

AREAL GEOLOGY OF THE DATE QUADRANGLE

STATE OF SOUTH DAKOTA
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EXPLANATION

SEDIMENTARY ROCKS

Qal

Alluvium

(Valley-bottom deposits of clay, silt, sand, and gravel in Rabbit and Antelope Creeks)

Qol

Older Alluvium

(Older alluvial deposits above present floodplains of Rabbit and Antelope Creeks)

Qtg

Terrace Gravel

(Terrace deposits of sand and gravel to 27' thick. Occasionally river silt or loess covered)

Tac

Chadron Formation

(A 6"-thick light tan, dense, microcrystalline, cherty, fresh-water limestone. Features light white-gray to top interbedded gray-buff bentonitic clays, silts, and shales. Some brilliant red and yellow clays near base. About 30' thick.)

Ttbr

Tongue River Boulders

(Remains of light gray, ortho-quartzite boulders weather brown), displaying high degree of sand polish and occasional impressions of roots and branches. Derived from Tongue River formation. Some boulders up to 10' in length.)

Lud

Ludlow Formation

(Interbeds of buff, yellow, and gray clays, silts, and fine-grained graywacke and slightly argillaceous sandstone and ripple-marked sandstone locally calcareous cemented. Tropic - Scotch Cap sandstone: Dark gray, fine-grained, micaceous, cross-bedded, some massive-bedded, weathered brown, iron-stained sandstone. About 5'-20' thick. Type - Hillen coal facies. Coal thickness 0-20", dark brown color and smooth, blocky to flakey, associated peat-clay and "blackjack" beds, melanterite, celestine, gypsum, and limonite. Facies about 5'-10' thick. May be one or more thin, discontinuous, local coals between Hillen and Shoshone facies. Tropic - Shoshone coal facies: 1-5 coals 0-4.5" thick, grading laterally into peat-clay and/or "blackjack" beds. Formation 240' thick.)

Khu

Upper Hell Creek

("Saber beds" of gray, buff, brown, bentonitic, micaceous bentonitic clays, silts (part loess), graywacke sandstone, and fine thin local coals, peat-clay, and "blackjack" beds. Few calcareous-cemented sandstone nodules. Mn-Fe concretions, and limonite-concretionary layers. About 240' thick.)

DRAINAGE

Intermittent Streams

Intermittent Lakes

CULTURE

Buildings

(House, church and school)

Roads and Trails

Altitudes

(In feet above sea level)

Bench Marks

(Monuments marking points of known altitude)

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

Top Hole

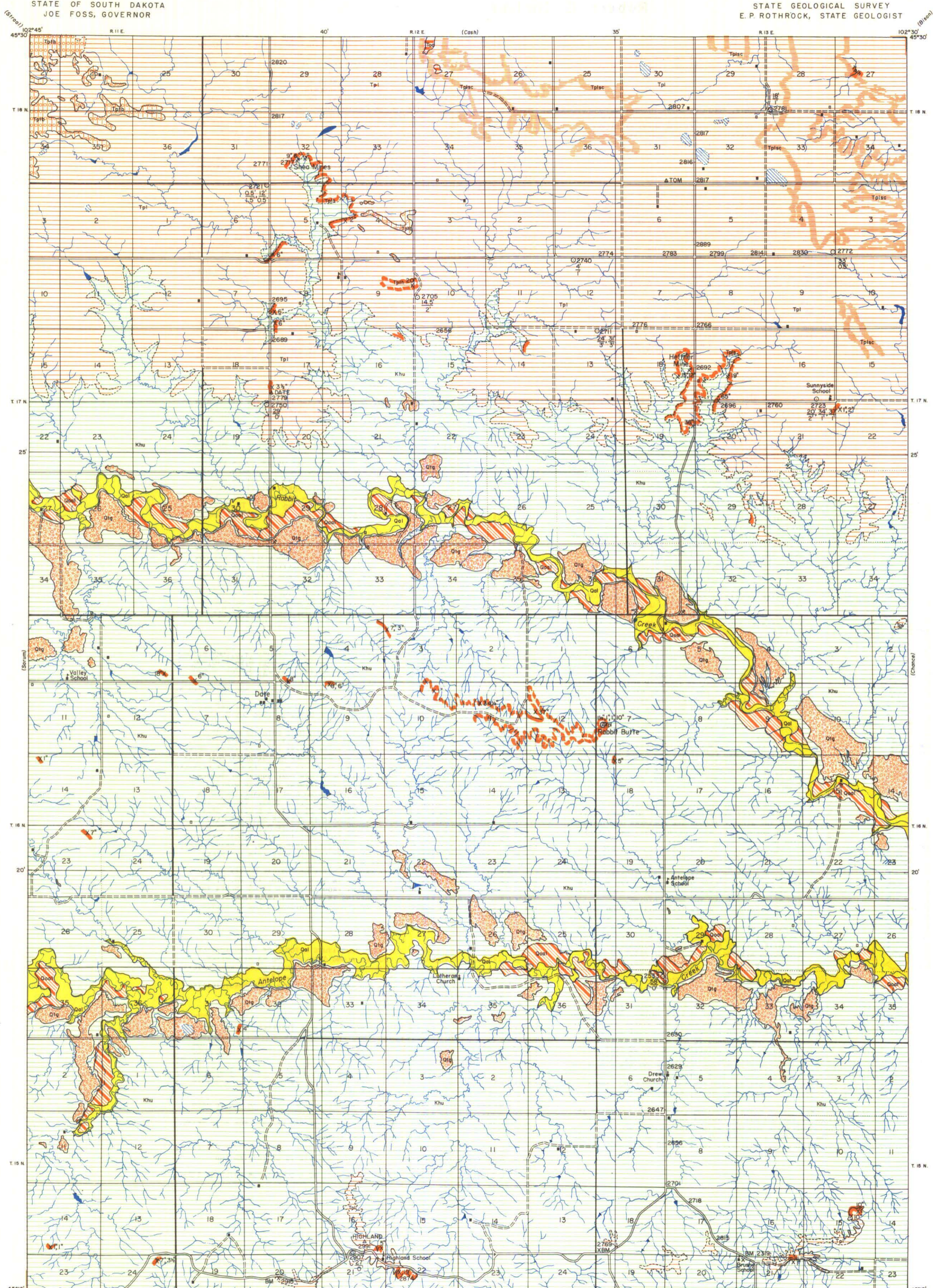
Altitude

Overburden

Drill Holes

Coal Thickness

(Exposed)



Geology by R. E. Curtiss.
Assisted by M. F. Nielsen and W. L. Foley.
Surveyed in 1954. Drafted by P. Rist.
Coal-test Holes Drilled in 1955.

Base Map by South Dakota State Geological Survey.

Scale = 1:25,000

Vermillion, South Dakota
1955

APPROXIMATE MEAN DECLINATION 1954



Quadrangle Location

AREAL GEOLOGY OF THE DATE QUADRANGLE

By
Robert E. Curtiss

INTRODUCTION

The quadrangle was mapped in August, 1954, as a part of the State Geological Survey's coal appraisal program. Exploratory coal-test drilling was done in June, 1955.

LOCATION

The quadrangle lies in Perkins County, south of State Highway 8. It is located about 35 airline miles southwest of Lemmon, approximately 81 miles northeast of Rapid City, and about 121 miles northwest of Pierre between parallels 45° 15' and 45° 30' north latitude and meridians 102° 45' west longitude and comprises an area of about 210 square miles. The quadrangle is named after the small settlement of Date which is located in the west-central part of the area.

TOPOGRAPHY AND DRAINAGE

The principal topographic features are the Antelope-Rabbit Creek interstream divide, Rabbit Butte, and the Antelope Creek-Moreau River interstream divide.

The Antelope-Rabbit Creek interstream divide trends east-west over the central portion of the area, and it is a rolling, grassed-over area that exhibits a sharp divide crest, excellently developed north of Date. Rabbit Butte, the highest point on the divide, is a symmetrical conical butte in Sec. 7, T. 16 N., R. 13 E. The butte towers about 210 feet above the divide.

The highest area in the quadrangle is found along the south border on the Antelope Creek-Moreau River divide. High, well-defined buttes form picturesque landmarks that may be viewed from a considerable distance.

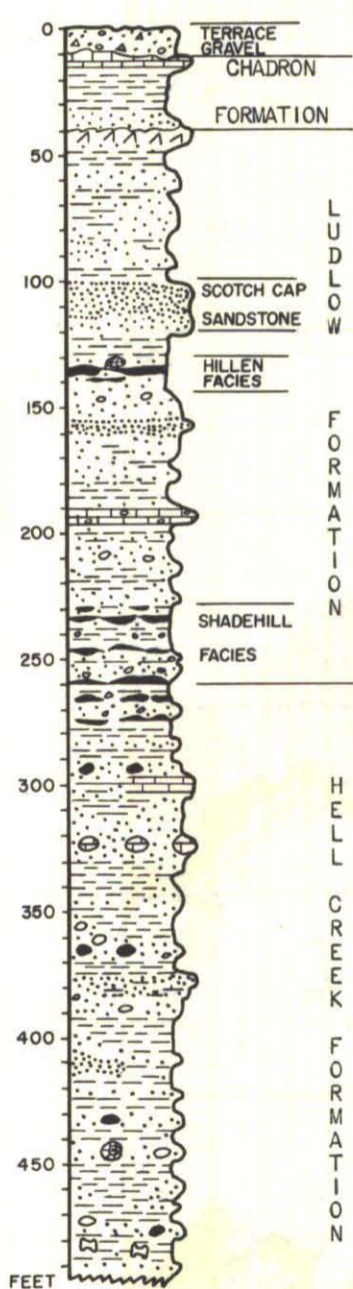
The drainage pattern in the quadrangle is dendritic, and a few springs emanate from the base of exposed coal beds.

The maximum altitude is 2,991 feet above sea level on the U. S. Coast and Geodetic Survey triangulation station Highland in Sec. 16, T. 15 N., R. 12 E. The minimum altitude is about 2,500 feet above sea level along Antelope Creek in Sec. 35, T. 16 N., R. 13 E. The quadrangle relief is approximately 491 feet, and the average altitude is about 2,745 feet above sea level.

STRATIGRAPHY

Geochronologically, the exposed stratigraphic sequence includes the Hell Creek formation (Upper Cretaceous age) and a portion of the overlying Ludlow formation (Paleocene age). The Hell Creek-Ludlow contact is conformable and represents continuous deposition with the exception of small diastems. Tertiary residuum is represented by fragments of silicified wood from the Tongue River formation (Paleocene age). Terrace gravels (Pleistocene age), older alluvium (Pleistocene-recent age), and alluvium (recent age) complete the exposed strata in the quadrangle.

GENERALIZED COLUMNAR SECTION



UPPER HELL CREEK, HELL CREEK FORMATION (Brown 1907)

This unit, which attains a thickness of about 240 feet, is characterized by drab, subdued medium to dark gray, brown, and buff colored, lenticular admixtures of channel and dune sands, partly eolian silts, bentonitic clays, thin seams of calciche, lime-cemented sandstones and thin coal beds, peat clay or fluorastrome beds, occasionally exhibits small resin pellets and fragments of vitrain and fusian coal. Small quantities of purple-black manganese-iron concretions and orange-brown limonitic layers are evident in eroded areas. Yellow melanterite and/or jarosite "haloes" surround marcasite nodules in loose, unconsolidated sand in Sec. 27, T. 16 N., R. 13 E. Unarticulated dinosaur bones, replaced by pyrite, were found along the "breaks" and local badlands in Sec. 4, T. 16 N., R. 13 E.

The Shadehill coal facies transects the Hell Creek-Ludlow contact. Five thin coals, one-inch to ten-inches thick, exist in the "somber beds" at Rabbit Butte. Here the coals are restricted to the Hell Creek whereas none occur in the basal Ludlow. However, coal is found in both the Hell Creek "somber beds" and overlying basal Ludlow in Sec. 15, T. 15 N., R. 13 E. The thickest upper Hell Creek coal measured 37 inches in Sec. 12, T. 16 N., R. 12 E., while the Shadehill at the Heffner Mine, Sec. 18, T. 17 N., R. 13 E. measured 21 inches.

In places, clinker and pseudoscoria, buff to brick red colored claystone, and ashes represent burned coal, peat-clay, and clay beds. Coal thicknesses and lithology may vary or be replaced laterally by "blackjack", peat-clay, or may be entirely missing.

LUDLOW FORMATION (Lloyd and Hares 1915)

About 220 feet are present in the quadrangle. It forms the bedrock across the northern one-third of the quadrangle, and Ludlow buttes cap the divide near the south boundary.

Lithologically, the formation consists principally of interbedded, lenticular light cream-colored clays, silts, graywacke and arkosic sands, and ripple-marked, cross-laminated sandstones. The basal portion displays varicolored clays and pink to rose colored calcareous nodules at Rabbit Butte and the buttes along the south divide.

The Shadehill biofacies contains from one to five coal beds, zero to 65-inches thick, which universally grade laterally into peat-clays and/or "blackjack" beds, and limonite, melanterite and/or jarosite, gypsum are associated minerals. The biofacies attains a thickness of about 40 feet.

Up to 90 feet of buff laminated, lenticular clays and silts and yellowish brown and cross-bedded, fine-grained micaceous, slightly glauconitic sand separate the Shadehill and Hillen biofacies.

The Hillen coal facies is located about 65 to 90 feet above the Shadehill coal facies. The facies appears to be 5 to 10 feet thick. Several coal zones exist, including two coals with dark brown color and streak and blocky to fissile bedding, maximum thickness of 20 inches of coal, peat-clays, and the minerals limonite, melanterite and/or jarosite and selenite gypsum.

The Scotch Cap sandstone, which varies between three and 20 feet in thickness, and is composed of dark gray, fine-grained, micaceous, cross-bedded, massive-bedded weathered lichen-surfaced, limonite-stained sandstone. Some loose unconsolidated sand is found in this interval. About 60 feet of upper Ludlow-strata overlies the Scotch Cap. These terrestrial sediments consist of buff clays, silts, sands, and sandstones.

Tongue River Boulders, Tongue River Formation (Taff 1909) Two areas in the northwestern portion of the quadrangle exhibit thick deposits of light gray, wind-polished orthoquartzite boulders with voids showing root and branch impressions. The surfaces are brown stained and highly wind-polished like ventifacts. Many boulders are five feet thick and 10 feet long.

CHADRON FORMATION (Darton 1899), WHITE RIVER GROUP (Meek and Hayden 1858) This formation constitutes the lower formation of the White River group of sediments. About 30 feet are exposed in buttes located in Sec. 27, T. 18 N., R. 12 E. This unit is composed of interbedded gray to buff highly bentonitic clays, silts, and sands. A thin, six inch to one foot thick light tan, dense, microcrystalline, fresh water limestone is found at the top of the buttes. Broken limestone fragments, containing milky chert or porcellanite, litter the Chadron surfaces. The formation was deposited on an erosional unconformity on the Ludlow formation.

TERRACE GRAVELS. Many terraces are found along both sides of Rabbit and Antelope Creeks. The maximum gravel thickness measured is 27 feet along Rabbit Creek in Sec. 10, T. 16 N., R. 13 E. The materials are largely limonite concretions, sandstone, limestone, milky quartz, silicified wood, and orthoquartzite.

OLDER ALLUVIUM. Higher alluvial terraces are found above the present valleys of Antelope and Rabbit Creeks. These deposits consist of heterogeneous mixtures of clay, silt, sand and gravel textures.

ALLUVIUM. This surficial deposit is restricted to present valley-bottom deposits of clay, silt, sand and gravel.

STRUCTURE

The regional dip is northeast toward the axis of the Dakota (Williston) Basin at the rate of 18 feet per mile. Small structural features such as normal faults (slump) are inherent to the Hell Creek formation. Heave and throw seldom exceed 25 feet. The determination of surface structure in the Hell Creek formation is further complicated because of primary sedimentational features such as large-scale lenticularity, cross-bedding, and differential compaction. Much of the uplands are grassed over. Structures have imposed no mining difficulties.

ECONOMIC GEOLOGY

This area contains a number of mineral resources of current or potential value. Coal mining is nonexistent today; however, several mines, including the Heffner, in Secs. 17, 18, T. 17 N., R. 13 E., and Sec. 32, T. 18 N., R. 12 E. operated years ago. Gravel is exploited periodically. Coal and coal by-products, clay, pseudoscoria, sandstone, and orthoquartzite may be of future importance.

COAL

AREAL EXTENT. The approximate boundary of the Hell Creek and Ludlow coals are shown on the map. The boundaries were established by natural exposures, coal mines, prospect pits, and 10 State Geological Survey coal-test holes.

THICKNESS. The Hell Creek coal attains a thickness of 37 inches; the Shadehill reaches 65 inches in thickness; and, the Hillen coal is 20 inches thick.

PHYSICAL CHARACTER. Much of the Hell Creek and Ludlow coals are banded, black (5YR2/1) in color and streak, hard, smooth surfaced, blocky with limonite stain and selenite gypsum crystals along the joints and bedding planes, sporadic subrounded amber-colored resin pellets, pyrite, marcasite and/or jarosite. These coals slack upon drying and are non-caking. The specific gravity averages between 1.2 and 1.25. Thin peat-clay beds and "blackjack" partings exist in the coal and super-and subjacent positions.

CHEMICAL CHARACTER. Chemical analyses provide a satisfactory basis for comparing coals and determining the rank and grade of coal and its commercial qualities. Proximate analyses furnish requisite data concerning the quality and combustion properties of coal (moisture, volatile and gaseous matter, fixed carbon or the chief heat-producing constituent, ash and sulphur). The moisture, volatile matter, and fixed carbon are resolved into carbon, hydrogen, oxygen, and nitrogen by the ultimate analyses.

Coal samples from the Shadehill coal, Heffner Mine (sample number 1) 21-inches thick, Sec. 18, T. 17 N., R. 13 E. and from an outcrop of Hillen coal (sample number 2) 19½-inches thick, NE¼ Sec. 9, T. 17 N., R. 12 E., were analyzed as received, meaning the samples represent the coal as mined. Proximate analyses show the following:

SAMPLE	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULPHUR	B.T.U.	DRY B.T.U.
1	33.20%	39.35%	18.37	9.08%	1.68%	6,997	10,460
2	41.91%	43.35%		15.74%	0.72%	3,878	6,676

Ash is lower in the Shadehill coal than the Hillen coal, and the B.T.U.'s are higher in the Shadehill.

Economically, if the coal is air-dried prior to consumption, the heating value will be increased approximately 3,000 B.T.U.'s. (See Dry B.T.U. in Table 1.)

CHARACTER OF OVERBURDEN. The overburden, which is both topmost Hell Creek and basal and middle Ludlow, imposes no difficulties to strip mining. Dirt-moving equipment readily disposes of these strata in other areas. Overburden thickness is shallow adjacent to the 65 inches of Shadehill coal that crops out along the road between Secs. 17, 20, T. 17 N., R. 13 E. If detailed drilling disclosed commercial thicknesses of Hillen coal under the Scotch Cap sandstone, then the sandstone would be a detriment to strip mining.

ESTIMATED COAL RESERVES. The total estimated coal tonnage, based on outcrops, mines and drill-hole data is about 3,815,735 tons. Tonnage is computed on the basis of a minimum thickness of 2½ feet, a specific gravity of 1.25 and 1,700 tons per acre-foot. Tonnage is further resolved into three categories: measured (coal reserves located within 0.5 miles from outcrops, mines, or coal-test holes), 308,550 tons; indicated (coal reserves located between 0.5 and 1.5 miles from outcrops, strip mines, or drill holes), 2,524,635 tons; and, inferred (coal reserves located more than 1.5 miles from outcrops, strip mines, or drill holes), 682,550 tons.

POTENTIAL MINING AREAS. Data from 10 State Geological Survey drill holes indicate a potential stripping area in Secs. 17, 18, 19, 20, T. 17 N., R. 13 E., where the coal thicknesses vary from 15 inches to 65 inches in thickness. Systematic drilling or augering is necessary in determining the precise qualities and quantities of coal and the thickness and character of overburden in this area.

SAND AND GRAVEL

Sand and gravel terrace deposits constitute a total of approximately 50,000,000 cubic yards and are located along Antelope and Rabbit Creeks. Much of the material is satisfactory for ordinary foundation and road utility. Gravel is presently exploited in Sec. 31, T. 17 N., R. 13 E.

The estimated volumes of sand and gravel that offer good possibilities for large-scale operation follow:

SECTION	LOCATION	TWP. N.	R. E.	ACRES	AVERAGE THICKNESS	CUBIC YARDS
10, 15		16	13	302	20'	9,760,667
29, 30, 31, 32		17	12	310	9'	4,504,104
27, 28, 33, 34		17	12	265	9'	3,849,252
31		17	13			
5		16	13	145	15'	3,513,840
14, 15		16	13	161	12'	3,109,216

CLAY AND PSEUDOSCORIA

Many bentonitic clayey strata in the Hell Creek formation can be used to seal leaking stock dams, thus conserving water. Pseudoscoria or burned pink to red claystone can be used for road metal.

ORTHOQUARTZITE AND SANDSTONE

The orthoquartzite boulders in the northwestern portion of the quadrangle can be used for building stone. The orthoquartzite is silicified and possesses excellent structural strength.

The Scotch Cap sandstone may also be used as a source for building stone and rip-rap for dams.