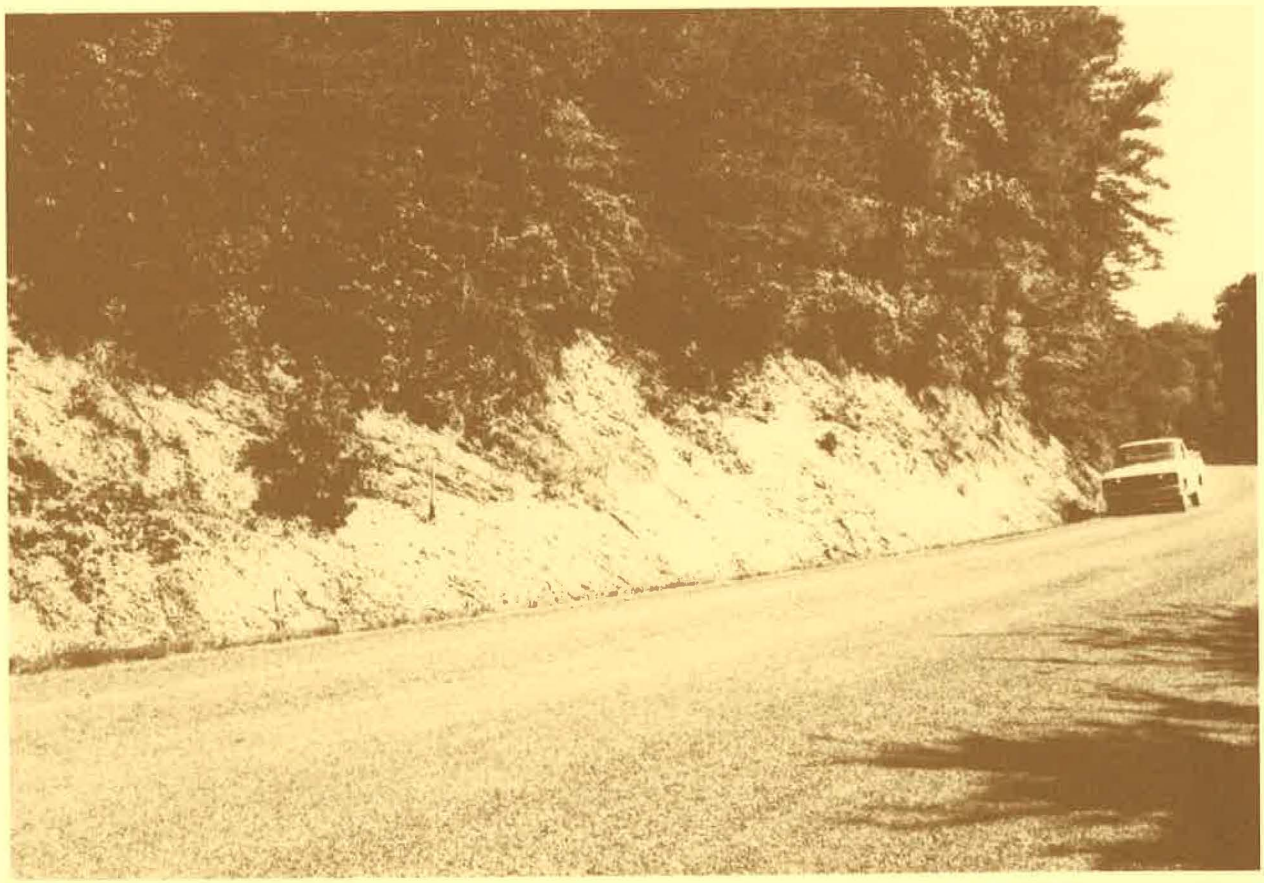
CERAMIC AND STRUCTURAL CLAYS, AND SHALES OF WHITFIELD COUNTY, GEORGIA

BRUCE J. O'CONNOR



DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

INFORMATION CIRCULAR 73

Cover Photo:
Typical exposure of Conasauga Group shales (Cambrian) along the east side of Brown Rd., 1 mile southeast of Deep Spring Church and Beaverdale Rd., approximately 9 miles northeast of Dalton and approximately 3 $^{1}/_{3}$ miles due south of sample location Wkr. 69-1.

CERAMIC AND STRUCTURAL CLAYS AND SHALES OF WHITFIELD COUNTY, GEORGIA

By

Bruce J. O'Connor
Principal Geologist

Information Circular 73

GEORGIA DEPARTMENT OF NATURAL RESOURCES
J. Leonard Ledbetter, Commissioner

ENVIRONMENTAL PROTECTION DIVISION
Harold F. Reheis, Assistant Director

GEORGIA GEOLOGIC SURVEY
William H. McLemore, State Geologist

ATLANTA, GEORGIA
1988

In memory of Dr. James W. Smith (1934-1988), who worked for the Georgia Department of Mines, Mining and Geology (c. 1966-1969) and who collected many of the northwestern Georgia clay and shale samples reported in this series of Information Circulars.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES

INTRODUCTION

This report presents a compilation of all available published and unpublished ceramic firing tests and related analytical data on samples from Whitfield County, Georgia. It provides information on mined and/or undeveloped clays, shales and related materials; and is intended for use by geologists, engineers and members of the general public. The report should aid in the exploration for deposits of ceramic raw material with economic potential for future development. This information may also be of use to those who wish to obtain information on the potential use of particular deposits at specific locations.

Tests by the U.S. Bureau of Mines, subsequently referred to as USBM, were performed by the Norris Metallurgy Research Laboratory, Norris, Tennessee and the Tuscaloosa Research Center, Tuscaloosa, Alabama under cooperative agreements with the Georgia Geologic Survey and its predecessors (i.e., the Earth and Water Division of the Ga. Department of Natural Resources; the Department of Mines, Mining and Geology; and the Geological Survey of Georgia). Many of the firing tests were performed on samples collected by former staff members of the Georgia Geologic Survey (and its predecessors) during several uncompleted and unpublished studies. These include work by Bentley (1964), Smith (1968?) and Tadkod (1980). Additional unpublished data presented in this compilation include work by TVA (see Butts and Gildersleeve, 1948, p. 124 and 125). Published data include studies by the following authors: Veatch (1909, p. 272 to 388), Smith (1931, p. 173 to 193), and Hollenbeck and Tyrrell (1969, p. 18 to 21).

Regardless of the source, all of the ceramic firing testing data presented in this report are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design. They do not preclude the use of the materials in mixes (Liles and Heystek, 1977, p. 5).

ACKNOWLEDGEMENTS

The author gratefully acknowledges the help of many individuals during the preparation of this report and the work of many who contributed to the earlier, unpublished studies included here. The cooperative work of the U.S. Bureau of Mines forms the main data base of this study. During the last several years Robert D. Thomson, Chief of the Eastern Field Operations Center, Pittsburgh, Pennsylvania, was responsible for administering the funding of costs incurred by the USBM. Others in that office who helped coordinate the program were Charles T. Chislaghi and Bradford B. Williams. Since 1966 M.E. Tyrrell, H. Heystek, and A.V. Petty, Ceramic Engineers, and Kenneth J. Liles, Research Chemist, planned and supervised the test work done at the USBM Tuscaloosa Research Center in Tuscaloosa, Alabama. Prior to 1966 this test work was supervised by ceramists H. Wilson, G.S. Skinner, T.A. Klinefelter, H.P. Hamlin and M.V. Denny at the former Norris Metallurgy Research Laboratory in Norris, Tennessee. Tests by the Tennessee Valley Authority were conducted under the supervision of H.S. Rankin and M.K. Banks at the Mineral Research Laboratory on the campus of North Carolina State College, Asheville, North Carolina, using samples collected by S.D. Broadhurst. Additional tests were conducted by professors W.C. Hansard, and L. Mitchell at the Department of Ceramic Engineering, Georgia Institute of Technology, Atlanta, Georgia. The majority of the unpublished tests were performed on samples collected by former staff geologists of the Georgia Geologic Survey, predominantly by J.W. Smith, A.S. Furcron, R.D. Bentley, N.K. Olsen, D. Ray, M.A. Tadkod, and G. Peyton, assisted by C.W. Cressler of the U.S. Geological Survey. N.K. Olsen and C.W. Cressler also have

provided the author with valuable advice and suggestions regarding sample locations and past studies. The advice and encouragement of my colleagues on the staff of the Georgia Geologic Survey are greatly appreciated. However, the contents of this report and any errors of omission or commission therein are the sole responsibility of the author.

LOCATION OF STUDY AREA

Whitfield County is located at the northeastern corner of the Valley and Ridge province of northwest Georgia (Fig. 1). No companies are currently mining clay or shale in the county, and only a few operations have been active here in the past (Table 1). The most abundant ceramic raw materials in the county are the shales and residual clays derived from the Conasauga Group; however, other units such as the Rome Formation, the Red Mountain Formation, and the Floyd Shale, as well as residual clays of the Knox Group, are locally well developed. The general nature of these and other geologic units which occur in the county are summarized on Table 2.

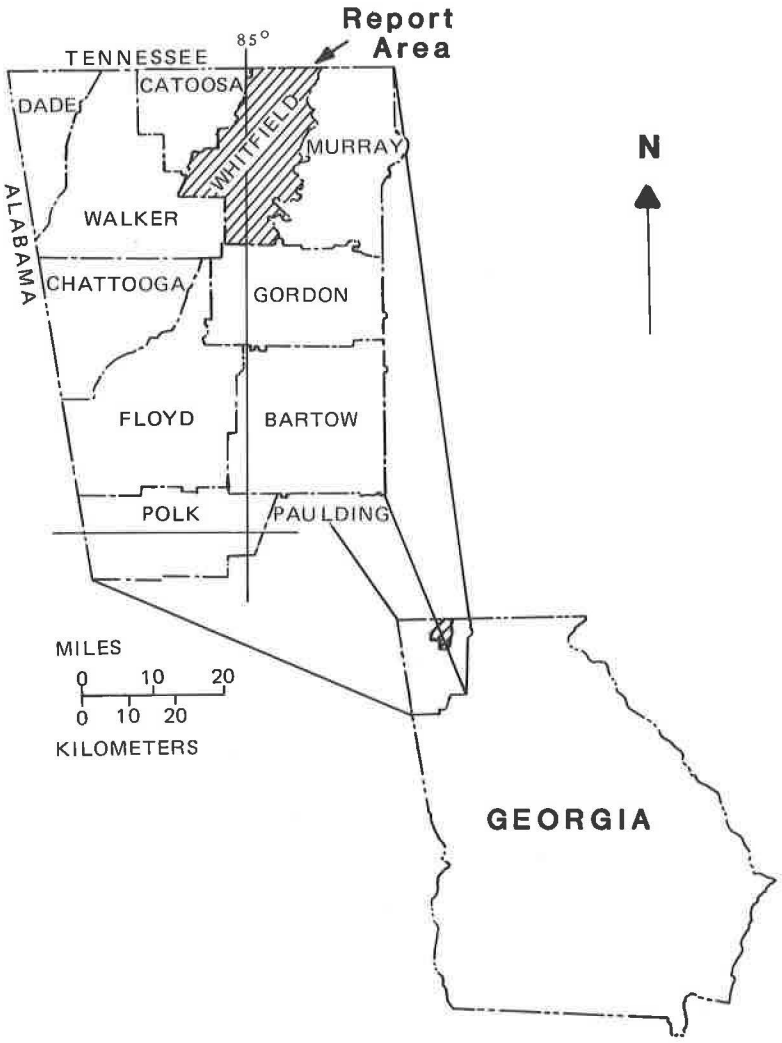


FIGURE 1

LOCATION OF WHITFIELD COUNTY REPORT AREA

(after Cressler, and others, 1976)

TABLE 1

Summary of 20th Century Clay and Shale Mines and Companies in Whitfield County, Georgia

Cohutta Talc Co. (1906), Dalton; micaceous clay (or Murray Co.?) Ceramic test: Wf. 45-1.

Dalton Brick & Tile Co. (1924), Dalton plant and pits: Face brick from Conasauga Group shale. Ceramic and other tests: Wf. 31S-39 and Wf. 52-1 & 2 (Smith, 1931, No. 39, p. 181; Butts and Gildersleve, 1948, No. 112; Cribb, 1953; Spalvins, 1969, p. 53; Munyan, 1957, p. 102 & 103).

Unknown ? (Pottery), 5 miles south of LaFayette, several years prior to 1909 (Veatch, 1909, p. 374).

NOTE:

The majority of the information for the companies listed above was taken from the Mining Directories (Circular 2, 1st to 18th editions) published by the Georgia Geologic Survey and its predecessors at irregular intervals since 1937. Some additional information came from the "Georgia Surface Mining and Land Reclamation Activities" published annually since 1969 by the Georgia Surface Mined Land Reclamation Program (Environmental Protection Division, Ga. Dept. of Natural Resources). Additional sources of information were found in the references cited at the end of each entry. Uncertainty in the dates is due to incomplete records in the Survey's files.

TABLE 2

Generalized Summary of Stratigraphic Units in Whitfield County, Northwest Georgia

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES 1/
Quaternary (and Tertiary?)	* Various unnamed bodies of alluvial, colluvial and residual material. Largely clay and sand, but also, locally gravel and breccia.
Mississippian	* Floyd Shale - Approx. 100-300 ft., silt and clay with some sandstone; limestone present at base. Approximate age-equivalent to Tuscambia Limestone and Monteagle Limestone. Fort Payne Formation (or Chert) - Approx. 100-200 ft., thin- to thick-bedded chert and cherty limestone. Locally includes: Lavender Shale Member - Approx. 100 ft., shale, massive mudstone and impure limestone.
Devonian	Chattanooga Shale - Approx. 15-40 ft., carbonaceous, fissile black shale. Armuchee Chert - Approx. 60 ft., thin- to thick-bedded chert.
Silurian	Red Mountain Formation (formerly Rockwood Formation) - Approx. 600-1200 ft., sandstone, red and green shale, with conglomerate, limestone and local hematitic iron ore.
Ordovician	Chickamauga Group (or Limestone) - Approx. 400 ft., dominantly limestones with some dolostone and lesser shale, claystone, siltstone, sandstone, and bentonite clay horizons. Equivalent, in part, to the Moccasin Limestone and Bays Formation and to the Rockmart Slate and Lenoir Limestone.
Cambrian-Ordovician	Knox Group - Approx. 3000-4000 ft., dominantly cherty dolostone, minor limestone. Includes: Longview Limestone - Approx. 500 ft.; Chepultepec Dolomite - Approx. 500 ft.; and Copper Ridge Dolomite - Approx. 2000-3000 ft.

TABLE 2

Generalized Summary of Stratigraphic Units in Whitfield County, Northwest Georgia (continued)

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES 1/
Cambrian	**Conasauga Group (or Formation) - Approx. 950-5000 ft., predominantly shale and limestone with minor sandstone; Includes: Maynardville Limestone Member - Approx. 1000 ft.; "Middle Unit" = Rutledge Limestone and Rogersville Shale? - Approx. 1000 ft.; and "Lower Unit" = Pumpkin Valley Shale and Honaker Dolomite? - Approx. 1000 ft. *Rome Formation - Approx. 500-1000 ft., shale, and interbedded sandstone, siltstone and quartzite.

NOTES:

* = Some ceramic firing tests have been made on shales or slates and clays of this unit.

(*) = Same as the above, but for residual clays only.

** = Numerous firing tests have been made on this unit.

1/ Descriptions based on data in Butts and Gildersleeve, 1948; Chowns, 1972, 1977; Chowns and McKinney, 1980; Crawford, 1983; Cressler 1963, 1964a and b, 1970, 1974; Cressler and others, 1979; Georgia Geologic Survey, 1976.

EXPLANATION OF KEY TERMS ON THE CERAMIC TEST AND ANALYSES FORMS

The test data and analyses which are presented here were compiled on a set of standardized forms (Ceramic Tests and Analyses) in the most concise manner consistent with the various laboratories represented. These forms are modified in large part after those used by the Pennsylvania Geological Survey (e.g., O'Neill and Barnes, 1979, 1981).

It should be noted that, although the great majority of these tests were performed by the USBM, it was decided not to reproduce their data forms directly for several reasons. First, the USBM forms contain several entries which are not essential to this project (e.g., Date received) or do not make the most efficient use of space. Second, the USBM forms have been changed several times over the span of decades covered by the present compilation. Finally, investigators from other laboratories have reported parameters which were not measured by the USBM.

The paragraphs which follow briefly describe, in alphabetical order, the more critical entries on the forms, the nature of the information included and, where possible, the various factors and implications to be considered in their interpretation. Many of the particular comments here are based on descriptive information published in the following sources. Tests by Georgia Geologic Survey authors are described in Veatch (1909, p. 50 to 64) and in Smith (1931, p. 19 to 25), while the particulars of the USBM studies are given in Klinefelter and Hamlin (1957, especially p. 5 to 41) and in Liles and Heystek (1977, especially p. 2 to 16). The discussions which follow are not intended to be exhaustive but are merely meant to remind the reader,

and potential user, of the key aspects of the information presented. Various technical texts and reports should be consulted for more detailed information (e.g., Clews, 1969; Grimshaw, 1972; Jones and Beard, 1972; Norton, 1942; Patterson and Murray, 1983). The abbreviations used on these test forms are defined in Table 4.

1. Absorption (%)

The absorption is a measure of the amount of water absorbed by open pores in the fired specimen and is given as a percentage of the specimen's dry weight. For slow firing tests, it is measured on fired specimens which have been boiled in water for 2 to 5 hours and then kept immersed in the water for up to 24 hours while cooling (Smith, 1931, p. 22; Klinefelter and Hamlin, 1957, p. 27-28; Liles and Heystek, 1977, p. 3). For the quick firing tests, however, the specimens are not boiled but only cooled and then immersed in water for 24 hours (Liles and Heystek, 1977, p. 4).

The absorption gives an indication of the amount of moisture which may be absorbed and subject to destructive freezing in outdoor structures. Less than 22% absorption is considered promising for slow-fired materials.

2. Appr. Por. (%) - Apparent Porosity, Percent

The apparent porosity is a measure of the amount of open pore space in the fired sample, relative to its bulk volume, and is expressed as a percent. As in the case of absorption values, it is based on the weight and volume of the specimen which has been boiled in water for 2 to 5 hours and then kept immersed in water for several hours as it cools (Klinefelter and Hamlin, 1957, p. 27 to 28; Liles and Heystek,

TABLE 3

Abbreviations for Terms on the Ceramic Firing Test Forms

ABBREVIATIONS

Appr. Por. = Apparent Porosity
App. Sp. Gr. = Apparent Specific Gravity

Btw. = Bartow County

°C = Degrees Celsius
Ct. = Catoosa County
Cht. = Chattooga County

Dd. = Dade County
Dist. = District
DTA = Differential Thermal Analysis

E. = East

°F = Degrees Fahrenheit
Fl. = Floyd County

g/cm^3 = Grams per cubic centimeter
Gdn. = Gordon County

Lab. & No. = Laboratory (name) and number (assigned in laboratory)
Lat. = Latitude
LOI = Loss on Ignition
Long. = Longitude
lb/in^2 = Pounds per square inch
lb/ft^3 = Pounds per cubic foot

Mry. = Murray County

N. = North
NE. = Northeast
NW. = Northwest

org. = Organic

Plk. = Polk County

S. = South
SE. = Southeast
SW. = Southwest
Sec. = Section

Table 3. Abbreviations for Terms on the Ceramic Firing Test Forms (continued)

7 1/2' topo. quad. = 7 and 1/2 minute topographic quadrangle

Temp. = Temperature
TVA = Tennessee Valley Authority

USBM = U.S. Bureau of Mines
USGS = U.S. Geological Survey

W. = West
Wkr. = Walker County
Wf. = Whitfield County

XRD = X-ray diffraction

1977, p. 3). The apparent porosity is an indication of the relative resistance to damage during freezing and thawing. Less than 20% apparent porosity is considered promising for slow-fired materials (O'Neill and Barnes, 1979, p. 14, Fig. 4).

3. App. Sp. Gr. - Apparent Specific Gravity

As reported in earlier USBM studies, the apparent specific gravity is a measure of the specific gravity of that portion of the test specimen that is impervious to water. This is determined by boiling the sample in water for 2 hours and soaking it in water overnight or 24 hours (Klinefelter and Hamlin, 1957, p. 27 to 28). These data were replaced by bulk density and apparent porosity measurements after the USBM moved its laboratories from Norris, Tennessee to Tuscaloosa, Alabama in 1965.

4. Bloating

Bloating is the term given to the process in which clay or shale fragments expand (commonly two or more times their original volume) during rapid firing. It results from the entrapment of gases which are released from the minerals during firing but which do not escape from the body of the host fragment due to the viscosity of the host at that temperature. Bloating is a desirable and essential property for the production of expanded lightweight aggregate where an artificial pumice or scoria is produced. Expanded lightweight aggregate has the advantages of light weight and high strength compared to conventional crushed stone aggregate. Bloating is not desirable, however, in making other structural clay products such as brick, tile and sewer pipe where the dimensional characteristics must be carefully controlled. In these cases bloating is extremely deleterious since it leads to variable and uncontrollable warping, expansion and general disruption of the fired clay body (Klinefelter and Hamlin, 1957, p. 39-41).

5. Bloating Test (or Quick Firing Test)

The Bloating Test refers to the process of rapidly firing (or "burning") the raw sample in a pre-heated furnace or kiln to determine its bloating characteristics for possible use as a lightweight aggregate. Although specific details of the different laboratory methods vary, all use several fragments of the dried clay or shale placed in a refractory plaque (or "boat") which in turn is placed in the pre-heated furnace for 15 minutes (Klinefelter and Hamlin, 1957, p. 41; Liles and Heystek, 1977, p. 4).

6. Bulk Density (or Bulk Dens.)

The bulk density is a measure of the overall density of the fired specimen based on its dry weight divided by its volume (including pores). Determinations are the same for slow firing and quick firing test samples, although for the latter the results are given in pounds per cubic inch as well as grams per cubic centimeter units (Klinefelter and Hamlin, 1957, p. 27 to 28 and 41; Liles and Heystek, 1977, p. 3 and 4). If quick-fired material yields a bulk density of less than 62.4 lb/ft^3 (or if the material floats in water), it is considered promising for lightweight aggregate (K. Liles, oral communication, 1984).

7. Color

The color of the unfired material, unless otherwise stated, represents the crushed and ground clay or shale. In most cases this is given for descriptive purposes only since it is generally of no practical importance for ceramic applications (only the fired color is significant). Here only broad descriptive terms such as light-brown, cream, gray, tan, etc. are used. Fired colors are more critical and therefore more specific descriptive terms and phrases are used (Klinefelter and Hamlin, 1957, p. 18 and 19). In many cases the Munsell color is given for a precise description (see discussion below).

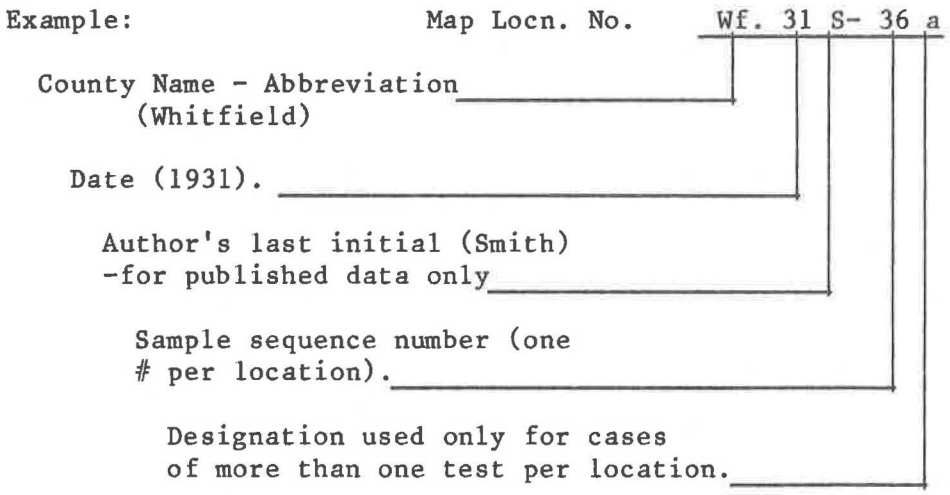
8. Color (Munsell)

This is a system of color classification based on hue, value (or brightness) and chroma (or purity) as applied to the fired samples in this compilation. It was used by Smith (1931, p. 23-25) and by the

USBM since the early 1970's (Liles and Heystek, 1977, p. 3; Liles, oral communication, 1982). In all other cases the fired color was estimated visually.

9. Compilation Map Location No.

This number or code was assigned by the author to provide a systematic designation to be used in plotting sample locations on the base maps as shown by the typical example below.



The map location number Wf. 31S-36 is derived from the county name (e.g., Wf. for Whitfield County), the year the tests were performed (e.g., 31 for 1931) plus the last initial of the author for major published sources (e.g., S for Smith), followed by a sequence number assigned in chronological order or sequential order for published data. (The only exceptions to this are the tests reported in Smith, 1931, wherein the sequence number of the present report is the same as the "Map location No." of Smith.) Each map location number represents a

specific location, or area, sampled at a particular time. In cases where several separate samples were collected from a relatively restricted area, such as an individual property, such samples are designated a, b, c, etc. Different map location numbers have been assigned to samples which were collected from the same general locality, such as a pit or quarry, but which were collected by different investigators at different times.

10. Cone

Standard pyrometric cones, or cones, are a pyrometric measure of firing temperature and time in the kiln. They are small, three-sided pyramids made of ceramic materials compounded in a series, so as to soften or deform in progression with increasing temperature and/or time of heating. Thus, they do not measure a specific temperature, but rather the combined effect of temperature, time, and other conditions of the firing treatment. The entire series of cones ranges from about 1112°F (600°C) to about 3632°F (2000°C) with an average interval of about 20°C between cones for a constant, slow rate of heating (Klinefelter and Hamlin, 1957, p. 29). For the past several decades the use of these cones has been limited to the Pyrometric Cone Equivalent (PCE) test (Liles and Heystek, 1977, p. 16). However, all of the ceramic firing tests reported by Veatch (1909) and Smith (1931) as well as some of the earliest USBM tests report firing conditions in terms of the standard cone numbers.

11. Drying Shrinkage

The drying shrinkage is a measure of the relative amount of shrinkage (in percent) which the tempered and molded material undergoes

upon drying. Although there are a variety of ways by which this can be measured, in this report the shrinkage values represent the percent linear shrinkage based on the linear distance measured between two reference marks or lines imprinted on the plastic specimen before drying. Even though the methods have varied in detail, the drying is usually accomplished in two stages: first, by air drying at room temperature (usually for 24 hours) and second, by drying in an oven followed by cooling to room temperature in a desiccator (Klinefelter and Hamlin, 1957, p. 30-31; Liles and Heystek, 1977, p. 3). In most cases the heating was at 212°F (100°C) for 24 hours; however, studies by Smith (1931, p. 20 and 21) employed 167°F (75°C) for 5 hours followed by 230°F (110°C) for 3 hours.

12. Dry Strength

The dry strength (or green strength) is a measure of the apparent strength of the clay or shale after it has been molded and dried. Unless otherwise indicated, it represents the tranverse, or crossbreaking, strength as opposed to either tensile strength or compressive strength. For the great majority of cases only the approximate dry strength is indicated as determined by visual inspection, using such terms as low, fair, good, or high (Klinefelter and Hamlin, 1957, p. 32-33; Liles and Heystek, 1977, p. 2). Smith (1931, p. 12-13) reports a quantitative measurement of this strength using the modulus of rupture (MOR) expressed in units of pounds per square inch (psi).

13. Extrusion Test

More extensive tests are sometimes made on clays and shales which

show good plasticity and long firing range in the preliminary test. In the Extrusion Test several bars are formed using a de-airing extrusion machine (i.e., one which operates with a vacuum to remove all possible air pockets). These bars are fired and tested for shrinkage, strength (modulus of rupture) and water saturation coefficient (Liles and Heystek, 1977, p. 8).

14. Firing Range

The term firing range indicates the temperature interval over which the material shows favorable firing characteristics. For slow-fired materials such desirable qualities include: a) good strength or hardness; b) good color; c) low shrinkage; d) low absorption; and e) low porosity. For quick-fired materials these include: a) good pore structure; b) low absorption; and c) low bulk density. For slow-firing and quick-firing tests the firing range should be at least 100°F (55°C) to be considered promising (O'Neill and Barnes, 1979, p. 15-18).

15. Hardness

The hardness, as measured on fired materials, indicates the resistance to abrasion or scratching. It is designated either in verbal, descriptive terms or in numerical terms using Mohs' hardness (Liles and Heystek, 1977, p. 3). It is used as an indication of the strength of the fired materials. Smith (1931), however, measured the fired strength with the modulus of rupture.

16. Hardness (Mohs')

The hardness of fired specimens using the Mohs' scale of hardness

is currently used by the USBM as a numerical measure of the fired bodies' strength (Liles and Heystek, 1977, p. 3). The values correspond to the hardness of the following reference minerals:

Mohs' Hardness No.	Reference Minerals
1	Talc
2	Gypsum
3	Calcite
4	Fluorite
5	Apatite
6	Orthoclase
7	Quartz
8	Topaz
9	Corundum
10	Diamond

A Mohs' hardness greater than 3 is considered promising for slow-fired materials.

17. HCl Effervescence

The effervescence in HCl is visually determined as none, slight or high based on the reaction of 10 ml of concentrated hydrochloric acid added to a slurry of 10 grams powdered clay or shale (minus 20 mesh) in 100 ml of water (Klinefelter and Hamlin, 1957, p. 17; Liles and Heystek, 1977, p. 4). This test gives a general indication of the amount of calcium carbonate present in the sample. An appreciable effervescence could be an indication of potential problems with lime pops and/or frothing of slow-fired ceramic products.

18. Linear Shrinkage, (%)

The term linear shrinkage represents the relative shrinkage of the clay body after firing. In most cases it represents the percent total linear shrinkage from the plastic state and is based on measurements

between a pair of standard reference marks imprinted just after molding (Klinefelter and Hamlin, 1957, p. 30-32; Liles and Heystek, 1977, p. 3). (Also see the discussion under Drying Shrinkage.) Smith (1931, p. 22) gives the shrinkage relative to both the dry, or green, state (under the column headed Dry) as well as the plastic state (under the column headed Plastic). A total shrinkage of 10% or less is considered promising for slow-fired materials.

19. Modulus of Rupture (MOR)

The modulus of rupture is a measure of the strength of materials (for crossbreaking or transverse strength in this compilation) based on the breakage force, the distance over which the force was applied and the width and thickness of the sample. The MOR is expressed in psi units (pounds per square inch) for the limited MOR data reported here (determined by Smith, 1931, p. 21 and 23).

20. Mohs'

See Hardness (Mohs').

21. Molding Behavior

See Working Properties.

22. Munsell

See Color (Munsell).

23. "MW" face brick

"MW" stands for moderate weather conditions. This is a grade of brick suitable for use under conditions where a moderate, non-uniform

degree of frost action is probable (Klinefelter and Hamlin, 1957, p. 36 and 37; ASTM Annual Book of Standards, 1974). (Also see "SW" face brick.)

24. PCE - Pyrometric Cone Equivalent

The PCE test measures the relative refractoriness, or temperature resistance, of the clay or shale; it is indicated in terms of standard pyrometric cones. The value given is the number of the standard pyrometric cone which softens and sags (or falls) at the same temperature as a cone made from the clay or shale being studied. These tests are usually only made on refractory materials which show favorable potential in the preliminary slow firing tests (i.e., high absorption, low shrinkage, and light fired color). The results are usually given for the upper temperature range Cone 12 (1337°C; 2439°F) to Cone 42 (2015°C; 3659°F) where the temperature equivalents are based on a heating rate of 150°C (270°F) per hour. With increasing temperature resistance the sample is designated as either a low-duty, medium-duty, high-duty, or super-duty fire clay (Klinefelter and Hamlin, 1957, p. 29-30 and 57-58; Liles and Heystek, 1977, p. 16).

25. pH

The pH is a measure of the relative acidity or alkalinity with values ranging from 0 to 14. (A pH of 7 is neutral. Values greater than this are alkaline whereas those which are less than 7 are acid.) Most of the ceramic tests by the USBM presented here show pH values as determined on the crushed and powdered raw material (in a water slurry) prior to firing (Klinefelter and Hamlin, 1957, p. 28; Liles and Heystek, 1977, p. 4).

Strongly acid or alkaline pH values may give some indication of potential problems with efflorescence and scum due to water-soluble salts in the clay. Unfortunately, no simple and direct interpretation is possible from the pH data alone. The best method for determining these salts is through direct chemical analysis as described under Soluble Salts. (Also see Solu-Br.)

26. Plasticity

See Working Properties.

27. Porosity, Apparent

See App. Por.

28. Quick Firing

See Bloating Test.

29. Saturation Coefficient

The saturation coefficient is determined only for specimens which have undergone the more extensive Extrusion Test. It is determined by submerging the fired specimen in cool water for 24 hours, followed by submerging the specimen in boiling water for 5 hours. The saturation coefficient is found by dividing the percent of water absorbed after boiling into the percent of water absorbed after the 24-hour submergence (Liles and Heystek, 1977, p. 8).

30. Shrinkage

See Drying Shrinkage and Linear Shrinkage.

31. Slaking

See Working Properties.

32. Slow Firing Test

Slow Firing Test refers to the process of firing ("burning") the dried specimen in a laboratory furnace or kiln. Although specific details of the different laboratory methods vary, all specimens are started at room temperature and are slowly heated to the desired temperature over a specific interval of time.

The majority of the slow firing tests by the USBM reported here were made using 15-minute draw trials. In this method a set of molded and dried test specimens are slowly fired in the kiln or furnace. The temperature is gradually raised to 1800°F (982°C) over a period of 3 to 4 hours (to avoid disintegration of the specimen as the chemically combined water is released) and the temperature is held constant for about 15 minutes. One specimen is removed from the kiln (a draw trial) and the temperature is raised to the next level (usually in intervals of 100°F). At each interval the temperature is again held constant for a 15-minute soak and then one specimen is withdrawn. This process is repeated until the final temperature is achieved (usually 2300 or 2400°F; 1260 or 1316°C) - see Klinefelter and Hamlin (1957, p. 19 and 30). The disadvantage of this draw trial method is that it tends to underfire the specimens, compared to the industrial process, since they are soaked for a relatively short time and quickly cooled by removal from the kiln.

Since the early 1970's the USBM has abandoned the draw trials and has adopted a method which more closely resembles the conditions of

commercial manufacture. As described by Liles and Heystek (1977, p. 2 and 3), one of the test specimens is slowly fired, over 24 hours, to 1832°F (1000°C), where it is held for a one-hour soak. The kiln is then turned off, but the specimen remains in the kiln as it slowly cools. (This gives a much closer approximation of most commercial firing processes.) This is subsequently repeated, one specimen at a time, for successive 50°C intervals usually up to 2282°F (1250°C). Unfortunately, only a relatively small part of the current data set is represented by USBM tests using this newer method.

The firing test methods used by Smith (1931, p. 21 and 22) are somewhat intermediate to the two methods described above. First, the specimens were slowly fired from 200 to 1200°F (93 to 649°C) over a period of 11 hours. The temperature was subsequently increased at a rate of 200°F per hour for approximately 4 hours followed by 100°F per hour until final temperature conditions were reached. At these later stages firing conditions were monitored using standard pyrometric cones in the kiln. The maximum firing temperature was determined from observed pyrometric cone behavior. This temperature was based on the temperature equivalent to 2 cones below the desired final cone. The kiln temperature was then held constant until the desired cone soaked down. Test specimens were then removed from the kiln and allowed to cool. Smith's firings averaged about 17 hours in the kiln and all specimens were fired to cones 06, 04, 02, 1, 3 and 5 wherever possible. No specific information is available on the methods employed by Veatch (1909) or the unpublished data from TVA or Georgia Tech.

33. Solu-Br. (Solu-Bridge)

Solu-Bridge measurements were used in the 1950's and 60's by the

USBM as a measure of the soluble salts (e.g., calcium sulfate) in the unfired raw material which might cause scum and efflorescence on fired products. "The solubridge and pH readings show the higher alkali samples. Solubridge determinations give the water soluble part of the alkalis and readings above 1.5 indicate fairly high soluble salt content. Clays containing high alkalies have rather short maturing temperatures and requires closer firing control. The alkalies also influence the color and lower the vetrification temperature." (H.P. Hamlin, written communication, 1957). In this method the pulverized clay or shale is boiled in water, left to stand overnight, and filtered. The content of soluble salts in the solution is then measured using the Solu-Bridge instrument readings applied to suitable calibration tables (Klinefelter and Hamlin, 1957, p. 28-29). These data are no longer collected because consistent and meaningful results are difficult to achieve.

34. Soluble Salts

Excessive water-soluble salts can cause problems with efflorescence or scum on fired clay products. (More than 3 to 4% calcium sulfate, and 1/2% magnesium or alkali sulfates are considered excessive.)

The most accurate determinative method is to boil the finely powdered sample in distilled water for 1/2 to 1 hour and let it soak overnight. The decanted solution is then analyzed for the soluble salts using standard chemical methods. The Solu-Bridge readings may also be used as a general measure of the soluble salts (Klinefelter and Hamlin, 1957, p. 28).

35. Strength

See Dry Strength and Modulus of Rupture.

36. "SW" face brick

"SW" stands for severe weather conditions. This is a grade of brick suitable for use under conditions where a high degree of frost action is probable (Klinefelter and Hamlin, 1957, p. 36 and 37, and the ASTM Annual Book of Standards, 1974). (Also see "MW" face brick.)

37. Temp. °F (°C)

The temperature at which the material was fired (both slow and quick firing tests) is given in Fahrenheit (°F) followed by the Celsius (°C) conversion in parentheses. In cases where only pyrometric cone values are available, the approximate temperature is given on the form and is based on the table of temperature equivalents in Norton (1942, p. 756, Table 128) or in Veatch (1909, p. 57).

38. Water of Plasticity (%)

This is a measure of the amount of water (as weight percent relative to the dry material) required to temper the pulverized raw clay or shale into a plastic, workable consistency. This is not a precise measurement, being dependent upon the experience of the technician, the type of equipment used and the plasticity criteria. In most cases it represents the amount of water necessary for the material to be extruded into briquettes from a laboratory hydraulic ram press. In general, high water of plasticity values tends to correlate with a greater degree of workability, higher plasticity and finer grain size. Unfortunately, high values also correlate with a greater degree of shrinkage, warping and cracking of the material upon drying. (See Klinefelter and Hamlin, 1957, p. 20-22; Liles and Heystek, 1977, p. 2.)

39. Working Properties (or Workability)

This area of working properties includes comments on the slaking, plasticity, and molding, or extruding behavior of the tempered material (Klinefelter and Hamlin, 1957, p. 5, 19-22 and 33-34). The term slaking refers to the disintegration of the dry material when immersed in water. It may range in time from less than a minute to weeks, but generally in the present report it is given only a relative designation such as rapid, slow, or with difficulty. Plasticity likewise is designated in a comparative manner in order of decreasing plasticity: plastic, fat (or sticky), semiplastic, short (or lean), semiflint and flint. Molding behavior is referred to as good, fair, or poor and is a general designation for the ease with which the material can be molded into test bars or briquettes.

These working properties are very imprecise and strongly dependent upon the judgement and experience of the operator. They do, however, give a general indication of how the material might respond to handling in the industrial process.

Ceramic Tests and Analyses of Clays and Shales

in Whitfield County, Georgia*

* The data presented in this report are based on laboratory tests that are preliminary in nature and will not suffice for plant or process design.

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.09V-1

County Whitfield. Sample Number -

Raw Properties: Lab & No. Ga. Survey.

Date Reported 1909. Ceramist O. Veatch, Ga. Survey.

Water of Plasticity - % Working Properties Poor plasticity.

Color Gray or yellow-green. Drying Shrinkage 3.7 % Dry Strength (tensile) 44 psi.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1958 (1070) (Cone 04)	Red	Good hardness	0.9	-	-	-
2066 (1130) (Cone 01)	Dark red	Vitrified	5.2	-	-	-
2138 (1170) (Cone 2)	Dark red	-	Slight swelling	-	-	-
2210 (1210) (Cone 4)	-	-	-	-	-	Viscous (fused?)

Remarks / Other Tests Possibly useful for making brick although the plasticity and tensil strength are low and it apparently fuses at a relatively low temperature (test data only given by Veatch, 1909, p. 402 without comments).

Preliminary Bloating (Quick Firing) Tests: Not determined.*

*Remarks Test results on this shale at Cone 2 and 4 above suggest that it may have potential for expanded lightweight aggregate manufacture.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis Not determined.

Oxide	Weight %
SiO_2	
TiO_2	
Al_2O_3	
Fe_2O_3	
FeO	
MnO	
MgO	
CaO	
Na_2O	
K_2O	
P_2O_5	
S (total)	
C (org)	
CO_2	
H_2O^-	
H_2O^+	
Ignition loss	
Total	

Mineralogy Mineral	volume %
Quartz	
Feldspar	
Carbonate	none.
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Carbonaceous matter	none.
Total	

Analyst _____ O. Veatch.

Date _____ c. 1909.

Method _____ HCl and visual examination?

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Dalton S. (Cntr.). Lat. _____, Long. _____.

Field No. -, Collected by O. Veatch. Date c. 1909.

Sample Method Grab (?). Weathering/alteration Unweathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Sample of unweathered gray or yellow-green, thin-bedded, hard, siliceous shale which weathers, red, yellow and purplish (decomposed shale) and finally into red and yellow clay. Sample from good exposures on bluffs of the Conasauga River near Tilton (Veatch, 1909, p. 402).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Clay, residual (Conasauga). Compilation Map Location No. Wf.09V-2

County Whitfield. Sample Number -

Raw Properties: Lab & No. Ga. Survey, #115.

Date Reported 1909. Ceramist O. Veatch, Ga. Survey.

Water of Plasticity - % Working Properties Good plasticity.

Color - Drying Shrinkage 7.1 % Dry Strength (tensile) 100 psi.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
2210 (1210) (Cone 4)	Buff	Vitrified	-	-	-	-
2606 (1430) (Cone 15)	-	-	-	-	-	Warped badly; slightly viscous.
2714 (1490) (Cone 18)	-	-	-	-	-	Partly melted.

Remarks / Other Tests This clay is probably suitable for stoneware and terra cotta mixtures (Veatch, 1909, p. 403).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	75.38
TiO_2	0.91
Al_2O_3	15.47
Fe_2O_3 (total)	1.37
FeO	-
MnO	trace
MgO	0.29
CaO	0.29
Na_2O	0.30
K_2O	1.73
P_2O_5	0.00
S (total)	trace
C (org)	-
CO_2	-
H_2O^-	0.48
H_2O^+	-
Ignition loss	4.20
Total	100.42

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

Analyst E. Everhart, Ga. Survey (in Veatch, 1909, p. 403 and Appendix B, No. 115, p. 416-417).

Date c. 1909.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot , Sec. , Dist. .

7 1/2' topo quad. Dalton S. (N.1/2) . Lat. , Long. .

Field No. - , Collected by O. Veatch. Date c. 1909.

Sample Method Grab (?). Weathering/alteration Residual clay from shale.

Structural Attitude -

Stratigraphic Assignment Recent (to Eocene?) clay from Conasauga Group (Cambrian).

Sample Description & Comments Sample of plastic clay from the Sanders property 3 mi. SE. of Dalton. In this region the Conasauga shale weathers into red and yellow residual clay, but exposures of weathered shale in gullies and small streams show a bluish or bluish-gray colored clay (Veatch, 1909, p. 403).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale, hard to soft. Compilation Map Location No. Wf.31S-36

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #36.

Date Reported 1931. Ceramist R. W. Smith. Ga. Survey.

Water of Plasticity 25.1 % Working Properties Good plasticity; fairly good slaking; fairly good molding; (column edges tend to tear slightly).

Color Brown. Drying Shrinkage 3.5 % Dry Strength (MOR) 137.4 psi.

Remarks Drying Behavior: Test bars all slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color** (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Dark salmon (1YR-5/6)	1378	3.9 (7.2)	19.8	-	Very slight
1920 (1050)	Light red (10R-5/5)	1218	4.4 (7.3)	19.3	-	*Very slight
2000 (1095)	Medium red (10R-4/5)	1588	3.7 (7.4)	15.9	-	Slight
2060 (1125)	Good red (10R-4/4)	1802	6.6 (9.8)	13.5	-	Some
2090 (1145)	Good chocolate-red (10R-4/3)	1871	6.4 (9.8)	11.0	-	Some
2160 (1180)	Dark chocolate (10R-3/3)	3153	8.3 (11.6)	3.0	-	Considerable, vitreous surface.

*Traces of a yellowish-white scum which is probably not detrimental.

Remarks / Other Tests Firing range - Cone 1 to 3 (commercial kiln = Cone 02 to 2). This shale is suitable for making building brick. The firing range is somewhat short, but the fired colors over that range are good (Smith, 1931, p. 177).

Preliminary Bloating (Quick Firing) Tests: Not determined.

**Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size 16 mesh. Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	54.08
TiO_2	1.09
Al_2O_3	21.40
Fe_2O_3 (total)	7.14
FeO	-
MnO	-
MgO	0.20
CaO	3.20
Na_2O	trace
K_2O	3.31
P_2O_5	0.19
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	9.39
Total	100.00*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	

(* = analysis recalculated on an H_2O^- - free basis by Smith, 1931, p. 176.)

Analyst E. Everhart. Ga. Survey. _____

Date c. 1930. _____

Method Standard "wet". _____

Sample Location Data:

County Whitfield. Land Lots 205 and 206. Sec. 3 , Dist. 11 .

7 1/2' topo quad. Cohutta (SW 1/4) . Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude Beds strike N.30°E. and dip 20 to 25°SE.

Stratigraphic Assignment Post-Knox sandstone and shale (Ordovician, Munyan, 1951) possibly Ottosee Formation and/or Tellico Sandstone? Mapped as Holston Limestone by Cressler (1974).

Sample Description & Comments Samples from the Duckett property (old D.W. Barry place) 1 mi. E. of Varnell, N. of the Varnell to Praters Mill road. Hard, greenish-drab to oilve-green fissile shale (weathers to flat pieces not flakes) from cuts in the bend of the old Varnell to Cohutta road. Also samples of softer shale from a small outcrop in a field near the southern end of the property (Smith, 1931, p. 174-177).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Soft shale and clay. Compilation Map Location No. Wf.31S-37

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #37.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 27.6 % Working Properties Fairly good plasticity; a bit "short" and mealy; fairly rapid slaking; good molding behavior.

Color Light brown. Drying Shrinkage 4.6 % Dry Strength (MOR) 117.2 psi.

Remarks Drying Behavior: All test bars somewhat warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Light salmon (5YR-6/7)	423	1.6 (6.4)	23.1	-	Some
1920 (1050)	Medium salmon (4YR-6/7)	705	3.0 (7.0)	19.9	-	Slight
2000 (1095)	Salmon (4YR-6/8)	552	2.7 (7.3)	20.2	-	Some
2060 (1125)	Light red (2YR-5/6)	867	4.3 (8.8)	18.1	-	Some
2090 (1145)	Good red (10R-5/5)	1090	4.7 (8.7)	16.1	-	Some
2160 (1180)	Deep red (1YR-5/5)	1137	5.8 (10.5)	15.8	-	Considerable

Remarks / Other Tests Firing Range = Cone 3-7 and higher (commerical kiln = Cone 2 to 7). This material may possibly be suitable for making building brick; however, the high porosity and low strength (MOR) may limit it to making common brick only (Smith, 1931, p. 181).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notations "5YR" and "10R" correspond respectively to the original notations "YR" and "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh. Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	61.26
TiO_2	0.54
Al_2O_3	22.50
Fe_2O_3 (total)	7.43
FeO	-
MnO	-
MgO	0.63
CaO	trace
Na_2O	0.15
K_2O	1.23
P_2O_5	0.19
SO_3	trace
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	6.15
Total	100.08*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 180.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot 279 , Sec. 3 , Dist. 12 .

7 1/2' topo quad. Dalton S. (N. edge) . Lat. _____, Long. _____.

Field No. _____, Collected by R. W.Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Samples of soft, brownish-drab, flaky shale (some weathers blocky) alternating with layers of somewhat sandy reddish-brown clay (residual from weathered impure limestone?) from scattered road and field outcrops on the Smith property 2 mi. SE. of Dalton, on the River Bend Rd. just E. of the Antioch Church Rd. junction, 1 mi. E. of the Southern and L & N RR. (Note that this is a mile further SE. than shown on the map in Smith, 1931, p. 179 to 181).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale, soft to semi-hard (Conasauga Group.) Compilation Map Location No. Wf.31S-38

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #38.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 23.2 % Working Properties Poor plasticity ("short" and grainy; slow slaking; poor molding behavior (clay column tends to tear on edges).

Color Brown. Drying Shrinkage 3.2 % Dry Strength (MOR) 135.3 psi.

Remarks Drying Behavior: Test bars all show some warpage.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Light salmon (3YR-6/6)	670	2.9 (6.3)	18.5	-	Some
1920 (1050)	Medium salmon (1YR-6/5	966	3.1 (6.1)	16.5	-	Some
2000 (1095)	Salmon (2YR-6/6)	1000	3.3 (6.5)	16.0	-	Slight
2060 (1125)	Light red (1YR-5/5)	1462	5.9 (8.8)	12.9	-	Slight
2090 (1145)	Good red (10R-5/5)	1507	6.3 (9.0)	11.6	-	Considerable
2160 (1180)	Deep red (10R-5/4)	1861	6.3 (9.2)	11.0	-	Considerable

Remarks / Other Tests Firing Range = Cone 1 to 6 and higher (commercial kiln = Cone 01 to 6). This shale is suitable for making building bricks (Smith, 1931, p. 179).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" correponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh. Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	59.26
TiO_2	1.11
Al_2O_3	21.29
Fe_2O_3 (total)	7.28
FeO	-
MnO	-
MgO	0.06
CaO	0.00
Na_2O	1.23
K_2O	0.70
P_2O_5	0.47
SO_3	1.22
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	7.37
Total	99.99*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 178.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot cor. of 242, 252 and 253, Sec. 3, Dist. 12.

7 1/2' topo quad. Dalton N. (SE 1/4). Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude Beds strike "nearly due north", dip 75 to 80° east.

Stratigraphic Assignment Conasauga Group (Cambrian) by Cressler (1974, Pl.2). Smith (1931, p. 177) notes a lack of similarity with typical Conasauga or Rome Formation of this region.

Sample Description & Comments Samples from road cut (about 100 ft. long) on the West and Thomas properties (N. and S., respectively) 2 1/2 mi. E. of Dalton at the fork of the Tibbs Bridge road and the Piney Grove road, about 2 mi. NE. of the Southern and L & N RR. The cut exposes soft to semi-hard, brownish to greenish drab-colored shale ranging from waxy to "short", sandy and blocky to slabby fracturing. Shale is interlayered with some very thin sandstone or chert beds and several thick beds of brown sandy clay (Smith, 1931, p. 177 to 179).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale, semi-hard (Conasauga). Compilation Map Location No. Wf.31S-39

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #39.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 25.5 % Working Properties Good plasticity; fairly rapid slaking; molding behavior good.

Color Yellowish-brown Drying Shrinkage 6.5 % Dry Strength (MOR) 400.5 psi.

Remarks Drying behavior: good.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Light red (2YR-5/6)	1398	3.0 (9.9)	14.5	-	Slight
1920 (1050)	Fair red (10R-4/5)	1757	4.0 (10.0)	11.7	-	Slight
2000 (1095)	Medium red (10R-4/4)	2208	4.7 (10.6)	8.8	-	Slight
2060 (1125)	Good red (10R-4/3)	2281	6.1 (12.2)	9.0	-	Slight
2090 (1145)	Good red (10R-3/5)	2527	5.7 (11.6)	6.6	-	Considerable
2160 (1180)	Deep red (8R-3/3)	3112	7.3 (13.4)	5.0	-	Some

Remarks / Other Tests Firing Range = Cone 03 to 5 (commercial kiln = Cone 04 to 4). Sample is of several unfired brick from the Dalton Brick and Tile Company plant (made from the nearby shale pit) which makes common and face brick fired to about 1950°F (1066°C) (Smith, 1931, p. 183).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	69.10
TiO_2	0.36
Al_2O_3	14.73
Fe_2O_3 (total)	6.38
FeO	-
MnO	-
MgO	0.14
CaO	0.55
Na_2O	0.30
K_2O	1.64
P_2O_5	0.11
S (total)	trace
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	6.66
Total	99.97*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 182.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Dalton S. (NW 1/4). Lat. _____, Long. _____.

Field No. _____, Collected by R W. Smith. Date c. 1930.

Sample Method Random samples of unfired brick from plant. Weathering/alteration Variably weathered.

Structural Attitude Strike N.10°E., dip "nearly vertical". Somewhat contorted and shows various dips in places.

Stratigraphic Assignment Conasauga Group (Cambrian) though quite different in appearance from the shales at the West and Thomas properties (Smith, 1931, p. 177).

Sample Description & Comments Sample of several green and dried brick from shale pit containing brownish-drab colored shale weathering into thin, flat pieces and large flakes. Pit is on a low shale ridge 1/8 mi. due E. of the Dalton Brick and Tile Company plant which is on the E. side of the L & N RR, 3 mi. S. of Dalton (Smith, 1931, p. 181 to 183).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale and clay (Conasauga). Compilation Map Location No. Wf.31S-40

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #40.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 29.2 % Working Properties Fair plasticity (trifle "short" and mealy); a little slow slaking; fair molding (clay column edges tend to tear).

Color Brown. Drying Shrinkage 7.0 % Dry Strength (MOR) 180.6 psi.

Remarks Drying behavior: all test bars slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-5/6)	931	4.5 (11.1)	16.4	-	Slight
1920 (1050)	Deep salmon (10R-5/5)	1030	5.0 (11.7)	14.6	-	Slight
2000 (1095)	Light red (10R-5/4)	1493	7.2 (13.6)	10.7	-	Considerable
2060 (1125)	Medium red (10R-5/4)	1531	7.6 (13.9)	10.1	-	Slight
2090 (1145)	Good red (10R-4/4)	1520	7.4 (13.9)	8.9	-	Considerable
2160 (1180)	Chocolate-red (10R-3/5)	1927	8.5 (15.0)	7.0	-	Some

Remarks / Other Tests Firing Range = Cone 02 to 6 (commercial kiln = Cone 03 to 5). This sample is suitable for making building brick (and possibly structural tile, sewer pipe and roofing tile). The shrinkage is a little high, but this could probably be reduced by blending with less weathered material (Smith, 1931, p. 186).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	56.86
TiO_2	1.11
Al_2O_3	24.10
Fe_2O_3 (total)	7.20
FeO	-
MnO	-
MgO	0.06
CaO	0.00
Na_2O	1.22
K_2O	0.70
P_2O_5	0.47
SO_3	1.21
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	7.38
Total	100.31*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 184.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot 9, Sec. 3, Dist. 13.

7 1/2' topo quad. Dalton S. (NW 1/4). Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Variably weathered.

Structural Attitude Strike "a little east of north", dip nearly vertical.

Stratigraphic Assignment Conasauga Group (Cambrian) shale and Recent (?) clay.

Sample Description & Comments Samples of soft to semi-hard, brownish-drab and greenish-colored shale (mostly fairly fissile and flaky, but some layers are sandy) with a few thin beds of weathered sandstone and a few layers of sandy brown clay (residual from argillaceous limestone?) up to 1 foot thick. Taken from cuts on the old Dalton-Calhoun highway (N-S) and a secondary E-W road across a low ridge parallel to and E. of the L & N RR., 3 1/2 mi. S. of Dalton and 1/2 mile S. of the Dalton Brick & Tile Co. (Wf.31S-39) on the Stark property (and adjacent Camp property) as described by Smith (1931, p. 183 to 186).

Compiled by B. J. O'Connor Date 6-28-88

CERAMIC TESTS AND ANALYSES

Material Shale and clay. Compilation Map Location No. Wf.31S-41

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #41.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 33.9 % Working Properties Good plasticity; rapid slaking; good molding behavior.

Color Light brown. Drying Shrinkage 7.5 % Dry Strength (MOR) 161.5 psi.

Remarks Drying behavior: test bars all somewhat warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-6/8)	1051	5.1 (12.5)	17.0	-	Some
1920 (1050)	Deep salmon (2YR-5/6)	1011	5.2 (12.6)	16.2	-	Some
2000 (1095)	Light red (10R-4/5)	1377	7.6 (14.8)	10.5	-	Considerable
2060 (1125)	Medium red (1YR-4/5)	1490	9.7 (16.6)	9.2	-	Considerable
2090 (1145)	Good red (10R-4/4)	1460	8.7 (15.4)	9.3	-	Considerable
2160 (1180)	Chocolate-red (10R-4/3)	1647	9.3 (15.9)	8.1	-	Some

Remarks / Other Tests Firing Range = Cone 02 to 6 (commercial kiln = Cone 03 to 5). Material is suitable for making building brick and possibly structural tile. The drying and firing shrinkages are a little high, but this would probably be improved by blending with a harder, less plastic shale (Smith, 1931, p. 188).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	57.52
TiO_2	1.13
Al_2O_3	20.99
Fe_2O_3 (total)	8.79
FeO	-
MnO	0.00
MgO	0.15
CaO	0.00
Na_2O	1.51
K_2O	0.96
P_2O_5	0.38
SO_3 (total)	trace
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	8.47
Total	99.90*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 187.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot 28, Sec. 3, Dist. 13.

7 1/2' topo quad. Dalton S. (NW. 1/4). Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c.1930.

Sample Method Grab samples. Weathering/alteration Residual and colluvial clay.

Structural Attitude -

Stratigraphic Assignment Recent(?) colluvial and residual clay (probably from nearby Cambrian Conasauga Group sediments).

Sample Description & Comments Stifly plastic, brownish-red to mottled yellow and red-colored clay with a little very soft, weathered, waxy, brownish-drab colored shale. At one place a little "water-worn" gravel is present. Deposit exposed in RR cut 10 ft. deep and several hundred ft. long on the Thomas and Thomas properties just N. of the junction of the L & N and Southern RR lines 4 mi. S. of Dalton (Smith, 1931, p. 186 to 188).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale, soft (Conasauga). Compilation Map Location No. Wf.31S-42

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #42.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 29.3 % Working Properties Fairly good plasticity (slightly mealy and "short"); fairly rapid slaking; good molding.

Color Brown. Drying Shrinkage 5.4 % Dry Strength (MOR) 115.8 psi.

Remarks Drying Behavior: test bars all somewhat warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Light salmon (3YR-6/7)	823	3.6 (8.2)	19.1	-	Some
1920 (1050)	Medium salmon (2YR-6/6)	787	4.3 (9.2)	16.8	-	Slight
2000 (1095)	Salmon (1YR-5/6)	1144	6.1 (11.3)	13.9	-	Some
2060 (1125)	Medium red (10R-5/5)	1324	7.0 (12.0)	12.5	-	Some
2090 (1145)	Good red (10R-4/5)	1533	7.4 (12.3)	10.0	-	Some
2160 (1180)	Chocolate-red (10R-4/4)	1563	8.0 (13.2)	9.5	-	Considerable

Remarks / Other Tests Firing Range = Cone 01 to 6 (commercial kiln = Cone 02 to 5). Shale is suitable for making building brick and possibly structrural tile. The shrinkage is somewhat high, but this could probably be lowered by blending with some harder and less weathered shale (Smith, 1931, p. 189).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	55.62
TiO_2	0.93
Al_2O_3	25.44
Fe_2O_3 (total)	7.44
FeO	-
MnO	-
MgO	0.10
CaO	0.00
Na_2O	1.00
K_2O	1.03
P_2O_5	0.12
S (total)	0.00
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	8.32
Total	100.00*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 188.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot 80, Sec. 3, Dist. 13.

7 1/2' topo quad. Dalton S. (W. side). Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude Beds strike N. 6°E., dip 75°E.

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Brownish-drab colored shale ranging from soft and flaky to harder, blocky and waxy with a few black streaks. Shale is interbedded with a few thin partings of soft, very plastic bluish-gray clay and a few layers of somewhat sandy, brown clay (up to 6 in. thick). Samples from a road cut about 300 ft. long on the "Dixie Hwy." (U.S. 41/Ga.3) on the Martin property just SE. of the Southern RR crossing about 1 mi. S. of Phelps station (Smith, 1931, p. 188 to 189).

Compiled by B. J. O'Connor Date 10-21-81

CERAMIC TESTS AND ANALYSES

Material Shale and clay, weathered. Compilation Map Location No. Wf.31S-43

County Whitfield. Sample Number

Raw Properties: Lab & No. Ga. Tech., #43.

Date Reported 1931. Ceramist R. W. Smith, Ga. Survey.

Water of Plasticity 32.1 % Working Properties Rather poor plasticity ("short" and mealy); a little slow slaking; fair molding (column edges tend to tear slightly).

Color Light brown. Drying Shrinkage 5.2 % Dry Strength (MOR) 135.2 psi.

Remarks Drying behavior: slight warpage.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Light salmon (3YR-6/7)	541	3.4 (8.2)	22.2	-	Slight
1920 (1050)	Medium salmon (3YR-5/6)	488	3.7 (8.3)	19.8	-	Slight
2000 (1094)	Salmon (2YR-5/6)	739	4.7 (9.5)	17.8	-	Considerable
2060 (1125)	Light red (1YR-5/5)	893	6.2 (10.7)	15.8	-	Slight
2090 (1145)	Good red (10R-4/5)	1505	7.0 (12.0)	12.9	-	Some
2160 (1180)	Deep red (10R-4/4)	1636	8.0 (14.0)	12.4	-	Some

Remarks / Other Tests Firing Range = Cone 1 to 5 and higher (commercial kiln = Cone 01 to 5). This material is suitable for making building brick; however the absorption is rather high and the fired strength (MOR) is low for the best quality face brick. It would best be used in a mixture with a more plastic shale or clay such as that from the Martin property at Wf.31S-42 (Smith, 1931, p. 193).

Preliminary Bloating (Quick Firing) Tests: Not determined.

*Note: Munsell color notation "10R" corresponds to the original notation "R-YR" reported in Smith (1931).

Crushing Characteristics (unfired material) Easy grinding.

Particle Size -16 mesh Retention Time Approx. 17 hours.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	57.16
TiO_2	0.73
Al_2O_3	23.94
Fe_2O_3 (total)	8.11
FeO	-
MnO	-
MgO	0.03
CaO	0.08
Na_2O	0.74
K_2O	1.56
P_2O_5	0.10
SO_3	0.04
C (org)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	7.50
Total	99.99*

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

(* - analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 192.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot 187, Sec. 3, Dist. 13.

7 1/2' topo quad. Dalton S. (SW cor.). Lat. _____, Long. _____.

Field No. _____, Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude Beds strike N.15°E. (approx. parallel to RR), dip 60-70°E.

Stratigraphic Assignment Mississippian Floyd Shale by Smith**(1931, p. 190, after Hayes unpub. ms.), but mapped as Cambrian Conasauga Group by Cressler (1974, Pl.2).

Sample Description & Comments Soft, brown, sandy and slightly fissile weathered shale (grading into clay in places) from both sides of the Southern RR from cuts 15 to 25 ft. deep and about 1000 ft. long just S. of Carbondale station. Land E and W of the RR is owned by Masters and Stone, respectively, about 9 mi. S. of Dalton and about 1 3/4 mi. N. of the Gordon County line (Smith, 1931, p. 190 to 193).

**Smith states that these cuts are "so different in appearance from the shales or even the residual clays from the Conasauga formation" (1931, p. 190).

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Shale. Compilation Map Location No. Wf.43-1

County Whitfield. Sample Number -

Raw Properties: Lab & No. Hansard, #WK1.

Date Reported 8-12-43. Ceramist W. C. Hansard.

Water of Plasticity - % Working Properties Good plasticity (waxy); no appreciable coarse grit.

Color Drab gray. Drying Shrinkage - % Dry Strength -

Remarks Excellent tiles formed in steel dies of hand press. No drying warpage.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038) (Cone 05)	Dark chocolate brown	Very hard*	21	Very low or zero	-	-
2000 (1093) (Cone 02)	Dark chocolate brown	Very hard*	24	Very low or zero	-	-

*Cannot be cut with a knife.

Remarks / Other Tests Fired tiles show a smooth, hard texture and very little warpage. High iron content, low maturing temperature and high shrinkage limit its use unless blended with a low shrinkage, low iron clay.

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time 8 hours.

Chemical & Mineralogical Data:: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO			
CaO		Montmorillonite	
Na_2O		Others	
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. -. Lat. _____, Long. _____.

Field No. -, Collected by L. H. Kinard. Date c. May 1942.

Sample Method Grab(?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments Clay sample from Kinard property in Whitfield County (mailed from Chatsworth 5-30-40). No further data available.

Compiled by B. J. O'Connor Date 6-27-88

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Wf.44-1

County Whitfield. Sample Number -

Raw Properties: Lab & No. USBM, Norris, Tn.; #M-201.

Date Reported 11-22-44. Ceramist H. Wilson, USBM.

Water of Plasticity - % Working Properties Good plastic workability.

Color Light. Drying Shrinkage - % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
2280 (1249) (Cone 9)	Light buff*	Steel hard	6	-	porous	-
2867 (1575) (Cone 20 to 23)	-	-	melted to brown slag	-	-	P.C.E.

* numerous dark iron specks formed on surface between Cones 6 & 9.

Remarks / Other Tests Too much iron for a white kaolin, too refractory for stoneware or terra cotta, but P.C.E. not high enough for good refractory clay. Properties may be improved by washing or it may be used in blends with other clays.

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size Most are less than 100 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O		Kaolinite	Considerable
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ H. Wilson, USBM.

Date _____ 11-22-44.

Method _____ Inferred from firing characteristics.

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Cohutta (?). Lat. _____, Long. _____.

Field No. -, Collected by C. P. Worthy. Date 1944.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments Clay sample from Mr. C. P. Worthy, Varnell, Georgia. Exact location unspecified, but probably is from Worthy's property in Whitfield county.

Compiled by B. J. O'Connor Date 1-25-82

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga) Compilation Map Location No. Wf.46-1

County Whitfield. Sample Number 4.

Raw Properties: Lab & No. N.C. State College Research Lab
Asheville, N.C.; TVA #100.

Date Reported 10-8-46. Ceramist M. K. Banks, TVA.

Water of Plasticity - % Working Properties -

Color Light gray-green to tan. Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.

Temp. °F (°C)	Color (Munsell)	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:

Preliminary Bloating (Quick Firing) Tests: Negative.

Temp. °F (°C)	Absorption %	Bulk Density g/cm^3	Bulk Density lb/ft^3	Pore Structure
2350 (1288)	-	-		-
2400 (1316)	-	-	-	-
2450 (1343)	-	-	-	-

Remarks Not usable, by itself, for expanded light weight aggregate manufacture.

Crushing Characteristics (unfired material) -

Particle Size -8 mesh. Retention Time 30 min. (in muffle furnace).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Dalton N. (cntr.). Lat. _____, Long. _____.

Field No. 4., Collected by S. D. Broadhurst (TVA). Date 1946?

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). Sample is a light gray-green to tan shale typical of the eastern outcrop belt of Conasauga Group. This sample is relatively fresh, pure shale, weathering rapidly into small flakes. Limestone occurs about 1/2 mi. to the E. but none was noted near the area sampled which is 6 mi. NE. of Dalton, 1 1/2 mi. E. of Ga. Hwy. 71.

Compiled by B. J. O'Connor Date 6-28-88

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.46-2

County Whitfield. Sample Number 5.

Raw Properties: Lab & No. M.C. State College Research Lab Asheville, N.C.; TVA #101.

Date Reported 10-8-46. Ceramist M. K. Banks, TVA.

Water of Plasticity - % Working Properties -

Color Gray-green to brown. Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.

Temp. °F (°C)	Color (Munsell)	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:

Preliminary Bloating (Quick Firing) Tests: Negative.

Temp. °F (°C)	Absorption %	Bulk Density g/cm^3	Bulk Density lb/ft^3	Pore Structure
2350 (1288)	-	-		-
2400 (1316)	-	-		Vitrified only (too refractory).
2450 (1343)	-	-		-

Remarks Not usable, by itself, for expanded light weight aggregate manufacture.

Crushing Characteristics (unfired material) -

Particle Size -8 mesh. Retention Time 30 min. (in muffle furnace).

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	#1 Weight %	#2
SiO_2	61.80	57.64
TiO_2	trace	trace
Al_2O_3	20.20	9.22
Fe_2O_3	6.60	4.38
FeO	0.00	0.00
MnO	-	-
MgO	1.78	0.91
CaO	2.64	14.24
Na_2O	-	-
K_2O	0.33	0.85
P_2O_5	-	-
SO_3	trace	trace
C (org)	-	-
CO_2	-	-
H_2O^-	0.45	0.70
H_2O^+	-	-
Ignition loss	6.00	12.02
Total	99.80	99.96

Mineralogy: Not determined.

Mineral	volume %
Quartz	
Feldspar	
Carbonate	
Mica	
Chlorite-vermiculite	
Montmorillonite	
Others	
Total	

Analyst L. H. Turner, Ga. Survey. (Collected by D. D. McArthur, Plant Manager)
#1: lab #8473; pugged shale.
Date 11-21-52 #2: lab #8474: shale.

Method Standard "wet".

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Dalton S. (NW. 1/4). Lat. _____, Long. _____.

Field No. 5, Collected by S. D. Broadhurst (TVA) 1946?

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). Sample of fresh, blocky but soft, gray-green to brown shale taken from Dalton Brick and Tile Company pit, 3 mi. S. of Dalton, E. of Southern RR (Butts and Gildersleeve, 1948, map location no. 112; also see Wf.31S-39).

Compiled by B. J. O'Connor Date 2-26-82

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.46-3

County Whitfield. Sample Number 6

Raw Properties: Lab & No. N.C. State College Research Lab
Asheville, N.C.; TVA #102.

Date Reported 10-8-46. Ceramist M. K. Banks, TVA.

Water of Plasticity - % Working Properties -

Color Brown to gray-green Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.0

Temp. °F (°C)	Color (Munsell)	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:

Preliminary Bloating (Quick Firing) Tests: Negative.

Temp. °F (°C)	Absorption %	Bulk Density g/cm^3	Bulk Density lb/ft^3	Pore Structure
2350 (1288)	-	-		-
2400 (1316)	-	-		Vitrified only (too refractory).
2450 (1343)	-	-		-

Remarks Not usable, by itself, for expanded light weight aggregate manufacture.

Crushing Characteristics (unfired material) -

Particle Size -8 mesh. Retention Time 30 min. (in muffle furance).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Dalton S. (SW. 1/4). Lat. _____, Long. _____.

Field No. 6, Collected by S. D. Broadhurst (TVA) Date 1946?

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). Sample of gray-green to brown shale from road cut on U.S. Hwy. 41 about 7 mi. S. of Dalton. Sandy layers are not too prevalent, but limestone occurs at intervals. However, large tonnages of easily workable shale occur in the area. (This is in the same outcrop belt as Sample 5 = Wf.46-2.)

Compiled by B. J. O'Connor Date 2-26-82

CERAMIC TESTS AND ANALYSES

Material Shale, sandy. Compilation Map Location No. Wf.57-1

County Whitfield. Sample Number -

Raw Properties: Lab & No. USBM, Norris, Tn.; #843.

Date Reported 9-9-57. Ceramist H. P. Hamlin; USBM.

Water of Plasticity 27 % Working Properties Slightly sandy and short working.

Color Brown-red. Drying Shrinkage 3 % Dry Strength -

Drying defects: None.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1800-2100 (982-1149)	Dark red-buff to dark red-brown.	-	-	-	-	-
2200-2300 (1204-1269)	brown to brown-black	-	-	-	-	Expansion begins at 2200°F (1204°C).

Remarks / Other Tests This shale might be suitable for making common brick and tile, but extrusion tests would be necessary to confirm this.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Tunnel Hill (?). Lat. _____, Long. _____.

Field No. -, Collected by C. I. Wood. Date 1957.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments Sample of brown-red shale submitted by Mr. Carl I. Wood, Rocky Face, Whitfield Co., Ga. (Exact location unspecified, but probably is from Wood's property in Whitfield Co.).

Compiled by B. J. O'Connor Date 1-25-82

CERAMIC TESTS AND ANALYSES

Material Shale (Rome). Compilation Map Location No. Wf.64-1

County Whitfield. Sample Number No. 27

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1553-Y

Date Reported 4-8-64 (Revised 1967) Ceramist M.V. Denny, USBM (Revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 26.0 % Working Properties Long working, smooth, plastic, fatty, (low plasticity.) pH=6.50 (Not effervescent with HCl)

Color Buff. Drying Shrinkage 2.5 % Dry Strength Good.

Remarks Drying Characteristics: Fair - slightly rough surface. (No defects.)

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Red-tan	Soft (2)	4.5(4.0)	25.0	40.8	1.63
1900 (1038)	Red-tan	Fair hard (3)	5.0	20.9	35.9	1.72
2000 (1093)	Light red-brown (Red-brown)	Hard (4)	9.0	16.9	30.9	1.83
2100 (1149)	Red-brown	Hard (4)	9.0	13.3	25.7	1.93
2200 (1204)	Chocolate	Very hard (5)	9.0	10.3	20.5	1.99
2300 (1260)	Black-brown (Dark brown)	Steel hard (6)	10.0	5.4	11.6	2.14

Remarks / Other Tests Fair color, absorption a little high. (Should fire to "MW" face brick specifications at about 2150°F, 1177°C). Potential Use: Brick. (Face brick).

Preliminary Bloating (Quick Firing) Tests: Negative.

Note: Appr. Por. and Bulk Dens. plus data and remarks in parentheses are from 1967 revised data sheets by Tyrrell.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. -. Lat. _____, Long. _____.

Field No. 27, Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Rome Formation (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Rome). Compilation Map Location No. Wf.64-2

County Whitfield. Sample Number No. 28

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1553-Z

Date Reported 4-8-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 24.6 % Working Properties Long working, smooth, plastic, fatty. (Low plasticity) pH=5.95(6.0) (Not effervescent with HCl.)

Color Red-brown. Drying Shrinkage 3.0 % Dry Strength Good. (Low.)

Remarks Drying Characteristics: Fair, wavey surface. (No defects).

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Red-tan	Fair hard (3)	4.0	25.6	41.2	1.61
1900 (1038)	Red-tan	Hard (4)	5.0	22.4	38.1	1.70
2000 (1093)	Light red-brown (Red-brown)	Hard (4)	6.5(6.0)	18.6	33.3	1.79
2100 (1149)	Red-brown	Very hard (5)	10.0	15.7	29.4	1.87
2200 (1204)	Red-brown	Very hard (5)	10.0	13.3	26.1	1.96
2300 (1260)	Dark red-brown (Red-brown)	Steel hard (6)	10.0	8.1	17.0	2.10

Remarks / Other Tests Poor color, cracks on heating, absorption a little high, surface craze. (Should fire to "MW" face brick specifications at about 2100°F, 1149°C.) Potential Use: None. (Face brick.)

Preliminary Bloating (Quick Firing) Tests: Negative.

Note: Appr. Por. and Bulk Dens. plus data and remarks in parentheses are from 1967 revised data sheets by Tyrrell.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. - _____. Lat. _____, Long. _____.

Field No. 28 , Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Rome Formation (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Clay (residuum). Compilation Map Location No. Wf.64-3

County Whitfield. Sample Number No. 29

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1554-A

Date Reported 5-8-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.).

Water of Plasticity 35.1 % Working Properties Long working, smooth, plastic, fatty. (Moderate plasticity.) pH=5.95(6.0) (Not effervescent with HCl).

Color Buff. Drying Shrinkage 5.0 % Dry Strength Good. (Fair.)

Remarks Drying Characteristics; Slight crazing. (No defects).

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	Fair hard (3)	9.0	18.2	32.4	1.78
1900 (1038)	Light brown	Hard (4)	12.5	12.5	25.5	2.04
2000 (1093)	Brown	Very hard (5)	19.0	1.3	3.3	2.54
2100 (1149)	Red-brown	Very hard (5)	20.0	0.5	1.3	2.58
2200 (1204)	Dark brown	Steel hard (6)	19.0 (Expanded)	0.4	-	-
2300 (1260)	Dark brown	Steel hard (6)	19.0	0.2	-	-

Remarks / Other Tests Fair color, shrinkage too high. (High firing shrinkage. Abrupt vitrification.) Potential use: None. (Not suitable for use as the principal component in vitreous clay products.)

Preliminary Bloating (Quick Firing) Tests: Negative.

Note: Appr. Por.and Bulk Dens. plus data and remarks in parentheses are from 1967 revised data sheets by Tyrrell.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. - _____. Lat. _____, Long. _____.

Field No. 29 , Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration Residuum.

Structural Attitude -

Stratigraphic Assignment Upper Ordovician (?)

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.64-4

County Whitfield. Sample Number No. 31

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1554-C

Date Reported 5-8-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 31.8 % Working Properties Long working, smooth, plastic, (Moderate plasticity.) pH=5.65(5.7) (Not effervescent with HCl.)

Color Yellow. Drying Shrinkage 5.0 % Dry Strength Good. (Fair.)

Remarks Drying Characteristics: Good, very slight scum. (No defects.)

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	Fair hard (3)	5.5(5.0)	24.2	40.9	1.69
1900 (1038)	Light brown	Hard (4)	8.5(8.0)	20.8	37.6	1.81
2000 (1093)	Brown	Very hard (5)	13.0	12.2	25.6	2.10
2100 (1149)	Brown	Very hard (5)	15.0	8.2	18.4	2.24
2200 (1204)	Chocolate	Steel hard (6)	15.0	5.5	12.7	2.30
2300 (1260)	Chocolate	Steel hard (6)	15.0	4.5	10.5	2.34

Remarks / Other Tests High absorption, high shrinkage, good color. (Should fire to "SW" face brick specifications at about 2100°F, 1149°C.) Potential use: Brick and tile, if quartz added to reduce shrinkage. (Face brick, sewer pipe).

Preliminary Bloating (Quick Firing) Tests: Negative.

Note: Appr. Por. and Bulk Dens. plus data and remarks in parentheses are from 1967 revised data sheets by Tyrrell.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. -. Lat. _____, Long. _____.

Field No. 31, Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.64-5

County Whitfield. Sample Number No. 82

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-A

Date Reported 6-26-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 26.6 % Working Properties Moderate plasticity. pH=6.3 Not effervescent with HCl.

Color Tan. Drying Shrinkage 5.0 % Dry Strength Fair.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	2	5.0	21.2	35.8	1.69
1900 (1038)	Light brown	3	9.0	14.4	26.9	1.87
2000 (1093)	Brown	4	10.0	10.3	20.8	2.02
2100 (1149)	Chocolate	5	12.0	3.8	8.6	2.27
2200 (1204)	Chocolate	5	12.0	2.4	5.5	2.30
2300 (1260)	-	-	Expanded	-	-	-

Remarks / Other Tests Should fire to "MW" face brick specifications at about 1950°F (1066°C). Potential use: Face brick.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. - . Lat. _____, Long. _____.

Field No. 82, Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.64-6

County Whitfield. Sample Number No. 83

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-B

Date Reported 6-26-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 32.8 % Working Properties Moderate plasticity. pH=5.4 Not effervescent with HCl.

Color Tan. Drying Shrinkage 6.0 % Dry Strength Fair.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	3	9.0	20.8	35.8	1.72
1900 (1038)	Light brown	4	10.0	19.6	35.5	1.81
2000 (1093)	Brown	5	14.0	17.0	30.8	1.81
2100 (1149)	Dark brown	5	15.0	10.7	21.6	2.02
2200 (1204)	Dark brown	6	15.0	10.0	20.2	2.02
2300 (1260)	Chocolate	6	15.0	6.7	14.1	2.10

Remarks / Other Tests High firing shrinkage. Should fire to "MW" face brick specifications at about 2050°F (1121°C). Potential use: Face brick.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. -. Lat. _____, Long. _____.

Field No. 83, Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.64-7

County Whitfield. Sample Number No. 84

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-C

Date Reported 6-26-64 (revised 1967) Ceramist M.V. Denny, USBM (revised by M.E. Tyrrell, Tuscaloosa, Ala.)

Water of Plasticity 19.8 % Working Properties Low plasticity. pH=7.1. Not effervescent with HCl.

Color Gray. Drying Shrinkage 4.0 % Dry Strength Low.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	3	5.0	16.3	29.7	1.82
1900 (1038)	Brown	4	6.0	11.9	23.2	1.95
2000 (1093)	Dark brown	5	9.5	8.3	17.3	2.03
2100 (1149)	Chocolate	5	10.0	2.3	5.2	2.24
2200 (1204)	-	-	Expanded	-	-	-

Remarks / Other Tests Should fire to "MW" face brick specifications at about 1900°F (1037°C). Potential use: Face brick.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. - . Lat. _____, Long. _____.

Field No. 84 , Collected by J.W. Smith? Date c.1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Wf.67-1

County Whitfield. Sample Number No. 147

Raw Properties: Lab & No. USBM, Tuscaloosa, Al.; G-9-10

Date Reported 1-11-67 Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 25.0 % Working Properties Low plasticity.
pH=5.9 Not effervescent with HCl.

Color Yellow. Drying Shrinkage 0.0 % Dry Strength Low.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	2	0.0	28.8	42.9	1.49
1900 (1038)	Tan	2	0.0	28.7	43.1	1.50
2000 (1093)	Tan	3	5.0	25.0	39.5	1.58
2100 (1149)	Light brown	4	5.0	23.1	37.7	1.63
2200 (1204)	Red brown	4	10.0	16.0	29.3	1.83
2300 (1260)	Dark brown	5	10.0	8.9	17.7	1.99

Remarks / Other Tests Low green strength; high maturing temperature. Potential use: Not suitable for use as the principal component in vitreous clay products.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. - . Lat. _____, Long. _____.

Field No. 147, Collected by J.W. Smith? Date c.1966.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Wf.67-2

County Whitfield. Sample Number No. 153

Raw Properties: Lab & No. USBM, Tuscaloosa, Al.; G-9-15

Date Reported 1-11-67 Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 20.7 % Working Properties Low plasticity.
pH=6.1 Not effervescent with HCl.

Color Brown. Drying Shrinkage 2.5 % Dry Strength Low.

Remarks No drying defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	3	5.0	18.2	31.9	1.75
1900 (1038)	Tan	4	10.0	11.5	22.3	1.94
2000 (1093)	Light brown	5	12.5	7.7	15.7	2.04
2100 (1149)	-	-	Expanded	-	-	-

Remarks / Other Tests Poor color; abrupt vitrification.

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (following 3-4 hr. to 1800°F, 982°C).

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. -. Lat. _____, Long. _____.

Field No. 153, Collected by J.W. Smith? Date c.1966.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 8-7-87

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.69-1

County Whitfield. Sample Number WHIT-1.

Raw Properties: Lab & No. USBM, Tuscaloosa,AL.; #WHIT-1.

Date Reported March 1969. Ceramist M. E. Tyrrell, USBM.

Water of Plasticity 14.4 % Working Properties -

Color Light gray. Drying Shrinkage 1.0 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Dark brown	4.0	3.8	15.9	-	-
2000 (1093)	Dark brown	5.0	3.8	15.3	-	1.79
2100 (1149)	Dark brown	5.5	4.0	10.0	-	-
2200 (1204)	Dark brown	6.0	2.0	14.2	-	-

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p. 21).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO		Montmorillonite	
CaO		Others	
Na_2O			
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Beaverdale (SW. 1/4). Lat. _____, Long. _____.

Field No. WHIT-1., Collected by R. P. Hollenbeck Date 1967.

Sample Method Channel (?). Weathering/alteration Slightly weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Light greenish-gray shale, slightly weathered (about 10 feet exposed) and overlain by soil. Sampled from upper 5 foot road cut on N. side of Ga. Highway 2, 5.1 mi. W. of intersection with Ga. Highway 225, and about 1.2 mi. W. of the Murray Co. line (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 6-28-88

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Wf.69-2

County Whitfield. Sample Number WHIT-2.

Raw Properties: Lab & No. USBM, Tuscaloosa, AL.; #WHIT-1

Date Reported March 1969. Ceramist M. E. Tyrrell, USBM.

Water of Plasticity 18.0 % Working Properties -

Color Light gray. Drying Shrinkage 3.6 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Pink	3.0	5.5	19.0	-	-
2000 (1093)	Pink	3.0	5.5	17.7	-	1.68
2100 (1149)	Red-brown	4.0	8.0	14.6	-	1.85
2200 (1204)	Red-brown	5.5	8.2	12.5	-	1.90

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p. 21).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

Chemical Analysis		Mineralogy	
Oxide	Weight %	Mineral	volume %
SiO_2			
TiO_2		Quartz	
Al_2O_3		Feldspar	
Fe_2O_3		Carbonate	
FeO		Mica	
MnO		Chlorite-vermiculite	
MgO			
CaO		Montmorillonite	
Na_2O		Others	
K_2O			
P_2O_5			
S (total)		Total	
C (org)			
CO_2			
H_2O^-			
H_2O^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Whitfield. Land Lot _____, Sec. _____, Dist. _____.

7 1/2' topo quad. Cohutta (SE. 1/4). Lat. _____, Long. _____.

Field No. WHIT-2., Collected by R. P. Hollenbeck. Date 1967.

Sample Method Channel (?). Weathering/alteration Slightly weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Light greenish-gray shale, slightly weathered (about 6 feet exposed) and overlain by soil. Road cut on north side of Ga. Hwy. 2, 1.9 mi. E. of intersection with Ga. Hwy. 71 (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 6-28-88

DATA SOURCES AND REFERENCES CITED

American Society for Testing and Materials, 1974 Annual Book of ASTM Standards:

C4-62 (Reapproved 1970) Standard specification for clay drain tile, Part 16, p. 1-7.

C13-69 (Replaced by C700-74) Specifications for standard strength clay sewer pipe, Part 16, p. 409-413.

C24-72 Pyrometric cone equivalent (PCE) of refractory materials, Part 17, p. 9-14.

C27-70 Classification of fireclay and high-alumina refractory brick, Part 17, p. 15-17.

C43-70 Standard definitions of terms relating to structural clay products, Part 16, p. 33-35.

C62-69 Standard specification for building brick (solid masonry units made from clay or shale), Part 16, p. 121-125.

C216-71 Standard specification for facing brick (solid masonry units made from clay or shale), Part 16, p. 121-125.

C410-60 (Reapproved 1972) Standard specification for industrial floor brick, Part 115, p. 217-218.

C479-72 Standard specification for vitrified clay liner plates, Part 16, p. 283-284.

C330-69 Specification for lightweight aggregates for structural concrete, Part 14, p. 229-232.

C315-56 (Reapproved 1972) Standard specification for clay flue linings, Part 16, p. 169-171.

American Society for Testing and Materials, 1974 Annual Book of ASTM Standards: Part 16, Chemical-resistant nonmetallic materials; clay and concrete pipe and tile; masonry mortars and units; asbestos-cement products.

Butts, C., and Gildersleeve, B., 1948, Geology and Mineral Resources of the Paleozoic Area in Northwest Georgia: Georgia Department of Mines, Mining and Geology Bulletin 54, 176 p.

Chowns, T. M., editor, 1972, Sedimentary Environments in the Paleozoic Rocks of Northwest Georgia: Georgia Geological Survey Guidebook 11, 102 p.

_____, editor, 1977, Stratigraphy and Economic Geology of Cambrian and Ordovician Rocks in Bartow and Polk Counties, Georgia: Georgia Geological Survey Guidebook 17, 21 p.

Chowns, T.M., and McKinney, F.M., 1980, Depositional Facies in Middle- Upper Ordovician and Silurian Rocks of Alabama and Georgia: in Frey, R.W., ed., Excursions in Southeastern Geology, vol. 2, Field Trip No. 16, p. 323-348, American Geological Institute, Falls Church, VA.

Clews, F. H., 1969, Heavy Clay Technology: 2nd ed., Academic Press, New York, N.Y., 481 p.

Crawford, T.J., 1983, Pennsylvanian Outliers in Georgia: in Chowns, T.M., ed., "Geology of Paleozoic Rocks in the Vicinity of Rome, Georgia" 18th Annual Field Trip, Georgia Geological Society, p. 30-41.

Cressler, C. W., 1963, Geology and Ground-water Resources of Catoosa County, Georgia: Georgia Department of Mines, Mining and Geology Information Circular 28, 19 p.

_____, 1964a, Geology and Ground-water Resources of the Paleozoic Rock Area, Chattooga County, Georgia: Georgia Department of Mines, Mining and Geology Information Circular 27, 14 p.

_____, 1964b, Geology and Ground-water Resources of Walker County, Georgia: Georgia Department of Mines, Mining and Geology Information Circular 29, 15 p.

_____, 1970, Geology and Ground-water Resources of Floyd and Polk Counties, Georgia: Georgia Department of Mines, Mining and Geology Information Circular 39, 95 p.

_____, 1974, Geology and Ground-water Resources of Gordon, Whitfield and Murray Counties, Georgia: Georgia Geological Survey Information Circular 47, 56 p.

Cressler, C. W., Franklin, M. A., and Hester, W. G., 1976, Availability of Water Supplies in Northwest Georgia: Georgia Geological Survey Bulletin 91, 140 p.

Cressler, C. W., Blanchard, H. E., Jr., and Hester, W. G., 1979, Geohydrology of Bartow, Cherokee, and Forsyth Counties, Georgia: Georgia Geologic Survey Information Circular 50, 45 p.

Georgia Geological Survey, 1976, Geologic Map of Georgia: Georgia Geological Survey, scale 1:500,000.

Grimshaw, R. W., 1972, The Chemistry and Physics of Clays and Other Ceramic Raw Materials: 4th ed., rev., Wiley-Interscience, New York, N.Y., 1024 p.

Hollenbeck, R.P., and Tyrrell, M.E., 1969, Raw materials for light-weight aggregate in Appalachian Region, Alabama and Georgia: U.S. Bureau of Mines RI-7244, 21 p.

Jones, T. J., and Beard, M. T., 1972, Ceramics: Industrial Processing and Testing: Iowa State University Press, Ames, Iowa, 213 p.

Kelly, K. L. and Judd, D. B., Color. Universal Language and Dictionary of Names: U.S. Dept. of Commerce, NBS Special Publication 440, 158 p.

Kline, S. W. and O'Connor, B. J., editors, 1981, Mining Directory of Georgia, 18th. ed.: Georgia Geologic Survey Circular 2, 49 p.

Klinefelter, T. A., and Hamlin, H. P., 1957, Syllabus of Clay Testing: U.S. Bureau of Mines Bulletin 565, 67 p.

Liles, K. J., and Heystek, H., 1977, The Bureau of Mines Test Program for Clay and Ceramic Raw Materials: U.S. Bureau of Mines IC-8729, 28 p.

Norton, F. H., 1942, Refractories: 2nd ed., McGraw-Hill Book Co., N.Y., 798 p.

O'Neill, B. J., Jr., and Barnes, J. H., 1979, Properties and Uses of Shales and Clays, Southwestern Pennsylvania: Pennsylvania Geological Survey Mineral Resources Report 77, 689 p.

_____, 1981, Properties and Uses of Shales and Clays, South-central Pennsylvania: Pennsylvania Geological Survey Mineral Resource Report 79, 201 p.

Patterson, S. H., and Murray, H. H., 1983, Clays: in Lefond, S. J., and others, eds., Industrial Minerals and Rocks; 5th ed., American Institute of Mining, Metallurgical and Petroleum Engineers, Inc., New York, p. 585-651.

Smith, J. W., 1968?, Tests for Clay Products in Northwest Georgia; unpublished manuscript, 47 p. (brief summary in: 1967 Annual Report of the Department of Mines, Mining, and Geology, 1968, p. 17-19).

Smith, R. W., 1931, Shales and Brick Clays of Georgia: Georgia Geological Survey Bulletin 45, 348 p.

Spencer, J.W.W., 1893, The Paleozoic Group; The Geology of Ten Counties of Northwestern Georgia: Georgia Geological Survey, 406 p.

Veatch, O., 1909, Second Report on the Clay Deposits of Georgia: Georgia Geological Survey Bulletin 18, 453 p.

Watson, T. L., 1904, A Preliminary Report on the Bauxite Deposits of Georgia: Georgia Survey Bulletin 11, 169 p.

White, W. S., Denson, N.M., Dunlap, J.C. and Overstreet, E.F., 1966, Bauxite Deposits of Northwest Georgia: U.S. Geological Survey Bulletin 1199-M, 42 p.

Georgia Geologic Survey
Information Circular 73
Plate 1

CLAY AND SHALE TEST LOCATIONS IN WHITFIELD COUNTY

EXPLANATION

09V-1 Numbers correspond to the "Map Location No. in text.

Exact sample location.

Approximate sample location.

Several samples collected over the enclosed area. Boundary dashed where approximate.

Major roads

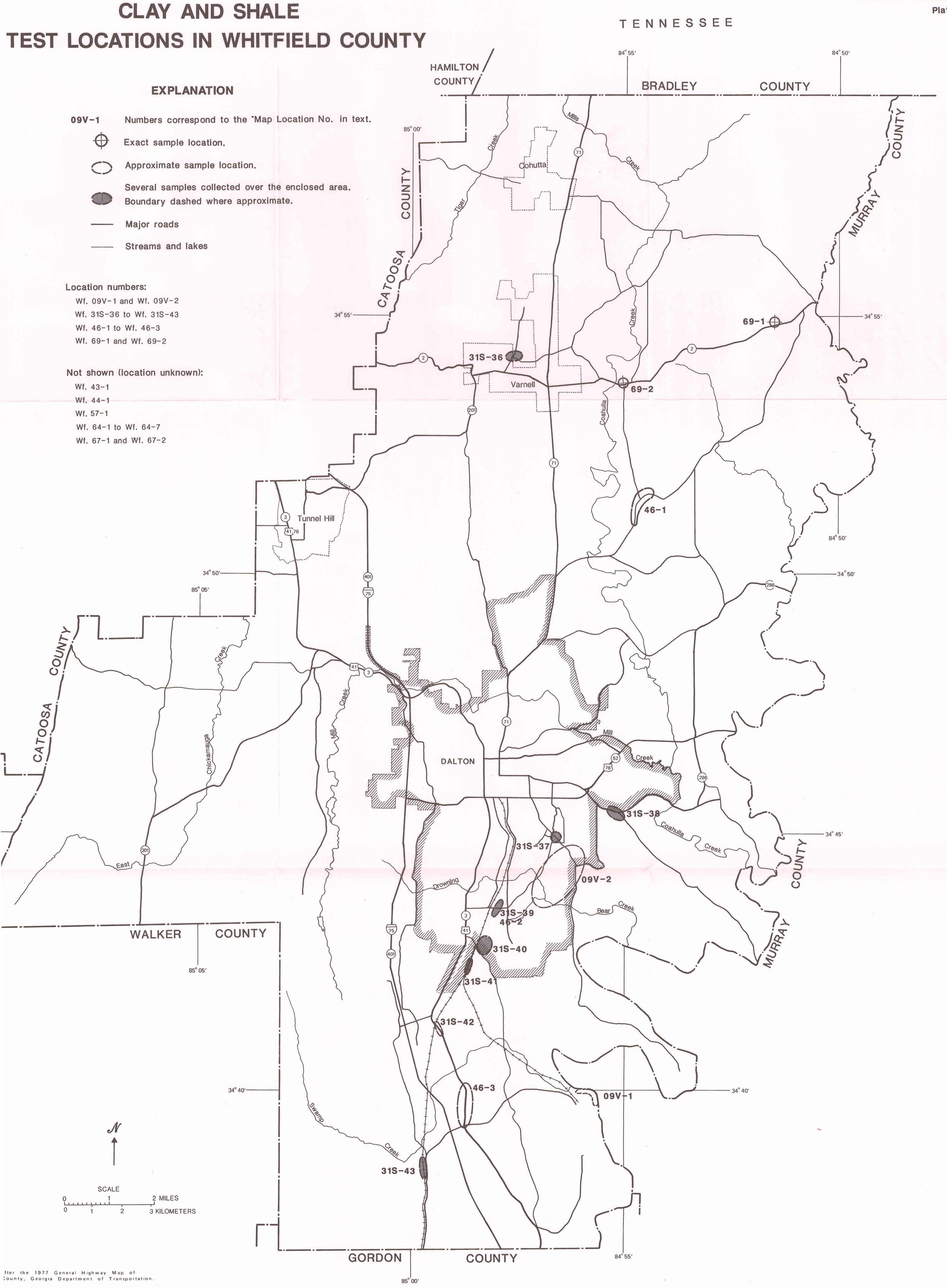
Streams and lakes

Location numbers:

Wf. 09V-1 and Wf. 09V-2
Wf. 31S-36 to Wf. 31S-43
Wf. 46-1 to Wf. 46-3
Wf. 69-1 and Wf. 69-2

Not shown (location unknown):

Wf. 43-1
Wf. 44-1
Wf. 57-1
Wf. 64-1 to Wf. 64-7
Wf. 67-1 and Wf. 67-2



SCALE
0 1 2 MILES
0 1 2 3 KILOMETERS

N

fter the 1977 General Highway Map of
County, Georgia Department of Transportation.