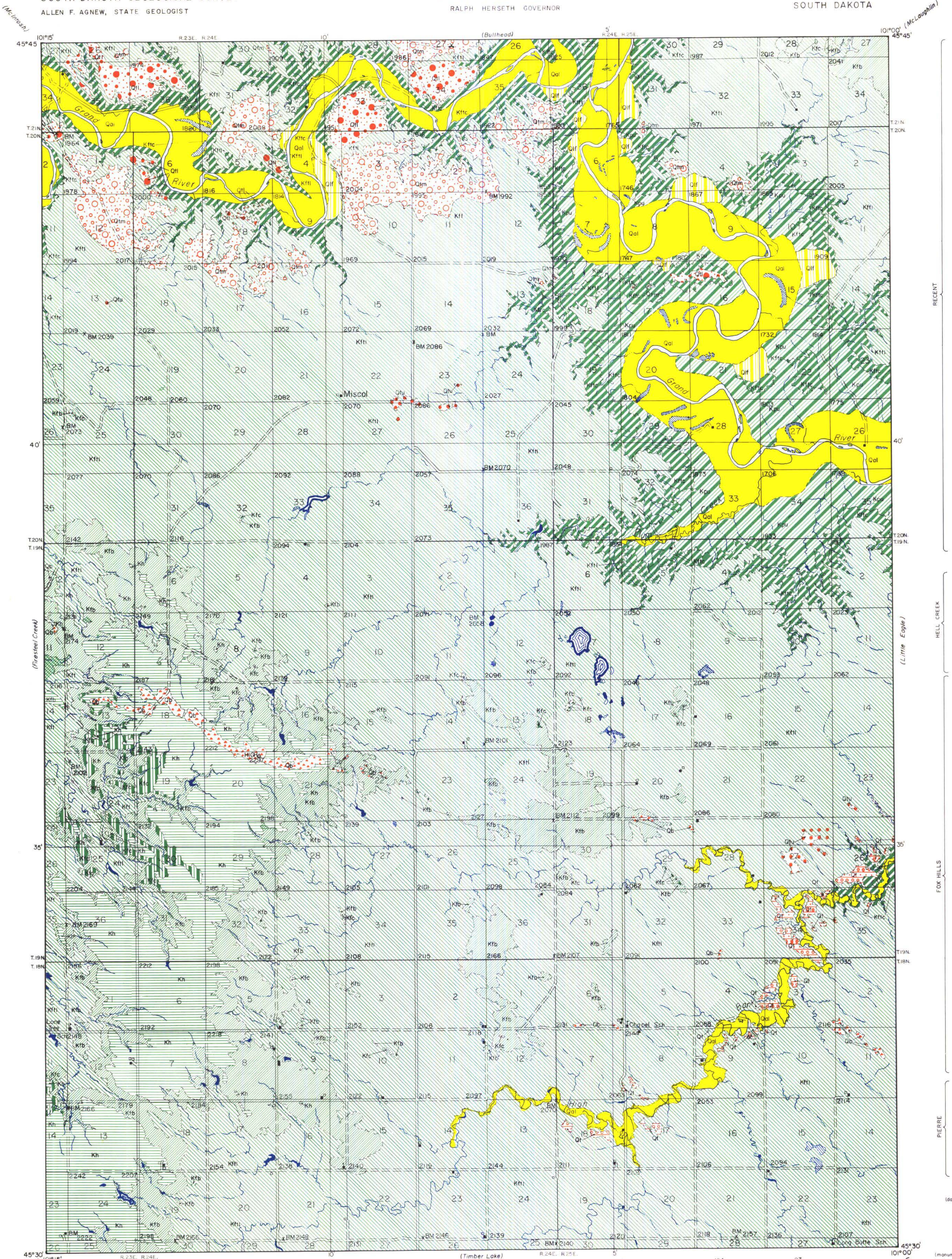
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH GOVERNOR

GEOLOGY of the MISCOL QUADRANGLE SOUTH DAKOTA



EXPLANATION

QUATERNARY — RECENT

Qal — Alluvium
(Floodplain deposits of silt, sand, and gravel in valley of present streams.)

Qlf — Landslide Deposits
(Slumped deposits of mixed Fox Hills lithologies, with lumpy surface; along Grand River.)

Qt — Terrace Deposits
(Undifferentiated terrace deposits of locally derived rubble in a matrix of fine sand.)

Qtl — Lower Terrace Deposits
(Alluvial sand and sandy gravel on terraces 140 feet above Grand River floodplain; mostly angular material of local derivation with some foreign material; average thickness 3½ feet.)

Qtm — Middle Terrace Deposits
(Pebble-gravel and coarse to fine sands on terraces 200 feet above the Grand River floodplain; mixture of angular locally derived material and rounded foreign pebbles; maximum thickness 7 feet.)

Qtu — Upper Terrace Deposits
(Boulder to pebble gravels and sands on terraces 260 to 280 feet above the Grand River floodplain; 50% of material is local; much of foreign material is glacial.)

Qb — Boulder Till Residuum
(Concentrations of glacial boulders and cobbles partially buried in loess; almost entirely igneous and metamorphic rocks.)

UNCONFORMITY

UPPER CRETACEOUS

HELL CREEK

Kh — Hell Creek Formation
(Lenticular buff to white very fine-grained arkosic sands with streaks and thin beds of brown peat-clay, gray to tan bentonitic clay and brown bentonitic siltstone, layer of orange to black limonitic concretions; 30 to 70 feet thick.)

FOX HILLS

Kfc — Colgate Member
(Two distinct lithologies; (1) gray fine to very fine-grained siliceous impure quartz sandstone with local crossbedding and ripple marks, and (2) thick massive buff-colored "oyster-bed" with matrix of calcite sand; 8 to 14 feet thick.)

Kfb — Bullhead Member
(Thin alternating beds of light-gray to buff fine-grained impure quartz sand and dark-gray clay; maximum thickness is 55 feet.)

Kftl — Timber Lake Member
(Massive to laminated, cross-bedded, light-gray to buff fine-grained impure quartz sand; reddish-brown calcareous and/or ferruginous ledges and nodular cemented areas; orange limonitic concretions; local molluscan fauna dominated by Tancredia; 170-240 feet thick.)

Kftc — Trail City Member
(Brown to light-gray fine-grained graywacke sand, clayey sand and gray clay, with yellow jarositic layers near base; scattered layers of spherical to lenticular dark-gray to rusty-brown limestone concretions that may be highly fossiliferous with Pteria, Gervillia, Protocardia and Discoscaphites; 80 to 120 feet thick.)

PIERRE

Kpu — Upper Pierre Unit
(Dark-gray clay-shale, bentonitic clay-shale, slightly bentonitic clay-shale; dark-gray to tan clay-shale with silt streaks, and brown to gray silty clay-shale; local disseminated selenite-jarosite, black to orange ironstone concretions; 160 feet thick.)

Contact
(dashed where approximately located)

X Gravel Pit

X BM 2061 Bench Mark
(monument showing exact altitude above sea level)

X 2122 Spot Altitude

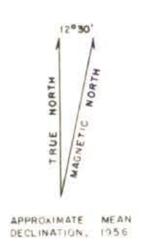
△ HIGH Triangulation Station
(monument marking exact geographic location)

House, School, and Church

Geology by Robert E. Stevenson, 1958
Assisted by R. K. Booker

Vertical and horizontal control from U.S. Geological Survey topographic maps of Miscol, Miscol NE, Miscol SW, and Miscol SE 7½ minute quadrangles, 1956

Drafted by H. D. Wong, 1959



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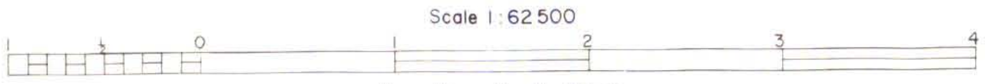
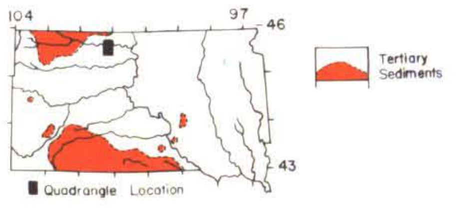


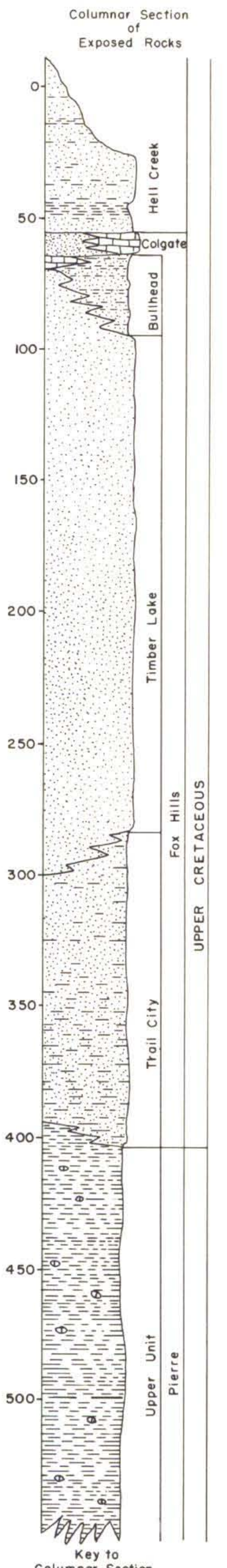
Vermillion, South Dakota
1959



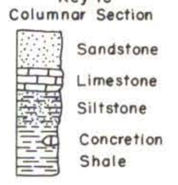
MISCOL QUADRANGLE

GEOLOGY OF THE MISCOL QUADRANGLE

by
R.E. STEVENSON



Key to Columnar Section



INTRODUCTION

The Miscol quadrangle includes about 213 square miles in 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 dotted with sandstone-capped buttes, and slopes slightly eastward. An elongate northwest-trending bouldery ridge lying above this erosional surface in the SW¼ of the quadrangle marks the remnants of a glacial moraine. The plain is partially covered by a thin veneer of loess. Incised into this plain in the northern part of the quadrangle are the valleys of the Grand River and its tributaries. The downcutting of the Grand River took place in four stages, each marked by depositional and erosional terraces. In the first stage a broad (6 miles wide), shallow (30-50 feet deep) valley was developed. During the second stage the valley narrowed to about 4 miles wide and deepened another 50-70 feet. Within the valley of stage 2, a narrower (1½ miles wide) valley about 50 feet deep was cut during the third stage. Later, the river cut down rapidly, forming a narrow valley only half a mile wide, and about 150 feet below stage three. The shape of the present valley is controlled by bedrock; the Fox Hills sandy strata form rather steep valley walls, whereas the Pierre shale forms gentle slopes.

The lowest elevation of the quadrangle, 1690 feet, is in the Grand River valley at the eastern edge of the quadrangle. The highest elevation, 2297 feet, is on the boulder ridge in the SW¼ of the quadrangle. The total relief is thus 607 feet.

The Grand River meanders across its floodplain with a gradient of 3.8 feet per mile. Both High Bank and Plum Creeks are permanent streams, tributary to the Grand. Other more or less permanent water bodies include stock reservoirs and a few shallow ponds in the east-central part of the quadrangle. In the southeastern corner of the mapped area there are a few intermittent playa-like ponds.

The climate of the Miscol 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, 5 miles to the south. It is a lightly populated ranching area containing one family per 5½ square miles. The southern edge of the quadrangle is about 5 miles north of the town of Timber Lake.

The mapping of the Miscol quadrangle was done in the summer of 1958 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 and U. S. Geological Survey topographic maps, with the assistance of R. K. Booker. Field conferences with B. C. Petsch and North Dakota State Geologist W. M. Laird are gratefully acknowledged. The writer thanks the many local residents who provided water well data.

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 and Hayden, 1862

The Pierre Formation was named from exposures at Fort Pierre (90 miles southeast of the Miscol quadrangle), and has been divided into six members along the Missouri Valley. These divisions are not usable in the Miscol area; the two upper members constitute one lithologic unit, here termed the Upper Pierre strata.

Upper Pierre strata. --These clay-shale strata are exposed in the bottom of the Grand River Valley in the northeastern part of the quadrangle.

The Upper Pierre (Kpu) in this area consists of five lithologic types; (1) dark-gray slightly bentonitic clay-shale with a few very thin bentonite seams, (2) dark-gray highly bentonitic clay-shale, (3) dark-gray slightly bentonitic clay-shale, (4) dark-gray to tan clay-shale with streaks of tan silt, and (5) brown to gray silty and sandy clay-shales interbedded with clay-shale, marked by layers of yellow jarosite, and transitional with the overlying Fox Hills Formation. All lithologies contain scattered crystals of clear selenite, streaks of limonitic material, and black to orange ironstone concretions. One hundred sixty feet of the Upper Pierre is exposed in the Miscol quadrangle.

Large fossils were not found in the Pierre Formation in the Miscol quadrangle, but a meager microfauna of foraminifera was found.

Fox Hills Formation, Meek and Hayden, 1862

The type area for this formation is Fox Ridge, about 35 miles south of the Miscol quadrangle. The Fox Hills has been subdivided into four members.

Trail City Member, Morgan and Petsch, 1945. --This member, named for exposures in the vicinity of Trail City, 20 miles east of the mapped area, is well exposed in the valleys of the Grand River, High Bank Creek, and Plum Creek.

The Trail City (Kftc) is brown to light-gray, fine-grained sand, clayey sand, and gray clay, which grade upward into a series of thin laminated sands and clays, with 2-inch layers of rusty sand. The clay content of the member increases downward. Local gray slabby sandy concretions, layers of jarosite fragments, and disseminated small silvery spherical marcasite concretions are present.

Spherical to lenticular dark gray to rusty-brown limestone concretions are scattered in fairly distinct layers in the lower part of the member; these concretions are locally highly fossiliferous, with the following mollusks: Pteria, Gervillia, Cucullea, Protocardia, Limopsis, Fusus, Sphenodiscus, and Discoscaphites. The Trail City ranges in thickness from 80 to 120 feet.

Timber Lake Member, Morgan and Petsch, 1945. --This member was named for exposures in the vicinity of Timber Lake, about 5 miles south of the southern border of the Miscol quadrangle. The buff sands of the Timber Lake Member (Kftl) cover approximately 60 percent of the quadrangle, forming most of the upland.

The member consists of massive to laminated and cross-bedded, light-gray to buff, fine- to very fine-grained, subround to subangular quartz sand with about 2 percent glauconite. Scattered throughout the formation are small orange-brown sandy limonitic concretions and iron-cemented areas. Several layers of large lenticular, buff to orange-brown calcareous cemented masses and 3- to 10-inch ledges of orange-brown calcareous impure sand are present. The Timber Lake Member has a few lenticular zones containing a fauna dominated by the thick-shelled pelecypod, Tancredia. The questionable fossil "Halymenites" is also scattered throughout the member. The Timber Lake Member is 170-240 feet thick.

Bullhead Member, Stevenson, 1956. --The type locality of this member lies about 2½ miles north of the northern border of the Miscol quadrangle, near the village of Bullhead. Good exposures of the Bullhead Member (Kfb) are very rare, as the member is commonly grassed over. It underlies most of the butte caps, and makes the low rounded hills and slopes in the southwestern part of the Miscol quadrangle.

The Bullhead Member ranges in lithology from a dark-gray silty clay to a series of thin alternating beds of light-gray to buff fine-grained impure sand and dark-gray clay. Some orange-brown limonitic concretions occur locally. The Bullhead is sparsely fossiliferous and ranges up to 55 feet in thickness.

Colgate Member, Calvert, 1912. --This member caps most of the buttes in the quadrangle, and forms a poorly defined ledge in the east-central part of the area. The Colgate Member (Kfc) is a discontinuous ledge-forming rock of two distinct lithologies. The most common lithology is the butte-capping gray siliceous fine- to very fine-grained subrounded to subangular impure sandstone with uncemented zones; it is characterized by abundant round to angular wood fragments, cross-bedding that dips northeastward, current ripple marks, oscillation ripple marks, and fossil leaves. In the west-central part of the quadrangle the Colgate is represented by a thick massive, buff-colored oyster bed with a calcareous silt and fine-grained sand matrix that includes small pebbles of clay and wood. Ostrea and a few specimens of gastropod Melania form the oyster bed fauna. The Colgate Member ranges in thickness from 8 to 14 feet, and at one locality (SW¼SW¼ sec. 24, T. 19 N., R. 23 E.), it rests upon the channeled surface of the Timber Lake Member.

Hell Creek Formation, Brown, 1907

This formation is present at the highest elevations in the southwestern quarter of the Miscol quadrangle, but is very poorly exposed. The Hell Creek Formation (Kh) is interbedded and lensing buff to white very fine-grained angular arkosic sands that are locally streaked with brown carbonaceous material, gray to tan bentonitic clay, brown peat-clay, and brown bentonitic siltstone. The formation, which ranges from 30 to 70 feet in thickness, contains layers of abundant orange to black limonitic concretions.

SURFICIAL DEPOSITS

The unconsolidated surficial deposits include till residuum and alluvial materials. An intermittent thin layer of loess and scattered glacial boulders were not mapped separately.

Till Residuum

Only a few exposures of glacial till are present west of the Missouri River in South Dakota. Instead, scattered erratics and local concentrations of boulders mark the former extent of the glacial ice. The glacial boulder concentrations are considered to be the erosional residuum of glacial till (Stevenson, 1957, 1960).

The boulder till residuum forms a distinctive and mappable lithologic unit, and for this reason the writer feels that it should have a formal stratigraphic name. Because of the good development of the glacial boulder concentrations 5¼ miles southwest of Miscol ranch in the Miscol quadrangle, the name Miscol till residuum, has been proposed (Stevenson, 1960).

The boulder till residuum (Qb) is present as a discontinuous ridge that extends northwesterly across the center of the quadrangle; the ridge is covered with 2 to 6 feet of boulders and cobbles. The till residuum is mostly (97-98 percent) glacially derived boulders (76 percent granite, 12 percent greenstone, 3 percent gneiss, 3 percent schist, 2 percent diorite, 2 percent quartz, 2 percent miscellaneous crystalline rocks, and a trace of dolomite). Boulders of silicified clay representing Paleocene Tongue River (?) Formation constitute the remaining 2-3 percent of the deposit (local patches contain as much as 30 percent). Local areas of finer debris (pebbles), which contain a higher concentration (10-15 percent) of carbonate rocks than does the coarser residuum, are present.

Although Flint (1955, p. 86) in South Dakota and Benson (in Lemke and Colton, 1958, p. 46) in North Dakota consider the boulder concentration together with the erratics to belong to the Iowan substage of the Wisconsin glacial stage, the writer believes that the deposit is older and possibly belongs to the Illinoian Stage (Stevenson, 1960).

Alluvial Deposits

The alluvial deposits have been divided into six categories: upper, middle, and lower terrace deposits that are recognizable along the Grand River and its tributaries, undifferentiated terrace deposits along High Bank Creek, landslide deposits, and alluvium. The Grand River terraces might possibly correlate with some of the substages of the glacial Wisconsin Stage.

Upper terrace deposits (Qtu) are present at three localities, 260 to 280 feet above the Grand River. These older terrace deposits consist of 3-4 feet of boulder- to pebble-gravel composed of at least 50 percent fragments of locally derived ironstone concretions, 30-40 percent glacially derived material (granite, greenstone, schist, etc.), and 5-10 percent material of western origin (petrified wood, quartz, agates).

Middle terrace deposits (Qtm) are found along the valley of the Grand River in the northern part of the quadrangle, about 200 feet above the river. The deposits, ranging up to 7 feet in thickness, are mainly fairly clean pebble gravel with 60 percent angular locally derived material (fragments of limonitic concretions, ferruginous, and calcareous sandstones) and 40 percent rounded foreign material (quartz, chert, quartzite, and rare granite), with interbedded lenses of light-gray coarse- to fine-grained quartzose sand.

Lower terrace deposits (Qtl) are alluvial sands and gravels that veneer terraces about 140 feet above the floodplain of the Grand River. The materials consist of 75 percent locally derived semi-angular pebbles (mostly limonitic concretions) and 25 percent rounded pebbles of granite, greenstone, chert, and quartz. The thickness averages about 3½ feet.

Undifferentiated terrace deposits (Qt) occur along High Bank Creek at two principal levels: 110-120 feet, and 30-50 feet, above the floodplain. The material is 90 percent locally derived angular fragments of limonitic concretions and ferruginous sandstone, together with cobbles of granite, greenstone, quartz, and petrified wood, and a few large boulders of crystalline rocks. The deposits range up to 10 feet in thickness.

Landslide (Qlf) deposits are present along parts of the Grand River, and are composed of mixed Fox Hills strata.

Alluvium (Qal) is sandy clay with lenses of sand and gravel along the floodplains of the 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 three oil tests nearby: Youngblood and Youngblood #1 Galvin (SE¼SE¼ sec. 25, T. 16 N., R. 22 E., 25 miles southwest of the quadrangle); Youngblood and Youngblood #1 Draskovich (SE¼SE¼ sec. 20, T. 23 N., R. 22 E., 30 miles northwest of the quadrangle); and Herndon #1 Merkel (SE¼SE¼ sec. 27, T. 17 N., R. 27 E., 25 miles southeast of the quadrangle). The identification of subsurface rock strata in this area is tentative, pending detailed sample studies.

STRUCTURAL GEOLOGY

The Miscol 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 12 feet per mile. Superimposed on this regional dip are some low flexures. Contours drawn at the base of the Colgate Member of the Fox Hills Formation disclose a low northwest-plunging nose-like fold with an amplitude of 60 feet, which trends through the center of the quadrangle. The dome mapped by Wilson (1922) in T. 18 and 19 N., R. 24 and 25 E., is part of this fold, which might actually have been caused by rapid lateral facies changes at the Colgate-Bullhead contact, rather than by structural movements. To the south, this fold merges with the regional dip in the southeastern part of the quadrangle.

Contours drawn at the Fox Hills-Pierre contact show a flattening of the regional dip in the northeastern part of the quadrangle. Morgan and Petsch (1945) suggested that there might be a low east-trending fold in this area, but the writer was unable to find such a structure.

ECONOMIC GEOLOGY

The principal mineral resource in the Miscol quadrangle is ground water, available at depths up to 150 feet in most parts of the area. Gravels have been produced in the Miscol quadrangle, and several other potentially economic mineral resources are present.

Ground Water

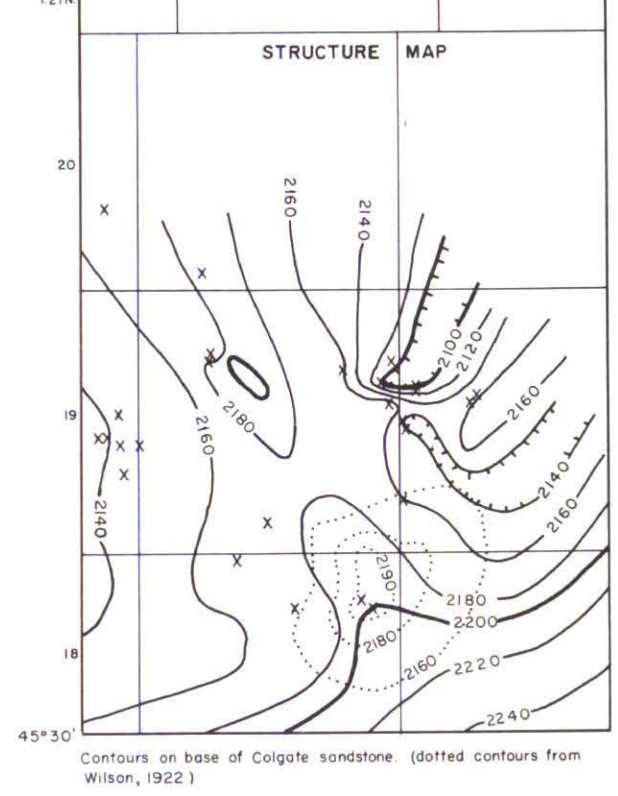
The Fox Hills Formation yields artesian water in all parts of the Miscol quadrangle except the valleys of the Grand River and its tributaries. The best water-bearing zone in the Fox Hills Formation is the sandy Timber Lake Member. In the Miscol quadrangle, wells that obtain water from this sand are 20 to 80 feet deep, except in the higher areas in the southwestern corner of the quadrangle, where water is obtained at depths of 100 to 140 feet.

Generally, water from the Timber Lake sand is of excellent chemical quality, and is suitable for all purposes. Locally the water may be slightly hard. Analyses of water from the upper and lower parts of the Timber Lake Member are given in Table 2.

In areas where the Fox Hills Formation has been eroded away, water can be obtained from the jointed shales of the underlying Pierre Formation. Shale wells are usually about 20 feet deep, and have a low capacity. Water from the Pierre shale is very hard and high in sulfate, sodium, and total solids (see Table 2), making it unsuitable for most domestic uses. It can, however, be used for stock without treatment.

In the valley of the Grand River, the alluvium is the ground water reservoir, at depths of 10 to 32 feet. The alluvial water is high in total solids and is very hard.

The Dakota (Newcastle) water-bearing sandstone lies at depths of 2200 to 2500 feet in the Miscol quadrangle, but it is not used as a water source because the Fox Hills water contains less impurities and lies at shallower depths.



Contours on base of Colgate sandstone. (dotted contours from Wilson, 1922)

Gravel

Gravels suitable for road surfacing are present in the terrace deposits along the Grand River and High Bank Creek. Most of these gravels have large amounts of sand, silt, and limonitic fragments. The high content of limonitic material prevents the use of these gravels as concrete aggregate. Two pits in the area have produced road metal in recent years.

Boulders of the boulder till residuum have been quarried for use as rip-rap.

Sand

It is possible that some of the sand in the Timber Lake Member could be used for cement and plaster, where there is little overburden.

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 unit in the vicinity of Mobridge (35 miles to the east) is potentially suitable for the manufacture of lightweight aggregate (Cole and Zetterstrom, 1954, p. 30).

Oil and Gas

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

It is possible that the low northwest-trending structural nose in the center of the quadrangle may be larger at depth, and thus may be a suitable site for the accumulation of oil and gas. Sedimentary traps are also possible in this area. The most favorable zones for prospecting are (1) the Madison Group at depths of 3800 to 4300 feet, (2) the Devonian strata at depths of 4300 to 5300 feet, and (3) the Red River Formation at depths of 4800 to 5800 feet.

Table 1. --Subsurface Formations

Series	Group Formation	Thickness (feet)	Lithology
CRETACEOUS	Pierre Formation	1000-1100	Dark-gray clay-shale, bentonitic clay with local limey specks and orange-brown limonitic concretions.
	Niobrara Formation	100-300	Light- to dark-gray speckled marl and calcareous clay-shale.
	Carlile Formation	315-410	Medium to dark-gray shale, silty in upper part.
	Greenhorn Formation	90-120	Light-gray sandy limestone with Inoceramus; gray to white speckled calcareous shale.
	Belle Fourche-Mowry Formations	370-410	Dark-gray shale, siliceous shale, and siltstone with local bentonite seams.
	New Castle Formation	50-90	White fine-grained quartzose sand and light-gray siltstone.
	Skull Creek Formation	180-240	Light to dark-gray micaceous shale with sideritic pellets; ironstone concretions.
	Inyan Kara Group	50-100	White to gray fine-grained sand and calcareous sandstone, dark-gray glauconitic siltstone; gray shale with sideritic pellets. Coarse-grained white sand in the lower part.
JURASSIC and TRIASSIC?	Morrison? Formation and older strata	270-410	Probably includes both the Morrison and Sundance Formations. Gray to tan glauconitic siltstone; light-gray sandstone and glauconitic sandstone; green, brown and gray shale and clay.
	Piper? Formation to Spearfish Formation	50-150	Light to yellow-gray dense limestone and dolomite; brown-red claystone, shale, and siltstone with anhydrite.
PERMIAN? and PENNSYLVANIAN	Minnelusa Formation	280-360	The pinkish dense limestone appearing near the top of this unit may represent the Minnekahta Formation. Varicolored, red-brown, purple and green shale; reddish-orange, pink to white, angular to rounded, medium- to fine-grained sandstone; pink to buff dolomitic sandstone; cream and pinkish-gray limestone; reddish dolomite, anhydritic dolomite and anhydrite; red and brown shale at the base.
MISSISSIPPIAN	Big Snowy Group	200-250	Dark-gray red and green shale with buff limestone. Black, gray to brown shale and coal. Light-gray to red coarse-grained sandstone to grit; buff fine-grained dolomite; varicolored, reddish brown, and gray shale.
	Madison Group	760-940	White to brown and gray dense limestone; white anhydritic limestone and anhydrite; base is marked by blue anhydrite = Charles Formation. Buff to brown to gray granular limestone with local oolitic zones = Mission Canyon Formation. Buff to gray dense limestone, sandy limestone and oolitic limestone = Lodgepole Formation.
	Englewood Formation	50-80	Orange, tan to lavender siltstone and calcareous siltstone with varicolored shale.
DEVONIAN and SILURIAN	Undifferentiated	250-560	Buff, brown and gray dense limestone and calcareous shale; dark-gray shale; white fine-grained calcareous sandstone; orange, white and pink dolomite; orange, white to gray limestone and dolomitic limestone.
ORDOVICIAN	Red River Formation	530-570	Buff to gray limestone, some sandy limestone and buff dolomite.
	Winnipeg Formation	170	Green and mottled shale; basal clean quartzose sandstone.
CAMBRIAN	Deadwood Formation	120	Buff medium grained sandstone and glauconitic sandstone; buff glauconitic dolomite and dolomitic sandstone.
PRECAMBRIAN			Red to pink coarse-grained granite; biotite schist.

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

Source of Water	in parts per million								Hardness as $CaCO_3$	Total Solids
	Ca	Mg	Na	SO_4	NO_3	Cl	Fe	F		
Timber Lake sand-upper(1)	33	1	440	426	1.2	0	0	0	87	1368
Timber Lake sand-lower(2)	52	17	67	47	0.1	3	.4	0	201	376
Pierre shale(3)	79	35	455	517	0	6	.6	0	340	
Alluvial deposits(4)	99	39	257	514	2	13	.8	.4	407	
Standard Limits(5)		125		250	10	250	.3	1.5	120	

Analyses by State Chemical Laboratory, Vermillion, South Dakota, 1959.

(1) Carlson farm, sec. 23, T 18 N., R. 23 E.
(2) Sassman farm, sec. 4, T. 18 N., R. 24 E.
(3) Chalmers farm, sec. 5, T. 19 N., R. 25 E.
(4) Bullhead Village in Bullhead quadrangle, 1 mile north (Jochens in Tychsen and Vorhis, 1955, p. 20).
(5) U. S. Dept. of Public Health (1946).

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