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The information contained in this circular was gathered by a unit of the WPA Geological Investigation Project, sponsored by The University of Texas, Bureau of Economic Geology. The purpose of this survey is to assemble information concerning the mineral resources of Texas and make it available to the public. It is hoped that this information will be a contribution to the industrialization of the State. The following report gives the results of work done in Gonzales County by Work Projects No. 17210 and No. 18496, from December 10, 1940, to November 3, 1941.

BLEACHING CLAY DEPOSITS IN GONZALES COUNTY, TEXAS*

by Carl R. Chelf, Supervisor

INTRODUCTION

Bleaching clay investigations in Gonzales County were made for the following reasons:

(1) To collect data on the types of deposits and mode of deposition
(2) To direct attention to any new sites discovered
(3) To eliminate seemingly valueless areas

Aid in this work was given by many individuals. Thanks are due E. H. Sellards, Director of the Bureau of Economic Geology, F. B. Plummer, H. B. Stenzel, Glen L. Evans, and Robert Redfield, geologists of the Bureau of Economic Geology, and W. N. McAnulty, State Supervisor of the Statewide Mineralogic Survey. Particular thanks are due to Mr. Thompson, County Agent of Gonzales County, Mr. Windrow, AAA Administrator, and Mr. Fred Jahn, Surveyor of the AAA office. Most of the included maps were made from aerial photographs furnished by the AAA office. Investigation of the Reed ranch site was made by John B. Means, Jr., Assistant Project Supervisor, who was in charge of the Gonzales County project after the writer was transferred to Llano County.

Several new deposits and extensions of mined areas resulted from the work, but it was not deemed necessary to make a thorough search throughout the entire width and length of outcrops known to be of potential value since it was soon found that the available supply in this county alone is sufficient at present production to last for many years.

To obtain data concerning the origin and mode of deposition, old mines with extensive exposures were examined in detail, and locations containing both bleaching clay and ash were given particular attention. The bulk of this work was carried on mainly in the Jackson group since this group contains by far the largest deposits in the county. Twist auger and drop auger were used in drilling test holes, and each type has its particular advantages in certain beds. For example, the drop auger is valuable in cutting through indurated beds but is less suitable for certain soft or plastic materials. Neither type is suited for cutting through pebbly gravels that overlie much of the Jackson group clays.

Sections were cleaned and excavated in certain areas to arrive at exact relations. Samples of clays were taken from sites investigated and these are available at the Bureau of Economic Geology. Bleaching tests have not been made with representative samples of clays for reasons discussed under the heading "Bleaching Clays."

Mining in Gonzales County.—Bleaching clay was not mined in Texas until 1907, but Florida had produced it as early as 1895, Colorado and New York in 1897, Utah in 1898, and Alabama and Massachusetts is 1904. Georgia and South Carolina began production the same year as Texas. Early attention to the Gonzales County clays was due to the mistaken idea that the whiter grades were true kaolinite and that these could be used in the ceramic industries. For this purpose the clays were of questionable value, and later development was initiated after it was found that they had bleaching properties.

Types of Clay.—The bulk of Gonzales County clays used in bleaching are variously classified, but most are of the non-swelling type and are not improved noticeably by acid leaching. Therefore, in a rough classification still used by some, they are generally referred to as "fuller's earth." The U. S. Bureau of Mines review of 1940 explains that census figures exceed compilations reported to the Bureau of Mines because of the confusing terminology used by producers. These clays, used mainly in bleaching, are often reported as "miscellaneous clay" or bentonite or fuller's earth. Gonzales County clays are mainly in the Jackson group, and most deposits show some direct or indirect evidence of having originated from volcanic ash. Accordingly, it is not considered improper to call them bentonite or sub-bentonite. Being naturally active, they are generally referred to by geologists as "fuller's earth." That intermediate grades of clay from unaltered ash to thoroughly leached "fuller's earth" occur in continuous sections has been demonstrated by deposits in several southern states. This is also true of some of the Gonzales County deposits. For convenience, the term bleaching clay will be used throughout this paper since the greater part of all the mined material is still used for this purpose.

Production and use.—In 1939 and 1940 the use of bentonite (Bureau of Mines terminology) reached an all-time high, but Texas registered a drop in production from 18,132 short tons in 1939 to 14,399 short tons in 1940. The U. S. Bureau of Mines statistics for the year 1939 show that 43 per cent of the total output of the United States was used in filtering and decolorizing oils, chiefly after acid activation, 16 per cent by the petroleum and natural gas industries in rotary and well drilling muds, and almost 25 per cent in foundries and steel works as a conditioning agent for molding sands. The increase in use by industries other than refining is of interest, since production is steadily dropping in Texas in spite of the advantage of a "place market." This trend in miscellaneous uses may eventually

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offset the declining curve of production. Of extreme potential importance is the discovery by Hauser and LeBeau (10)[1] that "artificial mica" can be produced from bentonite.

More than 40 known and proposed uses for bentonite are listed by Davis, Vacher, and Conley (3). The following is a partial list: as a binder, filler, and plasticizer, molding sand in foundry work, filler in paper, oilcloth, linoleum, and cordage, filler in rubber, in ceramics for improving the properties of certain clays, to increase the mechanical strength of portland cement, bentonite mixed with oil as a waterproofing agent in cement, putty, in soaps, de-inking newspapers, refining of oils and fats, horticultural sprays, animal dips, insecticides, synthetic transparent mineral films.

Texas clays are already used to a certain extent in molding sands and this use will surely increase. The finely ground material is used by the Churchwell Chemical Company of Gonzales, Texas as a filler in a horticultural spray.

Although reported production in Texas of these types of clays has declined somewhat in the past few years, it is likely that increasing uses will be found to offset this trend.

The production of fuller's earth (Bureau of Mines terminology) in Texas also declined frim 38,338 short tons in 1939 to 34,039 short tons in 1940, a drop of over 4000 tons. However, Texas remains one of the leading producers in the United States with only Florida and Georgia ranking above it.

Market trend in bleaching clays.—The activable earths are steadily taking the place of the naturally adsorptive types (fuller's earth), but to a lesser extent in areas where the latter enjoys a location or place market as is the case of the majority of Texas clays. The production of "fuller's earth" has dropped in the entire United States for more than ten years partly because of the substitution of other clarifying agents. Ordinarily, the activable earths are more efficient and can be used more economically. Bauxite is an example of a new agent which has the advantage of long use since it can be revivified again and again before it is discarded. Magnesol, a new bleaching compound, is another product that is finding increasing use in the refining industry.

Bleaching clays.—Certain clays are naturally adsorptive or have bleaching powers without acid treatment. These clays are not improved by acid leaching. Others are known as activable clays since they are improved marked by violent leaching with mineral acids. Activable types are classified by some authors as bentonite and the naturally adsorptive clays as fuller's earth. A classification of bleaching clays from Schroter (20) is as follows:

(1) Naturally adsorptive: "fuller's earth"
(2) Activable (improved by leaching): bentonite
(3) Naturally semiadsorptive: bauxite

The first two varieties are composed chiefly of the mineral montmorillonite which may be replaced by sapenite or beidellite. As pointed out by Baker (2) and others, neither bentonite or fuller's earth are distinct mineral substances. The work of Ross and Shannon (19) defines bentonite as a rock that contains 75 per cent or more of the clay-like minerals montmorillonite or beidellite, and the methods of identification and separation uinto the many sub-varieties have been outlined by the same authors. Davis, Vacher, and Conley (3) divide the bentonites into the four following groups: alkali bentonite, alkali sub-bentonite, alkali-earth bentonite, and alkali-earth sub-bentonite. Wyoming-type bentonite is in the first or alkali bentonite group, and most oil-refining clays are in the last named or alkali-earth sub-bentonite group. For commercial purposes, the classification of bleaching clays is of little importance. Likewise, most authors state that the composition, within certain limits, has little to do with the bleaching properties of a clay. Clays are generally evaluated commercially by making actual bleaching tests on the substances which are to be clarified. Bleaching clays differ so widely in their selective-adsorptive power that some are valueless or nearly so when used with certain oils and are excellent with others. In present usage, Texas bleaching clays are variously classified as southern or sub-bentonites or meta-bentonites or fuller's earth. The meta-bentonites are similar in mineral and chemical composition to the northern or so-called true bentonites, but are not characterized by the unusual gelation and swelling properties. Texas bleaching clays continue to be consumed chiefly in the bleaching and purifying of oils, fats, waxes, and preparing oil-well drilling muds. Of the Texas bleaching clays, Davis, Vacher, and Conley (3) write the following: "Clays of the non-swelling or meta-bentonite type occur in considerable quantities in Texas, and an important production, largely used in oil-well drilling fluids and for bleaching purposes, was reported for 1934-38."

Origin of bleaching clays. — The origin of various bleaching clays has been dealt with by Miser, (13), Porter (17), Shearer (23), Grim (7), Davis and Messer (4), Schroter and Campbell (20, 21) and many others. The results of these writers can be summarized as follows: Some Arkansas deposits are alteration products of basaltic dikes; Georgia fuller's earth was deposited as calcareous clay; some western deposits originated from basic rocks; California deposits of high-magnesia type have come from basic tuff; a deposit of Utah bentonite is a decomposed dacitic breccia. Studies by Bay and Nutting and others indicate that deposits in the southeastern states have been derived largely from volcanic ash. The sequence of change, according to Nutting (15), is from ash to bentonite, if the ash fall is quickly submerged; if the ash is subjected to weathering, transportation, and washing, the change is from the original product to fuller's earth. Gonzales County deposits show good field evidence of volcanic ash origin. Many "bentonite" deposits are now known to be the resulting product of devitrification and decomposition of volcanic ash. Nelson (14), Hewett (11), Ross and Shannon (19), Wherry (26), and others have described such deposits. A summary of their evidence to support this points to the following conclusions as proofs: palimpsest ash structure is bentonites; presence of feldspar; absence of quartz generally contained in clay sediments; the chemical composition of bentonites is such that it is the expected result of alteration by leaching and devitrification; field relationships. Schroter and Campbell (21) in a recent paper state that any rock of "favorable composition" (usually siliceous to intermediate) may be altered to bleaching clay of commercial efficiency. In general, then, instances are known in which basic intrusives, clastic fine-grained sediments, and metamorphics have been altered to favorable clays, but the most common parent material is the pyroclastic felsitic detritus such as volcanic ash or tuff.

Geologic distribution in Gonzales County. — As shown in figure 1, formations from Wilcox to Oakville extend across the county in a northeast-southwest direction. Of the eleven formations or groups, bentonite or bleaching clay was found in the Cook Mountain, Yegua, Jackson, and Catahoula, but the only commercial deposits worked are in the Jackson group. The bleaching clays range in thickness from an inch to an average of about 3 feet and are mined entirely by stripping or open pit method. A few scattered beds have been worked that contained as much as 14 feet of desirable clay, but these are rare. The overburden has been removed in the past by

[1]Figures in parentheses refer to corresponding entries in the bibliography.

hand and scrapers, but draglines and power shovel are now used. High dips in most of the Gonzales County pits have been a hindrance in mining since an increased load of overburden must be removed as the clay is recovered downdip. Consequently, where beds have not thickened progressively to offset the cost of deep recovery, pits have spread parallel to the strike in order to recover the shallower material. The final overburden is picked and shoveled away by hand because of the possibility of contamination by softer clay, sand, or soil.

Almost any grade of bentonite clay was used up to a few years ago, but it is more closely graded at the present time. The principal type of clay sought in the county today is a brittle variety which breaks into large rectangular pieces, has a conchoidal fracture, soapy feel, opaline to transleucent appearance when fresh, and has no visible grains other than occasional included mica. Softer varieties once mined are now largely discarded.

Plummer (16) writes the following in regard to the Jackson sediments: "It consists of shallow-water, marine, and beach deposits, composed of medium and fine-grained, thin-bedded sand, argillaceous and tuffaceous clays and tuffs, and lentils of coarse, rounded, and polished sand grains. In many places the beds are somewhat fossiliferous. They represent the lower, or Eocene, portion of the pyroclastic epoch, during which violently active volcanoes began to play an important part in supplying material to the sediments."

Bentonite in the Mount Tabor member of the Cook Mountain formation. — One locality yielding bentonite was found on the A. M. and M. D. Lindemann brothers farm one-fourth of a mile north of Cost on a small stream known as Lindemann Slough. In the 45 feet of dark chocolate-colored shales, gray shales, and sands, there is a 20- to 24-inch stratum of drab-green bentonite which contains much black mica. The substance is waxy in the upper 12 to 14 inches, uniform in grain, soapy, and disintegrates readily upon drying. This deposit can be traced laterally for more than a hundred yards along the exposure, but recent slumping has partly covered the outcrop. The quantity of overburden is too great for this clay to be mined, but it may be of some value as a stratigraphic marker in the section. Figure 2 gives the location of this site and other localities in the vicinity that yield marine fossils.

Bentonite in the Yegua formation. — A site in the Yegua formation was investigated on the Hunter Cook farm about three-fourths of a mile north of State Highway No. 200, 6 miles southwest of Gonzales. In a test pit, a 9-foot section of bentonite separated by thin seams of ash was found beneath 9½ feet of brown glaucenitic plant-bearing sandstone. The bentonite is a light gray soapy variety, somewhat gritty because of included ash which forms numerous partings. It is doubtful if this bentonite could be used because of the great amount of included ash and great overburden. The bentonite bed, as well as the overlying sandstone, may be a good stratigraphic marker. The highly cross-bedded sandstone carries numerous well-preserved leaf and stem imprints as well as occasional seeds. This rich-colored brown stone has been used locally for many years for chimneys, and in recent years the State Highway Department used this rock to build a small part of the retaining walls on the south bank of Guadalupe River at the bridge south of Gonzales (fig. 3).

Bentonite in the Jackson group. — The principal producing beds in the county are in the Jackson group, and mining is in the Caddell and McElroy members. New beds of a good grade were discovered by this project in upper Jackson, and these are to be exploited. The Jackson clays have been known locally for many years. Some varieties, particularly the white, cream, and pink, have a kaolin-like appearance upon drying. Production of those clays has been largely from pits confined to the Hell's Gate area, 6 miles south of Gonzales; Kent DuBose land, 7 miles southeast of Gonzales on the Shiner road; the Bennett and Clark pit, 6½ miles southeast of Waelder on the Waelder-Moulton road.

Hell's Gate pits. — Six miles south of Gonzales on the left side of State highway No. 29 on the Lou DuBose and Oscar DuBose tracts, there is a series of pits which extend from the highway to the bluff known as Hell's Gate on Guadalupe River. Figure 4 shows this area and the now abandoned pits. The distance of continuous operation is approximately 1.6 miles. This is perhaps the best known bentonite occurrence in the county and was formerly worked by the Coon Company and later by the Earthen Products Company. Practically all of the available clay has now been extracted. Figure 5 is a generalized section across the pit immediately above Hell's Gate. The bleaching clay stratum, a cream-colored variety when fresh, occurs as a long and narrow wedge-shaped bed in the Wellborn formation, beginning at a fraction of an inch in thickness on the updip side or outcrop side, gradually increasing downdip to a maximum thickness of 4 feet, where it suddenly terminates due to Wellborn-time erosion. Sandstones and shales below the bleaching clay and chocolate-shale strata dip almost imperceptibly in short distances in areas near the basin, as shown in figure 5, but these have been truncated, giving rise to a steep dipping basin to the southeast. The intra-formational unconformity as evidenced by beds at this site and approximately 2 miles northeast in other clay pits on the Kent DuBose tract show that this break in deposition is probably not local in character. The basin deposit which includes the bentonite exhibits a much greater dip than the "normal dipping" beds of underlying Wellborn sandstones and shale. At the point on the downdip side of this pit where operations ceased, as much as 25 feet of overburden was removed for approximately 4 feet of clay. Had these beds continued at the average rate of thickening, they could have been mined indefinitely. The remaining wedge of bentonite before mining represented a strip roughly 200 feet in width. Figure 3 also shows how the bentonite bed ends abruptly on the downdip side of the pits and how its former position was replaced by the chocolate-colored plant-bearing shales. Although the material mined was free of grit, aragenite concretions from a foot to 9 feet in diameter are scattered promiscuously in the pits. These concretions, often manganese coated, were moved in mining when there was little danger of crumbling, but the larger ones were left in place. These have been reported (12) as huge aragonite-replaced palm stumps lying at the edge of the old lagoonal basin, but their size, general shape, and lack of structure so evident in other plants preserved in Jackson sediments are too marked. An unusual feature of the cream-colored bleaching clays in Gonzales County is the lack of any fossil plant remains, molluscs, or burrows. Some opalized wood and plant stems and portions of leaves are found in the soft underlying sand. Portions of trunks or limbs are also occasionally found with borings probably made by *Teredo*. Burrows such as these described by Stenzel (25) are found throughout the series of sands below the bentonite stratum.

Remaining clay on the updip side of the old pits is heavily impregnated with limonite but becomes relatively free of included matter as the beds rapidly thicken downdip. Iron is generally of no serious consequence in any of the mines since it develops only between old bedding planes and joints. As in other pits the bentonite section begins with a soft somewhat mealy variety and grades into, or sometimes rapidly changes, to a hard consolidated conchoidally fracturing material which lies in definite beds. The harder central stratum is generally overlain by a stratum somewhat like the lower bed in appearance. The more indurated central bed is the stratum which has been mined. Tests on clays from these deposits made by P. G. Nutting of the United States Geological Survey, indicated that they are naturally active, but not activable. The following comments are taken from Nutting's work (15): "The samples from the pit being worked by the Earthen Products Company south of Gonzales is a fairly good fuller's earth and is not increased in bleaching power by acid treatment. It is chemically exceedingly tough, so we gave it a longer leach which halved the bleaching power. The material appears to have been pure bentonite, high in calcium. The underlying bentonite is nearly normal, but a little too much leached to be of commercial interest."[2]

Waelder deposits. — The first pit opened in the Jackson near Waelder was by the Bennett and Clark Company on the J. L. Johnson land, 2.5 miles east and 5.5 miles south of the town. The workings are on a northeastward sloping hillside, and mining has proceeded along the strike of the beds. Near the outcrop, overburden was shallow, but in later recovery on the downdip side there was a substantial increase until it reached 12 feet.

The mined clay is brown when fresh and occurs in a 2.5- to 3-foot stratum. Grayish-brown overlying and underlying beds are not very unlike the sought after material. Other pits have recently been opened in this area and are worked from beds equivalent in age to the Hell's Gate pits. None of the new pits approach the size of the Kent DuBose or L. D. DuBose and Oscar DuBose pits. In appearance, these recently mined clays are the same in quality as other Wellborn occurrences. This area of the county is practically untouched, and much valuable prospecting is yet to be done.

Kent DuBose pits. — Mines on the Kent DuBose land are located approximately 6.5 miles southeast of Gonzales on the left side of State Highway No. 200. These pits are essentially an eastern extension of the Hell's Gate beds and are also in the Wellborn formation.

Mining extends northeast from the highway for approximately 1 mile. The clay is recovered from the outcrop downdip until the overburden becomes prohibitive. The rapid dip of the beds, as in the Hell's Gate pits, makes it essential to confine operations to a relatively narrow strip along the strike. Because of the relatively favorable hill slope conditions and consequent preservation, a large area of shallow clay was mined near the highway, but an increased dip of beds due to differential erosion of hard and soft beds of underlying sandstone caused a rapidly increasing overburden to accumulate. In the pits that are worked at the present, 15 feet of overburden is removed for approximately 15 inches of clay. The downdip limits of clay have not been reached in the pits; consequently, it is not known whether the bed disappears due to erosion, as in the case of the Hell's Gate stratum. Figure 5, a generalized cross section of the strata of the Hell's Gate pits, shows the same condition of abnormal dip slope caused by partial truncation of Wellborn beds. The overlying beds carry an abundance of nonmarine fossils such as leaves and plant stems.

It is assumed that the quality of these clays is as satisfactory as other local clays that are mined because of the great thickness of overburden removed to obtain a relatively thin stratum. The mined bed in recent pits lies beneath 15 feet of gray to chocolate-colored fatty shales. The central hard stratum of mined clay is a delicate flesh-pink variety, somewhat opaline in appearance when fresh, and breaks into large flattened rectangular blocks. Limonite adheres to the clay on the bedding planes and is present in the oblique cracks developed in the clay, but this is largely removed with steel brushes before shipment. Chunks disintegrate rapidly upon drying, and the live delicate color is lost.

Kennard pits. — Pits have recently been opened on the Kennard tract immediately across State highway No. 200 and south of the described Kent DuBose mines. These are extensions of the DuBose and Hell's Gate pits.

The mined stratum is pink in the pit near the highway, but reconnaissance shows that soapy white and grayish-blue clays are also present. The clay is not unlike that of the Kent DuBose mines. This tract, although not large, will yield a fair quantity of clay.

Reed ranch deposit. — The Reed area is located approximately 8 miles southeast of Gonzales and 1 mile south of the Gonzales-Shiner highway. As shown on figure 8, the deposits are approximately southwest of the Kent DuBose and Kennard pits. The outcrop of the bentonite strikes N. 60° and can be easily traced, since a small stream follows the outcrop in this area. The minable portion of this bed varies from 12 to 16 inches in thickness and has a variable overburden in the area drilled. A typical section of the beds of this area is shown on the map, figure 9. The Reed ranch bentonite is a hard, brittle, white to pinkish-colored variety with a definite conchoidal fracture. Fresh exposures exhibit a soapy, waxy texture and may be cut into thin shavings like soap. It is relatively pure, the main contamination being thin layers of limenite occurring along the bedding planes within the bentonite.

Hinton farm deposit. — A soapy white stratum of bleaching clay from 6 to 8 inches in thickness is located on the J. R. Hinton farm, 8 miles south of Gonzales in badlands developed immediately below the DuBose cemetery. At this place beds of cross-bedded sandstones, ash, and clay dip gently to the northwest. Although the stratum of hard clay is thin, overburden would be of no serious consequence for some distance along the outcrop. It is doubtful, however, if this site is valuable enough to work at the present time in view of other available thicker beds.

Oscar DuBose pit. — A brownish-red or chocolate-colored fatty bentonitic clay is mined from a pit on the Oscar DuBose farm near State highway No. 29, 9.5 miles south of Gonzales. This clay is similar in appearance to the grade mined in the old Bennett and Clark pit near Waelder. Material from this pit is used by the Milwhite Company. The producing beds grade latorally into sands and ashy clays. This is apparently another small basin deposit.

Terryville sites. — A large bentonite deposit was located in the vicinity of Terryville, southwest of Gonzales. Extensive testing along the outcrop proved the existence of a thin but consistent bed of clay covering many acres. The clay lies in a long narrow basin on a sandstone which is highly cross-bedded and quartzitic in part. Everywhere on the outcrop the clay is overlain by volcanic ash which attains a maximum thickness in the trough of 21 feet. Figure 11 is a generalized cross section of the strata near Terryville. A map of Terryville area contoured on the base of the clay is also included in this report (fig. 10).

Drill holes in the basin pass through a consistent series of strata beginning with volcanic ash, followed by a partially altered ash, a bed of hard bentonite, another bed of partially altered ash. This series apparently lies on the erosional surface of a quartzitic sandstone. On the northwest or outcrop side, drill holes reach the clay at a consistent dip descending to the southeast, but upon reaching the maximum depth of the basin, the ash and clay section rises rapidly and is replaced by a member of the underlying sand series, shown by figure 11.

The best exposures of clay are on the Terryville State School land and the Joe Dunning tract. The best appearing grade is white to cream-colored, very hard and brittle, breaks into rectangular blocks, and has a good conchoidal fracture. Due to the hardness of this material, it does not disintegrate so rapidly as other clays examined in the county. Exposures, however, weather and have the characteristic "bloom" of bentonite.

The class of material present, the available quantity, and relatively shallow overburden on the updip side of the basin, make this one of the most promising sites tested. The bed of the grade of clay most likely to be of use in bleaching averages from 1 to 1.5 feet at the

[2]Practically all of the clay has now been used since this was written.

outcrop and extends on the Joe Dunning, Robert Nelson, and Will Brassfield farms, and on the Terryville School land. Lateral extensions of these beds would probably be the result of further testing along the strike.

Guy Moore deposit. — A bed of white bentonite was found on the Guy Moore farm near Terryville. The exposure is in the new channel of a small stream which formed by cutting around an earth dam. This site is about 250 yards from the Guy Moore house. The exposed bed shows approximately 1 foot of brittle clay which is very much like the Hell's Gate material. Preliminary testing shows that several carloads are present, and lateral testing would probably reveal a fairly good quantity. At the outcrop the beds have about 3 feet of overburden, and this apparently thickens rapidly downdip.

Other miscellaneous deposits. — Several small deposits of cream-colored clay show in road cuts on the Gonzales-Watson School road. One of these shows the typical basin occurrence so common to other Jackson deposits in this county.

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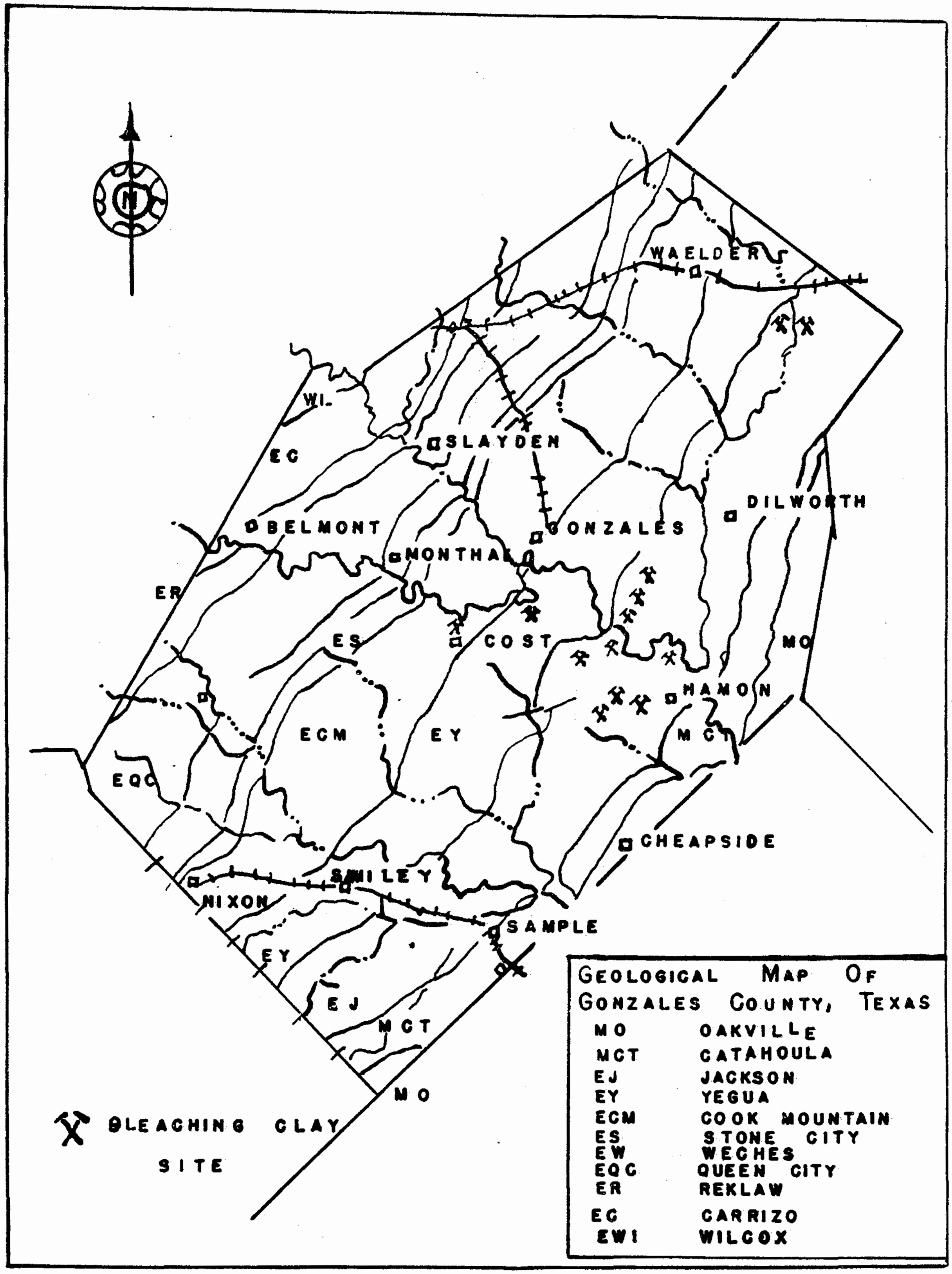
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MO
HAMON
ECM
EY
MCT
EQC
CHEAPSIDE
SMILEY
NIXON
SAMPLE
EY
EJ
MCT
MO
BLEACHING CLAY SITE
GEOLOGICAL MAP OF GONZALES COUNTY, TEXAS
MO OAKVILLE
MCT CATAHOULA
EJ JACKSON
EY YEGUA
ECM COOK MOUNTAIN
ES STONE CITY
EW WECHES
EQC QUEEN CITY
ER REKLAW
EC CARRIZO
EWI WILCOX

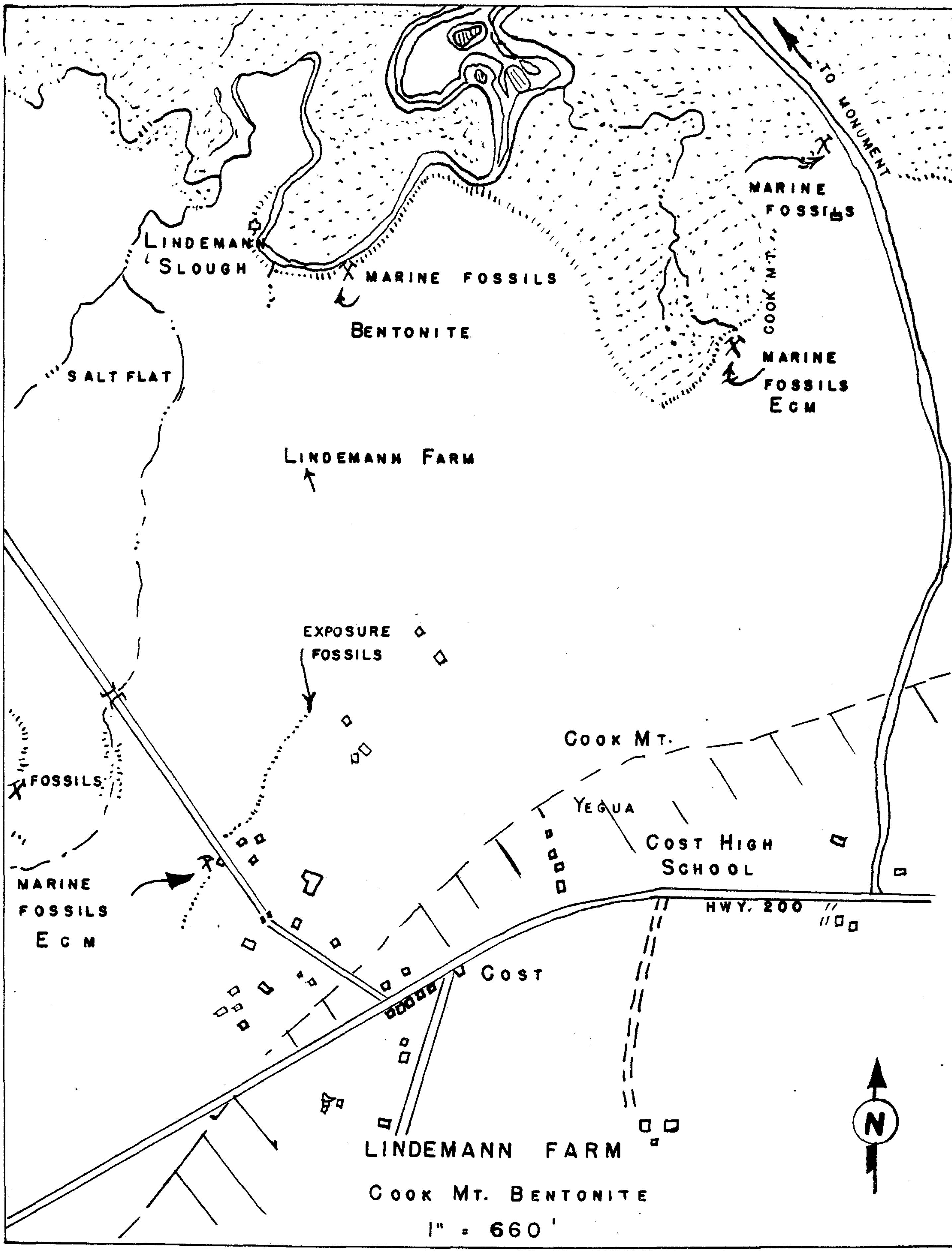

TO MONUMENT
MARINE FOSSILS
LINDEMANN SLOUGH
MARINE FOSSILS
BENTONITE
COOK MT.
MARINE FOSSILS
ECM
SALT FLAT
LINDEMANN FARM
EXPOSURE FOSSILS
COOK MT.
YEGUA
FOSSILS
COST HIGH SCHOOL
HWY. 200
MARINE FOSSILS
ECM
COST
N
LINDEMANN FARM
COOK MT. BENTONITE
1" = 660'

FIG. 2

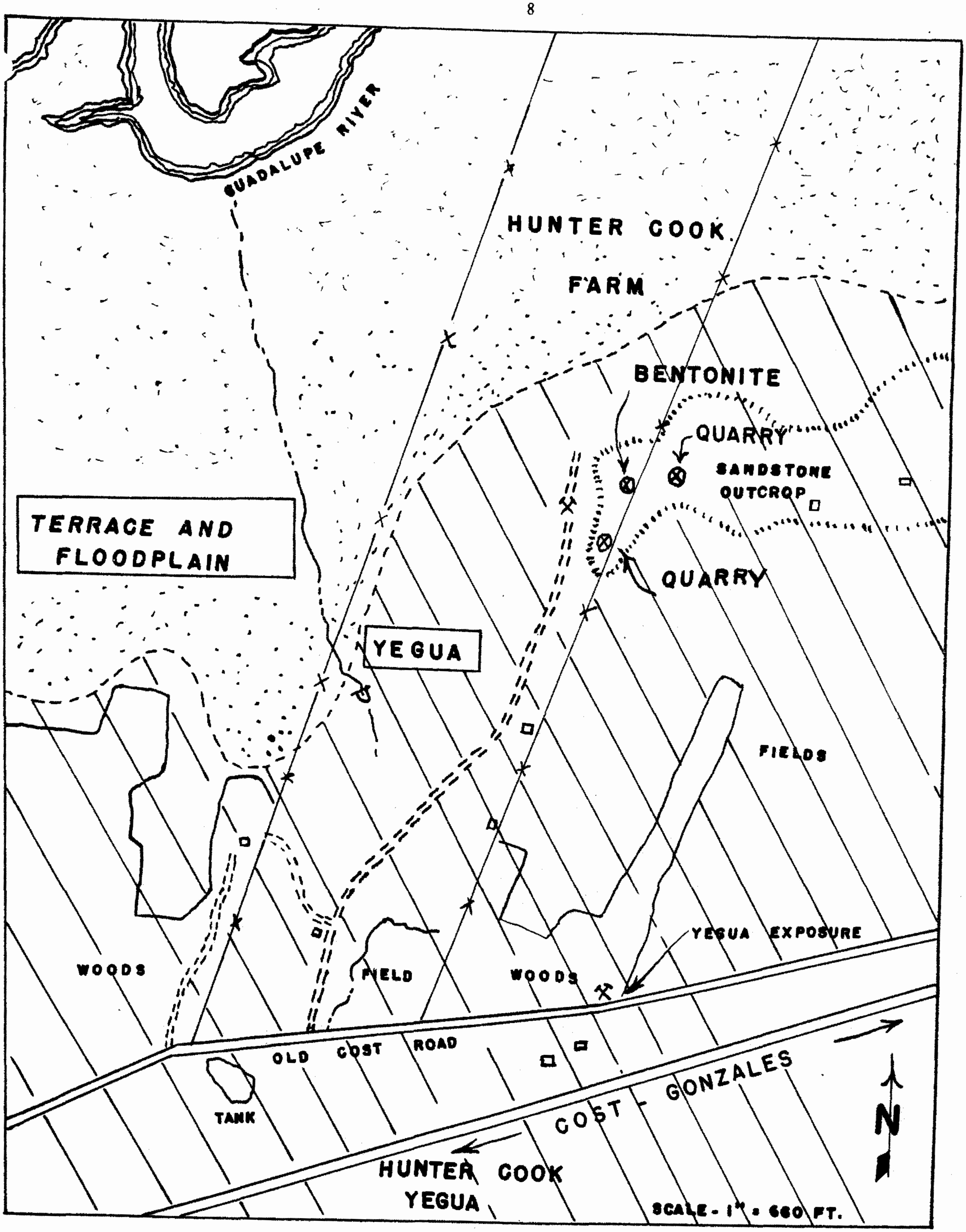

GUADALUPE RIVER
HUNTER COOK
FARM
BENTONITE
QUARRY
SANDSTONE
OUTCROP
QUARRY
TERRACE AND
FLOODPLAIN
YEGUA
FIELDS
WOODS
FIELD
WOODS
YEGUA EXPOSURE
OLD COST ROAD
TANK
COST - GONZALES
HUNTER COOK
YEGUA
N
SCALE - 1" = 660 FT.

FIGURE 3

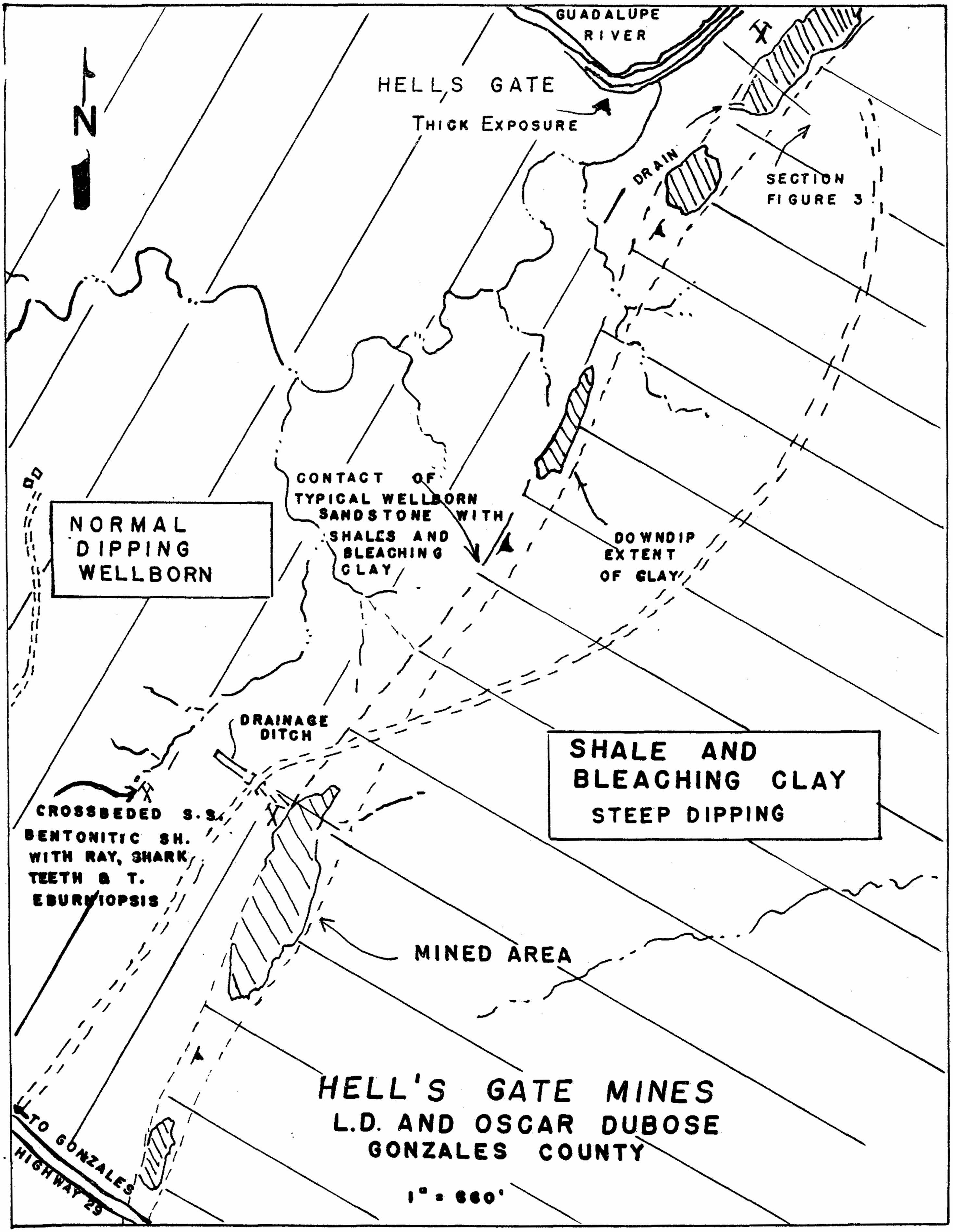
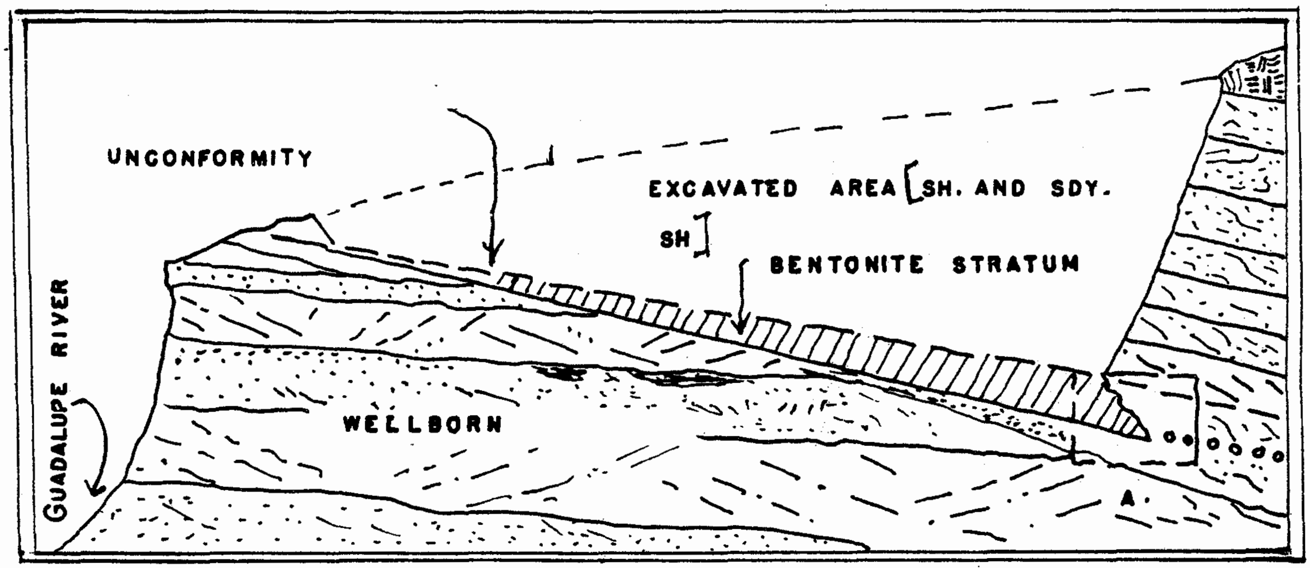

GUADALUPE RIVER
HELLS GATE
THICK EXPOSURE
N
DRAIN
SECTION FIGURE 3
CONTACT OF TYPICAL WELLBORN SANDSTONE WITH SHALES AND BLEACHING CLAY
NORMAL DIPPING WELLBORN
DOWNDIP EXTENT OF CLAY
DRAINAGE DITCH
SHALE AND BLEACHING CLAY
STEEP DIPPING
CROSSBEDED S.S.
BENTONITIC SH. WITH RAY, SHARK TEETH & T. EBURNIOPSIS
MINED AREA
HELL'S GATE MINES
L.D. AND OSCAR DUBOSE
GONZALES COUNTY
1" = 660'
TO GONZALES
HIGHWAY 29

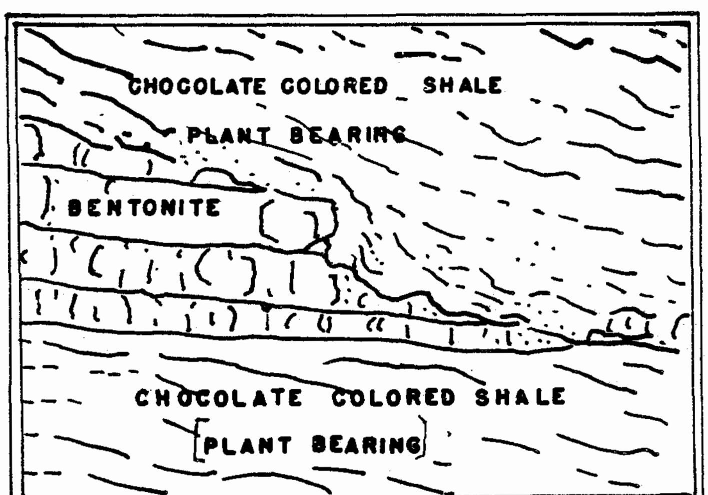
FIGURE 4



GENERALIZED SECTION AT HELLS GATE MINE

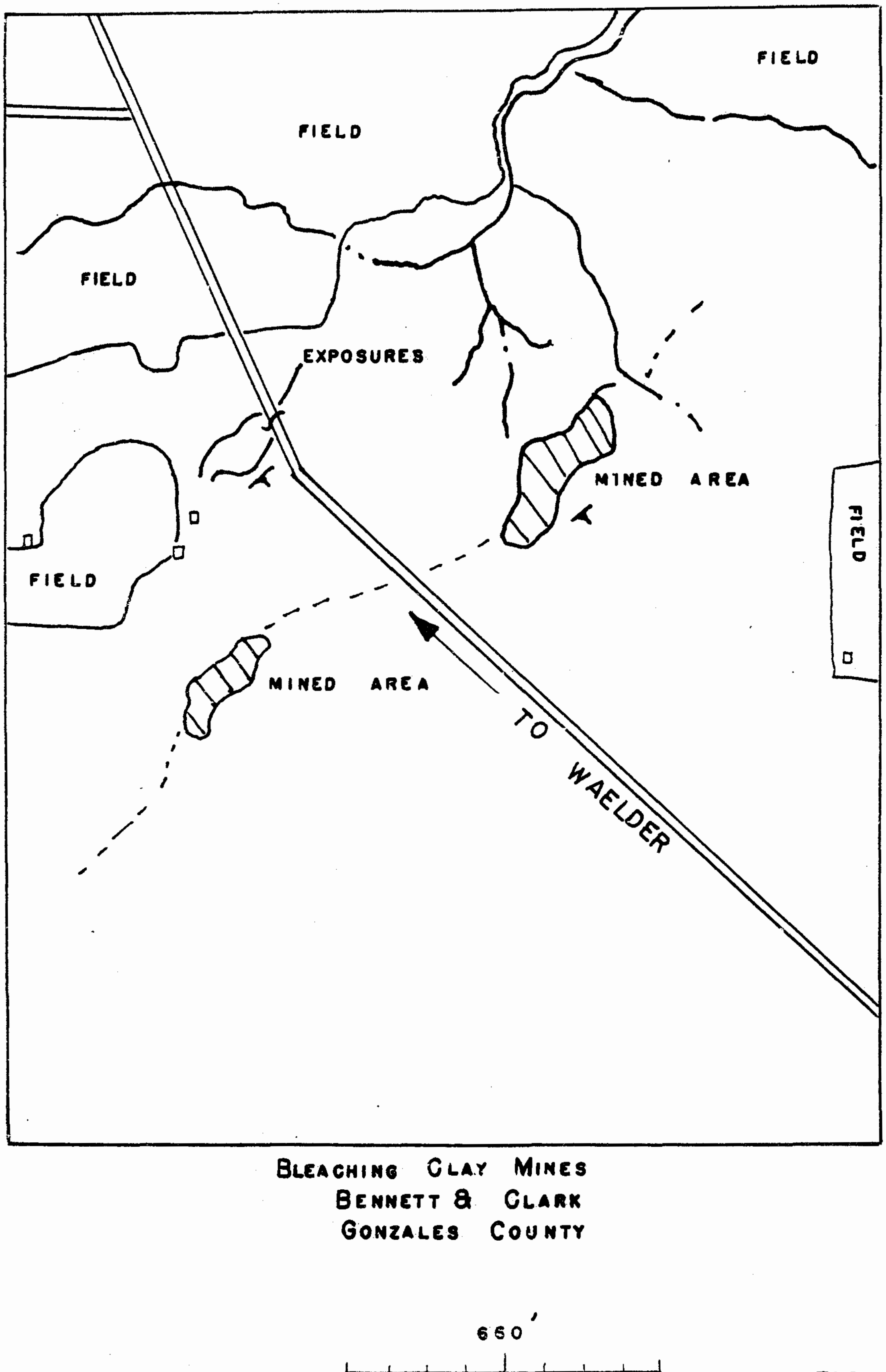
L. D. DuBose Ranch

[DETAIL OF INSET A SHOWN BELOW]



A. DOWNDIP EXTENT OF BENTONITE SHOWING TRUNCATION OF BEDS.

FIG. 5



BLEACHING CLAY MINES
BENNETT & CLARK
GONZALES COUNTY

FIG. 6

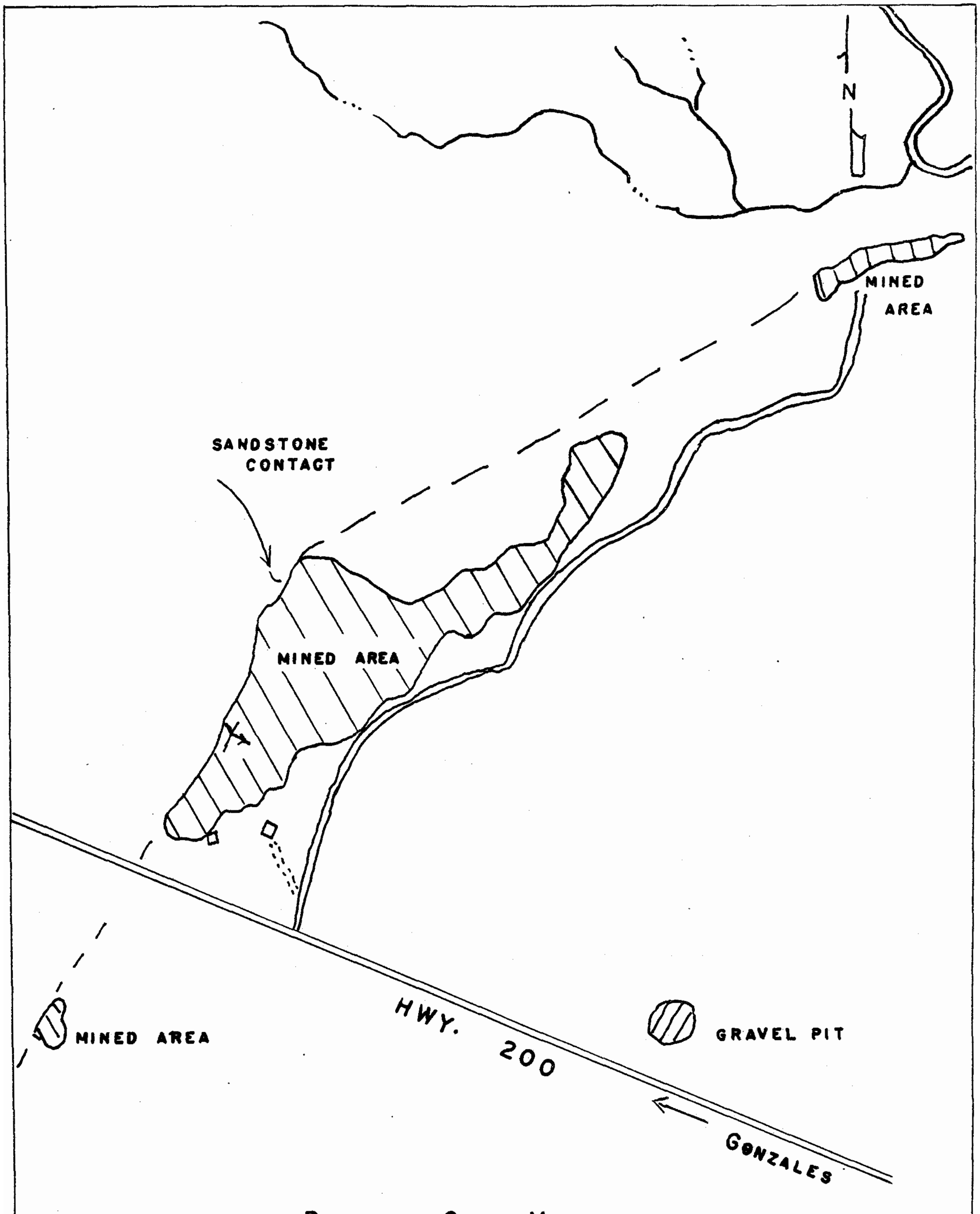
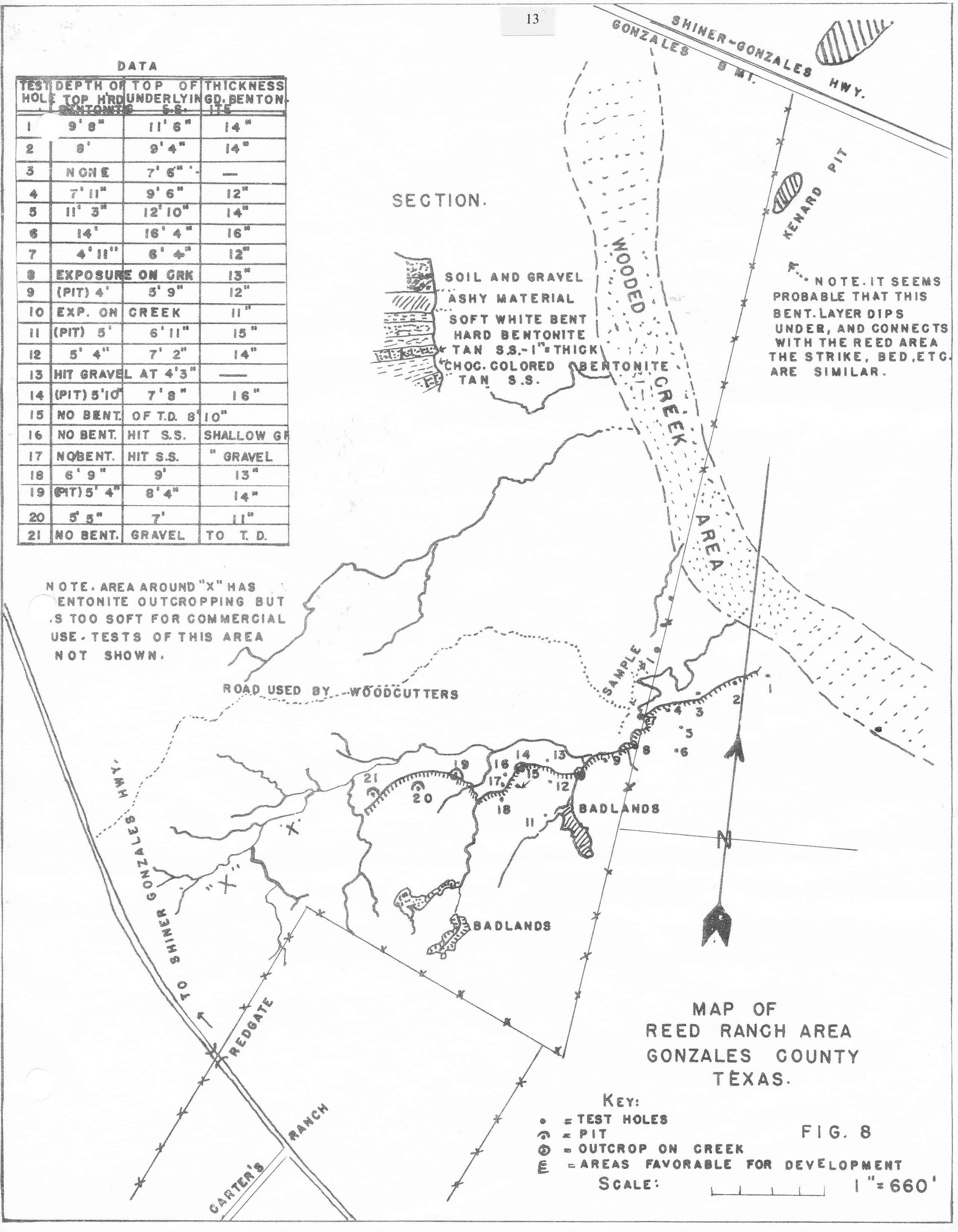


FIG. 7

BLEACHING CLAY MINES
KENT DU BOSE TRACT
GONZALES COUNTY

DATA

TEST HOLE	DEPTH OF TOP HRD BENTONITE	TOP OF UNDERLYING S.S.	THICKNESS GD. BENTON-ITE
1	9' 8"	11' 6"	14"
2	8'	9' 4"	14"
3	NONE	7' 6"	—
4	7' 11"	9' 6"	12"
5	11' 3"	12' 10"	14"
6	14'	16' 4"	16"
7	4' 11"	6' 4"	12"
8	EXPOSURE ON GRK		13"
9	(PIT) 4'	5' 9"	12"
10	EXP. ON CREEK		11"
11	(PIT) 5'	6' 11"	15"
12	5' 4"	7' 2"	14"
13	HIT GRAVEL AT 4'3"		—
14	(PIT) 5'10"	7' 8"	16"
15	NO BENT.	OF T.D. 8' 10"	
16	NO BENT.	HIT S.S.	SHALLOW GR
17	NO BENT.	HIT S.S.	" GRAVEL
18	6' 9"	9'	13"
19	(PIT) 5' 4"	8' 4"	14"
20	5' 5"	7'	11"
21	NO BENT.	GRAVEL	TO T. D.



MAP OF
REED RANCH AREA
GONZALES COUNTY
TEXAS.

FIG. 8

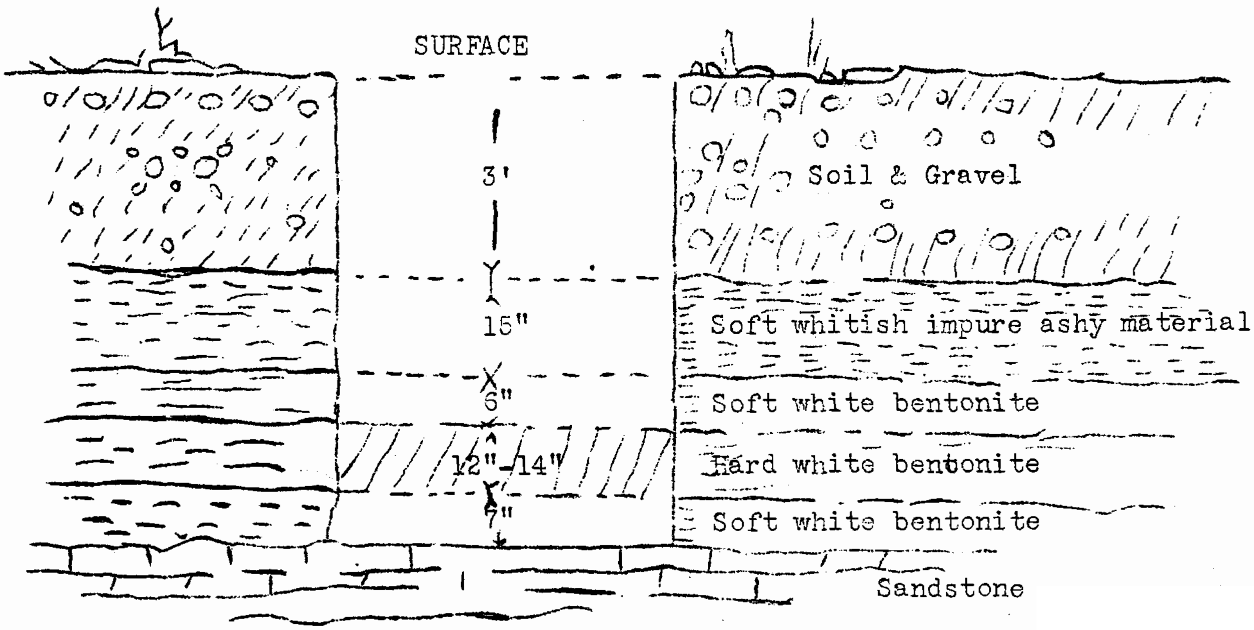
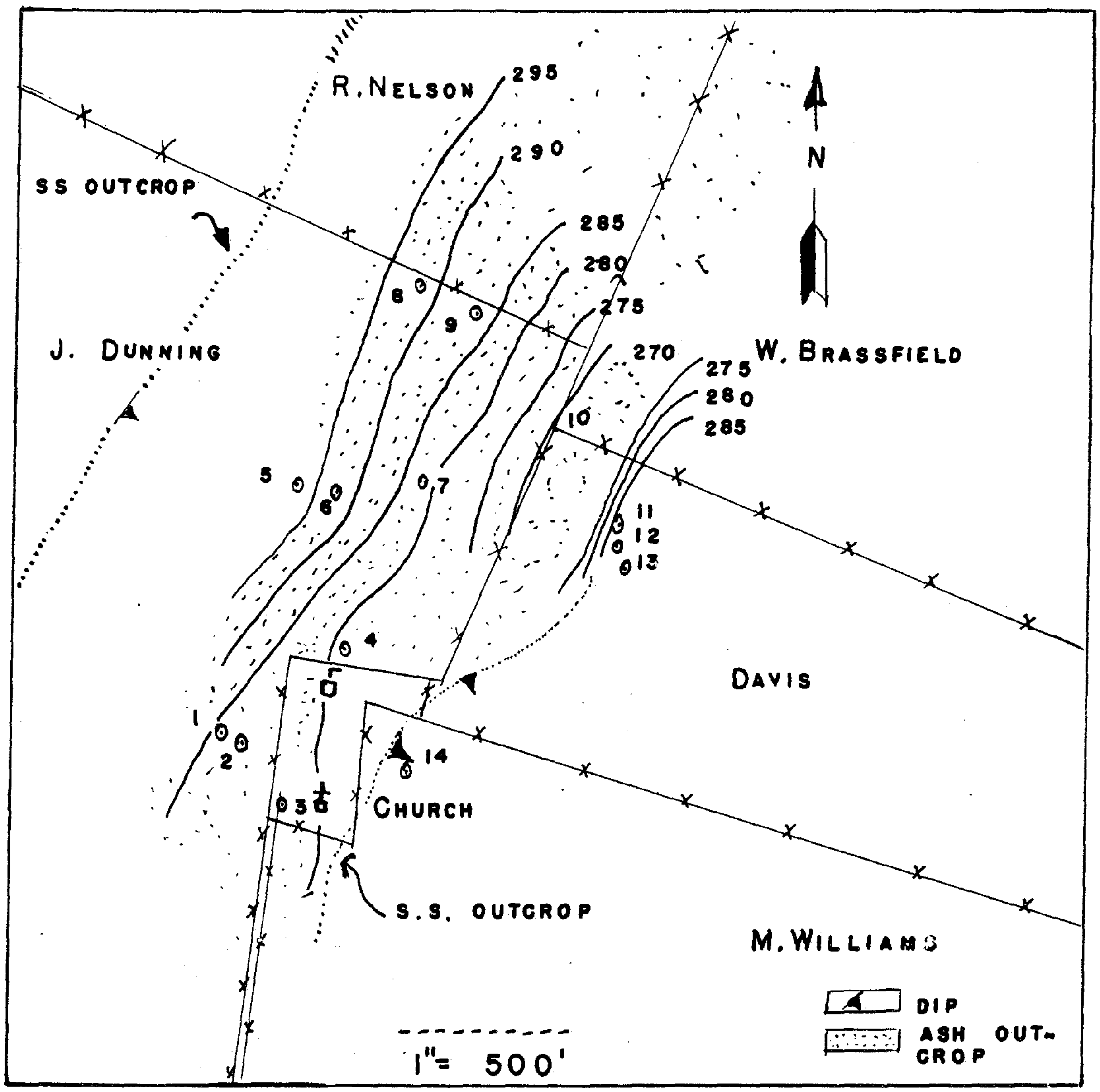


FIG. 9

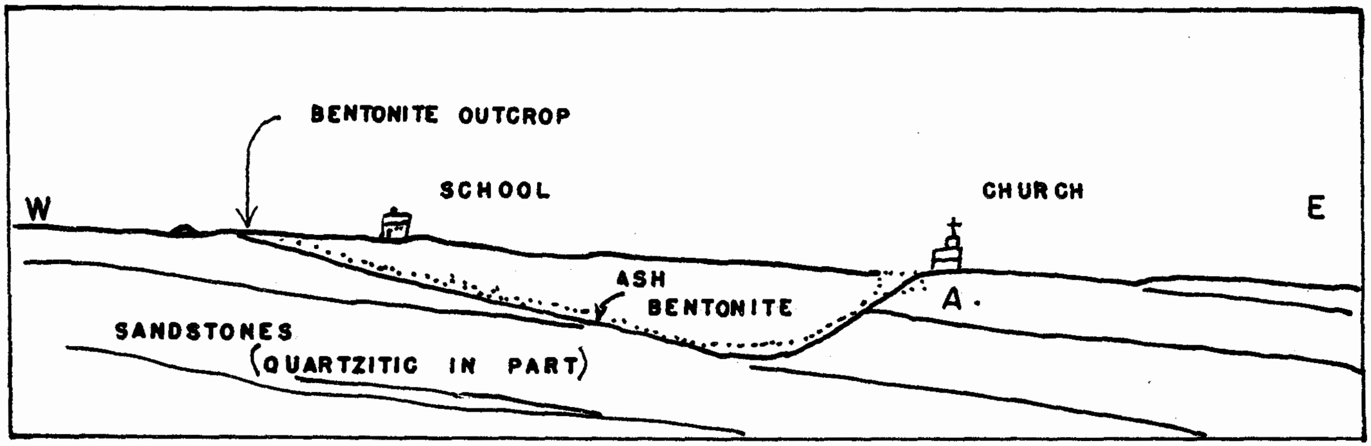
Typical Section of Locality

Pit No. 7

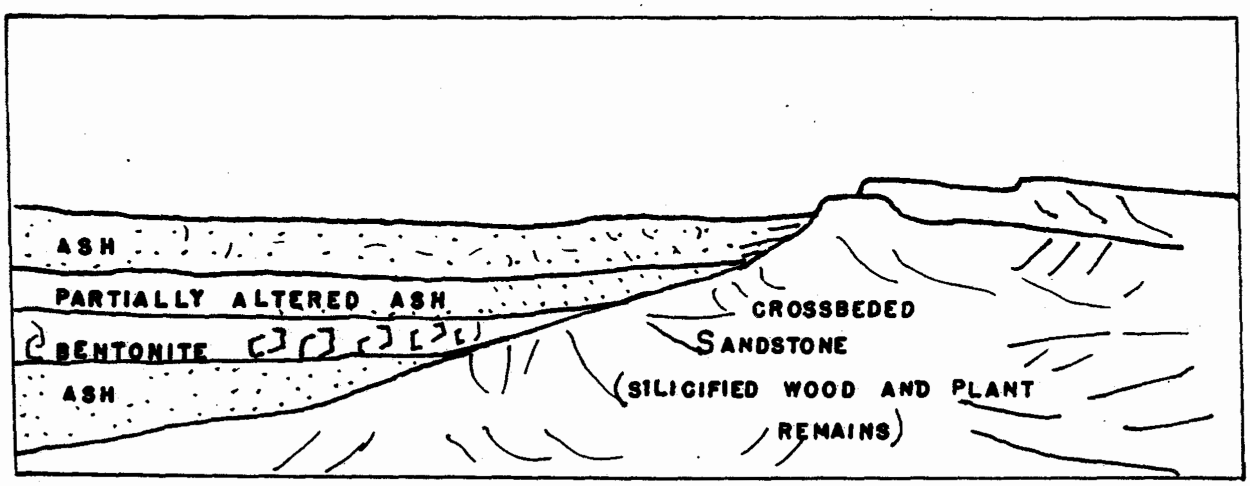


MAP OF TERRYVILLE COMMUNITY SHOWING TEST HOLES IN BENTONITE-ASH DEPOSIT CONTOURED ON BASE OF BENTONITE.

FIG. 10



GENERALIZED CROSS SECTION OF ASH AND BENTONITE STRATA AT TERRYVILLE COMMUNITY. BENTONITE LIES BELOW ASH BED. DETAIL A OF SECTION NEAR CHURCH SHOWN BELOW.



DETAIL OF A NEAR TERRYVILLE CHURCH

FIG. 11