University of Texas Bulletin
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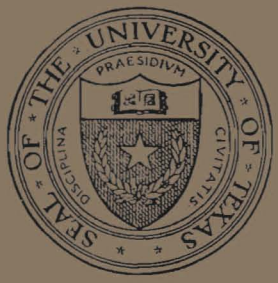
The Underground Position of the Austin Formation in the San Antonio Oil Fields

BY
E. H. SELLARDS

Bureau of Economic Geology and Technology
Division of Economic Geology
J. A. Udden, Director of the Bureau and Head of the Division



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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston.

Cultivated mind is the guardian genius of democracy. . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar.

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The Underground Position of the Austin Formation in the San Antonio Oil Fields

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NOTES ON THE OIL AND GAS FIELDS OF WEBB AND ZAPATA COUNTIES

By E. H. Sellards

At the present time oil or gas is being obtained from several localities in Webb and Zapata counties. The localities include the Charco Redondo oil wells, Jennings gas pool, and Mirando oil pool in Zapata County, and the Reiser gas wells and Schott oil pool and the gas wells of the Carolina-Texas Oil Company in Webb County. Of these several localities, the Reiser field is the oldest as a commercial field, having been discovered in 1909, although previous to that time oil had been noted in shallow wells drilled for water at the Charco Redondo Ranch. The following notes on the producing fields of these two counties are based on a reconnaisance of about ten days made in April and May, 1922.

Stratigraphic Geology

At the March meeting of the American Association of Petroleum Geologists, Dr. A. C. Trowbridge read a paper on the Coastal Plains formations in Texas, adjacent to the Rio Grande, which it is understood, will be published. Not wishing to anticipate in any way the results given in this paper by Trowbridge, the geology and stratigraphy of this area will be referred to at this time only in a very general way.

Immediately at Laredo and for a few miles to the east, the rocks exposed in the stream beds and rock cuts are chiefly sandstones, often glauconitic, probably representing the Cook Mountain formation. Next to the east and extending almost, if not quite, to Reiser, is a broad belt in which clays predominate, although some oyster shell beds are included. These clays represent the Yegua formaton. About twenty-two miles east of Laredo (three miles west of Reiser) is found a belt of very sandy land which may possibly represent a remnant of the

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Fayette, or a sandy horizon in the Yegua. At Reiser and in a clay pit nearby, are seen clays and oyster shall beds not unlike those of the Yegua.

Next east of Reiser, near Aguilares, and extending thence north and south is a belt of country in which the land is in places sandy and in which there are occasional outcrops of a light-colored rock with a limited amount of sand. This rock, which in places is chiefly volcanic ash containing plant impressions, probably represents the Fayette formation. Next to the east is found a belt of clay land which widens in the northern part of Webb County and possibly represents the Frio formation.

About thirty-five miles east of Laredo is a prominent escarpment beyond which the land is level and slopes gradually to the east. The formation capping this escarpment is the Reynosa, which consists of caliche filled gravel and in places of caliche rock. The age of this formation is either Pleistocene or Pliocene. In the face of the escarpment, underneath the Reynosa capping, there is found in places a coarse sandstone which may be of Miocene age.

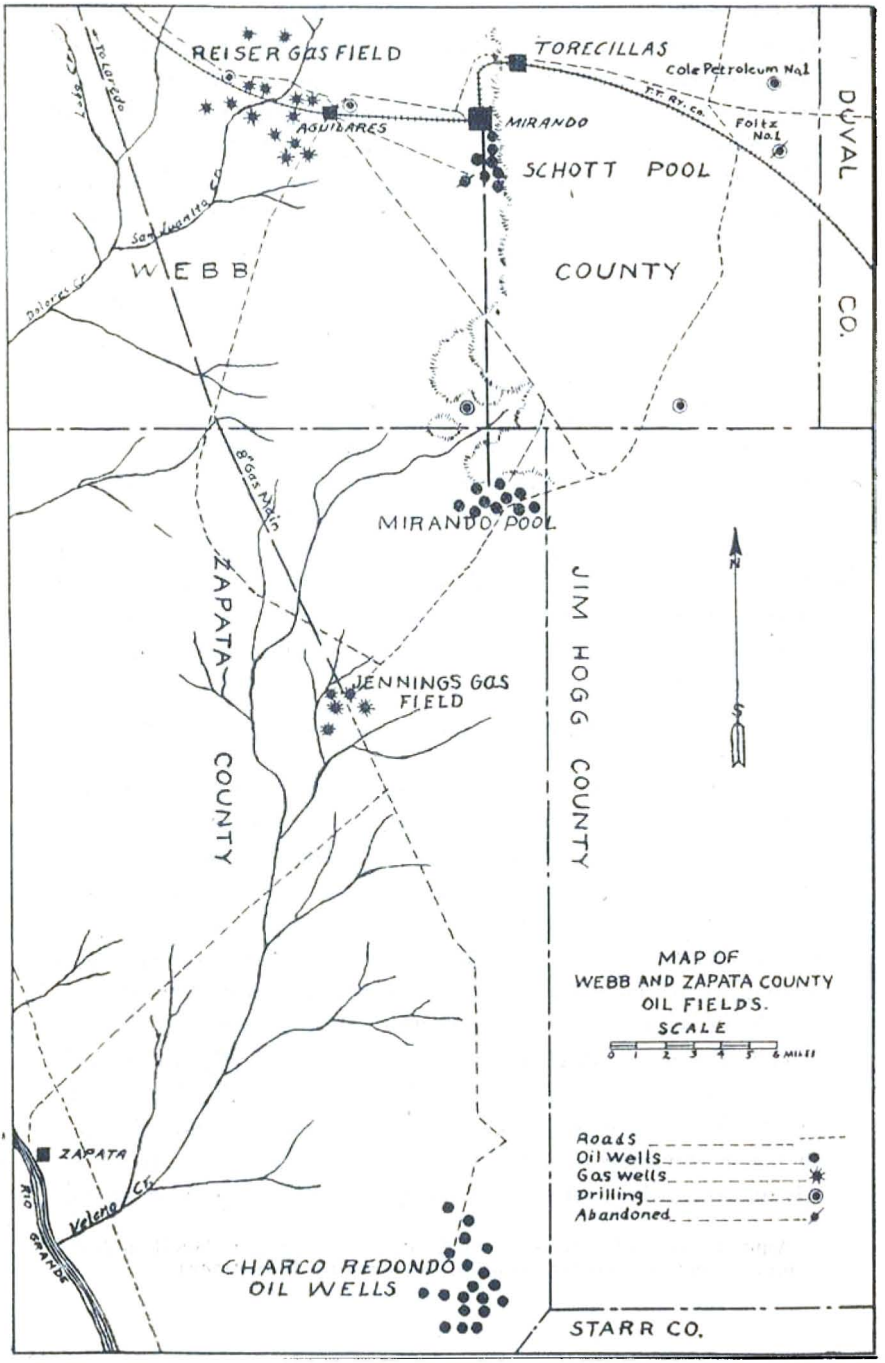
It is thus seen that the formations found at the surface are chiefly those of the Eocene series, together with possibly limited Miocene exposures, and in the eastern part of these two counties, the Reynosa limestone and gravels. Adjacent to the stream beds, of course, are Pleistocene and recent terrace deposits.

Regional Dip

The regional dip in this area is to the east. To the north and northeast of this area, the strike of both Eocene and Cretaceous formations is northeast-southwest, the dip being southeast. In the central and southern parts of Webb and in Zapata counties, the strike of the Eocene formations is approximately north-south, the dip being, as stated, to the east. The average rate of dip has not been determined.

Topographic Features

In traveling east from Laredo, it is to be noted that for several miles, after crossing Chacon Creek, the country is characterized


REISER GAS FIELD
TORECILLAS
Cole Petroleum No.1
T. P. Ry. Co.
Foltz No.1
DUVAL CO.
AGUILARES
MIRANDO
SCHOTT POOL
Laredo
San Juanita Co.
WEBB
COUNTY
Dolores Co.
8" Gas Main
MIRANDO POOL
N
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JIM HOGG COUNTY
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WEBB AND ZAPATA COUNTY
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ZAPATA
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CHARCO REDONDO
OIL WELLS
STARR CO.

by successive minor ridges which trend, in general, north-south. These ridges have a rather abrupt west face and represent west facing escarpments, marking the outcropping edges of east dipping strata. In some instances the escarpments are held up by a hard stratum consisting chiefly of oyster shell rock. About eleven miles east of Laredo the land becomes more nearly level. Just east of Mirando City is the pronounced Reynosa escarpment to which reference has already been made.

Location of the Oil and Gas Fields with Respect to the Topographic Features

The Charco-Redondo and Jennings fields are located in or near the belt of country referred to above as probably representing the Fayette formation. Each of these localities is some distance from the Reynosa escarpment, the Charco-Redondo locality being possibly seven miles, and the Jennings field probably not quite so far. The Reiser gas field is likewise seven or eight miles west of the Reynosa escarpment. On the other hand, the Mirando and Schott pools and the gas wells of the Carolina-Texas Company are located immediately at the foot of this escarpment.[1]

Charco-Redondo Wells

The Charco-Redondo oil wells are located in the southeastern part of Zapata County. The wells, now producing, are shallow, varying from 135 to 160 feet in depth. The oil is from sands and sandy shales, slightly greenish in color, found associated with, and usually underlying an oyster shell stratum, which serves as cap-rock. About twenty-one wells have been drilled, of which sixteen are now being pumped, the production being from one to three barrels per day per well.

The oil sand at this locality dips to the east. Thus the westernmost of the wells obtain production at a depth of from 135 to 140 feet, while wells farther to the east on land of equal or lower elevation find the oil sand at from 150 to 160 feet. About one mile west of the oil wells there is a west facing

[1]Among gas wells more recently obtained by the Carolina-Texas Company one is reported to be located on the escarpment.

scarp held up by an oyster shell stratum. This oyster shell bed is probably the same as that associated with the oil sand, indicating the eastward dip in the formations.

The producing sands at this locality are probably in the Fayette formation. The oil has a gravity of about 18.5 B, and is said to yield a good quality of lubricating oil.

The Jennings Gas Field

The Jennings Gas Field is located in the northeastern part of Zapata County, about seven miles from the east and nine miles from the north county line. This field was discovered in 1914 when a test well for water obtained gas. Ten or more wells have been drilled. Two of these, failing to obtain gas, were drilled to a greater depth and obtained fresh water at about 1900 feet. The yield in the gas wells is said to be, for each successful well, between ten and twelve million cubic feet initial.

Surface exposures of the light colored slightly sandy rock with strata of volcanic ash provisionally referred to the Fayette formation were observed four or five miles northwest of the Jennings Field. No exposures were seen immediately within the gas fields, but it is probable that the surface formation at this locality is Fayette. The gas horizon at this locality lies between 1200 and 1300 feet below the surface. It seems probable that the gas horizon is within the Yegua formation, although formation thicknesses at this locality are not fully determined.

The Mirando Pool

The Mirando Pool is located in the northeastern part of Zapata County, about two miles from the east and three from the north county line. The discovery well in this field was completed in the spring of 1921. Since that time drilling has been actively continued in this field. These wells are located at the foot of the Reynosa escarpment, and at a place where, as indicated on the sketch map, the escarpment bends abruptly to the east.

The producing sands in this field lie at a depth approximating 1450 feet from the surface. The wells are about seven miles

north and five miles east of the Jennings gas pool. Since the regional dip is to the east, if the gas at Jennings is from the Yegua, it seems probable that the oil at Mirando Pool is likewise from this formation. On this point, however, the evidence is at present inconclusive. The logs of the deep wells in and near this pool indicate that sandstones are entered at about 1700 feet.

The wells at the west edge of the Mirando Pool produce gas, while in the central part of the pool the wells yield oil with but little gas. The oil is from 21.5 B gravity, and is said to contain very little gasoline.

The Reiser Gas Field

The Reiser Gas Field, in Webb County, is located on and near the Texas-Mexican Railway, twenty-five miles east of Laredo. About twelve gas wells have been obtained at this locality, the best of which are reported to have made twenty or twenty-five million cubic feet of gas per day. Formerly the gas from this field supplied Laredo, but is used at the present time only for local purposes.

The chief gas horizon at Reister is found at a depth of from 650 to 800 feet. Probably the gas in this field is obtained from the Yegua formation, although, as in the case of the other fields in this area, the age of the producing horizon cannot be regarded as definitely determined.

The Schott Pool

The Schott Pool is located about thirty-five miles east of Laredo, and one and one-half miles south of Mirando City. The discovery well in this field was completed December, 1921. This pool is located near the foot of the Reynosa escarpment. The country is somewhat rolling, and there are occasional hills remaining as outliers or remnants of the Reynosa formation.

The producing horizon of the Schott Pool is found at a depth of from 1525 to 1550 feet. About three miles southwest of this pool are exposures which appear to represent the Fayette formation from which it seems probable that the wells of the

Schott Pool, like those of the Mirando Pool, start near the top of the Eocene. Production in the Schott Pool is being obtained from seventy-five to one hundred feet deeper than in the Mirando Pool, the surface elevation being essentially the same. Whether or not production in the Schott Pool is from the same horizon as in the Mirando Pool is undetermined at this time. At Mirando City, some oil has been obtained at a depth of about 1630 feet.

A well located about three-fourths of a mile northwest of the Schott Pool apparently passed the oil producing horizon at about 1635 feet. This well continuing to a greater depth encountered a thick body of slightly sandy, blue and pink somewhat calcareous shale which was penetrated to a depth of 2500 feet, where sandstones were encountered.

In the Schott Pool as in the Mirando Pool, gas is found in wells west of those producing oil, apparently marking the west margin of the pool. The producing sands as indicated by the wells dips to the east with possibly a structural nose. The oil of the Schott Pool appears to be very similar in character to that of the Mirando Pool. The well of the Kanoka Oil Company in the Schott Pool, after being cleaned, produced not less than 800 barrels per day.

The Carolina-Texas Oil Company Gas Wells

The Carolina-Texas Oil Company has a well from which gas has been obtained, located about seven miles east of north of Torrecillas. This well is at the foot of the Reynosa escarpment, and at a place where a small stream enters from the highland, forming a reentrant in the margin of the scarp.

Some gas was obtained in this well at 1295 feet, but the principal gas horizon is reported at a depth of 2015 feet. The formation from which the gas is obtained is undetermined. This well is about ten miles north and four miles east of the Schott Pool. A second well drilled at this locality obtained some gas at 1296 feet.[1]

[1]Two additional wells drilled since this manuscript was submitted and located east of the first two wells are reported to have obtained gas.

Well Records

A summary of representative wells in these two counties is given in the table which follows. In addition a number of logs are included indicating the drilling conditions in the several fields.

Summary of Representative Wells in Webb and Zapata Counties

Name of Well.	Location.	Depth.	Remarks.
Carolina-Texas Oil Co.	Surv. 268, 7 miles N. N. E. of Torrecillas	2015	Gas show at 1270-1279. Gas at 2015.
Zapata Oil and Gas Co.	Charco Redondo	1735	Oil sand at 163-168. Gas show in sand at 932-965.
Texas Company.	Jennings Gas Field.		
Jennings No 4	1½ mi. N. W. of Ranch House	3015	Fresh water at 1961.
Jennings No 3	2½ mi. N. E. of Ranch House	1367?	12 M gas at 1265-1367. Rock pressure 455 lbs.
Cuellor No. 1	1½ mi. E. N. E. of Ranch House	1234?	9 M gas at 1229-1234. Rock pressure 460 lbs.
	Mirando Pool.		
Keeton Synd. No. 2	N. W. pt. of pool. Blk. 23	1467	Gas at 1445-1467.
Mirando Oil Co. No. 2	S. pt. of pool. Blk. 5	1502	Show of oil at 1447-1452.
Mirando Oil Co. No. 3	S. pt. of pool. Blk. 5	1426	Producer. Discovery Well.
Mirando Oil Co. No. 4a	S. pt. of pool. Blk. 5	1468	Oil sand at 1433-1442.
Mirando Oil Co. No. 7	Central pt. of pool. Blk. 17	1490	Oil sand 1470-1476. 100 bbls.
Witherspoon Oil Co. No. 4	N. pt. of pool. Blk. 18	2000	Sandrock 1735-2000.
Witherspoon Oil Co. No. 1	Central part of pool	1460	Reported producing. 80 bbls.
Tenn-Zapata Oil Co. No. 1	S. W. pt. of pool. Blk. 16	1476	Gas well, sand 1443-1455.
Zapata Red. & Ref. Co.	Surv. 113, S. of pool	1730	Reported dry.
Producers Oil Company.	Reiser Gas Field.		
B. & M. No. 5 (Completed by Brethwith & Allison)	Near Reiser	2598	Water at about 1800 ft. Sands 200 ft. from surf. Gas reported at 2500 ft.
Reiser No. 1	1 mi. E. of Reiser	2240	Mineral water at 1500±.
Reiser No. 4	At Reiser	685	Gas in use for local supply.

Summary of Representative Wells in Webb and Zapata Counties—Continued

Name of Well.	Location.	Depth	Remarks.
	Schott Pool.		
Kanoka Oil Co. No. 1	N. Central pt. of pool. Blk. 6	1559	Oil sand at 1545-1559. Reported making 800 bbls. per day.
Laurel Oil Co. No. 1	W. pt. of pool. Blk. 9	1539	Gas well.
Leaseholders Oil Co. No. 1	W. pt. of pool. Blk. 10	1599	Gas well.
Schott Oil Co. No. 2	Central pt. of pool. Blk. 11	1532	Gas and oil at 1530-1532.
Schott Oil Co. No. 3	E. part of pool. Blk. 12	1588	Oil at 1571-1588.
Schott Oil Co. No. 1	West of pool. Sur. 462	1750	Ends in red and blue shale and gumbo.
South Plains Oil & Gas Co.	N. W. of pool. Sur. 460	2500	Below 1600 chiefly red and blue shales.
Laredo Oil Co. No. 2	In Mirando City	1685	Oil at about 1635.

Well Logs in Webb County

The following logs of wells in Webb County are arranged alphabetically according to owners of the land on which the wells are located, and the company owning the well.

Log of Albercas No. 1, Albercas Oil Co., Survey 836, About Three Miles North Slightly West of the Mirando Pool

	Depth in Feet.		Thickness.
	From.	To.	
Red sandy clay	0	42	42
Blue clay and boulders	42	79	37
Shale	79	132	53
Gumbo	132	142	10
Shale and boulders	142	163	21
Green shale and boulders	163	246	83
Lime rock	246	250	4
Hard sandy shale	250	281	31
Blue and green gumbo and shale	281	410	129
Hard gummy shale	410	506	96
Shale and boulders	506	613	107
Water sand	613	671	58
Gumbo	671	710	39
Gummy shale and boulders	710	778	68
Shale and sand, oil showing. Tested out but no results	778	789	11
Hard shale	789	840	51
Packed sand	840	871	31
Shale and sand	871	961	90
Hard shale	961	992	31
Gumbo	992	1,055	63
Hard shale	1,055	1,142	87
Gumbo	1,142	1,172	30
Shale and boulders	1,172	1,280	108
Hard sandy shale	1,280	1,309	29

Log of Albercas No. 1, Albercas Oil Co., Survey 836, About Three Miles North Slightly West of the Mirando Pool—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Gumbo	1,309	1,318	9
Hard and soft shale, blue and brown	1,318	1,445	127
Shale and boulders	1,445	1,489	44
Packed sand	1,489	1,491	2
Hard shale	1,491	1,505	14
Lime rock	1,505	1,507	2
Hard shale, pyrites and boulders	1,507	1,548	41
Lime rock	1,548	1,550	2
Gumbo	1,550	1,559	9
Shale and boulders	1,559	1,585	26
Hard gumbo	1,585	1,661	76
Hard shale	1,661	1,684	23
Gumbo	1,684	1,709	25
Hard shale and boulders	1,709	1,720	11
Hard and soft sand rock	1,720	1,727	7
Hard sand rock, showing gas.			
Tested, no results	1,727	1,734	7
Soft sand	1,734	1,739	5
Hard shale, total depth	1,739	1,797	58

Began December 7, 1921; completed February 11, 1922; set 8", casing at 743'; set 6" casing at 1735'; 1 ft. in rock. 8" casing leftt in hole and derriok left standing with intention of drilling deeper.

Log of Barusly No. 1. Carolina Texas Oil Co. Survey 268, About Four Miles Northeast of Mirando City

	Depth in Feet.		Thickness.
	From.	To.	
Clay	0	22	22
Rock	22	48	26
Sand	48	56	8
Rock	56	59	3
Shale	59	72	13
Sand	72	77	5
Shale and boulders	77	103	26
Rock	103	108	5
Sandy shale	108	141	1
Rock	141	142	1
Sand	142	160	18
Rock	160	162	2
Sandy shale	162	195	33
Rock	195	197	2
Sand	197	217	20
Gas rock	217	220	3
Sand	220	228	8
Rock	228	229	1
Sandy shale	229	254	25
Gumbo	254	260	6
Sand	260	270	10
Sand and boulders	270	310	40
Rock	310	312	2
Sand boulders	312	375	63
Rock	375	380	5
Sandy shale	380	402	22
Gumbo	402	407	5
Sand and boulders	407	428	21
Pay	428	435	7
Gumbo	435	440	5
Sand and boulders	440	460	20

Log of Barusly No. 1. Carolina Texas Oil Co. SSurvey 268, About Four Miles Northeast of Mirando City—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Rock	460	464	4
Sandy shale and boulders	464	610	146
Gumbo	610	616	6
Water sand	616	630	14
Sand and boulders	630	760	130
Pink gumbo	760	764	4
Sand and boulders	764	780	16
Gas sand	780	796	16
Sand and boulders	796	827	31
Pay sand	827	835	8
Sand and boulders	835	910	75
Gumbo	910	916	6
Hard sand	916	930	14
Sandy shale	930	970	40
Sand	970	1,000	30
Rock	1,000	1,002	2
Sandy shale	1,002	1,060	58
Rock	1,060	1,065	5
Water sand	1,065	1,070	5
Sand	1,070	1,085	15
Gumbo	1,085	1,088	3
Sand and boulders	1,088	1,130	42
Gumbo	1,130	1,135	5
Rock	1,135	1,137	2
Pack sand	1,137	1,155	18
Gumbo	1,155	1,168	13
Gumbo	1,168	1,195	27
Sandy shale	1,195	1,222	27
Gumbo	1,222	1,226	4
Sandy shale	1,226	1,270	44
Pay	1,270	1,295	25
Clay (?)	1,295	1,322	27
No log 1,322 to 1,401. This well deepened by Trussle, Brown & Hodges.			
Sandy shale	1,401	1,466	65
Sand and shale	1,466	1,535	69
Shale and boulders	1,535	1,550	15
Sand	1,550	1,568	18
Gumbo	1,568	1,573	5
Shale and boulders	1,573	1,600	27
Gumbo	1,600	1,608	8
Sandy shale and boulders	1,608	1,654	46
Shale	1,654	1,685	31
Gumbo	1,685	1,700	15
Sandy shale	1,700	1,725	25
Hard shale	1,725	1,732	7
Shale	1,732	1,800	68
Gumbo	1,800	1,815	15
Hard sand	1,815	1,827	12
Shale	1,827	1,995	168

Total depth, 2,015. Shale grades into sandy shale and apparently into a coarse grained sandstone, which is producing about 8 M cu. ft. gas.

Log of Breckenridge No. 1, South Plains Oil & Gas Co., Survey No. 460, Southeast Corner of Block 15, About One Mile Southwest of Mirando City

	Depth in Feet.		Thickness.
	From.	To.	
Surface clay	0	20	20
Yellow clay and boulders	20	72	52
Red clay and shale	72	120	48
Lime rock	120	122	2
Hard shale and boulders	122	240	118
Gumbo	240	261	21
Lime rock	261	272	11
Hard green shale and boulders	272	349	77
Shale	349	400	51
Chalk rock	400	422	22
Gumbo	422	428	6
Shale	428	451	23
Packed sand	451	471	20
Hard lime rock	471	474	3
Gumbo	474	487	13
Soft gummy shale	487	620	133
Soap stone	620	623	3
Soft shale	623	670	47
Gumbo	670	680	10
Shale and boulders	680	710	30
Hard shale	710	771	61
Lime rock	771	772	1
Shale and boulders	772	815	43
Gumbo	815	830	15
Hard shale	830	882	52
Sand rock	882	892	10
Soft lime rock	892	905	13
Shale and boulders	905	940	35
Hard lime rock	940	951	11
Gumbo	951	958	7
Soft shale	958	993	35
Sand rock	993	997	4
Hard sandy shale	997	1,040	43
Water sand	1,040	1,060	20
Hard shale	1,060	1,135	75
Sandy shale	1,135	1,155	20
Gumbo	1,155	1,160	5
Soft shale	1,160	1,212	52
Gumbo	1,212	1,219	7
Hard sandy shale and boulders	1,219	1,282	63
Lime rock	1,282	1,286	4
Hard shale and streaks of gumbo	1,286	1,327	41
Sand rock	1,327	1,331	4
Sandy shale	1,331	1,348	17
Gumbo	1,348	1,393	45
Hard shale and boulders	1,393	1,426	33
Sandy shale	1,426	1,441	15
Gumbo	1,441	1,444	3
Soft shale	1,444	1,460	16
Hard gummy shale	1,460	1,470	10
Shale and boulders	1,470	1,488	18
Gumbo	1,488	1,498	10
Soft sandy shale	1,498	1,502	4
Sand rock	1,502	1,506	4
Sandy shale	1,506	1,509	3
Gumbo	1,509	1,547	38
Hard sandy shale	1,547	1,556	9
Soft gummy shale	1,556	1,579	23
Gumbo	1,579	1,595	16
Soft sandy shale; set 8″ pipe	1,595	1,603	8
Shell rock	1,603	1,604	1
Sand	1,604	1,635	31

Log of Breckenridge No. 1, South Plains Oil & Gas Co., Survey No. 460, Southeast Corner of Block 15, About One Mile Southwest of Mirando City—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Sandy shale; set liner and bailed	1,635	1,641	6
Shale	1,641	1,660	19
Gumbo	1,660	1,665	5
Green shale	1,665	1,725	60
Gumbo	1,725	1,731	6
Packed sand	1,731	1,741	10
Shale	1,741	1,747	6
Gumbo	1,747	1,751	4
Hard blue shale	1,751	1,784	33
Pink shale	1,784	1,785	1
Green shale, soft and hard streaks	1,785	1,831	46
Pink shale and lime streaks	1,831	1,860	29
Blue gumbo	1,860	1,866	6
Pink shale with streaks of gumbo	1,866	1,947	81
Gyp. gumbo	1,947	1,957	10
Hard pink shale	1,957	1,972	15
Blue shale	1,972	1,998	26
Gumbo	1,998	2,004	6
Pink shale	2,004	2,015	11
Gumbo	2,015	2,021	6
Hard blue shale	2,021	2,036	15
Blue gumbo	2,036	2,055	19
Blue gumbo	2,055	2,060	5
Lime rock	2,060	2,061	1
Gyp. gumbo	2,061	2,067	6
Blue shale	2,067	2,100	33
Gumbo	2,100	2,106	6
Blue shale	2,106	2,128	22
Hard pink shale	2,128	2,176	48
Gyp. gumbo	2,176	2,180	4
Sand	2,180	2,186	6
Sand and shale streaks	2,186	2,195	9
Hard gummy shale	2,195	2,202	7
Green shale and boulders	2,202	2,240	38
Blue shale soft and gummy	2,240	2,300	60
Green shale	2,300	2,360	60
Blue and pink shale	2,360	2,405	45
Pink shale	2,405	2,475	70
Soft lime rock	2,475	2,476	1
Gumbo	2,476	2,480	4
Hard shale and lime streaks	2,480	2,500	20
Not recorded	2,500	2,527	27
Sand shale	2,527	2,540	13
Sand and shale streaks	2,540	2,542	2
Dry sand, gas show	2,542	2,550	8
Hard sand and boulders gas show	2,550	2,562	12
Hard shale and shells	2,562	2,578	16
Gumbo	2,578	2,588	10
Sand	2,588	2,591	3
Pink shale and boulders	2,591	2,603	12
Hard shale and sand streaks	2,603	2,623	20
Gumbo	2,623	2,630	7
Hard pink gummy shale	2,630	2,665	35
Pink and blue shale	2,665	2,689	24
Rock and pyrites	2,689	2,690	1
Blue slate shale	2,690	2,709	19
Soft shale and sand streaks	2,709	2,726	17
Sulphur water sand	2,726	2,746	20
Hard sand	2,746	2,775	29
Soft shale and sand streaks	2,775	2,802	27
Hard sand	2,802	2,807	5
Blue shale	2,807	2,816	9
Shale and boulders	2,816	2,859	43

Log of Breckenridge No. 1, South Plains Oil & Gas Co., Survey No. 460, Southeast Corner of Block 15, About One Mile Southwest of Mirando City—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Hard sand gas showing	2,859	2,879	20
Hard sand	2,879	2,885	6
Hard sand gas showing	2,885	2,900	15
Hard sand	2,900	2,928	28
Sulphud water sand	2,928	2,940	12
Shale and boulders	2,940	2,980	40
Shale and gumbo	2,980	3,009	29

Log of Folts No. 1, Santa Maria de los Angeles Survey, About One-half Miles East of Bruni, In Eastern Part of Webb County

	Depth in Feet.		Thickness.
	From.	To.	
Soil	0	5	5
Sand and clay	5	10	5
Sand and clay	10	50	40
Hard sand	50	75	25
Lime rock	75	105	30
Gravel and water sand	105	115	10
Sandy shale	115	175	60
Water sand	175	225	50
Hard shale	225	325	100
Gumbo	325	400	75
Blue shale	400	525	125
Water sand	525	625	100
Blue shale	625	800	175
Gummy red shale	800	1,000	200
Blue shale	1,000	1,100	100
Gummy red shale	1,100	1,200	100
Black shale	1,200	1,300	100
Hard blue shale	1,300	1,400	100
Gumbo	1,400	1,475	75
Hard sandy shale	1,475	1,500	25
Soft blue shale	1,500	1,600	100
Gas sand	1,600	1,625	25
Hard black shale	1,625	1,700	75
Sea shell	1,700	1,705	5
Sandy shale	1,705	1,790	85
Sea shell	1,790	1,800	10
Soft sandy shale	1,800	1,810	10

Casing set at 1,875 in cement; 4½" lines set at 1,650.
Hole was bailed dry, making quite a bit of gas; pulled lines and finished hole at 1,810', with no oil showing.

Log of Kanoka No. 1, Survey 54, About One and One-half Miles South of Mirando City. After Cleaning Well Produced 800 bbls. or More. Discovery Well of the Schott Pool

	Depth in Feet.		Thickness.
	From.	To.	
Surface soil	0	5	5
Yellow clay	5	18	13
Soft lime clay	18	42	24
Loose gray shale	42	74	32
Red and blue shale	74	110	36
Water sand	110	116	6
Fine blue sand	116	150	34
Red mixed shale	150	210	60
Hard red clay	210	230	20
Red mixed shale	230	252	22
Soft lime clay	252	274	22
Red mixed shale	274	296	22
Blue shale	296	320	24
Gummy shale	320	332	12
Red and blue shale	332	373	41
Hard gummy shale	373	399	26
Gumbo	399	411	12
Soft lime rock	411	420	9
Red and blue shale	420	448	28
Hard lime rock	448	453	5
Red and blue shale	453	512	59
Hard lime rock	512	522	10
Hard blue shale and lime	522	601	79
Hard gummy shale	601	622	21
Lime rock	622	635	13
Red and blue shale	635	660	25
Lime rock	660	672	12
Hard blue shale	672	700	28
Lime rock	700	776	76
Red and blue shale	776	844	68
Lime rock	844	860	16
Red and blue shale	860	940	80
Lime rock	940	978	38
Red and blue shale	978	1,000	22
Lime rock	1,000	1,023	23
Red and blue shale	1,023	1,073	50
Gumbo	1,073	1,084	11
Lime rock	1,084	1,102	18
Gumbo	1,102	1,114	12
Hard gummy shale	1,114	1,129	15
Red and blue shale	1,129	1,140	11
Lime rock	1,140	1,162	22
Hard gummy shale	1,162	1,184	22
Gumbo	1,184	1,196	12
Red and blue shale	1,196	1,216	20
Gumbo	1,216	1,227	11
Lime rock	1,227	1,248	21
Gummy shale	1,248	1,271	23
Lime rock	1,271	1,282	11
Gumbo	1,282	1,293	11
Red and blue shale	1,293	1,304	11
Gumbo	1,304	1,313	9
Lime rock and shale	1,313	1,328	15
Red and blue shale	1,328	1,350	22
Lime rock	1,350	1,362	12
Hard blue shale	1,362	1,374	12
Red and blue shale	1,374	1,396	22
Lime rock	1,396	1,406	10
Hard blue shale	1,406	1,440	34
Lime rock	1,440	1,462	22
Hard blue shale	1,462	1,499	37
Lime rock (gas big)	1,499	1,508	9
Hard blue shale	1,508	1,513	5
Hard lime rock (gray sand) set casing 1515'	1,513	1,515	2

Log of Kanoka No. 1, Survey 54, About One and One-half Miles South of Mirando City. After Cleaning Well Produced 800 bbls. or More. Discovery Well of the Schott Pool—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Lime rock	1,515	1,517	2
Shells and shale	1,517	1,522	5
Sand rock	1,522	1,523	1
Shale and sand	1,523	1,533	10
Gumbo	1,533	1,537	4
Shells and shale	1,537	1,543	6
Hard lime rock	1,543	1,545	2
Hard sand (heavy oil sand)	1,545	1,559	14

Stopped in gumbo.
Set casing in cement.
Set 66', 7".

Log of Laredo Oil Co., Well No. 1, Survey 458, in Mirando City

	Depth in Feet.		Thickness.
	From.	To.	
Surface	0	10	10
White lime and sand	10	18	8
Gravel	18	20	2
Sand	20	35	15
Clay	35	45	10
Sand, clay and shell	45	61	16
Pink shale	61	62	1
Red clay	62	76	14
Gray shale	76	86	10
Blue and gray shale	86	96	10
White lime rock	96	101	5
Gray shale	101	115	14
Pink gumbo	115	133	18
Blue shale	133	148	15
Gray gumbo	148	179	31
Brown shale	179	184	5
Blue shale	184	194	10
Gray shale	194	205	11
Sandy shale	205	213	8
Hard shale	213	231	18
Gumbo	231	246	15
Shale	246	256	10
Sandy shale	256	284	28
Blue gumbo	284	294	10
Brown shale	294	304	10
Gumbo	304	330	26
Brown gumbo	330	344	14
Blue gumbo	344	360	16
Gray gumbo	360	375	15
Blue shale	375	385	10
Blue gumbo	385	393	8
Sandy shale	393	413	20
Rock	413	414	1
Blue shale	414	434	20
Brown shale	434	454	20
Shale and sand	454	460	6
Gray shale	460	480	20
Gumbo	480	510	30
Blue shale	510	525	15
Lime rock	525	533	8
Blue shale	533	555	22
Gray gumbo	555	587	32

Log of Laredo Oil Co., Well No. 1, Survey 458, in Mirando City—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Slate with coal	587	615	28
Gumbo	615	654	39
Rock	654	656	2
Blue shale	656	664	8
Gray gumbo	664	715	51
Blue shale	715	759	44
Gumbo	759	760	1
White lime rock	760	778	18
Blue shale	778	800	22
Brown shale	800	816	16
Gray shale	816	824	8
Rock	824	825	1
Gray shale	825	875	50
Brown shale	875	883	8
Gray and blue shale	883	905	22
Soft gumbo	905	920	15
White lime rock	920	952	32
Blue shale	952	960	8
Lime rock	960	972	12
Blue shale	972	978	6
Gray shale	978	1,014	36
Gumbo	1,014	1,029	15
Lime rock	1,029	1,039	10
Blue shale	1,039	1,049	10
Blue gumbo	1,049	1,059	10
Light gray shale	1,059	1,076	17
Blue gumbo	1,076	1,084	8
Shale	1,084	1,089	5
Lime rock	1,089	1,092	3
Blue shale	1,092	1,114	22
Gumbo	1,114	1,146	32
Gray shale	1,146	1,165	19
Shale and gumbo	1,165	1,185	20
Gumbo	1,185	1,215	30
Shale	1,215	1,230	15
Gray shale	1,230	1,260	30
Lime rock	1,260	1,275	15
Gumbo	1,275	1,285	10
Soft lime rock	1,285	1,291	6
Gumbo	1,291	1,321	30
Blue shale	1,321	1,341	20
Gumbo	1,341	1,411	70
Shale	1,411	1,431	20
Gumbo	1,431	1,446	15
Shale and gumbo	1,446	1,466	20
Gumbo	1,466	1,496	30
Blue shale	1,496	1,521	25
Gumbo	1,521	1,531	10
Shale	1,531	1,561	30
Gumbo	1,561	1,581	20
Shale	1,581	1,621	40
Gumbo	1,621	1,636	15
Shale	1,636	1,650	14
Hard rock	1,650	1,654	4
Sand (oil sand)	1,654	1,662	8
Rock	1,662		

This well gave a flow of oil when first drilled. Subsequently abandoned on account of water trouble.

Log of Well On Reisor Ranch, Producers Oil Co., B. & M. Lease Well No. 5, Survey 1617, About One-fourth Mile South of Reiser's Station. Total Depth 2,598

	Depth in Feet.		Thickness.
	From.	To.	
Surface sand	0	3	3
Sandy red clay	3	6	3
Brown sand	6	12	6
Gravel with some salty water	12	14	2
Brown shale	14	45	31
Sandy yellow clay	45	58	13
Brown shale	58	110	52
Sand	110	118	8
Shale	118	126	8
Shale	126	164	38
Gumbo	164	170	6
Shale	170	208	38
Lime shells with some sand	208	220	12
Red clay	220	286	66
Sand salt water	286	292	6
Shale black	292	334	42
Sand	334	339	5
Sandy shale	339	404	65
Gumbo	404	413	9
Shale black	413	476	63
Sand	476	482	6
Shale	482	564	82
Gumbo	564	570	6
Brown shale	570	642	72
Sand, gas show	642	649	7
Black shale	649	674	25
Gumbo	674	686	12
Red clay	686	793	107
Sand	793	798	5
Shale with sand shell	798	885	87
Sandy shale	885	914	29
Gray salt sand	914	926	12
Brown shale	926	938	12
Sand	938	945	7
Shale with sand	945	987	42
Sandy shale	987	1,032	45
Blue shale, sand shells, iron	1,032	1,116	84
Gumbo	1,116	1,123	7
Sand	1,123	1,138	15
Sandy blue shale	1,138	1,184	46
Sand	1,184	1,192	8
Black shale	1,192	1,208	16
Sand	1,208	1,227	19
Water sand	1,227	1,248	21
Sandy shale	1,248	1,285	37
Sand, water	1,285	1,312	27
Shale	1,312	1,324	12
Sand	1,324	1,332	8
Sand, set 8"	1,332	1,369	37

This well is said to have been subsequently drilled to a depth of 2,598 feet. Water was obtained at about 1,800 feet, and gas is reported at about 2,500 feet.

Log of Garcia No. 2, Schott Oil Co., Survey 54, About One and One-half Miles South of Mirando City. Gas and Oil Well, Initial Production Oil Reported at 74 bbls.

	Depth in Feet.		Thickness.
	From.	To.	
Yellow sand	0	2	2
Soft lime clay	2	10	8
Yellow clay	10	30	20
Blue shale	30	57	27
Red clay	57	107	50
Soft lime rock	107	135	28
Hard blue shale	135	163	28
Lime rock	163	165	2
Hard blue shale	165	220	55
Blue shale and sand	220	260	40
Gumbo	260	290	30
Blue shale	290	330	40
Red and blue shale	330	342	12
Blue shale and sand	342	475	133
Soft lime rock	475	490	15
Hard blue shale and sand	490	537	47
Lime rock	537	563	26
Tough gumbo	563	600	37
Lime rock	600	637	37
Gumbo	637	670	33
Lime rock	670	673	3
Gumbo	673	685	12
Lime rock	685	687	2
Gumbo	687	700	13
Hard blue shale	700	745	45
Lime rock	745	750	5
Red and blue shale	750	800	50
Soft lime rock	800	805	5
Red and blue shale	805	861	56
Lime rock	861	873	12
Gumbo	873	897	24
Blue shale	897	900	3
Lime rock	900	918	18
Gumbo	918	937	19
Blue shale and sand	937	960	23
Tough gumbo	960	983	23
Soft rock	983	1,000	17
Hard blue shale	1,000	1,020	20
Gumbo	1,020	1,067	47
Lime rock	1,067	1,083	16
Red and blue shale	1,083	1,100	17
Gumbo	1,100	1,115	15
Lime rock	1,115	1,160	45
Hard blue shale	1,160	1,187	27
Lime rock	1,187	1,193	6
Hard blue shale	1,193	1,213	20
Gumbo	1,213	1,237	24
Lime rock	1,237	1,275	38
Gumbo	1,275	1,297	22
Hard blue shale	1,297	1,317	20
Lime rock	1,317	1,350	33
Gumbo	1,350	1,357	7
Hard blue shale	1,357	1,384	27
Lime rock	1,384	1,400	16
Blue shale	1,400	1,410	10
Soft blue mud	1,410	1,427	17
Soft lime rock	1,427	1,449	22
Red and blue shale	1,449	1,467	18
Soft lime rock	1,467	1,482	15
Hard lime rock	1,482	1,500	18
Tough gumbo	1,500	1,510	10
Hard lime rock	1,510	1,515	5
Soft lime rock	1,515	1,523	8
Hard lime rock	1,523	1,527	4
Hard blue rock, sandstone	1,527	1,530	3
Porous gray sand rock	1,530	1,532	2

Log of Urban No. 1, Rio Grande Oil & Gas Co., Survey 7; Ten or Twelve Miles North of Laredo

	Depth in Feet.		Thickness.
	From.	To.	
Yellow clay	0	18	18
White shale	18	30	12
Blue shale	30	60	30
Pink shale	60	80	20
Sand	80	90	10
Blue shale	90	260	170
Cave	260	265	5
Blue shale	265	290	25
Cave	290	295	5
Blue shale	295	360	65
Cave	360	365	5
Blue shale	365	545	180
Sand, showing of oil	545	553	8
Blue shale	553	633	80
Slate	633	800	167
Water sand	800	881	81
Shale	881	960	79
Sand	960	1,000	40
Slate	1,000	1,006	6
Sand	1,006	1,058	52
Slate	1,058	1,075	17
Sand	1,075	1,093	18
Water sand	1,093	1,103	10
Slate	1,103	1,122	19
Sand	1,122	1,140	18
Slate	1,140	1,145	5
Sand	1,145	1,210	65
Slate	1,210	1,220	10
Sand	1,220	1,255	35
Slate	1,255	1,263	8
Sand	1,263	1,320	57
Sand	1,320	1,340	20
Water sand	1,340	1,365	25
Brown shale	1,365	1,369	4
Sand	1,369	1,400	31
Slate	1,400	1,404	4
Sand, began undercreaming 1,130'	1,404	1,450	46
Red rock	1,450	1,455	5
Sand	1,455	1,470	15
Red rock	1,470	1,472	2
Sand	1,472	1,515	43
Broken formation, sand, slate, red rock	1,515	1,580	65
Sand	1,580	1,600	20

Casing record: Set 12½", casing at 553'; 10" at 1,058'.

Log Wells in Zapata County

Log of Hinnant No. 6, Mirando Oil Co., Survey 114, Block 5, Lot 1, Initial Production 150 bbls., Mirando Pool

	Depth in Feet.		Thickness.
	From.	To.	
Clay and gravel	0	98	98
Pack sand	98	100	2
Blue shale	100	140	40
Hard shale	140	150	10
Shale and sand	150	170	20
Shale	170	360	190
Boulders	360	371	11

Log of Hinnant No. 6, Mirando Oil Co., Survey 114, Block 5, Lot 1, Initial Production 1500 bbls., Mirando Pool—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Shale	371	590	219
Gumbo	590	600	10
Shale	600	638	38
Sandy shale	638	641	3
Shale	641	658	17
Boulders	658	665	7
Shale	665	720	55
Boulders	720	725	5
Hard sandy shale	725	815	90
Hard red gumbo	815	826	11
Hard shale	826	857	31
Rock	857	860	3
Shale	860	863	3
Hard shale and boulders	863	1,040	177
Green gumbo	1,040	1,059	19
Hard shale	1,059	1,099	40
Green gumbo	1,099	1,108	9
Hard shale and boulders	1,108	1,123	15
Blue shale	1,123	1,167	44
Hard shale boulders	1,167	1,231	64
Stiff blue gumbo	1,231	1,257	26
Hard shale	1,257	1,320	63
Shale and boulders	1,320	1,384	64
Hard shale	1,384	1,401	17
Green gumbo	1,401	1,412	11
Pay shale and sand	1,412	1,425	13
Gumbo	1,425	1,431	6
Hard shale	1,431	1,448	17
Pay sand and shale	1,448	1,462	14
Boulders	1,462	1,467	5

Log of Hinnant No. 7, Mirando Oil Co., Survey 307, Block 17, Lot 4, Completed November 26, 1921, Mirando Pool

	Depth in Feet.		Thickness.
	From.	To.	
Clay and gravel	0	12	12
Mixed shale	12	48	36
Hard sandy shale	48	65	17
Mixed shale	65	182	117
Hard shale	182	220	38
Hard shale and boulder	220	273	53
Hard sand	273	275	2
Sandy shale	275	348	73
Hard sand and boulder	348	362	14
Rock	362	365	3
Hard shale	365	385	20
Hard sand	385	387	2
Sandy shale	387	501	114
Hard shale	501	545	44
Green shale and boulder	545	567	22
Hard shale	567	587	20
Hard shale and boulder	587	704	117
Gumbo	704	710	6
Hard shale and boulder	710	760	50
Gumbo	760	778	18
Hard shale and boulder	778	840	62
Gumbo and boulder	840	865	25
Hard shale and boulder	865	906	41
Hard shale	906	956	50
Gumbo	956	991	35

Log of Hinnant No. 7, Mirando Oil Co., Survey 307, Block 17, Lot 4, Completed November 26, 1921, Mirando Pool—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Hard shale and boulder	991	1,030	39
Hard shale and boulder	1,030	1,034	4
Gumbo	1,034	1,040	6
Hard shale and boulder	1,040	1,071	31
Boulder	1,071	1,081	10
Hard shale	1,081	1,165	84
Gumbo	1,165	1,180	15
Hard shale and boulder	1,180	1,252	72
Gumbo and boulder	1,252	1,290	38
Hard shale and boulder	1,290	1,362	72
Hard shale	1,362	1,392	30
Gumbo	1,392	1,403	11
Shale	1,403	1,446	43
Gumbo	1,446	1,470	24
Hard sand	1,470	1,476	6
Shale	1,476	1,490	14

Casing record: 6", 1,398'; initial production reported at 100 bbls.

Log of Hinnant No. 3, Witherspoon Oil Co., Survey 115, Block 3, Mirando Pool

	Depth in Feet.		Thickness.
	From.	To.	
Red clay and gravel	0	60	60
Soft shale	60	186	126
Shale and boulders	186	336	150
Loose shale	336	520	184
Shale and boulders	520	620	100
Gumbo	620	645	25
Hard gumbo	645	655	10
Shale and boulders	655	710	55
Gumbo	710	720	10
Hard gumbo	720	760	40
Gumbo and gravel	760	810	50
Hard gumbo	810	840	30
Pink shale	840	900	60
Gumbo	900	920	20
Shale	920	940	20
Hard gumbo	940	980	40
Gumbo	980	995	15
Pink shale	995	1,050	55
Hard sand and boulders	1,050	1,070	20
Shale and boulders	1,070	1,100	30
Gumbo and shale	1,100	1,150	50
Hard gumbo	1,150	1,200	50
Shale	1,200	1,220	20
Hard sand and boulders	1,220	1,260	40
Hard gumbo	1,260	1,320	60
Hard sand and boulders	1,320	1,350	30
Sandy shale	1,350	1,360	10
Sand and shale	1,360	1,364	4
Gumbo	1,364	1,368	4
Shale	1,368	1,375	7
Sand, good oil showing	1,375	1,390	15
Soft shale	1,390	1,435	45
Hard sand, oil showing	1,435	1,440	5
Shale and sand	1,440	1,490	50

Reported producing 90 bbls. per day in April, 1922.

Log of Hinnant No. 4, Witherspoon Oil Co., Survey 307, Block 18, Mirando Pool; Well Abandoned

	Depth in Feet.		Thickness.
	From.	To.	
Red clay and gravel	0	60	60
Shale	60	180	120
Shale and boulders	180	400	220
Gumbo	400	460	60
Gumbo and particles of iron	460	520	60
Boulders and shale	520	600	80
Gumbo	600	680	80
Shale and boulders	680	760	80
Sand rock	760	770	10
Hard gumbo	770	820	50
Hard sandy shale	820	860	40
Sand and boulders	860	900	40
Hard gumbo	900	940	40
Shale and boulders	940	1,110	170
Hard shale	1,110	1,140	30
Boulders and gumbo	1,140	1,220	80
Shale and boulders	1,220	1,250	30
Gumbo	1,250	1,260	10
Shale and sand upper pay	1,260	1,380	120
Hard gumbo and sand	1,380	1,435	55
Soft shale and sand	1,435	1,445	10
Hard brown gumbo	1,445	1,450	5
Hard gumbo	1,450	1,490	40
Sand	1,490	1,500	10
Gumbo	1,500	1,563	63
Rock	1,563	1,565	2
Hard gumbo	1,565	1,600	35
Sand	1,600	1,610	10
Gumbo	1,610	1,690	80
Rock	1,690	1,692	2
Sandy shale	1,692	1,700	8
Not recorded	1,700	1,735	35
Hard sand rock	1,735	2,000	265

Log of Slator No. 1, Producers Oil Co., Jose Borego Vosquez Grant, Within About a Mile of North County Line; Elevation 595

	Depth in Feet.		Thickness.
	From.	To.	
Soil	0	45	45
Shale	45	65	20
Sandy shale	65	84	19
Black shale	84	208	124
Gumbo	208	221	13
Sand	221	230	9
Shale	230	345	115
Gumbo	345	395	50
Shale	395	507	112
Sand	507	512	5
Shale	512	691	179
Gumbo	691	720	29
Shale with iron	720	814	94
Rock, white	814	820	6
Shale, black	820	1,104	284
Sand	1,104	1,106	2
Black shale	1,106	1,116	10
Sand	1,116	1,119	3
Shale	1,119	1,291	172
Sulphur, water, sand and shale	1,291	1,400	109
Blue shale	1,400	1,419	19
Sand	1,419	1,424	5

Log of Slator No. 1, Producers Oil Co., Jose Borego Vosquez Grant, Within About a Mile of Nrth County Line; Elevation 596—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Shale	1,424	1,443	19
Shale and sand	1,443	1,460	17
Sand and iron	1,460	1,493	33
Shale	1,493	1,503	10
Rock and sand	1,503	1,508	5
Shale	1,508	1,527	19
Rock sand and iron (show gas 1,532–1,540)	1,527	1,551	30
Sulphur water, sand	1,557	1,563	6
Sand and iron	1,563	1,580	17
Shale	1,580	1,588	8
Flinty rock and sand	1,588	1,612	24
Shelly shale	1,612	1,649	37
Sand and iron	1,649	1,747	98
Shale	1,747	1,759	12
Shells and pyrite	1,759	1,791	32
Shale	1,791	1,895	104
Lime rock	1,895	1,902	7
Shelly shale	1,902	1,920	18
Lime shell	1,920	1,925	5
Shelly shale	1,925	1,964	39
Slate	1,964	1,984	20
Shelly shale	1,984	2,020	36
Shale and slate	2,020	2,107	87
Shale, sandy	2,107	2,194	87
Sand	2,194	2,195	1
Shale, sandy	2,195	2,210	15

Log of Zapata Oil & Gas Co., in Charco Redondo Field, Southeast Part of Zapata County, Yellow Clay and Sand

	Depth in Feet.		Thickness.
	From.	To.	
Yellow clay and sand	0	18	18
Light green clay	18	70	52
Blue and green shale	70	78	8
Boulders and slate	78	83	5
Blue clay and slate	83	163	80
Oil sand	163	168	5
Shells, fossil oysters	168	169	1
Clay and shale	169	194	25
Light blue clay	194	240	46
Shale and fossil shells	240	258	18
Clay and dark shale	258	271	13
Shells and shale	271	283	12
Red clay	283	307	24
Clay, thin sand strata	307	323	16
White clay	323	362	39
Red clay	362	381	19
Green shale	381	390	9
Hard green shale	390	438	48
Shell and shale	438	443	5
Shells and shales	443	610	167
Sand and shale	610	619	9
Green and blue shale	619	648	29
Gumbo	648	662	14
Red and green shales	662	714	52
Shells and shale	714	760	46
Tough gumbo	760	769	9
Brown shale	769	783	14
Hard slaty shale	783	789	6
Gumbo	789	803	14

Log of Zapata Oil & Gas Co., in Charco Redondo Field, Southeast Part of Papata County, Yellow Clay and Sand—Continued

	Depth in Feet.		Thickness.
	From.	To.	
Hard shale and boulders	803	807	4
Shale and soft slate	807	826	19
Dull brown gumbo	826	841	15
Hard sand and shells	841	848	7
Shale, shells and concretions	848	860	12
Shale	860	932	72
Sand and boulders, gas bubbles	932	965	33
Blue shale	965	992	27
Sand and shale, pyrite	992	998	6
Shale	998	1,037	39
Light green clay	1,037	1,043	6
Dark shale	1,043	1,069	26
Gumbo	1,069	1,078	9
Blue shale	1,078	1,118	40
Sand and green shale	1,118	1,130	12
Hard sandstone	1,130	1,150	20
Sand and shale	1,150	1,172	22
Hard sandstone	1,172	1,175	3
Shale and gumbo	1,175	1,220	51
Shale and sandstone	1,226	1,238	12
Gumbo	1,238	1,247	9
Shale and shells	1,247	1,263	16
Black shale and pyrite	1,263	1,270	7
Clay	1,270	1,286	16
Hard dark shale	1,286	1,298	12
Sand and shale	1,298	1,302	4
Hard sandstone	1,302	1,308	6
Shale	1,308	1,329	21
Shale and gumbo	1,329	1,341	12
Hard rock	1,341	1,347	6
Shale and slate	1,347	1,.62	15
Shells	1,362	1,368	6
Soft white clay	1,368	1,385	17
Shale and slate	1,385	1,397	12
Black shale and shells	1,397	1,426	29
Clay, with shells	1,426	1,448	22
Shell rock gypsum	1,448	1,462	14
Shale and shells	1,462	1,479	17
Sand and shale	1,479	1,497	18
Soft white clay	1,497	1,501	4
Hard rock concretions	1,501	1,506	5
Shale	1,506	1,508	2
Rock	1,508	1,519	11
Soft white clay	1,519	1,524	8
Rocks	1,524	1,531	7
Shale and clay	1,531	1,560	29
Shale and shells	1,560	1,583	23
Clay and boulders	1,583	1,609	26
White clay	1,609	1,619	10
Shales and clay	1,619	1,640	21
Rock slaty	1,640	1,646	6
Rocks, concretions and gypsum	1,646	1,658	12
Sandstone	1,658	1,673	15
White clay boulders	1,673	1,687	14
Shells and concretions	1,687	1,702	15
Sandstone slate	1,702	1,707	5
Rock pyrite	1,707	1,712	5
Gumbo	1,712	1,717	5
Sandstone	1,717	1,728	11
Shale and sand	1,728	1,735	7

THE UNDERGROUND POSITION OF THE AUSTIN FORMATION IN THE SAN ANTONIO OIL FIELDS

By E. H. Sellards

The Austin formation, or Austin chalk, underlies all of the oil fields of the San Antonio district, and is itself productive of oil in the Alta Vista and Mission fields and perhaps to a lesser extent elsewhere. It is a thick formation, varying from possibly three hundred and fifty to four hundred and fifty feet or more, consisting of a chalky, usually light colored or blue rock, and with the possible exception of the Eagleford, which lies next below it, is the most readily indentifiable formation of the Upper Cretaceous series. For this reason it is perhaps the most serviceable of the Upper Cretaceous formations in deciphering structural conditions from well records. It is true that the transition from the overlying Taylor to the Austin is gradual, and that there is probably a lack of uniformity on the part of drillers in recognizing the top surface of the chalk. However, such inconsistencies as arise from this cause, although of importance in detailed mapping, probably do not materially affect the accuracy or records when used in mapping general or regional structures.

The well records here used are those of the Bureau of Economic Geology of the University of Texas, and include many records contributed or made available by several oil companies and individuals.

In Bexar County, the Austin is found at the surface in a belt of country extending through the county in a northeast-southwest direction and passing near, but mostly north of San Antonio. At its northwest margin this belt of Austin exposures is marked by a more or less well defined west-facing escarpment. Beyond this escarpment to the northwest, the Austin is wanting, and the formations at the surface, with the exception of the Eagleford, are of Lower Cretaceous age. On the other hand, to the southeast the Austin passes underneath later formations and is found, as stated, underlying the oil fields.

While the Austin passes below the surface to the southeast, the rate per mile at which it drops to a lower level is by no means uniform. On the contrary it is found from well records that while, in places, the formation drops very abruptly to a lower level, elsewhere it again rises towards the surface, resulting in alternately structurally high and low areas.

To the southeast of the Alta Vista and Somerset fields, the Austin evidently drops to a lower level very rapidly, although there may of course be as yet undetected interruptions or reversals in the dip. That the average rate of descent of the Austin is rapid, however, is demonstrated by the fact that the formation, unless greatly altered in character, was not reached in the Richter well near Pleasanton, about twenty miles south of the Alta Vista field although drilling was continued to a depth of 4015 feet, or to a level of about 3665 feet below sea level.

In the northwestern part of Atascosa County the Austin formation lies at a depth of 1700 or 1800 feet. The drop to the Richter well, allowing for difference in elevation, amounts to not less than 2500 or 2600 feet in fifteen miles. The average rate of descent in the formation crossing Atascosa County in a southeasterly direction is therefore not less than an average of 165 or 175 feet per mile.

In referring to the underground position of the Austin chalk it is of course understood that this formation is but one of a series of formations lying in natural order, the one upon the other, and that where the records are such as to indicate that one of the formations lies at a relatively high elevation it may be with confidence concluded that the other formations of the same series, when not separated by an unconformity, likewise lie at a relatively high level at that locality. In this way a certain formation recognizable in well logs may be used in determining structural conditions, regardless of whether the formation itself is productive or not, and from structural conditions in turn may be inferred to some extent the probability of oil production in that particular locality. Accordingly the Austin, for the reasons given, is here used in depicting the structural conditions in this region so far as these conditions

can be shown on a small map and from wells that are in some parts of the area much fewer in number than could have been desired.

General Structural Conditions in the San Antonio District

No more than brief reference will be made at this time to the general structural conditions in the San Antonio district, these conditions having been somewhat fully described elsewhere. The Balcones zone of folding and faulting, as is well known, passes through this district. The inner margin of this fault zone (inner in the sense of farthest inland from the Gulf) is marked in this part of the State by a pronounced southeast facing escarpment, the trend of the fault zone being northeast-southwest. Beyond the escarpment to the northwest the formations, which are those of the Lower Cretaceous, are but little disturbed by faulting and have a very moderate and scarcely perceptible dip towards the Gulf. To the southeast of this escarpment, on the other hand, is a region of profound disturbance, the formations being both faulted and folded. This disturbed zone is known to be more than twenty miles in width and it may be much wider. The faults observed are normal or tension faults, the downthrow being in the direction of the dip of the fault plane. In most of the faults the downthrow is to the southeast. This, however, is not invariable as faults are seen at the surface and recognized in well drilling in which the downthrow is in the opposite direction or to the northwest. In that case the dip of the fault plane, where observed, is likewise to the northwest. The faults with downthrow to the southeast exceed in number, as already stated, those with downthrow to the northwest; they likewise in general exceed in intensity or in amount of throw. Moreover the regional dip is to the southeast and while there are reversals of dip, these are seldom continued for any great distance. The ultimate result of faulting and folding in this zone is to carry the formations very rapidly to a lower level. When averaged across the county from the Balcones Escarpment to the eastern part of Bexar County the rate of drop in the formations will

be found to fall between 100 and 150 feet per mile, probably a close approximation to 125 feet per mile. But that such an average rate of descent can be applied only in the most general way, becomes apparent from an inspection of the map and records which follow.

Contour Map on the Austin Formation

On the accompanying map there is assembled the information now available on the underground position of the Austin formation in the San Antonio oil fields. The belt of surface outcropping of the Austin is indicated on this map by the shaded area. To the east of its outcropping area the position of the Austin is indicated so far as practicable from records now at hand, by contouring, the contours being in depth below sea level as indicated. Likewise the location of the wells used in contouring is indicated and the depth with respect to sea level, at which the Austin was found in that particular well, is entered on the map.

In this connection it should be stated that the surface elevation of the various wells has been taken largely from the topographic map, although for a number of the wells not on the topographic maps the elevation has been determined approximately by barometer readings. There is necessarily a small possible error in elevation of wells, and this should be taken into consideration in using the map. The possible error from this source, however, is probably less than the average error incident to recording and interpreting well logs, and is probably negligible or nearly so in regional mapping.

In 1920 a bulletin on the geology of Bexar County was issued by the Bureau of Economic Geology, in which structural conditions were indicated by contouring on the Del Rio, a Lower Cretaceous formation.[1] A comparison of the map issued at that time, with the present map, shows that the major structural features recognized from the Del Rio formation, are like-

[1]*The Geology and Mineral Resources of Bexar County*, by E. H. Sellards, University of Texas, Bureau of Economic Geology and Technology, Bulletin 1932, March, 1920.

wise shown by contouring on the Austin formation. However, by the aid of wells drilled during the past two years, the mapping has now been extended into Atascosa and Medina counties. Accordingly the map now issued includes the greater part, but not all, of Bexar County, and a small part of Atascosa and Medina counties. In the southeastern part of Bexar County but little drilling has been done, and in this part of the county no progress in contouring the underground structure has been made. For this reason this part of the county is not included in the present map.

In the map previously issued based on the Del Rio formation, faulting, so far as recognized from underground records, was indicated. The present map has been simplified to the extent of not attempting to indicate such apparent lines of faulting. It may be stated, however, that such new records as have been added since the first map was published in so far as they relate to faulting support the interpretation previously given.

Structural Conditions as Indicated by Contouring on the Austin Formation

The outcropping belt of the Austin in Bexar and eastern Medina counties shows notable irregularities of outline not accounted for by erosion. Thus in the western part of Bexar County north of the Portranca public road there is a broad belt of the Austin which extends in a southwesterly direction into Medina County. This belt of Austin forms a ridge of much greater elevation than the plains at either side. The level and much lower land at the north and at the south is, for the most part, covered by terrace gravels, but such exposures as are seen indicate the Taylor formation. When followed to the southwest, the Austin formation is found to pass under later formations. Again immediately north of San Antonio there is found a similar, although much narrower belt of the Austin formation, extending into the northwestern part of the city, and forming the surface exposures seen in Brackenridge and San Pedro parks. Surface exposures of the Austin, in

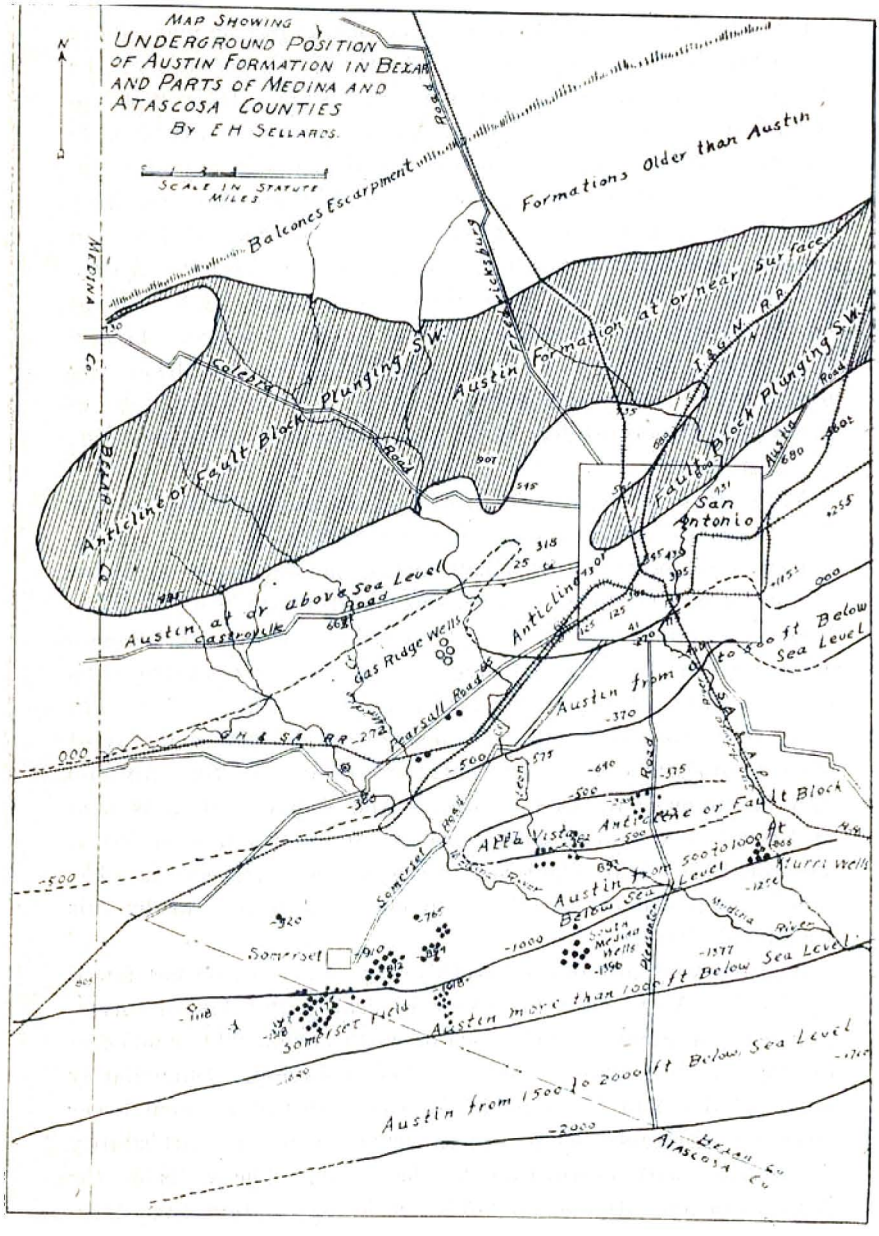

Fig. 1.—Map showing approximately the underground position of the Austin formation in Bexar and in the adjacent parts of Medina and Atascosa Counties. Shading indicates area where the Austin is at or near the surface. Contours on the Austin chalk. Contour interval 500 feet. Sea level datum.

this locality, are found at an elevation of 800 feet or more above sea, while both to the north and to the south the top of the Austin is encountered at a much lower level. It is thus apparent that these two belts of Austin exposures are due to structural conditions. In the case of the Austin exposures in San Antonio, faults are observed which limit the exposures at the south, these faults giving rise to the San Pedro, San Antonio and Salado Springs. At the north side, the Austin is limited by faults with downthrow to the north or by abrupt northwest dips in the strata. In the case of the broad belt in the western part of the county, the structural conditions are produced either by step-faulting or by folding. In each instance the structural feature is a southwest plunging anticline or fault block.

While these structural features are observable at the surface in the central part of the county, they are more or less obscured south of the Austin belt by the non-resistant character of the formations together with the mantling surface materials. From examination of the well records, however, it becomes apparent that this type of structure, southwest plunging anticlines or fault blocks, is characteristic of the area as far south at least as the south line of Bexar County. Thus the fault block seen from surface exposures in the city of San Antonio may be followed by well records to the oil and gas wells west of Leon Creek, and possibly also as far as the Medina River. The Gas Ridge field, which has produced chiefly gas, and in addition a small amount of oil, is obviously accounted for by this structural feature.

Another very pronounced structurally high area is that found at the Alta Vista oil field. At this locality the Austin formation lies about 300 feet below sea or within about 900 or 965 feet of the present surface (900 log; 965 samples). Immediately north of the Alta Vista field the Austin lies at a much lower level, the difference being so great as to suggest the probability of faulting with downthrow to the north. The wells of the Alta Vista and Mission oil fields are located within this structurally high area.

Relation of Producing Wells to Structure.

The principal groups of producing wells in this region are indicated on the map. These include the Somerset field, South Medina and Yturri wells, Alta Vista and Mission pools, and the Gas Ridge wells. It will be seen that these producing wells are associated with the structural features of this area. It is probable that production is controlled in some fields by faulting and in others by folding. In either case production is likely to come chiefly from the southeast slope of the structurally high feature. That is, the favorable location for a well is either on or somewhat east of the axis of the "structure." This is probably due to the fact that the structural features of this area are unsymmetrical, the northwest slope being short and hence affording but little collecting area for oil. The southeast slope, on the other hand, in which the strata are returning to their normal southeast dip, is likely to be long and thus to afford a considerable collecting ground for oil. With regard to the kind of faults that favor accumulation, it is to be remembered that there are many faults of varying intensity making up what is known as the Balcones fault zone. Most of these faults have the downthrow to the southeast, that is in the direction of the regional dip. Such faults, with downthrow to the southeast, do not provide favorable conditions for the accumulation of oil, for the reason that they merely intensify the rate of dip or descent of the formations to the southeast. Some of the faults of this zone, however, have the downthrow to the northwest. In all of these faults, the fault plane dips towards the downthrow side. In the case of a fault with the downthrow to the northwest, it follows therefore, that the "drag" which is incidental to faulting amounts to or brings about a short abrupt dip of the formations in the direction of the downthrow, or in this instance to the northwest. These conditions, without doubt, explain the fact that it is the faults with downthrow to the northwest that bring about conditions favorable for production, the drag to the fault plane serving as reverse dip, aided possibly by deposition in the fault plane.

Producing Formations

With regard to producing formations, more or less production, or oil showings, have been obtained from all of the Upper Cretaceous formations in this area and possibly to some extent from the Midway, which overlies the Cretaceous. In the Somerset field the principal production is from about 500 feet above the top of the Austin chalk and probably near the contact of the Taylor and Navarro formations. The Lower Cretaceous now known to produce oil in Limestone and Caldwell counties, is present, underlying the Upper Cretaceous.

Well Records

The wells used in recording the underground position of the Austin formation are listed in the following table. The "map entry," given in the table, appears also on the map and is intended to assist in locating the well. It records also the elevation of the top surface of the Austin with respect to sea level as nearly as has been determined for that particular locality. Thus the entry 412 records the top of the Austin as 412 feet above sea level. Entries preceded by the minus sign, as —1700, record depth of the Austin below sea level. In addition to the logs used in mapping a few have been added in Bexar, Medina, and Atascosa counties, which are beyond the area covered by the map.

BEXAR COUNTY

Name of Well.	Location	Elevation	Total Depth.	Top of Austin.	Map entry.
Allen, D. J.	Kelly Field?	'80	1,054	600	80
Applewhite	16 mi. S	500	1,952	1,896	—1,396
Arrowhead Oil Co.	2¾ mi W., 1 mi. N Somerset	650±	1,700	1,570	—920
Basse, E. F.	5 mi. N San Antonio	760T	590	25±	735
Benke, Mrs K.	22 mi. N. W	1,090T	1,600	700	730
Blue Wing Club	12 mi. S	490T	2,444	1,746	—1,256
Brendle, H.	527 Bandera St., S. A.	720		180	540
Breckenridge Well	Near Salado Creek	630	1,018	70±	560
Brown, Marathon Oil Co.	2 mi. due E. Somerset	625±		1,519	—894
Cassin	9 mi. S. S. A.	550	1,463	973?	—423
Clamp, C. C.	6 mi. west	700	1,452	662	38
Collins Gardens	S. W. Pt S. A.	650		525	125
Carney, Glen	7½ mi E. of San Antonio	650	1,226	530±	120
Elder and Wolf	8½ mi S S A. (Alta Vista)	600	1,?86	9?0±	—300

BEXAR COUNTY—Continued

Name of Well	Location	Elevation.	Total Depth	Top of Austin.	Map entry.
Frederick Well	7½ mi. S W San Antonio	655	1,200	740	—85
Guenther Milling Co.	902 Morales St., S. A.	675		250±	425
Government Well, Aviation Post	6 mi. N. E	735T	874	55±	680
Government Well	Hackberry St., near Ave C	689	729	258	431
Heil, H	4 5 mi. W	682	1,266	621	62
Hill and Roby	7.5 mi. S.	625	1,800	1,200	—575
Hofheintz, R. H.	N. of Kelly Field	680	1,453	600	80
Holtz	9 mi. S W.	610	1,065	1,200±	—575
Hot Wells	4 5 mi. S.	575	1,878	990	—415
Kearney Oil and Pipe Line Co.	12 mi. S of S A.	610	2,355	957	—347
Kreutch, O	5.5 mi E. S A	675	1,000	420±	255
Kunz	1 mi. S E. of Somerset	638	1,050	1,150	—512
Legler, W. F	5 mi. W	695	1,555	670	25
Linn 2	12 mi S	550	1,443	1,094	—544
Lone Star Brewing Co.	120 Jones Ave	660	805	248	412
Lamm 1, Ulf-Valnes Exploration Co.	16 mi S	500	2,693	2,200±	—1,700
Masterson 1, Meecham Oil Co	18 mi W	750	2,245	255	495
McIntosh, Mrs.	7 mi E of S A.	700	668	30±	670
Mathey 1, Bexar Petroleum Co	1 mi W Losoya	515	2,332	1,892	—1,377
Medina Oil Co.	12 mi S	530	1,833	1,012	—482
M K T Ry	Landa	784	643	60±	724
Perrinot Well, Schlather Ind.	2 mi S. W Martinez	680T	1,375	1,239	—559
Porch Well	11½ mi S	530T	1,505	Not reached	—975+
Ridder, A. J.	13 mi. S W.	628	2,911	900±	—272
S A & A. P. Ry	Probaa and Simpson Sts.	630	1,103	500	130
San Antonio City Water	Market St	650	880	220	430
San Antonio City Water	Conception Mission	607	1,440	780	175
San Antonio Portland Cement Co.	5 mi. N	740	667	60	680
Schmidt, Marathon Oil Co.	1⅛ mi. due E. Somerset	635±		1,579	—944
Shatuck Well	19th St. W.	678	667	335	343
Smith, Sarach	2 mi. E. S. E. of Somerset	650±	1,668	Not reached	—1,018+
Southern Ice Co	Frio and Durango Sts.	655	822	260	395
Southwest Land Corporation	4 mi. W.	708	1,000	390	318
Somerset Well	Somerset, cored by Kerr at 1600. Austin 1,560-1,950.	650	2,320	1,560	—910
St. Louis College	W. 5.t	760	702	215	545
Steves, Mrs. J.	Steves Garden	645	1,185	604	41
Steves, Mrs. J.	509 King Williams St.	645	758	250	395
Steves, Ed.	8.5 mi. S. of S. A.	660	1,840	1,300±	—640±
Sullivan, D.	3½ mi. S. E. of S. A.	620	1,100	505±	115
Taft, L. S.	7 mi. E. of S. A.	665	1,240	880	215
Terrell Hot Well	5.2 mi. S. of S. A.	630	1,956	1,000	—370
Terrell, J. H.	S. W. city limits, S. A.	675	1,140	550	125
Texas Steam Laundry	205 Losoya St.	665	748	290	375
Tommins, R.	South city limits, S. A.	630	1,500	900	—270
Union Meat Co.	Laredo and Ralph Sts., S. A.	640	1,400	340	300
Voght, Wm.	14 mi. S. W. of S. A.	605	1,850	985±	—380
Walsh, Meechum Oil Co.	12 mi. S. of S. A.	550	1,736	1,403	—853
Waring Well	7.5 mi. N. W. of S. A.	920	2,853	13	907
Yturri 1, W. H. Reynolds et al.	9½ mi. S. San Antonio	510±	3,460	1,476?	966?

MEDINA COUNTY

Name of Well.	Location.	Elevation.	Total Depth.	Top of Austin.	Map entry.
Blackaller 1, Mid-Frio Oil Co.	5 mi. E and 3 mi. N. of the S. W. corner of county	800T	3,115	1,960	—1,160?
W. Gainand, Somerset, Western Oil Co.	Thomas Surv. 516	745	1,648	1,550	—805
Gray Well	Abt. 1 mi. S. E., Lytle 8 mi., 113½ Th. Thomas				
Haas, Geo.	4½ mi. S. W. of Dunlay	1,000	1,000	975	125
Kimble, Osman Oil Co.	Near Devine, 2 mi. S. W. S. Reiden, John No. 28	670	2,540	2,287	—1 617
McClure, T. S., 1	3 mi. S. W. Dunlay Sta on S. P. Ry. See T. S. McClure, 142 Goliad St.		1,283	710	

ATASCOSA COUNTY

Name of Well.	Location.	Elevation.	Total Depth.	Top of Austin.	Map entry.
Caruthers 11, Grayburg Oil Co.	About 2 mi. S. W. Somerset		2,378	1,775	
Childress No. 1, Leming Oil & Gas Co. Now owned by Hollingsworth, Pleasan on	1 mi. S. of Leming	450A	2,600	Not reached	—2,150+
Foster, Grayburg Oil Co.	Somerset Oil Field 5½ mi. W. S. W Somerset Survey 523	745A		1,863T	—1,118
Fowler, Gulf Production Co. Fowler Lease No. 2	Somerset Oil Field 2. mi. S. W. Somerset		1,829	1,825	—1,175
Hartung Lease 1. W. 1. Grayburg Oil Co.	Survey 140, 3 mi. ± S. W. Somerset		1,979	1,968	—1,318
Hartung 17, Grayburg Oil Co.	4½ mi. S. W. Somerset Surv. 385, J. J. Knott		2,729	2,290	—1,640
McCain Lease 1. W. 2. Grayburg Oil Co.	Survey 1,970, S W. of Somerset		1,975	1,973	—1,323
Muennick Well 2. Grayburg Oil Co.	Atascosa County		1,908	1,908	—1,253
Richter 1, Galvan Oil Co.	1½ mi. N. E., Pleasanton, E. H.,, Timmons Surv., N. W. part	350A	4,015	Not reached	—3,665+