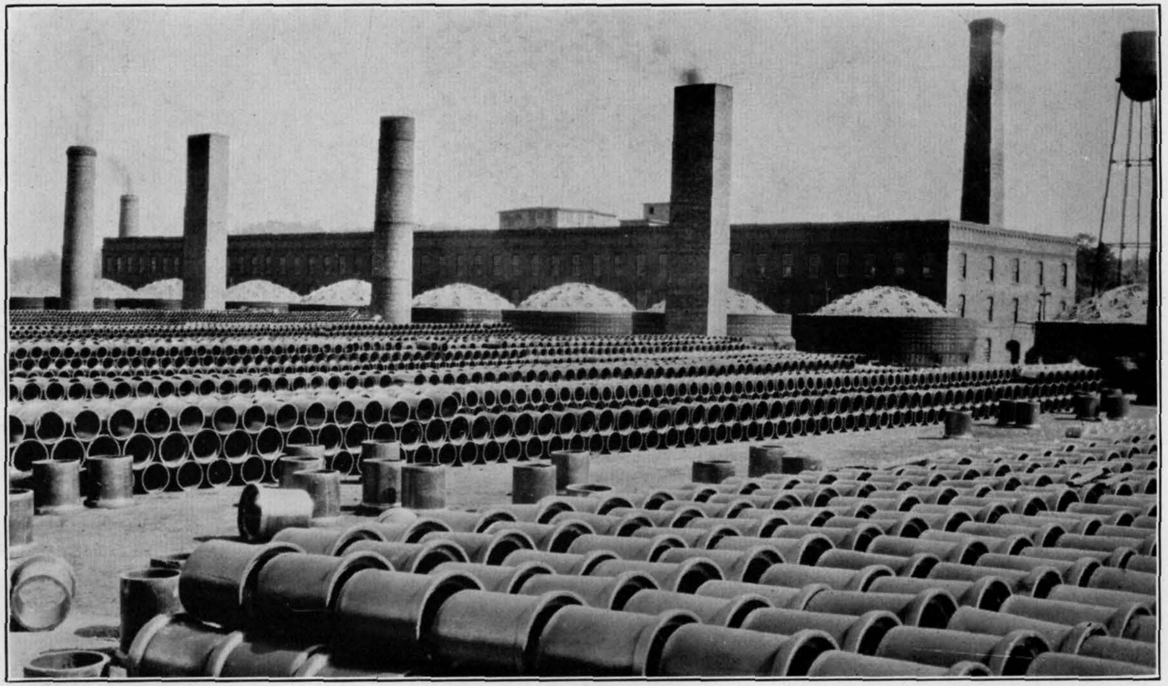

W. S. DICKEY CLAY MFG. COMPANY, SEWER PIPE PLANT NO. 11, NEAR FLINTSTONE, WALKER COUNTY.

GEOLOGICAL SURVEY OF GEORGIA

S. W. McCALLIE, State Geologist

BULLETIN NO. 45

SHALES AND BRICK CLAYS

OF

GEORGIA

BY

RICHARD W. SMITH

Assistant State Geologist

1931

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GEOLOGICAL SURVEY OF GEORGIA,

ATLANTA, SEPTEMBER 1, 1931.

To His Excellency, RICHARD B. RUSSELL, JR., Governor and President of the Advisory Board of the Geological Survey of Georgia.

SIR: I have the honor to transmit herewith for publication the report of Mr. Richard W. Smith, Assistant State Geologist, on the Shales and Brick Clays of Georgia. This report is the fourth report published by the State Geological Survey on the ceramic materials of the State. The first report, published in 1898, was confined entirely to the Cretaceous clays of south Georgia, the second report included not only the Cretaceous clays of south Georgia but gave a general description of the clays of the entire State, the third report was confined solely to the sedimentary clays of the Coastal Plain, including not only the Cretaceous clays but also the Eocene clays of the Tertiary age, whereas this report is confined to the shales and the brick clays of the entire State.

The large amount of information brought together in this report will be of great assistance in the expansion of the heavy clay products industry of Georgia that will accompany the industrial growth of the South.

Very respectfully yours,

S. W. McCALLIE,

State Geologist.

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PREFACE

Two reports on the clays of Georgia were issued prior to 1926 by the Georgia Geological Survey. Bulletin 6, A Preliminary Report on a Part of the Clays of Georgia by Dr. Geo. E. Ladd, issued in 1898, was concerned only with the sedimentary kaolins along the Fall Line. Bulletin 18, A Second Report on the Clay Deposits of Georgia by J. O. Veatch, issued in 1909, was a comprehensive report on all the clay resources of the State and did much towards furthering their utilization.

Since Veatch's report was issued, the clay mining and working industries of Georgia have shown a remarkable progress. The production of sedimentary kaolin from Middle Georgia for filler, white ware, and refractory uses was in 1927 over five times that of 1909. The brick and tile industry using the alluvial clays of Middle Georgia has greatly increased. The shales of Northwest Georgia have found an extensive use in the manufacture of brick, tile, and sewer pipe. The increasing interest in the industry has lead to the discovery of many deposits unknown at the time of Veatch's investigation. The need of a new detailed survey of the clay resources of the State was imperative.

The writer began his investigation of the clays of the State in July, 1926. The field seasons of 1926 and 1927 were spent in Middle and South Georgia simultaneously investigating the kaolins, bauxites, brick clays, and fullers earths. The ceramic tests on the kaolin and bauxite clay samples collected were made by the writer in the winters of 1926–27 and 1927–28 at the Ceramic Laboratory of the Georgia School of Technology. The mass of data on these sedimentary kaolins and bauxitic clays alone was so great that it was written up and published in 1929 as Bulletin 44, The Sedimentary Kaolins of the Coastal Plain of Georgia.

The writer spent the summer and fall of 1929 and the spring of 1930 investigating the shales of Northwest Georgia. The ceramic tests on the shale samples, together with the brick clay samples previously collected from Middle and South Georgia, were made in the winter of 1929–30 and the summer and fall of 1930 at the Ceramic Laboratory of the Georgia School of Technology under the direction of Dr. A. V. Henry, Director of the Department of Ceramics. During a part of the time the writer was assisted by one of the ceramic students. All of the chemical analyses that accompany the laboratory tests were made by Dr. Edgar Everhart, Acting Chemist of the Georgia Geological Survey.

This report has been written for two very different types of readers: the average man who is interested in the mineral resources of Georgia or who is interested in the possible uses and value of one of the deposits described in this report, and the ceramist or heavy clay product manufacturer who is thinking of locating a plant in Georgia and wishes accurate information as to the location and character of the raw materials he needs for his particular product. The average man will not understand all of the detailed property descriptions and ceramic tests without a careful study of the introductory sections of the report, particularly those on Properties of Clays and Uses of Red-firing Shales and Clays. The ceramist or heavy clay product manufacturer will find the basic facts that he desires, along with much explanatory matter that has long been familiar to him, and will make his own interpretation of the data given. Neither should fail to read the concluding chapter on the Future of the Industry.

The writer wishes to acknowledge his thanks to Mr. S. W. McCallie, State Geologist of Georgia, for criticism and advise; to Dr. A. V. Henry, Prof. W. H. Vaughan, and the other members of the Ceramic Department of the Georgia School of Technology, who cooperated so willingly in the laboratory work and gave much valuable advice during the writing of the report; to Katherine Cox Smith for measuring the colors of the test bars and for preparing the drawings of Figures 5–25; to Mr. J. M. Mallory, General Industrial Agent of the Central of Georgia Railway for assistance and information; to the Munsell Color Company, Inc., Baltimore, Md., for criticism of the description of their color system and for the use of the electrotypes for Figures 1 and 2; to Mr. Julius Rink, Mr. J. L. Rowland of LaFayette and Mr. J. M. Dobbins of Cassandra for freely giving of their time in showing the writer the shale deposits of Walker County; to the secretaries of the Chambers of Commerce of Rome, Macon, Augusta, and Columbus for valuable publicity and assistance; to the newspaper editors in all the counties visited for publicity; to the managers and superintendents of all of the shale and clay pits and brick, tile, and sewer pipe plants visited for their help and courtesy; and to the many citizens without whose interest and cooperation the investigation would not have been a success.

Richard W. Smith,
Assistant State Geologist.

Atlanta, Georgia, September 1, 1931.

SHALES AND BRICK CLAYS OF GEORGIA

HISTORY OF THE INDUSTRY

The first brick used in the colony of Georgia were brought from England. Examples of these brick may be seen today in some of the colonial houses of Savannah and Augusta. The "Old Pink House" in Savannah, built for James Habersham in 1789; the "Owens House" on Oglethorpe Avenue, built in 1812 or 1815; and the outhouses of the "Read House" at 118 East State Street are built of English brick.[1] The brick in the "Old Clayton Home" on Greene Street, Augusta, and in the wall around St. Paul's churchyard are reputed to have been brought from England.

The first brick manufactured in Georgia were probably made at Ebenezer on the Savannah River in Effingham County. According to Veatch[2]:

"A colony of Salzburgers settled here in 1733 and in 1769 built a brick church, the bricks being made at this locality, which is at the present time in a state of tolerable preservation and is still used for religious services. The brick are a dark red, a little larger than standard size, and quite sandy and porous."

Building brick were often made on the larger plantations in the early days. An annular pit about three feet deep and eight to fifteen feet in diameter was dug near a deposit of swamp or bottom-land clay on the plantation. A revolving post in the center of the pit supported one end of a pole that passed through the center of a disk-shaped stone, like a mill-stone. A mule fastened to the other end of the pole served as power for making the stone travel around the pit, tempering the clay to the consistency of paste. The bricks were fashioned in hand-made molds, air dried, laid in the form of a rough rectangular kiln, and fired with wood fires.

Permanent brick works were probably soon established where there were deposits of alluvial clays near the larger settlements. One of these old brick works near Savannah has recently been described[3] as follows:

"Henry McAlpin, a native of Scotland, heir of a 'goodly inheritance,' well educated, came from Charleston, South Carolina, to Savannah about 1805. Soon after his arrival at Savannah, he began to purchase adjoining tracts of land in its vicinity, and these in entirety became the planatation known as the 'Hermitage'—the original name of the plot whereon is now the ruins of his mansion and where his railroad was located. He stocked the plantation with horses and slaves and with the assistance of these, constructed a brick manufacturing plant for the purpose

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[1]Personal correspondence with J. M. Mallory, Savannah, Ga.

[2]Veatch, J. O., Second report on the clay deposits of Georgia: Georgia Geol. Survey Bull. 18, p. 322, 1909.

[3]Colquitt, Dolores Boisfeullet, America's first railroad was built in Jan., 1820 at Hermitage Plantation here, Savannah Morning News, Dec. 1, 1929.

of utilizing a stratum of clay found on the premises which proved admirably suited for bricks.

"The railroad built by McAlpin in January, 1820, ran between the kilns of this brick manufactory which was located about fifty feet away from the bank of the Savannah River and three hundred yards south of the present mansion ruins at the 'Hermitage.' Its purpose was to transport from kiln to kiln a large frame house, fifty-one by forty-five feet with a nearly square pitched roof which was used to cover a kiln while it was being filled with green or unburned brick, and removed when the kiln was fired. This house was carried on the railroad by an enormous, strong, four-wheeled truck set upon flanged iron rails.

"* * * Horses were doubtless the motive power used for McAlpin's railroad, for it is known that he kept many of these animals, and besides, at the time of the building of his railroad, the steam locomotive was unknown. * * *

"The manufacturing proved a success, turning out, over a period of about half a century, great quantities of bricks noted for their size and durability, and they are what are known today as 'Savannah gray brick.' These went into the construction of buildings, many of which are in existence, erected in this city during its thriving commercial era preceding the Civil War. The old culverts of the Central of Georgia Railway are built of 'Hermitage' bricks."

Mallory[1] states in regard to these culverts:

"* * * the culverts or viaducts under our railroad, just as you leave Savannah were built of these brick. One of the viaducts was completed in 1852 and the other in 1859. Both are in splendid condition and have served the heavier motive power and equipment which have been added throughout the years."

Another early brick plant was the Delaigle Brick Yards in Augusta, established in 1808 by Nicholas de l'Aigle, a French refugee, who came to this country in 1804, and about whom many legends still exist. This plant was sold in 1868 to Dennis Hallahan, who operated it for many years. The following description of the plant is by M. J. Hallahan,[2] son of the owner and for many years superintendent of the business.

"The outfit, consisting of a mule and six men, could manufacture 7,000 green brick a day. * * * The clay (alluvial from the flood-plain of the Savannah river) was dumped into a 'pug' mill and mixed into a dough. The 'pug' mill was a large cylindrical vat into which fitted a pulverizer, or what could be termed a dasher, which turned and sometimes acted as a plunger in pulverizing the clay. It turned by means of a long pole, which protruded therefrom, that turned around according to the pace set by a walking mule.

"After being sufficiently pulverized, the soft dough was put away into molds at the mill and toted to the drying section a few yards away. Two bricks were moulded and laid out to dry at the same time. The molds were turned bottom up and with expert hands, the laborer lifted the molds without making an imprint on the soft brick.

"This was the first step in manufacturing hand-made brick. As the brick dried on one side and then the other, they were set on end, on edge, and, as they hardened, other brick were stacked upon them, leaving enough room for the air to circulate. At times a heavy rain came up and washed the stacks of green brick to the ground.

"In those days it took a week to run off a kiln of brick. The kiln was constructed much simpler than the present ones and was big enough to turn out tons upon tons of the product. No means of equalizing the heat so as burn brick at the top and bottom of the kiln at the same degree was then used. This resulted in three grades of brick. Those stacked in the center of the kiln were the most beautiful * * * and the durability excellent. The upper layer did not receive the full benefit of the heat, resulting in a softer and most undependable brick. This product sold

[1]Mallory, J. M., Gen. Industrial Agent, Cent. of Ga. Ry., letter to writer, Jan. 31, 1931.

[2]From interview by Jack Bates, courtesy of the Augusta Chamber of Commerce.

cheapest and was used for inside construction. The bricks stacked next to the fire were overheated, giving the product a dark, purplish hue. These were used in the rear of the less-seen sections of structures. However, they were durable.

"The season for making brick extended from March 1 to the middle of October. Some seasons not more than one or two kilns were run off. At most, one a month. The Delaigle yards sold brick over a wide range of territory. Often the product was used as ballast in ships plying North and South as means of shipping. * * * The dwelling on Greene Street in Augusta, known as the John D. Twiggs place was the summer home of Nicholas de l'Aigle and was constructed of the finest specimen of the Delaigle plant."

Brick plants were also early established at Macon, Columbus, Milledgeville, Atlanta, and other centers of population. By 1888 the industry was well established, as shown by the following figures collected by the U. S. Geological Survey[1]:

Brick production of Georgia in 1888

Albany	3,000,000
Atlanta	22,000,000
Augusta	15,000,000
Columbus	12,000,000
Dublin	1,500,000
Fort Gaines	500,000
Macon	25,000,000
Milledgeville	1,600,000
Rome	15,000,000
Total	95,600,000

The shale deposits of Northwest Georgia were not used for the manufacture of brick until 1905. The Rome Brick Company, now the Rome Plant of the B. Mifflin Hood Brick Company (see page 112), used a mixture of Conasauga shale and alluvial clay to manufacture common and pressed brick. Soon after this the Legg Brothers Company, now the Calhoun Plant of the B. Mifflin Hood Brick Company (see page 212), at Calhoun used Conasauga shale for the manufacture of face brick.

Vitrified paving brick were first made at Campania, about 20 miles west of Augusta, by the Georgia Vitrified Brick Company (see page 285) in 1902.

The first commercial manufacture of sewer pipe in Georgia was at Stevens Pottery in Baldwin County in the late sixties or early seventies. W. P. Stapler, president of the former Stevens, Inc., states[2]:

"Mr. Henry Stevens of Cornwall, England, came to Georgia in the fifties. He bought a large tract of land at what is now known as Stevens Pottery for the timber. This timber was sawed and kaolin was discovered on this land. He sent back to England and imported some potters, and in 1861 began the manufacture of jugs, jardinieres, vases, urns, etc.

"He operated the property until his death; at which time Mr. W. C. Stevens, his eldest son, and Mr. J. H. Stevens, his second son, took over the management of Stevens Pottery. They continued making the potteries and added to this line, flower pots and sewer pipe. A hollow tree was rounded out with a smooth plunger attached and through this the mud was forced out into a hollow pipe, and the collars were put on by hand. * * *

"In about 1900 the pottery business was discontinued and the pottery section of the plant was devoted to the manufacture of fire brick. In the meantime, the sewer pipe business had been extended until it was the largest portion of the production.

[1]Day, D. T., U. S. Geol. Survey Mineral Resources, 1888, p. 558, 1890.
[2]Stapler, W. P., personal correspondence with the writer, 1928.

"In 1916 fire destroyed the fire brick or pottery plant. A large new plant was rebuilt * * * and equipped solely for the production of fire brick. Since that time, both Mr. W. C. and Mr. J. H. Stevens have died, but the fire brick business has increased to the extent that in 1926, we discontinued the manufacture of sewer pipe."

The manufacture of heavy clay products is now one of the most important industries in Georgia dependent on mineral resources, as shown by the following table of production statistics:

Production of Heavy Clay Products in Georgia[1]

Product	1928	1927	1926
Common brick:			
Number establishments	13	14	14
Thousands	149,002	175,232	227,218
Value	$ 1,216,910	$ 1,405,268	$ 1,885,416
Face brick:			
Number establishments	6	6	6
Thousands	24,902	26,557	34,256
Value	$ 346,188	$ 382,027	$ 562,413
Hollow brick, Terra cotta, Flue lining:			
Number establishments	5	4	4
Tons	10,738	10,617	13,054
Value	$ 556,310	$ 459,445	$ 646,486
Hollow building tile:			
Number establishments	6	6	7
Tons	115,720	89,411	158,967
Value	$ 596,179	$ 475,605	$ 902,421
Roofing tile, Drain tile:			
Number establishments	6	4	5
Squares	7,184	7,184	16,193
Tons	2,631	2,538	3,849
Value	$ 106,089	$ 106,914	$ 242,171
Paving blocks, Fire brick, Segment blocks:			
Number establishments	6	5	11
Thousands	13,460	25,090	20,355
Tons			600
Value	$ 315,089	$ 608,784	$ 574,980
Sewer pipe, chimney pipe and tops:			
Number establishments	8	7	6
Tons	41,068	92,826	98,180
Value	$ 492,819	$ 1,407,364	$ 1,115,106
Wall coping:			
Number establishments			3
Tons	a	a	693
Value	a	a	$ 8,702
Total Value [b]	$ 3,630,441	$ 4,853,942	$ 5,957,486

[a]Not given separately, but value included in total.
[b]Includes value of miscellaneous products not given separately above.

[1]From Mineral Resources, U. S. Bureau Mines, 1926, etc.

PROPERTIES OF CLAYS[1]

Clay may be defined as "an earthy or stony mineral aggregate consisting essentially of hydrous silicates of alumina, plastic when sufficiently pulverized and wetted, rigid when dry, and vitreous when fired at a sufficiently high temperature."[2]

CLASSIFICATION OF CLAYS

Clays may be classified according to their origin, chemical and physical properties, or uses. The first classification is, perhaps, of most interest to the geologist, the second and third, which are related, to the technologist or ceramist.

An example of a classification according to origin is the following by Ries,[3] modified slightly by the writer:

Ries's Classification

A. Residual clays. Formed in place by rock alteration due to various agents, of either surface or deep-seated origin.

- I. Those formed by surface weathering, the processes involving solution, disintegration, or decomposition of silicates.
  - (a) Primary kaolins, white in color and usually white firing.

Parent Rock	*Shape*
Granite, Pegmatite, Rhyolite, Limestone, Shale, Feldspathic Quartzite, Gneiss, Schist, etc.	Blankets; tabular steeply dipping masses; pockets or lenses.

  - (b) Ferruginous clays, derived from different kinds of rocks. Red and buff firing. (Ex. Residual clays of Georgia derived from schist and gneiss.)
- II. White residual clays formed by the action of ascending waters possibly of igneous origin.
  - (a) Formed by rising carbonated waters.
  - (b) Formed by sulphate solutions.
- III. Residual clays formed by action of downward moving sulphate solutions.
- IV. White residual clays formed by replacements, due to action of waters supposedly of meteoric origin.

B. Colluvial clays, representing deposits formed by wash from the foregoing and of either refractory or non-refractory character.

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[1]Much of the information in this section was obtained from:
Ries, H., Clays; their occurence, properties, and uses: 3d ed., 1927.
Veatch, J. O., Second report on the clay deposits of Georgia: Georgia Geol. Survey Bull. 18, 1909.
Stout, Wilbur, and others, Coal-formation clays of Ohio: Ohio Geol. Survey 4th ser., Bull. 26, 1923.

[2]Standard definition. The standards report for the American Ceramic Society for 1928: Am. Ceramic Soc. Jour., vol. 11, p. 347, 1928.

[3]Ries, H. Op. cit., pp. 36–37.

C. Transported clays.
- I. Deposited in water.
  - (a) Marine clays or shales. Deposits often of great extent. (Georgia shales) White-firing clays. (Sedimentary kaolins, ball clays)
    Fire clays or shales, buff-firing.
    Impure clays or shales. { Calcareous. / Non-calcareous.
  - (b) Lacustrine clays. (Deposited in lakes or swamps.)
    Fire clays or shales.
    Impure clays or shales, red-firing.
    Calcareous clays, usually of surface character.
  - (c) Flood-plain clays.
    Usually impure and sandy. (Alluvial brick-clays of Georgia.)
  - (d) Estuarine clays. (Deposited in estuaries.)
    Mostly impure and finely laminated.
  - (e) Delta clays.
- II. Glacial clays, found in the drift, and often stony. May be either red or cream-firing.
- III. Wind-formed deposits. (Some loess.)
- IV. Chemical deposits. (Some flint-clays.)

Other classifications are based on physical properties or uses. One of the best of these is that of Parmelee,[1] based on both the physical properties and uses of clays.

A shale is a thinly stratified, consolidated sedimentary clay, originally of marine or lacustrine origin, with well marked cleavage parallel to the bedding. Fine grinding or weathering of a shale will restore more or less of the plasticity and other characteristics of the original clay. Further metamorphism of a shale by heat and pressure results in slate, in which form fine grinding produces little or no plasticity.

CHEMICAL PROPERTIES

Clay, in its simplest form, would consist entirely of hydrated aluminum silicate, such as kaolinite or allied minerals. Since clays are formed from the decomposition of the earth's crust, simple clays are rarely ever found. All clays contain more or less accessory constituents in addition to the hydrated silicates of aluminum. The quantity of accessory constituents varies greatly in different clays; ranging from a few per cent in the case of some of the sedimentary kaolins to 50 or more per cent in the case of some of the brick and other clays of common occurrence. All the constituents of clay influence its behavior in one way or another, their effect often being noticeable when only small amounts are present. The various accessory constituents in clay have different properties. Most of them promote fusion, but some are far more active than others. A few are influential also in the development of colors. In a general way, the finer the accessory minerals and the more evenly they are distributed in the clay, the greater their effect

[1]Parmelee, C. W., and Schroyer, C. R., Further investigations of Illinois fire clays: Illinois Geol. Survey Bull. 38, pp. 278–280, 1922.

in producing changes. The chemical analysis of a clay may give some indication of its properties, but its value is limited because it does not show the exact minerals in which the elements are combined, the fineness of the grains, and other factors upon which the physical properties depend. The influence of the various components usually found in clays can perhaps best be discussed individually.

SILICA

Silica is present in clay in two forms, namely, uncombined as silica or quartz, and in silicates. The uncombined silica is usually quartz, but flint, chalcedony, or hydrous silica may be present. The silicates may be kaolinite or other hydrous aluminum silicates, micas, feldspars, glauconite, hornblende, garnet, etc.

In the chemical analyses accompanying this report, the free and the combined silica are reported together. Probably over half of the silica found in the shales is free silica.

ALUMINA

Most of the alumina found in clays is in combination with silica, as a silicate. Kaolinite (39.8 per cent alumina) and other hydrous aluminum silicates account for most of this, but some of the alumina may be present as feldspar, mica, and other silicates. The average alumina content of the shales and brick clays of Georgia, as shown by the chemical analyses that accompany this report, is about 20 per cent, slightly more than half of the amount in theoretically "pure clay."

IRON

Iron may be present in clays in the form of: *limonite* or other yellow and brown hydrous iron oxides; *hematite,* the red iron oxide (Fe_2O_3); *magnetite,* the black iron oxide (Fe_3O_4); *pyrite* or "fool's gold" (FeS_2), *siderite* ($FeCO_3$), and *glauconite,* a green hydrated silicate of potash and iron. Most of the accompanying chemical analyses report the iron as ferric oxide, Fe_2O_3, although in some of the analyses the ferrous oxide, FeO, has been separately determined. The common ferrous minerals found in clays are pyrite (FeS_2) and siderite ($FeCO_3$).

The iron oxides have both a coloring action and a fluxing action. In general, clay containing less than 1 per cent ferric oxide fires white; from 1 to 2 per cent fires to a light cream-color; and increasing amounts over 2 per cent fire to cream, buff, and red colors. However, the color to which a clay will fire cannot accurately be predicated from the amount of ferric oxide shown by the chemical analysis. The color and depth of shade probably depend upon: (1) the amount of iron in the clay; (2) the minerals or chemical combination in which the iron is present; (3) the size of the particles; (4) the presence of other minerals that may influence the color; (5) the temperature of firing; (6) the degree of fusion; and (7) the condition of the kiln atmosphere. For example, two of the shales sampled for this report had 5.26 per cent ferric oxide (dry basis). At cone 3 one fired to a light brownish-red and the other to a good red. The fluxing action of iron oxide probably depends upon similar factors.

The iron oxide content of the samples of shales and brick clays of Georgia ranged from 2.65 per cent to 14.05 per cent, with an average of about 7.00 per cent.

TITANIUM

Titanium is an element which is very common in clays, usually in the form of rutile (TiO_2), but occasionally as titanite ($CaTiSiO_5$ and ilmenite ($FeTiO_3$). These minerals are usually in the form of very minute crystals or needles, visible only with the aid of a microscope.

Titanium seems to have both a fluxing and a coloring action. Even very small amounts will lower the vitrification point of a clay and increase the coloring action of other coloring agents present.

The shales and brick clays of Georgia usually contain less than one per cent of titanium dioxide.

ALKALIES

The alkalies commonly present in clays include soda (Na_2O) and potash (K_2O). Several common minerals may serve as sources of these alkalies, but probably most of it is furnished by feldspar and mica.

The alkalies are considered to be the most powerful fluxing agent that clay contains. They serve, in firing, to bind the particles together in a dense, hard body, permitting the ware to be fired at a lower temperature. Alkalies alone seem to exert little or no coloring influence on the fired clay, although in some instances potash appears to deepen the color of a ferruginous clay in firing.

The alluvial clays of Georgia generally contain less than one per cent of soda or potash. The average of 43 analyses of typical shales showed 1.06 per cent soda (Na_2O) and 1.60 per cent potash (K_2O).

LIME

Lime is found in many clays, and in the low-grade ones may be present in large quantities. Quite a number of minerals may serve as sources of lime in clays, but all fall into one of the three following groups:

1. Carbonates: calcite ($CaCO_3$), dolomite ($CaMg\ (CO_3)_2$). Lime in this form if finely divided has a marked fluxing action, shortens the vitrification range, increases porosity, and decreases the coloring action of iron.

2. Silicates: some feldspars, garnets, and amphiboles. The effect of these is much less pronounced than that of lime carbonate. They serve as fluxes, but do not cause a rapid softening of the clay.

3. Sulphates: gypsum. Gypsum, when found in clay, has probably been formed by sulphuric acid, liberated by the decomposition of iron pyrite, acting on lime carbonate. On firing, the chemically combined water is first driven off, then the gypsum decomposes with the evolution of sulphur trioxide (SO_3), often causing swelling or blistering of the ware.

The shale deposits of Georgia, especially those of the Conasauga and Red Mountain formations, often contain lime carbonate in the form of irregular lenses and horses of limestone, interbedded layers and thin partings of limestone, and layers of shale containing more or less lime in the form of calcite crystals and lime carbonate nodules. The limestone is easily recognized. The limy shale often has a light-blue cast. In either case the presence of lime carbonate can be detected by testing with dilute acid. The majority of the chemical analyses of the samples collected for this report show no lime.

The alluvial clays often show very small amounts of lime, probably in the form of small nodules of lime carbonate. Experience with these clays has shown that this lime seldom causes trouble in the manufacturing processes.

MAGNESIA

Magnesia (MgO) rarely occurs in clay in larger quantities than one per cent. When present, its source may be any one of several classes of compounds, that is silicates, carbonates, and sulphates. Silicates, such as the black mica or biotite, are probably the most important source. Biotite decomposes readily, and, its chemical combination being thus destroyed, the magnesia is set free, probably in the form of a soluble compound, which may be retained in the pores of the clay. Magnesia acts as a flux, making the clay soften slowly.

The shales and alluvial clays of Georgia all contain small amounts of magnesia, ranging from a trace to 1.94 per cent. The average is less than half of one per cent.

SULPHUR

Many clays contain at least a trace of sulphur, and some of them show appreciable quantities. It may be present as:

1. Sulphate, such as gypsum ($CaSO_4.2H_2O$), epsomite ($MgSO_4.7H_2O$), or melanterite ($FeSO_4.7H_2O$).
2. Sulphide, as pyrite (FeS_2).

Sulphur in any form is one of the most detrimental impurities in clays, as its compounds are instrumental in scumming, lowering of fusion point, bloating of body, and blistering.

Less than half of the shales and alluvial clays sampled contained even traces of sulphur, and the average is only a fraction of one per cent.

PHOSPHORIC ACID

Phosphorus, or the phosphoric acid radical, P_2O_5, is common in small quantities in clays. It may be present in the form of the phosphate of lime, the phosphate of iron, or even other phosphates. Its effect in small quantities is not known, but in sufficient quantities it may act as a flux at moderate temperatures.

Nearly all of the shales and alluvial clays of Georgia contain at least traces of P_2O_5, but of those sampled the maximum (an alluvial clay) was only 0.64 per cent.

WATER IN CLAY

Water is present in clays as free water and chemically combined water.

Free water: This includes that which is held in the pores of the clay by capillarity and surface tension. It may include water of plasticity, shrinkage water, and pore water.

Water of plasticity is that which is driven off when the clay is dried from a condition of maximum plasticity to 110°C.

Shrinkage water is that portion of the water of plasticity which is driven off up to the point where shrinkage ceases.

Pore water is that portion of the water of plasticity which is driven off from the point where shrinkage ceases until the clay has reached approximately constant weight at 110°C.

The water of plasticity is therefore equal to the sum of the shrinkage and pore water.

The samples collected and tested by the writer were all rather thoroughly air-dried before the chemical analyses were made. The moisture determined was therefore usually less than 1 per cent and represented only a portion of the pore water. In order that the analyses given in the report may be directly compared, they have all been recalculated on a dry basis, eliminating the free water.

Chemically combined water: Chemically combined water is that which occurs in the clay in chemical combination, the water of crystallization of the hydrous minerals. That which is combined in hydrous aluminum silicates passes off chiefly between 400°C. and 600°C. Muscovite loses its water between 500°C. and 700°C., and hydrous iron oxides dehydrate between 150°C. and 350°C.

In the analyses accompanying this report, the chemically combined water is reported in the *Loss on Ignition.* Loss on ignition also includes any carbon dioxide, sulphur, and organic matter which may be present in the clay.

PHYSICAL PROPERTIES OF CLAYS

The physical properties of a clay in the raw or green state, and its reactions to the forming and firing processes necessary to produce clay ware of any sort, are, to a large extent, the deciding factors in determining the value of the clay and the uses to which it is best suited. A knowledge of these properties and the tests by which they are determined is essential to a correct understanding of the descriptions and tests given in a subsequent part of this report. In this description emphasis has been placed upon the most important physical properties of the shales and brick clays of Georgia.

PROPERTIES IN THE RAW STATE

GRINDING

Shale, being a rock form of clay, must be ground before it can be tempered with water to a plastic condition and formed into clay products. The ease of grinding of shales varies considerably. Some are soft and readily crush into flaky fragments which in turn grind readily to a powder. Others are brittle and grind to a powder with little difficulty. But some shales, especially those that are slightly metamorphosed, are tough and require long grinding.

The alluvial clays require no grinding to develop plasticity. In many cases, however, a preliminary crushing is advisable to break up lumps and to insure a uniform mixture of the materials.

SLAKING

The slaking of clays is the property they have, when dry, of crumbling and disintegrating into a pulverulent mass when immersed in an excess of water. The time required for this varies from a few minutes in the case of soft porous clays to several weeks for tough shales, and some may be incompletely disintegrated even after that. In slaking, the water first fills the pore spaces of the clay; then the particles of clay are entirely surrounded by a film of water, being separated from each other by the thickness of the film, thus causing an increase in the volume of the clay. In an excess of water, the clay grains become so far separated from each other that the clay mass crumbles. The process seems to be entirely physical and it is doubtful if any disintegration is due to chemical action, as in the slaking of quick lime.

The slaking property is one of some practical importance, as easily slaking clays temper more readily when worked. A number of the Georgia shales, especially if but little weathered, are slow slaking. This can be overcome, to a considerable extent, by fine grinding, long pugging, the use of hot water, or the use of certain electrolytes.

PLASTICITY

Plasticity may be defined as the property which many clays possess of changing form under pressure, without rupturing, which form they retain when the pressure ceases, it being understood that the amount of pressure required, and the degree of deformation possible, will vary with the material.

A number of theories have been advanced in explanation of this property, but clay technologists are not yet fully agreed upon the cause. Probably the most widely accepted theory at the present time is the colloid theory, which assumes that clay grains of non-plastic character are surrounded by a film of colloidal material. This colloidal material, which may vary in its composition, is in a film of water. This mixture has properties of a viscous fluid. The colloidal fluid acts as a cementing film which holds the mass together and gives the material properties which are intermediate between those of a solid and a liquid. It is probable, however, that plasticity is due not to one but to several causes.

No practical method has been devised for measuring plasticity, and the loose terms used to describe it are of little value for comparative purposes. The description of plasticity is a matter of judgment and will vary with the individual. Very fine-grained, plastic clays are commonly described as "fat" or "sticky", while coarse-grained, sandy clays, or those lacking in plasticity, are termed "short" or "lean." The water of plasticity is not a measure of plasticity, but of the amount of water necessary to develop maximum plasticity in a clay.

Plasticity generally bears a relation to the air shrinkage and drying qualities of clays. Those clays which are most plastic generally have the highest drying shrinkage and are more likely to warp and crack in drying. Clays used in the manufacture of heavy clay products must have sufficient plasticity to form without cracking in the molding processes. More plasticity is required to form complicated shapes such as structural and roofing tile and sewer pipe than to form brick.

Alluvial clays generally have a good plasticity. The plasticity of the shales ranges from good for the soft and the weathered shales to poor for the hard unweathered and the metamorphosed shales. The residual clays derived from the weathering of gneiss and schist are usually "short" or lacking in plasticity.

STRENGTH

The air-dried or "green" strength of a clay is a very important property in the manufacture of clay products. A good green strength enables them to be handled and to resist shocks before firing without serious loss from breakage.

The strength of a dry clay may be determined by the transverse, tension, or compression tests. Formerly the tensile strength was the property commonly determined, but now the transverse strength test is usually employed because it gives more uniform results.

The transverse strength is the resistance which a bar of clay offers to a load applied at right angles to its length. The test is made by molding the clay into a bar which is thoroughly dried, supported on two knife-edges, and broken by slowly increased weight applied to a knife-edge on the upper surface. From the weight required to break the bar, the cross-section of the bar, and the distance between the supports, the green modulus of rupture is calculated. This is a factor of the transverse strength expressed in pounds per square inch or in corresponding metric units.

In general a clay having a good plasticity will also have a high green modulus of rupture. For example the average green modulus of rupture for seven typical Floyd shales, which develop a good plasticity, was 190.5 pounds per square inch; while the average for 14 typical shales from the Red Mountain formation, which usually have a rather grainy and poor plasticity, was 109.2 pounds per square inch. Some shales, however, which have a rather poor plasticity develop a surprisingly high green strength. On the other hand, some very plastic alluvial clays tend to laminate when extruded through a die, and these laminations are a cause of low green strength.

The average green modulus of rupture of 42 typical shales, eliminating those which were weathered almost to a clay and those which had been partly metamorphosed to a slate, was 109.2 pounds per square inch. The average green modulus of rupture of nine samples of the Fall Line alluvial clays was 430.2 pounds per square inch.

DRYING SHRINKAGE

The diminution in volume of clay, due to the loss by evaporation of the water used in developing plasticity, is termed air shrinkage or drying shrinkage. The drying shrinkage of a clay may be expressed either in terms of its length (linear drying shrinkage) or in terms of its volume (volume drying shrinkage). It depends upon such factors as the texture of the clay and the amount of colloidal material it contains, the amount of water used to develop maximum plasticity, and the rate and method of drying.

A knowledge of the drying shrinkage of a clay is important for the production of exact and uniform sizes of clay ware. A high drying shrinkage can often be counteracted by the addition of sandy materials or grog. These in addition make the mixture more porous, facilitating the drying, permitting the water to escape more readily, and reducing the danger from warping and cracking.

The shales of Georgia have a drying shrinkage averaging about 3.5 per cent. The Fall Line alluvial clays, as might be expected from their greater plasticity, have a drying shrinkage averaging about 8.8 per cent for the samples tested.

FIRED PROPERTIES

FIRING SHRINKAGE

All clays shrink during some stage of the firing, even though they may expand slightly at certain temperatures. The firing shrinkage, like the drying shrinkage, varies within wide limits, the amount depending largely on the texture and fusibility, and to a less extent on the quantity of volatile elements, such as combined water, organic matter, and carbon dioxide. After the volatile elements have been driven off, the clay is left more or less porous, in addition to its porosity caused by the grains not fitting closely together. As fusion begins, the pore spaces are closed up by the gradual melting of the constituent grains of the clay, thereby causing a gradual, but not always uniform, shrinkage in volume, until the point of vitrification is reached, when the mass approaches a homogeneous and non-porous condition. Beyond vitrification there may be expansion due to the volatilization of the clay. Expansion sometimes takes place before vitrification in clays containing an excess of silica, due to the change in crystal form of the silica grains from alpha to beta quartz and, to a less extent, a permanent conversion to crystoballite or tridymite and other forms.

Either the linear or volume firing shrinkage at any temperature or cone (see page 16) may be determined. It may be expressed in terms of the plastic volume or length or in terms of the dry volume or length. The total shrinkage is the sum of the drying shrinkage and the firing shrinkage, provided both are expressed in the same terms.

In the manufacture of clay ware it is important to obtain as low a firing shrinkage as possible in order to prevent cracking and warpage and to maintain uniformity of size. This may be done by mixing clays, or by the addition of materials such as sand or siliceous clays that in themselves have no firing shrinkage within the firing range of the ware.

ABSORPTION AND POROSITY

The porosity of a clay may be defined as the volume of pore-space between the clay particles, expressed in percentages of the total apparent volume of the clay, and depends upon the shape and size of the particles making up the mass. There are two types of pores in fired clays, open and closed. The volume of the latter cannot be directly measured. Thus there are two types of porosity; true porosity, which represents the volume of the open plus the closed pores; and apparent porosity, which represents the volume of the open pores only.

Absorption is a measure of the apparent porosity represented by the quantity of water a unit weight of the body will take up.

Absorption in a fired clay decreases as the firing continues and the firing shrinkage decreases the volume of the pore space, approaching zero as the clay approaches vitrification. It has an important bearing upon the strength of a fired clay body, its behavior as an absorbent, and its resistance to weathering, shock, abrasion, erosion, and discoloring agents.

FIRED STRENGTH

The fired strength of heavy clay products is an important measure of their durability. The transverse strength is most commonly measured, as described above under green strength, using fired bars instead of the air-dried bars. It is expressed as the fired modulus of rupture in pounds per square inch or in corresponding metric units.

As clay ware is fired to increasingly higher temperatures up to the point of vitrification, the fired strength increases gradually but not always uniformly. The strength of ware fired beyond the vitrification point often decreases, due to the formation of a brittle, glassy structure.

COLOR

The color of fired clay ware is largely due to iron oxide, although other factors enter in so that the color to which a clay will fire cannot be determined from the amount of iron oxide shown in the chemical analysis. The colors which a fired clay may show depend upon:

1. The quantity and surface factor of iron oxide contained in the clay. Usually at least four or five per cent of iron oxide is necessary to give a good red color to the fired clay. Other conditions being equal, increasing amounts of iron tend to deepen the red color.

2. The other constituents of the clay accompanying the iron. The presence of lime in small quantities often prevents the development of a good red color in the fired clay. An excess of alumina sometimes

appears to form compounds with the iron that give the fired clay a yellow color. Certain fluxes, such as potash, appear to deepen the red color of ferruginous clays.

3. The composition of the fire-gases during the firing. Oxidizing conditions are necessary to produce a good red color in firing a ferruginous clay. Lack of oxygen or the presence of sulphur dioxide atmosphere, especially during the period when the water of crystallization is being driven off, often reduces the iron oxide from the ferric to the ferrous condition with the production of complex iron silicates which give the vitrified clay a black color and sometimes cause bloating.

4. The degree of vitrification. The vitrification of ferruginous clays progressively darkens their red color and often changes it to brown, green, or black, due to the formation of ferrous silicate.

5. The temperature at which the clay is fired. The red color of ferruginous clays becomes deeper as higher temperatures are reached, due to increased oxidation.

WARPAGE AND CRACKING

Warpage and cracking in a fired clay body are due primarily to unequal shrinkage during either or both the drying and the firing stages. Such conditions are very difficult to avoid with clays having a high shrinkage. The shales of northwest Georgia showed but little warpage. The test bars of the Fall Line alluvial clays showed slightly more warpage, with the exception of those containing enough sandy material to reduce the shrinkage and warpage. Some of the highly plastic residual and alluvial clays of South Georgia showed considerable warpage and, in a few cases, were badly cracked.

SCUMMING

The appearance of a white coating on the surface of heavy clay products following drying, firing, or even after use, is known to the clay worker as *scum*. Scumming is due to the presence of water-soluble salts, usually sulphates of lime and magnesia, derived from the clay itself, from the tempering water, from the action of kiln gases, or even, when the scum appears after use, from the mortar or from absorbed ground water. The term *efflorescence* is sometimes used to designate those accumulations of soluble salts upon the surface which have been brought there in solution and deposited when the water evaporated. The term *scum* would therefore be restricted to those deposits of soluble salts formed by the action of gases upon the wares during drying and firing.

A few of the shales and clays tested for this report showed traces of scumming, or more properly efflorescence. This scum was probably formed from soluble salts contained within the shale or clay. It is not definitely known how much soluble matter is permissible in a clay without danger of its forming a white coating, but it is probable that less than 0.1 per cent may cause trouble.

FIRING RANGE

The process of vitrification of a clay is usually a gradual one. Immediately after a clay has been dehydrated it shows its maximum porosity. As the temperature is raised, some of the clay particles begin to soften by fusion, binding the mass together. As the temperature continues to rise, more of the mass becomes softened, and more of the clay body goes into solution so that the composition of the softened portion changes. It will be seen, therefore, that while in the early stages of vitrification, there may be considerable pore space between the grains, these will be gradually filled by fused material, provided there is a sufficient quantity of it.

We may recognize three stages in the vitrification process as follows:

1. Incipient vitrification, in which just enough of the clay material has softened to stick the mass together.

2. Complete vitrification, at which point the interspaces are filled with fused material, the mass, however, being still able to support its own weight without distortion.

3. Fusion at which point the body has softened so that it no longer will withstand the pressure of its own weight without deformation.

The ideal conditions desired in a clay to be used for the manufacture of heavy clay products are for a long range in temperature between the incipient vitrification and the complete vitrification, and particularly for only a slight increase in shrinkage and strength and decrease in absorption during that latter part of this stage. It is almost impossible to control the temperature in firing ware so that it will be equal in all parts of the kiln. Therefore, if there is but slight change in the shrinkage, strength, and absorption of the ware during the last stage of the firing, the chances are better for obtaining ware of uniform properties from all portions of the kiln. This range of temperature, or rather heat treatment, between the time when the ware begins to have the desired properties and the stage of complete vitrification is called the *firing range* of the clay. The firing range can be expressed in terms of temperature. Better yet, as the results depend upon the effects of temperature plus the time of firing, or heat treatment, it may be expressed in terms of standard pyrometric cones.

Standard pyrometric cones are pyrometric measures of heat treatment in the form of a series of cones, made from ceramic materials, and carefully compounded so as to soften or deform in progressive order. They do not definitely measure temperature, but the combined effect of temperature and time or conditions of heat treatment. They were first established by Seger and are often called Seger cones. The series of American standard pyrometric cones with their end points as determined by Fairchild and Peters[1] is given in the following table:

[1]Fairchild, C. O., and Peters, M. F., Amer. Ceramic Soc. Jour. vol. 9, p. 738, 1926

End Points of American Standard Pyrometric Cones

Cone No.	End Point (heated in air)			
	Heated at 20°C. per hour		Heated at 150°C. per hour	
	°C.	°F.	°C.	°F.
022	585	1085	605	1121
021	595	1103	615	1139
020	625	1157	650	1202
019	630	1166	660	1220
018	670	1238	720	1328
017	720	1328	770	1418
016	735	1355	795	1463
015	770	1418	805	1481
014	795	1463	830	1526
013	825	1517	860	1580
012	840	1544	875	1607
011	875	1607	905	1661
010	890	1634	895	1643
09	930	1706	930	1706
08	945	1733	950	1742
07	975	1787	990	1814
06	1005	1841	1015	1859
05	1030	1886	1040	1904
04	1050	1922	1060	1940
03	1080	1976	1115	2039
02	1095	2003	1125	2057
01	1110	2030	1145	2093
1	1125	2057	1160	2120
2	1135	2075	1165	2129
3	1145	2093	1170	2138
4	1165	2129	1190	2174
5	1180	2156	1205	2201
6	1190	2174	1230	2246
7	1210	2210	1250	2282
8	1225	2237	1260	2300
9	1250	2282	1285	2345
10	1260	2300	1305	2381
11	1285	2345	1325	2417
12	1310	2390	1335	2435
13	1350	2462	1350	2462
14	1390	2534	1400	2552
15	1410	2570	1435	2615
16	1450	2642	1465	2669
17	1465	2669	1475	2687
18	1485	2705	1490	2714
19	1515	2759	1520	2768
20	1520	2768	1530	2786
			Heated at 100°C. per hour	
23	....	....	1580	2876

End Points of American Standard Pyrometric Cones —Continued.

Cone No.	End Point (heated in air)			
	Heated in Arsen furnace at 600° per hour.		Heated at 100°C. per hour	
	°C.	°F.	°C.	°F.
26	....	....	1595	2903
27	....	....	1605	2921
28	....	....	1615	2939
29	....	....	1640	2984
30	....	....	1650	3002
31	....	....	1680	3056
32	....	....	1700	3092
33	....	....	1745	3173
34	1755	3191	1760	3200
35	1775	3227	1785	3245
36	1810	3290	1810	3290
37	1830	3326	1820	3308
38	1850	3362	1835	3335
39	1865	3389	....	....
40	1885	3425	....	....
41	1970	3578	....	....
42	2015	3659	....	....

Standard pyrometric cones are used in firing clay ware or test pieces by embedding a series of three or more different cones in a vertical or slightly inclined position in a plastic clay base, and placing them adjacent to the ware. As the temperature rises, the cones, in order, soften and bend over. The end point is when the tip just touches the base, when the cone is said to be "down." They are widely used in the firing of all types of clay ware, sometimes as the only means of measuring the heat treatment, and sometimes to supplement the use of pyrometers.

The shales of Northwest Georgia generally have a long firing range. The samples of typical shales from the Conasauga, Floyd, and Red Mountain formations collected for this report had an average firing range of six to seven cones. The samples of the Fall Line alluvial clays had an even longer firing range.

FIELD AND LABORATORY METHODS FOR THIS REPORT

FIELD METHODS

The investigation of the shales and brick clays of Georgia was of necessity limited by the large area that had to be covered in a short time. The producing plants and the principal outcrops within reasonable distance from transportation were visited. Many of these deposits were located through publicity in the newspapers, often in co-operation with the local chambers of commerce.

The natural outcrops and the mining pits were examined and described, together with all the factors that would influence the commercial value of the deposit. No prospecting could be attempted because of limited time and money. Favorably located outcrops that were approximately representative of the deposit, and were not obviously unfit for use, were sampled. Wherever possible a 25-pound groove sample of the entire thickness of the outcrop was taken. Many outcrops, however, were such that a grab sample taken at intervals along the outcrop was considered more representative than a groove sample. In both cases the surface of the outcrop was cleaned before taking the sample. The following samples were collected: 84 shales and associated clays from North Georgia, 10 Fall Line alluvial clays, 9 South Georgia alluvial and residual clays, and 9 weathered schists from just north of the Fall Line in Middle Georgia.

It will be observed that many more shale samples were collected than of alluvial clays. This is due primarily to the fact that the shales, because of their mode of occurrence, give rise to numerous natural outcrops, while the alluvial clays are concealed as stream valley deposits which are generally covered with a layer of overburden and can be examined only by prospecting.

LABORATORY METHODS

The large number of samples and the limitations of time and funds necessarily limited the tests that could be made to those most essential. Yet they show certain characteristics of the clays that will determine the line that further investigation should take. Thorough prospecting and further laboratory and plant tests on representative samples should be carried on before money is invested in a plant to manufacture heavy clay products from any of these clays.

The chemical analyses were made by Dr. Edgar Everhart, Acting Chemist of the Georgia Geological Survey, except when otherwise specified. The physical and pyro-chemical tests were made by the writer at the Ceramic Laboratory of the Georgia School of Technology under the direction of Dr. A. V. Henry, the director of the Ceramic Department. The methods followed were suggested by Prof. W. H. Vaughan, Associate Professor of Ceramics. The writer was assisted in some of the testing by one of the Junior Ceramic students. The Munsell color measurements were made by Katharine Cox Smith.

The tests, which are described in detail below, were designed to determine as far as possible the firing range of the clay and its suitability for the manufacture of heavy clay products. The tests followed as closely as possible the methods recommended by the American Ceramic Society.[1] The errors in the results, some of which are apparent from a study of the shrinkage, absorption, and strength curves given in the report, are due primarily to two causes: (1) Errors in firing due to unequal heat distribution in the kiln and occasional reducing condition of the kiln atmosphere; and (2) Errors due to an insufficient number of test bars because of lack of clay or breakage in handling.

PREPARATION

Each sample was dried for about 24 hours at 80°C. and then ground to pass a 16 mesh screen. Notes were taken of the ease of grinding of the material and of the ground color. The ground material was then tempered with sufficient water to make plastic, wedged on a damp cloth to remove air bubbles and to make uniform, wrapped in a damp cloth, and placed in a humidor over night to age. Notes were taken of the rapidity of slaking and of the plasticity of the tempered clay.

The plastic clay, after aging over night, was extruded in two columns through a Mueller roll-press and wire-cut into test bars approximately 1 1/16 by 1 1/16 by 6 inches when plastic. Notes were taken on the molding behavior of the clay. As soon as possible after forming, the bars were numbered and stamped with a marker making two lines exactly 10 centimeters apart. Forty or more such bars were made from each sample, whenever possible. A number of the shale samples, as is noted in the tests, required more aging before they had sufficient plasticity to form good bars by this method. Several samples of shales and residual clays never acquired sufficient plasticity to form test bars with the Mueller roll-press. Test bars were formed from some of these by hand in steel molds, but a few samples had to be discarded without making further tests.

WATER OF PLASTICITY

The plastic weight of five of the test bars was determined as soon as possible after forming the bars. After drying at room temperature to leather hardness, the bars were dried for five hours at 75°C. and then for three hours at 110°C., and allowed to cool to room temperature in a dessicator. The bars were again weighed after cooling. The difference between the plastic weight and the dry weight, divided by the dry weight, times 100, gave the percentage of water of plasticity. From this the amount of water necessary to temper a given weight of dry clay can be determined.

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[1]Am. Ceramic Soc. Jour. Vol. 11, 1928.

GREEN MODULUS OF RUPTURE

Ten of the test bars, including the five on which the water of plasticity was determined, were dried as described above and used for the green modulus of rupture tests. The bar to be broken was supported on two knife edges 5 inches apart. Another knife-edge rested on the middle of the bar equi-distant from the two supports and a bucket was hung from it. Water was permitted to flow uniformly into the bucket until the weight broke the bar. The width and depth of the bar at the point of fracture were than measured and the weight of the bucket plus the water was determined. The modulus of rupture was calculated from the formula:

$$M = \frac{3Pl}{2bd^2}$$

M = modulus of rupture in pounds per square inch.
P = breaking load in pounds.
l = length between knife-edges in inches.
b = breadth of bar in inches.
d = depth of bar in inches.

LINEAR DRYING SHRINKAGE

The remaining 30 bars were dried as described above. After cooling, the distance between the marks on the bars was measured in centimeters. The difference between this length and 10 centimeters, which was the plastic length between the marks, divided by 10 centimeters, times 100, gave the percentage of linear drying shrinkage based on the plastic length.

FIRING

Separate firings were made to cones 06, 04, 02, 1, 3 and 5 in a rectangular laboratory gas-fired, down-draft kiln. Five bars of each sample were fired to each cone. Less than five bars were used in a few cases due to breakage or lack of material. The bars were stacked on the checker work bottom of the kiln in alternate rows with about half an inch space between each bar in a row. Care was taken not to place all of the bars of one sample together. For example, in the cone 06 firing, all of the No. 1 bars were placed in the kiln, then all of the No. 2 bars, etc.

The heat was controlled by an electrical pyrometer with the thermocouple about midway of the back of the kiln. During the last three or four hours of the firing, standard pyrometric cones (see page 16) at the front top and bottom of the kiln were also used. The firings averaged about 17 hours, and were made according to the following schedule:

Firing Schedule

First 4 hours = 200°F.—700°F.;
Next 2 hours = 700°F.—900°F.;
Next 5 hours = 900°F.—1200°F.; followed by
Increase of 200°F. an hour until two hours before the first cone (two before the cone fired to) is expected down; followed by
Increase of 100°F. an hour until the first cone (two before the cone fired to) is down, followed by
Holding temperature nearly uniform to soak the last two cones down. This should distribute the heat uniformly throughout the mass of test bars in the kiln.

Firing Data

Cone	Length of Firing in Hours	Highest Temperature Recorded	Remarks
06	18	1880°F.	Good heat distribution.
04	17½	1920°F.	Good heat distribution. Slightly reducing conditions.
02	14	1920°F.	Cones came down close together. Poor heat distribution. Reducing conditions.
1	16½	1980°F.	Top of kiln slightly overfired.
3	18	2020°F.	Poor heat distribution. Slightly reducing conditions.
5	16½	2060°F.	Bottom of kiln slightly overfired.

FIRING SHRINKAGE

After the bars had cooled, the length between the marks was measured in centimeters. The difference between the dry length and the fired length, divided by the dry length, times 100, gave the percentage of linear firing shrinkage in terms of dry length. The difference between the plastic length and the fired length, divided by the plastic length, times 100, gave the percentage of total linear shrinkage in terms of the plastic length.

ABSORPTION

After measuring for the firing shrinkage, the test bars were weighed to an accuracy of 0.1 grams. They were then placed in water and boiled for two hours and cooled to room temperature while submersed in the water. Each bar was then wiped free of surplus water with a damp cloth and again weighed to an accuracy of 0.1 grams. The difference between the wet weight and the dry weight, divided by the dry weight, times 100, gave the percentage of absorption.

WARPAGE AND SCUMMING

The test bars were carefully examined and any warpage or scumming noted.

FIRED MODULUS OF RUPTURE

The modulus of rupture of the fired bars was determined in much the same way as the green modulus of rupture, except that the testing was done on a Rhiele transverse strength machine. The data recorded and the formula used for calculating the modulus of rupture were the same as given above.

COLOR

The fired bars were laid out on a table in order and the fired colors noted. In cases of variation of the color of test bars of the same sample fired to the same cone, due to unequal heat distribution in the kiln or to the action of kiln gases, the color corresponding to an average of the several bars was recorded.

In addition, the colors, or the average colors, were measured by comparison with the Munsell Book of Color,[1] a scientific arrangement of color charts according to hue, value, and chroma, with a simple method of notation of all colors. Color, according to the Munsell system, has three qualities:

1. *Hue* is that quality of color by which we distinguish red from yellow, yellow from green, green from blue, etc. It is the first characteristic of color that the eye detects. The five principal hues, according to the Munsell system are Red, Yellow, Green, Blue and Purple, and are indicated by their first initials, R for red, Y for yellow, etc. These are subdivided into 20 hues and intermediate hues, Red (R), Red Yellow-Red (R-YR), Yellow-Red (YR), Yellow-Red Yellow (YR-Y), Yellow (Y), etc.; and may be further subdivided numerically as shown in Figure 1.

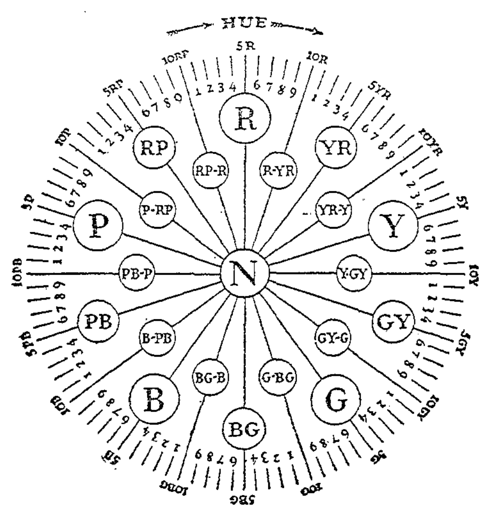

Figure 1. Diagram of the Hue Circle with the Munsell hue notation.

1–Munsell Book of Color, Abridged Ed., Universal Color Standards, Inc., Baltimore, 1929.

2. *Value* is the visual measure of the variable light-strength of color, in other words, the lightness or darkness of a color. Pure white is the lightest color we can see. Pure black is so dark that no color can be seen in it. But between the two can be distinguished various degrees of light-strength, ranging from the darkest gray just above black to the lightest gray just below white, and chromatic colors can also be seen at these various intermediate levels of light-strength. The Munsell system divides colors into 10 intermediate values representing equal visual steps and grading from the darkest, indicated by the numeral 1, to the lightest, indicated by the numeral 9. Theoretical pure black is indicated by the numeral 0, and theoretical pure white by the numeral 10. Therefore 5 represents the middle value.

3. *Chroma* is the measure of the degree of color-strength in a color, or the brightness or dullness of a color. Two colors may be the same in Hue and the same in Value, and yet be different in color-strength. One may be a light bright red and the other a light grayish-red. Chroma is measured in steps graduated from Neutral Gray out to the strongest Chroma obtained in any hue at any given level of Value. These steps are numbered from Neutral Gray toward the Maximum Chroma.

To sum up then, color has three properties, Hue, Value, and Chroma, each of which must be given before a color can be described. Hue is the name of a color, Value is the lightness or darkness of a color, and Chroma is the brightness or dullness of a color. The Munsell notation indicating these three properties gives them in the following order, H-V/C; H naming the Hue, V, above and to the left of the line, giving the numerical Value, and C, below and to the right of the line, giving the numerical Chroma. Thus R-YR-5/4 indicates a Red Yellow-Red hue of the 5th value and the 4th chroma.

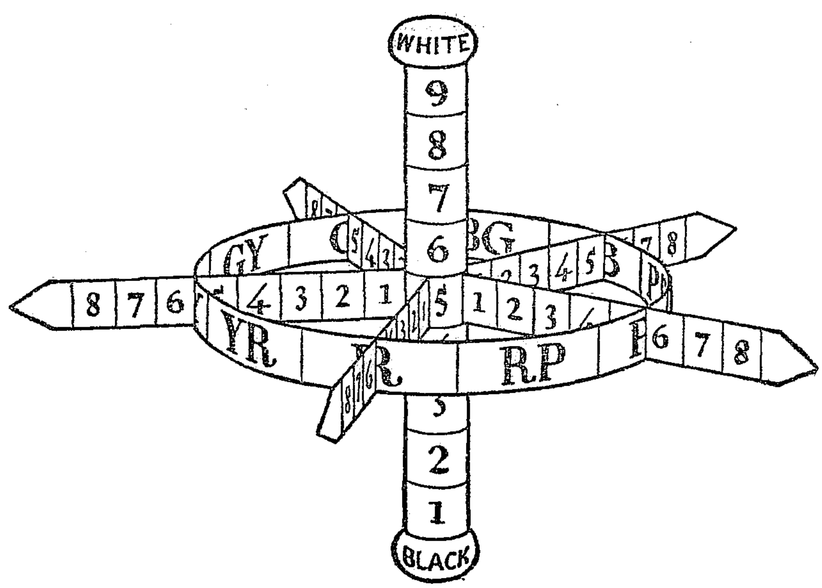

Figure 2. Diagram showing Hue, Value, and Chroma in their relation to each other.

These three dimensions of color can best be represented as the color sphere shown in Figure 2. The top pole of the color sphere[1] is White, the bottom pole Black, and the axis is the graduated scale of Neutral Grays, representing the different Values. The circular band represents the hues in their proper sequence. The paths pointing outward from the center show the steps of Chroma, increasing in strength as indicated by the numerals.

The colors of the fired test bars were measured by comparing them with the Munsell color charts. Most of the colors were of Red Yellow-Red (R-YR) or Yellow-Red (YR) hues, although some were between these two hues or between these and the Red or Yellow-Red Yellow and were estimated and indicated by the numerical method of indicating the hue (see Figure 1). In the laboratory tests given in this report, the Munsell notation of the fired colors of the test bars follow the usual color names. The actual color of the bar, or a close approximation, can be seen by consulting a Munsell Book of Color.

FIRING RANGE

The firing range of the shale or clay was determined, in consultation with Dr. Henry and Prof. Vaughan, by a comparison of the fired color, the hardness, the total shrinkage, the absorption, and the fired modulus of rupture. In general, it is that portion of the period between incipient vitrification and fusion in which commercial colors are developed and there are but slight changes in the total shrinkage, the absorption, and the fired modulus of rupture. The lower limit is marked by too light colors and a high absorption. The upper limit is marked by too dark colors, and often an increase in the absorption and a decrease in the shrinkage and the modulus of rupture, due to bloating and the formation of a glassy and vesicular structure.

CORRELATION OF LABORATORY TESTS AND PLANT PRACTICE

Little or nothing has been published on the relation between physical and pyro-chemical tests made on a clay in the laboratory and the same properties determined on heavy clay products made from that clay in a commercial plant. The principal variables that may cause a difference in the properties are:

1. Method of grinding. Clay or shale samples for laboratory testing are ground rapidly, usually in a roll-crusher and for purposes of uniformity are usually screened to a definite size. In plant practice the grinding is usually done slowly in a dry pan and the clay may or may not be screened. Particle size has a marked effect on the physical and pyrochemical properties of the fired ware.

2. The tempering and pugging of the laboratory sample is usually done by hand and is often not as thorough as the tempering and pugging action of the wet pan, pug mill, or brick machine of the commercial plant.

[1]The 413 scientifically correct color samples found on the charts in the Book of Color are definite points in this color sphere separated from each other by equi-distant steps of Hue, Value and Chroma.

3. The method of formation of the test bars and of the commercial ware is quite different. The test bars are usually formed by hand in steel molds or by extrusion from a small laboratory machine, and the pressures obtained are usually much lower than those developed in the stiff-mud brick machine commonly used to form commercial heavy clay products. This difference in the intimacy of contact of the particles probably has a considerable effect on the properties tested.

4. The test bars are commonly fired rather rapidly in small masses in a laboratory kiln, while the commercial ware is fired more slowly in large masses. Similar results are probably obtained at lower temperatures in a commercial kiln than in a laboratory kiln.

Vaughn[1] has recently made a series of tests along this line at the Ceramic Laboratory of the Georgia School of Technology and at the Daisy, Tennessee plant of the B. Mifflin Hood Company. Two clays were tested. Test bars were made of samples prepared by the usual laboratory methods by both the slop-mold and the Mueller laboratory roll-press methods of forming bars. Half of these were fired in the laboratory kiln and the other half in a commercial kiln. Another set of test bars was prepared by extrusion through a special die on the stiff-mud brick machine at the plant, and again part were fired in the laboratory and a part at the plant. Still another set of test bars was made by the laboratory methods of forming the bars from clay that had been ground, tempered, pugged, and extruded as a column from the brick machine, and again were fired in both the laboratory and the commercial kilns. Certain tests were also made on commercial tile that had been formed in the usual way but part fired in the laboratory kiln and part in the commercial kiln.

The results of this experiment, while not including tests on enough clays to be at all conclusive, are interesting in that they give an indication of the correlation between laboratory tests and the properties of commercial ware. The results obtained from the two clays checked fairly closely with each other and also with a less complete test carried on with a third clay at another plant. From the averages of these results the following factors were obtained for computing the properties of commercial ware from the laboratory tests, using test bars made on the Mueller roll-press:

1. The drying shrinkages obtained in the laboratory were higher than those of the commercial ware. The factor for dividing laboratory drying shrinkages to obtain plant drying shrinkages was 1.6.

2. The green strengths obtained in the laboratory were lower than those obtained on the commercial ware. The factor for multiplying the laboratory green modulus of rupture to obtain the green modulus of rupture of the commercial ware was 2.17.

3. The laboratory total shrinkages were higher than the plant total shrinkages. The factor for dividing the total shrinkage obtained in the laboratory to get the total shrinkage of the commercial ware was 1.3.

[1]Vaughn, W. H., personal communication.

4. The absorptions of the laboratory test bars were higher than the absorptions of the commercial ware. The factor for dividing the laboratory absorptions to obtain the plant absorptions was 1.4.

5. The laboratory fired strengths were lower than the fired strengths of the plant products. The factor for multiplying the laboratory fired modulus of rupture to obtain the modulus of rupture of the commercial ware was 1.68.

It is to be hoped that experiments of this nature will be made on many other clays and more authentic factors obtained.

USES OF RED FIRING SHALES AND CLAYS

Red-firing shales and clays are used in the manufacture of a number of products, most of which come under the classification of heavy clay products. These heavy clay products include building brick, paving brick, structural tile, sewer pipe, drain tile, conduits, quarry tile, roofing tile, chemical brick and acid rings. A general knowledge of the raw materials used, the methods of manufacture, and the required specifications of these products is necessary to determine the possible uses for the shale and clay deposits of Georgia described in this report.

BUILDING BRICK

Building brick are fired clay blocks that may vary all the way from weak, porous, and crude, to strong, dense, and of attractive color and finish. They are often divided into two classes: *common brick*, used for backing and foundation purposes; and *face brick*, used on the exterior or facing of walls. There are all graduations between brick suited only for common brick and good quality face brick. In addition, face brick culls are often used for common brick and the better quality common brick are often used for facing purposes. Therefore these terms are now falling out of use and both common and face brick are called building brick.

Alluvial clays, residual clays, and shales are all used in the manufacture of building brick. In general, a clay or shale for this purpose should have a laboratory green modulus of rupture of at least 70 pounds per square inch in order that the green bricks may be handled without too much breakage. The total laboratory linear shrinkage should be less than 16 per cent. A shrinkage greater than this may give formation troubles such as laminations and difficulty in getting a uniform size of the finished product, and is apt to cause excessive warpage and cracking in drying. The maximum laboratory absorption allowable for the best facing brick is 9 per cent, although a higher absorption may be allowed in brick for foundation and backing purposes. The minimum laboratory fired modulus of rupture allowable for facing brick is 1200 pounds per square inch, and for the best quality should be more than 1500 pounds per square inch. However, satisfactory bricks for backing purposes are often made from clays having a much lower fired strength. Whether or not fired strength is a criteria of weathering resistance depends on the amount of laminations in the bricks. The fired color of the clay must be pleasing if it is to be used in the manufacture of brick for facing purposes. For backing purposes the color is not as important, although light colors in completely fired brick are often erroneously considered to be the result of underfiring, and such brick have a considerable sales resistance to overcome.

The manufacture of building brick begins with the preparation and tempering of the clay. Shale must be ground, generally in a dry pan, and screened. Alluvial clays usually do not need grinding, but are often put through a disintegrator to break up the lumps, and are sometimes screened. The addition of the water or "tempering" is done in a wet pan, or a pug mill, or both in series. Building brick are usually formed by the stiff-mud process, in which the clay is forced by an auger through a die in the form of a continuous column which is automatically cut off into the individual bricks. Face brick are usually side-cut, while common brick are generally end-cut.

The brick are dried either by setting them on wooden pallets and placing them in open-air drying sheds, or by setting them on cars which travel slowly through tunnels which are heated by a coal fire or by waste heat from the kilns.

The dried brick are fired in some type of kiln, the kind often depending on the type of brick produced. Common brick are sometimes fired in kilns made of the green brick, or in up-draft scove kilns in which the side walls are permanent and a temporary roof of fired brick is laid over the green brick. The product made in these kilns is not uniform either in color or degree of firing. The best grades of building brick are fired in either periodic or continuous down-draft kilns. The periodic kilns may be either rectangular or round. The continuous kilns are of two types: (1) in which the ware is stationary and the fire progresses through the kiln, and (2) in which the fire is stationary and the ware travels through it on tunnel cars.

The firing of a kiln of brick, whatever the type of the kiln, takes place in several steps. The *watersmoking period* at the beginning of the firing is that during which the moisture in the ware is driven off. During this period it is necessary to raise the heat slowly, but with sufficient draft to carry the water vapor out of the kiln.

Following the water smoking, the temperature of the kiln can be raised fairly rapidly until the *oxidation period* begins at about 450°C. or 842°F. This period may extend up to 950°C. or 1,742°F. With clay containing considerable carbon, sulphur, and ferrous iron, the temperature must be raised slowly during the oxidation period and an abundance of air must be furnished to the kiln, in order that the volatile substances such as carbon and sulphur may be oxidized and driven off and the iron compounds in the clay oxidized to the red ferric state. If the temperature is raised too rapidly or if the kiln gases are reducing rather than oxidizing, the result will be a formation of a black core in the ware, often accompanied with bloating and a glassy structure. The Georgia shales and residual clays are relatively low in carbon, sulphur, and ferrous iron and do not require a long oxidation period.

The period during which the combined water is driven off begins and ends at a little lower temperature than the oxidation period. Following the end of the oxidation period, the kiln temperature can again be raised fairly rapidly until the finishing temperature of the kiln is approached. The last stage of the firing is a *soaking period* during which the kiln is held at the same temperature or with a slight increase of temperature in order that the heat distribution shall be as nearly equal as possible throughout the entire mass of brick in the kiln.

A range of dark colors in face brick is often obtained by *flashing* during the soaking period. The brick are fired in the usual way with oxidizing conditions to nearly the temperature required for finishing the firing. The temperature is then dropped 60° to 100°F., the air supply is cut down, and a reducing condition in the kiln obtained by firing with such carbon and carbon dioxide producing fuels as slack coal, slack coal and tar, slack coal and oil, sawdust and tar, refuse rubber, etc. This is continued, alternately with oxidizing conditions, from one to six hours, depending on the intensity of the flash-action desired. The result is a formation of ferrous silicates and a deposition of carbon on the surface of the ware, giving beautiful brownish-red, brown and black colors to the brick.

The whole kiln cycle, including setting, firing, cooling, and drawing, requires from two to four weeks. During the drawing the culls are rejected, the commercial brick graded for color and imperfections, and stacked for storage or loaded for shipment.

The American Society for Testing Materials has promulgated the following standard specifications[1] for building brick made from clay or shale:

Standard Specifications for Building Brick
A. S. T. M. Designation: C62–30

"1. These specifications cover brick made from clay or shale and properly burned, intended for use in brick masonry.

PHYSICAL PROPERTIES AND TESTS

"2. (a) The bricks shall be classified as Grades A, B, and C on the basis of the following requirements. The classification of any lot of bricks shall be determined by the results of the tests for that requirement in which it is lowest, unless otherwise specified as provided in Section 8:

Name of Grade	Compressive Strength (bricks flatwise), lb. per sq. in., mean gross area		Modulus of Rupture (bricks flatwise), lb. per sq. in., gross area	
	Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Minimum
Grade A	4500 or over	3500	600 or over	400
Grade B	2500–4500	2000	450 or over	300
Grade C	1250–2500	1000	300 or over	200

NOTE.—The above classifications are based on strength and do not necessarily measure weather resistance.

[1]Am. Soc. Testing Mats., Standards, Pt. II, pp. 166–167, 1930.

(b) The tests shall be conducted in accordance with the Tentative Methods of Testing Brick (Compression, Flexure and Absorption) (A. S. T. M. Designation: C 67–30 T), of the American Society for Testing Materials.

"3. For the purpose of tests, bricks representative of the commercial product shall be selected by a competent person appointed by the purchaser, the place or places of selection to be designated when the purchase order is placed. The manufacturer or seller shall furnish specimens for tests without charge. All bricks shall be carefully examined and their condition noted before testing. For the purpose of tests, not less than ten brick shall be required for each investigation. In general, two samples of ten brick each shall be tested for each 100,000 bricks contained in the lot under consideration; but where the total quantity exceeds 500,000 one sample of 10 brick from each 100,000 shall be tested. Additional representative samples may be taken at any time or place at the discretion of the purchaser.

STANDARD SIZES

"4. The standard sizes shall conform to the following dimensions, with a permissible variation, plus or minus, of 1/16 in. in depth, 1/8 in. in width, and ¼ in. in length:

Type	Depth, in.	Width, in.	Length, in.
Common brick	2¼	3¾	8
Rough-face brick	2¼	3¾	8
Smooth-face brick	2⅛	3 7/8	8

WORKMANSHIP AND FINISH

"5. When any particular surface appearance or uniformity is desired, it shall be as mutually agreed upon.

INSPECTION AND REJECTION

"6. All brick shall comply with the following requirements for general properties under visual inspection:

(a) They shall be free from cracks, warpage, stones, pebbles, or particles of lime that would affect their serviceability or strength.

(b) Bricks of Grades A and B, when struck together, shall give a ringing sound.

"7. If the visual inspection, Section 6, appears to indicate inferior strength, the brick may be rejected unless the physical tests show the quality or grade to be as specified.

"8. At the option of the purchaser, acceptance may be based on the visual inspection requirements specified in Section 6 and the results of one of the strength tests (compression or flexure) specified in Section 2. While the compression strength is considered as generally giving the better basis for classification purposes, the flexure test gives important information on the strength and proper manufacturing details."

STRUCTURAL TILE

Structural tile or hollow tile are hollow building units made from fired clay and are usually rectangular in cross-section and with one or more parallel cells. In recent years they have found an ever increasing use replacing backing brick in foundations, floors, and walls, as fire-proofing inclosing steel framework, and as partitions in the interior of buildings. The various forms of structural tile are described by the American Society for Testing Materials[1] as follows:

[1]Am. Soc. Testing Mats., Standards, Pt. II, pp. 287–288, 1930.

Standard Definitions of Terms Relating to Hollow Tile

"1. *Hollow-Tile.*—Hollow building units with parallel cells. NOTE.–In the present state of the art the term 'hollow tile', if used without a qualifying adjective, is understood to mean clay hollow tile. The term 'terra cotta', which is applied to ornamental building units of burned clay, should not be used to designate hollow tile.

"2. *Load-Bearing Wall Tile.*—Hollow tile for use as a load-bearing structural unit in walls.

(a) *Hollow Floor Tile.*—Hollow tile for use as a load-bearing structural unit in floors.

(b) *Foundation Tile.*—Hollow tile for use as a load-bearing structural unit in foundations.

(c) *Side-Construction Tile.*—Hollow tile designed to receive its principal stress at right angles to the direction of its cells.

(d) *End-Construction Tile.*—Hollow tile designed to receive its principal stress parallel to the direction of its cells.

(e) *Book-Tile.*—Hollow tile with tongue and groove edges resembling a book in shape.

(f) *Salt-Glazed Tile.*—Clay hollow tile with a vitreous glaze on its surfaces produced by burning salt in the kiln at the temperature used in finishing the burning.

"3. *Hollow Tile Fireproofing.*—Hollow tile for use as a protection for structural members against fire.

(a) *Split Tile.*—Hollow tile which has been knifed parallel with its cells in the process of manufacture for the purpose of separation into two equal units.

(b) *Partition Tile.*—Hollow tile for use in building interior partitions, subdividing areas into rooms or enclosing stairways or shafts, and carrying no superimposed load.

(c) *Furring Tile.*—Tile of suitable design for lining the inside of walls and carrying no superimposed load.

(d) *Porous Hollow Tile.*—Clay hollow tile in which the natural porosity of the clay has been increased by the admixture of other ingredients.

DESIGNATION OF DIMENSIONS

"7. *Length.*—In the case of hollow tile, that dimension measured between its cut ends.

"8. *Thickness.*—In the case of hollow tile, that dimension designed to lie at right angles to the face of the wall, floor, or other member in which it is used.

"9. *Width.*—In the case of hollow tile, that dimension measured at right angles to the direction of its thickness and length.

NOTE.—In practice, the first dimension given represents thickness; the second, width; the third, length.

PARTS, OPENINGS AND SURFACE FEATURES

"10. *Shell.*—In the case of hollow tile, the outer walls.

"11. *Webs.*—In the case of hollow tile, the partitions dividing it into cells.

"12. *Cells.*—In the case of hollow tile, the openings parallel with its shell and webs.

"13. *Scoring.*—In the case of hollow tile, the grooves formed in the exterior faces of the shell to increase the bond of mortar, plaster, or stucco."

Alluvial clays and shales are both used in the manufacture of structural tile. Such clays should develop sufficient plasticity to flow smoothly through the irregular shaped dies commonly used. In general, they should show a laboratory green modulus of rupture of not less than 100 pounds per square inch. The total linear shrinkage, determined in the laboratory, should not be more than 16 per cent. The laboratory absorption within the vitrification range should be less than 15 per cent for medium-fired tile and less than 10 per cent for hard-fired tile. The laboratory fired modulus of rupture necessary depends upon the load which will be applied to the commercial tile. For hard-fired tile it should not be less than 1800 pounds per square inch. The color to which the clay fires should be of little importance, yet light colors in structural tile meet with sales resistance even when the other properties are favorable.

Structural tile are manufactured in much the same way as building brick. The clay is ground, screened, tempered, pugged, extruded by an auger-machine through a die that simultaneously forms the shell and webs, and wire-cut into the individual tile. The tile are commonly fired in round down-draft periodic kilns.

The following are the important features of the specifications for structural tile, as given by the American Society for Testing Materials[1]:

Standard Specifications for Hollow Burned-Clay Load-Bearing Wall Tile

A. S. T. M. Designation: C34–30

SPECIFICATIONS

"1. These specifications apply to hollow load-bearing wall tile made from surface clay, shale, fire clay or admixtures thereof.

CLASSIFICATION

"2. (a) According to the results of the physical tests, tile shall be classified as hard, medium and soft on the basis of the following strength and absorption requirements, the class of any lot being determined by the requirement which gives it the lowest rating:

Class	Absorption, per cent			Compressive Strength Based on Gross Area, lb. per sq. in.			
				End Construction		Side Construction	
	Mean of 5 Tests	Individual Maximum	Individual Minimum	Mean of 5 Tests	Individual Minimum	Mean of 5 Tests	Individual Minimum
Hard	6 to 12	15	5	2000 or more	1400	1000 or more	700
Medium	12 to 16	19	5	1400 or more	1000	700 or more	500
Soft	16 to 25	28	5	1000 or more	700	500 or more	350

(b) Where end-construction tile are used on the side they shall meet the requirements of that construction, and *vice versa*.

(c) All tile shall be so designed that substantially the same masonry strength will be developed in all wall thicknesses for which they are to be used.

[1]Am. Soc. Testing Mats., Standards: Pt. II, pp. 272–286, 1930.

WEIGHTS

"3. (a) The tile shall have the following dry weights when determined as specified in Section 17:

Size of Unit, in.	Number of cells	Standard Weight, lb.
3¾ by 12 by 12	3	20
6 by 12 by 12	6	30
8 by 12 by 12	6	36
10 by 12 by 12	6	42
12 by 12 by 12	9	52
3¾ by 5 by 12	1	9
8 by 5 by 12	3	16
8 by 5 by 12 ("L" Shaped)		16
8 by 6¼ by 12 ("T" Shaped)	4	16
8 by 7¾ by 12 (Square)	6	24
8 by 10¼ by 12 ("H" Shaped)	7	32
8 by 8 by 8 (Cube)	9	18

NOTE.—Units of the same general design as those listed in the above table, but of smaller size, shall weigh not less per unit volume.

(b) A tolerance of 5 per cent under and 12.5 per cent over will be allowed on the above standard weights.

DIMENSIONS

"4. No dimension shall vary more than 3 per cent from the standard dimensions for any form of tile.

WEATHER RESISTANCE

"5. All tile used in exterior work subjected to weathering conditions shall be able to withstand 100 alternate freezings and thawings. Tile classed as hard or medium by these specifications may be considered as meeting the weathering requirement, provided they are burned to the normal maturity for the given clay. Tile classed as soft shall be accepted as meeting the weathering requirement only on the basis of freezing tests.

FIRE RESISTANCE

"6. The tile shall meet the following requirements as tested according to the Tentative Specifications for Fire Tests of Building Construction and Materials (A. S. T. M. Designation: C19-26T) of the American Society for Testing Materials as they apply for bearing walls and partitions and to be acceptable shall develop the following resistance periods as tested unplastered:

Thickness of wall, in.	Number of Units in Wall Thickness	Number of Cells in Wall	Resistance Period Hours [a]
8	1	2	1½
8	1	3	2
12	1	3	3
12	2	3	4
12	2	4	5
16	2 or 3	4	6
16	2 or 3	6	8

[a]These are near the minimum values developed in tests. The average results will generally be higher. Plaster coatings ¾ in. thick applied on both sides and remaining in place throughout the fire test will increase the periods by 1 to 2 hours.

WORKMANSHIP AND FINISH

"7. All tile shall be well burned, reasonably free from laminations and from such cracks, blisters, surface roughness, and other defects as would interfere with the proper setting of the tile or impair the strength or permanence of the construction.

"8. The exterior surface of all tile intended for plaster or stucco shall be scored in such a manner as to give good adhesion."

Standard Specifications for Hollow Burned-Clay Fireproofing, Partition and Furring Tile
A. S. T. M. Designation: C56-30

"1. These specifications apply to hollow fireproofing, partition and furring tile made from surface clay, shale, fire clay or admixtures thereof.

CLASSIFICATION

"2. According to the results of the physical tests, tile shall be classified as hard, medium and soft on the basis of the following absorption requirements:

Class	Absorption, per cent		
	Mean of 5 Tests	Individual Maximum	Individual Minimum
Hard	6 to 12	15	5
Medium	12 to 16	19	5
Soft	16 to 25	25	5

WEIGHTS

"3. (a) The tile shall have the following dry weights when determined as specified in Section 16:

STANDARD PARTITION TILE

Dimension, in.	Minimum Number of Cells	Standard Weight, lb.
3 by 12 by 12	3	15
4 by 12 by 12	3	16
6 by 12 by 12	3	22
6 by 12 by 12	4	25
8 by 12 by 12	4	30
10 by 12 by 12	4	35
12 by 12 by 12	4	40

(b) A tolerance of 5 per cent will be allowed on the above standard weights.

DIMENSIONS

"4. No dimension shall vary more than 3 per cent from the standard dimensions for any form of tile."

The fire resistance is to be specified by the purchaser. The specifications of workmanship and finish are the same as those given for load-bearing wall tile.

Standard Specifications for Hollow Burned-Clay Floor Tile

A. S. T. M. Designation: C57–30

"1. These specifications apply to hollow floor tile made from surface clay, shale, fire clay or admixtures thereof.

CLASSIFICATION

"2. (a) According to the results of the physical tests, tile shall be classified as hard, medium and soft on the basis of the following strength and absorption requirements, the class of any lot being determined by the requirement which gives it the lowest rating:

Class	Absorption, per cent			Compressive Strength Based on Net Area, lb. per sq. in.			
				End Construction		Side Construction	
	Mean of 5 Tests	Individual Maximum	Individual Minimum	Mean of 5 Tests	Individ. Minimum	Mean of 5 Tests	Individ. Minimum
Hard	6 to 12	15	5	4600 or more	3000	2400 or more	1700
Medium	12 to 16	19	5	3200 or more	2250	1600 or more	1100
Soft	16 to 25	25	5	2000 or more	1400	1200 or more	850

(b) Where end-construction tile are used on the side they shall meet the requirements of that construction, and *vice versa*.

WEIGHTS

"3. (a) The tile shall have the following dry weights when determined as specified in Section 16.

FLAT ARCH

Depth of Arch in inches	Average Weight Per Square Foot of Floor, lb.
6	26
7	29
8	32
9	35
10	38
11	42
12	50

SEGMENTAL ARCH

6	30
8	36
10	40

The standard weights of tile for use in combination hollow tile and concrete construction are the same as those previously given for standard partition tile. The tolerance of weight and dimensions and the specifications for fire resistance and workmanship and finish are the same as given for fireproofing, partition and furring tile.

ROOFING TILE[1]

Tiles of fired clay, which since the days of antiquity have been the most durable and beautiful roofing material, are finding an ever increasing use in America. They are made in many shapes and styles, all of which fall under three groups: the Mediterranean type characterized by a semi-circular or curved cross-section; the Nordic or shingle type; and the flat interlocking type which in appearance is often between the Mediterranean and the shingle type. The Mediterranean type in uniform brick-red colors has been the most common in the United States, often on buildings utterly unsuited architecturally for it. Within the last few years this type has been more restricted to the style of buildings for which it was originally designed, shingle tile have increased in use for the Northern style of architecture, and softer ranges in colors have predominated.

Roofing tile are made from the better grades of alluvial clays and from the softer and more plastic shales. The varieties of tile are so numerous and their requirements so varied it will be impossible to discuss them in any detail in this report. The predominant characteristics desired are: a plasticity sufficient to process the tile, a green and fired strength sufficient to prevent breakage of such thin ware, and a pleasing fired color. The laboratory tests should show a minimum green strength of 125 pounds per square inch and a minimum fired strength of 1500 pounds per square inch. A low total shrinkage is necessary for the interlocking type of tile, but not for shingle tile. The laboratory absorptions may range from 4 per cent to 18 per cent depending on the type of tile. The flat type should be used more in northern climates and therefore would require a lower absorption. The Mediterranean types can stand a higher absorption because they are more generally used in southern climates.

Roofing tile are formed either by extrusion from an auger machine or, with most of the interlocking types, by power pressing slugs of the tempered clay that have been extruded from an auger machine. They are fired in the usual way in either rectangular or round down-draft kilns.

QUARRY TILE

Quarry tile is the name given to red or buff vitrified unglazed floor tile of square or rectangular shape. They are finding a steadily increasing use in walks, porches, terraces, sun parlors, corridors, etc.

[1]For a very complete discussion of roofing tile see Worcester, W. G., and Orton, Edward, Jr., The manufacture of roofing tiles: Ohio Geol. Survey, 4th ser., Bull. 11, 1910.

The plain forms are by far the most common, but they are sometimes made with a design pressed in the surface, and colored glazes are occasionally used in the depressions of the design.

Quarry tile are made by either the stiff-mud or the dry-press process from the better grades of alluvial clay or from shale. A clay for this purpose must have a fair plasticity and must process without laminations. The laboratory tests should show a minimum green strength of 90 pounds per square inch, a total shrinkage of less than 16 per cent, a maximum absorption of 6 per cent without overfiring, a fired strength of 2000 pounds per square inch, and a firing range of not less than four cones in which pleasing colors as well as the above properties are developed.

SEWER PIPE

Sewer pipe was formerly often made from alluvial clay, but is now made almost entirely from shales and fire clays or mixtures thereof. The clay is ground, screened, and tempered in the usual way. The pipe, however, are formed by extrusion from a sewer pipe press. This consists of a vertical steam cylinder, the piston of which is connected to the piston of a smaller clay cylinder beneath. The piston being drawn up clear of the clay cylinder, tempered clay is fed into the clay cylinder by a belt conveyor. The piston descends under steam pressure, forcing the clay out through the die at the lower end of the clay cylinder. The extruded pipe is supported on a counter-balanced pipe table and cut off at the desired length. The pipes are usually dried in heated drying rooms and are fired to a vitreous condition in either round or rectangular downdraft kilns.

Sewer pipe are commonly salt glazed. This is done by firing in the usual way up to the temperature necessary for the vitrification of the ware, then introducing common salt at intervals into the fire box, where it is volatilized and attacks the ware, forming a glaze, probably of an insoluble sodium silicate.

A clay to be suitable for the manufacture of sewer pipe should have a plasticity sufficient to process well. The laboratory tests should show a green modulus of rupture of at least 125 pounds per square inch, a total linear shrinkage of less than 16 per cent, and, for first quality ware, an absorption of less than 12 per cent. In addition to the above qualities, the clay must be one that will take a salt glaze. Parmelee[1] states:

"All clays cannot be salt glazed, since it is necessary (1) to have present a certain amount of silica in a finely divided condition, (2) suitable body compositions. Barringer has given the following limits of body composition within which the glazing may be expected to operate successfully. They are:

	Percentage composition	
1 Al_2O_3: 4.0 SiO_2	Silica	62.0—77.5
1 Al_2O_3:12.5 SiO_2	Alumina	23.0—12.5
	Alkalies, etc.	15.0—12.0

(3) A suitable body texture. If the body is too dense, or if it burns glassy, it resists the attack and will not develop a proper glaze. If it is too porous, at the salting temperature, the glaze will not form."

[1]Parmelee, C. W., Outlines of essentials of glaze composition: Mimeographed outline, 1929.

The clay sewer pipe industry has in recent years met with severe competition from cement-concrete sewer pipe. The result has been a raising of the specifications until it is difficult for them to be met by either type of sewer pipe. The principal physical tests in the specifications for clay sewer pipe adopted as standard by the American Society for Testing Materials[1] are hydrostatic pressure, absorption, and crushing strength.

"Water pressure * * * shall be internally applied to the specimen as follows:
5 lb. per sq. in. for 5 minutes.
10 lb. per sq. in. for 10 minutes.
15 lb. per sq. in. for 15 minutes.

"The specimens shall show no leakage under these pressures. Moisture appearing on the surface of the pipe in the form of patches or beads, adhering to the surface, shall not be considered leakage."

The maximum absorptions allowed is 8 per cent. The average crushing strengths shall be equal or more than those given in the following table:

Internal Diameter, in.	Average Crushing Strength, lb. per lin. foot.	
	Knife-Edge and Three-Edge Bearings.	Sand Bearings.
4	1000	1430
6	1000	1430
8	1000	1430
10	1100	1570
12	1200	1710
15	1370	1960
18	1540	2200
21	1810	2590
24	2150	3070
27	2360	3370
30	2580	3690
33	2750	3930
36	3080	4400
39	3300	4710
42	3520	5030

Much of the sewer pipe on the market that will stand a hydrostatic pressure of 10 pounds per square inch for 10 minutes is considered satisfactory for general use.

DRAIN TILE

Drain tile are made from similar materials and in much the same manner as sewer pipe, except that they are often more porous and they are never glazed.

The American Society for Testing Materials[2] divides drain tile into the following three classes, according to the purpose for which they are suited:

"*Farm Drain Tile*, for ordinary private drainage work on farms, for moderate sizes and depths;

"*Standard Drain Tile*, for ordinary district land drainage at moderate depth;

"*Extra-Quality Drain Tile*, for district land drainage, for considerable depths and where extra quality is desired."

[1] Am. Soc. Testing Mats., Standards: Pt. II, pp. 227-237, 1930.

[2] Am. Soc. Testing Mats., Standards: Pt. II, pp. 249–264, 1930.

The physical requirements for these different classes of drain tile are given below:

Internal Diameter of Tile, in.	Farm Drain Tile				Standard Drain Tile				Extra-Quality Drain Tile			
	Minimum Average Ordinary Supporting Strength, lb. per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent			Minimum Average Ordinary Supporting Strength, lb. per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent			Minimum Average Ordinary Supporting Strength, lb. per linear ft.	Maximum Average Absorption by Standard Boiling Test, per cent		
		Shale and Fire-Clay Tile	Surface-Clay Tile	Concrete Tile		Shale and Fire-Clay Tile	Surface-Clay Tile	Concrete Tile		Shale and Fire-Clay Tile	Surface-Clay Tile	Concrete Tile
4	800	11	14	12	1200	9	13	10	1600	7	11	9
5	800	11	14	12	1200	9	13	10	1600	7	11	9
6	800	11	14	12	1200	9	13	10	1600	7	11	9
8	800	11	14	12	1200	9	13	10	1600	7	11	9
10	800	11	14	12	1200	9	13	10	1600	7	11	9
12	800	11	14	12	1200	9	13	10	1600	7	11	9
15	1000	11	14	12	1300	9	13	10	1600	7	11	9
18	(Not permitted)	(Not permitted)	(Not permitted)	(Not permitted)	1400	9	13	10	1800	7	11	9
21					1550	9	13	10	2100	7	11	9
24					1700	9	13	10	2400	7	11	9
27					1850	9	13	10	2700	7	11	9
30					2000	9	13	10	3000	7	11	9
33					2150	9	13	10	3300	7	11	9
36					2300	9	13	10	3600	7	11	9
39					2450	9	13	10	3900	7	11	9
42[a]					2600	9	13	10	4200	7	11	9

[a]Larger sizes recommended as standard are as follows: 45, 48, 54, and 60 in.

Freezing and thawing tests may also be demanded by the purchaser, or, in case the tile fail to meet the absorption requirements, by the manufacturer.

"The number of freezing and thawings to be endured shall be as follows: For farm drain tile, 24; for standard drain tile, 36; for extra-quality drain tile, 48." "Failure under the freezing and thawing treatment shall be considered to be reached when:

(a) The specimens show superficial disintegration or spalling with loss of weight of more than 5 per cent of the initial dry weight; or

(b) The specimens are badly cracked in other than lamination planes; or

(c) The specimens show evident serious loss of structural strength."

Tile that have passed the freezing and thawing tests cannot be rejected for failure to meet the absorption requirements.

CONDUITS

Conduits are vitrified salt-glazed pipes or tile suitable to receive and protect underground electric wires, telephone cables, etc. Alluvial clays are usually not satisfactory for this purpose, but any shale or similar clay that will meet the specifications for first-class sewer pipe, particularly the resistance of a hydrostatic pressure of 15 pounds per square inch for 15 minutes, will probably be satisfactory for the manufacture of conduits.

ACID TOWER PACKING

Shapes suitable for packing the towers used in the manufacture of sulphuric acid are made from red-firing clays and are vitrified but are not usually salt-glazed. The clay must be one capable of withstanding strong reducing action, as a combination of the iron as ferrous silicate, at least on the surface of the ware, is desired.

PAVING BRICK

Fired clay bricks have been used for road paving since the days of the Romans. With the advent of the automobile their popularity increased. When well made and properly laid they make an excellent road, durable and non-skid. But many a mile of paving brick road was laid with such insufficient foundation that irregularities and even holes soon developed. This, together with the popularity of the concrete road, gave paving brick a bad name that has materially reduced their production in the last decade.

Recent experiments indicate that paving brick laid on a thin layer of tar or asphalt over a thick concrete base, while by no means cheap, has a wearing power under heavy traffic superior to that of concrete and would be desirable for heavy traffic trunk-line highways. Another possibility of great interest is the laying of paving brick on a base of some noncorrosive sheet metal, such as stainless steel. This would do away with a larger part of the foundation cost, and yet give a paving brick road that would not become wavy.

Clays that will form a hard dense body and that have a long vitrification range are desirable for the manufacture of paving brick. Those most frequently employed are shales and fire clays, these being often found to give the desired vitrified body at not too high a temperature.

The laboratory tests of a clay, to be suitable for the manufacture of paving brick, should show a green modulus of rupture of at least 70 pounds per square inch; a vitrification range of at least four and preferably six cones; a total shrinkage of less than 14 per cent; and a fired modulus of rupture of not less than 2,000 pounds per square inch within the vitrification range. The absorption should be less than 8 per cent and should not vary more than two per cent throughout the vitrification range.

Paving brick are usually formed on a stiff-mud brick machine, but are often repressed before firing. They are fired to vitrification, usually in round or rectangular down-draft kilns.

The specifications for paving brick of the American Society for Testing Materials[1] provide that the brick shall pass a visual inspection which shall eliminate brick varying in size by more than 1/8 inch in either transverse dimension, or more than 1/4 inch in length, and all broken, chipped, cracked, warped, kiln-marked, or obviously underfired brick; and a rattler test made according to definite specifications in standard apparatus. Ten brick, together with a charge of large and small cast-iron balls, are placed in the rattler and revolved 1800 times at a rate of 30 revolutions per minute.

"The percentage of loss in the rattler test of the respective sizes of paving brick specified shall conform to the following maximum requirements:

Size of Brick: Transverse Dimensions, In.	Size of Brick: Length In.	Loss in Rattler Test, per cent
2½ by 4	8½	26
3 by 3½	8½	26
3 by 4	8½	24
3½ by 4	8½	22

LIGHT-WEIGHT AGGREGATES

A new industry of recent years has been the manufacture of artificial light-weight concrete aggregates for building construction. The scope of this industry has been described by Hughes[2] as follows:

"The trend in modern building construction is definitely toward the use of weight-reducing materials. The basic advantage of lighter structural weight is obvious; reduction of dead load with retention of equivalent strength affords the possibility of increasing the live load, or if this is not desirable or necessary it makes feasible a reduction in size of structural steel members and corresponding savings in other plases of construction. * * *

"Burned shale aggregate now available in many sections of the country will make concrete weighing only 100 lb. per cubic foot, saving roughly 35 per cent in weight

[1]Am. Soc. Testing Mats., Standards: Pt. II, pp. 170–178, 1930.

[2]Hughes, H. H., Scope of the light-weight aggregates industry: Am. Inst. Min. & Met. Eng., Tech. Pub. No. 405, 1931.

and sacrificing none of the strength of a rock-sand mix. It may be more expensive, but actual experience has shown that the saving in dead load will effect a reduction in structural steel which in many instances will more than offset the increased cost of the aggregate. The vesicular nature of most light-weight aggregates gives the concrete especially good insulating, fireproofing and soundproofing properties; yet absorption is comparatively low. * * * The largest outlet at present for light-weight aggregates is in the manufacture of precast building units.

"All light-weight aggregates fall into one of three divisions, depending upon their source: (1) Those which occur naturally, such as volcanic cinder, tuff, pumice and coal; (2) those formed as by-products in industrial processes, including cinders, slag and sawdust; and (3) those manufactured specifically for use as concrete aggregate."

Included in the third group are three products made from clay; Haydite, Lytag, Cel-Seal.

"*Haydite* is a light-weight burned shale aggregate, developed and patented by the late Stephen J. Hayde. * * * Haydite is a vesicular, clinkerlike aggregate which, because of its semivitrified nature, has exceptional strength, considering its light weight and cellular structure. It is produced by burning in a rotary kiln a clay or shale, which retains its original chemical moisture content as it enters the kiln. Preheating at the charging end of the kiln vitrifies a thin layer on each particle, which prevents the gradual escape of gases during burning. Near the discharge end the material is subjected to high temperature and the resulting semifusion permits the sudden release of pent-up gases, causing each particle to expand into a porous clinker. After cooling and thorough wetting, the material is crushed and screened. One fine and two coarse sizes are produced. The average screen analysis of the sand-size Haydite is 17 per cent retained on 14 mesh, ranging to 12.5 per cent passing 100 mesh with a fineness modulus of 2.65. The coarse grade is composed of ¾ in. to 4-mesh particles and the intermediate grade of ½ in. to 4-mesh; their fineness moduli are 6.70 and 6.20, respectively. Absolute control of the process insures uniformity of the product.

"The weight of Haydite varies from 1500 to 1600 lb. per cubic yard for the sand size to about 1200 lb. for the ¾ in. * * * Haydite aggregate is especially desirable for structural concrete for all purposes where weight and strength are important factors. The average weight of Haydite concrete is only 100 lb. per cubic foot, a decided reduction from concrete made with ordinary natural aggregates. * * * About one-half of the total Haydite production at the present time is used as aggregate in the manufacture of precast light-weight building units, which are highly satisfactory for all purposes where light-weight units can be utilized advantageously. * * *

"Haydite is less dependent upon special raw materials than other aggregates of the light-weight group. Practically any shale or clay is satisfactory, although material containing some carbonaceous matter gives the best results. Judging from the present trend, Haydite appears to be moving toward the Atlantic seaboard markets, but the manufacturers certainly will not overlook the large potential markets of the South and Southwest, where burned shale aggregates will be free from competition of other members of the light-weight group which are excluded from those areas because of the lack of raw materials."

"*Lytag* is the trade name of a light-weight aggregate now being produced experimentally in Chicago. It is a burned shale or clay product manufactured under patents which protect the process as well as the machinery used in its manufacture. Practically every shale, clay, and even sand or loam will show vesicular structure when sintered by the Lytag process, but easily fusible common shale and clay will give a more satisfactory product at a cheaper operation cost.

"The sintering process for making Lytag is unique in the light-weight field. Shale crushed to 11-mesh fineness is mixed with a small proportion of granulated coal in a pug mill, an important feature of the process being the addition of moisture. It is then spread over suction chambers and ignited by a flame applied for only about 30 seconds. Combustion without flame continues downward, aided by down draft.

The combustion process may be likened to smoking a pipe, a match lights it, suction keeps it ignited and the ashes correspond to the sinter that remains in the grate. The machine employed apparently corresponds, at least in principle, to the Dwight-Lloyd sintering machine extensively used for roasting and calcining ore.

"The properties of the sinter are more dependent upon the process itself than upon the raw shale. The operator may vary the shale-coal ratio or the moisture content, he may change the speed of revolution or the depth of the charge, or he may add other constituents to the mix. All these variations will alter the nature of the product and this flexibility of operation is one of the principal advantages of the process. A peculiar feature is that the vesicular sinter shrinks in size rather than expands as is characteristic of other burned shale aggregates.

"No commercial production of Lytag has yet been attempted and no accurate information regarding properties and tests of the material has yet been published."

"*Cel-Seal* * * * is a burned clay product * * * that has scarcely passed the experimental stage as yet.

"Cel-Seal is made by pugging a mixture of soil and clay and forcing it through a die. It is then broken or cut into pieces of various sizes, each one of which is covered with a thin coating of fine silica sand, the sand coating serving to keep the fragments from sticking together. After burning in a rotary kiln the resultant clinkered particles are screened to the desired sizes."

It would seem from the above descriptions that nearly all of the shales and clays of Georgia have possibilities for the manufacture of light-weight aggregates, and that the controlling factors would be primarily accessibility and market. In regard to this market Hughes[1] states:

"The Southern, Southwestern and Pacific Coast States must not be overlooked. Slag is available in the Birmingham district, * * * but elsewhere in this extensive area burned shale aggregates could be manufactured with little competition from other members of the light-weight group. Either Haydite expansion or introduction of new burned shale products now in the experimental stage will no doubt extend the field of light-weight aggregates to include the principal cities in these sections of the country."

The pioneers in this market will undoubtedly have to do considerable educational work convincing the consumers of the economy of using light-weight aggregates in their proper function.

No specific tests were made on the samples collected for this report to determine their suitability for the manufacture of light-weight aggregates. Probably a low vitrification point, together with a rapid development of a glassy and vesicular structure when carried beyond that point, are the properties most desired. Therefore some of the shales and clays that are the least desirable for the manufacture of heavy clay products may be the best suited for the manufacture of light-weight aggregates. Lack of specific mention of this use for any of the clays described in the report does not indicate that the writer considers them to be unsuited for this use.

[1]Hughes, H. H., Op. cit., p. 15.

FACTORS AFFECTING THE UTILIZATION OF CLAY DEPOSITS

A number of factors, in addition to the quality of the clay, must be considered in determining the possibility of mining and utilizing any deposit of clay or shale. These factors are discussed in brief below with special reference to the shales and brick clays of Georgia. They are given as much consideration as possible in the detailed descriptions of deposits that make up the bulk of this report.

MARKET

Heavy clay products, because of their relatively low value and high weight per unit, will not usually stand the cost of shipping to long distances. Therefore a local or a nearby market is essential, and the producer nearest to a large market has the advantage in that market.

The market for a heavy clay product depends upon:

(1) The consumption of the product within the area considered.

(2) The source of the product now being used, whether locally made or shipped in from a distance. If largely locally made, the new producer can only hope to monopolize the market by producing a superior product or selling at a lower cost. If largely shipped in from a distance, a local producer, assuming manufacturing costs to be equal, would have the advantage of the freight rate on his competitor's product.

ACCESSIBILITY

The value of a clay deposit decreases sharply with its distance from railroad transportation. The clay, either in a raw state or in the form of a finished product, must be transported to its market. Spur tracks from the railroad to the deposit can be built only at a considerable cost. The problem is usually solved by narrow-gauge tram haulage of the crude clay from the mine to a plant built near the railroad, but if the distance is long or the grade steep, the haulage and maintenance costs are high. The limit of distance from a railroad beyond which a clay deposit cannot be economically worked depends upon the quality and value of the clay or the product made from it. At the present time in Georgia no heavy clay product manufacturer would consider building a plant to use a clay deposit more than a mile from the railroad. As deposits nearer the railroads are exhausted in the future this limit may be extended.

SIZE OF DEPOSITS

The tonnage of clay in a deposit must be at least approximately determined by prospecting before going to the expense of opening up the deposit for mining. A modern plant for the manufacture of heavy clay products requires a large investment and should only be undertaken with a sufficient tonnage of the clay in sight to insure production long enough to amortize the investment. This in most cases would be 35 to 40 years.

CHARACTER AND UNIFORMITY OF DEPOSITS

The ideal clay deposit would be uniform in character throughout the entire deposit, so that a ton of clay mined from any place would be exactly like a ton mined from any other part of the deposit.

Such an ideal condition is rarely ever found in a clay deposit. Shale deposits, while sometimes of remarkable uniformity, often vary considerably across the strata. The amount of weathering of the beds, as well as the presence of such impurities as silica and lime, may have a marked effect on the properties of the shale. The presence of layers, lenses, or "horses" of limestone that must be discarded or avoided add greatly to the cost of mining. The alluvial clays are noted for their lack of uniformity and their variation in sand content.

Great care should be taken in prospecting a clay deposit to note variations in the clay and impurities. Auger borings and drill holes should be supplemented by prospect pits or wells which better expose such variations.

OVERBURDEN

Overburden consists of any material overlying a deposit that must be removed and thrown away in order to mine the deposit. The shale deposits of Georgia are usually found in rather steeply inclined beds, and therefore where sufficiently weathered to be of ceramic value are practically free from overburden. The alluvial clays are sometimes covered with a thin layer of sand or loam, but the overburden is seldom thick enough to offer a serious obstacle to mining.

DRAINAGE

Surface water is often very troublesome to a clay producer. The operator of a deposit located on a slope sufficiently high above the streams can dig drainage ditches to prevent a greater part of the surface water from entering the pit and to quickly remove that which does find its way in. The operator of a deposit located in a flat valley bottom must install and operate at a considerable expense pumping equipment to remove the rain water and often a considerable seepage from nearby streams.

WATER SUPPLY

A nearby supply of pure soft water is desirable for the operation of the boilers of any steam-powered equipment used in mining a clay deposit, or operating a ceramic plant, and for the purpose of tempering the clay. Many of the Georgia shale and clay deposits are located with abundant streams conveniently near to the deposits or the plant sites.

CLIMATE

Advantages of the climate of one region over another often means lower mining and manufacturing costs for that region. The climate of Georgia is suitable for mining and all types of plant operations the year around. The warm weather of the summer has no effect on the colored labor commonly employed for unskilled labor. Rain may cause slight interruptions of mining operations in the winter months, but cold weather or snow practically never. Plant buildings need not be heavily constructed, and heating costs are low. Less fuel is required for power or the manufacture of ceramic products because of lessened radiation losses. Living conditions are ideal.

LABOR

Georgia has the advantage of low-priced and plentiful labor. Unskilled labor adapted to the climatic conditions is supplied by the colored population. The white population is of intelligent native American stock capable of being trained to fulfill any class of skillful labor necessary. The cost of living is and will remain cheaper than in the more rigorous climate of the North.

POWER

Power is necessary for any mining or ceramic operation. Low-priced coal from Alabama and Tennessee and an abundance of interconnected hydro-electric power insure lowered mining and manufacturing costs in Georgia. Natural gas, the ideal ceramic fuel, piped from Louisiana is available in the Atlanta and Macon districts and over a good part of Northwest Georgia that is underlain by the shale deposits.

SHALE DEPOSITS OF GEORGIA

DISTRIBUTION[1]

The shale deposits of Georgia are found in the northwest part of the State in the area of Paleozoic sedimentary rocks known as the Appalachian Valley, or simply "The Valley", so called because its general surface, though 600 to 800 feet above sea level and made up of ridges as well as stream valleys, is 1,000 to 2,000 feet below the summits of the mountains on either side. It is a continuation of the Valley of Tennesee, the Shenandoah Valley of Virginia, the Cumberland Valley of Pennsylvania, and the Kittatinny Valley of New Jersey. In the other direction it continues into central Alabama, where it passes beneath the sediments of the Coastal Plain.

The Valley in Georgia is bounded on the east and south by the Cohutta Mountains and the Piedmont Plateau, and on the northwest by the Lookout Plateau. It includes all or parts of the following counties: Polk, Floyd, Chattooga, Dade, Walker, Catoosa, Whitfield, Murray, Gordon, and Bartow. The Valley may be divided physiographically into three parts: the Rome Valley, the Armuchee Ridges, and the Chickamauga Valley (see figure 3).

The Rome Valley is a broad fertile valley extending from the Tennessee line on the north to the Alabama line on the west. It is almost entirely drained by the Coosa River and its tributaries, the Etowah, Oostanaula, Coosawattee, and Conasauga rivers. Its south and east boundary is that of the Valley. Its north and west boundary follows the foot of a series of ridges including Lavender, Horn, and Chattoogata mountains. It includes some of the richest farming land in the State and some of the best of the shale deposits described in this report. The principal towns are Rome, Dalton, Cartersville, Cedartown, and Calhoun. It is served by a number of railroads including the Atlanta to Chattanooga lines of the Southern Railway and the Nashville, Chattanooga and St. Louis Railway; the Atlanta to Knoxville line of the Louisville & Nashville Railroad; the Macon to Chattanooga line of the Central of Georgia Railway; and the Atlanta to Birmingham line of the Seaboard Air Line Railway.

The middle section of the Valley, which may be called the Armuchee Ridges, lies west and north of the Rome Valley. Its south and east boundary has been described above. Its northwest boundary follows the foot of Gaylor and Taylor ridges and White Oak Mountain. The whole area is made up of a series of long, narrow and roughly parallel ridges rising some 700 feet above the floors of the intervening valleys.

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[1]Physiographic descriptions largely from Campbell, M. R., Physical Geography of Georgia: The Valley Province: Georgia Geol. Survey, Bull. 42, pp.133–147, 1925.

These ridges, although not very high, are steep-sided and have been quite a barrier to transportation in an east-west direction. Two improved highways and two railroads only cross them. The Central of Georgia Railway from Rome to Summerville follows a winding route around the end of Lavender Mountain and between Gaylor and Taylor ridges. The west branch of the Dixie Highway between Rome and Summerville follows a natural gap between the ridges at Armuchee and Crystal Springs and crosses Taylor Ridge through a high wind gap. The east branch of the Dixie Highway and the Nashville, Chattanooga and St. Louis Railway from Dalton to Ringgold cross the ridges through water gaps at Rocky Face and Ringgold.

The section of the Valley here called the Chickamauga Valley, lying between the Armuchee Ridges on the east and the Lookout Plateau on the west, is drained by the Chattooga River on the south and Chickamauga Creek on the north. The divide between them, however, is so low as to be scarcely noticeable. A few low but fairly continuous ridges, such as Missionary Ridge and the Shinbone Ridge that parallels the foot of the Lookout Plateau, rise above the fairly level and smooth floor of the valley. The area is traversed by the Macon to Chattanooga line of the Central of Georgia Railway and the Chattanooga to Gadsden line of the Tennessee, Alabama and Georgia Railroad. The principal towns in the area are LaFayette and Summerville. Certain of the shale deposits described in this report occur in this area.

The Lookout Plateau of Georgia is a continuation of the Cumberland Plateau of Tennessee and Kentucky and the Alleghany Plateau of West Virginia and Pennsylvania. It consists of two flat-topped ridges, Sand Mountain and Lookout Mountain, separated by the narrow valley of Lookout Creek. These ridges rise to a height of slightly more than a thousand feet above the valleys in a steep slope capped by almost vertical cliffs of sandstone from 200 to 300 feet in height. Only a small part of Sand Mountain, which is an extension of Walden Ridge in Tennessee, crosses the northwest corner of Georgia. Lookout Mountain as it enters the State from Alabama has a width of about nine miles. Near the Alabama line a great spur, known as Pigeon Mountain, branches off from Lookout Mountain and extends for about ten miles northeast into the Valley. The main ridge of Lookout Mountain continues a little east of north, with an average width of two miles, to Chattanooga, where it ends in the famous Lookout Point overlooking the city. The V-shapped valley between Pigeon and Lookout mountains is known as McLamore Cove. The valley of Lookout Creek between Lookout and Sand Mountains averages three miles in width. It is mostly underlain by limestone, although deposits of shale, described later in detail, outcrop in a series of low ridges parallel to each side of the valley and similar to the Shinbone Ridge that parallels Pigeon Mountain and the west side of Lookout Mountain in the Valley. In fact the valley of Lookout Creek might be considered as an arm of the Valley extending between Lookout and Sand mountains, much as McLamore Cove extends between Lookout and Pigeon mountains.

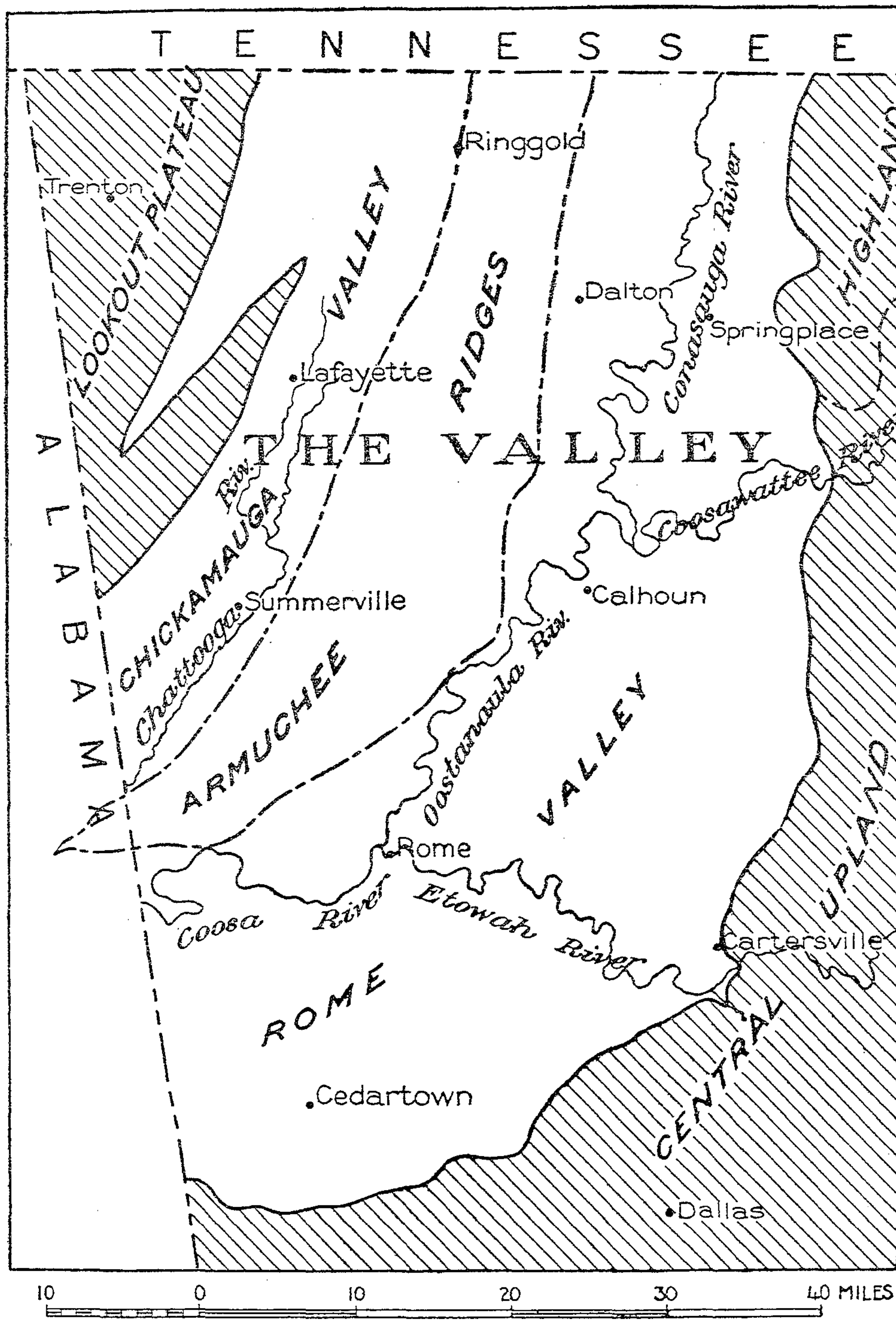

Figure 3. The Appalachian Valley and the Lookout Plateau of Georgia.

GEOLOGY OF NORTHWEST GEORGIA

STRATIGRAPHIC AND PHYSIOGRAPHIC HISTORY

The sedimentary rocks of the Valley and the adjoining Lookout Plateau consists of shales, limestones, and sandstones, and range in age from Early Cambrian to Pennsylvanian. They are composed of material derived from a land mass to the southeast, the ancient continent of Appalachia, and deposited in a shallow sea; the sandstones nearest the shore line, the shales (as clay) further away from the shore, and the limestones in the clearest water. As the shore line oscillated back and forth or conditions of erosion and deposition changed during this time, the various materials were laid down one on top of the other. The deposition was interrupted at times by elevation above sea level and even erosion. Thus thousands of feet of sediments were deposited, the record from which we can read the several cycles of sedimentation, interruption, and erosion. The smaller of these cycles mark the division of the rocks into geologic formations, the larger into series and systems (see table on page 53).

At the close of the Pennsylvanian time the area was elevated above sea level, and the period of the formation of the Appalachian Mountains began. The forces that thrust up these mountains, of which we now see a small remnant, exerted tremendous lateral pressure from the southeast against this area of horizontal sedimentary rocks, forcing them into hugh folds. As the pressure increased the folds in the eastern and southeastern part of the area nearest the mountains were compressed, overturned, and in places faulted or broken. Beds were thrust over each other. The beds in the adjoining edge of the Piedmont Plateau and the Cohutta Mountains were metamorphosed or recrystallized almost beyond recognition and thrust over the less metamorphosed beds, forming the Cartersville fault that marks the eastern and southern boundary of the Valley.

All the beds in the eastern and southeastern part of the area are on edge and some are partly metamorphosed, sandstones to quartzites and shales to slates. In the Rome district and extending northeast from it the Cambrian shales have been thrust for at least four or five miles over the younger Mississippian rocks. This overthrust fault is known as the Rome Fault, and is described in more detail in the description of the geology of Floyd County on page 73. In the northwest part of the Valley and the adjoining Lookout Plateau the beds were left in large and fairly gentle folds.

The land gradually elevated in the geologic ages that followed, allowing the streams to cut down into it and carry off the debris into the ocean. This elevation and erosion did not take place uniformly, but in cycles of elevation, a rapid cutting of V-shaped valleys by the streams, a more gradual widening of these valleys, sometimes progressing long enough to reduce the land to a low peneplain (almost a plain) over which the streams sluggishly meandered, and then another elevation and a repetition of the cycle.[1]

One of these cycles is believed to have been far advanced in Cretaceous time, at the end of which the region had been reduced to an almost level plain from which the Cohutta Mountains and a few small hills in northwest Georgia rose like islands. The flat, nearly level top of the Lookout Plateau and a portion of the Piedmont Plateau are remnants of this peneplain, preserved because they were underlain by hard rocks that resisted erosion during the following cycles.

This Cretaceous peneplain in what is now the Valley was soon destroyed in the erosion that followed the next elevation of the land. The beds in this region were all on edge, exposing mostly soft and easily eroded shales and limestones, with only narrow beds of hard chert and sandstone between. The beds in the Lookout Plateau region were only in fairly gentle folds. Figure 4 shows how heavy beds of sandstone protected the synclines or troughs of these folds from erosion, while on the anticlines or arches the sandstone beds were worn through exposing the softer and more easily eroded limestones and shales beneath, forming the valleys of Lookout and Willis creeks and McLamore Cove.

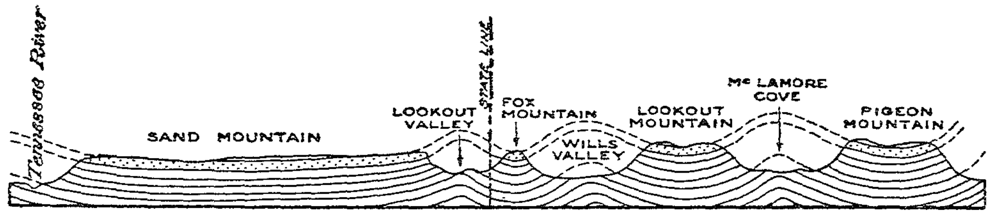

Figure 4. Structure section showing the relation of hard rocks to Sand and Lookout mountains.

The next peneplain of which we have definite traces left is believed to have reached an advanced stage at the end of the Eocene time, although evidences of it are poorer in Georgia than in Middle Tennessee where it forms the Highland Rim. However, much of the floor of the Valley between streams in the Rome and Chickamauga valley areas rises to a uniform height of about 1,000 feet above sea level. These areas probably represent the remnants of this Eocene peneplain. One of the largest of these areas is on either side of the Etowah River valley northwest of Cedartown and north and northwest of Cartersville. The main beds of sandstone and chert in the Armuchee Ridges area, narrow as they are in their upturned position, resisted erosion sufficiently to remain well above the peneplain.

The third cycle has only just ended, geologically speaking. It was not as long or as marked as the other two and only the areas of softer

[1]See Hayes, C. W., Physiography of the Chattanooga district, in Tennessee, Georgia and Alabama: U. S. Geol. Survey Nineteenth Ann. Rept., pt. 2, pp. 1–58, 1899; and

Johnson, D. C., Tertiary history of the Tennessee River: Jour. Geology, vol. 13, pp. 194–231, 1905.

and more easily eroded rocks along the main stream valleys were base-leveled to a plain. The broad, flat valleys of the Coosa River and its tributaries form the largest area of this peneplain, which is often called the Coosa Peneplain. The area west of Rome called the "flatwoods", parts of which are capped with water-worn gravels, is typical of this peneplain. Smaller plains have been formed adjacent to Chickamauga and Lookout creeks. The altitude of the Coosa Peneplain varies from 700 feet at the southern edge of the valley to 800 feet at the northern edge.

The elevation of the land that marked the beginning of the Quarternary or Recent geologic period established new base-levels for the streams, toward which they have only just begun to cut their beds. The present river flood plains are some 20 to 80 feet below the Coosa Peneplain.

GEOLOGICAL FORMATIONS[1]

The Appalachian Valley and the Lookout Plateau of Georgia are underlain by sedimentary rocks ranging in age from Lower Cambrian to Pennsylvanian. These rocks have been intensely folded and broken over much of the area so that they are highly inclined, striking in a general northeast-southwest direction and dipping to the southeast, their sequence interrupted or repeated by normal and thrust faults. The processes of erosion have carved them into plateaus, ridges, and valleys.

The various formations into which these beds can be divided are shown in the table on page 53, followed by a description of each with especial emphasis placed on those containing shale of economic importance. Their distribution is shown on the geologic map facing page 66. This map is largely the result of the geologic work of C. W. Hayes over thirty years ago. Detail work in a few areas by other geologists have made a few changes. Recent work in the adjoining states indicates that detailed geologic work in Georgia would result in many changes in the geologic map. Some of these changes would consist in splitting up certain formations into two or more new formations as outlined in the following descriptions. Others would consist in the re-correlation of certain beds. The Georgia Geological Survey hopes to undertake this much needed geologic work within the next few years.

[1]Largely compiled from:

Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Ringgold folio (No. 2), 1892; Stevenson folio (No. 19), 1895; and Rome folio (No. 78), 1902.

Spencer, J. W., The Paleozoic group: the geology of ten counties of northwest Georgia; Georgia Geol. Survey, 1893.

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

Shearer, H. K., The slate deposits of Georgia: Georgia Geol. Survey, Bull. 34, 1918.

Hull, J. P. D., LaForge, Laurence, and others, Manganese deposits of Georgia: Georgia Geol. Survey, Bull. 35, 1919.

Butts, Charles, Geology of Alabama: The Paleozoic rocks: Alabama Geol. Survey, Spec. Rept. No. 14, pp. 41–230, 1926.

GENERALIZED TABLE OF GEOLOGIC FORMATIONS OF THE PALEOZOIC OF NORTHWEST GEORGIA

SYSTEM	SERIES	FORMATION	THICKNESS IN FEET
Carboniferous	Pennsylvanian	Walden sandstone	930–1000
		Lookout sandstone	400–500
	Mississippian	Pennington shale	0–515
		Bangor limestone } Probably equivalent in time	500–900
		Floyd shale } Probably equivalent in time	0–2000
		Fort Payne chert	0–510
Mississippian or Devonian		Chattanooga black shale	0–30
Silurian		Red Mountain formation	600–1800
Ordovician		Rockmart slate } Partly equivalent in time (see page 60)	0–2500
		Chickamauga limestone } Partly equivalent in time (see page 60)	100–1800
Ordovician to Cambrian		Knox dolomite	3000–5000
Cambrian		Conasauga formation	1000–2000
		Rome formation } Probably equivalent in time	700–2500
		Cartersville formation } Probably equivalent in time	600–1000
		Shady limestone	800–1500
		Weisner quartzite	2000–5000

CAMBRIAN SYSTEM

WEISNER QUARTZITE

The Weisner quartzite crops out in the vicinity of Indian Mountain which extends from Alabama into the northwest corner of Polk County, and in a belt about 15 miles long just east of Cartersville, where deposits of ochre are associated with it. The formation consists of vitreous quartzite, quartz-sericite schist, lenses of conglomerate, and considerable beds of softer sandy shales. The thickness of the formation is uncertain because of weathered outcrops, repetition by faulting, and because the base is nowhere exposed, the beds passing under the Cartersville thrust fault. Some of the conglomerate lenses suggest a delta origin, according to Hayes.[1]

[1]Hayes, C. W., Geological relations of the iron ores in the Cartersville district Georgia: Am. Inst. Min. Eng., Trans. vol. 30, p. 405, 1901.

SHADY LIMESTONE

The Shady limestone was formerly called the Beaver limestone in the United States Geological Survey folios of this region and the publications of the Georgia Geological Survey. According to Butts[1], it has been discovered that the typical "Beaver" limestone of Beaver Ridge, Tennessee, is not the same as the limestone here described but is a younger formation. The limestone in Georgia formerly called "Beaver" and now called "Shady" has been definitely correlated by stratigraphic and fossil evidence with the Shady limestone of Shady Valley, Johnson County, Tennessee.

The Shady limestone in the Valley of Georgia overlies the Weisner quartzite and forms a narrow belt near Cartersville and also in the vicinity of Indian Mountain in Polk County. It consists of argillaceous, dolomitic limestone, but is generally deeply weathered to a dark-red residual clay. Deposits of brown iron ore, manganese, and barite are found in this residual clay in the Cartersville district.

CARTERSVILLE FORMATION

The Shady limestone in the Cartersville district is overlain by a belt of slate, shale, and feldspathic sandstone, most of which is characterized by an unusually high content of potash. This formation has been named and described by Shearer[2] as the Cartersville formation". According to him the formation can probably be correlated with the Apison shale or the Rome formation of the Rome, Ringgold, and Cleveland quadrangles, and the Watauga shale of the Roan Mountain quadrangle of Tennessee, although the exposures are not continuous and the lithologic character is quite different.

The Cartersville formation forms a belt with an average width of about half a mile, extending from the Etowah River through Cartersville and for 15 miles northwest through White to a point on the Cartersville Fault about two miles northeast of Rydal. Between Cassville and McCallie the formation has been repeated in several irregular belts by folding or faulting.

The greater part of the formation is made up of soft, light-colored shale, usually weathering to a gray clay. With the shale are occasional lenses, with a maximum thickness of 50 feet, of gray or purplish-gray slate, and thin beds of feldspathic sandstone and common siliceous sandstone. The structure is complicated and the relation of these beds to each other is uncertain. The thickness of the formation is probably not more than 1,000 feet and it may be considerably less. Almost all of the beds, according to Shearer, are characterized by a potash content of from 4 to 9 per cent, and attempts were made during the World War to utilize some of the beds as a source of potash.

[1]Butts, Charles, Geology of Alabama: The Paleozoic rocks: Alabama Geol. Survey, Spec. Rept. No. 14, p. 64, 1926.

[2]Shearer, H. K., The slate deposits of Georgia: Georgia Geol. Survey, Bull. 34, pp. 48–49, 128–132, 1918.

Two samples of more or less weathered shale from the Cartersville formation are described on pages 263 and 267. It is interesting to note that neither of these samples showed an unusually high content of potash.

ROME FORMATION

The Rome formation is the oldest strata showing over much of the Appalachian Valley of Georgia, and underlies the Conasauga formation, from which, at places it can only be distinguished with difficulty. In its type locality south of Rome it is characterized by thin-bedded, fine-grained sandstones and sandy shales in various shades of red, purple, green, yellow, and white, often of a distinctly banded appearance. Northeast of Rome the upper portion of the formation consists chiefly of shale.

Hayes[1] has mapped the Rome formation in three long narrow bands striking across the Valley in a general northeast direction. The longest of these outcrops of the Rome formation starts on the southern edge of Floyd County and continues in a northeast direction through Rome, crossing Gordon County to the west of Plainville, Calhoun, and Resaca, and in Whitfield County widens and, near Tilton, is split into two bands that extend north, one almost to and the other beyond the Tennessee line. The lithological characteristics of the formation in its type locality at the southern end of this long outcrop have been described above. The northern end of the outcrop, as observed by the writer east of Dalton, consists of soft brownish-and greenish-drab shale with fairly numerous thin partings of fine-grained sandstone or chert. It differs from the overlying Conasauga shale only in being less fissle, in containing the sandstone partings, and in containing no visible lenses of limestone.

Another narrow band of the Rome formation begins near Villanow in the southeastern part of Walker County and extends northeast through the western edge of Whitfield County and the eastern edge of Catoosa County to the Tennessee line, Hayes[2] has described these beds as follows:

"The lower portion of the formation is composed of alternating layers of sandstone and shale. Passing upwards the proportion of shale gradually increases so that toward the top only a few thin siliceous beds occur which can scarcely be called sandstone. The shales are usually brown or dark olive green, while the sandstone beds are reddish, brown, or purple, with occasional thin layers of white quartzite."

The third large area of the Rome formation as mapped by Hayes extended from the Etowah River northward through Bartow, Gordon, and Murray counties. Part of this irregular area in Bartow County has been described and mapped by Shearer as the Cartersville forma-

[1]Hayes, C. W., U. S. Geol. Survey, Geol. Atlas, Ringgold folio (No. 2), 1892; Rome folio (No. 78), 1902; and unpublished manuscript maps of the Cartersville and Dalton quadrangles.

[2]Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Ringgold folio (No. 2), 1892.

tion, as described above. North of Pine Log in Bartow, Gordon, and Murray counties, the shales mapped by Hayes as belonging to both the Rome and the Conasauga formations have in places been more or less metamorphosed into slates, concealing the differences that exist between these formations in other sections. The writer's field work in this area has convinced him that the shales in some places mapped by Hayes as belonging to the Conasauga formation cannot be distinguished lithologically from others mapped by Hayes as belonging to the Rome formation. In the geologic map that accompanies this report all of this area north of the Cartersville formation has been mapped as the Conasauga formation, with the exception of a small area north of Chatsworth.

Certain of the shale areas of the Rome formation, as now mapped, have possibilities for the manufacture of heavy clay products. The writer is of the opinion, however, that future detail mapping of the Rome-Conasauga boundary, with the increased knowledge derived from geologic work in adjoining states, may change its location considerably from that shown on the accompanying geologic map.

CONASAUGA FORMATION

The Conasauga formation occurs in the western part of the Valley in narrow bands extending from the Alabama line northeast through Chattooga, Walker, the western part of Whitfield, and Catoosa counties to the Tennessee line. The valleys of the Coosa, Oostanaula, and Conasauga rivers contain broad outcrops of the formation, the western edge of which has been thrust over and is resting on younger rocks. The formation on the eastern edge of the Valley in general occupies broad valleys and is intimately associated with the Rome formation.

Hayes[1] has described the Conasauga formation as follows:

"At its type locality, in the Dalton quadrangle to the northeast, it consists of a great thickness of fine clay shales with occasional beds of limestone. The latter vary in thickness from a few inches to several hundred feet, and are always rather pure, blue limestone. In the vicinity of Rome and northeastward to the margin of the quadrangle the formation consists at the base of several hundred feet of fine olive clay shale, then beds of oolitic limestone, and finally 1000 or more feet of calcareous shales, interbedded toward the top with blue limestone. Southward from Rome the formation changes considerably by an increase in the amount of limestone."

The broad "flatwoods" area of the Coosa Valley is largely underlain by another type of the Conasauga formation. The upper part of the formation outcropping along the eastern margin of the valley is made up largely of siliceous shales, sandstones, and clay shales containing numerous siliceous concretions. The intermediate division is composed of clay shales containing varying amounts of limestone, at some places thinly interbedded with the shales and at others in massive beds. The lower portion of the formation consists wholly of clay or slightly sandy shales.

[1]Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Rome folio (No. 78) pp. 2–3, 1902.

The shales of the Conasauga formation in the eastern part of Gordon County and in Bartow County south and east of Adairsville have been more or less metamorphosed to a green slate which weathers to a reddish siliceous-appearing shaly soil. Massive lenses of limestone occur in the eastern part of Gordon County.

The limestones of the Conasauga vary from pure, oolitic, and dark blue to light gray, argillaceous, and earthy. They are characterized by the absence of chert and by the presence of white secondary calcite veins. In the crushing to which these rocks were subjected by earth movements, the shales readily adjusted themselves by folding, while the limestones, being more rigid, were fractured. The openings thus produced were filled with calcite deposited by percolating waters containing lime in solution.

Butts[1], in his work in Alabama, has discovered that, in addition to lithologic differences, the southeastern areas of the Conasauga formation, which correspond to the areas in Floyd County, Georgia, southeast of the belt of the Rome formation, contain a totally different group of fossils from the northwestern areas of the Conasauga formation that correspond to the Coosa Valley areas of Georgia. The southeastern areas contain an Arctic fauna of Middle Cambrian age. So far as at present known, the northwestern areas contain none of this Middle Cambrian fauna, but have different assemblages of early Upper Cambrian fossils of Rocky Mountain, Pacific, Mississippi Valley, and European types. This suggests a barrier between the two areas during the time of deposition. If latter investigation should prove this to be true, the southeastern areas now mapped as Conasauga should be separated and given a new name.

There are many areas of Conasauga clay shale comparatively free from limestone in Floyd, Bartow, Gordon, Whitfield, and Murray counties. The unweathered shale is too hard to develop the plasticity needed in the manufacture of ceramic products without fine grinding and long pugging. But over most of these areas surface weathering has softened the shale to a depth of 25 to 30 feet so that it makes an excellent material, with the proper treatment, for the manufacture of certain heavy clay products.

ORDOVICIAN AND ORDOVICIAN OR CAMBRIAN SYSTEMS

KNOX DOLOMITE

The Knox dolomite of Georgia unconformably overlies the Conasauga formation. The formation attains a thickness of 3,000 to 5,000 feet, being the thickest formation, as well as having the most extensive outcrop, of the Paleozoic group in Georgia. The Knox dolomite underlies a broad area in the southeastern part of the Rome Valley, as well as smaller areas in the northern part of that physiographic district. In the Armuchee Ridges district it underlies a portion of the narrow valleys

[1]Butts, Charles, The geology of Alabama: The Paleozoic rocks: Alabama Geol. Survey Spec. Rept. No. 14, pp. 67–78, 1926.

between the sandstone ridges. A large part of the Chickamauga Valley region is underlain by the Knox dolomite, which here often forms long narrow ridges such as Missionary Ridge.

The Knox dolomite in Georgia consists of more or less massive beds of dolomite or dolomitic limestone, usually deeply weathered so that fresh outcrops are infrequent. The basal portion of the formation usually weathers to red loamy soils comparatively free from chert, while the upper portions on weathering give rise to considerable chert, sometimes compact and flint-like and sometimes porous. These cherty beds are sometimes overlain by more non-cherty dolomite, and in the eastern part of the Valley the upper part of the formation contains some sandy beds.

The Knox dolomite was formerly placed at the base of the Ordovician, but for a number of years it has been known that the fossils found in the lower portion of the formation most nearly resemble those of the upper Cambrian, while the fossils found in the upper portion of the formation are more like those of the Ordovician. Butts[1] has divided the beds in Alabama that probably correspond to the Knox dolomite of Georgia into the following five formations:

Age	Formation	Characteristic Chert
Lower Ordovician Beekmantown series	Newala limestone	Non-cherty
	Longview limestone	Compact but brittle and fragile; weathers to small fragments.
Ordovician or Cambrian	Chepultepec dolomite	Soft, porous and fossiliferous
	Copper Ridge dolomite	Dense, hard, jagged, almost flinty.
	Ketona dolomite	Non-cherty

The Ketona dolomite may correlate with the basal chertless portion of the Knox dolomite in Georgia. The Copper Ridge and the Chepultepec dolomites are most certainly present in Georgia. The Copper Ridge forms the principal chert ridges characteristic of the Knox dolomite and the Chepultepec is known to be present at Dalton and near Rocky Face. Butts has mapped the rocks of Beekmantown age as extending into Georgia in the Big Willis Valley (south of Johnson Crook, Dade County), and Ulrich[2] has observed them near Ringgold.

[1]Butts, Charles, Op. cit., pp. 78–99.

[2]Ulrich, E. O., Revision of the Paleozoic systems: Geol. Soc. America Bull., vol. 22, 672, 1911.

It is possible that they are present elsewhere, although non-cherty members may have been mapped with the Chickamauga limestone.

Butts personally favors Ulrich's[1] Ozarkian system for the "Ordovician or Cambrian," but makes no mention of Ulrich's Canadian system for the beds of Beekmantown age.

ORDOVICIAN SYSTEM

CHICKAMAUGA LIMESTONE

The Chickamauga limestone in Georgia includes all the rocks of Ordovician age lying above the Knox dolomite and below the Red Mountain formation, with the exception of the Rockmart slate described below. It includes beds of Stones River, Black River, Trenton, and Richmond ages, not all of which are present at any one area of the formation. During most of the Ordovician time a northeast-southwest barrier of Knox dolomite, probably located somewhere along the eastern edge of the Chickamauga Valley, separated the Appalachian Valley into two basins which usually had no connection with each other and were alternately invaded by arms of the sea. Thus the deposits on one side of this barrier differ in both lithologic character and fossil content from those on the other side of the barrier.

The Chickamauga formation is exposed in long narrow areas where the rocks are steeply dipping, and broad valleys where exposed on the crests of gentle anticlines. Lookout Valley is underlain by deposits of hard flaggy blue limestone of Stones River, Black River, and Trenton age; overlain, at least in the northern end of the valley, by reddish thin-bedded limestones and calcareous shales and sandstones of Richmond age which have formerly been mapped with the Red Mountain (Rockwood) formation. The type area in the valley of West Chickamauga Creek and at the eastern foot of Lookout and Pigeon Mountains consists of thin-bedded blue limestones with some beds of earthy, purple and dove-colored limestone. Further east at the foot of Taylor Ridge and in the valley west of Summerville, the formation consists of earthy limestone and calcareous shale.

Bentonite, a clay derived from the alteration of volcanic ash, occurs in a bed 1 to 20 feet in thickness in limestone of Black River (Lowville) or basal Trenton age in the valleys of Lookout and West Chickamauga creeks. It is of interest chiefly because it shows that during Ordovician time there were active volcanoes near enough to the Appalachian Valley for the ash to be carried by wind and deposited in the sea.

The Chickamauga formation on the east and southeast side of the barrier described above is increasingly earthy and sandy. The beds are of lower Stones River, Blount, and Black River age. In the vicinity of Rocky Face between Dalton and Tunnel Hill, the top of the formation consists of brownish and reddish sandy shales of Black River (Low-

[1]Ulrich, E. O., Op. cit., pp. 627–646.

ville) age that were formerly mapped as a part of the Red Mountain (Rockwood) formation. Near Dalton and east of Varnell in Whitfield County and near Loughridge in Murray County are outcrops of the Athens shale and Tellico sandstone of Blount age that have been included with the Chickamauga limestone on the accompanying geologic map. According to Butts[1], these beds are probably equivalent to the Rockmart slate in Polk County.

The Chickamauga limestone underlying the Rockmart slate in the southeastern part of the Valley consists of fine-grained high-calcium limestone interbedded with gray to grayish-blue magnesium limestone, and is probably of Stones River age.

The Chickamauga limestone, therefore, is a name given to an aggregate of calcareous deposits that were laid down in seas that invaded portions of the Valley at widely separated intervals, between which the region was probably low land that was undergoing slight erosion. The sites of these seas did not always coincide, so that the sequence and ages of the beds of this comprehensive stratigraphic unit differ greatly from place to place. Ultimately the several units of which the Chickamauga is composed will be separately mapped and described and the name will then pass out of use.

ROCKMART SLATE

The Rockmart slate crops out in Polk County on the southern edge of the Valley. It overlies Chickamauga limestone of Stones River age, and is probably of Blount age and therefore equivalent to the Athens shale and Tellico sandstone of Tennessee, and to the interval between the Stones River and the Black River beds of the Chickamauga limestone elsewhere in the Valley.

The lower 1500 feet of the formation in the vicinity of Rockmart consists largely of dark blue to black shales and slates of remarkable uniformity in lithologic character and chemical composition. It weathers to flaky fragments or massive indurated clays of gray, olive-green, yellow, and reddish-brown colors. The upper portion is more variable, containing highly ferruginous sandstones suggestive of the Tellico sandstone, cherty limestones, and conglomerate. Near the Cartersville Fault the Rockmart slate has been metamorphosed into a true schist. Westward from Rockmart the slate is interbedded with impure limestones (a common facies of the Athens shale) and is generally softer and more calcareous than that near Rockmart. Several samples of the softer weathered and shaly phases of the Rockmart slate are described on pages 69-72.

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[1]Butts, Charles, Op. cit., p. 107, and personal correspondence.

SILURIAN SYSTEM

RED MOUNTAIN FORMATION

The Red Mountain formation has been described and mapped as the Rockwood formation in most of the Georgia Geological Survey publications, following the usage of Hayes[1] in several geologic folios of the United States Geological Survey. The name "Red Mountain," given it by the Alabama Geological Survey[2] from one of several mountains of that name in Alabama, has priority and was used by Spencer[3] in the first report on this region by the Georgia Geological Survey.

The Red Mountain formation is found in the ridges of the Armuchee Ridges division of the Valley and in a series of low ridges paralleling the foot of Lookout, Pigeon, and Sand mountains. The formation in Georgia admirably illustrates the progressive change in lithologic character usually observed in a sedimentary deposit in approaching the shore line of the sea in which it was deposited.

In the valley of Lookout Creek in Dade County the formation consists of about 600 feet of more or less calcareous shale with some thin interbedded limestone. East of Lookout Mountain the formation is somewhat thicker and contains no limestone, but some beds of sandy shale with thin sandstone layers. A persistant thin layer of red fossiliferous iron ore is found near the middle of the formation in both of these areas. In White Oak Mountain and Taylors Ridge the formation consists of heavy brown sandstone with occasional beds of sandy shale. The red iron ore has become thinner and in places has disappeared. Beds of brownish and purplish sandy shale that were formerly mapped at the base of the formation near Rocky Face and south along Chattoogata Mountain are now correlated with a part of the Chickamauga limestone as described on page 59. The base is therefore now placed at a heavy bed of white sandstone or quartzite resembling the Clinch sandstone of Tennessee. In Lavender and Horseleg (Mount Alto) mountains in Floyd County, the Red Mountain formation is composed almost entirely of heavy-bedded sandstones. Thus we see an increase in thickness and in the coarseness of the clastic material as the shore line of the ancient sea is approached.

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[1]Hayes, C. W., The overthrust faults of the southern Appalachians: Geol. Soc. America Bull., vol. 2 p. 143, 1890.

Geology of the Northeastern Alabama and adjacent portions of Georgia and Tennessee: Alabama Geol. Survey Bull. 4, p. 43, 1892.

U. S. Geol. Survey Geol. Atlas, Ringgold folio (No. 2), 1894; Stevenson folio (No. 19), 1895; Rome folio (No. 78), 1902.

[2]Tuomey, Michael, First biennial report on the geology of Alabama: Alabama Geol. Survey, p. 10, 1850.

[3]Spencer, J. W., The Paleozoic group: The geology of ten counties of northwestern Georgia: Georgia Geol. Survey, pp. 48-49, 1893.

Butts[1] has the following to say as to the age of the Red Mountain formation in Alabama:

"As determined by Ulrich, through the study of its fossils, the Red Mountain formation is correlated with two divisions of the general Silurian stratigraphic succession. The lower part, which differs in thickness from place to place, is of late Medina (Albion) age, and the upper part is of early Niagara (Clinton) age. The Medina part extends to the top of the Irondale seam.**The Medina part of the Red Mountain formation corresponds to the Brassfield limestone of Ohio and Kentucky and perhaps in part or in whole to the Clinch sandstone of Tennessee and Virginia.** The white sandstone at the base of the Red Mountain in Beaver Creek Mountains east of Asheville and in Colvin Mountain is also regarded as of Medina age.**The Clinton age of the upper part of the Red Mountain formation is very definitely established by the presence of *Pentamerus oblongus*, one of the most characteristic Clinton fossils."

Detailed geologic work will be necessary to determine whether both Medina and Niagara rocks are represented in the Red Mountain formation of Georgia. The white sandstone forming the cliff on Chattoogata Mountain at Rocky Face is probably Medina.

The weathered clay shales of the Red Mountain formation in Walker and Dade counties are in many places suitable for the manufacture of heavy clay products and are described on pages 122-172. The resistant Fort Payne chert that overlies the Red Mountain formation has formed a series of ridges, known as Shinbone Ridge, parallel to the foot of Sand, Lookout, and Pigeon mountains. The shales are exposed on the slopes towards the Valley and the beds are all dipping towards the mountains at angles usually ranging from 20° to 60°. The shales are often artificially exposed by the mining of the red iron ore. Above the iron ore and for a short distance below it the shale is fine-grained, olive or yellowish-green, and weathers into flat fragments an eighth of an inch or more in thickness, rather than flaky. The shale below the iron ore often grades downward into beds that weather into brown and red clay with thin shaly layers, probably residual from calcerous beds. There is a possibility that these beds will be found to be of Richmond age of the Ordovician (classed as Silurian by Ulrich[2]) and more properly classed with the Chickamauga limestone rather than the Red Mountain formation.

DEVONIAN SYSTEM

ARMUCHEE CHERT

FROG MOUNTAIN SANDSTONE

The Armuchee chert of the Devonian was mapped by Hayes[3] on Horseleg Mountain, the northeastern portions of Lavender and Sims mountains, a portion of Taylor Ridge, Turkey Mountain, and, on John and Horn mountains, extending about 10 miles into the Ringgold quandrangle. He regarded it as probably equivalent in age to the Frog Mountain sandstone.

[1]Butts, Charles, The Geology of Alabama: The Paleozoic rocks: Alabama Geol. Survey, Spec. Rept. No. 14, pp. 139-141, 1926.

[2]Ulrich, E. O., Revision of the Paleozoic: Geol. Soc. America Bull., vol. 22, p. 339, 1911.

[3]Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Rome folio (No. 78), 1902.

Butts[1] regards the typical Frog Mountain sandstone of Onondaga age, but uses the term to include any Devonian sandstone that underlies the Fort Payne chert or the Chattanooga shale. In regard to its extension into Georgia he states:

"The Frog Mountain sandstone extends still farther northeastward into Georgia, where it is present in Lavender Mountain and in Horseleg Mountain, about 1 mile west of Rome, in Floyd County, and was mapped by Hayes in the Armuchee chert. At the last place *Spirifer macrothyris* occurs in coarse, soft reddish sandstone. Both in Lavender and Horseleg mountains this sandstone is immediately underlain by fossiliferous chert which is clearly the Armuchee chert of Hayes as described in the Rome folio. This chert is well exposed in the railroad cut at the southwest end of Lavender Mountain about half a mile west of the railroad station at Lavender. At this place it is about 50 feet thick. From this chert at the north end of Lavender Mountain, *Rhipidomella, Stropheodonta magnifica, Chonetes hudsonicus, Anoplia nucleolata, Meristella rostellata, Spirifer tribulis,* and *Platystoma ventricosa,* all of Oriskany age, have been collected. A collection of silicified fossils from Catoosa County, Ga., 40 miles north of Rome, contains *Eatonia peculiaris* and a *Spirifer* of the type of *S. murchisoni* or *S. angularis.* Both species of Spirifer are Oriskany forms, and the *Eatonia,* although recorded rarely from beds of Onondaga age, is of more common occurrence in older beds, as those of Oriskany or even still older (Helderberg) age."

MISSISSIPPIAN OR DEVONIAN SYSTEM

CHATTANOOGA SHALE

The Chattanooga shale is a jet-black highly fissle shale usually ranging from 1 to 40 feet in thickness, overlain at places by 1 to 3 feet of a blue or greenish clay shale containing rounded phosphatic concretions. The formation is usually found on the slopes of the ridges of the Valley, overlying the Red Mountain formation and underlying the Fort Payne chert, but as it weathers easily outcrops are seldom seen except in bluffs and highway and railroad cuts. Such outcrops are often coated with a white to yellow scum of sulphur or alum salts derived from the weathering of pyrite or "fool's gold" which is often present in nodules and scattered crystals. In addition to the carbonaceous matter which causes the black color, the shale contains a substance called "kerogen", probably derived from microscopic plant spoor, which when heated distills into mineral oil. This, while of no economic importance at the present time, has often caused the shale to be mistaken for coal. The Chattanooga shale is occasionally mined for use as a paint pigment.

The Chattanooga shale was formerly thought to be Devonian in age and equivalent to the Genesee and Portage shales of New York. Butts[2] follows Ulrich in believing that in Kentucky and Virginia the 500 feet of the Chattanooga formation contains beds of Devonian age at the bottom and Mississippian age at the top. As these beds extend south through Tennessee they become thinner by the gradual disappearance of the lower beds, so that in southern Tennessee, Georgia, and Alabama the Chattanooga shale is all of Mississippian age and equivalent to the Sunbury shale of Ohio.

[1]Butts, Charles, Op. cit., pp. 148–158.
[2]Butts, Charles, Op. cit., pp. 158–161.

CARBONIFEROUS SYSTEM

MISSISSIPPIAN SERIES

FORT PAYNE CHERT

The Fort Payne chert when fresh, exposures of which are seldom seen, is a siliceous and somewhat argillaceous limestone. On weathering it gives rise to a very characteristic chert. This chert generally has a porous stony texture and is gray, splotched with black or rust-colored stains. It is usually intersected with fine fracture planes along which it breaks into fine fragments. It is also highly fossiliferous, the most characteristic forms being large crinoid stems and large brachiopods of the *Spirifer* type.

The Fort Payne chert in the northwestern part of the Valley has acted as the resistant bed that formed the "Shinbone Ridge" parallel to the base of Sand, Lookout, and Pigeon mountains. In the Armuchee Ridges area it is less resistant than the sandstone of the Red Mountain formation and is usually found near the foot of the slopes of the ridges.

The greater part of the Fort Payne chert is of Keokuk age. The base of the Fort Payne in Alabama, according to Butts[1], includes beds of New Providence or Burlington age. These beds may extend into Georgia.

WARSAW AND ST. LOUIS LIMESTONES

The Fort Payne chert in the northern part of Alabama is overlain by limestones mapped as the Tuscumbia limestone but known to be equivalent to the Warsaw and St. Louis limestones of Middle Tennessee and the Mississippi Valley. The St. Louis limestone and perhaps the Warsaw extends as a thin bed from Alabama into Georgia on the west side of Lookout Mountain, where it has been included with the Bangor limestone on the geologic map. Detailed mapping may reveal these limestones elsewhere in Georgia.

FLOYD SHALE

The Floyd shale together with the Bangor limestone illustrate, as did the Red Mountain formation, the progressive change away from the original shore line from clastic sediments to limestones. West and north of Rome practically the entire Chester group of the Mississippian and perhaps equivalents of the Warsaw and St. Louis limestones are represented by the sandy shales and fine clay shales of the Floyd. In Texas and West Armuchee valleys to the northwest the bottom of the formation is fine clay shale while the top has been replaced by a thin bed of the Bangor limestone. Still further northwest in Lookout and Sand Mountains the formation consists almost wholly of limestone with a few shaly beds and has been mapped as the Bangor limestone, described below.

The Floyd shale in the broad valley west of Rome and north of the Coosa River is a black, dark-brown, and dark-green shale of a crumpled

[1]Butts, Charles, Op. cit., pp. 162–167.

and fragile, crumbling texture, so that it breaks up on handling into small and still smaller flakes with slickensided and greasy-looking surfaces. Some of the black portions resembled much weathered Chattanooga shale. Interbedded with it at a few places are some layers and lenses of impure limestone. Seven samples of the Floyd shale from this region are described on pages 75-99. The Floyd shale to the north in Gordon and Whitfield counties just east of Horn and Chattoogata mountains is more sandy and much less fissle. Samples of this sandy phase are described on pages 190, 224 and 229. The shaly member at the base of the Bangor limestone at the foot of the east slope of Lookout Mountain could be called an extension of the Floyd shale.

BANGOR LIMESTONE

The Bangor limestone as mapped in Georgia on the slopes of Sand, Lookout, and Pigeon mountains probably includes only rocks of Chester age, and is thus nearly equivalent in age to the Floyd shale west of Rome. Maynard[1] has described the lithologic character of the Bangor limestone as follows:

"The Bangor formation, consisting of limestones and shales, varies considerably in thickness within a small area. In the valley of Nickajack Creek the lower portion of the formation contains much nodular chert imbedded in a heavy-bedded dark bluish-gray, high calcium limestone, while the upper beds at this point are largely concealed. Along the eastern side of Sand Mountain the Bangor formation consists of limestones in the lower portion of the formation and they reach a thickness of 800 feet, while the shales in the upper portion are largely concealed by the soil derived from these shales and the float derived from the overlying formations. The limestones of the Bangor formation in this area are only occasionally exposed over the mountain side and contain a very considerable amount of nodular chert imbedded in a heavy-bedded dark grayish-blue, high-calcium limestone. The limestone also contains many beds of interstratified, fine-grained, dark-blue, magnesium limestone.

"Along the western side of Lookout Mountain the lower portion of the Bangor limestone contains a considerable amount of chert while the upper portion is largely free from chert. The limestone also contains some argillaceous and interstratified magnesian limestone. The shales are yellowish-green, red, carbonaceous, black, and brown.

"The limestones along the eastern side of Lookout Mountain near the Tennessee line are very thin and are succeeded by a considerable thickness of shales (Pennington) which have been included in this formation. As we proceed to the south the limestones become thicker.

"Pigeon Mountain, which is a spur of Lookout Mountain, contains the greatest thickness of the Bangor limestone in the Appalachian Valley region of Georgia. At this point the limestones reach a thickness of 900 feet, while they are overlain directly by the Lookout sandstones and shales. In the northern portion of the mountain the overlying formations have been entirely eroded away and have left the Bangor limestones forming a mountain of 800 to 900 feet in height without a covering. The Bangor limestone to the east of Lookout Mountain is largely free from chert. The formation attains a thickness in Little Sand Mountain of about 500 feet."

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[1]Maynard, T. P., Limestones and cement materials of North Georgia: Georgia Geol. Survey, Bull. 27, pp. 105–106, 1912.

Butts[1] has restricted the Bangor Limestone in Alabama to the upper part of the Chester group. The base of the Bangor as thus restricted is equivalent to the Glen Dean limestone of Illinois and Kentucky, and the top is overlain by the argillaceous limestones and shales of the Pennington formation. Butts[2] states that on the north end of Lookout Mountain in Tennessee, beneath the Bangor limestone (restricted) are outcrops, in ascending order, of Ste. Genevieve limestone (presumably overlying the St. Louis limestone), the Gasper limestone, the Golconda formation, and the Hartselle sandstone, all of lower Chester age.

The chert mentioned above as occurring in the base of the Bangor limestone as mapped in the northwest corner of Georgia may indicate that these beds are to be correlated with the St. Louis or the Ste. Genevieve limestones, both of which give rise to chert elsewhere. The Oxmoor sandstone described by Hayes[3] as occurring between the Floyd shale and the Bangor formation on Judy and Rocky mountains in the Rome quadrangle may be equivalent to the Hartselle sandstone.

PENNINGTON SHALE

Overlying the Bangor limestone as restricted by Butts, but included in the top of it as now mapped in the northwest corner of Georgia, are the argillaceous limestones and shales, of which the predominant color is red, of the Pennington formation. The ceramic possibilities of the shales of this formation have not been investigated for this report because of their inaccessible position on the upper slopes of Sand and Lookout Mountains.

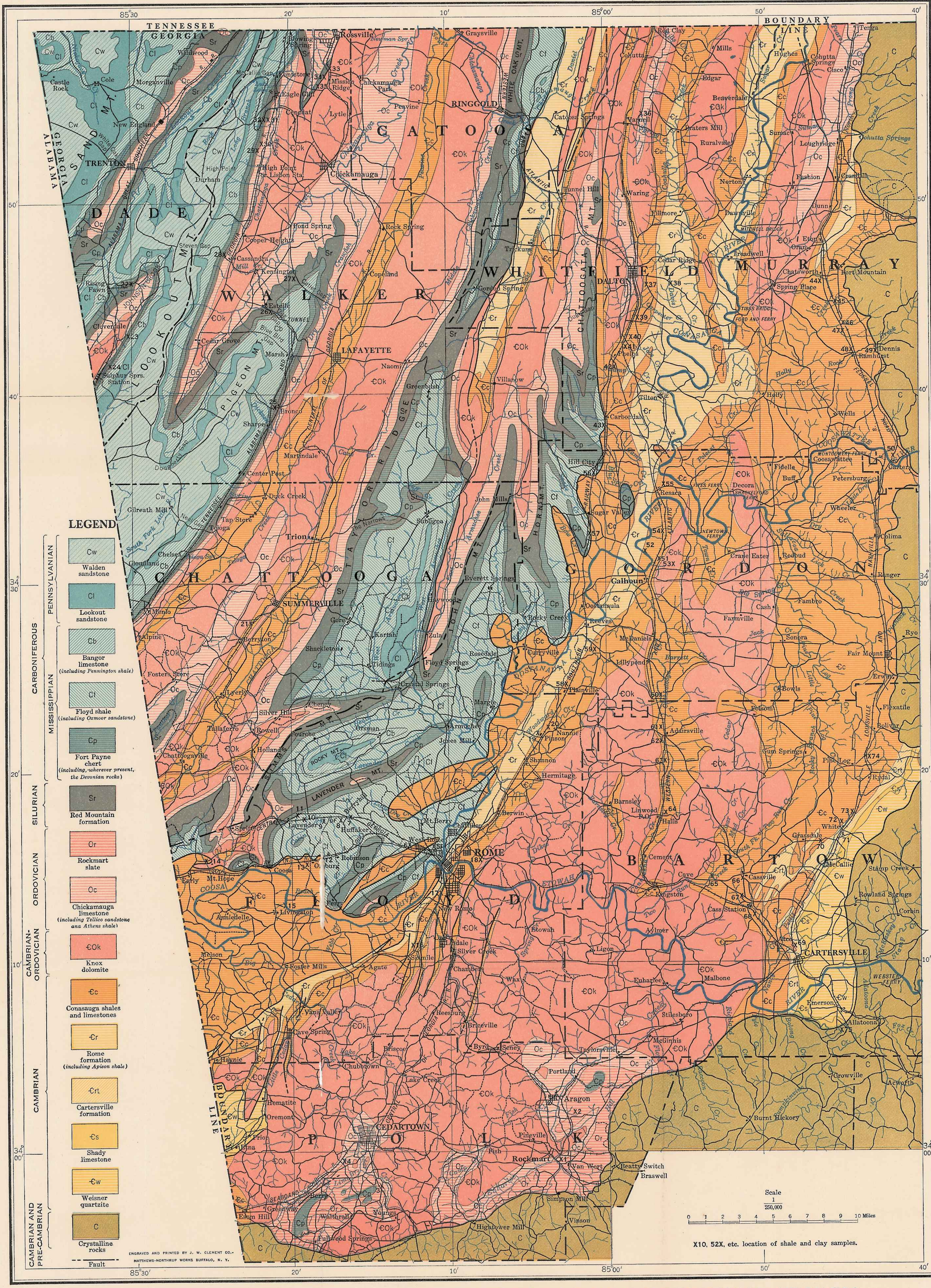
PENNSYLVANIAN SERIES

LOOKOUT FORMATION

The Lookout formation, which forms the base of the "Coal Measures" of Georgia, consists of sandstones, conglomerates, and shales with a few seams of coal. The lower portion of the formation is made up of sandstone above which occur interbedded sandstones and shales, followed by coarse sandstone and conglomerate. The upper limit of the formation is at the top of a heavy bed of sandstone and conglomerate which forms the cliff along Sand, Lookout, and Pigeon mountains. The coal seams of the Lookout formation are thin and unimportant in Lookout Mountain, but on Sand Mountain they are thick enough in places to have been mined in the vicinity of Cole and Castle Rock.

The Lookout formation crops out as a rather narrow band around the brow of Pigeon and Lookout Mountains and a wider area on Sand Mountain. Its preservation in these mountains or plateaus is due to the synclinal structure of the rocks. Where the rock structure was in

[1]Butts, Charles, Geology of Alabama: The Paleozoic rocks: Alabama Geol. Survey, Spec. Rept. No. 14, pp. 195-199, 1926.
[2]Butts, Charles, Op. cit., p. 192.
[3]Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Rome folio (No. 78), 1902.



GEOLOGICAL MAP OF APPALACHIAN VALLEY AND LOOKOUT PLATEAU OF GEORGIA

Compiled by Richard W. Smith, Assistant State Geologist, From Maps by Spencer, Maynard, and Shearer, the Ft. Payne, Ringgold and Rome Folios of the U. S. Geological Survey, Manuscript Maps of the Dalton, Cartersville, and Tallapoosa Quadrangles by Hayes and Others, and Field Notes of the Author

1931

the form of an anticline or arch, as over Lookout Valley and McLamore Cove, the Lookout formation has been entirely removed. That the Lookout formation once extended much further to the southeast than Lookout Mountain is shown by its presence capping Rocky Mountain in Floyd County and Little Sand Mountain in Chattooga County, some fifteen miles southeast of Lookout Mountain. These isolated outcrops are due to small local synclines. The formation was once continuous as a broad arch with that of Lookout Mountain.

WALDEN SANDSTONE

The Walden sandstone includes all those sandstones and shales which overlie the massive sandstone and conglomerate bed that marked the top of the Lookout formation. The formation includes several seams of coal, one of which has been mined for years at Durham on Lookout Mountain.

The Walden sandstone forms the capping over most of Lookout and Pigeon mountains and the highest portions of Sand Mountain.

DISTRIBUTION AND DESCRIPTION OF DEPOSITS BY COUNTIES

POLK COUNTY

Polk County, of which Cedartown is the county seat, is the southernmost county in the Appalachian Valley region of Georgia. The county is drained by Cedar and Euharlee creeks and their tributaries. The Atlanta to Chattanooga line of the Southern Railway crosses the eastern part of the county, passing through Rockmart and Aragon. The Atlanta to Birmingham line of the Seaboard Air-Line Railway crosses the county from east to west, passing through Rockmart and Cedartown. The Cartersville Branch of this railroad extends northeast from Rockmart to the Bartow County line. The Macon to Chattanooga line of the Central of Georgia Railway crosses the middle of the county in a north-south direction, passing through Cedartown.

The Cartersville Fault that separates the Appalachian Valley of Georgia from the Piedmont Plateau roughly parallels the southern and eastern boundary of the county at an average distance of two miles. The fault line is not marked by distinct differences in topography, as is the case north of Cartersville, because metamorphism has extended to the Ordovician rocks below the fault plane.

The greater part of the middle and northern parts of Polk County are underlain by the Knox dolomite, which has here formed nearly flat or gently rolling land with only a few of the cherty ridges characteristic of the formation in other counties. The Chickamauga limestone overlies the Knox dolomite, occurring in large outcrops in the vicinity of Cedartown and north of Aragon and in narrow bands elsewhere below the Rockmart slate.

The Rockmart slate forms three very irregular belts or areas in the eastern and southern portions of Polk County. One of these areas extends from east of Portland and Aragon, south of Rockmart, and then southwest almost to Hightower Mill. Another band about a mile in width extends from just south of the Seaboard Air Line Railway at Fish southward almost to the Cartersville Fault. Its position, surrounded by a narrow band of the Chickamauga limestone except where cut by a fault on the south, shows its structure to be a syncline or basin, The third area, with an average width of three miles, extends from just south of Cedartown southwestward to the Cartersville Fault. Its structure is also that of a syncline.

The lower 1500 feet of the Rockmart slate in the Rockmart area consists of uniform fine-grained dark-colored slate and shale. Above this is shale interbedded with limestone conglomerate, sandy shales, and sandstone. Near the Cartersville fault the shales have at places been metamorphosed to schist which is hardly distinguishable from the older metamorphic rocks on the east side of the fault. Westward from Rockmart, in the Fish and Cedartown areas, the slate is softer and more calcareous than near Rockmart, at places resembling a hard shale although the cleavage is usually distinctly slaty.

These outcrops of the Rockmart slate form a range of irregular hills and ridges, the highest of which are capped by Fort Payne chert.

The deeply-weathered basal portion of the Rockmart slate has been used at Rockmart for the manufacture of paving brick, but because of slow slaking it was difficult to process. Other samples of the softer weathered Rockmart slate from representative outcrops proved, as described below, to be even slower in slaking. The softer sandy shales of the upper part of the Rockmart slate, where examined by the writer, appeared to be too siliceous for use in the manufacture of heavy clay products. These slates and shales of the Rockmart formation might prove to be satisfactory for the manufacture of lightweight aggregates (see page 41).

RHODES, SMITH, AND WHITE PROPERTIES

The A. G. Rhodes Estate (A. W. Farrar, Rockmart, local agent) of about 160 acres is just southwest of Rockmart, south of Euharlee Creek, on both sides of the Rockmart-Buchanan road and crossing the Seaboard Air Line Railway south of the depot. The land is mostly a series of northeast-southwest ridges underlain by slate and shale of the Rockmart slate. East of the railroad the outcrops are all of hard blue slate which has at places been quarried in the past. Along the Rockmart-Buchanan road are outcrops of hard drab to greenish-drab shale or weathered slate, somewhat resembling that of the brick company pit but slightly more fissle and shale-like.

The Rhodes Estate is joined on the south by the Dr. R. B. Smith (Rockmart) property of 40 acres west of the road and the N. A. White (Rockmart) property of some 300 to 400 acres, including the top and south slope of the slate ridges and extending south into the valley. The outcrops on top of the ridge are of hard olive-green thin-bedded, slaty shale or weathered slate.

The shale or weathered slate underlying the north slope of this ridge is probably much like that in the brick company quarry. A flat plant site just south of Euharlee Creek would have abundant water and could be reached by a short spur-track from the railroad.

C. O. WHITEHEAD PROPERTY

The property of C. O. Whitehead (Rockmart, Box 205) consists of 37 acres between the Rockmart-Dallas Highway and the Seaboard Air Line Railway, 1½ miles south of Rockmart. About 6 acres of the property are in the first series of ridges south of Van Wert. The cuts of the highway on this ridge show hard drab-colored shale resembling the "Caen rock" of the brick plant. The cut of the railroad, which has a maximum depth of 40 feet, shows the following section from north to south: 70 feet (horizontal distance) of red argillaceous sandstone, 35 feet of hard, waxy-looking, olive-green shale, 125 feet of hard blue slate with occasional thin shaly beds, 100 feet of hard drab to olive-green shale, and 100 feet mostly of reddish-brown argillaceous sandstone. The cleavage of the slaty beds strikes N. 60° E. and dips 55° SE.

JOE GRICE PROPERTY

The Joe Grice (Rockmart) property of about 80 acres is 2 miles south of Rockmart at the overhead bridge where the Rockmart-Dallas Highway crosses the Seaboard Air Line Railway. The low railroad cuts east of the bridge show alternating beds of yellow argillaceous sand and soft to semi-hard, "short" and "punky" drab and reddish-drab shale. Some of the shale is soft and somewhat flaky, some siliceous and porous, and some semi-hard, streaked with red in narrow irregular bands so that pieces of it resemble cedar-wood that has been exposed to the weather. The whole deposit is much cross-bedded. Taken as a whole, it appears to be too siliceous to be of value for the manufacture of heavy clay products.

The railroad for three-quarters of a mile west of the highway runs through a series of deep cuts mostly in hard blue slate and sandstone. The last of these cuts on the Whitehead property is described above.

MRS. J. G. RANDALL PROPERTY
(Map location No. 2)

The Mrs. J. G. Randall (Rockmart) property is one mile east of Aragon and half a mile to three-quarters of a mile east of the Cartersville Branch of the Seaboard Air Line Railway, and consists of about 80 acres in Land Lots 435 and 436, 18th Land District, 3d Section, Polk County.

The property includes the series of ridges that mark the boundary between the Rockmart slate and the underlying Chickamauga limestone. The ridge nearest the railroad is said to have outcrops of limestone on the west side and of slate or shale on the east side. A prospect pit on the south slope of the next ridge to the east showed limestone, but scattered outcrops indicate that most of the ridge is underlain by hard gray slaty shale. Laboratory tests on a grab sample of this are given below.

Laboratory tests on a grab sample of hard gray slaty shale from the Mrs. J. G. Randall property, one mile east of Aragon, Polk County.

Chemical Analysis:

Loss on ignition	3.46
Soda (Na_2O)	.44
Potash (K_2O)	2.02
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	18.22
Ferric oxide (Fe_2O_3)	6.45
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.02
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.14
Silica (SiO_2)	68.13
	99.88

Grinding: Hard, tough.
Ground Color: Light grayish-brown.
Slaking: Very slow.
Plasticity: Almost none.
Molding Behavior: After aging five days the material did not have sufficient plasticity to form test bars on the Mueller roll-press.

The sample was therefore discarded as unsuitable, by itself, for the manufacture of heavy clay products.

M. O. HUNTINGTON PROPERTY

(Map location No. 3)

The M. O. Huntington (Cedartown, Rt. 4) property of 320 acres is on the Central of Georgia Railway 3 miles south of Cedartown and south of Cedar Creek. A small pit beside the old Cedartown-Buchanan road, just east of the railroad at the section houses, shows hard brownish-drab siliceous shale weathering into splintery fragments an inch or two long. This shale was formerly used for road material. The shale is striking N. 10° E. and dips 55° SE. Similar shale is showing in the road cuts south to the railroad crossing and underlies several low ridges east of the railroad. The laboratory tests on a grab sample of this shale from the pit and the road outcrops are given below. More shale of this type crops out beside the road at the southern end of the property three-quarters of a mile south of the railroad crossing. A road cut on the slope of the ridge west of the section houses exposes hard light-gray very sandy shale.

Laboratory tests on a grab sample of hard brownish-drab shale from the M. O. Huntington property on the Central of Georgia Railway, three miles south of Cedartown, Polk County.

Chemical Analysis:

Loss on ignition	6.53
Soda (Na_2O)	1.09
Potash (K_2O)	1.47
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	19.77
Ferric oxide (Fe_2O_3)	6.51
Titanium dioxide (TiO_2)	.98
Sulphur trioxide (SO_3)	.03
Phosphorus pentoxide (P_2O_5)	.18
Silica (SiO_2)	63.53
	100.09

Grinding: Fairly easy.
Ground Color: Light brown.
Slaking: Slow
Plasticity: Very poor, grainy.
Moulding Behavior: Plasticity too poor, even after aging 5 days, to form test bars with the Mueller roll-press.

The sample was therefore discarded without further tests as not suitable, by itself, for the manufacture of heavy clay products. There is a possibility, however, that this shale might be suitable for the manufacture of light-weight aggregates (see page 41).

DR. LEADBETTER ESTATE

(Map location No. 4)

The Dr. Leadbetter Estate (C. H. Graves, Cedartown, Admins.) consists of 300–400 acres on both sides of the Seaboard Air Line Railway, 2 to 2½ miles southwest of Cedartown. The railroad follows a valley formed by a narrow outcrop of Chickamauga limestone. The ridge west of the railroad is underlain by the red clay and chert of the Knox dolomite. The ridge east of the railroad rises to 75 to 100 feet above the valley and is underlain by the Rockmart slate. Outcrops along the road show hard slaty brownish-to grayish-drab shale striking N. 40° E. and dipping 60° SE. The laboratory tests on a grab sample of this are given below. Probably 50 to 75 acres of the property are underlain by this shale or weathered slate.

Laboratory tests on a grab sample of hard, slaty brownish-drab shale from the Dr. Leadbetter Estate, 2½ miles southwest of Cedartown on the Seaboard Air-Line Railway, Polk County.

Chemical Analysis:

Loss on ignition	5.94
Soda (Na_2O)	.19
Potash (K_2O)	1.59
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	23.39
Ferric oxide (Fe_2O_3)	7.04
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.05
Phosphorus pentoxide (P_2O_5)	.49
Silica (SiO_2)	60.46
	100.06

Grinding: Difficult, tough.
Slaking: Very slow.
Plasticity: Almost none.
Molding Behavior: After aging 5 days the plasticity was too poor to form test bars on the Mueller roll-press.

The sample was therefore discarded without further tests. The shale or weathered slate, by itself, is not suited for the manufacture of heavy clay products. It might possibly be suited for the manufacture of light-weight aggregates (see page 41).

FLOYD COUNTY

Floyd County, north of Polk County, is in two of the physiographic divisions of the Appalachian Valley of Georgia (see figure 3, page 49). The northern part of the county is in the area of long, narrow steep-sided ridges known as the Armuchee Ridges, from the settlement of Armuchee nine miles north of Rome. The rest of the county is in the broad valley area known as the Rome Valley. The Oostanaula River from the north and the Etowah River from the east unite at Rome to form the Coosa, which flows westward to the Alabama line.

Rome, the county seat, is a busy industrial and distributing center, the sixth city in population in Georgia. The Atlanta to Chattanooga line of the Southern Railway and the Macon to Chattanooga line of the Central of Georgia Railway cross at Rome, the Southern Railway continuing north in the valley of the Oostanaula River, the Central of Georgia Railway turning westward to the west end of Lavender Mountain and then north through a winding gap to the Chattooga and Chickamauga Valley. The Rome to Gadsden and Attalla line of the Southern Railway extends westward across the Coosa Valley. The Rome to Anniston line of the Southern Railway extends southwest through Cave Springs where the State School for the Deaf is located. The Rome Branch of the Nashville, Chattanooga & St. Louis Railway follows the Etowah River from Kingston in Bartow County.

The southeastern third of Floyd County is underlain by the Knox dolomite which forms a gentle rolling plateau or series of ridges the tops of which rise to a common level, that of the Eocene peneplain (see page 51). A band of the underlying Cambrian rocks occupies the east side of the valley of the Oostanaula River, and south of the Coosa River broadens into the wide valley area known as the "Flatwoods" country. The northwestern third of the country is underlain by the Silurian and Mississippian rocks.

This middle belt of Cambrian rocks was the most affected by the period of deformation that closed the Paleozoic age (see page 50). It, a region of relatively soft shales, was caught between the more rigid areas of Knox dolomite on the southeast and the sandstones of the Red Mountain formation on the northwest. These shales were finely plicated and intersected by many faults, two of which were of major importance. During the early stages of the deformation the shales of the Conasauga formation were thrust at a very low angle for miles over the younger Silurian and Mississippian rocks. The effect of this thrust fault was to strengthen the area, which had previously been structurally weak, and the subsequent compression resulted in the development in folds and faults on either side of the belt. The overthrust and underthrust rocks acted like one and were, together with the fault plane, gently folded. Later as the region was elevated the overthrust beds, and to some extent the underlying beds, were removed from the anticlines but were preserved in the synclines. This has resulted in the very sinuous fault line, described by Hayes[1] as the Rome Fault, that forms the western border of the Cambrian belt.

The second fault, which is comparable in size to the Rome Fault although differing from it materially, forms the western boundary of the Rome formation and has been named the Coosa Fault. The siliceous shales and sandstones of the Rome formation are thrust over the Conasauga shales at an angle of about 15°. This fault probably took place during a later part of the deformation than did the Rome fault. The

1—Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Rome folio (No. 78) p. 5, 1902.

fault plane has therefore not been subsequently deformed, and its intersection with the present surface is much more regular than that of the Rome fault.

The Rome formation of the Cambrian forms, to the north of Rome, a band averaging a mile in width just west of and parallel to the Southern Railway. South of Rome the outcrop is much narrower and is roughly parallel to and west of the Rome to Anniston line of the Southern Railway. The entire western border of the formation is the Coosa thrust fault described above. In the vicinity of Sixmile, Vans Valley, and Cave Springs, minor faults have caused small forks to extend southward from the main outcrop. The Rome formation in Floyd County consists of sandy shales and fine-grained sandstones, usually brilliantly colored red, purple, green, and white. Its siliceous character causes it to be more resistant to erosion than the beds on either side and to form a series of low ridges. The shales are too siliceous to be of value for the manufacture of heavy clay products.

The outcrops of the Conasauga formation in Floyd County appear as a narrow band east of the ridges of the Rome formation, and as areas of varying width west of those ridges. Southwest of Rome the formation underlies the broad "Flatwoods" area south of the Coosa River. The lithologic character of these two areas of outcrops is somewhat different. The eastern area at Rome and northeastward in Floyd County is composed of several hundred feet of clay shales at the base, then beds of fairly pure oolitic limestone, and finally 1000 feet or more of shales, calcareous at places and interbedded toward the top with blue limestones. South of Rome, as at Vans Valley and Cave Springs, the eastern area of the formation is composed almost wholly of limestone.

In the broad Coosa Valley outcrop, the upper part of the Conasauga formation along the eastern margin of the valley is made up largely of siliceous shales. The middle of the formation is composed of clay shales containing varying amounts of limestone, at some places thinly interbedded with the shales and at others in massive beds. The lower portion of the formation consists wholly of clay shales which at places are slightly sandy.

The clay shales of the Conasauga formation at places in Floyd County, as near Rome and along the Gadsden line of the Southern Railway west of Oreburg, are suitable for the manufacture of heavy clay products. The deposits in these areas are described below. Good shale undoubtedly occurs in other areas of the Conasauga, but too far from transportation to be of economic value.

The Red Mountain formation of Silurian age in Floyd County is composed almost wholly of relatively resistant sandstone, exposed on the crests of anticlines and forming Horseleg (Mount Alto), Lavender, Sims, and John mountains. The synclinal areas between Horseleg and

Lavender mountains, between Lavender and Sims mountains, and east of Johns Mountain are largely underlain by the Floyd shale of Mississippian age.

The Floyd shale in the broad area west of Rome and south of Lavender Mountain is a dark-green, dark-brown, and black fissle shale of a crumpled and crumbling, fragile texture, weathering into thin soft and easily broken flakes, often with slickensided and greasy-looking surfaces. It is usually easily distinguished from the thicker flakes and flat pieces of the Conasauga shale, which in places overlies it due to the Rome overthrust fault described above.

A number of deposits of the Floyd shale in this area west of Rome are described below. Floyd shales, perhaps equally suited for ceramic purposes, underlie Big and Little Texas valleys north of Lavender Mountain and the valley of John Creek in the northern extension of Floyd County, but are too far from transportation to be of value.

The commercial shales of Floyd County are therefore to be found in both the Conasauga formation and the Floyd shale. The Floyd shales are usually softer and process better than those of the Conasauga, but the fired colors, as a whole, are not as good. In prospecting the shales of either formation, the presence of lime must be watched for and avoided.

ROMEGA CLAY PRODUCTS COMPANY PROPERTY
THE BERRY SCHOOLS

(Map location No. 5)

The Romega Clay Products Company property, now owned and operated by the Berry Schools (Mount Berry), is on the northeast side of the Central of Georgia Railway and the Rome to Gadsden line of the Southern Railway at their intersection in West Rome. It consists of 57½ acres in Land Lots 203 and 238, 23d District, 3d Section, Floyd County. The plant was built in 1907 by the Crucial Fire Brick Company. This company for several years manufactured fire brick from a mixture of bauxite and bauxite clay or kaolin from the Hermitage or Bobo districts of Floyd County and alluvial or semi-alluvial clay from the south pit described below. These fire brick are reported to have given satisfactory service in the kiln fire boxes of several North Georgia brick plants. Later the Romega Clay Products Company manufactured building brick and structural tile from a mixture of shale and clay. In the spring of 1930 after a year of idleness, the plant was sold to the Berry Schools and is now being operated by the students under the direction of a superintendent. The entire production of building brick, made from the shale only, is being used for the construction of new school buildings.

Shale Pit

The shale pit or "North Pit" is about an eighth of a mile north of the plant near the Central of Georgia Railway's spur track to the Berry Schools. The pit is about 50 feet wide and 100 feet long, and the average height of the face is 10 feet. The shale, which appears to belong to the Floyd shale, is greenish-brown with considerable black stain and breaks into semi-hard small to medium sized flakes or flat pieces. Interbedded with it are frequent layers averaging 8 inches in width of plastic brown clay sometimes containing fine sand. The beds are striking nearly east-west and dipping about 80° to the south, with the exception of an area in the middle of the east side of the pit where the dip was 40°, due probably to slumping. The clay streaks were probably originally argillaceous limestone, the lime having dissolved out during surficial weathering, leaving the clay behind.

The shale is mined with a steam-shovel with a 1-cubic yard dipper, loaded into mine cars, and hauled to the plant by a gasoline locomotive.

Laboratory tests are given below on a six-foot groove sample of the shale, including one clay streak, from the west side of the pit.

Laboratory tests on a six-foot groove sample of semi-hard greenish-brown Floyd shale from the North Pit of the Romega Clay Products Company property (Berry Schools) in West Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.06
Soda (Na_2O)	.84
Potash (K_2O)	.66
Lime (CaO)	.00
Magnesia (MgO)	.13
Alumina (Al_2O_3)	25.17
Ferric oxide (Fe_2O_3)	6.30
Ferrous oxide (FeO)	.60
Titanium dioxide (TiO_2)	.93
Sulphur trioxide (SO_3)	.35
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	57.99
	100.14

Grinding: Easy.

Ground Color: Light brown.

Slaking: A little slow.

Plasticity: Poor and grainy at first, good after aging overnight.

Molding Behavior: Good.

Drying Behavior: Test bars slightly warped.

Water of Plasticity: 26.1 per cent.

Linear Drying Shrinkage (based on plastic length): 4.2 per cent.

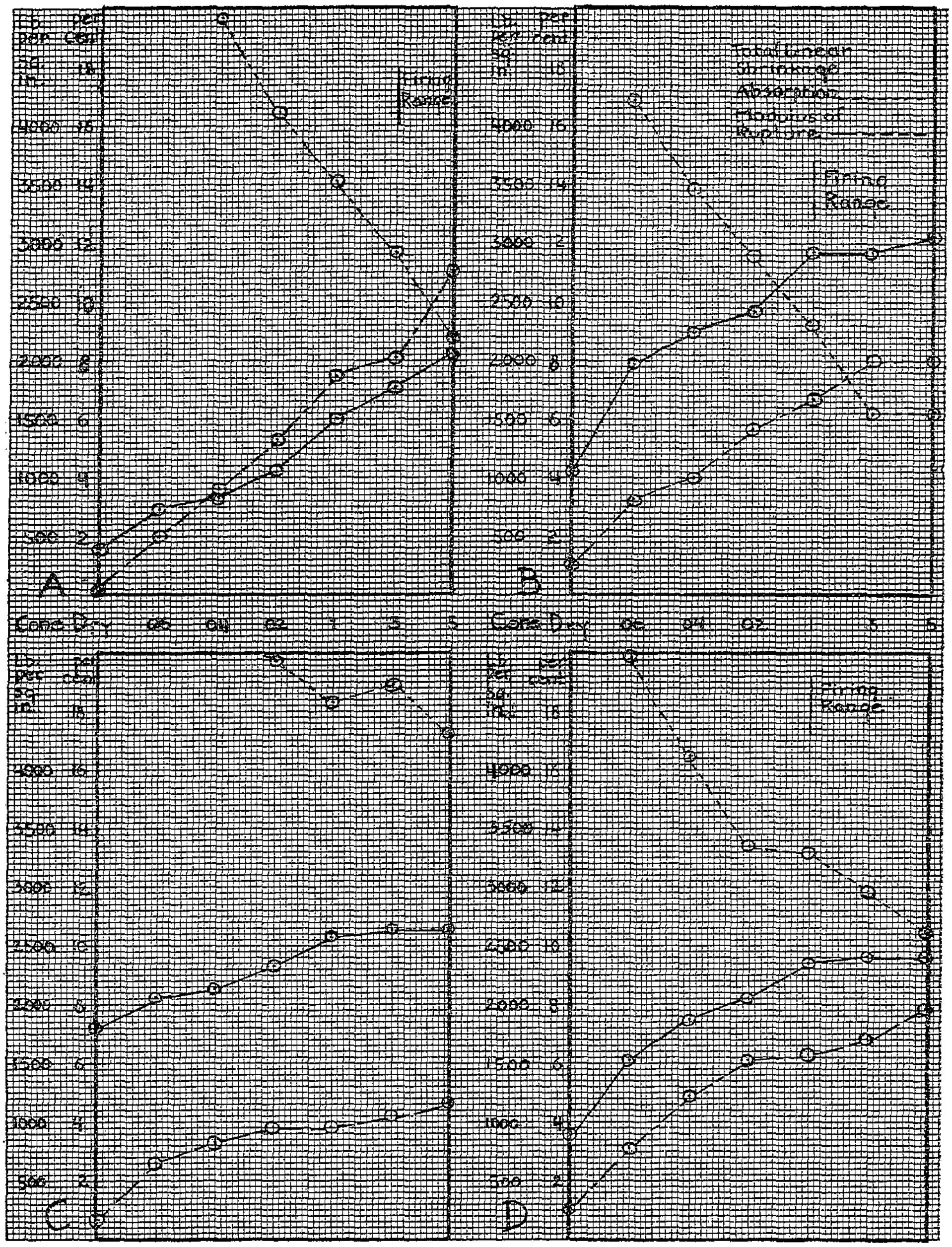


Figure 5. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Rockmart shale from Rockmart, Polk County.

B. Floyd shale from the Romega Clay Products Co. pit, West Rome, Floyd County.

C. Clay from the Romega Clay Products Co. pit, West Rome, Floyd County.

D. Floyd shale from the W. S. Dickey Clay Mfg. Co. pit, 3 miles west of Rome, Floyd County.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.6	7.9	16.9	844	Salmon (YR-7/8)[b]	Slight
04	4.9	9.0	13.9	1005	Salmon (YR-7/6)[b]	Slight
02	5.6	9.7	11.6	1435	Light red (R-YR-6/6)[b]	Slight
1	8.1	11.7	9.2	1663	Medium red (R-YR-5/5)[b]	Some
3	7.6	11.7	6.2	2261	Deep red (R-YR-5/4)[b]	Considerable
5	8.5	12.2	6.2	2263	Dark red (R-YR-5/3)[b]	Some

[a]See graph, Figure 5-B, page 77.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1-5. Commercial kiln: Cone 01-4.

Clay Pit

The clay pit or "South Pit" is 200 yards southeast of the plant adjoining the right of way of the Southern Railway. It is about 300 feet long and 75 feet wide with a face on the north side averaging 20 feet in height. The face shows an extremely variable reddish-brown to mottled yellow clay containing, especially near the top and in the north end of the face, numerous angular to water-worn chert pebbles up to several inches in diameter. The clay as a whole has a sticky, gummy plasticity, although, like the color and chemical composition, the plasticity varies considerably in short distances. The clay is said to extend for some distance below the floor of the pit, but was not mined deeper because of lack of drainage would have prohibited the use of the small steam-shovel used in mining.

The clay shows but few recognizable signs of bedding, but these appear to be nearly horizontal. The origin of the deposit is obscure. The chert resembles that of the Fort Payne chert which underlies the Floyd shale, and a glance at the geologic map facing page 66 will show that the Fort Payne has been mapped as extending nearly to this point. The water-worn chert pebbles point to an alluvial origin. Yet the angular pebbles are in the majority, and the deposit as a whole can probably be classed as colluvial, or a mixture of residual material from the Floyd shale and the Fort Payne chert, slumped and partly transported to its present site.

The laboratory tests given below are on a sample consisting of two six-foot grooves from different places in the pit.

Laboratory tests on a groove sample of clay from the South Pit of the Romega Clay Products Company property (Berry Schools) in West Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.75
Soda (Na_2O)	.73
Potash (K_2O)	1.51
Magnesia (MgO)	.80
Alumina (Al_2O_3)	10.58
Ferric oxide (Fe_2O_3)	8.41
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	69.49
	100.18

Grinding: Easy.
Ground Color: Yellow.
Slaking: Rapid.
Plasticity: Excellent.
Molding Behavior: Excellent.
Drying Behavior: Little or no warpage.
Water of Plasticity: 31.6 per cent.
Green Modulus of Rupture: 172.7 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 7.2 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.1	8.2	23.0	646	Salmon (YR-7/9)[b]	Little or none
04	2.0	8.5	20.8	817	Salmon (3YR-7/6)[b]	Slight
02	2.3	9.3	19.8	953	Salmon red (R-YR-6/7)[b]	Slight
1	3.1	10.3	18.3	976	Light red (R-YR-5/7)[b]	Slight
3	3.0	10.5	18.9	1051	Fair red (R-YR-5/6)[b]	Slight
5	3.5	10.5	17.3	1143	Medium red (R-YR-5/5)[b]	Slight

[a]See graph, Figure 5-C, page 77.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Not reached.

Plant

Under the management of the Romega Clay Products Company, building brick and structural tile were manufactured from a mixture of two parts of clay from the South Pit to one of shale from the North Pit. The materials as brought in from the pits were dumped in separate storage piles. The clay, before use, was dried by spreading it in a thin layer on a drying floor made of welded steel plates underlain by steam ducts. The larger chert pebbles were culled by hand. The clay and shale were mixed and ground in two 9-foot dry pans. These discharged into bucket elevators, from which the clay went through stationary screens into a storage bin. The oversize of the screens is said to have consisted largely of the chert fragments from the clay and was discarded. The ground clay was tempered and pugged in two 8-foot pug mills, extruded as a column from a combined pugmill and stiff-mud brick and tile machine, and automatically sidecut into brick or tile. These were hacked onto metal cars and dried in an 8-tunnel, 120-foot, waste-heat drier. They were fired in a 25-foot round down-draft kiln, two 30-foot round down-draft kilns, and four 15 by 30-foot rectangular down-draft kilns, all forced draft. When visited by the writer in 1929 the kilns were all in rather bad shape. No structural tile were in stock, but the brick were mostly fair quality face brick in a pleasing range of colors. The underfired brick were sold for common brick.

When again visited in the spring of 1930 at the beginning of the operation of the plant by the Berry Schools, the bricks were being made from shale from the North Pit only. This appears to be a very advisable change as, judging from the above tests, the only desired property derived from the clay of the South Pit was increased plasticity and ease of processing the brick, the fired properties being undesirable. Probably an increase in the fineness of grinding and in the length of pugging would sufficiently increase the plasticity of the shale. The difficulty of drying the clay from the South Pit before grinding added considerably to the cost of manufacture.

The distance to which the shale pit can be extended to the northwest is limited by Little Dry Creek, but there is said to be more shale between the Berry Schools spur track and the main line of the Central of Georgia Railway, and large deposits of similar shale to the north on the main Berry Schools property.

W. S. DICKEY CLAY MFG. COMPANY

Headquarters: Kansas City, Mo. (See also pages 164 and 307).

Rome Shale Pit: Three miles west of Rome on the Central of Georgia Railway. (Map location No. 6).

Rome Plant: East Rome on Southern Railway just south of Etowah River. I. T. Woodward, Local Manager.

Shale Pit

The Rome shale pit of the W. S. Dickey Clay Mfg. Company is on the Central of Georgia Railway on the outskirts of West Rome and about a mile west of the Romega Clay Products Company property described above. The property extends south to the Gadsden line of the Southern Railway and consists of 100 acres in Land Lot 201, 23rd District, 3d Section, Floyd County.

The shale pit was opened in 1920 and is said to have been worked steadily for the first years and rather intermittantly since then. When visited in 1929 about 10 acres had been mined to an average depth of 20 feet. The pit was irregular in shape and extended south nearly to the Southern Railway. This irregularity was partly due to avoiding areas of interbedded shale and sandstone. Some of the "sandrock" or porous sandstone in these siliceous areas was black and resembled clinkers.

The shale varied considerably in lithologic character from place to place in the pit. Near the Central of Georgia Railway on the northeast corner of the pit it was soft, reddish-brown in color, and almost clay-like. Much of the shale was dark-brown and dark gray in color, crumpled in appearance, and broke into soft fragile flakes. Occasional patches were black and finely fissle, resembling the Chattanooga black shale. On the west side of the middle of the pit was an area of rather hard shale that broke into thin curved (concoidal) fragments rather than flaky. The shale at the south end of the pit was greenish-drab to drab, breaking into semi-hard thin pieces or flakes, and resembled that of the North Pit of the Romega Clay Products Company property described above. The laboratory tests are given below on a grab sample of the shale, including all of the types described above.

No limestone was observed in the pit, but the presence of lime in small quantities in the shale at places near the bottom of the pit and on the east side is said to have given some trouble. The best of the shale yet unmined is said to lie west of the present pit.

The greater part of the shale undoubtedly belongs to the Floyd shale formation. Yet the Rome fault, on the western border of the area of the overthrust Conasauga formation that is preserved in the syncline northwest of Horseleg Mountain, must lie close to the property and probably accounts for some of the variations in lithologic character and attitude of the beds. Some of the shale may even belong to the Conasauga formation.

The shale was mined by steam-shovel and loaded directly into standard gondola freight cars for shipment to the Macon, Chattanooga, and Rome plants of the company.

Laboratory tests on a grab sample of soft to semi-hard Floyd shale from the Rome shale pit of the W. S. Dickey Clay Mfg. Company, West Rome, Floyd County.

Chemical Analysis:

Loss on ignition	6.16
Soda (Na_2O)	2.74
Potash (K_2O)	1.88
Lime (CaO)	.00
Magnesia (MgO)	.48
Alumina (Al_2O_3)	16.34
Ferric oxide (Fe_2O_3)	4.33
Ferrous oxide (FeO)	.32
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.55
Phosphorus pentoxide (P_2O_5)	.27
Silica (SiO_2)	66.94
	100.01

Grinding: Fairly easy, brittle.
Ground Color: Light brownish-gray.
Slaking: Fairly rapid.
Plasticity: Fairly good.
Molding Behavior: Good.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 25.7 per cent.
Green Modulus of Rupture: 144.8 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.5	6.1	19.9	778	Pinkish-tan (YR–8/4)[b]	Very slight
04	3.9	7.5	16.5	1209	Buff-pink tan (YR–7/5)[b]	Very slight
02	4.8	8.2	13.4	1522	Tan-brown (YR–7/5)[b]	Very slight
1	6.0	9.4	13.2	1569	Light brown (YR–6/6)[b]	Slight
3	6.2	9.6	11.9	1705	Dead Light-brown (YR–6/5)[b]	Some
5	6.3	9.6	10.5	1987	Dead light-brown (YR–5/5)[b]	Slight

[a]See graph, Figure 5-D, page 77.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher.

This shale is not used by itself at any of the plants, but in a mixture containing a shale from Tennessee and fire clay from Alabama.

Rome Plant

The Rome Plant of the W. S. Dickey Clay Mfg. Company is in East Rome on the Southern Railway south of the Etowah River. This plant was built in 1906 as the Morrison & Trammel Brick Company, manufacturing building brick from alluvial clay from the terrace of the Etowah River adjoining the plant. It was purchased by the W. S. Dickey Clay Mfg. Company and turned into a sewer-pipe plant in 1915.

This plant makes sewer pipe from a mixture of shale from the Rome Pit described above, shale from a pit at Graysville, Tennessee, and fire clay from the Birmingham District of Alabama. The materials are mixed and ground in a 9-foot dry pan, and tempered and pugged in two 9-foot wet pans. The sewer pipe are formed from the plastic clay on a steam-cylinder sewer-pipe press, and are dried from 4 to 6 days in steam-heated drying rooms. The pipe are fired in ten 30-foot round down-draft kilns, of which two are on one stack and the rest have individual stacks. They are fired to about 1860°F. and then salt-glazed. Electrical pyrometers are used to regulate the heat, standard pyrometric cones to determine the end point, and trial pieces to regulate the salt glaze. The firing takes about 5 days, or about 8 to 10 days for a complete turnover of each kiln.

The capacity of the plant is about 50 tons per day of good quality sewer pipe in sizes from 4 inches to 24 inches in diameter, including the necessary "Y's", "T's", and bends. The plant has not been in operation since 1928.

CAMP AND KNOWLES PROPERTIES

A cut on the Central of Georgia Railway about half a mile west of Dickey's Rome shale pit described above and 3 miles northwest of of Rome just beyond the section houses at mile post S-374.7 shows outcrops of Floyd shale. South of the railroad is the property of Mrs. W. C. Camp (Rome) of 110 acres, and north of the railroad is the 368 acre property of W. A. Knowles (Rome). The cut is probably in Land Lot 126, 4th District, 4th Section, Floyd County.

This cut, which averages about 6 feet in depth, exposes gray to brown semi-hard fissle shale with fairly frequent interbedded layers of chert or sandstone less than an inch in thickness. These chert or sandstone layers may be derived from the weathering of layers of very siliceous limestone. The beds are striking about N. 65°-70° E. and dipping about 65° to the south. The cut is on a low ridge of about 80 to 100 acres between two branches of Little Dry Creek, and the shale could probably be mined to a depth of 20 feet with natural drainage.

The following tests by Henry[1] are a sample of the shale collected by him.

[1]Henry, A. V., Official report as Consulting Geologist, Industrial Development Dept., Central of Georgia Railway Company, Savannah, Ga.

Laboratory tests by Dr. A. V. Henry on a sample collected by him from a cut at Mile Post S-374.5, Chattanooga Division, Central of Georgia Railway, 2 3/4 miles northwest of Rome, Floyd County.

Material: Shale, dark brown, stratified and unweathered.
Location: At Mile Post S-374.5, Chattanooga Division, 2 3/4 miles north of Rome, Georgia. Outcrop approximately 10 feet high and 125 feet long. Exposed in old cut immediately west of section house.
Overburden: None.
Plasticity: Fair.
Calcium carbonate: None.
Drying Shrinkage: 3.8 per cent.
Green Modulus of Rupture: 92 pounds per square inch.
Burned to 1995° F.:
Color: Spotted, salmon.
Density: Fair.
Total Shrinkage: 7.5 per cent.
Burned to 2174° F.:
Color: Medium red.
Density: Good.
Total Shrinkage: 8.3 per cent.

H. A. DEAN PROPERTY

The H. A. Dean (Rome) property is adjoining and north of the Central of Georgia Railway at mile post S-375, 3½ miles northwest of Rome. On it is a pit covering less than an acre and not over 15 feet in depth from which Stevens, Inc. (now out of business) mined shale for several years prior to 1926 and shipped to their plant at Stevens Pottery, Baldwin County, Georgia, for use in the manufacture of sewer pipe.

The shale, which belongs to the Floyd shale formation, is striking N. 50° E. and dipping about 50° NW. Across the southwestern corner of the pit is a band, 25 feet in width, of hard shale, dark gray in color with some brown streaks, breaking into layers a quarter to half an inch in thickness. To the northwest of this is a band, 50 feet in thickness, of soft light-brown, gray, and white shale in layers a quarter to a half inch in thickness. A few thin cherty layers and nodules are showing, but the chert is not abundant. The greater part of the mining has been in this soft shale. It is bounded on the northwest by a 15 foot band of hard gray sandy shale or argillaceous sandstone breaking into layers 3 or 4 inches across. The extreme northwest corner of the pit showed a few feet of alternating layers a foot or two in thickness of the soft brown and hard gray shales. The shale in this pit has quite a different lithologic aspect from the soft dark-brown to black crumpled and flaky type of shale most common in the Floyd shale formation. The writer is of the opinion that these beds are toward the base of the formation.

The following tests by Henry[1] are on a sample collected by him from this pit.

[1]Henry, A. V., Op. cit.

Laboratory tests by Dr. A. V. Henry on a sample of shale from the property of H. A. Dean, 3 miles north of Rome and 1¾ miles south of Morrison on the Chattanooga Division of the Central of Georgia Railway.

Overburden: None.
Water Supply: Obtained from small creek about one-fourth mile distant from deposit.
Drainage: When properly mined, can be readily drained.
Calcium Carbonate: None.
Plasticity: Good.
Drying Shrinkage: 4.6 per cent.
Burned to 1950° F.:
Total Shrinkage: 8.7 per cent.
Color: Mottled red and white.
Density: Fair.
Burned to 2110° F.:
Total Shrinkage: 9.2 per cent.
Color: Fair red mottled with white.
Density: Good.
Remarks: Working properties of this clay are excellent but the color is such as not to be well adapted to the manufacture of face brick. However, it could be used successfully in the production of hollow tile and common building brick.

F. J. KELLEY PROPERTY

The property of F. J. Kelley (2030 E. 72nd St., Chicago, Ill.), known as the Old Webb Place, consists of 615 acres lying between the Rome to Lavender Station road south of Huffaker and the Central of Georgia Railway, 4½ to 6 miles northwest of Rome. It fronts for nearly a mile and a half along the railroad, from mile post S-376 to S-377.5.

Soft plastic shale is said to have formerly been exposed in the ditch beside the railroad track at mile post S-377.2, but none was visible when visited by the writer. Hard gray fissle sandy shale outcrops at several places on the slope towards the south and the Lavender Station road. It appears to be too slow slaking to be of much value.

THOMAS BERRY PROPERTY
(Map location No. 7.)

The Thomas Berry (Rome) property consists of about 260 acres on both sides of the Central of Georgia Railway at Berryhill Station, 6½ miles northwest of Rome. South of the railroad the land is gently rolling and does not rise more than 20 to 25 feet above Berryhill Branch of Beach Creek.

Floyd shale outcrops in the ditches and cuts along the Rome to Lavender Station road south of Berryhill Station. Near the house this shale is soft dark-gray to black and weathers into fine waxy flakes, but it gradually becomes harder and more sandy towards the railroad. Half way from the house to the railroad is a 10 foot bed of dark-blue argillaceous and siliceous limestone. Beyond this nearly to the railroad are outcrops of soft dark-gray to brown waxy shale slightly less flaky than that near the house. The only outcrops in the fields west of the road are of soft flaky but rather sandy gray shale, possibly derived from the weathering of the argillaceous and siliceous limestone described above. Laboratory tests are given below on a grab sample of the shale from the outcrops along the road and in the field. The property should be prospected to determine the extent and the character of the shale away from the outcrops described above.

Laboratory tests on a grab sample of soft flaky gray to brown Floyd shale from the Thomas Berry property at Berryhill Station, 6½ miles northwest of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	5.81
Soda (Na_2O)	.45
Potash (K_2O)	1.21
Lime (CaO)	.00
Magnesia (MgO)	1.51
Alumina (Al_2O_3)	15.91
Ferric oxide (Fe_2O_3)	5.12
Titanium dioxide (TiO_2)	.37
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	69.75
	100.13

Grinding: Easy.
Ground Color: Light brown.
Slaking: Fairly rapid.
Plasticity: Grainy at first, good after aging overnight.
Molding Behavior: Fair. Slight tendency of bars to swell, crack, and tear at edges, requiring high oil-pressure.
Drying Behavior: Good.
Water of Plasticity: 23.5 per cent.
Green Modulus of Rupture: 161.9 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.9 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.9	4.8	17.6	918	Pale salmon (YR–8/4)[b]	None
04	2.6	5.4	16.2	1043	Light salmon (YR–7/6)[b]	None
02	3.6	6.5	14.1	1419	Reddish-salmon (YR–7/5)[b]	None
1	5.0	7.8	12.1	1720	Light brownish-red (YR–6/6)[b]	Very slight
3	5.8	8.4	10.3	1967	Medium brownish-red (YR–6/5)[b]	Considerable
5	5.9	8.8	8.8	2310	Medium brownish-red (YR–5/5)[b]	Some (one test bar considerable)

[a]See graph, Figure 6–A, page 89.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 and higher. Commercial kiln: Cone 1–5 and possibly higher.

The above tests indicate that, except for the fired color, the shale is suitable for the manufacture of building brick, structural tile, and possibly roofing tile. The addition of a red-firing shale or even a surface clay, such as the one described below, might improve the fired color.

Laboratory tests are given below on a sample of stiffly-plastic deep brick-red residual clay collected by the owner from several outcrops on low ridges north of the railroad. This clay is probably residual from an impure limestone layer of the Floyd shale formation. Prospecting would be necessary to determine its extent and thickness.

Laboratory tests on a sample, collected by the owner, of stiffly-plastic deep brick-red residual clay from north of the railroad on the Thomas Berry property at Berryhill Station, 6½ miles northwest of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	9.42
Soda (Na_2O)	.68
Potash (K_2O)	.44
Lime (CaO)	.00
Magnesia (MgO)	.45
Alumina (Al_2O_3)	14.69
Ferric oxide (Fe_2O_3)	8.98
Titanium dioxide (TiO_2)	1.38
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	63.01
	99.05

Grinding: Easy.

Ground Color: Reddish-brown.

Slaking: Rapid.

Plasticity: Good, somewhat sticky.

Molding Behavior: Laminated considerably in coming through the die.

Drying Behavior: Test bars warped slightly.

Water of Placticity: 39.8 per cent.

Green Modulus of Rupture: 174.5 pounds per square inch. The laminations caused considerable variation in the individual results. If lamination could be avoided the green strength would probably be higher than indicated above.

Linear Drying Shrinkage (based on plastic length): 11.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.9	14.8	17.5	940	Salmon (YR–6/6)[b]	Slight
04	4.0	14.9	15.8	973	Dark salmon (7YR–7/5)[b]	Slight
02	5.2	15.9	14.1	541	Fair red (R–YR–5/5)[b]	Slight
1	6.6	17.1	12.5	1058	Fair red (R–YR–5/5)[b]	Slight
3	4.9	15.7	13.2	1178	Good red (R–YR–5/5)[b]	Considerable
5	5.4	16.1	11.9	993	Good red (R–YR–5/5)[b]	Some

[a]See graph, Figure 6–B, page 89.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The lack of uniform results is, to a considerable extent, due to the laminated structure of the test bars. This is shown by checks and cracks in the fired test bars, and curved rather than straight fractures on the broken ends.

Firing Range: Cone 04–5 and higher.

The above tests indicate that by itself this clay is suitable only for the manufacture of common building brick. If added to the shale south of the railroad in amounts up to possibly one part of clay to two parts of shale, it should improve the color of the fired product without detrimental results.

BERRYHILL ESTATE

(Map location No. 8)

The Berryhill Estate (Mrs. C. A. Berryhill, Rome) consists of 160 acres lying on both sides of the Central of Georgia Railway half a mile west of Berryhill Station and 7 miles northwest of Rome.

A small cut on the railroad near the Lavender Station road shows a few feet of soft waxy gray to drab shale striking NE–SW and dipping about 45° SE., overlain by hard black shale resembling the Chattanooga shale and underlain by hard sandy shale which under cover is probably calcareous. These rocks probably belong to the Floyd shale.

The land south of the railroad is a series of low ridges and knolls 25 to 30 feet in height. In the valley between two of these low ridges, a quarter of a mile south of the railroad on the private road that leads south to the Alabama Road, are outcrops of soft gray to drab and grayish-lavender flaky and waxy shale. Apparently both of these ridges and perhaps all of this section of the property are underlain by this shale. Laboratory tests are given below on a grab sample of shale from these outcrops.

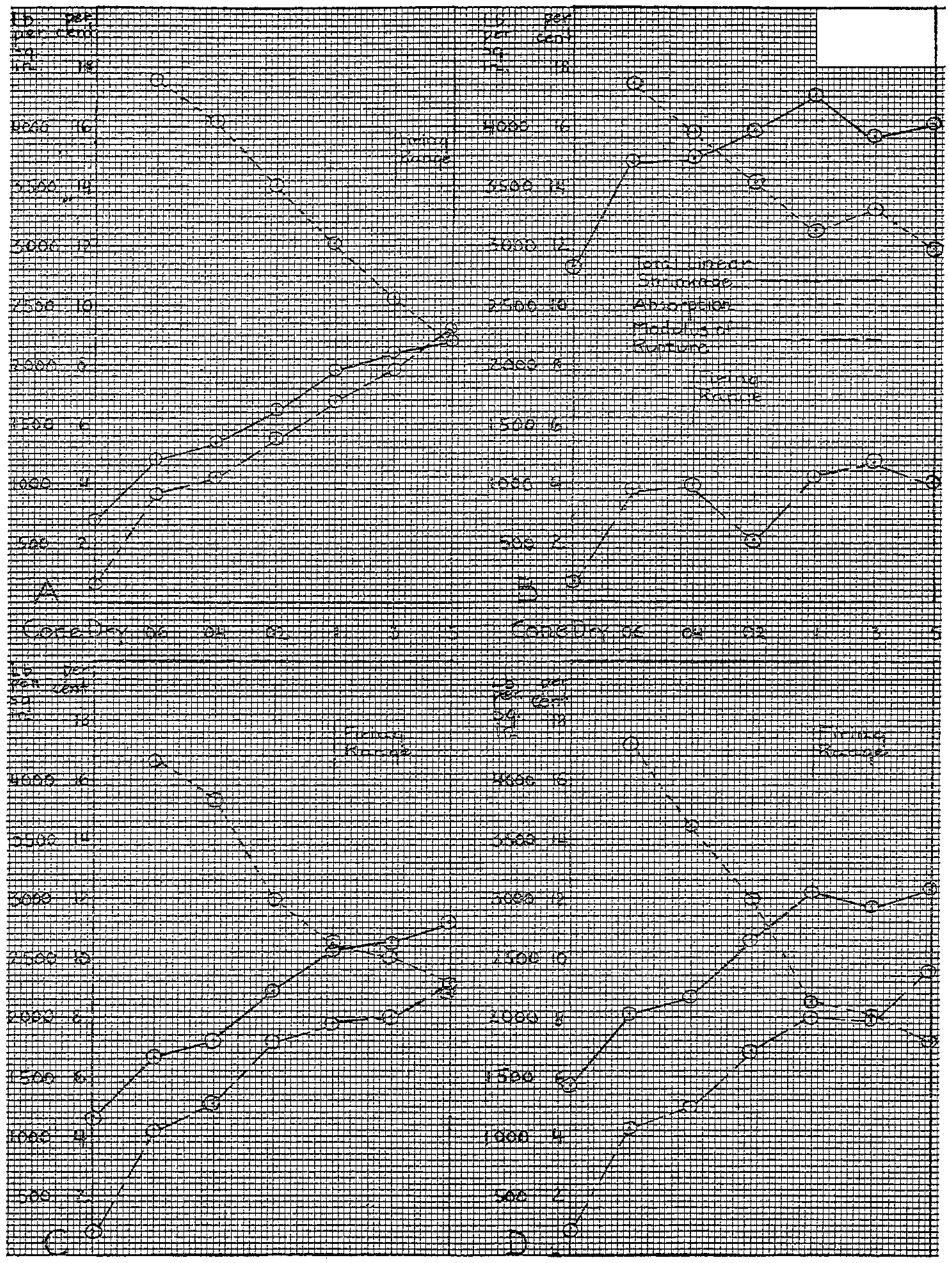


Figure 6. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Floyd shale from the Thomas Berry property, Berryhill Station, Floyd County.

B. Residual clay from the Thomas Berry property, Berryhill Station, Floyd County.

C. Floyd shale from the Berryhill Estate, 7 miles northwest of Rome, Floyd County.

D. Floyd shale from the S. Levinson property, 8 miles northwest of Rome, Floyd County.

Laboratory tests on a grab sample of soft gray to drab flaky and waxy Floyd shale from the Berryhill Estate, 7 miles northwest of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	6.07
Soda (Na_2O)	.47
Potash (K_2O)	.86
Lime (CaO)	.00
Magnesia (MgO)	.05
Alumnia (Al_2O_3)	21.67
Ferric oxide (Fe_2O_3)	5.26
Titanium dioxide (TiO_2)	.55
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	65.02
	99.95

Grinding: Easy.
Ground Color: Drab.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Good.
Water of Plasticity: 24.9 per cent.
Green Modulus of Rupture: 199.1 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based (on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.4	6.7	16.7	1063	Pale salmon (YR–7/4)[b]	Slight
04	2.8	7.2	15.4	1294	Light salmon (YR–7/5)[b]	Slight
02	4.6	8.9	12.0	1789	Medium salmon (YR–7/6)[b]	None
1	5.7	10.2	10.4	1943	Light brownish-red (YR–6/6)[b]	None
3	6.3	10.5	10.0	1982	Light brownish-red (YR–6/6)[b]	Slight
5	6.5	11.2	9.1	2184	Medium brownish-red (YR–6/5)[b]	Slight

[a]See graph, Figure 6-C, page 89.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 01–5 and possibly higher.

The above tests indicate that, except for the fired color which is poor, this shale is suitable for the manufacture of building brick, structural tile, and possibly roofing tile. The color might possibly be improved by adding some surface or residual clay such as the red clay sample from the Thomas Berry property described above. It may be possible that the less weathered portions of the formation contain more iron and would fire to a deeper red color.

The property should be prospected to determine the extent and thickness of the shale deposit.

S. LEVINSON PROPERTY

(Map location No. 9.)

The S. Levinson (Rome) property is south of the Rome to Lavender Station road and on both sides of the Central of Georgia Railway, 1½ miles west of Berryhill Station and 8 miles northwest of Rome. It consists of 80 acres in Land Lot 81, 4th District, 4th Section, Floyd County.

A cut on the Lavender Station road near a small church shows semi-hard to hard gray flaky shale. South of the railroad several shallow gullies show soft gray flaky shale striking NE–SW and dipping 75° SE. The shale is overlain by about five feet of clay and gravel. The laboratory tests are given below on a grab sample of this shale from three outcrops about 15 feet apart. The property is gently rolling and is probably nearly all underlain by shale (of the Floyd shale formation) which could be mined to a depth of 15 to 20 feet with natural drainage. It is impossible to tell without prospecting whether or not the sample taken is representative of the deposit as a whole.

Laboratory tests on a grab sample of soft gray flaky Floyd shale from gully outcrops on the S. Levinson property on the Central of Georgia Railway, 8 miles northwest of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.10
Soda (Na_2O)	1.48
Potash (K_2O)	1.36
Lime (CaO)	trace
Magnesia (MgO)	.23
Alumnia (Al_2O_3)	19.12
Ferric oxide (Fe_2O_3)	2.84
Titanium dioxide (TiO_2)	.74
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.34
Silica (SiO_2)	66.94
	100.15

Grinding: Easy.
Ground Color: Brownish-gray.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Excellent.
Drying Behavior: A little slow in drying. Warped slightly.
Water of Plasticity: 26.8 per cent.
Green Modulus of Rupture: 224.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 5.7 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.5	8.1	17.2	1059	Pale salmon (6YR–7/5)[b]	Slight
04	3.7	8.7	14.5	1266	Light salmon (7YR–7/5)[b]	Some
02	5.2	10.6	12.0	1728	Light salmon (7YR–7/5)[b]	Some
1	7.2	12.2	8.5	1987	Medium salmon (4YR–6/5)[b]	Some
3	6.5	11.7	8.0	1968	Light brownish-red (3YR–6/4)[b]	Considerable
5	7.3	12.3	7.2	2130	Medium brownish-red (3YR–5/3)[b]	Some

[a]See graph, Figure 6-D, page 89.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 1–5.

The above tests indicate that the shale sampled, except for the fired color which is poor, is suitable for the manufacture of building brick, structural tile, and possibly roofing tile. The color might be improved by the addition of some surface or residual clay such as the red clay described on page 87. It may be possible that the deeper and less weathered portions of the shale contain more iron and would fire to a better color.

OCONEE CLAY AND SHALE PRODUCTS COMPANY

(Map location No. 10.)

Headquarters: Milledgeville, Georgia. (See page 313).

The shale pit of the Oconee Clay and Shale Products Company (Milledgeville) is on a 10 acre tract on the south side of the Central of Georgia Railway, 7/8 of a mile west of Hillery Station, 1 3/8 miles east of Lavender Station, and 9 miles northwest of Rome.

The pit was opened about the first of 1929, and when visited by the writer in July of that year was about 75 feet long, 30 feet wide, and the working face at the western end was 15 feet in height. The Floyd shale, as exposed in the pit, has at this point weathered to a soft mottled gray, brown, and red clay showing little or no shaly structure or bedding and more nearly resembling an impure mottled kaolin in appearance. The lower six feet of the face is mostly a light-gray clay having a pseudoplasticity when rubbed between the fingers. The clay under the bottom of the pit is said to be harder and with depth passes into a true shale. Laboratory tests are given below of a groove sample from two places on the face of the pit.

The clay is mined by hand, the bottom of the face being undermined, the face shot down with a small charge, and the lumps broken up with picks to a convenient size to handle. The clay is loaded into standard gondola freight cars by a gasoline-driven mechanical loader. It is shipped to the company's plants at Milledgeville where it is used, mixed with a residual clay, in the manufacture of structural and drain tile (see page 313).

Laboratory tests on a groove sample of soft mottled gray, brown, and red clay or weathered shale from the pit of the Oconee Clay and Shale Products Company, Central of Georgia Railway, 9 miles northwest of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	6.42
Soda (Na_2O)	1.72
Potash (K_2O)	1.32
Lime (CaO)	.00
Magnesia (MgO)	.11
Alumina (Al_2O_3)	24.38
Ferric Oxide (Fe_2O_3)	4.05
Ferrous oxide (FeO)	.31
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.11
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	60.39
	99.90

Grinding: Easy.

Ground Color: Light grayish-brown.

Slaking: Rapid.

Plasticity: Very good.

Molding Behavior: Excellent.

Drying Behavior: All somewhat warped.

Water of Plasticity: 27.0 per cent.

Green Modulus of Rupture: 157.9 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 6.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.3	8.7	18.2	895	Salmon (YR–7/5)[b]	Some
04	3.6	8.9	16.7	1235	Salmon (3YR–6/5)[b]	Some
02	5.0	10.2	13.9	1543	Salmon (1YR–6/4)[b]	Some
1	6.3	12.0	10.3	1837	Salmon-red (2YR–6/4)[b]	Some
3	6.2	11.8	9.5	1859	Light-red (R–YR–5/5)[b]	Some
5	8.1	13.3	7.4	2187	Fair-red (R–YR–5/4)[b]	Considerable.

[a]See graph, Figure 7-A, page 97.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 and higher.

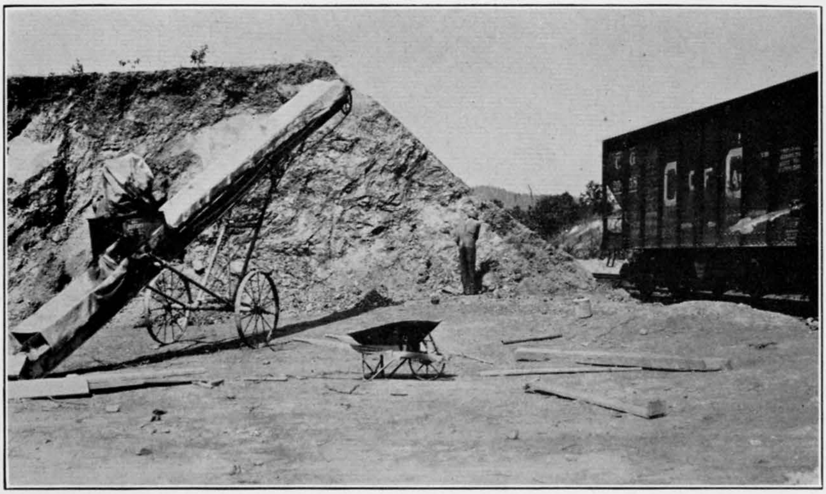
T. A. LONG PROPERTY

(Map location No. 11).

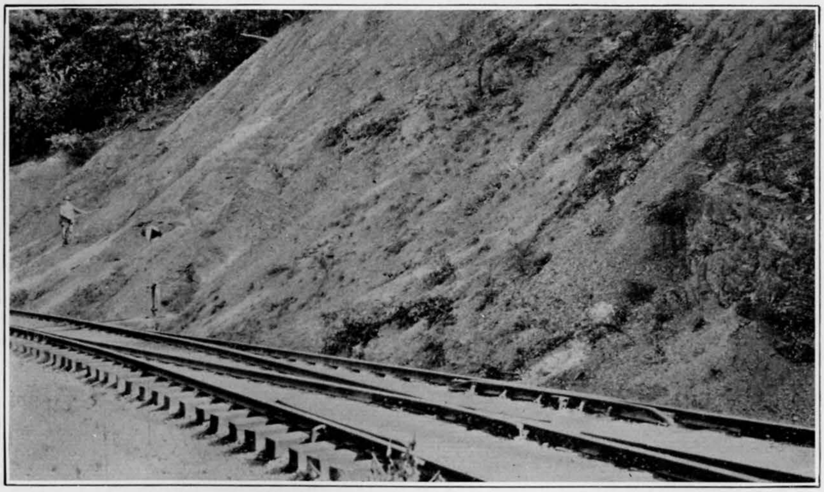
The T. A. Long (Rome, Rt. 5) property of 766 acres nearly surrounds the 10 acres of the Oconee Clay and Shale Products Company, which were originally a part of this property, and extends west for nearly a mile along both sides of the Central of Georgia Railway to a quarter of a mile east of Lavender Station, and north to and across the Rome to Lavender Station road.

Shale of the Floyd formation outcrops at a number of places scattered over the property and the owner estimates that at least 100 acres are underlain by shale.

A foot or so of fissle black shale resembling the Chattanooga black shale is showing in the cut of the Rome to Lavender Station road at the foot of the slope of a low ridge near the western edge of the property, a quarter of a mile east of Lavender Station and an eighth of a mile north of the Central of Georgia Railway. It is overlain by 8 to 10 feet of fairly soft waxy brown shale breaking into thin flat pieces rather than fine flakes. Similar outcrops are showing beside the road on the next low ridge an eighth of a mile to the east. Laboratory tests on a grab sample of the black and the brown shale from both outcrops are given below. At both places the shale appears to be striking about N. 60° E. and dipping about 15° to 20° to the southeast, although slumping made the measurements uncertain.



A. SHALE PIT, OCONEE CLAY AND SHALE PRODUCTS COMPANY, NEAR LAVENDER STATION, FLOYD COUNTY.



B. OUTCROP OF RED MOUNTAIN SHALE ON THE J. O. McCALLIE PROPERTY, NEAR CENCHAT, WALKER COUNTY.

Laboratory tests on a grab sample of soft waxy brown and fissle black shale from outcrops on the western side of the T. A. Long property, a quarter of a mile east of Lavender Station, Floyd County.

Chemical Analysis:

Loss on ignition	7.50
Soda (Na_2O)	2.05
Potash (K_2O)	.76
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumnia (Al_2O_3)	22.03
Ferric oxide (Fe_2O_3)	7.50
Ferrous oxide (FeO)	.32
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.56
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.14
Silica (SiO_2)	59.91
	100.77

Grinding: Easy.
Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Excellent.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 29.3 per cent.
Green Modulus of Rupture: 235.7 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.9	11.7	14.8	1803	Light-red (YR-6/7)[b]	Slight
04	5.6	12.2	12.0	1798	Fair-red (R-YR-5/6)[b]	Slight
02	6.8	13.0	10.0	1681	Good red (R-YR-5/4)[b]	Slight
1	7.4	13.3	9.2	2278	Medium red (R-YR-5/6)[b]	Slight
3	7.4	13.1	7.3	2300	Dark red (R-YR-4/5)[b]	Slight
5	7.5	13.6	5.8	2584	Excellent dark red (R-YR-4/4)[b]	Some

[a]See graph, Figure 7-B, page 97.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars show a slight tendency to lamination which may have somewhat affected the green and fired moduli of rupture. The fired bars all show slight traces of scumming or efflorescence, probably not enough to hurt the commercial value of heavy clay products made from the shale. The bars fired to cones 04 and 02 show traces of black-coring.

Firing Range: Cone 04–5. Commercial kiln: Cone 04–3.

The tests given above indicate that this shale is suitable for the manufacture of building brick, structural tile, roofing tile, and possibly quarry tile, conduits, and sewer pipe.

More of the Floyd shale is exposed in the cut of the Rome to Lavender Station road about a mile and a quarter east of Lavender Station and nearly half a mile due north of the Oconee Clay and Shale Products Products Company pit, where the transmission lines of the Georgia Power Company cross the road. At this place the several feet of shale showing is fairly soft and weathers into layers a quarter to one inch in thickness. The surface when cut with a knife has a waxy appearance. The color ranges from dark gray to chocolate-brown. Laboratory tests are given below on a grab sample of the shale from this outcrop. The owner states that the holes dug in erecting the transmission line disclosed similar shale for a short distance north of the road and along the whole distance south of the road to the railroad.

Laboratory tests on a grab sample of soft dark-gray to chocolate-brown Floyd shale from the eastern side of the T. A. Long property, 1¼ miles east of Lavender Station, Floyd County.

Chemical Analysis:

Loss on ignition	6.66
Soda (Na_2O)	1.55
Potash (K_2O)	1.21
Lime (CaO)	.00
Magnesia (MgO)	.27
Alumina (Al_2O_3)	17.18
Ferric oxide (Fe_2O_3)	13.86
Ferrous oxide (FeO)	.19
Titanium dioxide (TiO_2)	.74
Sulphur trioxide (SO_3)	.11
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	58.28
	100.05

Grinding: Easy.
Ground Color: Grayish-brown.
Slaking: Rapid.
Plasticity: Good. Very sticky at first, then stiffer.
Molding Behavior: Good.
Drying Behavior: Good, only slight warpage.
Water of Plasticity: 31.4 per cent.
Green Modulus of Rupture: 228.9 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.5 per cent.

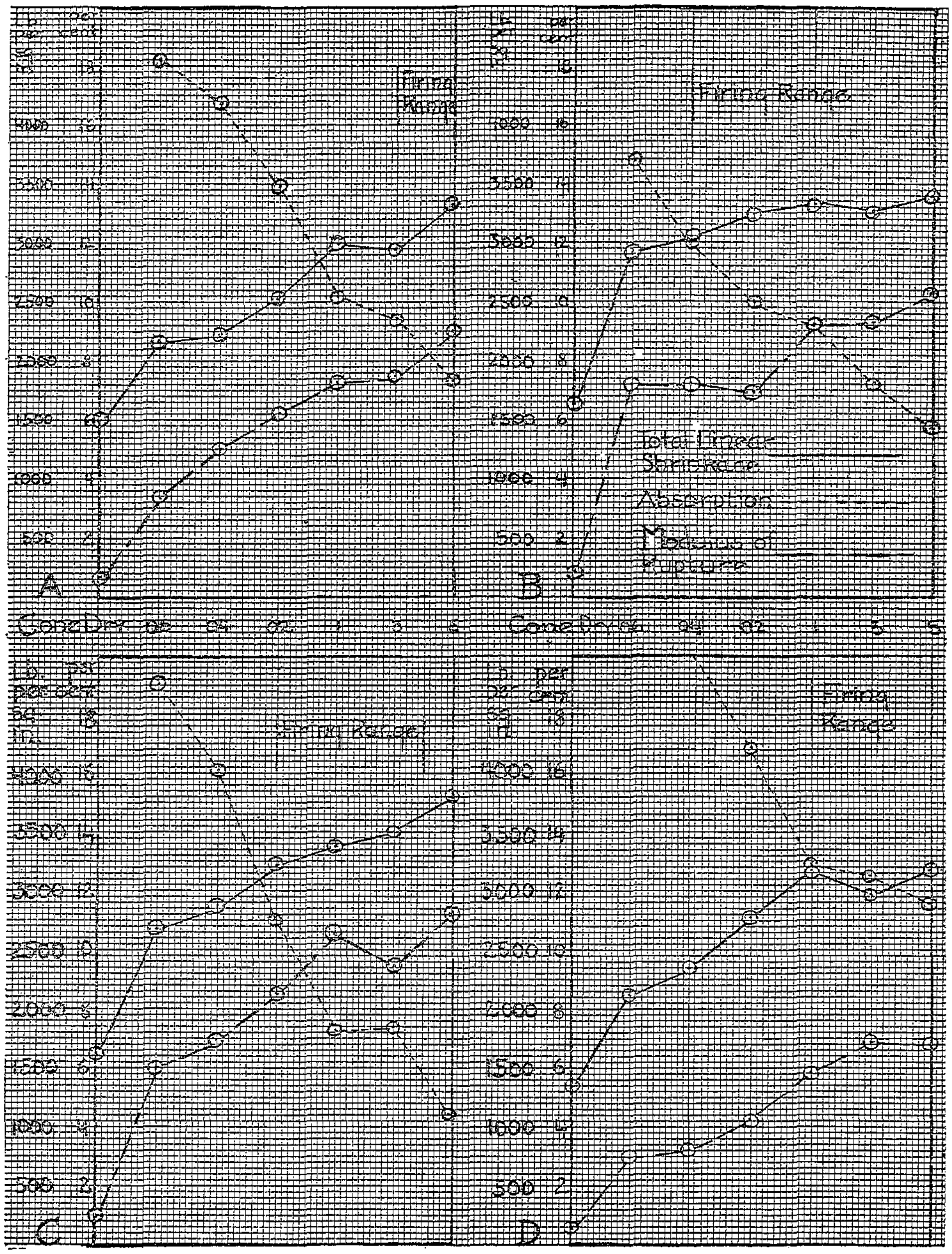


Figure 7. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Weathered Floyd shale from the pit of the Oconee Clay and Shale Products Company, 9 miles northwest of Rome, Floyd County.

B. Floyd shale from the west side of the T. A. Long property near Lavender Station, Floyd County.

C. Floyd shale from the east side of the T. A. Long property near Lavender Station, Floyd County.

D. Shale from the J. L. Johnson property near Oreburg, Floyd County.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.3	10.7	19.1	1483	Salmon (6YR–7/5)[b]	Slight
04	5.1	11.5	16.1	1739	Salmon (3YR–6/6)[b]	Some
02	7.0	12.9	11.1	2134	Salmon (3YR–6/6)[b]	Slight
1	8.8	13.5	7.3	2639	Fair red (R–YR–5/6)[b]	Some
3	8.6	14.0	7.4	2375	Medium red (R–YR–5/5)[b]	Slight
5	9.9	15.2	4.4	2784	Dark brownish-red (R-YR-4/4)[b]	Some to Considerable

[a]See graph, Figure 7-C, page 97.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5. Commercial kiln: Cone 02–4.

The above tests indicate that this shale is suitable for the manufacture of building brick, structural tile, and possibly roofing tile and sewer pipe.

The property should be thoroughly prospected to determine the thickness and extent of the workable shale. The writer is of the opinion that the property contains a considerable deposit of shale similar to the two samples described above. There are several flat plant sites along the railroad. The nearest supply of surface water sufficient for manufacturing purposes is Cabin Creek, half a mile or more south of the railroad, but deep wells might furnish a sufficient supply.

F. H. SCHLAPBACK PROPERTY

The F. H. Schlapback (Silver Creek) property is west of and adjoining the T. A. Long property described above. The cut of the Central of Georgia Railway an eighth of a mile east of Lavender Station and the ridge to the south of the railroad show outcrops of hard light to dark-gray siliceous shale, apparently too non-plastic to be of value for ceramic purposes. The next cut to the east shows semi-hard gray to brown shale containing some thin inter-bedded chert layers. This eastern edge of the property may contain some plastic shale like that sampled on the adjoining end of the Long property and described above.

The following tests by Henry[1] are on a sample collected by him of mottled light and medium tan, soft and weathered shale from a cut on the Central of Georgia Railway at Mile Post S-381.5, three-quarters of a mile east of Lavender Station, presumably the cut on the eastern edge of the Schlapback property.

Laboratory tests by Dr. A. V. Henry on a sample of weathered shale from a railroad cut three-quarters of a mile east of Lavender Station at Mile Post S-381.5.

Overburden: None.
Plasticity: Excellent.
Calcium Carbonate: None.
Drying Shrinkage: 6.2 per cent.
Green Modulus of Rupture: 200 pounds per square inch.
Burned to 1900° F.:
Color: Salmon.
Density: Fair.
Total Shrinkage: 10.4 per cent.
Burned to 2174° F.:
Color: Deep red.
Density: Good.
Total Shrinkage: 13.5 per cent.

J. L. JOHNSON PROPERTY

(Map location No. 12.)

The J. L. Johnson (Rome, Rt. 5) property, formerly known as the Barry Wright Place, consists of 500 acres south of the Rome to Gadsden line of the Southern Railway between Robinson and Oreburg stations and about three-quarters of a mile from each. It is about 7½ miles west of Rome.

When visited by the writer in 1929, a well had just been dug for water at the house, which is on a spur extending north from a low ridge to the south of the railroad. This well passed through 8 feet of soil and sub-soil containing water-worn gravel, and 20 feet of soft plastic yellowish-brown shale breaking into small waxy-looking flakes. The laboratory tests on a grab sample of the shale thrown out of the well are given below. The shale is said to have been slightly harder at the bottom of the well.

Semi-hard brown to drab-colored shale outcrops at several places around the edge of the ridge. This property, as can be seen on the geologic map facing page 66, is close to the Rome fault line where the Conasauga shale is thrust over the younger Floyd shale. The writer is of the opinion that the shale sampled belongs to the Floyd shale formation.

[1]Henry, A. V., Official report as Consulting Geologist, Industrial Development Dept., Central of Georgia Railway Company, Savannah, Georgia, 1926.

Laboratory tests on a grab sample of soft yellowish-brown shale from a well on the J. L. Johnson property, three-quarters of a mile east of Oreburg, Floyd County.

Chemical Analysis:

Loss on ignition	6.99
Soda (Na_2O)	.75
Potash (K_2O)	.48
Lime (CaO)	.00
Magnesia (MgO)	1.94
Alumina (Al_2O_3)	21.17
Ferric oxide (Fe_2O_3)	9.36
Ferrous oxide (FeO)	.00
Manganous oxide (MnO)	.58
Titanium dioxide (TiO_2)	.56
Sulphur trioxide (SO_3)	.28
Phosphorus pentoxide (P_2O_5)	.53
Silica (SiO_2)	57.43
	100.07

Grinding: Easy.
Ground Color: Yellowish-brown.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Good, very little warpage.
Water of Plasticity: 32.4 per cent.
Green Modulus of Rupture: 148.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 5.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.2	8.5	21.6	742	Salmon (YR-6/6)[b]	Slight
04	4.0	9.4	20.2	799	Light red (2YR-6/5)[b]	Slight
02	5.8	11.1	16.8	1065	Light red (3YR-6/5)[b]	Slight
1	7.6	12.7	12.8	1478	Medium red (R-YR-5/5)[b]	Some
3	7.2	11.9	12.5	1707	Good red (R-YR-5/4)[b]	Some
5	8.0	12.8	11.6	1698	Good red (R-YR-4/4)[b]	Some

[a]See graph, Figure 7-D, page 97.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 02–5.

The above tests indicate that this shale is suitable for the manufacture of building brick and medium-fired structural tile. The property should be thoroughly prospected to determine the extent, thickness, and character of the shale. The overburden of 8 feet in this well probably represents nearly the maximum overburden in the ridge. The shale in the ridge could probably be mined to a depth of 20 to 25 feet with natural drainage.

JEFFRIES, ALLEN, AND WALKER PROPERTIES

The J. H. Jeffries (Rome, Rt. 5) property of 126 acres is south of the Alabama Road and extends from the side-road to Oreburg Station east for half a mile and on the eastern end extends south to and across the Rome to Gadsden line of the Southern Railway. It is adjoined on the east by the Johnson property described above.

Holes dug for the poles of the transmission line of the Georgia Power Company, which crosses the eastern part of the property, struck soft flaky greenish-buff shale. The land has a gentle slope and is not over 10 feet above drainage.

The cut of the road from the Alabama road to Oreburg Station on the western edge of the property exposes about 15 feet of fairly soft flaky gray shale with a crumpled and broken structure. The low ridge between the Alabama Road and the railroad is evidently underlain by this shale. The property west of the cross-road and adjoining the Alabama Road is owned by W. H. Allen. Adjoining the railroad on both sides of the road to Oreburg Station is the 40 acre tract of W. L. Walker.

An examination of the geologic map facing page 66 shows that the line of the Rome Fault is quite irregular at this place. The crumpled flaky shale along the road to Oreburg Station is evidently the Floyd shale, but part of the Jeffries and Allen properties must be underlain by the Conasauga shale.

These properties should be prospected to determine the character, extent, and thickness of their shale deposits.

JOE MARTIN PROPERTY

(Map location No. 13.)

The Joe Martin (Rome, Rt. 8) property is adjoining and south of the Rome to Gadsden line of the Southern Railway just west of Oreburg Station, 8 miles west of Rome. It consists of 77¾ acres in Land Lot 186, 4th Land District, 4th Section, Floyd County.

The land rises fairly rapidly from the railroad to a ridge some 80 to 100 feet above the level of the railroad. The top of the ridge is capped by about 10 feet of silt, sand, and water-worn gravel, a river-terrace deposit of the Coosa peneplain stage (see page 52). Debris from this capping covers the surface of the slopes to varying depths. Beneath the gravels are shales of the Conasauga formation.

The property is said to have been prospected thoroughly by the W. S. Dickey Clay Manufacturing Company. The prospecting wells and borings are said to have been continued through the overburden and shale until water was struck at depths varying from 30 to 40 feet on top of the ridge to 10 feet on the lower slopes. The maximum overburden is said to have been 10 feet and the average less than 5 feet. The shale is said to have been soft and plastic, and processed well. The fired color, strength, and absorption are said to have been satisfactory, but the total shrinkage was greater than the company desired. The option was renewed once after the prospecting and was then dropped.

When visited by the writer in 1929, the prospect wells had been filled in. The only outcrop visible on the north slope of the ridge was 3 feet of soft plastic brownish-red shale in a gully under 5 feet of silt and gravel. The laboratory tests on a grab sample of this are given below. It may or may not be representative of the whole deposit.

Laboratory tests on a grab sample of soft brownish-red Conasauga shale from a 3 foot gully outcrop on the Joe Martin property at Oreburg Station, 8 miles west of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	8.72
Soda (Na_2O)	.92
Potash (K_2O)	.83
Lime (CaO)	.00
Magnesia (MgO)	.23
Alumina (Al_2O_3)	17.76
Ferric oxide (Fe_2O_3)	6.85
Ferrous oxide (FeO)	.79
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.56
Sulphur trioxide (SO_3)	.24
Phosphorus pentoxide (P_2O_5)	.19
Silica (SiO_2)	63.01
	100.10

Grinding: Easy.

Ground Color: Reddish-brown.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Good.

Drying Behavior: All test bars slightly warped.

Water of Plasticity: 34.6 per cent.

Green Modulus of Rupture: 208.9 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 6.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.1	10.4	20.3	997	Salmon (4YR-6/7)[b]	Slight
04	5.7	11.5	16.9	1249	Salmon-red (2YR-6/8)[b]	Some
02	6.3	14.0	13.6	1542	Light-red (R-YR-5/7)[b]	Very slight
1	10.4	16.0	8.1	2197	Good red (R-YR-5/6)[b]	Some
3	9.2	14.9	8.5	1849	Dark red (R-YR-4/5)[b]	Considerable
5	10.3	16.5	6.7	2053	Dark brownish red (R-YR-4/4)[b]	Some to considerable

[a]See graph, Figure 8-A, page 105.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5. Commercial kiln: Cone 01–4.

The above tests indicate that this shale should be satisfactory for the manufacture of building brick and possibly for structural tile and sewer pipe. The total shrinkage is high, which might cause warpage and make it difficult to maintain uniform size of finished products. The addition of a harder or more siliceous shale might improve the ceramic properties.

EVANS AND RUSSELL PROPERTIES

(Map location No. 14)

The road from Lavender Station to Early Station forms, at King Creek 1 3/8 miles east of Early Station, the boundary between the Cicero Evans (Coosa) property of 190 acres north of the road, and the George Russell (Gaylesville, Ala.) property south of the road. The Russell property of 160 acres extends south to the Alabama Road, and its southern boundary is only a few hundred feet north of the Rome to Gadsden line of the Southern Railway, half way between Early and Mt. Hope stations and 14 miles west of Rome.

The cut of the road between the properties for 75 feet on the slope east of King Creek exposes soft olive-green to drab Conasauga shale weathering flaky at places and splintery at others. The outcrops are striking N. 70° W. and dipping 45° to the north. The laboratory tests on a grab sample of shale from this outcrop are given below. The shale evidently underlies the ridge north of the road on the Evans property and a similar ridge on both properties west of King Creek, all in Land Lot 101, 15th District, 4th Section. The main ridge on the Russell property west of King Creek and between the two roads is partly underlain by the Knox dolomite, but fragments of shale are said to be plowed up in the fields along the slopes of the ridge and along the Alabama Road.

Laboratory tests on a grab sample of soft olive-green to drab Conasauga shale from the Cicero Evans and George Russell properties north of the Southern Railway between Early and Mt. Hope stations, 1¼ miles west of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.89
Soda (Na_2O)	.72
Potash (K_2O)	1.63
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	27.56
Ferric oxide (Fe_2O_3)	5.91
Titanium dioxide (TiO_2)	.81
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	55.43
	99.95

Grinding: Fairly easy, brittle.
Ground Color: Light grayish-brown.
Slaking: Fairly rapid.
Plasticity: A little grainy at first, good after aging overnight.
Molding Behavior: Good.
Drying Behavior: Good. Little or no warpage.
Water of Plasticity: 27.4 per cent.
Green Modulus of Rupture: 153.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 5.0 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.4	10.3	12.0	1259	Dark salmon (1YR–6/8)[b]	Slight
04	5.8	10.5	10.3	1463	Light red (1YR–5/7)[b]	Slight
02	6.6	11.3	7.2	2060	Medium red (1YR–5/5)[b]	Slight
1	9.1	13.6	3.8	2589	Good red (1YR–4/4)[b]	Some
3	7.0	11.5	3.1	1839	Deep chocolate-red (2YR–3/5)[b]	Bad
5	6.7	11.4	2.1	2570	Deep chocolate (2YR–3/3)[b]	Considerable.

[a]See graph, Figure 8-B, page 105.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5. Commercial kiln: Cone 02–4.

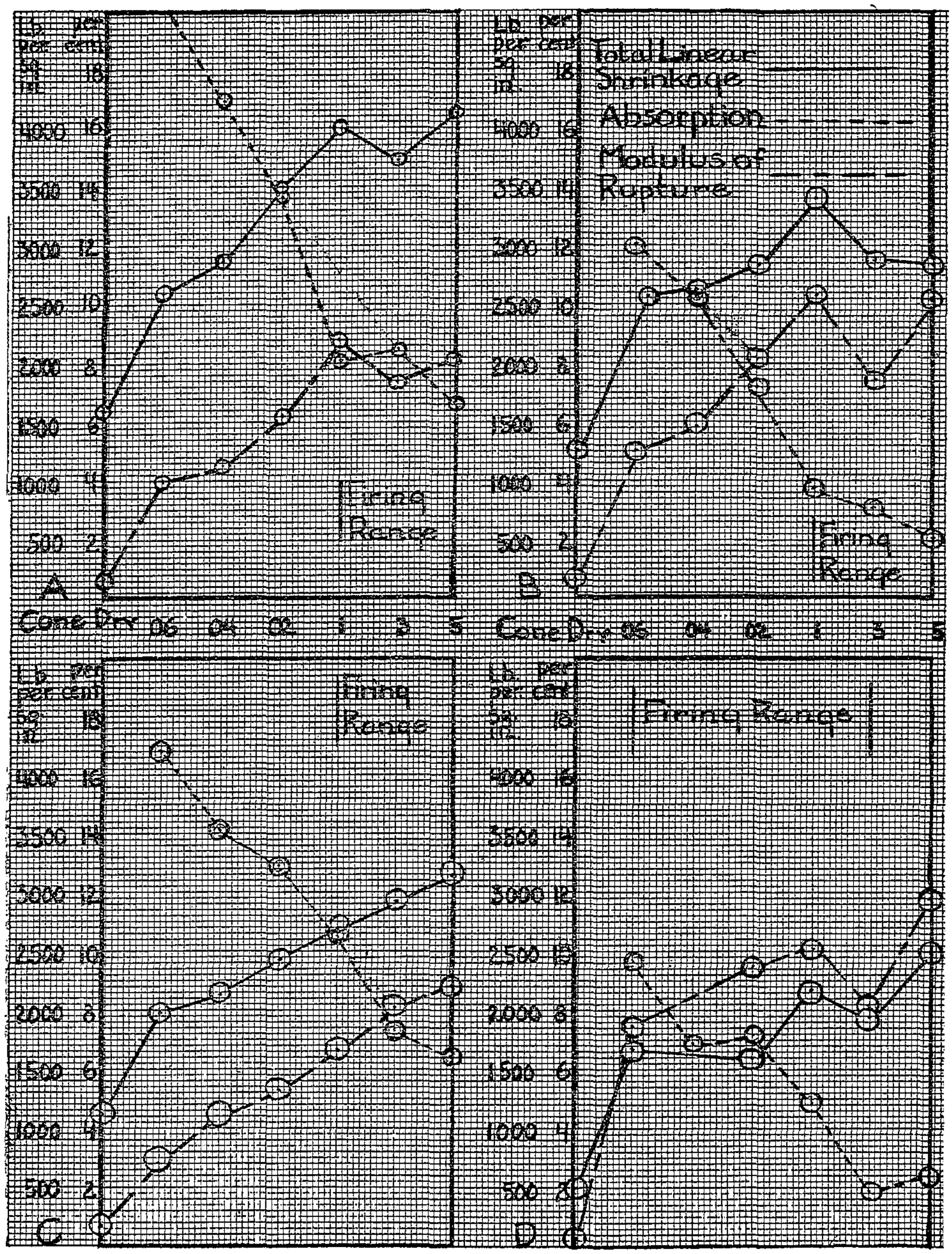


Figure 8. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Conasauga shale from the Joe Martin property, Oreburg, Floyd County.

B. Conasauga shale from the Evans and Russell properties near Early and Mt. Hope stations, Floyd County.

C. Conasauga shale from the Williams and Cooper properties, Turner Bend, Coosa River, Floyd County.

D. Conasauga shale from the Mrs. P. M. Foster property, Sixmile Station, Floyd County.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly for structural tile, sewer pipe, and the shingle type of roofing tile.

The properties should be thoroughly prospected to determine the extent of the shale.

An outcrop beside the Alabama Road near Mt. Hope Station about a mile west of these properties shows similar soft flaky olive-green Conasauga shale, but the shale is cut by several veinlets of white calcite, principally as a coating or filling of joint planes. The shale is striking N. 70° E. and is nearly vertical.

Similar outcrops of soft flaky olive-green Conasauga shale with veinlets of white calcite are exposed beside the road to Foster Bend one mile south of Early Station.

SHALE DEPOSITS ALONG THE COOSA RIVER

The Coosa River is officially classed as a navigable stream, and the Government operates locks at Mayo Bar about 6½ miles (air-line) southwest of Rome. Steamboat service was formerly maintained between Rome and Gadsden, Alabama. At the present time there is considerable agitation for a Government-operated barge line from Rome down the Coosa and Alabama rivers to the Gulf at Mobile. Through the courtesy of the Rome Chamber of Commerce, the writer made a reconnaissance trip by motor-boat down the Coosa River to the mouth of Cedar Creek near the Alabama line.

Government Locks

Just below the Government locks on the south bank of the river is an outcrop of hard gray crinkly-looking shale striking about N. 60° E. and dipping at an angle of 30° to the southeast. It is overlain at the locks by massive limestone and underlain by a thin bed of impure limestone.

Turner Bend

(Map location No. 15).

On the south bank of the river at Turner Bend, 10 miles (air-line) west of Rome, near the line between the Mrs. J. B. Williams (Rome, Rt. 6) and the L. N. Cooper properties in Land Lot 286, 4th District, 4th Section, is a bluff rising to about 50 feet above the river. A lens of massive limestone is exposed near the water-line on the up-stream side of the bluff, but the rest of the bluff is an outcrop, about 50 feet across, of soft olive-green Conasauga shale breaking into thin flat pieces and flakes having a waxy look. The shale appears to contain no limestone. The laboratory tests on a grab sample of the shale from near the top of the bluff are given below.

Laboratory tests on a grab sample of soft olive-green Conasauga shale from the Mrs. J. B. Williams and the L. N. Cooper properties, Turner Bend, Coosa River, 10 miles west of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.18
Soda (Na_2O)	trace
Potash (K_2O)	1.24
Lime (CaO)	.48
Magnesia (MgO)	.04
Alumina (Al_2O_3)	20.84
Ferric oxide (Fe_2O_3)	7.32
Ferrous oxide (FeO)	.64
Titanium dioxide (TiO_2)	.93
Sulphur trioxide (SO_3)	.24
Phosphorus pentoxide (P_2O_5)	.12
Silica (SiO_2)	60.92
	99.95

Grinding: Fairly easy.
Ground Color: Brownish-drab.
Slaking: Fairly rapid.
Plasticity: Good. (Clay was a little too wet and bars swelled slightly).
Molding Behavior: Good.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 26.8 per cent.
Green Modulus of Rupture: 171.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.5	7.9	16.8	701	Salmon (3YR–6/7)[b]	Slight
04	4.4	8.5	14.1	1107	Light red (R–YR–5/5)[b]	Slight
02	5.4	9.7	12.9	1318	Medium red (R–YR–5/3)[b]	Slight
1	6.8	10.8	10.5	1636	Fair red (R–YR–5/4)[b]	Slight
3	7.4	11.7	7.3	2032	Deep red (R–YR–4/5)[b]	Considerable
5	8.4	12.5	6.4	2203	Very-deep red (8R–4/3)[b]	Some

[a]See graph, Figure 8-C, page 105.
[b]Color notation according to the Munsell system, see page 23.

Firing Range. Cone 1–5 higher. Commercial kiln: Cone 02–5.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile, roofing tile, and sewer pipe.

The cuts of the Rome to Livingston road at Hampton Swamp Creek on the same Mrs. J. B. Williams property, 1¼ miles east of Livingston and half a mile south of the Coosa River, expose soft to semi-hard waxy greenish-drab to brown Conasauga shale containing occasional streaks less than half an inch in thickness of waxy white clay. The shale outcrops are overlain by about 5 feet of river-terrace silt and gravel.

Near Anniedelle

The south bank of the river north of Anniedelle and south of Mt. Hope station on what is known as the Curtin Place shows a 15-foot outcrop of soft to semi-hard gray and olive-green Conasauga shale, overlain by 10 to 15 feet of river-terrace sand and gravel.

Morton Bend

At Morton Bend, 2 miles south of Early Station, the north-west bank of the river shows a 300-foot outcrop of fairly soft flaky olive-green Conasauga shale much like that sampled at Turner Bend but containing occasional stringers 1 to 3 inches across of white calcite. A few chert nodules are also showing. The shale appears to be striking nearly east-west and dipping 75°–80° to the north. About 100 yards upstream is an outcrop of hard calcareous shale or argillaceous limestone full of the same white calcite stringers.

Foster Bend

The shallow and more rapid stretches of the river at Foster Bend south of Anniedelle are caused by outcrops of hard gray to black calcareous and carbonaceous shale and impure limestone.

Two miles to the east of Foster Bend along the road between Foster Mills and Livingston are outcrops of fairly soft greenish-drab Conasauga shale more or less interbedded with thin limestone layers.

MRS. P. M. FOSTER PROPERTY

(Map location No. 16.)

The Mrs. P. M. Foster (Rome, Rt. 6) property of about 115 acres is half a mile north of Sixmile Station on the Rome to Anniston line of the Southern Railway and on the Rome to Cave Spring highway.

Semi-hard to hard greenish-drab to brown Conasauga shale is showing for nearly 500 feet in the cuts of the highway. The beds are apparently striking N. 25° E. and dipping about 65° to the east. At the southern end they pitch gently to the south and at the northern end more steeply to the north. The shale at each end of the outcrop is semi-hard and somewhat fissle, but in the middle of the outcrop it is harder, less fissle, and appears to be more siliceous. Laboratory tests are given below on a sample of the shale composed of a 6 foot groove sample from the southern end of the outcrop, a grab sample from the middle, and a 3-foot groove sample from the northern end. The low ridge between the highway and the railroad and probably a part of the slope west of the highway are underlain by this shale.

Laboratory tests on a sample of semi-hard to hard greenish-drab to brown Conasauga shale from the Mrs. P. M. Foster property, half a mile north of Sixmile Station, Floyd County.

Chemical Analysis:

Loss on ignition	6.76
Soda (Na_2O)	1.17
Potash (K_2O)	1.94
Lime (CaO)	.00
Magnesia (MgO)	.13
Alumina (Al_2O_3)	24.92
Ferric oxide (Fe_2O_3)	7.80
Titanium dioxide (TiO_2)	.55
Sulphur trioxide (SO_3)	.59
Phosphorus pentoxide (P_2O_5)	.26
Silica (SiO_2)	55.94
	100.06

Grinding: Fairly easy, brittle.
Ground Color: Light brown.
Slaking: Slow.
Plasticity: Poor and grainy, even after aging a week.
Molding Behavior: Poor. Bars swelled and cracked.
Drying Behavior: Slight warpage.
Water of Plasticity: 20.7 per cent.
Green Modulus of Rupture: 75.1 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.8	6.7	9.7	1879	Light red (2YR-6/7)[b]	Slight
04	[c]	[c]	6.9	[c]	[c]	[c]
02	4.6	6.4	7.2	2383	Medium red (R-YR-5/5)[b]	Some
1	6.8	8.7	4.9	2534	Good red (R-YR-4/4)[b]	Considerable
3	6.4	7.8	1.9	2034	Deep brownish-red (R-YR-3/5)[b]	Bad
5	8.2	10.0	2.4	2934	Deep brownish-red (R-YR-3/4)[b]	Bad.

[a]See graph, Figure 8-D, page 105.
[b]Color notation according to the Munsell system, see page 23.
[c]All the bars at cone 02 broke in handling. Absorption measured on two half bars.

Remarks: The bars at cone 3 showed more or less black-coring. Those at cone 5 showed the beginning of a glassy structure and were somewhat kiln-marked, due to over-firing.

Firing Range: Cone 06–3. Commercial kiln: Cone 06–1.

The above tests indicate that this shale would be satisfactory for building brick and possibly structural tile. The slow slaking and poor molding behavior could probably be overcome by fine grinding, long pugging, the use of hot water for tempering, or the use of certain electrolytes in the tempering water. The relatively low temperatures at which a glassy and vesicular structure develops indicates that this shale might have advantages for the production of light-weight aggregates (see page 41).

CURRY AND PRIMROSE TAPESTRY COMPANY PROPERTIES

Hard shale is showing in the cuts of the road from the Rome-Cave Spring highway to the Primrose Tapestry Company plant on the Rome to Anniston line of the Southern Railway, 4 miles south of Rome. The beds are striking N. 30° E. and dipping 45° southeast. Near the railroad on the Primrose Tapestry Company property the shale is drab-colored and somewhat fissle, but to the west near the highway on the property of J. W. Curry (Rome, Rt. 6) it is thicker-bedded and is almost a sandstone. These beds form a ridge to the south and may belong to the Rome formation.

This shale is probably too hard to be of value for the manufacture of heavy clay products, but possibly it might be suitable for the manufacture of light-weight aggregates.

MRS. FLORA McAFEE JONES PROPERTY

The property of Mrs. Flora McAfee Jones (Rome) is a long narrow property extending for a mile along the Central of Georgia Railway from 2½ to 3½ miles south of Rome between the old Lindale road and the new Rome-Lindale Highway.

The boundary between the Conasauga shale on the west and the Knox dolomite on the east is close to the new Lindale highway. The topmost beds of the Conasauga shale, as shown by outcrops on the highway near the southern end of the property and in a low cut of the railroad near the northern end, are hard gray to drab shale containing more or less thin interbedded chert.

The low ridge west of the railroad is underlain by semi-hard to soft fissle to almost flaky olive-green and greenish-drab Conasauga shale striking N. 20° E. and dipping about 75° to the east. Near the northern end outcrops are showing only on the east slope of the ridge, but on the private road crossing the southern end of the property the outcrop is fully 300 feet across. At this place there are several layers 6 to 8 inches in thickness of sandy red clay, and a 6 inch layer, parallel to the bedding, of a light-colored dense fine-grained siliceous and feldspathic rock which resembles felsite (an igneous rock) but is more likely an arkose, a fine-grained sedimentary rock composed of silica and feldspar. This rock thickens near the middle of the property to a lens 15 feet in thickness, where it has been quarried at one time, but it can be traced only a short distance north of the quarry.

The property should be prospected to determine the extent and character of the shale deposits. The shale seen appears to be similar in character to that on the Graham property described below.

J. M. GRAHAM PROPERTY

(Map location No. 17.)

The property of J. M. Graham (Rome) consists of about 20 acres in Land Lot 324, 23d District, 3d Section, on the west side of the Southern Railway just north of New Rome and 1½ miles south of Rome.

A low knoll or ridge a quarter of a mile in length between the railroad and Silver Creek to the west shows outcrops of semi-hard to hard greenish-drab Conasauga shale weathering into small flat pieces and long splinters. The beds are striking N. 20° E. and are nearly vertical. The laboratory tests on a grab sample of this shale are given below. The top of the ridge is about 30 feet above the railroad and 50 feet above the creek on the western side. The only part of the ridge showing no traces of shale is a strip about 100 feet wide along the railroad.

Laboratory tests on a grab sample of semi-hard to hard greenish-drab Conasauga shale from the J. M. Graham property on the Southern Railway 1½ miles south of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	6.12
Soda (Na_2O)	.90
Potash (K_2O)	2.72
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	26.34
Ferric oxide (Fe_2O_3)	6.45
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	56.32
	99.94

Grinding: Fairly easy, brittle.

Ground Color: Light brownish-gray.

Slaking: Very slow.

Plasticity: Very poor, even after aging a week.

Molding Behavior: Poor. Test bars swelled, cracked, and tore on edges.

Drying Behavior: All somewhat warped.

Water of Plasticity: 24.1 per cent.

Green Modulus of Rupture: 44.3 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 3.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.3	6.7	14.2	726	Dark salmon (3YR-6/8)[b]	Some
04	5.0	8.3	9.8	1588	Light red (1YR-5/5)[b]	Considerable
02	5.0	8.2	10.3	1260	Medium red (2YR-5/6)[b]	Considerable
1	5.5	8.8	9.0	1773	Medium red (1YR-5/5)[b]	Considerable
3	5.9	9.3	5.2	1809	Good red (R-YR-4/4)[b]	Bad
5	7.3	11.2	2.3	2547	Deep brownish-red (R-YR-3/4)[b]	Bad

[a]See graph, Figure 9-A, page 115.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Broken ends of test bars at cone 5 show a vitrified and slightly glassy structure.

Firing Range: Cone 02–3. Commercial kiln: Cone 04–2.

The above tests indicate that this shale would be satisfactory for the manufacture of building brick if the plasticity and molding behavior could be improved. This could probably be done by finer grinding, longer pugging, the use of hot tempering-water, or the use of certain electrolytes in the tempering-water. The comparitively low temperature at which a vesicular and glassy structure would develop indicates that it might have advantages for the manufacture of light-weight aggregates (see page 41).

B. MIFFLIN HOOD COMPANY
ROME PLANT

(Map location No. 18.)

Headquarters: Daisy, Tennessee. B. Mifflin Hood, Pres.
Rome Plant: North Rome. J. K. Keith, Local Supt.

The Rome plant of the B. Mifflin Hood Company was built in 1895 and operated for nearly 20 years by the Rome Brick Company, making common and pressed brick from a mixture of alluvial clay and shale. Soon after its purchase in 1925 by the B. Mifflin Hood Company it was converted to the manufacture of roofing tile. For this purpose a mixture of about six parts of alluvial clay to one part of Conasauga shale are used.

The shale pit is just east of the plant and is about 100 feet in length and 75 feet across, with a face averaging 25 feet in height. The soft brownish-drab Conasauga shale is striking N. 30° E. and is nearly vertical. It is overlain by 5 to 15 feet of overburden consisting of weathered shale and clay and high-terrace silt and gravel. The shale is mined by hand, loaded into mine cars, and transported to the plant by gravity. The laboratory tests are given below on a grab sample of this shale taken from the storage pile at the plant.

Laboratory tests on a grab sample of soft brownish-drab Conasauga shale from the pit of the B. Mifflin Hood Company, North Rome, Floyd County.

Chemical Analysis:

Loss on ignition	5.83
Soda (Na_2O)	1.55
Potash (K_2O)	1.66
Lime (CaO)	.00
Magnesia (MgO)	.14
Alumina (Al_2O_3)	18.65
Ferric oxide (Fe_2O_3)	9.07
Titanium dioxide (TiO_2)	.37
Sulphur trioxide (SO_3)	.52
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	62.20
	99.99

Grinding: Easy.
Ground Color: Brownish-tan.
Slaking: Rapid.
Plasticity: Fair, a little "short".
Molding Behavior: Fair. Column of clay tore some at edges and broke easily.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 27.2 per cent.
Green Modulus of Rupture: 62.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.1 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.0	7.8	15.7	992	Salmon (4YR–6/6)[b]	Slight
04	4.8	7.7	15.7	1122	Salmon (2YR–5/5)[b]	Slight
02	5.9	8.7	12.9	1423	Dark salmon (2YR–6/5)[b]	Some
1	8.8	11.5	8.8	1958	Fair red (R–YR–4/4)[b]	Some
3	9.9	12.9	5.8	2342	Good red (R–YR–4/3)[b]	Considerable
5	10.9	13.8	2.8	2775	Deep chocolate-red (R–YR–3/3)[b]	Considerable.

[a]See graph, Figure 9-B, page 115.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–5. Commercial kiln: Cone 02–4.

The alluvial clay pit is south of the plant on a terrace of the Etowah River, about 10 feet above low-water level. The clay is a plastic blue to brown alluvial clay containing more or less fine sand and some fine mica flakes. After removing about 8 inches of soil as overburden, the clay is mined by pick and shovel to a depth of 6 feet, loaded into mine cars, and hauled up an incline to the plant. The laboratory tests on a grab sample of this alluvial clay from the storage pile at the plant are given below.

Laboratory tests on a grab sample of plastic blue to brown alluvial clay from the pit of the B. Mifflin Hood Company near the Etowah River, North Rome, Floyd County.

Chemical Analysis:

Loss on ignition	7.68
Soda (Na_2O)	1.18
Potash (K_2O)	.78
Lime (CaO)	.10
Magnesia (MgO)	.23
Alumina (Al_2O_3)	19.68
Ferric oxide (Fe_2O_3)	5.50
Titanium dioxide (TiO_2)	.46
Sulphur trioxide (SO_3)	.35
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	63.95
	99.91

Grinding: Easy.
Ground Color: Dark buff.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Excellent.
Drying Behavior: Good, very little warpage.
Water of Plasticity: 26.4 per cent.
Green Modulus of Rupture: 344.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 8.1 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.0	10.1	16.2	1140	Light salmon (YR-7/6)[b]	Very slight
04	2.0	9.9	15.1	1227	Salmon (4YR-6/6)[b]	Slight
02	3.5	11.3	12.7	1260	Dark Salmon (1YR-6/5)[b]	Very slight
1	4.2	12.2	12.4	1346	Light red (2YR-5/5)[b]	Very slight
3	3.0	10.4	12.5	1388	Medium-light red (1YR-5/6)[b]	Slight
5	4.1	11.9	11.2	1385	Medium red (1YR-5/4)[b]	Slight

[a]See graph, Figure 9-C, page 115.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 01–5 and higher.

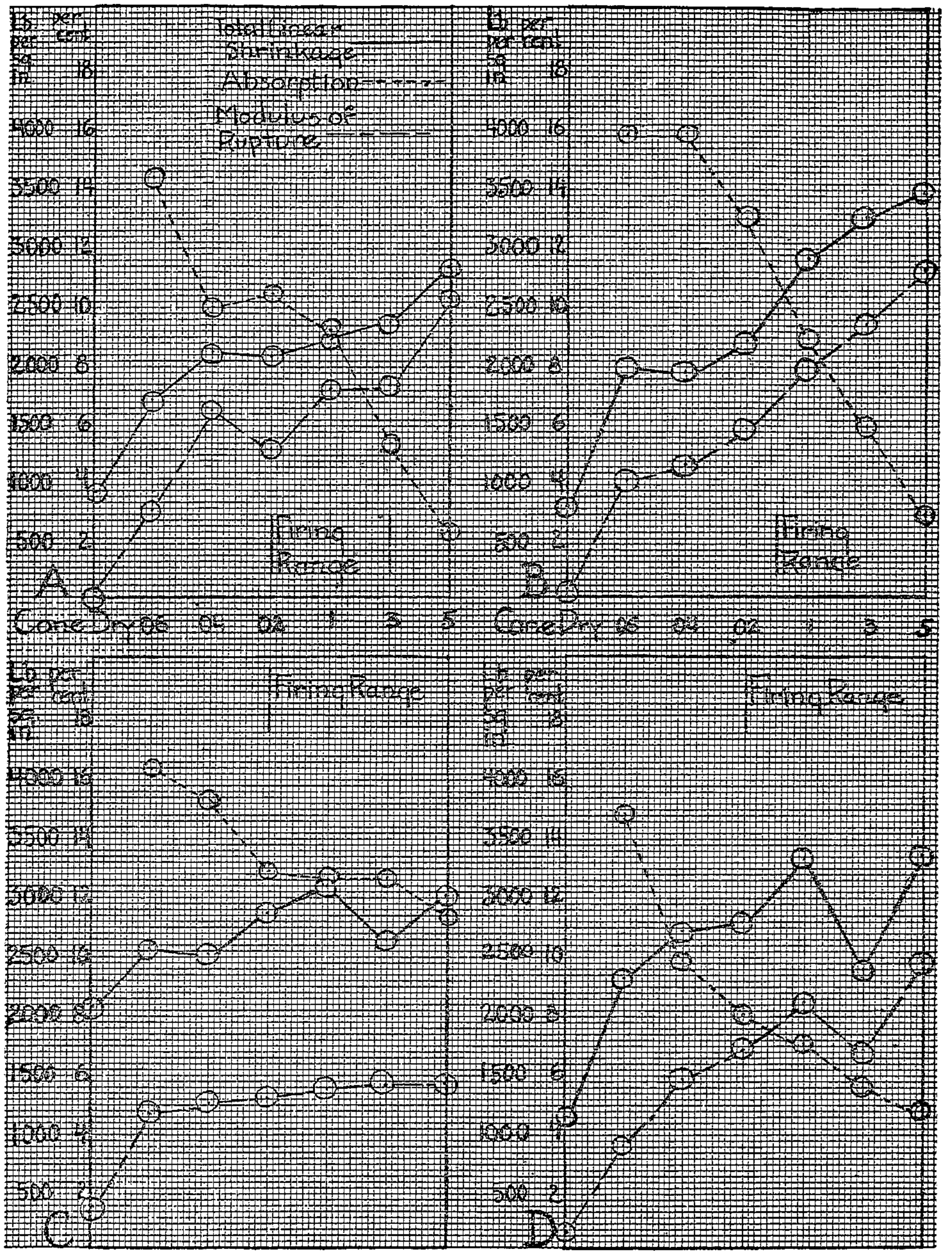


Figure 9. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Conasauga shale from the J. M. Graham property, 1½ miles south of Rome, Floyd County.

B. Conasauga shale from the B. Mifflin Hood Company, North Rome, Floyd County.

C. Alluvial clay from the B. Mifflin Hood Company, North Rome, Floyd County.

D. Conasauga shale from the J. D. Taylor property, 2 miles southwest of Summerville, Chattooga County.

Plant

At the plant the shale and clay from the storage floor are mixed in the proper proportions by shoveling and are fed by a conveyor belt to a dry pan which grinds and further mixes them. From the dry pan the mixture goes to vibrating screens of 12 to 20 mesh, depending on the type of ware, the oversize being returned to the dry pan, the undersize going to a storage bin.

The ground clay from the storage bin is fed to a pugmill where water is added and the clay tempered and pugged. This discharges into a stiff-mud brick machine which forces the clay through dies and extrudes it as a ribbon which, for some varieties, is automatically cut off into roofing tile, or with other varieties, is cut off into slugs which are repressed into tiles. The formed tiles are stacked in cars and dried at 100° F. in a 7 track coal-fired tunnel drier.

The tile are fired to cone 05 to 06 or about 1960° F. to 1980° F. in three 30-foot and three 25-foot round down-draft kilns. Both electrical pyrometers and standard pyrometric cones are used to control the heat.

The capacity of the plant is about 10,000 pieces per day, mostly of shingle tile of the following types:

Machine finish: 6 inches by 15 inches.

"Old Europe" (rough surface and odd colors): 7 inches by 13 inches.

Repressed: 6 inches by 13 inches.

Curved and S-shaped Spanish tile have been made.

WATTERS AND LACY PROPERTIES

The J. T. Watters (Hermitage) property of 160 acres is west of and adjoining the Southern Railway, 1¾ miles west of Hermitage and 6½ miles northeast of Rome, in Land Lot 69, 23d District, 3d Section. An outcrop beside the public road shows very hard dark-red siliceous shale belonging to either the Conasauga or the Rome formations. It is too hard and non-plastic to be of value for the manufacture of heavy clay products, but might be suitable for the manufacture of light-weight aggregates.

Similar shale is showing in Land Lot 52 adjoining on the north and belonging to W. T. Watters (Hermitage).

Hard olive-green to reddish-brown Conasauga shale slightly softer than that described above crops out on the Rome-Calhoun Highway just north of the road to Hermitage and three-quarters of a mile east of the Southern Railway. The land west of the highway is the Mrs. A. E. Watters Estate (in charge of J. T. Watters, Hermitage), and that east of the highway belongs to J. B. Lacy (Rome, Rt. 2).

HOGAN AND PIERCE PROPERTIES

The T. M. Hogan (Rome, Rt. 2) property of about 100 acres is on the road leading north from the Rome-Calhoun Highway to Pinson Station and is east of and adjoining the Southern Railway about a mile south of Pinson Station. The southern boundary of the property is a road leading west to the railroad and then south to Shannon. South of this road is the 20 acre property of J. H. Pierce (Shannon).

Hard greenish-drab siliceous shale is exposed on both sides of the Pinson Station road on the Hogan property, and a low ridge east of the road is underlain by it. Similar but more reddish-colored shale is showing on the Shannon road near Mr. Pierce's house. These shales resemble those sampled on the W. T. Watters property described below, and are probably too hard to be of value for the manufacture of heavy clay products.

W. T. WATTERS PROPERTY

(Map location No. 19.)

The W. T. Watters (Hermitage) property of 115 acres is in Land Lots 256 and 257, 24th Land District, 3d Section, and is west of and adjoining the Southern Railway at Pinson Station, 10 miles northeast of Rome. The property extends north from Pinson Station along the railroad for a quarter of a mile and corners with the National City Bank Property described below.

A low cut just north of the station and the ridge to the west of the railroad show outcrops of hard brownish-red shale weathering into slabs 1 to 2 inches thick, probably belonging to the Conasauga formation. The next knoll or ridge to the northwest shows alternating outcrops of limestone and similar shale striking N. 45° E. and dipping about 65° to the southeast. Another knoll near the northern edge of the property has outcrops of hard brownish-red shale similar to that on the adjoining property of the National City Bank. The laboratory tests on a grab sample of the shale from the outcrops on both ends of the property are given below.

Laboratory tests on a grab sample of hard brownish-red Conasauga shale from the W. T. Watters property at Pinson Station, 10 miles northeast of Rome, Floyd County.

Chemical Analysis:

Loss on ignition	5.85
Soda (Na_2O)	.10
Potash (K_2O)	2.31
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	26.10
Ferric oxide (Fe_2O_3)	9.50
Ferrous oxide (FeO)	.76
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.17
Phosphorus pentoxide (P_2O_5)	.20
Silica (SiO_2)	54.04
	99.93

Grinding: Fairly easy, brittle.
Ground Color: Reddish-brown.
Slaking: Very slow.
Plasticity: Very poor, even after aging a week.
Molding Behavior: Had so little plasticity that the sample was discarded without further tests.

The above tests indicate that this shale, by itself, is not suitable for the manufacture of heavy clay products. It might, however, be suitable for the manufacture of light-weight aggregates.

Adjoining on the north and across the Southern Railway from the National City Bank property described below, is the property of W. J. Biddy (Plainville), underlain by a continuation of the same shale.

NATIONAL CITY BANK PROPERTY

(Map location No. 20.)

A property of about 30 acres belonging to the National City Bank (Rome) is on the east side of the Southern Railway, a quarter of a mile to half a mile north of Pinson Station, in Land Lot 257, 24th District, 3d Section, Floyd County.

A railroad cut exposes 12 to 15 feet of hard reddish-brown to gray Conasauga shale weathering into slabs and breaking into sharp splintery fragments. A few layers are softer but are slightly sandy. The laboratory tests are given on a 12-foot groove sample from this outcrop, together with a few pieces of more weathered shale from a shallow prospect hole near the road.

Laboratory test on a sample of hard gray to brownish-red Conasauga shale from a railroad cut on the National City Bank property, a quarter of a mile north of Pinson Station, Floyd County.

Chemical Analysis:

Loss on ignition	5.32
Soda (Na_2O)	.76
Potash (K_2O)	1.85
Lime (CaO)	.00
Magnesia (MgO)	.20
Alumina (Al_2O_3)	22.05
Ferric oxide (Fe_2O_3)	7.62
Ferrous oxide (FeO)	.00
Manganous oxide (MnO)	.43
Titanium dioxide (TiO_2)	.54
Sulphur trioxide (SO_3)	.12
Phosphorus pentoxide (P_2O_5)	.13
Silica (SiO_2)	60.67
	99.69

Grinding: Fairly easy, brittle.
Ground Color: Reddish-brown.
Slaking: Very slow.
Plasticity: Very poor, even after aging a week.
Molding Behavior: The ground shale had so little plasticity that the sample was discarded without further tests.

The above tests indicate that this shale is not suitable for the manufacture of heavy clay products. In 1928 and 1929 the property was optioned and prospected by parties interested in using the shale for the manufacture of haydite, a light-weight aggregate described on page 41. The shale is said to have been found satisfactory.

CHATTOOGA COUNTY

Chattooga County is north and west of Floyd County, separated from it by Simms and John mountains with a gap between them at Crystal Springs. The Georgia-Alabama state line forms the western boundary, and Walker County adjoins on the north.

The Macon to Chattanooga line of the Central of Georgia Railway enters the county on its southern border at Sprite and passes through a winding gap between Gaylor Ridge, Simms Mountain, and Taylor Ridge into the valley of the Chattooga River near Lyerly. Following the valley northward, the railroad passes through Summerville, the county seat, and Trion, an important mill town.

The Tennessee, Alabama, and Georgia Railroad from Gadsden, Alabama to Chattanooga, Tennessee, enters the county near Menlo and follows the valley between Shinbone Ridge and Lookout Mountain.

The west branch of the Dixie Highway passes north through West Armuchee Valley to Gore, crosses Taylor Ridge through a high wind-gap to Summerville, and follows the Central of Georgia Railway northward through Trion to Walker County. A State highway extends westward from Summerville through Menlo to Cloudland, a summer resort on the brow of Lookout Mountain.

The synclinal valley of West Armuchee Creek in the eastern part of the county is underlain by the Floyd shale and Bangor limestone of Mississippian age, with an isolated outlier, Little Sand Mountain, of the Lookout formation of Pennsylvanian age. The Floyd shale in this valley contains considerable interbedded limestone, but there are areas of clay shale comparatively free from limestone that would probably be of value for the manufacture of heavy clay products if railroad transportation were available. Taylor Ridge, formed by the sandstone beds of the Red Mountain formation of Silurian age, acts as a barrier between West Armuchee Valley and the railroad in Chattooga Valley.

Chattooga River flows in a belt of the Conasauga shale of Cambrian age, and to the west and separated from it by a low ridge of the Knox dolomite, is a narrower belt of the Conasauga formation. Several shale deposits from these belts are described below. Another long narrow outcrop of the Conasauga formation follows the valley of Teloga Creek on the west side of the broad area of Knox dolomite and Chickamauga limestone known as Broomtown Valley. Only one outcrop of shale was noticed by the writer in this area, which may be largely underlain by limestone.

Shales, which are more or less sandy, sandstone, and thin beds of fossiliferous iron ore of the Red Mountain formation are exposed on Dirtseller Mountain, 2½ miles southwest of Lyerly, and all along the

Shinbone Ridge that parallels the foot of Lookout Mountain. The shales on Dirtseller Mountain are too far from the railroad to be of commercial value. The Red Mountain shales observed by the writer in crossing Shinbone Ridge at several places were all too hard or siliceous to be of value for the manufacture of heavy clay products. It is entirely possible, however, that more careful investigation and prospecting might reveal deposits of shale suitable for this purpose.

TAYLOR FARM

The old Taylor Farm (J. D. Taylor, Summerville) of 188 acres is on the north side of the Chattooga River on the Bolling Bridge road, 2½ miles south of Summerville and 1½ miles east of the Central of Georgia Railway.

The cut of the road just north of the bridge exposes soft to semi-hard greenish-brown Conasauga shale full of very thin interbedded layers of hard brownish-drab sandstone, almost a chert at places. These sandstone or chert layers are usually less than an inch in thickness, but probably make up at least a third of the mass of material. The shale itself might be suitable for the manufacture of heavy clay products, but with this amount of siliceous material included, the shale would be very "short" and the green and fired properties would probably be unsatisfactory.

TAYLOR'S DICK DENSON PLACE

(Map location No. 21)

The Dick Denson Place, owned by J. D. Taylor (Summerville) is just west of the Central of Georgia Railway two miles southwest of Summerville on the old road to Berryton and Lyerly.

An outcrop beside the road between the railroad crossing and the small branch exposes soft olive-drab Conasauga shale showing no trace of sandy or cherty layers. The shale is striking N. 20° E. and dipping 75°–80° E. The strike is at only a slight angle to the road, so that although the shale is exposed for about 75 feet along the road, the outcrop represents a stratigraphic thickness of only about 20 feet. The laboratory tests are given below of a grab sample of the shale from several places along the outcrop. Some flakes of shale are showing in the soil of the field between the road and the railroad, several hundred feet to the east.

Laboratory tests on a grab sample of soft olive drab Conasauga shale from J. D. Taylor's Dick Denson place, 2 miles southwest of Summerville, Chattooga County.

Chemical Analysis:

Loss on ignition	7.17
Soda (Na_2O)	1.88
Potash (K_2O)	2.19
Lime (CaO)	trace
Magnesia (MgO)	1.03
Alumina (Al_2O_3)	23.27
Ferric oxide (Fe_2O_3)	6.95
Ferrous oxide (FeO)	.46
Titanium dioxide (TiO_2)	.60
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.40
Silica (SiO_2)	56.11
Total	100.06

Grinding: Easy.
Ground Color: Brownish-drab.
Slaking: Rapid.
Plasticity: Good after aging overnight.
Molding Behavior: Good.
Drying Behavior: Test bars all warped slightly.
Water of Plasticity: 26.3 per cent.
Green Modulus of Rupture: 126.3 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	4.8	9.1	14.7	858	Dark salmon (2YR-6/7)[b]	Slight
04	6.5	10.7	9.7	1426	Light red (R-YR-5/6)[b]	Some
02	6.9	11.0	7.9	1673	Medium red (R-YR-4/4)[b]	Slight
1	9.6	13.2	6.9	2065	Good red (R-YR-4/5)[b]	Some
3	5.2	9.4	5.4	1672	Good chocolate-red (R-YR-4/3)[b]	Bad
5	9.2	13.3	4.6	2408	Good chocolate-red (R-YR-4/3)[b]	Considerable to bad.

[a]See graph, Figure 9-D, page 115.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5. Commercial kiln: Cone 04–4.

The above tests indicate that this clay is suitable for the manufacture of building brick and possibly structural tile, sewer pipe, and roofing tile.

The cut of the road an eighth of a mile south of the outcrop sampled and just south of the house, exposes a little siliceous shale too "short" to be of value for ceramic purposes. This is west of a continuation of the strike of the beds sampled.

The property should be prospected to determine the extent and character of the shale deposit. The land is nearly level and mining pits would not have natural drainage.

NORTH OF SUMMERVILLE

The outcrops in the belt of the Conasauga formation north or northwest of Summerville are nearly all of residual red clay, occasionally quite sandy. The cuts and ditches of the Dixie Highway on a low knoll 1.7 miles northeast of Summerville expose some soft greenish-drab shale containing a little chert at one place. Traces of shale are showing in the field east of the road on the J. P. Henry property. The Central of Georgia Railway is about 500 feet west of the road.

A small outcrop of similar shale is showing in the highway cut 3.6 miles northeast of Summerville, but no shale is showing in other cuts to the north and south.

DADE COUNTY

Dade County, in the extreme northwest corner of Georgia, is bounded on the east by Walker County, on the north by Tennessee, and on the west by Alabama. The county lies wholly within the Lookout Plateau physiographic division. The valley of Lookout Creek separates the plateau into Sand Mountain on the west and Lookout Mountain on the east. Lookout Creek rises a short distance beyond the State line in Alabama and flows northeast to Rising Fawn in an anticlinal valley that is a continuation of the sixty-mile long valley of Willis Creek in Alabama. At Rising Fawn, Lookout Creek turns northwest for three miles across a gentle syncline and then again flows northeast in another anticlinal valley to Tennessee. The stream follows the anticlines or arches of the rocks rather than the synclines or troughs because the hard sandstone beds of the Lookout and Walden formations were protected from erosion during the Cretaceous peneplanation stage (see page 51) in the synclines but were worn through on the anticlines exposing the more easily eroded shales and limestones beneath. Subsequent drainage took the line of least resistance and excavated the valley in these shales and limestones, leaving the surface of Lookout and Sand mountains nearly as level as it was at the end of the Cretaceous age. The relation of the dip of the rocks and the position of the hard beds is shown in Figure 4, page 51, which is a northwest-southeast structural section just south of Rising Fawn. The gap through which Lookout Creek flows from Willis Valley to Lookout Valley is just north of Fox Mountain.

The steep slopes and nearly vertical cliffs of Sand and Lookout mountains have acted as a barrier forcing transportation to the valley between them. A few mountain roads climb to the top of the plateau, but the only one in Georgia with a grade suited to continuous automobile traffic is a privately owned road in Johnson Crook near Rising Fawn. The interstate highway and the Alabama Great Southern Railroad of the Southern Railway System between Chattanooga and Birmingham follow Lookout Creek valley, passing through the settlements of Morganville, New England, Trenton, the county seat, and Rising Fawn, once the site of a busy iron mine and blast furnace.

The center of Lookout Valley is underlain by the limestones of the Chickamauga formation. On either side of the valley and about three-quarters of a mile from the foot of Sand and Lookout mountains are ridges or a series of hills known as Shinbone Ridge and caused by the Fort Payne chert which outcrops near their crest. The slopes facing the valley are underlain by the shales, shaly limestones, and thin seams of red iron ore of the Red Mountain formation. Several deposits of these shales in and south of Johnson Crook are described below. The shales north of Rising Fawn, wherever observed, contain too much interbedded limestone to be of value for the manufacture of heavy clay products.

The lower slopes of Sand and Lookout mountains, and the valleys between them and the Shinbone Ridges, are underlain by the limestones of the Bangor formation. The Pennington shales and the heavy sandstone beds of the Lookout formation underlie the upper slopes, and the Walden sandstone caps the plateau.

B. W. NEWSOM PROPERTY

(Map location No. 22)

The B. W. Newsom (Rising Fawn) property, formerly the Rising Fawn Furnace of the Hurt Estate, consists of more than 2,000 acres in Johnson Crook northeast and east of Rising Fawn. It includes Land Lots, 183, 184, 185, 212, 213, 214, 215, 217-218 (furnace), 219, 220, 249, 250, 251, and 252 in the 11th District, 4th Section; and Land Lots 81 and 82 in the 18th District, 4th Section.

The Rising Fawn iron furnace on Hurricane Creek one mile east of the town of Rising Fawn was in nearly continuous operation from 1874 to 1896 and from 1903 to 1909. The greater part of the iron ore used was mined from open cuts and underground workings in a seam of the Red Mountain formation which averaged 46 inches in thickness exclusive of shale partings. The sides of the old iron ore cuts have now largely slumped and were of little value in exposing the shale of the Red Mountain formation.

The beds of the Red Mountain formation near the old Rising Fawn furnace are striking N. 45° E. and in general are dipping gently to the northwest. At places there are minor folds, contortion of the beds, and small thrust faults.

The beds immediately underlying the iron ore are exposed in the bluff of Hurricane Creek opposite the old furnace on the southern edge of Land Lots 217 and 218 and the northern edge of 251 and 252. About 20 feet of impure argillaceous limestone with frequent thin shaly layers are exposed. The shaly layers are largely gray in color, changing to olive-green towards the top. These beds are said to be underlain by a very sandy iron ore seam from which only a few tons have been mined.

The land south of the bluff rises to a series of hills 75 or more feet above the stream and so situated that over large areas the iron ore was close to and parallel with the surface, and was easily mined. Some of the higher hills are capped with the shales overlying the iron ore and which are exposed in the old workings. These shales, wherever exposed, are semi-hard olive-green and somewhat fissle, and contain numerous thin interbedded layers of limestone which is often fossiliferous and contains enough iron oxide to make them a decided red color.

A short distance east of the furnace the iron ore out-croppings cross Hurricane Creek and extend northeast into Johnson Crook. The shales of the Red Mountain formation overlying the iron ore are not well exposed in this area. There are a number of exposures in the cuts of the new Newsom Highway, but they are all of about the same stratigraphic horizon as the road is about parallel to the strike of the beds. These cuts are about 20 feet above the iron ore and expose from 10 to 40 feet of hard thin-bedded olive-green shale breaking with a hackly fracture. A few thin interbedded layers of sandstone are showing at places. One outcrop shows several small thrust faults. The laboratory tests are given below of a 3-foot groove sample of the shale from one of these road cuts, together with a 5-foot groove sample of similar shale from the face of an old iron ore mine just south of and below the level of the road.

Laboratory tests of an 8-foot groove sample of hard-olive-green shale from the Red Mountain formation on the B. W. Newsom property on the Newsom Highway, half a mile northeast of Rising Fawn Furnace, Dade County.

Chemical Analysis:

Loss on ignition	5.69
Soda (Na_2O)	1.82
Potash (K_2O)	2.03
Lime (CaO)	.00
Magnesia (MgO)	.04
Alumina (Al_2O_3)	21.72
Ferric oxide (Fe_2O_3)	8.08
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_3)	trace
Silica (SiO_2)	59.69
Total	99.98

Grinding: Hard, tough.
Ground Color: Brownish-gray.
Slaking: Very slow.
Plasticity: Poor. Weak and grainy, even after aging 2 days.
Molding Behavior: Very poor. Column of clay swelled, cracked and tore at edges in going through the die.
Drying Behavior: All test bars slightly warped.
Water of Plasticity: 18.5 per cent.
Green Modulus of Rupture: 111.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.1	8.0	9.0	1264	Light red (1YR-5/7)[b]	Slight
04	3.9	6.8	8.0	1666	Medium red (R-YR-4/5)[b]	Some
02	3.9	7.0	6.8	1672	Fair red (9R-4/4)[b]	Slight
1	7.1	10.1	4.6	2246	Good red (R-YR-4/4)[b]	Slight
3	0.7	4.0	4.1	1536	Deep red (R-YR-3/4)[b]	Bad
5	4.0	7.3	2.8	2088	Deep chocolate red (R-YR-3/3)[b]	Bad

[a]See graph, Figure 10-A, page 131.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cone 3 had a pimply surface, were kiln-marked, were all more or less black-cored, and showed the beginnings of a glassy structure. Those fired to cone 5 had a pimply surface, were badly kiln-marked, and had a glassy structure.

Firing Range: Cone 06–2. Commercial kiln: Cone 07–1.

The shales nearer the top of the Red Mountain formation are exposed in the cut of an old road and in the drain to the hollow west of the road, an eighth of a mile north of the old furnace. The lowest bed exposed is an impure limestone or calcareous shale, but the shales above are apparently free from lime and slightly softer than those just described. The laboratory tests are given below on a 10-foot groove sample of these olive-green to brownish and reddish-drab shales.

Laboratory tests on a 10-foot groove sample of semi-hard to hard olive-green to brownish-drab shale from near the top of the Red Mountain formation on the B. W. Newsom property, an eighth of a mile north of Rising Fawn Furnace, Dade County.

Chemical Analysis:

Loss on ignition	4.23
Soda (Na_2O)	1.44
Potash (K_2O)	1.92
Lime (CaO)	.00
Magnesia (MgO)	.08
Alumina (Al_2O_3)	19.38
Ferric oxide (Fe_2O_3)	7.13
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.09
Silica (SiO_2)	64.77
Total	99.95

Grinding: Fairly easy, brittle.
Ground Color: Grayish-drab.
Slaking: Slow.
Plasticity: Poor at first, better after aging 4 days.
Molding Behavior: Fair. Tendency for column of clay to tear at edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 17.1 per cent.
Green Modulus of Rupture: 109.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.8 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.4	5.0	11.5	1176	Light red (1YR-5/6)[b]	Slight
04	4.1	6.8	9.0	1690	Medium red (R-YR-5/6)[b]	Slight
02	4.6	7.3	6.8	2322	Fair red (R-YR-4/5)[b]	Slight
1	6.3	8.9	5.4	2417	Good red (R-YR-4/4)[b]	Some
3	2.7	5.4	3.2	2377	Deep red (R-YR-3/5)[b]	Considerable
5	3.6	6.5	1.7	2828	Deep chocolate red (R-YR-3/4)[b]	Considerable

[a]See graph, Figure 10-B, page 131.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cones 06 to 1 show a little efflorescence or scum on the surfaces that were uppermost in the kiln. The test bars fired to cones 3 and 5 show none of this scum, but they have a somewhat pimply surface and their broken ends show the beginnings of a glassy structure.

Firing Range: Cone 04–2. Commercial kiln: Cone 05-1.

The above tests on these two samples show that these shales are suitable, if properly handled, for the manufacture of building brick and possibly structural tile. Their tendency to slow slaking and poor plasticity could probably be largely overcome by fine grinding, long pugging, the use of hot tempering water, or the addition of certain electrolytes to the tempering water.

A large part of the Red Mountain shales on this property are undoubtedly calcareous. Yet, because of low angles of dip and local folding, the non-calcareous shales may underlie a large area. Careful prospecting and a constant check for the presence of lime will be necessary.

The site of the old furnace would make an excellent plant site. Sufficient water could be obtained from Hurricane Creek. The spur track from the furnace to Rising Fawn has been maintained.

C. E. COPPINGER PROPERTY

(Map location No. 23)

The C. E. Coppinger (Wildwood, Rt. 1) property, known as the Old Amous Place, is at the foot of Lookout Mountain about 3 miles south of Rising Fawn and three-quarters of a mile east of the Alabama Great Southern Railroad and the junction of the roads from Johnson Crook and Rising Fawn to Sulphur Springs Station. The property consists of 40 acres in Land Lot 1, 12th District, 4th Section, Dade County.

A wet-weather branch from the slope of Lookout Mountain has interrupted the low ridge that parallels the foot of the mountain, and has exposed the following section:

Geologic section on the C. E. Coppinger property; 3 miles south of Rising Fawn, Dade County.

	Thickness in feet
Mississippian:	
Fort Payne chert:	
14. White to cream-colored tripoli, full of nodules and thin layers of chert. Beds vary in dip	36+
13. Covered	50
12. Massive-bedded chert	48
Mississippian or Devonian:	
Chattanooga shale:	
11. Soft, somewhat sandy gray to blue shale	4
10. Hard fissle black shale	15

Silurian:

Red Mountain formation:

9.	Steel-blue, greenish-drab, and reddish-brown shale with numerous interbedded 1-inch layers of chert or sandstone. Soft at top, thinner bedded and somewhat harder at bottom	54
8.	Hard gray calcareous shale and thin beds of argillaceous limestone	12
7.	Hard gray somewhat sandy shale with some harder irregular layers of sandstone	12
6.	Soft to semi-hard brown shale and sandy clay	15
5.	Soft to semi-hard brown to drab shale, breaking with a hackly fracture	20
4.	Covered	10
3.	Thin-bedded hard to semi-hard olive-green shale weathering into thin flat pieces	45
2.	Covered. Appears to be the place where iron ore was mined	2
1.	Soft to semi-hard reddish to greenish-drab shale, not very fissle	70+
		393

The laboratory tests are given below on a grab sample of shale from beds 1, 3, and 5 of the section above. These beds are underlying the west slope of the low ridge.

Laboratory tests on a sample of soft brown and drab and semi-hard olive-green shale from the Red Mountain formation on the C. E. Coppinger property, 3 miles south of Rising Fawn, Dade County.

Chemical Analysis:

Loss on ignition	5.69
Soda (Na_2O)	1.82
Potash (K_2O)	2.03
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	16.57
Ferric oxide (Fe_2O_3)	5.14
Titanium dioxide (TiO_2)	1.82
Sulphur trioxide (SO_3)	.03
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	67.12
Total	100.33

Grinding: Easy.
Ground Color: Brown.
Slaking: Very slow.
Plasticity: Poor, even after aging a week.
Molding Behavior: Rather poor. Column of clay tears on edges.
Drying Behavior: Test bars all somewhat warped.
Water of Plasticity: 22.8 per cent.
Green Modulus of Rupture: 85.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	3.1	5.8	14.5	752	Light red (3YR-6/7)[b]	Slight
04	3.9	6.2	12.2	1016	Medium red (R-YR-5/6)[b]	Slight
02	5.8	8.0	10.6	1418	Fair red (R-YR-5/5)[b]	Some
1	7.0	9.1	7.6	2102	Good red (R-YR-4/5)[b]	Slight
3	5.7	8.0	5.8	1505	Deep red (R-YR-4/4)[b]	Considerable
5	8.2	10.7	3.6	2881	Deep red (R-YR-4/3)[b]	Considerable

[a]See graph, Figure 10-C, page 131.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Test bars fired to cone 3 were black-cored slightly, those fired to cone 5 showed the beginning of a glassy structure in the broken ends and had a pimply surface.

Firing Range: Cone 04–3. Commercial kiln. Cone 05–2.

These tests indicate that this shale is suitable, if properly handled, for the manufacture of building brick. Its slow slaking, lack of plasticity, and corresponding low green strength could probably be improved by fine grinding, long pugging, the use of hot tempering water, and the use of certain electrolytes in the tempering water.

The property should be prospected to determine the extent and characteristics of the shale. Some of the higher beds not included in this sample could possibly be used to advantage. The pits would have natural drainage. The best plant site would be west of this property close to the railroad and Lookout Creek.

P. G. BIBLE PROPERTY

The property of P. G. Bible (Rising Fawn) adjoins and is south of the Coppinger property described above, on the east side of Lookout Creek, about 3 miles south of Rising Fawn, 2 miles north of Sulphur Springs Station, and half a mile east of the Alabama Great Southern Railroad of the Southern Railway System.

This property contains a continuation of the ridge of which a geologic section is given above, and the shale deposits are probably very similar. The iron ore, said to be about 25 inches in thickness, outcrops about 50 feet east of the creek bluff. Semi-hard to hard green fissle shale above the iron ore shows up at several places on the banks of a wet-weather branch or drain. Still further to the east and above this, the shale contains some thin layers of sandstone. The 50 or more feet below the Chattanooga shale are covered. The property should be prospected to determine the extent and character of the shale deposits.

G. W. BIBLE PROPERTY

The property of G. W. Bible (Rising Fawn, Rt. 2), known as the "Squire Bible Place", is south of and adjoining the P. G. Bible property described above, on the east side of Lookout Creek in Land Lot 117, 18th District, 4th Section, of Dade County. It is about 1½ miles north of Sulphur Springs Station and is a quarter to half a mile east of the Alabama Great Southern Railway.

The ridge underlain by the shales and iron ore of the Red Mountain formation on the P. G. Bible property described above extends southward across this property. Iron ore has been mined about 50 feet west of Lookout Creek, and the old workings expose some fissle olive-green shale above and below the iron ore. The bluff of the creek shows about 40 feet of alternate layers of shale and fairly heavy-bedded sandstone, probably near the base of the Red Mountain formation. The slope of the ridge from the iron ore east to the Chattanooga black shale near the top of the ridge (a horizontal distance of about 300 feet) is mostly covered, a few scattered outcrops showing much-weathered drab to olive-green shale. This slope should be prospected to determine the character and extent of the shale. Mining would be simple and the pits would have natural drainage.

T. B. BLAKE PROPERTY

(Map location No. 24)

The T. B. Blake (Sulphur Springs) property is on the east side of the Alabama Great Southern Railroad, half a mile north of Sulphur Springs Station in Land Lot 119, 18th District, 4th Section, of Dade County.

The following geologic section shows the beds from the Chickamauga limestone to the Chattanooga shale as shown by outcrops along the public road that crosses the Alabama Great Southern Railroad and Lookout Creek and extends east and northeast up Lookout Mountain. The thickness of the beds was measured by pacing, and is therefore only approximate. The beds are striking N. 35° E. and dipping about 50° SE.

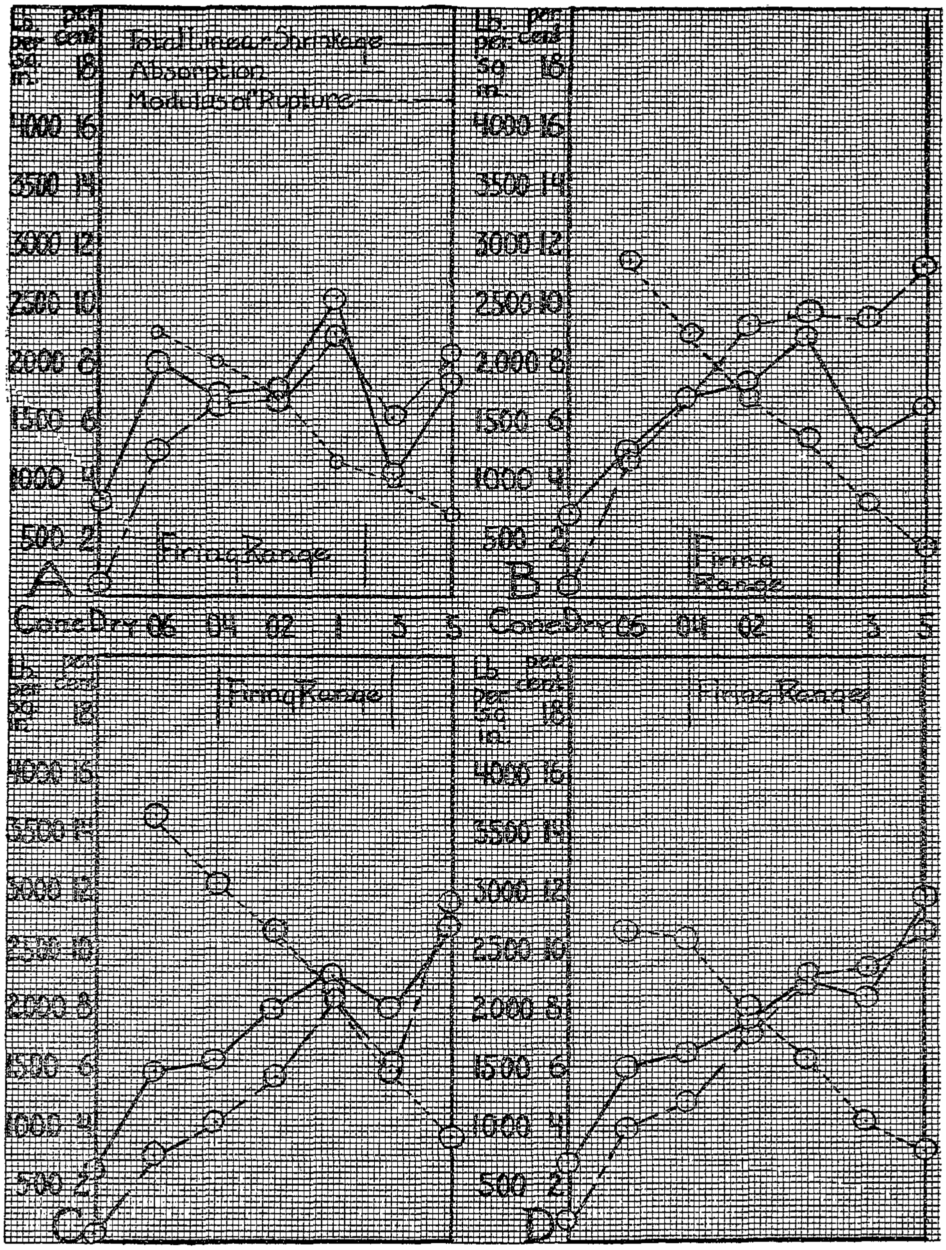


Figure 10. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Red Mountain shale from the Newsom Highway on the B. W. Newsom property, Rising Fawn, Dade County.

B. Red Mountain shale from north of Rising Fawn Furnace, B. W. Newsom property, Rising Fawn, Dade County.

C. Red Mountain shale from the C. E. Coppinger property, 3 miles south of Rising Fawn, Dade County.

D. Red Mountain shale from the T. B. Blake property, Sulphur Springs Station, Dade County.

Geologic Section along road from Sulphur Springs east to Lookout Mountain, half a mile north of Sulphur Springs Station, Dade County.

	Thickness in feet
Mississippian or Devonian:	
Chattanooga shale:	
10. Fissle black shale	15
Silurian:	
Red Mountain formation:	
9. Covered	10
8. Semi-hard to hard olive-green shale containing a few thin beds of sandstone	40
7. Covered	75
6. Semi-hard to hard olive-green shale, practically free of sandstone	75
5. Red fossiliferous iron ore, has been mined	2½
4. Hard to semi-hard olive green shale, nearly free of sandstone at the base, but with numerous and fairly heavy-bedded sandstone and sandy limestone layers toward the top	140
3. Lower or "sandy" iron ore seam, said to be too siliceous and calcareous to be mined	5
2. Covered, includes Lookout Creek	50
Ordovician:	
Chickamauga limestone:	
1. Massive gray and dove-colored limestone, top beds exposed just east of railroad	+
	412½+

The laboratory tests are given below of a grab sample collected at intervals along the outcrops of beds (6) and (8) above. Some of these beds are exposed south of the road on the bluff where Lookout Creek swings to the east.

Laboratory tests of semi-hard to hard greenish-drab Red Mountain shale from above the iron ore on the T. B. Blake property, half a mile north of Sulphur Springs Station, Dade County.

Chemical Analysis:

Loss on ignition	4.47
Soda (Na_2O)	2.53
Potash (K_2O)	4.02
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	18.92
Ferric oxide (Fe_2O_3)	5.85
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	63.06
Total	99.95

Grinding: Fairly easy.
Ground Color: Brownish-gray.

Slaking: Slow.
Plasticity: Poor, even after aging a week.
Molding Behavior: Rather poor. Tendency of clay column to tear at edges.
Drying Behavior: All test bars somewhat warped.
Water of Plasticity: 19.8 per cent.
Green Modulus of Rupture: 100.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.6	6.0	10.7	996	Light red (2YR-6/7)[b]	Some
04	4.1	6.5	10.4	1209	Medium red (R-YR-5/6)[b]	Some
02	5.0	7.6	8.0	1807	Fair red (R-YR-5/5)[b]	Some
1	6.2	8.9	6.3	2248	Good red (R-YR-4/5)[b]	Some
3	5.7	8.4	4.1	2331	Deep red (R-YR-4/4)[b]	Considerable
5	7.2	9.8	3.1	2652	Deep chocolate red (R-YR-4/4)[b]	Considerable

[a]See graph, Figure 10-D, page 131.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 3 had a pimply surface and were slightly black-cored. Those fired to cone 5 were slightly kiln-marked and showed the beginnings of a glassy structure on their broken ends.

Firing Range: Cone 04–3. Commercial kiln: Cone 05–2.

The above tests indicate that this shale is suitable, if properly handled, for the manufacture of building brick. The slow slaking and lack of plasticity could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

The property should be prospected to determine the extent and the character of the shale. It is possible that some of the shale below the iron ore is suitable for the manufacture of heavy clay products. In prospecting, careful watch must be kept for the presence of lime.

TATUM AND BLAKE PROPERTIES

The following geologic section is probably representative of the beds of the Red Mountain formation and the overlying beds on the west side of the valley south of Rising Fawn. The section was measured along a private road west of the Chattanooga to Birmingham highway at the junction with the road to Sulphur Springs Station two miles south of Rising Fawn and one mile west of the Alabama Great Southern Railroad of Cloverdale Station. The land south of the private road is owned by Jack Tatum and that north of the road by T. B. Blake (Sulphur Springs). The beds are striking N. 30° E. and are mostly dipping about 50° to the northwest.

Geologic section west of Chattanooga-Birmingham Highway, 2 miles south of Rising Fawn, Dade County.

	Thickness in feet
Mississippian:	
Bangor limestone:	
18. Massive gray to blue crystalline limestone	+
17. Covered	100+
Fort Payne chert:	
16. Fairly thin-bedded chert with 6 inch layer at base. Sooty, black material in cracks and joint planes for 4 feet above basal layer	21
15. Red clay with a few black streaks	3
14. Soft black clay	2½
13. Mostly brown and red clay, grading into alternate layers of sandy brown shale and chert at bottom. Some of chert is a breccia cemented by brown and black iron ore	36
Mississippian or Devonian:	
Chattanooga shale:	
12. Light bluish-gray shale containing fine sand	3
11. Massive fissle black shale	23
Silurian:	
Red Mountain formation:	
10. Covered and red clay. Near top is outcrop of gray plastic clay	60
9. Fairly fissle hard olive-green to drab shale containing a few thin layers of sandstone	21
8. Covered	20
7. Fissle hard to semi-hard olive-green shale	81
6. Red fossiliferous iron ore, has been mined	3+
5. Semi-hard to hard green to drab shale with frequent thin beds of sandstone. Shale gets softer and sandy towards base	200+
4. Soft red ferrugineous sandstone, the lower or "sandy" iron ore seam	6
3. Alternate layers of sandy shale and red clay, gradually getting flatter then dipping the other way 25 feet west of the highway	60+
Chattanooga-Birmingham Highway.	
2. Red clay with a few beds of sandy shale partly covered and structure uncertain	100+
Ordovician:	
Chickamauga limestone:	
1. Massive limestone	+
	738½+

The shales of beds (5), (7), and (9) should be prospected.

About 40 feet of hard olive-green shale, probably from above the iron ore and corresponding to bed (7) of the above section, is showing in the bank of a small branch on the Neuman property about a mile south of this section and half a mile west of the highway.

HAWKINS AND HALE PROPERTIES

The R. L. Hawkins (Rising Fawn, Rt. 2) property occupies the south end and the Graham Hale (Rising Fawn) property the north end of a ridge south of Rising Fawn between Lookout Creek on the west and the Alabama Great Southern Railroad on the east.

The steep bluff on the south end of the ridge above Lookout Creek, one mile south of Rising Fawn and just east of the Birmingham-Chattanooga Highway shows the following geologic section:

Geologic Section on the R. L. Hawkins property, 1 mile south of Rising Fawn, Dade County.

	Thickness in feet
Mississippian:	
Fort Payne chert:	
9. Hard gray shale	+
8. Hard white finely-divided silica or tripoli with thin layers of chert	5
7. Hard fissle gray shale	10
Mississippian or Devonian:	
Chattanooga shale:	
6. Fissle black shale	15
Silurian:	
Red Mountain formation:	
5. Hard, slightly-fissle reddish-brown shale and a few layers of fossiliferous limestone	25
4. Semi-hard to hard fissle olive-green shale with a few layers of sandstone	100+
3. Red iron ore that has been mined	3½
2. Mostly covered but a few outcrops of shale and sandstone	100+
1. Heavy beds of sandstone	10+
	268½+

The beds are striking N. 20° E. and dipping about 25° to the northwest. The shale of bed (4) is said to underlie the east slope of the ridge all the way to the railroad, half a mile to the north, and should be prospected.

The cuts along the railroad on the Graham Hale property show only the shale below the iron ore. The north end shows 25 to 30 feet of hard to semi-hard fissle olive-green shale, underlain by layers of shaly limestone and calcareous shale, and then alternate layers of shale and sandstone.

LOOKOUT VALLEY

The shales of the Red Mountain formation were examined at a number of places where exposed in the Shinbone Ridges on both sides of Lookout Valley from Pudding Ridge on the Alabama line past Trenton, New England, Morganville, and Wildwood to the Tennessee line 18 miles to the northeast. In every case thin interbedded layers of limestone are of such frequent occurrence that the shales are unfit for the manufacture of heavy clay products.

The most complete exposure is in the cuts of a new road from Morganville west across the ridge to Sligo Valley at the foot of Sand Mountain. The geologic section exposed is given below:

Geologic Section along road from Morganville to Sligo Valley on the east slope of the Shinbone Ridge, Dade County.

	Thickness in feet
Silurian:	
Red Mountain formation:	
4. Semi-hard to hard flaky olive-green shale with thin interbedded limestone layers about every 5 feet	50+
3. Alternate beds up to 1 foot in thickness of dark-blue to reddish-brown crystalline limestone and drab to olive-green shale	30+
2. Brown sandy shale and clay with a few layers of flaky greenish-drab shale	40+
Ordovician:	
Chickamauga limestone:	
1. Massive limestone	+
	120+

The shales above the iron ore observed at other outcrops in the valley are very similar to bed (4) above.

WALKER COUNTY

Walker County, which is east of Dade and north of Chattooga counties, includes portions of the Armuchee Ridges and Chickamauga Valley divisions of the Appalachian Valley, and the east edge of the Lookout Plateau (see Figure 3, page 49).

The Macon to Chattanooga line of the Central of Georgia Railway and the West Branch of the Dixie Highway follow the Chattooga-Chickamauga Valley, passing through the county seat, LaFayette, through Chickamauga, Chickamauga Park which is the scene of the famous battle, and Rossville, on the Tennessee line. A branch of the Central of Georgia Railway extends from Chickamauga to the coal mines on top of Lookout Mountain at Durham. The Tennessee, Alabama and Georgia Railroad between Gadsden and Chattanooga follows the base of Pigeon Mountain, crosses to McLamore Cove at Estelle, and follows the base of Lookout Mountain from Cassandra to Chattanooga.

The southeastern part of the county is crossed by the Armuchee Ridges, which here are composed of Taylor Ridge on the west, Horn and Mill Creek mountains on the east, with Dick Ridge between them separating the East and West Armuchee valleys. These ridges are formed by resistant sandstone beds of the Red Mountain formation, which here contains no shale suitable for ceramic purposes. East Armuchee Valley is underlain by shales of the Rome and Conasauga formations, the Knox dolomite, and the Chickamauga limestone. West Armuchee Valley is underlain by the Floyd shale. The shales of the Conasauga and Floyd formations may at places in these valleys be suitable for the manufacture of heavy clay products, but are too isolated to be of commercial value.

The broad Chattooga-Chickamauga Valley is underlain by narrow to broad northeast-southwest bands of the Knox dolomite and the Chickamauga limestone, and by one belt of the Conasauga formation passing through LaFayette. This belt of the Conasauga formation is composed of argillaceous limestones with some calcareous shales and is largely valley-forming. The writer observed no outcrops of shale in it that appeared to be suited for the manufacture of heavy clay products. The more cherty layers of the Knox dolomite form long ridges such as the famous Missionary Ridge that extends from Chattanooga southwestward into Walker County.

The western boundary of the county is on top of Lookout Mountain, passing close to the west brow at the northern end and the east brow at the southern end. Near the southwest corner of the county a spur of the Lookout Plateau, known as Pigeon Mountain, extends northeastward into the Valley. It is flat-topped for about 9 miles from the main plateau, and then continues as an irregular ridge and a series of foothills for another 9 miles. Figure 4, page 51, shows the synclinal structure of Lookout and Pigeon mountains and the anticlinal structure of McLamore Cove between them. As was the case in Lookout Valley in Dade County, a series of comparatively low ridges, generally known as Shinbone Ridge, parallel the foot of Lookout and Pigeon Mountains at an average distance of half a mile from them. Shinbone Ridge is caused by the relatively hard and resistant chert beds of the Fort Payne chert, which usually outcrops near its crest. The beds are always dipping gently towards the mountain. The Red Mountain formation underlies the slope of the ridge away from the mountain; that is, the east slope of the ridge parallel to the foot of Lookout Mountain and on the east side of Pigeon Mountain, and the west slope of the ridge on the west side of Pigeon Mountain. The Red Mountain formation is also exposed by faulting in a V-shaped area that extends some 5 miles southward from the Tennessee line, the eastern side of which forms the west slope of Missionary Ridge for some distance.

The Red Mountain formation is composed largely of fissle olive-green clay shales, with some interbedded sandstone and a few calcareous beds. Near the middle are one or more thin seams of red iron ore that have been mined at a number of places. The lower part of the formation below the iron ore grades into brown and yellow residual clay, often somewhat sandy, containing only scattered layers and flakes of shale. A number of deposits of shale suited for the manufacture of heavy clay products are described below. They are generally slow slaking and at first have rather poor plasticity, but if properly handled have excellent fired properties. The best results could probably be obtained in most cases by a mixture of the shale from the middle and upper parts of the formation and some of the plastic residual clay from the lower part of the formation.

The Bangor limestone occupies the lower slopes of Pigeon and Lookout Mountains and the valley between their base and the Shinbone Ridge. The Lookout sandstone forms the upper slope and the cliffs at the brow of the mountains, and the Walden sandstone underlies their nearly flat tops.

MCWHORTER PROPERTY

(Map location No. 25)

The property of Misses Carrie and Julia McWhorter (LaFayette, Rt. 5) consists of 80 acres, mostly on Shinbone Ridge at the foot of Pigeon Mountain, an eighth of a mile west of Bronco Station on the Tennessee, Alabama and Georgia Railroad.

The cuts of the Bronco to Campbell Gulf road show outcrops of soft to semi-hard greenish-drab shale from the Red Mountain formation, probably above the iron ore. The beds are striking N. 20° E. and dipping about 70° W. The road at this place makes only a slight angle with the strike of the beds, so that the shale exposed probably represents a stratigraphic thickness of not more than 20 feet. The laboratory tests are given below on a grab sample of the shale from several places along the outcrop.

Laboratory tests on a sample of soft to semi-hard Red Mountain shale from the Misses McWhorter property on Shinbone Ridge at Bronco Station, Walker County.

Chemical Analysis:

Loss on ignition	5.61
Soda (Na_2O)	.67
Potash (K_2O)	.97
Lime (CaO)	.00
Magnesia (MgO)	.00
Alumina (Al_2O_3)	22.45
Ferric oxide (Fe_2O_3)	7.01
Titanium dioxide (TiO_2)	.55
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.00
Silica (SiO_2)	63.72
Total	100.98

Grinding: Easy.
Ground Color: Light brown.
Slaking: A little slow.
Plasticity: Grainy at first, better after aging overnight.
Molding Behavior: Fairly good. Slight tendency for column of clay to tear at edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 22.0 per cent.
Green Modulus of Rupture: 95.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.8 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.4	5.9	14.8	954	Salmon (2YR-6/7)[b]	Slight
04	4.0	6.9	12.9	1175	Dark salmon (R-YR-5/7)[b]	Slight
02	5.6	8.5	10.1	1548	Fair red (R-YR-5/5)[b]	Some
1	6.7	10.2	7.7	2200	Good red (R-YR-5/4)[b]	Slight
3	7.7	10.1	4.6	2327	Good red (R-YR-4/5)[b]	Some
5	8.1	10.2	4.8	2664	Deep red (R-YR-4/3)[b]	Some

[a]See graph, Figure 11-A, page 147.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cones 02 and 3 were slightly black-cored. Those fired to cone 5 showed the beginnings of a glassy structure on the broken ends.

Firing Range: Cone 02–5. Commercial kiln: Cone 03–3.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile. It is impossible to tell without prospecting whether or not the sample is representative of any sizable deposit. The deposits would have natural drainage and are situated close to and above the level of a flat plant site on the railroad. Water could be obtained from a creek a quarter of a mile to the south or from Duck Creek east of the railroad.

WATSON PROPERTY

MARSH MINING COMPANY

The Watson property, surface rights owned by R. P. Watson (LaFayette), mineral rights owned by the Marsh Mining Company (c/o Mrs. Emma Marsh, Chattanooga, Tenn.) is on the Blue Bird Gap road at Shinbone Ridge, two miles west of LaFayette and seven-eighths of a mile east of the Tennessee, Alabama and Georgia Railroad. It is in Land Lots 41 and 68, 7th District, 4th Section, Walker County.

The cuts along the road where it crosses Shinbone Ridge expose rocks of the Red Mountain formation as shown in the following section by Maynard[1], beginning where the road crosses the grade of an old spur track from the Tennessee, Alabama and Georgia Railroad:

Geologic Section along Blue Bird Gap Road at Shinbone Ridge, 2 miles west of LaFayette, Walker County.

Unit No.	Description of Units	Horizontal distance feet	Thickness feet
20	Concealed	400	
19	Olive-green shales with many beds of green and some soft brown sandstone	70	30.6
18	Yellowish-green and red argillaceous shales with some thin bedded sandstones; light-brown fossiliferous sandstone at the bottom; *pentamerous* sp. abundant	170	43.8
17	Concealed	370	115.4
16	Shales, largely concealed	40	12.7
15	Brown sandstone and arenaceous shale	40	10.9
14	Shallow syncline of sandstone	60	3.5
13	Yellowish-green shales, largely concealed	300	7.9
12	Olive-green and yellowish-green shale with some arenaceous splintery shale	200	91.2
11	Concealed	210	147.8
10	Shales, largely concealed	80	47.2
9	Olive-green and yellowish green shale	125	70.2
8	Yellowish-green shale with some flaggy sandstones. Iron ore bed 16 inches thick at top	50	49.3
7	Yellowish-green shales with some flaggy sandstones	70	56.7
6	Concealed	230	179.9
5	Yellowish green shale and thin bedded flaggy sandstone. Shale somewhat red and brown on the weathered surface	70	68.2
4	Yellowish-green fissile somewhat arenaceous shale	100	72
3	Concealed	250	93.5
2	Arenaceous yellowish-green and olive-green shale	50	39.3
1	Yellowish-green and olive-green arenaceous somewhat hackly shale	100	97.8
	Rockwood-Chickamauga contract		

The writer is of the opinion that, of the shales exposed, the best for the manufacture of heavy clay products would be units (1) and (4) on the east slope of the ridge about seven-eighths of a mile from the railroad. The shales would probably be slow slaking and would require

[1]Maynard, T. P., Limestones and cement materials of North Georgia; Georgia Geol. Survey Bull. 27, pp. 232–233, 1912.

fine grinding and long pugging. The shales of unit (9), largely concealed when visited by the writer, should also be prospected.

SOUTHERN STATES COAL AND IRON COMPANY
ESTELLE HOLDINGS

(Map location No. 26)

The Southern States Coal and Iron Company (F. K. Rosmond, Sec., Chattanooga, Tenn.) owns the mineral rights over a large area on the west side of Pigeon Mountain at Estelle Station on the Tennessee, Alabama and Georgia Railroad. The red fossiliferous iron ores have been extensively mined at various times for a mile north of the railroad and for 3 miles south of the railroad as far as the "Pocket", a nearly enclosed valley 1½ miles south of Blue Bird Gap.

The shales and the iron ore of the Red Mountain formation are underlying a series of irregular ridges, sometimes attaining an elevation of 300 feet above the general stream level, parallel to the foot of Pigeon Mountain. Some of the ridges are connected with the main slope of the mountain by narrow saddles, through which tunnels had to be cut for the tram line used during the iron ore mining. The beds are striking about N. 40° E. and dipping gently (5° to 15°) to the southeast. Frequent hollows at right angles to the strike of the beds caused an extensive outcrop of the iron ore, which was mined by both open cut and underground methods. The mines have been idle for about 10 years, and the faces of the pits have slumped and their surfaces grown over until it is often difficult to distinguish them from overburden dumps.

The cuts of the Tennessee, Alabama and Georgia Railroad in Land Lots 252, 254, 255, 256 and 285, 8th District, 4th Section, expose the following geologic section from the top of the Chickamauga limestone, 500 yards west of Estelle Station, to the Chattanooga shale at the mouth of the tunnel, a mile and a quarter to the east.

Geologic section along the Tennessee, Alabama and Georgia Railroad at Estelle, Walker County.

	Thickness	
	Feet	Inches
Mississippian or Devonian:		
Chattanooga shale:		
29. Massive fissle black shale, over tunnel mouth. Said to be 30 feet thick	10+	
28. Hard massive dark-brown and black sandstone, varying rapidly in thickness	3+	
27. Crumpled black shale with fragments showing slickensided surfaces, thickest where bed above is thinest	0	0 to 6
26. Very hard dark-green shale breaking with a hackly fracture and weathering on the surface to a sticky clay	5	
Silurian:		
Red Mountain formation:		
25. Hard gray shale	4	
24. Covered. Valley near mouth of tunnel	20+	
23. Soft sandy brown and drab shale and thin layers of brown sandstone	25	

		Feet	Inches
22.	Covered. Big or east trestle	30	
21.	Solid, massive brown sandstone	2	
20.	Alternate layers of sandy drab shale and brown sandstone, averaging 2 inches in thickness with a maximum of 6 inches	30+	
19.	Hard greenish-drab shale breaking with a small hackly fracture, almost flaky. A few ½-inch beds of brown sandstone. The second sample described below is a partial groove sample of this shale	14	
18.	Thin-bedded gray to red limestone and light-blue calcareous shale	11	
17.	Soft to semi-hard greenish-drab shale, harder and more compact near top. Occasional thin streaks of brown sandstone. The first sample described below is a 5-foot groove sample from west of the middle trestle and an 8-foot groove sample from east of the trestle. The middle is mostly covered	45+	
16.	Massive sandstone breaking blocky	1	6
15.	Soft red iron ore	0	6
14.	Cross-bedded sandstone, siliceous limestone, and a little hard shale. No beds over 6 inches thick	18	
13.	Red iron ore, at places siliceous	0	10
12.	Cross-bedded sandstone and hard greenish-gray shale	3	
11.	Solid, massive slightly calcareous shale	1	2
10.	Thinly interbedded sandstone and soft red iron ore	3	
9.	Thin interbedded layers of brownish sandstone and hard greenish-gray shale. Sandstone and shale in about equal amounts at bottom but sandstone increasing towards top. Solid 14-inch layer of sandstone 5 feet below top	110+	
8.	Hard greenish-gray shale with frequent thin sandstone layers. Some of shale is light bluish-gray and contains lime	30	
	West trestle		
7.	Hard sandy shale and thin-bedded soft sandstone. Weathers rough and irregular at bottom, but with shaly structure at top	30	
6.	Reddish-brown to drab somewhat sandy clay with a few thin shale layers	5	
5.	Soft drab and reddish-brown shale weathering to flat pieces 1/8 inch to ¼ inch thick, interbedded with drab to reddish-brown "short" siliceous clay	25	
4.	Covered	5+	
3.	Soft greenish-drab sandstone and sandy shale in beds 1 inch to 1 foot in thickness	25	
2.	Covered	10+	
Ordovician:			
	Chickamauga limestone:		
1.	Gray to blue thin-bedded argillaceous limestone	+	
	Total	467½+	feet

The following laboratory tests were made on a sample of the shale from unit (17) of the above geologic section. The sample consisted of a 5-foot groove sample from the base of the unit west of the middle trestle, and an 8-foot groove sample from the top of the unit east of the trestle. The middle of the unit is only poorly exposed in the hollow crossed by the trestle.

Laboratory tests on a sample of semi-hard greenish-drab Red Mountain shale from both sides of the middle trestle of the Tennessee, Alabama and Georgia Railroad, Southern States Coal and Iron Company property, Estelle, Walker County (Unit 17, geologic section above).

Chemical Analysis:

Loss on ignition	5.26
Soda (Na_2O)	1.06
Potash (K_2O)	.81
Lime (CaO)	.00
Magnesia (MgO)	.42
Alumina (Al_2O_3)	23.36
Ferric oxide (Fe_2O_3)	7.16
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	61.29
Total	100.09

Grinding: Fairly easy, brittle.
Ground Color: Brown.
Slaking: Slow.
Plasticity: Poor at first, somewhat better after aging 5 days.
Molding Behavior: Fair. Slight tendency of clay column to tear at edges.
Drying Behavior: Test bars all somewhat warped.
Water of Plasticity: 18.9 per cent.
Green Modulus of Rupture: 87.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	3.6	6.2	11.4	1150	Dark salmon (1YR-5/7)[b]	Some
04	3.3	5.8	9.9	1235	Dark salmon (R-YR-5/6)[b]	Some, to considerable
02	4.9	7.5	8.2	1764	Fair red (R-YR-5/5)[b]	Some
1	6.4	8.7	6.4	2134	Good red (R-YR-4/5)[b]	Slight
3	4.6	7.2	5.7	2006	Brownish-red (R-YR-4/5)[b]	Considerable
5	5.8	8.3	3.9	2365	Deep brownish red (R-YR-4/3)[b]	Considerable

[a]See graph, Figure 11-B, page 147.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cone 3 have a slight pimply appearance on the surface, and are slightly black-cored, showing evidences of reducing conditions. Those fired to cone 5 have a pimply appearance on the surface, are slightly kiln-marked, and show a dark somewhat glassy fracture. All of the test bars show slight traces of bluish-white scum, probably not enough to affect their use in the manufacture of heavy clay products.

Firing Range: Cone 03–2, best at cone 01–2.

The following laboratory tests are on a partial groove sample of a 14-foot bed of hard greenish-drab shale, unit (19) in the above geologic section, outcropping east of and stratigraphically above the previous sample.

Laboratory tests on a sample of hard greenish-drab Red Mountain shale east of the middle trestle of the Tennessee, Alabama and Georgia Railroad, Southern States Coal and Iron Company property, Estelle, Walker County (Unit 19, geologic section above).

Chemical Analysis:

Loss on ignition	5.42
Soda (Na_2O)	1.31
Potash (K_2O)	1.64
Lime (CaO)	.00
Magnesia (MgO)	.60
Alumina (Al_2O_3)	18.40
Ferric oxide (Fe_2O_3)	8.08
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.12
Silicia (SiO_2)	63.69
Total	99.99

Grinding: Fairly easy, brittle.

Ground Color: Brownish-drab.

Slaking: Rather slow.

Plasticity: Poor at first, fair after aging 2 days.

Molding Behavior: Fair. Slight tendency for clay column to tear on edges.

Drying Behavior: Test bars all slightly warped.

Water of Plasticity: 18.0 per cent.

Green Modulus of Rupture: 103.5 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 2.8 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.1	5.9	10.6	1505	Dark salmon (1YR-6/6)[b]	Slight
04	3.5	6.4	8.8	1754	Dark salmon (R-YR-5/5)[b]	Little or none
02	4.0	6.7	6.5	2169	Good red (R-YR-5/5)[b]	Slight
1	6.6	9.3	4.6	2622	Deep red (R-YR-4/5)[b]	Some
3	2.3	5.1	3.2	2012	Brownish-red (R-YR-3/6)[b]	Bad
5	2.3	4.8	2.2	2202	Deep brownish red (R-YR-3/4)[b]	Bad

[a]See graph, Figure 11-C, page 147.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 02 were somewhat black-cored, indicating reducing conditions in the kiln. The bars fired to cones 3 and 5 had a vitreous, pimply surface and a dark, somewhat glassy fracture.

Firing Range: Cone 04–2. Commercial kiln: Cone 04–1.

The above tests indicate that both of these shales, if properly handled, should be satisfactory for the manufacture of building brick and structural tile. Their worst feature is their slow slaking and the resulting poor green strength and structure of the test bars. This could probably be largely eliminated in plant practice by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

The old iron ore mines south of Estelle, when visited by the writer, had largely slumped in and grown over, so that mining dumps were far more common than actual outcrops of shale. Hard greenish-drab shale containing thin calcareous layers was showing at the mouth of the first tunnel of the old tram line. The good shale probably overlies this, but is not exposed.

Blue Bird Gap

The old road from McLamore Cove across Blue Bird Gap intersects the old tram line of the Southern States Coal and Iron Company in Land Lot 307, 11th District, 4th Section, about 1½ miles south of the

Tennessee, Alabama and Georgia Railroad at Estelle. The public road up the slope east of the tram line exposes the following geologic section, as measured by Maynard[1]:

Geologic section along the Blue Bird Gap road on the west side of Pigeon Mountain, Walker County.

Unit No.	Description of Units	Thickness feet
7	Chattanooga black shales	15
6	Rockwood [Red Mountain] shales; concealed	60
5	Olive-green hackly arenaceous shale with many sandy layers. *Halysites* sp. occur about 15 feet below the top of this unit	25
4	Olive-green and yellowish-green somewhat hackly arenaceous shale	15
3	Thin-bedded gray and brown sandstones and interbedded hackly and fissle olive-green shales. About 10 feet below the top of this unit the sandstones are heavy-bedded	30
2	Olive-green, fissle shales practically free from sandstone	80
1	Yellowish-green, interbedded shales and sandstones. At the bottom of this unit occurs heavy-bedded brown sandstones above which there is a bed of red ore; at the top of the unit there is a thin bed of red ore	30
	Intersection of Blue Bird Gap road. The section ends with the base of the Rockwood [Red Mountain] formation; however, the contact of the Rockwood and the underlying Chickamauga limestone is some distance to the west, due to the gentle dip of the rocks	
		255

The writer believes that the 80 feet of semi-hard olive-green fissle shale of unit (2) in the section above would develop more plasticity than the shale sampled at Estelle. Only a few beds of sandstone not over an inch in thickness were observed. The beds appear to be dipping slightly to the west, but this may be due to slumping. The top of this shale bed is at a gap with a straight slope north to Estelle. At one time, before construction of the tram road last used, the iron ore was hauled up an incline to this gap and then was lowered down an incline to Estelle. The writer was able to recognize the next three units above these shales as given in the section above, but could find no trace of the Chattanooga shale.

Shale enough to supply a large heavy clay products plant could be obtained from the slope near this section. The writer is of the opinion, however, that prospecting nearer the railroad might reveal similar deposits.

[1]Maynard, T. P., Limestones and cement materials of North Georgia: Georgia Geol. Survey Bull. 27, pp. 234-235, 1912.

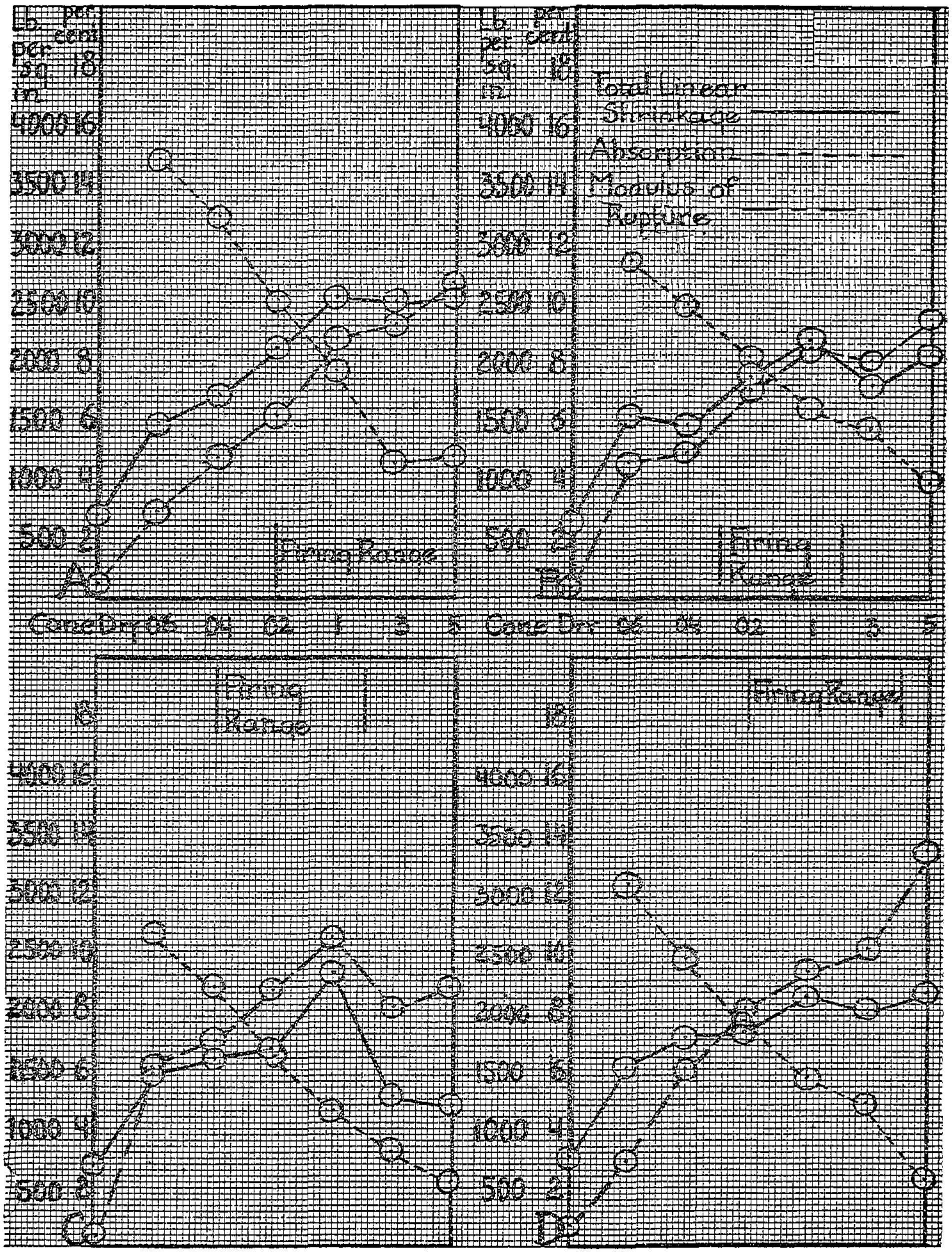


Figure 11. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Red Mountain shale from the Misses McWhorter property, Bronco, Walker County.

B. Red Mountain shale from near the middle trestle, Southern States Coal and Iron Co., Estelle, Walker County.

C. Red Mountain shale from near the east trestle, Southern States Coal & Iron Co., Estelle, Walker County.

D. Red Mountain shale from the Mrs. J. F. Shaw property, Cassandra, Walker County.

The Pocket

The nearly enclosed valley or natural amphitheater known as "The Pocket" is on the west side of Pigeon Mountain 1½ miles south of Blue Bird Gap and 3 miles south of the Tennessee, Alabama and Georgia Railroad at Estelle. It was the terminus of the Southern States Coal and Iron Company's tram line from Estelle. The company is said to have done considerable stripping but very little mining of the red iron ore in this valley during their last operations.

The bluff over the stream and the mouth of the tram-line tunnel (the 7th south of Estelle) on the north side of The Pocket showed hard green and gray shale containing traces of lime and a few sandstone layers.

The road up the slope of Pigeon Mountain shows the following section:

Geologic section on west side of Pigeon Mountain at "The Pocket", 3 miles south of Estelle, Walker County.

	Approximate thickness in feet
Mississippian:	
Bangor limestone:	
8. Massive gray-blue limestone	+
Fort Payne chert:	
7. Thin-bedded gray chert weathering blocky	20
Mississippian or Devonian:	
Chattanooga shale:	
6. Mostly covered but with fragments of fissle black shale	20
Silurian:	
Red Mountain formation:	
5. Hard olive-green shale with thin sandstone layers	10
4. Small weathered outcrops of semi-hard (?) olive-green shale, some sandstone fragments, and covered	30
3. Hard olive-green shale with hackly fracture	10
2. Covered	40
1. Level of iron ore workings	+
	130

Thus the 210 feet of the Red Mountain formation above the iron ore at Blue Bird Gap has apparently thinned to about 100 feet.

THE GLENN-WARTHEN PROPERTY

(Map location No. 27)

The property owned by R. M. W. Glenn and S. M. Warthen (LaFayette) consists of about 4,200 acres on the northern end of Pigeon Mountain in a single tract some two miles wide (east-west) and 4 miles long (north-south). The outcrops of the iron ore and shales of the Red Mountain formation cross the property in a northeast-southwest direction.

The writer examined several outcrops of shale above and below the iron ore in Catlett Gap in Land Lot 211, 8th District, 4th Section. This is two miles northeast of the Tennessee, Georgia and Alabama Railroad at Estelle, and is three miles west of the Central of Georgia Railway at Warren Station. These all seem to be hard gray to drab shale with a hackly fracture, a few layers containing traces of lime. The bluff above the stream in a small hollow on the north side of the road showed about 10 feet of hard gray to drab shale with no traces of lime or sandstone. The laboratory tests on a 5-foot groove sample from this outcrop are given below.

Laboratory tests on a 5-foot groove sample of hard gray to drab Red Mountain shale from the Glenn-Warthen property, Catlett Gap, 2 miles northeast of Estelle, Walker County.

Chemical Analysis:

Loss on ignition	2.35
Soda (Na_2O)	.47
Potash (K_2O)	1.00
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	17.07
Ferric oxide (Fe_2O_3)	5.68
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.96
Phosphorus pentoxide (P_2O_5)	.08
Silica (SiO_2)	71.50
Total	100.01

Grinding: A little difficult. Shale is tough rather than brittle.
Ground Color: Brownish-drab.
Slaking: Very slow.
Plasticity: Very poor, even after aging a week.
Molding Behavior: Too poor plasticity to form bars on Mueller roll-press.

The sample was therefore discarded without further testing. The southwestern corner of the property is the next land lot to the west. The whole property therefore is rather far from railroad transportation to pay to prospect in the hopes of finding a deposit of better shale.

D. M. BULLARD PROPERTY

The property of D. M. Bullard (Kensington, Rt. 2) is on the Bowers Gap branch of Mill Creek, one mile southwest of Cassandra and the Tennessee, Alabama and Georgia Railroad.

The branch from Bowers Gap of Lookout Mountain in cutting through the Shinbone Ridge has been exposed about 60 feet of semihard olive-green Red Mountain shale containing only a few thin beds of sandstone. These beds overlie the iron ore which is in three rather thin seams separated by 10 to 15 feet of shale. The beds are striking N. 20° E. and are dipping about 40° to the west. The Chattanooga black shale is showing more than 100 feet to the west of the top of the 60 feet of olive-green shale.

This shale underlies the west slope of Shinbone Ridge and could easily be mined. The pits would have natural drainage.

MRS. J. F. SHAW PROPERTY

(Map location No. 28)

The Mrs. J. F. Shaw (LaFayette) property is one mile northwest of Cassandra on Mill Creek and a road known locally as the "Terrapin Trail". It is five-eighths of a mile west of the Tennessee, Alabama and Georgia Railroad in Land Lots 157 and 158, 11th District, 4th Section.

The cuts of the road where the Terrapin Trail crosses the Shinbone Ridge expose rocks of which the following is a geologic section:

Geologic section along the Terrapin Trail on the Mrs. J. F. Shaw property, one mile northwest of Cassandra, Walker County.

	Approximate thickness in feet
Mississippian or Devonian:	
Chattanooga shale:	
4. Partly covered and outcrops of massive fissle black shale	30+
Silurian:	
Red Mountain formation:	
3. Covered	25+
2. Hard to semi-hard olive-green and greenish-drab shale, some layers more fissle than others, and several layers of sandstone and inch or two in thickness. (See tests on sample below)	153
1. Alternate layers of greenish-drab shale and brown sandstone. Heavy sandstone beds at top. Partly covered at bottom	120+
Creek	
	328+

The beds are striking N. 20° E. and are dipping 35° to the west. The Chattanooga black shale outcrops near the top of the ridge, so that nearly the whole eastern slope is underlain by the shales of the Red Mountain formation. The iron ore horizon is probably near the base of unit (1) in the above section, although no outcrops of it are showing.

The following laboratory tests are on a sample consisting of pieces collected every two feet along the outcrop of unit (2) of the above section.

Laboratory tests on hard to semi-hard olive-green to greenish drab Red Mountain shale from the Mrs. J. F. Shaw property, one mile northwest of Cassandra, Walker County.

Chemical Analysis:

Loss on ignition	3.84
Soda (Na_2O)	.80
Potash (K_2O)	1.11
Lime (CaO)	.00
Magnesia (MgO)	.06
Alumina (Al_2O_3)	21.63
Ferric oxide (Fe_2O_3)	5.76
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	65.89
	100.18

Grinding: Fairly easy, brittle.
Ground Color: Brownish-gray.
Slaking: Very slow.
Plasticity: Very poor and grainy at first, fair after aging two days.
Molding Behavior: Poor. Tendency for column of clay to crack and tear on the edges.
Water of Plasticity: 18.0 per cent.
Green Modulus of Rupture: 179.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.5	6.1	12.3	985	Salmon (2YR-6/8)[b]	Slight
04	3.9	7.1	9.8	1495	Dark salmon (1YR-6/7)[b]	Slight
02	4.6	7.3	7.6	1990	Light red (2YR-6/7)[b]	Little or none
1	5.8	8.5	5.7	2317	Good red (R-YR-5/4)[b]	Slight
3	5.5	8.0	4.9	2522	Good red (R-YR-4/4)[b]	Some
5	6.1	8.6	2.3	3348	Brownish-red (R-YR-3/4)[b]	Some to considerable

[a]See graph, Figure 11-D, page 147.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 5 have a vitrified and pimply looking surface and the fracture shows traces of a glassy structure.

Firing Range: Cone 02–4. Commercial kiln: Cone 02–3.

The above tests indicate that, if properly handled, this shale should be suitable for the manufacture of building brick and structural tile. The slow slaking and the resulting poor plasticity and green strength could probably be remedied by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

The property should be prospected to determine the extent of the shale deposits. It is possible that the lower part of the Red Mountain formation below the iron ore may contain a deposit of plastic residual clay that, mixed with the shales tested, would improve the working qualities.

S. F. EVANS PROPERTY

The S. F. Evans property is on the Cooper Gap road, three-quarters of a mile west of the Tennessee, Alabama and Georgia Railroad and 2½ miles north of Cassandra.

The cuts of the road crossing the Shinbone Ridge show about 60 feet of semi-hard to hard greenish-drab shale similar to that on the Shaw property described above, overlain by interbedded shale and sandstone. These beds are probably overlying the iron ore. The Chattanooga black shale outcrops near the forks of the road on the west side of the ridge. The top and east slope of the ridge should be prospected to determine the quality and extent of the shale.

HENRY BROTHERS PROPERTY

The property of the Henry Brothers (Rex Henry, Cassandra, in charge) is about 2 miles north of Cooper Heights and three-quarters of a mile west of the Tennessee, Alabama and Georgia Railroad.

The property includes about three-quarters of a mile of the Shinbone Ridge that parallels the foot of Lookout Mountain. Red iron ore in two beds about 30 feet apart with hard greenish-drab shale between is showing at the eastern foot of this ridge. No outcrops were observed above the top iron ore bed. For about 50 feet vertically above the iron ore there are no fragments of sandstone showing on the surface of the ground, but above this is a small outcrop of massive sandstone, then for 80 feet the slope is strewn with sandstone fragments. The top of the ridge is covered with chert fragments from the Fort Payne chert. The eastern slopes of the ridge for some distance above the iron ore should be prospected to determine the character and extent of the shale.

JONES PROPERTY

MARSH MINING COMPANY

The Mrs. J. W. Jones property, mineral rights owned by the Marsh Mining Company (Mrs. Emma Marsh, Chattanooga, Tenn.), is one-half to three-quarters of a mile west of the Tennessee, Alabama and

Georgia Railroad at High Point Station, in Land Lots 305 and 306, 10th District, 4th Section.

Hard olive-green shale, similar to that on the Mallicoat and Southern States Coal and Iron Company properties described below, is exposed just above the iron ore near the foot of the chain of hills known as Shinbone Ridge. The east slope of the ridge above the iron ore should be prospected to determine the character and extent of the shale.

SOUTHERN STATES COAL AND IRON COMPANY
HIGH POINT HOLDINGS
G. W. MALLICOAT PROPERTY

(Map location No. 29)

The G. W. Mallicoat (Alton Park, Tenn., Rt. 6) property is just west of the Chattanooga Valley road three-quarters of a mile north of High Point Station in Land Lot 271, 10th District, 4th Section. Adjoining and to the west of the Mallicoat property in Land Lots 271 and 272 is the property of the Southern States Coal and Iron Company (F. K. Rosmond, Sec., Chattanooga, Tenn. (see page 141).

The properties are drained by a small branch rising on the slopes of the Shinbone Ridge and flowing into Chattanooga Creek just east of the Tennessee, Alabama and Georgia Railroad.

A local variation in the dip of the rocks, forming a small syncline, has caused the red iron ore of the Red Mountain formation to crop out on both of these properties. The iron ore on the Mallicoat property is at one place overlain by an outcrop of 20 feet of hard gray to greenish-drab shale dipping gently to the west. Further west up the hollow near the eastern edge of the Southern States Coal and Iron Company a bluff exposes 30 feet of hard olive-green shale with one or two thin sandstone layers, dipping 15° to 20° to the east. The laboratory tests on a grab sample of this shale are given below. The Chattanooga black shale forms a bluff and has been mined for paint pigment to the west just across the line on the J. W. Thomas (St. Elmo, Tennessee) property in Land Lot 269. This black shale, which is 10 feet in thickness, solid, and massive, is overlain by the Fort Payne chert and underlain by about 15 feet of hard gray shale weathering on the surface to a mealy clay. The beds at the mine are nearly level, but just to the west they start to dip to the west again, the natural dip of the beds that form the Shinbone Ridge.

Laboratory tests on a sample of hard olive-green Red Mountain shale from the G. W. Mallicoat and the Southern States Coal and Iron Company properties, three-quarters of a mile north of High Point Station, Walker County.

Chemical Analysis:

Loss on ignition	4.84
Soda (Na_2O)	.97
Potash (K_2O)	1.83
Lime (CaO)	.00
Magnesia (MgO)	.55
Alumnia (Al_2O_3)	25.62
Ferric oxide (Fe_2O_3)	4.27
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	60.84
	100.01

Grinding: Fairly easy, brittle.
Ground Color: Gray.
Slaking: Very slow.
Plasticity: Very poor and grainy at first, fair after aging 4 days.
Molding Behavior: Fair. Clay column has slight tendency to crack and tear on the edges.
Drying Behavior: Test bars somewhat warped.
Water of Plasticity: 16.5 per cent.
Green Modulus of Rupture: 116.8 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	1.9	4.3	11.9	799	Light salmon (3YR-6/7)[b]	Some
04	2.4	4.8	10.6	1283	Dark salmon (1YR-6/6)[b]	Some
02	2.8	5.3	10.1	*c*	Light red (R-YR-5/5)[b]	Some
1	4.6	6.8	7.3	1708	Good red (R–YR–4/5)[b]	Some
3	2.6	5.0	4.0	2100	Deep red (R-YR-4/4)[b]	Some
5	4.1	6.5	5.2	2515	Brownish-red (1YR-4/4)[b]	Considerable

[a]See graph, Figure 12-A, page 159.
[b]Color notation according to the Munsell system, see page 23.
[c]All test bars broken in handling.

Remarks: The test bars fired to cones 06 to 1 showed slight traces of scum or efflorescence, not present on those fired to cone 3 and 5. This scum was not enough to give serious trouble in manufacturing heavy clay products. The test bars fired to cones 3 and 5 were slightly kiln-marked, had a pimply surface, and their fractured ends showed traces of a glassy structure.

Firing Range: Cone 02–2. Commercial kiln: Cone 03–1.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile. Its tendency to slow slaking and poor plasticity could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. The firing range is only three cones.

These properties should be prospected to determine the character and extent of the shale deposits. It is possible that the lower part of the Red Mountain formation, below the iron ore, contains some plastic residual clay that, if mixed with the shale, might improve the working qualities. These properties are favorably situated close to the railroad, with natural drainage, and with a sufficient water supply in Chattanooga Creek east of the railroad.

HAYES AND HARTLINE PROPERTIES

The S. G. Hayes (Alton Park, Tenn., Rt. 3) property is north of and adjoining the Mallicoat and the Southern States Coal and Iron Company properties described above, west of the Chattanooga Valley road and one mile north of High Point Station, in Land Lot 269, 10th District, 4th Section.

Hard olive-green shale below the red iron ore is showing in the next hollow to the north of the outcrops described above. The beds are dipping 60° to 70° to the west. Only a few small outcrops of similar shale but containing a few thin beds of sandstone are showing above the iron ore. The east slope of the Shinbone Ridge on this and the Mrs. M. J. Hartline (Alton Park, Tennessee, Rt. 3) property adjoining on the north should be prospected to determine the character and extent of the shale deposits.

MRS. W. W. SCOTT PROPERTY

(Map location No. 30)

The Mrs. W. W. Scott (Alton Park, Tenn., Rt. 3) property is west of the Tennessee, Alabama and Georgia Railroad at the Chattanooga Valley road crossing, one and a half miles north of High Point Station and one mile south of Cenchat. It includes parts of Land Lots 217 and 252, 9th District, 4th Section, Walker County.

Limestone of the Chickamauga limestone formation is showing at the house. The back yard is said to be crossed by a bed of the bentonite, a plastic clay derived from the weathering of volcanic ash, that crops out on the Parrish property adjoining on the south.

About 400 yards west of the railroad at the foot of a low ridge is a small pit from which several cars of plastic red and mottled drab and red residual clay were mined several years ago. The clay was shipped to the W. S. Dickey Clay Mfg. Company plant near Flintstone (see page 164) and was used with shale in the manufacture of sewer pipe. This is probably near the base of the Red Mountain formation. The slope above this pit shows a few outcrops of soft brown weathered shale, striking about N. 20° E. and dipping about 30° to the west. Only the part of the Red Mountain formation below the iron ore is underlying this property.

The following laboratory tests are on a sample of soft brown sandy shale and residual clay collected by the owner from three feet beneath the surface in two prospect pits dug after the writer's visit to the property.

Laboratory tests on a sample of soft sandy brown shale and plastic residual clay from the base of the Red Mountain formation on the Mrs. W. W. Scott property, one mile south of Cenchat, Walker County.

Chemical Analysis:

Loss on ignition	6.25
Soda (Na_2O)	1.24
Potash (K_2O)	1.69
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	24.54
Ferric oxide (Fe_2O_3)	8.65
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.00
Phosphorous pentoxide (P_2O_5)	.10
Silica (SiO_2)	56.75
	99.95

Grinding: Easy.

Ground Color: Light brown.

Slaking: Rapid.

Plasticity: Fair. A little "short".

Moulding Behavior: Good.

Drying Behavior: Good. Little or no warpage.

Water of Plasticity: 33.9 per cent.

Green Modulus of Rupture: 168.7 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 7.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	7.0	14.3	13.9	2072	Light red (1YR-6/7)[b]	Little or none
04	9.5	16.6	8.7	2731	Fair red (R-YR-5/5)[b]	Slight
02	9.1	16.5	7.0	2259	Good red (R-YR-4/5)[b]	Some
1	13.7	20.6	2.6	3713	Good red (R-YR-4/4)[b]	Slight
3	12.8	19.6	2.1	2615	Dark red (R-YR-3/6)[b]	Some
5	13.7	20.2	0.9	3975	Dark red (R-YR-3/5)[b]	Some

[a]See graph, Figure 12-B, page 159.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cones 04, 02, and 3 were all more or less black-cored. Those fired to cones 3 and 5 had a vitreous appearance and the fractures showed a glassy structure.

Firing Range: Cone 04–5. Commercial kiln: Cone 04–3.

The above tests indicate that this clay has too high a shrinkage to use by itself in the manufacture of heavy clay products. It is very likely, however, that a mixture of this clay and a slow slaking shale, such as is found in the Red Mountain formation above the iron ore in this vicinity, would process better and would have qualities better suited for the manufacture of heavy clay products than either the clay or the shale by itself.

This mixture of soft weathered shale and residual clay is probably derived from the weathering of beds of very argillaceous limestone with frequent shaly layers. It is doubtful if the clay of this character extends more than 15 or 20 feet below the surface of the ground. The property should be carefully prospected to determine the extent and the character of the deposit.

M. Q. LONG PROPERTY

(Map location No. 31)

The M. Q. Long (Alton Park, Tenn., Rt. 3) property lies between the Tennessee, Alabama and Georgia Railroad and the Durham Branch of the Central of Georgia Railway, half a mile to one mile southwest of

Cenchat, the crossing of the two railroads. It consists of 230 acres in Land Lots 199 and 234 of the 10th District, 3d Section, and Land Lot 216 of the 9th District, 3d Section, Walker County. In addition, the mineral rights, except the iron ore, are owned on 25 adjoining acres of the Samuels property on the west side of the Durham Branch of the Central of Georgia Railway. The property is adjoining and is north and west of the Mrs. W. W. Scott property described above.

The west side of the property consists of a series of irregular ridges 50 to 100 feet in height, a part of the Shinbone Ridge that parallels the east slope of Lookout Mountain. It is underlain by shale and red fossiliferous iron ore of the Red Mountain formation, striking about N. 5° E. and dipping 15° to 20° to the west. The iron ore is said to be 2½ to 3 feet in thickness and is the "Upper Seam." The soft ore was mined out some 26 to 30 years ago, leaving a number of small pits now partly slumped in. These pits and natural outcrops expose 20 to 50 feet of hard olive-green fissile shale. No limestone beds or partings were seen. Laboratory tests are given below of a composit sample of two 5-foot groove samples from nearby mining pits. The main iron ore bed is underlain by a considerable thickness of shale which is reported to contain two iron ore seams 6 to 8 inches in thickness. These shale beds are covered and their character could not be determined. Fairly numerous thin sandstone fragments cover the surface of the ground, indicating sandstone partings in this shale.

The northeast corner of the property slopes gently towards the Tennessee, Alabama and Georgia Railroad and Chattanooga Creek, and is underlain by soft weathered shale and brown and red clay, probably similar to that on the Mrs. W. W. Scott property described above.

Laboratory tests on hard olive-green Red Mountain shale from the M. Q. Long property, three-quarters of a mile south of Cenchat, Walker County.

Chemical Analysis:

Loss on ignition	5.12
Soda (Na_2O)	.69
Potash (K_2O)	1.81
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	23.80
Ferric oxide (Fe_2O_3)	7.90
Titanium dioxide (TiO_2)	.85
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.15
Silica (SiO_2)	59.96
	100.28

Grinding: Fairly easy, brittle.
Ground Color: Grayish-drab.
Slaking: Slow.
Plasticity: Poor and grainy at first, fair after aging 2 days.
Molding Behavior: Fair. Slight tendency for clay column to tear at edges.

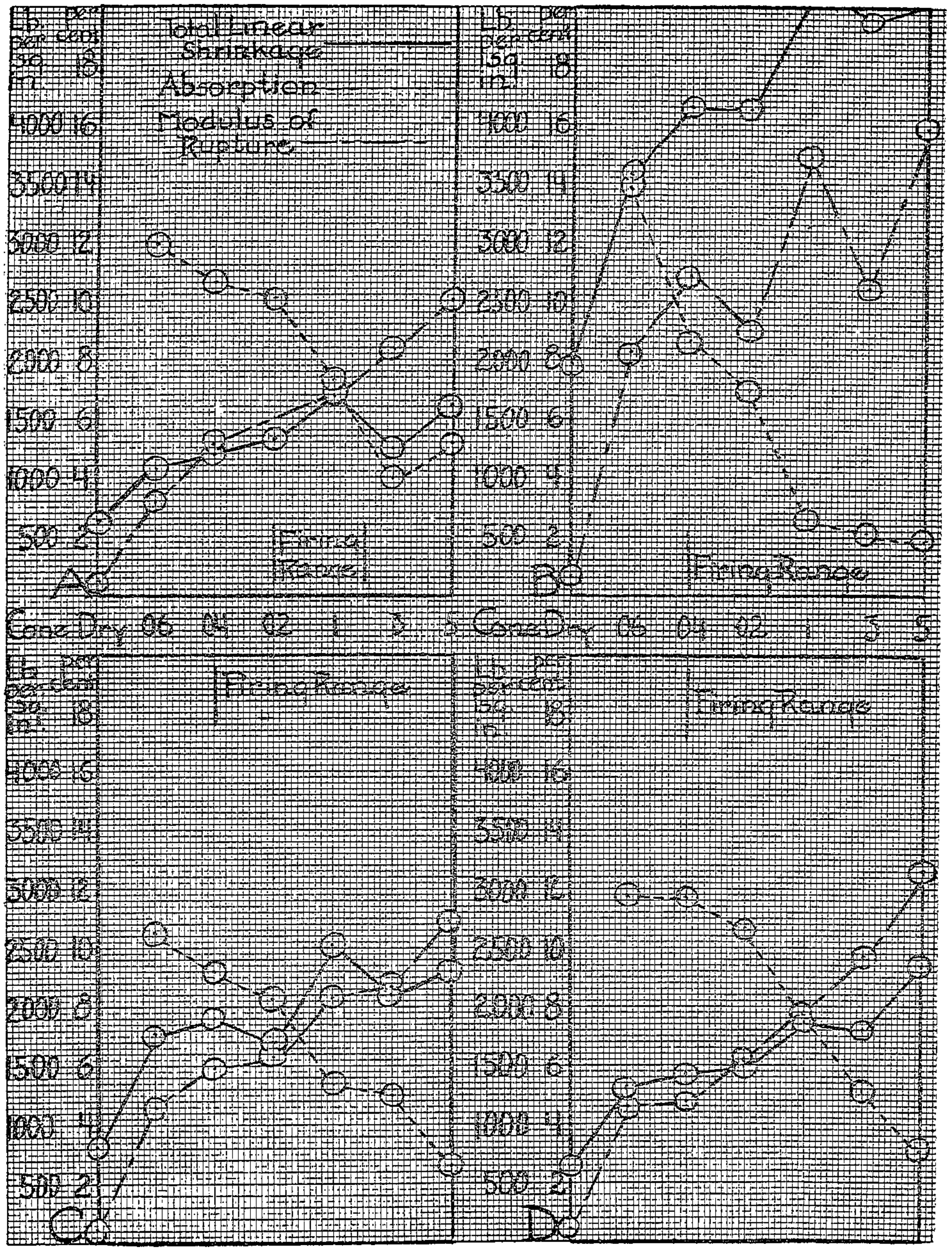


Figure 12. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Red Mountain shale from the G. W. Mallicoat property, one mile north of High Point Station, Walker County.

B. Weathered Red Mountain shale from the Mrs. W. W. Scott property, 1½ miles north of High Point Station, Walker County.

C. Red Mountain shale from the M. Q. Long property, Cenchat, Walker County.

D. Red Mountain shale from the J. O. McCallie property, one mile west of Cenchat, Walker County.

Drying Behavior: Good. Little or no warpage.
Water of Plasticity: 18.4 per cent.
Green Modulus of Rupture: 114.5 pounds per square inch.
Linear Drying Shrinkage: (*based on plastic length*): 3.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.2	7.1	10.5	1165	Fair red (1YR-5/7)[b]	Very slight
04	4.6	7.6	9.2	1482	Fair red (R-YR-5/7)[b]	Slight
02	3.5	6.8	8.3	1573	Good red (R-YR-5/5)[b]	Some
1	7.1	10.1	5.4	2086	Good red (R-YR-4/5)[b]	Slight
3	4.9	8.4	5.0	2165	Good red (R-YR-4/5)[b]	Some
5	6.2	9.2	2.6	2717	Dark red (R-YR-3/5)[b]	Considerable

[a]See graph, Figure 12-C, page 159.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Some of the bars fired to cones 04, 02, and 3 were black-cored. The bars fired to cone 5 showed slight traces of kiln-marking and their fracture had a slight glassy look.

Firing Range: Cone 04–5. Commercial kiln: Cone 04–3.

The above tests indicate that the shale sampled is suitable for the manufacture of building brick, structural tile, roofing tile, and possibly sewer pipe. The tendency towards slow slaking and the resulting low green modulus of rupture could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. The addition of a small amount of a plastic residual clay, such as that on the Mrs. W. W. Scott property described above, might make the shale easier to process without the loss of the other desirable qualities.

The owner estimates that about 75 acres of the Long property and 5 acres of the Samuels property are underlain by shale with little or no overburden. The shale could be mined by steam shovel and the pits would have natural drainage. The shale outcrops adjoin the Durham Branch of the Central of Georgia Railway, but the topography is such that the best plant site is probably one on the east side of the property about half a mile from the Tennessee, Alabama and Georgia Railroad.

Water could be obtained from the small branch north of the Central of Georgia Railway or from Chattanooga Creek east of the Tennessee, Alabama and Georgia Railroad.

The shale underneath the iron ore and the soft weathered shale and clay on the east side of the property should be prospected and tested, as well as the shale over the iron ore represented by the sample tested. Careful watch should be made for the presence of lime.

J. O. MCCALLIE PROPERTY

(Map location No. 32)

The J. O. McCallie (Alton Park, Tenn., Rt. 3) property is on the Durham Branch of the Central of Georgia Railway, one mile west of Cenchat. It consists of 338 acres in Land Lots 199, 200, 233, 234, 235, and 236, 10th District, 4th Section. The greater part of the shale deposits described below occur in Land Lots 199 and 234. The property is adjoined on the east by the M. Q. Long property, described above.

The railroad makes a horse-shoe bend across the property, cutting southwest along the edge of the Shinbone Ridge that parallels the slopes of Lookout Mountain and then swinging northward along the foot of the main slope of the mountain. Within the bend of the railroad and paralleling the eastern side is the valley of a small branch which has been dammed to form Cenchat Lake.

Hard olive-green fissle shale of the Red Mountain formation is exposed for about 1,000 feet in the cuts along the eastern side of the horseshoe bend of the railroad (see Plate II-B, facing page 94). This shale is above the red fossiliferous iron ore and is overlain by the Chattanooga black shale, which is mined near the curve of the railroad. The beds are striking N. 20° E. at a slight angle to the railroad track, and, except for a few minor variations, dip about 30° to the west. The stratigraphic thickness of the shale deposits is probably about 200 feet. Some heavy beds of sandstone are showing near the middle of the outcrops, but the shale on either side shows only a few thin sandstone partings. The land rises rapidly south of these cuts to a ridge, the top of which is some 350 feet above the railroad. Shale is exposed to the very top of this slope.

The shales below and above the iron ore are exposed at places on the more gentle slope southwest and west of Cenchat Lake between the arms of the horse-shoe bend of the railroad. A few tons of shale have been mined from a pit near the lake. To the west and about 80 feet above this, more shale has been exposed by the mining of iron ore. The ore is said to have averaged three feet in thickness. No sandstone is showing at either of these exposures. The shales which are exposed in the railroad cuts extend under the slopes west of this last outcrop.

The laboratory tests are given below on a sample of the shale from the two outcrops between the bends of the railroad and at intervals along the railroad cuts.

Laboratory tests on a sample of hard olive-green shale from above and below the iron ore of the Red Mountain formation on the J. O. McCallie property, one mile west of Cenchat, Walker County.

Chemical Analysis:

Loss on ignition	4.85
Soda (Na_2O)	.51
Potash (K_2O)	1.72
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	22.22
Ferric oxide (Fe_2O_3)	7.00
Titanium dioxide (TiO_2)	1.01
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	62.80
	100.11

Grinding: Fairly easy. Slightly tough rather than brittle.
Ground Color: Grayish-drab.
Slaking: Slow.
Plasticity: Poor and grainy at first, fair after aging 2 days.
Molding Behavior: Good.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 19.6 per cent.
Green Modulus of Rupture: 111.9 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.9	5.3	11.8	1157	Dark salmon (2YR-6/8)[b]	Slight
04	2.9	5.7	11.7	1205	Fair red (R-YR-6/7)[b]	Slight
02	3.6	6.0	10.6	1522	Good red (R-YR-5/6)[b]	Some
1	5.2	7.5	7.7	1912	Good red (R-YR-5/5)[b]	Some
3	4.6	7.2	5.1	2413	Good red (R-YR-4/4)[b]	Considerable
5	7.1	9.4	3.1	3147	Dark red (R-YR-3/4)[b]	Considerable

[a]See graph, Figure 12-D, page 159.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 04–5. Commercial kiln: Cone 04–3.

The above tests indicate that the shale sampled is suitable for the manufacture of building brick, structural tile, roofing tile, and possibly sewer pipe. The tendency to slow slaking and the resulting low green strength could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. The shale sampled, while not strictly surficial material, was more or less weathered. It is possible that 10 to 20 feet under the surface the shale would be too hard and non-plastic to use by itself.

This property evidently contains a very large deposit of shale with little or no overburden, so located that it could be mined by steam shovel. The pits would have natural drainage. A good plant site near Cenchat Lake is already connected with the railroad by a spur track. Sufficient water for a ceramic plant could be obtained from Cenchat Lake. In prospecting the property care should be taken to watch out for the presence of lime in the shale. Even small quantities might cause scumming and narrow the firing range.

J. L. KNOX PROPERTY

The J. L. Knox (Alton Park, Tennessee, Rt. 3) property is at the foot of Lookout Mountain half a mile due west of Eagle Cliff Station on the Tennessee, Alabama and Georgia Railroad. The Durham Branch of the Central of Georgia Railway is not far to the west of the property line, but is well up on the slope of the mountain above the property. The property consists of 200 acres in Land Lot 162 of the 10th District, 4th Section, and Land Lot 145 of the 9th District, 4th Section, Walker County.

Near the eastern edge of the property is a small pit from which a few carloads of stiffly plastic red and brown residual clay were mined several years ago. This clay, according to the owner, was mined for the Flintstone Plant of the W. S. Dickey Clay Mfg. Company (see page 164) to mix with their shale to increase the plasticity and processing qualities, but it was evidently not satisfactory for this purpose. A prospect well near the pit is said to have passed through 35 feet of this clay.

The cuts of the private road to the west show a similar red clay with occasional partings of reddish-brown shale, probably from the base of the Red Mountain formation. This clay has the appearance of that sampled on the Mrs. W. W. Scott property and described on page 155.

Still further west is a low ridge, the northern end of the Shinbone Ridge, rising only 25 or 30 feet above the general level of the property. Along this ridge are trenches where the soft iron ore, apparently 20 to 30 inches in thickness, was mined years ago, but the sides have slumped in and very little shale is showing. A small valley 200 feet across lies between the ridge and the main slope of the mountain.

A little hard greenish-drab shale (under the iron ore) is showing by the house on the Z. C. Patton Estate adjoining this property on the south. Both of these properties should be prospected and the shale and residual clay deposits tested.

W. S. DICKEY CLAY MFG. COMPANY

FLINTSTONE PLANT, NO. 11.

Headquarters: Kansas City. Missouri. (See pages 80 and 307).

Flintstone Plant: Blowing Spring Station (Flintstone P. O.), Walker County, Georgia. W. G. Evans, Supt.

The Flintstone or No. 11 Plant (see Plate I) of the W. S. Dickey Clay Mfg. Company is just east of the Tennessee, Alabama and Georgia Railroad at Blowing Springs Station, two miles north of Flintstone and three-quarters of a mile south of the Tennessee State Line. This plant was built about 1905 by the American Sewerpipe Company, using an alluvial clay from the valley of Chattanooga Creek for the manufacture of sewer pipe, drain tile, and wall coping. Later shale of the Red Mountain formation from near Flintstone was mixed with the clay. The plant was purchased by the W. S. Dickey Clay Mfg. Company about 1915. Still later as the shale and clay deposits were exhausted, the sewer pipe were made from a mixture of shale from the company's pits at Rome, Georgia (see page 80), and Graysville, Tennessee, and fire clay from the Birmingham District of Alabama.

The clays are brought into the plant in standard gondola freight cars and dumped on a storage floor in separate piles. The proper number of wheelbarrow-loads of each shale and fire clay to give the desired mixture are dumped into two dry pans, where it is mixed and ground. The ground clay is screened through two vibrating screens, 6-mesh and 8-mesh, and the over-size is returned to the dry pans. The undersize goes to storage bins or is fed directly to four wet pans, where water is added and the clay is tempered and pugged. The sewer pipe and flue linings are formed from the plastic clay by three steam-cylinder sewer-pipe presses, and are dried from four to six days in steam-heated drying rooms.

The sewer pipe and flue linings are fired in 23 round down-draft kilns: 6 36-foot, 4 32-foot, and 13 30-foot; on 11 stacks. The sewer pipe are fired to about 1900° F. and are salt-glazed. The flue linings (made from Birmingham fire clay only) are fired to a slightly higher temperature and are not glazed. The heat is controlled by electrical pyrometers, the end point of the firing determined by standard pyrometric cones, and the amount of salt glaze is determined by trial pieces.

The capacity of the plant is about 100 tons per day of good quality sewer pipe in sizes from 4 inches to 36 inches in diameter, including the necessary Y's and T's; and flue lining in sizes 8½ inches by 8½ inches to 20 inches by 24 inches in cross-section.

J. R. MCFARLAND PROPERTY

(Map location No. 33)

The J. R. McFarland (Rossville) property is on the Central of Georgia Railway where it crosses Missionary Ridge, two miles south of Rossville and three-quarters of a mile north of Mission Ridge Station, in Land Lot 80, 9th District, 4th Section, Walker County.

Missionary Ridge was formed by the resistant chert beds of the Knox dolomite of Cambrian or Ordovician age, which here have been thrust over the much younger Red Mountain formation of Silurian age. The Knox dolomite therefore forms the top and east slope of the ridge, while the Red Mountain formation forms the west slope. The railroad and the public road from Mission Ridge to Rossville follow a gap through the ridge, the McFarland property being on the western side of the gap.

The beds of the Red Mountain formation are exposed in several cuts along the Central of Georgia Railway at and north of the railroad bridge over the public road. Near the bridge cherty red clay of the Knox dolomite is thrust over beds of sandy brown clay and soft shale of the Red Mountain formation. The fault plane and the Knox dolomite beds are striking about N. 20° E. and dipping 20° to 25° to the east, while the clay and the shale beds of the Red Mountain formation are dipping 75° to the east. One hundred feet to the north is another thrust fault within the Red Mountain formation (see Plate III–A), brown sandy clay with thin shale partings being thrust at an angle of 75° over crumpled beds of sandy clay and shale. The north end of this cut and another small cut, some 300 feet to the north, show brown sandy shale with thin interbedded layers of sandy brown clay, the beds dipping 23° to the east. The stratigraphic thickness represented by these outcrops is about 150 feet. The land rises above and east of the cuts to an irregular ridge, the western slope of which is underlain by the shale and clay outcropping in the cuts. The laboratory tests are given below on a grab sample of the sandy brown shale and clay from both of these cuts. The owner estimates that about 10 acres of the property are underlain by these deposits. They could easily be mined by steam shovel, and the pits would have natural drainage.

Laboratory tests on sandy brown shale and residual clay from the Red Mountain formation on the J. R. McFarland property, Central of Georgia Railway two miles south of Rossville and three-quarters of a mile north of Mission Ridge Station, Walker County.

Chemical Analysis:

Loss on ignition	6.46
Soda (Na_2O)	1.32
Potash (K_2O)	1.80
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	23.64
Ferric oxide (Fe_2O_3)	8.00
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.44
Silica (SiO_2)	57.71
	100.10

Grinding: Easy.
Ground Color: Light brown.
Slaking: Fairly rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Slight warpage.
Water of Plasticity: 28.0 per cent.
Green Modulus of Rupture: 106.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.7 per cent.

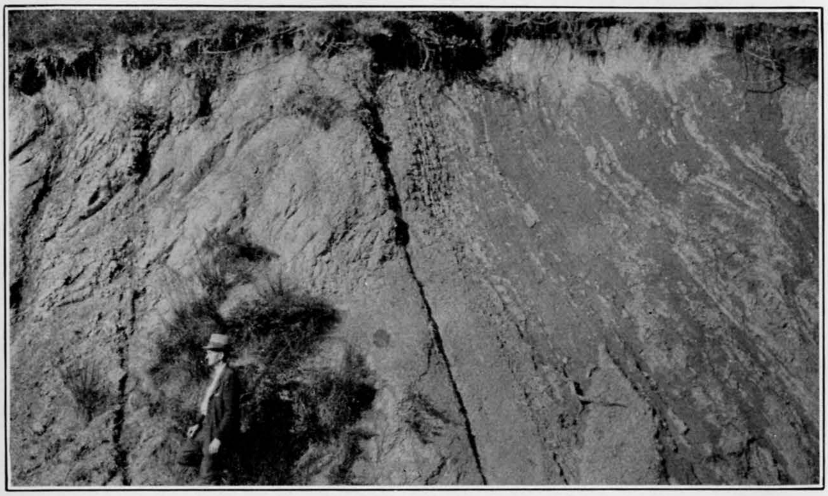
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.3	8.7	14.2	1375	Deep salmon (2YR-5/5)[b]	Slight
04	5.7	9.0	14.1	1528	Medium red (R-YR-5/4)[b]	Slight
02	6.3	9.5	11.8	1886	Medium red (1YR-5/5)[b]	Some
1	10.7	14.0	5.5	2682	Good red (R-YR-4/4)[b]	Some
3	12.0	15.5	3.5	2896	Deep red R-YR-3/5)[b]	Considerable
5	12.3	15.8	1.5	3539	Deep brownish red (R-YR-3/4)[b]	Considerable

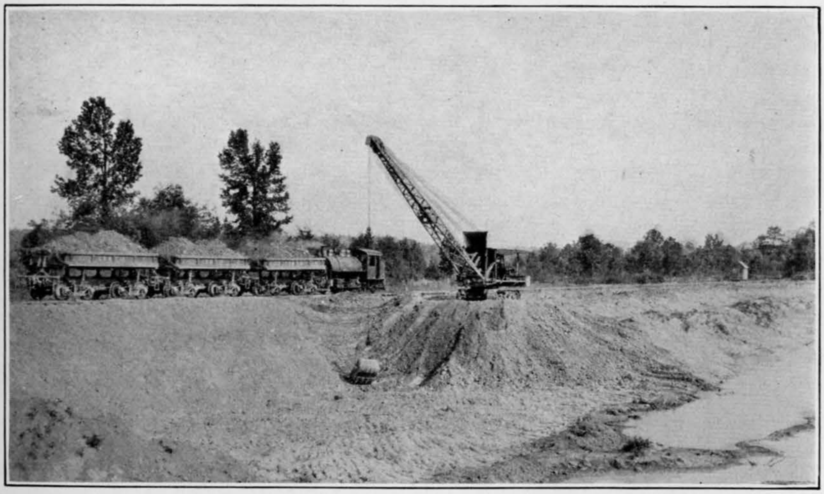
[a]See graph, Figure 13-A, page 171.
[b]Color notation according to the Munsell system, see page 23.

Remarks: One of the bars fired to cone 02 was black-cored. The bars fired to cone 5 were kiln-marked, had a vitreous look on the surface, and their fractures showed a somewhat glassy structure.

Firing Range: Cone 02–4. Commercial kiln: Cone 02–3.



A. OVERTHRUST FAULT IN THE RED MOUNTAIN FORMATION ON THE J. R. MCFARLAND PROPERTY, TWO MILES SOUTH OF ROSSVILLE, WALKER COUNTY.



B. ALLUVIAL CLAY PIT OF THE COLUMBUS BRICK AND TILE COMPANY, COLUMBUS, MUSCOGEE COUNTY.

The above tests indicate that this material is satisfactory for the manufacture of building brick, structural tile, roofing tile, quarry tile, and possibly sewer pipe. The worst feature is the slightly high shrinkage. This would probably be improved if a more sandy clay or a slower slaking shale were mixed with the material tested. The shale and clay tested, while not strictly surficial material, were more or less weathered. This weathered material probably extends 10 to 15 feet or even deeper below the surface. The unweathered material below is liable to contain lime, which should be carefully watched for in prospecting.

MISSION RIDGE BRICK COMPANY

(Map location No. 34.)

The Mission Ridge Brick Company (c/o Miller Bros., Chattanooga, Tenn.) is on the west side of the Central of Georgia Railway at Mission Ridge Station, 3 miles south of Rossville, in Land Lots 101, 102, and 115, 9th District, 4th Section, Walker County.

The plant was built in 1902 by the Miller-Burns Fire Brick Company manufacturing fire brick from a cherty white clay of the residual kaolin type, derived from the Knox dolomite formation which outcrops on the east side of Missionary Ridge near the plant. The property has since that time passed through several hands and the product changed to face brick manufactured from Red Mountain shale from a pit on the opposite side of the ridge.

Shale Pit

The shale pit is on the west side of Missionary Ridge, a quarter of a mile west of the plant. Semi-hard to hard greenish-drab shale striking N. 22° E. and dipping about 25° to the east or towards the center of the ridge is exposed for a vertical distance of 75 to 80 feet in a series of connecting pits or mining levels. Some of the shale breaks into smooth flat pieces, some has a rough hackly fracture, and some weathers flaky. Thin layers of hard sandstone which weathers blocky are fairly numerous especially towards the top of the Red Mountain formation, where the shale between appears to be somewhat soft, short, and sandy. A bed of the red iron ore is said to have once been mined from near the middle of the shale pit, but the writer could find no traces to indicate its location.

Laboratory tests are given below of a grab sample of shale from several levels in the pit. The shale was loosened by blasting, mined by hand, and loaded into small tram cars which were pushed to a tipple on each mining bench over an incline. Larger cars were hoisted on this incline to the top of the ridge and lowered down the further side to the plant. The top of the ridge is about 150 feet above the plant and the lower part of the shale pit. The top and the east slope are covered by chert fragments from the beds of the Knox dolomite which have been thrust up over the younger Red Mountain formation.

Laboratory tests on semi-hard to hard greenish-drab Red Mountain shale from the pit of the Mission Ridge Brick Company, Mission Ridge Station, Walker County.

Chemical Analysis:

Loss on ignition	5.14
Soda (Na_2O)	2.73
Potash (K_2O)	2.78
Lime (CaO)	.00
Magnesia (MgO)	.92
Alumina (Al_2O_3)	16.81
Ferric oxide (Fe_2O_3)	5.67
Ferrous oxide (FeO)	1.43
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.85
Phosphorous pentoxide (P_2O_5)	trace
Silica (SiO_2)	61.83
	99.08

Grinding: Fairly easy, brittle.
Ground Color: Brownish-gray.
Slaking: A little slow.
Plasticity: Poor and grainy at first, fair after aging 3 days.
Molding Behavior: Fair. Tendency for clay column to tear at edges.
Drying Behavior: Test bars somewhat warped.
Water of Plasticity: 21.0 per cent.
Green Modulus of Rupture: 105.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	3.2	6.2	13.1	1052	Dark salmon (2YR-5/5)[b]	Some
04	3.9	6.9	10.7	1542	Fair red (R-YR-4/5)[b]	Some
02	4.8	7.8	7.0	2250	Good red (1YR-4/3)[b]	Some
1	7.7	10.7	6.0	2606	Deep red (R-YR-4/3)[b]	Some
3	4.3	7.6	5.3	2477	Brownish red (R-YR-4/4)[b]	Considerable
5	5.8	8.7	2.7	2694	Deep brownish red (R-YR-3/3)[b]	Considerable

[a]See graph, Figure 13-B, page 171.
[b]Color notation according to the Munsell system, see page 23.

Remarks: One of the test bars fired to cone 04, two fired to cone 02, and all fired to cone 3 were more or less black-cored. The test bars fired to cones 3 and 5 were slightly kiln-marked, had a vitreous appearance on the surface, and their fractures had a somewhat glassy appearance.

Firing Range: Cone 04–2. Commercial kiln: Cone 04–1.

The above tests indicate that this clay is suited for the manufacture of building brick and structural tile and possibly for roofing tile, quarry tile, and sewer pipe. Its tendency to slow slaking with resulting poor plasticity and green strength could probably be improved by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

Plant

The plant, which when visited by the writer had not been in operation for about five years, had the usual equipment of a small brick plant. The shale was ground in a dry pan, tempered and pugged in a single-log pug mill, extruded as a column by a stiff-mud brick machine, and side cut into brick. The green brick were dried in a 6-track steam-heated tunnel drier and fired in four 30-foot round down-draft kilns. The plant at one time had six such kilns. The capacity was about 10,000 brick per day of face brick said to have been of pleasing appearance and good quality. The most objectionable manufacturing feature was probably the cost of hauling the shale from the pit to the top of the ridge and lowering it to the plant.

T. W. BROWN PROPERTY

The T. W. Brown (c/o Brown Fence Co., 1616 Broad St., Chattanooga, Tenn.) property is on Missionary Ridge a quarter to one and a quarter miles south of Mission Ridge Station of the Central of Georgia Railway. It consists of 258 acres in Land Lots 114, 115, 138, and 139, 9th District, 4th Section, Walker County. The property is adjoined on the north by the property of the Mission Ridge Brick Company, described above.

Missionary Ridge, which at this point is 150 to 200 feet in height, extends about N. 25° E. across the property. The west slope of the ridge is underlain by shales and iron ore of the Red Mountain formation of Silurian age, and the top and east slope of the ridge are underlain by cherty debris from the Knox dolomite of Cambrian or Ordovician age, a much older formation which has been pushed up over the Silurian rocks by a thrust fault. The shale beds of the Red Mountain formation are striking parallel to the ridge and dip about 25° to the east or into the ridge. The best exposure of these beds is on a private road leading from the Brown house on the top of the ridge down into the west valley. The highest exposure of shale is about 100 feet below the top of the ridge, and consists of a few feet of soft brownish-drab shale overlying a seam of soft argillaceous red iron ore. This may not represent the top of the Red Mountain formation as higher shale beds may be concealed by chert slumping down from the top of the ridge.

Continuing down the road, the next 50 feet is covered with soil and cherty debris, followed by a few feet of shale separating several thin seams of red iron ore. Below this is about 80 feet of shale varying from soft and brownish-drab at the bottom to semi-hard and greenish-drab at the top. The shale near the top comtains a few thin partings or seams of sandstone. The laboratory tests are given below on a grab sample of this shale taken at intervals all along the outcrop. The 40 feet below this outcrop is partly covered but shows several outcrops of red clay with a few shale fragments and is followed by an outcrop of the Chickamauga limestone that occupies the valley west of the ridge.

The shale deposits therefore are in the form of a deposit 80 feet or more in total vertical thickness and extending for a mile across the property. They could be mined by steam shovel and the pits would have natural drainage. Water for plant operation is available in the valley west of the shale deposits, but the railroad is on the opposite side of the ridge. This problem could be solved by: (1) extending a spur track south from the railroad where it crosses the ridge one and a half to two miles to the north; (2) transporting the shale over the ridge and down to a plant at the railroad by an incline or an aerial-tramway; or (3) tunnelling the ridge at its narrowest point on the property.

Laboratory test on a grab sample of soft to semi-hard greenish-drab Red Mountain shale from the T. W. Brown property, three-quarters of a mile south of Mission Ridge Station, Walker County.

Chemical Analysis:

Loss on ignition	5.34
Soda (Na_2O)	1.63
Potash (K_2O)	1.98
Lime (CaO)	.00
Magnesia (MgO)	.12
Alumina (Al_2O_3)	23.25
Ferric oxide (Fe_2O_3)	6.56
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.07
Silica (SiO_2)	59.98
	99.84

Grinding: Easy.
Ground Color: Brown.
Slaking: A little slow.
Plasticity: Poor and "short" at first, fair after aging overnight.
Molding Behavior: Fair. Slight tendency for clay column to tear on edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 23.9 per cent.
Green Modulus of Rupture: 102.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.7 per cent.

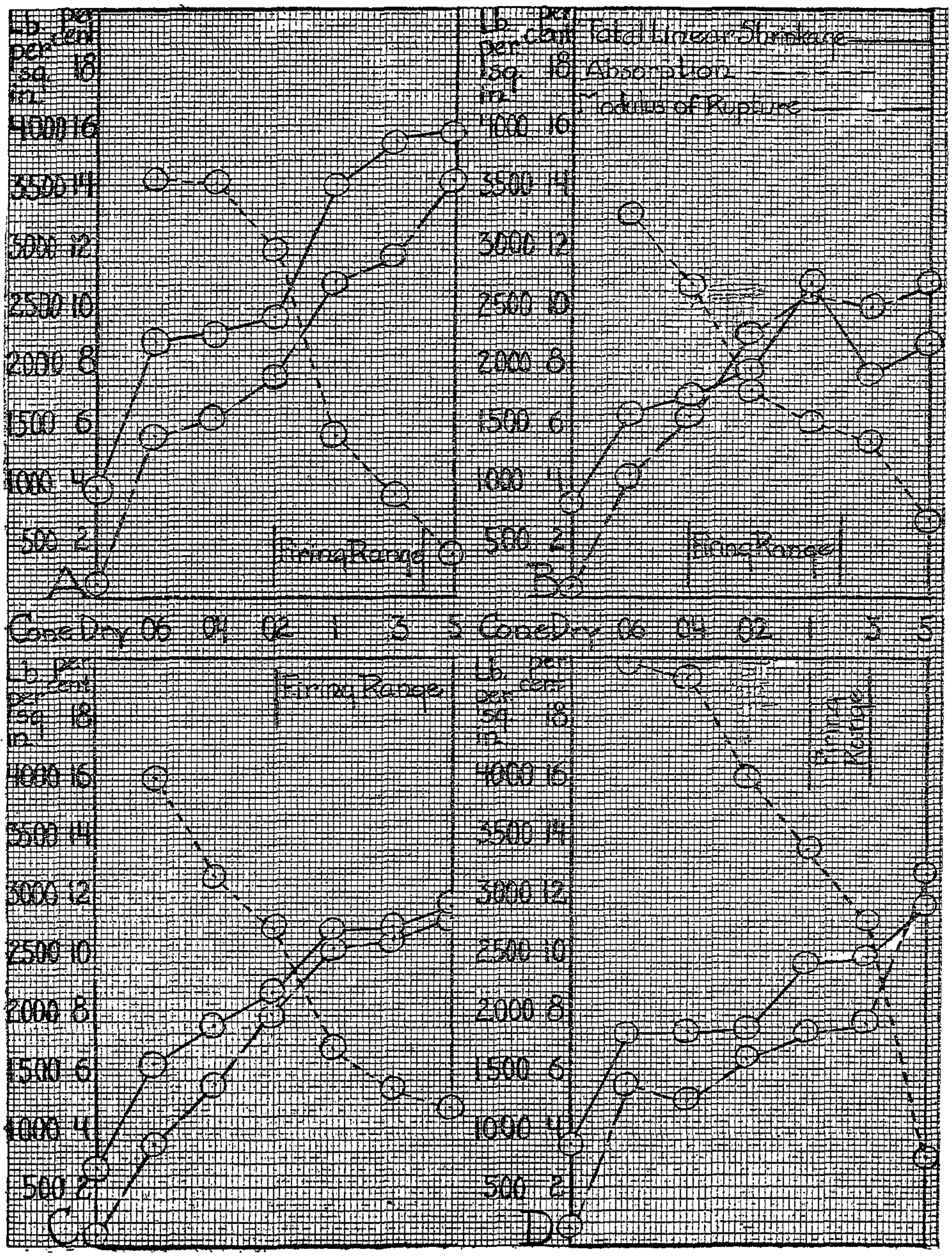


Figure 13. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Sandy weathered Red Mountain shale from the J. R. McFarland property, 2 miles south of Rossville, Walker County.

B. Red Mountain shale from the Mission Ridge Brick Co., Mission Ridge Station, Walker County.

C. Red Mountain shale from the T. W. Brown property, just south of Mission Ridge Station, Walker County.

D. Shale from the Ike Duckett property, one mile east of Varnell, Whitfield County.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	3.3	6.2	15.9	889	Dark salmon (2YR-6/8)[b]	Slight
04	4.8	7.5	12.5	1382	Fair red (1YR-5/7)[b]	Slight
02	6.1	8.6	10.8	1985	Good red (R-YR-5/5)[b]	Some
1	8.4	10.7	6.7	2533	Good red (R-YR-4/5)[b]	Some
3	8.4	10.8	5.3	2611	Good red (R-YR-4/4)[b]	Considerable
5	9.1	11.5	4.7	2785	Dark red (R-YR-4/3)[b]	Considerable.

[a]See graph, Figure 13-C, page 171.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5. Commercial kiln: Cone 02–4.

The above tests indicate that this shale is suitable for the manufacture of building brick, structural tile, and possibly for roofing tile and sewer pipe. The tendency of the shale to be slow slaking could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

The shale sampled was more or less weathered. It is possible that 10 to 25 feet under the surface the shale would be too hard and nonplastic for use by itself. A mixture of such hard shale and the weathered material or a plastic clay, such as that showing in the outcrops at the foot of the slope, might be satisfactory. Care should be taken in prospecting to watch out for sandstone layers and especially for the presence of lime, which might cause scumming and narrow the firing range.

CATOOSA COUNTY

Catoosa County, which is east of Walker County, is partly in the Chickamauga Valley and partly in the Armuchee Ridges, physiographic divisions of the Appalachian Valley of Georgia (see Figure 3, page 49). The boundary between the two divisions is Taylor Ridge and its continuation to the north, White Oak Mountain. This ridge is formed by the heavy resistant sandstone beds that almost entirely make up the Red Mountain formation in this county. Chickamauga Creek has cut through the ridge at Ringgold, the county seat, forming the gap through which the East Branch of the Dixie Highway and the State owned Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway) pass on their way from Atlanta to Chattanooga.

The beds underlying the west or Chickamauga Valley part of Catoosa County can be seen along the Ringgold to Chickamauga Park road which crosses them at right angles to their strike. From east to west the following formations are encountered: a narrow belt of the Chickamauga limestone at Ringgold; a broad band of the Knox dolomite, the cherty layers of which have formed low ridges; a narrower belt of the Conasauga formation, largely composed of argillaceous limestones, forming the valley of Peavine Creek; a narrower belt of the Knox dolomite forming the Peavine Ridges; a broad area of the Chickamauga limestone forming the valley of West Chickamauga Creek and underlying a part of the famous Chickamauga Battle Field; and, at the intersection of the road with the West Branch of the Dixie Highway at Chickamauga Park, another area of the Knox dolomite.

East of Taylor Ridge and White Oak Mountain is another valley, drained also by Chickamauga Creek through the gap at Ringgold. Just east of the ridge is an irregular area underlain by the Floyd shale, which here is largely composed of sandstones and very sandy shales. This is succeeded on the east by a broad belt of the siliceous shales of the Rome formation, a part of which was mapped by Hayes [1] as the Apison shale, and a narrower belt of the Knox dolomite.

Catoosa County apparently contains no deposits of shale suitable for the manufacture of heavy clay products. The shales of the Rome formation are much too siliceous to be of value. The Conasauga formation in the valley of the Peavine Creek is largely valley forming, and the only shale outcrops seen were far from a railroad. The Red Mountain formation is here composed of heavy-bedded sandstone with a few very siliceous shale beds. The Floyd shale in this area is composed of soft sandstones and very siliceous shales and clays.

WHITFIELD COUNTY

Whitfield County is east of Catoosa and Walker counties and north of Gordon County. The Conasauga River forms the east boundary and the Tennessee State Line the north boundary of the county. Dalton, the county seat, is a thriving manufacturing town and trading center. The Atlanta to Chattanooga line of the Southern Railway and the State owned Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway) cross at Dalton, the Southern Railway following a narrow valley of the Conasauga formation north to the Tennessee line, the Western and Atlantic turning

[1] Hayes, C. W., U. S. Geol. Survey Geol. Atlas, Ringgold folio (No. 2), 1892.

northwest through the gap in Chattoogata Mountain at Rocky Face and entering Catoosa County near Tunnel Hill.

The western part of Whitfield County is in the physiographic division known as the Armuchee Ridges (see page 47). The eastern boundary of the Armuchee Ridges at this point is Chattoogata Mountain. The valley of Mill Creek just west of Chattoogata Mountain is underlain by the Chickamauga limestone, the top of which includes beds of brownish sandy shales (see page 59). Next to the west is a belt of Knox dolomite, at places forming a low ridge, followed by the valley of East Chickamauga Creek which is underlain by a narrow belt of the Conasauga formation and a wider belt of the Rome formation. The shales of the Rome formation in this belt are too siliceous to be suitable for the manufacture of heavy clay products. No shale outcrops were observed in the narrow belt of the Conasauga formation near the railroad at Tunnel Hill.

The middle and eastern part of the county are in the physiographic division known as the Rome Valley. It is a broad rolling valley area draining by numerous creeks into the Conasauga River, and largely underlain by irregular areas of the Rome, Conasauga, and Knox dolomite formations. The Rome formation, as mapped by Hayes[1] and shown on the geologic map facing page 66, is largely composed of siliceous shales of no value for the manufacture of heavy clay products. The outcrops in the vicinity of Tilton on the Western and Atlantic Railroad (Nashville, Chattanooga and St. Louis Railway) in the southern part of the county are of this type. East of Dalton the formation, as mapped, contains beds of clay shale with thin sandstone or chert partings, a few deposits of which are described below. The Conasauga formation at places contains deposits of shale suitable for the manufacture of heavy clay products, a number of which are described below. At other places the formation is composed largely of limestone, or is valley forming and presents no outcrops. Small areas of the Athens shale and Tellico sandstone, shown on the geologic map facing page 66 as Chickamauga limestone, crop out in the vicinity of Dalton and in a narrow belt in the northern part of the county east of Varnell.

The Rome Fault, described in Floyd County on page 73, enters Whitfield County south of Carbondale and continues north at the foot of the east slope of Chattoogata Mountain. At Carbondale the Conasauga formation has been thrust over an area of the Floyd shale, here composed of a sandy clay with occasional layers of soft sandy shale. One deposit of this Floyd shale has been described below.

IKE DUCKETT PROPERTY

(Map location No. 36)

The Ike Duckett (Dalton) property, known as the old D. W. Barry place, is north of the Varnell to Praters Mill Road, one mile east of

[1]Hayes, C. W., Manuscript geologic map of the Dalton Quadrangles.

Varnell. It includes parts of Land Lots 205 and 206, 11th District, 3d Section.

The road from Varnell to Cohutta and Red Clay makes a sharp bend to the southeast on this property, descending from a low Knox dolomite ridge to cross one of the headwater branches of Spring Creek. At this bend the cuts of the road show hard fissle greenish-drab to olive-green shale, weathering into flat pieces rather than flaky, and greatly resembling the shales of the Red Mountain formation. It is striking N. 30° E. and dipping 20° to 25° SE. The road outcrop is some 40 to 50 feet long but probably does not represent more than 15 to 20 feet in stratigraphic thickness. It is underlain by soft red somewhat sandy iron ore of which 6 inches is visible, but the soil is very red for about 3 feet. A few outcrops of massive crystalline limestone are showing near the branch, some 300 feet east of the shale outcrops.

The east slope of the ridge for five-eighths of a mile south of these outcrops to the Varnell-Praters Mill road is underlain by a belt of the shale 100 feet or more in width, as shown by fragments in the soil and a few small outcrops. Some of the outcrops in the field were of softer shale than that by the road. The laboratory tests are given below on a grab sample of the shale from the road outcrop and from a smaller and softer outcrop in the field near the southern end of the property.

These beds were mapped by Hayes[1] as belonging to the Athens shale and Tellico sandstone. According to Hull[2], who described the manganese deposits of this region:

> "The rocks of the district are Cambrian and Ordovician formations, including the Knox dolomite, Holston marble, and Tellico sandstone, named in ascending order. The Holston marble outcrops in the valleys and the Tellico sandstone forms the low broken hills mantled with red soil. The general strike is north-northeast parallel to the folding and faulting. The Tellico formation contains red calcareous sandstone and siliceous limestone. It uncomfortably overlies the Holston marble. Both formations contain pelmatozoans, bryozoans, and other Paleozoic fossils."

The crystalline limestone or marble outcrops noted on the property are overlying the shale and the iron ore. Therefore if the iron ore is in the Tellico sandstone formation, the limestone cannot be correlated with the Holston marble.

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[1]Op. cit.

[2]Hull, J. P. D., and others, Manganese deposits of Georgia: Georgia Geol. Survey Bull. 35, pp. 189–196, 1919.

Laboratory tests on hard to soft greenish-drab shale from outcrops on the Ike Duckett property, 1 mile east of Varnell, Whitfield County.

Chemical Analysis:

Loss on ignition	9.39
Soda (Na_2O)	trace
Potash (K_2O)	3.31
Lime (CaO)	3.20
Magnesia (MgO)	.20
Alumina (Al_2O_3)	21.40
Ferric oxide (Fe_2O_3)	7.14
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.19
Silica (SiO_2)	54.08
	100.00

Grinding: Easy.
Ground Color: Brown.
Slaking: Fairly rapid.
Plasticity: Good.
Molding Behavior: Fairly good. Slight tendency for clay column to tear on edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 25.1 per cent.
Green Modulus of Rupture: 137.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.9	7.2	19.8	1378	Dark salmon (1YR-5/6)[b]	Very slight
04	4.4	7.3	19.3	1218	Light red (R-YR-5/5)[b]	Very slight
02	3.7	7.4	15.9	1588	Medium red (R-YR-4/5)[b]	Slight
1	6.6	9.6	13.5	1802	Good red (R-YR-4/4)[b]	Some
3	6.4	9.8	11.0	1871	Good chocolate red (R-YR-4/3)[b]	Some
5	8.3	11.6	3.0	3153	Dark chocolate (R-YR-3/3)[b]	Considerable

[a]See graph, Figure 13-D, page 171.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars at all cones except 3 and 5 showed traces of a yellowish-white scum, probably not in sufficient qualities to be a serious detriment in the manufacture of heavy clay products. The bars fired to cone 5 were slightly kiln-marked, their surface had a vitreous look, and their broken ends showed the beginnings of a glassy structure.

Firing Range: Cone 1–3. Commercial kiln: Cone 02–2.

The above tests indicate that this shale is suitable for the manufacture of building brick. The firing range is rather short, but the colors within that range are good.

WEST AND THOMAS PROPERTIES.

(Map location No. 38)

The J. A. West (Dalton, Rt. 2) and the R. L. P. Thomas (Dalton, Rt. 2) properties are two and a half miles east of Dalton at the forks of the Tibbs Bridge road and the Piney Grove road, near the corner between Land Lots 242, 243, 252, and 253, 12th District, 3d Section. The nearest railroad is the Nashville, Chattanooga and St. Louis Railway and the Southern Railway just south of Dalton, about 2 miles southwest of these properties.

The cuts of the public roads between the West property on the north and the Thomas property on the south show outcrops of soft to semi-hard brownish- to greenish-drab shale varying from waxy to "short" and sandy and breaking into blocks and flat fragments one-half to one inch in thickness. Interbedded with the shale are very thin sandstone or chert layers and several thick layers of brown sandy clay. The beds are striking nearly due north and are dipping 75° to 80° to the east.

These beds are in an area mapped by Hayes[1] as the Rome formation. They are quite different from the typical fissle olive-green Conasauga shale of the Dalton Brick and Tile Company and other properties to the south, yet neither do they resemble the very siliceous shales of the typical Rome formation found in the vicinity of Tilton and in the belt that extends southwest to Rome.

The laboratory tests are given below of a sample of the shale taken at 5-foot intervals along a cut about 100 feet in length at nearly right angles to the strike of the beds. A large area in this vicinity, on the gently rolling ridge between Mill Creek and Davis Creek, is probably underlain by this shale.

[1]Hayes, C. W., Manuscript geologic map of the Dalton quadrangle.

Laboratory tests on a sample of soft to semi-hard brownish and greenish-drab shale from the West and Thomas properties 2½ miles east of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	7.37
Soda (Na_2O)	1.23
Potash (K_2O)	.70
Lime (CaO)	.00
Magnesia (MgO)	.06
Alumina (Al_2O_3)	21.29
Ferric oxide (Fe_2O_3)	7.28
Titanium dioxide (TiO_2)	1.11
Sulphur trioxide (SO_3)	1.22
Phosphorus pentoxide (P_2O_5)	.47
Silica (SiO_2)	59.26
	99.99

Grinding: Easy.
Ground Color: Brown.
Slaking: Slow.
Plasticity: Poor. Short and grainy.
Molding Behavior: Poor. Tendency for clay column to tear on edges.
Drying Behavior: Test bars all show some warpage.
Water of Plasticity: 23.2 per cent.
Green Modulus of Rupture: 135.3 pounds per square inch.
Linear Drying Shrinkage (Based on plastic length): 3.2 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.9	6.3	18.5	670	Light salmon (3YR-6/6)[b]	Some
04	3.1	6.1	16.5	966	Medium salmon (1YR-6/5)[b]	Some
02	3.3	6.5	16.0	1000	Salmon (2YR-6/6)[b]	Slight
1	5.9	8.8	12.9	1462	Light red (1YR-5/5)[b]	Slight
3	6.3	9.0	11.6	1507	Good red (R-YR-5/5)[b]	Considerable
5	6.3	9.2	11.0	1861	Deep red (R-YR-5/4)[b]	Considerable

[a]See graph, Figure 14-A, page 185.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–6 and higher. Commercial kiln: Cone 01–6.

The above tests indicate that this shale is suitable for the manufacture of building brick. The deposit is rather far from the railroad to be used in the immediate future.

DALTON–CHATSWORTH HIGHWAY

Numerous outcrops beside the Dalton-Chatsworth Highway along the ridge from the cemetary, two and a half miles east of Dalton, to Mill Creek a mile further to the east, show shale similar to that described above on the West and Thomas properties. At places the shale is more fissle and more nearly resembles the Conasauga rather than the Rome formation. At places, especially near the west end of these outcrops, there are alternate bands of shale and somewhat sandy brown clay. Thin layers of sandstone are fairly frequent, but make up only a small part of the deposits.

Much contorted siliceous shale full of sandstone and resembling the typical Rome formation is showing just east of Mill Creek. The east slope of the ridge between Mill and Coahulla creeks shows outcrops of olive-green fissle shale, typical of the Conasauga formation. These deposits are all too far from the railroad to be of value for the manufacture of heavy clay products.

J. H. SMITH PROPERTY

(Note. The location number 37, on the geologic map facing page 66, should be a mile further southeast at the junction of the road to the river and the road to the southwest crossing Carpenter Creek.)

The J. H. Smith (Dalton, Rt. 2) property is on the River Bend Road just beyond the junction with the Antioch Church Road, two miles southeast of Dalton and one mile east of the Nashville, Chattanooga and St. Louis Railway and the Southern Railway. The property consists of about 30 acres lying between the two roads and east of the River Bend Road, in Land Lot 279, 12th District, 3d Section.

Scattered outcrops along the road and in the fields expose alternate bands of soft flaky brownish-drab shale and somewhat sandy reddish-brown clay. Some of the shale weathers blocky rather than flaky. These outcrops are near the boundary between the Conasauga shale and the Rome formation as mapped by Hayes[1].

They more nearly resemble the shale sampled on the West and Thomas properties and described above than the typical Conasauga shale on the Dalton Brick and Tile Company property described on page 181. The laboratory tests on a grab sample of this shale and clay are given below.

[1]Hayes, C. W., Op. cit.

Laboratory tests on soft brownish-drab shale and reddish-brown clay from the J. H. Smith property, 2 miles southwest of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	6.15
Soda (Na_2O)	.15
Potash (K_2O)	1.23
Lime (CaO)	trace
Magnesia (MgO)	.63
Alumina (Al_2O_3)	22.50
Ferric oxide (Fe_2O_3)	7.43
Titanium dioxide (TiO_2)	.54
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.19
Silica (SiO_2)	61.26
	100.08

Grinding: Easy.
Ground Color: Light brown.
Slaking: Fairly rapid.
Plasticity: Fairly good. A trifle "short" and mealy.
Molding Behavior: Good.
Drying Behavior: All test bars somewhat warped.
Water of Plasticity: 27.6 per cent.
Green Modulus of Rupture: 117.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	1.6	6.4	23.1	423	Light salmon (YR-6/7)[b]	Some
04	3.0	7.0	19.9	705	Medium salmon (4YR-6/7)[b]	Slight
02	2.7	7.3	20.2	552	Salmon (4YR-6/8)[b]	Some
1	4.3	8.8	18.1	867	Light red (2YR-5/6)[b]	Some
3	4.7	8.7	16.1	1090	Good red (R-YR-5/5)[b]	Some
5	5.8	10.5	15.8	1137	Deep red (1YR-5/5)[b]	Considerable

[a]See graph, Figure 14-B, page 185.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–7 and higher. Commercial kiln: Cone 2–7.

The above tests indicate that this material has possibilities for the manufacture of building brick, although its high porosity and low strength might limit it to common brick only. The property should be prospected to determine the character and extent of the deposits.

The River Bend road half a mile southeast of the J. H. Smith property climbs slightly to a low ridge underlain by similar or somewhat more fissle shale. Outcrops are found on the properties Rev. J. T. Nichols, F. J. Nelson, Andrew Nix, and G. E. Smith. These properties are 1½ to 2 miles east of the Nashville, Chattanooga and St. Louis Railway and the Southern Railway. Similar exposures of shale were seen south of High Point School all the way to the river.

DALTON BRICK AND TILE COMPANY

(Map location No. 39)

Headquarters: Dalton, Georgia.

P. B. Fite, President.

W. H. Erskin, Superintendent.

The face brick plant of the Dalton Brick and Tile Company is on the east side of the Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway), three miles south of Dalton. The plant was built in 1924 and has been in nearly continuous operation ever since.

Shale Pit

The shale pit is an eighth of a mile due east of the plant on a low ridge caused by outcrops of the shale of the Conasauga formation. The shale in general is brownish-drab in color and weathers into thin flat pieces and large flakes. It is striking N. 10° E. and is nearly vertical, although at places it is somewhat contorted and shows various dips.

The shale is mined by steam-shovel, loaded into steel side-dump mining cars, and transported to the plant by a gasoline engine of the converted tractor type.

The following laboratory tests were made on a sample of the shale obtained by taking several green and dried brick at random.

Laboratory tests on semi-hard brownish-drab Conasauga shale from the Dalton Brick and Tile Company, 3 miles south of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	6.66
Soda (Na_2O)	.30
Potash (K_2O)	1.64
Lime (CaO)	.55
Magnesia (MgO)	.14
Alumina (Al_2O_3)	14.73
Ferric oxide (Fe_2O_3)	6.38
Titanium dioxide (TiO_2)	.36
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	69.10
	99.97

Grinding: Easy.
Ground Color: Yellowish-brown.
Slaking: Fairly rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Good.
Water of Plasticity: 25.5 per cent.
Green Modulus of Rupture: 400.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.0	9.9	14.5	1398	Light red (2YR-5/6)[b]	Slight
04	4.0	10.0	11.7	1757	Fair red (R-YR-4/5)[b]	Slight
02	4.7	10.6	8.8	2208	Medium red (R-YR-4/4)[b]	Slight
1	6.1	12.2	9.0	2281	Good red (R-YR-4/3)[b]	Slight
3	5.7	11.6	6.6	2527	Good red (R-YR-3/5)[b]	Considerable
5	7.3	13.4	5.0	3112	Deep red (8R-3/3)[b]	Some

[a]See graph, Figure 14-C, page 185.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 03–5. Commercial kiln: Cone 04–4.

Plant

At the plant the shale is dumped onto a large stock pile, from which it is fed to two dry pans for grinding. Bucket elevators carry the ground shale to 16 mesh vibratory screens, from which the oversize is returned to the dry pans and the undersize is fed to a double-log pug mill, where water is added and the shale is tempered and pugged to a plastic clay. The plastic clay from the pug mill is discharged into a stiff-mud auger brick machine, where the clay is forced through a die and extruded in the form of a continuous column which is automatically cut into side-cut brick.

The green brick are hacked onto steel drying cars, dried at 250° F. in a 12-track direct-fired radient heat tunnel drier, and transported on the cars to the kilns. The bricks are fired to about 1950° F. in six 32-foot round down-draft kilns. Most of the kilns are flashed (see page 29) at the end of the firing period to produce deeper colors. The temperature is controlled and the end point determined by electrical pyrometors.

The capacity of the plant is about 40,000 brick per day. The product is an excellent quality shale face brick in colors ranging from light red through deep cherry-red to almost black. The production is about evenly divided between smooth surface and rough surface or "velvet texture" brick. Shipments are made to all Southern states. The underfired and second quality brick are sold as common brick. The company is planning to manufacture structural tile, floor tile, and roofing tile at a later date.

BUELL STARK PROPERTY

(Map location No. 40.)

The Buell Stark (Dalton, Rt. 1) property is on the east side of the Nashville, Chattanooga and St. Louis Railway, three and a half miles south of Dalton and half a mile south of the Dalton Brick and Tile Company, in Land Lot 9, 13th District, 3d Section.

The property is crossed by a low ridge parallel to the railroad and 75 to 100 feet in height, underlain by shale of the Conasauga formation. The old Dalton-Calhoun highway and another road running due east cross the ridge and expose outcrops of soft to semi-hard brownish-drab and greenish shale striking a little east of north and dipping nearly vertically into the ground. Most of the shale is fairly fissle and flaky, although some layers are sandy and there are a few thin layers of weathered sandstone and a few layers up to a foot in thickness of sandy brown clay. The outcrops are at least 450 feet across and extend onto the W. M. Camp (Dalton, Rt. 1) property on the east slope of the ridge. A 5-foot outcrop of shaly limestone is exposed by the old highway at the foot of the ridge.

The following laboratory tests were made on a grab sample taken at intervals along both roads and is probably representative of the shale exposed:

Laboratory tests on a sample of soft to semi-hard brownish- and greenish-drab Conasauga shale from the Buell Stark property, 3½ miles south of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	7.38
Soda (Na_2O)	1.22
Potash (K_2O)	.70
Lime (CaO)	.00
Magnesia (MgO)	.06
Alumina (Al_2O_3)	24.10
Ferric oxide (Fe_2O_3)	7.20
Titanium dioxide (TiO_2)	1.11
Sulphur trioxide (SO_3)	1.21
Phosphorus pentoxide (P_2O_5)	.47
Silica (SiO_2)	56.86
	100.31

Grinding: Easy.
Ground Color: Brown.
Slaking: A little slow.
Plasticity: Fair. A trifle "short" and mealy.
Molding Behavior: Fair. Tendency for clay column to tear on edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 29.2 per cent.
Green Modulus of Rupture: 180.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 7.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.5	11.1	16.4	931	Salmon (3YR-5/6)[b]	Slight
04	5.0	11.7	14.6	1030	Deep salmon (R-YR-5/5)[b]	Slight
02	7.2	13.6	10.7	1493	Light red (R-YR-5/4)[b]	Considerable
1	7.6	13.9	10.1	1531	Medium red (R-YR-5/4)[b]	Slight
3	7.4	13.9	8.9	1520	Good red (R-YR-4/4)[b]	Considerable
5	8.5	15.0	7.0	1927	Chocolate red (R-YR-3/5)[b]	Some

[a]See graph, Figure 14-D, page 185.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–6. Commercial kiln: Cone 03–5.

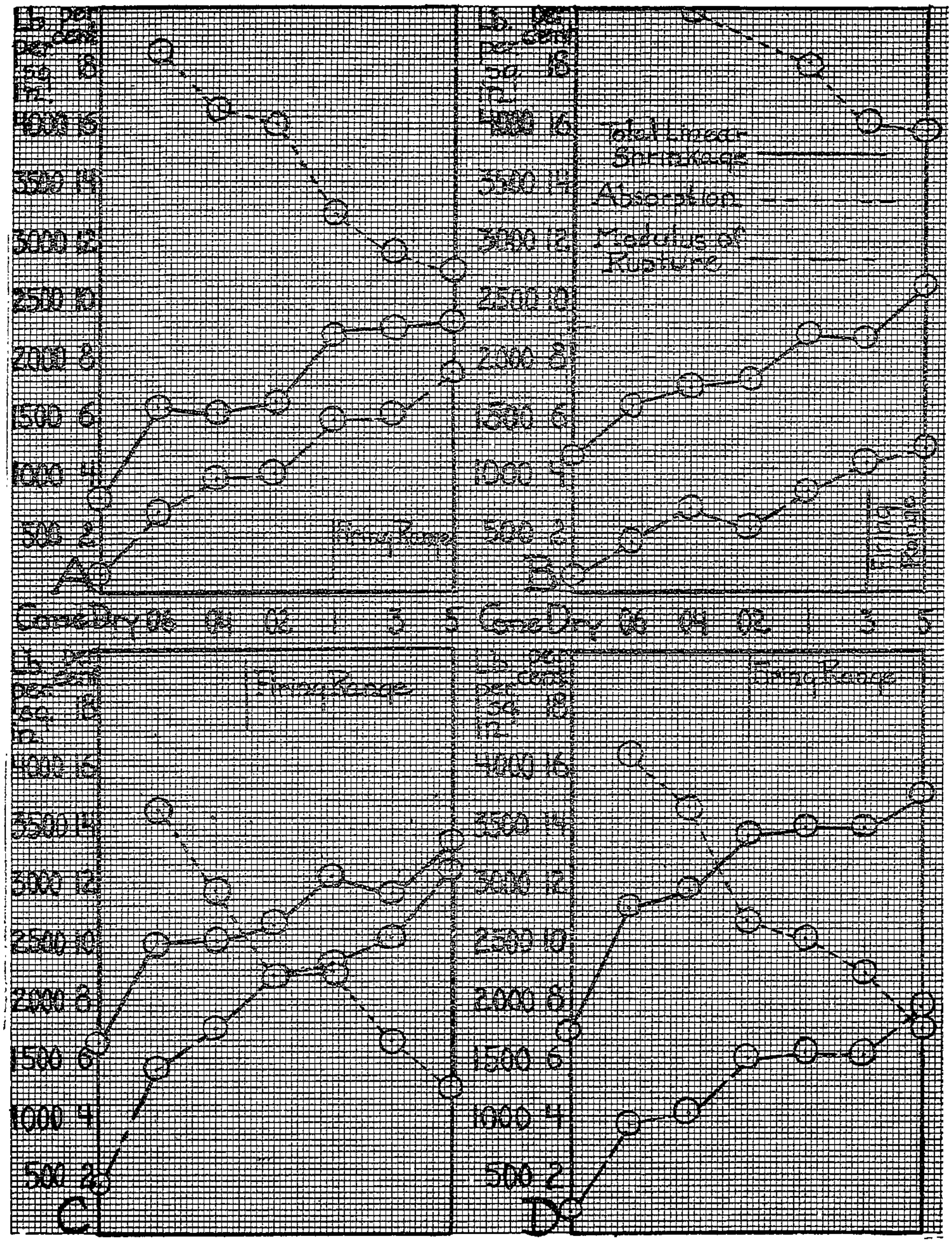


Figure 14. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Rome shale from the West and Thomas properties, 2 miles east of Dalton, Whitfield County.

B. Rome shale from the J. H. Smith property, 2 miles southeast of Dalton, Whitfield County.

C. Conasauga shale from the Dalton Brick & Tile Co., 3 miles south of Dalton, Whitfield County.

D. Conasauga shale from the Buell Stark property, 4 miles south of Dalton, Whitfield County.

The above tests indicate that the shale sampled is suitable for the manufacture of building brick and possibly structural tile, sewer pipe, and roofing tile. The total shrinkage is a little high but would probably be reduced with the inclusion of less weathered material.

These two properties should be thoroughly prospected to determine the extent of the shale deposits. Mr. Stark estimates that at least 40 acres of his property and 30 acres of the W. M. Camp property are underlain by shale similar to that sampled. In prospecting, careful watch must be made for the presence of lime in the shale. The deposits are well situated adjoining and above a flat plant site on the railroad and could be mined by steam shovel with natural drainage in the pits. Sufficient water for plant purposes could probably be obtained from Jobs Creek nearby.

THOMAS PROPERTIES

(Map location No. 41)

The W. F. Thomas (Dalton) property is east of the Nashville, Chattanooga and St. Louis Railway, and the Mrs. N. A. Thomas (Dalton) property is west of the Southern Railway, just north of the point where the two railroads bend away from each other after adjoining for four miles south of Dalton. The properties are in Land Lot 28, 13th District, 3d Section, Whitfield County.

Both sides of a railroad cut about 10 feet deep and several hundred feet long show a stiffly-plastic brownish-red to mottled yellow and red clay with a little very soft waxy brownish-drab shale. The deposit appears to be partly residual and partly colluvial in origin. At one place the clay contains a little water-worn gravel.

The laboratory tests are given below on a grab sample of the clay and shale from several places in the cut. Prospecting would be necessary to determine whether or not it is representative of a sizable deposit. The topography west of the railroads is such that it is doubtful if there is much of a deposit above drainage level. East of the railroads the land gradually rises to a low ridge, a continuation of the one on the Stark property described above, that may be underlain by the Conasauga shale.

Laboratory tests on a sample of reddish-brown clay and very soft brownish-drab shale from railroad cuts on the W. F. and Mrs. N. W. Thomas properties, 4 miles south of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	8.47
Soda (Na_2O)	1.51
Potash (K_2O)	.96
Lime (CaO)	.00
Magnesia (MgO)	.15
Alumina (Al_2O_3)	20.99
Ferric oxide (Fe_2O_3)	8.79
Titanium dioxide (TiO_2)	1.13
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.38
Silica (SiO_3)	57.52
	99.90

Grinding: Easy.
Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Test bars all somewhat warped.
Water of Plasticity: 33.9 per cent.
Green Modulus of Rupture: 161.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 7.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	5.1	12.5	17.0	1051	Salmon (3YR-6/8)[b]	Some
04	5.2	12.6	16.2	1011	Deep salmon (2YR-5/6)[b]	Some
02	7.6	14.8	10.5	1377	Light red (R-YR-4/5)[b]	Considerable
1	9.7	16.6	9.2	1490	Medium red (1YR-4/5)[b]	Considerable
3	8.7	15.4	9.3	1460	Good red (R-YR-4/4)[b]	Considerable
5	9.3	15.9	8.1	1647	Chocolate red (R-YR-4/3)[b]	Some

[a]See graph, Figure 15-A, page 191.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–6. Commercial kiln: Cone 03–5.

The above tests indicate that this material is suitable for the manufacture of building brick and possibly structural tile. The drying and firing shrinkages are a little high. The ceramic properties would probably be improved by the addition of a harder and less plastic shale.

W. C. MARTIN PROPERTY

(Map location No. 42)

The W. C. Martin (Dalton) property consists of about a thousand acres of land lying between the Southern Railway and the Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway), south of Phelps Station and in the vicinity of Swamp Creek, some six to eight miles south of Dalton. The East Branch of the Dixie Highway crosses the property for two miles south of the overhead bridge over the Southern Railway.

The Dixie Highway just southeast of the overhead bridge over the Southern Railway, in Land Lot 80, 13th District, 3d Section, cuts through a low knoll or ridge, exposing for about 300 feet beds of soft brownish-drab Conasauga shale striking N. 6° E. and dipping 75° E. The shale varies from soft and flaky to slightly harder, blocky and waxy looking, with a few black streaks. Interbedded with the shale are a few thin partings of soft very plastic bluish-gray clay and a few layers up to 6 inches in thickness of somewhat sandy brown clay. The laboratory tests are given below on a sample of the shale taken at intervals all along the outcrop.

The low ridge extends north of the highway for about a quarter of a mile. The 25 or 30 acres on it should be prospected to determine the extent of the deposit. There is a flat plant site adjoining the Southern Railway south of the highway. Water could be obtained from Swamp Creek to the south.

Laboratory tests on soft brownish-drab Conasauga shale from the W. C. Martin property on the Southern Railway 6 miles south of Dalton, Whitfield County.

Chemical Analysis:

Loss on ignition	8.32
Soda (Na_2O)	1.00
Potash (K_2O)	1.03
Lime (CaO)	.00
Magnesia (MgO)	.10
Alumina (Al_2O_3)	25.44
Ferric oxide (Fe_2O_3)	7.44
Titanium dioxide (TiO_2)	.93
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.12
Silica (SiO_2)	55.62
	100.00

Grinding: Easy.
Ground Color: Brown.
Slaking: Fairly rapid.
Plasticity: Fairly good. Slightly mealy and "short".
Molding Behavior: Good.
Drying Behavior: Test bars all somewhat warped.
Water of Plasticity: 29.3 per cent.
Green Modulus of Rupture: 115.8 pounds per square inch.
Linear Firing Shrinkage (based on plastic length): 5.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.6	8.2	19.1	823	Light salmon (3YR-6/7)[b]	Some
04	4.3	9.2	16.8	787	Medium salmon (2YR-6/6)[b]	Slight
02	6.1	11.3	13.9	1144	Salmon (1YR-5/6)[b]	Some
1	7.0	12.0	12.5	1324	Medium red (R-YR-5/5)[b]	Some
3	7.4	12.3	10.0	1533	Good red (R-YR-4/5)[b]	Some
5	8.0	13.2	9.5	1563	Chocolate red (R-YR-4/4)[b]	Considerable

[a]See graph, Figure 15-B, page 191.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–6. Commercial kiln: Cone 02–5.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile. The total shrinkage is somewhat high, but this could probably be lowered by the inclusion of some harder and less weathered shale.

Another highway cut about three-quarters of a mile south of the overhead bridge exposes alternate layers of soft brownish to greenish-drab shale and sandy brown clay. The clay is much contorted and contains a few thin layers of sandstone or chert. This is half a mile east of the Southern Railway and nearly two miles west of the Nashville, Chattanooga and St. Louis Railway. Half a mile further south on the south side of Swamp Creek another highway cut exposes contorted greenish-drab shale full of irregular layers of dark-blue argillaceous limestone. Some of these limestone layers contain the irregular white calcite veinlets typical of the limestones of the Conasauga formation.

The road leading east from the overhead bridge across a part of the north end of the property to the Nashville, Chattanooga and St. Louis Railway does not expose many outcrops, but some soft flaky shale mixed with reddish-brown clay is showing. A low ridge just west of and parallel with the railroad should be prospected. A few outcrops of fissle and flaky greenish-drab shale are showing on this ridge.

CROWN COTTON MILL COMPANY PROPERTY

The property of the Crown Cotton Mill Company (Dalton) is adjoining and north of the W. C. Martin property described above, some six miles south of Dalton on the road from Center Point School and the bridge over the Southern Railway on the East Branch of the Dixie Highway to the Nashville, Chattanooga and St. Louis Railway.

The ditch and cuts of the road on a low ridge half a mile east of the Southern Railway expose outcrops of a mixture of mottled red and brown stiffly-plastic clay and soft yellowish-drab shale, in appearance much like that sampled on the West and Thomas properties and described on page 177. Probably about 15 or 20 acres are underlain by this material.

Outcrops on the slope of a ridge to the east of this show alternate bands 5 or 6 feet in width of soft greenish-drab shale and reddish-brown clay. At the top of the hill is a 30-foot outcrop of the shale with no clay layers. This ridge should be thoroughly prospected to determine the extent and character of the deposits. The clay bands interbedded with the shale may be derived from the weathering of an argillaceous limestone, and careful watch for lime must be made in prospecting. The Nashville, Chattanooga and St. Louis Railway is in the valley just east of this ridge.

CARBONDALE CUT

(Map location No. 43)

The Southern Railway just south of Carbondale Station, about nine miles south of Dalton, passes through a cut about 1,000 feet in length and 15 to 25 feet in depth. The land between the railroad and the public road to the east, about 5 acres is owned by Mrs. Nannie Masters. The land west of the road is owned by J. B. Stone (Dalton, Rt. 1). Both properties are in Land Lot 187, 13th District, 3d Section, Whitfield County.

The sides of the cut expose soft brown sandy and slightly fissle weathered shale grading into clay at places. The beds are striking N. 15° E., nearly parallel with the railroad, and are dipping 60° to 70° to the east. The following laboratory tests were made on a grab sample taken at intervals on both sides of the railroad.

A glance at the geologic map facing page 66 shows that the Rome Fault (see page 50) swings across the railroad at this point and that the material in the cut, so different in appearance from the shales or even the residual clays from the Conasauga formation, belongs to the Floyd shale of Mississippian age.

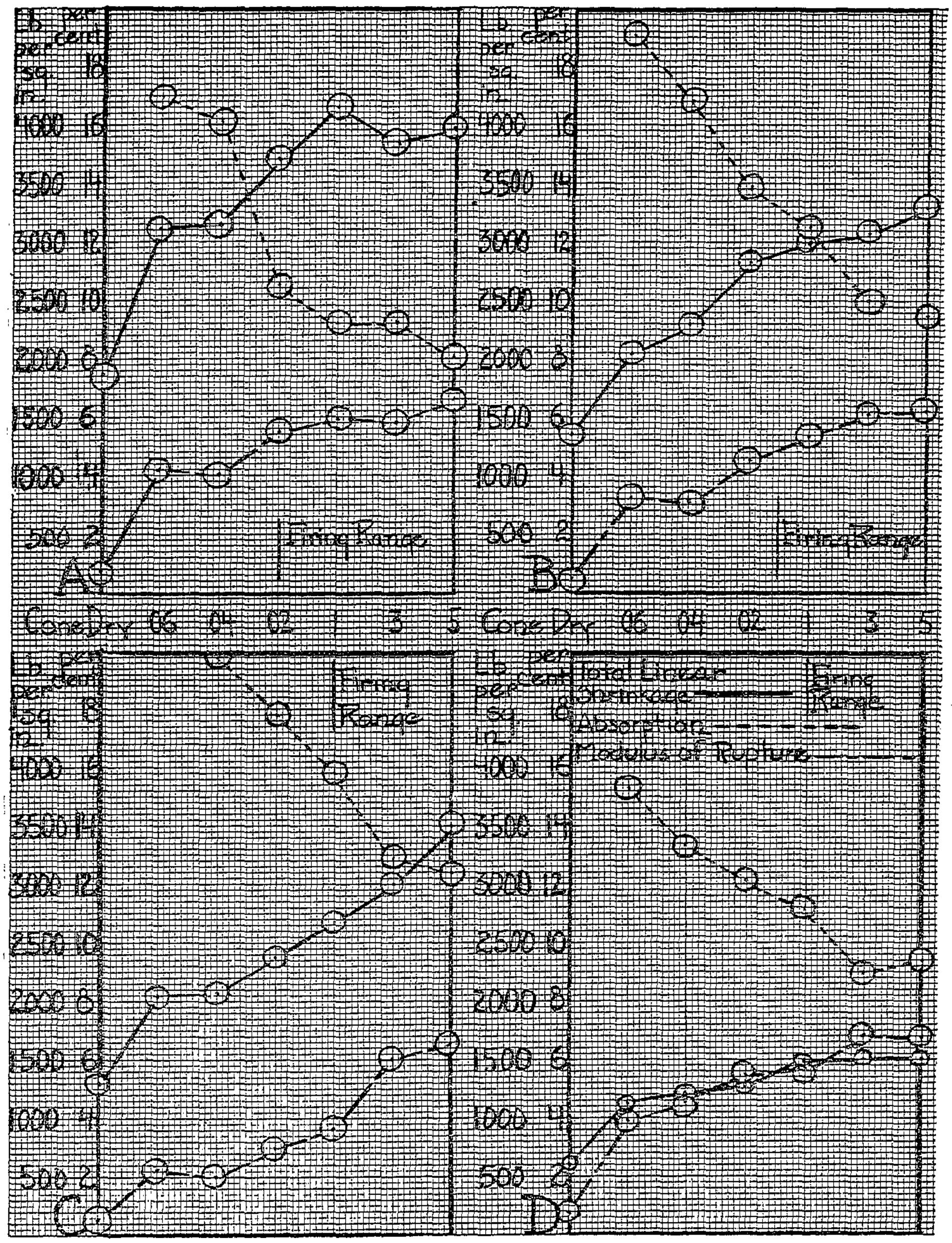


Figure 15. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Weathered Conasauga shale and clay from the Thomas properties, 4½ miles south of Dalton, Whitfield County.

B. Conasauga shale from the W. C. Martin property, 5 miles south of Dalton, Whitfield County.

C. Weathered Floyd shale and clay from the Mrs. Nannie Masters property Carbondale Station, Whitfield County.

D. Shale from the Chatsworth Clay Mfg. Co., Chatsworth, Murray County.

Laboratory tests on soft brown sandy Floyd shale and clay from the Masters and Stone properties, Carbondale, Whitfield County.

Chemical Analysis:

Loss on ignition	7.50
Soda (Na_2O)	.74
Potash (K_2O)	1.56
Lime (CaO)	.08
Magnesia (MgO)	.03
Alumina (Al_2O_3)	23.94
Ferric oxide (Fe_2O_3)	8.11
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.04
Phosphorus pentoxide (P_2O_5)	.10
Silica (SiO_2)	57.16
	99.99

Grinding: Easy.
Ground Color: Light brown.
Slacking: A little slow.
Plasticity: Rather poor. "Short" and mealy.
Molding Behavior: Fair. Slight tendency for clay column to tear at edges.
Drying Behavior: Slight warpage.
Water of Plasticity: 32.1 per cent.
Green Modulus of Rupture: 135.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 5.2 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.4	8.2	22.2	541	Light salmon (3YR-6/7)[b]	Slight
04	3.7	8.3	19.8	488	Medium salmon (3YR-5/6)[b]	Slight
02	4.7	9.5	17.8	739	Salmon (2YR-5/6)[b]	Considerable
1	6.2	10.7	15.8	893	Light red (1YR-5/5)[b]	Slight
3	7.0	12.0	12.9	1505	Good red (R-YR-4/5)[b]	Some
5	8.0	14.0	12.4	1636	Deep red (R-YR-4/4)[b]	Some

[a]See graph, Figure 15-C, page 191.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 01–5.

The above tests indicate that this material is suitable for the manufacture of building brick. The absorption is rather high and the fired strength low for the best quality of face brick. This material could best be used in a mixture with a more plastic shale or clay, for instance the shale sampled on the W. C. Martin property (see page 188) some five miles to the north.

MURRAY COUNTY

Murray County is in the northeast corner of the Appalachian Valley of Georgia and the western part of the Highland area known as the Cohutta Mountains. It is east of Whitfield County and north of Gordon County. The county is drained by the Conasauga River and its tributaries, except for a small area on the southern edge that drains into the Coosawattee River. The Atlanta to Cincinnati line of the Louisville and Nashville Railroad enters the county near Carters and extends north through Ramhurst, Chatsworth, the county seat, Eton, Crandall, and Tenga, on the Tennessee line. State highway No. 61, known as the Tennessee Highway, roughly parallels the railroad. State highway No. 2, from Dalton to Chatsworth, passes through Spring Place, formerly the county seat.

The Cartersville Fault which forms the eastern boundary of the Appalachian Valley of Georgia is in Murray County well marked by the foot of the bold front of the Cohutta Mountains which form the eastern half of the county. The principal peaks of these mountains in Murray County rise to heights of 2,000 to 3,000 feet above the Valley and add much to the beauty of the scenery.

The rolling land of the Valley in the western half of the county is largely underlain by rocks of the Rome and Conasauga formations of Cambrian age and the Knox dolomite of Cambrian or Ordovician age. The Conasauga River which forms the western boundary of the county flows for most of the way in a belt of the siliceous shales of the Rome formation. Another belt of Rome formation extends south from Cohutta Springs to just north of Chatsworth where it forms a sandstone ridge. Hayes[1] mapped this belt of the Rome formation as continuing south through Chatsworth, west of Ramhurst and Wells and east of Holly, to the Gordon County line. The field work of the writer has convinced him that the greater part of this area is not underlain by the typical siliceous shales of the Rome formation, but by a hard greenish-drab clay shale more or less intimately interbedded with thin layers of sandstone. Typical outcrops of this can be seen in the city limits of Chatsworth and in the pit of the Chatsworth Clay Manufacturing Company. At places it weathers to a red color and into flat slabs with irregular red and gray bands that closely resemble weathered pieces of cedar wood. Throughout most of the area it cannot be distinguished

[1]Hayes, C. W., Manuscript geologic map of the Dalton quadrangle.

from the area of metamorphosed slaty shale and slate in the Conasauga formation in Gordon and Bartow counties. The writer has therefore tentatively mapped this area as belonging to the Conasauga formation on the geologic map facing page 66.

Typical semi-hard fissle greenish-drab shales of the Conasauga formation are found at places along the Louisville and Nashville Railroad and the Tennessee Road south of Chatsworth, in the south central part of the county, and in a narrow band roughly east of and parallel to the Conasauga River. The deposits along the railroad and the Tennessee Road are described below. The road from Resaca in Gordon County northeast through Holly to Spring Place for about 10 miles in Murray County passes over deposits of fissle and flaky Conasauga shale that would probably be suited for the manufacture of heavy clay products but are at present too far from railroad transportation. At places, as on the Carter farm in the southern part of the county, the Conasauga formation contains large lenses and beds of massive crystalline limestone.

A large area near Spring Place and north to the Tennessee line is underlain by the red cherty clays and cherts of the Knox dolomite. A smaller area near Fashion, Loughbridge, Cisco, and Tenga underlain by deposits of the Athens shale and Tellico sandstone of Ordovician age is shown on the geologic map facing page 66 as the Chickamauga limestone.

B. E. MESSER PROPERTY

The B. E. Messer (Chatsworth, Rt. 1) property is one mile northeast of Chatsworth on the Louisville and Nashville Railroad and on the east side of the new Tennessee Road.

A railroad cut exposes shale of the Conasauga (or Rome) formation which is hard, olive-green, and weathering to splintery pieces on the south end; but softer, more fissle, and of olive-green to reddish-brown color in the middle and north-end of the cut. A low ridge of about 15 acres between the railroad and the new Tennessee Road is underlain by this shale. Similar shale is said to outcrop at places on the property east of the railroad.

CHATSWORTH CLAY MFG. COMPANY

(Map location No. 44)

Headquarters: Chatsworth, Georgia.

V. C. Pickering, President.

H. L. Keheley, Superintendent.

The plant of the Chatsworth Clay Mfg. Company was built about 1905 as the Penley Brick Company, using alluvial clay from the flood plain of Holly Creek for the manufacture of common brick. Since that time the plant has passed through several hands. The present owners purchased the plant and remodeled it in 1929, converting it into a face brick plant using a deposit of shale a quarter of a mile west of the plant

Pit

The shale pit is on the west side of the Tennessee Road, just south of Chatsworth and a quarter of a mile west of the plant. When visited by the writer in the spring of 1930 it had only recently been opened and was only about 75 feet long, 30 feet wide, and 5 feet deep. The shale is semi-hard to hard, greenish-drab in color, and breaks into thin flat pieces rather than flakes. Thin interbedded layers, an inch or less in thickness, of sandstone are fairly frequent. One or two thin streaks of plastic bluish-gray calcareous clay were seen. The shale is striking a little east of north and dipping about 30° to the east. It is of the type mapped by Hayes as belonging to the Rome formation but believed by the writer to be a variety of the Conasauga formation. The laboratory tests are given below on a 3-foot groove sample from two places in the pit. The company owns 20 acres west and southwest of the pit, said to be all underlain by the shale.

Laboratory tests on a groove sample of semi-hard to hard greenish-drab shale from the pit of the Chatsworth Clay Mfg. Company, Chatsworth, Murray County.

Chemical Analysis:

Loss on ignition	6.60
Soda (Na_2O)	.36
Potash (K_2O)	1.69
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	19.18
Ferric oxide (Fe_2O_3)	8.41
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	62.91
	100.18

Grinding: A little difficult. Shale tough rather than brittle.

Ground Color: Brownish-gray.

Slaking: Slow.

Plasticity: Poor and grainy at first, better after aging 4 days.

Molding Behavior: Fair. Tendency for clay column to swell, crack, and tear on the edges.

Drying Behavior: Test bars slightly warped.

Water of Plasticity: 16.8 per cent.

Green Modulus of Rupture: 188.0 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 2.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	1.9	4.5	15.3	972	Salmon (1YR-6/7)[b]	Slight
04	2.4	4.8	13.4	1159	Salmon (1YR-6/6)[b]	Slight
02	2.8	5.1	12.1	1362	Salmon red (1YR-6/5)[b]	Slight
1	4.3	5.9	11.2	1422	Good red (R-YR-5/5 [b]	Slight
3	4.0	6.0	9.0	1697	Good red (R-YR-4/4)[b]	Some
5	4.0	6.0	9.4	1691	Dark red (R-YR-4/3)[b]	Some

[a]See graph, Figure 15-D, page 191.
[b]Color notation according to the Munsell system, see page 23.

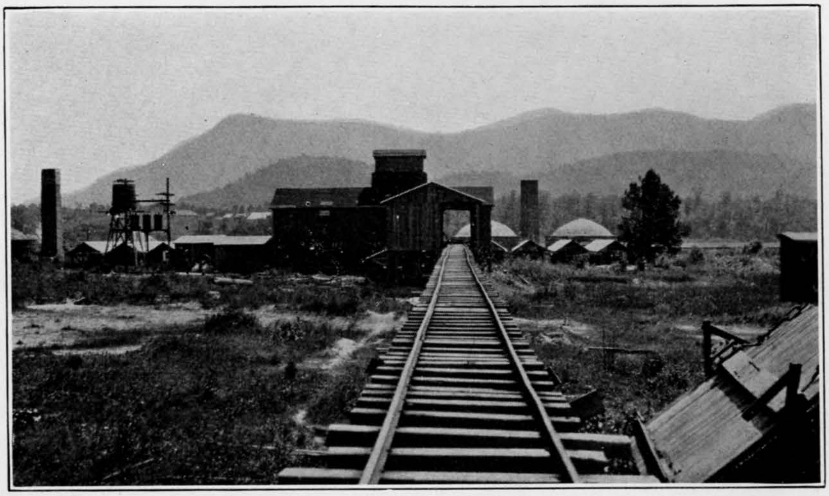
Firing Range: Cone 1 to 5 and higher. Commercial kiln: Cone 01–5.

The shale is mined by pick and shovel, loaded into side-dump tram cars, and hauled to the plant by a narrow-gauge dinky locomotive.

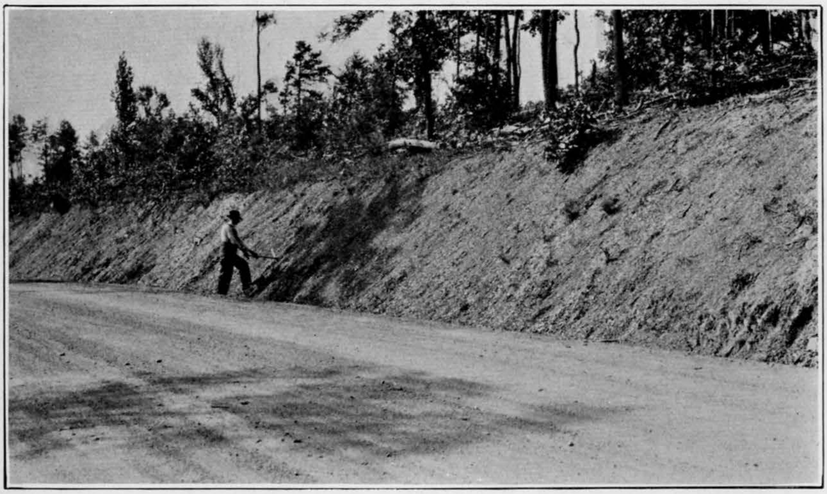
Plant

The shale from the pit is dumped onto a storage pile. A conveyor belt under the pile carries the shale as needed and feeds it to a dry pan, where it is ground. The ground shale from the dry pan goes to a mechanically vibrated screen with mesh 3/16 of an inch apart. The oversize from the screen is returned to the dry pan, the undersize goes to a 12-foot pug mill where water is added and the material is tempered and pugged to a plastic clay. An auger-type stiff-mud brick machine extrudes the clay in a column which is automatically cut off into side-cut bricks.

The bricks are hacked by hand onto wooden pallets which are stacked on a car and carried to open-air drying sheds, the drying taking from one to five days according to the weather. The dried bricks are fired to about 1850° F. in 4 round down-draft kilns. Two of the kilns are on one stack, one kiln has an external stack of its own, and the fourth has an internal stack. The firing takes from 7 to 8 days, the end point and the amount of flashing being determined by trial pieces and by the amount of settling of the brick.



A. FACE BRICK PLANT OF THE CHATSWORTH CLAY MFG. COMPANY, CHATSWORTH, MURRAY COUNTY.



B. OUTCROP OF CONASAUGA SHALE ON THE DAVIS AND STREET PROPERTIES, TENNESSEE HIGHWAY NEAR RAMHURST, MURRAY COUNTY.

The product is a good quality shale face brick in smooth, velvet, and rough texture surfaces and in colors varying from cherry red to greenish and blue-brown or black flashed brick. The capacity of the plant is about 10,000 brick per day. The second quality brick are sold for common brick. The brick show some variation in size and imperfections due to large particles. The company plans to alter the plant soon to give the material finer grinding and longer pugging which should improve the quality of the product.

MRS. FRANK PEEBLES PROPERTY

The Mrs. Frank Peebles (Chatsworth) property of 80 acres is on the new Tennessee Highway south of and adjoining the Chatsworth Clay Mfg. Company property described above. Cuts along the new highway three-quarters of a mile west of the Louisville and Nashville Railroad expose hard and semi-hard greenish-drab shale with fairly frequent very thin layers of sandstone. A few thin streaks of impure limestone were seen. The shale is of the same type and is practically continuous with that mined in the pit of the Chatsworth Clay Mfg. Company.

SWANSON AND BARKESDALE PROPERTIES

(Map location No. 45)

The G. W. Swanson (Chatsworth) property of 140 acres is on the Louisville and Nashville Railroad one and a half miles south of Chatsworth. The property is north of an old road that extends from the old Tennessee Road west to Spring Place. The property lies on both sides of the old Tennessee Road and the railroad, and extends a short distance west of Holly Creek but not to the new Tennessee Highway. The Joe Barkesdale (Chatsworth) property of 280 acres is south of the Swanson property and the old road to Spring Place. It extends west to and beyond the new Tennessee Highway and south along the railroad for half a mile.

A low ridge on these properties between the old Tennessee Road and the railroad is underlain by the typical fissle shale of the Conasauga formation. Outcrops in several railroad cuts, in the old Spring Place road between the two properties, and for several hundred feet along the road running east from the old Tennessee Road towards Fort Mountain all show soft to semi-hard greenish-drab fissle shale. No sandstone or calcareous layers were in evidence. The laboratory tests on a grab sample of this shale from several places along these outcrops are given below.

Laboratory tests on a sample of soft to semi-hard fissle greenish-drab Conasauga shale from the G. W. Swanson and Joe Barkesdale properties, 1½ miles south of Chatsworth, Murray County.

Chemical Analysis:

Loss on ignition	7.10
Soda (Na_2O)	.25
Potash (K_2O)	.76
Lime (CaO)	.00
Magnesia (MgO)	.41
Alumina (Al_2O_3)	26.59
Ferric oxide (Fe_2O_3)	6.46
Ferrous oxide (FeO)	1.63
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.96
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	56.37
	100.53

Grinding: Easy.
Ground Color: Drab.
Slaking: A little slow.
Plasticity: Poor and grainy at first, fair after aging 3 days.
Molding Behavior: Fair. Tendency for clay column to swell, crack, and tear on the edges.
Drying Behavior: Very slight warpage.
Water of Plasticity: 23.1 per cent.
Green Modulus of Rupture: 80.3 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.9	4.5	19.6	556	Salmon (2YR-6/7)[b]	Very slight
04	3.3	5.7	17.9	898	Salmon (R-YR-5/5)[b]	Slight
02	3.6	6.2	15.9	1030	Salmon red (R-YR-5/5)[b]	Slight
1	5.0	7.2	14.6	1237	Medium red (R-YR-5/4)[b]	Slight
3	5.1	7.5	12.9	1298	Good red (R-YR-4/5)[b]	Some
5	6.6	8.7	11.2	1670	Dark red (9R-4/3)[b]	Some

[a]See graph, Figure 16-A, page 205.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–6 and higher. Commercial kiln: Cone 1–6.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile. The tendency to slow slaking with resulting poor plasticity, low strength, and high absorption could probably be remedied by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. The fired colors within the firing range are good.

Shale of the type sampled above is showing for several hundred feet along the road running east from the old Tennessee Road towards Cohutta Mountain. Beyond this are outcrops of a hard olive-green shale with bands of gray and blue slaty material weathering gray and red. The greater part of this would probably be slow slaking and develop little or no plasticity. Some could probably be mixed with the more plastic shale in the manufacture of certain heavy clay products. Similar shale is showing on the Barkesdale property between the road and the railroad on the hill just north of where the old Tennessee Road comes in sight of the railroad.

The new Tennessee Highway as it crosses the Barksdale property south of the Mrs. Frank Peebles property described above exposes semi-hard to hard greenish-drab shale with considerable very thin sandstone layers, similar to that sampled in the pit of the Chatsworth Clay Mfg. Company and described on page 195.

The writer estimates that about 50 acres on the Swanson and 20 acres on the Barkesdale properties are underlain by shale of the type sampled. Probably an even larger area on the Barksdale property is underlain by harder shale varying from the type of the brick company pit on the part of the property west of Holly Creek to an almost slaty type on the southeast corner of the property. The deposits should be thoroughly prospected, with careful attention for the presence of lime.

Just south of the old road to Spring Place a flat field of about an acre and a half on the railroad would make an excellent plant site. An abundance of water could be obtained from Holly Creek.

ANDERSON AND MORT PEEBLES PROPERTIES

(Map location No. 46)

The T. P. Anderson (Chatsworth) property is on the Louisville and Nashville Railroad, three miles south of Chatsworth at the junction of the old Tennessee Road and the new Tennessee Highway.

A cut on the railroad about 200 feet long and 10 to 15 feet deep exposes hard olive-green almost slaty shale breaking into large thin flat pieces. The farm road running east from the railroad exposes outcrops of this shale which have weathered to red and drab colors, some pieces being banded and resembling weathered pieces of cedar wood. Several knolls north and south of the road are underlain by the shale. The laboratory tests are given below on a grab sample of hard shale from the railroad cut and softer shale from the road, taken in the proportion of about three parts of the hard shale to one of the softer weathered shale.

Laboratory tests on hard olive-green slaty shale and softer weathered red and drab shale from the T. P. Anderson property, 3 miles south of Chatsworth, Murray County.

Chemical Analysis:

Loss on ignition	5.19
Soda (Na_2O)	1.05
Potash (K_2O)	1.57
Lime (CaO)	.00
Magnesia (MgO)	.15
Alumina (Al_2O_3)	23.71
Ferric oxide (Fe_2O_3)	4.36
Ferrous oxide (FeO)	3.31
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	1.04
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.43
Silica (SiO_2)	59.15
	99.96

Grinding: Rather difficult. Tough rather than brittle.
Ground Color: Reddish-brown.
Slaking: Slow.
Plasticity: Poor and grainy at first, better after aging 3 days.
Molding Behavior: Fair. Tendency for clay column to crack and tear on the edges.
Drying Behavior: Good. Test bars slightly warped.
Water of Plasticity: 20.8 per cent.
Green Modulus of Rupture: 83.1 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.4	4.7	18.0	538	Salmon (3YR-6/6)[b]	Some
04	3.7	5.6	14.9	1089	Salmon (1YR-6/5)[b]	Some
02	4.1	6.0	15.0	966	Salmon red (2YR-6/6)[b]	Some
1	5.3	7.2	10.2	2008	Fair red (R-YR-5/5)[b]	Some
3	5.8	7.5	9.4	2230	Medium red (R-YR-5/4)[b]	Some
5	7.1	9.0	7.8	2098	Dark red (R-YR-4/3)[b]	Considerable

[a]See graph, Figure 16-B, page 205.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–6 or higher. Commercial kiln: Cone 01–6.

The above tests indicate that this material is satisfactory for the manufacture of building brick and possibly structural tile. The tendency of the harder shale to be slow slaking, with the resulting low green strength, could to some extent be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. The deposits are well situated adjoining and above the railroad where they could be mined with steam shovel and the pits would have natural drainage. Water could be obtained from a branch of Holly Creek nearby.

The Anderson property is adjoined on the east by the old Red Place owned by Mort Peebles (Chatsworth) and underlain by deposits of a similar shale. A few outcrops near the boundary with the Anderson property show a little softer and greenish-drab somewhat flaky shale more like that sampled on the Swanson and Barkesdale properties described above.

WILBANKS, NIX AND WETHERWOOD PROPERTIES

The Mike and G. W. Wilbanks (Ramhurst, Rt. 1) property is east of the Tennessee Highway and the Louisville and Nashville Railroad at Mt. Zion Church, three and a half miles south of Chatsworth and two to two and a half miles north of Ramhurst.

Hard olive-green shale is showing in the railroad cut. Outcrops of this shale weathered to a softer drab and reddish-drab material are exposed along the private road to the east. This shale is much like that sampled on the Anderson property and described above.

The O. L. Nix (Ramhurst, Rt. 1) property adjoining the Wilbanks property on the east about three-quarters of a mile east of Mt. Zion Church contains three rounded knolls covering about 5 acres that are underlain by hard slaty drab to red very fissle shale. More of this shale is said to underlie the Mrs. Mattie L. Wetherwood (Ramhurst, Rt. 1) property that adjoins on the north and lies between the Nix property and the Anderson and Mort Peebles properties described above.

WILBANKS AND CLAYTON PROPERTIES

(Map location No. 47)

The G. W. Wilbanks (Ramhurst, Rt. 1) property is on the Tennessee Highway and the Louisville and Nashville Railroad at Chicken Creek, two miles north of Ramhurst. It consists of about 300 acres in Land Lots 307 and 308, 26th District, 3d Section, Murray County. The Mrs. Fannie Clayton (Central, S. C.) property adjoins and is south of the Wilbanks property, the property line crossing the Tennessee Highway on the slope south of Chicken Creek. The Clayton property consists of about 600 acres and extends east for about half a mile east of the Louisville and Nashville Railroad, south along the highway to Yellow Creek, and west to the Spring Place—Ramhurst road.

The cut of the highway at the house on the Wilbanks property north of Chicken Creek shows soft to semi-hard fissle Conasauga shale, mostly greenish-drab in color but with some red streaks. Interbedded with it are layers of plastic red clay, but the shale predominates. A few small outcrops of shale were showing in the woods to the northwest. The land was nearly level or gently rolling and the surface of the ground was strewn with water-worn pebbles and boulders.

The cuts of the Tennessee Highway all the way up the ridge south of Chicken Creek on both properties show soft to semi-hard fissle Conasauga shale, mostly a greenish-drab color but with some reddish and purplish-brown streaks. The shale at the end of the outcrop nearest the creek is the hardest. On the slope there are several narrow layers of red and gray plastic clay interbedded with the shale. At the top of the ridge the clay streaks become wider and more numerous and for a short distance the outcrop is mostly red clay. The beds are striking N. 25° E. and dipping about 60° to the southeast. The laboratory tests are given below on a grab sample of the shale and plastic clay taken at intervals all along this outcrop. Similar shale is showing all down the south slope of the ridge to Yellow Creek, making the length of outcrop along the highway about three-quarters of a mile.

Laboratory tests on a grab sample of soft greenish-drab Conasauga shale from the G. W. Wilbanks and Mrs. Fannie Clayton properties on the Tennessee Highway 2 miles north of Ramhurst, Murray County.

Chemical Analysis:

Loss on ignition	6.33
Soda (Na_2O)	.23
Potash (K_2O)	1.19
Lime (CaO)	.00
Magnesia (MgO)	.42
Alumina (Al_2O_3)	20.88
Ferric oxide (Fe_2O_3)	8.28
Ferrous oxide (FeO)	1.06
Manganous oxide (MnO)	.50
Titanium dioxide (TiO_2)	.94
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.16
Silica (SiO_2)	60.68
	100.67

Grinding: Easy.
Ground Color: Light brown.
Slaking: A little slow.
Plasticity: A little grainy at first but fair after aging overnight.
Molding Behavior: Fair. Slight tendency for clay column to tear on the edges.
Drying Behavior: Test bars somewhat warped.
Water of Plasticity: 22.3 per cent.
Green Modulus of Rupture: 150.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) per cent	Total Linear Shrinkage (based on plastic length)[a] per cent	Absorption[a] per cent	Modulus of Rupture[a] Lbs. per sq. in.	Color	Warpage
06	2.5	5.5	17.0	985	Salmon (3YR-6/6)[b]	Some
04	4.2	7.0	13.4	1458	Salmon (2YR-6/5)[b]	Some
02	4.6	7.3	12.0	1691	Salmon red (1YR-6/5)[b]	Considerable
1	5.9	8.8	10.6	1774	Fair red (R-YR-5/5)[b]	Considerable
3	6.3	9.2	7.5	2048	Medium red (R-YR-4/3)[b]	Considerable
5	7.7	10.4	5.3	2686	Dark red (R-YR-3/3)[b]	Considerable

[a]See graph, Figure 16-C, page 205.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Two of the test bars fired to cone 04 and one fired to cone 3 were black-cored, indicating reducing conditions.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 1–5 or 6.

The above tests indicate that this shale is suitable for the manufacture of building brick, structural tile, and possible roofing tile and sewer pipe.

These two properties are underlain by a large deposit of shale of this type and should be prospected. A few acres of flat land adjoining the railroad near Chicken Creek, but above its flood plain, would do for a plant site. The shale between the railroad and the Tennessee Highway alone would probably last a heavy clay products plant for many years.

DAVIS AND STREET PROPERTIES

(Map location No. 48)

The S. B. Davis (Tails Creek) property of about 200 acres is south of and adjoining the Mrs. Fannie Clayton property described above. It extends along the Tennessee Highway from Yellow Creek on the north to the top of the hill just north of Pisgah Church, a distance of about half a mile. The property extends eastward to the Louisville and Nashville Railroad and westward for about a quarter of a mile from the highway. South of the Davis property is the Mrs. Ida Street (Ramhurst) property of about 300 acres. The Street property extends southward along the highway to just south of the road to Ramhurst, a distance of about half a mile, eastward to the Louisville and Nashville Railroad, and westward to the Spring Place–Ramhurst road.

The highway cuts on the hill south of Yellow Creek and on the hill or ridge near the south end of the Davis property show semi-hard to hard olive-drab Conasauga shale weathering into thin flat pieces and, at the hardest places, into long splintery or pencil-shaped fragments. At places the weathered shale is stained red. The laboratory tests are given below on a grab sample at a number of places along the outcrop (see Plate IV-B) near the line between the Davis and Street properties. Highway cuts on the Street property near Pisgah Church, recently cut at the time of the writer's visit, exposed an olive-green shale somewhat harder than that sampled but with an almost translucent and greasy look and a soapy feeling. The shale near Mrs. Street's house at the junction of the road to Ramhurst and the Tennessee Highway is still harder but not exactly slaty. Hard slaty shale is said to be exposed in a railroad cut north of Ramhurst.

Laboratory tests on a grab sample of semi-hard to hard olive-green Conasauga shale from outcrops on the S. B. Davis property near the Mrs. Ida Street property, Tennessee Highway near Pisgah Church, three-quarters of a mile northwest of Ramhurst, Murray County.

Chemical Analysis:

Loss on ignition	5.59
Soda (Na_2O)	1.17
Potash (K_2O)	.97
Lime (CaO)	.00
Magnesia (MgO)	.07
Alumina (Al_2O_3)	16.19
Ferric oxide (Fe_2O_3)	6.26
Ferrous oxide (FeO)	1.03
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorous pentoxide (P_2O_5)	trace
Silica (SiO_2)	67.93
	100.12

Grinding: Easy.

Ground Color: Light brown.

Slaking: A little slow.

Plasticity: Grainy at first, fair after aging 3 days.

Molding Behavior: Fair. Tendency for clay column to crack and tear on edges.

Drying Behavior: Test bars all slightly warped.

Water of Plasticity: 21.4 per cent.

Green Modulus of Rupture: 100.9 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 1.9 per cent.

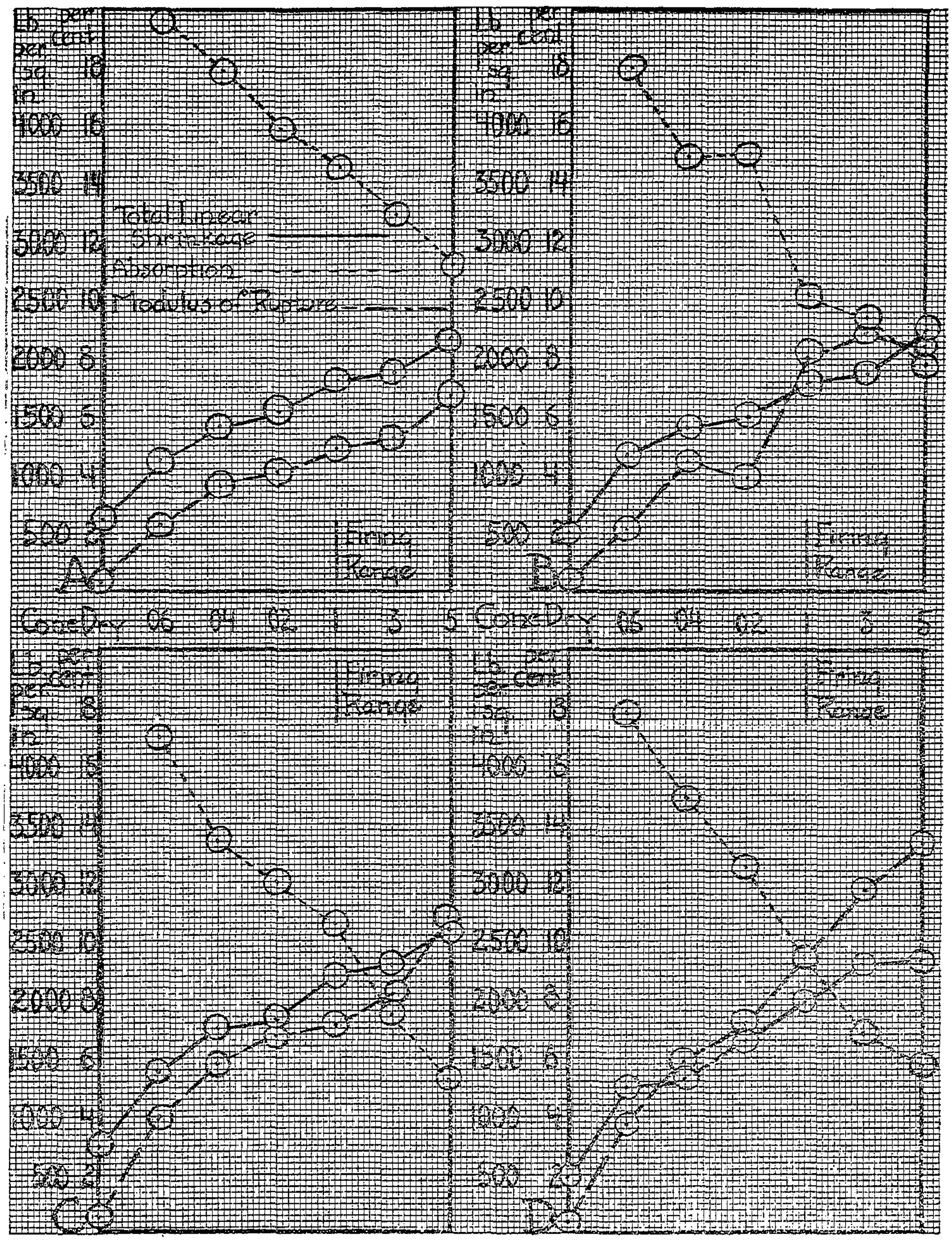


Figure 16. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Conasauga shale from the Swanson and Barksdale properties, 2 miles south of Chatsworth, Murray County.

B. Conasauga shale from the T. P. Anderson property, 3 miles south of Chatsworth, Murray County.

C. Conasauga shale from the Wilbanks and Clayton properties, 2 miles north of Ramhurst, Murray County.

D. Conasauga shale from the Davis and Street properties, Ramhurst, Murray County.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.9	5.0	17.8	934	Salmon (3YR-6/7)[b]	Slight
04	3.4	5.3	14.9	1472	Salmon red (1YR-6/6)[b]	Slight
02	4.8	6.6	12.5	1809	Salmon red (R-YR-5/5)[b]	Some
1	6.3	7.9	9.4	2330	Medium red (R-YR-5/4)[b]	Some
3	7.5	9.2	6.8	2922	Medium red (R-YR-4/4)[b]	Some
5	7.9	9.3	5.7	3337	Dark red (R-YR-4/3)[b]	Some

[a]See graph, Figure 16-D, page 205.
[b]Color notation according to the Munsell system, see page 23.

Remarks: One of the test bars fired to cone 02 was black-cored, indicating slight reducing conditions.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 1–5.

The above tests indicate that this shale is suited for the manufacture of building brick and possibly structural tile, roofing tile, and sewer pipe. The tendency towards slow slaking and the resulting poor plasticity and molding behavior could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the addition of certain electrolytes to the tempering water.

The area between the Tennessee Highway and the Louisville and Nashville Railroad about half a mile to the east is made up of rolling and irregular knobs and ridges, topography typical of land underlain by shale. The few outcrops seen were of shale similar to that sampled. The writer estimates that at least 100 acres of these two properties are underlain by the Conasauga shale. The shale between the railroad and the highway alone would probably last a heavy clay products plant for a generation, even taking into consideration that the weathered shale probably does not extend more than 10 to 20 feet beneath the surface. The property should be thoroughly prospected and separate tests made on each variety of shale found.

MIDDLETON AND NELSON PROPERTIES

The H. Middleton (Ramhurst) property is on the east side of the Louisville and Nashville Railroad at Ramhurst, and touches the railroad at the north end and again at the south end of the property on either side of the settlement of Ramhurst. The property extends for three-eighths of a mile east along the Fields Gap of the Ramhurst–Ellijay road and for half a mile each way north and south of the road. It consists of about 200 acres in Land Lots 3 and 4, 25th District, 3d Section.

The property of W. W., J. H., and J. R. Nelson (Ramhurst) is an L–shaped property of about 200 acres adjoining the Middleton property and west and south of it. It extends from Rock Creek south along the west side of the railroad to the southern edge of the Middleton property and then on both sides of the railroad for a quarter of a mile further south. The western edge of the property is west of the Tennessee Highway.

A railroad cut south of Ramhurst and Rock Creek between the Middleton and the Nelson properties expose semi-hard to hard somewhat fissle greenish-drab shale in alternate bands 15 to 20 feet across. Some of these layers resemble the shale sampled on the Davis and Street properties adjoining on the north and described above. Similar shale, striking N. 35° E. and dipping 60° SE., is exposed along the Ramhurst-Ellijay road and probably underlies the irregular knobs and ridges north and south of the road.

About three-quarters of a mile south of Ramhurst on the Nelson property the railroad cut known locally as "The Big Cut" exposes very hard slaty shale unsuited for the manufacture of heavy clay products. This ridge, known as "The Backbone" also crosses the Tennessee Highway.

The Middleton property and the part of the Nelson property north of the Backbone should be prospected to determine the extent and character of the shale deposits.

J. B. BUTLER PROPERTY

(Map location No. 49)

The J. B. Butler (Chatsworth) property of 160 acres is on the Fields Gap or the Ramhurst–Ellijay road, a quarter of a mile south of old Dennis post office on Rock Creek and one and a quarter miles due east of Ramhurst and the Louisville and Nashville Railroad.

Cuts along the Fields Gap road expose soft "short" somewhat plastic clay in thin stratified layers striking N. 20° E. and dipping 30° to 35° to the southeast. Some of these layers are a bright yellow ochre color, some red with thin shale-like partings, and there is one band 15 feet in width of soft red shale. The clay and shale all contain some fine sand, giving them a "short" and mealy texture. These outcrops extend for a mile along the road. The clay is said to underlie the fields west of the road, where it was formerly exposed in gullies 20 to 40 feet deep, now largely filled in. It has probably been derived from the weathering of an argillaceous and siliceous limestone layer of the Conasauga formation. The deposits do not extend very far up the slope to the east of the road, being cut off by the Cartersville Fault that forms the eastern boundary of the Appalachian Valley of Georgia. Laboratory tests are given below on a sample composed of a 3-foot groove sample from each variety of the clay from the road outcrops.

Laboratory tests on a sample of soft plastic yellow to red clay and soft red shale from the J. B. Butler property on the Fields Gap Road, 1¼ miles east of Ramhurst, Murray County.

Chemical Analysis:

Loss on ignition	5.68
Soda (Na_2O)	.45
Potash (K_2O)	1.30
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	17.69
Ferric oxide (Fe_2O_3)	9.20
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.80
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	1.11
Silica (SiO_2)	63.80
	100.03

Grinding: Easy.
Ground Color: Red.
Slaking: Fairly rapid.
Plasticity: Poor. "Short" and mealy.
Molding Behavior: Rather poor. Tendency for the clay column to crack and to tear at the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 36.1 per cent.
Green Modulus of Rupture: 44.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.8	6.6	27.8	521	Salmon (2YR-6/6)[b]	Slight
04	5.4	7.9	23.3	988	Salmon (1YR-5/4)[b]	Some
02	6.2	8.5	21.4	1084	Salmon red (R-YR-5/5)[b]	Some
1	9.0	11.4	17.5	1575	Good red (R-YR-4/4)[b]	Some
3	10.2	12.0	15.4	1741	Good red (R-YR-4/3)[b]	Considerable
5	11.2	13.4	11.5	1951	Dark red (R-YR-4/2)[b]	Considerable

[a]See graph, Figure 17-A, page 213.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fire to cone 04 were slightly flashed, indicating reducing conditions at the end of the firing period.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 1–5.

The above tests indicate that this clay is suitable only for the manufacture of building brick. The worst feature is its low green strength and the high rate of shrinkage and absorption within the firing range as shown by the steepness of the curves in Figure 17-A, page 213.

S. M. CARTER PROPERTY

(Map location No. 50)

The S. M. Carter (Carters) property is a large plantation of several thousand acres north of the Coosawattee River and south of Sugar Creek on both sides of the Louisville and Nashville Railroad. A large part of the plantation is rolling blue-grass land underlain by a broad belt of limestone of the Conasauga formation. But between Mineral Springs Branch and Wilbanks Branch, and again east of the Louisville and Nashville Railroad just north of Carters Station, are irregular hills and ridges underlain by more or less metamorphosed slaty shales of the Conasauga formation.

The shale between Mineral Springs Branch and Willbanks Branch is exposed in two cuts on the Louisville and Nashville Railroad one mile north of Carters Station and one mile south of Coniston Station. The cuts show a hard slightly fissle slaty shale varying in color from light green where unweathered to a reddish brown on the weathered surface. None of this material, weathered or hard, would develop sufficient plasticity to be suited for the manufacture of heavy clay products.

The cuts on the new location of the Tennessee Highway just north of the Coosawattee River at Carters Station expose a hard reddish to greenish-drab somewhat slaty shale weathering on the surface to a bright red color with some flat pieces striped red and drab and resembling chips of weathered cedar wood. The weathered material, although fairly soft, is somewhat "short" and crumbly. The outcrops are overlain by about 4 feet of red and brown alluvial clay full of rounded quartz gravel. The first cut north of the river is about 500 feet in length. The alluvial clay only is exposed to the north of this nearly to the top of the hill, where a similar but slightly harder shale is exposed. Limestone, soft red shale, and red and brown clay are exposed on the north slope of the ridge towards a branch of Willbanks Branch. The laboratory tests are given below on a grab sample of the partly weathered and weathered reddish-brown to red shale from the 500 foot outcrop, with a few pieces from the harder outcrop at the top of the hill.

Laboratory tests on a sample of semi-hard to hard reddish-brown and red shale from the S. M. Carter property near Carters Station, Murray County.

Chemical Analysis:

Loss on ignition	5.35
Soda (Na_2O)	.76
Potash (K_2O)	1.38
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	17.63
Ferric oxide (Fe_2O_3)	8.57
Titanium dioxite (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.12
Silica (SiO_2)	65.35
	100.07

Grinding: Easy.
Ground Color: Red.
Slaking: Slow.
Plasticity: Poor. Short and grainy even after aging.
Molding Behavior: Plasticity too poor to form test bars on the Mueller roll-press, and bars were made by hand in a slop mold.
Drying Behavior: Rapid, with practically no warpage.
Water of Plasticity: 27.0 per cent.
Green Modulus of Rupture: 35.3 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 1.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.1	3.1	21.8	564	Salmon (3YR-6/6)[b]	Little or none
04	2.6	4.5	19.1	1195	Salmon red (1YR-6/6)[b]	Little or none
02	3.3	5.1	18.5	826	Salmon red (1YR-5/5)[b]	Slight
1	4.6	6.1	15.1	1414	Medium red (R-YR-5/4)[b]	Little or none
3	4.2	6.1	14.2	1419	Medium red (R-YR-4/5)[b]	Some
5	4.8	6.5	13.7	1222	Good red (9R-4/4)[b]	Some

[a]See graph, Figure 17-B, page 213.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Not reached in these tests.

The above tests indicate that this shale, by itself, is not suited for the manufacture of heavy clay products. The green and fired strengths are low and the absorption is very high. The fired colors from cone 1–5 are good and with a small amount of a more plastic shale or an alluvial clay to act as a binder, the material might be used.

GORDON COUNTY

Gordon County is south of Whitfield and Murray counties, northeast of Floyd County, north of Bartow County, and, at its northwest corner, touches both Walker and Chattooga counties. It is almost wholly within the Rome Valley physiographic division of the Appalachian Valley of Georgia (see Figure 3, page 49). The county is drained by the Oostanaula River and its tributaries, including parts of the Conasauga and Coosawattee rivers.

Three railroads cross the county in a north-south direction. The Atlanta to Chattanooga line of the Southern Railway crosses the western part of the county, passing through the settlements of Plainville, Oostanaula, Sugar Valley, and Hill City. The State owned Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway) crosses the middle of the county, passing through Calhoun, the county seat, and Resaca. The western part of the county is crossed by the Atlanta to Cincinnati line of the Louisville and Nashville Railroad, which passes through Fairmount, Ranger, and Colima.

The East Branch of the Dixie Highway parallels the Western and Atlantic Railroad, and State Highway No. 61, known as the Tennessee Highway, parallels the Louisville and Nashville Railroad.

The oldest rocks exposed in Valley area of Gordon County are the siliceous shales of the Rome formation. These enter the county on the Floyd County line west of Plainville and continue northward to the Whitfield County line in a belt averaging a little over a mile in width, passing west of Calhoun and Resaca.

The Conasauga formation outcrops on either side of the Rome formation and in a broad belt in the eastern part of the county. The belts of the Conasauga formation crossed by the Southern Railway and the Nashville, Chattanooga and St. Louis Railway are composed of fissle olive-drab clay shales together with more or less limestone in irregular lenses and beds. A number of these shale deposits are described below. The eastern belt crossed by the Louisville and Nashville Railroad is composed of shales which have largely been metamorphosed to hard slaty shales and green slates unsuited for the manufacture of heavy clay products. Hayes[1] mapped a strip through the

[1]Hayes, C. W., Manuscript geologic maps of the Dalton and Cartersville quadrangles.

middle of these as belonging to the Rome formation, but the field work of the writer has convinced him that these cannot be distinguished from the ones mapped by him as metamorphosed Conasauga shales and slates. The belt is bounded on the east by the Cartersville Fault.

The western edge of the Conasauga has been thrust over beds of sandy shale and clay belonging to the much younger Floyd shale. Two deposits of this are described below. This thrust fault is the Rome Fault described on pages 50 and 73. The extent of the thrusting can be seen on the road between Sugar Valley and Resaca two miles east of the main Rome Fault, where the Conasauga shales have been worn through, exposing a large area of the Fort Payne chert.

The ridges on the western edge of the county are caused by the resistant sandstone beds of the Red Mountain formation.

B. MIFFLIN HOOD COMPANY
(LEGG PLANT)

(Map location No. 51)

Headquarters: Daisy, Tenn. (See pages 112 and 243).
B. Mifflin Hood, President.

Legg Plant: Calhoun, Georgia.
J. A. White, Superintendent.

The Legg Plant of the B. Mifflin Hood Company is between the Dixie Highway and the Nashville, Chattanooga and St. Louis Railway on the north side of Calhoun. It was built in 1906 by the Legg Brothers, who manufactured face brick by the dry-press process from Conasauga shale. The kilns were at first fired by coal but later by producer gas manufactured at the plant. The plant was sold to the B. Mifflin Hood Company in 1919. In 1927 the plant was remodeled, changing to the stiff-mud process of forming the brick and to the use of coal rather than producer gas for firing.

Shale Pit

The shale pit extends for half a mile north of the plant, parallel to the Dixie Highway. At the northern end where it was being worked when visited by the writer in 1930, the pit was about 50 feet wide and 8 feet deep. The shale, which belongs to the Conasauga formation, varies from soft and light brown at the top, through semi-hard and greenish-drab in the middle, to hard and dark gray on the bottom of the pit. Horizontally the shale grades at places into a mottled red and light-brown clay with traces of a shaly structure. The laboratory tests on a grab sample including all varieties of the shale and clay are given below. The material is mined with an electric shovel and loaded

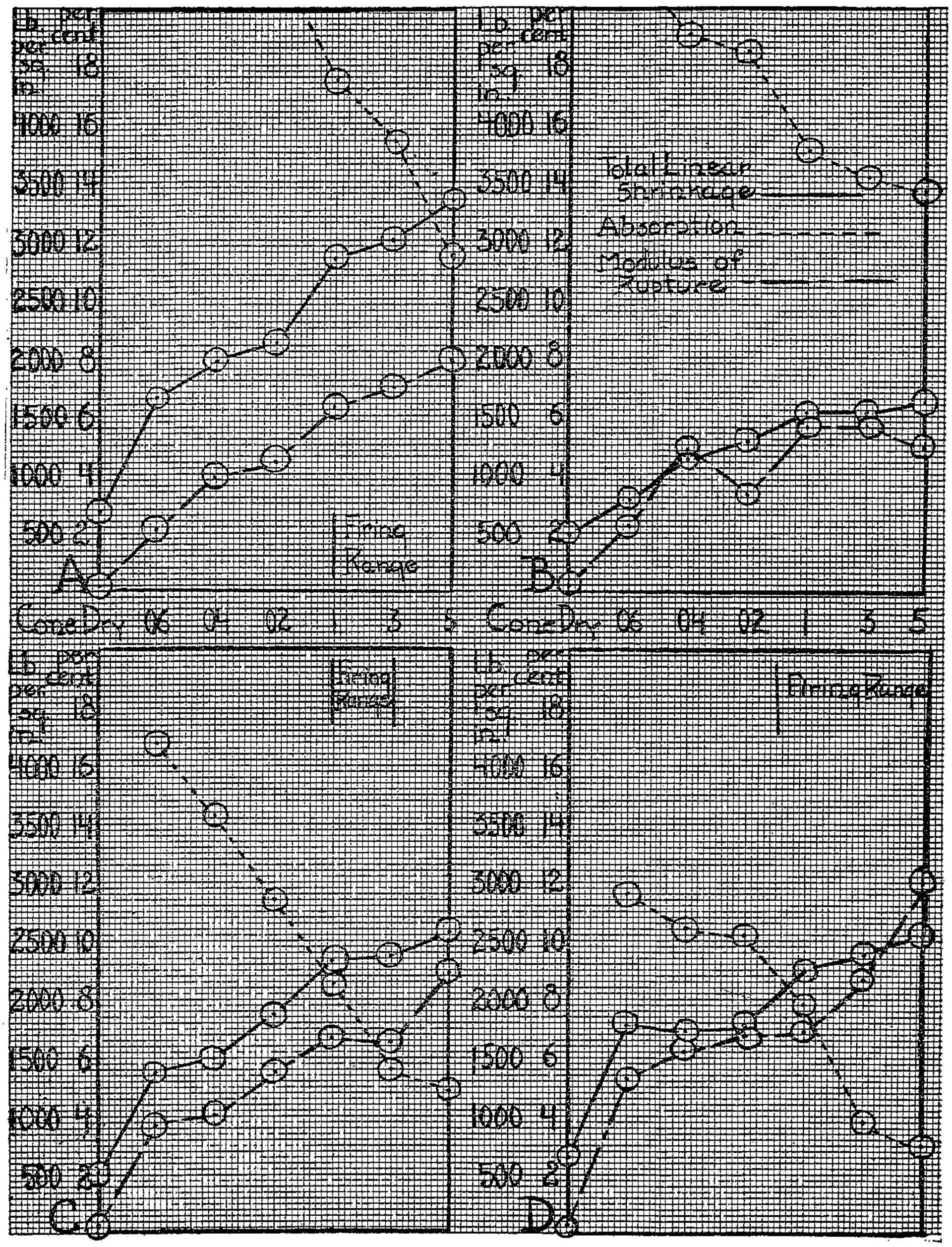


Figure 17. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Residual clay from the J. B. Butler property, one and a quarter miles east of Ramhurst, Murray County.

B. Hard red shale from the S. M. Carter property, Carters Station, Murray County.

C. Conasauga shale from the Legg Plant of the B. Mifflin Hood Company, Calhoun, Gordon County.

D. Conasauga shale from the Chapman property, one mile northwest of Calhoun, Gordon County.

into side-dump mining cars which are hauled to the plant by a gasoline locomotive on a narrow-gauge tram line. The shovel bucket in scraping up the face of the pit effectively mixes the hard unweathered shale from the bottom and the weathered shale from the top. The clay areas are not mined in wet weather because it is difficult to dry the clay sufficiently to prevent clogging of the screens at the plant.

Laboratory tests on a grab sample of soft brown clay and soft brown to hard gray Conasauga shale from the pit of the B. Mifflin Hood Company's Legg Plant, Calhoun, Gordon County.

Chemical Analysis:

Loss on ignition	5.35
Soda (Na_2O)	.37
Potash (K_2O)	2.31
Lime (CaO)	.00
Magnesia (MgO)	.55
Alumina (Al_2O_3)	20.79
Ferric oxide (Fe_2O_3)	5.50
Ferrous oxide (FeO)	.89
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_3)	trace
Silica (SiO_2)	63.44
	100.12

Grinding: Easy.

Ground Color: Light brownish-gray.

Slaking: Rather slow.

Plasticity: Poor and grainy at first, fair after aging overnight.

Molding Behavior: Fair. Tendency for clay column to crack and tear on the edges.

Drying Behavior: Little or no warpage.

Water of Plasticity: 22.7 per cent.

Green Modulus of Rupture: 75.5 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 2.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lbs. per sq. in.*	Color	Warpage
06	3.6	5.5	16.8	912	Salmon (4YR-6/7)[b]	Little or none
04	4.1	6.0	14.3	1019	Dark Salmon (2YR-6/6)[b]	Slight
02	6.2	7.5	11.4	1386	Light red (R-YR-5/5)[b]	Slight
1	7.5	9.3	8.5	1674	Good red (R-YR-4/5)[b]	Considerable
3	7.5	9.5	5.6	1638	Deep red (R-YR-3/5)[b]	Considerable
5	8.5	10.3	4.9	2231	Deep-red (R-YR-3/4)[b]	Considerable

[a]See graph, Figure 17-C, page 213.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cone 5 had a vitrified appearance on the surface and their broken ends showed the beginnings of a glassy structure.

Firing Range: Cone 1–3. Commercial kiln: Cone 01–2.

Plant

The shale brought into the plant from the mine is dumped in a storage shed. A belt conveyor under the storage shed removes the shale as needed and feeds it to a dry pan where it is ground. The ground shale is screened by a vibratory screen, the oversize going to a second dry pan for further grinding and then to a second vibratory screen. The screens used are 15 mesh for the manufacture of smooth-face brick and 10 mesh for rough texture brick. The undersize from both screens drops to a storage bin.

The ground and screened shale is fed to a long single-shaft disintegrator where tempering is accomplished. This disintegrator discharges into a combination double pug mill and auger brick machine, which forces the clay out in a continuous column which is automatically cut off into side-cut brick.

The green brick are hacked onto steel cars and dried at 200° F. in a steam-heated 6-track tunnel drier. The kilns consist of one long rectangular down-draft chambered kiln, the alternate chambers constituting separate kilns, remodeled from the old continuous kiln; and two smaller rectangular Eudaly kilns. The long kiln is fired with induced draft, the short kilns each have two stacks. The brick are fired to cone 07 or about 1750° F. in the bottom of the kiln. Electrical pyrometers, standard pyrometric cones, trial pieces, and the amount of settling are all used to regulate the firing and determine the end-point.

The brick are an excellent quality shale face brick made in smooth, "velvet", and "rough" texture surfaces and a "Sand-Harvard" rough-texture Colonial brick. The colors range from cherry red to dark flashed browns and blacks. The underfired and second quality brick are sold as common brick. The capacity of the plant is about 41,000 brick per day.

R. L. HILL PROPERTY

The property of R. L. Hill (Calhoun, Rt. 3) is north of and adjoining the shale pit of the B. Mifflin Hood Company, one and a quarter miles north of Calhoun, between the Dixie Highway and the Nashville, Chattanooga and St. Louis Railway. About four of the six acres in the property are underlain by a continuation of the shale sampled from the pit of the B. Mifflin Hood Company and described above.

CHAPMAN, LEWIS, AND HENDERSON PROPERTIES.

(Map location No. 52)

The W. H. and J. E. Chapman (Calhoun, Rt. 3) property is on the east side of the Oostanaula River, one and a quarter miles north of Calhoun and half to three-quarters of a mile west of the Nashville, Chattanooga and St. Louis Railway and the B. Mifflin Hood Company's brick yard. It consists of 248 acres in Land Lots 154 and 156, 14th District, 3d Section. The C. E. Lewis (Calhoun, Rt. 3) property of 70 acres is east of the Chapman property. The J. S. Henderson property is north of the Chapman property and corners with the Lewis property.

A series of low ridges extending north from the river across these properties is underlain by shales and clay of the Conasauga formation. The ridge on which the Chapman house is located is entirely underlain by soft to semi-hard drab shale much like that in the pit of the brick plant but slightly less fissle. The east side of the next ridge to the west shows only stiffly plastic red clay, probably residual from a very argillaceous limestone layer, but on the south end and west side of this ridge are more outcrops of shale similar to that on the first ridge. The laboratory tests are given below on a grab sample of this shale from several places on both ridges. The owner estimates that about 75 acres of the Chapman property are underlain by this shale. The deposits also extend onto the Lewis and Henderson properties. At places on these properties river terrace deposits of water-worn gravel and sand cover the top of the ground for a foot or two and would have to be removed as overburden. Shale pits would have natural drainage. A tram line to a plant at the railroad could be constructed with little or no grading.

Laboratory tests on a sample of soft to semi-hard drab Conasauga shale from the W. H. and J. E. Chapman property on the Oostanaula River 1¼ miles north of Calhoun, Gordon County.

Chemical Analysis:

Loss on ignition	5.27
Soda (Na_2O)	.50
Potash (K_2O)	2.05
Lime (CaO)	.00
Magnesia (MgO)	.21
Alumina (Al_2O_3)	24.62
Ferric oxide (Fe_2O_3)	7.05
Ferrous oxide (FeO)	.82
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	58.62
	100.06

Grinding: Easy.
Ground Color: Light brown.
Slaking: A little slow.
Plasticity: Grainy at first, fair after aging overnight.
Molding Behavior: Fair. Slight tendency for clay column to tear at the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 21.1 per cent.
Green Modulus of Rupture: 77.8 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.2	7.1	11.6	1326	Dark salmon (2YR-6/7)[b]	Slight
04	4.1	7.0	10.4	1560	Light red (R-YR-5/6)[b]	Some
02	4.8	7.1	10.2	1713	Fair red (R-YR-5/5)[b]	Some
1	6.3	9.0	7.8	1733	Good red (R-YR-4/5)[b]	Some
3	7.5	9.5	3.8	2189	Deep red (R-YR-3/5)[b]	Bad
5	8.0	10.2	3.0	3004	Deep red (R-YR-3/3)[b]	Bad

[a]See graph, Figure 17-D, page 213.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–5. Commercial kiln: Cone 02–4.

The above tests indicate that this shale is suitable for the manufacture of building brick. The green modulus of rupture is probably too low for the manufacture of structural tile, roofing tile, or sewer pipe. This could probably be improved by the addition of some of the residual red clay noted on one of the ridges, or by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water. These three properties should be thoroughly prospected and further ceramic tests made on representative samples.

JACKSON, KEYS, AND JOLY PROPERTIES

The Lewis and Henderson properties described above are adjoined on the north by the E. L. Jackson (Calhoun) property of 80 acres, two miles north of Calhoun and three-quarters of a mile west of the Nashville, Chattanooga and St. Louis Railway. Several low knolls or ridges are underlain by soft drab Conasauga shale and red clay. The shale is similar in appearance to that sampled on the Chapman property and in the pit of the B. Mifflin Hood Company, both described above.

Outcrops of the stiffly plastic red clay with an occasional outcrop of shale are showing on the Mose Keys property to the southeast and the Chett Joly property to the east and north, between the Jackson property and the railroad.

These properties should all be prospected to determine the extent and character of the deposits.

D. L. PRATER PROPERTY

(Map location No. 53)

The D. L. Prater (Calhoun) property is 2 miles northeast of Calhoun on the Newtown road. A foot or two of plastic yellow clay is showing at the edge of a flat meadow east of the road. A well at a tenant house nearby is said to have passed through 30 feet of similar clay. The clay is probably residual or colluvial in origin and has been derived from an area of the Knox dolomite that is comparatively free from chert.

The laboratory tests are given below on a grab sample of this clay from shallow outcrops at the edge of the meadow. The clay probably underlies all of the flat land which is at least 10 acres in extent. The property is only a mile and a quarter due east of the Nashville, Chattanooga and St. Louis Railway, but between them is a chert ridge so that a tram line would probably have to follow down the road to Calhoun, a distance of two miles.

Laboratory tests on a sample of plastic yellow clay from the D. L. Prater property, two miles northeast of Calhoun, Gordon County.

Chemical Analysis:

Loss on ignition	6.32
Soda (Na_2O)	.59
Potash (K_2O)	.44
Lime (CaO)	.00
Magnesia (MgO)	.28
Alumina (Al_2O_3)	13.01
Ferric oxide (Fe_2O_3)	3.24
Ferrous oxide (FeO)	.72
Titanium dioxide (TiO_2)	.93
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	74.50
	100.03

Grinding: Easy.
Ground Color: Light tan.
Slaking: Rapid.
Plasticity: Good. Sticky.
Molding Behavior: Good, except that the clay column had a tendency to stick to the metal platen over which it was travelling.
Drying Behavior: Test bars all very slightly warped.
Water of Plasticity: 32.8 per cent.
Green Modulus of Rupture: 241.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.7 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	0.4	7.3	24.8	672	Pinkish ivory (YR-7/6)[b]	Very slight
04	0.3	7.1	25.3	906	Pale pinkish tan (YR-7/6)[b]	Very slight
02	0.8	7.4	23.6	1241	Light pinkish tan (YR-7/5)[b]	Very slight
1	1.3	8.3	24.1	1022	Medium pinkish tan (YR-6/7)[b]	Slight
3	1.0	7.4	23.6	1251	Pinkish salmon (4YR-6/6)[b]	Very slight
5	1.8	8.5	22.5	1204	Pinkish salmon (3YR-6/6)[b]	Slight

[a]See graph, Figure 18-A, page 221.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Above Cone 5.

The above tests indicate that this clay, because of the high absorption, is suitable only for the manufacture of flower pots and crude pottery such as jugs and churns, with the possible exception of light-colored and highly porous roofing tile suitable for use in Southern climates only. Small amounts of this clay would greatly aid the plasticity and molding ability of a slow slaking shale.

PENDLEY AND FREEMAN PROPERTIES

(Map location No. 54)

The J. J. Pendley (Calhoun, Rt. 3) property is three and a half miles north of Calhoun and just north of Damascus Church. Its eastern edge fronts on the Nashville, Chattanooga and St. Louis Railway for half a mile, and the western edge is just east of the Dixie Highway. It consists of 75 acres in Land Lot 8, 14th District, 3d Section. The Pendley property is adjoined on the west side by the 35 acre property of Mrs. Lucille Freeman (Calhoun, Rt. 3), most of which lies west of the Dixie Highway.

The land on these two properties is gently rolling with low ridges and knolls rising about 50 feet above the general drainage level. These ridges on the Pendley property are underlain by soft to semi-hard drab Conasauga shale as shown by fragments on top of the ground and several shallow washes. The Dixie Highway cuts through one of these ridges on the Freeman property exposing the shale to a depth of 25 feet and for a distance of about 200 feet. The beds are striking northeast and dipping about 45° to the southeast. A few beds of plastic red clay not over a foot in thickness are showing between much thicker beds of shale. The following laboratory tests were made on a grab sample of the shale from the shallow outcrops on the Pendley property and the highway cut on the Freeman property.

Laboratory tests on a sample of soft to semi-hard drab Conasauga shale from the J. J. Pendley and Mrs. Lucille Freeman properties, 3½ miles north of Calhoun, Gordon County.

Chemical Analysis:

Loss on ignition	7.20
Soda (Na_2O)	.99
Potash (K_2O)	1.52
Lime (CaO)	.00
Magnesia (MgO)	.05
Alumina (Al_2O_3)	26.25
Ferric oxide (Fe_2O_3)	7.25
Ferrous oxide (FeO)	.50
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.14
Silica (SiO_2)	55.23
	100.05

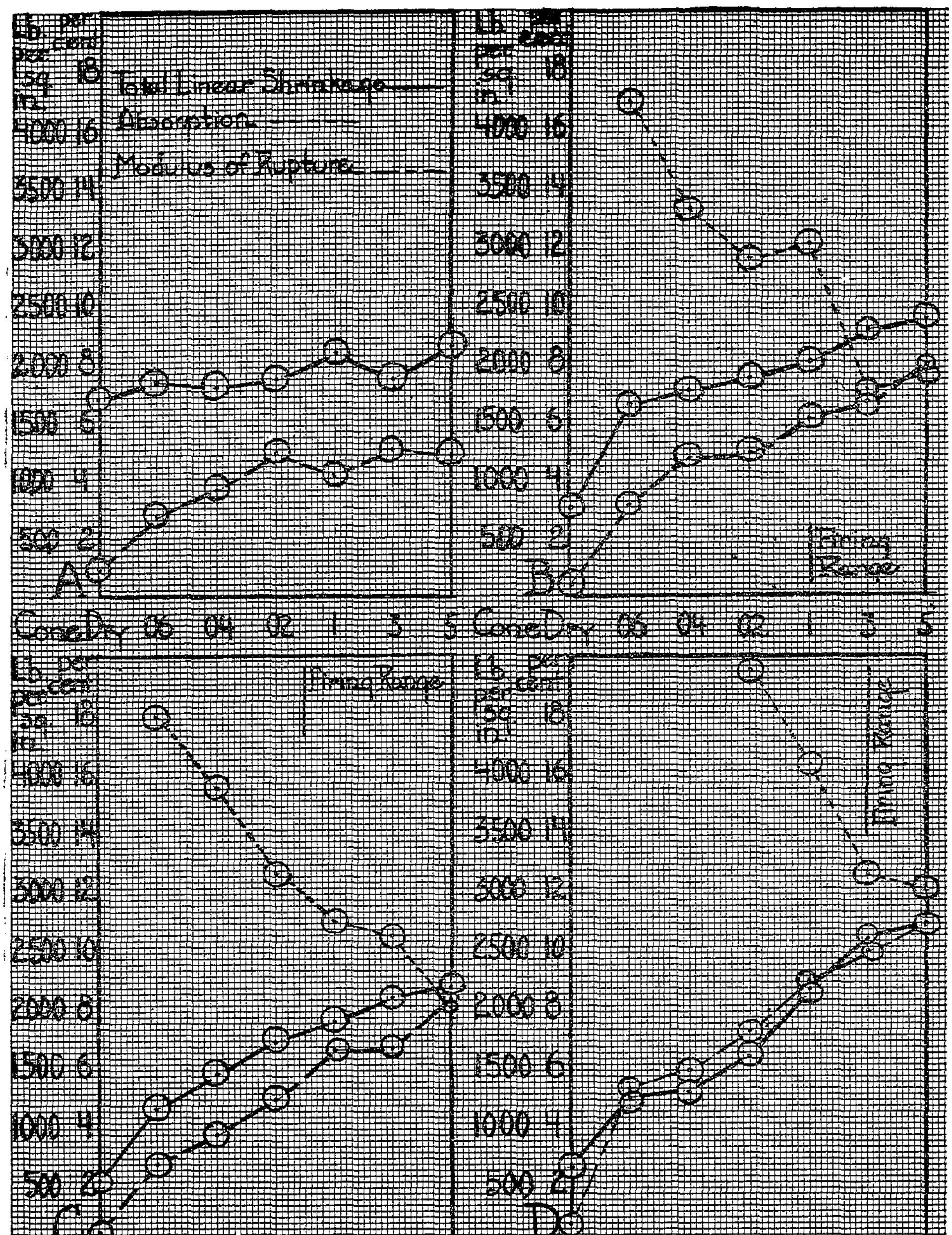


Figure 18. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Colluvial clay from the D. L. Prater property, 2 miles northeast of Calhoun, Gordon County.

B. Conasauga shale from the Pendley and Freeman properties three one-half miles north of Calhoun, Gordon County.

C. Conasauga shale from the A. L. Edwards property, half a mile east of Resaca, Gordon County.

D. Weathered Floyd shale from the John Russell property, one and a half miles south of Sugar Valley, Gordon County.

Grinding: Fairly easy, brittle.
Ground Color: Yellow.
Slaking: Fairly rapid.
Plasticity: Fair.
Molding Behavior: Fair, Slight tendency for clay column to crack and to tear on the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 21.8 per cent.
Green Modulus of Rupture: 89.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 3.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.9	6.5	16.9	766	Salmon (2YR-6/6)[b]	Slight
04	4.0	7.0	13.2	1162	Light red (R-YR-5/4)[b]	Slight
02	4.5	7.4	11.5	1229	Good red (R-YR-4/4)[b]	Slight
1	5.7	8.0	12.0	1517	Good red (R-YR-4/5)[b]	Some
3	6.5	9.1	7.0	1690	Deep red (R-YR-4/3)[b]	Some
5	7.2	9.5	7.7	1855	Deep red (R-YR-3/3)[b]	Some

[a]See graph, Figure 18-B, page 221.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5. Commercial kiln: Cone 01–4.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly medium-fired structural tile. The plasticity and the green strength could probably be improved by fine grinding, long pugging, the use of hot tempering water, or the addition of certain electrolytes to the tempering water.

These properties and the Tate Estate (in charge of A. H. Tate, Calhoun, Rt. 3), adjoining on the east, south, and southwest, should be prospected to determine the extent and character of their shale deposits.

A. L. EDWARDS PROPERTY

(Map location No. 55)

The A. L. Edwards (Dalton) property extends from the Nashville, Chattanooga and St. Louis Railway just north of Resaca to and across the Resaca-Chatsworth road, half a mile to the east, and extends north to the Conasauga River. It consists of 334 acres in Land Lots 302, 303, 311, 312, and 313, 13th District, 3d Section.

Two northeast-southwest ridges, separated by a valley a quarter of a mile in width, cross the property, the eastern one being higher and longer than the western one. Limestone of the Conasauga formation underlies the west side of the west ridge, the land between it and the railroad, and the valley between the two ridges. But the east side of the west ridge and both sides of the east ridge are underlain by semi-hard to hard drab to reddish-brown shale, fissle and flaky at places and more massive at others. The following laboratory tests are on a grab sample of this shale from the west side of the western ridge in outcrops along the Resaca-Chatsworth road from its junction with the Fites Ferry road almost to the Conasauga River.

Laboratory tests on a sample of soft to hard drab to reddish-brown Conasauga shale from the A. L. Edwards property, half a mile east of Resaca, Gordon County.

Chemical Analysis:

Loss on ignition	5.63
Soda (Na_2O)	.48
Potash (K_2O)	2.48
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	19.89
Ferric oxide (Fe_2O_3)	5.26
Ferrous oxide (FeO)	1.29
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	64.22
	99.98

Grinding: Easy.
Ground Color: Light brown.
Slaking: A little slow.
Plasticity: Fair.
Molding Behavior: Fair. Tendency for clay column to crack and tear at the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 19.9 per cent.
Green Modulus of Rupture: 79.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.7	4.5	17.9	656	Light salmon (3YR-6/6)[b]	Slight
04	3.9	5.7	15.5	909	Salmon (2YR-6/5)[b]	Slight
02	4.8	6.8	12.5	1199	Deep salmon (1YR-6/4)[b]	Slight
1	5.3	7.5	10.9	1625	Medium red (R-YR-5/5)[b]	Slight
3	6.5	8.3	10.4	1636	Good red (R-YR-4/5)[b]	Considerable
5	7.1	8.6	8.0	2035	Deep red (R-YR-4/3)[b]	Considerable

[a]See graph, Figure 18-C, page 221.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–6. Commercial kiln: Cone 02–5.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile and roofing tile. The tendency to slow slaking with the resulting poor plasticity and low green strength could probably be overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

This property, together with the Byron Nation (Resaca) property of 40 acres which adjoins on the south, should be prospected to determine the extent of the shale. Careful watch should be made for the presence of lime, even small amounts of which might cause scumming and shorten the firing range. A plant located on the railroad just north of Resaca or at the northern end of the western ridge could get shale from both ridges with a haul of not over half a mile. The shale pits would have natural drainage. Plenty of water could be obtained from either the Oostanaula or the Conasauga rivers, depending on the plant location.

GEORGE BANDY PROPERTY

(Map location No. 56)

The George Bandy (Hill City) property is on both sides of the Southern Railway from a quarter of a mile to one mile south of Hill City. It consists of about 400 acres in Land Lots 305, 316, 318, and 320, 13th District, 3d Section.

A railroad cut half a mile south of Hill City exposes a mixture of soft weathered brown and drab shale and red or mottled red and gray clay, overlain by a foot or two of waterworn gravel or gray gravelly clay. The cut is about 500 feet long and 10 to 15 feet deep. The north end of the cut shows red clay with a few shale fragments on the east bank but only gravel on the west bank. The amount of shale in the east bank increases to the south, and the west bank shows mottled red and gray clay with a little shale, overlain by the gravel. The laboratory tests are given below on a 3 to 6 foot groove sample from three different places in the cut. The land on either side of the railroad is gently rolling and is covered with a gray gravelly soil with no shale showing.

The shale and clay exposed in the cut belongs to the Floyd shale of Mississippian age, which in this county is an argillaceous and somewhat sandy limestone, with some shaly layers, that weathers to shale and clay deposits of the type seen. A glance at the geologic map facing page 66 shows that the fault line separating the Conasauga formation from the Floyd shale is just to the east, and on the southern end of the property swings west across the railroad.

Laboratory tests on a sample of soft brown and drab Floyd shale and mottled red and gray clay from the George Bandy property, half a mile south of Hill City, Gordon County.

Chemical Analysis:

Loss on ignition	6.95
Soda (Na_2O)	.45
Potash (K_2O)	.98
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	14.88
Ferric oxide (Fe_2O_3)	8.28
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.06
Silica (SiO_2)	67.64
	100.16

Grinding: Easy.
Ground Color: Brown.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Test bars all considerably warped.
Water of Plasticity: 36.5 per cent.
Green Modulus of Rupture: 232.1 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 8.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	5.2	14.0	17.7	1411	Light salmon (3YR-6/7)[a]	Considerable
04	5.7	14.2	15.9	1590	Medium salmon (2YR-6/7)[a]	Considerable
02	6.1	14.2	14.4	1482	Salmon (4YR-6/7)[a]	Considerable
1	9.0	16.3	10.5	2088	Light red (1YR-5/5)[a]	Considerable
3	9.5	17.1	7.3	2249	Medium red (R-YR-4/4)[a]	Considerable
5	10.0	17.6	6.0	2398	Good red (R-YR-4/3)[a]	Considerable

[a]Color notation according to the Munsell system, see page 23.

Remarks: The clay has a slight tendency to laminate in coming through the die of the Mueller roll-press. One of the test bars fired to cone 04 was slightly black-cored.

Firing Range: Cone 01–6. Commercial kiln: Cone 02–5.

The above tests indicate that this material has a rather high shrinkage and a tendency to laminate. If mixed with a more siliceous material or an ordinary rather slow slaking shale it should be satisfactory for the manufacture of building brick, structural tile, roofing tile, and possibly sewer pipe.

More red and brown shale and red clay, much like the more shaly parts of that sampled in the cut, is showing in the road cuts at the cross roads just east of the railroad a quarter of a mile south of the cut.

A drainage ditch, recently cut when visited by the writer, in a small hollow a few hundred yards north of the cross roads exposed a very plastic gray and brown clay containing some grit. A similar clay was showing in a shallow gully half way up the slope. The clay is said to outcrop in other hollows in the vicinity. At the writer's request a prospect pit was dug at a point about an eighth of a mile north of the cross roads and a few hundred feet east of the road of Hill City, just above one of these small hollows or valleys. Clay was struck six inches below the surface and the pit went through 5 feet of very plastic light-gray and brown-stained clay containing some grit. The bottom foot graded into a bright blue color, and at one corner of the pit soft brown shale was struck. The laboratory tests are given below of a 4 foot groove sample of the clay from this prospect pit.

This clay is probably residual from an impure limestone layer of the Conasauga formation, although it might be an alluvial clay deposited by a former stream. Such a stream would account for the existance of the water-worn gravel and sandy gray clay that covered the surface on the north end of the property. Prospecting would be necessary to determine the extent of the deposit of this plastic clay. The owner estimates that 30 to 50 acres of the property have a similar topography with hollows and swampy bottom land. The Luke Pitman (Sugar Valley, Rt. 1) property of 40 to 50 acres adjoining and south of the Bandy property is said to be largely swampy land that might be underlain by such a plastic clay.

Laboratory tests on a sample of plastic light-gray to blue and somewhat brown-stained clay from a prospect pit on the George Bandy property, three-quarters of a mile south of Hill City, Gordon County.

Chemical Analysis:

Loss on ignition	3.26
Soda (Na_2O)	.48
Potash (K_2O)	.47
Lime (CaO)	.51
Magnesia (MgO)	.41
Alumina (Al_2O_3)	7.20
Ferric oxide (Fe_2O_3)	2.17
Ferrous oxide (FeO)	trace
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	84.35
	99.95

Grinding: Easy.

Ground Color: Light brownish-gray.

Slaking: Rapid.

Plasticity: Good but very sticky.

Molding Behavior: Good, but slight tendency to laminate.

Drying Behavior: Test bars all show considerable warpage.

Water of Plasticity: 26.3 per cent.

Green Modulus of Rupture: 307.1 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 6.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	0.7	7.3	19.1	990	Yellow cream (7YR-7/7)[a]	Considerable
04	0.8	7.1	19.2	973	Pale salmon (6YR-7/7)[a]	Considerable
02	1.1	7.8	17.6	1203	Light salmon (YR-7/6)[a]	Some
1	1.8	8.7	16.4	1382	Medium salmon (4YR-6/6)[a]	Considerable
3	2.6	9.3	15.5	1521	Salmon (2YR-5/6)[a]	Considerable
5	3.4	10.4	13.9	1683	Salmon (3YR-5/5)[a]	Bad

[a]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–8 and higher. Commercial kiln: Cone 2–7 or higher.

The above tests indicate that this clay has poor fired colors, a rather high absorption, and a slight tendency to laminate. It should be suitable for the manufacture of flower pots, crude pottery such as jugs and churns, and possibly for light-colored highly porous roofing tile suitable for use in Southern climates only.

JONES, NEIGHBORS, AND CLARIDA PROPERTIES

The properties of Richard Jones, Morris Neighbors, and Jeff Clarida (Col.) (Sugar Valley, Rt. 1) all corner near the old Rome-Dalton road half a mile west of the Southern Railway and west of the George Bandy property described above, one mile south of Hill City.

Soft drab flaky and fissle Conasauga shale is showing in the road cuts on a low ridge just south of the four corners made by the old Rome-Dalton road and the road from Resaca. The properties should be prospected to determine the extent and character of the shale. This shale, or mixture of it and the shaly clay from the railroad cut on the Bandy property or the plastic clay from east of the railroad, might be suitable for a number of heavy clay products.

W. C. SHUGART PROPERTY

The W. C. Shugart (Sugar Valley, Rt. 1) property of about 500 acres is one and a half miles southeast of Hill City on the south road from Hill City to Resaca. The western edge of the property adjoins the George Bandy property described above, half a mile east of the Southern Railway.

The greater part of the property is rolling land underlain by soft brownish-drab Conasauga shale with frequent streaks and bands of red and gray clay. The property should be prospected to determine the extent and character of the deposit. This shale, or a mixture of it and the shaly clay or the plastic clay from the Bandy property, might be suited for the manufacture of a number of heavy clay products.

JOHN RUSSELL PROPERTY

(Map location No. 57)

The property of John Russell (Sugar Valley, Rt. 1) is at the foot of Baugh Mountain on the Southern Railway, one and a half miles south of Sugar Valley, in Land Lot 113, 14th District, 3d Section.

A low rise east of the railroad is underlain by a brown sandy shale, only slightly fissle and practically a sandy clay, showing numerous casts of Mississippian fossils including gastropods and brachiopods. The material has probably been derived from the weathering of an argillaceous limestone member of the Floyd shale. The fine sand present in the clay makes it a little "short".

The laboratory tests are given below on a grab sample of this material. The low rise known to be underlain by this material covers 12 to 15 acres and is not over 20 feet above the drainage level. Prospecting will be necessary to determine the extent of the deposit and the depth of weathering.

Laboratory tests on a sample of soft "short" brown Floyd shale or clay from the John Russell property on the Southern Railway, one and a half miles south of Sugar Valley, Gordon County.

Chemical Analysis:

Loss on ignition	4.35
Soda (Na_2O)	trace
Potash (K_2O)	1.95
Lime (CaO)	.00
Magnesia (MgO)	.66
Alumina (Al_2O_3)	14.66
Ferric oxide (Fe_2O_3)	3.83
Ferrous oxide (FeO)	trace
Titanium dioxide (TiO_2)	.74
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	73.85
	100.04

Slaking: Fairly rapid.
Plasticity: Fair. Somewhat "short".
Molding Behavior: Fair. Slight tendency for clay column to crack and tear on the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 32.7 per cent.
Green Modulus of Rupture: 132.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.5 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.2	4.9	24.3	1266	Pale salmon (YR-7/6)[b]	Slight
04	2.8	5.1	22.7	1461	Light salmon (6YR-7/6)[b]	Some
02	3.8	6.3	19.5	1770	Medium salmon (3YR-6/6)[b]	Slight
1	6.5	8.6	16.2	2202	Salmon (1YR-5/5)[b]	Considerable
3	8.3	10.3	12.5	2491	Light chocolate red (R-YR-5/5)[b]	Some
5	8.3	10.8	12.0	2700	Medium chocolate red (1YR-4/4)[b]	Some

[a]See graph, Figure 18-D, page 221.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 and higher. Commercial kiln: Cone 2–5.

The above tests indicate that this material is suited for the manufacture of building brick and possibly medium-fired structural tile.

J. W. AND J. D. HARRINGTON PROPERTIES

The J. W. Harrington (Calhoun, Rt. 5) property is on the Oostanaula-Sugar Valley road, two miles north of Oostanaula and just west of the Southern Railway.

A road cut on the north slope of a low ridge exposes outcrops of soft to semi-hard flaky drab Conasauga shale resembling that in the pit of the brick plant at Calhoun. The cuts on the south slope of the ridge, however, showed only stiffly-plastic red clay. More shale is said to be showing on the J. D. Harrington (Calhoun, Rt. 5) property adjoining on the south. The low ridge between the public road and the Southern Railroad should be prospected to determine the extent and character of the shale.

M. H. BOWEN PROPERTY

The M. H. Bowen (Calhoun, Rt. 5) property is on the old Rome-Dalton road, five-eighths of a mile due west of Oostanaula Station on the Southern Railway. The land is nearly flat or gently rolling and the surface is covered with a deposit 2 to 12 feet in thickness of water-worn gravel and sandy gray and yellow clay, deposited by a former level of the Oostanaula River.

About 14 acres of the property east of the road were prospected about 1927. The prospect pits are said to have passed through 2 to 12 feet of the alluvial clay and gravel mixture and from 10 to 20 feet of shaly clay grading from a soft gray-blue and brown plastic clay with soft flaky fragments of brown shale at the top to a hard grayish-drab shale at the bottom. The pits were stopped when the hardness of the shale made further digging difficult. The material left in the dump piles beside these pits was, when visited by the writer in 1930, too weathered to be taken as a representative sample. The shale resembled that of the Conasauga formation. Mining pits would not have natural drainage.

H. J. WOODRUFF PROPERTY

The H. J. Woodruff (Calhoun, Rt. 5) property of 75 acres is on the east side of the Southern Railway just south of Oostanaula Station.

About 25 acres of the property is flat low-lying land said to be underlain by a deposit of plastic blue alluvial clay, probably deposited by a former level of the Oostanaula River. Several tons of this were mined a few years ago and shipped to the B. Mifflin Hood Company plant at Calhoun, where it is said to have been pronounced "an excellent tile clay". When visited by the writer in 1930 the pits were full of water and a representative sample could not be obtained without prospecting.

The Mrs. G. S. Fulton Estate (in charge of H. J. Woodruff, Calhoun, Rt. 5) is south of and adjoining the Woodruff property. Several acres of river terrace or "second bottom" land on this property just above the flood plain of the Oostanaula River are said to be underlain by a deposit of alluvial clay. This is said to have been prospected several years ago by Mr. L. N. Legg, formerly of the old Legg Brothers Brick Company at Calhoun and of the Plainville Brick Company at Plainville, who pronounced it suitable for the manufacture of building brick.

PLAINVILLE BRICK COMPANY, INC.

(Map location No. 58)

Headquarters and Plant: Plainville, Ga.
H. L. B. Legg, Superintendent and Vice-President.
M. H. Hammond, Secretary-Treasurer and General Manager.

Atlanta Office: 613 Red Rock Building, Atlanta, Ga.

The plant and shale pits of the Plainville Brick Company, Inc. are on the west side of the Southern Railway just north of Plainville, Gordon County. The plant was built in 1923 and has been in practically continuous operation ever since, manufacturing face brick from a deposit of the Conasauga shale.

Shale Pit

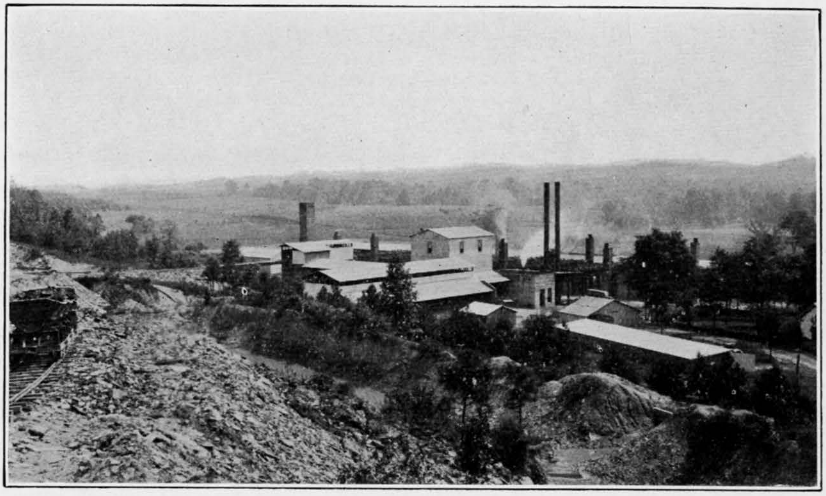
The shale pit is on the east slope of a ridge 80 to 100 feet high that parallels the Southern Railway. It is near the western border of the belt of Conasauga formation that extends northeast from Rome through Gordon and Murray counties. The shale, which is striking N. 45° E. and dipping about 45° SE., varies from soft and brownish-drab on the weathered surface to hard and grayish-drab at a depth of 15 to 20 feet. It breaks into flat pieces a quarter to one inch in thickness. In it are occasional light-gray to greenish-gray streaks containing lime. These are discarded in mining to avoid trouble from scumming or efflorescence. The laboratory tests are given below on a sample of the shale consisting of several green brick taken at random from the plant.

Laboratory tests on a sample of soft to hard brownish-drab Conasauga shale from the Plainville Brick Company, Inc., Plainville, Gordon County.

Chemical Analysis:

Loss on ignition	6.64
Soda (Na_2O)	.99
Potash (K_2O)	1.18
Lime (CaO)	.81
Magnesia (MgO)	.71
Alumina (Al_2O_3)	23.98
Ferric oxide (Fe_2O_3)	8.32
Manganous oxide (MnO)	.38
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.17
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	56.96
	100.98

Grinding: Easy.
Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Good.



A. FACE BRICK PLANT OF THE PLAINVILLE BRICK COMPANY, PLAINVILLE, GORDON COUNTY.

B. SHALE PIT OF THE PLAINVILLE BRICK COMPANY, PLAINVILLE, GORDON COUNTY.

Molding Behavior: Good.
Drying Behavior: Good. Little or no warpage.
Water of Plasticity: 21.3 per cent.
Green Modulus of Rupture: 177.8 pounds per square inch.
Linear Firing Shrinkage (based on plastic length): 3.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.2	5.9	15.7	1241	Dark salmon (1YR-5/6)[b]	Slight
04	3.0	6.1	15.1	1631	Light red (R-YR-5/5)[b]	Slight
02	5.3	8.2	9.5	2217	Medium red (R-YR-5/4)[b]	Slight
1	5.7	8.5	8.4	2237	Good red (R-YR-4/5)[b]	Some
3	7.2	9.9	5.2	2679	Good deep red (R-YR-4/4)[b]	Some
5	7.5	10.1	4.8	2797	Good deep red (R-YR-3/4)[b]	Some

[a]See graph, Figure 19-A, page 235.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 01–5.

Plant

The shale from the pit is dumped into a hopper which feeds it to a knob-roll disintegrator that crushes the larger pieces. From the disintegrator the shale goes to a dry pan for a preliminary grinding before going to a storage bin. The shale is drawn off from the storage bin as needed and fed to two dry pans for further grinding. The ground shale is elevated to two vibratory screens of about 15 mesh, the oversize being returned to the dry plans and the undersize to a large single-log pug mill. Water is added to the shale in the pug mill and the material is thoroughly tempered and pugged to a plastic clay. This plastic clay is fed to a stiff-mud auger brick machine which extrudes it as a column which is automatically cut off into side-cut bricks.

The green bricks are hacked to steel drying cars and dried at about 250°F. in an 8-track steam-heated tunnel drier. The dried bricks are transported on the drier cars to the kilns. The bricks are fired in seven rectangular down-draft kilns holding about 180,000 brick each. Each kiln is slowly fired to about 1850° F., the firing taking about eight days, and then flashed to darken the color of the brick. Coal was used until the summer of 1930 when natural gas, piped from Louisiana, was introduced. At the present time both coal and gas are in use. The heat is regulated and the end-point determined by electrical pyrometers, trial pieces, and the amount of settling of the brick.

The product is an excellent quality shale face brick with a wide range of pleasing colors from light red through deep cherry red to brown, blue, and black flashed colors. The brick are made in smooth, "Velvet", and "Vertex" textures. The capacity of the plant is about 50,000 brick per day.

The Plainville Brick Company, Inc., in addition to the deposit of shale on the ridge west of the plant, also owns a large deposit of similar Conasauga shale on the west slope of a ridge three-quarters of a mile east of Plainville and just north of the Plainville-Calhoun road. The valley between this ridge and the railroad is underlain by limestone of the Conasauga formation.

ALLEN AND DEW PROPERTIES

The W. H. Allen (Plainville, Rt. 1) property of 150 acres and the Andy Dew (Col.) (Plainville, Rt. 1) property of 40 acres are west of the Southern Railway, three-quarters to one mile north of Plainville.

These properties contain a continuation of the same ridge on which is the shale pit of the Plainville Brick Company, Inc., described above. Outcrops beside the public road near the boundary between the two properties show a semi-hard slightly fissle reddish-brown to drab shale, with a few layers of red clay. These properties should be prospected to determine the extent and character of the shale deposit. The Dew property contains the north end of the ridge and probably not over 10 acres are underlain by shale. The Allen property to the south probably contains a larger deposit. The Oscar Gunn property and the Mose Goswick property between the Allen property and the Plainville Brick Company also contain a continuation of the shale deposit.

PROPERTIES EAST OF PLAINVILLE

A series of irregular ridges and knobs underlain by shale of the Conasauga formation extend from the Floyd County line northeast for about two miles parallel to and half a mile to one mile east of the Southern Railway.

Soft to semi-hard brownish-drab fissle and flaky shale is showing on the B. F. Carden (Plainville, Rt. 1) property of 140 acres west of Rome-Calhoun highway one and three-quarters miles northeast of Plainville. The shale is striking N. 50° E. and dipping 55° S. E. The de-

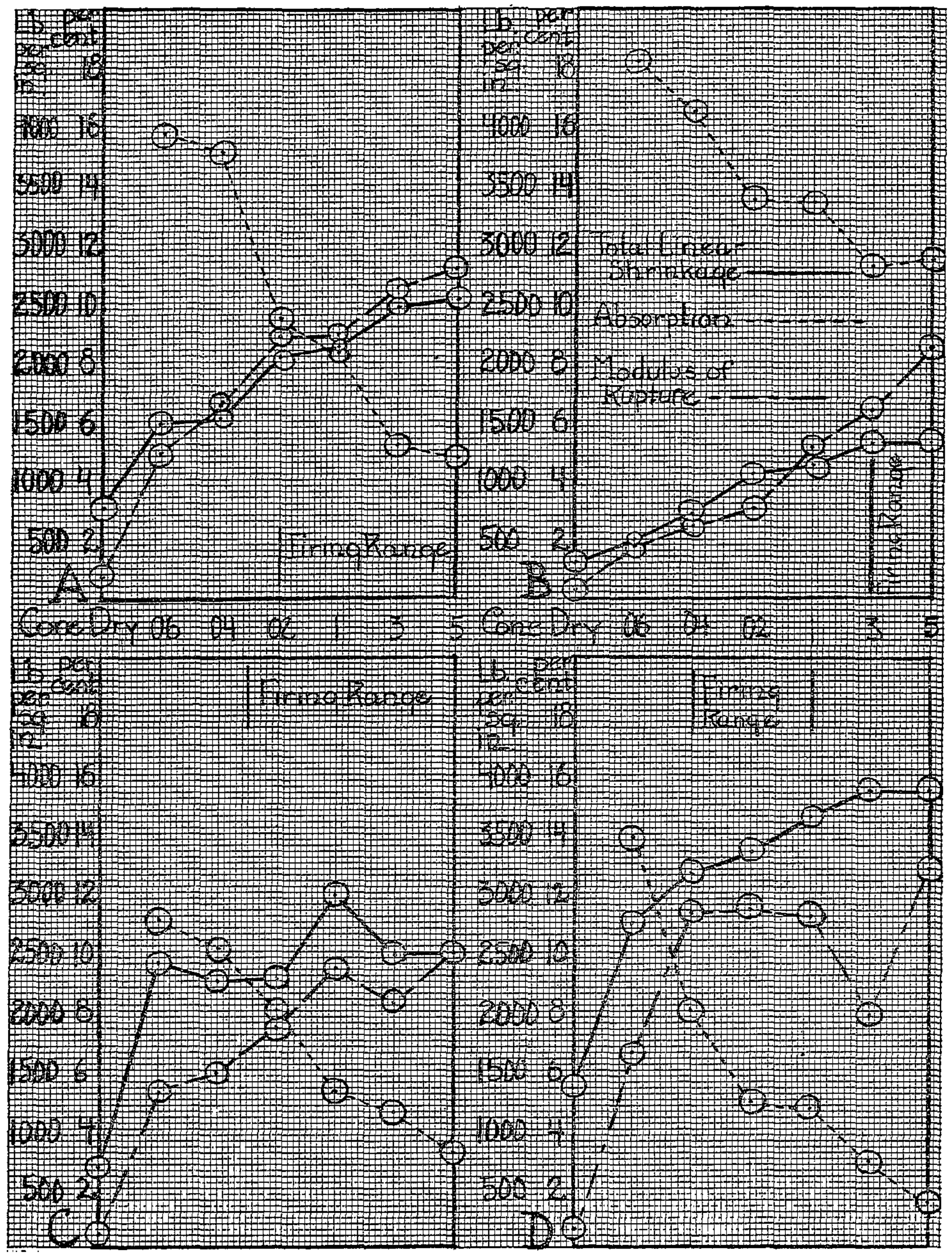


Figure 19. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Conasauga shale from the Plainville Brick Company, Plainville, Gordon County.

B. Conasauga shale from the Maddox and Matthews property, three miles north of Plainville, Gordon County.

C. Conasauga shale from the H. R. Bennett property on the N. C. & St. L. Ry., just north of Bartow County in Gordon County.

D. Clay and shale from the Boyd Orchard Company property, Adairsville, Bartow County.

posits, which possibly cover 40 acres, are in two ridges or series of knolls with a narrow valley between underlain by red clay derived from the weathering of an impure limestone layer. The shale in the west ridge is harder and less fissle than that of the east ridge. The Scott Floyd (Plainville, Rt. 1) property lies between the Carden place and the Southern Railway. The eastern edge of the Floyd property contains a little shale, but most of the property is valley land underlain by limestone of the Conasauga formation. The shale ridges on these two properties should be prospected.

Between the Carden property and the Plainville-Calhoun road the west side of the shale ridges is owned by the Plainville Brick Company, Inc., as described above, and the east side is owned by Jean Goswick on the north and West Walters (Col.) on the south. South of the Plainville-Calhoun road and west of the Rome-Calhoun highway is the Jack Scott property, and south of that to the Floyd County line is the R. J. Gothwick property. These properties should all be prospected to determine the extent and the character of the shale deposits.

MADDOX AND MATTHEWS PROPERTY

(Map location No. 59)

The G. E. Maddox and Aubrey Matthews (Rome) property of 90 acres, known as the Reeves Farm, is west of the Rome-Calhoun highway and south of the road to Curryville, three miles northeast of Plainville.

A ridge west of the house rises to 80 to 100 feet above the general drainage level and contains some 30 to 40 acres. This ridge is underlain by hard greenish-drab to reddish-drab shale breaking into slabs one-quarter to three-quarters of an inch in thickness. The beds are striking N. 30° E. and dipping 60° to 75° NW., and belong to the Conasauga formation. The laboratory tests are given below on a grab sample from outcrops on the east and south sides of the ridge. The deposits are half a mile east of the Southern Railway. A tram line could follow the valley of a small branch northwest to the railroad.

Laboratory tests on a grab sample of hard greenish-drab to reddish-drab Conasauga shale from the Maddox and Matthews property, three miles northeast of Plainville, Gordon County.

Chemical Analysis:

Loss on ignition	5.24
Soda (Na_2O)	.98
Potash (K_2O)	1.51
Lime (CaO)	.00
Magnesia (MgO)	.03
Alumina (Al_2O_3)	19.76
Ferric oxide (Fe_2O_3)	7.77
Titanium dioxide (TiO_2)	.82
Sulphur trioxide (SO_3)	.00
Silica (SiO_2)	63.97
	100.08

Grinding: Fairly easy.
Ground Color: Brownish-gray.
Slaking: Very slow.
Plasticity: Very poor and grainy, even after aging a week.
Molding Behavior: Very poor. Clay column swelled, cracked, and tore on the edges, requiring high oil pressure to form bars.
Drying Behavior: Fairly rapid, with slight warpage.
Water of Plasticity: 18.9 per cent.
Green Modulus of Rupture: 60.9 pounds per square inch.
Linear Firing Shrinkage (based on plastic length): 1.2 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.0	2.0	18.2	456	Salmon (3YR-6/6)[b]	Slight
04	1.6	2.9	16.5	618	Dark salmon (2YR-5/5)[b]	Considerable
02	2.8	4.2	13.5	765	Light red (3YR-5/5)[b]	Slight
1	3.2	4.5	13.4	1274	Fair red (R-YR-4/5)[b]	Some
3	4.1	5.3	11.3	1594	Good red (9R-4/4)[b]	Bad
5	4.3	5.3	11.5	2142	Good red (9R-4/3)[b]	Bad

[a]See graph, Figure 19-B, page 235.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 and higher. Commercial kiln: Cone 2–5.

The above tests indicate that this shale is suited only for the manufacture of common building brick. The green and fired strengths are low and the absorption high. It is possible that fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water might overcome the tendency to slow slaking and, with more intimate contact between the particles, improve the fired properties sufficiently for the material to be used for the manufacture of face brick and structural tile.

JONES AND SHIELDS PROPERTIES

The V. B. Jones (Calhoun, Rt. 4) property is south of the Lilypond-Liberty School road and the J. P. Jones (Calhoun, Rt. 4) property is north of the road, one mile northwest of Lilypond, a small station on the Nashville, Chattanooga and St. Louis Railway.

These properties are located on the western side of a ridge of the Knox dolomite that is west of and parallel to the railroad. Soft to semi-hard fissle and flaky greenish-drab to reddish-drab Conasauga shale outcrops on the western slopes of the ridge, forming irregular knolls and spurs from the main ridge. About 5 acres of the V. B. Jones property and 10 acres of the J. P. Jones property are underlain by this shale. These deposits look as though the shale might be suitable for the manufacture of heavy clay products, but the shale would have to be hauled over the ridge that lies between the deposits and the railroad. The saddle of the ridge crossed by the road is at least 100 feet higher than either the shale deposits or the railroad.

Similar shale underlies nearly all of the 160 acres of the John Shields (Calhoun, Rt. 4) property adjoining on the west, and outcrops at intervals all along the road as far as Liberty School on the Rome-Calhoun highway and on the road from Liberty School to McDaniels Station.

ALLEN AND NELSON PROPERTIES

The M. L. Allen (Calhoun) property of 160 acres is two and a half miles south of Calhoun on a cross road between the Calhoun-McDaniels road and Liberty School. The northern end of the property is less than a quarter of a mile west of the Nashville, Chattanooga and St. Louis Railway.

The ridge of the Knox dolomite that parallels the road west of Lilypond and McDaniels has here become much lower and narrower and ends near the railroad and the northeast corner of this property. About 20 acres of the property at the western foot of this ridge are underlain by soft to semi-hard fissle drab and reddish-drab Conasauga shale in a belt half a mile long and several hundred feet wide. To the west of this the few outcrops showing are of red clay with a few flakes of shale.

These deposits continue onto the Pruitt Nelson (Calhoun) property adjoining on the south. Both of these deposits should be prospected to determine the character and extent of the shale. A flat plant site could be obtained along the railroad northwest of the Allen property and an abundance of water could be pumped from Oothkalooga Creek just east of the railroad.

STRIPLING AND BENNETT PROPERTIES

The Mrs. M. M. Stripling, W. F. Stripling, and H. Bennett (all Adairsville, Rt. 1) properties are on the Nashville, Chattanooga and St. Louis Railway one and a half to two miles south of Lilypond.

The land west of the railroad is a gently rolling plateau some 20 to 25 feet above the railroad, underlain by red clay and soft to semi-hard fissle brownish-drab shale of the Conasauga formation. Outcrops are not frequent, but they indicate that the shale occurs as narrow bands in wider bands of red clay. A little shale is showing east of the railroad on the W. F. Stripling property. These properties, totalling 240 acres, should be prospected to determine the extent of the shale deposits. Some of the red clay could probably be used with the shale in the manufacture of most heavy clay products.

H. R. BENNETT PROPERTY

(Map location No. 60)

The H. R. Bennett (Adairsville, Rt. 1) property is on the west side of the Nashville, Chattanooga and St. Louis Railway just north of the Bartow County line in Gordon County. It consists of 160 acres in Land Lots 143 and 158, 15th District, 3d Section,

Soft to semi-hard brownish-drab Conasauga shale with a few narrow bands of red clay are showing for a quarter of a mile west of the railroad in the cuts of a road that extends from the Dixie Highway west to Plainville. The laboratory tests are given below on a grab sample taken at intervals along these outcrops. North of the road the land rises to a low ridge some 30 to 40 feet above the railroad, but south of the road the ridge flattens out to a flat field drained by a branch of Oothkalooga Creek just south of the county line. Probably about 25 acres are underlain by the shale and should be prospected. The deposits would have natural drainage. A flat plant site could be obtained along the railroad south of the road. Oothkalooga Creek east of the railroad would furnish an abundance of water.

Laboratory tests on a sample of soft to semi-hard brownish-drab Conasauga shale from outcrops on the H. R. Bennett property on the Nashville, Chattanooga and St. Louis Railway just north of the Bartow County line in Gordon County.

Chemical Analysis:

Loss on ignition	6.45
Soda (Na_2O)	.49
Potash (K_2O)	2.01
Lime (CaO)	.00
Magnesia (MgO)	.28
Alumina (Al_2O_3)	23.56
Ferric oxide (Fe_2O_3)	5.65
Ferrous oxide (FeO)	1.43
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	59.15
	99.94

Grinding: Easy.
Ground Color: Light brown.
Slaking: A little slow.
Plasticity: Fair.
Molding Behavior: Fair. Tendency for clay column to crack and tear at the edges.
Drying Behavior: Test bars all slightly warped.
Water of Plasticity: 25.1 per cent.
Green Modulus of Rupture: 100.8 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	6.8	9.4	11.1	1310	Light red (2YR-5/6)[b]	Slight
04	6.0	9.0	10.1	1471	Fair red (R-YR-5/7)[b]	Some
02	6.8	9.1	8.0	1848	Medium red (R-YR-5/4)[b]	Slight
1	9.5	11.9	5.3	2363	Good red (R-YR-4/5)[b]	Some
3	7.3	9.9	4.6	2068	Chocolate red (R-YR-4/4)[b]	Considerable
5	7.6	10.0	3.2	2485	Deep chocolate red (R-YR-3/4)[b]	Bad

[a]See graph, Figure 19-C, page 235.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 5 are slightly kiln-marked have a vitreous look on the surface, and their broken ends show traces of a glassy structure.

Firing Range: Cone 03–5. Commercial kiln: Cone 04–4.

The above tests indicate that this shale is suitable for the manufacture of building brick and possibly structural tile and roofing tile.

DEPOSITS ALONG THE LOUISVILLE & NASHVILLE RAILROAD.

The deposits of Conasauga shale along the Louisville and Nashville Railroad in the eastern part of Gordon County have all been metamorphosed to hard slaty shales varying from typical green slates to hard slightly fissle shales. None of them would develop sufficient plasticity to be suitable for the manufacture of heavy clay products. The surface weathered material derived from them is short and crumbly. The deposits have the most favorable appearance are of the type of the shale on the S. M. Carter property in Murray County, described on page 209, and the Bowen and Bradford properties in Bartow County, described on page 272.

BARTOW COUNTY

Bartow County is south of Gordon County, east of Floyd County, and northeast of Polk County. The northern part of the county is drained by creeks flowing northward to the Coosawattee and Oostanaula rivers; the middle and southern part by the Etowah River and its tributaries. Cartersville, the county seat, is a thriving manufacturing, mining, and agricultural center.

The State owned Western and Atlantic Railroad (leased to the Nashville, Chattanooga and St. Louis Railway) extends northwestward across the county, passing through Allatoona, Emerson, Cartersville, Cass Station, Kingston, and Adairsville. The Rome Branch of the Nashville, Chattanooga and St. Louis Railway follows the Etowah River westward from Kingston. The Atlanta to Cincinnati line of the Louisville and Nashville Railroad, after using the Western and Atlantic Railroad tracks to Cartersville, extends northward through White and Rydal. The southwestern corner of the county is crossed by the Cartersville Branch of the Seaboard Air Line Railway from Cedartown in Polk County.

The Dixie Highway from Atlanta extends northwest through Emerson and Cartersville to Cass Station where it branches, the West Branch going via Kingston to Rome and the East branch via Cassville and Adairsville to Dalton. State highway No. 61, known as the "Tennessee Highway", follows the Louisville and Nashville Railroad northward from Cartersville.

All of Bartow County except the eastern and part of the southern edges is in the Rome Valley, one of the physiographic divisions of the Appalachian Valley of Georgia (see Figure 3, page 49). The Cartersville Fault that marks the boundary between the Appalachian Valley and the Piedmont Plateau crosses the southern boundary of Bartow County near the corner of Polk County, swings eastward south of the Etowah River to a point on the Western and Atlantic Railroad half way between Emerson and Allatoona, and then swings northward to Gordon County at an average distance of two miles east of the Louisville and Nashville Railroad.

The western half of Bartow County is largely underlain by the Knox dolomite. An irregular band of the Conasauga formation extends south from Gordon County along the Western and Atlantic Railroad and the valleys of Oothkalooga and Connesena creeks almost to Kingston, with small isolated outliers at Kingston and Barnsley. A broader band of the Conasauga formation forms the eastern border of the area of Knox dolomite, widening near the Gordon County line to a width of eight miles.

The western belt of the Conasauga formation near Adairsville and south to Halls Station contains deposits of typical fissle Conasauga shale, some of which are described below. The shales of the eastern belt of the Conasauga formation have all been more or less metamorphosed, varying from hard somewhat fissle shale to hard green slate. They weather to a soft but "short" and crumbly reddish-drab shale. A number of deposits of these shales are described below.

A narrow band of the Cartersville formation of Cambrian age (see page 54) extends northwestward through Cartersville and White and east of Rydal to the Cartersville Fault. This is largely composed of potash-bearing siliceous shales which weather to a gray clay. Two deposits from this formation are described below.

East of the Cartersville formation is a narrow band of the Shady limestone and then a broader band underlain by the Weisner quartzite. The deposits of brown iron ore, manganese ore, ochre, and barite that have been mined so extensively in Bartow County are in these two formations.

B. I. CHAMLEE PROPERTY

The B. I. Chamlee (Adairsville) property is one and a half miles north of Adairsville between the Dixie Highway and the Nashville, Chattanooga and St. Louis Railway. The property is one-half to three-quarters of a mile south of the H. R. Bennett property, described above, in Gordon County.

The owner, who has done some prospecting, states that about 38 acres of the property are underlain by fissle brownish-drab Conasauga shale similar to that on the Bennett property and in the shale pit of the B. Mifflin Hood Company at Adairsville, described below. This shale has given rise to three low knolls or ridges, one south of a small branch of Oothkalooga Creek and just north of the old cemetery, and two north of the branch and the Chamlee house. The deposits of shale on these knolls could be mined by steam shovel in pits having natural drainage, and are adjacent to the railroad. The railroad crosses Oothkalooga Creek near the northwest corner of the property.

A low ridge west of the railroad between Oothkalooga Creek and a branch from the west is also said to be underlain by a similar deposit of shale except that there are frequent layers of red clay interbedded with the shale. This deposit is on the W. M. King, C. W. Satterfield, and C. P. Turner properties.

Mr. Chamblee states that the bottom land on the Turner and perhaps on the Satterfield property is underlain by a deposit of plastic alluvial and colluvial clay similar to that in the clay pit of the B. Mifflin Hood Company at Adairsville.

These shale and clay deposits should be thoroughly prospected and tested.

B. MIFFLIN HOOD COMPANY

ADAIRSVILLE PLANT

(Map location No. 61)

Headquarters: Daisy, Tennessee. (See pages 112 and 212.)
B. Mifflin Hood, President.

Adairsville Plant: Adairsville, Georgia.
B. I. Chamlee, Local Superintendent.

The roofing tile plant of the B. Mifflin Hood Company is on the west side of the Nashville, Chattanooga and St. Louis Railway on the northern outskirts of Adairsville. The plant was built about 1906-07 by the Adairsville Brick Company, manufacturing common and face brick from a deposit of the Conasauga shale. The plant was later operated by the Georgia Brick and Tile Company and sold by them in 1924 to the B. Mifflin Hood Company. The B. Mifflin Hood Company in 1925–26 changed the product to roofing tile manufactured from a deposit of colluvial clay adjoining their shale deposit.

Old Shale Pit

The old shale pit extends north of the plant for a quarter of a mile along the south end and west side of a low ridge. The weathered shale at the top of the pit is soft and somewhat flaky and is greenish-drab to reddish-drab in color. Towards the bottom it grades into fairly hard greenish-drab shale that at places breaks into flat pieces but at other places is only slightly fissle. Interbedded with the shale are frequent layers of reddish-brown plastic clay varying in width from a few inches to three feet. The beds in general are striking N. 10° E. and dipping 45° to 50° E., but there are minor variations in the dip. A few small "horses" of limestone were showing at the south end of the pit, but none elsewhere. The laboratory tests are given below on a grab sample of the shale taken at intervals across the north end of the pit where the last mining was done.

Laboratory tests on a sample of greenish-drab Conasauga shale from the old shale pit of the B. Mifflin Hood Company, Adairsville, Bartow County.

Chemical Analysis:

Loss on ignition	4.90
Soda (Na_2O)	.42
Potash (K_2O)	3.42
Lime (CaO)	.00
Magnesia (MgO)	.13
Alumina (Al_2O_3)	23.83
Ferric oxide (Fe_2O_3)	5.95
Ferrous oxide (FeO)	.86
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.34
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	59.18
	100.05

Grinding: A little difficult. Tough rather than brittle.

Ground Color: Brownish-gray.

Slaking: Somewhat slow.

Plasticity: Grainy at first, good after aging three days.

Molding Behavior: Good. (Clay was a little too wet and bars swelled slightly as extruded through the die.)

Drying Behavior: Good. Slight warpage.

Water of Plasticity: 23.4 per cent.

Green Modulus of Rupture: 109.3 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 2.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.0	7.5	10.6	1470	Medium red (1YR-5/5)[b]	Slight
04	4.6	7.3	10.4	1416	Fair red (R-YR-5/5)[b]	Slight
02	5.3	7.5	8.6	1825	Good red (1YR-5/4)[b]	Slight
1	7.3	9.7	5.9	2321	Good chocolate-red (1YR-4/4)[b]	Considerable
3	5.3	7.8	4.5	1917	Deep chocolate-red (R-YR-3/4)[b]	Bad
5	4.0	6.8	2.6	2257	Very deep chocolate (R-YR-3/4)[b]	Very bad

[a]See graph, Figure 20-B, page 247.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 3 were kiln-marked, had a somewhat pimply vitrified appearance on the surface, and their broken ends showed traces of a glassy structure. The bars fired to cone 5 were badly kiln-marked, had a pimply vitrified appearance on the surface, and their broken ends had a glassy and almost black look.

Firing Range: Cone 04–2. Commercial kiln: Cone 06–1.

Clay Pit

The clay pit (see Plate VI) from which the company is now obtaining all of their raw material is north of the plant adjoining the right-of-way of the Nashville, Chattanooga and St. Louis Railway and just east of the ridge underlain by shale. When visited by the writer in 1930 the pit was several hundred feet long, 40 feet wide, and was being mined to a depth of about 10 feet.

The clay is a mottled brown to light-gray, sometimes almost white, fairly plastic clay. It has probably been derived from surface weathering of the Conasuaga shale on the ridge to a clay which was washed to the adjoining low land; in other words, colluvial in origin. The superintendent of the plant states that his grandfather as a boy used to go swimming in a small swimming hole on the site of the clay pit. The laboratory tests are given below on a grab sample of the clay taken from a steam shovel dipper-full scooped from bottom to top of the working face. The clay is said to get redder in color and less plastic towards the shale ridge.

Laboratory tests on a grab sample of plastic mottled brown to light-gray colluvial clay from the clay pit of the B. Mifflin Hood Company, Adairsville, Bartow County.

Chemical Analysis:

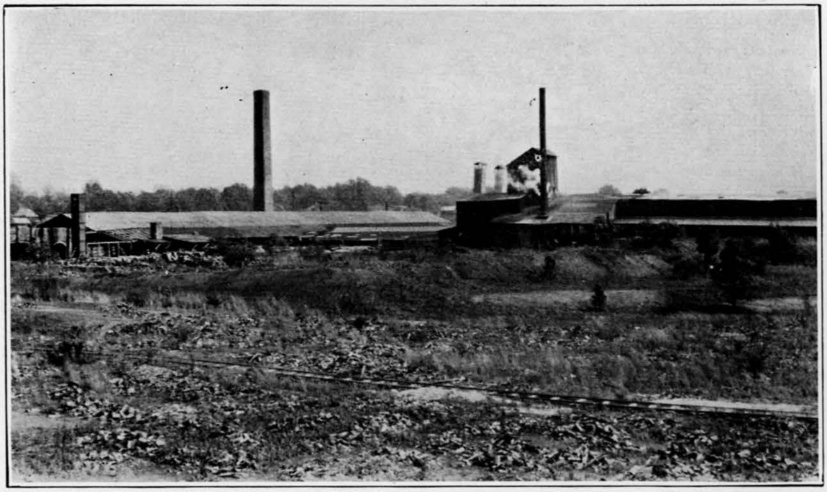
Loss on ignition	9.40
Soda (Na_2O)	.89
Potash (K_2O)	2.70
Lime (CaO)	.98
Magnesia (MgO)	.11
Alumina (Al_2O_3)	19.59
Ferric oxide (Fe_2O_3)	11.01
Manganous oxide (MnO)	1.46
Titanium dioxide (TiO_2)	.78
Phosphorus pentoxide (P_2O_5)	.46
Silica (SiO_3)	52.71
	100.09

Grinding: Easy.
Ground Color: Light grayish-brown.
Slaking: Rapid.
Plasticity: Good, sticky.
Molding Behavior: Excellent.
Drying Behavior: Slight warpage.
Water of Plasticity: 30.2 per cent.
Green Modulus of Rupture: 288.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.5 per cent.

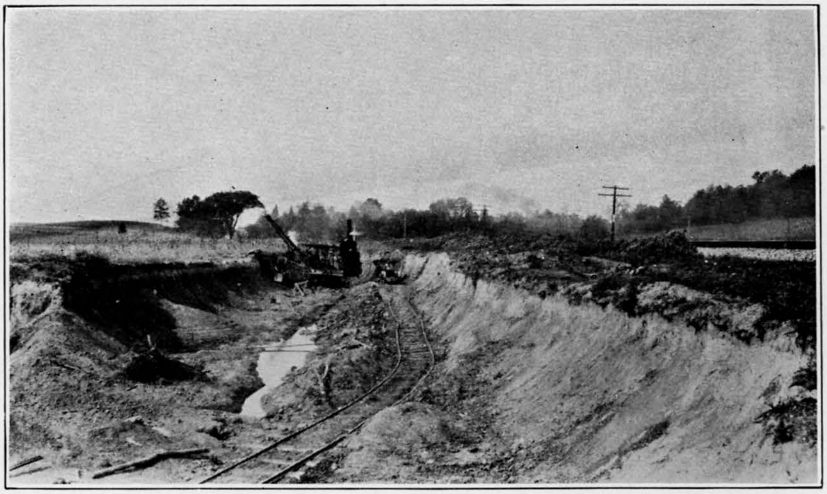
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	8.7	14.8	8.8	1938	Good red (white specks) 2YR-4/3)[b]	Some
04	7.6	14.1	8.9	1966	Chocolate red (white specks) (2YR-3/3)[b]	Considerable
02	5.4	11.8	9.0	1624	Chocolate red (white specks) (3YR-4/2)[b]	Considerable
1	6.7	12.7	8.1	2352	Deep chocolate red (white specks) (1YR-4/3)[b]	Bad

[a]See graph, Figure 20-A, page 247.
[b]Color notation according to the Munsell system, see page 23.



A. ROOFING TILE PLANT OF THE B. MIFFLIN HOOD COMPANY, ADAIRSVILLE, BARTOW COUNTY.



B. CLAY PIT OF THE B. MIFFLIN HOOD COMPANY, ADAIRSVILLE, BARTOW COUNTY.

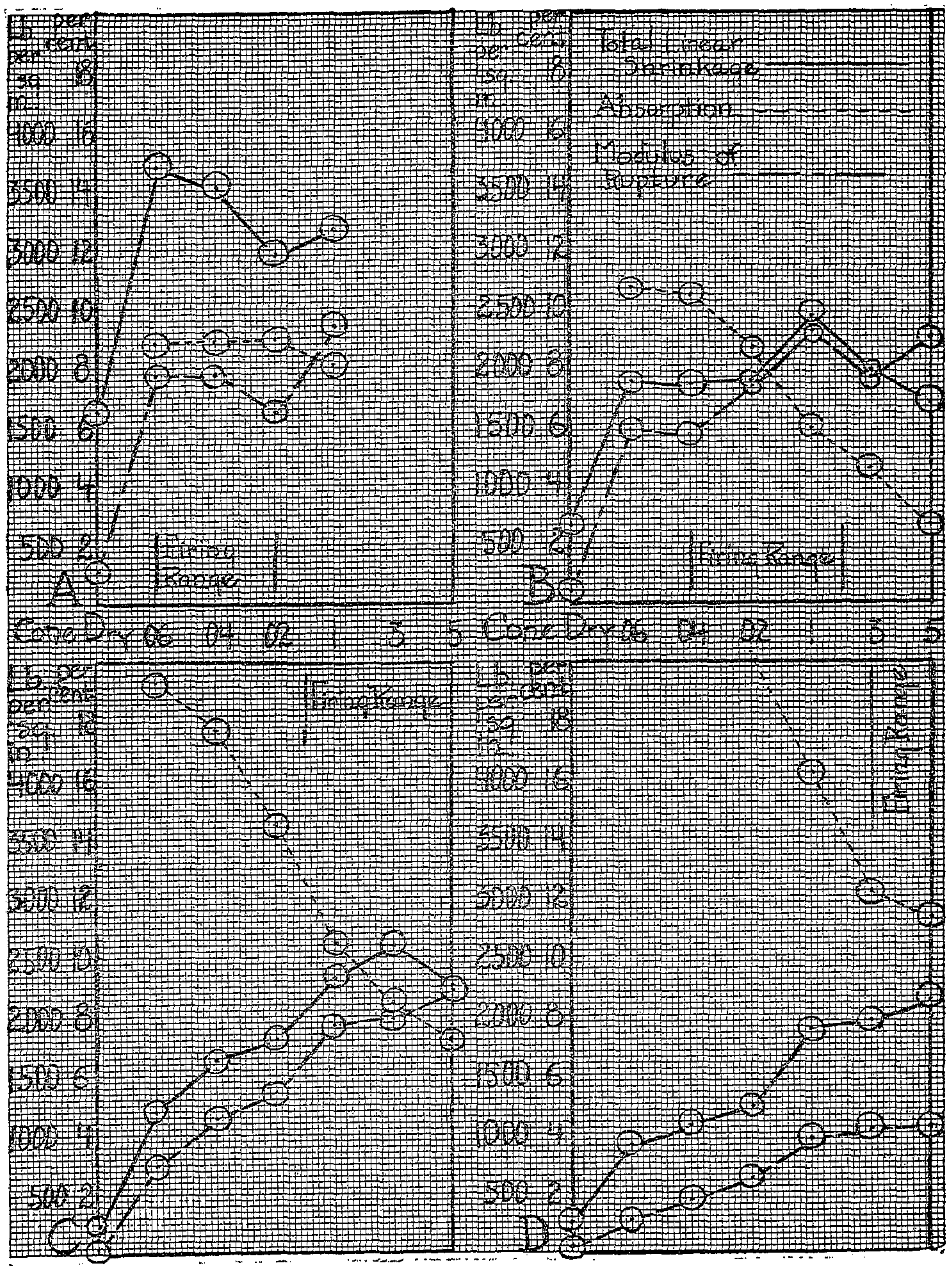


Figure 20. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Colluvial clay from the B. Mifflin Hood Company, Adairsville, Bartow County.

B. Conasauga shale from the B. Mifflin Hood Company, Adairsville, Bartow County.

C. Conasauga shale from the W. E. Pearson property, one mile south of Adairsville, Bartow County.

D. Red Conasauga shale from the Clemons and Greenfield properties, Halls Station, Bartow County.

Remarks: The broken ends of the bars fired to cone 04 and 02 showed flashing. The bars fired to cone 1 were kiln-marked, had vitreous surfaces, and their broken ends showed a glassy structure. No tests bars were fired to cones 3 and 5.

Firing Range: From less than cone 06 to cone 02. Commercial kiln: Less than cone 04.

The clay is mined by steam shovel, loaded into side-dump tram cars, and hauled to the plant by a gasoline locomotive on a narrow-gauge tram line.

Plant

The clay as it is brought into the plant is dumped onto a storage pile. A conveyor belt under the storage pile carries the clay to a dry pan where it is ground. The ground clay is elevated to 16-mesh vibrating screens. The oversize or tailings from the screens are fed to a 3-foot by 30-foot rotary gas-fired dryer from which the small particles, containing about 4 per cent of moisture, are dropped onto the conveyor belt feeding the dry pan from the clay storage. The fines or undersize from the screens are fed to a large single-shaft disintergrator. Here the clay is tempered and discharged into a combination pug mill and auger machine which is fitted for the extrusion of a continously curved ribbon which is automatically cut off into roofing tile. Even tapered-barrel Mission tile are automatically cut from a continuous ribbon of clay.

The green tile are stacked on end in wooden drier cars and dried to about 120°F. in a 14-track steam-heated tunnel dryer. The tile are fired to about cone 08 or 1640°F. in rectangular down-draft kilns. The kilns consist of one long kiln with five separate compartments, each holding 85 to 180 tons of tile, converted from an old continuous kiln; and one rectangular Eudaly kiln slightly larger than a separate compartment of the big kiln. The long kiln is on one large stack, but the Eudaly kiln has two small stacks of its own. The heat is controlled and the end point determined by electrical pyrometers and draw trials. The firing of each unit takes about four days.

The capacity of the plant is about 9,000 pieces of tile per day in three shapes: Straight-barrel Mission, Tapered-barrel Mission, and Roman Pan. The product is in soft pleasing salmon, salmon-red and chocolate shades that blend admirably with the Latin and Mediterranean types of architecture.

BOYD ORCHARD COMPANY

(Map location No. 62)

The Boyd Orchard Company (c/o C. M. Boyd, Adairsville) owns a large tract of land on the Snow Springs School road just southwest of Adairsville on the west side of Oothkalooga Creek.

A field about a quarter of a mile across (east-west) and a mile long (north-south) between Oothkalooga Creek and the foot of the ridge of Knox dolomite to the west is underlain by red, brown, and mottled yellow and red clay and fissle greenish-drab shale of the Conasauga formation. The greater part of the field is underlain by the clay, which is probably derived from the weathering of a very argillaceous limestone. The shale is confined to three or four strips 50 to 150 feet in width, striking N. 10° E. and dipping 75° E.

A deep gully near the north end of the field exposes clay varying from soft mottled red and yellow, to hard blocky, almost shale like, and yellow to brown in color. The laboratory tests on a grab sample of all varieties of clay from this gully are given below.

Laboratory tests on a grab sample of residual red, brown, and mottled yellow and red clay from the Boyd Orchard Company property, half a mile southwest of Adairsville, Bartow County.

Chemical Analysis:

Loss on ignition	5.12
Soda (Na_2O)	trace
Potash (K_2O)	2.68
Lime (CaO)	.00
Magnesia (MgO)	.20
Alumina (Al_2O_3)	25.79
Ferric oxide (Fe_2O_3)	5.80
Ferrous oxide (FeO)	1.27
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	58.31
	100.09

Grinding: Easy.

Ground Color: Drab.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Excellent.

Drying Behavior: Slight warpage.

Water of Plasticity: 30.7 per cent.

Green Modulus of Rupture: 148.5 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 5.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	6.1	11.0	13.9	1649	Salmon (4YR-6/6)[b]	Slight
04	8.2	12.7	8.0	2827	Light red (R-YR-5/4)[b]	Some
02	8.8	13.4	4.9	2836	Medium red (R-YR-5/4)[b]	Some
1	9.9	14.6	4.7	2800	Good-red (R-YR-4/4)[b]	Some
3	10.2	15.5	2.9	1946	Deep red (R-YR-3/5)[b]	Some
5	10.2	15.5	1.5	3190	Deep chocolate red (1YR-3/4)[b]	Considerable

[a]See graph, Figure 19-D, page 235.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cones 04 and 3 were all more or less black-cored, indicating reducing conditions. The test bars fired to cone 3 were slightly kiln-marked, had a somewhat vitrified appearance on the surface, and their broken ends showed traces of a glassy structure. Those fired to cone 5 were considerably kiln-marked, had a vitrified look, and their broken ends showed a glassy structure.

Firing Range: Cone 04–1. Commercial kiln: Cone 05–01.

The above tests indicate that this clay would be satisfactory for the manufacture of building brick and possibly structural tile and roofing tile. The firing range is short and the manufacturing process would have to be carefully controlled. The addition of some of the typical Conasauga shale that occurs with the clay would lengthen the firing range and reduce the total shrinkage.

The approximately 160 acres underlain by this clay and shale should be carefully prospected. No part of the deposit is more than half a mile from the railroad. Oothkalooga Creek lies between the property and the railroad except near the southern end where the railroad crosses the creek.

W. E. PEARSON PROPERTY

(Map location No. 63)

The W. E. Pearson (Adairsville) property of 40 acres is on the west side of the Nashville, Chattanooga and St. Louis Railway south of Swains Branch and one mile south of Adairsville. The property is about a quarter of a mile wide and three-quarters of a mile long, fronting the railroad.

A ridge 80 to 100 feet above the main drainage level parallels the railroad and is underlain by shale of the Conasauga formation. The shale, as showing in gullies on the east side of the ridge, road cuts on the west side, and as fragments in the soil, is fissle, soft to semi-hard, and grayish-drab to brownish-drab in color. The laboratory tests are given below on a grab sample from a gully on the east side of the ridge and from a cut on the Adairsville-Kingston road.

Laboratory tests on a grab sample of soft to semi-hard brownish-drab Conasauga shale from the W. E. Pearson property, one mile south of Adairsville, Bartow County.

Chemical Analysis:

Loss on ignition	5.31
Soda (Na_2O)	.58
Potash (K_2O)	1.41
Lime (CaO)	.00
Magnesia (MgO)	.35
Alumina (Al_2O_3)	26.11
Ferric oxide (Fe_2O_3)	6.08
Ferrous oxide (FeO)	2.57
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	56.83
	100.15

Grinding: Fairly easy.
Ground Color: Light brown.
Slaking: Slow.
Plasticity: Poor and grainy at first, better after aging overnight.
Molding Behavior: Fair. Tendency for clay column to crack and to tear on the edges.
Drying Behavior: Rapid, with only slight warpage.
Water of Plasticity: 23.4 per cent.
Green Modulus of Rupture: 32.4 per cent.
Linear Drying Shrinkage (based on plastic length): 1.4 per cent.
Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	3.4	4.8	19.4	759	Light salmon (3YR-6/6)[b]	Slight
04	4.8	6.5	17.7	1148	Dark salmon (2YR-5/5)[b]	Slight
02	5.5	7.2	14.5	1352	Light red (2YR-6/5)[b]	Slight
1	7.8	9.3	10.5	1924	Fair red (1YR-5/5)[b]	Some
3	8.7	10.4	8.5	1985	Good red (R-YR-4/3)[b]	Considerable
5	7.8	9.0	7.2	2236	Good red (R-YR-4/4)[b]	Considerable

[a]See graph, Figure 20-C, page 247.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–6. Commercial kiln: Cone 02–5.

The above tests indicate that this shale has possibilities for the manufacture of building brick. Its tendency to slow slaking and poor plasticity could be partly overcome by fine grinding, long pugging, the use of hot tempering water, or the use of certain electrolytes in the tempering water.

The property should be prospected to determine the extent and character of the shale. A flat area of about three acres adjoining the railroad would make a good plant site. Water could be obtained from Swains Branch on the north end of the property or from Oothkalooga Creek east of the railroad.

The shale is said to extend onto the Mrs. Collett property adjoining on the south, the Mrs. Dexter Long property south of that, and the C. J. Ward property south of the Long property, all adjoining the Nashville, Chattanooga and St. Louis Railroad.

CLEMMONS AND GREENFIELD PROPERTIES

(Map location No. 64)

The C. W. Clemmons (Linwood) and the J. C. Greenfield (Citizens Southern Bank Bldg., Atlanta) properties are on the east side of the Nashville, Chattanooga and St. Louis Railway at Halls Station and Linwood P. O., five miles south of Adairsville. The Clemmons property of 45 acres is north of the secondary road running east from Halls Station, and the Greenfield property of about 150 acres is south of the road.

Most of the land on these properties is rolling, with low ridges and knolls rising from 50 to 75 feet above the railroad. Along the railroad is a flat meadow or bottom land of 10 to 15 acres drained by the headwater branch of Connesena Creek. The ridges and knolls show numerous outcrops of soft to semi-hard reddish-brown to drab Conasauga shale, somewhat fissle at places but only slightly so at others, The soft weathered surface material is somewhat crumbly and "short". The less weathered shale is hard and brownish-drab in color. The laboratory tests are given below on a grab sample of this shale from scattered road and gully outcrops on both properties. The deposits could be easily mined by steam shovel and the pits would have natural drainage.

Laboratory tests on a sample of soft to semi-hard reddish-brown to drab Conasauga shale from the W. C. Clemmons and J. C. Greenfield properties, Halls Station, Bartow County.

Chemical Analysis:

Loss on ignition	6.14
Soda (Na_2O)	.51
Potash (K_2O)	2.58
Lime (CaO)	.00
Magnesia (MgO)	.39
Alumina (Al_2O_3)	36.75
Ferric oxide (Fe_2O_3)	7.57
Ferrous oxide (FeO)	.96
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	44.28
	100.09

Grinding: Easy.
Ground Color: Reddish-brown.
Slaking: Slow.
Plasticity: Poor and grainy, even after aging several days.
Molding Behavior: Poor. Clay column cracked and tore on the edges even when wet enough to swell as it came through the die.
Drying Behavior: Rapid with very slight warpage.
Water of Plasticity: 25.4 per cent.
Green Modulus of Rupture: 31.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 1.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.6	3.6	22.9	261	Light salmon (3YR-6/6)[b]	Slight
04	3.3	4.3	20.7	423	Salmon (1YR-5/5)[b]	Slight
02	3.9	4.9	20.3	640	Salmon (2YR-6/5)[b]	Slight
1	6.6	7.5	16.2	945	Light red (1YR-5/5)[b]	Some
3	6.9	7.8	12.2	1038	Medium red (R-YR-4/4)[b]	Some
5	8.0	8.5	11.3	1057	Good red (R-YR-4/3)[b]	Considerable

[a]See graph, Figure 20-D, page 247.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 and higher. Commercial kiln: Cone 2–5 and possibly higher.

The above tests indicate that this shale, by itself, is not suitable for the manufacture of heavy clay products. The shale is slow slaking, the plasticity and molding behavior poor, the green and fired strengths low, and the absorption high. It might possibly be suited for the manufacture of light-weight aggregate (see page 41).

The flat bottom land next to the railroad is said to be underlain by a deposit of plastic gray to brown alluvial or colluvial clay, and is so mapped by Fuller and Shores[1] on the soil map of Bartow County. This should be prospected and ceremic tests made of the deposit is large and fairly uniform. It is possible that this plastic clay might be suitable for use as a binder for the shale, and that heavy clay products could be made from a mixture of one part of plastic clay with two or three parts of shale.

BISHOP AND JACKSON PROPERTIES

The J. L. Bishop (3–219 Knights Bridge Rd., S. W. 7, London, England) property of 106 acres and the Robert Jackson (Cartersville) property of about 300 acres are on the West Rome) Branch of the Dixie Highway, just west of Two Run Creek and half a mile north of the Nashville, Chattanooga and St. Louis Railway, about three and a quarter miles east of Kingston.

Soft drab shale and red clay from the Conasauga formation are exposed on a low knoll and ridge on the Bishop property and in highway cuts on the Jackson property. That the layers of red clay are derived from the weathering of argillaceous limestone is shown by a small outcrop of limestone sticking up through the red clay on the south side of the knoll on the Bishop property. The low ridge extending from the highway to the creek on the Bishop property and the eastern side of the Jackson property contain more or less shale and should be prospected.

MILNER AND MUMFORD PROPERTIES

(Map location No. 65)

The Mrs. Florence Milner (Cartersville) property north of the West (Rome) Branch of the Dixie Highway and the R. S. Mumford (Cartersville) property between the highway and the Nashville, Chattanooga and St. Louis Railway three-quarters of a mile to the south, are both east of Two Run Creek about three and a half miles east of Kingston.

A cut on the highway between the two properties exposes soft to hard shale varying from drab to brown and red in color and from very soft and crumbly to quite hard. Some of the soft to semi-hard shale is fissle, but some of the harder is non-fissle and even schistose and mica-

[1]Fuller, G. L., and Shores, H. H., Soil survey of Bartow County, Georgia: U. S. Dept. Agriculture, Soil Survey Rept., Series 1926, No. 11, 1930.

ceous, indicating considerable metamorphism. In with the shale are streaks of soft black to red clay. The hard shale contains a few chert nodulus. The laboratory tests are given below on a grab sample of all types of the shale taken at intervals along the cut. The Milner property north of the highway contains irregular ridges probably underlain by this shale. A low ridge of about 100 acres extending from the highway to the railroad on the Mumford property is said to be underlain by a mixture of shale and red clay.

Laboratory tests on a sample of soft to hard drab to brownish-red shale from the Mrs. Florence Milner and the R. S. Mumford properties on the Dixie Highway at Two Run Creek about three and one-half miles east of Kingston, Bartow County.

Chemical Analysis:

Loss on ignition	5.08
Soda (Na_2O)	.74
Potash (K_2O)	2.10
Lime CaO)	.00
Magnesia (MgO)	.23
Alumina (Al_2O_3)	24.36
Ferric oxide (Fe_2O_3)	6.38
Ferrous oxide (FeO)	.38
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	59.90
	100.07

Grinding: Fairly easy.
Ground Color: Reddish-brown.
Slaking: Slow.
Plasticity: Poor, "short" and mealy, even after aging three days.
Molding Behavior: Too short to form bars on the Mueller roll-press. The clay column cracked badly even when soft enough to swell on coming through the die.

The sample was therefore discarded without further tests as unsuited, by itself, for the manufacture of heavy clay products. It is possible that some of the red clay said to underlie the ridge between the highway and the railroad might have sufficient plasticity to act as a binder in mixtures of the shale and clay, enabling them to be used in the manufacture of heavy clay products.

Similar shale is showing on a low knoll of about four acres on the J. C. McTier (Cass Station) property south of the Nashville, Chattanooga and St. Louis Railway about two and a quarter miles west of Cass Station and just east of the southern end of the Mumford property.

W. D. PITTARD PROPERTY

(Map location No. 65)

The Old Hawks Place owned by W. D. Pittard (Cassville) is just west of the village of Cassville, two miles north of the Nashville, Chattanooga and St. Louis Railway on the East (Dalton) Branch of the Dixie Highway.

The slopes of a low ridge an eighth of a mile west of the highway and rising some 30 to 40 feet above a small wet-weather branch exposes outcrops of mottled deep-red to grayish-white stiffly plastic clay with spots and irregular streaks of white and brown clay. This clay has probably been derived from the weathering of a soft calcareous shale or a very impure limestone, and at places shows traces of a shaly structure or bedding planes. The laboratory tests are given below on a grab sample of all colors of the clay from several gully outcrops on the slope.

Building brick are said to have been made from this clay some time before the Civil War when Cassville was the county seat of Cass County and later Bartow County. The old court house burned by Sherman's army in 1864 was built of these brick and a few, dark-red in color and extra large in size, are still in use in the sidewalk in front of one of the stores.

Laboratory tests on a sample of stiffly-plastic deep-red, gray, and mottled brown and gray residual clay from the W. D. Pittard property at Cassville, Bartow County.

Chemical Analysis:

Loss on ignition	8.03
Soda (Na_2O)	.61
Potash (K_2O)	3.37
Lime (CaO)	.00
Magnesia (MgO)	.06
Alumina (Al_2O_3)	18.85
Ferric oxide (Fe_2O_3)	9.79
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.15
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	58.04
	99.90

Grinding: Easy.
Ground Color: Red with yellow specks.
Slaking: Rapid.
Plasticity: Good.
Molding Behavior: Good.
Drying Behavior: Good. Slight warpage.
Water of Plasticity: 29.0 per cent.
Green Modulus of Rupture: 126.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.4	11.8	14.9	1135	Salmon (3YR-6/7)[b]	Some
04	5.6	12.1	12.9	1094	Light red (2YR-6/6)[b]	Some
02	6.5	12.6	10.8	1293	Light red (R-YR-5/5)[b]	Some
1	8.2	14.6	9.4	1467	Medium red (1YR-5/5)[b]	Some
3	7.2	12.9	10.2	1507	Good red (R-YR-4/5)[b]	Some
5	9.0	14.8	8.3	1613	Good red (R-YR-4/4)[b]	Some

[a]See graph, Figure 21–A, page 269.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 02–5.

The above tests indicate that this clay is suited to the manufacture of building brick. This and the adjoining properties to the north and south should be prospected to determine the extent of the clay.

Another property owned by Mr. Pittard, known as the Old Vernon Place, is just east of Cassville. It includes 25 to 30 acres of a ridge about 100 feet high that parallels the Dixie Highway from the junction of the East and West branches a mile and a half to the south to a point a mile or so north of Cassville. Outcrops of soft reddish-brown to hard greenish-drab shale are exposed on the slopes and top of this ridge. Some of the shale is fissle, but some breaks into large pieces with only traces of a shaly structure. The softer weathered portions are somewhat crumbly. The laboratory tests are given below on a grab sample of the shale from several scattered outcrops.

Laboratory tests on a sample of soft reddish-brown to hard greenish-drab Conasauga shale from the W. D. Pittard property, Cassville, Bartow County.

Chemical Analysis:

Loss on ignition	5.35
Soda (Na_2O)	1.06
Potash (K_2O)	1.82
Lime (CaO)	.00
Magnesia (MgO)	.12
Alumina (Al_2O_3)	26.41
Ferric oxide (Fe_2O_3)	8.10
Ferrous oxide (FeO)	.28
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.21
Phosphorus pentoxide (P_2O_5)	trace
Silica ($SiO2$)	55.85
	100.10

Grinding: Easy.
Ground Color: Brown with green specks.
Slaking: Slow.
Plasticity: Poor ("short"), even after aging two days.
Molding Behavior: Poor. Clay column cracked and tore on the edges even when wet enough to swell on coming through the die.
Drying Behavior: Fairly rapid. Slight warpage.
Water of Plasticity: 27.3 per cent.
Green Modulus of Rupture: 35.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 1.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.8	2.5	26.0	512	Pale salmon (4YR-6/6)[b]	Slight
04	3.5	4.8	22.2	708	Salmon (1YR-6/5)[b]	Slight
02	5.0	6.0	20.2	718	Salmon (1YR-5/5)[b]	Slight
1	7.6	9.0	17.5	1488	Medium red (R-YR-4/5)[b]	Slight
3	7.4	7.8	16.0	1056	Good dull red (R-YR-5/4)[b]	Considerable
5	8.7	10.5	12.0	1639	Deep dull red (R-YR-4/3)[b]	Some

[a]See graph, Figure 21-B, page 259.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher.

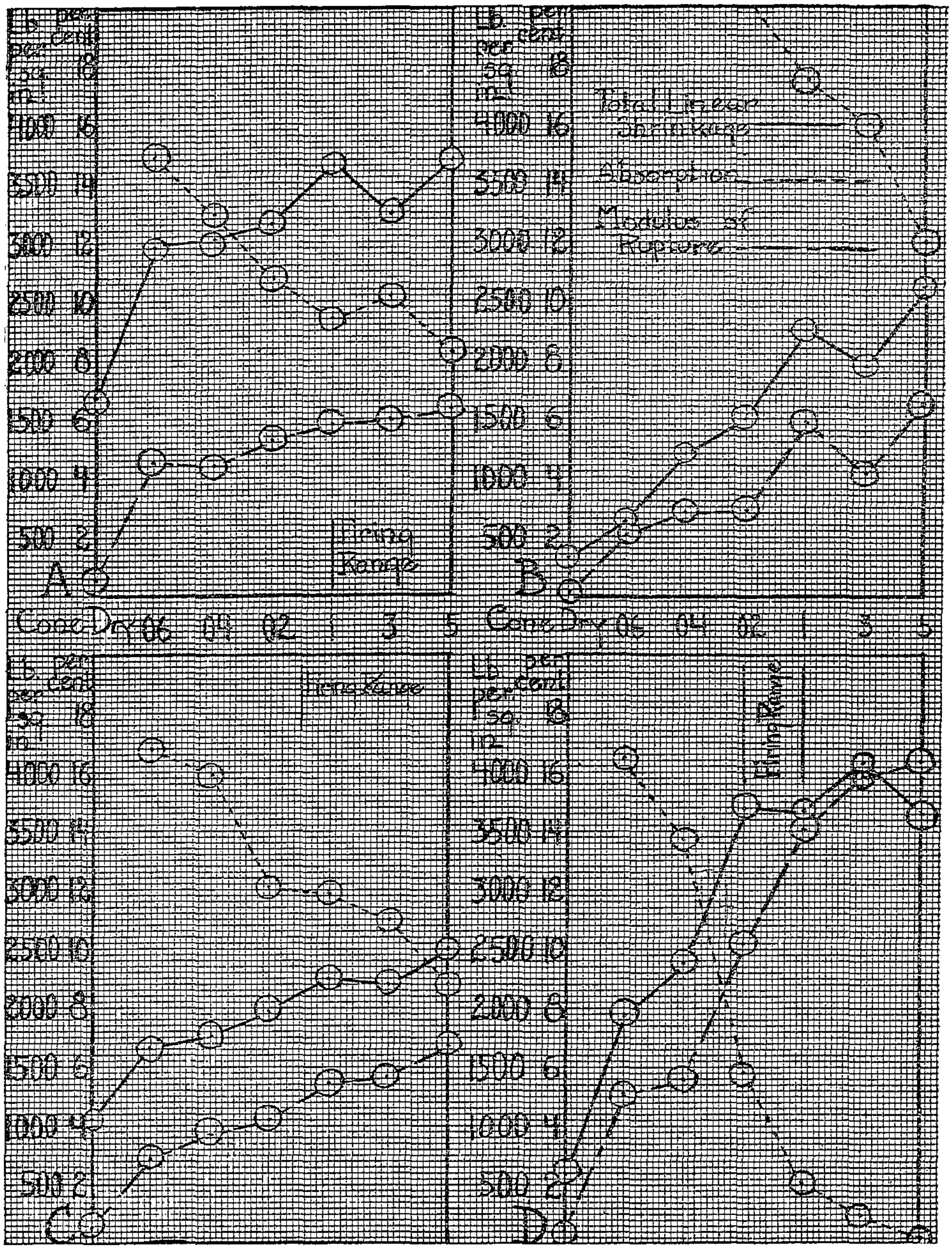


Figure 21. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Residual clay from the W. D. Pittard property, Cassville, Bartow County.

B. Conasauga shale from the W. D. Pittard property, Cassville, Bartow County.

C. Hard shale and clay from the Mrs. T. Q. Richardson property, half a mile southeast of Cass Station, Bartow County.

D. Clay and weathered Cartersville shale from the Dr. R. E. Adair property, Cartersville, Bartow County.

The above tests indicate that, because of the lack of plasticity, the low green and fired strengths, and the high absorption of this shale, it is not suited, by itself, for the manufacture of heavy clay products. A mixture of this shale and the red residual clay from the same property described above would probably be suitable for the manufacture of building brick and perhaps other heavy clay products.

BEARDON AND MCKELVY PROPERTIES

(Map location No. 67)

The S. H. Beardon (Cass Station) property is on the Dixie Highway three-quarters of a mile northwest of Cass Station and an eighth of a mile east of the junction of the East and West branches of the highway. The nearest point on the Nashville, Chattanooga and St. Louis Railway is an eighth of a mile to the south. About 40 acres of this property and nearly all of the adjoining 90 acre property belonging to Tom McKelvy (Cass Station) are on a ridge that extends north from the highway towards Cassville. This end of the ridge is underlain by shale similar to that on the same ridge on the Pittard property at Cassville, described above. It appears to be a somewhat metamorphosed variety of the Conasauga shale.

A small cut on the highway and the sides of the old location of the road on the Beardon property show outcrops of soft to semi-hard drab to reddish-brown and red shale, flaky and fissle at places but only slightly so at others. Much of the shale weathers into irregular pieces streaked red and drab and resembling pine bark or chips of weathered cedar wood. The laboratory tests are given below on a grab sample of this shale from several of these outcrops.

Laboratory tests on a grab sample of soft to semi-hard drab to red shale from the S. H. Beardon property on the Dixie Highway three-quarters of a mile northwest of Cass Station, Bartow County.

Chemical Analysis:

Loss on ignition	5.50
Soda (Na_2O)	.23
Potash (K_2O)	.10
Lime (CaO)	.00
Magnesia (MgO)	.29
Alumina (Al_2O_3)	28.68
Ferric oxide (Fe_2O_3)	8.35
Titanium dioxide (TiO_2)	1.08
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	55.67
	99.90

Grinding: Easy.
Ground Color: Red.
Slaking: Slow.
Plasticity: Very poor, even after aging three days.
Molding Behavior: Too poor to form bars on the Mueller roll-press.

The sample was therefore discarded without further tests as unfit, by itself, for the manufacture of heavy clay products. It is possible that it might be satisfactory for the manufacture of light-weight aggregates (see page 41). If a deposit of a plastic residual clay, such as the one on the Pittard property (described above) at Cassville, could be found nearby, blends of the shale and clay would probably be satisfactory for the manufacture of building brick and possibly other heavy clay products.

MRS. T. Q. RICHARDSON PROPERTY

(Map location No. 68)

The Mrs. T. Q. Richardson (Cass Station) property of 120 acres, known as the Hargis Homestead, is on the west side of the Nashville, Chattanooga and St. Louis Railway a quarter to half a mile southeast of Cass Station.

A cut on the railroad about 500 feet long and averaging 8 feet high exposes hard drab Conasauga shale, fissle at places but only slightly fissle at others. This shale has formed a low ridge parallel to the railroad. More shale is showing at the south end of the ridge, but on the west slope of the ridge near the family graveyard the only outcrops are of plastic yellow clay, together with some brown and red plastic clay. These clays are probably residual from an impure limestone layer of the Conasauga formation. The ridge to the west across a little valley exposes only red clay.

The laboratory tests are given below on a grab sample composed of about equal parts of the hard shale from the railroad cut and the soft plastic yellow clay from the west side of the ridge. The shale by itself is probably too slow slaking to be of value for the manufacture of heavy clay products.

Laboratory tests on a sample of equal parts of hard drab shale and soft plastic yellow clay from the Mrs. T. Q. Richardson property, half a mile southeast of Cass Station, Bartow County.

Chemical Analysis:

Loss on ignition	9.89
Soda (Na_2O)	.37
Potash (K_2O)	1.94
Lime (CaO)	.00
Magnesia (MgO)	.28
Alumina (Al_2O_3)	34.01
Ferric oxide (Fe_2O_3)	7.92
Ferrous oxide (FeO)	trace
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	44.72
	100.05

Grinding: Easy.
Ground Color: Light brown.
Slaking: The clay slakes rapidly, the shale slowly, making the mixture grainy at first.
Plasticity: Clay had sticky plasticity. Mixture is slightly grainy at first but fairly good after aging.
Molding Behavior: Good.
Drying Behavior: Only slight warpage.
Water of Plasticity: 23.8 per cent.
Green Modulus of Rupture: 93.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.2 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.3	6.6	16.8	713	Light salmon (3YR-6/7)[b]	Slight
04	2.6	7.0	15.9	922	Salmon (2YR-6/6)[b]	Slight
02	4.1	7.9	12.1	1050	Light red (2YR-6/6)[b]	Slight
1	5.0	9.0	11.9	1359	Fair red (R-YR-5/5)[b]	Slight
3	4.6	8.8	11.0	1414	Medium red (R-YR-4/5)[b]	Some
5	5.9	10.0	8.8	1682	Good red (R-YR-4/3)[b]	Some

[a]See graph, Figure 21-C, page 259.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 01–5. Commercial kiln: Cone 02–4.

The above tests indicate that this mixture of shale and clay is satisfactory for the manufacture of building brick. The property should be thoroughly prospected to determine the extent and character of the deposits.

JIM NOLAN PROPERTY

The Jim Nolan (Cass Station) property is on the west side of Nancy Creek three-quarters of a mile west of Atco on the old road from Cass Station to Ladd's quarry.

The cuts and ditches of the old road north of the Atco to Harden Bridge road show mottled yellow and white clay with frequent soft much weathered fragments of yellow and drab shale, changing to red clay at the top of the low ridge west of the creek. The property, which is not over half a mile west of the Nashville, Chattanooga and St. Louis Railroad, should be prospected.

DR. R. E. ADAIR PROPERTY

(Map location No. 69)

The Dr. R. E. Adair (Cartersville) property is just north of the city limits of Cartersville and east of and adjoining the freight yards of the Louisville and Nashville Railroad. It consists of about 40 acres in Land Lot 267, 4th District, 3d Section, Bartow County.

The land is nearly flat with one or two low knolls rising from 10 to 15 feet above the general drainage level. The property is drained at the north and south ends by small wet-weather branches which flow into Pettit Creek to the west.

A light to dark-gray stiffly-plastic clay is exposed at places in the drainage ditches and at other places is turned up in plowing the fields. Occasionally this clay is stained red and brown. At the request of the writer, the owner had a prospect pit dug in the middle of the property. This pit passed through seven feet of clay, varying from soft massive and light gray at the top to dark gray and nearly as soft at the bottom, but having a distinct shaly structure striking to the northwest and dipping 60° to the southeast.

This clay is evidently derived from the weathering of a shaly portion of the Cartersville formation (see page 54). The whole property appears to be underlain by the clay and shale under little or no overburden. It probably could be mined to a depth of 10 to 15 feet without taking too much unweathered shale. The pits would be largely below drainage level and, except in dry weather, water would have to be pumped from them. An excellent plant site could be obtained adjoining the railroad.

The following laboratory tests were made on a six-foot groove sample from top to bottom of the prospect pit:

Laboratory tests on a six-foot groove sample of soft gray clay and much weathered shale of the Cartersville formation *from a prospect pit on the Dr. R. E. Adair property just north of Cartersville, Bartow County.*

Chemical Analysis:

Loss on ignition	3.07
Soda (Na_2O)	.79
Potash (K_2O)	2.34
Lime (CaO)	.00
Magnesia (MgO)	.13
Alumina (Al_2O_3)	29.11
Ferric oxide (Fe_2O_3)	6.44
Ferrous oxide (FeO)	.58
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.59
Silica (SiO_2)	56.09
	100.05

Grinding: Easy.
Ground Color: Very light gray.
Slaking: Rapid.
Plasticity: Fair. A little "short".
Molding Behavior: Fair. Some tendency for clay column to crack and tear on the edges, but with high oil pressure made good-looking bars.
Drying Behavior: Good. Little or no warpage.
Water of Plasticity: 27.8 per cent.
Green Modulus of Rupture: 96.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. Per sq. in.*	Color	Warpage
06	5.5	7.8	16.5	1282	Salmon (3YR-6/5)[b]	Very slight
04	7.3	9.5	13.7	1382	Dark salmon (2YR-5/5)[b]	Very slight
02	12.5	14.8	5.8	2548	Light red (1YR-5/4)[b]	Slight
1	12.7	14.7	2.1	3514	Fair red (R-YR-4/3)[b]	Some
3	14.1	16.3	1.0	3994	Deep red (1YR-3/3)[b]	Considerable
5	12.4	14.6	0.1	4088	Gun-metal black (YR-3/2)[b]	Bad

[a]See graph, Figure 21-D, page 259.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 3 were slightly kiln-marked, had a vitrified appearance, and their broken ends showed the beginnings of a glassy structure. The bars fired to cone 5 were badly kiln-marked, were vitrified to a glaze on the surface, and the broken ends showed a glassy structure.

Firing Range: Cone 02–1. Commercial kiln: Cone 04–01.

The above tests indicate that the clay has the very narrow firing range of cones 02 to 1 in the laboratory kiln, which probably would correspond to cones 04 to 01 in a commercial kiln. The clay is probably suited only for the manufacture of common brick, flower pots, crude pottery, and possibly light-colored, porous roofing tile suited only for use in Southern climates. Great care would have to be taken to keep within the narrow firing range. It is possible that, because of the relatively low vitrification point, the clay might be especially suited for the manufacture of light-weight aggregates (see page 41).

Similar soft gray shale weathering to clay is exposed to the northeast on the Mrs. Pauline Boling (Atlanta) property between the Adair property and the Tennessee Highway, and on the A. V. Neal (Cartersville) property east of the Tennessee Highway.

BLACK, RANDOLPH, GUYTON, AND WARD PROPERTIES

(Map location No. 70)

The properties of Joe Black (White, Rt. 2), Mrs. Julia Randolph (Atlanta), R. L. Guyton (White, Rt. 2) and John Ward (White) are one mile west of the Louisville and Nashville Railroad on the road from White to Grassdale. The Black property is north of the road and the Randolph, Guyton, and Ward properties, in order from east to west, are south of the road.

The road after leaving the Tennessee Highway curves around the end of a ridge underlain by hard slaty shale belonging to the Cartersville formation. At the last bend of the road just west of the ridge, and all along the straight stretch to Grassville the ditches beside the road expose soft weathered shale and clay of the Conasauga formation. The material varies from soft flaky brown to red shale to yellowish-brown to reddish-brown slightly sandy clay. The beds are striking N. 5° E. and dipping 30° to 45° east. The land is gently rolling and is drained by a branch of Pettit Creek. The laboratory tests are given below on a grab sample of this shale and clay taken at intervals along the ditch for a distance of over 200 feet.

Laboratory tests on soft brown to red shale and yellow to brown clay from the Black, Randolph, Guyton, and Ward properties, one mile east of Grassdale, Bartow County.

Chemical Analysis:

Loss on ignition	6.71
Soda (Na_2O)	trace
Potash (K_2O)	3.44
Lime (CaO)	.00
Magnesia (MgO)	.03
Alumina (Al_2O_3)	23.06
Ferric oxide (Fe_2O_3)	10.87
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.03
Silica (SiO_2)	54.95
	100.01

Grinding: Very easy.
Ground Color: Reddish-brown.
Slaking: Rapid.
Plasticity: Fair. (Slightly "short" and grainy).
Molding Behavior: Poor. Clay column swelled and cracked.
Drying Behavior: Good. Little or no warpage.
Water of Plasticity: 29.6 per cent.
Green Modulus of Rupture: 57.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	5.3	7.2	19.2	917	Salmon (2YR-6/6)[b]	Slight
04	6.5	8.5	16.8	1240	Light red (1YR-5/5)[b]	Some
02	8.3	10.1	9.8	1607	Fair red (2YR-5/4)[b]	Slight
1	10.7	12.7	8.8	2185	Good red (1YR-5/4)[b]	Considerable
3	12.8	14.6	6.0	2401	Good red (R-YR-4/4)[b]	Considerable
5	13.7	15.3	3.8	2616	Chocolate red (1YR-3/4)[b]	Some

[a]See graph, Figure 22-A, page 275.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to cone 5 were somewhat kiln-marked, their surface had a vitreous appearance, and their broken ends showed traces of a glassy structure.

Firing Range: Cone 02–4. Commercial kiln: Cone 03–2.

The above tests indicate that this mixture of shale and clay is suited for the manufacture of building brick only. The green strength was too poor for the manufacture of other heavy clay products.

T. A. BENNETT PROPERTY

(Map location No. 71)

The T. A. Bennett (Bolton) property of 40 acres is between the Tennessee Highway and the Louisville and Nashville Railroad a quarter of a mile south of White in Land Lot 298, 5th District, 3d Section.

The American Potash Company during the World War mined on this property a slaty shale from the Cartersville formation for its potash content. Shearer[1] described the deposit and the mining operations as follows:

"There are 16 beds of purplish, slaty shale totaling about 60 feet, in a total stratigraphic thickness of 250 or 300 feet. The strike varies from N. 45° E. to N. 72° E., and the dip from 40° to 70° SE. The beds of bluish slaty shale, which contain the most potash, are interbedded with light-colored, weathered shale and feldspathic sandstone. There is only one thin bed of true quartzite, which outcrops at the north end of the section.

"The quarry is in the hill just west of the railroad cut, where the surface is about 20 feet above the railroad level. The quarry was opened in April, 1918, and in June the opening was about 200 feet long, 50 feet wide and 15 feet deep. Since that date work has continued at an increasing rate.

"The beds worked are near the center of the section exposed in the railroad cut. The material shipped is selected so as to keep the content of potash above 9 per cent, although it is probable that the average of all beds exposed in the quarry would be about 8 per cent. In the southwest corner of the quarry eight distinct beds are shown. The lowest is feldspathic sandstone, overlain by four beds of good shale (shipping material) with a total thickness of 10.5 feet, and three beds of poorer, sandy shale (waste) with a total thickness of 8 feet. The remainder of the section across the beds to the railroad is of the same character with beds of purplish, high-potash shale from 1 to 5 feet thick alternating with sandy beds of lower grade. None of the material in the quarry or railroad cut has sufficient hardness and fissility to be called slate."

When visited by the writer in 1930 the pit had been exposed to 12 years of weathering. The shale was semi-hard but somewhat crumbly and varied in color from light yellow, through gray, to a purplish gray. There had been considerable slumping of the sides of the mining pit or quarry. The laboratory tests are given below on a sample collected at frequent intervals across the quarry at right angles to the strike of the beds.

Laboratory tests on a sample of semi-hard yellow, gray, and purplish-gray Cartersville shale from the old potash mine on the T. A. Bennett property, White, Bartow County.

[1]Shearer, H. K., Slate deposits of Georgia: Georgia Geol. Survey Bull. 34, pp. 150-152, 1918.

Chemical Analysis:

Loss on ignition	4.96
Soda (Na_2O)	.57
Potash (K_2O)	2.42
Lime (CaO)	.00
Magnesia (MgO)	2.02
Alumina (Al_2O_3)	33.90
Ferric oxide (Fe_2O_3)	6.28
Ferrous oxide (FeO)	.35
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.15
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	48.48
	100.04

Grinding: Fairly easy. Brittle rather than tough.
Ground Color: Bluish-gray.
Slaking: Slow.
Plasticity: Poor, "short".
Molding Behavior: Poor. Clay column cracked and tore on the edges even when wet enough to swell slightly as it came through the die.
Drying Behavior: Rapid, with only slight warpage.
Water of Plasticity: 24.5 per cent.
Green Modulus of Rupture: 50.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 1.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.3	5.4	14.8	1237	Light salmon (4YR-6/6)[b]	Slight
04	4.7	6.0	15.9	1307	Salmon (3YR-6/5)[b]	Slight
02	6.8	8.0	12.4	1455	Dark salmon (3YR-5/5)[b]	Some
1	10.2	11.2	7.5	2476	Fair red (R-YR-4/4)[b]	Some
3	11.6	12.2	1.8	3433	Deep chocolate red (R-YR-3/2)[b]	Considerable
5	12.1	13.1	0.3	3562	Deep chocolate (R-YR-2/2)[b]	Considerable to bad.

[a]See graph, Figure 22-B, page 275.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cone 3 were kiln-marked, had a vitrified appearance on the surface, and their broken ends showed traces of a glassy structure. The bars fired to cone 5 were badly kiln-marked, were vitrified almost to a glaze on the surface, and their broken ends had a decidedly glassy structure.

Firing Range: Cone 01–2.

The above tests indicate that this shale is not suited for the manufacture of heavy clay products because of its low green strength and very short firing range. The fact that it vitrifies at a comparatively low temperature might make it especially suited for the manufacture of lightweight aggregates (see page 41). The shale is said to underlie about 10 acres of the property, as shown by prospecting at the time of the mining for potash.

It is interesting to note that the chemical analysis of the sample collected by the writer is much lower in potash than analyses made by the Georgia Geological Survey during the former mining. This may possibly be due to contamination during the 12 years in which the quarry has been exposed to the weather.

HANEY AND RICHARDS PROPERTIES

The property of A. W. Haney (White) is half a mile west of White on the road to Adairsville. It is adjoined on the north by the L. F. Richards (White) property.

A low ridge parallel to the railroad crosses both of these properties. The cuts of the White-Adairsville road crossing this ridge on the Haney property expose bands of hard gray shale, the fragments of which have a silky luster, soft weathered gray to brown crumbly shale, and red and mottled red and brown stiffly plastic clay. Two of the hard bands grade into gray limestone. On the top of the ridge on the Richards property are outcrops of hard slaty drab-colored shale. A prospect pit is said to have passed through 15 to 20 feet of drab to purplish-pink slaty shale and stopped in hard slate that split well.

It is very doubtful if any of the shale exposed on these two properties would develop sufficient plasticity, even with long grinding, for them to be used in the manufacture of heavy clay products. They might possibly be suited for the manufacture of light-weight aggregates.

HAMRICK AND SULLINS PROPERTIES

(Map location No. 72)

The J. M. Hamrick (White) property is a mile and a quarter west of White and half a mile south of the White to Adairsville road. It consists of about 100 acres in Land Lot 245, 5th District, 3d Section.

The land is rolling with low knolls and ridges covered with fragments of semi-hard to hard red shale having a crenulated fracture and a silky luster, together with frequent fragments of white vein quartz. No outcrops of shale in place were seen.

The B. R. Sullins (White) property is northeast and corners with the Hamrick property, on the White to Adairsville road. It consists of about 100 acres in Land Lot 259, 5th District, 3d Section.

Shale similar to that on the Hamrick property continues onto this property. Outcrops in the road cuts are of semi-hard to hard gray to brownish-red shale, mostly breaking into fragments having a finely crenulated appearance and a silky luster. The material is probably Conasauga shale that has been partly metamorphosed. Laboratory tests are given below on a grab sample of both the red and the gray shale from the road outcrops. The deposit is about a mile northwest of the Louisville and Nashville Railroad at White.

Laboratory tests on a sample of semi-hard to hard gray to brownish-red shale from the B. R. Sullins property, one mile north-west of White, Bartow County.

Chemical Analysis:

Loss on ignition	4.66
Soda (Na_2O)	2.54
Potash (K_2O)	.44
Lime (CaO)	.00
Magnesia (MgO)	.25
Alumina (Al_2O_3)	22.51
Ferric oxide (Fe_2O_3)	7.08
Ferrous oxide (FeO)	1.16
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.08
Silica (SiO_2)	60.31
	100.12

Grinding: Easy.
Ground Color: Red.
Slaking: Slow.
Plasticity: Very poor. "'Short".
Molding Behavior: Too poor, even after aging several days, to form test bars on the Mueller roll-press.

The sample was therefore discarded without further tests as unsuited, by itself, for the manufacture of heavy clay products. The sample is probably typical of similar deposits on other properties in this general area.

J. L. PARKER PROPERTY

(Map location No. 73)

The J. L. Parker (White) property is on the west side of the Tennessee Highway one mile north of White in Land Lot 318, 5th District, 3d Section. The Louisville and Nashville Railroad is just across the highway from the property.

Semi-hard red shale is showing near the house and on the north end of a low knoll south of the house. It is striking a little east of north and is nearly vertical. In the middle of the knoll is an outcrop of soft "short" plastic gray clay with fragments of brown iron ore on the top of the ground. At the foot of the knoll on the southeast side is an outcrop of fine-grained gray quartzite.

This is evidently the contact between the Conasauga formation on the west and the Cartersville formation on the east. The strike of the contact is such that about 20 acres west of the house are underlain by the shales of the Conasauga formation. The laboratory tests are given below on a grab sample of this red shale from the outcrops near the house and on the north end of the knoll.

Laboratory tests on a sample of semi-hard red shale from the J. L. Parker property, one mile north of White, Bartow County.

Chemical Analysis:

Loss on ignition	4.15
Soda (Na_2O)	.50
Potash (K_2O)	.44
Lime (CaO)	.00
Magnesia (MgO)	.64
Alumina (Al_2O_3)	30.33
Ferric oxide (Fe_2O_3)	6.31
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	56.64
	99.91

Grinding: Easy.
Ground Color: Reddish-purple.
Slaking: Very slow.
Plasticity: Very poor and "short", even after aging several days.
Molding Behavior: Plasticity too poor to form bars on the Mueller roll-press.

The sample was therefore discarded without further tests as not suited, by itself, for the manufacture of heavy clay products. It is possible that some of it could be used in blends with a more plastic clay or shale.

The flat land between the knoll and the highway and south of the knoll, drained by a headwater branch of Pettit Creek, is said to be underlain by a deposit of plastic gray and brown clay. This should be prospected and tested to see if it is satisfactory as a binder for the shale for the manufacture of heavy clay products.

Similar drab and red shale is exposed on the T. A. Bennett (Bolton) property, the A. J. Callaway (788 Tift Ave., S. W., Atlanta) property, and the J. M. Yancy (White) property which adjoin the Parker property on the north and northeast.

J. B. MAHAN PROPERTY

The J. B. Mahan (Rydal) property is just east of the Louisville and Nashville Railroad at Rydal Station. Outcrops of semi-hard to hard light-gray shale breaking into fissle fragments with a silky luster are exposed around the edge of a low knoll. The weathered material is fragile and crumbly. It resembles that sampled on the Sullins property near White and described above. Small outcrops of limestone are sticking through the shale at one or two places.

A red shale similar but somewhat harder than that exposed on the Mahan property is showing on the Mrs. L. O. Wooden (Rydal) property west of the Tennessee Highway at Rydal.

These shales evidently belong to a somewhat metamorphosed layer of the Conasauga formation. It is very doubtful if they would have sufficient plasticity, even with long grinding, for the manufacture of heavy clay products. They might, however, be suitable for the manufacture of light-weight aggregates (see page 41).

BOWEN AND BRADFORD PROPERTIES

(Map location No. 74)

The S. W. Bowen (Rydal, Rt. 2) and the S. R. Bradford (Rydal) properties are on the Tennessee Highway and the Louisville and Nashville Railroad one mile north of Rydal. The Bowen property is west of the railroad and the Bradford property east of the railroad and the highway.

The highway and the railroad have cut through a ridge on these properties exposing hard shale of the Conasauga formation. The shale is mostly drab to purplish-brown in color and is very fissle, breaking into large thin slabs with a silky luster. Where weathered softer on the surface it is rather fragile and crumbly. Some of the shale is crenulated and has a somewhat schistose structure. The laboratory tests are given below on a grab sample of all varieties of this shale from scattered places along the highway cut. The irregular knolls and ridges on these properties probably contain a large tonnage of easily mined shale.

Laboratory tests on a sample of semi-hard to hard drab to purplish-brown shale from the S. C. Bowen and S. R. Bradford properties, one mile north of Rydal, Bartow County.

Chemical Analysis:

Loss on ignition	6.80
Soda (Na_2O)	.70
Potash (K_2O)	2.44
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	19.80
Ferric oxide (Fe_2O_3)	12.31
Titanium dioxide (TiO_2)	.90
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	57.32
	100.27

Grinding: Fairly easy. Brittle rather than tough.
Ground Color: Brownish-red.
Slaking: Very slow.
Plasticity: Poor and grainy, even after aging several days.
Molding Behavior: Too poor to form test bars on the Mueller roll-press. Bars formed by slop-molding.
Drying Behavior: Rapid with little or no warpage.
Water of Plasticity: 26.2 per cent.
Green Modulus of Rupture: 27.2 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 1.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	1.0	2.5	23.7	337	Pale salmon (4YR-6/6)[a]	None
04	2.1	3.6	20.1	581	Light salmon (3YR-6/5)[a]	None
02	3.1	4.6	17.4	820	Salmon (2YR-6/5)[a]	None
1	3.8	5.2	14.7	1569	Light red (R-YR-5/5)[a]	Very slight
3	7.4	9.5	11.6	1357	Fair red (R-YR-5/4)[a]	Slight
5	7.4	9.0	8.4	2010	Good red (9R-4/4)[a]	Slight

[a]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 3–5 or 6. Commercial kiln: Cone 1–5.

The above tests indicate that this shale, by itself, is not suited for the manufacture of heavy clay products. It is very slow slaking, has low green and fired strengths, and has a high absorption. It might possibly be used in a blend with a plastic clay or shale. There is a possibility also that it might be suited for the manufacture of lightweight aggregates (see page 41).

OLD ATLANTA VITRIFIED BRICK COMPANY PROPERTY

H. A. BEARD PROPERTY

(Map location No. 75)

The property of the old Atlanta Vitrified Brick Company, now owned by H. A. Beard (Rochester, Vt.) is on the south side of Pumpkinvine Creek two miles due south of Emerson, just south of the Cartersville fault that separates the metamorphic Pre-Cambrian rocks of the Piedmont Plateau from the sedimentary Paleozoic rocks of the Appalachian Valley.

A hard graphic schist was formerly quarried from this property, ground, and used as a fertilizer filler. The quarry, which is on the side of the valley of a small branch of Pumpkinville Creek in Land Lots 1113 and 1120, 4th District, 3d Section, has a face which is 400 to 500 feet long and 75 to 90 feet high. The material is a dark-gray to black micaceous schist full of sooty graphite and containing considerable quartz in fine grains and numerous grains and nodules of purite. The laboratory tests are given below on a grab sample of this material from several places in the quarry.

The Atlanta Vitrified Brick Company was organized in 1914 and erected a plant at the mouth of the small valley for the purpose of manufacturing vitrified building and paving brick from this graphitic schist. An alluvial clay from a very small deposit in the valley bottom of the small branch was used as a binder. The plant is said to have had a capacity of 30 to 35 thousand brick per day. After firing only a few kilns of brick, the company went into the hands of a receiver.

When visited by the writer the spur track from Emerson had been removed but the remains of the buildings and the brick-kilns could be seen. One kiln of fired brick had never been drawn and showed very soft, porous, and crumbly light-pink to salmon-colored brick. Other brick scattered around the place were more dense and hard, although not vitrified, were of pleasing speckled pink and brown colors, and showed numerous quartz grains. They nearly all had one or more large longitudinal cracks, probably due to cracking of the column of clay as it came through the die. The laboratory tests below explain why the business was not a success.

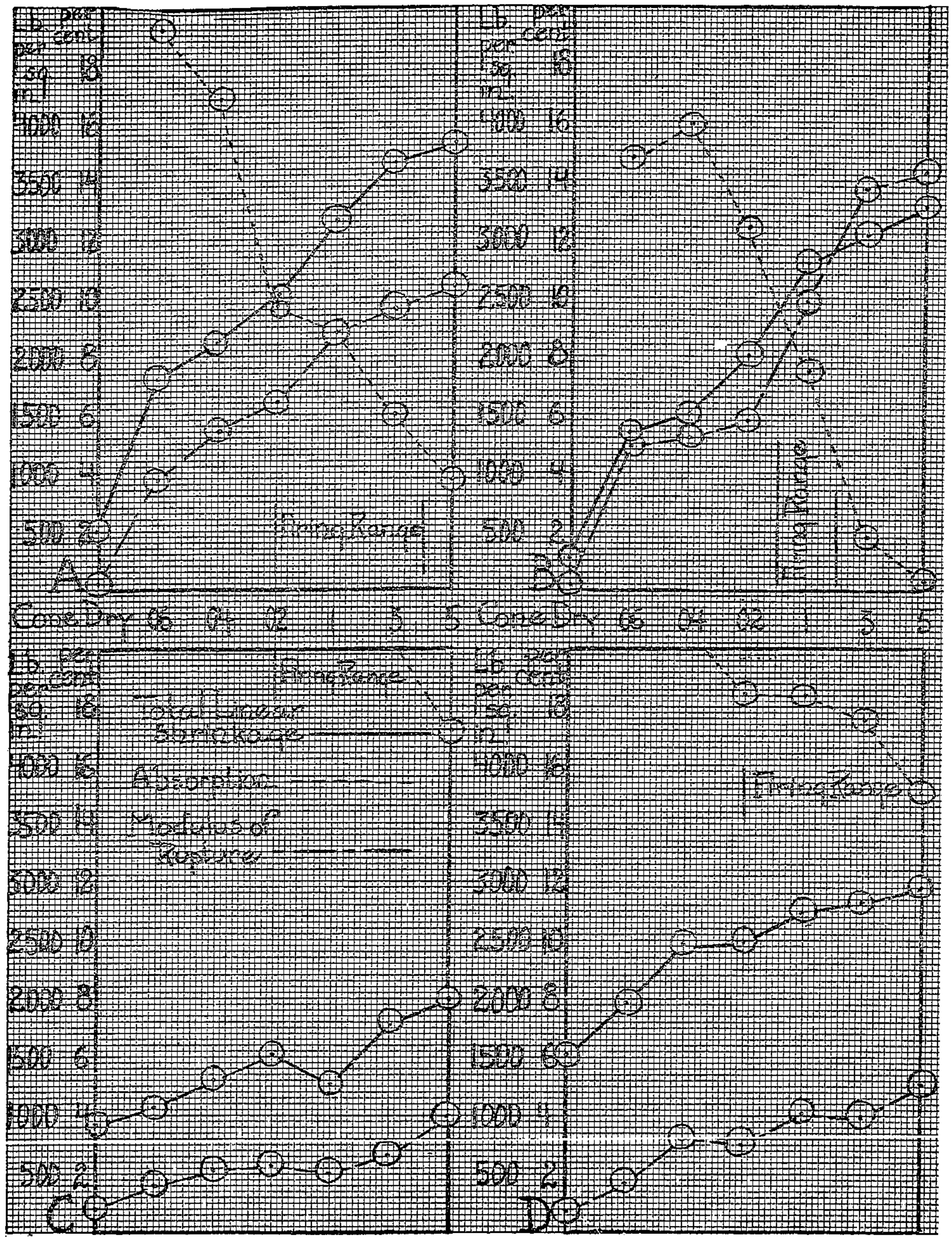


Figure 22. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Soft shale and clay from the Black, Randolph, Guyton, and Ward properties, one and three-fourths miles southwest of White, Bartow County.

B. Cartersville shale from the T. A. Bennett property, White, Bartow County.

C. Colluvial clay from the Upper Pit of the Chattahoochee Brick Company Chattahoochee Station, Fulton County.

D. Colluvial clay from the Lower Pit of the Chattahoochee Brick Company Chattahoochee Station, Fulton County.

Laboratory tests on a grab sample of dark-gray to black hard graphitic schist from the old Atlanta Vitrified Brick Company quarry on the H. A. Beard property, two miles south of Emerson, Bartow County.

Chemical Analysis:

Loss on ignition	8.15
Soda (Na_2O)	.83
Potash (K_2O)	.69
Lime (CaO)	.71
Magnesia (MgO)	.65
Alumina (Al_2O_3)	29.94
Ferric oxide (Fe_2O_3)	.36
Ferrous oxide (FeO)	.64
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.66
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	56.40
	99.94

Grinding: Fairly easy.
Ground Color: Black.
Slaking: Slow, if any at all.
Plasticity: Practically none.
Molding Behavior: Impossible to form test bars by either the Mueller roll-press or by hand in steel molds.

The sample was therefore discarded without further tests as not suited, by itself, for the manufacture of heavy clay products. The writer knows of no large deposit of clay in the vicinity that would have sufficient plasticity to blend with this graphitic schist for the manufacture of heavy clay products.

RESIDUAL AND ALLUVIAL CLAYS

RESIDUAL CLAYS OF THE PIEDMONT PLATEAU

ORIGIN

The Piedmont Plateau of Georgia is largely underlain by mica-schists, gneisses, and granites of the Pre-Cambrian age. The intense metamorphism which has affected the first two of these rocks is due to at least two major periods of deformation; one previous to Paleozoic time and the other at the close of the Paleozoic (see page 50). Since that time the region has passed through a series of cycles of elevation, erosion, reduction to a peneplain, and re-elevation, resulting in a gently sloping plateau above which rise a few monadnocks such as Stone Mountain and Kennesaw Mountain.

During this long period of elevation and erosion the rocks were weathered to great depths. Exposures of fresh rock are found only along the valleys and stream courses where erosion has proceeded faster than disintegration and decomposition. Elsewhere the bed-rocks are covered with a thick mantle of the products of their decay. The composition of this weathered material of course varied with the chemical and mineral composition of the parent rock and the processes of disintegration and decomposition. It generally results on the surface in a red stiffly plastic and more or less sandy clay, showing none of the structure of the parent rock. This grades downward through less plastic and more gritty brown and yellow material, to a soft gray crumbly material that retains all of the structure of the original hard rock. The lower layers that retain the original rock structure are a result of disintegration without decomposition. The red upper layers have passed through this state and have then been exposed to further weathering which has produced a decomposition of the original minerals.

These residual clays are generally too siliceous and lacking in plasticity to be of value for the manufacture of heavy clay products. At places, however, the composition of the original rock and the processes of weathering have produced clays that have been successfully used by themselves or mixed with other clays in the manufacture of brick, structural tile, and other heavy clay products. At other places in the stream valleys the weathering has been followed by slumping and a partial transportation for short distances that has further altered the clays and made them suitable for use in the manufacture of clay products. Such deposits are more properly called colluvial rather than residual in origin.

The writer has made no attempt to locate undeveloped deposits of these residual and colluvial clays of the Piedmont Plateau, but has confined himself to visiting and describing the deposits now in use.

DISTRIBUTION AND DESCRIPTION OF DEPOSITS

HALL COUNTY

HUDSON BRICK COMPANY

Headquarters and Plant: Gainesville, Georgia.
M. D. Hudson, Manager.

The Hudson Brick Company, on the east side of the Southern Railway near the Gainesville depot, manufacture common brick from residual and colluvial clays. Veatch[1] in 1909 described the deposit as follows:

"At the yard of M. D. Hudson, opposite that of Wheeler and Son, there is 14 feet of red clay underlain by 5 feet of bluish-white, more plastic clay. These clays are not in place, but are typical, colluvial deposits. They are mixed two-thirds red and one-third "white."

The writer was told that these clays were spread out on the yard and allowed to weather for a year before being used.

The clay being used at the time of the writer's visit in 1930 was a mottled brownish-red to gray colluval clay containing considerable fine sand and some mica. It was probably originally derived from a micaceous schist. The deposit was 8 to 10 feet in thickness, the upper foot or foot and a half being bright red in color. The clay bottomed on a mixture of white sand with a little white to gray very plastic "pipe clay". The laboratory tests are given below on a grab sample of the colluvial clay from several places in the pit.

Laboratory tests on a sample of brownish-red to gray colluvial clay from the pit of the Hudson Brick Company, Gainesville, Hall County.

Chemical Analysis:

Loss on ignition	7.02
Soda (Na_2O)	.38
Potash (K_2O)	.67
Lime (CaO)	.00
Magnesia (MgO)	trace
Alumina (Al_2O_3)	19.08
Ferric oxide (Fe_2O_3)	6.94
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	65.22
	100.22

Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Fair, but slightly "short".

[1]Veatch, J. O., Second report on the clay deposits of Georgia: Georgia Geol. Survey Bull. 18, p. 333, 1909.

Molding Behavior: Fair. Tendency for clay column to crack and to tear on the edges, even when wet enough to swell slightly.
Drying Behavior: Good. No warpage.
Water of Plasticity: 27.5 per cent.
Green Modulus of Rupture: 99.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.3	5.6	21.5	286	Salmon (3YR-6/7)[b]	Little or none
04	1.4	6.0	20.4	369	Salmon (R-YR-5/6)[b]	Little or none
02	2.7	7.7	18.6	460	Salmon red (2YR-6/6)[b]	Little or none
1	2.6	7.0	19.1	389	Light red (1YR-5/6)[b]	Very slight
3	2.4	7.0	19.1	407	Fair red (R-YR-5/5)[b]	Slight
5	2.9	7.3	18.1	552	Good red (R-YR-4/5)[b]	Slight

[a]See graph, Figure 23-A, page 287.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Not indicated by these tests.

This clay is mined by steam shovel, loaded into small side-dump cars, and hauled to the plant by a gasoline tractor-type of engine on a narrow-gauge track. At the plant it is dumped onto a storage pile or is fed to a dry pan and then to a ground storage pile. From this it is fed as needed into a single-shaft granulator which thoroughly mixes it and breaks up some of the lumps. The clay from the granulator is fed to a pug mill where water is added and the clay is tempered and pugged to a stiffly-plastic condition. The plastic clay goes to an auger brick machine which forces it through a die as a continuous column which is automatically cut off into end-cut brick. These brick are hacked to single-deck steel drying cars and dried to about 200°F. in a 4-track waste-heat tunnel drier.

The brick are fired to 1950°F.–1990°F. in five 30-foot round down-draft kilns on one large stack. Electrical pyrometers are used to control the heat and to determine the end point. The capacity of the plant is about 25,000 brick per day. The product is a fair quality common brick in colors ranging from salmon red to deep cherry red, and finds a ready sale in Northeast Georgia.

Since the writer's visit to the plant in 1930, the company has optioned a shale deposit on the Central of Georgia Railway west of Rome in Floyd County. This shale will be mined and shipped to Gainesville for mixing with the colluvial clay described above to increase the green and fired strengths and to decrease the absorption. A small amount of this shale should greatly improve the product.

FULTON COUNTY

Fulton County, of which the county seat is Atlanta, is an excellent market for heavy clay products, but its clay resources are very small. Sandy alluvial clays along the Chattahoochee and South rivers have been used in the past for the manufacture of common brick, but the deposits within reach of transportation are practically exhausted. A weathered schist, which could hardly be called a residual clay, was at one time used near Chattahoochee and Bolton in a mixture with a plastic alluvial clay. According to Veatch[1] its plasticity and green strength are too low for it to be used alone. The Chattahoochee Brick Company, as described below, are at present using colluvial clays derived from the weathering and partial transportation of this micaceous schist.

CHATTAHOOCHEE BRICK COMPANY

Headquarters: First National Bank Bldg., Atlanta, Georgia.
H. L. English, President.

Plant: Chattahoochee Station.
A. A. Harvill, Superintendent.

The Chattahoochee Brick Company, located near Chattahoochee Station on the Southern Railway, has been producing building brick since 1885.

Clay Pits

The clay now used by the Chattahoochee Brick Company comes from two pits in the second bottom or terrace of the Chattahoochee River, although the clays from both pits could more properly be classed as colluvial in origin rather than alluvial. The slopes of the river valley are underlain by a micaceous schist which weathers to a very short crumbly clay. This has slumped at places and been transported for short distances and then the top of the deposit plained off by the meandering of the river when at a higher elevation than its present bed.

[1]Veatch, J. O., Op. cit., p. 328.

The upper pit is about one and five-eighths of a mile south of the plant and a quarter of a mile south of the Bankhead Highway. The face shows about six feet of gray to brown somewhat plastic clay containing considerable fine sand and mica flakes, overlain by two feet of brown very sandy clay and soil that is removed as overburden. The laboratory tests are given below on a grab sample of the clay from several places in the pit. The clay is mined by steam shovel and loaded into side-dump tram cars for transportation to the plant.

Laboratory tests on a sample of gray to brown colluvial clay from the upper pit of the Chattahoochee Brick Company, Chattahoochee Station, Fulton County.

Chemical Analysis:

Loss on ignition	6.80
Soda (Na_2O)	.86
Potash (K_2O)	.27
Lime (CaO)	.00
Magnesia (MgO)	.40
Alumina (Al_2O_3)	23.30
Ferric oxide (Fe_2O_3)	5.73
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.09
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.18
Silica (SiO_2)	61.53
	100.16

Ground Color: Yellowish-brown.

Slaking: Rapid.

Plasticity: Fair. A little "short".

Molding Behavior: Fair. Slight tendency for clay column to tear on the edges. (In overcoming this the clay got too wet and swelled slightly on coming through the die.)

Drying Behavior: Good. Little or no warpage.

Water of Plasticity: 29.5 per cent.

Green Modulus of Rupture: 195.6 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 3.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) per cent	Total Linear Shrinkage (based on plastic length)[a] per cent	Absorption[a] per cent	Modulus of Rupture[a] Lb. per sq. in.	Color	Warpage
06	0.8	4.3	25.1	404	Salmon (4YR-6/6)[b]	None
04	1.5	5.2	24.0	531	Dark salmon (3YR-5/6)[b]	None
02	2.4	6.1	22.3	579	Light red (R-YR-5/5)[b]	None
1	1.7	5.1	22.4	508	Fair red (2YR-5/5)[b]	Some
3	3.6	7.2	20.5	660	Medium red (R-YR-5/4)[b]	Some
5	4.7	8.0	17.2	997	Good red (R-YR-4/5)[b]	Considerable

*a*See graph, Figure 22-C, page 275.
*b*Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 03–5 and possibly higher.

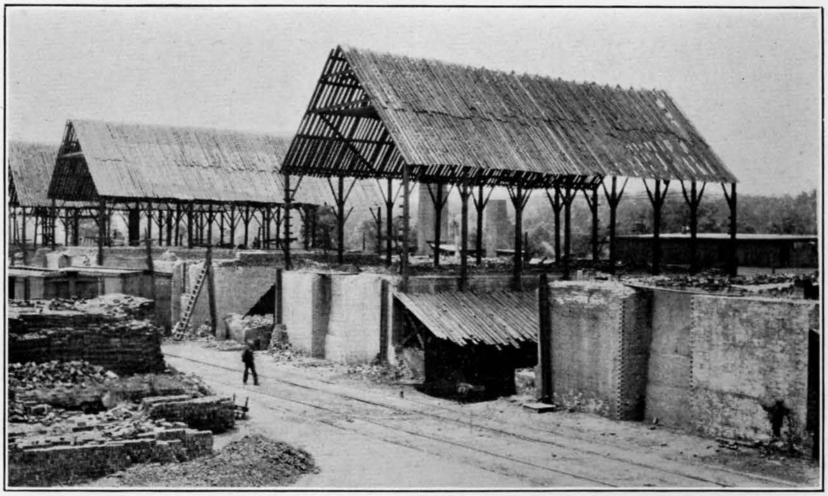
The lower pit is about three-eighths of a mile further down the river from the pit just described and about two miles south of the plant. The face of the pit shows about eight feet of mottled yellow and reddish-brown stiffly plastic clay more nearly resembling an alluvial clay than the clay in the upper pit. The laboratory tests are given below on a grab sample from several places in the pit. The deposit is mined by steam shovel and loaded into side-dump tram cars for transportation to the plant.

Laboratory tests on a sample of stiffly plastic mottled yellow and reddish-brown colluvial clay from the lower pit of the Chattahoochee Brick Company, Chattahoochee Station, Fulton County.

Chemical Analysis:

Loss on ignition	6.90
Soda (Na_2O)	trace
Potash (K_2O)	.26
Lime (CaO)	.00
Magnesia (MgO)	.66
Alumina (Al_2O_3)	24.24
Ferric oxide (Fe_2O_3)	7.29
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.09
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	59.63
	100.07

A. NORTH CLAY PIT OF THE CHATTAHOOCHEE BRICK COMPANY, CHATTAHOOCHEE, FULTON COUNTY.



B. SCOVE BRICK KILNS AT THE CHATTAHOOCHEE BRICK COMPANY, CHATTAHOOCHEE, FULTON COUNTY.

Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Good. Slightly sticky.
Molding Behavior: Excellent.
Drying Behavior: Good. Only slight warpage.
Water of Plasticity: 32.6 per cent.
Green Modulus of Rupture: 198.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 6.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.0	7.9	23.4	429	Salmon (YR-7/6)[b]	None
04	4.0	9.9	20.8	784	Dark salmon (4YR-6/5)[b]	Slight
02	4.7	10.0	18.5	750	Light red (2YR-5/5)[b]	Slight
1	5.4	11.0	18.4	1029	Fair red (2YR-5/4)[b]	Slight
3	5.4	11.3	17.6	999	Medium red (2YR-5/4)[b]	Slight
5	6.0	11.8	15.1	1274	Good red (R-YR-5/4)[b]	Slight

[a]See graph, Figure 22-D, page 275.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02-5 and higher.

Plant

At the plant the clays from the two pits are dumped into separate storage bins. The two clays are fed, in the proper amounts to give the mixture desired, onto a conveyor belt that runs under both bins and discharges into a large single-shaft disintegrator of the pug mill type. This disintegrator discharges into a large pug mill where water is added and tempering is accomplished. The plastic clay from the pug mill goes to an auger brick machine which forces the clay through a die and extrudes it as a continuous column that is automatically cut off into end-cut bricks. The die on the brick machine is so constructed that a thin film of sand is dusted onto the faces of the clay column being extruded. If, as sometimes happens during the winter months, the clay from the mines is too wet, enough dried but unfired bricks are passed through a roll crusher onto the conveyor belt feeding the disintegrator to bring the mixture to the right moisture content.

The green bricks are hacked onto steel drying cars and dried to about 150°F. in a 30-track direct-fired tunnel drier. The bricks are fired in 14 large open-top up-draft scove kilns, a layer of fired bricks being laid over the top course of the green bricks for a roof. The firing is regulated and the end-point determined by the amount of settling of the bricks. The firing of each kiln takes about 8 to 10 days.

The product, which is of the common brick type, finds a ready market in the Atlanta district and nearby towns.

RICHMOND COUNTY

The alluvial clays of the Augusta District of Richmond County are described on pages 316-325.

Just northwest of Augusta and west along the Georgia Railroad as far as Belair, the sands and clays of the Cretaceous are resting unconformably upon the upturned edges of a fissle metamorphic rock resembling a phyllite. The beds of the phyllite are striking about N. 45° E. and are nearly vertical. Their outcrop extends northeast to the Savannah River and into South Carolina. The northwestern boundary of the belt crosses the Charleston and Western Carolina Railway near Martinez and strikes the Savannah River near the mouth of Reeds Creek and the Columbia–Richmond county line. The southeastern boundary of the belt is not definitely known, but it probably emerges from beneath the Cretaceous sediments within the city limits of Augusta. Thus the belt has a width of three and a half to four miles. The contact between the phyllite and the granite or granite-gneiss to the northwest is apparently parallel to the strike of the cleavage of the phyllite. These beds are probably of Pre-Cambrian age and were originally of sedimentary origin, perhaps, according to Veatch[1], a very siliceous shale. The metamorphism which it has undergone has obliterated all trace of its original texture and structure.

These phyllites weather to a depth of from 20 to 80 feet. The weathered material grades from soft and crumbly at the top to semi-hard, and hard often with a greasy look and a soapy feeling, at the bottom. It splits into small flat pieces and flakes which vary in color from gray to white, yellow, red, and brown. The cleavage planes often have a silky lustre due to the presence of oriented flakes of sericite or chlorite.

These weathered phyllites, while usually "short" and mealy, at places contain enough clay to be suited alone or with other clays for the manufacture of heavy clay products.

[1]Veatch, J. O., Second report on the clay deposits of Georgia: Georgia Geol. Survey Bull. 18, p. 358, 1909.

GEORGIA VITRIFIED BRICK COMPANY

Headquarters: Augusta, Georgia.
John M. Clark, Treasurer and General Manager.

Mines: Belair, Richmond County, Georgia.
C. E. Baker, Superintendent.
Campania, Columbia County, Georgia.

Plant: Campania, Georgia.
H. M. Verdery, Superintendent.

The Georgia Vitrified Brick Company, established in 1903, are producers of vitrified paving brick, sewer pipe, and fire brick (for own use only, none sold on market). The paving brick are made entirely from weathered phyllite, locally called "shale", from the Belair pits. The sewer pipe are made from a mixture of the "shale" from the Belair pits and a dark gray-blue plastic sedimentary clay from beds of Eocene age in the Campania pit. The fire brick are made from a mixture of white "shale" from the Belair pits, sand, and a white kaolinitic clay of Eocene age from the Campania pit.

Belair Pits

The "shale" pits of the Georgia Vitrified Brick Company are south of the Georgia Railroad at Belair, nine miles west of Augusta. The "shale" is a weathered fissle metamorphic rock resembling phyllite. At the time of the writer's visit to the property in 1927, the material was being mined from three separate pits. The main pit was about 1050 feet long by 350 feet wide with an average depth of about 75 feet. The "North Side" pit, north of the main pit, is about 275 feet long, 100 feet wide, and 20 feet deep. The "Fire Clay" pit, south of the main pit, is much smaller.

Five varieties of the "shale" are recognized and separately mined from these pits. They are:

A. Hard gray. This is mined from the west side of the main pit. It is semi-hard to hard, slightly-greenish gray in color, and has a somewhat greasy look and a soapy feeling, like soap-stone. After grinding and tempering it develops a poor to fair plasticity.

B. Soft gray. This is mined from the east side of the main pit. It is soft to semi-hard and more nearly resembles a true shale than the hard gray. It contains considerable fine silica sand, so that after grinding and tempering the plasticity is poor and quite "short".

C. Soft red. This is mined from the east side of the pit over the soft gray type. It is somewhat softer and less fissle than the soft gray and is a bright hematite-red in color. It is "short" and develops but little plasticity.

D. North-side gray. This is mined from the North-side Pit. It is semi-hard to hard, fissle, and is more argillacous than the other varieties. It develops a fair plasticity.

E. White. This "shale", which is soft, "short", gritty, and pure white in color, occurs as a 16-foot layer in the South or Fire Clay Pit. It is only mined for the manufacture of fire brick.

Samples were collected of all of these five types of the weathered phyllite, but as some of them developed little or no plasticity it was impossible to make the ceramic tests on the individual samples. In the laboratory tests given below, the chemical analyses are given of the individual samples. These are followed by the laboratory tests on a composit sample of equal parts of the first four of these samples, that is all except the white "shale". This is not in the proportions in which these materials are used in the manufacture of paving brick.

Laboratory tests on samples of weathered phyllite, locally called "shale", from the pits of the Georgia Vitrified Brick Company at Belair, Richmond County.

Chemical Analyses:

	A.	B.	C.	D.	E.
Loss on ignitition	5.50	8.00	7.01	7.41	8.73
Soda (Na_2O)	.31	.35	.03	.09	.36
Potash (K_2O)	.93	.15	1.17	1.22	.20
Lime (CaO)	1.30	.00	.00	.18	.00
Magnesia (MgO)	1.10	1.10	trace	1.51	trace
Alumina (Al_2O_3)	20.47	21.96	19.41	20.79	21.69
Ferric oxide (Fe_2O_3)	8.37	8.47	8.13	7.89	2.33
Manganous oxide (MnO)		trace			
Titanium dioxide (TiO_2)	1.10	.90	.91	.91	1.08
Sulphur trioxide (SO_3)	.00	.30	.00	.00	.34
Phosphorus pentoxide (P_2O_5)	.13	.25	.16	.16	.42
Silica (SiO_2)	60.91	58.55	63.05	59.90	65.09
	100.12	100.03	99.87	100.06	100.24

A. Hard gray. B. Soft gray. C. Soft red. D. Northside gray. E. White.

Note. The following tests were made on a composit sample of equal parts of A, B, C, and D.

Grinding: Fairly easy.

Ground Color: Light gray with red specks.

Slaking: Rapid.

Plasticity: Rather poor. "Short".

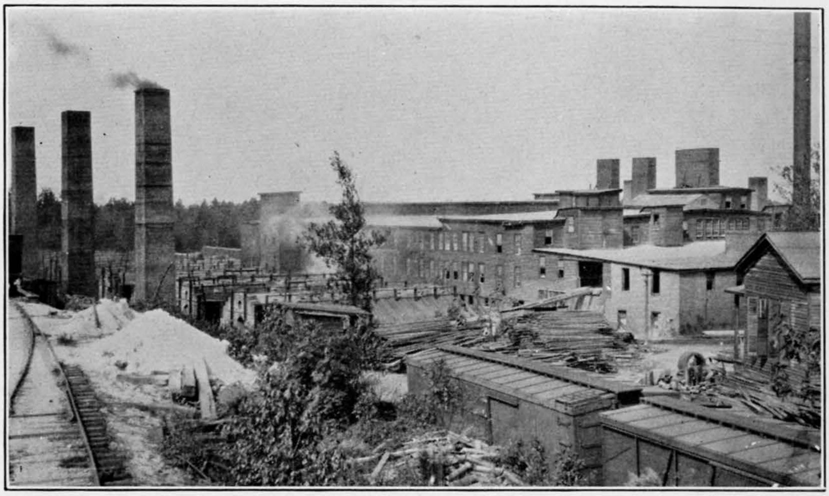
Molding Behavior: Impossible to form bars on Mueller roll-press because clay slipped on itself due to soft weathered mica flakes. The test bars were made by hand in a steel mold.

Drying Behavior: Rapid with no warpage.

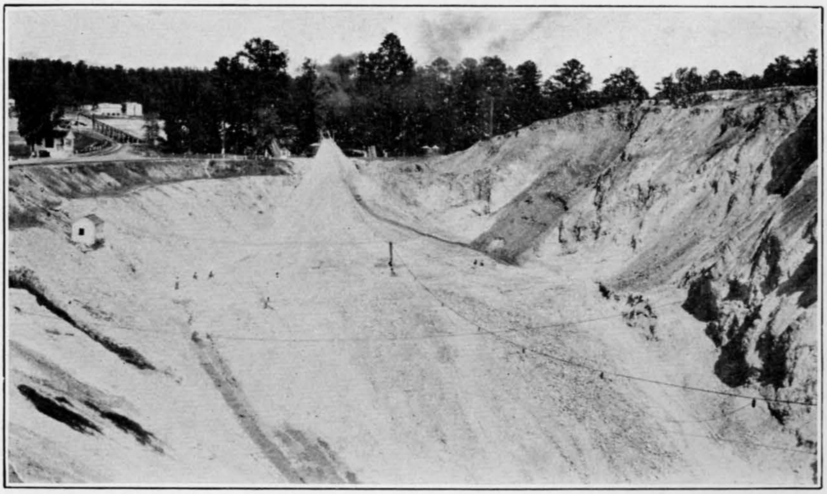
Water of Plasticity: 21.8 per cent.

Green Modulus of Rupture: 118.3 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 3.4 per cent.



A. PAVING BRICK AND SEWER PIPE PLANT OF THE GEORGIA VITRIFIED BRICK COMPANY, CAMPANIA, COLUMBIA COUNTY.



B. MAIN "SHALE" OR WEATHERED PHYLLITE PIT OF THE GEORGIA VITRIFIED BRICK COMPANY, BELAIR, RICHMOND COUNTY.

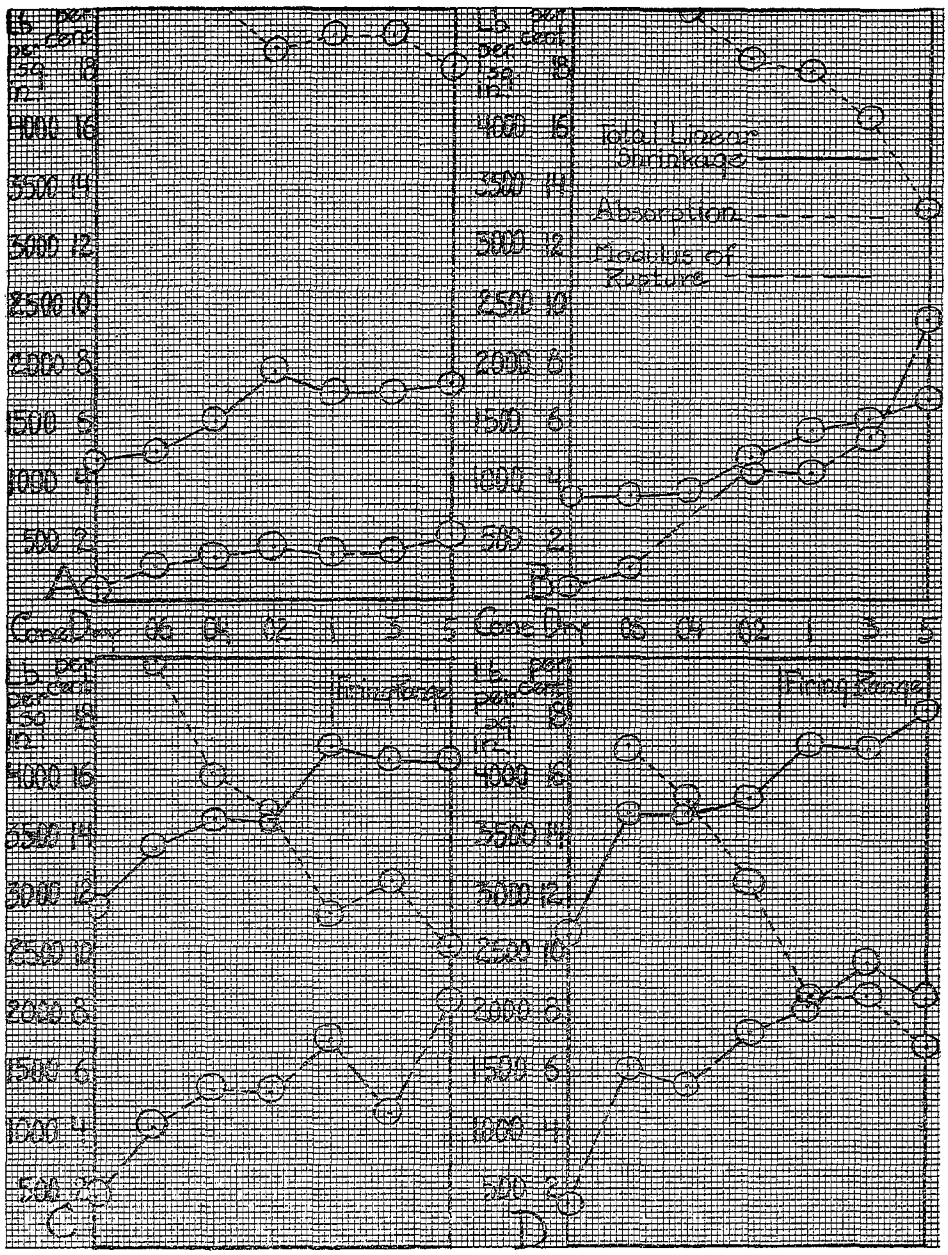


Figure 23. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Colluvial clay from the Hudson Brick Company, Gainesville, Hall County.

B. Weathered phyllite or "shale" from the Georgia Vitrified Brick Company pits at Belair, Richmond County.

C. Alluvial clay from the Mrs. L. M. Kendrick property, 2½ miles southeast of Columbus, Muscogee County.

D. Alluvial clay from the Columbus Brick and Tile Company, Columbus, Muscogee County.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) per cent	Total Linear Shrinkage (based on plastic length)[a] per cent	Absorption[a] per cent	Modulus of Rupture[a] Lb. per sq. in.	Color	Warpage
06	0.2	3.5	23.2	266	Light pinkish-brown (4YR-6/4)[b]	None
04	0.6	3.6	20.0	[c]	Light brown (6YR-6/4)[b]	None
02	1.7	4.8	18.3	1100	Light reddish-brown (4YR-5/5)[b]	None
1	2.7	4.7	17.9	1071	Light reddish-brown (1YR-5/4)[b]	Little or none
3	2.8	6.1	16.3	1378	Reddish-brown (R-YR-5/4)[b]	Very slight
5	3.3	6.8	13.2	2365	Dark reddish-brown (R-YR-5/3)[b]	Slight

[a]See graph, Figure 23-B, page 287.
[b]Color notation according to the Munsell system, see page 23.
[c]All test bars fired to this cone were accidentaly broken before the modulus of rupture could be measured.

Firing Range: Not reached by these tests.

The weathered phyllite or "shale" is mined by a drag-line scraper. The material is first loosened by a plow attached to the drag-line. The scraper then moves the material up the sloping end of the pit to a tipple over a spur track from the railroad, where it is dumped into standard gondola cars for transportation to the plant at Campania.

Plant

The plant of the Georgia Vitrified Brick Company is at Campania in Columbia County, about 21 miles west of Augusta. The clays mined at Campania and the "shales" brought in from the Belair mines are dumped into separate storage bins from which they can be drawn as needed and transported to either the paving brick or the sewer pipe plants.

The paving brick are made from a definite mixture of "shales" from the Belair pits. The materials are ground and mixed in a dry pan and screened through 8-mesh vibrating screens. The oversize from the screens is returned to the dry pan. The undersize goes to a wet pan where water is added and the clay is tempered and further ground. The wet pan discharges into a pug mill where the clay is further pugged. The plastic clay from the pug mill is fed to an auger-type brick machine which extrudes the clay as a continuous column which is automatically cut into side-cut bricks. One of the brands of paving brick, the "Augusta block", is repressed.

The green brick are hacked to wooden double-deck drier cars and dried for three days in a steam-heated 18-track tunnel drier. The dried brick are fired in 10 rectangular down-draft kilns, two kilns to a stack. Electric pyrometers, standard pyrometric cones, and trial pieces are all used to regulate the heat and to determine the end point. The product is a vitrified paving brick in two brands, Augusta Block and Vertical Fiber, that are said to more than meet the standard rattler tests. The principal market is in Georgia, Florida, South Carolina, and North Carolina.

The sewer pipe are made from a mixture of the hard gray and "North-side" gray weathered phyllite or "shale" from the Belair mines and a plastic blue sedimentary clay mined at Campania. The sewer pipe plant is much like the paving brick plant. The ground material is screened through a 10-mesh instead of an 8-mesh screen, and the tempering and pugging takes place in two wet pans instead of a wet pan followed by a pug mill. The sewer pipe are formed on two steam-cylinder sewer-pipe presses and are dried in steam-heated drying rooms. They are fired in eight 30-foot round down-draft kilns and are salt-glazed.

W. R. REEVES PROPERTY

The W. R. Reeves (Augusta, Rt. 2) property is on the Skinner Road about two and a half miles west of the city limits of Augusta, two miles south of Martinez on the Charleston and Western Carolina Railway, and two and a half miles north of the Georgia Railroad at Camp Hancock.

The contact between the Cretaceous sands and the underlying vertical strata of Pre-Cambrian weathered phyllite crosses Skinner Road on this property at an elevation of about 325 feet above sea level. The weathered phyllite at this point is soft, mealy, and very white, and is full of minute stringers of quartz. Further down the road are outcrops of soft gray phyllite containing more sericite than the similar material at Belair. This is followed by beds of brownish-red and purplish-red color.

On the private road east of the house are wide outcrops of light greenish-gray weathered phyllite looking much like the soft gray "shale" at Belair. The laboratory tests are given below on a grab sample of this.

Laboratory tests on a sample of soft light-gray weathered phyllite from the W. R. Reeves property on the Skinner Road, two miles south of Martinez, Richmond County.

Chemical Analysis:

Loss on ignition	8.76
Soda (Na_2O)	.23
Potash (K_2O)	.09
Lime (CaO)	.00
Magnesia (MgO)	.55
Alumina (Al_2O_3)	18.17
Ferric oxide (Fe_2O_3)	3.95
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.34
Phosphorus pentoxide (P_2O_5)	.10
Silica (SiO_2)	67.02
	99.94

Grinding: Easy.
Ground Color: Light brownish-gray.
Slaking: Rapid.
Plasticity: Poor. "Short".
Molding Behavior: Rather poor. Clay column cracked and tore on the edges even when wet enough to swell on coming through the die.
Drying Behavior: Rapid with no warpage.
Water of Plasticity: 27.8 per cent.
Green Modulus of Rupture: 152.6 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	1.3	3.7	25.2	717	Light salmon (YR-7/6)[a]	Slight
04	1.5	4.0	24.2	457	Salmon (3YR-6/6)[a]	None
02	2.9	5.2	22.1	613	Salmon (4YR-6/6)[a]	None
1	4.8	6.5	18.8	1042	Salmon (4YR-6/5)[a]	Slight
3	5.5	8.3	16.0	1474	Dark salmon (2YR-5/5)[a]	Some
5	5.0	8.2	17.1	1315	Dark salmon (4YR-6/4)[a]	Some

[a]Color notation according to the Munsell system, see page 23.

Firing Range: Not reached by these tests.

The above tests indicate that, because of poor fired colors, high absorption, and low fired strength, this material is not suited for use, by itself, in the manufacture of heavy clay products.

WASHINGTON COUNTY

A belt of Pre-Cambrian phyllite, similar to that just described in Richmond County, is exposed in the stream valleys in the northern part of Washington County. The higher land between the valleys is covered by the sands and clays of the Cretaceous. The width of the belt is not known, but from the strike of the beds and the distance between the outcrops described below, it cannot be less than two and a half miles. It may be a continuation of the Richmond County belt, the intervening stretches being covered by the sediments of the Coastal Plain.

J. C. KELLEY SONS' PROPERTY

The property of J. C. Kelley Sons (Mitchell), known as the Harrison Farm, is on the west side of the Ogeechee River on the Sandersville-Mitchell or the Harrison's Bridge road, about two and a half miles north of Chalker and 16 miles north of Sandersville.

Outcrops beside the road on the slope to the river expose a stratigraphic thickness of about 60 feet of soft fissle weathered phyllite striking about N. 75° E. and nearly vertical in dip. The weathered fragments are rather crumbly, some having a talcose feel from flakes of sericite, others feeling slightly gritty from fine silica. The colors range from white to dark red, with yellowish-brown and yellow predominating. The laboratory tests are given below on a grab sample of all colors and varieties of this material. The nearest railroad shipping point is Chalker, two and a half miles to the south, on the Augusta–Tennille Branch of the Georgia and Florida Railroad.

Laboratory tests on a sample of soft weathered vari-colored phyllite from the J. C. Kelley Son's Harrison Farm, just west of the Ogeechee River on the Sandersville-Mitchell road, Washington County.

Chemical Analysis:

Loss on ignition	4.66
Soda (Na_2O)	.52
Potash (K_2O)	1.57
Lime (CaO)	1.10
Magnesia (MgO)	.70
Alumina (Al_2O_3)	15.06
Ferric oxide (Fe_2O_3)	4.45
Titanium dioxide (TiO_2)	.36
Sulphur trioxide (SO_3)	.26
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	71.30
	99.98

Grinding: Easy.
Ground Color: Light tan with white flakes.
Slaking: Rapid.
Plasticity: Very poor. "Short" and mealy with a narrow range between too dry and too wet.
Molding Behavior: Impossible to make bars on the Mueller roll-press because of clay slipping on itself due to flakes of sericite or other micas. Bars made in slop-molds were too fragile after drying to test.

The sample was therefore discarded without further tests as unsuited, by itself, for the manufacture of heavy clay products.

JOHN GILMORE PROPERTY

The John Gilmore (Sandersville) plantation is at Hamburg on the Little Ogeechee River near the junction of the Sandersville-Warrenton road and the Sandersville-Mitchell road. It is about two and a quarter miles due west of the Kelley property described above.

The south slope of the valley of Little Ogeechee River at Hamburg shows outcrops of hard fissle gray phyllite, almost a slate, striking northeast-southwest and standing on edge. At places the top of the ground is strewn with slaty fragments and fairly large fragments of milky vein-quartz. The laboratory tests are given below on a grab sample of this hard phyllite.

Similar outcrops are showing near the west end of the property a mile and a quarter west of Hamburg. A well at a tenant house near the highway on the top of the ridge south of Hamburg is said to have been started in Cretaceous sediments but struck soft white "shale" at an unknown depth.

Laboratory tests on a sample of hard fissle gray phyllite, almost a slate, from the John Gilmore property at Hamburg, Washington County.

Chemical Analysis:

Loss on ignition	4.16
Soda (Na_2O)	.18
Potash (K_2O)	.14
Lime (CaO)	.00
Magnesia (MgO)	.51
Alumina (Al_2O_3)	24.10
Ferric oxide (Fe_2O_3)	8.96
Titanium dioxide (TiO_2)	.54
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.05
Silica (SiO_2)	61.28
	99.92

Grinding: Fairly easy. Brittle rather than tough.
Ground Color: Silver-gray.
Slaking: Very slow.
Plasticity: Very poor, even after aging several days.
Molding Behavior: Impossible to form bars on the Mueller roll-press.

The sample was therefore discarded as unsuited, by itself, for the manufacture of heavy clay products.

BALDWIN COUNTY

Residual or "hill-side" clays, derived from the deep weathering of a granitic rock, probably a granite-gneiss, are used in mixtures with other clays by three companies at Milledgeville in Baldwin County. These clays are described on pages 310, 313 and 315 in the section on the alluvial clays of the Milledgeville District.

ALLUVIAL CLAYS OF THE FALL LINE

ORIGIN

The boundary line between the hard crystalline rocks of the Piedmont Plateau and the softer sedimentary rocks of the Coastal Plain is called the Fall Line. This name has been derived from the fact that the streams in flowing from the hard to the soft rocks have usually developed water falls or rapids. It is because of these falls, a source of power and the head of navigation, that so many important cities are located on the Fall Line all the way from Alabama to New England. The Fall Line in Georgia is a crooked line connecting Columbus, Macon, Milledgeville, and Augusta.

The streams, after making the descent from the Piedmont Plateau to the Coastal Plain, have their velocities checked. Instead of flowing through the relatively narrow V-shaped valleys which they were able to cut in the hard rocks, they meander at a reduced velocity over a wide flood plain cut in the softer sediments. At this reduced velocity they are not able to carry all of their load of sediment, and are forced to drop some of it, building up their beds to form a flood plain. At normal times the sands, which are the first to be dropped, are deposited, usually on the inside of the bends of the river. During the flood periods the streams, carrying a heavy load of sediment, spread out over the wide valley and, as their velocity is reduced away from the main channel, drop their load. The sands and coarser silts are deposited nearest the channel, the finer clays over the wide areas of sluggish water on the sides of the valleys.

Thus were deposits of alluvial clays formed in the flood plains of the streams south of Columbus, Macon, Milledgeville, and Augusta. A slight elevation of the land during comparatively recent geologic time has started the streams cutting down into these flood plains, so that the deposits are in terraces from 20 to 50 feet above the present level of the rivers. As might be expected from their origin, the deposits vary considerably in extent, thickness, and quality. They are usually in small to large lenses from 2 to 15 feet in thickness, with an average thickness of about 8 feet. They vary in extent from an acre to several square miles. The lenses thin rapidly on their edges or pass into material too sandy for use. The clay usually grades from a bluish-gray stiffly-plastic clay at the bottom to yellow or brown somewhat more sandy clay at the top, often containing soft black iron oxide accretions. The deposits are sometimes overlain by a foot or two of soil or sand. They are usually underlain by a water-bearing sand or gravel.

These alluvial clay deposits have for years furnished the raw material for a thriving building brick and structural tile industry. The clay is easily mined, processes well, and can be fired rapidly, developing excellent colors. The relatively small space devoted to them in this report is not because they are unimportant, but because without prospecting, which the Georgia Geological Survey lacked time and money to undertake, but few of the undeveloped deposits could be examined. An attempt to persuade property owners to prospect in advance of the writer's visit met with but little success.

DISTRIBUTION AND DESCRIPTION OF DEPOSITS BY DISTRICTS

COLUMBUS DISTRICT

The alluvial clays of the Columbus District occur south of Columbus in the first terrace, 40 to 50 feet above the Chattahoochee River, and in smaller terraces on some of the principal tributary creeks. The clay is generally very plastic, but varies considerably in thickness and texture. At the present time only one plant is located on the Georgia side of the river.

COLUMBUS BRICK AND TILE COMPANY

Headquarters: Columbus, Georgia. (See also page 329.)
Telfair Stockton, President.
C. W. Dickson, Vice President and General Manager.
E. B. Willis, Production Manager.

Columbus Plant: Columbus, Georgia.
C. L. Abney, Local Superintendent.

The Columbus Plant of the Columbus Brick and Tile Company, producing common building brick and structural tile, is on the southeastern outskirts of Columbus, south of the Cusseta Highway. The present clay pits are some three miles south of the plant between the Old Lumpkin Road and the Chattahoochee River.

Clay Pit

The Company owns between 300 and 400 acres of flat terrace land some 50 feet above the present river level, underlain by a deposit of alluvial clay. The following section shows the average thickness of the beds exposed in the pits.

Average section of alluvial clay pits of the Columbus Brick and Tile Company, Columbus, Muscogee County.

		Average thickness in feet
4.	Soil and sand. Overburden	$1\frac{1}{2}$
3.	Brown and red somewhat sandy stiffly-plastic clay, gradually changing into bed below	5+ or —
2.	Steel-blue plastic clay, drying light-gray to white and brittle. Sometimes sandy. Bottom foot or two often contains white water-worn quartz gravel	4 to 6
1.	White to brown sand and gravel	10+

The laboratory tests are given below on a grab sample of the clay from beds (2) and (3) in the section above.

Laboratory tests on a grab sample of steel-blue to brown alluvial clay from the pits of the Columbus Brick and Tile Company, Columbus, Muscogee County.

Chemical Analysis:

Loss on ignition	10.57
Soda (Na_2O)	.67
Potash (K_2O)	.47
Lime (CaO)	.00
Magnesia (MgO)	.10
Alumina (Al_2O_3)	27.46
Ferric oxide (Fe_2O_3)	7.15
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	52.86
	100.38

Ground Color: Light grayish-tan.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Excellent.

Drying Behavior: Test bars badly warped.

Water of Plasticity: 35.7 per cent.

Green Modulus of Rupture: 380.1 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 10.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) per cent	Total Linear Shrinkage (based on plastic length)[a] per cent	Absorption[a] per cent	Modulus of Rupture[a] Lb. per sq. in.	Color	Warpage
06	4.3	14.7	17.0	1534	Light salmon (4YR-7/6)[b]	Very bad
04	4.3	14.7	15.1	1369	Salmon (6YR-7/5)[b]	Very bad
02	5.1	15.2	12.4	1823	Dark salmon (4YR-6/6)[b]	Very bad
1	8.0	17.1	8.4	2085	Light red (3YR-5/5)[b]	Very bad
3	7.3	16.9	8.5	2415	Fair red (1YR-5/5)[b]	Very bad
5	8.2	18.2	6.8	2091	Fair red (1YR-5/4)[b]	Very bad

[a]See graph, Figure 23-D, page 287.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The bars fired to come 3 were slightly black-cored, indicating reducing conditions in the kiln. The broken ends of all of the bars showed them to be laminated.

Firing Range: Cone 01–5. Commercial kiln: Cone 02–5.

The above tests indicate that the writer, in taking the sample, included more of the bottom plastic clay and less of the top siliceous clay than is done in mining. The addition of more of the top reddish-brown siliceous clay would eliminate the lamination and warpage, and cut down the shrinkage.

The overburden is removed and the clay mined by an electric drag-line excavator with a 40-foot boom and a three-quarter cubic yard bucket (see Plate III-B, facing page 166). The clay is transported to the plant in side-dump tram cars drawn by narrow-gauge 21-ton locomotives.

Plant

At the plant the cars are hauled up an incline and dumped into a hopper over a large disintegrator, or else are dumped into a storage bin from which the clay can be removed by a drag hoist and a belt conveyor. The clay from the disintegrator is passed through a double granulator, the upper set of rolls being of unequal diameters, the lower of equal diameters. The clay from the granulator is carried by a belt conveyor to either the tile unit or the brick unit. The tile unit consists of a double-shaft pug mill where water is added and the clay tempered and pugged, and an auger-type tile machine extruding a continuous column of web and shell which is automatically cut off into structural tile. The various sizes and styles of tile can be made by changing the die and sometimes the auger of the machine. The brick unit consists of a single-shaft pug mill for tempering and pugging the clay, and an auger-type brick machine extruding a continuous column of clay that is automatically cut off into brick. With the proper die and cutter either end-cut or side-cut brick can be made.

The tile or brick are hacked to steel drier cars and dried to about 250°F. in either a 34-track waste-heat tunnel drier operated by the Rogers system or an 8-track waste-heat tunnel drier operated by the Minter system. The dried tile and brick are fired to from 1800°F. to 1850°F. in 16 28-foot and 1 36-foot round down draft kilns operated by the Rogers system, three kilns to a stack; 5 30-foot round down-draft kilns operated by the Minter system under induced draft; or a Dressler muffle-type tunnel kiln fired by producer gas on a 52 hour schedule. In the Dressler kiln the brick, loaded on cars, travel slowly through the kiln. The production of the plant is 125,000 common brick and 175 tons of structural tile per day. A number of sizes and types of tile are made, the largest output being in the interlocking type.

MRS. L. M. KENDRICK ESTATE

The Mrs. L. M. Kendrick Estate (c/o Miss Lelia Kendrick, 2404 Glade Rd., Columbus) consists of about 80 acres on Werocoda Creek near the junction of the Cusseta Highway and the Old Lumpkin Road, two and a half miles southeast of the center of Columbus and half a mile to three-quarters of a mile west of the Central of Georgia Railway and the Seaboard Air Line Railway.

About 45 acres of the property are in a flat terrace some 20 to 25 feet above the level of the creek. This terrace extends west of the property half a mile to the Chattahoochee River. The old clay pits of the Columbus Brick and Tile Company are almost due west of this property.

The banks of the creek where it cuts through this terrace expose about 15 feet of stiffly-plastic gray alluvial clay, somewhat brown-stained at the top and grading into a sand-clay mixture at the bottom. The clay dried into very hard lumps on the surface exposures. It is overlain by a foot or two of soil. Laboratory tests are given below on a 12 foot groove sample of this clay. It is impossible to tell without prospecting whether or not the whole terrace is underlain by similar clay. Such alluvial terrace deposits at some places extend under large areas, at others change rapidly into material too sandy for ceramic use. If the deposit is of sufficient size, the clay could be mined by a steam shovel or a drag-line excavator and trammed to a plant on the railroad.

Laboratory tests on a 12-foot groove sample of stiffly-plastic gray to brown alluvial clay from the Mrs. L. M. Kendrick Estate, Werocoda Creek south of Columbus, Muscogee County.

Chemical Analysis:

Loss on ignition	9.58
Soda (Na_2O)	.16
Potash (K_2O)	.16
Lime (CaO)	trace
Magnesia (MgO)	.26
Alumina (Al_2O_3)	26.21
Ferric oxide (Fe_2O_3)	6.04
Titanium dioxide (TiO_2)	.64
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.26
Silica (SiO_2)	57.06
	100.37

Ground Color: Light yellowish-gray.
Slaking: Rapid.
Plasticity: Good (sticky).
Molding Behavior: Formed well but tendency to laminate.
Drying Behavior: Some warpage.
Water of Plasticity: 34.5 per cent.
Green Modulus of Rupture: 446.3 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 11.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.7	13.5	19.9	1007	Very pale salmon (7YR-7/5)[b]	Some
04	3.4	14.5	16.0	1330	Light salmon 8YR-7/4)[b]	Some
02	3.6	14.5	14.7	1297	Light salmon (9YR-7/5)[b]	Some
1	5.5	17.0	11.3	1753	Salmon (7YR-6/6)[b]	Considerable
3	5.5	16.5	12.4	1111	Salmon (YR-6/6)[b]	Considerable
5	6.2	16.5	10.2	2096	Salmon 6YR-6/5)[b]	Considerable

[a]See graph, Figure 23-C, page 287.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 01–5 and possibly higher.

The above tests indicate that this clay is suitable for the manufacture of common brick and possibly medium-fired structural tile. The shrinkage and absorption are high, the fired strength rather low. The colors of the fired test pieces are none too good, but it is possible that the inclusion of some of the stained material and flashing at the end of the firing period might give better colors. The inclusion of more sandy material would probably lower the shrinkage and eliminate the tendency to laminate, but would not improve the absorption.

GEORGIA GRAVEL COMPANY

W. M. MORRIS PROPERTY

The W. M. Morris property, leased to the Georgia Gravel Company (C. P. Mullen, President and General Manager, Columbus), consists of 200 acres on Bull Creek, three miles east of Columbus and one mile northeast of Muscogee Station on the Columbus to Macon line of the Central of Georgia Railway.

The terrace on either side and some 12 to 15 feet above the level of the creek is overlain by 6 to 12 feet of gray-blue to yellow somewhat sandy alluvial clay, bottoming on sand and gravel. The bottom foot or so of the clay at places is very plastic and dark-blue in color. The laboratory tests are given below on samples of both the gray-blue to yellow clay and the very plastic dark-blue basal clay. The samples were combined after the chemical analyses were made.

Laboratory tests on grab samples of alluvial clays from the Georgia Gravel Company or W. M. Morris property, Bull Creek one mile northeast of Muscogee Station, Muscogee County.

A. Stiffly plastic gray-blue to yellow alluvial clay.

B. Very plastic dark-blue alluvial clay from the base of the deposit.

Chemical Analyses:	A	B.
Loss on ignition	8.28	10.73
Soda (Na_2O)	.21	.20
Potash (K_2O)	.06	.25
Lime (CaO)	.00	.29
Magnesia (MgO)	trace	trace
Alumina (Al_2O_3)	11.56	22.53
Ferric oxide (Fe_2O_3)	6.29	2.65
Titanium dioxide (TiO_2)	.92	.92
Sulphur trioxide (SO_3)	trace	.55
Phosphorus pentoxide (P_2O_5)	.64	.44
Silica (SiO_2)	72.15	61.33
	100.11	99.89

Note: The following tests were made on the two samples combined.

Ground Color: Light brownish-gray.
Slaking: Rapid.
Plasticity: Good (sticky).

Molding Behavior: Excellent.
Drying Behavior: Some warpage.
Water of Plasticity 30.4 per cent.
Green Modulus of Rupture: 570.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 9.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	1.3	11.1	19.4	765	Light salmon (7YR-7/6)[a]	Some
04	1.8	11.3	18.6	924	Light salmon (8YR-7/5)[a]	Some
02	2.7	11.9	16.9	982	Medium salmon (8YR-7/4)[a]	Some
1	3.4	12.4	15.8	1163	Salmon (YR-6/6)[a]	Some
3	3.1	12.5	16.0	1172	Salmon (4YR-6/5)[a]	Considerable
5	3.5	12.7	15.4	1238	Salmon (4YR-6/5)[a]	Considerable

[a]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 1–5 and higher. Commercial kiln: Cone 01–5 and possibly higher.

The above tests indicate that this clay is suitable for the manufacture of common brick, flower pots, and crude pottery. The absorption is high and the fired strength low. The fired colors are poor but could probably be improved with the addition of more surface material and by flashing at the end of the firing period.

MACON DISTRICT

The alluvial clays of the Ocmulgee River at Macon have long been used for the manufacture of building brick and structural tile. Sewer pipe were formerly made from them, but at present the sewer pipe plants in Macon are using shale shipped in from northwest Georgia and Tennessee.

The clay is underlying the broad second bottom or swamp land, three to four miles in width, south of Macon. The deposits are quite variable and pockety. They range from 2 to 25 feet in thickness, the average thickness being about 8 to 10 feet. The clay near the surface is brown or yellow in color, usually quite sandy, while at greater depth it is lighter colored or bluish and quite plastic. The deposits are overlain by one to three feet of sand or loam which is removed as overburden. They are underlain by a fine water-bearing sand which necessitates leaving a foot or so of clay in the bottom of the pit to prevent flooding by water from the underlying sand. The sand content of the clay varies considerably, often in short distances, and at places there are irregular areas too sandy to be utilized. The deposits must therefore be carefully prospected, and in mining great care must be taken to mix the clay from different parts of the pit or from different pits in order that the shrinkage and other fired properties of the product may be uniform from day to day.

CHEROKEE CLAY PRODUCTS COMPANY

Headquarters and Plant: Macon, Georgia.

S. T. Coleman, President.

W. E. Dunwody, Vice President.

K. W. Dunwody, General Superintendent

The plant of the Cherokee Clay Products Company is near the West Yard of the Central of Georgia Railway at South Macon. The clay pits are on the second bottom of the Ocmulgee River about two and a half miles southeast of the plant.

Clay Pits

The clay is the usual type of Fall Line alluvial clay, ranging in color from yellow and brown at the top to a gray-blue at the bottom and varying greatly in the sand content. The deposit is from 1 to 25 feet in thickness, averaging 10 to 12 feet. The overburden of soil and sand averages a foot in thickness. The following laboratory tests are on a grab sample of the clay obtained at the plant after mixing and storing, this being more representative than a sample from any one place in the clay pit.

Laboratory tests on a sample of gray-blue to brown alluvial clay from the Cherokee Clay Products Company, Macon, Bibb County.

Chemical Analysis:

Loss on ignition	8.51
Soda (Na_2O)	.31
Potash (K_2O)	.33
Lime (CaO)	.00
Magnesia (MgO)	.24
Alumina (Al_2O_3)	20.34
Ferric oxide (Fe_2O_3)	7.70
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.01
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	61.67
	100.11

Ground Color: Light brown.
Slaking: Rapid.
Plasticity: Good (slightly sticky).
Molding Behavior: Excellent.
Drying Behavior: Rapid and little or no warpage.
Water of Plasticity: 27.6 per cent.
Green Modulus of Rupture: 351.5 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 7.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.9	10.2	18.4	1094	Salmon (4YR-6/6)[b]	None
04	2.9	10.4	16.6	1149	Salmon red (2YR-5/5)[b]	None
02	4.3	11.8	14.8	1524	Light red (1YR-5/4)[b]	None
1	4.9	12.1	14.0	1459	Good red (2YR-4/4)[b]	None
3	4.5	11.9	14.4	1577	Good red (1YR-4/4)[b]	Some
5	5.1	12.7	12.5	1722	Good dark red (1YR-4/3)[b]	Some

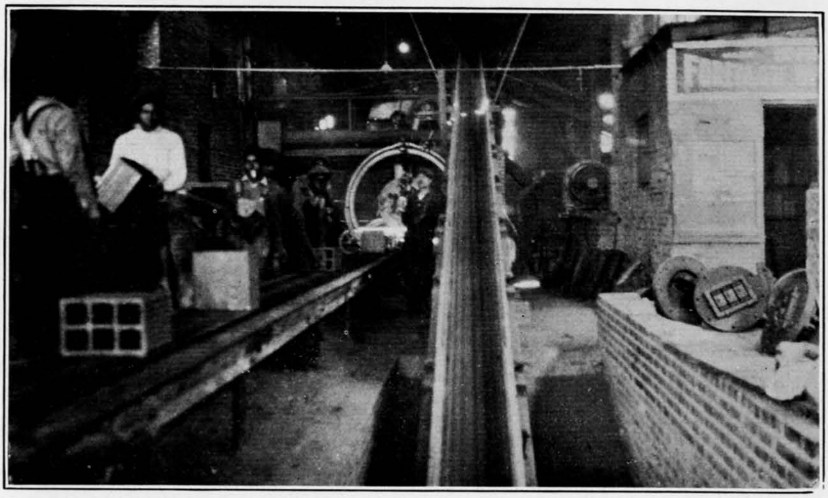
[a]See graph, Figure 24-A, page 305.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 03–5.

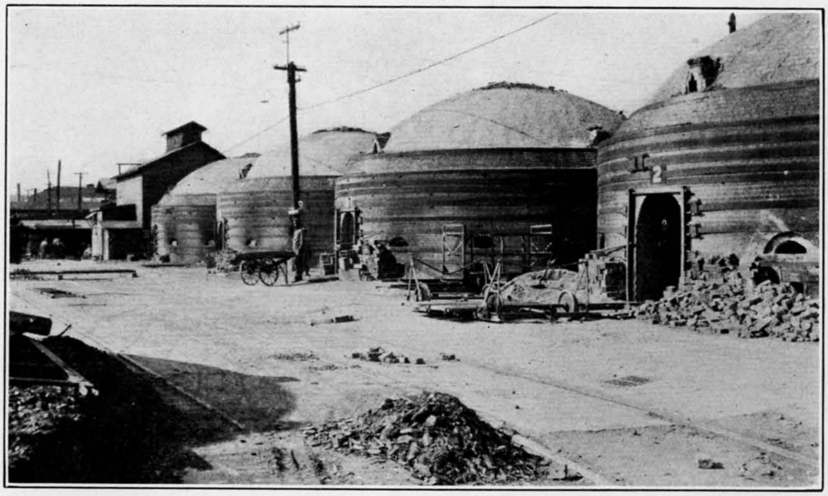
The clay is mined by an electric drag-line excavator with a 40-foot boom and a 1¼-cubic yard bucket. It is transported to the plant in 6-cubic yard side-dump cars, drawn by three 30-ton narrow-guage locomotives specially built low to clear a low underpass under the tracks of the Georgia Southern and Florida Railway of the Southern Railway System.

Plant

At the plant the clay is distributed as evenly as possible over a section of a large storage yard. At this storage yard a section at a time is built up in horizontal layers, left to age for several months, and then used by cutting as near as possible to vertical slices across the section. The distribution is done by an overhead conveyor belt and the clay is removed by a conveyor belt in a tunnel beneath the section. In this way the clay from various parts of the pits is thoroughly mixed and aged before using, and mining need not be carried on during the bad weather of the winter months.



A. STRUCTURAL TILE MACHINE IN OPERATION, CHEROKEE BRICK COMPANY, MACON, BIBB COUNTY. THE LARGE CIRCLE IN THE BACKGROUND IS THE AUTOMATIC ROTARY CUTTER IN FRONT OF THE TILE MACHINE. EXTRA DIES ARE SHOWING ON THE RIGHT.



B. ROUND DOWN-DRAFT KILNS AT THE CHEROKEE BRICK COMPANY, MACON, BIBB COUNTY.

The plant consists of four complete units for forming the products: two for structural tile, one for end-cut common brick, and one for side-cut face brick. Each unit consists of a double smooth-roll disintegrator, a singe-shaft granulator, a double-roll disintegrator, a 12-foot pug mill where the clay is tempered and pugged, and an auger-type brick or tile machine which extrudes a column of clay that is automatically cut off into brick or a continuous shell and web which is automatically cut off into structural tile (see Plate IX-A).

The green tile and brick are hacked to steel drying cars and dried in a 45-track waste-heat tunnel drier, the tile at 140°F. and the brick at 200°F. They are fired to cone 02 to 01 or about 1950°F. to 2000°F. in 18 30-foot and 19 32-foot round down-draft kilns. Both standard pyrometric cones and electrical pyrometers are used in firing the kilns and determing the end point. The face brick are usually flashed.

The products are medium-hard fired structural tile in a variety of styles and sizes, a good quality clay face brick in a range of pleasing colors, and durable end-cut common-brick. The culls of the side-cut brick are also sold as common brick. The capacity of the plant is approximately 200,000 common brick, 25,000 face brick, and 150 tons of tile per day.

BIBB BRICK COMPANY

Headquarters: Macon, Georgia.

W. J. Massee, President.

O. J. Massee, Jr., Vice President and Treasurer.

Plant: Macon, Georgia.

G. S. Woodruff, Superintendent.

The plant of the Bibb Brick Company is at 10th and Oak Streets. The clay pits are on the second bottom or swamp land of the Ocmulgee River, about two and a half miles south of the plant.

Clay Pits

The alluvial clay showing in the pits ranges from yellowish-drab to brown at the top to steel-blue and gray at the bottom, and varies considerably in sand content. The top layers are usually more sandy and less plastic than the bottom. The thickness generally averages about 8 feet, although there are many minor variations and occasionally pockets and streaks of sand to be discarded or left behind. The clay is overlain by one to three feet of sand and soil overburden and is underlain by water-bearing sand. The laboratory tests are given below on a grab sample of the clay taken at random from a stock pile at the plant, this being more representative than a sample from any one place in the pits.

Laboratory tests on a sample of brown to blue alluvial clay from the Bibb Brick Company, Macon, Bibb County.

Chemical Analysis:

Loss on ignition	8.70
Soda (Na_2O)	.55
Potash (K_2O)	.20
Lime (CaO)	.00
Magnesia (MgO)	.30
Alumina (Al_2O_3)	25.29
Ferric oxide (Fe_2O_3)	7.97
Titanium dioxide (TiO_2)	.91
Sulphur trioxide (SO_3)	.61
Phosphorus pentoxide (P_2O_5)	.40
Silica (SiO_2)	55.15
	100.08

Ground Color: Light grayish-brown.
Slaking: Rapid.
Plasticity: Good (slightly sticky).
Molding Behavior: Excellent. (Had clay a little too wet and test bars swelled slightly in coming through the die.)
Drying Behavior: Rapid. Some warpage.
Water of Plasticity: 30.4 per cent.
Green Modulus of Rupture: 390.8 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 8.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.7	10.6	18.5	1035	Salmon (3YR-6/6)[b]	Some
04	3.1	11.1	16.3	1313	Salmon red (1YR-5/5)[b]	Some
02	3.8	11.5	16.3	1304	Light red (R-YR-6/5)[b]	Some
1	4.8	11.8	14.1	1305	Good red (1YR-5/5)[b]	Some
3	4.3	11.3	14.5	1429	Good red (R-YR-4/5)[b]	Some
5	4.8	12.5	13.1	1606	Good red (R-YR-4/4)[b]	Considerable

[a]See graph, Figure 24-B, page 305.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 04–5 and higher. Commercial kiln: Cone 04–5.

The clay is mined by an electric drag-line excavator with a 40-foot boom and a 1¾-cubic yard scraper bucket. The clay is transported

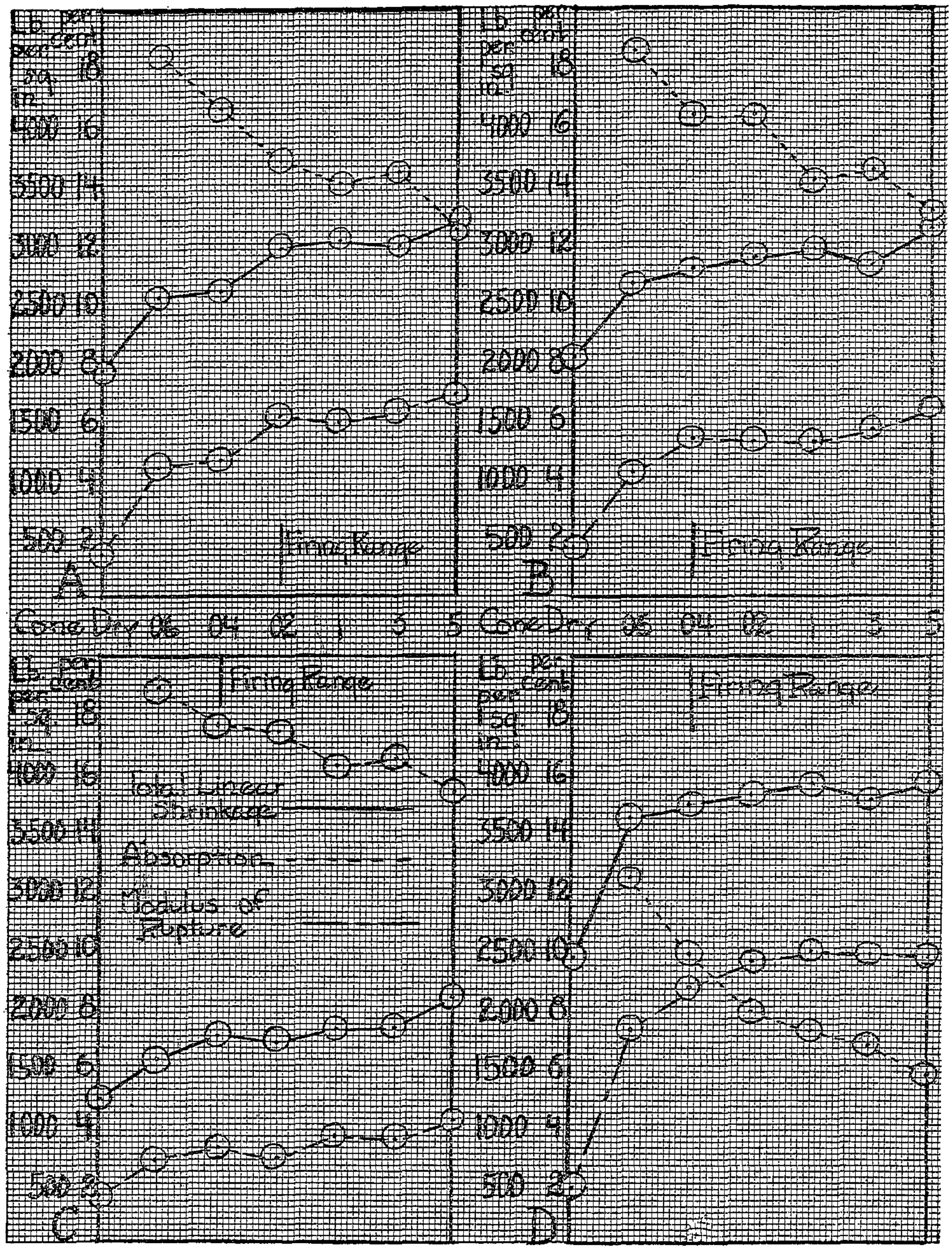


Figure 24. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Alluvial clay from the Cherokee Brick Company, Macon, Bibb County.

B. Alluvial clay from the Bibb Brick Company, Macon, Bibb County.

C. Mixture of alluvial and residual clay from the Milledgeville Brick Works, Milledgeville, Baldwin County.

D. Alluvial clay from Plant No. 3, Hagler Brick Company, Augusta, Richmond County.

to the plant in 8 cubic yard side-dump tram cars hauled by two 38-ton narrow-gauge locomotives.

Plant

At the plant the clay is either dumped on a large storage pile or in one of the hoppers that feed the three separate units for forming the three products: Common brick, face brick, and structural tile.

Unit No. 1 consists of a granulator, where water is added, and an auger-type brick machine extruding a continuous column of clay that is automatically cut off into end-cut common brick.

Unit No. 2 consists of a granulator, a disintegrator, a pug mill, and an auger-type brick machine extruding a continuous column of clay that is automatically cut off into side-cut face brick.

Unit No. 3 consists of a granulator, a disintegrator, a pug mill, and an auger-type tile machine extruding a continuous shell and webb that is automatically cut off into structural tile. The various types of tile are made by changing the die of the tile machine.

The brick and tile are dried in a 60-track waste heat tunnel drier, the brick to about 250°F. and the tile to about 200°F. They are fired to about 1950°F. in 28 round down-draft kilns, of which two are 30 feet in diameter, seven are 32 feet, six are 36 feet, and 13 are 40 feet. The firing is regulated by electrical pyrometers and the end points determined by the Veritas system of standard pyrometric disks. The kilns are coaled with truck tractors and are facing a depressed loading track so that the car doors are on a level with the ground.

The products are medium-hard fired structural tile in a variety of styles and sizes, good quality clay face brick in a range of pleasing colors, and durable end-cut common brick. The culls of the side-cut brick are also sold as common brick. The capacity of the plant is approximately 200 tons of structural tile and 250,000 brick per day. The production of building brick is usually about equally divided between common and face brick.

STEWARD BROTHERS PROPERTY

The Steward Brothers property (c/o T. J. Steward, 501 Mulberry St., Macon) consists of about 900 acres in Bibb and Twiggs counties on the Cochran Road about two and a half to three miles south of Swift Creek Station on the Macon, Dublin and Savannah Railroad.

About 400 acres of the property south and southwest of Browns Mountain between the Cochran Road and the Macon to Brunswick line of the Southern Railway is second bottom or swamp land drained by Ocmulgee River and Stone Creek. This is said to have been prospected by auger borings several years ago and to be underlain by a deposit of blue alluvial clay averaging 13 feet in thickness with practically no overburden. Samples were sent off to be tested and were reported as satisfactory for the manufacture of building brick and structural tile. The writer was unable to get a sample of this clay.

W. S. DICKEY CLAY MFG. COMPANY

PLANTS NO. 22 AND NO. 23

Headquarters: Kansas City, Mo. (See also pages 80 and 164.)
Macon Plants:
W. H. Mitchell, Superintendent.

Plant No. 22

Plant No. 22 (formerly the sewer pipe works of the Bibb Brick Company) is at 10th and Pine Streets, Macon. At this plant sewer pipe in sizes up to 36 inches in diameter, together with the necessary T's and Y's, and segment blocks that can be assembled into sewers from 30 inches to 108 inches in diameter, are made from a mixture of shale from Rome, Georgia (see page 81), Graysville, Tennessee, and fire clay from the Birmingham District of Alabama.

The materials are brought into the plant in open gondola cars and dumped into separate storage bins. A belt conveyor under these bins feeds the materials, in the proper proportions, to three dry pans where they are mixed and ground. The ground material is elevated to vibratory screens with mesh one-sixteenth of an inch apart. The oversize from the screens is returned to the dry pans; the undersize is fed to five large wet pans where water is added and the mixture is tempered and pugged to a plastic clay. The sewer pipe and segment blocks are formed on three steam-cylinder sewer pipe presses, and are dried from 3 to 15 days in steam-heated drying rooms. They are fired to about 1900°F. in ten 30-foot, nine 32-foot, and seven 36-foot round downdraft kilns and are then salt glazed. Electrical pyromters are used to regulate the heat during firing and standard pyrometric cones to determine the end point. The salt glazing is regulated by trial pieces.

The capacity of the plant is about 160 tons per day of good quality sewer pipe.

Plant No. 23

Plant No. 23 (formerly H. Stevens Sons Co. and built about 1885) is near the West Yard of the Central of Georgia Railway at South Macon, about two and a half miles southwest of the center of Macon.

At this plant sewer pipe, segment blocks, wall coping, drain tile, and chimney tops are made from a mixture of shale from Rome, Georgia (see page 81), shale from Graysville, Tennessee, and fire clay from the Birmingham District of Alabama; and flue linings are made from the Birmingham fire clay alone.

The plant is much like the No. 22 plant described in detail above except that there are only two dry pans, two screens, three wet pans, and two sewer-pipe presses. The products are fired in 16 30-foot round down-draft kilns. The sewer pipe, segment blocks, wall coping, and chimney tops are salt glazed. The drain tile and flue lining are unglazed. The capacity of the plant is approximately 125 tons per day.

MILLEDGEVILLE DISTRICT

The second bottom of the Oconee River near Milledgeville is underlain by a deposit of fine-grained, plastic alluvial clay ranging in color from brown at the top to blue at the bottom. The deposits range in thickness from 2 to 20 feet and are underlain by the fine water-bearing sand.

The hills on either side of the river are underlain by granitic rocks, probably a granite-gneiss. They have deeply weathered to a residual clay, bright orange-red and stiffly plastic on top but grading with depth into a grayish-brown and gray soft crumbly material which retains the structure and appearance of the original rock.

MILLEDGEVILLE BRICK WORKS

Headquarters and Plant: Milledgeville, Georgia.

K. G. McMillan, President and General Manager.

The Milledgeville Brick Works were started by J. W. McMillan in 1883, the first brick made being used in the Georgia State Asylum for the Insane near Milledgeville. The company now produces common and face brick from a mixture of alluvial and residual clays.

Clay Pits

The alluvial clay pits, when visited by the writer in the fall of 1926, were in the low terrace or second bottom of the Oconee River a quarter to half a mile south of the plant. The clay is a fine-grained plastic alluvial clay containing more or less sand. Its color varies from brown at the top to gray-drab and gray-blue at the bottom. The deposit averages 18 to 20 feet in thickness, underlain by water-bearing sand and overlain by a foot or less of soil and sand overburden. The following laboratory tests are on a grab sample of the clay obtained from the storage bin at the plant.

Laboratory tests on a sample of plastic brown to blue alluvial clay from the Milledgeville Brick Works, Milledgeville, Baldwin County.

Chemical Analysis:

Loss on ignition	7.14
Soda (Na_2O)	.20
Potash (K_2O)	.32
Lime (CaO)	.84
Magnesia (MgO)	.42
Alumina (Al_2O_3)	28.62
Ferric oxide (Fe_2O_3)	6.21
Manganus oxide (MnO)	trace
Titanium dioxide (TiO_2)	.92
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.17
Silica (SiO_2)	55.66
	100.50

Ground Color: Light-brown.
Slaking: Rapid.
Plasticity: Good (sticky).
Molding Behavior: Excellent.
Drying Behavior: Considerable warpage.
Water of Plasticity: 28.8 per cent.
Green Modulus of Rupture: 559.0 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 8.4 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	3.2	11.3	14.9	1454	Light red (4YR-6/6)[a]	Bad
04	4.5	12.3	11.8	1812	Fair red (1YR-5/5)[a]	Considerable
02	4.2	12.3	12.6	1883	Fair red (2YR-5/5)[a]	Considerable
1	5.7	13.8	10.5	2048	Good red (1YR-5/4)[a]	Considerable
3	5.0	12.8	11.2	2138	Good red (R-YR-5/4)[a]	Considerable
5	6.4	14.2	8.3	2656	Good dark red (R-YR-4/4)[a]	Considerable

[a]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 04–5 and possibly higher. Commercial kiln: Cone 04–5.

The clay is mined by an electric slack-line scraper. The mining is done in long narrow pits with a narrow ridge left between the pit being worked and the previous pit to keep out the water which soon fills up the pit. The scraper drags the clay to a hopper over the narrow-gauge track, where it is loaded into side-dump cars which are hauled to the plant by a gasoline locomotive.

The residual or "hillside" clay pit is on the slope just west of the plant. The generalized section showing in the pit is given below.

General section showing in the residual or "hillside" clay pit of the Milledgeville Brick Works, Milledgeville, Baldwin County.

		Thickness in feet
4.	Top soil	0 to 1
3.	Tough red clay showing very little trace of the original rock structure, grading downward into orange-red clay showing traces of the gneissic structure	10 to 15
2.	Bluish-gray "clay" looking in place like solid rock but is soft and powdery. The feldspars have entirely altered to kaolin, and the biotite has weathered to soft golden flakes. All of the original structure is preserved including individual grains, gneissic structure, joint planes, etc.	30 to 35
1.	Darker blue more solid "clay" like above only not so much weathered. The former feldspar grains have probably not entirely been kaolinized and other minerals are fresher. This material is said to act as a flux for the other clays. It is said to continue below the bottom of the pit, gradually containing more pieces of solid rock until fresh unweathered rock is reached	10+
	Total	50 to 60

The following laboratory tests are on a grab sample of this residual clay containing all of the types described above in approximately the proportion in which they are mined.

Laboratory tests on a sample of soft "short" red to blue-gray clay residual from the weathering of a granite-gneiss, Milledgeville Brick Works, Milledgeville, Baldwin County.

Chemical Analysis:

Loss on ignition	8.99
Soda (Na_2O)	.03
Potash (K_2O)	.46
Lime (CaO)	.00
Magnesia (MgO)	.00
Alumina (Al_2O_3)	26.27
Ferric oxide (Fe_2O_3)	10.80
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.11
Silica (SiO_2)	52.35
	100.11

Ground Color: Red with gray specks.
Slaking: Rapid.
Plasticity: Very poor, "short" and sandy.
Molding Behavior: Impossible to form bars in the Mueller roll-press. Test bars were made very wet in a slop-mold.

Drying Behavior: Rapid with no warpage.
Water of Plasticity: 26.7 per cent.
Green Modulus of Rupture: 31.9 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 2.6 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length) *per cent*	Absorption *per cent*	Modulus of Rupture *Lb. per sq. in.*	Color	Warpage
06	-0.5	2.0	26.8	[a]	Brownish-red (3YR-6/7)[b]	None
04	0.0	2.5	27.6	[a]	Brownish-red (3YR-6/7)[b]	None
02	1.5	3.9	25.5	82	Brownish-red (3YR-5/6)[b]	None
1	1.2	4.0	26.1	190	Medium brownish-red (3YR-5/6)[b]	Slight
3	0.8	2.9	26.3	194	Dark brownish-red (2YR-5/5)[b]	Some
5	1.0	3.4	24.5	196	Dark brownish-red (2YR-4/5)[b]	Some

[a]Test bars broken before strength tests could be made.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Not reached by these tests.

The mining of the residual clay is done by an electric slack-line scraper, the clay being dragged to a hopper over a narrow-gauge track and dumped into side-dump cars which are pushed by hand the short distance to the plant.

The following laboratory tests were made on a composit sample of equal parts of the alluvial clay and the residual clay whose tests are given above. This is not the proportion of these two clays used by the Milledgeville Brick Works, but is given to illustrate the affect that the residual clay has on the alluvial clay in reducing shrinkage and warpage at the expense of the absorption and fired strength.

Laboratory tests on a composit sample of equal parts of alluvial clay and residual or "hillside" clay from the Milledgeville Brick Works, Milledgeville, Baldwin County.

Slaking: Rapid.
Plasticity: Fairly good, a trifle "short."
Molding Behavior: Good. (Clay was a little too wet and the test bars swelled slightly on coming through the die.)

Drying Behavior: Rapid with little or no warpage.
Water of Plasticity: 24.9 per cent.
Green Modulus of Rupture: 397 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 4.9 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.4	6.2	18.9	706	Salmon (4YR-6/6)[b]	None
04	2.0	7.0	17.6	797	Salmon red (4YR-6/4)[b]	None
02	2.2	6.8	17.4	717	Light red (3YR-6/5)[b]	None
1	2.6	7.2	16.2	908	Fair red (2YR-5/5)[b]	Some
3	2.5	7.3	16.5	870	Medium red (1YR-5/4)[b]	Slight
5	3.4	8.3	15.3	1040	Good red (R-YR-4/4)[b]	Some

[a]See graph, Figure 24-C, page 305.
[b]Color notation according to the Munsell system, see page 23.

Remarks: The test bars fired to cone 04 were slightly flashed, indicating reducing conditions at the end of the firing.
Firing Range: Cone 04–5 and higher. Commercial kiln: Cone 02–5.

Plant

The clays at the plant are stored in separate bins from which they are fed, in the proper proportion, through a double-roll granulator to a large pug mill where water is added and the mixture is tempered and pugged to a plastic clay. The plastic clay is fed to an auger-type brick machine which can be fitted with the proper auger, die, and automatic cutter to make either end-cut or side-cut brick. The end-cut brick are automatically stamped with the company's name before cutting by a steel roll that is synchronized with the speed of the column of clay so that the name always appears on the proper place on the brick

The brick are hacked to wooden drying cars and dried in a waste-heat or coal-fired 10-track tunnel drier. The drier cars are pushed to the kiln doors and the brick carried into the kiln by a gravity carrier with rubber-covered rolls. The bricks are fired to about 1900°F. in a Haigh semi-continuous kiln with 31 sections, each holding about 25,000 brick. As each section is set a paper partition is put up between it and the next section to regulate the draft so that it will be down-draft in each section. The fire progresses through the kiln, firing a section at a time, each section being water-smoked (see page 28) and the draft air being pre-heated by the heat from the preceding sections. In addition to the Haigh kiln there is a 36-foot round down-draft kiln which is fired between each complete firing of the continuous kiln to keep the heat up and the draft going in the 152-foot stack which serves both kilns. The heat is controlled and the end-point determined by electrical pyrometers.

The fired brick are loaded from the kiln directly into freight cars. The capacity of the plant is about 45,000 brick per day. The production is about evenly divided between common brick and face brick. The brick are good quality and have a pleasing range in color from salmon-red to deep cherry-red.

OCONEE CLAY AND SHALE PRODUCTS COMPANY

Headquarters and Plants: Milledgeville, Georgia.

J. S. Bone, President.

H. G. Bone, General Manager.

Frank Bone, Secretary and Treasurer.

Russell Bone, General Superintendent.

The Oconee Clay and Shale Products Company, formerly the Oconee Brick and Tile Company, have two plants in Milledgeville. At Plant No. 1 sewer pipe, drain tile, and flue lining are made. The sewer pipe is made from a mixture of shale from a pit on the Central of Georgia Railway in Floyd County in northwest Georgia (see page 92) and red hillside clay, residual from a granite-gneiss, from a pit near Milledgeville. More of the shale than of the clay is used in this mixture. The drain tile are made from a mixture composed largely of the residual clay but with a small amount of shale. The flue lining is made from a mixture of shale, residual clay, and white sedimentary kaolin, formerly mined from a pit on the Georgia Railroad in Hancock County[1] but now purchased on the open market. Structural tile and building brick are made at Plant No. 2. The residual clay, together with small amounts of the shale and sedimentary kaolin are used in the manufacture of the structural tile. The building bricks are made from a mixture of the residual clay and the shale.

Residual Clay Pit

The residual or "hillside" clay pit is on the Georgia Railroad just northeast of Milledgeville. The pit, when visited by the writer in 1926, had a 20 foot face. The upper 10 feet showed a tough red clay showing no traces of the original rock structure. This graded downward into 10 feet of bright orange-red clay with some bluish-gray places towards

[1]See Smith, R. W., Sedimentary Kaolins of the Coastal Plain of Georgia: Georgia Geol. Survey Bull. 44, p. 296, 1929.

the bottom that showed some of the gneissic structure of the original rock. The lower layers that were showing in the residual clay pit of the Milledgeville Brick Works (see page 310) were not reached in this pit. The clay is probably somewhat more plastic than that sampled from the Milledgeville Brick Works pit.

Scattered across the face of the pit are several dikes, varying in width from one inch to 15 feet, of some igneous rock that weathers to a soft light buff-colored siliceous material with greenish streaks. These are culled from the clay as much as possible in mining.

The mining is done by a steam shovel and the clay is loaded into standard gondola cars for transportation to the plant.

Plant No. 1

Sewer pipe, drain tile, and flue lining are all made at the No. 1 plant. The materials, which are stored in separate bins, are mixed and ground in a large dry pan and screened through an 8-mesh vibratory screen. The oversize from the screen is returned to the dry pan; the undersize goes to two wet pans where water is added and the material is tempered and pugged to the consistency of a plastic clay. The ware is formed on two steam-cylinder sewer pipe presses. The sewer pipe are dried in steam heated drying rooms, the drain tile and flue lining in a 12-track waste-heat tunnel drier. The ware is fired in seven 30-foot round down-draft kilns regulated by electrical pyrometers. The sewer pipe are fired to about 1900°F. and salt glazed. The drain tile are fired to a slightly lower temperature and the flue lining to a slightly higher temperature, and neither are salt glazed. The capacity of the plant is about 60 tons per day of which over half is sewer pipe.

Plant No. 2

Structural tile and building brick are made at the No. 2 plant from a mixture of the residual clay and small amounts of the shale and (tile only) the sedimentary kaolin. The materials are stored in separate piles from which they are carried in wheel barrows to a dry pan where they are mixed and ground. The ground material is screened on an inclined screen with mesh a sixteenth of an inch apart. The oversize is returned to the dry pan, the undersize goes to a wet pan where water is added and the material is tempered and pugged to a plastic condition. At the time of the writer's visit in 1926 the only product was structural tile which were formed on a steam-cylinder tile press. When the manufacture of building brick was started an auger-type of brick machine was installed, from which, with the proper dies, either brick or tile can be truded and automatically cut off.

The tile were dried in a 15-track tunnel drier using either waste-heat from the kilns or exhaust-steam from the tile press. The drier cars were carried two at a time to the kilns on an electric trolly transfer car. The tile were fired to about 2000°F. in seven 30-foot round down-draft kilns, using electrical pyrometers to regulate the heat and trial pieces to determine the end-point. The capacity of the plant was about 80 tons per day of structural tile in a range of sizes.

PORTER BRICK COMPANY

Headquarters and Plant: Milledgeville, Georgia.

C. C. Porter, President.

The plant of the Porter Brick Company, manufacturers of common building brick, is on the Georgia Railroad on the east side of the Oconee River about three and a half miles northeast of Milledgeville. The brick are made from a mixture of plastic alluvial clay from the second bottom or terrace of the Oconee River and a red residual or "hillside" clay much like that used by the Milledgeville Brick Works and the Oconee Clay and Shale Products Company.

The alluvial clay pits in the second bottom of the Oconee River near the plant show an average of five feet of very plastic blue, sometimes brown stained, clay; overlain by 6 to 18 inches of sandy overburden and underlain by 2 to 3 feet of sandy clay followed by water-bearing sand. The clay is mined by an electric slack-line scraper, the mining being done in long narrow pits with a ridge left between each pit to keep out the water as much as possible. The clay is trammed to the foot of the slope below the plant and then hoisted up an incline to the plant.

At the time of the writer's visit to the property in 1926 the residual or "hillside" clay was being mined from a small pit on the road north of the plant that showed reddish-brown to orange-red somewhat sandy clay showing but little traces of the original rock structure. Quartz veins six inches to a foot in thickness were of such frequent occurrence that the company was planning to open another pit in the low ridge just east of the railroad. This deposit will be mined by steam shovel and trammed across the railroad to the plant.

The two clays are dumped on separate storage piles at the plant. From those storage piles they are fed in the proper proportion onto a belt elevator which carries them to a double-roll granulator through which they drop to a large pug mill. Here water is added and the mixture is tempered and pugged to a plastic clay. This is fed to an auger-type brick machine which extrudes it as a column which is automatically cut off into end-cut brick.

The green brick are dried in a 10-track coal-fired tunnel drier and are then fired to about 1950 F. in three 30-foot and three 40-foot round down-draft kilns. The kilns are regulated and the end-point determined by electrical pyrometers. The capacity of the plant is about 65,000 brick per day. The product is a good quality end-cut common brick in colors ranging from salmon-red to dark red.

AUGUSTA DISTRICT

Deposits of a peculiar residual clay from Richmond County west of Augusta have already been described on pages 284-291.

The alluvial clays of the Augusta District underlie the second bottom or terrace of the Savannah River. This terrace, which is about two miles in width and some 30 to 40 feet above low water level of the river, is underlain by sand with local pockets of gravel and irregular deposits of sandy and plastic clays. The workable clay generally has a thickness of 6 to 12 feet although a thickness of 32 feet at one place has been reported. The deposits often show rapid variations in the sand content and at places are frequently interrupted by narrow curved "channels" filled with sand.

These clays have long been the center of a thriving building brick and, in recent years, structural tile industry. They can be fired to a somewhat porous but very durable dark-red product. At the present time there are six plants on the Georgia side of the river with a combined capacity of about 650,000 brick and 300 tons of tile per day. These plants are all clustered on the outskirts of Augusta between the Central of Georgia Railway and the Charleston and Western Carolina Railway. Their clay pits are on the northern edge of the Phinizy Swamp. It is not known whether or not such clays are underlying the similar terraces on the New Savannah Road and the Central of Georgia Railway west and south of the swamp.

GEORGIA-CAROLINA BRICK COMPANY

Headquarters: 748 Reynolds Street, Augusta, Georgia.

J. C. Hagler, President.

The Georgia-Carolina Brick Company is a holding company and sales organization. It controls the production and markets the product of the following subsidiary companies: Hagler Brick Company (two plants); Augusta Clay Products Company; Dunbar Brick Company; Augusta Face Brick Company; and the Hankinson Brick Company. Only the first three of these companies have plants on the Georgia side of the river and will be described below.

Hagler Brick Company

Plant No. 3

The No. 3 plant of the Hagler Brick Company, a subsidiary of the Georgia-Carolina Brick Company, is at the foot of First Street near the southeast corner of the city limits of Augusta. The clay pits, at the time of the writer's visit in 1927, were about a mile south of the plant.

The clay pits show an average of seven feet of mottled blue-gray and brown fairly plastic clay containing near the top some small nodules of yellow and black iron oxide. The sand content is said to be rather low and fairly uniform. At the bottom it grades into water-bearing sand. The top of the deposit extends to the grass roots, but about a foot is removed as overburden because of tree and plant roots. The clay is mined by a steam drag-line excavator with a 1¼-cubic yard bucket. The deposit is mined in long strips the width of the reach of the machine, leaving a wall the width of the dinky tracks between each strip to prevent flooding by water from the old pits. The clay is loaded into wooden side-dump cars and trammed to the plant, where the cars are hauled up an incline and dumped into a storage bin.

The following laboratory tests were made on a sample of this clay consisting of several green brick obtained from scattered points in the open air drying-shed at the plant.

Laboratory tests on mottled blue-gray and brown plastic alluvial clay from the Hagler Brick Company, Plant No. 3 of the Georgia-Carolina Brick Company, Augusta, Richmond County.

Chemical Analysis:

Loss on ignition	11.10
Soda (Na_2O)	.18
Potash (K_2O)	.12
Lime (CaO)	.90
Magnesia (MgO)	trace
Alumina (Al_2O_3)	18.09
Ferric oxide (Fe_2O_3)	7.11
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.16
Silica (SiO_2)	61.20
	99.96

Ground Color: Grayish-brown.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Excellent.

Drying Behavior: Rather slow with some warpage.

Water of Plasticity: 30.8 per cent.

Green Modulus of Rupture: 459.6 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 9.7 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	4.8	14.4	12.4	1790	Deep salmon (3YR-6/6)[b]	Slight
04	5.4	14.9	9.8	2178	Light red (2YR-5/5)[b]	Slight
02	6.3	15.2	7.8	2384	Light red (R-YR-5/4)[b]	Slight
1	6.6	15.6	7.2	2478	Medium red (1YR-5/4)[b]	Slight
3	6.2	15.1	6.7	2437	Good red (R-YR-5/4)[b]	Some
5	6.9	15.7	5.7	2418	Good red (R-YR-4/4)[b]	Considerable

[a]See graph, Figure 24-D, page 305.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Two each of the bars fired to cones 04 and 1 and one of the bars fired to cone 3 were black-cored, indicating reducing conditions in the kiln. All of the test bars showed more or less bluish-gray scum or efflorescence on the corners and top surfaces.

Firing Range: Cone 04–5. Commercial kiln: Cone 05–4.

The clay from the storage bin is fed through a single-shaft granulator into a single-shaft pug mill where water is added and the material is tempered and pugged to the plasticity required. The plastic clay is fed to an auger-type machine which extrudes it as a column which is automatically cut off into end-cut brick. The brick are dried in either a 12-track tunnel drier heated by exhaust steam or on pallets in open-air drying sheds (principally used during the summer months). They are fired to about 1800°F. in ten 30-foot round down-draft kilns, using electrical pyrometers to regulate the heat and determine the end-point. The capacity of the plant is about 80,000 brick per day. The product observed by the writer ranged in color from light salmon-red to dark red, had a fair ring when struck together, and would be classed as a good quality common brick. None of them showed evidences of the scumming noted in the test bars.

Hagler Brick Company
Plant No. 8

The No. 8 plant of the Hagler Brick Company is on Gwinnett Street near the foot of Fourth Street, and the clay pits are about three-quarters of a mile to the south.

The clay deposit is said to be much like that of the other plant of the Hagler Brick Company, described above. It is mined by an electric drag-line excavator with a 45-foot boom and a 1¼-cubic yard bucket, loaded into side-dump mine cars, and trammed to the plant.

At the plant the clay is passed through a granulator of the pug mill type, a disintegrator with two cylindrical rolls, one revolving faster than the other, and a combination pug mill and auger-type brick machine which extrudes a column of clay that is automatically cut into side-cut brick. The brick are dried in either a 16-track waste-heat tunnel drier or on pallets in open-air drying sheds. They are fired to about 1800°F. in nine 30-foot, one 32-foot, and two 34-foot round down-draft kilns, using induced draft. The capacity of the plant is about 100,000 brick per day. The product observed by the writer was a good clay face brick in good red colors.

Augusta Clay Products Company

The Augusta Clay Products Company, a subsidiary of the Georgia-Carolina Brick Company, is on the New Savannah Road. The plant burned in 1925 and had not been rebuilt when the writer investigated the industry in Augusta in 1927. The plant has since been rebuilt and is now manufacturing structural tile from an alluvial clay deposit nearby. The plant is said to have ten 32-foot kilns and to have a capacity of 100 tons per day.

Dunbar Brick Company

The Dunbar Brick Company, a subsidiary of the Georgia-Carolina Brick Company, is near the foot of Fourth Street. The plant has not been in operation since 1926.

The clay deposit, which is about half a mile south of the plant, is said to resemble that of the Hagler Brick Company described above. It was mined by a steam drag-line excavator, loaded into side-dump cars, and hauled to the plant by a tractor-type of gasoline locomotive.

The plant consists of a granulator (pug-mill type), a double-roll disintegretor, a pug mill, an auger-type of brick machine with an automatic cutter making end-cut brick, open-air drying sheds and an 18-track steam heated tunnel drier, and eight 30-foot round down-draft kilns on individual stacks. The capacity is about 60,000 brick per day.

MERRY BROTHERS BRICK AND TILE COMPANY

Headquarters and Plants: Augusta, Georgia.

A. H. Merry, President.

Merry Brothers Brick and Tile Company, founded in 1898, now operates two plants. The main plant producing common and face brick and structural tile is on Gwinnett Street between the south ends of First and Second streets. The old McKenzie Brick Company Plant on the New Savannah Road produces common brick. In addition the company is sales agent for the Electric City Brick Company described below.

Main Plant

The main plant of the Merry Brothers Brick and Tile Company obtains its clay from pits about five-eighths of a mile south of the plant. The pits show from 9 to 11 feet of blue-gray to brown plastic alluvial clay containing some sand, usually with no overburden but occasionally overlain by sand up to three or four feet thick. Some irregular pockets and long narrow streaks of sand or more sandy clay are found in the usable clay and have to be discarded or avoided in mining. One such curved streak of sand about 30 feet wide crossed the entire property and probably marked a former river channel. At the edge of the Phinizy Swamp is a deposit of light-blue clay containing some lime and firing to a buff color. The clays are underlain by water-bearing sand. The following laboratory tests are on a sample of the clay obtained by taking several green brick at random from the plant. This probably gave a more representative sample than one obtained from any one place in the pit.

Laboratory tests on a sample of blue-gray to brown alluvial clay from the Merry Brothers Brick and Tile Company, Augusta, Richmond County.

Chemical Analysis:

Loss on ignition	5.27
Soda (Na_2O)	.15
Potash (K_2O)	.31
Lime (CaO)	.00
Magnesia (MgO)	.07
Alumina (Al_2O_3)	20.84
Ferric oxide (Fe_2O_3)	5.32
Titanium dioxide (TiO_2)	1.10
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.06
Silica (SiO_2)	64.79
	97.91

Ground Color: Light grayish-brown.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Excellent.

Drying Behavior: Fairly rapid, with little or no warpage.

Water of Plasticity: 23.6 per cent.

Green Modulus of Rupture: 375.5 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 7.1 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	1.3	8.2	18.4	651	Salmon (YR-6/6)[b]	None
04	1.3	8.3	17.2	705	Light red (YR-6/6)[b]	None
02	1.3	8.1	16.6	732	Light red (2YR-5/5)[b]	None
1	2.2	9.0	16.2	851	Medium red (3YR-5/5)[b]	Very slight
3	1.6	9.0	16.1	871	Good red (2YR-5/4)[b]	Very slight
5	2.7	10.0	15.8	969	Good red (1YR-4/4)[b]	Very slight

[a]See graph, Figure 25-A, page 323.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 06–5 and higher. Commercial kiln: Cone 07–5 and possibly higher.

The clay is mined by an electric drag-line excavator, loaded into cars, and trammed to the plant where the cars are hauled up an incline and dumped into a large hopper. Some of the clay from the pit of the McKenzie plant (described below) has at times been mixed with the clay from the main pit although this was not being done at the time of the writer's visit.

At the plant the clay was passed through a granulator of the pug mill type and a double-roll disintegrator into large storage bins. From these bins the clay was fed to three units: One, consisting of a pug mill and a combination pug mill and auger-type brick machine, made side-cut face brick; another, consisting of a double-shaft pug mill and an auger-type brick machine made end-cut common brick; the third, consisting of a double-shaft pug mill and an auger-type tile machine, made structural tile.

The brick and tile were dried on pallets in an open-air drying shed or on cars in a 50-track waste-heat tunnel drier. They were fired to about 1800°F. in four 30-foot round down-draft kilns and two Haigh semi-continuous rectangular kilns 840 and 612 feet in length. These Haigh kilns are so arranged that each chamber is down-draft during the firing, but the fire progresses from one chamber to the next. Electric pyrometers and standard pyrometric cones were used with the round down-draft kilns to regulate the heat and to determine the end-point. The Haigh kilns were regulated by the amount of settling of the brick or tile. The face brick were flashed to improve the color. The capacity of the plant was about 200 tons of structural tile and 250,000 brick per day. The production of building brick was about evenly divided between end-cut common brick and side-cut face brick. The face brick had a good ring when struck together, were very uniform in size, and showed a good range of pleasing colors. The culls and second quality side-cut brick were sold for common brick. At the time of the writer's visit in 1927 another side-cut brick unit was being installed and plans were made for installing machinery for screening the clay for the face brick units after it had passed through the granulator and disintegrator. The company has also successfully experimented with the addition of small amounts of certain mineral oxides to the clay at intervals to give a wider range of colors in the face brick.

McKenzie Plant

The plant of the former McKenzie Brick Company is on the New Savannah Road about a mile south of Augusta. The clay pit is a short distance south of the plant adjoining the public road. The clay in this pit is said to average 18 to 22 feet in thickness and 32 feet was mined at one place. The clay resembles that of the other pits in the Augusta district, but is said to have somewhat different working properties. It is said to contain less sand and to be stiffer and less plastic than the clay from the main Merry Brothers pit, but it processes well in the plant and the fired products have good strength and color. The laboratory tests are given below on a 14-foot groove sample collected from the northwest corner of the pit near the public road. This sample appeared to contain more rather than less sand than the sample from the main Merry Brothers pit.

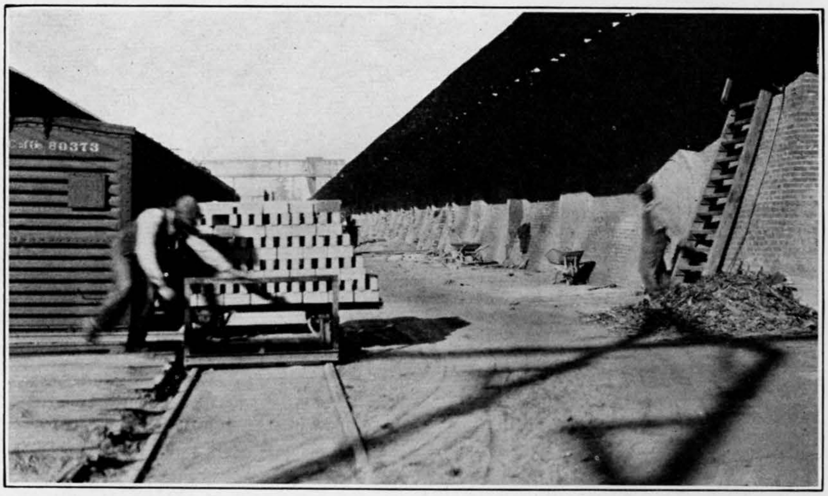
The continuity of the clay deposit is interrupted by several long narrow curving bodies of sand, probably old river channels. A short distance west of the New Savannah Road, not over 250 yards from the clay pits, is a deep gravel pit.

Laboratory tests on a 14-foot groove sample of blue-gray to brown alluvial clay from the McKenzie pit of the Merry Brothers Brick and Tile Company, Augusta, Richmond County.

Chemical Analysis:

Loss on ignition	7.66
Soda (Na_2O)	.34
Potash (K_2O)	.97
Lime (CaO)	.00
Magnesia (MgO)	.33
Alumina (Al_2O_3)	19.39
Ferric oxide (Fe_2O_3)	7.71
Titanium dioxide (TiO_2)	.99
Sulphur trioxide (SO_3)	.18
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	62.69
	100.26

A. OPEN-AIR DRYING SHEDS, MERRY BROTHERS BRICK AND TILE COMPANY, AUGUSTA, RICHMOND COUNTY.



B. HAIGH BRICK KILNS, MERRY BROTHERS BRICK AND TILE COMPANY, AUGUSTA, RICHMOND COUNTY.

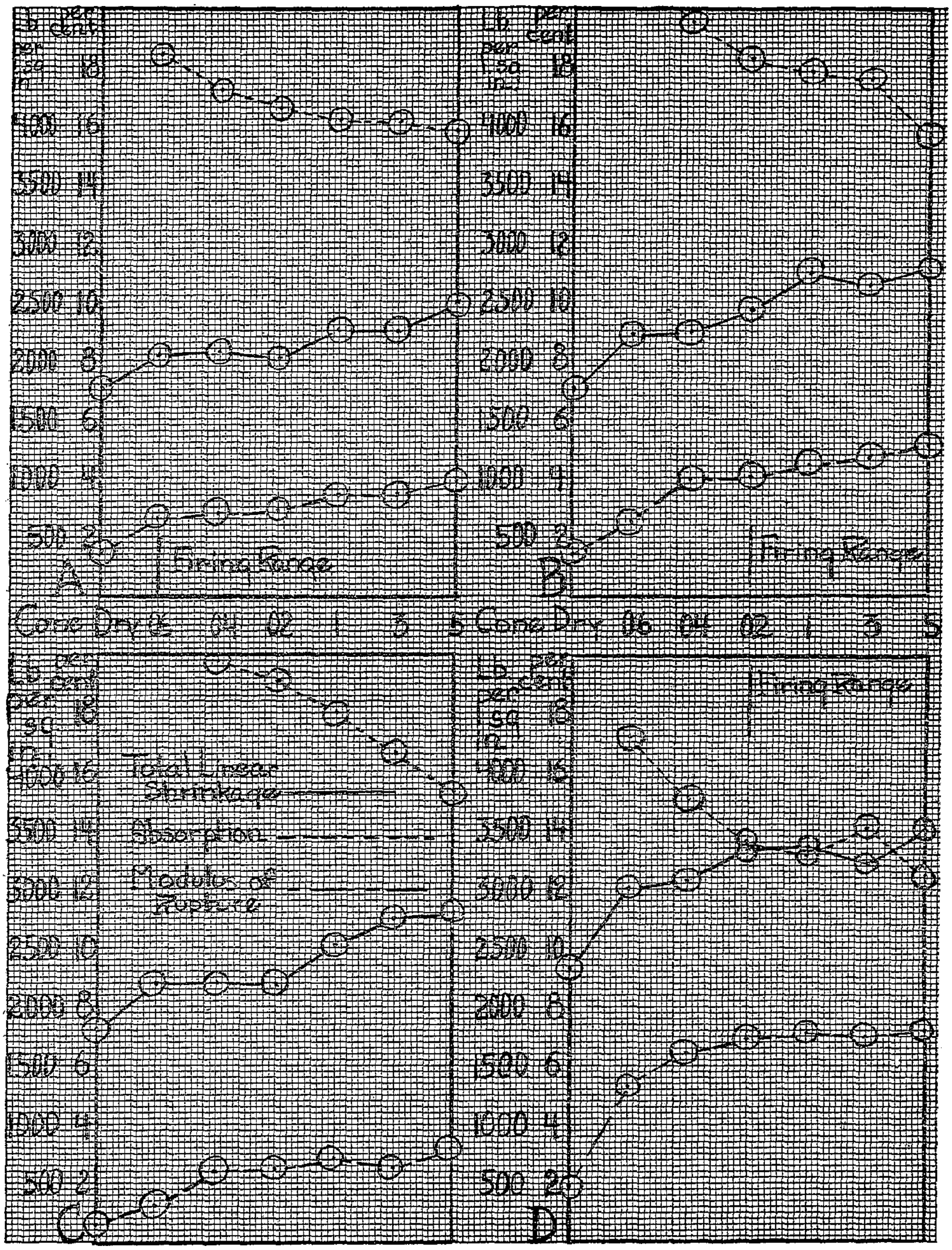


Figure 25. Graphs showing total linear shrinkage, absorption, and modulus of rupture of:

A. Alluvial clay from Merry Brothers Brick and Tile Company, Augusta, Richmond County.

B. Alluvial clay from the McKenzie Pit, Merry Brothers Brick and Tile Company, Augusta, Richmond County.

C. Residual and colluvial clay from the Arnold Brick Yard, two miles northeast of Thomasville, Thomas County.

D. Alluvial clay from the Bainbridge Brick Company, Bainbridge, Decatur County.

Ground Color: Light-brown.

Slaking: Rapid.

Plasticity: Fairly good, slightly "short" at first.

Molding Behavior: Good.

Drying Behavior: Rapid with little or no warpage.

Water of Plasticity: 30.3 per cent.

Green Modulus of Rupture: 338.1 pounds per square inch.

Linear Drying Shrinkage (based on plastic length): 7.0 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.1	8.9	21.9	625	Salmon (4YR-6/6)[b]	Very slight
04	2.3	9.0	19.5	994	Dark salmon (3YR-6/5)[b]	Very slight
02	3.2	9.8	18.2	1008	Light red (R-YR-5/5)[b]	Very slight
1	4.1	11.0	17.8	1122	Medium red (4YR-5/5)[b]	Very slight
3	3.7	10.6	17.6	1158	Good red (R-YR-5/5)[b]	Some
5	4.8	11.2	15.6	1292	Good red (R-YR-5/4)[b]	Slight

[a]See graph, Figure 25-B, page 323.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 03–5 and possibly higher.

The clay is mined by a drag-line excavator and is loaded into side-dump tram cars for haulage to the plant. At the plant the clay is passed through a double-roll disintegrator into a pug mill where water is added and the clay is tempered. From this the clay passes to a combination pug mill and auger-type brick machine which extrudes a column of clay that is automatically cut off into end-cut brick. The brick are dried on pallets in open-air drying sheds (used principally during the summer months) or on cars in a 20-track steam-heated tunnel drier. They are fired to about 1850°F. in 12 30-foot round down-draft kilns.

The capacity of the plant is about 80,000 common brick per day.

ELECTRIC CITY BRICK COMPANY

Headquarters and Plant: Augusta, Georgia.
W. D. Merry, President.
Sales Agent: Merry Brothers Brick and Tile Company, Augusta.

The Electric City Brick Company, established in 1912, is on Gwinnett Street near the Merry Brothers plant. The clay pits are about three-eighths of a mile south of the plant.

The clay pits show a deposit of alluvial clay ranging from an average thickness of 10 feet under 2 feet of sandy overburden at the north end to a thickness of 12 or 15 feet with less overburden at the south or swamp end. The clay has a gray-blue to brown color and resembles that in the other pits in the district. That at the south end is said to contain less sand than that of the north end of the deposit. The clay is mined by a steam drag-line excavator and trammed to the plant in side-dump cars. Some of the sandy overburden from the north end of the deposit is mixed with the less sandy clay from the south end.

At the plant the clay is fed to a large pug mill where water is added and the clay is tempered and pugged. The plastic clay is fed to an auger-type brick machine which extrudes a continuous column of clay which is automatically cut off into end-cut brick. The brick are either dried on pallets in open-air drying sheds or on cars in a 16-track waste-heat tunnel drier. They are fired to about 1800°F. in 12 32-foot round down-draft kilns. Part of the kilns are on individual stacks. The others are operated by the Minter system with induced draft. The capacity of the plant is about 80,000 common brick per day.

ALLUVIAL AND RESIDUAL CLAYS OF SOUTH GEORGIA

The flood plains and second bottoms of the larger streams of South Georgia are often underlain by deposits of alluvial clay. The deposits are usually thin and pockety and are usually suitable only for the manufacture of a poor grade of common brick. Veatch[1] in 1909 recorded the manufacture of building brick at the following places: Douglas, Coffee County; Bainbridge, Decatur County; Albany, Dougherty County; Lumber City, Jeff Davis County; Dublin, Laurens County; Townsend and Darien Junction, McIntosh County; Mt. Vernon, Montgomery County; Hawkinsville, Pulaski County; Omaha, Stewart County; Thomasville, Thomas County; and Odessa, Wayne County.

The only brick plants to survive of those listed above are the plants at Bainbridge and Thomasville, described below, and one at Omaha not visited by the writer. Common brick were made at Albany until a few years ago. At the time of the writer's visit in 1927 the last plant had just been dismantled. At that time sand-lime brick were being manufactured in Albany, but the company has since gone into bankruptcy.

Roofing tile were for years made by the Ludowici Roofing Tile Company at Ludowici in Long County, using an alluvial clay from a terrace deposit along the Altamaha River, but the property is now abandoned.

Three samples of undeveloped river terrace alluvial clays were collected by the writer; one from the Flint River at Daphne in Crisp County, and the other two from the Alapaha River one mile west of Stockton in Lanier County. The laboratory tests on these samples proved them to be too sandy to be of value for the manufacture of even common building brick.

Four samples of plastic surface or swamp clays were collected; two from Brooks and two from Lowndes counties. The laboratory tests on these clays showed them to be of the "pipe clay" type, and to have a very high drying shrinkage with resulting warpage and cracking, and a very low fired strength. The addition of sandy material to cut down the shrinkage and warpage would increase the absorption too much. It is possible that some of the clay could be calcined until the greater part of the shrinkage had taken place and then mixed with enough plastic clay to form the brick, and thus manufacture a building brick. This method would add to the cost of manufacture and would only be warranted in a region distant from a source of building brick. It is very doubtful if the freight rate on Macon brick to this part of South Georgia would be sufficiently high to justify this additional cost of manufacture of local brick.

[1]Veatch, J. O. Second report on the clay deposits of Georgia: Georgia Geol. Survey Bull. 18, 1909.

ARNOLD BRICK YARD

Headquarters and Plant: Thomasville, Thomas County, Georgia.
Adam Arnold, Owner and Manager.

The Arnold Brick Yard is on the Atlanta, Birmingham and Coast Railroad two miles northeast of Thomasville. Common brick are manufactured from a deposit of sedimentary clay in the Alum Bluff or Hawthorn formation of Miocene age; the deposit, according to Veatch[1], having been somewhat altered from its original condition by having at one time been covered by a pond.

When visted by the writer in 1927 the deposit was 10 to 12 feet in thickness. The clay varied from massive white clay resembling sedimentary kaolin to plastic light-gray clay like "pipe clay" or impure fullers earth. Much of it is stained red, brown, and yellow and there are some deep red and purplish-red spots. Some of the clay is sandy and there are frequent sand partings between layers of clay. The laboratory tests are given below on a grab sample of the clay. The deposit is overlain by a foot and a half or two feet of sand and loam overburden, and is underlain by yellow sand and some very sandy clay.

Laboratory tests on a grab sample of residual or sedimentary clay from the pit of the Arnold Brick Yard, two miles northeast of Thomasville, Thomas County.

Chemical Analysis:

Loss on ignition	8.00
Soda (Na_2O)	.20
Potash (K_2O)	.10
Lime (CaO)	.00
Magnesia (MgO)	.10
Alumina (Al_2O_3)	17.40
Ferric oxide (Fe_2O_3)	3.22
Manganous oxide (MnO)	.16
Titanium dioxide (TiO_2)	.72
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	3.61
Silica (SiO_2)	66.51
	100.02

Ground Color: Very light brownish-gray.
Slaking: Rapid.
Plasticity: Good, very sticky.
Molding Behavior: Good.
Drying Behavior: Fairly rapid. Little or no warpage.
Water of Plasticity: 26.5 per cent.
Green Modulus of Rupture: 143.4 pounds per square inch.
Linear Drying Shrinkage (based on plastic length): 7.2 per cent.

[1]Veatch, J. O., Op. cit., p. 363.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) per cent	Total Linear Shrinkage (based on plastic length)[a] per cent	Absorption[a] per cent	Modulus of Rupture[a] Lb. per sq. in.	Color	Warpage
06	1.6	8.8	21.5	311	Light pink (4YR-7/4)[b]	Slight
04	2.0	8.8	19.8	582	Light tan (YR-Y-8/4)[b]	Slight
02	2.0	8.8	19.1	622	Pinkish-cream (9YR-8/5)[b]	Slight
1	3.0	10.1	18.0	684	Light pinkish-tan (7YR-8/4)[b]	Slight
3	3.4	11.0	16.7	638	Light salmon (8YR-7/4)[b]	Some
5	4.7	11.2	15.3	808	Light salmon (YR-Y-7/3)[b]	Some

[a]See graph, Figure 25-C, page 323.
[b]Color notation according to the Munsell system, see page 23.

Remarks: Three of the test bars fired to cone 3 were badly checked.

Firing Range: Above cone 5.

The above tests indicate that this sample was probably not representative of the clay used to manufacture brick. The inclusion of more of the surface material would probably have darkened the color and lowered the firing range.

Plant

The clay, which is mined by pick and shovel from several places in the pit, is loaded into small cars and hoisted up an incline to the plant. At the plant it is passed through a double smooth-roll granulator into a pug mill where water is added and the clay is tempered and pugged to a plastic condition. The plastic clay is fed to an auger-type brick machine which extrudes a continuous column of clay that is automatically cut off into end-cut brick. The brick are hacked to a brickyard wheel barrow and carried to open-air drying sheds. The dried brick are fired in temporary up-draft rectangular scove kilns, about 160,000 brick per kiln. The firing takes about eight days, of which about four and a half days is the water-smoking period (see page 28). The firing is regulated and the end-point determined by the amount of settling of the brick.

The capacity of the plant is between 5,000 and 10,000 common brick per day. The brick seen by the writer were a light cherry-red in color and showed some white spots and some fused black spots that at places caused blisters. The brick all showed considerable checking.

BAINBRIDGE BRICK COMPANY

The Bainbridge Brick Company, a subsidiary of the Columbus Brick and Tile Company (see page 294), is on the Flint River just west of Bainbridge, Decatur County. Common building brick are made from a deposit of alluvial clay under the flood-plain of the Flint River.

The deposit of alluvial clay underlies the second bottom or terrace which is only a little above the river so that the pits are flooded in high water. The deposit is 100 to 150 yards wide and averages 10 feet in thickness. It is underlain by water-bearing sand and gravel. The clay is blue-gray to brown in color, somewhat sandy and is plastic when wet but dries very hard and stiff. The laboratory tests are given below on a grab sample from the stock pile at the plant.

Laboratory tests on a sample of gray-blue to brown alluvial clay from the Bainbridge Brick Company, Bainbridge, Decatur County.

Chemical Analysis:

Loss on ignition	8.52
Soda (Na_2O)	.61
Potash (K_2O)	.27
Lime (CaO)	.42
Magnesia (MgO)	.15
Alumina (Al_2O_3)	19.85
Ferric oxide (Fe_2O_3)	7.40
Manganous oxide (MnO)	trace
Titanium dioxide (TiO_2)	.94
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.42
Silica (SiO_2)	62.34
	100.92

Ground Color: Light grayish-brown.

Slaking: Rapid.

Plasticity: Good.

Molding Behavior: Excellent.

Drying Behavior: Fairly rapid, with little or no warpage.

Water of Plasticity: 31.4 per cent.

Green Modulus of Rupture: 490.3 pounds per square inch.

Linear Firing Shrinkage (based on plastic length): 9.3 per cent.

Firing Tests:

Cone	Linear Firing Shrinkage (based on dry length) *per cent*	Total Linear Shrinkage (based on plastic length)[a] *per cent*	Absorption[a] *per cent*	Modulus of Rupture[a] *Lb. per sq. in.*	Color	Warpage
06	2.8	12.0	17.2	1330	Medium salmon (YR-7/5)[b]	Little or none
04	3.6	12.3	15.1	1611	Salmon (4YR-6/6)[b]	Slight
02	4.6	13.4	13.5	1732	Dark salmon (4YR-6/5)[b]	Little or none
1	4.4	13.4	13.2	1772	Light red (4YR-6/5)[b]	Little or none
3	4.0	12.9	14.1	1738	Light red (3YR-5/5)[b]	Little or none
5	5.1	14.0	12.4	1795	Light red (3YR-5/5)[b]	Slight

[a]See graph, Figure 25-D, page 323.
[b]Color notation according to the Munsell system, see page 23.

Firing Range: Cone 02–5 and higher. Commercial kiln: Cone 03–5 and possibly higher.

The clay is mined by pick and shovel and loaded into small mine cars which are hauled up an incline to the plant. At the plant the clay is fed from a storage pile into a single-shaft pug mill where water is added and the clay is tempered and pugged to a plastic condition. The plastic clay is fed to an auger-type brick machine which extrudes it as a continuous column which is automatically cut off into end-cut brick. The brick are hacked onto steel drying cars and run under open-air drying sheds. The dried brick are fired in two 30-foot round down-draft kilns, using electrical pyrometers to regulate the firing and to determine the end-point. The capacity of the plant is about 7,000 common brick per day.

FUTURE OF THE INDUSTRY

We have seen in the previous pages of this report that Georgia is well blessed with raw materials for the manufacture of heavy clay products.

The shales of Northwest Georgia are suitable for the manufacture of excellent quality face brick and other heavy clay products. The Floyd shales of Floyd County probably process and fire the easiest of these shales, although their fired colors are not always satisfactory. The Red Mountain shales of Walker County and the Conasauga shales of Whitfield, Murray, Gordon, Floyd, and Bartow counties are somewhat slower slaking, but if handled properly make an equally satisfactory product.

The alluvial clays along the principal streams just below the Fall Line in Middle Georgia are excellent for the manufacture of medium-fired structural tile, building brick, and other heavy clay products. The writer has not been able to describe many undeveloped deposits, yet there is no reason to suppose that the deposits are even approaching exhaustion.

A convenient supply of suitable raw material is, however, but one of the requisites necessary for a heavy clay products industry. A nearby market for the product is of equal importance. This can perhaps be best illustrated by a more detailed account of the history of the building brick industry of Georgia during the last few years than was given in the introductory section of this report.

The natural market of the building brick industry of Georgia is Georgia, Florida, and adjoining parts of South Carolina and Alabama. When, therefore, in 1923 and 1924 the real estate boom of Florida began to acquire its momentum, the building brick industry of Georgia, already flourishing, could not supply the demand. Any brick, no matter how poor, could be sold at a fancy price. Later, as the shortage of freight cars placed an embargo on all except food products, the price was doubled. The story is told of three car-loads of northern face brick needed to finish a Miami office building that were shipped in refrigerator cars, several times iced in transit, and had to be "defrosted" before they could be unloaded.

The result was that practically every brick manufacturer in Georgia increased the capacity of his plant. All supposed that the Florida business was permanent. Thus the building brick industry of Georgia was expanded to a capacity that may safely be estimated at twice the demand of normal times. Then came the present depression with building at a minimum. For the last year or two plants have either been completely shut down with yards fully stocked or have run on the smallest production possible to hold an organization together.

Emergency measures were necessary. The Southern Brick and Tile Company was organized in 1930 as a consolidation of the Bibb Brick Company and the Cherokee Clay Products Company of Macon, the Georgia-Carolina Brick Company of Augusta, and the Columbus Brick and Tile Company of Columbus. Sales forces were combined and orders were prorated to the plants still in operation. But even these measures were evidently not sufficient, for the Southern Brick and Tile Company was dissolved on August 15, 1931, the separate companies again assuming control of their plants.

The picture is equally dark for the other heavy clay products industries. One might ask why the Georgia Geological Survey should investigate the raw materials for an industry already showing such an overproduction. It is because the Survey believes that now is the time to gather information ready to aid the industry in the better days that are surely coming. The Georgia Geological Survey has abundant faith that the next two or three decades will see a steady and rapid industrial expansion of the South. This will be not only in textiles which have led in the past, but in all products that can be manufactured cheaper in the South than in the other sections of the country because of nearness of raw materials, low cost of manufacture, and more ideal climatic conditions. This industrial expansion will of necessity increase the market for all heavy clay products beyond the capacity of the present plants and make room for new plants using some of the raw materials described in this report.

In the meantime the attention of the heavy clay product industry in Georgia should be turned towards lowering production costs, and improving the quality and expanding the possible market for their wares. Scientific instead of "rule-of-thumb" methods of processing and firing often result in improved products and less culls at a lower manufacturing cost. The building brick manufacturers, instead of hinging their sales talk on the relative merits of alluvial clay and shale brick, should unite against their common enemies; building stone, Portland cement, and lumber. The market of the small home builder should be enlarged by propaganda pointing out the advantages of face brick in beauty, cost of up-keep and insurance, and permanence; and by the use of free plans, specifications, and advice to home builders who cannot afford to hire an architect. Southern architects should be given an opportunity to use locally manufactured hand-made colonial bricks with which so many beautiful results have been obtained in the North and East. The public is often not aware of the relatively low cost of the greatly improved floor and roofing tile now manufactured. The shingle-type of roofing tile should be pushed for the style of houses not suited for the Latin-type of tile and now largely covered with composition roofs. The expenditure of an amount for advertising relatively equal to that spent yearly by the Portland cement or the building stone industry would work wonders with the heavy clay products industry.

Every heavy clay products manufacturer should ask himself the following questions:

1. Am I making the product best suited to my raw materials and the demands of the public?

2. Can I in any way improve my product in beauty, service or durability?

3. Can I lower my manufacturing costs without enlarging my capacity or cheapening my product?

4. How can I enlarge the market for my product?

The future of the heavy clay products industry in Georgia is bright in spite of the dark clouds at present. The raw materials are here for the company that makes a thorough study of the market for its product and carefully prospects and tests its deposit of clay or shale to make sure that the material is suited for the product and the market.

APPENDIX A

NOTES ON THE OCCURRENCE OF BENTONITE IN GEORGIA

Bentonite, a peculiar clay derived from the weathering of volcanic ash, was first identified in the Southeast in 1920 by W. A. Nelson[1], the deposits occurring in the Ordovician limestones of Middle Tennessee. Later similar clays were discovered at the same horizon in Alabama, Kentucky, Georgia, and, according to Nelson[2], Virginia.

The bentonite in Georgia occurs as a bed 1 to 20 feet in thickness in limestone of Black River (Lowville) or basal Trenton age of the series of Ordovician limestones mapped on the geologic map facing page 66 as the Chickamauga limestone. The clay varies from greenish-cream to drab in color and from waxy to crumbly and "short". It usually has a sticky plasticity. When the dry clay is placed in an excess of water it usually slakes rapidly with a considerable increase in volume. If the slaked clay is blunged to form a slip, the water remains milky for hours, indicating a large percentage of colloidal material. It is of interest chiefly because of its origin.

During the Middle Ordovician, Northwest Georgia, northern Alabama, and a large part of Tennessee and Kentucky were covered by a shallow continental sea, bordered on the east by a continent which probably contained a range of mountains. One of these mountains, the location of which is very uncertain, erupted with explosive violence, throwing up millions of tons of very fine, light volcanic ash of a glassy nature. This was probably carried for miles by the wind, settled down on the ocean over a wide area, and soon settled to the bottom of the sea. Here the alteration from fine glass particles to a clay probably took place before the material was covered with limestone. The further history of the deposit, including the deposition of thousands of feet of overlying sediments, the elevation above the ocean and deformation of the beds that followed the close of the Paleozoic era, and the erosion to the present topography, has all been described on pages 50–53.

Spence[3] lists the following possible uses for bentonite: As an absorbent; as a retarding agent in gypsum plasters; as a suspending agent in pottery glazes; for dewatering petroleum, gasoline and different

[1]Nelson, W. A., Notes on a volcanic ash bed in the Ordovician of Middle Tennessee: Tennessee Geol. Survey Bull. 25, pp. 46–48, 1921.
Volcanic ash bed in the Ordovician of Tennessee, Kentucky, and Alabama: Geol. Soc. Amer. Bull., vol. 33, no. 3, pp. 605–615, 1922.

[2]Nelson, W. A., Volcanic ash in the Ordovician of Virginia: Geol. Soc. Amer., Bull., vol. 37, no. 1, pp. 149–150 (abst.), 1926; Pan-Am. Geologist, vol. 45, no. 1, p. 96, 1926.

[3]Spence, H. S., Bentonite; Feldspar: Canada, Mines Branch, Inves. Min. Resources and the Mining Industry, 1923, pp. 1–3, 1924.

oils; in the dye industry as a mordant and as a base for lake colors; as an accelerator and stabilizer in emulsions made up of water and various oils, fats and resins; for fertilizer filler; in foundry work as a bond for sand; as a sticking or spreading agent in insecticidal sprays and dusts; as a filler in paints; as a substitute for clay in pencils and crayons; for pharmaceutical uses and in cosmetics; in soaps; and as a water-softening agent. The demand for bentonite is at present very limited.

A few outcrops of bentonite in Northwest Georgia are described below. The material weathers easily and is usually only seen in recent excavations or road cuts.

DADE COUNTY

JOHNSONS CROOK

An outcrop of the bentonite crosses the Rising Fawn Furnace to Sulphur Springs public road on the Wesley Forrester (Rising Fawn) property a quarter of a mile south of Cave Springs Church and a mile south of Rising Fawn Furnace. The ditch beside the road shows two and a half feet of soft plastic greenish-drab clay, overlying six inches of a similar but very sandy clay and then thin-bedded argillaceous limestone. The beds are striking N. 55° E. and are dipping about 15° to the northwest. The beds immediately overlying the clay are not showing, but more thin-bedded limestone is showing just to the south. The chemical analysis is given below of a groove sample of the clay.

Chemical analysis of a groove sample of a two and a half foot bed of soft plastic greenish-drab clay or bentonite from the Wesley Forrester property in Johnsons Crook, Dade County.

Loss on ignition	12.61
Soda (Na_2O)	1.37
Potash (K_2O)	1.42
Lime (CaO)	7.59
Magnesia (MgO)	trace
Alumina (Al_2O_3)	15.45
Ferric oxide (Fe_2O_3)	1.94
Titanium dioxide (TiO_2)	.27
Sulphur trioxide (SO_3)	.00
Phosphorous pentoxide (P_2O_5)	.12
Silica (SiO_2)	59.77
	100.54

TRENTON

The ditches and cuts of the public road to White Oak Gap, half a mile west of the court house at Trenton expose about 20 feet of bentonite between layers of the Chickamauga limestone. The beds are dipping about 20° to the west and the apparent thickness may have been somewhat increased by slumping. The middle of the outcrop is massive drab clay having a speckled appearance from flakes of golden colored mica. The edges of the deposit are lighter colored and are more weathered on the surface. The following chemical analysis is of a grab sample of both types of the material.

Chemical analysis of a sample of greenish-cream to greenish drab plastic clay or bentonite from a 20 foot outcrop between limestone layers on the White Oak Gap road, half a mile west of Trenton, Dade County.

Loss on ignition	8.51
Soda (Na_2O)	2.24
Potash (K_2O)	2.46
Lime (CaO)	4.31
Magnesia (MgO)	trace
Alumina (Al_2O_3)	18.75
Ferric oxide (Fe_2O_3)	3.46
Titanium dioxide (TiO_2)	.28
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	.07
Silica (SiO_2)	57.01
	97.09

The land south of the road belongs to Mrs. George Gifford (Trenton) North of the road are the S. Jeffrey (Trenton) and Mrs. Nellie Fry (Trenton) properties.

WALKER COUNTY

HIGH POINT STATION

Soft plastic clay, probably bentonite, is exposed in a gully on the J. J. Parrish (Alton Park, Tenn., Rt. 3) property just west of the Chattanooga Valley public road and the Tennessee, Alabama and Georgia Railroad, one and a half miles north of High Point Station. The beds are striking about N. 10° C. and are dipping about 35° to the west. The following section shows the beds exposed from top to bottom or west to east.

Section showing beds of bentonite clay exposed in the Chickamauga limestone on the J. J. Parrish property, one and a half miles north of High Point Station, Walker County.

		Thickness	
		Feet	Inches
7.	Reddish-brown somewhat sandy clay grading into bed below	2	0
6.	White cheesy clay full of golden mica flalkes	2	0
5.	Light-gray flint rock	0	1
4.	White finely crystalline limestone	1	0
3.	Soft waxy olive-green clay	7	0
2.	Greenish-gray limestone, slightly lighter colored than clay below	1	0
1.	Greenish-cream colored clay, soft and weathered in places, waxy and with a somewhat shaly structure at others. Resembles fullers earth	10	0
	Total	23	1

A grab sample, chemical analysis given below, was collected from beds (1) and (3) of the section above.

Chemical analysis of greenish waxy bentonite from the J. J. Parrish property, one and a half miles north of High Point Station, Walker County.

Loss on ignition	5.80
Soda (Na_2O)	.82
Potash (K_2O)	1.94
Lime (CaO)	.14
Magnesia (MgO)	.27
Alumina (Al_2O_3)	21.80
Ferric oxide (Fe_2O_3)	7.04
Titanium dioxide (TiO_2)	.74
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	61.52
	100.07

The bentonite bed is said to extend to the north across the Mrs. W. W. Scott property described on page 155.

COOPERS HEIGHTS

An outcrop beside the Coopers Gap road on the Strickland property, half a mile west of Coopers Heights Station on the Tennessee, Alabama and Georgia Railroad, shows two to three feet of soft greenish-drab cheesy clay overlain by eighteen inches to two feet of speckled white or light green mealy clay full of golden mica flakes, much like that in bed (6) of the section on the Parrish property given above. This is in Land Lot 94, 11th District, 4th Section. The chemical analysis is given below of a grab sample of the soft greenish-drab bentonite.

Chemical analysis of a sample of soft greenish-drab bentonite from the Strickland property, half a mile west of Coopers Heights Station on the Coopers Gap road, Walker County.

Loss on ignition	4.70
Soda (Na_2O)	.91
Potash (K_2O)	1.68
Lime (CaO)	.16
Magnesia (MgO)	.26
Alumina (Al_2O_3)	14.84
Ferric oxide (Fe_2O_3)	4.98
Titanium dioxide (TiO_2)	.73
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	1.04
Silica (SiO_2)	70.57
	99.87

CASSANDRA

An outcrop beside the road on the G. P. Baker (Kensington, Rt. 2) property just west of the Chattanooga Valley Road and a half a mile north of Cassandra shows about five feet of soft mealy greenish-drab clay full of mica. This clay or bentonite is overlying a dark-gray to drab limestone with an inch of white chert between the limestone and the clay. The beds are striking N. 25° E. and dipping 35° to the west. No limestone is showing above the bentonite, the ditches of the road showing a soft and much weathered white, gray and red clay that did not have the sticky plasticity of the bentonite. Somewhat more weathered outcrops of the bentonite are showing a quarter of a mile to the north. The deposit crosses Land Lots 131 and 158, 11th District, 4th Section. The following chemical analysis is from a grab sample of the bentonite from both outcrops.

Chemical analysis of soft mealy greenish-drab bentonite from the G. B. Baker property, half a mile north of Cassandra, Walker County.

Loss on ignition	6.06
Soda (Na_2O)	3.09
Potash (K_2O)	1.96
Lime (CaO)	.37
Magnesia (MgO)	.04
Alumina (Al_2O_3)	27.93
Ferric oxide (Fe_2O_3)	4.97
Titanium dioxide (TiO_2)	.74
Sulphur trioxide (SO_3)	trace
Phosphorus pentoxide (P_2O_5)	.14
Silica (SiO_2)	54.69
	99.99

CHATTOOGA COUNTY

DUCK CREEK

A small specimen of greenish-drab bentonite, rather mealy but with a sticky plasticity, was recently sent in to the Georgia Geological Survey from the B. A. Chastain property, Land Lot 55, 13th District, 4th Section, in Chattooga County just south of the Walker County Line. This is about one and a half miles west of Duck Creek and one mile south of Center Post Station on the Tennessee, Alabama and Georgia Railroad.

DIRTSELLER MOUNTAIN

A deposit of light green micaceous clay, later identified as bentonite, on the B. F. Gilmer property about three miles west of Lyerly at the northwest end of Dirtseller Mountain was described by Veatch[1] as follows:

"The following are tests on a sample of light green, micaceous altered shale from the property of B. F. Gilmer, located about 3 miles west of Lyerly at the northwest end of Dirtseller Mountain. Stratigraphically, the clay lies near the base

[1]Veatch, J. O., Second report on the clay deposits of Georgia: Georgia Geol Survey, Bull. 18, pp. 391–392, 1909.

of the Rockwood formation. [Error. Is in the Chickamauga limestone of the Ordovician]. A small quantity of this clay has been mined and shipped, but the writer was unable to find out for what purpose it was used. The clay doubtless occurs in large quantity, though it is rather inaccessible. It showed an air shrinkage of 8.4 per cent; at cone 07, it burned salmon, and to a dense body, was not vitrified; at cone 5, it was melted into a dark greenish glass.

"The following is a chemical analysis of the Gilmer clay:

Moisture at 100°C.	3.288
Loss on ignition	6.030
Silica	53.083
Alumina	23.420
Ferric oxide	2.667
Lime	trace
Magnesia	3.236
Manganous oxide	trace
Sodium oxide	.780
Potassium oxide	6.990
Titanium dioxide	.368
	99.862

"The clay contains a high percentage of potash, 6.99 percent., and the total fluxing impurities is 13.673 percent., and it would be expected to have a low fusing point."

The following chemical analysis is of a sample of bentonite from the old pit collected in 1924 by Col. Wesley Schropshire of Summerville.

Chemical analysis of bentonite from the Gilmer property at the foot of Dirtseller Mountain, Chattooga County.

Moisture at 100°C.	4.26
Loss on ignition	5.48
Soda (Na_2O)	.57
Potash (K_2O)	3.72
Lime (CaO)	.00
Magnesia (MgO)	1.20
Alumina (Al_2O_3)	28.00
Ferric oxide (Fe_2O_3)	1.66
Ferrous oxide (FeO)	.49
Manganous oxide (MnO)	.00
Titanium dioxide (TiO_2)	.72
Sulphur trioxide (SO_3)	.00
Phosphorus pentoxide (P_2O_5)	trace
Silica (SiO_2)	53.72
	99.82

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