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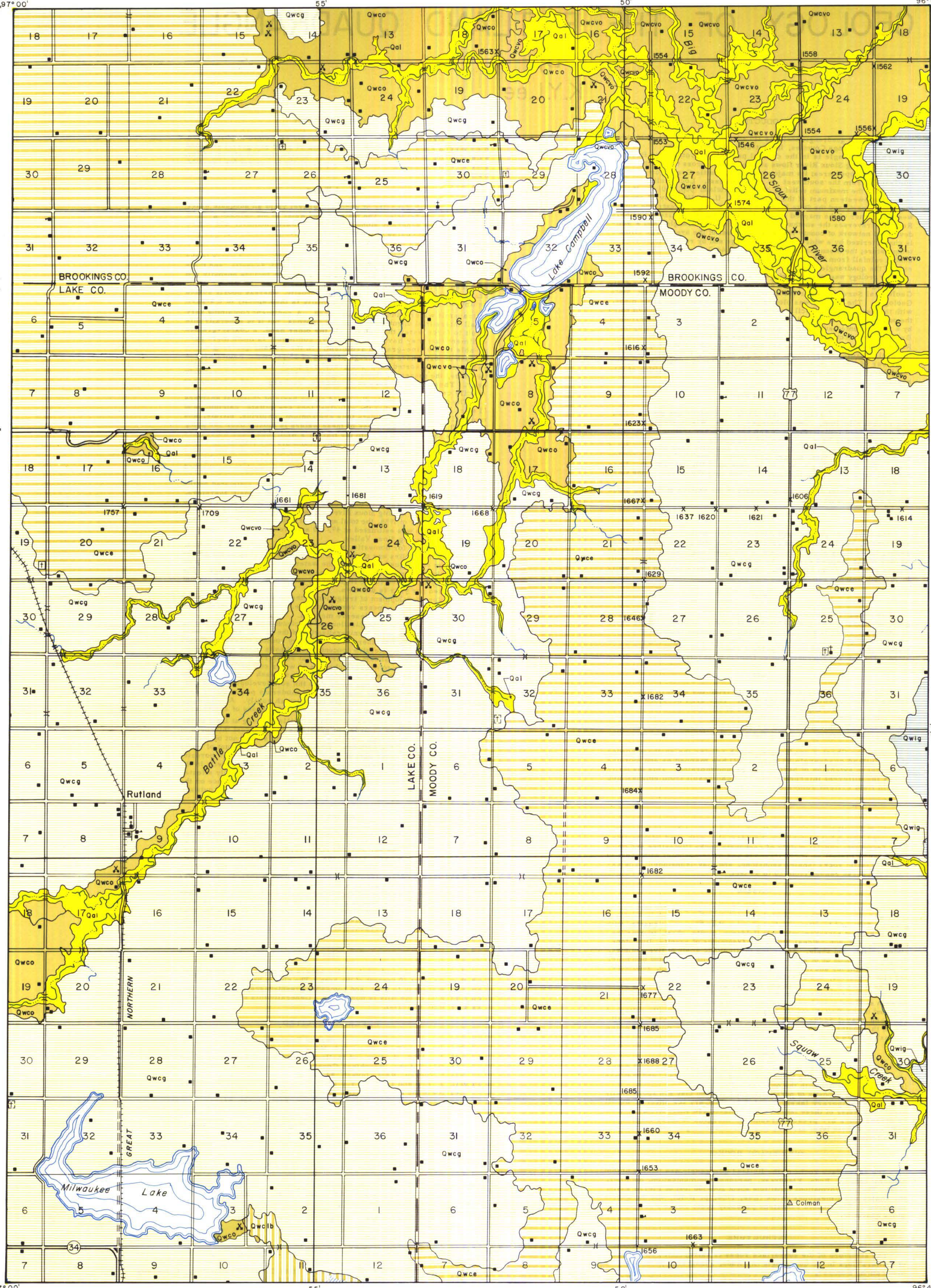
GEOLOGY of the RUTLAND QUADRANGLE SOUTH DAKOTA



R.51W. R.50W.

Scale 1:62,500

1 1/2 0 1 2 3 4 Miles

9° 30'

TRUE NORTH

MAGNETIC NORTH

APPROXIMATE MEAN DECLINATION, 1958

Geology by K. Y. Lee, 1958

Assisted by Cecil Harris

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

Drafted by R.K. Booker, 1959

Quadrangle Location

EXPLANATION

QUATERNARY

Qal — **Alluvium**
(Alluvial silt, sand and gravel along the Big Sioux River and its tributaries.)

PLEISTOCENE — WISCONSIN

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

Qwcvo — **Cary Outwash-Valley Train**
(Chiefly silt, sand, and gravel; in the Big Sioux and its tributary valleys.)

Qwco — **Cary Outwash Terrace**
(Chiefly sand and gravel; remnants along the Big Sioux and its tributaries. About 20 feet above present stream beds.)

Qwcg — **Cary Ground Moraine**
(Sandy till, gray to brownish-or greenish-gray; generally rolling surface; well-integrated drainage pattern, and undulating topography; local stratified sand lenses.)

Qwce — **Cary End Moraine**
(Boulder-clay till, gray to bluish-, greenish-, and brownish-gray; ridgelike; local stratified sand lenses.)

Qwig — **Iowan? Ground Moraine**
(Pebble-clay till, gray to brownish-gray, somewhat bluish-to blackish-gray, compact, mostly oxidized; well-integrated drainage pattern, and undulating topography; local stratified sand lenses.)

Geologic Contact
(dashed where approximately located)

X Gravel Pit

x 1682 Spot Altitude

▲ COLMAN
(monument marking exact geographic location)

House, school, and church

RUTLAND QUADRANGLE

Vermillion, South Dakota
1960

GEOLOGY OF THE RUTLAND QUADRANGLE

By

K.Y. Lee

INTRODUCTION

The Rutland quadrangle includes 216 square miles in parts of Moody, Lake, and Brookings Counties, in east-central South Dakota.

The quadrangle is in the central part of the Coteau des Prairies upland. The Big Sioux River flows southeasterly across the northeastern part of the mapped area; its major tributary, Battle Creek, crosses the quadrangle from the southwest to the northeast. Local relief is up to 49 feet, and the maximum relief is 204 feet. Rutland (pop. 150) is situated in the southwestern part of the quadrangle. U. S. Highway 77 crosses the eastern part, and the State Route 34 passes through the extreme southwestern corner of the mapped area. The mainline of the Great Northern Railroad traverses the southwestern part of the quadrangle, and a well-developed network of county roads serves most of the area. The climate is characterized by a wide temperature range and by rapid fluctuations in temperature; the mean annual temperature is 44.7 degrees. The average annual rainfall from 1935 to 1957 at Flandreau Weather Station, 10 miles east of the quadrangle, was 23.7 inches.

The geology was mapped during the summer of 1958 as part of a series of investigations of South Dakota's economic mineral resources by the State Geological Survey, under the supervision of Dr. A. F. Agnew, State Geologist. The geology was plotted on air photos and plane table maps, with the assistance of Cecil Harris. Hand-auger borings supplemented the outcrop information. Thicknesses of outwash deposits were determined by a jeep-mounted auger drill operated by Howard Loitwood and Spencer Brooks, and electrical resistivity surveys were run by Daniel Lum and Robert Benson. Special thanks are due to the residents of the quadrangle for their cordial cooperation and help, and to J. E. Powell, District Engineer of the U. S. Geological Survey at Huron, South Dakota, for furnishing facilities and contributing counsel during the writing of this report.

SURFICIAL DEPOSITS

The surficial deposits consist chiefly of Pleistocene glacial drift, and recent alluvium. Two substages of the Wisconsin glacial stage are recognized tentatively as Iowan (?) and Cary (Flint, 1955). Only the Cary deposits have been studied regionally by the State Geological Survey; therefore, and because earlier deposits have not been dated by the Carbon-14 method, the pre-Cary Iowan is qualified with a question mark. The Wisconsin glacial drift is made up of till and outwash. Lake deposits occur locally on the Cary till, and near the margin of the Cary outwash.

Recent alluvial deposits are present in the valleys of the Big Sioux River and its tributaries.

Iowan (?)

The Iowan (?) glacial drift consists of till with included stratified sand lenses, and is mapped as ground moraine with gently rolling topography; it occupies about 1 percent of the quadrangle along the eastern border of the mapped area. The depth of leaching on top of this drift ranges generally from 1 to 2 feet. This drift is characterized by a well-integrated drainage pattern.

Till

The Iowan (?) pebble-clay till is gray to brownish- and yellowish-gray, somewhat bluish-gray to black; it is mostly oxidized. On the basis of lithologic study (Powell, Lee, 1960), the pebble fraction of the till averages 58 percent limestone and dolomite, 30 percent igneous and metamorphic rocks, and about 12 percent shale, clay-ironstone, and sandstone. The exposed thickness ranges from 15 to 35 feet.

Cary

The Cary drift represents deposits from the eastern limb of the James ice lobe, which lay to the west. This drift occupies about 95 percent of the quadrangle, and consists of till with included stratified sand lenses, and outwash; the depth of leaching is as much as one foot. Topographically this drift is characterized by rough end moraine, by rolling ground moraine _/, and by flat outwash valley train and terraces.

_/ In the Chester quadrangle, which adjoins the southern border of the Rutland quadrangle, Tipton (1959) has mapped as end moraine the southern extension of part of this ground moraine. This disparity shows the different interpretations that can result from emphasizing certain field criteria rather than others.

Till

The Cary till is made up chiefly of gray to greenish- and brownish-gray, and somewhat bluish-gray boulder-clay with sand-rich matrix. Rock fragments consist mainly of carbonate rocks (limestone and dolomite), and crystalline rocks (igneous and metamorphic) with about 10 percent clastic rocks (shale, sandstone, and clay-ironstone). The exposed thickness ranges from 20 to 45 feet.

Outwash

The Cary glacial outwash is subdivided topographically into valley train and terrace. The material comprising the outwash is sand and gravel. The sand fraction consists of more than 85 percent quartz, with about 15 percent accessory minerals (feldspar, pyrite, chert, tourmaline, pyroxene, and iron-oxides), and some fragments of granite, limestone, slate, schist, and shale. According to lithologic study of five samples, the gravel is made up of an average of 46 percent limestone and dolomite, 42 percent igneous and metamorphic rocks, 10 percent shale, sandstone, and clay-ironstone, and 2 percent chert.

The outwash valley train and terrace are confined to the Big Sioux Valley and its tributaries from the southwest and the northeast. The outwash sand and gravel were derived from the end moraines to the northwest and the southwest, mainly outside the quadrangle. Locally collapsed sand and gravel occur along the southern border of Lake Campbell, and in the southeastern part of Milwaukee Lake. The thickness of the outwash ranges from 7 to 39 feet.

Alluvium

Recent alluvial deposits of clay, silt, and sand and gravel occur along the sides of the Big Sioux River and its tributaries, and they are intermingled locally with the outwash valley train.

Lacustrine deposits of parallel-bedded silt and clay are sporadically present in temporary lakes, created by the Cary ice sheet in the till area. The water of these lakes seems to have been short-lived, because no strand lines are present around the margins of these lakes. The sediments of these lakes are thus mostly recent in origin, and are mingled with alluvial deposits.

SUBSURFACE ROCKS

The subsurface rocks of the Rutland quadrangle are inferred from drillers' logs (A. Rude, Flandreau, personal communication, Summer, 1958). The rock formations constitute about 200-300 feet of Pierre shale, the shales and limestones below (Lee, 1958, p. 11-12), and the Dakota sandstone. The Dakota sandstone probably rests on the Precambrian Sioux quartzite.

STRUCTURE

The structure of the subsurface rocks is extrapolated on the basis of drillers' logs in the quadrangle (A. Rude, Flandreau, personal communication, Summer, 1958).

The Cretaceous strata are relatively flat and lie unconformably on the eroded surface of the Precambrian Sioux quartzite. The regional structure of these Cretaceous strata seems to be a rather broad anticlinal fold, whose crest extends northward approximately through the northeastern part of the quadrangle, plunging gently into the Brookings quadrangle (Lee, 1958, p. 12).

ECONOMIC GEOLOGY

The Wisconsin glacial drift is of major economic importance in the mapped area. The outwash deposits of sand and gravel are good water-bearing sediments, and are used in construction industries. Clay, derived mainly from glacial tills, is potentially important for ceramic ware.

Ground Water

The outwash deposits of sand and gravel yield an adequate water supply in the quadrangle. The main ground water in the outwash gravels and sands flows generally along these pre-outwash channels, and drains along the present course of the Big Sioux River. The rainfall percolates downward through the sandy soil into the zone of saturation, thus recharging the outwash deposits.

The factors controlling the occurrence of the ground water in the outwash are the physical properties of the outwash deposits, and their distribution. The physical properties of the outwash include porosity and permeability, which are deduced on the basis of textural study. Generally, well-sorted sediments have high porosity, whereas poorly sorted sediments are less porous. Permeability is the capacity of a deposit to transmit water under hydraulic head. A sediment containing very small interstitial openings may be very porous, but it is generally difficult to force water through it. On the other hand, a coarse-grained sediment that may have less porosity, commonly is much more permeable than a fine-grained sediment. In the Rutland quadrangle, the outwash deposits have an average porosity of 25 percent. Rather coarse and moderately sorted sand and gravel are predominant in the outwash; therefore, the passage of fluids through these sediments is comparatively easy. Thus the processes of discharge, recharge, and recovery are readily carried out.

The quality of water is discussed on the basis of chemical analyses (Table 1), which show that the principal ions are sulfate, calcium, and magnesium. The subordinate ions are sodium, chloride, nitrate, and iron. The carbonate hardness of these waters is mostly over 500 ppm, except the water produced from the Hardey's well; thus these waters are rather hard for human use (U. S. Public Health Service Standards, 1946). The concentration of sulfate in sample 1 is above 250 ppm; this ion causes a laxative effect on the human body, and also makes poor irrigation water. As a whole, the water produced from the outwash in the mapped area is generally satisfactory for irrigation.

The storage capacity of water in the outwash is estimated on the basis of the average regional porosity of each outwash deposit; therefore, the potential storage capacity in the outwash, as a whole, is about 101,500 acre-feet, of which the Big Sioux River outwash contains about 78 percent. During the summer of 1958, the total amount of water stored in the outwash of the quadrangle was estimated at 49,700 acre-feet, of which 73 percent was stored in the Big Sioux Valley.

Water is used for domestic, stock, irrigation, and public supplies. The irrigation supplies are confined to the Big Sioux Valley in the northeastern part of the quadrangle, and the water pumpage per season could not be obtained from the owners because of the lack of recordings. The public supply is limited to the High School at Rutland, where the amount of water used per year is unknown.

The future development of irrigation in the outwash, especially along the Big Sioux Valley, appears very favorable. However, several items concerning such irrigation deserve mention.

As a result of evapo-transpiration and re-circulation especially during the dry season, an increase in mineralization of the ground water probably will accompany irrigation; therefore, necessary counter measures should be taken to prevent the excessive concentration of salts in the soil. Chemical analysis of water should be carried out regularly during the period of irrigation in order to observe changes of water composition.

The soil developed on the surface of the outwash is generally light in texture, and more silty and sandy than the soil developed on the surface of the till; the former has a rapid to moderate permeability, and water can percolate downward into the outwash easily. Accordingly, irrigation of this land could be suitably carried out by means of sprinklers.

Each well in the outwash should be drilled or dug at least to the bottom of the outwash in order to penetrate the greatest thickness of water-saturated material. Wells for irrigation should not be located near the borders of the outwash. Generally, a great amount of water can be stored in the lower part of the outwash, owing to the high porosity of the sand and gravel there. During the pumping season, wells in the outwash and in the tills near the outwash border are usually affected by continuous pumpage; but it will not have appreciable influence on the water level in wells in the till several miles away from the outwash (for further details, see Powell, Lee, 1960).

Sand and Gravel

The outwash deposits of sand and gravel occupy 35 square miles (16 percent) of the quadrangle. A conservative reserve of these materials is computed as 641,650,000 cubic yards. The outwash is gray, brownish- to reddish-gray, calcareous, ferruginous, with a considerable amount of impurities. On the basis of screen analysis, the outwash sand and gravel ranges from well-sorted to poorly sorted. The gross composition of the outwash is a mixture of quartz pebbles and cobbles associated with fine- to coarse-grained quartz sand, and some silt and clay. The silt-clay fraction is generally low in weight percentage; thus these materials have a low plasticity index, and are suitable for road construction and concrete aggregate. They are not good refractory substances, owing to the presence of calcite, alkalies, iron-oxides, and other silicate minerals.

Clay

In the Rutland quadrangle, clay occurs mainly in the glacial tills, which cover about 40 percent of the area. The clay is brownish-, bluish-, and yellowish-gray to gray, and somewhat greenish-gray. The principal clay mineral in the tills is nontronite. Generally this clay could serve as a ceramic material.

REFERENCES CITED

Flint, R. F., 1955, Pleistocene Geology of Eastern South Dakota: U. S. Geol. Survey, Prof. Paper 262, 168 p.

Lee, K. Y., 1958, Geology and Shallow Ground Water Resources of the Brookings Area, Brookings County, South Dakota: S. Dak. State Geol. Survey, Rept. Invest. 84, 62 p.

Powell, J. E., and Lee, K. Y., 1960, Geology and Ground Water Resources of the Flandreau Area, Brookings, Moody and Lake Counties, South Dakota: S. Dak. State Geol. Survey, Rept. Invest. 87.

Tipton, M. J., 1959, Geology of the Chester quadrangle: S. Dak. State Geol. Survey, Geol. Quadrangle, map and text.

U. S. Public Health Service, 1946, Drinking Water Standards: Public Health Repts., v. 61, no. 11, p. 371-384.

Table 1. --Water Analyses of Wells in the Outwash Deposits*

Sample No.	Ca	Mg	Na	Fe	Mn	F	SO_4	Cl	N	Hardness ($CaCO_3$)
	Contents (ppm)									
1	209	46	35	1.2	-	-	498	10	6	712
2	199	26	20	-	-	-	214	39	-	602
3	120	2	5	-	-	-	100	2	-	307

*Analyst: D. J. Mitchell, State Chemist, State Chemical Laboratory, University of South Dakota, Vermillion, South Dakota, 1958.

1. G. F. Hinkley, SW¼NE¼ sec. 27, T. 109 N., R. 50 W.
2. G. Strenge, SE¼NE¼ sec. 7, T. 108 N., R. 50 W.
3. LeRoy Hardey, SW¼SW¼ sec. 31, T. 109 N., R. 49 W.