fault is not known to extend south of the south end of Johns Mountain. The area between the fault just described and the Rome fault is occupied by a complex of narrow anticlines and synclines pitching southward and carrying the older formations of the Armuchee ridges beneath a large irregular area of Floyd shale in Floyd County and the eastern part of Chattooga County.

Floyd syncline—West of the Rome fault is a broad synclinal area with very irregular outline which may appropriately be named the Floyd syncline from the large area of Floyd shale which occupies it. On the north the syncline is divided into two main lobes by the anticlinal Armuchee ridges which extend in Johns Mountain to the vicinity of Crystal Springs, four miles southeast of Gore, Chattooga County. The southwest limb of the Floyd syncline is likewise divided into lobes by Simms and Lavender Mountains which extend northeast and pitch beneath the Floyd not far southwest of the southern end of Johns Mountain. There are two main lobes of the Floyd syncline, one on the east extending from the southern end of the Armuchee Ridges to the east-west line of the Rome fault; and one on the west roughly marked by Subligna and Gore. The eastern lobe has the small area of Pottsville of Rock Mountain on its axis, and the western lobe has the long, narrow area of Little Sand Mountain along its southeast margin.

In general the rocks of the Floyd syncline are only moderately deformed, even dips of 5 to 20 degrees prevailing. Locally, as near the faults and the margins of the anticlinal tongues the thin-bedded shale and sandstone are contorted. An example is on U. S. Highway 27, 1½ miles northwest of Armuchee. Over large areas the strata are nearly flat, as in Rocky and Little Sand Mountains.

Peavine anticline—From the Floyd syncline the rocks rise westward to an anticline of the Conasauga formation which follows Peavine Valley—whence the name. It is also marked by the town of Lafayette. But south of the latitude of the town of Trion this anticline is complicated by faults and a syncline near its middle. A wide strip of Conasauga first comes to the surface east of Summerville. West of this strip are two faults causing a repetition of the Conasauga and Knox in long, narrow strips. Midway between Summerville and Menlo a syncline carrying Ordovician and Silurian rocks extends northeast to the latitude of Trion. On the northwest there appears to be another fault of slight displacement which brings the lower part of the Knox up into contact with the Murfreesboro, perhaps faulting out the Newala limestone south of Rock Spring.

Pigeon Mountain syncline—The Pigeon Mountain syncline is marked by the prominent ridge of Pigeon Mountain which is an offshoot or spur of Lookout Mountain. Its axis extends north through Chickamauga Park and into Tennessee east of Missionary Ridge.

McLemore anticline—Next west of the Pigeon Mountain syncline is the anticline of McLemore Cove which pitches to the southwest and dies out in Lookout Mountain in northwestern Chattooga County south of Lookout village. This anticline separates Lookout and Pigeon Mountains. The center of the anticline is occupied by Knox dolomite, and its axis approximately coincides with Missionary Ridge. Chickamauga Creek, the type locality of the "Chickamauga" limestone, flows along its southeast limb. The anticline is asymmetrical, the dips on the northwest limb being 25 to 80 degrees, while those on the southeast limb are five degrees or less to the axis of the Pigeon Mountain syncline. At the north end of this anticline in Georgia is the triangular, southern extremity of a southward pitching offset anticline which expands northward in the city of Chattanooga. The National Cemetery is near its axis. This anticline is bounded on both sides by southward converging faults, between which it is a relatively down-thrown block with the Red Mountain formation down-thrown into contact with the Knox dolomite on both sides. It is an unusual structure in the Appalachian Valley, and probably is not correctly interpreted.

Lookout syncline—The Lookout syncline is named from Lookout Mountain along the middle of which extends the synclinal axis, the position of which is plainly shown on U. S. Highway 11, and on the N. C. & St. L. Railroad at the north end of the mountain. For considerable distances on either side of the axis the dips are low, five degrees or less, but they steepen to nearly vertical at the east base and to 25 degrees east at the west base of the mountain. Across the summit of the mountain at any latitude, the Pottsville sandstone is nearly horizontal on the average. To the synclinal structure is due the presence of the Pottsville with its valuable coal beds on the top of the mountain.

Wills Creek anticline—The north end of the Wills Creek anticline which extends south to Attalla, Alabama, just enters Georgia in the cove, well known as Johnsons Crook. The anticline brings up the Knox dolomite along its axis, and pitches to the north beneath the coal measures about east of Rising Fawn.

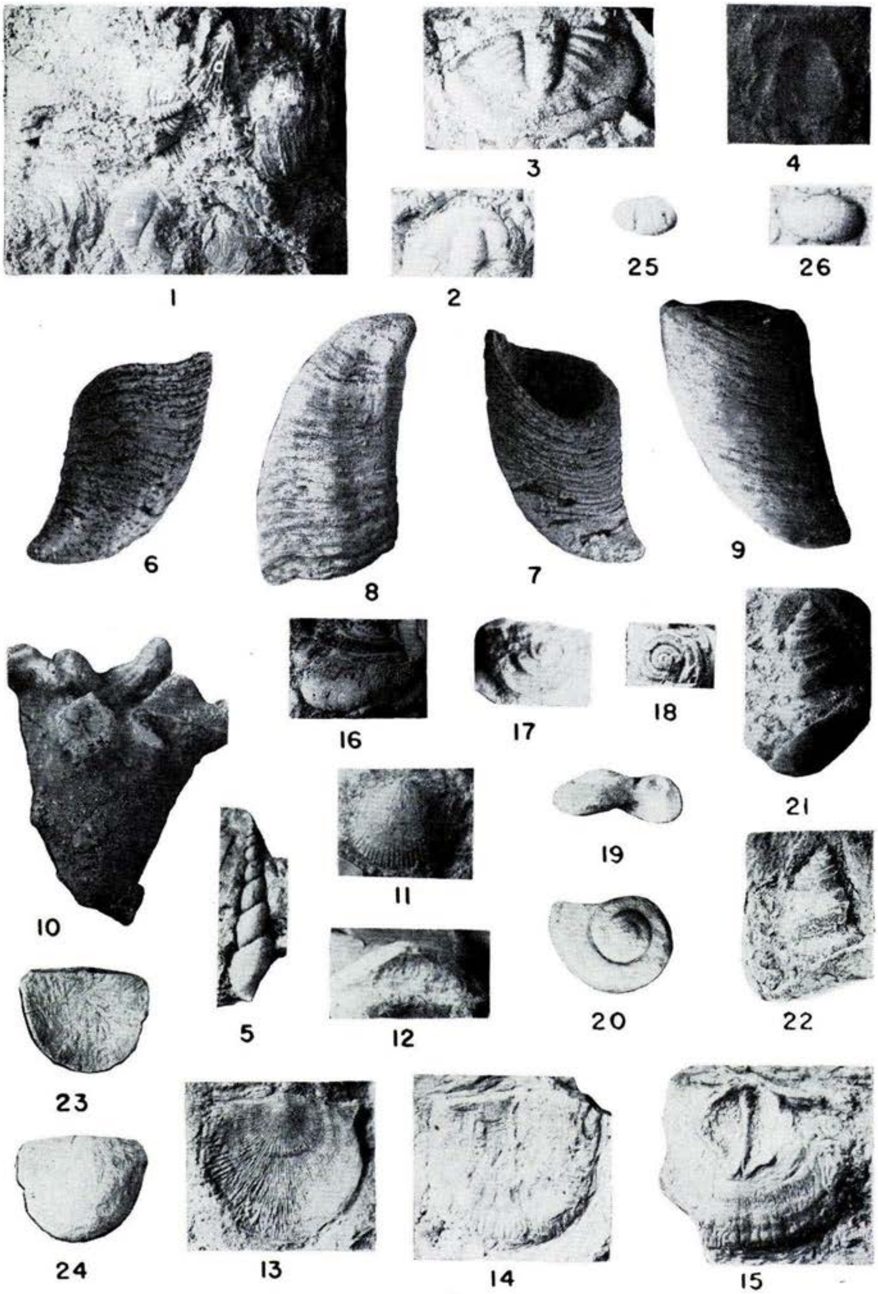
Syncline—A shallow syncline crosses through Rising Fawn across which at one time the Pottsville sandstone of Lookout Mountain was connected with the Pottsville of Fox Mountain.

Lookout Valley anticline—Bordering Lookout Mountain on the northwest is Lookout Valley which is eroded upon an anticline here named as above. The Lee Highway follows this anticline nearly to Rising Fawn. The axis pitches to the south, and the anticline disappears in a few miles into Alabama between Fox and Sand Mountains. The axis of the anticline almost all its length in Georgia is occupied by the Trenton limestone. No lower rocks crop out. At the north end of the anticline in Georgia it is crossed just north of Wildwood by a shallow-syncline carrying the Sequatchie and Red Mountain formations. The width of the cross syncline north and south is about one mile. Just north of the cross syncline and just south of the State line the Trenton limestone rises to outcrop on a low dome on the anticline, and the outcrop continues with interruptions for 15 miles or more into Tennessee. The dip on the southeast of the anticline is 25 to 40 degrees; on the northwest it is 10 degrees, and decreases westward nearly to only a degree or two or becomes substantially flat within two or three miles northwest of the axis. The coal measures and underlying Bangor limestone in the northwest corner of Dade County are about horizontal.

FOSSIL PLATES AND EXPLANATIONS

In the course of his field studies Dr. Butts collected many fossil specimens from the Paleozoic formations of northwest Georgia. Reference is made by him in the text to the most common and significant fossils of each formation. To the average reader fossil names and descriptions have little meaning or interest unless accompanied by illustrations. Unfortunately, Dr. Butts did not have an opportunity to describe and photograph the different species collected. Most of the characteristic forms are, however, illustrated in his report on "Geology of the Appalachian Valley in Virginia," published in 1940-41 as Bulletin 52 of the Virginia Geological Survey. Dr. Arthur Bevan, State Geologist of Virginia, has kindly granted permission to use illustrations from Part II of this bulletin in the accompanying plates of fossils. This opportunity is taken to acknowledge the invaluable assistance of Dr. G. Arthur Cooper, Curator, United States National Museum, in assembling the necessary negatives of those fossils selected for the plates from the files of the National Museum. Dr. Cooper also made the negatives of the forms which are not illustrated in the Virginia bulletin.

As stated in Part II of Virginia Geological Survey Bulletin 52: All the fossil figures are of natural size, except those designated in the plate descriptions by the notations X 2, X 4, etc., which indicate that the figures are two or four or more times the natural size, respectively.



Rome, Shady, Conasauga, Newala, Murfreesboro, and Lenoir Fossils

Explanation of Plate 1

Number

1. Small slab, with three species: a and b, *Kutorgina* cf. *K. cingulata* Billings; a, ventral valve; b, dorsal valve; c, *Nisusia* cf. *N. festinata* (Billings) ; d, *Kootenia browni* Resser. Shady dolomite. From Virginia Geological Survey Bulletin 52.

2. *Solenopleura virginica* Resser.
Rome formation. From Virginia Geological Survey Bulletin 52.

3,4. *Coosia calanus* (Walcott).
3 tail, internal mold; 4, head, external mold. Conasauga formation. From Virginia Geological Survey Bulletin 52.

5. *Hormotoma* cf. *H. artemesia* (Billings).
Internal mold in chert. Newala limestone. From Virginia Geological Survey Bulletin 52.

6-9. *Ceratopea* sp. (Operculum of unknown gastropod)
6, 7, opposite sides of a specimen; 8, 9, opposite sides of another specimen. Newala limestone. From Virginia Geological Survey Bulletin 52.

10. *Nicholsonella pulchra* Ulrich.
Murfreesboro limestone. From Virginia Geological Survey Bulletin 52.

11,12. *Mimella* sp.
11, ventral valve; 12, posterior view of different specimen. Murfreesboro limestone. From Virginia Geological Survey Bulletin 52.

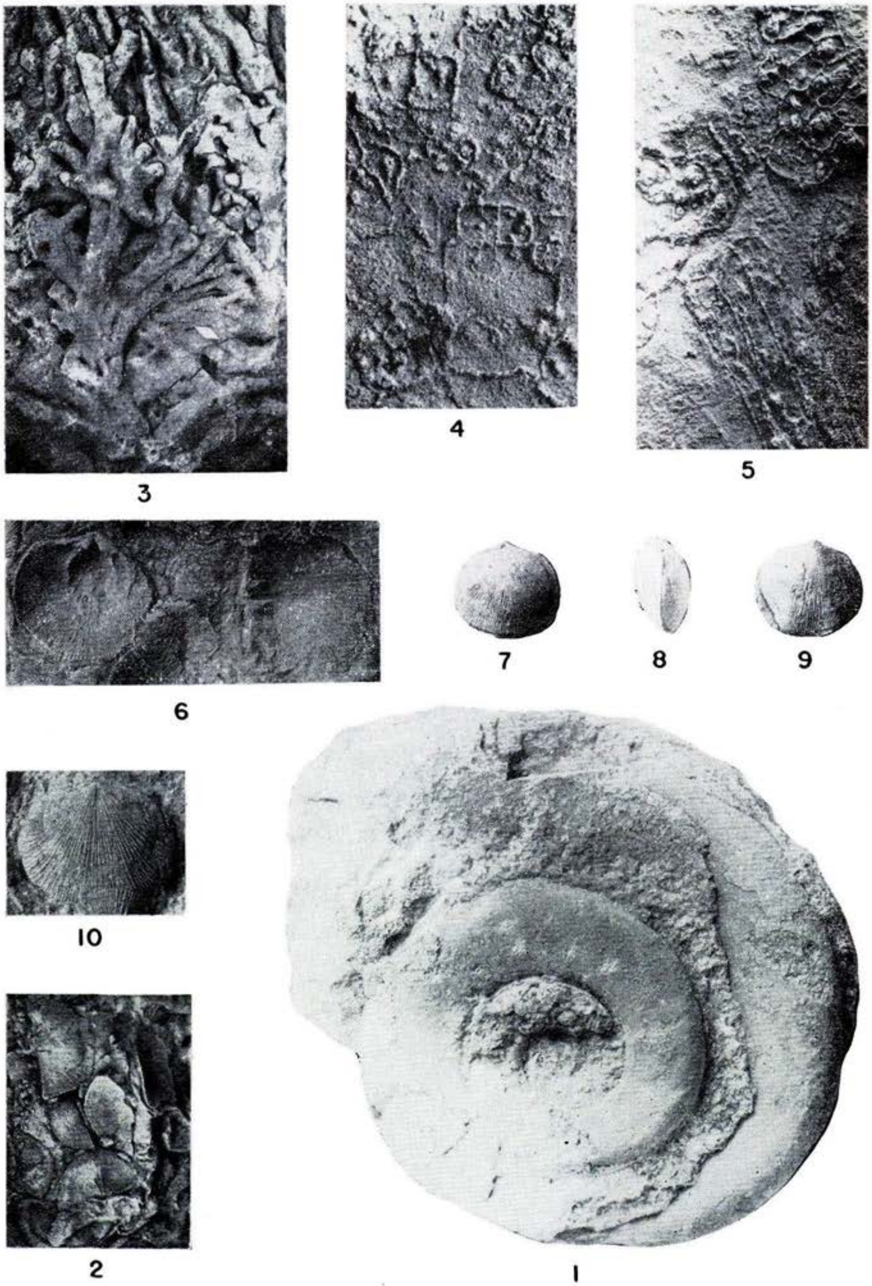
13-15. *Strophomena incurvata* (Shepard).
13, ventral valve; 14, dorsal valve; 15, interior of another ventral valve. Murfreesboro limestone. From Virginia Geological Survey Bulletin 52.

16-20. *Helicotoma tennesseensis* Ulrich and Scofield.
16, impression of an external mold in chert; 17, apical view of an impression of an external mold; 18, apical view of an impression of an external mold of small specimen; 19, 20, profile and apical views of an exfoliated specimen. Murfreesboro limestone. From Virginia Geological Survey Bulletin 52.

21,22. *Lophospira bicincta* (Hall).
Murfreesboro limestone. From Virginia Geological Survey Bulletin 52.

23,24. *Rafinesquina* cf. *R. minnesotensis* (Winchell).
Dorsal and ventral views of the same individual. Lenoir (Ridley) limestone. From Virginia Geological Survey Bulletin 52.

25,26. *Leperditia* cf. *L. fabulities* pinguis Butts.
Lenoir (Ridley) limestone. From Virginia Geological Survey Bulletin 52.



Lenoir, Lebanon, and Lowville Fossils

Explanation of Plate 2

Number

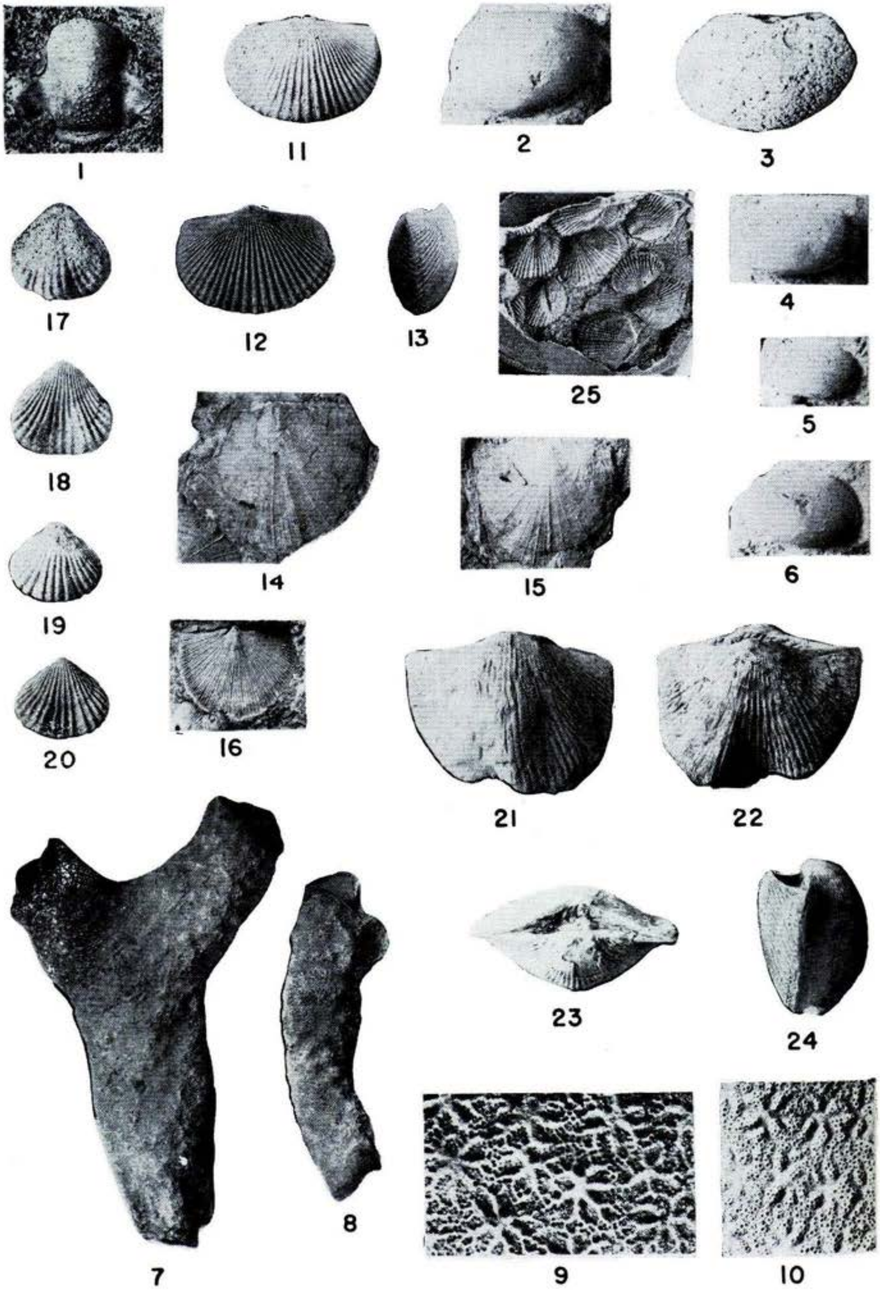
1. *Maclurites magnus* Lesueur.
   Supposed umbilical view of a specimen giving the appearance of left-hand coil. Lenoir (Ridley) limestone. From Virginia Geological Survey Bulletin 52.

2. *Sowerbyella lebanonensis* Bassler.
   Lebanon limestone. From G. Arthur Cooper, United States National Museum.

3. *Camárocladia implicatum* Bassler, X ½.
   Lebanon limestone. From G. Arthur Cooper, United States National Museum.

4,5. *Tetradium cellulosum* (Hall), X 4.
   Cross and longitudinal sections of dividing coralites. Lowville limestone. From Virginia Geological Survey Bulletin 52.

6-10. *Pionodema subaequata* (Conrad).
   6, interior of a ventral (left), and of a dorsal (right) valve; 7-9, dorsal, profile, and ventral views of a specimen; 10, ventral view of a specimen from the same slab as shown in 6. Lowville limestone. From Virginia Geological Survey Bulletin 52.



Lowville, Trenton, and Maysville Fossils

Explanation of Plate 3

Number

1. *Bathyurus* aff. *B. johnstoni* Raymond.
Lowville limestone. From Virginia Geological Survey Bulletin 52.

2-6. *Leperditia fabulites* (Conrad).
2, 3, X 2. 2, 3, 4, right valves; 5, 6, left valves. Lowville limestone. From Virginia Geological Survey Bulletin 52.

7-10. *Constellaria teres* Ulrich and Bassler.
7, 8, two specimens natural size to show exteriors; 9, 10, parts of surfaces of two other specimens, X 4, to show arrangement of cells. Trenton limestone. From Virginia Geological Survey Bulletin 52.

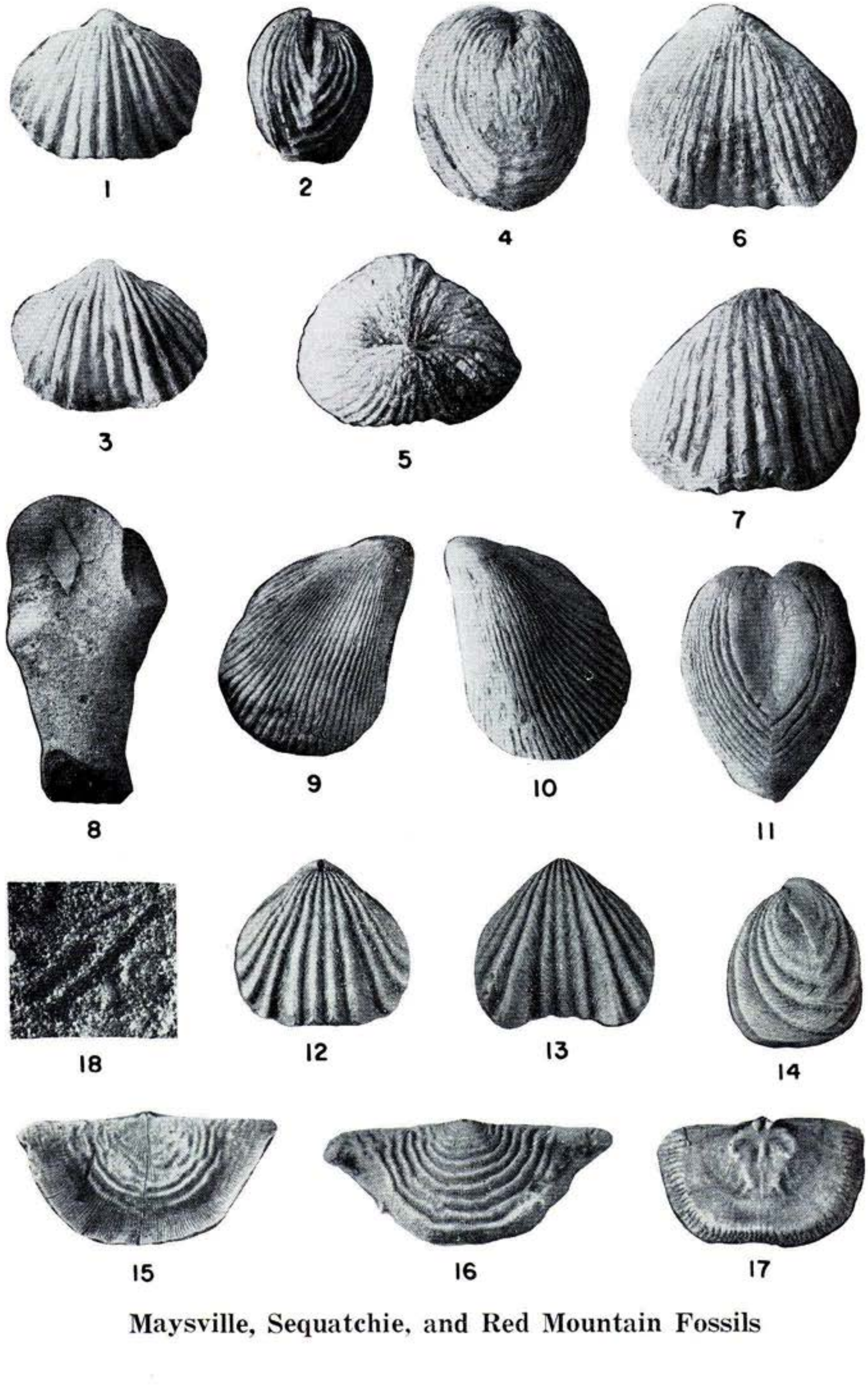
11-13. *Hebertella frankfortensis* Foerste.
Dorsal, ventral, and profile views of a specimen. Trenton limestone. From Virginia Geological Survey Bulletin 52.

14-16. *Refinesquina alternata* (Emmons).
14, 15, ventral valves, exteriors. Trenton limestone. From Virginia Geological Survey Bulletin 52.

17-20. *Rhynchotrema increbescens* (Hall).
17, 18, dorsal and ventral views of a specimen; 19, 20, dorsal and ventral views of another specimen. Trenton limestone. From Virginia Geological Survey Bulletin 52.

21-24. *Hebertella sinuata* Hall and Clarke.
Dorsal, ventral, posterior, and profile views of a whole specimen. Maysville formation. From Virginia Geological Survey Bulletin 52.

25. *Zygospira modesta* Hall.
Clay impression from an external mold of several specimens in fine-grained sandstone. Maysville formation. From Virginia Geological Survey Bulletin 52.



Maysville, Sequatchie, and Red Mountain Fossils

Explanation of Plate 4

Number

1-7. *Orthorhynchula linneyi* (James).
1-3, dorsal, profile, and ventral views of a specimen; 4-7, profile, posterior, ventral, and dorsal views of a large specimen. Maysville formation. From Virginia Geological Survey Bulletin 52.

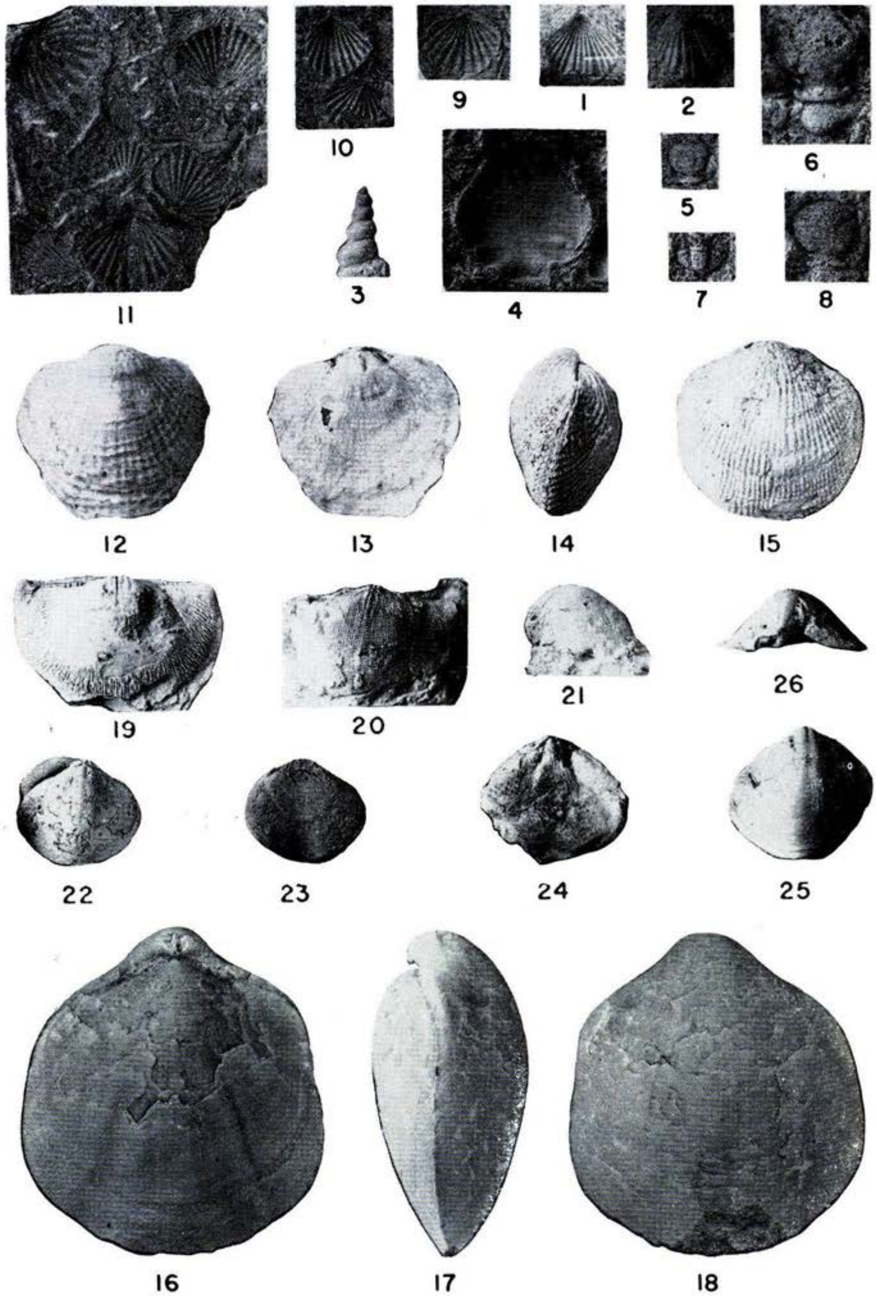
8. *Rhombotrypa quadrata* Rominger.
Sequatchie formation. From G. Arthur Cooper, United States National Museum.

9-11. *Byssonychia radiata* (Hall).
Right and left valves and byssal view of a whole specimen. Sequatchie formation. From Virginia Geological Survey Bulletin 52.

12-14. *Rhynchotrema capax* (Conrad).
Dorsal, ventral, and profile views of a specimen. Sequatchie formation. From G. Arthur Cooper, United States National Museum.

15-17. *Leptaena richmondensis* Foerste.
Dorsal, ventral, and interior views of a specimen. Sequatchie formation. From G. Arthur Cooper, United States National Museum.

18. *Helopora fragilis* Hall, X 4.
Poorly preserved external mold in sandstone. Lower division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.



Red Mountain and Armuchee Fossils

Explanation of Plate 5

Number

1,2. *Camarotoechia neglecta* (Hall).
Ventral and dorsal valves. Lower division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.

3. *Hormotoma subulata* (Conrad).
Lower division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.

4-8. *Phacops pulchellus* Foerste.
4, X 4; 5-8, X 2; 4, external mold of head; 5, 6, 8, internal molds of heads; 7, internal mold of tail. Lower division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.

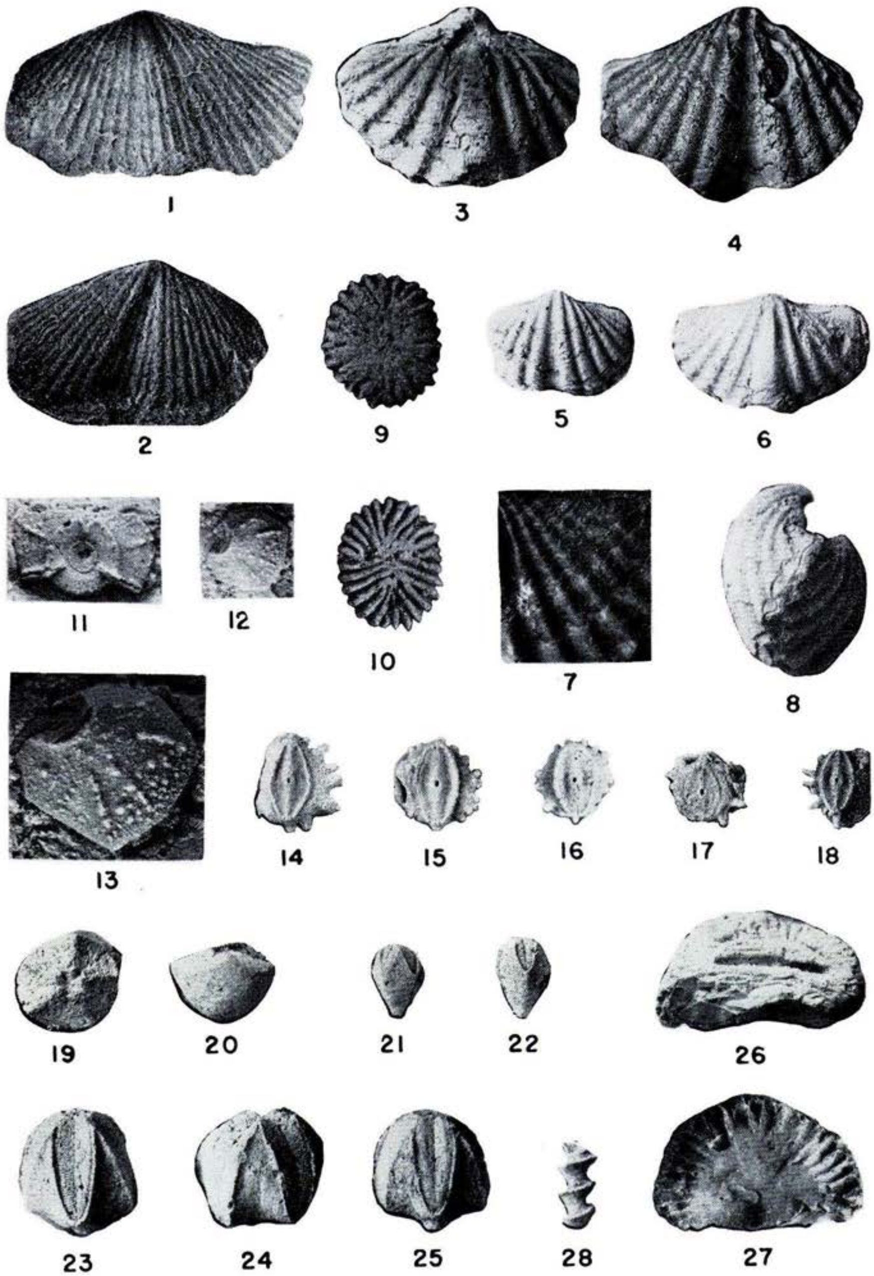
9-11. *Anoplotheca hemisphaerica* (Sowerby).
9, external mold of a ventral valve; 10, external mold of a ventral valve (above), and of a dorsal valve (below); 11, internal molds of 3 ventral valves and external mold of 1 dorsal valve. Upper division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.

12-15. *Atrypa reticularis* (Linné).
12, 13, ventral and dorsal views; 14, 15, profile and ventral views of another specimen. Upper division of Red Mountain formation. From Virginia Geological Survey Bulletin 52.

16-18. *Pentamerus oblongus* Sowerby.
Dorsal, profile, and ventral views. Upper division of Red Mountain formation. From G. Arthur Cooper, United States National Museum.

19-21. *Eodevonaria (Chonetes) arcuata* (Hall).
19, internal mold of a ventral valve; 20, 21, ventral and profile views of a specimen. Armuchee chert. From Virginia Geological Survey Bulletin 52.

22-26. *Pentagonia unisulcata* (Conrad).
22, 23, dorsal and ventral valves, internal molds of a specimen; 24-26, ventral, dorsal, and posterior views of an internal mold. Armuchee chert. From Virginia Geological Survey Bulletin 52.



Armuchee, Fort Payne, "Bangor," and Bangor (Restricted) Fossils

Explanation of Plate 6

Number

1,2. *Spirifer divaricatus* Hall.

1, external mold of a ventral valve; 2, clay impression from the same. Armuchee chert. From Virginia Geological Survey Bulletin 52.

3-8. *Spirifer duodenarius* (Hall).

3, 8, dorsal and profile views of the same specimen; 4, 5, ventral valves of other specimens; 6, internal mold of a dorsal valve; 7, part of external mold of a dorsal valve, X 4, showing ornamentation of fine cancellated lines. Armuchee chert. From Virginia Geological Survey Bulletin 52.

9,10. *Hadrophyllum ovale* Bassler.

Fort Payne chert. From G. Arthur Cooper, United States National Museum.

11-18. *Platycrinus penicillus* Meek and Worthen = *P. huntsvillae* Wachsmuth and Springer.

All X 2 except 13. 11-13, parts of bases. 13, same as 12, X 4, differently posed. 14-18, stem plates. The elliptical, spiny stem plates and tricarinate bases are characteristic of this species. "Bangor" limestone, Ste. Genevieve horizon. From Virginia Geological Survey Bulletin 52.

19-20. *Agassizocrinus* cf. *A. ovalis* Miller and Gurley?

Ventral and side views of the infrabasal disc. "Bangor" limestone, Gasper horizon. From Virginia Geological Survey Bulletin 52.

21,22. *Pentremites pyriformis* Say?

"Bangor" limestone, Gasper horizon. From Virginia Geological Survey Bulletin 52.

23-25. *Pentremites "godoni"* Ulrich, not De France.

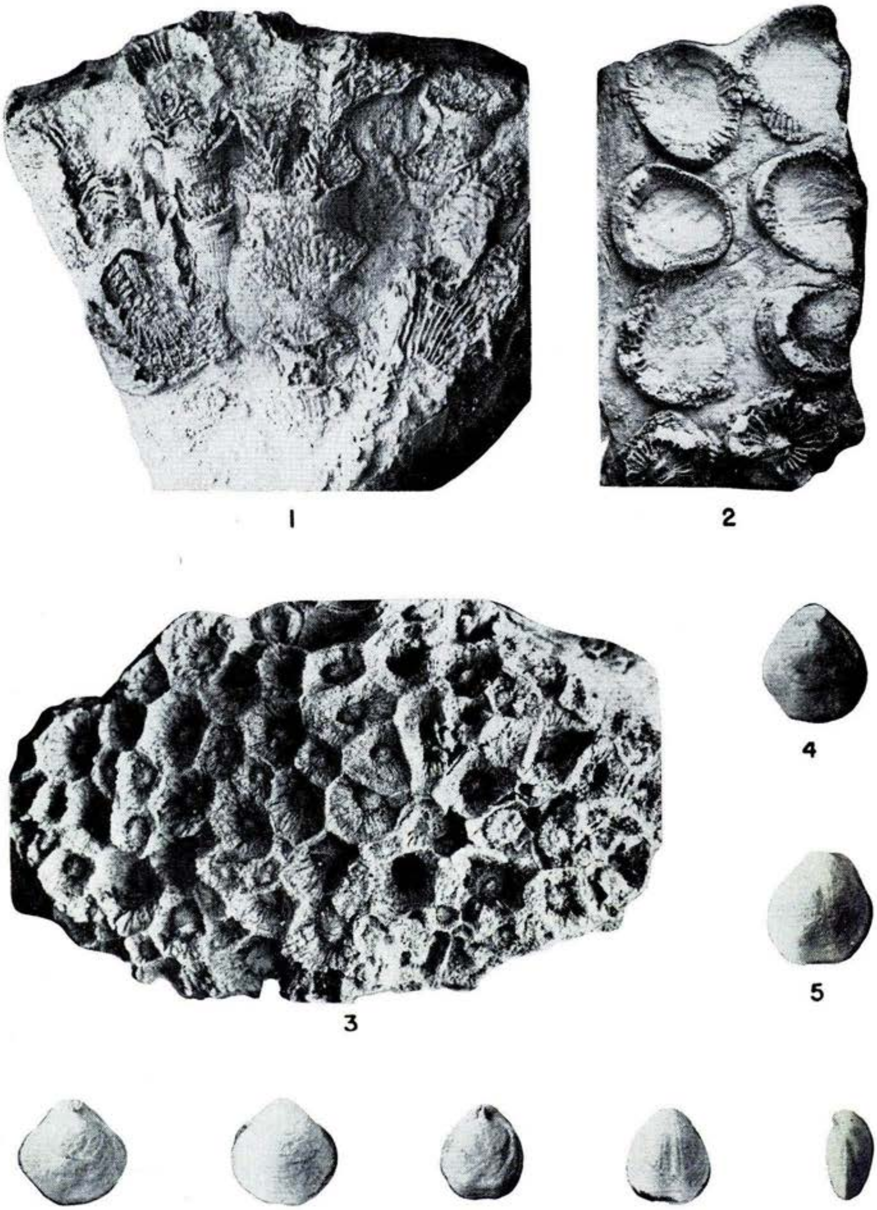
"Bangor" limestone, Gasper horizon. From Virginia Geological Survey Bulletin 52.

26,27. *Campophyllum? gasperense* Butts.

26, side view of a fragment preserving a few tabulae and part of the calyx; 27, calycinal view. "Bangor" limestone, Gasper horizon. From Virginia Geological Survey Bulletin 52.

28. *Archimedes communis* Ulrich.

Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.



"Bangor" Fossils

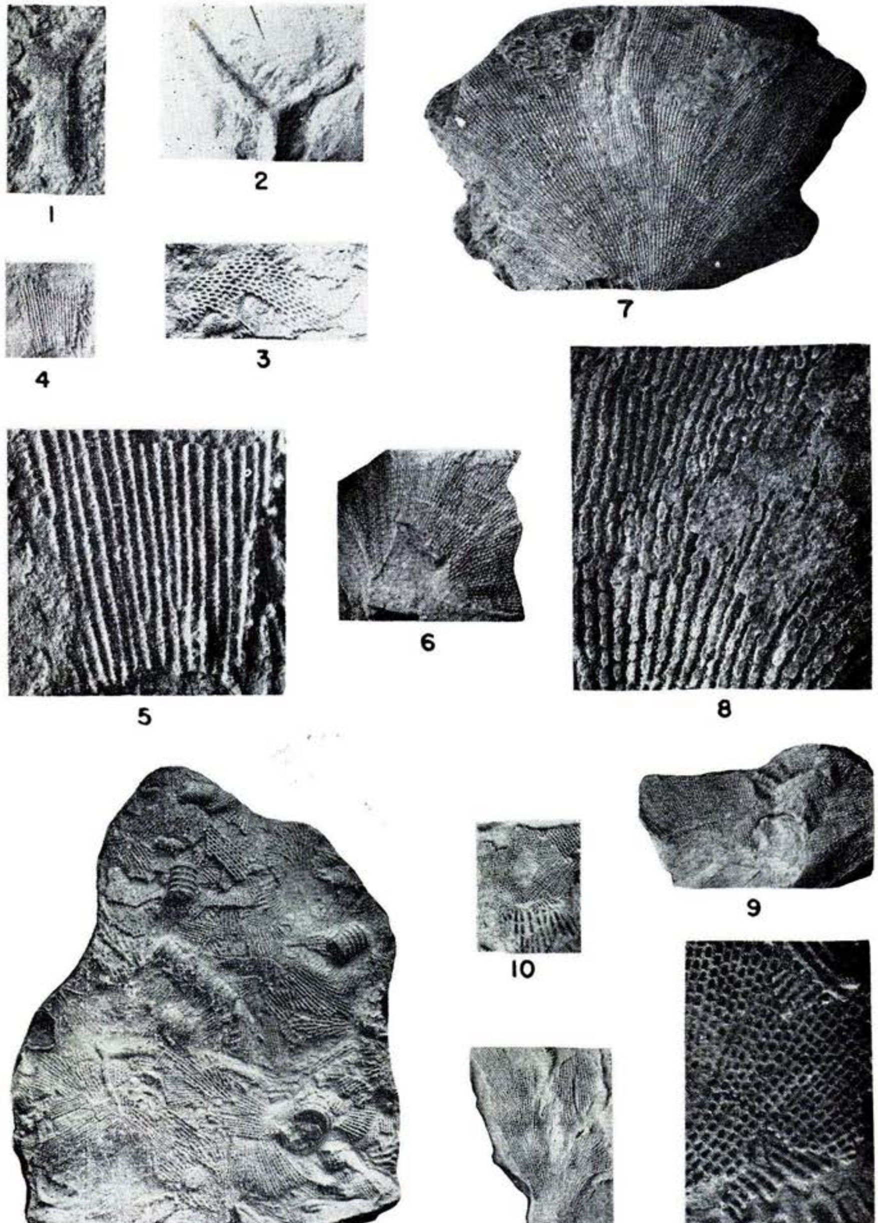
Explanation of Plate 7

Number

1,2. *Lithostrotionella prolifera* (Hall).
1, side and sectional view; 2, calycinal view. "Bangor" limestone, St. Louis horizon. From Virginia Geological Survey Bulletin 52.

3. *Lithostrotionella "canadensis"* (Castelnau).
Calycinal view. "Bangor" limestone, St. Louis horizon. From Virginia Geological Survey Bulletin 52.

4-10. *Girtyella indianensis* (Girty)?
4-7, dorsal and ventral views of two whole specimens; 8-10, dorsal, ventral, and profile views of another specimen. "Bangor" limestone, Gasper horizon. From Virginia Geological Survey Bulletin 52.



Bangor (Restricted)' Fossils

Explanation of Plate 8

Number

1,2. *Prismopora serrulata* Ulrich.
Two poorly preserved specimens but showing the characteristic cross section, and the celluliferous surface very faintly in 1. The triangular cross section is shown at the lower end of the specimen of 2. Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.

3. *Fenestrellina cestriensis* (Ulrich).
Noncelluliferous surface. Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.

4-8. *Fenestrellina serratula* (Ulrich).
4, 5, external molds of the celluliferous surface showing the proximal parts of the matrix filling the cells. 5, part of 4, X 4. 6-8, external molds of the celluliferous surface in shale. 8, part of 7, X 4. Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.

9-12. *Fenestrellina tenax* (Ulrich).
9, also *F. serratula* (right). The difference in the size of the fenestrules in *F. tenax* and *F. serratula* is shown by these figures. 11, part of 10, X 4. A small part of a species with larger fenestra, probably *F. cestriensis*, on lower margin of 10 and 11. Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.

13. Slab with *Fenestrellina*, mostly *F. tenax* and *F. serratula*. Bangor limestone (Restricted). From Virginia Geological Survey Bulletin 52.

MINERAL RESOURCES OF THE PALEOZOIC AREA IN NORTHWEST GEORGIA

By Benjamin Gildersleeve

INTRODUCTION

The first comprehensive account of the economic geology of northwest Georgia appeared in 1893 when J. W. Spencer, State Geologist of Georgia, published his report on *The Paleozoic group: the geology of ten counties of northwestern Georgia.* In this volume Spencer describes the geology, geography, mineral resources, and soils of the same area covered by the present report. His remarks on the importance and purpose of geological investigations are still opportune and are here quoted, in part, as a preface to the following chapter on mineral resources:

> The legitimate work of a survey is to discover and make known the structure of the rock formations and the relations thereto of everything of economic or scientific interest—not alone precious ores, but building materials, supply of water, the character of the soils and everything that can be made useful. In the deposits of useful ores, etc., his duty is not so much to give a catalogue of properties, but of the belts of their occurrence, and how they are related to the rock formations, so that private interests can start where he leaves off and develop the resources with the smallest chance of failure. The work is also educational, so that the student can learn something of the region and extend the knowledge of the science.

The following summary of the mineral resources of northwest Georgia is based largely on field surveys made during the period November 1945 to June 1946 by B. Gildersleeve, J. L. Calver, K. H. Teague, and S. D. Broadhurst, staff members of the Regional Products Research Division, Commerce Department, Tennessee Valley Authority. Other basic information was obtained from published reports by State and Federal surveys.

In this summary data are given for each mineral with respect to geographic location, geologic occurrence, status of development, and, where possible, chemical analyses and estimates of reserves.

Table 1

Mineral production in northwest Georgia in 1944*

MINERAL		TONNAGE (Short tons)	VALUE
Barite		108,851	$929,090
Cement & Lime**		66,065	570,023
Coal		21,250	85,000
Flagstone		4,900	13,250
Iron ore	Crude: Washed:	1,414,990 285,523	687,494
Limestone		379,780	637,305
Manganese	Crude: Washed:	3,106 885	59,855
Ocher		6,216	128,659
Slate (granules)		37,970	244,900

* Georgia Department of Mines, Mining and Geology

** Not at liberty to publish figures of cement and lime separately.

BARITE

Description

Barite, sometimes called barytes, heavy spar, or tiff is one of the heaviest of the non-metallic minerals. It is usually white in color and opaque except on thin edges. The specific gravity varies from 4.3 to 4.6 and the hardness from 2.5 to 3.5. Its composition is barium sulphate—pure barite contains 65.7 percent barium oxide and 34.3 percent sulphur trioxide.

Uses

Barite is used principally as a heavy medium in drilling muds, in the manufacture of lithopone and various paints, in the manufacture of barium chemicals, and as a filler in various products. Among the many products in which it is used as a filler are: rubber, oilcloth, paper, plastics, and resins. Limited quantities are used as extenders and loaders in paint. The most extensive use of lithopone is as a white pigment in paint; however, it is also used in the manufacture of linoleum, textiles, rubber, and other products. Barite is the source of many barium products such as: barium sulphide, Blanc fixe, barium carbonate, barium chloride, barium nitrate, barium dioxide, barium monoxide, etc.

Location of Deposits

Barite is rather widely distributed in northwest Georgia, but the more important deposits are practically limited to the Cartersville district in Bartow County. A small district which has been inactive for many years includes old prospects near Eton, Murray County. Other deposits occur in isolated localities throughout a belt about 75 miles long and up to 25 miles in width, extending from near Ruralvale in Whitfield County, six miles south of the Tennessee-Georgia line, to the vicinity of Esom Hill, Polk County. According to McCallie (see references) the reported occurrence near Esom Hill is doubtfully in Georgia. Localities in this belt listed by McCallie are: (1) near Bass Ferry, eastern Floyd County (not on mineral index map), (2) south of Plainville, northeastern Floyd County, (3) southwest of Stilesboro, southwestern Bartow County, (4) north of Kingston, western Bartow County, (5) north of Plainville, southwestern Gordon County, and near Ruralvale, eastern Whitfield County (not on mineral index map).

Character and Occurrence of Ores

The barite deposits have been classified according to their mode of occurrence as: (1) vein, (2) replacement, (3) breccia, (4) residual, (5) colluvial, and (6) alluvial. The first three occur in hard rock and the last three are found in unconsolidated material. The important barite occurrences in northwest Georgia are residual deposits associated with the Shady dolomite formation of Cambrian age. The principal types of ore are:

1. Crystalline—Generally white to bluish-white in color, coarse to fine texture and translucent on thin edges.
2. Granular—Dull white, fine granular, opaque.

The ore bodies are almost always in zones of shattering or areas of structural disturbances where conditions are favorable for solution and deposition. The larger ore bodies are near the great Cartersville fault and smaller deposits are in proximity to smaller faults.

Production

The production of barite in 1944 from the Cartersville district amounted to 108,851 short tons, valued at $929,090. For this year Georgia ranked second to Missouri in the production of domestic barite.

PRODUCERS

The principal producers of crude barite in the past three years are listed in the following table. Locations of operations active in 1946 are shown on the accompanying mineral resource map.

Table 2

Producers of crude barite

PRODUCER	MAP LOCATION NO.
Barytes Mining Company	11
Dellinger, Brown, and Duckett	10
T. E. Johnsey	15 (Closed in 1944)
New Riverside Ocher Company	14
Paga Mining Company	7 and 10
George E. Shropshire	16
L. A. Wood Company	(Closed 1945)
Thompson-Weinman Company	6
Barium Reduction Company	10

Reserves

Because the important barite occurrences are residual deposits, it is difficult to estimate the reserves which can be mined economically. Insofar as can be judged from operations to date, the reserves are sufficiently great to afford continued production for many years.

References

Furcron, A. S. and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

Hale, D. P., Jr., *Modern mining and beneficiation of barite at Cartersville, Georgia,* Am. Inst. Min. Eng. Tech. Pub. 973, 1938.

Harness, C. L., and Barsigian, F. M., *Barite, witherite, and barium chemicals,* Minerals Yearbook, 1944.

———— *Mining and marketing of barite,* U. S. Bur. Mines Inf. Circ. 7345, 1946.

Hull, J. P. D., *Barytes deposits of Georgia,* Georgia Geol. Survey Bull. 36, 1920.

Kesler, T. L., *Structure and ore deposition at Cartersville, Georgia,* Am. Inst. Min. Eng. Tech. Pub. 1226, 1940.

———— Geologic and topographic maps: Paga No. 1 Barite Mine (Plates 1 and 2), Tucker Hollow Barite Mine, Parrott Barite Mine and Nulsen Barite Mine, Bartow County, Georgia: U. S. G. S., 1945

McCallie, S. W., *Mineral resources of Georgia,* Georgia Geol. Survey Bull. 23, 1926.

BAUXITE

Description

Bauxite is a mixture of several minerals constituting partly consolidated materials which have been formed in place by surface weathering of rocks. It is an earthy ore composed of hydrated alumina. The color may be white, gray, reddish, and yellow. Bauxite occurs as rounded grains or spherical shaped concretions embedded in clay-like material. The specific gravity is low (2.55) and the hardness varies because of its habit of crumbling.

Uses

Bauxite is the chief ore of aluminum; it is also used in the chemical, abrasive, refractory, cement, and oil refining industries.

Location of Deposits

The majority of the bauxite deposits have been found in Bartow and Floyd counties. Only a few widely separated deposits occur in Walker, Chattooga, Gordon and Polk counties. Watson (see references) grouped the principal areas of occurrences into three districts, namely: (1) Hermitage district, Floyd and Bartow counties, (2) Bobo district, Floyd and Polk counties, and (3) Summerville district, Chattooga and Walker counties. The numerous workings (now abandoned) in these districts are described in detail by Watson and need not be listed here; however, the areas included in the districts may be summarized as follows:

HERMITAGE DISTRICT

This district comprises an area of more than 50 square miles, lying between Rome, Floyd County, Kingston and Adairsville, Bartow County, east of the Oostanaula River and north of the Etowah River. It includes the adjacent northeastern and northwestern portions, respectively of Floyd and Bartow counties. The greatest concentration of deposits is in the vicinity of Hermitage, Floyd County.

BOBO DISTRICT

This district includes that portion of Floyd County underlain by the Knox dolomite formation (see Geologic Map) which is south of the Etowah River and east of the Southern Railway, together with the extreme north central portion of Polk County (north of Lake Creek).

SUMMERVILLE DISTRICT

This district is less well-defined than the Hermitage and Bobo districts. It includes three deposits near Summerville and one near Trion in Chattooga County and one deposit near Harrisburg in the southern part of Walker County.

OTHER LOCALITIES

There are several isolated deposits concerning which little information is available. The locations of two such occurrences given by Watson are as follows: Calhoun district—Bailey bank, located approximately one mile northeast of Calhoun, Gordon County; and the Martin property, about five miles southwest of Kingston and three miles southwest of the Etowah River, Bartow County.

Character and Occurrence of Ores

The bauxite in northwest Georgia varies considerably with respect to color, hardness, structure, and chemical composition. The ores have been classified into five types according to structure, namely: (1) Pebble ore; (2) pisolitic ore; (3) oolitic ore; (4) vesicular ore; and (5) amorphous ore.

In all of these types the color varies from white and cream to various shades of pink and deep red. On the basis of color the ore is classified as non-ferruginous white to cream colored bauxite, and ferruginous red colored bauxite. Among the minerals most commonly associated with the bauxite are halloysite, kaolin, and gibbsite.

Most of the bauxite deposits occur as compact ore bodies in the form of well-defined pockets associated with residual clays of the Knox dolomite formation. They are found in all parts of this formation and are not confined to any definite or particular horizon. Usually the vertical and horizontal dimensions are nearly equal. However, the nature of the ore bodies indicates they are surface, pocket deposits which are not very extensive in depth. They are grouped, or occur about certain centers and along apparent lines of weakness. In contradistinction to the bauxite occurrences in the Hermitage district which are frequently grouped about certain centers, the deposits in the Bobo district apparently lie along north and south lines coincident with parallel faults between the Conasauga and Knox formations. The ore bodies are free from inclusions of residual material and there are no gradations from bauxitic clay into the enclosing residual clay. They are, however, somewhat closely associated with iron and manganese deposits. The majority of these deposits are at altitudes of 900 to 950 feet.

The ore formerly mined in northwest Georgia varied considerably in chemical composition as indicated in the following table.

Table 3

*Analyses (Ranges in composition) of northwest Georgia bauxites**

District	I	II	III
Al_2O_3	46.72 to 67.53	51.14 to 62.68	57.56 to 75.03
Fe_2O_3	None to 11.17	0.36 to 13.86	0.65 to 2.40
TiO_2	Trace to 9.04	2.08 to 5.05	0.96 to 4.40
SiO_2	0.79 to 21.47	1.30 to 19.56	0.80 to 3.35
Water	23.33 to 33.27	24.21 to 32.70	19.00 to 35.00

I Hermitage District. 60 analyses.
II Bobo District. 14 analyses.
III Summerville District. 5 analyses.

Production

In 1887 the first bauxite discovered in America was found about two miles east of Hermitage, Floyd County. Mining operations began the following year and until 1909 all of the Georgia production came from the northwest counties. Many of the mines in northwest Georgia were abandoned not long after the discovery (1907-1915) of deposits in the Coastal Plain and Piedmont areas of the State. For example, the mines with extensive workings near Adairsville, Bartow County (Map Nos. 38 and 40) and south of Rome, Floyd County (Map No. 78) were abandoned about 1920. The Hermitage area (Map No. 41) was last worked about 1926. In recent years almost the entire

*Compiled from data in Ga. Geol. Surv. Bull. 11. See references.

State production has come from deposits in the Coastal Plain, principally in Sumter and Wilkinson counties. Deposits five miles east of Cave Springs, Floyd County (Map No. 74) were worked for two years (abandoned March 1946).

Reserves

No estimates are available of possible and/or probable bauxite reserves in northwest Georgia. Because of the irregular and disconnected pockety forms of the ore bodies which grade into the enclosing structureless clay, it is almost impossible to appraise, with any degree of certainty, tonnages of mineable ore. Many of the deposits formerly worked appear to be mostly exhausted. The areas covered by the districts described above are large and no doubt there may be concealed deposits which might be brought into production in the future, should the demand or depletion of other sources warrant the expense of detailed exploration.

References

Furcron, A. S., and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

McCallie, S. W., *Mineral resources of Georgia,* Georgia Geol. Survey Bull. 23, 1926.

Thoenen, J. R. and Burchard, E. F., *Bauxite resources of the United States,* U. S. Bur. Mines Rept. Inv. 3598, 1941.

Watson, T. L., *Bauxite deposits of Georgia,* Georgia Geol. Survey Bull. 11, 1904.

BENTONITE

Description

Bentonite is a clay-like substance derived from the weathering or alteration of volcanic ash. It is composed essentially of clay minerals of the montmorillonite family and usually contains some beidellite. These deposits occur in highly folded rocks, thus are more properly referred to as metabentonites.

Uses

Bentonites may have different properties, such as variation in color, colloid content, etc., both in different localities and in different parts of the same deposit. In addition, they usually contain some objectional impurities, such as sand, which must be removed to make them usable. Variations in the nature and purity of bentonite, therefore, are of great importance in determining its usability. Among the many purposes for which bentonite has been used and for which its use has been suggested are: decolorizing vegetable and mineral oils; as an ingredient of molding sands and in oil well drilling mud; in ceramic products, soaps, detergents, portland cement, lubricating greases, refractories, paints, water softeners, dentifrices, cosmetics, drugs, pharmaceuticals, stove polish, de-inking news print, sealing agents, soil fixatives and fertilizers, dye fixatives, fabric waterproofing, and a multitude of other uses.

Location of Deposits

The bentonites are restricted to the narrow belts of limestones of Ordovician age and are best seen along the flanks of Lookout Mountain, Pigeon Mountain, Missionary Ridge, Taylor Ridge, and at the northwest end of Dirtseller Mountain. Detailed descriptions of various localities, together with chemical analyses, are given by Bay and Smith (see references). Representative occurrences may be summarized as follows:

Dade County—Two horizons of bentonite are exposed along a county road about 1600 feet west of U. S. Highway 11 near the southern city limits of Trenton. The lower (stratigraphically) bed is about 18 inches thick and the upper bed from 15 to 20 feet thick. The unusual thickness of the upper bed in this locality is probably due to squeezing. The character of bentonite at this locality is given under analysis No. 2 in the following table. The same horizons also are exposed along U. S. Highway 11, two miles north of Trenton.

An occurrence of bentonite is reported by Bay and Smith (see references) as a 2½ foot bed in a road cut adjoining the Wesley Forrester property, one mile south of Rising Fawn furnace and one-half mile south of Cave Creek Church. Analysis No. 1 in the following table represents a "groove" sample from this deposit.

Catoosa County—Two bentonite beds, each averaging about three feet in thickness, are exposed along U. S. Highway 27, one mile south of Chickamauga National Park. These beds are correlated with the two horizons previously described near Trenton, Dade County.

Walker County—Detailed descriptions of localities in the vicinities of High Point station, Coopers Heights, Cassandra, and Cedar Grove are given by Bay and Smith and need not be repeated here (see references). For chemical analyses see localities 3, 4, and 5 in the following table.

Chattooga County—The lower bentonite horizon of the Trenton (Dade County) area outcrops along the east flank of Pigeon Mountain just south of Harrisburg (Walker County). At this locality the bed has a thickness, according to Bay and Munyan (see references), of eight feet. The same horizon, presumably, occurs at the northwest end of Dirtseller Mountain, three miles west of Lyerly. See analyses 6 and 7 in the following table.

Table 4

*Analyses of bentonite from northwest Georgia**

LOCALITY	1	2	3	4	5	6	7
Ign. loss	12.61	8.51	5.80	4.70	6.06	6.03	5.48
Na_2O	1.37	2.24	0.82	0.91	3.09	0.78	0.57
K_2O	1.42	2.46	1.94	1.68	1.96	6.99	3.72
CaO	7.59	4.31	0.14	0.16	0.37	trace	0.00
MgO	trace	trace	0.27	0.26	0.04	3.24	1.20
Al_2O_3	15.45	18.75	21.80	14.84	27.93	23.42	28.00
Fe_2O_3	1.94	3.46	7.04	4.98	4.97	2.67	1.66
TiO_2	0.27	0.28	0.74	0.73	0.74	0.37	0.72
SO_3	0.00	0.00	0.00	0.00	trace	——	0.00
P_2O_5	0.12	0.07	trace	1.04	0.14	——	trace
SiO_2	59.77	57.01	61.52	70.57	54.69	53.08	53.72

Localities on next page.

1. Johnsons Crook, Dade County.
2. White Oak Gap Road, one-half mile west of Trenton, Dade County.
3. One and one-half miles north of High Point Station, Walker County.
4. One-half mile west of Coopers Heights Station, Walker County.
5. One-half mile north of Cassandra, Walker County.

6 and 7. Foot of Dirtseller Mountain, 3 miles west of Lyerly, Chattooga county.

*Compiled from "Shales and Brick Clays of Georgia," Ga. Geol. Surv. Bull. 45, 1931.

Character and Occurrence of Deposits

The bentonites occur in beds ranging from a few inches up to several feet in thickness in limestones of Ordovician age. The most persistent horizons are the upper Lowville and basal Trenton. The thickest and most easily distinguished horizons in the field occur in the Trenton formation. They are two in number and are separated by thin shaly limestones approximately 25 feet thick. Of these the thicker, lower horizon is immediately above the base of the Trenton. In places the beds are repeated by folding so that it is difficult to measure their true thickness accurately. The lower bed has coarse phases and is plastic. It is usually bluish-green in color and is underlain by two or three inches of green-gray chert. This chert layer is dense, fossiliferous, ripple marked, and iron stained. The upper bed is micaceous or fibrous and more often yellowish-white than green in color. It is generally underlain by, or associated with, a thin chert layer. This chert layer differs from the one associated with the lower bentonite bed in that it is less than one inch thick, is unfossiliferous, un-ripple marked, and is gray in color.

Possibilities for Development

The most desirable localities which could be developed are in areas where the dip of the strata is low, or corresponds to the topography, so that strip mining methods may be employed, and also in areas that contain abnormal thickness of bentonite due to repetition of the beds by folding. Some of the more likely areas suggested for mining are:

1. Catoosa County—South of Chickamauga and Chattanooga National Military Park, beginning about 2¾ miles east of Chickamauga and continuing southward along the strike of the strata.

2. Walker County—Along the west base of Missionary Ridge south of Rossville.

3. Dade County—Near the southern city limits of Trenton and west of U. S. Highway 11 along the strike of the beds. There may be other desirable areas in this belt of Ordovician formations. (Oml on geologic map.)

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CEMENT

Raw Materials

Ordinary portland cement is made from relatively pure limestone and clay or shale; if the limestone is clayey, less shale is used. The usual mix contains about 75 percent lime carbonate and the remainder largely free silica and aluminum silicate. However, for making certain types of cement the constituents are mixed in other proportions. Cement rock (also called natural cement rock) is an argillaceous limestone containing lime, silica, and alumina, and usually magnesia in varying proportions which is used in the manufacture of natural cement.

Uses

Portland and natural cements are used for a great many purposes in so many different kinds of buildings and constructions that no attempt is made here to enumerate them. Portland cement is used in mammoth construction work where great strength and soundness are required, in various types of heavy masonry, as a paving material, etc. Natural cement is used as a mortar or "masonry" cement in construction.

Location of Raw Materials

Limestones and shales suitable for the manufacture of portland cement are of widespread occurrence in the Paleozoic area. In the vicinity of Rockmart and at Portland (Davitte), Polk County, the Newala limestone of Ordovician age and the Rockmart shales and slates of Mississippian age have been used in the manufacture of portland cement. Natural cement formerly was made from limestone of the Conasauga formation according to McCallie (Knox dolomite according to Maynard) at Cement, Linwood, and Kingston (?) in Bartow County, and from Chickamauga limestone (Lowville-Moccasin ?) at Rossville in Walker County. Individual localities of limestone and shale deposits are described by Maynard in Bulletin 27 of the Georgia Geological Survey and will not be listed here.

Production

Manufacture of natural cement in this area began as early as 1851, and continued for a period of over 70 years. The manufacture of portland cement began in 1903 at Rockmart, Polk County, and has continued since that date.

Reserves

The reserves of limestones and shales suitable for the manufacture of Portland cement are practically inexhaustible.

References

Furcron, A. S., and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

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CLAY

General Statement

The clay resources of the Paleozoic area of Georgia have been described in detail by Veatch, Smith, and others (see references). There are various classifications of clay according to origin, chemical and physical properties, and uses. Clays of various kinds are mixed or blended for use in making ceramic products. In the following review no attempt is made to conform to any particular classification and nomenclature in describing the principal types.

Residual Clays

These clays were formed in place from the decay of preexisting rocks, principally limestones and shales. In northwest Georgia the residual clays are of considerable extent and occur in large quantities but are, for the most part, of a ferruginous character. They are best suited to common and face brick manufacture, but have been utilized very little in recent years.

A strong bonding clay is generally required in utilizing the residual clays of the Knox dolomite formation which possess poor plasticity and strength. The Knox residual clays are highly siliceous and contain some chert fragments which make possible their use at some localities for fire brick. Pressed brick and fire brick were made from such residual clays at a plant (now abandoned) located at Mission Ridge, Walker County. Two miles north of Aragon, Polk County (Map No. 46) a clay deposit was worked for about nine years for use in making tile and as an ingredient in wall plaster.

Clays which are the weathered products of shales are common in the region but, as a rule, are not sufficiently pure to be marketed separately from the shales from which they are derived. Residual clay derived from shale was once used for common brick at Adairsville, Bartow County; at Calhoun, Gordon County; and for stoneware pottery at Lafayette, Walker County.

Alluvial and Colluvial Clays

Alluvial clays are those deposited by flowing water. Colluvial clays represent deposits formed by wash from residual clays.

Alluvial clays suitable for use in the manufacture of common clay products are found along the larger streams. They were once used for making sewer pipe, drain pipe, and wall coping in a plant located at Blowing Springs, Walker County, and for common brick at Chatsworth, Murray County. For a number of years these clays have been utilized for making common brick and roofing tile in plants at Rome, Floyd County, and for common brick at Cartersville, Bartow County. Colluvial clay was once shipped in small quantities from a deposit near Cedar Grove in McLamore Cove, Walker County. The manufacture of roofing tile from a deposit of colluvial clay at Adairsville, Bartow County, was begun in 1926. This operation has been abandoned for a number of years.

Shales

Very large deposits of shales (hardened clays) occur at many horizons throughout the region. When properly handled they are suitable for use in the manufacturing of any of the common heavy clay products, such as building brick, fire brick, sewer pipe, earthenware, structural and roofing tiles.

The principal shales best suited for clay products include those in the Rome and Conasauga (Cambrian), Red Mountain (Silurian), Floyd and Rockmart (Mississippian) formations.

In general the shales are siliceous, deficient in plasticity, have poor slacking properties, low air-dry strength, burn to a hard body at low temperatures, and have low vitrifying points. Some of the methods employed in making such shales more adaptable are: fine grinding, long pugging, use of hot tempering water,* and certain electrolytes in the tempering water.

Kaolin

Kaolin, also sometimes called china clay or porcelain clay, is a clay composed mainly of hydrous aluminum silicate.

Some of the clays associated with the bauxite deposits in Floyd, Bartow, Polk, and Chattooga counties approach kaolins in chemical composition. These clays occur as small, scattered, pocket deposits which are more or less circular in form; and as large, irregular-shaped masses enclosing small bauxite bodies.

*Mixing of water with clay to develop plasticity is called "tempering".

The clays are variously colored (white, mottled, pink, yellow, red) depending upon the amount and distribution of iron oxides. For the greater part of these clays the plasticity, air-dried tensile strength, and air shrinkage are all low. These clays are highly refractory, but crack badly when burned alone as the fire shrinkage is high. Consequently, it would be necessary to calcine them before use in making refractories.

According to Veatch (see references) most of the deposits are near Rome and Cave Springs, Floyd County. Other localities are in the southern part of Floyd County and adjacent part of Polk County, in Bartow County near Barnsley and Adairsville, and in Chattooga County near Summerville.

Caen Stone

In places the Rockmart slate weathers into a banded, indurated clay with ligneous structure once known locally as "Caen stone." It was probably so-named because it can be sawed or turned into ornaments in a similar fashion to the famous limestone from Caen, France, which is used for carved archi-tectual work. Because of its lack of plasticity and low tensile strength this clay, apparently, is of little ceramic value unless mixed with other clays and even so has no inherent properties of special importance.

Production

Statistics are not available for the production during recent years of clay and clay products in northwest Georgia which include brick plants at Dalton, Whitfield County, and Plainville, Gordon County; a plant making sewer tile, building tile and roofing tile at Milledgeville, Baldwin County, and an art pottery at Cartersville, Bartow County.

Reserves

The potential reserves of clays and shales suitable for making heavy clay products are unlimited. Deposits of kaolin-like clays are small and less widely distributed in their occurrence.

Possibilities for New Developments

At the present time it appears that capacities of existing plants for the manufacture of heavy clay products exceed market demands. Any new developments in this industry should be directed towards expanding the market and the lowering of production costs. It is not a business to be undertaken by the amateur without technical or experienced assistance.

This statement is applicable to both the mining of crude clay for shipment and the manufacture of clay wares. It is believed that some of the shales in northwest Georgia are suitable for the manufacture of light-weight concrete aggregate and that a ready market could be developed for such a product. The possibilities of utilizing the shales of the region for this purpose are described under "Light-Weight Aggregate" (see page 124).

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COAL

Description

Coal is a carbonaceous substance derived from vegetable matter through geological processes. Successive stages in the formation of coal from the lowest to the highest ranks are: vegetation, peat, lignite, bituminous, anthracite, graphite. The main chemical changes which take place involve chiefly the loss of moisture and volatile constituents (oxygen, hydrogen, etc.) and increase in the proportions of fixed carbon and ash. The physical changes which take place are chiefly a darkening in color, increased compaction, increased hardness and changes in fracture or character of broken surfaces. There is often considerable variation in chemical and physical properties within individual ranks of coals and, so far, a completely satisfactory classification has not been devised.

Uses

Bituminous coal is the greatest source of energy for general industrial and domestic purposes. The major uses include: locomotive fuel, beehive and by-product coke, electrical utilities, steel and rolling mills, cement mills, gas manufacture, collier fuel, various other domestic and industrial uses.

Location of Deposits

The coal deposits are limited to Lookout, Sand, and Pigeon mountains in Dade, Walker, and Chattooga counties. In Dade County the deposits occur on the northern portion of Sand Mountain and the western part of Lookout Mountain. In Walker County the deposits are found on Pigeon Mountain and the eastern part of Lookout Mountain, the most important occurrences being on an elevation of Lookout Mountain known as Round Mountain. In Chattooga County the deposits are confined to a small area on the western part of Lookout Mountain in the extreme northwest corner of the county. The total coal area is approximately 170 square miles.

Character and Occurrence of Coal Beds

The Georgia coal fields are a part of the Appalachian coal-bearing region and are co-extensive with outliers of the Cumberland Plateau which is so prominently developed in the adjoining states of Tennessee and Alabama. The coals are of the bituminous type and occur in the Pottsville series of the Pennsylvanian system. This series is composed of a great accumulation of alternating sandstones, shales, conglomerates, coal beds, and underclays which, in northwest Georgia, approximates 1,500 feet in thickness. A dozen or more beds of coal have been recognized in this area, but only about six beds have been worked commercially.

The regional structure of the coal fields, with few exceptions, is relatively simple. The Pennsylvanian and underlying strata, which were laid down as horizontal beds, have been changed by vertical uplift and lateral compression into a number of large anticlines (up-bending arches) and synclines (down-bending troughs). Subsequent erosion has been most active along the axes of the up-bended folds, resulting in the formation of the present valleys which now occupy areas that are structurally anticlines. By the same token the complimentary folds or synclines are now represented physiographically by mountains. Lookout Mountain, Sand Mountain, and Pigeon Mountain in which the coal fields occur are such synclinal structures. The structure of the region is important because it has a direct bearing on the character and preservation of the coal beds and problems involved in mining them.

In 1945 investigations of the coal deposits of Sand and Lookout Mountains were made by the United States Geological Survey (detailed geologic mapping), the United States Bureau of Mines and Georgia Power Company (diamond drilling). The results of this work were published in August, 1946, by the United States Geological Survey as *Coal deposits on Sand and Lookout Mountains, Dade and Walker Counties, Georgia—Preliminary map* by V. H. Johnson. Printed on a single sheet are: (1) a geologic map showing coal outcrops, mines, prospects and locations of diamond-drill holes; (2) sections of drill holes; (3) tabulated data on coal exposures; (4) chemical analyses; (5) estimated coal reserves; and (6) a short text describing the stratigraphy of the area.

SAND MOUNTAIN COAL AREA, DADE COUNTY

This area occupies the extreme northwest corner of Dade County. It lies between Marion County, Tennessee, on the north and Jackson County, Alabama, on the west.

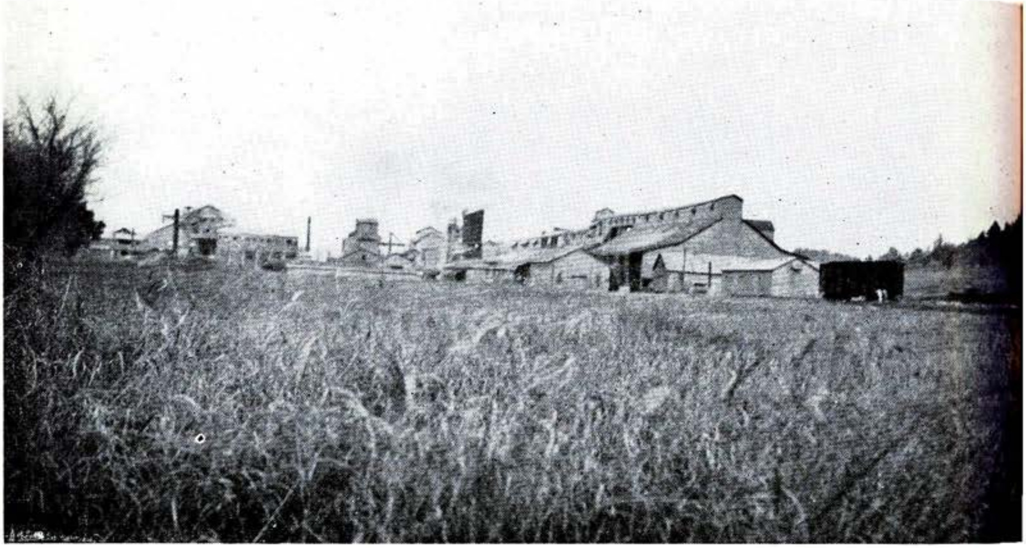

Fig. 6. Portland cement plant at Rockmart, Polk County, Georgia.

Fig. 7. Limestone quarry at cement plant shown above.

There are a number of recognized coal beds in this locality, but only three have been worked on a commercial scale. They are, in ascending order, the Rattlesnake, Dade, and Etna.

Rattlesnake Bed—The Rattlesnake is a double coal bed with a sandstone top and shale bottom. It is best displayed in the area east of Cole City. The total thickness of coal averages about 56 inches at the Ferndale Mine, but the character of the sandstone top is such that the bed may vary rapidly in thickness in comparatively short distances. The coal is essentially the same on both sides of the middleman which varies from 2 to 20 inches in thickness. According to chemical analysis, this is a medium bituminous coal.

The Rattlesnake bed was worked at the Ferndale and Rattlesnake mines and at numerous smaller openings.

Dade Bed—The Dade coal bed has its greatest development in the area east and southeast of Cole City. Although quite variable in thickness, the Dade coal is more extensive or persistent than the underlying coal beds. In the area southeast of Cole City, the Dade bed has an average thickness of 36 to 40 inches. It has a sound shale top and smooth shale bottom. The bottom few inches of coal are usually rashy and, in most places, there is a one inch fire clay parting near the middle of the bed. Throughout most of the area of its occurrence, the coal in the Dade bed has been crushed by earth movements and the weight of overlying strata. The size of the coal produced depends largely upon the degree of crushing which the bed has received, and for this reason it is variable for the various localities mined. The Dade is a medium volatile bituminous coal.

For a number of years the Dade bed was the largest producer of coal in Georgia. This production came from the Dade, Slope, Ferndale, Tatum, and other mines in the vicinity of Cole City.

Etna Bed—The Etna coal bed is best developed in the vicinity of Nickajack Cove, northwestern Dade County. This is one of the most persistent coal beds in the area and usually outcrops near the bluff line. It averages about 24 inches; however, in local areas it may either attain a thickness of four feet, or narrow to only a few inches. These abnormal thicknesses are occasioned by folds or squeezes in the enclosing strata, by repetition due to faulting, and by natural thick deposits of coal in small basins. This is always a uniformly clean coal bed delimited by a smooth, hard sandstone top. The Etna is a medium volatile bituminous coal, and is reported to have long been used for making high-grade coke.

In 1939 there were several truck mines working the Etna bed. Of these the Pat O'Brien, Murphy, Green, and Shirley were the most active. The Castle Rock Mine, located southwest of Cole City, is reported to have been worked out. The Etna coal bed was worked for some time at the now abandoned Raccoon Mine north of Cole City.

DURHAM COAL AREA, DADE AND WALKER COUNTIES

The Durham area, located on the Round Mountain portion of Lookout Mountain, is situated partly in Dade County and partly in Walker County. The most valuable coal beds are those in the vicinity of Durham mines, located on Round Mountain about 15 miles southwest of Chattanooga, Tennessee. This mountain, as the name suggests, is somewhat circular in outline, measuring approximately five miles in circumference.

There are three workable coal beds about 150 feet apart in elevation in the Durham area. These beds outcrop in an irregular circular pattern with the bottom bed underlying the largest area, and the top bed underlying the smallest and most irregular area. All of the beds dip at an agle of about six degrees toward the center of the mountain and, therefore, they lie in the form of a basin, the lowest portions being near the Central of Georgia Railway at the Durham Station. The workable beds, in ascending order, are:

No. 4 Bed—The average thickness of this bed varies from 22 inches on the east to 29 inches on the west side of Round Mountain. It has a hard shale top from which the coal readily breaks free. Over a part of the area now mined there is a stratum of carbonaceous fire clay approximately one inch thick above the bed which comes down when the coal is shot, thus making it difficult to mine clean coal. The top is sufficiently sound to permit mining with a minimum amount of timbering. As shown by chemical analysis, this is a low volatile bituminous coal of low ash and sulphur content, and B.t.u. in excess of 14,000.

No. 5 or Durham Bed—About 165 feet above the No. 4 bed is the No. 5 bed or Durham bed which averages 28 inches of top coal, 17 inches of parting or "middleman," and 24 inches of bottom coal. The greatest elevations of the outcrop are on the east and west sides of the mountain at points directly opposite each other and about 100 feet above the lowest outcrops of the bed at the entrance to the mines at Durham Station. The character of the coal is about the same on both sides of the slate parting. Chemical analyses show this to be a low volatile bituminous coal.

"A" Bed—Approximately 100 feet above the No. 5 or Durham bed is the "A" bed which, in places, attains a thickness of 33 inches, averages about 24 inches. It underlies a smaller area than any of the other beds. Most of this coal is still intact, as only a few mines have been opened on this bed and the production from it has been small. According to chemical analysis, this bituminous coal is higher in ash and lower in heat value than the other coals in the Durham area.

COAL AREA IN CHATTOOGA COUNTY

The coal deposits are confined to a small area in the northwest corner of this county, near the Georgia-Alabama line. They occur as thin, irregular beds and in pockets along the eastern brow of Lookout Mountain. Thicknesses of from 10 to 18 inches are reported in prospect openings. As yet the deposits have not been mined.

Coal Analyses

The identifications of coal beds given in the following analyses are based partly upon comparisons of measured sections, partly upon field traverses along outcrops, partly upon previous investigations, and to some extent upon similarities of physical and chemical characteristics.

The mine and outcrop samples were collected in cooperation with and analyzed by the United States Bureau of Mines.

Table 5

*Analyses of northwest Georgia coals**

Location and Description of Sample	Laboratory Number	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur a/	Air-dry Loss	British Thermal Units	Softening temp. of ash (°F.)
DADE COUNTY									
Small drift mine. Bed: Durham #5. Sample from north outcrop. Coal 52 inches. Parting 17 inches.	B-42736	2.7	20.4	73.0	3.9	0.9	2.1	14640	2470
Abandoned drift on "A" bed. Right rib 150 feet in on west outcrop of "A" bed. Coal 30 inches. Rashy coal 3 inches.	B-42737	3.4	19.1	60.5	17.0	1.6	2.6	12270	2850
Pit D-3. Bed: Dade (?) 30 feet in old test pit. Coal 39 inches. Parting 1 inch.	B-43051	3.2	23.4	60.6	12.8	0.5	2.0	12880	2880
Shirley mine (Old Dade). Bed: Dade. About 50 feet in on right rib. Coal 47 inches.	B-43048	2.8	23.2	60.6	13.4	0.4	1.7	12830	2890
Green mine. Bed: Dade (?) About 15 feet on left rib in new Opening. Coal 28 inches.	B-43049	3.2	25.4	65.4	6.0	1.4	2.4	14230	2170
Ferndale mine. Bed: Rattlesnake. About 200 feet in on left rib. Lower bed. Coal 36 inches. Partings 20½ inches.	B-43047	4.4	23.2	63.1	9.3	0.9	3.1	13240	2750
Murphy mine. Bed: Etna. About 200 feet in on right rib. Coal 23 inches.	B-43093	2.9	26.8	63.4	6.9	3.2	2.0	14030	2130

* All samples collected and analyzed by U. S. Bureau of Mines.

a/Ultimate analysis of sulphur in sample as received, other figures are proximate analysis of sample as received.

Table 5 (continued)

*Analyses of northwest Georgia coals**

Location and Description of Sample	Laboratory Number	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur a/	Air-dry Loss	British Thermal Units	Softening temp. of ash (°F.)
DADE COUNTY (Continued) Tatum Gulch mine. Bed: Dade. About 500 feet in from old air Shaft. Coal 46 inches. Parting 1 inch.	B-43050	3.3	23.9	59.3	13.5	0.9	2.1	12710	2890
Old Pat O'Brien (Wagon) mine. Bed: Etna. 200 feet north 20 feet west on left rib of heading. Coal 24½ inches.	B-42853	3.5	27.2	64.0	5.3	1.0	2.4	14250	2280
Test Pit. Bed: Red Ash (?) 6 feet in test pit on left rib. Coal 20 inches.	B-42854	4.8	26.5	63.9	4.8	1.5	3.3	13930	2030
WALKER COUNTY Durham Mine. Bed: Durham #5. Lower bench. 160 feet west on right rib of 1st right heading in drift on east outcrop. Coal 29 inches.	B-42731	3.1	19.1	68.3	9.5	0.8	2.4	13660	2840
Durham Mine. Bed: Durham #5. Upper bench, 160 feet west on right rib of 1st right heading in drift on east outcrop. Coal 21 inches. Parting 9 inches.	B-42730	3.1	19.7	72.5	4.7	1.5	2.4	14500	2190
Durham Mine. Bed: Durham #4. 750 feet west on main heading and 1000 feet south on 3rd left on right rib. Coal 20½ inches.	B-42728	3.2	19.7	73.2	3.9	0.7	2.4	14560	2470

* All samples collected and analyzed by U. S. Bureau of Mines.

a/Ultimate analysis of sulphur in sample as received, other figures are proximate analysis of sample as received.

Table 5 (continued)

*Analyses of northwest Georgia coals**

Location and Description of Sample	Laboratory Number	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur a/	Air-dry Loss	British Thermal Units	Softening temp. of ash (°F.)
WALKER COUNTY (Continued) Durham Mine. Bed: Durham #4. 600 feet west at side track on left rib of main heading. Coal 20 inches.	B-42727	2.9	19.8	72.9	4.4	0.6	2.1	14570	2400
Durham Mine. Bed: Durham #4. Star Grass Drift, north 49° west 180 feet and 75 feet to right on left rib of 1st heading right. Coal 19 inches.	B-42726	3.4	20.3	73.7	2.6	0.6	2.7	14770	2310
Small Drift. (Truck mine) Bed: Durham #4. (?) 100 feet in on left rib. South outcrop. Coal 30¾ inches. Partings 10¾ inches.	B-42734	4.4	18.7	66.5	10.4	1.1	3.5	13210	2600
Test pit on main road southeast side of Lookout Mountain. Bed: Sewanee (?) Coal 24 inches. Bone coal and rash 15 inches.	B-42735	2.6	20.7	54.4	22.3	1.2	1.9	11520	2690

* All samples collected and analyzed by U. S. Bureau of Mines.

a/Ultimate analysis of sulphur in sample as received, other figures are proximate analysis of sample as received.

Production

Coal mining in northwest Georgia antedates the Civil War. Prior to 1891 all of the production came from Dade County. Active mining operations began on Round Mountain, Walker County, in 1891 and the mines near Durham are the only ones which have remained in continuous production since this date. Coke ovens were formerly operated at Chickamauga, Walker County, and at Cole City and Rising Fawn, Dade County. A maximum annual coal production of 416,000 net tons was attained in 1903. Production has declined greatly since this date and for the past 25 years has been confined, for the most part, to the Durham area. In addition to the underground workings which furnish the main production in this area, a strip mine is in operation on Lookout Mountain about 11 miles southwest of Point Lookout in Tennessee. Here the "A" coal bed is being worked by contour stripping methods. The overburden consists of soft shale and ranges from 10 to 20 feet in thickness, averaging 15 feet. The coal bed varies from 2 to 2½ feet in thickness and it is estimated that the daily production is 200 tons.

The latest available statistics show that in 1942 the production amounted to 31,000 tons and in 1944 it was 21,250 short tons valued at $85,000. Curtailment of production since the peak period of 1891-1903 has been attributed to high operational costs of mining thin beds and beds subject to variations in thickness and, to some extent, depletion of the more workable deposits.

Reserves

The following reserves are presented as conservative estimates and, as such, are subject to revision.

Area and Coal Bed	Average thickness in inches	Acreage underlain by bed	Percent of Area worked out	Percent of Area unworkable
Sand Mountain Area				
Etna	24	1380	10	25
Dade	40	13800	20	20
Rattlesnake	36	13800	15	30
Durham Area				
"A"	32	670	5	20
No. 5	38	1500	70	15
No. 4	24	7700	1	15

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FLUORITE

Description

Fluorite, calcium fluoride, occurs in a variety of colors as cleavable masses and in crystal form as cubes.

Location of Deposits

Cubes of purple-colored fluorite associated with barite, galena and calcite occur in Knox dolomite at an abandoned quarry located 1½ miles southeast of Graysville, Catoosa County. The fluorite and associated minerals are in a brecciated zone about five feet thick. An unsuccessful attempt was made 15 years ago to find a workable deposit and the exploratory shaft was abandoned at a depth of 20 feet.

Green fluorite is reported to occur near Ranger, Gordon County. The deposits are small and, insofar as known, have not been explored.

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HALLOYSITE

Description

Halloysite is a massive, clay-like, earthy material which breaks with a conchoidal fracture and usually resembles unglazed porcelain. It is translucent to opaque, has a pearly to waxy luster, and in color may be white, grayish, greenish, yellowish, bluish, or reddish. It is one of five clay minerals in the kaolin group and has the same chemical composition, $Al_2Si_2O_5(OH)_4$, as kaolinite, dickite, and nacrite. Endellite, the more highly hydrated mineral of the group, has the composition $Al_2Si_2O_5(OH)_8$. The names, nature and origin of these minerals, commonly included under the name of kaolin, have been the subject of much controversy. For many years the identification of clay minerals was based on chemical methods. Conflicting results obtained by different investigators were due, in large measure, to the lack of reliable criteria for differentiating species. In recent years new and improved methods (optical, X-ray, chemical, thermal) of studying the mineralogy of clays have been perfected which permit the differentiation of species and establishment of criteria for their recognition.

Uses

According to Watkins (see references), the production from near Gore, Chattooga County, was used for the purpose of manufacturing aluminum sulphate—each ton of halloysite, upon treatment, yielding approximately 2½ tons of alum.

Most of the halloysite observed in the old workings is badly stained by iron and manganese. These impurities would affect adversely the color and translucency of fired wares. Although a relatively pure material can be obtained by acid leaching, halloysite so treated loses most of its plasticity. The utility of this halloysite as a ceramic material would, therefore, be more or less restricted to products in which color and translucency are not important.

Location of Deposits

The better known occurrences of halloysite in northwest Georgia, and the only ones ever worked, are in the vicinity of Rising Fawn, Dade County, and near Gore, Chattooga County.

Character and Occurrence of Deposits

CHATTOOGA COUNTY

The largest and most extensively mined halloysite deposit examined during the field investigations occurs along the lower slopes of Taylor Ridge, six miles north of Gore. Heretofore, this deposit has been reported as being in or at the base of the Fort Payne formation.

Field investigations made preparatory to compiling this report show that the halloysite at this locality occurs as a bedded deposit in the Armuchee chert formation at a horizon which is at least 25 feet stratigraphically below the Fort Payne. The following facts support this view:

1. At places where the contact between the Red Mountain formation and the overlying Armuchee chert formation is well exposed, the halloysite is found 20 to 30 feet above this contact.
2. The Chattanooga shale formation occurs about 12 to 15 feet, stratigraphically, above the halloysite.
3. The Fort Payne chert formation occurs in normal stratigraphical position above the Chattanooga shale.

The halloysite bed varies from one to six feet in thickness, averaging about 28 inches. It was traced along strike for a distance of over three miles. Thicknesses in excess of 36 inches are probably due to repetitions by folding, inasmuch as there has been marked disturbance within the horizon and local rolls or undulations are numerous. Slickensides are present in the halloysite at many places. The strata a few feet above and below the halloysite are, apparently, undisturbed and dip at a low angle (10° to 15°) southeastward.

In the old mine workings the roof is formed by chert with, in some places, white plastic clay; and the floor is generally a thin to thick-bedded, sandy umberish clay. Locally thin layers of silicified shell fragments *(Spirifer* sp. ?) are present in the underclays. In places cross-cutting stringers of halloysite penetrate the underlying clays and also extend into fractures of the overlying chert beds. Elsewhere in the mine both clay and chert occur within the halloysite bed.

The predominant colors of the halloysite are white, tan, and dark gray. Most of the material has a mottled appearance and waxy luster, is badly stained by iron and manganese oxides, and breaks with a conchoidal fracture.

DADE COUNTY

A bedded deposit of halloysite occurs along the east slope of a hill, located between the Southern Railway and U. S. Highway 11, one mile south of Rising Fawn. The halloysite is milky white (weathered) and, apparently, varies from two to four feet in thickness. It dips 50 to 60 degrees westward and occurs just above the top of the Red Mountain formation. It seems quite likely that this horizon, like the occurrence in Chattooga County, is in the Armuchee chert formation and not in the Fort Payne, as previously reported. Prospecting or exploration work must be done to obtain a better understanding of the character and extent of this deposit.

Tests and Analyses

Laboratory identification tests were made by the U. S. Geological Survey on samples from the deposit six miles north of Gore with the following results*: "A thermal analysis was made of the white, smooth and wax-like specimen. It gave a curve which indicated a composition in the endellite ($Al_2O_3.2\ SiO_2.4\ H_2O$)—halloysite ($Al_2O_3.2\ SiO_2.2\ H_2O$) series. Optical studies, by Dr. Ross, showed some variation in the index of refraction amongst the four samples which would indicate that these specimens represent various degrees of dehydration of endellite."

According to Watkins (see references) analyses of carefully taken samples are as follows:

Table 6

Chemical Analyses of Halloysite

	White sample	Buff sample
Water	19.95	20.40
Silica	42.20	37.10
Alumina	37.30	41.00
Iron Oxide	Trace	Trace
Manganese Oxide	0.11	0.38
Cobalt Oxide	0.12	1.06
Titanium	Trace	Trace
Lime	Trace	Trace

*Letter from H. Ries, Ithaca, New York to H. S. Rankin, TVA, January 24, 1947.

Presumably these selected samples were taken during the period the deposit was worked. As noted above, the halloysite now exposed in the old workings is rather badly stained by iron and manganese, hence the percentages of these impurities would probably be higher than is indicated in the analyses given by Watkins. It is believed that material approaching these analyses cannot be obtained until the old workings are reopened and less stained halloysite is exposed.

Production

There are no available records of the tonnages of halloysite produced in northwest Georgia. According to Veatch (see references) small amounts of halloysite were mined near Rising Fawn, Dade County, between 1889 and 1894. The most extensive development in the area was the mine north of Gore, Chattooga County, which was operated by the North American Chemical Company about 1913. The workings at this locality consist of eight principal mine entries and over 35 short prospect drifts and pits. Local residents report that from 10 to 15 miners were employed and that "several" carloads of halloysite were hauled by wagons from the mine to Gore for shipment on the Rome and Northern Railroad. This railroad has since been abandoned and removed. Judging from the size and extent of the underground workings, it is estimated that 500 to 600 tons of halloysite were shipped from this locality.

Reserves

Insofar as can be determined from natural exposures and old workings, the deposit north of Gore in Chattooga County contains over one million tons (all grades combined) of halloysite above local drainage. No estimate is offered here as to the probable reserves in Dade County because of insufficient data due to scarcity and distribution of exposures.

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IRON ORES

General Statement

The ores of iron that have been mined in northwest Georgia, in order of their importance, are brown iron ore (chiefly limonite), and red iron ore (hematite). Detailed discussions of the geology, occurrence, methods of mining, descriptions of individual deposits, etc., of these ores have appeared in earlier reports (see references) and need not be repeated here. The locations of the principal mines worked in recent years are indicated on the accompanying mineral resource map.

Description

Brown iron ore is a general group name for a number of hydrous iron oxide minerals. The principal brown iron ore minerals in northwest Georgia are limonite and goethite. They are yellowish-brown to nearly black in color and have a yellowish brown streak.

The red iron ores are chiefly of two types, "oolitic" consisting of small, rounded and flattened granules, and "fossil" consisting of small fossils and fossil fragments in which the lime has been replaced by hematite (ferric oxide). These ores have a characteristic red streak.

Uses

The brown iron ores have been an important source of iron since deposits were first worked prior to the Civil War. Very little iron has been smelted from the red fossil ores of northwest Georgia in the past 25 years, most of the production being used for paint pigments.

Location of Deposits

The brown iron ore deposits are widely distributed, but the principal commercial deposits which have been developed occur in Polk, Bartow, and Floyd counties. Deposits have been worked on a small scale in Gordon, Murray, and Whitfield counties. The principal brown iron ore localities are:

Bartow County

Eastern district—a crescentic area beginning two miles south of Emerson and extending northward about 20 miles.

Iron Hill district—about seven miles southwest of Kingston.

Linwood district

Polk County

Cedartown district
Grady district (Fish Creek district of old reports)
Esom Hill district
Etna Valley district
Aragon district

Floyd County

Cave Spring district—(1 to 2 miles southwest of Cave Spring)

Silver Creek district—near Reesburg, 2 to 3 miles south of Lindale.

The red fossil ores are confined to Dade, Walker, Catoosa, and Chattooga counties. Their distribution is co-extensive with the Red Mountain formation (Clinton) of Silurian age shown on the accompanying geologic map.

Character and Occurrence of Ores

Brown iron ores occur as compact, irregular masses in pockets, lenses, or irregularly-shaped deposits of variable size in residual clays associated with the Weisner quartzite, Newala limestone, Knox dolomite, and Shady dolomite formations. Because of their irregular occurrence it is difficult to determine the size and extent of the deposits except through actual mining or by prospecting. Good ore has been mined in numerous localities to depths of 100 feet.

The important beds of red fossil ore (hematite) are restricted to the Red Mountain formation which consists almost entirely of sandstone and shale with a few thin beds of limestone in the lower half of the formation.

The ores occur in stratified beds varying from a few inches to as much as five feet, but are generally less than three feet in thickness. According to Burchard (see references) the thicknesses of ore in northwest Georgia areas are as follows:

Lookout Valley—Exclusive of partings, the important ore bed varies from two feet five inches to three feet.

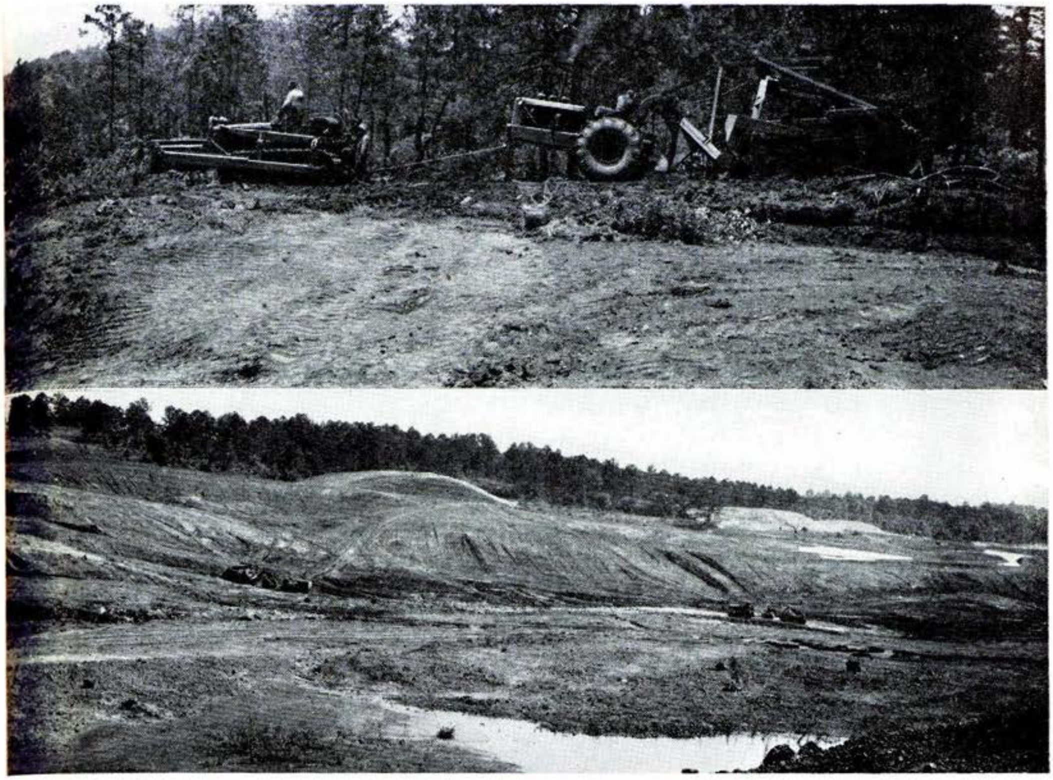

Fig. 8. Views of brown iron ore pits in Polk and Bartow counties, Georgia. These large deposits permit the use of self-loading equipment which mines and hauls ore to the washer.

Fig. 9. Brown iron ore washing plant in Bartow County, Georgia.

Johnson Crook—Three seams occur, of which one is workable. This bed varies from three feet eight inches to five feet including shale partings.

Menlo—The ore bed in this area varies from one to three feet exclusive of partings.

Pigeon Mountain—The lower of three beds is the most important. It varies in thickness from two to four feet, usually exceeding two and one-half feet with shale partings.

McLamore Cove—The ore varies from one to three feet and in places there are two seams.

Missionary Ridge—The ore varies from one and one-half to two and one-half feet and usually contains shale partings.

Dirtseller Mountain—The ore bed ranges from one foot two inches to two feet four inches and averages about one foot six inches in thickness.

Taylor Ridge—The thicker of two beds in this area varies in thickness from one foot five inches to two feet five inches and usually contains shale partings.

The quality of the ore is about the same as that of the fossil ore in the Birmingham, Alabama, district.

In Bartow County, between Emerson and the Etowah River, and at a locality about two miles southwest of White, bands of specular hematite occur in quartzite. The ore bodies are small and the greater part are quite siliceous, so that only the richer portions could be worked as was once done on a small scale south of the Etowah River.

Production

A number of charcoal furnaces for the utilization of brown iron ores were operated in northwest Georgia from 1840 until they were destroyed during the Civil War. They were rebuilt after 1870 and some were in blast until about 1912, using red and brown ore. Both coke and charcoal furnaces were used. Since this date no pig iron has been produced in Georgia—all of the ore being shipped to furnaces in other states, chiefly Alabama and

Tennessee. High freight rates to furnaces outside of the State have been largely responsible for curtailed production of ore except during periods of unusual demand such as World Wars I and II. Production in war time is greatly accelerated because the extraordinary demand for iron results in both price increases and acceptance of lower grades of ore at the smelters. About 1941 brown iron ore operations picked up markedly and in 1944 it was the fourth leading mineral product in Georgia. The production for that year came largely from Bartow and Polk counties and amounted to 285,523 tons valued at $687,494.

Hematite (red fossil ore) has been worked intermittently on a small scale at a few mines in the past 25 years, and most of the production has gone into paint manufacture.

Reserves

Tonnage estimates of brown iron ore which can be mined are not available, but it is the consensus of opinion that they are large. During the period 1940-1942 the iron ore deposits in Bartow, Polk, and Floyd counties were prospected by the W. P. A. under the supervision of the Georgia Geological Survey. These explorations have been of great assistance to present and recent mining operations by extending known ore deposits and by the discovery of new ones. The records of this work are on file in the office of the Georgia Geological Survey of Atlanta. Many of the deposits have been prospected in the past several years by the U. S. Bureau of Mines.

The reserves of hematite (red ore) are still considerable, although much of the easily gained "soft" ore has been mined out. Less than 4 percent of the reserves estimated by Burchard (see references) as "Available Ore" in 1908 has been mined. His 1908 estimates are regarded, therefore, as still applicable to this region and are summarized in the following table:

Table 7

Reserves of Iron Ore

Subdivision	Length (feet)[a]	Width (feet)[b]	Thickness (feet)[c]	Iron (percent)[d]	Ore (long tons) Available	Ore (long tons) Not at present Available
New England-Wildwood	20,000	5,000	2.37	22-30	———	12,650,000
Rising Fawn	10,000	(1,000) (4,000)	4.5	20-30	2,500,000 ———	——— 10,000,000
Pudding Ridge	7,500	700	2.5	20-33	———	850,000
Cenchatt	7,500	1,200	2.25	25-32	———	1,000,000
Eagle Cliff	15,000	1,800	2.5	25-33	———	4,000,000
Estelle	30,000	(2,500) (5,000)	2.5	28-35	13,000,000 ———	——— 25,000,000
Copeland	18,000	2,500	2.7	20-32	———	8,000,000
Broncho	18,000	1,000	2.5	25-30	———	3,000,000
Taylor Ridge	12,000	1,500	1.5	20-30	———	1,800,000
Dirtseller Mountain (Collyarton)	30,000	1,000	1.5	(h 25-30) (s 45-55)	3,000,000	———
					18,500,000	66,300,000
					84,800,000	

a. Total length of outcrop. b. Distance down the dip to which the ore bed may be regarded as workable, either under present or future conditions. Where two distances are given the upper one represents the distance probably workable under present conditions. c. Average thickness of the ore bed. d. (h) hard ore; (s) soft ore.

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LIGHT-WEIGHT AGGREGATE

General Statement

In recent years there has been a growing demand for light-weight aggregates, particularly by the manufacturers of concrete blocks and other precast building units. Various materials such as shale, clay, furnace slag, perlite, tuff, pumice and coke "breeze" have been used in the production of light-weight materials sold under trade names like "Haydite," "Waylite," "Lytag," etc.

The advantages of light-weight building units are obvious. A reduction of dead-weight factors affords possibilities either of increasing the live load or reduction in size of structural steel members, as well as savings through increased speed of laying.

Laboratory Tests

In the survey of the mineral resources of northwest Georgia recently completed, samples were collected from the major shale-bearing formations of the area as follows: Pottsville formation (shale member associated with coal beds), Rockmart slate, Floyd shale, Red Mountain formation, Conasauga shale and Rome shale. This sampling was done for the purpose of obtaining data indicating which shale types, if any, would readily expand into a strong, cellular light-weight material.

Preliminary tests were run on these samples at the North Carolina State College Research Laboratory, Asheville, North Carolina. The procedure used (see references) involved heating a crucible containing a known weight of shale (–8 mesh size) in a muffle furnace through a temperature range of 2,000° F. to 2,450° F. The samples were held at various temperatures within this range for 30 minutes, and the degree of expansion noted for each sample at each temperature. It was found that for this range of firing the shales from the Pottsville, Floyd, and Red Mountain formations were too refractory and did not expand. One of three Rockmart slate samples, two of nine Conasauga shale samples, and two of five Rome shale samples showed expansion characteristics as outlined in the following table:

Table 8

Bloating tests of northwest Georgia shales

	2350° F.		2400° F.		2450° F.	
Sample	Pounds per Cubic foot	Pore Structure	Pounds per Cubic foot	Pore Structure	Pounds per Cubic foot	Pore Structure
1			67	Excellent	40	Excellent
2			45	Excellent	36	Good
3			60	Excellent	30	Excellent
4					66	Poor
5	28	Fair	31	Poor		

1. Rome shale—From road cut one-half mile south of Whitfield-Gordon County line, along U. S. Highway 41, Gordon County.

2. Rome shale—From road cut, one mile northwest of railroad station of Plainville, Gordon County.

3. Conasauga shale—Six miles south of Rome and one-fourth mile north of junction of U. S. Highways 411 and 27, Floyd County.

4. Conasauga shale—From shale quarry adjacent to U. S. Highway 411, four miles south of Fairmount (Gordon County), in Bartow County.

5. Rockmart slate—From quarry one-fourth mile southeast of Seaboard Airline Railroad station at Rockmart, Polk County.

Possibilities for Development

The results of the preliminary tests given above are favorable indications of the possibilities for producing light-weight aggregate from some of the shale deposits of northwest Georgia, particularly those in the Rome and Conasauga formations. Both of these formations extend over large areas, as can be observed from the geologic map. It should be emphasized, however, that detailed field and laboratory research must be done before successful production of light-weight products from these shales can be assured.

References

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LIMESTONE AND DOLOMITE

Description

Limestone is one of the common sedimentary rocks. It is composed chiefly of calcium carbonate, usually in the form of the mineral calcite, together with varying amounts of impurities. Limestones vary in color from white or light gray to dark gray and black. In texture they vary from amorphous and semicrystalline to crystalline. They also vary with respect to hardness, specific gravity, and compactness. The classifications of limestones are based largely on their chemical composition, however, many varieties are given names based on their structure, most abundant accessory constituent, or predominant fossil. High calcium limestones consist almost entirely of calcium carbonate. Those rocks composed of the double carbonate of magnesium and calcium approximating the mineral dolomite in composition (magnesium carbonate 45.65%, calcium carbonate 54.35%) are called dolomites. There are various intermediate carbonate rocks to which the terms magnesian or dolomitic limestone are applied.

Uses

Limestone, including dolomite, is used for a large variety of purposes. Among the chief products are crushed stone for road metal, railroad ballast, concrete aggregate and agricultural limestone; as a flux in smelting iron ore; dimension stone for various construction purposes, especially in foundations, walls, chimneys, flagging; and in the manufacture of cement and lime. Lime has a greater and more diversified number of uses than any other limestone product. It enters, either directly or indirectly, into the manufacture of multitudinous chemical and industrial products. The purity of the limestone used is of paramount importance in the utilization of the lime it yields, because impurities present in the stone remain in the lime. Whereas almost any good limestone is satisfactory for agricultural purposes, that used for chemical lime must conform to rigid physical and chemical specifications.

Location of Deposits

Limestone and dolomite formations are the most widely distributed rocks in northwest Georgia and occur in each of the ten counties of the Paleozoic area. Detailed descriptions of many localities and chemical analyses are given by Maynard in Bulletin 27 of the Georgia Geological Survey (see references).

Character and Occurrence of Deposits

The lithology and distribution of the limestone and dolomite formations are described by Mr. Butts in the foregoing portion of the text under "Stratigraphy." Throughout portions of their areal extent they are deeply weathered and at such locations are represented chiefly by residual clays and chert. The principal limestone formations may be characterized briefly as follows:

Shady dolomite—A bluish-gray, medium coarsely crystalline dolomite. Fresh rock in natural exposures is relatively scarce.

Conasauga formation—Thin bedded blue limestones are interstratified with shales. They are commonly exposed in more limited areas than the shales of this formation, but may attain thicknesses of from 100 to 200 feet.

Knox dolomite—Predominantly a thick bedded gray dolomite. In places limestone is interbedded with dolomite. This formation is deeply weathered in most localities and exposures of dolomite are rare. Some of the better exposures are near Graysville, Catoosa County, and at Ladds, two miles southwest of Cartersville, Bartow County.

Newala limestone—A pure (high calcium carbonate), thick-bedded, blue limestone with, in places, blue-gray, fine crystalline and some compact dove-colored limestone layers. Outcrops are found in narrow belts as, for example, along both sides of Missionary Ridge.

Murfreesboro limestone—The lithology of this limestone varies in character in different outcrop belts. In places it is a blue or dove-colored, compact or crystalline, fossiliferous limestone—elsewhere the formation is red or gray-mottled limestone interbedded with blue or dove-colored limestone. Black, ropy chert occurs through the limestone in some localities.

Mosheim limestone—A compact dove-colored limestone. This is a very persistent limestone horizon but because of small thickness it is not extensively exposed. It is a very pure limestone.

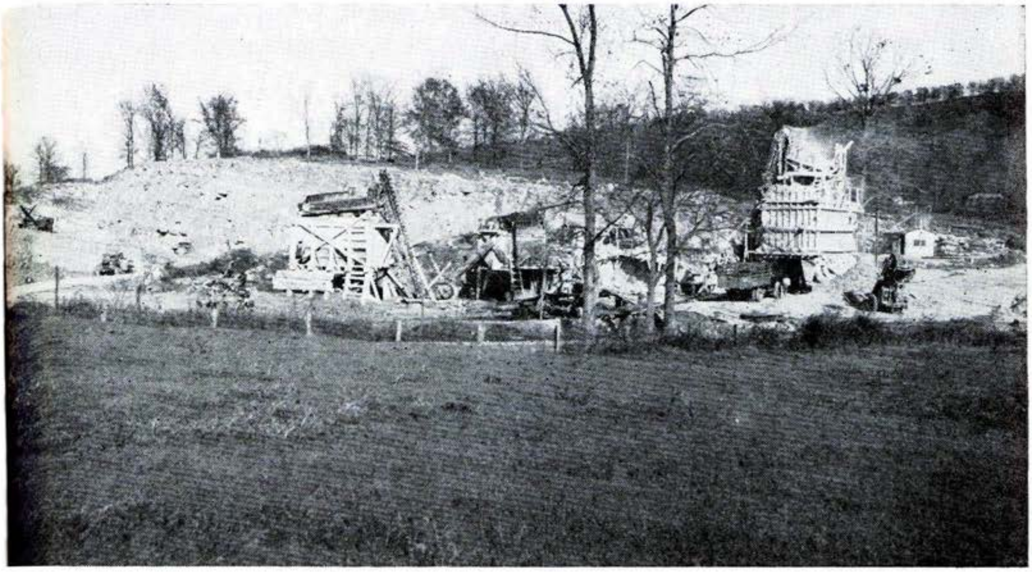

Fig. 10. Limestone quarry and plant for producing crushed stone, three miles southwest of Rossville, Walker County, Georgia.

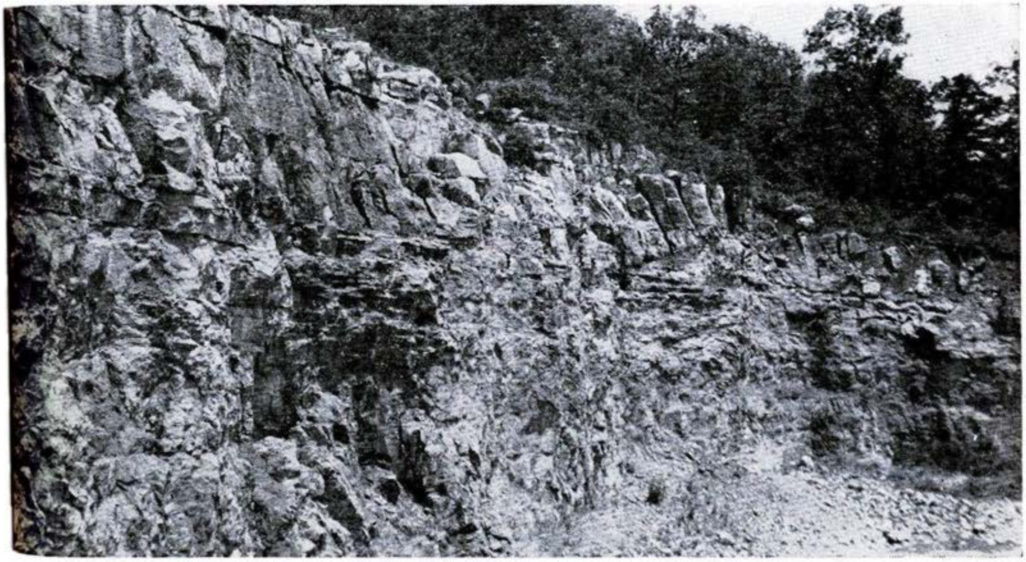

Fig. 11. Limestone quarry two miles northwest of Cassandra, Walker County, Georgia.

Lenoir limestone—A dark gray, medium coarsely crystalline limestone. In places it contains considerable quantities of fossiliferous black chert.

Lebanon limestone—This is a very fossiliferous and argillaceous (clayey), thin-bedded limestone intercalated in gray shelly limestone.

Holston marble—A coarsely crystalline fragmental limestone. Its occurrence is confined to a narrow belt east of Varnell and Cohutta, Whitfield County. Exposures are scarce as the formation is deeply weathered.

Lowville-Moccasin limestone—This formation has two facies, the Lowville being blue or dove-colored limestone, and the Moccasin being predominantly a red-colored argillaceous and calcareous rock (mudrock).

Trenton limestone—A very fossiliferous thin-bedded to shelly, blue-gray coarsely crystalline limestone. It is generally a rather pure limestone but, in places, contains some argillaceous layers. The Trenton limestone is best exposed in Lookout Valley.

"Bangor" limestone—This is a group name (see text by Mr. Butts) which includes all of the limestones in northwest Georgia of Mississippian age. They occur in Lookout and Pigeon Mountains. Included in the "Bangor" are the Ste. Genevieve, Gasper, and Bangor (restricted) formations, all of which are similar lithologically and, for the most part, chemically high-grade limestones. These limestones are predominantly gray to bluish-gray in color, coarsely crystalline and thick bedded.

Limestone and Dolomite Analyses

Limestone and dolomite deposits were sampled throughout the area to obtain general information from a standpoint of geographic distribution and stratigraphic horizons. This sampling is indicative of the character of the more important horizons in the different belts of outcrops and does not represent a comprehensive coverage of all of the possible quarry sites. Some of the formations, such as the Shady dolomite and Lebanon limestone, were not sampled because of one or more of the following features: (1) scarcity of fresh rock outcrops, (2) small thickness of beds which could be quarried, and (3) inaccessibility to good transportation.

Detailed descriptions and analyses of limestone and dolomite are to be found in earlier reports of the Georgia Geological Survey (see references) and need not be repeated here.

Table 9

Limestone Samples—Northwest Georgia

For use in the report the limestone samples have been arranged in consecutive order, beginning with the oldest formation, as follows:

Formation	Report Sample Number	Field Sample Number	Laboratory Sample Number
Conasauga	1	11	7299
Conasauga	2	21	7345
Conasauga	3	19	7343
Conasauga	4	18	7342
Conasauga	5	12	7300
Knox dolomite	6	10	7298
Knox dolomite	7	20	7344
Knox dolomite	8	16	7340
Knox dolomite	9	17	7341
Newala	10	6	4153
Newala	11	8	7296
Newala	12	13	7337
Newala	13	14	7338
Newala	14	15	7339
Lenoir	15	5	4152
Trenton	16	1	4148
Fort Payne	17	9	7296
Bangor (unrestricted)	18	2	4149
Bangor (unrestricted)	19	3	4150
Bangor (unrestricted)	20	4	4151
Bangor (unrestricted)	21	7	7295

Chemist's Remarks

Spectroscopic tests for strontium and vanadium failed to indicate their presence.

Exhaustive qualitative tests failed to indicate the presence of titanium, barium or zinc, with the exception of a faint trace in Sample No. 16.

Phosphorus, manganese, and sulphur occur occasionally in negligible amounts or in traces only.

In this series of 21 assays, loss-on-ignition has been calculated as carbonic dioxide (CO_2). Loss-on-ignition with carbonaceous rocks represents the algebraic sum of a number of chemical changes involving both losses and gains, and its amount will depend largely on the temperature employed.

At a temperature of 800°C. with crucible covered, carbon dioxide, water (if present in combination) and carbonaceous matter escape wholly. Sulphides (if present) are oxidized to sulphates, and all of the sulphur is retained as sulphate by the calcium present.

Above 800°C. the sulphate is gradually decomposed, with eventual loss, the alkalies (if present) begin to escape, the potassium faster than the sodium. By careful control of temperature these losses are avoided.

L. H. Turner.

Sample No. 1

Name and Location: Abandoned quarry in Graysville, Catoosa County.
Formation: Conasauga
Dip: 30° SE
Description: Chip sample from quarry face representing 100 feet of thick-bedded strata. Chiefly blue-gray, medium grained argillaceous limestone. Some beds are vaughnitic.

Sample No. 2

Name and Location: County Road Quarry. 2 miles northeast of Pleasant Grove, Whitfield County.
Formation: Conasauga
Dip: Horizontal to 10° SE
Description: Chip sample from rock on quarry floor. Mainly black, finely crystalline, thin-bedded limestone. Over 100 feet of strata exposed in quarry face.

TABLE 9

Analysis of limestone and dolomite*

REPORT SAMPLE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
CHEMICAL COMPOSITION																					
SILICA (SiO_2)	6.00	3.26	2.16	.114	4.84	6.00	5.66	0.74	1.38	1.60	1.52	5.38	5.00	4.00	2.75	4.10	0.62	0.73	1.48	0.18	0.56
ALUMINA (Al_2O_3)	1.01	0.24	0.73	0.33	1.07	0.54	1.18	0.42	0.27	0.50	0.42	1.14	0.80	0.59	1.15	2.24	0.30	0.36	1.08	0.00	0.24
FERRIC OXIDE (Fe_2O_3)	0.69	0.84	0.21	0.37	0.79	0.60	0.62	0.42	0.69	0.40	0.42	0.72	0.66	0.41	0.67	1.04	0.50	0.40	0.44	0.36	0.42
MAGNESIUM OXIDE (MgO)	2.00	3.02	3.08	2.76	3.12	15.54	5.81	20.71	20.77	3.26	1.75	10.92	1.98	2.95	2.42	1.304	0.83	0.493	1.63	0.891	0.49
CALCIUM OXIDE (CaO)	51.30	51.00	51.30	52.00	50.42	31.18	45.20	30.84	30.96	50.94	54.20	41.20	50.80	50.66	50.40	49.86	54.00	55.56	53.30	54.36	56.82
STRONTIUM OXIDE (SrO)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SODIUM OXIDE (Na_2O)	0.97	0.38	0.59	0.27	1.06	0.98	0.31	0.21	0.53	0.93	0.76	0.64	0.71	0.92	0.79	0.84	0.91	0.62	0.97	0.77	0.53
POTASSIUM OXIDE (K_2O)	0.73	0.56	0.27	0.38	0.28	0.71	0.38	0.13	0.41	0.43	0.94	0.19	0.84	0.70	0.58	0.89	0.34	0.51	0.52	0.62	1.00
WATER HYGROSCOPIC (H_2O)	0.00	0.05	0.00	0.00	0.02	0.12	0.02	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.11	0.06	0.00	0.03	0.00	0.04
WATER COMBINED (H_2O)	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.055	0.00	0.00	0.00	0.02	0.035	0.225	0.02	0.05	0.05	0.022	0.01
CARBON DIOXIDE (CO_2)	38.00	40.50	41.60	42.60	38.80	44.54	40.45	46.29	44.85	42.60	39.92	40.00	39.50	39.65	41.94	40.552	42.49	40.552	41.81	43.633	40.05
TITANIUM DIOXIDE (TiO_2)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Trace	0.00	0.00	0.00	0.00	0.00
PHOSPHOROUS PENTOXIDE (P_2O_5)	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.005	0.012	0.00	0.00	0.00	0.01	0.007	0.005	0.00	0.012	0.004	0.001	0.00
SULPHUR TRIOXIDE (SO_3)	0.08	0.00	0.055	0.116	0.04	0.11	0.022	0.12	0.034	0.59	0.01	0.104	0.036	0.063	0.597	0.502	0.05	0.28	0.31	0.055	Trace
MANGANESE OXIDE (MnO)	Trace	Trace	0.00	Trace	Trace	Trace	Trace	Trace	0.00	0.00	Trace	0.00	Trace	Trace	0.00	0.007	Trace	0.00	0.00	0.00	0.00
VANADIUM PENTOXIDE (V_2O_5)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BARIUM OXIDE (BaO)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ZINC OXIDE (ZnO)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UNDETERMINED	0.00	0.12	0.005	0.034	0.00	0.00	0.048	0.08	0.101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.433	0.00	0.00	0.00
TOTALS	100.78	100.00	100.00	100.00	100.44	100.32	100.00	100.00	100.00	101.317	100.00	100.294	100.326	100.003	101.339	101.675	100.12	100.00	101.624	100.892	100.16
CALCIUM CARBONATE ($CaCO_3$)	91.56	91.02	91.56	92.81	90.00	55.65	81.21	55.04	55.26	90.918	96.50	73.54	90.67	90.42	89.954	88.99	96.37	99.163	95.129	97.022	99.00
MAGNESIUM CARBONATE ($MgCO_3$)	4.18	6.32	6.44	5.77	6.53	32.51	12.15	43.32	44.44	6.818	3.56	22.84	4.14	6.17	5.061	2.727	1.74	1.031	3.409	1.864	1.03
TOTAL CARBONATES	95.74	97.34	98.00	98.58	96.53	88.16	93.36	98.36	98.70	97.736	100.06	96.38	94.81	96.59	95.015	91.717	98.11	100.194	98.538	98.886	100.03
CALCIUM CARBONATE EQUIVALENT (Theoretical)	96.52	98.52	99.20	99.66	97.75	94.24	95.63	100.00	100.00	99.011	100.35	99.54	95.58	97.74	95.961	92.227	98.43	100.387	99.175	99.235	100.22

* Analyses by L. H. Turner, Chemist, Georgia Department of Mines, Mining and Geology.

Sample No. 3

Name and Location: O. O. Davis (operator) quarry, 4 miles east of Dalton, Whitfield County.
Formation: Conasauga
Dip: Nearly horizontal
Description: Chip sample from rock on quarry floor representing 35 feet of dark-gray, medium to finely crystalline limestone exposed in quarry face.

Sample No. 4

Name and Location: Abandoned quarry, 1½ miles south of Fairmount, Gordon County.
Formation: Conasauga
Dip: Horizontal to 30° SE
Description: Dark blue-gray, finely crystalline and medium gray, finely crystalline to dense limestone. Chip sample from rock on quarry floor; sample representative of 80 feet of strata exposed in quarry.

Sample No. 5

Name and Location: Floyd County quarry, 2½ miles southwest of Rome, Floyd County.
Formation: Conasauga
Dip: 60° SE
Description: Sample from stockpile of crushed rock for road metal. Very dark gray, finely crystalline limestone with stringers and veinlets of white calcite. Quarry face, about 130 feet high, contains about 250 feet of strata.

Sample No. 6

Name and Location: Hales quarry adjacent to N. C. & St. L. Railroad, 1.5 miles east of Graysville, Catoosa County.
Formation: "Knox" dolomite
Dip: 15° SE
Description: Chip sample from rock on quarry floor; quarry face has in excess of 100 feet of strata. Mainly light to medium gray, medium crystalline, thick bedded, cherty dolomite.

Sample No. 7

Name and Location: Abandoned quarry 1½ miles due west of Dalton, Whitfield County.
Formation: "Knox" dolomite
Dip: About 30° SE
Description: Dark-gray, finely crystalline, thick-bedded dolomitic limestone. Chip sample from rock in quarry floor; 30 feet of strata exposed in quarry face.

Sample No. 8

Name and Location: Abandoned quarry on U. S. Highway No. 41, 3 miles southeast of Adairsville, Bartow County.

Formation: "Knox" dolomite
Dip: Nearly horizontal
Description: Medium-gray, medium to coarsely crystalline dolomitic limestone. Chip sample representing 30 feet of strata.

Sample No. 9

Name and Location: Ladd Lime and Stone Company. 2 miles southwest of Cartersville, Bartow County.
Formation: "Knox" dolomite
Dip: 32° SE
Description: Dark-blue to light-gray, medium crystalline dolomitic limestone. Chip sample from rock on quarry floor representing 25 feet of strata in the lower working face.

Sample No. 10

Name and Location: Outcrop on dirt road to Fisher's building stone quarry, 200 yards east of county road, 1 mile north of Pond Spring, Walker County.
Formation: Newala
Dip: Nearly horizontal
Description: Light-gray, finely crystalline to dense, thick-bedded limestone and vaughnite. Chip sample from outcrop representing 25 feet of strata.

Sample No. 11

Name and Location: Quarry site 1 mile west of Georgia Highway No. 151, 3 miles north of Catoosa-Walker County line, Catoosa County.
Formation: Newala
Dip: Nearly horizontal
Description: Chip sample from outcrop representing 30 feet of strata. Mainly light-gray, dense, thick-bedded limestone and vaughnite.

Sample No. 12

Name and Location: Southern States Portland Cement Company, 1.5 miles north of Rockmart, Polk County.
Formation: Newala
Dip: 20° to 60° SE
Description: Crusher sample of light blue-gray dolomitic limestone used for road metal.

Sample No. 13

Same location as Sample No. 12.
Description: Dark-gray, finely crystalline limestone used in manufacture of Portland cement. Crusher sample.

Sample No. 14

Name and Location: Abandoned quarry of Piedmont Portland Cement Co., 1.8 miles northeast of Aragon Station, Polk County.

Formation: Newala

Dip: Horizontal to 40° SE

Description: Chip sample from quarry face representing 80 feet of strata. Mainly dark-gray, finely crystalline limestone and medium to light blue-gray dolomitic limestone.

Sample No. 15

Name and Location: Dave L. Brown Quarry, 2 miles south of Rossville, Walker County.

Formation: Lenoir

Dip: 15° SE

Description: Crusher sample. Blue-gray, finely crystalline to dense, thin-bedded limestone. Quarry face about 50 feet high.

Sample No. 16

Name and Location: Dave L. Brown Quarry, ¼ mile south of Morganville and 500 feet east of Southern Railway, Dade County.

Formation: Trenton

Dip: 15° SE

Description: Chip sample of dark-gray, medium to coarsely crystalline, fossiliferous limestone from outcrop of 50 feet of thin-bedded strata. Several 2-inch layers of shale occur in the section.

Sample No. 17

Name and Location: Fry Quarry, 1 mile north of U. S. Highways 41 and 76, 2 miles east of Ringgold, Catoosa County.

Formation: Fort Payne

Dip: Horizontal

Description: Chip samples from quarry face and rock on quarry floor, representing 20 feet of thick-bedded strata. Mainly medium to dark gray, medium crystalline, oolitic limestone.

Sample No. 18

Name and Location: Abandoned Southern Iron and Steel Company Quarry, 1 mile northeast of Rising Fawn, Dade County.

Formation: Bangor (unrestricted)

Dip: 10° NW

Description: Chip sample from outcrops above upper quarry face representing 50 feet of strata. The limestone is mainly medium-gray, medium crystalline, and thick-bedded; it is in part oolitic and in part finely crystalline.

Sample No. 19

Same location as Sample No. 18

Description: Chip sample from upper quarry representing the upper 50 feet of strata exposed in quarry face. Limestone mainly medium gray, medium crystalline and thick bedded; oolitic and finely crystalline in part. Several thin layers of chert nodules are present but compose less than 0.5 percent of strata.

Sample No. 20

Same location as Sample No. 18

Description: Chip sample from upper quarry face representing 35 feet of strata in middle portion of face, immediately below Sample No. 19. Mainly light to medium gray, medium to coarsely crystalline, oolitic, and fossiliferous, massive limestone containing cross-bedding.

Sample No. 21

Name and Location: Abandoned Horine Development Company Quarry, on DeGieve property, 1 mile west of Georgia Highway No. 2, 3.5 miles west of LaFayette, Walker County.

Formation: Bangor (unrestricted)

Dip: Nearly horizontal

Description: Chip sample from rocks on quarry floor. Light to medium-gray, fine to medium crystalline, thick-bedded limestone; in part oolitic. Abandoned quarry has 15-foot face.

Production

In 1944 tonnages of limestone produced in northwest Georgia aggregated 379,780 short tons valued at $637,305. This production was used principally for cement, road surface material, agricultural stone and lime.

Reserves

The limestone reserves are enormous and could support large scale operations for many years of such products as cement, agricultural stone and lime, building stone, and road metal. Detailed sampling and chemical analysis of stone at numerous localities would be necessary to appraise thoroughly the most suitable locations for the production of limestone suitable for chemical and other special uses. The dolomite reserves, although large, are somewhat more limited. The Knox dolomite is the most extensive of the calcareous formations; however, because of deep weathering, the localities where it can be quarried are none too plentiful.

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MANGANESE

Description

There are more than 100 manganese minerals (silicates, oxides and carbonates) of which only a few, possibly less than a dozen, are of value as ores of manganese. In Georgia only the oxides of manganese are important. Of these the predominant ore minerals are pyrolusite and psilomelane associated with which are manganite and braunite, and the earthy oxide, wad. These oxide minerals frequently occur admixed in varying proportions and cannot always be separated. Commonly (with the exception of wad) the ore is crystalline, in whole or in part, contains minute crystals of pyrolusite throughout the masses, and varies from dark steel-gray to iron black or bluish-black in color. It is found as nodules which have a partial layered or concentric structure, as crystalline masses, irregular and mammillary or botryoidal lumps, small gravel, stalactitic and needle-like ore.

Uses

Manganese is used for a great many purposes, particularly in the metallurgical and chemical industries. The most important use is in the manufacture of the iron and manganese alloys, spiegeleisen and ferromanganese which, in turn, are used in the manufacture of steel. It is also used in making alloys other than iron such as aluminum, copper, and zinc, and in the manufacture of dry cell batteries. Among the many chemical uses of manganese are the manufacture of chlorine, bromine, and disinfectants; as a decolorizer of glass; and as a coloring agent in paints, glass, pottery, brick; as a mordant in fixing colors in dyeing; and various medical and chemical compounds.

Location of Deposits

The manganese deposits have a wide geographic distribution in northwest Georgia, but the most important occurrences have been found in the vicinities of Cartersville and Cave Springs. The principal districts in which it has been mined are:

Cartersville district—Bartow County
Cave Springs district—Northwest Polk and southwest Floyd counties
Tunnel Hill district—Whitfield and Catoosa counties
Varnell-Cohutta district—Whitfield County.

Character and Occurrence of Ores

CARTERSVILLE DISTRICT

The largest and most productive deposits are in the Cartersville district, where the ores occur in residual clay derived from the Weisner quartzite and the Shady dolomite formations. The ore occurs in the clay as irregular pockets and lenticular bodies, as concretions or nodules or various shapes ranging in size from small grains to masses weighing several tons, and as irregular stringers and veins. In places the nodules are scattered as single lumps through the clay, elsewhere they are concentrated in pockets. It is prevailingly dark blue in color and usually partially or completely crystalline. The ore pockets vary considerably in size and in proximity to each other. Associated with the manganese are deposits of brown iron ore (chiefly limonite), ocher, and barite. The brown iron ores contain small percentages of manganese and the manganese ores contain some iron. Between these extremes there are intermediate, gradational ores in which the oxides of iron and manganese are present in various admixtures. Depending upon the preponderant oxide such ores are called manganiferous iron ore, or ferruginous manganese.

CAVE SPRINGS DISTRICT

The mode of occurrence and character of the ore in the Cave Springs district are very similar to those of the Cartersville district. In the Cave Springs district, however, the ores occur in residual clays of the Knox dolomite formation and are usually associated with cherty masses. This association has resulted in the formation of a manganiferous chert breccia in which considerable quantities of angular chert fragments are cemented in a matrix of manganese oxides. As in the Cartersville district, brown iron ore is frequently associated with the manganese deposits. The deposits are smaller and less extensive than those in the Cartersville district.

TUNNEL HILL DISTRICT

The deposits in the Tunnel Hill district also occur in residual clays of the Knox dolomite. The mode of occurrence, character of ore, and associated minerals are similar to those of the Cave Springs district.

VARNELL-COHUTTA DISTRICT

In this district the manganese is associated with red iron ore (hematite) in residual soils which are the weathered products of calcareous portions of the Tellico sandstone formation. The ore horizon is underlain by the Holston marble formation. High grades of both manganese (chiefly psilomelane) and iron ores were once mined from the same deposits.

Production

The Cartersville district in Bartow County has produced most of the manganese mined in the State. Manganese was first mined in 1866 and during the period 1866-1942 the Cartersville district shipped 205,600 short tons. In 1942 it produced 4,715 short tons. One mine (see accompanying mineral resource map for mine locations) in the Cartersville district shipped practically all of the manganese mined in Georgia in 1944. The total production for 1944 was 3,106 short tons of crude ore (885 short tons of washed ore) valued at $59,855.

Reserves

The manganese deposits have been studied for many years by mining companies, as well as both State and Federal geological surveys. Despite detailed investigations, however, estimates of reserves have not been published for the various districts. This may be attributed to a desire on the part of mining companies not to make such information available to their competitors, and in part to general reluctance of geologists and mining engineers to make over-all tonnage estimates of such irregularly occurring ores.

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OCHER

Description

The term ocher (or ochre) is applied to the earthy, pulverulent forms of hematite and limonite (iron oxides) more or less admixed with impurities such as clayey material. Hematite usually gives red-colored ochers and limonite gives yellow or brown-colored ochers. Various shades of each color are due to the degree of hydration and oxidation and to the amount and kinds of impurities present.

Uses

The ochers of the Cartersville district in Bartow County have been used principally in the manufacture of linoleums and oil-cloths. Ocher is also used in the manufacture of paints and as a pigment for coloring mortars and various ceramic products.

Location of Deposits

The ocher deposits occur in a north-south trending belt about eight miles in length and less than two miles in width, located one mile east of Cartersville, Bartow County. The southern end of this belt is west of Emerson and approximately two miles south of the Etowah River. The largest operations are about two miles southeast of Cartersville.

Character and Occurrence of Ores

The ocher deposits have nearly equal occurrence in places in shattered zones of the Weisner quartzite formation and in residual clays derived from the quartzite. Contacts are usually gradational between the ocher and enclosing quartzite and between the ocher bodies and surrounding clays. Light, bright yellow and dark yellow are the prevailing varieties, but various intermediate shades between these extremes are also found. The differences in color are due, principally, to admixed clayey material—the darker the color the greater the amount of clay impurity. Silica and small amounts of manganese oxide are present as impurities but, apparently, they have little effect on the physical appearance of the ocher.

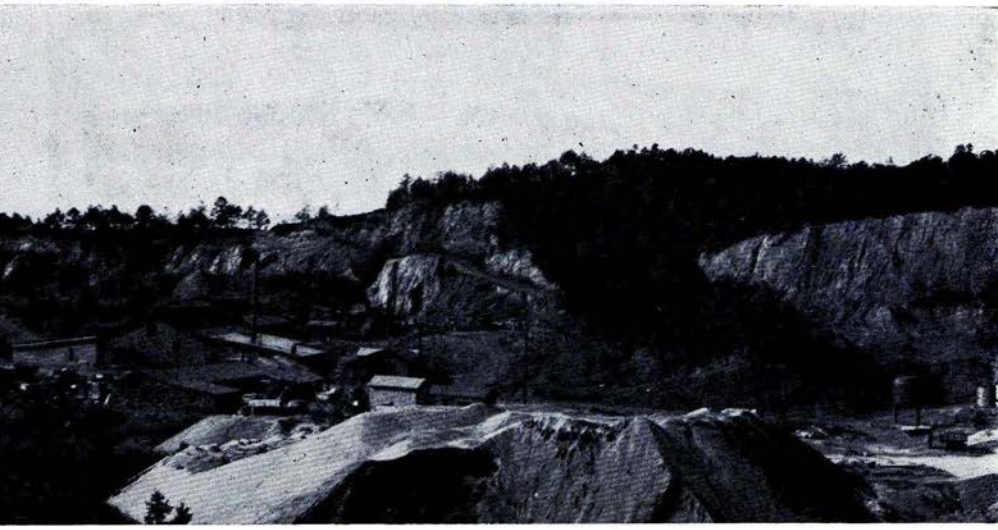

Fig. 12. Ocher pit and plant at Cartersville, Bartow County, Georgia.

Fig. 13. Flagstone quarry (Weisner quartzite formation), five miles east of Rydal, Bartow County, Georgia.

Production

Ocher mining began in the Cartersville district in 1877 and the bulk of the production was formerly exported to England and Scotland for use in the manufacture of linoleums and oilcloths. In recent years a large percentage of the production has been used for the same purposes in plants located in the United States. During the recent war a large amount of ocher was used by the Government in camouflage paint for equipment and clothing. The 1944 production amounted to 6,216 short tons valued at $128,659. Georgia ranks second to Pennsylvania in processing natural mineral pigments. The more important deposits which have been extensively mined are shown on the accompanying mineral resource map. (Map numbers 9, 12, 19, 21, 22).

Reserves

Inasmuch as little prospecting is done in advance of mining, no definite estimates of reserves are available. It is believed, however, that they are sufficiently large to assure continued production for a long time.

References

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POTASH

Location of Deposits

The shales of the Rome formation are potash-bearing north of Cartersville, Bartow County, in a belt 15 miles long and one to four miles wide. The best exposures are in the vicinity of White, a station on the L&N Railway. These shales, which contain from 7 to 10 percent potash, have been referred to in earlier reports (see references) as potash-bearing slates of the Cartersville formation—a terminology no longer in common use.

Production

The deposits were mined during World War I when the supply of German potash was cut off and before the deposits in western United States had been discovered. This production was from an area located about one-half mile south of White, and the shale was treated for the extraction of potash in a cement plant located at Portland, Polk County.

Possibilities for Development

A number of processes have been patented which would be as suitable for the direct extraction of potash from the shales of this area as for any other rocks of equal potash content. It is doubtful, however, if these deposits can be considered anything but a stand-by source, for the present producing capacity of domestic potash mines is more than adequate to meet normal demands.

References

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ROAD MATERIAL

Character and Distribution of Deposits

The materials used for road construction in northwest Georgia are quite abundant and well distributed. They consist of limestone, chert, shale (including slate), and sandstone. The character and occurrence of these are described in the preceding portion of the report dealing with the stratigraphy of the region. Those most suitable for road building are the Knox dolomite, the succeeding limestones of Ordovician and Mississippian ages and residual cherts of the Knox and Fort Payne formations. The sandstones are generally too friable for use as road surfacing material. In general, the shales of the area are also inferior materials for road construction. The Rockmart slate in Polk County is used for surfacing secondary roads.

References

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SAND AND GRAVEL

Description

The terms sand and gravel are applied to unconsolidated materials derived from the weathering of rocks and the transportation and sorting of the resultant rock fragments by running water. The terms have to do with the size and shape of rock particles, rather than their mineral or chemical composition. In general, the term sand is applied to unconsolidated materials, the grains of which are larger than 0.0029 inches in diameter and smaller than 0.25 inches in diameter. The grain size of gravel, as commonly used, varies from 0.25 inches in diameter to about 3.5 inches in diameter.

Uses

Sand and gravel are used for a variety of purposes in general construction, such as concrete, mortar, plaster, roofing, and paving materials. Sands which meet certain specifications are used for molding sands (foundry and core sands), glass manufacture, abrasives, etc. Gravel is used for road surfacing, roofing, aggregate, railroad ballast, and similar purposes.

Location of Deposits

In the Paleozoic area of northwest Georgia sands and gravels are mostly found along streams. In places the sandstone and conglomerates of Sand, Pigeon, and Lookout Mountains are loosely consolidated so that they are easily crushed and furnish excellent sand for construction purposes.

Character and Occurrence of Deposits

Some of the sandstone beds referred to above contain considerable quantities of small gravels, usually less than one-half inch in diameter. Both the sand and gravel consist almost entirely of quartz.

Sand and gravel pits have been dug from flood plains and bottom lands of the major streams of the area. In addition, deposits occurring in the stream beds have been worked by dredging and pumping. The stream deposits usually are quite clean, whereas those found in flood plains and bottom lands generally contain variable amounts of admixed clay.

Production

Most of the commercial production at one time came from near Emerson and Kingston in Bartow County; Rome, Floyd County; and from the Oostanaula and Etowah Rivers. Statistics for production in recent years are not available.

Reserves

Although some of the pits have been worked out, the reserves are believed to be very large throughout most of the Paleozoic area.

References

Furcron, A. S., and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

McCallie, S. W., *Mineral resources of Georgia,* Georgia Geol. Survey Bull. 23, 1926.

Teas, L. P., *Preliminary report on the sand and gravel deposits of Georgia,* Georgia Geol. Survey Bull. 37, 1921.

SANDSTONE

Description

Sandstone is a sedimentary rock composed of mineral grains smaller than pebbles more or less firmly cemented together. In most cases the predominant mineral constituent is quartz. The common bonding or cementing materials are silica, iron oxide, calcium carbonate, and clay.

The term "sandstone" includes a number of varieties to which specific names are given based, for the most part, on composition, color, and use. Some of these varieties are: "quartzite," a type so strongly cemented that the rock breaks as easily through the grains as through the cement; "conglomeratic sandstone," one in which pebbles are prominent; "ferruginous sandstone," one rich in iron; "argillaceous sandstone," one containing appreciable amounts of clay; "calcareous sandstone," one containing appreciable amounts of calcium carbonate; "micaceous sandstone," one containing considerable mica; "brownstone," so-named for its color; "flagstone," one that splits readily into slabs suitable for flagging.

Uses

Sandstone (depending upon its hardness, structure, and freedom from impurities) is used for a variety of purposes such as building stone, flagging, abrasives, aggregate, glass manufacture, and ferrosilicon.

Location of Deposits

Sandstones are widely distributed in the Paleozoic area. They are, perhaps, most prominently developed in Sand, Lookout, Pigeon, and Little Sand Mountains. A number of locations which offer possibilities for opening flagstone quarries are described by Sullivan (see references) in Information Circular 15 of the Georgia Geological Survey. Similar thin-bedded sandstones have been extensively worked near Crab Orchard, Tennessee, for constructional stone and, the Georgia deposits might well be quarried for the same purpose.

Character and Occurrence of Deposits

The principal sandstone horizons, in ascending stratigraphic order, occur in the Weisner quartzite, Rome, Sequatchie, Red

Mountain, and Pottsville formations. The lithology and distribution of these formations are described in the foregoing text under "Stratigraphy" and are also indicated on the accompanying geologic map. Their general character and representative occurrences may be summarized as follows:

WEISNER QUARTZITE

This formation consists of a thick succession of beds of hard, quartzitic sandstone and conglomerate alternating with shales. It forms Indian Mountain in Polk County, and Little Pine Log Mountain, Bartow County.

ROME FORMATION

The Rome is characterized by vari-colored interbedded sandstones and shales. Quartzitic sandstone of this formation forms Camp Ground Ridge between Chatsworth and Eton, Murray County. Thin-bedded gray sandstones are prominent in the area northwest of Cartersville and east of Cassville, Bartow County.

SEQUATCHIE FORMATION

This formation is composed mostly of red shales and sandstones. Very fine-grained, rusty sandstone is well exposed at the summit of Taylor Ridge, just west of the Narrows, on the road northeast of Trion, Chattooga County.

RED MOUNTAIN FORMATION

This formation is largely composed of thin sandstones interbedded with shales. Thick-bedded, predominantly fine-grained, gray sandstone occurs in the base of the formation. The sandstones are conspicuous in many ridges as, for example, Taylor Ridge east of Summerville, Chattooga County, and Rocky Face Mountain, northwest of Dalton, Whitfield County.

POTTSVILLE FORMATION

The Pottsville formation is composed of thick sandstones, conglomerates and shales, with a dozen or more coal beds. At the base of the Pottsville is a thick-bedded, coarse-grained, conglomeratic sandstone known as the "Lookout sandstone." The sandstones and shales of the Pottsville which lie above the "Lookout" are known as the "Walden sandstone" formation. These sandstones are best developed on Sand, Lookout, Little

Sand, and Pigeon Mountains. Some of the beds are quite friable and can be crushed easily for sand.

Production

No production statistics are available for sandstone operations in northwest Georgia. In Dade County a small flagstone quarry has been opened in thin-bedded sandstone of the Pottsville formation on Lookout Mountain, 1¼ miles northeast of the intersection of State Highways 157 and 2. In Bartow County the Weisner quartzite formation is worked for flagstone and facings for homes and small commercial structures. The quarry is located 6 miles (airline) northeast of White and one mile east of Rydal on the Canton road.

Reserves

The reserves of sandstone as such are enormous. However, the possibilities of using special varieties, or stone which would meet definite chemical and physical specifications are largely unexplored.

References

Furcron, A. S., *The flagstone industry of Georgia,* Georgia Geol. Survey Inf. Circ. 12, 1940.

Sullivan, J. W., *The geology of the Sand-Lookout Mountain area of northwest Georgia,* Georgia Geol. Survey Inf. Circ. 15, 1942.

SLATE

Description

Slate is a general term for dense rocks formed from fine-grained deposits such as shales and having a texture so fine that the individual grains or crystals cannot be distinguished with the naked eye. It has an excellent parallel cleavage so that it breaks into thin plates which are indistinguishable from one another lithologically.

Uses

Dimension slate (blocks cut to specified sizes and shapes) is used for roofing, electrical bases and switchboards, billiard-table tops, school slates and blackboards, grave vaults and covers, floor tiles, sinks and many other purposes. Slate granules and flour are used in the manufacture of composition roofing products.

Location of Deposits

Roofing slates are found in Polk, Bartow, Gordon, and Murray counties. The deposits occur in three belts, namely:

Rockmart belt—The Rockmart belt somewhat parallels the Cartersville fault. It extends from a point about two miles southeast of Taylorsville, Bartow County, to about five miles south of Rockmart, Polk County.

Cedartown belt—A small belt occurs southwest of Cedartown, Polk County.

Fairmount belt—This belt extends from near White, Bartow County, northward through Fairmount, Gordon County, into Murray County.

Character and Occurrence of Deposits

The slates of the Rockmart and Cedartown belts occur in the Rockmart formation of Mississippian age. They are generally dark blue to black in color and fine grained. In the Fairmount belt the slates occur in the Conasauga formation of Cambrian age. These slates are more or less calcareous and contain considerable quantities of chlorite. Because of abundance of the latter mineral the slates have a blue-green color.

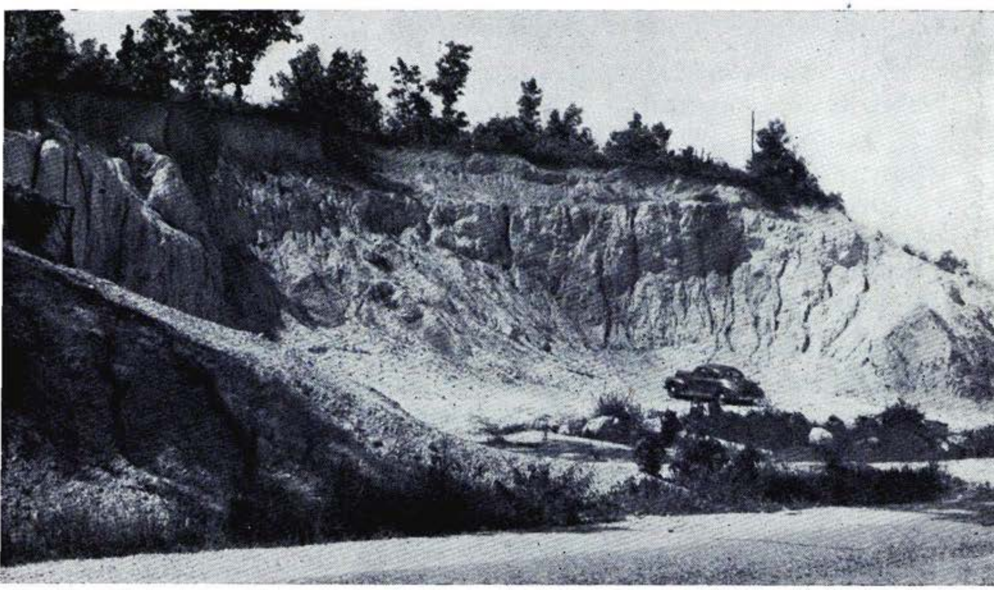

Fig. 14. Chert quarry (road surfacing material) U. S. Hy. 27, two miles south of Summerville, Chattooga County, Georgia.

Fig. 15. Slate quarry (Rockmart slate formation) Rockmart, Polk County, Georgia.

Production

Slate was quarried in the Rockmart district, Polk County, from about 1850 until the Civil War. The greatest development period was from 1880-1900. Since 1906 slate quarrying has declined steadily and there have not been more than two or three producers in any year. Production statistics are not available for recent years, but it has been estimated that the total production for the Rockmart district is approximately 50,000 squares (dimension slate).

Along the Cartersville fault (boundary fault described in Part I), the Conasauga shale formation has been altered to a medium green-colored slate. Since 1920 roofing granules have been produced from this slate at a plant located between Bolivar, Bartow County, and Fairmount, Gordon County (Map No. 35).

Reserves

The reserves for both dimension slate and granules are extremely large.

References

Furcron, A. S., and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

McCallie, S. W., *Mineral resources of Georgia,* Georgia Geol. Survey Bull. 23, 1926.

Shearer, H. K., *Slate deposits of Georgia,* Georgia Geol. Survey Bull. 34, 1918.

TRIPOLI

Description

Tripoli is essentially soft silica in a very fine or pulverulent form. Good grades average more than 95 percent silica. The alumina content is generally less than 2 percent and iron ranges from less than 0.2 percent to not more than 2 percent.

Uses

The most important use of tripoli is in the abrasive industry, especially as a fine polishing agent. It is also used as a filler in special paints, in the manufacture of rubber, in refractory cements, in special cements and concrete, and as a filter in water purification systems.

Location of Deposits

The tripoli deposits have a wide distribution throughout northwest Georgia. Some of the better known occurrences are in the vicinities of Lyerly and Harrisburg, Chattooga County; Silver Creek, Floyd County; Spring Place, Murray County; and Dalton, Whitfield County. These and other deposits are described in "Tripoli Deposits of Georgia" by G. W. Crickmay. (Ga. Geol. Surv., Info. Cir. 9, 1937).

Character and Occurrence of Deposits

Georgia tripoli is composed of fine grains of chalcedonic quartz. It has a low specific gravity and usually is loosely coherent. The color varies from white to reddish-brown, depending on the presence of small but variable amounts of iron oxides.

Most of the deposits occur as irregular beds from a few inches to several feet thick associated with chert layers in residuum of the Knox dolomite formation. In Chattooga County near Harrisburg tripoli deposits are associated with the "Bangor" limestone formation. Small deposits near Cartersville, Bartow County, occur in areas underlain by the Shady dolomite formation.

Two theories have been advanced for the origin of the Georgia tripoli. Perhaps the most commonly accepted explanation holds that the tripoli is a residual product originating from decomposition of siliceous limestone. The other theory postulates the introduction of silica by solutions subsequent to the formation of the enclosing rocks.

Production

Both underground and open-cut methods were used in northwest Georgia to mine tripoli. Only a limited amount was produced and the mines have not been worked since about 1936.

Reserves

The tripoli deposits have been only partly developed and their areal extent is not well known. The abandoned underground mines are inaccessible and the sides of old open-cut pits are so slumped that it is difficult to appraise the potential reserves. In order to compete with similar material produced in Missouri and Illinois it would be necessary to erect plants to crush, screen and classify the tripoli into a uniform product.

References

Crickmay, G. W., *Tripoli deposits of Georgia,* Georgia Geol. Survey Inf. Circular 9, 1937.

Furcron, A. S., and others, *Mineral resources of Georgia,* Georgia Geol. Survey, 1938.

McCallie, S. W., *Mineral resources of Georgia,* Georgia Geol. Survey Bull. 23, 1926.

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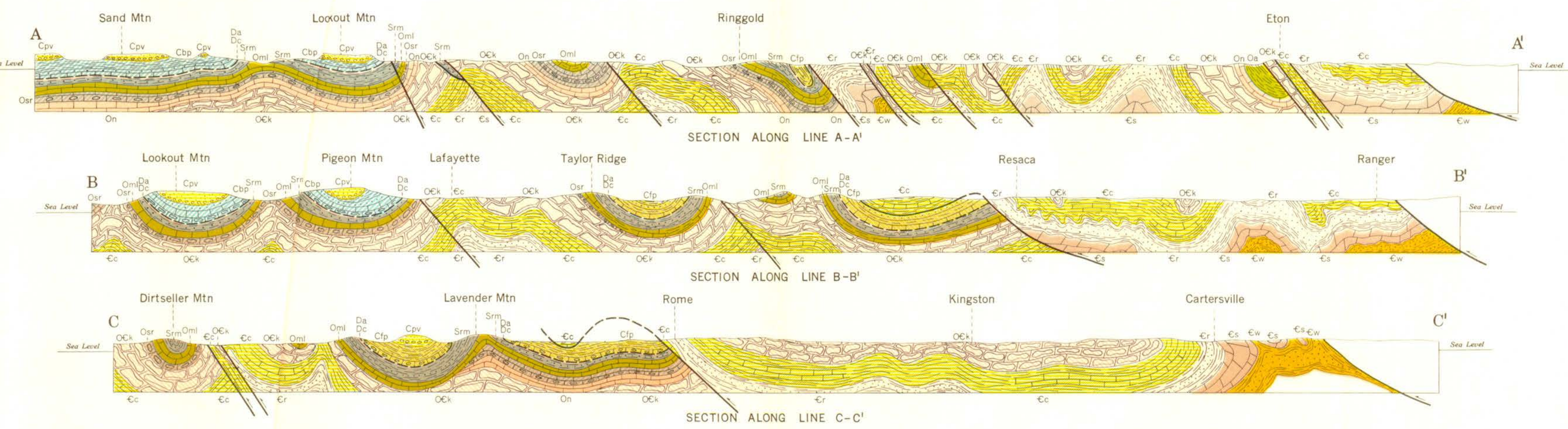

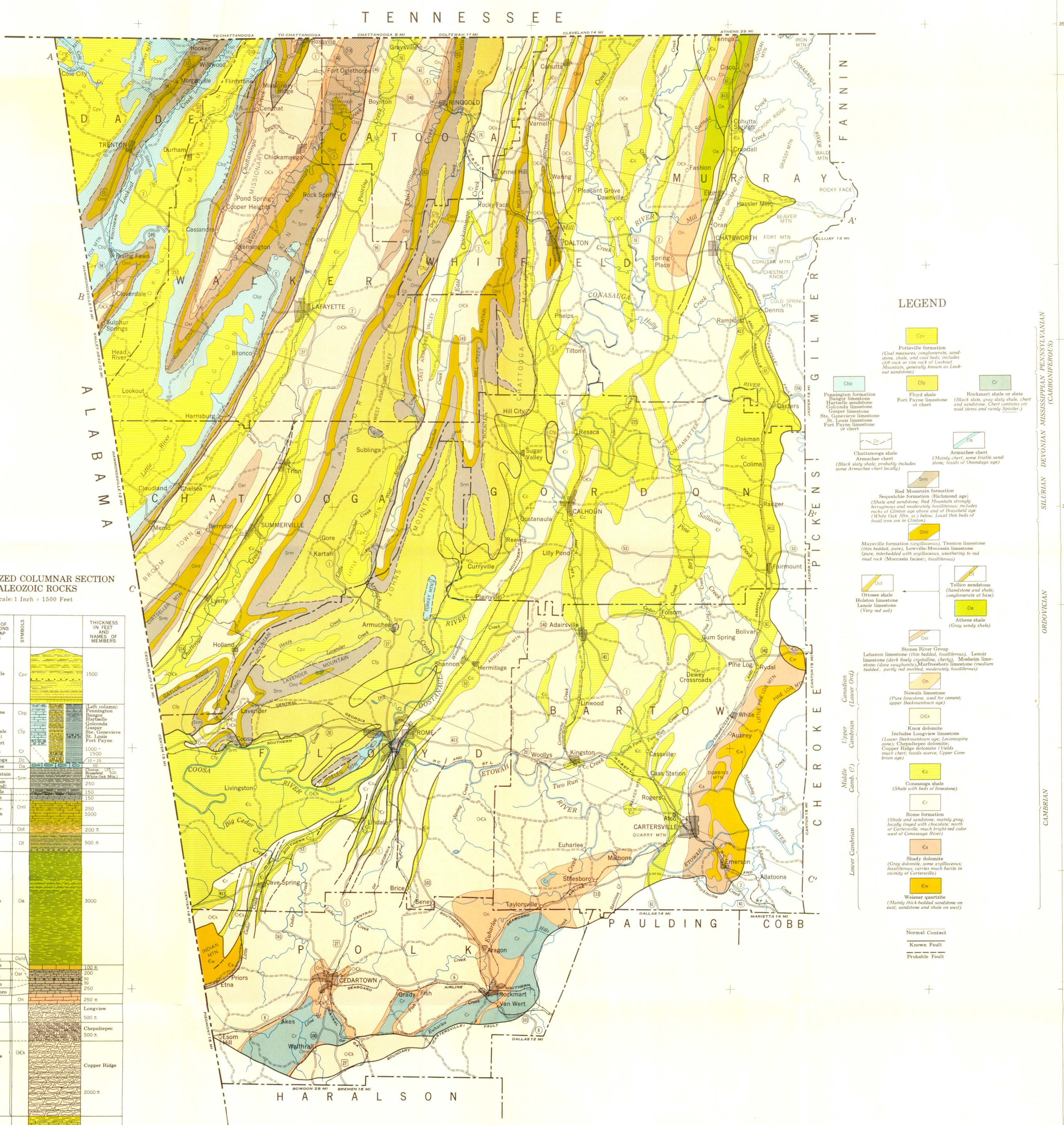

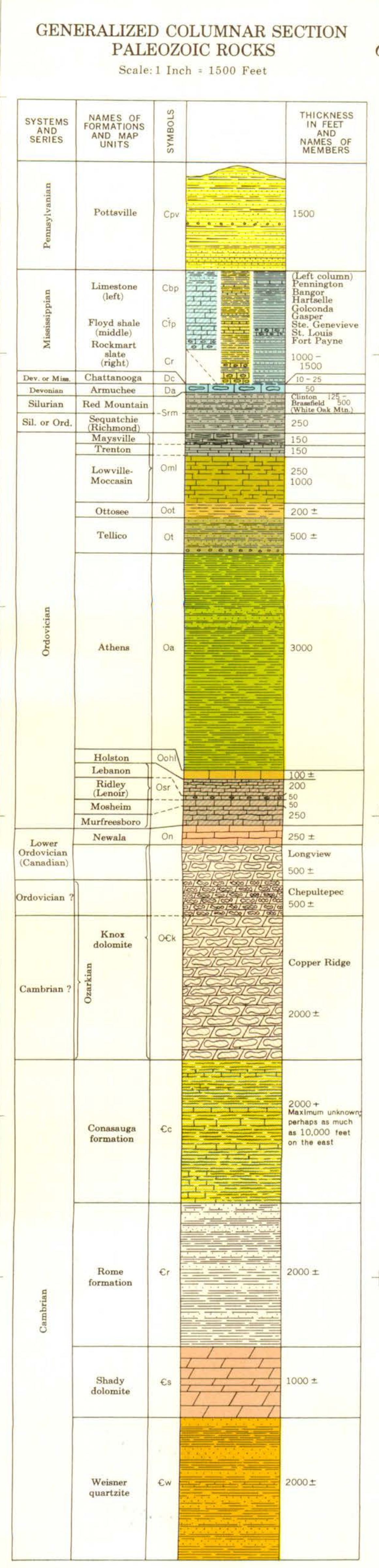

GEOLOGIC MAP OF NORTHWEST GEORGIA

BY CHARLES BUTTS

GEORGIA DEPARTMENT OF MINES, MINING AND GEOLOGY
IN COOPERATION WITH THE
TENNESSEE VALLEY AUTHORITY

Base maps having scales of one inch to one mile and one inch to one-half mile were used in the preparation of this re-issue of the geology of the Paleozoic area published in the 1939 edition of the State Geologic Map. Several revisions, made by geologists of the Commerce Department, Tennessee Valley Authority, are based on additional information obtained in recent surveys of mineral resources, together with changes necessitated in the transfer of formational contacts to the new base map, prepared by the Maps and Surveys Division, Tennessee Valley Authority.

SCALE OF MILES

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1946

MINES, QUARRIES AND PROSPECTS

BARITE
6. Du Pont mine, Bartow County.
7. Paga Mining Company mines (No. 1), Bartow County.
8. Nulsen mine, Bartow County.
10. Paga Mining Company mine (No. 2), Bartow County.
11. Barite Mining Company mine, Bartow County.
14. New Riverside Ocher Company mine (No. 1), Bartow County.
15. T. E. Johnsey mine, Bartow County.
16. George E. Shropshire mine, Bartow County.
18. New Riverside Ocher Company mine (No. 2), Bartow County.

BAUXITE
38. Gilbreath and other mines, Bartow County.
40. Barnsley mines, Bartow County.
41. Hermitage mines, Floyd County.
72. Cave Springs mines, Floyd County.
73. Montgomery & Phillips mines, Floyd County.
74. Prospect Church mine, Floyd County.
76. Reynolds prospect, Floyd County.
77. Bobo mine, Floyd County.
78. Asbury mine, Floyd County.
79. Bradshaw mine, Floyd County.
84. J. T. Waters mine, Floyd County.
92. Armington mine, Walker County.

CEMENT
39. Howard Hydraulic Cement company quarry (natural cement rock), Bartow County.
49. Southern States Portland Cement Company plant, Polk County.

CHERT
88. County chert pit (Largest and most continuously worked pit in the area. Numerous small pits throughout northwest Georgia not shown), Gordon County.

CLAY
46. Ladd Lime and Stone Company pits, Polk County.

COAL
96. Inglis Industries mine, Dade County.
100. V. P. Serodino Company, Inc. mine, Dade County.

COAL (Continued)
102. Progressive Industries mines, Walker County.
Numerous old mines in Dade and Walker Counties not shown.

FLAGSTONE
34. Upshire quarry, Bartow County.
101. Progressive Industries quarry, Dade County.

HALLOYSITE
89. J. E. Brand mine, Chattooga County.
97. Halloysite mine, Dade County.

IRON
1. C. M. Jones mine (No. 1), Bartow County.
2. C. M. Jones mine (No. 2), Bartow County.
3. Mibb mine, Bartow County.
4. Crow mine, Bartow County.
5. Allatoona mine, Bartow County.
20. Hurricane Hollow mines, Bartow County.
23. Dobbins mine (No. 1), Bartow County.
24. Dobbins mine (No. 2), Bartow County.
26. Old Guyton mine, Bartow County.
27. Bufford Mountain mine (No. 1), Bartow County.
28. Bufford Mountain mine (No. 2), Bartow County.
32. Sugar Hill mine (No. 1), Bartow County.
33. Sugar Hill mine (No. 2), Bartow County.
44. Hodge Mining Company mines, Bartow County.
45. T. H. Randall mine, Polk County.
47. Albea & York mine, Polk County.
51. Grady mine (No. 1), Polk County.
52. Grady mine (No. 2), Polk County.
53. J. K. Davis mine, Polk County.
54. J. D. Waddell mine, Polk County.
55. John Purcell mine, Polk County.
56. Reed mine, Polk County.
57. Woodstock mine, Polk County.
58. Lary mine, Polk County.
59. G. M. Leslie mine, Polk County.
60. Peek mine, Polk County.
61. Edward Graves prospect, Polk County.
62. J. F. Hill prospect, Polk County.

IRON (Continued)
63. Cedartown mine (No. 1), Polk County.
64. Cedartown mine (No. 2), Polk County.
65. E. H. Alred mine, Polk County.
66. T. J. Woodard mine, Polk County.
67. Clemmons Hill mine, Polk County.
68. Charlie Fite mine (No. 1), Polk County.
69. Charlie Fite mine (No. 2), Polk County.
70. Oredell mine, Polk County.
71. Hematite mine, Polk County.
93. Sugar Valley Land Company mine, Walker County.

LIMESTONE
36. Aggregate quarry, Gordon County.
37. Highway quarry, Bartow County.
43. Ladd Lime and Stone Company quarry, Bartow County.
48. Piedmont Portland Cement Company quarry, Polk County.
49. Southern States Portland Cement Company quarry, Polk County.
80. County quarry, Floyd County.
90. Aggregate quarry, Chattooga County.
95. Horine Development Company quarry, Walker County.
98. Southern Iron & Steel Company quarry, Dade County.
99. Dave L. Brown quarry, Dade County.
103. Road quarry, Walker County.
104. Road quarry, Walker County.
105. Dave L. Brown quarry, Walker County.
106. Graysville quarry, Catoosa County.
107. Hales quarry, Catoosa County.
108. Clark quarry, Catoosa County.
109. Fry quarry, Catoosa County.
111. Dalton City quarry, Whitfield County.
114. Jet Black Marble Company quarry, Whitfield County.
115. County quarry, Whitfield County.

MANGANESE
5. Allatoona mine, Bartow County.
19. Blue Ridge Ocher Company mine (No. 1), Bartow County.
21. Blue Ridge Ocher Company prospect, Bartow County.
22. Blue Ridge Ocher Company mine (No. 2), Bartow County.
23. Dobbins mine (No. 1), Bartow County.
24. Dobbins mine (No. 2), Bartow County.

MANGANESE (Continued)
25. Houck mine, Bartow County.
29. White Manganese Corporation mines (No. 1), Bartow County.
30. White Manganese Corporation mine (No. 2), Bartow County.
31. Chumley Hill mine, Bartow County.
75. Berkstresser prospect, Floyd County.
110. Catoosa Mining Company prospects, Whitfield County.

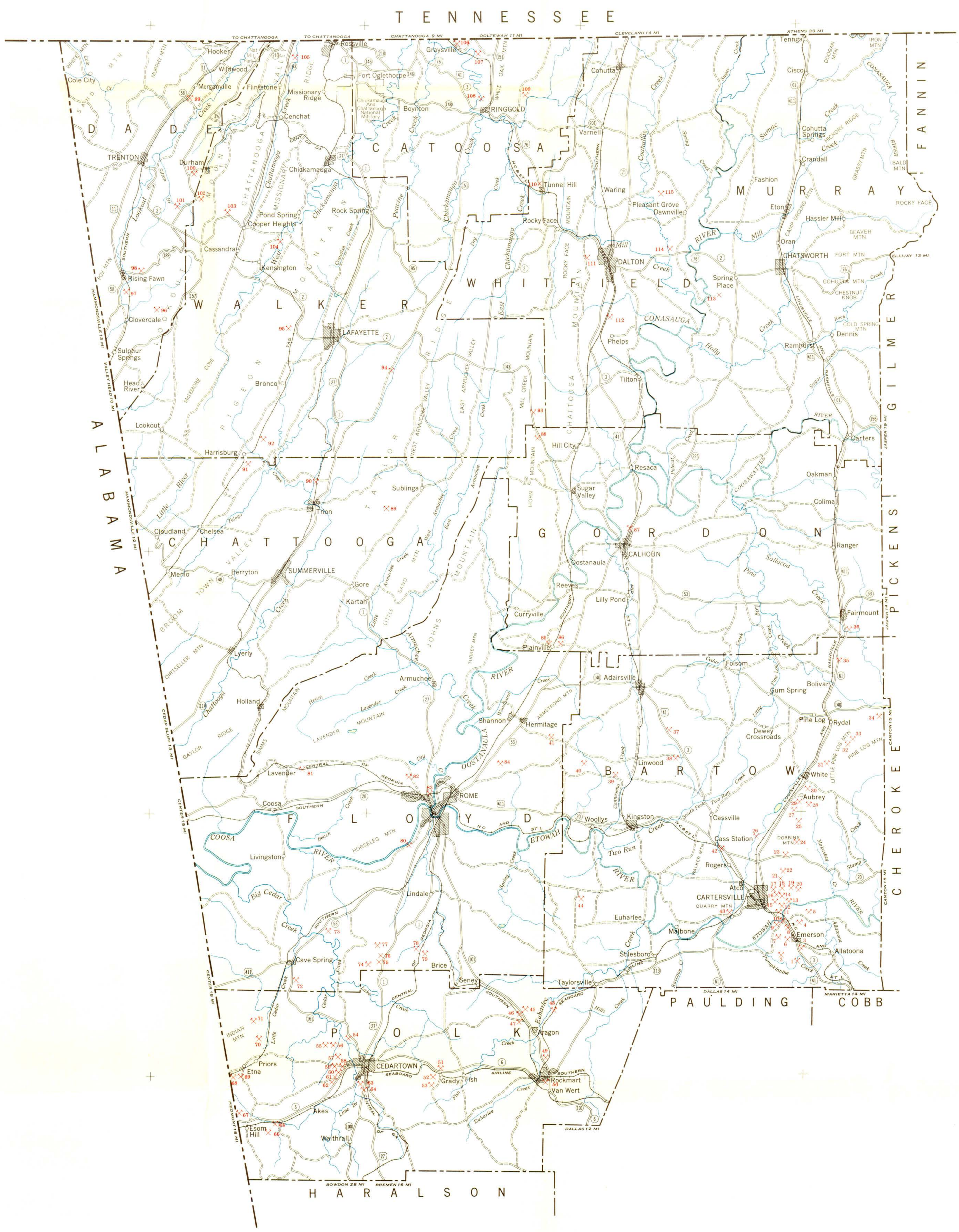
OCHER
9. Georgia Peruvian Company mine, Bartow County.
12. New Riverside Ocher Company mines, Bartow County.
13. American Ocher Company mine, Bartow County.
14. New Riverside Ocher Company mine (No. 1), Bartow County.
17. Cherokee Ocher Company mine, Bartow County.
19. Blue Ridge Ocher Company mine (No. 1), Bartow County.
21. Blue Ridge Ocher Company prospect, Bartow County.
22. Blue Ridge Ocher Company mine (No. 2), Bartow County.

SHALE
35. Funkhouser Company quarry, Bartow County.
42. Georgia Art Pottery Company pits, Bartow County.
81. Oconee Clay Products Company pits, Floyd County.
82. Berry School shale pit, Floyd County.
83. Rome City shale quarry, Floyd County.
85. Plainville Brick Company pits (No. 1), Gordon County.
86. Plainville Brick Company pits (No. 2), Gordon County.
87. Calhoun shale pit, Gordon County.
112. Dalton Brick and Tile Company pits, Whitfield County.

SLATE
50. Rockmart slate quarry, Polk County.

TRIPOLI
91. Dallas York mine, Chattooga County.
94. Boss mine, Walker County.
113. Farrar prospect, Murray County.

× Prospects
⚒ Mines and quarries



NORTHWEST GEORGIA AREA
MINES, QUARRIES AND PROSPECTS

GEORGIA DEPARTMENT OF MINES, MINING AND GEOLOGY
IN COOPERATION WITH THE
TENNESSEE VALLEY AUTHORITY

SCALE OF MILES
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MAPS AND SURVEYS DIVISION

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