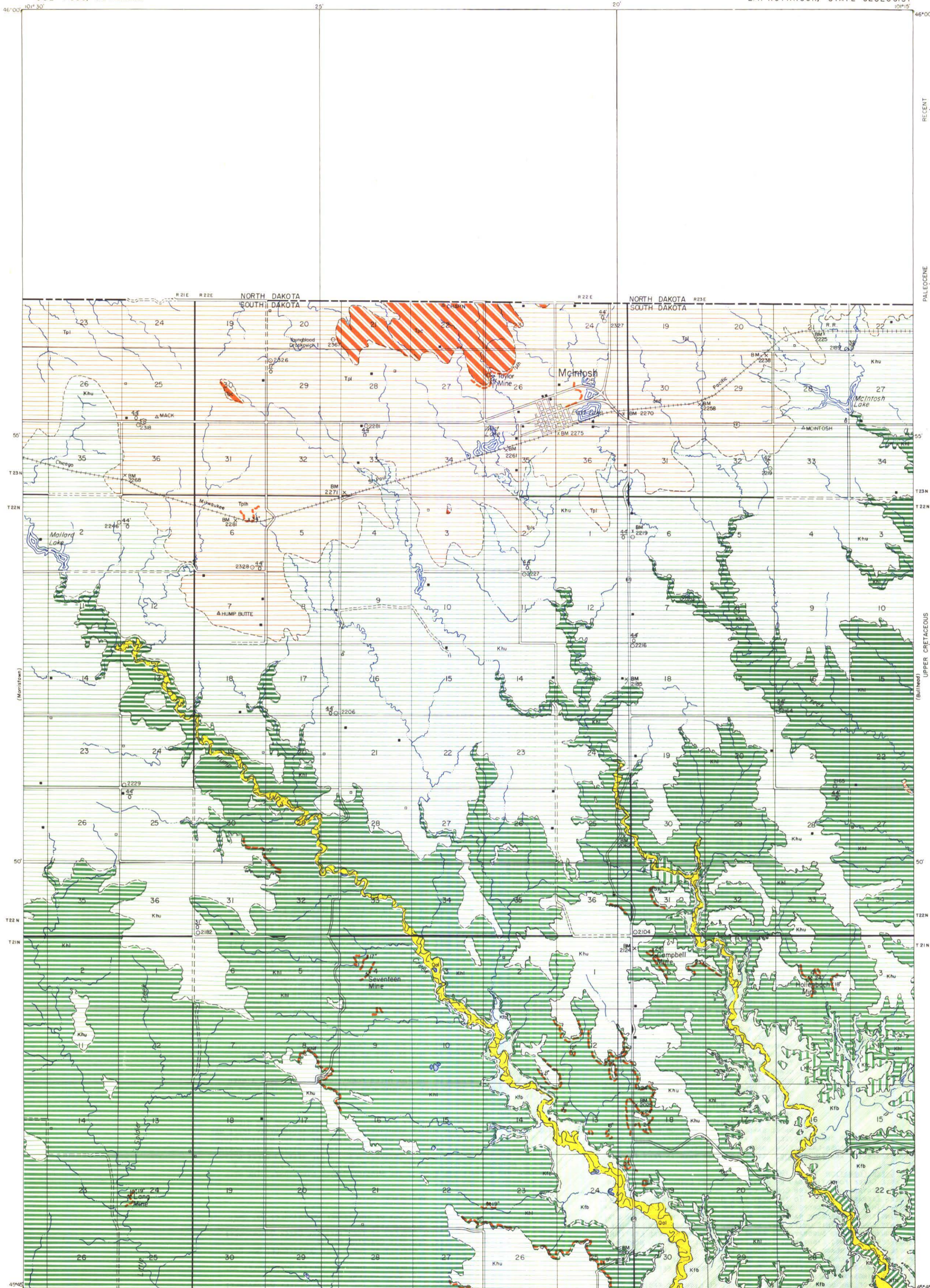


AREAL GEOLOGY OF THE MCINTOSH QUADRANGLE

STATE OF SOUTH DAKOTA
JOE FOSS, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

Qal
Alluvium
(Floodplain deposits of silt, sand, and gravel in present major stream valleys)

Qtd
Terrace Deposits
(Terrace deposits of fluvial angular to rounded gravel and silty sand of local derivation)

Tps
Cannonball Formation
(Poorly exposed fine sands and thin-bedded clay shales with numerous grey limestone concretions and calcareous sandstone lenses inter-fingers with Ludlow formation. Marine invertebrate fossils)

Tpl
Ludlow Formation
(Interbedded buff fine arkosic sands, "pepper and salt" fine greywacke sands, and brown to grey slightly bentonitic clay. The sands are in part calcareous, forming hard lenses. Tpl and Tplh - Shadehill and Hillen lignitic facies: one or more thin seams (0-14") of black blocky or fissile lignite and associated sands, clays, and peat-clays. Inter-fingers with Cannonball formation.)

Khu
Upper Member
(Lensing interbeds of buff or pepper and salt fine greywacke and arkosic sands, bentonitic in part, and grey to tan bentonitic clay, silt, and sandy clay. Some layers of ferruginous concretions.)

Khl
Lower Member
(Lensing interbeds of white to tan fine greywacke, arkosic sands in part bentonitic and somewhat cross-bedded, grey slightly bentonitic clay, and buff to brown bentonitic clay, and buff to brown bentonitic clay, silt, and sandy clay. Occasional layers of ferruginous concretions. Khl Isabel - Firesteel coal facies: 6"-17" seam of black lignitic coal and associated beds of brown peat-clay.)

Klg
Colgate Member
(White to grey fine to medium greywacke with occasional clay pebbles. Some cross-bedding and occasional oscillation ripple marks. Marine fossils.)

Kfb
Bullhead Member
(Alternating thin beds of buff slightly bentonitic sandstone, siltstone, and clay.)

Kft
Timber Lake Member
(Massive buff friable fine slightly glauconitic feldspathic sandstone with marine fossils.)

Ktr
Trail City Member
(Thin interbeds of grey bentonitic clayey siltstone with occasional thin streaks of fine white sand.)

2219
Altitudes
(in feet above sea level)

x B.M.
Bench Marks
(Monuments marking points of known altitude)

▲ MACK
Triangulation Stations
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location.)

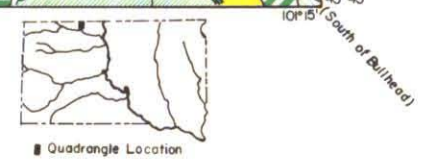
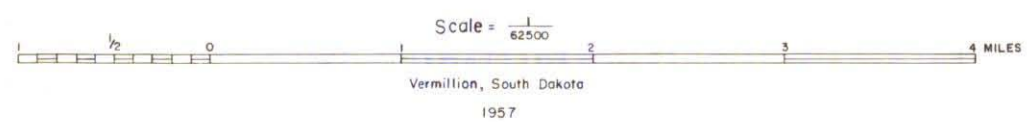
⊗ Operating
⊗ Abandoned
Coal mines and Gravel pits

x 24"
Coal Thickness
(Exposed)

2227 Top Hole
44' Altitude
44' Overburden
0 Thickness
Drill Holes

Dams
(Large, small earthen or cement.)

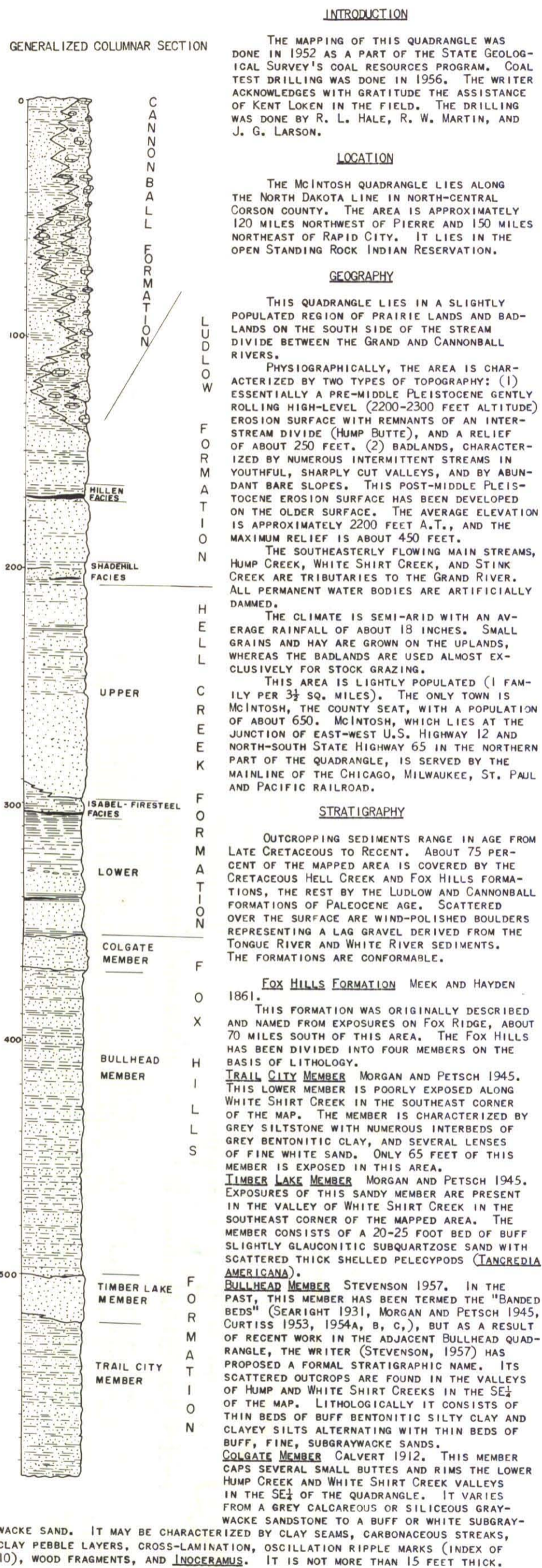
Geology by R.E. Stevenson
Assisted by Kent Loken
Surveyed in 1952
Coal Test Holes Drilled in 1956
Base Map by South Dakota State Geological Survey.



GEOLOGY OF THE MCINTOSH QUADRANGLE

By

Robert E. Stevenson



UPPER UNIT. SCATTERED EXPOSURES ARE PRESENT OVER THE ROLLING PRAIRIE LANDS IN THE CENTRAL PART OF THE MAPPED AREA. THE UNIT IS PRINCIPALLY LIGHT GRAY, WHITE AND BUFF, MEDIUM TO COARSE SUBQUARTZOSE TO GRAYWACKE SANDS. LOCAL CROSS-LAMINATION, SCATTERED CEMENTATIONS AND LAYERS OF ORANGE LIMONITIC AND BLACK FERROMANGANESE CONCRETIONS CHARACTERIZE THESE SANDS. THERE ARE NUMEROUS LENSES AND INTERBEDS OF GRAY TO BROWN SANDY CLAY, DARK GRAY TO TAN BENTONITIC CLAY, TAN BENTONITIC SILT, AND LOCAL BROWN PEAT-CLAYS. THESE INTERBEDS CONTAIN SCATTERED PLANT FRAGMENTS. THE UNIT HAS A THICKNESS OF 80 FEET.

LUDLOW FORMATION LLOYD AND HARES 1915

SCATTERED OUTCROPS ARE FOUND ON THE GRASSED UPLANDS AND HUMP BUTTE IN THE NORTHERN PART OF THE MAPPED AREA. LIKE THE LOWER HELL CREEK, THE LUDLOW IS A SERIES OF HETEROGENEOUS INTERBEDDED AND LENTICULAR SANDY STRATA. WHITE TO TAN, AND GREY MEDIUM GRAINED SUBQUARTZOSE AND SUBGRAYWACKE SANDS WITH CROSS-LAMINATION, SLABBY CALCAREOUS CEMENTATIONS, PLANT FRAGMENTS AND SHALE PARTINGS; LIGHT GRAY AND BROWN CLAY AND SILTY CLAY WITH PLANT FRAGMENTS; AND BROWN PEAT-CLAYS.

LOCALLY AT THE BASE OF THE FORMATION IS THE SHADEHILL LIGNITIC FACIES: ABOUT 10 FEET OF INTERBEDDED SAND, CLAY AND PEAT-CLAY WITH ONE OR MORE THIN SEAMS OF BLACK FISSILE LIGNITE. TWENTY-FIVE FEET ABOVE THE SHADEHILL FACIES IS THE HILLEN LIGNITIC FACIES: INTERBEDDED SAND, CLAY AND PEAT-CLAY WITH A 2 TO 3 1/2 INCH SEAM OF BLACK FISSILE TO BLOCKY LIGNITE.

THE LUDLOW FORMATION IS ABOUT 65 TO 160 FEET THICK IN THIS AREA AND LATERALLY INTERFINGERS WITH THE CANNONBALL FORMATION.

CANNONBALL FORMATION LLOYD 1914

THERE ARE NO GOOD EXPOSURES OF THE FORMATION IN THIS AREA, BUT FRAGMENTS OF THE DIAGNOSTIC CONCRETIONS ARE SCATTERED OVER THE HILLS NORTH AND NORTHWEST OF MCINTOSH.

BUFF TO DARK GREY SILTY SAND, SILT, SANDY CLAY, AND CLAY WITH ABUNDANT ROUND, LENTICULAR OR IRREGULAR DARK GRAY DENSE LIMESTONE CONCRETIONS AND OCCASIONAL SMALL LENSES OF GRAY CALCAREOUS SANDSTONE. THE LIMY ROCKS CARRY A MARINE FAUNA OF SMALL MOLLUSKS DOMINATED BY THE GASTROPODS *FASCIOLARIA* AND *EPITONIAM*.

THE FORMATION, LENTICULAR IN CHARACTER, INTERFINGERS WITH THE LUDLOW AND HAS A MAXIMUM THICKNESS OF ABOUT 170 FEET.

ALLUVIAL DEPOSITS

THERE IS A SMALL AREA OF TERRACE DEPOSITS ADJACENT TO STINK CREEK. THE MATERIAL IS SILTY AND SANDY GRAVEL, ANGULAR IN SHAPE AND OF LOCAL DERIVATION. RECENT ALLUVIUM (SILT, SAND AND GRAVEL) IS FOUND IN THE BOTTOMS OF THE MAJOR DRAINAGE UNITS.

STRUCTURE

THERE IS A SLIGHT REGIONAL DIP (12 FEET PER MILE) TO THE NORTHWEST AND THE CENTER OF THE DAKOTA (WILLISTON) BASIN, THE MAJOR STRUCTURAL FEATURE OF THE AREA. SUPERIMPOSED ON THIS REGIONAL STRUCTURE ARE SMALL NORMAL FAULTS AND SLUMPS WITH A MAXIMUM DISPLACEMENT OF 35 FEET (AVERAGE 5-10 FEET) AND SMALL GENTLE FOLDS WITH A MAXIMUM AMPLITUDE OF ABOUT 65 FEET. AXIAL DIRECTIONS OF THESE MINOR STRUCTURES SHOW NO DEFINITE PATTERN.

ECONOMIC GEOLOGY

THE ONLY ECONOMIC MINERAL RESOURCE BEING CURRENTLY EXPLOITED IS WATER, MOST VALUABLE IN THIS SEMI-ARID COUNTRY. LIGNITE WAS PRODUCED HERE DURING THE NINETEEN-THIRTIES, AND RECENTLY AN OIL TEST BORING WAS MADE.

LIGNITE

THERE ARE THREE DISCONTINUOUS LIGNITE FACIES IN THIS AREA: THE ISABEL-FIRESTEEL FACIES OF THE LOWER HELL CREEK; AND THE SHADEHILL AND HILLEN FACIES OF THE LUDLOW FORMATION. OVER MOST OF THE AREA, NONE OF THE SEAMS ARE THICK ENOUGH TO HAVE PRESENT DAY COMMERCIAL POTENTIALITIES; HOWEVER, IN SEC. 6, T22N., R21E., THE HILLEN SEAM ATTAINS A THICKNESS OF 34 INCHES WHERE THERE IS AN ESTIMATED 340,000 SHORT TONS OF LIGNITE.

THE THREE LIGNITES HAVE THE SAME GENERAL PHYSICAL CHARACTERISTICS: BLOCKY TO FISSILE, BANDED, BLACK IN COLOR, BROWNISH BLACK STREAK, MODERATELY BRITTLE, DULL LUSTER AND SLACKING UPON EXPOSURE TO AIR. THE SEAMS CONTAIN OCCASIONAL SUBELLIPTICAL BODIES OF PYRITE OR MARCASITE, STREAKS AND SMALL BODIES OF MELANITERITE AND SCATTERED GYPSUM (SELENITE) CRYSTALS. THE LIGNITE IS NON-COKING. PROXIMATE ANALYSES AND COMBUSTION PROPERTIES OF THE DIFFERENT LIGNITES ARE GIVEN IN TABLE I.

TABLE I PROXIMATE ANALYSES OF REPRESENTATIVE LIGNITES*

LIGNITE	LOCATION	MOISTURE	VOLATILES	CARBON	ASH	SULFUR	B.T.U.
HILLEN	S. 6., T22N., R22E.	45.19%	28.30%	14.86%	11.69%	0.44%	4,018
ISABEL-FIRESTEEL	S. 19., T21N., R23E.	38.26%	32.69%	19.56%	9.49%	0.38%	5,132

* ANALYZED BY THE STATE CHEMICAL LABORATORY, VERMILION, S. D.

WATER

THE FOX HILLS FORMATION YIELDS WATER OVER THE ENTIRE QUADRANGLE AND THERE ARE PROBABLY LOCAL WATER-BEARING STRATA IN THE HELL CREEK FORMATION. THE ALLUVIUM IN THE MAJOR STREAMS MAY YIELD WATER IN SUFFICIENT QUANTITIES FOR DOMESTIC USE.

MOST OF THE WELLS ARE IN THE TIMBER LAKE OR BULLHEAD STRATA OF THE FOX HILLS, AT DEPTHS OF 60 TO 330 FEET. IN THE DEEPER WELLS, ARTESIAN PRESSURE CAUSES THE WATER TO RISE ABOUT 40 FEET (MAXIMUM 200 FEET) ABOVE THE WATER-BEARING STRATA.

ANALYSES MADE ON WELL WATERS FROM THE ADJACENT BULLHEAD QUADRANGLE (STEVENSON, 1957) INDICATE THAT WATER FROM THE FOX HILLS IS USUALLY FAIRLY SOFT WITH HIGH SULFATE AND SODIUM CONTENT. TOTAL SOLIDS RUN FROM 350 TO 1561 P.P.M. IRON MAY BE PRESENT IN OBJECTIONAL QUANTITIES. THE FLUORIDE CONTENT IS BELOW THE OPTIMUM CONTENT OF 1.0 P.P.M. THE SHALLOWER HELL CREEK WATER IS USUALLY SLIGHTLY SOFTER THAN THAT OF THE FOX HILLS.

THE DAKOTA SANDSTONE, PRINCIPAL GROUND WATER AQUIFER OF THE NORTHERN GREAT PLAINS, IS PRESENT IN THIS AREA AT DEPTHS OF 2800 TO 3400 FEET. THE HIGH COST OF DEEP DRILLING PREVENTS THE USE OF THIS WATER-BEARING FORMATION AS A SOURCE OF WATER IN THIS AREA.

CLAY

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

SANDSTONE

THE COLGATE MEMBER OF THE FOX HILLS FORMATION LOCALLY FORMS A HARD SANDSTONE LEDGE UP TO 15 FEET IN THICKNESS. THIS COULD PROVIDE BLOCK OR BUILDING STONE.

OIL AND GAS

THERE ARE NO VISIBLE SURFACE STRUCTURES IN WHICH OIL AND GAS MIGHT ACCUMULATE AT DEPTH, BUT BURIED STRUCTURES AS WELL AS SEDIMENTARY TRAPS MAY EXIST. THE BEST POSSIBILITIES FOR OIL PRODUCTION ARE IN THE MISSION CANYON FORMATION (AT DEPTHS OF ABOUT 5100 FEET) WHICH IS PRODUCTIVE TO THE NORTH IN NORTH DAKOTA. THE YOUNGBLOOD-DRASKOVICH NO. 1 OIL TEST, 3 MILES NORTHWEST OF MCINTOSH, DRILLED IN 1954 TO THE CAMBRIAN DEADWOOD FORMATION? AT 7465, HAD A SMALL OIL SHOW IN THE MISSION CANYON LIMESTONE. THE WELL WAS PLUGGED AS A DRY HOLE.

REFERENCES CITED

- CURTISS, R. E., (1953) AREAL GEOLOGY OF THE ISABEL QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P
- (1954A) AREAL GEOLOGY OF THE FIRESTEEL CREEK QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P
- (1954B) AREAL GEOLOGY OF THE GOPHER QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P
- (1954C) AREAL GEOLOGY OF THE GLAD VALLEY QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P
- (1954D) AREAL GEOLOGY OF THE WORTHLESS CREEK QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P
- MORGAN, R. E., AND PETSCH, B. C., (1945) A GEOLOGICAL SURVEY IN DEWEY AND CORSON COUNTIES, SO. DAK.; SO. DAK. GEOL. SURVEY, REPT. INVEST. 49, 53P
- SEARIGHT, W. V., (1931) THE ISABEL-FIRESTEEL COAL AREA; SO. DAK. GEOL. SURVEY, REPT. INVEST. 10, 35P
- STEVENSON, R. E., (1957) GEOLOGY OF THE BULLHEAD QUADRANGLE; SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, 1P