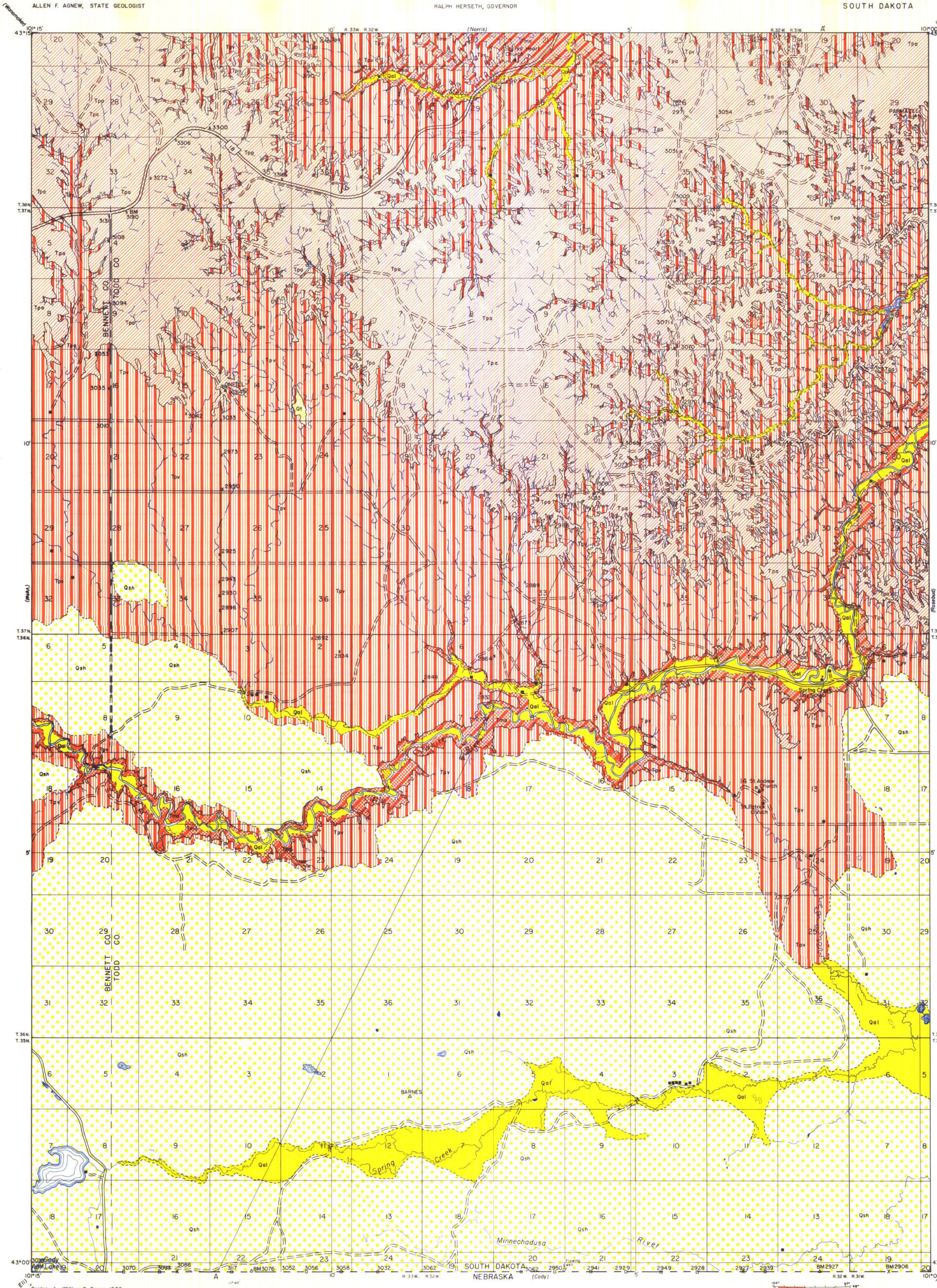
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the SPRING CREEK QUADRANGLE SOUTH DAKOTA



EXPLANATION

QUATERNARY

RECENT

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

Qt — Terrace Deposits
(Fluvial deposits of silt, sand, and gravel; about 15 feet above present valleys of smaller streams.)

PLEISTOCENE

Qsh — Sand Hills Formation
(Unconsolidated fine- to medium-grained sand; mainly well rounded frosted quartz grains with some feldspar; characterized by dunes and blowouts, local relief exceeds 100 feet.)

UNCONFORMITY

TERTIARY

PLIOCENE (OGALLALA GROUP)

Tpa — Ash Hollow Formation
(Greenish-gray to light-gray calcareous sandstone with abundant caliche and local boxwork structure; basal limestone, or limey sandstone overlain by 1-4 feet of volcanic ash; flesh-colored limestone about 35 feet above; thickness of formation 95-150 feet.)

Tpv — Valentine Formation
(Unconsolidated greenish-gray to brownish fine- to med.-grained feldspathic sand with zones of cement near the top; basal coarse sand or fine gravel and volcanic ash; top is greenish-gray sand with scattered caliche; thickness of formation about 90 feet.)

UNCONFORMITY

MIOCENE

Tma — Arikaree Group
(Porous pink silty claystone and very fine-grained poorly cemented pinkish-buff sandstone; patches of pink montmorillonite throughout; a zone of nodular sandstone concretions about 30 feet below top; about 70 feet of formation exposed.)

Contact
(dashed where approximately located)

Gravel Pit

X BM 3190
Bench Mark
(monument showing exact altitude above sea level)

X 3092
Spot Altitude

△ ONEILL
Triangulation Station
(monument marking exact geographic location)

House, School, and Church

Geology by William D. Sevon, 1959
Assisted by Cecil Harris and Eldon J. Hovelsrud

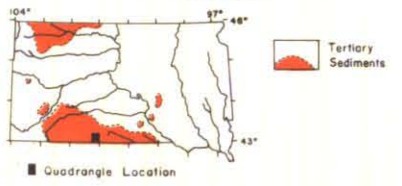
Vertical and horizontal control surveyed from triangulation and level lines of Federal surveys.

Map drafted by Bruno C. Petsch, 1960

Approximate Mean Declination, 1959

Scale 1:62,500

Vermillion, South Dakota
1960



GEOLOGY OF THE SPRING CREEK QUADRANGLE

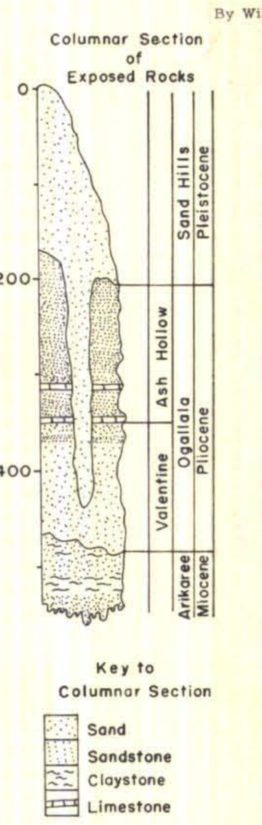
by

W. D. SEVON

GEOLOGY OF THE SPRING CREEK QUADRANGLE

By William D. Sevon

Columnar Section of Exposed Rocks



INTRODUCTION

The Spring Creek quadrangle includes about 218 square miles in the southwestern part of Todd County and the adjoining part of southeastern Bennett 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. Two contrasting physical settings exist in the Spring Creek quadrangle: a dissected remnant of the high plains in the northern half, and sand hills in the southern half. A northwest-trending ridge of high plains sediments is being dissected by the Little White River and its numerous tributaries. Steep-sided valleys on all but the southwestern side of the ridge make the area somewhat rugged, with local relief up to 350 feet and maximum relief of about 600 feet. The sand hills area is characterized by sand dunes, blowouts, and a complete lack of drainage. Local relief in the sand hills area exceeds 100 feet, and maximum relief is about 250 feet. The Little White River flows eastward across the center of the quadrangle to within a mile of the eastern border, where it turns to the northeast and flows out of the quadrangle. Through the central part of the quadrangle, the Little White River valley averages 600 to 700 feet wide and 150 feet deep. Spring Creek flows eastward through a broad valley across the southern part of the quadrangle. About 1/4 mile from the eastern border the broad valley turns and continues to the southeast, while Spring Creek turns and enters a steep narrow northwest - trending valley. Spring Creek joins the Little White River near the center of the quadrangle. The narrow valley of the eastward flowing Minnechadusa River enters the aforementioned broad valley about 2 miles southeast of the point where Spring Creek turns to the northwest (about 1½ miles east of the quadrangle). The relationship of the broad valley to Spring Creek and the Minnechadusa River suggests that Spring Creek once flowed southeastward through the broad valley, but has since been captured by a tributary of the Little White River, because of the steeper gradient of the latter. Upper Cut Meat Creek originates in the north-central part of the quadrangle, and flows northward.

U. S. Highway 18 crosses the northwestern corner of the quadrangle. The rest of the quadrangle is served by trails and a few graded roads in the west-central and east-central parts. Spring Creek Day School is the only settlement in the area. The climate is characterized by a wide temperature range, an average annual rainfall of 18 inches, and strong winds. The raising of cattle, sheep, and small amounts of small grains are the chief sources of income in the area.

The geology was mapped during the summer of 1959 under the supervision of Dr. Allen F. Agnew, State Geologist, with the geologic assistance of Cecil Harris and Eldon J. Hovelsrud.

SURFICIAL DEPOSITS

Unconsolidated deposits associated with the present drainage are separated into two groups: (1) alluvium in present stream valleys, and (2) terrace deposits along present stream courses. Unconsolidated dune sand of the Sand Hills Formation is present in the southern half of the quadrangle.

Alluvium (Qal) consists of silt, sand, and small amounts of gravel, which resulted from stream reworking of older bedrock and surficial deposits. The alluvium averages about 4 feet in thickness, but local deposits along the Little White River exceed 10 feet. Many of the small tributaries contain alluvium, which is unmapped because of the small width of the deposits.

The only mapped terrace deposit (Qt) is in sec. 13, T. 37 N., R. 33 W. The deposit consists of 1 foot of gravel, overlain by 1 to 5 feet of sand. The gravel is composed of sandstone and limestone pebbles that average 1 inch in diameter. Traces of gravel occur along several streams in the central part of the quadrangle, and along Upper Cut Meat Creek, but none are large enough to be mapped.

The Sand Hills Formation (Qsh) is unconsolidated fine- to medium-grained rounded to well-rounded frosted sand. The sand is composed mainly of quartz with some feldspar and other dark minerals. Dunes and blowouts characterize the topography of the Sand Hills Formation. Some dunes have been dissected and show steep cross-bedding. Yucca plants are normally found on the dunes, and increase in number toward Nebraska. A few large blowouts have intersected the ground water table, and have become stabilized by the moisture; some of these blowouts contain small ponds. Grass cover on both the dunes and blowouts is good, thus preventing present movement of the sand. The Sand Hills Formation is composed of sand derived from Pliocene Ogallala sediments during the Pleistocene epoch.

EXPOSED SEDIMENTARY ROCKS

Arikaree Group, Darton, 1899

The Arikaree Group (Tma), named for the Arikaree Indians of western Nebraska, is exposed along the sides of the Little White River valley throughout 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 northeast. 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 is somewhat porous pink silty claystone and very fine-grained poorly cemented pinkish-buff sandstone. The claystone contains patches of pink montmorillonite, and occasional small ball-like structures which show brown and white concentric rings when broken. The claystone weathers to a very light-pinkish buff color with a smooth, steep slope. The sandstone is apparently interbedded with the claystone and occurs at various levels below the top of the group. The sandstone, where exposed in contact with the overlying Valentine Formation, has a zone of calcareous nodular sandstone concretions about 30 feet below the contact. These concretions range from 1 to 6 inches in diameter, and are the result of local cementation. Isolated patches of pink montmorillonite are also present in the sandstone. The contact between the Arikaree Group and the overlying Valentine Formation is normally obliterated by slopewash of sand from the Valentine. About 70 feet of Arikaree is exposed in the quadrangle.

Ogallala Group, Darton, 1899.

The Ogallala Group, exposed throughout the northern half of the quadrangle, includes the Valentine (below) and the Ash Hollow Formations. The Ogallala Group is a series of fluviatile sand, gravels and sandstones with lime, limestone, and volcanic ash layers. These sediments were deposited on a relatively flat Miocene erosion surface.

Valentine Formation, Barbour & Cook, 1917.

The Valentine Formation (Tpv), named for exposures near Valentine, Nebraska (40 miles southeast of the quadrangle), is mainly unconsolidated calcareous-cemented to very fine- to medium-grained greenish gray to tan feldspathic sand. The base of the unit is normally marked by a very coarse-grained feldspathic sand or a fine-grained feldspathic gravel. The basal gravel is composed of quartz, feldspar, and igneous pebbles averaging 3/4-inch in diameter, and is locally cemented with calcite. Vertebrate bones and bone chips are locally present in this basal unit. The stratigraphic relationships of this gravel have been established by the writer in the Ring Thunder area, a few miles to the northeast (Sevon, 1960). The basal unit is normally overlain by about 12 feet of very fine- to medium-grained light-gray to reddish-brown feldspathic sand which locally contains thin layers of white-weathering greenish bentonitic clay in the lower part. A 1- to 4-foot layer of silver-gray volcanic ash normally overlies the sand unit. The ash is composed of minute angular glass shards. Locally, the ash grades upward into a sand similar to that below the ash, and shows signs of having been reworked by stream action. The remainder of the Valentine Formation is mainly unconsolidated greenish-gray to brownish fine- to medium-grained feldspathic sand. A cemented zone occurs locally near the top of the formation. In sec. 2, T. 37 N., R. 33 W., this cemented zone takes the form of elongate elliptical (in cross section) calcareous concretions ranging from 1 to 8 inches in diameter, and up to 5 feet in length. The concretions are horizontal, and are oriented northeast-southwest. These concretions occur in two zones separated by 10 feet of sand. The upper zone is 22 feet below the base of the overlying Ash Hollow Formation. In sec. 5, T. 37 N., R. 33 W., the cemented material occurs as an irregular zone about 20 feet thick, which weathers with a very rough, pitted surface. The top of the Valentine Formation is placed above a fine- to medium-grained greenish-gray compacted sand containing scattered pieces of caliche. This sand lies below the basal limey zone of the Ash Hollow Formation. The Valentine Formation is about 115 feet thick in the northern half of the Spring Creek quadrangle. The Valentine Formation appears to thicken somewhat in the southern half of the quadrangle, but the overlying Sand Hills Formation prevents measurement of the amount of thickening. This apparent thickening to the south suggests that the Post-Miocene erosional surface may slope to the south.

Ash Hollow Formation, Engelmann, 1876.

The Ash Hollow Formation (Tpa), named for exposures in Ash Hollow Canyon, near Lewellen, Nebraska (about 125 miles south of the Spring Creek quadrangle), caps the uplands of the northern half of the quadrangle, and is a series of calcareous silt, limestone, volcanic ash, and sandstone. The base of the Ash Hollow Formation is placed at the base of a limey zone that marks the base of a more or less regular series of cemented sands. A 1- to 4-foot zone of white calcareous silt occurs locally. This silt is commonly fossiliferous, yielding numerous vertebrate bones and teeth. In places, this silt grades laterally into a thin flaggy flesh-colored white-weathering limestone, or a white limey sandstone which ranges from 50 to 85 percent quartz grains. This limey zone is locally overlain by a 1- to 4-foot layer of silver-gray volcanic ash that is partly clean and partly mixed with sand. Where neither the silt of the limestone nor the ash is present, the base of the formation is marked by a zone of calcareous cement that contains considerable caliche, in contrast to the sands of the underlying Valentine Formation, which lack caliche. In all cases, the more resistant material of the basal unit causes a topographic change, which is readily recognizable. The remainder of the Ash Hollow Formation is, for the most part, fine- to medium-grained greenish-gray to light-gray calcareous sandstone that contains varying amounts of white caliche. The caliche occurs as slender springs of root-like structures. These caliche rootlets are normally coated with sand, and locally weather to form an intricate boxwork structure. The sandstone is normally medium-gray on weathered surfaces, partly because of lichens which grow on the sandstone. A zone of fine-grained flesh-colored limestone occurs in places about 35 feet above the base of the formation. The limestone is ½ to 1 foot thick, white-weathering, flaggy, and commonly contains a few fossil gastropod shells. In the SW¼ sec. 24, T. 37 N., R. 32 W., a brilliant white porous marl occurs at about the same stratigraphic position as the limestone. This marl contains abundant irregular vugs, is light in weight, very hard, and has a bell-like ring when struck with a hammer. A hard-greenish siliceous sandstone composed of about 50 percent medium-grained sand and 50 percent opaline silica occurs in NE¼ sec. 31, T. 38 N., R. 31 W., about 15 feet below the top of the formation. This sandstone weathers to a soft white sandstone, and ranges from ½ to 1 foot in thickness. The sandstone resembles the Bijou facies of the Ogallala Group, but contains more opaline silica than is commonly found in the Bijou. Small round fossil fruits of the hackberry tree, Celtis willistoni are present locally in the Ash Hollow Formation. A few grass seeds (Stipidium sp?) were found in NW¼ sec. 12, T. 37 N., R. 32 W., near the top of the Ash Hollow. The Ash Hollow Formation is about 150 feet thick in the east-central part of the quadrangle, and about 180 feet thick in the northwestern part.

SUBSURFACE ROCKS

Rocks probably present in the subsurface of the Ring Thunder quadrangle, based on a well drilled near the border (English #1 Kocer, SW¼ SW¼ sec. 30, T. 37 N., R. 36 W.), include about 200 feet of White River silts, sands, and clays, 650 feet of Pierre shale, 200 feet of Niobrara chalk, 320 feet of Carlile shale, 60 feet of Greenhorn limestone, 275 feet of Bell Fourche-Mowry shales, 210 feet of Morrison-Sundance(?) shale and sand, 55 feet of Opeche (?) shale, and 205 feet of Minnelusa (?) sandstone and shale. The basement rock in the Spring Creek quadrangle is probably granite, which underlies the Minnelusa.

STRUCTURE

Sedimentary strata in the Spring Creek quadrangle appear to be flat lying, but the base of the Ash Hollow Formation rises about 220 feet from the east-central part of the quadrangle to the northwestern part, indicating a dip of about 18 feet per mile to the southeast.

ECONOMIC GEOLOGY

Ground water is available in all parts of the quadrangle. Volcanic ash is present in the northern part of the quadrangle, and limestone is present in the northeastern part.

Ground Water

Water of good quality can be obtained from shallow wells drilled into the Arikaree Group in the northern part of the quadrangle, and along the Little White River. Water of good quality is also available from wells drilled through the Valentine Formation to the top of the Arikaree. Surface water percolates rapidly through the permeable Valentine Formation and collects on top of the less permeable Arikaree. Springs occur locally along the Little White River, but most of the water in the Little White River comes from its source area west of the Spring Creek quadrangle. Water may be obtained locally from wells drilled into the Ash Hollow Formation, but variations in permeability within this unit make the wells unreliable. Water of good quality may also be obtained from wells drilled into the Sand Hills Formation.

Chemical analyses of water samples from wells drilled into White River and Arikaree sediments are given in Table I. 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

The water in Spring Creek comes from a few springs along its valley and from springs which supply the small lakes at the head of Spring Creek, at the western edge of the quadrangle. In normal years water is present along the complete length of the creek, but in dry years the flow is intermittent, with permanent flow for only a short distance below each spring. The Minnechadusa River, which lies to the south of Spring Creek, has a continuous flow of water even in dry years. The water supply for the Minnechadusa River is also from springs, and the greater amount of water (in contrast to Spring Creek) may be the result of a greater water supply from a southward-dipping ground water table, which might be controlled to some extent by the southward-dipping Miocene erosional surface, previously discussed.

Volcanic Ash

Deposits of volcanic ash occur in the lower part of the Ash Hollow Formation throughout the northern part of the quadrangle. These deposits range from 1 to 4 feet in thickness, and from pure ash to mixed sand and ash. The deposits are generally poorly exposed, thus masking their true areal extent, but they appear to be extensive. Volcanic ash is used as an abrasive.

Limestone

Small deposits of a fine-grained flaggy limestone occur near the middle part of the Ash Hollow Formation. The limestone varies from ¼ to 1 foot thick, is relatively pure, and could possibly be quarried for road aggregate.

Table 1. --Chemical Analyses of Representative Water Samples

Sample	Farm Name and Location	Probable Source Material	Parts Per Million: Sulfate (SO_4)	Chloride (Cl)	Sodium (Na)	Calcium (Ca)	Magnesium (Mg)	Alkalinity*	Hardness ($CaCO_3$)	Iron (Fe)	Manganese (Mn)	Total Solids
1	NW¼ sec. 30, T. 38N., R. 32W.	Tma	17	2	19	60	1	18 180	153	Trace	None	288
2	Howard Byrne, NE¼ sec. 27, T. 37N., R. 33W.	Tpv	8	1	4	52	None	8 117	117	None	None	194
3	James O;Neill NE¼ sec. 23, T. 37N., R. 33W.	Tpv	7	1	4	57	3	16 155	153	Trace	None	230
4	Tom Arnold, NW¼ NE¼ sec. 10, T. 36 N., R. 32 W.	Sand Hills?	35	2	8	53	None	9 127	130	None	None	236
5	SW¼ NE¼ sec. 16, T. 36 N., R. 32 W.	Sand Hills?	8	Trace	4	32	None	3 13	284	Trace	----	178

* Alkalinity expressed as: Methyl Orange
Phenolphthalein

Analyses by State Chemical Laboratory, Vermillion, 1960.

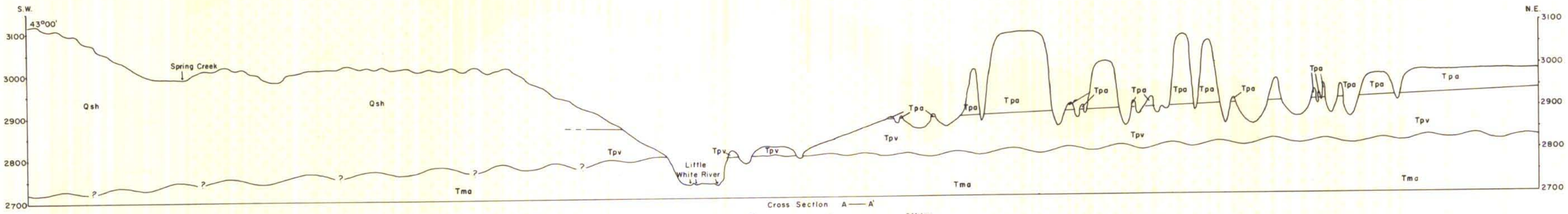
REFERENCES CITED

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

Matthew, W. E. and Gidley, J. W., 1904, New or Little Known Mammals from the Miocene of South Dakota: Amer. Mus. Nat. Hist., Bull. 20, p. 241-6.

Sevon, W. D., 1960, Geology of the Ring Thunder Quadrangle: South Dakota Geol. Survey, Geol. Quad., map and text.

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'

0 2 Miles
Scale