STATUS OF MINERAL RESOURCE INFORMATION FOR THE FLANDREAU INDIAN RESERVATION, SOUTH DAKOTA

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Administrative Report BIA-86
1981

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SUMMARY AND CONCLUSIONS

Sand and gravel is the major known mineral resource on the Flandreau Indian Reservation. Small amounts have been produced in the area, mainly from several pits in glacial outwash deposits. Large amounts of unexploited sand and gravel are available in glacial outwash and in alluvium located along and in the valleys of the Big Sioux River and Flandreau Creek and their tributaries.

In addition to small pockets of sand and gravel, potentially usable clay deposits are present in ground-moraine deposits occupying highlands between stream valleys. Clays in ground-moraine are likely to be present in abundant amounts but they are likely to be of low-purity with limited commercial applications.

INTRODUCTION

This report was prepared for the U.S. Bureau of Indian Affairs (BIA) by the U.S. Geological Survey (USGS) and the U.S. Bureau of Mines (USBM) under an agreement to compile and summarize available information about the geology, mineral resources, and potential for economic development of certain Indian lands. Source materials were published and unpublished reports and personal communications. There was no fieldwork.

Location and Access

The Flandreau Indian Reservation is located near Flandreau, the county seat of Moody County, in east-central South Dakota. The reservation includes 2,183 acres of tribal land in three segments lying north, east, and south of Flandreau; in addition, 176 acres of government land adjacent to the city on the north is occupied by the BIA Flandreau Indian School (Figure 1). According to BIA, the population of the reservation (excluding students boarding at the Indian school) was estimated at 385 in 1979, and the population of Flandreau was 2,114 (1980 Census).

Commercial air transportation and train service are available at Sioux Falls (population 81,343), 42 miles south of Flandreau, and at Brookings (population 14,951), 29 miles northwest of Flandreau. Bus and truck service are available at Flandreau. Tracks of the Chicago, Milwaukee, St. Paul and Pacific Railroad, which had served Flandreau until recently and crossed a part of the reservation, have been abandoned and the rails removed. State Highway 32 connects the city with Interstate 29, which is 8 miles to the west; State Highway 13 passes through the city from south to north and provides access to much of the reservation (Figure 1). Some tracts of reservation land are accessible, however, only via unimproved dirt roads.

The reservation is in the Coteau des Prairies section of the Great Plains physiographic province; this upland region has been profoundly affected by glaciation (Flint, 1955, p. 5-9). Topography of the region is gently rolling; the elevation at Flandreau is 1,570 feet above sea level, and maximum relief in the area is about 100 feet. The Big Sioux River meanders through the area, flowing to the south in a ½- to l-mile-wide floodplain (valley) cut about 50 feet into the surrounding countryside. The climate is temperate, and average annual precipitation is about 23 inches. Most of the land in the area is devoted to agriculture.

Map Coverage

The entire reservation lies within the USGS 7½-minute topographic map of the Flandreau Quadrangle (scale 1:24,000). This map is available from the USGS Branch of Distribution, Box 25286, Denver Federal Center, Denver, Colorado 80225.

A geologic map of the Flandreau 15-minute quadrangle (scale 1:62,500) has been prepared by Lee (1960); this map is available from the South Dakota Geological Survey, Science Center, University of South Dakota, Vermillion, South Dakota 57069, along with other maps and reports published by the State survey.

Previous and Ongoing Studies

Several geologic studies have been done in the region around Flandreau; most focus on the glacial geology and (or) the hydrology and ground-water resources, however, and information about mineral resources of the area is scant. Much of the earlier work was summarized and augmented in a comprehensive report by Flint (1955).

More recently, reports by Lee (1960) and Lee and Powell (1961) describe the geology of the Flandreau area in more detail and include short sections on mineral resources of the area. Ellis and Adolphson (1969) and Ellis and others (1969) discuss the hydrology of the area. This year (1981), the South Dakota Geological Survey began a comprehensive 3-year study of the geology and mineral resources of Moody and adjacent Lake Counties (Richard Hammond, South Dakota Geological Survey, oral communication, 1981).

GEOLOGY

The surface area of the reservation is covered entirely by glacial deposits and modern alluvium. The ground surface is gently undulating on the upper surfaces of the glacial deposits. The thickness of the glacial deposits is highly variable due to irregularities of both surface and of the pre-glacial surface.

The bedrock underlying the glacial debris is mainly Sioux Quartzite, of Precambrian age. The reservation lies on the north flank of an east-west-trending ridge of Sioux Quartzite upon which may be a thin remnant of the Pierre Shale which laps on from the north (see Figure 2 and Table 1).

Glacial Deposits

For this report, glacial deposits have been divided into two types: ground-moraine (thought to be of Iowan age) and outwash (Cary age) (see Figure 3 and Table 2).

Ground-moraine is an unsorted mixture of debris deposited by a glacier, consisting of boulders, gravel, sand, and clay from many sources. Much of the material is unsorted; but pockets of sand and gravel and clay are usually present from place to place.

Outwash is water-laid material deposited by meltwater from the glacier, and consists of mainly sand and gravel in stream terraces and alluvial fans.

TABLE 1

Stratigraphic Relations in the Flandreau area.

Modified from Lee and Powell, 1961

Stratigraphic information was obtained from a study of samples from 61 shallow test holes drilled in the area, from logs of deep wells drilled in and near the area, and from published material. The stratigraphic nomenclature used in this report conforms generally to that used by Flint in U. S. Geological Survey Professional Paper 262 published in 1955.

The stratigraphic section for the Flandreau area is summarized in the following table.

```
Cenozoic
      Quaternary system
            Recent series:
                  Alluvium
                  Lake deposits
            Pleistocene series:
                  Wisconsin stage
                        Cary substage
                        Tazewell (?) substage
                        Iowan (?) substage

Mesozoic
      Cretaceous system
            Upper Cretaceous series:
                  Pierre Shale

Precambrian
      Sioux Quartzite
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Subsurface Rocks

Pierre Shale

The Pierre Shale, if present at all beneath the glacial deposits on the reservation, would occur as thin remnants of carbonaceous black or gray shale resting on Sioux Quartzite. According to the map showing bedrock beneath southeastern South Dakota as estimated from various drill hole records (Figure 2), only Sioux Quartzite can be expected beneath the reservation. That map, however, is an estimate; and small remnants of Pierre Shale may be present beneath the reservation. Pierre Shale is surely present a short distance to the north.

Sioux Quartzite

The Sioux Quartzite is a massive unit of pinkish Precambrian quartzite which underlies a large part of eastern South Dakota.

The axis of the Sioux Quartzite Ridge runs east-west, south of Flandreau, and plunges westward (see Figure 2) beneath sedimentary rocks of successively older age. To the east and north, the quartzite crops out in Iowa and Minnesota; and outcrops exist to the south in Minnehaha County.

Certainly the major bedrock unit beneath the glacial deposits of the Flandreau Reservation is Sioux Quartzite.

MINERAL RESOURCES

The following sections summarize available information about energy, metallic, and nonmetallic mineral resources that occur, or that may possibly occur, within the Flandreau Indian Reservation. The commodities discussed include identified, as well as undiscovered mineral resources, and mineral occurrences, as these terms are defined under a classification system adopted by the U.S. Bureau of Mines and the U.S. Geological Survey (1980) and used in this report.

Mineral production from the reservation has been limited to small amounts of sand and gravel. Clay resources may be present also. No other mineral resource has been identified on the reservation.

Energy Resources

This part of South Dakota is rated unfavorable for accumulation of hydrocarbons because sedimentary rocks, the usual source and host rocks for petroleum and natural gas, are absent or very thin (Miller, 1971, p. 715). Nevertheless, small flows of natural gas have been produced from water wells in eastern South Dakota for many years. The gas comes from swamp deposits buried in the glacial drift (Rothrock, 1944, p. 117-118). Widespread occurrences of this type indicate that small flows of natural gas, suitable for local use, might be found in wells on the reservation.

Flakes of coal (lignite) in glacial drift and coal in thin beds ranging up to 6 inches in thickness are reported in the Big Sioux River valley (Rothrock, 1944, p. 81-82). These occurrences are of no economic significance, however, and the chance is remote that even a localized deposit of minable thickness is present in the region.

Recently, exploration for uranium has centered on the Sioux Quartzite and underlying rocks of Precambrian age along the Sioux Ridge, because the geologic setting is similar to that at major uranium deposits in Australia and Canada (Ansfield and Stach, 1981, p. 189). Although the potential seems low, uranium resources on the reservation should not be ruled out.

Metallic Resources

No metallic mineral resource is known on the reservation, but there is a fair chance that some gold and copper could be recovered as by-products of sand and gravel operations. Occasional gold nuggets and copper nuggets have been recovered from the Big Sioux Placers for many years. In the past, a few placer mines have been operated in the Big Sioux drainage; but the gold distribution has been too inconsistent to sustain mining.

According to Rothrock, 1944, p. 48, gold and copper nuggets have been found in gravels of glacial origin, usually in terrace deposits. He

further states that gold and other metals were moved into South Dakota from Canada by glacial ice and were flushed into the gravel deposits by meltwater. It is reasonable to expect that gold and copper nuggets may be present in all types of gravel in the region which were derived from glacial deposits, including modern stream gravels.

Due to the inconsistent distribution of gold and copper contained in the "Big Sioux Placers" (glacially related gravel deposits) they offer little promise for development for recovery of the metals alone. However, passive traps can be installed on gravel-washing machinery to recover such gold and copper nuggets as are present in sand and gravel being processed. Such traps are in use in other parts of the country; and recovery is sometimes remarkably good, adding a welcome by-product to a sand and gravel operation.

Nonmetallic Resources

Sand and gravel and, perhaps, clay resources occur on the reservation; these commodities are described in more detail below. The Sioux Quartzite undoubtedly underlies the area; this formation is quarried extensively for stone where it crops out to the south and east of the reservation, but its depth beneath the glacial drift at Flandreau precludes its recovery there.

Sand and Gravel

Sand and gravel is the principal mineral resource in the Flandreau area; even so, opportunities for development of this resource on the reservation are limited.

Small amounts of sand and gravel have been taken from a pit on government land in the NW¼SW¼SW¼ sec. 14, T. 107 N., R. 48 W. (Figure 1). Material was used by the Tribe and the Indian school. In the past, sand and gravel was produced from tribal land near the center of the E½SW¼ sec. 10, T. 107 N., R. 48 W.; this area has been reclaimed.

Sand and gravel occurs principally in deposits of glacial outwash where the action of water has sorted the drift and removed much of the clay and silt. (Glacial till contains too much fine-sized material to be useful as a source of sand and gravel.) The outwash deposits occur as valley-train and as terrace deposits and are almost wholly confined to the floodplain of the Big Sioux River at Flandreau (Lee and Powell, 1961).

According to Lee and Powell (1961, p. 22-24), the outwash deposits consist of a gravel (coarse) fraction that contains granules, pebbles, and cobbles up to about 3 inches in size; half are fragments of limestone, dolomite, and a little chert, 40 percent are fragments of igneous and metamorphic rock, and 10 percent are fragments of sandstone, shale, and clay ironstone. The sand and silt (fine) fraction is mostly quartz grains and includes a small amount of rock fragments and accessory detrital minerals. Overall, quartz constitutes about 85 percent of the combined coarse and fine fractions. Outwash deposits in the Flandreau Quadrangle range from 4 to 44 feet in thickness.

Lee (1960) rates the sand and gravel outwash suitable for road construction and for concrete aggregate, but not all material appears suitable for concrete aggregate because of the rather large

amount of chemically and (or) physically unstable rock fragments (Flint, 1955).

Geologic evaluation of outwash deposits on tribal lands (Figure 3) would show the location and quality of sand and gravel resources. Geophysical surveys, based on differences in electrical resistivity, have been used with limited success in this region to distinguish outwash from till (Lum, 1961). Sampling favorable areas using a truck-mounted auger, coupled with a study of logs of existing test holes and wells (Lee and Powell, 1961), would show the quality and quantity of sand and gravel resources present.

Table 3 shows estimated sand and gravel reserves in the Big Sioux River valley and the Flandreau Creek valley. Both of these valleys include some tribal land which includes large tracts of favorable gravel-bearing material.

Clays

Widespread deposits of glacial till contain large proportions of clay and silt. According to Lee (1960), "this material could serve as a ceramic material." More likely, some of this material might be used as common clay to make structural clay products such as brick and tile. Development of this resource probably would not occur on the reservation, however, unless deposits of exceptional quality and quantity are found there.

TABLE 3
Estimated Reserves of Sand and Gravel in the Outwash Deposits of the Flandreau Creek and Big Sioux Valleys
Modified from Lee and Powell, 1961

Location of outwash	Area (nearest thousand acres)	Reserves of sand and gravel (cubic yards)
Big Sioux River valley	30,000	1,000,000,000
Flandreau Creek valley	2,000	40,000,000
Total	32,000	1,040,000,000

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Table 2.--Generalized section of surficial geology of the Flandreau Indian Reservation and vicinity, South Dakota. Modified from Lee and Powell, 1961

System	Series	Stage	Substage	Lithology and water-yielding characteristics	Thickness (feet)
Quaternary	Recent			Alluvium: clay, silt, and sand with some gravel; yields little or no water to wells.	3 to 25
				Lake deposits: clay and silt; chiefly confined to till area; yield little or no water to wells.	4 to 20
	Pleistocene	Wisconsin	Cary	Outwash deposits forming plains, terraces, and valley trains; sand and gravel with silt and clay at top; yield moderate to large supplies of water.	4 to 85
				Till: boulder clay with rock fragments in a sand-rich matrix. Gray to brownish and greenish gray when moist; light gray to buff when dry; overlain by patches of loess; contains stratified sand lenses which locally yield small supplies of water to wells.	20 to 45
			Iowan (?)	Till: pebble clay, gray to brownish-gray; somewhat bluish-gray, compact, mostly oxidized; overlain by 1 to 6 feet of loess; contains stratified sand lenses which locally yield small supplies of water to wells.	20 to 60

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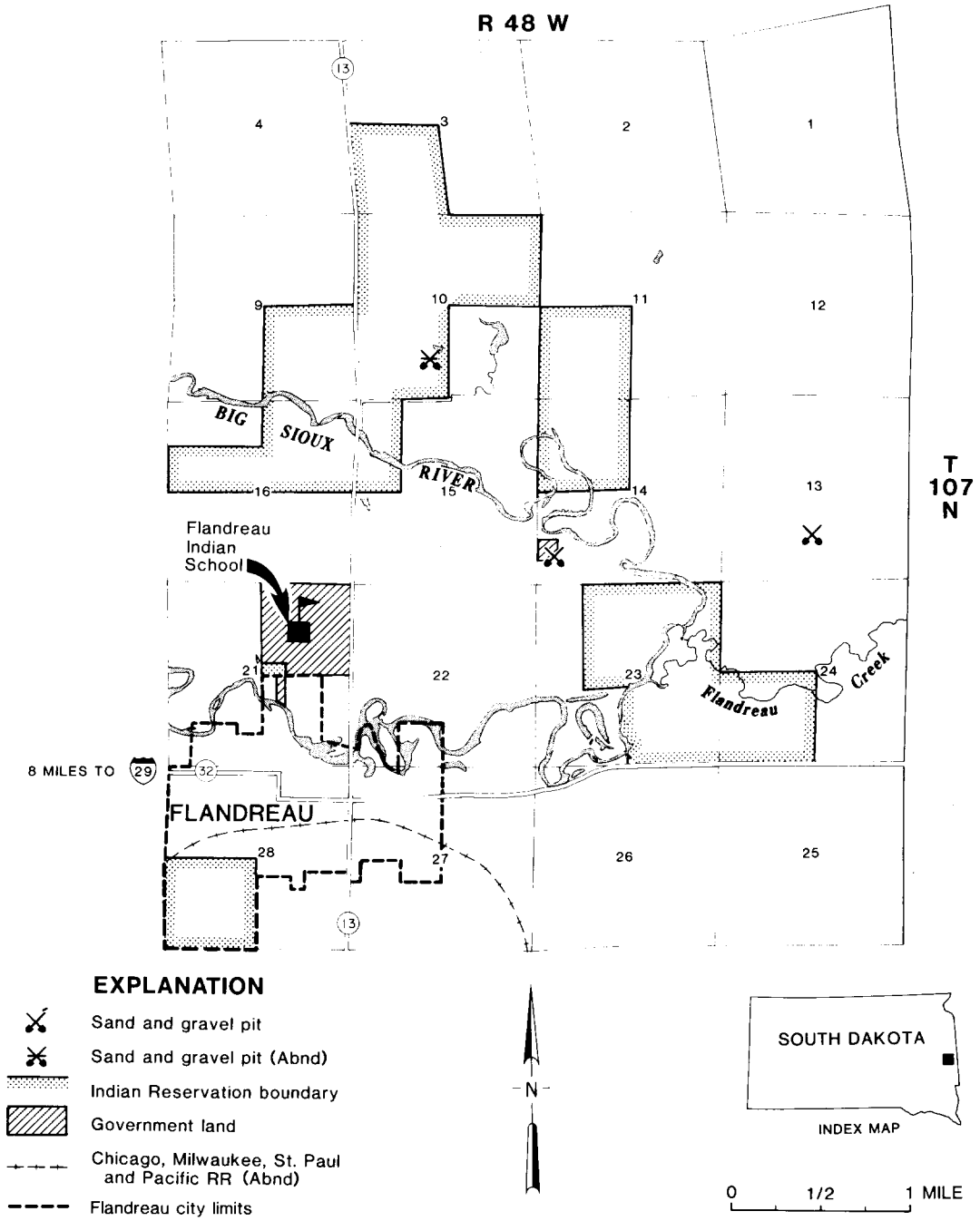

Figure 1. Flandreau Indian Reservation and vicinity, Moody, County, South Dakota, showing cultural features and sand and gravel resources.

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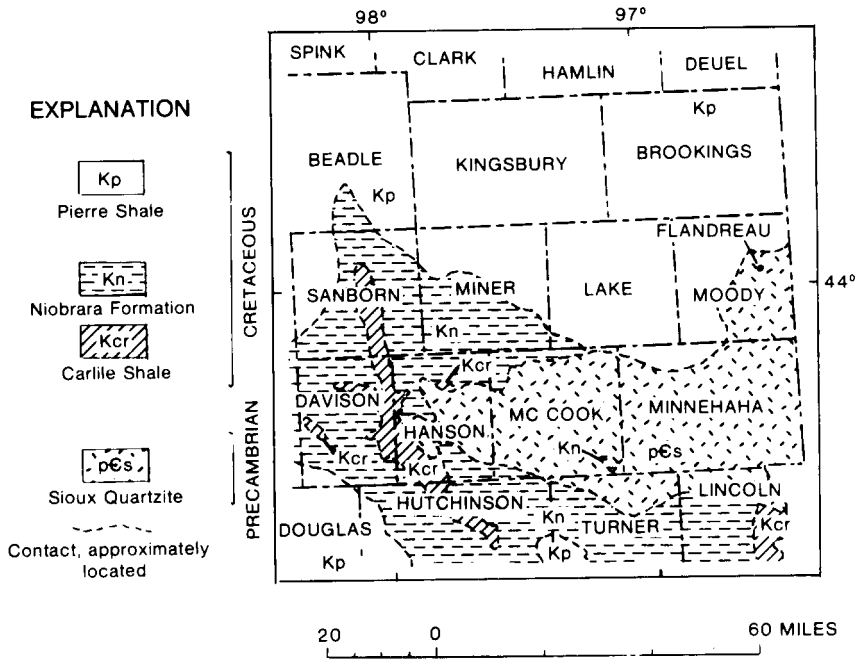

Figure 2. Sketch map showing inferred distribution of bedrock units beneath the glacial drift in part of southeastern South Dakota. Compiled from various sources; modified from Flint, 1955, p. 25.

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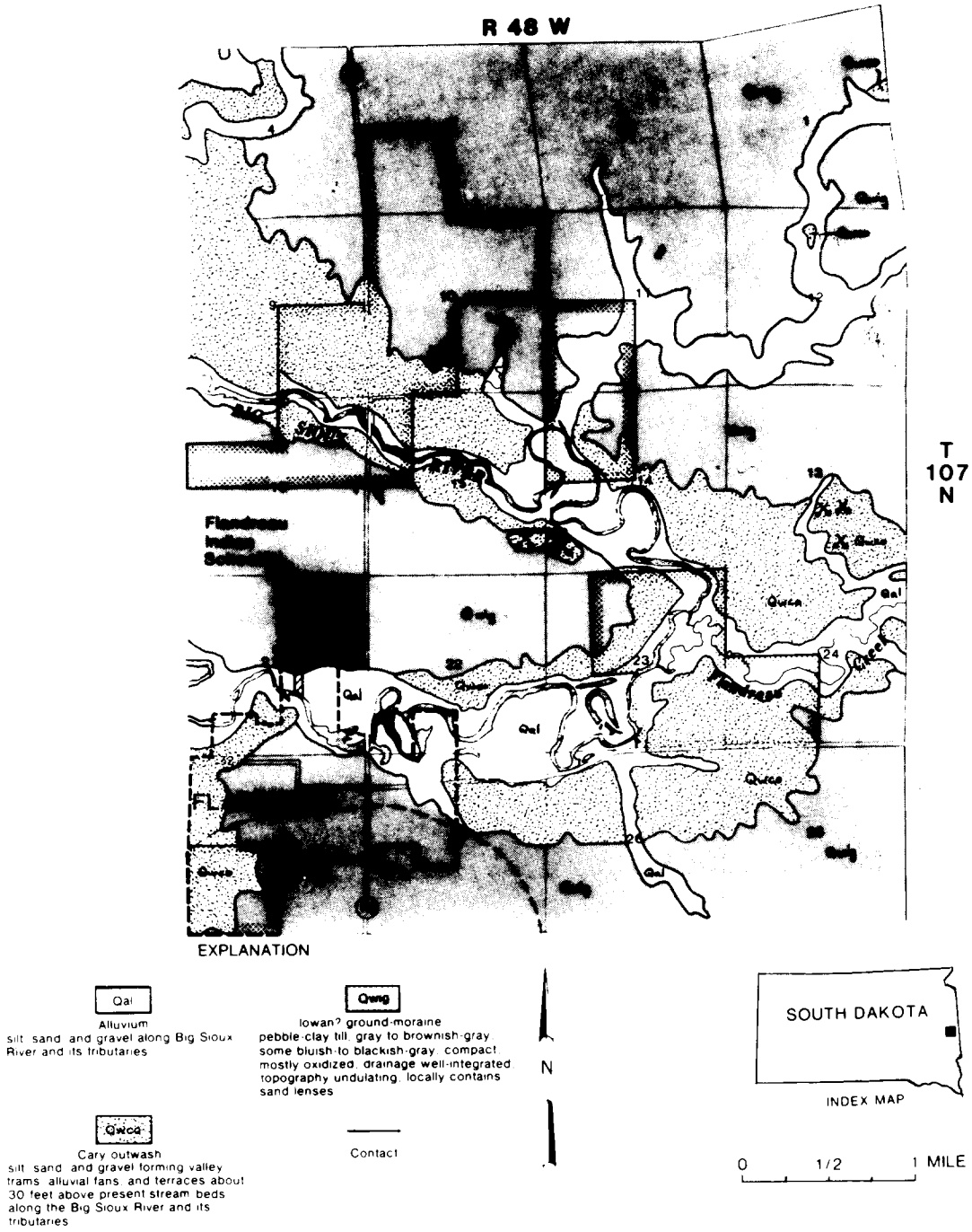

Figure 3. Map showing surficial geology of the Flandreau Indian Reservation and vicinity, South Dakota. Modified from map by K.Y. Lee, 1958, in Lee and Powell, 1961.