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Buried Hill at Wilcox-Carrizo Contact in East Texas

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BURIED HILL AT WILCOX-CARRIZO CONTACT IN EAST TEXAS[1]

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ABSTRACT

A recently discovered buried hill, at least 77 feet high, is composed of strata of the Wilcox group (lower Eocene) and covered on its flanks by cross-bedded sands of the lower Carrizo and at the top by level-bedded shales and silts of the upper Carrizo formation. Peculiar small funnel-shaped pits filled with Carrizo sand extend into the underlying Wilcox ball clay at the peak of the hill. Other extensions fill shrinkage cracks of the clay. These and other features of the contact demonstrate a disconformity at the base of the Carrizo sand caused by rejuvenation that occurred shortly before Carrizo sand deposition.

Buried hills composed of strata of the Wilcox group and covered by Carrizo sand have recently been discovered in East Texas. They are significant for the evaluation of the much discussed boundary between the Wilcox group (lower Eocene) and the Claiborne group (middle Eocene) in the Gulf Coastal Plain.

The Wilcox-Carrizo boundary was investigated for the first time by William Kennedy. As geologist for the Southern Pacific Railroad, under the direction of E. T. Dumble, he investigated during January and February, 1909, the section exposed along the Rio Grande and submitted his report[3] to E. T. Dumble on January 31, 1910. This report was the basis for E. T. Dumble's paper[4] on the Carrizo formation.

Kennedy noticed a divergence of dip between the Carrizo sand and the underlying Wilcox group. This led him to assume that the Carrizo sand rested with an obvious, although low-angle, angular unconformity not only on the Wilcox group but also on the Midway group and Upper Cretaceous beds; the Carrizo sand successively overstepped these older units. His interpretation led him to believe that there were several places at which the Carrizo sand rested directly on rocks as old as the Upper Cretaceous. One of these places described by him was at the junction of Arroyo de Reparo with the Rio Salado in adjoining Mexico. Later observers[5] have not substantiated these extreme conclusions of Kennedy,

[1] Manuscript received, January 26, 1951. Published by permission of the director of the Bureau of Economic Geology, The University of Texas.

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The writer wishes to express his grateful appreciation to Frank E. Kendrick of the Lone Star Gas Company, Dallas, who loaned the manuscript copy of William Kennedy's "Report on Geology of Rio Grande Valley" to the Bureau of Economic Geology and allowed it to be copied, and to Selwyn O. Burford of the Humble Oil and Refining Company, Tyler, who gave information concerning the section exposed in the clay pit at Athens, which has also been checked by the writer. A. L. Lyth, Jr., was the writer's assistant at the time the detailed observations in the clay pits were made, and helped in making them.

[3] William Kennedy, "Report on Geology of Rio Grande Valley, January 31, 1910." Copy of original manuscript on file in Bureau of Economic Geology, The University of Texas.

[4] E. T. Dumble, "The Carrizo Sands," *Trans. Texas Acad. Sci.*, Vol. II (1911), pp. 52–53.

[5] For comparison: *(Please (urn to the next page)*

and they seem based on two erroneous interpretations of observable facts. 1. The divergence of dips is present but is probably caused to some extent by the large-scale cross-bedding in the Carrizo sand; hence, it is a possibly more apparent than real dip divergence. 2. The sands which were regarded by Kennedy as Carrizo sand resting on formations older than Wilcox are not Carrizo sand but are local sand bodies of diverse ages. Some of these sands may be very young terrace sands or even dune sands. In defense of Kennedy it must be recalled that he had very little published information to rely on and that time available to him was not sufficient to solve the complex stratigraphic conditions of the large area investigated by him. However, he did recognize the erosional break at the base of the Carrizo sand.

Dumble[6] re-emphasized this interpretation in 1915 by stating in his report on northeastern Mexico: "On Amole Creek the Wilcox appears below the Carrizo in places, while at others the Carrizo sands rest directly upon the Midway or even on the Escondido beds." Arroyo del Amole is a right tributary of the Rio Grande in the State of Coahuila, entering the Rio Grande a few miles south of the north line of Webb County, Texas.

Kennedy's interpretation as published by Dumble of an extensive angular unconformity at the base and overstep by the Carrizo sand onto much older formations had a profound influence on later investigators. The influence persisted to 1929 and 1930. Hence, similar interpretations were given in the writings and on the maps of later investigators who worked in the general area of the Rio Grande from 1911 to 1929.

Liddle's report[7] of 1921 on Medina County, Texas, showed outliers of Carrizo sand on the basal and middle part of the outcrop belt of the Wilcox group and far removed from the normal Carrizo outcrop belt. According to Liddle the basal part of the Carrizo sand rested on different beds of the Wilcox, and the higher gray sandstone of the Carrizo extended by transgression farther north than the basal part, thereby combining what would now be called overlap and overstep.[8]

W. G. Kane and G. B. Gierhart, "Areal Geology of Eocene in Northeastern Mexico," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 19, No. 9 (September, 1935), pp. 1357–88.

W. G. Kane, "Structural Geology of Border Province of Northeastern Mexico Adjacent to Zapata and Starr Counties, Texas," *ibid.*, Vol. 20, No. 4 (April, 1936), pp. 403–16.

[6] E. T. Dumble, "Tertiary Deposits of Northeastern Mexico," *Proc. California Acad. Sci.*, 4th Ser, Vol. 5, No. 6 (June, 1915), pp. 163–93, Pls. 16–19.

[7] R. A. Liddle, "The Geology and Mineral Resources of Medina County," *Univ. Texas Bull. 1860* (1921). 177 pp., Pl. 9 (map).

[8] To avoid the existing confusion of terms denoting such relationships, the following definitions are followed here.

Overstep is the truncation of strata below unconformities where younger strata step over the truncated edges of the older series. Overlap is the progressive pinching-out of a transgressive series above an unconformity where successively younger beds lap over the feather edges of the older beds of the same series through gradual spread of sedimentation.

Compare discussion of these terms in F. A. Melton, "Onlap and Strike-Overlap," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 31, No. 10 (October, 1947), pp. 1868–78; and R. H. Lovely and F. A. Melton, *ibid.*, Vol. 32, No. 12 (December, 1948), pp. 2295–97.

The map published by A. C. Trowbridge[9] in 1923 indicated an unconformity at the base of the Carrizo and showed the Carrizo as spreading over to the Cretaceous rocks, overstepping both the Wilcox and the Midway groups, north of Carrizo Springs. Significantly, Trowbridge had already disallowed the extensive overstep indicated by Kennedy along the course of the Rio Grande where Trowbridge presumably had best first-hand observations available but had accepted the overstep at a distance of 15 miles northeast of the river.

Deussen's classical and greatly respected work[10] published in 1924 showed the Carrizo sand overstepping the Wilcox and Midway groups and resting on or against the Cretaceous in southwestern Uvalde County, but east of southeastern Uvalde County no far-reaching overstep was indicated by him. He also stated that in southwest Texas there was a considerable overstep at the base of the Carrizo which had almost obliterated the outcrop of the underlying Wilcox group in certain localities. The map explanation indicated an unconformity, and the text (p. 59) stated the Carrizo sand as lying in places unconformably above the Wilcox group. Deussen extended the known area of the Carrizo outcrop from the Rio Grande embayment to the Brazos River by reconnaissance mapping. The distance involved was about 230 miles. In this tracing of the Carrizo sand he was aided by a map of Bexar County prepared by E. H. Sellards.[11]

In the late 1920's considerable mapping was done by geologists in the employ of oil companies, and their work resulted in a gradual revision of ideas about the Carrizo sand. The first publication to present these new interpretations and to show corresponding revision in areal mapping in South Texas was F. M. Getzendaner's.[12] His map (p. 1430) of the Rio Grande embayment showed the Carrizo sand resting on the Wilcox group alone without overstep onto formations older than Wilcox, and he saw "a beautifully exposed erosional, unconformity at the base of the Carrizo sand at its type locality west of Carrizo Springs" (p. 1435). The Carrizo sand was for the first time extended from the Brazos River, to where Deussen had mapped it, eastward across the entire state. Before this time the Carrizo sand had never been correctly identified in East Texas. This work of tracing the sand by reconnaissance mapping over a distance of about 250 miles is to the credit of geologists of the Humble Oil and Refining Company. The results of this work were incorporated in the article by E. A. Wendlandt and G. M. Knebel.[13] Their map showed the Carrizo resting on the Wilcox group alone,

[9] A. C. Trowbridge, "A Geologic Reconnaissance in the Gulf Coastal Plain of Texas Near the Rio Grande," *U. S. Geol. Survey Prof. Paper 131-D* (1923), pp. 85–107, Pl. 28 (map).

[10] Alexander Deussen, "Geology of the Coastal Plain of Texas West of Brazos River," *ibid., Prof. Paper 126* (1924). 145 pp., Pl. 8 (map). Reprinted by *Univ. Texas Bur. Econ. Geol.* (1930).

[11] E. H. Sellards, "The Geology and Mineral Resources of Bexar County," *Univ. Texas Bull. 1932* (1920). 202 pp., 1 map.

[12] F. M. Getzendaner, "Geologic Section of Rio Grande Embayment, Texas, and Implied History," *Bull. Amer. Assoc. Petrol. Geol.*, Vol. 14, No. II (November, 1930), pp. 1425–37.

[13] E. A. Wendlandt and G. M. Knebel, "Lower Claiborne of East Texas, with Special Reference to Mount Sylvan Dome and Salt Movements," *ibid.*, Vol. 13, No. 10 (October, 1929), pp. 1347–75.

and they noted the disconformable contact between the two. L. W. MacNaughton[14] gave the exact location of exposures showing the Wilcox-Carrizo contact in East Texas.

In contrast to the interpretation proffered by Kennedy and his followers, the more recent reports have these observations in common: (1) an extensive overstep by the Carrizo sand onto formations older than upper Wilcox is not shown on their maps;[15] (2) an erosional break, that is, a disconformity, at the base of the Carrizo sand is recognized; and (3) exact locations at which this erosional break can be seen are given.

Since 1930 the erosional break at the base of the Carrizo has been seen in so many places that it has come to be accepted as a characteristic of the Wilcox-Carrizo contact, very useful in field work for the recognition of this boundary. It is now known to be traceable throughout the outcrop area of the Carrizo sand in Texas as a continuous regional disconformity.[16]

Clear and instructive exposures of the Wilcox-Carrizo contact can be seen in the three ball-clay pits operated by the Troup Works of the General Refractories Company, the Termo Fire Brick Company, and the Reliance Brick Company, from 0.80 to 0.55 mile airline distance, S. 85°W. and S. 50°W., from the church at Henry's Chapel, a small community in northeastern Cherokee County, Texas, on Farm Road 13 (Troup-Henderson road) about 5 miles east-southeast of Troup.[17] In these pits the Carrizo formation is the overburden of the ball clay which is the top of the Wilcox group at that place. The Wilcox ball clay does not rise much above the level (368–357 feet above sea-level) of the flood plain along creek branches nearby, which are right tributaries of Hampton Creek. The surrounding divides between the branches are capped by the Newby member, the base of which is about 400 feet above sea-level in the vicinity of the clay pits, and by the lower half of the Marquez member, both of the Reklaw formation, Claiborne group.

The only easily traceable, marine key bed in this vicinity is the Newby member. The member is a slightly glauconitic, fossiliferous, slightly muscovitic,

[14] A. C. Ellisor, "Correlation of the Claiborne of East Texas with the Claiborne of Louisiana," *ibid.,* p. 1343, footnote 3.

[15] The latest geologic map of Texas, "Geologic Map of Texas" edited by George W. Stose 1/500,000, *U. S. Geol. Survey* (1937), which was compiled between 1924 and 1935 from maps submitted by many geologists, shows the Carrizo sand overstepping the Midway and Wilcox groups and resting on the Escondido formation (Upper Cretaceous) for a distance of 8 miles in east-central Maverick County. The writer does not wish to imply any criticism of this part of the map; he has had no opportunity to visit the area.

[16] H. B. Stenzel, "The Geology of Leon County, Texas," *Univ. Texas Pub. 3818,* 1938 (1939), p. 64.

———, "The Surface Relationships of the Carrizo Sand of Texas," *Tulsa Geol. Soc. Digest,* Vol. 9 (1941), PP. 70–72.

[17] *Cf.* H. B. Stenzel, "Ball Clay of the Troup District, Texas," *Univ. Texas Pub. 5019* (1950), pp. 5–37.

F. K, Pence, "Characteristics of Texas Ball Clay near Troup," *ibid.,* pp. 39–51.

——— "Troup Quadrangle," 15-Minute Series, 1/62,500, *U. S. Geol. Survey* (1943).

argillaceous, fine sand. The faunal content is monotonous; aside from very rare occasional strays, only two species of mollusks have been found, a new subspecies of the pelecypod *Venericardia planicosta* Lamarck and the gastropod *Turrilella turneri* Plummer, but these two are abundant in some layers. Weathering has

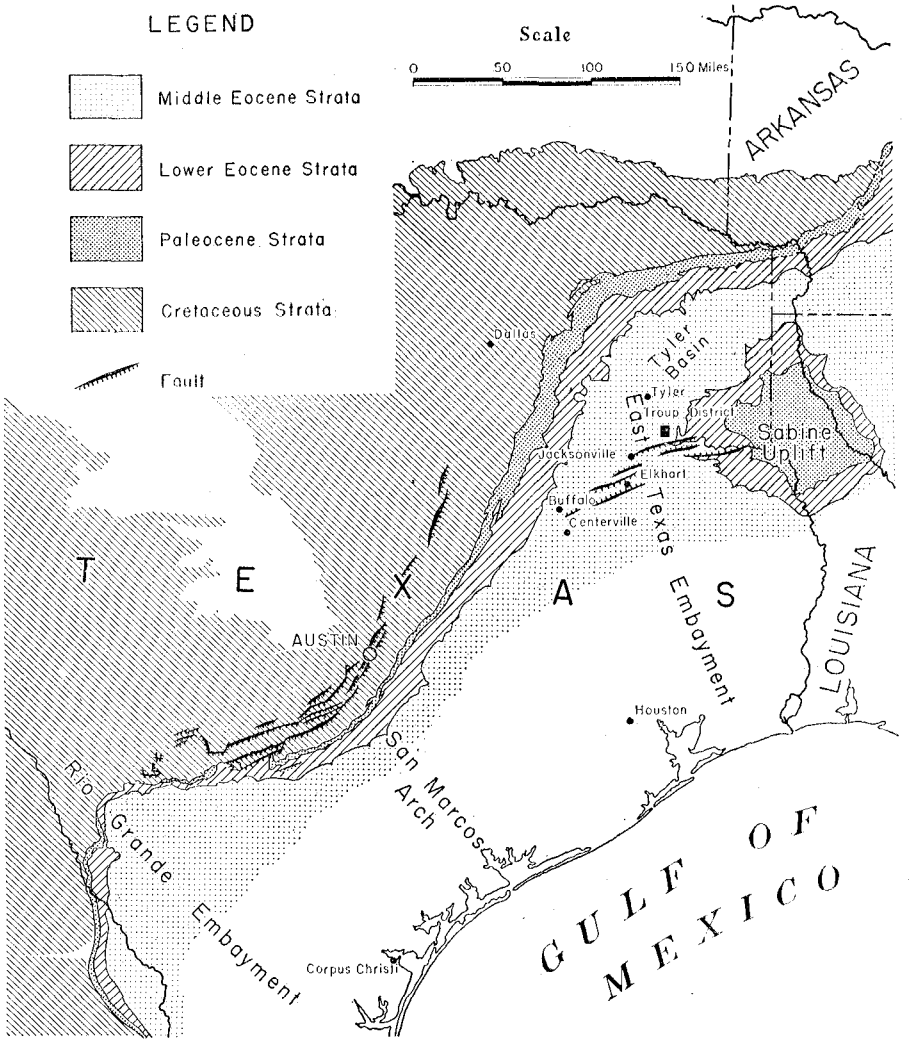

FIG. 1.—Regional geologic setting of Tyler basin and Troup district (black rectangle) in Gulf of Mexico basin. Henry's Chapel is in Troup district.

changed nearly all the glauconite to limonite and thereby changed the original color of the rock to red and orange colors, has indurated some of the layers to limonite-cemented sandstone, and has leached the fossils leaving only their well preserved imprints. This kind of rock is well known to East Texas geologists as

the *Venericardia* rock and is characteristic of the Newby member from Leon and Freestone counties eastward to Rusk County. The Newby member in the vicinity of the clay pits is 5–7 feet thick and rests with a very slightly undulating erosion surface on the gray or brownish black, thinly bedded, muscovitic, lignitic, fine sands, silts, and silty clay shales of the upper Carrizo. In many places bore holes filled with Newby glauconitic sand extend into the underlying strata for a few inches. The Newby member of this area is a marine or probably brackish-water deposit as indicated by its monotonous molluscan fauna, glauconite content, type of bedding, and basal erosional disconformity. The member is the result of an invasion of the sea. As the sea advanced over soft and incoherent sediments of the Carrizo formation it must have had very little difficulty in reducing the top of the Carrizo formation to a nearly even surface. Hence, the base of the Newby member is regarded as a level reference horizon. This conclusion is, of course, important in the interpretation of the relationships of the strata below the reference horizon.

The thickness of the Carrizo formation, beneath the Newby member of the Reklaw formation, is variable in this area. At the clay pits the following thicknesses were measured: 27.4–28.7 feet at Thermo Fire Brick Company pit and 29.6–35.0 feet at General Refractories Company pit. At short distances from the clay pits the thickness of the formation is much larger. At a distance of 1.85 miles southeast from the nearest pit, along the county road connecting Henry's Chapel with Martin's Chapel and rising southward from the swampy bottom of Mill Creek, a thickness of at least 104 feet is indicated for the Carrizo formation, the base of which is exposed along the road. At a distance of 1.55 miles N. 16° E. from the nearest clay pit two geophysical shot holes, 49 and 49-B, with elevations of 383 and 388 feet above sea-level, respectively, afford reliable thickness data. The holes were within a few feet of each other; 49 was on the left bank of a headwater branch of Grissom Creek, 0.49 mile south of the north line of the county and 1.12 miles west-southwest of the county road fork of 403 feet altitude. At that place the Newby member crops out on the slope leading down to the floodplain at an elevation of 393.3 feet. The holes were drilled in the presence of the writer; both drilling characteristics and cuttings were excellent so that the top of the Wilcox could be determined accurately. The top of the Wilcox group was at a depth of 93 feet in hole 49-B; hole 49 was lost in the loose sand of the Carrizo at 75 feet. Hence, the thickness of the Carrizo formation here is 98.3 feet. Similar thickness data can be given for the region east of the clay pits but would be merely needless repetition. In a short distance west of the clay pits, regional dip carries the Wilcox, Carrizo, and Reklaw underground so that information is unobtainable.

These data demonstrate a buried hill composed of Wilcox strata with its peak near the Thermo Fire Brick Company clay pit. The hill is at least 77 feet high; it slopes at least 41 feet per mile on the southeast and 44 feet per mile on the north-northeast. As the hill was composed of such soft and non-coherent rocks as loose

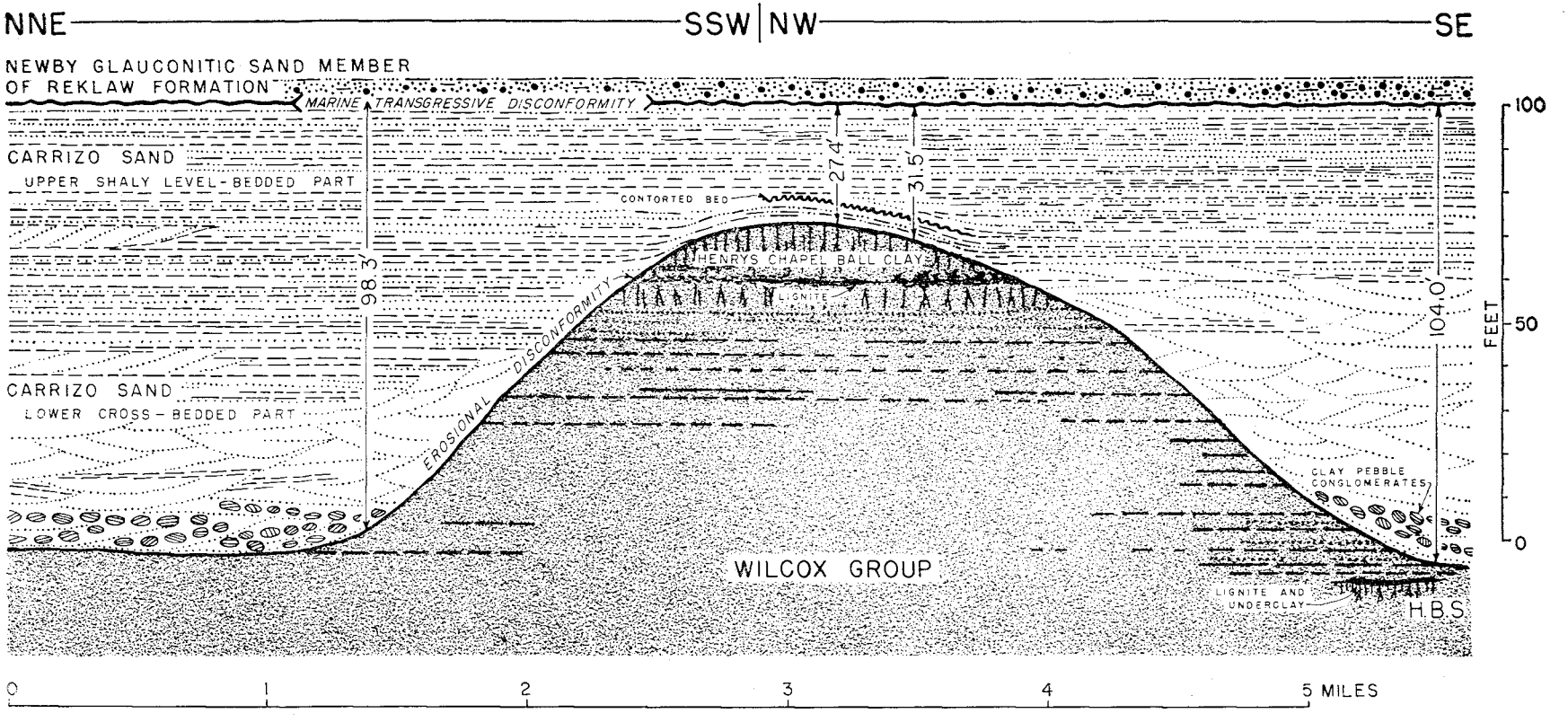

FIG. 2.—Cross section through buried hill compose i of Wilcox strata and covered by Carrizo sand near Henry's Chapel in northeastern Cherokee County, Texas.

fine sands, sandy clay-shales, and lignite seams, the slopes of the hill are fairly impressive. However, the present hills in this area are about 3–4 times as steep, although they are composed of similar soft rocks.

The peak of the buried hill is occupied by a 20.1-foot thick ball clay forming the top of the Wilcox group here. The ball clay as exposed in the pits is slightly harder than the average Eocene clay shale and is tough, blocky, devoid of bedding planes so that it does not break down readily but forms large blocks. It should be somewhat more resistant to erosion than the average Eocene clay and certainly very resistant to chemical weathering because of its composition. The ball-clay cap may have resisted erosion and preserved the hill at the beginning of Carrizo deposition.

The Carrizo formation of the general area is composed of two parts: a lower loose, cross-bedded, porous, medium-grained sand and an upper more coherent, level-bedded, muscovitic, silty shale and very fine sand sequence. The transition from one to the other is very gradual in some places; in others it takes place within a foot or two. The transition occurs at different stratigraphic levels in various places, indicating that deposition of one occurred simultaneously with the deposition of the other, but everywhere deposition of the lower cross-bedded sands was followed by deposition of silty shales. The upper shaly part is about 30 feet thick in the area but is highly variable in thickness elsewhere. Both parts of the Carrizo formation are lignitic; the lower faintly, and the upper more noticeably. At the base of the cross-bedded sands of the Carrizo, up to 10 feet above the base of the formation, shale-pebble conglomerates in a sand matrix are common in this area. The shale pebbles are flattish but well rounded, lie in irregular arrangement or follow the cross-bedding; they are derived from the underlying Wilcox. The basal contact with the Wilcox under the cross-bedded sands is a smoothly undulating disconformity with some channeling effects.

In the vicinity of the clay pits the Carrizo formation consists of the upper level-bedded shaly sequence only. The sequence is excellently exposed in the clay pits.

In the Thermo Fire Brick Company pit the basal 12 feet of the sequence are exposed in the back wall of the pit. The sequence is friable where fresh, slightly indurated where iron-stained through weathering, and largely dirty orange to rusty yellow. The freshest parts are devoid of rusty colors and are light brownish gray and contain evidently some lignitic material; on weathering iron staining becomes abundant. Bedding generally is thin. Individual beds range from thinnest laminae to 1.5 feet in thickness. The more shaly layers are commonly thinner-bedded than the purer sands. The sequence, although shaly, is highly porous and seeps water. The thickest of the sand beds, 1.5 feet thick, has disturbed contorted bedding in its basal 0.5 foot; bedding is turned up in rolls, the heads of which are about 0.9 foot apart. The disturbed bedding is apparently caused by subaqueous sliding that occurred shortly after deposition of the basal 0.5-foot thick layer but before the upper part of the 1.5-foot thick sand bed was

deposited, because the upper part and all succeeding beds are undisturbed and level-bedded.

In the south wall of the General Refractories Company pit the upper Carrizo shaly sequence is exposed for 15 feet from its base. The upper part of the sequence is weathered, and the less shaly sand layers weather more readily than the shales, giving a color banding of bright rusty weathered colors with unweathered chocolate-browns. Such weathering fades out downward but reaches down to within 2.5 feet of the base of the Carrizo. The freshest Carrizo has a medium to dark brownish gray streaked color; the darker bands may even grade to sooty black depending on the admixture of finely divided lignitic matter. The freshest sandy layers have grayish color with a bluish cast caused by finely divided lignitic

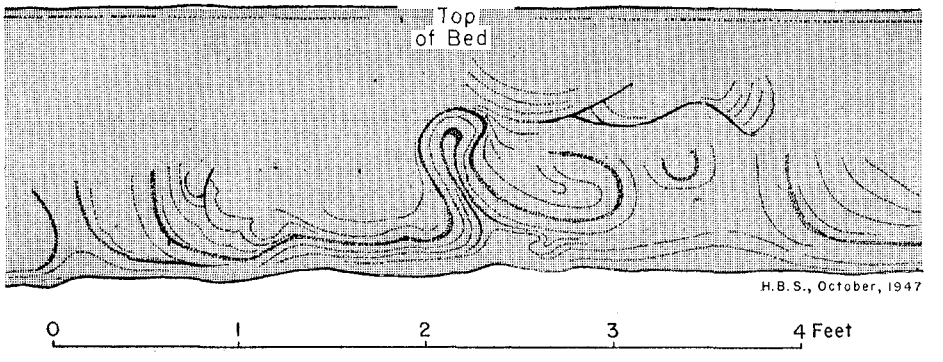

FIG. 3.—Contorted bedding in sand layer of upper Carrizo sand, caused by subaqueous sliding, exposed in south wall of clay pit of Thermo Fire Brick Company near Henry's Chapel in northeastern Cherokee County, Texas.

matter and marcasite. Sandy parts are friable; however, because of coherence of the whole sequence, chunks and even large fallen blocks largely retain their shape. Bedding is thin, level, and extensive. Individual layers no more than 0.2 foot thick can be traced continuously through the whole pit for 400 feet. In detail, bedding is also elongate-lenticular. Some sand layers separated by thin shale partings are ripple-marked and show on the walls of the pit as a series of small lenses, each 1.3 centimeters thick and 6.4 centimeters long, strung horizontally in rhythmic sequence. A slight bulging caused by channeling is visible at the base of some of the thicker sand layers. One grayish black, more lignitic than the others, shaly silt layer is penetrated by many lighter gray, sand-filled bore holes 3–8 millimeters in diameter. Lignitized plant fragments are present on some bedding planes, and lignitized leaf imprints have been found in the shaly layers. One of the nearly black layers contains small flat pieces of xyloid lignite. Slightly larger lenses of sooty black, silkily lustrous, xyloid lignite, up to 3 mm. thick and up to 3 cm. long, are present within the basal 0.1 foot of the Carrizo formation above the Wilcox contact. These xyloid lignite lenses taper out to a very sharp thin end at their margins; hence, they must be regarded as syngenetic

and not as fragmental. The whole sequence of the Carrizo is more or less lignitic. Small muscovite flakes are present in nearly all layers. Marcasite concretions up to 0.2 foot in diameter are present but rare; they are found mainly in two layers, the basal 2.5-foot-thick layer and the contorted layers. The basal 2.5-foot thick layer of the Carrizo differs slightly from the other beds. It is more massive, bedding-less in appearance. Its more shaly, darker, more lignitic parts are dis-

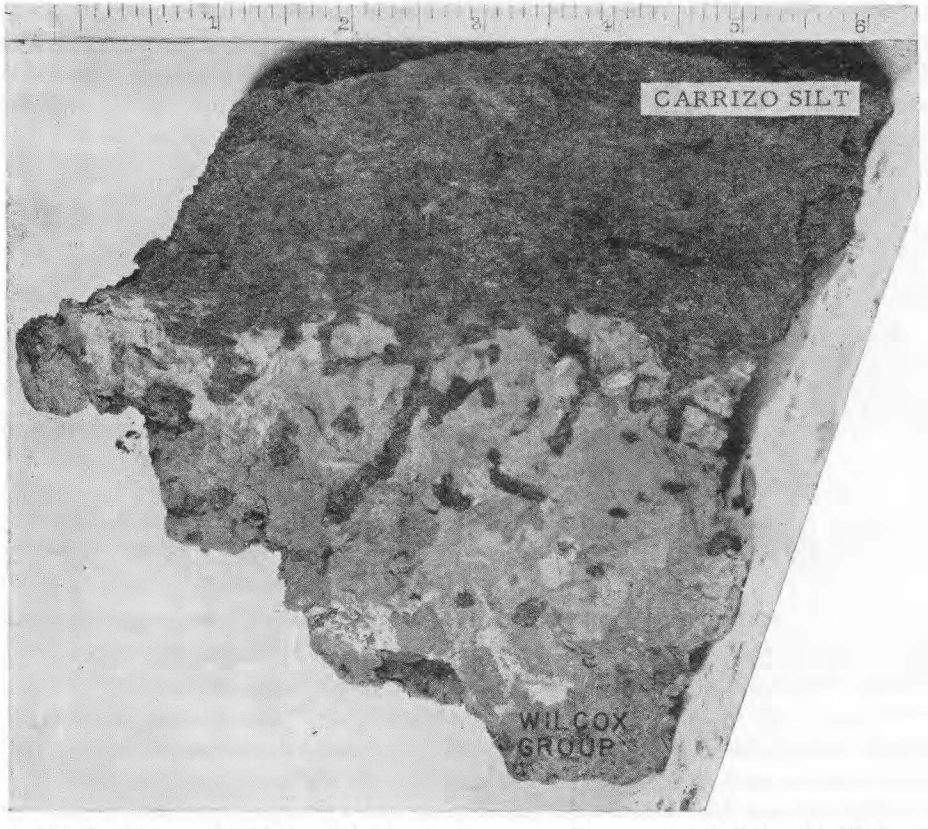

FIG. 4.—Photograph of piece of Wilcox-Carrizo contact from west wall of clay pit of General Refractories Company, Troup Works, near Henry's Chapel in northeastern Cherokee County, Texas. Scale on top is in inches.

continuous clouds extending rarely for more than 2.5 cm. laterally. It has obscure sandy pipes or bore holes(?) that weld the layer into a massive, indistinctly bedded unit. It is a slightly muscovitic, argillaceous, lignitic silt with small lenses of xyloid lignite. The entire Carrizo sequence in the pit does not contain any individually outstanding layer. The most noticeable layer is the contorted bed. This is a massive-appearing sand bed, averaging 1.5 feet in thickness and lying 3.9 feet above the base of the Carrizo formation; it has contorted interior bedding.

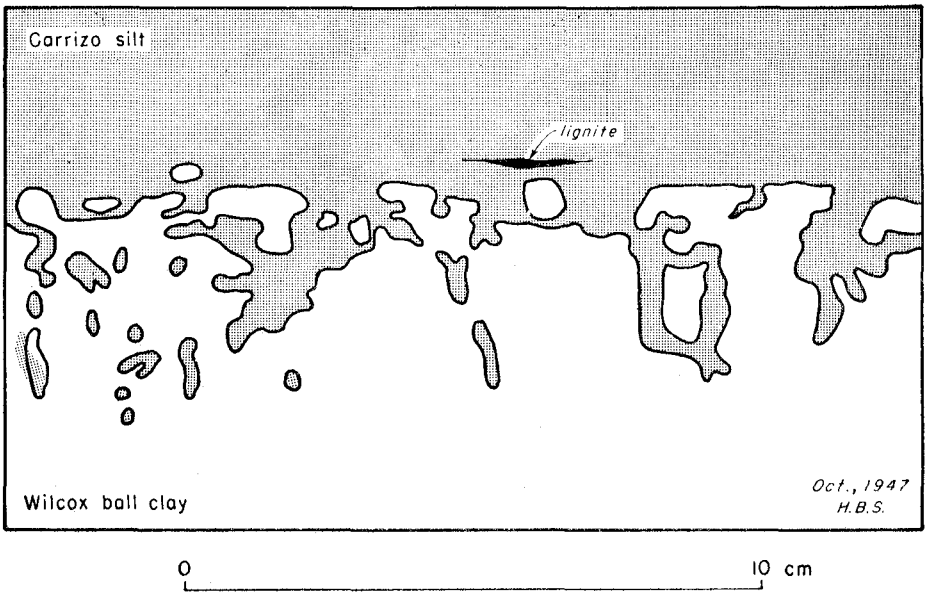

FIG. 5.—Vertical section through Wilcox-Carrizo contact on west wall of clay pit of General Refractories Company, Troup Works, near Henry's Chapel in northeastern Cherokee County, Texas.

It is presumably the same layer as that exposed in the other clay pits and in the channel of the creek on the northwest. At least there is one layer exhibiting contorted bedding in all four places and it is in the same stratigraphic position (3.9–5.7 feet) above the base of the Carrizo formation. If it is the same layer it can be traced for 3,500 feet from the northwest to the southeast, although its maximal observed thickness is only 2.3 feet. This is the only known contorted layer of the Carrizo formation in Texas.

The disconformable contact between the ball clay of the Wilcox group and the overlying shaly Carrizo is easily studied in these pits. As a whole it is parallel with the bedding of the two, but in small detail it is highly irregular, although such irregularities commonly are no more than 0.1–0.2 foot in vertical extent.

Countless small extensions of the Carrizo go 2.5–5 cm. down into the ball clay; a few have been found to penetrate to a maximum of 10 cm. These extensions are commonly very irregular in shape, but they are wider at the top and become narrower downward, ending in a bluntly rounded tip. Their lower ends are approximately circular in horizontal section. Hence, most of the extensions can be regarded as highly irregular funnels narrowing downward. If one excavates carefully with a small knife into the ball clay below the bluntly rounded tips of these silt-filled funnels in the direction in which they point, one finds a nearly vertical thin tube in the clay. The ball clay is replete with these tubes which are filled with the same clay as the matrix in which they rest but are separated from

the surrounding clay by a thin black-brown lignitic film. The tubes are long, extending down for several feet; most of them are 6 feet long; some are 9 feet long. They are slender, their average and common diameter being 2.5 mm. although ranging from 1 to 3 mm. They are found to branch downward at acute angles of divergence. Evidently they are fossilized roots of plants. Because their cores are filled with Wilcox ball clay, the plants must have grown and decayed during Wilcox time, and the roots were filled with the clay after their decay. Therefore the fossil roots were already filled with clay and in existence before the top of Wilcox was eroded and before any Carrizo sediments were deposited on the clay. Evidently the root tracks were less resistant to erosion, and the erosion preceding the Carrizo deposition excavated more easily along the roots than on the ball clay matrix and produced irregular funnel-shaped pits above each root track.

Other kinds of extensions of the Carrizo sand into the Wilcox ball clay are rare, but a few were found which wedged out downward with an acute angle

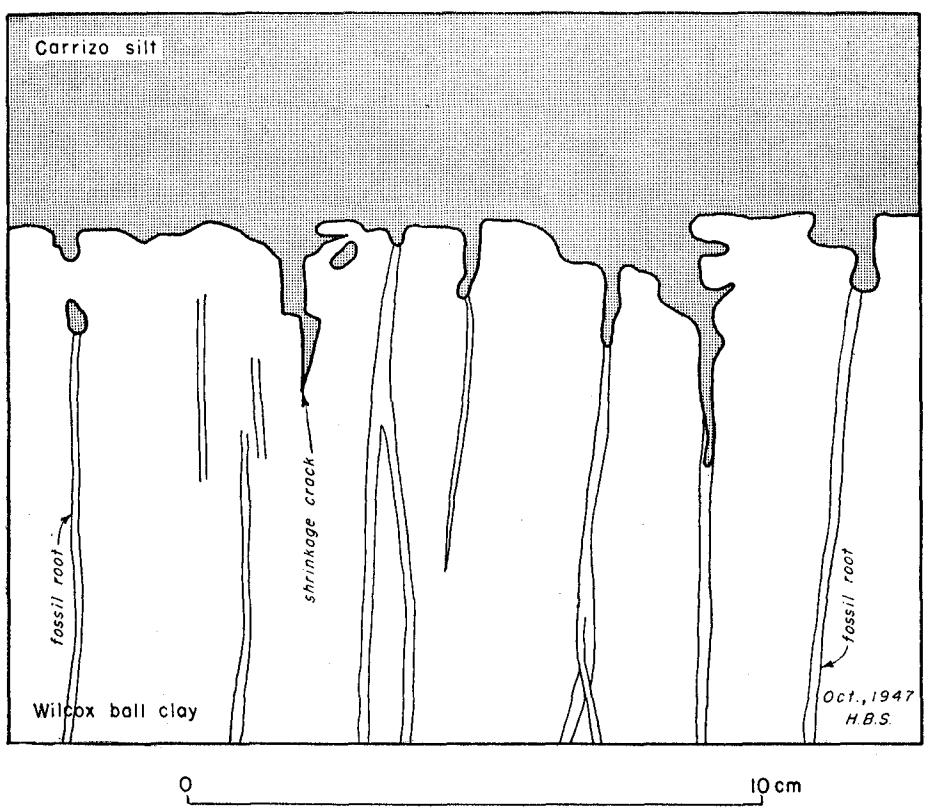

FIG. 6.—Vertical section through Wilcox-Carrizo contact with one shrinkage crack and funnel-shaped Carrizo silt extensions dug out downward to show relation to fossil roots. Same wall as in Figure 5.

ending in a sharp point. Their horizontal section is not rounded but elongate, ending sharply both ways. Some extensions of this kind do not go down straight but are offset as a dog leg (Fig. 6). This kind of extension is apparently the filling of a shrinkage crack in the Wilcox ball clay, and the shrinkage must have occurred shortly before the deposition of the overlying Carrizo silt which simply washed or sifted into the crack without destroying its sharp features.

There are so many of these irregularities and extensions at the contact that it is minutely and exceedingly irregular. Nevertheless, there are no boulders

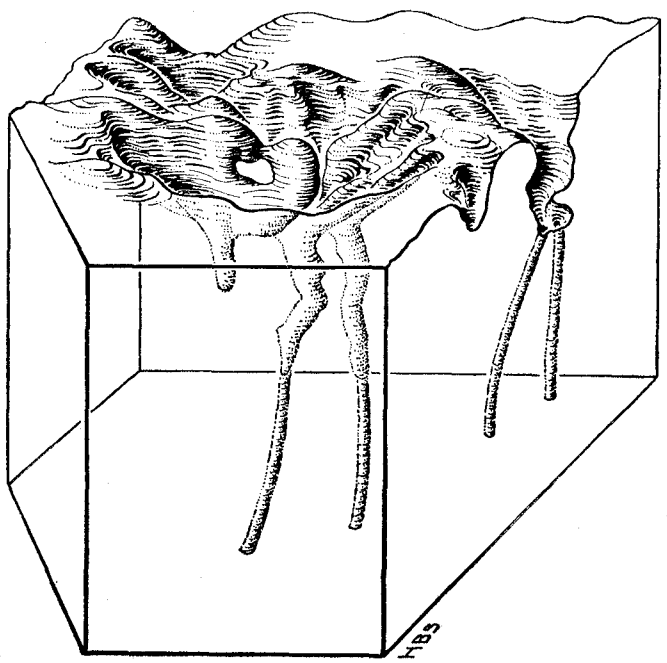

FIG. 7.—Block diagram of Wilcox-Carrizo contact, showing irregular funnel-shaped pits and their relation to fossil roots in clay. Natural size.

or pebbles of ball clay enclosed in the base of the Carrizo silt. Shale-pebble conglomerates, which are so common in the basal cross-bedded sands of the Carrizo encircling the area of the clay pits, are absent at the base of the shaly Carrizo silt sequence of the clay pits.

The ball clay of the Wilcox is light bluish gray and devoid of bedding planes, breaks subconchoidally and hackly, and is slightly harder than the average Eocene clay-shale of the region. It is cut by numerous slickenside-covered, undulating, glistening partings of low inclination from the horizontal. This ball clay is present only in the vicinity of the pits. Elsewhere the Wilcox is composed of fine sands, silty clay shales, and thin lignite seams.

These features demonstrate an interval of erosion between the Wilcox group and the Carrizo sand capable of having produced a hilly topography with a relief of at least 77 feet. This hilly topography is probably extensive in East Texas in the Tyler basin because at Athens in Henderson County on the west flank of the basin there is a similar buried Wilcox hill, on top of which the entire Carrizo sand is only 9.8–10.1 feet thick, as can be seen clearly in the new clay pit of the Harbison-Walker Refractories Company at the east end of town. The clay pits of the Henry's Chapel district in Cherokee County are on the east flank of the basin. Rejuvenation must have occurred shortly before Carrizo sand deposition began. The lower cross-bedded sands of the Carrizo are indicative of rejuvenated stream action. Their smoothly undulating basal disconformity with its effects of channeling and their shale-pebble conglomerates indicate anastomosing or shifting rejuvenated stream channels or distributaries among which the now buried hill rose above the depositional level. Gradually the hill was buried by Carrizo sand, and the effects of rejuvenation faded. Its peak was buried under deposits of comparatively sluggish muddy waters in a reducing environment where such highly oxidizable and fragile products as plant leaves, lignite, and marcasite could be deposited intact or formed. However, before all of the hill was buried it was probably exposed to the atmosphere without any protecting deep soil cover, so that some shrinkage cracks could develop in the clay and be buried intact. Thus, the depth of the water surrounding the almost buried hill could not have been great at that time. After the hill was buried by slightly more than 3.9 feet of sediment, the last deposit, a thin sand layer, started to slide down the gentle slope, but sedimentation of sand continued and the crumpled layer was covered by undisturbed sand and later by silts and shales.

The buried hill topography discussed here has important practical consequences in the search for additional deposits of the valuable clay and in the use of the Wilcox-Carrizo contact as a horizon on which to map structures favorable for the accumulation of petroleum. It also emphasizes the division between the Wilcox and the Carrizo and favors placing the Carrizo formation in the Claiborne group rather than in the Wilcox group.