

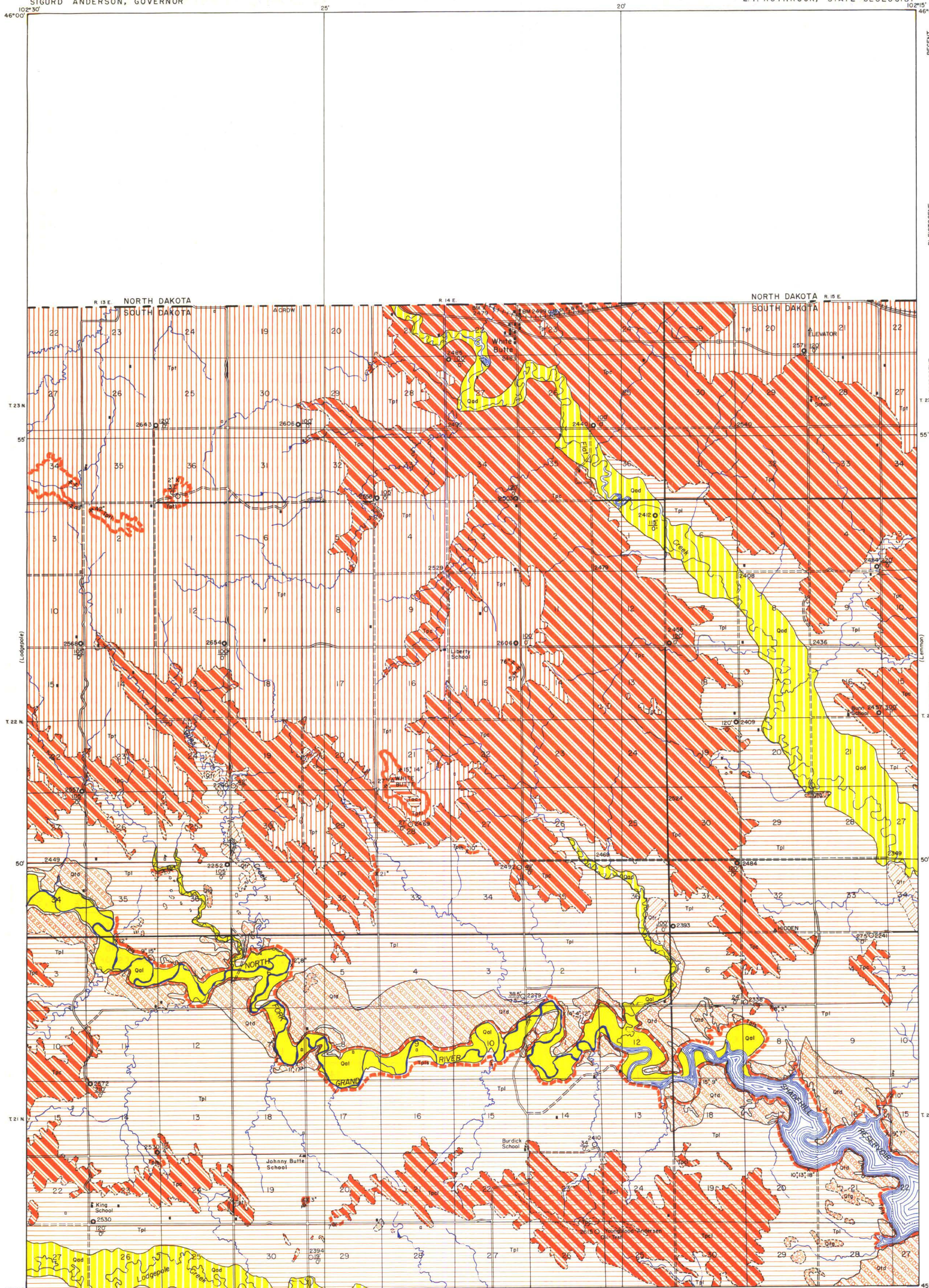
AREAL GEOLOGY OF THE HAYNES QUADRANGLE

EXPLANATION

SEDIMENTARY ROCKS

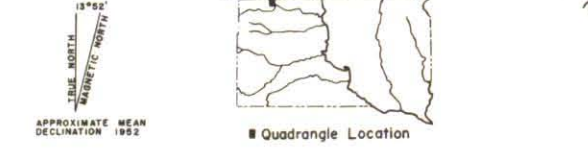
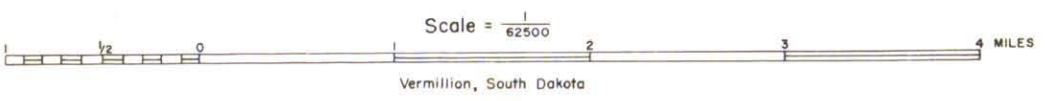
STATE OF SOUTH DAKOTA
SIGURD ANDERSON, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



- RECENT**
 - QUATERNARY**
 - PLEISTOCENE**
 - OLIGOCENE**
 - Eocene**
 - PALEOCENE**
 - TERTIARY**
- Qal**
Alluvium
(Floodplain deposits of silt, sand, and gravel in present major stream valleys.)
 - Qad**
Alluvial Deposits
(Floodplain and low terrace deposits of angular gravel, silt, and clay of local derivation.)
 - 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 and Tongue River formations.)
 - Qtg**
Terrace Gravel
(High terrace deposits of arkosic coarse sand and gravel.)
 - Tac**
Chadron Formation
(Rose, greenish, purple, and gray clayey sand, silt, and clay with local pebble horizons; white-gray fine semi-crystalline limestone.)
 - Tpl**
Tplf
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, brown peat-clay and thin lignite seams Tplf-Lodgepole facies-one or more seams (5'-4"-5") of black blocky lignite and associated clays and peat-clays.)
 - 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. Marine invertebrate fossils. Interfingers with upper Ludlow.)
 - Tpl**
Cannonball-Ludlow Transition Strata
(Grey to buff, medium and fine-grained arkosic sands, silty clay, and clay with numerous buff, grey to dark grey calcareous sandstone ledges and lenses. Rare marine invertebrate fossils. Gradational with Cannonball and Ludlow formation.)
 - Tplh**
Tpl
Tplf
Ludlow Formation
(Grey to buff, medium and fine-grained arkosic and graywacke sands, clayey sands and sandy clays. Numerous slobby ledges and lenses of calcareous sandstone. Abundant cross-bedding and local ripple marks. Tplh-Hillen facies-one or more thin (1'-3") seams of black fissile lignite and associated clays. Tplf-Shadehill facies-several thin black blocky and fissile lignite seams (1'-3"-3") and associated sands, clays, and peat-clays.)
- DRAINAGE**
 - Intermittent Streams
 - Intermittent Lakes
 - CULTURE**
 - Buildings and Roads
(House, church, and school)
 - Bench Marks and Triangulation Stations
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of known altitude and exact geographic location, respectively.)
 - Operating
Abandoned
 - Coal mines and Gravel pits
Top Hole
Altitude
Overburden
Thickness
 - Drill Holes
(State Geological Survey
Seismograph Shot Holes
Courtesy of Geotech. Corp. of Del.)
 - Coal Thickness
(Exposed)

Geology by R. E. Stevenson.
Assisted by A. K. Stoley, D. L. Fairbanks, R. L. Hale, E. E. Lutzen, M. J. Tipton.
Surveyed in 1953. Drafted by P. Rist.
Coal-test Holes Drilled in 1954.



Base Map by South Dakota State Geological Survey.

APPROXIMATE MEAN DECLINATION 1953

Quadrangle Location

x 36"

AREAL GEOLOGY OF THE HAYNES QUADRANGLE

By
Robert E. Stevenson

INTRODUCTION

THE MAPPING OF THIS QUADRANGLE WAS DONE IN 1953 AS A PART OF THE STATE GEOLOGICAL SURVEY'S COAL RESOURCES PROGRAM. EXPLORATORY DRILLING FOR SUBSURFACE COAL WAS DONE THE FOLLOWING YEAR.

LOCATION

THIS QUADRANGLE LIES IN THE NORTH CENTRAL PART OF PERKINS COUNTY ALONG THE NORTH DAKOTA LINE. THE AREA IS APPROXIMATELY 140 MILES NORTHWEST OF PIERRE AND 127 MILES NORTH NORTHEAST OF RAPID CITY.

GEOGRAPHY

THE AREA IS A REGION OF ROLLING PRAIRIE LANDS INTERRUPTED IN THE SOUTH BY THE VALLEYS OF THE NORTH FORK OF GRAND RIVER AND LODGEPOLE CREEK. THE RELIEF IS APPROXIMATELY 600 FEET, THE HIGHEST POINT BEING WHITE BUTTE, A CHADRON-CAPPED EROSION REMNANT NEAR THE CENTER OF THE QUADRANGLE.

THE NORTH FORK OF GRAND RIVER MEANDERS OVER A 0.6 TO 1.3 MILE WIDE VALLEY CHARACTERIZED BY A NARROW FLOODPLAIN AND SERIES OF THREE DEPOSITIONAL TERRACES (THE UPPER TERRACE IS APPROXIMATELY 25 FEET ABOVE THE RIVER). FLAT CREEK IS A MEANDERING INTERMITTENT STREAM WITH A WIDE FLOODPLAIN. LODGEPOLE CREEK, THE OTHER MAJOR STREAM, IS ALSO INTERMITTENT.

THE NORTH ARM OF SHADEHILL RESERVOIR IS A PERMANENT BODY OF WATER IN THE VALLEY OF THE GRAND RIVER IN THE SOUTHWEST PART OF THE QUADRANGLE. THE ONLY OTHER PERMANENT WATER BODIES ARE DAMMED UP PORTIONS OF FLAT CREEK IN THE VICINITY OF WHITE BUTTE.

THE CLIMATE IS SEMI-ARID WITH AN AVERAGE RAINFALL OF 14-17 INCHES. DRYLAND FARMING AND STOCK GRAZING ARE THE PRINCIPAL AGRICULTURAL PURSUITS.

THE AREA IS SPARSELY INHABITED, AND THE ONLY COMMUNITY IS WHITE BUTTE WITH AN APPROXIMATE POPULATION OF 50. THIS VILLAGE IS SERVED BY BOTH THE MAIN LINE OF THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD AND U. S. HIGHWAY 12. NUMEROUS COUNTY AND TOWNSHIP ROADS MAKE THE AREA FAIRLY ACCESSIBLE.

STRATIGRAPHY

ONLY TERTIARY AND QUATERNARY ROCKS ARE EXPOSED ROCKS IN THIS QUADRANGLE.

LUDLOW FORMATION LLOYD AND HARES 1915. OUTCROPS OF THIS FORMATION ARE GENERALLY RESTRICTED TO THE SOUTHERN HALF OF THE MAP ADJACENT TO THE MAJOR WATER COURSES. THE INTERBEDDED AND LENSING STRATA CONSIST MAINLY OF BUFF TO GREY MEDIUM TO FINE-GRAINED SUB-GRAYWACKE SAND AND GREY CLAY WITH NUMEROUS INTERBEDS OF BUFF CLAYS AND GREY SANDY CLAYS. THE LODGEPOLE SANDS ARE CHARACTERIZED BY OCCASIONAL LIMONITIC CONCRETIONS, SLABBY TO LEDGE-LIKE CALCAREOUS CEMENTATIONS, CROSS-BEDDING AND OSCILLATION RIPPLE MARKS (INDEX 10).

AT THE BASE OF THE FORMATION IS THE SHADEHILL LIGNITIC FACIES - 40+ FEET OF INTERBEDDED GREY SHALE, CLAY, AND SILTY CLAY; BUFF FINE SUBGRAYWACKE SAND WITH CEMENTATIONS; BROWN PEAT-CLAY; AND 3 TO 7 THIN SEAMS OF BLACK, BLOCKY TO FISSILE LIGNITE WHICH RANGE IN THICKNESS FROM 1" TO 18" (AVERAGE 5" TO 8").

ABOUT 125 FEET ABOVE THE SHADEHILL FACIES IS THE HILLEN LIGNITIC FACIES - ABOUT 5 TO 15 FEET OF INTERBEDDED GREY CLAY, FINE BUFF SUBGRAYWACKE SAND, BROWN PEAT-CLAY, AND 1-2 BLACK FISSILE LIGNITE SEAMS UP TO 21-INCHES THICK. THE LODGEPOLE FORMATION IS 220+ FEET THICK, THE UPPER PORTION INTERFINGERS WITH THE CANNONBALL FORMATION.

ALONG THE SOUTHERN EDGE OF THE MAPPED AREA, THERE IS A RIDGE CONSISTING OF INTERBEDDED AND INTERLENSING LODGEPOLE AND CANNONBALL SEDIMENTS. THE INTERFINGERING IS SO CLOSE THAT IT WAS IMPOSSIBLE TO MAP THE FORMATIONS SEPARATELY, SO THEY WERE MAPPED UNDER THE DESIGNATION CANNONBALL-LUDLOW TRANSITION STRATA.

CANNONBALL FORMATION LLOYD 1914. EXPOSURES OF THIS FORMATION ARE RARE, BUT FRAGMENTS OF ITS DIAGNOSTIC CONCRETIONS ARE SCATTERED OVER THE LOWER UPLANDS IN THE CENTRAL NORTHEAST AND SOUTHWEST PARTS OF THE MAPPED AREA. THE CANNONBALL FORMATION CONSISTS OF NUMEROUS SMALL AND MEDIUM, DARK GREY, DENSE, LIMESTONE CONCRETIONS AND LARGER LIGHT GREY LENTICULAR AND LEDGE-LIKE CALCAREOUS CEMENTATIONS IN A MATRIX OF GREY TO BUFF CLAY, FINE SUB-QUARTZOSE SAND, AND CLAYEY SAND. THE LIMY ROCKS CONTAIN A MARINE FAUNA OF SMALL MOLLUSKS.

THIS FORMATION VARIES IN THICKNESS FROM 80 TO 180 FEET WITH THE LOWER PORTION INTERFINGERING WITH THE UPPER LODGEPOLE.

TONGUE RIVER FORMATION (TAFF 1909). THE BUFF SANDS OF THIS FORMATION MAKE UP THE UPLAND AREAS IN THE NORTHWEST QUARTER AND NORTHEAST CORNER OF THE MAPPED AREA. LITHOLOGICALLY IT CONSISTS OF THICK, CROSS-BEDDED, BUFF TO TAN (EVEN PINKISH), MEDIUM-TO FINE-GRAINED SUBGRAYWACKE SAND WITH NUMEROUS LENTICULAR, SUB-SPHERICAL, AND ELONGATE CALCAREOUS CEMENTATIONS. OCCASIONALLY INTERBEDDED WITH THESE SANDS ARE BROWN AND GREY CLAYS, SILTY CLAYS, AND CLAYEY SANDS. THE FORMATION IN THIS AREA IS ABOUT 190 FEET THICK.

ABOUT 113 FEET ABOVE THE BASE OF THE FORMATION IS THE LODGEPOLE LIGNITE FACIES - 1 TO 3 SEAMS OF BLACK, BLOCKY, AND FISSILE LIGNITE (LOCALLY CLAYEY) WHICH RANGE FROM 2" TO 50" AND ASSOCIATED BROWN PEAT-CLAY AND BROWN TO GREY CLAY. THE FACIES IS ABOUT 26 FEET THICK.

CHADRON FORMATION DARTON 1899. EXPOSURES OF THESE SEDIMENTS ARE RESTRICTED TO WHITE BUTTE, WHERE THEY LIE ON THE TONGUE RIVER FORMATION. IT CONSISTS MAINLY OF PASTEL-COLORED SHALES, CLAYS, BENTONITIC CLAYS, AND SILTY CLAYS WITH INTERBEDDED AND LENSING LIGHT COLORED CLAYEY SANDS WITH LOCAL LENSES OF GRIT AND PEBBLE CONGLOMERATES. ABOUT 92 FEET ABOVE THE BASE THERE IS A 4-FOOT LEDGE OF WHITE DENSE CRYSTALLINE LIMESTONE WITH SOME SMALL CHERT NODULES. A FEW BONE FRAGMENTS WERE FOUND.

TERRACE GRAVELS: IN THE SOUTHEAST CORNER OF THE QUADRANGLE, SOUTH OF SHADEHILL RESERVOIR, ARE SEVERAL HILLOCKS CAPPED BY A THIN VENEER OF CLEAN, WELL-ROUNDED SUB-ARKOSIC PEBBLE GRAVEL TO COARSE SAND.

TERRACE DEPOSITS: ALONG THE NORTH FORK OF THE GRAND RIVER THERE ARE A NUMBER OF TERRACES CAPPED WITH 0 TO 5 FEET OF INTERLENSING SAND, SILT, AND GRAVEL.

TERRACE RUBBLE: LOW TERRACE DEPOSITS, CONSISTING OF COARSE ANGULAR GRAVEL AND CLAYEY SAND, ARE ADJACENT TO THE LARGER CREEKS IN THE CENTRAL PART OF THE MAPPED AREA. THE MATERIAL IS LOCALLY DERIVED FROM THE CANNONBALL AND TONGUE RIVER FORMATIONS.

STRUCTURE

THERE IS A SLIGHT REGIONAL DIP (16 FEET PER MILE) TO THE NORTH NORTHEAST AND THE AXIS OF THE DAKOTA (WILLISTON) BASIN. SUPERIMPOSED UPON THIS REGIONAL STRUCTURE ARE SMALL SECONDARY FAULTS AND FOLDS WITH AMPLITUDES AND DISPLACEMENTS OF LESS THAN 20 FEET.

ECONOMIC GEOLOGY

AT THE PRESENT TIME NO MINERAL RESOURCES ARE BEING EXPLOITED FROM THIS AREA ALTHOUGH THERE ARE COMMERCIAL QUANTITIES OF LIGNITE, SAND AND GRAVEL.

COAL: THERE ARE THREE COAL HORIZONS IN THIS AREA, THE SHADEHILL AND HILLEN FACIES OF THE LODGEPOLE FORMATION, AND THE LODGEPOLE FACIES OF THE TONGUE RIVER FORMATION. THE ONLY ONE OF THESE WITH PRESENT-DAY COMMERCIAL POTENTIALITY IS THE LODGEPOLE FACIES WHICH CONTAINS MINABLE QUANTITIES OVER MOST OF ITS OUTCROP AREAS IN THE NORTHWEST QUARTER OF THE MAPPED AREA.

LODGEPOLE COAL: LODGEPOLE LIGNITE WAS MINED IN THIS AREA IN THE EARLY 1900'S AND IN THE THIRTIES. THERE IS ONE MINABLE SEAM RANGING IN THICKNESS FROM 40" TO 57". THE LIGNITE IS BANDED, BLACK IN COLOR, BROWNISH BLACK (5YR1/2) IN STREAK, BRITTLE, BLOCKY OR FISSILE, WITH MINOR AMOUNTS OF MARCASITE PELLETS, MELANITERITE STREAKS, AND GYPSUM CRYSTALS. SOME OF THE LIGNITE IS HIGH IN CLAY IMPURITIES (BONE LIGNITE) AND THERE ARE OCCASIONAL THIN CLAY PARTINGS IN THE SEAM. THE LIGNITE SLACKS MODERATELY UPON DRYING AND IS NON-COKING. THE CHEMICAL CHARACTER OF THE COAL IS SHOWN BY THE PROXIMATE ANALYSES IN TABLE 1. THIS ANALYSIS ALSO SHOWS THE COMMERCIAL QUALITY AND COMBUSTION PROPERTIES OF THE COAL. IT MIGHT BE NOTED THAT AIR DRYING WILL INCREASE THE B.T.U.'S BY 3,000 TO 4,000 UNITS.

LIGNITE RESERVES IN THIS QUADRANGLE ARE ESTIMATED TO BE 1,139,170 TONS. THIS TONNAGE ESTIMATION IS BASED ON OUTCROP 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 TONNAGE ESTIMATE IS LISTED UNDER TWO HEADINGS: MEASURED (WITHIN 0.5 MILES FROM AN OUTCROP) - 63,920 TONS, AND INDICATED (BETWEEN 0.5 - 1.5 MILES FROM THE OUTCROP) - 1,075,200 TONS. THE OVERBURDEN, WHICH GETS UP TO 85 FEET IN THICKNESS, IN MOST CASES CONSISTS IN PART OF A MASSIVE PARTIALLY CEMENTED SANDSTONE WHICH MIGHT PROVE DETRIMENTAL TO STRIP MINING. WHERE THIS SANDSTONE IS MISSING, STRIP MINING IS FEASIBLE, BUT OTHERWISE UNDERGROUND METHODS WOULD HAVE TO BE USED. MOST OF THE ABANDONED MINES WERE UNDERGROUND.

LUDLOW COAL: THE SHADEHILL AND HILLEN LIGNITES OF THE LODGEPOLE FORMATION CAN BE BRIEFLY DESCRIBED AS FOLLOWS: HILLEN- FISSILE TO BLOCKY, BLACK, BRITTLE IN PART, LIGNITE SEAMS 0-21" THICK; SHADEHILL-FISSILE TO BLOCKY, BLACK, BRITTLE, LIGNITE SEAMS 1" TO 18" THICK, ARE NOT THICK ENOUGH TO HAVE COMMERCIAL VALUE UNDER PRESENT CONDITIONS. A PROXIMATE ANALYSIS OF THE SHADEHILL LIGNITE IS GIVEN IN TABLE 1.

TABLE 1

COAL	LOCATION	MOISTURE	VOLATILES	CARBON	ASH	SULPHUR	B.T.U.
LODGEPOLE	S. 15, T22N, R14E	33.39%	45.43%	9.99%	11.19%	1.28%	5,802
SHADEHILL	S. 11, T21N, R14E	31.65%	43.11%	20.85%	4.39%	0.39%	6,975

SAND AND GRAVEL: THE TERRACE DEPOSITS ALONG THE NORTH FORK OF THE GRAND RIVER WHICH CONSIST OF SILT, SAND, AND GRAVEL (MOSTLY QUARTZ, PETRIFIED WOOD, QUARTZITE, AND IGNEOUS ROCKS) ARE SUITABLE FOR ROAD SURFACING. WASHING AND SIZING WOULD PROVIDE SAND FOR CONCRETE AGGREGATE. ESTIMATED CUBIC YARDAGES OF THE LARGE DEPOSITS ARE GIVEN IN TABLE 2.

TABLE 2

SECTION	TWP.	RGE.	ACRES	THICKNESS	EST. CUBIC YARDS
2,3,4,5,6 7,8,9,10,11	21N	14E	1,436	2' (?)	4,633,493
13 7,17,18	21N 21N	14E 15E	328	4'	2,116,693
15,16,22	21N	15E	121	3½'	682,440
2,11	21N	14E	71	4½'	514,653

GENERALIZED COLUMNAR SECTION

