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PRE-DAKOTA CRETACEOUS FORMATIONS OF NORTHWESTERN TEXAS AND NORTHEASTERN NEW MEXICO

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INTRODUCTION

Cretaceous rocks are distributed sporadically in northwestern Texas and northeastern New Mexico. These beds, mainly of Comanchean age (fig. 1) are relatively insignificant in most local sections and have been afforded only cursory consideration by geologists who, for the most part, are concerned with deeper stratigraphic horizons. Far too frequently one hears a remark regarding the absence of Cretaceous beds in some areas that implies the beds were unfortunately removed by pre-Ogallala erosion. A close examination of the distribution of the Cretaceous beds, and comparison with locations of major pre-Cretaceous tectonic features, reveals a startling coincidence. It appears, likewise, that earlier Mesozoic units, i.e., the Santa Rosa Sandstone, the Chinle Formation, and the Morrison Formation, might be controlled similarly.

This paper is a "progress report" type presentation by the writers. More definitive conclusions must await the completion of our current study of lithostratigraphic and biostratigraphic relationships of the units.

GENERAL STRATIGRAPHY OF CRETACEOUS ROCKS

Cretaceous units in the area consist of normal marine, estuarine, and terrestrial rocks. Normal marine sediments

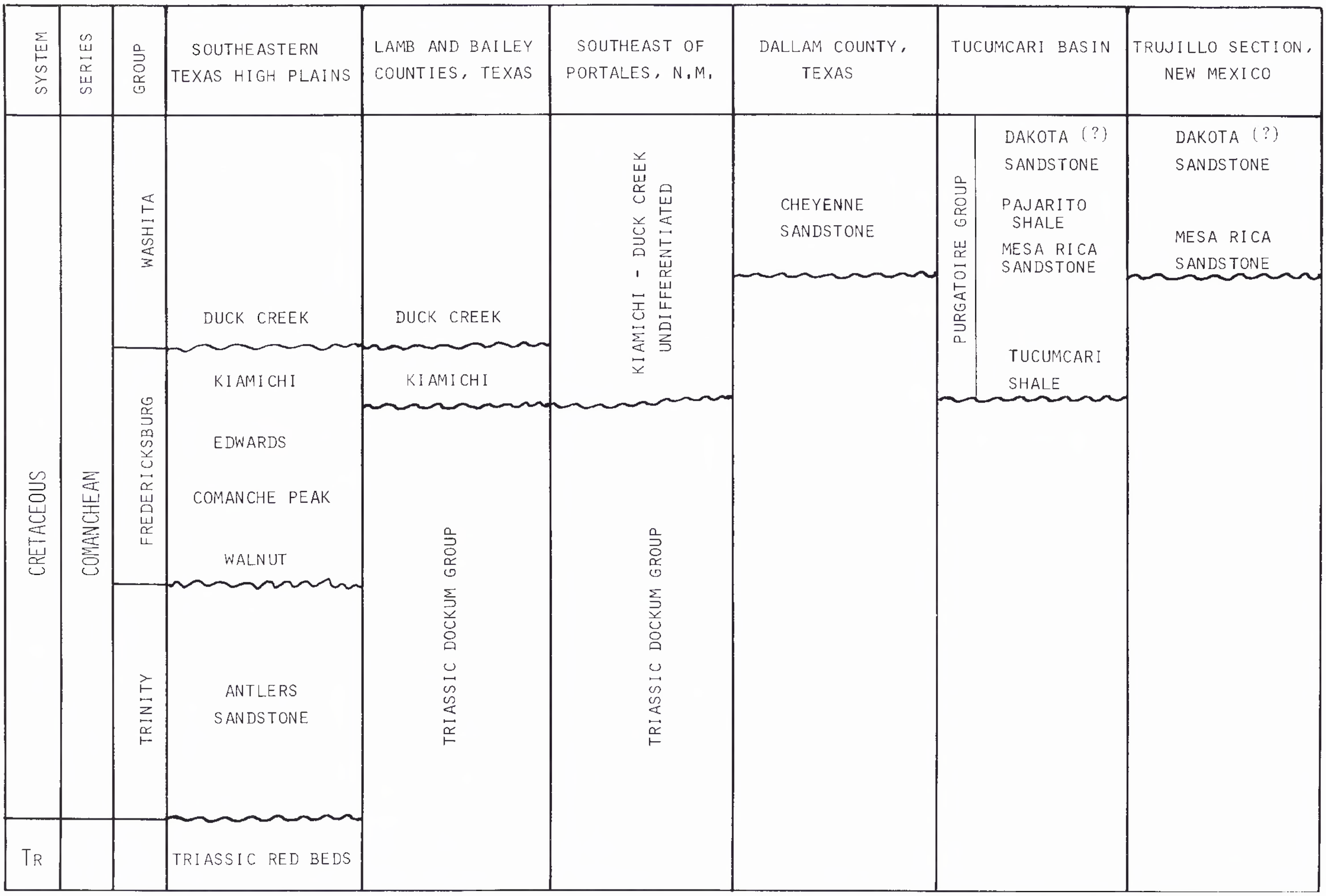


Figure 1. Correlation of Cretaceous Formations, Northwestern Texas and Northeastern New Mexico.

occur in all Texas High Plains localities except for several small exposures in northwestern Dallam County (Brand, 1953, p. 16). They extend, also, into New Mexico but appear to be limited to the Tucumcari basin, with an attenuated extension southward to near Portales, New Mexico. Marine beds disappear to the north and west of Tucumcari, where they apparently interfinger with nonmarine strata (Dobrovolny and Summerson, 1946). Exact locations of the marine to nonmarine facies changes have not yet been established; the writers are currently investigating this problem.

STRATIGRAPHY OF THE MARINE CRETACEOUS BEDS

The base of the marine Cretaceous section of the Texas High Plains and northeastern New Mexico is characterized by the presence of a basal sandstone; in the Texas area this unit has been assigned to the Antlers Formation (Bureau of Economic Geology, Geologic Atlas Project, Lubbock Sheet). The unit contains remarkably pure quartz sand with lenses of quartz gravel (fig. 2). Mineralogically the sands are similar to those of underlying formations, especially the Triassic beds of West Texas. Locally one finds fragments of petrified wood associated with the gravel lenses. This blanket of sand and gravel is a part of the veneer on the Wichita paleoplain (Hill, 1900) and, in reality, is the residue from weathering of pre-Cretaceous beds. The pre-Cretaceous landscape was a low, featureless, sand-covered plain. The early Cretaceous sea transgressed this surface and incorporated insoluble residues from underlying formations into a basal sandstone and conglomerate.

The stratigraphic position of the basal sandstone layer ranges from pre-Walnut (basal Fredericksburg in the southeastern part of the Texas High Plains to a position subjacent to the Kiamichi Formation (uppermost Fredericksburg) in the western part (Brand, 1953, p. 8), and to a possible nasal Washita position in the Tucumcari, New Mexico area.

Cretaceous units in the Llano Estacado of Texas, first studied in detail by Brand (1953), are assignable to the Trinity, Fredericksburg, and Washita Groups of the Comanchean Series (fig. 1).

Initial zonation of this sequence was based primarily upon the occurrences of ammonites, but other macrofossils may serve as markers in local areas. Zonation on the basis of microfossils has been established through the works of Stultz (1935), Kessinger (1953), and Brooks (1959). Figure 3 shows a zonation based upon macrofossils which appears to be applicable within the area of interest to this field conference.

From the preceding it is evident that the Cretaceous units of late Fredericksburg and Washita ages in the Texas High Plains are both physically and genetically related to the Tucumcari Shale of the Tucumcari basin and should, perhaps, be considered a part of a single lithostratigraphic unit.

The zone of *Craginites* is of particular interest to a study of marine Cretaceous rocks because it seems to occupy a stratigraphic position younger than the typical Kiamichi beds of north Texas, but older than typical Duck Creek strata. Adkins (1927) observed the occurrence of *Craginites (Elobiceras)* in the Fort Stockton region of Trans-Pecos Texas and assigned strata containing this form to an unnamed "post-Kiamichi" unit. *Craginites* has been found in the Llano Estacado only in exposures in the latitude of the Permian Palo Duro basin. A fragment of this form was found recently by the writers in the road cut south of San Jon, New Mexico.

The possible presence of late Kiamichi sediments in parts of the Tucumcari basin raises the question of the nature of the Fredericksburg-Washita boundary in northeastern New Mexico. Brand (unpublished) has demonstrated the disconformable relationship between the Kiamichi and Duck Creek units in Lamb County, Texas. Brand and Mattox (in preparation) suggest that the pre-*Eopachydiscus* section is possibly Kiamichi in age; this tenet is supported by the occurrence of *Craginites*. The thin limonitic layer near the base of the Tucumcari Shale indicates an interval of subaerial exposure before the invasion of the seas that carried the *Eopachydiscus* faunal assemblage.

DEPOSITIONAL HISTORY OF MARINE CRETACEOUS BEDS

Marine beds of both northwestern Texas and northeastern New Mexico were deposited in an epicontinental sea which transgressed from the southeast. Sites of deposition were within the littoral and epineritic zones. Major controlling tectonic features of Texas can be extended into New Mexico, especially into the Tucumcari basin.

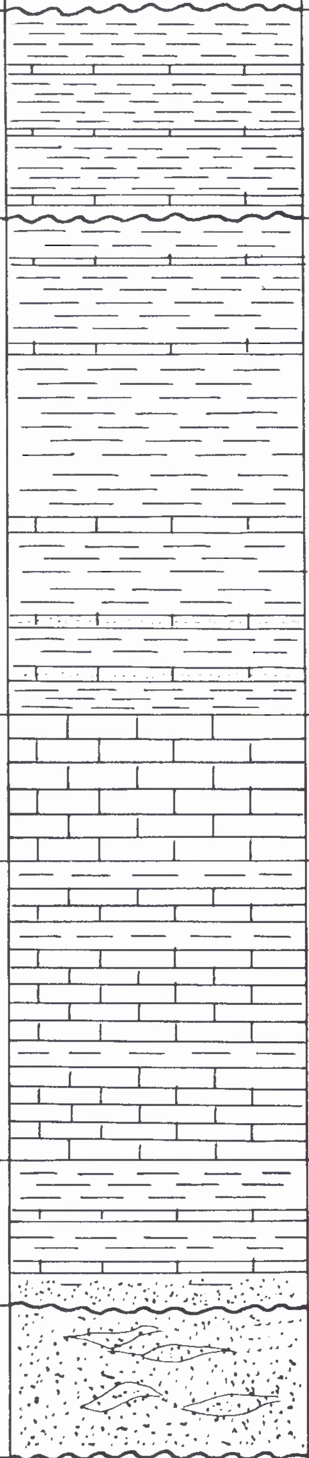
Deposition of Walnut through Comanche Peak sediments was essentially continuous, with only minor oscillations of sea level. Some clastic materials, mainly mud, were supplied from the provenance. Edwards time saw the stabilization of shorelines and the establishment of a uniform environment over much of central Texas. The approximate position of the limit of Edwards reef deposition is shown on the map of major structural features (fig. 4). Following Edwards deposition the west Texas area was exposed subaerially, at least in the areas of major Edwards bioherm development. The absence of significant clastic materials in the Edwards beds attests to a very small supply of detritus from the provenance. The Kiamichi Formation records an expansion of the sea, especially into the area of the Palo Duro basin, along with a renewed supply of fine-grained sediments from the provenance. The change to dominant clastic deposition probably reflects a humid climate and deep weathering in the provenance.

Near the end of the Fredericksburg interval the sea retreated to form a broad littoral swamp in which uppermost Kiamichi beds were deposited. Washita time was initiated by renewed marine expansion and the shoreline attained its maximum northwestward extension into the Tucumcari basin. Here, the Tucumcari Shale accumulated; nonmarine beds were deposited simultaneously to the north and west of Tucumcari. The Mesa Rica Sandstone and the Pajarito Shale record an increased supply of detrital materials and a consequent marine regression as the Mesa Rica-Pajarito delta prograded from northwest to southeast.

Pre-Ogallala erosion did remove some upper Comanchean beds from the region. One can only speculate as to the total Washita section that accumulated. It appears, however, that Washita time was one of general marine regression toward the Gulf Coast because progressively younger Washita beds appear to the southeast.

CRETACEOUS UNITS IN THE TUCUMCARI BASIN

Cretaceous units within the area under consideration in this field conference consist of, in ascending order, the Tucumcari



SYSTEM	SERIES	GROUP	FORMATION	TERTIARY AND QUATERNARY	THICKNESS FEET	CHARACTERISTICS
CRETACEOUS	COMANCHEAN	WASHITA	Duck Creek		0-40	Yellow-brown to dark gray shale and thin gray to brown limestone and sandstone. <u>Desmoceras brazoense</u> at base.
						Unconformity
		FREDERICKSBURG	Kiamichi		108	Dark gray to yellow-brown shale and thin light gray to yellow-brown limestone and sandstone Lower portion contains numerous specimens of <u>Gryphaea navia</u>; upper portion <u>Gryphaea tucumcarii</u>, <u>Oxytropidoceras</u> spp. throughout
			Edwards		20-30	Thick to massive white to yellow-brown "Rudistid" limestone Forms escarpment in southeast.
			Comanche Peak		50-80	Thick to massive light gray argillaceous limestone with light gray marly inter-beds.
			Walnut		8-23	Light gray shale and sandy shale and light gray argillaceous limestone. <u>Gryphaea mucronata</u> and <u>Ostrea crenulimargo</u> abundant.
						Unconformity
		TRINITY	Antlers		10-25	Light gray to purple loosely consolidated sand and lenticular quartz gravel beds. Triassic shale pebbles in basal portion.
						Unconformity
TRIASSIC	DOCKUM GROUP			REDBEDS		

Figure 2. Columnar Section of Cretaceous of Llano Estacado. [Modified after Brand (1953).]

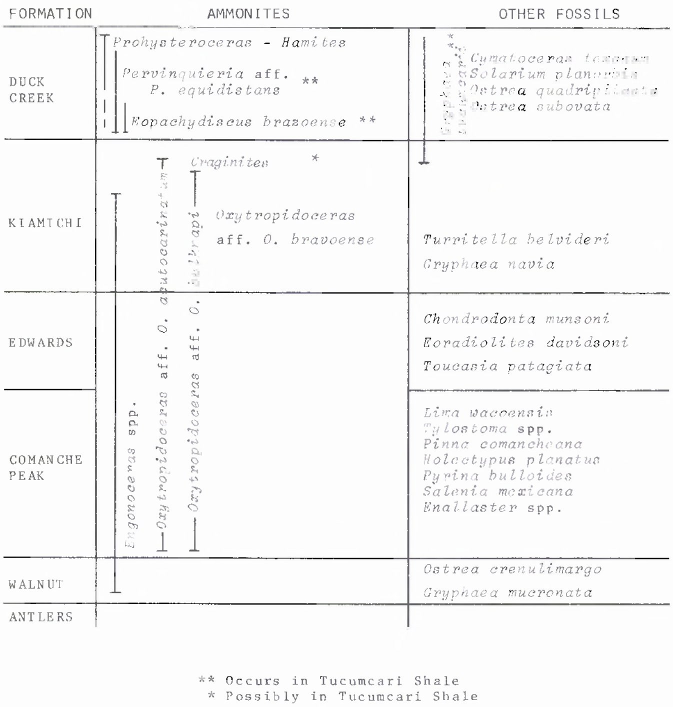


Figure 3. Zonation of Marine Cretaceous of Llano Estacado.

Shale, the Mesa Rica Sandstone, and the Pajarito Shale; the Dakota Sandstone has not been positively identified in the area. Drobovolny and Summerson mapped a small exposure of Graneros Shale on the downthrown side of the Bonita fault approximately 8 miles southeast of Mesa Redonda. Drobovolny and Summerson (1946) established the Tucumcari Shale, the Mesa Rica Sandstone, and the Pajarito Shale as members of the Purgatoire Formation. Griggs and Read (1959, p. 2007) recommended that the usage of the term Purgatoire Formation be abandoned in this area, and that the former members be elevated to the rank of formation. The present writers believe that the Tucumcari Shale should be included in the marine units of the Texas High Plains and that the predominantly nonmarine Mesa Rica Sandstone and Pajarito Shale might best be referred to a Purgatoire Group. For purposes of this report, however, the suggestion of Griggs and Read has been followed.

TUCUMCARI SHALE

The Tucumcari beds, named by Cummins (1892), originally included layers which comprise the Mesa Rica Formation. The name, which was subsequently abandoned, is from Tucumcari Mountain, approximately four miles south of Tucumcari, Quay County, New Mexico (see photo). Perhaps the most conspicuous feature found in most exposures of this unit is the profusion of the "oyster-like" pelecypod *Gryphaea tucumcarii* Marcou from near the middle of the shale section. Lithically the Tucumcari Shale consists of thin-bedded to fissile shale in the lower 10 feet followed by gray shale and yellowish-brown clay in the medial part. The upper part appears to interfinger with thin sandstone beds which are lithically similar to the overlying Mesa Rica Sandstone.

The basal 10 feet of the formation is particularly interesting because it contains small (dwarfed) pelecypods and other macrofossils. This euxinic environment, similar to the one recorded near the top of the Kiamichi Formation in the Texas High Plains, probably was developed in an estuary in the Cretaceous shoreline and was, perhaps, at least partly cut off from normal marine circulation. These basal dark shale beds are succeeded by normal marine shale and clay which contain normal macrofossil forms.

Brooks (1959) suggested in his study of the micropaleontology of the Tucumcari Shale that the unit might be subdivided into three parts as follows:

1. A lower interval characterized by a profusion of the pelecypod *Gryphaea;* this interval includes the lower one-half of the formation.
2. A medial unit which contains all elements of the Tucumcari macrofauna except *Pinna comancheana* and *Tylostoma.*
3. An upper argillaceous unit which contains *Pinna commancheana* and *Tylostoma.*

He further stated that a unique feature of sections along the highway and railroad west of Tucumcari is the occurrence of a "biostromal" layer which contains numerous *Turritella, Gryphaea tucumcarii,* and *G. marcoui.* This unit lies directly on the Morrison Formation in both localities and is, accordingly, the basal Cretaceous unit of the area. Traced laterally, however, the biostromal unit disappears. Recent observations indicate that Brooks' biostromal unit is a near-shore facies of the *Craginites* interval of the San Jon section.

The following fauna has been collected by the writers from exposures throughout the Tucumcari area:

Species	Range
Ostrea quadriplicata Shumard	Washita (Duck Creek)
O. subovata Shumard	Lower Washita
*Gryphaea corrugata*Say	Kiamichi-Duck Creek
G. marcoui Gabb	Fredericksburg
G. tucumcarii Marcou	Kiamichi-Duck Creek
Exogyra texana Roemer	Fredericksburg
Plicatula sp.	Washita
Neithea occidentalis (Conrad)	Fredericksburg
Trigonia emoryi Conrad	Fredericksburg-Washita
Protocardia texana (Conrad)	Fredericksburg-Washita
Pinna comancheana Cragin	Fredericksburg-Washita
Cardita belviderensis Cragin	Washita
Tapes belviderensis Cragin	Washita
Cyprimeria sp.	Fredericksburg-Washita
Turritella seriatum-granulata Roemer	Fredericksburg-Washita
Eopachydiscus aff. *E. laevicaniculatum* Roemer	Duck Creek
Pervinquieria equidistans (Cragin)	Duck Creek
Craginites aff. *C. serratescens*	Late Kiamichi

From the above it is evident that the Tucumcari Shale contains elements of both the Kiamichi and the Duck Creek faunas. The basal Duck Creek in the Texas High Plains and in Trans-Pecos Texas is marked by the first appearance of *Eopachydiscus* followed closely by *Pervinquieria.* The writers know no locality in West Texas in which these two forms occur together. *Craginites* is probably assignable to a late Kiamichi age; it is not known to occur with either *Eopachydiscus* or *Pervinquieria* in West Texas. It should be noted, however, that the Tucumcari Shale is a usable lithostratigraphic entity which is distinctly different from underlying and overlying beds. Accordingly, it should be considered as a single mappable unit regardless of its precise biostratigraphic relationships.

Following is a section of the Tucumcari Shale in the north

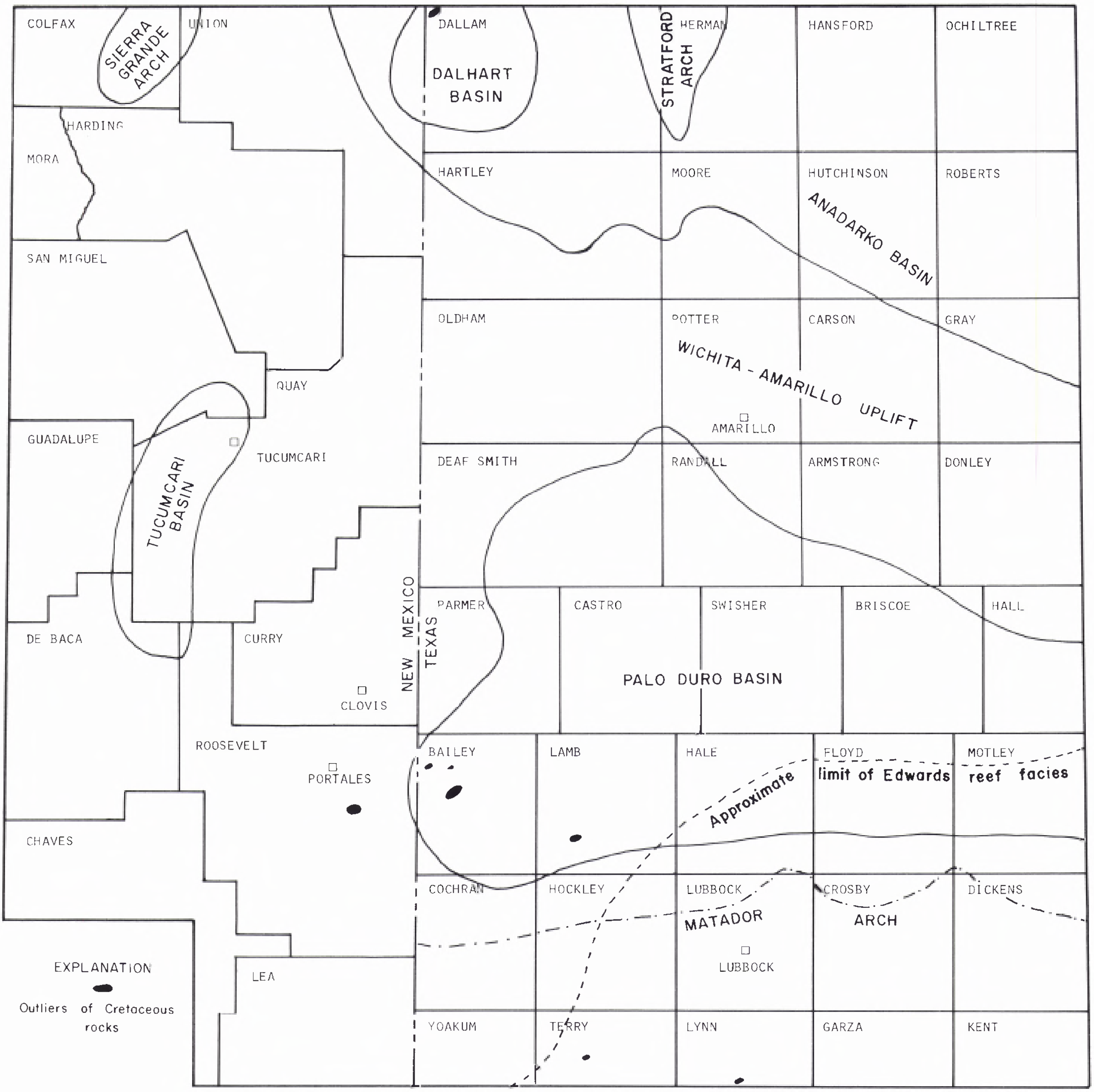


Figure 4. Major Subsurface Structural Features of Northwestern Texas and Northeastern New Mexico.

face of the Llano Estacado escarpment about 9 miles south of San Jon, New Mexico. (Modified after Brooks, 1959)

Cretaceous:
Mesa Rica Sandstone
Tucumcari Shale

		feet
12.	Shale, yellowish-brown, weathers light yellowish-brown, fissile, silty, slightly calcareous	8.0
11.	Shale, light-gray, slightly calcareous, scattered limonite concretions. Fossiliferous, fauna includes: *Gryphaea corrugata, G. tucumcarri, Exogyra texana, Trigonia emoryi, Inoceramus (?),* and *Protocardia texana*	2.9
10.	Shale, dark-gray, weathers medium- to light-gray, slightly silty and calcareous	24.0
9.	Shale, grayish-brown, weathers light gray, fissile to thin-bedded with thin selenite stringers	13.8
8.	Limestone, arenaceous, light yellowish-brown, weathers orange-brown. The bed appears to be lenticular as it cannot be traced throughout the outcrop	1.3
7.	Shale, grayish-brown, weathers light-gray, with thin selenite stringers. Fragments of reworked fossils	1.7
6.	Limestone, arenaceous, mottled gray, weathers light yellowish-brown, fine to coarsely crystalline. Contains numerous *Gryphaea tucumcarii* and *G. corrugata*	1.0

5. Shale, dark-gray to black, weathers light to medium gray, fissile, calcareous 5.1
4. Limestone, light-gray, weathers light yellowish-brown, hard, laterally persistent. Fossiliferous, fauna includes: *regularis*, *Turritella seriatum-granulata*, and *Trigonia emoryi* 1.3
3. Shale, dark-gray to black, weathers light to medium gray, with thin stringers of selenite. Fossiliferous, fauna includes: *Eopachydiscus laevicaniculatum*, and *Pervinquieria equidistans* 15.8
2. Limestone, arenaceous, light-gray, well indurated 04
1. Shale, dark-gray to black, weathers light to medium gray, slightly calcareous and silty. A fragment of *Cragin-ites* has been recently recovered from this unit 4.7

Total 80.0

Jurassic:
Morrison Formation

MESA RICA SANDSTONE

The Mesa Rica Sandstone, named by Dobrovolny and Summerson (1946), forms the precipitous cliffs at the top of the numerous buttes and mesas in the Tucumcari area as well as the uppermost escarpment along the Canadian River north of Tucumcari. It possibly extends as far as the Creston Range in the Las Vegas, New Mexico area. Lithically the Mesa Rica consists of sandstone with minor shale and clay interbeds. The base is typically marked by a conglomerate which, in most sections, contains abraded fossil fragments. Crossbedded sandstone occurs throughout the unit. Some of these beds exhibit fluviatile festoons, whereas others appear to be beach deposits. Deposition of the Mesa Rica Sandstone undoubtedly involved several oscillations of sea level. At the top of the Mesa Rica thin shale units, similar to the overlying Pajarito Shale, are interbedded with typical Mesa Rica sandstone. These are probably deltaic swamp and lake deposits. In general, the Mesa Rica Sandstone is an accumulation of sediment within the environment of a prograding delta.

Following is a section of the Mesa Rica Sandstone in the north face of the Llano Estacado escarpment approximately 9 miles south of San Jon, New Mexico. (Modified after Brooks 1959)

Cretaceous:
Pajarito Shale
Mesa Rica Sandstone *feet*

8. Sandstone, medium-brown, weathers yellowish-brown, fine- to medium-grained, grains subrounded. Limonite stains near top 16.2
7. Sandstone, light-gray, weathers yellowish-brown, loosely consolidated, uniformly medium-grained contains lenticular beds of purple sandstone 13.9
6. Sandstone, yellowish-brown, conglomeratic, well-indurated. The upper one-half foot contains alternating layers of clean quartz sand and limonite. Immediately below this layer is an interval of channel-fill sandstone and conglomerate 5.2
5. Sandstone, light yellowish-brown, weathers light brown, friable. Quartz grains are well sorted and subrounded. Contains scattered abraded fossil fragments 5.0
4. Sandstone, light reddish-brown, weathers dusky red to light brown. Chert pebbles in upper part 4.3
3. Sandstone, pale-yellow, weathers pale orange to brown, well-indurated, poorly sorted. Scattered chert pebbles and fossil fragments 3.1
2. Sandstone, light yellowish-brown, weathers light yellowish-brown, fine-grained, well-sorted. Chert pebbles near base 8.6
1. Conglomerate, mostly chert pebbles and fragments of fossils. Occupies scour features in underlying Tucumcari Shale 0.8

Total 57.1

Cretaceous:
Tucumcari Shale

Pajarito Shale

The Pajarito Shale, named by Drobovolny and Summerson (1946), is restricted to several relatively small areas of the Tucumcari region. It crops out in the escarpment south of San Jon and in the downthrown block of the Bonita fault. Also, it crops out widely on Mesa Rica, in the northwestern part of Quay County.

Lithically, the Pajarito Shale consists primarily of shale with crossbedded sandstone interbeds. The shale is typically "bentonitic," light gray silty, and poorly laminated. The sandstone interbeds are typically light yellowish gray to white and many of them contain limonitic concretions or discontinuous thin iron-enriched layers. Near the top of the section is a thick sandstone which is lithically similar to the Mesa Rica Sandstone; this unit has been suggested as being a possible Dakota Sandstone equivalent in this area. The present writers, however, prefer to consider the sandstone as being a part of the Pajarito Formation pending their completion of work in the areas north and west of Tucumcari.

The Pajarito and Mesa Rica Formations appear to interfinger, at least in the San Jon area, and probably record a change from dominant channel sand deposition in the Mesa Rica unit followed by development of delta plain lakes in which the silty Pajarito Formation accumulated. A renewal of sand supply again produced the typical channel sands found in the upper part of the formation. Locally, the upper sand is overlain by silty "bentonitic" shale similar to the typical Parajito sediments lower in the section.

Drobovolny and Summerson (1946) reported the occurrence of *Ostrea quadriplicata* from exposures of the Pajarito Shale in northwestern Quay County. This species suggests a possible Duck Creek age for the containing beds. The Pajarito Shale does not contain a microfauna, with the exception of possible palynomorphs.

Following is a section of the Pajarito Shale in the north face of the Llano Estacado escarpment approximately 9 miles south of San Jon, New Mexico. (Modified after Brooks, 1959)

Tertiary:
Ogallala Formation
Cretaceous:
Pajarito Shale *feet*

3. Shale, light-gray, weathers grayish white, silty, bentonitic. Upon exposure, the shale fractures into small subrectangular blocks. . . . to base of Ogallala 10.0
2. Sandstone, medium yellowish-brown, weathers light yellowish brown, crossbedded. Similar to upper beds of Mesa Rica 8.0
1. Shale, as above with thin sandstone stringers and scattered limonite-rich layers 13.3

Total 31.3

Cretaceous:
Mesa Rica Sandstone

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