

AREAL GEOLOGY OF THE GLAD VALLEY QUADRANGLE

EXPLANATION
SEDIMENTARY ROCKS

QUATERNARY

- Qal**
Alluvium
(Valley-bottom deposits of clay, silt, sand, and gravel in present streams)
- Qol**
Older Alluvium
(Alluvial terrace deposits above present floodplains)
- Q1g**
Terrace Gravel
(Terrace deposits of sand and gravel 1'-4' thick)
- Tpl**
Ludlow Formation
(Buff to gray silty clay, brown to rose shaly clay, weathers light gray, fine-grained lens-like, slabby, cross-laminated, ripple-marked sandy siltstone, buff-yellow silty sand. Tpis-basal Shadell coal bed: one or more coals (lignite and subbituminous C), 1'-6" thick, associated clays, silts, sands, peat-clays, and "blackjack"; a black carbonaceous clay, beds 40'-60' thick.)

TERTIARY

- Khu**
Upper Hell Creek
(“Somber beds” of lenticular bentonitic clays, silts, (part loess), sands, peat-clays, and few clay-peats. A few “blackjack” beds and buff-top high-rank graywacke and quartzose sandstones. Collium or slope wash in barren-slope areas. Small quantities of black Mn-Fe concretions in badland areas. Some brown orthoquartzite boulders scattered on surface. About 300'-350' thick.)
- Khi-1**
Isabel-Firesteel Coal Member
(Black, blocky subbituminous C coal, some lignite, 0'-15' thick, often carries “blackjack” as partings in coal or super- and/or subcoast positions. Brown clay-peat beds associated with coal or represents coal beds when coal is absent.)
- Kh**
Lower Hell Creek
(Medium to dark gray lenticular bentonitic clays, silts (part loess), sands, thin peat-clay beds. Some block Mn-Fe concretions and rubble. Few Ostracod biotopes, occasional dinosaur (Trachodon or Triceratops (?) bones. About 50'-75' thick.)

CRETACEOUS

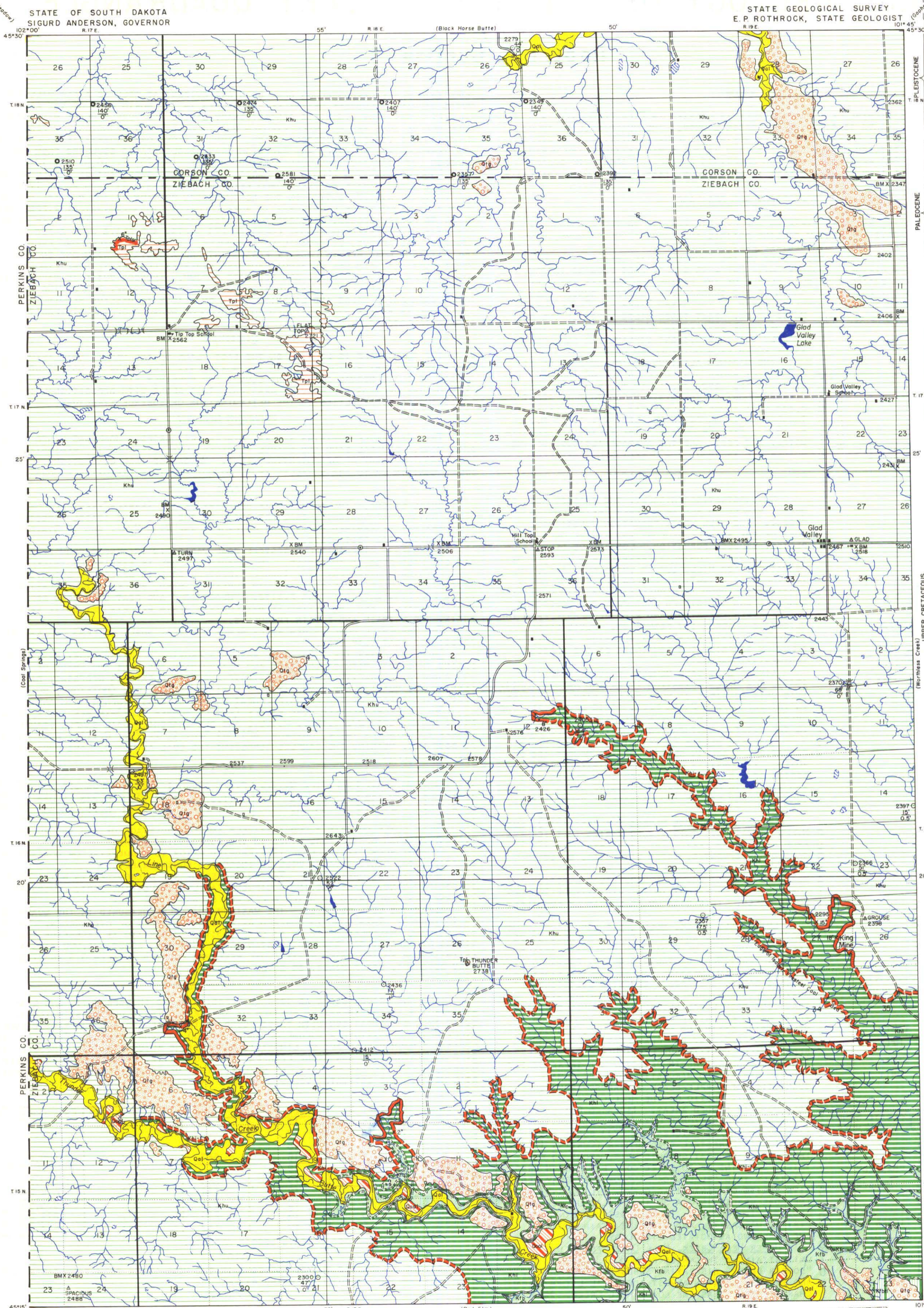
- K1c**
Colgate Sandstone
(“Pepper-and-salt” high-rank graywacke sandstone, calcareous cement, cross-laminated, spheroidal-concretionary, weathers brown 5'-15' thick.)
- K1b**
“Banded” Member
(Alternating light and medium gray clayey sand and silt with small brown limonite concretionary layers, some thin streaks of plant matter. About 40'-50' thick.)
- K1b1**
“Banded” and Timber Lake Members, Undifferentiated
(Insufficient outcrop data preclude subdivision K1b-“Banded” Member: same lithology and thickness as above K1b-Timber Lake Sand Member: buff-yellow sand. About 25'-50' 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
- Drill Holes
(State Geological Survey, Seismograph Shot Holes, Courtesy of Geotech. Corp. of Del.)



STATE OF SOUTH DAKOTA
SIGURD ANDERSON, GOVERNOR

STATE GEOLOGICAL SURVEY
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Coal-Test Holes Drilled in 1954

Base Map by South Dakota State Geological Survey.

Scale = 1:25,000
Vermillion, South Dakota
1954

Approximate Mean
Reclamation 1952

Quadrangle Location

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By
Robert E. Curtiss

LOCATION

ABOUT SEVEN-EIGHTHS OF THE QUADRANGLE IS LOCATED IN ZIEBACH COUNTY, AND APPROXIMATELY ONE-EIGHTH IS SITUATED IN CORSON COUNTY. THE QUADRANGLE IS ABOUT 93 MILES NORTHWEST OF PIERRE, 102 MILES NORTHEAST OF RAPID CITY, AND 34 MILES SOUTH OF LEMMON BETWEEN PARALLELS 45°15' AND 45°30' NORTH LATITUDE AND MERIDIANS 101°45' AND 102°00' WEST LONGITUDE AND COMPRISES AN AREA OF ABOUT 210 SQUARE MILES. THE SMALL TOWN OF GLAD VALLEY IS LOCATED ON STATE HIGHWAY 8 IN THE EAST-CENTRAL LOCALE.

TOPOGRAPHY AND DRAINAGE

THUNDER BUTTE, THE MOST STRIKING TOPOGRAPHIC FEATURE IN THE QUADRANGLE, RISES 300 FEET ABOVE THE GENTLY ROLLING PRAIRIE AND FORMS A CONSPICUOUS, PICTURESQUE LANDMARK IN THE SOUTH-CENTRAL PART OF THE AREA.

MOST OF THE AREA COMPRISES A PART OF THE THUNDER BUTTE CREEK-BLACK HORSE BUTTE INTERSTREAM DIVIDE. THUNDER BUTTE CREEK IS A WEST-EAST FLOWING INTERMITTENT STREAM WHICH DRAINS THE SOUTH SLOPES OF THE DIVIDE AND EMPTIES INTO THE MOREAU RIVER, ABOUT FOUR MILES SOUTH OF THE QUADRANGLE. SURFACE RUNOFF FROM THE DIVIDE'S NORTH SLOPE IS CONVEYED NORTH TO THE GRAND RIVER VIA BLACK HORSE BUTTE CREEK, ABOUT THREE MILES NORTH OF THE AREA. THE DRAINAGE PATTERN IS DENDRITIC, EXHIBITING SHARPLY-CUT INTERMITTENT STREAMS. A FEW SPRINGS ISSUE FORTH FROM OUTCROPPING COAL BEDS.

THE MAXIMUM ALTITUDE IN THE QUADRANGLE IS 2,738 FEET ABOVE SEA LEVEL ON TOP OF THUNDER BUTTE IN SE¼ Sec. 26, T. 16 N., R. 18 E., ZIEBACH COUNTY. THE MINIMUM ALTITUDE IS ABOUT 2,135 FEET ABOVE SEA LEVEL AT THE WATER LEVEL IN THUNDER BUTTE CREEK IN NE¼ Sec. 22, T. 15 N., R. 19 E., ZIEBACH COUNTY. THE RELIEF IS APPROXIMATELY 603 FEET, AND THE AVERAGE ALTITUDE OF THE QUADRANGLE IS ABOUT 2,436 FEET ABOVE SEA LEVEL.

STRATIGRAPHY

CHRONOSTRATIGRAPHICALLY, THE EXPOSED ROCK SEQUENCE RANGES IN AGE FROM UPPER CRETACEOUS TO RECENT. THE HELL CREEK FORMATION CONSTITUTES MOST OF THE SURFACE GEOLOGY AND IS THE ONLY COMPLETELY-EXPOSED FORMATION. CONTINUOUS DEPOSITION AND CONFORMABLE CONTACTS PREVAIL FROM THE OLDEST FORMATION, FOX HILLS (UPPER CRETACEOUS AGE), TO THE YOUNGEST FORMATION, LUDLOW (PALEOCENE AGE). TERTIARY RESIDUUM IS REPRESENTED BY ORTHOQUARTZITE BOULDERS AND SILICIFIED WOOD FROM THE PALEOCENE TONGUE RIVER FORMATION AND A CONGLOMERATE FROM THE OLILOCENE CHADRON (?) FORMATION. PLEISTOCENE GRAVELS, PLEISTOCENE-RECENT ALLUVIUM, AND RECENT ALLUVIUM COMPRISE THE REMAINDER OF THE EXPOSED SEDIMENTATIONAL UNITS.

TIMBER LAKE SAND MEMBER (MORGAN AND PETSCH 1945), **FOX HILLS FORMATION** (MEEK AND HAYDEN 1861). THIS UNIT CONSISTS OF BUFF-YELLOW SAND AND VARIES IN THICKNESS FROM 25-50 FEET. THIS MEMBER AND THE OVERLAYING "BANDED" MEMBER ARE UNDIFFERENTIATED IN THE EXTREME SOUTHEASTERN PORTION OF THE AREA.

"BANDED" MEMBER (SEARIGHT 1931), **FOX HILLS FORMATION**. FROM 40-50 FEET OF THE MEMBER ARE EXPOSED. IT CONSISTS OF A BANDED, INTERCALATED SERIES OF LIGHT TO MEDIUM DARK GRAY CLAYEY SAND AND SILT WITH ORANGE-BROWN LIMONITE STAIN AND SMALL CONCRETIONARY LAYERS AND STREAKS OF BROWN PLANT MATTER.

COLGATE SANDSTONE MEMBER (CALVERT 1912), **FOX HILLS FORMATION**. THIS MEMBER VARIES IN THICKNESS FROM FIVE TO 15 FEET. THE "PEPPER-AND-SALT", CALCAREOUS-CEMENTED, CROSS-LAMINATED, SHALY TO M FLAGGY BEDDED, HIGH-RANK GRAYWACKE SANDSTONE WEATHERS A LIGHT BROWN "SPHEROIDAL-CONCRETIONARY" FORM, AND IT CROPS OUT IN THE VICINITY OF THUNDER BUTTE CREEK. THIS STRATUM IS SPARINGLY FOSSILIFEROUS.

LOWER HELL CREEK, HELL CREEK FORMATION (BROWN 1907). THIS UNIT RANGES IN THICKNESS FROM 50-75 FEET AND CONSISTS OF MEDIUM TO DARK GRAY INTERBEDDED, LENTICULAR BENTONITIC CLAYS, PREDOMINANTLY CROSS-LAMINATED LOESSIAL SILTS, LARGELY FINE-GRAINED SANDS, CALCAREOUS-CEMENTED SILTSTONES, GRAYWACKE SANDSTONES, AND HETEROGENEOUS SIZE FRACTIONS FROM LOCAL FLOODPLAIN-CHANNEL DEPOSITS, RUSTY BROWN LIMONITIC CONCRETIONS, AND YELLOW MELANTERITE STAIN AND NODULES. THIN, DISCONTINUOUS BROWN PEAT-CLAY AND CLAY-PEAT (FLORASTROME) BEDS USUALLY CONTAIN SMALL FRAGMENTS OF FUSAIN AND AMBER-COLORED RESIN PELLETS, AND INFREQUENTLY CONTAIN PYRITE AND MARCASITE NODULES. SMALL QUANTITIES OF PURPLE-BLACK MANGANESE-IRON CONCRETIONS (DIAGNOSTIC OF THE HELL CREEK FORMATION) ARE FOUND IN ERODED AREAS. ISOLATED *OSTREA* BIOTERMES, AND OCCASIONAL UNARTICULATED DINOSAUR (*TRACHODON* AND/OR *TRICERATOPS* (?)) BONES ARE FOUND.

ISABEL-FIRESTEEL COAL MEMBER (CURTISS 1952). THIS BIO-LITHOSTRATIGRAPHIC UNIT, ABOUT 25 FEET THICK, CONTAINS UP TO THREE COAL BEDS WHICH GRADE LATERALLY INTO "BLACKJACK" AND/OR PEAT-CLAY BEDS WITH SPLITS OF BENTONITIC CLAYS, SILTS, AND SANDS. THE COAL GRADES INTO A 56-INCH "BLACKJACK" IN SEC. 31, T. 16 N., R. 18 E. FOSSIL RESIN PELLETS, PYRITE, MARCASITE, AND LIMONITE STAIN OCCUR IN THE COAL AND ASSOCIATED LITHOLOGY.

UPPER HELL CREEK, HELL CREEK FORMATION. THIS UNIT ATTAINS A THICKNESS FROM 300-350 FEET. THESE "SOMBER BEDS", DISPLAYING SUBDUED GRAYS, BUFFS, AND BROWNS, CONTAIN ALMOST IDENTICAL LITHOLOGICAL CHARACTERISTICS AS THE LOWER HELL CREEK. HOWEVER,

MORE THIN BLACK CARBONACEOUS CLAY BEDS ARE EVIDENT AS WELL AS A FEW HILL AND BUTTE CAPPING HIGH-RANK GRAYWACKE SANDSTONES IN THE NORTH PART OF THE AREA. LOCALLY-PERSISTENT LIMONITIC CONCRETIONARY LAYERS AND PURPLE-BLACK MANGANESE-IRON CONCRETIONS ARE NOT WELL EXPOSED DUE TO COVER, BUT OCCASIONALLY FORM A BLACK RUBBLE VENEER ON BEDROCK ROADS. TONGUE RIVER ORTHOQUARTZITE BOULDERS ARE SCATTERED ON THE SURFACE, AND GREENISH GRAY CONGLOMERATIC BOULDERS FROM THE CHADRON (?) FORMATION ARE CONCENTRATED IN SECS. 14, 23, T. 16 N., R. 18 E.

LUDLOW FORMATION (LLOYD AND HARES 1915). THE LOWER PART OF THE FORMATION IS PRESENT AND VARIES BETWEEN 40-60 FEET IN THICKNESS. IT CAPS ABOUT 17 HILLS AND BUTTES. SIXTEEN BUTTES IN THE NORTHWESTERN PORTION OF THE MAP ARE SURFACED WITH A TWO-FOOT THICK LIGHT GRAY TO BUFF COLORED, CROSS-LAMINATED, RIPPLE-MARKED, SHALY TO FLAGGY BEDDED, CALCAREOUS-CEMENTED SANDY SILTSTONE. THE LOWER 40 FEET CONSISTS OF BUFF-YELLOW SANDS, LOESSIAL (?) SILTS, AND CLAYS WITH A FEW ROSE COLORED, CALCAREOUS, BOTRYOIDAL-LIKE NODULES. THE SHADEHILL COAL FACIES: ONE SIX-INCH COAL BED IS LOCALLY PERSISTENT AND ASSOCIATED WITH ONE ONE-FOOT BROWN PEAT-CLAY AND ONE ONE-FOOT BROWNISH LAVENDER CLAY-PEAT, SOME LIMONITE STAIN, MELANTERITE NODULES, AND SELENITE GYPSUM. THUNDER BUTTE IS CAPPED WITH 40-60 FEET OF VERY LIGHT GRAY TO BEIGE QUARTZOSE SANDSTONE, DISPLAYING FAINT BROWN IRON OXIDE HALOS AND LIMONITE STAIN ON FLAGGY TO MASSIVE BEDDING. THIS SANDSTONE IS ARBITRARILY ASSIGNED TO THE LUDLOW BECAUSE OF THE SIMILARITY TO LUDLOW SANDSTONES.

STRUCTURE

THE QUADRANGLE IS LOCATED ON THE EAST FLANK OF THE DAKOTA (WILLISTON) BASIN. THERE IS A SLIGHT REGIONAL DIP TO THE NORTHWEST. THE FLANK IS NOT STRUCTURALLY SMOOTH AS SMALL NORMAL FAULTS AND SLUMPS AND POSSIBLY STRUCTURAL "HIGHS" EXIST. MUCH OF THE UPLANDS ARE HEAVILY GRASSED. THIS ALONG WITH DEPOSITIONAL IRREGULARITIES IMPOSE DIFFICULTIES IN THE DETERMINATION OF SURFACE STRUCTURE.

ECONOMIC GEOLOGY

THE QUADRANGLE CONTAINS SEVERAL MINERAL RESOURCES. COAL WAS MINED AT THE KING MINE. SEVERAL SAND AND GRAVEL TERRACES, COAL BY-PRODUCTS, BENTONITIC CLAYS, AND SANDSTONES MAY BE OF POTENTIAL VALUE. MANGANESE-IRON CONCRETIONS, SOME OF WHICH CONTAIN UP TO 51% METALLIC IRON, DO NOT EXIST IN EXPLOITABLE QUANTITIES.

COAL

AREAL EXTENT. THE APPROXIMATE BOUNDARY OF THE ISABEL-FIRESTEEL COAL AND A SMALL OUTCROP OF SHADEHILL COAL ARE SHOWN ON THE MAP. THE ISABEL-FIRESTEEL COAL BOUNDARY WAS DETERMINED BY NATURAL OUTCROPS, THE KING MINE, AND 12 STATE GEOLOGICAL SURVEY COAL-TEST HOLES.

THICKNESS. THE ISABEL-FIRESTEEL COAL VARIES IN THICKNESS FROM ZERO TO ONE AND ONE-HALF FEET IN THICKNESS. THE SHADEHILL COAL IS SIX-INCHES THICK.

PHYSICAL CHARACTER. THE ISABEL-FIRESTEEL COAL IS GENERALLY BROWNISH BLACK (5YR2/1) IN COLOR AND STREAK, SMOOTH SURFACED, HARD, BLOCKY, WITH OCCASIONAL RESIN PELLETS, MARCASITE AND PYRITE. "BLACKJACK" AND PEAT-CLAY BEDS REPLACE THE COAL LATERALLY, AND THE PEAT-CLAY MAY CONTAIN RESIN PELLETS, LIMONITE SPECKS AND STAIN, AND VITRAIN AND FUSAIN FRAGMENTS.

THE SHADEHILL COAL IS GENERALLY BLACK COLORED, SHALY OR LESS BLOCKY, WITH ASSOCIATED PEAT-CLAY BEDS.

CHEMICAL CHARACTER. CHEMICAL ANALYSES PROVIDE A SATISFACTORY BASIS FOR COMPARING THIS COAL WITH OTHER COALS AND DETERMINING THE RANK AND GRADE OF COAL AND ITS COMMERCIAL QUALITIES. THE PROXIMATE ANALYSIS FURNISHES NECESSARY DATA CONCERNING THE QUALITY AND COMBUSTION PROPERTIES OF THE COAL (MOISTURE, VOLATILE MATTER, FIXED CARBON OR THE PRINCIPAL HEAT-PRODUCING CONSTITUENTS, ASH AND SULPHUR).

ONE ISABEL-FIRESTEEL COAL SAMPLE (SAMPLE NUMBER 1) 15-INCHES THICK, KING MINE, SE¼ NE¼ Sec. 27, T. 16 N., R. 19 E., AND ONE SHADEHILL COAL SAMPLE (SAMPLE NUMBER 2) 6-INCHES THICK, OUTCROP, NE¼ SW¼ Sec. 1, T. 17 N., R. 17 E., WERE ANALYZED AS RECEIVED, MEANING THE SAMPLES REPRESENT THE COAL AS MINED. THE PROXIMATE ANALYSES FOLLOW:

TABLE 1

SAMPLE	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULPHUR	B.T.U.	DRY B.T.U.
1	39.44%	39.44%	11.37%	10.10%	0.33%	5,043	8,327
2	32.84%	38.56%	20.32%	8.28%	0.27%	6,300	9,381

THESE COALS CONTAIN A COMPARATIVELY SMALL PERCENTAGE OF ASH AND SULPHUR, TYPICAL OF MUCH OF THE COAL MINED IN THE SURROUNDING AREAS.

ECONOMICALLY, IF THE COAL IS AIR-DRIED PRIOR TO COMMERCIAL OR DOMESTIC CONSUMPTION, THE HEATING VALUE WILL BE INCREASED CONSIDERABLY.

CHARACTER OF OVERBURDEN. THE CHARACTER OF THE OVERBURDEN IS NOT A DETRIMENT TO STRIP MINING. EARTH-MOVING EQUIPMENT EASILY REMOVES THE DIRT. OVERBURDEN THICKNESSES PENETRATED IN DRILL HOLES ARE SHOWN ON THE MAP.

ESTIMATED COAL RESERVES. THE MAXIMUM THICKNESS MEASURED IN THE QUADRANGLE IS 18 INCHES. THIS COAL IS COVERED BY AT LEAST 50 FEET OF OVERBURDEN. THE OVERBURDEN-COAL THICKNESS RATIO IS AT LEAST 33:1. THIS RATIO IS EXCESSIVE FOR STRIP MINING BY PRESENT-DAY COMMERCIAL STANDARDS. HOWEVER, ABOUT 504,900 TONS ARE ESTIMATED ON AN INDICATED BASIS (COAL RESERVES LOCATED BETWEEN 0.5 AND 1.5 MILES FROM OUTCROPS, STRIP MINES, OR DRILL HOLES).

SAND AND GRAVEL

SAND AND GRAVEL OCCUR AS TERRACE DEPOSITS ALONG THUNDER BUTTE AND LINE CREEK AND ALSO IN THE NORTHEASTERN PORTION OF THE AREA. THESE DEPOSITS, WHICH ARE QUITE THIN BY COMPARISON WITH THOSE FOUND IN THE COAL SPRINGS QUADRANGLE IMMEDIATELY WEST, CONSTITUTE A VOLUME OF ABOUT 10,000,000 CUBIC YARDS. THE DEPOSITS CONTAIN A HIGH PERCENTAGE OF LIMONITIC CONCRETIONS WHICH ARE EASILY REDUCED IN SIZE BY WEATHERING, SANDSTONE PEBBLES, ORTHOQUARTZITE, ROCK CRYSTAL AND MILKY QUARTZ, A FEW ARKOSIC PEBBLES, ET CETERA. THIS MATERIAL IS ADEQUATE FOR ORDINARY ROAD METAL. THE ESTIMATED VOLUMES OF SAND AND GRAVEL FOLLOW:

TABLE 2

SECTIONS	TWP. N.	RGE. E.	ACRES	AVE. THICKNESS	EST. CUBIC YARDS
36	16	17			
1	15	17			
31	16	18			
5,6	15	18	667	2½'	2,689,427
2,3	17	19			
28,33,34	18	19	605	1½'	1,463,293
10,11	15	18	254	2½'	1,024,467
19,30,31	16	18	291	2'	975,997
4,9,10	15	18	255	2'	822,800
21	15	19	152	2½'	613,067

NUMEROUS TERRACES CONTAIN LESSER AMOUNTS.

CLAY

CERTAIN BENTONITIC CLAYEY HORIZONS IN THE HELL CREEK FORMATION CAN BE USED TO SEAL STOCK DAMS, THUS CONSERVING WATER.

SANDSTONE

THE FOX HILLS COLGATE SANDSTONE AND SANDSTONES IN THE HELL CREEK FORMATION COULD PROVIDE BLOCK OR BUILDING STONE FOR FOUNDATIONS AND RIP-RAP.

