SOUTH DAKOTA GEOLOGICAL SURVEY
ALLEN F. AGNEW, STATE GEOLOGIST

STATE OF SOUTH DAKOTA
RALPH HERSETH, GOVERNOR

GEOLOGY of the HARTFORD QUADRANGLE SOUTH DAKOTA

(Lake Madison) (Chester) (Dell Rapids) (Humboldt) (Sioux Falls) (Parker) (Lennox) (Canton)

97°00' 55' R.51W. R.50W. 50' R.50W. R.49W. 96°45'
43°45' 43°30'
T.103N. T.102N. T.101N. 40' 35'

Lyons Crooks Hartford Sioux Falls

Skunk Creek Sioux River Willow Creek Big Sioux River Minnehaha Creek Cherry Creek

CHICAGO ST. PAUL NORTHERN MINNEAPOLIS AND OMAHA GAS

BM 1568 BM 1514 BM 1478 BM 1442 BM 1446 HERMAN

Wall Lake

MINNEHAHA COUNTY LINCOLN COUNTY

EXPLANATION

RECENT

Qal — Alluvium
(Semistratified deposits of gravel, sand and silt, humic, brown to black, 0-20 feet thick, in stream flood plains and lake beds.)

PLEISTOCENE

WISCONSIN

$Qwco_3$ — (Late) Cary Valley Train Outwash
(Stratified deposits of poorly-sorted fine sand to coarse gravel; generally oxidized; level topography; 10-40 feet thick.)

$Qwco_2$ — (Middle) Cary Outwash
(Terrace remnants along Skunk Creek valley; stratified deposits of poorly-sorted sand and gravel; oxidized, level topography, 30-50 feet above $Qwco_3$; up to 50 feet thick.)

Qwce — Cary End Moraine
(Boulder-clay till consisting of 60-70% olive-gray to olive-brown calcareous clay and silt, with rock fragments; friable; ranges up to 60 feet in exposed thickness; knob & kettle topography.)

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 25 feet of calcareous buff loess; extremely well-dissected surface; maximum exposed thickness 30 feet.)

unconformity

QUATERNARY

PRECAMBRIAN

Pcs — Sioux Formation
(Pink to red orthoquartzite consisting wholly of silica-cemented rounded sorted quartz sand, interbedded with flaggy red to purple sericitic mudstone and coarse pebble conglomerate; well jointed, up to 100 feet exposed, dips southward about 5°.)

Contact
(dashed where approximately located)

Gravel Pit

X BM 1478
Bench Mark
(monument showing exact altitude above sea level)

△ NEWMAN
Triangulation Station
(monument marking exact geographic location)

House, school, and church

Cemetery

Levee

Geology by Fred V. Steece 1958

Assisted by J. H. Hoff

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

Drafted by Cecil Harris, Fred V. Steece, H. D. Wong

APPROXIMATE MEAN DECLINATION 1958
TRUE NORTH 9°15' MAGNETIC NORTH

Scale 1:62 500
1 1/2 0 1 2 3 4 Miles

Vermillion, South Dakota
1959

104° 97° 46° 43°
Quadrangle Location

HARTFORD QUADRANGLE

GEOLOGY OF THE HARTFORD QUADRANGLE

by

Fred V. Steece

INTRODUCTION

The Hartford quadrangle occupies 216 square miles of the western half of Minnehaha County in southeastern South Dakota; it lies at the extreme southern edge of the Coteau des Prairies (Rothrock, 1943, map). The drainage is controlled by the Big Sioux River and Skunk Creek.

The topography is characterized by mature well-dissected loess-covered uplands in the northeastern half of the quadrangle, and by youthful poorly-drained uplands in the southwestern half. Small areas of flat bottom-land occupy the stream valleys. The average relief is about 35-40 feet, and the total relief is 200 feet, as shown by hills at the northern end (1650) and by the Big Sioux River at the southern border (1450).

The center of population is the city of Sioux Falls (pop. 70,910), part of which is included in the quadrangle. Other populated areas are Hartford (pop. 592) and Crooks (pop. 120), and the unincorporated communities of Lyons and Ellis.

U. S. Highway 16 and State Routes 38 and 17 are the chief roads in the quadrangle, and are supplemented by several paved county roads as well as improved gravel roads on nearly every section line. The Chicago, St. Paul, Minneapolis, and Omaha railroad serves Ellis and Hartford, and the Great Northern railroad serves the towns of Lyons and Crooks; both railroads likewise serve the city of Sioux Falls. 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. Agriculture, cattle raising, and meat packing are the chief industries in the quadrangle; corn is the main crop grown.

The geologic mapping was done on air photos in the summer of 1958. Outcrop information was supplemented by hand-auger borings, and the thicknesses of various deposits were determined by 26 holes drilled by 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 Hartford 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 Hartford quadrangle.

Glacial Drift

Glacial drift comprises all the material transported and deposited 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 Hartford quadrangle represents the Kansan(?) and Illinoian(?) stages, and the Cary substage of the Wisconsin glacial Stage. Yarmouthian interglacial deposits are also present in the quadrangle; they were deposited between the Kansan and Illinoian stages.

Kansan(?) Stage

Kansan(?) till is exposed at only two localities in the Hartford quadrangle. One exposure, about two miles northeast of Hartford (NW¼ sec. 11, T. 102 N., R. 51 W.), reveals deposits of Kansan(?), Yarmouthian, Illinoian(?), and Wisconsin age. The other exposure, in the northeastern part of Sherman Park (NE¼SW¼ sec. 19, T. 101 N., R. 49 W.), shows deposits of Kansan(?), Yarmouthian, and Illinoian(?) age.

The Kansan(?) till is composed of boulder clay that is normally well oxidized. The till is dark olive-brown to dark olive-gray, normally calcareous except in the upper few feet, compact, and vertically jointed; it breaks into blocks and the faces are coated with orange-brown iron-oxide. The average composition of the till is 50 percent carbonate rocks, 35 percent igneous and metamorphic rocks, and 15 percent other rocks. The maximum exposed thickness of the Kansan(?) till measures 25 feet.

Pearlette Ash.--In the exposure northeast of Hartford, volcanic ash that is identified as Pearlette (Frye, Swineford, and Leonard, 1948) is situated between two tills, the upper of which Flint (1955) has identified as Iowan, and the lower one as Kansan. The Pearlette ash of Kansas is latest Kansan in age (Frye, Swineford, and Leonard, 1948). Flint's identification of the upper till as Iowan is based on the presence of loess which he correlated with the Loveland of Late Illinoian age. If the loess is indeed Loveland, then the upper till in this exposure and thus the till that lies at the surface of much of the quadrangle may be Early Wisconsin in age, possibly Farmdale or Iowan. (The detailed discussion of this problem will be presented in Steece, Tipton and Agnew, in preparation).

Yarmouthian Interglacial Stage

Silts containing fossil gastropods were found at both localities mentioned above. The deposits consist of brown to gray silt and clay and range up to several feet in thickness. The diagnostic fossils found in them, are: Planorbula vulcanata vulcanata Leonard, Gastrocopta procarmifera Leonard, Gyralus labiatus Leonard, and one Aftonian to Yarmouthian form, Deroceras aenigma, Leonard. The first three are typical of the Sappa Member of the Meade Formation of Kansas, (Leonard, 1950, 1952) of Yarmouthian Age.

Illinoian(?) Stage

Illinoian(?) till is exposed as ground moraine in the northeastern half of the quadrangle. The surface of the Illinoian(?) till is maturely dissected, having 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 the prevailing winds, northwest-southeast; 2) glacial depositional features; 3) reflection of the structure or topography of the shallowly buried Sioux Formation.

Material referred to as Illinoian(?) till in this quadrangle is typically dark olive-brown to dark olive-gray; it is less blocky than the Kansan(?) till, and the jointing is less well-defined than in the Kansan(?) till. The Illinoian(?) is, however, as compact as the older till, and is normally calcareous except in the upper few feet. The average composition of the Illinoian(?) is 50 percent carbonate rocks, 30 percent igneous and metamorphic rocks, and 20 percent other rocks.

The maximum exposed thickness of the Illinoian(?) till measures 30 feet. Overlying the Illinoian(?) till is a varying thickness of Iowan(?) and younger loess. The loess is normally calcareous, yellowish-brown in color, and has a maximum thickness of 25 feet. The Moody silt-loam soil is developed on the loess surface, varying from several inches to three feet.

Previously, no extensive deposits of Illinoian drift have been mapped in South Dakota. Flint (1955) tentatively identified several isolated exposures of till as Illinoian. Simpson (1952) likewise identified several local occurrences as Illinoian. Warren (1952) showed that at least part of the Missouri River is Illinoian in age, therefore, implying the former existence of Illinoian ice in the region of Eastern South Dakota.

Wisconsin Stage

Cary Substage.--Apparently, only the Cary substage of the Wisconsin glacial stage is represented in the Hartford quadrangle. Whether older Wisconsin drift was deposited and later covered by Cary ice is unknown. Because of the scarcity of good exposures in the area of Cary drift, the latter is presumed to rest directly on Illinoian(?) or older drift.

Cary drift occupies roughly the southwestern half of the quadrangle, the valley of Skunk Creek, and the Big Sioux River valley. Till occupies about 95 percent of the above area, and outwash sands and gravels occupy the valleys of the Big Sioux River and Skunk Creek.

The Cary till in the Hartford quadrangle represents the easternmost advance of Cary ice upon the Illinoian(?) till and occurs as part of a broad end moraine--the Altamont Moraine of Chamberlin (1881) and Todd (1899)--which is about 20 miles wide at the southern Minnehaha County line. The topography of this end moraine is only in places comparable to the typical Altamont topography of northeastern South Dakota, at the northern end of the Coteau des Prairies. The Cary till area has a subdued youthful topography whose local relief does not exceed 25 feet, and normally is only about 10 feet; it contains numerous small undrained depressions the largest of which is Wall Lake, a perennial body of water. Some rudimentary drainage has been developed on the surface of the Cary till area, especially where drainage is controlled by the Big Sioux River or by Skunk Creek.

Cary till is normally dark olive-gray where unweathered, to moderate yellowish-brown where weathered. The upper few feet of exposed till is usually oxidized, but the till is ordinarily calcareous throughout. The till is friable to semi-compact, and reveals only very widely spaced nearly vertical joints. The joint faces generally are coated with caliche or iron-oxide. The average composition of the Cary till is 40 percent carbonate rocks, 10 percent igneous and metamorphic rocks, and 50 percent other rocks. Thin patches of loess are scattered over the surface of the Cary till; the loess is buff-colored and is calcareous. The Barnes silt-loam soil is developed on the surface of the Cary till or on the loess above the till.

The thickness of the Cary till is not known accurately. In the bluffs along Skunk Creek, 5-60 feet of the till is exposed, but it is undoubtedly much thicker than this in places, especially on the higher parts of the moraine. At least 157 feet of drift was logged in the city well at Hartford. The Humboldt City well, seven miles west of Hartford and just outsice the quadrangle, penetrated 312 feet of glacial drift, part or all of which may be Cary.

Two levels of Cary outwash deposits are recognized in the Hartford quadrangle; the valley floor level is mapped as Qwco3 as in the adjoining Sioux Falls quadrangle (Steece, 1959), and a higher terrace level is mapped as Qwco2. The terrace deposits were laid down as valley fill along the lower Skunk Creek from its fork to its mouth, by melt-waters of the earliest and easternmost of the several Cary ice advances in the James lobe. Later melt-waters dissected these deposits and lowered the bed of the stream before the next deposition of outwash materials. This enlarged and filled the main valley of Skunk Creek, except for a six mile segment which was constricted by advancing ice during Middle(?) Cary time; this Middle(?) Cary outwash can be traced to its source in the Middle(?) Cary moraine system west of Madison, about 30 miles northwest of Hartford. The outwash deposits in the valley of the Big Sioux River probably represent deposition of Cary and even older substages. It is possible that no late Cary outwash was deposited in the Big Sioux River valley.

The outwash deposits have level surfaces that are capped with Bearden loam and silt-loam soils. The outwash deposits consist of poorly-sorted sand and gravel, with minor amounts of silt, clay, and boulders. The average composition of the gravels is 45 percent carbonate rocks, 35 percent igneous and metamorphic rocks, and 20 percent other rocks. The gravels are usually stained with iron-oxide and range from 5-47 feet in thickness; they average about 25-30 feet thick.

Recent Alluvium

Alluvium of Recent age occupies the flood plains of the Big Sioux River and Skunk Creek. The material consists of dark partly stratified gravel, sand, and silt, with lesser amounts of clay and humus. The alluvium ranges up to 20 feet thick and averages about 6-8 feet.

BEDROCK DEPOSITS

Precambrian Rocks

The Sioux Formation (Baldwin, 1950) is exposed as "sheep backs" at several localities in the Hartford quadrangle, and well logs in the surrounding region show that the rock underlies the entire mapped area.

The Sioux Formation is pink to red hard silica cemented sandstone (orthoquartzite). It is jointed, bedded, and cross-bedded, with interbedded red to purple sericitic claystone ("pipestone", "slate") and coarse conglomerate. The formation is estimated by Baldwin (1950) to be as much as 3,000 feet thick. The rock is composed of 97-98 percent silica and 2-3 percent minor constituents such as iron-oxide and alumina.

Younger Rocks

Because information is lacking, the subsurface rocks cannot be known with certainty, but probably no sedimentary rocks younger than the Sioux Formation are present in this quadrangle. Rothrock (1958), however, has suggested the presence of Cretaceous shales above the Sioux Formation northeast of Sioux Falls (Steece, 1959). It is not known whether these shales extend westward into the Hartford quadrangle, or not.

STRUCTURE

The only known structural features of the Hartford quadrangle are limited to the Sioux Formation. According to Baldwin (1950), the Sioux Formation has been folded into a series of minor warps. In this quadrangle a northeast-trending anticline lies between Sioux Falls and Hartford, parallel to the Sioux Falls-Rowena trough (Steece, 1959). The general attitude of the Sioux Formation in the area shows 4°-6° dip in a S. 10°-30° E. direction.

ECONOMIC GEOLOGY

Shallow Ground Water

All the unconsolidated Pleistocene deposits in the quadrangle contain interstitial water, but the water contained in the outwash sands and gravels is greater in quantity and higher in quality than that found in any of the other surface materials.

The total area occupied by outwash deposits in the quadrangle is 25 square miles. Terraces occupy about 4 square miles of this area, and generally do not have a permanent water table. The remaining 13,440 acres contains an average thickness of 22 feet of water-saturated sand and gravel. Considering the average porosity of the deposits to be 30 percent, the outwash contained 28,900,000,000 gallons or 88,700 acre-feet of water in the summer of 1958.

Precipitation constitutes the major recharge to the sand and gravel reservoir.

The quality of water (Table 1) in the outwash deposits of the Hartford quadrangle is generally good for irrigation.

Excessive concentrations of sodium, sulfate, carbonate, and chloride ions are considered harmful to plant development (Eaton, 1936). The water in the outwash deposits in the Hartford quadrangle falls within the classification of good irrigation water, with one exception (Sample No. 7, Table 1).

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 quantity available. Domestic supplies of water may be obtained from buried stream channels (Flint, 1955, pl. 7).

Table 1.--Analyses of Water Samples from the Hartford Quadrangle

Sample No.	Constituents - ppm												Irr. Class
	Ca	Mg	Fe	Mn	Na	Cl	F	SO_4	NO_3	Tot. Sol.	PP	MO	Hard.	
6*	102	34	0	0	10.0	16	0	122	8.2	538	-	201	395	I
7	259	101	0.3	Tr	27.0	0	0	775	1.2	1526	8	300	1061	III
8	159	59	Tr	0	16.0	0	0	388	0.8	910	4	260	638	II
9	75	29	Tr	0	20.0	0	0	23	0.3	402	-	322	305	I
10	90	30	0	0	15.0	4	0	95	1.1	458	8	272	348	I
11**	182	63.3	--	--	33.8[2]	4	.32	416	0.6	1000	-	---	716.7	---
12**	485	129.4	4.0[1]		41.70[2]	20	.95	1448.8	0	2601	-	---	1753.8	---
13	---	125	0.3[1]		-----	250	1.5	250	10.0	500	-	---	-----	---

[1]Taken as Fe and Mn together.
[2]Reported as Na and K combined.

Class I Good to excellent.
Class II Good to injurious.
Class III Injurious to unsatisfactory.

*Samples 6-10 analyzed by S. Dak. State Chemical Laboratory, Vermillion, November 1958.
**Sample 11, Hartford City Well No. 2, and Sample 12, Crooks City Well analyzed by S. Dak. State Department of Health, Pierre, 1956.

6. J. C. McGee, NW¼SW¼ sec. 8, T. 103 N., R. 50 W., Minnehaha County.
7. Floyd Kelly, SE¼NW¼ sec. 10, T. 102 N., R. 51 W., Minnehaha County.
8. Harold Person, SW¼NW¼ sec. 19, T. 102 N., R. 50 W., Minnehaha County.
9. Adolph Anderson, SW¼SW¼ sec. 21, T. 102 N., R. 50 W., Minnehaha County.
10. Delbridge Farm, N¼ cor. sec. 12, T. 101 N., R. 50 W., Minnehaha County.
11. Hartford City Well No. 2.
12. Crooks City Well.
13. United States Public Health Service, Standards for Drinking Water, 1946. Figures are maximum allowable.

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

The estimated reserve of sand and gravel in the Hartford quadrangle is 562,000,000 cubic yards. The material is composed chiefly of carbonate and igneous and metamorphic rock fragments, with less than 2 percent silt and clay. Minor amounts of shale, chalk, and clay-ironstone (limonite) are present as deleterious constituents. In general, the material is adequate for road metal and concrete aggregate. The larger pits are located west of Sioux Falls near Ellis.

Quartzite

Because of its extreme hardness and durability, the Sioux quartzite ("Sioux Falls Granite") has long been quarried in Sioux Falls for commercial purposes. The chief use of the rock is for concrete aggregate, road metal, and riprap. The rock is quarried at the west edge of Sioux Falls near the Fairgrounds.

Clay

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

Oil and Gas

There is little possibility of oil or gas in the Hartford quadrangle, because suitable host rocks for petroleum probably are not present.

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