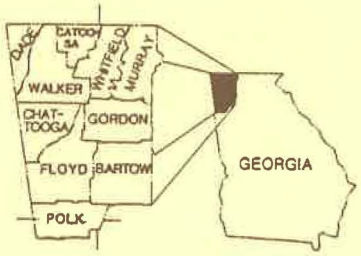
CERAMIC AND STRUCTURAL CLAYS AND SHALES OF DADE COUNTY, GEORGIA

BRUCE J. O'CONNOR



DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

INFORMATION CIRCULAR 67

COVER PHOTO: Exposure of flat-lying strata of the Gizzard Formation (Pennsylvanian) in a coal strip mine pit operated by Jackson County Mining Corporation on Sand Mountain about 4 miles northwest of Trenton, Dade County, Georgia (New Home 7½' topographic quadrangle). The bedded sandstone in the upper half of the highwall belongs to the lower portion of the Warren Point Member, whereas the underlying shale as well as the thin coal seam at the floor of the pit belongs to the upper portion of the Raccoon Mountain Member (T. J. Crawford, personal communication, 1985).

Photo by E. A. Shapiro, 1984.

CERAMIC AND STRUCTURAL CLAYS AND SHALES OF DADE COUNTY, GEORGIA

By

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Information Circular 67

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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This report presents a compilation of all available published and unpublished ceramic firing tests and related analytical data on samples from Dade County, Georgia.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 Georgia 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 uncompleted and unpublished studies (Smith, 1968?). Additional unpublished data presented in this compilation are from TVA (see Butts and Gildersleeve, 1948, p. 124 and 125). The only published data are from Smith (1931, p. 122 to 136 and 336 to 337) and Sullivan (1942, p. 52 to 55).

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, Pennsylvannia, 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 Professor W.C. Hansard 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, 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

Dade County is located at the northwestern corner of the Valley and Ridge province of northwest Georgia (Fig. 1). There are no companies currently mining clay or shale in the county and none have been active here in the past. The most abundant ceramic raw materials in the county are the shales and underclays associated with coals in the Crab Orchard Mountains and the Gizzard Groups; however, other units such as the Pennington Shale, the Red Mountain Formation shales and 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 1.

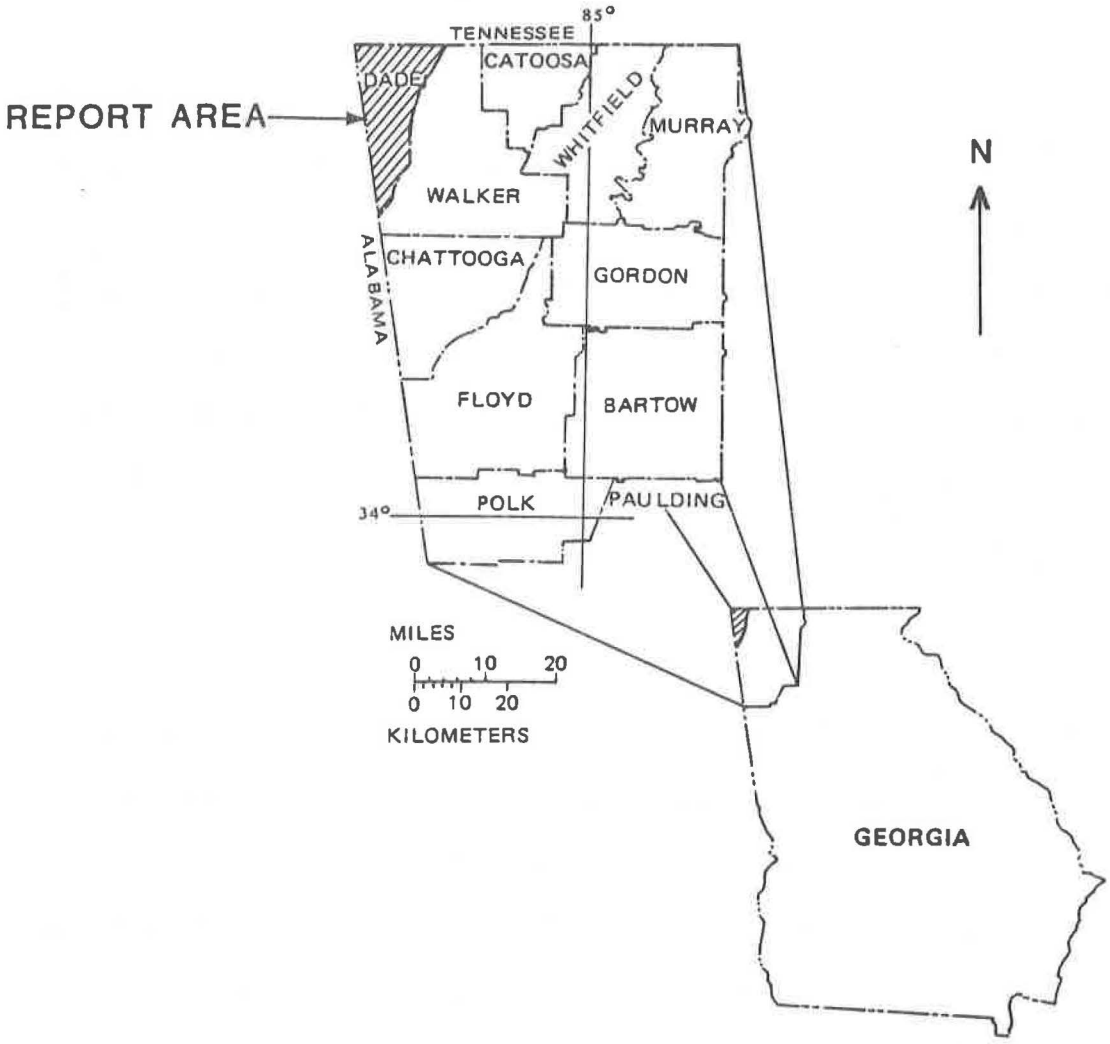


FIGURE 1

LOCATION OF DADE COUNTY REPORT AREA

(after Cressler, and others, 1976)

TABLE 1

Generalized Summary of Stratigraphic Units in Dade 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.
Pennsylvanian	Pottsville Formation Crab Orchard Mts. Formation (or Group) or Walden Sandstone - Sandstone, shale, coal, conglomerate and limestone. Includes: Rockcastle Member (or Sandstone or Conglomerate) - Approx. 50 ft., predominantly sandstone with dark shale; Vandever Member (or Formation or Shale) - Approx. 400 ft., light to dark shale with interbedded siltstone, fine-grained sandstone, and coal; Newton Member (or Sandstone or Bonair Sandstone) - Approx. 100 ft., cross-bedded sandstone; Whitwell Member (or Shale) - Approx. 200 ft., light-gray to black shale with some siltstone, sandstone and coal; and Sewanee Member (or Conglomerate) - Approx. 250 ft., conglomeratic sandstone with minor coal. ** Gizzard Formation (or Group or Member) or Lookout Sandstone (or Formation) - gray to tan shale, with interbedded siltstone, sandstone, coal and fire clay. Includes: Signal Point Member (or Shale) - Approx. 35 ft., shale with some coal; Warren Point Member (or Sandstone) - Approx. 150 ft., conglomeratic sandstone with minor coal; and Raccoon Mtn. Member (or Formation) - Approx. 300 ft., shale with coal.
Mississippian	Pennington Formation (or Shale) - Approx. 100-300 ft., gray, green and red shale. Sandstone present in middle. Bangor Limestone - Approx. 300-480 ft., fine- to coarse-grained gray limestone with interbedded shale at top. Monteagle Limestone - Approx. 250 ft. Includes: Golconda Formation (or Limestone) - Approx. 15-20 ft., green fissile shale containing some thin limestone; Gasper Limestone - Approx. 150 ft., gray, non-cherty limestone; and Ste. Genevieve Limestone - Approx. 245 ft., gray, limestone.

TABLE 1

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

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES [1/]
Mississippian, cont'd.	Tuscumbia Limestone - Approx. 125 ft. Includes: St. Louis Limestone - Approx. 125 ft., gray, very cherty limestone; and Warsaw Limestone - Approx. 50 ft. Fort Payne Formation (or Chert) - Approx. 10-400 ft., thin- to thick-bedded chert and cherty limestone. Locally includes: Lavender Shale Member - Approx. 0-200 ft., shale, massive mudstone and impure limestone.
Devonian	Chattanooga Shale - Approx. 5-25 ft., carbonaceous, fissile black shale. Armuchee Chert - Approx. 0-125 ft., thin- to thick-bedded chert.
Silurian	** Red Mountain Formation (formerly Rockwood Formation) - Approx. 150-1200 ft., sandstone, red and green shale, with conglomerate, limestone and local hematitic iron ore.
Ordovician	Sequatchie Formation - Approx. 75-250 ft., sandstone, siltstone, shale, calcareous shale and limestone. * Chickamauga Group (or Limestone) - Approx. 1000-2300 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. Includes: Maysville Formation and Trenton Limestone; Lowville-Moccasin Limestone; Lebanon Limestone; and Murfreesboro Limestone.

TABLE 1

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

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES 1/
Ordovician, cont'd.	Lenoir Limestone - Approx. 0-100+ ft. Includes: Mosheim Limestone Member - 35 ft.; and Deaton Member - 0-100+ ft.
Cambrian-Ordovician	Knox Group - Approx. 2000-4500 ft., dominantly cherty dolostone, minor limestone. Includes: Newala Limestone - Approx. 100-400 ft., limestone and dolostone; Longview Limestone - Approx. 350 ft.; Chepultepec Dolomite - Approx. 800+ ft.; and Copper Ridge Dolomite - Approx. 2500 ft.

NOTES:

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

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

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

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 determined 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 determined 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 2.

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 determined 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 2

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 2. 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 U.S. Bureau of Mines 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 and 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 and 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 and 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).

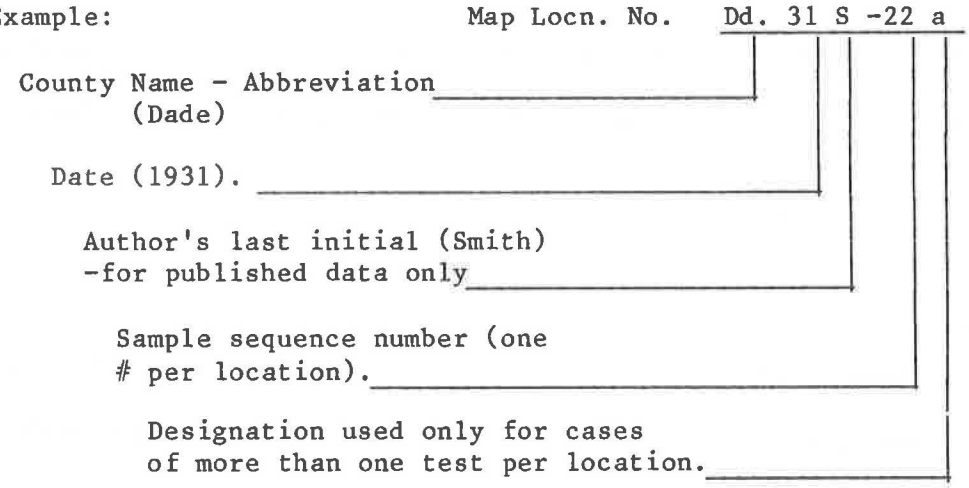
8. Color (Munsell)

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 Dd. 31 S - 22a is derived from the county name (e.g., Dd. for Dade 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 cross-breaking, 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 equal to or greater than 4 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 alkalinity or acidity 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, but not all, 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°). 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. 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 parenthesis. In cases where only pyrometric cone values are available (e.g., Smith, 1931), the approximate temperature is given on the form and is based on the table of temperature equivalents in Norton (1942, p. 756, Table 128).

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 Dade 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 Hard green shale (Red Mtn.). Compilation Map Location No. Dd. 31S-22a

County Dade. Sample Number D-5-A

Raw Properties: Lab & No. Ga. Tech.; #22.

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

Water of Plasticity 18.5 % Working Properties Very slow slaking, poor plasticity, weak and grainy (even on aging 2 days), very poor molding behavior.

Color Brownish-gray. Drying Shrinkage 3.3 % Dry Strength (MOR) 111.2 psi.

Remarks Drying properties: All test bars warped slightly.

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 (1 YR-5/7)	1264	5.1 (8.0)	9.0	-	slight
1920 (1050)	Medium red (R-YR-4/5)	1666	3.9 (6.8)	8.0	-	some
2000 (1095)	Fair red (9R-4/4)	1672	3.9 (7.0)	6.8	-	slight
2060 (1125)	Good red R-YR-4/4)	2246	7.1 (10.1)	4.6	-	slight
2090 (1145)	Deep red (R-YR-3/4)	1536	0.7 (4.0)	4.1	-	bad (pimply surface)
2160 (1180)	Deep choc. red (R-YR-3/3)	2088	4.0 (7.3)	2.8	-	bad (pimply surface)

Remarks / Other Tests Firing range = Cone 06 to 2 (commercial kiln = Cone 07 to 1). Possibly suitable for building brick and structural tile if properly handled to overcome the poor working properties (Smith, 1931, p. 127).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Hard, tough grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy Not determined.	
Oxide		Weight %	Mineral	volume %
SiO_2		59.69		
TiO_2		0.91	Quartz	
Al_2O_3		21.72	Feldspar	
Fe_2O_3	(total)	8.08	Carbonate	
FeO		-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		0.04		
CaO		0.00	Montmorillonite	
Na_2O		1.82	Others	
K_2O		2.03		
P_2O_5		trace		
S	(total)	0.00	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		5.69		
Total		99.98*		

(* = analysis recalculated on a H_2O^- --free basis by Smith, 1931, p. 124).

Analyst E. Everhart, Ga. Survey.

Date c. 1931

Method Standard "wet".

Sample Location Data:

County Dade. Land Lot c.217 (& 218?), Sec. 4, Dist. 11.

7 & 1/2' topo quad. Trenton (SE. corner). Lat. _____, Long. _____.

Field No. D-5-A, Collected by R.W. Smith Date 10-16-29

Sample Method Groove samples. Weathering/alteration Fresh.

Structural Attitude Strike about N.45°E., dip "gently to the northwest".

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Hard olive-green shale from the B. W. Newsom property 1/2 mile NE. of Rising Fawn Furnace: a 3 ft. groove sample from a cut on the Newsom Hwy. (Ga. 189) and a 5 ft. groove from an old iron ore mine-face, just S. of and below road level (Smith, 1931, p. 123-125).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Hard, green to brown shale (Red Mtn.). Compilation Map Location No. Dd. 31S-22b

County Dade. Sample Number D-5-B

Raw Properties: Lab & No. Ga. Tech.; #22.

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

Water of Plasticity 17.1 % Working Properties Poor plasticity (better after aging 4 days), slow slaking, fair molding behavior.

Color Grayish-drab. Drying Shrinkage 2.8 % Dry Strength (MOR) 109.4 psi.

Remarks Drying props.: All test bars warped slightly.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage (& Remarks)
1840 (1005)	Light red (1YR-5/6)	1176	2.4 (5.0)	11.5	-	slight (minor scumming)
1920 (1050)	Medium red (R-YR-5/6)	1690	4.1 (6.8)	9.0	-	slight (minor scumming)
2000 (1095)	Fair red (R-YR-4/5)	2322	4.6 (7.3)	6.8	-	slight (minor scumming)
2060 (1125)	Good red (R-YR-4/4)	2417	6.3 (8.9)	5.4	-	some (minor scumming)
2090 (1145)	Deep red (R-YR-3/5)	2377	2.7 (5.4)	3.2	-	considerable (pimply surface)
2160 (1180)	Deep choc. red (R-YR-3/4)	2828	3.6 (6.5)	1.7	-	considerable (pimply surface)

Remarks / Other Tests Firing range = Cone 04 to 2 (commercial kiln = Cone 05 to 1). Possibly suitable for building brick and structural tile if properly handled to overcome the poor working properties (Smith, 1931, p. 127).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Fairly easy, brittle grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy	Not determined.
Oxide		Weight %	Mineral	volume %
SiO_2		64.77		
TiO_2		0.91	Quartz	
Al_2O_3		19.38	Feldspar	
Fe_2O_3	(total)	7.13	Carbonate	
FeO		-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		0.08		
CaO		0.00	Montmorillonite	
Na_2O		1.44	Others	
K_2O		1.92		
P_2O_5		0.09		
S	(total)	0.00	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		4.23		
Total		99.95*		

(* = analysis recalculated on a H_2O^- --free basis by Smith, 1931, p. 126.)

Analyst E. Everhart, Ga. Survey.

Date c. 1931

Method Standard "wet":

Sample Location Data:

County Dade. Land Lot c. 217 & c.218, Sec. 4, Dist. 11.

7 & 1/2' topo quad. Trenton (SE. corner). Lat. _____, Long. _____.

Field No. D-5-B, Collected by R.W. Smith Date 10-16-29

Sample Method 10 ft. groove Weathering/alteration Somewhat weathered (?)

Structural Attitude (see Dd. 31S-22a).

Stratigraphic Assignment Red Mountain Formation (Silurian) - near stratigraphic top.

Sample Description & Comments Semi-hard to hard, olive-green to reddish- and brownish-drab shale from old road cut and drain, 1/8 mile north of Rising Fawn Furnace, B. W. Newsom property (Smith, 1931, p. 125-127).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Shale, hard to soft (Red Mtn.) Compilation Map Location No. Dd. 31S-23

County Dade. Sample Number D-9

Raw Properties: Lab & No. Ga. Tech., #23.

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

Water of Plasticity 22.8 % Working Properties Poor plasticity (even after aging a week), very slow slaking, rather poor molding behavior.

Color Brown. Drying Shrinkage 2.9 % Dry Strength (MOR) 85.2 psi.

Remarks Drying props.: All test bars warped somewhat.

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 (3YR-6/7)	752	3.1 (5.8)	14.5	-	slight
1920 (1050)	Medium red (R-YR-5/6)	1016	3.9 (6.2)	12.2	-	slight
2000 (1095)	Fair red (R-YR-5/5)	1418	5.8 (8.0)	10.6	-	some
2060 (1125)	Good red (R-YR-4/5)	2102	7.0 (9.1)	7.6	-	slight
2090 (1145)	Deep red (R-YR-4/4)	1505	5.7 (8.0)	5.8	-	considerable
2160 (1180)	Deep red (R-YR-4/3)	2881	8.2 (10.7)	3.6	-	considerable (pimply surface)

Remarks / Other Tests Firing range = Cone 04 to 3 (commercial kiln = Cone 05 to 2). Suitable for building brick manufacture if properly handled to overcome the poor working properties (Smith, 1931, p. 129).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy Not determined.	
Oxide		Weight %	Mineral	volume %
SiO_2		67.12		
TiO_2		1.82	Quartz	
Al_2O_3		16.57	Feldspar	
Fe_2O_3	(total)	5.14	Carbonate	
FeO		-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		trace		
CaO		0.00	Montmorillonite	
Na_2O		1.82	Others	
K_2O		2.03		
P_2O_5		0.11		
S	(total)	0.03	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		5.69		
Total*		100.33 *		

(* = analysis recalculated on a H_2O^- --free basis by Smith, 1931, 128.)

Analyst E. Everhart, Ga. Survey.

Date c. 1931

Method Standard "wet".

Sample Location Data:

County Dade. Land Lot 1, Sec. 4, Dist. 12.

7 & 1/2' topo quad. Sulphur Springs (NE. 1/4) Lat. _____ Long. _____.

Field No. D-9, Collected by R.W. Smith Date 10-19-29

Sample Method Grab samples from beds 1, 3 & 5 (= lower 147 ft. of 240 ft. of exposed Red Mtn. Fm.) Weathering/alteration None to some.

Structural Attitude -

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Soft to semi-hard, reddish- to greenish-drab, olive green, and brown shale from C.E. Coppinger property about 3 miles south of Rising Fawn, 3/4 mile east of the Alabama Great Southern RR at the base of Lookout Mtn. along a "wet-weather branch" (Smith, 1931, p. 127-129).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Semi-hard to hard shale (Red Mtn.) Compilation Map Location No. Dd. 31S-24

County Dade. Sample Number D-7

Raw Properties: Lab & No. Ga. Tech., #24.

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

Water of Plasticity 19.8 % Working Properties Poor plasticity (even on aging a week), slow slaking, rather poor molding behavior.

Color Brownish-gray Drying Shrinkage 2.7 % Dry Strength (MOR) 100.0 psi.

Remarks Drying props.: All test bars warped somewhat.

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-6/7)	996	3.6 (6.0)	10.7	-	some
1920 (1050)	Medium red (R-YR-5/6)	1209	4.1 (6.5)	10.4	-	some
2000 (1095)	Fair red (R-YR-5/5)	1807	5.0 (7.6)	8.0	-	some
2060 (1125)	Good red (R-YR-4/5)	2248	6.2 (8.9)	6.3	-	some
2090 (1145)	Deep red (R-YR-4/4)	2331	5.7 (8.4)	4.1	-	considerable (pimply surface)
2160 (1180)	Deep choc. red (R-YR-4/4)	2652	7.2 (9.8)	3.1	-	considerable

Remarks / Other Tests Firing range = Cone 04 to 3 (in commercial kiln = Cone 05 to 2). The shale is suitable for building brick manufacture if properly handled to overcome the poor working properties (Smith, 1931, p. 133).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Fairly easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy Not determined.	
Oxide		Weight %	Mineral	volume %
SiO_2		63.06		
TiO_2		1.10	Quartz	
Al_2O_3		18.92	Feldspar	
Fe_2O_3	(total)	5.85	Carbonate	
FeO		-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		trace		
CaO		.00	Montmorillonite	
Na_2O		2.53	Others	
K_2O		4.02		
P_2O_5		trace		
S	(total)	0.00	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		4.47		
Total		99.95*		

(* = analysis recalculated on a H_2O^- --free basis by Smith, 1931, p. 132).

Analyst E. Everhart, Ga. Survey.

Date c. 1931

Method Standard "wet".

Sample Location Data:

County Dade. Land Lot 119, Sec. 4, Dist. 18.

7 & 1/2' topo quad. Sulphur Springs (NE. 1/4) Lat. ____ Long. ____.

Field No. D-7, Collected by R.W. Smith Date 10-19-29

Sample Method Grab samples from beds 6 and 8 (= upper 115 ft. of 397.5 ft. section of Red Mtn. Fm.) Weathering/alteration None or little.

Structural Attitude Beds strike N.35°E., dip about 50°SE.

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Samples from road cuts on the T. B. Blake property on the east side of the Alabama Great Southern RR, about 1/2 mile north of Sulphur Springs Station, of semi-hard to hard olive-green shale above a 2.5 ft. iron ore bed. A few thin beds of sandstone are present but were not sampled in this section (Smith, 1931, p. 130 - 133).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay, bentonite (Chickamauga). Compilation Map Location No. Dd. 31S-A

County Dade. Sample Number D-6

Raw Properties: Lab & No. -

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

Water of Plasticity - % Working Properties Soft, plastic.

Color Greenish-drab. Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.

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

Remarks / Other Tests Lithology and chemical analysis only reported by Smith (1931, p. 336).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy	Not determined.
Oxide		Weight %	Mineral	volume %
SiO_2		59.77		
TiO_2		0.27	Quartz	
Al_2O_3		15.45	Feldspar	
Fe_2O_3		1.94	Carbonate	
FeO	(total)	-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		trace	Montmorillonite	
CaO		7.59	Others	
Na_2O		1.37		
K_2O		1.42		
P_2O_5		0.12		
S	(total)	0.00	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		12.61		
Total		100.54		

(* = analyis recalculated on an H_2O^--free basis by Smith, 1931, p. 336).

Analyst E. Everhart, Ga. Survey.

Date c. 1930

Method Standard "wet".

Sample Location Data:

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

7 & 1/2' topo quad. Trenton (SE. corner). (or Sulphur Springs, NE. corner?) Lat. _____, Long. _____.

Field No. D-6, Collected by R.W. Smith Date 10-19-29

Sample Method Groove sample. Weathering/alteration Somewhat weathered?

Structural Attitude Beds strike N. 55°E. and dip about 15° NW.

Stratigraphic Assignment In the Chickamauga Limestone (Ordovician).

Sample Description & Comments Sample from the W. Forrester property in Johnsons Crook on the public road from Rising Fawn Furnace to Sulphur Springs, 1/4 mi. S. of Cave Springs Church and 1 mi. S. of Rising Fawn Furnace. Analysis is on a groove sample of a 2.5 ft. thick bed of soft, plastic, greenish-drab clay which overlies 0.5 ft. of a similar, but very sandy clay (not sampled) and thin-bedded, argillaceous limestone (Smith, 1931, p. 336).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay, bentonite (Chickamauga). Compilation Map Location No. Dd. 31S-B

County Dade. Sample Number D-10

Raw Properties: Lab & No. -

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

Water of Plasticity - % Working Properties Plastic.

Color Greenish cream to drab. Drying Shrinkage - % Dry Strength -

Slow Firing Tests:

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

Remarks / Other Tests Lithology and chemical analysis only given in Smith (1931, p. 336-337).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis			Mineralogy	Not determined
Oxide		Weight %	Mineral	volume %
SiO_2		57.01		
TiO_2		0.28	Quartz	
Al_2O_3		18.75	Feldspar	
Fe_2O_3	(total)	3.46	Carbonate	
FeO		-	Mica	
MnO		-	Chlorite-vermiculite	
MgO		trace		
CaO		4.31	Montmorillonite	
Na_2O		2.24	Others	
K_2O		2.46		
P_2O_5		0.07		
S	(total)	0.00	Total	
C	(org.)	-		
CO_2		-		
H_2O^-		*		
H_2O^+		-		
Loss on Ignition		8.51		
Total*		97.09		

(* = analysis recalculated on an H_2O^- --free basis by Smith, 1931, p. 337).

Analyst E. Everhart, Ga. Survey.

Date c. 1930

Method Standard "wet".

Sample Location Data:

County Dade. Land Lot , Sec. , Dist. .

7 & 1/2' topo quad. Trenton (NE. corner). (or New Home, SE. corner?) Lat. , Long. .

Field No. D-10, Collected by R.W. Smith Date 10-19-29

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude The "beds are dipping about 20° to the west".

Stratigraphic Assignment In the Chickamauga Limestone (Ordovician).

Sample Description & Comments Taken from ditch and road cuts on road from Trenton to White Oak (or Whiteoak) gap, 1/2 mile west of Trenton, on the Mrs. G. Gifford property (N. of road) and the S. Jeffery and Mrs. N. Fry properties (S. of road). Exposures show 20 ft. of massive clay (between limestone beds) with flakes of golden-colored mica. The middle of the clay is greenish drab, but the margins are more weathered and lighter colored greenish-cream (Smith, 1931, p. 336-337).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay with coal particles. Compilation Map Location No. Dd. 41-1a

County Dade. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #Da. L-1.

Date Reported June 1942. Ceramist W.C. Hansard, Ga. Tech.

Water of Plasticity 21.2 % Working Properties Plasticity - fair.

Color Medium gray. Drying Shrinkage 4.2 % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Remarks
1900 (1038) (Cone 05)	Gray-tan	-	-	-	-	Disrupted on firing
2000 (1093) (Cone 1)	Buff	-	-	-	-	due to high coal content.

Remarks / Other Tests Data reported in Sullivan (1942, p. 54 and 55). Not likely to be useful for making heavy clay products unless coal can be removed.

Preliminary Bloating (Quick Firing) Tests: Not determined.

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^+			
Total			

Analyst

Date

Method

Sample Location Data:

County Dade. Land Lot 17, Sec. , Dist. 19.

7 & 1/2' topo quad. New Home (NW. 1/4). Lat. , Long. .

Field No. -, Collected by J.W. Sullivan Date c. 1941.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Underclay to coal seam (Pennsylvanian).

Sample Description & Comments Medium gray clay with some hard lumps and coal particles collected from below a thin coal bed on the Lofty and Ford property (Sullivan, 1942, p. 54 - 55). In general these are fine-grained clays which usually contain varying amounts of carbonized plant remains and occur in beds 2 to 4 feet thick. (Location is about 3/4 mile south of the Tenn. state line and about 2 miles east of the Ala. state line.)

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Dd. 41-1b

County Dade. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #Da. X-3.

Date Reported June 1942. Ceramist W.C. Hansard, Ga. Tech.

Water of Plasticity 19.4 % Working Properties Plasticity-fair.

Color Gray-tan. Drying Shrinkage 5.5 % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Remarks:
1900 (1038) (Cone 05)	Light buff	-	7.6	20.0	-	Fair strength, good texture
2000 (1093) (Cone 1)	Medium	steel-hard	12.0	9.6	-	Smooth surface texture.

Remarks / Other Tests Good glazing properties (several colors tried). "These clays seem to possess suitable properties for structural products and possibly for pottery wares . . . " (Sullivan, 1942, p. 53).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Pulverizes well.

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^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Dade. Land Lot 17 , Sec. _____, Dist. 19 .

7 & 1/2' topo quad. New Home (NW. 1/4) . Lat. _____, Long. _____.

Field No. - , Collected by J.W. Sullivan. Date c. 1941.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Clay from above coal seam (Pennsylvanian).

Sample Description & Comments Sample is of a gray-tan clay from above the coal on the Lofty and Ford property (Sullivan, 1942, p. 54 - 55). In general these are fine-grained clays which usually contain varying amounts of carbonized plant remains and occur in beds 2 to 4 feet thick. (Location is apparently the same as for 41-1a.)

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay (underclay). Compilation Map Location No. Dd. 41-2

County Dade. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #Da. X-2.

Date Reported June 1942. Ceramist W.C. Hansard, Ga. Tech.

Water of Plasticity 24.7 % Working Properties Plasticity - good.

Color Light tan. Drying Shrinkage 7.0 % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Remarks
1900 (1038) (Cone 05)	Buff	-	10.6	16.5	-	Good strength, smooth surface texture.
2000 (1093) (Cone 1)	Rich	steel-hard	17.0	4.1	-	Very smooth surface smooth.

Remarks / Other Tests Good glazing properties (several colors tried). "These clays seem to possess suitable properties for structural products and possibly for pottery wares . . . "(Sullivan, 1942, p. 53).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) Readily pulverized.

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_2			
P_2O_5			
S (total)		Total	
C (org.)			
CO_2			
H_2O^-			
H_2O^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Dade. Land Lot 71, Sec. _____, Dist. 19.

7 & 1/2' topo quad. New Home (NE. 1/4). Lat. _____, Long. _____.

Field No. -, Collected by J.W. Sullivan. Date c. 1941.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Underclay to coal seam (Pennsylvanian).

Sample Description & Comments Sample is of a light tan, soft, readily pulverized underclay collected from the Knight property at coal mine opening #9 (Sullivan, 1942, p. 54 - 55). In general these fine-grained clays contain varying amounts of carbonized plant remains and occur in beds 2 to 4 feet thick. Location is about 3 miles NE. of the center of New England and about 1/4 mile E. of New Home Road.

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Dd. 41-3

County Dade. Sample Number -

Raw Properties: Lab & No. Ga. Tech., # Da. X-4.

Date Reported June 1942. Ceramist W.C. Hansard, Ga. Tech.

Water of Plasticity 22.4 % Working Properties Excellent.

Color Tan-gray. Drying Shrinkage 7.3 % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Remarks
1900 (1038) (Cone 05)	Medium buff	-	9.4	20.2	-	Fair strength, good texture.
2000 (1093) (Cone 1)	Deep buff	steel-hard	13.5	10.3	-	Smooth surface texture.

Remarks / Other Tests Good glazing properties (several colors tried). "These clays seem to possess suitable properties for structural products and possibly for pottery wares..." (Sullivan, 1942, p. 53 - 55).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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^+			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Dade. Land Lot 160, Sec. _____, Dist. 19. (Johnson, 1946, #55).

7 & 1/2' topo quad. Trenton (NE. 1/4). Lat. _____, Long. _____.

Field No. -, Collected by J.W. Sullivan. Date c. 1941.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Clay from between 2 thin coal seams (Pennsylvannian).

Sample Description & Comments Sample is of a tan-gray, fairly soft clay from between two thin coal seams taken from outcrops on Ga. Rt. 143 through Magsby* Gap about two miles S. 70°W. of Trenton (Sullivan, 1942, p. 54 - 55). In general these fine-grained clays contain varying amounts of carbonized plant remains and occur in beds 2 to 4 feet thick. (Also = locn. #55 of Johnson, 1946.)

*"Magby Gap" on county highway map but "Magnic Gap" on Trenton 7 & 1/2' topo map.

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay Compilation Map Location No. Dd. 46-1

County Dade. Sample Number -

Raw Properties: Lab & No. USBM, Norris, Tn.; #Ga. 18.

Date Reported 6-6-46 Ceramist H. Wilson, USBM.

Water of Plasticity - % Working Properties Plasticity - fair.

Color - Drying Shrinkage - % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
2075 (2235) (Cone 2)	-	"fairly hard"	-	-	porous	-

Remarks / Other Tests Possible use in making common red brick. (Insufficient material submitted for complete testing.)

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data: Not determined.

Chemical Analysis Oxide	Weight %	Mineralogy 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^+			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Dade. Land Lot 316, Sec. _____, Dist. 10.

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

Field No. # 1, Collected by L. T. Gillen. Date 5-7-46

Sample Method Grab (?) Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Pennsylvanian.

Sample Description & Comments Clay (underclay?) sample from coal mine strip pit on "A" seam for L.T. Gillen, Progressive Industries. Located S. of Ga. Hwy. 170 about 3/4 mile W. of Durham and 1/4 mile W. of the Walker Co. line.

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Shale (Red Mtn.). Compilation Map Location No. Dd. 46-2

County Dade. Sample Number 22.

Raw Properties: Lab & No. TVA, N.C. State College Research Lab Asheville, N.C.; TVA #118.

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

Water of Plasticity - % Working Properties -

Color Drab red-green. Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.

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

Preliminary Bloating (Quick Firing) Tests: Negative.

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

Remarks Not useable, by itself, for lightweight aggregate manufacture.

locn. no. Dd. 46-2, cont.

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

Chemical Analysis Oxide	Weight %	Mineralogy 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^+			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 & 1/2 topo quad. Trenton (SE. 1/4). Lat. _____, Long. _____.

Field No. # 22 Collected by S. D. Broadhurst (TVA). Date 1946?

Sample Method Grab (?) Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). Sample from 1 mi. southeast of Rising Fawn in the vicinity of old iron mine workings. Material is a drab, red-green and relatively soft shale, but the available tonnages here would be limited.

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay (potter's clay). Compilation Map Location No. Dd. 46-3

County Dade. Sample Number -

Raw Properties: Lab & No. Ga. Tech.

Date Reported 4-11-46. Ceramist W.C. Hansard, Ga. Tech.

Water of Plasticity - % Working Properties -

Color - Drying Shrinkage - % Dry Strength -

Slow Firing Tests: No data.

Temp. °F (°C)	Color (Munsell)	Hardness (Moh's)	Linear Shrinkage, %	Absorption %	Appr. Por. %	Bulk Density, g/cm^3

Remarks / Other Tests "A very fine clay for making vases and such, giving a satiny finish to objects that were not especially glazed" according to notes by G. Peyton regarding discussion with W.C. Hansard.

Preliminary Bloating (Quick Firing) Tests: Not determined.

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^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

County Dade. Land Lot 160, Sec. _____, Dist. 19.

7 & 1/2' topo quad. Trenton (NE. 1/4). Lat. _____, Long. _____.

Field No. -, Collected by G. Peyton. Date 1946.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Pennsylvanian.

Sample Description & Comments Clay from ditch exposures at road side about 1,000 ft. below the top of Magnic Gap (formerly Magsby Gap) (also see tests on underclay near here = Dd. 41-3) and opposite a side road. Property a part of the Page estate and was subsequently sold to Dr. Middleton of Trenton (unpublished notes from the Ga. Survey files).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Shale (Vandever). Compilation Map Location No. Dd. 64-1

County Dade. Sample Number No. 16

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

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

Water of Plasticity 24.1 % Working Properties Long working, smooth, gritty, fatty, plastic. (Low plasticity.) pH = 4.9. (Not effervescent with HCl.)

Color Yellow-tan. Drying Shrinkage 2.5 (0.0)% Dry Strength Good. (Low.)

Remarks Drying props.: (No defects.) Good, slightly warped surface.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	Soft (2)	0.5 (0.0)	21.5	35.7	1.66
1900 (1038)	Tan	Soft (2)	2.5	20.1	34.4	1.71
2000 (1093)	Tan	Fair hard (3)	5.0	15.7	28.7	1.83
2100 (1149)	Light brown	Hard (4)	7.5	12.7	24.5	1.93
2200 (1204)	Light brown	Very hard (5)	9.0	11.0	21.9	1.99
2300 (1260)	Brown	Very hard (5)	9.0	8.4	17.5	2.08

Remarks / Other Tests (Should fire to "MW" face brick specifications at about 2100° F, 1149°C.) Absorption high, not quite enough plasticity. Potential Use: Inside tile or glazed tile brick? (Face brick.)

Preliminary Bloating (Quick Firing) Tests: Negative.

NOTE: App. Por. and Bulk Dens. data as well as 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^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. ("new 41"), 16, Collected by J.W. Smith. Date c. 1963

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Vandever Shale (Pennsylvanian).

Sample Description & Comments About 40 feet south of Ga. Highway 170, 0.47 mile northeast of intersection with Ga. Highway 157. Yellow-tan shale in Rockcastle Sandstone (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Shale, weathered (Red Mtn.). Compilation Map Location No. Dd. 66-1

County Dade. Sample Number No. 119

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala., #G-7-6

Date Reported 5-11-66 Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 20.9 % Working Properties Low plasticity. pH = 5.35

Color Tan. Drying Shrinkage 0.0 % 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	0.0	23.0	-	1.67
1900 (1038)	Tan	3	2.5	19.2	-	1.78
2000 (1093)	Tan	4	5.0	12.8	-	1.97
2100 (1149)	Light brown	5	7.5	8.2	-	2.14
2200 (1204)	-	-	Expanded	-	-	-

Remarks / Other Tests Low green strength; short vitrification range. Potential Use: None (ceramic).

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^+			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 & 1/2' topo quad. Hooker (NE. 1/4). Lat. _____, Long. _____.

Field No. ("new 39"), 119, Collected by J.W. Smith. Date c. 1966.

Sample Method Composite of many grab samples, every 2 ft. along road. Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Ga. Highway 299, 1.1 mi. W. of intersection with U.S. Highway 11. Weathered light greenish-gray shale with a very few siltstone beds up to 4 inches thick. Outcrop 700 ft. long, and up to 30 ft. high (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Shale (Red Mtn.). Compilation Map Location No. Dd. 66-2

County Dade. Sample Number No. 120

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala., #G-7-7

Date Reported 5-11-66 Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 21.4 % Working Properties Low plasticity. pH= 5.70

Color Tan. 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	2.5	22.7	-	1.68
1900 (1038)	Tan	3	2.5	18.7	-	1.80
2000 (1093)	Tan	4	5.0	12.2	-	1.99
2100 (1149)	Light brown	5	7.5	7.9	-	2.15
2200 (1204)	-	-	Expanded	-	-	-

Remarks / Other Tests Low green strength, short vitrification range. Potential Use: None (ceramic).

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^+			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 & 1/2' topo quad. Trenton (NE. 1/4). Lat. _____, Long. _____.

Field No. ("new 40"), 120, Collected by J.W. Smith. Date c. 1966.

Sample Method Channel sample across exposed stratigraphic interval. Weathering/alteration -

Structural Attitude Beds strike N.40°E., dip 25°SE.

Stratigraphic Assignment Red Mountain Formation (Silurian).

Sample Description & Comments Ga. Highway 143, 0.6 mile W. of intersection with U.S. Highway 11 in Trenton. Light greenish-gray shale with a very few siltstone beds up to 2 inches thick. Outcrop along road 250 ft., up to 15 ft. high. 1.5 ft. hematite bed in about middle of section, about 0.5 mile E. of Dd. 66-1 and 0.3 mile W. of Dd. 67-2 (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay/shale (?) Compilation Map Location No. Dd. 67-1

County Dade. Sample Number No. 146

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

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

Water of Plasticity 23.3 % Working Properties Low plasticity. pH = 4.7. Not effervescent with HCl.

Color Yellow. Drying Shrinkage 5.0 % Dry Strength Fair.

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	21.3	35.6	1.67
1900 (1038)	Tan	3	5.0	19.5	33.9	1.74
2000 (1093)	Tan	4	10.0	11.6	22.9	1.97
2100 (1149)	Light brown	5	15.0	6.9	14.8	2.14
2200 (1204)	Dark brown	6	15.0	4.6	10.1	2.19
2300 (1260)	Dark brown	7	15.0	4.5	9.7	2.15

Remarks / Other Tests Should fire to "MW" face brick specifications at about 2000°F (1093°C). Potential Use: Building brick. (Also see "Extrusion Tests").

Preliminary Bloating (Quick Firing) Tests: Negative.

TUSCALOOSA METALLURGY RESEARCH LABORATORY

Clay Evaluation: Extrusion Tests

Sender's identification: 146 Date 9/28/67

Tuscaloosa number: G-9-9

Body composition:

Raw clay through 6 mesh: 100 %.

Tempering water: 24.0 % of dry batch weight.

Vacuum on machine: 28 inches of mercury.

Drying: 24 hours in air; 24 hours at 140°F (60°C).

Drying shrinkage: 3.1 %.

Modulus of rupture, dry unfired: 660 psi.

Firing:

Time- 24 hours
Temperature- 2000°F (1093°C)
Cone- 02

Total shjrinkage: 11.5 %.

Absorption, 5-hour boiled: 1.6 %.

Absorption, 24-hour soaked: 1.6 %.

Saturation coefficient: 1.00

Apparent porosity: 3.8 %.

Bulk density: 2.37 g/cc.

Fired modulus of rupture: 4020 psi.

Mohs' hardness: 7

Color: Brown.

Comments: Might be satisfactory for face brick, sewer pipe or quarry tile.

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_2		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^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 146, Collected by J.W. Smith? Date c. 1966

Sample Method Grab? Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments Location unknown.

Compiled by B.J. O'Connor Date 11-19-82

CERAMIC TESTS AND ANALYSES

Material Clay (weathered "bentonite"). Compilation Map Location No. Dd. 67-2

County Dade. Sample Number No. 166

Raw Properties: Lab & No. USBM, Tuscaloosa, No. G-10-6

Date Reported 1-16-67 Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 38.5 % Working Properties Low plasticity. pH = 8.9. Highly effervescent with HCl.

Color Tan. Drying Shrinkage - % Dry Strength Low.

Remarks Drying defects: cracks.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1800 (982)	Tan	Poor bond	-	-	-	-
1900 (1038)	Tan	Poor bond	-	-	-	-
2000 (1093)	Buff	Poor bond	-	-	-	-
2100 (1149)	Buff	Poor bond	-	-	-	-
2200 (1204)	-	Melted	-	-	-	-

Remarks / Other Tests Poor ceramic bond. Abrupt vitrification. Potential Use: None (ceramic).

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^+			
Other volatiles			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 & 1/2' topo quad. Trenton (NE. 1/4). Lat. _____, Long. _____.

Field No. 166, ("F"), Collected by J.W. Smith. Date c. 1966.

Sample Method Channel sample. Weathering/alteration Deeply weathered.

Structural Attitude Bedding strikes N.30°E. and dips 35°NW.

Stratigraphic Assignment "Bentonite" in Chickamauga Group (Ordovician).

Sample Description & Comments Ga. Hwy. 143 in Trenton, 0.3 mile west of intersection with U.S. Hwy. 11. Very deeply weathered bentonite bed 4 to 5 feet thick, 0.3 mile east of Dd. 66-2 (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 11-19-82

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CLAY AND SHALE TEST LOCATIONS IN DADE COUNTY