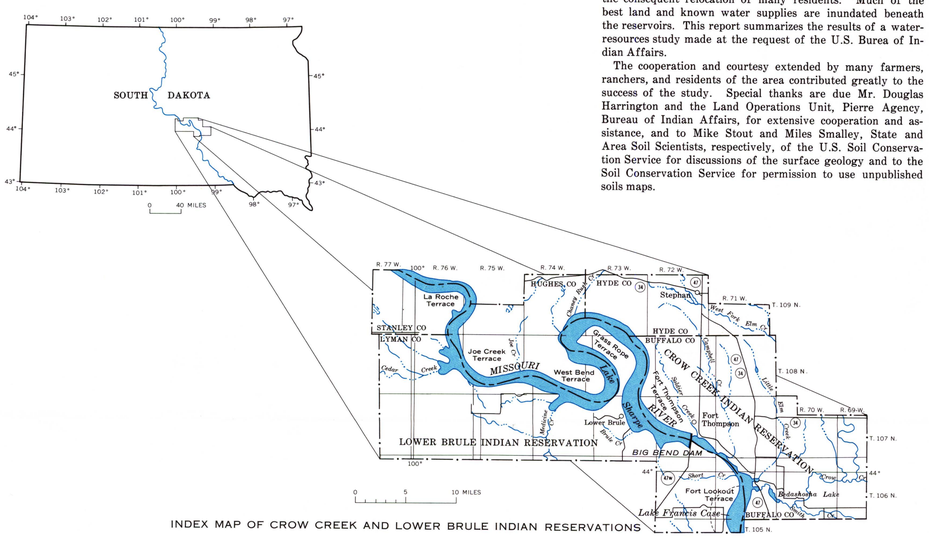
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED AS PART OF THE PROGRAM OF THE
DEPARTMENT OF THE INTERIOR FOR THE
DEVELOPMENT OF THE MISSOURI RIVER BASIN

HYDROLOGIC INVESTIGATIONS
ATLAS HA-499 (SHEET 1 OF 2)

INTRODUCTION



INDEX MAP OF CROW CREEK AND LOWER BRULE INDIAN RESERVATIONS

INTRODUCTION

Effective improvement of economic and social conditions of Indians living on Crow Creek and Lower Brule Reservations has been hampered by lack of adequate and reliable information about the quantity and quality of water supplies available for development. Compounding the problem, and making especially pressing the need for discovery and development of new water supplies, is the recent filling of Fort Randall and Big Bend Reservoirs on the Missouri River, and the consequent relocation of many residents. Much of the best land and known water supplies are inundated beneath the reservoirs. This report summarizes the results of a water-resources study made at the request of the U.S. Burea of Indian Affairs.

The cooperation and courtesy extended by many farmers, ranchers, and residents of the area contributed greatly to the success of the study. Special thanks are due Mr. Douglas Harrington and the Land Operations Unit, Pierre Agency, Bureau of Indian Affairs, for extensive cooperation and assistance, and to Mike Stout and Miles Smalley, State and Area Soil Scientists, respectively, of the U.S. Soil Conservation Service for discussions of the surface geology and to the Soil Conservation Service for permission to use unpublished soils maps.

LOCATION AND SETTING

The Crow Creek and Lower Brule Indian Reservations are separated by the Missouri River in central South Dakota. The reservations are in the Missouri Plateau division of the Great Plains physiographic province. The Crow Creek Reservation extends from the Missouri River trench section eastward into the Coteau du Missouri; Lower Brule Reservation extends from the Missouri River trench westward into the Pierre Hills section.

The topography is basically a high rolling upland cut by the deep meandering trench of the Missouri River. Erosion has cut deeply into the upland near the trench to sculpture a bad-lands type area known locally as the "breaks". The breaks are more extensively developed on the west side of the Missouri. Six fairly flat well-defined terraces extend along the river as shown on the index map.

Except for the terraces and part of the rolling uplands, much of the land is unsuitable for large scale crop production because of rugged topography or poor soils. The Bureau of Indian Affairs (1964 and 1965) soil and range studies found that only 16 percent of Lower Brule Reservation and 37 percent of Crow Creek is arable land suitable for production of cultivated crops. Thus much of the area is rangeland or hayland with scattered fields of cultivated crops, mostly raised for livestock feed. In 1970 more than 80 percent of the land was used for grazing.

Individual livestock water supplies are fairly small and widely dispersed, a necessity for successful ranching under existing climatic and topographic conditions. The low precipitation, generally low soil fertility, and moderately high relief support a fairly sparse plant growth that must be carefully managed to prevent overgrazing and yet make optimum use of available range resources. The Bureau of Indian Affairs soil and range studies (1964 and 1965) found an average range capacity of 2.6 acres per animal month (a maximum of more than 8), or about 21 acres per animal each grazing season. Rangeland requirements of this magnitude necessitate low livestock population densities, frequent shifting of stock between pastures, or both. Availability of adequate supplies of water close to feeding areas is critical to success in livestock production. Long travel between food and water can result in livestock weight losses rather than weight gains. Thus, to maximize stock production and to make best use of rangeland requires many, dispersed, water supplies. For many ranchers the least expensive way to improve water supplies is to capture and hold spring runoff and occasional summer storm flow by building dams or excavating dugouts in ephemeral streams and drainageways.

SURFACE-WATER RESOURCES

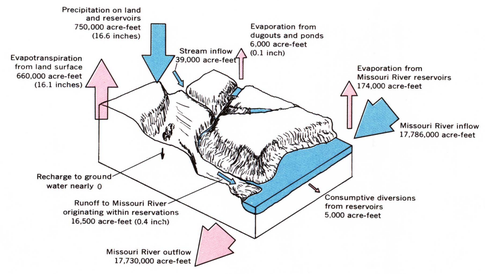


DIAGRAM SHOWING APPROXIMATE ANNUAL HYDROLOGIC BUDGET, CROW CREEK AND LOWER BRULE INDIAN RESERVATIONS

SURFACE-WATER RESOURCES

The Missouri River and its reservoirs, both in volume and in potential for development, vastly overshadow all other sources of surface water on the two reservations. The average annual flow of the Missouri through the area is about 17.73 million acre-feet; compared to this, the average annual surface-water runoff of 0.017 million acre-feet or, even, the total annual rainfall of 0.68 million acre-feet are relatively insignificant. Yet, in 1970, surface water sources other than the Missouri impoundments were more important to the economy; and for much of the region probably will remain so in the future because most of the area is suitable only for rangeland.

The surface-water hydrology of the two reservations is summarized in the following diagram showing the approximate annual hydrologic budget.

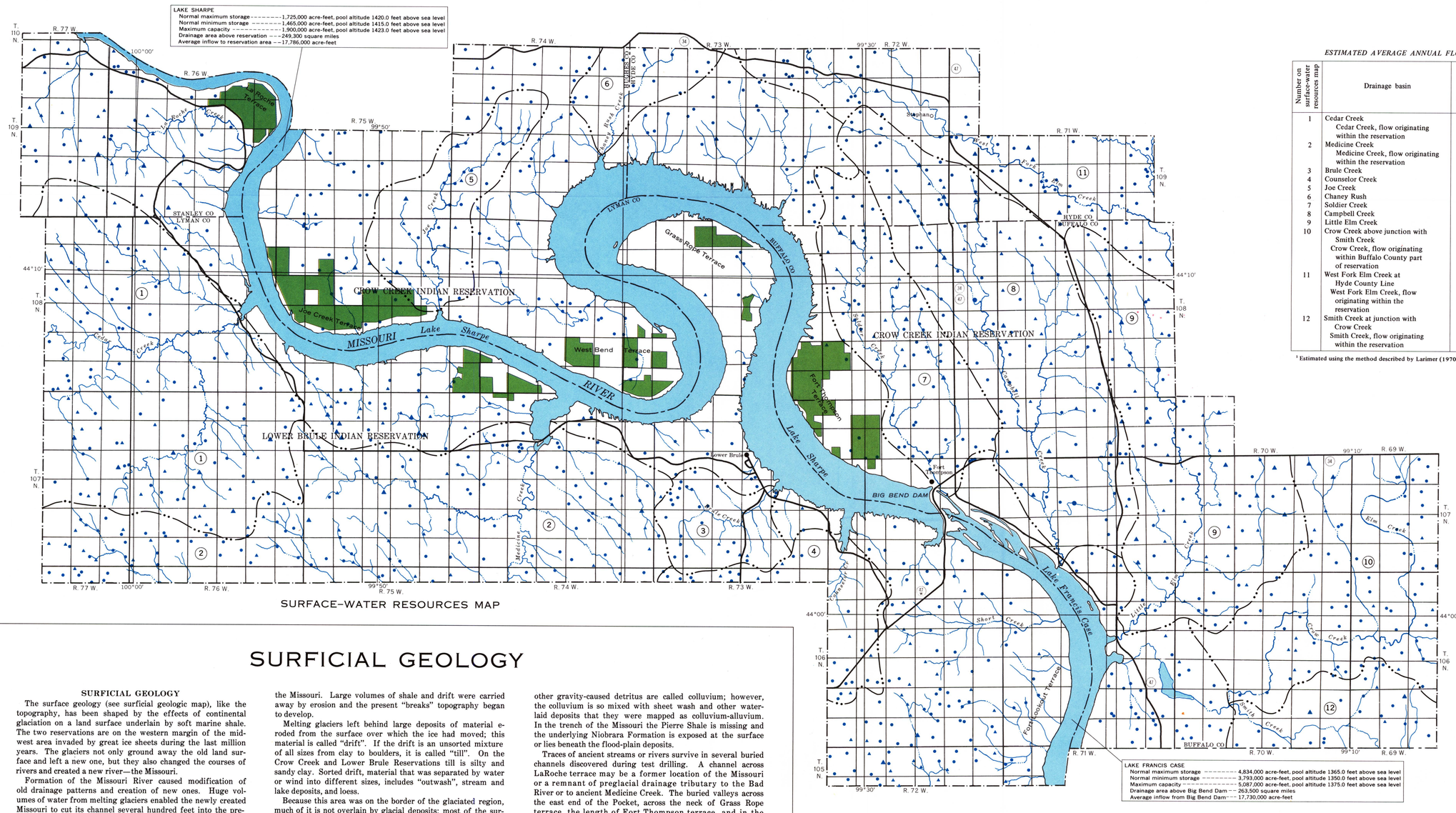
The Missouri River and the lower reaches of Crow Creek are the only streams that flow all year. Most local streamflow is from snowmelt and spring rain. In most years more than 95 percent of streamflow reaching the Missouri River occurs in March, April, and May. Runoff from summer storms usually evaporates or infiltrates the subsurface before it reaches the Missouri.

The estimated average annual flows in selected streams are shown in the table below.

The Missouri River reservoirs are an almost untouched water resource. Aside from power generation and flow-regulation functions, and considering the use of these reservoirs as water supplies only, development by the end of 1970 was negligible. Within the boundaries of the two reservations less than 10 acre-feet was used for public supplies at the towns of Fort Thompson and Lower Brule, about 4,900 acre-feet was diverted to irrigate 4,200 acres of cropland, and some, probably less than 50 acre-feet, was consumed by livestock. The reservoirs, particularly Lake Sharpe and the tailwaters of Big Bend Dam on Lake Francis Case, also provided outstanding recreational use for fishermen, boaters, and others interested in camping, water sports, and waterfowl hunting.

The chemical quality of surface water ranges from very good to very poor, depending upon the water source and time of year. The system of large reservoirs on the Missouri River has stabilized the quality of river water to a year-round average of about 500 mg/l (milligrams per liter) of dissolved solids. Tributary streams, stock dams, and dugouts, however, may vary greatly in water quality during the year. Water quality is best in spring during snowmelt and poorest in late summer or fall when pools and ponds may have been stagnant for several months.

The samples analyzed for this report were collected near the end of the snowmelt runoff period on April 1, 1971. Water from streams tributary to the Missouri River contained from 476 to 2,890 mg/l dissolved solids. Medicine Creek water contained 12 μg/l (micrograms per liter) of cadmium, slightly more than the 10 μg/l limit recommended by the U.S. Public Health Service. Water from Joe Creek and Cedar Creek contained 0.2 and 0.1 μg/l mercury, respectively, and both contained 8 μg/l cadmium. The source of both the cadmium and mercury found in these samples is unknown, but probably is from natural leaching of the Pierre Shale.



SURFACE-WATER RESOURCES MAP

ESTIMATED AVERAGE ANNUAL FLOWS IN SELECTED STREAMS.[1]

Number on surface-water resources map	Drainage basin	Drainage area (sq. mi.)	Annual streamflow: Acre-ft per sq. mi.	Annual streamflow: Cubic feet per second	Annual streamflow: Acre-ft
1	Cedar Creek	164	20.7	4.7	3,400
	Cedar Creek, flow originating within the reservation	81.5	20.3	2.3	1,660
2	Medicine Creek	689	20.9	19.9	14,400
	Medicine Creek, flow originating within the reservation	80.5	21.6	2.4	1,740
3	Brule Creek	12.7	22.8	.4	290
4	Counselor Creek	29.3	22.2	.9	650
5	Joe Creek	20.4	21.1	.6	430
6	Chaney Rush	18.3	23.5	.6	430
7	Soldier Creek	29.9	21.7	.9	650
8	Campbell Creek	69.4	21.6	2.1	1,500
9	Little Elm Creek	66.2	22.0	2.0	1,450
10	Crow Creek above junction with Smith Creek	814	22.5	25.3	18,300
	Crow Creek, flow originating within Buffalo County part of reservation	48.1	22.9	1.5	1,100
11	West Fork Elm Creek at Hyde County Line	71.7	22.3	2.2	1,600
	West Fork Elm Creek, flow originating within the reservation	35.2	22.7	1.1	800
12	Smith Creek at junction with Crow Creek	359	22.8	11.2	8,200
	Smith Creek, flow originating within the reservation	39.4	22.1	1.2	870

[1] Estimated using the method described by Larimer (1970).

EXPLANATION

Stock dams and dugouts through 1970

	Number	Estimated area	Estimated storage
Less than 1 acre	820	1,852 acres	9,210 acre-feet
1 to 5 acres	270		
5 to 20 acres	65		
More than 20 acres	3		

Land developed for irrigation with surface water through 1970

Public water supplies from surface water in 1970

③ Selected drainage basins
Basin numbers refer to table

SURFICIAL GEOLOGY

SURFICIAL GEOLOGY

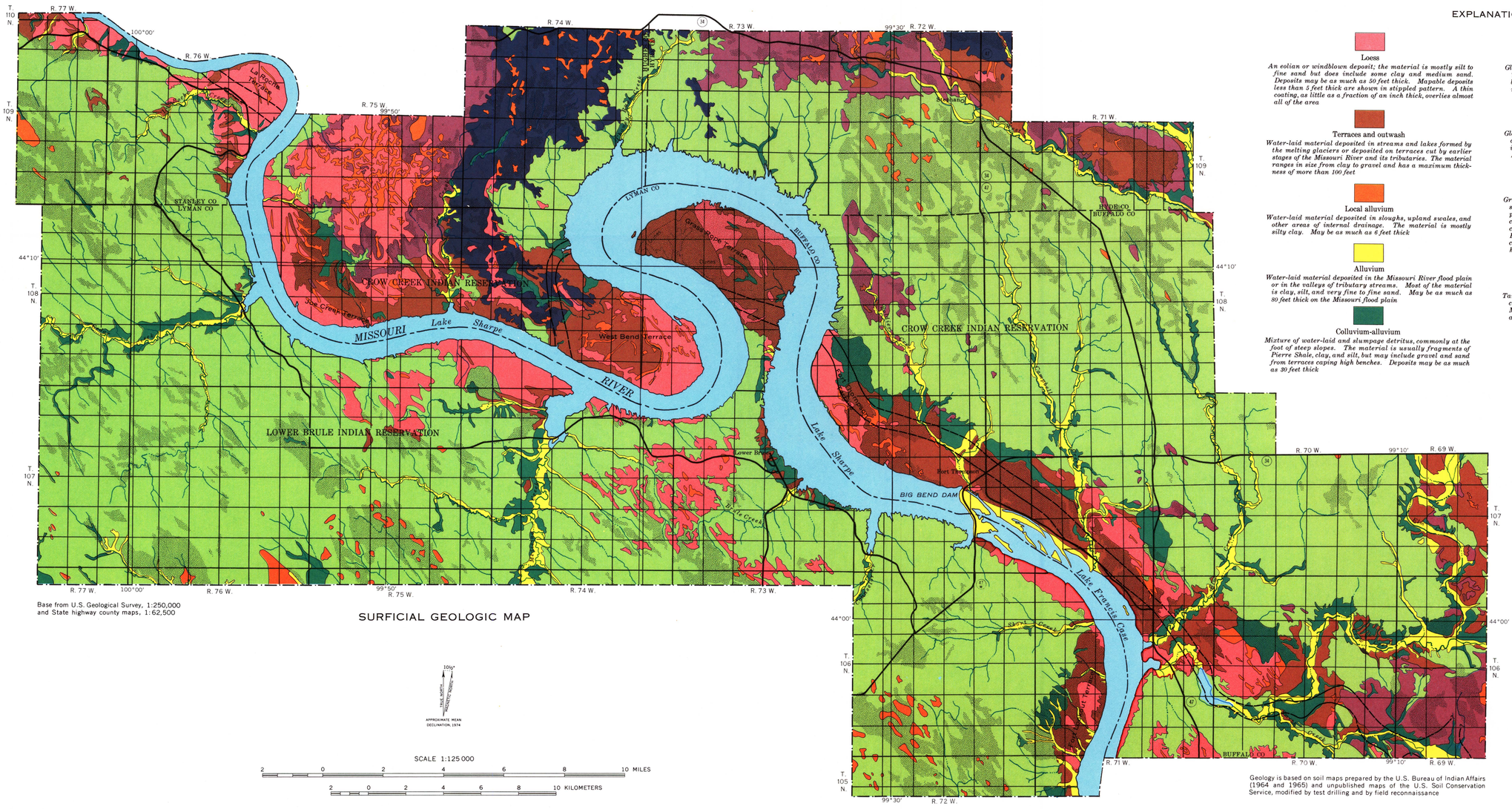
The surface geology (see surficial geologic map), like the topography, has been shaped by the effects of continental glaciation on a land surface underlain by soft marine shale. The two reservations are on the western margin of the midwest area invaded by great ice sheets during the last million years. The glaciers not only ground away the old land surface and left a new one, but they also changed the courses of rivers and created a new river—the Missouri.

Formation of the Missouri River caused modification of old drainage patterns and creation of new ones. Huge volumes of water from melting glaciers enabled the newly created Missouri to cut its channel several hundred feet into the pre-existing land surface. As the Missouri cut its trench deeper, it left remnants of its valley behind as terraces. Tributary streams rapidly cut their channels deeper to keep pace with the Missouri. Large volumes of shale and drift were carried away by erosion and the present "breaks" topography began to develop.

Melting glaciers left behind large deposits of material eroded from the surface over which the ice had moved; this material is called "drift". If the drift is an unsorted mixture of all sizes from clay to boulders, it is called "till". On the Crow Creek and Lower Brule Reservations till is silty and sandy clay. Sorted drift, material that was separated by water or wind into different sizes, includes "outwash", stream and lake deposits, and loess.

Because this area was on the border of the glaciated region, much of it is not overlain by glacial deposits; most of the surface is underlain by Pierre Shale. Due to the high relief and softness of the Pierre Shale, slumping is very common, particularly in the "breaks". Deposits of slumped material and other gravity-caused detritus are called colluvium; however, the colluvium is so mixed with sheet wash and other water-laid deposits that they were mapped as colluvium-alluvium. In the trench of the Missouri the Pierre Shale is missing and the underlying Niobrara Formation is exposed at the surface or lies beneath the flood-plain deposits.

Traces of ancient streams or rivers survive in several buried channels discovered during test drilling. A channel across LaRoche terrace may be a former location of the Missouri or a remnant of preglacial drainage tributary to the Bad River or to ancient Medicine Creek. The buried valleys across the east end of the Pocket, across the neck of Grass Rope terrace, the length of Fort Thompson terrace, and in the Crow Creek-Smith Creek area probably are part of one ancient channel, that of Medicine Creek.



SURFICIAL GEOLOGIC MAP

Base from U.S. Geological Survey, 1:250,000 and State highway county maps, 1:62,500

APPROXIMATE MEAN DECLINATION, 1974

SCALE 1:125 000
2 0 2 4 6 8 10 MILES
2 0 2 4 6 8 10 KILOMETERS

EXPLANATION

Loess
An eolian or windblown deposit; the material is mostly silt to fine sand but does include some clay and medium sand. Deposits may be as much as 50 feet thick. Mapable deposits less than 5 feet thick are shown in stippled pattern. A thin coating, as little as a fraction of an inch thick, overlies almost all of the area

Terraces and outwash
Water-laid material deposited in streams and lakes formed by the melting glaciers or deposited on terraces cut by earlier stages of the Missouri River and its tributaries. The material ranges in size from clay to gravel and has a maximum thickness of more than 100 feet

Local alluvium
Water-laid material deposited in sloughs, upland swales, and other areas of internal drainage. The material is mostly silty clay. May be as much as 6 feet thick

Alluvium
Water-laid material deposited in the Missouri River flood plain or in the valleys of tributary streams. Most of the material is clay, silt, and very fine to fine sand. May be as much as 80 feet thick on the Missouri flood plain

Colluvium-alluvium
Mixture of water-laid and slumpage detritus, commonly at the foot of steep slopes. The material is usually fragments of Pierre Shale, clay, and silt, but may include gravel and sand from terraces caping high benches. Deposits may be as much as 30 feet thick

Ground moraine
Glacial drift deposited beneath the ice of the continental glaciers. The material is a heterogeneous mixture of sizes from clay to boulders, but mostly is clay, silt, and sand. Deposits are as much as 100 feet thick

End moraine
Glacial drift deposited at the margins of the continental glaciers; deposits more easily detected if the glacial margin remained in the same general location for an extended period of time. Deposits may be as much as 120 feet thick

Pierre Shale
Gray, brown, and black, locally green, tough, gummy, marine shale, non-calcareous to highly calcareous. Contains widely persistent beds or zones of bentonite and iron-manganese concretions. Where exposed at the surface, the top few feet commonly is weathered, particularly west of the Missouri River; there the Pierre may be reduced to a highly weathered clay residuum to a depth of as much as 30 feet. The Pierre has a maximum thickness of about 550 feet

Niobrara Formation
Tannish to bluish-gray and light to dark-gray chalky, highly calcareous marine shale. Exposed in the walls of the Missouri trench south of Big Bend Dam. The Niobrara has a maximum thickness of about 160 feet

Loess
Not more than 5 feet thick

Contact

Buried drainageways or valley
Dashed where inferred

Geology is based on soil maps prepared by the U.S. Bureau of Indian Affairs (1964 and 1965) and unpublished maps of the U.S. Soil Conservation Service, modified by test drilling and by field reconnaissance

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1974—W73014

GEOHYDROLOGY OF CROW CREEK AND LOWER BRULE INDIAN RESERVATIONS, SOUTH DAKOTA

By
Lewis W. Howells

1974

For sale by U.S. Geological Survey, price $1.25 per set