SOUTH DAKOTA GEOLOGICAL SURVEY

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GEOLOGY of the TIMBER LAKE QUADRANGLE SOUTH DAKOTA

EXPLANATION

QUATERNARY

RECENT

Qal — Alluvium

(Floodplain deposits of silt, sand, and gravel in present stream valleys.)

Qt — Terrace Deposits

(Undifferentiated terrace deposits of locally derived fluvial rubble in a matrix of fine sand.)

UNCONFORMITY

HELL CREEK

Kh — Hell Creek Formation

(Buff to white very fine grained arkosic sand, gray to bentonitic clay, and brown bentonitic siltstone with numerous orange to black limonitic concretions; 65 feet thick.)

FOX HILLS

UPPER CRETACEOUS

Kfc — Colgate Member

(Thin bedded gray siliceous fine to very fine-grained locally friable, graywacke sandstone; cross-bedded, ripple-marked and with a few limonitic concretions, locally fossiliferous, 13 to 32 feet thick.)

Kfb — Bullhead Member

(Thin alternating beds of light-gray to buff very fine-grained graywacke sand and dark-to brown-gray fissil silty clay; locally small orange limonitic concretions; fossils rare; 0 to 35 feet thick.)

Kftl — Timber Lake Member

(Massive to laminated and cross-bedded, buff to light-gray fine- to very fine-grained graywacke sand; reddish-brown calcareous and ferruginous sandstone ledges and nodular cemented areas; orange limonitic and rarely gray calcareous concretions; Tancredia americana, Pteria linguaformis and Idonarca nebrascensis each dominate a fossil zone in the Timber Lake member; 110 to 230 feet thick.)

Kftc — Trail City Member

(Mottled buff coarse silt to sandy silt and dark-gray to gray silty clay with local beds of buff to brown very fine-grained graywacke sand; scattered layers of dense to sandy gray to brown spherical to lenticular fossiliferous limestone concretions; yellow jarositic layers and local selenite crystals in lower part; Discoscaphites nicoletti, Gervillia recta, and Protocardia subquadrata each dominate a concretionary zone; 80 to 200 feet thick.)

PIERRE

Kpu — Upper Pierre Unit

(Gray to dark-gray blocky to fissile clay-shale and bentonitic clay-shale with orange to black ironstone concretions and scattered selenite crystals; 165 feet thick.)

Contact (dashed where approximately located)

Fault, showing upthrown (U) and down thrown (D) sides.

x Gravel Pit

x BM 2159 Bench Mark (monument showing exact altitude above sea level)

x 2122 Spot Altitude

△ TIMBER LAKE Triangulation Station (monument marking exact geographic location)

House, School, and Church

Geology by R. E. Stevenson 1958–59
Assisted by R. K. Booker and C. L. Johnson

Vertical and horizontal control surveyed from triangulation and level lines of Federal surveys

Drafted by H. D. Wong, 1960

APPROXIMATE MEAN DECLINATION, 1959

Scale 1:62 500

Vermillion South Dakota
1960

Tertiary Sediments

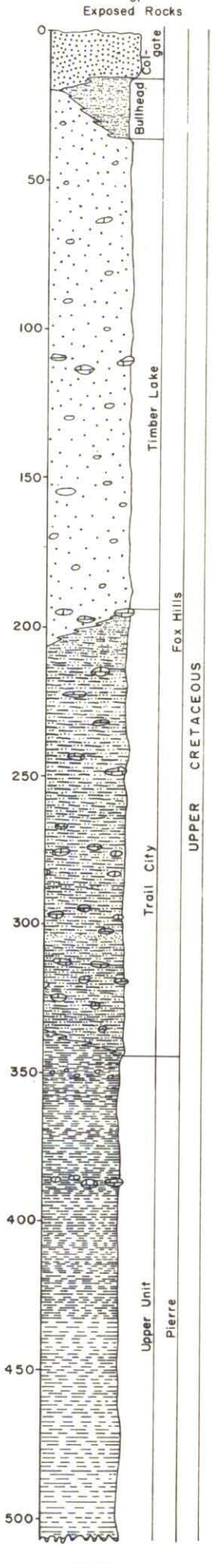
Quadrangle Location

TIMBER LAKE QUADRANGLE

GEOLOGY OF THE TIMBER LAKE QUADRANGLE

by
R.E. STEVENSON

Columnar Section of Exposed Rocks



Key to Columnar Section

Sandstone
Limestone
Siltstone
Concretion
Shale

INTRODUCTION

The Timber Lake quadrangle includes about 213 square miles in the north-central part of Dewey County and the south-central part of Corson County in north-central South Dakota.

The mapped area lies in the prairie lands of the Great Plains physiographic province. The surface is a gently rolling erosional plain with scattered buttes, and slopes slightly eastward. Along the southern edge and in the southeastern quarter of the quadrangle the plain is dissected by tributaries of the Moreau River including Redwater Creek and Little Moreau Creek, which have cut down about 200 feet below the erosional plain. At many places in the quadrangle the bedrock is covered by a thin veneer of loess.

The principal water courses are the intermittent Little Moreau and Redwater Creeks in the southern part of the quadrangle. Permanent water bodies consist of the artificial Little Moreau Lake, and numerous stock reservoirs. Scattered across the central part of the quadrangle are a number of intermittent playa-like lakes that occupy sand blowouts including Timber, Horseshoe, and Livermant Lakes.

The climate of the Timber Lake quadrangle is semi-arid, with a mean annual rainfall of 17.2 inches and an average annual temperature of 44.4 degrees Fahrenheit at Timber Lake. The quadrangle is a lightly populated ranching area with one family per 2.6 square miles. The only settlement, Timber Lake, with a population of 550, is the county seat of Dewey County. State Route 8 crosses the northern part of the quadrangle, and State Route 63, a graveled road, extends southward from Route 8 near the western edge of the quadrangle. A branch line of the Chicago, Milwaukee, St. Paul & Pacific Railroad crosses the northern part of the quadrangle.

The geology was mapped in the summers of 1958 and 1959 under the supervision of Dr. A. F. Agnew, as part of the State Geological Survey's program of studying South Dakota's economic mineral resources. The geology was mapped on air photos, supplemented by plane table surveys with the assistance of R. K. Booker and C. L. Johnson. The writer thanks the many local residents who provided water well data. Field conferences with Dr. Karl Wange are gratefully acknowledged.

EXPOSED SEDIMENTARY ROCKS

Exposed bedrock includes marine shales and sands of the Pierre and Fox Hills Formations, overlain by the fluviatile deposits of the Hell Creek Formation; all are of Late Cretaceous age.

Cretaceous System

Pierre Formation, Meek & Hayden, 1862

The Pierre was named from exposures at Ft. Pierre (75 miles southeast of the Timber Lake quadrangle), and has been divided into six members along the Missouri Valley. These divisions are not usable in this area, as the two upper members merge into one lithologic unit termed the Upper Pierre unit.

Upper Pierre unit. --Exposures of the Upper Pierre unit are present in the lower parts of the dissected areas along the southern edge and in the southeastern one-ninth of the quadrangle.

The Upper Pierre (Kpu) is gray to dark-gray blocky to fissile clay-shale, and gray to dark-gray fissile to bentonitic clay-shale. At the top of the formation the clay-shale becomes slightly silty and brown to gray in color. All lithologic types contain scattered crystals of selenite, ironstained streaks along joint cracks, and black to orange-brown ironstone concretions. Locally at the top of the unit there are intermittent layers of yellow jarosite.

No megafossils were found in the Pierre Formation in the Timber Lake quadrangle. The Pierre does, however, contain a few scattered microfossils, mostly arenaceous foraminifers. One hundred and sixty-five feet of the Upper Pierre unit is exposed in the quadrangle.

Fox Hills Formation, Meek & Hayden, 1862

The type area for this formation is Fox Ridge on the Cheyenne River-Moreau River divide, about 25 miles south of the Timber Lake quadrangle. Four members of the Fox Hills Formation are recognized in this area.

Trail City Member, Morgan & Petsch, 1945. --This member, named for exposures near Trail City, 20 miles to the east, is exposed in the upper part of the dissected areas along the southern edge and in the southeastern one-ninth of the quadrangle. Locally, concretionary layers form erosional benches.

The Trail City (Kftc) is principally a subblocky mottled rock consisting of buff coarse silt to sandy silt, and dark-gray to gray silty clay to clay. There are streaks and beds of buff to brown, very fine-grained, locally glauconitic graywacke sand. In the basal part of the member there are several intermittent layers of yellow jarosite. Local patches of disseminated selenite crystals are present in the lower part, which has a higher clay content. Scattered in fairly distinct layers are dense to sandy gray to light-gray limestone concretions and red spherical to lenticular ferruginous limestone concretions, some of which have coats of slabby gray calcareous very fine-grained graywacke sandstone and coarse-grained siltstone, and some of which are highly fossiliferous.

Dr. Karl Wange (oral communication, 1959) pointed out to the writer the zonal arrangement of marine fossils in the Trail City Member.

The basal concretionary layers (lower 25 feet) are characterized by an abundance of Discoscaphites nicoletti. The concretions of the next higher fossil zone contain large accumulations of Gervillia recta and Limopsis parvula. Because of the great abundance of these fossils and their shapes, these concretions have been termed "peanut brittle." A series of concretions dominated by the small pelecypod Protocardia subquadrata and locally by Pteria nebrascana begins 50-70 feet above the base. The lower concretionary zones become partially barren in the southwestern corner of the quadrangle. Loose arenaceous foraminifera are present along with a few megafossils, but most of the latter are restricted to the concretions. Other common fossils are: Tellina scitula, Yoldia evansi, Y. scitula, Pteria linguiformis, Ostrea cf O. pellucida, Inoceramus sp., Nucula cancellata, Corbula cf C. inornata, Anchura americana, Fasciscolaria culbertson, F. buccinoides, Spironema tenuilineata, Trachytriton vinculum, Lunatia concinna, Glosteriscus tenuilineatus, Discoscaphites nebrascensis, D. mandanensis, D. abyssinus, D. spp (several undescribed nodose forms), Sphenodiscus lenticularis, S. sp. (a small form), and Eutrephoceras dekay. The sphenodiscids do not occur in the basal concretionary zone.

The Trail City Member ranges in thickness from 30 to 200 feet, thickening rapidly westward. The basal contact with the Pierre Formation, although it may locally be fairly sharp, is usually transitional through several feet of strata. The contact is marked by an increase in the silt content upward, and, by a color change from gray to light gray or buff.

Timber Lake Member, Morgan & Petsch, 1945. --This member was named for exposures in the vicinity of Timber Lake. No type section was designated (Morgan and Petsch, 1945), but a section at Little Moreau Lake was published. Although the Timber Lake Member (Kftl) covers the upland (85 per cent of the mapped area), good exposures are limited and nowhere is a complete section exposed. Locally, concretionary layers form erosional benches and cap hills.

The member consists of massive to laminated and cross-bedded, light-gray to greenish-gray to buff, fine- to medium-grained, subround to subangular graywacke sand (locally the uppermost beds are indurated to sandstone), containing about 2 percent glauconite. Present throughout the member are thin bedding plane layers of hard yellow-brown limonitic claystone, small orange-brown to yellow-brown ironstone and claystone concretions, and brown-coated gray sandy limestone concretions. Locally near its base the member becomes slightly clayey and silty. Several strata in the Timber Lake Member are characterized by 6- to 24-inch ledges and lenticular to subspherical cementations of reddish-brown, fine to very fine, calcareous and/or ferruginous graywacke with gray sandy limestone concretions.

Locally, in the northern part and in the western half of the Timber Lake quadrangle, a few accumulations of the fossil pelecypod Tancredia americana are present. Five to twenty feet above the Tancredia zone is a fauna characterized by Pteria linguiformis, and containing Dosinopsis nebrascensis, Ostrea pellucida, Pteria nebrascana, Limopsis parvula, Mactra sp, Panopea occidentalis, Idonarca cf I. shumardi, and Discoscaphites cf. D. nebrascensis. In the southern part and in the eastern half of the mapped area there are several layers of fossiliferous concretions characterized by the large, thick-shelled Idonarca nebrascensis and containing Yoldia evansi, Nucula planimarginata, Pteria linguiformis, Gervillia recta, Idonarca shumardi, Panopea occidentalis, Dosinopsis nebrascensis, Anchura americana, Discoscaphites cf D. nebrascensis, and Sphenodiscus lenticularis. The first (lower) fauna seems to be indicative of a brackish water environment, and the second, a normal marine environment. Most outcrops of the upper Timber Lake have abundant specimens of the questionable fossil "Halymenites major".

The contact with the underlying Trail City Member, although transitional, is marked by the red-brown sandy concretions and cemented areas locally containing abundant large Idonarca nebrascensis. The Timber Lake Member thins as the Trail City Member thickens, ranging from 110 to 230 feet.

Bullhead Member, Stevenson, 1956. --The type locality of this member lies about 20 miles north of the northern border of this quadrangle, near the village of Bullhead. Good exposures of the Bullhead Member (Kfb) are very rare as most of the member is grassed over. It underlies the butte caps and makes up the highland slopes in the northwestern quarter of the mapped area.

The Bullhead member is a series of thin alternating beds of light-gray to buff very fine-grained graywacke sand and dark-gray to brown-gray fissile silty clay. Locally some small orange-brown limonitic concretions occur. No fossils were found in the Bullhead in the Timber Lake quadrangle. The member, which is absent in the southwestern part of the quadrangle, ranges up to 35 feet in thickness.

Colgate Member, Calvert, 1912. --This member forms butte caps throughout the entire quadrangle. The Colgate Member (Kfc) is a discontinuous, hard gray siliceous fine- to very fine-grained, subangular to subround graywacke sandstone, together with a lower coarser and more friable sandstone. Cross-bedding with a southwest dip is common and many bedding planes are marked by oscillation ripple marks. Round to angular fossil wood fragments are scattered throughout the Colgate and are locally concentrated as layers. There are occasional yellow- to red-brown limonitic claystone concretions.

Locally in the southwestern part of the Timber Lake quadrangle the siliceous graywacke sandstone contains pockets of ferruginous fossiliferous sandstone. The fauna consist of the following forms: Ostrea subtrigonalis, Pteria linguiformis, P. nebrascana, Mactra formosa, Nucula subplana, Tellina scitula, Discoscaphites nebrascensis, and D. abyssinus. On many of the bedding plane surfaces are low rounded (one-eighth to one-fourth inch wide) sinuous ridges, presumably of organic origin.

Locally the Colgate Member contains plant remains. At one place the Colgate sandstone yielded the following: Dryophyllum subfalcatum, Viburnum marginatum, Laurus lanceolata, Vitis stantoni, Sassafras montana, Cinnamomum affine, Sapindus cretaceus, Liriodendron sp., Salix sp., and Cornus sp.

The Colgate Member ranges in thickness from 13 to 32 feet.

Hell Creek Formation, Brown, 1907

This formation is very poorly exposed in the northwestern corner of the Timber Lake quadrangle at the highest elevations. The Hell Creek Formation (Kh) is interbedded and lensing buff to white very fine-grained angular arkosic sands with streaks of brown carbonaceous material, gray to tan bentonitic clay, and brown slightly bentonitic siltstone. Scattered through the strata are layers of abundant orange to black limonitic claystone concretions. The formation is 65 feet thick in the mapped area.

SURFICIAL DEPOSITS

The unconsolidated surficial deposits are all alluvial materials. A thin intermittent layer of wind-blown loess was not mapped separately.

Alluvial Deposits

Two types of alluvial deposits, terrace deposits and alluvium, are present in the Timber Lake quadrangle.

Terrace deposits (Qt) include the alluvial materials deposited during the different stages of down-cutting of the Little Moreau and Redwater Creeks. Redwater Creek is represented by terrace levels 100, 90, and 50 feet above creek level, and Little Moreau Creek is represented by terrace levels 100 and 70 feet above creek level. The deposits consist of 75 to 90 percent reworked Fox Hills sand and 10 to 25 percent pebble- and cobble-size angular ironstone, limestone, and sandstone concretionary fragments. The coarser material with a sand matrix occurs as lenses in the sand deposits. The thickness is extremely variable, ranging from a few feet to 15 feet.

Alluvium (Qal) is sandy clay with lenses of sand and gravel along the floodplains of the present major streams.

SUBSURFACE ROCKS

The character and thickness of the subsurface rock units are shown in Table 1. These data are based on reconnaissance studies by the State Geological Survey of samples and electric logs from oil tests nearby: Youngblood & Youngblood #1 Galvin (SE¼SE¼ sec. 25, T. 16 N., R. 22 E., 12 mi. W. of the quadrangle); Youngblood & Youngblood #1 Draskovich (SE¼SE¼ sec. 20, T. 23 N., R. 22 E., 45 mi. NW of the quadrangle); Herndon #1 Merkel (SE¼SE¼ sec. 27, T. 17 N., R. 27 E., 15 mi. E. of the quadrangle); and Herndon #1A O'Leary (SE¼SW¼ sec. 13, T. 15 N., R. 23 E., 10 mi. SW of the quadrangle). The identification of subsurface rock strata in this area is tentative, pending detailed sample studies.

STRUCTURAL GEOLOGY

The Timber Lake quadrangle is on the eastern flank of the South Dakota part of the Williston Basin, and the bedrock shows a regional dip to the northwest of about 15 feet per mile. The regional dip is probably irregular with small flexures and faults. Minor faulting in the Colgate sandstone butte caps was mapped in the southwestern corner of the mapped area. The faults, striking N. 40-50° W., have a maximum displacement of 65 feet and are downthrown to the north.

The structure contours drawn on the Fox Hills-Pierre contact by Morgan and Petsch (1945) indicate a northwest-trending nose in the southern part of the quadrangle. The existence of such a structure was not verified by the present field study.

ECONOMIC GEOLOGY

The principal mineral resource in the Timber Lake quadrangle is ground water, available at depths up to 175 feet in most parts of the quadrangle. Gravel and crushed rock have been produced in this area, and several other potentially economic mineral resources are present.

Table 1. --Character and Thickness of the Subsurface Rock Units

Series	Group or Formation	Thickness (feet)	Lithology
CRETACEOUS	Pierre Formation	900-1300	Dark-gray clay-shale, bentonitic clay with local limey specks, orange-brown to tan limonitic concretions, and gray dense limestone concretions.
	Niobrara Formation	280-300	Light- to dark-gray speckled marl and calcareous clay-shale.
	Carlile Formation	330-470	Medium- to dark-gray shale, silty in upper part.
	Greenhorn Formation	80-90	Light-gray calcite sandstone with Inoceramus; gray to white speckled calcareous shale.
	Belle Fourche-Mowry Formations	400-410	Dark-gray shale, siliceous shale, and siltstone with local bentonite seams.
	Newcastle Formation	80-90	White fine-grained quartzose sand and light-gray siltstone.
	Skull Creek Formation	160-180	Light- to dark-gray micaceous shale with iron pellets; ironstone concretions.
	Inyan Kara Group	40-90	White to gray fine-grained sands and calcareous sandstone, dark-gray glauconitic siltstone; gray shales with iron pellets. Coarse white sands in lower part.
JURASSIC	Morrison? Formation and older rocks	250-270	Probably includes both Morrison and Sundance Formations. Gray to tan glauconitic siltstone; light-gray sandstone and glauconitic sandstone; green, brown, and gray shale and clay.
JURASSIC-TRIASSIC	Piper? Formation to Spearfish? Formation	120-125	Light to yellowish-gray dense limestone and dolomite. Brown-red claystone, shale, and siltstone with anhydrite.
PERMIAN and PENNSYLVANIAN	Minnelusa Formation	270-320	The pinkish dense limestone appearing near the top of this unit may represent the Minnekahta Formation. Varicolored, red-brown, purple, and green shales; reddish-orange, pink to white, angular to round, medium to fine-grained sandstone; pink to buff dolomitic sandstone; cream to pinkish-gray limestone; and reddish dolomite, anhydritic dolomite, and anhydrite. Red and brown shales at base.
MISSISSIPPIAN	Big Snowy Group	245-280	Dark-gray, red and green shales with buff limestone; black, gray to brown shale and coal; light-gray to red coarse sandstone to grit; buff fine grained dolomite; and varicolored, reddish-brown and gray shales.
	Madison Group	680-720	Charles facies; white to brown and gray dense limestone; white anhydrite; base is marked by a blue anhydrite. Mission Canyon facies; buff to brown to gray granular limestone with local oolitic zones. Lodgepole facies; buff to gray dense limestone, calcite sandstone, and oolitic limestone.
	Englewood Formation	105-110	Orange, tan to lavendar siltstone and calcareous siltstone with varicolored shales.
DEVONIAN ? SILURIAN	Undifferentiated Strata	250-300	Buff, brown, and gray dense limestone and calcareous shale; dark-gray shale; white fine-grained calcareous sandstone; orange, white and pink to gray limestone and dolomitic limestone.
ORDOVICIAN	Red River Formation	500-540	Buff to gray limestone, some calcite sandstone and buff dolomite.
	Winnipeg Formation	170-180	Green and mottled shale; basal clean quartzose sandstone.
CAMBRIAN	Deadwood Formation	180-230	Buff medium-grained sandstone and glauconitic sandstone; buff glauconitic dolomite and dolomitic sandstone.
PRECAMBRIAN			Red to pink coarse-grained granite and biotite schist.

Ground Water

The Fox Hills Formation yields artesian water in all parts of the Timber Lake quadrangle except the valleys of Little Moreau and Redwater Creeks. The Timber Lake sand is the best water-bearing zone in the quadrangle. Wells that obtain water from this sand are 20 to 80 feet deep (62 percent are less than 45 feet deep). Along Little Moreau Creek there are a number of springs issuing about 35 feet above the base of the Timber Lake sand.

Generally, water from the Timber Lake sands is of excellent chemical quality (Table 2).

Where the Timber Lake sands are thin or tight, wells obtain water from sands in the Trail City Member of the Fox Hills Formation. Although these wells range in depth from 20 to 175 feet, 50 per cent are more than 100 feet. The water from the Trail City Member is locally high in sodium, sulfate, and total solids (Table 2).

In areas where the Fox Hills Formation has been eroded away or will not produce a sufficient quantity, water can be obtained from the jointed shales of the underlying Pierre Formation. Such wells have a low capacity. Water from the Pierre shale is high in sulfate, sodium, and total solids (Table 2), making it unsuitable for most domestic uses or for irrigation. It can, however, be used without treatment for stock.

Table 2. --Chemical Analyses of Representative Waters in the Timber Lake Quadrangle

Source of Water	in parts per million							
	Ca	Mg	Na	SO_4	Cl	Fe	Total Solids	Hardness
Timber Lake Sand (1)								
Timber Lake Sand (2)	56	5	13	26	4	none	236	160
Timber Lake Sand (3)	130	23	55	164	9	none	624	420
Trail City Sand (4)	94	5	562	996	50	1.5	1994	255
Pierre Shale (5)	72	15	284	401	22	trace	1084	243
Standard Limits (6)		125		250	250	0.3	500	120

Analyses by State Chemical Laboratory, Vermillion, South Dakota, 1960.

(1) Amerini farm, sec. 5, T. 17 N., R. 24 E.
(2) Casewell farm, sec. 14, T. 17 N., R. 24 E.
(3) O'Leary farm, sec. 24, T. 15 N., R. 23 E.
(4) Simon farm, sec. 8, T. 15 N., R. 24 E.
(5) Long farm, sec. 31, T. 16 N., R. 25 E.
(6) U. S. Bureau of Public Health (1946).

The Newcastle water-bearing sandstone lies at depths of 2500 to 2900 feet in the Timber Lake quadrangle, but is not used as a water source because the Fox Hills water has fewer impurities and lies at shallower depths.

Gravel

Gravels suitable for surfacing farm and county roads are present in the terrace deposits along the Little Moreau and Redwater Creeks. The gravels are high in sand and limonitic fragments. The large amount of limonitic material prevents their use as concrete aggregate. Two small pits in the area have produced road metal.

Sand

It is possible that some of the sands of the Timber Lake Member could be used as cement and plaster sand.

Sandstone

The Colgate Member is generally a hard thin-bedded sandstone. In the summer of 1959, the Mobridge Sand and Gravel Company quarry on a butte in sec. 18, T. 15 N., R. 23 E. was producing 50 cubic yards of crushed Colgate sandstone daily. The sandstone could also be quarried for use as flagstone or rip-rap.

Shale and Clay

The highly bentonitic clay-shales of the Pierre Formation constitute excellent material for sealing earthen dams. Some of the non-bentonitic shales of the Pierre could be used in the manufacture of bricks. The upper Pierre clay-shale in the vicinity of Mobridge (35 miles to the east) is potentially suitable for the manufacture of light-weight aggregate (Cole and Zetterstrom, 1954, p. 30).

Oil and Gas

The Timber Lake quadrangle lies on the eastern flank of the Williston Basin, a major oil and gas producing area. The basin's production comes principally from tectonic upwarps in the center and along the western edge, but some oil pools are in sedimentary traps along the northeastern flank.

Although there are no proved surface structures, there is the possibility of subsurface structures and sedimentary traps which might be oil and gas reservoirs. The most favorable zones for prospecting are (1) Madison Group at depths of 3600 to 3900 feet, (2) Devonian strata at depths of 4400 to 4700 feet, and (3) the Red River Formation at depths of 4700 to 5000 feet.

REFERENCES CITED

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