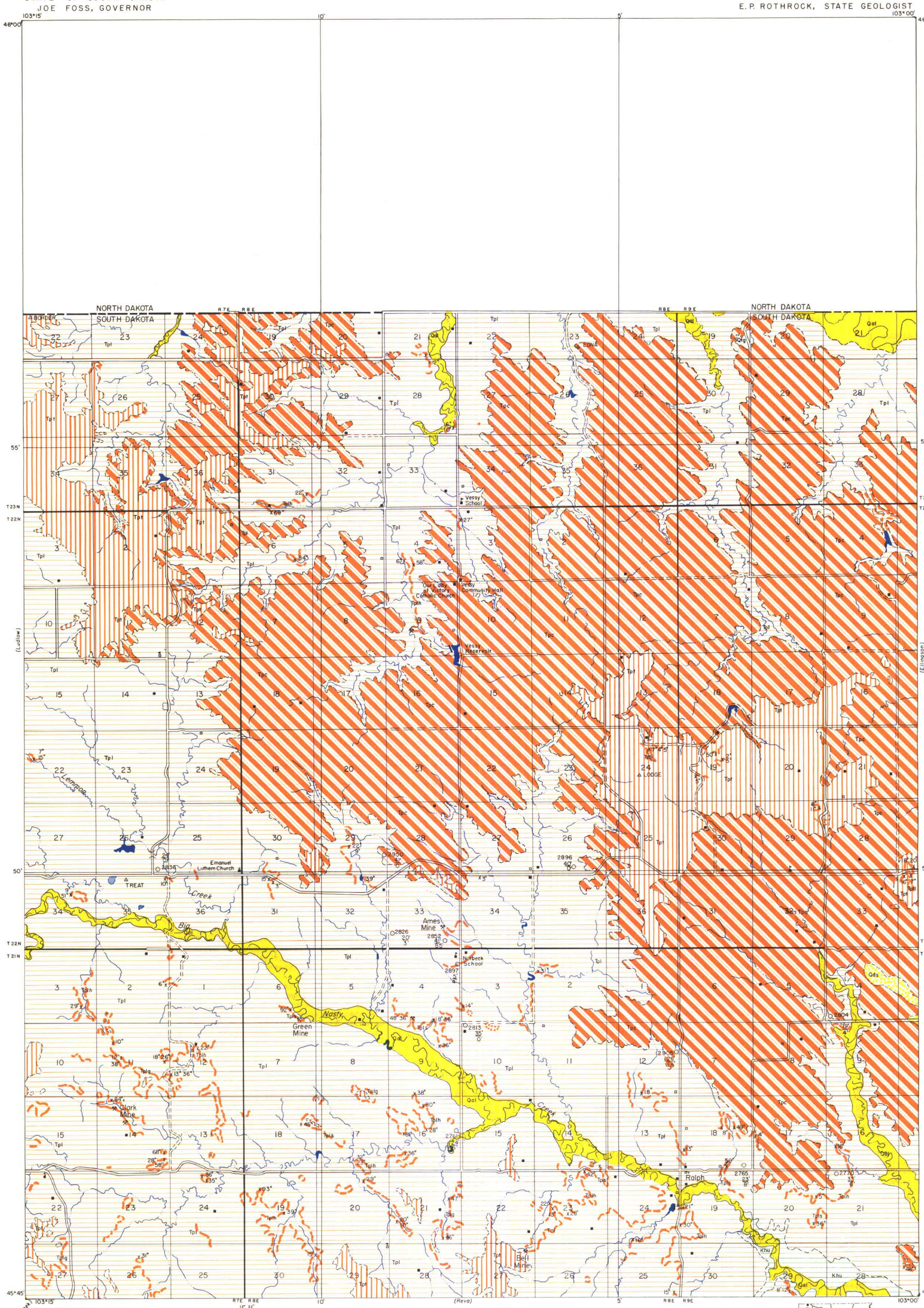
AREAL GEOLOGY
OF THE
RALPH QUADRANGLE

STATE OF SOUTH DAKOTA
JOE FOSS, GOVERNOR

STATE GEOLOGICAL SURVEY
E.P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

RECENT

Qal — Alluvium
(Floodplain deposits of silt, sand and gravel including low terrace deposits)

Qds — Dune Sand
(Grassed-over dunes of quartz sand)

PLEISTOCENE

Qtd — Terrace Deposits
(Terrace deposits of fluvial silt, sand and gravel along the North Fork of the Grand River up to 4 feet thick)

TERTIARY

PALEOCENE

Tpl — Tongue River Formation
(Buff to grey, massive, cross-bedded, medium grained, calcareous subgraywacke sandstone; buff subgraywacke sand with calcareous cementations; and buff clayey silt, clay, and bentonitic clay. Tptl–Lodgepole facies buff to grey clay, subgraywacke sand, brown peat-clay and occasional seams of black blocky lignite (2 to 50 inches thick. Thickness averages about 220 feet)

Tpc — Cannonball Formation
(Buff to grey laminated fine subgraywacke sand, silty sand and sandy clay with abundant dark gray dense limestone concretions. A few local ledges of calcareous sandstone. Marine invertebrates. Interfingers with upper Ludlow formation. The formation ranges in thickness from 0 to 95 feet)

Tpl — Tplg, Tplh, Tpls — Ludlow Formation
(White to buff, cross-bedded, fine to medium grained subgraywacke sand and silty sand with rare calcareous cementations. Interbeds of somber to grey or brown clay, silty clay, and fissile siltstone. Scattered orange-red limonitic concretions. Tpls–Shadehill facies–Interbedded white to grey sands, brown peat-clay, and several seams of black blocky lignite (8 to 96 inches thick). Tplh–Hillen facies–Brown to grey sand, silt and clay, brown peat-clay, and several seams of black blocky lignite (11 to 90 inches thick). Tplg–Giannonatti facies–Several seams of black blocky lignite (9 to 68 inches thick) and associated beds of clay and peat-clay. The formation varies in thickness between 137 and 247 feet)

CRETACEOUS

UPPER CRETACEOUS

Kh — Hell Creek Formation
(Interbedded dull grey to brown clay, silt and bentonitic clay with occasional white medium grained subgraywacke sand. 25 feet exposed here)

DRAINAGE

Intermittent Streams

CULTURE

Roads, Trails and Buildings

Contacts
(Dashed where approximately located)

Coal Mine
(Abandoned)

x 36"
Coal Thickness
(Exposed)

3068 / 49 / 0
Coal Test Holes
(Altitude, overburden thickness or depth of hole over thickness of coal)

x B.M. 2468
Bench Mark
(Monument showing exact altitude above sea level)

△ RENA
Triangulation Station
(Monument marking an exact geographic location)

Geology by R.E. Stevenson
Assisted by C.E. Dodson Jr., S.G. Collins
Surveyed in 1954-55
Coal Test Holes Drilled in 1955

Base Map by South Dakota State Geological Survey

APPROXIMATE MEAN DECLINATION 1955

Scale = 1/62500

1 0 1 2 3 4 MILES

Vermillion, South Dakota

1957

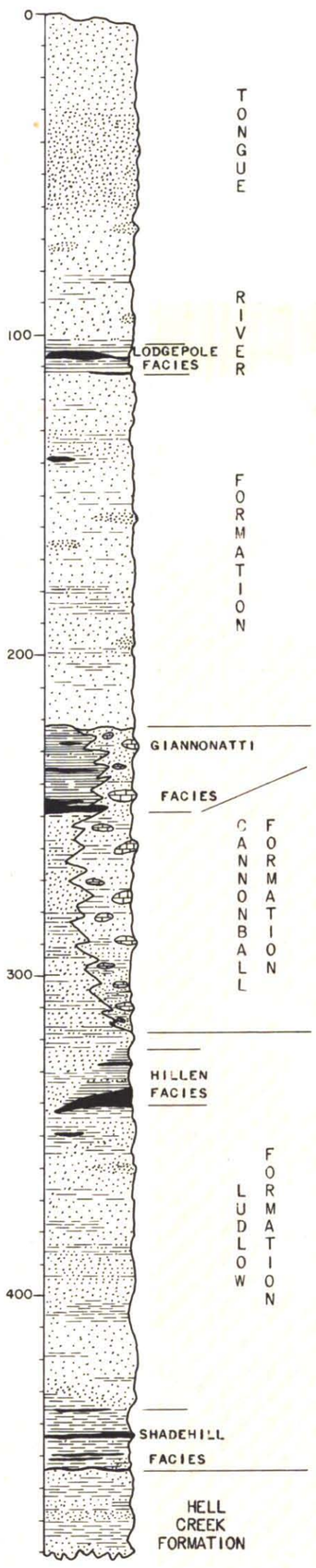
■ Quadrangle Location

GEOLOGY OF THE RALPH QUADRANGLE

By

Robert E. Stevenson

GENERALIZED COLUMNAR SECTION



INTRODUCTION

This quadrangle was mapped in 1954 and 1955 as a part of the State Geological Survey's coal resources program. Test drilling for subsurface coal was done in 1955. The writer acknowledges with gratitude the field assistance of S. G. Collins and C. R. Dodson. The drilling was done by R. Schoon and O. Rosenbaum.

LOCATION

The Ralph quadrangle lies in the northeast part of Harding County along the North Dakota line. It is about 170 miles northwest of Pierre and 120 miles north of Rapid City.

GEOGRAPHY

This area is one of rolling prairies with scattered buttes and mesas rising 300 feet above the major erosion level. Cut into this erosion surface are the wide shallow valleys of Big Nasty Creek and its tributaries. The buttes and mesas, some of which are bounded by sandstone cliffs, are remnants of an older (pre-Pleistocene) erosion surface.

The North Fork Grand River and its valley cut across the northeast corner of the mapped area. The river meanders across a fairly wide flood plain bordered by poorly defined low erosional terraces and a higher gravel terrace.

The average rainfall is 12 inches, giving rise to a semi-arid climate. The only permanent water bodies are the Vessey and Ralph Reservoirs and numerous small stock lakes.

This is a sparsely populated (1 family per 2½ square miles) agricultural area devoted to stock grazing and the growing of feed and small grain. There is a combination store and post office at Ralph, the area's only settlement. Numerous county and township roads make the area accessible.

STRATIGRAPHY

Formations ranging in age from late Cretaceous to Recent are exposed at the surface. Both the Paleocene Ludlow and Cannonball formations are completely exposed. The Cretaceous Hell Creek strata are mostly covered by later deposits and the Paleocene Tongue River beds have been partly eroded. Contacts between the above formations are conformable, but they underlie the Quaternary deposits with a marked unconformity.

Hell Creek Formation Brown 1907. Scattered exposures of this formation are restricted to an area of about 200 acres along Big Nasty Creek in the southeastern corner of the map. The strata consist of 25+ feet of interbedded dull grey to brown clays, silts, and bentonitic clays with occasional white medium grained subgraywacke sands.

Ludlow Formation Lloyd and Hares 1915. Outcrops of the formation are scattered over the southwest half of the mapped area and along the northern edge.

The formation is a series of interlensing sandy sediments characterized by three lignitic facies. It is dominantly cross-bedded, locally ripple-marked, white to buff, fine to medium grained subgraywacke sand and silty sand with interlensing brown to grey clay, silty clay, and fissile siltstones. There are scattered orange red limonitic concretions throughout the 122-248 feet of strata.

At the base of the formation is the Shadehill lignitic facies: about 25 feet of interbedded buff fine subgraywacke sand; buff, brown to gray clay and silt; brown peat-clay; and several seams of black fissile lignite (8 to 96 inches thick). Scattered throughout the facies are small nodular masses of melanterite.

About 85 to 100 feet above the Shadehill facies is the Hillen lignitic facies: interlensing buff subgraywacke sand; buff, brown to grey clay and siltstone; brown peat-clay; and several seams (11 to 90 inches thick) of black fissile to blocky lignite, all characterized by nodules of melanterite. This facies, about 22 feet thick, contains the Widow Clark seam of Winchester (1916) and Searight (1930).

Seventy-five feet above the Hillen, just below the base of the Tongue River formation, is the third Ludlow lignite facies, the Giannonatti: a series of interlensing buff to grey clay and sandy clay; buff fine-grained, cross-bedded subgraywacke sand, brown peat-clay, and several seams (9 to 68 inches thick) of black blocky to fissile lignite. The facies is about 15 to 25 feet thick and may be a correlative of the Bison facies 35 miles to the east (Bolin 1955).

The lignite seams of the Ludlow formation are all characterized by occasional marcasite concretions, melanterite or jarosite nodules and scattered selenite crystals.

Cannonball Formation Lloyd 1914. In the eastern and north-central part of the mapped area are scattered fragments of the diagnostic rounded concretions of the Cannonball formation. These small to medium-sized (3 inches to several feet), light to dark grey, dense to fine-grained limestone concretions are imbedded in a buff to light grey clayey laminated subgraywacke sand, silty sand, and silty or sandy clay. Occasionally there are calcareous subgraywacke sandstone ledges or cementations. Some of the concretions contain a marine fauna of small pelecypods and gastropods.

The formation, which is about 95 feet thick to the east and pinches out in the northwestern part of the quadrangle, interfingers with the upper part of the Ludlow formation.

Tongue River Formation (Taff 1909). Outcrops of the sandstones making up the formation are found in the upland areas in the northwest and east-central parts of the mapped area and scattered buttes and mesas in the south half of the quadrangle. Locally it may form cliffed buttes and mesas.

The formation, about 220 feet thick, is dominantly sandy, being characterized by a local massive cliff forming, cross-bedded, buff to grey, medium-grained calcareous subgraywacke sandstone which may occasionally show well developed current ripples (Index-10). Below this sandstone are interbedded and lensing buff to grey, medium to fine grained subgraywacke sand, clayey sand, and silt with lenticular calcareous cementations; tan, buff to light cream clayey silt, clay, and bentonitic clay; 2 to 5 inch seams of black fissile lignite and the Lodgepole lignitic facies. The Lodgepole facies which lies about 110 feet above the base of the formation consists of about 25 feet of interlensing buff to grey clay, and sandy clay; tan to brown fine subgraywacke sand; brown peat-clay; black lignitic-clay; and scattered seams (2 to 50 inches thick) of black blocky to fissile lignite.

Terrace Deposits. Along the North Fork Grand River is a terrace capped by up to 4 feet of coarse sand and grit with lenses of pebble conglomerate, all very cross-bedded. At least 50% of the material is local in origin.

Recent Deposits. On the southeastern edge of the mapped area there is a small area of grassed-over sand dunes. The dunes are less than 12 feet in height and generally small. The sand is medium to fine grained, rounded and frosted.

Mapped as alluvium are recent accumulations of silt, sand and gravel in the valleys of the major rivers and streams.

STRUCTURE

The Ralph quadrangle lies on the southwest flank of the Dakota (Williston) Basin and is characterized by a regional dip of 10 feet per mile. Minor faults and shallow folds (amplitude and displacement less than 20 feet) are present, but have no persistent strike.

ECONOMIC GEOLOGY

At the present time there is no exploitation of mineral resources, but in the early 1900's considerable mining of lignite was done, primarily for local consumption. Additional lignite mining on a local scale was done during the 1930's. A small gravel deposit along the North Fork Grand River has commercial potentialities.

COAL: All of the lignitic horizons in this area, the Shadehill, Hillen, and Giannonatti facies of the Ludlow formation and the Lodgepole facies of the Tongue River formation contain mineable seams.

Shadehill facies: Mineable seams range from 30 to 96 inches in thickness. The lignite is black in color with a brownish-black streak, brittle, banded, fissile, and locally blocky. It contains occasional crystals of selenite, balls of marcasite, and streaks of melanterite. The lignite is non-coking and slacks upon drying (increasing the B.T.U. content). Tonnage estimates for the Shadehill lignites are shown in Table 2. Roof rock and floor are either clay or sand.

Hillen facies: The commercial seams range in thickness from 30 to 90 inches. The Hillen lignites have the same general physical characteristics as the Shadehill lignites (see above). Table 2 gives the tonnage estimates of this lignite. Roof rock is usually sand, but may be clay while the floor is peat-clay or clay.

Giannonatti facies: There are two mineable seams varying in thickness from 30 to 68 inches. These lignites have the same general physical characteristics as the Shadehill lignites (see above). Tonnage estimates are given in Table 2. The roof rock is usually peat-clay or sand and the floor is peat-clay.

No Ludlow coals were analyzed from this area, but analyses from the adjacent quadrangles, Ludlow to the west and Ellingson to the east have been published (Stevenson 1956a, 1956b).

Lodgepole lignites: There is one mineable seam, 30 to 50 inches thick. The lignite is black in color, brownish-black in streak, brittle, blocky or fissile and like the Ludlow lignites it contains small quantities of melanterite or jarosite, selenite and marcasite. It is non-coking and slacks upon drying. A proximate analysis of this lignite is shown in Table 1. Tonnage estimates for the Lodgepole lignite in the Ralph quadrangle are given in Table 2. The roof-rock is silt, clay or sand, and locally an ironstone concretionary zone, the floor is sand or clay.

TABLE 1 Proximate Analyses of Lignite

Coal	Sec.	Tps.	Rge.	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulfur	B.t.u.
Lodgepole*	19	22N.	9E.	43.7	31.7	10.2	14.4	1.5	3,891

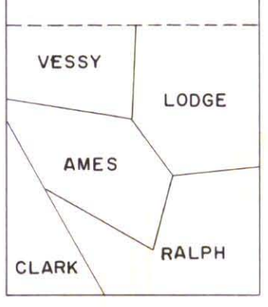
* Analyses by State Chemical Laboratory, Vermillion, S.D.

TABLE 2 Lignite Tonnage Estimates in Short Tons

DISTRICT*	Shadehill	Hillen	Giannonatti	Lodgepole	Total
Vessey		11,940,000			11,940,000
Lodge				530,000	530,000
Ames	2,404,000	4,270,000			6,674,000
Clark		1,612,000	368,000		1,981,000
Ralph	6,056,000	2,683,000	3,007,000		11,746,000
TOTAL	8,460,000	20,505,000	3,376,000	530,000	32,871,000

* See Fig. 1.

Fig. 1
INDEX MAP FOR LIGNITE TONNAGE ESTIMATES



In most of the lignite areas, the overburden is such that strip mining methods may be used in removing the coal; however in some instances in the case of the Giannonatti and Lodgepole lignites where the overburden is thick and partially sandstone, underground mining may be necessary.

SAND AND GRAVEL: Sand and gravel bars in the North Fork Grand River and some of the adjacent terrace deposits could be utilized for road surfacing and some concrete aggregates if sized and washed. The estimated volume for the terrace deposit in Sec. 19, T23N., R9E., is 62,000 cubic yards.

OIL AND GAS: There are no visible surface structures in which oil and gas might accumulate, but buried structures as well as sedimentary traps may exist at depth. The best horizons for possible production are the Mission Canyon formation (at depths of about 7100 feet) which is productive to the north in North Dakota and the Ordovician Red River formation (at depths of about 8900 feet) which is productive in the South Cave Hills (Custer) field 18½ miles west of this quadrangle.

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