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FIELD EXCURSION NO. 10, NOVEMBER 11, 1962

TERTIARY FORMATIONS BETWEEN AUSTIN AND HOUSTON WITH SPECIAL EMPHASIS ON THE MIOCENE AND PLIOCENE

John A. Wilson[1]

GENERAL

The group will depart from the north entrance of Memorial Stadium (23rd Street between San Jacinto Blvd. and Red River Street, Austin, Texas) at 7:00 A. M., Sunday, November 11, 1962. The bus will face east. Those in cars line up behind the bus facing the same direction. Box lunch will be furnished.

A detailed road log for the trip was not made. The route is outlined on the map (Fig. 1). It will follow Texas 71 from Austin to LaGrange; Texas 159, Texas 237 and U. S. 290 to Brenham; Texas 90 to Navasota; Texas 6 to Hempstead; Texas 159 to Bellville; Texas 36 to Sealy; and U. S. 90 to Houston.

INTRODUCTORY GEOLOGY

The regional strike in this part of the Gulf Coastal Plain is NE - SW and the regional dip is about 1^{o} to the southeast. The route along Texas 71 from Austin to LaGrange will cross the Upper Cretaceous and Lower Tertiary at a slight angle to the direction of dip.

In spite of the impression you may receive from this short trip over well traveled highways, there are many outcrops on the Coastal Plain. Most of them are along the banks of tributaries to the major rivers. The major rivers like the Colorado and Brazos have alluvial-filled valleys with well-developed terrace systems. Only where a meander of the larger streams strikes the bed-rock valley wall do you find an exposure. The upland divide areas, in this part of Central Texas, are partly covered with broad sheets of gravel, variously termed "high level gravel" or "Uvalde Gravel", which quite effectively mask the bed rock. No bones have ever been found in them. More about them later.

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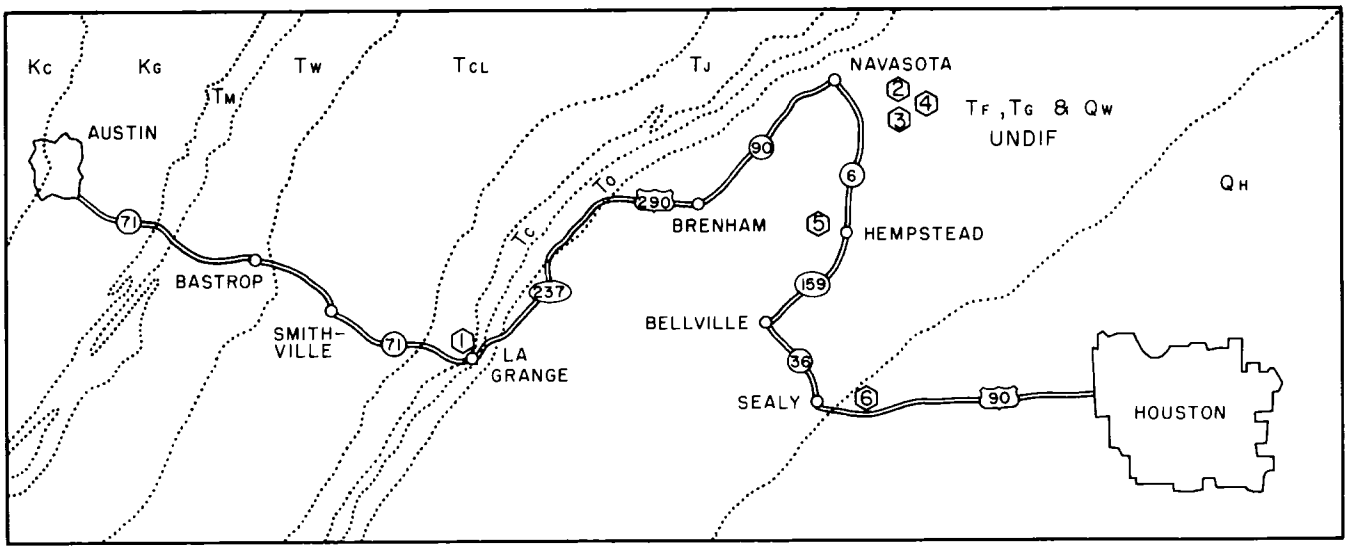


MODIFIED FROM GEOLOGICAL HIGHWAY MAP OF THE DALLAS GEOLOGICAL SOCIETY

0 10 20 30 40 50 MILES

Q_H	HOUSTON GROUP PLEISTOCENE
Q_W	WILLIS FORMATION PLEISTOCENE ?
T_G	GOLIAD FORMATION
T_F	FLEMING FORMATION MIOCENE
T_O	OAKVILLE FORMATION MIOCENE
T_C	CATAHOULA FORMATION OLIGOCENE ?
T_J	JACKSON GROUP EOCENE
T_{CL}	CLAIBORNE GROUP EOCENE
T_W	WILCOX GROUP EOCENE
T_M	MIDWAY GROUP PALEOCENE
K_G	UPPER CRETACEOUS
K_C	LOWER CRETACEOUS

FIGURE 1. GENERALIZED GEOLOGIC MAP SHOWING FIELD TRIP ROUTE AND STOPS.

There are two general keys to the surface geology of the Tertiary of the coastal plain: 1) scarps formed by the inface of the gently, gulfward dipping cuestas, and 2) the vegetation. Those sands that have a lime or silica cement and the mudstones that have a lime cement are more resistant and form cuestas. Some are low and subtle, others are high and prominent.

In general the vegetation reflects the bedrock. Mesquite and huisache grow in the chernozems formed from the weathering clay. Cultivated crops on this soil are cotton and sorghum. Sands weather to podsols and support the Blackjack and Post oaks. Watermelon is grown on the podsols of the cleared areas. The high level gravels also support a Blackjack-Post oak flora so, when mapping, one has to use the vegetation carefully. Nonetheless, part of this area is a classic one for showing bedrock control of vegetation.

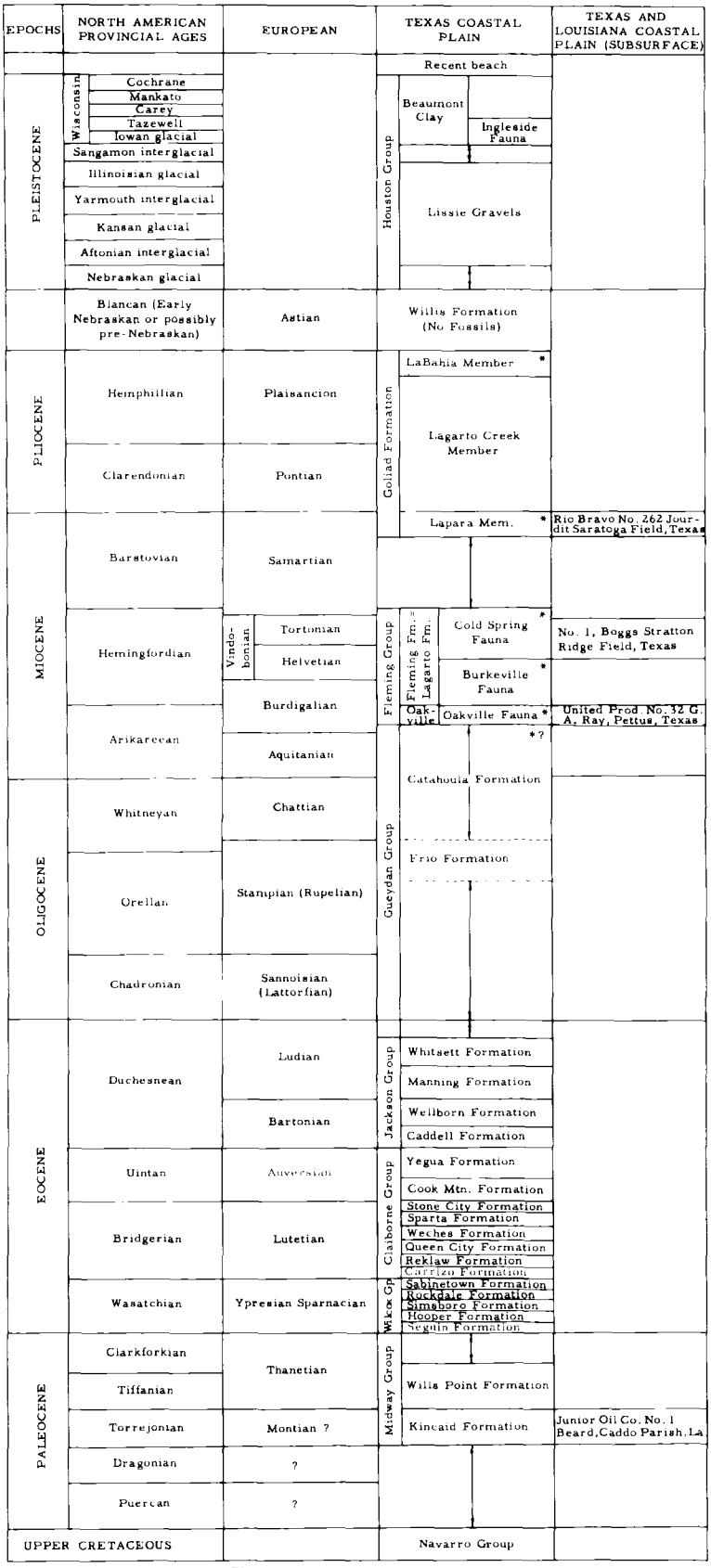
AUSTIN TO LAGRANGE

The Austin Chalk outcrops across the street from Memorial Stadium. It is of Late Cretaceous age and roughly correlates with the Niobrara Chalk of Kansas. We will be on the Austin Chalk as we proceed along Manor Road to Airport Boulevard. At this intersection we are on one of the higher terraces of the Colorado River. We quickly drop to the lower terraces and cross the Colorado River. Bergstrom Air Force Base is on a lower terrace. Beyond Bergstrom, where Texas 71 crosses Onion Creek, there is an exposure of the Taylor Marl on the left side of the highway. The mosasaur skull on exhibit at the Texas Memorial Museum came from this locality.

The Taylor Marl is overlain by the Navarro Clay (the sequence of formations is given on Fig. 2) which also contains occasional bones of mosasaurs. Note the black soil. You are crossing the Black Prairie of Central Texas, a physiographic unit which includes the limestones, marls and clays of the Upper Cretaceous and Paleocene that weather to a chernozem soil. Most of the cotton and grain feeds are grown in the area. The Balcones Fault zone bounds the Black Prairie on the west and the Wilcox escarpment forms the boundary on the east. The vegetation on the Black Prairie where the fields are uncultivated is mesquite, broom-weed and huisache.

The Navarro Clay is the highest Cretaceous formation and is marine to the very top. Overlying the Navarro is the Midway group of the Paleocene, also marine clay. The contact between the two is poorly and rarely exposed. Evidence is accumulating that the "unconformity" between them is of submarine origin. Contrary to general opinion, this area was probably not uplifted and subjected to subaerial erosion, but was subjected to submarine scour (Rainwater, 1960).

At the top of the Midway near-shore sands, oyster reefs and other evidence of shallow-water conditions appear. These grade on up into the non-marine Wilcox group of the Eocene. This change is marked by a rather abrupt inface of a cuesta which is held up by partly cemented lenses of sand. The change in vegetation from the open mesquite prairie or the cultivated land to the Post oak-Blackjack oak forest is abrupt.



* Mammal bearing (not including Pleistocene)

FIGURE 2. CORRELATION TABLE SHOWING SEQUENCE OF TERTIARY AND QUATERNARY STRATIGRAPHIC UNITS.

The upland between the Wilcox escarpment and the town of Bastrop is covered by "high level gravel" so we will not be able to see an exposure of the Wilcox which consists of a succession of alternating sands and clays, deposited on the shoreward side of but probably very close to sea level.

At Bastrop we once again cross the Colorado River. On the west side, as we drop down from the high level gravel-covered surface, note the well-developed river terrace system. On the east side of the river we climb up the inface of the cuesta formed by the Carrizo Sand. The combination of the higher humidity near the river and the deep sandy soil has made conditions right for a relict flora. The edge of the main piney woods area is approximately 100 miles farther east.

The near-shore conditions of the Carrizo are succeeded by the marine Reklaw Formation. The upper member, the Marquez (pronounced mar-kay) is a dark gray, glauconitic, highly fossiliferous clay. It is not exposed along this highway.

Red and orange colored sands on the left of the highway are exposures of the Queen City Formation. This is another near-shore formation of the Middle Eocene Claiborne group which consists of alternating marine and non-marine formations. As we cross the Colorado River for the third time at Smithville you will perhaps see an exposure of the Weches Formation on the south bank to the left of the highway. The Weches is fossiliferous, glauconitic clay with sharks teeth, fish bone fragments and otoliths. It overlies the Queen City.

Between the marine Weches Formation and the marine Cook Mountain Formation is the unfossiliferous near-shore Sparta Sand. It and the Cook Mountain are exposed in stream cuts away from the highway. Beyond Smithville the highway is, for a way, on a Pleistocene river terrace.

Just beyond Kirtley, we leave the terrace and pass outcrops of the non-marine but near-shore Yegua Formation. It is lignitic with alternating lenses of silt and clay. The Upper Eocene Jackson group begins approximately at Plum but is poorly exposed along this highway.

As we near LaGrange you can see Monument Bluff on the right. The bluff is the inface of the Oakville cuesta.

STOP 1. Catahoula - Oakville on Texas 71, south of LaGrange.

The Catahoula Formation in Central Texas is a light green, non-calcareous clay. Near the top of the Catahoula are channel lenses of cross-bedded calcirudite which is the Oakville lithology. There is no single line of contact between the Catahoula and the Oakville, but rather a zone within which channel calcirudites become more common and finally take over.

Uplift along the Balcones Fault zone rejuvenated the rivers and streams to the northwest. They gradually, at first, began to erode the Upper Cretaceous Navarro and Taylor clays and to transport this material toward the Gulf. The calcirudite lenses contain as high as 77% reworked calcareous fragments, most of which

are Cretaceous Exogyra shells, Inoceramus prisms, shark and ray teeth, and Foraminifera. (A micropaleontologist identified samples of the Oakville as being of Cretaceous age, an example of paleontology without stratigraphy! For Upper Cretaceous to be at the surface here an uplift of approximately 7000 feet would be needed. This would make an attractive structure to petroleum geologists).

The Oakville Formation contains three different lithologic types of rock which were deposited in three different environments. Cross-bedded, coarse, lense-shaped bodies of poorly-sorted calcirudite are stream channel sands. Grain size analyses (Ragsdale, 1960) show that they are quite similar to modern river sands. The clay, within which the channel sands are imbedded represents the back-levee or back-swamp environment. Thin-bedded sands represent flood-plain deposits where the sand spread out from the channels.

The rivers and streams during this time could not have been entrenched as they are now, because the outcropping Oakville and Fleming Formations form a continuous band parallel to the coast. Yet the shoreline during that time was about as far away as the present shore is from LaGrange, about 100 miles. The back-swamp deposits of one river merged with the back-swamp deposits of adjacent rivers forming one vast deltaic plain, very likely with open savannahs here and there.

X-ray analyses (Anderson, 1958; Thomas, 1960) show that the Catahoula in Central Texas is a calcium-montmorillonite without illite. The Oakville and Fleming clay is sodium-rich, mixed-layer montmorillonite with illite. The Upper Cretaceous Taylor and Navarro clays are of almost identical composition with the Oakville and Fleming clays.

The Oakville formation is divided into a Lower Oakville member, and the Moulton Sandstone member which forms the rim of Monument Bluff.

One-half mile south of Stop 1 an Archaeohippus blackbergi upper tooth was found. More about the fauna later.

LAGRANGE TO NAVASOTA

From LaGrange to Navasota the route is parallel to the strike of the formations and, as far as Carmine, the road follows closely the Catahoula-Oakville contact. In stream cuts along the road may be seen first Catahoula then Oakville lithology. The cuesta is more difficult to see here but it will be pointed out at Carmine.

Just beyond Carmine a road leads off to the right to Wood and Wood's (1937) Water Run locality. It was there that a Coenopus cf. ? premitis maxilla was earlier found. It was discovered in what is supposed to be Catahoula Formation and all by itself, for it is the only vertebrate from the Catahoula. This dates the Catahoula here as Oligocene. A search has been made for other vertebrate fossils but so far without success.

From Carmine to Brenham to Navasota the route is on the rolling terrane of the Fleming Formation. Calcirudite lenses in the clay are more resistant and hold

up the hills. Miocene calcareous clays are much more fertile than the Eocene sands so cotton and sorghum farms and good pastures are common. The dominant trees are the Live oaks. Small dense forests of Post oak and Blackjack oak indicate outliers of Willis sand. More about this later.

There are many places along the creek banks and in road cuts between Carmine and Navasota where I have collected a bone here, a tooth there. For instance, when an underpass was cut for U. S. 290 to skirt Brenham a Synthetoceras nasal horn, an Amphicyon longiramus lower jaw, and a handful of merychippine teeth were found. If this area were badlands, it would be paradise for the vertebrate paleontologist; teeth and bones are plentiful but outcrops are few.

NAVASOTA AND VICINITY

STOP 2. Lower Oakville exposed in cut of Farm Road 244 near Navasota

Here you can see a fossiliferous calcirudite lense in the Oakville, the Catahoula below and the Oakville cuesta. Perhaps you will find a tooth or two. Garvin Gully, about a mile to the east, is practically grown over with grass and, at present, not worth visiting.

The Garvin Gully fauna, to date, includes the following:

Lepisosteus (gar)
Amieurus? decorus (catfish)
Trionyx (soft-shelled turtle)
Alligator sp.
(land turtle)
Paleolagus sp. (rabbit)
Paleocastor cf. simplicidens (beaver)
Daphaenodon superbus (dog-like carnivore)
Amphicyon longiramus (dog-like carnivore)
Cynodesmus iamonensis (dog-like carnivore)
Parahippus blackbergi (horse)
Hippodon vellicans (horse)
Hippodon texanus (horse)
Anchitherium australis (horse)
Diceratherium sp. (rhinoceros)
Dinohyas hollandi (giant pig-like form)
Cynorca proterva (peccary)
?oreodont (small grazing artiodactyl)
Oxydactylus cf. brachyodontus (camel)
?Oxydactylus floridanus (camel)
Machaeromeryx sp. (small deer-like form)
Blastomeryx sp. (small deer-like form)
?Floridatragulus sp. (deer-like form)
Synthetoceras rileyi (deer-like form)

The Garvin Gully fauna correlates approximately with the Thomas Farm local fauna. Hippodon vellicans is probably conspecific with Parahippus leonensis of the Thomas Farm. In Texas, about 10 of every 100 teeth of H. vellicans show a connected crotchet.

From the Farm Road 244 locality we will retrace our route to Navasota. Note that for a way we travel on the top of the Oakville escarpment. On a very clear day you can almost see Texas A. & M. College about 20 miles to the north. Turn east on Texas 90. About two miles east of Navasota some new road cuts have yielded a rhino jaw and merychippine, synthetocerine and camel teeth.

STOP 3. Fleming Formation, road cut on Texas 90 two miles east of Navasota.

We are now south of the Oakville escarpment and, therefore, stratigraphically higher than the Moulton Sandstone member of the Oakville. Garvin Gully itself is about a mile and a half north and over the hill. The clay of the Fleming formation is the same composition as that of the Oakville, but the calcirudite lenses are more widely scattered through the clay. Only two low-crowned merychippine teeth have been found at this locality but they are sufficient to identify the Burkeville fauna.

The Burkeville fauna contains somewhat more advanced forms than the Garvin Gully fauna. The horses have connected crotchets, the synthetocerines are a little larger and Aphelops meridianus, and Mylagaulus and Edaphocyon pointblankensis are introduced to the fauna.

Once more we retrace our route to Navasota. At the junction with Texas 6 turn south then east (left) on Texas 105. At the top of the first rise we find the Willis Sand overlying Fleming Clay.

STOP 4. Fleming-Willis contact on Texas 105, one mile east of Navasota.

The Willis Formation is perhaps an eastern facies of the high-level or Uvalde gravel. We crossed some outliers of the Willis in Washington County but from Grimes County eastward the Willis is much more prevalent. It is red, mottled, deeply leached sand that occupies the upland, inter-river areas. It dips beneath the Pleistocene Lissie and Beaumont Formations and overlies the Miocene-Pliocene Goliad Formation.

The Willis can be traced into the Williana Formation of Louisiana. To my knowledge, no bones have been found in either Formation. From their stratigraphic position the Willis and Williana are presumed to be either latest Pliocene or Early Pleistocene.

NAVASOTA TO STEPHEN F. AUSTIN STATE PARK NEAR SEALY

Retrace route to Texas 6 and turn south toward Hempstead. We are going up in the section but still in Fleming, capped by Willis. Just before reaching Hempstead turn west (right) on U. S. 290 and cross the Brazos River. Exposures in the road cut on the west side of the Brazos River are the type section of the Lagarto Formation, which equals the Fleming Formation.

STOP 5. Type section of Lagarto clay on U. S. Highway 290 between Chapel Hill and the Brazos River

The Lagarto clay Formation is traceable into the Fleming Formation, and Stenzel, Turner and Hesse (1944) and Wilson (1956) have used the latter name. At this site Quinn discovered vertebrate remains which belong to the Cold Spring

fauna. In the clay on the south side of the road Quinn found a mastodont skull. The channel sand on the north side of the road has produced horse teeth, synthetocerine teeth, and part of a rhino skull. More and better material has come from Cold Spring which is about 80 miles to the northeast.

THE COLD SPRING FAUNA

Lepisosteus	Diceratherium
?Trionyx	Teleoceras
Mylagaulus	Hippodon sp.
Amphicyon longiramus	Merychippus sp.
Aleurodon francisi	Protohippus sp.
mastodont	Pliohippus circulis
Ticholeptus rileyi	Eoequus wilsoni
Hesperhys sp.	Nanhippus sp.
Procamelus sp.	hipparionid
Synthetoceras francisi	Calippus francisi
Machoeromeryx	Griphippus sp.

Backtrack on U. S. 290 to Hempstead. Go south on Texas 6 (within Hempstead) to Texas 159 and follow it to Bellville. From Bellville continue south on Texas 36 to Sealy. We are traveling on Willis almost all the way to Sealy. The Willis has never been mapped in detail and the contact between the Fleming and Goliad has not been determined.

At Sealy turn east on U. S. 90 and go about two miles before turning north to Stephen F. Austin State Park. Here we will meet with Field Trip No. 3 which is under the leadership of H. A. Bernard, R. J. LeBlanc and C. F. Major.

STOP 6. Meander bend of Brazos River in Stephen F. Austin State Park exposing Goliad below Pleistocene

A small patch of Goliad is exposed. At this site E. L. Lundelius, Jr. found three horse teeth, two belonging to Pliohippus and one to a Neohipparion. This places us within the section where the Lapara Creek Fauna is found.

Most of the Lapara Creek fauna was collected in southwest Texas near Beeville, but elements of it are being found farther to the northeast. This is a controversial fauna. Quinn (1955) studied some of the horses and Wilson (1960) has studied the carnivores. The rest of the fauna is still to be investigated. One controversy involves whether it is Miocene or Pliocene. However, those who have studied the fauna agree it is close to the line. Quinn (1955) reasoned that since the horses show shorter crowns than those of the Burge l.f. and that at that time it was informally agreed that the Burge l.f. was earliest Pliocene, then the Lapara Creek horses had to be latest Miocene. More controversial, was his extending Pliocene names of horses into the Miocene. If his first premise is granted, the horses are more clearly related to the Pliocene genera than to Merychippus.

Even more controversial was Quinn's (1955) identification of so many species in a single fauna. I have slowly been working on the horses on a statistical basis and would welcome assistance from anyone on this problem.

Fig. 3 (modified from Quinn, 1955) shows the regional extent of the biostratigraphic units in the Miocene of the Texas Coastal plain. The more important localities are numbered as follows:

Map No.	B. E. G. No.	County	Location
1	31160	Newton	Near Burkeville
2	31087	Tyler	Near Town Bluff
3	31057	Polk	Near Moscow
4	31183	Polk	Near Goodrich
5	31200	Polk	Near Goodrich
6	31219	San Jacinto	Near Cold Spring
7	31191	San Jacinto	Near Cold Spring
8	31243	San Jacinto	Near Point Blank
9	31190	San Jacinto	Near Point Blank
10	31242	San Jacinto	Near Point Blank
11	30873	Walker	Aiken Hill
12	40071	Grimes	Near Navasota
13	40070	Grimes	Sommers Pit
14	31272	Washington	Near Chapel Hill
15	40067	Washington	Hidalgo Bluff
16	40068	Washington	Near Carmine
17	31259	Fayette	Near LaGrange
18	31278	Fayette	Near Amandsville
19	31273	Lavaca	Near Shiner
20	31262	DeWitt	Near Concrete
21	30896	Bee	Near Berclair
22	31132	Bee	Near Birnabba
23	31080	Bee	Near Berclair
24	31170	Bee	Near Normanna
25	30936	Live Oak	Near George West
26	30904	Live Oak	Near George West
27	31089	Duval	Palangana dome
28	30895	Goliad	Goliad State Park
29			Saratoga field
30	40539	Austin	S. F. Austin State Park
31	40193	DeWitt	Near Hocheim
32	40224	San Jacinto	Near Point Blank

Return to U. S. 90 and proceed east to Houston.

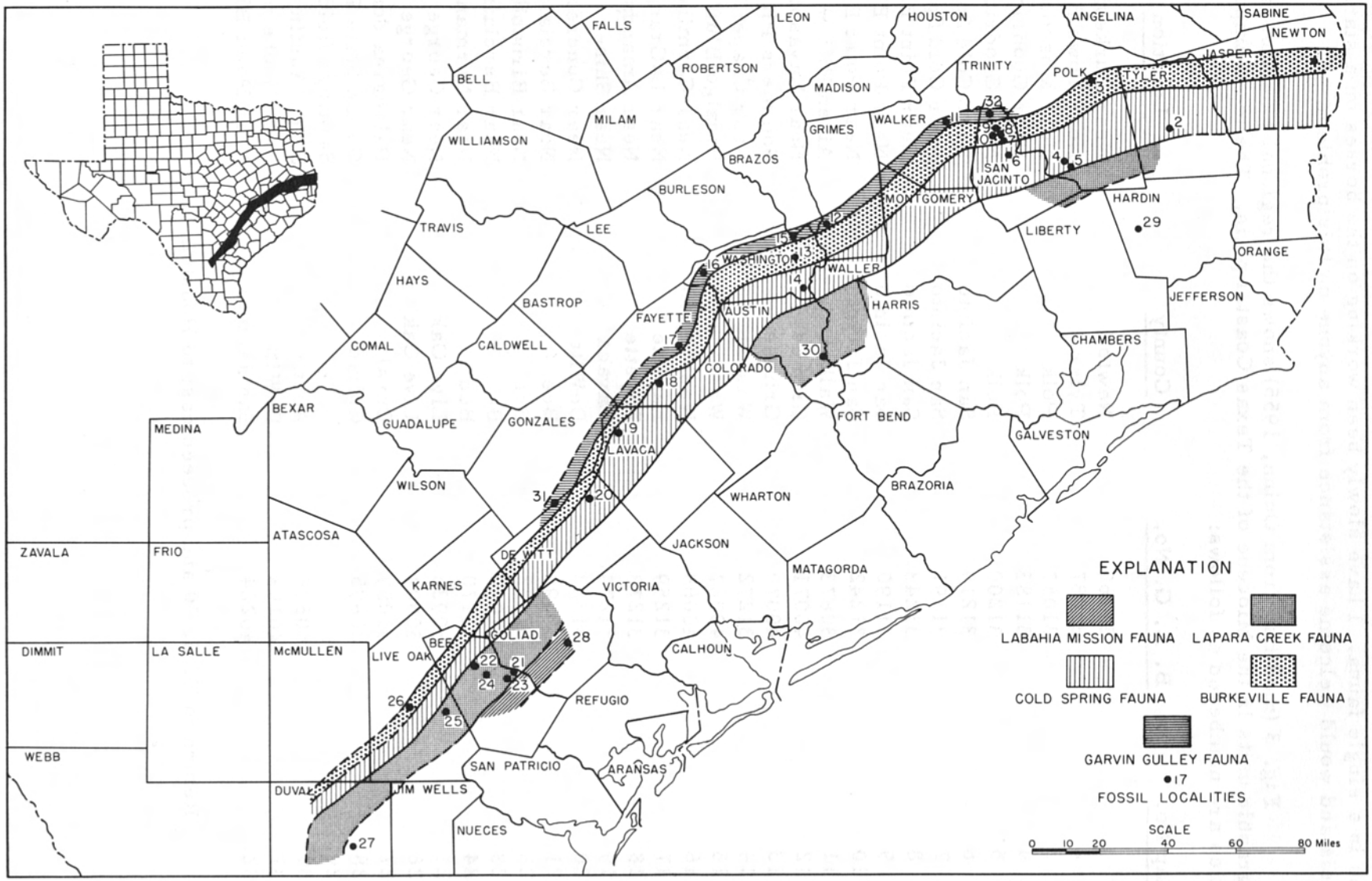


FIGURE 3. MAP OF MIOCENE BIOSTRATIGRAPHIC UNITS IN TEXAS COSTAL PLAIN (MODIFIED FROM QUINN, 1955)

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