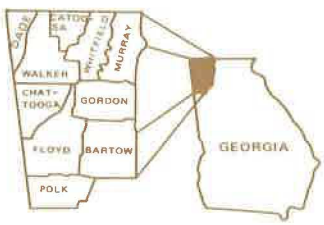
CERAMIC AND STRUCTURAL CLAYS, SHALES AND SLATES OF MURRAY COUNTY, GEORGIA

Bruce J. O'Connor



DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION DIVISION
GEORGIA GEOLOGIC SURVEY

Information Circular 70

Cover Photo: Loading Conasauga Shale, used for face brick manufacture, in the shale pit of the Chatsworth Clay Mfg. Co., west of the Tennessee Rd., Ga. Hwy. 61; south of Chatsworth. See map location no. Mry. 31S-44 for tests on samples from this location.

Photo by R.W. Smith, May 24, 1935; courtesy of the Georgia Department of Archives and History.

CERAMIC AND STRUCTURAL CLAYS, SHALES AND SLATES OF MURRAY COUNTY, GEORGIA

By

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Information Circular 70

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This report presents a compilation of all available published and unpublished ceramic firing tests and related analytical data on samples from Murray County, Georgia.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

Tests by the U.S. Bureau of Mines, subsequently referred to as USBM, were performed by the Norris Metallurgy Research Laboratory, Norris, Tennessee and the Tuscaloosa Research Center, Tuscaloosa, Alabama under cooperative agreements with the Georgia Geologic Survey and its predecessors (i.e., the Earth and Water Division of the Ga. Department of Natural Resources; the Department of Mines, Mining and Geology; and the Geological Survey of Georgia). Many of the firing tests were performed on samples collected by former staff members of the Georgia Geologic Survey (and its predecessors) during several uncompleted and unpublished studies. These include work by Bentley (1964), Smith (1968?) and Tadkod (1980). Additional unpublished data presented in this compilation include work by TVA (see Butts and Gildersleeve, 1948, p. 124 and 125). Published data include studies by the following authors: Veatch (1909, p. 397 to 398), Smith (1931, p. 193 to 211), and Hollenbeck and Tyrrell (1969, p. 18 to 20).

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

ACKNOWLEDGEMENTS

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

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

LOCATION OF STUDY AREA

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

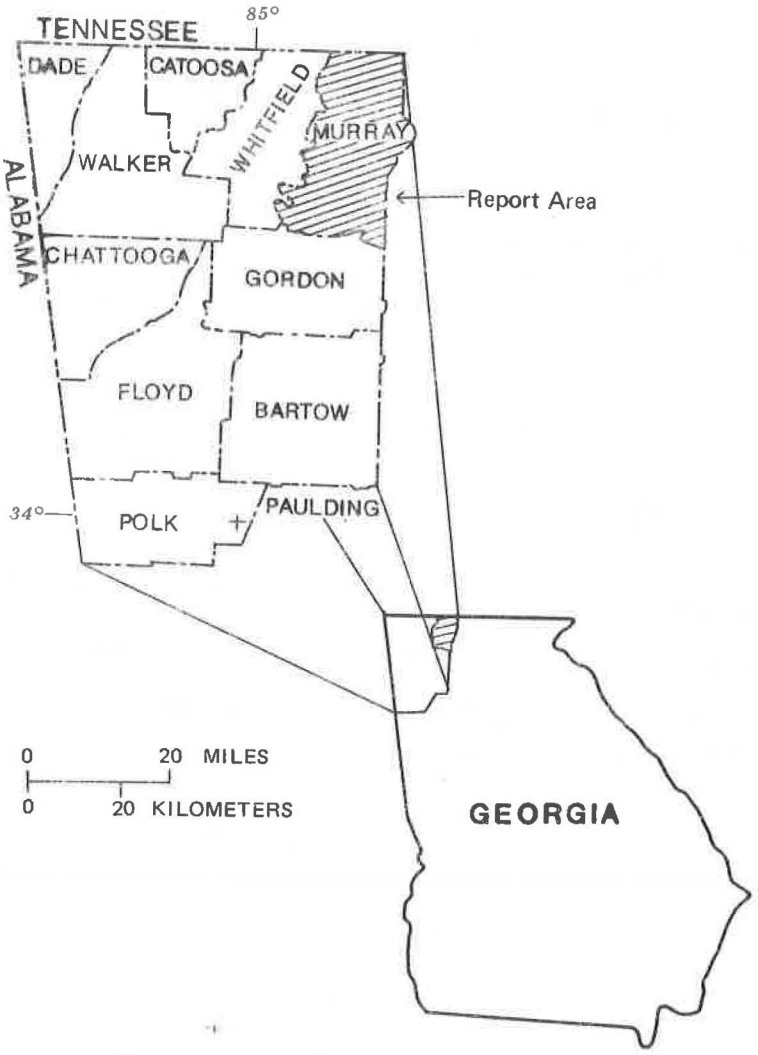


FIGURE 1

LOCATION OF MURRAY COUNTY REPORT AREA

(after Cressler, and others, 1976)

TABLE 1

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

Chatsworth Clay Manufacturing Co. (1929), Chatsworth plant and pits: Face brick from (Conasauga Group) shale. Purchased from Penley (Henley?) Brick Co., 1929. Ceramic test: Mry. 31S-44 (Smith, 1931, No. 44, p. 194).

Cohutta Talc Co. (1906), Dalton?: Talc. Ceramic test (micaceous talc): Mry. 41-1 (& Mry. 45-2?) (Furcron & Teague, 1947).

Georgia Talc Co. (1905), Chatsworth: Talc. Ceramic test: Mry: 45-1. Presently owned by Southern Talc Co.

Penley Brick Co. (c. 1905), Chatsworth plant and pits: Common brick from alluvial clay (Veatch, 1909, p. 397 & 423). Purchased by Chatsworth Clay Co., 1929 (Smith, 1931, No. 44, p. 194).

*Southern Talc Co. (1936), Chatsworth: Talc and crushed slate. Formerly Georgia Talc Co. Ceramic test: Mry. 45-1 (?)

NOTE:

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

*Active pit.

TABLE 2

Generalized Summary of Stratigraphic Units in Murray County, Northwest Georgia

CHRONOSTRATIGRAPHAIC 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.
Ordovician	Chota Formation - Approx. 1500 ft., crossbedded, reddish gray sandy limestone and calcareous sandstone. *Athens Shale - Approx. 3000-4000 ft., gray calcareous clayey and silty shale, siltstone, and sandstone.
Cambrian-Ordivician	Knox Group - Approx. 3000-4000 ft., dominantly cherty dolostone, minor limestone. Includes: Newala Limestone - Approx. 300-400 ft., limestone and dolostone; Longview Limestone - Approx. 500 ft.; Chepultepec Dolomite - Approx. 500 ft.; and Copper Ridge Dolomite - Approx. 2000-3000 ft.
Cambrian	**Conasauga Group (or Formation) - Approx. 950-5000 ft., predominantly shale and limestone with minor sandstone; Includes: Maynardville Limestone Member - Approx. 1000 ft.; "Middle Unit" = Rutledge Limestone and Rogersville Shale? - Approx. 1000 ft.; and "Lower Unit" = Pumpkin Valley Shale and Honaker Dolomite? - Approx. 1000 ft. *Rome Formation - Approx. 300-500 ft., shale, and interbedded sandstone, siltstone and quartzite. Chilhowee Group (or Weisner Formation) - Approx. 300 ft., quartz sandstone, quartzite, conglomerate, and siltstone.

TABLE 2

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

CHRONOSTRATIGRAPHIC UNIT	STRATIGRAPHIC UNITS - THICKNESS AND ROCK TYPES 1/
Precambrian	Ocoee Supergroup - Slate, phyllite, quartzite, metagraywacke, mica schist, biotite gneiss, granite, minor talc & soapstone.

NOTES:

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

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

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

1/ = Descriptions based on data in 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 performed by the USBM, it was decided not to reproduce their data forms directly for several reasons. First, the USBM forms contain several entries which are not essential to this project (e.g., Date received) or do not make the most efficient use of space. Second, the USBM forms have been changed several times over the span of decades covered by the present compilation. Finally, investigators from other laboratories have reported parameters which were not measured by the USBM.

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

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

1. Absorption (%)

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

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

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

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

TABLE 3

Abbreviations for Terms on the Ceramic Firing Test Forms

ABBREVIATIONS

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

Btw. = Bartow County

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

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

E. = East

°F = Degrees Fahrenheit
Fl. = Floyd County

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

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

Mry. = Murray County

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

org. = Organic

Plk. = Polk County

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

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

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

Temp. = Temperature
TVA = Tennessee Valley Authority

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

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

XRD = X-ray diffraction

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

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

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

4. Bloating

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

5. Bloating Test (or Quick Firing Test)

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

6. Bulk Density (or Bulk Dens.)

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

7. Color

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

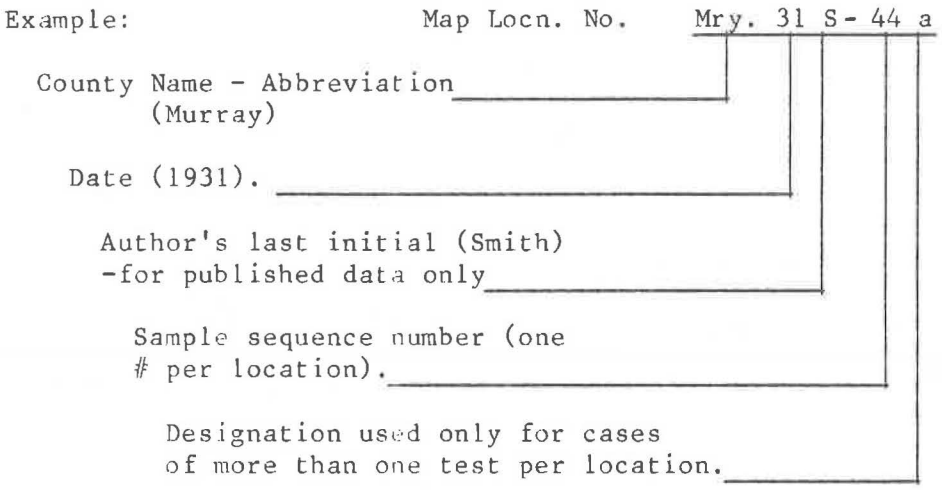
8. Color (Munsell)

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

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

9. Compilation Map Location No.

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



The map location number Mry. 31S-44 is derived from the county name (e.g., Mry. for Murray County), the year the tests were performed (e.g., 31 for 1931) plus the last initial of the author for major published sources (e.g., S for Smith), followed by a sequence number assigned in chronological order or sequential order for published data. (The only exceptions to this are the tests reported in Smith, 1931, wherein the sequence number of the present report is the same as the "Map location No." of Smith.) Each map location number represents a

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

10. Cone

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

11. Drying Shrinkage

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

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

12. Dry Strength

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

13. Extrusion Test

More extensive tests are sometimes made on clays and shales which

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

14. Firing Range

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

15. Hardness

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

16. Hardness (Mohs')

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

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

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

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

17. HCl Effervescence

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

18. Linear Shrinkage, (%)

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

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

19. Modulus of Rupture (MOR)

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

20. Mohs'

See Hardness (Mohs').

21. Molding Behavior

See Working Properties.

22. Munsell

See Color (Munsell).

23. "MW" face brick

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

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

24. PCE - Pyrometric Cone Equivalent

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

25. pH

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

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

26. Plasticity

See Working Properties.

27. Porosity, Apparent

See App. Por.

28. Quick Firing

See Bloating Test.

29. Saturation Coefficient

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

30. Shrinkage

See Drying Shrinkage and Linear Shrinkage.

31. Slaking

See Working Properties.

32. Slow Firing Test

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

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

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

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

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

33. Solu-Br. (Solu-Bridge)

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

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

34. Soluble Salts

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

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

35. Strength

See Dry Strength and Modulus of Rupture.

36. "SW" face brick

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

37. Temp. °F (°C)

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

38. Water of Plasticity (%)

This is a measure of the amount of water (as weight percent relative to the dry material) required to temper the pulverized raw clay or shale into a plastic, workable consistency. This is not a precise measurement, being dependent upon the experience of the technician, the type of equipment used and the plasticity criteria. In most cases it represents the amount of water necessary for the material to be extruded into briquettes from a laboratory hydraulic ram press. In general, high water of plasticity values tends to correlate with a greater degree of workability, higher plasticity and finer grain size. Unfortun-

ately, 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, Shales, and Slates in Murray County, Georgia*

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

CERAMIC TESTS AND ANALYSES

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

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Survey, #70.

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

Water of Plasticity 18 % Working Properties Rather low plasticity; slakes very slowly or not at all.

Color Yellow to olive green. Drying Shrinkage 2.6 % Dry Strength (tensile) 40 psi.

Remarks Drying properties excellent.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color	Hardness	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1922 (1050) (=Cone 05)	Red	"steel hard"	3.5	-	-	-
2066 (1130) (=Cone 01)	Dark red	vitrified	6.0	-	-	-
2102 (1150) (=Cone 1)	Dark red	-	6.5	-	-	-
2210 (1210) (=Cone 4)	Very dark red	complete vitrification	7.0	-	-	-

(Free from cracking and warping on firing.)

Remarks / Other Tests Although it has low plasticity and dry strength "It should make an excellent common and dry press building brick,: and possibly vitrified brick (Veatch, 1909, p. 397).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	57.31
TiO_2	1.10
Al_2O_3	21.52
Fe_2O_3(total)	7.65
FeO	-
MnO	0.04
MgO	2.47
CaO	0.22
Na_2O	1.29
K_2O	2.70
P_2O_5	0.00
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	1.02
H_2O^+	-
Ignition loss	5.28
Total	100.60

Mineralogy: Not determined.

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

Analyst E. Everhart, Ga. Survey (in Veatch, 1909, p. 398 and Appendix B, No. 70, p. 414 and 415).

Date c. 1909.

Method Standard "wet".

Sample Location Data:

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

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

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

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

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian) shale.

Sample Description & Comments Sample of yellow to olive green, fine grained, lamellar shale taken from a cut on the L & N Railroad, 1/2 mile north of the Chatsworth station. The shale here is overlain by a relatively thin deposit of Quaternary(?) gravel (Veatch, 1909, p. 397-398).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale, greenish-drab (Conasauga). Compilation Map Location No. Mry.31S-44

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #44.

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

Water of Plasticity 16.8 % Working Properties Plasticity - poor and grainy, better on aging 4 days; slaking - slow; molding behavior - fair, column tends to swell, crack and tear edges.

Color Brownish-gray Drying Shrinkage 2.4 % Dry Strength (MOR) 188.0 psi.

Remarks Drying Behavior: Test bars slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (1YR-6/7)	972	1.9 (& 4.5)	15.3	-	Slight
1920 (1050)	Salmon (1YR-6/6)	1159	2.4 (& 4.8)	13.4	-	Slight
2000 1095)	Salmon red (1YR-6/5)	1362	2.8 (& 5.1)	12.1	-	Slight
2060 (1125)	Good red (10R-5/5)	1422	4.3 (& 5.9)	11.2	-	Slight
2090 (1145)	Good red (10R-4/4)	1697	4.0 (& 6.0)	9.0	-	Some
2160 (1180)	Dark red (10R-4/3)	1691	4.0 (& 6.0)	9.4	-	Some

Remarks / Other Tests Firing range: Cone 1 to 5 (commerial kiln: Cone 01 to 5). Shale was used by the Chatsworth Clay Mfg. Co. in making face brick at their plant in Chatsworth (Smith, 1931, p. 194-196).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Grinding a little difficult, tough rather than brittle.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	62.91
TiO_2	0.92
Al_2O_3	19.18
Fe_2O_3(total)	8.41
FeO	-
MnO	trace
MgO	trace
CaO	0.00
Na_2O	0.36
K_2O	1.69
P_2O_5	0.11
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	6.60
Total	100.18*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 195.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

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

Field No. 44., Collected by R. W.Smith. Date 1930.

Sample Method 3 ft. groove. Weathering/alteration Weathered.

Structural Attitude Strike "a little east of north" and dip approx. 30°E.

Stratigraphic Assignment Conasauga Group (Cambrian) - mapped as Rome Formation by Hayes (1892).

Sample Description & Comments Sample from 2 places in shale pit on W. side of Tenn. Road (Ga. Hwy. 61) just S. of Chatsworth and 1/4 mile west of brick plant (pit is 75 x 30 ft. and 5 ft. deep). Shale is semi-hard to hard and greenish-drab colored. It breaks into thin, flat pieces (not flakes) and is interbedded with thin sandstone beds (1 in. thick or less) and minor layers of plastic, bluish-gray, calcareous clay (Smith, 1931, p. 194-197).

Compiled by B. J. O'Connor Date 10-16-81

CERAMIC TESTS AND ANALYSES

Material Shale, soft to semi-hard (Conasauga). Compilation Map Location No. Mry.31S-45

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #45.

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

Water of Plasticity 23.1 % Working Properties Plasticity - poor and grainy, fair on aging 3 days; slaking - a little slow; molding - fair, tends to swell, crack and tear on edges.

Color Drab. Drying Shrinkage 2.5 % Dry Strength (MOR) 80.3 psi.

Remarks Drying Behavior: Very slight warpage.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (2YR-6/7)	556	1.9 (& 4.5)	19.6	-	Very slight
1920 (1050)	Salmon (10R-5/5)	898	3.3 (& 5.7)	17.9	-	Slight
2000 (1095)	Salmon red (10R-5/5)	1030	3.6 (& 6.2)	15.9	-	Slight
2060 (1125)	Medium red (10R-5/4)	1237	5.0 (& 7.2)	14.6	-	Slight
2090 (1145)	Good red (10R-4/5)	1298	5.1 (& 7.5)	12.9	-	Some
2160 (1180)	Dark red (9R-4/3)	1670	6.6 (& 8.7)	11.2	-	Some

Firing Range: Cone 1 to 6 and higher (commercial kiln 1 - Cone 1 to 6).

Remarks / Other Tests Suitable for making building brick and possibly structural tile. The somewhat poor working properties could possibly be improved by fine grinding, long pugging, hot tempering and/or electrolytes in the tempering water (Smith, 1931, p. 199).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	56.37
TiO_2	0.96
Al_2O_3	26.59
Fe_2O_3	6.46
FeO	1.63
MnO	0.00
MgO	0.41
CaO	0.00
Na_2O	0.25
K_2O	0.76
P_2O_5	trace
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	7.10
Total	100.53*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- free basis by Smith, 1931, p. 198.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

7 1/2' topo quad. Calhoun Northeast (NE. corner). Lat. _____, Long. _____.

Field No. 45., Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian) shale.

Sample Description & Comments Samples of soft to semi-hard greenish-drab shale (no sandstone or calcareous layers visible) from outcrops on the L & N Railroad, the old Spring Place Rd. and on the old Tenn. Road (toward Ft. Mtn.), 1 1/2 miles south of Chatsworth on the G. W. Swanson and J. Barksdale properties (Smith, 1931, p. 197-199).

Compiled by B. J. O'Connor Date 10-16-81

CERAMIC TESTS AND ANALYSES

Material Shale, hard and soft. Compilation Map Location No. Mry.31S-46

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #46.

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

Water of Plasticity 20.8 % Working Properties Plasticity - poor and grainy, better on aging 3 days; slaking - slow; and molding - fair, column edges tend to crack and tear.

Color Reddish-brown Drying Shrinkage 2.0 % Dry Strength (MOR) 83.1 psi.

Remarks Drying behavior: Good, test bars slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-6/6)	538	2.4 (& 4.7)	18.0	-	Some
1920 (1050)	Salmon (1YR-6/5)	1089	3.7 (& 5.6)	14.9	-	Some
2000 (1095)	Salmon red (2YR-6/6)	966	4.1 (& 6.0)	15.0	-	Some
2060 (1125)	Fair red (10R-5/5)	2008	5.3 (& 7.2)	10.2	-	Some
2090 (1145)	Medium red (10R-5/4)	2230	5.8 (& 7.5)	9.4	-	Some
2160 (1180)	Dark red (10R-4/3)	2098	7.1 (& 9.0)	7.8	-	Considerable

Firing Range: Cone 1 to 6 or higher (commercial kiln = Cone 01 to 6).

Remarks / Other Tests Satisfactory for making building brick and possibly structural tile. The harder shale has poorer working properties which could possibly be improved by fine grinding, long pugging, hot tempering water and/or electrolytes in the water (Smith, 1931, p. 201).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Rather difficult grinding (tough rather than brittle).

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide		Weight %
SiO_2		59.15
TiO_2		1.04
Al_2O_3		23.71
Fe_2O_3		4.36
FeO		3.31
MnO		0.00
MgO		0.15
CaO		0.00
Na_2O		1.05
K_2O		1.57
P_2O_5		0.43
S	(total)	0.00
C	(org.)	-
CO_2		-
H_2O^-		*
H_2O^+		-
Ignition loss		5.19
Total		99.96*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 200.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

7 1/2' topo quad. Ramhurst (NW. side . Lat. _____, Long. _____.

Field No. 46., Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Variably weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian) shale.

Sample Description & Comments Composite sample of hard, olive green shale (almost a slate-breaking into large, thin flat pieces) from L & N Railroad cut combined with soft shale weathered to red and drab colors (3 parts hard to 1 part hard shale) from a farm road east of the RR. Samples taken from the T. P. Anderson property, 3 miles south of Chatsworth at the junction of the old Tennessee Road and Ga. Hwy. 61 (the "new Tenn. Highway", Smith (1931, p. 199-201)).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Clay (plastic, red and gray) and Shale, soft greenish-drab (Conasauga). Compilation Map Location No. Mry.31S-47

County Murray. Sample Number -

Raw Properties: Lab & No. Ga.Tech., #47.

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

Water of Plasticity 22.3 % Working Properties Plasticity - a little grainy, fair on aging overnight; slaking - a little slow; molding - fair, slight tendency to tear edges.

Color Light brown. Drying Shrinkage 3.0 % Dry Strength (MOR) 150.5 psi.

Remarks Drying behavior: test bars somewhat warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-6/6)	985	2.5 (& 5.5)	17.0	-	Some
1920 (1050)	Salmon (2YR-6/5)	1458	4.2 (& 7.0)	13.4	-	Some
2000 (1095)	Salmon red (1YR-6/5)	1691	4.6 (& 7.3)	12.0	-	Considerable
2060 (1125)	Fair red (10R-5/5)	1774	5.9 (& 8.8)	10.6	-	Considerable
2090 (1145)	Medium red (10R-4/3)	2048	6.3 (& 9.2)	7.5	-	Considerable
2160 (1180)	Dark red (10R-3/3)	2686	7.7 (& 10.4)	5.3	-	Considerable

Firing Range: Cone 1 to 5 and higher (commercial kiln = Cone 1 to 5 or 6).

Remarks / Other Tests This shale is suitable for making building brick, structural tile and possibly roofing tile and sewer pipe (Smith, 1931, p. 203).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	60.68
TiO_2	0.94
Al_2O_3	20.88
Fe_2O_3	8.28
FeO	1.06
MnO	0.50
MgO	0.42
CaO	0.00
Na_2O	0.23
K_2O	1.19
P_2O_5	0.16
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	6.33
Total	100.67*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- free basis by Smith, 1931, p. 202.)

Analyst E. Everhart, Ga. Survey.

Date 1931.

Method Standard "wet".

Sample Location Data:

County Murray. Land Lots 307 and 308, Sec. 3, Dist. 26.

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

Field No. 47., Collected by R. W. Smith Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude Beds strike N.25°E., dip approx. 60°SE.

Stratigraphic Assignment Conasauga Group (Cambrian) shale.

Sample Description & Comments Samples from cuts on the "Tenn. Highway" (Ga. Hwy. 61) 2 miles north of Ramhurst and immediately south of Chicken Creek, on the G. W. Wilbanks and F. Clayton properties. The fissile shale ranges from soft to semi-hard (mostly greenish-drab but with some reddish and purplish-brown streaks) which is interlayered with red and gray plastic clay. The shale is hardest at the north end, nearest the creek, whereas the clay layers are thickest and most numerous to the south at the top of the ridge (Smith, 1931, p. 201-203).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale, hard olive green Compilation Map Location No. Mry.31S-48
Conasauga).
County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #48.

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

Water of Plasticity 21.4 % Working Properties Plasticity-grainy at first, fair on aging 3 days; slaking -- a little slow; molding -- fair, column edges tend tear and crack.
Color Light brown. Drying Shrinkage 1.9 % Dry Strength (MOR) 100.9 psi.

Remarks Drying Behavior: Test bars all slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-6/7)	934	2.9 (& 5.0)	17.8	-	Slight
1920 (1050)	Salmon red (1YR-6/6)	1472	3.4 (& 5.3)	14.9	-	Slight
2000 (1095)	Salmon red (10R-5/5)	1809	4.8 (& 6.6)	12.5	-	Some
2060 (1125)	Medium red (10R-5/4)	2330	6.3 (& 7.9)	9.4	-	Some
2090 (1145)	Medium red (10R-4/4)	2922	7.5 (& 9.2)	6.8	-	Some
2160 (1180)	Dark red (10R-4/3)	3337	7.9 (& 9.3)	5.7	-	Some

Firing Range: Cone 1 to 5 and higher (commercial kiln - Cone 1 to 5).

Remarks / Other Tests Shale is suited for making building brick and possibly for structural tile, roofing tile and sewer pipe. The poor working properties may possibly be overcome by fine grinding, long pugging, hot tempering water, and/or electrolytes in the water (Smith, 1931, p. 206).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide		Weight %
SiO_2		67.93
TiO_2		0.91
Al_2O_3		16.19
Fe_2O_3		6.26
FeO		1.03
MnO		0.00
MgO		0.07
CaO		0.00
Na_2O		1.17
K_2O		0.97
P_2O_5		trace
S	(total)	0.00
C	(org.)	-
CO_2		-
H_2O^-		*
H_2O^+		-
Ignition loss		5.59
Total		100.12*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 204.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

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

Field No. 48., Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Some weathering.

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian) shale.

Sample Description & Comments Samples of hard to semi-hard, olive drab shale weathering into thin, flat or splintery pieces which are stained red in places. These are from the cuts on the Tennessee Highway (Ga. Hwy. 61) south of the Wilbanks and Clayton properties (Mry. 31S-47), on a hill about 1/2 mile south of Yellow Creek just north of Pisgah Church near the Davis and Street property line, 3/4 mile northwest of Ramhurst (Smith, 1931, p. 203-206).

Compiled by B. J. O'Connor Date 5-22-87

CERAMIC TESTS AND ANALYSES

Material Soft shale and plastic clay. Compilation Map Location No. Mry.31S-49

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #49.

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

Water of Plasticity 36.1 % Working Properties Plasticity - poor, "short" and mealy; Slaking - fairly rapid; molding behavior - rather poor, column edges tend to crack and tear.

Color Red. Drying Shrinkage 2.7 % Dry Strength (MOR) 44.0 psi.

Remarks Drying Behavior: Test bars all slightly warped.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Warpage
1800 (1005)	Salmon (2YR-6/6)	521	3.8 (& 6.6)	27.8	-	Slight
1920 (1050)	Salmon (1YR-5/4)	988	5.4 (& 7.9)	23.3	-	Some
2000 (1095)	Salmon red (10R-5/5)	1084	6.2 (& 8.5)	21.4	-	Some
2060 (1125)	Good red (10R-4/4)	1575	9.0 (& 11.4)	17.5	-	Some
2090 (1145)	Good red (10R-4/3)	1741	10.2 (& 12.0)	15.4	-	Considerable
2160 (1180)	Dark red (10R-4/2)	1951	11.2 (& 13.4)	11.5	-	Considerable

Firing Range: Cone 1 to 5 and higher (commercial kiln = Cone 1 to 5).

Remarks / Other Tests This material is only suitable for making building brick. The worst features are the low green strength along with the high shrinkage and absorption values through out the firing range (Smith, 1931, p. 209).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	63.80
TiO_2	0.80
Al_2O_3	17.69
Fe_2O_3(total)	9.20
FeO	-
MnO	trace
MgO	trace
CaO	0.00
Na_2O	0.45
K_2O	1.30
P_2O_5	1.11
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	5.68
Total	100.03*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- free basis by Smith, 1931, p. 208.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

7 1/2' topo quad. Ramhurst (center). Lat. _____, Long. _____.

Field No. 49., Collected by R. W. Smith. Date c. 1930.

Sample Method 3 ft. grooves Weathering Alteration Weathered shale and residual clay from weathering of impure limestone.

Structural Attitude Strike of thin stratified layers N. 20°E., dip 30 to 35° SE.

Stratigraphic Assignment Conasauga Group (Cambrian) shale and Recent (?) residual clay from argillaceous and siliceous Conasauga limestone.

Sample Description & Comments Groove samples from all varieties of material from road cuts on the "Fields Gap" (Ellijay-Ramhurst) road, 1/4 mile south of the old Dennis post office and Rock Creek, 1 1/4 mile E. of Ramhurst. Material form the J. B. Butler property is largely soft, "short" to somewhat plastic clay in thinly stratified layers ranging from bright yellow-ochre to red in color (from weathering of impure limestone). Lesser amounts of soft red shale is found as thin partings between clay layers and as beds up to 15 ft. thick (Smith, 1931, p. 207-209).

Compiled by B. J. O'Connor Date 10-19-81

CERAMIC TESTS AND ANALYSES

Material Shale, hard to semi-hard (Conasauga). Compilation Map Location No. Mry.31S-50

County Murray. Sample Number -

Raw Properties: Lab & No. Ga. Tech., #50.

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

Water of Plasticity 27.0 % Working Properties Plasticity - poor, short and grainy even on aging; slaking - slow; molding - poor. Bars hand-made in slop mold.

Color Red. Drying Shrinkage 1.9 % Dry Strength (MOR) 35.3 psi.

Remarks Drying Behavior: Rapid. Practically no warpage.

Slow Firing Tests:

Approx. Temp. °F (°C)	Color* (Munsell)	Hardness (MOR, psi.)	Linear Shrinkage, % dry (plastic)	Absorption %	Appr. Por. %	Other data: Warpage
1840 (1005)	Salmon (3YR-6/6)	564	1.1 (& 3.1)	21.8	-	Little or none
1920 (1050)	Salmon red (1YR-6/6)	1195	2.6 (& 4.5)	19.1	-	Little or none
2000 (1095)	Salmon red (1YR-5/5)	826	3.3 (& 5.1)	18.5	-	Slight
2060 (1125)	Medium red (10R-5/4)	1414	4.6 (& 6.1)	15.1	-	Little or none
2090 1145	Medium red (10R-4/5)	1419	4.1 (& 6.1)	14.2	-	Some
2160 (1180)	Good red (9YR-4/4)	1222	4.8 (& 6.5)	13.7	-	Some

Firing Range: Not reached in these tests.

Remarks / Other Tests This shale is not suited, by itself, for making heavy clay products particularly due to the low green and fired strengths (MOR's) and the high absorption values. Fired colors are good, however, and blending the shale with small amounts of more plastic shale or clay as a binder might improve these poor strength and absorption values sufficiently to make the shale usable (Smith, 1931, p. 211).

Preliminary Bloating (Quick Firing) Tests: Not determined.

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

Crushing Characteristics (unfired material) Easy grinding.

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

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	65.35
TiO_2	0.91
Al_2O_3	17.63
Fe_2O_3(total)	8.57
FeO	-
MnO	-
MgO	trace
CaO	0.00
Na_2O	0.76
K_2O	1.38
P_2O_5	0.12
S (total)	0.00
C (org.)	-
CO_2	-
H_2O^-	*
H_2O^+	-
Ignition loss	5.35
Total	100.07*

Mineralogy: Not determined.

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

(* = analysis recalculated on an H_2O^- -free basis by Smith, 1931, p. 210.)

Analyst E. Everhart, Ga. Survey.

Date c. 1930.

Method Standard "wet".

Sample Location Data:

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

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

Field No. 50., Collected by R. W. Smith. Date c. 1930.

Sample Method Grab samples. Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Conasauge Group (Cambrian) shale.

Sample Description & Comments Samples of weathered to partly weathered, red to reddish-brown, hard to semi-hard somewhat slaty shale. Even though it is fairly soft, the weathered shale is somewhat "short" and crumbly. Samples from 500 ft. long cuts on new (in 1930) site of "Tenn. Hwy. (Ga. Hwy. 61) just north of the Coosawattee River (Carters Stn.) with a few pieces of hard shale from top of the hill - all from the S. W. Carter property (Smith, 1931, p. 209-11).

Compiled by B. J. O'Connor Date 10-19-81

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Mry.45-1

County Murray. Sample Number -

Raw Properties: Lab & No. USBM, Norris, Tn.; #X-77.

Date Reported 8-28-45. Ceramist H. Wilson, USBM.

Water of Plasticity - % Working Properties Poor to fair plasticity and workability.

Color Light cream. Drying Shrinkage Normal to low. % Dry Strength -

Slow Firing Tests:

Approx. Temp. °F (°C)	Color (Munsell)	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
2150 (1177)	"grayed stoneware" (+ multitude of red-black specks due to presence of a fine iron mineral grit).	-	-	-	-	

Remarks / Other Tests If iron mineral can be removed this clay would be better for art pottery and possibly other types of near whiteware. Otherwise possibly usefull for gray face brick, specialty brick or tile, but would have to be fired higher than usual for hardness and vitrification (approx. 2150°F, 1177°C).

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size - Retention Time -

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	Weight %
SiO_2	50.18
TiO_2	1.10
Al_2O_3	36.37
Fe_2O_3(total)	2.18
FeO	-
MnO	-
MgO	0.84
CaO	0.54
Na_2O	-
K_2O	-
P_2O_5	-
S (total)	-
C (org.)	-
CO_2	-
H_2O^-	1.11
H_2O^+	-
Ignition loss	7.72
Total	100.04

Mineralogy: Not determined.

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

Analyst L. H. Turner, Ga. Survey (unpublished files). Lab No. 3881)

Date 7-20-45.

Method Standard "wet".

Sample Location Data:

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

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

Field No. -, Collected by J. W. Glean. Date 1945.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment "Paleozoic area" Conasauga Group (Cambrian).

Sample Description & Comments Clay sample from the Paleozoic area near Ramhurst for Mr. J. W. Glenn (Ga. Talc Company) - exact location unspecified. (Chemical analysis form states "Adjoins place south of old Butler Place." Possibly near Mry. 31S-49.)

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

CERAMIC TESTS AND ANALYSES

Material Clay. Compilation Map Location No. Mry.45-2

County Murray. Sample Number -

Raw Properties: Lab & No. USBM, Norris, Tn.; #Ga-7.

Date Reported 12-12-45. Ceramist Speil, USBM.

Water of Plasticity 48 % Working Properties Very poor workability (platy - due to micaceous particles).

Color Light cream. Drying Shrinkage 3.5 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
2240 (1225) (=Cone 8)	White	Very soft	1.2	44	-	-
2350 (1285) (=Cone 11)	-	Very soft	-	41	-	

Remarks / Other Tests Not satisfactory for use, by itself, for making ceramic products; however, it might be beneficiated to yield a good grade of fine mica.

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^+				
Ignition loss		_____		
Total				

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. - , Collected by (F. F. Farrar ?) Date c. Sept. 1945.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments Sample of micaceous clay (talc or sericite ?) submitted by the Cohutta Talc Company of Dalton (Whitfield Co.), Ga. (Exact location unspecified, but probably associated with their talc properties on Fort Mountain in eastern Murray Co.).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

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

County Murray. Sample Number TVA 19.

Raw Properties: Lab & No. N.C. State College Research Lab
Asheville, North Carolina; TVA #116.

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

Water of Plasticity - % Working Properties -

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

Slow Firing Tests:

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

Preliminary Bloating (Quick Firing) Tests: Negative.

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

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

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 19. , Collected by K. H. Teague (TVA). Date 1946?

Sample Method Grab (?) Weathering/alteration _____

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H.S. Rankin (TVA, 10-22-46). Sample is a relatively hard and blocky, brown to red shale taken from a road-cut on U.S. Hwy. 411, 3 miles north of intersection with Ga. Hwy. 136 (formerly Ga. Hwy. 156).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

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

County Murray. Sample Number 20-21.

Raw Properties: Lab & No. N.C. State College Research Lab
Asheville, North Carolina; TVA #117.

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

Water of Plasticity - % Working Properties -

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

Slow Firing Tests:

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

Preliminary Bloating (Quick Firing) Tests: Negative.

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

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

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 1/2' topo quad. Ramhurst (W. cntr.). Lat. _____, Long. _____.

Field No. 20-21, Collected by K. H. Teague (TVA). Date 1946?

Sample Method Grab (?) Weathering/alteration _____

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments Interim report on tests from N.C. Research Lab via H. S. Rankin (TVA, 10-22-46). Sample from roadcuts on U.S. 411, where the L & N R.R. crosses over, about 7 miles south of Chatsworth and 1 1/2 mile south of Ramhurst. Samples, taken along road for about one-fourth mile, are of gray to green shale, quite tough and blocky, and which weathers relatively slowly. Large tonnages are available here.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Athens). Compilation Map Location No. Mry.64-1

County Murray. Sample Number 32

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1554-D
Date Reported 5-8-64. (revised 1967) Ceramist M. V. Denny, USBM. (revised by M.E. Tyrrell, Tuscaloosa, Ala.)
Water of Plasticity 13.8 % Working Properties Short working, smooth, mealy. (Low plasticity.) pH=9.15 (High effervescence with HCl.)
Color Gray. Drying Shrinkage 0.5(0.0) % Dry Strength Fair. (Low).

Remarks Drying Characteristics: Poor, scum, crazing, rough. (No defects.)

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Light brown	Soft (2)	0.5(0.0)	21.9	37.0	1.69
1900 (1038)	Light brown	Fair hard (3)	0.5(0.0)	21.5	37.0	1.72
2000 (1093)	Medium brown	Fair hard (3)	0.5(0.0)	21.6	36.5	1.69
2100 (1149)	Chocolate	Hard (4)	0.5(0.0)	14.4	26.8	1.86
2200	Dark brown	Glassy	Melted (Expanded)	-	-	-

Remarks / Other Tests Considerable carbonate, some sulfate, causing white coating. Melts about 2150°F (1177°C). (Probably limy. Abrupt vitrification.) Potential Use None. (Not suitable for use in vitreous clay products.)

Preliminary Bloating (Quick Firing) Tests: Negative.

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

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 32 _____, Collected by J. W. Smith? Date Approx. 1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Athens Shale (Ordovician).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Mry.64-2

County Murray. Sample Number 85

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-D
Date Reported 6-26-64. (revised 1967) Ceramist M. V. Denny, USBM. (revised by M.E. Tyrrell, Tuscaloosa, Ala.)
Water of Plasticity 26.8 % Working Properties Moderate plasticity. pH=5.7. Not effervescent with HCl.
Color Tan. Drying Shrinkage 5.0 % Dry Strength Fair.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	2	5.0	26.2	41.4	1.58
1900 (1038)	Tan	3	9.0	21.3	36.2	1.70
2000 (1093)	Light brown	4	9.0	17.0	28.9	1.70
2100 (1149)	Chocolate	5	10.0	11.2	22.0	1.96
2200 (1204)	Chocolate	5	10.0	10.4	20.4	1.96
2300 (1260)	Dark brown	6	10.0	8.9	17.4	1.96

Remarks / Other Tests *Should fire to building brick specifications at about 2100°F (1149°C). Potential Use: Building brick. Good firing range.

Preliminary Bloating (Quick Firing) Tests: Negative.

*With revisions by K.J. Liles (written communication, 1987).

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 85, Collected by J. W. Smith? Date Approx. 1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Conasauga). Compilation Map Location No. Mry.64-3

County Murray. Sample Number 86

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-E
Date Reported 6-26-64. (revised 1967) Ceramist M. V. Denny, USBM. (revised by M.E. Tyrrell, Tuscaloosa, Ala.)
Water of Plasticity 27.8 % Working Properties Low plasticity. pH=6.0 Not effervescent with HCl.
Color Tan. Drying Shrinkage 0.0 % Dry Strength Low.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	2	0.0	25.4	39.4	1.55
1900 (1038)	Tan	3	4.0	19.7	33.3	1.69
2000 (1093)	Light brown	4	5.0	16.4	29.2	1.78
2100 (1149)	Brown	5	9.0	9.8	19.3	1.97
2200 (1204)	Chocolate	5	10.0	6.3	13.0	2.06
2300 (1260)	Dark brown	6	10.0	3.5	7.5	2.13

Remarks / Other Tests *Should fire to building brick specifications at about 2150°F (1177°C). Potential Use: Building bricks. Good firing range.

Preliminary Bloating (Quick Firing) Tests: Negative.

*With revisions by K.J. Liles (written communication, 1987).

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 86 _____, Collected by J. W. Smith? Date Approx. 1963.

Sample Method Grab (?). Weathering/alteration - _____

Structural Attitude - _____

Stratigraphic Assignment Conasauga Group (Cambrian). _____

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

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

County Murray. Sample Number 87

Raw Properties: Lab & No. USBM, Norris, Tenn.; No. 1556-F
Date Reported 6-26-64 (revised 1967) Ceramist M. V. Denny, USBM. (revised by M.E. Tyrrell, Tuscaloosa, Ala.)
Water of Plasticity 29.0 % Working Properties Low plasticity.
pH=6.1 Not effervescent with HCl.
Color Red. Drying Shrinkage 0.0 % Dry Strength Low.

Remarks Drying Characteristics: No defects.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data: Bulk Dens. gm/cc
1800 (982)	Tan	2	0.0	28.1	44.4	1.58
1900 (1038)	Tan	2	1.0	24.1	41.0	1.70
2000 (1093)	Light brown	3	5.0	20.2	36.8	1.82
2100 (1149)	Brown	4	7.5	14.1	28.2	2.00
2200 (1204)	Chocolate	4	10.0	8.1	18.2	2.25
2300 (1260)	Dark brown	5	10.0	4.1	9.8	2.40

Remarks / Other Tests *Should fire to building brick specifications at about 2150°F (1177°C). Poor color. Potential Use: Building brick.

Preliminary Bloating (Quick Firing) Tests: Negative.

*With revisions by K.J. Liles (written communication, 1987).

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time 15 min. draw trials (folowing 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^+			
Ignition loss			
Total			

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 87, Collected by J. W. Smith? Date Approx. 1963.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment Conasauga Group (Cambrian).

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Clay/shale? Compilation Map Location No. Mry.67-1

County Murray. Sample Number 148

Raw Properties: Lab & No. USBM, Tuscaloosa, AL; G-9-11

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

Water of Plasticity 30.1 % Working Properties Low plasticity.
pH=4.8 Not effervescent with HCl.

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	2	5.0	29.4	42.3	1.44
1900 (1038)	Tan	2	5.0	29.3	42.8	1.46
2000 (1093)	Tan	3	5.0	27.5	41.3	1.50
2100 (1149)	Light brown	4	7.5	23.7	37.7	1.59
2200 (1204)	Brown	5	7.5	20.7	34.4	1.66
2300 (1260)	Dark brown	6	10.0	14.5	26.5	1.83

Remarks / Other Tests *Low green strength; high maturing temperature. Suitable for use as building brick at 2200°-2300°F(1204°-1260°C).

Preliminary Bloating (Quick Firing) Tests: Negative.

*With revisions by K. J. Liles (written communiction, 1987).

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 148, Collected by J. W. Smith? Date Approx. 1966.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Clay/shale? Compilation Map Location No. Mry.67-2

County Murray. Sample Number 149

Raw Properties: Lab & No. USBM, Tuscaloosa, AL; G-9-12

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

Water of Plasticity 25.9 % Working Properties Low plasticity.
pH=4.7 Not effervescent with HCl.

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)	Light tan	2	2.5	28.1	41.3	1.47
1900 (1038)	Light tan	3	2.5	26.9	40.6	1.51
2000 (1093)	Light tan	4	5.0	19.5	33.3	1.71
2100 (1149)	Light brown	5	10.0	11.3	22.1	1.96
2200 (1204)	Gray	6	12.5	5.3	11.4	2.15
2300 (1260)	Gray	7	12.5	4.1	9.0	2.19

Remarks / Other Tests *Should fire to building brick specifications at about 2100°F (1149°C). Low green strength. Potential use: Building brick.

Preliminary Bloating (Quick Firing) Tests: Negative.

*With revisions by K.J. Liles (written communication, 1987).

Crushing Characteristics (unfired material) -

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

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. 149, Collected by J. W. Smith? Date Approx. 1966.

Sample Method Grab (?). Weathering/alteration -

Structural Attitude -

Stratigraphic Assignment -

Sample Description & Comments No further data available.

Compiled by B. J. O'Connor Date 6-15-86

CERAMIC TESTS AND ANALYSES

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

County Murray. Sample Number MUR-1.

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

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

Water of Plasticity 20.1 % Working Properties -

Color Orange red. Drying Shrinkage 2.4 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Medium tan	3.0	3.0	27.5	-	1.49
2000 (1093)	Pink	4.0	3.5	26.4	-	1.52
2100 (1149)	Red brown	4.5	5.5	16.5	-	1.56
2200 (1204)	Dark brown	5.5	8.0	14.5	-	1.93

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p. 20).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

7 1/2' topo quad. Oakman (N. center). Lat. _____, Long. _____.

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

Sample Method Channel (?). Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Conasauga Formation (Cambrian) shale.

Sample Description & Comments Sample of reddish-brown shale, weathered (about 10 feet exposed) overlain by soil. Sampled from lower 6 feet of road cut on east side of U.S. Highway 411, 1.9 miles north of intersection with Ga. Hwy. 136 (formerly 156) (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 1-30-82

CERAMIC TESTS AND ANALYSES

Material Slate (Consauga Formation). Compilation Map Location No. Mry.69-2

County Murray. Sample Number MUR-2.

Raw Properties: Lab & No. USBM, Tuscaloosa, AL.; #MUR-2.

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

Water of Plasticity 17.5 % Working Properties -

Color Light tan. Drying Shrinkage 0.8 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Dark tan	4.5	0.8	26.5	-	-
2000 (1093)	Dark tan	5.0	0.8	26.5	-	1.44
2100 (1149)	Red brown	5.5	2.0	22.4	-	1.60
2200 (1204)	Red brown	6.5	5.5	16.3	-	1.80

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p. 20).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

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

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

Structural Attitude -

Stratigraphic Assignment Conasauga Formation (Cambrian) slate.

Sample Description & Comments Sample of light gray and tan slate, slightly weathered (about 6 feet exposed) overlain by soil. Road cut on north side of U.S. Hwy. 76, 1 mile east of intersection with U.S. Hwy. 411 (Hollenbeck and Tyrrell, 1969 p.18).

Compiled by B. J. O'Connor Date 6-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Athens). Compilation Map Location No. Mry.69-3

County Murray. Sample Number MUR-3.

Raw Properties: Lab & No. USBM, Tuscaloosa, AL.; #MUR-3.

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

Water of Plasticity 21.8 % Working Properties -

Color Tan. Drying Shrinkage 4.1 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Medium tan	4.0	8.5	21.5	-	-
2000 (1093)	Pink	4.0	8.5	20.3	-	1.60
2100 (1149)	Red brown	5.0	12.0	12.2	-	1.87
2200 (1204)	Dark brown	6.5	15.5	4.7	-	1.98

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p. 20).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. MUR-3., Collected by R. P. Hollenbeck. Date 1967.

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

Structural Attitude -

Stratigraphic Assignment Athens Shale (Ordovician)

Sample Description & Comments Sample of moderately weathered gray shale (about 10 feet exposed) overlain by sandstone. Collected from center of exposure on cut in hill about 200 yards west of U.S. Highway 411, 1.3 miles south of intersection with Ga. Highway 2 (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 1-30-82

CERAMIC TESTS AND ANALYSES

Material Shale (Athens). Compilation Map Location No. Mry.69-4

County Murray. Sample Number MUR-4.

Raw Properties: Lab & No. USBM, Tuscaloosa, AL.; #MUR-4.

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

Water of Plasticity 11.2 % Working Properties -

Color Gray. Drying Shrinkage 2.1 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Pink	4.0	0.8	-	-	-
2000 (1093)	Pink	4.0	1.0	20.0	-	1.69
2100 (1149)	Red brown	4.5	1.0	18.5	-	1.87
2200 (1204)	Dark brown	7.0	6.0	7.4	-	2.03

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p.20).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. MUR-4, Collected by R.P. Hollenbeck. Date 1967.

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

Structural Attitude -

Stratigraphic Assignment Athens Shale (Ordovician).

Sample Description & Comments Sample of hard gray calcareous shale, slightly weathered (about 20 feet exposed - sample taken from lower 6 feet) from road cut on north side of paved road, 1 mile west of intersection with U.S. Highway 411. Intersection is just north of Sumac Creek (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 6-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Rome Formation). Compilation Map Location No. Mry.69-5

County Murray. Sample Number MUR-5.

Raw Properties: Lab & No. USBM, Tuscaloosa, AL.; #MUR-5.

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

Water of Plasticity 21.1 % Working Properties -

Color Red gray. Drying Shrinkage 2.4 % Dry Strength -

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1900 (1038)	Medium tan	3.0	5.2	25.0	-	1.60
2000 (1093)	Dark tan	4.0	5.2	24.6	-	-
2100 (1149)	Dark tan	4.5	8.0	19.1	-	1.64
2200 (1204)	Red brown	5.0	8.5	15.6	-	1.93

Remarks / Other Tests Hollenbeck and Tyrrell (1969, p.20).

Preliminary Bloating (Quick Firing) Tests: Negative.

Crushing Characteristics (unfired material) -

Particle Size -20 mesh. Retention Time -

Chemical & Mineralogical Data: Not determined.

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

Analyst _____ _____

Date _____ _____

Method _____ _____

Sample Location Data:

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

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

Field No. MUR-5. , Collected by R.P. Hollenbeck. Date 1967.

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

Structural Attitude -

Stratigraphic Assignment Rome Formation (Cambrian) shale.

Sample Description & Comments Sample of red and gray shale, moderately weathered (about 12 feet exposed) overlain by soil. Sample from upper 6 feet on road cut on the north side of Ga. Highway 2, 2.3 miles west of intersection with Ga. Highway 225, about 1-1/2 miles east of Whitfield County line (Hollenbeck and Tyrrell, 1969, p. 18).

Compiled by B. J. O'Connor Date 9-15-86

CERAMIC TESTS AND ANALYSES

Material Shale (Red Mtn.). Compilation Map Location No. Mry.80-1

County Murray. Sample Number Clay No. 7.

Raw Properties: Lab & No. Marazzi Ceramiche, #M.P. 1796.

Date Reported March 1980. Ceramist L. Lorici.

Water of Plasticity - % Working Properties Schistose.

Color Brown. Drying Good % Dry Strength -
Pressing Good. Fluidizing Good.

Slow Firing Tests:

Temp. °F (°C)	Color	Hardness (Mohs')	Linear Shrinkage, %	Absorption %	Appr. Por. %	Other data:
1976 (1080) (=cycle 1)	-	-	-	-	-	-
2030 (1110) (=cycle 2)	-	-	2.2	-	12.3	-
1994 (1090) (=cycle 3)	-	-	3.2	-	9.6	

(DTA and Dilatometric Analyses on file. - unpubl. report.)

Remarks / Other Tests Illitic shale with high mica and low clay mineral contents. ("C": much too refractory and not at all suitable for making tile.)

Preliminary Bloating (Quick Firing) Tests: Not determined.

Crushing Characteristics (unfired material) -

Particle Size < 40 Retention Time Cycle 1: 40-45 min.
Cycle 2: 70-75 min. in roller kiln.
Cycle 3: 200-230 min.

Chemical & Mineralogical Data:

Chemical Analysis

Oxide	(A) Weight %	(B)
SiO_2	63.22	68.4
TiO_2	0.70	1.0
Al_2O_3	18.80	18.2
Fe_2O_3	6.96	7.7
FeO	-	-
MnO	0.04	-
MgO	1.15	0.9
CaO	0.11	0.0
Na_2O	0.02	-
K_2O	3.10	3.0
P_2O_5	-	-
S (total)	-	-
C (org.)	-	-
CO_2	-	-
H_2O^-	-	-
H_2O^+	-	-
Ignition loss	5.68	(5.8)
Total	99.78	99.2 w/o LOI

Mineralogy

Mineral	volume % (A)	(B)
Quartz		x
Feldspar		
Carbonate		
Mica		x
Chlorite-vermiculite	(15)	
Montmorillonite		
Others	(85)	x
Total	-	-

x = present.
(A) - clays and micas only.

Analyst A) R. Landrum, GA Survey
B) Marazzi Ceramiche.

M.A. Tadkod, GA Survey.
M. Ceramiche.

Date Aug. and Sept. 1979

Aug. and Sept. 1979.

Method A) Atomic Absorption
B) XRF and Spectrophotometry.

X-ray diffraction.

Sample Location Data:

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

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

Field No. 10A., Collected by M.A. Tadkod. Date July 1979.

Sample Method Grab. Weathering/alteration Weathered.

Structural Attitude -

Stratigraphic Assignment Probably Athens Shale (Ordovician).*

Sample Description & Comments Sample from a roadcut on GA Hwy. 2 about 1/8 mi. east of Cisco (Tadkod, 1979 & 1980, unpubl. data). *Notes state "Red Mtn. Formation" but this area is mapped as Athens Shale (Cressler, 1974, Pl. 3).

Compiled by B. J. O'Connor Date 6-15-86

DATA SOURCES AND REFERENCES CITED

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

- C4-62 (Reapproved 1970) Standard specification for clay drain tile, Part 16, p. 1-7.
- C13-69 (Replaced by C700-74) Specifications for standard strength clay sewer pipe, Part 16, p. 409-413.
- C24-72 Pyrometric cone equivalent (PCE) of refractory materials, Part 17, p. 9-14.
- C27-70 Classification of fireclay and high-alumina refractory brick, Part 17, p. 15-17.
- C43-70 Standard definitions of terms relating to structural clay products, Part 16, p. 33-35.
- C62-69 Standard specification for building brick (solid masonry units made from clay or shale), Part 16, p. 121-125.
- C216-71 Standard specification for facing brick (solid masonry units made from clay or shale), Part 16, p. 121-125.
- C410-60 (Reapproved 1972) Standard specification for industrial floor brick, Part 115, p. 217-218.
- C479-72 Standard specification for vitrified clay liner plates, Part 16, p. 283-284.
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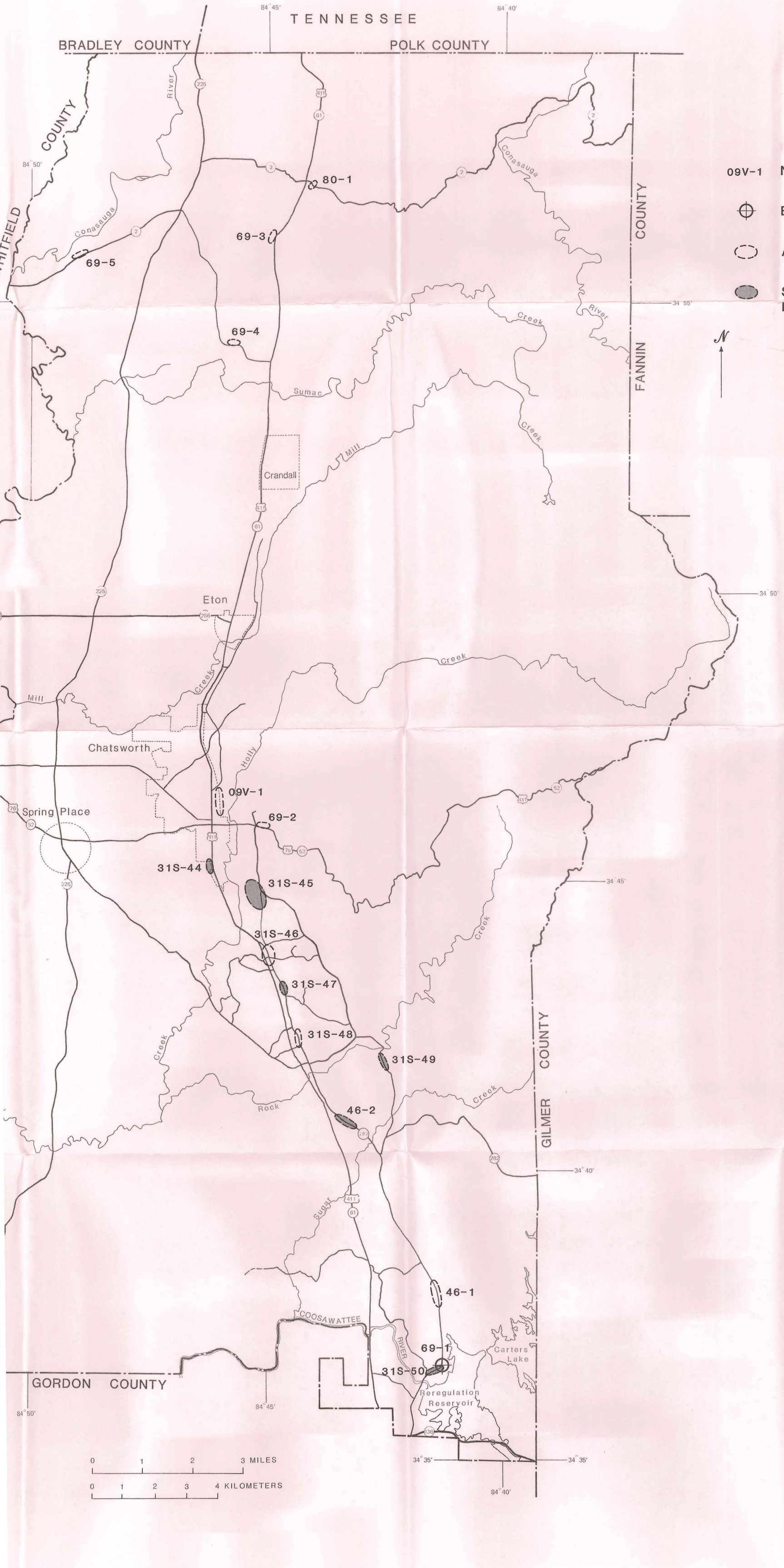
Plate 1

CLAY, SHALE AND SLATE TEST LOCATIONS IN MURRAY COUNTY



EXPLANATION

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

Exact sample location.

Approximate sample location.

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

Location numbers:

Mry. 09V-1

Mry. 31S-44 to Mry. 31S-50

Mry. 46-1 and Mry. 46-2

Mry. 69-1 to Mry. 69-5

Mry. 80-1

Not shown (location unknown):

Mry. 45-1 and Mry. 45-2

Mry. 64-1 to Mry. 64-4

Mry. 67-1 and Mry. 67-2