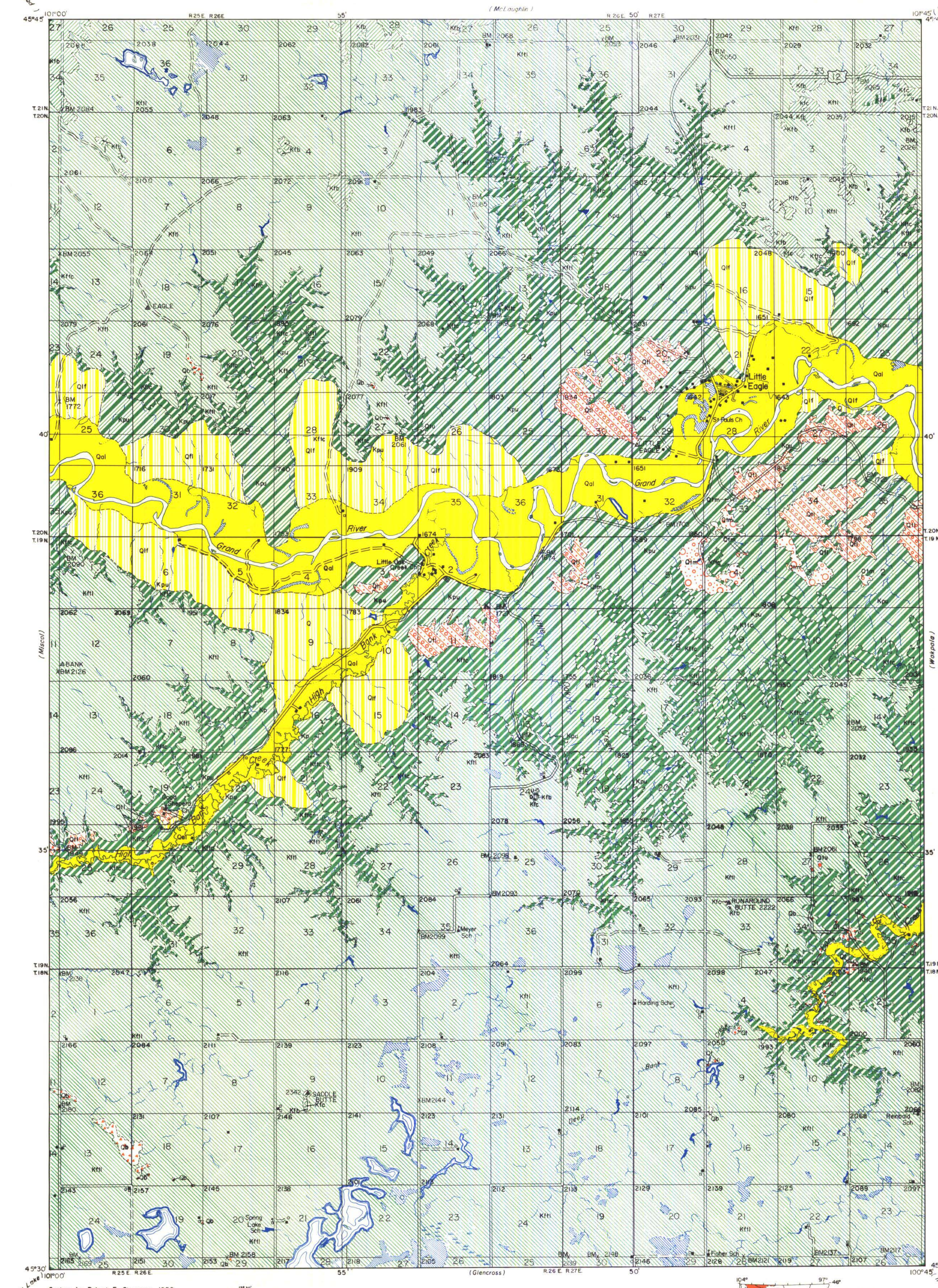
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the LITTLE EAGLE QUADRANGLE SOUTH DAKOTA



EXPLANATION

QUATERNARY — RECENT

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

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

Qt — Terrace Deposits
(Sand and sandy gravel, mostly angular material of local derivation, but does contain some foreign materials.)

Qtl — Lower Terrace Deposits
(Alluvial sand and sandy gravel on terraces 150 feet above Grand River floodplain; mostly angular material of local derivation with some foreign material; 15 to 20 thick.)

Qtm — Middle Terrace Deposits
(Sandy gravel on terraces 220 feet above Grand River floodplain; mostly locally derived angular material with some foreign pebbles; about 5 feet thick.)

Qtu — Upper Terrace Deposits
(Pebble and cobble gravel composed of 60percent rounded material of glacial or western origin, and 40 percent angular material of local derivation; 1 to 2 feet thick.)

Qb — Boulder Till Residuum
(Concentrations of glacial boulders and cobbles with some finer debris; in loess matrix; almost entirely crystalline rocks.)

UNCONFORMITY

UPPER CRETACEOUS — FOX HILLS

Kfc — Colgate Member
(Thin-bedded gray siliceous fine to very fine-grained graywacke sandstone; cross-bedded and ripple-marked; a few limonitic concretions; up to 30 feet thick.)

Kfb — Bullhead Member
(Thin alternating beds of buff to light-gray coarse graywacke silt to very fine-grained sand and gray to brown laminated clay-shale to silty clay-shale; locally very thin olive-green bentonites and flaky orange limonitic concretions; fossils rare; 20 to 112 thick.)

Kftl — Timber Lake Member
(Massive to laminated and cross-bedded, light-gray fine- to very fine-grained graywacke sand; ledges and cemented areas of reddish-brown calcareous and or ferruginous sandstone; yellow-brown to orange limonitic claystone concretions; fauna dominated by Pteria linguaformis; 100 to 155 feet thick.)

Kftc — Trail City Member
(Mottled sub-blocky buff coarse silt to sandy silt and dark-gray to gray silty clay to 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; jarositic layers and locally, selenite in lower part; Discoscaphites nicoletti, Gervillia recta, and Protocardia, each dominate a concretionary faunal zone, thickness ranges from 55 to 110 feet.)

UPPER CRETACEOUS — PIERRE

Kpu — Upper Pierre Unit
(Gray to dark-gray blocky to fissile clay-shale and bentonitic clay-shale, lower part contains local beds of dark-gray to tan fissile calcareous clay-shale, orange to black ironstone concretions and selenite crystals throughout; 220 feet thick.)

Geologic Contact
(dashed where approximately located)

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

X
Gravel Pit

X BM 2050
Bench Mark
(monument showing exact altitude above sea level)

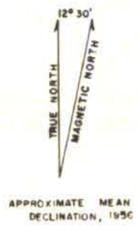
Δ BANK
(monument marking exact geographic location)

House, School, and Church

Geology by Robert E. Stevenson 1959
Assisted by Curtis L. Johnson

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

Drafted by H. D. Wong, 1959



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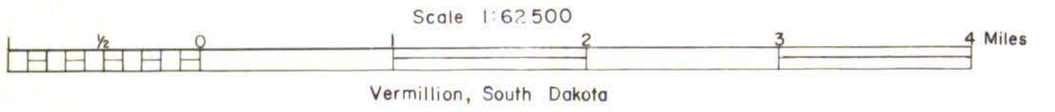
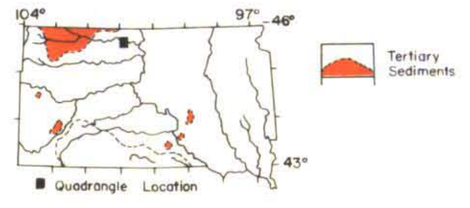


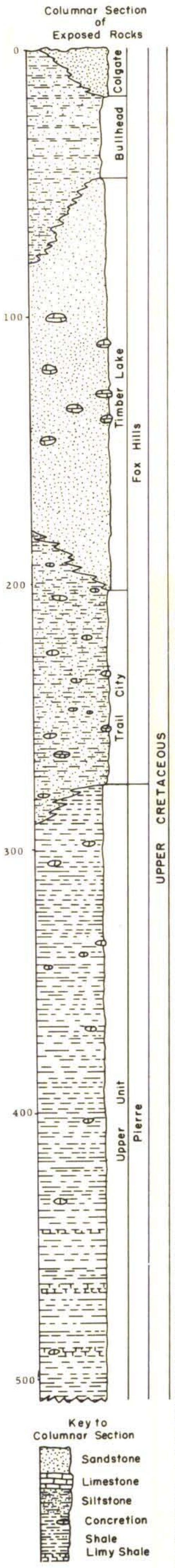
Vermillion, South Dakota
1960



LITTLE EAGLE QUADRANGLE

GEOLOGY OF THE LITTLE EAGLE QUADRANGLE

By
Robert E. Stevenson



INTRODUCTION

The Little Eagle quadrangle includes about 213 square miles in the southeastern part of Corson County in north-central South Dakota.

The quadrangle lies in the prairie lands of the Great Plains physiographic province. The surface is gently rolling erosional plain dotted with sandstone capped buttes, slopes slightly eastward, and is incised by the broad valleys of the Grand River and its tributaries. The walls of the Grand River Valley are gentle and contain many slumped areas. The four erosional stages of the Grand River present in the Miscol quadrangle to the west (Stevenson, 1959) are also present in the Little Eagle quadrangle, each marked by terraces. In the first stage a broad shallow (50-80 feet deep) valley was developed. During the second stage, the valley narrowed to 2-4 miles wide, and deepened 70 to 90 feet more. The third stage cut within the valley of the second stage a slightly narrower (1½-3½ miles wide) valley, 50 feet lower. During the last stage the river cut down rapidly to form the present mile-wide valley 150 feet below the terraces left by the third stage.

In the Little Eagle quadrangle more than 50 percent of the valley-wall slopes are covered by slumped material showing typical hummocky topography. Although most of the slumped material is the clay-shale of the Pierre Formation, much of the Fox Hills Formation was also affected. The lower parts of the valley walls in the unslumped areas are cut in Pierre shale with gentle slopes, but the upper parts are cut in the more resistant Fox Hills sandstones and are characterized by steeper slopes.

The Grand River meanders across its flood plain with a gradient of 3.9 feet per mile. The major tributary, High Bank Creek, is a permanent stream meandering over a narrow, well-developed floodplain. Little Oak and Deep Bank Creeks are intermittent tributaries of the Grand River. Other permanent water bodies are stock reservoirs. Intermittent playa-like ponds in blowouts are found in the southern third and northwestern ninth of the quadrangle.

The climate of the Little Eagle quadrangle is semi-arid with a mean annual rainfall of 17.2 inches and an average temperature of 44.4°F. at Timber Lake, 10 miles to the southwest. It is a lightly populated ranching area containing 1 family per 3½ square miles. The only settlement is the Indian village of Little Eagle, which has a population of about 300.

The mapping of the Little Eagle quadrangle was done in the summer of 1959 under the supervision of Dr. A. F. Agnew as part of the State Geological Survey's program of studying the State's economic mineral resources. The geology was mapped on air photos and U. S. Geological Survey topographic maps, with the assistance of C. L. Johnson. The writer thanks the many local residents who provided water well data. Field conferences with Dr. Karl Waagé are gratefully acknowledged.

EXPOSED SEDIMENTARY ROCKS

Exposed bedrock includes marine shale, silt, and sand of the Pierre and Fox Hills Formations of late Cretaceous age.

Cretaceous System

Pierre Formation, Meek and Hayden, 1862

The Pierre was named from exposures at Ft. Pierre (90 miles southeast of the Little Eagle quadrangle), and has been divided into six members along the Missouri Valley. These divisions are not tenable in this area, the two upper members merging into one lithologic unit, termed in this report the Upper Pierre unit.

Upper Pierre unit. --Many of the exposures of the Upper Pierre strata in the valleys of the Grand River and High Bank Creek are slumped.

The Upper Pierre (Kpu) is dark-gray blocky to fissile clay-shale and fissile bentonitic clay-shale. One hundred and seventy feet below the top of the Pierre Formation, local beds of dark-gray to tan, fissile to blocky calcareous clay are present. In the upper part of the unit the clay-shale locally contains a few thin silt streaks. All lithologies contain scattered crystals of selenite, rusty streaks, iron-stained joint cracks, and black to orange-brown limonitic claystone concretions. At the top of the unit are local and intermittent layers of yellow jarosite.

The calcareous layers contain a small microfauna of foraminiferids, and an occasional fragment of Baculites. The bulk of the Pierre in this area contains scattered microfossils but is barren of larger forms. Two hundred and twenty feet of the Upper Pierre is exposed in the quadrangle.

Fox Hills Formation, Meek and Hayden, 1862

The type area for this formation is Fox Ridge on the Cheyenne River-Moreau River divide, about 35 miles south of the Little Eagle quadrangle. Four members of the Fox Hills Formation are recognized in this area.

Trail City Member, Morgan and Petsch, 1945. --This member was named for exposures near Trail City, about 2 miles south of the southern border of the Little Eagle quadrangle. Exposures of the Trail City Member (Kftc) are found in the non-slumped parts of the area dissected by the Grand River and its tributaries.

A mottled sub-blocky rock consisting of interlensing buff coarse silt to sandy silt, and dark-gray to gray silty clay to clay makes up the bulk of the member. A bed of buff to brown, very fine-grained, locally glauconitic impure argillaceous sand is present about 35 feet above the base of the member. Elsewhere in the member, there are several intermittent layers of yellow jarosite and local patches of disseminated selenite crystals. Scattered in fairly distinct layers are spherical to lenticular locally fossiliferous concretions of dense to sandy gray to light-gray limestone and red-brown ferruginous limestone. Some of the concretions have a coat of slabby gray calcareous very fine-grained impure argillaceous sandstone and coarse-grained siltstone.

Dr. Karl Waagé pointed out to the writer the zonal arrangement of marine fossils in the concretions of the Trail City Member (oral communication, 1959). The basal concretionary layers (lower 25 feet) are characterized by an abundance of Discoscaphites nicolleti. The next higher fossil zone contains large accumulations of Gervillia recta and Limopsis parvula. Because of the great abundance of these peanut-shaped fossils, these concretions have been termed "peanut brittle". About 35 to 75 feet above the base of the member begins a series of concretions dominated by the small pelecypod Protocardia subquadrata, and locally by Pteria nebrascana. A few megafossils and scattered arenaceous foraminiferids occur loose in the sediments, but most are restricted to the concretions. Common fossils are: Nucula planimarginata, N. cancellata, Tellina scitala, Inoceramus sp., Goniomya americana, Pteria linguiformis, Ostrea cf. O. pellucida, Lunatia concinna, Anchura americana, Fasciscolaria culbertsoni, F. buccinoides, Spironema tenuilineata, Discoscaphites nebrascensis, D. mandanensis, D. abyssinius, D. spp.(several undescribed nodose forms), Sphenodiscus lenticularis, S. sp. (a small form), Eutrephoceras dekayi. The sphenodiscids do not occur in the basal concretionary zone.

The Trail City Member ranges in thickness from 55 to 110 feet, thinning to the northeast.

The basal contact with the Pierre Formation, although it may locally be fairly sharp, is usually transitional over several feet of strata. The contact is marked by an increase in the silt content upward, and by a color change.

Timber Lake Member, Morgan and Petsch, 1945. --This member was named for exposures in the vicinity of Timber Lake, about 6 miles southwest of the Little Eagle quadrangle. The buff sands of the Timber Lake Member (Kftl) crop out in about 50 percent of the quadrangle, forming the uplands.

The Timber Lake Member is a massive to laminated, greenish-tinted, light-gray to buff fine- to very fine-grained, subrounded to subangular graywacke sand with small to medium amounts of glauconite. Much of the member is well cross-bedded in many directions. Locally near the base the member becomes slightly clayey and silty. There are a number of 5- to 14-inch ledges of reddish-brown ferruginous calcareous fine-grained impure argillaceous sandstone. Scattered throughout the member are subspherical to lenticular reddish-brown calcareous and/or ferruginous cross-bedded cemented areas and thin layers or concretions of hard yellow-brown limonitic claystone.

The dominant Timber Lake fossil to the north, northwest, and west, Tancredia americana, is absent in this area, and Idonarca nebrascensis which dominates the Timber Lake Member to the south and southwest is restricted to the southwestern part of the quadrangle. The fauna of the Timber Lake in the northeastern part of this quadrangle consists of forms associated with Tancredia to the north, and is characterized by Pteria linguiformis. The fauna contains: Ostrea pellucida, Tellina scitula?, Protocardia subquadrata, Idonarca shumardi, and Discoscaphites nebrascensis. Most outcrops of the upper Timber Lake have abundant specimens of the questionable fossil "Halymenites major".

The contact with the underlying Trail City Member is usually fairly distinct, but locally may be transitional and marked by a gradual change from silt to sand. The Timber Lake Member ranges in thickness from 100 to 155 feet.

Bullhead Member, Stevenson, 1956. --The type locality of this member lies about 4 miles northwest of the northwestern corner of the Little Eagle quadrangle. Good exposures of the Bullhead Member (Kfb) are rare as most of the member is either grassed over or covered by talus. The Bullhead underlies the butte caps and topographic highs along the **northwest edge** of the mapped area.

The Bullhead Member is a series of thin (1 inch to 1 foot) alternating beds of gray to brown fissile and laminated clay-shale with local silt streaks, and buff to light-gray coarse graywacke to very fine-grained sandy silt. Small flaky concretionary layers of yellow-brown limonitic claystone are found throughout the formation. Locally there are series of alternating thin beds of gray clay-shale and olive-green bentonite.

The only fossils are scattered specimens of Ostrea glabra, in the upper Bullhead in strata equivalent to the Colgate Member. The Bullhead Member ranges from 20 to 112 feet in thickness, the great variation being caused by facies changes with the overlying Colgate sandstone and the upper part of the underlying Timber Lake sand.

Colgate Member, Calvert, 1912. --This member caps the upland buttes in the quadrangle. The Colgate Member (Kfc) is a discontinuous ledge-forming hard gray thin-bedded siliceous fine- to very fine-grained, subangular to subrounded graywacke sandstone together with beds of slightly indurated graywacke sand. Cross-bedding is common and many bedding planes are marked by oscillation ripple marks (index 5-7). Rounded to angular fossil wood fragments are scattered throughout the Colgate. Small brown limonitic claystone concretions are locally present in this member. On some bedding plane surfaces, low rounded (1/8 to 1/2 inch wide) sinuous ridges presumably of organic origin, are present. The Colgate Member ranges up to 30 feet in thickness.

SURFICIAL DEPOSITS

The unconsolidated surficial deposits include glacial till residuum and alluvial material. An intermittent thin layer of loess and scattered glacial erratics 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, 1959, 1960). Boulder concentrations characteristic of the till residuum are present on an intermittent N. 50° W.-trending ridge, which is an extension of the ridge of till residuum that crosses the Miscol quadrangle to the west. Other areas of till residuum are on the upland north of the Grand River in Sections 19 and 22, T. 20 N., R. 26 E.

The boulder till residuum (Qb) consists of glacial boulders, cobbles, and pebbles (81 percent granite, 8 percent greenstone, 6 percent gneiss, 2 percent diorite, 1 percent each gabbro, quartzite, and dolomite) in a loess matrix. Boulders of silicified clay representing "let-down" Paleocene Tongue River (?) Formation constitute twelve percent of the deposit.

Although Flint (1955, p. 86) in South Dakota and Benson (in Lemke and Colton, 1958, p. 46) in North Dakota considered the till residuum together with the scattered glacial erratics to belong to the Iowan substage of the Wisconsin glacial stage, the writer (Stevenson, 1960) has assigned the deposit to the Illinoian (?) glacial stage.

Alluvial Deposits

The alluvial deposits have been divided into five categories: upper, middle, and lower terrace deposits that are recognizable along the Grand River, undifferentiated terrace deposits along High Bank and Deep Bank Creeks, and alluvium. The Grand River terraces might possibly correlate with some of the substages of the Wisconsin glacial stage.

Upper terrace deposits (Qtu) were found at one locality 330 feet above the Grand River. These consist of 1 to 2 feet of sandy pebble and cobble gravel composed of 40 percent angular fragments of locally derived ironstone concretions and sandstone, 30 percent glacially derived material (granite, diorite, greenstone, chert), and 30 percent material of western origin (petrified wood, felsite, quartz).

Middle terrace deposits (Qtm) are found along the valley of the Grand River, about 220 feet above the river. The deposits, ranging up to two feet in thickness, consist of sandy pebble gravel with 70 percent angular locally derived material (fragments of limestone concretions, ferruginous and calcareous sandstone) and 30 percent rounded foreign material (quartz, chert, granite, greenstone) with lensing interbeds of coarse to very fine sand.

Lower terrace deposits (Qtl) are alluvial sand and sandy gravel that veneer broad terraces lying 150 feet above the floodplain of the present Grand River. The materials consist of a fine-grained cross-bedded gravel with scattered boulders, lenses, and streaks of medium-grained sand. Near the base of the 15- to 20-foot thick deposit is a 3½-foot bed of buff medium-grained graywacke sand (reworked Timber Lake sand). The gravel contains 70 percent semiangular locally derived pebbles (mostly limonitic concretions and ferruginous sandstone) and 30 percent rounded pebbles of foreign origin (mostly granite, but also quartz, chert, greenstone, lava, and petrified wood).

Undifferentiated terrace deposits (Qt) occur along High Bank Creek 80 to 100 feet above the present floodplain, and along Deep Bank Creek 40 to 70 feet above the floodplain. The deposits are composed of interlensing sand and sandy gravels. Seventy to eighty percent of the pebbles are of local origin (limonitic concretions and ferruginous sandstone) and 20 to 30 percent are of glacial or western origin (mostly granites and greenstones). The deposits range up to 15 feet in thickness.

Alluvium (Qal) is sandy clay with many lenses of sand and a few lenses of pebble gravel, comprising the floodplains of the modern large streams.

SUBSURFACE ROCKS

The thickness and character of the subsurface rock units are shown in Table 1. These data are based on preliminary studies by Survey geologists of samples and electric logs from the following nearby oil tests: Youngblood & Youngblood #1 Galvin (SE¼SE½ sec. 25, T. 16 N., R. 22 E., 22 miles southwest of the quadrangle); Youngblood & Youngblood #1 Draskovich (SE¼SE¼ sec. 20, T. 23 N., R. 22 E., 24 miles northwest of the quadrangle); Herndon #1 Merkel (SE¼SE¼ sec. 27, T. 17 N., R. 27 E., 6 miles south of the southern border of the quadrangle); Herndon #1A O'Leary (SE¼SW¼ sec. 13, T. 15 N., R. 23 E., 21 miles southwest of the quadrangle); and Peppers #1 State (NE¼NE¼ sec. 36, T. 123 N., R. 76 W., 40 miles southeast of the quadrangle). The identification of subsurface rock units in this area is tentative, pending detailed sample studies.

STRUCTURAL GEOLOGY

The Little Eagle 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. Structure contours on the base of the Colgate Member of the Fox Hills Formation show a flattening in the northern half of the quadrangle. The dome mapped by Wilson (1922) in T. 18 N., R. 26 E. is in the southern part of the quadrangle. These may not be tectonic structures, for the irregularities could result from facies changes. One of the Colgate-capped buttes is cut by a minor fault striking N. 75° W., with a displacement of approximately 22 feet downthrown to the south.

ECONOMIC GEOLOGY

Ground water, available at depths up to 250 feet, is the major mineral resource of the Little Eagle quadrangle. Gravel and rip-rap have been produced in this area and several other potentially economic mineral resources are present.

Ground Water

The Fox Hills Formation yields artesian water in all parts of the Little Eagle quadrangle except in the valleys of the Grand River, High Bank Creek, and Deep Bank Creek.

The Timber Lake sandstone is the best water-bearing zone in this area. In the Little Eagle quadrangle, wells that obtain water from this sand range in depth from 25 to 100 feet (most are 60 feet deep or less). On the south side of the divide between the Grand River and High Bank Creek there are several springs issuing from the Timber Lake sandstone just above the contact with the Trail City siltstone (maximum flow 1 gal per min in 1959). Generally the Timber Lake sand provides water of excellent chemical quality which is suitable for all purposes.

Analyses of water from the upper and lower parts of the Timber Lake Member are given in Table 2.

Where the Timber Lake sands are thin, tight, or missing, wells obtain water from sands in the Trail City Member of the Fox Hills Formation. These wells are 20 to 150 feet deep, with half of them more than 80 feet deep.

In areas where the sands of the Fox Hills Formation have been removed by erosion, water can be obtained from the jointed shales of the underlying Pierre Formation. Shale wells are usually shallow and have low capacities. 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 without treatment for stock.

In the valleys of the Grand River and High Bank Creek, alluvium is a ground water reservoir at depths of 16 to 20 feet. Locally, water can be obtained from pits dug in the thicker terrace deposits.

The Newcastle ("Dakota") water-bearing sandstone lies at depths of 2200 to 2600 feet in the Little Eagle quadrangle, but is normally not used as a water source because the Fox Hills water has fewer impurities and lies at shallower depths.

Gravel

Gravel suitable for surfacing roads is present in terrace deposits along the Grand River, High Bank Creek, and Deep Bank Creek. Most of these gravels have a high percentage of sand. The presence of limonitic material prevents the use of these gravels as concrete aggregate. Two pits in the area have produced road metal. Boulders of the till residuum were being removed in the summer of 1959 for use as rip-rap.

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, which could be commercially quarried for use as flagstone, rip-rap, or crushed rock aggregate.

Shale and Clay

The highly bentonitic clay-shales of the Pierre Formation constitute excellent material for sealing earth dams. Some of the non-bentonitic shales of the Pierre could be used for the manufacture of bricks. The upper Pierre clay-shale in the vicinity of Mobridge (20 miles to the east) is potentially suitable for the manufacture of light-weight aggregate (Cole and Zetterstrom, 1954, p. 30).

Oil and Gas

The Little Eagle quadrangle lies on the eastern flank of the Williston Basin, a major oil and gas producing area. Production of the basin comes from anticlines in the center and along the western edge, and some oil pools are found in sedimentary traps along the northeastern flank.

Although there are no proved surface structures with closure, there is a possibility of subsurface structures as well as sedimentary traps which might be oil and gas reservoirs. The most favorable zones for prospecting are: (1) the Madison Group at depths of 3400 to 4600 feet, (2) the Devonian strata at depths of 4300 to 5200 feet, and (3) the Red River Formation at depths of 4600 to 5700 feet.

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

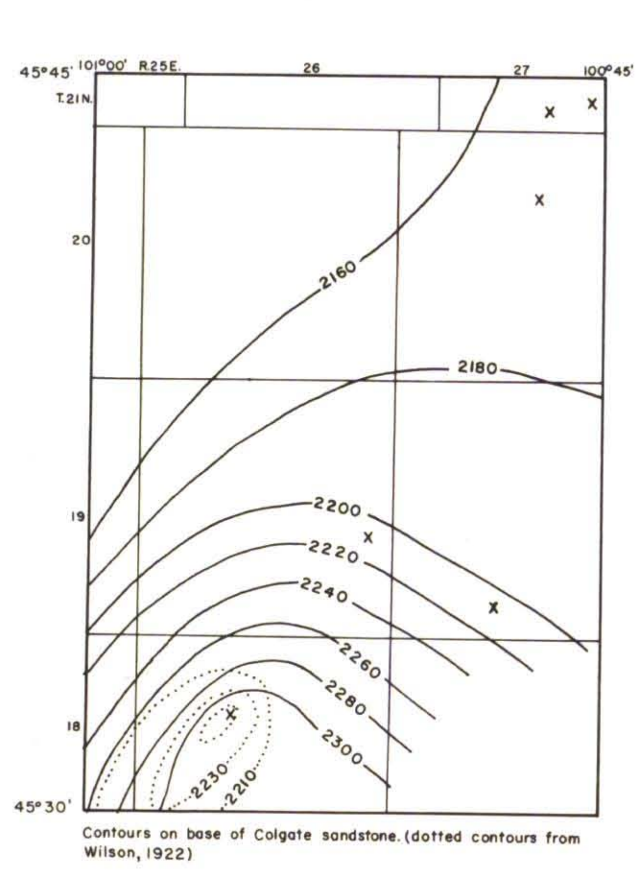
Series	Group or Formation	Thickness (feet)	Lithology
CRETACEOUS	Pierre Formation	900-1300	Dark-gray clay-shale, bentonitic clay with local limey specks, orange-brown to tan limonitic concretions, and gray dense limestone concretions.
	Niobrara Formation	280- 300	Light- to dark-gray speckled marl and calcareous clay-shale.
	Carlile Formation	380- 470	Medium- to dark-gray shale, silty in the upper part.
	Greenhorn Formation	80-90	Light-gray sandy limestone with Inoceramus; gray to white speckled calcareous shale.
	Belle Fourche and 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	150- 180	Light- to dark-gray micaceous shale with sideritic pellets; ironstone concretion.
	Inyan Kara Group	40-90	White to gray fine-grained sands and calcareous sandstone, dark-gray glauconitic siltstone; gray shale with sideritic 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 shales and clay.
TRIASSIC	Piper? Formation to Spearfish? Formation	120-125	Light- to yellowish-gray dense limestone and dolomite. Brown-red claystone, shale, and siltstone with anhydrite.
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 shale; 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 the 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 Formation; white to brown and gray dense limestone; white anhydrite; base marked by a blue anhydrite. Mission Canyon Formation; buff to brown to gray granular limestone with local oolitic zones. Lodgepole Formation; buff to gray dense limestone, calcite sand, and oolitic limestone.
	Englewood Formation	105- 110	Orange, tan to lavender siltstone and calcareous siltstone with varicolored shale.
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 dolomite, 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.
PRE-CAMBRIAN			Red to pink coarse-grained granite and biotite schist.

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

		Parts Per Million									
Sample No.	Source of Water	Ca	Mg	Na	SO_4	NO_3	Cl	Fe	F	Hardness	Total Solids
1	Timber Lake sand-upper	90	30	31	51		5	Tr		344	348
2	Timber Lake sand-lower	34	5	54	44		2	None		105	274
3	Trail City sand-middle	41	10	153	191		5	0.5		230	644
4	Trail City sand-lower	64	9	224	360		22	Tr		241	916
5	Pierre shale	79	35	455	517		6	0.6		340	
6	Alluvial deposits	73	22	91	153	40	30	2.0	0.4	273	597
7	Standard Limits		125		250	10	250	0.3	1.5		

Analyses by State Chemical Laboratory, Vermillion, S. D., 1959

1. Selzer farm, Sec. 31, T. 18 N., R. 27 E.
2. Meyer farm, Sec. 26, T. 19 N., R. 26 E.
3. Crawford farm, Sec. 24, T. 19 N., R. 26 E.
4. Van Orman farm, Sec. 3, T. 18 N., R. 27 E.
5. Chalmers farm in Miscol Quadrangle 5 miles west (Stevenson, 1959)
6. SW¼ sec. 35, T. 20 N., R. 28 E., 4 miles east of quadrangle (Jochens, 1955, p. 20).
7. U. S. Bureau of Public Health (1946)



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