FIELD TRIP GUIDEBOOK

Environments of Deposition Wilcox Group

TEXAS GULF COAST

Houston Geological Society
October 12, 1968

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FOREWORD

Nearly all of the type localities of the various lithic units of the Wilcox group of Texas crop out conveniently close to one another along the route of our field trip. It is not, however, the purpose of this trip to examine type localities for their own sake, but rather to examine some of the various facies of a depositional system, attempt to assign environments of deposition to the various components of the system, and to relate these depositional components one to another and to the regional depositional framework.

Seven principal depositional systems have been recognized in the lower part of the Wilcox group in Texas (Fisher and McGowen, 1967). These systems have been named as follows:

1. Mt. Pleasant Fluvial System
2. Rockdale Delta System
3. Pendleton Lagoon-Bay System
4. San Marcos Strandplain-Bay System
5. Cotulla Barrier Bar System
6. Indio Bay-Lagoon System
7. South Texas Shelf System

The Rockdale Delta System is the dominant depositional element in Texas, and time and distance will confine our field trip to facies of this system at outcrop (see Figure 1). Figure 2 shows the position of the various units of the Wilcox group, their generalized genetic origin, and the relative stratigraphic position of each stop on this trip. A roadlog has also been included in the guidebook appendix for an interesting trip through the lower Wilcox Indio Bay-Lagoon System of South Texas. The reader is referred to page 28 in the Appendix for the regional depositional setting.

Interpretation of environments of deposition for the sediments which we will see on this trip is based primarily upon sedimentary structures, vertical and lateral sequence relationships, lithologic character, and contained fauna (or absence of same). Palynomorph assemblages recovered from sediments deposited in closed environments often reflect only local flora, and are therefore, indicative of the environment of deposition. The local flora, in turn, gives one a basis for interpretation of the prevailing climate at the time of deposition. The application of palynology to the zonation of the Wilcox group, and interpretations of environments of deposition and climatic conditions has added much to our understanding of this vertically and laterally complex depositional system. A brief paper by W. C. Elsik entitled "Palynology of the Wilcox Group" may be found in the guidebook appendix.

Should you disagree with any of the geological interpretations found in this guidebook, we, of the Field Trip Committee, would be pleased to hear from you. For we believe as R. A. Daly that "Science is built on a long succession of mistakes. Their recognition has meant progress."

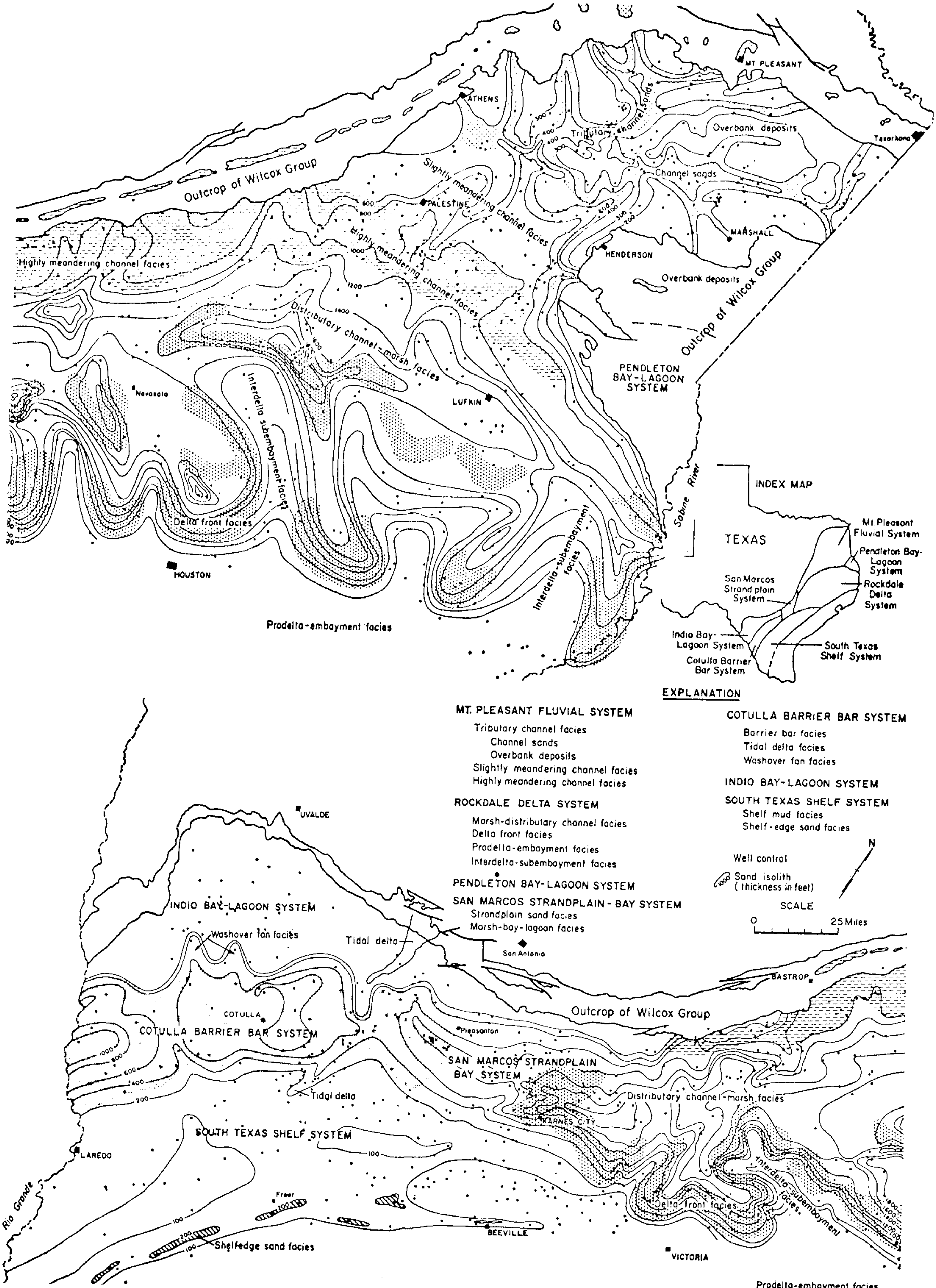

Fig. 1 - Principal depositional systems, lower part of Wilcox Group, Texas (From Fisher & McGowan, 1967, p. 106-107).

<table>
<tr><th>Series</th><th>Group</th><th>Formation</th><th>Member</th><th>General Out-crop environment</th><th>Stop #</th></tr>
<tr><td rowspan="2">EOCENE</td><td rowspan="7">WILCOX</td><td>Carrizo</td><td></td><td>Fluvial system</td><td rowspan="2">1</td></tr>
<tr><td>Sabinetown</td><td></td><td>Shore-face to shallow marine</td></tr>
<tr><td>--?--</td><td rowspan="4">Rockdale</td><td>Calvert Bluff</td><td rowspan="2">Palustrine, marsh, and swamp</td><td>5</td></tr>
<tr><td rowspan="6">PALEOCENE</td><td>Butler clay beds</td><td>4</td></tr>
<tr><td>Simsboro sand</td><td>Highly meandering fluvial sands</td><td rowspan="2">3</td></tr>
<tr><td>Hooper clay</td><td>Palustrine, swamp and marsh</td></tr>
<tr><td rowspan="2">Seguin</td><td>Caldwell Knob</td><td>Local oyster banks;brackish</td><td rowspan="2">2</td></tr>
<tr><td rowspan="2">MIDWAY</td><td>Solomon Creek</td><td>Littoral, shore-face</td></tr>
<tr><td>Wills Point</td><td></td><td>Marine</td><td></td></tr>
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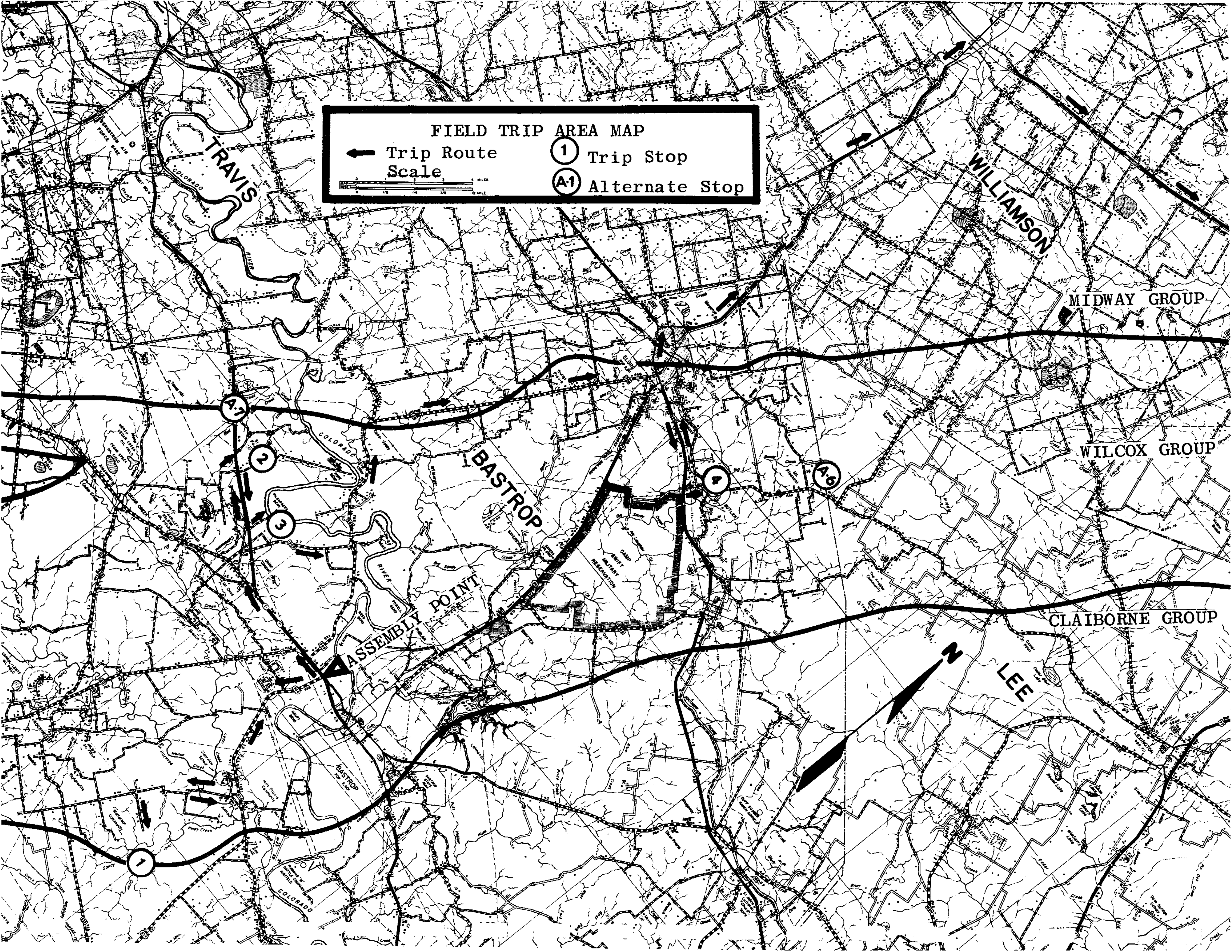
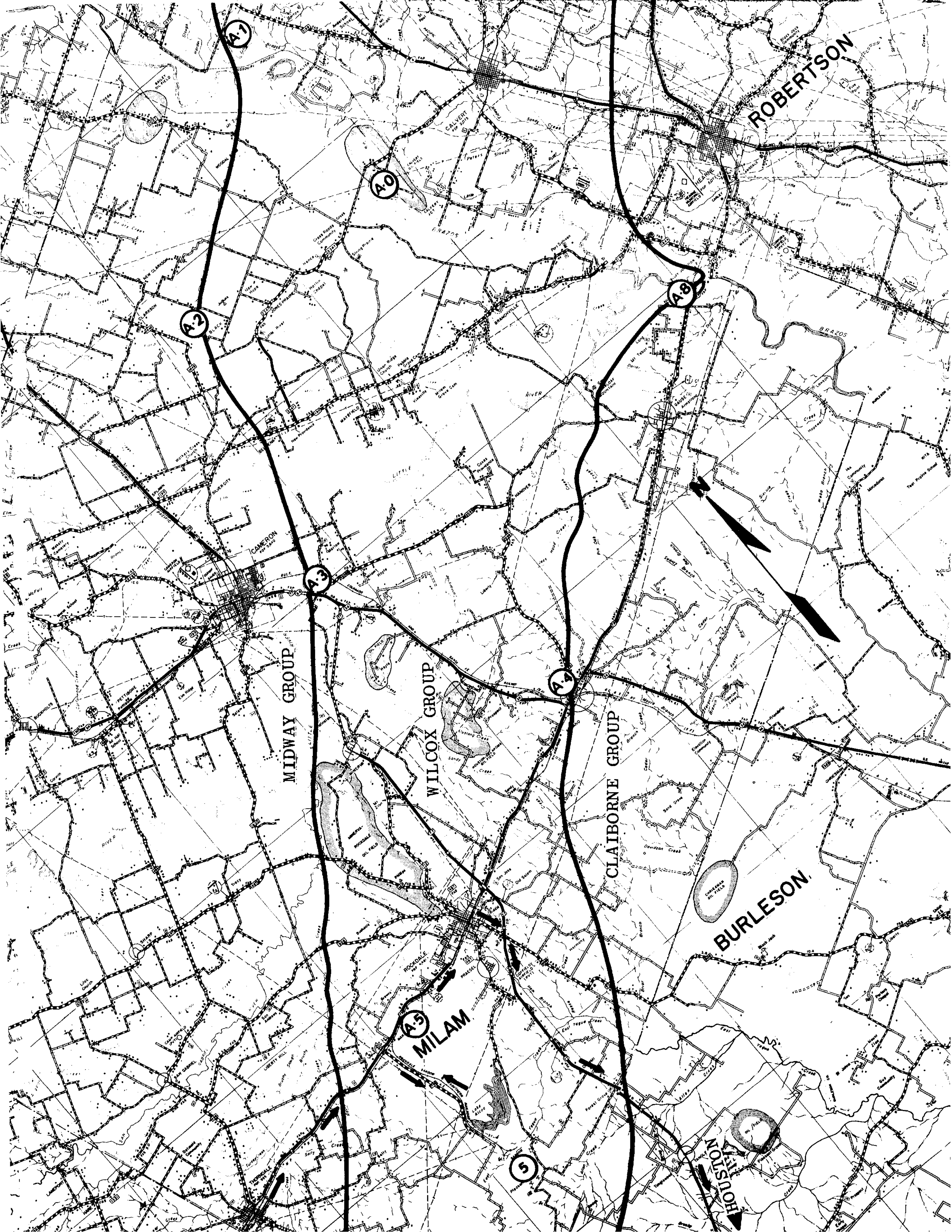
Fig. 2 - Currently recognized stratigraphic units at outcrop, generalized environment of deposition, and stratigraphic location of field trip stops.


FIELD TRIP AREA MAP
Trip Route
Scale
1 Trip Stop
A-1 Alternate Stop
TRAVIS
WILLIAMSON
BASTROP
LEE
MIDWAY GROUP
WILCOX GROUP
CLAIBORNE GROUP
ASSEMBLY POINT
COLORADO
RIVER
N
1
2
3
4
A-6
A-7



A-1
A-0
A-2
A-8
A-3
A-4
A-5
5
ROBERTSON
MIDWAY GROUP
WILCOX GROUP
CLAIBORNE GROUP
BURLESON
MILAM
HOUSTON
N
CAMERON
ROCKDALE
CALVERT
HEARNE
BRAZOS

HOUSTON GEOLOGICAL SOCIETY

FIELD TRIP ROAD LOG, SATURDAY, OCTOBER 12, 1968

NOTE: Allow two and one-half hours driving time from Houston, plus any time for breakfast if you so desire, to rendezvous at assembly point northwest of Bastrop promptly at 8:15 A.M.

00.00 U.S. Hwy. 90 (Katy Freeway) at Gessner. Head west on I.S. 10 and U.S. Hwy. 90.

23.8 Brookshire City limits.

58.2 Columbus exit. Turn right (north) on U.S. Hwy. 90.

60.5 Brazos River.

60.7 Colorado County Courthouse.

61.1 Jct. U.S. Hwy. 90 and State Hwy. 71. Turn right on Texas 71.

85.7 LaGrange City limits.

87.1 Fayette County Courthouse.

105.5 Smithville southeast city limits. Continue through Smithville on Texas 71.

106.8 Jct. Texas Hwy. 95 and Texas 71. Keep right on Texas Hwys. 71 and 95 to Bastrop.

119.4 Colorado River at west edge of Bastrop.

Historical Note: Bastrop, located on the old San Antonio Road, is one of the oldest settlements in Texas. The town, originally called Mina, was named in honor of Baron de Bastrop and was incorporated on December 18, 1837. It was here at Bastrop that the first newspaper in Texas, the Colorado Reveille (Bastrop Advertiser) was published in 1851.

121.3 ASSEMBLY POINT: Junction Texas Hwys. 71 and 21 with FM 304 to left. Turn left onto FM 304 and pull well off shoulder.

(000.0)

5.6 Turn right on paved road to Watterson.

8.3 Watterson Ranch.

9.6 Turn left on gravel road.

11.2 End of road at pasture. Walk to bluffs along Sandy Creek.

STOP 1: Carrizo-Sabinetown on Sandy Creek.

At this locality we will examine an excellent outcrop of lower Carrizo sand which unconformably overlies steeply dipping beds of the Sabinetown exposed in cut bank bluffs along Sandy Creek. The Carrizo formation at this locality is perhaps best documented by T. W. Todd (1956, Univ. Texas M. A. thesis).

At least fifty feet of lower Carrizo river channel sands may be observed at this locality. Sedimentary structures indicate that the direction of transport was southeasterly much as it is today.

Excellent examples of both fluvial (Carrizo) and nearshore (Sabinetown) sands are exposed in the bluffs along Sandy Creek. The entire bluff upstream is composed of festoon cross-bedded point-bar sand. Large blocks of backswamp clay derived from the caving banks, are incorporated in these fluvial sands. The thick clay lens approximately half way up the bluff suggests that two stages of development were required to deposit this sand section. Downstream, thin parallel laminae dipping basinward are visible just above the level of the stream and are indicative of forebeach deposits. Associated with these sands are bedded clay and glauconitic sands of the shoreface zone.

The Carrizo sand in this area contains 10-20% metamorphic rock fragments. An abundance of mica and the heavy minerals, dominated by kyanite and staurolite, indicate a major source in the southern Appalachians with some contribution from the Ouachitas (Folk, 1960).

At alternate Stop A-8, the gradational upper contact of the Carrizo sand with the Newby member of the Reklaw formation may be seen. Another excellent exposure of about seventy feet of upper Carrizo sand may be seen at Little River Bluff, Milam County, two and one-half miles west of location A-8 on the field trip map. The Carrizo formation at Little River Bluff has been interpreted as being a relatively uninterrupted regressive sequence grading from an upper shore face environment at the base through beach, dune, lagoon-bay and into tidal flat sediments of what may be basal Reklaw (Etheridge, 1968).

There appears to be a considerable amount of relief on the Carrizo-Wilcox unconformity on Sandy Creek; north of the Colorado River the relief may be in excess of 100 feet locally. The steep dip displayed here by upper Wilcox beds immediately below the Carrizo sand may also be seen at Stop A-11 in Bexar County. Penecontemporaneous slump structures suggest rapid deposition on an unstable, possibly depositionally steep surface.

Beds assigned to the Sabinetown formation at this locality consist primarily of very fine sand (as opposed to quartz grains up to 3 mm. in length in the overlying Carrizo), silt, and clay. Some of the sands are richly glauconitic and some of the irregularly bedded, gray, silty, noncalcareous clays contain in excess of 15% glauconite.

Mineralogically, the Sabinetown is a subgraywacke, containing 5-15% slate and phyllite fragments, commonly chloritic. Basic volcanism contributed much hexagonal biotite, apatite, and sphene. Garnet, kyanite, and staurolite are abundant in the heavy minerals. The Sabinetown was apparently derived partly from the Ouachitas, and partly from the Southern Appalachians (Folk, loc. cit.). Here we begin to see the tremendous influx of metamorphic rock fragments, kyanite and staurolite produced by the Eocene Mitchell uplift in the Southern Appalachians (Todd, 1956).

Carrizo samples collected for palynomorphs from the upstream bluff yielded poor recovery. Downstream, abundant palynomorphs were recovered from Sabinetown clay and shale. Palynomorphs recovered included

Botryococcus, Pediastrum, Schizosporis sp., Sphagnum (rare), Laevigatosporites spp., Selaginella (reworked Cretaceous), Osmunda, Cicatricosisporites dorogensis, Lycopodium sp., Hamulatisporites sp., Perotrilites sp., Gleichenia (reworked Cretaceous), Classopollis (very rare), Taxodium (common), Pinus (common, in part reworked Cretaceous), Picea (common, in part reworked Cretaceous), Cyperaceae, Nudopollis terminalis, Thomsonipollis magnificus-group (very rare), Thomsonipollis sp., Carya simplex, Betulaceae-Myricaceae, Platycarya (common), Engelhardtia spp., Castanea (common), Alnus, Ulmus, Aesculiidites spp., Acer, Tilia, Pistillipollenites mcgregorii (very rare), Sapotaceae (very rare), Nyssa (very rare), Wetzeliella sp., and an undifferentiated dinoflagellate (possibly reworked).

Two specimens of Wetzeliella, a marine Tertiary dinoflagellate, were recovered from one sample collected from sediments tentatively identified as shoreface. However, none of the samples examined were obviously marine or brackish.

00.0 Leave Stop 1 and return to Jct. Watterson road and FM 304.

5.7 Turn left on FM 304.

11.3 Jct. FM 304 and Texas Hwy. 21. Turn left on Texas 21.

19.9 Turn off highway to right on old abandoned highway.

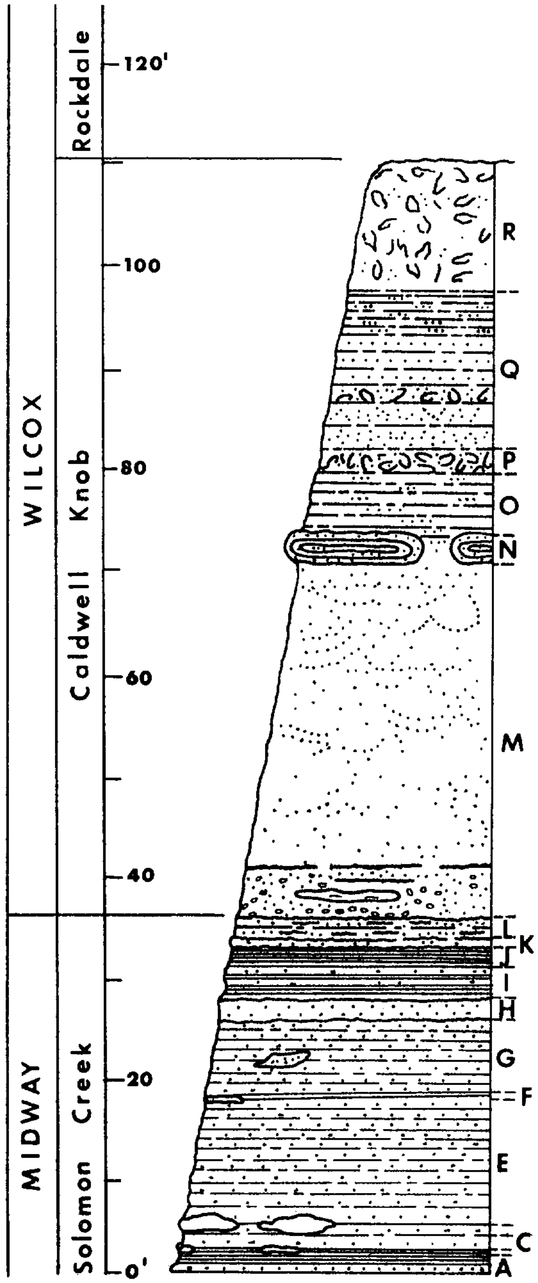
STOP 2 - Type Caldwell Knob oyster beds west of Colorado River, western Bastrop County.

Caldwell Knob is a small butte-shaped outlier which is capped by an oyster bed consisting almost entirely of Ostrea duvali Gardner. Although Plummer (1933, p. 577) states that the type locality for the Caldwell Knob oyster bed is Caldwell Knob, 10 miles north of Bastrop, it is believed that he was referring to the mounds of oysters at this locality near the headwaters of Moss Branch which are 10 miles west-northwest of Bastrop.

Caldwell Knob and the nearby site of Old Caldwell village were probably named for John Caldwell, an early settler who was elected county commissioner for Bastrop County in 1840.

The Moss Branch-Caldwell Knob section is the type locality of the Seguin formation of F. B. Plummer (1933, p. 574-577) and its upper member the Caldwell Knob oyster bed. Plummer apparently named the formation Seguin for Seguin, in Guadalupe County, Texas, the largest city along the outcrop of the Seguin formation. He notes that "the formation at Seguin is obscured largely by alluvium along Guadalupe River," and he states that "The type locality is the section along the banks of Moss Branch about 1 mile north of Old Caldwell village."

Plummer described the Caldwell Knob member of the Seguin formation as consisting of a layer of oyster shells averaging a foot in thickness. Beckman and Turner (1943) redefined the Caldwell Knob to include the beds lying between the disconformity at the base of the gray, massive sand, their Bed M, and the top of the uppermost "oyster reef", Bed R, (see section, Fig. 3).



	Feet
Caldwell Knob member	
R. Oyster bed, *Ostrea duvali*	13
Q. Silts and sands, covered near base, becoming clayey near top. Oyster reef in middle	15.3
P. Oyster bed	2.3
O. Silt and clay, gray to yellow brown, thin-bedded, laminated	6.3
N. Sand ledge, brown, concretionary, dense, calcareous	3
M. Sand, gray, fine-grained, massive, cross-bedded. Base characterized by streaks and pebbles of clay	35
Disconformity	
Solomon Creek member	
L. Silty, sandy and finely laminated	1.5
K. Sand, fine yellow to gray	1
J. Clay and very fine laminated silt	2
I. Clay and sand alternating 6-18 inches	3
H. Sand, laminated and cross-bedded	2
G. Clays, laminated and very fine silty sand, 18-inch sand lens occurs within this interval	8
F. Sand, laminated and concretionary	.5
E. Silty sands, finely laminated, and clays	11
D. Calcareous concretionary layer of silty sand	1–2
C. Sand, soft, silty, gray	1–2
B. Fossiliferous concretion with *Ostrea* cf. *crenulimarginata*	.5
A. Sand, silty, laminated	1

Fig. 3 - Moss Branch section , 11-T-74, from Beckman and Turner (1943, p. 614).

Beds below the disconformity they assign to the Solomon Creek member of the uppermost Midway (Paleocene). The disconformity, thus recognized, is placed not only within the Seguin formation, but within the Solomon Creek member of Plummer as well.

This is also the type locality for Ostrea (Ostrea) duvali Gardner. It has been incorrectly identified as Ostrea multilirata Conrad. Ostrea multilirata Conrad is easily distinguished from O. (O.) duvali Gardner by the right or unattached valve being strongly ribbed and the ribs on both valves being sharper. Ostrea multilirata is not a member species of Ostrea (Ostrea), but Ostrea duvali is. H. B. Stenzel believes that Ostrea crenulimarginata Gabb from the Porters Creek and Wills Point formations of the Midway group is the probable ancestor of Ostrea duvali, and the latter probably the ancestor of Ostrea arrosis Aldrich from the Nanafalia formation of eastern Alabama and Georgia. Giannone (1951) figured five other rarely occurring mollusk species from this locality in addition to O. duvali.

The most eastward documented outcrop of the O. duvali oyster lentils occurs along the crest of the hills above Little Brazos River on the Miller Campbell farm (locality A-1), Robertson County. At this point, some 75 miles northeast of the Caldwell Knob locality, the oyster lentils probably pass into the subsurface due to divergence of the outcrop belt with the depositional strike of the oyster bank facies.

Regarding the stratigraphic significance of these oyster lentils an earlier guidebook states:

"The importance of such deposits cannot be over emphasized. Marine equivalents of these brackish beds must be present in the subsurface section not far gulfward of this locality, so stratigraphers and subsurface geologists should find a widespread marker bed which would permit them to subdivide the Wilcox, correlate it regionally, map structure within the Wilcox, and be able to better predict the facies most favorable for oil and gas in this great mass of clastic sediments."

The fallacy in the above reasoning is that the basinward facies equivalent of these brackish transition beds is probably intertongueing marine shales of the Midway group, in the lowermost several hundred feet of subsurface Wilcox.

The sand in the thin exposure along the edge of the stock tank, approximately 50 feet below the O. duvali beds, may be the result of fluvial deposition. The near horizontal laminae and small-scale cross-bedding are indicative of the upper portion of either a point-bar or a distributary-mouth-bar. Study of the unexposed basal portion of the sand unit is required before the specific type of sand body can be properly ascertained. In either case, however, it is reasonable to suspect that this sand is associated with a deltaic sequence.

The overlying lagoonal deposits transgressed this progradational sequence as the delta plain subsided below sea level. The transgression followed diversion of the stream and abandonment of the distributary network. The numerous oyster banks are a prominent facies of these lagoonal deposits. Similar counterparts of these Paleocene oyster reefs and banks in transgressive bay facies are prevalent in the Recent deposits of coastal Louisiana.

Several samples from this locality were examined for microfaunal content. No foraminifers were present in washed residues. Samples collected for palynological study were equally disappointing.

The gradation from the marine Paleocene Midway group into the nonmarine Paleocene strata of the lower portion of the Wilcox group is a relatively abrupt transition, reflecting rapid progradation across a relatively broad, shallow shelf. The Midway-Wilcox transition was found exposed in a freshly dug stock-tank located near the southern branch of Little Pond Creek, Milam County, Texas (locality A-2). Three samples were collected and studied for foraminiferal content and six for palynological content. The location of the samples collected are shown in Fig. 4 below.

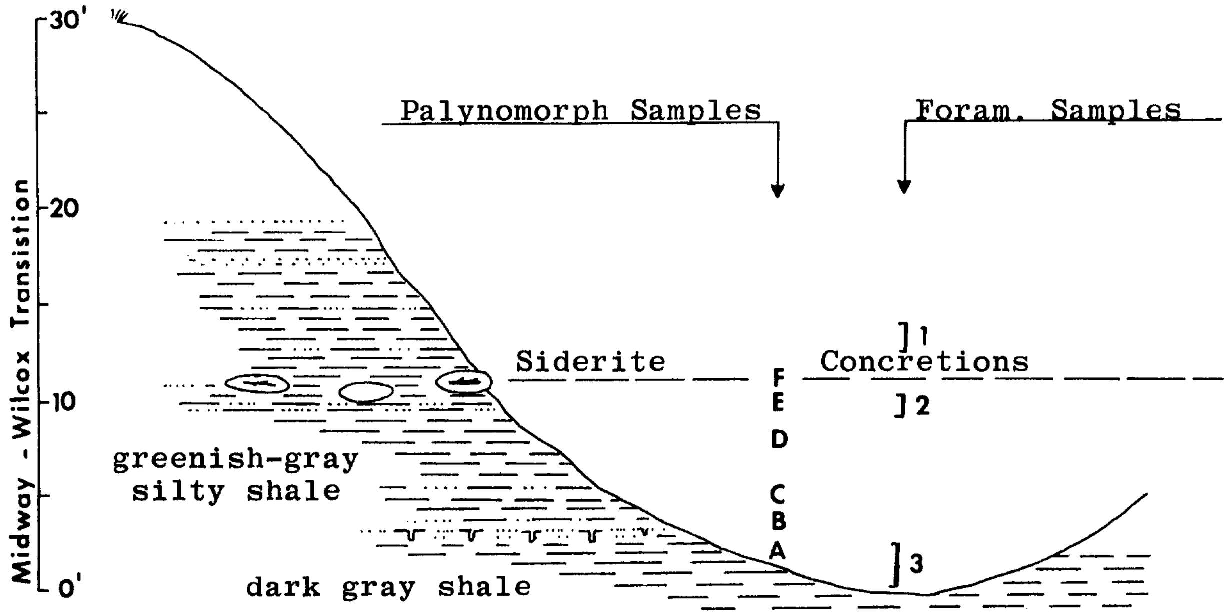


Fig. 4 - Sketch of stock tank section exposed near branch of Little Pond Creek, Milam County.

Gray Midway clay from the base of the stock tank (Sample 3) contained the following marine fauna indicative of at least 200 foot water depths:

Ammobaculites midwayensis	R	Ammobaculites expansus	R
Haplophragmoides canariensis (?)	R	Robulus midwayensis	A
Robulus orbicularis (?)	R	Lenticulina sp.	R
Vaginulina longiforma	C	V. subaculeata tuberculata	R
V. robusta	R	Nodosaria affinis	R
Nodosaria granti	R	Dentalina cf. gardnerae	A
Siphonina prima	C	Epistominella exigua	C
"Rotalia" aequilateralis	R	Ceratobulimina perplexa	R
Gyroidina subangulata	R	Anomalina ammoinoides acuta	A
Anomalina welleri	R	Globigerina pseudo-bulloides	A
Globigerina sp.	C	Brachycythere plena	R
Haplocytheridea	C	Cythereis prestwichiana	R
Cythereis midwayensis	R	"Cythereis" sp.	R
Cythereis spiniferrima	R	Mollusk fragments	A
Echinoid fragments	C		
Fine plant fragments	A		

Samples 1 and 2 collected 8 to 10 feet higher in the section contained only Ammobaculites midwayensis (R), Haplophragmoides sp. (small, C), and plant fragments, possibly indicating a brackish environment of deposition.

Of the six samples collected for palynomorphs sample E was essentially barren. The rest of the palynomorphs assemblage was about the same for all the samples except for the occurrence of a few dinoflagellates and acritarchs in the lower two samples, A and B, and the occurrence of Liquidambar in samples C and higher.

Reworked Paleozoic spores include Pilosisporites, Murospora, Convolutispora, Densosporites spp., Mirisporites (?), additional undifferentiated trilete spore genera, and undifferentiated pollen.

Reworked Cretaceous includes Perotrilites, Tsuga (?), Callialisporites, Gleichenia, Schizaeaceae (Cicatricosisporites spp.), Picea, Aquilapollenites, Classopollis, and Proteacidites.

Palynomorphs in place include a megaspore of Isoetes, a Riccia tetrad, Lycopodium spp., Divisisporites, Deltoidospora, Hamulatisporites spp., Gleichenia, Ceratopteris (?), Sphagnum spp., Triplanosporites, Cicatricosisporites, Polypodium (subdued ornamentation), Picea, Pinus, Ephedra voluta, Classopollis, Taxodium distichum-type, Liliacidites, Pandanus (?), Cyperaceae, Chenopodiaceae, Liquidambar, Normapolles undifferentiated, Planera, Ulmus, Alnus, Pachysandra, Betulaceae-Myricaceae, Engelhardtia, Platycarya (?), Salix (?), Aeqculiidites circumstriatus, Tricolpopollenites spp., Nyssa, Holkopollenites chemardensis, pre-Symplocoipollenites, Thomsonipollis sp., Thomsonipollis magnificoides, dinoflagellates undifferentiated, and acritarchs undifferentiated.

The marine influence in this section is apparent from the number of dinoflagellates and acritarchs recovered from the basal samples. That a nearshore environment is represented is suggested by the occurrence of Isoetes, a marsh plant, and Riccia, a low-lying Bryophyte. In addition, the occurrence of sedges (Cyperaceae), Chenopodiaceae, Ceratopteris (?), Sphagnum spp., Liliacidites and Pandanus (?) indicates marsh conditions near the depositional environment.

The Midway-Wilcox transition may also be seen at Locality A-3 (Stop 5, Smith, 1959) at Little River bluff, 100 yards downstream from the Hwy. 36 bridge. About 30 feet of weathered silt, fine sand and clay are exposed at this locality. The section contains more clay toward the base and some glauconite near low stage water level. A few Ammobaculites midwayensis, and Haplophragmoides sp. occur locally through the section. This section is slightly higher than Locality A-2 on Little Pond Creek and slightly lower than the Moss Branch Section at Stop 2.

Six samples were collected from deeply weathered glauconitic (?) clays, silts and channel fill sands at Little River Bluff. Three samples were practically barren. The samples are notable for their content of reworked Paleozoic spores, mainly heavy-walled types which are more resistant to weathering. Genera represented include *Tasmanites* spp., *Cymatiosphaera*, *Punctatisporites*, *Dictyotriletes*, *Densosporites* spp., *Murospora* spp., *Lycospora*, *Foveotriletes*, *Wilsonites*, *Potonieisporites*, *Pityosporites*, *Striatites* spp., and additional saccate genera which were not identified due to destruction of the body wall by crystal growths in the original enclosing sediment. Additional reworked forms include the Upper Cretaceous genera *Gleichenia* and *Rugobivesiculites*.

Palynomorphs in place in a reasonable state of preservation include *Gleichenia*, *Hamulatisporites* spp., *Divisisporites*, *Deltoidospora*, *Ephedra voluta*, *Alnus*, *Engelhardtia*, *Triatriopollenites dilatus*, *Tricolpopollenites* spp., Betulaceae-Myricaceae, *Nudopollis* sp., Normapolles undifferentiated, *Thomsonipollis magnificus*-group, *Nyssa* spp., *Botryococcus*, and *Rhizophagites* (modern fungal contamination?).

There are no dinoflagellates or acritarchs; undoubtedly poor preservation is in part responsible. One microforam (organic, acid resistant layer) was seen -- the two initial cells of a rotalid type. The microforam was recovered from near the middle of the exposed section.

No environmental interpretation can be made on the basis of these palynomorphs. However, we make the assumption that a major drainage system and/or a marine environment would be necessary for this concentration of reworked Paleozoic palynomorphs.

00.0 Leave Stop 2.

0.6 Old Caldwell Village townsite.

0.8 Sandstone in road cut on right.

1.2 Jct. old highway and Texas 71. Turn left on Texas 71.

1.7 Cemented sandstone boulders along highway right-of-way contain a few oysters and *Ophiomorpha* burrows.

5.3 Turn left on paved road to River Oaks Subdivision and park.

STOP 3 - Simsboro sand and Hooper clay at Wilbarger's (Hooper) Bend on Colorado River, western Bastrop County.

Geohistorical Note: Josiah Pugh Wilbarger was one of the first settlers in this area. In 1829, Wilbarger moved to Stephen F. Austin's "little colony" in the bend of the Colorado River, which on most modern-day maps is named Wilbarger's Bend. However, the Hooper clay member of the Rockdale formation was named from earlier maps of this area which designated this kink in the river as Hooper Bend. Stratigraphic confusion between the Hooper clay and the Butler clay will be discussed at our next stop.

At this locality on the south bank of the Colorado River, we are approximately two and one quarter miles southeast (downdip) from our previous stop. Stratigraphically, we are over 200 feet higher in the Wilcox group. The hills here are capped with Quaternary terrace gravels which are underlain by Simsboro sand. Approximately half way down the hill the Simsboro channel sands rest disconformably on the Hooper member. The Simsboro-Hooper contact can best be seen in ravine exposures at less easily accessable or posted localities elsewhere along the bend.

Stenzel (1951) proposed that the Hooper formation include that part of the Wilcox between the Seguin formation (top of Caldwell Knob oyster lentil) and the erosional disconformity at the base of the overlying Simsboro sand. According to Stenzel, this would include about 325 feet of regressive, interbedded, non-marine lignitic clays and poorly developed lignite beds with some marine glauconitic sands.

Five samples of clay, lignitic, underclay and gray clay from this locality were examined for palynomorphs. In addition to a normal Rockdale assemblage similar to that recovered from the shales and lignites of the Calvert Bluff member in southwest Milam County, the following palynomorphs were recovered.

Reworked forms included the Paleozoic gymnosperm Striatites and the Cretaceous Perotrilites, Styx, Cicatricosisporites, Gleichenia, Pterospermopsis, Araucariacites, Proteacidites, Aquilapollenites, Ephedra spp., Classopollis (common), undifferentiated dinoflagellates, Balisphaeridium spp., and Exesipollenites.

Palynomorphs in place include Fusiformisporites (common), Schizosporis ligneolus, Tetraporina rugosa, Isoetes subengelmanni, Laevigatosporites spp. (common), Polypodium, Sphagnum (rare), Deltoidospora spp., Hamulatisporites spp., Cicatricosisporites dorogensis, Osmunda, Lycopodium, Taxodium (very rare), Classopollis, Ephedra voluta (common), Baltisphaeridium sp., Pinus (common, possibly reworked Cretaceous), Arecipites, Liliacidites spp., Trudopollis pertrudens (rare), Nudopollis terminalis, Thomsonipollis magnificus group (common), Thomsonipollis paleocenicus, Engelhardtia spp. (common), Triatripollenites dilatus (rare to common), Planera, Ulmus, Alnus (very rare), Betulaceae-Myricaceae, Carya simplex, Tilia, Bombacaceae (very rare), Myocolpopollenites, Chenopodiaceae (common), Tricolpopollenites hians (common), Quadrapollenites vagus, Castanea, Aesculidites circumstriatus, Holkopollenites, pre-Symplocoipollenites (common), Nyssa, undifferentiated dinoflagellates and Hystrichosphaeridium sp.

Marine or brackish influence is evident from the occurrence of dinoflagellates and acritarchs. However, they are rare and in part reworked from the Cretaceous. The common occurrence of Chenopodiaceae also suggests proximity to shoreline. Modern Chenopodiaceae are halophytic plants growing in deserts and along shorelines.

Samples of gray, non-calcareous, thinly laminated (varved?) clay beneath the lignite seam contained abundant plant material, poorly sorted quartz grains, and mica. No foraminifers or ostracodes were present. Some sandy clays contained rare, near vertical burrows less than 1/8" in diameter.

0.9 Return to highway; turn left on Texas 71.

1.7 Jct. Texas 71 and FM 1209 north. Turn left on FM 1209.

5.4 Turn left on FM 969 at "T" jct.

9.9 Turn right on FM 1704 to Elgin.

20.1 Jct. FM 1704 and Loop 109 at south edge of Elgin. Turn left on Loop 109.

20.4 Jct. Loop 109 and Texas Hwy. 95 and U.S. Hwy. 290. Turn left on Texas 95 and U. S. 290.

22.3 Payne Brick Company on left. Note Simsboro sand exposed in road cuts and in fields.

24.8 Turn left on FM 696 toward Lexington.

26.0 Turn left to Butler clay pits on paved road at row of yellow tile brick houses.

26.2 Turn right on unpaved road through brick yard.

26.4 Cross creek and take center road at three-prong fork.

27.0 STOP 4 - Simsboro sand and Butler clay exposed in pits of Butler Clay and Tile Manufacturing Company, northern Bastrop County.

At this locality we will examine beds in the lower portion of the Calvert Bluff formation. Until recently the exact stratigraphic assignment of these beds was not well understood. The case history of the clarification of the true stratigraphic relationship of the Butler clay is, perhaps, a classic example of stratigraphic confusion. Plummer (1933, p. 82-93) named the Butler clay for exposures of commercial clay at Butler, northern Bastrop County. Plummer considered the Butler clay to occur beneath the Simsboro sand and at the base of the Rockdale formation. Plummer's initial stratigraphic error was further compounded by M. Grace Wilmarth (1938, p. 304-305) when she gave Butler, Freestone County, as the type locality for the Butler clay. In 1953 Stenzel (p. 53-54), citing W. C. Sharp, Jr., University of Texas, 1951, M. A. thesis, considered the Butler clay a member of the Calvert Bluff formation which overlies the Simsboro sand. Sharp (1966, p. 1444-1454) clarified the stratigraphic confusion and recognized the former Butler clay member as being a basal bed of the Calvert Bluff formation (see Fig. 5 on next page).

		F. B. Plummer (1933)		W. W. Sharp, Jr. (1966)	
		Formation	Member	Formation	Lentil
EOCENE SERIES	WILCOX GROUP	Rockdale	Calvert Bluff	Calvert Bluff *	
			Simsboro	Simsboro	
			Butler*	Hooper	
		Seguin	Caldwell Knob Solomon Creek	Seguin	Caldwell Knob oyster bed

Fig. 5 - Comparison between stratigraphic section of Plummer and stratigraphic section Sharp. (After Sharp, 1966, p. 1448).

Sixteen samples from the Butler Clay and overlying Calvert Bluff (?) channel sand were examined for palynomorphs. Samples from the channel sand and adjacent clay bed below were barren. Lower clay samples are fossiliferous and contain an assemblage lacking marine or brackish palynomorphs. Taxodium (cypress) pollen and reworked Cretaceous and Paleozoic palynomorphs were lacking.

Several schizosporous algae types are present. The palynomorph assemblage is essentially the same as that found in the Rockdale lignite exposed in southwest Milam County (Stop 5), but Polypodium (fern indicating moist to swampy conditions) is much more common. The environment should be interpreted as one of back swamp or open lake sedimentation.

At Black Shoals-on-the-Brazos, Robertson County, Texas (Smith, 1959, Stop 9; Locality A-O this guidebook) seventeen samples were collected from an interval between and just below two concretionary layers, including the 6 inch lignite at several lateral intervals. This is a short distance north (upriver) from the type locality of the Calvert Bluff member and roughly correlative with Stop 4. Taxodium (cypress) is more common in the shales and silty clays. Monosulcate pollen of Liliacidites, Calamuspollenites, and Arecipites, all from herbaceous plants, occur commonly in the samples from both above and below the lignite. The lignite contains abundant fragmented cuticle, comprising 90% of some macerated samples. Also abundant in those lignite samples are microthyriaceous germlings and mature bodies, fungal epiphytes of plant leaves, most commonly found in the modern tropics. Occasional samples from the lignite carry the palynomorphs Laevigatosporites sp. (common), Liliacidites spp., Calamuspollenites pertusus (common), pre-Symplocoipollenites, Engelhardtia spp., Quadrapollenites sp., Nyssa spp., Taxodium sp. (rare), Aesculiidites circumstriatus, Tricolpopollenites hians, and Moraceae.

Palynomorphs recovered from the silt and clay include Microthyriaceae, Fusiformisporites sp. (common), Laevigatosporites spp., Polypodium sp. (common), Selaginella (reworked?), Hamulatisporites spp. (in part reworked), Lycopodium sp., Cicatricosisporites dorogensis (very rare), Osmunda sp., Deltoidospora sp., Sphagnum spp., Styx (reworked), Taxodium (common), Classopollis spp. (in part reworked), Pinus and Picea spp. (reworked?), Calamuspollenites pertusus (common), Arecipites sp., Liliacidites spp. (common), Aquilapollenites spp. (very rare, reworked), Proteacidites (very rare, reworked), Thymelaeaceae (polyforate, reticulate pollen, common), Chenopodiaceae (very rare), Pachysandra sp. (very rare, first reported occurrence for the Gulf Coast Tertiary), Alnus, Ulmus, Betulaceae-Myricaceae, Engelhardtia spp., Triatriopollenites dilatus (very rare), Carya simplex, Thomsonipollis magnificus-group (rare), Pistillipollenites mcgregorii (very rare), Tricolpopollenites hians, Aesculiidites circumstriatus, Nyssa spp., pre-Symplocoipollenites (abundant), Salix (?), abundant plant fibers of several types (herbaceous?), and one questionably reworked dinoflagellate specimen. Abundant to common refers to abundance in at least one of several samples.

Also collected and identified from the concretions at this locality on the Brazos River are numerous leaf specimens of fig and mulberry.

The lignite reflects deposition in quiet waters, probably a marsh with little influx of clastics. The silt and clay represents an influx of clastics, perhaps into a similar environment, but carrying reworked material from a source well removed from this locality. This is in contrast to the lignites higher in the Calvert Bluff member exposed in southwest Milam County (Stop 5). There the lignite was deposited in an environment more nearly a hardwood swamp in at least some stages of development.

No foraminifers or ostracods were recovered from Calvert Bluff sediments collected at Butler Clay pit (Stop 4) or Black Shoals-on-the Brazos (Locality A-O).

00.0 Return to FM 696.

00.8 Turn right on FM 696.

2.2 Turn right on U. S. Hwy. 290.

5.0 Elgin city limits.

7.0 Jct. U. S. Hwy. 290 to Austin and Texas Hwy. 95. Keep to right on Texas Hwy. 95 to Taylor.

23.3 Jct. Texas 95 and U. S. 79 in downtown Taylor. Turn right on U. S. 79.

35.9 Jct. U. S. 79 and FM 486 in Thorndale; continue straight on U. S. 79.

43.2 Turn right on FM 1786 South to Alcoa plant.

48.2 Bear left across RR tracks.

48.8 Enter Alcoa plant.

STOP 5- Calvert Bluff sands, clays, and lignite of Rockdale formation exposed in open pit lignite mines. Upper Wilcox, Calvert Bluff member.

Note: Industrial Generating Company requests that absolutely no photographs be taken of their operations at this locality.

This stop is located approximately seven miles southwest of Rockdale, Texas, immediately south of the Alcoa plant site in southwestern Milam County. The outcrop is unique in that unweathered sediments are constantly being exposed as the Industrial Generating Company strip mines the Wilcox lignites for the Alcoa operation. This is one of the two large, existing lignite-mining operations in the State.

We will see from 65 to 80 feet of friable sand, clay, and lignite of the Calvert Bluff member of Plummer's Rockdale formation. The Rockdale formation varies between 300 to 1000 feet in thickness along strike and embraces a multitude of stratigraphic problems. This outcrop should, however, be roughly equivalent to the Calvert Bluff section at the Brazos River (See Fig. 6).

Lignite deposits in Milam County are the most important and most exploited lignites in Texas. At lease 34 different companies have operated mines in this county during the past 70 years. Early mining efforts were centered in the general areas of Rockdale and Milano in the southwestern and south-central parts of the county and near Jones Prairie in the northeast; of these, the Rockdale area was the most important. Most early mining in the county was by shafts which generally sunk to 60 to 100 feet, but in recent years mining has been exclusively by open pit.

Lignites in Milam County are in the Calvert Bluff member and extend northeast across the county to the Brazos River, apparently connecting with lignite deposits at Calvert Bluff in Robertson County (Fig. 6). Several beds of lignite are present but generally only two or three are of commercial importance. Individual seams locally are up to 20 feet thick but average about 7 feet; lignite currently mined by Industrial Generating Co. averages 13 feet in thickness (Fisher, 1963).

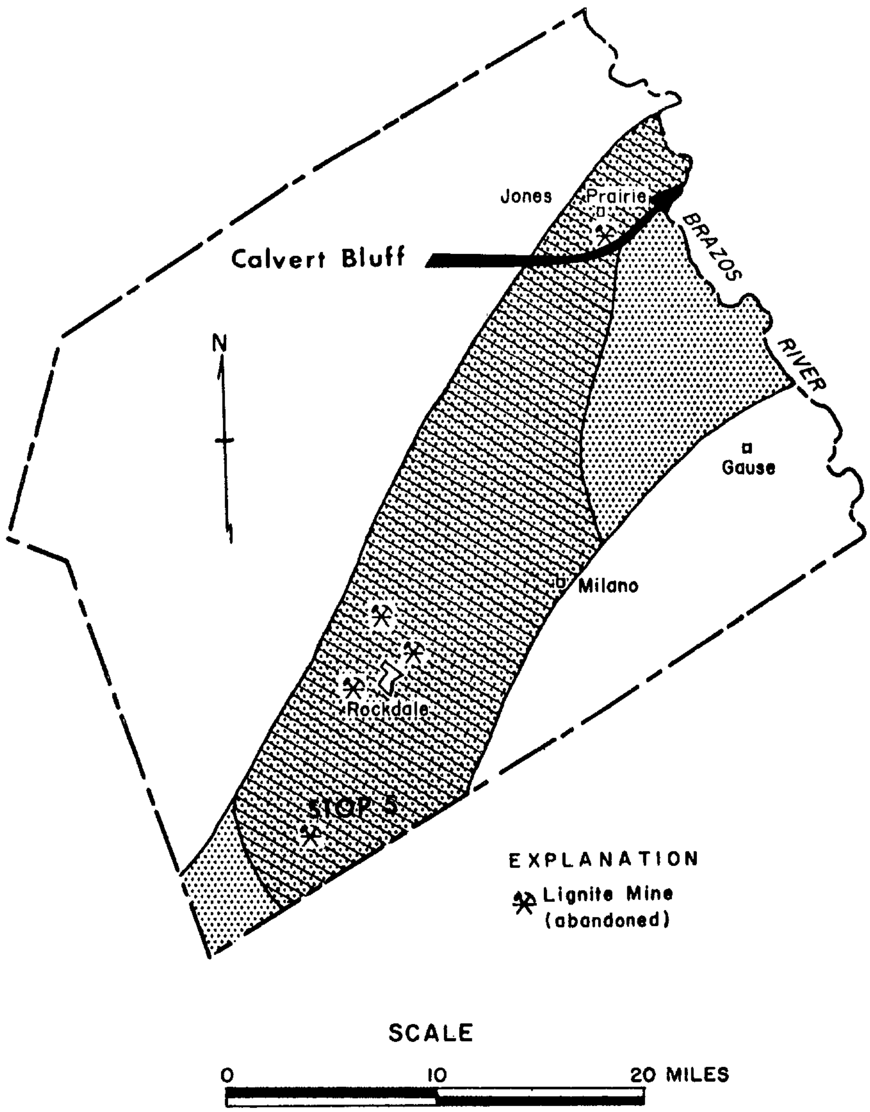


Fig. 6 - General distribution of Wilcox lignite deposits in Milam County, Texas. Area of principal deposits ruled. Modified from Fisher (1963, p. 59).

We will probably see, depending upon the location and progress of the strip mining operation, the following generalized section (See Fig. 7).

	Avg. Thks.
Thinly interbedded gray shale, silt and sand cut locally by distributary channels filled with light gray to buff, friable sand.	60'
Lignite bed, "rider seam" which pinches out westward.	2'

	Avg. Thks.
Shale or underclay, dark gray, "middle-band", thickens westward	2'
Lignite, "main stem", pyritic, dark brown to black, dull to vitrous luster.	13'
Clay and sand clay, gray to white, "black-jack", fire clay.	0-?'

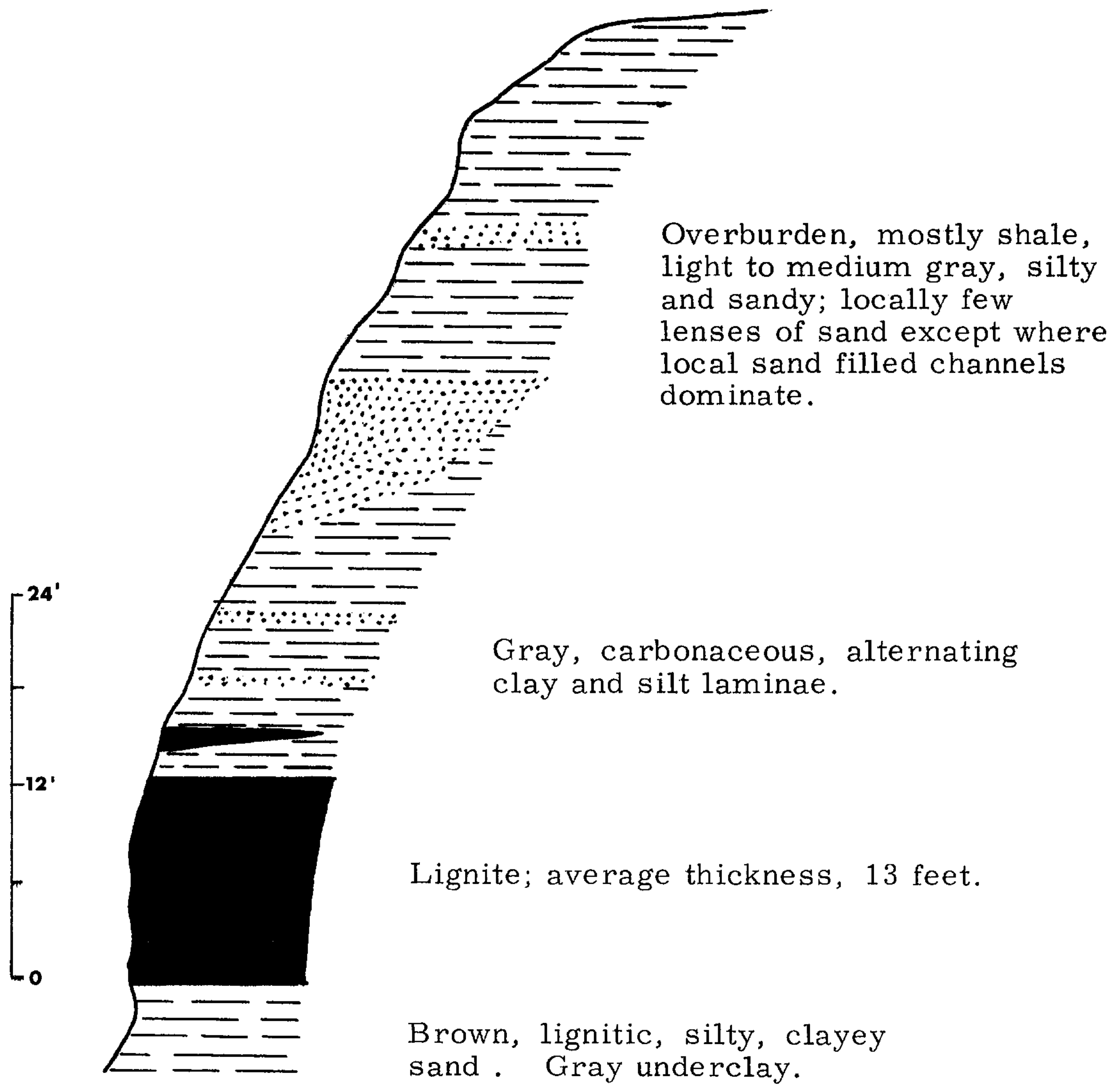


Fig. 7 - Diagrammatic section of strip mine of Industrial Generating Company, at end of Farm Road 1785, 5 miles south of U.S. Highway 79, southwest of Rockdale, Milam County, Texas. Modified from Fisher (1963, p. 59).

Approximately 100 samples were examined from the main lignite seam (and rider lignite downdip), overlying shale, and underclay. The main lignite seam contains a very rich floral assemblage. Included are the equivalent of the following modern taxa:

Microthyriaceae (leaf fungi) - rare.
Engelhardtia (hardwood) - abundant.
Pediastrum (fresh-water algae) - rare.
Carya (hickory) - common.
Sphagnum (peat moss, now temperate) - several sp. present.
Pterocarya (n. temperate zone)- very rare.
Polypodium (cosmopolitan fern) - rare.
Alnus (n. temperate and Andes) - rare.
Gleicheniidites (Gleicheniaceae?) (tropical to s. temperate) - rare.
Ulmaceae (hackberry and related plants) - rare.
Lycopodium (tropical and temperate fern) - common.
Betulus types: common.
  Betulaceae (tropical to n. temperate).
  Myricaceae (temperate and sub-tropical).
  Casuarinaceae (Australia and Polynesia).
Aneimia types (Schizaeaceae-tropical and sub-tropical) - common.
Taxodium (cypress) - rare.
Bombax types: - rare.
  Tiliaceae (tropical and temperate).
  Sterculiaceae (chiefly tropical).
  Bombacaceae (tropical).
Ephedra (warm temperate, generally arid area plant) - rare.
Pinus (pine - temperate and on mountains in n. tropical) - rare.
Salix? (willow-cosmopolitan) - rare.
Chenopodiaceae (cosmopolitan but nearly all are halophytic-salt tolerant) - rare.
Pandanus (sea coast or marsh trees - tropical) - rare.
Nyssa (swamp tree) - common.

In general, a marsh environment is indicated for the underclay and basal part of the lignite. Fresh water marsh and hardwood swamp conditions then fluctuate through the main lignite seam; which are terminated by the influx of clastics and reworked Cretaceous palynomorphs. The overlying shale also contains abundant Taxodium and rare hystrichs which may be reworked.

Interpretation of the freshwater nature of the underclay and lignite producing environments is based on the abundance of Schizosporis and Tetraporina types of algae, and the less common occurrence of Botryococcus and Pediastrum.

Spores and pollen of the marsh plants Isoetes, Selaginella, Sphagnum, Restionaceae, Pandanus, Typha and Chenopodiaceae occur in the lignite. Representatives of the tropical families Caesalpiniacea, Papilionaceae, Bombacaceae and Thymelaeaceae are present. Noteworthy is the lack of Quercus, which should be present if this were a temperate pollen assemblage.

00.0 Leave Stop 5 and return to Hwy. 79 via FM 1786.

6.0 Turn right (east) on U. S. 79 to Rockdale.

6.8-7.1 Note steeply eastward dipping beds of Wilcox group along RR cuts to right of highway.

11.6 Turn right on FM 908 in downtown Rockdale.

13.2 Turn right on U. S. Hwy. 77 to Houston via Giddings, LaGrange, and Columbus.

END OF FIELD TRIP.

APPENDIX

Palynology of the Wilcox Group

by

W. C. Elsik

The Wilcox Group has been the object of considerable palynologic study, primarily due to the lack of conventional marine microfossils in a largely nonmarine section which expands to several thousand feet in the subsurface. If just for economic reasons, it is imperative that stratigraphic subdivisions be made. Secondly, environmental interpretations are somewhat more feasible in continental sections, granting, of course, that there is still some mixing of wind blown and water borne palynomorphs. Palynomorphs recovered from sediments deposited in closed environments such as bogs, swamps, marshes with no major drainage or stream pattern, and landlocked lakes often reflect only the local flora, and are, therefore, indicative of the environment of deposition. Floodplain sediments, distributary and lagoonal sediments, and all marine environments often contain an admixture of palynomorphs from several sources.

One characteristic of modern and Neogene marine sediments in the Gulf Coast is the occurrence of reworked palynomorphs. The origin, mode of transportation and final preservation of these Paleozoic and Mesozoic palynomorphs are obscure. The Rockdale, Sabinetown and Carrizo formations generally lack reworked Paleozoic palynomorphs. Generally it can be said that the Midway group and Seguin formation below and the Reklaw formation of the Claiborne group above contain a greater number of reworked palynomorphs. This is due to the normally marine to brackish nature of those deposits and the admixture of reworked fossils at the time of deposition.

Fairchild and Elsik (in press) have compared the composition and ranges of distinctive palynomorphs in the Midway-Wilcox-Claiborne sequence of the Gulf Coast. A comparison was made to the published works of Kedves (1967) and Krutzsch (1957 and 1960) (See Fig. 1). The ranges of additional species have been determined from a study of samples collected from localities described in this guidebook (See Fig. 2). In general the Wilcox palynomorph assemblage resembles closely the Lower Eocene and Paleocene of Europe. Midway Paleocene contains an abundance of the group Normapolles, Ephedra, and triatriate forms grading into the normal Engelhardtia-type. Taxodium, Sphagnum and reworked Classopollis are common in the shales and Holkopollenites chemardensis is common in the lignites. This holds true for basal Wilcox also. About the middle of the Rockdale Formation (Butler clay member?) pre-Symplocoipollenites and Thomsonipollis magnificus-group become more abundant in both the shales and the lignite, although reworked material is still detected in some of the floodplain to brackish (?) shales and clays. Near the top of the Calvert Bluff Member of the Rockdale Formation Thomsonipollis becomes less abundant and genera such as Symplocoipollenites, Platycarya, and representatives of the Sapotaceae become noticeable constituents of the microflora, indicating a cooler (temperate) climate. Additional genera such as Acer and Anacolosiidites appear for the first time in Sabinetown and Carrizo sediments. By the beginning of Claiborne time, numerous genera of temperate plants appear in the microflora.

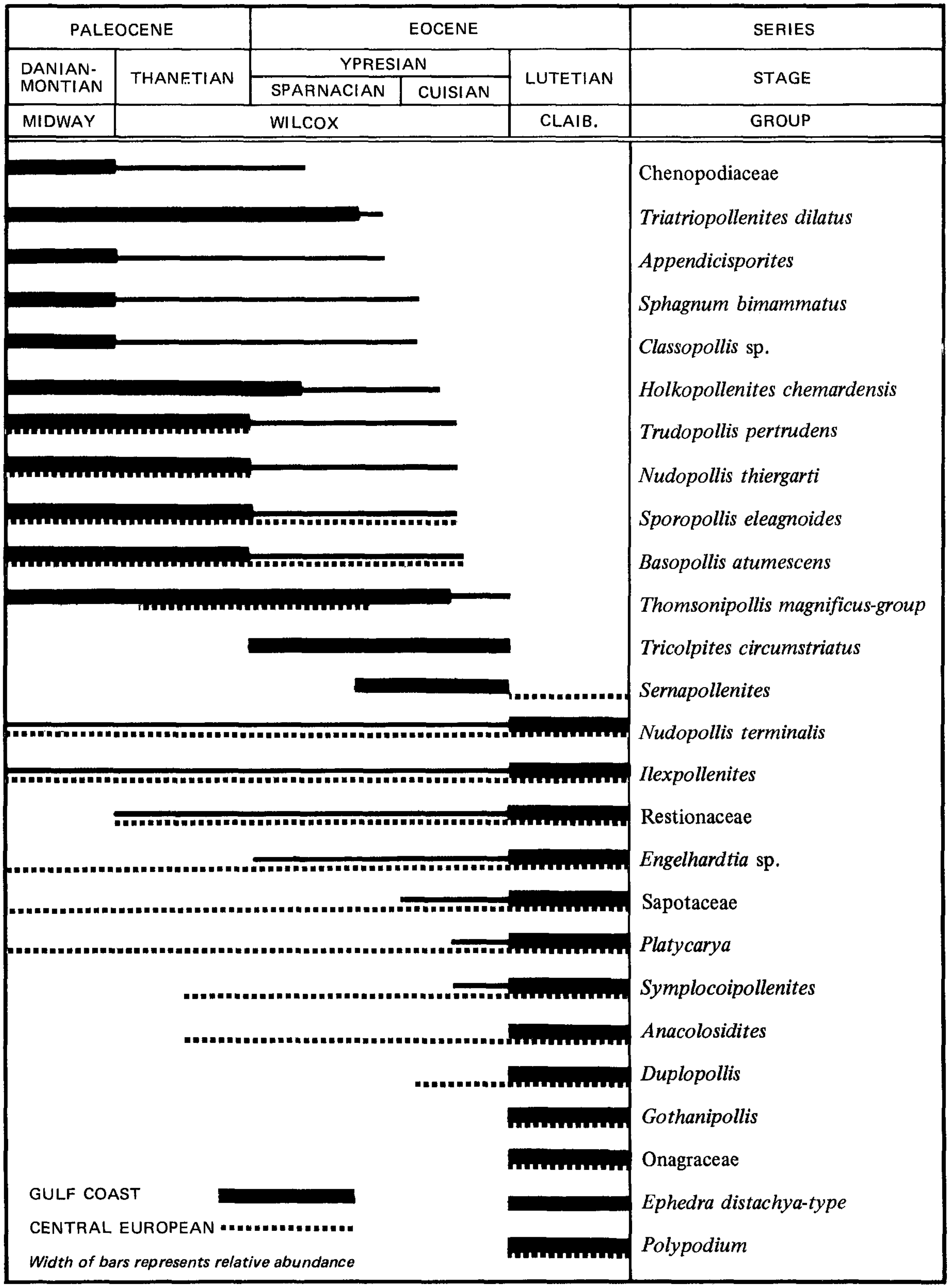


Fig. 1. Gulf Coast and Central European palynomorph assemblages compared (from Fairchild and Elsik, in press).

Jones (1962) compared the palynology of the Midway and Wilcox assemblages in south-central Arkansas. It appears from his illustrations of Sabine Formation (Wilcox Group) palynomorphs that the Sabine is in part Claiborne equivalent, or equally possible, there are uppermost Wilcox sediments present in south-Central Arkansas which are lacking the Texas Gulf Coast. The striking change across the Midway-Wilcox boundary as reported by Jones can be explained by a corresponding lack of lower Wilcox sediments in south-central Arkansas.

It is hazardous to make generalizations about the climate during Wilcox deposition. Reworking of resistant palynomorphs should have by no means been limited to Mesozoic and Paleozoic forms. Samples which contain abundant Picea (spruce) and Pinus (pine) pollen contain other Upper Cretaceous palynomorphs. Picea and Pinus are common in some Upper Cretaceous samples in the Gulf Coast. By restricting our interpretations to palynomorph assemblages from closed swamp or marsh environments, such as is postulated for the lignite exposed at Stop 5, there is less chance of reworked admixture. Furthermore, the flora is local with little or no admixture from contemporaneous highland sources. Recovered from the lignite at Stop 5 were the equivalents of the extant taxa Taxodium, Restionaceae, Pandanus, Thymelaeaceae, Alfaroa (?), Engelhardtia, Carya, Alnus, Ulmaceae, Rubiaceae, Bombacaceae, Nyssaceae, Sapotaceae, Aesculus, Sapindaceae, Caesalpiniaceae, Phaseolus (Papilionaceae), and Schizaeaceae. Both tropical and temperate representatives are present, but the microflora has not yet attained the dominantly temperate aspect of uppermost Wilcox and Claiborne sediments. Noteworthy is the lack of Quercus throughout all but uppermost Wilcox. Quercus should be present in any temperate assemblage of this age.

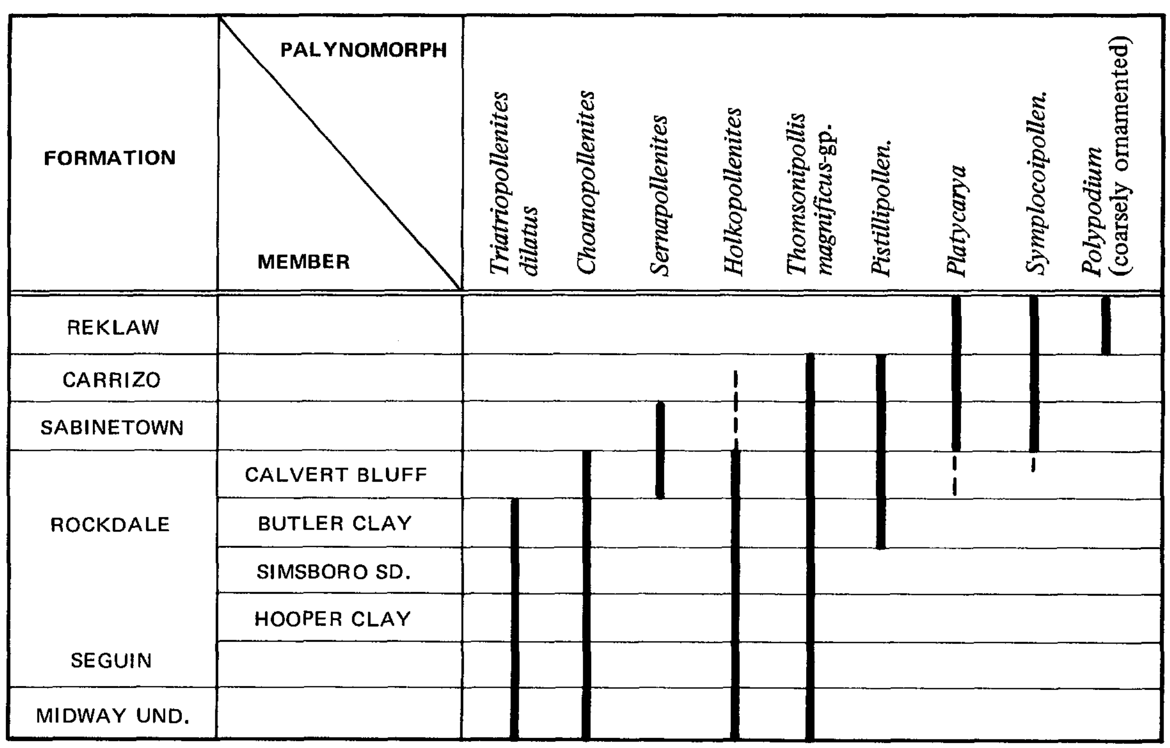


Fig. 2. Ranges of selected Wilcox palynomorphs.

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FIELD GUIDE

INDIO LAGOON SYSTEM, WILCOX GROUP, SOUTH TEXAS

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REGIONAL SETTING

The northern and western part of the Gulf Coast Basin, including the area west of the Alabama River and extending into northern Mexico, contains a predominantly terrigenous clastic Cenozoic sequence approximately 15,000 meters thick. The basin fill occurs as a series of thick, gulfward-dipping, offlap wedges of terrigenous clastic sediments separated by thin, normally glauconitic or marly units. Typical of several of these Cenozoic clastic wedges are rocks of the lower part of the Wilcox group in Texas.

As commonly defined the lower Wilcox of the northern and western Gulf Coast Basin includes predominantly terrigenous clastic sediments overlying marine muds and clay of the Midway Group (Paleocene-lower Eocene) and generally underlying marine muds of the middle part of the Wilcox. In the outcrop sections we will examine today the overlying unit is fluvial sands of the Carrizo Formation (upper Wilcox). Within the lower Wilcox of Texas we have recognized several large-scale depositional systems. The dominant element is a large delta system (Rockdale System) consisting of thick lobate wedges of muds, sands, and carbonaceous deposits (Fig. 1). These sediments comprise distributary channel-interdistributary delta plain, delta front, prodelta, and interdelta facies. Seven delta complexes with 16 individual delta lobes make up the delta system. Maximum thickness of on-delta sequence (delta plain facies) is about 1,000 meters; off-delta sequences (prodelta facies) range upward to as much as 1,700 meters thick. The lower Wilcox Rockdale Delta System covers an area of about 60,000 square kilometers; it is comparable in size, number of delta complexes; shape of individual delta lobes, and facies composition to the Recent Mississippi Delta System of the northwestern Gulf of Mexico (Fig. 1).

The Rockdale Delta System grades up present structural dip to a relatively thin terrigenous clastic system of fluvial origin (Mt. Pleasant Fluvial System, Fig. 1). Specific facies within the fluvial system reflect relative upslope position and differences in size of stream regimes. Only a part of the original Mt. Pleasant Fluvial System is presently preserved; the size of the delta system developed gulfward of it suggests a large, interior-draining complex of streams comparable to the modern Mississippi River System.

Accumulation of sediments in delta-flank depressions (Pendleton and San Marcos Systems) marginal to the lower Wilcox fluvio-delta systems, as well as redistribution of sediments from shoal-water areas of the delta system by longshore and littoral drift, resulted in distinct depositional systems laterally associated with the delta system. During destruction prevailingly southwestward longshore and littoral drift carried sands away from the area of primary delta deposition. This situation is analogous to that in the Recent northwestern Gulf of Mexico in which there is a prevailing southwest transport of sands from the active and abandoned deltas of the Mississippi Delta System. In the lower Wilcox, a strandplain depositional system, made up of elongate to areally extensive sheet sands interbedded with marine and lagoonal muds, developed along strike immediately down-current from the delta system. Formation of this depositional system (San Marcos Strandplain System) is at least mechnically comparable to the Recent Chenier System of southwestern Louisiana associated with the Mississippi Delta System (Fig. 1).

More distant from the delta system, sands accumulated along depositional strike as a series of chiefly elongate units, making up a barrier bar system (Cotulla Barrier Bar System), Fig. 1); it consists of a sequence of 8 to 10 individual barrier bars and is analogous to the barrier bar system southwest of the Recent Mississippi Delta System of which the modern Galveston-Bolivar Island is a part. Seaward of the Cotulla Barrier Bar System is the South Texas Shelf System (Fig. 1) made up chiefly of marine muds and analogous to the Texas-Louisiana Shelf of the modern northwestern Gulf of Mexico. Landward complement of the lower Wilcox barrier bar system is an extensive mud system (Indio Lagoon System, Fig. 1), facies of which we will examine today.

Lagoonal systems, therefore, make up important parts of such large clastic wedges as the lower Wilcox and certain other clastic wedges in the northern and western Gulf Coast Basin. They include two main types: (1) delta-flank embayment systems (Pendleton and San Marcos Systems) developed marginal to the fluvio-delta systems and analogous to such modern features as Lake Ponchartrain, Lake Borgne, Vermilion Bay, West Cote Blanche Bay, Grand Lake, and White Lake associated with the Mississippi Delta System; and (2) systems developed landward of barrier bar systems along strike and distant from the delta system and analogous to modern bays and lagoons of the Texas Coast that Al Scott and his colleagues have studied. The Indio Lagoon System that we will be seeing today is the second type.

INDIO LAGOON SYSTEM

The Indio Lagoon System developed landward of the several elongate barrier bar sands that make up the Cotulla Barrier Bar System. Principal lithologic component of the Indio System is mud, although locally sand is predominant. Muds are mostly gray to buff, calcareous to locally gypsiferous, pyritic, and in some cases glauconitic or dolomitic. They range from distinctly laminated to extensively burrowed. Marine fossils are chiefly mollusks, commonly thick-shelled forms. Circular mounds with internal structures presumably of algal origin are commonly associated with the muds. Plant fossils and a few thin, discontinuous lignite beds are locally common. Sands within the Indio System are of various textures though mostly fine grained and moderately well sorted; sand facies are related to local depositional features, with source seaward from the barrier bar system or landward from minor streams.

In addition to lithologic and biologic composition and overall facies relationships, the Cotulla and the Indio Systems show other features common to modern barrier bar and lagoon systems. First, sand isolith patterns depicting the lagoonal side of the barrier bar system are generally more irregular than those of the seaward side; further, the transition from sand to mud is more abrupt on the lagoonal than on the seaward side. Secondly, in southeastern Frio and northeastern LaSalle counties, sand isoliths of the Cotulla Barrier Bar System are sharply indented on the lagoonal side with a less pronounced indentation on the opposite or seaward side. Position and configuration of these indentations suggest former existence of a tidal channel complex. Under such conditions, flood and ebb tidal surges move through a channel or inlet in the bar, causing sand to accrete in the form of tidal deltas both within the lagoon and seaward onto the foreshore of the bar. Anomalous thickness of sand in the Indio Lagoon System accumulated as a lagoonal tidal delta complex updip from the terminus of the tidal channel; lobate extension of sand on the foreshore side of the bar and immediately south of the tidal channel complex represents tidal deltas constructed by ebb tide transport of sand. Assuming these features to be tidal channel and complementary tidal delta complexes, the position of the deltas with respect to the channel complex, as well as the shape and configuration of the tidal channel, substantiate the inference of prevailingly southwestward sediment transport by longshore drift.

Characteristics of principal mud facies in the Indio Lagoon System reflect accumulation either as lagoon-center or lagoon-margin deposits; local sand facies are related to specific depositional features, including tidal deltas, washover fans, and small lagoon-margin delta and fluvial units. Examples of specific facies in the Indio System as developed in outcrop will be seen in the scheduled stops.

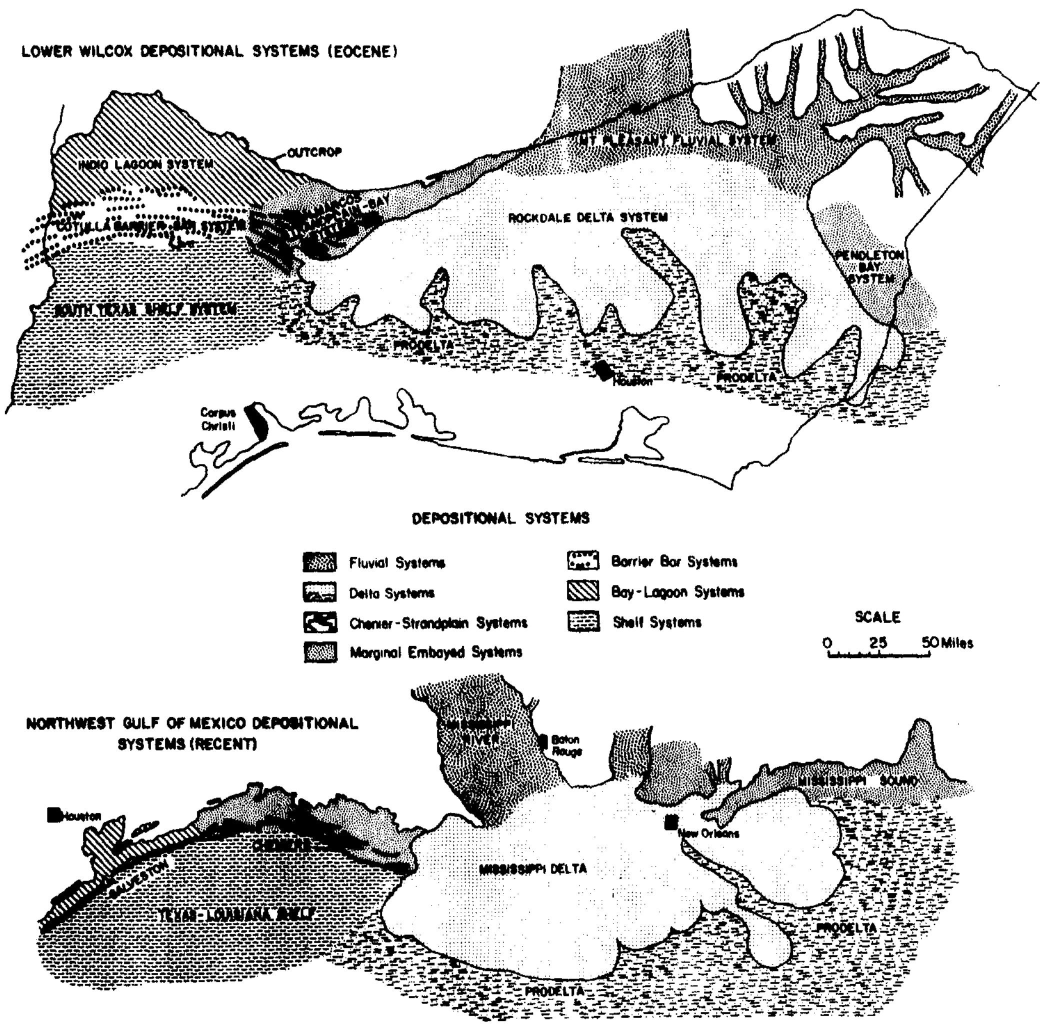
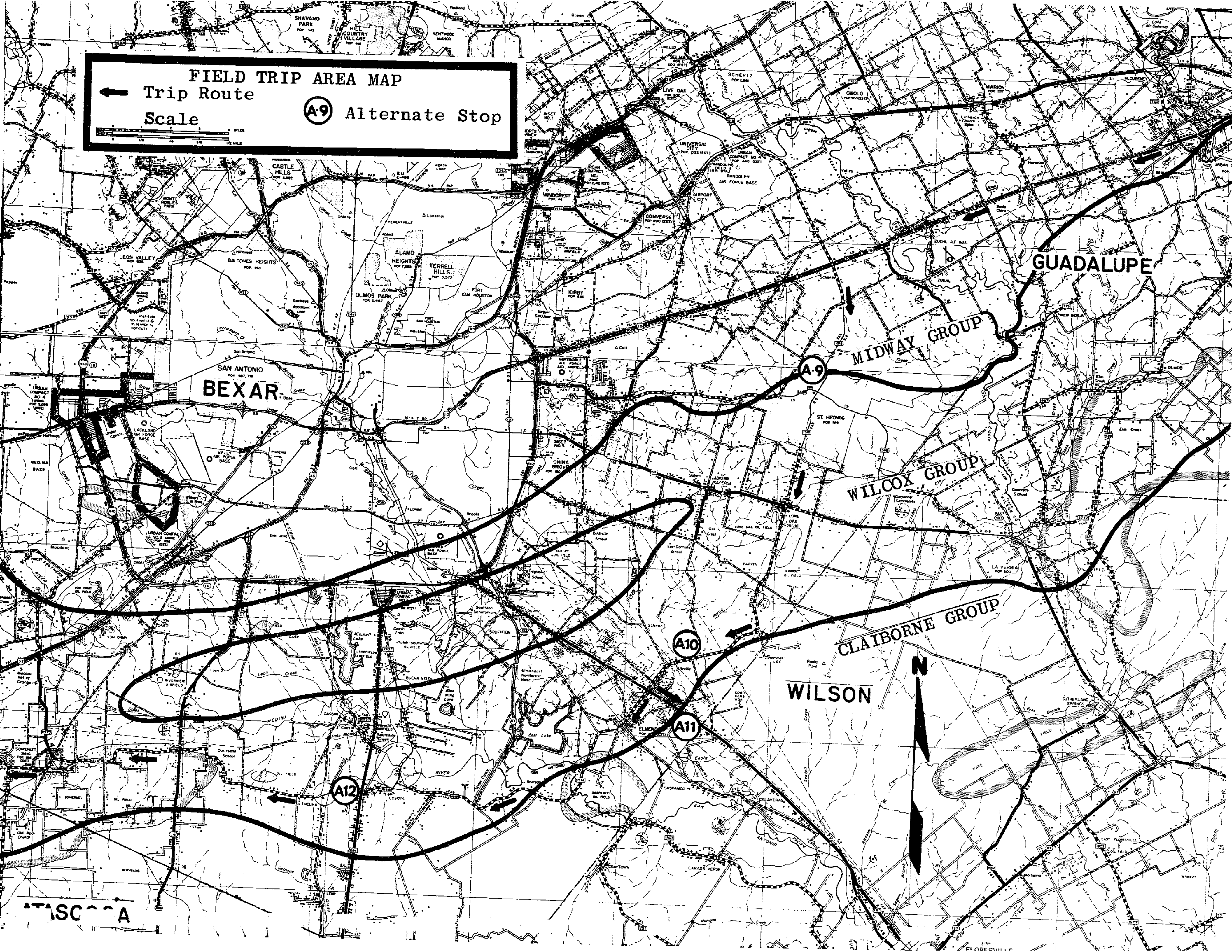
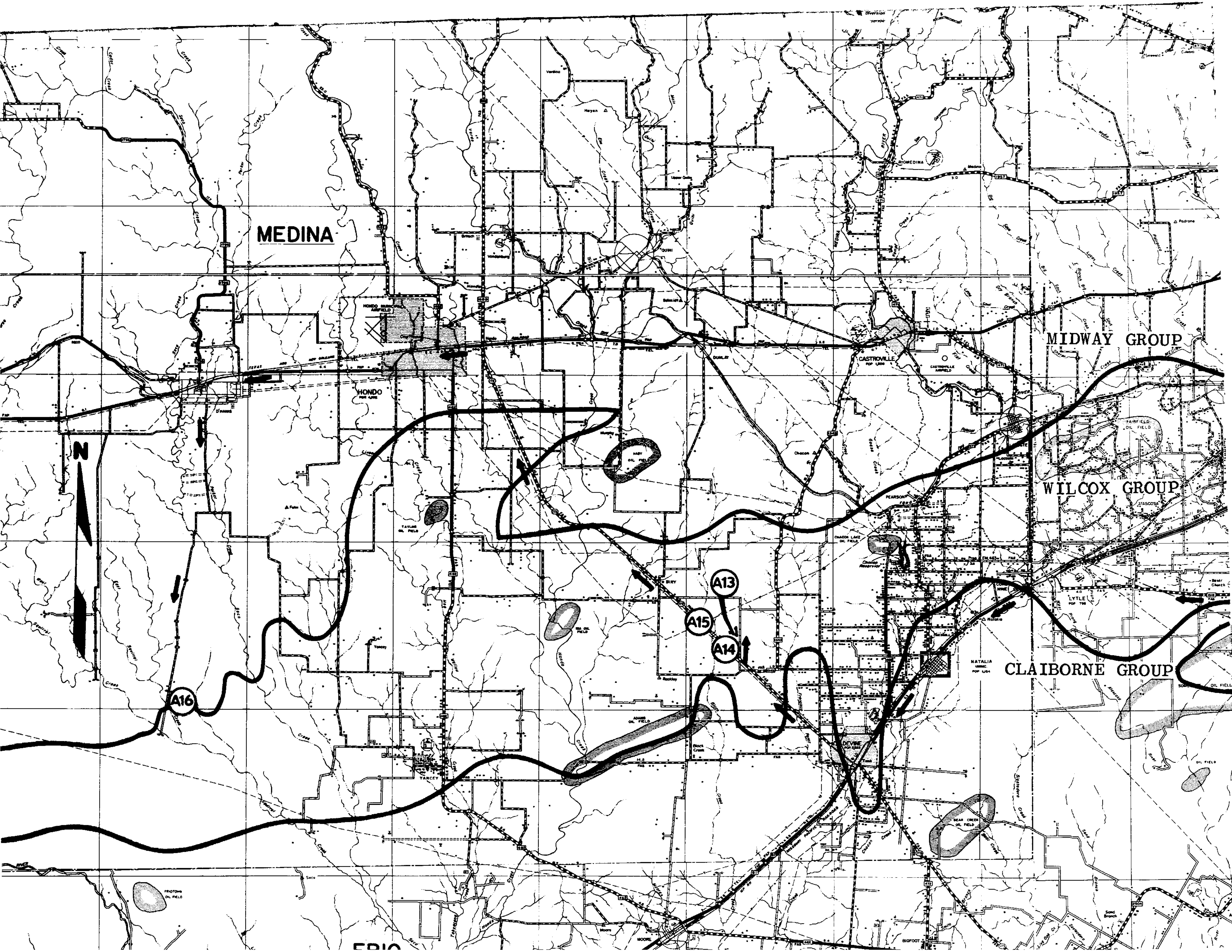


Fig. 1.--Relationship of Indio Lagoon System to other depositional systems of the lower Wilcox in Texas and comparison of lower Wilcox depositional systems with those of the Recent northwestern Gulf of Mexico.


FIELD TRIP AREA MAP
Trip Route
A-9 Alternate Stop
Scale
GUADALUPE
MIDWAY GROUP
WILCOX GROUP
CLAIBORNE GROUP
BEXAR
WILSON
N
A-9
A10
A11
A12
SAN ANTONIO
SCHERTZ
CIBOLO
MARION
UNIVERSAL CITY
CONVERSE
KIRBY
ALAMO HEIGHTS
TERRELL HILLS
OLMOS PARK
FORT SAM HOUSTON
CASTLE HILLS
BALCONES HEIGHTS
LEON VALLEY
SHAVANO PARK
HILL COUNTRY VILLAGE
KENTWOOD MANOR
LIVE OAK
SELMA
WINDCREST
CHINA GROVE
ST. HEDWIG
LA VERNIA
LACKLAND AIR FORCE BASE
KELLY AIR FORCE BASE
RANDOLPH AIR FORCE BASE
SOUTHTON
BUENA VISTA
ELMENDORF
SUTHERLAND SPRINGS
EAST FLORESVILLE



MEDINA
MIDWAY GROUP
WILCOX GROUP
CLAIBORNE GROUP
A13
A14
A15
A16
N
HONDO
CASTROVILLE
DEVINE
NATALIA
LYTLE
YANCEY
PEARSON

SOUTH TEXAS WILCOX FIELD TRIP

ROAD LOG

Mileage

00.0 Seguin, Texas County Courthouse; Junction U. S. 90A and Texas 123. Proceed north on Texas Hwy. 123.

00.8 Jct. U. S. 90 and Texas 123. Turn left on U. S. 90.

02.2 Texas Lutheran College on left.

02.5 (Jct. U. S. 90 and Texas 46) Continue straight on U. S. 90.

03.3 (Jct. U. S. 90 and FR 464) Continue on U. S. 90.

04.0 Guadalupe River.

05.3 (Jct. U. S. 90 and FR 725).

06.4 Jct. U. S. 90 and Interstate Hwy. 10.

15.6 Cibolo Creek, Bexar County.

17.8 FM 1518 exit.

18.0 Exit right on FM 1518.

18.2 Jct. 1518 South, stop sign. Turn left on FM 1518 crossing prairie developed on Midway clays.

22.3 STOP A-9: Lower Wilcox forebeach sand from roadcut across fence on right side of highway. Note Ophiomorpha burrows, low angle cross-bedding, armored mud balls, local horizons or organic material, heavy minerals, ironstone inclusions, calcareous cement and weathering features.

Continue southward on FM 1518.

22.9 Junction FM 1346. Continue south on FM 1518.

27.2 Jct. FM 1518 and U. S. Hwy. 87. Continue on FM 1518.

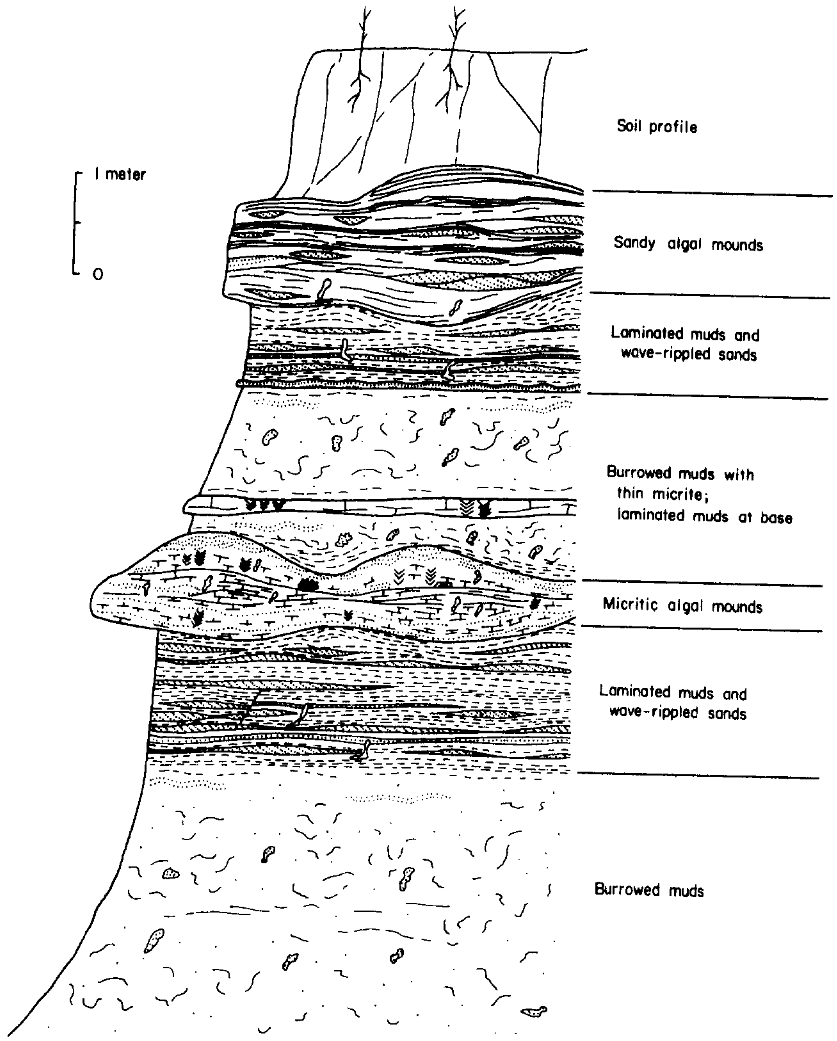
27.8 Note "Hangmans" oak tree over road.

27.9 Lone Oak oil field on right; Cooksey oil field to left. Note mesquite country developed on Wilcox soils.

34.3 STOP A-10: Mud-Algal Facies, Indio Lagoon System (abandoned clay pit of Dickey Clay Company).

The most common facies of the Indio Lagoon System, as presently preserved, consists of muds commonly alternating with presumed algal mound structures (Fig. 2). This facies is not developed adjacent to local sand facies and presumably represents deposition in the more central part of the lagoon or at least away from local sand-depositing environments. Two kinds of mud units occur in this lagoon-center facies. One type consists of evenly parallel laminated muds commonly interlaminated with wave-rippled, very fine-grained, well-sorted sands and silts (these are best seen in the lower level of the pit). The other type of mud is burrowed, generally completely so, though some burrowed muds show relict lamination (best seen in upper level between the two levels of mounds). Circular masses which in cross sections are either biconvex or convex upward with flat bases are associated with mud sequences of this facies. They range in size from about 3 decimeters to 3 meters in diameter with average maximum thickness about 7 decimeters. These circular mounds range from those consisting of very fine-grained sand interlaminated with mud, both of which are calcareous (upper mounds), to those that are chiefly laminated, impure micrites (lower mounds). Laminae are commonly crinkled; a few calcite laminae occur. A small amount of primary or early diagenetic dolomite is present; some laminae of gypsum appear to be primary. A few of the sand laminae are wave-rippled, especially those forming the upper parts of the mounds. Certain of the mud laminae show mud crack structures; cone-in-cone structures are common. External and internal geometry, along with stratigraphic association, suggest these mounds accumulated through trapping or baffling action of algal mats; some of the calcium carbonate may have been precipitated through photosynthesis of algae. Plan-distribution of these mounds may be observed on the floor at the upper level of the pit.

A vertical repetition in sequence is shown by units of the mud-algal facies (Fig. 2). Burrowed muds are succeeded by laminated muds and these in turn are overlain by algal mounds. The mounds are overlain by a thin unit of laminated muds which grade vertically to burrowed muds. The burrowed muds possibly accumulated in the deeper part of the lagoon; the interlaminated mud and wave-rippled sand and the presumed algal mounds apparently represent shoaling conditions. Primary or early diagenetic dolomite, gypsum of possible primary origin, and local mud cracks suggest supratidal to intertidal deposition. The mud-algal facies does not occur near local sand facies associated with tidal deltas, washover fans or lagoon-margin deltas, nor is it associated with lagoon-margin or marsh muds.



Stop A-10 (Fig. 2). --Typical sequence of mud-algal or lagoon-center facies, Indio Lagoon System; based on exposures in Saspamco clay pit of Dickey Clay Company, Bexar County, Texas.

Continue southwest on FM 1518.

36.1 Jct. U. S. 181, continue on FM 1518.

37.2 Elmendorf City limits; population 205 and one spotted dog.

37.6 RR crossing. Turn left on 3rd Ave.; continue southeast parallel to RR tracks.

40.3 Turn left on gravel road; cross RR tracks.

40.4 Saspamco School on left. Continue straight on main gravel road to Saspamco Mercantile Co.; bear to right around store.

40.8 Saspamco Tile and Sewer Pipe Company office. Permit Stop 3 through Mr. K. A. Whitaker, Supt., W. S. Dickey Clay Mfg. Co., Saspamco Co. 78153.

Follow winding gravel road to clay pit.

42.5 Sharp right into pit.

STOP A-11: Carrizo sand and upper Indio clay exposed in clay pit.

Approximately 20 feet of fluvial point bar sands cut into about 20 feet of steeply dipping gray, lagoonal clays, sandy clays, and sand lenses of the upper Indio formation. This section is about 40 feet stratigraphically higher than the one seen at Stop 2.

Note internally cross-bedded tabular bedding, troughs and other sedimentary features in Carrizo sand.

Circle back through Elmendorf and continue westward along strike.

Return to main gravel road.

42.7 Turn right.

43.2 Jct. gravel road and U. S. Hyw.181. Turn left on 181.

44.3 Jct. U. S. 181 and FM 1518. Left on FM 1518.

45.4 Elmendorf city limits again!

45.8 RR crossing, continue southwest through Elmendorf.

48.9 San Antonio River; Caution: one-lane bridge. Saspamco oil field.

52.8 Jct. U. S. Hwy. 37 (under construction). Continue straight on FM 1518.

55.7 Jct. 1937, continue west on 1518.

57.2 Jct. U. S. 281, continue west on 1518.

Note outcrops about one mile south on U. S. 281.

57.7 STOP A-12: Basal Indio foreshore strandplain sand exposed in road cut.

Abundant iron-cemented *Ophiomorpha* burrows may be seen weathering from sand on both sides of road.

64.5 Jct. Texas Hwy. 16. Continue on FM 1518.

64.9 Somerset oil field; prairie developed on fault block of Midway shale on right.

68.0 Somerset; population 876.

68.2 Note native stone building on left.

68.3 Jct. FM 1518 and FM 2173. Turn left on 1518.

68.6 Turn right on FM 1518.

69.9 Jct. FM 476 on left. Continue west on 1518.

76.4 Jct. U. S. Hwy. 81 (Interstate 35). Turn left on access road to IS 35; stay on access road (2-way traffic).

77.0 Jct. Benton City Road; continue straight.

77.1 Turn left our Interstate Hwy. 35; (135 miles to Laredo). Continue southwest on IS 35.

85.7 End of expressway.

85.9 Jct. Texas Hwy. 173. Turn right on Hwy. 173 west.

86.8 Jct. Texas Hwy. 173 and 81. Continue straight on 173.

91.6 Jct. FM 1343.

92.2 Turn right on gravel road.

STOP A-13, A-14, A-15: Tidal Delta Facies, Indio Lagoon System (road cuts and quarry along Route 173).

A local sand facies developed in the subsurface of Frio County and extending to the outcrop in southeastern Medina County occurs within the Indio Lagoon System updip of an inferred tidal channel complex of the Cotulla Barrier Bar System (Fig. 3). Internal structures and spatial relationship of specific rock units indicate accumulation of this facies as part of a lagoon-side tidal delta complex. Units of this facies include deposits laid down both during flood and ebb surges with accumulation both within tidal distributary channels and on interchannel flats (Fig. 3). Deposits of the tidal distributary channels occur as trough or festoon cross-bedded sands; those of the interchannel flats are chiefly plane-bedded sands associated with thin avalance-bedded sands. Sands are uniformly fine-grained and well sorted.

Three samples collected from Stop A-13, tidal flat mudflow or lagoon fill stratigraphically higher than A-14, were barren except for one specimen of a small, finely reticulate, deeply incised Bombacaceous grain.

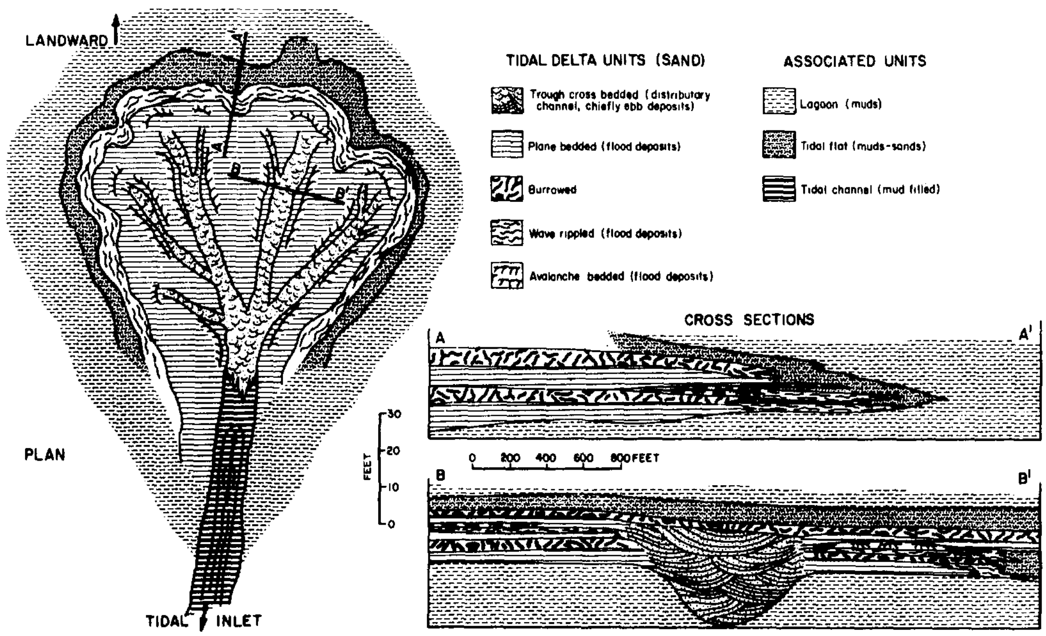


Fig. 3 - Plan and cross-section reconstruction of lagoon-side tidal delta facies, Indio Lagoon System; based on road cuts along Highway 173 between Devine and Hondo, Medina County, Texas. Tidal delta distributary channel deposits shown in outcrop A-13; tidal delta interdistributary channel deposits, at approximate stratigraphic interval of outcrop A-13 is shown in outcrop A-14.

Turn around, return to Texas Hwy. 173.

93.2 Hwy. 173, turn right. Note thin veneer of Carrizo sand capping hill.

93.8 <u>STOP A-14:</u> (Fig. 3)

The interchannel flats of the tidal delta facies consist of basal plane-bedded sand units grading vertically to extensively burrowed sand units. Both of these grade laterally, and away from the channel fill, to meta-rippled sand units which pass to thin, laminated mud and sand units and distally to lagoonal muds. The plane-bedded sands are interpreted as overbank deposits laid down on interchannel flats during flood surges. An alternate interpretation of the plane-bedded sand is a beach deposit with the slightly undulatory upper surface representing beach cusps. Of the small scale avalanche-bedded units associated with the plane-bedded sands, faces dip either toward or away from the tidal distributary channel, presumably representing both flood and ebb deposition. The upper, burrowed part of the overbank sequence represents destruction of structures in sediments on the interchannel flats apparently as they became slightly emergent. The overbank sequence of basal plane-bedded sand units and upper burrowed sand units shows an upward increase in amount of mud or content graded bedding. Sedimentary structures and depositional relationships of specific units of the overbank sequence are similar to those found in modern tidal deltas in bays and lagoons of the Texas Coast. Structures and composition of modern tidal delta distributary channels are largely unknown.

W. C. Elsik collected four samples from the deeply weathered section at this locality. Three samples were barren except for modern root cells and the fungus Rhizophagites. One sample contained an assemblage indicative of an Upper Wilcox age. Palynomorphs recovered included Triplanosporites, Laevigatosporites spp., Gleichenia, Hamulatisporites, Concavisporites, Deltoidospora, Picea, Pinus, Taxodium, Arecipites, Calamuspollenites, Liliacidites spp., Aquilapollenites, Alnus, Thomsonipollis magnificoides, small nyssoid forms, Acer, Platycarya (common), Betulaceae-Myricacea, Pistillipollenites mcgregorii, Triatriopollenites aroboratus, and a questionable fragment of a dinoflagellate.

Gleichenia and Aquilapollenites indicate reworked material. The abundance of Arecipites, Liliacidites and Calamuspollenites indicate much herbaceous vegetation in the vicinity.

Continue northwest on Hwy. 173.

94.4 Black Creek.

95.0 STOP A-15: (Fig. 3).

Tidal distributary channel fill is nearly symmetrical in cross section and consists of moderate scale cross sets (about 3 decimeters to 1 meter deep and 1 to 2 meters wide). These grade vertically to shallower, but commonly wider troughs, and laterally to plane-bedded interchannel sands. The channel fill discordantly overlies lagoonal muds. Trends of trough axes are southerly or toward the barrier bar system. During flood stage, scouring was dominant in the channel; principal deposition as indicated by the seaward trend of troughs occurred during ebb surge. Calcareous crusts at the base of most of the troughs may have resulted from leaching of shell detritus. Toward the barrier bar, and in the subsurface, the tidal channel complex becomes relatively straight and nondistributive and is filled with mud rather than sand. Presumably it underwent scour both during flood and ebb surges and was filled with mud only after healing and filling of the tidal inlet at the barrier bar.

Three samples collected from locality A-15 were also barren.

Continue northwest on Hwy. 173 to Hondo.

100.4 Hondo Creek.

105.8 From about this point to the next stop you will be crossing Midway and upper Cretaceous outcrops.

107.8 Jct. Texas Hwy. 173, U. S. Hwy. 90, and FM 689. Turn left on U. S. 90 to Hondo.

108.3 Hondo City limit.

109.4 Sign: "This is God's country. Please don't drive through it like hell."

Continue west on U. S. 90 through Hondo.

118.3 Jct. FM 2200, turn left (south) on 2200.

122.8 Turn right onto dirt road, H. F. Richardson Ranch.

123.0 Road turns right.

123.5 Road turns left.

124.3 Seco Creek.

124.6 Right turn around hill.

126.4 Climb hill out of flood plain of Seco Creek.

126.5 Fork; keep left.

126.8 Fork to left; keep straight (to right).

127.2 Top Edwards Plateau.

127.9 Fork; bear right over cattle guard.

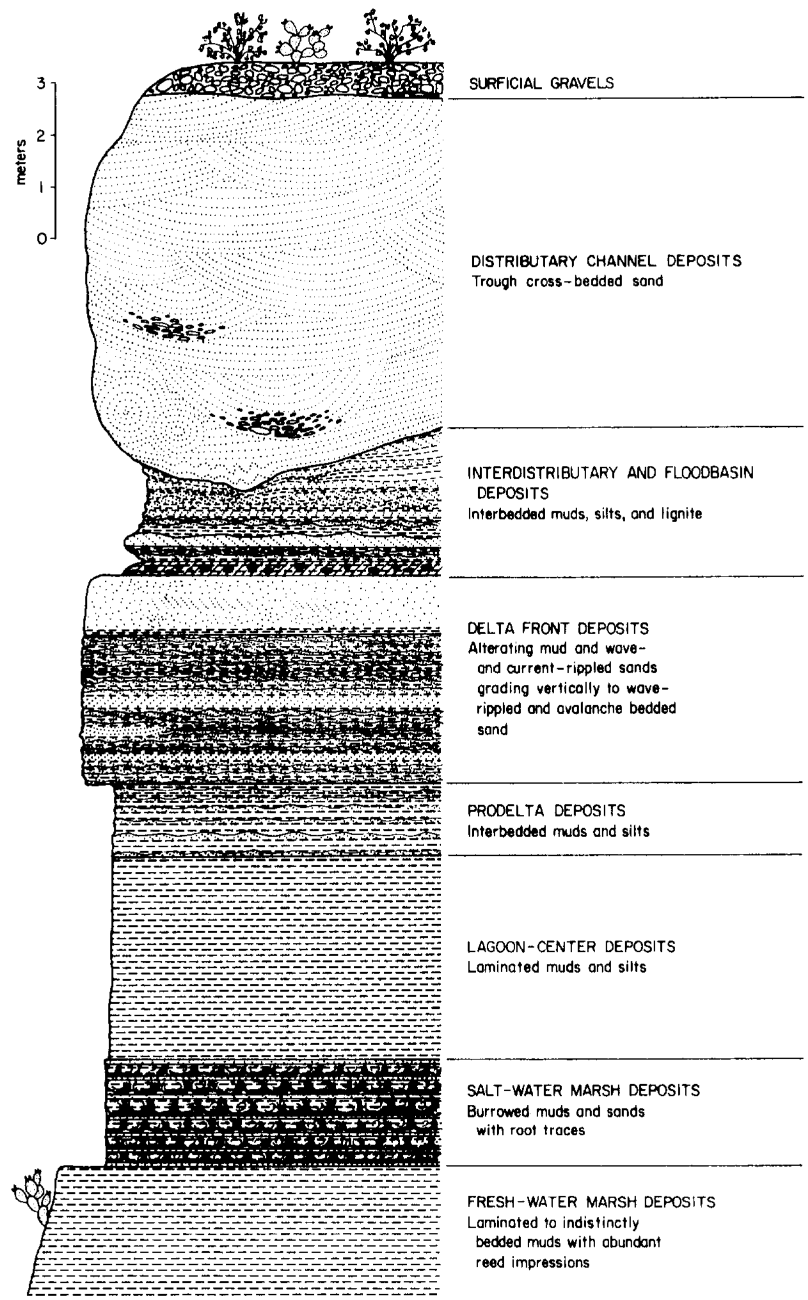
128.2 Cattle guard; HFR ranch.

130.0 Fork; bear left on Matt Koch Road.

131.4 Gate and fork in road, keep straight along fence line.

131.5 STOP A-16: Basal Indio section exposed in abandoned borrow pits around crest of hill to right of road. (Abandoned quarries of D'Hanis Brick and Tile Company)

Lagoonal muds and associated sand occurring as the most updip preserved parts of the Indio Lagoon System show compositional and structural features indicative of mainland-side, lagoon-margin accumulation. Mud deposition was chiefly as parts of fresh- to salt-water marshes; principal sand units accumulated as relatively small bay-head or lagoon-margin deltas (Fig. 4).



Stop A-16 - (Fig. 4) - Typical sequence, lagoon-margin facies, Indio Lagoon System; based on exposures in abandoned clay pits of D'Hanis Brick and Tile Company, 11 miles south of D'Hanis, Medina County.

Mud units, lower part of section

Muds of lagoon-margin facies are chiefly gray-brown to medium brown with various carbonaceous materials making up 1 to 10 percent. Structural types include (1) indistinctly bedded muds, and (2) extensively burrowed muds. The indistinctly bedded muds contain abundant reed and reed-like plants similar to those found in modern fresh-water Sagittaria marshes. The extensively burrowed muds are medium brown and commonly contain fragmental plant remains. Burrows range from about 2 mm. to 5 cm. in diameter and are nonwalled, suggesting formation by worms, insects, or certain mollusks. Root traces are common. Sand units associated with the burrowed muds locally show wave-ripple structures, though commonly primary structures in the sands have been obliterated by burrowers. Internal structures of the extensively burrowed muds and sands are similar to those found in modern high marshes along Texas bay margins. The laminated mud and silt units found in association with these lagoon-margin deposits are similar to those found in the lagoon-center mud-algal facies and apparently represent more lagoonward deposition than the lagoon-margin marsh deposits.

Delta sequence, upper part of section

Predominantly sand units occurring as part of lagoon-marine facies of the Indio Lagoon System show internal structures referrable to specific environments of small deltas as well as vertical textural and structural trends reflecting delta progradation (Fig. 4). Typical delta sequences show lagoonal muds grading vertically to a thin unit made up of undulatory interbeds of muds and fine sandy silts representing prodelta deposition. This unit grades upward to alternating muds and wave- and current-rippled sand laid down as the lower and seaward part of distributary mouth bars (delta front deposits); a few small scour-fill structures associated with this unit apparently are related to distributary channel surges. The next unit in vertical sequence consists of fine- to medium-grained sand displaying wave-ripple and current-ripple across laminae and locally avalanche-bedded structures; this is interpreted as deposits of the crest and seaward flank of a distributary mouth bar (delta front deposits). The delta front units of these lagoon-margin delta sequences are overlain by interbedded mud, fine sand, and lignitic clay units typical of interdistributary, crevasse splay, and floodplain deposition, and relatively thick units of fine- to medium-grained sand, displaying moderate scale trough cross-beds and representing distributary channel fill. The vertical succession of units resulted from lagoonward progradation of the lagoon-margin delta.

Ten samples were collected from this locality by W. C. Elsik for palynological examination. All were barren except for one sample near the base of Fisher's salt-water marsh bed. This sample contained one specimen of Ephedra voluta and Ceratopteris (?). No environmental interpretation can be based on this rare occurrence. The two forms do occur together, however, in the Midway-Lower Wilcox of central and east Texas.

Turn around; return to D'Hanis; turn right on U. S. 90 to Hondo and points east.

Adios. Vaya con Dios, 'Amigos!