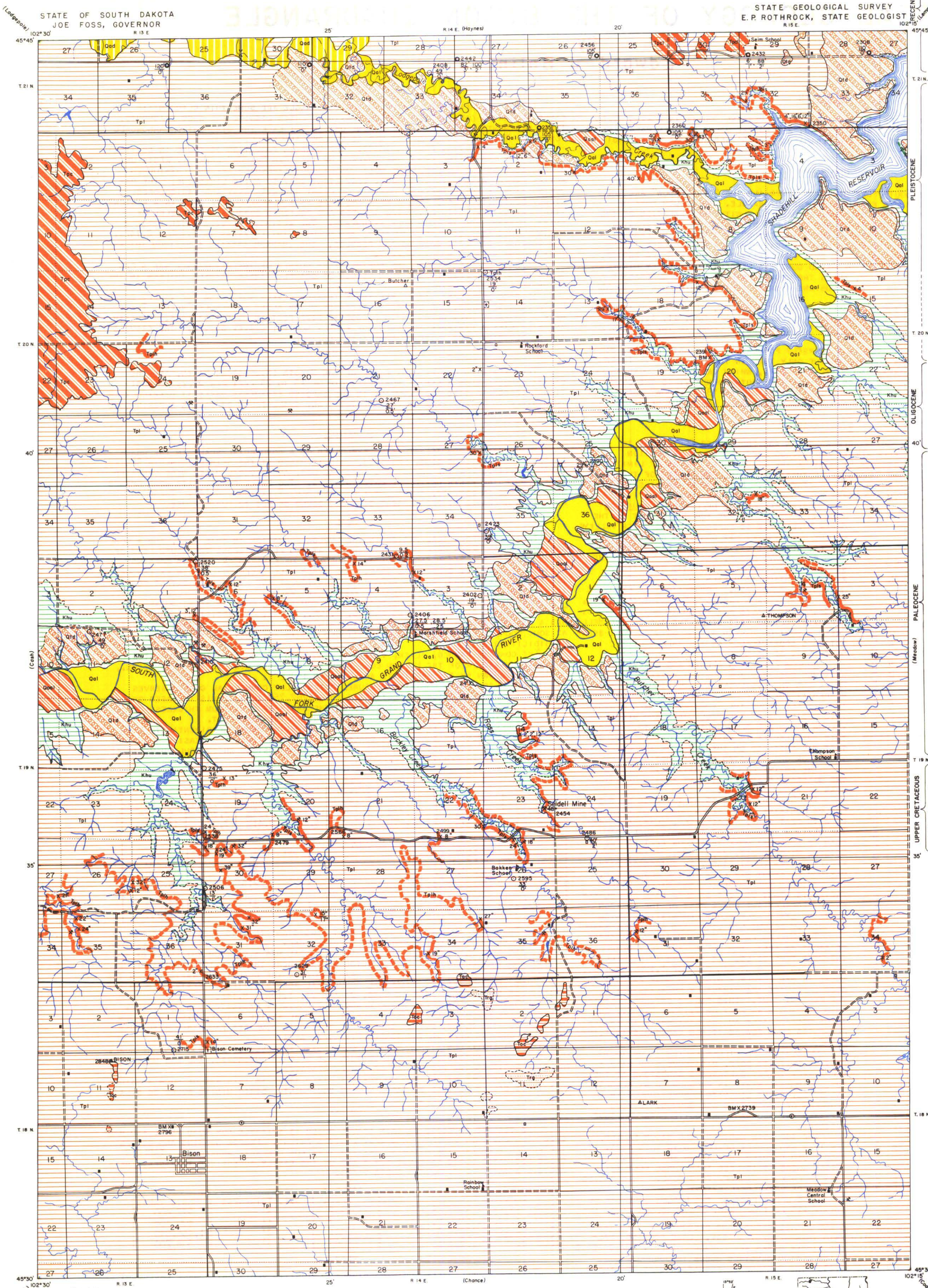


AREAL GEOLOGY OF THE BISON QUADRANGLE

EXPLANATION SEDIMENTARY ROCKS



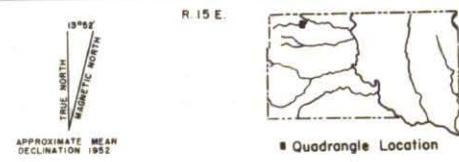
- Qal**
Alluvium
(Floodplain deposits of clay, silt, and sand in valleys of present streams)
 - Qad**
Alluvial Deposits
(Floodplain and low terrace deposits of angular gravel, silt and clay of local derivation)
 - Qal**
Older Alluvium
(Old valley bottom deposits of present streams, 1-5' above present floodplain)
 - Qtd**
Terrace Deposits
(Poorly sorted deposits of clay to conglomeratic gravel on terraces along major streams)
 - Qtg**
Terrace Gravel
(Remnants of high terrace deposits of coarse sand and gravel)
 - Trg**
Residual Gravels
(Conglomeratic gravels consisting of rounded, polished pebbles and cobbles derived from the Chadron, vary from a thin sprinkling to about 10' in thickness)
 - Toc**
Chadron Formation
(Pale green and variegated bentonite and sandy bentonite, with a thin, light gray, shaly limestone at top and a conglomeratic, coarse sand at base)
 - Tpc**
Cannonball Formation
(Buff to gray clay and calcareous sandstone with numerous dark gray limestone concretions. Marine invertebrate fossils quite rare. Interfingers with upper Ludlow)
 - Tpl**
Cannonball-Ludlow Transition Strata
(Gray to buff clay, sand, and calcareous sandstone, sandstone glauconitic in places. Gradational with the Cannonball and Ludlow formations.)
 - Tpl**
Ludlow Formation
(Buff, white, and gray, sand, silt, and silty clay with ledges of hard, calcareous sandstone. Tpl-Bison coal, up to 2.8' of coal and clay-peat. Tpl-Hillman coal, rather persistent coal bed up to 3'2" thick, with much black-jack and clay-peat at some exposures. Tpl-Shadehill beds, 1 or more coal beds up to 4' thick, and associated black-jack, clay-peat, and gray clay)
 - Khu**
Upper Hell Creek
(Light to dark gray, bentonitic clay and sandy clay, weathers to "popcorn" surface, and some buff sand, ironstone concretions in lower part, several thin, discontinuous beds of coal and black-jack)
-
- DRAINAGE**
 - Intermittent Streams
 - Intermittent Lakes
 - CULTURE**
 - Roads, Trails, and Buildings
(House, church, and school)
 - BM**
Bench Marks and Altitudes
(Monuments marking points of known altitude and altitudes in feet above sea level)
 - TRNA**
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
 - X 36"**
Coal Thickness
(Exposed)
 - 2323**
Drill Holes
(2323 Top Hole
36 Altitude
27 Overburden
7752523)
 - State Geological Survey
Seismograph Shot Holes
Courtesy of Geotech Corp. of Del.

STATE OF SOUTH DAKOTA
JOE FOSS, GOVERNOR
R 13 E

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST
R 15 E

Geology by E. J. Bolin.
Assisted by F. J. Buckmeier, D. L. Fairbanks, R. L. Hale, M. J. Tipton.
Surveyed in 1953. Drafted by P. Rist.
Coal-Test Holes Drilled in 1954.

Scale 1:25000
Vermillion, South Dakota
1955



AREAL GEOLOGY OF THE BISON QUADRANGLE

By
Edward J. Bolin

LOCATION

The quadrangle occupies the central part of Perkins County in northwestern South Dakota. It includes an area of about 210 square miles between parallels 45°30' and 45°45' north latitude and meridians 102°15' and 102°30' west longitude.

GEOGRAPHY

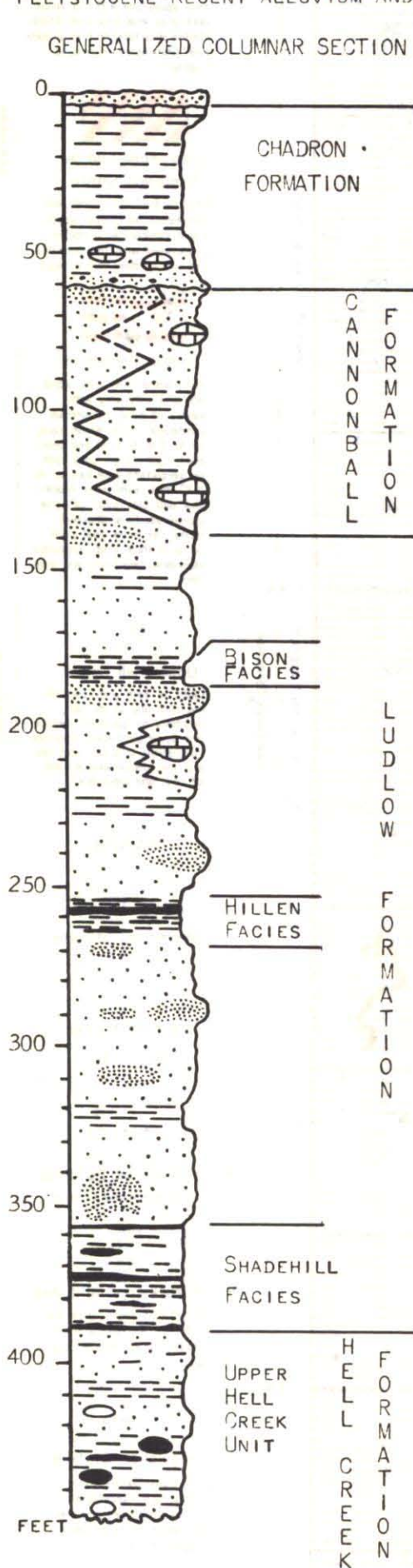
The valley of the South Fork of Grand River and the "Big Meadow" are the most conspicuous topographic features of the quadrangle. The South Fork of Grand receives the runoff from the entire quadrangle with the exception of the southern two tiers of sections which are somewhat dissected by south flowing tributaries to Thunder Butte Creek. The "Big Meadow" is a vast peneplane with a gentle eastward slope on the South Fork of Grand-Thunder Butte Creek inter-stream divide. Its surface is broken by a few flat-topped White River buttes. The area north of the South Fork of Grand consists largely of a deeply dissected "breaks" topography. However, along the western margin of the quadrangle a small area capped with Cannonball sandstone remains of the South Fork of Grand-Lodgepole Creek divide.

The total relief of the quadrangle is about 575 feet. The maximum altitude is 2,848 feet on a small remnant of White River in the NE $\frac{1}{4}$ Sec. 11, T.18N., R.13E., and the minimum altitude is 2,273 feet at water level in the Shadehill reservoir.

The quadrangle is situated in a sparsely populated, semi-arid region. Bison, the county seat of Perkins County, is the only town in the quadrangle. There are no railroads in the area, and State Highway 8, which crosses the quadrangle in an east-west direction two miles north of the south boundary, is the only highway. Farm to market roads abound in the area of the "Big Meadow" where most of the land is under cultivation, and a graded road runs north out of Bison to White Butte.

STRATIGRAPHY

Exposed rocks in the quadrangle range in age from Upper Cretaceous to recent. The Upper Hell Creek (Upper Cretaceous age) and Ludlow formation (Paleocene age) form the bedrock of most of the quadrangle. Areas of limited extent are underlain by the Cannonball formation, marine equivalent of the upper Ludlow, and the Chadron formation (Oligocene age). Pleistocene gravels and Pleistocene-recent alluvium and loess are found in the river valleys.



UPPER HELL CREEK, HELL CREEK FORMATION (Brown 1907). Only the top 40-60 feet of the Upper Hell Creek is exposed in the river valleys of the quadrangle. It consists of bentonitic shales, clays, silts and sands exhibiting dull shades of gray, brown, and buff. Locally the sands have become cemented into resistant, roughly lenticular masses which project from many steep exposures. Concretions of limonite and manganese-iron are common, and thin, black, carbonaceous shales are found in most outcrops. Approximately 40 feet below the top of the Hell Creek a horizon marked by one or more coal beds outcrops sporadically in the valley of the South Fork of Grand.

LUDLOW FORMATION (Lloyd and Hares 1915). Wherever possible the contact between the Hell Creek and the overlying Ludlow formation was placed at the base of a coal facies which lies immediately above the "somber" colored bentonitic sediments of the Hell Creek and below the yellow to buff Ludlow sands and silts. Where this coal facies is absent or covered, the contact was extended on the basis of topography or the color change noted at this horizon.

The entire Ludlow formation is exposed in the quadrangle and it attains a maximum thickness of about 330 feet.

The Shadehill facies at the base of the Ludlow contains up to seven coal beds associated with peat clay, "blackjack", clay, and sand. The maximum thickness of an individual coal seam is somewhat more than four feet at the Seidell mine in Sec. 23, T.19N., R.14E. The facies varies considerably in thickness with a maximum of about 47½ feet in the quadrangle.

Between the Shadehill and Hillen coal facies is about 95 feet of buff sand and clayey sand. Locally the lower part of the horizon contains large calcareous cementations which frequently assume log-like and grotesque shapes.

The Hillen facies has a maximum thickness of about 25 feet, and where typically developed includes four coals. It appears to be well developed in the southern part of T.19N., R.14E., where it was formerly mined to some extent, but good exposures are virtually non-existent at the present time. This facies extends westward into the southern part of T.19N., R.13E., and thins considerably to the east where it is represented by a few scattered exposures in T.19N., R.15E.

Overlying the Hillen facies is up to 70 feet of white to buff, micaceous sand with a relatively thick, calcareous sandstone at the top. Limonite stain is pronounced at places, and small, round limonite concretions with a nucleus of loose sand are common. Gypsum crystals are abundant and quite large in some outcrops.

The top coal horizon, the Bison facies, is thin and poorly developed in this area. It was found exposed only along the road north of Bison where it is less than three feet thick and includes a single, thin coal. This facies may be of very local extent.

The upper part of the Ludlow consists of about 115 feet of sand, argillaceous sand, and

clay. Buff, very fine-grained sand and argillaceous sand predominate. In the upper part the sands are cemented into thin-bedded, slabby, ledge-forming, calcareous sandstone. Cross-bedding and ripple marks are common locally. Calcareous cementations, limonite concretions, and gypsum crystals occur throughout.

CANNONBALL FORMATION (Lloyd 1914). The Cannonball formation caps the flat-topped ridge which extends from the west into T.20N., R.13E. At the top of the formation is a resistant, calcareous, subgraywacke sandstone which contains wood fragments and small marine mollusks. The Cannonball interfingers with the upper Ludlow in this region and the contact is very arbitrary. It probably attains a thickness of 50 to 75 feet.

In the northeastern quarter of the quadrangle are some thin glauconitic sands and hard, calcareous sandstones with included lignite and wood fragments. These sediments are probably of marine origin but lack the diagnostic Cannonball fossils. They are shown on the map as Ludlow-Cannonball.

CHADRON FORMATION (Darton 1899). The Chadron formation is found in scattered deposits projecting above the surface of the "Big Meadow" where it rests unconformably on the Ludlow. The most conspicuous exposures are on flat-topped buttes capped with a thin, slabby, very light gray to white limestone. The major portion of the formation consists of light greenish gray and varicolored, highly bentonitic clay. At or near the base is a coarse quartz sand in a bentonitic clay matrix, with scattered rounded and polished cobbles and pebbles of chert, quartz, and igneous rock fragments. The residual gravels which reach a maximum thickness of nearly 10 feet, and occupy limited areas in T.18N., R.14E., are composed of these cobbles and pebbles. The Chadron attains a maximum thickness in the area of about 57 feet.

TERRACE GRAVELS: Near the northeastern corner of the quadrangle are a few small hummocks capped with a thin veneer of gravel. These gravels thicken in the quadrangle to the north.

TERRACE DEPOSITS: There are three terrace levels bordering the valley of the South Fork of Grand, and scattered terraces occur along Lodgepole Creek. These have a cover of silt which is in excess of five feet in most instances. Beneath the silt lies a variable thickness of poorly sorted, clayey gravel. The gravels are nearly five feet thick on some terraces.

STRUCTURE

The area lies on the west flank of the Dakota (Williston) Basin, and the strata exposed show a gentle northeast dip of 15 to 25 feet per mile. Depositional irregularities and slumping in the exposed sediments makes it difficult or impossible to detect from surface features any small folds or faults superimposed on this regional structure.

ECONOMICS

No mineral products are being exploited on a commercial scale in the quadrangle at the present time. However, coal is mined at the Seidell mine in Sec. 23, T.19N., R.14E., for the operator's personal use, and several mines were operated on a commercial basis until the late thirties. Two small gravel pits were opened on a terrace in Sec. 12, T.19N., R.13E., and Sec. 7, T.19N., R.14E. These are not being operated at the present time but could be put to further use.

COAL

There are three coal facies in the Ludlow formation in this area, and a coal horizon in the Upper Hell Creek is exposed at two places along the South Fork of Grand River. The Bison facies of the Ludlow is of limited extent and does not contain potentially commercial coal. The Upper Hell Creek coal is in excess of two feet in thickness, but is apparently lenticular and limited in extent so it is not considered to be of potential commercial value.

The Hillen facies contains potentially commercial coal in Secs. 30 and 31, T.19N., R.14E., and in Secs. 25 and 26, T.19N., R.13E. A persistent coal seam has a maximum thickness of 39 inches in this area. More than one coal is present at some localities, but the above mentioned bed is the only one with commercial possibilities.

The coal is banded, black, vertically jointed and horizontally laminated. The chemical character of the Hillen coal from an abandoned mine in Sec. 31, T.19N., R.14E., is shown by the proximate analysis in Table 1.

The Hillen facies contains measured potentially commercial coal reserves (within 0.5 mile of outcrops) estimated to be 267,750 tons. This is based on outcrop and drill hole data, and computed on the basis of a minimum thickness of 2½ feet, specific gravity of 1.25, and 1,700 tons to the acre foot.

The overburden is in excess of 35 feet and might prove detrimental to commercial development of the Hillen coals. It consists largely of easily removable clayey sand, but in places much hard, calcareous sandstone which would have to be broken up prior to removal is present.

TABLE 1

SAMPLE	MOISTURE	VOL. MATTER	FIXED CARBON	ASH	SULPHUR	B.T.U.	DRY B.T.U.
HILLEN	42.06%	45.77%	---	14.38%	1.34%	3,844	6,634*
SHADEHILL	31.09%	32.49%	30.75%	5.67%	0.41%	7,879	11,434

TABLE 2

HILLEN COAL		
LOCATION	AVE. COAL THICKNESS	TONS
Secs. 25, 26, T.19N., R.13E.	2.5'	38,250
Sec. 30, T.19N., R.14E.	2.5'	93,500
Sec. 31, T.19N., R.14E.	2.5'	136,000
BISON COAL		
Secs. 23, 24, T.19N., R.14E.	3'	112,200
Sec. 1, T.20N., R.14E., Sec. 6, T.20N., R.15E.	2.5'	701,250

The Shadehill coal facies is the most persistent in this area, but is considered to be of potential commercial value at only two places. In Sec. 1, T.20N., R.14E., and Sec. 6, T.20N., R.15E., where the coal has a maximum thickness of 40 inches; and in the vicinity of the Seidell mine where the coal is more than four feet thick. Outcrops and drill hole data indicate the coal thins rapidly from the above mine, so the area of potential commercial possibilities is restricted to the vicinity of the present mine in Secs. 23 and 24, T.19N., R.14E.

The Shadehill coals are hard, black, horizontally laminated and vertically jointed. The chemical characteristics of the coal at the Seidell mine are shown in Table 1. The B.T.U. output shows that this coal compares favorably with that now mined commercially in the Isabel-Firesteel area.

The Shadehill contains estimated commercial reserves of 813,450 tons of coal. This represents measured reserves (within 0.5 mile of outcrops), and was made on the same basis as the estimation of Hillen reserves.

The overburden at the two localities cited above is thin and of such a nature that it is easily removed by earth moving equipment. Strip mining would be relatively cheap at both places.

GRAVEL

The terrace deposits contain gravel which is suitable for road metal and has been used for that purpose to a very limited extent. Proper washing and screening should also provide material satisfactory for concrete aggregate. Table 3 shows estimated cubic yardages for a few of the easily accessible terraces. These contain a total of 3,342,826 cubic yards.

TABLE 3

LOCATION	ACRES	AVE. THICKNESS	CUBIC YARDS
Secs. 12, 13, T.19N., R.13E.	202	3'	977,680
Secs. 1, 12, T.19N., R.13E.	62	4'	400,106
Secs. 2, 11, T.19N., R.13E.	301	3'	1,456,840
Sec. 7, T.19N., R.14E.	63	5'	508,200

CLAY

The Upper Hell Creek contains highly bentonitic clays which make excellent material for the construction of stock dams.

* UNABLE TO GET COMPLETE COMBUSTION AND FIGURE GIVEN FOR B.T.U. IS THEREFORE ONLY AN ESTIMATE.