THE PRODUCING HORIZON IN THE RIOS WELL IN CALDWELL COUNTY

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The Producing Horizon in the Rios Well in Caldwell County

BY

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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 PRODUCING HORIZON IN THE RIOS WELL IN CALDWELL COUNTY

BY E. H. SELLARDS

Caldwell County lies within the Gulf Coastal Plain of Texas, near its west margin. The Balcones escarpment, which forms the boundary line between the Coastal Plains and the Edwards Plateau, passes west of this county, but within five or six miles of the county line. The formations at the surface in Caldwell County are those of the Upper Cretaceous and the Lower Tertiary. The Upper Cretaceous formations include the Taylor and Navarro, while of the Tertiary formations, there are present the Midway and the Wilcox. To what extent other Eocene formations, including the Carrizo and Mt. Selman, are developed in this county has not been determined.

Except where concealed by terrace materials, the Navarro and Taylor formations of the Upper Cretaceous lie at the surface over a narrow belt at the west margin of the county. This Cretaceous belt is widest at the south side of the county and narrows to the north margin of the county where its width scarcely exceeds two miles, and where the Navarro formation only is present. The town of Maxwell lies within the Cretaceous, although near its east margin.

Next east of the Cretaceous is the Midway formation, which occupies a narrow belt passing through the county from north-northeast to south-southeast. Coöperative work between the United States Geological Survey and the Bureau of Economic Geology of the University has resulted in identifying several Midway localities within this area. Among these localities is one four and six-tenths miles slightly south of west of Lockhart where clays are exposed containing a Midway fauna. Other similar localities are found on the Lockhart-Austin road, one and one-half and two miles north of Lockhart. From a well about eleven miles west of south of Lockhart and about two miles southwest of Joliet, Midway fossils were obtained. This well, which starts in the Wilcox formation, was drilled to the depth of 340 feet. Shell bearing clays and shales are reported in the

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well beginning at sixty feet from the surface and extending to the full depth of the well. The Midway fossils obtained were from the dump, their position in the well being unknown except that certain of them are stated to have come from 320 feet. These localities indicate that the Midway is found a few miles west of Lockhart and probably extends somewhat east of Lockhart. The trend of the outcropping belt of the formation is north-northeast to south-southwest. Next east of the Midway is the Wilcox formation.

In traveling south from Lockhart, on the Lockhart-Luling road, exposures representing the Wilcox are first seen on Clear Fork Creek and its tributaries about four miles south of Lockhart. On the San Marcos River six miles northwest of Luling and near the Cartwright wells is an exposure consisting of very sandy micaceous clays including several strata of cone-in-cone concretionary layers. This exposure is referred provisionally to the Wilcox. The eastern margin of the Wilcox has not been determined, but the formation may be expected to have a greater width than the Midway and to pass through the county from north-northeast to south-southwest. It is probable that formations later than the Wilcox come into the section before reaching the east county line. Sands probably representing the Carrizo formation are seen near Ivy, in the southeastern part of the county.

Regional Structural Features. The regional dip in Caldwell County is in a southeasterly direction, so that, with the exception of any reversals in dips that may occur, successively younger formations come into the section as one travels to the east or southeast. The average rate of dip in the formations across the full width of this county has not been determined. It is known, however, that the Austin formation, which is found at the surface in and near San Marcos, is encountered in the Cartwright and Thompson wells at depths varying from 1742 to 1835 feet. The Austin exposures at San Marcos are at an elevation approximating 600 feet above sea, while the elevation of the Cartwright wells, as indicated by the topography map, is possible 150 feet lower. Taking this difference in surface elevation into consideration, this record indicates that the Austin drops to a

lower level across this interval at a rate approximating 100 feet per mile. It is probable that this change in level comes about through faults as well as through dips.

Zone of Faulting. The Balcones Escarpment seen at San Marcos marks the west margin of the Balcones Fault Zone. Faulting in this zone is particularly heavy in the vicinity of San Marcos, so much so that the Austin formation, which has a thickness of several hundred feet, occupies in this area no more than a very limited surface exposure, and in places is almost entirely faulted out of the section. The Balcones Zone of faulting occupies a considerable width and includes most if not all of Caldwell County. To what extent, however, faulting is developed in this county, can be determined only by careful detailed investigation.

Local Structural Conditions. In many of the faults of the Balcones Fault Zone, including the large fault, which is responsible for the Balcones Escarpment, the downthrow is to the southeast. However, within this fault zone are occasional faults in which the downthrow is in the opposite direction, that is, to the northwest. One of these faults with downthrow to the northwest is seen in an exposure on the left bank of the San Marcos River, six miles northwest of Luling, and near the Cartwright wells. The fault in this place trends in a northeasterly direction and the fault plane dips steeply to the northwest. The faulting in this immediate locality may be somewhat complicated, but that at least one fault occurs having downthrow to the northwest is indicated by the "drag."

Thickness of Formations. The deep well drilled at Maxwell, starting probably in the Navarro formation, apparently penetrates all of the underlying Cretaceous. In this well white rock, presumably the Austin, is recorded from 760 to 1036 feet, or through an interval of 267 feet. "Gumbo," probably representing the Eagleford formation, is found from 1036 to 1071 feet. The several lower Cretaceous formations are scarcely separable, the one from the other, in the well log. However, the Lower Cretaceous, as a whole, apparently extends from 1071 to about 3405 feet, indicating a total thickness of the Lower

Cretaceous at the locality of 2334 feet. Below the Cretaceous at 3415 feet, are found rocks of undetermined age, but believed on the authority of Dr. J. A. Udden, who examined samples through this interval, to be older than the Cretaceous.

A measurement of the full thickness of the Cretaceous above the Austin in this county has not been obtained. However, a shallow well two miles southwest of Joliet, located on the Mercer farm, apparently terminated in the Midway, as indicated by the fossils on the dump, at a depth of 340 feet. The Rios well, not more than two miles to the southwest of this shallow well, entered the Austin at 1635 feet. These records indicate for the Cretaceous, above the Austin in this county, a total thickness of approximately 1350 feet, or less. The thickness of the Midway and Wilcox and other Eocene formations in this eastern part of the county, has not been determined.

Available Literature and Geologic Maps. The geologic literature on Caldwell County is limited. The Austin quadrangle mapped by the United States Geological Survey includes a small part of the northwest corner of the county, and the map of that quadrangle indicates the distribution of the late Cretaceous and early Tertiary formations in that area. The Geologic map which accompanies Bulletin 44 of the University of Texas indicates approximately the Cretaceous and Tertiary areas of the county. The investigation now in progress in coöperation between the United States Geological Survey and the Bureau of Economic Geology and Technology of the University of Texas will afford the data for a publication to be issued when the investigation has been completed, relating to the Midway formation of this and adjoining counties.

Oil Production. One well producing oil in this county has recently been obtained. This well, which is owned by the United North and South Oil Company, is located on the Rios farm about six and one-half miles northwest of Luling, and about one and one-half miles from the San Marcos River. The well was drilled in about August 10, and is flowing by heads and making some water with the oil. The gravity of the oil is reported as being about 28-B.

Production in this well is, with little doubt, associated with the fault already referred to as being seen near the Cartwright wells on the San Marcos River. Faults with downthrow to the northwest bring about conditions favorable to production for wells located near but east of the fault line. On the other hand, faults with downthrow to the southeast, which are much more common than those with the downthrow to the northwest, do not necessarily influence production. The explanation is probably found in the fact that since the regional dip is to the southeast a fault with downthrow in that direction merely accentuates the dip, while a fault with downthrow in the opposite direction, that is, to the northwest, has the effect, by reason of the "drag," incident to faulting, of reversing the dip. The more or less complete filling of the fault plane with secondarily accumulated materials may likewise assist in forming a trap for accumulation of oil. Oil pools controlled by faults of this kind are likely to extend, if at all, with the trend of faults.

The Producing Horizon

In a press bulletin issued by the Bureau of Economic Geology and Technology of the University of Texas, August, 1922, the writer expressed the tentative conclusion that the producing horizon in the Rios well in Caldwell County, known as the Luling well, is probably from the Georgetown-Edwards series of limestones of the Lower Cretaceous. In view of the general interest as to the producing horizon in this well, it seems worth while to give more fully the evidence on which this conclusion is based. As in the previous paper the data given are from the records of the Bureau of Economic Geology and Technology of the University of Texas, and used with the permission of the Director of the Bureau.

Of several wells drilled in Caldwell County, the record of the three Cartwright wells, located about one and one-half miles southwest of the Rios well, is perhaps the most complete. That Cartwright 2 had penetrated the Eagleford, Buda, and Del Rio formations, and entered the Georgetown-Edwards series of limestones was determined by Dr. J. A. Udden as early as April, 1922. The interpretation of the formations penetrated in the

Cartwright wells is greatly facilitated by having at hand a core taken at the depth of 2117 feet, which contains a number of fossils. The most abundant fossil in the rock at this depth is the small shell known as the "ram's horn" shell, *Exogyra arietina*. As this fossil is characteristic of the Del Rio formation we have from this core a definite starting point in the interpretation of the record of the well. By the aid of the samples and from the driller's log the Del Rio, in this well, is identified as extending from 2068 feet to 2176 feet. Under the Del Rio is a porous limestone impregnated with petroleum. This limestone is interpreted as of the Georgetown-Edwards series of limestones. Drilling in Cartwright 2 was continued to 2411 feet.

Next above the Del Rio formation in Cartwright 2 is found thirty-four feet of limestone, representing the Buda formation. This rock differs from the Buda as commonly observed in wells in that it is for the most part chalk-like in appearance and contains glauconite. The rock next above this limestone is identified from the driller's log and from samples as the Eagleford formation, which in this well has a thickness of forty-nine feet. Next above the Eagleford is the Austin Chalk, which has, according to the driller's log, a thickness of 249 feet. No samples of the Austin have been received from Cartwright 2. However, a core was taken from Cartwright 3 at a depth of 1923 feet, and hence within the interval assigned to the Austin.

Inasmuch as the Cartwright wells afford valuable aid in the interpretation of the formations in this county there is included in the following paragraphs the description of samples from one of these wells made while the well was in process of drilling. The descriptions are by Dr. J. A. Udden, and are included with his permission. The log of this well is given subsequently.

Description of samples from the United North and South Oil Company's Cartwright 2, on G. C. Kimble League, six and one-half miles northwest of Luling, two and one-half miles southeast of Prairie Lea, Caldwell County. Submitted by W. F. Peale, Luling, Texas.

BY J. A. UDDEN AND P. T. SEASHORE

	Depth in Feet
Sample consists of two fragments of a core of grey, thinly laminated, calcareous shale containing fish remains, such as bones and scales. This shale splits readily along the laminations. In thin section the shale is seen to be of uniformly fine texture, and to contain a great abundance of foraminifera like Orbulina, Globigerina, and Nodosaria (?). Several ostracod valves noted. The laminations in this shale are caused by layers which are composed largely of foraminifera. The bands of foraminifera are from ½ to 1/3 mm. apart. The more clayey bands between the layers of foraminifera are composed of still finer layers, possibly consisting of flattened foraminifera. In this matrix are white calcareous lentils, which probably consist of flat or flattened organic fragments. There are flat layers of black bituminous material. In matrass the shale gives strong odor of bitumen. When inserted in an open flame the shale burns and gives off the odor of burning peat and tallow. In washed material some yellowish calcite and a few scattered crystals of pyrite noted. Fossils: Globigerina, Orbulina, and Textularia. Several fragments of fish scales and Inoceramus prisms present. Eagleford.	1993
Very light grey, soft, almost white limestone or chalk. In thin section it is seen to be of very fine texture and to contain a number of cavities filled with a yellowish green mineral. Several spherical cavities, evidently of organic origin, filled with calcite noted. These range in size from .3 mm. to .1 mm. in diameter.	2038
White limestone containing many minute fragments of glauconite (?) and some shell fragments. In thin section the limestone is seen to be very fine-grained. Several fissures and cavities filled with calcite noted. Foraminifera are found in great abundance. Such forms as Orbulina, Globigerina, Lagena, and Nodosaria were recognized. Several ostracod valves noted. In places where the green grains are not found, the rock has the typical appearance of the Buda limestone	2040
Sample consists of a 3″ core of bluish grey calcareous	

Depth in Feet

shale or marl. Megascopically it is seen to contain shells of Pelecypods. Among these can be recognized Exogyra arietina Roemer. Considerable calcite and pyrite noted in the washed material. Fossils: Orbulina, Globigerina, Textularia, Cristellaria, Anomalina, Nodosaria, Polymorphina (?), and several unrecognizable forms. A sponge spicule present. Six different types of ostracods noted. Of these one has a pitted, two have smooth, and three have a highly ridged carapace. Del Rio in aspect 2117

The sample consists of several pieces of a four-inch core. It is a soft dolomitic and bituminous yellowish grey limestone, containing some fossil fragments. Among these were noted a piece of the test of a sea urchin, several ostreid fragments, fragments of a Requienia patagiata.(?) In thin section the rock is seen to have a lumpy texture and to contain imbedded fragments of fossils mostly replaced by calcite. From below the Del Rio, probably Georgetown, possibly the Edwards..... 2182-2184

Grey marly shale with some yellowish grey dolomitic limestone like that of the preceding sample. The shale contains foraminifera such as Textularia and Globigerina, Anomalina ammonoids, and Cristellaria. A large oblong ostracod, an echinoid spine, fragments of shells and fragments of a Bryozoan (monticuliporcid (?) noted. The latter forms a flat tablet and the polyps or zoöecia are more or less arranged in orderly lines..... 2184-2188

The sample consists of two large pieces of a grey limestone like that in the preceding sample and two large pieces which show effects of heating and wearing by the drill. The rock itself, so affected, seems to have been calcareous. A fifth fragment is perhaps an impure calcareous chert. The rock is too much altered by the drill to be recognized..... 2197-2198

The sample consists of a dozen large pieces. Five of these appear to be impure soft and fragile dolomite like some of the rock described above. It contains sufficient oil to give a strong odor. The other pieces are grey marly shale, some of which contain many small fossils. Fossils: Cristellaria cultrata, Truncatulina, Anomalina, Nodosaria zippei(?),

	Depth in Feet
Bythocypris, Nodosaria radicula, Nodosaria pauperata, Nodosaria consobrina. These foraminifera are of a larger size than is common in the Cretaceous	2218-2220
Sample consists of a piece of a core of yellowish dirty grey, porous dolomite, highly impregnated with oil. It contains some very large calcite crystals and fragments of poorly preserved mollusk shells. In thin section the limestone is finely crystalline. Aspect of Edwards limestone.....	2235-2236
Sample consists of a piece of a core of yellowish dirty grey dolomite impregnated with oil. On a polished surface this dolomite is seen to contain shreds and specks of bitumen. These shreds are mostly parallel to the bedding plane. In thin section the dolomite is seen to be finely granular and to contain minute fissures filled with a bituminous material.	2240-2241
Sample consists of a piece of a core of grey, somewhat soft and chalk-like limestone. This limestone is seen to contain many minute cavities filled with calcite. These are evidently casts of foraminifera. In thin section the limestone is seen to be finely crystalline and to contain specks of a black material.	2242-2243
Sample consists of a piece of a core of grey compact limestone containing many shell fragments. There are also included in the sample several pieces of grey marl. The shell fragments present in the limestone are believed to be Requienia. In thin section the limestone is seen to be fine grained and has a lumpy texture. Many minute crystals of calcite noted. In the washed material from the marl, calcite and pyrite were noted. The pyrite occurs partly in irregular grains, partly as oolitic masses and very largely also as fillings in the shells of foraminifera. Some minute crystals of sphalerite and perhaps some of Galena (?) were noted. Fossils: Nodosaria, Polymorphina, Textularia, Globigerina, Anomalina, and Pulvinulina were the foraminifera noted. Several prisms which resembled those from Inoceramus and a minute shark's tooth, like one previously noted in the Upper Cretaceous. . . .	2245-2246

Depth in feet

A piece of a core of dirty yellowish brown porous dolomite highly impregnated with oil. This dolomite is irregularly laminated. Most of the laminations tend toward about a 15° dip, one is nearly horizontal, while another dips into it, the whole being perhaps the result of cross-bedding. Evidence not conclusive. In thin section the dolomite is seen to have a slightly lumpy texture and to be very finely granular. Two limited areas in one section have a finer and different texture from the rest, and appear to be only slightly altered remains of fossils in the original rock 2250-2251

Sample consists of several pieces of a core of light grey limestone and a piece of grey very slightly calcareous clay. On a polished surface the limestone is seen to contain many foramininfera casts filled with calcite. In thin section the limestone is seen to be granular and to contain many foraminifera. The washed material from the clay contains a few fossils: Foraminifera resembling Cristellaria gibba, Rotalia, Nodosaria, and Anomalina noted. Fragments from larger shells, like those from pelecypods also present. 2258-2259

Sample consists of several pieces of a core of dirty brownish grey porous dolomite highly impregnated with oil. Some of the pieces of the core are changed to a porcelain-like consistency by heat developed in drilling. In thin section the dolomite is seen to be very finely granular..... 2265-2266

Sample consists of about four cubic inches of light and dark grey marl and a piece of a core of light grey limestone. Into the marl has been introduced pockets of glauconite rock, almost pure glauconite. This mixing may perhaps be due to work by the drill. If such is not the case the sample suggests that the drill has been going through a fault breccia or a cave deposit. The glauconite is in part almost black and in part green. The grains show the usual external reticulated sutures. In size these grains range up to ½ mm. in diameter. In thin section the limestone is seen to be granular with small pockets of calcite representing casts of foraminifera. In the washed material from the marl, the following fossils were found: Foraminifera resembling

Depth in Feet

Nodosaria zeppei, Nodosaria obliqua, Nodosaria radicula, Nodosaria nitida, Nodosaria consobrina, Cristellaria obtusata, Cristellaria cultrata, Cristellaria gibba, Cristellaria mamilligera, Anomalina ammonoides, Anomalina grosserugosa, Rotalia Tritaxia, Lagena, Polymorphina lactea, Polymorphina compressa, Pulvinulina, four types of Frondicularia, one of which is very narrow and about 4 mm. long, Globigerina, Textularia sagittula, Truncatulina refulgens, Spirillina, and several other foraminifera which could not be determined. Ostracods, both with smooth and with fluted and pitted carapaces noted. Fragments of Pelecypod and gastropod shells, Dentalium fragments and Inoceramus prisms (?) present. Several otoliths, fish teeth and spines and Echinoid spines were also noted.... 2269-2270

Sample consists of several pieces of grey marl and a piece of a core of light grey chalk-like limestone. The grey limestone under the hand lens shows traces of fossils, minute crystals of calcite, and areas of lighter colored limestone. In thin section the limestone is seen to be finely granular and very uniform in texture. The washed material from the marl contains some calcite and pyrite. Bright red hematite grains noted. These range up to 1 mm. in diameter. Fossils: A large Cristellaria cultrata measuring about 1 mm. in diameter, a nodosaria resembling Nodosaria pauperata, several Anomalina ammonoides and a fragment which may represent Frondicularia. An ostracod present, which is very wide at the hinge, this wide part being covered with longitudinal flutings. Several fragments of well-preserved thick fish scales and many Echinoid spines present. Several fragments of granular calcite, which were washed from the marl, show slickensides with very straight and delicate striations on one surface..... 2273-2274

Sample consists of several pieces of grey marl and a piece of a core of dirty brownish grey somewhat dolomitic limestone showing embedded fragments of fossils. In the washed material from the marl are found fragments of brownish finely crystalline dolomitic limestone, a few fragments of a black bituminous material, and several aggregates of minute crystalline pyrite. Fossils: Fragments of a

Depth in Feet

Nodosaria, Textularia, ostracods, fragments of casts from Gastropods and Inoceramus prisms. In thin section the limestone is seen to be finely crystalline and to contain areas filled with clear calcite. Slickensides on granular calcite noted..... 2280-2281

Sample consists of a piece of a core of soft grey porous limestone and several pieces of grey calcareous shale or marl. In the washed material from the marl were found fragments of white limestone and grey dolomitic limestone. Considerable glauconite present. These glauconite grains show the regular reticulated surfaces. Fossils: Anomalina, Globigerina, Textularia, Cristellaria cultrata (?), Cristellaria gibba (?), a ribbed Nodosaria, Vaginulina, Nodosaria pauperata (?), an ostracod carapace, and several Inoceramus prisms noted. Fragments of shells like those from pelecypods, and fish remains, such as fragments of spine noted. A small black spherical body about .3 mm. in diameter with a smooth polished exterior. This body resembles some found in the Conn Bros. No. 2, near Kyle in Hays County. On a polished surface the limestone is seen to contain small nodules of a lighter colored limestone. Some very fine quartz sand and small areas filled with calcite. In thin section this limestone is seen to be fine grained and to have a lumpy texture, rather chalk-like..... 2305-2306

Sample consists of several pieces of a grey marl and a piece of a core of grey limestone. On a polished surface this limestone is seen to contain some minute cavities filled with calcite. Many black specks noted. These cavities and specks are evidently casts of foraminifera. The limestone is seen to contain irregular lumps of darker rock surrounded by a matrix of lighter colored rock. These lumps range in size upward to more than an inch and reminds one of blotchings seen in the Austin Chalk. In thin section the limestone is seen to be fine in texture and to contain a few obscure traces of foraminifera. The washed material from the marl contains mainly fragments of light grey limestone, considerable pyrite, and a few grains of glauconite. Much of the material has been altered by the heat generated in drilling. Several ostracod carapaces,

	Depth in Feet
a Pulvinulina, a Globigerina, and a Textularia present in the sample.....	2408-2409
Sample consists of several fragments of grey marl and a piece of a core of pure and minutely crystalline white strontianite. One surface of the core of strontianite has an adhering layer of grey limestone. The contact between the limestone and the strontianite is very irregular, but bends in such a way as to suggest that the strontianite has been deposited in a cavity in the limestone or has grown as a concretion. In thin section the limestone is seen to be finely textured and to contain many minute crystals of calcite. The washed material from the marl yields mostly fragments of a light grey limestone, brownish crystalline dolomite and white strontianite (?). A few crystals of pyrite noted. Many of the fragments have changed to a porcelain-like substance by heat developed by the drill. Prisms like those from Inoceramus noted. A Textularia and Globigerina present.....	2448-2449

NOTE BY J. A. UDDEN:—The samples from 2245-2246 down to 2280-2281 show several features that strongly suggest that the drill in this distance has been close to a fault plane. The strongest evidence is in the occurrence of a shale or marl which contains a fauna of Upper Cretaceous fossils, such as occur in the upper part of the Taylor or in the Navarro. Upper Cretaceous material was found occurring below the Georgetown and perhaps below or in the Edwards limestone. The presence of glauconite in association with the marls having an Upper Cretaceous fauna corroborates such a conclusion. The same may be said of the occurrence of straight slickensides and such minerals as sphalerite, hematite, galena(?), and abundant pyrite. The fact that limestone and bodies of glauconite have been worked into some of the marl suggests that the drill may have gone through a fault breccia. Pieces of marl in which this was observed appeared to be parts of a core, but little disturbed by the work of the drill.

Another explanation that would account perhaps equally well for the finding of Upper Cretaceous material in the Upper Comanchean and for the mineralization and brecciation noted would be that the drill has in the distance from 2245-2281 penetrated a cavern deposit. In a fault plane one would rather expect to find more calcite than occurs in the present samples. On the other hand, more sand would perhaps be expected in a cavern deposit than was found in the present samples. The strongest evidence for this material being regarded as a cavern deposit is the presence in the marl of what appears to be sorted

glauconite grains, which are most likely to have been washed together by running water, such as might form a cavern deposit. Fragments of harder parts of the country rock are usually present in the cavern deposits, into which they are introduced either by falling from the walls of the caverns or by water running in the caverns.[1]

Since writing the above it appears possible that the samples may represent material mixed in drilling.

The Rios Well

The record of the Rios well is made up from cores and cuttings of the rock drilled through, and from the driller's log. According to the log, chalk rock was drilled through in this well from 1630 feet to 1868 feet, a total of 238 feet. No samples have been obtained of this chalk. However, immediately under the chalk, at 1898 feet, samples were obtained which are of the character of the Eagleford formation. From the log some difficulty is experienced in fixing the lower limits of the Eagleford in the Rios well. It seems probable, however, that the Eagleford is to be regarded as extending to 1961 feet, having thus a thickness of 93 feet. This interval of 93 feet includes 50 feet logged as "broken rock" and as limestone, which may or may not be properly included in the Eagleford. Next underlying the Eagleford is a light colored limestone rock identical in character with that regarded as the Buda in the Cartwright well, the rock being chalky in appearance, and containing glauconite. In my previous publication I referred to the presence of glauconite as an unusual feature of the Buda formation. Recently, however, Dr. R. T. Hill has called my attention to the Austin folio of the United States Geological Survey, in which the Buda limestone found on Shoal Creek, in the vicinity of Austin, is said to be glauconitic. The glauconite of the Shoal Creek rock, however, is inconspicuous and not easily recognized, in this respect differing from the conspicuous green glauconitic particles in the rock from these wells.

A sample from the Rios well at 2005 feet presents the lithologic appearance of the Del Rio formation, although from this sample, which is limited in quantity, no index fossils of that formation were obtained. A sample taken at 2136 feet consists in part of a very porous limestone impregnated with petroleum.

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[1]Bull. U. S. Geol. Survey, No. 505, p. 87, 1912.

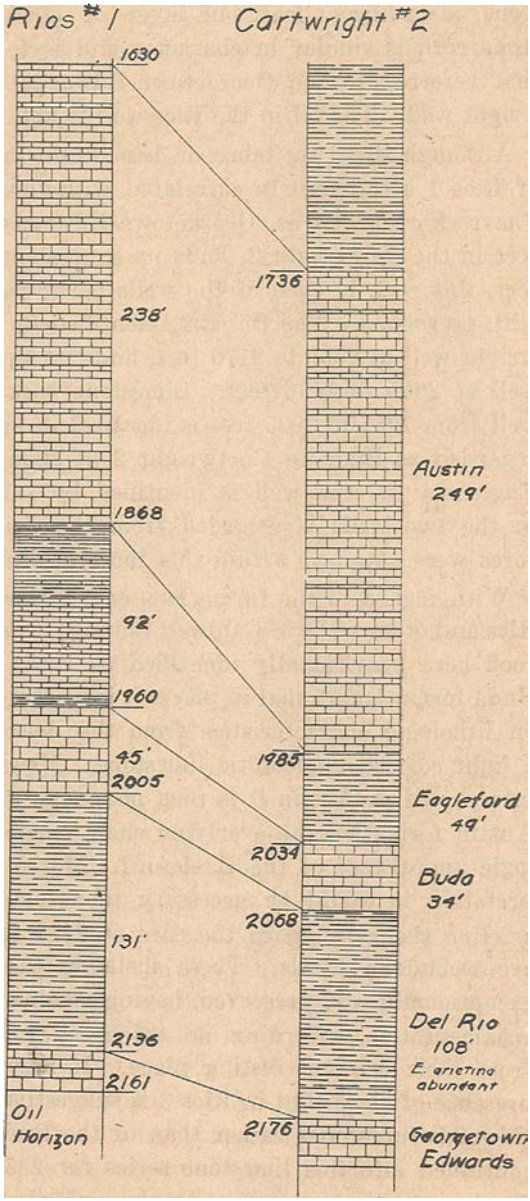

Fig. 1. Sketch showing formations drilled through in the Rios and Cartwright wells from the Austin to the Georgetown-Edwards formation. The interpretation as here given is from the drillers' logs and from samples. The top and bottom of each formation is determined from the drillers' log, while the identification of the formation itself is in most instances from samples of rock cuttings or cores. The statement, "E. arietina abundant," refers to the abundance of this fossil in a core taken at 2117 feet in Cartwright No. 2.

Vertical scale of sketch: One inch equals 100 feet.

Successive samples below this depth to 2160 feet consist of limestone, including at least one layer of black flint. This limestone rock is similar in character and is to be correlated with that referred to the Georgetown-Edwards series in the Cartwright well. The oil in the Rios well is obtained at 2161 feet.

Although differing more or less in thickness the formations of Rios 1 are definitely correlated with those of Cartwright 2. The rock regarded as Georgetown-Edwards, entered at 2176 feet in the Cartwright 2, finds its equivalent in Rios 1, at 2136 feet, this rock in each of the wells being porous and saturated with petroleum. The Del Rio, identified by fossils in the Cartwright well at 2068 to 2176 feet, finds its equivalent in the Rios well at 2005 to 2136 feet. Limestone rock found in the Rios well from 1961 to 2005 feet is identical in appearance with that regarded as Buda in Cartwright 2 at 2034 to 2068 feet. The Eagleford in each well is identified by samples. The Austin in the two wells is recorded from the driller's log, although cores were obtained within this interval from Cartwright 3.

With regard to the formations encountered in drilling in the Rios and other wells in Caldwell County, it may be noted that the rock here provisionally identified as Buda is unusual for the Buda formation, in that in places it is scarcely to be distinguished on lithologic characteristics from the Austin formation, being a light colored glauconitic limestone. However, if this rock is interpreted as Austin it is then necessary to include within the Austin formation the overlying shale member having the lithologic appearance of the Eagleford. Moreover, upon this interpretation it would be necessary to assume that the *Exogyra arietina* shells found in the core at 2117 feet in Cartwright 2 are secondary fossils. These shells in the core, however, are exceptionally well preserved, having retained their most delicate ornamentation, affording no evidence of having been moved from their original resting place. It may be added that the presence of black flint in Rios 3 is suggestive of the Georgetown-Edwards limestones rather than of the Buda, and that drilling continued into this limestone series for 235 feet in Cartwright 2, supported by numerous samples, afforded no reason to doubt the reference of the limestones to this series. From within the

interval assigned to the Buda, cores have been obtained from Cartwright 3 indicating that alternating with or above the glauconitic rock of the Buda are layers which are not glautonitic and which are typical of the Buda in texture.

In order to complete the record available on the Rios well there is here included the description of samples from this well, the log being given on a later page. A description of samples obtained from Cartwright 3 is likewise included. The records on these wells taken as a whole are believed to justify the conclusion that the oil from the Rios well is obtained from the Georgetown-Edwards limestones in the Lower Cretaceous. In case of an overthrust or thrust fault, if such has occurred, production may, of course, be obtained from the Upper Cretaceous after passing through Lower Cretaceous formations.

Description of samples from United North and South Oil Co.'s Rios No. 1, one and one-half miles northeast of Cartwright No. 3, John Henry League in Caldwell County. Samples submitted by W. F. Peale, Luling, Texas.

BY E. H. SELLARDS AND P. T. SEASHORE

	Depth in Feet
Sample consists of several pieces of grey, slightly micaceous, slightly calcareous shale. In the washed material were found grains of glauconite, pieces of calcite, flakes of muscovite, and a few quartz sand grains. Fossils: Cristellaria, Globigerina, Textularia, Anomalina, Nodosaria, Frondicularia, Vaginulina, and Tritaxia, fish scales, spines, and otoliths, a part of an annelid jaw (?), Pelecypod shell fragments, ostracods, and Inoceramus prisms. Two corals noted. Probably Eagleford.....	1898
Sample consists of two pieces of a core of light grey limestone and a sample of cuttings consisting of grey marl and white limestone. The washed material from the marl contains some glauconite, a few quartz sand grains and several crystals of pyrite. Fossils: Inoceramus prisms, Textularia, Tritaxia, Globigerina, Cristellaria, Anomalina, Nodosaria, ostracods, and shell fragments. On a polished surface the limestone is seen to contain a large number of minute cavities filled with microscopic crystals of pyrite. In thin section the limestone is seen to contain a very large number of foraminifera, many slender	

	Depth in Feet
needle-like spines and Echinoid spines and tissue. Many of the foraminifera have been replaced by pyrite.	1960
Sample consists of a piece of grey finely textured marl. Washed material consists of pieces of calcite and crystals of pyrite. Fossils: Inoceramus prisms, Globigerina, Textularia, and Ostracods. Probably Del Rio.	2005
Grey marl and dirty yellowish grey porous limestone. The limestone is impregnated with oil. In the washed material from the marl were noted glauconite, crystals of pyrite, a few pieces of calcite, and a number of fragments of a black soft material resembling asphalt. Fossils: Inoceramus prisms, Cristellaria, Tritaxia, Nodosaria, Textularia, Globigerina, and Echinoid spines. In thin section the limestone is seen to be fine-grained and to have a slightly lumpy texture. The entire section is filled with microscopic crystals of calcite. Several veins and larger areas are made up of crystals of calcite	2136
Like sample of 2136.	2138
Sample consists of pieces of yellowish grey porous limestone and grey and almost black marl. The entire sample is permeated with oil. The washed material from the marl contains aggregates of minute crystalline pyrite and pieces of calcite. Inoceramus prisms, Cristellaria, Anomalina, Vaginulina, Textularia, ostracods, and pelecypod shell fragments. In thin section the limestone is seen to be finely grained and to have a lumpy texture. A few small areas of calcite noted.	2139-2140
Sample consists of dark grey marl and two pieces of a core of yellowish grey porous limestone. The entire sample is impregnated with oil. In the washed material from the marl were noted many fragments of limestone like that represented by the core, pieces of calcite, crystals of pyrite, grains of glauconite, and fragments of black flint. Fossils: Cristellaria, Anomalina, Nodosaria, Globigerina, Textularia, ostracods. Inoceramus prisms and fragments of shell from other pelecypods...	2144

Depth in Feet

Light grey marl. In the washed material were found a few pieces of calcite, crystals of pyrite, and pieces of a black asphaltic material. Fossils: Inoceramus prisms, Echinoid spines, Globigerina, Tritaxia, Cristellaria, and pelecypod shell fragments..... 2155

Sample consists of several pieces of a core of dirty yellowish grey porous laminated limestone. The laminations consist of thin layers of a black bituminous material. Traversing the entire core and parallel to the bedding plane is a vein of black flint. In this flint can be seen imbedded obscure traces of organisms. In thin section the limestone is seen to be finely granular and to contain small areas filled with calcite..... 2157

Sample consists of grey marl. In the washed material were found a few pieces of yellowish grey limestone, pyrite, and calcite. A few grains of glauconite noted. Fossils: Cristellaria, Anomalina, Globigerina, Textularia, ostracods, Inoceramus prisms, fish scales, and pelecypod shell fragments..... 2158

Description of samples from United North and South Oil Company's Cartwright 3, two and one-half miles southeast of Prairie Lea and six and one-half miles northwest of Luling, G. C. Kimble Survey, Caldwell County. Submitted by W. F. Peale, Luling, Texas.

BY E. H. SELLARDS AND P. T. SEASHORE

Depth in Feet

Sample consists of grey marl. The washed material consists mainly of fossils, pieces of calcite, and grains of glauconite and crystals of pyrite. The glauconite shows regular reticulated sutures. Fossils: Inoceramus prisms, pelecypod shell fragments, a fragment of an Ammonoid, Nodosaria, Cristellaria, Pulvinulina, Vaginulina, Tritaxia, Anomalina and ostracods. In the washed material from ⅛ mm. in diameter and down were found many Textularia, Globigerina, and Orbulina..... 1195-1225

Grey slightly micaceous marl. In the washed material were found a number of fragments of Inoceramus shells, shell fragments from other pelecypods, Textularia, Tritaxia, Anomalina, Cristellaria, Truncatulina, and several smooth carapaced ostracods. A black, smooth surfaced, ellipsoidal body noted.

	Depth in Feet
This body measures 1.25 mm. in length, and .4 mm. in diameter	1349-1380
Grey marl, lithologically like preceding sample. In the washed material were found a few aggregates of minutely crystalline pyrite, pieces of calcite, and fragments of clay-ironstone. Fossils: Inoceramus prisms, Nodosaria, several thin keeled Cristellaria, Pulvinulina, Frondicularia, Textularia, Globigerina, and ostracods	1500-1590
Grey marl containing some fine sand. In the washed material were found several aggregates of minutely crystalline pyrite, fragments of fine grained highly calcareous sandstone, larger quartz sand grains. A few brown, red and pinkish chert grains also noted. Several pieces of clear calcite, and some scattered grains of glauconite present. Fossils: Inoceramus prisms and shell fragments, fragments from other pelecypods, a large Cristellaria cultrata, several thin keeled Cristellaria, Pulvinulina, Textularia, Globigerina, Anomalina, and a number of varieties of ostracods	1590-1642
Sample consists of grey marl. In the washed material are found a few quartz sand grains, piece of white calcite, pyrite and glauconite, and a number of fossils. Fossils: Fragments of Inoceramus and other pelecypod shells, Anomalina ammonoides, Cristellaria gibba, Cristellaria cultrata, Nodosaria, Lagena, Textularia, Globigerina and Orbulina	1642-1700
Grey slightly micaceous marl. The washed material consists mainly of grains of glauconite and fossils, a few quartz sand grains noted. Fossils: Inoceramus prisms, Cristellaria, Nodosaria, Anomalina, Textularia, Pulvinulina, Globigerina, and Orbulina. A few echinoid spines also noted. A few black ellipsoidal bodies with a smooth polished exterior surface present	1785-1798
Sample consists of grey marl. In the washed material were found a few grains of glauconite and aggregates of minutely Crystalline pyrite. Fossils: Textularia, Globigeria, Anomalina, Cristellaria, Lagena, Polymorphina, Pulvinulina, ostracods, Inoceramus prisms, and echinoid spines	1816-1841

Depth in Feet

Sample consists of several pieces of a core of grey limestone containing a large amount of glauconite and minute crystalline pyrite. On a polished surface the limestone is seen to contain a large number of lentils of lighter colored limestone. A few small shell fragments noted. One piece of the core is in part made up of grey compact marl. In thin section the limestone is seen to be finely textured and to contain a large number of foraminifera, echinoid spines, and many small slightly curved spines, which probably represent section of ostracod carapaces. Among the foraminifera can be recognized Obulina, Globigerina, and Nodosaria(?)..... 1923

Sample consists of a piece of a core consisting in part of grey compact marl, in part of light grey shaly limestone. The washed material from the marl was seen to contain fragments of grey shaly limestone, quartz sand grains, calcite, and pyrite. Many oblate and prolate spheroids measuring from ¼ to ½ mm. in diameter noted. These colitic spherules are black, and have a smooth polished exterior. They are made up of concentric layers and are partially made up of pyrite. These bodies are similar to those found in Cohn Bros. No. 2, Hays County, at a depth of 145′-150′, and in the United North and South Oil Co.'s Cartwright 2, Caldwell County, at a depth of 2305′-2306′. Globigerina, Textularia, Orbulina, ostracods, and a shell fragment noted. In thin section the limestone is seen to be made up almost entirely of Orbulina and Globigerina..... 2013

Sample consists of a piece of a core of dark bluish grey, very slightly calcareous shale of fine texture. In the washed material were found pieces of calcite, pyrite, and a few fish scales. In closed tube yields enough bituminous material to sustain a flame..... 2039

Sample consists of several pieces of a core of dirty grey limestone. On a polished surface the limestone is seen to contain a large number of shell fragments. Several large crystals of calcite noted. In thin section the limestone is seen to be fine grained and to contain a number of cavities filled with calcite. The entire section is traversed by a network of lighter colored limestone. Foraminifera like Orbulina and Globigerina are found in great abundance.

	Depth in Feet
A Nodosaria noted. Echinoid spines and tissue also present	2047
Sample consists of several pieces of a core of grey mottled limestone. On a polished surface this limestone is seen to contain areas of lighter colored limestone, an aburdance of glauconite, blotches of minutely crystalline pyrite, shell fragments, and a very large number of foraminifera. In thin section the limestone is seen to contain a number of cavities filled with calcite. Many foraminifera, Echinoid spines, and shell fragments.....	2052
Sample consists of several pieces of a core of white limestone together with a piece of grey limy shale. In the washed material from the marl were found a few pieces of calcite and a small amount of pyrite. Inoceramus prisms and a few shell fragments noted. On polished surface the limestone is seen to contain considerable glauconite and some small shell fragments. In thin section the limestone is seen to be made up almost entirely of foraminifera. Scattered throughout the sections are found Echinoid spines and tissue and small bodies of minute crystalline pyrite	2065
Sample consists of grey marl and fragments of white limestone. In the washed material were found a few quartz sand grains, crystals of pyrite, crystals of calcite, and grains of glauconite. Fossils: Cristellaria, Anomalina, Nodosaria, Textularia, Globigerina, Tritaxia, Inoceramus prisms, ostracod carapaces, and echinoid spines.....	2065-2078
Sample consists of a core of white limestone containing a large number of minute grains of glauconite. A piece of a core of greenish grey compact limy shale. This material also contains considerable glauconite. In the washed material from the marl a large number of Inoceramus prisms were noted. In thin section the limestone is seen to be very fine grained. Several cavities filled with calcite noted. The limestone is seen to be blotched with areas of a darker colored limestone. The limestone contains a very large amount of foraminifera. Among these can be recognized Orbulina, Globigerina, and Textularia. Fragments from larger shells and echinoid spines also noted.....	2078

	Depth in Feet
Sample consists of several pieces of a core of white limestone. On a polished surface the limestone is seen to contain a large number of minute cavities filled with microscopic crystals of pyrite. Many shell fragments also noted. In thin section the limestone is seen to contain a very large number of foraminifera. Among these can be recognized Orbulina, Globigerina, Nodosaria, and Anomalina. Echinoid spines and small shell fragments.....	2087
Sample consists of several pieces of a core of grey limestone containing a large number of minute bodies filled with microscopic crystals of pyrite. In thin section the limestone is seen to be finely grained, and to contain a large number of foraminifera Echinoid spines and tissue and shell fragments. Some of the foraminifera shells have been replaced by pyrite	2092

Production From the Lower Cretaceous in Texas

In this connection it may be noted that the Lower Cretaceous formations have previously yielded some oil in the State. The shallow wells in the South Bosque Field in McLennan County obtain oil from these formations. In Panola County very large gas wells have been obtained from a horizon that is probably about 500 feet below the top of the Lower Cretaceous, some of these gas wells having afforded a production of not less than twenty million cubic feet of gas per day. A small amount of oil has likewise been obtained from a horizon in Panola County which is probably at, or near, the top of the Lower Cretaceous. The Jones well near Kosse, in Limestone County, apparently obtained oil from a Lower Cretaceous horizon. These several gas and oil wells indicate that the Lower Cretaceous should not be neglected as containing possible oil producing formations in Texas.

Well Logs

Although not including all wells drilled in the county, the wells, logs of which are given here, may be regarded as representative of drilling conditions in the west half of the county.

Formations in the east part of the county may be expected at an increased depth over that shown by wells in the west part of the county.

Log of A. P. Cartwright 1, United North and South Oil Co.'s, G. C. Kimble Survey, six and one-half miles northwest of Luling, and two and one-half miles southeast of Prairie Lea. Drilling commenced March 29, 1921. Log corrected by steel line measurement at 1784 feet.

	Depth in Feet		
	From	To	Thickness
Surface clay and sand	0	18	18
Rock	18	34	16
Sand	34	64	30
Rock	64	108	44
Shale	108	128	20
Rock	128	130	2
Shale	130	138	8
Gumbo and gyp	138	143	5
Shale	143	155	12
Gumbo—set and cemented 10″ casing at 160′. Reduced hole to 9⅞	155	160	5
Shale and boulders	160	460	300
Gumbo	460	474	14
Shell and shale	474	504	30
Sand rock	504	507	3
Shell and shale	507	537	30
Sand rock and pyrites of iron	537	538	1
Hard sand rock	538	542	4
Sandy shale, showing oil and gas at 550′	542	552	10
Sandy shale	552	593	41
Rock	593	594	1
Shale	594	634	40
Gypsum	634	653	19
Shale and boulders	653	656	3
Gypsum and gumbo	656	697	41
Sand rock	697	699	2
Shell and shale	699	714	15
Shell	714	721	7
Gumbo	721	731	10
Shell	731	771	40
Gumbo	771	775	4
Shale	775	784	9
Shale (sticky)	784	823	49
Gumbo	823	833	10
Shale and shell	833	853	20
Rock	853	854	1
Soft shale	854	928	74
Gumbo	928	976	48
Lime rock—reduced hole to 8½″	976	988	12
Shale	988	1,062	74
Gumbo	1,062	1,071	9
Shale	1,071	1,109	38
Gumbo	1,109	1,121	12
Shale	1,121	1,264	43
Shale and boulders	1,264	1,334	70

	Depth in Feet		
	From	To	Thickness
Gumbo	1,334	1,342	8
Shale	1,342	1,489	147
Gumbo	1,489	1,496	7
Hard shale	1,496	1,514	18
Shale	1,514	1,522	8
Gumbo	1,522	1,542	20
Shale	1,542	1,567	25
Sandy gumbo	1,567	1,581	14
Shale	1,581	1,586	5
Shale and shell	1,586	1,630	44
Gumbo	1,630	1,636	6
Shale	1,636	1,700	64
Broken lime rock	1,700	1,708	8
Sandy shale	1,708	1,738	30
Gumbo	1,738	1,744	6
White shale	1,744	1,766	22
Broken lime rock	1,766	1,778	12
Gumbo	1,778	1,786	8
Chalk rock (hard)	1,786	1,788	2
Measurement with steel line showed 1784			
Chalk rock	1,784	1,786	2
Reamed hole to 9⅞″—set 8″ from 988 casing (did not cement)			
Chalk rock	1,786	1,981	193
Chalk and slate	1,981	2,075	84
Showing oil and gas at 2,000′.			
Shale and slate	2,075	2,105	30
Blue slate	2,105	2,135	30
Shale with pyrites gravel	2,135	2,190	55
Broken lime	2,190	2,200	10
Water sand—cool sulphur water	2,200	2,211	11
Pyrite rock	2,211	2,215	4
Very hard—set 6″ casing but failed to shut off water.			
Water sand—hot sulphur water	2,215	2,229	14
Hard sand rock—very fine sand	2,229	2,231	2
Oil sand—showing oil and gas	2,231	2,236	5
Measurement with steel line		2,232	
Sandy lime with iron	2,232	2,240	8
Hard lime	2,240	2,276	36
Sandy lime with iron	2,276	2,288	12
Soft lime	2,288	2,304	16
Hard lime	2,304	2,332	28

Interpretation: This well which starts probably in the Wilcox appears to have entered the Austin formation at or near 1784 feet. The record is indefinite as to the base of the Austin, and the thickness of the Eagleford and Buda. However, these two formations probably lie between 1,981 and 2,075, the "blue slate" at 2105 to 2135 probably represents a part of the Del Rio. The Georgetown-Edwards limestones are probably entered at or near 2,190, the sulphur water obtained at 2,200 and at 2,215 being quite certainly from these limestones. The well probably terminates in the Edwards.

Log of the Cartwright No. 2, of the United North and South Oil Company, Ca'dwell County. Depths Corrected By Steel Line Measurement.

	Depth in Feet		
	From	To	Thickness
Surface	0	3	3
Doby	3	6	3
Sand	6	8	2
Clay	8	12	4
Rock	12	14	2
Sandy shale	14	59	45
Rock	59	65	6
Rock sand (gas)	65	104	39
Lignite	104	108	4
Rock, sand	108	134	25
Gumbo	134	138	4
Rock sand	138	141	3
Clay	141	149	8
Hard sand	149	164	15
Clay	164	168	4
Shale	168	198	30
Clay	198	204	6
Shale	204	237	33
Sand (water)	237	250	13
Shale	250	283	33
Clay	283	338	55
Shale	338	359	21
Clay	359	396	37
Sand	396	401	5
Clay	401	434	33
Boulder	434	435	1
Clay	435	497	62
Rock	497	498	1
Hard sandy shale	498	507	9
Rock	507	508	1
Shale	508	529	21
Pyrite	529	562	33
Clay	562	580	18
Sand rock	580	581	1
Clay	581	639	58
Boulder	639	640	1
Shale	640	665	25
Clay	665	697	32
Rock	697	698	1
Hard shale	698	705	7
Clay and gyp	705	724	19
Shale and gyp	724	744	20
Boulders	744	745	1
Shale and gyp	745	798	53
Shale	798	803	5
Shale and gyp	803	809	6
Clay	809	898	89
Rock	898	899	1
Clay	899	1,084	185
Shale	1,084	1,095	11
Clay	1,095	1,162	67
Shale	1,162	1,188	26
Clay	1,188	1,201	13
Shale	1,201	1,244	43

	Depth in Feet		
	From	To	Thickness
Clay and gyp	1,244	1,250	6
Shale	1,250	1,369	119
Clay	1,369	1,426	57
Shale	1,426	1,494	68
Clay	1,494	1,519	25
Gyp	1,519	1,535	16
Shale	1,535	1,542	7
Clay	1,542	1,556	14
Shale and gyp	1,556	1,580	24
Clay and gyp	1,580	1,634	54
Clay with sand	1,634	1,654	20
Shale and gyp	1,654	1,688	34
Gummy shale	1,688	1,697	9
Gyp	1,697	1,736	39
Chalk	1,736	1,985	249
Shale and pyrites	1,985	2,000	15
Gummy shale	2,000	2,008	8
Shale and pyrites	2,008	2,034	26
Lime and shale	2,034	2,068	34
Gummy shale	2,068	2,098	30
Sandy gumbo and boulders	2,098	2,112	14
Sandy shale and pyrites	2,112	2,130	18
Sandy shale	2,130	2,152	22
Sandy shale, hard	2,152	2,176	24
Hard sand rock, sulphurous	2,176	2,177	1
Conglomerate	2,177	2,186	9
Shale	2,186	2,192	6
Sandy lime and pyrites	2,192	2,194	2
Pack sand (shale)	2,194	2,195	1
Shale and lime	2,195	2,219	24
Sandy lime pyrites	2,219	2,222	3
Pyrites rock	2,222	2,224	2
Hard sand	2,224	2,232	8
Rock pyrites	2,232	2,233	1
Shale	2,233	2,234	1
Sandy lime rock, sulphurous and gaseous	2,234	2.257	23
Shale	2,257	2,260	3
Sandy lime	2,260	2,262	2
Shale	2,262	2,263	1
Sandy lime	2.263	2,270	7
Sandy shale	2,270	2,276	6
Sandy lime	2,276	2,277	1
Sandy shale and lime	2,277	2,294	17
Sandy shale and lime (doby)	2,294	2,312	18
Sandy shale and lime	2,312	2,326	14
Pure lime	2,326	2,340	14
Pyrite	2,340	2,341	1
Lime	2,341	2,350	9
Shale	2,350	2,352	2
Shale and lime	2,352	2,411	59

Interpretation: The interpretation of this well has already been given. The Austin is regarded as extending from 1736 to 1985 feet; the Eagleford from 1985 to 2034 feet; the Buda from 2034 to 2068 feet; the Del Rio from 2068 to 2176 feet. At or near 2176 feet the Georgetown-Edwards limestones are entered, in which formations the well probably terminates.

Log of Cartwright No. 3, United North and South Oil Company, Located to the East of, and Near Cartwright No. 2

	Depth in Feet		
	From	To	Thickness
Surface	0	7	7
Sand, shale and gravel	7	36	29
Broken rock	36	59	23
Sandy shale	59	85	26
Rock	85	86	1
Clay	86	89	3
Rock	89	90	1
Clay	90	120	30
Rock	120	125	5
Hard shale	125	145	20
Hard shale	145	304	159
Boulder	304	305	1
Gumbo	305	416	111
Shale	416	467	51
Rock	467	468	1
Hard shale	468	516	48
Rock	516	518	2
Broken rock	518	522	4
Shale and boulders—showing gas about 550'	522	595	73
Gumbo	595	629	34
Rock	629	631	2
Gumbo and boulders	631	647	16
Sticky shale	647	713	66
Rock	713	714	1
Shale and boulders	714	780	66
Gumbo	780	796	16
Shale	796	803	7
Gumbo	803	821	18
Gumbo and lime	821	838	17
Hard shale	838	843	5
Gumbo	843	864	21
Shale and some gas	864	893	29
Gumbo	893	944	51
Shale	944	995	51
Gumbo	995	1,005	10
Soft lime	1,005	1,008	3
Gumbo	1,008	1,012	4
Gumbo	1,012	1,063	51
Hard shale	1,063	1,071	8
Shale and gumbo	1,071	1,079	8
Gumbo	1,079	1,144	65
Mucky shale	1,144	1,190	46
Shale and shells, gas showing	1,190	1,220	30
Mucky shale	1,220	1,235	15
Gumbo	1,235	1,320	85
Mucky shale	1,320	1,344	24
Shale and shell	1,344	1,375	31
Mucky shale	1,375	1,420	45
Gumbo	1,420	1,429	9
Shale	1,429	1,500	71
Gypsy gumbo	1,500	1,525	25
Shale, lime, shell	1,525	1,622	97
Hard shale and lime	1,622	1,637	15

	Depth in Feet		
	From	To	Thickness
Gyp-gumbo	1,637	1,675	38
Mucky shale	1,675	1,695	20
Gyp-gumbo	1,695	1,709	14
Shale and boulders, some gas	1,709	1,736	27
Hard shale, gumbo	1,736	1,760	24
Broken lime	1,760	1,790	30
Took tape line measurement 1795'			
Austin chalk—use roller bit	1,790	2,004	214
Shale and lime	2,004	2,019	15
Broken chalk and shale	2,019	2,034	15
Shale and gypsum	2,034	2,036	2
Buda lime	2,036	2,058	22
Clay	2,058	2,060	2
Lime	2,060	2,087	27

Interpretation: Austin, 1760 to 2004; Eagleford from 2004 to 2036; Buda entered at 2036 feet. Cartwright 3 was abandoned on account of difficulties in drilling and a second well started on this locality, known as Cartwright 4. In Cartwright 4 chalk is recorded as extending from 1768 to 1994; Eagleford shales from 1994 to 2035: Buda limestone entered at 2035 feet. Depths in both wells corrected by steel line measurements.

Log of United North and South Oil Co.'s Rios No. 1 Well, Caldwell County.

Surface clay	0	25	25
Sand and gravel	25	55	30
Gummy shale and boulders	55	115	60
Gumbo, boulders	115	171	56
Gumbo	171	176	5
Sand and gravel	176	197	21
Shale and boulders	197	282	85
Gummy shale	282	430	148
Gumbo and boulders	430	480	50
Rock	480	482	2
Gummy shale	482	514	32
Rock	514	517	3
Gumbo and boulders	517	564	47
Rock	564	565	1
Gummy shale	565	609	44
Gumbo	609	620	11
Rock	620	627	7
Gumbo	627	638	11
Shale and boulders	638	703	65
Gumbo	703	724	21
Shale and boulders	724	1,055	331
Gumbo	1,055	1,130	75
Shale and boulders	1,130	1,175	45
Saltwater sand	1,175	1,195	20
Shale and boulders	1,195	1,270	75
Gumbo	1,270	1,290	20
Shale and boulders	1,290	1,385	95
Gummy shale	1,385	1,405	20
Chalky shale	1,405	1,440	35
Chalk and shell	1,440	1,499	59
Hard sandy shale	1,499	1,570	71
Gumbo	1,570	1,630	60

	Depth in Feet		
	From	To	Thickness
Chalk rock	1,630	1,868	238
Hard shale and shell	1,868	1,875	7
Broken chalk and shale	1,875	1,905	30
Hard rock and pyrites	1,905	1,911	6
Broken chalk rock	1,911	1,918	7
Lime rock	1,918	1,955	37
Shale	1,955	1,961	6
Limy rock	1,961	2,005	44
Gray marl at	2,005		
Gray marl and yellow limestone at	2,136		
Fine grained limestones at	2,139		
Yellowish gray porous limestones at	2,144		
Light gray marl at	2,155		
Yellowish gray porous rock at	2,157		
Gray marl at	2,158		
Sand (?) Containing oil	2,161		

Interpretation: This well starts in the Wilcox and enters the Austin at or near 1,635 feet. The formations below the Austin are difficult to interpret from the driller's log, but from an examination of a number of samples it seems probable that the formations penetrated include the Eagleford, Buda and Del Rio, the well terminating in the Georgetown-Edwards limestones. The record at and below 2,005 feet is made up from samples, except the last entry which is the driller's record. (See Fig. 1.)

Log of the C. T. Schawe Well in Caldwell County

(Elevation B. M. at Maxwell is 604. Completed in 1914. Casing: 600′, 10″; 800′, 8″; 6″ set from 1400′ to 3312′ with 300′ of screen at bottom.)

	Depth in Feet		
	From	To	Thickness
White rock	0	10	10
Gravel	10	14	4
Rock	14	15	1
Yellow clay	15	54	39
Black soapstone	54	90	36
Blue gumbo	90	110	20
Soapstone	110	120	10
Blue gumbo	120	164	44
Black shale	164	234	70
Black gumbo	234	374	140
Shale	374	399	25
White gumbo	399	659	260
Shale	659	690	31
White gumbo	690	760	70
White rock, show of oil	760	1,036	276
Gumbo	1,036	1,071	35
White lime rock	1,071	1,113	42
White rock	1,113	1,142	29
Brown rock, porous	1,142	1,354	212
Brown rock, porous	1,354	1,425	71
Brown rock, porous	1,425	1,470	45
Brown rock	1,470	1,516	46
White rock, very hard, sulphur	1,516	1,524	8
Brown rock, porous, with hard white layers	1,524	1,567	43

	Depth in Feet		
	From	To	Thickness
Gray rock, hard	1,567	1,615	48
Rock, porous, sulphur water	1,615	1,629	14
Hard gray rock, sulphur water	1,629	1,652	23
White lime rock	1,652	1,786	134
Hard gray rock	1,786	1,808	22
White lime rock	1,808	1,843	35
Brown rock, layers white	1,843	1,922	79
Hard white rock	1,922	1,929	7
Brown rock, layers white	1,929	1,961	32
Brown rock	1,961	2,038	77
Gumbo, mud hole	2,038	2,046	8
Brown rock, very hard	2,046	2,054	8
Brown porous rock	2,054	2,161	107
Hard gray rock	2,161	2,175	14
Soft gray rock	2,175	2,238	63
Hard gray rock	2,238	2,284	46
Gumbo, mud hole	2,284	2,290	6
White lime rock	2,290	2,377	87
Soft brown rock, show of water	2,377	2,462	85
Brown rock, white layers	2,462	2,498	36
Hard brown rock	2,498	2,525	27
Gray sand rock	2,525	2,540	15
Soft brown rock	2,540	2,677	137
Hard white lime	2,677	2,717	40
Soft yellow sand rock	2,717	2,763	46
White lime rock	2,763	2,773	10
Yellow sand rock	2,773	2,907	134
Hard blue rock	2,907	2,918	11
Hard gray rock	2,918	2,937	19
Yellow sand rock	2,937	2,986	49
White sand rock	2,986	3,025	39
Gumbo, mud hole	3,025	3,061	36
Yellow rock, gumbo mixed	3,061	3,070	9
Red and blue gumbo, mixed	3,070	3,104	34
Hard white sand rock	3,104	3,117	13
White sand rock, soft and hard streaks	3,117	3,312	117

The driller's log extends to 3,312 feet only. However, samples were obtained at intervals to a depth of 3,445 feet. Description of these samples follow:

Descriptions of samples from C. T. Schawe Well at Maxwell. Samples obtained by Alexander Deussen.

BY J. A. UDDEN

	Depth in Feet
Reddish-brown, medium-grained, quartzitic, calcareous sand; sand consists largely of sub-angular clear quartz grains. Other minerals present are orthoclase(?), hornblende, hematite, etc. Trinity sands. (11 ft.)	3323
Medium coarse-grained red sand, slightly calcareous; sand consists of angular grains of clear quartz, and fragments of hematite, orthoclase(?), etc.; quartz is predominant. Typical Trinity formation. (20 ft.)	3375

	Depth in Feet
Reddish-brown, slightly calcareous, medium coarse-grained sand; color is not so red as preceding; sand consists chiefly of angular clear quartz grains averaging .5 mm. in diameter; also present limonite, hematite, orthoclase(?), etc. Trinity formation. (15 ft.)	3405
Large fragments of red, compact, non-calcareous shale; some large angular fragments of greenish-grey talc-like compact non-carcareous shale; some large fragments of angular milky quartz, averaging ⅛ inch in diameter. This material taken out while bailing the well. Marked as sample No. 5. Represents probably the Trinity formation	3400
Fragments of bluish-black, non-calcareous shale; material is friable; a few grains of quartz possibly from the stratum above. Material has an entirely different aspect and color from the materials above. Probably represents Carboniferous or earlier. (10 ft.)	3415
Fragments of blue, non-calcareous shale; friable. Carboniferous(?). (10 ft.)	3425
Small, sub-angular fragments of drab, non-calcareous shale. Carboniferous (?). (14 ft.)	3439
Sub-angular fragments of blue and gray non-calcareous shale. Material pulverizes into small fragments averaging .5 mm. in diameter. (6 ft.)	3445

Interpretation of the log: This well, starting probably in the Navarro formation, apparently enters the Austin at 760 feet and passes the base of the Austin at 1,036 feet. The Eagleford probably extends from 1,036 to 1,071 feet, being logged as "gumbo." The Lower Cretaceous apparently extends from 1,071 to 3,405 feet. From 3,405 to 3,445 feet the formation is identified by Dr. J. A. Udden as indicated in the description of the samples, as pre-Cretaceous.

Log of the Texas Southern Oil and Lease Syndicate's Thompson No. 1, 2½ Miles S. E. of Prairie Lea, Caldwell County

	Depth in Feet		
	From	To	Thickness
Clay and gravel	0	35	35
Rock	35	53	18
Shale	53	88	35
Rock	88	94	6
Gumbo	94	155	61
Shale (oil and gas showing)	155	160	5
Gumbo	160	455	295
Shale	455	475	20

	Depth in Feet		
	From	To	Thickness
Gumbo	475	494	19
Shale	494	514	20
Gumbo	514	525	11
Rock	525	528	3
Gumbo	528	545	17
Sandy shale (showing gas)	545	555	10
Rock	555	560	5
Gumbo	560	588	28
Sandy shale	588	610	22
Gumbo	610	628	18
Sandy shale	628	636	8
Gumbo	636	680	44
Shale (showing of oil and gas)	680	684	4
Gumbo	684	698	14
Shale (showing of oil)	698	710	12
Gumbo	710	730	20
Shale	730	739	9
Gumbo	739	751	12
Shale	751	764	13
Gumbo	764	772	8
Shale and streaks of gumbo	772	812	40
Gumbo	812	823	11
Shale and gas	823	830	7
Gumbo	830	848	18
Shale	848	855	7
Soft gumbo	855	861	6
Hard gumbo	861	871	10
Shale	871	890	19
Gumbo	890	895	5
Shale	895	901	6
Hard gumbo	901	932	31
Shale (showing of oil and gas)	932	945	13
Sticky shale	945	998	43
Shale	998	1,011	13
Gumbo with streaks of shale	1,011	1,037	26
Gumbo	1,037	1,058	21
Shale	1,058	1,070	12
Gumbo	1,070	1,078	8
Sticky shale	1,078	1,200	122
Gumbo	1,200	1,300	100
Shale	1,300	1,334	34
Gumbo	1,334	1,345	11
Shale	1,345	1,407	62
Gumbo	1,407	1,411	4
Shale	1,411	1,445	34
Gumbo	1,445	1,478	33
Shale	1,478	1,493	15
Gumbo	1,493	1,498	5
Shale	1,498	1,620	122
Gumbo	1,620	1,633	13
Shale	1,633	1,674	41
Gumbo	1,674	1,700	26
Shale	1,700	1,721	21
Gumbo	1,721	1,735	14
Shale (good gas pressure showing of oil)	1,735	1,835	100
Austin chalk	1,835	2,050	215
Gray shale (oil)	2,050	2,063	13

	Depth in Feet		
	From	To	Thickness
Black shale.	2,063	2,067	4
Slaty shale (black).	2,067	2,073	6
Shale and lime (oil) uncertain.			
Gray limestone (large per cent of sand)			
Total depth.	2,092		

At 2,063 to 2,067 there was suffcient gas to shake the floor of the derrick.

Interpretation: This well, which is located to the east of and near the Cartwright wells, enters the Austin at 1,835 feet, drillers record. No samples have been obtained, but from the log it seems probable that the base of the Austin was passed at 2,050 feet, and that the gray and black shales from 2,050 to 2,073 represented the Eagleford, the gray limestone next below being probably the Buda.

The depth given in the log are those recorded by the driller. A steel line measurement made after the well had been completed and cleaned is said to have indicated that the total depth of the well is 2,044 feet, or 48 feet less than the depth given in the drillers record. This correction of 48 feet is to be applied in whole or in part to the Austin chalk and other formations in the well.

The Ghormley Well in Guadalupe County

In a well now being drilled by the United North and South Oil Company, on the Ghormley farm, near Sullivan, in Guadalupe County, chalk is recorded by the driller at having been entered at 2084 feet. From a core taken at 2371 feet (corrected depth) E. W. Brucks has obtained a shell, which appears to be the right valve of *Exogyra arietina,* a fossil characteristic of the Del Rio formation.

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