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**MAJOR AQUIFERS IN CODINGTON AND
GRANT COUNTIES, SOUTH DAKOTA**

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South Dakota Geological Survey,
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ABSTRACT

Seven glacial aquifers and two bedrock aquifers were described in Codington and Grant Counties. The glacial aquifers store about 7.57 million acre-ft of water and the granite wash bedrock aquifer stores about 0.77 million acre-ft of water in Codington and Grant Counties. The amount of water stored in the Dakota bedrock aquifer was not determined.

The areal extent of the glacial aquifers was determined to be 30 square miles for the Antelope Valley aquifer; to range from 140 to 190 square miles for the Lonesome Lake, Big Sioux, and Reville aquifers; 260 square miles for the Veblen aquifer; 760 square miles for the Prairie Coteau aquifer; and 840 square miles for the Altamont aquifer.

The average thicknesses of the glacial aquifers range from 21 to 60 feet. The Big Sioux and Antelope Valley aquifers generally are at or near land surface. The average depth to the top of the Veblen, Prairie Coteau, and Lonesome Lake aquifers ranges from 52 to 270 feet. The average depth to the top of the Reville aquifer is 295 feet and the Altamont aquifer is 460 feet.

Maximum reported well yields are the largest (800–1,100 gallons per minute) from the Antelope Valley, Big Sioux, and Prairie Coteau aquifers. Maximum reported well yields from the Veblen, Lonesome Lake, Reville, and Altamont aquifers generally are less than 150 gallons per minute. Predominant chemical constituents in water from the glacial aquifers are calcium, sodium, bicarbonate, and sulfate. Average dissolved-solids concentrations of water from the aquifers ranged from 350 to 2,120 milligrams per liter.

The two bedrock aquifers described in Codington and Grant Counties are the Dakota and granite wash aquifers. Based on data from only one well, the top of the Dakota aquifer is at about 1,230 feet below land surface. Water from the well completed in the Dakota aquifer is a sodium sulfate type and had a dissolved-solids concentration of 1,480 milligrams per liter. The granite wash aquifer is limited to northeastern Grant County, has an average thickness of 42 feet, and averages 190 feet below land surface. Water from the granite wash aquifer is also a sodium sulfate type.

The average annual water use in Codington and Grant Counties during 1985 was 18.34 million gallons per day. Major water uses include gravel mining, irrigation, and public supply.

INTRODUCTION

This Information Pamphlet is one of a series of reports on water-resources studies of South Dakota counties. It is designed to acquaint the reader with the general distribution, quantity, and quality of ground water available from the major aquifers in Codington and Grant Counties. Information in this pamphlet is based on data (fig. 1) collected by the U.S. Geological Survey and the South Dakota Geological Survey during 1982 through 1989.

Copies of this publication and other county reports may be obtained from the South Dakota Geological Survey as they become available. Additional information about the hydrology and geology may be obtained from the U.S. Geological Survey in Huron or the South Dakota Geological Survey in Vermillion.

The inch-pound units used in this report may be converted to metric (SI) units by the following conversion factors:

Multiply inch-pound unit	By	To obtain metric unit
acre-foot (acre-ft)	1233	cubic meter
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
grains per gallon	17.12	milligrams per liter
mile (mi)	1.609	kilometer
million gallons per day (Mgal/d)	0.04381	cubic meter per second
square mile (mi ²)	2.590	square kilometer

DEFINITIONS OF TERMS

Aquifer: A formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

Bedrock: A general term for the rock, usually consolidated, that underlies soil, sand, clay or other unconsolidated material.

Confined aquifer: An aquifer in which the water in a tightly cased well completed in the aquifer rises above the top of the aquifer.

Dissolved solids: The sum of all dissolved material in water, expressed as the weight (milligrams) of solute per unit volume (liter) of water.

Glacial aquifer: As used in this report, an aquifer consisting mainly of unconsolidated sand and gravel deposited as outwash from a glacier.

Glacial outwash: Gravel, sand, silt, and clay that was deposited by water from melting ice. In this report, the term is restricted to sand and gravel.

Hardness: Dissolved calcium and magnesium salts in water that decrease the lathering ability of soap and form scale in boilers and pipes. Hardness is reported as concentration of calcium carbonate and is classified by the U.S. Geological Survey as follows:

Classification	Milligrams per liter	Grains per gallon
Soft	0 - 60	0 - 3.5
Moderately hard	61 - 120	3.6 - 7.0
Hard	121 - 180	7.1 - 10.5
Very hard	More than 180	More than 10.5

Large-capacity well: Defined by South Dakota law as a well capable of yielding at least 18 gallons per minute on a sustained basis.

Milligrams per liter (mg/L): A unit expressing the concentration of chemical constituents in solution as mass (milligrams) of solute per unit volume (liter) of water. One milligram per liter is approximately equal to one part per million.

Specific conductance: The ability of water to conduct an electric current. Generally, this is a measure of the dissolved chemical constituents in water.

Till: A general term applied to all unsorted rock material (clay, sand, gravel, boulders) transported by glaciers and deposited directly on land or in the sea.

Water table: That water surface in an unconfined aquifer at which the pressure is atmospheric.

GLACIAL AQUIFERS

Seven glacial aquifers were delineated in Codington and Grant Counties (Hansen, 1990). The aquifers consist of medium to coarse unconsolidated sand and gravel deposited by meltwater from receding glaciers. The Big Sioux and Antelope Valley aquifers generally are at or near land surface and are underlain by till. Till consists of grayish-blue clay and contains small amounts of fine sand and silt. The depth to the top of the Veblen and Prairie Coteau aquifers ranges from 1 to 380 feet below land surface. The depth to the top of the Reville, Lonesome Lake, and Altamont aquifers ranges from 105 to 668 feet below land surface. Hydrologic characteristics of these aquifers are given in table 1.

Water-level fluctuations in observation wells screened in the glacial aquifers are caused by seasonal changes in recharge and discharge. Water levels generally rise from February through June because recharge from snowmelt and spring rainfall is greater than discharge. Water levels generally decline from July through January because discharge from wells and/or evapotranspiration are greater than recharge (Hansen, 1990).

Big Sioux Aquifer

The Big Sioux aquifer consists of poorly to well-sorted surficial outwash that ranges from medium sand to medium gravel, is generally less than 10 ft below land surface, and averages 22 ft thick. The aquifer is limited to the flood plain of the Big Sioux River and its tributaries (fig. 2), and is underlain by till. In most locations, the aquifer becomes coarser and more sorted with depth.

Predominant chemical constituents in water from the Big Sioux aquifer are calcium and bicarbonate. Dissolved-solids concentrations of water from the aquifer ranged from 280 to 1,140 mg/L (milligrams per liter) and averaged 580 mg/L. Hardness concentrations determined by onsite analysis averaged 400 mg/L. Water from the aquifer is used for irrigation, domestic, municipal, and stock-watering purposes. Reported discharge from irrigation wells in the Big Sioux aquifer is as much as 1,100 gal/min.

TABLE 1. Summary of the hydrologic characteristics of the major aquifers in Codington and Grant Counties

[--, not determined]

Aquifer name	Areal extent (square miles)	Maximum aquifer thickness (feet)	Average aquifer thickness ¹ (feet)	Range in depth to top of aquifer below land surface (feet)	Average depth to top of aquifer below land surface ¹ (feet)	Range of ground-water level below land surface ² (feet)	Average water level below land surface ³ (feet)	Predominantly confined (C) or water-table (WT) aquifer	Estimated volume of water in storage ⁴ (acre-feet)	Range of reported well discharges ⁵ (gallons per minute)	Suitability for irrigation ⁶
GLACIAL AQUIFERS											
Big Sioux	150	54	22	0-12	3	-1 - 31	8	WT	320,000	50-1,100	Yes.
Antelope Valley	30	52	32	1-57	9	2 - 22	10	WT	92,000	50-800	Yes.
Prairie Coteau	760	62	21	21-380	138	-3 - 101	33	C	1.5 million	50-1,100	Yes.
Veblen	260	155	27	1-210	52	1 - 81	29	C	670,000	10-50	Yes.
Lonesome Lake	140	98	29	200-380	270	80 - 100	90	C	390,000	10-20	Yes.
Revillo	190	150	60	105-665	295	-1 - 71	30	C	1.1 million	50-150	No.
Altamont	840	132	43	319-668	460	5 - 250	150	C	3.5 million	10-50	No.
BEDROCK AQUIFERS											
Dakota ⁷	--	--	--	1,230	--	--	--	C	--	--	No.
Granite wash	190	94	42	75-444	190	-3 - 116	22	C	770,000	10-550	No.

¹ Arithmetic mean from test-hole data.

² A negative number indicates feet above land surface.

³ Arithmetic mean from observation-well data.

⁴ Storage was estimated by multiplying average thickness by areal extent and multiplied by specific yield of 0.15.

⁵ Reported data.

⁶ Based on the South Dakota irrigation-water standards (Koch, 1983).

⁷ Data for aquifer available from only one well.

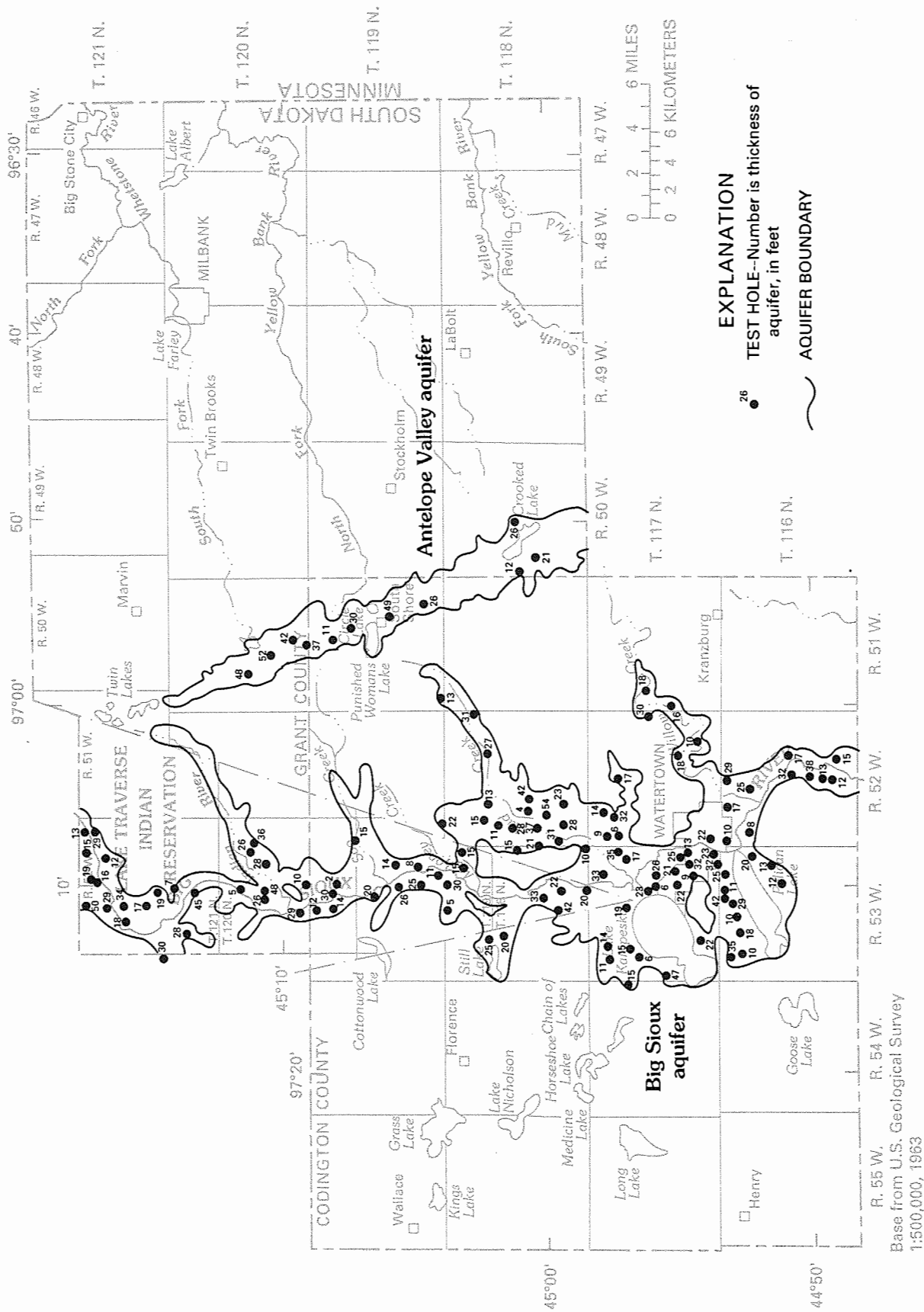


Figure 2.--Extent and thickness of the Big Sioux and Antelope Valley aquifers in Codington and Grant Counties (modified from Hansen, 1990).

Antelope Valley Aquifer

The Antelope Valley aquifer is a glacial-outwash aquifer that lies near the land surface in northeastern Codington and western Grant Counties (fig. 2). The aquifer is composed of brown, very coarse sand to coarse gravel and averages 32 ft thick. The aquifer is hydraulically connected to numerous small lakes and sloughs.

Predominant chemical constituents in water from the Antelope Valley aquifer are calcium and bicarbonate. Specific conductance, determined from onsite analyses, ranged from 320 to 1,850 $\mu\text{S}/\text{cm}$ (microsiemens per centimeter at 25°C) and averaged 1,000 $\mu\text{S}/\text{cm}$. Dissolved-solids concentrations of water from the aquifer ranged from 344 to 352 mg/L and averaged 350 mg/L in four samples. Hardness concentrations, also determined by onsite analysis, ranged from 150 to 890 mg/L and averaged 500 mg/L. Reported discharge from wells in the Antelope Valley aquifer is as much as 800 gal/min. Water from the aquifer is used for irrigation, domestic, and stock-watering purposes.

Prairie Coteau Aquifer

The Prairie Coteau aquifer is composed of brown to gray, coarse to very coarse, well-rounded sand and fine gravel and averages 21 ft thick. The aquifer underlies much of Codington County (except the extreme eastern part and a north-south strip near the center) and the western two townships of Grant County (fig. 3). The top of the aquifer may be as little as 21 ft below land surface in northwestern Codington County and as much as 380 ft below land surface in eastern Codington County. The aquifer may be hydraulically connected to the Big Sioux aquifer, the Coteau Lakes aquifer (in Roberts County), and possibly to Long Lake.

Predominant chemical constituents in water from the Prairie Coteau aquifer in western Grant and eastern Codington Counties are calcium and bicarbonate. In western Codington County, the predominant chemical constituents are calcium and sulfate. Dissolved-solids concentrations ranged from 430 to 660 mg/L and averaged 510 mg/L in western Grant County and eastern Codington County. Dissolved-solids concentrations ranged from 650 to 2,250 mg/L and averaged 1,490 mg/L in western Codington County. Water from the aquifer is used for irrigation in western Grant and northern Codington Counties. Water from the aquifer also is used for irrigation, domestic, and stock-watering purposes.

Veblen Aquifer

The Veblen aquifer is located in eastern Grant County (fig. 4), is composed of brown, medium to coarse sand and fine gravel, and averages 27 ft thick. Coarse sand to coarse gravel was found in T. 121 N., R. 47 W., near the North and South Forks of the Whetstone River. As much as 155 ft of sand and gravel is present 2 to 3 mi northeast of Milbank. The extent of this thick section of sand and gravel was limited to about 1 mi². The average depth below land surface for the aquifer is 52 ft; however, in the northeastern part of Grant County, the aquifer is near land surface.

Water from the Veblen aquifer is a mixed chemical type in which calcium and sulfate are predominant but which also contains significant concentrations of magnesium and bicarbonate. Dissolved-solids concentrations ranged from 880 to 3,000 mg/L and averaged 1,300 mg/L. Hardness

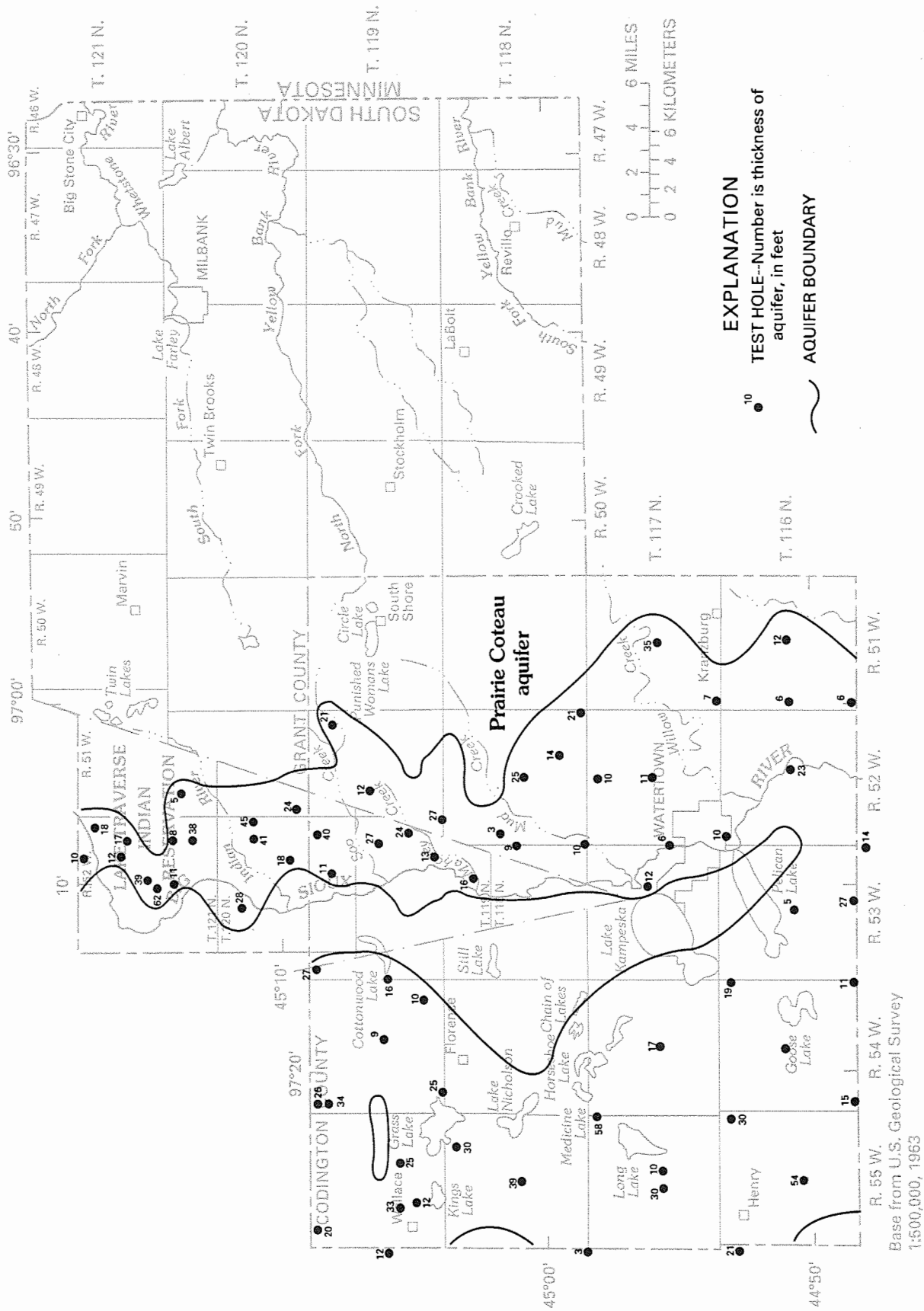


Figure 3.--Extent and thickness of the Prairie Coteau aquifer in Codington and Grant Counties (modified from Hansen, 1990).

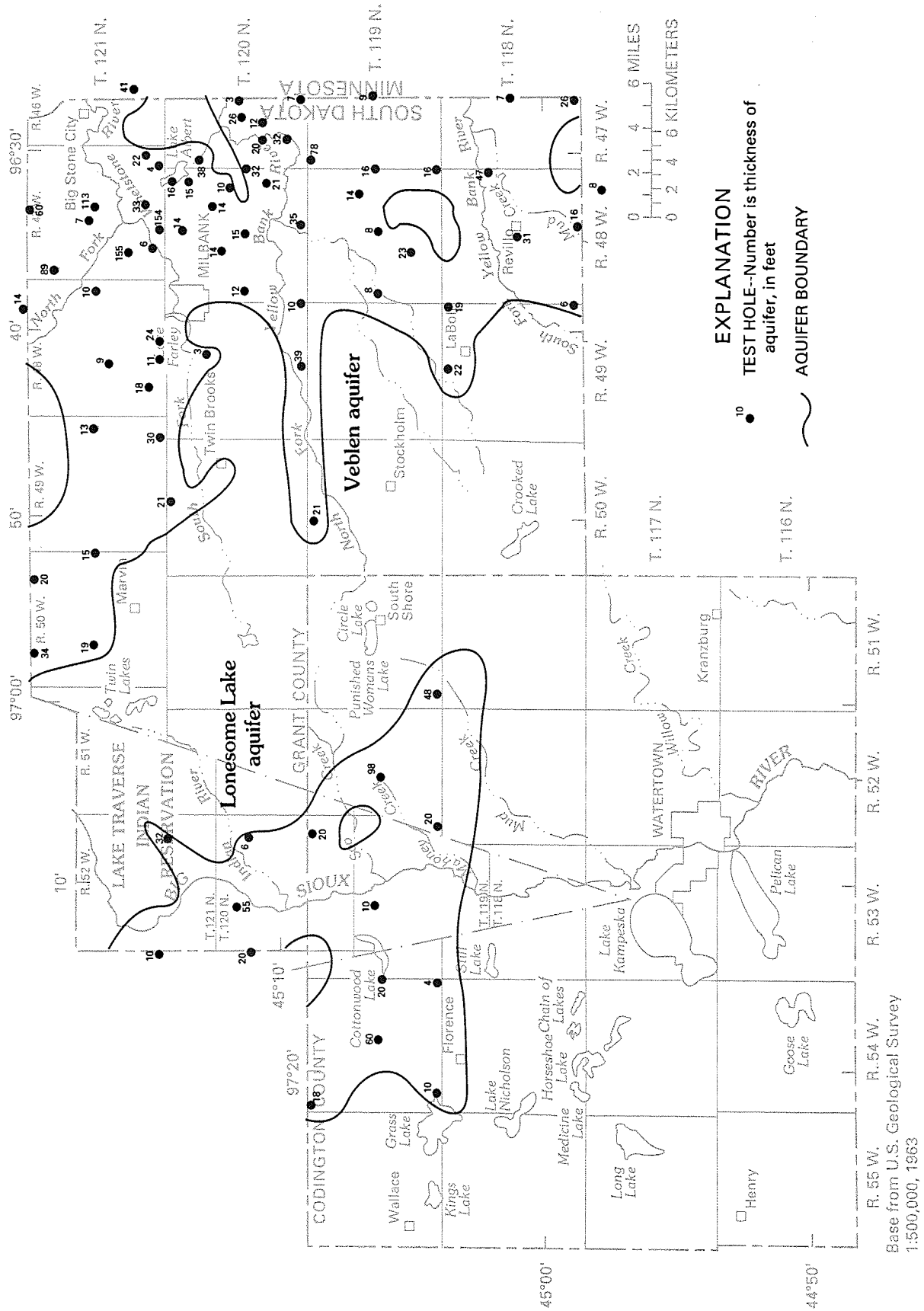


Figure 4.--Extent and thickness of the Lonesome Lake and Veblen aquifers in Codington and Grant Counties (modified from Hansen, 1990).

Base from U.S. Geological Survey 1:500,000, 1963

concentrations ranged from 390 to 2,170 mg/L and averaged 860 mg/L. Water from the aquifer is used for domestic, municipal, and stock-watering purposes.

Lonesome Lake Aquifer

The Lonesome Lake aquifer is located in northern Codington and western Grant Counties (fig. 4), consists of light brown to gray, well-rounded, coarse sand to fine gravel, and averages 29 ft thick. The aquifer contains as much as 20 percent clay near the bottom. The depth to the top of the aquifer ranges from 200 to 380 ft and averages 270 ft below land surface.

Predominant chemical constituents in water from the Lonesome Lake aquifer are calcium and sulfate. Specific conductance (determined by onsite analysis) of water from three observation wells screened in the aquifer were 1,380, 1,220, and 2,730 $\mu\text{S}/\text{cm}$. Water from the aquifer is used primarily for stock watering.

Revilla Aquifer

The Revilla aquifer is located in central Grant County (fig. 5), trends northwest-southeast, and is composed of gray, fine to very coarse gravel. The average aquifer thickness is 60 ft and the aquifer is as much as 150 ft thick in southern Grant County. Depth to the top of the aquifer ranges from 105 ft in the eastern part of the aquifer to 665 ft in the western part. The average depth below land surface is 295 ft.

Predominant chemical constituents in water from the Revilla aquifer are calcium and sulfate, with significant concentrations also of bicarbonate. Specific conductance of water from the aquifer, determined by onsite analysis, ranged from 1,070 to 1,900 $\mu\text{S}/\text{cm}$ and averaged 1,480 $\mu\text{S}/\text{cm}$. Hardness concentrations ranged from 490 to 1,000 mg/L and averaged 625 mg/L. Water from the aquifer is used for domestic, municipal, and stock-watering purposes.

Altamont Aquifer

The Altamont aquifer is located in almost all of Codington County and in western Grant County (fig. 6). It is composed of well-rounded, medium to coarse sand. The aquifer is interbedded with silt and clay layers in the northwest quarter of Codington County. The average thickness of the aquifer is about 43 ft. The depth to the top of the aquifer ranges from 319 to 668 ft and averages 460 ft below land surface.

Predominant chemical constituents in water from the Altamont aquifer are sodium and sulfate. Dissolved-solids concentrations ranged from 1,700 to 2,600 mg/L and averaged 2,120 mg/L. Specific conductance, determined from 40 onsite analyses, ranged from 1,950 to 4,020 $\mu\text{S}/\text{cm}$ and averaged 3,160 $\mu\text{S}/\text{cm}$. Hardness concentrations, also determined from 40 onsite analyses, ranged from 530 to 1,800 mg/L and averaged 840 mg/L. The aquifer is used primarily for domestic and stock-watering wells, but these uses are declining as rural water systems are installed.

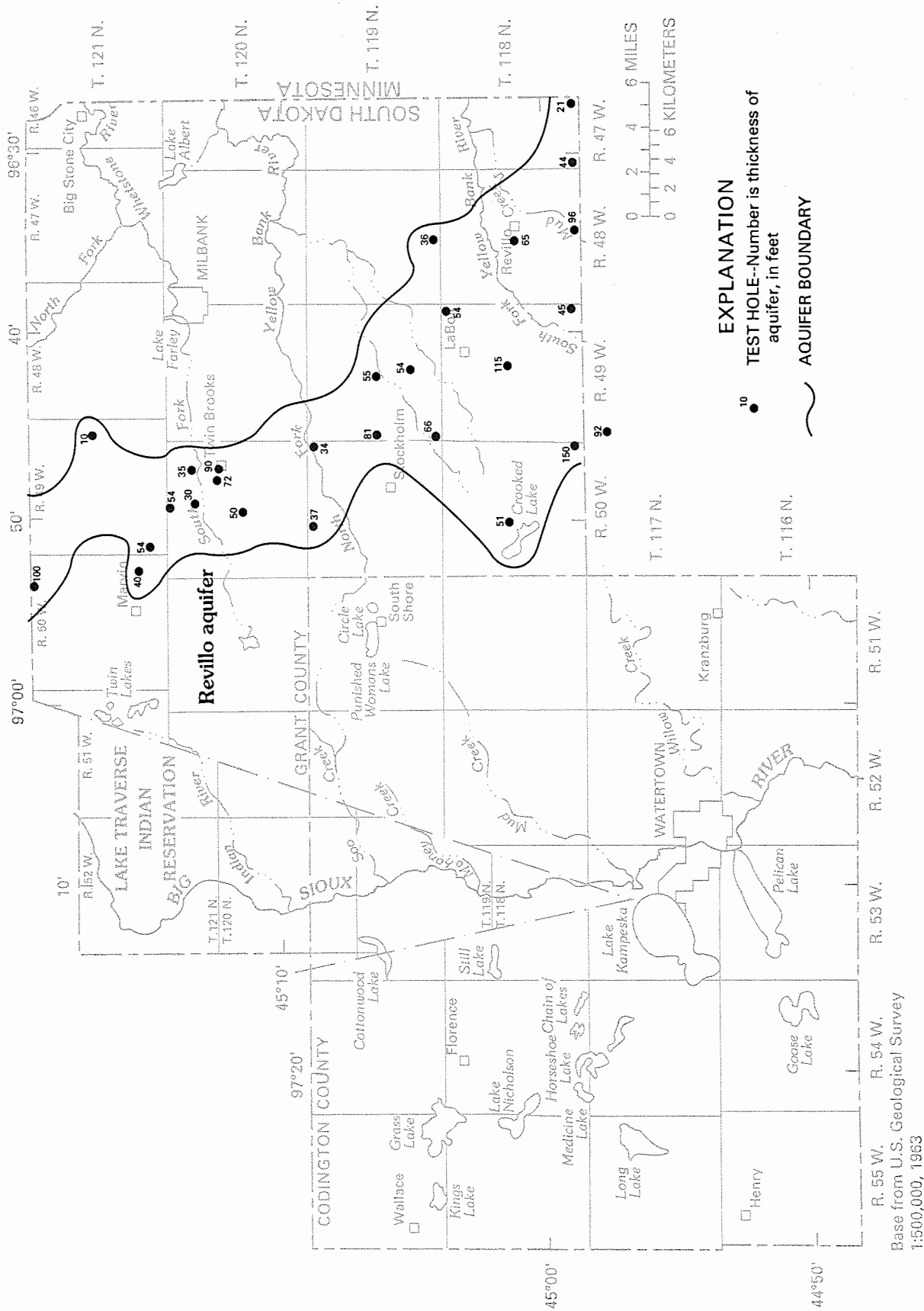


Figure 5.--Extent and thickness of the Revillo aquifer in Grant County (modified from Hansen, 1990).

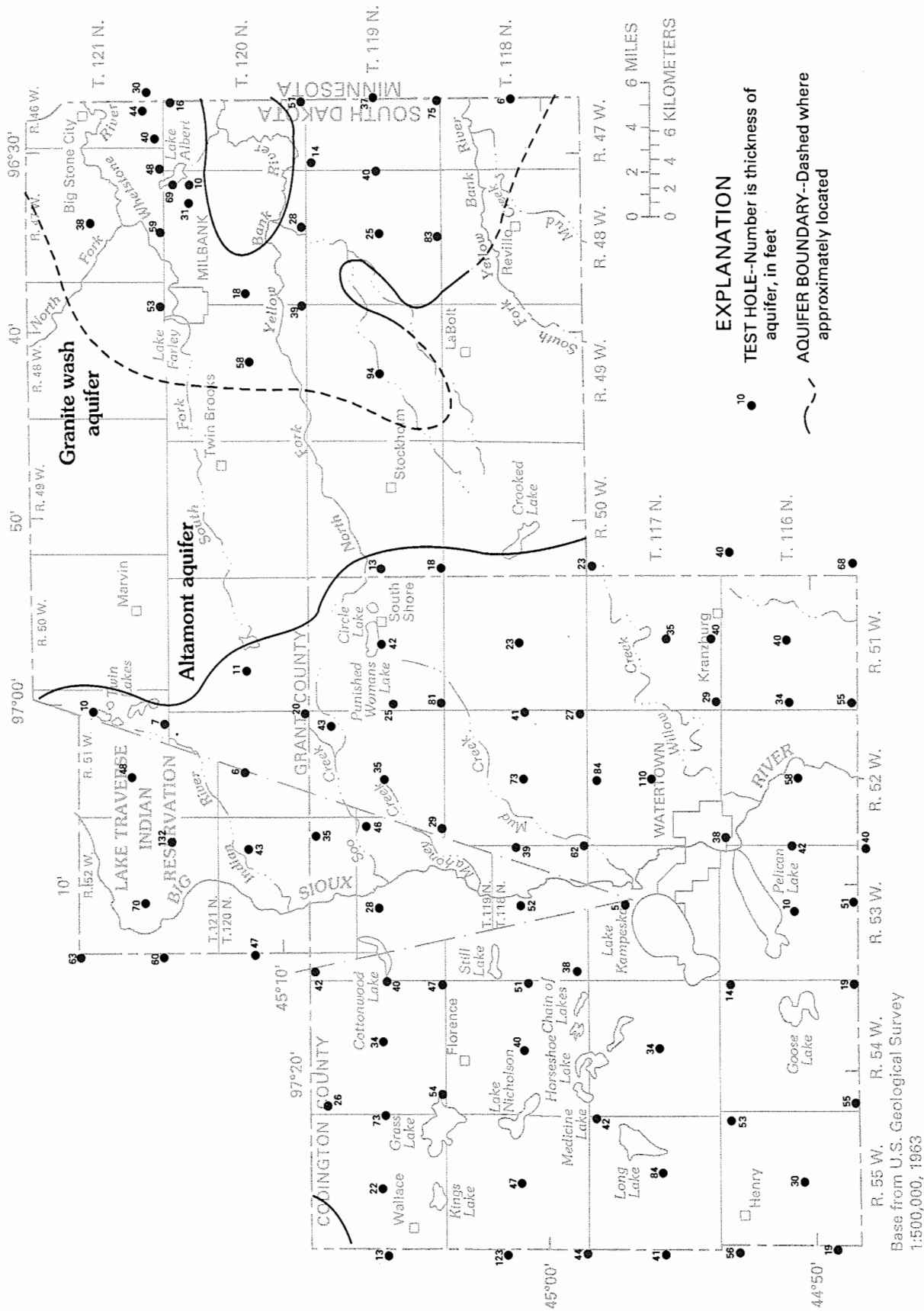


Figure 6.--Extent and thickness of the Altamont and granite wash aquifers in Codington and Grant Counties (modified from Hansen, 1990).

BEDROCK AQUIFERS

Dakota Aquifer

The Dakota aquifer, in the Dakota Formation of Cretaceous age, is composed of a fine-grained, gray to brown sandstone that contains interbedded layers of shale. Data for the aquifer are available only from one well located in T. 116 N., R. 52 W., where the top of the aquifer is at 1,230 ft below land surface. Water from the aquifer, based on one sample, is a sodium sulfate type with a dissolved-solids concentration of 1,480 mg/L.

Granite Wash Aquifer

The granite wash aquifer is located in northeastern Grant County (fig. 6) and is composed of uncemented, coarse, pink to blue to gray, quartzose sand. The average thickness of the aquifer is 42 ft. The aquifer, which overlies the informally named Milbank granite in eastern Grant County, ranges from 75 to 444 ft below land surface and averages 190 ft below land surface. The western boundary of the aquifer in Grant County was approximated because test holes did not penetrate to a depth sufficient to reach the top of the aquifer.

Predominant chemical constituents in water from the granite wash aquifer are sodium and sulfate. Dissolved-sodium concentrations ranged from 440 to 630 mg/L and averaged 550 mg/L. Dissolved-sulfate concentrations ranged from 930 to 1,600 mg/L and averaged 1,200 mg/L. Specific conductance ranged from 3,990 to 6,050 $\mu\text{S}/\text{cm}$ and averaged 4,575 $\mu\text{S}/\text{cm}$. Water from the aquifer is used primarily for domestic and stock-watering wells.

LARGE-CAPACITY WELLS

The best possibilities for obtaining large-capacity wells capable of supplying more than 500 gal/min are in the areas where the aquifers are composed of coarse sand and gravel and are more than 20 ft thick. Before wells are constructed, test holes often are drilled to determine the thickness of the aquifer and to provide samples for determining the grain size of the aquifer material. This information helps in the selection of the proper slot size and length of screen to be used in the construction of a well. Controlled pumping of the well for at least several hours indicates the yield of the aquifer at that locality and provides a representative water sample for chemical analysis. Measurement of the recovery of water level in the well provides information that is useful for estimating the yield of a well during longer pumping periods. If the well is to be used for irrigation, knowledge of the type of soil, subsoil, and topography are also important in selecting the most suitable irrigation system. Increased ground-water development, especially in stream valleys, may decrease streamflow.

WATER USE

Gravel-mining activities were the primary users of water (7 Mgal/d) in Codington and Grant Counties during 1985. Seventeen percent of the total amount of water used in the counties was for irrigation, and 98 percent of the water used for irrigation was ground water. About 33 percent of the

ground water used for irrigation was withdrawn from the Big Sioux aquifer and about 66 percent was withdrawn from the Prairie Coteau aquifer. All the withdrawals in Codington and Grant Counties for public-water supply (17 percent of total use) were from ground water. The city of Watertown and the Sioux Rural Water System obtain water from the Big Sioux aquifer. The cities of Milbank and Reville obtain their supply from the Reville aquifer. About sixty percent of the water used for stock watering was derived from surface-water sources and 40 percent from ground-water sources. Well-inventory data indicate that the primary source of ground water for stock watering are the Prairie Coteau and Altamont aquifers. Total water use in Codington and Grant Counties during 1985 was 18.34 Mgal/d.

SUMMARY

Seven glacial aquifers and two bedrock aquifers were described in Codington and Grant Counties. The glacial aquifers store about 7.57 million acre-ft of water and the granite wash bedrock aquifer stores about 0.77 million acre-ft of water in Codington and Grant Counties. The amount of water stored in the Dakota bedrock aquifer was not determined.

The areal extent of the glacial aquifers was determined to be 30 mi² for the Antelope Valley aquifer; 140 to 190 mi² for the Lonesome Lake, Big Sioux, and Reville aquifers; 260 mi² for the Veblen aquifer; 760 mi² for the Prairie Coteau aquifer; and 840 mi² for the Altamont aquifer.

The average thickness of the Big Sioux aquifer is 22 ft, and the average thickness of the Antelope Valley aquifer is 32 ft. These aquifers generally are at or near land surface, and maximum reported well yields range from 800 to 1,100 gal/min. Predominant chemical constituents in water from these aquifers are calcium and bicarbonate. Dissolved-solids concentrations of water from the Big Sioux aquifer averaged 580 mg/L and from the Antelope Valley aquifer averaged 350 mg/L. Water from the aquifers is used for irrigation, domestic, municipal, and stock-watering purposes.

The average thicknesses of the Prairie Coteau, Veblen, and Lonesome Lake aquifers range from 21 to 29 ft, and the average depths to the top of these aquifers range from 52 to 270 ft. Maximum reported yields from these aquifers range from 20 to 1,100 gal/min. Predominant chemical constituents in water from the Prairie Coteau aquifer in western Grant and eastern Codington Counties are calcium and bicarbonate and in western Codington are calcium and sulfate. Dissolved-solids concentrations in water samples from the Prairie Coteau aquifer averaged 510 mg/L in western Grant County and eastern Codington County and 1,490 mg/L in samples from western Codington County. Predominant chemical constituents in water from the Veblen and Lonesome Lake aquifers are calcium and sulfate. Dissolved-solids concentrations in water from the Veblen aquifer averaged 1,300 mg/L. Water from the aquifers is used for irrigation, domestic, municipal, and stock-watering purposes.

The average thickness and depth to the top of the Reville aquifer are 60 and 295 ft, respectively. The average thickness and depth to the top of the Altamont aquifer are 43 and 460 ft, respectively. Maximum reported well yields from these aquifers range from 50 to 150 gal/min. Predominant chemical constituents in water from the Reville aquifer are calcium and sulfate and from the Altamont aquifer are sodium and sulfate. Specific conductance of water from the Reville aquifer averaged 1,480 μ S/cm, and dissolved-solids concentrations of water from the Altamont aquifer

averaged 2,120 mg/L. Water from the aquifers is used for domestic, municipal, and stock-watering purposes.

The two bedrock aquifers described in Codington and Grant Counties are the Dakota and granite wash. Based on data from only one well, the top of the Dakota aquifer is at about 1,230 ft below land surface. Water from the well completed in the Dakota aquifer is a sodium sulfate type and had a dissolved-solids concentration of 1,480 mg/L. The granite wash aquifer is limited to northeastern Grant County, has an average thickness of 42 ft, and averages 190 ft below land surface. Water from the granite wash aquifer is also a sodium sulfate type.

The average annual water use in Codington and Grant Counties during 1985 was 18.34 Mgal/d. Major water users in Codington and Grant Counties were gravel mining (38 percent), irrigation (17 percent), and public supply (17 percent).

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