SOUTH DAKOTA GEOLOGICAL SURVEY
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STATE OF SOUTH DAKOTA
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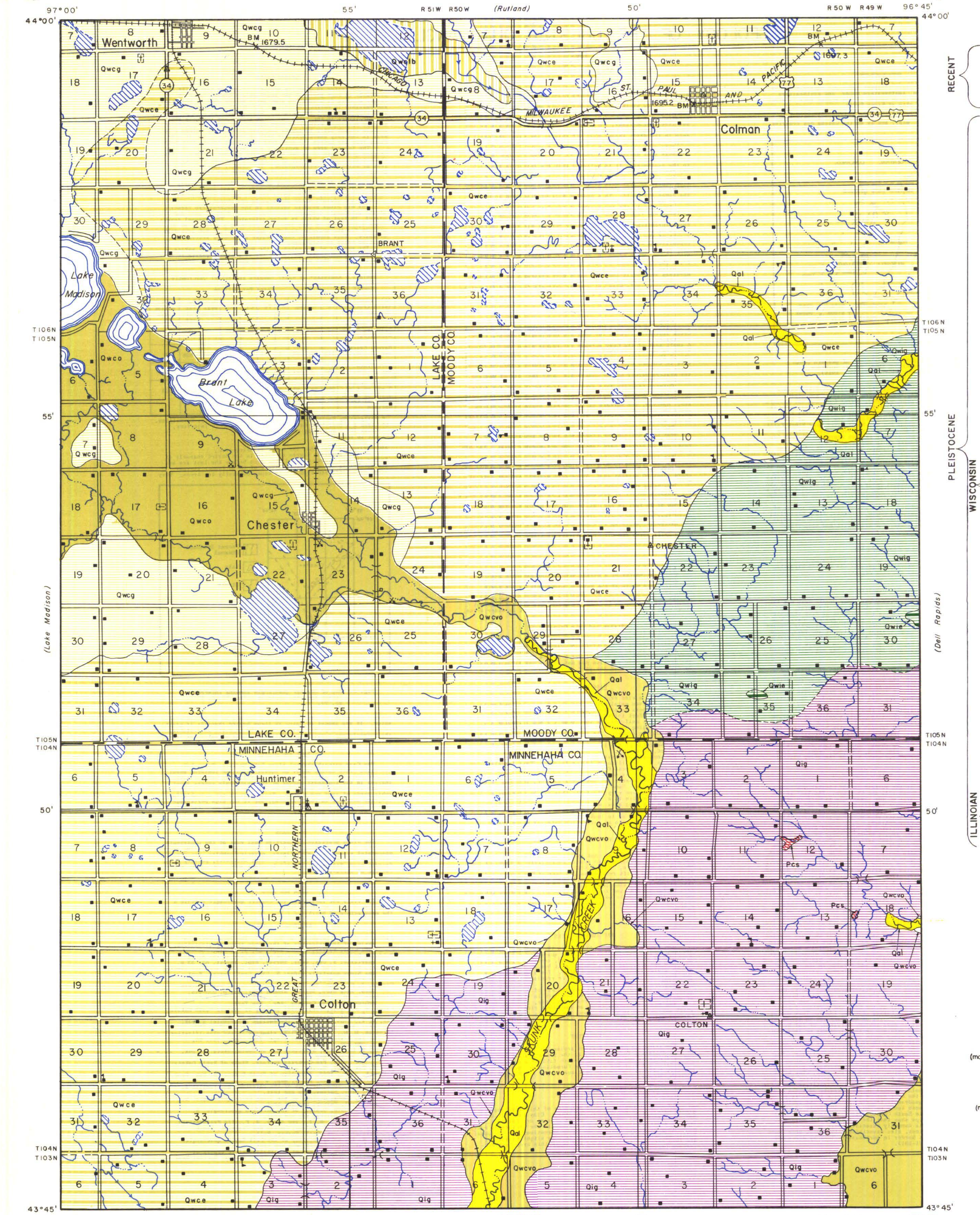
GEOLOGY of the CHESTER QUADRANGLE SOUTH DAKOTA



EXPLANATION

QUATERNARY

RECENT

Qal — **Alluvium**
(Floodplain deposits of silt and sand along the larger streams)

PLEISTOCENE — WISCONSIN

Qwclb — **Cary Lake Deposits**
(Parallel-bedded deposits of silt, sand, and clay, evident by strand lines above present lake and slough shores)

Qwcvo — **Cary Valley Train Outwash**
(Stratified meltwater deposits of gravel, sand, and silt confined to narrow stream valleys; has flat topographic expression)

Qwco — **Cary Outwash Plain**
(Stratified meltwater deposits of gravel, sand, and silt unconfined; has flat topographic expression)

Qwcg — **Cary Ground Moraine**
(Relatively flat accumulations of till; characterized by swell and swale topography, undrained depressions, and boulder-strewn surface)

Qwce — **Cary End Moraine**
(Ridge-like accumulations of till; characterized by rough topography, undrained depressions, and boulder-strewn surface)

Qwig — **Iowan Ground Moraine**
(Relatively flat accumulations of till; characterized by well developed drainage, smooth slopes, and no undrained depressions-- up to six feet of loess cover)

Qwie — **Iowan End Moraine**
(Ridge-like accumulations of till; characterized by high, smooth, well-drained topography-- up to six feet of loess cover)

ILLINOIAN

Qig — **Illinoian Ground Moraine**
(Accumulations of till; characterized by well developed drainage, deep dissection, steep slopes; up to eight feet of loess cover)

PRECAMBRIAN

Pcs — **Sioux Formation**
(Pink, blocky, well-jointed quartzitic sandstone)

Contact
(dashed where approximately located)

Gravel Pit

X BM 1737
Bench Mark
(monument showing exact altitude above sea level)

△ BRANT
Triangulation Station
(monument marking exact geographic location)

House, school, and church

Cemetery

Geology by M. J. Tipton, 1958
Assisted by H. D. Wong
Vertical and horizontal control surveyed from triangulation and level lines of Federal surveys
Drafted by R. L. Bruce

TRUE NORTH — MAGNETIC NORTH 9°30'
APPROXIMATE MEAN DECLINATION, 1958

Scale 1:62500
1 0 1 2 3 4 Miles

Vermillion, South Dakota
1959

■ Quadrangle Location

Chester Quadrangle

GEOLOGY OF THE CHESTER QUADRANGLE

by

M. J. Tipton

INTRODUCTION

The Chester quadrangle includes about 217 square miles in northwestern Minnehaha, southwestern Moody, and southeastern Lake Counties. The southern border of the mapped area is about 10 miles north of the city of Sioux Falls.

The area is in the Western Lake and Dissected Till Plain sections (fig. 1) of the Central Lowlands physiographic province (Fenneman, 1938, map), and is on the Coteau des Prairies

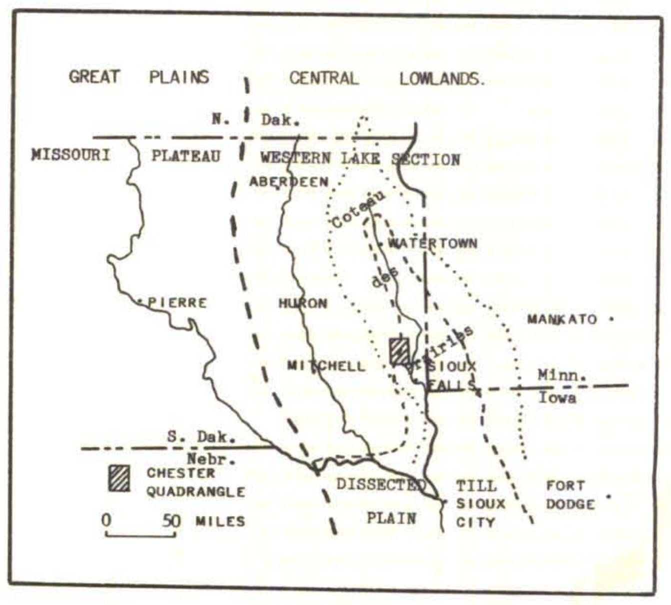


Fig. 1. Map showing physical divisions of eastern South Dakota and adjoining area. (after Rothrock, 1943; Fenneman, 1938; and Carman, 1915).

(Rothrock, 1943, map), a relatively high plateau-like feature of eastern South Dakota, southwestern Minnesota, and northwestern Iowa (Carman, 1915, p. 243). Brant Lake and the eastern part of Lake Madison, in the northwest part of the area, are the largest bodies of water in the quadrangle. These lakes feed Skunk Creek which flows southward through the center of the quadrangle and eventually joins the Big Sioux River near Sioux Falls. Elevations range from 1500 to 1725 feet above sea level. The maximum relief of the mapped area is thus approximately 225 feet, and the local relief ranges up to 100 feet.

State Route 34 and the Chicago, Milwaukee, St. Paul, and Pacific Railroad cross the northern part of the quadrangle, and the Great Northern Railroad crosses the central part; U. S. Highway 77 is present in the northeastern corner. The population is centered in the towns of Colton (pop. 521), Colman (pop. 509), Wentworth (pop. 270), Chester (pop. 160), and the unincorporated community of Huntimer. Gravel roads make almost any part of the quadrangle easily accessible. The climate is characterized by a wide temperature range and an average precipitation of 23 inches per year.

The geology was mapped on air photos during the summer of 1958 under the supervision of Dr. A. F. Agnew, State Geologist. The writer is grateful to Fred V. Steece, who mapped the adjacent quadrangle to the south, for his advice and cooperation in the field work.

SURFICIAL DEPOSITS

The quadrangle is covered by unconsolidated material that can be separated into three main groups: (1) glacial deposits, (2) stream deposits, and (3) wind deposits.

Glacial Deposits

The first ice sheet to cover the upper Middle West was the Nebraskan, and it was followed by the Kansan, Illinoian, and Wisconsin sheets. The Wisconsin ice advanced at five separate times; from oldest to youngest, the Iowan, Tazewell, Cary, Mankato, and Valders. A sixth subdivision of the Wisconsin, called the Farmdale, is said to be present in Illinois and Iowa, below the Iowan (Leighton, 1958, p. 299-302). Although the Nebraskan, Kansan, and Illinoian deposits are present in eastern South Dakota, some of the Wisconsin ice advances may not have reached this area.

The ice sheets deposited drift consisting of clays, silts, sands, gravels, and boulders reworked from bedrock and from older surficial deposits. In the Chester quadrangle the drift ranges in thickness from zero, in the southeastern part of the quadrangle where the bedrock crops out (see Precambrian Rocks), to 410 feet in the Colman city well (see Subsurface Sedimentary Rocks).

The drift is divisible into three lithologic groups: till, outwash, and glacial lake deposits. Till consists of unsorted and unstratified material that ranges in size from boulders to clay. The till was produced through abrasion by the ice sheet against the land surface. Outwash consists of stratified sand, gravel, and silt reworked from the drift and deposited by the meltwater streams of the ice sheet. Glacial lake deposits consist of thinly laminated silt, sand, and clay, deposited from streams as they entered ponded water behind temporary glacial dams.

Till

The till exposed at the surface in the Chester quadrangle is of Illinoian (?), Iowan (?), and Cary age. The till in the northern and western parts of the quadrangle is Cary in age, that in the southeastern part is Illinoian (?) in age, and the remainder is Iowan (?) in age. The age of the latter tills is questioned pending the results of a more regional study (Steece, Tipton, and Agnew, In Preparation).

The tills are differentiated by topographic differences and to some extent by the amount of loess cover (wind-blown silts and clays). The Cary till surface is poorly drained, containing many undrained depressions, and has steep slopes which in places are strewn with boulders. The Iowan (?) till surface is well drained, having no undrained depressions, and has smooth slopes and a relatively low relief that gives the surface a flat appearance. The Illinoian (?) till surface is very well drained, having no undrained depressions, and is deeply dissected. In general, the Cary till has a thin and sporadic loess cover, whereas the Iowan (?) and Illinoian (?) tills have a more extensive and thicker loess cover; however, the Cary till is locally covered with thick loess (see Wind Deposits).

The geomorphic expression of the Cary till in the Chester quadrangle is mapped as end moraine, which is till left as linear ridge-like accumulations along the margins of the ice sheet by lodgement and conveyor-belt or snowplow action of the moving ice. A few patches of Cary ground moraine are found in the northwestern part of the quadrangle. Ground moraine is till that was carried forward in, on, or beneath the ice and deposited from its under surface or let down from the upper surface, forming a moraine of low relief, which is devoid of transverse linear elements. Lee (1959), in the Rutland quadrangle to the north, has mapped ground moraine in some places adjacent to end moraine in the Chester quadrangle. This disparity shows the different interpretations that can result from emphasizing certain criteria rather than others.

The Cary end moraine in the Chester quadrangle marks the easternmost advance of the Cary ice sheet in the James River lobe. This end moraine is not as rough and rugged, and does not have as much local relief as the Cary end moraines farther north near Watertown, South Dakota (Steece, 1958). This can be explained either (1) by a thinning of the Cary ice in the Chester area which would result in more subdued moraines, or (2) by the possibility that the end moraines in this area may be lodgement-type, and the moraines farther north snowplow-type.

The Iowan (?) drift in the Chester quadrangle formed ground moraine except along the southern border where a broad, ridge-like high may be the erosional remnant of an end moraine. The crest of this high is marked by a line of nearly continuous hills that can be traced from the Chester quadrangle across the Dell Rapids quadrangle (Tipton, 1959a) to the east. The hills are probably not held up by bedrock highs, as scattered data show the drift to be thickest beneath the hills. Stratified Iowan (?) drift forms gravel knolls (kames) in the vicinity of these remnant end moraines in the Dell Rapids quadrangle to the east, and in the Sioux Falls quadrangle (Steece, 1959a) to the southeast. These are the only kames known on the Iowan (?) drift of the Coteau des Prairies in South Dakota, and their occurrence near these high ridges helps show that the ridges are end moraines, as stratified drift is commonly associated with end moraines. Similar remnant moraines, also associated with kames, were found along the Iowan drift border in northeastern Iowa by Alden and Leighton (1917, p. 171-181).

The Illinoian (?) and Iowan (?) drifts in the Dell Rapids area were both mapped as Iowan by Flint (1955, pl. 1). The topographic difference between the two drifts is visible in the field, and is strikingly apparent on air photos and topographic maps. The change in topography between the two drifts roughly parallels the area where the bedrock of Sioux Formation crops out (see Precambrian); thus the nearness of this bedrock to the surface in the Illinoian (?) drift area might cause the difference in the drift topography. If this is the case, the drift mapped as Illinoian (?) could be of Iowan (?) age. Another possible explanation is that the Sioux Formation formed an obstacle that halted the advance of the Iowan (?) ice in this area; thus the Illinoian (?) drift was not covered by Iowan (?) to the southwest. It is believed that the latter is the best explanation (1) because of the position of the Iowan (?) end moraine remnants, and (2) because several areas of Sioux Formation exposures just east of the Dell Rapids quadrangle (Tipton, 1959a) in Minnesota do not show any change in the topography of the Iowan (?) drift. This problem will be discussed in more detail by Steece, Tipton, and Agnew (In Preparation).

In general, the topography of the Cary drift in this area is rough and rugged, that of the Iowan (?) drift is smooth and undulating, and that of the Illinoian (?) is well dissected. These three types of topography may reflect different characteristics of the individual ice sheets, but more probably are the result of the difference in age and thus the effect of post-depositional erosion. This is best shown in the upper Middle West by the scarcity of pre-Wisconsin end moraines as contrasted with the numerous rough and rugged end moraines on the young drift sheets. Either the pre-Wisconsin ice sheets did not build extensive end moraines, or more reasonably, the earlier end moraines were built and have since been destroyed by erosion.

The lithology and degree of weathering of the tills in the Chester quadrangle were not used as criteria for age differentiation because of the scarcity of outcrops.

Outwash

Cary outwash deposits are present in a channel which trends southeasterly from Lake Madison and Brant Lake and follows Skunk Creek southward through the Hartford quadrangle (Steece, 1959b) eventually joining the Big Sioux Valley outwash near Sioux Falls. A small part of the Cary outwash is present along the Big Sioux River in the extreme southeastern corner of the quadrangle. The age of the outwash deposits was determined by tracing the channel back to the end moraine from which it originated; for the Skunk Creek outwash this is a Cary end moraine about ten miles west of the western border of the quadrangle, near the city of Madison (Tipton, 1959b, p. 2).

Outwash deposits laid down by meltwater streams are recognized topographically by their level surfaces as contrasted with the undulating surface of the tills, which were deposited by the ice. However, the surface of the outwash deposits is rolling where the meltwaters deposited blocks of ice along with the gravels (collapsed outwash), or when the gravels were deposited around hills of till, as near Lake Madison and Brant Lake.

The composition of the outwash deposits along Skunk Creek and near Lake Madison and Brant Lake varies locally, but in general averages about 60 percent soft carbonates and argillaceous rock, and 40 percent hard igneous and metamorphic rocks. The Big Sioux outwash deposits average about 50 percent of each.

The texture of the Skunk Creek outwash deposits varies locally, containing 10-40 percent gravel, 60-90 percent sand, and less than one percent silt. The Big Sioux outwash deposits average about 60 percent sand, 39 percent gravel, and one percent silt.

The Skunk Creek outwash deposits, between Lake Madison and the southern border of the quadrangle, cover about 20 square miles and average about 28 feet thick. The thickness ranges up to a maximum of 74 feet in sec. 24, T. 105 N., R. 51 W. The Big Sioux outwash deposits in the southeastern corner of the quadrangle cover less than two square miles and average about 32 feet thick. The thickness ranges up to a maximum of 49 feet in sec. 6, T. 103 N., R. 49 W. The above mentioned thicknesses were determined by 33 drill holes and nine resistivity stations.

Glacial Lake Deposits

Glacial lake deposits, as shown by strand lines, are present above the shores of a marshy area in the northern part of the quadrangle. The marsh is a southeastern extension of the Milwaukee Lake basin of the Rutland quadrangle to the north (Lee, 1959). The strand line consists of a more or less continuous bench that stands about five feet above the present floor of the marsh; in the Chester quadrangle the bench is not lined with ice-rafted boulders, which are present in other areas.

Stream and Lake Deposits

Recent alluvial deposits consist of silt and sand reworked by present streams from bedrock and older surficial deposits. The alluvium in the Chester quadrangle is confined to the lake beds, Skunk Creek, and a small creek in the northeastern part. The Recent lake-bed alluvium was not mapped, as it is covered by water during part of the year.

Wind Deposits

Loess is a wind deposit of silt, clay, and a few sand particles derived mainly from outwash plains. In the Chester quadrangle, loess is present sporadically on the Cary drift; it is up to five feet thick, but averages about 1½ feet. The loess is spread more uniformly on the Iowan (?) and Illinoian (?) drifts, averaging about four feet thick on the former and about six feet on the latter. The loess is generally unleached where covered by soil; otherwise it may be leached up to three feet deep. The color of the loess varies from a light buff where unoxidized, to orange.

An unusual northwest-southeast lineation is visible on air photos of the Illinoian (?) drift area. This lineation may be the result of loess deposition by a prevailing wind; however, as this lineation is not apparent on the ground and because some of the linear elements are not loess-covered, they may be due to some other cause. Some of the linear elements are as much as four miles long and very straight; thus may be drumlins or drumlinoids. A drumlin is a streamlined hill or ridge of glacial drift with its long axis parallel to the direction of flow of a former glacier, and a drumlinoid is a rock structure modified by ice movement so as to look like a drumlin. These drumlins or drumlinoids contain no stratified material where tested.

SUBSURFACE SEDIMENTARY ROCKS

Sedimentary rocks are not exposed in the Chester quadrangle, and deep well borings are so sparse that little is known of the bedrock in this area. A well drilled at Colman penetrated 410 feet of glacial drift resting on 226 feet of Cretaceous sedimentary rocks. The latter consisted of 136 feet of Graneros (?) shale, 50 feet of Dakota (?) sandstone, 19 feet of Fuson (?) shale, and 21 feet of Lakota (?) sand in descending order. In the southeastern part of the quadrangle no Cretaceous rocks occur, as the Precambrian Sioux Formation is exposed at the surface (see Precambrian Rocks).

PRECAMBRIAN ROCKS

The Sioux Formation is exposed in the southeastern part of the quadrangle, and in this area is a quartzite consisting of fine grains of iron-coated quartz sand, cemented with silica. The rock has a greasy luster because it breaks through the quartz grains rather than around them. The iron coating on the quartz grains imparts a pinkish or reddish color to the formation.

The Sioux quartzite is blocky because of a well developed joint pattern, and the bedding of the rock in this area dips slightly to the south and southwest (Baldwin, 1949, p. 13).

The Sioux Formation forms an east-west ridge, the axis of which passes through Mitchell and Sioux Falls (fig. 1); the Chester quadrangle lies on the northern slope of this ridge.

STRUCTURE

The structure of the bedrock sediments in this quadrangle is very difficult to determine, as the sediments are not exposed and well records are very few. Petsch (1953a) showed a slight northwesterly dip on the Greenhorn Formation in this area; this probably reflects the topographic surface of the Precambrian (Petsch, 1953b).

ECONOMIC GEOLOGY

The most valuable geologic products of this quadrangle are ground water, sand and gravel, and stone. Clay and silt could become economically important, but at present are not used. Oil and gas might possibly have been trapped in the Cretaceous rocks where they pinch out against the Sioux Formation, but the possibility of any significant quantity is very slight because of the thin section of sedimentary strata in this area (see Subsurface Sedimentary Rocks).

Ground Water

Ground water in quantity adequate to supply farm wells is available in most parts of the quadrangle. Ground water in larger amounts is present in some parts of the outwash channels, and possibly in buried channels of streams that drained this area before the last ice advance. Ground water is also present in sand lenses in the till, but these lenses are commonly small and are recharged with water very slowly; however, they generally contain enough water to supply domestic wells. The Colman city well is the only known artesian well in this area, and it produces from the Lakota (?) sand (see Subsurface Sedimentary Rocks).

The largest area of available shallow ground water in the Chester quadrangle is in the Skunk Creek outwash channel. This channel contains an average of 28 feet of sand and gravel, 15 feet of which is water-saturated. The channel covers 12,800 acres and, assuming a porosity of 30 percent for the gravels, contains about 57,000 acre-feet of water. This is probably enough water to supply irrigation wells in most parts of the channel, especially if the wells are not placed too near the edges of the channel where the gravels are thinnest.

The Big Sioux outwash channel in the southeastern corner of the quadrangle contains an average of 32 feet of sand and gravel, 18 feet of which is water-saturated. The channel covers about 1,120 acres in this area and, assuming a porosity of 30 percent for the gravels, contains approximately 6,048 acre-feet of water. This should be enough water to support several irrigation wells in this area.

The quality of the water in the outwash channels varies greatly in short distances (table 1); it probably varies seasonally as well so that periodic analyses should be made before

Table 1. Analyses* of Water Samples in Chester Quadrangle

SAMPLE (All samples taken from outwash wells)	Parts Per Million									
	Ca	Na	Mg	N	Fe	Cl	SO_4	Hardness $CaCO_3$	Total Solids	Irrigation Class **
Public Health Drinking Water Standards***	--	--	125	10	0.3	250	250	---	1000	
Barney Erickson sec. 7-105-51	112	23	27	2	3.3	3	172	390	628	I
Vern Brown sec. 8-105-51	55	9	41	14	0	3	106	314	496	I
Marr's Resort 3 mi. west of quad. on south shore of Lake Madison	286	59	83	2	0	136	670	1052	1576	III

* Analyses by South Dakota State Chemical Laboratory, Vermillion.
** Class I - excellent to good, Class II - good to injurious, Class III - injurious to unsatisfactory.
*** Not to exceed.

and during the time that the water is being used.

Another possible source of water is the buried channels of former streams, which drained this area before the last ice advance. The locations of the valleys of these former streams (fig. 2) is inferred from linear topographically low areas. They

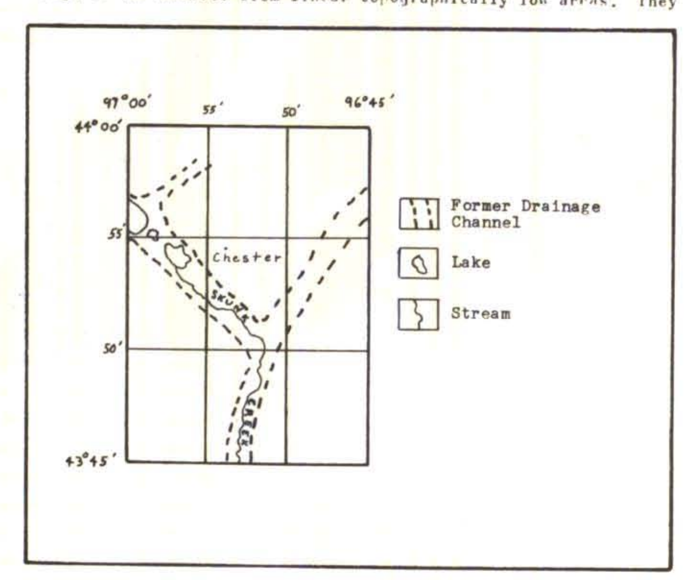


Fig. 2. Map of Chester quadrangle showing inferred former drainage channels (after Flint, 1955, pl. 7).

contain deposits of sand and gravel which may be saturated with water. If the amount of water in these buried channels is great enough, and the physical character of the deposits is suitable, the channels may provide an additional source of water for irrigation.

Sand and Gravel

The Cary outwash channel along Lake Madison, Brant Lake, and Skunk Creek covers about 20 square miles and contains about 500,500,000 cubic yards of sand and gravel. The Cary outwash channel in the southeast corner of the quadrangle covers about one and three-fourths square miles and contains about 55,000,000 cubic yards of sand and gravel. These gravels are suitable for subgrade material in road building, and if the high percentage of soft material were removed, could possibly be used for bituminous or concrete aggregate.

Stone

The Sioux quartzite is quarried just east of the quadrangle near Dell Rapids (Tipton, 1959a) for building stone, paving blocks, monumental stone, tube-mill liners, grinding pebbles, rip-rap, crushed stone, filter beds, engine sand, abrasives, poultry grit, foundry sand, filler, silica brick, glass sand, and in the manufacture of ferro-silicon.

Clay and Silt

The tills and loesses of the Chester quadrangle contain a large amount of clay and silt, which might possibly be used in the manufacture of brick and tile.

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