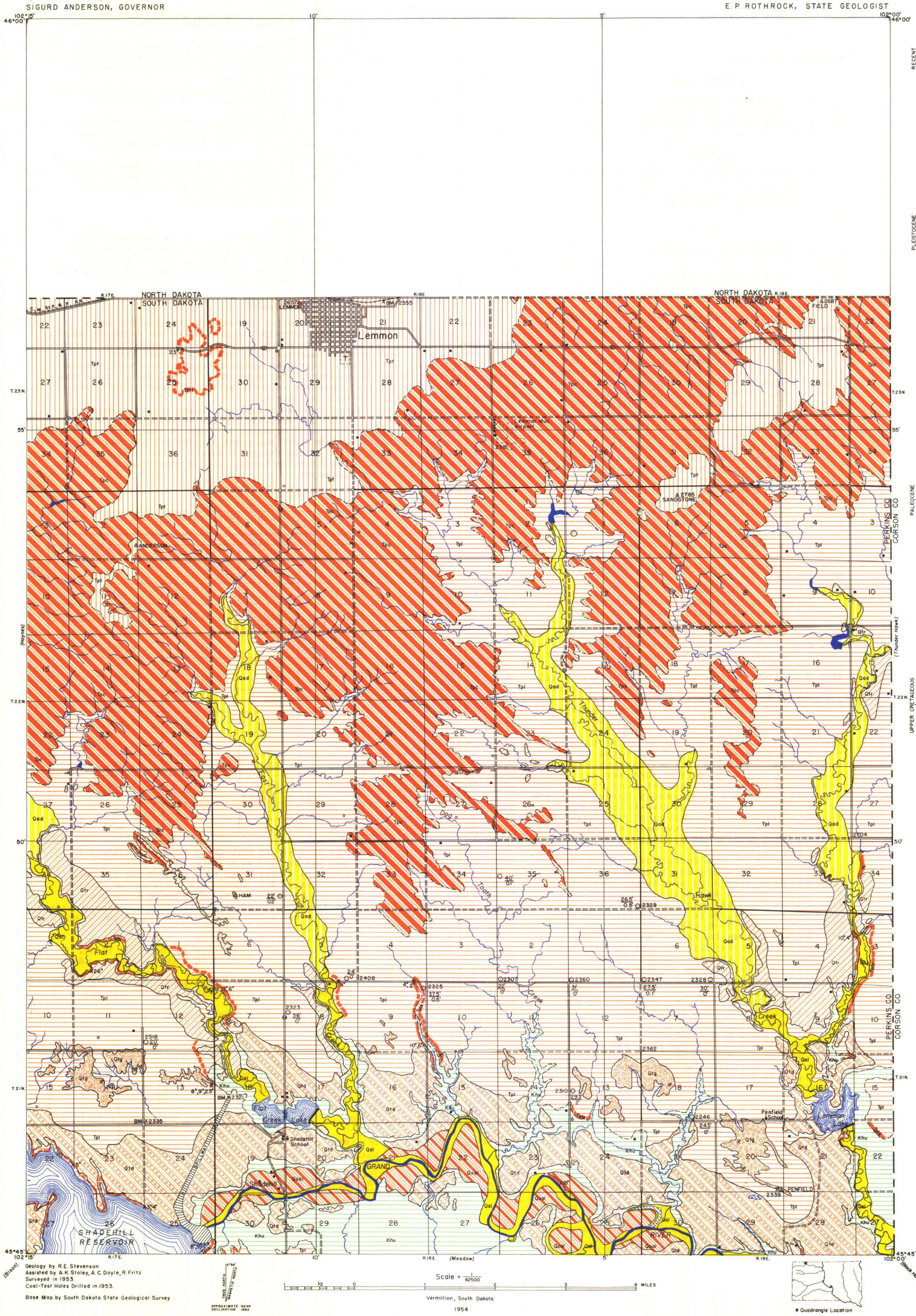
AREAL GEOLOGY
OF THE
LEMMON QUADRANGLE

STATE OF SOUTH DAKOTA
SIGURD ANDERSON, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



Geology by R.E. Stevenson
Assisted by A.K. Staley, A.C. Doyle, R. Fritz
Surveyed in 1953.
Coal-Test Holes Drilled in 1953.

Base Map by South Dakota State Geological Survey

APPROXIMATE MEAN DECLINATION 1953

Scale = 1/62500

Vermillion, South Dakota
1954

EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

RECENT

Qal — Alluvium
(Floodplain deposits of silt, sand, and gravel in present major stream valleys.)

Qad — Alluvium Deposits
(Floodplain and low terrace deposits of angular gravel silt, and clay of local derivation.)

PLEISTOCENE

Qaal — Older Alluvium
(Older valley-bottom deposits above present streams)

Qtd — Terrace Deposits
(Terrace deposits of silt, sand, and gravel along the Grand River.)

Qtr — Terrace Rubble
(Terrace deposits of fluvial angular gravel and silty sand locally derived mainly from the Cannonball formation.)

Qtg — Terrace Gravels
(High terrace deposits of sub-quartzose coarse sand and gravel.)

TERTIARY

PALEOCENE

Tpt — Tongue River Formation
(Grey, brown to rose, medium to coarse grained quartzose semi-consolidated, cross-bedded sand with abundant irregular calcareous cementations; grey to tan clay, silty clay, and clayey sands with plant fragments. Tpt1-Ludgepole facies- a seam (1'-2') of black fissil lignite.)

Tpc — Cannonball Formation
(Grey to buff clay and fine grained quartzose sand and clayey sand with numerous dark grey limestone concretions. Abundant calcareous sandstone ledges and lenses. Local ferruginous sandstone ledges. Marine invertebrate fossils. Interfingers with upper Ludlow.)

Tpl — Ludlow Formation
(Grey to buff, medium and fine grained, arkosic and graywacke sands, clayey sands and sandy clays. Numerous slabby lenses and ledges of calcareous sandstone. Abundant cross-bedding and local ripple marks. Tpls-Shadehill facies- 1 to 6 black blocky or fissile lignite (2"-1'1") seams and associated sands, clays and peat-clays.)

CRETACEOUS

UPPER CRETACEOUS

Hell Creek Formation

Khu — Upper Member
(Dark grey to buff bentonitic clay and silty clay and grey to buff slightly bentonitic sand. Several horizons of brown and black peat-clay. Numerous Fe-Mn concretions. Upper coal horizon- 0-1.5' seam of black block lignite and associated beds of brown peat-clay.)

DRAINAGE

Intermittent Streams

Intermittent Lakes

CULTURE

Buildings
(House, church and school)

Roads and Trails

1684
Altitudes
(In feet above sea level)

X B.M. 1706
Bench Marks
(Monuments marking points of known altitude.)

Δ RENA
Triangulation Stations
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location.)

Operating
Abandoned
Coal mines and Gravel pits

2323 Top Hole
Altitude
36' Overburden
2' Thickness
Drill Holes

Shell Oil Co.
Winter No.1
Oil-test Borings

Dams
(Large, small earthen or cement.)

Parks
(State, recreation grounds)

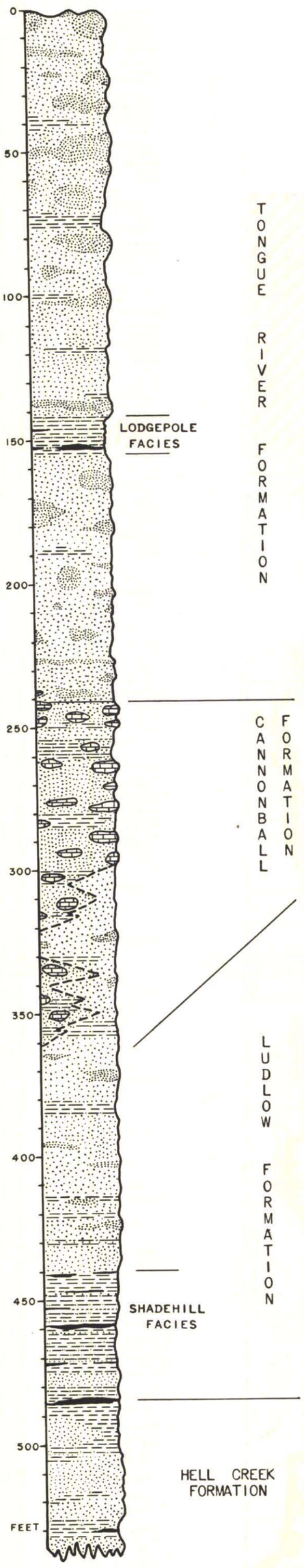
■ Quadrangle Location

GEOLOGY OF THE LEMMON QUADRANGLE

By

Robert E. Stevenson

GENERALIZED COLUMNAR SECTION



INTRODUCTION

This quadrangle was mapped in the summer of 1953 as a part of the State Geological Survey's coal resources program. Exploratory drilling for subsurface coal was also done in 1953.

LOCATION

The quadrangle lies in the northeastern corner of Perkins County and along the North Dakota line. The area is approximately 134 miles northwest of Pierre and 134 miles northeast of Rapid City.

GEOGRAPHY

The area is a sparsely inhabited region of rolling prairie lands interrupted in the south by the valley of the Grand River. The quadrangle has an approximate relief of 575 feet. Its northern edge lies on the Grand-Cannonball divide. The larger streams are intermittent and empty into the Grand River.

The Grand River meanders over a 2 to 2½ mile wide valley. The valley is characterized by a floodplain with oxbow basins and a series of three depositional terraces.

The five permanent water bodies are all artificial lakes; Lemmon Lake, Flat Creek Lake, a portion of Shadehill Reservoir, and two small unnamed lakes in Sec. 16, R. 19 E., T. 22 N., and Sec. 2, R. 18 E., T. 22 N. Shadehill Dam, built by the U. S. Bureau of Reclamation, is 120' high and 1960' long excluding the spillway. It is located at the junction of the North and South forks of the Grand River, about 1.1 miles west of Shadehill.

The climate is semi-arid with an average rainfall of 14-17 inches. Dryland farming and stock grazing are the principal agricultural pursuits.

The only town in the area is Lemmon with a population of 2,760, but there is a postoffice and store at Shadehill. Lemmon is served by the mainline of the Chicago, Milwaukee, St. Paul and Pacific. U. S. Highway 12, an east-west route, passes through Lemmon and South Dakota Highway 73 goes south from Lemmon through Shadehill. Numerous county and township roads make this region fairly accessible.

STRATIGRAPHY

Cretaceous, Tertiary, and Quaternary sediments comprise all of the exposed rocks.

Hell Creek formation Brown 1907, Upper Member: Along the Grand River at the southern edge of the map, 25-85 feet of the Hell Creek formation outcrops. The strata are interbedded and lensing, buff and grey subgraywackes, dark grey to brown bentonitic clays, buff bentonitic clayey sands, grey clays, and brown peat-clays. Locally there is a coal horizon with 3" to 18" of black, blocky, and fissile lignite. There are numerous horizons of manganese-iron concretions, and occasional local cementations.

Ludlow formation (Lloyd and Hares 1915): The scattered exposures are restricted to the southern half of the quadrangle and best seen along the major streams. The Ludlow is a heterogenous series of lensing lithologies; grey to buff, medium-to fine-grained arkosic and graywacke sands, clayey sands and sandy clays with numerous slabby lenticular and ledge-like calcareous cementations, and grey to brown, fissile to massive silt and clay. The strata are both thin-bedded and massive, exhibiting abundant cross-bedding and occasional oscillation ripple marks (index-10-).

Locally at the base of the formation is the Shadehill lignite facies: 20 (?) to 70 feet of interbedded brown peat-clay; grey shale, clay and silty clay; grey and buff fine, subgraywacke sand with cementations; and 5 to 7 seams of black, blocky, and fissile lignite, which range in thickness from 1" to 27" (average 3" to 8").

The Hillen lignitic facies, which outcrops in the quadrangles to the east and west, was not seen.

The formation is approximately 150 to 200' thick and the upper portion interfingers with the Cannonball formation.

Cannonball formation Lloyd 1914: Good outcrops of this formation are rare, but fragments of the characteristic concretions are scattered over the lower uplands in the east-central, north-central and west-central parts of the map area. The Cannonball formation consists of abundant small and medium, dense, dark grey limestone concretions, and larger ledge-like or lenticular calcareous cementations in a matrix of grey to buff silty clay, and clayey fine-grained graywacke sand. Locally, there is a 2"-7" ledge of ferruginous and calcareous graywacke sandstone. The limy rocks carry a marine fauna of small to medium molluscs.

The Cannonball formation has an approximate thickness of 120 feet. The lower part of the formation interfingers laterally with the upper part of the Ludlow.

Tongue River formation (Taff) 1909: The large cementations of these strata are exposed on the high upland ridges in the northwest and northeast portions of the map. Its lithology is dominated by massive, commonly cross-bedded, buff and tan, medium to fine, (local scattered clay pebbles) subgraywacke sand with numerous lenticular, sub-spherical and elongate calcareous cementations. Interbedded with these sands are brown and grey clays, grey silty clays, brown peat-clays and buff clayey sands. Some of the clays contain well preserved leaves. The formation is approximately 240 feet thick.

About 90 feet above the base is the Lodgepole lignite facies, a discontinuous seam 9" to 23" thick of black fissile clayey lignite with associated clays and peat clays. Here the facies is about 3 feet thick, but in the next quadrangle west, it reaches a thickness of 26 feet.

Terrace Gravels: In the southern part of the quadrangle, adjacent to the Grand River, is a series of high terraces capped with 3 to 20 feet of subarkosic pebble to granule gravels and coarse sand.

Terrace Deposits: Along the Grand River and the lower reaches of Thunder Hawk and Flat Creeks are a number of terraces capped by fine to coarse sand, some silt and occasional pebble conglomerates. This capping ranges from a thin veneer to about 4 feet in thickness.

Terrace Rubble: Low terrace deposits adjacent to a major stream which consist of coarse angular gravel and silty to clayey sand. The material is derived principally from the Ludlow, Cannonball, and Tongue River formations. They vary in thickness from a thin veneer to about 3 feet.

STRUCTURE

There is a slight regional dip (20 feet per mile) to the northwest and center of the Dakota (Williston) Basin. There are local steepenings of this dip, i.e. region of Lemmon Lake where it gets up to 40 to 50 feet per mile. Superimposed upon this regional structure are small minor folds and faults with amplitudes and displacements of less than 20 feet.

ECONOMIC GEOLOGY

Gravel is the only currently exploited mineral resource in this area. There is in addition small amounts of bentonitic clay which has potential value. Small quantities of lignite have been mined in the past, but according to present-day standards, there are no commercial coal deposits in this area.

Gravel: Pebble gravel and coarse sand deposits occur on a series of high terraces adjacent to the Grand River. The material is clean, highly quartzose and may be used for concrete aggregate and road metal. Estimated cubic yardage for the larger deposits is given in Table 1.

The terraces of the Grand River are covered by coarse alluvial deposits of gravel, sand, and silt. These are adequate for use as roadmetal. The estimated cubic yardages of the larger deposits is shown in Table 1.

Angular gravel deposits occur along the lower reaches of Flat and Thunder Hawk Creeks. These deposits are characterized by broken concretions and sandstone fragments from local formations and contain a high percentage of silt and clay. They can be used as road metal.

TABLE 1

Sections	Twp. N.	Rge. E.	Acres	Ave. thick.	Est. Cubic Yds.
Terrace Gravels					
17,20,21,28	21	19	200	10	3,549,333
10,11,14,15	21	17	138	7	1,558,477
11,12,13,14	21	17	81	7	914,760
13,18	21	18-19	158	3(?)	764,720
Terrace Deposits					
23,24,25,18,19	21	17-18	961	3	4,651,240
19,20,21,27,28,29 30	21	19	1325	2(?)	4,275,333
23,24,25,19,30	21	18-19	646	2	2,084,426
19,20	21	18	307	4(?)	1,981,173
14,15,22,23	21	18	360	3	1,742,400
7,17,18	21	18	321	3	1,553,640
14,15,22,23	21	18	265	3½	1,497,173
Terrace Rubble					
27,34,35,1,2	21-22	17	1218	2(?)	1,965,040
33,3,4,9	21-22	19	1090	2½	1,758,583

Clay: Some of the clay horizons in the Hell Creek formation contain a high percentage of bentonite and may be used as a sealer in earthern dams.

Coal: None of the coals present in this area have present-day commercial potentialities. The Ludlow formation in this quadrangle contains one discontinuous coal horizon--the Shadehill lignite facies. The Tongue River contains a discontinuous horizon of lignite--the Lodgepole facies. There is a local lignite horizon in the upper Hell Creek which outcrops in the banks of the Grand River in Sec. 23, T. 21 N., R. 16 E.

A brief description of these lignites follows:

Hell Creek lignite; black, fissile and blocky lignitic coal 18" thick. Exposures cover a very small area, less than ½ miles in linear distance. An analysis is given in Table 2.

Shadehill; 5 to 7 black, fissile and blocky lignitic coal seams, varying in thickness from 1" to 27" (average 3"-8"). Thicknesses over 18" are not common. Analyses are given in Table 2.

Lodgepole; black, fissile, in part clayey lignitic coal discontinuous seam which may thin to peat-clay in less than a quarter mile.

TABLE 2

Coal	Location	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	BTU
Hell Creek	Along Grand River S. 23, T21N., R.16E.	31.93%	34.97%	25.30%	7.80%	0.38%	7,356
Shadehill	Lemmon Lake Spillway S.18, T.21N., R.16E.	30.79%	38.09%	24.98%	6.14%	0.63%	7,650
Shadehill	Shadehill Spillway S.21, T.21N., R.17E.	25.32%	28.52%	16.76%	29.40%	0.36%	5,354