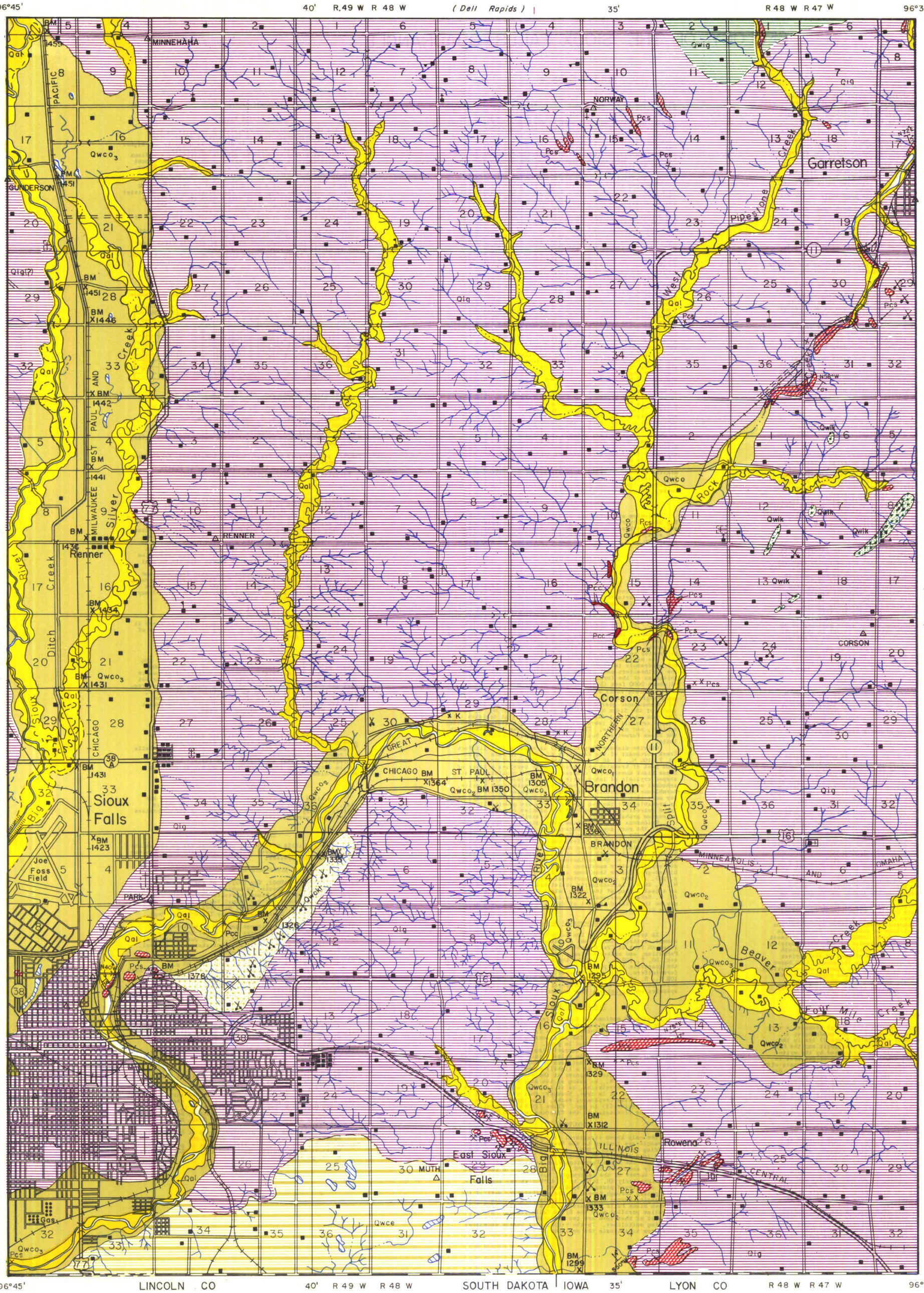
SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the SIOUX FALLS QUADRANGLE SOUTH DAKOTA

(Chester) (Dell Rapids) (Ihlen) (Hartford) (Hills) (Canton) (Lennox) (Larchwood)

96°45' 40' R.49 W R 48 W 35' R 48 W R 47 W 96°30'
43°45' 43°30'
T103N T102N T102N T101N

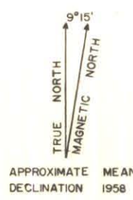


LINCOLN CO SOUTH DAKOTA IOWA LYON CO

Geology by Fred V. Steece, 1958
Assisted by Jerald H. Hoff,

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

Drafted by H. D. Wong, 1959

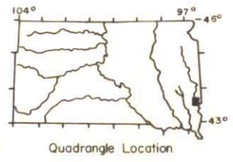


APPROXIMATE MEAN DECLINATION 1958

Scale 1:62 500

1 1/2 0 1 2 3 4 Miles

Vermillion, South Dakota
1959



Quadrangle Location

EXPLANATION

RECENT

Qal — Alluvium
(Semistratified deposits of gravel sand and silt; Humic, Brown to black; 0-20 feet thick in stream flood plains.)

PLEISTOCENE — WISCONSIN

Qwco3 — (Late) Cary Valley Train Outwash
(Stratified deposits of poorly-sorted fine sand to coarse gravel; generally oxidized; Level topography

Qwco2 — (Middle) Cary Outwash
(Terrace remnants along Big Sioux River valley; stratified deposits of pooly sorted sand and gravel; oxidized, level topography; 40-50 feet above Qwco3; up to 50 feet thick)

Qwco1 — (Early) Cary Outwash
(Terrace remant near Brandon. Stratified deposits of coarse poorly-sorted sand and gravel; oxidized, level topography; nearly 100 feet above Qwco3 more than 100 feet thick.)

Qwck — Cary Kame Terrace
(Ice-contact stratified fairly well sorted sand and gravel, well bedded; oxidized; pseudo constructional topography; up to 90 feet thick.)

Qwce — Cary End Moraine
(Boulder-clay till consisting of 60 to 70% olive-gray to olive-brown calcareous clay and silt, with rock fragments; friable, ranges up to 40 feet thick, slightly modified constructional topography.)

Qwig — Iowan? Ground Moraine
(Boulder-clay till consisting of 60-70% of olive-gray to olive-brown calcareous silt & clay, with rock fragments; friable to compact; may be oxidized and/or leached in upper part; probably 30-40 feet thick; level and well drained surface; covered with as much as as 4 feet of calcareous loess.)

Qwk — Iowan? Kame
(Ice-contact stratified well sorted sand and gravel; excellent bedding; oxidized, typically elongate northeast-southwest; up to 50 feet thick.)

ILLINOIAN

Qig — Illinoian? Ground Moraine
(Boulder-clay till consisting of 60-70% olive-gray to olive-brown mostly calcareous clay and silt, with rock fragments; compact; generally oxidized and leached in upper part; covered with as much as 40 feet of calcareous buff loess; extremely well-dissected surface; up to 120 feet thick.)

unconformity

CRETACEOUS

K — Cretaceous? shale
(Brown to gray plastic shale containing foraminifera, exposed in Big Sioux valley. 60 feet thick.)

unconformity

PRECAMBRIAN

Pcc — Corson Intrusive
(Dark gray to black Gabbroic Diabase consisting of Labradorite, Oligoclase, Augite, Biotite, Olivine, Magnetite, Hornblende and Apatite; weathers to light-brown easily disintegrated mass.)

Pcs — Sioux Formation
(Pink to red orthoquartzite consisting wholly of silica-cemented rounded, sorted quartz sand, intbedded with flaggy red to purple sericitic mudstone and coarse pebble conglomerate; well jointed; up to 150 feet in exposed thickness; dips about 5° southward.)

Contact
(dashed where approximately located)

X Gravel Pit

X BM 1329
Bench Mark
(monument showing exact altitude above sea level)

△RENNER
Triangulation Station
(monument marking exact geographic location)

House, school, and church

Cemetery

QUARTERNARY

SIOUX FALLS QUADRANGLE

GEOLOGY OF THE SIOUX FALLS QUADRANGLE

by

Fred V. Steece

INTRODUCTION

The Sioux Falls quadrangle occupies 216 square miles of the eastern half of Minnehaha County in southeastern South Dakota; it lies at the extreme southern edge of the Coteau des Prairies or Prairie Hills (Rothrock, 1943, map). The drainage is controlled by the Big Sioux River and several tributaries.

The topography is characterized by well-dissected loess-covered uplands, with small areas of flat bottomland along the streams; the uplands are poorly-drained along the southern border of the quadrangle. The average relief is 30-40 feet, and the total relief is 350 feet, as shown by hills along the northern border (1600) and by the Sioux River at the southern border (1250). Near the southern border of the quadrangle the Big Sioux River drops 100 feet in about 5 miles, resulting in rapids that gave the city of Sioux Falls its name.

The center of population in the quadrangle is the city of Sioux Falls (metropolitan population 70,910). Other towns are Garretson (pop. 745), and Brandon (pop. 250), and the unincorporated communities of Corson, Renner, and Rowena.

U. S. Highways 16 and 77, and State Route 38 converge in Sioux Falls. State Route 11 serves Garretson and Corson. In addition, nearly every section line is marked by an improved gravel road or by paved county roads. Five railroads serve the city of Sioux Falls: the Great Northern; the Illinois Central; the Chicago, Milwaukee, St. Paul and Pacific; the Chicago, St. Paul, Minneapolis and Omaha; and the Chicago, Rock Island and Pacific. Commercial air service to Sioux Falls is provided by Braniff, North Central, and Western Airlines.

The climate of the area is characterized by rapid and extreme fluctuations in temperature, with long cold winters and short hot summers. The average annual temperature at Sioux Falls (U. S. Weather Bureau Station, 1930-1957) is 43°F., and the average annual precipitation is 25.2 inches. Sioux Falls is an important agricultural and industrial center in eastern South Dakota.

The geologic mapping was done on air photos in the summer of 1958. Outcrop information was supplemented by hand-auger borings, and the thickness of various deposits was determined by 39 holes drilled with jeep-mounted auger drills.

This work was done as part of the State Geological Survey's program of mapping the water and gravel resources of the Big Sioux River drainage basin, under the direction of Dr. A. F. Agnew, State Geologist. The writer expresses his thanks to M. J. Tipton for his counsel and advice in field conferences, and to the residents of the Sioux Falls quadrangle for their cooperation and aid during the course of the field work.

SURFICIAL DEPOSITS

Pleistocene glacial and interglacial deposits, and Recent alluvium make up the surficial deposits of the Sioux Falls quadrangle.

Glacial Drift

Glacial drift comprises all the material transported and deposited directly or indirectly by glacial ice. Drift includes till, outwash and loess. Till is nonsorted, nonstratified boulder clay; outwash is poorly sorted stratified sand and gravel; and loess is wind-blown sand, silt and clay derived from the ablation of till and outwash.

The glacial drift of the Sioux Falls quadrangle represents the Kansan(?), and Illinoian(?) stages, and the Iowan(?) and Cary substages of the Wisconsin glacial Stage. Yarmouthian interglacial deposits are also present in the area; they were deposited between the Kansan and Illinoian stages.

Kansan(?) Stage

Kansan(?) till is exposed at only a few localities in the quadrangle, and therefore little is known of its areal extent. However, it is assumed that the Kansan(?) deposits underlie the surface drift everywhere in the quadrangle. The identification of the till here described as Kansan(?) is based on an exposure northeast of Sioux Falls where silts containing diagnostic Yarmouthian fossil gastropods show the underlying till to be pre-Yarmouth, probably Kansan in age. The Kansan(?) till is dark olive-gray to dark olive-brown in color; it is commonly blocky and profusely jointed, with brown to reddish-brown faces. Normally the till is very compact, but where it is badly weathered it is friable. The Kansan(?) till is oxidized in the upper part--up to 30 feet thick--and is normally calcareous except in the upper few feet where it may be only feebly calcareous or noncalcareous.

The approximate average composition of the Kansan(?) till pebbles in the 4-8 mm size is 50 percent carbonate rocks, 35 percent igneous and metamorphic rocks, and 15 percent all other rocks. The till is at least 45 feet thick.

Yarmouthian Interglacial Stage

In northeastern Sioux Falls (NE¼NW¼ sec. 9, T. 101 N., R. 49 W.) 15 feet of clays, sands and fossiliferous silts are exposed above about 30 feet of till; drill holes show that the till is at least 125 feet thick. The presence of abundant shells of the gastropod Gyralus labiatus Leonard among the fauna suggests Yarmouthian age for the deposits. Therefore the underlying till is probably Kansan in age.

Illinoian(?) Stage

Illinoian(?) till (Qig) is exposed as ground moraine in most of the Sioux Falls quadrangle. The surface of the Illinoian(?) till is maturely dissected, exhibiting a unique pseudorectangular drainage pattern that is due to one or more of the following natural controls: 1) alignment of loess ridges in the direction of prevailing wind, northwest-southeast; 2) glacial depositional features; 3) reflection of the structure or topography of the shallowly buried Sioux Formation.

The Illinoian(?) till is typically dark olive-brown where oxidized, to dark olive-gray where fresh. The till is less blocky than the Kansan(?) and the jointing is less well-defined than in the older till. The Illinoian(?) is, however, as compact as the Kansan(?) till, and is normally calcareous except in the upper few feet which may be leached. The approximate average composition of the Illinoian(?) till is 50 percent carbonate rocks, 30 percent igneous and metamorphic rocks, and 20 percent all other rocks.

The maximum exposed thickness of the Illinoian(?) till is 120 feet. A varying thickness of loess of Iowan(?), and younger, age overlies the Illinoian(?) till. The loess is normally calcareous, yellowish-brown in color, and has a maximum thickness of 41 feet, north of Garretson. The Moody silt-loam soil is developed on the loess, and ranges up to 3 feet in thickness.

Previously, no extensive deposits of Illinoian drift have been mapped in South Dakota. Flint (1955) identified several isolated exposures of till in southeastern South Dakota as Illinoian. Simpson (1952) likewise correlated the deposits at several localities in southeastern South Dakota with the Illinoian Stage. Warren (1952) showed that at least part of the Missouri River is Illinoian in age, thus implying the former existence of Illinoian drift over eastern South Dakota. The present identification of part of the surface drift in the Sioux Falls quadrangle as Illinoian(?) is based on regional studies (Steece, Tipton, and Agnew, in preparation). This area of Illinoian(?) deposits has been mapped by Chamberlin (1881), Todd (1894), Shimek (1912), Rothrock and Newcomb (1926), Rothrock and Otton (1947), Rothrock (1958), and Leverett and Sardeson (1932) as Kansan drift, and by Flint (1955) as Iowan drift.

Wisconsin Stage

Iowan(?) Substage.--Iowan(?) till (Qwig) occupies a very small area near the northern border of the quadrangle; it represents the southernmost advance of Iowan(?) ice in the region. The Iowan(?) border in this quadrangle and the Dell Rapids quadrangle to the north was delineated by the writer and M. J. Tipton (Tipton, 1959) on the basis of features in the Dell Rapids quadrangle, which are presumably remnants of an Iowan(?) end moraine. This boundary has not previously been mapped. The Iowan drift in this quadrangle, even though mapped as ground moraine is probably subdued end moraine.

Topographically, the Iowan(?) differs from the Illinoian(?) in being more level and less dissected. However, it is well-drained and markedly more mature than the Cary till at the southern border. The Iowan(?) till surface is normally covered with thin calcareous brownish-yellow loess of Iowan(?) and younger ages.

The Iowan(?) till is dark olive-gray to dark olive-brown; it weathers dusky yellow to yellowish-brown. The till is normally calcareous but may have been leached or partially leached locally to a depth of several feet. The till is friable to compact; where it is compact, widely spaced joints may be present, usually containing iron-oxide staining and calcium carbonate.

The approximate average composition of the Iowan(?) till is 50 percent carbonate rocks, 10 percent igneous and metamorphic rocks, and 40 percent all other rocks. The thickness of the Iowan(?) till in the Sioux Falls quadrangle probably does not exceed 30-40 feet. The Moody silt-loam soil is commonly present on the surface of the Iowan(?) drift.

A few small kames were deposited in the east-central part of the quadrangle probably by Iowan ice when it reached its maximum in the Sioux Falls quadrangle. The kames consist of fairly well-sorted bedded sands and gravels; they generally do not cover more than several thousand square yards each.

Cary Substage.--Till and outwash comprise the deposits of Cary age in the quadrangle. The Cary till (Qwce) in the Sioux Falls quadrangle represents the easternmost advance of the Cary ice of the James lobe, and is part of a broad end moraine more than 20 miles wide at the Minnehaha County line. This was mapped by Chamberlin (1881) and Todd (1899) as the Altamont moraine. The topography of the end moraine is only locally similar to the typical Altamont in northeastern South Dakota. This deposit is much younger than the Illinoian(?) or the Iowan(?), and thus differs markedly from them in topography. Some of the ruggedness of the Cary surface is subdued by thin deposits of loess, but many undrained depressions exist. Some rudimentary drainage, however, is present especially near the Big Sioux Valley.

The Cary till is normally light to dark olive-gray to dark olive-brown; it weathers dusky yellow to moderate yellowish-brown. The till is normally calcareous throughout, and is oxidized in the upper few feet. It is friable to compact, exhibiting poorly developed widely-spaced joints. The approximate average composition of the Cary till is 40 percent carbonate rocks, 10 percent igneous and metamorphic rocks, and 50 percent all other rocks. Buff loess that is normally calcareous overlies the Cary till discontinuously. The loess thins rapidly from 8 feet near the Cary till boundary to a few inches near the southern border of the quadrangle. The Barnes silt-loam soil, up to one foot thick, is developed on the loess. The thickness of the Cary till in the Sioux Falls quadrangle is probably no greater than 20 feet; the maximum exposed thickness is about 15-20 feet.

Several deposits of outwash sand and gravel of Cary age have been mapped in this quadrangle. The area mapped as Qwckt (kame terrace) northeast of Sioux Falls was probably in an ice-contact situation during the rerouting of the Big Sioux River in Early Cary time. This material consists of fine to coarse sands and gravels that preserve excellent depositional features. In places this sand and gravel appears to be more than 90 feet thick. However, because the material is draped over till walls, the actual thickness probably does not exceed 30 to 40 feet. The tops of these deposits stand as much as 200 feet above the valley floor on both the north and south walls of the Big Sioux Valley.

Three levels of Cary outwash deposits occur in the Big Sioux River valley. Two terrace levels occur above the valley floor, a higher one mapped as $Qwco_1$, and a lower one mapped as $Qwco_2$. Terrace 1 stands nearly 100 feet above the Big Sioux flood plain, and 40 to 50 feet higher than terrace $Qwco_2$. More than 75 feet of gravel is exposed in Split Rock Creek east of Brandon. The high terrace $Qwco_1$ is preserved as a remnant of Early(?) Cary valley fill from a source in West Skunk Creek, 15 miles northwest of Sioux Falls. This terrace was formed by Middle(?) Cary meltwaters which dissected the Early(?) Cary valley fill, and deposited outwash at a lower level. This lower outwash was itself later dissected, forming the lower terrace remnants mapped as $Qwco_2$. Late(?) Cary outwash represented on the map by $Qwco_3$, was thinly deposited (up to 40 feet thick) in the Big Sioux Valley. The terrace remnants are characterized by extremely level surfaces, and are usually little more than a square mile in area.

The outwash deposits, except for the ice-contact material mentioned above, consist of poorly-sorted stratified more or less oxidized sand and gravel. The average composition is 35 percent igneous and metamorphic rocks, 45 percent carbonate rocks, and 20 percent other rocks.

Recent Alluvium

Alluvium of Recent age occupies the flood plains of the Big Sioux River and its major tributaries. The material consists of dark poorly-stratified to stratified gravel, sand, and silt, with lesser amounts of clay and humus. The alluvium ranges up to a maximum thickness of 20 feet, and averages about 6-8 feet.

BEDROCK DEPOSITS

Precambrian Rocks

The Sioux Formation (Baldwin, 1950) is the basement rock in the Sioux Falls quadrangle. The formation is chiefly pink orthoquartzite composed of 97-98 percent silica and 2-3 percent alumina and iron-oxide. Interbedded with the massive quartzite are layers of fissile red to purple mudstone up to 15 feet thick, layers of coarse silica-cemented conglomerate, and thin layers of unconsolidated iron-stained sand. The quartzite exhibits such primary depositional features as ripple marks, cross-bedding, and mud cracks. Surface markings include glacial striations, glacial grooves, crescentic chatter marks, and glacial and wind polish. The Sioux Formation is jointed vertically and horizontally.

The maximum exposed thickness of the Sioux Formation in the quadrangle is about 120 feet at Palisades State Park, in the northeastern part of the quadrangle. The total aggregate thickness of the formation in the quadrangle has been estimated at about 3000 feet (Baldwin, 1950, p. 31, 32).

Gabbroic rocks were found in two localities in the quadrangle. A small area of gabbro is exposed at the site of an abandoned quarry northeast of Sioux Falls on the flood plain of the Sioux River in NE¼ sec. 11, T. 101 N., R. 49 W. The rock was first described by Todd (1904); it contains lath-shaped crystals of labradorite and augite, biotite, magnetite, apatite, and olivine. The gabbro is not seen in contact with the Sioux Formation, but is presumed to have intruded the latter.

Olivine diabase (Beyer, 1897) is exposed in Split Rock Creek northeast of the community of Corson in secs. 15 and 22, T. 102 N., R. 48 W., below about 25 feet of drift. Fifteen feet of brownish weathered diabase overlies a layer of dense black unweathered diabase. The rock consists of lath-shaped crystals of labradorite and oligoclase feldspars, anhedral augite, magnetite and olivine, with minor biotite, hornblende and apatite. This rock is exposed discontinuously for more than a mile in the valley of Split Rock Creek. It is probable that the two igneous rocks are genetically related intrusives, because of their similar compositions. The intrusion probably forms a dike that strikes about N. 45° E.

Evidences of metamorphism associated with the emplacement of the rock are few, because the contact between the igneous rocks and the Sioux Formation cannot be seen. However, two localities do offer some evidence of metamorphism. Very hard slaty mudstone is exposed in SE¼ sec. 10, T. 102 N., R. 48 W., on the north bank of Split Rock Creek about half a mile northeast of the northernmost outcrop of diabase; this differs from other mudstones in the quadrangle in being bluish-gray rather than some shade of red (Baldwin, 1950, p. 24). In the extreme northeast corner of sec. 27, T. 101 N., R. 49 W., talc-chlorite schist was struck at 10(?) feet in a test boring of the South Dakota Highway Department (R. A. Schoon, personal communication, 1958). This schist may be the altered product of dark igneous rock such as the above diabase.

Cretaceous(?) Rocks

In test borings for the Northern States Power Company atomic-electric power plant northeast of Sioux Falls, at least 65 feet of Cretaceous(?) shales overlie the Sioux Formation, and underlie glacial drift. In a hole in SW¼SE¼ sec. 30, T. 102 N., R. 48 W. the lower 20 feet of section above the quartzite is a plastic brown clay containing Cretaceous(?) foraminifera. This clay is also exposed in SE¼ sec. 28, T. 102 N., R. 48 W. Rothrock (1958) and Baldwin (unpublished notes in files of State Geological Survey) have reported sponge spicules and Radiolaria from shales in this sequence.

Tertiary(?) Rocks

Weathered medium- to coarse-grained noncalcareous, yellow sandstone containing pink grains of quartz and feldspar overlies the weathered diabase in an exposure in sec. 22, T. 102 N., R. 48 W. The sandstone is 2-6 feet thick and is probably western-derived in part. The sandstone is overlain by 2-4 feet of white compact flaggy volcanic ash(?), Baldwin (1950, p. 25). The relationship of these rocks to the Cretaceous rocks was not seen in the field, but Baldwin (1950, p. 25) referred to a tightly cemented calcareous very fine-grained sandstone exposed at the east ¼-cor. sec. 30, T. 102 N., R. 48 W., as being of the same formation. This is a doubtful correlation, as it is based only on physical appearance. If it is true, however, that the rocks in question overlie Cretaceous rocks, then the former are probably Tertiary(?) in age. Flint (1955) has referred the rocks under discussion to the Pliocene Ogallala(?) Formation.

STRUCTURE

The only known structural features of the Sioux Falls quadrangle are limited to the Precambrian Sioux Formation. According to Baldwin (1950), the Sioux Formation has been folded into a series of minor warps. Throughout most of the quadrangle the Sioux Formation dips an average of five degrees generally southward (S. 18°E. to S. 50°W.). In the southeastern corner of the quadrangle, however, this dip reverses to northwesterly (N. 14°W. to N. 40°W.) at the same angle. Thus, a westward plunging synclinal trough is evident; its axis passes through Rowena in the southeastern part of the quadrangle, thence west-southwesterly into Lincoln County. Between Sioux Falls and Hartford is a northeast trending anticline parallel with the Sioux Falls trough. At Garretson and west of that town are two essentially parallel southward-plunging anticlines. In the vicinity of Corson anomalous dips seem to indicate the presence of a small basin (Baldwin, 1950).

ECONOMIC GEOLOGY

Shallow Ground Water

All the unconsolidated Pleistocene deposits in the Sioux Falls quadrangle contain interstitial water. The water in the outwash deposits is greater in quantity and higher in quality than that in any of the other materials.

The total area occupied by outwash deposits in the Sioux Falls quadrangle is 38½ square miles or 25,000 acres. About 65 percent of this area, which is along the Big Sioux River from the northern border of the quadrangle to where the channel narrows south of Sioux Falls in sec. 27, T.101 N., R. 49 W., is considered a reliable source of shallow ground water in quantities large enough for irrigational or industrial use. The average thickness of water-saturated material is 23 feet, and the average porosity is 30 percent. Thus 35,200,000,000 gallons or 108,000 acre-feet of water was present in transient storage in the outwash in the summer of 1956. The remaining 35 percent of the outwash materials exists as terraces ($Qwco_1$, $Qwco_2$, Qwckt), in which the water table is low because of inadequate recharge.

Recharge is accomplished chiefly by the Big Sioux River and by direct precipitation.

The Sioux Falls City water system pumps some 300 billion gallons of water annually.

The quality of water in the quadrangle (Table 1) is generally good for irrigation and industrial use. Although the glacial outwash in the Big Sioux Valley contains an enormous amount of shallow ground water of excellent quality, little is available for irrigation at the present time because of the water rights of the city of Sioux Falls.

Table 1.--Analyses of Water Samples of the Sioux Falls Quadrangle

Sample Number	constituents – ppm										Tot. Sol.	Hardness
	Ca	Mg	Fe	Mn	Na	Cl	F	SO_4	NO_3	HCO_3		
1	102	30	1.7	0	14.0	6	0.2	80	0	0	470	377
2	113	32	4.5	T	27.0	0	0.4	163	0.3	0	582	412
3	124	37	6.4	0.7	25.0	5	0.4	146	0.1	0	596	461
4	108	33	1.4	0.9	13.0	0	0.2	147	0.4	0	542	404
5	116	35	0.6	T	12.0	0	0.2	134	0	0	546	435
6	37	33	0.1	0	39.8	18	0.3	184	0	48	342	229
7	86	30	0.0	0	28.3	9	0.4	28	4.0	405	406	339
8	--	125	0.3		---	250	1.5	250	10.0	---	500	---

1. F. R. Straw, SE¼SE¼ sec. 33, T. 101 N., R. 48 W.
2. H. A. Stanton, SE¼NE¼ sec. 16, T. 101 N., R. 48 W.
3. Martin Dien, NW¼SE¼ sec. 5, T. 102 N., R. 49 W.
4. J. Endahl, CNE¼ sec. 29, T. 103 N., R. 49 W.
5. Ed Wehde, CNW¼ sec. 8, T. 103 N., R. 49 W.
6. Sioux Falls City water supply (treated)
7. Garretson City water supply, Well no. 1.
8. U. S. Public Health Service Drinking Water Standards, 1946; figures are maximum allowable.

Samples 1-5 analyzed by State Chemical Laboratory, Vermillion, November 1958.
Samples 6 and 7 analyzed by State Department of Health, Division of Sanitary Engineering, Pierre, 1956.

Only locally does the Big Sioux River valley below Sioux Falls contain sufficient valley fill to supply irrigation waters. The terraces along the Big Sioux River downstream from Sioux Falls may supply limited amounts of water, but cannot be considered reliable sources of copious irrigation supplies because their recharge is slower than the natural discharge.

Some wells in the quadrangle draw water from sand and gravel accumulations in the till, but this water is generally unsuitable for irrigation because of the small quantities available. Buried stream channels (Flint, 1955, pl. 7) may yield domestic supplies of water.

Deep Ground Water

Where the Sioux Formation is unconsolidated or where it is intensely fractured, the rock yields moderate amounts of water of fairly good quality.

Sand and Gravel

Sand and gravel deposits in the quadrangle occupy 38½ square miles, with an estimated reserve of 1,300,000,000 cubic yards. The material is composed chiefly of carbonate and igneous and metamorphic rocks, with less than 2 percent silt and clay. Minor amounts of shale, chalk, and clay-iron-stone (limonite) are present as deleterious constituents. In general, the material is adequate for road metal and concrete aggregate. The largest gravel pits are northeast of Sioux Falls in the area mapped as Qwckt.

Quartzite

Because of its extreme hardness and durability, the pink quartzite of the Sioux Formation (locally known as "Sioux Falls Granite") has long been quarried in Sioux Falls for commercial purposes. The chief use is for concrete aggregate, road metal and riprap. The largest quarries are in secs. 12 and 13, T. 101 N., R. 50 W., at the west edge of Sioux Falls.

Clay

The tills in the area contain 60-70 percent silt and clay. Brick-making and ceramic industries could obtain sufficient clay from till for their needs, if the properties of the clays were satisfactory.

Oil and Gas

There is little possibility of finding oil or gas in the Sioux Falls region, because suitable host rocks for petroleum probably are not present.

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