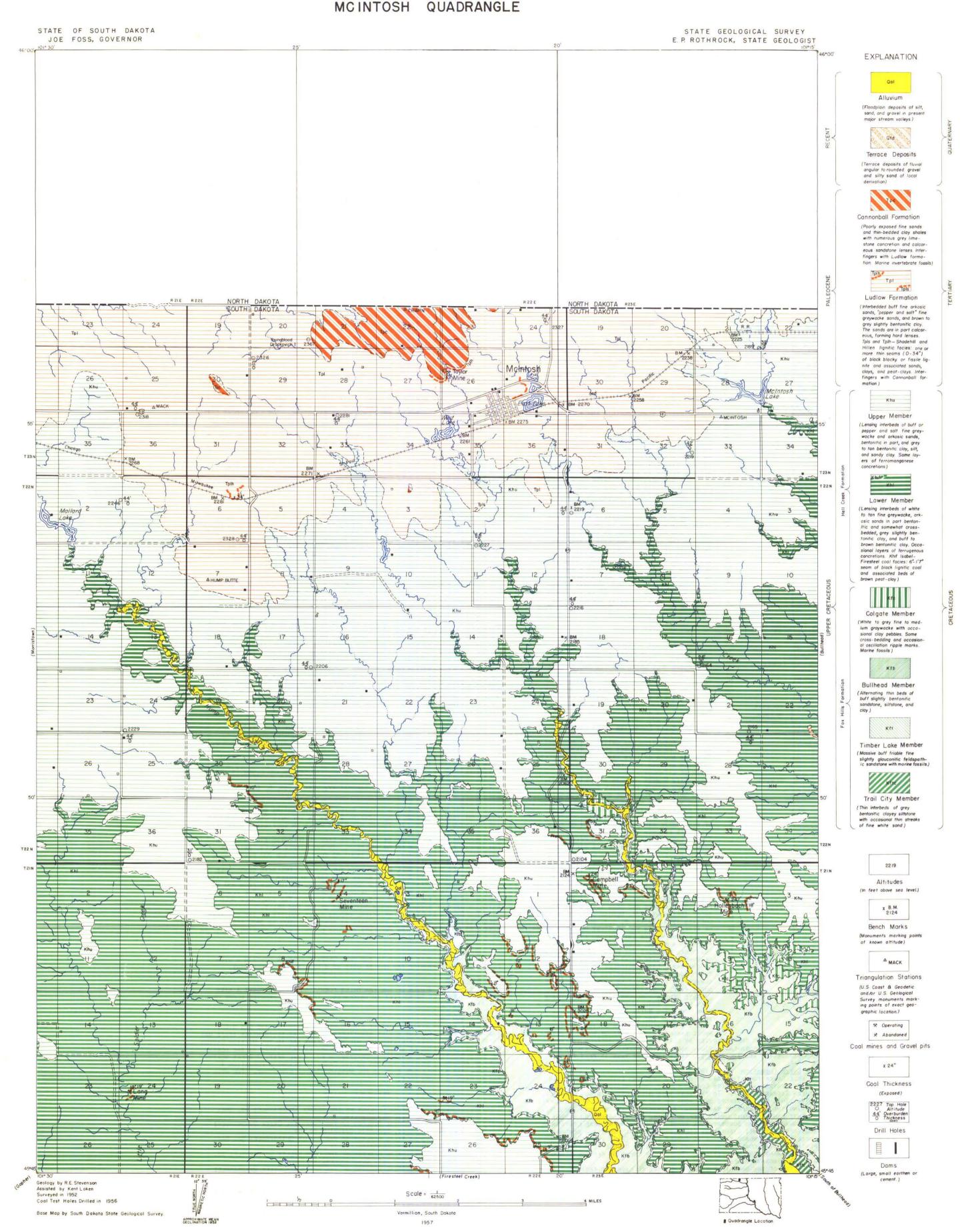
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# GEOLOGY OF THE MC INTOSH QUADRANGLE

By

### Robert E. Stevenson

#### INTRODUCTION

GENERALIZED COLUMNAR SECTION D A SHADEHILL UPPER ISABEL - FIRESTEEL LOWER COLGATE BULLHEAD MEMBER

THE MAPPING OF THIS QUADRANGLE WAS DONE IN 1952 AS A PART OF THE STATE GEOLOG-ICAL SURVEY'S COAL RESOURCES PROGRAM. COAL TEST DRILLING WAS DONE IN 1956. THE WRITER ACKNOWLEDGES WITH GRATITUDE THE ASSISTANCE OF KENT LOKEN IN THE FIELD. THE DRILLING WAS DONE BY R. L. HALE, R. W. MARTIN, AND J. G. LARSON.

#### LOCATION

THE MCINTOSH QUADRANGLE LIES ALONG THE NORTH DAKOTA LINE IN NORTH-CENTRAL CORSON COUNTY. THE AREA IS APPROXIMATELY 120 MILES NORTHWEST OF PIERRE AND 150 MILES NORTHEAST OF RAPID CITY. IT LIES IN THE OPEN STANDING ROCK INDIAN RESERVATION.

#### GEOGRAPHY

THIS QUADRANGLE LIES IN A SLIGHTLY POPULATED REGION OF PRAIRIE LANDS AND BAD-LANDS ON THE SOUTH SIDE OF THE STREAM DIVIDE BETWEEN THE GRAND AND CANNONBALL RIVERS.

PHYSIOGRAPHICALLY, THE AREA IS CHAR-ACTERIZED BY TWO TYPES OF TOPOGRAPHY: (1) ESSENTIALLY A PRE-MIDDLE PLEISTOCENE GENTLY ROLLING HIGH-LEVEL (2200-2300 FEET ALTITUDE) EROSION SURFACE WITH REMNANTS OF AN INTER-STREAM DIVIDE (HUMP BUTTE), AND A RELIEF OF ABOUT 250 FEET. (2) BADLANDS, CHARACTER-IZED BY NUMEROUS INTERMITTENT STREAMS IN YOUTHFUL, SHARPLY CUT VALLEYS, AND BY ABUNDANT BARE SLOPES. THIS POST-MIDDLE PLEISTOCENE EROSION SURFACE HAS BEEN DEVELOPED ON THE OLDER SURFACE. THE AVERAGE ELEVATION IS APPROXIMATELY 2200 FEET A.T., AND THE MAXIMUM RELIEF IS ABOUT 450 FEET.

THE SOUTHEASTERLY FLOWING MAIN STREAMS. HUMP CREEK, WHITE SHIRT CREEK, AND STINK CREEK ARE TRIBUTARIES TO THE GRAND RIVER. ALL PERMANENT WATER BODIES ARE ARTIFICIALLY

THE CLIMATE IS SEMI-ARID WITH AN AVERAGE RAINFALL OF ABOUT 18 INCHES. SMALL GRAINS AND HAY ARE GROWN ON THE UPLANDS, WHEREAS THE BADLANDS ARE USED ALMOST EX-CLUSIVELY FOR STOCK GRAZING.

THIS AREA IS LIGHTLY POPULATED (I FAM-ILY PER 3½ SQ. MILES). THE ONLY TOWN IS MCINTOSH, THE COUNTY SEAT, WITH A POPULATION OF ABOUT 650. McIntosh, which lies at the Junction of East-West U.S. Highway 12 and North-South State Highway 65 in the Northern PART OF THE QUADRANGLE, IS SERVED BY THE MAINLINE OF THE CHICAGO, MILWAUKEE, ST. PAUL AND PACIFIC RAILROAD.

## **STRATIGRAPHY**

OUTCROPPING SEDIMENTS RANGE IN AGE FROM LATE CRETACEOUS TO RECENT. ABOUT 75 PER-CENT OF THE MAPPED AREA IS COVERED BY THE CRETACEOUS HELL CREEK AND FOX HILLS FORMATIONS, THE REST BY THE LUDLOW AND CANNONBALL FORMATIONS OF PALEOCENE AGE. SCATTERED OVER THE SURFACE ARE WIND-POLISHED BOULDERS REPRESENTING A LAG GRAVEL DERIVED FROM THE TONGUE RIVER AND WHITE RIVER SEDIMENTS. THE FORMATIONS ARE CONFORMABLE.

FOX HILLS FORMATION MEEK AND HAYDEN

1861. THIS FORMATION WAS ORIGINALLY DESCRIBED AND NAMED FROM EXPOSURES ON FOX RIDGE. ABOUT 70 MILES SOUTH OF THIS AREA. THE FOX HILLS HAS BEEN DIVIDED INTO FOUR MEMBERS ON THE BASIS OF LITHOLOGY.

TRAIL CITY MEMBER MORGAN AND PETSCH 1945. THIS LOWER MEMBER IS POORLY EXPOSED ALONG WHITE SHIRT CREEK IN THE SOUTHEAST CORNER OF THE MAP. THE MEMBER IS CHARACTERIZED BY GREY SILTSTONE WITH NUMEROUS INTERBEDS OF GREY BENTONITIC CLAY, AND SEVERAL LENSES OF FINE WHITE SAND. ONLY 65 FEET OF THIS MEMBER IS EXPOSED IN THIS AREA. TIMBER LAKE MEMBER MORGAN AND PETSCH 1945. EXPOSURES OF THIS SANDY MEMBER ARE PRESENT IN THE VALLEY OF WHITE SHIRT CREEK IN THE SOUTHEAST CORNER OF THE MAPPED AREA. THE

MEMBER CONSISTS OF A 20-25 FOOT BED OF BUFF SLIGHTLY GLAUCONITIC SUBQUARTZOSE SAND WITH SCATTERED THICK SHELLED PELECYPODS (TANCREDIA BULLHEAD MEMBER STEVENSON 1957. IN THE PAST. THIS MEMBER HAS BEEN TERMED THE "BANDED

BEDS" (SEARIGHT 1931, MORGAN AND PETSCH 1945, CURTISS 1953, 1954A, B, C,), BUT AS A RESULT OF RECENT WORK IN THE ADJACENT BULLHEAD QUAD-RANGLE, THE WRITER (STEVENSON, 1957) HAS PROPOSED A FORMAL STRATIGRAPHIC NAME. ITS SCATTERED OUTCROPS ARE FOUND IN THE VALLEYS OF HUMP AND WHITE SHIRT CREEKS IN THE SET OF THE MAP. LITHOLOGICALLY IT CONSISTS OF THIN BEDS OF BUFF BENTONITIC SILTY CLAY AND CLAYEY SILTS ALTERNATING WITH THIN BEDS OF BUFF, FINE, SUBGRAYWACKE SANDS. COLGATE MEMBER CALVERT 1912. THIS MEMBER CAPS SEVERAL SMALL BUTTES AND RIMS THE LOWER HUMP CREEK AND WHITE SHIRT CREEK VALLEYS IN THE SET OF THE QUADRANGLE. IT VARIES FROM A GREY CALCAREOUS OR SILICEOUS GRAY-

WACKE SANDSTONE TO A BUFF OR WHITE SUBGRAY-WACKE SAND. IT MAY BE CHARACTERIZED BY CLAY SEAMS, CARBONACEOUS STREAKS, CLAY PEBBLE LAYERS, CROSS-LAMINATION, OSCILLATION RIPPLE MARKS (INDEX OF 10), WOOD FRAGMENTS, AND INCERAMUS. IT IS NOT MORE THAN 15 FEET THICK.

TIMBER LAKE

MEMBER

TRAIL CITY

MEMBER

ELL CREEK FORMATION BROWN 1907 THE HELL CREEK FORMATION CAN BE DIVIDED INTO TWO LITHOLOGIC UNITS IN THIS AREA OF CENTRAL AND WESTERN CORSON COUNTY, NORTHWESTERN DEWEY COUNTY AND NORTHERN ZIEBACH COUNTY. TO THE WEST THIS DISTINCTION IS NOT POSSIBLE. LOWER UNIT. THIS UNIT OUTCROPS OVER MOST OF THE SOUTHERN HALF OF THE MAPPED AREA, FORMING THE PICTURESQUE BADLANDS. A VARIETY OF INTERBEDDED AND LENS-ING SEDIMENTS COMPRISE THIS UNIT: BUFF TO WHITE, CROSS-LAMINATED, MEDIUM GRAINED SUBQUARTZOSE AND SUBGRAYWACKE SANDS AND SILTS WITH LOCAL LENTICULAR CALCAREOUS CEMENTATIONS; LIGHT GRAY SILT; BROWN TO GREY CLAY AND BENTONITIC CLAY; LOCAL SEAMS OF BLACK FISSILE TO BLOCKY LIGNITE (2-19 INCHES THICK); BROWN PEAT-CLAY WITH COAL FRAGMENTS; AND HORIZONS OF ORANGE TO BLACK IRON-STONE AND FERROMANGANESE CONCRETIONS. THROUGHOUT THESE 60 FEET OF STRATA

ARE SCATTERED DINOSAUR BONES.

AT THE TOP OF THE UNIT IS THE ISABEL-FIRESTEEL LIGNITIC FACIES: 7 TO 10 FEET OF INTERBEDDED BROWN PEAT-CLAY, TAN TO BUFF SILTSTONE, GRAY CLAY, AND LOCAL SEAMS OF BLACK FISSILE LIGNITE (3 TO 24 INCHES THICK). ASSOCIATED WITH THE LIGNITES AND PEAT-CLAYS ARE SCATTERED FRAGMENTS OF MELANTERITE, MARCASITE, AND GYPSUM.

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

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 LUD-LOW IS A SERIES OF HETEROGENOUS 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 FRAG-MENTS; AND BROWN PEAT-CLAYS.

LOCALLY AT THE BASE OF THE FORMATION IS THE SHADEHILL LIGNITE 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 34 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 NORTH-

WEST 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 EPITONIUM.

THE FORMATION, LENTICULAR IN CHARACTER, INTERFINGERS WITH THE LUDLOW

AND HAS A MAXIMUM THICKNESS OF ABOUT 170 FEET.

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 DER-IVATION. 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 FEA-TURE 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.

IGNITE 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., R2IE., 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 MELANTERITE AND SCATTERED GYPSUM (SELENITE) CRYSTALS. THE LIGNITE IS NON-COKING. PROXIMATE ANALYSES AND COMBUSTION PROPERTIES OF THE DIF-FERENT LIGNITES ARE GIVEN IN TABLE 1.

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%	AND TRANSPA	The same of the sa	0.44%	
ISABEL- FIRESTEEL	S.19, T21N., R23E	38,26%	32.69%	19.56%			

\* ANALYZED BY THE STATE CHEMICAL LABORATORY, VERMILLION, S. D.

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.

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.

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

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. | OIL TEST, 3 MILES NORTH-WEST 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, IP
(1954A) AREAL GEOLOGY OF THE FIRESTEEL CREEK QUADRANGLE;

SO. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, IP (1954B) AREAL GEOLOGY OF THE GOPHER QUADRANGLE; SO. DAK.

GEOL. SURVEY, GEOLOGIC QUADRANGLES, IP

(1954c) AREAL GEOLOGY OF THE GLAD VALLEY QUADRANGLE; So.

DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, IP

(1954d) AREAL GEOLOGY OF THE WORTHLESS CREEK QUADRANGLE;

So. DAK. GEOL. SURVEY, GEOLOGY OF THE WORTHLESS CREEK QUADRANGLE,
So. DAK. GEOL. SURVEY, GEOLOGIC QUADRANGLES, IP
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, IP