SOUTH DAKOTA GEOLOGICAL SURVEY
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STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the OKREEK QUADRANGLE SOUTH DAKOTA

EXPLANATION

QUATERNARY

RECENT

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

Qc — Colluvium
(Incoherent clay, silt, and sand near headwater regions of some streams; formed by stream action and gravity movement.)

PLEISTOCENE

Qtl — Lower Terrace Deposits
(Clay, silt, sand, and gravel of local origin; 1-12 feet thick; lower terrace along Oak Creek)

Qtm — Middle Terrace Deposits
(Clay, silt, sand, and gravel of local origin; 1-12 feet thick; upper terrace along Oak & Butte Creeks.)

Qtu — Upper Terrace Gravels
(Sand and gravel of local origin; 1-5 feet thick; caps high level hills.)

TERTIARY

PLIOCENE

Tb — Bijou Facies
(Green coarse-grained conglomerate, 20 feet thick; green cross-bedded medium- to fine-grained quartzitic sandstone, 45 feet thick.)

Tpa — Ash Hollow Formation
(Tan to olive calcareous arkosic sandstone with caliche and box-work; forms white upland cap rock; about 65 feet thick.)

Tpv — Valentine Formation
Tan to olive medium- to fine grained arkosic sand; thin layers of olive silt and green claystone; about 200 feet thick.)

MIOCENE

Tmm — Mellette Facies
(Flesh-colored dense fossiliferous limestone. 1-3 feet thick at 150, 165, and 175 feet above base of Arikaree formation.)

Tma — Arikaree Formation
(Basal siliceous quartz sandstone with pitted surface, 1-6 inches thick; porous silicified pink claystone and siltstone with small patches of pink montmorillenite and ball-like sturctures; up to 238 feet thick.)

OLIGOCENE

Tow — White River Group (Undifferentiated)
(Basal quartz sand and gravel overlain by white to light-gray siltstone and pink bentonitic clays; ledge-forming yellowish-green silicified claystone at 25-70 feet above base. Upper strata pink bentonitic clays and silts; top marked by wormy tan siltstone; thickness of group 70-150 feet.)

CRETACEOUS

UPPER CRETACEOUS

Kpu — Pierre Formation (Upper Unit)
(Lower part dark-gray marine shale, calcareous, white-specked. Uppet part light-gray to olive-tan shale, blocky to thin bedded; weathers yellowish-brown; gypsum and iron sulfate minerals along viens and bedding planes; thin limestone concretions at top; thickness of unite 260-270 feet.)

Kpl — Pierre Formation (Lower Unit)
(Dark-gray to black slightly calcareous blocky benfonitic marine shale; gray lenticular limestone concretions at top; thickness at least 60 feet.)

Contact
(dashed where approximately located)

Gravel Pit

X BM 2100
Bench Mark
(monument showing exact altitude above sea level)

X 2122
Spot Altitude

△ OKREEK
Triangulation Station
(monument marking exact geographic location)

House, School, and Church

OKREEK QUADRANGLE

Geology by W. D. Sevon, 1958
Assisted by Joan J. Sevon
Vertical and horizontal control surveyed from triangulation and level lines of Federal surveys
Drafted by LaVern Zamow and R. L. Bruce

APPROXIMATE MEAN DECLINATION, 1958

Scale 1:62 500
1 0 1 2 3 4 Miles
Vermillion, South Dakota
1959

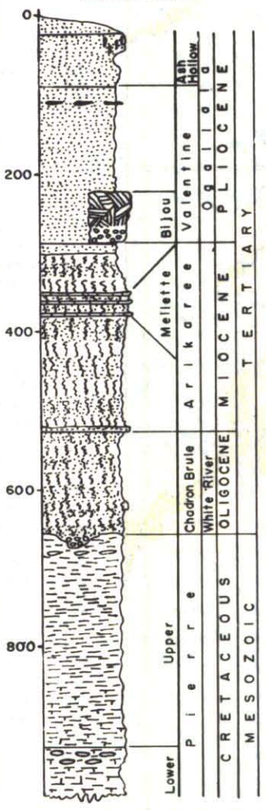
Tertiary Sediments
Quadrangle Location

GEOLOGY OF THE OKREEK QUADRANGLE

by

W.D. Sevon

Columnar Section of Exposed Rocks



Key to Columnar Section

- Sandstone Concretions or Caliche
- Sand or Sandstone
- Cross-bedded Sandstone
- Limestone
- Claystone
- Siltstone
- Gravel or Conglomerate
- Limestone Concretions
- Calcareous shale
- Shale

INTRODUCTION

The Okreek quadrangle includes about 218 square miles in the southeastern part of Mellette County and the adjoining part of northeastern Todd County.

The quadrangle, in the region of outcropping Tertiary rocks in the south-central part of the state, is in the Missouri Plateau section of the Great Plains physiographic province. The area is characterized by rolling plains topography punctuated with numerous buttes. Major drainages in the area are Butte Creek (NW part of the mapped area), Oak Creek (central part), White Horse Creek (eastern part), and Antelope Creek (SW corner). All of these streams flow northward into the White River except Antelope Creek, which flows southeastward into the Keyapaha River. Local relief ranges up to 350 feet, and maximum relief in the quadrangle is about 750 feet, as shown by elevations of less than 2049 at Okreek, to greater than 2714, in the southwestern part of the quadrangle. Settlements in this sparsely populated area are Wood (pop. 260), Okreek (pop. 120), and Mosher (pop. 25). U. S. Highway 18 and State Route 40 cross respectively the central and northern parts of the quadrangle, and State Route 53 originates in the north-central part and extends northward. A well-developed network of unsurfaced roads serves most of the area, but those roads underlain by shales or clays are nearly impassable when wet. The climate is characterized by a wide temperature range, an average rainfall of 19 inches, and by strong winds.

The geology was mapped during the summer of 1958 under the supervision of Dr. Allen F. Agnew, State Geologist, with the geologic assistance of Mrs. Joan Johnson Sevon.

SURFICIAL DEPOSITS

Unconsolidated deposits associated with present drainage are divided into three main groups: (1) alluvium in present stream valleys, (2) colluvium in the headwater regions of some of these streams, and (3) upper and lower terrace deposits adjacent to these streams. Terrace gravels are either high-level terrace deposits along present streams, or deposits of old stream channels.

Alluvium (Qal) consists of silt, sand, and gravel, which resulted from stream reworking of older bedrock and surficial deposits. It is entirely of local origin, derived from the Tertiary and Cretaceous bedrock of the area. Colluvium (Qc) consists of loose incoherent clay, silt, and sand formed in part by stream reworking of local bedrock, and in part by gravity movement downslope.

Terrace deposits (Qtm and Qtl) are clay, silt, sand, and gravels. The gravels are claystone, siltstone, sandstone, and limestone pebbles, generally less than one inch in diameter. These materials are entirely of local origin. The lower part of these deposits of mixed clay, silt, and gravel ranges from 1 to 10 feet in thickness, and is covered with 1 to 2 feet of quartz sand. Terrace gravels (Qtu) are sand and gravel of local origin capping small hills both near present streams and in isolated positions representing deposits of older stream channels. These deposits are 1 to 5 feet thick.

EXPOSED SEDIMENTARY ROCKS

Pierre shale, a marine deposit of Cretaceous age, is present throughout the quadrangle, but is overlain in the western and southern parts by Tertiary fluviatile and lacustrine sediments of Oligocene, Miocene, and Pliocene age. The Oligocene White River strata are silty claystone, siltstone, sandstone, gravel, and bentonite; the Miocene Arikaree strata are claystone, sandstone, and limestone; the Pliocene Ogallala sediments are unconsolidated sands, sandstone, and quartzitic sandstone.

Pierre Formation Meek & Hayden, 1862

The Pierre Formation, named from exposures near Ft. Pierre (60 miles north of Okreek), constitutes the bedrock in the northern and eastern half of the quadrangle. Natural exposures of the Pierre can be found only along Oak Creek in the northeastern part of the area. In the Okreek quadrangle the Pierre cannot be divided into the members which are recognizable along the Missouri River (Searight, 1937); therefore the Pierre is here divided into the two conformable lithologic units described by Agnew (1957).

Lower Pierre unit

The lower Pierre unit (Kpl) is dark-gray to black slightly calcareous bentonitic shale that weathers light-gray with occasional iron-stained streaks. It is blocky when fresh, but weathers first to thin flakes and finally to a structureless mass of clay. The upper part of this unit contains layers of dark-gray lenticular argillaceous concretions which range up to three inches in thickness and 1½ feet in diameter. Some of these concretions have as cores the long cephalopod Baculites. At least 60 feet of this unit is exposed in the quadrangle.

Upper Pierre unit

The upper Pierre unit (Kpu) is gray calcareous shale (below) and gray to brownish silty shale (above). The lower part of this unit is a dark-gray calcareous blocky shale which weathers light-gray to brownish, and in places is iron-stained. Broken surfaces of the shale show minute white calcareous spots which may be crushed foraminiferal shells. Some megafossil fragments can be found. The upper part of this unit is light-gray to olive-tan shale that weathers yellowish-brown. It ranges from blocky to thin-bedded and from non-calcareous to very calcareous. Minute gypsum crystals and iron-sulfate minerals are present along bedding planes and in veins throughout this unit. Several thin layers of light-gray to yellowish-brown limestone concretions are present near the top. A placer of thin limonitic plates locally covers slopes developed in this shale. The top of the upper Pierre unit is marked by a 10-15 foot weathered zone (Interior Formation of Ward, 1922) of yellowish-brown to reddish-brown bentonitic shale that is yellowish-brown and platy when fresh. The upper Pierre unit is 260-270 feet thick, the variation being due to an unconformity at the top.

White River Group Meek & Hayden, 1858

The White River Group, named for exposures along the White River in the Badlands, to the west, is exposed in a band trending southeastward across the center of the quadrangle, and includes the Chadron (below) and Brule Formations. Because no discernible contact between the two formations exists in the Okreek quadrangle, the Chadron and Brule have been mapped together (Tow).

The base of the White River Group is marked by a poorly cemented coarse-grained quartz sand mixed with a gravel of rounded and polished quartz and chert pebbles ranging up to one inch in diameter. The basal sand and gravel is overlain by alternating layers of white to light-gray argillaceous siltstone and light-gray to pink bentonitic clays. A distinct, ledge-forming, yellow-green silicified claystone containing small pea-ball structures is common 25-70 feet above the base of the unit. This resistant claystone occurs only where there are no overlying impervious sediments, suggesting that it is the result of case-hardening by ground water. In the southeastern part of the area a small stripped plain has been formed on top of this claystone owing to the easy removal of the loose overlying Ogallala sands. The upper strata of the White River Group are olive-pink bentonitic clays interbedded with pink calcareous siltstone and pink calcareous argillaceous silts. All of these sediments weather light-pink. Weathering causes the siltstone layers to project slightly, producing a stair-step profile. The top of the unit is marked by several feet of light-tan well-cemented siltstones interbedded with thin bands of pink slightly calcareous clays. These siltstones weather to characteristic wormy surfaces. The thickness of the White River Group in this area ranges from about 150 feet in the west-central part to about 70 feet in the east-central part. These strata appear to be unfossiliferous. The White River Group is overlain unconformably by Miocene Arikaree sediments in the western half of the area, and by Pliocene Ogallala sediments in the southeastern half of the area.

Arikaree Formation Darton, 1899)

The Arikaree Formation (Tma), named after the Arikaree Indians of western Nebraska, overlies the White River sediments in the western quarter of the quadrangle. It consists of somewhat porous pink silicified claystone and pink silicified siltstone, both of which weather light-pink to white, and contain scattered small patches of pink montmorillonite. Small ball-like structures show brown and white concentric rings when broken. The base of the unit is marked locally by a medium- to coarse-grained siliceous grayish-white sandstone that is composed of subangular quartz and chert grains and small pink clay pebbles, which weather readily to a characteristic pitted surface. This sandstone varies from two to six inches in thickness. The upper part of this formation contains a loosely cemented, very fine-grained, light-gray calcareous quartz sandstone containing elongate nodular sandstone concretions. The thickness of the Arikaree (including the Mellette facies described below) in the Okreek quadrangles ranges up to 238 feet. The Arikaree Formation is unconformably overlain in the southwestern part of the area by the Pliocene Ogallala Group.

Mellette facies Agnew, 1957

The unit here redefined as the Mellette facies of the Arikaree Formation was originally named the Mellette Formation, but further study has shown the Mellette to be a facies of the Arikaree. The Mellette facies consists of flesh-colored dense fossiliferous limestones containing veins and isolated crystals of calcite and dendrites of manganese oxide. The limestones weather a brilliant white. Abundant siliceous gastropod remains are usually present, along with other irregularly shaped masses of silica. These siliceous materials project slightly on weathered surfaces. The limestones vary from 1 to 3 feet in thickness and occur at about 150, 165, and 175 feet above the base of the Arikaree Formation, forming caprocks on numerous buttes in the west-central part of the quadrangle. The lower limestone unit locally grades laterally into a white calcareous siltstone that contains small masses of pink montmorillonite.

Ogallala Group Darton, 1899

The Ogallala Group, exposed in the uplands of the southern quarter of the quadrangle, includes the Valentine (below) and Ash Hollow Formations, and the Bijou quartzite facies. The Ogallala Group is a series of fluviatile silts, sands and sandstones.

Valentine Formation Barbour & Cook, 1917

The Valentine Formation (Tpv), named for exposures near Valentine, Nebraska (35 miles south of the quadrangle), is tan to olive unconsolidated compact, medium- to fine-grained arkosic sand with occasional thin layers of olive silt and greenish calcareous claystone. Some horizontal calcareous sandstone concretions occur about 20 feet below the top of the unit. The unconsolidated nature of this formation allows rapid weathering to smooth sand slopes, and thus few natural exposures are available. The Valentine Formation ranges up to 200 feet in thickness in the mapped area.

Ash Hollow Formation Engelmann, 1876

The Ash Hollow Formation (Tpa), named for exposures in Ash Hollow Canyon, near Lewellen, Nebraska (about 150 miles southwest of the Okreek quadrangle), is light-tan to olive, medium- to fine-grained calcareous arkosic sandstone. Variations in the strength of cement cause three generalized zones to be recognizable in this unit. The lower zone is about 25 feet of well-cemented sandstone which weathers to a smooth olive to white surface. A poorly cemented middle zone weathers rapidly and tends to obliterate the underlying unit by slump. The upper zone is very well-cemented and forms the prominent caprock. The weathered surface is rough, and recesses and projections are common. Vertical root-like projections occur in abundance, and locally form box-work structures. Veins and root-like structures of calcium carbonate, called caliche, are abundant. The sandstone weathers white, but lichens generally give the surface a gray cast. This upper unit ranges up to 25 feet in thickness, and the total thickness of the formation is about 65 feet. Several feet of fine brown wind-blown quartz sand are generally present on top of the larger uplands that are underlain by the Ash Hollow Formation. Fossilized seeds and vertebrate bones are not uncommon in this formation.

Bijou facies Stevenson, 1953

The Bijou facies (Tb) of the Ogallala Group, originally named the Bijou Formation, is green coarse-grained conglomerate and green cross-bedded medium- to fine-grained quartzitic sandstone. The former lithology is composed of rounded quartz, chert, and feldspar pebbles. Fractures in the pebbles and some of the cleavage planes in the feldspar pebbles are stained green. The cement is siliceous and its strength varies, allowing prominent recesses and projections to develop upon weathering. The conglomerate has a maximum thickness of 20 feet, but is local. The quartzitic sandstone is composed of siliceous cemented quartz, feldspar, and green claystone grains. The cement is very strong, causing the sandstone to fracture across the individual grains in the manner of a true quartzite. Green color is present in both the individual grains and in the cement. The Bijou sandstone ranges up to 45 feet in thickness. It rests unconformably on the White River Group in the northern part of the Okreek quadrangle.

SUBSURFACE ROCKS

Information on rocks probably present in the subsurface of the Okreek quadrangle is based on General Crude #1 Vogt oil test, seven miles east of the quadrangle, the railroad wells at Mosher and Wood, and the Rosebud well in sec. 10, T. 39 N., R. 27 W., a quarter of a mile west of the quadrangle. Subsurface rocks include 950-1200 feet of Pierre shale at the top, 200 feet of Niobrara chalk, 200-250 feet of Carlile shale, 50 feet of Greenhorn limestone, 150-200 feet of Graneros shale, 150-250 feet of Newcastle sandstone-Skull Creek shale, 150-250 feet of Fall River-Fuson-Lakota sandstone and shale, 25-50 feet of Morrison? shale, 350 feet of Spearfish? shale, 200-250 feet of Minnelusa sandstone, 200 feet of Red River ("Whitewood") dolomite and 25-75 feet of Winnipeg sand and shale. Basement rock in the Okreek quadrangle is probably Precambrian granite, as shown by the Vogt well.

STRUCTURE

The sedimentary strata of the Okreek quadrangle are nearly flat-lying (see cross section A-A'). Although no distinct continuous beds exist on which a dip may be measured, the stripped plain formed on the claystone of the White River Group in the southeastern part of the quadrangle appears to have a slight dip to the south.

ECONOMIC GEOLOGY

Ground water is available in all parts of the quadrangle. Sand and gravel are available in terrace deposits. Thin limestone layers cap buttes in the west-central part of the quadrangle, and quartzitic sandstone caps buttes in the northwestern part. Bentonitic shale is present throughout the center of the area. Other potentially economic products are oil and gas.

Ground Water

Ground water adequate in amount for farm supplies is available throughout the quadrangle. Good quality water can be obtained from shallow wells penetrating the Tertiary sediments and the Quaternary alluvium and terrace deposits. Water obtained from the Pierre shale contains excessive alkali and is unsuitable for human consumption.

Sand and Gravel

Sand and gravel possibly suitable for road material are present in terrace deposits throughout the quadrangle. These deposits contain a high percentage of carbonate and argillaceous material and therefore should be used with caution. A limited amount of well-sorted quartz and chert gravel occurs at the base of the White River Group.

Limestone

The limestones of the Mellette facies cap several buttes in the west-central part of the area. These limestones range from 1 to 3 feet in thickness, are dense, fine-grained and relatively pure. The limestone could be stripped for road aggregate.

Quartzitic sandstone

The Bijou quartzitic sandstone caps a few buttes in the northwestern part of the quadrangle. This sandstone is hard and durable, and could be used for road metal. Its unusual color might make it desirable for monumental and ornamental stone.

Bentonite

Bentonitic sediments are characteristic of the lower part of the White River Group, and are present throughout the central part of the quadrangle. Bentonite is a potential source for sealing or bonding material.

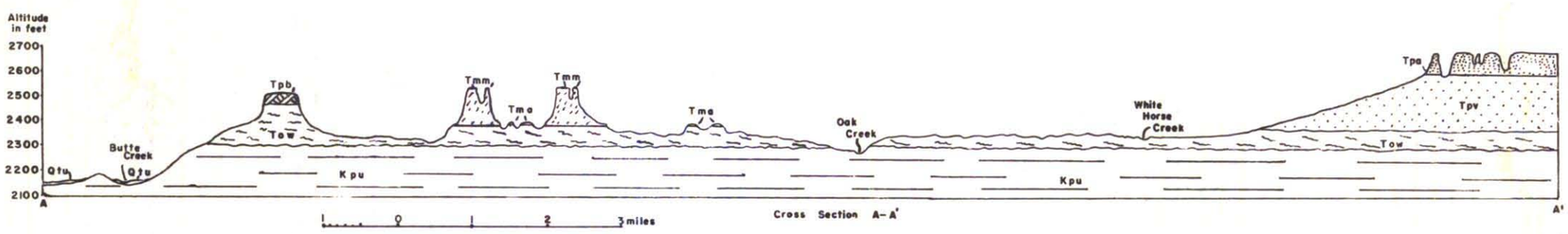
Oil and Gas

Gas has been produced from the "Lakota" sandstone near Pierre, and gas shows have been obtained in deep oil tests to the south and west of Pierre. In the Okreek quadrangle the "Dakota" sandstone lies at depths estimated to range from about 1800 feet at Wood to about 2300 feet in the southeastern corner of the quadrangle. No structures favorable for prospecting are apparent in the area. Potentially productive deep zones, the "Whitewood" dolomite and Winnipeg sandstone, are probably present in the subsurface at depths up to 1000 feet or more below the top of the Lakota.

REFERENCES CITED

Agnew, A. F., 1957, Geology of the White River quadrangle: South Dakota Geol. Survey, Geol. Quad., map and text.

Searight, W. V., 1937, Lithologic stratigraphy of the Pierre Formation of the Missouri Valley in South Dakota: South Dak. Geol. Survey, Rept. Invest. 27, 63 p.



Cross Section A–A'