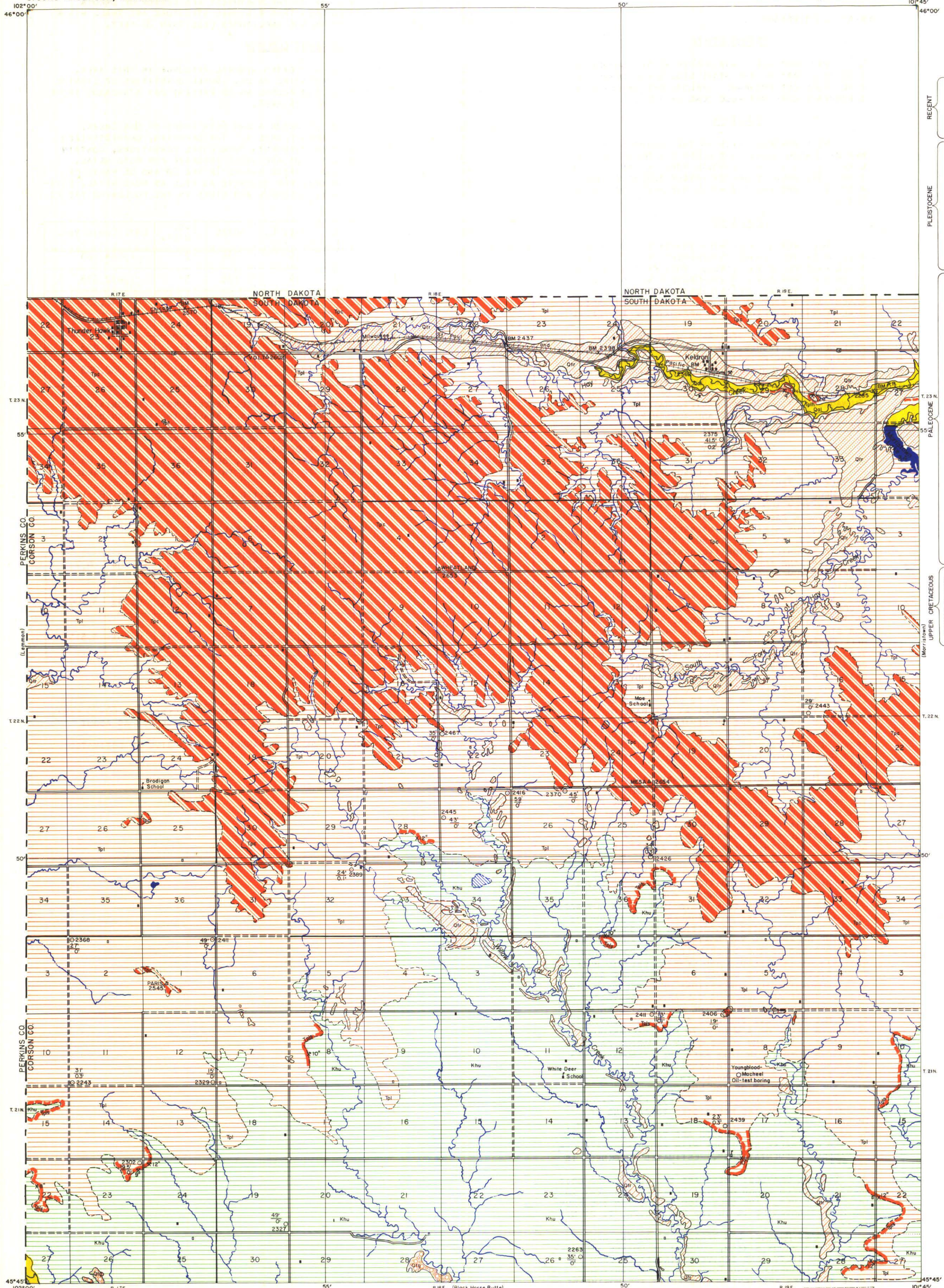


AREAL GEOLOGY OF THE THUNDER HAWK QUADRANGLE

STATE OF SOUTH DAKOTA
SIGURD ANDERSON, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

SEDIMENTARY ROCKS

- Qal**
Alluvium
 (Floodplain deposits of silt, sand, and gravel in present major stream valleys.)
- Qtr**
Terrace Rubble
 (Terrace deposits of fluvial angular gravel and silty sand locally derived mainly from the Cannonball formation.)
- Qtg**
Terrace Gravels
 (High terrace deposits of arkosic sand and gravel.)
- Tpl**
Tongue River Formation
 (Tan to rose medium grained sandstone with occasional clay pebbles. Abundant irregular "cementations".)
- Tpl**
Cannonball Formation
 (Gray to buff clay and clayey fine graywacke sand with numerous dark gray limestone concretions. Abundant calcareous sandstone ledges and lenses. Marine invertebrate fossils. Inter-fingers with upper Ludlow.)
- Tpl**
Ludlow Formation
 (Gray to buff, medium and fine grained, arkosic and graywacke sands, clayey sands and sandy clays. Numerous slobby lenses of calcareous sandstone. Abundant cross-bedding. Tpl and Tplh-Shadehill and Hillen lignite facies. One or more thin (1"-2") seams of black blocky or fissile lignite and associated sands, clays and peat-clays.)
- Kh**
Upper Member
 (Dark grey to buff bentonitic clay and grey to buff slightly bentonitic sand. Several horizons of brown peat-clay. Numerous F&M concretions.)

RECENT
 QUATERNARY
 PLEISTOCENE
 TERTIARY
 PALEOCENE
 UPPER CRETACEOUS
 Hell Creek formation
 (Morrison)

DRAINAGE

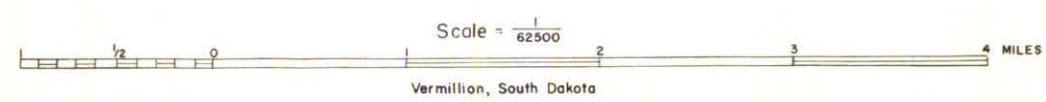
- Intermittent Streams
- Intermittent Lakes

CULTURE

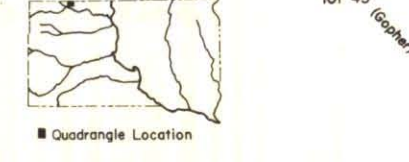
- Buildings
 (House, church, and school)
- Roads and Trails
- 1684
 Altitudes
 (In feet above sea level)
- x B.M.
1706
 Bench Marks
 (Monuments marking points of known altitude)
- ▲ PARIS
 Triangulation Stations
 (U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location)
- * Operating
x Abandoned
 Coal mines and Gravel pits

- Coal Thickness
 (Exposed)
- 2323 Top Hole
35 Altitude
2 Overburden
2 Thickness
 Drill Holes
- Shell Oil Co.
Winter No. 1
 Oil-test Borings
- Dams
 (Large, small earthen or cement.)

Geology by R. E. Stevenson
 Assisted by A. K. Stoley, A. C. Doyle, D. Swift
 Surveyed in 1953
 Coal-Test Holes Drilled in 1953
 Base Map by South Dakota State Geological Survey



Vermillion, South Dakota
1954



BY

ROBERT E. STEVENSON

INTRODUCTION

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

LOCATION

THE QUADRANGLE LIES IN THE NORTHWESTERN CORNER OF CORSON COUNTY AND ALONG THE NORTH DAKOTA LINE. IT IS IN THE STANDING ROCK INDIAN RESERVATION. THE AREA IS APPROXIMATELY 127 MILES NORTHWEST OF PIERRE AND 137 MILES NORTHEAST OF RAPID CITY.

GEOGRAPHY

THIS AREA IS A LIGHTLY INHABITED REGION OF ROLLING PRAIRIE LANDS INTERRUPTED IN THE SOUTH BY SMALL PATCHES OF BAD LANDS. MOST OF THE QUADRANGLE IS ON THE CANNONBALL RIVER-GRAND RIVER DIVIDE. ALL THE MAJOR STREAMS ARE INTERMITTENT. THE ONLY PERMANENT WATER BODY IN THE QUADRANGLE IS THE ARTIFICIAL MORRISTOWN LAKE. THE APPROXIMATE RELIEF IS 400 FEET.

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

THE ONLY TOWNS IN THE AREA, THUNDER HAWK, WITH A POPULATION OF 90 AND KELDROEN, WITH 30-40 INHABITANTS, ARE BOTH ON THE MAINLINE OF THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD AND U. S. HIGHWAY 12. MANY COUNTY AND TOWNSHIP ROADS MAKE THE AREA FAIRLY ACCESSIBLE.

STRATIGRAPHY

SURFACE ROCKS OF THIS QUADRANGLE CONSIST OF CRETACEOUS, TERTIARY, AND QUATERNARY SEDIMENTS.

HELL CREEK FORMATION BROWN 1907, **UPPER MEMBER**: APPROXIMATELY 160 FEET OF THESE STRATA OUTCROP IN THE SOUTHERN PART OF THE MAP AREA. THE MEMBER IS A HETEROGENEOUS SERIES OF INTERBEDDED AND LENSING LITHOLOGIES, DARK GREY TO BUFF BENTONITIC CLAY, GREY TO BUFF SLIGHTLY BENTONITIC GRAYWACKE AND SANDY SILT WITH SAND AND OCCASIONAL BROWN PEAT-CLAYS. THERE ARE NUMEROUS HORIZONS OF MANGANESE-IRON CONCRETIONS.

LUDLOW FORMATION LLOYD AND HARES, 1915: OUTCROPS OF THIS FORMATION ARE FOUND ALONG HAY CREEK, ON THE EASTERN EDGE OF THE AREA, AND IN AN IRREGULAR STRIP ACROSS THE CENTER OF THE MAP. LIKE THE HELL CREEK, THE LUDLOW CONSISTS OF A VARIETY OF INTERBEDDED AND LENSING LITHOLOGIES: GREY TO BUFF, CROSS-BEDDED MEDIUM- AND FINE-GRAINED ARKOSIC AND GRAYWACKE SANDS, SILTY SANDS, AND SANDY CLAYS; NUMEROUS SLABBY LENSES OF CALCAREOUS SANDSTONE ("CEMENTATIONS"), AND GREY TO BROWN FISSILE TO MASSIVE SILT AND CLAY. LOCALLY AT THE BASE OF THE FORMATION THERE IS THE SHADEHILL COAL FACIES CONSISTING OF 15 PLUS FEET OF GREY TO BROWN CLAYS, BROWN PEAT-CLAYS, AND BUFF TO RUSTY SILTY SANDS WITH ONE OR MORE THIN INTERBEDDED LIGNITE SEAMS ($\frac{1}{2}$ " TO 12").

THE HILLEN FACIES, STRATIGRAPHICALLY ABOUT 60 TO 80 FEET ABOVE THE SHADEHILL, OUTCROPS LOCALLY IN THE NORTHEAST CORNER OF THE MAP AREA. THE FACIES CONSISTS OF ONE OR MORE LIGNITIC COAL SEAMS (3" TO 26" THICK) INTERBEDDED WITH GREY TO DARK GREY CLAY, BROWN PEAT-CLAY, AND GREY TO BUFF CLAYEY GRAYWACKE SANDS. FACIES THICKNESS IN THIS AREA** IS 8 FEET PLUS.

THE LUDLOW IS APPROXIMATELY 125-200 FEET IN THIS AREA. THE UPPER PORTION INTERFINGERS LATERALLY WITH THE LOWER CANNONBALL FORMATION.

CANNONBALL FORMATION LLOYD 1914: GOOD OUTCROPS OF THIS FORMATION ARE NOT ABUNDANT, BUT FRAGMENTS OF THE CHARACTERISTIC CONCRETIONS ARE SCATTERED OVER THE UPLANDS IN THE NORTH-CENTRAL AND NORTHWEST PORTIONS OF THE QUADRANGLE. THE FORMATION CONSISTS OF INTERBEDDED AND LENSING GREY TO BUFF CLAY, SILTY CLAY AND CLAYEY FINE GRAYWACKE SAND WITH ABUNDANT SMALL CONCRETIONS OF DENSE GREY LIMESTONE. THERE ARE NUMEROUS CALCAREOUS GRAYWACKE LENSES AND LEDGES; AND IN THE NORTHEAST CORNER T. 22 N., R. 17 E., THERE IS A 3" TO 6" CONTINUOUS IRREGULAR LEDGE OF A MEDIUM TO FINE CALCAREOUS GRAYWACKE. THE LIMY ROCKS CARRY A MARINE FAUNA OF MOLLUSCAN FORMS. IN THIS AREA THE CANNONBALL HAS AN APPROXIMATE MAXIMUM THICKNESS OF 200'. THE LOWER PART OF THE CANNONBALL INTERFINGERS LATERALLY WITH THE UPPER PART OF THE LUDLOW.

TONGUE RIVER FORMATION (Taff), 1909: EXPOSURES OF THIS FORMATION ARE RESTRICTED TO CAPPING OF THUNDER HAWK BUTTE IN THE W $\frac{1}{2}$ SW $\frac{1}{4}$ SEC. 25, T. 23 N., R. 23 E. THE STRATA EXPOSED ARE TAN TO ROSE MEDIUM-GRAINED GRAYWACKE SANDSTONE WITH ABUNDANT IRREGULAR, CALCAREOUS "CEMENTATIONS". ESTIMATED THICKNESS IS 25'***

TERRACE GRAVELS: THESE ARE THE PEBBLE AND GRIT ARKOSIC GRAVELS FOUND ON HIGH TERRACES ADJACENT TO THE GRAND RIVER. THE ONLY HIGH TERRACE IN THE THUNDER HAWK QUADRANGLE IS IN THE SW $\frac{1}{4}$ SEC. 26, T. 21 N., R. 17 E.

TERRACE RUBBLE: LOW TERRACE DEPOSITS, GENERALLY NEAR A MAJOR STREAM, CONSIST OF COARSE ANGULAR GRAVEL AND SILTY SAND DERIVED PRINCIPALLY FROM THE LUDLOW, CANNONBALL, AND TONGUE RIVER FORMATIONS. THESE TERRACES ARE BEST DEVELOPED IN THE NORTHEAST CORNER OF THE MAPPED AREA.

STRUCTURE

THERE IS A SLIGHT REGIONAL DIP TO THE NORTHWEST AND CENTER OF DAKOTA (WILLISTON) BASIN. SUPERIMPOSED UPON THIS REGIONAL STRUCTURE ARE SMALL MINOR FAULTS AND FOLDS WITH DISPLACEMENTS AND AMPLITUDES LESS THAN 20 FEET.

ECONOMIC GEOLOGY

GRAVEL IS THE ONLY CURRENTLY EXPLOITED MINERAL RESOURCE IN THIS AREA. IN ADDITION TO GRAVEL, CLAY HAS POTENTIAL VALUE. SMALL QUANTITIES OF LIGNITE COAL HAVE BEEN MINED IN THE PAST, BUT ACCORDING TO PRESENT DAY STANDARDS THERE ARE NO COMMERCIAL COAL DEPOSITS IN THIS AREA.

GRAVEL: ANGULAR GRAVEL DEPOSITS OCCUR ALONG BOTH FORKS OF HAY CREEK, WILLOW CREEK, AND OTHER SMALLER UNNAMED CREEKS. THE DEPOSITS, CHARACTERIZED BY BROKEN CONCRETIONS AND SANDSTONE FRAGMENTS FROM LOCAL FORMATIONS, CONTAIN A HIGH PERCENTAGE OF SILT AND CLAY, BUT ARE STILL ADEQUATE FOR ROAD METAL. THE HIGH TERRACE DEPOSITS OF CLEAN TERRACE GRAVEL IN THE SW AND SE PARTS OF THE MAP AREA MAY BE USED AS AGGREGATE FOR CONCRETE AS WELL AS ROAD METAL. ESTIMATED VOLUMES FOR THE LARGER GRAVEL DEPOSITS ARE GIVEN IN THE FOLLOWING TABLE:

SECTIONS	TWP. N.	RGE. E.	ACRES	AVE. THICK.	EST. CUBIC YDS.
27,28,33,34	23	19	336	2'	1,084,160
19,28,29,30	23	19	128	5'	1,032,533
27,23	23	19	92	5'	742,133
29	23	19	89	4'	574,347
17,19	22	19	76	4'	490,453
19,24,30	23	18-19	150	1 $\frac{1}{2}$ '	362,963

CLAY: SOME OF THE CLAY HORIZONS IN THE HELL CREEK FORMATION CONTAIN A HIGH PERCENTAGE OF BENTONITE AND MAY BE USED AS A SEALER IN EARTHEN DAMS.

COAL: THE LUDLOW FORMATION IN THIS AREA CONTAINS TWO DISCONTINUOUS COAL HORIZONS, THE HILLEN AND SHADEHILL FACIES. NEITHER HAS PRESENT DAY COMMERCIAL POTENTIALITIES. A BRIEF DESCRIPTION OF EACH FACIES FOLLOWS.

SHADEHILL; BLACK FISSILE AND RARELY BLOCKY, OFTEN BONEY, LIGNITIC COAL SEAMS VARYING IN THICKNESS FROM $\frac{1}{2}$ " TO 12". THE THIN SEAMS CONTAIN A LARGE AMOUNT OF CLAY.

HILLEN; BLACK, FISSILE TO BLOCKY, LIGNITIC COAL IN SEAMS 3" TO 26" IN THICKNESS. THICKNESSES OF OVER 18" ARE RESTRICTED TO A VERY SMALL AREA, UNDER AN ACRE.

FOLLOWING ARE COAL ANALYSES FROM THIS GENERAL AREA:

COAL	LOCATION	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULFUR	B.T.U.
SHADEHILL	MINE, SEC. 24, T.21N., R.17E.	37.52%	27.45%	7.87%	27.16%	0.24%	3,100
HILLEN	MORRISTOWN VIC. 3 MILES EAST OF KELDROEN	45.40%	29.37%	9.69%	15.54%	0.66%	3,515

* MEASUREMENTS IN NEARBY QUADRANGLES GIVE THE COMPLETE THICKNESS AS 60-70 FEET.

** MEASUREMENTS IN NEARBY QUADRANGLES GIVE THE COMPLETE THICKNESS AS ABOUT 40 FEET.

*** MEASUREMENTS IN THE ADJACENT LEMMON QUADRANGLE TO WEST GIVE AN ESTIMATED THICKNESS OF AT LEAST 100 FEET.

GENERALIZED COLUMNAR SECTION

