MINERAL RESOURCES OF TEXAS

UVALDE COUNTY

F. M. GETZENDANER

Uvalde County is located in southwestern Texas, including a part of the north margin of the Gulf Coastal Plain and the south margin of the Edwards Plateau. Its principal mineral resources are asphalt rock, clay, limestone, gravel, trap rock, surface and underground water. Some shows of oil and gas have been found at several localities, and small production of oil has been obtained on the Pulliam ranch in the southern part of the county. The Southern Pacific Railroad crosses the county east-west, the San Antonio, Uvalde & Gulf Railroad of the Missouri Pacific System enters from the south, and the Uvalde & Northern Railroad extends from Uvalde up the Nueces River Valley to Camp Wood in Real County. The surface elevation varies from about 800 feet above sea level at the south side of the county to 1700 or more feet in the northern part.

STRATIGRAPHIC GEOLOGY

The formations at the surface in Uvalde County are mostly those of the Cretaceous and Eocene periods. In the northern and central parts of the county the Cretaceous formations are exposed in order of age from north to south: Glen Rose, Comanche Peak, Edwards, Georgetown, Del Rio, Buda, Eagle Ford, Austin, Anacacho-Taylor, and Escondido. By southeastward dip and faulting these formations pass underground and are succeeded in the southeastern part of the county by lower Eocene formations: Midway, Indio, and Carrizo. In addition to these formations, a very considerable part of the county is occupied by extensive

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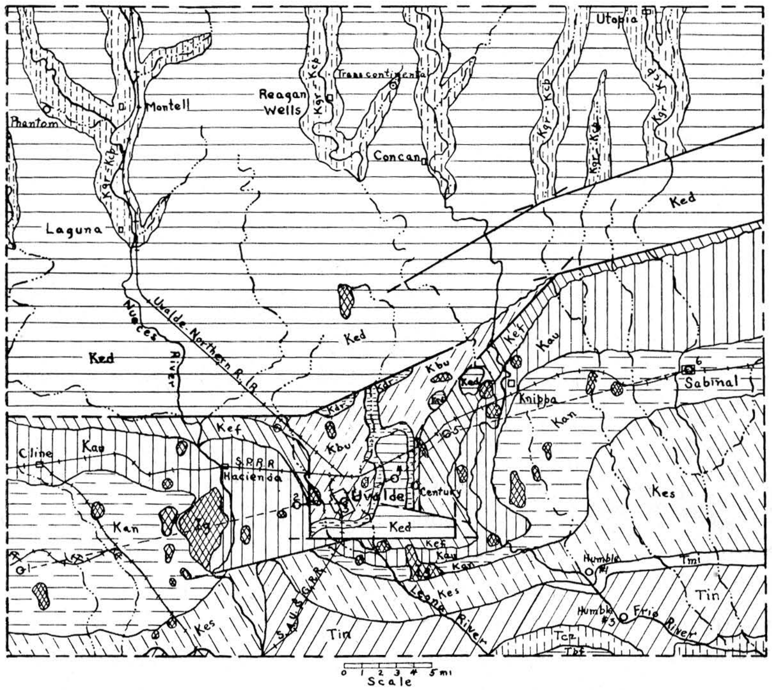

Fig. 10. Map of Uvalde County showing formation contacts and well locations. Mapping adapted from T. Wayland Vaughan's map of the Uvalde quadrangle, supplemented by field work by the author. The formations shown and the symbols by which they are indicated are as follows: Glen Rose and Comanche Peak (Kgr, Kcp), Edwards (Ked), Del Rio (Kdr), Buda (Kbu), Eagle Ford (Kef), Austin (Kau), Anacacho (Taylor) (Kan), Escondido (Kes), Midway (Tmi), Indio (Tin), Carrizo (Tcz), and igneous (Ig).

terrace deposits of Pleistocene, and possibly, in part Pliocene, age. The highest and oldest of these terrace gravel beds is known as the Uvalde formation, correlated with the Reynosa. At a lower level is the later extensive terrace known as the Leona formation. Terrace and alluvial deposits of late Pleistocene and recent age border the streams.

The Upper Cretaceous beds of Uvalde County, in common with those of southwestern Medina County, northern Zavala County, and southeastern Kinney County, contain

considerable sedimentary serpentine. This ranges from a single bed a few feet thick to two or more separated deposits composing parts of one or several formations all the way from middle Eagle Ford to middle Escondido or higher. The serpentines are interbedded with sediments normal to their respective formations. They contain fossils, including foraminifera and bryozoa, and fragments of limestone, most of which are water worn. Getzendaner has stated that the source of these sedimentary serpentines was extrusives in the Upper Cretaceous sea.[1] Intrusions of igneous materials came later and cut all of the Cretaceous formations, and some serpentines were derived from these by alteration in place.

The formations underlying the Cretaceous are imperfectly known in this county, as only a few wells have been drilled through the Cretaceous. A well on the Patterson ranch in the northern part of the county entered Paleozoic rock at depth 1723 feet. Samples, representing cavings from this well coming from between 1700 and 2400 feet, include hard, black, finely micaceous shale. Similar shale is found at depth 2450 feet. These samples, although nonfossiliferous, are similar to the shales in the Humble Oil & Refining Company No. 1 Thompson, in southwestern Bandera County, which contained a number of species characteristic of the Pennsylvanian. They do not furnish sufficient evidence, however, for referring the shales to a definite subdivision. The total depth of the well is 4220 feet, but no samples were seen below 2450 feet. Another well, Phantom Oil Company No. 1 Cloudt, in the northwestern part of the county, entered rock under the Cretaceous at about 1830 feet. This rock, as indicated by samples, is thought also to be of Pennsylvanian age. Farther south in the county no wells have been drilled through the Cretaceous. On the basis of well records in the adjoining counties, Sellards maps the extension of the highly folded

[1] Getzendaner, F. M., Geologic Section of the Rio Grande Embayment, Texas, and Implied History. Bull. Am. Assoc. Petr. Geol., Vol. 14, pp. 1428, 1429, 1930.

and somewhat altered Ouachita facies of Oklahoma as passing through the central part of this county.[2] A geologic section across the county is given in Figure 11.

FORMATION CHARACTERISTICS AND THICKNESSES

In the table which follows, the formations of this county are listed in order including thicknesses.

Table of Formations

Carrizo sand	100+, limited in this county to a narrow strip at the south edge of the county, between the Sabinal and Leona Rivers	Quartz sandstone, sometimes with shale partings
Indio	400 (oldest member of the Wilcox)	Lignitic, micaceous, sandy shales and calcareous sandstone
Midway	250 (in this county mostly concealed by Indio overlap and faulting)	Glauconitic shales, impure limestones, and lime concretions and, locally, sands
Escondido	500	Shales, limestones, sandstones, serpentine
Anacacho-Taylor	500	Limestones and serpentine in western part of county. Alternating limestone, shale and serpentine in central and eastern parts
Austin chalk	500	Chalky limestones and serpentine
Eagle Ford	75–200	Laminated argillaceous limestone, black shales, and crystalline flagstones and serpentine
Buda	60–125	Limestone
Del Rio	60–125	Clay, with thin beds of limestone
Georgetown	50–150 (mostly cut out on surface by faulting)	Limestone
Edwards	500–700	Limestone
Comanche Peak	60	Limestone
Glen Rose	600–2500+ (only top 400 feet exposed)	Shales with occasional beds of limestone, in northern part of county. Limestone and anhydrite with occasional beds of shale in southern part of county
Basement sands	300–600 (not exposed)	Sand, red clay, limestone, and chert

[2]Sellards, E. H., Map of the Paleozoic of Ouachita Facies in Texas. Bureau of Economic Geology, University of Texas, 1931.

STRUCTURAL GEOLOGY

The principal structural feature of Uvalde County is a complicated system of faulting and folding, most of which is probably related to the Balcones fault system. Reference to a geologic map of the state, particularly to Vaughan's map of the Uvalde Quadrangle,[3] will show a marked extension of the Comanchean southward from the Edwards Plateau, the axis of this extension passing about 3 miles east of the town of Uvalde. In an unpublished manuscript, G. Jeffrey has aptly named this the "Uvalde Salient." Measured on the exposed Comanchean alone, the Uvalde Salient extends 11 miles southward from the main line of the Balcones fault, and is about 7 miles wide at the town of Uvalde. On younger beds both dimensions are much greater. Attention is directed to the fact that there is very little displacement along the line of the Balcones fault where the Uvalde Salient departs from the main Comanchean province to the northward. There is evidence that even some of the displacement shown there by Vaughan's map is due to the collapsing of cavern roofs in the Edwards rather than to deeply penetrating faults. On the other hand, at the southern end of this Comanchean extension, Escondido (Navarro in age) is downthrown on a level with the Edwards limestone by a zone of faulting 1 to 2 miles wide and 8 miles long, the displacements aggregating about 1300 feet within less than two miles.

[3]Vaughan, Thomas Wayland, Description of the Uvalde Quadrangle, U. S. Geol. Surv., Geologic Atlas, Uvalde Folio (No. 64), 1900.

Whether this southern fault system is actually identical in time and cause with the Balcones or not, it gives an interesting view of existing conditions to consider it as an offset of the Balcones fault, the two lines being connected on either side of the Uvalde Salient by cross faults, those on the eastward striking north and northeast and being downthrown on the east and southeast sides, and those on the westward striking nearly north and south and being downthrown on the west side. According to this view the Uvalde Salient would be an eroded southern extension of the Edwards Plateau. The Uvalde Salient is arched as well as faulted. The respective eastward and westward dips extend far beyond the cross faults mentioned, and the arching extends southward into the Tertiary of southern Uvalde and northern Zavala counties several miles beyond the southern faults mentioned. The section, Figure 11, crosses this salient.

The normal dip in Uvalde County is south-southeast. The rate of dip on the Plateau portion is about 25 feet per mile, and within the influence zone of the Balcones fault, about 100 feet per mile. In the Coastal Plain portion the average rate is 75 feet per mile, but increases to 130 feet per mile in the extreme southern part of the county.

ECONOMIC GEOLOGY

Asphalt.—Outcrops of rock asphalt occur entirely across the southern part of the county. The most extensive and best known deposits, however, are in the vicinity of Turkey Creek and Little Muela Creek in the southwestern part of the county, where three companies quarry, crush, and ship large quantities of this valuable paving rock. The ages of the asphalt-impregnated rock range from middle Anacacho to Upper Escondido, and both limestones and sandstones are represented. Only the limestone, and that of Anacacho age, is being used at present. The asphaltum content of the rock ranges as high as 20 per cent, but the most suitable for paving purposes is 10 to 12 per cent asphaltum content.

The history of the development of these asphalt deposits is a long one. The first quarry was opened by Herbert L. Terrell of New York City in 1891. In 1893 the Litho Carbon Company, a New Jersey corporation, owned by New York parties, bought from Terrell the exclusive right (except for paving purposes, which right was retained by Terrell) to quarry the rock, and extract and prepare the asphaltum for market. This company erected a quarrying, crushing, and extracting plant and laboratory which was remarkable for its time. The quarry was lighted by electric arc lights and operated day and night, a generator at the plant supplying the electricity. The town of Carbondale, composed of the executives, foremen, and laborers of the Litho Carbon Company, was the first community in southwest Texas, except San Antonio, to be lighted by electricity. There was a battery of cast iron retorts with condensors for extracting the asphaltum from the crushed limestone and recovering the solvent. The asphaltum was run into pine boxes holding about 200 pounds of the wax. A railroad seven miles long was built from the plant to the Southern Pacific Railroad at Cline, and the wax was shipped to eastern cities.

In 1894 a separate corporation, the Litho Carbon Rubber Company, acquired an interest in the asphaltic limestone deposits, equipped an experimental laboratory, and began research work in synthesizing an industrial product from para gum and asphaltum. This laboratory also developed several pigments from the asphaltum. However, nothing in the way of a commercial success resulted from these experiments.

In 1896 asphaltum began arriving at the Atlantic seaboard by boats from the Island of Trinidad and was offered at prices with which the Uvalde product could not compete. The Litho Carbon Company went into the hands of a receiver in January, 1897, and its realty and equipment were sold to R. T. Rockeby in December of the same year. In 1897 Rockeby sold the assets to The Uvalde Asphalt Company, which secured some paving contracts in New York City and for a time used the Uvalde product but later discontinued shipments from Texas and closed down the plant.

In 1900 the Parker Washington Company of West Virginia secured a paving contract in San Antonio, on part of which they used crushed asphaltic limestone from this same locality. This was the first use of the crushed Uvalde rock asphalt for paving purposes, all former operators having extracted the wax from the rock. From 1901 until 1912 these deposits were not worked. In 1910 J. B. Smyth of Beaumont acquired the lands formerly owned by the Litho Carbon Company and two years later, through the corporation organized by him, The Uvalde Rock Asphalt Company, began developing this crushed rock for road and street paving purposes. Their venture was a success from the beginning. R. L. White and the Texas Asphalt Company have followed in the development of the industry and also own valuable deposits and plants.

The shipments of Uvalde County rock asphalt for the year 1929 were 320,931 tons. The companies now operating are Texas Rock Asphalt Company, Uvalde Rock Asphalt Company, and White's Uvalde Mines.

Clay.—An abundance of Del Rio clay and Anacacho and Escondido shales occur near rail transportation, but none have been utilized thus far. Bentonite occurs associated with serpentine of Eagle Ford age in a well on the Malarkey farm west of Uvalde, but no outcrop of it is known within the county.

Limestone.—There is an abundance of limestone of Edwards, Austin, and Anacacho ages outcropping along railroads, but none has been utilized recently except as crushed rock for road metal and for concrete grout. The pioneers of the county built numerous houses of limestone, and the old courthouse and old city hall at Uvalde, both of which were torn down and replaced a few years ago, were built of Austin chalk.

Gravel.—Almost limitless deposits of gravel occur in this county. Considerable thicknesses of it cap the higher hills

and ridges of the Coastal Plain, and it is found along successively younger terraces, on down to the great gravel bars of the present streams. This gravel is the principal material used for foundations in the extensive system of highways being built across the county in every direction, and for concrete grout and railroad ballast, although for the latter purpose it is giving way to "trap rock." Most of this gravel is derived from Comanchean flints and cherts, although the younger terraces contain numerous lime fragments.

Trap rock.—A large industry in quarrying and crushing nephelite-basalt has been developed in this county by the Texas Trap Rock Company. The quarry and crushing plant are on the Southern Pacific Railroad near Knippa. Their product is used in making concrete grout, road metal, and railroad ballast. The Uvalde Rock Asphalt Company purchases considerable quantities of small-screen trap rock which it uses, mixed with crushed rock asphalt, in a proprietary paving material which it calls "Duraco." The Texas Trap Rock plant has been in operation about twelve years. In round numbers their shipments in 1929 were 165,000 tons; in 1930, 177,500 tons.

Water.—Uvalde County is supplied with an abundance of underground water. The larger wells, used for town water systems and for irrigation, derive their water from two sources—the Edwards limestone, and Pleistocene gravels. Pleistocene gravel water is limited to relatively small localities in the broader stream valleys, while the Edwards source is almost county wide. The large wells, however, are limited to the southern quarter of the county. The Uvalde city water system well obtains water from the Edwards limestone and produces at the full capacity of the pumps, which is 1600 gallons per minute. There are numerous Edwards limestone wells which produce at the rate of 400 to 600 gallons per minute, the production apparently being limited only by the capacity of the pumps. A well obtaining water from Pleistocene gravel on the Uvalde Pecan Plantation 12 miles southeast of Uvalde produces at

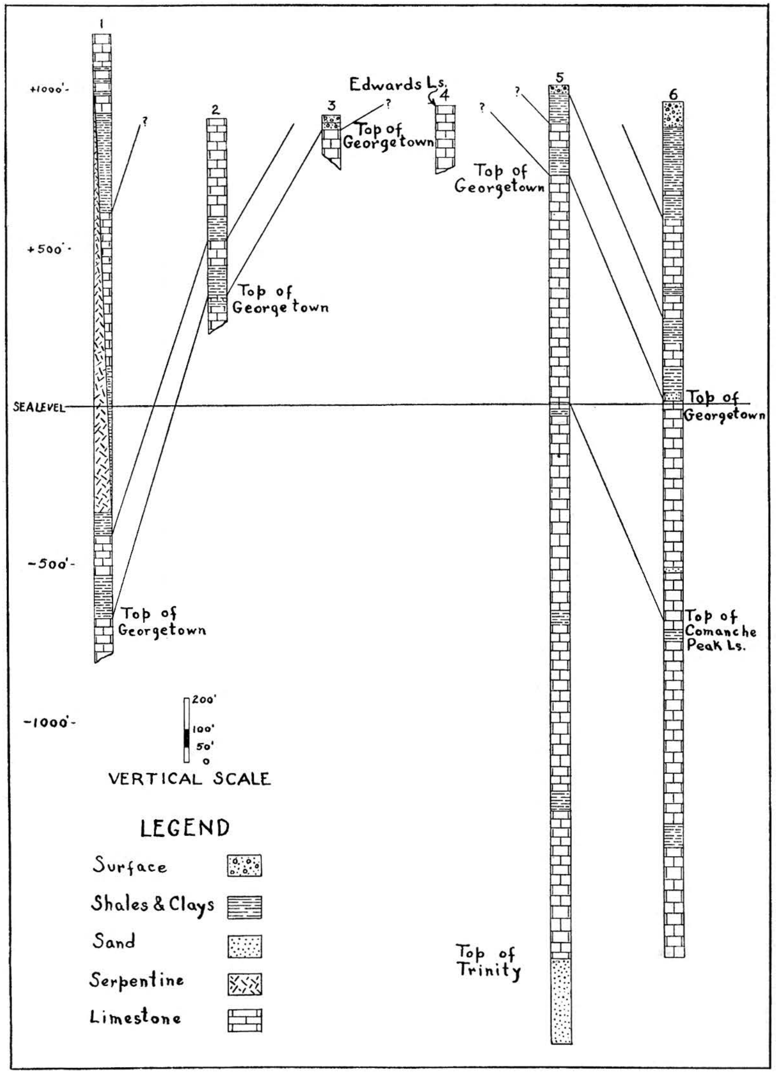

Fig. 11. Geologic section across Uvalde County on the line A–B of Fig. 10. The wells used in the section are as follows: 1, Smyth (Pure Oil Co.); 2, Malarkey; 3, Uvalde; 4, Ebarb; 5, Walcott (Bell Oil & Gas Corp.); 6, Sabinal. For descriptions of wells No. 5 and 6 see pages 108 to 110.

the capacity of a large centrifugal pump from which a flow of 2300 gallons per minute has been measured, according to information given by the owners. There are a few localities where the Edwards limestone is not charged, and one locality where its water is mineralized. These conditions are believed to be caused by faulting. Much of the northern part of the county is abundantly watered by springs, coming from the Edwards limestone. These springs supply strongly flowing streams as far southward as the Balcones fault. There the Edwards limestone is downthrown and speedily dips below the stream beds, its porous horizons again taking in the same water they previously discharged through the springs. Thence comes the supply in this limestone tapped by the wells in the southern part of the county. A portion of the stream water flows on past, and this, together with flood waters, charges the Pleistocene gravels. There is a zone of dry Edwards limestone between the southernmost springs and the Balcones fault, proving that the Edwards limestone is completely bled of its water when it reaches the Balcones fault, and that the water it carries on the Coastal Plain farther south is all taken in to it at and south of the fault. There is a little irrigation directly from the streams by gravity, but not so much as formerly.

North of the Balcones fault there are a few wells which derive their water from the Basement sands. Among these are the Jesus Gonzales and the Kincaid wells, both on the divide between the West Frio and the Nueces River, in a zone where the Edwards limestone is dry. At Reagan Wells, a health resort on the West Frio, the water is derived from the Glen Rose formation. An analysis of this water in grains per U. S. gallon is as follows:

Calcium carbonate	1.17
Calcium sulphate	95.93
Magnesium sulphate	74.98
Sodium chloride	1.52
Iron carbonate	0.03

There are numerous wells and some springs from the Glen Rose, many of which show similar mineralization.

The upper part of the Comanche Peak limestone sometimes affords spring and well water. There are no known wells producing water from the Georgetown limestone, Del Rio clay, Buda limestone, or Eagle Ford formation, except one from the Buda limestone lying against a fault. The water probably enters the broken Buda from the Edwards limestone just a few feet distant, across the fault.

There are several wells deriving small supplies of water from the Austin chalk, but the chalk contains no definite water horizon, and numerous wells drilled into it are dry. Both the Anacacho and Escondido have porous lenses, locally, and afford a few fairly good wells, but at many places wells drilled into these formations are failures.

Many small wells get their water from the serpentines. These serpentine waters are generally mineralized; a sample from one well that appears typical gives the following analysis:

Radicals	Parts per Million
Sodium	7
Calcium	457
Magnesium	146
Chloride	1038
Sulphate	40
Bicarbonate	305
Carbonate	0
	1993

Chloride salinity	97.25%
Sulphate salinity	2.75%

WELL RECORDS

Records of the following wells in this county indicate the drilling conditions and the formations penetrated.

Cloudt 1, Phantom Oil Co.; southwest corner of Sec. 661, G. C. & S. F. Ry. Co.; 9 mi. from north and 2 from west county line. Elevation, 1511. T. D. 2710. Cable tools.

DRILLER'S LOG

	Depth in Feet
Limestone	0–70
Hard limestone	140
Shale	230
Shelly limestone	256
Water sand	260
Hard limestone	270
Water sand	275
Blue shale	305
Hard limestone	353
Blue shale	370

	Depth in Feet
Hard limestone	480
Blue shale	500
Gray shale	525
Sandy shale	535
Gray shale	545
Shale	565
Limestone	580
White shale	585
Limestone shells	695
Limestone, sandy	705
Limestone, white	780
Broken limestone	825
Water sand	845
Limestone shells	875
Hard limestone	935
Hard sandy limestone, gray	965
Sand	1000
Broken limestone	1020
Sand	1025
Sandy limestone, hard	1030
Limestone	1043
Water sand	1056
Limestone, white, hard	1075
Sand, water	1090
Limestone, hard	1095
Sand	1120
Limestone	1135
Hard limestone	1148
White limestone	1165
Slate and limestone shells	1185
Slate	1195
Limestone	1198
Slate	1230
Gray shale	1237
Red rock	1241
Hard sand	1247
Sandy shale	1270
Red rock	1277
Slate	1278
Limestone	1281
Sandy shale	1288
Hard sand	1300
Water sand	1310
Hard sand	1337
Water sand	1345
Hard sand	1360
Sand, soft	1369
Water sand	1392
Red rock	1399
Sand, hard	1405
Sand	1418
Water sand	1448
White limestone	1449
Red sandy shale	1457
Sand	1460
Hard sand	1485
Water sand	1505
Fine gravel	1525
Hard red sand	1535
White limestone	1537
Water sand, pink	1549
Fine sand and fine gravel	1556
Water sand	1569
Hard sand	1573
Coarse gravel	1585
Very hard sand	1600
Hard sand	1603
Water sand	1610
Sand and gravel	1630
Hard gray sand	1663
Hard sandy slate	1670
Sandy slate	1675
Sandy limestone	1700
Limestone	1702
Hard limestone	1710
Hard sand	1725
Hard white sand	1745
Hard gray sandy limestone	1750
Hard sandy limestone	1790
Hard black shale and limestone shells	1810
Hard sandy limestone	1830
Hard sandy limestone, gray	1840
Sandy limestone	1865
Sandy limestone, hard	1895
Black shale	1900
Sandy limestone, hard	1912
Black shale and broken limestone	1930
Limestone	1935
Hole caving	1970
Hole caving badly—gray limestone and slate	1981
Hard gray sand	1995
Hard gray sand, very sharp	2010
Black slate	2025
Limestone, gray	2090
Hard limestone	2095
Hard gray sandy limestone	2112
Hard sandy shale	2118
Hard gray sandy limestone	2120
Hard sandy limestone	2145
Hard sand	2175
Hard limestone	2238
Sand	2245
Sandy limestone	2253
Log wanting	2710

The following note on this well is from the records of the Bureau of Economic Geology.

Samples at depths 1690, 1938–45, and 1981–85 include very black, shiney, slickensided shale. Samples from 2230–40 are largely gray sandstone, one piece of which is cut by calcite vein. This sandstone is otherwise not altered. Most of the samples below the Cretaceous are dark unaltered shale, probably Pennsylvanian.

In this well the following formations are represented:

Glen Rose	0–1205
Basement sands (approx.)	1205–1830
Pennsylvanian	1830–2253

Patterson 1, Transcontinental Oil Co.; I. K. Henry surv. 934, about 20 mi. north of Uvalde. Elevation, 1600. T. D. 3930. Cable tools.

DRILLER'S LOG

	Depth in Feet
Gravel	0–11
Hard limestone	250
Blue clay	255
Hard limestone	450
Blue clay	480
Hard limestone	520
Blue clay	528
Hard limestone	770
Loose brown limestone	780
Hard and soft limestone	1052
Blue clay	1060
Soft pink sand (Gyp crystal)	1072
Hard limestone	1190
Blue clay	1210
Soft sand	1216
Blue clay	1224
Soft limestone	1231
Blue mud	1270
Soft limestone	1275
Slate and shale	1290
Red rock	1390
Shale and sand	1330
Soft sand (water)	1335
Red boulders	1345
Limestone	1355
Blue shale	1380
Pink sand	1425
Red rock	1430
Pink sand	1452
Blue clay	1464
Pink sand	1510
Limestone and shale	1520
Limestone shells, hard	1530
Pink sand	1552
Limestone shells	1560
Water sand	1570
Limestone shells	1575
Gray sand (pebbles)	1627
Fine water sand	1634
Coarse sand	1657
Red rock	1660
Coarse sand	1678
Brown clay	1716
Sand	1723
Slate	2800
Black limestone (salt water at 2827)	2845
Slate	2940
Black limestone	2947
Gray limestone (gritty)	2952
Slate and shells	3035
Black limestone	3043
Brown sand	3047
Slate and shells	3070
Black limestone (gritty)	3118
Slate and shells	3205
Black limestone	3252
Slate and shells	3270
Black limestone (sandy)	3300
Gray sand	3315
Slate and shells	3737
Black limestone	3743
White limestone	3756
Gray sand	3768
Slate and shells	3906
Limestone	3915
Slate and shells	3930

The following note on this well is from the records of the Bureau of Economic Geology.

Cavings from this well thought to be from between 1700 and 2400 feet include several pieces from 1 to 2½ inches across consisting of

dark finely micaceous shale with no schistosity or folding. Similar shale is found in samples at depth 2450 feet; probably Pennsylvanian.

In this well the following formations are represented:

Surface, Edwards and Comanche Peak	0– 250
Glen Rose	250–1210
Basement sand	1210–1723
Pennsylvanian	1723–3930

Kincaid 3, Humble Oil and Refining Co.; a little south of center of Hipolito Sotello surv. 377 and on the northeast bank of Frio River, southeastern part of county. Elevation, 768. T. D. 2324. Cable tools.

DRILLER'S LOG

	Depth in Feet
Yellow clay	35
Gravel	67
Dark shale	100
Gray sandy shale	170
Gray water sand	185
Gray shale	212
Gray sandy shale	251
Water sand	258
Blue shale	295
Sandy shale	340
Gray sand	346
Blue shale	352
White limestone	375
Blue shale	400
Gray shale (water 470–480)	485
Blue shale	515
Gray sand	520
Blue shale	587
Limestone	590
Gray sand (water)	600
Gray shale	690
Blue shale	785
Blue gumbo	840
Gray sand and shale (water, salty)	850
Gray sand, very hard	870
Gray limestone, hard	885
Blue gumbo	890
Gray shale	900
Gray sand and limestone	920
Gray sand, limestone and shale	975
Brown shale or mud	985
Asphalt	1000
Blue shale	1015
Chlorite	1060
Blue mud	1065
Blue sand and shale	1075
Blue shale	1175
Asphalt	1180
Blue chlorite	1342
White chalk	1369
Gray chalk	1405
Blue mud	1412
Blue chlorite	1434
Blue mud	1439
White chalk	1455
Gray sand and chalk	1489
White chalk	1620
Gray sand and chalk (water)	1630
White chalk	1650
Gray chalk	1720
Gray sand and chalk and "gray sandy chalk"	1845
Gray sandy limestone	1850
Gray sandy limestone, hard	1865
Black sandy shale	1870
Eagle Ford shale	1975
Buda limestone	2075
Del Rio clay	2167
White and gray limestone	2324

From paleontological data, the following formations are identified in this well:

Indio	0– 260
Midway	260– 346
Escondido	346– 840
Anacacho	840–1330
Austin chalk	1330–1850
Eagle Ford	1850–1975
Buda limestone	1975–2075
Del Rio clay	2075–2167
Georgetown-Edwards	2167–2310

Serpentine was found in this well as follows:

With a parting of dark gray limestone at 1045–1055 containing Anacacho fossils	970–1065
The serpentine being interbedded with limestone, both containing Anacacho fossils	1135–1330
"Highly altered basic igneous rock and pyrite:" Numerous Austin foraminifera, Ostracods, Echinoid fragments, Bryozoa	1360–1370
Mixed with limestone in sample	1395–1400
Blue, highly altered igneous rock containing Ostracods and Echinoid spines	1412–1434

Sabinal City Well; drilled by M. W. Dobbs in 1918. T. D. 2700. Cable tools.

DRILLER'S LOG

	Depth in Feet
Soil, clay and gravel	82
Limestone	90
Shale	280
Shell	282
Shale	375
Chalky limestone (some water at 515)	590
Brown shale	610
Limestone	685
Black and brown shale	765
Hard and chalky limestone	842
Shale	915
Water "sand" (?)	940
White and gray limestone	1470
"Sand" rock (water)	1478

The following descriptions are by the Texas Bureau of Economic Geology. A few practically identical descriptions are consolidated.

	Depth in Feet
Crystalline limestone	1525
White and gray limestone	1678
Limestone and "marl"	1700
Gray limestone	1710
Gray limestone, blue marl	1728
Limestone and marl (water 1905–1912)	1912
Gray and white limestone	1968
Gray marl and light gray limestone	2000

	Depth in Feet
Gray organic fragmental limestone	2080
Gray limestone and gray shale	2098
Gray organic fragmental limestone	2107
Dark bluish-gray marly shale and light gray limestone	2160
Light gray limestone	2175
Gray marly shale	2210
Light gray limestone	2230
Gray limestone and marly shale	2260
Gray limestone	2285
Light gray limestone and some gray marly shale	2320
Light gray porous limestone, some gray shale	2335
Gray limestone and gray marly shale	2355
Light gray limestone	2453
Light buff limestone	2503
Light buff crystalline limestone	2578
Gray organic fragmental limestone and some crystalline limestone	2605
Gray limestone	2633
Gray, organic fragmental limestone	2655
Gray limestone	2680
Gray organic, fragmental limestone	2700

With one exception, which is noted, the following interpretations are by the writer:

Surface and Anacacho	0– 375
Austin chalk	375– 685
Eagle Ford	685– 765
Buda limestone	765– 842
Del Rio	842– 915
Georgetown-Edwards	940–1640
Comanche Peak and Glen Rose	1640–2700

NOTE: In a letter to W. D. Heard, Mayor of Sabinal, dated April 7, 1919, Dr. J. A. Udden says that the base of the Edwards is at about 1640 feet.

On completion of this well, the casing was raised, permitting the Edwards and Glen Rose water to mix. A sample was analyzed by D. F. Crider as follows:

	Parts per Million
Calcium sulphate	1186
Magnesium sulphate	823
Sodium sulphate	280
Magnesium bicarbonate	189
Aluminum	none
Iron	none
Silica (Oxide)	5
Total solids	3258

The writer observed the drilling of this well and noted the occurrence of water in the Edwards at about 975, and again from 1470 to 1530, but as flowing water was hoped for, it was passed up and, later, cased off. At 1670 there was highly mineralized water in the upper

Glen Rose. At 2320 to 2335 in porous limestone a flow of water was obtained that filled the hole to within less than 100 feet of the surface. This was mineralized but not as highly as that from 1670. The water from this well was very unsatisfactory for public use and in 1928 the City of Sabinal was advised by the writer to plug off the Glen Rose water with a cement plug at 1460–1470. This was done and the salinity of the water was reduced but the supply was then inadequate. Being convinced that the upper Edwards water was still cased off, the writer recommended that a second well be drilled by the side of the old one. This was done and the drilling stopped before the base of the Edwards was reached. The result was an abundance of water of low salinity.

Walcott 1, Bell Oil and Gas Corporation; 1000 ft. east of Ange Switch on the Southern Pacific Railroad, 4 mi. east of Uvalde. T. D. 3030. Cable tools.

DRILLER'S LOG

	Depth in Feet
Yellow limestone	72
"Oil sand"	80
Blue shale	120
White limestone	195
Blue shale	283
Description of samples:	
White chalky limestone, pyrite, and finely crystalline limestone	425
White cryptocrystalline limestone	610
Cream-colored, very finely-textured sandstone with calcite cementation	640
Cream-colored, dolomitic granular limestone	675
No samples, 675–1355	
Cream-colored cryptocrystalline limestone and gray calcareous shale	1355 and 1396
White chalky limestone	1410
Light gray cryptocrystalline limestone	1420
Blue shale	1498 and 1540
Cream-colored, granular, porous limestone	1550 and 1710
Soft, cream-colored granular, oölitic limestone	1730, 1735 and 2015
Dark gray shale and shell fragments	2212
Dark-blue-gray, noncalcareous shale	2500
Light gray, cryptocrystalline limestone	2720
Blue, gray, and red, highly calcareous clay	2755
Fine textured sandstone with calcareous cement	2765 and 2820
Blue-gray, calcareous shale	2845
Loose, fine sand and fragments of unctuous shale	2890
Rather coarse, friable sandstone with calcareous cement	2910
Loose sand, medium-sized angular fragments of quartz	2950
Loose quartz sand and light, blue-green shale	2990
Loose quartz sand, coarse and fine mixed	3030

In this well the following formations are represented:

Surface and Eagle Ford	0– 120
Buda limestone	120– 195
Del Rio clay	195– 283
Georgetown-Edwards-Comanche Peak	283–about 1000
Glen Rose	about 1000–2755
Basement sands	2755–3030

Available Literature and Maps.—Some early observations on this county made by George G. Shumard during 1855 are published in The Geology of West Texas, pp. 63–68, 1886. The northern part of the county is included in Folio 64 of the U. S. Geological Survey. The southern part of the county is included in maps accompanying Professional Papers 90 and 126 of the U. S. Geological Survey. Notes on the lignite deposits are given in the Fourth Annual Report of the Texas Geological Survey, 1892. The igneous rocks of this county are described in The University of Texas Bulletin No. 2744. This county is mapped in part in Bull. American Association of Petroleum Geologists, Volume 14, pp. 1425–1437, 1930.

ZAVALA COUNTY

F. M. GETZENDANER

Zavala County is situated within the Gulf Coastal Plain, being one of the second tier of counties from the Balcones fault. Its principal mineral resources are asphalt, caliche, clay, coal, natural gas, gravel, sand, and surface and underground water. Showings of oil have been encountered at numerous localities, but no commercial production has been obtained. The San Antonio, Uvalde & Gulf branch of the Missouri Pacific Railroad traverses the county from north to south. The surface elevation ranges from 580 feet, in the Nueces Valley at the south line of the county, to 964 feet at the summit of Batesville Hill, about four miles from the north line.

STRATIGRAPHIC GEOLOGY

Formations represented on the surface in Zavala County range from the Upper Cretaceous to the Claiborne group of the Eocene. In ascending order in the geologic section, and from north to south across the county, these are: Escondido of the Cretaceous; and Midway, Indio, Carrizo, Bigford, Mount Selman, and Cook Mountain of the Tertiary. Mantling all these formations at many places are the Reynosa formation on the higher hills and ridges, and the Leona and recent terraces in the valleys and along the streams.

The underlying formations of the Cretaceous as low in the section as the Glen Rose, are known in the northern part of the county from several wells drilled in Zavala and Uvalde counties along their common boundary. These wells reveal that sedimentary serpentine occurs at various points throughout the Upper Cretaceous as far south as Batesville. One well, the Southern Crude Oil Purchasing Company's No. 1 Washer, penetrated 1758 feet of Glen Rose, of which continuous cores were taken. In the southern part of the county the well that penetrates deepest into the section is Wiegan Bros. No. 1 Gates, near Loma Vista. It

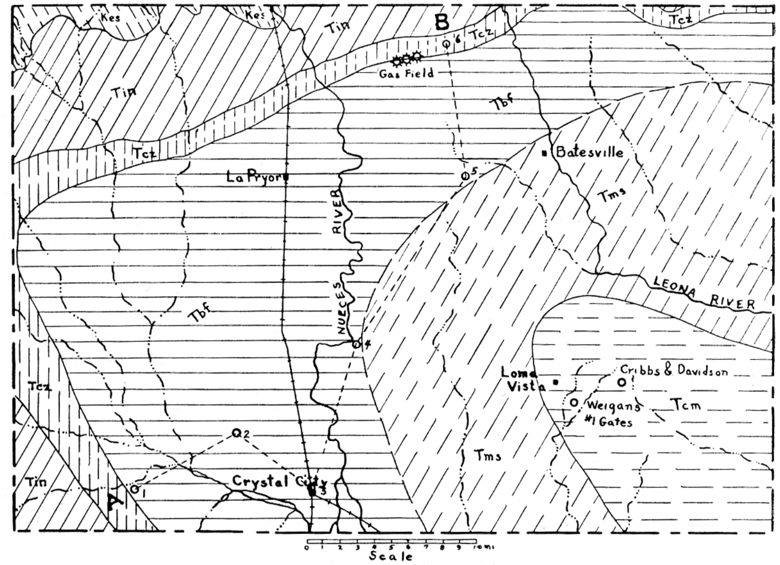

Fig. 12. Map of Zavala County showing formation contacts. The formations shown and the symbols by which they are indicated are as follows: Escondido (Kes), Indio (Tin), Carrizo (Tcz), Bigford (Tbf), Mount Selman (Tms), Cook Mountain (Tcm).

suspended drilling in the Escondido formation at 3215. A core from 2975 contained Midway fossils, while a core from somewhere between 3030 and 3050, the depth of the well at that time, was Escondido in age. A well further south, in western Dimmit County, penetrated several hundred feet of Austin chalk.

FORMATION CHARACTERISTICS AND THICKNESSES

The formations of this county, with their thicknesses, are shown in their order in the section in the following table:

Table of Formations

Cook Mountain	200 (Only basal part occurs in this county)	Shales containing Ostrea alabamaensis, with thin beds of limestone containing Callocardia astartoides Gardner

QAe18XX

Mount Selman	500 (Mostly concealed by Quarternary. Known mainly from Gates (Wiegan Bros.) Cribbs & Davidson and Commercial Nat. Bank fee wells)	Shales, and clays, often lignitic, sand, sandstone, lime concretions, coal; some glauconite
Bigford	700–800	Micaceous and gypseous shales and clays, often bentonitic and lignitic, sand and sandstone, lime and iron concretions and cone-in-cone; at some localities, glauconitic
Carrizo sand	100–300	Quartz-grained sandstone with occasional lenses of shale
Indio	400–800 (The variation in thickness is by progressive and rather uniform increase from north to south)	Lignitic, micaceous sandy shales, and calcareous sandstone, coal, occasional local sands
Midway	125–350 (Only outcrops are in northeastern part of county and one small outcrop near the Nueces River)	Shales, lime concretions, impure limestones, some local sands — all glauconitic
Escondido	500–2000 (Outcrops only in northwestern part of county)	Shales, limestones, sandstone, with serpentine in the northern part of the county
Anacacho	500–800	Shale, limestones, serpentine in the northern part of the county
Austin chalk	500–800	Limestone, argillaceous limestone, shales. Serpentine in the northern part of county
Eagle Ford	200–450 (May be thicker in southern part of county)	Black and gray shales some flaggy limestone, serpentine as far south as No. 1 Price (Capps)
Buda limestone	125–200 (May be thicker in southern part of county)	Limestone
Del Rio clay	125–200 (Its character and thickness are known only in northern part of county)	Shales and clays, thin beds of limestone

Georgetown-Edwards and Comanche Peak	800 (These formations have not been differentiated in Zavala County and nothing is known of them excepting in northern part of county)	White and gray limestone
Glen Rose	2500+ (Known only from Southern Crude Oil Corp. No. 1 Washer, Union Oil Co. No. 1, Anderson and No. 6 Pulliam)	Gray limestone, gray to black shales, anhydrite

STRUCTURAL GEOLOGY

The dominating structural feature in Zavala County is a large geosyncline, best characterized as the Carrizo sand artesian basin. The axis of this syncline extends southeastward from a point on the western line of the county about 10 miles south of the northwest corner, passing out of the county a little north of its southeast corner, and continuing on through the town of Gardendale in La Salle County and into western McMullen County. To the northwestward this geosyncline is clearly indicated in northeastern Maverick and southeastern Kinney County. The contact lines and strike lines everywhere pivot on the axis of this structure. In northern Zavala County the dip on the Midway is about South 40 East with a rate of about 130 feet per mile. In the southern margin of the county it is about North 75 East with a rate of about 80 feet per mile.

ECONOMIC GEOLOGY

Asphalt.—A ledge of asphaltic sandstone outcrops in the bed of the Nueces River near the north line of the county. It has never been utilized, although the asphaltum content ranges as high as 20 per cent.

Caliche.—Caliche is common on the hills and ridges in the northern part of Zavala County and has been used as a road surfacing material and as a foundation for a rock asphalt surface. It is adapted to economical use and makes a good foundation for asphalt topping, and is a good, but short-lived topping, used alone. Some deposits of caliche

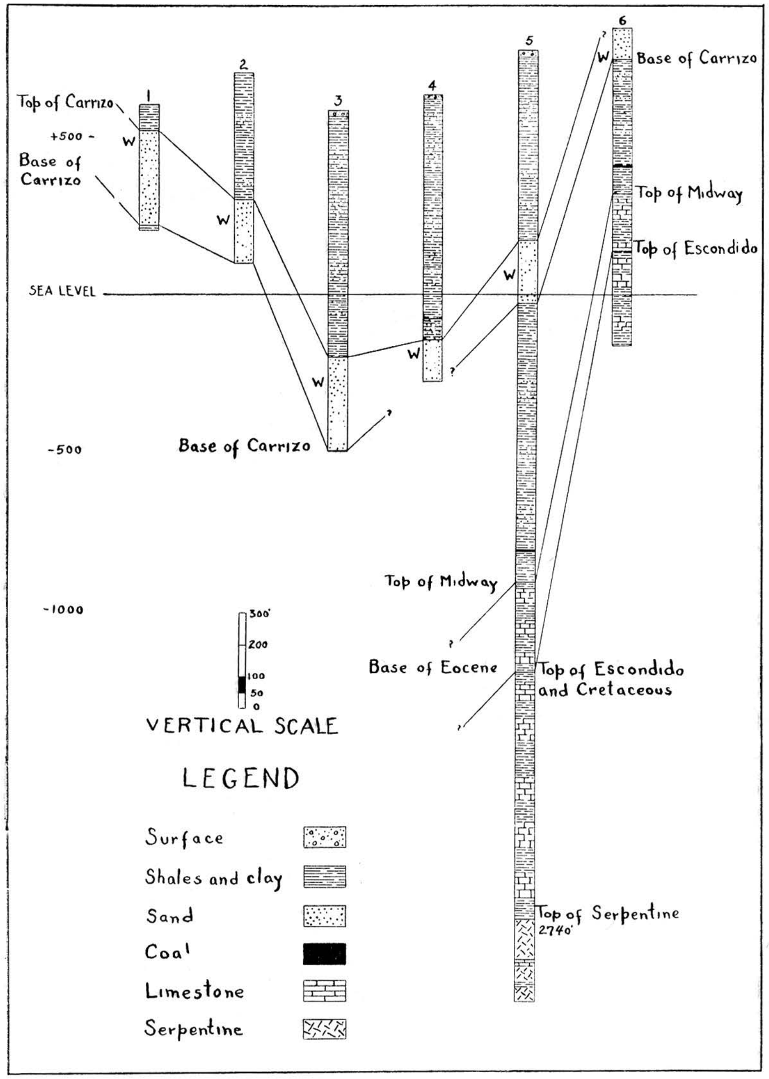

Fig. 13. Geologic section in Zavala County on the line A–B of Figure 12. Wells used in the section are as follows: 1, B. H. Erskine, Jr., water well, near center of north line of C. C. Gibbs surv. 541½; 2, T. B. Jones, water well, (now Gunter Hardy) Bl. 12, I. G. N. Ry. surv. 7; 3, Holsomback and Garner, water well; 4, Huffman water well 3; 5, Price 1; 6, West 5.

are exceptionally pure carbonate of lime and, where coal and gas are close at hand, as in Zavala County, probably could be economically calcined in the making of lime.

Clay.—Clays and shales, apparently adapted to brick making and ceramics, are plentiful in the Indio and Bigford formations, near rail transportation and natural gas. No attempt has been made to develop them. Some of these clays are bentonitic.

Coal.—Both the Indio and Bigford formations are highly lignitic, and beds of coal and lignite occur in both. A bed of coal 5 or 6 feet thick, with an eight-inch shale parting, outcrops in the east bank of the Nueces River near the south line of the Pulliam ranch, and there is a similar outcrop on the same side of the river two or three miles farther north on the same ranch. Both of these are in the Indio formation. A thin bed of coal in the Bigford outcrops in the bed of the Nueces River south-of-east of the town of La Pryor. Samples from many widely distributed wells show that these beds are rather general in their extent over the county.

On the I. T. Pryor ranch, which has more wells than any other locality in the county, 26 wells logged a total of 194 feet of coal in the Indio formation, or an average of 7.4 feet per well. However, some wells on this ranch log no important beds of coal. This is partly due to hurried drilling and lack of attention to formations, but some wells that have been carefully sampled prove that there are localities where the coal is not present in important thicknesses. Such "blind spots" are local, however, and coal has been found on all sides of them.

The roof of this coal is sandy shale. Except far down the dip, where it is probably too deep for economical mining, little water is encountered until depths below the coal are reached.

In 1920, five holes were drilled on the northern part of this ranch under the direction of G. Jeffreys, for the purpose of making a survey of the thickness of the coal and determining its qualities. These five wells showed the thicknesses of the coal at the respective locations to be as follows: 16 feet, 15 feet, 4 feet, 3 feet, and 4 feet—an average of 8.4 feet.

Thirteen air dry samples of coal from these five wells were analyzed by David Hancock of Birmingham, Alabama, the average of the thirteen analyses being as follows:

Impurities	16.5%
Clean coal	83.5
Moisture	6.11
Volatile matter	37.30
Fixed carbon	40.99
Ash	15.50
Sulphur	1.97

B. T. U. (dry coal basis), 11231.

The samples were first freed from impurities by floating on a solution of 1.55 specific gravity. The clean coal was then analyzed with the results as shown by the original analyses from which the above average was calculated by the author.

A sample from one of the same holes was analyzed by Herman Nestor of San Antonio as follows:

Ash	11.05%
Sulphur	3.02
Moisture	15.32
Fixed carbon	53.00
Average Sp. Gr.	1.32

Calorific value, 11530 B. T. U.

Gas.—Considerable quantities of gas are found at shallow depths on the ranches of Ike T. Pryor, A. W. West, and T. P. Lee. The source of most of this gas is sandy shales, porous fossiliferous limestone, sometimes thin sands, in the upper part of the Escondido. A few wells have encountered gas in the Midway. The depths of most of this production range from 600 to 850 feet, with flush volumes ranging from 3,000,000 to 30,000,000 cubic feet per day. Some wells being drilled for oil have encountered volumes of gas approximating this larger extreme at from 1000 to 2000 feet in depth. The Texas Gas Utilities Company has wells on the Pryor and West ranches from which they are supplying gas to the towns of Uvalde, La Pryor, Crystal City, and Carrizo Springs.

Gravel.—The northern half of this county is well supplied with gravel. Many of the hills and ridges are capped by gravel of Reynosa age, while Leona and recent gravels occur at numerous places in the valleys and in the stream beds. These gravels are well adapted for road metal and concrete aggregates, and are being so used.

Oil.—Numerous wells have been drilled for oil in Zavala County but so far no commercial quantities have been found, although there have been many showings which seemed important and have encouraged further drilling. Among these wells that encountered more or less oil are the Farmers Life Insurance Company well (H. L. Graves), in the northwestern part of the county, at 3440 to 3600, in basal Edwards or upper Glen Rose; the N. B. Pulliam and R. L. Anderson wells (C. L. Bloom), near the Nueces River and the north line of the county, at 500 to 1000 feet in Anacacho and Escondido, some of the oil being in serpentine; the Nat Washer well (Southern Crude Oil Purchasing Company), three or four miles down the Nueces River from the Bloom wells, at 2950 to 3200 feet, in anhydrite, black shale, and gray limestone in the extreme top of the Glen Rose; the I. T. Pryor and West Ranch wells (National Refining Company, Continental Oil Company, the Sun Oil Company, La Pryor Oil & Gas Company, and others), at 750 to 3400, in Escondido, Anacacho, Eagle Ford, and Edwards lime. Several of these shows were in serpentine.

With one or two exceptions the oil in these showings has been black and heavy, ranging from 12° to 18° Baumé. Pulliam No. 1 (Bloom) just across the line in Uvalde County, produced three or four barrels per day of oil from 880 feet (Anacacho) that tested 23.8° Baumé, and La Pryor Oil and Gas Company No. 1 Pryor had one showing of oil at 1225 (lower Escondido) that was about the same gravity or lighter.

Sand.—The quartz sand of the Carrizo formation outcrops across both the northern and western borders of the county. Some use of this sand has been made locally for plaster and concrete aggregates, but there has been no development of it on a commercial scale. With an abundance of gas at the outcrop, there is no apparent reason why it might not be successfully used in glass making.

Water.—Zavala County, being divided into two almost equal parts by the axis of the large Carrizo sand artesian basin, is bountifully supplied with underground water. Cometa, in the southwestern part of the county, was one of the first communities to utilize Carrizo sand water for irrigation. Crystal City is the center of a large irrigation district which ships thousands of carloads of irrigation-grown vegetables annually. About one-half of the county is underlaid by Carrizo sand deep enough to be charged with water and shallow enough for practical irrigation from wells. Less than one-fourth of this area is now under irrigation. In addition to the underground water, the Nueces River and Carmanche and Espantosa lakes supply large quantities of water for irrigation by pumps.

WELL RECORDS

Records of the following wells in this county indicate the formations penetrated.

T. R. Price 1, Capps-Baldwin et al; W. E. Erskine surv. 34, 6200 ft. from northeast line and 350 from southeast line of survey, 5 mi. west of Batesville. T. D. 3008.

DRILLER'S LOG

	Depth in Feet
Surface clay	0–47
Black shale	53
Clay, white	61
Shale with streaks of sand	157
Sand	180
Shale with streaks of hard sand	195
Hard sand streaks	270
Hard sand	310
Sandy shale	355
Hard sand	395
Blue shale	480
Hard sand	497
Hard sandy shale	590
Shale	595
Hard sand	655
Hard sandy shale	695
Hard sand	726
Shale and boulders	765
Hard sand, showing of gas	850
Hard sand and shale	883
Shale and boulders	900
Hard sand	923
Sticky shale	935

	Depth in Feet
Hard sand	963
Hard sand, limestone shells	971
Limestone with pyrites of iron	1008
Hard sandy shale	1025
Sticky shale	1045
Hard sand and shale	1078
Hard shale and limestone shells	1099
Hard sandy limestone	1108
Sandy shales with streaks of chalk	1116
Hard sand	1128
Brown shale	1133
Sand, white	1153
Sticky shale	1159
Hard sand and shale	1211
Hard sand with streaks of shale	1238
Hard sand rock	1243
Sticky shale and hard boulders	1279
Hard sand	1280
Sticky shale	1286
Hard sand	1290
Sandy shale	1294
Hard sand	1311
Sandy shale	1360
Hard sandy shale	1374
Coal	1384
Broken sand and shale	1398
Shale with hard streaks of sand	1427
Hard sand	1458
White shale with streaks of chalk	1557
Hard sand	1592
Hard shale, brown	1596
Chalk	1604
Hard shale and streaks of sand	1610
Hard sand	1614
Hard shale and boulders	1648
Sticky shale	1660
Shale and boulders	1670
Lignite	1688
Sticky shale	1767
White clay or shell	1798
Sticky shale	1803
White shale	1849
Limestone shell, hard and white	1881
Sand, dark gray	1897
Sandy shale	1904
Broken hard sand and shale	1933
Limestone shell	1936
Shale, black	1946
Limestone shells and sand	1956
Shale	1965
Hard sand	1970
Limestone shell	1993
Hard sand	2013
Broken sand, shale very hard	2028
Hard sand, dry	2049
Sand, shale, and pyrites	2056
Sticky shale	2060
Sandy limestone	2067
Sandy limestone and shell	2086
Hard sand	2092
Limestone rock	2100
Limestone shell	2117
Hard sand, dry	2132
Sticky shale	2148
Hard sand	2162
Sticky shale	2184
Hard sand	2211
Sticky shale	2215
Hard sand	2217
Broken sand and shale, hard	2253
Hard sandy limestone	2263
Hard shale	2268
Limestone shell with streaks of limestone	2311
Hard shale and limestone streaks	2314
Sandy limestone	2317
Limestone shale and streaks of hard limestone	2336
Sticky shale	2378
Hard shale and pyrites	2380
Sticky shale	2386
Limestone shells	2396
Shale and boulders	2414
Hard sandy shale	2436
Gumbo	2440
Shale	2456
Limy shale, hard	2480
Shale and limestone streaks	2531
Hard sandy shale	2546
Limy shale	2555
Shale	2592
Shale and limestone	2599
Slate	2619
Sticky shale	2656
Sandy shale and boulders	2738
Sand rock	2762
Green shale and boulders	2792
Shale with streaks of serpentine	2821
Serpentine, dry	2854

	Depth in Feet		Depth in Feet
Hard sand	2876	Shale	2950
Shale brown	2902	Sandy shale	2978
Serpentine with hard streaks of chalk	2936	Sticky shale	3006
Limestone rock	2939	Shale	3008

Much caving was experienced during the drilling of this well, with the result that many of the samples were mixtures from various depths. The interpretation, which is therefore only approximately correct as to the formation contacts, is as follows:

Bigford	0– 595
Carrizo sand	595– 850
Indio	850–1688
Midway	1688–1965[1]
Escondido	1965– ?

Fragments of serpentine were noted in a sample from 2200–2250, and were minor constituents of samples down to 2700 feet, the samples from that depth being predominantly gray calcareous shale containing Escondido fossils. From 2700 to 2800 the serpentine became important parts of the samples, the other portions being limestone and sandstone. From 2800 to 2854 all was serpentine. From 2854 to 2902 the samples were mostly sandstone and shale containing foraminifera, with some serpentine. From 2902 to 2978, serpentine and shale were in about equal proportions. The limestone and streaks of chalk logged by the driller from 2902 to 2939 were not noted in the samples examined in the laboratory of the Humble Oil & Refining Company, whose determinations are followed in this interpretation, but this does not exclude the possibility of their presence, since the samples were widely spaced—2900, 2920, 2940, 2960, 2978, 3000 and 3008.

The sample from 2978 was gray, fine, quartz-grained sandstone, with some fragments of serpentine. Below this to the bottom of the hole at 3008, was gray shale and serpentine, containing foraminifera. No distinctive Anacacho or Austin fossils or lithology were noted, although it is believed that the drill was nearing the Austin chalk when the well was abandoned.

Weathersby 1, Cribbs and Davidson; 1385 ft. east of west line and 1525 south of north line of Bl. A, Sec. 44, A. B. & M. surv., about 4½ mi. east of Loma Vista. T. D. 1802.

[1]No samples were received between 1550 and a sample labeled 1740–60, which contained Midway fossils. Since that sample was from what the driller calls "sticky shale," the top of the Midway is believed to be as high as the top of that shale, or 1688 feet. It can not go higher on account of the lignite—1670–1688, which must be Indio.

DRILLER'S LOG

	Depth in Feet		Depth in Feet
Soil	0–2	Sand—fresh water 190′ from top	897
Gravel	6	Brown shale	903
Sand rock	40	Light blue shale	913
Red rock	50	Light blue shale	955
Blue shale	87	Gray shale	970
Gray limestone	89	Gray shale	980
Blue shale	185	Blue dry sand	981
Gray sand	220	Blue shale	1004
Blue shale	248	Brown shale	1009
Brown shale	255	Blue shale	1024
Sandy gray shale	270	Sand—brackish water	1054
Sandy limestone—salty water	272	Limestone	1056
Brown shale	280	Brown shale	1070
Blue shale	284	Gray shale	1078
Light shale	290	Sandy limestone	1080
Gray sand	304	Gray shale	1105
White shale	360	Brown shale	1116
Blue shale	365	Blue shale	1121
Coal	367	Blue sand—dry	1130
Gray sand (fresh water)	382	Blue shale	1160
White shale	423	Sand	1202
Brown shale	435	Sandy gumbo	1217
White shale	476	Blue sand dry	1233
Brown shale	484	Sandy gumbo	1280
Light shale	492	Blue sand (water)	1297
Sandy shale	498	Brown shale	1303
Sand water	555	Blue sand (water)	1312
Blue shale	565	Blue shale	1327
Blue sand—water 200′ of top	601	Blue sand	1331
Gray shale	610	Brown shale	1337
Brown shale	618	Blue sand (water)	1348
Blue shale	665	Brown and blue shale	1395
Blue sand—fresh water	674	Sand	1400
Blue shale	685	Brown shale	1419
Light shale	692	Sand	1423
Blue shale	750	Blue shale	1444
Sandy shale and lignite	780	Sandy limestone	1465
Sandy shale	815	Blue shale	1473
Blue muddy shale	835	Sand	1615
Blue sand	850	Gray shale	1660
Blue shale	865	Sand	1704
		Gray lignitic shale	1802

Outcrops near this well have an assemblage of fossils that are regarded as basal Cook Mountain, and the Carrizo sand is rather definitely from 1473 to 1704; and from 1704 to 1802 (the bottom of the well) is Indio. Fossils were noted in only one drill sample, that being from 1105. These fossils were fragments of shells and Ammobaculites sp. Two feet of coal was found at 365–367, and lignite and mica were noted almost continuously from that point to the bottom of the hole, excepting in the Carrizo. Lignite and mica are common in the Bigford and the Mount Selman, both of which are predominantly clays and shale. In the absence of fossils that might distinguish them, there is no way to differentiate these two formations in this well. In the following section, the Cook Mountain is defined by comparison of the log and samples with the section in an escarpment on the old J. B. Moore ranch, south of the well, and by using the known thickness of the Bigford along the Nueces River.

Cook Mountain	0– 185
Mount Selman	185– 692
Bigford	692–1473
Carrizo	1473–1704
Indio	1704–1802

Huffman water well No. 3; near center north line Sec. 31, Subdivision Cross S ranch, 3 mi. north of Indio.

DRILLER'S LOG

	Depth in Feet		Depth in Feet
Surface soil	0–3	Sandy shale	580
Loose clay	20	Silica, hard sand rock	618
Clay and gravel	70	Brown sandy shale	630
Clay and gravel	96	Blue sandy shale	652
Blue shale	215	Hard gray shell	658
Sand, salt water	225	Sand	670
Blue shale	345	Gray sand, water	690
Hard gray limestone	360	Sandy shale	770
Blue shale	445	Carrizo sand	907

The following formations are represented:

Bigford	0– 770
Carrizo sand	770– 907

Holsomback and Garner water well; on northern boundary of Crystal City.

DRILLER'S LOG

	Depth in Feet		Depth in Feet
Surface soil	0–3	Hard shale	385
Shell rock	8	Hard sandy shale	530
Yellow clay	18	Hard sandy shale	600
Hard sand	40	Sand rock	630
Lignite	43	Hard sandy shale	675
Soft shale	100	Sand rock	710
Hard sand	141	Hard sandy shale	775
Hard shale	298	Water sand	1075
Hard sandy shale	350		

This well was sampled from top to bottom under the direction of the author, and the samples were worked by Alva C. Ellisor, or under her direction, for the purpose of determining the age of the artesian sand at Crystal City. From the surface to 775 were lignitic, micaceous, sandy shales and sandstones with numerous siderite concretions. One or two Ostracods and a single chara seed were the only fossils that were noted. From 775 to 1075 was white, quartz-grained, unconsolidated sand. No glauconite was noted in any of the samples. More recent wells give a cross-section on closely spaced wells from Crystal City to the Carrizo sand outcrops, to the southward at Carrizo Springs and to the northward, north of La Pryor. The water sand affording large yield is throughout Carrizo. In the above log, therefore, the following formations are represented:

Bigford	0– 775
Carrizo sand	775–1075

A. W. West 5, Texas Fuel and Gas Co.; M. Suniga surv. 44, 1900 ft. to south line, 4850 to west line, 12½ mi. south of Uvalde.

DRILLER'S LOG

	Depth in Feet		Depth in Feet
Yellow sand	0–100	Gray shale	590
Brown shale	150	Green shale	610
Water sand	165	Gray sandy shale	630
Hard shale	170	Gray shale	700
Sandy shale	190	Gray shale	710
Water sand	205	Sandy shale	745
Blue shale	225	Oil sand	750
Water sand	255	Hard sand	773
Dark shale	285	Sand, water	785
Brown shale	290	Blue shale	816
Dark brown gumbo	398	Hard shell	818
Hard shell	400	Gray shale	825
Blue shale	430	Broken shells	835
Coal	435	Blue shale	847
Blue shale	450	Limestone	852
Water sand	455	Blue shale	863
Sandy shale	465	Sandy limestone	865
Sand	480	Blue shale	878
Water sand	490	Limestone	880
Dry sand	510	Blue shale	1000
Gumbo	520		

In this well the following formations are represented:

Carrizo sand	0– 100
Indio	100– 510
Midway	510– 630
Escondido	630–1000

Available Literature and Maps.—The extreme northern part of this county is included in the map accompanying Folio 64 of the U. S. Geological Survey. The Cretaceous-Eocene contact is mapped in Professional Paper 90 and a part of the county in Professional Paper

126 of the U. S. Geological Survey. Notes on the lignite deposits are contained in the Fourth Annual Report of the Texas Geological Survey, 1892. Some of the igneous rocks are described in The University of Texas Bulletin No. 2744. This county is mapped in part in Bull. American Association of Petroleum Geologists, Volume 14, pp. 1425–1437, 1930. Information on the underground water is contained in Memorandum for the Press issued by the Department of the Interior, Feb. 16, 1931.

MAVERICK COUNTY

F. M. GETZENDANER

Maverick County lies within the Rio Grande Valley and along its entire western side is bounded by the Rio Grande. Its principal mineral resources are coal, gas, clay, gravel, sand, and water, principally surface water. Three or more wells in the county have had important indications of oil. A branch line of the Southern Pacific Railroad extends from Eagle Pass northward to the main line at Spofford in Kinney County. The elevation varies from 625 feet at the southwestern corner of the county on the Rio Grande, to 1000 feet near the center of the north boundary line.

STRATIGRAPHIC GEOLOGY

Beds of the Upper Cretaceous and lower Eocene occur on the surface in Maverick County, mantled at many places by Pleistocene and recent gravels, sands, and soils. The oldest beds outcrop along the Rio Grande and Tequesquite Creek in the northwestern corner of the county. These are near the middle of the Austin chalk. Going from this locality to the southeastern corner, the following formations are crossed in succession: Austin chalk, Upson clay, San Miguel, Olmos, and Escondido of the Upper Cretaceous; and Midway, Indio, and Carrizo of the Eocene. There is a semicircular outcrop of Carrizo sand in the eastern part of the county, on the Eagle Pass-La Pryor highway.

On Canyon Grande Creek and Tequesquite Creek, in the northwestern part of the county, there are unusual Pleistocene deposits, consisting of cross-bedded sands overlying limestone gravels. At places the sands appear to be about 20 feet thick. In Las Moras Creek, near the north line of the county, the water flows over a large deposit of travertine, causing a drop of some ten feet in the bed of the creek. The travertine seems to be laid down on a bed of gravel.

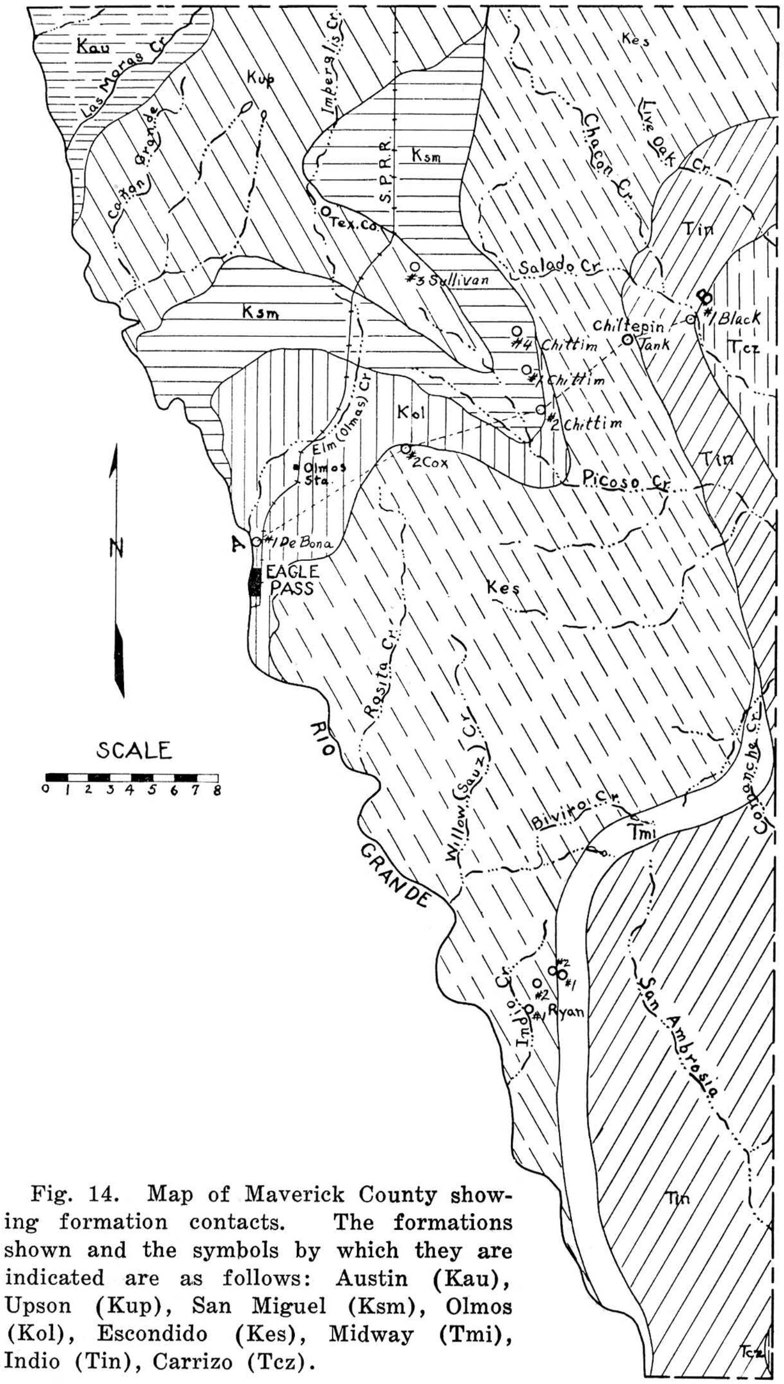

Fig. 14. Map of Maverick County showing formation contacts. The formations shown and the symbols by which they are indicated are as follows: Austin (Kau), Upson (Kup), San Miguel (Ksm), Olmos (Kol), Escondido (Kes), Midway (Tmi), Indio (Tin), Carrizo (Tcz).

The Reynosa formation (probably Pleistocene) on the ridges south of Cuevas Creek in the southern part of the county contains around 25 per cent of rounded igneous pebbles of an entirely different character from the igneous masses around Brackettville and Uvalde, showing acidic rather than basic affinities. Their source was in the Trans-Pecos country south of Alpine, or in the Burro Mountains of northern Coahuila, in both of which localities similar rocks occur. This terrace is not less than 125 feet above the present bed of the Rio Grande. The time necessary for the transportation of this material a minimum distance of 125 miles, plus the time necessary for the Rio Grande to lower its channel a minimum depth of 125 feet, is evidence of the considerable age of the Reynosa terrace.

The section underlying the Comanchean in Maverick County is unknown, as no well has reached it, although the Rycade Oil Company No. 2 Chittim was drilled to the depth of 7635 feet, and its No. 5 Sullivan, which penetrated deeper into the section, is 7500 feet in depth.

FORMATION CHARACTERISTICS AND THICKNESSES

Carrizo	Not fully represented in this county	Quartz-grained sand, usually cross-bedded
Indio	600–800	Micaceous and lignitic shales and sandy shales, coal and beds of calcareous sandstone, limestone concretions. The Indio in this county is in part marine and contains pelecypods, gastropods, foraminifera and some glauconite
Midway	150–375	Shales, clays, lime concretions, impure limestones, at places a thin sandstone near top—all glauconitic
Escondido	800–1200, (including older marine Navarro beds known from wells but not appearing at surface)	Predominantly shales and sandy shales, with occasional sandstones and limestones, some in series 50–75 thick

Olmos	400–600	Non-marine Navarro, predominantly lignitic shales and sandy shales, coal and a few thin beds of sandstone. Iron concretions and silicified wood common
Farias beds (This name is provisionally suggested for a series of beds not described in existing literature.)	0–900 (Known only from Humble Oil & Refining Company No. 1 Sullivan and No. 1 City National Bank, the latter in Dimmit County)	Top 200 feet very glauconitic with non-lignitic sandy shales and impure sandstones. Middle 400 feet very lignitic, but containing a marine fauna. Basal 325 feet very micaceous, calcareous sandy shales with a prolific microfauna of the basal Navarro
San Miguel	400	Sands and sandy limestones at base; shales, clay and sandy shales at top. Marine fauna
Upson clay	550	Gypseous clays, shales, sandy shales, lime concretions with veins of barite, and barite concretions; 20 to 25 feet of marl at base. Equivalent to Taylor of farther east
Austin chalk.	750–1000 (About the upper one-half exposed in Maverick County. The lithologic demarkation between Austin and Eagle Ford often difficult)	Chalky limestone, marls and some shale
Eagle Ford.	450–950 (The Eagle Ford and older formations are known in this county only from well data)	Flaggy limestone, marls, carbonaceous shales
Buda limestone	150–375	White limestone
Del Rio clay	150–375	Calcareous shales and clays with flags of brown sandy limestone
Georgetown limestone.	700	White limestone. The base of the Georgetown or the top of the Edwards contained 20 feet of rock salt in the Rycade Oil Corporation No. 2 Chittim
Edwards limestone	800	White and gray limestone with chert
Comanche Peak limestone	Undifferentiated thus far in the well data	
Glen Rose	3000	Gray, brown and black limestone. Is producing gas and some oil
Trinity	500+ (Known from Rycade Oil Corporation No. 5 Sullivan and No. 2 Chittim. The base of the Trinity was not reached in either of them)	Gray sandstones, varicolored shales, thin limestones and cherts

STRUCTURAL GEOLOGY

The largest structural feature in Maverick County is a plunging anticline which extends entirely across the county from northwest to southeast. It enters the north line of the county west of Las Moras Creek, crosses the Southern Pacific Railroad north of Paloma switch, and continues in an approximately straight line nearly to the east line of the county, where it bends more to the eastward and so passes south of Carrizo Springs in Dimmit County. This structural feature was named the Chittim anticline by Vanderpool.[*] The structural feature was clearly indicated in 1907 in the mapping of this region by Udden. To a subsidiary structure in the southern part of the county, Udden applied the term Lampasitas arch.[1]

Away from the influence of this structure, the dips in the northern part of the county are south-southeast and in the southern part of the county, east-southeast.

ECONOMIC GEOLOGY

Coal.—Coal has been mined north of Eagle Pass for many years. The mode of occurrence and character of this coal

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*Vanderpool, H. C., Cretaceous section of Maverick County, Texas, Journal of Paleontology 4, pp. 252–258, 1930.

[1]Udden, Johan August, A Report on a Geological Survey of the Lands Belonging to the New York and Texas Land Company, Ltd., in the Upper Rio Grande Embayment in Texas, Augustana Library Publication No. 6, pp. 88–90, 1907.

has been well described by Udden.[2] At present these mines are not operated, due to the financial depression and the availability of natural gas for fuel.

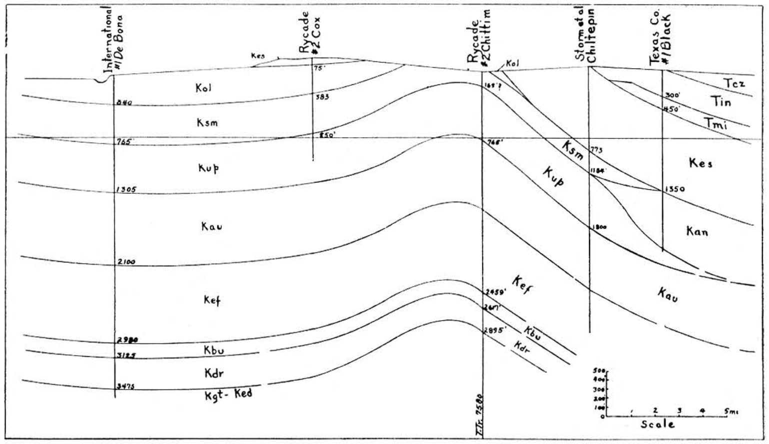

Fig. 15. Geologic section across Maverick County on the line A-B of Figure 14. The symbols used in indicating the formations are as follows: Kgt-Ked, Georgetown-Edwards; Kdr, Del Rio; Kbu, Buda; Kef, Eagle Ford; Kau, Austin; Kup, Upson; Ksm, San Miguel; Kol, Olmos; Kes, Escondido; Tmi, Midway; Tin, Indio; Tcz, Carrizo.

Oil and Gas.—Oil and gas were discovered in Maverick County in 1902 by Charles Lindenborn while he was drilling a water well for Fleming and Davidson on Section No. 116, I. & G. N. R. R. Co., Block 6. The gas became ignited and destroyed his rig. Repeated attempts were made after that to find oil and gas in paying quantities, but they were without success until 1926, when the Rycade Oil Corporation discovered about 28,000,000 cubic feet of wet gas per day in their No. 1 Chittim. This made considerable high gravity oil, estimated at 40 or 50 barrels per day. This production was from 5518 to 5561, from the Glen Rose. The well was later abandoned due to the loss of drilling tools in the hole. Their No. 3, a close north offset to No. 1, produced, initially, 11 million cubic feet of gas and some oil

[2] Loc. cit., pp. 75–78.

at approximately the same depth as No. 1. This well also had a promising showing of oil in the Georgetown at 3205, flowing by heads for about 36 hours at the rate of 150 barrels per day. The oil was 44 gravity. The same Company's No. 5 Chittim made 4 million feet of gas at 5540. This gas is reported to have tested three gallons of gasoline per 1000 cubic feet of gas. No. 6 Chittim, which was drilled by the Texas Gas Utilities Company, made about 4½ million feet of gas and an estimated 70 barrels of 65 gravity oil at 5525 to 5570 feet. This gas gauged about 2000 pounds pressure to the square inch. It is piped to the towns of Eagle Pass and Del Rio, where it is used for domestic and industrial consumption.

Numerous other wells have made important showing of oil and gas, but none so far has produced in commercial quantities. All of these producing gas wells are within a circle of half mile in diameter, and near the crest of the Chittim anticline.

Clay.—The Upson clay, Olmos, Escondido, Midway, and Indio formations, contain abundant clay and shales, some of which probably are adapted to brick making and ceramics. Being near a gas field these clays and shales may prove a valuable resource of the county, although no use has as yet been made of them.

Gravel.—The abundant Reynosa and younger gravels have been used to some extent for building roads and for concrete mixtures, for which they are well adapted.

Sand.—The only sand in the county of sufficient purity to be valuable is the Carrizo sand. This occurs in two small outcrops far from present populated centers and rail transportation, and is therefore, under present conditions, of little value.

Water.—There are no widespread porous horizons in the geologic section in Maverick County that afford sufficient water for irrigation. Along the Rio Grande and in some of the smaller valleys there are wells deriving water from Pleistocene gravels. There are a few wells near Darling switch and southward for ten or twelve miles, that derive small supplies of water from the San Miguel sands, and in the southeastern part of the county, in the San Ambrosia valley, there are several good wells producing from a sandy horizon in the Indio formation. The rest of the county is supplied with water either from surface tanks or from the Rio Grande and its tributaries. Las Moras Creek is supplied perennially from the springs of the same name at Brackettville, in Kinney County. There are also some lasting natural lakes, as on Elm Creek some 20 miles northeast of Eagle Pass.

For many years irrigation has been successfully practiced at Eagle Pass, at Hopedale, three or four miles north of Eagle Pass, and at Rosita, some seven or eight miles south of Eagle Pass. The water for all these projects is pumped from the Rio Grande. The county is now (1931) constructing a large gravity canal at the cost of six million dollars. This canal when completed will be about 90 miles long. The headworks on the Rio Grande are in Kinney County and the south end will be about 25 miles southeast of Eagle Pass in Maverick County. It will supply water for a large acreage of fertile land. In addition to being an irrigation project this canal is expected to develop 12,000 horsepower through a hydroelectric plant, 12 miles north of Eagle Pass, belonging to the Central Power and Light Company.

WELL RECORDS

Records of the following wells in this county indicate the formations penetrated.

DRILLER'S LOG

De Bona 1, International Oil and Gas Co.; Remigio Casanova surv. 40, 400 ft. east of Rio Grande River, 1½ mi. north of Eagle Pass. Elevation, approximately 735.

DRILLER'S LOG

	Depth in Feet
Soil	0–15
Yellow clay	35
Gravel	41
Sandstone	51
Blue shale and sand—some water	65
Blue sand—some water	75
Blue sandy shale	145
Gray sandy shale	190
Dark brown shale	195
Coal	202
Dark brown shale	219

	Depth in Feet
Gray sandy shale	231
Coal and gas	237
Gray sand	340
Brown shale	440
Gray sandy shale	472
Brown shale	585
Hard shell	588
Brown shale	595
Blue sand	605
Blue shale	625
Shell	627
Gray shale	720
Sand shell	724
Gray shale	755
Sand, water	765
Brown shale	825
Brown shell	1000
Brown shale	1140
Shell	1144
Brown shale	1305
White limestone—breaks with sand	2100
Gray and black shale	2500
Black shale—showing of oil	2765
Hard black shale	2975
White limestone shell—showing of oil and gas	2980
Gray limestone	3115
Hard dark gray limestone	3125
Blue gumbo	3175
Black limestone	3180
Blue shale	3375
Gray limestone—black streaks	3490
Hard gray limestone	3555
Very hard shell	3557
Broken gray limestone	3590

The following descriptions of samples from this well are from the records of the Bureau of Economic Geology.

	Depth in feet
Laminated and indurated gray marl or gray impure and laminated limestone. A few fragments of light gray limestone are present. The shale is thinly laminated, highly calcareous, and contains flakes of biotite, and some *Inoceramus* prisms. A few scattered grains of pyrite were also noted	1750–1800
Bluish-gray impure limestone and dark blue calcareous shale. In washed material *Inoceramus* prisms, ostracod valves, *Frondicularia*, *Anomalina*, and small *Textularia* were noted	1800
Gray impure limestone and dark calcareous shale. In washed material *Inoceramus* prisms, ostracod valves, *Frondicularia*, *Anomalina*, and small *Textularia* were noted. In thin section many of the forms mentioned above were seen	2150
Gray impure limestone and dark calcareous shale. Washed material shows *Inoceramus* prisms and foraminifera. In closed tube bituminous fumes sufficient to form a few globules of oil were given off. Sulphur fumes were noted	2190
Similar to material from 2150. In closed tube bituminous fumes having a decided odor of tar were given off. A heavier deposit of oil was formed than in the preceding sample. Similar material at 2465, 2468, 2480, and 2491	2460
Dark bituminous shaly limestone consisting of a mass of foraminifera principally of a single chambered oval to spherical form having a thick wall. The bituminous impregnation appears to be somewhat uneven, some fragments being only partly darkened. Bituminous and ammonia fumes were noted in closed tube test. Similar material at 2518 and 2530	2510
Dark calcareous shale. Many small *Globigerinas* and	

Depth in feet

Textularia were noted in washed material. *Inoceramus* also present. Considerable pyrite in lumps noted. Strong bitumen and ammonia fumes. Similar material at 2640, 2664, 2722, 2805, 2840 and 2860 ... 2600

Dark calcareous hard shale. Some fragments of brown bentonite which does not slake in water are present in the sample. Strong bitumen and ammonia fumes were noted ... 2940

Very dark gray foraminifera bearing limestone highly impregnated with bitumen. Some bituminous shale also present. In thin section both the limestone and the shale are seen to consist almost entirely of segments of *Globigerina* and of *Textularia*. In washed material a cluster of *Inoceramus* prisms was noted. In closed tube very strong bituminous fumes were given off. Similar material at 2970 ... 2950

Gray fine textured limestone. In thin section many small tests and fragments of foraminifera are seen. In one fragment a few small crystals, apparently of dolomite, are seen in the fine textured matrix. In fine washed material also many of these crystals are seen. In closed tube test bituminous fumes sufficient to sustain a flame and a peculiar odor were noted. When heated in open flame a greasy odor was noted. Black oil on water reported as coming from limestone at depth 2990. The gas from the well will burn one or two feet above the casing ... 2980–2990

Light gray compact limestone of uniform texture. A section of the limestone shows it to contain many organic remains, chiefly of small foraminifera and of shell fragments. Some areas of coarse crystalline texture occur in the rock. One fragment of the rock in section shows an area suggesting healed brecciation. Glauconite grains occur at intervals through the section. Rhombohedral crystals are scattered in the rock. These crystals dissolve in acid much more slowly than does the rock. This suggests that they may be dolomite. Blown out by shot. Similar limestone at 3115 ... 3000

Dark gray foraminiferal limestone ... 3125

Black moderately hard shale some of which is slightly calcareous and some markedly less calcareous though showing a very slight reaction in acid. Much pyrite in both granular lumps and cubic crystals is present. In washed material an abundance of Echinoid spines and plates showing spine bases were seen. Two ostracods ornamented with nodes and prominences, and *Anomalina*, several *Globigerina*, and a few *Textularia* (of such small size that the chambers are not easily visible under 22x magnification), were noted. Many minute diamond shaped crystals which dissolve very slowly in cold dilute hydrochloric acid were also seen in fine washed material ... 3130

Black indurated shale which has evidently been subjected to considerable pressure. Cleavage planes are very well developed, causing the material to break in nearly square pegs of

Depth in feet

slivers. Impressions of two *Pectinidae* were seen in the sample. In washed material foraminifera are quite abundant. Echinoid spines and fragments of plates and pyrite abundant. Similar material at 3175, 3275, and 3305 ... 3150

Dark gray calcareous shale and impure shaly limestone. Pyrite is noticeably less abundant and the calcareous content noticeably increased in this sample. (The foraminifera are the same, but Echinoids seem to be absent.) A large *Textularia* with low, narrow chambers which are very much elongated parallel to the line of junction of the chambers, was seen in this sample. This form is not common. ... 3365

Gray slightly impure soft limestone and darker gray calcareous shale. Only an occasional small lump of pyrite was seen. Foraminifera noted include *Cristellaria*, *Textularia*, and *Anomalina*. Many spherical and oval bodies present in the limestone section and also in washed material noted. The rock is granular in texture but an occasional single rhombic crystal about .06 mm. was seen. In washed material also many of these crystals were seen. Strong sulphur fumes given off. Similar material in numerous samples from 3440 to 3550 ... 3375

Very light gray fossiliferous limestone and some dark gray bituminous limestone, both containing some pyrite. In thin section the limestone is seen to contain many spherical and oval bodies, and a few *Globigerina* and *Textularia* and rhombohedral crystals of dolomite. Many of the spherical bodies are seen to have very thick walls, the thickness of the wall in many cases being equal to one-third or one-half of the radius. When sample was heated in closed tube, strong bituminous fumes and faint ammonia fumes were given off ... 3560

Dark gray limestone ... 3565

Black marly indurated clay or shale, and gray limestone ... 3565–3590

Suggested interpretation:

Pleistocene	0– 41
Olmos	41– 340?
San Miguel	340?– 765
Upson clay	765–1305
Austin chalk	1305–2100
Eagle Ford	2100–2975
Buda limestone	2975–3125
Del Rio clay	3125–3375
Georgetown	3375–3590

Chittim 2, Rycade Oil Co.; I. & G. N. surv. Bl. 7, Sec. 158, 12 mi. east and 8 north of Eagle Pass. Elevation, 745. T. D. 7635.

DRILLER'S LOG

	Depth in Feet
Black shale	0–60
Brown sand (oil show)	64
Blue shale	765
Chalk	1190
Gray limestone	1250
Chalk	1645
Limestone	1850
Limestone and shale	1970
Limestone	2385
Limestone (show oil)	2459
Gray limestone	2502
Very hard limestone	2516
Gray limestone	2617
Blue shale	2896
Limestone	3635
Sandy limestone (water)	3645
Sandy limestone	3675
Salt	3695
Black limestone	3900
Gray limestone	3980
Water sand	4000
Sandy limestone	4030
Limestone	4035
Black limestone	4154
Gray limestone (showing oil and gas)	5130
Gray limestone	5310
Brown limestone	5455
Gray limestone	5510
Blue limestone	5625
Brown limestone	5650
Gray limestone	5665
Brown limestone	5755
Black limestone	5795
Gray limestone	5810
Brown limestone	5887
Black limestone	5938
Brown limestone	6178
Black limestone	6188
Gray limestone	6203
Sandy limestone	6217
Gray limestone	6232
Brown limestone	6800
Black limestone	7083
Brown limestone	7100
Black limestone	7200
Black limestone	7588
Sandy limestone	7620
Black limestone	7635

Suggested interpretation:

San Miguel	0– 64?
Upson clay	64?– 765
Austin chalk	765–1850
Eagle Ford	1850–2459
Buda limestone	2459–2617
Del Rio clay	2617–2896
Georgetown limestone	2896–3695?
Edwards limestone	3695?–4525?
Glen Rose	4525?–7588
Trinity	7588–7635

Cox 2, Rycade Oil Co.; 100 ft. west of east line and 2950 north of south line of Sec. 169, Bl. 7, I. & G. N. surv., 310 ft. north of Cox 1. Elevation, 895. T. D. 1200.

DRILLER'S LOG

	Depth in Feet
Yellow clay	42
Black shale	65
Blue shale	69
Sandstone	75
Blue shale	90
Black shale	115
Gray shale	140
Sandy shale	150
Gray shale	180
Blue shale	186
Blue sandstone	195
Blue shale	201
Blue sandy shale	221
Blue sand with coal	240
Blue sandy shale	262
Sandy shale	281

	Depth in Feet
Water sand	300
Blue sandy shale	305
Coal and black shale	315
Blue and black shale	335
Brown limestone	338
Blue sandy shale	349
Dark shale	367
Blue sandstone	369
Brown and black shale	376
Coal	383
Limestone	386
Gray shale	388
Hard sandstone (fine)	398
Blue shale	408
White sandy limestone	413
Limestone	428
Blue shale	438
Light gray shale	452
Dark sandy shale	485
Dark gray shale	528
Dark sandy shale	537
Sandy lime and shell	540
Blue sandy shale and limestone shell	545
Blue sandy shale	580
Dark gray sandy shale	609
Dark gray shale	640
Sandy limestone (some water)	645
Blue shale	658
Dark shale (sandy)	675
Blue sandy shale	691
Blue sandstone	705
Blue sandy shale	769
Dark shale	781
Gray sandy shale	800
Dark sandy shale	810
Sandy shale	820
Sandy limestone (water) (made 2 bailers an hour)	833
Water sand (160 foot water in hole)	850
Blue shale	862
Limestone	864
Blue shale	890
Sandy shale and hard shells	900
Gray limestone	913
Blue shale	943
Dark sandy shale	959
Blue sandy shale	995
Dark sandy shale	1030
Blue sandy shale	1052
Sandy limestone	1065
Dark shale, sandy (caving)	1070
Blue sandy limestone	1085
Gray shale	1127
Blue shale	1132
Gray sandy shale	1146
Blue sandy shale	1162
Hard sandy limestone	1185
Dark sandy shale (caving badly)	1195
Dark blue sandy shale (caving badly)	1200

Suggested interpretation:

Surface and Escondido	0– 75
Olmos	75– 383
San Miguel	383– 850
Upson clay	850–1200

Black 1, Texas Petroleum Company; 625 ft. north of south line and 200 east of west line of B. B. B. & C. surv. 366½.

DRILLER'S LOG

	Depth in Feet
Blue shale	0–64
Coal	68
Blue shale and water sands	250
Pure water sand	300
Blue shale	450
Shells and shale	500
Blue shales, some limestone	980
Water sand	1010
Blue shale	1260
Hard shells and limestone	1310
Black shale (reported lignite)	1335
Blue shale	1350
Sand—show of oil	1390
Blue shale	1430
Water sand	1495
White chalky shale	1520
Lignite?	1525
Shell rock, blue shale, and brown shale	1705
Unknown	2025
Reported oil show	2025

Suggested interpretation:

Indio	0– 300
Midway	300– 450
Escondido	450–1350
Anacacho	1350–2025

Chittim 1, Fred E. Storm et al; 695 ft. east of west line and 1040 north of south line of Bl. 7, Sec. 160, I. G. R. R. Co.

DRILLER'S LOG

	Depth in Feet
Surface	0–20
Shell limestone	25
Shale	35
Water sand	39
Shale	91
Water sand	95
Shale	240
Water sand	249
Shale	353
Water sand	567
Blue and black shale	690
Limestone shell	695
Shale	765
Water sand	773
Sandy shale	830
Shale	1000
Sandy shale	1005
Blue shale	1179
Sandy limestone (show oil and gas)	1184
Blue and black shale	1570
Sandy shale (water)	1600
Blue shale	1741
Sandy limestone	1775
Hard blue shale	1800
Austin chalk with an occasional break of black shale	3004

Suggested interpretation:

Surface	0– 20
Escondido	20– 773
San Miguel	773–1184
Upson clay	1184–1800
Austin chalk and Eagle Ford	1800–3004

Available Literature and Maps.—The Cretaceous-Eocene contact in this county is mapped in Professional Paper 90 of the U. S. Geological Survey. The geology of this county is shown in a report on a geological survey of the lands belonging to the New York and Texas Land Company, Ltd. by J. A. Udden, in Augustana Library Publication No. 6, 1907. The Cretaceous formations of this county are discussed in The University of Texas Bulletin No. 2748. This county is mapped in part in Bull. American Association of Petroleum Geologists, Volume 14, pp. 1425–1437, 1930. The Cretaceous section in this county is described in Journal of Paleontology, Vol. 4, pp. 252–258. Information on the underground water is contained in Memorandum for the Press issued by the Department of the Interior, Feb. 16, 1931.