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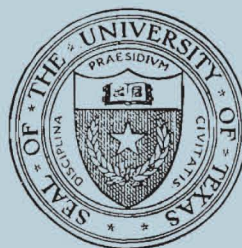
No. 4915

August 1, 1949

CLAY DEPOSITS OF THE CISCO GROUP OF NORTH-CENTRAL TEXAS

By

F. B. PLUMMER, H. B. BRADLEY, AND F. K. PENCE



Bureau of Economic Geology
Research Laboratory in Ceramics

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THE UNIVERSITY OF TEXAS
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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston

Cultivated mind is the guardian genius of Democracy, and while guided and controlled by virtue, the noblest attribute of man. It is the only dictator that freemen acknowledge, and the only security which freemen desire.

Mirabeau B. Lamar

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Clay Deposits of the Cisco Group of North-Central Texas

F. B. Plummer, H. B. Bradley, and F. K. Pence

INTRODUCTION

This report contains the results of a joint investigation by the Bureau of Economic Geology and the Research Laboratory in Ceramics of The University of Texas of certain commercially important clay deposits in north-central Texas. Since 1940 these clays have attracted increasing attention and development. In 1941 Mr. Guy Quinn of Eastland commenced use of the clay for receptacles for cacti which he marketed in large numbers from his commercial cactus garden. In 1946 the N. D. Gallagher Clay Products Company erected a pottery plant using clay from a pit near the Quinn pit. In the same year, the Cisco Clay Products Company was organized, and also Mr. and Mrs. Horace Horton of Eastland established a plant in Eastland for manufacture of glazed pottery from the clay which had been used in the other enter-

prises and which has been named Quinn clay in this report. In addition, the Harbison-Walker Refractories Company, Athens, Texas, used the clay from time to time to mix with east Texas clay.

Through the efforts of Eugene C. Clemens, of the Texas Vitrified Pipe Company, who investigated the clays of the region, and officials of the Eastland and Cisco Chambers of Commerce, the two research organizations made preliminary examinations of the clays. These revealed that clay deposits of importance extended beyond the immediate vicinity of Eastland and Cisco and that clays other than the Quinn clay merited investigation. Accordingly, the present investigation was initiated in 1946 with the objectives of determining the field occurrence and ceramic properties of these clays in north-central Texas.

GEOLOGY OF THE CLAY DEPOSITS

F. B. Plummer and H. B. Bradley

This section of the report is devoted to the field occurrence of the clays. Stratigraphically the clays belong in the Cisco group of Pennsylvanian age. Discussion of details of stratigraphy of the region is limited to strata closely associated with the clay beds which can be used in tracing and prospecting the clays. For greater detail concerning the stratigraphy of the region and classification of the rocks, the reader is referred to publications cited at the end of this section and to The University of Texas Bulletin 3232.

Maps, profiles, and sections accompanying the report show local stratigraphic position of the clays, character of various outcrops, and positions from which samples were secured for examination by the Research Laboratory in Ceramics. The important clays have been named Quinn,

Curry, and Craddock from farms and ranches on which good exposures exist. These clays are described in greatest detail, but there is a limited discussion of the Finis shale which may have commercial importance.

QUINN CLAY

Name.—Quinn clay is a new name given to a clay stratum near the top of the Cisco group of upper Pennsylvanian age in north-central Texas. The clay outcrops 2 miles east of the town of Cisco, Eastland County, where a pit has been opened, and is used for making clay products at Cisco and at Eastland. (See Pl. II, locality 12.)

Stratigraphic position.—The Quinn clay is a purplish-red, green, and maroon clay which occurs between the Parks Mountain

sandstone or its probable equivalent, the Cisco Lake sandstone, and the upper Breckenridge limestone, as shown in the stratigraphic sections, Plates VI, VII, and VIII. Throughout its extent it is most conveniently mapped as the clay between the lower Crystal Falls limestone and the upper Breckenridge limestone. Since the lower Crystal Falls limestone occurs just beneath the Parks Mountain sandstone, this latter boundary is a convenient and easily mappable one. However, in some places, particularly in the vicinity of Cisco, the upper Crystal Falls limestone is absent, and the base of the sandstone has to be the upper boundary of the clay. The Quinn clay, therefore, is best described as the next to the lowest clay in the Harpersville formation, as defined in the report and map by Plummer and Moore (1922). Between Sandy Creek and Breckenridge in Stephens County, a sandstone lentil is present in the section just above the Breckenridge limestone and occupies the stratigraphic position of most of the Quinn clay, as shown on the map (Pl. III) and the vertical sections (Pl. VII).

Type locality.—The type locality is on the Quinn tract, on the north side of the Eastland-Cisco highway (U.S. highway No. 80), 2 miles east of Cisco. Here the first clay pit in the member was opened by Mr. Guy Quinn, Sr., of Eastland, Texas.

Extent and thickness of the Quinn clay.—The Quinn clay has been mapped from old Fort Belknap on the Brazos River, southwest to Crystal Falls, thence south to the Cretaceous sand peninsula 4 miles south of Cisco. South of the Cretaceous sand peninsula it occurs 3 miles north of Grosvenor and has been traced southward along the Brown-Coleman County line to the Santa Fe Railroad 3 miles west of Bangs and thence south and a little west to the Colorado River south of Rockwood. A few miles north of old Fort Belknap the clay is obscured by thick layers of sand and sandstone which appear in the section of upper Cisco strata. South of the Colorado River in McCulloch County, the clay undoubtedly extends as far as the Cretaceous sand 15 miles south of Waldrip. Thus it is fully 150 miles in

extent, measured along the outcrop from north to south, and has an average width of about one-third of a mile. In general its outcrop including the interbedded sandstone is widest in northern Stephens and Young counties and narrowest in Eastland, Brown, and Coleman counties. In Stephens County a sandstone lentil is present in the section, and the Quinn clay is replaced by sand for a distance of about 16 miles. The extent and shape of the outcrop of the clay are shown on Plates III and IV. It extends north and slightly east from Rockwood to Grosvenor, nearly due north from Cisco to Crystal Falls, and northeast from Crystal Falls to old Fort Belknap. The average thickness of the clay is 30 feet. Its maximum total thickness in 26 sections measured is 48 feet, and its minimum thickness 21. The table on page 7 gives a compilation of all measured thicknesses. The location of these measured sections is shown on Plates I through V.

Description.—The Quinn clay has a purplish-red or maroon color, changing and interspersed with bluish- and grayish-green hues. It is a hard, compact, colloidal, joint clay rarely laminated and breaking along conchoidal planes rather than along laminations. In general it has more the appearance of a joint clay or a ball clay than a shale or a shaly clay. When excavated it breaks off in quite large, hard dense chunks having curved surfaces which in many cases have a greasy or serpentinous feel. In many places, as, for example, at the type locality at the Quinn pits, east of Cisco (Pl. II, locality 12), it is quite uniform in texture and appearance from top to bottom and laterally for long distances. Compared with most other clays in this region, it is quite free of ferruginous nodules, concretions, pebbles, or other impurities. In a few places, however, as for example, east of the Fee ranch house near Cisco (Pl. II, locality 13), the clay contains numerous gypsum (selenite) crystals which appear to extend only a slight distance back into the clay. In other places the clay contains one or two thin seams of coal, 1 to 2 inches thick. At the outcrop 2 miles south of Cisco (Pl. II, locality 11), there are two thin layers of coal,

each 2 inches thick and located 5 and 10 feet respectively from the top of the clay. In numerous localities, particularly those in Brown and Coleman counties, a seam of fine light-colored sand or silt-stone 3 to 8 inches thick occurs near the

Thicknesses of Quinn clay.

Plate No.	Locality No.	Fig. No.	Locality	Thickness of outcrop in feet
—	1	—	East side of Santa Anna-Brady highway, 0.7 mile south of Colorado River bridge, McCulloch County.....	48
I	3	1	Taylor deposit. South side of Brownwood-Coleman highway, 3.3 miles west of Bangs, Brown County.....	14+
I	4	—	George deposit. East side of road and west end of outlier, 5.5 miles northwest of Bangs, Brown County.....	33
I	5	—	Shore deposit. Southeast side of outlier, 1.3 miles east of Eureka Baptist Church and 2.1 miles north-northeast of Buffalo, Brown County.....	47
I	6	—	Cutbirth deposit. 0.4 mile west of road, 3 miles south and 1 mile west of Grosvenor, Brown County.....	43
I	7	—	Gaines deposit. East side of road, 0.5 mile west and 0.5 mile south of Grosvenor, Brown County.....	23+
I	8b	—	West side of road, 0.5 mile east of Grosvenor, Brown County.....	42
I	9	2	DeBusk deposit. East side of Cross Plains road, 16 miles north of Brownwood and 0.5 mile northeast of Panther Creek School, Brown County.....	15+
II	10	—	One-tenth mile west of Rising Star highway, 3 miles south of Cisco, Eastland County.....	22
II	11	3	Wilson deposit. West side of Rising Star highway, 2 miles south of Cisco, Eastland County.....	10+
II	12	4	Quinn pit. North side of Eastland highway, 2 miles east of Cisco, Eastland County.....	32
II	12a	5	Gallagher pit. West of Quinn pit and north side of Eastland highway, 2 miles east of Cisco, Eastland County.....	6+
II	13	6	Fee deposit. South side of Breckenridge highway, 2 miles northeast of Cisco, Eastland County.....	26
II	14	—	West side of road, 3 miles north-northeast of Cisco, Eastland County.....	32(?)
II	15	7	Wright and Harrell deposit. One-half mile east of Lake Cisco dam, 0.1 mile north of fish hatchery, Eastland County.....	34
II	16	—	Cisco Country Club deposit. East side of old Breckenridge-Cisco road, 1.6 miles north-northeast of Lake Cisco dam, Eastland County.....	32(?)
II	17	—	East side of old Breckenridge-Cisco road, 1 mile south of Eastland-Stephens County line, Eastland County.....	25
III	18	—	West side of old Breckenridge-Cisco road, 0.15 mile south of Sandy Creek bridge, Stephens County.....	3
III	18a	—	Two-tenths mile east of old Breckenridge-Cisco road, 0.4 mile south of Sandy Creek bridge, Stephens County.....	28
III	18b	—	One-tenth mile east of old Breckenridge-Cisco road, 0.6 mile south of Sandy Creek bridge, Stephens County.....	27+
III	21a	8	Beal deposit. East side of road 1.25 miles south of Breckenridge High School, Stephens County.....	30
IV	22	9	Veal deposit. West side of Woodson highway, 5 miles north of Breckenridge, Stephens County.....	29
IV	23	—	Hubbard Creek Crossing. North side of Crystal Falls-Breckenridge road, 1 mile southwest of Crystal Falls, Stephens County.....	22
IV	25	—	North side of Crystal Falls-Eliasville road, 1.3 miles northeast of Crystal Falls, Stephens County.....	21
V	26	—	Cotten deposit. East of Wagon Timber Branch, 0.2 mile north of Crystal Falls road, and 4 miles west of Eliasville, Young County.....	42
V	27	10	Linderman deposit. West side of Eliasville road, 0.9 mile south of Graham-Woodson road, 10 miles west of Graham, Young County.....	31
V	29	—	Dixon deposit. One-fourth of a mile north of Brazos River and 3¼ miles southeast of Newcastle, Young County.....	—
V	30	11	Smith deposit. North side of Graham road, 5 miles east of Newcastle, Young County.....	35

middle of the section. In other areas, as, for example, around Cisco, the silt is absent. About 1 mile north of the Stephens-Eastland County line a sandstone about 10 feet in thickness appears in the Quinn clay about 3 feet above its base. The sandstone is dark reddish-brown, coarse grained in places, contains pebbles of conglomerate, is friable, and weathers to form broad sandy plains in Stephens County. In the vicinity of Sandy Creek the sandstone thickens to 45 feet or more and almost completely occupies the space of the Quinn clay in the section. From Sandy Creek in Stephens County the sandstone lentil continues northward, to within 1 mile of the Curry farm deposit (Pl. III, locality 20) where it apparently disappears from the section. In a few places, as for example, near the town of Grosvenor and in the section on Hubbard Creek south of Crystal Falls, one or more thin bands of impure siderite or ferruginous carbonate occur in the section. The siderite bands are 1 to 4 inches thick, break up into small irregular-shaped fragments, and fall down as nodules of crumbly detritus partly covering the hard clay. More details regarding these layers and lentils of extraneous matter are given in the description of the individual sections and localities subsequently discussed. With the exception of the thin seams of siderite, no carbonate has been noticed anywhere in the Quinn clay. The Quinn clay appears to be essentially an ancient mud deposit laid down on near land or lagoonal mud flats along an ancient sea coast, exposed to weather and completely leached of all its carbonates before deposition of overlying strata, the only fossils found in it being a few coal plant leaves in layers in or near the thin seams of coal.

Stratigraphic sections.—The changes in the character of the Quinn clay are best shown by the stratigraphic sections (Pls. VI, VII, and VIII). Plate VI shows the correlation of the clay in Brown County, Plate VII shows the stratigraphic section in Eastland and Stephens counties, and Plate VIII shows the sections in Young County. The sections in Brown and Coleman counties indicate that the lower

Crystal Falls limestone occurs 15 to 30 feet below the Parks Mountain sandstone and that Quinn clay is present below the limestone. Furthermore, a layer of fine sandstone or a coarse siltstone is present in various positions in the Quinn clay. No thin coal layers were found in the clay in Brown or Coleman counties. The sections in Eastland County indicate that the Cisco Lake sandstone (probably the equivalent of the Parks Mountain sandstone) lies directly above the lower Crystal Falls limestone with no intervening clay. Furthermore, no siltstone or sandstone was found in the clay south of the south line of Stephens County. About 1 mile north of the south line of Stephens County, a sandstone lentil 10 to 45 feet thick appears in the section cutting out part and in some places all of the clay and greatly obscuring the outcrop. One mile south of Breckenridge a 10 to 15-foot sandstone lentil appears in the lower portion of the Quinn clay. The extent of this lentil is unknown. The character of this sandstone is very similar to the former sandstone and could be a continuation of it. North of Breckenridge in the vicinity of Crystal Falls a thin sandstone about 1 foot thick is found in about the middle of the Quinn clay, but the thick sandstone lentil has disappeared. The position of the thin bands of coal and of siderite is also shown in the sections. In Young County, north of the Clear Fork of the Brazos River (Pl. VIII), no coal was found in the section, and the thin layer of fine-grained sandstone persisted. The presence of the thin bands of siderite and thin bands of fine-grained sandstone in the section will be detrimental to clay mining operations where an operator desires to remove all the clay. However, the clay is sufficiently thick in most cases to make it possible to open clay pits either below or above the sandstone layer. The siderite bands, on the other hand, do not appear to be persistent, and in most cases it is possible to choose sites where little siderite is present.

Noteworthy localities.—Of 26 or more localities examined, the following, because of their location near good roads and railroads and because of the apparently

better than average quality of the clay, are selected as worthy of special description.

These deposits are described briefly below and illustrated by graphic sections showing profile of the surface, thickness, and succession of strata.

Taylor deposit.—This deposit is well exposed along a low escarpment in a recently excavated water hole on the south side of the Brownwood-Coleman road, 3.3 miles west of Bangs, Brown County (Pl. I, locality 3). The clay may be examined in the sides of the pit and along a low east-facing escarpment for a distance of 200 feet. The profile of the deposit and section of the clay are shown graphically in figure 1. The clay consists of maroon, purple, and greenish-gray clay which is hard, breaks with a conchoidal fracture, and is comparatively pure

and free of nodules, concretions, or mineral veins. In places the surfaces of the clay are stained red and yellow mainly from iron oxide. About 14+ feet of clay is exposed, and it appears to be of fairly uniform and good quality. The clay outcrops along the face of a valley, as shown in figure 1, and is overlain along the escarpment by about 22 feet of medium to coarse brown sandstone and 5 feet of conglomerate. Excavation along the face of the escarpment will be easy, but due to the thick overburden of sandstone the width of the available clay is narrow. The deposit is favorably located adjacent to a paved highway and close to the Santa Fe Railroad.

DeBusk deposit.—The DeBusk deposit is a good exposure of clay along a low south-facing escarpment north of a small lake on the east side of the Brownwood-

Noteworthy clay deposits.

Map locality No.	Name of landowner	Locality	Maximum exposed thickness in feet
3	Taylor	South side of Brownwood-Coleman road, 0.1 mile east of Coleman County line and 3.3 miles west of Bangs, Brown County	14+
9	DeBusk	East side of Brownwood-Cross Plains road, 16 miles northwest of Brownwood, Brown County	10
11	Wilson	West side of Cisco-Rising Star road, 2 miles south of Cisco, Eastland County	10
12	Quinn	North side of Cisco-Eastland road, 2 miles east of Cisco, Eastland County	20
12a	Gallagher	North side of Cisco-Eastland road, 2 miles northeast of Cisco, Eastland County	6+
13	Fee	South side of Cisco-Breckenridge road, 2 miles northeast of Cisco, Eastland County	9
15	Wright and Harrell	One-half mile east of Lake Cisco dam, 500 feet north of fish hatchery, Eastland County	24
21a	Beal	East side of road, 1¼ miles due south of Breckenridge High School, Stephens County	5
22	Veal	West side of Breckenridge-Woodson road, 5 miles northwest of Breckenridge, Stephens County	12
27	Linderman	South side of Graham-Woodson road, 10 miles west of Graham, Young County	6
30	Smith	North side of Newcastle-Graham road, 5 miles east of Newcastle, Young County	4

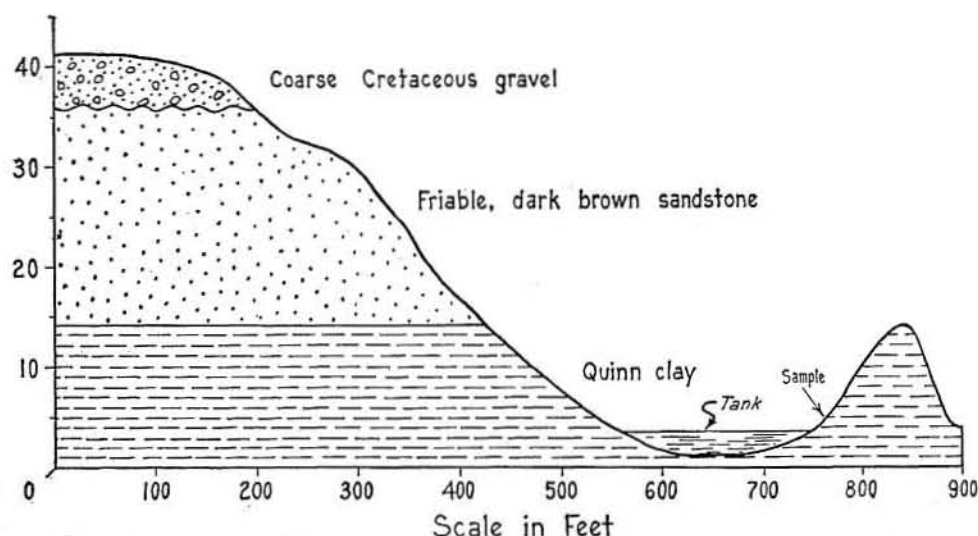


Fig. 1. Cross section of Quinn clay at the Taylor deposit on the south side of the Coleman-Brownwood road, 3.3 miles west of Bangs in Brown County.

Cross Plains road, 16 miles northwest of Brownwood, Brown County (Pl. I, locality 9). About 10 feet of clay in the lower half of the section is exposed, as shown in figure 2. The clay consists of maroon, red, and greenish-gray hard clay interbedded with a thin light gray siltstone layer about 3 to 6 inches thick. The clay appears to be of fair quality and free of contaminating mineral matter. The clay

limestone. The pit is located adjacent to a good highway, which is to be paved in the near future, and 3.2 miles north of the paved road leading to Brownwood State Park. It is, however, 16 miles distant by road from the nearest railroad at Brownwood.

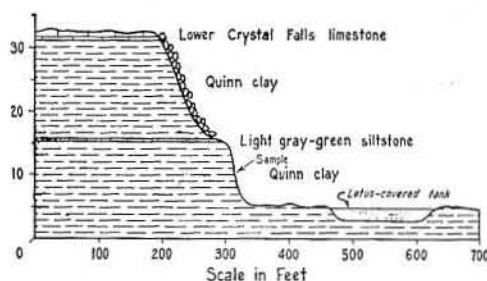


Fig. 2. Cross section of Quinn clay at the DeBusk deposit on the east side of the Cross Plains road, 16 miles north of Brownwood in Brown County.

above the siltstone is covered with grass and talus for the most part but is known to contain some siderite nodules and appears to be less desirable than the lower clay. The lower clay is at least 10 feet thick and may be 15 to 18 feet, as indicated by the diagram (fig. 2). The best clay is overlain by the thin siltstone, by 15 feet of poorer clay, and by 1 foot of

Wilson deposit.—The Wilson deposit is located in the west side of the Cisco-Rising Star road, 2 miles south of Cisco, Eastland County (Pl. II, locality 11). The exposure consists of a large barren area covering a flat, broad valley between sandstone-capped ridges, and containing two small water holes excavated for obtaining a water supply for cattle. A cross section through the deposit is shown in figure 3. About 10 feet of clay is exposed over the valley bottom, and the clay is overlain on the ridges by a massive deposit of coarse, cross-bedded sandstone and conglomerate having a total thickness of 28 feet. The clay is apparently of fairly good quality but contains two thin layers of impure much weathered and disintegrated coal 1 inch to 2 inches thick. The upper layer is about 3 feet from the top of the clay, and the second layer is about 5 feet below the top. The clay above the lower coal is maroon, red, and greenish-gray. In places where the clay is oxidized, it grades into yellow and brownish-yellow hues. It is hard, fairly

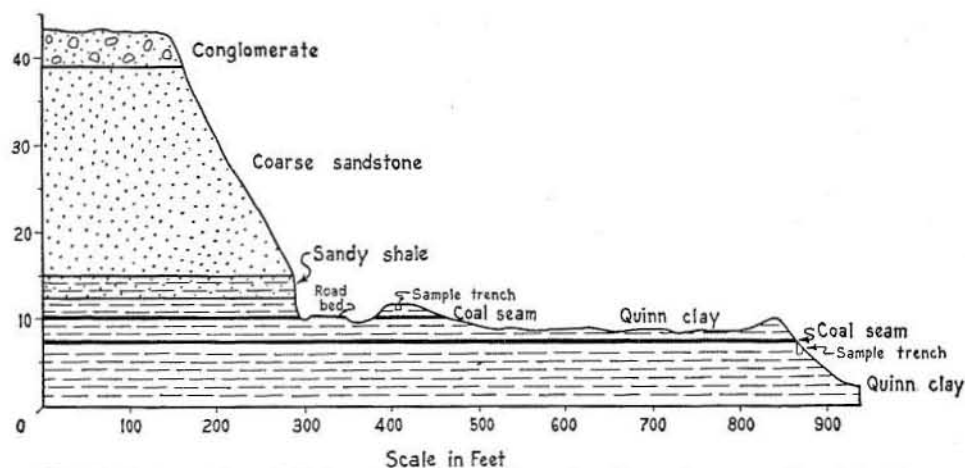


Fig. 3. Cross section of Quinn clay at the Wilson deposit on the west side of the Rising Star road, 2 miles south of Cisco in Eastland County.

uniform in quality, and for the most part free from impurities except iron oxide, which apparently is the cause of the variegated coloration. The clay below the lower thin coal layer is somewhat lighter in color, somewhat more laminated and more shaly, and may have somewhat different ceramic qualities. Although only 10 feet of clay is exposed, it is estimated that there is at least a total of 20 feet and perhaps 30 feet available for excavation over the valley bottom and along

the slopes of the ridges. In most places the soil and silt washed down from the slopes is 3 to 5 feet thick. The deposit is located on a paved highway only 2 miles from the city limits of Cisco.

Quinn deposit.—The Quinn deposit is the site of the original discovery of the pottery clay near Cisco. It is located on the north side of the Cisco-Eastland highway, 2 miles east of Cisco, Eastland County (Pl. II, locality 12). The pit is

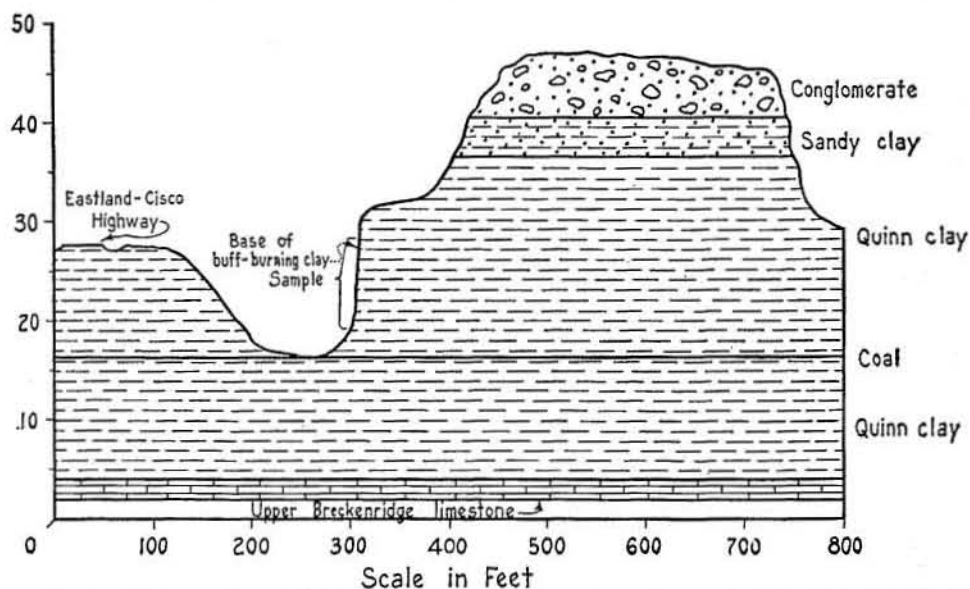


Fig. 4. Cross section of Quinn clay at the Quinn pit on the north side of the Eastland highway, 2 miles east of Cisco in Eastland County.

located on the southeast side of a circular hill having clay along its slopes and capped by massive sandstone and conglomerate, as shown in the cross section through the Quinn pit (fig. 4). Twenty-five feet of clay is exposed on the slopes of the hill and in the walls of the pit, and measurements made of the entire outcrop and of depth of core holes indicate that the total thickness of the clay is 32 feet. The upper 3 feet of the clay is usually weathered or of poor quality and the lower 2 feet, in most cases, contains calcium carbonate and caliche so thin that there remains about a maximum of 27 feet of good quality clay in the section. The clay is variegated in color, varying from maroon and red to grayish-green, bluish-green, and even purple.¹ The clay is remarkably uniform in texture containing few concretions, few ironstones, and no siderite, but one thin seam of coal or carbonaceous shale was noted at the bottom of the pit, and in a few places coal plants have been found in the shale. The overlying sandy shale is 4 feet thick, and the sandstone and conglomerate are about 10 feet thick. Accordingly, excavations for the clay are best located along the slopes of the hill below the conglomerate and above the upper Breckenridge limestone, which occurs in the valley about one-third of a mile northeast of the ridge. Knowing the slope of the clay surface, the thickness of the soil, the thickness of the clay above the limestone, and the length of the exposure, it is possible to calculate the amount of available clay in a rectangular 23-acre plot situated along the clay slope with its west edge bordering the sandstone on the hill top. H. B. Bradley found that along the slope the average thickness of the clay below the soil line is 23 feet and that the reserves of clay in a 23-acre rectangular tract situated as mentioned above amounts to approximately 800,000 cubic yards.

Gallagher deposit.—The Gallagher clay deposit (Pl. II, locality 12a) borders the Quinn deposit on the west and extends

completely around the sandstone-capped hill just described with the exception of the acreage held by Mr. Guy Quinn. The Gallagher pit is across the fence west of the Quinn pit, and the deposit is in every way similar to that on the Quinn land except that the available reserve of clay is much larger. For a cross sectional view of this deposit, see figure 5. Mr.

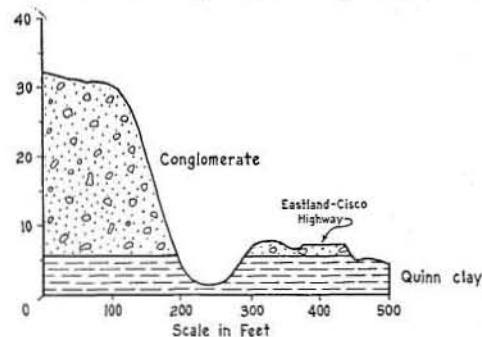


Fig. 5. Cross section of Quinn clay at the Gallagher pit on the north side of the Eastland highway, 2 miles east of Cisco in Eastland County.

Gallagher has built a small pottery plant west of his pit for manufacturing ornamental pottery and is preparing to erect a plant for manufacture of brick and tile on a tract of land on the north side of the hill. Thus these excellent clay deposits in the vicinity of Cisco and Eastland are beginning to be developed rather extensively.

Fee deposit.—The Fee clay deposit is situated on the south side of the Cisco-Breckenridge highway, 2 miles northeast of Cisco and one-half mile east of the Fee ranch house (Pl. II, locality 13). The exposure is along the side of the road ditch and on the slopes of a rather steep-sided valley leading south from the road. This deposit (fig. 6) is apparently in every way similar to the Quinn and Gallagher deposits and is located only 1 mile to the north. Below a slumped limestone block, the thickness of the best quality of clay at this locality is estimated to be about 18 feet, while the amount exposed is only about 4 feet. The thickness of the clay above the slumped block is about 8 feet, and only the top 5 feet is exposed. The clay as exposed in the ditch near the bottom of the section is dark

¹The upper 9 feet of the clay in the Quinn pit is reddish and bluish-gray in color and burns to a light buff. The lower 11 feet of clay is yellow, dark red, and maroon and burns to a light pastel-red or pinkish-red color.

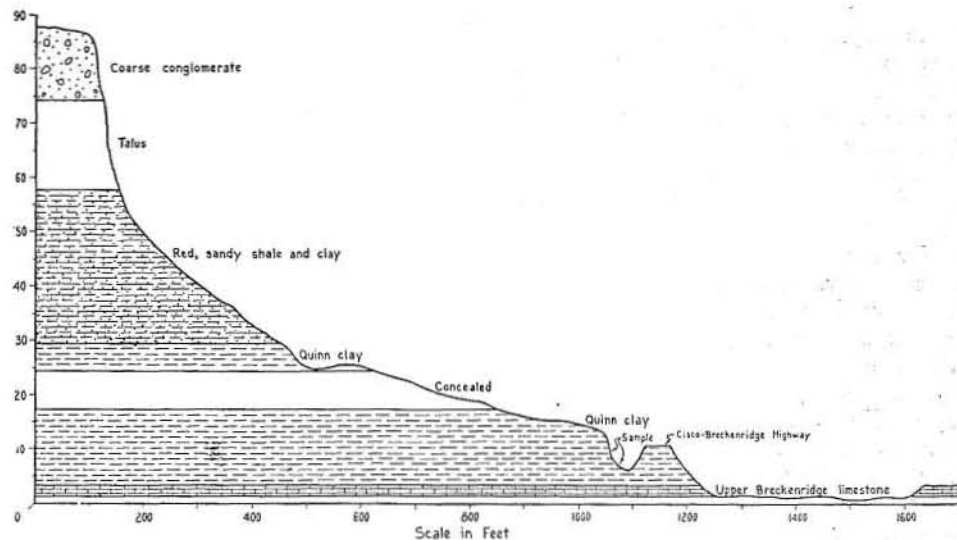


Fig. 6. Cross section of Quinn clay at the Fee deposit on the south side of the Breckenridge highway, 2 miles northeast of Cisco in Eastland County.

maroon red, stiff, colloidal, free from silt and marl, but containing some calcium sulphate in the form of transparent selenite crystals. The clay on the sides of the valley is overlain by about 28 feet of clay and sandy clay and covered with sand and detritus from the sandstone on the top of the hillside. The upper sandy clay in turn is capped by 15 to 30 feet of coarse sandstone and conglomerate; a small exposure of limestone in a bed about 1 foot thick occurs between the pure stiff clay and the sandy clay above. The limestone outcrop is small, badly slumped, and is not shown on the map; however, it is thought to represent the southernmost exposure of lower Crystal Falls limestone in Eastland County. This limestone in many places marks the top of the best quality Quinn clay. This Fee ranch exposure is the nearest Quinn clay outcrop to the city of Eastland and is advantageously located on a good highway.

Wright and Harrell deposit.—This deposit is located one-half mile east of Lake Cisco on the north side of Sandy Creek valley, 3.6 miles north of Cisco, Eastland County (Pl. II, locality 15). The clay is exposed along a steep south-facing escarpment forming the north side of the valley. Slope wash and gully cutting have removed much of the soil, leaving exposed one of the most complete sections of

Quinn clay to be found anywhere in Eastland County. Altogether, about 24 feet of clay out of a total of 34 feet of section is available for inspection and sampling, as indicated by figure 7. The clay, like that described from other exposures, is a dark

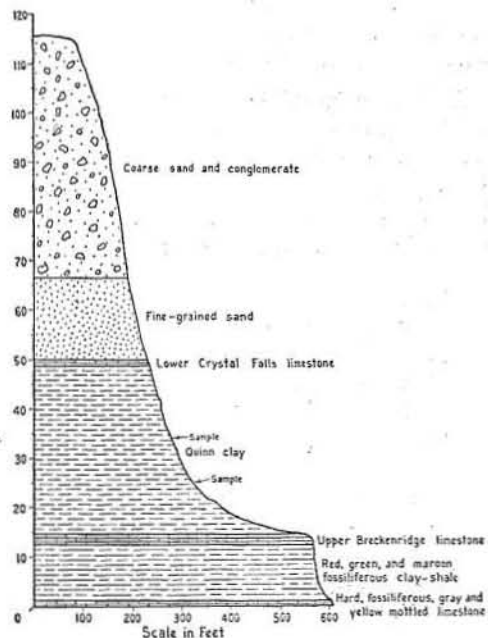


Fig. 7. Cross section of Quinn clay at the Wright and Harrell deposit, north of the State Fish Hatchery and one-half mile east of Lake Cisco dam in Eastland County.

maroon clay, oxidized to brown and yellow colors and mixed with masses of clay which are bluish-green and bluish-gray. The clay rests upon the upper Breckenridge limestone and is overlain by a sandy fossiliferous limestone thought to be the lower Crystal Falls bed. The clay is quite uniform in quality from top to bottom and for the most part is fairly free of foreign matter, although it contains a few iron concretions and a few nodules of ferruginous material. Above the Crystal Falls limestone there is 65 feet of sandstone and conglomerate which forms a steep bluff that weathers into large blocks which fall down the slope, and in many places completely obscures the clay with a thick layer of sand and sandstone talus. The steepness of the scarp and the thickness of the overburden would handicap commercial development, but the locality is noteworthy because the gullies along the scarp have exposed to view the most complete section of Quinn clay to be seen anywhere. Doubtless good sites for clay pits can be opened by removing the sandstone overburden with a scraper or bulldozer. The exposure is only one-half mile east of the Cisco-Moran paved highway and 3.6 miles north of Cisco, so that this locality is quite accessible.

Beal deposit.—This clay deposit is located on the east side of the north-south highway, $1\frac{1}{4}$ miles due south of the Breckenridge High School in Stephens County (Pl. III, locality 21a). The exposure is in a ditch along the east side of

the road and below a low north-facing escarpment capped by limestone near an old abandoned oil well. About 5 feet of rather deeply weathered clay is exposed, and the total thickness of the deposit is probably not more than 30 feet, because at this locality a lentil of sand comes into the lower part of the section replacing the upper Breckenridge limestone and extending up into the Quinn clay, a distance of 10 to 15 feet.² A measurement made one-half mile south of the locality indicated 30 feet of clay containing some sand in its lower portion, as shown in the profile and cross section, figure 8. Because of the siltstone and sandstone lentil the general uniformity of the Quinn clay is modified. It is thinner, more sandy at the base, and contains impurities not found generally at other places. In fact the clay is of such quality that the exposure would not be included in this list of promising localities except for the fact that it is the nearest locality to the city of Breckenridge. It is located where the clay can be examined and sampled easily. Much of the clay is bluish-green in color with reddish-maroon and brownish-red hues. It is compact, hard, and cut by many cracks and joint fractures. Many iron concretions are on the surface, and other types of nodules of undetermined composition undoubtedly are present. The pit which has been excavated to obtain the sample, however, indicated a fairly good

²In addition a siltstone layer 18 inches thick occurs 17 feet below the lower Crystal Falls limestone.

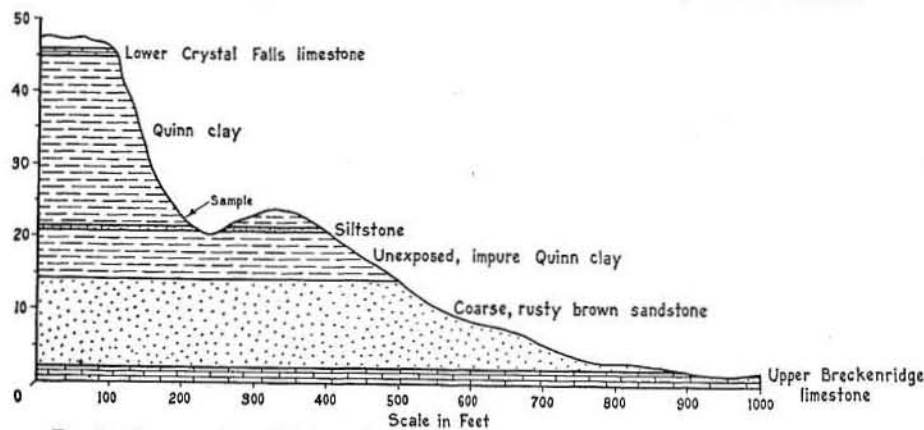


Fig. 8. Cross section of Quinn clay at the Beal deposit on the east side of the road, $1\frac{1}{4}$ miles south of the Breckenridge High School in Stephens County.

clay of about typical appearance, and it is possible that the nodules noted on the surface may have come down from the limestone horizon above. The clay rests upon a coarsely grained, cross-bedded sandstone about 12 feet thick and is overlain by a thin much weathered and broken limestone about 1 foot in thickness. The overburden of soil and limestone is about 3 to 5 feet and, therefore, the opening of a pit will not be difficult, if, upon further testing, the clay proves to be of economic value.

Veal deposit.—The Veal deposit is located on the west side of the Breckenridge-Woodson highway, 5 miles north of Breckenridge and 1.6 miles south of the road fork to Crystal Falls in Stephens County (Pl. IV, locality 22). About 12 feet of Quinn clay is exposed in a ditch and along an east-facing escarpment on the side of a small hill, capped by limestone and large boulders of sandstone, immediately west of the highway. The clay here is separated into two divisions by a siltstone or fine-grained sandstone 6 inches in thickness. The position of the siltstone in the section is shown in figure 9. The lower portion of the clay is about 19 feet thick and the upper about 10 feet. About 12 feet of the lower clay is exposed. It is a dark maroon to brick-red, hard, compact, much jointed clay. The lower 8 or 10 feet appears to be free from contamination and of very good quality. The upper 10 feet is badly weathered. The upper portion of the clay above the siltstone is poorly exposed, the surface being covered with many siderite and other types of iron nodules, and it is concluded that the lower clay is superior to the upper portion. A large area of the lower clay is exposed along the road side on both sides of the hill with little overburden except the usual depth of soil. The exposure, therefore, is a most favorable one for opening a clay pit, located as it is on a paved highway only 5 miles north of the city of Breckenridge.

Linderman deposit.—The nearest deposit of Quinn clay to the city of Graham in Young County is located on the west side of the road leading south to Eliasville, 0.9 of a mile south from the Graham-

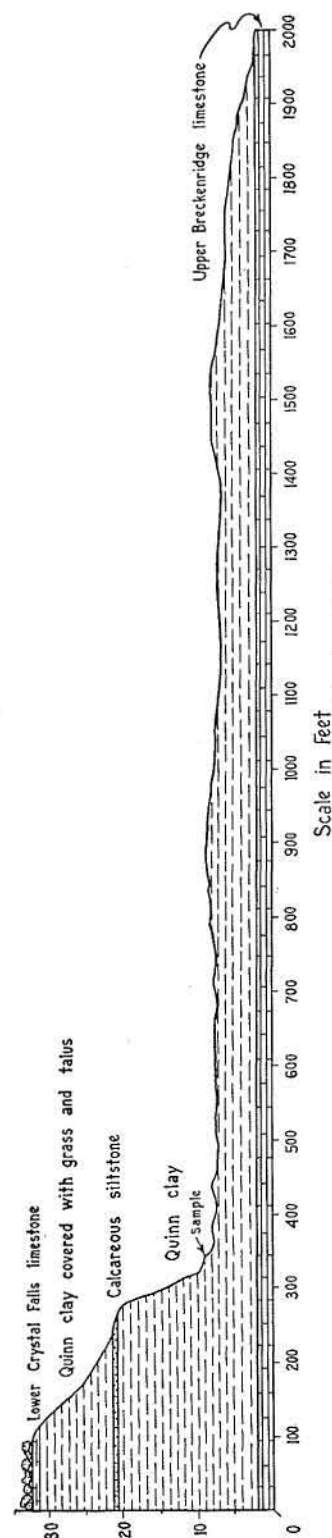


Fig. 9. Cross section of Quinn clay at the Veal deposit on the west side of the Woodson highway, 5 miles north of Breckenridge in Stephens County.

Woodson highway (Pl. V, locality 27). The clay is exposed along the road ditch adjacent to a low east-facing escarpment capped by lower Crystal Falls limestone. The total thickness of the clay at this locality is 31 feet. Of this only about 6 feet is exposed. A profile and graphic section of the clay are shown in figure 10.

of some form of iron so that the chunks which break off along the fracture lines are coated with a deep red color. When the coloring matter is scraped off, the rest of the clay is grayish-green. It is clear that in this shallow near-surface exposure the red coloring matter, in most cases distributed more or less uniformly through

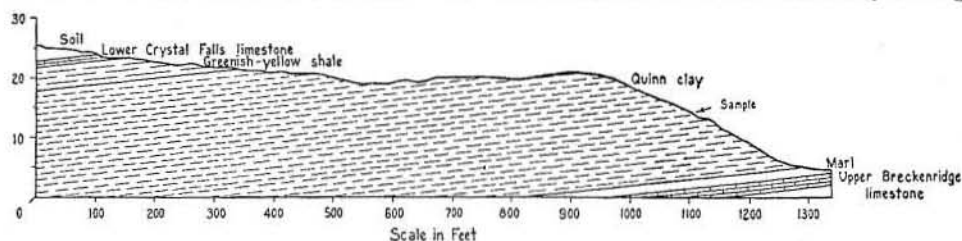


Fig. 10. Cross section of Quinn clay at the Linderman deposit on the west side of the Eliasville road, 0.9 mile south of the intersection with the Graham-Woodson road, 10 miles west of Graham in Young County.

The clay is maroon, brick-red grading in spots into grayish and bluish-green colors. It is hard, breaks with curved fractures, is highly plastic when wet, and apparently is fairly free from contaminating materials, at least none were encountered in the pit excavated in collecting the sample. There are, however, a few ironstone concretions and other nodules on the surface of the outcrop. On the whole, the clay at this place looks to be of fair quality, but the distance of the locality from Graham, 10 miles, is an unfavorable factor in development.

Smith deposit.—The Smith deposit is located on the north side of the Graham-Newcastle highway, 5 miles east of the road leading to Fort Belknap in the town of Newcastle, Young County (Pl. V, locality 30). The clay is exposed in the road ditch in front of a very low east-facing outcrop of lower Crystal Falls limestone. The total exposure is about 4 feet. The total thickness of clay at this locality, calculated by projecting the upper Breckenridge limestone westward from its outcrop one-half mile to the east, as indicated by figure 11, is 35 feet—a figure which is tentative since the exact angle of dip of the Breckenridge limestone at this place is unknown. The clay is greenish-gray, hard, much cracked and fractured so that it is excavated easily into irregular-shaped chunks. The cracks and crevices in the clay are filled with a dark maroon stain

of the clay, is concentrated in the cracks and thin crevices. The clay is reported to be white burning. There is little overburden except soil over the clay. A very large area nearly 2,000 feet along the highway is exposed, and if upon core drilling or deeper excavating, the clay proves to be of good quality, this site will be quite favorable for a clay pit.

Chemical and mineralogical composition.—Only limited information on the chemical and mineralogical composition of the Quinn clay is included in this section of the report. Additional data will be found in the section in which the ceramic properties of the clay are discussed.

Analysis of clay from Quinn pit, 2 miles east of Cisco.

(Bruce Williams Laboratory, Joplin, Missouri)

	Percent by weight
SiO ₂	64.32
Al ₂ O ₃	21.11
Fe ₂ O ₃	2.92
TiO ₂	1.73
MnO	2.4
P ₂ O ₅	0.03
SO ₂	0.02
CaO	0.25
MgO	0.03
K ₂ O	0.53
Na ₂ O	1.78
*Ignition loss	6.96

*Mostly combined water, volatile basic oxides, and carbonaceous material.

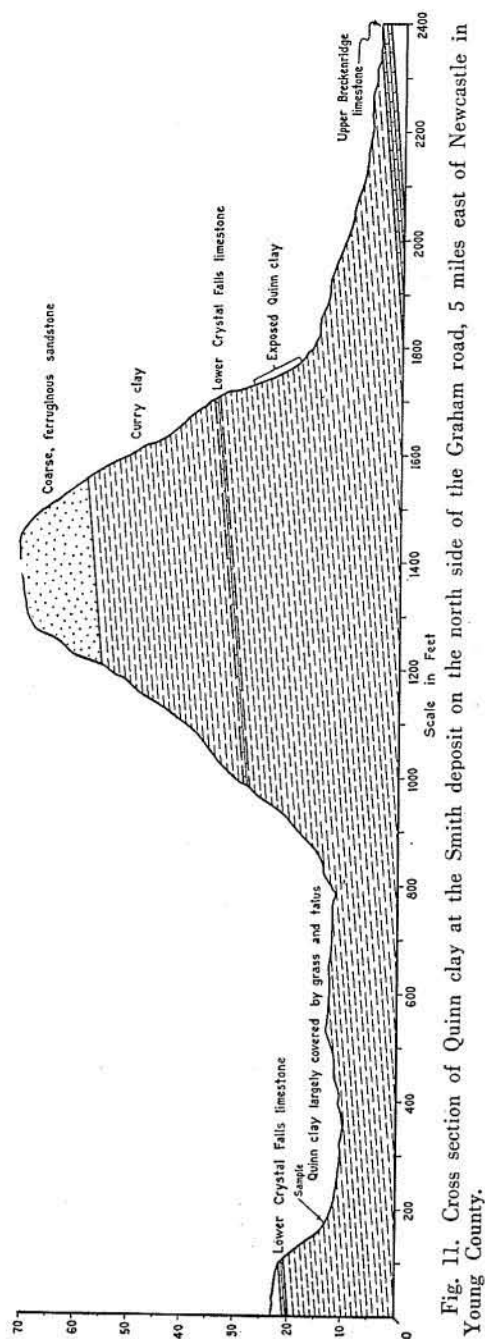


Fig. 11. Cross section of Quinn clay at the Smith deposit on the north side of the Graham road, 5 miles east of Newcastle in Young County.

The composition of a clay is a general guide to its properties but must be supplemented by ceramic tests. The analysis above indicates the Quinn clay is high in silica and alumina, has appreciably less iron and manganese oxide, and smaller

amounts of other constituents except sodium oxide and titanium oxide. The low calcium oxide content is a noteworthy and desirable property of this clay.

Dr. R. E. Grim of the Illinois State Geological Survey kindly examined samples of a number of the clays described in the report, employing the differential thermal technique. His results for samples of Quinn clay are given below.³

Mineral composition of Quinn clay.

	Kaolinite	Illite	Montmorillonite
Quinn pit (locality 12)	1/3	2/3	—
Smith deposit (locality 30)	1/4	3/4	trace

CURRY CLAY

Name.—The Curry clay is named for the Curry farm located 5 miles south and 2¼ miles west of Breckenridge, Stephens County, where the clay is excellently exposed and where it was first sampled and tested for making pottery. (See Pl. III, locality 20.)

Stratigraphic position.—The Curry clay occurs between the upper and lower Crystal Falls limestone layers, just above the Quinn clay in the areas where the thick sandstone deposits of the Parks Mountain and its probable equivalent, the Cisco Lake sandstone, do not occur (Pls. VI, VII, and VIII). Thus the Curry clay is not found to any extent in Eastland County but is well developed in Stephens County from near the south county line north as far as the city of Breckenridge. It occurs also in Young County west of Graham between the Graham-Woodson road and Newcastle. There is a thin section of Curry clay also in Brown County near Grosvenor.

Description and thickness.—The Curry clay closely resembles the Quinn clay in general appearance. It is purplish-red and greenish-red, grading in places into deep maroon. In the field it is difficult to distinguish the Curry clay from the Quinn lithologically, and probably the clay represents simply a continuation of the same sedimentary conditions, under which the Quinn clay was deposited, in those

³Letter to John T. Lonsdale, March 1, 1947.

areas where sand and gravel were not present. When examined critically some differences may be noted, and its qualities for making pottery are said to be somewhat less desirable. The Curry clay contains, in most cases, more ironstone concretions and ferruginous nodules. It does not contain the fine-grained, light-colored siltstone found in most cases in the Quinn clay. It does contain a thin seam of coal which is quite persistent, and in most cases the coal overlies a thin seam of bright yellow copiapite (?) which is quite conspicuous. In general, the Curry clay is less uniform and contains more mineral impurities in the form of iron compounds than does the Quinn clay.

The thickness of the Curry clay varies from a few feet to 32 feet depending upon the thickness of sand in the section above it. It is thickest in those areas where no sandstone occurs and is thinnest in the Cisco area where in places it is entirely replaced by sandstone. The table below shows typical measurements of the Curry clay.

Stratigraphic sections.—The position of the Curry clay in the geologic section, its thickness, and relationship to the strata above and below are shown in the columnar sections, Plates VI, VII, and VIII. It will be seen from these sections

that in most places the Curry clay is thinner, less uniform, and less continuous than the Quinn clay. Nevertheless, it is sufficiently developed to be of some commercial importance in western Brown, southern Stephens, and central Young counties, provided its ceramic qualities are acceptable.

Description of noteworthy localities.—The following localities for the Curry clay have been selected for description because of proximity to towns, transportation lines, or apparent good qualities.

Gaines deposit.—An exposure of the Curry clay overlying Quinn clay may be seen along the north side of a haystack-shaped hill, 0.5 mile west and 0.5 mile south of Grosvenor (Pl. I, locality 7). The Quinn clay is well exposed at the base of the hill on the east side of the highway, and the Curry clay is poorly exposed on the north side of the slope above the lower Crystal Falls limestone and below 15 feet of the sandstone which caps the hill. The thickness of the clay here is 32 feet with only about 5 feet exposed.

Byrd deposit.—The Curry clay occurs above the lower Crystal Falls limestone and below the Cisco Lake sandstone along the west side of the country road leading north from the hamlet of Gros-

Measured sections of Curry clay.

Plate No.	Locality No.	Figure No.	Name of landowner	Locality	Thickness, feet
I	4	—	E. F. George	1.3 miles east of Buffalo, 2 miles west and 4.5 miles north of Bangs, Brown County	16
I	7	—	I. B. Gaines	0.5 mile west and 0.5 mile south of Grosvenor, Brown County	32
I	8a	12	J. H. Byrd	0.1 mile north and 0.1 mile east of Grosvenor, Brown County	13
I	9a	—	West of DeBusk ranch	1.6 miles east and 2 miles north of Grosvenor on west side of Brown-wood-Cross Plains highway, Brown County	13
III	19	13	Troy Loudder	7¼ miles south and 2¼ miles west of Breckenridge in northeast corner of section 2263, Stephens County	24+
III	20	14	Curry	2¼ miles west and 5 miles south of Breckenridge, south of Curry ranch house, Stephens County	27+
V	28	15	Allar Company	2.4 miles west of McCan Bridge on south side of Graham-Woodson highway, 0.4 mile west of the Eliasville road fork, Young County	28

venor, 0.15 mile northeast of town (Pl. I, locality 8a). The clay is dark red, compact, and hard. When excavated it breaks off into irregular-shaped blocks with conchoidal faces. It is everywhere non-calcareous except in the lower 1 foot of the section where the clay is in contact with the lower Crystal Falls limestone. It grades upward into sandy clay which in turn is overlain by a coarse-grained, friable, yellowish and pinkish-gray sandstone. A graphic section of the Curry clay at the Byrd deposit is shown in figure 12. The

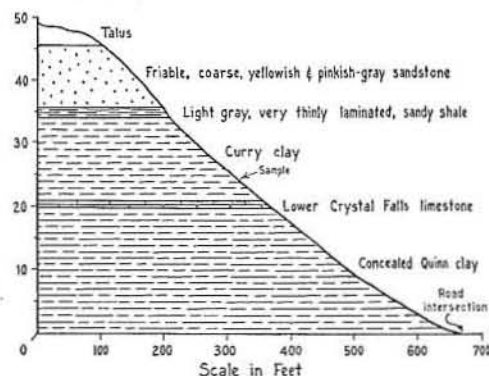


Fig. 12. Cross section of Curry clay at the Byrd deposit on the west side of the road, 0.15 mile northeast of Grosvenor in Brown County.

total thickness of the clay is 13 feet, of which the lower 5 feet is exposed. It is capped by 15 feet of sandy shale, sandstone, and talus. In appearance this Curry clay closely resembles the Quinn clay. It is, however, thinner and appears somewhat less plastic.

Loudder ranch deposit.—This deposit is located just north of the Loudder ranch house on the west side of the road, $7\frac{1}{4}$ miles south and $2\frac{1}{4}$ miles west of Breckenridge along a north-facing escarpment capped by the upper Crystal Falls limestone (Pl. III, locality 19). The clay is well exposed along gullies cutting back into the escarpment and in a water hole dug for a water supply for cattle near the base of the escarpment. The clay is reddish and greenish-gray and in places is somewhat more shaly and contains more ferruginous concretions than does the Quinn clay but otherwise resembles it closely. The thickness of the Curry clay

exposed at this locality is about 24 feet; however, the top 10 feet is more shaly than the lower 14 feet. The total thickness is not known because the lower Crystal Falls limestone below is covered by soil and slope wash, as shown in figure 13.

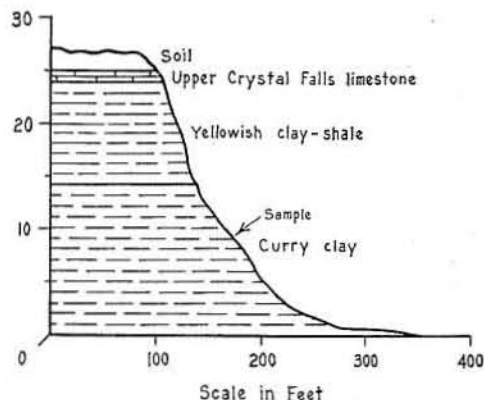


Fig. 13. Cross section of Curry clay at Loudder deposit just north of the ranch house, $7\frac{1}{4}$ miles south and $2\frac{1}{4}$ miles west of Breckenridge in Stephens County.

Curry deposit.—This deposit is located on the Curry ranch immediately south of the Curry ranch house, $2\frac{1}{4}$ miles west and 5 miles south of Breckenridge in Stephens County (Pl. III, locality 20.) In some ways it is the most remarkable of the clay locality exposures because the clay is exposed over an area of approximately 20 acres with no overburden above it. No grass or brush of any significance grows on the outcrop, and it resembles badland areas of South Dakota and Kansas. One can walk over the outcrop and see all its variations of color and texture. Very large tonnages of clay are available simply by scraping off the weathered portion. The clay is quite similar to the other deposits of the Quinn member.

It is maroon, reddish-purple, gray, or green, depending upon the state of oxidation, leaching, or re-precipitation of the iron compounds associated with the clay. The iron compounds apparently are present in small quantity, but only a very minute amount of iron is necessary to give the colloidal clay a very distinct color. Much of the coloring matter is deposited in very thin films on the joints and tiny cracks that form in the clay as it dries out

and shrinks. Most of the minute cracks are located near the surface so that the bright variegated colors are less and less apparent with depth. The dull red color, however, persists and is quite noticeable in cores from oil wells, even at several hundred feet beneath the surface. The section of Curry clay south of the Curry house shows about 27 feet of clay, the top 4 feet being quite shaly, and it is estimated that there is at least 10 feet more of clay beneath the surface. A pit 4 feet deep has been dug in the middle of the exposure without indicating any change in appearance or composition of the clay. About 17 feet below the top of the clay there is a thin seam of coal about 2 inches thick, as shown by figure 14. Just below the coal a bright yellow seam of copiapite (?) about one-half inch thick is quite conspicuous. The clay also contains a few small black ferruginous nodules. On the whole, however, the clay is fairly pure and apparently of good quality. The location of this deposit, $2\frac{1}{2}$ miles from a paved highway, mitigates against commercial development.

Allar Company deposit.—Another exposure of the Curry clay occurs along the south side of the Graham-Woodson road, 0.4 mile west of the Eliasville road fork and 2.4 miles west of the McCan Bridge in Young County (Pl. V, locality 28). The thickness of the clay at this locality is 28 feet, and the amount of vertical exposure is about 12 feet. The base of the clay rests upon lower Crystal Falls limestone, and the top of the section is capped with loose slabs of upper Crystal Falls limestone, as indi-

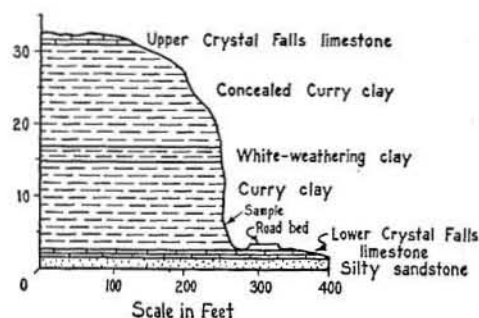


Fig. 15. Cross section of Curry clay at the Allar Company deposit, on the south side of the Graham-Woodson road, 0.4 mile west of the Eliasville road fork in Young County.

cated in figure 15. The clay is similar in color, texture, and general appearance to the Curry deposit described above, but the section contains more concretions, nodules, and other contaminating material, and it is thought that the clay at this locality may prove to be of poorer quality.

Chemical and mineral composition of the Curry clay.—One analysis of the Curry clay is given below.

Analysis of clay from Curry pit, $2\frac{1}{4}$ miles west and 5 miles south of Breckenridge, Stephens County.

(R. M. Wheeler, analyst)

	Percent by weight
SiO ₂	57.35
Al ₂ O ₃	26.90
Fe ₂ O ₃	0.92
TiO ₂ + ZrO ₂	1.86
CaO	1.42
MgO	1.04
Na ₂ O + K ₂ O	0.88
Ignition loss	9.04

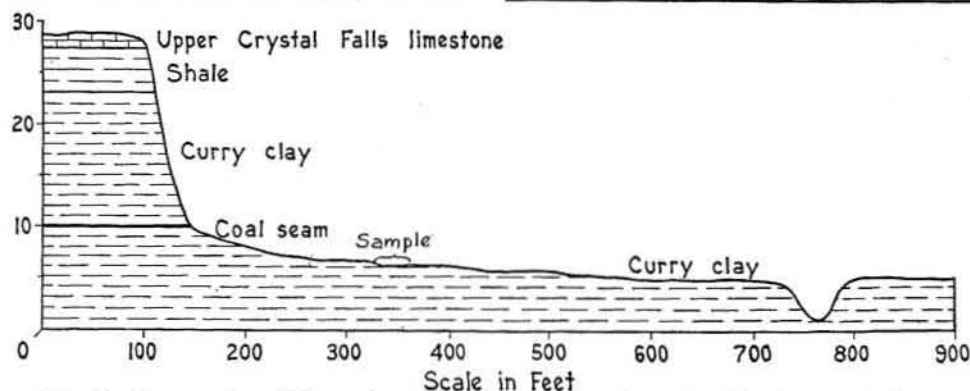


Fig. 14. Cross section of Curry clay at the Curry pit on the south side of the ranch house, $2\frac{1}{4}$ miles west and 5 miles south of Breckenridge in Stephens County.

It will be noted that the clay differs somewhat chemically from the Quinn clay. Silica and iron oxide are lower and alumina is distinctly higher.

Dr. R. E. Grim examined one sample of the clay from the Curry pit. He reported that the clay mineral fraction is composed of a little more than one-fourth kaolinite and that the remainder is illite. A trace of montmorillonite was suggested.⁴

CRADDOCK CLAY

Name.—The Craddock clay is named from the Craddock farm and Craddock Lake located 1 mile northwest of the town of Cisco, Eastland County. The clay is excellently exposed in a deep gully at the spillway of Craddock Lake (formerly called Twin Lake).

Stratigraphic position.—The Craddock clay occurs as an under clay just below the Newcastle coal bed, an upper coal bed in the Cisco group which is found just below the Belknap limestone, as shown in sections, figures 16–18. The coal and clay outcrop along the side of the escarpment capped by the Saddle Creek limestone or a massive sandstone. In many places the clay is obscured by talus and soil covering the slopes of the Saddle Creek ridge. In a few favorable places, however, the coal and under clay are well exposed.

Description and thickness.—The Craddock clay is a black or very dark gray, hard, compact joint clay weathering gray, and in most places oxidizing upon exposure to pink, red, and even maroon colors.

⁴Letter to John T. Lonsdale, March 1, 1947.

At the type locality the Craddock clay is weathered and has a light bluish-gray color mottled with pink, red, and rusty yellow stains. Here the clay is quite free of concretions or contaminating minerals, but in other places, as along a small stream on the Cohn ranch, 2 miles northwest of Cisco and along a road cut west of Crystal Falls, the clay contains large rounded hematite concretions, 3 to 6 inches in diameter, and numerous large selenite crystals. Accordingly, in places, at least, it is much less pure than the Quinn clay. However, in the exposures near Craddock Lake and at a locality 1.8 miles west of Breckenridge, the clay is quite uniformly free from contaminating nodules and apparently of good quality.

The thickness of the Craddock clay averages about 8 feet. Measurements are shown in the table below.

Description of noteworthy localities.—Descriptions of the most noteworthy localities where the Craddock clay has been studied and sampled follow.

Craddock Lake deposit.—The Craddock Lake deposit is located on the east side of Craddock Lake along the sides of the spillway of the lake on land belonging to the city of Cisco and located one-fourth mile west of and a little north of Cisco Junior College (Pl. II, locality 31). The clay underlies a 26-inch seam of coal and is underlain by shale, as shown in the section, figure 16. The clay is a compact, hard joint clay which when freshly exposed breaks along conchoidal fractures to form large irregular-shaped blocks which have a dark grayish-blue color mottled with pink blotches. In places the blotches are so numerous that the clay takes on a pinkish or reddish appearance.

Measured sections of Craddock clay.

Plate No.	Locality No.	Figure No.	Name of landowner	Locality	Thickness, feet
II	31	16	City of Cisco	1,500 feet west of Cisco Junior College and 150 feet east of Craddock Lake, Eastland County.....	8
—	32	17	Ashburn	North side of U. S. highway No. 80, 1.8 miles west of courthouse in Breckenridge, Stephens County.....	6½
IV	24	18	Crystal Falls deposit	0.1 mile west of Crystal Falls on south side of road, Stephens County	5+

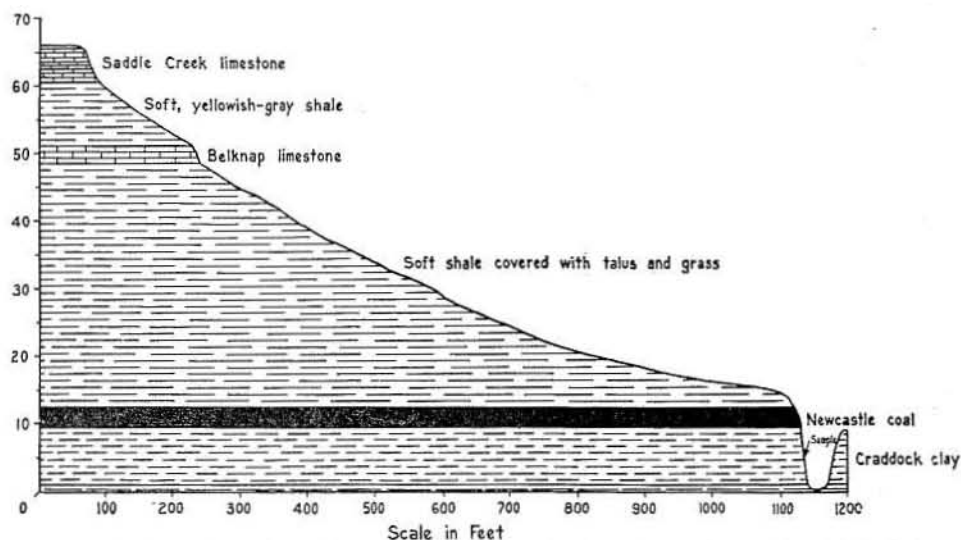


Fig. 16. Cross section of Craddock clay at the type locality, the spillway of Craddock Lake on land belonging to the city of Cisco in Eastland County.

In other places there are rusty yellow stains on the surface of the clay and along fracture lines in the clay. No concretions, iron nodules, or gypsum crystals were seen in the clay at Craddock Lake, although these impurities are rather common in the clay at other localities. The thickness of the clay is about 8 feet. The clay and coal are well exposed along the deep gully east of the spillway for a distance of several hundred feet.

Ashburn deposit.—This deposit is located along the Breckenridge-Abilene highway in a road cut 1.8 miles west of the Stephens County courthouse in Breckenridge. The clay occurs just below the Newcastle coal seam and is underlain by siltstone and shale. Where measured, the clay was exactly 6.5 feet thick, as shown in the section, figure 17. The clay is dark gray, weathering light gray, and is stained and intermixed with red and buff-colored ferruginous material. It also contains a few crystals of gypsum and concretions of limonite and other impurities. The clay in this locality appears to be of lower grade than that at Craddock Lake.

Crystal Falls deposit.—The Crystal Falls deposit is located 0.2 mile west of the general store at Crystal Falls along a cut on the south side of the road (Pl. IV, locality 24). The clay is overlain by

the Newcastle coal bed, and its base is obscured by detritus in the bottom of the ditch, as shown in the section, figure 18. The clay is gray in color, weathering reddish and pinkish-gray with rusty yellow

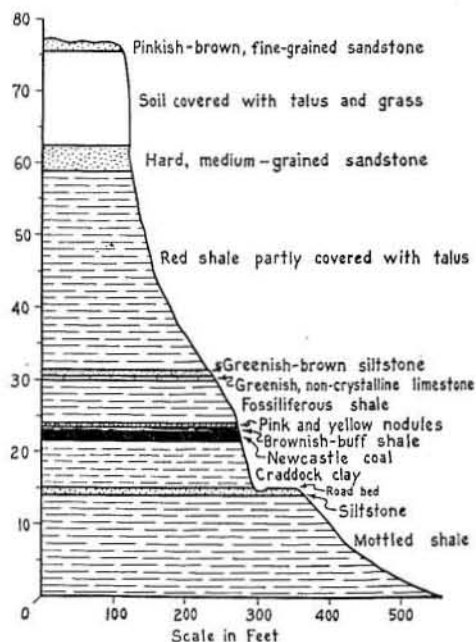


Fig. 17. Cross section of Craddock clay at the Ashburn deposit on the north side of U.S. highway No. 80, 1.8 miles west of Breckenridge in Stephens County.

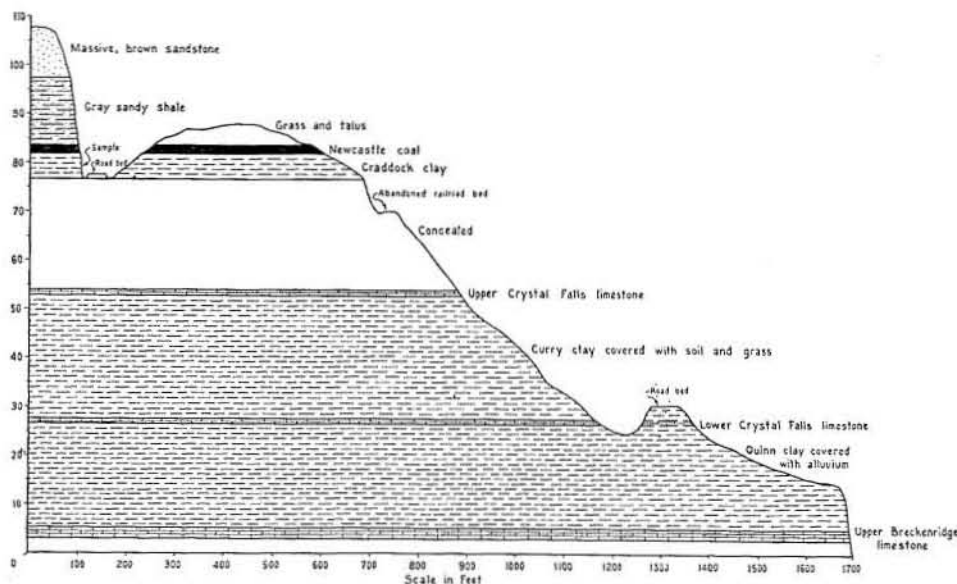


Fig. 18. Cross section of Craddock clay at the Crystal Falls deposit on the south side of the road, 0.2 mile west of Crystal Falls in Stephens County.

streaks. In places it contains numerous gypsum crystals and does not appear to be of as good quality as at the type locality near Cisco. The total thickness exposed is about 5 feet, capped by about 25 feet of sandy shale and sandstone.

Mineral composition.—A sample of the Craddock clay from the spillway of Craddock Lake was examined by Dr. R. E. Grimm. He reported⁵ that the clay mineral component of this sample is a mixture of illite and kaolinite. About one-fourth of the clay mineral fraction as determined from the differential curve is kaolinite.

FINIS SHALE

Name and stratigraphic position.—The name Finis was given by Plummer and Moore (1922) to the lowest shale in the Cisco division. The type locality is at Finis in Jack County. In the Eastland region the Finis shale rests upon the Home Creek limestone below and is overlain by the Eastland sandstone, a name given by Plummer and Hornberger (1935) to the sandstone west and north of the city of Eastland.

Description and thickness.—The Finis shale in the Eastland region is a dark

gray-blue, hard compact, well-laminated shale which breaks off into thin plates and shaly fragments and weathers to a light yellowish-gray color. The lower portion of the shale is fairly pure and contains in most places only a few soft small concretions of limonite and still fewer small calcareous nodules. The upper portion is similar but more sandy and is interbedded with thin bands of fine-grained sand or siltstone a fraction of an inch to 1 inch thick. Proceeding upward in the section, the bands of fine-grained sandstone become thicker and closer together, until at the top the shale is replaced by a thick bed of medium to coarse sandstone, 3 to 15 feet thick. The thin bands of silt and sandstone are covered with markings of plants and trails of animals and indicate a shallow near-shore type of deposition. The sandstone varies in thickness and shows everywhere quite strong cross-bedding of the beach and shallow-water type. The upper sandy beds constitute quite a serious overburden in excavating the good shale below. Sites for pits where the overburden is only soil and slope wash from the friable sandstone above can be selected, however, by proceeding a few hundred feet away from the escarpment.

⁵Letter to John T. Lonsdale, March 1, 1947.

Noteworthy localities.—The Finis shale has not been mapped in detail. The only localities studied and sampled are as follows: Weaver exposure, City of Eastland shale pit, and spillway at Lake Eastland.

Weaver exposure.—This exposure is located along an east and south-facing escarpment 1.3 miles east of the city of Eastland and one-fourth mile north of the Texas and Pacific Railroad. Profile and cross section of the outcrop are shown in figure 19. The Finis shale consists of two divisions: (1) a lower fairly pure siliceous shale occupying the broad gentle slope north of the railroad track and east of the escarpment; and (2) an upper sandy shale and shale interbedded with thin bands of sandstone which occupies the upper portion of the escarpment capped by the Eastland sandstone, as shown in the section, figure 19. The thickness of the lower economically important shale is 45 feet. The thickness of the upper sandy shale and overlying sandstone is 28 feet. A good site for a shale pit is north of the railroad track just east of the

escarpment, where the shale is 10 to 30 feet thick.

City of Eastland shale pit.—This pit is located on land belonging to the City of Eastland, one-half mile west of the city and one-fourth mile north of the Texas and Pacific Railroad, near the top of a low east-facing sandstone-capped escarpment. The locality was an experimental pit opened by the Chamber of Commerce of Eastland and by Mr. Guy Quinn. The shale was tested by Mr. Quinn for manufacture of pottery but was found to be better adapted for brick and tile than for pottery. Recently the site has been taken over by the Texas Aggregate Company which is erecting a plant near by for manufacture of light weight aggregate for concrete. The material in the pit is similar to the lower shale in the Weaver exposure but is somewhat more compact and does not contain the bands of siltstone which overlie the lower shale on the Weaver tract. The long gentle slope north of the railroad track and immediately east of the sandstone-capped escarp-

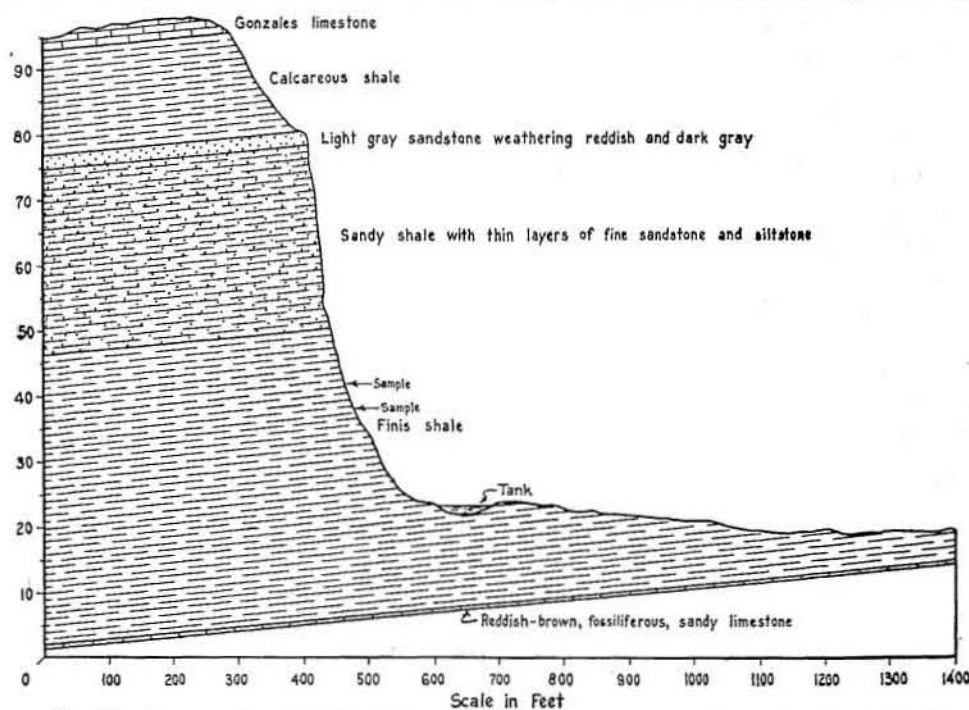


Fig. 19. Cross section of Finis shale at the Weaver exposure on the north side of the T. & P. Railroad track, 1.3 miles east of Eastland in Eastland County.

ment is an excellent locality for opening a shale pit. Since the experimental pit is only a few feet deep, and no sampling or testing of the lower portion of the shale has been attempted, core drilling is necessary to ascertain the thickness and quality of the shale.

Lake Eastland spillway exposure.—Shale is exposed on both the north and south sides of the spillway of Lake Eastland located one-half mile west and one-half mile north of Eastland. The shale is similar to the shale described at the Weaver exposure. The top of the slope is capped by the massive cross-bedded Eastland sandstone, and below the sandstone is exposed about 10 feet of sandy shale containing thin layers of sandstone. Below the sandy shale 15 feet of fairly uniformly pure shale of apparently good quality is exposed. Records of core drilling at the dam site are not available, and the thickness of this shale at this site is unknown. Presumably the total thickness is about the same as on the Weaver tract.

Chemical analysis.—Chemical analyses of samples of this shale collected from the city of Eastland pit and from the exposure on the Weaver tract have been supplied by Mr. Guy Quinn of Eastland.

	City of Eastland pit	Weaver exposure
	Percent by weight	
Loss on ignition.....	11.47	7.11
Silica	62.69	62.14
Iron oxide (Fe_2O_3)	4.39	4.85
Aluminum oxide (Al_2O_3)	16.51	15.93
Calcium oxide (CaO)	1.44	2.77
Magnesium oxide (MgO)48	.89

It will be seen from these analyses that the Finis shale is high in silica and iron oxide and fairly low in alumina and lime.

ACKNOWLEDGMENTS

The writers are much indebted to Mr. B. A. Butler of the Cisco Chamber of Commerce, to Mr. H. J. Tanner of the Eastland Chamber of Commerce, and to Mr. Gene Maddox of the Brownwood Chamber of Commerce for their help, encouragement, and many courtesies extended during the field work. Mr. Guy Quinn, owner of a large pottery plant at Eastland, supplied much information including chemical analyses and assisted in the work in many ways. Mr. Eugene Clemens, of the Texas Vitriified Pipe Company, furnished valuable data on the physical and chemical qualities of the clays and was a most helpful and inspiring companion in inspecting and visiting the clay deposits around Cisco and Eastland. Mr. G. A. Plummer of the Lone Star Gas Company, Eastland, Texas, and Mr. Don Choate of Cisco, Texas, furnished base and land maps which were of much aid in correcting land lines and determining ownerships. Mr. D. P. Dean furnished subsurface geological sections showing stratigraphic position of the clays in Eastland County.

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CERAMIC TECHNOLOGY OF THE CLAYS

F. K. Pence

INTRODUCTION

Preliminary tests on samples of these north-central Texas clays made in the Research Laboratory in Ceramics of The University of Texas as early as November of 1940 displayed ceramic properties which justified the recommendation of their use in the manufacture of art pottery and related products. The outstanding qualities revealed were freedom from harmful impurities, good plasticity when mixed with water, normal drying shrinkage, exceptional strength in the dry state, and the development of a light cream or buff color on firing at the low maturing temperature of Cone 04 to Cone 02, approximately 1920° to 2000° F. The first samples were submitted by H. J. Tanner, Manager of the Eastland Chamber of Commerce, and were taken near the highway between Eastland and Cisco where a pit was later opened (this corresponds to locality 12 of this report). Upon more extensive sampling, the samples at a depth exceeding 4 to 6 feet

fired to a pink or light red color. Otherwise the ceramic properties remained the same.

Data covering the wide range of samples treated in this report conform in general to the original findings. Firings were made over a range of pyrometric Cone 06 to pyrometric Cone 1 in order to determine the rate at which a given sample would approach vitrification. It is also quite desirable that after the desired density has been reached, a considerable further increase in temperature can be applied to the clay without over-fire. When this can be done, the clay is said to have a satisfactory firing range.

In order to facilitate interpretation of the data as applied to the fired test pieces, data on total shrinkage and absorption after boiling in water three hours

$$\text{(Absorption} = \frac{\text{Wet wt.} - \text{Dry wt.}}{\text{Dry wt.}})$$

are plotted in curve form and accompany tabulations of tests.

CERAMIC TESTS

QUINN CLAY, LOCALITY 1

Pl. I

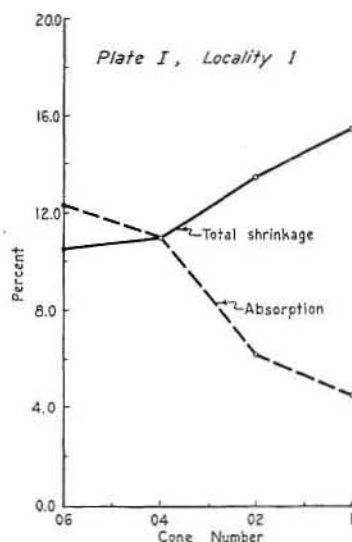
Colorado River bridge deposit.—East side of Santa Anna-Brady highway, 0.7 mile south of Colorado River bridge, McCulloch County.

Raw color: purple
Lime content: none
Average drying shrinkage: 7.0%
Water of plasticity: dry basis, 29.1%; wet basis, 22.5%
Average dry modulus of rupture: 607 lbs./sq. in.
Average fired shrinkage at cone 02: 8.7%
Average fired modulus of rupture at cone 02: 4700 lbs./sq. in.

Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 20)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	10.5	12.3
04	pink	11.0	11.0
02	dark pink	13.5	6.2
1	dark pink	15.5	4.5



QUINN CLAY, LOCALITY 3

Pl. I

Taylor deposit.—South side of Brownwood-Coleman highway, 3.3 miles west of Bangs, Brown County (fig. 1).

Raw color: purple
Lime content: none
Plasticity: good
Drying shrinkage: 7.4%

FIRING TEST (fig. 20)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pinkish-buff	8.0	12.9
04	pink	8.5	9.97
02	reddish-brown	13.0	3.86
1	brown	13.5	0.00

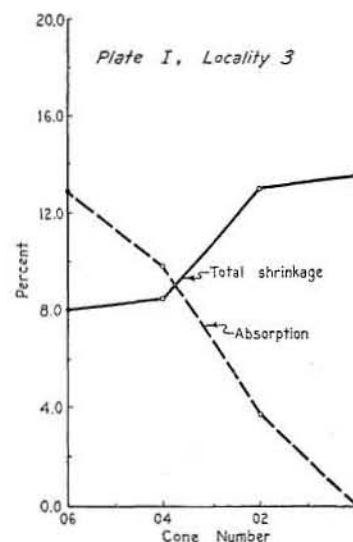


Fig. 20. Absorption and total shrinkage curves of Quinn clay from Colorado River bridge deposit, McCulloch County, and Taylor deposit, Brown County.

QUINN CLAY, LOCALITY 4

PL. I

George deposit.—East side of road and west end of outlier, 5.5 miles northwest of Bangs, Brown County.

Raw color: grayish-purple

Lime content: low

Average drying shrinkage: 7.5%

Water of plasticity: dry basis, 30.4%; wet basis, 23.4 %

Average dry modulus of rupture: 804 lbs./sq. in.

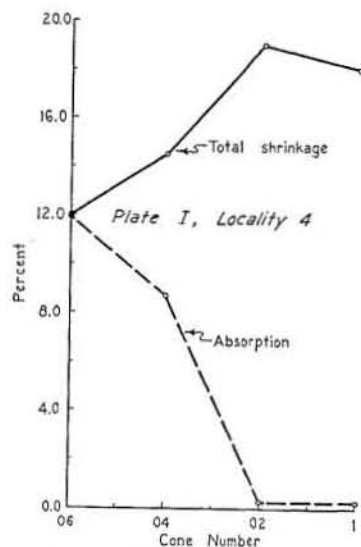
Average fired shrinkage at cone 02: 7.3%

Average fired modulus of rupture at cone 02: 4710 lbs./sq. in.

Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 21)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	12.0	11.95
04	pink	14.5	8.70
02	dark pink	19.0	0.27
1	dark pink	18.0	0.27



QUINN CLAY, LOCALITY 5

PL. I

Shore deposit.—Southeast side of outlier, 1.3 miles east of Eureka Baptist Church and 2.1 miles north-northeast of Buffalo, Brown County.

Raw color: purple

Lime content: none

Average drying shrinkage: 6.5%

Water of plasticity: dry basis, 23.3%; wet basis, 19.0%

Average dry modulus of rupture: 644 lbs./sq. in.

Average fired shrinkage at cone 02: 5.8%

Average fired modulus of rupture at cone 02: 4910 lbs./sq. in.

Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation not complete on fired bars.

FIRING TEST (fig. 21)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	7.5	13.00
04	pink	9.0	10.95
02	red	13.0	6.38
1	red	15.0	3.58

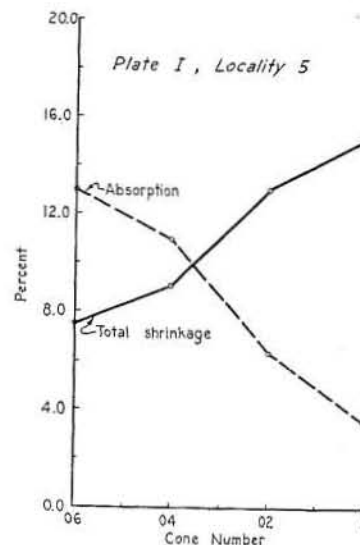


Fig. 21. Absorption and total shrinkage curves of Quinn clay from George and Shore deposits, Brown County.

QUINN CLAY, LOCALITY 6

Pl. I

Cutbirth deposit.—0.4 mile west of road, 3 miles south and 1 mile west of Grosvenor, Brown County.

Raw color: grayish-pink

Lime content: none

Plasticity: good

Drying shrinkage: 8.9%

FIRING TEST (fig. 22)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	orange	10.0	12.30
04	orange	12.5	9.45
02	brown	15.5	1.07
1	brown	18.0	0.00

QUINN CLAY, LOCALITY 7

Pl. I

Gaines deposit.—East side of road, 0.5 mile west and 0.5 mile south of Grosvenor, Brown County.

Raw color: gray

Lime content: none

Average drying shrinkage: 8.6%

Water of plasticity: dry basis, 29.0%; wet basis, 22.6%

Average dry modulus of rupture: 1123 lbs./sq. in.

Average fired shrinkage at cone 02: 5.1%

Average fired modulus of rupture at cone 02: 3140 lbs./sq. in.

Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 22)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pinkish-purple	13.5	11.80
04	pinkish-purple	13.5	11.60
02	pinkish-purple	16.0	6.93
1	pinkish-purple	16.0	3.48

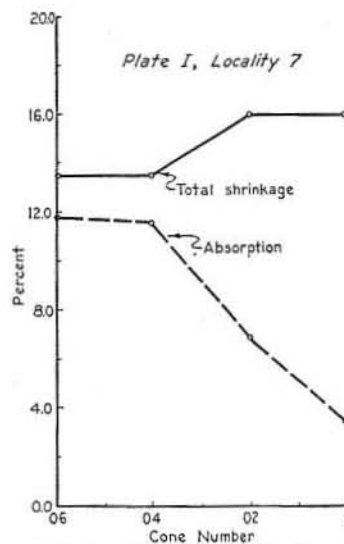
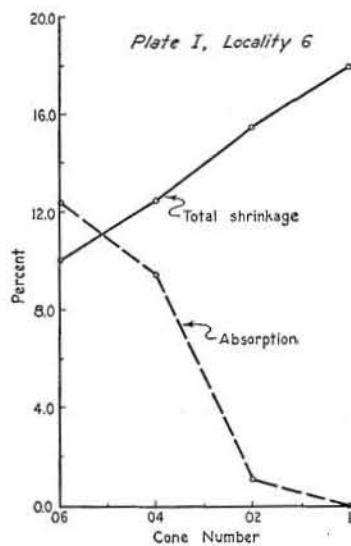


Fig. 22. Absorption and total shrinkage curves of Quinn clay from Cutbirth and Gaines deposits, Brown County.

QUINN CLAY, LOCALITY 9

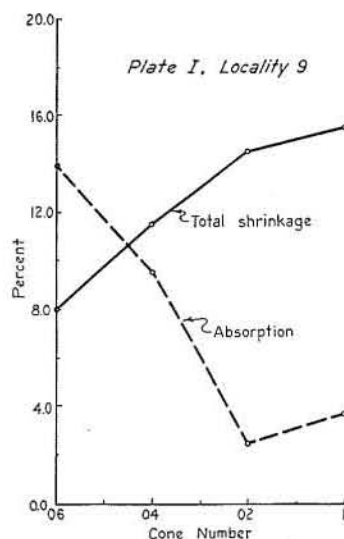
Pl. I

DeBusk deposit.—East side of Cross Plains road, 16 miles north of Brownwood and 0.5 mile northeast of Panther Creek School, Brown County (fig. 2).

Raw color: reddish-brown
Lime content: none
Plasticity: good
Drying shrinkage: 6.5%

FIRING TEST (fig. 23)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	8.0	13.9
04	light red	11.5	9.5
02	reddish-brown	14.5	2.5
1	reddish-brown	15.5	3.7



QUINN CLAY, LOCALITY 10

Pl. II

Rising Star highway deposit.—One-tenth mile west of Rising Star highway, 3 miles south of Cisco, Eastland County.

Raw color: purple
Lime content: none
Plasticity: good
Drying shrinkage: 8.0%

FIRING TEST (fig. 23)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light reddish-buff	9.5	12.1
04	reddish-buff	12.5	7.4
02	reddish-tan	14.0	2.1
1	reddish-tan	16.0	1.4

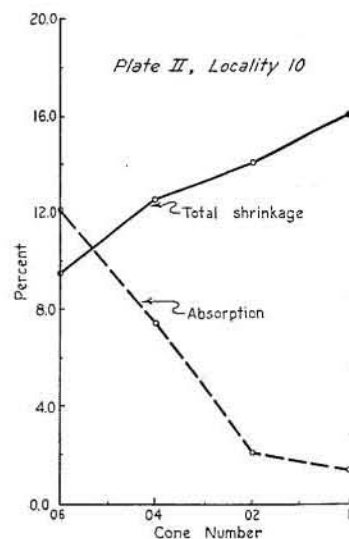


Fig. 23. Absorption and total shrinkage curves of Quinn clay from DeBusk deposit, Brown County, and Rising Star deposit, Eastland County.

QUINN CLAY, LOCALITY 11

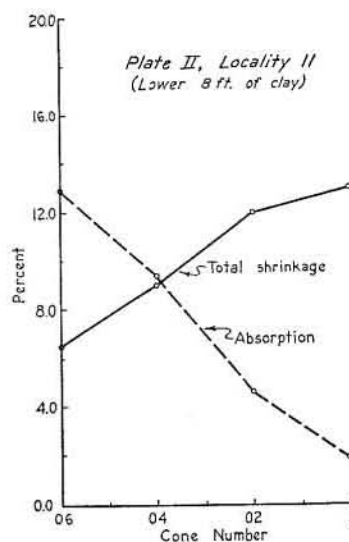
Pl. II

Wilson deposit.—Lower 8 feet of clay, west side of Rising Star highway, 2 miles south of Cisco, Eastland County (fig. 3).

Raw color: gray
Lime content: none
Plasticity: good
Drying shrinkage: 6.5%

FIRING TEST (fig. 24)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	6.5	12.9
04	light red	9.0	9.4
02	light reddish-brown	12.0	4.6
1	reddish-brown	13.0	1.9



QUINN CLAY, LOCALITY 12

Pl. II

Quinn pit.—North side of Cisco-Eastland road, 2 miles east of Cisco, Eastland County (fig. 4).

Raw color: red, brown, green, and gray
Lime content: none
Plasticity: good
Drying shrinkage: ?

FIRING TEST (fig. 24)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	8.0	13.4
04	tan	10.0	7.7
02	light brown	13.5	0.2
1	brown	13.5	0.3

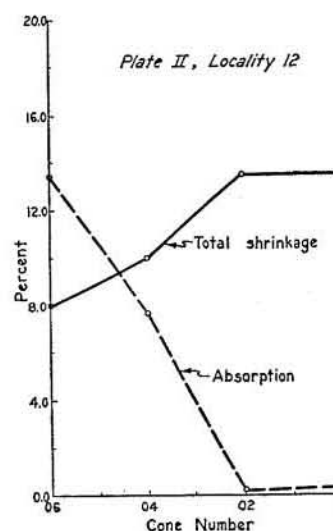


Fig. 24. Absorption and total shrinkage curves of Quinn clay from Wilson deposit and from Quinn pit, Eastland County.

QUINN CLAY, LOCALITY 13

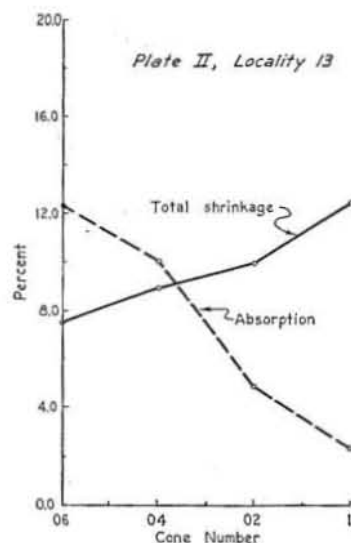
Pl. II

Fee deposit.—South side of Breckenridge highway, 2 miles northeast of Cisco, Eastland County (fig. 6).

Raw color: gray and red
Lime content: low
Plasticity: good
Dry shrinkage: ?

FIRING TEST (fig. 25)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light buff	7.5	12.3
04	light buff	9.0	10.1
02	light tan	10.0	4.9
1	tan	12.5	2.4



QUINN CLAY, LOCALITY 15

Pl. II

Wright and Harrell deposit.—Upper 8 feet of clay, one-half mile east of Lake Cisco dam, 0.1 mile north of fish hatchery, Eastland County (fig. 7).

Raw color: gray
Lime content: small amount
Plasticity: good
Drying shrinkage: 7.0%

FIRING TEST (fig. 25)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	reddish-buff	8.0	13.5
04	reddish-buff	11.0	7.9
02	reddish-tan	13.0	3.2
1	light reddish-brown	13.5	0.4

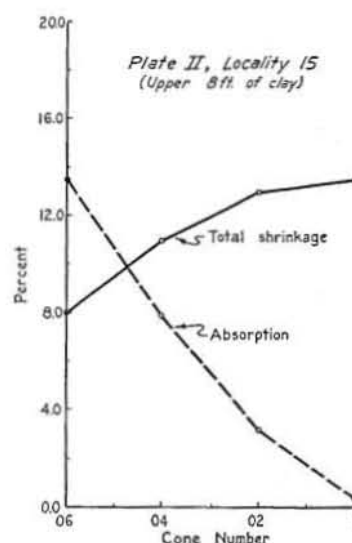


Fig. 25. Absorption and total shrinkage curves of Quinn clay from Fee deposit and Wright and Harrell deposit, Eastland County.

QUINN CLAY, LOCALITY 15

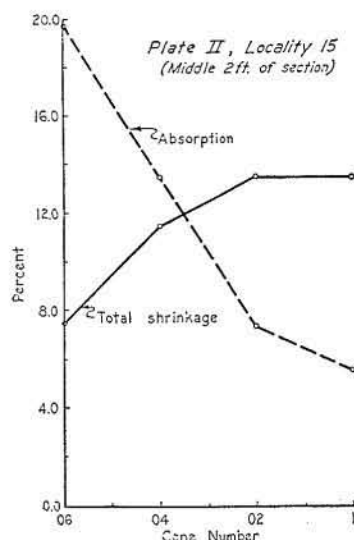
Pl. II

Wright and Harrell deposit.—Middle 2 feet of section, one-half mile east of Lake Cisco dam, 0.1 mile north of fish hatchery, Eastland County (fig. 7).

Raw color: almost black (carbonaceous)
Lime content: none
Plasticity: good
Drying shrinkage: 5.5%

FIRING TEST (fig. 26)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light reddish-pink	7.5	19.7
04	light reddish-brown	11.5	13.5
02	reddish-brown	13.5	7.4
1	reddish-brown	13.5	5.6



QUINN CLAY, LOCALITY 15

Pl. II

Wright and Harrell deposit.—Lower 4 feet of clay, one-half mile east of Lake Cisco dam, 0.1 mile north of fish hatchery, Eastland County (fig. 7).

Raw color: purple
Lime content: low
Plasticity: good
Drying shrinkage: 6.5%

FIRING TEST (fig. 26)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light reddish-pink	8.0	14.0
04	light reddish-pink	10.5	8.1
02	light reddish-brown	11.5	4.4
1	brown	13.0	2.9

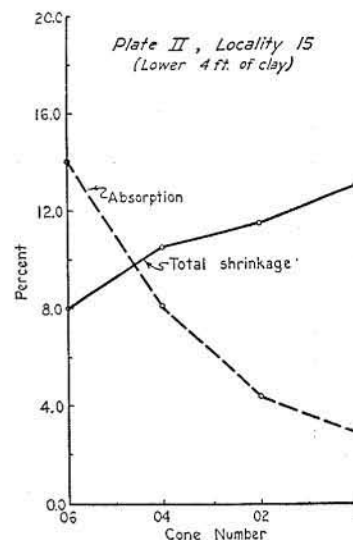


Fig. 26. Absorption and total shrinkage curves of Quinn clay from Wright and Harrell deposit, Eastland County.

QUINN CLAY, LOCALITY 16

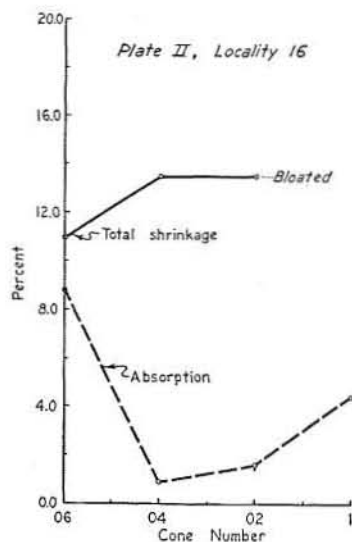
Pl. II

Cisco Country Club deposit.—East side of old Breckenridge-Cisco road, 1.6 miles north-northeast of Lake Cisco dam, Eastland County.

Raw color: grayish-green
Lime content: high
Plasticity: good
Drying shrinkage: 7.5%

FIRING TEST (fig. 27)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light reddish-pink	11.0	8.8
04	light reddish-brown	13.5	0.9
02	reddish-brown	13.5	1.6
1	reddish-brown	bloated	4.4



QUINN CLAY, LOCALITY 17

Pl. II

Old Breckenridge-Cisco road deposit.—East side of road, 1 mile south of Eastland-Stephens County line, Eastland County.

Raw color: red
Lime content: none
Plasticity: good
Drying shrinkage: 7.5%

FIRING TEST (fig. 27)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	9.5	12.00
04	light red	13.0	6.02
02	deep brown	16.0	0.26
1	deep brown	16.0	0.13

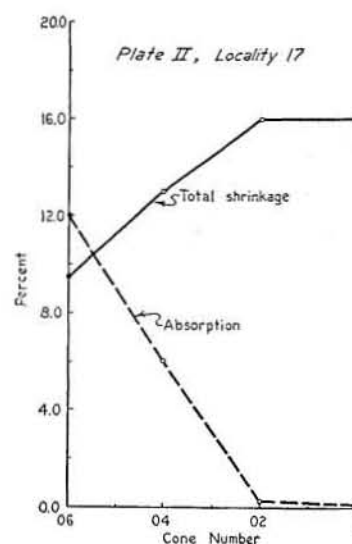


Fig. 27. Absorption and total shrinkage curves of Quinn clay from Cisco Country Club and old Breckenridge road deposits, Eastland County.

QUINN CLAY, LOCALITY 18

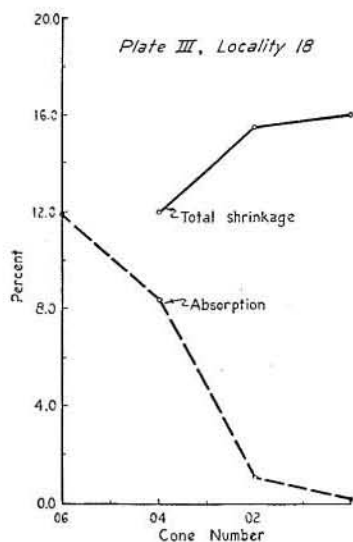
PL. III

Sandy Creek bridge deposit.—West side of old Breckenridge-Cisco road, 0.15 mile south of Sandy Creek bridge, Stephens County.

Raw color: red and gray mottled
Lime content: none
Plasticity: good
Drying shrinkage: 8.7%

FIRING TEST (fig. 28)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	—	11.90
04	pink	12.0	8.40
02	tan	15.5	1.06
1	tan	16.0	0.13



QUINN CLAY, LOCALITY 21A

PL. III

Beal deposit.—East side of road 1.25 miles south of Breckenridge High School, Stephens County (fig. 8).

Raw color: gray
Lime content: none
Plasticity: good
Drying shrinkage: 8.0%

FIRING TEST (fig. 28)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink-gray	10.0	17.00
04	pink-gray	11.5	12.10
02	gray-green	16.5	0.29
1	gray-green	18.0	0.43

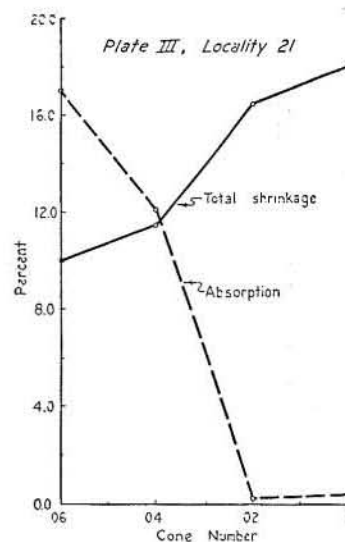


Fig. 28. Absorption and total shrinkage curves of Quinn clay from Sandy Creek bridge and Beal deposits, Stephens County.

QUINN CLAY, LOCALITY 22

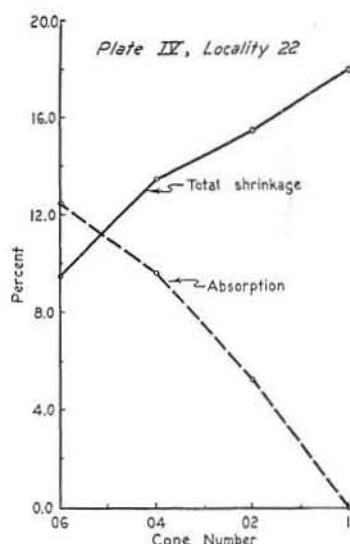
Pl. IV

Veal deposit.—West side of Woodson highway, 5 miles north of Breckenridge, Stephens County (fig. 9).

Raw color: red
Lime content: none
Average drying shrinkage: 7.6%
Water of plasticity: dry basis, 29.4%; wet basis, 22.8%
Average dry modulus of rupture: 667 lbs./sq. in.
Average fired shrinkage at cone 02: 8.4%
Average fired modulus of rupture at cone 02: 8420 lbs./sq. in.
Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 29)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	orange	9.5	12.50
04	orange	13.5	9.65
02	red	15.5	5.25
1	red	18.0	0.00



QUINN CLAY, LOCALITY 23

Pl. IV

Hubbard Creek crossing deposit.—North side of Crystal Falls-Breckenridge road, 1 mile southwest of Crystal Falls, Stephens County.

Raw color: red and gray
Lime content: none
Average drying shrinkage: 7.9%
Water of plasticity: dry basis, 27.8%; wet basis, 21.8%
Average dry modulus of rupture: 804 lbs./sq. in.
Average fired shrinkage at cone 02: 8.2%
Average fired modulus of rupture at cone 02: 7900 lbs./sq. in.
Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 29)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	orange	10.0	12.40
04	orange	11.0	9.80
02	red	15.0	2.20
1	red	16.0	0.38

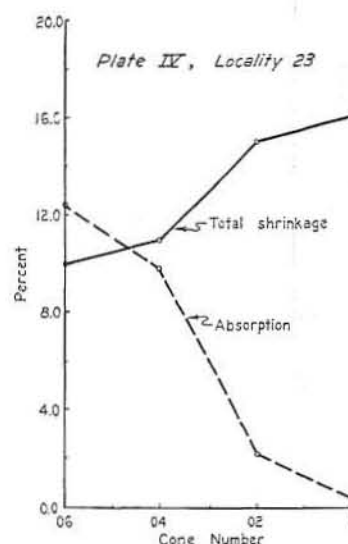


Fig. 29. Absorption and total shrinkage curves of Quinn clay from Veal and Hubbard Creek crossing deposits, Stephens County.

QUINN CLAY, LOCALITY 26

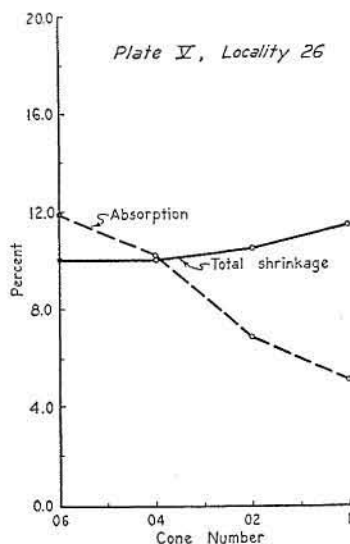
PL. V

Cotten deposit.—East of Wagon Timber Branch, 0.2 mile north of Crystal Falls road, and 4 miles west of Eliasville, Young County.

Raw color: gray
Lime content: none
Plasticity: good
Drying shrinkage: 8.5%

FIRING TEST (fig. 30)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light pink	10.0	11.9
04	light pink	10.0	10.2
02	cream	10.5	6.9
1	cream	11.5	5.1



QUINN CLAY, LOCALITY 27

PL. V

Linderman deposit.—West side of Eliasville road, 0.9 mile south of Graham-Woodson road, 10 miles west of Graham, Young County (fig. 10).

Raw color: reddish-purple
Lime content: none
Plasticity: good
Drying shrinkage: 9.5%

FIRING TEST (fig. 30)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	10.5	11.4
04	light red	11.5	9.3
02	light red	14.5	6.1
1	light red	14.5	4.6

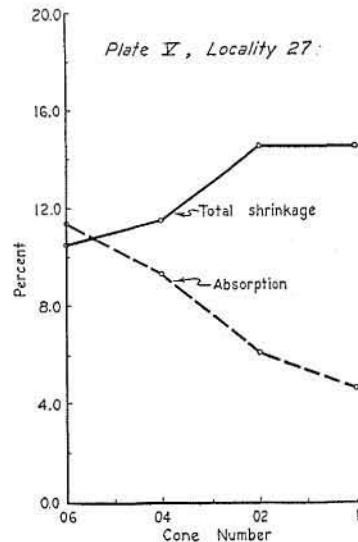


Fig. 30. Absorption and total shrinkage curves of Quinn clay from Cotten and Linderman deposits, Young County.

QUINN CLAY, LOCALITY 29

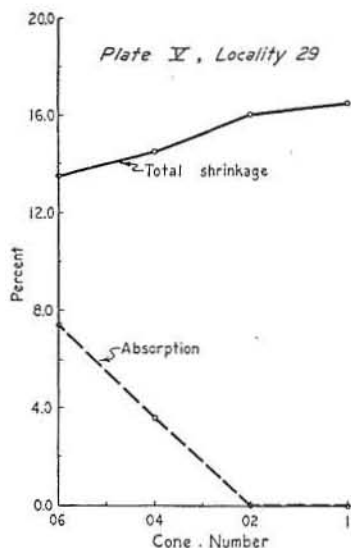
PL. V

Dixon deposit.—One-fourth mile north of Brazos River, 1 mile east and one-half mile south of old Fort Belknap, Young County.

Raw color: reddish-purple
Lime content: none
Plasticity: good
Drying shrinkage: 10.0%

FIRING TEST (fig. 31)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	13.5	7.4
04	light red	14.5	3.6
02	dark reddish-brown	16.0	0.0
1	dark reddish-brown	16.5	0.0



QUINN CLAY, LOCALITY 30

PL. V

Smith deposit.—North side of Graham road, 5 miles east of Newcastle, Young County (fig. 11).

Raw color: gray-purple
Lime content: none
Plasticity: good
Drying shrinkage: 7.5%

FIRING TEST (fig. 31)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light cream	7.5	12.4
04	light cream	7.5	10.4
02	light cream	11.5	6.1
1	cream	12.5	4.5

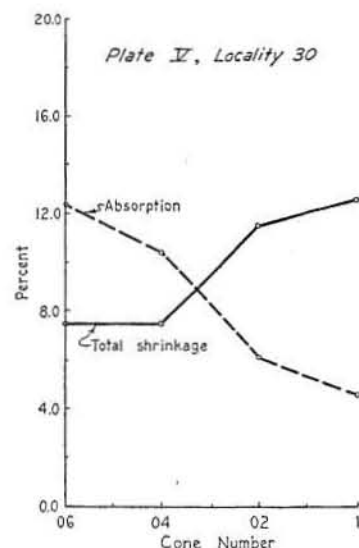


Fig. 31. Absorption and total shrinkage curves of Quinn clay from Dixon and Smith deposits, Young County.

CURRY CLAY, LOCALITY 8A

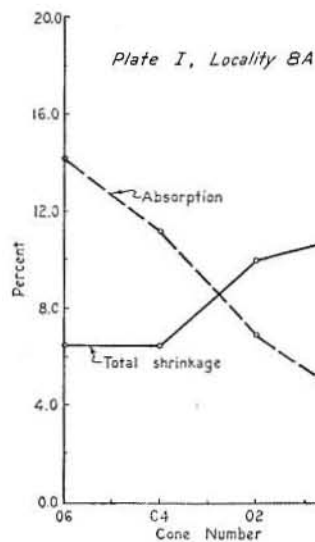
Pl. I

Byrd deposit.—0.1 mile north and 0.1 mile east of Grosvenor, Brown County (fig. 12).

Raw color: red
Lime content: large
Plasticity: good
Drying shrinkage: 6.1%

FIRING TEST (fig. 32)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	pink	6.5	14.10
04	pink	6.5	11.20
02	dark pink	10.0	6.98
1	red	11.0	4.20



CURRY CLAY, LOCALITY 19

Pl. III

Loudder deposit.—7 $\frac{1}{4}$ miles south and 2 $\frac{1}{4}$ miles west of Breckenridge in north-east corner of section 2263, Stephens County (fig. 13).

Raw color: gray-pink
Lime content: none
Plasticity: good
Drying shrinkage: 7.5%

FIRING TEST (fig. 32)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	cream	8.0	12.9
04	cream	8.0	11.8
02	cream	8.5	9.1
1	cream	8.5	7.9

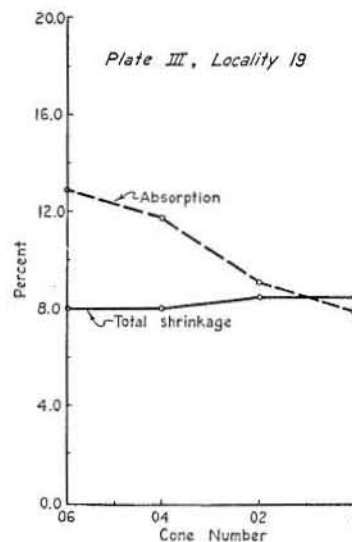


Fig. 32. Absorption and total shrinkage curves of Curry clay from Byrd deposit, Brown County, and Loudder deposit, Stephens County.

CURRY CLAY, LOCALITY 28

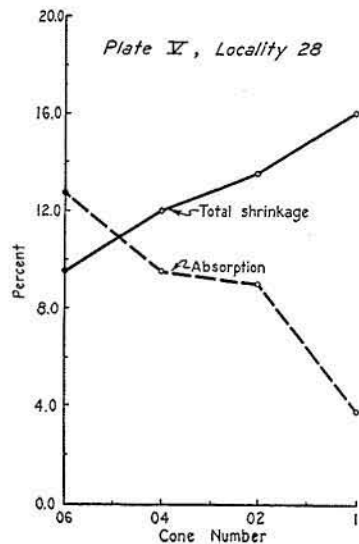
Pl. V

Allar Company deposit.—2.4 miles west of McCan Bridge on south side of Graham-Woodson highway, 0.4 mile west of Eliasville road fork, Young County (fig. 15).

Raw color: reddish-brown
Lime content: none
Average drying shrinkage: 8.5%
Water of plasticity: dry basis, 31.0%; wet basis, 23.8%
Average dry modulus of rupture: 863 lbs./sq. in.
Average fired shrinkage at cone 02: 7.2%
Average fired modulus of rupture at cone 02: 8990 lbs./sq. in.
Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 33)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light red	9.5	12.7
04	light red	12.0	9.5
02	light reddish-brown	13.5	9.0
1	reddish-brown	16.0	3.8



CURRY CLAY, LOCALITY 20

Pl. III

Curry deposit.—2 $\frac{1}{4}$ miles west and 5 miles south of Breckenridge, south of Curry ranch house, Stephens County (fig. 14).

Raw color: dark gray-black
Lime content: none
Plasticity: good, sticky
Drying shrinkage: 7.0%
Sample showed high percentage of scum.

FIRING TEST (fig. 33)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	-----	-----	-----
04	buff	12.5	6.2
02	light tan	15.0	0.6
1	dark tan	15.0	0.0

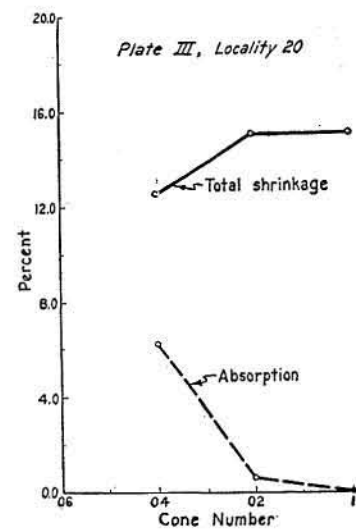


Fig. 33. Absorption and total shrinkage curves of Curry clay from Curry pit, Stephens County, and Allar Company deposit, Young County.

CRADDOCK CLAY, LOCALITY 24

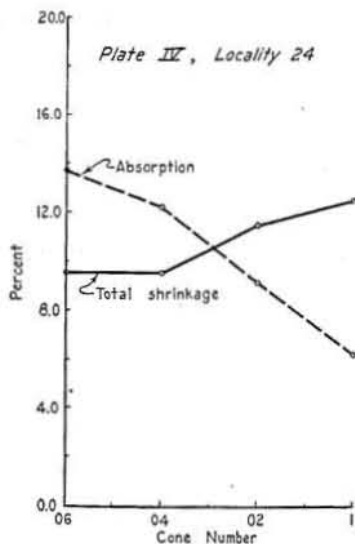
PL. IV

Crystal Falls deposit.—0.1 mile west of Crystal Falls on south side of road, Stephens County (fig. 18).

Raw color: purple-gray
Lime content: none
Plasticity: good
Drying shrinkage: 8.5%

FIRING TEST (fig. 34)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	reddish-pink	9.5	13.7
04	reddish-pink	9.5	12.2
02	reddish-pink	11.5	9.1
1	reddish-tan	12.5	6.2



CRADDOCK CLAY, LOCALITY 31

PL. II

City of Cisco deposit.—1500 feet west of Cisco Junior College and 150 feet east of Craddock Lake, Eastland County (fig. 16).

Raw color: red-gray
Lime content: none
Average drying shrinkage: 6.5%
Water of plasticity: dry basis, 29.2%; wet basis, 22.6%
Average dry modulus of rupture: 504 lbs./sq.in.
Average fired shrinkage at cone 02: 6.5%
Average fired modulus of rupture at cone 02: 5870 lbs./sq.in.

Remarks: Bars made with de-airing extruding machine. Clay worked satisfactorily. Oxidation complete on fired bars.

FIRING TEST (fig. 34)

Cone Number	Color	Percent total shrinkage	Percent absorption
06	light reddish-pink	6.0	15.6
04	reddish-pink	8.0	12.1
02	light reddish-brown	11.5	5.7
1	reddish-brown	12.5	2.0

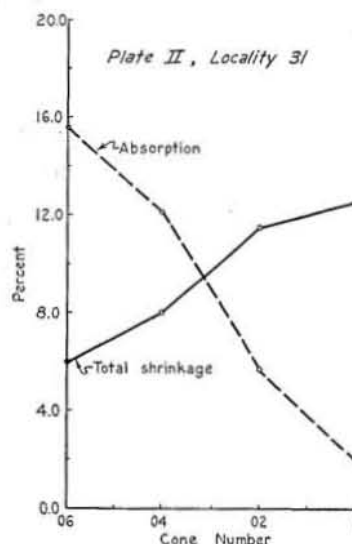


Fig. 34. Absorption and total shrinkage curves of Craddock clay from Crystal Falls deposit, Stephens County, and City of Cisco deposit, Eastland County.

The foregoing data set forth the performance of the clays when prepared by the normal plastic process. In the manufacture of art pottery and specialty products, the process of fabrication known as "casting" is of equal importance. In this process the clay is made into a "slip" with water and the ware formed by pouring the slip into plaster molds. Sample from locality 12 was used in determining the most favorable specifications governing the composition of a casting slip. This was found to be as follows: To a given amount of dry clay add 60% water, 0.06% sodium silicate solution (40° Baumé), 0.30% barium carbonate. (All percentages are based on weight of dry clay used.) This will make up a casting slip carrying the maximum percentage of clay solids.

The barium carbonate introduced into the above formula is for the purpose of precipitating soluble salts which would otherwise concentrate at the surface of the ware and form "scumming." This scumming would render the glazing of the ware more difficult. However, normal results can be obtained with suitable glazes applied to products made up according to the foregoing formula.

The performance of the clay in fabrication by the casting process showed the following unfavorable factor:

1. A rather slow casting rate due to slight tendency to gelling; probable maximum production two casts per day.

The following are favorable factors:

1. Good mold release.
2. Very little cracking in spite of rather high drying shrinkage.

SUMMARY AND CONCLUSIONS

The one property of the clays treated in this report which tends to approach the danger limit is the rather high total shrinkage obtained at the temperature of optimum density. It will be noted that in the major number of samples this total shrinkage is in excess of 12.5 percent. This is somewhat high for the use of this material in heavy structural clay products but does not disqualify it for art wares. It is preferable that the total shrinkage should not exceed 11 to 12½ percent. There are a number of localities, however, which do not exceed this figure.

The favorable factors applying to wares fabricated by either plastic or slip casting process are:

1. Good plasticity and working properties.
2. Satisfactory drying behavior.
3. High strength of dried product.
4. Satisfactory firing range in which adequate density is reached at low temperature of Cone 04 to Cone 02.

It is recommended, therefore, that the prospective users of clays from the area covered in this report select those of the lower shrinkage and which fire to such light or dark shade as may be desired.

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