

## **STRATIGRAPHIC UNITS OF LOWER ALBIAN CENTRAL TEXAS**

### **ABSTRACT**

Central Texas, during the Albian of the Cretaceous, was an archetypical example of a carbonate depositional environment. The Trinity, Fredericksburg, and Washita stages encompass the Comanche Seires during the Albian age. The earliest stage is the Trinity, which contains, ascending, the Travis Peak, Glen Rose, and Paluxy formations. Overlying the Trinity, is the Fredericksburg stage containing the Walnut Creek, Comanche Peak, Edwards, and Kiamichi stages.

The Gulf Coast region was a carbonate platform with a local buildup developed onto the ramp. This created a shallow water environment updip and a marine deep-water environment below the buildup. Therefore, Central Texas exhibits a variety of lithology and fossil content throughout its extent. Farthest inland are terrestrial fossils and deltaic sandstones and gravels. Continuing southward, the formations become increasingly marine. Corals, rudistids, and other shallow water fauna are well preserved in reef complexes. Carbonate content increases as the formations continue basinward. On the shelf, fossils and lithology reflect the deep water environment where the dip of the ramp becomes increasingly steep.

Central Texas during the Albian experienced a transgressive event. This is evidenced by the progress landward of each formation further updip onto the Llano uplift region. Occasionally there were progradational pulses such as during the Trinity. Other alterations to the typical pattern occurred. When the buildup on the ramp trapped a shallow water environment, the region experienced periods of evaporation evidenced by the presence of thin evaporite beds in the Edwards formation. The change in water level is also reflected in the fossil content where terrestrial fossils, such as dinosaur tracks, plants fossils and other non-marine remnants are preserved over coral,

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rudistid, and stromatolite beds.

### INTRODUCTION

The youngest period of the Mesozoic Era is the Cretaceous, commonly divided into lower and upper epochs at the boundary of the Albian and Cenomanian ages. Several different dates are given for this division, ranging from 100 million years ago to 94 million years ago. The lower boundary for the Albian, the Aptian-Albian boundary, is well defined by the first occurrence of the ammonite *Douvilleiceras mamillatum* (Scott and Kidson, 1977). The early Albian age of the Gulf coast region has two stages found within the Comanche Series. First is the Trinity stage, often referred to as Trinity sands, is named for exposures on the Trinity Rivers of Texas. Overlying the Trinity is the Fredericksburg stage. Each of these stages are part of the overall transgressive event which occurred in the Gulf region during the Albian.

The Comanche series, named for Comanche, Texas and indirectly for the Comanche Indians who lived in the area, was first studied by R.T. Hill in the late 1880s. In the Gulf Coastal region, the Comanche series is older than the Coahuilan series and predates the Gulfian series. An Aptian progradational event exposed the northern areas to erosion so that the Comanchean has an unconformable contact with the Coahuilan. However, downdip toward the Gulf, the boundary becomes gradational. An angular unconformity marks the boundary between the Comanche and Gulfian series, which also becomes gradational as it continues downdip. Aerially, the Comanche Series stretches from Oklahoma and northeastern Texas southward towards Mexico, Arkansas, Louisiana, Mississippi, and Georgia. It is subdivided into three stages: the Trinity, Fredericksburg, and Washita stages. Initially these designations were lithologic unit names, but have since changed

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to the chronostratigraphic titles (Murray, 1961). The Comanche series is exposed extensively in central Texas and Mexico, however it extends subsurface in the eastern areas.

The Albian age begins in the middle of the Trinity Stage. Initially designated the Trinity Sands, the Trinity Stage was named for exposures on the Trinity Rivers of Texas. R. T. Hill described the Trinity in 1888, but only identified the basal Travis Peak formation. His description has been modified to include all units of the Comanche Series that were older than the Fredericksburg Stage. Lithologically, the Trinity contains fine, closely packed white sandstones and gypsiferous marl occasionally interbedded with limestone. The fossiliferous, wave-marked limestone beds are no more than ten inches thick. Some areas contain poor saccharoidal gypsum. Updip, the stage begins at a minimal thickness and increases continually downdip toward the Gulf until it reaches a thickness of greater than 4,000 feet. Later, R. T. Hill subdivided the Trinity into three formations: Travis Peak (the basal section), the Glen Rose, and the Paluxy, the currently accepted definition of the Trinity (Wilmarth, 1968). Beginning in southeastern Oklahoma, the Trinity extends through Texas, southwestern Arkansas, and northwestern Louisiana. The Trinity represents a period of overall transgression, however it has been subdivided into three clastic-carbonate couplets exhibiting cyclic sedimentation. In ascending order the couplets are: the Sycamore Sandstone and the Sligo Limestone, the Hammet Shale and Cow Creek Limestone, and the Hensel Sandstone and Glen Rose Limestone. Although each couplet represents a transgressive-regressive pulse, as a whole, the stage progressed farther landward toward the Llano uplift (Petta, 1977).

The Fredericksburg Stage was named for exposures in the outskirts of Fredericksburg,

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Gillespie County, Texas. First described by R. T. Hill in 1887, the Fredericksburg is composed of limestones with some flints and chalk units. It strikes northeast to southwest and dips toward the southeast at a gradient of nine to sixteen meters per kilometer (Petta, 1977). Initially, R. T. Hill placed the boundary between the Washita and the Fredericksburg stages at the top of the Caprina chalky limestone, now called the Edwards formation. Descending, the Caprina was underlain by the Comanche Peak chalk beds, and the basal alternating beds of the Caprotina. Later in 1891, the included units changed to the Caprina limestone (Edwards), Comanche Peak Chalk, Walnut Clays, and the Paluxy sands. This definition placed the Kiamichi clays into the Washita stage. However, the inclusion of the Paluxy sands and Kiamichi clays has varied. Currently, the approved definition places in ascending order, the Walnut Clay, Comanche Peak, Edwards, Goodland, and the Kiamichi in the Fredericksburg Stage (Wilmarth, 1968).

### **Glen Rose Formation**

The Glen Rose formation is the thickest unit in the Trinity stage. R. T. Hill defined the formation in 1891, naming it for the type section in Glen Rose, Somervell County, Texas. The lithology of Glen Rose is a the calcareous-argillaceous unit overlying the Travis Peak sandstone and underlying the Paluxy sandstone. It contains soft yellow fossiliferous beds, siliceous at the base and alternating with fine argillaceous sandstone with occasional beds of almost pure crystalline limestone chalk (Wilmarth, 1968). It attains a maximum thickness of 2,000 feet in the subsurface of southern Texas and the adjacent areas of eastern Mexico. However, it thins as the formation continues updip to the northwest. The formation is further subdivided into two members separated by a *Corbula* bed first recognized by F. L. Whitney. The lower member is exposed in incised river and creek valleys

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from Austin to San Antonio. The upper Glen Rose member is exposed northward from the Llano uplift region. It contains a sequence of nonresistant beds of calcareous clay alternating with resistant beds of dolomite, lime mudstones or fine to medium-grained limestone and has two distinct evaporite intervals (Bay, 1977). Streams and waterfalls create a staircase topography in Central Texas.

The Glen Rose formation is rich in fossil content reflecting its shallow marine shelf environment. Stromatolites and ripple-marked calcareous sands indicate its intertidal phase. Deeper water regions contain the pelecypod *Corbula harveyi* and other *Corbula*-bearing layers. The *Corbula* bed extends for more than 8,000 square kilometers and is used as a regional stratigraphic marker (Petta, 1977). The Glen Rose shelf facies a diverse mollusk assemblage including clams, oysters, foraminifers, and *Orbitolina texana*. The key caprinid genus *Coalcomana* is found in the Glen Rose with *Coalcomana ramosa* throughout the region (Coogan, 1977). Other facies contain coral colonies and rudistids still attached to each other and preserved in their growth positions in environments of higher energy. In the transitional environment between the shelf and reef there are skeletal grainstones with whole shells of the pelecypod *Chondrodonta* and the gastropod *Nerinea* (Achauer, 1977). The four principal laterally equivalent facies contain oyster biostromes, monopleurid biostromes, caprinid reefs, and plant fragment beds. Plant fossils include cycad stumps found updip in the formation. The oysters indicate the paleoshoreline adjacent to the Llano uplift and the transitional region contains monopleurids. The Caprinid mounds occur between the paleoshore and the transitional region. Tabular caprinid reefs surround plant fragment facies. Some of the most famous fossils within the Glen Rose formation are the tridactyl dinosaur tracks on top of

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the monopleurid biostromes. Both theropod and sauropod tracks are exposed along the Paluxy River in the Dinosaur Valley State Park in Glen Rose, Texas (Spearing, 1991). In addition to the track fossils, reptilian bones and scratch marks are present in a supratidal unit overlying stromatolites.

The Glen Rose is part of the overall carbonate environment of the region and consists of a variety of shallow marine environments on the Comanche shelf behind the shelf margin of the Stuart City complex. Deposition consisted of normal shelf sediments locally interrupted by caprinid reef and mound development (Petta, 1977). However, no reefs or mounds are found in the Glen Rose member updip from the shelf margin. After the reef phase, a period of extensive intertidal flat environments existed. The lower Glen Rose had low-energy, shallow water deposits and a large tidal flat followed by slightly deeper water with good circulation. After that period, this region experienced restricted circulation during deposition of the lagoonal *Corbula* bed. Overlying the *Corbula* beds are a set of evaporite stringers interbedded with *Corbula* in an increasingly more restricted circulation environment. Also seen in the lower Glen Rose, the central Texas region experienced a high energy rudist reef trending northeastward and a grainstone complex overlying a low-relief carbonate ramp profile. It prograded seaward over slightly deeper water, low-energy, lime mudstones, and wackestones with a resultant growth of over 1,250 feet vertically over a horizontal distance of thirty miles (Bay, 1977). The reef beds facies is overlain by a calcrete zone about a foot thick (Auchauer, 1977). The upper Glen Rose has deposition on a sloping shallow seafloor which combines with an influx of clastic sediments from the Llano uplift region. A repetition of reefs formation occurred three times due to subtidal conditions after subaerial exposure. Occasionally, evaporite beds precipitated, an indication of the hypersaline sea conditions where water depths never

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exceeding five meters (Petta, 1977).

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### Paluxy, Walnut Clay, and Comanche Peak Formations

Overlying the Glen Rose formation in central Texas are the Paluxy sandstones, another formation found within the Trinity group, Comanche series. R. T. Hill defined the Paluxy sands at the exposures near the town of Paluxy and along Paluxy Creek in Somervell County, Texas. Originally, Hill placed the Paluxy formation into the Fredericksburg group, but was later placed into the Trinity by Taff in 1892 and Hill in 1894. The formation contains fine white gray to yellowish packsand which is stratified and occasionally cross-bedded and often oxidizes to red at the surface. Southward, the Paluxy is replaced from the base upward in a downdip direction by dark calcareous-argillaceous strata which form the Mooringsport formation (Wilmarth, 1977). This creates a pattern of detrital sands and mud tongues from the north interfingering with platform carbonates of the south (Frazier, 1991). It resembles the earlier Travis Peak sandstone formation, but can be differentiated by its absence of fine pebbles and is more calcareous and argillaceous versus the Travis sands containing a greater iron content. The thickness of the Paluxy ranges from a minimum of 15 feet and attains a maximum of 1,500 feet. It extends aurally from northeastern Texas southeastward through Arkansas, Louisiana, Mississippi, and Alabama (Wilmarth, 1977). R. T. Hill interpreted the Paluxy formation as the beginning of a new cycle of sedimentation after Glen Rose.

The basal section of the Fredericksburg Stage is the Walnut Clay formation. It overlays the Paluxy formation in the Central Texas area. Named by R. T. Hill in 1891, the Walnut Clay type section was defined in Walnut (also called Walnut Springs), Bosque County, Texas. The formation contains yellow laminated clay marls. Thicknesses range from zero to 130 feet thick. The biostratigraphic marker for the formation is the oyster *Exogyra texana*. In the Texas-Arkansas

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border region, the Walnut formation underlies the *Gryphaea* rock of the same period. However, the Walnut Clay is not present everywhere the *Gryphaea* rock is present. The *Gryphaea* unit lithologic composition is chalky whitish limestones alternating with the yellow clay or marl and fossil content includes gryphate oysters. Sometimes the oyster beds are ten to fifty feet thick solid masses occasionally embedded in a calcareous matrix (Murray, 1961). Occasionally, the Walnut Clay formation and the *Gryphaea* rock are used interchangeably in descriptions of the Fredericksburg group.

The Comanche Peak formation was named by R. T. Hill in 1889 for the exposures near at Comanche Peak, Hood County, Texas. The formation forms the majority of the peak and is capped by the Edwards Limestone. Early in its definition, Hill used the Comanche Peak limestone as a synonym for the Fredericksburg Stage or the Lower Fredericksburg division of the Comanche Series. The formation consists of fossiliferous, soft, yellowish and whitish chalky limestone or buff limestone of greater or lesser compactness. The thickness ranges from 300 to 400 feet. In Central Texas, it overlays the Walnut Clay formation and conformably underlies the Caprina Limestone or Edwards Formation. At the top boundary, the formation contains plant-rich skeletal wackestone. It has abundant fossils including bivalves, gastropods, ammonites, and echinoids. The hard Comanche Peak limestone beds were deposited in clear, shallow marine water (Spearing, 1991).

### **Edwards Formation**

R. T. Hill and T. W. Vaughn named the Edwards formation in 1898 for the Edwards Plateau region, the formation being the main component of scarps and mesas in southwestern Texas,

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although the type section is along a creek in city of Austin, Texas. Originally, it was named the Caprina limestone, but was changed to Edwards in 1898. It overlies the Comanche Peak formation and underlies the Kiamichi Limestone in Central Texas, the Georgetown Limestone or Fort Worth Limestone in other areas. Lithologically, it contains mostly white limestone, but when weathered shows a buff, cream-yellow and dull-gray layers of varying hardness. It is crystalline, but also is found to be dolomitic, fossiliferous and frequently massive cherty limestone in the form of flint nodules (Wilmarth, 1968). It is harder than the Comanche Peak limestone and weathers into cliffs. It thickens from southward through facies changes into the underlying Comanche Peak formation, with an average thickness of 600 feet. The Edwards has an unusually thickness in Bell County where it replaced thirty feet of the Comanche Peak below it and extends sixty feet into the Kiamichi formation. This area was named the Moffat Lentil in 1961. The Edwards grainstones of the Moffat Lentil in Bell County is approximately equal chronologically to the Comanche Peak wackestones in the north Texas-Tyler basin (Kerr, 1977). Over the Llano uplift, the Edwards contains tidal-flat mudstones, foraminiferal grainstones and other skeletal carbonates (Boggs, 1987). The Edwards formation has produced significant petroleum products and is an essential aquifer for the state of Texas (Rose, 1970).

In 1964, Lozo and Smith subdivided the Edwards plateau into two formations separated by a regional disconformity indicated by a distinct change in lithology. This change shows an original resistant clay-free miliolid and gastropod lime grainstone changing to a soft fossiliferous marl containing bivalves, oysters, gastropods, oxytropidoceroid ammonites, and echinoids. The thin marl layer was informally named the *Doctor Burt Ammonite Zone*.<sup>@</sup> To support their claim, they cited

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the presence of mollusks boring into underlying limestone, oysters cemented onto the iron-stained upper surface of the limestone and the abrupt widespread lithologic change as evidence of the disconformity. Others doubt the interpretation of the Edwards division at the ADoctor Burt Zone.® One reason is that there is no single continuous discontinuity surface at the base. Also, because there is the lack of a sharp contact between differing beds in localized areas, it does not mean they are separate members (Rose, 1970).

The Edwards formation is defined biostratigraphically with ammonites and rudists of the Albian patch reef. It contains various ammonites such as *Ammites acutocarinatus* and *Oxytropidoceras*, which provides the intercontinental correlation of outcropping. The formantifer *Dictyoconus walnutensis* is a regional stratigraphic marker for the middle Albian. Two rudists species found are *Caprotina Sellaea* and *Pachytraga*. The genera *Monopleura* and *Toucasia* are common in Edwards also. The caprinid *Caprinuloidea gracilis* and *C. anguis* are seen in various locations. Other fossils include the radiolitid *Praeradiolites edwardensis*. Species of the coalcomaninid genus, *Texicaprina* are abundant in the reef and bank deposits (Coogan, 1977). The ADoctor Burt Ammonite Zone® contains a soft fossiliferous marl with a rich fauna of bivalves, oysters, gastropods, echinoids, and oxytropidoceroid ammonites (Rose, 1970). The Edwards paleoenvironment was a shallow marine intertidal deposition. The ascending sequence consists of alternating skeletal grainstone and burrowed wackstone deposited as mobile grain shoals. Overlying that area are rudist bafflestones associated with shallow-water patch reefs followed by an accretion-bedded skeletal grainstone of a prograding beach complex. Continuing is a dolomitized wackstone deposited in a restricted low-energy lagoon capped by an intertidal burrowed and

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supratidal laminated mudstone. Subaerial exposure of the uppermost mudstone sequence is demonstrated by paleocaliche, desiccation cracks, marsh deposits, and caliche-algal boundstone (Kerr, 1977). The upward sequence begins with reef-derived sands near the shelf margin and grades through inner-shelf bioclastic beach sands, lagoonal lime muds and supratidal dolomitic muds (Boggs, 1987).

### **The Carbonate Depositional Basin**

The Albian in Central Texas is a good example of a typical carbonate depositional environment. It was a time of an overall transgression interrupted by a basinward progradational event during the Glen Rose and Paluxy depositional periods. This twenty to thirty mile shift in deposition was a response to an inland uplift or a reduced rate of subsidence along the entire northern Gulf Coast. Clastic and carbonate sediments were deposited into clear-water continental and marine environments creating sequences of depositional facies. Sediments begin from an alluvial valley into a deltaic complex and across coastal plains to a shelf and the Gulf basin. The shelf exhibits three main depositional facies. The inner shelf often contains deltaic sandstones and gravels which interfinger seaward. The middle shelf facies contains limestones and dolomites with marine fauna including corals, echinoids, and milioloids. Lastly, the outer shelf faunal fossils includes rudistids, corals, encrusting algae, and stromatolites (McFarlan, 1977). During the late Glen Rose and into the Fredericksburg Stage, high energy facies built a complex 1,300 feet vertically and six miles landward horizontally. This created a change in slope between the shallow water of the shelf and its margin and the deep water of the ancient Gulf and formed a sediment trap in the Central Texas area (Bay, 1977). The carbonate shelf environment was a flat region of shallow water bounded on one side by land and on the other by a break

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in slope which separates it from areas of deeper open-marine circulation. These shallow water areas created evaporite deposits and limestones forming the remaining formations of the Fredericksburg. Intermediate zones have rudist reef complexes. Carbonate sediments were deposited basinward. Finally, the Edwards formation is composed of carbonate skeletal carbonate sands formed in a beach environment, restricted lagoonal muds, and supratidal dolomites onto the platform (Boggs, 1987). The Edwards formation provides an example of how shelves are preferentially dolomitized compared to the basins they border (Wilson, 1975).

### **CONCLUSION**

The Comanche Series is an excellent indicator of the carbonate shelf environment of the Gulf coast region. The Albian carbonate platform and shelf is seen in the shift of fossil content beginning with the deep water marine life, shallower reef complexes, and finally in the updip regions terrestrial trace, plant, and reptile fossils. The early Cretaceous of Texas was a period of a rich variety of life.

The lithology of the region also exhibits the typical facies shifting seen in transgressional events, although there were a few progradational pulses. Deltaic sandstones and gravels progressed further landward. Vertical transgressive successions are seen ascending from sandstones through carbonates and eventually the muds of the Kiamichi. Occasionally evaporite deposits formed when a buildup on the shelf temporarily enclosed the updip areas during the Edwards. While there were several shallower periods, overall the transgressive sequences are clearly seen throughout these units.

The lower Cretaceous Comanche series is an extensively studied set of formations. The petroleum products extracted in from the units provides a source for fossil fuels. One of the most important aquifers in Texas is found in the Edwards formation. The early Albian Trinity and Fredericksburg stages have a wide variety of fossil content, lithologic compositions, and provide a good

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example of carbonate facies sedimentation.

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