Test-Hole Exploration for Light-Firing Clay in Cloud and Ellsworth Counties, Kansas

By Norman Plummer, Clarence S. Edmonds, and Maynard P. Bauleke

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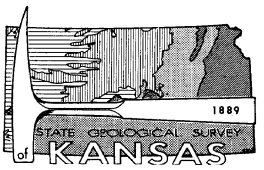

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ABSTRACT

In two areas in Kansas (Ellsworth County, sec. 25, T. 15 S., R. 7 W., and Cloud County, sec. 12, T. 8 S., R. 2 W.) the Dakota Formation was systematically drilled to determine the availability of light-color-burning clay. Beds of light-burning clay lack continuity in Cloud County in the upper part of the Dakota; however, in the Ellsworth County area the lower part of the formation contains well-defined, continuous layers of light-burning clay. The lack of continuity of one and the well-defined continuity of the other is not confined to the test localities but extends over areas of several square miles. These conditions are not typical of clays in these two stratigraphic positions, but they illustrate the extreme variations in extent and continuity of beds that can be expected in the commercial exploitation of clays in either the upper or lower beds of the formation. Both test areas have clay deposits suitable for structural clay products.

Résumé

On a foré systématiquement la Formation Dakota dans deux régions du Kansas (l'Ellsworth County, sec. 25, T. 15 S., R. 7 W., et le Cloud County, sec. 12, T. 8 S., R. 2 W.) pour déterminer la disponibilité d'une argile d'un brûlement couleur claire. Les couches d'argile de brûlement clair n'ont pas de continuité dans le Cloud County dans la partie supérieure du Dakota; cependant, dans la région de l'Ellsworth County la partie inférieure de la formation contient des couches bien-définies et continues d'argile de brûlement clair. Le manque de continuité de l'un et la continuité bien-définie de l'autre n'est pas limité aux localitiés d'essai mais s'étend sur des régions de plusieurs kilomètres carrés. Ces conditions ne sont pas typiques des argiles dans ces deux positions stratigraphiques, mais elles montrent les extrêmes variations d'étendue et de continuité des couches qu'on peut s'attendre dans l'exploitation du commerce des argiles ou dans les couches supérieures ou les inférieures de la formation. Toutes deux régions d'essai ont des dépôts d'argile convenables à de structuraux produits argileux.

Resumen

En dos áreas en Kansas (Ellsworth County, sec. 25, T. 15 S., R. 7 W., y Cloud County, sec. 12, T. 8 S., R. 2 W.) la Dakota Formation fué perforada sistemáticamente para determinar la disponibilidad de arcilla de color claro cuando horneada. Las capas de este tipo de arcilla carecen de continuidad en la parte superior de la Dakota Formation en el Cloud County; sin embargo, en el área del Ellsworth County la parte inferior de la formación contiene capas continuas y bien definidas de este tipo de arcilla. La carencia de continuidad en la parte superior y la continuidad bien definida en la parte inferior no son confinadas a las localidades de pruebas, pero se extienden sobre áreas de varios kilómetros cuadrados. Estas condiciones no son típicas de arcillas en estas dos posiciones estratigráficas, pero ilustran las variaciones extremas en extensión y continuidad de capas que puedan ser encontradas durante la explotación comercial de arcillas en las capas superiores o inferiores de la formación. En ambas áreas de puebas hay depósitos de arcillas que sirven para productos estructurales.

Anszug

Die Dakota Formation wurde in zwei Gebieten in Kansas (Ellsworth County, sec. 25, T. 15 S., R. 7 W., und Cloud County, sec. 12, T. 8 S., R. 2 W.) systematisch erbohrt, um das Vorhandensein von hellfarbig brennendem Ton zu erkunden. Betten von hell brennendem Ton zeigen im Cloud County im oberen Teil des Dakota keine Kontinuität, wohingegen der untere Teil der Formation in dem Gebiet im Ellsworth County gut definierte kontinuierliche Schichten von hell brennendem Ton enthält. Fehlende Kontinuität im einen und gut ausgeprägte Kontinuität im anderen ist nicht auf die Testgegenden beschränkt, sondern erstreckt sich über mehrere Quadratkilometer. Diese Zustände sind für Tone in diesen zwei stratigraphischen Positionen nicht typisch, aber sie illustrieren die sehr grossen Variationen in Ausdehnung und Kontinuität der Betten, die bei der kommerziellen Ausbeutung von Tonen in sowohl den oberen wie auch den unteren Betten der Formation erwartet werden können. Beide Testgebiete weisen Ablagerungen auf, die für baugewerbliche Tonprodukte geeignet sind.

INTRODUCTION

In 1949 a chemical manufacturer showed interest in using Kansas clay as a parting agent for ammonium fertilizers and as a diluent for insecticides. On the basis of information gathered from pit samples taken in 1938 through 1940 and reported subsequently (Plummer and Romary, 1947), two locations, in sec. 25, T. 15 S., R. 7 W. (Ellsworth County), and in sec. 12, T. 8 S., R. 2 W. (Cloud County), were chosen as possible sources of supply (Fig. 1). Test holes were drilled during the spring and summer of 1949.

To be useful for the above applications a clay deposit must have the following characteristics: (1) light-gray to almost white color, (2) minimum overburden, and (3) large size. None of the clay sampled from the two locations met all of the requirements. The main deterrent was lack of whiteness in the raw clay. Clay deposits in both areas have potential as a raw material for the manufacture of red and buff structural clay products.

The purpose of this report is to describe the ceramic properties of selected clays from the two locations and the general geology of the deposits.

Acknowledgments

The areas were investigated and sampled by R. G. Hardy,* then of Mineral Products Company, Kansas City, Missouri, and Norman Plummer, State Geological Survey of Kansas.

GENERAL GEOLOGY

Clay, silt, and sandstone described in this report are in the Dakota Formation. The subdivision of the Dakota Formation and its relationship to underlying and overlying formations is shown below.

Cretaceous System
- Upper Cretaceous Series
  - Graneros Shale
- Lower? Cretaceous Series
  - Dakota Formation
    - Janssen Clay
    - Terra Cotta Clay
- Lower Cretaceous Series
  - Kiowa Shale

Geologists working in Central Kansas use the unofficial term "Andrews section" to designate the lower, predominantly gray part of the Terra Cotta Clay. The Andrews section is well exposed on the Andrews Ranch 1 to 2 miles east of Kanopolis both in clay pits of the Acme Brick Company and on natural outcrops. In this report, the predominantly red-mottled upper two-thirds to three-fourths of the Terra Cotta Clay will be designated "upper Terra Cotta" and the lower, thinner, predominantly gray part the "Andrews section."

The Janssen Clay is made up of clay, siltstone, and sandstone, as well as carbonaceous material, lignite, limonite, hematite, and siderite. The rocks are predominantly gray with some irregular yellow stains; shades of red are rare.

The Terra Cotta Clay also is made up of clay, siltstone, and sandstone. In the upper two-thirds to three-fourths of the member (upper Terra Cotta), coloring from iron compounds is more evident than in the Janssen and red-mottled gray clay is a distinctive feature. The sandstone beds commonly are yellow, although gray to nearly white colors are not uncommon, and all weather to brown. The lower part of the Terra Cotta (Andrews section) is similar in appearance to the Janssen, but it probably contains less clay and more sand and silt. The Andrews section is easily distinguished from the upper Terra Cotta in the field. Commonly clay beds of the Andrews section are gray with irregular yellow stains, and the sandstone and siltstone tend to be more evenly bedded with less staining from ferric iron compounds than beds in the upper Terra Cotta. Beds near the Kiowa-Dakota contact in the lower part of the Andrews section commonly contain compounds of ferrous iron that tend to produce brownish colors in the fired clay.

Members of the Dakota Formation show many similar characteristics. Most of the clay is structureless and slakes rapidly in water. Shaly bedding is not common in the clay, though lamination may produce a shaly appearance on some weathered outcrops. Kaolinite is the dominant clay mineral in the Dakota Formation in Kansas. Illite is present, but usually does not exceed 25 percent except in the lower part of the Andrews section. Recent work (P. C. Franks, personal communication) indicates that some of these lower clays in central Kansas may contain as much as 50 percent illite. Whether or not these high-illite clays are in the Dakota Formation, or represent a mixed transition between

* Mr. Hardy is now on the staff of the Industrial Minerals Division of the State Geological Survey.

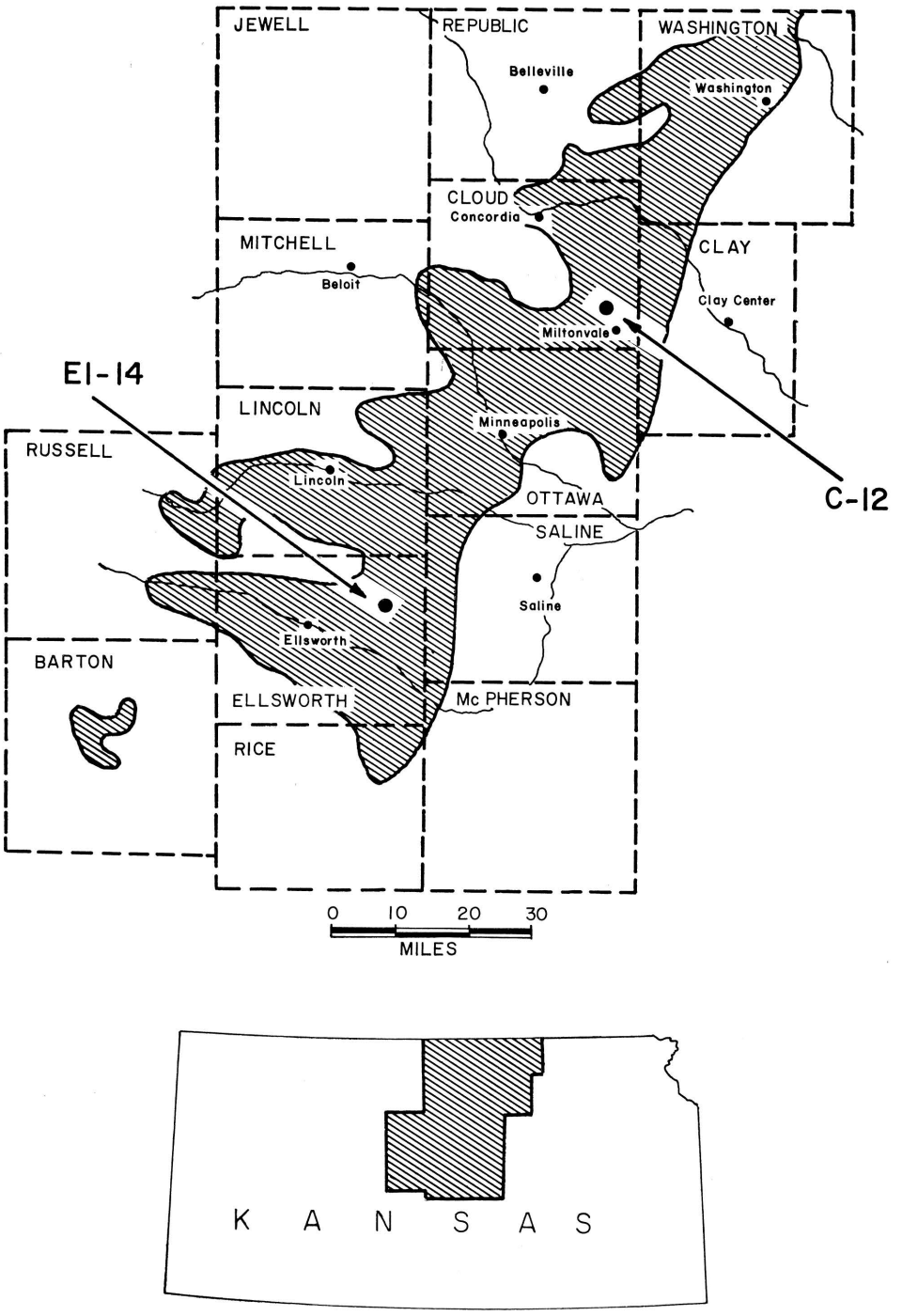


FIGURE 1.—Index map of test-hole areas C-12 and EL-14 and outcrop of the Dakota Formation.

Dakota Formation and Kiowa Shale has not been definitely established; in many locations the contact has been fixed arbitrarily. In the Kiowa Shale below the Dakota Formation and in the Graneros Shale above, illite is the dominant clay mineral. Kaolinite is rarely found in the Graneros Shale, but as much as 50 percent of it has been observed in the upper part of the Kiowa Shale. Montmorillonite may occur in both. Thin beds of nearly pure montmorillonite are found in places in the Graneros Shale.

Siderite ($FeCO_3$) pellets, usually less than one-eighth inch in diameter, are characteristic of unweathered clay from the Dakota Formation. Upon weathering, the siderite normally alters to limonite or other iron oxides. Both pyrite (FeS_2) and selenite ($CaSO_4 \cdot 2H_2O$) are found scattered throughout the Dakota Formation. The red-mottled clay rarely, if ever, contains pyrite; selenite crystals are common on the outcrop. Both pyrite and selenite are found in the gray clay, especially in that of darker gray color.

Calcareous-cemented sandstone and siltstone, locally called "quartzite," occur as concretions in zones throughout the formation; rarely, the cementing material is barite or silica. The zones seemingly have local continuity, and exposures of the quartzite follow definite directional trends, generally northeast-southwest.

Accurate information is not available concerning the total thickness of the Dakota Formation in Ellsworth and Cloud Counties. In a relatively small area southwest of Russell in Russell County, the Dakota ranges in thickness from 213 to 300 feet (Swineford and Williams, 1945). It is estimated that the minimum thickness of the Dakota Formation in Ellsworth County is greater than 200 feet, but that it probably does not exceed 300 feet. The maximum combined thickness observed for the Dakota Formation and the Kiowa Shale in Cloud County is 400 feet (Bayne and Walters, 1959), but the thickness of the Kiowa Shale is believed to be less than 100 feet. The Dakota Formation may exceed 300 feet in thickness in the northwestern corner of Cloud County, but it is probably less than 300 feet in the C-12 area (Fig. 1).

The upper 120 feet of the Dakota Formation that was penetrated by test borings in the C-12 area (Cloud County) includes the Janssen Clay (at the top of the Dakota Formation and in contact with the overlying Graneros Shale) and slightly less than half of the upper Terra Cotta Clay. The lower 109 feet of the Dakota Formation that was explored by test drilling in the EL-14 area (Ellsworth County) includes about one-third of the upper Terra Cotta and all of the Andrews section. The lowermost beds of the Andrews section are in contact with the Kiowa Shale (underlying the Dakota Formation). Thus the beds discussed in this report constitute the full thickness of the Dakota Formation, except for approximately 50 feet of the section near the middle of the formation.

TEST HOLES

Drilling

Most test holes for the Cloud County area (C-12) were drilled along contour lines (Fig. 2); the Ellsworth County (EL-14) test holes were drilled on a grid pattern (Fig. 3).

Holes were drilled using a 2-inch fish-tail rotary bit. Samples obtained by this wet rotary drilling are susceptible to contamination from overlying layers and from the recirculated clay mixed with the drilling water. Much of the buff-firing clay showed a pinkish tint when fired. This tint is attributed to contamination from overlying red-firing layers. Buff-firing clay taken from pits in the same area (Plummer and Romary, 1947) did not show this pink tint. Furthermore, for the 120 feet of clay sampled, the total thickness of buff-firing clay obtained from the pit samples exceeded the thickness obtained by rotary drilling. Undoubtedly most of the clay listed as pink-firing would have fired to some shade of buff if uncontaminated samples could have been recovered. The drilling log of each test hole is listed in the Appendix.

Clay Stratigraphy

One representative set of graphic logs through each test-hole area, C-12 in Cloud County (Fig. 4) and EL-14 in Ellsworth County (Fig. 5), illustrates the clay stratigraphy. On the left side of each test-hole column is recorded the raw sample (unfired) color; on the right side is recorded the fired color (cone 02, or 2075°F) and the percent water absorption (five-hour boil) for each interval from which sample bricks were made. Samples were not retained for ceramic testing from all of the intervals. It was impossible to recover samples from some of the intervals, and others were worthless because of contamination by caving or by the drilling mud. Samples deeply stained with red, brown,

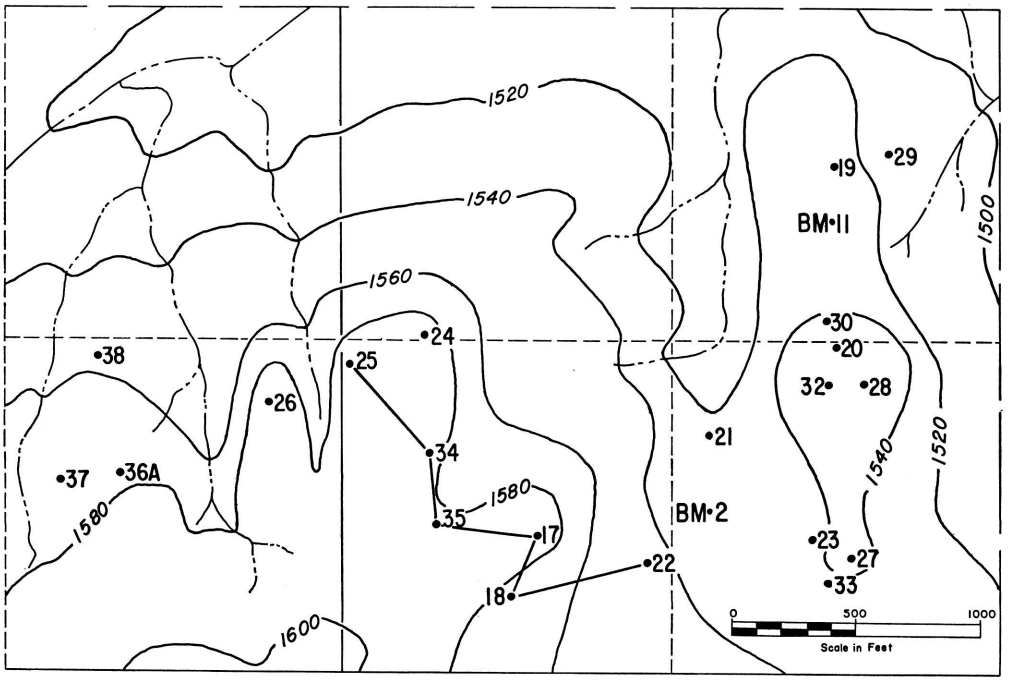


FIGURE 2.—Test-hole pattern and topography at C-12 (Cloud County), showing location of test holes described in Appendix and line of section shown in Figure 4. C-12 area is E½ SE¼ sec. 11 and SW¼ sec. 12, T. 8 S., R. 2 W.

or yellow were obviously red-firing and were not retained.

The highest elevation at the top of the test holes is about 1600 feet above sea level in the C-12 area, and 1610 feet in the EL-14 area. Stratigraphically, the upper bed in the Ellsworth County area is possibly as much as 200 feet below the highest elevation in the Cloud County area because of the north-northeast component of the regional dip.

The normal sequence of beds in the Janssen is, from the top downward: gray sand or silt, dark-gray clay, and lighter gray clay. The upper Terra Cotta Clay commonly is gray with red mottling. The normal sequence of beds in the lower part of the Terra Cotta (Andrews section) is the reverse of that in the Janssen. From the top of the Andrews section downward the order is: light- to medium-gray clay, dark-gray clay, and sandstone or silt. The Kiowa Shale, where present, underlies the last-named beds.

The test-hole logs (Appendix) show much greater complexity than the above description would imply, but the relationship indicated provides a useful means for generalizing the com-

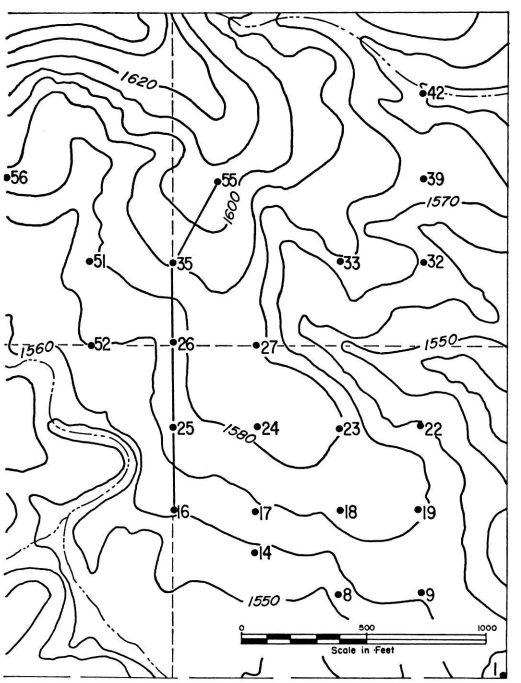


FIGURE 3.—Test-hole pattern and topography at EL-14 (Ellsworth County), showing location of test holes described in Appendix and line of section shown in Figure 5. EL-14 area is E½ **NE**¼ and E½ W½ NE¼ sec. 25, T. 15 S., R. 6 W.

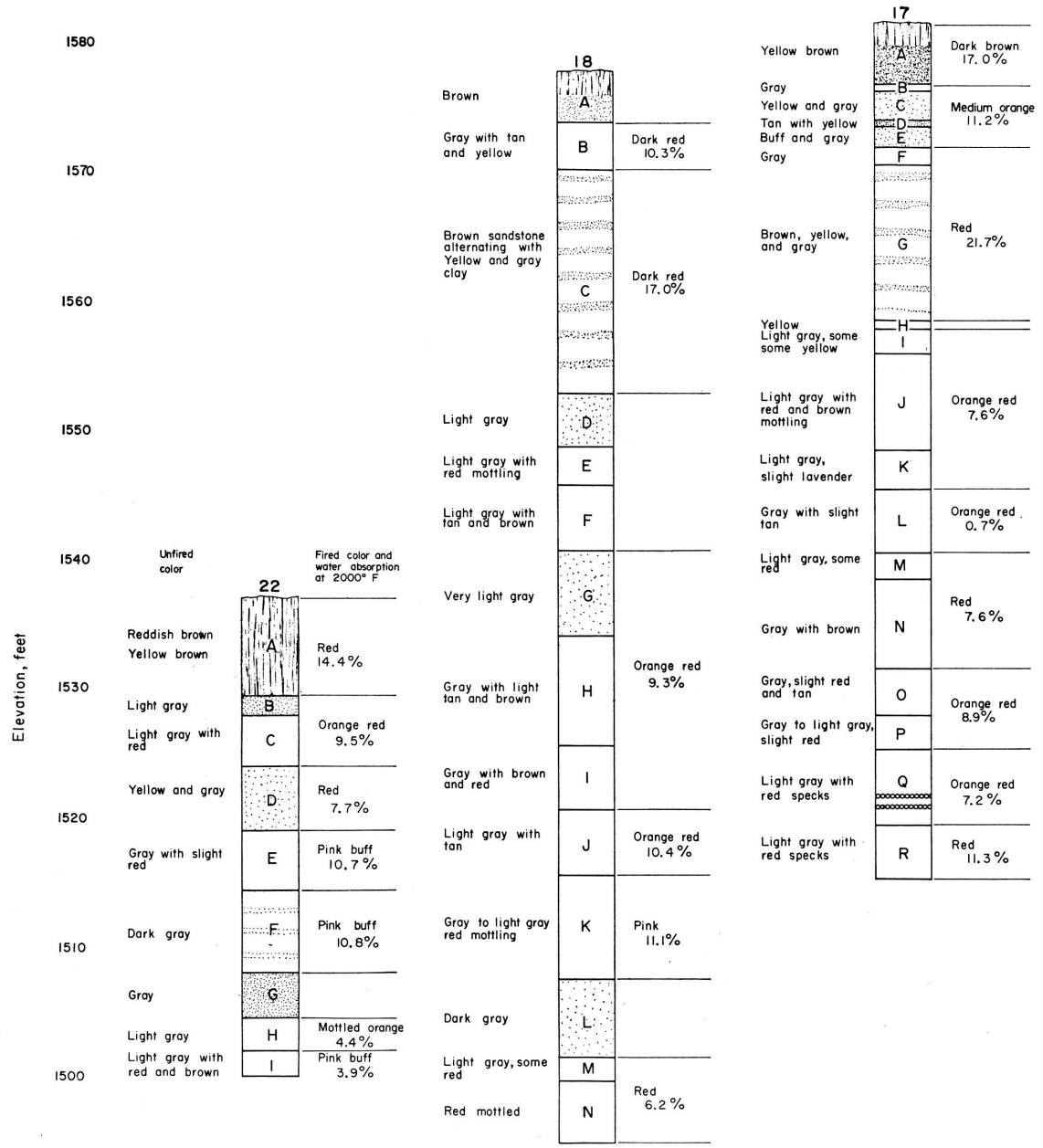
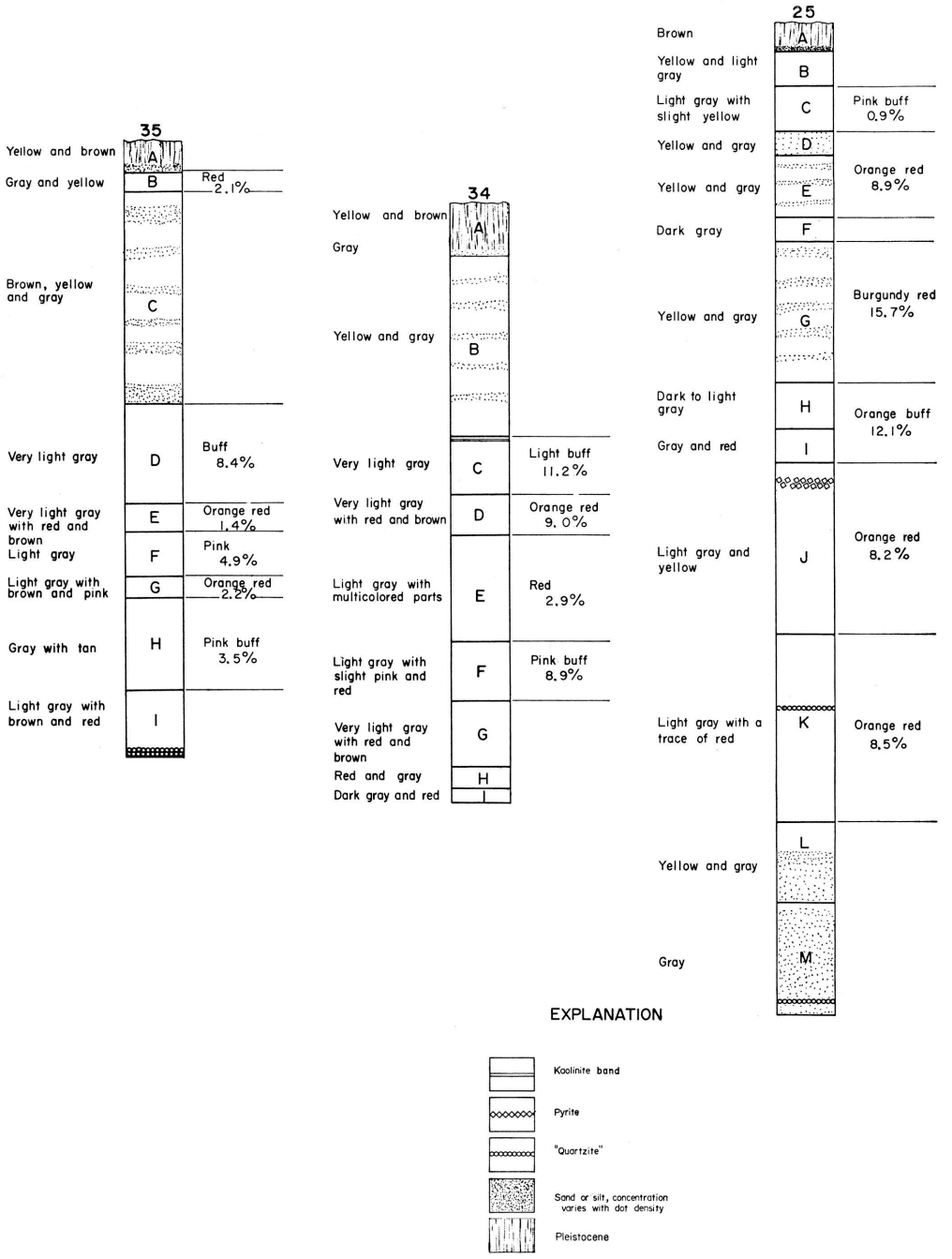


FIGURE 4.—Graphic logs of selected test holes in C-12 area. (Locations of test



holes shown on Figure 2; for test-hole numbers, see Appendix, Cloud County.)

plexity, and it explains, for example, why red-mottled clay underlies the beds of gray clay in the C-12 area, whereas the gray beds underly the red-mottled ones in the El-14 area.

Throughout the outcrop area of the Dakota Formation in central and north-central Kansas, the thickness and continuity of the clay and sandstone beds show considerable lateral variation despite the fact that the general character is fairly constant. In general the beds of the Janssen Clay are fairly continuous, although thicknesses vary greatly. Field evidence indicates that the lithology of the upper Terra Cotta, characterized by red-mottled clay, possibly ranges locally from 90 percent clay to 90 percent sandstone and silt. Deposits of buff-firing clay have been found within the upper Terra Cotta, but little is known about either their lateral or vertical distribution. The beds of the Andrews section seem to be much less continuous and constant in thickness than those of the Janssen. Furthermore, the Andrews section may be very thin, or possibly missing in some areas. Where exposed, however, the Andrews section is characteristic enough to be recognizable.

The test-hole logs (Appendix) seem to contradict the above statements because neither the Janssen Clay in Cloud County (C-12) nor the Andrews section in Ellsworth County (EL-14) are typical of the Dakota Formation in Kansas. Although inconsistency is typical of the Dakota Formation, the Janssen at C-12 and the Andrews section at EL-14 are more aberrant than usual.

The Janssen Clay in the C-12 area of Cloud County, in contrast to the Andrews section in the EL-14 area in Ellsworth County, is made up of irregularly-shaped bodies of clay, sand, and silt of uncertain magnitude, showing great variation in thickness and lateral extent. The greatest local variability known in the Janssen Clay was observed in this area. In addition to the variability in size and shape of the deposits, irregular beds of red-mottled clay were observed in the Janssen, or at the horizon of more or less typical Janssen clays. Although Janssen beds at C-12 are certainly not typical of the Dakota Formation as a whole, the irregular shape and extent of the beds and the presence of red-mottled clay in stratigraphically anomalous positions persist in adjacent sections 2, 13, 14, and 23. Similar conditions have been observed in: (1) sec. 32, T. 7 S., R. 2 W., 3 miles northwest of C-12, (2) sec. 15, T. 5 S., R. 2 W., 13 miles northwest, and (3) sec. 14, T. 8 S., R. 4 W., about 8 miles to the west. Similar irregularities have also been noted in western Washington County, western Ottawa County, and eastern Hodgeman County. However, irregularities of this character apparently are confined to relatively small areas, and extensive beds of high-grade clay have been found adjacent to them.

Thin bands of white kaolinite have been observed in the Janssen at many localities (Plummer and Romary, 1947, p. 62), but in the C-12 area a kaolinite band was clearly present in only one test hole. It is probable that the kaolinite was present in other holes but was not detected because of the thinness of the bands and mixing caused by the drilling method.

The persistence of widespread and commonly thick beds of red-mottled clay is the most characteristic feature of the upper Terra Cotta. Gray clays, firing to colors ranging from nearly white to buff and sufficiently extensive to be of economic importance, occur within the red-mottled series of beds. The gray, light-firing-color clays constitute only a minor part of the otherwise dominantly red-mottled series, which apparently is continuous across the outcrop belt of the Dakota Formation in Kansas, except where irregular beds of sandstone and siltstone occur. In a few areas in central eastern Ottawa County, sandstone is dominant.

Upper Terra Cotta clays were found in the upper part of the higher elevation test holes at EL-14 and above the gray clay series. The same type of red-mottled clay was found in the lower part of the test holes at C-12 and below the dominantly gray clays of the Janssen. No doubt significant variations could be found within the red-mottled upper Terra Cotta clays, but any difference is difficult to detect because of the general uniformity of appearance. The red-mottled clays, although they have excellent working and firing characteristics, fire to colors ranging from dark buff to dark red. Such clays are usually of less economic importance than the white- or buff-firing clays. However, some red-mottled clay in the upper Terra Cotta fires to a dark-buff color and is refractory. One clay sampled 2½ miles southeast of C-12 in the SW¼ sec. 31, T. 8 S., R. 1 E., Cloud County, is the most refractory clay from the Dakota Formation tested in our laboratory (Plummer and others, 1960). The clay had a pyrometric cone equivalent of cone 31½, which classifies the clay as a high-duty refractory fireclay ac-

cording to A.S.T.M.* designation C-27-58T. It is possible that similar clay will be found throughout the Dakota Formation in Kansas when additional samples are tested.

A total thickness of 120 feet of the Dakota Formation was penetrated by test borings in the C-12 area. Earlier work in this general area (Plummer and Romary, 1947) indicated that at least 70 feet of the upper Terra Cotta, mainly red-mottled clay, is to be found below the bottom of the lowest test hole. In comparison with the C-12 area, red-mottled clay is less abundant at the EL-14 locality and does not occur in continuous, thick beds. However, previous work (Plummer and Romary, 1947) in Ellsworth County has revealed large deposits of red-mottled clay. One such deposit about 3 miles northeast of EL-14 is over 90 feet thick and extends over an area of at least 1 square mile. A composite sample of the entire thickness fired to a dark-buff color.

The most complete development of the Andrews section observed by the authors in Kansas is in the EL-14 area. The EL-14 beds can be traced for several miles, and the total thickness in this area is the maximum thickness so far observed in Kansas. The clay, silt, and sandstone beds are comparable in lithology and sequence with beds previously sampled (Plummer and Romary, 1947) in Ellsworth County in: (1) sec. 28 and 29, T. 15 S., R. 7 W. (Andrews' Ranch), 4 miles west of EL-14, (2) sec. 34, T. 16 S., R. 8 W., 11 miles southwest, (3) sec. 19, T. 15 S., R. 6 W., 1 mile northeast, and (4) sec. 14, T. 15 S., R. 6 W., 5 miles northeast of EL-14. Clay deposits of commercial size have been found in all four locations listed above and have been used in the manufacture of buff-firing bricks.

In the EL-14 area, more than one fairly continuous band of white kaolinite was detected in the Andrews section. Similar bands have been observed (Plummer and Romary, 1947) in the lower beds of the Dakota in other areas, but at the EL-14 locality a larger number and more continuous bands were found than elsewhere in the Andrews section.

CERAMIC TESTING

General procedures for ceramic testing were as follows:

Sample preparation: Clay was ground to pass a minus 20-mesh screen.

* American Society for Testing and Materials.

Making of test bricks: Sufficient water was added to the clay to convert it to a formable plastic material. All samples were mixed and molded by hand. After forming, test bricks were weighed in the plastic state and shrinkage marks, 7.00 cm apart, were marked.

Drying: Bricks were air dried for 48 hours, then placed in a drying oven at 110°C for 24 hours to complete the drying. After drying, the bars were weighed to obtain dry weight, and distance between shrinkage marks was measured to obtain dry shrinkage. From these data, percent water of plasticity and percent drying shrinkage were calculated.

Firing: Firing was done in a Kanthal wound electric furnace to cone 2 (2075°F) and cone 4-5 (2129-2156°F) in an oxidizing atmosphere. After cooling, the test bricks were measured for firing shrinkage, tested for cold and hot water absorption, weighed for ignition loss calculations, and tested for hardness relative to steel. The results of the ceramic tests are listed in the Appendix in conjunction with the test hole logs.

Calculation: The following relationships were used:

1. Water of plasticity

$$\frac{\text{plastic weight} - \text{dry weight}}{\text{dry weight}} \times 100 = \text{percent water of plasticity}$$

2. Loss on igniton

$$\frac{\text{dry weight} - \text{fired weight}}{\text{dry weight}} \times 100 = \text{percent loss on ignition}$$

3. Drying shrinkage

$$\frac{\text{plastic length} - \text{dry length}}{\text{dry length}} \times 100 = \text{percent drying shrinkage}$$

4. Firing shrinkage

$$\frac{\text{dry length} - \text{fired length}}{\text{dry length}} \times 100 = \text{percent firing shrinkage}$$

5. Total shrinkage (includes drying and firing shrinkage)

$$\frac{\text{plastic length} - \text{fired length}}{\text{dry length}} \times 100 = \text{percent total shrinkage}$$

6. Percent water absorption. Bricks were saturated by two methods: 24-hour soak in cold water and 5-hour soak in boiling water.

$$\frac{\text{saturated weight} - \text{dry weight}}{\text{dry weight}} \times 100 = \text{percent absorption}$$

7. Saturation coefficient

$$\frac{\text{percent absorption (cold water)}}{\text{percent absorption (hot water)}} = \text{saturation coefficient}$$

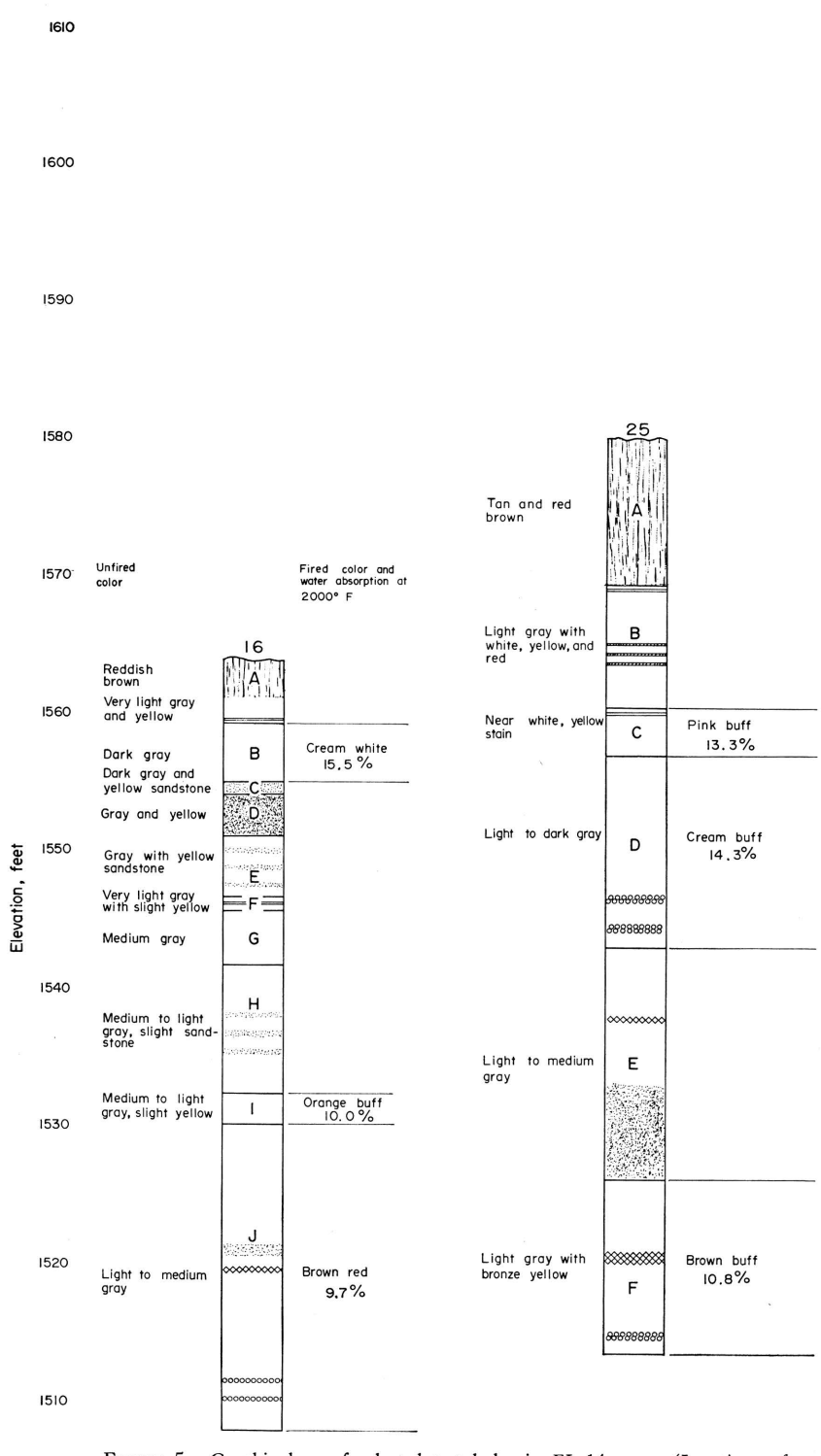
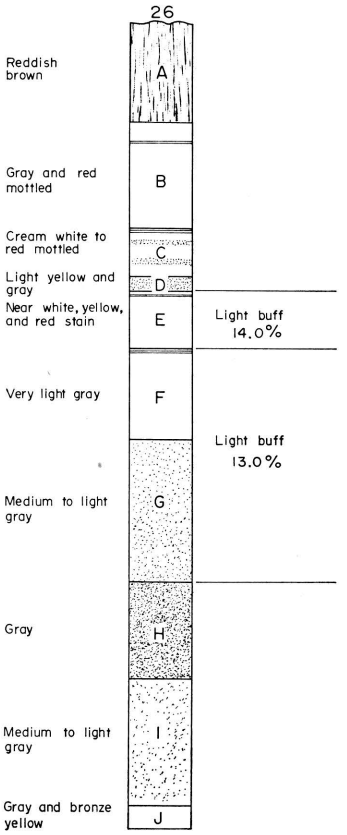
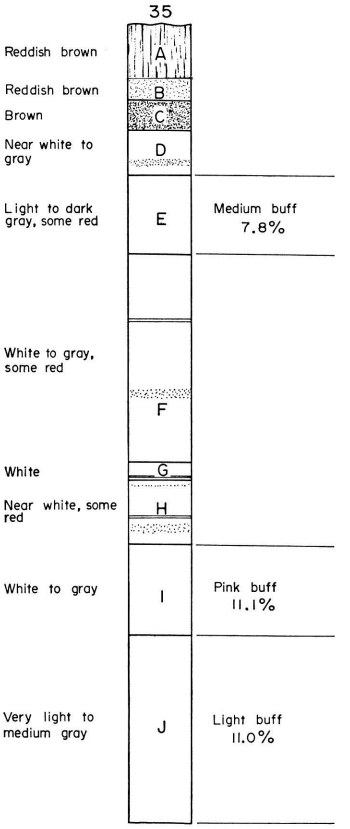
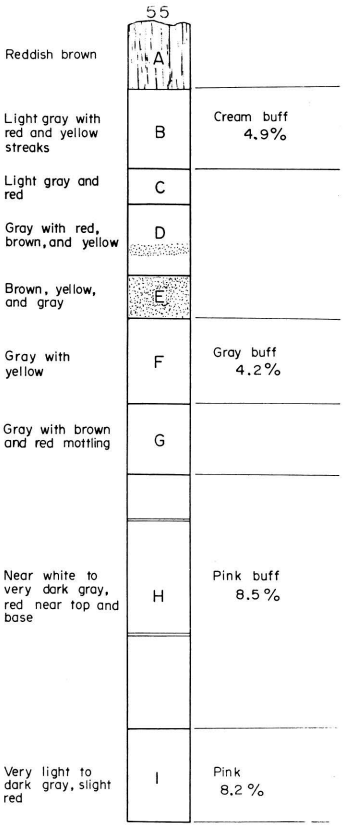
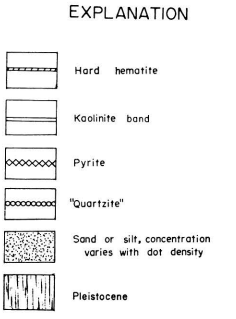


FIGURE 5.—Graphic logs of selected test holes in EL-14 area. (Locations of test









holes shown on Figure 3; for test-hole numbers, see Appendix, Ellsworth County.)

Hardness relative to steel: Fired test bricks were scratched with a standard triangular file and rated: softer than steel (STS), hard as steel (HS), and harder than steel (HTS).

Fired color: The fired color varies with the oxidizing or reducing conditions in the kiln, so only the general shade of the color is given.

SUMMARY

A comparison of areas C-12 and EL-14 shows the lithologic variability that exists within the Dakota Formation. The buff-firing clay deposits in the C-12 area are erratic in thickness and lack continuity. Contrastingly, the EL-14 area has extensive, thick zones of buff-firing clay and a large tonnage of clay could be removed from a small area. Neither area appears to have excessive quantities of pyrite present in the buff-firing clay. The clay is suitable for production of high quality structural clay products.

A conservative estimate of the amount of buff-firing clay in each of the areas is 5 million tons. Assuming a weekly consumption of 1000 tons of clay, each area could support a structural clay plant for at least 100 years. No use of the red-firing clay has been considered in this estimate.

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APPENDIX

Test-Hole Logs and Ceramic Properties

C-12
Test hole BM-2
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1529.0 feet

CLOUD COUNTY

Test hole log				*Ceramic properties*											
								Percent linear shrinkage		Percent absorption					
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Clay, yellow, weathered.	4.8	4.8	4.07	18.3	2	Red	4.97	6.72	7.96	10.69	0.74	STS
						4	Red	5.72	7.47	7.20	10.49	0.69	HTS
B	Clay, light gray with yellow.	2.2	7.0	4.38	15.7	2	Pink buff	1.49	5.97	6.72	8.63	0.78	HS
						4	Pink buff	2.22	6.70	5.58	8.25	0.67	HTS
C	Clay, light gray.	4.0	11.0	5.11	16.0	2	Pink buff	2.96	6.66	4.97	5.38	0.92	HTS
						4	Pink buff	3.70	7.40	3.46	3.96	0.87	HTS
D	Clay, medium gray with yellow.	2.5	13.5	4.61	6.6	2	Buff	0.72	0.72	9.48	11.90	0.80	STS
						4	NO SAMPLE FIRED						
E	Sand.	1.0	14.5										
F	Clay, light gray with yellow.	4.1	18.6	5.16	17.9	2	Orange red	3.01	8.27	4.01	4.54	0.88	HTS
						4	Orange red	3.76	9.02	2.43	2.67	0.91	HTS
G	Clay, light gray with red and yellow.	7.4	26.0	5.68	19.2	2	Red	4.48	8.57	2.73	2.97	0.92	HTS
						4	Red	5.19	8.89	1.78	2.25	0.79	HTS

C-12
Test hole BM-11
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1539.0 feet

Test hole log				*Ceramic properties*											
								Percent linear shrinkage		Percent absorption					
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, yellow.	2.0	2.0										
B	Clay, light gray and yellow.	2.0	4.0	6.23	17.5	2	Red	4.45	8.15	5.08	7.03	0.72	HTS
						4	Red	4.45	8.15	3.99	6.06	0.66	HTS
C	Clay, light gray, red and yellow.	3.5	7.5	4.77	16.8	2	Red	5.97	10.45	3.24	3.78	0.86	HTS
						4	Red	3.37	8.21	2.50	2.89	0.87	HTS
D	Clay, gray and yellow.	4.0	11.5	5.35	19.4	2	Light pink brown	5.97	10.45	3.77	3.95	0.95	HTS
						4	Light brown	4.48	8.96	1.49	2.15	0.69	HTS
E	Clay, dark gray with yellow; some concretionary sand.	3.0	14.5	2.50	12.6	2	Pink buff	0.00	2.19	9.00	12.12	0.74	STS
						4	Pink buff	0.75	2.94	8.38	12.17	0.69	STS
F	Clay, sandy or silty.	9.0	23.5										

C-12
Test hole 17
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1582.3 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Sandstone, brown to yellow, argillaceous.	4.8	4.8	5.53	17.0	2	Dark brown	2.94	2.94	14.14	17.02	0.83	STS
						5	Dusky red	3.68	3.68	12.96	16.48	0.79	STS
B	Clay, gray.	0.5	5.3										
C	Sandstone and clay mixed.	2.2	7.5										
D	Clay, tan and yellow; hard, brown sandstone.	0.5	8.0	6.78	13.8	2	Medium orange	1.47	5.15	8.12	11.21	0.72	STS
						5	Light reddish brown	2.94	4.41	6.22	9.47	0.66	HS
E	Sand, buff and gray, grading into gray clay.	1.5	9.5										
F	Clay, gray.	1.5	11.0										
G	Sand, brown and yellow; clay streaks.	12.0	23.0	2.58	12.3	2	Red	0.00	0.00	16.62	21.68	0.77	STS
H	Clay, yellow and gray.	0.5	23.5			5	Red	0.00	0.00	15.21	19.69	0.77	STS
I	Clay, light gray, some tan.	2.0	25.5										
J	Clay, light gray with red and lavender-brown mottling.	7.5	33.0	6.55	19.2	2	Orange red	4.08	7.10	6.96	7.59	0.92	HTS
						5	Light red	4.46	7.48	3.38	3.36	0.93	HTS
K	Clay, light gray, slightly lavender.	3.0	36.0										
L	Clay, gray, purplish-tan.	5.0	41.0	8.51	19.8	2	Orange red	4.48	10.45	0.49	0.74	0.66	HTS
						5	Reddish brown	5.97	10.45	0.17	0.25	0.68	HTS
M	Clay, light gray, some red and brown.	2.0	43.0										
N	Clay, gray and brown.	7.0	50.0	7.59	19.7	2	Red	3.76	9.02	7.01	7.55	0.93	STS
						5	Red	5.59	10.05	2.12	2.56	0.83	HTS
O	Clay, light gray with sparse red and tan.	3.5	53.5	6.70	16.8	2	Orange red	2.24	6.72	6.47	8.89	0.73	HTS
P	Clay, light gray, slightly red.	2.5	56.0			5	Light red	8.73	8.21	4.73	7.20	0.66	HTS
Q	Clay, light gray.	6.0	62.0	4.48	14.8	2	Orange red	3.70	4.44	7.18	9.74	0.74	HTS
						5	Mottled red	5.23	5.97	5.06	8.13	0.62	STS
R	Clay, gray to light gray.	4.0	66.0	5.11	14.5	2	Red	1.48	5.18	7.77	11.32	0.69	HTS
						5	Orange red	1.48	5.18	5.97	9.87	0.60	STS

C-12
Test hole 18
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1578.3 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, clay, and sandstone mixture; brown.	4.0	4.0										
B	Clay, gray with tan and yellow.	3.7	7.7	6.62	22.4	2	Dark red	1.49	3.71	9.16	10.75	0.85	HS
						5	Red	2.96	5.18	5.01	6.48	0.77	HTS
C	Sandstone, brown, alternating with yellow and gray clay in 1.0-foot to 1.5-foot beds.	17.2	24.9	3.77	15.7	2	Dark red	0.00	0.00	12.54	17.01	0.74	STS
						5	Red	0.72	0.72	11.32	16.12	0.70	STS
D	Clay, light gray, silty.	4.1	29.0										
E	Clay, light gray and red mottled.	3.0	32.0										
F	Clay, light gray, changing to tan and brown.	5.0	37.0										
G	Clay, very light gray, some sand.	6.5	43.5										
H	Clay, gray with light brown or tan.	8.5	52.0	7.84	17.0	2	Orange red	4.48	7.10	7.74	9.31	0.83	HTS
I	Clay, gray with dark red, brown, and lavendar.	5.0	57.0			5	Light red	5.22	7.84	5.25	7.72	0.79	HTS
J	Clay, light gray and tan brown.	5.0	62.0	5.80	17.7	2	Orange red	2.99	7.47	8.99	10.41	0.86	HTS
						5	Mottled red	2.99	7.47	6.36	8.11	0.78	HTS
K	Clay, gray to light gray, red mottling toward bottom.	8.0	70.0	4.94	15.8	2	Pink	0.75	5.23	9.78	11.08	0.88	STS
						5	Reddish yellow	1.49	5.97	8.33	9.71	0.86	HTS
L	Clay, dark gray; sand.	6.0	76.0										
M	Clay, light gray, some red.	2.0	78.0	5.27	15.0	2	Red	3.68	6.62	4.89	6.17	0.79	HTS
N	Clay, red mottled into reddish brown.	4.0	82.0			5	Dark red	4.41	7.35	3.48	4.62	0.75	HTS

C-12
Test hole 19
Location: sec. 12, T. 8 S., R. 2 W.
Elevation 1536.0 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, yellow to brown.	3.0	3.0										
B	Sand, yellow and gray.	3.0	6.0	4.16	15.7	2	Red	1.49	5.97	8.03	11.58	0.69	STS
						5	Red	1.49	5.97	6.26	10.20	0.61	HTS
C	Clay, gray, some tan and yellow.	3.6	9.6	5.85	22.3	2	Red	4.55	10.61	3.64	3.90	0.93	HTS
						5	Red	5.26	10.52	0.79	1.06	0.75	HTS
D	Clay, yellow and gray.	3.9	13.5	5.17	17.4	2	Red	2.22	5.92	7.53	9.91	0.76	HTS
						5	Red	3.00	7.48	4.55	7.00	0.65	HTS
E	Sand, yellow; little clay.	2.5	16.0	3.24	15.3	2	Red	1.47	4.41	8.94	11.91	0.75	STS
F	Clay, yellow, some sand.	0.5	16.5			5	Red	2.26	5.18	6.89	10.14	0.68	STS
G	Clay, gray, slightly yellow.	3.0	19.5	5.04	19.3	2	Red	4.48	8.96	4.08	4.41	0.93	HTS
						5	Pale red	4.48	8.96	0.90	1.14	0.79	HTS
H	Clay, gray, some red.	2.5	22.0	4.72	19.8	2	Red	3.76	9.02	5.10	6.57	0.78	HTS
						5	Red	5.26	10.52	2.11	2.44	0.86	HTS
I	Clay, yellow, with sandstone.	2.0	24.0										
J	Sandstone, hard, brown.	0.9	24.9	5.42	15.7	2	Brown red	4.48	8.96	10.31	14.57	0.71	STS
K	Sand, yellow to gray.	8.6	33.5			5	Dark red	5.48	9.96	7.80	11.90	0.66	STS
L	Clay, yellow, red, and gray.	3.5	37.0	6.10	19.3	2	Red	5.22	9.70	1.90	2.69	0.71	HTS
						5	Red	5.97	10.45	0.95	1.35	0.70	HTS

C-12
Test hole 20
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1548.3 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residium.	2.0	2.0										
B	Sand, tan to buff.	6.5	8.5										
C	Clay, light gray and slightly yellow.	23.5	32.0	2.42	12.7	2	Pink buff	0.00	2.94	7.72	10.27	0.75	STS
						5	Pink buff	0.76	3.70	6.69	9.27	0.72	STS
D	Clay, gray with slight red and yellow.	6.4	38.4	5.31	18.0	2	Orange red	3.00	7.48	5.53	6.73	0.82	HTS
E	Clay, gray.	2.0	40.4			5	Light reddish brown	3.73	8.21	3.55	4.65	0.76	HTS
F	Clay, red and gray.	6.6	47.0	5.43	16.0	2	Red	5.14	8.08	3.38	3.61	0.94	HTS
						5	Red	5.15	8.09	0.97	1.34	0.72	HTS

C-12
Test hole 21
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1521.4 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, reddish.	2.5	2.5	3.52	16.7	2	Red	1.49	5.97	9.32	14.22	0.66	STS
						5	Red	1.49	5.47	8.56	13.23	0.65	STS
B	Clay, light gray.	1.0	3.5										
C	Sand, buff and yellow.	2.5	6.0	2.27	10.4	2	Red	+1.44*	0.00	8.90	12.36	0.72	STS
D	Clay, light gray, sandy.	2.0	8.0			5	Red	0.00	1.45	8.00	11.45	0.70	STS
E	Sand, yellow; clay, gray.	3.5	11.5										
F	Clay, light gray.	1.0	12.5	1.49	16.9	2	Mottled red	1.48	5.18	2.44	3.88	0.62	HTS
						5	Mottled red	3.70	7.40	2.86	3.21	0.89	HTS
G	Clay, red and gray.	3.5	16.0	5.45	18.1	2	Red	3.01	8.27	6.32	9.77	0.65	HTS
						5	Red	4.48	8.96	4.72	7.87	0.60	HTS

* (+) indicates expansion.

C-12
Test hole 22
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1537.5 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, reddish brown (Pleistocene).	7.6	7.6	4.75	18.2	2	Red	0.75	5.23	10.47	14.39	0.73	STS
						5	Red	1.49	5.97	9.49	13.79	0.69	HTS
B	Clay, light gray, silty.	1.4	9.0	5.05	16.1	2	Orange red	1.49	5.97	7.29	9.50	0.77	STS
C	Clay, light gray, red toward base.	4.0	13.0			5	Red	2.24	6.72	5.40	7.60	0.71	HTS
D	Clay, yellow and gray, some silt.	5.0	18.0	5.04	17.8	2	Red	2.99	7.47	6.42	7.69	0.83	HTS
						5	Orange red	2.99	7.47	4.87	6.47	0.75	HTS
E	Clay, red to gray.	4.6	22.6	4.83	16.9	2	Pink buff	1.02	5.99	9.47	10.71	0.88	HS
						5	Pink buff	2.18	8.17	8.12	9.30	0.88	HTS
F	Clay, dark gray, some silt layers.	6.4	29.0	3.64	10.8	2	Pink buff	+2.26*	3.00	8.98	10.87	0.83	STS
						5	Pink buff	+1.50*	3.76	8.14	10.20	0.70	HTS
G	Clay, gray; sand, hard, gray.	3.5	32.5										
H	Clay, light gray.	2.5	35.0	5.29	18.1	2	Mottled orange	4.48	8.96	3.62	4.35	0.83	HTS
						5	Medium red	1.55	4.49	1.55	2.04	0.76	HTS
I	Clay, light gray, red and brown.	1.9	36.9	4.97	17.9	2	Pink red	4.45	8.15	3.85	4.38	0.88	HTS
						5	Mottled red	5.26	8.96	1.97	2.12	0.93	HTS

* (+) indicates expansion.

C-12
Test hole 23
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1537.0 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residual sandstone.	1.0	1.0										
B	Clay, light gray and slightly yellow.	8.5	9.5	3.69	15.6	2	Pink buff	1.48	5.63	6.87	8.58	0.82	HTS
						5	Pink buff	3.79	9.85	5.35	6.95	0.77	HTS
C	Clay, light gray, increasing yellow downward.	2.5	12.0	4.71	15.0	2	Orange red	2.22	5.92	6.32	6.97	0.91	HTS
						5	Mottled pink	2.96	6.66	3.40	4.55	0.75	HTS
D	Clay, light gray and yellow.	4.0	16.0	4.82	14.3	2	Red	2.22	5.92	6.88	8.77	0.78	HTS
						5	Red	2.94	6.64	4.87	7.01	0.69	HTS
E	Clay, light gray, yellow streaks.	6.5	22.5	3.30	16.5	2	Pink buff	0.75	6.29	8.52	10.74	0.80	STS
						5	Reddish yellow	2.26	7.52	6.57	9.66	0.68	HTS
F	Clay, red, gray, and yellow.	6.5	29.0	4.21	17.5	2	Red	2.94	5.88	7.37	9.97	0.74	HTS
						5	Red	3.70	7.40	5.47	8.20	0.67	HTS
G	Clay, gray with light brown.	4.0	33.0	7.17	22.1	2	Red	5.30	11.36	0.26	0.34	0.76	HTS
						5	Dark red	5.26	10.52	0.09	0.17	0.53	HTS

C-12
Test hole 24
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1575.7 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Sand, yellow, brown, and gray.	15.0	15.0	2.63	13.7	2	Red	0.00	0.00	15.27	21.35	0.72	STS
						5	Red	0.00	0.00	15.49	21.51	0.72	STS
B	Clay, light gray, silty.	10.5	25.5										
C	Clay, light gray with brown and red mottling.	11.0	36.5	7.84	17.1	2	Medium red	5.24	10.11	2.34	2.80	0.84	HTS
						5	Mottled red	5.58	9.67	0.63	1.14	0.54	HTS

C-12
Test hole 25
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1589.1 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and sandstone, brown.	2.0	2.0										
B	Clay, yellow and light gray.	2.5	4.5										
C	Clay, light gray, some yellow streaks.	3.5	8.0	6.51	22.3	2	Pink buff	5.97	10.45	0.52	0.86	0.60	HTS
						5	Pale brown	5.97	10.45	0.09	0.26	0.35	HTS
D	Sand, yellow and gray.	2.0	10.0										
E	Clay, yellow and gray, some sandstone layers.	3.5	13.5	4.24	15.8	2	Orange red	1.49	5.97	6.94	8.93	0.78	STS
						5	Red	2.22	5.92	4.62	6.97	0.66	HTS
F	Clay, dark gray.	1.0	14.5										
G	Sand, yellow and gray; clay, silty, alternating beds.	12.5	27.0	4.03	13.5	2	Burgundy red	0.00	1.45	12.99	15.72	0.83	STS
						5	Red	0.73	2.92	11.88	15.05	0.79	STS
H	Clay, dark to light gray.	3.5	30.4	8.30	14.2	2	Orange buff	0.74	4.44	10.94	12.14	0.90	STS
						5	Pink	2.22	5.92	7.08	8.97	0.79	HTS
I	Clay, gray and red.	2.5	33.0										
J	Clay, light gray, trace of pyrite and yellow.	13.0	46.0	5.99	18.5	2	Orange red	2.26	7.52	8.24	9.39	0.88	HTS
						5	Pink	4.49	8.97	4.49	5.39	0.83	HTS
K	Clay, light gray, traces of red.	14.0	60.0	5.22	18.2	2	Orange red	3.70	7.40	7.34	8.54	0.86	HTS
						5	Pink	4.49	8.97	4.49	5.39	0.83	HTS
L	Clay, yellow and gray; sand, fine.	6.0	66.0										
M	Clay, gray; sand; "quartzite"? at 73.5 feet.	8.5	74.5										

C-12
Test hole 26
Location: sec. 11, T. 8 S., R. 2 W.
Elevation: 1588.1 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residium.	1.5	1.5										
B	Clay, gray.	4.3	5.8	7.97	25.8	2	Brown red	5.34	12.21	0.37	0.47	0.79	HTS
						5	Brownish red	5.34	12.21	0.44	0.87	0.51	HTS
C	Sand, yellow and brown; clay, gray and yellow.	1.7	7.5	4.21	17.6	2	Red	1.48	5.18	8.13	10.79	0.75	STS
D	Clay, gray and yellow, silty.	3.0	10.5			5	Red	3.70	7.40	4.84	7.76	0.62	HTS
E	Clay, gray and yellow; sand.	7.5	18.0	2.83	12.9	2	Pink red	0.50	1.45	11.42	14.85	0.77	STS
F	Sand, buff.	6.5	24.5			5	Pink	0.00	1.45	10.36	14.06	0.74	STS
G	Clay, light gray with tan and yellow.	6.0	30.5	4.81	14.0	2	Pink	0.74	4.44	10.10	11.95	0.85	STS
						5	Pink brown	0.74	4.44	9.10	11.22	0.81	HS
H	Clay, gray and red mottled.	5.5	36.0	6.51	20.4	2	Red	5.22	9.70	4.06	4.15	0.98	HTS
						5	Red	5.97	10.45	0.49	1.07	0.46	HTS
I	Clay, light gray with tan and yellow.	12.5	48.5	6.38	17.8	2	Orange red	4.45	8.15	4.94	5.25	0.94	HTS
						5	Pink	5.52	9.73	1.49	2.03	0.73	HTS
J	Clay, gray with some brown.	3.5	52.0	7.81	17.5	2	Red	4.07	7.78	5.59	6.31	0.87	HTS
						5	Red	5.19	8.89	2.16	3.93	0.74	HTS
K	Clay, gray with red mottling.	6.4	58.4	7.84	18.0	2	Orange red	5.88	8.82	3.21	3.61	0.89	HTS
						5	Mottled red	5.15	8.09	1.03	1.59	0.65	HTS

C-12
Test hole 27
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1541.8 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, residual sandstone, and some clay.	18.0	18.0										
B	Clay, gray; sand, buff.	1.5	19.5										
C	Clay, gray, slight trace of brown.	16.5	36.0										
D	Sand, buff to light brown.	4.8	40.8										
E	Clay, gray sand mixture.	1.2	42.0	8.63	18.3	2	Red	4.45	8.15	7.51	8.96	0.84	HTS
						5	Dark red	4.97	8.67	5.52	7.77	0.71	HTS
F	Clay, light gray; sand, gray.	2.0	44.0	6.43	19.0	2	Red	4.41	7.35	3.78	3.86	0.98	HTS
						5	Burgundy red	5.18	8.88	1.10	1.91	0.57	HTS

C-12
Test hole 28
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1542.6 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, residual sandstone, and clay.	11.0	11.0										
B	Clay, gray with tan or yellow.	10.0	21.0										
C	Clay, light gray.	1.5	22.5	4.46	17.7	2	Pink buff	2.99	7.47	6.89	7.92	0.87	HTS
						5	Pink brown	3.73	8.21	4.69	5.70	0.82	HTS
D	Clay, dark gray, slight tan stain.	5.0	27.5	4.36	15.5	2	Pink buff	2.21	5.15	6.66	8.00	0.83	HTS
						5	Pink brown	3.70	7.40	4.20	5.31	0.79	HTS
E	Clay, light gray with red mottling.	6.5	34.0										
F	Clay, gray, some red.	6.0	40.0	6.51	19.0	2	Red	5.97	10.45	1.58	2.14	0.74	HTS
						5	Red	5.22	9.70	0.39	0.47	0.83	HTS

C-12
Test hole 29
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1509.0 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residium.	2.0	2.0										
B	Sand, yellow.	7.5	9.5										
C	Clay, gray and red mottled.	4.0	13.5	6.42	20.7	2	Brownish red	5.97	10.45	1.02	1.44	0.71	HTS
						5	Brown red	5.97	10.45	0.47	0.87	0.54	HTS
D	Clay, tan and gray yellow.	2.0	15.5	5.09	14.1	2	Red	0.00	3.70	7.79	9.95	0.78	STS
						5	Red	0.74	4.44	6.20	9.04	0.69	HTS
E	Clay, yellow and red mottled.	2.2	17.7										
F	Clay, yellow and gray mottled.	1.1	18.8										
G	Clay, gray, some yellow.	3.0	21.8	4.99	16.8	2	Red	1.49	5.97	8.51	10.73	0.79	HS
H	Sand; clay, yellow.	1.5	23.3			5	Red	2.96	6.66	6.59	9.18	0.72	HTS
I	Clay, gray and yellow tan to red.	1.5	24.8										
J	Clay, light gray.	4.0	28.8	5.33	16.9	2	Pink	3.70	7.40	5.62	6.78	0.83	HS
						5	Pink	5.19	8.89	2.90	4.31	0.67	HTS
K	Clay, brownish gray.	1.5	30.3	7.28	24.0	2	Brownish red	6.02	11.28	1.19	1.82	0.65	HTS
L	Clay, gray, trace of red and yellow.	3.5	33.8			5	Brownish red	6.02	11.28	0.46	1.10	0.42	HTS
M	Clay, gray, some dark red, hematite.	2.0	35.8										
N	Clay, light gray.	4.5	40.3	5.90	17.0	2	Pink	2.26	7.52	7.18	9.67	0.74	STS
O	Clay, gray with red.	1.5	41.8			5	Pink	2.99	8.25	4.88	7.55	0.65	HTS

C-12
Test hole 30
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1538.7 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and sand.	1.5	1.5										
B	Clay, gray and yellow.	3.5	5.0										
C	Clay, gray with tan to red.	3.2	8.2	4.14	16.9	2	Pink	2.23	6.32	7.18	8.79	0.82	HS
D	Clay, reddish brown, some gray.	8.2	16.4			4	Medium red	2.60	6.69	6.46	8.50	0.77	HTS
E	Clay, light gray, red and yellow.	3.4	19.8										
F	Sandstone, dark brown.	1.2	21.0										
G	Clay, light gray, slight yellow.	7.0	28.0										
H	Clay, dark to light gray.	2.4	30.4										
I	Sand, gray; some clay.	1.6	32.0										

C-12
Test hole 32
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1540.1 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residium.	2.0	2.0										
B	Clay, yellow and gray.	1.5	3.5	4.81	13.5	2	Pink buff	1.48	5.18	6.61	7.48	0.88	HTS
C	Clay, gray, few yellow streaks.	3.3	6.8			4	Light buff	1.48	5.18	6.25	7.65	0.82	HTS
D	Clay, light gray.	3.0	9.8	3.89	18.8	2	Light buff	2.24	6.72	8.25	9.94	0.87	STS
						4	Light buff	2.99	7.47	6.93	8.76	0.79	HTS
E	Clay, gray changing to yellow.	1.1	10.9	4.63	14.0	2	Red brown	2.21	5.15	5.66	6.76	0.84	HS
						4	Red brown	2.21	5.15	5.08	6.56	0.77	HTS
F	Clay, yellowish red.	1.8	12.7	4.47	15.3	2	Pink	1.49	5.97	6.66	8.07	0.83	HTS
						4	Red brown	2.22	6.70	5.92	7.82	0.76	HTS
G	Clay, gray with yellow.	2.3	15.0	4.32	17.4	2	Brown buff	2.24	6.72	6.96	8.19	0.85	HS
						4	Red brown	3.01	8.27	5.79	7.72	0.75	HTS
H	Clay, gray.	2.4	17.4										
I	Clay, gray, some yellow.	2.5	19.9										
J	Ironstone, concretionary, hard, underlain by yellow and red clay.	1.2	21.1										
K	Clay, dark gray.	2.9	24.0	4.66	15.5	2	Pink buff	0.75	5.23	8.71	10.48	0.83	STS
						4	Pink	1.49	5.97	8.39	10.83	0.77	STS
L	Clay, gray, some yellow.	2.0	26.0										
M	Clay, gray and light yellow.	4.3	30.3	4.97	19.6	2	Pink	4.48	8.96	4.33	4.65	0.93	HTS
						4	Orange red	3.76	9.02	3.35	3.76	0.89	HTS
N	Clay, light gray with red mottling.	4.1	34.4										
O	Clay, brown, tan, and gray.	2.8	37.2	6.01	17.2	2	Red	4.45	8.15	2.21	2.51	0.88	HTS
						4	Red	5.15	8.90	1.76	2.52	0.70	HTS
P	Clay, light brown to brown.	1.8	39.0										

C-12
Test hole 33
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1537.0 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residual sandstone.	2.0	2.0										
B	Clay, light gray, yellow stain.	8.9	10.9	2.97	17.1	2	Light buff	0.75	5.23	9.81	11.42	0.86	HTS
						4	Light buff	3.73	8.21	9.21	10.96	0.84	HTS
C	Clay, light gray with light yellow and red.	3.4	14.3	6.14	22.1	2	Red	5.30	11.36	1.55	1.88	0.82	HTS
						4	Red	6.06	12.12	1.04	1.74	0.60	HTS
D	Clay, light gray with yellow, red, and lavender stain.	6.7	21.0	5.87	22.0	2	Red	5.26	10.52	0.17	0.26	0.65	HTS
E	Clay, gray and sandy; sand, yellow.	1.5	22.5			4	Red	5.88	11.21	0.18	0.44	0.41	HTS
F	Clay, gray; fine sand.	1.9	24.4	3.67	14.9	2	Orange red	2.21	5.15	7.84	10.27	0.76	HTS
G	Clay, gray; sand, yellow.	2.6	27.0			4	Orange red	2.21	5.15	6.75	9.21	0.71	HTS
H	Clay, varying shades of gray; some thin concretionary sand.	14.0	41.0	7.81	16.8	2	Brown red	5.22	9.70	1.27	1.59	0.80	HTS
						4	Brownish red	2.21	5.15	0.78	1.40	0.56	HTS
I	Clay, very light gray.	6.4	47.4	7.21	13.4	2	Pink buff	2.21	5.15	7.34	7.90	0.93	HTS
						4	Pink yellow brown	6.67	10.37	6.31	8.29	0.76	HTS
J	Clay, light gray; sand, yellow and buff.	2.6	50.0										
K	Clay, light gray, gritty.	2.5	52.5										
L	Clay, gray and red mottled.	2.5	55.0										

C-12
Test hole 34
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1575.7 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residual sandstone, yellow and brown.	2.5	2.5										
B	Clay, gray.	1.5	4.0										
C	Sandstone, clayey, yellow; clay, light gray, silty in alternating thin beds.	13.5	17.5										
D	Clay, very light gray; thin white kaolin at top.	4.3	21.8	4.83	16.5	2	Light buff	0.75	5.23	10.46	11.23	0.93	HS
						4	Light buff	0.75	5.23	9.75	11.20	0.87	STS
E	Clay, very light gray, red, brown, and yellow traces.	3.2	25.0	6.16	18.0	2	Orange red	2.99	7.47	8.13	8.99	0.90	HTS
						4	Red	3.01	8.27	6.49	7.83	0.83	HTS
F	Clay, light gray, red, brown, greenish-tan bands.	8.0	33.0	7.19	20.0	2	Red	6.62	9.56	2.61	2.87	0.92	HTS
						4	Red	6.62	9.56	0.49	0.90	0.54	HTS
G	Clay, light gray, pink and red.	4.5	37.5	5.49	19.1	2	Pink buff	1.49	5.97	8.33	8.88	0.94	HTS
						4	Pink	3.73	8.21	6.23	7.18	0.87	HTS
H	Clay, very light gray, some red specks, and brown.	5.0	42.5										
I	Clay, red and gray.	1.5	44.0										
J	Clay, dark gray with red and brown.	1.0	45.0										

C-12
Test hole 35
Location: sec. 12, T. 8 S., R. 2 W.
Elevation: 1579.9 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and sandstone, yellow and brown.	2.0	2.0										
B	Clay, gray, weather stained.	1.5	3.5	7.54	22.3	2	Red	5.22	9.70	0.88	2.10	0.42	HTS
						4	Dark red	6.72	11.20	0.96	2.19	0.44	HTS
C	Clay, yellow and gray; sandstone in thin layers.	16.0	19.5										
D	Clay, very light gray.	7.4	26.9	5.52	19.7	2	Light buff	3.01	8.27	7.09	8.42	0.84	HTS
						4	Light buff	3.76	9.02	5.96	6.88	0.87	HTS
E	Clay, very light gray, some red and brown.	2.1	29.0	7.27	20.9	2	Orange red	3.70	7.40	0.94	1.36	0.69	HTS
						4	Red	6.67	10.37	0.25	0.34	0.74	HTS
F	Clay, light gray.	3.5	32.5	7.40	17.9	2	Pink	5.15	8.09	4.37	4.94	0.88	HTS
						4	Pink	4.41	7.35	2.64	3.39	0.78	HTS
G	Clay, light gray, some brown and pink.	1.5	34.0	6.50	21.1	2	Orange red	5.97	10.45	1.09	2.18	0.50	HTS
						4	Pink	5.97	10.45	0.59	1.18	0.50	HTS
H	Clay, gray with slight tan and pink.	7.0	41.0	5.30	19.6	2	Pink buff	4.48	8.96	3.37	3.54	0.95	HTS
						4	Pink brown	5.19	8.89	1.32	1.90	0.69	HTS
I	Clay, light gray with brown and red layers.	5.0	46.0										

C-12
Test hole 36A
Location: sec. 11, T. 8 S., R. 2 W.
Elevation: 1571.1 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, residual clay, and sandstone fragments.	4.0	4.0										
B	Clay, light gray to yellow.	6.0	10.0	4.53	14.9	2	Pink	0.00	3.70	11.43	12.91	0.89	STS
						4	Pink	0.74	4.44	11.00	13.10	0.84	HS
C	Clay and sandstone, yellow.	3.5	13.5										
D	Clay, light gray with red, brown, and yellow.	4.0	17.5										
E	Clay, gray with brown and red.	2.5	20.0	9.05	24.9	2	Red	8.21	12.69	0.18	0.37	0.49	HTS
						4	Red	6.82	12.88	0.09	0.28	0.32	HTS
F	Clay, light gray, some tan.	4.7	24.7	7.23	22.9	2	Red	6.06	12.12	0.41	0.58	0.71	HTS
						4	Red	5.30	11.36	0.09	0.18	0.50	HTS
G	Clay, gray in varying shades, some red and brown.	5.8	30.5	7.17	16.7	2	Red	2.94	5.88	8.78	9.53	0.92	HTS
						4	Mottled red	4.40	7.38	7.74	8.41	0.92	HTS
H	Clay, light gray.	2.0	32.5	6.86	20.1	2	Red	5.22	9.70	0.85	1.35	0.63	HTS
I	Clay, light gray with brown and tan.	3.0	35.5			4	Red	5.97	12.03	0.50	1.08	0.46	HTS
J	Clay, light to dark gray.	7.5	43.0										
K	Sand, fine, very light gray.	2.0	45.0	7.26	20.0	2	Light brown	4.82	8.52	1.14	1.50	0.76	HTS
L	Clay, dark gray.	7.0	52.0			4	Light brown	5.50	10.82	0.35	0.86	0.40	HTS

C-12
Test hole 37
Location: sec. 11, T. 8 S., R. 2 W.
Elevation: 1575.3 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and sand, fine, yellow.	5.5	5.5										
B	Clay, light gray, some yellow.	3.2	8.7										
C	Clay, very light gray, some yellow.	1.9	10.6										
D	Sand, dark yellow, clayey.	2.2	12.8										
E	Clay, near white to light gray; some red, yellow, brown, and lavender mixed in.	11.2	24.0										
F	Clay, very light gray, some tan.	6.8	30.8										
G	Clay, medium gray.	2.5	33.3	7.20	19.4	2	Red	4.45	8.15	7.11	8.50	0.84	HTS
						4	Red	5.22	9.70	6.47	7.86	0.82	HTS
H	Clay, medium to light gray.	2.7	36.0	5.90	13.5	2	Orange red	0.75	5.23	8.54	10.58	0.79	HTS
						4	Orange red	2.99	7.47	7.01	9.17	0.76	HTS
I	Clay, light gray, red and yellow.	5.5	41.5										
J	Sand, brown; clay, brown, red, and gray.	4.5	46.0										

C-12
Test hole 38
Location: sec. 11, T. 8 S., R. 2 W.
Elevation: 1547.7 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, weathered clay, and sandstone (lower 3.5 feet).	4.5	4.5										
B	Clay, very light gray, some yellow.	2.5	7.0										
C	Sand; clay, yellow.	1.7	8.7										
D	Clay, light gray, some yellow.	5.3	14.0	3.53	15.1	2	Pink buff	0.74	3.67	8.95	11.75	0.76	STS
E	Sand; clay, yellow and gray.	2.5	16.5			4	Pink buff	0.74	3.68	8.25	11.43	0.72	HTS
F	Clay, dark gray, some yellow.	3.5	20.0										
G	Sand, gray, clayey.	1.5	21.5										
H	Clay, light yellow and light gray, some red.	3.0	24.5										
I	Clay, brownish red, some gray.	2.5	27.0										

ELLSWORTH COUNTY

EL-14
Test hole 1
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1577.1 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, upper 1.5 feet; clay, gray and red mottled, lower 2.0 feet.	3.5	3.5										
B	Sand, brown and yellow.	0.5	4.0										
C	Clay, light gray to yellow; some silt and sand.	2.0	6.0										
D	Sand, buff; clay, light gray.	10.3	16.3										
E	Clay, gray, some yellow.	7.4	23.7	5.78	18.4	2	Buff	3.70	7.40	7.20	8.09	0.89	HS
						4	Buff	4.45	8.15	4.77	5.76	0.83	HTS
F	Clay, medium gray with some yellow; sandstone, fine, thin hard streaks.	3.3	27.0										
G	Clay, light to dark gray; some yellow and brown sand.	11.5	38.5										
H	Clay, dark to light gray; more sand than above.	4.8	43.3	9.40	15.4	2	Red	2.24	6.72	8.90	11.26	0.79	HS
						4	Red	2.24	6.72	6.63	9.76	0.68	HTS
I	Sand, brown; clay, dark gray.	1.9	45.2										
J	Clay, medium to light gray; pyrite in lower part.	22.0	67.2	6.15	16.0	2	Brown red	3.70	7.40	5.61	8.45	0.66	HS
						4	Brown red	4.45	8.15	4.17	6.64	0.63	HTS
K	Clay, gray; some sand and pyrite.	8.3	75.5										

EL-14
Test hole 8
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1559.8 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, brownish red.	2.0	2.0										
B	Clay, light gray and yellow; silt and fine sand.	3.0	5.0										
C	Clay, light gray and yellow; yellow increases with depth.	6.0	11.0	3.63	16.2	2	Buff	0.00	2.94	13.22	15.11	0.87	STS
						4	Buff	1.45	4.39	12.67	14.11	0.88	HTS
D	Clay, light gray.	3.0	14.0										
E	Clay, gray; sand, yellow, red, and gray.	3.0	17.0										
F	Clay, medium gray; sandstone streaks.	9.7	26.7	3.93	16.2	2	Buff	0.00	4.48	9.52	12.28	0.78	STS
						4	Buff	0.00	4.48	9.12	12.40	0.74	STS
G	Clay, multicolored, tan, brown, red, gray, bronze; some sand.	2.3	29.0										
H	Clay, various shades of gray; sandstone, thin layers; "quartzite" layers 10 feet above base and at base.	19.5	48.5	5.74	17.1	2	Brown	2.24	6.72	6.67	9.82	0.68	STS
						4	Brown	3.73	8.21	4.40	7.18	0.61	HTS

EL-14
Test hole 9
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1562.6 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, subsoil, and clay, weathered.	9.5	9.5										
B	Clay, gray and yellow.	1.0	10.5										
C	Sandstone, brown; some clay.	0.7	11.2										
D	Clay, light to dark gray, some yellow.	4.3	15.5										
E	Clay, medium gray; some thin yellow concretion material.	0.4	15.9										
F	Clay, light to dark gray, some white.	8.6	24.5										
G	Clay, gray; fine sand.	2.5	27.0										
H	Clay, medium to light gray; some pyrite; some sand streaks.	30.0	57.0	5.96	16.4	2	Mottled buff	1.49	5.71	7.82	10.17	0.77	STS
						4	Dark buff	3.70	7.40	6.26	8.46	0.74	HTS
I	Sand, with light gray clay.	8.0	65.0										

EL-14
Test hole 14
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1562.2 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, reddish brown.	9.0	9.0										
B	Clay, gray; some brown sandstone.	1.0	1.0										
C	Clay, light gray, some yellow streaks.	4.0	14.0	4.06	16.0	2	Very light buff	0.00	2.94	10.48	11.57	0.91	STS
D	Clay, light gray.	2.0	16.0			4	Very light buff	0.75	3.69	10.46	11.46	0.91	STS
E	Sand; clay, gray and yellow.	2.9	18.9										
F	Clay, light to medium gray.	10.6	29.5	6.19	15.6	2	Orange buff	0.75	5.23	7.93	10.81	0.73	STS
G	Clay, gray and tan.	1.7	31.2			4	Reddish brown	2.99	7.47	6.91	9.94	0.70	HTS
H	Clay, banded in various shades of gray.	23.8	55.0	5.74	15.7	2	Reddish brown	2.94	5.88	6.63	9.47	0.70	STS
						4	Lavender	3.68	6.62	5.09	8.16	0.62	HTS
I	Sand; "quartzite" at top.	2.0	57.0										

EL-14
Test hole 16
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1563.5 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, clay, silt, and sandstone; reddish brown.	2.5	2.5										
B	Clay, very light gray, some yellow.	2.0	4.5										
C	Clay, dark gray.	4.2	8.7	4.73	14.4	2	Cream white	0.73	2.18	13.74	15.48	0.89	STS
						4	Cream white	0.73	2.18	14.20	15.91	0.89	STS
D	Clay, dark gray, with yellow sandstone.	0.8	9.5										
E	Sand, gray and yellow; some gray clay.	3.0	12.5										
F	Clay, gray; yellow sandstone bands.	4.5	17.0										
G	Clay, very light gray, slightly yellow.	1.0	18.0										
H	Clay, medium gray.	3.0	21.0										
I	Clay, medium to light gray; little sand.	10.3	31.3										
J	Clay, medium to light gray, some light yellow or buff.	1.7	33.0	6.57	15.9	2	Orange buff	2.24	6.66	7.64	10.04	0.76	STS
						4	Orange buff	2.96	7.38	6.60	8.87	0.75	HTS
K	Clay, light to medium gray; some silt and pyrite; sandstone near base; "quartzite" at 1513 and 1510 feet.	23.0	56.0	5.01	17.1	2	Brown red	3.00	9.00	6.93	9.70	0.73	STS
						4	Brown red	3.00	8.94	5.02	8.01	0.62	HTS

EL-14
Test hole 17
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1571.1 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil; 1.0 foot sandy clay, bright red.	4.0	4.0										
B	Clay, yellow, red, and gray mixture, with sand.	5.0	9.0										
C	Clay, very light gray, some yellow and red.	1.5	10.5										
D	Clay, very light to medium gray.	4.5	15.0	4.78	19.9	2	Cream white	0.75	6.01	11.24	11.36	0.98	STS
						4	Cream white	1.50	6.76	11.93	13.17	0.91	STS
E	Clay, gray; some yellow sandstone.	1.5	16.5										
F	Clay, very light to dark gray.	12.0	28.5										
G	Sand, buff and gray.	1.2	29.7										
H	Clay, gray; some sand and silt; "quartzite" at 1539 feet and at base.	19.0	48.7										

EL-14
Test hole 18
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1576.7 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil; clay, red, yellow and gray mottled, in lower 2.0 feet; some hematite.	6.0	6.0										
B	Clay, gray, lavender, and yellow; some brown and yellow sandstone.	10.0	16.0										
C	Clay, very light gray.	2.0	18.0										
D	Clay, gray to dark gray; some pyrite, silt, lignite and limonite material.	5.2	23.2	5.06	14.4	2	Buff	0.00	2.19	12.01	15.24	0.79	STS
						4	Buff	0.00	2.19	11.04	14.55	0.76	STS
E	Clay, light gray.	9.0	32.2										
F	Sand, buff and gray.	3.3	35.5										
G	Clay, medium to light gray, with fine white sand.	7.5	43.0	4.09	15.6	2	Pink	0.74	4.41	11.25	13.84	0.81	STS
						4	Pink buff	1.47	5.14	10.37	13.47	0.77	STS
H	Clay, dark to light gray layers.	2.0	45.0	5.63	15.2	2	Orange	1.49	5.97	7.32	10.09	0.73	STS
I	Clay, light gray and yellow.	2.0	47.0			4	Pink	2.22	6.70	6.13	9.33	0.66	HTS
J	Clay, light gray; some silt and sand; "quartzite" 7.5 above base.	18.0	65.0										
K	Clay, gray; some sand; "quartzite" near base.	11.0	76.0	4.57	14.5	2	Burgundy red	0.00	4.48	6.53	9.80	0.67	STS
						4	Brown	2.96	6.66	4.54	8.18	0.56	HTS

EL-14
Test hole 19
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1573.0 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, dark brown.	4.0	4.0										
B	Sand; clay, brownish red.	5.5	9.5										
C	Clay, light to medium gray, yellow; some fine sand near base.	3.5	13.0										
D	Clay, light gray, sandy.	2.5	15.5										
E	Clay, light gray, sandy.	1.5	17.0										
F	Clay, light gray, some yellow.	1.7	18.7										
G	Sand and clay in alternating layers, gray and yellow.	3.3	22.0										
H	Clay, light gray to nearly white, no silt or sand.	7.0	29.0										
I	Sand; clay, light gray.	2.5	31.5										
J	Clay, medium to light gray; some white sand and gray silt.	10.0	41.5	4.13	16.1	2	Buff	0.75	5.23	10.40	12.90	0.81	STS
						4	Buff	2.22	6.70	8.63	11.59	0.74	HTS
K	Clay, light gray and yellow.	1.5	43.0	6.91	18.3	2	Orange red	5.97	10.45	3.88	4.95	0.78	HTS
						4	Medium red	6.27	10.97	2.82	4.12	0.68	HTS
L	Clay, light to medium gray; alternating layers of fine sand and clay in lowest 5 feet, "quartzite" layers near middle.	24.0	67.0	5.39	16.3	2	Burgundy red	2.95	6.27	6.60	9.42	0.70	HS
						4	Red buff	3.70	7.21	4.53	7.06	0.64	HTS

EL-14
Test hole 22
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1566.7 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, upper 0.5 feet; clay, yellow, lower 3.5 feet.	4.0	4.0	NO CERAMIC DATA									
B	Clay, gray and red mottled, gray and yellow.	1.7	5.7										
Ca	Clay, very light gray, containing dark sand.	1.8	7.5										
Cb	Sandstone, yellow.	0.5	8.0										
D	Clay, sandy, light gray with yellow.	2.3	10.3										
E	Clay, plastic to silty, light to medium gray; contains thin lenses? of yellow and gray sand; pyrite near base.	9.4	19.7										
F	Clay, plastic to silty, very light to dark gray in 1- to 2-foot bands, some thin sand streaks.	16.0	35.7										
G	Clay, reddish brown and gray.	1.8	37.5										
H	Clay, very light to medium gray; 0.3 foot "quartzitic" fine sandstone 1 foot above base.	9.5	47.0										

EL-14
Test hole 23
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1580.3 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and silty clay, reddish brown (Pleistocene).	7.5	7.5										
B	Residual clay and sand (Dakota).	1.0	8.5										
C	Clay, yellow, red, and gray in mixed layers, and red and brown sandstone.	10.5	19.0										
D	Clay, near white; fine sand, white and yellow.	3.0	22.0	4.93	13.6	2	Buff	0.00	2.94	11.29	13.84	0.82	STS
E	Clay, dark gray, with some lignite.	4.0	26.0			4	Light pink buff	0.00	2.94	10.72	13.78	0.78	STS
F	Clay, medium gray, some silt and sand streaks; "quartzite" at base.	34.0	60.0	6.09	16.6	2	Buff	0.74	4.48	9.38	11.50	0.82	STS
						4	Cream	1.85	5.60	8.12	10.10	0.00	HTS

EL-14
Test hole 24
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1586.7 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, upper 2.0 feet; clay, silty, tan to red brown, lower 7.0 feet (Pleistocene, undifferentiated).	9.0	9.0	NO CERAMIC DATA									
B	Sand, yellow.	1.5	10.5										
C	Clay, light gray with red mottled and yellow bands; sandstone, red and yellow, in lower 1.7 feet, containing hematite.	10.7	21.2										
D	Clay, light gray and yellow; thin sandstone near middle.	8.3	29.5										
E	Clay, light to dark gray; some lignite; thin silt bands in lower half.	6.5	36.0										
F	Clay, medium to light gray; thin sandstone beds at 42, 46 and 54 feet; silty clay from 48 to 51 feet; dense "quartzite" at base.	28.0	64.5										

EL-14
Test hole 25
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1580.0 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, tan and red brown, silty (Pleistocene).	10.5	10.5										
B	Clay, light gray with bands of near white, yellow, and red; 3 bands of hard hematite.	9.0	19.5										
C	Clay, nearly white, yellow stain.	3.5	23.0	4.12	16.1	2	Pink buff	0.74	4.44	11.89	13.27	0.90	
						4	Pink buff	0.74	4.44	11.64	12.65	0.92	
D	Clay, alternating light and dark gray.	14.0	37.0	5.50	17.4	2	Cream buff	0.00	4.48	12.48	14.31	0.87	
						4	Buff	0.00	4.48	12.14	13.65	0.89	
E	Clay, light to medium gray, some pyrite and silt streaks; silty clay in lower 7.0 feet.	17.0	54.0										
F	Clay, light gray and bronze yellow, with thin hard layers "quartzite."	13.0	67.0	5.61	17.9	2	Brown buff	2.24	6.72	7.97	10.79	0.74	
						4	Dirty pink	2.99	7.47	7.27	10.27	0.71	

EL-14
Test hole 26
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1577.5 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil, clay, and silt; reddish brown (Pleistocene).	7.0	7.0										
B	Clay, gray, red and white mottling; hematite near base.	7.5	14.5										
C	Clay, cream white; some thin sandstone.	3.5	18.0										
D	Sand, light yellow, with gray clay.	1.0	19.0										
E	Clay, near white, some yellow and red stain.	4.0	23.0	6.23	14.1	2	Light buff	0.00	2.94	12.89	14.00	0.92	STS
						4	Light buff	1.47	3.68	12.04	13.40	0.92	
F	Clay, very light gray.	6.5	29.5	4.13	13.1	2	Light buff	0.74	3.68	10.89	13.01	0.84	STS
G	Clay, medium to light gray; some silt. ..	10.0	39.5			4	Light buff	0.74	3.68	11.15	13.05	0.85	
H	Clay, gray and buff, alternating with sand.	7.0	46.5										
I	Clay, medium to light gray; some silt. ..	9.0	55.5										
J	Clay, gray and bronze yellow.	1.5	57.0										

EL-14
Test hole 27
Location: sec. 15, T. 15 S., R. 7 W.
Elevation: 1588.3 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and silty clay, tan to reddish brown (Pleistocene).	9.7	9.7										
B	Clay, light gray and red.	3.8	13.5										
C.	Clay, light gray, some yellow and red.	2.3	15.8	7.06	20.7	2	Cream	3.01	8.27	9.83	10.31	0.95	HS
						4	Cream buff	3.73	8.99	8.18	8.41	0.97	HTS
D	Clay, gray, yellow, and red mixture; some silt.	10.1	25.9										
E	Clay, nearly white (kaolin?).	5.4	31.3										
F	Clay, very light gray with red and tan portions.	3.2	34.5										
G	Clay, very light to dark gray; some lignitic silt layers.	13.5	48.0										
H	Clay, light gray to gray, some yellow; some layers very silty.	15.0	63.0	4.32	15.0	2	Pink buff	0.00	3.70	9.59	11.71	0.82	STS
						4	Yellow buff	1.47	5.17	8.66	10.97	0.79	HTS

EL-14
Test hole 32
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1573.5 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and silty clay, reddish brown (Pleistocene).	3.0	3.0										
B	Clay, light gray with yellow and red; hematite 2.0 feet from base.	6.5	9.5										
C	Clay, light gray and yellow.	4.0	13.5	3.37	15.0	2	Pink red	0.00	2.94	11.72	12.98	0.90	STS
						4	Pink	0.00	2.94	11.10	12.36	0.90	STS
D	Clay, very light gray, red, and yellow; some sand; hematite 2.0 feet below top.	6.0	19.5										
E	Clay, light gray; some silt.	5.0	24.5	3.76	14.1	2	Light buff	+0.75*	4.51	10.98	13.17	0.83	STS
						4	Light buff	+1.49*	2.54	11.25	13.20	0.85	STS
F	Clay, light gray with red and bronze mottling.	0.5	25.0										
G	Clay, gray, various shades and hardness in layers; lignite 6.5 feet from base.	19.5	44.5	4.86	16.2	2	Buff	1.47	4.41	10.53	12.03	0.88	STS
						4	Mottled buff	2.22	5.92	8.78	10.59	0.83	HTS
H	Clay, light gray, some bronze, yellow, and red mottling.	4.0	48.5	5.52	16.3	2	Gray brown	3.70	7.40	6.23	8.53	0.73	HTS
						4	Brown buff	4.46	8.16	4.06	6.48	0.63	HTS
I	Clay, light gray; "quartzite" at base.	7.0	55.5										

* (+) indicates expansion.

EL-14
Test hole 33
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1578.0 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and residium.	2.0	2.0										
B	Clay, light gray.	2.7	4.7										
C	Clay, light gray mixed with red, white, and yellow; hematite 1.0 foot from base.	7.0	11.7										
D	Clay, very light gray and yellow.	3.0	14.7	4.90	13.9	2	Pink buff	0.74	3.68	9.67	10.80	0.90	STS
						4	Pink buff	0.74	3.68	8.91	10.81	0.88	HTS
E	Sandstone, hard, brown and red, with hematite.	1.3	16.0										
F	Clay, gray, red, and yellow.	1.4	17.4										
G	Clay, light gray, red, tan, and lavender; hematitic silt at base.	8.6	26.0										
H	Clay, nearly white to dark gray in alternating beds; fine sand in some layers; "quartzite" 10 feet below top.	26.0	52.0	4.42	14.6	2	Light buff	0.00	3.70	9.86	11.36	0.87	STS
						4	Light buff	0.00	3.70	9.74	11.54	0.84	HTS
I	Clay, gray with dark red and yellow.	1.0	53.0										

EL-14
Test hole 35
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1594.1 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and silty clay, reddish brown (Pleistocene).	3.5	3.5										
B	Silt to sand, clayey, reddish brown.	1.5	5.0										
C	Sand, brown.	2.0	7.0										
D	Clay, near white to gray, some yellow; thin sand layers; thin sandstone near base.	3.5	10.5										
E	Clay, shades of gray; some red areas. ..	5.5	16.0	8.11	22.2	2	Medium buff	4.51	9.77	7.19	7.75	0.93	HTS
						4	Yellow buff	5.26	10.52	5.33	5.66	0.94	HTS
F	Clay, varying from white to gray in layers, some red and yellow; sand and silt in some layers.	14.7	30.7										
G	Clay, white, hard, kaolin.	1.3	32.0										
H	Clay, nearly white, red areas; some sand.	4.5	36.5										
I	Clay, white to gray.	6.5	43.0	5.91	14.8	2	Pink buff	0.74	4.44	9.87	11.08	0.89	HTS
						4	Pink buff	0.75	4.44	9.68	11.04	0.88	HTS
J	Clay, very light to medium gray.	13.5	56.5	5.29	14.2	2	Light buff	0.74	4.44	9.62	10.98	0.88	HTS
						4	Buff	0.75	4.44	9.57	11.26	0.85	HTS

EL-14
Test hole 39
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1578.2 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, tan to red brown (Pleistocene).	8.5	8.5										
B	Clay, near white to light gray, some yellow.	3.8	12.3										
C	Clay, light gray to white; contains hematite and some sand near top.	10.2	22.5										
D	Clay, very light gray to medium gray with yellow, sandy; "quartzite" near base.	6.0	28.5										
E	Clay and sandstone, white and various shades of gray, sparse yellow.	8.1	36.6	3.98	14.1	2	Buff	0.75	3.69	10.30	11.93	0.86	HS
						4	Buff	1.47	4.41	9.95	11.45	0.83	HTS
F	Clay, medium gray, some red and brown.	3.4	40.0										
G	Clay, gray, light to dark in layers.	7.0	47.0	3.85	15.5	2	Buff	0.74	4.44	9.61	11.79	0.82	HTS
						4	Buff	0.75	4.44	9.04	11.63	0.78	HTS
H	Clay, gray and bronze.	3.0	50.0	6.82	25.7	2	Orange red	3.82	10.69	4.44	4.88	0.91	HTS
						4	Light red	4.62	11.49	3.36	3.53	0.95	HTS
I	Clay, medium gray, streaks of brown and red; "quartzite" at base.	7.0	57.0										

EL-14
Test hole 42
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1569.5 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Clay, creamy white, some red stains.	5.0	5.0										
B	Clay, creamy white with red and yellow mottling.	2.0	7.0	4.66	16.1	2	Cream pink	0.75	5.25	10.64	11.66	0.91	STS
						4	Pink buff	0.75	5.23	10.23	11.48	0.89	STS
C	Clay, yellow to gray with red mottling, hematitic near middle.	8.0	15.0										
D	Clay, light gray, red and yellow staining.	2.0	17.0										
E	Clay, gray; sand, 0.5 foot.	3.0	20.0	3.31	13.1	2	Pink buff	0.00	2.34	10.11	11.90	0.85	STS
						4	Pink buff	0.74	3.68	10.21	12.59	0.81	STS
F	Clay, light gray.	2.5	22.5										
G	Sandstone, hematitic; clay, gray and red mottled.	1.8	24.3										
H	Clay, light gray.	3.5	27.8	4.75	15.7	2	Buff	0.00	2.94	11.67	13.85	0.84	STS
						4	Buff	0.74	3.68	11.49	13.93	0.82	STS
I	Clay, dark gray, hard.	1.2	29.0										
J	Clay, gray, brown and red mottling.	3.5	32.5										
K	Clay, gray.	2.1	34.6										
L	"Quartzite."	0.3	34.9										

EL-14
Test hole 51
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1581.5 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, brown.	1.0	1.0										
B	Clay, gray, red stains, with creamy white layer in middle.	8.5	9.5										
C	Siltstone, clayey, hematitic and limonitic, with gray and yellow clay.	6.0	15.5										
D	Clay, gray and yellow; some sand and silt.	2.0	17.5										
E	Clay, light to medium gray, 1.0 foot white 7 feet above base, plastic except 3 feet silty near middle of bed.	18.5	36.0	4.28	16.7	2	Light buff	1.86	6.33	9.50	10.80	0.88	STS
						4	Light buff	1.97	5.95	8.48	10.09	0.84	HS
F	Clay, dark to medium gray, thin hard silt streaks.	5.3	41.3	6.13	16.0	2	Brown buff	0.00	3.70	10.20	13.08	0.92	STS
						4	Buff	0.75	4.45	8.63	11.95	0.72	HTS
G	Sand, clayey, medium gray, and brown.	2.2	43.5										
H	Clay, gray with bronze yellow; some sand.	1.0	44.5	7.44	17.9	2	Mottled red	2.99	7.47	8.76	11.15	0.79	HTS
						4	Mottled red	2.24	6.72	7.89	10.24	0.77	HTS
I	Clay, to light gray; some sand.	3.5	48.0	8.15	23.5	2	Yellow brown	6.76	12.02	0.66	1.41	0.47	HTS
						4	Red ivory	6.02	12.08	0.41	0.81	0.51	HTS
J	Clay, medium gray with sparse red mottling, and 1.0 foot lavender.	4.0	52.0										

EL-14
Test hole 52
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1570.2 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Clay, gray and red, weathered.	1.5	1.5										
B	Clay, bright yellow and gray.	2.0	3.5										
C	Clay, light gray with red mottling and hematite, yellow in lower 3.0 feet.	4.5	8.0										
D	Clay, creamy white (upper 1.0 foot) into pink and gray.	2.7	10.7										
E	Clay, very light gray.	1.3	12.0										
F	Clay, light gray, yellow, and red.	2.5	14.5										
G	Clay, light to medium gray.	3.0	17.5	5.04	15.7	2	Light buff	0.74	3.68	12.44	14.57	0.85	STS
H	Clay, dark gray.	3.8	21.3			4	Light buff	0.74	3.70	11.86	14.23	0.83	STS
I	Clay, light to medium gray.	7.1	28.4										
J	Clay, light gray, bronze yellow, and red brown.	3.1	31.5										
K	Sand; clay, light gray.	1.0	32.5										
L	Clay, varying shades of gray.	9.7	42.2	5.86	15.3	2	Medium red	2.22	5.92	7.44	10.02	0.74	HTS
M	Clay, red, brown, and gray.	4.8	47.0			4	Red	2.75	6.45	6.50	8.87	0.73	HTS

EL-14
Test hole 55
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1611.1 feet

Test hole log				*Ceramic properties*										
								Percent linear shrinkage		Percent absorption				
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, reddish brown (Pleistocene).	4.5	4.5										
B	Clay, light gray with red and yellow streaks.	5.5	10.0	7.62	22.4	2	Buff	3.03	9.09	4.25	4.91	0.87	HTS
						4	Cream buff	3.82	10.69	3.12	3.81	0.82	HTS
C	Clay, light gray and red.	2.5	12.5										
D	Clay, gray with streaks of yellow, red, and brown; limonitic sandstone, 14.0-14.5 feet.	5.2	17.7										
E	Sand, brown and yellow, clay streaks. ..	3.0	17.7										
F	Clay, gray with yellow streaks.	6.0	26.7	8.64	23.1	2	Gray buff	6.67	10.37	3.45	4.18	0.83	HTS
						4	Gray buff	8.82	11.76	0.99	1.53	0.65	HTS
G	Clay, gray with brown and red mottling.	5.3	32.0										
H	Clay, very light gray to black, some red near top and base, white at 37 and 43 feet; hematite at 44 feet.	18.0	50.0	8.65	17.4	2	Pink	4.41	7.35	7.61	8.87	0.93	HTS
						4	Pink	4.95	7.89	6.67	7.16	0.93	HTS
I	Clay, light gray with red speckles.	6.5	56.5	6.98	17.7	2	Pink buff	2.24	6.72	8.00	8.50	0.94	HTS
						4	Pink buff	2.49	7.47	7.08	7.50	0.94	HTS

EL-14
Test hole 56
Location: sec. 25, T. 15 S., R. 7 W.
Elevation: 1591.2 feet

Test hole log				*Ceramic properties*									
								Percent linear shrinkage		Percent absorption			
Sample	Description	Thickness, feet	Depth, feet	Percent ignition loss	Percent water of plasticity	Fired to cone	Fired color	Fired	Total	24 hours, cold water	5 hours, boiling water	Saturation coefficient	Hardness as to steel
A	Soil and clay, reddish brown (Pleistocene).	7.0	7.0										
B	Clay, layered varying colors of red, gray, yellow, and white; hematite at 13.8 feet; sandstone, clayey, 15.0-16.7 feet.	12.5	19.5										
C	Clay, very light gray, near-white yellow specks near base.	5.0	24.5	4.70	14.6	2	Buff	0.00	2.94	11.13	12.56	0.89	STS
						4	Buff	0.00	2.94	11.54	12.85	0.90	HS
D	Clay, gray with red mottling.	1.5	26.0	6.42	17.1	2	Pink buff	3.68	6.62	7.74	8.14	0.95	HTS
						4	Pink buff	4.46	7.40	6.87	7.19	0.96	HTS
E	Clay, light to medium gray, silty near base.	8.5	34.5										
F	Clay, light gray with yellow and brownish red.	2.0	36.5										
G	Clay, varying shades of gray, with thin hard sandstone or siltstone in lower 6.0 feet.	10.5	47.0	4.59	14.0	2	Light buff	+1.49*	2.99	10.83	12.33	0.88	STS
						4	Buff	0.74	4.44	10.18	11.87	0.86	HTS
H	Clay, gray with bronze yellow, thin sandstone near base.	4.5	51.5	6.22	19.2	2	Red	4.55	10.61	4.13	4.37	0.95	HTS
I	Clay, gray with red, lavender, yellow, and tan streaks.	11.0	62.5			4	Red	5.22	11.22	2.18	2.63	0.83	HTS
J	Clay, medium to dark gray with sparse red and yellow stains; silt alternating with gray sand in lower 8.0 feet, thin "quartzite" 4.0 feet from base.	14.5	77.0	6.37	18.9	2	Tan	3.37	7.85	5.31	5.83	0.91	HTS
						4	Brown buff	4.48	8.96	3.38	3.61	0.94	HTS

* (+) indicates expansion.

BULLETIN 165 **1963 REPORTS OF STUDIES**

Part 1. **Preliminary Report on Conodonts of the Meramecian Stage (Upper Mississippian) from the Subsurface of Western Kansas,** by Thomas L. Thompson and Edwin D. Goebel, p. 1-16, fig. 1-3, August, 1963.

Part 2. **Sources of Error in Thermoluminescence Studies,** by Jesse M. McNellis, p. 1-23, fig. 1-26, December, 1963.

Part 3. **Test-Hole Exploration for Light-Firing Clay in Cloud and Ellsworth Counties, Kansas,** by Norman Plummer, Clarence S. Edmonds, and Maynard P. Bauleke, p. 1-47, fig. 1-5, December, 1963.