Cretaceous Cyclic Platform Carbonates of Central Texas

Prepared for:
South Central Section Meeting of the Geological Society of America
Field Trip #3

Led by:

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Outline of Trip:

STOP 1 - South San Gabriel River/Highway 183, Glen Rose/Walnut Contact

STOP 2 - Whitestone Quarries, Cedar Park, Whitestone, and Keys Valley Marl Members of the Walnut Formation

STOP 3 - Rudist Biostrome, Walnut Formation (Lunch)

STOP 4 - Loop 360/FM 2244, Glen Rose, Walnut and Edwards Formations

STOP 5 - Dinosaur trackways at Zilker Park botanical gardens, Edwards Formation

Introduction

We designed this field trip to introduce participants to Cretaceous carbonate rocks in the vicinity of Austin, Texas (Fig. 1, 2). In a short time and in a small area, participants will be able to view a spectrum of carbonate platform depositional and diagenetic features. The outcrops we will visit include cyclic shallow-water carbonate strata, sequence boundaries, reservoir facies, rudist buildups, and dinosaur trackways. These sediments and the features they contain provide a record of life and environmental conditions on the Central Texas Carbonate Platform about 100 million years ago, during Lower Cretaceous (Albian/Aptian) time. This platform is preserved for over 500 km from Austin to Ft. Stockton, and is of comparable scale to modern shallow water carbonate environments such as Florida Bay, the Bahama Banks, and the Persian Gulf sabkhas. The exposures to be visited offer an opportunity to consider relationships between sea level, depositional environment, cyclicity, hardground development, and dolomitization.

Setting

During Lower Cretaceous time the area that is now Austin was located on a broad, shallow carbonate-dominated shelf. This shelf was part of a larger carbonate-evaporite platform system that encircled the ancestral Gulf of Mexico (Fig. 3, 4, 5). Proterozoic granites and Paleozoic sediments of the Llano uplift were exposed as islands to the northwest of the central Texas area. These islands contributed siliciclastics to the area until the middle Albian when they were covered by carbonates. High energy and supratidal conditions were maintained on these islands through Albian time (Moore, 1995). The shallow seas of this platform were connected to the Western Interior Seaway to the northwest (McFarlan and Menes, 1991). To the northeast of the Austin area was the North Texas Tyler Basin. It was an area of deeper, quieter water with mixed carbonate-siliciclastic marine shelf environments. Further to the northeast, siliciclastic shorelines formed in what are now Arkansas and Oklahoma. To the southeast, the seaward margin of the central Texas carbonate platform was marked by the rudist-coral-stromatoporoid reefs of the Start City Reef Trend (Fig. 5) (Rose, 1972). Seismic and field studies suggest a steep, well defined carbonate mud-dominated slope into the ancestral Gulf of Mexico (Conklin and Moore, 1977, Moore, 1995). To the southwest of the Austin area was the Devils River trend. Traveling southwest of Austin, the marine to supratidal environments of the platform give way to pure carbonate, open-marine shelf environments, shoaling upward into an arcuate, high energy trend of rudist-dominated buildups. This trend marks the margin of the Maverick Basin, a well-defined intrashelf basin (Rose, 1972, Moore, 1995).

Structure

The structural deformation of the study area is simple. Regional dip of strata in the area is 4 m per km to the southeast (Moore, 1964). Fractured zones, however, are important to groundwater flow and diagenesis. The state of Texas and the city of Austin is divided by the Balcones Fault Zone, a major system of *en echelon* normal faults extending from Dallas to Del Rio with a maximum vertical displacement of about 400 m near San Antonio, where Upper Cretaceous rocks are juxtaposed against the Lower Cretaceous (Rose, 1972, Moore, 1995). This fault system was active during the Miocene, in response to extensional tectonics and salt diapirism in the Gulf of Mexico.

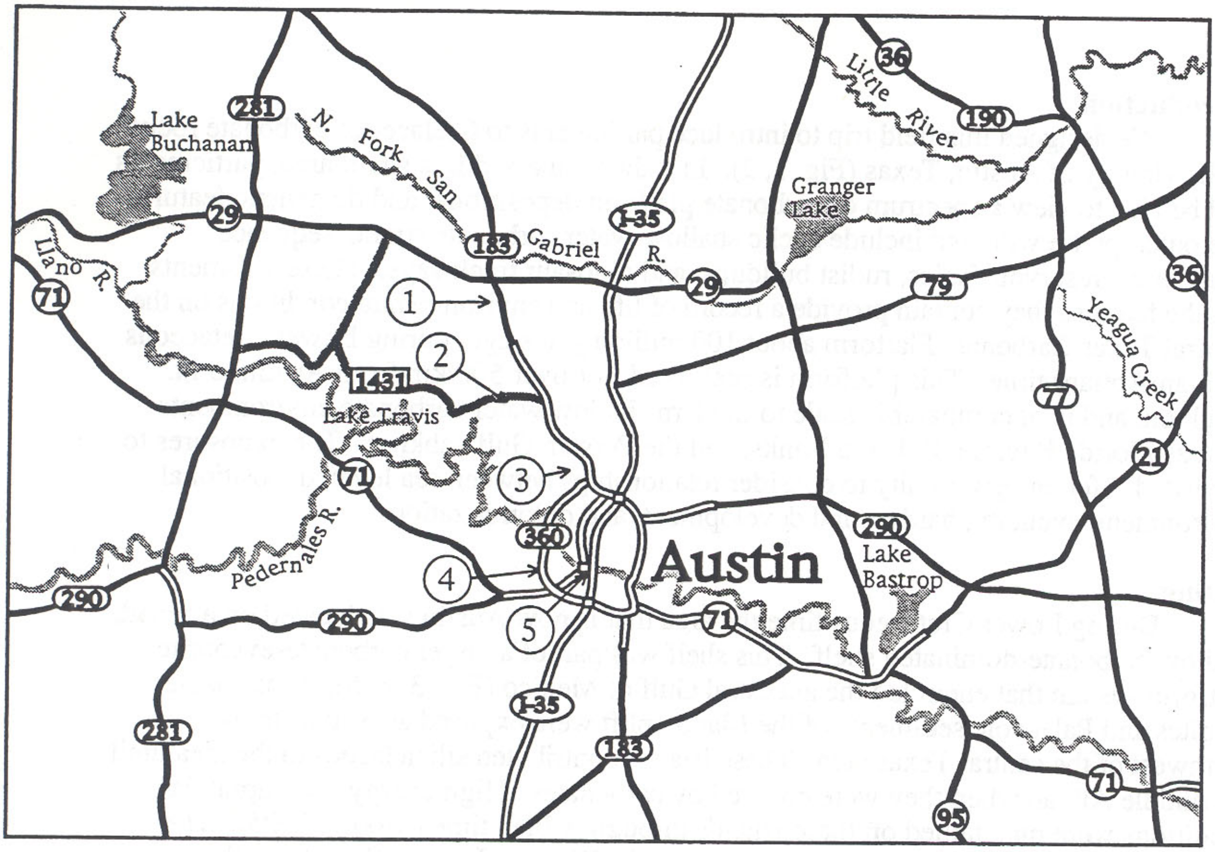


Fig. 1. Location map for field trip. Stops are numbered 1 through 5.

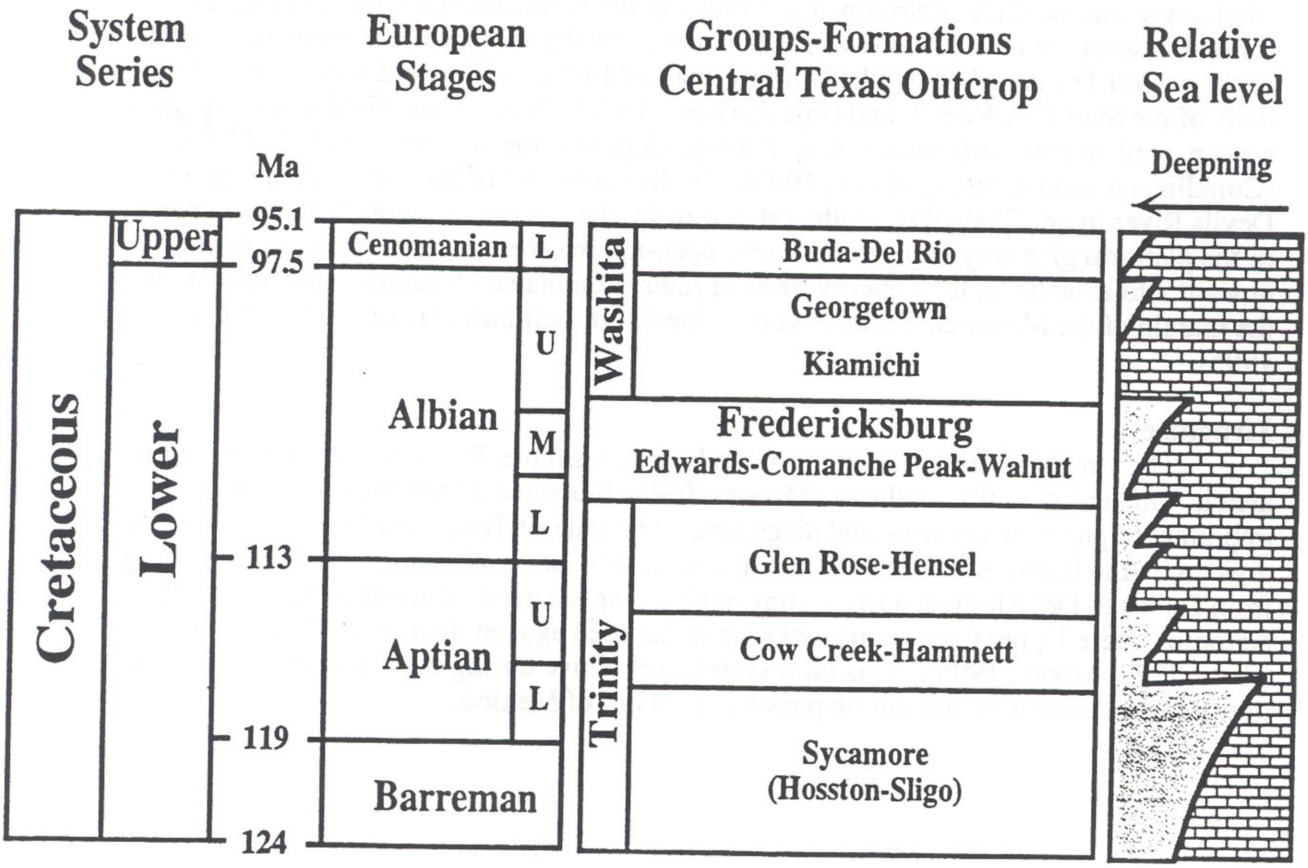


Fig. 2. General stratigraphic setting for central Texas. (From Moore, 1995; modified from Scott, 1993)

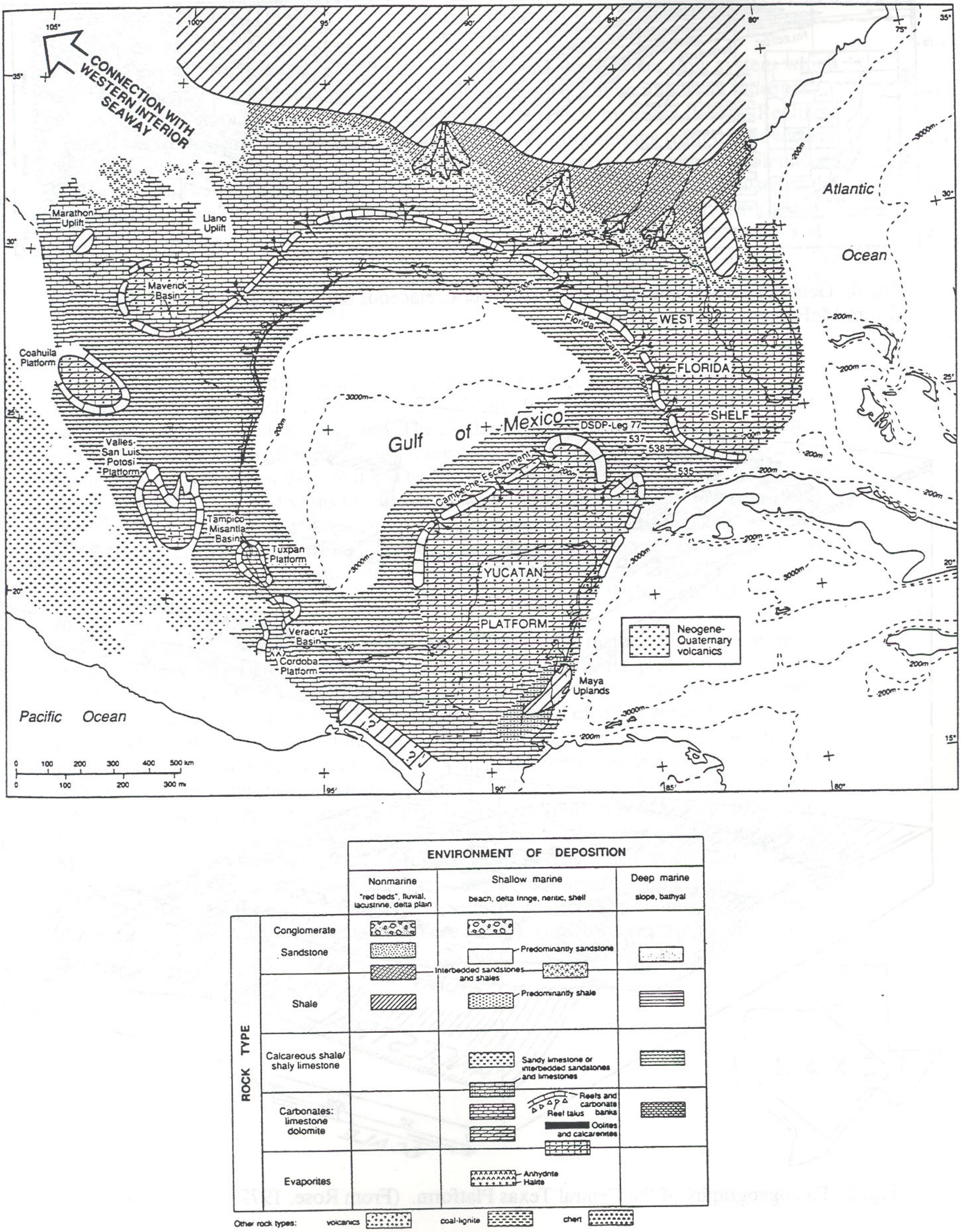


Fig. 3. Lithofacies paleogeographic map, Albian. (From McFarlan and Menes, 1991)

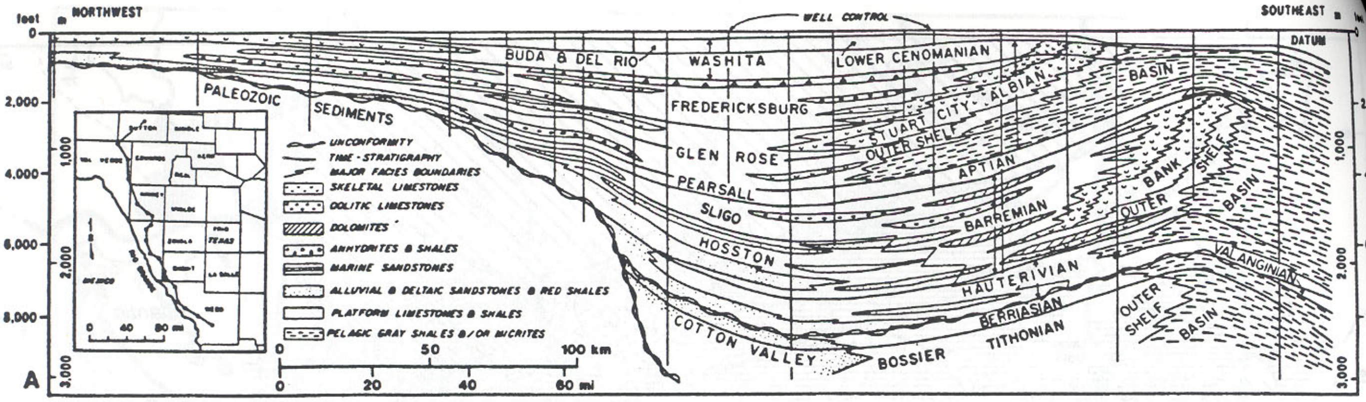


Fig. 4. Generalized regional dip section of Lower Cretaceous deposits across South Texas. (From McFarlan and Menes, 1991)

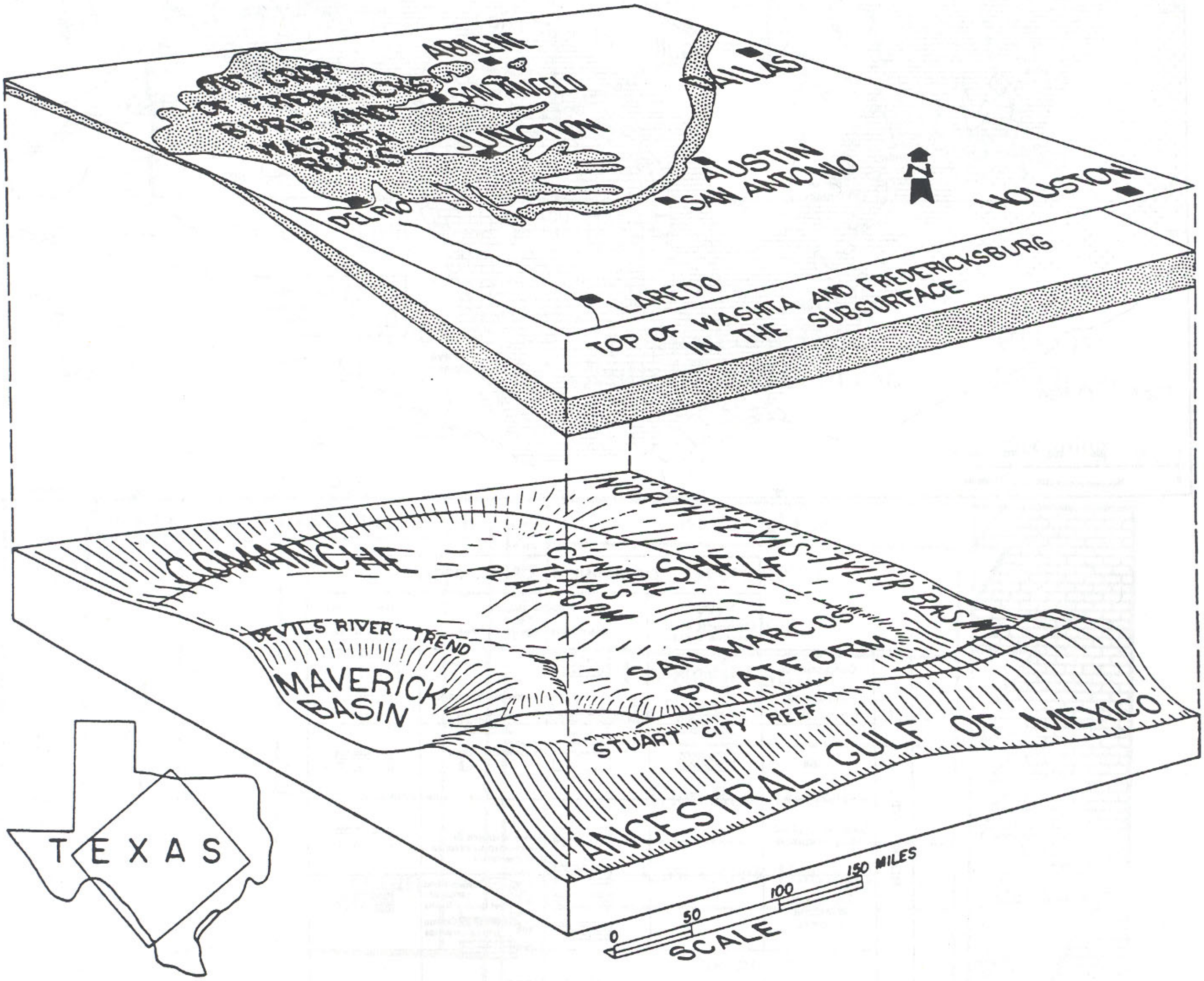


Fig. 5. Paleogeography of the Central Texas Platform. (From Rose, 1972)

Hydrogeology

Strata of the Edwards Group comprise a regional groundwater flow system which provides drinking water to the city of San Antonio and serves as an important industrial and recreational resource throughout central Texas (see review by Sharp, 1990). Recharge to the Edwards aquifer occurs via 1) streams and discharging springs from the Edwards Plateau, which lies to the north of the Balcones Fault Zone and is comprised of Glen Rose, Walnut and Edwards strata, and 2) direct infiltration where the Edwards is exposed at the surface and in hydraulic continuity with the confined portions of the aquifer. Original depositional fabrics of Lower Cretaceous carbonate rocks and subsequent fracturing and faulting play significant roles in creating confining and aquifer units, as well as controlling flow directions and chemical evolution of groundwater (e.g., Abbott and Woodruff, 1986; Sharp, 1990; Oetting et al., 1996)

Stratigraphy

The Cretaceous of Central Texas is divided into three groups: the Trinity, Fredericksburg, and Washita (Fig. 6, 7). The Trinity Group consists of shallow marine carbonates and terrestrial siliciclastics. The Fredericksburg Group consists of shallow marine limestone and marl representing more open marine conditions, with less coarse siliciclastics than those of the Trinity. The Washita Group consists of deeper marine shelf limestones and shales and spans the Upper-Lower Cretaceous boundary (Moore, 1995). We will examine portions of the Trinity and Fredericksburg and the boundary between them. In the Trinity Group, we will visit the Glen Rose Formation. In two localities we will see the regional unconformity on the top of the Glen Rose Formation. In the Fredericksburg Group we will look at several members of the Walnut and Edwards formations (Moore, 1995).

The Lower Cretaceous in Central Texas represents a major gulf-wide marine transgression with progressive over-stepping and drowning of the previous sequence. Lozo and Stricklin (1956) noted that the Lower Cretaceous units of central Texas can be packaged in genetically related units or couplets composed of siliciclastics at the base, followed by carbonates, and terminated by unconformities. They termed these units Divisions and related their development to changes in relative sea level. Lozo was strongly influenced by the stratigraphic work of L. Sloss and his students. Lozo and Stricklin (1956) and subsequent Cretaceous workers (Lozo and Smith, 1964; Moore, 1964, 1967; Rose, 1972) recognized three divisions within the Trinity (the Lower Hosston-Sligo; the Middle Cow Creek-Hammett; the Upper Glen Rose-Hensel), the Fredericksburg Division and the Washita Division. These units are widely used as regional time-stratigraphic units in south and central Texas (Moore, 1995) and form the basis for the modern sequence stratigraphic framework developed by Moore (1995), which we will use on this trip.

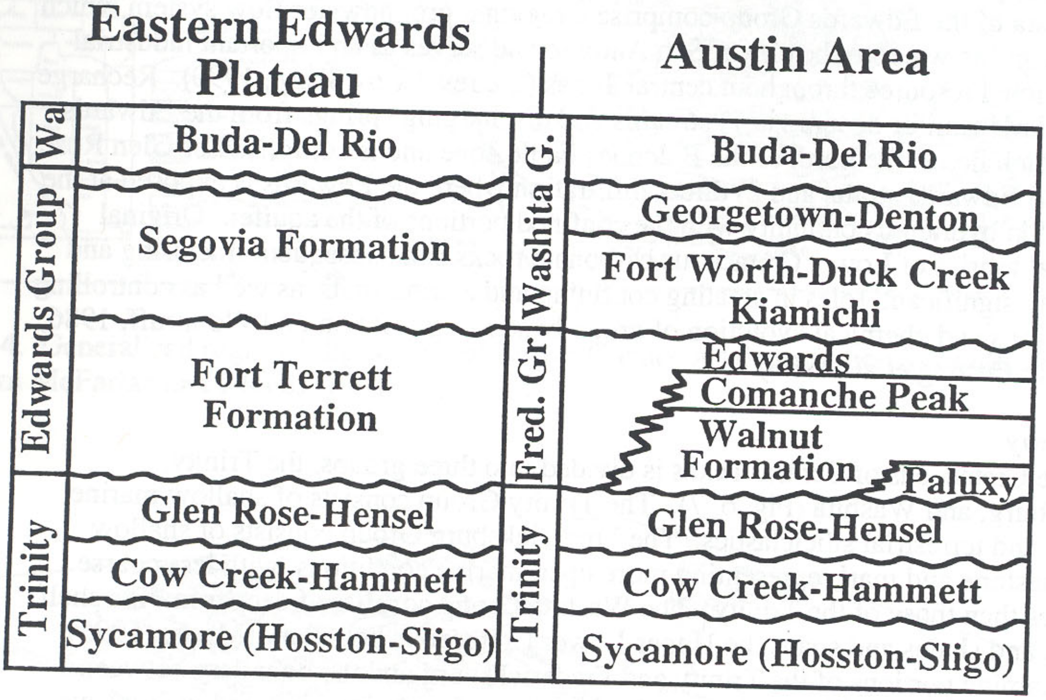


Fig. 6. Lithostratigraphic setting, central Texas. (From Rose, 1972)

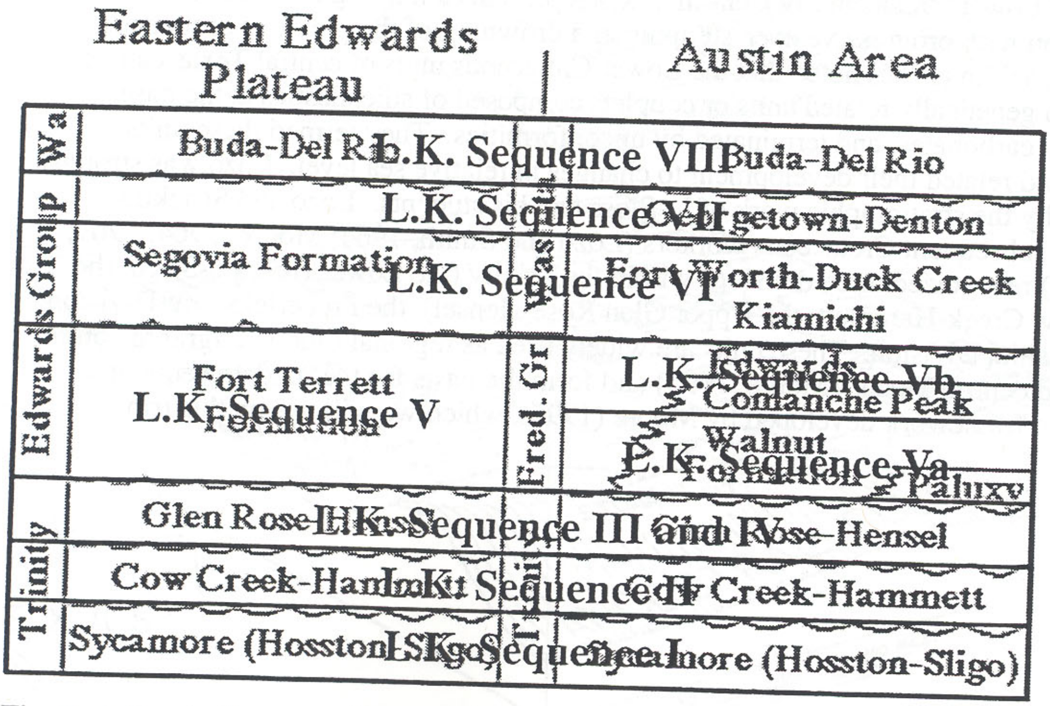


Fig. 7. Lithostratigraphy of Rose (1972) overlain by sequence stratigraphy of Moore (1995). (From Moore, 1995)

STOP 1

South San Gabriel River / Highway 183
(Glen Rose/Walnut Contact)
(Boundary between sequences IV-V)

Directions:

Park on the west side of Highway 183 just north of the South San Gabriel River bridge and follow the path to the river. Walk under the bridge, down to the river, and then downstream some 50 meters, to the low outcrop on the north bank of the river (Figure 8).

Geological Setting and Significance:

As you walk down the path on the western side of the bridge, note the large bluffs on the other side of the river (looking toward Austin; Fig. 8, now unfortunately mostly covered). These bluffs are developed in the Cedar Park and Bee Caves members of the Walnut Formation. Fig. 9 is a measured section in the vicinity of this stop. The section of interest, the Bull Creek Member of the Walnut, crops out in a low cut along the north side of the river to the east of the highway. The Fredericksburg (Sequence V) in this area consists of fossiliferous, massive, nodular limestone, and marl. The river bed exposes the upper surface of the Glen Rose (top of Sequence IV). This contact is a Texas-sized unconformity, exposed in many localities across the Central Texas Platform. The upper Glen Rose contact at the South San Gabriel River is marked by mud cracks, dinosaur tracks (Figure 10, 11), and pholad bivalve borings (Figure 12).

The Glen Rose at this site comprises dolomitized foraminifera packstones. The overlying Bull Creek Member is composed of nodular, fossiliferous, lime wackestones-to-grainstones. Three cycles can be seen in the section (Figure 13). Each cycle starts with nodular marls and ends with packstones-to-grainstones. Foraminifera, bivalves and intraclasts are the predominant grains. The upper contact of each cycle is a well-developed hardground of apparent marine origin. These surfaces are marked by pholad bivalve borings and encrusting oysters.

The Glen Rose-Walnut transition is marked by a pronounced increase in faunal diversity and a mineralogical change from dolomite to calcite (Fig. 14). The unconformity is a regional sequence boundary (Scott, 1993; Moore, 1995) and is interpreted as the top of Sequence IV (Fig. 7; Moore, 1995). The Fredericksburg Group (Sequence V) in this area is equivalent to the Fort Terret Formation found to the west (Kerrville/Junction area). In the Austin area, several units within the Bull Creek onlap this sequence boundary (Moore, 1964). Just to the north, the Paluxy Sand, a quartzose clastic unit, occupies the space between the Bull Creek and the Glen Rose (see stop 4). The Bull Creek onlaps and partially erodes the feather edge of the Paluxy, suggesting that the Paluxy is the low stand systems tract (LST) of Sequence V.

The Bull Creek Member probably represents the early transgressive systems tract (TST) for Sequence V. The stacked, meter-scale parasequences suggest a rather low rate of accommodation space generation as would be expected at the start of a transgression. The highly fossiliferous marls of the Bee Cave just above the Bull Creek probably encompass the maximum flooding surface (MFS) of Sequence V and record the acceleration of relative sea level rise. We will look at equivalent relationships closer to Austin later today at stop 4.

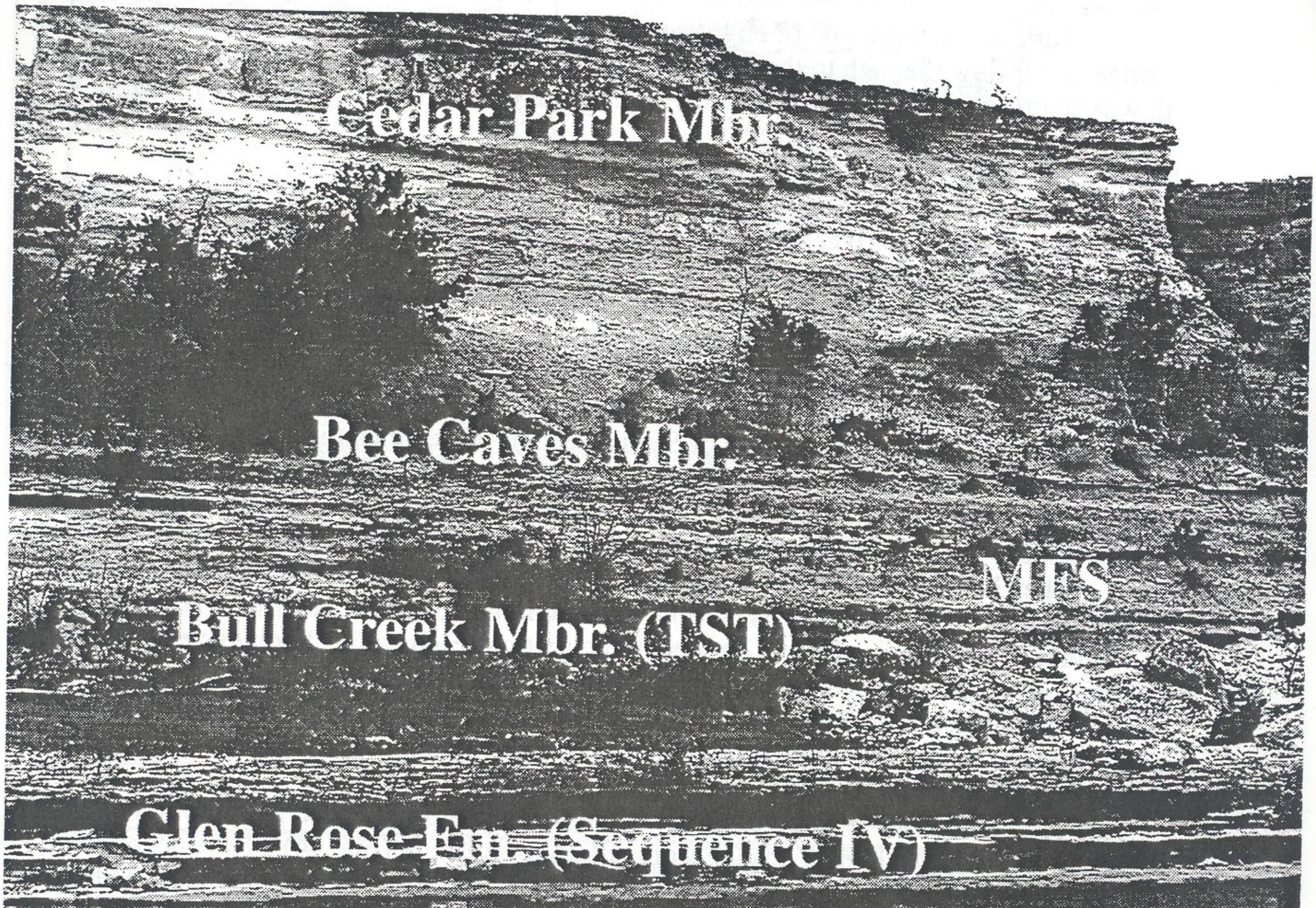


Fig. 8. Photograph from the 1960's of the cliff on the western side of the bridge at Stop 1. This cliff is now completely overgrown.

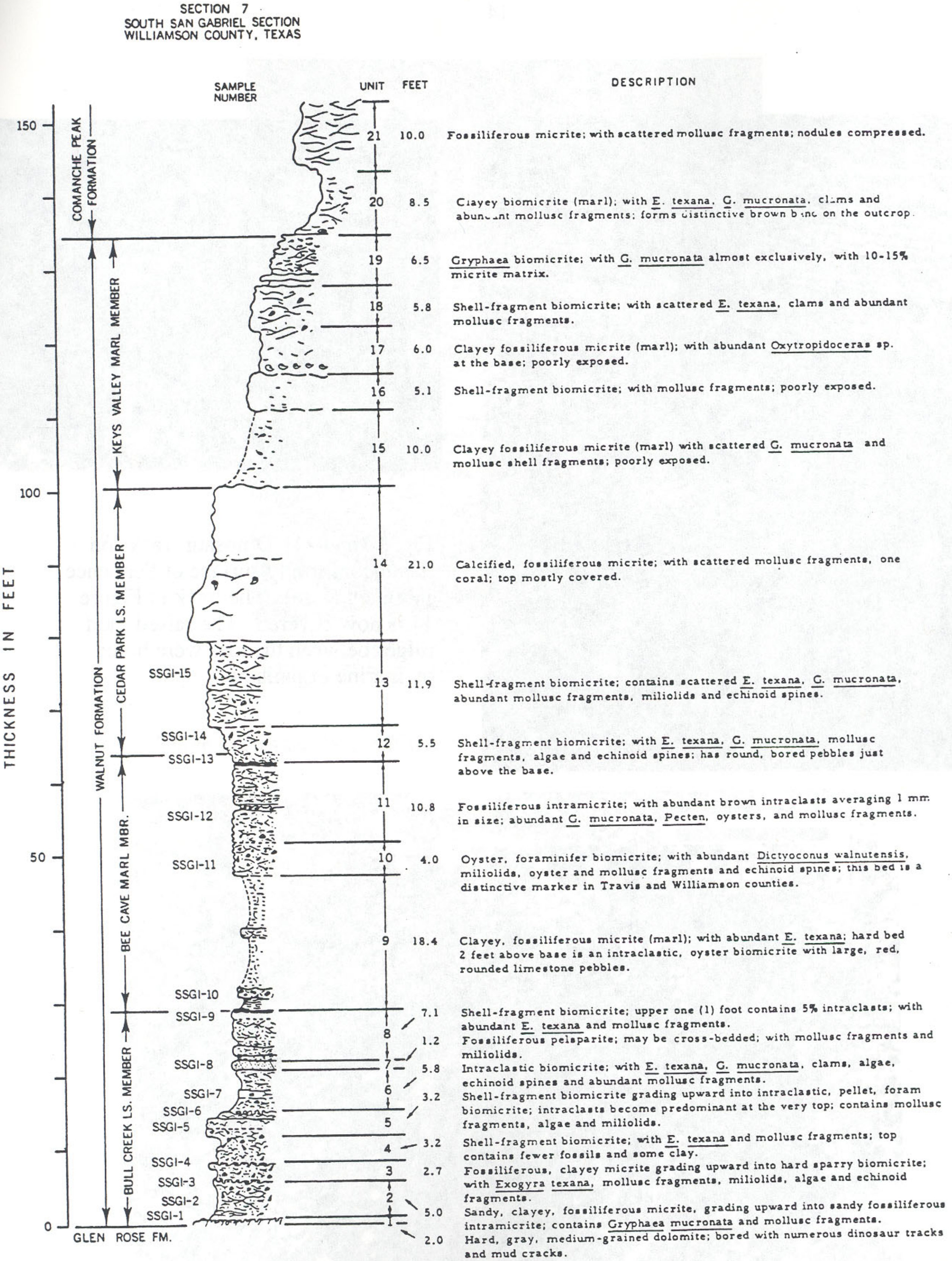


Fig. 9. Measured section from the Fredericksburg (Sequences IV and V) (From Moore, 1964)

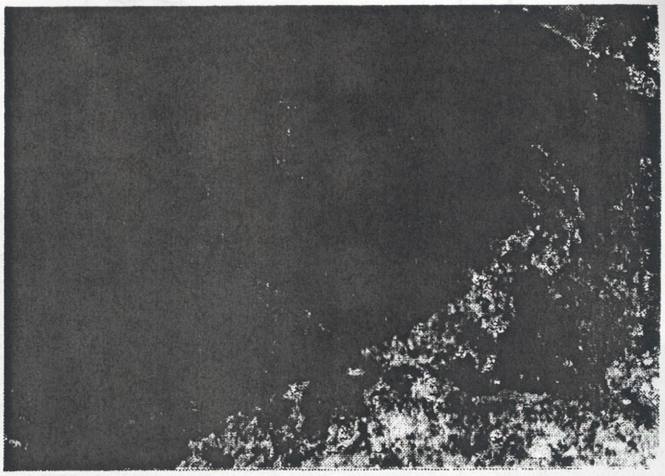


Fig. 10 and 11. Dinosaur tracks on the unconformity surface of Sequence IV (Glen Rose). The track in Figure 11 is now covered. The raised mud ridges between the toes were bored by marine organisms.

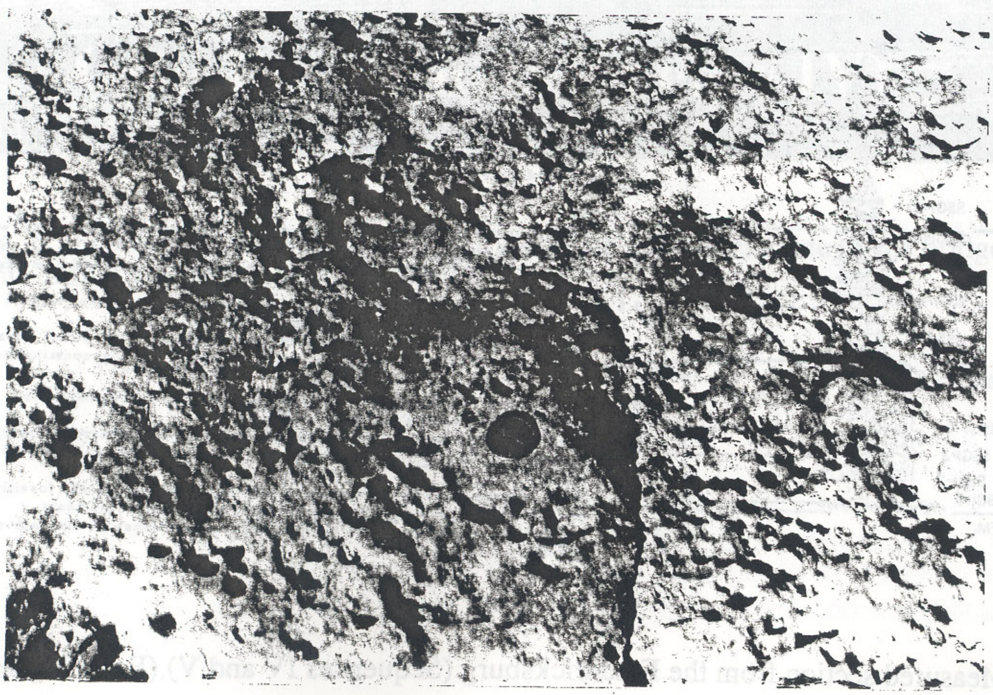


Fig. 12. The unconformity surface of Sequence IV at Stop 2 is riddled by marine clam borings.

Fig. 13. Three cycles can be identified in the Bull Creek Member at this locality.

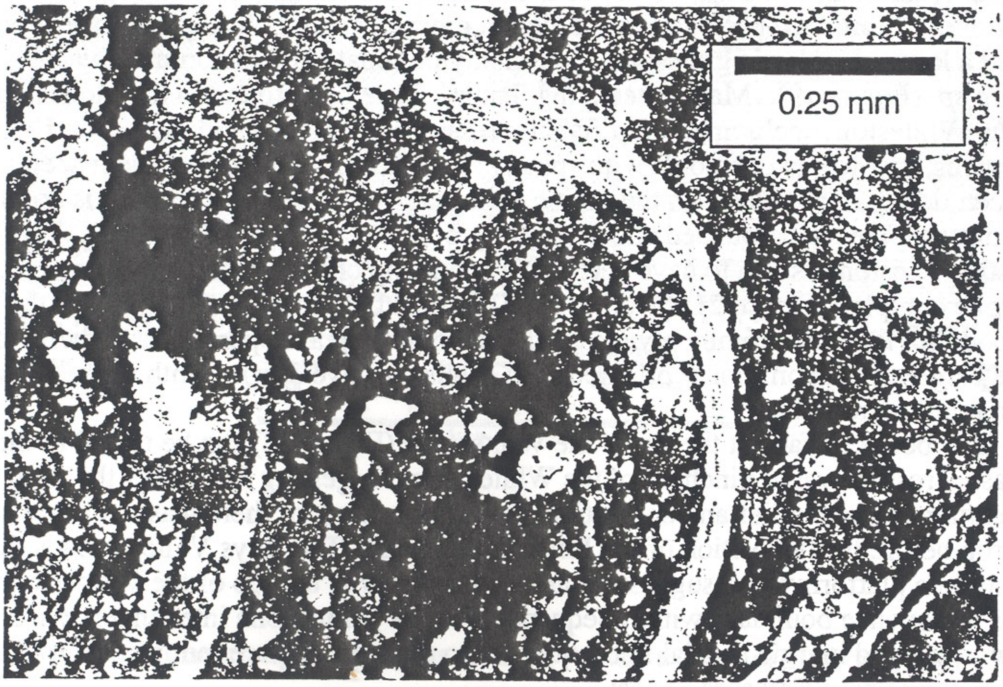


Fig. 14. Photomicrograph of sample from the Bull Creek Member above the contact with the Glen Rose.

STOP 2

Whitestone Quarries
(Cedar Park, Whitestone, Keys Valley Marl Members of the Walnut Formation)
(High-Energy Grainstone Margin of the Central Texas Platform)

Directions: The entrance to the Ruby Stone Quarry is 2.3 mi south of 1431 on Lime Creek Road. Permission to enter the quarry must be obtained from Mr. Ruby and all participants must sign a waiver of liability.

Geological Setting and Significance:

The quarry floor is the Cedar Park Member. The allochems in this rudist-bearing pellet grainstone are all well-rounded. To the north this surface is bored by pholad clams (Moore, 1964; Loucks, et al., 1978). The lower portion of the walls of this part of the quarry are the Whitestone Member . This grainstone sequence attains a thickness of 21 m (70 feet), and occupies an outcrop band 8 km (5 miles) wide and 96 km (60 miles) long, on the northeastern margin of the Central Texas Platform. Figure 15 illustrates a regional stratigraphic section from the Central Texas Platform into the East-Texas Tyler Basin, showing the Whitestone position along the margin of the platform. The Moffat mound is another grainstone complex within the Edwards Limestone, northeast of the study area, that is parallel to but offset and younger than the Whitestone. This relationship suggests that the Central Texas Platform expanded eastward through time (Moore, 1995).

Figure 16 is a composite stratigraphic section of the Whitestone exposed in the quarries in this vicinity done by Loucks, et al. (1978). The Keys Valley Marl onlaps the upper surface of the Whitestone and is present as a thin, 8-10 foot sequence containing ammonites. The upper surface of the Whitestone is extensively bored by pholad bivalves and other organisms, and often occurs as a flat, table-like surface (Figure 17). The Whitestone exhibits two basic facies: an upper, cross-bedded, oolitic grainstone (Figure 18); and a lower, bioclastic grainstone, commonly dominated by the ornate bivalve *Trigonia sp.* (Figure 19). Many interesting features have been found in the blocks quarried from the Whitestone including: jelly fish impressions, palm logs and palm frond impressions, and whole echinoids with spines. The depositional environment seems to have been tidally dominated. In the oolitic facies herringbone cross-bedding is common and grains are fine, well-rounded and commonly oolitically coated (Figure 20). The bioclastic grainstones seem to have been associated with channels through the main grainstone complex (Figure 21) (Moore, 1995). In the bioclastic facies, shells of the gastropod *Turritella* are commonly oriented with their long axes parallel and shells of the bivalve *Trigonia* are commonly oriented with shells concave down. Both of these features suggest rapid current flow.

The bored surface at the top of the Whitestone (Figure 22) can be traced to the northeast across the rapid pinchout of the Whitestone, suggesting that either the shelf margin attained some relief and deposition slowed or ceased, or there was a relative sea level drop before the deposition of the Keys Valley Marl. The Keys Valley onlaps the bored surface platformward, suggesting an unconformity at the top of the Whitestone and perhaps a sequence boundary within Sequence V. The Whitestone interfingers with shallow, restricted marine to tidal flat sequences to the west that are reminiscent of the Fort Terrett of the eastern Edwards Plateau.

Both facies of the Whitestone are widely used as a decorative building stone. The ooid facies (Cordova Cream) is used for carving decorative valences, columns, and intricate cut pieces. The *Trigonia* stone (Cordova Shell) (Figure X) is used as decorative facing stone. Much of the University of Texas is faced in stone obtained from these quarries. The decorative stone is becoming increasingly difficult to find. Figure X illustrates the quarry operations in the vicinity in the early 60's. The stone from the quarries that can be visited today is being used as crushed stone in the building trade (Moore, 1995).

As we drive south along 183 we cross a prominent physiographic feature termed the Jollyville Plateau. It is held up by the massive rudist-bearing limestones of the Edwards Formation. We will examine the Edwards Formation at stop 4 today, which varies widely in thickness near Austin from 15 to over 100 m (Moore, 1995).

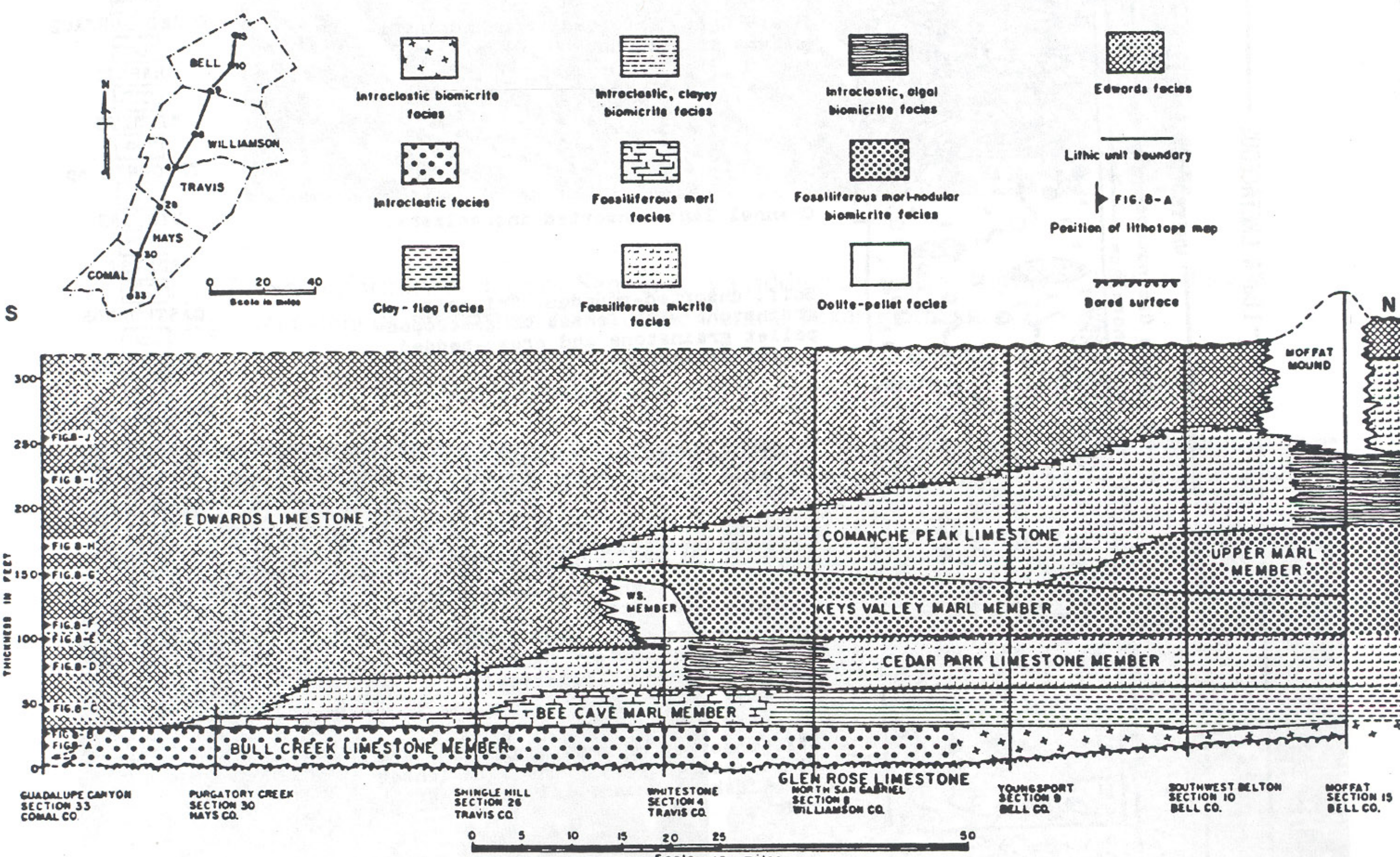


Fig. 15. Regional lithostratigraphic cross section, Austin to the north (from Moore, 1961, 1964).

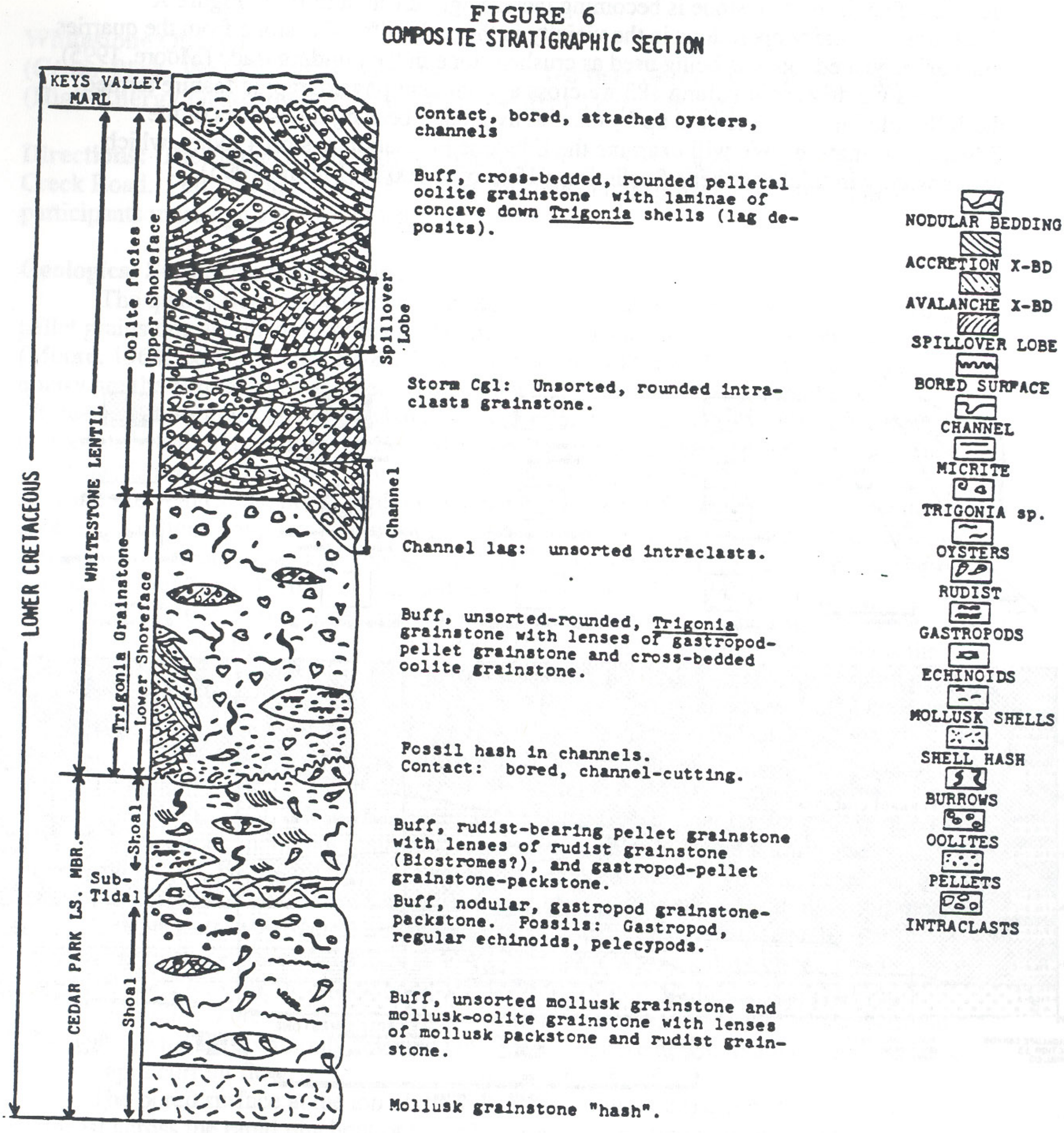


Fig.16. Measured section of the Fredericksburg group (from Loucks et al., 1978).

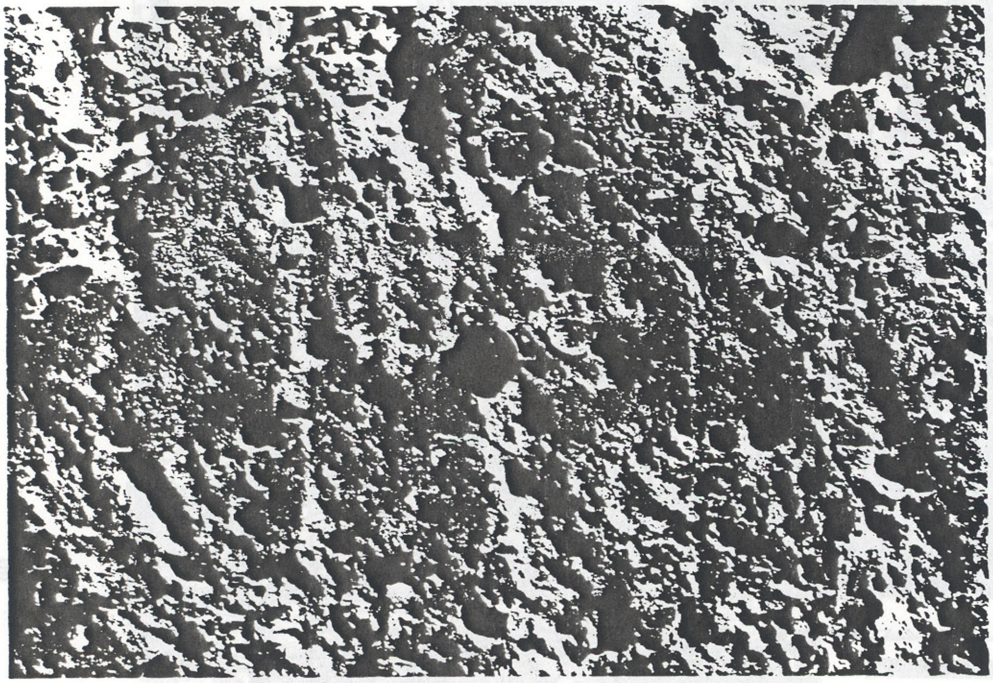


Fig. 17. Unconformity surface of Sequence Va riddled by marine borings. This surface is of regional extent on the eastern flank of the Central Texas Platform.

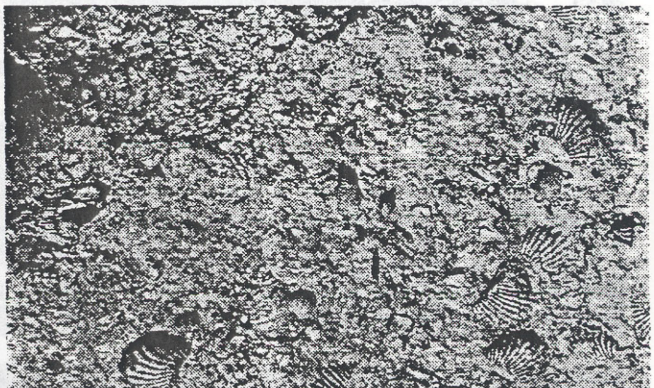


Fig. 18. Bi-directional cross beds in ooid grainstones near the top of Sequence Va at Stop 4 (from Moore, 1995).

Fig. 19. Fossil grainstone beaneath the ooid grainstone in the upper part of Sequence Va. This facies is termed the *Trigonia* stone because of the distinctive bivalves molds seen in the photo (from Moore, 1995).

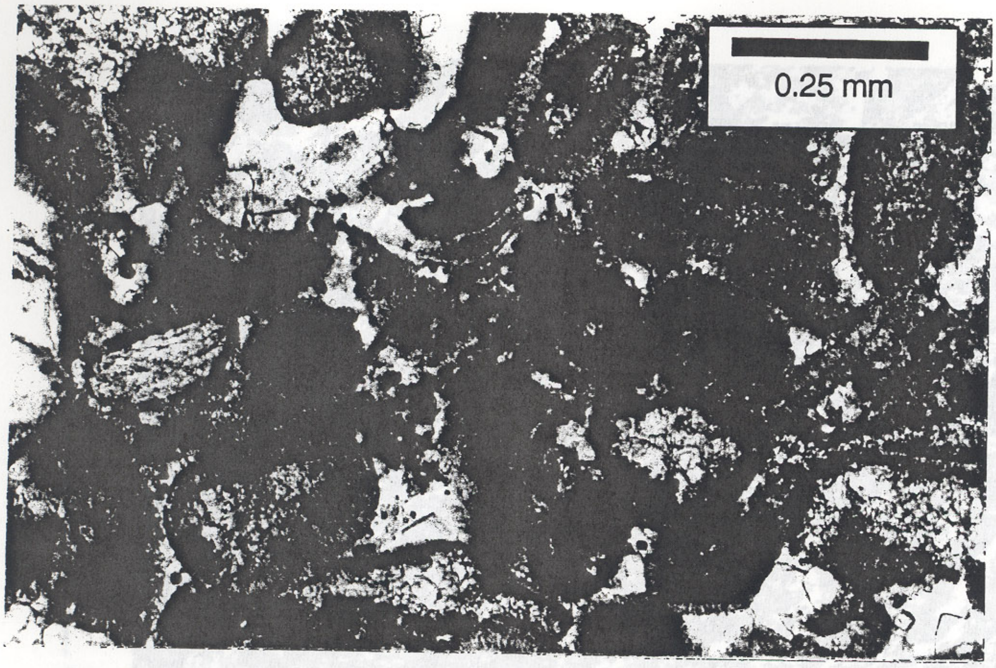


Fig. 20

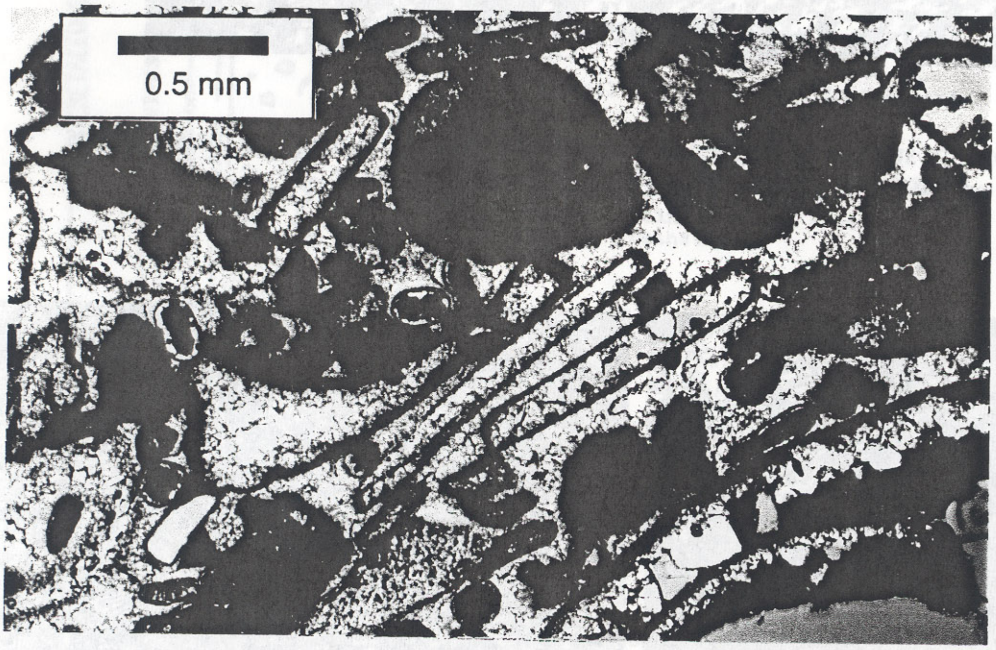


Fig. 21

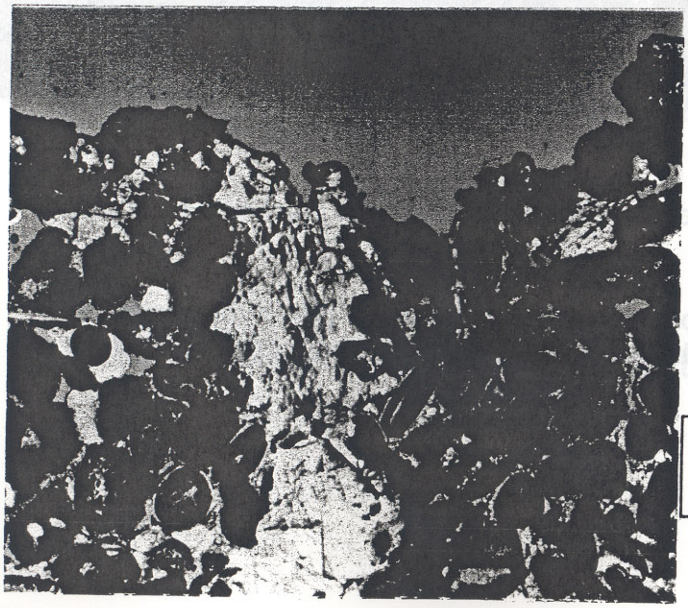


Fig. 22

Fig. 20. Ooid grainstone from the ooid facies.

Fig. 21. Fossil grainstone from the *Trigonia* facies.

Fig. 22. Whitestone bored exposure surface.

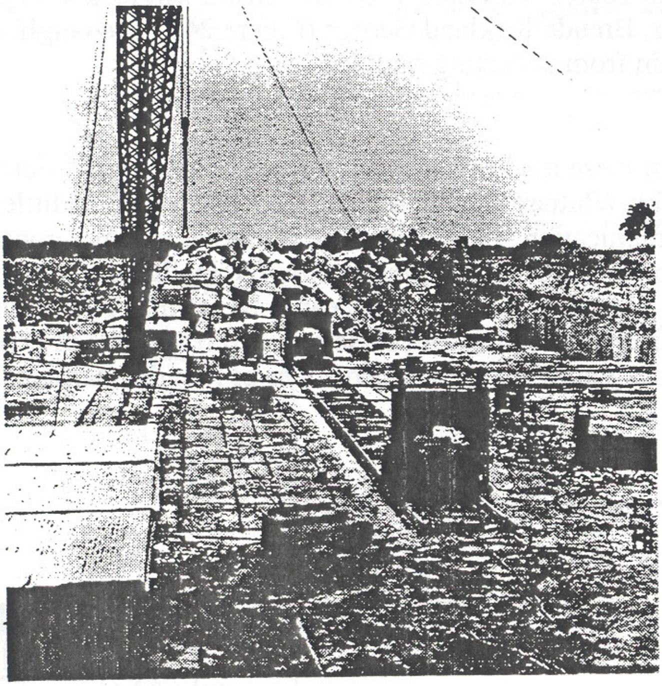


Fig. 23. Early quarry operations near the village of Whitestone. Most of these quarries have been quarried out and subsequently filled in (from Moore, 1995).

STOP 3

Rudist Biostromes
(Walnut Formation)

Directions:

This locality is in a residential area. From Highway 183 turn to the west onto Balcones Woods/Floral Park, turn left onto Rain Creek and immediately turn right onto Sausalito Dr, proceed to 10004 Sausalito. The bioherm we will look at is partially in the front yard of trip leader, Brenda Kirkland George (Figure 24). The neighbors have requested that we refrain from collecting samples.

Geologic Setting:

The existence of these muddy rudist biostromes in the Walnut Formation was noted as early as 1948 by Whitney and Young, but they have received little study to date (Young, personal communication, 1996) (Fig. 25). These biostromes contain: caprinid and toucasid rudists, some encrusted by *Lithocodium/Bacinella,* and echinoderms, ostracods, and peloids. Some of the rudists appear to be *in situ*. The small out crops in the back yard are grainstone composed of coarse rounded fragments of echinoderm, gastropod, oyster, rudist along with fine grained zones of rounded particles and peloids (Figure 26, 27).

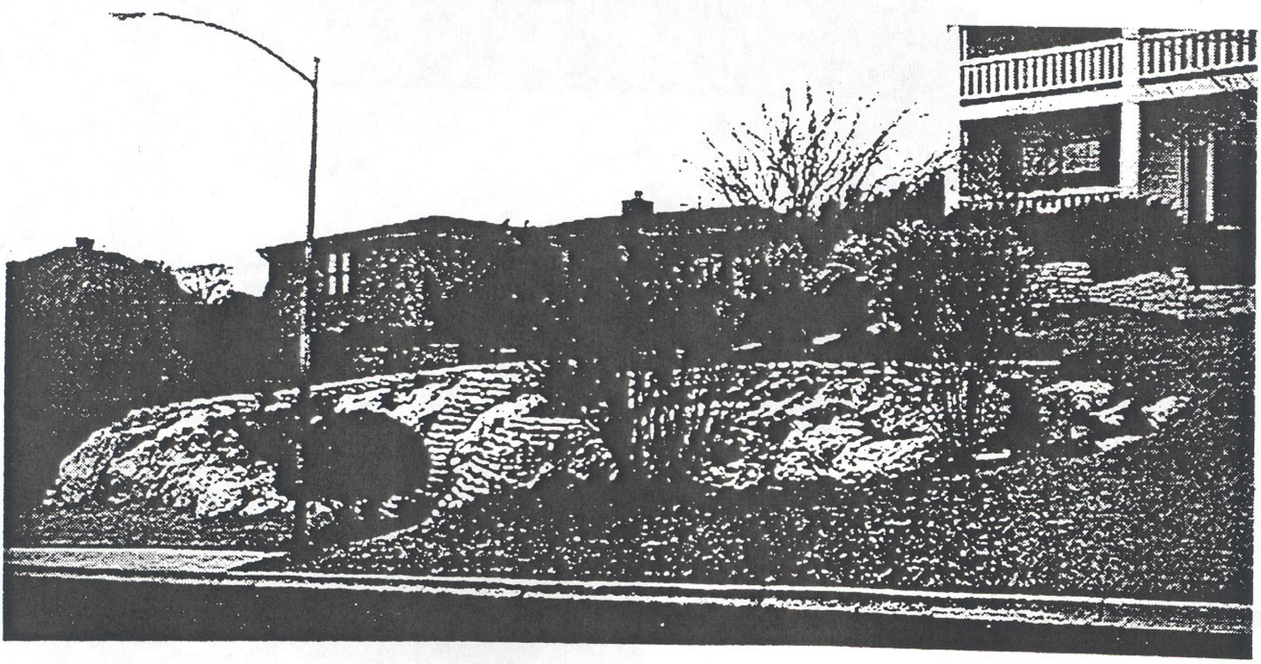


Fig. 24. Residential biostrome.

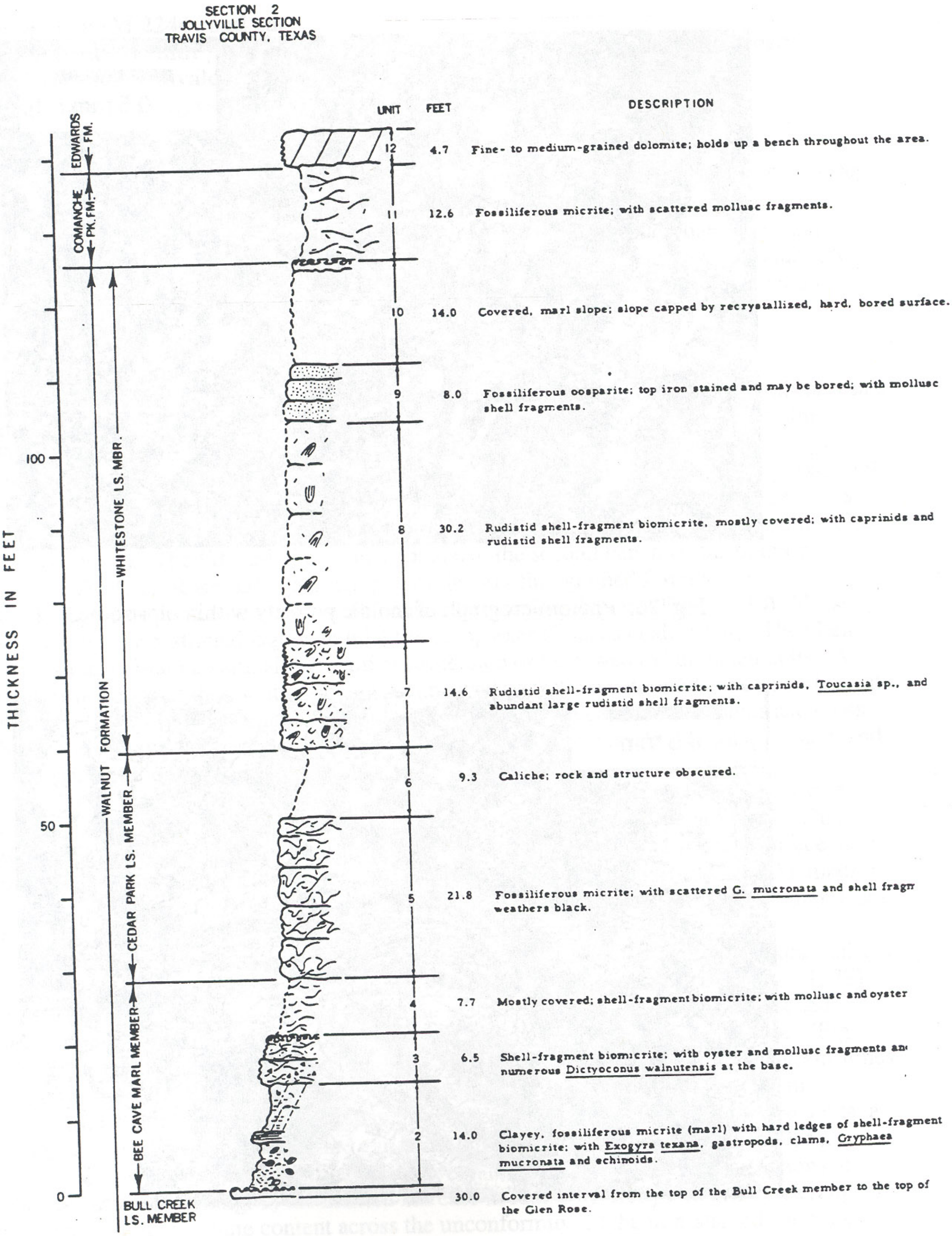


Fig. 25. This section was measured just north of Stop 3. Most of these units can be identified in this neighborhood, though portions of the section are covered by development.

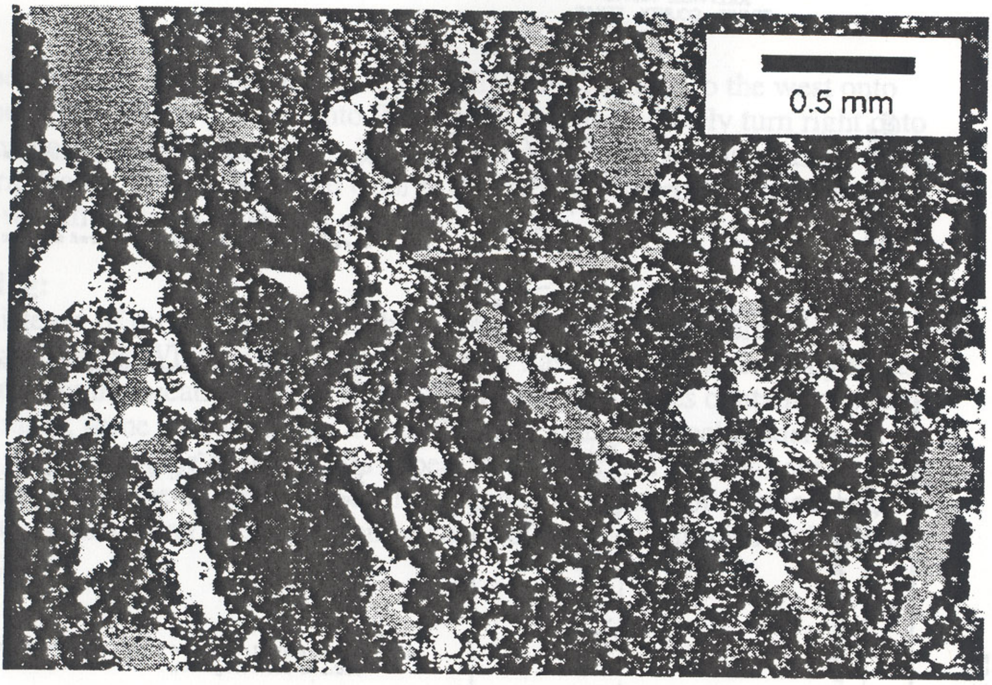


Fig. 26. Photomicrograph of moldic porosity within biostrome.

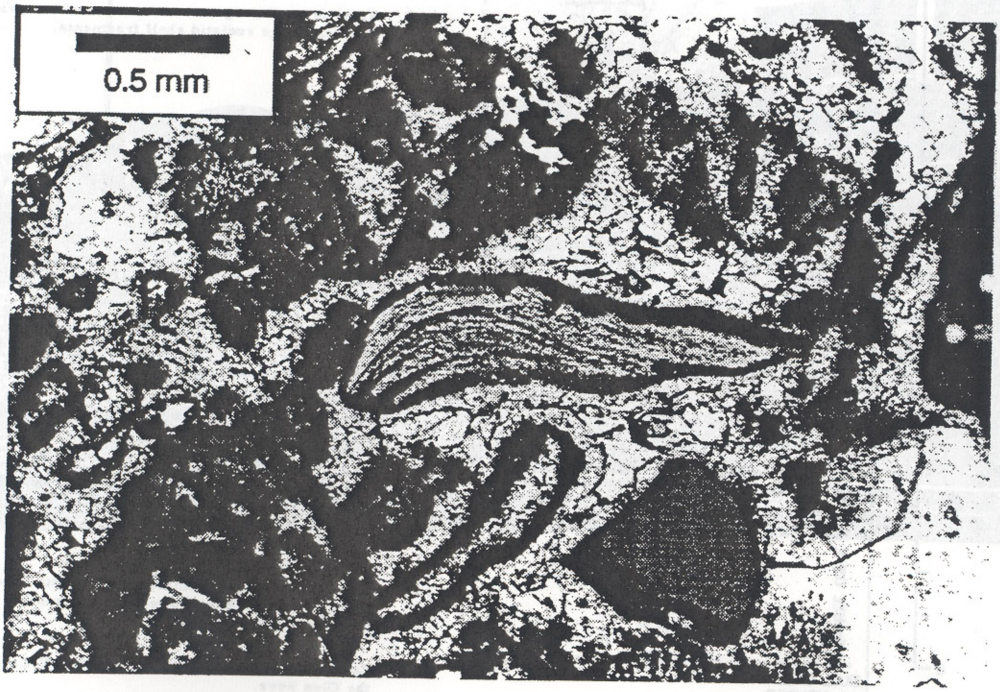


Fig. 27. Photomicrograph of sample from the grainstone outcrop in the back yard.

STOP 4

Loop 360/FM 2244 road cut
(Glen Rose, Walnut [Bull Creek, Bee Cave, Cedar Park Members], Edwards [Whitestone Equivalent] Formations)
(Highstand-transgressive systems tracts of Sequences IV-V)

Directions:

This extensive, terraced outcrop is located at the intersection of Loop 360 and FM 2244 (Bee Caves Road). A convenient place to park is the office building parking lot accessible from the entrance ramp on the northeast section of the interchange. *Please exercise extra caution as there are numerous loose blocks on the walls of this relatively new roadcut. Examine the wall above you before hammering and stay back from the edges of the benches.*

Geological Setting and Significance:

The extensive road cut section stratigraphically spans approximately 5 million years and is near the type localities of the Bull Creek and Bee Cave members of the Walnut Formation (Moore, 1964). Figure 28 is a photo of the road cut with scale, contacts, and stratigraphic nomenclature superimposed. The Glen Rose-Walnut contact is approximately halfway up the base of the cut at the top of a thick sequence of thinly bedded limestones and dolomites. The road-sign 'exit' arrow on the shoulder of southbound 360 points close to this contact. The Edwards Fm. crops out above the second bench at this outcrop.

The Glen Rose carbonates are predominantly fine-grained foraminifera wackestones to packstones that are dolomitized to varying degrees (Fig. 29, 30). These strata represent restricted lagoon to tidal flat complexes (Loucks et al., 1978). The Glen Rose strata contain a vertically-repetitive succession of burrowed to laminated units. A composite cycle of these units contains a burrowed packstone with mudstone intraclasts at the base (Fig. 34), a horizontally-laminated grainstone with small-scale ripples and cross-beds, and a wavy-laminated packstone with evidence for stromatolitic binding of sand and mud-sized carbonate during deposition.

The upper surface of the Glen Rose at this site is iron-stained, bored by marine organisms and encrusted by oysters, as seen on the correlative surface at Stop 1. This wide-spread surface extends over the entire Central Texas Platform. It is the surface upon which the Paluxy Sand is deposited, and upon which the overlying Bull Creek Member onlaps. At this site, the Paluxy is absent, and the Bull Creek sits directly on the Glen Rose (Moore, 1995).

The Bull Creek comprises 11 meters of burrowed, nodular limestone (foraminifera -peloid-bivalve packstone to fossiliferous, foraminifera -peloid grainstone) (Fig. 31, 32). There are three massively-bedded packstone units, each overlain by medium-bedded grainstones. The packstones contain a wide range of grain sizes and fossil types (Fig. 33). The grainstones contain fossil fragments, peloids, and coated grains. The grainstones are cross-bedded on a range of scales and in places are disrupted into large (0.5 m) intraclasts that exhibit imbricate and random orientation. The Bull Creek also contains a number of distinct surfaces that are variously bored and iron-stained (Moore, 1995).

There are numerous similarities between the Glen Rose-Walnut successions at Stops 1 and 4, including: 1) the marked increase in faunal diversity and grain size range, and decrease in dolomite content across the unconformity; 2) the iron-stained and bored hardgrounds at the unconformity and within the Walnut; and 3) the occurrence of packstone-grainstone cycles at the base of the Walnut. Among the contrasts between these successions are that the Walnut at Stop 4 contains 1) more numerous hardgrounds within the packstone units, 2) thicker packstone-grainstone cycles, and 3) higher energy sedimentary structures in the grainstone units. A number of the hardground surfaces, like those seen at Stop #1 at the South San Gabriel River, lack evidence of subaerial exposure, and can be interpreted as marine hardgrounds that may be a consequence of a filling of available accommodation space in a relatively high energy system. In this scenario, the hardground represents a distinct cessation of sedimentation and sediment by-pass at the end of a shoaling upward cycle. The thicker cycles and higher energy characteristics of the Walnut units at Stop 4 are consistent with the more seaward position of Stop 4 relative to Stop 1. Moore (1964) documented significant Bull Creek onlap in the direction of Stop 1.

The top of the Bull Creek at Hwy. 360 is a flat exposure surface with well developed mudcracks and marine borings (Fig. 35), overlain directly with the fossiliferous marls of the Bee Cave Member of the Walnut Formation. Note that the hardground capped parasequences of the Bull Creek are thin compared to the much thicker Sequence V parasequences (up to 10 m) above the Bee Cave flooding surface. The Bull Creek could represent the early transgressive systems tract of Sequence V, with the stacked, relatively thin parasequences suggesting slow rates of accommodation space generation at the beginning of Sequence V, with a rapid acceleration of accommodation marked by the Bee Cave flooding event.

When the siliciclastics of the Paluxy are considered, however, another possibility presents itself. If the Paluxy sands, deposited on the Glen Rose and occupying the same stratigraphic space as the Bull Creek, represent the lowstand systems tract of Sequence V, then the Bull Creek could be a carbonate lowstand wedge and be laterally equivalent to the Paluxy, with the initiation of the transgressive systems tract at the Bee Cave flooding surface. The parasequence stacking patterns found in the Bull Creek, however, tend to favor an early transgressive systems tract for the unit.

The Bee Cave Member is an open marine unit known for its extensive and varied fauna and flora, including bivalves, echinoids, ammonites, green algae and foraminifera. The units above the Bull Creek, such as the Bee Cave, Cedar Park and Keys Valley, all start with clay-rich marls at the base and terminate with relatively pure white nodular limestones. This pattern may indicate an initial deeper water, carbonate-starved, clay-rich phase followed by a carbonate-dominated, clay-poor catch-up phase. Each of these cycles (parasequences) in the East Texas-Tyler Basin average about 10 meters in thickness and are probably fourth-order sequences in the sense of Vail et al. (1991). The bedded limestones at the top of the 360 cut, called locally Edwards Limestone (Fig. 28), are the lateral equivalents of the Walnut grainstones found acting as a shelf margin at Stop #2 in the Whitestone Quarries just north of Austin (the top of the Cedar Park Member is 30 meters above the Glen Rose at Whitestone as well as in the 360 road cut).

Questions to ponder at Stop 4 include:

1) Are the carbonate rock sequences at this outcrop cyclic? What is the nature of the cyclicity, if present?

2) What causes the pronounced change in fauna, sedimentary structures, mineralogy, and parasequence thickness across the Glen-Rose Walnut boundary? Are these changes coincidental or do they have a common (or related) causal mechanism?

3) What mechanism could produce the relationship between dolomite distribution and accommodation space?

4) What process could have formed the hardgrounds observed in the Bull Creek?

5) What are the structural features in the Edwards Fm. at the top of the outcrop?

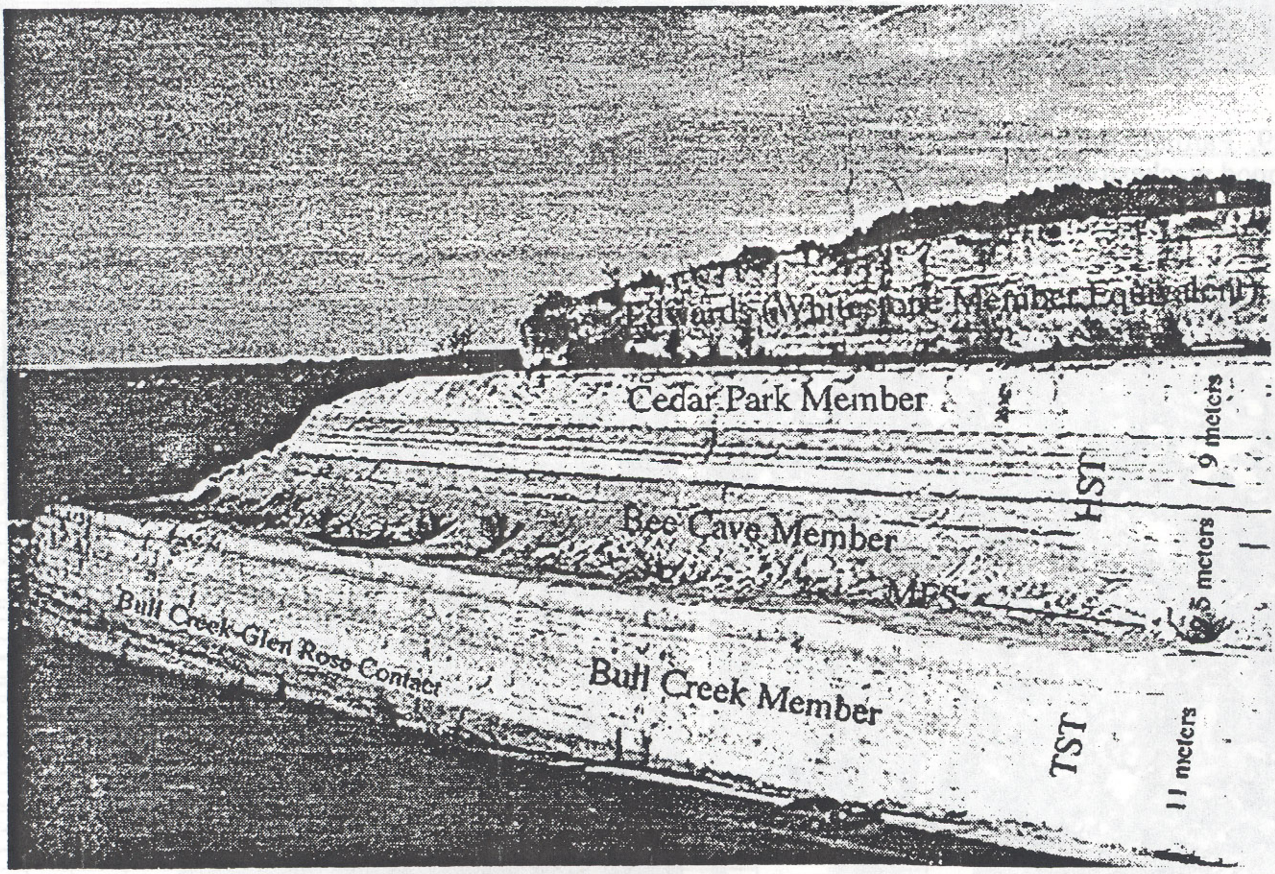


Fig. 28. Road cut on Loop 360 at Bee Caves Road.

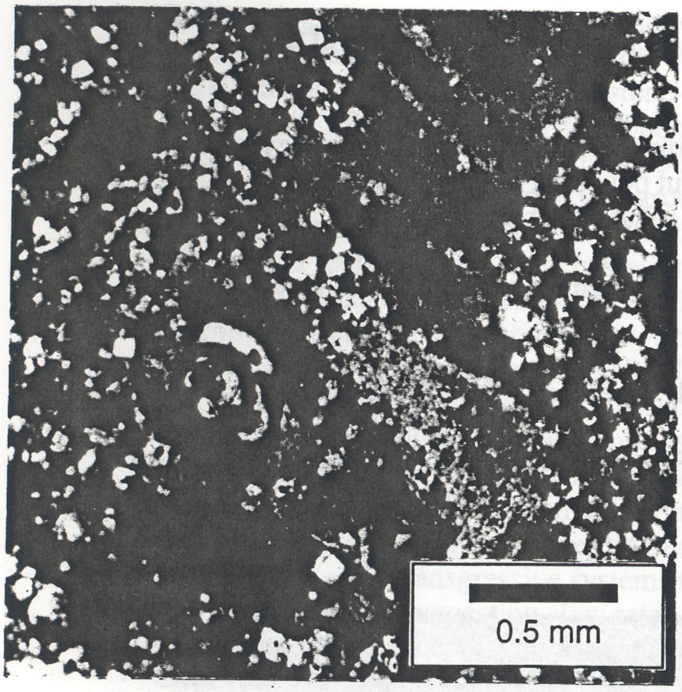


Fig. 29. Partially-dolomitized foraminifera gastropod wackestone, Glen Rose Fm.

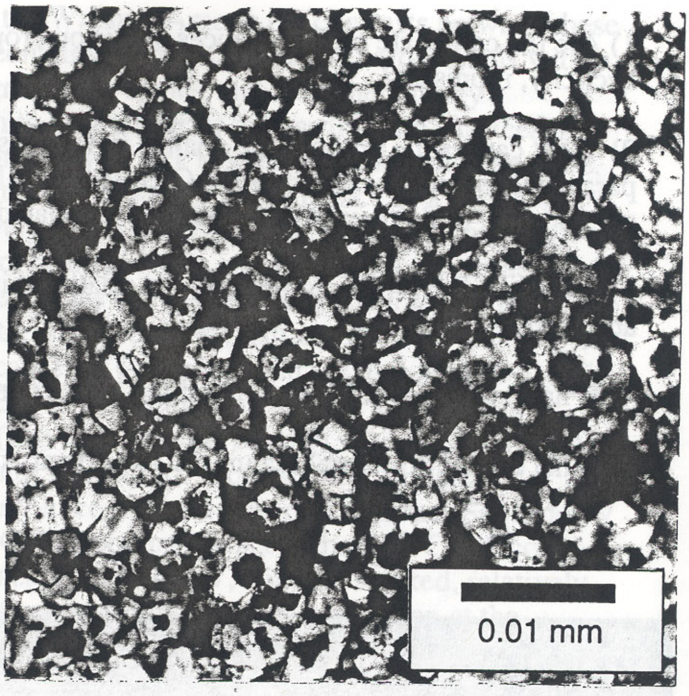


Fig. 30. Pervasively dolomitized mudstone, Glen Rose Formation.

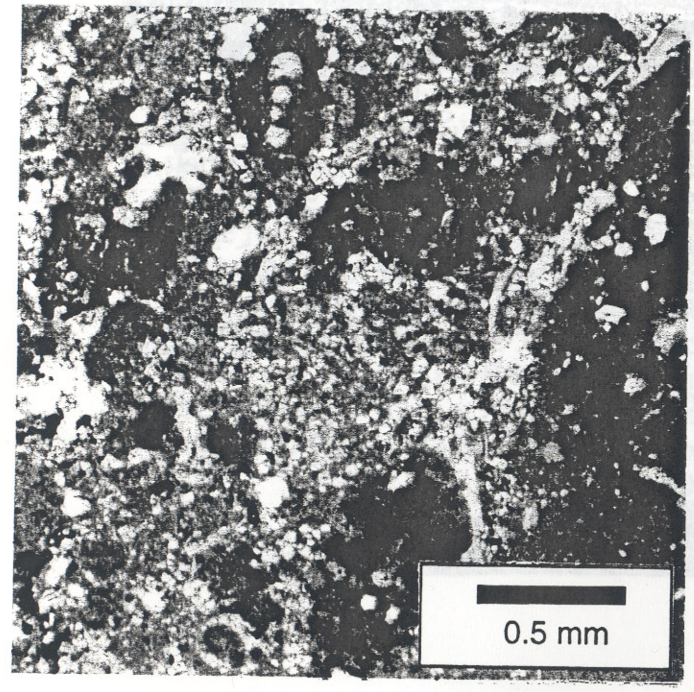


Fig. 31. Foraminifera packstone, Bull Creek Member of the Walnut Formation. Foraminifera are extensively micritized.

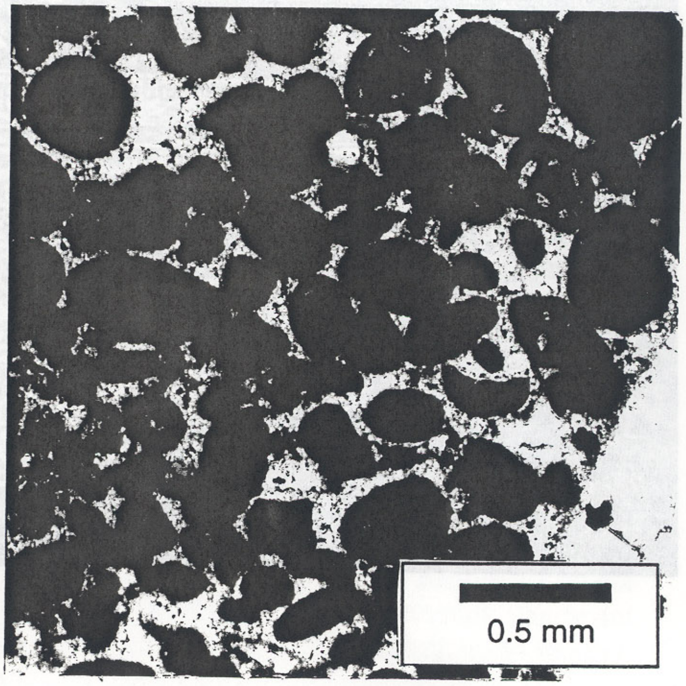
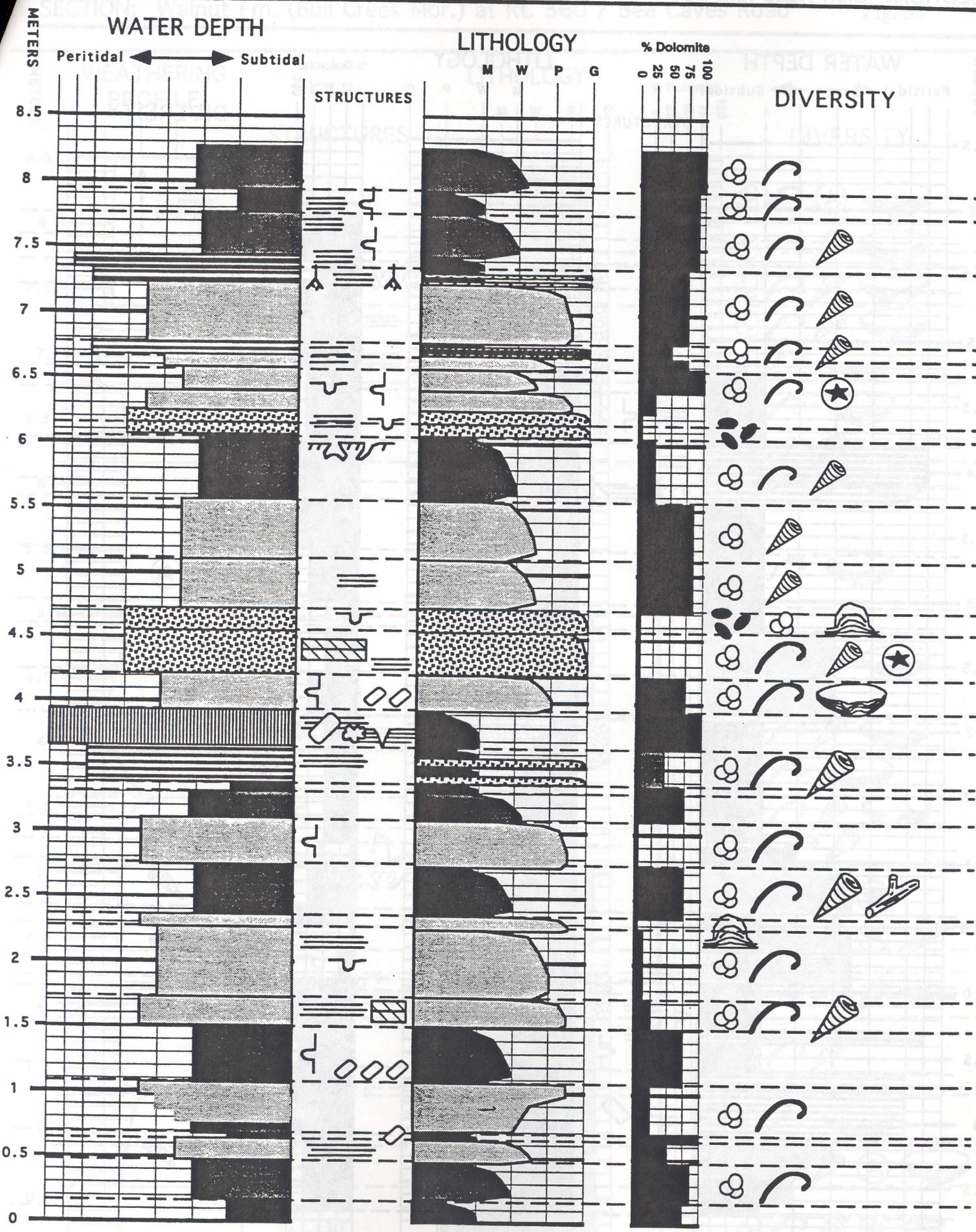


Fig. 32. Foraminifera-gastropod grainstone, Bull Creek Formation.

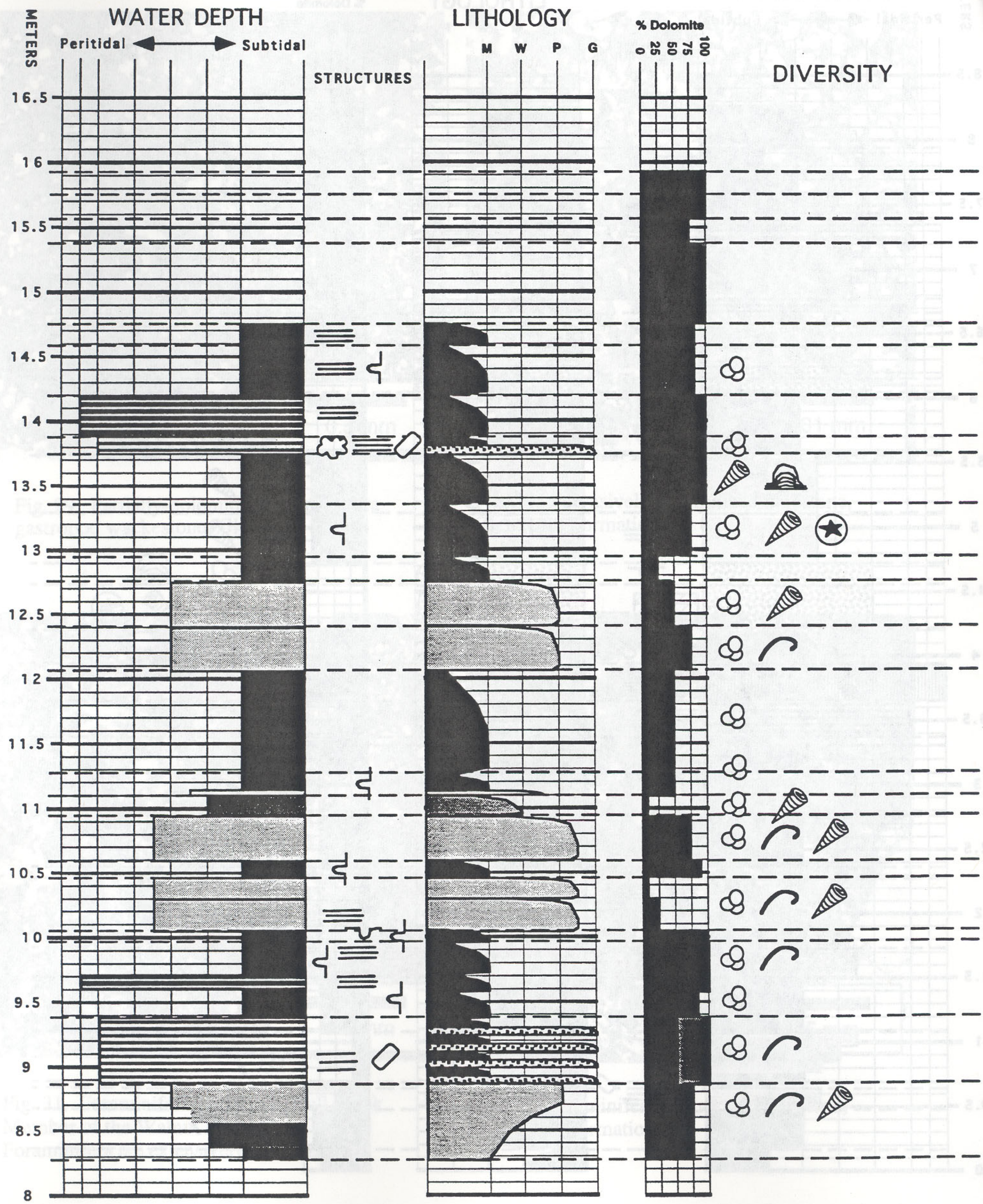
SECTION: Glen Rose Fm. at Rt. 360 / Bee Caves Road

Fig. 33



SECTION: Glen Rose Fm. at Rt. 360 / Bee Caves Road

Fig. 33



SECTION: Walnut Fm. (Bull Creek Mbr.) at Rt. 360 / Bee Caves Road

Fig. 33

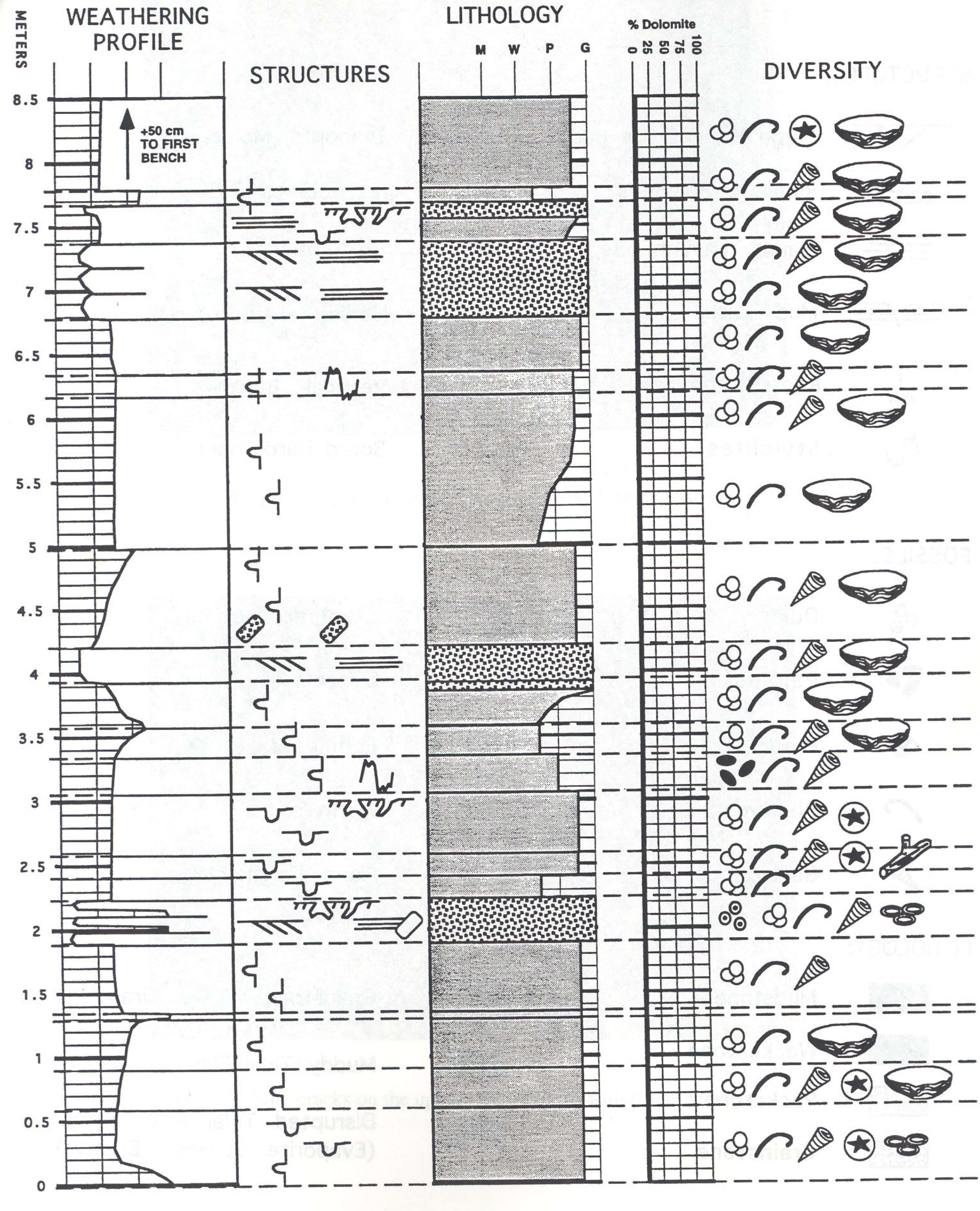


Fig. 33

KEY TO SYMBOLS ON MEASURED SECTIONS

STRUCTURES:

 Large Scale Cross Beds

 Ripple Cross Beds

 Planar Laminations

 Mud Cracks

 Root Mottles

 Stylolites

 Evaporite Molds

 Intraclasts

 Lithoclasts

 Horizontal Burrows

 Vertical Burrows

 Bored Hardground

FOSSILS:

 Ooids

 Peloids

 Forams

 Bivalves

 Gastropods

 Stromatolites

 Oysters

 Echinoids

 Worm Tubes

 Plant Fragments

LITHOLOGY:

 Mudstone

 Wackestone

 Packstone

 Grainstone

 Grainstone w/ Mud Drape

 Muddy Tidal Flat

 Disrupted Tidal Flat (Evaporite Collapse Breccia)

Fig. 34. Mudstone intraclasts in a foraminifera bivalve packstone.

Fig. 35. Mud cracks on the upper surface of the Bull Creek Member.

STOP 5

Dinosaur trackways at Zilker Park botanical gardens (Edwards Formation)

Directions:
The gardens are located on the north side of Barton Springs Road in Zilker Park.

Geological Setting and Significance:

Dinosaur trackways were recently discovered at this site while brush was being cleared to develop a butterfly trail. The tracks of several different species of dinosaurs and the tracks and bones of a marine turtle are preserved in tidal flat deposits of the Edwards Formation. The flagstone nature of weathering of the Edwards here has revealed a high-resolution sequence of plan and cross-sectional views of the development of desiccation features in these tidal flat deposits.

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