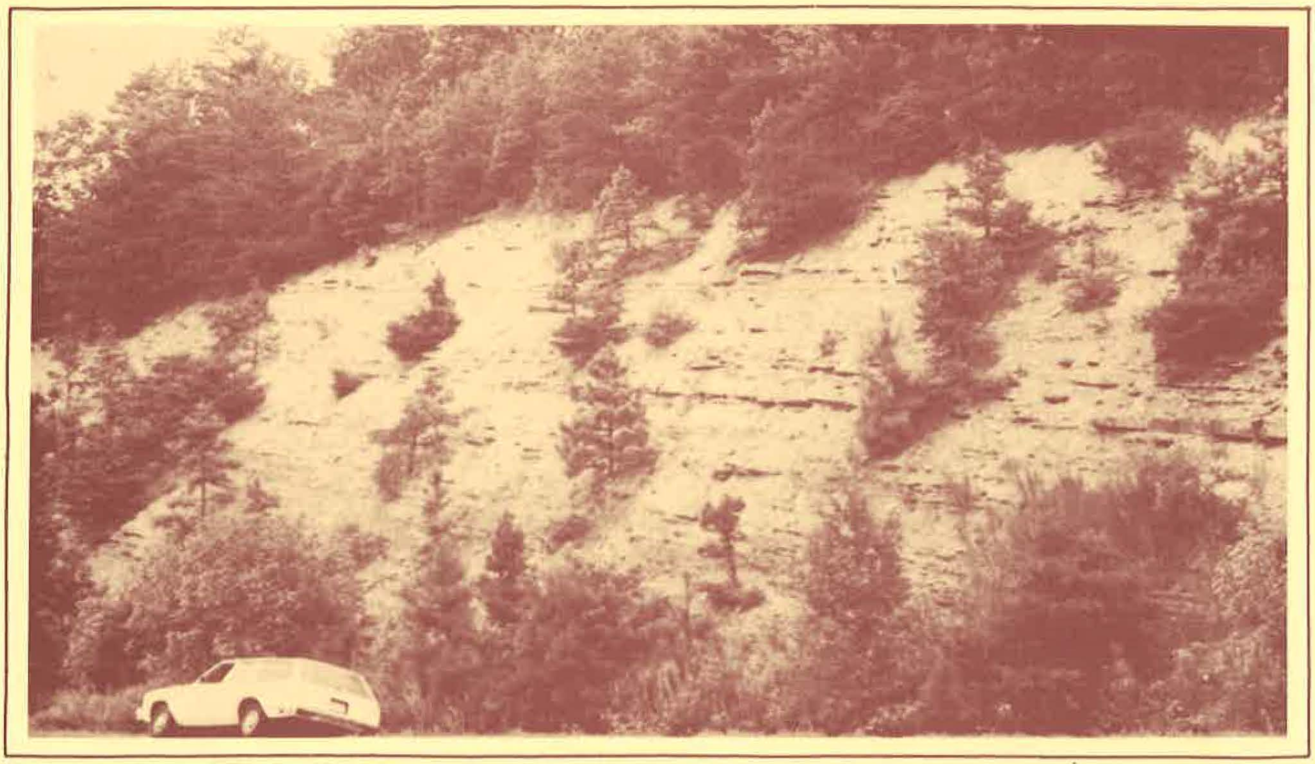
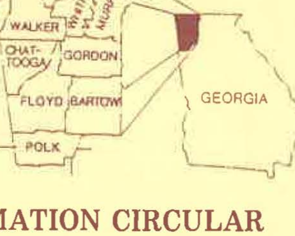
CERAMIC AND STRUCTURAL CLAYS AND SHALES OF CATOOSA COUNTY, GEORGIA

BRUCE J. O'CONNOR





DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

INFORMATION CIRCULAR **65**

COVER PHOTO: Road cut exposures of Red Mountain Formation shale with interbedded sandstone on the north side of U.S. I-75 east of the main cuts at Ringgold. (Map location no. Ct 66-3 is from the same general area.)

CERAMIC AND STRUCTURAL CLAYS AND SHALES OF CATOOSA COUNTY, GEORGIA

By

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Information Circular 65

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INTRODUCTION

This report presents a compilation of all available published and unpublished ceramic firing tests and related analytical data on samples from Catoosa County, Georgia.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samples collected by former staff members of the Georgia Geologic Survey (and its predecessors) during uncompleted and unpublished studies (Smith, 1968?). Additional unpublished data presented in this compilation are from TVA (see Butts and Gildersleeve, 1948, p. 124 and 125).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 by Veatch (1909, p. 389 to 390).

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. 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

Catoosa County is located at the northern end 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 residual clays derived from the Rome Formation and the Conasauga Group; however, other units such as the Floyd Shale and 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.

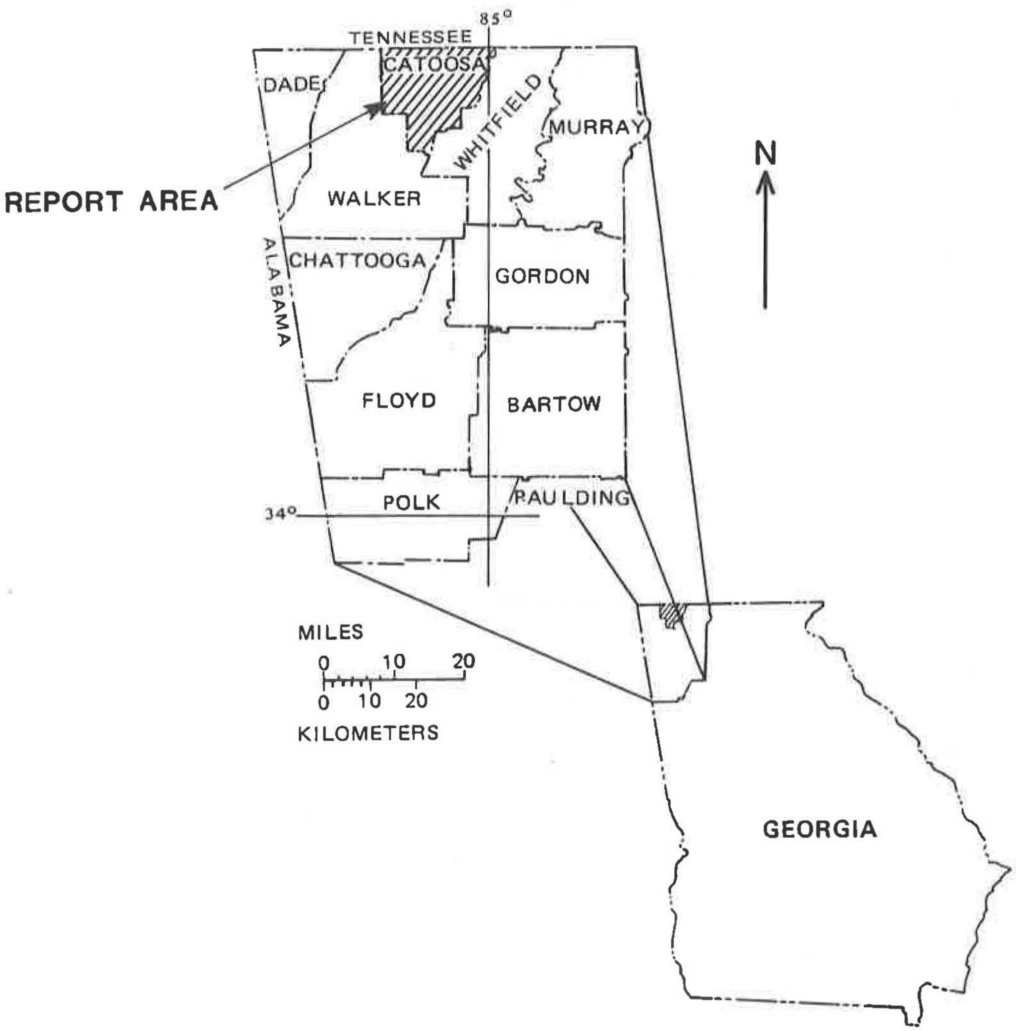

FIGURE 1

LOCATION OF CATOOSA COUNTY REPORT AREA

(after Cressler, and others, 1976)

TABLE 1

Generalized Summary of Stratigraphic Units in Catoosa 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	Lookout Sandstone - Approx. 440-593 ft., sandstone, shale, and conglomerate. Sewanee Conglomerate (or Sandstone or Member) or Bonair Sandstone - Approx. 100-240 ft., sandstone, orthoquartzite and conglomerate. Gizzard Group (or Formation or Member) - Approx. 200 ft., gray to tan shale, with local interbedded siltstone, sandstone, coal and fire clay. Includes: Warren Point Sandstone (or Member) - Approx. 100 ft.; and Raccoon Mountain Formation (or Member) - Approx. 50-100 ft.
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. * Floyd Shale - Approx. 100-2000 ft., silt and clay shale with some sandstone; limestone present at base. Approximate age-equivalent to Tuscumbia and Monteagle Limestones. 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. Tuscumbia Limestone - Approx. 125 ft. Includes: St. Louis Limestone - Approx. 125 ft., gray, very cherty limestone; and Warsaw Limestone - Approx. 50 ft.

TABLE 1. Generalized Summary of Stratigraphic Units in Catoosa County, Northwest Georgia (continued)

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES 1/
Mississippian, cont'd.	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. 125 ft., thin- to thick-bedded chert.
Silurian	* Red Mountain Formation - Approx. 150-1200 ft., sandstone, siltstone, 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 limestone with some dolostone and lesser shale, claystone, siltstone, sandstone, and bentonite clay horizons. Equivalent, in part, to the Moccasin and the Bays formations and to the Rockmart Slate and Lenoir Limestone. Includes: Maysville Formation and Trenton Limestone; Lowville-Moccasin Limestone - Approx. 200-500 ft.; Lebanon Limestone; and Murfreesboro Limestone. 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.

TABLE 1. Generalized Summary of Stratigraphic Units in Catoosa 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 - Approx. 50-300 ft.; "Upper Unit" = Nolichucky Shale - Approx. 200-1000 ft., and Maryville Limestone? - Approx. 200-600 ft.; "Middle Unit" = Rutledge Limestone and Rogersville Shale? - Approx. 200-400 ft.; and "Lower Unit" = Pumpkin Valley Shale and Honaker Dolomite? - Approx. 30-500 ft. Rome Formation - Approx. 100-5000 ft., shale, and interbedded sandstone, siltstone and quartzite. Includes the "Cartersville Formation" of Shearer (1918).

NOTES:

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

1/ Descriptions based on data in Bergenback and others, 1980; Butts and Gildersleeve, 1948; Chowns, 1972, 1977; Chowns and McKinney, 1980; Crawford, 1983; Cressler, 1963, 1964a and 1964b, 1970, 1974; Cressler and others, 1979; Croft, 1964; Georgia Geologic Survey, 1976; 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. App. 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. <u>Bulk Density</u> (or <u>Bulk Dens.</u>)

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. <u>Color</u>

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 signi-
cal importance for ceramic applications (only the fired color is signi-
ficant). 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. <u>Color (Munsell)</u>

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, oral communication, 1982; Liles and Heystek, 1977, p. 3). In all other cases the fired color was estimated visually.

9. <u>Compilation Map Location No.</u>

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.

Example: Map Locn. No. Ct. 09 V - 1 a

- County Name - Abbreviation (Catoosa) — Ct.
- Date (1909). — 09
- Author's last initial (Veatch) -for published data only — V
- Sample sequence number (one # per location). — 1
- Designation used only for cases of more than one test per location. — a

The map location number Ct. 09V-1a is derived from the county name (e.g., Ct. for Catoosa County), the year the tests were performed (e.g., 09 for 1909) plus the last initial of the author for major published sources (e.g., V for Veatch), 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 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 (Liles and Heystek, 1977, p. 16; Klinefelter and Hamlin, 1957, p. 29-30 and 57-58).

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 Catoosa 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 Floyd shale. Compilation Map Location No. Ct.09V-1

County Catoosa. Sample Number -

Raw Properties: Lab & No. Ga. Survey, location no. 14.

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

Water of Plasticity - % Working Properties Fair plasticity (when ground to pass 40 mesh).

Color "Dark". Drying Shrinkage 4.3 % Dry Strength (tensile) 45 psi.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Remarks Other data:
1958 (1070)	Red	-	6.2	-	-	Dense, tough body
2066 (1030)	Dark red	-	7.4	-	-	Completely vitrified
2246 (1230)	Dark red	-	7.4	-	-	Vitrified, slight warping
2534 (1390)	-	-	-	-	-	Vesicular and warped

Remarks / Other Tests This shale would be "suitable for common building brick and offers a possibility for paving blocks." (Veatch, 1909, p. 389).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis

Oxide		Weight %
SiO_2		57.98
TiO_2		1.14
Al_2O_3		20.40
Fe_2O_3	(total)	6.80
FeO		
MnO		0.03
MgO		1.59
CaO		0.24
Na_2O		0.43
K_2O		4.54
P_2O_5		0.00
S	(total)	0.00
C	(org.)	-
CO_2		-
H_2O^-		1.71
H_2O^+		
Loss on ignition		5.25
Total		100.11

Mineralogy: Not determined.

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

Analyst E. Everhart (in Veatch, 1909, p. 390; also Appendix B, No. 14, p. 410-411).

Date c.1909

Method Standard "wet".

Sample Location Data:

County Catoosa. Land Lot ___, Sec. ___, Dist. ___.

71/2' topo quad. Ringgold (SW. 1/4). Lat. ___, Long. ___.

No. 14 (p. 410)., Collected by O. Veatch. Date c. 1909

Sample Method Grab (?) Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Floyd Shale (Mississippian).

Sample Description & Comments From outcrops on the Western & Atlantic (now L & N) Railroad, 1 1/2 miles east of Ringgold (Veatch, 1909, p. 389-390).

Compiled by B.J. O'Connor Date 11-1-82

CERAMIC TESTS AND ANALYSES

Material Shale (Rome Formation). Compilation Map Location No. Ct. 46-1.

County Catoosa. Sample Number 3

Raw Properties: Lab & No. N.C. State College Research Lab Asheville, N.C.; TVA #99.

Date Reported 10-18-46 Ceramist M. K. Banks, TVA

Water of Plasticity - % Working Properties -

Color Reddish brown to gray. Drying Shrinkage - % Dry Strength -

Slow Firing Tests: Not determined.

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

Preliminary Bloating (Quick Firing) Tests: Negative.

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

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

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: None.

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^+			
Loss on Ignition			
Total			

Analyst ______ ______

Date ______ ______

Method ______ ______

Sample Location Data:

County Catoosa. Land Lot ____, Sec. ____, Dist. ____.

71/2' topo quad. Tunnel Hill (NE. 1/4) . Lat. ____, Long. ____.

Field No. 3, Collected by S.D. Broadhurst (TVA). Date Oct. 1946.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Rome Formation (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). From roadcut on U.S. 41 hwy., just north of Whitfield Co. line. Reddish-brown to gray sandy shale with abundant thin sandstone beds 1/2 - 6 inches thick. The resulting high silica content probably makes the material too refractory for bloating.

Compiled by B.J. O'Connor Date 9-29-80

CERAMIC TESTS AND ANALYSES

Material Weathered shale (Red Mtn. Fm.). Compilation Map Location No. Ct. 66-1.

County Catoosa Sample Number No. 114 ("new 23")

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala., #G-7-1

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

Water of Plasticity 16.8% % Working Properties Low plasticity.

Color Tan. Drying Shrinkage 2.5 % Dry Strength Low.

Remarks: No drying defects. pH = 6.00.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Density g/cm^3
1800 (982)	Tan	3	2.5	15.1	-	1.86
1900 (1038)	Tan	3	2.5	12.5	-	1.95
2000 (1093)	Tan	4	5.0	9.4	-	2.08
2100 (1149)	Light brown	4	7.5	6.6	-	2.19
2200 (1204)	Brown	6	7.5	4.7	-	2.24
2300 (1260)	-	-	(melted)	-	-	-

Remarks / Other Tests Low green strength, color is marginal.
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^+			
Loss on ignition			
Total			

Analyst ______ ______

Date ______ ______

Method ______ ______

Sample Location Data:

County Catoosa. Land Lot ______, Sec. ______, Dist. ______.

71/2' topo quad. Tunnel Hill (NW. 1/4). Lat. ______, Long. ______.

Field No. 114, ("new 23"), Collected by J.W. Smith Date 1966

Sample Method Composite of several grab samples along exposure. Weathering/alteration Weathered.

Structural Attitude Beds strike N.14°E., dip 20°E.

Stratigraphic Assignment Red Moutain Formation (Silurian) shale.

Sample Description & Comments A weathered, greenish-gray (olive-drab) shale with a very few siltstone beds 1 to 2 inches thick from dirt road cut about 600 feet long and up to 20 feet high. Sample from a dirt road at the head of Houston Valley on the E. flank of Taylor Ridge, about 2.6 miles SW. of Copeland Crossing (L.& N. Railroad) and about 3/4 mile NW. of Houston Valley Church (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 1-29-82

CERAMIC TESTS AND ANALYSES

Material Weathered shales (Rome Fm.). Compilation Map Location No. Ct. 66-2

County Catoosa. Sample Number No. 115 ("new 22").

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala., #G-7-2.

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

Water of Plasticity 15.6 % Working Properties Low plasticity.

Color Brown. Drying Shrinkage 2.5 % Dry Strength Low.

Remarks No drying defects. pH = 5.90.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Density g/cm^3
1800 (982)	Tan	2	2.5	22.7	-	1.63
1900 (1038)	Tan	2	2.5	22.6	-	1.65
2000 (1093)	Tan	3	2.5	19.8	-	1.73
2100 (1149)	Light brown	4	2.5	16.4	-	1.84
2200 (1204)	Brown	6	2.5	12.4	-	1.92
2300 (1260)	Dark brown	7	7.5	5.9	-	2.13

Remarks / Other Tests Low green strength, color is marginal. 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			
CaO		Montmorillonite	
Na_2O		Others	
K_2O			
P_2O_5			
S (total)		Total	________
C (org.)			
CO_2			
H_2O^-			
H_2O^+			
Loss on Ignition	________		
Total			

Analyst ________________ ________________

Date ________ ________

Method ________________ ________________

Sample Location Data:

County Catoosa. Land Lot ____, Sec. ____, Dist. ____.

71/2' topo quad. Ringgold (SE. 1/4). Lat. ______, Long. ____.

Field No. ("new 22"), 155 , Collected by J.W. Smith Date 1966.

Sample Method Channel sample along entire length of roadcut. Weathering/alteration Weathered.

Structural Attitude Bedding contorted but strikes largely N.25°E., dip 90°.

Stratigraphic Assignment Rome Formation (Cambrian) shale.

Sample Description & Comments Southwest side of I-75, 1.5 miles southeast of U.S. Highway 41 overpass. Weathered brown and light greenish-gray shale with several beds of siltstone 1 to 2 inches thick. Outcrop along road about 480 feet long and up to about 15 feet high (after Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 1-29-82

CERAMIC TESTS AND ANALYSES

Material Weathered shale (Red Mtn. Fm.). Compilation Map Location No. Ct. 66-3

County Catoosa. Sample Number No. 116 ("new 20").

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala.; #G-7-3.

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

Water of Plasticity 16.3 % Working Properties Low plasticity.

Color Red-brown. Drying Shrinkage 2.5 % Dry Strength Low.

Remarks No drying defects. pH = 6.10

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Density, g/cm^3
1800 (982)	Tan	2	2.5	20.3	-	1.72
1900 (1038)	Tan	2	2.5	17.2	-	1.82
2000 (1093)	Tan	3	2.5	14.7	-	1.91
2100 (1149)	Light brown	4	2.5	12.4	-	1.97
2200 (1260)	Brown	5	7.5	5.9	-	2.18
2300 (1260)	-	-	(melted)	-	-	-

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			
CaO		Montmorillonite	
Na_2O		Others	
K_2O			
P_2O_5			
S (total)		Total	
C (org.)			
CO_2			
H_2O^-			
H_2O^+			
Loss on Ignition			
Total			

Analyst

Date

Method

Sample Location Data:

County Catoosa. Land Lot , Sec. , Dist. .

71/2' topo quad. Ringgold (SW. 1/4). Lat. , Long. .

Field No. ("new 20"), 116, Collected by J.W. Smith. Date 1966.

Sample Method Channel sample (on 1st cut bench) over 195 horizontal ft., omitting 30 ft. of silty beds.

Weathering/alteration Weathered.

Structural Attitude Beds strike N.25°E. and dip 15°SE.

Stratigraphic Assignment Red Mountain Formation (Silurian) shale.

Sample Description & Comments Southwest side of I-75, 1.5 miles west of U.S. Highway 41 overpass. Weathered shale, largely brown, a little greenish gray, several silty beds 1 to 2 inches thick. Road cut 450 feet long and about 55 feet high and 0.7 mile NW. of Ct. 66-4 (after Smith, 1968?, unpub. ms.).

Compiled by B.J. O'Connor Date 1-29-82

CERAMIC TESTS AND ANALYSES

Material Weathered shales (Lavender shale Member).

Compilation Map Location No. Ct. 66-4

County Catoosa.

Sample Number No. 117 ("new 19").

Raw Properties:

Lab & No. USBM, Tuscaloosa, Ala.; #G-7-4.

Date Reported 5-11-66

Ceramist M.E. Tyrrell, USBM.

Water of Plasticity 29.3 % Working Properties Moderate plasticity.

Color Yellow. Drying Shrinkage 2.5 % Dry Strength Fair.

Remarks No drying defects. pH = 5.30.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other Data: Bulk Denisty, g/cm^3
1800 (982)	Tan	3	2.5	31.6	-	1.42
1900 (1038)	Tan	3	2.5	31.4	-	1.43
2000 (1093)	Tan	4	7.5	28.9	-	1.48
2100 (1149)	Tan	4	7.5	26.4	-	1.53
2200 (1204)	Light brown	5	10.0	18.9	-	1.68
2300 (1260)	Gray	6	10.0	12.3	-	1.74

Remarks / Other Tests Maturing temperature too high for structural clay products. Potential use: flue lining.

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

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^+	
Loss on Ignition	
Total	

Mineralogy

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

Analyst

Date

Method

Sample Location Data:

County Catoosa. Land Lot ____, Sec. ____, Dist. ____.

71/2' topo quad. Ringgold (SE. 1/4) . Lat. ____, Long. ____.

Field No. ("new 19"), 117 , Collected by J.W. Smith. Date 1966.

Sample Method Channel sample across stratigraphic thickness.

Weathering/alteration Weathered.

Structural Attitude Beds strike N.15°E. and dip 20°SE.

Stratigraphic Assignment Lavender Shale Mbr. Ft. Payne Chert (Mississippian).

Sample Description & Comments Southwest side of I-75, 0.8 mile northwest of U.S. 41 overpass. Light-brown, weathered, fossiliferous shale. Roadcut about 750 feet long and about 30 feet high, 0.7 mile SE. of Ct. 66-3 (after Smith, 1968? unpubl. ms.).

Compiled by B.J. O'Connor Date 1-29-82

CERAMIC TESTS AND ANALYSES

Material Weathered shale (Conasauga Fm.) Compilation Map Location No. Ct. 66-5

County Catoosa. Sample Number No. 118 ("new 21").

Raw Properties: Lab & No. USBM, Tuscaloosa, Ala.; #G-7-5.

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

Water of Plasticity 22.0% % Working Properties Low plasticity.

Color Brown. Drying Shrinkage 2.5 % Dry Strength Low.

Remarks No drying defects. pH = 5.35

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Density, g/cm^3
1800 (982)	Tan	3	2.5	23.2	-	1.66
1900 (1038)	Tan	2	2.5	20.4	-	1.73
2000 (1093)	Tan	3	5.0	16.5	-	1.84
2100 (1149)	Light brown	4	5.0	13.0	-	1.95
2200 (1260)	Brown	5	7.5	8.7	-	2.04
2300 (1260)	-	-	(melted)	-	-	-

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^+			
Loss on Ignition			
Total			

Analyst ______ ______

Date ______ ______

Method ______ ______

Sample Location Data:

County Catoosa. Land Lot ______, Sec. ______, Dist. ______.

71/2' topo quad. Ringgold (SE. 1/4) . Lat. ______, Long. ______.

Field No. 118, ("new 21") , Collected by J.W. Smith. Date 1966.

Sample Method Horizontal channel sample. Weathering/alteration Weathered.

Structural Attitude Highly folded; most bedding dips steeply and strikes about N-S.

Stratigraphic Assignment Conasauga (or Rome?) Formation (Cambrian) shale.

Sample Description & Comments Weathered, light greenish-gray shale from outcrop 105 feet long and about 8 feet high on driveway to barn on west side of road within 50 feet of barnyard gate. Location is on County Road S-1286 about 0.15 mile N. of the "courthouse" in Catoosa (near Tiger Creek?) (After, Smith, 1968?, unpubl. ms.).

Compiled by B.J. O'Connor Date 1-29-82

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.

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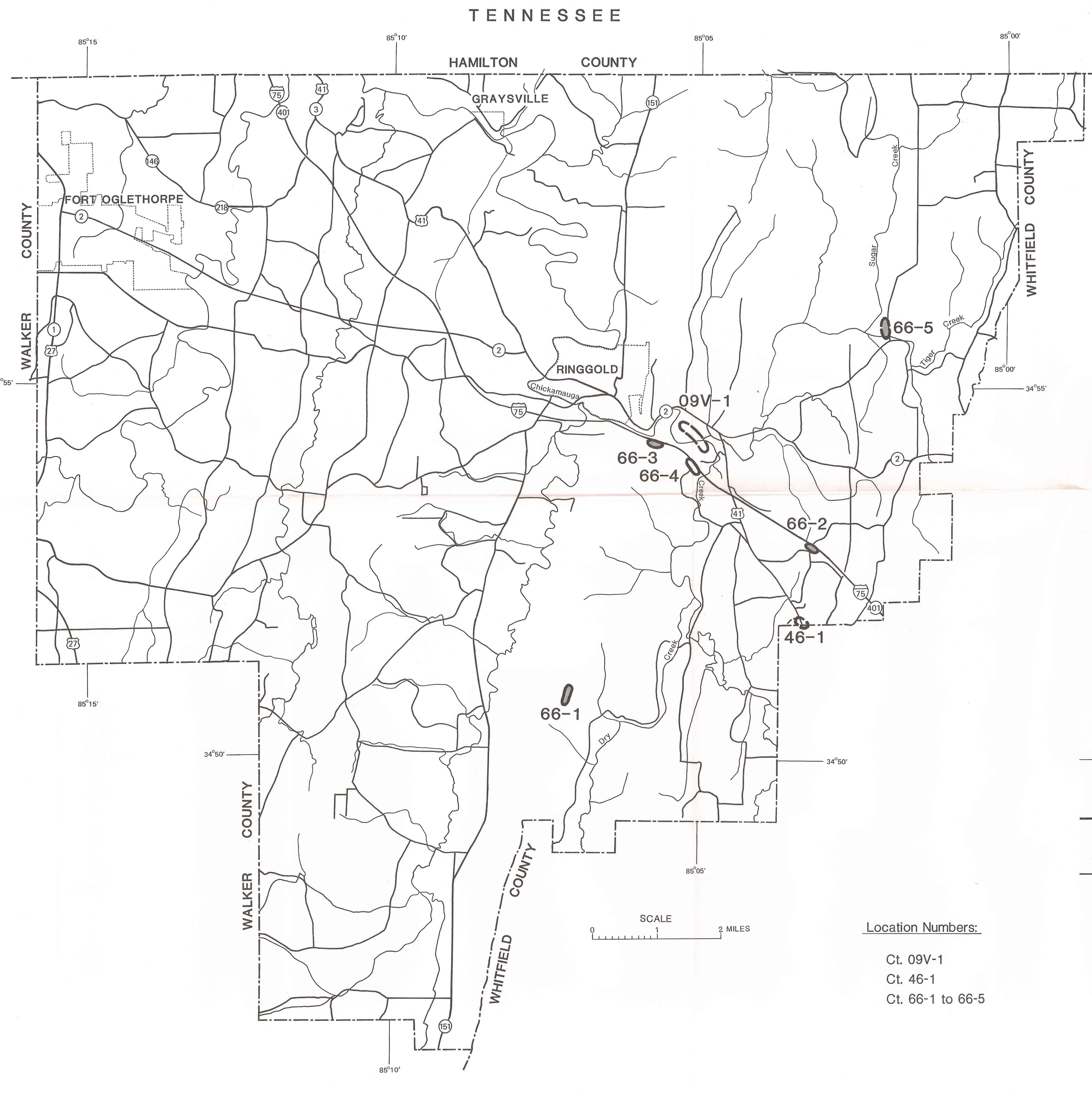
CLAY AND SHALE TEST LOCATIONS IN CATOOSA COUNTY



EXPLANATION

66–2 Numbers correspond to the "Map Location No." in text.

Approximate location for a single sample.

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

Streams and lakes

Highways and major roads

Minor roads

Modified after the 1975 General Highway Map of Catoosa County, Georgia Dept. of Transportation.