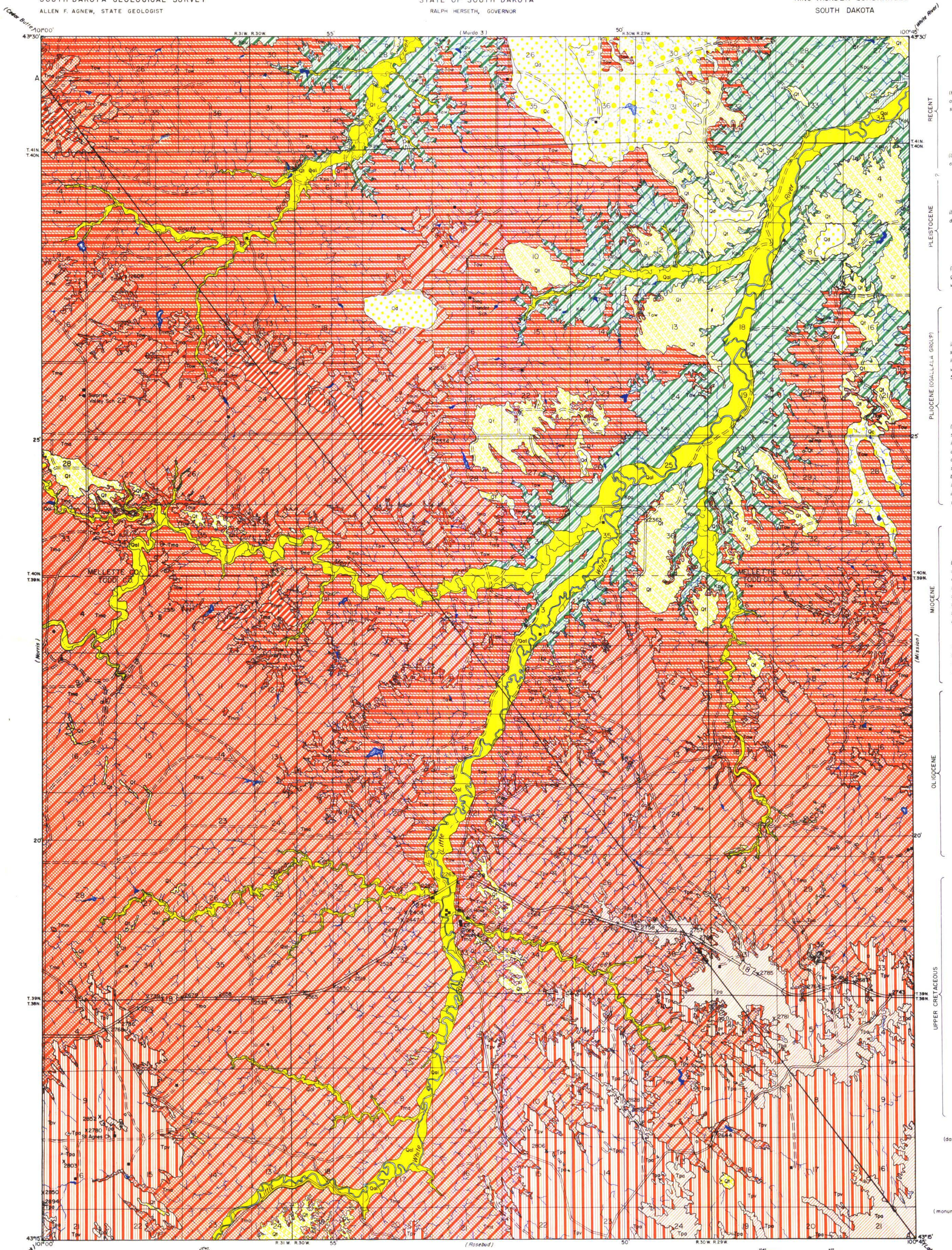
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the RING THUNDER QUADRANGLE SOUTH DAKOTA



EXPLANATION

QUATERNARY

RECENT

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

Qc — Colluvium
(Loose deposits of silt and sand, on gentle slopes.)

PLEISTOCENE

Qd — Dunesand
(Eolian deposits of quartz sand; in dunes and blowouts on uplands.)

Qt — Terrace Deposits
(Fluvial deposits of silt, sand, and gravel; about 175 feet above present valleys of major streams.)

UNCONFORMITY

TERTIARY

PLIOCENE (OGALLALA GROUP)

Tpa — Ash Hollow Formation
(Light-tan to light-gray calcareous sandstone with abundant caliche, locally with boxwork structure; weathered surface gray, about 50 feet thick.)

Tpv — Valentine Formation
(Unconsolidated tan to olive-gray sand with feldspathic and garnetiferous gravel in the lower part; a 5- to 10- foot thick light-gray calcareous ledge-forming sandstone, 0-26 feet above the base; brownish to flesh-colored fossiliferous limestone, ½ to 1 foot thick, in upper part; thickness of formation is 0 to 110 feet.)

UNCONFORMITY

MIOCENE

Tmm, Tma — Arikaree Group
(Basal brownish-gray siliceous sandstone, 1 inch to 1 foot thick, and brownish siliceous wormy siltstone; somewhat porous pink silicified claystone and pink very fine-grained poorly cemented sandstone, with patches of pink montmorillonite; thickness of formation 175 to more than 350 feet; Tmm- Mellette facies, flesh-colored fine-grained dense fossiliferous limestone, weathers white, ½ to 3 foot thick ledges at 25 and 90 feet above base of Arikaree.)

OLIGOCENE

Tow — White River Group
(Undifferentiated)
(Chadron formation, below-basal white quartz and chert gravel; greenish-yellow bentonitic clay and claystone, with peaball pellets, 8 to 35 feet thick. Brule formation,- Lower unit: Banded pinkish to grayish laminated clayey siltstone and calcareous light-gray sandstone, weathers to stair-step profile; 115 feet thick. Upper unit: pinkish to olive bentonitic clay and white to gray wormy siltstone; weathers to rounded humps; about 70 feet thick: total thickness of White River group (193-220 feet))

UNCONFORMITY

CRETACEOUS

UPPER CRETACEOUS

Kpu — Upper Pierre Unit
(Gray to black calcareous marine shale (below) and light-gray to brownish silty shale (above); minute gypsum crystals common along bedding planes and veins, iron sulfate minerals common; thin layers of green bentonite and argillaceous limestone concretions, yellow-brown to purple bentonitic weathered zone at top; erosional unconformity at top with relief of 0-30 feet; thickness of unit 210-230 feet.)

Kpl — Lower Pierre Unit
(Medium- to dark-gray calcareous bentonitic marine shale; weathers to clayey mass; upper part has 3 layers of lenticular dark-gray argillaceous limestone concretions; thickness of unit in the quadrangle about 85 feet.)

Geologic Contact
(dashed where approximately located)

Gravel Pit

Quarry

x BM 2605
Bench Mark
(monument showing exact altitude above sea level)

x 2730
Spot Altitude

House, School, and Church

Geology by W. D. Sevon, 1959
Assisted by Joan J. Sevon

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

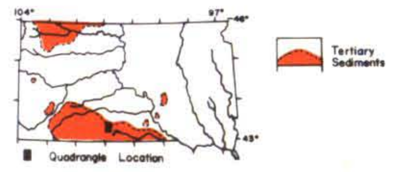
Drafted by H. D. Wong, 1959

APPROXIMATE MEAN DECLINATION, 1959

Scale 1:62 500

1 ½ 0 1 2 3 4 Miles

Vermillion, South Dakota
1960

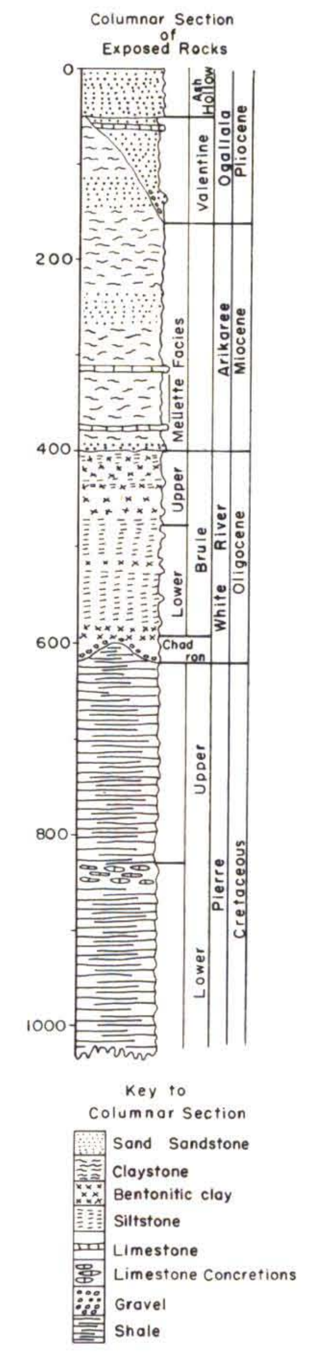


RING THUNDER QUADRANGLE

GEOLOGY OF THE RING THUNDER QUADRANGLE

by
W.D.SEVON

Columnar Section of Exposed Rocks



INTRODUCTION

The Ring Thunder quadrangle includes about 218 square miles in the south-central part of Mellette County and the adjoining part of north-central Todd County, South Dakota.

The quadrangle, in the Missouri Plateau section of the Great Plains physiographic province, is in the region of outcropping Tertiary continental deposits in the south-central part of the State. The topography of the quadrangle is controlled almost entirely by the Little White River and its numerous tributaries, which have created an intricate system of ridges and valleys. The Little White River, with a gradient of about 11 feet per mile, flows northeastward across the center of the quadrangle, and is joined by Soldier Creek (south-central part of the map), Ti-Shena-Ze Creek (south-central part), and Cut Meat Creek (central part). South Branch Pine Creek originates in the northwestern part of the quadrangle and flows northeastward to join the Little White River near the town of White River (about 5 miles north of the northeastern corner of the quadrangle). The deep dissection in the south half of the area creates a local relief of up to 350 feet. Maximum relief in the quadrangle is about 800 feet. There are no settlements in this sparsely populated area. U. S. Highway 18 crosses the southern part of the quadrangle, and an unnumbered paved road runs southward from Highway 18 to Rosebud, near the eastern border of the area. A few unsurfaced roads serve the area, but much of the quadrangle can be reached only by trail. The climate is characterized by a wide temperature range, an average annual rainfall of 17 inches, and by strong winds. Raising of cattle and small grains are the chief sources of income for the area.

The geology was mapped during the summers of 1958 and 1959 under the supervision of Dr. Allen F. Agnew, State Geologist, with the geologic assistance of Mrs. Joan Johnson Sevon in 1958 and Cecil Harris in 1959.

SURFICIAL DEPOSITS

Unconsolidated deposits associated with present drainage are separated into three main groups: (1) alluvium in present stream valleys, (2) colluvium, and (3) high level terrace deposits along present stream courses. Dune sand is present in small amounts.

Alluvium(Qal) consists of silt, sand, and gravel which resulted from reworking by streams of older bedrock and surficial deposits, and is confined to present stream valleys. The material comprising the alluvium is predominantly of local origin, having been derived from the bedrock of the area. The alluvium is seldom more than 10 feet thick, and probably averages about 4 feet in thickness. Although alluvium is present along the Little White River, the stream bed is on bedrock.

Colluvium (Qcl) consists of loose sand and silt, and was formed in part by reworking of terrace deposits, and in part by gravity movement downslope.

Terrace deposits (Qt) are clay, silt, sand, and gravel. The deposits occur about 175 feet above the floor of the Little White River valley and at lesser elevations above the floors of smaller tributary valleys; generally the terraces in the tributaries are at least 50 feet above the floor of their valleys. The deposits present along the Little White River consist generally of half a foot to a foot of gravel, overlain by 5 to 10 feet of sand and silt. The gravel is composed of well-rounded siltstone, sandstone, limestone, quartz, and igneous pebbles, generally less than 1 inch in diameter, but locally as large as 4 inches. The terrace deposits along the tributaries have similar gravels, little or no sand, and are generally less than 1 foot thick. Gravels in some small terrace deposits (secs. 14, 22, 23, and 26, T. 39 N., R. 30 W.) are derived entirely from gravels which occur in the lower part of the Valentine Formation; these gravels are composed of well-rounded quartz, feldspar, and igneous pebbles.

Dune sand (Qds) is loose very fine- to medium-grained, sub-rounded to well-rounded quartz sand. The sand grains are predominantly frosted. The dune sand areas are characterized by knob and depression topography, sand blowouts, and yucca plants.

EXPOSED SEDIMENTARY ROCKS

Tertiary fluviatile and lacustrine deposits of Oligocene, Miocene and Pliocene age are present throughout the quadrangle, except in the northeastern part where the Pierre shale, a marine deposit of Cretaceous age, is exposed along the Little White River and some of its tributaries. The Oligocene White River strata are silty claystones, siltstones, sandstones, gravels and bentonitic clays; the Miocene Arikaree strata are claystones, sandstones, and limestones; the Pliocene Ogallala strata are unconsolidated sands, sandstones, gravels, conglomerates and limestones.

Pierre Formation, Meek & Hayden, 1862.

The Pierre Formation, named from exposures near Ft. Pierre (70 miles northeast of the quadrangle), is exposed along the Little White River and some of its tributaries in the northeastern part of the quadrangle. In the Ring Thunder quadrangle, the Pierre Formation 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 units used by Agnew (1957).

Lower Pierre Unit

The lower Pierre unit (Kpl) is medium- to dark-gray calcareous bentonitic shale that weathers light gray. The shale is blocky where fresh, but weathers first to thin flakes and finally to a structureless clay mass. The upper part of this unit is marked by 3 layers of lenticular dark-gray argillaceous limestone concretions which range up to 2 feet in diameter. The layers are separated from each other by about 2 feet of shale. The concretions commonly contain as cores the cephalopod Baculites, and individual Baculites specimens occur locally within the shale. About 85 feet of this lower Pierre unit is exposed in the Ring Thunder quadrangle.

Upper Pierre Unit

The upper Pierre unit (Kpu) is gray to black calcareous shale (below) and light-gray to brownish silty shale (above). The lower part of this unit is a dark-gray to black calcareous bentonitic blocky shale which weathers light gray. Minute gypsum crystals are common along the bedding planes, as are white calcareous spots which may be crushed foraminiferal shells. The upper part of this unit is light-gray to brownish calcareous to non calcareous blocky to thin-bedded shale which weathers light gray to yellowish brown, with some rust-colored iron sulfate staining. Thin layers of greenish bentonite occur in the upper part of this unit, as do several thin (1 to 2 inches thick) layers of dark-gray argillaceous limestone concretions. Small gypsum crystals and iron sulfate minerals are present along the bedding planes and in veins throughout this unit. A placer of thin limonitic plates locally covers slopes developed on this shale. The top is marked by a 10- to 15-foot weathered zone (Interior Formation of Ward, 1922) of light-gray to yellowish-brown to reddish to purple bentonitic shale, and an erosional surface having a relief of as much as 30 feet. The upper Pierre unit is 210 to 230 feet thick in the Ring Thunder quadrangle.

White River Group, Meek & Hayden, 1858.

The White River Group, exposed in the northern half of the quadrangle, includes the Chadron (below) and Brule Formations. The group is a series of clays, siltstones, and sandstones, with a basal gravel, which appear to be unfossiliferous.

Chadron Formation, Darton, 1899.

The Chadron Formation, named from exposures near Chadron, Nebraska (120 miles southwest of the Ring Thunder quadrangle), is greenish-yellow bentonitic clay and claystone, white silt and sand, and gravel. The basal part of the formation contains 1 to 13 feet of sand and gravel. The sand is very fine- to coarse-grained sub-angular to well-rounded white quartz, and is locally slightly cemented with silica. The gravel is composed of well-rounded and well-polished quartz, chert, and igneous pebbles ranging from one-fourth of an inch to 3 inches in diameter, and averaging about three-fourths of an inch. The gravel occurs as layers within the sand, and locally shows steep cross-bedding. The basal sands and gravels are commonly overlain by 1 to 5 feet of grayish-white silt and clay. This silt-clay layer grades upward into a grayish-green to yellowish-green bentonitic silicified claystone containing small pea-ball pellets. This silicified claystone locally forms a resistant ledge and a waterfall caprock in several tributary valleys on the east side of the Little White River. Where the resistant ledge is absent, a greenish-gray bentonitic clay occurs locally at the same zone. This clay weathers into rounded humps. A layer of thin (1-2 inches) lenticular gray limestone concretions is locally present at the top of this clay. The top of the Chadron Formation is marked by the top of the resistant claystone where present, the limestone concretion layer where present, and by a slight color change from light greenish gray (below) to light pinkish gray in the clays and silts. The Chadron Formation is 8 to 35 feet thick in the Ring Thunder quadrangle. This small thickness of the Chadron Formation, and the difficulty of locating the Chadron-Brule contact, because of slope wash and vegetative cover, made it necessary to map the two formations together (Tow).

Brule Formation, Darton, 1899.

The Brule Formation, named for the Brule Indians in southern South Dakota, can be sub-divided in the Ring Thunder quadrangle into two lithologic units similar to those recognized by Agnew (1957) in the White River quadrangle. The lower unit is mainly banded pinkish to grayish laminated clayey siltstone, and thin layers (½-1 foot) of hard calcareous light-gray to white siltstone. Some gray poorly cemented fine-grained quartzose sandstone and pinkish bentonitic claystone are present. Veinlets of white chalcedony are locally present. The clayey siltstone weathers into vertical faces, and the harder siltstones and sandstones form ledges which project slightly, giving a stairstep appearance. The lower unit of the Brule is about 115 feet thick. The upper unit is pinkish to olive bentonitic clay and white to gray siltstone which weathers to a wormy appearance. The bentonitic clays occur as beds up to 27 feet thick, weather into smooth rounded humps similar to those of the Chadron Formation, and are separated by the wormy siltstones. The wormy siltstones vary from calcareous to non-calcareous, and locally grade imperceptibly into the somewhat coarser brownish siliceous siltstones of the overlying Arikaree Group. The upper unit of the Brule is about 70 feet thick in the Ring Thunder quadrangle.

Arikaree Group, Darton, 1899.

The Arikaree Group (Tma), named for the Arikaree Indians of western Nebraska, overlies the White River strata in all but the northeastern part of the quadrangle. The strata here described as the Arikaree Group are the same as those named the Rosebud beds by Matthew and Gidley (1904), 10 miles to the south. Lugn (1939) states that the Rosebud beds are equivalent in age to the Gering, Monroe Creek, and Harrison Formations of the Arikaree, and to at least the lower part of the Marsland Formation of western Nebraska. J. C. Harksen and Dr. J. R. Macdonald (personal communications, 1959) believe that the Rosebud lithology in the vicinity of the Rosebud Indian Agency can be traced 75 miles westward to sediments present above the Harrison Formation in the vicinity of Wounded Knee, S. Dak., and that this material is the age equivalent of the Marsland Formation. The writer feels that more study of this problem is necessary before positive correlation can be made, and prefers to map the sediments as undifferentiated Arikaree.

The Arikaree Group in the Ring Thunder quadrangle is mainly a somewhat porous pink silicified claystone and pink very fine-grained poorly cemented sandstone. The base of the Arikaree is marked locally by a fine- to medium-grained siliceous brownish-gray sandstone that is composed mainly of quartz, and contains coarse grains of pink clay which weather out, producing a pitted surface. This sandstone ranges from 1 inch to 1 foot in thickness. Where this basal sandstone is absent (and locally below the sandstone where it is present), the base of the Arikaree is marked by a brownish siliceous siltstone which weathers to a wormy appearance, and locally grades imperceptibly downward into the lighter colored White River siltstones. The wormy appearance is due to the more rapid weathering of irregular clay masses in the siltstone. The Arikaree siltstones are less wormy in appearance and are darker in color than the underlying White River siltstones. An impure flesh-colored laminated limestone which weathers white (sec. 21, T. 40 N., R. 30 W.) and a calcareous cross-bedded channel sand and gravel (sec. 32, T. 40 N., r. 30 W.) also mark the base locally. The basal gravel is composed of sub-angular to rounded quartz, siltstone, and claystone grains which range in size from fine sand to fine gravel. Most of the Arikaree Group north of U. S. Highway 18 is a somewhat porous pink silicified claystone containing patches of pink montmorillonite. The claystone weathers to a smooth steep pinkish surface which lacks the stairstep appearance of the underlying White River strata. South of U. S. Highway 18 the claystone is interbedded with thick (up to 60 feet) layers of poorly cemented very fine-grained pink sandstone which contains isolated patches and veins of pink montmorillonite. This sandstone weathers to a somewhat lighter color than the claystone, but still has a slight pinkish color. Locally, the upper part of this formation contains a loosely cemented very fine-grained light-gray calcareous sandstone that contains nodular concretions. The concretions are composed of the same type of sand as the enclosing unit, and are apparently the result of more complete cementation. The total thickness of the Arikaree Group (including the Mellette facies described below) in the Ring Thunder quadrangle exceeds 350 feet south of U. S. Highway 18, but is only about 175 feet thick north of U. S. Highway 18. The Arikaree Group is unconformably overlain in the southeastern and southwestern parts of the quadrangle by the Pliocene Ogallala Group.

Mellette facies, (Agnew, 1957)

The Mellette facies (Tmm) of the Arikaree Group, named for exposures near Mellette triangulation station, Mellette County, South Dakota, (about 7 miles east of the northeastern corner of the Ring Thunder quadrangle) is present in the northwestern quarter of the quadrangle. The Mellette is a flesh-colored dense fossiliferous limestone containing veins and isolated crystals of calcite, and local dendrites of manganese oxide. The limestone weathers to a brilliant white. Abundant gastropod shells composed of silica and calcite are common, but attempts to remove them from the limestone for identification have not been successful. Irregularly shaped masses of silica are also present. The siliceous masses and the gastropod remains project slightly from weathered surfaces. The lime occurs at about 25 and 90 feet above the base of the Arikaree Group and each zone varies from 6 inches to 3 feet in thickness. The upper limestone is extensive and caps numerous buttes in the northwestern quarter of the quadrangle, whereas the lower limestone occurs only as a thin remnant in the east-central and extreme northwestern part of the quadrangle.

Ogallala Group, Darton, 1899.

The Ogallala Group, exposed in the uplands of the southeastern and southwestern parts of the quadrangle, includes the Valentine (below) and Ash Hollow Formations. The Ogallala Group is a series of fluviatile sands, gravels, sandstones, and limestones. These sediments were deposited on a Miocene erosion surface having a relief of about 100 feet.

Valentine Formation, Barbour & Cook, 1917

The Valentine Formation (Tpv), named for exposures near Valentine, Nebraska (40 miles southeast of the quadrangle), is unconsolidated tan to olive-gray compact fine- to medium-grained feldspathic sand, and light-gray calcareous fine- to medium-grained feldspathic sandstone. The base of the Valentine Formation is marked locally by an unsorted garnetiferous, feldspathic sand and gravel. This sand and gravel is locally cemented with calcite. The pebbles are well rounded, low in sphericity, and average 1 inch in diameter. Most exposures of this gravel yield vertebrate bones and teeth, which have been identified by Dr. J. R. Macdonald as early Pliocene in age; this gravel is similar in lithology, and correlates faunally with the gravel in the Mission gravel pit (sec. 35, T. 40 N., R. 28 W., Mellette County, South Dakota). Where exposed along or near U. S. Highway 18 in the southeastern part of the quadrangle, this gravel marks the base of the Valentine Formation; farther south, along Soldier Creek, its position ranges from the base to 20 feet above the base. The rest of the Valentine Formation is predominantly unconsolidated tan to olive fine- to medium-grained compact feldspathic sand which locally contains thin layers of greenish bentonitic clay in the lower part, and elongate irregularly shaped calcareous concretions varying from 2 inches to 3 feet in length, near the base and near the top of the formation. A light-gray calcareous fine- to medium-grained feldspathic sandstone occurs along the Soldier Creek drainage, and forms a consistent ledge 5 to 10 feet thick. Except for generally considered to be characteristic of the Ash Hollow Formation by the South Dakota State Geological Survey. A brownish to flesh-colored lithographic to silty brittle limestone occurs locally (sec. 2, T. 38 N., R. 30 W.) in the upper part of the Valentine Formation (25 feet above the cemented zone), and may mark the base of the Ash Hollow Formation. The limestone weathers to a brilliant white color. Abundant fossil gastropod shells are present in the limestone. These shells are larger than those found in the Mellette facies (page 9), and appear to be original shell remains whereas the Mellette shells have been replaced by calcite and silica. Large masses of greenish translucent silica which alter to white during weathering, dendrites of manganese oxide and liesegang rings (circular rings which indicate rhythmic precipitation as in a gel) are also present in the limestone. The limestone varies from 6 inches to 1 foot in thickness. The Valentine Formation ranges up to 100 feet in thickness in the southeastern part of the quadrangle, and is about 110 feet thick in the southwestern part. The large variation in the southeastern part is due to the unconformity at the top of the Arikaree Group. In Sec. 31, T. 39 N., R. 29 W., the Valentine Formation was not deposited because of an Arikaree topographic high, and the Ash Hollow Formation rests directly on the Arikaree. The Valentine Formation thickens considerably to the south.

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 Ring Thunder quadrangle), is light-tan to light-gray fine- to medium-grained calcareous feldspathic sandstone, containing abundant veins and root-like structures of caliche (calcium carbonate). The caliche material is more resistant to weathering than the rest of the sandstone, and a very rough weathered surface develops. Where they are well developed, root-like cemented areas with caliche cores the cementation, this sandstone is lithologically similar to the unconsolidated Valentine sand, although the presence of cement in the Ogallala sediments is form an intricate mass called "boxwork". The Ash Hollow caps the highest elevations in the quadrangle, and locally forms a prominent ledge. Where well developed, the ledges are gray in color, owing to the black and gray lichens covering the surface. Small round fossil fruits of the hackberry tree, Celtis willistoni are found occasionally in the Ash Hollow Formation. The Ash Hollow Formation is about 50 feet thick in the Ring Thunder quadrangle.

SUBSURFACE ROCKS

Rocks probably present in the subsurface of the Ring Thunder quadrangle, based on a well drilled near the border (English #1 Kocer, SW¼SW¼SW¼ sec. 30, T. 37 N., R. 36 W.), include about 1800 feet of Pierre shale, 200 feet of Niobrara chalk, 320 feet of Carlile shale, 60 feet of Greenhorn limestone, 275 feet of Belle Fourche-Mowry shales, 210 feet of Morrison-Sundance(?) shales and sands, 55 feet of Opeche(?) shale, and 205 feet of Minnelusa sandstone and shale. The basement rock in the Ring Thunder quadrangle is probably granite, which underlies the Minnelusa.

STRUCTURE

Sedimentary strata in the Ring Thunder quadrangle are flat-lying. The Arikaree Formation thickens greatly to the south (see cross section A-A') suggesting that some dip may have existed on the pre-Miocene depositional surface.

ECONOMIC GEOLOGY

Ground water is available in all parts of the quadrangle. Sand and gravel are present in some terrace deposits, in the lower Valentine gravels, and in the basal Chadron gravels. Thin limestone layers are present in the northwestern part of the quadrangle. Bentonitic sediments are present in the northern half of the quadrangle.

Ground Water

Ground water adequate in amount for farm supplies is available throughout the quadrangle. Water of good quality can be obtained from shallow wells penetrating the Tertiary sediments and some of the Quaternary terrace deposits. Wells drilled into the White River strata may go dry during very dry years, but wells deriving water from Arikaree sediments are generally productive then. Adequate quantities of water of good quality can be obtained from wells in the Ogallala sediments, if 100 feet or more of the Ogallala is penetrated. Springs occur locally at the Ogallala-Arikaree contact because of the distinct change in permeability between the two lithologic units. The thickening of both the Ogallala and Arikaree sediments to the south suggests that the ground water in both formations flows slightly to the south. Terrace deposits with large thicknesses of sand may yield small quantities of water of good quality if they are not close to the Pierre shale. Water obtained from the Pierre shale contains excessive alkali and is unsuitable for human consumption.

Chemical analyses of water samples from wells drilled into White River and Arikaree sediments are given in Table 1. The U. S. Public Health Service (1946) states that in water for domestic use, the following chemical substances should not exceed the stated concentrations:

	Parts per Million
Iron and Manganese together	0.3
Magnesium	125
Chloride	250
Sulfate	250
Total Solids	500

(1,000 ppm total solids is acceptable if better water is not available)

Hardness, reported as $CaCO_3$, is rated as follows:

Parts per Million	Hardness	Comments
0- 60	Soft	Suitable for all domestic uses
61-120	Moderately hard	
121-200	Hard	May require softening process

In samples 1 and 2, the large amount of sodium (Na) in relation to the small amount of calcium (Ca) is notable. This relationship is probably the result of sodium in the water replacing calcium in the bentonites of the White River sediments, thereby increasing the amount of sodium in solution and decreasing the amount of calcium.

Sand and Gravel

Sand and gravel suitable for road material is present in the gravel deposits of the Valentine Formation. The gravel is composed chiefly of quartz and feldspar, and ranges in size up to 3 inches in diameter (averaging 1 inch). Three gravel pits have been quarried. The variation in thickness and lateral extent of the gravel make detailed exploration imperative before any quarrying operation is attempted. Limited quantities of well-sorted quartz and chert gravel are present at the base of the White River strata. Terrace deposits in the quadrangle generally have small amounts of gravel, but thick sand overburden.

Limestone

The limestones of the Mellette facies are present in the northwestern part of the quadrangle. These limestones range from 6 inches to 3 feet in thickness, are dense, fine-grained, and relatively pure. The limestone could possibly be economically quarried for road aggregate.

Bentonite

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

Table 1.--Chemical Analyses of Representative Water Samples

Sample	Farm Name and Location	Probable Source Material	Parts Per Million									
			Sulfate (SO_4)	Chloride (Cl)	Calcium (Ca)	Magnesium (Mg)	Alkalinity*	Hardness ($CaCO_3$)	Iron (Fe)	Manganese (Mn)	Sodium (Na)	Total Solids
1	Harold Krogman(1), NE, NW, Sec. 22, T. 40N., R. 30W	Tow	109	44	30	2	364 38	82	None	None	195	690
2	Harold Krogman(2), NE, NW, Sec. 22, T. 40N., R. 30W	Tow	112	67	13	None	348 36	31	None	Trace	227	778
3	Arnold Scott, NW, SW, Sec1 T. 38N., R. 31W	Tma	21	2	42	None	15 151	103	6.4	Trace	30	228
4	Francis Bristow, SW, Sec. 31 T. 39N., R. 29W	Tma	17	5	54	None	22 169	129	Trace	None	29	298

*Alkalinity expressed as: Methyl Orange
Phenolphthalein

Analyses by State Chemical Laboratory, Vermillion, 1960.

REFERENCES CITED

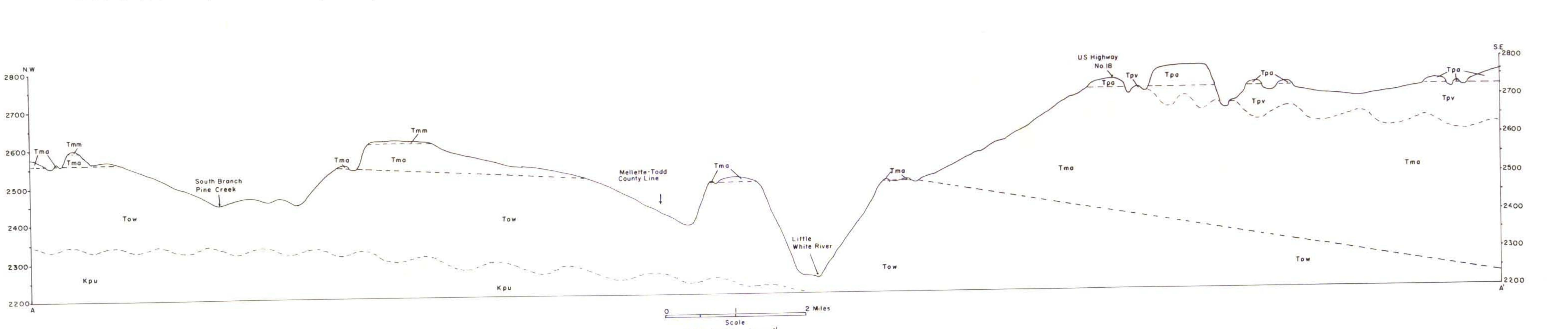
Agnew, A. F., 1957, Geology of the White River Quadrangle: South Dakota Geol. Survey, Geol. Quad., map and text.

Lugn, A. L., 1939, Classification of the Tertiary System in Nebraska: Bull. Geol. Soc. America, v. 50, p. 1245-76.

Matthew, W. D. and Gidley, J. W., 1904, New or Little Known Mammals from the Miocene of South Dakota: Bull. Amer. Mus. Nat. Hist. 20, p. 241-246.

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

U. S. Public Health Service, 1946, Drinking Water Standards: Reprint No. 2697, 14 p., from Public Health Reports, v. 61, no. 11, p. 371-384.



Cross Section A —— A'