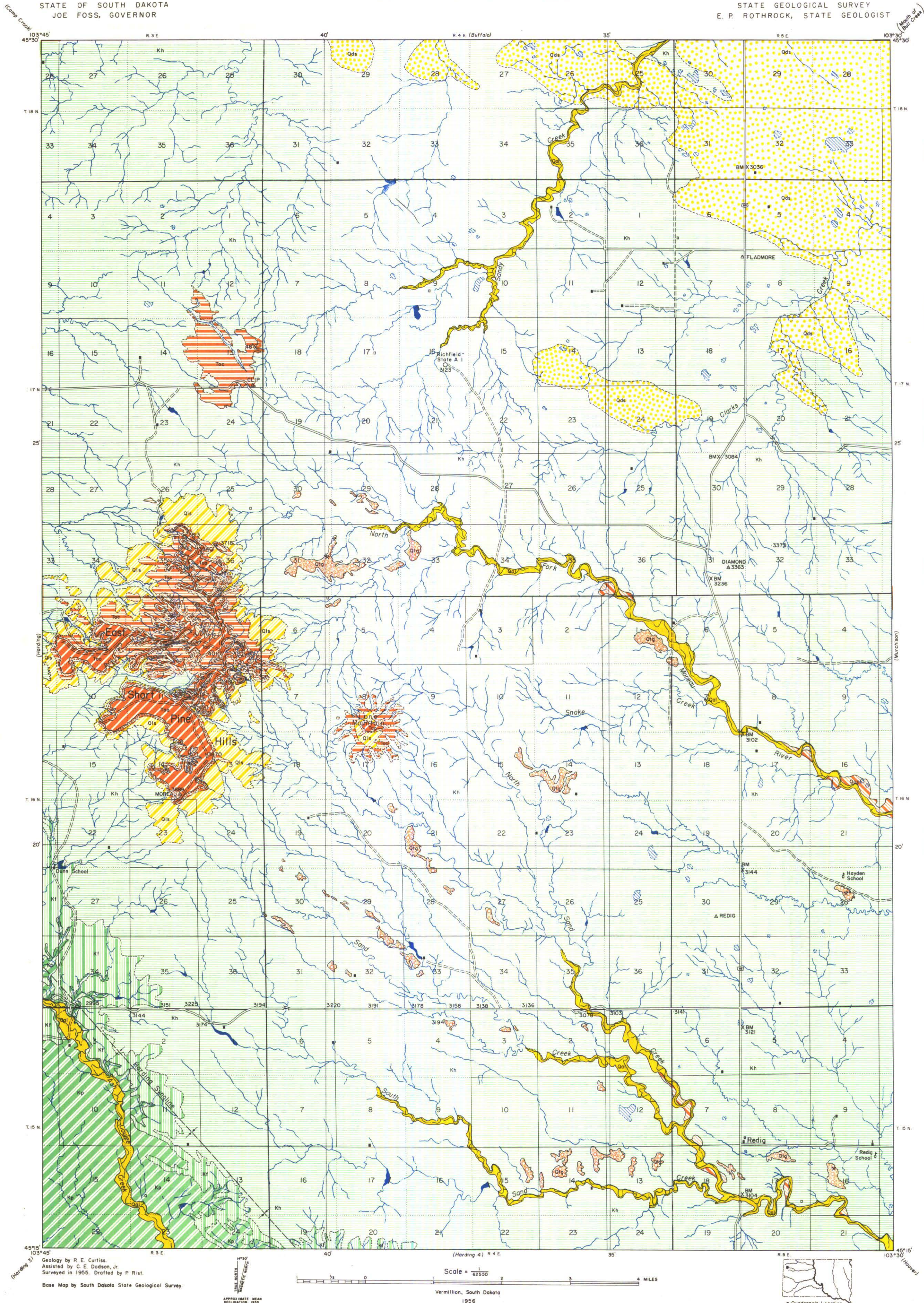


AREAL GEOLOGY OF THE REDIG QUADRANGLE

STATE OF SOUTH DAKOTA
JOE FOSS, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

- Alluvium
(Recent valley-bottom deposits of clay, silt, sand, and gravel in present streams)
- Dune Sand
(Rounded, cross-bedded dunes with deflation "blowouts" and composed largely of fine- to medium-grained quartz sand up to 40' relief)
- Landslide
(Landslide blocks of Anikaree (Flora Opalita?) and White River sediments confined to the East Short Pine Hills and Lone Mountain)
- Older Alluvium
(Older alluvial deposits above present floodplains of recent streams)

PLEISTOCENE

- Terrace Gravel
(Terrace deposits of sand and gravel with some clay and very coarse material, (1) to 1.5' thick)

MODERN FLUVIDENE

- Anikaree (?) or Ogallala (?) Formation
(Clay-forming, mass- and butt-capping sandstone, generally greenish, cherty, quartzitic in part, with secondary structures, indurated clay, silt, sand and volcanic ash; and, luffaceous and conglomeratic sandstones. Sand and conglomerate mark base. Over 50' thin sand gravel layers. Thickness up to 196')

OLIGOCENE

WHITE SANDS GROUP

- Brule Formation
(Massive, horizontal bands of green, brown, and pink benitic clays; intercalated, cross-bedded channel sands and sandstones, and luffaceous sandstones with calcareous layers; green chertaceous seams; green clay nodules and sand, fine-grained, sandy concretions; and, fossiliferous lenses. Up to 95' thick)
- Chadron Formation
(About 10' thin, wavy limestones underlain by olive, cream, buff, and gray sandstone; calcareous clay with channel sandstones, "dazzling white" sand, basal cross-bedded, medium- to coarse-grained, limestone sand and gravel and bentonitic lenses. Up to 133' thick)
- Hell Creek Formation
Undifferentiated
(Buff, laminated claystone and siltstone, fossiliferous and cross-bedded, of coal, peat, clays, and black carbonaceous clay near top; intercalated "amber beds" of dull gray and brown bentonitic clay; three conspicuous buff to yellow cross-bedded sand and concretions, and dinosaur bones, weathers to badland topography, locally termed the "Jumpoff". About 407' exposed)
- Fox Hills Formation
Undifferentiated
(Light buff to yellow, cross-bedded, fine- to medium-grained sand and sandstone with calcareous matrix (possibly Colgate member), and buff to gray sandy and silty clays with intercalated sand streaks in lower portion (resembles Trail City member). About 100' thick)
- Pierre Formation
Undifferentiated
(Dark gray shale-like benitic clay with several thin, limestone-shaped bentonite beds and selenite gypsum crystals of top, and scattered calcareous concretions with golden calcareous nodules and pebbles and gypsum concretions. Weathering produces a light gray "popcorn" surface. About 50' exposed)

UPPER CRETACEOUS

DRAINAGE

- Intermittent Streams

CULTURE

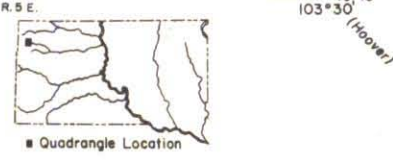
- Buildings
(House, church, and school)
- Roads and Trails
- Triangulation Stations
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location)
- Oil-test Borings
- Quarry

Geology by R. E. Curtiss.
Assisted by C. E. Dodson, Jr.
Surveyed in 1955. Drafted by P. Rist.

Base Map by South Dakota State Geological Survey.

Scale = 1:25,000

Vermillion, South Dakota
1956



AREAL GEOLOGY OF THE REDIG QUADRANGLE

By
Robert E. Curtiss

INTRODUCTION

THE MAPPING OF THIS QUADRANGLE WAS DONE IN 1955 AS A PART OF THE STATE GEOLOGICAL SURVEY'S COAL RESOURCES PROGRAM. TWO 60-FOOT STRATIGRAPHIC HOLES WERE DRILLED BY THE SURVEY IN AUGUST, 1955.

LOCATION

THE QUADRANGLE LIES IN SOUTH-CENTRAL PORTION OF HARDING COUNTY AND IS LOCATED APPROXIMATELY 80 AIRLINE MILES NORTH-NORTHWEST OF RAPID CITY AND ABOUT 182 MILES NORTHWEST OF PIERRE BETWEEN PARALLELS 45°15' AND 45°30' NORTH LATITUDE AND 103°30' AND 103°45' WEST LONGITUDE AND COMPRISES AN AREA OF ABOUT 210 SQUARE MILES.

PHYSIOGRAPHY AND DRAINAGE

A VARIETY OF TOPOGRAPHIC FEATURES MARKS THIS QUADRANGLE AS ONE OF THE MOST PHYSIOGRAPHICALLY INTERESTING AND PICTURESQUE IN NORTHWESTERN SOUTH DAKOTA. THE PRINCIPLE FEATURES ARE THE EAST SHORT PINE HILLS, THE "JUMPOFF" AREA, AND THE SAND DUNE TOPOGRAPHY.

THE EAST SHORT PINE HILLS AND LONE MOUNTAIN, A MESA AND BUTTE, RESPECTIVELY, ARE SITUATED IN T. 17-18 N., R. 3-4 E. THEY TOWER BETWEEN 800 AND 900 FEET ABOVE THE SETTLEMENT OF REDIG WHICH IS LOCATED ABOUT SIX MILES SOUTHEAST OF LONE MOUNTAIN. THE LOCAL RELIEF OF THESE FEATURES APPROXIMATES 500 FEET. BOTH ARE CAPPED BY AN EXTREMELY RESISTANT SANDSTONE WHICH EXHIBITS SHEAR CLIFFS OR EROSION SCARPS EXCEEDING 100 FEET. THE CLIFFS ARE RIMMED WITH RELATIVELY THICK BUT SHORT STANDS OF *PINUS PONDEROSA*. MUCH OF THE NORTHERN SECTOR OF THE EAST SHORT PINE HILLS IS IN MIDDLE MATURITY AS STREAM DISSECTION HAS REDUCED THE FORMER EXTENSIVE FLAT-TOPPED MESA TO ALMOST KNIFE-EDGED RIDGES. LONE MOUNTAIN IS A BUTTE WHICH HAS BEEN DETACHED FROM THE EAST SHORT PINE HILLS. A WELL-DEVELOPED JOINT SYSTEM, WHICH STRIKES ABOUT N. 42° E. AND N. 45° W., IN THE ARIKAREE (?) OR OGALLALA (?) CAPROCK OF THE MESA IS PARTICULARLY SUSCEPTIBLE TO SLUMP AND LANDSLIDE.

THE UNDERLYING CHADRON AND BRULE FORMATIONS SLUMP AND ARE ERODED AWAY FROM BENEATH THE CAPROCK. WITHOUT THE SUPPORT OF THESE FORMATIONS, THE CAPROCK BREAKS OFF AT THE JOINTS.

AN ECHELON LANDSLIDE BLOCKS ARE CONSPICUOUS AT THE SOUTH END OF THE EAST SHORT PINE HILLS. THE JOINTS ARE ALSO ATTACKED BY FROST ACTION AND GULLY EROSION.

THE "JUMPOFF" AREA, WHICH IS LOCATED NORTH OF THE EAST SHORT PINE HILLS IN T. 17 N., R. 3-4 E., EXHIBITS PRONOUNCED, GROTESQUE BADLAND TOPOGRAPHY. THE HELL CREEK FORMATION, COMPOSED LARGELY OF BENTONITIC CLAYS, SILTS, AND SANDS, IS RELATIVELY NONRESISTANT TO EROSION AND HAS A TENDENCY OF WEATHERING TO AN INTRICATE LABYRINTH OF MINUTELY-DISSECTED RIDGES, FLUTED COLUMNS, BUTTRESSES, PINNACLES, EARTH SPIRES, "STACKS" OR "HUMPS", AND CAVERNS. SLIGHTLY INCLINED PLANES, APPROXIMATING DESERT PEDIMENTS, EXIST AT THE BASE OF THE "STACKS". THESE PLANES SLOPE DOWNSTREAM AND ARE GENERALLY THINLY VENEERED WITH BROKEN CALCICE-CEMENTED SANDSTONE, LIMONITE, AND MANGANESE-IRON CONCRETIONS AND OCCASIONALLY DINOSAUR BONES. WHERE TRIBUTARY GULLIES MERGE ON A PLANE, COALESCING ALLUVIAL FANS ARE FORMED BY SHEETFLOOD. DURING DRY PERIODS, DEFLATION PROCESSES REMOVE THE FINE MATERIAL OF LESS THAN 0.1 MIN. IN DIAMETER. EXTENSIVE GRASSED, PEDIMENT FLATS ARE FOUND BETWEEN THE "STACKS". THE DEVELOPMENT OF THESE FLATS MAY BE GOVERNED BY A TEMPORARY BASE LEVEL AND MAY BE ROUGHLY CORRELATIVE WITH TERRACE DEVELOPMENT ALONG THE LITTLE MISSOURI RIVER.

SMALL BUTTES, CAPPED WITH HELL CREEK SANDSTONE, FORM LANDMARKS THAT TOWER BETWEEN 50 AND 100 FEET ABOVE THE RELATIVELY FLAT TERRAIN.

DUNE SAND TOPOGRAPHY IS PROMINENT IN THE NORTH-EASTERN PORTION OF THE QUADRANGLE. THE DUNES ARE LONGITUDINAL IN SHAPE WITH OGHOURD OR ROUNDED CREST. MUCH OF THE AREA IS GRASSED OVER; HOWEVER, OCCASIONAL "BLOWOUTS" REVEAL EXCELLENT BEDDING.

THE NORTHERN PARTS OF THE QUADRANGLE DRAINS NORTHWARD TO THE SOUTH FORK OF GRAND RIVER IN THE BUFFALO QUADRANGLE AND NORTHWEST TO THE LITTLE MISSOURI RIVER IN THE CAMP CROOK QUADRANGLE. DRAINAGE IN THE SOUTHERN PORTION OF THE AREA FLOWS SOUTHEASTERLY TO THE MOREAU RIVER. THE NORTH FORK OF MOREAU RIVER ORIGINATES IN THE NORTHERN SECTOR OF THE EAST SHORT PINE HILLS. THE EAST SHORT PINE HILLS OCCUPY A PORTION OF THE LITTLE MISSOURI-GRAND RIVER AND MOREAU RIVER INTERSTREAM DIVIDE.

THE DRAINAGE PATTERN IS ROUGHLY PARALLEL IN THE SOUTHERN PART OF THE QUADRANGLE AND APPEARS TO BE STRUCTURALLY ADJUSTED. THE INTERMITTENT STREAMS GENERALLY FLOW NORTHWEST-SOUTHEAST AND PARALLEL WITH STRUCTURAL TRENDS WHICH ARE TERMED THE HARDING SYNCLINE AND THE BULLOCK ANTICLINE.

MANY SPRINGS ISSUE FROM THE EAST SHORT PINE HILLS.

THE HIGHEST ALTITUDE IN THE QUADRANGLE IS 4,010 FEET ABOVE SEA LEVEL ON THE EAST SHORT PINE HILLS IN SEC. 1, T. 16 N., R. 3 E. THE LOWEST POINT IS ABOUT 2,950 FEET ABOVE SEA LEVEL IN SEC. 22, T. 15 N., R. 5 E. IN SAND CREEK. THE RELIEF OF THE QUADRANGLE IS APPROXIMATELY 1,060 FEET, AND THE AVERAGE QUADRANGLE ALTITUDE IS ABOUT 3,480 FEET ABOVE SEA LEVEL.

STRATIGRAPHY

SURFACE FORMATIONS RANGE IN AGE FROM UPPER CRETACEOUS TO RECENT. THE FOX HILLS (UPPER CRETACEOUS AGE) AND THE CHADRON AND BRULE (OLIGOCENE AGE) FORMATIONS ARE COMPLETELY EXPOSED IN THE QUADRANGLE. STRATIGRAPHIC BOUNDARIES BETWEEN THE PIERRE-FOX HILLS, HELL CREEK, AND THE CHADRON-BRULE FORMATIONS ARE GENERALLY CONFORMABLE WITH THE EXCEPTION OF DIASTEMES. MARKED UNCONFORMITIES EXIST BETWEEN THE HELL CREEK-CHADRON AND THE BRULE-ARIKAREE (?) OR OGALLALA (?) FORMATIONS. TONGUE RIVER BOULDERS (PALEOCENE AGE), TERRACE GRAVELS (PLEISTOCENE AGE), OLDER ALLUVIAL TERRACES AND LOESS (PLEISTOCENE TO RECENT AGE), AND LANDSLIDES, DUNE SAND, AND ALLUVIUM (RECENT) ARE SURFICIAL SEDIMENTATIONAL UNITS EXPOSED IN THE QUADRANGLE.

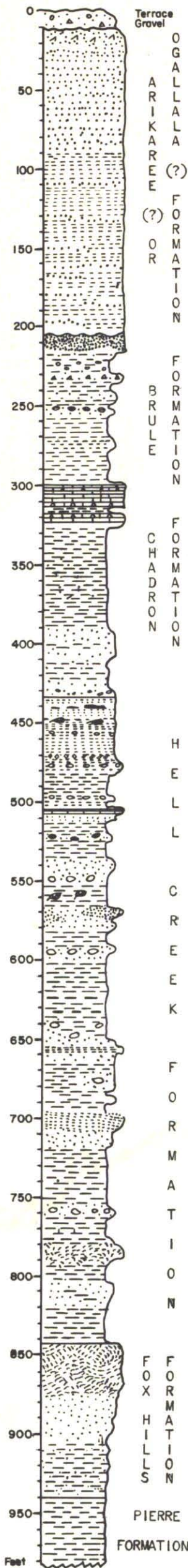
THE PIERRE FORMATION IS MARINE; THE FOX HILLS REPRESENTS A SHORE LINE FACIES OF THE REGRESSIVE PIERRE SEA; THE HELL CREEK IS TERRESTRIAL, COMPOSED OF EOLIAN, PALUDAL AND LACUSTRINE, AND CHANNEL AND ALLUVIAL DEPOSITS.

PIERRE FORMATION UNDIFFERENTIATED (Meek and Hayden 1862). APPROXIMATELY 50 FEET OF THE UPPER PART OF THE PIERRE FORMATION IS EXPOSED IN THE SOUTH-WESTERN CORNER OF THE AREA. LITHOLOGICALLY, IT CONSISTS OF DARK BLuish GRAY SHALE-LIKE BENTONITIC CLAY THAT WEATHERS TO LIGHT GRAY "POPCORN" SURFACES. WET BENTONITE IS PLASTIC AND SLIPPERY. SEVERAL BUFF-OLIVE BENTONITE BEDS WHICH MARK THE PIERRE-FOX HILLS CONTACT, LIMONITE, SELENITE GYPSUM CRYSTALS, AND DARK GRAY LIMESTONE CONCRETIONS WITH GOLDEN CALCITE GOODES AND GYPSUM AND MELANTERITE-STAINED VEINLETS. THE LITHOLOGY IS WELL EXPOSED IN NE $\frac{1}{4}$ SEC. 34, T. 16 N., R. 3 E.

FOX HILLS FORMATION UNDIFFERENTIATED (Meek and Hayden 1861). THE FORMATION ATTAINS A THICKNESS OF ABOUT 100 FEET. IT IS COMPOSED OF TWO DISTINCT LITHOLOGIES. THE LOWER UNIT, WHICH IS A TRANSITION INTERVAL BETWEEN THE PIERRE AND FOX HILLS FORMATION, CONSISTS PRINCIPALLY OF THIN STREAKS. THE COLOR AND TEXTURE FAVORS THE FOX HILLS. LIMONITIC NODULES ARE FAIRLY ABUNDANT. THIS UNIT RESEMBLES THE TRAIL CITY MEMBER WHICH EXISTS IN THE EASTERN PART OF THE COAL REGION.

THE UPPER SEDIMENTATIONAL UNIT IS COMPOSED OF BUFF-YELLOW, CROSS-LAMINATED, FINE-TO MEDIUM-GRAINED SAND AND SANDSTONE WITH MANY ORANGE-BROWN FOSSIL PLANTS (?) *HAYMENTES MAJOR* LESQUEUREUX. THE SAND MAY BE THE COLGATE MEMBER. IT CROPS OUT IN SW $\frac{1}{4}$ SEC. 27, T. 16 N., R. 3 E. A THICK FOSSIL SOIL (?) MARKS THE CONFORMABLE CONTACT WITH THE OVER-LYING HELL CREEK FORMATION.

GENERALIZED COLUMNAR SECTION



HELL CREEK FORMATION UNDIFFERENTIATED (Brown 1907). THE MEASURED THICKNESS IS 407 FEET, AND THE TOP PORTION MAY BE MISSING. THE ISABELL FIRESTEEL COAL MEMBER IS NOT PRESENT IN THIS AREA; THEREFORE, THE FORMATION IS UNDIFFERENTIATED. THIS CARTOGRAPHIC UNIT CONSISTS PREDOMINANTLY OF "SOMBER" OR DULL LIGHT TO DARK GRAY, BUFF, AND BROWN HORIZONTAL BANDS OF LENTICULAR, INTERBEDDED ADMIXTURES OF BENTONITIC CLAY, SILT, AND SAND, AND A LOCAL FOUR-INCH COAL, BROWN PEAT-CLAYS, BLACK CARBONACEOUS CLAYS, THIN CALCICE SEAMS BOTH ALONG THE BEDDING PLANES AND CROSS JOINTS, CARBONIZED WOOD FRAGMENTS, PURPLE-BLACK MANGANESE-IRON CONCRETIONS, CONTAINING ABOUT 51 PERCENT METALLIC IRON BUT NOT IN COMMERCIAL QUANTITIES, YELLOW MELANTERITE AND/OR JAROSITE NODULES AND STAIN, SELENITE GYPSUM CRYSTALS, ORANGE-BROWN LIMONITE NODULES, AND UNARTICULATED DINOSAUR BONES. THREE SANDSTONE AND SAND DEPOSITS OCCUPY TOP, MIDDLE AND LOWER POSITIONS IN THE FORMATION. THE SANDS ARE CROSS-BEDDED, SIMILAR TO THE FOX HILLS SANDS, AND ARE EXPOSED BENEATH THE SANDSTONE THAT CAPS NUMEROUS BUTTES.

ABOUT 50 FEET OF RUSTY BROWN TO BUFF LAMINATED CLAYSTONE AND SILTSTONE OVERLIE THE "SOMBER BEDS" AT THE NORTHERN END OF THE EAST SHORT PINE HILLS. THIS INTERVAL INCLUDES ABUNDANT CROCODYLIAN TEETH AND GANOID FISH SCALES. LOESS BLANKETS MANY HELL CREEK EXPOSURES.

CHADRON FORMATION (Darton 1899) **WHITE RIVER GROUP** (Meek and Hayden 1858). THE FORMATION, WHICH IS 133 FEET THICK, COMPRISES THE LOWER STRATIGRAPHIC UNIT OF THE WHITE RIVER GROUP. THIS UNIT IS COMPOSED OF A BASAL CROSS-BEDDED, MEDIUM- TO COARSE-GRAINED, LIMONITE-STAINED SAND AND GRAVEL UP TO FOUR-FOOT THICK, MARKING THE EROSIONAL UNCONFORMITY WITH THE UNDERLYING HELL CREEK FORMATION. MUCH OF THE UNIT IS COMPOSED OF LIGHT TO MEDIUM GRAY, OLIVE, AND BUFF BENTONITIC CLAY, CHERT AND QUARTZ SAND, CHANNEL SANDSTONES, AND "DAZZLING WHITE" SAND. THE UNIT WEATHERS TO BOTH A CASE-HARDENED, FLUTED SANDY SURFACE AND A "HUMPBACK" BENTONITIC SURFACE. THE TOP IS COMPOSED OF ABOUT 10 SIX-INCH TO THREE-FOOT THICK DIRTY GRAY VUGGY FRESH-WATER LIMESTONE OR CALCICE BEDS THAT CONTAIN CHALCEDONY. SEVERAL LOWER JAWBONES OF BRONTOTHERES WERE FOUND BY THE AUTHOR AND IDENTIFIED BY J. R. MACDONALD.

BRULE FORMATION (Darton 1898) **WHITE RIVER GROUP** (Meek and Hayden 1858). THIS MAPPABLE UNIT IS THE UPPER FORMATION OF THE WHITE RIVER GROUP. IT RESTS ON THE THIN LIMESTONE SERIES OF THE CHADRON FORMATION. IT CONSISTS PRINCIPALLY OF UP TO 95 FEET OF HORIZONTAL BANDS OF GREEN, BROWN, AND PINK BENTONITIC CLAYS, LENS-LIKE CROSS-LAMINATED CHANNEL SANDS, QUARTZOSE SANDSTONE, AND TUFFACEOUS SANDSTONE, CALCICE (?) LAYERS, GREEN CHALCEDONY LAYERS, GREEN CLAY NODULES, AND LOCALLY ABUNDANT CIRCULAR FINE-GRAINED SANDY CONCRETIONS AND FOSSIL OREODON (?) *MERYCOLDODON* (?) JAWS COLLECTED BY THE AUTHOR AND C. E. DODSON, JR. AND IDENTIFIED BY J. R. MACDONALD.

ARIKAREE (?) FORMATION (Darton 1899) OR **OGALLALA (?) FORMATION** (Darton 1898). THE AUTHOR FOUND NO FOSSIL EVIDENCE TO ESTABLISH THE EXACT AGE OF THE ROCK UNIT OR UNITS. THE LOUP FORK BEDS OF MECK AND HAYDEN, 1862, INCLUDES THE ARIKAREE (?) AND OGALLALA (?) FORMATIONS. THE UNIT VARIES IN THICKNESS BETWEEN 60 AND 196 FEET.

THE MESA- AND BUTTE-CAPPING FORMATION CONSISTS OF GRAY-BUFF TO GREEN CONGLOMERATIC SANDSTONE LENSES, SANDSTONE CONCRETIONS, INTERBEDDED SEMI-INDURATED TUFFACEOUS SAND, SCATTERED GRAY BARITE ROSETTES AND OVER 50 THIN GREENISH SANDSTONE CONGLOMERATES THAT ARE COMPOSED OF WIND-POLISHED QUARTZ, CHALCEDONY, CHERT, LIMESTONE, AND CHLORITE PEBBLES.

STRUCTURE

THE OROGENIC FORCES WHICH UPFOLDED THE BLACK HILLS ARE RESPONSIBLE FOR THE BLACK HILLS ELLIPTICAL DOME, FOR THE DAKOTA (WILLISTON) BASIN, AND FOR THE SERIES OF LOW EN ECHELON FOLDS WHICH OCCUR IN HARDING COUNTY AND PARTLY IN THE REDIG QUADRANGLE. THE REGIONAL DIP IS NORTHEAST AT THE RATE OF ABOUT 30 TO 40 FEET PER MILE. THE DETAILED AREAL MAPPING, COUPLED WITH DIP AND STRIKE READINGS, INDICATE THAT TWO "TRENDS", NAMELY THE HARDING SYNCLINE AND THE BULLOCK ANTICLINE EXTEND INTO THE QUADRANGLE FROM THE HARDING QUADRANGLE TO THE WEST AND THE CAMP CROOK QUADRANGLE TO THE NORTHWEST. COMPASS READINGS WERE TAKEN ON A THIN FOX HILLS SANDSTONE JUST ABOVE THE PIERRE-FOX HILLS CONTACT IN T. 15 N., R. 3 E. WHICH SHOW THE SANDSTONE DIPPING UP TO SIX DEGREES NORTHEAST WHICH IS APPROXIMATELY NORMAL TO THE HARDING SYNCLINAL AXIS. DIPS WITH OVER TWO DEGREES OF REVERSAL WERE MEASURED IN SEC. 8, T. 17 N., R. 4 E. ON HELL CREEK PEAT-CLAY BEDS. OF COURSE THE HELL CREEK DIPS MAY BE PSEUDO-STRUCTURAL; THAT IS, THE BULK OF THE FORMATION POSSESSES DEPOSITIONAL IRREGULARITIES SUCH AS LENTICULARITY, CROSS-BEDDING, CONTEMPORANEOUS EROSION AND REDEPOSITION, AND SLUMPING WHICH ARE SEDIMENTATIONAL STRUCTURES THAT RESEMBLE ANGULAR UNCONFORMITIES AND STRUCTURAL DIPS. THEREFORE, THE DETERMINATION OF SURFACE STRUCTURE IS COMPLICATED.

LITHOLOGICALLY, CERTAIN BENTONITIC CLAYEY BEDS IN THE HELL CREEK RESEMBLE THIN EXPOSURES OF PIERRE BENTONITIC CLAY AND A CROSS-BEDDED SAND IN THE LOWER HELL CREEK RESEMBLES THE FOX HILLS SAND. THEREFORE, IT IS ADVISABLE TO APPROACH THE QUADRANGLE FROM THE SOUTH AND CARRY THE PIERRE-FOX HILLS CONTACT NORTH INTO THE QUADRANGLE AS THE EXPOSURES ARE THIN, LARGELY GRASSED OVER, AND INTERMITTENTLY OBTUSCURED BY ALLUVIUM AND COLLUVIUM, A HETEROGENEOUS AGGREGATE OF ROCK DETRITUS.

ECONOMIC GEOLOGY

NO MINERAL RESOURCES ARE COMMERCIALY EXPLOITED AT THE PRESENT TIME. ON LARGE GRAVEL TERRACE IN SECS. 31, 32, T. 7 N., R. 4 E., HAD BEEN QUARRIED PERIODICALLY, AND OTHER GRAVEL TERRACES OFFER FAIR POSSIBILITIES. URANIUM EXISTS IN MINOR QUANTITIES IN THE HELL CREEK FORMATION. ORTHOQUARTZITE BOULDERS AND SANDSTONE COULD BE USED FOR BUILDING STONE AND RIPRAP FOR DAMS. THE ONLY COAL ENCOUNTERED WAS A LOCAL FOUR-INCH-THICK SEAM IN SEC. 13, T. 17 N., R. 3 E., CLAYS ARE ABUNDANT IN THIS AREA.

OIL AND/OR GAS MAY BE PRESENT IN THE SUBSURFACE ROCKS. THE RICHFIELD OIL-TEST, WHICH IS LOCATED IN SEC. 16, T. 17 N., R. 4 E., WAS DRILLED TO A DEPTH OF 8,236 FEET IN 1955 WITH NEGATIVE RESULTS.

GRAVEL

THIRTY-THREE SAND AND GRAVEL TERRACES CONSTITUTE A TOTAL OF ABOUT 5,900,000 CUBIC YARDS AND ARE LOCATED EAST, SOUTHEAST, AND SOUTH OF THE EAST SHORT PINE HILLS AND LONE MOUNTAIN, THE PROVENANCE AREAS. THESE DEPOSITS CONTAIN LARGE QUANTITIES OF ARIKAREE (?) OR OGALLALA (?) SANDSTONE, GRIT, PEBBLES, AND LARGE COBBLES, AND CHADRON AND BRULE CLAY BALLS, QUARTZ, CHALCEDONY, CALCICE LIMESTONE, AND CHERT. WASHING AND SCREENING WOULD BE NECESSARY TO RENDER THE MATERIAL SUITABLE FOR GOOD CONCRETE AGGREGATE AND ADEQUATE ROAD METAL.

THE ESTIMATED VOLUMES OF SAND AND GRAVEL FOR THE LARGEST TERRACES ARE AS FOLLOWS:

TABLE I

SECTION	LOCATION	T. N.	R. E.	ACRES	AVERAGE THICKNESS	CUBIC YARDS
31, 32	17	4	122	8'	1,574,613	
21, 28	16	4	52	7'	589,512	
14, 15	16	4	48	5'	343,790	
13, 14	15	4	36	5'	343,625	
16	15	5	30	5'	242,000	
33	17	4	30	5'	242,000	

URANIUM

URANIUM CLAIMS HAVE BEEN STAKED IN THE EAST SHORT PINE HILLS AND LONE MOUNTAIN AREAS. THE AUTHOR SAMPLED MANY VALIDATION PITS AND OUTCROPS. A FOUR-INCH-THICK COAL, NEAR THE TOP OF THE HELL CREEK FORMATION IN SEC. 13, T. 17 N., R. 3 E., WAS ASSAYED RADIOMETRICALLY AND FOUND TO CONTAIN 0.20 PERCENT URANIUM EQUIVALENT. NO CHEMICAL ASSAY WAS MADE. THIS THIN COAL IS VERY LOCAL. SEVERAL THIN HELL CREEK PEAT-CLAYS, LOCATED JUST NORTH OF LONE MOUNTAIN IN SEC. 8, T. 16 E., R. 4 E., ARE RADIOACTIVE; HOWEVER, RADIOMETRIC TESTS GAVE NON-COMMERCIAL RESULTS. URANIUM MAY EXIST IN COMMERCIAL QUANTITIES IN THE EAST SHORT PINE HILLS AND LONE MOUNTAIN AREAS.

ORTHOQUARTZITE AND SANDSTONE

LOCALLY ABUNDANT ORTHOQUARTZITE BOULDERS OF EXCEPTIONAL HARDNESS OCCUR IN SEC. 14, T. 16 N., R. 3 E. THESE BOULDERS MAY BE USED FOR FOUNDATION WORK.

THE ARIKAREE (?) OR OGALLALA (?) SILICA-CEMENTED SANDSTONE AND SEVERAL HELL CREEK SANDSTONE ARE EXCELLENT SOURCES OF BLOCK OR BUILDING STONE AND RIPRAP FOR DAMS.

CLAY

THE PIERRE FORMATION AND CERTAIN BENTONITIC CLAY BEDS IN THE HELL CREEK, CHADRON, AND BRULE FORMATIONS CAN BE USED TO LINE OR SEAL STOCK DAMS. THE PIERRE CLAY MIGHT PROVE TO BE AN ACCEPTABLE RAW MATERIAL FOR THE MANUFACTURE OF LIGHT-WEIGHT AGGREGATE.