BUREAU OF ECONOMIC GEOLOGY
The University of Texas
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JOHN T. LONSDALE, Director

Report of Investigations—No. 21

Geology of Hood Spring Quadrangle, Brewster County, Texas

By

ROY W. GRAVES, JR.

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Illustrations

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ABSTRACT

The Hood Spring quadrangle, in the central part of Brewster County, Texas, contains a segment of the southeast rim of the Marathon basin. It includes a part of the complexly folded and faulted Paleozoic rocks that occur in the center of the Marathon basin and also includes Cretaceous rocks exposed in the Maravillas scarp. This scarp has three stratigraphically separate cuestas that are formed by southeastward gently dipping beds. The southwestern corner of the quadrangle contains a faulted and folded segment of the Santiago Mountain range.

Rocks of Cambrian (Dagger Flat formation), Ordovician (Marathon, Alsate, Fort Peña, Woods Hollow, and Maravillas formations), Devonian (Caballos novaculite), and Pennsylvanian (Tesnus formation) ages occur in the area of Palaozoic outcrops. A conodont fauna from the upper part of the Caballos novaculite indicates a Middle to Upper Devonian age for those beds. Most of the Cretaceous rocks exposed in the quadrangle belong to the Comanche series (Glen Rose, Maxon, Walnut—Comanche Peak, Edwards, Kiamichi, Georgetown, Grayson, and Buda formations) and are similar to equivalent age strata in central Texas. Gulf series rocks (Boquillas and Terlingua formations) have a restricted occurrence in the southwestern corner of the quadrangle.

Tertiary intrusions include plugs, dikes, and sills of rhyolite, trachyte, and basalt which cut Cretaceous and Paleozoic rocks. These intrusives belong to the southern Trans-Pecos Texas suite of alkalic igneous rocks.

INTRODUCTION

LOCATION

The Hood Spring quadrangle, Brewster County, Texas, is approximately 15 miles southeast of the village of Marathon (fig. 1). It is a 15-minute quadrangle extending west and south from the intersection of 103°00′ west longitude and 30°00′ north latitude and includes a large segment of the southeast part of the Marathon basin. State highway No. 227 from Marathon, Texas, to Big Bend National Park traverses the western part of the quadrangle.

PURPOSE AND SCOPE OF THE WORK

This investigation is a part of the current Trans-Pecos Texas mapping program of the Bureau of Economic Geology, The University of Texas. The Marathon region has been under geologic investigation, both in reconnaissance and in detailed studies, since 1890. A comprehensive summary of the history of geologic exploration in this area is given by King (1937, pp. 2-3), who included in his report on the Marathon region the reconnaissance geology of the northern part of the Hood Spring quadrangle. The present report is a detailed study of the geology of the Hood Spring quadrangle.

FIELD WORK

The writer first visited the Marathon region with Charles Laurence Baker in the summer of 1937 and in 1939 spent approximately six weeks in the field as assistant to S. S. Goldich. Several weeks were spent in 1940 collecting samples of

[1] Presented in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The University of Texas, May 1949.

the Paleozoic limestones and shales for determination and identification of the conodont faunas (Ellison and Graves, 1941; and Graves and Ellison, 1941). Detailed field work was carried on from July 15 to September 1, 1947, and during the months of June and August 1948.

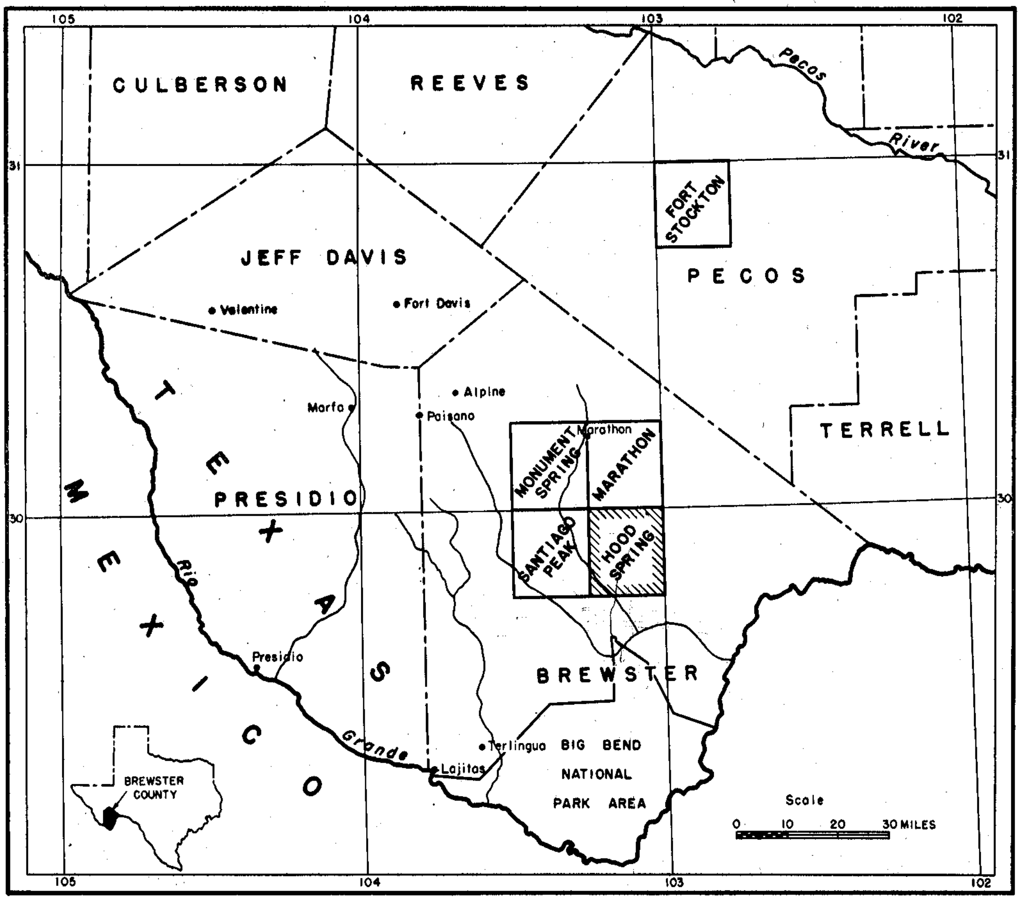

FIG. 1. Index map showing Hood Spring quadrangle and adjacent quadrangles covered by published geologic reports.

ACKNOWLEDGMENTS

Grateful acknowledgment is made for the assistance rendered the writer by the various members of the staff of the Bureau of Economic Geology and of the Department of Geology of The University of Texas. Special thanks are due to Dr. H. P. Bybee and to Dr. John T. Lonsdale for their kind efforts in directing the work. The writer is indebted to Mr. R. B. Haynie and Mr. R. L. Manly for assistance in the field; to Dr. L. W. Stephenson, of the U. S. Geological Survey, for the privilege of discussing, in the field, broader aspects of Cretaceous stratigraphy; and to Mr. W. S. Adkins, of the Shell Oil Company, for assistance with specific problems of correlation. Thanks are due to Dr. S. S. Goldich for assistance and advice in the field and for reading the report. The writer is indebted to a number of geologists for paleontologic determinations acknowledged in the text. Many courtesies were extended to the writer by the ranchers of the area, and their interest and hospitality made the field work a pleasure.

PHYSIOGRAPHY

PHYSICAL FEATURES

The Marathon region is an erosional basin that occupies roughly the center of a broad structural dome. The basin is bounded on the north, east, and southeast by gently outward-dipping strata that are younger in age and generally different in composition than the central, folded rocks. On the southwest flank, it is bordered by the Santiago Mountain range, which is a steeply dipping monoclinal flexure.

The region presents interesting contrasts, in both geological and physiographic features. The bounding escarpment of the Marathon basin, with the gentle slopes of its rim-rock limestone cuestas, contrasts sharply with the lower-lying interior plains and hogbacks. In general, these contrasts are the result of the superior resistance of the bordering limestones under the prevailing semiarid climate. King (1931, pp. 12–25; 1937, 3–19) has discussed the physiographic features of the Marathon region, and the discussion here will therefore be limited to the physiographic features of the Hood Spring quadrangle.

The quadrangle presents five distinctive types of physiographic features: (1) the Paleozoic hogbacks, (2) the rim-rock escarpment (Maravillas scarp), (3) the Santiago Mountains, (4) a bolson alluvial plain, and (5) igneous intrusive peaks. In the northwest corner of the quadrangle are outcrops of complexly folded and faulted Paleozoic rocks. The most prominent features of this area are the northeast-trending novaculite hogbacks of the Tinaja Mountains and a group of olive-drab hills of intricately folded sandstones and shales that lie between the Tinaja Mountains and the Cretaceous limestone rim-escarpment. On the southeast rim of the basin the Cretaceous rocks form three escarpments with accompanying cuestas. The northwesternmost is formed by the Glen Rose limestone, the middle one by the overlying Edwards limestone, and the third by the Georgetown limestone. These three escarpments, which collectively were called Maravillas scarp by Hill (1900, p. 4), lie almost completely within the Hood Spring quadrangle and trend in a northeast direction. The limestone beds in the escarpments and cuestas dip gently to the southeast.

The Santiago Mountain range extends across the southwest part of the quadrangle, southwest of Maravillas Creek, and is a narrow belt of folded limestones bordering the Marathon basin on the southwest. The south and southeastern parts of the quadrangle are occupied by an alluvial plain of the bolson type. This area is considered to be the northwest extension of the broad synclinal flexure which occupies a position between the junctions of Maravillas and San Francisco Creeks with the Rio Grande (Baker and Bowman, 1917, pp. 152–153).

Intrusive igneous rocks form prominent topographic features on the southwest and northeast ends of the Maravillas scarp. At the southwest end of the escarpment these intrusives are plugs intruded in the Glen Rose and Edwards limestones and now stand above the cuestas as high conical peaks. At the northeast end of the escarpment the intrusives are sill-like bodies in the Tesnus formation.

EROSIONAL AGENCIES

Running water is the predominant erosional agency in this region, which is subjected to occasional torrential rains. Violent flash floods occur in localized areas, resulting in the transportation of large rock fragments for short distances in the intermittent stream courses. The northwest, west, and southwest parts of the quadrangle are drained by Maravillas Creek and the north and northeast areas by San Francisco Creek. Most of the central, south, and southeast areas drain into the southeast bolson. Headward erosion by several consequent streams on the dip slope of the cuestas has cut through the Maravillas scarp into the area of folded Paleozoic rocks. Where the streams have not progressed so far, they have cut down to the Paleozoic rocks beneath the cuestas.

Chemical weathering appears to be of minor importance. Solution-pitted surfaces occur on the dip slopes of the limestone cuestas, and the igneous rocks of the area generally disintegrate into slabby masses following flow structure lines or into rounded, spheroidal boulders probably originating from exfoliation.

CLIMATE AND VEGETATION

The climate of Trans-Pecos Texas is arid to semiarid. Annual rainfall ranges from 8 to 17 inches, about half of which comes during the late summer months. Temperatures reach a maximum of about 110° F. and may fall to as low as 0° F. The average mean temperature of the summer months is 60° F. and of the winter months 45° F.

Vegetation is that found typically in the semiarid regions of the Southwest and includes cholla, lechuguilla, sotol, ocotillo, prickly pear, catclaw, creosote bush, and sage, and mesquite, cottonwood, live oak, cedar, and persimmon trees.

GENERAL GEOLOGY

DISTRIBUTION OF ROCKS

Only a part of the rock sequence of the Marathon basin (Table I) is exposed in the Hood Spring quadrangle. The succession of the pre-Permian rocks is incomplete in most places because some of the Lower and Middle Ordovician strata have been eliminated by thrust faulting. In a small area in the northwest part of the quadrangle a complete sequence of rocks from the Upper Cambrian Dagger Flat sandstone to the Lower Pennsylvanian Tesnus formation (fig. 2) is exposed. Limestones and cherts of the Maravillas formation and novaculite and chert of the Caballos formation predominate in the Tinaja range and in the ridges and scattered hogbacks to the northwest. Tesnus sandstones, quartzites, and shales are complexly folded in the wide belt of rugged hills between Tinaja range and the Maravillas scarp. The formation also occupies the synclinal troughs between the hogbacks. The Glen Rose formation in the Maravillas scarp rests with angular unconformity on folded Tesnus sandstone and shale (Pl. II).

The Cretaceous rocks comprising most of the strata of the Hood Spring quadrangle are mainly limestones with some interbedded marls and sandstones. Comanche rocks predominate in areal extent and thickness and in one small area, in the southwest corner of the quadrangle, rocks of Gulf age are exposed.

Igneous rocks are all fine-grained intrusives occupying individually only relatively small areas but forming the highest peaks in the quadrangle. Plugs, dikes, and sill-like intrusions occur in more than 30 separate, distinct bodies.

CAMBRIAN SYSTEM

DAGGER FLAT SANDSTONE

Distribution and lithology.—The Dagger Flat sandstone is exposed at one locality in the extreme northwest corner of the

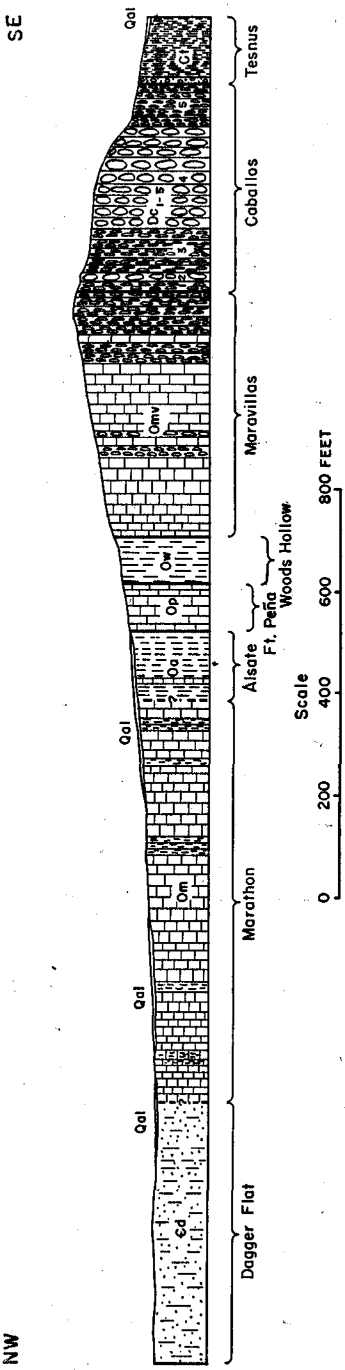

FIG. 2. Cross section of Paleozoic rocks in the northwest corner of Hood Spring quadrangle in a ridge 1½ miles east-northeast of Buttrill ranch.

quadrangle (fig. 2). This exposure, only a few hundred feet wide, is the southern end of the belt mentioned by King (1937, p. 22) as "displayed for a distance of 4 miles northeast from the Buttrill Ranch." The upper contact is concealed by alluvium and vegetation but is tentatively placed at the base of the dark gray limestones of the overlying Marathon limestone. Not more than 300 feet of the Dag-

Table I. Geologic formations in the Marathon region.[1]

AGE	FORMATION	THICKNESS (feet)
Recent	Alluvium	----------
Pleistocene (?)	Terrace gravel	10–100
Tertiary	Lava and tuff	3,000+
	Unconformity	
Gulf Cretaceous	Terlingua formation	1,200+
	Boquillas formation	700+
Comanche Cretaceous		
Washita group	Buda limestone	60+
	Grayson marl	20–70
	Georgetown limestone	175–500
Fredericksburg group	Kiamichi marl	40+
	Edwards limestone	150–300
	Comanche Peak, Walnut } undifferentiated	50+
Trinity group	Maxon sandstone	60–150
	Glen Rose formation	400–550
	Unconformity	
Triassic (?)	Bissett conglomerate	700
	Unconformity	
Permian	Tessey limestone	1,000
	Capitan limestone	1,800
	Word formation	1,500
	Leonard formation	1,800
	Unconformity	
	Wolfcamp formation	500
	Unconformity	
Pennsylvanian	Gaptank formation	1,800
	Haymond formation	3,000
	Dimple limestone	300–1,000
	Tesnus formation	300–7,000
	Unconformity	
Devonian (?)	Caballos novaculite	250–600
	Unconformity	

Upper Ordovician	Maravillas chert	100–400
	Woods Hollow shale	180–500
Middle Ordovician	Fort Peña formation	175
Lower Ordovician	Alsate shale	25–100
	Marathon limestone	350–900
Upper Cambrian	Dagger Flat sandstone (base concealed)	300+

[1] Modified from King (1937, p. 21).

ger Flat is exposed because it is covered by alluvium. The Dagger Flat in this area is a medium-grained,[2] tan or buff sandstone which weathers to a light brown and includes interbedded moderate brown, medium-grained, sandy limestones which are sparingly fossiliferous.

Fauna and age.—The only Dagger Flat fossils seen in this area were fragmentary and unidentifiable. King (1937, p. 23) stated that in the Marathon basin, the formation is characterized by *Agnostus, Lingula,* and *Obolus,* and that the formation probably is of Upper Cambrian age.

ORDOVICIAN SYSTEM

MARATHON LIMESTONE

Distribution and lithology.—In the northwest corner of the quadrangle, the Marathon limestone is predominantly limestone, with some interbedded shale, chert, sandstone, and several beds of edgewise limestone conglomerate. Both the upper and lower contacts of the formation are obscured by rubble, vegetation, and alluvium. The beds are vertical and are approximately 800 feet thick.

The limestones are flaggy, dense, dark gray to grayish black. The sandstones are fine to medium grained, moderate brown, weathering to a rough, darker brown surface. The shales are slightly fissile with a splintery fracture and are moderate olive-brown to light brown. The edgewise conglomerate is composed of flat, medium gray pebbles of limestone half an inch to 4 inches long embedded in a darker gray, fine-grained limestone matrix.

Fauna and age.—Only a few unidentifiable graptolite fragments were found in the Marathon limestones at this locality. According to King (1937, p. 30), the formation is equivalent to the Deepkill of New York and is of Beekmantown age.

ALSATE SHALE

Distribution and lithology.—A narrow band of Alsate shale crops out in the northwest part of the quadrangle parallel to the exposures of the Marathon limestones arid shales. Exposures are poor because the gentle slope is littered with rock debris. The beds are vertical and are estimated to be 200 feet thick. At this locality, the formation is predominantly shale with some interbedded calcareous, pale brown sandstone and dense, medium gray, laminated limestone, all of which weather to a moderate yellowish brown.

Fauna and age.—No specifically identifiable fossils were found in the Alsate shale in the area, but elsewhere in the Marathon basin, King (1937, p. 32) reported graptolites, brachiopods, and trilobites that are indicative of a late Beekmantown age.

FORT PEÑA FORMATION

Distribution and lithology.—At the single exposure of the Fort Peña formation in the northwest corner of the quadrangle the upper and lower contacts are obscure, but the beds are vertical and are approxi-

[2] In this paper, grain sizes of sedimentary rocks are those of the Wentworth scale.

mately 150 feet thick. The rocks are dense, fine-grained, brownish-gray limestones that have a conchoidal fracture and weather to a distinctive yellow brown. Interbedded with the limestones are some medium-grained, medium dark gray, calcareous sandstones and light brown shales.

Fauna and age.—Only a few oboloid brachiopods were found in the Fort Peña rocks in this area. Graptolites and brachiopods are reported by King (1937, p. 34) from the Fort Peña strata, and these indicate a possible Chazyan age. This correlation is confirmed by the conodonts (Graves and Ellison, 1941, p. 4) that are comparable to typical Plattin and Decorah faunas of the Mississippi Valley.

WOODS HOLLOW SHALE

Distribution and lithology.—The Woods Hollow shale crops out in three places in the Hood Spring quadrangle. One exposure is at the base of the ridge in the extreme northwest corner of the quadrangle. Here upper and lower contacts are fairly well exposed, and the vertical beds are approximately 100 feet thick. The rocks are mostly grayish-green and greenish-black, thinly laminated, splintery shales with minor interbedded thin, dense, brownish-gray limestone. The smallest exposure, about 50 feet in diameter, occurs along the trace of the northwesternmost thrust fault on the northeast end of the hogback that parallels the Tinaja range on the northwest. The third exposure is at the center of an anticlinal valley in this range and is about 100 feet wide and 2 miles long. Here the formation is composed of hard, fissile, grayish-olive shale that is cut by numerous diagonal bands of caliche.

Fauna and age.—The formation contains graptolites, bryozoans, trilobites, mollusks, and brachiopods that indicate a Middle Ordovician age (King, 1937, pp. 35–36) and may possibly be correlated with the Trenton. The conodont fauna from the limestones of the Woods Hollow (Graves and Ellison, 1941, p. 5) indicates a correlation with the Plattin and Decorah.

MARAVILLAS FORMATION

Distribution and lithology.—The Maravillas limestones and cherts are prominent on the northwest slopes of the hogbacks. One outcrop approximately 50 feet wide occurs along the trace of the thrust fault that parallels the Maravillas scarp for a distance of about 8 miles northeastward from the southwest end of the escarpment (Pl. I). In many places in the Hood Spring quadrangle, the lower contact of the Maravillas formation is a fault contact where the Maravillas has overridden Tesnus shales and sandstones. It ranges in thickness from a few feet along one of the faults to approximately 300 feet in the Tinaja Mountains. The formation is composed of fine to medium-grained, medium dark gray to grayish-black, fossiliferous limestones interbedded with dense, black, nodular to bedded chert. The chert is most abundant near the middle and upper part of the formation.

Fauna and age.—The most prominent fossils are graptolites, corals, brachiopods, and bryozoans which King (1937, p. 42) interpreted as Upper Ordovician in age. A similar fauna is known from the equivalent of a part of the Montoya limestone of the El Paso area. The conodont fauna (Graves and Ellison, 1941, p. 5) is similar to that of the Maquoketa shale of the Mississippi Valley.

DEVONIAN SYSTEM

CABALLOS NOVACULITE

Distribution and lithology.—The Caballos novaculite is the main ridge-maker of the Marathon region. The hogbacks of the area are capped and controlled by resistant cherts and novaculite. Most of the ridges of the Tinaja Mountains and the hills and hogbacks to the northwest are composed of the rocks of this formation (Pl. III).

The lower contact of the Caballos novaculite is commonly a fault contact, where the Caballos has been thrust over the Tesnus shales and sandstones, faulting out one or more of the members of the Caballos. The upper contact with the Tesnus formation is unconformable and not well exposed. The formation was divided by King (1937, p. 47) into five members: (1) lower chert, (2) lower novaculite, (3) middle chert, (4) upper novaculite, and (5) upper chert.

The physical and chemical characteristics of the Caballos novaculite are similar to those of the Arkansas novaculite. The cherts are dense, banded, and show a variety of colors from light tan or light gray to green, red, purple, and black. King (1937, p. 47) reported an average thickness of 200 feet in the northwest part of the basin and a maximum thickness of 600 feet in the south part of the basin. The variation in thickness of the formation in the south part of the Marathon basin is illustrated in the following sections, which also show a distinct variation in the composition of the upper novaculite member.

Section in the extreme northwest corner of the Hood Spring quadrangle (Pl. VIII and Pl. III, A).

	Thickness (*feet*)
Tesnus formation.	
Caballos novaculite—	
Upper chert member.	
6. Covered. Some pale reddish-brown translucent chert in float with a few blocks apparently in place	85
Upper novaculite member.	
5. Light gray to white, porcelaneous novaculite in beds 2 to 8 feet thick. Very badly shattered. The shattered angular blocks weather to white porcelaneous appearance and are stained orange along some of the fractures	198
Middle chert member.	
4. Covered	63
3. Shallow gully within outcrop area of member. Mostly covered. Appears to be interbedded thin, fissile, siliceous, olive-drab, dull-lustered shale and thin-bedded, black and grayish-black, dull-lustered chert	24
Lower novaculite member.	
2. Small low ridge 2 to 3 feet high of light gray to white, porcelaneous novaculite which is badly shattered. Weathers to angular blocks of white porcelaneous appearance with some dark gray to orange staining	17
Lower chert member.	
1. Mostly covered. Appears to be dense, tan to gray, translucent chert	24
Total	411

Section one-fourth of a mile southeast of Three-Mile Hill (Santiago Peak quadrangle) (fig. 3).

	Thickness (*feet*)
Tesnus formation—	
12. Bright grayish-green, hard, fissile, splintery shale	....
11. Interbedded black chert and silicified breccia-conglomerate in beds 1 inch to 1 foot thick. Conglomerate beds average 3 inches in thickness, composed of greenish-gray, angular chert granules cemented by black chert	20
Caballos novaculite—	
Upper chert member.	
10. Mostly covered. Few scattered outcrops of green, dull-lustered chert or siliceous shale and some gray to green translucent chert. In upper part of interval appears some light gray and green-banded, translucent chert	150
Upper novaculite member.	
9. White, massive novaculite which is badly shattered	35
8. Brown and gray-banded, translucent chert in beds 1 inch to 2 inches thick. Some black chert with thin white, brown, or pale green bands. Banding and bedding may be irregular or undulatory. Some gray chert with purplish bands or streaks	117
7. Light brown, irregularly bedded, dull-lustered chert containing in places greenish-gray nodules. Beds range from 1 inch to 1 foot in thickness	40
6. Light brownish-gray, somewhat banded chert in beds 1 inch to 18 inches thick	70
5. Dense, white, dull-lustered, shattered novaculite in beds 1 foot to 4 feet thick. Jointed approximately perpendicular to bedding planes. Weathering stains surfaces orange, brown, and black	83
Middle chert member.	
4. Covered. Ant hills show fragments of green to greenish-gray, thin-bedded, fissile, siliceous shale	34

	Thickness *(feet)*
Lower novaculite member.	
3. Low ridge of light gray, shattered, porcelaneous novaculite which weathers to white surfaces	57
Lower chert member.	
2. Covered. At contact with underlying Maravillas chert the Caballos is light gray, moderate to very dark red chert. In some places are small outcrops of light gray to tan, massive, translucent chert in beds 1 foot to 4 feet thick	33
Total Caballos	619
Maravillas formation—	
1. Light gray, banded chert in beds 6 to 18 inches thick with some interbedded, dark gray, fine-grained limestone	....

Fauna and age.—Fossils have been reported from only a few localities of the Caballos novaculite in the Marathon region. King (1937, p. 52) reported conodonts, linguloid brachiopods, and Radiolaria. The following conodonts were collected by the writer (Graves, 1952) from the upper chert member on East Bourland Mountain (Monument Spring quadrangle) and were identified by Dr. S. P. Ellison:

Palmatolepis perlobata Ulrich and Bassler
Palmatolepis subperlobata Branson and Mehl
Palmatolepis delicatula Branson and Mehl
Palmatolepis sp.
Polygnathus sp.
Hindeodella sp.
Ozarkodina sp.
Synprioniodina sp.

The limestone lens in the upper chert member in the Payne Hills (Monument Spring quadrangle) in the northwestern part of the Marathon basin yielded the following conodonts in acetic acid residues:

Icriodus curvatus Branson and Mehl
Icriodus latericrescens Branson and Mehl
Icriodus symmetricus Branson and Mehl
Palmatolepis sp.
Spathognathodus aculeatus Branson and Mehl
Spathognathodus stabilis Branson and Mehl
Bryantodus sp.
Centrognathodus (?) sp.
Ligonodina (?) sp.
Oistodus sp.
Oistodus inclinatus Branson and Mehl
Ozarkodina sp.
Hibbardella (?) sp.

The presence of *Palmatolepis* and *Icriodus* indicates that the upper chert member of the Caballos formation is Middle to Upper Devonian age (Ellison, 1946, fig. 2; pp. 105–107). This fauna correlates with the Woodford shale of Oklahoma and with the Chattanooga and Grassy Creek shales of the Mississippi Valley.

PENNSYLVANIAN SYSTEM

TESNUS FORMATION

Distribution and lithology.—The Tesnus sandstones and shales occupy most of the troughs of the inter-hogback areas and underlie the Glen Rose cuesta of the Maravillas scarp (Pl. II). Between the Maravillas scarp and the Tinaja range, sandstones and quartzites of the formation form a series of low hills and hogbacks. The lower contact with the Caballos formation is not well exposed, and in only two places was the basal conglomerate observed. The upper contact with the Dimple formation is not seen because the highly folded sandstones and shales of the Tesnus disappear under the Cretaceous limestone in the Maravillas scarp. The formation is chiefly sandstone and is estimated to be several thousand feet in thickness. Throughout the Marathon basin, the Tesnus has a varied lithology, predominantly shale at the base and sandstone and quartzite in the upper parts. The composition changes to the south and southeast and the lower part of the formation is predominantly sandstone in the Hood Spring quadrangle. The formation may be considered to be one of interbedded sandstones and shales, with some arkose, chert, and a basal conglomerate. The shales are hard, fissile, green, red, brown, and black. Sandstones are mostly dense, thin-bedded, greenish-brown, fine-grained rocks locally quartzitic. These rocks weather to a rusty brown or olive-drab. The green color is produced by a chloritic matrix.

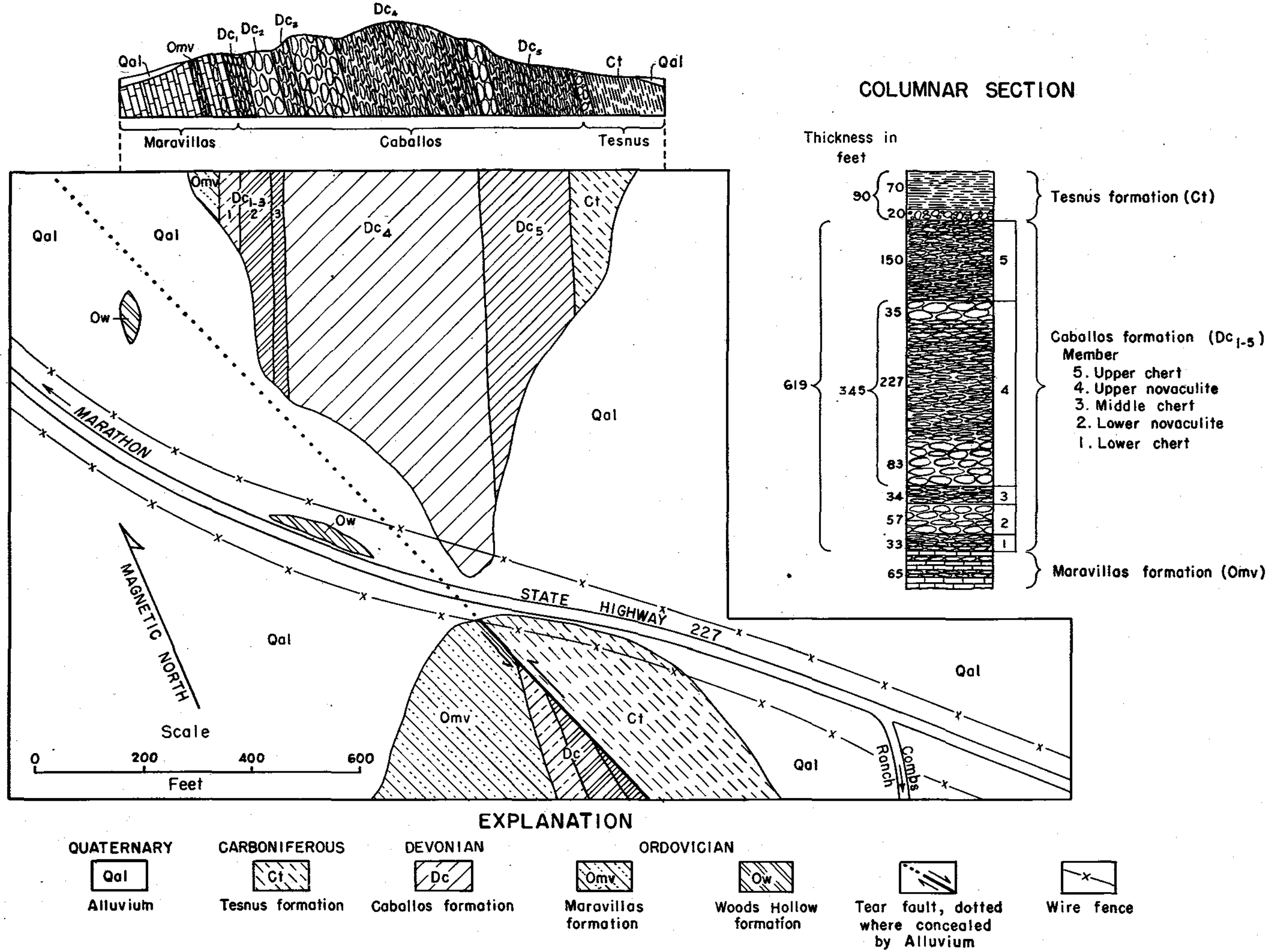

FIG. 3. Sketch map and cross section of Caballos novaculite on north side of State highway No. 227, one-fourth mile southeast of Three-Mile Hill (Santiago Peak quadrangle), 17 miles south of Marathon, Texas.

Fauna and age.—The known fossils are poorly preserved and are not diagnostic. King (1937, pp. 61–62) stated that the formation is probably conformable with the overlying Lower Pennsylvanian Dimple limestone and that the plant remains and Foraminifera indicate that the formation, in its upper part at least, is of Lower Pennsylvanian age. Conodonts from both the thin limestone beds of the Tesnus-Dimple transition zone and from the Dimple limestones (Ellison and Graves, 1941, p. 2) indicate a correlation with the Smithwick of central Texas and with the Wapanucka and lower John's Valley shale of southern Oklahoma. The underlying Tesnus is therefore older than rocks of that age.

CRETACEOUS SYSTEM

GLEN ROSE FORMATION

Distribution and lithology.—The Glen Rose formation forms the northwest cuesta of the Maravillas scarp and caps the hills and small cuestas that are the basinward erosion remnants of the Maravillas scarp. It occurs in a small outcrop near the base of the large ridge in the southwest part of the quadrangle and is involved in the thrust-fault ridge that trends parallel to Maravillas Creek in that area.

The formation is composed of thick-bedded, light gray to cream, fine-grained, dense limestones with some interbedded marls and sandstones. Alternating marls, limestones, and fine-grained, ripple-marked, and cross-bedded sandstones and siltstones are characteristic of the upper part of the formation. The limestones and marls contain abundant small shell fragments. Based on lithology, the upper part of the Glen Rose is interpreted to be a near-shore or littoral facies. Everywhere in the Hood Spring quadrangle a brown, red, purplish, or light gray conglomerate is present at the base of the formation. The conglomerate is composed of sandstone, limestone, novaculite, and chert pebbles, and cobbles half an inch to 6 inches in diameter derived from the Paleozoic rocks, embedded in a cherty to sandy matrix. Interbedded with the conglomerate are thick beds of medium to coarse-grained, calcareous sandstone.

Stratigraphic relations.—The Glen Rose rests with angular unconformity on the highly folded Tesnus sandstones and shales. The upper contact with the Maxon sandstone is conformable. The formation has a uniform thickness of about 475 feet in the Maravillas scarp. Sections of the formation follow.

Section of Glen Rose formation in natch northeast of Hill 4750 in the northeast part of the Hood Spring quadrangle.

	Thickness (feet)
Maxon sandstone—	
Pink, cross-bedded, fine-grained sandstone	1.0
Glen Rose formation—	
27. Cream-colored marl	8.5
26. Small ledge of cream to pinkish-tan, fine-grained, calcareous, slightly cross-bedded sandstone	1.5
25. Fine-grained, argillaceous, laminated, somewhat ripple-marked sandstone	5.5
24 Nodular marl which weathers to light cream-yellow	27.0
23. Small ledge of tan, nodular, dense, fine-grained limestone in beds 18 inches thick	3.0
22. Interbedded yellowish to cream-colored marl and light tan to grayish-tan, nodular, thin-bedded limestone. Sparingly fossiliferous	43.0
21. Moderate yellowish-brown, dense limestone which weathers to rounded yellowish, light brown surfaces	1.0
20. Light gray, yellow-mottled limestone	0.5
19. Covered. Probably marl	12.0
18. Ledge of light brown, dense limestone in beds 1 foot to 14 feet thick containing numerous rudistids	36.5
17. Light cream-colored marl with few interbedded ledges of nodular, rudistid-bearing limestone which contains shell fragments. Lower 16 feet contains *Porocystis.* Upper 64 feet contains abundant *Orbitolina*	116.0
16. Bed of grayish-yellow, dense, argillaceous limestone or calcareous siltstone	1.5
15. Light cream-colored marl	6.5
14. Prominent, cliff-forming, dark tan, rudistid-bearing, dense limestone	52.0

	Thickness *(feet)*
13. Partly covered. Some interbedded dark tan, dense, lithographic limestone in beds 6 to 18 inches thick, and light gray marl. Forms a gentle to steep slope between two cliffs. Near top are two beds of limestone each 3 feet thick	33.0
12. Dark tan to buff, massive, cliff-forming, dense, fine-grained limestone with subconchoidal fracture, in beds 2 to 15 feet thick which weathers to medium gray to moderate reddish-orange. Thinner beds weather to slaty, somewhat rounded, small slabs. Base of zone somewhat fossiliferous containing unidentifiable pelecypods and gastropods. Few scattered nodules of calcite 1 inch to 3 inches in diameter near base. Highly fossiliferous cream-colored limestone 67 feet above base contains small pelecypods and gastropods..............................	86.0
11. Fine-grained, argillaceous limestone which weathers into nodules..	1.5
10. Single bed of tan, dense, very fine-grained limestone with subconchoidal fracture. Weathers medium gray...............................	5.5
9. Light gray to tan, sandy limestone which locally contains streaks of chert granules and coarse sand..................................	6.0
8. Light gray to tan, coarse-grained, somewhat sandy limestone in beds 1 inch to 3 inches thick.....	1.5
7. Calcareous, sandy, conglomeratic, medium to fine-grained sandstone which has thin band of chert granules at top...........................	0.5
6. Grayish-pink to light tan, fine-grained, well-indurated sandstone. Weathers into dark grayish-brown angular blocks............	6.5
5. Light brown, fine-grained, conglomeratic, argillaceous sandstone which weathers to rounded, grayish-brown surfaces. Top 6 to 9 inches contains granules of chert. Small nodules of calcite throughout..	6.5
4. Covered..	5.0
3. Sandy conglomerate.....................	2.0
2. Pale reddish-brown, dense, fine-grained sandstone with few scattered granules and pebbles of chert. Weathers dark reddish brown..	3.0
1. Moderate reddish-brown, sandy, calcareous conglomerate composed of coarse sand to pebbles 1 inch in diameter. Pebbles are novaculite and green and black chert. Beds are 1 foot to 2 feet thick and are silicified in some parts..	6.5
Total Glen Rose....................	478.0
Tesnus formation—	
Fine-grained sandstone bleached light cream to tan. Only about 1 foot of formation visible beneath Glen Rose conglomerate..............	....

Composite section of Glen Rose from Hill 4105 to Hill 4250 in the west-central part of the Hood Spring quadrangle.

	Thickness *(feet)*
Maxon formation—	
Cross-bedded sandstone	
Glen Rose formation—	
47. Prominent ledge of light brown to moderate reddish-brown limestone...	2.0
46. Light gray, nodular marl containing shell fragments................	4.0
45. Tan, dense, nodular limestone, containing *Trigonia, Exogyra, Tylostoma*.......................................	2.0
44. Interbedded cream to tan marl and thin-bedded, very fine-grained sandstone. Marl contains abundant shell fragments....................	14.0
43. Tan, dense limestone...................	1.0
42. Grayish-yellow marl. Nonfossiliferous...	6.5
41. Tan, dense limestone..................	1.0
40. Interbedded light gray to cream-colored marl and nodular limestone containing abundant shell fragments. Marl and limestone contain *Protocardia, Trigonia, Pecten, Tapes,* and other pelecypods, and gastropods....................	15.0
39. Ledge of pale yellowish-brown, dense limestone which weathers to rough light gray surfaces.......	1.0
38. Tan, fragmental shell marl.........	7.5
37. Small ledge of pale reddish-brown limestone with fragmental appearance, containing large elongate Foraminifera on weathered surfaces................................	0.5
36. Cream-colored marl containing shell fragments...........................	2.5
35. Light tan, dense, sublithographic limestone which weathers to light gray flattened nodules..................	2.5
34. Cream to tan marl with a few thin beds of limestone which weather to nodules. Beds contain *Orbitolina*......................................	17.5
33. Tan, dense limestone....................	0.5
32. Light gray *"Orbitolina"* marl.....	3.0
31. Tan, nodular limestone which weathers light gray......................	4.0

		Thickness (*feet*)
30.	Cream and gray marl containing shell fragments	4.0
29.	Tan, dense limestone which weathers to light gray nodules	5.0
28.	Interbedded light gray to tan, nodular marl and limestone, containing *Protocardia, Trigonia*	15.5
27.	Light brown, dense, sublithographic limestone which weathers darker brown	0.5
26.	Small ledge of grayish-yellow siltstone which weathers to rounded cobbles and boulders	2.0
25.	Light brownish-gray, dense, flaggy limestone in beds 1 inch to 3 inches thick	4.0
24.	Small ledge of light brownish-gray, dense, nodular, argillaceous limestone. Contains *Porocystis*	1.0
23.	Grayish-yellow to cream-colored marl containing abundant *Porocystis* and shell fragments	4.0
22.	Tan, dense, sublithographic limestone having subconchoidal fracture. Beds 1 foot to 3 feet thick; contain abundant large rudistids	15.0
21.	Tan, dense, sublithographic limestone in beds 2 to 6 inches thick, weathering light gray. Contains *Porocystis, Tylostoma, Protocardia*	6.5
20.	Interbedded cream to gray, nodular limestone and marl. Contains abundant *Orbitolina* and a few *Trigonia, Tylostoma, Protocardia*	7.5
19.	Ledge of tan, dense limestone which weathers light brownish gray	2.5
18.	Cream to gray marl containing few *Orbitolina*	5.0
17.	Yellowish-tan, dense limestone weathering to yellowish-gray mottled, rounded surfaces	1.0
16.	Cream to gray *"Orbitolina"* marl	6.5
15.	Ledge of tan to gray *"Orbitolina"* limestone weathering to platy or flattened nodules	4.0
14.	Light gray *"Orbitolina"* marl	4.0
13.	Ledge of light brown, dense, massive, sublithographic limestone containing unidentifiable pelecypods at base and few *Orbitolina* throughout	4.0
12.	Cream-colored marl containing abundant *Orbitolina*. Few beds of limestone which may be up to 18 inches in thickness. Interval composed predominantly of tests of *Orbitolina*	25.0
11.	Ledge of tan, dense limestone. Contains *Orbitolina* and *Protocardia*	1.0
10.	Cream-colored *Orbitolina* marl with some nodular limestone. Float contains *Protocardia* and *Porocystis*	8.5
9.	Pale yellowish-brown, dense limestone which weathers into nodules. Beds 6 inches to 1 foot thick; contain *Orbitolina* and *Pecten*	5.0
8.	Grayish-yellow, dense, very fine-grained limestone or calcareous siltstone having conchoidal fracture. Weathers to yellowish-gray, rounded cobbles	1.0
7.	Grayish-yellow *"Orbitolina"* marl. Hundreds of *Orbitolina* in float	7.0
6.	Ledge of dense, tan limestone which weathers light gray	1.5
5.	Interbedded yellowish-gray marl and light tan, thin-bedded, nodular limestone	9.0
4.	Tan, dense, finely crystalline limestone in beds 1 foot thick, with some interbedded nodular limestone in beds one-fourth inch to 1 foot thick. Numerous rudistids with some *Gryphaea, Exogyra, Protocardia.* Nodular beds containing large poorly preserved *Ostrea* (?)	12.5
3.	Prominent cliff of tan, massive, sublithographic to finely crystalline limestone in beds 2 to 6 feet thick, with uneven to subconchoidal fracture. Irregular to rough-weathered surfaces are light gray with reddish and purplish stainings. Cliff face commonly orange. Top 10 feet appears to be broken and recrystallized. A zone 15 to 25 feet below top of cliff contains granules of chert	196.0
2.	Light tan, medium-grained, dense, conglomeratic limestone in beds 1 foot to 3 feet thick. Contains streaks and sheets of grit and granules in zones up to 3 inches thick. Some detrital chert and novaculite grains disseminated throughout	9.0
1.	Covered slope. Basal conglomerate covered. Some yellowish-gray, calcareous, fine-grained sandstone exposed. Thickness of sandy, conglomeratic basal beds estimated	25.0
	Total Glen Rose	477.0

The thickness and composition of the Glen Rose formation are rather uniform in the Marathon region. King (1937, p. 113) reported a thickness of 559 feet in the Del Norte Mountains, and Eifler (1943, p. 1621) gave a thickness of 458 feet in the Cochran Mountains. Nowhere in the Marathon region does the formation attain the thickness of 800 feet reported in central Texas.

Fauna and age.—The fauna of the upper marl zones of the Glen Rose formation is more varied than that of the lower, dense limestones. These upper beds contain many *Orbitolina texana* and *Porocystis globularis.* The lower thick-bedded limestones, and the limestones associated with the marl in the upper part of the section, contain numerous *Toucasid,* caprinids, and rudistids. The following fossils occur in the Glen Rose beds in the Hood Spring quadrangle:[3]

Echinoidea
- *Enallaster texanas* (Roemer)
- *Loriolia texana* (Clark)

Foraminifera
- *Orbitolina texana* (Roemer)

Pelecypoda
- *Arctica mediale* (Conrad)
- *Arctica* sp.
- *Caprina* (?) sp.
- *Cardium chihuahuensis* Böse
- *Cardium* sp.
- *Cyprimeria texana* (Roemer)
- *Exogyra* sp.
- *Gryphaea* sp.
- *Homomya* sp.
- *Lima wacoensis* Roemer
- *Modiola* sp.
- *Monopleura* sp.
- *Ostrea* sp.
- *Pecten (Neithea) irregularis* Böse
- *Pecten stantoni* Hill
- *Protocardia texana* (Conrad)
- *Protacardia* sp.
- *Tapes chihuahuensis* Böse
- *Tapes decepta* (Hill)
- *Toucasia* sp.
- *Trigonia* sp.

Gastropoda
- *Alipes* sp.
- *Glauconia branneri* Hill
- *Lunatia praegrandis* (Roemer)
- *Turritella* sp.
- *Tylostoma chihuahuense* Böse

Unknown
- *Porocystis globularis* (Giebel)

The Glen Rose beds are the lowermost Cretaceous rocks exposed in the Hood Spring quadrangle. They are essentially equivalent to the Glen Rose limestone in central Texas.

[3] The writer is indebted to Prof. F. L. Whilney for assistance in identifying the Cretaceous megafossils listed in this paper.

MAXON SANDSTONE

Distribution and lithology.—The Maxon sandstone crops out high on the forward face of the middle cuesta of the Maravillas scarp along its entire length. It occurs as a narrow belt along the southeast and southwest edges of the high ridge in the area southwest of Maravillas Creek in the southwestern corner of the quadrangle.

The Maxon formation is a light gray to light brown, fine to medium-grained, friable to dense, cross-bedded sandstone with beds of less than 1 inch to 10 or more feet thick (Pl. IV, A). There are some interbedded sandy marls and locally, in at least two localities, thick-bedded, fossiliferous limestone lenses.

Stratigraphic relations.—The contact of the Maxon sandstone with the underlying Glen Rose is conformable. The formation represents a continuation of the shoreline type of deposition which started in upper Glen Rose time and continued throughout Maxon time. The formation thins progressively southwestward from 157 feet at the northeast end of the Maravillas scarp to 115 feet at its southwest end and 63 feet in the area south of Maravillas Creek where the formation is predominantly calcareous. The upper contact marks the boundary between the Trinity and Fredericksburg groups. The following sections indicate the nature of the Maxon formation:

Section of Maxon formation on south slope of hill 1 mile south of Hill 4750 on northeast end of the Maravillas scarp.

	Thickness *(feet)*
Walnut formation—	
Grayish-yellow to yellowish-buff, dense, nodular, slightly sandy marl which contains abundant *Exogyra texana* in top 2 feet........	4.5
Maxon sandstone—	
12. Mostly covered. Some yellowish to purplish-stained, medium-grained, friable sandstone............	11.0
11. Very light gray to tan, fine-grained, argillaceous, cross-bedded sandstone which is light brown to grayish yellow near top of interval....................................	13.5

	Thickness (*feet*)
10. Covered	6.0
9. Pink and yellow-stained, very fine-grained, dense, argillaceous sandstone	4.5
8. Grayish-yellow to cream-colored, nodular, sandy marl. Grades into siltstone at top	3.0
7. Ledge of grayish-yellow to buff, medium to coarse-grained, dense to friable, cross-bedded sandstone in beds half an inch to 2 feet thick, which weathers pale reddish brown	16.5
6. Mostly covered. Appears to be interbedded light-colored, medium-grained, friable sandstone and light gray to very light gray sandy marl with some grayish-yellow limestone near top	44.5
5. Massive ledge of light tan to cream-colored, cross-bedded, fine to medium-grained sandstone in beds 1 foot to 3 feet thick with a few thin beds 1 inch thick. Weathers into large, moderate brown, angular boulders. Upper part of interval is not cross-bedded and is slightly friable	14.5
4. Interbedded, tan, fine-grained sandstone and light gray, almost white, nodular sandy marl. Marl predominates near center of interval and contains gastropods and pelecypods. Top 15 feet partly covered but appears to be mostly buff to cream to yellow sandstone	25.0
3. Nodular, thick-bedded, fine-grained, slightly friable sandstone in beds 3 inches to 1 foot thick. Buff to yellow to pale reddish brown on weathered surfaces. Grades laterally to massive cross-bedded sandstone in beds 1 foot thick	5.5
2. Mostly covered. Few beds of light tan, fine-grained sandstone exposed	11.0
1. Light brown, fine-grained, dense, cross-bedded, ripple-marked sandstone in beds 2 to 9 inches thick	2.0
Total Maxon	157.0
Glen Rose formation—	
Covered	6.0
Yellowish-buff, nodular limestone in beds 6 inches thick	5.0

Section of Maxon formation on north side of Hill 4250 at the southwest end of the Maravillas scarp.

	Thickness (*feet*)
Walnut formation—	
Grayish-yellow marl which contains abundant *Exogyra texana* at base	....
Maxon sandstone—	
7. Light tan to light gray, fine to medium-grained, cross-bedded sandstone beds 2 inches to 1 foot thick. Bottom 15 feet of interval is marl and grades upward through sandy marl to nodular, argillaceous sandstone to cross-bedded beds above. Sandstone is mostly friable	17.5
6. Pale red, dense, very fine-grained, argillaceous sandstone or siltstone. Weathers pale brown	2.0
5. Covered	11.5
4. Light gray to cream-colored, dense, fine-grained limestone beds 2 to 5 feet thick. Sandy near base. Contains abundant *Actaeonella dolium* throughout	14.0
3. Mostly covered. Probably light gray to cream-colored marl. A marl bed at top of interval contains *Actaeonella dolium* in abundance	35.5
2. Buff to yellow, very fine-grained, argillaceous sandstone or siltstone which weathers to grayish-pink, elongated, rectangular pebbles	1.5
1. Light tan to gray, coarse-grained, friable, cross-bedded sandstone beds 6 inches to 5 feet thick	33.0
Total Maxon	115.0
Glen Rose formation—	
Light brown to moderate reddish-brown, dense, sublithographic limestone. Forms prominent ledge	2.0

The Maxon formation is variable in thickness. King (1931, p. 92; 1937, p. 114) reported 145 feet near Tesnus Station and 102 feet at Housetop Mountain. Eifler (1943, pp. 1623-1624) found 73 feet of the formation in the Cochran Mountains and measured 114 feet in the southeastern part of the Santiago Peak quadrangle. Owing to the transitional nature of the upper Glen Rose beds from interbedded sand and marl to the predominantly sandstone beds of the basal Maxon, and the consequent difficulty in fixing the lower limit of the Maxon, it is possible that some of the reported differences in thickness are caused by change in facies or by individual differences in interpreting the lower boundary.

Fauna and age.—The Maxon sandstone is sparingly fossiliferous. Locally, in calcareous lenses, it contains the involute gastropod *Actaeonella dolium* which is apparently restricted to these beds. The following fossils are found in the Maxon sandstone in the Hood Spring quadrangle:

Pelecypoda
- *Arctica mediale* (Conrad)
- *Exogyra texana* Roemer
- *Protocardia texana* (Conrad)
- *Tapes decepta* (Hill)
- *Trigonia* sp.

Gastropoda
- *Actaeonella dolium* Roemer
- *Turritella* sp.
- *Tylostoma chihuahuense* Böse
- *Glauconia branneri* Hill

Because of its gradational relationship with the underlying Glen Rose formation and the absence of definite faunal evidence to the contrary, the Maxon sandstone is here placed in the Trinity group and is considered to be essentially the stratigraphic equivalent of the Paluxy sand.

WALNUT AND COMANCHE PEAK FORMATIONS

Distribution and lithology.—The marls and interbedded shell-fragment limestones of the Walnut and Comanche Peak formations are exposed above the Maxon sands and below the cliff-forming Edwards limestones in the middle cuesta of the Maravillas scarp. These beds occur also in the area southwest of Maravillas Creek. A division between the Walnut and Comanche Peak was not attempted, because in this region these rocks grade upward from marl with interbedded limestone to limestone ledges separated by thin beds of marl. The marls are relatively soft, fossiliferous, nodular, and light gray to grayish yellow. Locally the beds are stained pale red-purple. The interbedded limestones are tan, dense, fine grained, and contain small shell fragments.

Stratigraphic relations.—The lower contact of the Walnut—Comanche Peak beds is in most places well defined by the change from the sands of the Maxon formation to soft marl. The contact of the Walnut—Comanche Peak beds with the Edwards limestone is extremely difficult to locate in the field. The contact, in this paper, is placed at the top of the highest limestone bed which has the rough-weathering, nodular appearance which is typical of the Walnut—Comanche Peak beds and which contains the same general type of shell fragments. The overlying basal bed of the Edwards limestone weathers to a lighter gray, smooth surface. This bed occurs several feet below the lowermost rudistid beds (Pl. V, A and B). The difficulty in recognizing the contact between the Comanche Peak and the Edwards may account for the variable thicknesses reported in the Hood Spring quadrangle. The Walnut—Comanche Peak beds are 35 feet thick at the northeast end of the Maravillas scarp, approximately 70 feet thick near the center, and 64 feet thick at the southwest end. Southwest of Maravillas Creek, thicknesses of 58 feet and 86 feet were measured.

The following section of the Walnut—Comanche Peak beds indicates the nature of the strata in the Hood Spring quadrangle.

Section of Walnut—Comanche Peak formations on southeast side of Hill 3367 in the southwest part of the Hood Spring quadrangle.

	Thickness *(feet)*
Walnut—Comanche Peak formations—	
11. Tan, dense, sublithographic limestone containing shell fragments. Weathers to irregular flattened nodules or plates giving shattered appearance..........................	1.5
10. Grayish-yellow, platy marl..........	1.0
9. Ledge of tan, massive, sublithographic limestone which weathers to rough, gray surface..........	3.0
8. Grayish-yellow, purplish-stained marl containing shell fragments..	1.5
7. Ledge of tan, sublithographic limestone which weathers to a rough, light gray surface. Contains numerous shell fragments..	2.5
6. Grayish-yellow to light gray, nodular marl or nodular limestone. Locally may be moderate yellow. Contains shell fragments............	7.0
5. Ledge of tan, dense limestone which weathers to slightly rough, light gray surface. Top of ledge contains large *Exogyra*................	2.0
4. Grayish-yellow to light gray, nodular, fossiliferous marl................	3.5

	Thickness (*feet*)
3. Ledge of tan, dense limestone which weathers to nodules locally. Weathered surfaces slightly rough, light gray. Top of ledge contains *Exogyra*...........................	1.0
2. Grayish-yellow, fossiliferous marl which weathers to flattened nodules. Locally may be bleached or stained to pale red-purple. *Exogyra* abundant near base of interval. Whole interval contains small shell fragments.................	29.0
1. Covered slope. Probably grayish-yellow, nodular marl....................	5.5
	57.5

The section above does not represent the complete sequence of the Walnut—Comanche Peak beds since neither the upper nor the lower contact is included. This is, however, the best exposure of these beds in the Hood Spring quadrangle and is representative of the formations (Pl. IV, B).

Elsewhere in the Marathon region equivalent strata are reported to be 50 to 90 feet in thickness, Eifler (1943, pp. 1629–1630) measured 45 feet east of Black Mountain and 52 feet northeast of YE Mesa in the Santiago Peak quadrangle. He assigned these beds to Member No. 1 of the Devils River limestone. King (1931, pp. 93-94; 1937, p. 114) reported more than 50 feet on the east side of the Marathon basin and 90 feet northwest of Gilliland Canyon in the Glass Mountains. In the Fort Stockton quadrangle, Adkins (1927, pp. 37–38) assigned about 91.5 feet of basal Fredericksburg limestones and marls to the "Comanche Peak and ? Walnut formations."

Fauna and age.—The undifferentiated Walnut and Comanche Peak formations, especially the lower marl, contain an abundant pelecypod fauna. *Exogyra texana* and *Holectypus planafus* are in greater abundance in these beds than in any other formation in the Hood Spring quadrangle. The upper limestones contain abundant fragmented shells but no specifically identifiable fossils. The following fossils occur in the marl beds:

Echinoidea
- *Holectypus planatus* Roemer
- *Loriolia texana* (Clark)

Pelecypoda
- *Cardium subcongestum* Böse
- *Cyprimeria texana* (Roemer)
- *Exogyra texana* Roemer
- *Gryphaea marcoui* Hill and Vaughn
- *Lima wacoensis* Roemer
- *Modiola* sp.
- *Ostrea* sp.
- *Pecten (Neithea) irregularis* Böse
- *Pholadomya* sp.
- *Pinna* sp.
- *Protocardia texana* (Roemer)
- *Protocardia* sp.
- *Tapes decepta* Hill
- *Trigonia* sp.

Gastropoda
- *Alipes* sp.
- *Turritella* sp.
- *Tylostoma chihuahuense* Böse
- *Tylostoma pedernales* Roemer
- *Tylostoma* sp.

Cephalopoda
- *Engonoceras piedenale* Von Buch
- *Engonoceras* sp.

The microfauna from the marl of the Walnut—Comanche Peak formations in the Hood Spring quadrangle was studied by Mrs. Helen Jeanne Plummer. She reported[4] the following species and states that the assemblage is suggestive of the central Texas Walnut:

- *Ammobaculites camerata* Lozo
- *A. laevigatus* Lozo
- *A. subgoodlandensis* Vanderpool
- *Choffatella* sp.
- *Conorbina conica* Lozo
- *Coskinolinoides adkinsi* Barker
- *Discorbis sp.*
- *Haplophragmoides* sp.
- *Lituola camerata* Lozo
- *L. inflata* Lozo
- *Ovalveolina* sp.
- *Pseudoparrella* sp.
- *Eponides acria* Loeblich & Tappan

On the basis of stratigraphic position, lithology, and fauna, the beds between the Maxon sandstone and the Edwards limestone are correlated with the Walnut and Comanche Peak formations in central Texas.

EDWARDS LIMESTONE

Distribution and lithology.—The Edwards limestone is the cap-rock of the middle cuesta of the Maravillas scarp along

[4]Personal communication.

its entire length in the Hood Spring quadrangle (Pl. V, C). The formation occurs also in the area southwest of Maravillas Creek and is involved in both the normal and thrust faulting.

Edwards limestone is fine grained to sublithographic, light tan to tannish gray, and occurs in beds from 6 inches to 16 feet thick. It is sparingly fossiliferous with the fossils almost invariably silicified. The rough, medium gray, weathered surface serves to distinguish the Edwards from both the Glen Rose and Georgetown formations. In addition to the silicified fossils, the limestone contains, at various irregular levels, tan to purplish chert nodules along the bedding planes. These nodules coalesce locally to form beds of faintly banded chert 3 to 6 inches thick. The chert beds and nodules occur in the upper part of the formation and downward to within 50 or 60 feet of the base. Chert occurs also in the upper part of the Georgetown, but Georgetown limestones contain *Gryphaea* beds which are not present in the Edwards formation.

Stratigraphic relations.—The contact of the Edwards with the Comanche Peak probably is conformable, and the two formations may represent continuous deposition (Pl. V, A and B). The upper contact is marked by a distinct change from the dense limestone of the Edwards to the soft, yellow marl of the Kiamichi.

The Edwards limestone is approximately 240 feet thick near the center of the Maravillas scarp but thickens to over 300 feet in the area southwest of Maravillas Creek. The following section is representative of the Edwards in the Hood Spring quadrangle.

Section on north side of ravine southwest of Hill 4300 southwest of Maravillas Creek.

	Thickness *(feet)*
Top of ridge.	
Georgetown limestone (incomplete)—	
38. Tan, dense, lithographic, fossiliferous limestone in beds 6 inches to 2 feet thick. Weathers somewhat platy with light brownish-gray, somewhat rough surfaces....	23.5
37. Light tan, dense, lithographic limestone in beds 5 to 15 feet thick. Weathers to light gray, somewhat rough, pitted surfaces which have a weathered crust 1/16 inch thick. Deeper weathering under crust causes limestone to be chalky and yellowish gray. Interval forms a prominent cliff. Few small *Pecten* occur approximately 20 feet above base of cliff........	95.0
36. Light gray, dense, sublithographic to lithographic limestone in beds 1 foot to 6 feet thick which weathers to smooth, very light gray or white surfaces. Interval mostly covered. Beds become thicker toward top..............	123.5
35. Covered........	143.0
Total Georgetown...............	385.0
Kiamichi marl—	
34. Ledge of grayish-tan, dense, fossiliferous limestone which weathers to rough, light brownish-gray surface. Contains numerous *Gryphaea*........	0.5
33. Covered. Appears to be yellow, fossiliferous, nodular marl..........	13.0
32. Ledge of light gray, nodular limestone which contains fossils and shell fragments and weathers to flat nodule........	2.0
31. Alternating yellow marl and light tan to light gray limestone which weathers to nodules........	13.5
30. Covered. Appears to be yellow, nodular marl which is sparingly fossiliferous........	17.0
Total Kiamichi....................	46.0
Edwards limestone—	
29. Ledge of light gray, dense, fine-grained limestone........	1.0
28. Light gray, nodular marl............	9.0
27. Prominent ledge of tan, irregularly bedded, nodular, dense limestone which weathers to a rough, light brownish-gray surface with reddish to purplish stains around zones of silicified shell fragments........	8.0
26. Light gray, thin-bedded, dense, sparingly fossiliferous limestone in beds 3 to 6 inches thick interbedded with light gray, nodular marl........	8.0
25. Light, tannish-gray, dense, fine-grained limestone in beds-1 foot to 2 feet thick, containing silicified shell fragments. Few small, rounded chert nodules near base	22.0

	Thickness (feet)
24. Light tannish-gray, cliff-forming, dense, fine-grained, somewhat fossiliferous limestone in beds 5. to 10 feet thick. Chert nodules and quartz-calcite geodes occur 1 foot above base. Twenty feet above base is bed of chert nodules approximately 3 inches thick, in some places coalesced to form a bed. Throughout this interval the chert beds are not continuous laterally but may extend for 3 or 4 to 50 feet. Shell fragments and small chert nodules scattered throughout upper part of interval. Approximately 1 foot below top is bed of tan chert 3 inches thick with thin layers of mashed, flattened, silicified shell fragments immediately above and below	71.0
23. Light tan, dense, thin-bedded, sublithographic limestone which weathers into flattened nodules and slabs. Bed 1 foot thick at top contains silicified shell fragments. Interval forms a narrow bench	5.0
22. Light tan, dense, very fine-grained limestone in beds 4 inches to 5 feet thick, with thicker beds predominating. Nine feet above base are geodes with white quartz crystals and white calcite. Only few chert nodules in upper part of interval. Base of interval has rudistid fragments. Twelve feet above base of interval is bed of limestone 4 feet thick which contains silicified shell fragments	22.0
21. Light to medium gray, dense, very fine-grained, sublithographic limestone in beds 6 inches to 4 feet thick which weathers to smooth, light gray surfaces. Four feet above base of interval irregularly shaped chert nodules occur along the bedding planes. These nodules are light bluish gray, light brownish gray, and tan and locally coalesce to give a bedded appearance	17.0
20. Light gray, dense, fine-grained limestone in beds 1 foot to 4 feet thick which weathers light brownish gray to light gray, rough surface. Few small chert nodules 2 feet above base. Ten feet above base are small purplish chert nodules. Larger, flattened, purplish to tan chert nodules occur 17 feet above base. Larger nodules are discoidal to elliptical, 3 inches thick, and 6 inches in diameter. All beds have numerous silicified shell fragments of *Pecten*, gastropods, and rudistids	40.0
19. Grayish-tan, dense limestone, which weathers to light gray, rough surfaces, showing fragments of silicified shells, mostly pelecypods	1.0
18. Tan, dense limestone which contains fairly large fragments of silicified pelecypod shells. Bottom of bed weathers to flattened nodules	10.0
17. Bench of tan limestone in beds 1 foot to 2 feet thick which weathers to light gray, flattened nodules with rough surfaces. Nonfossiliferous	12.0
16. Light tannish-gray, dense, fine-grained limestone in beds 3 to 6 feet thick. Forms prominent cliff, very similar to cliff below. Weathers to light brownish-gray, rough surface, stained and and streaked purplish. Nonfossiliferous	44.0
15. Bench between cliffs. Softer limestone similar to that below.	13.0
14. Tannish-gray, dense, fine-grained limestone beds 1 foot to 6 feet thick, which weather to rough, light brownish-gray surfaces with some purplish stains. Some beds weather to nodular or platy fragments. Interval forms a prominent cliff	26.0
Total Edwards	309.0
Walnut—Comanche Peak formation—	
13. Purplish-gray to tan, soft limestone which weathers to dark yellowish orange. Contains numerous shell fragments	1.0
12. Light tannish-gray, dense limestone in beds 6 inches to 2 feet thick which weathers to rough, light brown surfaces and in some places to flattened nodules. Few scattered shell fragments	15.0
11. Light gray to tan, nodular marl which is mostly covered. Contains few *Exogyra* and some small shell fragments	8.0
10. Prominent ledge of light brownish gray, dense, fine-grained limestone which weathers light grayish-tan somewhat streaked with purplish to reddish stains. Contains few shell fragments	2.0
9. Yellowish-gray to light gray marl interbedded with limestone which weathers to flattened nodules. Most of interval contains shell fragments. *Exogyra* abundant	13.0

	Thickness (*feet*)
8. Ledge of tannish-gray, dense, very fine-grained limestone which contains numerous small shell fragments and weathers light gray	2.5
7. Covered. Appears to be light gray, nodular marl which weathers into small nodules half an inch to 2 inches in diameter. Some flat nodules contain fine shell fragments	44.5
Total Walnut—Comanche Peak	86.0
Maxon sandstone—	
6. Light brownish-gray, nodular to sandy limestone which is mottled purplish. Top of bed highly fossiliferous and contains *Actaeonella dolium*	1.0
5. Moderate red to tan, dense, fine-grained limestone in 2 beds: lower 7 feet thick, upper 4 feet thick. Weathers to light brown to brownish gray and forms promident ledge. Weathered surfaces show irregular streaks of sand...	11.0
4. Covered. Top 2 feet is light tan, mottled purplish, nodular sandy marl. Few small shell fragments	6.5
3. Dark tan, dense, fine-grained limestone, mottled purplish. Lower bed 2 feet thick, upper bed 6 inches thick. Somewhat fossiliferous. Beds contain *Exogyra* and some small *Actaeonella dolium,* fragments	2.5
2. Covered. Lower 10 feet appears to be yellowish, nodular, sandy marl interbedded with light tan, fine-grained, argillaceous sandstone	30.0
1. Tan, pale red, and grayish red-purple, dense, indurated, fine-grained, cross-bedded sandstone in beds 3 inches to 3 feet thick which weathers grayish brown with rough surfaces. Vertical jointing causes sandstone to break off into large angular blocks. Lower part of interval and top more cross-bedded than middle	12.0
Total Maxon	63.0

In the limestone areas bordering the Marathon basin, the Edwards limestone has the same composition and a similar thickness. King (1937, p. 115) gave a maximum thickness of 200 feet. Eifler (1943, pp. 1629–1630) measured a thickness of 209 feet east of Black Mountain and a thickness of 255 feet northeast of YE Mesa in the Santiago Peak quadrangle. In the Fort Stockton quadrangle, Adkins (1927, pp. 38–39) tentatively correlated 50 feet of clay below the Kiamichi marl with the Goodland. He (Adkins, 1933, p. 339) later named these beds the University Mesa marl and correlated them with the Edwards limestone.

Fauna and age.—A profusion of *Toucasia* characterizes the Edwards limestone in the Marathon region. The silicified remains of the Edwards fauna are difficult to identify specifically, but the general association of forms is distinctive. The following fossils were collected from the Edwards limestone in the Hood Spring quadrangle:

Pelecypoda
- *Caprina* (?) sp.
- *Pecten (Neithea) duplicicosta* Roemer
- *Radiolites* (?) sp.
- *Toucasid* sp.

Gastropoda
- *Cerithium* sp.

Fauna, lithology, and stratigraphic position permit correlation of the Edwards in the Hood Spring quadrangle with the Edwards limestone in central Texas.

KIAMICHI MARL

Distribution and lithology.—The Kiamichi marl is exposed in a narrow belt along the base of the third and least prominent cuesta of the Maravillas scarp. Northwest of this cuesta it occurs as erosion remnants in small, conical, isolated hills on the dip slope of the Edwards limestone. It also occurs in the fault blocks southwest of Maravillas Creek and is involved in the thrust fault which forms the ridge paralleling Maravillas Creek. The formation is composed of soft, yellow marl with some interbedded, thin, yellowish-gray limestone. The Kiamichi is one of the most distinctive formations in the Hood Spring quadrangle and is of uniform character over the entire area of its outcrops.

Stratigraphic relations.—Both the upper and lower contacts of the Kiamichi formation are easily recognized. The yellow marl rests upon the dense limestone of the Edwards and underlies the thin-bedded, light gray, sublithographic Georgetown limestone. The uppermost bed is limestone, 6 inches to 1 foot thick, composed predominantly of *Gryphaea* shells.

The formation is variable in thickness. It is 57 feet thick at the northeast end of its outcrop, 35 feet near the middle of the Maravillas scarp, and 46 feet southwest of Maravillas Creek. The following section was measured at the northeast end of the Maravillas scarp and is representative of the formation.

Section of Kiamichi marl on small hill at road junction half a mile south-southeast of elevation 3632 in east-central part of the Hood Spring quadrangle.

	Thickness *(feet)*
Top of hill.	
Georgetown limestone—	
10. Light gray, thin-bedded, sparingly fossiliferous, dense, sublithographic limestone	34.0
Kiamichi marl—	
9. Hard, yellow marl which contains great abundance of *Gryphaea* at top. Upper portion mostly covered	9.5
8. Ledge of light grayish-tan, dense, fossiliferous limestone which weathers to light gray nodules with rough surfaces	2.0
7. Hard, grayish-yellow, fossiliferous marl which weathers into nodules	8.0
6. Ledge of light brownish-gray limestone which weathers to yellowish-gray flattened nodules	3.5
5. Yellow marl	3.0
4. Small ledge of light brownish-gray, nodular limestone which weathers to yellowish gray	6.0
3. Somewhat covered. Bright yellow marl which weathers to yellow or yellowish-gray nodules. May be interbedded with nodular, light gray marl or limestone. Numerous fossils in float; gastropods and pelecypods	25.0
Total Kiamichi	57.0
Edwards limestone—	
2. Tan, dense limestone which contains few rudistids and other pelecypods. Weathers to moderately smooth light gray surfaces	9.5
1. Prominent ledge of tan, massive limestone which weathers to rough, medium gray surfaces and to a nodular appearance	18.0

The Kiamichi marl ranges from 30 to 70 feet in thickness in the Santiago Peak quadrangle (Eifler, 1943, p. 1627). King (1931, p. 96) reported 62 feet in the Glass Mountains but did not mention the presence of the formation on either the east side or west side of the Marathon basin. In the Fort Stockton area, Adkins (1927, p. 41) measured a thickness of 66.5 feet of Kiamichi clay.

Fauna and age.—The Kiamichi marl is the most distinctive of the Cretaceous formations both in composition and fauna. It is characterized by several species of *Oxytropidaceras,* a profusion of *Gryphaea* specimens particularly in the top of the formation, and an abundance of *Enallaster texanus.* The following fossils were collected from the Kiamichi marl beds in the Hood Spring quadrangle:

Echinoidea
- *Enallaster texanus* Roemer

Pelecypoda
- *Cardium subcongestum* Böse
- *Cyprimeria crassa* Meek
- *Cyprimeria texana* Roemer
- *Exogyra texana* Roemer
- *Gryphaea corrugata* Gabb
- *G. hilli* Cragin
- *G. mucronata* Gabb
- *Homomya knowltoni* Hill
- *Modiola* sp.
- *Pecten (Neithea) subalpinus* Böse
- *Protocardia texana* (Conrad)
- *Tapes aldemanensis* Böse
- *T. chihuahuensis* Böse
- *T. decepta* Hill

Gastropoda
- *Alipes* sp.
- *Lunatia* sp.
- *Turritella* sp.

Cephalopoda
- *Engonoceras* sp.
- *Oxytropidoceras acutocarinatum* (Shumard)
- *O. chihuahuensis* Böse
- *Oxytropidoceras* sp.

Although the Kiamichi guide fossil *Gryphaea navia* was not positively identified in collections from the Hood Spring quadrangle, the faunal assemblage indicates a correlation with the Kiamichi in central Texas.

GEORGETOWN LIMESTONE

Distribution and lithology. — The Georgetown limestone forms the third and least prominent cuesta of the Maravillas scarp. The strata dip gently under the alluvium that covers the bolson deposits in the southeast corner of the quadrangle. The formation occurs at the top and on either side of the high ridge in the southwest corner of the quadrangle and in the Overthrust ridge that parallels Maravillas Creek. The Georgetown is uniform, predominantly dense to sublithographic, light tan limestone in beds 1 foot to 6 feet thick. Two zones of soft, argillaceous limestone or marl occur in the upper part of the formation. Near the top, it contains rounded, brown chert nodules and some silicified fossils.

Stratigraphic relations. — The contact with the Kiamichi is distinct and is marked by a bed of Kiamichi *Gryphaea*-bearing limestone. The Georgetown limestone is the uppermost Cretaceous in the Maravillas scarp area. The Grayson marl which normally succeeds the Georgetown occurs along the overthrust ridge south of Maravillas Creek, but it is not in contact with Georgetown limestone.

Near the center of the Maravillas scarp the Georgetown is 393 feet thick, and in the high ridge southwest of Maravillas Creek it is 385 feet thick, but both sections are incomplete. The following section of the Georgetown limestone was measured near the center of the Maravillas scarp.

Composite section from ravine 1¼ miles south-southwest of Hill 4216 to Hill 4116 near the center of the Hood Spring quadrangle.

	Thickness *(feet)*
Top of ridge.	
Georgetown limestone (incomplete)—	
28. This interval is offset to west of interval below. Light tan, dense limestone in beds 1 foot to 3 feet thick. Nodules of light gray to tan to pale pink chert in irregular shapes appear 5 feet above base. Limestone weathers to rough, medium light gray surfaces. Interval sparingly fossiliferous with some silicified shell fragments	29.0
27. Top of hill. Light tan to cream-colored, dense, very finely granular limestone in beds 1 foot to 3 feet thick	16.5
26. Cream-colored, fossiliferous limestone in beds 1 foot to 3 feet thick which weathers to irregular, small slabs	70.5
25. Light tan to light gray, massive, cliff-forming limestone with some chalky pockets. Weathers to rough, medium light gray surfaces. Face of cliff pitted, somewhat honeycombed, and sparingly fossiliferous. Weathering of soft intervals gives cliff an hourglass-shaped face	71.0
24. Mostly covered. Light tan to light gray, dense, sublithographic limestone which weathers white to light gray	206.0
Total Georgetown	393.0
Kiamichi marl (base of Hill 4116)—	
23. Yellow, nodular marl capped by 2-foot thick bed of *"Gryphaea"* limestone	35.0
Edwards limestone (top of hill northwest of Hill 4116)—	
22. Tan, dense limestone in beds 1 foot to 6 feet thick. Beds near base of interval form cliff about 60 feet high. Upper beds average 2 feet thick. Interval has chert nodules throughout and sparse, silicified fossils. Characteristic rough, medium gray, weathered surfaces	134.0
21. Light tan to light gray, dense limestone in beds 6 inches to 2 feet thick. Interval contains some chert near top and scattered silicified *Pecten* and rudistids throughout. Forms rubble-covered, steep slope. Chert occurs as nodules along bedding planes and may coalesce locally to form a bed	44.0
20. Light tan, massive, dense limestone in beds 4 to 16 feet thick which forms a prominent cliff. Weathers to nodules or slabs in places with medium gray, rough surfaces. Face of cliff locally is orange and contains soft, chalky pockets. Top of interval has few silicified fossils, *Pecten,* rudistids, *Toucasid.* Rudistids occur within 15 feet of base	62.0
Total Edwards	240.0
Walnut—Comanche Peak formations—	
19. Base of high cliff. Limestone containing numerous shell fragments. Weathers to nodules	30.5
18. Light tan, nodular limestone in beds 2 feet thick	8.5
17. Tannish-gray, dense limestone which weathers medium gray	4.0

	Thickness (feet)
16. Yellow to orange-tan marl which weathers to nodules and contains shell fragments. *Protocardia, Tylostoma, Exogyra,* echinoids	29.0
Total Walnut—Comanche Peak	72.0
Maxon sandstone—	
15. Yellowish-tan, argillaceous to silty sandstone in beds 6 inches to 3 feet thick	16.5
14. Yellowish-tan, somewhat nodular, silty sandstone with some purplish staining	2.5
13. Covered. Appears to be marl	20.5
12. Yellowish to orange-tan, dense, silty, very fine-grained sandstone	2.0
11. Mostly covered. Lower part light tan, laminated, very fine-grained sandstone	89.5
10. Tan, cross-bedded, ripple-marked, fine-grained sandstone which weathers grayish yellow to brownish gray	15.0
Total Maxon	146.0
Glen Rose formation—	
9. Interbedded, dark tan, dense limestone and silty sandstone near top of interval. Top of interval is limestone bed 4 inches thick	13.5
8. Interbedded grayish-yellow to cream-colored marl and light tan, nodular, fossiliferous limestone. Shell fragments, *Trigonia, Protocardia, Tylostoma,* and other pelecypods and gastropods	25.0
7. Orange-tan, dense, fine-grained, silty sandstone which weathers to dark yellowish orange	1.0
6. Partly covered. Appears to be mainly light tan, fine-grained, thin-bedded, laminated sandstone which is locally ripple-marked	24.5
5. Ledge of orange-tan, silty, dense limestone which weathers to yellowish-brown, rounded surfaces	1.0
4. Grayish-yellow to cream-colored marl which contains *Trigonia, Tylostoma, Protocardia,* few *Orbitolina,* and shell fragments	13.0
3. Ledge of tan limestone which weathers to yellow-brown, nodular slabs	1.0
2. Interbedded, dark tan, nodular, fossiliferous limestone and cream-colored marl which weathers to nodules	15.0
1. Ledge of dark tan, dense limestone	1.5

Eifler (1943, p. 1628) reported 475 to 500 feet of the Georgetown limestone in the Santiago Peak quadrangle. He assigned these beds to Member No. 4 of the Devils River limestone. In the west side of the Marathon basin, King (1937, p. 115) reported about 200 feet of Georgetown. The section in the Glass Mountains (King, 1931, p. 96) is incomplete but appears to have a maximum thickness of about 200 feet. Equivalent strata in the Fort Stockton quadrangle have been subdivided by Adkins (1927, pp. 42–49) into zones that are correlated with the north Texas sequence. The Fort Stockton section ranges from 250 to 300 feet in thickness and apparently is of a different facies.

Fauna and age.—The thick limestone beds of the Georgetown formation contain an abundant though rather poorly preserved pelecypod and gastropod fauna and a few ammonites. Abundant *Gryphaea washitaensis* in the upper limestone beds and *Inoceramus comancheanus* and *Pervinquieria leonensis* are indicative of a Georgetown age. The following fossils are found in the Georgetown limestone in the Hood Spring quadrangle:

Pelecypoda
- *Alectryonia carinata* (Lamarck)
- *Cardium subcongestum* Böse
- *Cyprimeria crassa* Meek
- *Gryphaea marcoui* Hill and Vaughn
- *G. washitaensis* Hill
- *Inoceramus comancheanus* Cragin
- *Lima wacoensis* Roemer
- *Pecten (Neithea) subalpinus* Böse
- *Pecten (Neithea) texanus* Roemer
- *Pinna guadalupae* Böse
- *Protocardia texana* (Conrad)
- *Trigonia* sp.

Gastropoda
- *Nerinea riograndensis* Stanton
- *N. occidentalis* Stanton
- *Turritella leonensis* Conrad
- *T. seriatus-granulata* Roemer
- *Tylostoma chihuahuense* Böse

Cephalopoda
- *Hamites* sp.
- *Oxytropidoceras* sp.
- *Perrinquieria leonensis* (Conrad)

The thick-bedded, dense limestone that occurs above the Kiamichi marl in the Hood Spring quadrangle is correlated with the Georgetown limestone in central Texas.

GRAYSON (DEL RIO) MARL

Distribution and lithology.—The Grayson (Del Rio) is exposed only on the north side of the Overthrust ridge south of Maravillas Creek (Pls. I and VII) where it is involved in the thrust faulting. As a consequence, its exact composition and thickness are indeterminable. The Grayson is marked by a covered slope between Buda limestone and Boquillas flaggy limestone. Scattered fragments of thin-bedded, laminated, sandy limestone show an abundance of the tests of the agglutinated, arenaceous foraminifer *Haplostiche texana*. The formation consists primarily of light gray to buff, sandy marl. Near the top are several beds of hard, laminated, sandy, fine-grained, moderate yellowish-brown, flaggy limestone. The marl zone contains many pseudomorphs of limonite after pyrite and some concretionary nodules of limonite.

Stratigraphic relations.—The upper and lower contacts of the Grayson were not seen in the Hood Spring quadrangle, but the apparent thickness of the formation is 70 feet.

The Grayson is persistent in the Del Norte and Santiago Mountains. King (1937, p. 115) reported a thickness of 15 or 20 feet of Grayson (Del Rio) on the west slope of the Del Norte Mountains, and Eifler (1943, p. 1631) reported 73 feet in the southwestern part of the Santiago Peak quadrangle. The Grayson occurs also in the Bone Spring quadrangle.

Fauna and age.—Because of the limited exposure of the Grayson in outcrops in the Hood Spring quadrangle, no systematic collecting was undertaken. *Haplostiche texana* (Conrad) is abundant in the float on the outcrops. This foraminifer in adjoining areas is associated with a typical Grayson fauna, and on this basis the beds in the Hood Spring quadrangle are correlated with the north Texas Grayson.

BUDA LIMESTONE

Distribution and lithology.—The Buda limestone is exposed in the area southwest of Maravillas Creek, where it crops out parallel to the Grayson beds. Like the Grayson it also was involved in the thrust faulting in that area (Pls. I and VII). The Buda continues southeast into the Bone Spring quadrangle along the thrust-fault ridge. The formation consists of three units: an upper limestone, a middle argillaceous limestone or marl, and a lower limestone. The upper and lower beds are light gray to light tan, dense, sublithographic, fossiliferous limestone that weathers white. The middle unit is softer, light gray, argillaceous limestone or marl.

Stratigraphic relations.—The contacts of the formation are not exposed because of the thrust fault and because of vegetation. However, a thickness of 80 feet was measured; the upper limestone is 40 feet thick, the middle marl 30 feet thick, and the lower limestone 10 feet thick. The Buda is 60 feet thick in the Del Norte Mountains (King, 1937, p. 115) and 76 feet thick in the southwestern part of the Santiago Mountains (Eifler, 1943, p. 1632). The Buda limestone is easily recognized and differentiated from the underlying Grayson and the overlying Boquillas flaggy limestone.

Fauna and age.—The ammonite *Budaiceras mexicanum* indicates the Buda age of the limestones that intervene between Grayson marl and Boquillas flaggy limestone in the Hood Spring quadrangle. The following fossils were collected chiefly from the middle, soft, argillaceous limestone or marl:

Echinoidea
- *Enallaster texanas* Roemer
- *Salenia volana* Whitney

Pelecypoda
- *Exogyra clarki* Stattuck
- *Lima wacoensis* Roemer
- *Ostrea* sp.
- *Pecten (Neithea) subalpinus* Böse
- *Trigonia* sp.

Gastropoda
- *Turritella* sp.

Cephalopoda
- *Budaiceras mexicanum* Böse

BOQUILLAS FORMATION

Distribution and lithology. — Flaggy limestones of the Boquillas formation occur in the southwestern corner of the quadrangle along the thrust-fault ridge south of Maravillas Creek (Pls. I and VII). These beds are involved here in the thrust faulting and only a small part of the total thickness is exposed. The beds also are exposed to the southeast in the Bone Spring quadrangle along the north side of the ridge.

The beds are predominantly tan, thin-bedded, fine-grained, sandy limestone that weathers to orange or moderate reddish orange. Some of the beds are 6 inches to 1 foot thick, but most are less than 3 inches thick.

Stratigraphic relations.—The lower contact of the Boquillas is obscured by faulting and alluvium. Only about 40 feet of the formation is exposed at any one place. King (1937, p. 116) mapped as Eagle Ford similar beds of undetermined thickness in the western foothills of the Del Norte Mountains. Boquillas beds in the Santiago Mountain range are described by Eifler (1943, p. 1632).

Fauna and age.—Only a very few impressions of *Inoceramus* were found in the flaggy limestones of the Boquillas formation in the Hood Spring quadrangle. The flaggy beds are distinctive and are interpreted as correlative to the Boquillas flags (Udden, 1907, p. 29) at their type locality.

TERLINGUA FORMATION

Distribution and lithology.—A single outcrop of Terlingua chalky limestone is located on the north side of a small hill approximately half a mile north of the west end of the Overthrust ridge in the southwest corner of the quadrangle (Pls. I and VII). The beds at this locality are yellowish-gray, nodular, chalky to very fine-grained, thin-bedded limestone at the base and grade upward into a ledge-forming, cream-colored, massive, chalky limestone. The thick-bedded, chalky limestone contains abundant fragments of the large *Inoceramus undulato-plicatus.*

Stratigraphic relations.—The thickness of the outcrop of the Terlingua formation in the Hood Spring quadrangle probably does not exceed 15 feet. The Terlingua formation is not reported as such in the area of the Del Norte Mountains, but Eifler (1943, p. 1632) included the *Inoceramus undulato-plicatus* zone in the top of the Boquillas formation in the Santiago Peak quadrangle.

Fauna and age.—A few species of pelecypods were found in the Terlingua chalky beds. The following fossils occur in the outcrop in the southwest corner of the quadrangle:

Pelecypoda
- *Gryphaea wratheri* Stephenson
- *Inoceramus undulato-plicatus* Roemer
- *Inoceramus* sp.
- *Ostrea* sp.
- *Spondylus guadalupae* Roemer
- *Tapes* sp.

Inoceramus undulato-plicatus indicates an Austin age for these beds.

ALLUVIAL DEPOSITS

GENERAL FEATURES

The alluvial deposits of the Hood Spring quadrangle may be grouped into three types: (1) stream alluvium, (2) gravel mantle on pediments and rock floors, and (3) bolson deposits. This separation is made mainly on the basis of their occurrence and not on age relationships. The stream alluvium, however, is younger than the pediment and rock floor gravel and the bolson deposits.

Stream alluvium covers large areas in the northwest part of the quadrangle along the flood plain of Hackberry Creek and in the southwest corner of the quadrangle along the course of Maravillas Creek. Other deposits are restricted to relatively short distances and lateral extent along most of the streams. The thin alluvium that covers the bolson deposits in the south and southeastern parts of the quadrangle is classified also with the stream alluvium.

The gravel mantle on the pediments and rock floors is a thin veneer of pebbles and cobbles composed almost entirely of detritus from the Paleozoic rocks. It is predominantly chert and novaculite pebbles derived from the Caballos and Maravillas formations and occurs most extensively as a relatively level plain in the vicinity of the Barrett ranch in the north-central part of the quadrangle and on the pediment on the northwest side of the Tinaja range. Minor deposits occur on either side of the hogback northwest of the Tinaja range and at the northeast end of the Maravillas scarp.

The bolson deposits are conglomeratic and on the west side of the bolson are composed of material derived from both the Paleozoic and Cretaceous rocks of the area. These deposits are probably predominantly calcareous toward the center of the basin.

STREAM ALLUVIUM

The flood plains of both Hackberry Creek and of Maravillas Creek are of considerable width. That of Maravillas Creek is approximately 2 miles wide and that of Hackberry Creek 1 mile wide in its lower reaches. The latter, however, decreases to less than one-half mile in width in some places. The thickness of the alluvial deposits in these valleys is unknown, but the streams have cut into the alluvium to depths of 2 to 6 feet. The deposits (Pl. IV, C) are composed mainly of pale brown soil with conglomeratic lenses 2 inches to 2 feet thick along more or less continuous levels. The conglomerate is made up of pebbles and cobbles of light-colored chert and novaculite of the Caballos formation and black chert of the Maravillas formation. The size range is from grit or granules to cobbles 4 or 5 inches in diameter. Minor amounts of grayish olive-green sandstone and quartzite of the Tesnus formation also occur in the alluvium. On the beds of the creeks, boulders are mixed with larger cobbles, some of which are derived from various types of igneous rocks.

GRAVEL MANTLE ON PEDIMENTS AND ROCK FLOORS

The gravel that occurs on the pediments and rock floors of the Hood Spring quadrangle is composed predominantly of cobble-size, and smaller, subangular fragments of Caballos chert and novaculite and of Maravillas black chert, some fragments of dark gray limestone, and locally of scattered igneous pebbles. As exposed on the dissected pediments, these gravel deposits are 5 to 25 feet thick.

The surfaces on which the gravel was deposited have been termed pediments and rock floors by King (1937, p. 14). Rock floors are relatively level, gently sloping surfaces that are produced in a semiarid climate by the erosion of non-resistant rocks. Pediments are rock floors that have steeper inclination near mountain areas. The origin of pediments and rock floors and their gravel mantle in the Marathon basin has been discussed at length by King (1931, pp. 18–22; 1937, pp. 14–19, 116).

The rock floors of the Hood Spring quadrangle have developed by the erosion of folded Tesnus rocks. They are relatively plane surfaces with gentle slope and they occur in areas away from the hogback ridges. The pediments are of similar origin but have steeper slopes and are located on the flanks of the ridges. The gravels that are deposited on the rock floor and pediment surfaces are derived from the weathering and erosion, of the hogbacks and ridges and are possibly in transit across these surfaces to the main drainage lines.

BOLSON DEPOSITS

The sediments filling the bolson that occupies the south-central and southeast part of the quadrangle are composed predominantly of calcareous detritus derived from the Cretaceous outcrops to the north. Along the western edge of the bolson the deposits are predominantly calcareous but also contain pebbles and cobbles of chert and novaculite from the Caballos and Maravillas formations. These materials probably represent flood-stage deposits from Maravillas Creek. Their thickness is not known. How far toward the center of the depression such material was deposited also is unknown.

The bolson deposits probably are similar to the gravels that occur in the southwest part of the quadrangle south of the overthrust ridge. These deposits may exceed 50 feet in thickness for they have been dissected in certain places to depths of about 30 feet. They are composed of a wide range of sizes of calcareous material derived from the weathering of the Cretaceous limestones (Pl. IV, D). The deposition of this material probably was contemporaneous with the filling of the bolson.

IGNEOUS ROCKS

GENERAL FEATURES

The igneous rocks in the Hood Spring quadrangle belong to the general suite of predominantly alkalic rocks that are characteristic of the southern Trans-Pecos Texas region (Lonsdale, 1940, p. 1619; King, 1937, p. 117). Two broad classes are recognized: (1) rhyolites and trachytes, commonly alkalic, some containing riebeckite or analcime, and (2) basalts, some with analcime. Most of the igneous rocks are porphyritic.

The igneous rocks occur as dikes, plugs, and sill-like masses. Most of the dikes that occur in the area of Paleozoic rocks parallel the strike of the sedimentary beds. Some of the sill-like masses may possibly represent intrusions along the bedding planes of the folded Tesnus rocks and could be mistaken for dikes. The plugs are roughly circular or somewhat elongated in outline. Four relatively large plugs intrude the Glen Rose and Edwards formations at the southwest end of the Maravillas scarp where they form prominent peaks.

The exact age of the igneous rocks is unknown, but having intruded Cretaceous rocks undoubtedly they are related to the Tertiary igneous activity in Trans-Pecos Texas. Similar rocks in the Terlingua-Solitario region are assigned by Lonsdale (1940, p. 1564) to the Tertiary.

RHYOLITES AND TRACHYTES

Rhyolitic rocks occur only in the vicinity of the northeast end of the Tinaja Mountains. These rocks are all similar and are dikes or sill-like intrusions in the Tesnus formation, with the exception of a small plug that occurs in the Caballos novaculite. The dikes are porphyritic in the center and are very fine grained to felsitic at their borders. They trend northeast, are 10 to 50 feet wide, and are several hundred feet to more than a mile in length.

These rocks have a trachytic texture and may be called soda rhyolites. The essential minerals are quartz, orthoclase, and anorthoclase with varying amounts of hornblende and riebeckite. Magnetite is a common accessory mineral. An opal-bearing trachyte, containing a small amount of quartz, occurs in the Tesnus formation as three small rounded hills approximately 1 mile east of Tinaja Spring. The opal occurs locally as a replacement between some of the feldspar grains.

Trachyte plugs project through the limestone cuestas in prominent peaks at the southwest end of the Maravillas scarp (Pl. VI, A). Two relatively large masses occur in the Tesnus formation in the northeast part of the quadrangle (Pl. VI, D). Minor intrusions occur in the limestones in other parts of the area.

The trachytes are porphyritic with fine-grained chilled borders. They are predominantly soda trachytes composed of orthoclase and anorthoclase with varying amounts of hornblende, riebeckite, aegirite, and aegirite-augite. Most of these rocks have well-developed trachytic texture and some of them contain analcime as a replacement in feldspar (Pl. VI, B). A small plug that occurs along a fault in the west-central part of the quadrangle contains microphenocrysts of leucite (?).

BASALTS

Basalt intrusives are widely scattered in the Hood Spring quadrangle except in one area near the center of the quadrangle where there are several occurrences. They form small plugs, roughly circular, about 50 feet in diameter (Pl. VI, C), or dikes that range from 5 to 20 feet in width and several hundred feet to almost a mile in length. Most of the dikes are less resistant to erosion than the limestones which they intruded and commonly appear as narrow, shallow trenches or depressions with more abundant vegetation than is supported on the surrounding limestones.

The basalts are all fine-grained, porphyritic, and non-porphyritic rocks which in some localities are either vesicular or amygdaloidal. Most of them contain plagioclase, olivine, augite, and magnetite. Several of the basalts have analcime as a replacement in feldspar, and two of them contain analcime in amygdules.

At one locality in the east-central part of the quadrangle approximately 2 miles west of the east boundary (Pl. I), the basic rocks appear to be younger than the trachytes. Here, trachydolerite underlies what was probably a trachyte sill in the Glen Rose formation. Metamorphosed stringers of Glen Rose are contained in the trachyte which rests on trachydolerite. The later intrusion has produced a semicircular fault which along the fault trace has brought Glen Rose metamorphosed marl against Edwards limestone.

CONTACT METAMORPHISM

Contact metamorphic effects produced by the plugs and dikes are minor, and the usual effect on the limestones is discoloration due to baking. Addition of small amounts of magnetite that has altered to hematite gives a reddish or red-streaked appearance. The baked limestones are medium to dark gray to medium bluish gray and are very similar in outward appearance to fire-baked limestone cobbles found in the scattered remains of Indian middens.

Typical contact metamorphic minerals are not abundant. Most of the contact rocks are only slightly recrystallized to fine-grained marble, and those that contain minerals other than calcite have feldspar, amphibole, and magnetite similar to that found in the near-by igneous intrusive. Where the rocks could be sampled at or very close to the contact, they appear in thin sections to be mixtures of calcite and the normal suite of minerals typical of the igneous rock.

One exception to the general nature of the contact metamorphism occurs at the central exposure of the intruded rocks in the east-central part of the quadrangle, about 2 miles west of the east boundary. In the upper part of the largest mass at this locality, small stringers or patches of green metamorphosed limestone occur in the trachyte. The metamorphic rock is composed of slightly less than 50 percent analcime of late formation with respect to the other minerals. The rock contains hornblende, orthoclase, plagioclase, and calcite. In this rock orthoclase and analcime are interstitial, but minor replacement of orthoclase by analcime has occurred.

STRUCTURAL GEOLOGY

GENERAL FEATURES

The structural history of the Marathon region has been described in detail (Baker and Bowman, 1917, pp. 107–112, 134–172; King, 1937, pp. 118–141) and will be reviewed here only briefly.

The Marathon orogenic epoch (King, 1937, p. 119), which began in early Pennsylvanian time and culminated in early Permian, reached a peak of maximum deformation at about the end of Pennsylvanian time. Compressive forces, acting from the southeast, produced folding and overthrusting, and in the locality of the Marathon basin caused the formation of a series of northeast-trending anticlinoria and synclinoria. The Fort Peña synclinorium separates the Marathon anticlinorium on the northwest and the Dagger Flat anticlinorium on the southeast. Relatively early, low-angle Overthrusts were folded and faulted by the later more intense deformation.

Following deposition of the Cretaceous sediments over the peneplained surface of the Paleozoic rocks, broad uplift produced the Marathon dome, and probably contemporaneous compressive forces from the southwest produced the monoclinal flexure which is the Del Norte—Santiago—Carmen Mountain chain.

The present erosion cycle of southern Trans-Pecos Texas is possibly the continuing result of very late regional uplift which has acted to rejuvenate the Rio Grande system effecting the dissection of gravel-covered pediments.

PALEOZOIC FOLDING AND FAULTING

The Tinaja Mountains, in the northwest part of the Hood Spring quadrangle, are a series of parallel hogbacks produced by steep folds and high-angle thrust faults (Pl. VIII). Three main thrust faults occur in the Tinaja range and one in a shorter, lower ridge to the southeast. The southeasternmost of the main thrust faults in the range is the southwest extension of the Hells Half Acre thrust fault (King, 1937, p. 130). At the widest part of the Tinaja Mountains the Caballos novaculite contains several tight folds between the thrust faults (Pl. VIII, structure sections). Northwest of Tinaja Spring several more tight folds occur in the novaculite (Pl. III, B). To the northwest of the Tinaja range are other hogbacks and isolated hills that show steep folds and thrust faults.

Parallel to the southwest end of the Maravillas scarp (Pl. I), in the folded Tesnus sandstones, a high-angle thrust fault has brought Maravillas limestones and cherts to the surface along the fault trace. The width of the Maravillas rocks ranges from a few feet to a maximum of about 50 feet. The fault, which extends in a northeast direction for a distance of about 8 miles from the southwest end of the Maravillas scarp, is possibly the southwestern continuation of the Devils Backbone thrust fault (King, 1937, Pl. 24) to the northeast in the Marathon quadrangle.

The hogback ridges are cut by numerous tear faults which have displaced the earlier folds and thrust faults horizontally. The two normal faults in the novaculite just north of Tinaja Spring in the Tinaja Mountains are of the same age as the thrust faults and were produced by a cross flexure contemporaneous with the main folding and faulting.

POST-CRETACEOUS STRUCTURAL FEATURES

The southeast rim of the Marathon basin is the southeast slope of the Marathon dome. The Cretaceous rocks have a northeast strike in the Maravillas scarp area and dip 3 to 6 degrees to the southeast. Minor normal faults are generally either parallel or perpendicular to the strike of the Cretaceous rocks. In the southwest part of the quadrangle a much faulted, northeast-tilted block of Comanche rocks extends about 5 miles northeastward from the monoclinal flexure of the Santiago Mountains. The faults in this block are normal and are either parallel or perpendicular to the strike of the beds (Pl. VII).

At two places in the Maravillas scarp

area, faulting is associated with igneous intrusion. Two small intrusive bodies of analcime-bearing trachyte occur along the east side of a small wedge-shaped graben in the west-central part of the quadrangle, and in the east-central part of the quadrangle, basalt and trachyte are associated with a semicircular fault that has been produced by the intrusion (Pl. 1). In an area that centers approximately 4 miles east of this intrusion, numerous small plugs and dikes of basalt occur. These basalts probably represent emplacements along the fracture system of the Cretaceous rocks from a deeper stock-like intrusion. Such a possibility is strengthened by the fact that in this area the Georgetown cuesta swings out approximately 1 mile to the northwest in a rough bow, forward of the general strike of the cuesta (Pls. I and V, C).

In the southwestern part of the quadrangle, near its south border, a low ridge of Cretaceous rocks parallels Maravillas Creek. This is the only place in the quadrangle where Cretaceous beds are involved in thrust faulting. The rocks are vertical or are overturned with dips of 70 degrees to the southwest. The ridge extends southeast for several miles in the Bone Spring quadrangle. At the northwest end of the ridge, Gulf Cretaceous limestones and marls are involved in the thrust faulting (fig. 4 and Pl. VII). Figure 4 is an interpretation of the fold and thrust fault that produced the ridge. The beds are overturned to the north and northeast. The northeastward overturning and overthrust here conform to the general trend of the structures along the northeastern border of the Mexican geosyncline in western Trans-Pecos Texas but is in direct contrast with the westward and southwestward overturning and overthrust of the Santiago Mountains which are only 5 miles to the southwest. The strike of this overthrusting is almost at right angles to the strike of the Paleozoic overthrusts.

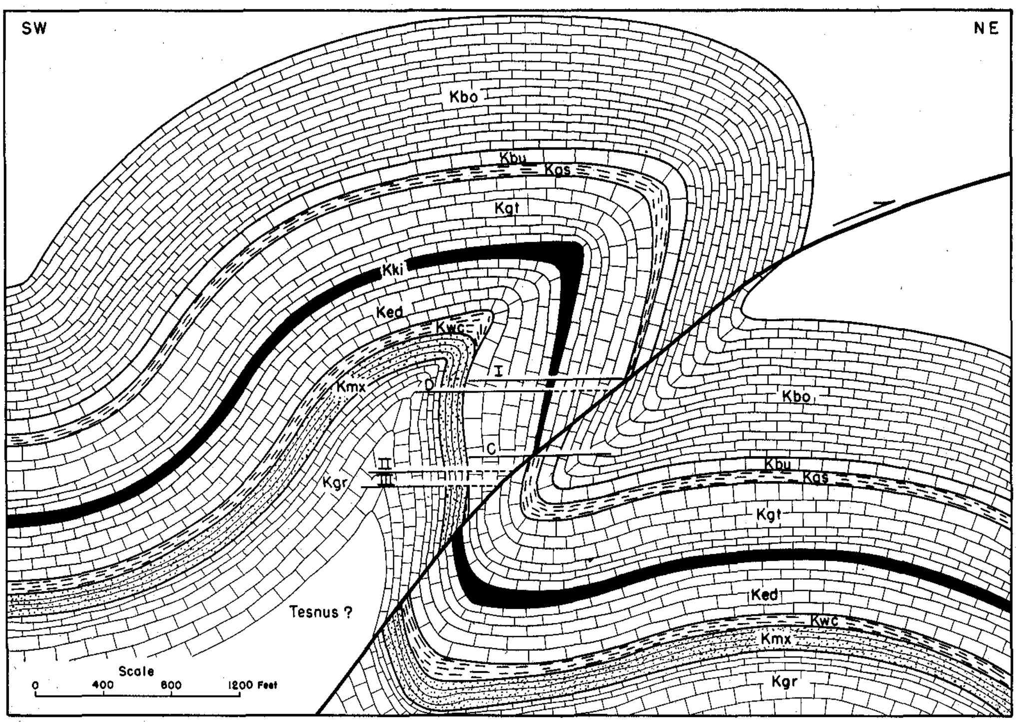

FIG. 4. Representation of the fold and thrust fault which produced the ridge parallel to Maravillas Creek in the southwest part of Hood Spring quadrangle. Horizontal lines represent the levels in the fold which are now visible in the tear-fault blocks of the ridge (see Pl. VII). Lettered lines refer to structure sections. Roman numerals refer to correspondingly numbered fault blocks.

SUMMARY OF GEOLOGIC HISTORY

The rocks of the Paleozoic era are varied in composition, with the earliest record being the deposition of an unknown thickness of clastic sediments of Upper Cambrian Dagger Flat sandstone. This deposition was followed by Lower to Middle Ordovician limestones, cherts, and shales of the Marathon, Alsate, Fort Peña, and Woods Hollow formations. A mid-Ordovician uplift is indicated by basal conglomerates of the Maravillas formation. After the deposition of the Middle to Upper Ordovician Maravillas limestone and chert, the history of the region is unknown until the deposition of the Upper Devonian Caballos novaculite. Caballos time was probably followed by broad uplift and retreat of the seas. This was followed by the deposition of a great thickness of Tesnus clastic sediments, possibly beginning in Upper Mississippian time, and continuing through Pennsylvanian time with the deposition of the overlying Dimple, Haymond, and Gaptank formations. Contemporaneous with the deposition of the Pennsylvanian formations was the long series of tectonic movements that mark the Marathon orogenic epoch and which continued into early Permian time.

During most of Permian time the area was relatively stable, and the great thickness of Permian reef deposits accumulated in the vicinity of the Glass Mountains, to the north of the Marathon basin.

Post-Permian uplift and erosion peneplained the Paleozoic rocks. Upon the peneplained surface the Comanche Glen Rose formation was deposited. The northward encroaching Glen Rose seas deposited locally a thin sheet of basal clastic material.

A thick series of Comanche, predominantly clear-water, limestones accumulated. The Gulf rocks were deposited in shallowing seas, as indicated by marls, shales and clays, and sandstones in the upper part of the series.

Post-Cretaceous uplift, folding, and thrusting produced the narrow, sinuous, monoclinal flexure of the Del Norte—Santiago—Carmen Mountains which border the Marathon basin on the west and southwest.

Igneous intrusive and volcanic rocks are probably early Tertiary to Miocene in age. The volcanic rocks to the west of the Marathon basin rest on the eroded edges of various Cretaceous formations. Gentle folding and faulting of the volcanic series occurred probably in Pliocene or later time.

The present erosion cycle is possibly the effect of a late Pleistocene uplift.

ECONOMIC GEOLOGY

No mineralization of commercial value was discovered in the Hood Spring quadrangle. In several localities along the novaculite hogbacks in the northwestern part of the quadrangle, the rocks contain relatively thin films of manganese and iron oxides along fractures.

The novaculite of the Caballos is too thoroughly shattered to be of value for whetstones. The gravels that are composed predominantly of novaculite and chert pebbles make excellent road metal for local use.

The greater part of the rainfall in the Marathon region flows, by surface run-off, into the intermittent streams. No permanent streams and only a small number of springs occur in the area. In the Hood Spring quadrangle, with the exception of two wells located in the alluvium along Maravillas Creek, only the area of Paleozoic rocks supports water wells. These are in the sandstones of the Tesnus formation and in the gravels and alluvial deposits. The wells average approximately 100 feet in depth and produce 5 to 10 gallons per minute. No producing water wells occur in the area of Cretaceous rocks in the Hood Spring quadrangle, though several have been drilled to depths greater than 1,000 feet.

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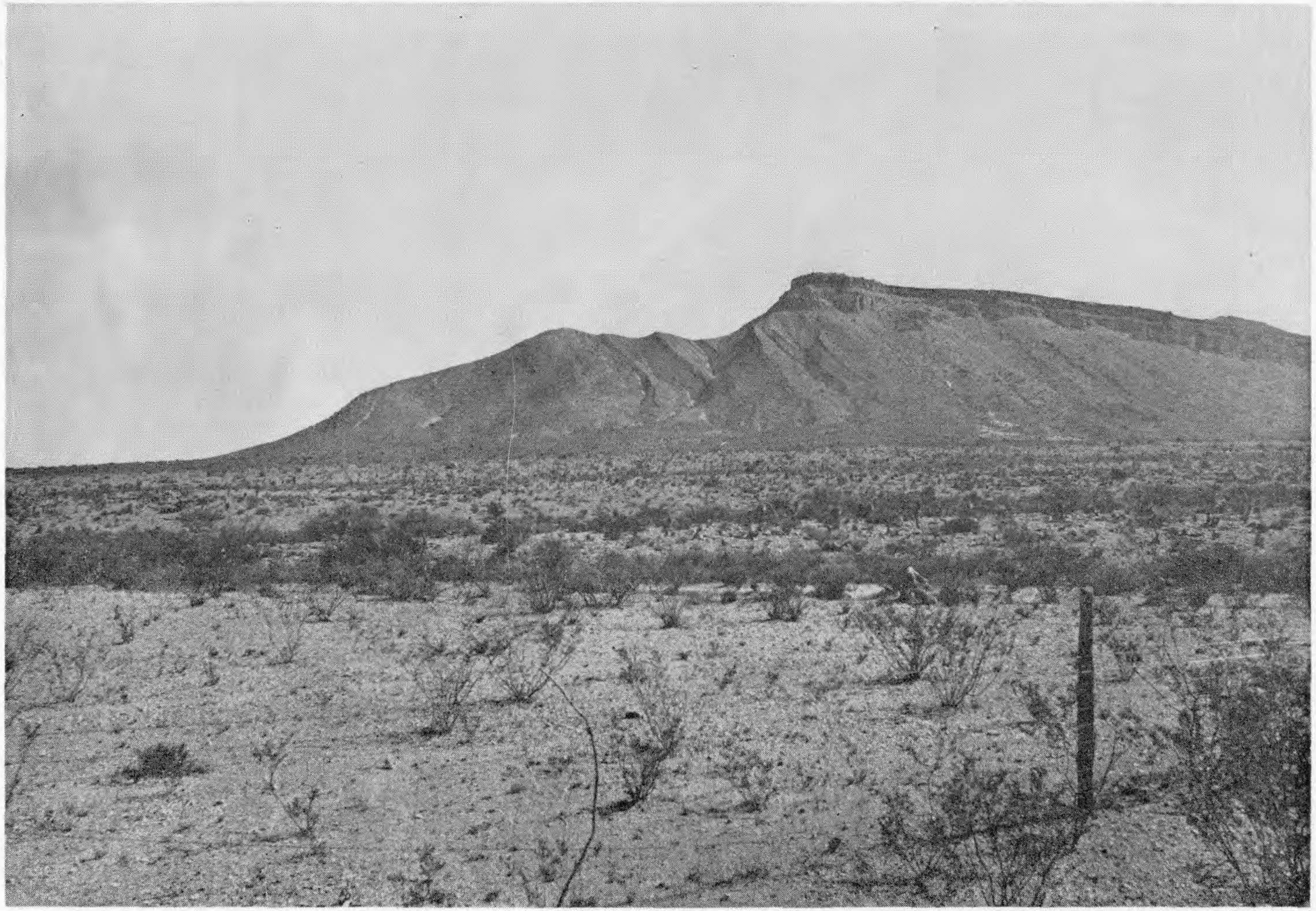


Angular unconformity in Maravillas scarp. Northeast end of Maravillas scarp. Thick-bedded Glen Rose limestone dips 3° southeast and rests with pronounced angular unconformity on steeply dipping Tesnus sandstones an d shales. Hill 4785.


A
B
C

Plate III

Caballos Formation

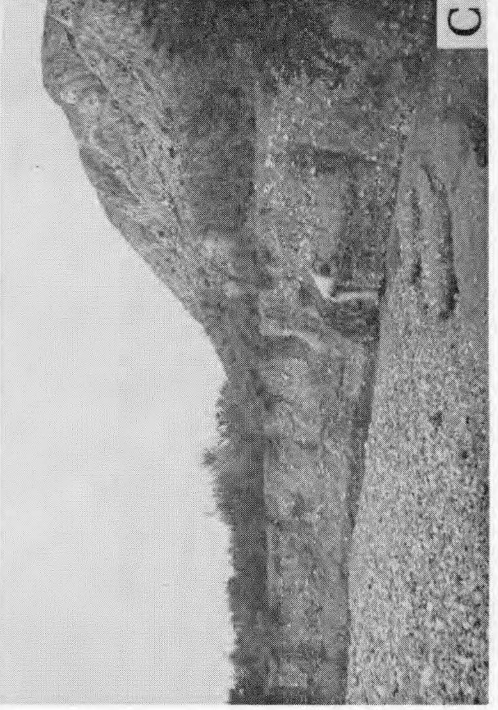
A. Ridge in the extreme northwest corner of Hood Spring quadrangle (fig. 1) showing massive nature of the upper novaculite member of the Caballos formation.

B. Anticlinal fold in upper novaculite member at Tinaja Spring (see Pl. V).

C. View northeast from top of ridge northwest of Tinaja Spring. Ridges are capped by Caballos cherts and novaculites. Valley in right foreground is eroded in Tesnus shale. Small hill in immediate foreground is produced by a cross flexure, and the beds are nearly horizontal.


A


B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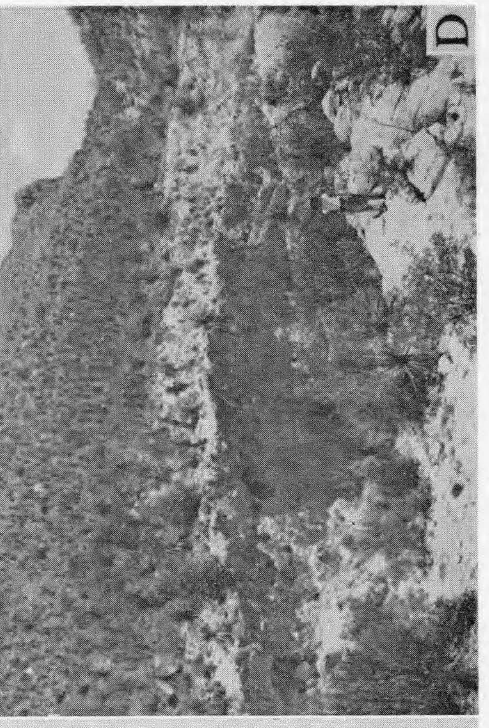
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Plate IV

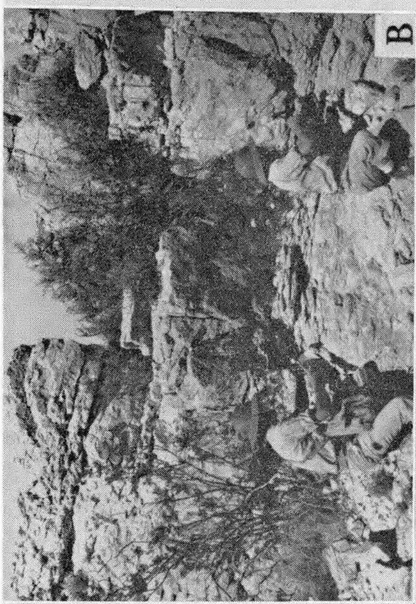
Cretaceous Formations and Quaternary Alluvium

A. Contact (hammer) of Glen Rose and Maxon formations in a creek in northwest corner of the east-central rectangle of Hood Spring quadrangle, east of Hill 4298.

B. Walnut-Comanche Peak beds at Hill 3367 in southwest corner of quadrangle.

C. Alluvium in right bank of Hackberry Creek just south of road crossing, 3¾ miles west of Barrett ranch, in northwest corner of quadrangle.

D. Calcareous gravels in left bank of unnamed creek, approximately three-fourths mile northwest of Hill 3367, southwest part of quadrangle.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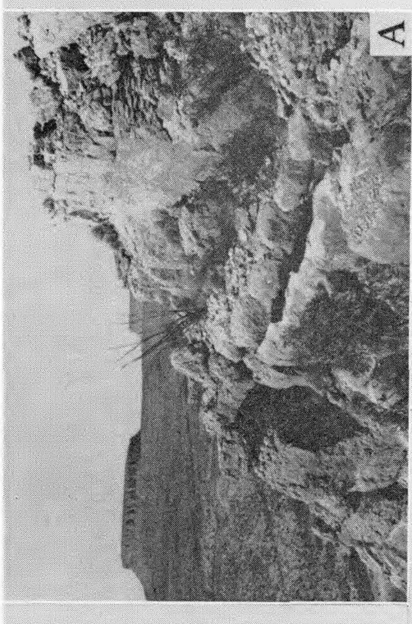
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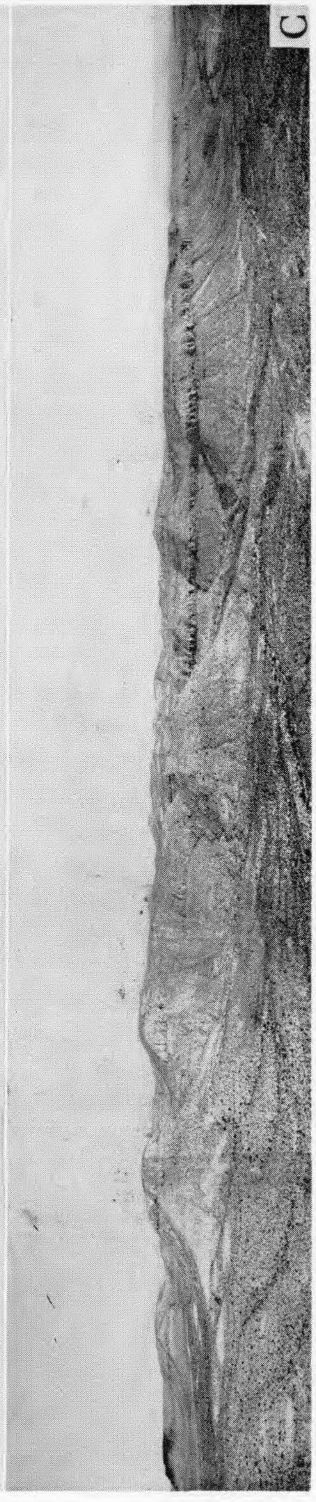
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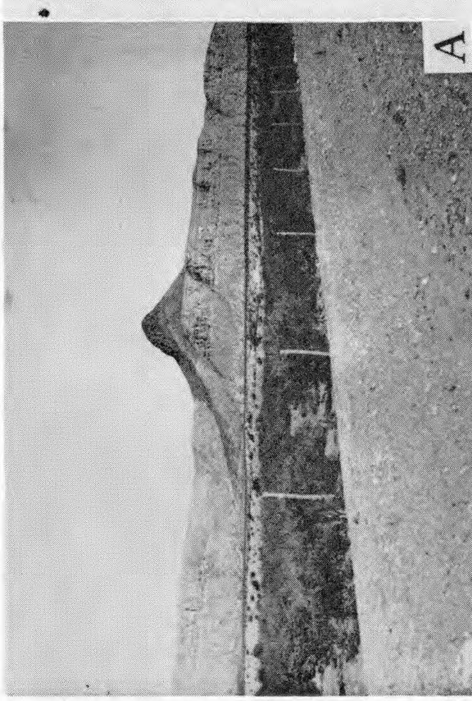
Plate V

Edwards Limestone

A. Contact of Edwards limestone and Walnut-Comanche Peak beds at top of Hill 4216 in northeast corner of the center rectangle of Hood Spring quadrangle. Contact is along line of vegetation at top of the thin ledge in the center of the photograph. Upper 3 feet of Edwards is a thick bed of rudistid-bearing limestone.

B. Closer view of contact of Edwards limestone and Walnut-Comanche Peak beds at same locality as "A." Brim of sun helmet of man on left is on the contact.

C. Panoramic view of the escarpment of Edwards cuesta viewed from southeast side of top of Hill 4216. The light-colored streak, near center of photograph, at base of hills on the dip slope of the cuesta is Kiamichi marl.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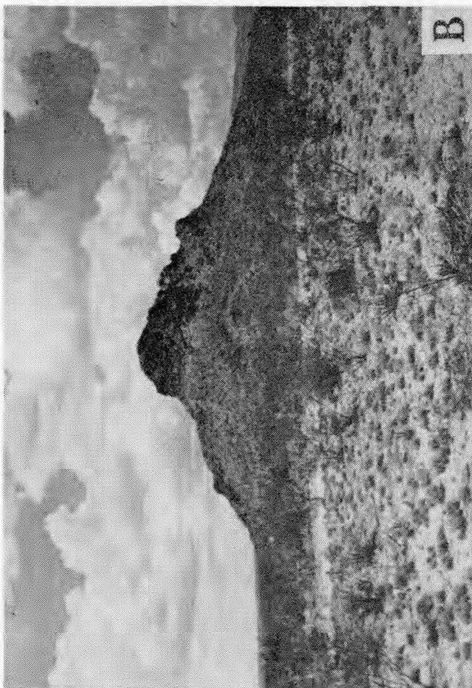
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Plate VI

Igneous Intrusives

A. Trachyte plug is intruded in Glen Rose limestone at Hill 4105 near west boundary of Hood Spring quadrangle.

B. Analcime-bearing trachyte plug surrounded by alluvium in the southeast corner of the qudrangle. A chilled, fine-grained border of the center mass forms the bench which surrounds the hill.

C. Small basalt plug intruded in the upper beds of Glen Rose formation. Located just south of Hill 4122 near the center of the quadrangle. Rill-like fluting at base of limestone ledge in background is characteristic of the weathering of the upper Walnut-Comanche Peak beds.

D. Southwest end of a trachyte dike southeast of Hill 4279 in the northeast corner of the quadrangle. Platy weathering caused by flow structure.

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