

# AREAL GEOLOGY OF THE MURCHISON QUADRANGLE

STATE OF SOUTH DAKOTA  
JOE FOSS, GOVERNOR

STATE GEOLOGICAL SURVEY  
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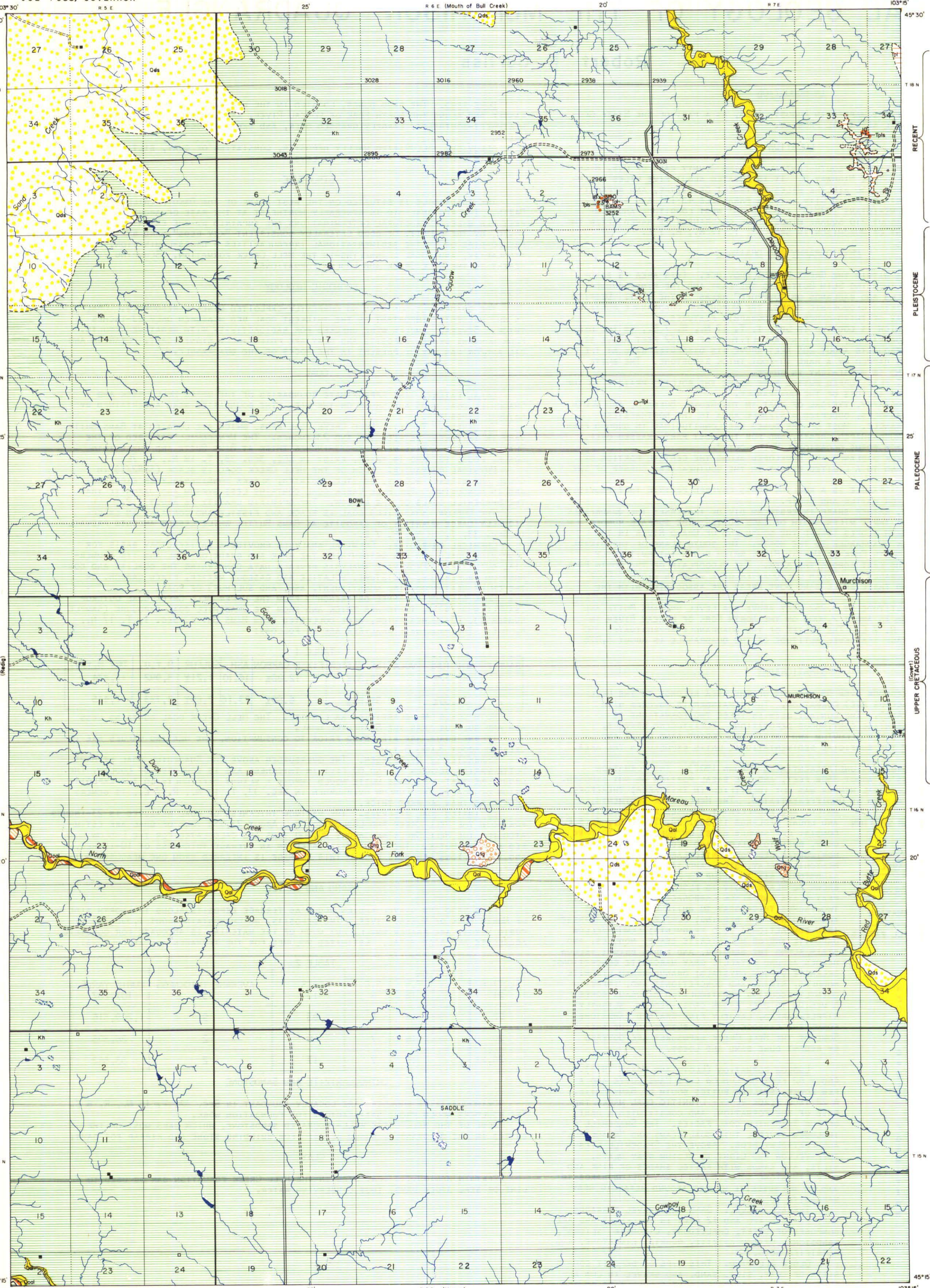
EXPLANATION

**SEDIMENTARY ROCKS**

- Qal**  
**Alluvium**  
(Recent valley-bottom deposits of clay, silt, sand, and gravel in present streams.)
- Qds**  
**Dune Sand**  
(Rounded, grassed longitudinal dunes with occasional "blowouts" and composed of fine- to medium-grained quartz sand. Up to 40' relief.)
- Qol**  
**Older Alluvium**  
(Older alluvial deposits above present floodplains of recent streams.)
- Q1g**  
**Terrace Gravel**  
(Terrace deposits of sand and gravel. 1 to 12' thick.)
- Q1p**  
**Ludlow Formation**  
(Orange-brown, lichen-surfaced, fine- to medium-grained, cross-bedded, jointed calcareous sandstone; buff to yellow and gray to cream clays, silts, and sands with brown limonite nodules, pink limestone nodules, and jarosite and/or melanterite haloes around marcosite nodules in sand. Tpls - Shadehill coal facies: several thin coals up to 23" thick with associated peat-clays, "blackjacks", gypsum, and melanterite and/or jarosite. Middle and upper portion of formation missing. About 62' exposed on Bams Butte.)
- Kh**  
**Hell Creek Formation Undifferentiated**  
("Somber beds" of lenticular interbeds of medium to dark gray bentonitic clays, silts (part loess), and sands (dune and channel), buff to yellow cross-bedded butte-capping sandstones; up to six thin 4- to 23 inch thick sooty to blocky black coal beds in the upper 60-70' interval at Bams Butte; and, peat-clays, "blackjacks", calciche seams, jarosite and/or melanterite haloes encircling marcosite nodules, and unarticulated dinosaur bones. Lower portion not exposed. About 300' exposed.)

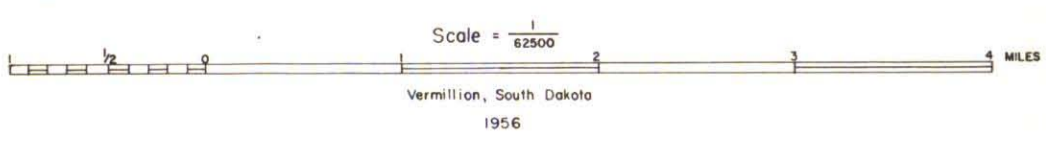
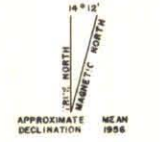
- DRAINAGE**
- Intermittent Streams**
  - Intermittent Lakes**
- CULTURE**
- Buildings**  
(House, church, and school)
  - Roads and Trails**
  - Altitudes**  
(In feet above sea level)
  - BAMS**
- Triangulation Stations**  
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location.)
- Operating**
  - Abandoned**
- Coal mines and Gravel pits**
- x 36"**
  - Coal Thickness (Exposed)**
  - 2323 Top Hole**  
**Altitude**  
**36 Overburden**  
**2 Thickness**
  - Drill Holes**

- RECENT**
- PLEISTOCENE**
- PALEOCENE**
- UPPER CRETACEOUS (Lower)**
- CRETACEOUS**

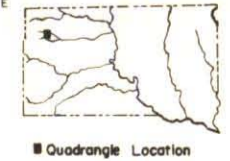


Geology by R.E. Curtis  
Assisted by C.E. Dodson, Jr.  
Surveyed in 1955. Drafted by F.V. Steece

Base Map by South Dakota State Geological Survey



Vermillion, South Dakota  
1956



(Hoover)

# AREAL GEOLOGY OF THE MURCHISON QUADRANGLE

By  
Robert E. Curtiss

## INTRODUCTION

THE QUADRANGLE WAS MAPPED IN AUGUST, 1955, AS A PART OF THE STATE GEOLOGICAL SURVEY'S COAL APPRAISAL PROGRAM.

## LOCATION

THE QUADRANGLE LIES IN SOUTH-CENTRAL HARDING COUNTY EAST OF U.S. HIGHWAY 85 AND SOUTH OF STATE HIGHWAY 8. IT IS LOCATED ABOUT FIVE MILES SOUTHWEST OF BUFFALO, ABOUT 156 AIRLINE MILES NORTHWEST OF PIERRE, AND APPROXIMATELY 88 MILES NORTH OF RAPID CITY BETWEEN PARALLELS 45°15' AND 45°30' NORTH LATITUDE AND MERIDIANS 103°15' AND 103°30' WEST LONGITUDE AND COMPRIZES AN AREA OF ABOUT 210 SQUARE MILES. THE QUADRANGLE IS NAMED AFTER THE ABANDONED SETTLEMENT OF MURCHISON IN SEC. 33, T. 17 N., R. 7 E.

## PHYSIOGRAPHY AND DRAINAGE

THIS AREA LIES WITHIN THE GREAT PLAINS PROVINCE. THIS AREA IS SANDWICHED BETWEEN THE IMPOSING SLIM BUTTES TO THE EAST AND THE PINE-STUDDED EAST SHORT PINE HILLS AND BADLANDS OR "JUMPOFF" AREAS TO THE WEST. DESPITE THE PAUCITY OF STRIKING GEOMORPHIC FORMS, THE MURCHISON QUADRANGLE CONTAINS AN INTERESTING ARRAY OF THIRD-ORDER PHYSIOGRAPHIC FEATURES.

BAMS BUTTE, WHICH IS LOCATED IN SEC. 1, T. 17 N., R. 7 E., IS THE HIGHEST POINT IN THE QUADRANGLE, ATTAINING AN ALTITUDE OF 3,252 FEET ABOVE SEA LEVEL. THE BUTTE PROJECTS ABOUT 285 FEET ABOVE ITS DISSECTED BASE AT THE WEST END, AND IT IS CAPPED BY A HARD 10-FOOT THICK SANDSTONE. THE BUTTE TRENDS EAST-WEST AND IS WEDGE-TENT IN SHAPE.

SMALL CONICAL, FLAT-TOPPED BUTTES RISE ABOVE THE ROLLING PRAIRIE IN THE SOUTHERN AND EASTERN SECTORS OF THE QUADRANGLE.

DUNE SAND TOPOGRAPHY, TYPICAL OF THAT IN THE REDIG, BUFFALO, AND MOUTH OF BULL CREEK QUADRANGLES, OCCUPIES A SIZABLE AREA IN THE NORTHWESTERN CORNER OF THE QUADRANGLE. MOST OF THE DUNES ARE LONGITUDINAL IN GROUND PLAN WITH ROUNDED OR OGHURD-SHAPED CRESTS, AND FOR THE MOST PART GRASSSED OVER, ALTHOUGH WIND EROSION FORMS OCCASIONAL "BLOW-OUTS".

LOCAL HELL CREEK BADLANDS ARE DEVELOPED ALONG THE CENTRAL PORTION OF THE WEST BOUNDARY AND TO A LIMITED EXTENT IN THE SOUTHEASTERN CORNER OF THE MAPPED AREA.

MOST OF THE QUADRANGLE IS A ROLLING GRASS-COVERED PRAIRIE THAT PROVIDES EXCELLENT GRAZING FOR CATTLE AND SHEEP.

ONE PROMINENT, RATHER SHARP INTERSTREAM DIVIDE TRAVERSES THE QUADRANGLE EAST AND WEST ABOUT THREE MILES SOUTH OF BAMS BUTTE. THE SURFACE RUNOFF DRAINS FROM THE NORTH SLOPES TOWARD THE SOUTH END OF GRAND RIVER IN THE MOUTH OF BULL CREEK QUADRANGLE TO THE NORTH. THE SOUTH FLANK OF THE DIVIDE IS DRAINED BY THE NORTH FORK OF MOREAU RIVER WHICH FLOWS INTERMITTENTLY FROM THE WEST TO THE EAST ACROSS THE AREA. THE FLOODPLAIN OF THE NORTH FORK OF MOREAU RIVER AVERAGES LESS THAN ONE-QUARTER OF A MILE IN WIDTH. FOUR GRAVEL TERRACES AND THREE SMALL SAND DUNE AREAS ARE ASSOCIATED WITH THE RIVER.

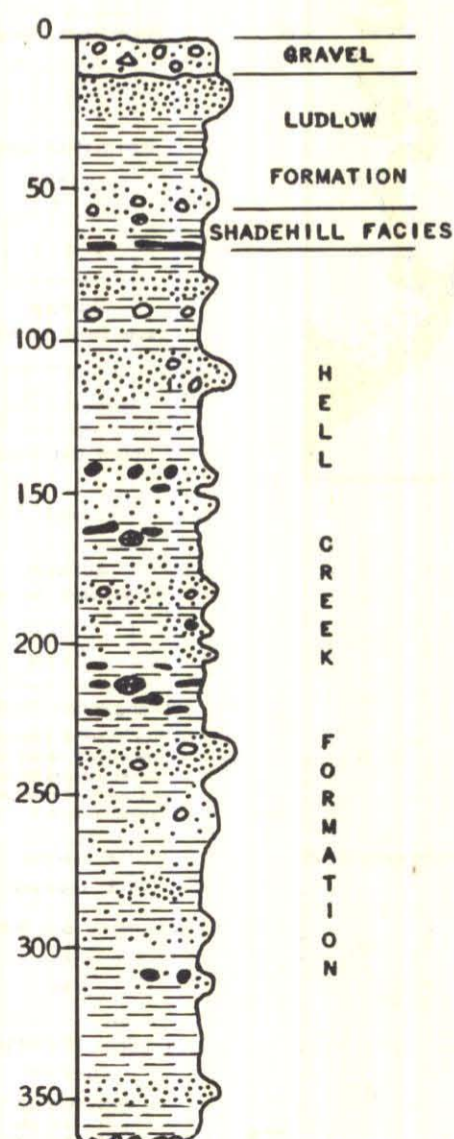
THE MAXIMUM ALTITUDE IS 3,252 FEET ABOVE SEA LEVEL ON BAMS BUTTE AND THE LOWEST ALTITUDE IS ABOUT 2,900 FEET ON THE NORTH FORK OF MOREAU RIVER IN SEC. 34, T. 16 N., R. 7 E. THE RELIEF OF THE QUADRANGLE APPROXIMATES 350 FEET, AND THE AVERAGE SEA LEVEL ALTITUDE OF THE QUADRANGLE IS ABOUT 3,076 FEET.

## STRATIGRAPHY

THE SURFACE BEDROCK OVER 95 PERCENT OF THE AREA BELONGS TO THE HELL CREEK (UPPER CRETACEOUS AGE) FORMATION. THE REMAINDER IS COVERED WITH LUDLOW (PALEOCENE AGE). THE CONTACT BETWEEN THESE TWO FORMATIONS IS CONFORMABLE, REPRESENTING CONTINUOUS DEPOSITION. PLEISTOCENE GRAVELS, PLEISTOCENE-RECENT OLDER ALLUVIUM AND LOESS, AND RECENT SAND DUNES AND ALLUVIUM REPRESENT THE SURFICIAL SEDIMENTATIONAL UNITS EXPOSED IN THE AREA.

**HELL CREEK FORMATION UNDIFFERENTIATED** (BROWN 1907). THE FORMATION ATTAINS A THICKNESS OF ABOUT 350 FEET, AND THE BASAL PORTION IS NOT EXPOSED. THE ISABEL-FIRESTEEL COAL MEMBER WAS NOT IDENTIFIED IN THIS AREA; THEREFORE, THE FORMATION WAS MAPPED AS UNDIFFERENTIATED. THE HELL CREEK SEDIMENTS, WHICH ARE EXCELLENTLY EXPOSED AT BAMS BUTTE AND LOCAL BADLANDS IN SEC. 22, T. 17 N., R. 5 E., CONSIST OF "SOMBER BEDS" OF DULL LIGHT TO DARK GRAY, BUFF TO YELLOW, AND MEDIUM TO DARK BROWN HORIZONTAL BEDS OF LENTICULAR ADMIXTURES OF BENTONITIC CLAY, SILT, AND SAND; SILTSTONE AND SANDSTONE, SIX THIN (UP TO 23-INCHES THICK), BROWN TO BLACK SOOTY TO BLOCKY COALS; BROWN PEAT-CLAYS AND BLACK CARBONACEOUS CLAYS; ABOUT TWO-INCHES THICK GRAY TO WHITE CALICHE SEAMS ALONG JOINTS AND BEDDING; PURPLE-BLACK MANGANESE-IRON CONCRETIONS; WOOD FRAGMENTS; LEMON-YELLOW JAROSITE AND/OR MELANTERITE SEAMS, NODULES, AND STAIN ALONG THE BEDDING, AND FORMS BRIGHT YELLOW HALOES AROUND METALLIC GRAY MARCASITE CONCRETIONS; SELENITE GYPSUM CRYSTALS; ORANGE-BROWN LIMONITE NODULES, STAIN, AND CONCRETIONS; AND, INFREQUENTLY OCCURRING UNARTICULATED DINOSAUR BONES. A MEDIUM TO DARK BROWN CROSS-BEDDED, SLIGHTLY RIPPLE-MARKED, LARGELY FINE-GRAINED SANDSTONE FORMS THE CAPROCK OF MANY BUTTES IN THE AREA. SOME OF THE HELL CREEK EXPOSURES ARE COVERED BY RECENT DUNE SAND AND LOESS.

## GENERALIZED COLUMNAR SECTION



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**LUDLOW FORMATION** (LLOYD AND HARES 1915). ABOUT 62 FEET OF LUDLOW CAPS BAMS BUTTE AND A FEW LOWER, SMALLER BUTTES SOUTH OF BAMS BUTTE. A 23-INCH BLACK BLOCKY LIGNITIC COAL MARKS THE BASE OF THE FORMATION, AND CONSTITUTES A PART OF THE SHADEHILL COAL FACIES. THE SHADEHILL INCLUDES SEVERAL THIN COAL SEAMS AND "BLACKJACK" AND PEAT-CLAY BEDS. ABOVE THE SHADEHILL LIES BUFF-YELLOW AND LIGHT TO MEDIUM GRAY CLAYS, SILTS, AND SANDS WITH PASTEL SHADES OF PINK AND BUFF LIMESTONE NODULES AND LEMON-YELLOW JAROSITE AND/OR MELANTERITE HALOES AROUND METALLIC GRAY MARCASITE NODULES.

**TERRACE GRAVEL.** SAND AND GRAVEL TERRACES VARY BETWEEN TWO AND 12 FEET IN THICKNESS AND ARE COMPOSED OF CHERT, CHALCEDONY, LIMONITE "SLICKS", SANDSTONE, ORTHOQUARTZITE, QUARTZ, LIMESTONE, AND PETRIFIED WOOD.

**OLDER ALLUVIUM.** THIS TYPE OF DEPOSIT CONSISTS OF CLAY, SILT, SAND, AND GRAVEL IN LOW ALLUVIAL TERRACES ABOVE PRESENT FLOODPLAINS OF RECENT STREAMS.

**DUNE SAND.** THE SAND DUNES, LOCATED IN THE NORTHWEST CORNER OF THE QUADRANGLE AND ALONG THE NORTH FORK OF MOREAU RIVER, ARE LONGITUDINAL, TRENDING NORTHWEST-SOUTHEAST, LARGELY GRASSSED OVER, AND EXHIBIT OCCASIONAL "BLOWOUT" AREAS.

**ALLUVIUM.** ALLUVIATED VALLEY DEPOSITS, CONSISTING OF CLAY, SILT, SAND, AND GRAVEL IN RECENT RIVER AND CREEK VALLEYS.

## STRUCTURE

THE QUADRANGLE IS SITUATED ON THE WEST FLANK OF THE DAKOTA (WILLISTON) BASIN. THE REGIONAL DIP IS GENERALLY NORTHEAST AT THE RATE OF ABOUT 20 TO 40 FEET PER MILE. STRUCTURAL DETERMINATIONS ARE IMPAIRED BY THE EXTENSIVE GRASS COVER, BY THE PAUCITY OF GOOD LATERALLY CONSISTENT "KEY BEDS", AND BY THE PSEUDO-DIPS OR BY THE SEDIMENTATIONAL IRREGULARITIES - CROSS-LAMINATION, LENTICULARITY, AND LOCAL CHANNELLING-IN THE HELL CREEK FORMATION. SLUMPING IS INHERENT TO THE HELL CREEK AND LUDLOW FORMATIONS.

## ECONOMIC GEOLOGY

THE QUADRANGLE CONTAINS NO CURRENTLY-EXPLOITED MINERAL RESOURCES. COAL IS NOT PRESENTLY IMPORTANT AS THE THICKEST COAL BED MEASURED ONLY 23-INCHES THICK. SEVERAL SAMPLES WERE CHECKED FOR RADIOACTIVITY WITH NEGATIVE RESULTS. FOUR DORMANT GRAVEL DEPOSITS AND CLAY ARE POTENTIALLY SIGNIFICANT. URANIUM AND OIL AND/OR GAS MAY BE PRESENT IN THE ROCKS OF THE QUADRANGLE.

## COAL

**AREAL EXTENT.** THE APPROXIMATE BOUNDARIES OF THE UPPER HELL CREEK AND SHADEHILL COAL BEDS ARE SHOWN ON THE MAP. THE BOUNDARIES WERE ASCERTAINED BY NATURAL EXPOSURES.

**THICKNESS.** THE FIVE HELL CREEK COAL BEDS, WHICH ARE LOCATED AT BAMS BUTTE VARY IN THICKNESS BETWEEN TWO AND 23-INCHES. THE MENDENHALL COAL BED OF THE SHADEHILL COAL FACIES MEASURED 23-INCHES THICK AT BAMS BUTTE AND THREE THIN COALS, FOUR, 10, AND 14 THICK, EXIST IN SE $\frac{1}{2}$ , SEC. 33, T. 18 N., R. 7 E.

**PHYSICAL CHARACTER.** MUCH OF THE HELL CREEK COAL IS BLACK (5YR2/1) IN COLOR AND STREAK, BLOCKY, BRITTLE, JOINTED, SLACKS CONSIDERABLY ON EXPOSURE, AND IS NONCOKING. THE HELL CREEK COAL CONTAINS LESS GYPSUM AND JAROSITE THAN THE SHADEHILL COALS OF THE LUDLOW. THE SPECIFIC GRAVITY IS ABOUT 1.2.

THE LUDLOW (SHADEHILL) COAL IS BLACK AND FISSILE AND CONTAINS AN EXCEPTIONALLY LARGE QUANTITY OF JAROSITE AT BAMS BUTTE, WHILE LESSER AMOUNTS PREVAIL IN SEC. 33, T. 18 N., R. 7 E.

**CHEMICAL CHARACTER.** CHEMICAL ANALYSES PROVIDE A SATISFACTORY BASIS FOR COMPARING COALS AND FOR DETERMINING THE RANK AND GRADE OF COAL AND ITS COMMERCIAL QUALITIES. PROXIMATE ANALYSIS REVEALS DATA CONCERNING THE QUALITY AND COMBUSTION PROPERTIES, (MOISTURE, VOLATILE AND GASEOUS MATTER, FIXED CARBON, OR THE CHIEF HEAT-PRODUCING CONSTITUENT, ASH, AND SULPHUR) OF COAL.

COAL SAMPLES (CHANNEL OR "TRENCH") FROM THE UPPER HELL CREEK COAL OUTCROP (SAMPLE NUMBER 1), 18-INCHES THICK AND FROM THE SHADEHILL COAL EXPOSURE (SAMPLE NUMBER 2), 23-INCHES THICK, WERE COLLECTED FROM BAMS BUTTE, SEC. 1, T. 17 N., R. 6 E. THE PROXIMATE ANALYSES ARE AS FOLLOWS:

TABLE 1

SAMPLE	MOISTURE	VOLATILE MATTER	FIXED CARBON	ASH	SULFUR	B.T.U.	DRY B.T.U.
1	42.22%	28.80%	12.88%	16.10	1.21%	3,992	11,274
2	31.60%	38.35%	6.89%	23.16	2.69%	3,733	7,415

BOTH COALS ARE CLASSIFIED AS LIGNITE. THE HELL CREEK COAL CONTAINS LESS ASH AND SULPHUR THAN THE SHADEHILL COAL.

IF THE COALS ARE AIR DRIED PRIOR TO CONSUMPTION, THE HEATING VALUES ARE INCREASED ABOUT 3,000 B.T.U.

**CHARACTER OF OVERBURDEN.** THE OVERBURDEN ABOVE THE SHADEHILL COAL AT BAMS BUTTE VARIES BETWEEN 50 AND 60 FEET IN THICKNESS AND IS COMPOSED OF LUDLOW. THE SANDSTONE THAT CAPS BAMS BUTTE WOULD IMPOSE A SLIGHT DIFFICULTY TO THE EXPLOITATION OF COAL. THE LUDLOW OVERBURDEN IN SEC. 33, T. 18 N., R. 7 E., IS GENERALLY LESS THAN 50 FEET THICK.

**ESTIMATED COAL RESERVES.** THE MAXIMUM THICKNESS OF COAL MEASURED IS 23-INCHES FOR BOTH THE HELL CREEK AND LUDLOW COALS. ABOUT 22,950 TONS OF COAL ARE ESTIMATED FOR THE HELL CREEK AND ABOUT 20,400 TONS ARE CALCULATED FOR THE LUDLOW COAL BED AT BAMS BUTTE. THE TONNAGE IS BASED ON AN AVERAGE THICKNESS OF 18-INCHES, AND, 1,700 TONS PER ACRE FOOT. THIS TONNAGE IS INFERRED FROM ONE MEASURED OUTCROP.

## SAND AND GRAVEL

FOUR SAND AND GRAVEL BODIES OCCUR AS TERRACE DEPOSITS ALONG THE NORTH SIDE OF NORTH FORK OF MOREAU RIVER. THE DEPOSITS, WHICH CONTAIN ABOUT 1,398,760 CUBIC YARDS, ARE RATHER SMALL, BUT MUCH OF THE MATERIAL IS ADEQUATE FOR CONCRETE AGGREGATE AND ROAD METAL. ESTIMATED VOLUMES FOR THE TERRACES ARE AS FOLLOWS:

TABLE 2

SECTION	LOCATION		ACRES	AVERAGE THICKNESS	CUBIC YARDS
	T.N.	R.E.			
21	16	6	13	5	107,287
22	16	6	83	9	1,209,516
20	16	7	9	2	28,395
20,21	16	7	17	2	53,562

## ORTHOQUARTZITE AND SANDSTONE

ORTHOQUARTZITE BOULDERS ARE LOCALLY ABUNDANT IN SEC. 32, T. 16 N., R. 6 E. THE BOULDERS WOULD PROVE SATISFACTORY FOR FOUNDATION WORK.

SOME OF THE HELL CREEK WELL-INDURATED SANDSTONE, WHICH CAPS MOST OF THE BUTTES IN THE QUADRANGLE, COULD BE USED FOR BUILDING STONE AND RIPRAP FOR DAMS.

## CLAY

CERTAIN BENTONITIC CLAY BEDS IN THE HELL CREEK FORMATION CAN BE USED TO LINE OR SEAL STOCK DAMS, THUS CONSERVING WATER.