THE UNIVERSITY OF TEXAS BULLETIN

No. 3027 July 15, 1930

THE GEOLOGY OF STONEWALL COUNTY, TEXAS

BY

L. T. PATTON

Bureau of Economic Geology

J. A. Udden, Director E. H. Sellards, Associate Director

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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, and while guided and controlled by virtue, is the noblest attribute of men. It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar

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THE GEOLOGY OF STONEWALL COUNTY, TEXAS

By

LEROY T. PATTON

INTRODUCTION

Stonewall County is located in the northwestern part of Texas about 150 miles from the western border of the State. The 100th meridian passes within a few miles of the eastern border of the county and the 33d parallel within

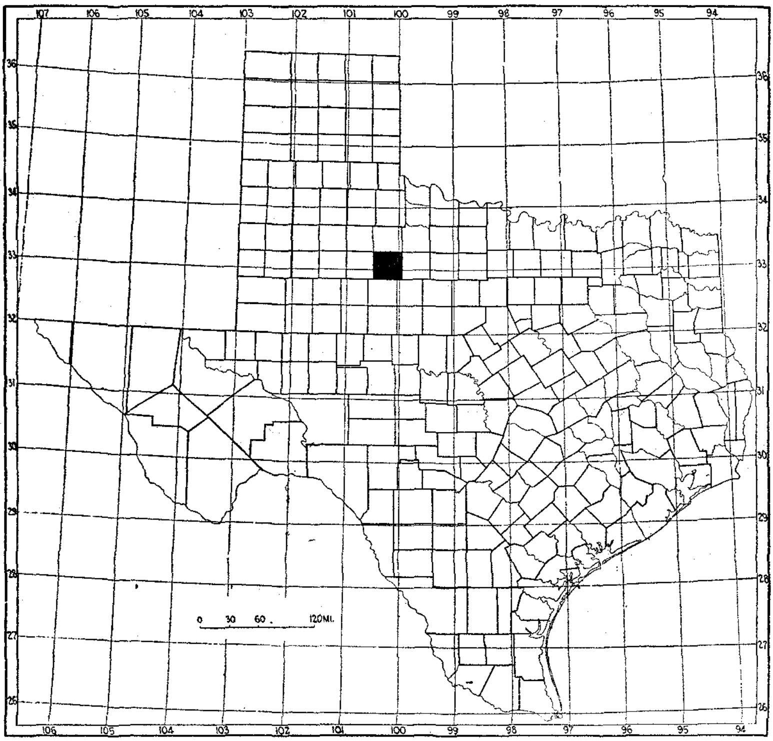

Fig. 1. Outline map of Texas showing the location of Stonewall County.

Manuscript submitted December 19, 1927; revised, August, 1930; published, December, 1930.

a few miles of the southern border. The location of the county is shown on the accompanying sketch map of the State of Texas (fig. 1). The area of the county is approximately 777 square miles.

A portion of the field work upon which this report is based was done during the fall of 1923, while the writer was acting as technical adviser of the Texas State Board of Water Engineers. The areas which were investigated at that time were mainly in the valleys of the Double Mountain Fork of the Brazos River and the Salt Fork of the Brazos River. This work was done for the purpose of determining the feasibility of building dams on these rivers for flood control and irrigation purposes. During the summer of 1925 the writer spent three months in the field completing the survey of the county.

No good base maps of the county were obtainable at the time the field work for this report was done. At that time the United States Geological Survey was just completing topographic surveys of small parts of the county in coöperation with the Texas State Board of Water Engineers. Advance sheets showing culture but without contours were kindly furnished to the writer by the Survey. However, these sheets cover only a small fraction of the total area of the county. The United States Geological Survey topographic map of the Roby quadrangle includes a strip of Stonewall County two and one-half miles wide and thirty miles long. Although this is only a very small portion of the county this map was a very great aid in the work. The base map used is in the main the land survey map published by the State Land Office with certain modifications and additions from data obtained from the advance sheets of the United States Geological Survey mentioned above and from other published maps. The lack of a good topographic map or even an accurate road map greatly increased the difficulties of the work.

Subsequent to the field work done by the author, the Coöperative Mapping Committee of the American Association of Petroleum Geologists and the Bureau of Economic

Geology carried on mapping work, including extensive plane table surveys in this and adjacent counties. Data from this work have been added to the geologic map mainly in details of boundary lines obtained from plane table surveys which were not possible for a geologist working without assistance to obtain.

Acknowledgment is hereby made to the Texas State Board of Water Engineers for their courtesy in permitting the incorporation in this report of data secured by the writer during the progress of investigations made while in their employ. Acknowledgment is also made to the citizens of the county, who extended to the writer every courtesy and aided the work in every possible way. Special acknowledgment is made to Mr. P. N. Moore and to Mr. J. H. Baldwin. To Dr. N. H. Darton of the United States Geological Survey the author extends acknowledgment for helpful suggestions in the field. Acknowledgment is also made to the United States Geological Survey for advance copies of topographic maps of small parts of the county and for a list of bench marks in certain parts of the county.

PHYSIOGRAPHY

PHYSIOGRAPHIC RELATIONS OF THE COUNTY

The county is located in the central part of the physiographic province known as the North Central Plains, a minor division of Great Plains Province. The North Central Plains province has been defined as that part of the Great Plains which lies east of the escarpment of the Panhandle High Plains and the Llano Estacado, north of the escarpment of the Edwards Plateau, and west and southwest of the escarpment of the Grand Prairie.[1]

In marked contrast to the High Plains and the Llano Estacado, which are depositional plains, the North Central Plains are erosional plains, which have been developed by the work of running water.

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[1]Hill, R. T., Geography and Geology of the Black and Grand Prairies, Texas: U.S. Geol. Surv., 21st Ann. Rept., 1901.

PHYSIOGRAPHY OF THE COUNTY

DRAINAGE

The county is drained by two principal river systems, the Double Mountain Fork of the Brazos River and the Salt Fork of the Brazos River.

The Double Mountain Fork of the Brazos River rises in the northwest part of the Llano Estacado, in Bailey and Lamb counties, and flows southeast to the southeast corner of Stonewall County. It enters the county from the south about three miles from the southwest corner, flows in a general easterly and northeasterly direction across the county and crosses the east border of the county about 10 miles from the southeast corner. Here it turns abruptly to the north and flows parallel to the east county line for 11 miles. At this place it makes an abrupt turn to the west and about one mile west of the point where it crosses the county line the second time, it forms a junction with the Salt Fork of the Brazos River. The main tributary streams within the county are Gypsum Creek, which joins the main stream from the south in the south-central part of the county; Tank Creek, which empties into the main stream about four and one-half miles south of the junction of the latter with the Salt Fork. During most of the year Double Mountain Fork is a sand choked stream flowing in many braided and distributing channels. Only during times of flood does it contain a large volume of water. It has an average fall in its course through the county of five feet per mile.

The Salt Fork of the Brazos also heads in the northwest part of the Llano Estacado in western Parmer County. It flows in a southwesterly direction to west-central Kent County, where it turns to the east, entering Stonewall County in the west-central part of the county. About four miles after entering the county it turns to the north anl flows northward for eight miles to its junction with Croton Creek. From here it turns east and flows in that direction for four miles, where it makes an abrupt turn to the north.

Its northward course is interrupted by a broad bend to the west. A few miles from the northern border of the county it turns and flows southeast to a point about five miles from the eastern border of the county, where it turns and flows to the northeast in broad sweeping curves to its junction with Double Mountain Fork. It then flows north leaving the county near the northwest corner. The main tributary from the south is Stinking Creek, which rises in the central part of the county and flows northeast. Croton Creek enters the county from the west and joins the main stream about six miles from the west county line. Dove Creek enters the county from the north, five miles from the northwest corner, and flows in a southeasterly direction to the juncture with the main stream. Weddington Creek rises in the north central part of the county and flows directly east joining Salt Fork near the northeast corner of the county.

RELIEF

Throughout the county the chief controlling factors in the development of the topography are the attitude of the rocks and presence of resistant strata of rocks alternating with softer and more easily eroded ones. East of the county the formations above the Clear Fork have been removed by erosion and the surface has been reduced to a gently rolling plain, as the Clear Fork consists for the most part of easily eroded shales and soft sandstones. In Stonewall County, however, the resistant ledges of the formations above Clear Fork have held up erosion, forming steep facing escarpments along their strike. Above each of the resistant strata the softer rocks have been removed by erosion so that a westward-sloping, comparatively level surface extending back to the next escarpment has been formed on each of these prominent ledges. Thus there has been developed a series of east facing escarpments with corresponding westward dipping slopes or cuestas—a type of topographic which is sometimes referred to as stair-step topography.

The first of the prominent escarpments, considered in their order from east to west, is the escarpment produced by the San Angelo formation. This escarpment is the most prominent in the southeastern part of the county, where it constitutes the eastern face of Flat Top Mountain. In this part of the county the San Angelo formation is underlain by the Merkle dolomite, the uppermost member of the Clear Fork series. The Merkle dolomite is a hard, resistant dolomite and aids greatly in producing the escarpment. In the northern part of the county, however, the Merkle dolomite is not present.

The San Angelo escarpment extends in a north-south line across the county a few miles west of the eastern border of the county. Northward from Flat Top Mountain it gradually dies down and disappears almost entirely near the mouth of Tank Creek in the east central part of the county. It reappears again to the north of this as the steep west bank of Salt Fork River below its junction with Double Mountain Fork River.

The deep trench of Double Mountain Fork River cuts through this escarpment about eight and one-half miles north of the southeast corner of the county. That part of the escarpment and cuesta slope south of the river is known as Flat Top Mountain. The strata in this part of the county dip to the northwest. Because of this dip that part of the cuesta slope which is on the south side of the river has a greater elevation than that on the north. This, together with the wide flaring mouth of the valley, where the river debouches on the level Clear Fork plain, helps to make Flat Top Mountain a prominent feature of the landscape.

West of the escarpment of the San Angelo formation, the next prominent escarpment is that capped by the dolomite strata of the upper part of the Blaine formation. The heavy gypsum beds below the dolomite strata aid greatly in forming the escarpment. This escarpment crosses the county in a general north-south direction four to six miles west of the San Angelo escarpment. It is from 50 to 200 feet in height and is the most prominent escarpment in the county. See fig. 2.

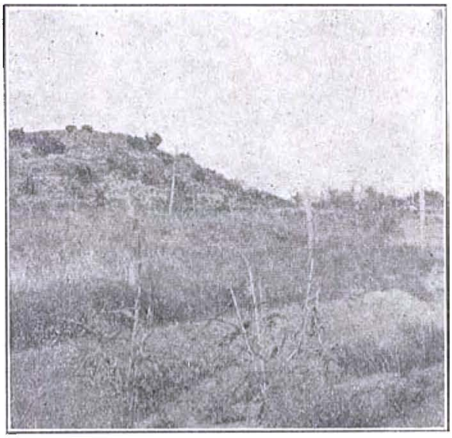

Fig. 2. Escarpment of the Blaine formation.

The next most conspicuous escarpment to the west is the one caused by a persistent ledge of gypsum at the base of the Peacock formation. It is well developed just west of Aspermont and in the vicinity of Swenson. It extends from the southern border of the county to some distance past the center. From here to the valley of Salt Fork River is an extensive sand dune region and no escarpment appears. It reappears, however, on the west side of the valley and extends to the northern part of the county. It is 50 to 100 feet in height.

West of the escarpment just described there is a less prominent one developed by a higher gypsum ledge of the Peacock formation. This escarpment is most conspicuous along that part of the valley of Salt Fork River immediately north of Oriana.

Between the major escarpments above described are many smaller ones most of which are only a few feet in height, but some have a height of 20 to 30 feet. Many of these minor escarpments are only a few hundred feet in length. Others have a length of several miles. The variable lithologic nature of much of the rocks of this region causes this variation in topographic expression. Strata which form escarpments in some places become soft and less resistant in short distances or disappear altogether.

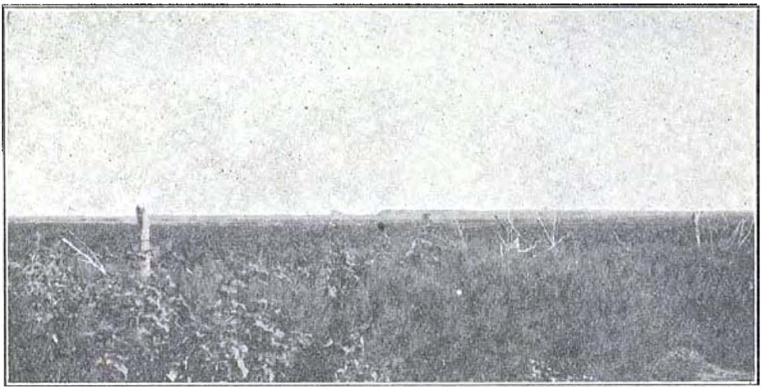

Fig. 3. Distant view of the escarpment of the Swenson gypsum.

Over wide areas, such as the district north of Old Glory between the escarpments of the San Angelo and the Blaine dolomite beds, and the district surrounding Aspermont between the last mentioned escarpment and the escarpment formed by the gypsum beds at the base of the Peacock formation, the country between any two escarpments in a gently rolling plain. In some parts of the county, however, such as the district north of Salt Fork River in the eastern part of the county, the cuesta slopes are very thoroughly dissected, and the country in consequence is very rough and difficult to traverse.

The most conspicuous topographic feature in the county is the erosional remnant Double Mountain. This stands on the comparatively level plain developed on the Peacock formation. It rises to a height of about 600 feet above the surrounding country, its summit being approximately 2500 feet above sea level. It can be seen from many distant parts of the county and is the dominating topographic feature of the western half of the county. This hill is an outlier of the Edwards Plateau and is capped by the same resistant rock, the Edwards limestone, upon which that plateau has been developed. No other outliers of this plateau are present in this county. On the flat-topped summit of this erosional remnant are found waterworn gravels of the kind so abundant in the deposits of the Llano Estacado. The presence of these gravels is evidence of a former erosion surface which has since been dissected.

The name Double Mountain was probably derived from the fact that a col cuts through the central part of the summit leaving two flat-topped summits separated by a shallow depression.

The valleys of the main rivers are in most places deep, steep sided trenches. These canyons are deeper and more rugged in the eastern part of the county than they are in the western because the rise of the strata to the east brings up the more resistant strata of the lower part of the geologic column. In those parts of the county where less resistant strata are encountered the valleys have widened somewhat and in places developed narrow flood plains. The canyons vary in depth from 50 to 200 feet.

Where the streams flow parallel to the strike of the formations the valleys are steep sided on the west and have long gentle slopes on the east. The valley of Salt Fork River in the western part of the county, the valley of Double Mountain Fork in the eastern part of Stonewall County and the western part of Haskell County, and the valley of Salt Fork River below its junction with Double Mountain Fork River, show this type of development.

Terraces such as would be expected in the normal course of valley development are present in many places in the main valleys. They are best developed in those parts of the county where the Blaine and San Angelo formations are exposed.

PHYSIOGRAPHIC HISTORY

The present topography of the county is the result of long continued erosion. The monadnock, Double Mountain, furnishes a partial measure of the amount of erosion which has taken place. It is evident that all of the strata which are represented in this erosional remnant were once continuous over the county. These strata include the upper part of the Peacock formation, and the strata of Triassic and Comanchean age.

The courses of the rivers through the county indicate that they may have started to flow upon a previous topography. In some parts of their courses they are not adjusted to structure but flow against the dip of the rock strata. The entrenched meanders of some of the principal streams also suggest that these rivers may have started to flow upon a previous topography. This does not mean that these streams are necessarily antecedent in the strict sense of the term, i.e., that were flowing upon a peneplain developed in a former cycle of erosion. They may, for example, have started their course upon the depositional plain of which the Llano Estacado was once a part and maintained their courses through the erosional history of subsequent time.

DESCRIPTIVE GEOLOGY

STRATIGRAPHY

With the exception of a few deposits of Cenozoic age and the Triassic and Comanchean strata in the erosional remnant, Double Mountain, the rocks exposed in Stonewall County belong to the Permian system. They consist for the most part of brick-red and gray shales, thick beds of gypsum, red and gray sandstones, and beds of dolomite. The Cenozoic deposits are fluvatile deposits most of which are probably reworked deposits from the Llano Estacado or its former extension.

PERMIAN SYSTEM

The Permian formations of the county belong to the Clear Fork and Double Mountain groups. Only a portion of the Clear Fork group is exposed in this county and the formations at the surface over the greater part of the county belong to the Double Mountain group.

CLEAR FORK GROUP

The term Clear Fork was first used by Cummins[2] to denote the middle portion of the Permian of Texas, which consists largely of shales but contains some dolomite and gypsum.

The total thickness of the Clear Fork group is estimated to be about 1000 feet. The part exposed in this county is the upper 100 feet and consists almost entirely of red sandy shale with thin layers of dolomite and gypsum and one conspicuous dolomite stratum. This dolomite layer, which occurs near the top of the formation in this county, has been named the Merkle dolomite by Wrather.[3] It is a hard gray rock, conspicuously characterized by ripple-marked surfaces. The ripple marks have amplitudes varying from one-half to one inch and wave lengths from two and one-half to three inches. Where considerable areas of the surface of this member are exposed, as for instance on Flat Top Mountain, this characteristic gives it a very striking appearance.

The Merkle dolomite is not present in the northeastern part of the county. Its absence may be due either to an erosional unconformity or to a gradual lithologic change to the north. There is some evidence in favor of the latter hypothesis. The Merkle dolomite extends only a short distance north of the east central part of the county. At these exposures it is somewhat sandy and impure. Several miles to the north near the Pitcock ranch headquarters, about one mile north of the junction of Salt Fork River and Double Mountain Fork River, a white calcareous sandstone with distinctive ripple marks is found beneath the San Angelo formation and in the same stratigraphic position in relation to the latter as that occupied by the Merkle dolomite. North of this locality some gray sandstones occur at or near the stratigraphic horizon of the Merkle dolomite. These facts

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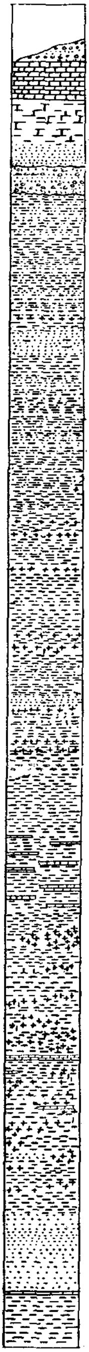
[2]Cummins, W. F., The Permian of Texas and Its Overlying Beds: Geol. Surv. Texas, First Ann. Rept., pp. 185-216.

[3]Wrather, W. E., Notes on the Texas Permian: Southwest Assoc. Petr. Geol. Bull. Vol. 1, pp. 93-96, 1917.



	Formation or Group	Minor Divisions	Character of Rocks	Character of Formation
0–30+			Sand and gravel	
	Unconformity			
	Edwards			
140+	Comanche Peak		Massive dolomite, marl, and sandstone Exposed only in Double Mountain	
	Trinity		Sand, exposed only in Double Mountain	
35+	Dockum		Sand and gravel exposed only in Double Mountain	
700–850	Peacock		Brick-red, shales and sandstones	Brick-red, sandy shale argillaceous sandstone, few gypsum beds, and few thin non-persistent beds of dolomite
		Oriana gypsum	Massive white gypsum	
		Swenson gypsum	Massive white gypsum	
550–600	Blaine	Aspermont dolomite	Beds of gray dolomite	Beds of massive gypsum, red shale, gray shale, dolomite, and some sandstone
60–183+	San Angelo			Red sandstone, some conglomerate and shale
	Unconformity			
100±	Clear Fork	Merkle dolomite *member*	Ripple-marked white dolomite	Red shale 1 prominent dolomite bed

Fig. 4. Generalized section of the rocks exposed at the surface in Stonewall County.

indicate that the absence of the characteristic Merkle dolomite in the northeastern part of the county may be caused by a gradual lithologic change.

In addition to the Merkle dolomite discussed above, the Clear Fork exposed in this county contains a few very thin layers of dolomite. It also contains a few layers of gypsum. The latter, however, is in most places in the form of satin spar and appears to have been formed secondary to the deposition of other sediments.

The Clear Fork group outcrops in a small area in the extreme southeastern part of the county, south of Flat Top Mountain. It is also exposed beneath the San Angelo in the sides of Flat Top Mountain, and in a narrow belt along the eastern border of the county north of Flat Top Mountain. It extends up the valley of Double Mountain Fork River as far as the northeastern corner of Sec. 163 B., B. and C. R.R. Co., about five miles from the eastern border of the county, where it passes beneath the river. Northward to the junction of the Double Mountain Fork and Salt Fork rivers it is exposed in a narrow strip extending along the eastern border of the county parallel to Double Mountain Fork River. It extends up the valley of Salt Fork River about one and one-half miles. North of the junction of Salt Fork and Double Mountain Fork rivers the only exposures of the Clear Fork are found in the steep banks bordering the west side of the river. On the east side it is exposed on the broad level plain developed on that side of the river.

The topographic expression of the Clear Fork in this county is very different from that east of the county. This difference is caused by the presence of the Merkle dolomite, which because of its resistant qualities produces escarpments such as that of Flat Top Mountain. These bold escarpments of the Merkle dolomite form a striking contrast to the level plain developed on the shale of the lower part of the series.

The thickest section of the Clear Fork measured in this county totals a little over 100 feet. Most of the other sections measure less than this. Exposures in this county, therefore, show only a fraction of the total thickness of the formation.

Neither the Merkle dolomite nor the shales of the formation contain any fossils.

Beede[4] reports that the base of the San Angelo formation in Coke County, Texas, is 270 feet above the Merkle dolomite. He also cites the apparent disappearance of the Merkle dolomite north of the junction of Salt Fork and Double Mountain Fork rivers in Stonewall County and expresses the belief that these facts are evidence of a disconformity between the Clear Fork and San Angelo formation. As shown in the preceding discussion of the character of the Clear Fork formation this disappearance may be caused by a gradual change in the lithologic character of the dolomite.

The following geologic sections show in some detail the nature of the Clear Fork exposures within the county.

Section No. 1. One-fourth mile south of the Aspermont-Sagerton bridge across Double Mountain Fork River.

		Ft.	In.
12.	Dark red shale	6	
11.	Blue shale containing large concretionary-like bodies one foot to fifteen inches in diameter. When weathered these break up into many small fragments	2	
10.	Dark red shale	3	
9.	Blue shale	1	9
8.	Dark red shale	6	
7.	Blue shale	1	9
6.	Dark red shale	2	6
5.	Blue shale	2	6
4.	Dark red shale with bluish-green streaks and circular spots. Streaks run both horizontally and vertically	10	
3.	Blue shale	0	3
2.	Red shale	5	
1.	Bluish-green shale with a little gypsum	1	
	Total of section	41	9

[4]Beede, J. W., and Christner, D. D., The San Angelo Formation: Univ. of Texas Bull. No. 2607, p. 12, Feb., 1926.

Section No. 2. Taken on Flat Top Mountain in approximately Sec. 28, Heirs of H. K. Day.

Base of San Angelo sandstone

		Ft.
6.	Red shale	4
5.	Merkle dolomite	2
4.	Blue shale	2
3.	Red shale	4
2.	Blue shale	1
1.	Dark red shale	89
	Total of section	102

Section No. 3. In approximately Sec. 145, B. B. & C. C., south side of Double Mountain Fork in the southeast part of the county.

		Ft.
7.	Bluish-green shale	2
6.	Red shale	9
5.	Merkle dolomite	½ to 2
4.	Bluish-green shale	1
3.	Red shale	46
2.	Blue shale	1
1.	Red shale	5
	Total of section	66

Section No. 4. West side of Salt Fork River in the northeastern part of Stonewall County, in approximately the northeastern part of the William Smith Survey, just east of the ranch headquarters of the Lee Crenshaw Ranch.

Bottom of the San Angelo

		Ft.	In.
13.	Blue shale	2	6
12.	Red shale	20	
11.	Blue shale	1	6
10.	Red shale, sandy	5	
9.	Red shale	1	
8.	Fibrous gypsum	1	
7.	Red shale	3	
6.	Fibrous gypsum		2
5.	Red shale	5	6
4.	Blue shale	1	
3.	Fibrous gypsum		2
2.	Red shale	1	0
1.	Concealed	21	
Water level.			
	Total of section	62	10

Section No. 5. In the west-central part of the Green B. Cook Survey, about one and one-half miles south of the junction of Salt Fork and Double Mountain Fork Rivers. Section taken on the south side of the river.

		Ft.
6.	Concealed to the top of the inner valley	8
5.	Light gray sandy shale with thin layers of impure limestone	6
4.	Concealed	10

		Ft.
3.	Massive, fine-grained, gray sandstone	4½ to 5
2.	Bluish-gray shale with few stains of malachite	10
1.	Dark red shale with thin beds of gypsum	50 to 75
	Total of section	114

Section No. 6. East part of the M. E. & P. R. R. Co. Survey, W. A. Pitcock A. 421, northeast part of the county about two and one-half miles north of the junction of Salt Fork and Double Mountain Fork rivers. Section taken on the west side of the river. Section begun about fifteen feet above the river.

Bottom of the San Angelo

		Ft.	In.
6.	Concealed	3	
5.	Light gray calcareous sandstone, fine-grained, and rather firmly cemented	8	
4.	Bluish-green shale	5	
3.	Dark red shale	12	
2.	Dolomite		3
1.	Dark red shale	8	
	Total of section	36	3

Section No. 7. West side of Salt Fork River in northeastern Stonewall County, in approximately the northeastern part of the William Smith Survey, one-fourth mile north of the ranch headquarters of the Lee Crenshaw ranch.

		Ft.
15.	Gray shale	1
14.	Red shale	3
13.	Gray shale	2
12.	Red shale	10
11.	Blue shale	1
10.	Red shale containing nodules of gypsum	8
9.	Blue shale containing nodules of gypsum	1
8.	Red shale	5
7.	Gray shale	1
6.	Red shale with some thin gypsum	8
5.	Hard blue sandy shale	1
4.	Red shale with some gypsum	10
3.	Bluish gypsum	2
2.	Red shale with thin layers of gypsum	8
1.	Red shale partly concealed	10
	Total of section	71

DOUBLE MOUNTAIN GROUP

With the exception of a few isolated outcrops, such as the outcrops of the Cretaceous and Triassic in the erosional remnant, Double Mountain, and the sands and gravels of Cenozoic age, the remainder of the rocks exposed in this county belong to the Double Mountain group.

The Double Mountain group as originally defined includes all of the sediments lying above the Clear Fork group and below the Triassic. In this report the Double Mountain group is divided into three formations, San Angelo, Blaine, and Peacock. The name Peacock formation is proposed for the sediments above the top of the Blaine formation as it is believed that these sediments cannot be satisfactorily correlated, at least for the present, with formations which have been described elsewhere for the sediments lying above the Blaine.

SAN ANGELO FORMATION

The San Angelo formation is the lower part of Cummins' original Double Mountain group. Cummins first defined the San Angelo formation.[5] His description was, however, from a locality in a different part of the State from this county. Subsequently Beede[6] traced the formation from its type locality across the State and published a description of it. He describes it as consisting of coarse siliceous conglomerates of clay and sandstone grading into shales to the northward in Coke and Tom Green counties.

The lithologic character of the San Angelo formation in Stonewall County is different from that of the type locality. In most of the exposures in the county the formation consists of massive, cross-bedded, red, and gray sandstone, and red shale. Considerable conglomerate is present, but, except in the southeastern part of the county, this conglomerate does not contain siliceous pebbles but is made up of pieces of dolomite and other sedimentary rocks. In the southeastern part of the county some exposures show an abundance of siliceous pebbles, and some siliceous pebbles occur as far north as Sec. 19, B. B., and C., R.R. Co., one mile north of Old Glory, but most of the exposures do not contain such pebbles. The massive red and gray sandstones of the formation increase to the north with corresponding decrease of the conglomeratic phase.

The outcrop of the San Angelo formation parallels that of the Clear Fork, being exposed in a narrow north-south

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[5]Cummins, W. F., and Lerch, O., Am. Geol., pp. 321-325.

[6]Beede, J. W., and Christner, D. D., The San Angelo Formation: Univ. Texas Bull. No. 2607, Feb., 1926.

strip across the county west of the outcrop of the Clear Fork. It is extensively exposed on the cuesta slope of Flat Top Mountain.

Where the San Angelo formation is largely made up of siliceous conglomerate it is sufficiently resistant to develop escarpments. In the part of the county where it is of this nature it is underlain by the Merkle dolomite, which is also a resistant rock, so that the escarpments formed in such places are not entirely caused by this formation. Where the formation consists of friable sandstones it breaks down easily and is not a good cliff-making formation. However, north of the confluence of the Double Mountain Fork and Salt Fork rivers, where the San Angelo is of less resistant nature than it is in the southern part of the county, it does act as a relatively good cliff maker. The river here is working westward leaving a broad flat on the east side and cutting steep banks on the west. The San Angelo forms the cap of these steep bluffs.

The thickest section of the San Angelo measured by the writer was taken on the west side of Salt Fork River about three miles north of the junction of Salt Fork River and Double Mountain Fork River. This section totals 133 feet. Most of the sections taken in other parts of the county show less than 50 feet. As the formation weathers down at the edge of the cliffs it is possible that the full thickness was not seen where some of these sections were measured.

The formation appears to be entirely barren of fossils so far as the exposures in this county are concerned.

The variation in thickness of the Clear Fork above the Merkle dolomite, and the disappearance of the Merkle dolomite in this county have been cited as evidence of an unconformity between the Clear Fork and the San Angelo.[7] An alternative hypothesis to account for the disappearance of the Merkle dolomite was tentatively suggested above in the discussion of this member. Irrespective of this, however, the evidence seems to be sufficient to warrant the

[7]Beede, J. W., and Christner, D. D., *op. cit.*

conclusion that an unconformity exists between the two formations.

The following detailed geologic sections show the character of the formation within the county.

Section 1. On the side of the Flat Top Mountain in southeastern part of the county in approximately the center of Sec. 28, Heirs of F. H. and K. Day, about one-half mile east of the Stonewall-Haskell county line in Haskell County and about two miles south of Double Mountain Fork.

		Ft.
2.	Sandstone very much cross-bedded and in places very conglomeratic. A few quartz pebbles in places but pieces mostly composed of limestone	6–10
1.	Red shale (Clear Fork)	4
	Top of Merkle dolomite	
	Total of section	14

Section 2. Approximately Sec. 145, B. B. & C. R. R., in bluff bordering the south side of Double Mountain Fork, directly south of Old Glory.

		Ft.
4.	Sandstone, reddish, more or less cross-bedded	6–10
3.	Massive sandstone, fine-grained, gray with slightly reddish tinge	12
2.	Bluish-green shale	2
1.	Red shale	9
	Total of section	33

Section 3. One mile north of Old Glory in the head of a small valley.

		Ft.
4.	Very soft friable sandstone and red shale	5
3.	Very coarse conglomeratic sandstone containing some siliceous pebbles	3
2.	Sandy red shale	8
1.	Red, very strongly cross-bedded sandstone	10
	Total of section	26

Section 4. North side of the Salt Fork approximately two and one-half miles west of the confluence of Salt Fork and Double Mountain Fork in the F. Davidson Survey.

	Ft.
Fine-grained, cross-bedded sandstone of light greenish tinge. Scattered through this are rather numerous stains of malachite. Exposure seen in a quarry at the base of the cliff	8–10

Section 5. West side of the Salt Fork about one-half mile north of the confluence of Double Mountain Fork and Salt Fork in the east part of W. A. Pitcock Survey.

		Ft.
3.	Massvie cross-bedded sandstone, very conglomeratic at the top	6–8
2.	Red shale	6

1.	Concealed	10
	Top of Clear Fork	
	Total of section	31

Section 6. North side of Salt Fork, approximately four miles from the east border of the county in F. Davidson Survey.

	Ft.
Sandstone	60

Section 7. SW ¼ of Sec. 3, Arnold and Bennett Survey approximately one and one-half miles south of Old Glory.

		Ft.
2.	Massive red sandstone containing some gray sandstone	8
1.	Red shale	5–6
	Total of section	14

BLAINE FORMATION

The Blaine formation was first defined by Gould[8] in Oklahoma who described it as including a series of gypsums, dolomites, and interbedded red shales. The Blaine formation in this county includes all of the sediments from the top of the San Angelo to the base of the Swenson gypsum member of the Peacock formation. This definition includes slightly more than the Blaine as originally defined in the type section in Oklahoma. The boundary between the Blaine and the Peacock is drawn at the base of the Swenson gypsum member for the reason that this member serves as a good key horizon in this and adjacent counties. The writer originally placed the upper boundary of the formation at the top of the dolomite beds as this would more nearly correspond to the Blaine as defined in Oklahoma, but on account of the fact that it was found by the coöperative mapping committee of the American Association of Petroleum Geologists and the Bureau of Economic Geology that the Swenson gypsum member serves as an excellent key horizon in other counties the boundary was changed in this county to correspond to that of adjacent counties.

The Blaine formation as defined above consists in this county of beds of massive gypsum, red shale, gray shale, dolomite, and some sandstone.

[8]Gould, C. N., A New Classification of the Permian Red Beds: Bull. Am. Assoc. Petr. Geol., Vol. VIII, No. 3, May-June, 1924.

The lower 100 to 150 feet consists of beds of shale, gypsum, some sandstone, and a few dolomite beds, shale, however, being the most prominent. Above this the gypsum ledges gradually increase in size and proportionate number and 200 to 250 feet of this part of the column is made up of alternating beds of gypsum and shale, the gypsum making up one-third to one-half of the whole.

The maximum thickness of any one gypsum bed is 30 feet. The individual beds in general are not this thick. This part of the column consists of many ledges of gypsum five to ten feet thick alternating with beds of shale. Many of the gypsum beds are not continuous and comparatively thick beds thin out and disappear laterally in short distances. A prominent characteristic of these gypsum beds, which is in contrast to the gypsum of the formation above, is a concretionary-like appearance, probably due to the presence of centers of recrystallization.

One of the thickest and most persistent beds of gypsum in this formation occurs near the top of the group. Its maximum thickness is 30 feet. In the valley of Double Mountain Fork River there are several caverns, which have been formed by solution of the gypsum of this ledge. One of these caverns has an opening about 15 feet in height. In many places beds of the interval immediately overlying the gypsum beds have been disturbed by slumping. This has no doubt been caused by the solution of the beds of gypsum, particularly the one just described, resulting in the formation of caverns the roofs of which have subsequently collapsed allowing the beds above to slump.

The shale of the formation varies greatly in color. Although red is present in nearly all exposures, it is by no means the dominant color, much of the shale being a light gray color and a lesser proportion having a bluish tinge. The different colored shales alternate with each other, which indicates that the color is due to the original nature of the shales and not to a leaching out of the original color. On the whole the shales of this formation do not present the typical appearance of the Permian red beds.

About 200 feet from the bottom of the formation there occurs a persistent dolomite bed, which is typically exposed as the capping of the inner terrace in the valley of Double Mountain Fork River and also in the valley of Salt Fork River. It is also exposed on the cuesta slope between the escarpment of the San Angelo and the escarpment of the gypsum and dolomite beds of the Blaine. On this cuesta slope it forms minor escarpments in a few places. The dolomite is white, hard, and in some places has partings of shale and in others nodules of gypsum. Some small deposits of galenite were found in this ledge in an exposure in a ravine opening into the valley of Double Mountain Fork River about eight miles from the east border of the county and one mile north of the river. Only a few deposits were found and there is so reason to believe that lead ore occurs in commercial quantities in this bed.

Above the heavy gypsum beds there is a series of prominent dolomite beds interstratified with shale anl some gypsum. One of the beds of this group was designated the Aspermont dolomite in a graphic section published by Wrather[9] in 1916. These dolomite and shale beds occupy an interval about 100 feet thick. The heavier and more prominent ledges occupy the lower part of the interval and gradually give way above to thinner beds and thicker strata of shale. The ledges are not continuous but lens out from place to place and other ledges appear. The beds in the lower part of the interval vary from thin bedded to massive. In some places the beds consist of alternating strata of thin bedded dolomite and shale, but the beds for the most part are massive dolomite. The indivilual dolomite beds in the lower part of the interval vary in thickness from one to ten feet, but the average is not over two feet. The number of dolomite beds varies also. There are from one to five of the more massive beds although not more than three are found at any one locality as a rule. In most localities three or four of the thin beds are present in the upper part of

[9]Wrather, W. E., Notes on the Texas Permian: Bull. Southwest. Assoc. Petr. Geol., Vol. 1, p. 106, 1916.

the interval. These beds are quite thin being at best only a few inches thick.

The dolomite of the lower beds is hard, white, and even granular in texture. In places it has a brecciated appearance being made up of rectangular pieces averaging less than an inch in length. As recementation appears to have taken place without disturbance of the individual pieces it is believed that this is a desiccation breccia.

These beds are cut in many places by numerous joints, which are generally perpendicular to the bedding planes and which divide the beds into more or less rectangular blocks six to twelve inches in length and four to six inches in breadth and thickness.

One of the most conspicuous characters of the dolomite of the more prominent beds is its porosity. In many places it is dense and non-porous but in others it contains many pores or openings ranging from less than one-sixteenth of an inch in diameter to as much as one inch in diameter. The latter size is relatively rare, however, and the smaller size the average.

In some localities the dolomite has in it many seams of gypsum and many small cavities filled with this material. The most typical exposure of this kind is at the south end of the bridge across Stinking Creek on the road leading north from Aspermont.

Near the top of this interval the shales are more or less calcareous. In this part of the interval occur some strata of calcareous shale cut by many thin vertical planes of calcareous material. The vein filling is more resistant than the shale and weathering causes the rock to have a peculiar honeycomb appearance. Some of the calcareous partings have been formed according to a fairly regular pattern but that of others is very irregular. However, all gradations from regular vertical veins, which are quite evidently mud cracks filled with cementing material, to the most fantastic patterns may be found. There seems to be no doubt, therefore, that all these have been caused by alternating intervals of desiccation and sedimentation.

The character of the shale of this interval varies considerably. As indicated above, some of the shales are quite calcareous but this does not hold for all of the beds. The color also varies and although red is the predominant color, the beds are by no means uniformly of that color, blue and gray shale occurring in many places.

Above the group of dolomite beds there is an interval of about 100 feet up to the base of the persistent gypsum bed designated as the Swenson gypsum bed, which marks the base of the succeeding formation. This interval is occupied by shale and sandstone mostly of a red color.

The Blaine formation as described above outcrops over a wide area comprising most of the eastern and central parts of the county. Its eastern border is a few miles from the eastern border of the county and its western boundary 10 to 12 miles from the west county line.

The Blaine is in general a cliff making formation. The gypsum and dolomite beds produce bold cliffs and escarpments.

Over considerable areas of the county where the dolomite beds outcrop there are many small mounds a few feet in height and having a maximum diameter of 50 to 75 feet. The surface of these mounds is without exception one of the dolomite strata. Dolomite layers tilted at various angles, some even standing vertical, occur in association with the mounds. The mounds and tilted strata have the appearance of having been caused by strata being forced up from beneath and they are commonly ascribed to gas blowouts. It will be recalled that the dolomite strata overlie the interval containing many thick gypsum strata and that one of the thickest and most persistent of these ledges is a few feet below the interval containing the dolomite beds. Solution of the gypsum beds in places allows the dolomite strata to slump down and this results in the attitude described above. Where such slumping occurs beneath strata less resistant than the dolomite beds erosion quickly restores the level so that these features are only preserved in the region of the outcrop of the dolomite beds.

The total thickness of the formation is about 550 to 600 feet.

The Blaine formation is in general unfossiliferous in this county. The dolomite beds, however, are in places very fossiliferous. The fossils are generally poorly preserved casts. Small pelecypods are the most abundant but their state of preservation is usually such that identification of genera and species is not possible.

Below are given a number of detailed sections of the formation.

Section 1. Section taken on the south side of Salt Fork Valley one-half mile north of the ford in the SW ¼ of Sec. 29, H. & T. C. R.R., Block D.

		Ft.	In.
54.	Dolomite capping cliff	3–5	
53.	Shale and concealed	30	
52.	Gypsum	20	
51.	Red shale	1	
50.	Gypsum	6	
49.	Red shale	12	6
48.	Gypsum	0	6
47.	Gray shale	2	0
46.	Gypsum	1	6
45.	Red shale	4	0
44.	Gypsum	5	0
43.	Red shale	2	6
42.	Gray shale	2	6
41.	Gypsum	5	3
40.	Red shale	3	0
39.	Gypsum	2	0
38.	Partially concealed but showing gray shale	10	0
37.	Gypsum	0	3
36.	Red shale	5	0
35.	Gypsum	1	0
34.	Shale	1	0
33.	Thin dolomite	0	1
32.	Bluish-gray shale	0	5
31.	Gypsum	5	0
30.	Shale	2	0
29.	Gypsum	1	6
28.	Blue shale and gypsum	10	0
27.	Dolomite	4	0
26.	Partly concealed but mostly gypsum	10	0
25.	Gypsum	5	6
24.	Concealed	10	
23.	Gypsum	2	0
22.	Gypsum	2	
21.	Gypsum	1	
20.	Anhydrite altering into gypsum	3	6
19.	Shale	0	6
18.	Gypsum	1	
17.	Shale and gypsum	1	

		Ft.	In.
16.	Gypsum	3	6
15.	Blue shale	0	6
14.	Gypsum	1	
13.	Blue shale	2	6
12.	Gypsum	2	
11.	Blue shale	4	
10.	Gypsum	15	
9.	Hard bluish-gray dolomite	1	
8.	Red shale with much gypsum	1	
7.	Very hard blue-gray dolomite	4	6
6.	Gray shale	5	
5.	Gypsum	3	
4.	Blue sandy shale	2	
3.	Concealed	3	
2.	Blue sandy shale	2	
1.	Concealed	3	
	Total of section	232	6

The above is a section in the interval containing the numerous gypsum beds.

Section 2. Section made by combining geologic section taken in Sec. A. B. and M., Block 2, and section taken in approximately the center of Sec. 2, J. L. Roberts one mile west of Salt Fork.

		Ft.	In.
81.	Dolomite		6
80.	Concealed	5	
79.	Dolomite in layers of about 3 in. in thickness	1	
78.	Dolomite, massive	2	
77.	Concealed	5	
76.	Gypsum	2	
75.	Concealed	9	6
74.	Gypsum	3	
73.	Gray shale	0	6
72.	Gypsum	3	0
71.	Gray shale	1	
70.	Dolomite	2	
69.	Concealed	4	
68.	Gypsum	1	
67.	Shale		1
66.	Gypsum	10	
65.	Red shale	5	
64.	Gypsum	2	6
63.	Gray shale	3	6
62.	Red shale	10	6
61.	Gypsum	1	
60.	Concealed	8	
59.	Gypsum	3	
58.	Concealed	5	
57.	Concealed	50	
56.	Red shale	5	7
55.	Gypsum	2	
54.	Red shale with some gypsum	5	
53.	Concealed	5	6
52.	Thin dolomite		2
51.	Gray shale	5	

		Ft.	In.
50.	Dolomite alternating with gray shale. Layers of dolomite about 3 in. thick—maximum 9 in.	10	
49.	Yellowish shale	5	
48.	Dolomite	8	
47.	Gray shale	3	
46.	Hard blue dolomite		1
45.	Gypsum	1	
44.	Red shale	2	
43.	Gypsum	2–3	
42.	Red shale	4	
41.	Lens of gypsum	0–3	
40.	Gray shale	8	
39.	Red shale	5	
38.	Gypsum	5–6	
37.	Gray shale	1	6
36.	Red shale	1	6
35.	Dolomite, thin-bedded		6
34.	Gray shale with much gypsum	2	
33.	Dolomite		2–3
32.	Gray shale	5	
31.	Dolomite		2
30.	Gray shale	5	
29.	Gypsum	3	
28.	Dolomite		2
27.	Blue gypsum	1	
26.	Red shale		6
25.	Satin spar		1
24.	Very dark red shale with nodules of gypsum		3
23.	Blue shale	5	
22.	Dolomite in layers varying from thin laminae to layers 6 in. thick	1–2	
21.	Blue shale	2–3	
20.	Gypsum	1	
19.	Blue shale		6
18.	Red shale	1	
17.	Gypsum	1	6
16.	Blue shale		9
15.	Gypsum	2	6
14.	Shale, red	7	9
13.	Gypsum	4	
12.	Shale, blue	3	
11.	Gypsum, massive	1	6
10.	Blue shale	1	9
9.	Gypsum		6
8.	Blue shale	3	
7.	Red shale	5	
6.	Gypsum, blue	1	6
5.	Shale, blue with many layers of gypsum	1	
4.	Shale, red with layers of satin spar	15	
3.	Gypsum, massive	1	
2.	Red shale	8	
1.	From the top of the San Angelo (estimated) concealed	50	
	Total of section	360	7

Section 3. Section taken on Kiowa Peak, an erosional remnant in the west central part of the Manuella Cordova Survey, three and

one-half miles from the east border of the county and two and one-half miles from the north border. The section begins at the base of the hill and extends up to the summit. The bottom of the section is approximately near the middle of the formation.

		Ft.	In.
41.	Gypsum and shale	5	
40.	Gypsum	1	
39.	Gray shale	1	
38.	Gypsum	1	6
37.	Gray shale	1	
36.	Red and gray shale	2	
35.	Gypsum	23	
34.	Red shale with gypsum	7	
33.	Red shale	15	
32.	Gypsum	1	
31.	Red shale	5	
30.	Gypsum	6	
29.	Red shale	3	
28.	Gypsum	1	
27.	Red shale	4	
26.	Gypsum	1	
25.	Red shale	1	
24.	Gypsum	1	
23.	Shale	1	
22.	Gypsum	4–5	
21.	Red shale	5	
20.	Gypsum	1	
19.	Red shale	2	
18.	Gypsum	1	
17.	Red shale	5	
16.	Gypsum	1	6
15.	Red shale	5	
14.	Gypsum	14	
13.	Red shale with some green shale	3	
12.	Gypsum	14	
11.	Gypsum	1	
10.	Gray shale	5	
9.	Gypsum	2	
8.	Gray shale	4	
7.	Gypsum	2	
6.	Concealed	5	
5.	Gypsum	1	
4.	Gray shale	3	
3.	Gypsum	2	
2.	Concealed	3	
1.	Gypsum	1	
	Total of section	166	

Section 4. Section taken in a ravine below the base of Section 3.

		Ft.
8.	Gypsum	2–3
7.	Blue shale	2
6.	Red shale	1
5.	Gypsum	1
4.	Blue shale	2

		Ft.
3.	Red shale with thin layers of gypsum about every 3 feet	30
2.	Blue-green shale	8
1.	Dark red shale	8

Section 5. In ravine approximately in the center of the Manuella Cordova Survey, in the northeast part of the county, approximately two miles from the east border, and two and one-half miles from the north border of the county. The section is approximately near the center of the Blaine formation.

		Ft.
9.	Thin dolomite, top of the terrace	
8.	Gypsum	2–3
7.	Blue shale	2
6.	Red shale	1
5.	Gypsum	1
4.	Blue shale	2
3.	Red shale with thin layers of gypsum about every 3 feet	30
2.	Blue-green shale	2
1.	Dark red shale	8
	Total of section	49

Section 6. Beginning at the river in south central part of Sec. 68, H. & T. C. R. R., Blk. D, and extending up a tributary valley to center of Sec. 76.
Top of hill

		Ft.	In.
33.	Dolomite	1	
32.	Concealed	7	
31.	Gypsum	1	
30.	Concealed	10	
29.	Dolomite, thin-bedded	2	
28.	Concealed	4	
27.	Gypsum	1	
26.	Concealed	1	
25.	Gypsum	7	
24.	Red shale	1	
23.	Gypsum	1	
22.	Concealed	6	
21.	Gypsum	5	
20.	Concealed	5	
19.	Gypsum	3	6
18.	Concealed	5	
17.	Red shale	5	
16.	Concealed	2	
15.	Gypsum	1	
14.	Concealed	5	
13.	Gypsum	10	
12.	Red and gray shale	6	
11.	Gypsum, earthy, inpure	9	
10.	Dolomite	1	
9.	Gypsum	9	
8.	Gray shale	5	
7.	Red shale	8	
6.	Gypsum	3	
5.	Blue shale	4	

		Ft.	In.
4.	Gypsum	5	
3.	Concealed	10	
2.	Dolomite	1–2	
1.	Concealed	5	
		150	6

Nos. 29 to 33 are beds in the lower part of the interval containing the dolomite strata.

Section 7. Section begun at the mouth of a small tributary to Salt Fork in the SE ¼ of Sec. 68, H. & T. C. R. R., Block F, ten miles from the east and eight and one-half miles from the north border of the county. Section continued up the valley of the tributary to the northwest.

		Ft.	In.
34.	Dolomite	5	
33.	Concealed	10	
32.	Red shale	6	
31.	Gypsum	1	
30.	Concealed	5	
29.	Calcareous shale	2	
28.	Dolomite		6
27.	Concealed	15	
26.	Dolomite	5	
25.	Concealed	10	
24.	Gypsum	2	
23.	Blue and gray shale	6	
22.	Massive gypsum	7	
21.	Dolomite	2	
20.	Gypsum		6
19.	Blue shale with gypsum	2	
18.	Red shale with many layers of crystalline gypsum	2	
17.	Red shale	9	
16.	Gypsum	2	
15.	Concealed and red shale	5	
14.	Massive gypsum	7	
13.	Concealed	9	
12.	Gypsum	5	
11.	Shale	1	
10.	Gypsum	5	
9.	Thin-bedded dolomite	2	
8.	Dolomite		9
7.	Blue shale	2	
6.	Hard blue shale which changes gradually to red in the middle and back to blue above	2	
5.	Blue shale interstratified with layers of gypsum	2	6
4.	Red shale		6
3.	Blue shale		9
2.	Red shale		5
1.	Gypsum	5	
	Total of section	139	11

Nos. 1 to 25 belong to the interval containing the larger number of gypsum beds.

Section 8. In approximately the NW ¼ of Sec. 163, B. B. and R., south side of Double Mountain Fork five miles from the east and five and one-half miles from the south border of the county.

		Ft.	In.
24.	Dolomite, massive to thin-bedded. Massive layers 8 inches to 1 foot thick	4–5	
23.	Yellowish-gray shale	8	
22.	Bluish-green shale	13	
21.	Red shale	5	
20.	Alternating shale and gypsum	1	
19.	Blue shale	1–2	
18.	Gypsum	1	
17.	Red and blue shale	12	
16.	Alternating gypsum and shale	3–4	
15.	Concealed	6	
14.	Dolomite, massive at the bottom and becoming thin at the top. Contains many nodular pieces of gypsum.		
13.	Shale, red and blue, partly concealed	12	
12.	Gypsum	1	6
11.	Red and blue shale	5	
10.	Massive gypsum	2	
9.	Red shale	10	
8.	Massive gypsum	4	
7.	Blue and red shale	10	
6.	Sandstone, reddish, more or less cross-bedded, rather fine-grained	4	
5.	Shale	1	
4.	Sandstone, bluish-green, fine-grained, cross-bedded	1	
3.	Red shale	11	
2.	Bluish-gray, thin-bedded sandstone	1	
1.	Dark red shale	5	
	River level		
	Total of section	124	6

This section begins not far above the base of the formation.

Section 9. On a bluff, on the south side of Double Mountain Fork, one-half mile west of Sudberry Ford, at approximately north central part of Sec. 347, William Vardeman Survey, about nine and one-half miles from the east border of the county.

		Ft.	In.
31.	Dolomite with some shale partings capping the edge of the cliff	4	
30.	Light gray shale	2–4	
29.	Gypsum	1	
28.	Dolomite		2
27.	Red shale	2	
26.	Gypsum	4	
25.	Dolomite		2
24.	Red and blue shale	10	
23.	Gypsum	2	
22.	Red shale	2	
21.	Gypsum	2	
20.	Red shale with much secondary gypsum	2	
19.	Light blue shale with nodules of gypsum, the gypsum making up at least 50 per cent of the whole	1	3

		Ft.	In.
18.	Blue shale	3	
17.	Gypsum	1	
16.	Blue shale	7	
15.	Gypsum	3	
14.	Shale	1	
13.	Gypsum	3	
12.	Shale	4	
11.	Gypsum		6
10.	Blue shale	5	
9.	Dolomite	1	
8.	Blue shale passing gradually into dolomite above	5	
7.	Gypsum	2	
6.	Blue shale	3	6
5.	Red shale	3	
4.	Gypsum	1	6
3.	Red shale grading into blue at the top	3	
2.	Gypsum	2	
1.	Concealed	14	
	River level		
	Total of section	97	1

This section is from the lower part of the formation.

Section 10. Begun at the mouth of Stinking Creek south side of creek south central part of H. & T. C. R. R., Block D, eleven miles from the east border of the county.

		Ft.	In.
16.	Dolomite, thin-bedded to massive	10	
15.	Concealed, some blue shale	15	
14.	Dolomite, flaggy	6	
13.	Concealed	5	
12.	Blue gypsum	1	
11.	Red shale	5	
10.	Dolomite, somewhat thin-bedded	6	
9.	Concealed	25	
8.	Massive gypsum	25	
7.	Red shale	5	
6.	Massive gypsum	6	
5.	Concealed	25	
4.	Massive gypsum	30	
3.	Dolomite, flaggy, containing seams and nodules of gypsum	7	6
2.	Hard blue shale		6
1.	Blue shale containing many nodules of gypsum	4	6
	River level		
	Total of section	176	6

Nos. 10 to 16 are representative of the lower part of the interval containing the dolomite beds.

Section 11. On a bluff, south side of Double Mountain Fork, approximately three miles west of the Aspermont-Hamlin Bridge.

		Ft.
8.	Thin capping of dolomite	
7.	Concealed	15
6.	Massive gypsum	12
5.	Concealed	8

		Ft.
4.	Massive gypsum	23
3.	Concealed	26
2.	Massive gypsum	4
1.	Concealed	17
	River level	
	Total of section	105

This section is from the upper part of the interval containing the heavy gypsum beds.

Section 13. East facing escarpment about one-half mile north of the Stamford and Northwestern R. R., Sec. 14, H. & T. C. R. R., Block D, six and one-half miles east of Aspermont.

		Ft.	In.
15.	Dolomite	1	
14.	Concealed	10	
13.	Gypsum		6
12.	Concealed	5	
11.	Gypsum		6
10.	Concealed	5	
9.	Gypsum	1	
8.	Shale, gray		6
7.	Gypsum		6
6.	Shale and concealed	4	
5.	Concealed	2	
4.	Gypsum, massive light gray	1	3
3.	Partly concealed, mostly light gray shale	6	
2.	Gypsum interstratified with earthy material in alternating layers about 1 inch thick	1	6
1.	Light gray shale partly concealed	6	
	Total of section	44	9

This section is from the upper part of the gypsum-bearing interval.

Section 14. In a small valley about seven miles directly south of Aspermont in the center of Sec. 19, T. & P. R. R., Block U.

		Ft.
4.	Soil	2
3.	Dolomite, hard, white	1–2
2.	Red shale partly concealed	21
1.	Massive gypsum	6

This section is from the upper part of the gypsum-bearing interval and the lower part of the dolomite-bearing interval.

Section 15. On an erosional remnant about two and one-half miles west of Old Glory.

Aspermont Member

		Ft.	In.
21.	Shale, red	9	
20.	Gypsum, massive	6	
19.	Shale, red	5	
18.	Dolomite, flaggy		6
17.	Shale, red	5	
16.	Gypsum	1	6
15.	Shale, gray	1	
14.	Gypsum, bluish-gray	1	

		Ft.	In.
13.	Gypsum		3
12.	Shale, red	4	
11.	Gypsum		8
10.	Shale, red	2	
9.	Gypsum		6
8.	Shale, red to gray, containing many layers of gypsum 1 to 2 inches thick	2	
7.	Gypsum, massive	3	
6.	Gray shale	2	
5.	Red shale	1	6
4.	Gypsum	1	6
3.	Gray shale	2	
2.	Red shale	10	6
1.	Gypsum, blue, finely laminated		6
	Total of section	59	5

This section is from the upper part of the gypsum-bearing interval.

Section 16. In approximately the east central part of Sec. 3, H. & T. C. R. R., Block D, about six miles from the east border and seven miles from the north border of the county.

		Ft.	In.
23.	Gray dolomite	5–6	
22.	Concealed	8	
21.	Gypsum	3	
20.	Shale	1	
19.	Gypsum	1	
18.	Shale		9
17.	Gypsum	1	
16.	Gray shale	1	6
15.	Alternating layers of thin-bedded dolomite and gray shale	3	
14.	Gray shale	5	
13.	Gypsum	3–4	
12.	Concealed	10	
11.	Gypsum	4	
10.	Gray shale	4	
9.	Gypsum	1	6
8.	Red shale	1	
7.	Blue shale	10	
6.	Red shale	3	
5.	Gypsum		6
4.	Red shale	3	
3.	Gypsum and gypsite	4	
2.	Concealed	2	
1.	Gypsum		1
	Total of section	87	4

This section is from the upper part of the gypsum-bearing interval and the lower part of the interval containing the dolomite beds.

Section 17. South side of Salt Fork about the middle of the north border of Sec. 102, H. & T. C. R. R., Block F, about two miles from the north border and thirteen miles from the west border of the county.

		Ft.	In.
18.	Gypsum, massive	7–8	
17.	Concealed and red shale	4	

		Ft.	In.
16.	Yellow, very sandy dolomite, varying almost to pure sandstone	2	
15.	Thin-bedded sandy dolomite	1	
14.	Blue shale interstratified with thin dolomite layers 2 to 3 inches in thickness	10	
13.	Dolomite	2	
12.	Red shale	16	
11.	Dolomite	5	
10.	Blue shale	1	6
9.	Gypsum interstratified with red shale	2	
8.	Dolomite, somewhat shaly and thin-bedded	2	
7.	Blue shale	1	6
6.	Blue shale filled with gypsum nodules, gypsum making up about 50 per cent of the whole	1	
4.	Blue gypsiferous shale	6	
3.	Red shale with many thin laminae of gypsum	1	6
2.	Blue gypsiferous shale	1–2	
1.	Red shale with many fine laminae	2	
		65	6

Nos. 8 to 18 belong to the lower part of the dolomite-bearing interval.

Section 18. South part of Sec. 12, Arnold and Bennett Block A, about eight miles southeast of Aspermont.

		Ft.
10.	Dolomite	1–2
9.	Concealed	8
8.	Gypsum	1
7.	Concealed	5
6.	Massive gypsum	4
5.	Concealed	5
4.	Gypsum and shale	8
3.	Red shale	5
2.	Massive gypsum	15–18
1.	Red shale	8
	Total of section	64

This section is from the upper part of the gypsum-bearing interval.

Section 19. Ravine in approximately SE ¼ of Sec. 17, Block A, Arnold and Bennett Survey, about one mile from Double Mountain Fork River and about nine miles southeast of Aspermont.

		Ft.	In.
25.	Alluvium	10	
24.	Gypsum	10	
23.	Dolomite, hard, blue, weathering to a dull gray. Very porous and containing many small geodes. Breaks up into large block 6 in. to 1 ft. in length and breadth	2–3	
22.	Red and blue shale	10	
21.	Fine-grained, firmly cemented, strongly cross-bedded red sandstone. In places shows a distinct lens and pocket structure	1	6
20.	Red and blue shale	5	
19.	Gypsum	5	
18.	Blue shale, very hard	4–6	

		Ft.	In.
17.	Satin spar		1
16.	Red shale	4	
15.	Satin spar		2
14.	Blue shale	10	
13.	Blue dolomite. Very firm hard dolomite to blue shale. Top ledge of this in places shows deposits of galenite	3	
12.	Gypsum, satin spar		1
11.	Blue shale		6
10.	Hard blue dolomite with many secondary pieces of gypsum	8	
9.	Blue shale		4
8.	Hard, blue limestone or dolomite containing many calcite concretions	2	
7.	Hard blue shale	2	
6.	Red shale	3	
5.	Gypsum, massive	1	6
4.	Light blue shale	5	
3.	Light blue shale	5	
2.	Light blue granular gypsum		6
1.	Very dark red shale with layers of satin spar	1	9
	Total of section	94	5

Section 20. Valley of small tributary to Salt Fork in approximately Sec. 142, H. & T. C. R. R., Block D, six miles from the north and fifteen miles from the east border of the county.

		Ft.	In.
23.	Massive gypsum	2	
22.	Red shale	16	
21.	Gypsum, earthy, impure, with alternating layers of shale	1–2	
20.	Red shale	8	
19.	Massive gypsum	2–3	
18.	Red shale	12	
17.	Gypsum	2	
16.	Red shale	4	
15.	Massive gypsum	4	
14.	Dolomite, hard, yellow containing much yellow shale which weathers to a deeply pitted honeycomb surface	2–3	
13.	Mostly concealed but with few exposures of blue and gray shale	32	
12.	Gypsum	2	
11.	Concealed	4	
10.	Yellow dolomite	1	
9.	Dolomite, thin-bedded to massive	7–8	
8.	Dolomite, massive	4	
7.	Concealed and blue shale	10	
6.	Thin flaggy dolomite	1	6
5.	Dolomite, hard gray, containing numerous casts of pelecypods	2	
4.	Concealed but with exposures showing gray shale	4	
3.	Gypsum	2	
2.	Gypsum	4	
1.	Finely laminated gypsum	4	
	Total of section	134	6

Section 21. On the south side of the valley of Double Mountain Fork, three miles from the south and thirteen miles from the eastern border of the county.

		Ft.
5.	Gypsum	3
4.	Red shale	5
3.	Gypsum	3
2.	Red shale	
1.	Partly concealed but evidently consisting of several beds of dolomite separated by about 5 feet of shale. (Estimated.)	20–25
	Total of section	36

Section 22. Approximately the center of Sec. 118, H. & T. C. R. R., Block D, approximately four miles directly north of Aspermont.

		Ft.	In.
4.	Thin dolomite		6
3.	Red shale	17	
2.	Argillaceous dolomite		6
1.	Red shale	12	
	Total of section	30	

This section is from the upper part of the interval containing the dolomite beds.

Section 23. SW ¼ of Sec. 99, H. & T. C. R. R., Block F.

		Ft.	In.
13.	Dolomite, more or less thin-bedded	5	
12.	Sandy yellow dolomite containing numerous small fossils	2	
11.	Dolomite broken by two different sets of joint planes, one inclined and one vertical	3	6
10.	Hard white dolomite	2	6
9.	Blue shale	4	
8.	Dolomite	1	6
7.	Gray shale interstratified with gypsum	2	
6.	Blue shale	2	
5.	Red shale	1	
4.	Blue shale similar to (3) below	1	
3.	Red shale interstratified with layers of gypsum about ⅛ inch thick	2	8
2.	Alternating strata of gypsum and red shale	2	
1.	Blue shale	2	
	Total of section	31	2

Nos. 8–13 are characteristic of the lower part of the interval containing the dolomite beds.

Section 24. In small valley in approximately the west central part of Sec. 19, T. & P. R. R., Block U, seven miles south of Aspermont.

		Ft.
4.	Soil	2
3.	Dolomite, hard, white	1–2

		Ft.
2.	Red shale, partly concealed	21
1.	Massive gypsum	6
	Total of section	31

No. 3 is one of the dolomite beds of the interval containing the larger number of such beds.

Section 25. *Approximately the center of the Peter Delane Survey, three miles northwest of Rayner.*

		Ft.
6.	White dolomite outcropping in thin layers interstratified with shale	5
5.	Gray shale	2–3
4.	Red shale	5
3.	Gypsum	4
2.	Red shale	2
1.	Dolomite	6
	Total of section	25

This section is from the interval containing the prominent dolomite beds.

Section 26. Valley of Stinking Creek, where road due north from Aspermont crosses the valley.

		Ft.	In.
15.	Impure argillaceous dolomite cut by many veins and weathering to a honeycomb appearance	2	
14.	Concealed but showing red shale in places	22	
13.	Dolomite, bluish color		6
12.	Gypsum	1	
11.	Dolomite, separated by bedding planes into strata 1 to 3 inches thick	1	3
10.	Blue shale		3
9.	Dolomite with many veins and concretionary-like nodules of gypsum, the gypsum making up as much as ¼ to ⅓ of the whole	1	9
8.	Dolomite, separated into layers 3 inches thick	1	3
7.	Dolomite, layers about 3 inches thick separated by thin layers of gypsum	1	
6.	Dolomite, hard, white, massive, upper six inches having veins of satin spar running through it	1	6
5.	Gypsum		6
4.	Concealed	5	
3.	Gypsum	1	
2.	Blue shale		3
1.	Finely laminated, blue gypsum	4	
	Total of section	43	3

This section is from the interval containing the prominent dolomite beds.

Section 27. Approximately the SW ¼ of Sec. 118, H. & T. C. R. R., Block F, south side of Salt Fork River two miles from the north and eleven miles from the west border of the county.

		Ft.	In.
8.	Dolomite in layers, 3 to 4 inches thick, more or less interstratified with gray shale	8	
7.	Gray shale	3	

		Ft.	In.
6.	Red shale	3	
5.	Massive gypsum	3	
4.	Red shale interstratified with gypsum	12	
3.	Blue gypsiferous shale	1	6
2.	Massive gypsum	3	
	Top of dolomite bed exposed at water level		
	Total of section	33	6

This section is from the dolomite-bearing interval.

Section 28. About one mile north of the ford across Salt Fork River five miles from the east border and eleven miles from the north border of the county.

		Ft.	In.
33.	Dolomite	1	
32.	Concealed	7	
31.	Gypsum	1	
30.	Concealed but apparently containing some gypsum	10	
29.	Dolomite, thin-bedded	2	
28.	Concealed	4	
27.	Gypsum	1	
26.	Concealed	4	
25.	Gypsum, somewhat earthy and impure	7	
24.	Red shale	1	
23.	Gypsum	1	
22.	Concealed	6	
21.	Gypsum	5	
20.	Concealed	5	
19.	Gypsum	3	
18.	Concealed	5	
17.	Red shale	5	
16.	Concealed	2	
15.	Gypsum	1	
14.	Concealed	5	
13.	Gypsum	10	
12.	Red and gray shale	6	
11.	Gypsum	9	
10.	Dolomite		1
9.	Gypsum	9	
8.	Gray shale	5	
7.	Red shale	8	
6.	Gypsum	3	
5.	Blue shale	4	
4.	Gypsum	5	
3.	Concealed	10	
2.	Thin dolomite		1–2
1.	Concealed	5	
	Total of section	150	2

Nos. 29 to 33 of this section represent the lower part of the division of the formation in which the gypsum beds decrease and the dolomites become more common.

Section 29. H. & T. C. R. R., Block D, five miles north of Aspermont. Section begun at dolomite capping the inner valley of Stinking Creek.

		Ft.	In.
6.	Impure argillaceous dolomite cut by many veins of calcite causing it to have a honeycomb appearance on the weathered surface	2–4	
5.	White dolomite		6–8
4.	Gray shale	10	
3.	Red shale	12	
2.	Gypsum	2	
1.	Concealed, mostly red shale	12	
		40	8

This section is from the upper part of the interval containing the dolomite beds.

Section 30. Valley of Weddington Creek, northeastern part of the county.

		Ft.
11.	Dolomite	½–1
10.	Concealed	36
9.	Dolomite	5–10
8.	Concealed	17
7.	Dolomite	3–6
6.	Concealed	15
5.	Gypsum, massive	30
4.	Concealed	20
3.	Gypsum	5
2.	Blue shale	1
1.	Gypsum	6
	Total of section	147

This section is from the upper part of the gypsum-bearing interval and the lower part of the dolomite-bearing interval.

Section 31. Valley of Double Mountain Fork in approximately the NW ¼ of Sec. 151, H. & T. C. R. R., Block 1, two miles from the south and eight miles from the west border of the county.

		Ft.
12.	Dolomite	1
11.	Massive, white gypsum	6–8
10.	Red shale with thin layers of gypsum	6
9.	Blue sandy shale	5
8.	Red shale	2
7.	Blue shale	3
6.	Red shale	5
5.	Blue shale	8
4.	Red shale	8
3.	Blue shale	8
2.	Red shale	1
1.	Concealed but apparently red shale	20
	Total of section	75

No. 11 of the section is the Swenson gypsum and this section, therefore, represents the upper part of the formation.

Section 32. Valley of Double Mountain Fork in approximately Sec. 149, H. and T.C. R.R., Block 1, one mile from the south and nine miles from the west border of the county.

	Ft.	In.
6. Gypsum	6	
5. Red shale with gypsum interstratified	6	
4. Gypsum, hard, blue, massive	6	3
3. Red shale with occasional layers of thin gypsum	84	
2. Gypsum, massive. Thins out and disappears to the west	5	
1. Red shale	4	
Total of section	111	3

No. 6 of the section is the Swenson gypsum and this section, therefore, represents the upper part of the formation.

PEACOCK FORMATION

The part of the Double Mountain group lying above the Blaine formation and below the Triassic is designated the Peacock formation in this report. The name is from the town of Peacock in the western part of the county where the formation is exposed. A prominent gypsum member, the Swenson gypsum member, exposed near the town of Swenson is taken as the base of the formation.

The Peacock formation consists almost entirely of brick-red, sandy shales, argillaceous sandstones, few gypsum beds, and very few thin and non-persistent beds of dolomite.

The upper one-fourth of the formation has been removed by erosion all over the county except in the erosional remnant, Double Mountain, in the southwestern part of the county. It is here protected from erosion by the overlying Triassic and Cretaceous.

The sandstones of the member are in most places somewhat fine-grained, friable, and contain much argillaceous material. The sandstones increase in abundance toward the top of the formation but throughout they are rather remarkable for their fineness of grain and the amount of silt which they contain.

The color of the Peacock formation is more nearly uniform than any of the lower members of the Double Mountain group. Although some gray and blue shales and sandstones occur, brick-red is the predominant color.

The formation weathers down to a red sandy soil. In places the amount of sand becomes very considerable and gives rise to sand dune country.

The gypsum beds of this formation have a more uniform granular texture than those of the Blaine and the peculiar concretionary appearance noted in the gypsums of the Blaine formation is not seen in this formation.

The Swenson gypsum member forms a prominent escarpment which can be traced from the south border of the county to near the town of Swenson. Near this place, however, the escarpment dies down and the gypsum bed disappears. From this location north to Salt Fork River the country is covered with sand dunes and no exposure of gypsum can be found. On the north side of Salt Fork River a prominent gypsum bed appears coming above the level of the river in Sec. 320, H. and T. C. R. R., Block D. This bed can be traced north on the north side of the river and up Dove Creek to near the north border of the county where it passes under the level of Dove Creek. This bed can also be traced for some distance on the east and south side of Salt Fork River, but in approximately Sec. 292, H. and T. C. R. R., Block D, only a few beds of impure gypsum appear at this horizon and east of this no exposures appear. This gypsum bed occupies the same stratigraphic position relative to the dolomite beds as the Swenson gypsum and is, therefore, correlated with it although it is not believed that the two beds are continuous across the area between Swenson and Salt Fork River. It does not seem probable that such prominent beds as these would everywhere be concealed by wind blown deposits. It seems more logical to believe that two basins or parts of the same basin were separated by a bar at the time of deposition of the gypsum beds. The character of the intervening country which is a typical sand dune area, the sand of which is apparently derived from the surface formation, lends strength to this hypothesis as it would be expected that such a bar would be largely composed of sand. Such an hypothesis is also in accord with the accepted theories of gypsum deposition. The boundary between the Blaine and the Peacock formations between Swenson and Salt Fork River is, therefore, a rather arbitrary one, being drawn on the projected horizon of the beds under discussion.

In many places the Swenson gypsum consists of two strata of gypsum separated by about five feet of shale. Each of these strata averages about five feet in thickness.

About 100 feet above the Swenson gypsum bed there occurs another rather prominent bed of gypsum, which may be known as the Oriana gypsum as it is exposed near the station of Oriana on the Stamford and Northwestern R.R. In places it also consists of two ledges separated by about five feet of shale. The lower beds vary in thickness from two to sixteen feet and the upper from three to five. This member is well exposed in the valleys of Double Mountain Fork and Salt Fork rivers. It caps the prominent cliffs of Double Mountain Fork about five to six miles from the western border of the county. West of this the cliffs capped by this bed are not so high since the westward dip of the rocks gradually brings this bed down to water level. The member is well exposed along the western side of Salt Fork River from Oriana to the junction of this stream with Croton Creek. It does not develop as prominent an escarpment as the Swenson gypsum but it is more resistant to weathering and erosion than the soft shales and sandstones of the formation and is, therefore, cliff-forming.

With the exception of the two gypsum members just described there are no other prominent gypsum beds in the formation although several thin and non-persistent beds occur at different horizons.

The Peacock formation outcrops over approximately the western one-third of the county. It breaks down easily so that its outcrops are in most places covered with residual soil but good exposures may be found in the valleys of the main streams and in the sides of the erosional remnant, Double Mountain.

The area of outcrop of the Peacock formation is much less rugged than the other parts of the county because the Peacock has only a few escarpment making members. Except those developed by the Swenson and Oriana gypsum members there are no prominent escarpments in this part of the county. Most of the area of outcrop of this formation is a gently rolling plain.

The total thickness of the formation is about 700 to 750 feet. The upper three hundred is found only in the erosional remnant, Double Mountain, having been removed by erosion from all other parts of the county.

As is to be expected in a member consisting entirely of red beds and gypsum the formation is devoid of any fossil record.

The following detailed sections show some of the distinctive characteristics of the formation.

Section. 1. North side of erosional remnant known as Double Mountain in the southwest part of the county.

Permian-Triassic contact concealed at this location but is about 20 feet above the top of No. 10.

		Ft.
10.	Red shale	16
9.	Red sandstone and sh_le	60
8.	Gypsum	5
7.	Hard gray sandstone	2
6.	Soft red sandstone and shale	26
5.	Gypsum	5
4.	Gypsum	5
3.	Soft red sandstone	35
2.	Gypsum	3
1.	Red clayey sandstone with some gypsum ledges and ledges of shale	136
	Total of section	293

Section 2. NW ¼ Sec. 183, H. and T.C. R.R., Block D, one mile from the north and four miles from the west border of the county.

		Ft.	In.
13.	Red shale	12	6
12.	Gypsum	2–3	
11.	Gray shale	4	
10.	Gypsum	1–2	
9.	Gypsum	1–2	
8.	Red shale	56	
7.	Gypsum	1–2	
6.	Gypsum	1	
5.	Gypsum	1	
4.	Concealed	3	
3.	Gypsum	3	
2.	Blue shale	2	6
1.	Red shale, rather dark, frequently interstratified with thin laminae of gypsum	37	6
	Total of section	128	6

Section 3. North side of Salt Fork River approximately the south central part of Sec. 250, H. and T.C. R.R., Block D, 12 miles from the west and seven miles from the north border of the county.

	Ft.	In.
9. Concealed to top of the bluff	10	
8. Gypsum	2	
7. Concealed	2	
6. Gypsum, impure, earthy	1	
5. Gypsum	1	
4. Concealed	3	
3. Gypsum	3	
2. Blue shale	2	
1. Red shale, rather dark, frequently interstratified with thin laminae of gypsum	37	6
Total of section	61	6

Nos. 3 to 8 belong to the Swenson gypsum member.

Section 4. Double Mountain Fork River two miles south and two and one-half miles east of the southwest corner of the county.

	Ft.	In.
6. Red sandy shale	25	
5. Fine grained sandstone	1	
4. Sandy shale	10	
3. Massive gypsum	14	
2. Blue finely laminated gypsum	1	
1. Red sandstone with abundant gypsum	3	
Total of section	54	

Section 5. About one mile down the river from Section 4.

	Ft.	In.
6. Red, sandy shale	25	
5. Gypsum, white, granular	4	
4. Red sandstone and shale	16	
3. Red sandstone	1	
2. Gypsum, white, granular	2	10
1. Red, sandy shale	26	10
Total of section	75	8

Section 6. North side of the valley of Double Mountain Fork in the south part of Sec. 314, H. and T.C. R.R., Block 1, one and one-half miles from the south and five miles from the west border of the county.

	Ft.	In.
7. Gypsum	4	
6. Red, silty shale with some sandstone	17	
5. Massive gypsum	4	
4. Concealed	40	
3. Red shale with layers of crystallized gypsum	10	
2. Blue shale		2
1. Red shale	4	
Total of section	79	2

Numbers 5 to 7 make up the Oriana gypsum member.

Section 7. Approximately the south part of Sec. 316, H. and T.C. R.R., Block 2, one and one-half miles north of the south border and seven miles from the west border of the county.

		Ft.	In.
9.	Gypsum	6	
8.	Red shale	15	
7.	Blue gypsum		6
6.	Shale, red	63	
5.	Gypsum		6
4.	Red shale	10	
3.	Blue gypsiferous shale	2	
2.	Red shale containing many thin layers of gypsum	23	
1.	Massive gypsum, bottom not seen Water level.		
	Total of section	120	

Section 10. Begun at the SW corner of Sec. 150, Block D, H. and T.C. R.R., one mile south and one and one-half miles west of Aspermont and continued up the hill to the top of the escarpment.

		Ft.	In.
5.	Gypsum	5	
4.	Red shale	3	
3.	Bluish gypsum	6	
2.	Red shale	16	
1.	Concealed	42	
	Total of section	72	

Numbers 3 to 5 represent the Swenson gypsum member.

Section 11. SW¼ of Sec. 191, H. and T.C. R.R., Block D, about two miles southeast of Swenson.

		Ft.	In.
4.	Massive gypsum	5	
3.	Red shale	4	
2.	Massive bluish gypsum	4	
1.	Red shale with some thin layers of gypsum	77	
	Total of section	90	

Numbers 2 to 4 belong to the Swenson gypsum member.

TRIASSIC AND CRETACEOUS SYSTEMS

The only rocks of these systems found in this county occur in the erosional remnant, Double Mountain, in the southwestern part of the county. These beds together with the uppermost beds of the Double Mountain group, which also occur only in this erosional remnant, formed the subject of a special investigation by E. T. Dumble and W. F. Cummins in the early days of the Texas Geological Survey.[10]

[10]Dumble, E. T., and Cummins, W. F., The Double Mountain Section: Am. Geol., Vol. 9, No. 6, June, 1892, pp. 347-351.

Their report on this work is one of the classics of Texas geology. In view of this fact it seems fitting that the part of their report which deals with the beds under discussion should here be quoted in full.

CRETACEOUS

1. Caprina Limestone.

The Caprina limestone which caps the mountains has a total thickness of forty feet. It is deeply fissured in places, and the rapid erosion of the softer underlying materials has scattered its debris down all sides of the mountain. In structure, it presents the usual characteristics of this limestone and on the surface often shows a ferruginous weathering of the *Caprina* so common in western Texas. The rock in this locality contains many *Hippurites* of large size, and the *Caprina* forms found in it are varied and some of them heretofore unknown. They have, however, since been found in rocks of the same horizon, in an exposure on Barton Creek near Austin, and also at other localities in western Texas.

2. Comanche Peak Series.

The rocks of the Comanche series are here separable apparently into three distinct divisions, the upper of which is a series of impure argillaceous limestones having an entire thickness of twenty feet, the top being much more shaly than the bottom. The fossils are very numerous and well preserved, but diligent search failed to show a single *Gryphaea pitcheri* in it. The second division is somewhat similar in composition but more indurated and is of a yellow color. Some of the fossils in this bed had been altered into calcite. In it we found very few specimens of *Gryphaea pitcheri.* The third division consists of a shaly limestone containing a great abundance of very small fossils overlying a marly limestone, which is in turn underlaid by the *Gryphaea* conglomerate, which here as elsewhere is almost a solid mass of individuals of this species. The fossils throughout are abundant and well preserved, and correspond in the main with those of typical sections farther east.

3. Trinity Beds.

Immediately underlying the *Gryphaea* conglomerate is a bed of yellow sand about ten feet in thickness, which at the time of making the section was considered as the upper portion of the Trinity sands. It differed, however, from the beds previously referred to this horizon in Texas, in the fossils which were found in it. These consisted of an oyster which differed from *O. franklini* Coquand, and is now recognized as a new species, *Pleurocera strombiformis* Schloth, *Exogyra* *texana* Roemer, *Gryphaea pitcheri* Mort. The association of these fossils in this way had not been reported previously, and in order to be certain of their existence together in the same stratum we dug into the bed far enough to prove it absolutely. Since later investigations have shown the "Alternating Beds" to be a part of the Trinity sands, and the fossiliferous part, and that at their thinning out on the northern border the fossils still continue for a limited distance in a calcareous sand, this bed would seem to indicate a similar condition at this locality, and that it should be referred to the "Alternating Beds" of the Trinity division. Otherwise it would appear to be a transition bed between the Trinity sands and the Comanche group.

Underlying the yellow sand are twelve feet of purple and mottled sand which are very gypsiferous, and below them we find a bed of cross-bedded indurated sands. A few bright colored pebbles are scattered through this bed and seem to be of somewhat larger quantity toward the base. In this bed are also found the botryoidal layers of sandstone so often observed in the same beds to the east.

TRIASSIC

The basal cross-bedded sands of the Trinity rest with slight unconformity upon a series of purple, red, and mottled sands which pass at the bottom into a conglomerate of bright colored pebbles. The same bright colored pebbles are found scattered through the bed from bottom to top singly and in nests or even forming thin strata in places. Although in the original section it was referred to the Trinity, the character of the material is now known to be identical with that described under the name of Dockum beds in the first annual report of this survey, and it is, therefore, referred to the Triassic, although we were unable to find fossils at the Double Mountain locality such as occur in the beds near Dockum.

These beds have a total thickness of thirty-five feet.

All of the deposits included in the Triassic and Cretaceous have a slight dip towards the southeast.

Because of the excellence of this pioneer work it is not thought necessary to add anything further to the description quoted above.

Some differences in the thickness of sections taken at different places on the mountain are noted. These discrepancies are due to the unconformities between the systems here represented.

TERTIARY AND QUATERNARY SYSTEMS

The representatives of these systems are found in a few deposits of gravel and sand, which are similar to the deposits of the Llano Estacado.

The deposit which is perhaps of the most interest is found on the top of Double Mountain. Here a thin veneer of water-worn gravel is spread over the flat top of the mountain. The deposit is composed of waterworn gravels, mostly quartzite, the individual pieces of which measure from a fraction of an inch to two inches in diameter.

Another deposit of sand and gravel, which is apparently Tertiary or Quaternary in age, is found in the extreme western part of the county, about two miles north of the Stamford and Northwestern Railroad. This deposit consists of stratified sand and gravel containing waterworn Cretaceous fossils. The presence of such waterworn fossils is characteristic of the Tertiary and Quaternary deposits of the Llano Estacado. The deposit consists mostly of sand, which is very strongly cross-bedded. The gravel occurs in lens-like layers and pockets.

Although this deposit is evidently Tertiary or Quaternary age, it is not the same age as the gravels on the top of Double Mountain, since the former have been deposited on a younger erosional surface.

Over wide areas in different parts of the county there are deposits of waterworn gravels in locations which show that they are not deposits of the present streams. These deposits are mostly composed of quartzite pebbles, as are most of the Tertiary gravels of the Llano Estacado. They may be reworked deposits from the Llano, but are evidently not deposits of the present streams.

The presence of Pleistocene mammalian remains, notably, species of *Elephas* in some of the stratified sand and gravel of the river terrace deposits of the county, proves that these deposits are of Pleistocene age. No mammalian fossils were collected by the writer, but he was shown specimens, which on reliable authority were reported to have been found in these deposits in this county.

STRUCTURAL GEOLOGY

The county is situated on the western side of the arch of the north central plains and the rocks, therefore, have a general westward dip. The dip of the rocks is greater in the eastern part of the county than in the western. The average dip of the rock strata throughout the county is W 27 N, 28 feet to the mile.

There are many small erratic dips of the rocks in different parts of the county which are caused by the solution of underlying gypsum and the consequent slumping of the rocks below. These in some places simulate true structural dips.

The main facts concerning the structure of the county are shown graphically in the structure sections in Figs. 5, 6, and 7.

ROCKS NOT EXPOSED

Some information concerning the rocks not exposed in this county may be obtained from the study of well logs of deep wells drilled in exploration for oil and gas and from a study of the samples obtained from these wells.

At the time that the field work for this report was being done only one well was being drilled in this county, namely, Thomas No. 1 of Nance et al., in Sec. 137, Block D, H.&T.C. R.R.; Ward No. 1, by the same company in Sec. 136, Block D, H.&T.C.R.R. had been started but operations had been temporarily suspended. The writer collected a set of samples from Thomas No. 1. Description of these samples accompany the log of the well given below.

Two wells had been drilled in the county before the field work for this report had been started but logs of these wells were not available.

Of the wells drilled since the completion of the field work, logs have been obtained of the Swenson Oil Company Ward No. 1, Sec. 286, Block D, H.&T.C.R.R.; Arkansas Fuel Oil Co., Craft No. 1, Sec. 120, H.&T.C.R.R., Block F; Zoch and McCamey Ward No. 1, Sec. 153, H.&T.C.R.R., Block D; Nance et al. Ward No. 2, Sec. 137, Block D, H.&T.C.R.R.

Samples from the Swenson Oil Co. Ward No. 1 were furnished the Bureau of Economic Geology by Mr. Carl B. Anderson, Tulsa, Oklahoma. These were described by Miss Oleta M. Richey of the Bureau staff. The descriptions accompany the well log given below. Samples of cores taken from the Arkansas Fuel Oil Company Craft No. 1 taken at the depths 3900 and 3955 were described by E. H. Sellards and Miss O. M. Richey. These descriptions also accompany the logs of this well given below.

Below are given copies of drillers' logs of the wells mentioned above together with descriptions of samples from a few of these wells.

THOMAS 1, NANCE ET AL.

Located in Section 137, Block D, H. & T. C. Ry. Company; about 6 miles north and about 1 mile west of Aspermont.

Drillers' Log

	Depth in feet		Depth in feet
Surface	105	Shale	870
Lime	118	Lime	895
Shale	125	Shale	915
Red bed	280	Lime	925
Lime	360	Shale and lime	965
Shale	385	Red bed	1010
Red bed	390	Light shale	1015
Brown shale	405	Red beds	1030
Light shale	420	Light shale	1035
Brown shale	430	Red beds	1050
Lime	435	Brown shale	1055
Red bed	440	Lime	1070
Light shale	450	Light shale	1080
Light shale	450	Brown shale	1090
Red bed	475	Black shale	1105
White sand	492	Lime	1115
Lime	525	Lime and shale	1135
Anhydrite	540	Shale	1185
White sand	675	Shale	1200
Shale	680	Shale	1215
Red bed	709	Hard lime	1230
Hard lime	717	Light shale	1230
Red bed	735	Brown shale	1260
Lime	750	Light shale	1325
Red bed	760	Lime and shale	1345
Shale	765	Brown shale	1360
Red bed	770	Red beds	1445
Shale	780	Lime	1458
Red beds	830	Red beds	1460
Lime	840	Lime	1465
Shale	845	Light shale	1520

Description of samples from cuttings by L. T. Patton.	Depth in feet
Light gray shale with a few pieces of gypsum	240–245
Light gray shale and gray anhydrite, latter making about one-fourth of sample	245–250
Gray and pink anhydrite	250–255
Gray anhydrite, some few pieces of red shale	255–260
White and gray anhydrite	260–265
Mostly cuttings of light gray dolomite with few pieces of anhydrite	265–270
Pieces of gray dolomite with few pieces of anhydrite	270–275
Mostly cuttings of gray dolomite	274–279
Mostly gray anhydrite with some few pieces of dolomite	280–285
Gray dolomite and anhydrite in about equal proportion	285–290
Dark gray anhydrite	290–295
Dark gray anhydrite with some pieces of light anhydrite	295–300
Gray dolomite	300–305
Dark gray anhydrite	305–310
Gray dolomite, anhydrite, and shale in about equal proportions	310–315
Red shale and pieces of anhydrite	315–320
Mostly cuttings of anhydrite with some shale	320–325
White anhydrite with few pieces of gray dolomite	325–330
Rather fine cuttings of gray dolomite and white anhydrite in equal proportions	330–335
Gray and pink anhydrite	335–340
Light gray anhydrite	340–345
Gray dolomite and white anhydrite in about equal proportions	345–350
Gray dolomite with a few pieces of anhydrite	350–355
Gray dolomite	355–360
Gray dolomite with a few pieces of anhydrite	360–365
Gray dolomite	365–370
Gray dolomite	370–375
Light gray dolomite and anhydrite in about equal proportions	375–380
Light blue shale with few pieces of gray anhydrite	380–385
Light gray shale	385–390
Mostly cuttings of gray anhydrite	390–395
Light gray shale with some pieces of anhydrite	395–400
Gray shale and anhydrite in about equal proportions	400–405
Gray dolomite and white anhydrite in about equal proportions	410–415
Light gray anhydrite with few pieces of bluish-gray shale	435–440
Anhydrite and dolomite in about equal proportions	440–445
Mostly anhydrite	445–450
Mostly pieces of red and gray shale with some pieces of anhydrite	450–455
Red and blue shale in about equal proportions	455–460
Light gray fine-grained sandstone, few pieces of red shale	460–465
Light red sand and sandstone. Individual grains well rounded, majority pass through mesh screen No. 48 and retained on 100-mesh	465–470
Pieces of brick-red and light gray fine-grained sandstone	470–475
Fine-grained brick-red sand, about one-half sample retained on 100-mesh screen and one-half on 200-mesh. Individual grains mostly well rounded, majority of grains quartz but feldspar and other minerals present	475–480

	Depth in feet
Fine-grained red sand, about two-thirds of which pass through 48-mesh screen, the remaining one-third through 100-mesh. Grains well rounded	480–485
Fine-grained red and gray sand evidently derived from a loosely cemented sandstone, a few pieces of which are seen in the sample	485–490
Mostly pieces of brick-red shale	490–495
Mostly pieces of brick red shale with some pieces of anhydrite and some fine-grained sand	495–500
Red and gray fine-grained sandstone in about equal proportions	500–505
Red and gray sandstone and brick-red shale	505–510
Mostly red shale with a few cuttings of dolomite and anhydrite	510–515
Mostly brick-red shale, some pieces of pyrite noted. Small amount of fine-grained sand	515–520
Mostly pieces of dark red shale, a little sand, and few pieces of anhydrite in washed material	520–525
Gray sandstone with calcareous cementation pieces of red shale	525–530
Similar to sample from 525–530 feet	530–535
White anhydrite with some red shale	535–540
Gray dolomite	540–545
Mixture of red shale and fine cuttings of gray dolomite	545–550
Red shale and cuttings of white anhydrite	550–555
Dark red shale containing considerable amount of mica in minute flakes and some pieces of gray sandstone	600–605
Similar to sample from 600–605 feet	605–610
Brick-red shale	610–615
Cuttings of hard blue somewhat calcareous shale	615–620
Rather dark red shale	620–625
Dark red and bluish-green shale in about equal proportions	625–630
Similar to samples from 625–630 feet	630–635
Dark red shale	635–640
Similar to sample from 635–640 feet	640–645
Similar to sample from 635–640 feet	645–650
Similar to sample from 645–650 feet	650–655
Dark red shale with few pieces of red shale	655–660
Mostly pieces of dark red shale with few pieces of anhydrite	665–670
Similar to sample from 650–655 feet	670–675
Dark red shale and white to gray anhydrite in equal proportions	670–675
Blue and red shale, the former being in largest proportion	675–680
Red and blue shale in about equal proportion	680–685
Red and bluish-green shale in about equal proportions	685–690
Red shale with few pieces of blue shale	690–695
Similar to sample from 690–695 feet	695–700
Dark red shale	795–800
Dark red and blue shale	700–705
Dark red shale with a few pieces of gray dolomite	705–710
Dark red shale and fine cuttings of gray dolomite and some pieces of anhydrite	710–715
Pieces of dark red shale	715–720
Dark red shale	720–725
Red shale with few pieces of blue shale	725–730
Similar to sample from 725–730 feet	730–735
Very finely-ground fragments of white gypsum	735–740

	Depth in feet
Similar to sample from 735–740 feet	745–750
Blue and red shale and pieces of white anhydrite	750–755
Entirely of red shale	755–760
Mostly blue shale with some pieces of red shale	760–765
Blue shale with a few pieces of anhydrite and some pieces of red shale	765–770
Mostly bluish-green shale	770–775
Red and bluish-green shale	775–780
Red shale with few pieces of anhydrite	780–785
Bluish-green shale with some pieces of red shale	785–790
Dark red shale	790–795
Red shale and pieces of anhydrite, shale making up larger proportion of sample	800–805
Red shale with few pieces of blue shale	805–810
Red and blue shale in about equal proportions	810–815
Bluish-green highly calcareous shale	815–820
Similar to sample from 815–820 feet	820–825
Cuttings of gray calcareous sandstone and sandy dolomite	830–835
Similar to sample from 815–820 feet	835–840
Blue and gray calcareous shale	840–845
Bluish-green shale, similar to that of preceding sample	845–850
Similar to the preceding, some pieces of anhydrite present	850–855
Gray and white dolomite	855–860
Light and dark gray dolomite	860–865
Anhydrite with some red and blue shale	865–870
Light gray dolomite, some pieces of blue and red shale and some pieces of anhydrite	870–875
Similar to the preceding sample	875–880
Gray sandstone, bluish-gray shale, and a little anhydrite	880–885
Anhydrite and some red and blue shale	885–890
Light blue shale and some pieces of anhydrite	890–895
Gray dolomite calcareous cemented sandstone and some anhydrite	895–900
Anhydrite with some blue shale	900–905
Light gray dolomite	905–910
Bluish-green shale	915–920
Dark gray dolomite and pieces of white anhydrite in about equal proportions	920–925
Bluish-green shale with a few pieces of anhydrite	925–930
Similar to the preceding	930–935
Blue and green shale in about equal proportion	935–940
Similar to sample from 935–940	940–945
Similar to the preceding	945–950
Bluish-gray dolomite and red shale	955–960
Gray and white anhydrite, red and blue shale	960–965
Mostly pieces of gray dolomite with some pieces of red and gray shale	965–970
Brick-red shale	970–975
Brick-red shale and some pieces of anhydrite	975–980
Same as 975–980	980–985
Brick-red shale	985–990
Brick-red shale with some pieces of blue shale and some anhydrite	990–995
Brick-red shale with some pieces of anhydrite	995–1000
Similar to 995–1000	1000–1005
Brick-red shale with few pieces of blue shale	1005–1010
Brick-red shale, blue shale, pieces of anhydrite, and some pieces of blue shale	1010–1015

	Depth in feet
Brick-red shale	1015–1020
Pieces of gray sandstone, white and gray anhydrite, and some gray shale	1020–1025
Gray shale with some pieces of gypsum and anhydrite	1025–1030
Gray sandy shale with some red shale	1030–1035
Dark red shale	1035–1040
Dark red shale	1040–1045
Dark red shale with a few pieces of blue shale	1045–1050
Gray dolomite	1050–1055
About equal proportions of dolomite and gray and white anhydrite	1055–1060
Mostly pieces of gray dolomite with some pieces of red shale	1060–1065
Mostly blue calcareous shale	1065–1070
Blue calcareous shale and some anhydrite	1070–1075
Mostly pieces of blue calcareous shale	1075–1080
Red shale and pieces of blue calcareous shale with some pieces of anhydrite	1080–1085
Mostly pieces of blue shale	1095–1100
Mostly pieces of gray anhydrite	1105–1110
Gray anhydrite	1115–1120
Gray dolomite and white anhydrite	1120–1125
Dark gray sandy shale	1125–1130
Mostly pieces of blue shale	1130–1135
Pieces of white anhydrite and some pieces of gray dolomite	1135–1140
Dark gray shale, some few pieces of dolomite and anhydrite	1140–1145
Gray anhydrite with some pieces of gray dolomite	1145–1150
Mostly pieces of anhydrite	1150–1155
Pieces of gray dolomite and gray shale	1155–1160
Gray calcareous shale	1165–1170
Light gray dolomite and gray shale	1160–1165
Gray calcareous shale	1170–1175
Same as 1170–1175	1175–1180
Same as 1175–1180 with the exception of some pieces of anhydrite	1180–1185
Light gray dolomite and pieces of white anhydrite	1185–1190
Dark red shale	1370–1385
Dark red shale with few pieces of dolomite	1385–1390
Red shale	1390–1395
Red shale	1430–1435
Red shale	1435–1440
Red shale with smoe pieces of gray dolomite	1440–1445
Red shale	1440–1449
Gray shale with some red shale	1454–1458
Gray shale with some anhydrite	1471–1475
Blue shale with some pieces of red shale	1475–1477
Sample similar to that of 1475–1477	1477–1480
Similar to 1477–1480	1480–1486
Blue shale with some gray shale	1486–1490

WARD 1, NANCE ET AL

Located in the northwest corner of the NE ¼ of Section 136, Block D, H. & T. C. Ry. Co.; 5½ miles north and 1 mile west of Aspermont.

Drillers' Log

	Depth in feet		Depth in feet
Surface	30	Lime	42
Red bed	36	Red bed	50

	Depth in feet
Hard sand	56
Lime	76
Red shale	86
Lime	98
Red shale	124
Lime	130
Cave (oil show)	148
Lime	150
Shale	156
Gypsum	175
Lime	190
Broken lime	236
Shale	290
Lime	241
Broken lime	280
Lime	415
Shale and sandstone	420
Lime	445
Lime and gypsum	464
Gumbo	480
Gypsum and lime	500
Red shale and lime	533
Sticky shale	550
Lime	570
Gypsum	590
Shale	627
Sand (oil show)	678
Lime	680
Lime	706
Shale	708
Lime	710
Sandy shale	720
Lime	740
Sticky shale	797
Red shale	814
Lime	845
Gypsum	847
Sand (oil show)	849
Shale	854
Lime	857
Sticky shale	861
Lime	871
Shale	876
Gypsum	878
Lime	894
Sandy shale	920
Lime	923
Shale	927
Lime	941
Gumbo	961
Lime	977
Broken lime	993
Gumbo	1007
Porous lime	1008
Red shale	1021
Lime	1042
Broken lime	1053
Gumbo	1056
Broken lime	1061
Lime	1072
Sticky shale	1115
Lime	1123
Sticky shale	1127
Lime	1134
Sticky shale	1137
Broken lime	1145
Lime	1161
Broken lime	1185
Lime	1187
Shale	1194
Sticky shale	1197
Broken lime	1204
Gypsum	1206
Broken lime	1214
Lime	1265
Gumbo	1274
Lime	1283
Broken lime	1331
Gumbo	1469
Lime	1485
Gumbo	1490
Broken lime (show of oil)	1497
Broken lime and shale	1630
Lime	1870
Shale	2120
Limestone	2135

J. Q. WARD, SWENSON OIL COMPANY

Located 1,390 feet south and 1,394 feet east of the northwest corner of Section 286, Block D, H. & T. C. Ry. Co.; 12 miles north and 9½ miles west of Aspermont. Elevation reported as 1,796 feet.

Drillers' Log

	Depth in feet
Soft yellow soil	2
Soft yellow sand	32
Hard white and gray lime and gyp	50
Soft red rock	201
Soft white gypsum	212
Soft white sand	216
Hard white lime	250
Hard light gyp	278
Soft dark shale	284
Soft red rock	290
Hard light lime	318
Soft gray light slate	327
Soft red rock	333

	Depth in feet
Hard white lime	360
Soft dark gray slate	365
Hard light lime	387
Soft light slate	392
Hard light lime	415
Soft light slate	420
Hard light lime	437
Soft red rock	445
Medium and hard white lime	500
Soft light shale	520
Medium light lime	535
Soft dark slate	540
Hard dark lime	544
Soft dark slate	550
Hard dark lime	553
Soft dark slate	570
Hard dark lime	580
Soft dark shale	590
Hard light lime	605
Soft dark slate	612
Hard light lime	630
Hard and soft light lime and breaks	640
Medium light lime	650
Soft dark slate	660
Hard gray lime	668
Soft black slate	676
Hard light lime	681
Hard and soft dark slate and shells	693
Hard gray lime	720
Hard gray lime and shells	740
Soft pink rock	742
Hard and soft light lime and shells	750
Soft red rock	770
Hard gray lime	775
Soft blue shale	785
Soft red rock	796
Hard gray lime	800
Soft red rock	825
Hard gray lime	855
Red rock	950
Hard gray lime	965
Soft red rock	975
Hard gray lime	988
Dark sandy lime	1000
Soft red rock	1020
Hard blue lime	1032
Soft light sandy shale	1058
Hard white lime	1067
Soft red rock	1085
Solid light lime	1093
Soft red rock	1125
Hard gray lime	1133
Soft red rock	1145
Hard gray lime	1157
Soft red rock	1164
Hard gray lime	1173
Soft light break	1178
Hard gray lime	1200
Soft gray shale	1205
Hard gray lime	1208
Soft red rock	1230
Hard gray lime	1265
Soft light slate	1270
Soft red rock	1290
Hard white lime	1292
Soft red rock	1296
Hard light lime	1314
Soft red rock	1383
Hard white lime	1415
Soft gray shale	1435
Hard gray lime	1444
Soft blue shale	1453
Hard and soft blue lime shells and slate blue	1490
Hard gray lime	1500
Soft light slate	1510
Hard gray lime	1515
Soft light slate	1520
Hard light lime	1540
Hard and soft lime and shells	1580
Soft blue slate	1590
Hard and soft slate and shells	1645
Soft red rock	1775
Soft blue shale	1780
Soft brown shale	1790
Hard white lime	1865
Soft light shale	1875
Hard white lime	1910
Soft light shale	1925
Hard light lime	1930
Soft blue shale	1940
Hard light gray lime	1945
Soft gray shale	1955
Very hard dark gray lime	2075
Hard dark gray lime with very small breaks	2130
Hard dark gray lime and marl	2185
Hard dark gray lime	2245
Hard black lime	2249
Hard dark gray lime with breaks of slate and black lime	2315
Hard dark gray lime and slate breaks	2358
Hard dark gray lime with breaks of slate and soft white lime	2430
Soft and hard dark gray slate and lime shells	2480

	Depth in feet
Soft blue shale	2485
Hard dark gray lime	2490
Soft dark gray shale	2500
Hard gray lime	2510
Hard gray slate and lime shells	2520
Soft blue shale	2535
Hard white lime	2540
Soft gray lime	2550
Hard gray lime	2600
Soft black slate	2610
Hard dark gray lime	2630
Hard dark gray gritty lime	2650
Hard dark gray lime	2670
Hard gray lime	2690
Soft brown sandy shale	2720
Soft blue shale	2740
Soft gray broken lime	2790
Soft light gray shale	2844
Hard black lime	2853
Hard gray lime	2865
Hard and medium cream sandy lime	2870
Hard and medium white sandy lime	2875
Hard and soft gray lime	2915
Medium blue gray lime	2950
Hard blue gray lime	2954
Soft slate	2958
Soft blue shale	2962
Hard blue lime shell and gray lime	2970
Hard gray lime	2981
Hard gray sandy lime	3008
Hard light gray sandy lime	3014
Hard gray sandy lime	3015
Soft black shale with marl	3025
Hard gray lime	3027
Soft black shale	3030
Sandy lime	3150

Description of samples from cuttings by Oleta M. Richey.

	Depth in feet.
Anhydrite	32–37
Gray dolomitic limestone and anhydrite	37–47
Reddish-brown, non-calcareous shale. Gypsum noted in the washed material	47–57, 57–67, 58
Pieces of reddish-brown, non-calcareous shale. Anhydrite and gypsum noted in the washed material	67–87
Reddish-brown, non-calcareous shale. Gypsum, anhydrite, and dolomitic limestone noted in washed material	87–97, 97–110
Reddish-brown, non-calcerous shale. Dolomitic limestone and anhydrite noted in the washed material	110–120, 120–130, 130–140
Pieces of reddish-brown, non-calcareous shale. Dolomitic limestone, gypsum, and anhydrite noted in the washed material	140–150, 150–160
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material. Also a little gypsum present	160–170
Reddish-brown, non-calcareous shale. Gypsum and anhydrite noted in the washed material	170–180
Pieces of reddish-brown, non-calcareous shale. Dolomitic limestone, anhydrite, and gypsum noted in the washed material	180–186
Reddish-brown, non-calcareous shale and gypsum. Dolomitic limestone noted in washed material	186–194
Reddish-brown, non-calcareous shale. Gypsum and anhydrite noted in the washed material	194–201, 201–212
Gray gypsum. Dolomitic limestone and anhydrite noted in the washed material	212–216
Pieces of light pinkish-gray, non-calcareous shale. Dolomitic limestone, anhydrite, and gypsum noted in the washed material	216–223, 223–230
Reddish-brown, non-calcareous shale. Gypsum and anhydrite noted in the washed material	230–240, 240–250, 250–260

	Depth in feet
Brownish-gray, non-calcareous shale. Gray limestone, anhydrite and gypsum noted in the washed material	260–270
Anhydrite. Light gray dolomitic limestone and anhydrite noted in the washed material 270–279,	279–284
Reddish-brown, non-calcareous shale. Gypsum and anhydrite noted in the washed material 294–300,	300–310
Gray dolomitic limestone	310–318
inkish-gray, non-calcareous shale. Anhydrite and dolomitic limestone noted in the washed material 318–325,	325–327
Gray, dolomitic limestone. Anhydrite and a little gypsum noted in the washed material 327–330,	330–340
Light gray, non-calcareous shale. Anhydrite noted in the washed material	340–350
Light gray, dolomitic limestone and anhydrite	350–355
Gray, non-calcareous shale, and dolomitic limestone. Anhydrite was noted in the washed material 350–360,	358–365
Light gray, non-calcareous shale. Anhydrite was noted in the washed material	365–375
Light gray, non-calcareous shale. Anhydrite and dolomitic limestone noted in the washed material	375–385
Light gray, slightly calcareous kaolin. Pieces of anhydrite and dolomitic limestone were noted in the washed material	385–395
Light brown, non-calcareous shale. Dolomitic limestone and anhydrite noted in the washed material	395–400
Reddish-brown, non-calcareous shale and anhydrite	400–415
Anhydrite	415–420
Reddish-brown, non-calcareous shale. Anhydrite present in the washed material 425–435,	435–445
Gray, non-calcareous shale and dolomitic limestone. Anhydrite noted in the washed material	445–450
Anhydrite and dolomitic limestone 450–460,	460–465
Gray, non-calcareous shale. Anhydrite and dolomitic limestone noted in the washed material	465–475
Anhydrite and dolomitic limestone	475–485
Light gray, non-calcareous shale. Dolomitic limestone and anhydrite noted in the washed material	485–500
Gray dolomitic limestone and anhydrite 500–510,	510–520
Gray, slightly calcareous shale, gray dolomitic limestone, and a little anhydrite	520–530
Gray, dolomitic limestone, and anhydrite 530–540,	540–550
Gray, non-calcareous shale and anhydrite. Dolomitic limestone present in the washed material 550–560,	560–570
Medium gray dolomitic limestone, gray non-calcareous shale, and anhydrite	570–580
Anhydrite and a little gray dolomitic limestone 580–590,	590–600
Gray and white anhydrite	600–605
White, gray, and a little pink anhydrite	605–610
Gray, calcareous shale, and a little anhydrite	610–620
Gray, white, and a little pink anhydrite. A little gray, non-calcareous shale noted in the washed material 620–630, 630–640, 640–650,	660–670
Like sample from 640–650 feet. A little dolomitic limestone present	650–660

	Depth in feet
Anhydrite and a little gray calcareous shale 670–680, 680–690, 690–700, 700–710, 710–720,	720–730
Like sample from 720–730 feet. Dolomitic limestone present	730–740
Anhydrite and dolomitic limestone	740–750
Reddish-brown, non-calcareous shale. Anhydrite present in washed material 750–760,	760–770
Medium gray, non-calcareous shale. Anhydrite present in the washed material 770–780,	780–790
Reddish-brown, non-calcareous shale. Anhydrite present in the washed material	790–800
Reddish-brown, non-calcareous shale	800–810
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material	810–820
Reddish-brown, non-calcareous shale. Dolomitic limestone and anhydrite present in the washed material 820–830, 830–840,	840–850
Reddish-brown, non-calcareous shale. In the washed material anhydrite was noted	850–900
Reddish-brown, non-calcareous shale. Anhydrite and a little gypsum noted in the washed material	900–950
Anhydrite, gray dolomitic limestone, and a little reddish-brown, slightly calcareous shale	950–965
Reddish-brown, non-calcareous shale, gray calcareous shale, and a little anhydrite noted in the washed material 965–975,	975–988
Gray, non-calcareous shale, fragments of gray calcareous shale, dolomitic limestone, and a little anhydrite	988–1000
Reddish-brown, non-calcareous shale. Gray dolomitic limestone and anhydrite noted in the washed material	1000–1010
Gray, dolomitic limestone, and anhydrite	1010–1020
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material	1020–1030
Reddish-brown, non-calcareous shale. Dolomitic limestone and anhydrite noted in the washed material	1032–1048
Non-calcareous, reddish-brown bentonitic shale. A little anhydrite noted in the washed material	1048–1058
Medium dark gray, dolomitic limestone, and anhydrite	1058–1067
Dark reddish-brown, non-calcareous shale. Dolomitic limestone and anhydrite noted in the washed material	1067–1077
Anhydrite and salt	1077–1090
Anhydrite, dolomitic limestone, and salt	1090–1093
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material 1093–1100, 1100–1130,	1130–1145
Gray, dolomitic limestone and anhydrite	1145–1160
Gray, non-calcareous shale. Anhydrite and gray dolomitic limestone noted in the washed material	1160–1170
Medium dark gray, dolomitic limestone, and anhydrite 1170–1180,	1180–1200
Drab reddish-brown, non-calcareous shale. Anhydrite noted in the washed material	1200–1205
Gray, calcareous shale, and anhydrite	1205–1210
Reddish-brown, non-calcareous shale in which anhydrite was noted 1210–1220,	1220–1230
Gray limestone, gypsum(?), and some anhydrite	1230–1240
Gypsum(?) and anhydrite	1240–1250

	Depth in feet
Anhydrite and dolomitic limestone	1250–1265
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material 1265–1270, 1270–1280,	1280–1290
Reddish-brown, non-calcareous shale. Gypsum and anhydrite present in the washed material	1290–1296
Anhydrite	1290–1300
Reddish-brown, non-calcareous shale. A very little anhydrite present in the washed material 1300–1350,	1350–1360
Reddish-brown, non-calcareous shale	1360–1370
Gray, dolomitic limestone, and anhydrite	1380–1390
Gray, dolomitic limestone	1400–1420
Grayish-brown, non-calcareous shale. Dolomitic limestone and anhydrite present	1425–1435
Gray, dolomitic limestone, dark gray non-calcareous shale, gypsum and anhydrite	1435–1444
Gray, non-calcareous shale. Anhydrite present in the washed material 1444–1450,	1450–1460
Gray, dolomitic limestone and a little anhydrite	1460–1500
Reddish-brown, non-calcareous shale, and anhydrite	1500–1510
Gray, non-calcareous shale, and a very little anhydrite	1510–1515
Gray, dolomitic limestone, and a little anhydrite	1515–1525
Gray, slightly calcareous shale, and anhydrite	1525–1560
Gray, non-calcareous shale, dolomitic limestone, and anhydrite	1560–1580
Medium gray, non-calcareous shale, dolomitic limestone. A very little anhydrite was noted in the washed material 1580–1600, 1600–1610, 1610–1630, 1630–1650,	1650–1660
Reddish-brown, non-calcareous shale. Anhydrite noted in the washed material	1660–1700
Reddish-brown, non-calcareous shale 1720,	1720–1750
Reddish-brown, non-calcareous shale. Dolomitic limestone noted in the washed material 1740–1750,	1750–1770
Reddish-brown, non-calcareous shale. Dolomitic limestone and anhydrite noted in the washed material	1770–1780
Gray, dolomitic limestone, and anhydrite	1780–1790
Reddish-brown, non-calcareous shale, gray dolomitic limestone, and a little anhydrite	1790–1810
Dark gray, slightly calcareous shale and anhydrite	1810–1830
Gray, non-calcareous shale and anhydrite. Dolomitic limestone noted in the washed material	1830–1840
Gray, dolomitic limestone, slightly calcareous, gray shale, and anhydrite	1840–1855
Gray, non-calcareous shale, gray dolomitic limestone, and anhydrite 1900–1910, 1910–1920, 1920–1930, 1950–1960,	1960–1970
Gray, dolomitic limestone, and anhydrite	1970–1980
Gray, non-calcareous shale, gray dolomitic limestone, and anhydrite	1980–1990
Gray, slightly calcareous shale, and anhydrite	1990–2000
Gray, non-calcareous shale, gray, dolomitic limestone, and anhydrite 2000–2010, 2030–2040, 2040–2050, 2050–2060, 2060–2070,	2070–2080
Gray, dolomitic limestone, and anhydrite 2080–2090,	2090–2100
Gray, slightly calcareous shale, dolomitic limestone, and anhydrite 2100–2110,	2110–2120
Dark gray, non-calcareous shale, and anhydrite	2130–2140

	Depth in feet
Gray, non-calcareous shale, gray limestone, and anhydrite	2160–2170
Medium dark gray, calcareaus shale, and gray limestone	2180–2190, 2190–2200
Gray, non-calcareous (?), gray, dolomitic limestone, and anhydrite	2200–2210, 2210–2220, 2220–2230
Gray, non-calcareous shale, gray, dolomitic limestone, and anhydrite	2240–2250
Gray, dolomitic limestone and anhydrite	2250–2260, 2260–2270
Like sample from 2250–2260 feet. Dark gray, calcareous shale noted	2270–2280
Like sample from 2270–2280 feet. Only a small amount of anhydrite	2290–2300
Medium dark gray, dolomitic limestone, gray, non-calcareous shale, anhydrite	2300–2310, 2310–2320, 2320–2330, 2330–2340
Gray, dolomitic limestone, and anhydrite	2340–2350, 2350–2360
Gray, dolomitic limestone, dark gray, slightly calcareous shale, and anhydrite	2360–2370, 2370–2380
Dark gray, non-calcareous shale, and anhydrite	2380–2390
Gray, slightly calcareous shale, medium dark gray, dolomitic limestone, and anhydrite	2390–2400, 2400–2410, 2410–2420, 2420–2430
Medium dark gray, non-calcareous shale, and anhydrite	2430–2440
Dark gray, non-calcareous shale, medium gray, dolomitic limestone, and anhydrite	2450–2460
Dark gray, non-calcareous shale, and a little anhydrite	2470–2480, 2480–2490, 2490–2500
Dark gray, non-calcareous shale, gray, dolomitic limestone, and anhydrite	2500–2510, 2510–2520
Gray, dolomitic limestone, and anhydrite	2520–2530
Dark gray, non-calcareous shale, gray, dolomitic limestone, and anhydrite	2530–2540, 2540–2550
Medium dark gray, non-calcareous shale, and anhydrite	2550–2560, 2560–2570
Medium gray, dolomitic limestone, dark gray, non-calcareous shale, and anhydrite. A little pyrite was noted in the washed material	2570–2580
Gray, dolomitic limestone, some dark gray, non-calcareous shale, and a little anhydrite	2580–2590
Gray, non-calcareous shale, and a very little anhydrite	2590–2600
Dark gray limestone and a very little anhydrite	2600–2610
Dark gray, non-calcareous shale, medium gray limestone, a very small amount of anhydrite	2610–2620, 2620–2630
Dark gray, non-calcareous shale, brownish-gray, dolomitic limestone, and a little anhydrite	2630–2640, 2640–2650, 2650–2660
Dark gray, dolomitic limestone, and a very little anhydrite. Fragments of very dark gray to black, non-calcareous shale were noted in the washed material	2660–2670, 2670–2680
Gray, dolomitic limestone, and anhydrite	2680–2690
Dark gray, non-calcareous shale, gray limestone, and anhydrite	2690–2700, 2700–2710
Medium gray limestone, dark gray, calcareous shale, and a very little anhydrite. Ostracoda, crinoid stems, and a fragment of a bryozoa noted in the washed material	2710–2720

	Depth in feet
Gray limestone, dark gray, non-calcareous shale, and a little anhydrite. Crinoid stems and bryozoa present in washed material	2720–2730, 2730–2740
Gray limestone and dark gray, non-calcareous shale. A little pyrite was noted in the washed material. Gastropods, ostracoda, crinoid stems, and fragments of bryozoa present	2740–2750
Gray limestone and dark gray, non-calcareous shale. A little pyrite noted in the washed material. Crinoid stems and bryozoa present	2750–2760, 2760–2770
Dark gray, non-calcareous shale, and light gray, crystalline limestone. A little pyrite present in the washed material. Crinoid stems and fragment of bryozoa presnt	2770–2780
Dark gray, calcareous shale. Pyrite present in the washed material. Sponge spicules present	2810–2820
Dark gray calcareous shale. A little pyrite present in the washed material	2820–2830
Dark gray, calcareous shale. A little pyrite was noted in the washed material. A sponge spicule and a fragment of a bryozoa noted also	2845–2850, 2850–2860, 2860–2870
Medium light gray limestone. Fragments of bryozoa noted in the washed material	2870–2880, 2880–2890
Gray, crystalline limestone, and dark gray, non-calcareous shale. Ostracoda and fragments of bryozoa noted in the washed material	2890–2900
Very fine cuttings of light grayish-white, crystalline limestone. A few clear quartz grains noted in the washed material. Two or three small, smooth ostracoda noted. Fragments of byrozoa present	2900–2910, 2910–2920, 2920–2930, 2930–2940
Light gray, crystalline limestone, and dark gray, calcareous shale. A few grains of clear quartz noted in the washed material	2940–2950
Dark gray, calcareous shale, some light gray limestone, pyrite, and a very little clear quartz. A few smooth ostracoda were noted in the washed material	2950–2960
Gray limestone. Pyrite noted in the washed material	2960–2970, 2970–2980, 2980–2990, 2990–3000
Dark gray, slightly calcareous shale. Pyrite noted in the washed material	3010–3020
Dark gray, calcareous shale and a few fragments of gray limestone	3015–3020
Dark blue-gray, calcareous shale. Small amount of pyrite noted in washed material. Calcite present	3020–3025, 3026–3030
Dark bluish-gray shale and light gray limestone. Pyrite was noted in the washed material. An ostracode noted	3030–3040
Bluish-gray, calcareous shale and light gray limestone. Some pyrite was noted in the washed material. Calcite present	3045–3050
Dark gray, non-calcareous shale and porous gray limestone	3040–3050, 3050–3060
White, crystalline limestone	3060–3070, 3070–3080
Brownish-gray, crystalline limestone	3080–3090, 3090–3100, 3100–3110
Gray, crystalline limestone	3110–3125, 3125–3135

	Depth in feet
Dark gray, calcareous shale, medium gray limestone, and a little calcite	3135–3140
Like sample from 3135–3140 feet. A little pyrite present	3140–3150
Dark gray, calcareous shale, gray porous limestone, a little pyrite, and some calcite	3150–3160
Like sample from 3150–3160 feet, except that the limestone is not porous	3160–3170
Dark gray, calcareous shale. A few fragments of light gray limestone and some pyrite were noted in the washed material	3170–3180
Dark gray, calcareous shale and light gray, porous limestone. Calcite noted in the washed material	3180–3190
Dark gray, calcareous shale, A few fragments of gray limestone noted in the washed material	3190–3197
Reddish-brown and dark gray, calcareous shale. A few fragments of gray limestone and a little pyrite noted in the washed material	3197–3198
White limestone	3205–3208, 3208–3210
White limestone and dark gray, calcareous shale	3210–3220, 3220–3229
Medium dark gray, calcareous shale. Fragments of gray limestone and some pyrite noted in the washed material	3229–3230, 3230–3240
Gray, calcareous shale and limestone	3240–3250
Dark gray, calcareous shale and some light gray limestone. Fragments of byrozoa and a few ostracoda present in the washed material	3250–3254
Dark gray, calcareous shale and light gray limestone. Crinoid stems and fragments of byrozoa noted in the washed material	3254–3257
Dark gray, slightly calcareous shale. Pyrite noted in the washed material. Crinoid stems, ostracoda, and fragments of byrozoa present	3257–3265
Dark gray, slightly calcareous shale. Ostracoda and crinoid stems noted in the washed material	3265–3275
Dark gray, calcareous shale	3275–3285, 3285–3290
Dark gray, calcareous shale. Crinoid stems and ostracoda noted in the washed material	3290–3295
Dark gray, calcareous shale. A crinoid stem noted in the washed material	3295–3312
Dark gray, calcareous shale and some light gray limestone. Pyrite noted in the washed material. Fragments of bryozoa noted	3220–3326
Gray limestone and dark gray, slightly calcareous shale. Calcite and pyrite noted in the washed material. Fragments of bryozoa, sponge spicules, a *Fusulina* (?) present	3325–3330
Dark gray, slightly calcareous shale, and gray limestone. In the washed material fragments of byrozoa, several ostracoda, sponge spicules, and a *Fusulina* (?) were noted	3330–3340
Dark gray, calcareous shale and gray limestone. Ostracoda, fragments of byrozoa, sponge spicules, *Fusulina* (?) and *Archaeodidaris* noted in the washed material	3340–3345
Dark gray and some light gray limestone	3345–3350

	Depth in feet
Medium dark gray, non-calcareous shale and some light gray limestone. A little pyrite noted in the washed material. Fragments of byrozoa, sponge spicules, crinoid stems, and ostracoda present	3350–3360
Dark gray, slightly calcareous shale and a little gray limestone. Pyrite noted in the washed material. Bryozoan fragments and crinoid stems present	3366
Medium dark gray, slightly calcareous shale and some gray limestone. Pyrite noted in the washed material. Bryozoa, sponge spicules, *Fusulina* (?), crinoid stems, and ostracoda present	3360–3370
Medium gray, non-calcareous shale and gray limestone. An ostracode, crinoid stems, sponge spicules, and fragments of bryozoa noted in the washed material	3370–3380
Medium dark gray, non-calcareous shale and some light gray limestone. An ostracode, crinoid stem, fragments of byrozoan, and sponge spicules noted in the washed material	3380–3390
Medium dark gray, calcareous shale and some gray limestone. Fragments of byrozoa and crinoid stems present in the washed material	3390–3400
Light gray limestone and dark gray, slightly calcareous shale. Fragments of byrozoa, and crinoid stems noted in the washed material	3400–3410
Dark gray, calcareous shale and light gray limestone. Crinoid stems and a few fragments of byrozoa noted in the washed material	3410–3420
Gray limestone and dark gray calcareous shale	3420–3425
Dark gray, non-calcareous shale and a little gray limestone. Pyrite was noted in the washed material. Fragments of byrozoa and crinoid stems noted in the washed material	3425–3430
Medium dark gray, non-calcareous shale. Pyrite noted in the washed material. Fragments of byrozoa present	3430–3440
Medium dark gray, calcareous shale	3440–3450, 3450–3460
Medium dark gray, calcareous shale. A little pyrite noted in the washed material. A gastropod and fragments of byrozoa noted	3460–3470
Medium dark gray, calcareous shale. A little pyrite and some brownish-gray limestone were noted in the washed material	3470–3480
Medium dark gray, calcareous shale and a little gray limestone. Some pyrite noted in the washed material	3480–3490
Medium dark gray, calcareous shale and gray limestone	3490–3511

CRAFT 1, ARKANSAS FUEL OIL COMPANY

Located in Section 120, Block F, H.&T.C. Ry. Co., about 14 miles north and about 6 miles west of Aspermont.

Drillers' Log

	Depth in feet
Sand	48
Red rock	60
Gravel	70
Brown shale	90
Red rock	100
Blue shale	105
Red rock	115
Gyp	130

	Depth in feet
Blue shale	135
Gyp	150
Lime and sand	163
Blue shale	168
Red rock	180
White slate	185
Hard white lime	201
Lime	215
Blue shale	220
Hard white lime	241
White lime	270
Red rock	275
Blue shale	280
Red rock	300
Shale	305
Lime	320
Blue shale	323
Hard lime	338
Blue shale	350
White lime	367
White slate	380
Lime	400
Blue shale	410
White lime	418
Blue shale	423
White lime	428
Blue shale	433
Lime	438
Blue shale	440
White lime	451
Shale	460
Brown shale	498
Blue shale	500
White lime	535
Broken lime	540
Blue shale	540
Brown shale	560
Lime	570
Red rock	615
White lime	618
Red rock	622
White lime	625
Red rock	665
Hard white lime	687
Red rock	700
Lime	710
Red rock	760
Light red rock	770
Lime	790
Red rock	808
Hard lime	830
Blue shale	835
Lime	840
Red rock	845
White lime	865

	Depth in feet
Brown shale	876
Lime	895
Red rock	904
Brown shale	925
White lime	935
Red rock	938
White lime	945
Red rock	960
Lime	980
Blue shale	983
Lime	993
White lime	1010
Blue shale	1012
White lime	1018
Hard white lime	1022
Red rock	1034
Lime	1040
Sand	1048
White lime	1050
Lime	1075
Red rock	1125
Lime	1167
Red rock	1175
Lime	1190
Red rock	1195
Lime	1206
Hard white lime	1217
Blue shale	1225
Red rock	1228
Blue shale	1252
Lime	1274
Blue shale	1284
Lime	1290
Blue shale	1302
White lime	1314
Blue shale	1317
Lime	1323
Blue shale	1328
Lime	1350
Blue shale	1364
White lime	1380
Blue shale	1390
White lime	1405
Blue shale	1410
Lime	1418
Blue shale	1455
Lime	1465
Brown shale	1470
Red rock	1515
Red rock	1618
Lime	1620
Broken sand	1625
Blue shale	1635
Lime	1650
Blue shale	1667

	Depth in feet
Lime	1673
Blue shale	1700
Broken lime	1710
Hard white lime	1737
Blue shale	1753
Lime	1765
Gray shale	1770
Hard lime	1788
Blue shale	1820
White lime	1825
Blue shale	1830
Lime	1834
Gray shale	1840
Lime	1847
Gray shale	1860
Lime	1963
Sandy lime	1983
Lime	2015
Blue shale	2017
Lime	2345
Blue shale	2350
Lime	2370
Blue shale	2373
Lime	2535
Sand	2547
Lime	2600
Sandy lime	2617
Sandy shale	2655
Sandy lime	2670
Lime	2685
Sandy lime	2692
White sandy shale	2716
Sandy lime	2765
Hard sandy lime	2823
Lime	2829
Hard sandy lime	2841
Blue shale	2858
Hard lime	2870
Hard white lime	2880
Lime	2915
Blue shale	2947
Hard lime	2953
Lime	2965
Blue shale	2967
Lime	3008
Gray shale	3025
Sandy lime	3050
Blue shale	3058
Lime	3063
Blue shale	3088
Lime	3091
Blue shale	3122
Shale	3134
Blue shale	3135
Red rock	3140

	Depth in feet
Black shale	3152
Blue shale	3156
Blue shale	3165
Blue shale	3170
Lime	3174
Red rock	3178
Blue shale	3189
Lime	3194
Blue shale	3198
Gray shale	3200
Lime	3200
Blue shale	3203
Broken lime	3221
Blue shale	3234
Brown shale	3238
Lime	3284
Shale	3302
Blue shale	3314
Lime	3321
Shale	3348
Lime	3361
Sandy lime	3372
Lime	3376
Lime	3382
Blue shale	3390
Lime	3395
Blue shale	3399
Lime	3430
Broken lime	3440
Gray lime	3445
Gray lime	3530
Hard lime	3533
Sandy lime	3544
White lime	3560
Brown lime	3565
Shale and lime	3569
Shale	3576
Shale	3585
Lime	3590
Shale	3591
Lime	3614
Gray sand	3617
Light sand	3623
Sand	3626
Blue shale	3630
Sandy lime	3631
Blue shale	3633
Sandy lime	3634
Dark shale	3636
Lime (Correct depth 3628)	3648
Hard lime	3665
Gummy lime	3700
Black lime	3702
Black lime	3755
Hard lime	3898

	Depth in feet
Sand	3902
Sandy lime	3906
Sandy lime	3918
Hard lime	4002
Packed sand and lime	4005
Hard sandy lime	4020
Sandy lime	4033
Hard lime	4076
Hard sandy lime	4081
Hard lime	4424
Total depth	4424

Small gas show at 3198 feet.
*Depths at which cores were taken.

Description of samples by E. H. Sellards and O. M. Richey.

Core of medium gray, calcareous sandstone in which pockets of dark gray sandstone were noted. In thin section the rock was seen to be medium grained	3900
Like sample from 3900	3955

WARD 1, ZOCH AND McCAMEY

Located 630 feet from the southwest corner of Section 153, Block D, H. & T. C. Ry. Co.; 2¼ miles west and 5½ miles north of Aspermont.

Drillers' Log

	Depth in feet
Lime	25
Gray shale	75
Gray shale	100
Lime	125
Gray shale	130
Lime	185
Gray shale	200
Lime	205
Red beds	205
Lime	265
Gray shale	275
Lime	295
Gray shale	310
Lime	340
Gray lime	355
Lime	390
Red beds	415
Lime	425
Shale	475
Red beds	490
Sand	545
Red beds	550
Lime	560
Red beds	700
Gray shale	710
Red beds	730
Lime	740
Red beds	760
Lime	770
Gray shale	795
Red beds	835
Lime	845
Shale	860
White lime	870
Red beds	880
Lime	890
Red bed	905
Lime	940
Shale	955
Red beds	975
Lime	980
Shale	985
Red bed cavings	1033
Red bed	1055
Lime	1085
Gumbo	1100
Gray shale	1115
Lime	1130
Shale	1150
Lime	1155
Shale	1160
Lime	1180
Shale	1195
Lime	1215
Shale	1225
Lime cavings	1245
Lime	1255
Shale	1285
Lime	1295
Shale	1315
Red beds	1340
Red beds	1465
Lime	1515
Shale	1540
Gray shale	1555
Lime	1600
Shale and shells	1630
Lime	1640
Shale	1645
Shale and shells	1665

	Depth in feet		Depth in feet
Lime	2035	Lime	2630
Shale	2045	Gray lime	2640
Shale and shells	2070	Lime	2725
Lime	2080	Sand	2745
Shale	2100	Shells	2750
Lime	2150	Lime	2765
Shale	2155	Hard gray lime	2778
Sand	2180	Gray lime	2800
Sand	2295	Blue shale	2815
Lime	2325	Blue shale	2840
Shale	2340	Lime	2840
Sandy lime	2365	Hard gray lime	2900
Shale	2395	Lime	2910
Sandy shale	2440	Blue shale	2920
Lime	2465	Blue shale	2928
Shale	2495	Sand	2931
Sand	2520	Gray sandy lime	2935
Lime	2550	Blue shale	2965
Lime	2565	Red rock	2980
Lime	2610	Gray sandy lime	3000
Shale	2620		

ECONOMIC GEOLOGY

Gypsum.—The gypsum deposits of the county are very great. The lower part of the Double Mountain group contains thick gypsum ledges, and there are many places where these could be quarried without undue expense. These ledges are of sufficient thickness to furnish an abundance of material. In general it may be said that any industry which could use large quantities of good rock gypsum would have no difficulty in finding abundant supplies at a number of different places in the county.

Gypsite.—The earthy impure variety of gypsum known as gypsite is widespread throughout the county. It is somewhat more abundant in the western part of the county, where the upper part of the Double Mountain group outcrops. North of the Stamford and Northwestern Railway in the western part of the county there is an abundance of outcrops of gypsite of varying areal extent. Since the manufacturers of some gypsum products prefer gypsite to the pure rock gypsum these deposits are of economic importance.

Salt.—In the valley of Dove Creek in the northwestern part of the county, there are some rather extensive salt flats. In these flats considerable salt accumulates as a result of evaporation and consequent crystallization. The salt forms a white crust one to three inches thick over considerable areas. These flats occur in sections 183, 184, and 198 of Block F, H.&T.C.R.R. They may possibly be made to serve as the source of a considerable amount of salt.

Building Stone.—No good material for building stone exists within the county. Both the Merkle dolomite and the dolomites of the Double Mountain are in general too thin-bedded to be used for construction.

Sand and Gravel.—The deposits of sand and gravel in the valleys of Salt Fork and Double Mountain Fork rivers are fairly extensive and easily accessible. The recent deposits made by the present streams are probably not of any value commercially because of the large proportion of silt, but the deposits of Tertiary and Quaternary age contain both sand and gravel of good commercial quality. These deposits are being worked to some extent at the present, several gravel pits being in operation in the neighborhood of the railroad in the valley of Double Mountain Fork River. These deposits contain good clean sand and gravel, which can be used for construction and for other purposes. On the east side of Salt Fork River below its junction with Double Mountain Fork River, gravel deposits are quite extensively exposed for some distance. A study of the records of shallow water wells in this vicinity indicates that these deposits extend beneath the surface of the gently sloping eastern side of the valley for several miles east of the river's edge and for a considerable distance parallel to the river.

Road Materials.—The dolomitic limestones of the Double Mountain formation would no doubt make fairly good material for crushed rock for road beds. These dolomite beds, however, would probably not furnish sufficient material for more than local use. The gravel deposits described above would make excellent road material but are probably more valuable for other purposes.

Oil and Gas.—Several wells have been drilled in this county in exploration for oil and gas but up to the time of the completion of the field work no production had been secured. As stated in the discussion of structure, the rocks of this county are tilted in a general westward direction, being a part of the geanticline of the North Central Plains. There may be some interruptions of this general dip which would create reservoirs for the accumulation of oil and gas but so far as the writer was able to observe there are no marked interruptions of the general dip of a nature which would be expected to form such reservoirs. Over a considerable part of the county it is difficult to obtain information with regard to underground structure from surface observations because of the lack of reliable key horizons. Neither the gypsum nor the dolomite beds serve as good horizon markers. The latter are perhaps the more satisfactory but detailed studies based on them would call for extensive plane table surveys, which were not possible under the conditions under which this work was done.

Copper.—Some small deposits of copper occur at or near the contact of the San Angelo and Double Mountain formations in the valleys of both Double Mountain Fork River and Salt Fork River. Several small pits have been opened at different places, but no deposits of commercial quantity have been found. The largest amount seen was in the F. Davidson survey on the north side of Salt Fork River about five miles from the east border of the county. A small amount of ore is reported to have been taken out at this place but there is no indication that there is more than a small local deposit. The deposits here occur in a fine-grained sandstone and consist of stains on the sandstone and a few small nuggets of malachite and azurite. There is no evidence to indicate that any considerable amount of copper deposits exists in the county.

Lead.—About eight miles from the east border of the county and one mile north of Double Mountain Fork River in a ravine tributary to the main valley the writer found some deposits of galenite in a ledge of dolomite in the lower part of the Blaine formation of the Double Mountain group. Some of the crystals of this exposure are of fair size but the total amount of the ore is very small and there is no indication that the ore occurs in commercial quantity. This is the only deposit which was seen in the county. As is common in many communities, there are legends in this county of lost lead mines, and it may be that some such deposit as this is responsible for these legends.

Water Supply.—As was indicated in the introductory chapter of this report, the first work done by the writer was a reconnaissance of several parts of this and adjacent counties in order to determine the geological conditions of certain areas where it was proposed to erect dams for flood control and irrigation purposes.

Considered from the standpoint of physiography only, the county has some excellent dam sites. The deep, narrow valleys of Double Mountain Fork and Salt Fork rivers have the topographic characters for good dam sites. In places also these valleys widen out, thus furnishing excellent reservoir sites. Water impounded in these valleys could be used advantageously to irrigate the level plain developed on the Clear Fork formation. However, if dams should be built in that part of the county where numerous and heavy gypsum ledges occur at horizons which would be at or below the level of the water in the reesrvoirs, there would be great danger of solution channels forming in the relatively soluble gypsum which would not only allow the escape of the impounded water but would endanger the structure itself. Dam sites where the level of the water would not be above the Clear Fork or San Angelo formation would be more favorable since there would not be this danger from the presence of gypsum. One dam site below the junction of Salt Fork and Double Mountain Fork rivers was approved for this reason. It is proposed to construct a dam at this place for the purpose of flood control and irrigation.

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