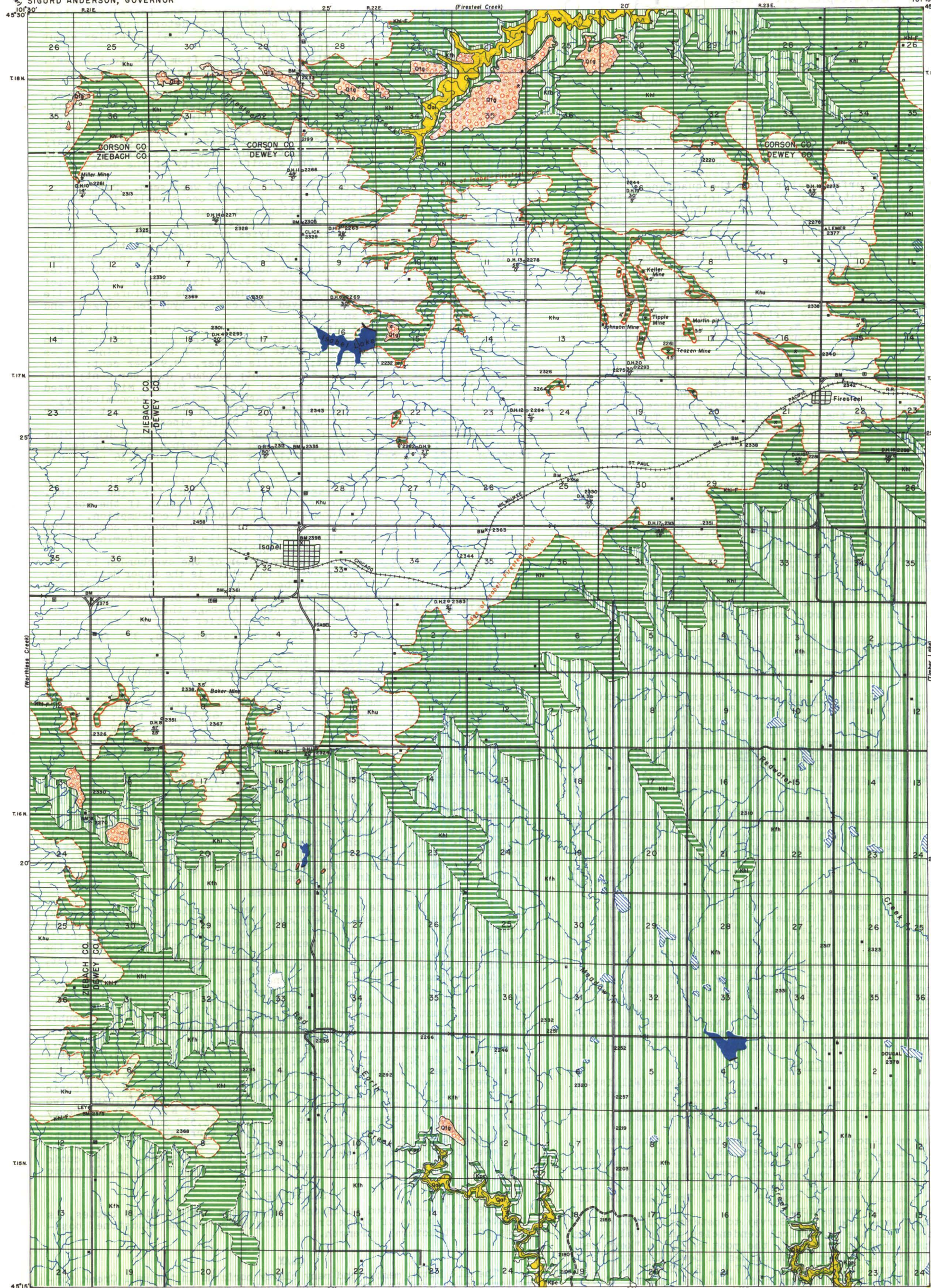
AREAL GEOLOGY
OF THE
ISABEL QUADRANGLE

STATE OF SOUTH DAKOTA
SIGURD ANDERSON, GOVERNOR

STATE GEOLOGICAL SURVEY
E. P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

RECENT

Qal — Alluvium
(Valley-bottom deposits of clay, silt, sand, and gravel in present streams.)

PLEISTOCENE — Wisconsin?

Qtg — Terrace Gravel
(Terrace deposits, heterogeneous mixtures, largely sand and gravel, abundant limonitic pebbles. 1'-12' thick)

CRETACEOUS

UPPER CRETACEOUS

Hell Creek Formation

Khu — Upper Hell Creek
(Somber beds of lens-like bentonitic clays, silts, part loess, sands, and peat-clays. Mn-Fe concretions. Local badlands. Few butte-top sandstones. Colluvium or slopewash in barren-slope areas. Residual, brown orthoquartzite boulders and silicified wood of Tertiary age scattered on surface. Upper part missing. About 135-160' thick.)

Khi-f — Isabel–Firesteel Coal Member
(Black lignite and subbituminous coal, 0'-6' thick, often carrys "black jack," a carbonaceous clay, as partings in coal or super- and/or subjacent positions. Three brown clay-peat beds generally with coal. Pseudoscoria, a buff to red burned claystone, often hill-forming. Gray to white coal ashes often found below pseudoscoria.)

Khl — Lower Hell Creek
(Medium to dark gray lens-like bentonitic clays, silts, part loess, sands, thin peat-clay beds. Mn-Fe concretions. Few Ostrea biostromes, occasional dinosaur (Trachodon or Triceratops?) bones. 40'-70' thick.)

Fox Hills Formation

Kfh — Fox Hills Undifferentiated
(General absence of sufficient outcrop data preludes subdivision: Trail City, Timber Lake, Banded, and Colgate members. Upper lithofacies: light gray sandstone weathers buff, hard, gray silicified sandstone caps prominent buttes, in part fossiliferous. Lower lithofacies: buff-yellow sand (Timber Lake member); banded, alternating sandstones, sands, silts, bentonitic clays, fossiliferous concretions carry part of Fox Hills mollusc an fauna (Trail City member) about 175-200 thick.)

Pierre Formation

Kpe — Elk Butte Member
(Flaky, bluish gray silty bentonitic clay, cone-in-cone concretions, few, thin iron-stained bentonites, selenite gypsum crystals at top. 114 exposed.)

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.)

▲ RENA — Triangulation Stations
(Monuments marking points of exact geographic location.)

Coal mines and Gravel pits
☆ Operating
☆ Abandoned

⊙ D.H. 7 — Number
36' — Overburden
2' — Thickness of coal
Drill Holes

Geology by R. E. Curtiss
Assisted by A. K. Staley, J. L. Bartling and M. F. Nielsen
Surveyed in 1951 Drawn by L. G. Stillwell

Based on triangulation and first order leveling by U.S. Coast and Geodetic Survey

TRUE NORTH
MAGNETIC NORTH
APPROXIMATE MEAN DECLINATION 1950

Scale 1/62500
0 1 2 3 4 Miles

1952

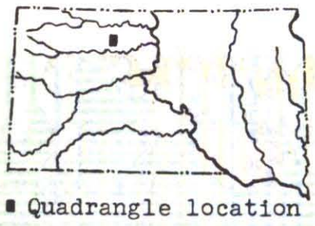
AREAL GEOLOGY OF THE ISABEL QUADRANGLE

by

Robert E. Curtiss

LOCATION

The quadrangle, which occupies portions of Corson, Dewey, and Ziebach Counties, is located approximately 40 miles west of the City of Mobridge and about 90 miles northwest of Pierre between parallels 45°15' and 45°30' north latitude and meridians 101°15' and 101°30' west longitude and comprises an area of about 211 square miles.



■ Quadrangle location

TOPOGRAPHY AND DRAINAGE

One prominent topographic feature is the Moreau-Grand interstream divide. It forms a sharp line of demarcation between the intermittent streams flowing north to the Grand River, and those which drain the south slopes toward the Moreau River.

The Grand River, which is located 12 miles north of this area, and the Moreau River, which is four miles to the south, are the master streams which receive the surface water from the quadrangle. Youthful, sharply-cut, intermittent stream channels intricately fringe the interstream divide. The drainage pattern is dendritic. Springs are commonly associated with coal outcrops.

Coal outcrops occur in stream valleys both to the north and south of the interstream divide. Most mining has been done along the outcrop where the overburden is the thinnest. The overburden is generally the thickest in the interstream divide.

The maximum altitude in the quadrangle is 2,458 feet above sea level on a ridge of upper Hell Creek clayey sand in SW¼, SE¼, Sec. 30, T. 17 N., R. 22 E., Dewey County. The minimum altitude is 1,994 feet above sea level in the channel of Red Earth Creek on the Elk Butte member in SW¼, NW¼, Sec. 19, T. 15 N., R. 23 E. The relief is about 464 feet, and the average altitude is about 2,226 feet above sea level.

STRATIGRAPHY

The surface formations range in age from Upper Cretaceous to Recent. The only completely exposed formation is the Fox Hills whose boundaries with the underlying Pierre formation and overlying Hell Creek are conformable. The exposed stratigraphic sequence represents continuous deposition through the Hell Creek formation. Tertiary residuum from the Tongue River formation of the Paleocene series, Pleistocene gravels, Pleistocene-Recent loess, and Recent alluvium complete the outcropping sediments in the area.

Elk Butte member, Pierre formation. About 114 feet of the upper portion of the member is exposed. It consists of dark gray, shale-like bentonitic clay in the middle and lower sections. However, the upper part grades into silty bentonitic clay. The clay breaks into polygonal chips which weather to gumbo, and the dry weathered surfaces reveal a "popcorn" appearance. Disseminated bentonite occurs throughout the member. Cone-in-cone structures, melanterite, ironstone concretions, and "nailhead" gypsum crystals are present.

Trail City member, Fox Hills formation. The member varies in thickness from 50-90 feet. The transition interval, between the Elk Butte and Trail City member, is composed of medium gray bentonitic clayey silt and is arbitrarily placed at the base of the Fox Hills formation. The lower part of the member consists of buff to light gray sandy bentonitic clayey silt and limonitic and fossiliferous concretions, containing 30 molluscan species.

Timber Lake sandstone member, Fox Hills formation. The member, 26 to 56 feet thick, is composed of gray, friable, moderately cross-laminated glauconite-quartz sandstone and unconsolidated sand, with shaly, flaggy, and massive bedding, intercalated streaks of limonite, gypsum, and plant matter.

"Banded" member, Fox Hills formation. An incomplete section of 93½ feet was measured. The member consists of an alternating series of buff-gray sands and silts with thin intercalated beds of silty and sandy bentonitic clays, and bentonitic clayey silts and sands with thin layers of brown plant matter. No invertebrate fossils were noted.

Colgate sandstone member, Fox Hills formation. The thickness ranges from one to 15 feet. The silica- and calcareous-cemented high-rank graywacke sandstones are medium gray in color, shaly to flaggy bedding, sparingly fossiliferous, with brown limonite stain and small fragments of silicified wood.

Lower Hell Creek, Hell Creek formation. This unit, which varies between 40 and 70 feet thick, is characterized by admixtures of medium gray sands, silts, and clays which weather light gray. The clays are composed largely of disseminated bentonite which are plastic and slippery when wet. Clay-peat beds are medium to dark brown, weakly indurated and compressed plant matter, containing minor amounts of clay and silt. Peat-clay beds contain more clay than plant matter. Dinosaur bones and Ostrea glabra, a pelecypod, occur uncommonly.

Isabel-Firesteel coal member, Hell Creek formation. The coal bed varies from zero to six feet in thickness. The coal often contains "blackjack", a tough carbonaceous clay, as partings in the coal, or in super-and/or subjacent positions. Pseudoscoria, a buff to red clinkered claystone, indicates the former presence of the coal. Ashes are frequently encountered directly beneath the pseudoscoria. Fossil resin, pyrite, marcasite, and limonite occur spasmodically in the coal.

Upper Hell Creek, Hell Creek formation. This unit, which ranges from 135 to 160 feet in thickness, is almost lithologically identical to the lower Hell Creek. However, pseudoscoria and ashes are absent, and fewer, thinner clay-peat beds were noted. Medium gray high-rank graywacke sandstones cap several small buttes. Black manganese-limonitic concretions are diagnostic of this unit and are locally abundant.

STRUCTURE

The quadrangle is located on the east flank of the Dakota(Williston) Basin. The direction of regional dip is generally northwest at a rate of about 10 to 25 feet per mile. The flank is not a structurally smooth surface or homocline, as gentle anticlines, synclines, and small faults exist.

One conspicuous small-scale system of anticlines and synclines was noted in the Johnson Mine, SW¼, NE¼, NW¼, Sec. 18, T. 17 N., R. 23 E., Dewey County. The axes of the folds apparently trend in a northeasternly direction at right angles to the regional dip. The crests of the anticlinal folds rise about 15 to 20 feet above the troughs of adjacent synclines. The dip of the beds averages from 5° to 10°. The folds die out and have no apparent surface expression.

Coal-test borings were made by the Survey to determine thicknesses of coal and overburden and the structural tendencies indicated by sea level altitudes established on the coal, the most reliable "key" bed. Structure contours indicate two small anticlines in Dewey County; Sec. 16, T. 17 N., R. 23 E., and Secs. 23, 24, T. 17 N., R. 22 E.

Small normal faults are not uncommon in the coal mines. Faults frequently displace the coal bed from several inches to about three feet. Slumping is characteristic of the Elk Butte member and the Hell Creek formation.

No mining difficulties have thus far resulted from structures associated with the coal. The problem of determining structures is complicated by a general absence of bedrock exposures, presence of erratic lenticularity of individual beds, and slumping.

ECONOMIC GEOLOGY

The quadrangle contains a variety of mineral resources, both of actual or currently-exploited and potential value. The most important actual resource is coal. Sand and gravel and sandstone are quarried periodically. Potential resources are coal by-products and bentonitic clay.

COAL

Areal extent. The approximate boundary of the Isabel-Firesteel coal bed is shown on the map. This boundary was determined by natural exposures, coal mines, and Survey drill holes. Coal underlies about 80 square miles of the quadrangle area.

Thickness. The coal varies in thickness from zero to six feet. The Isabel-Firesteel coal consists of one minable seam in this quadrangle.

Physical character. The coal is banded, black in color and streak, hard, brittle, smooth surfaced, vertically jointed or blocky, usually exhibits an iron stain along the bedding and joints, subrounded amber-colored resin pellets, minor amounts of gypsum, pyrite, and marcasite. The coal shows four alternating, visibly distinct varieties of primary coals--durain, fusain, vitrain, and clarain. The coal slacks moderately upon drying and is noncoking. The specific gravity of the coal varies between 1.20 and 1.25.

No splits in the Isabel-Firesteel coal bed were seen. Partings of black carbonaceous clay ("blackjack") are found occasionally in the coal or in super- and/or subjacent positions and range anywhere from a fraction of an inch to several inches in thickness.

Chemical character. Chemical analyses provide a satisfactory basis for comparing the coal with other coals and determining the rank and grade of coal and its commercial qualities. The proximate analysis furnishes necessary data concerning the quality and combustion properties of coal (moisture, volatile or gaseous matter, fixed carbon or the chief heat-producing constituent, ash, and sulphur). The moisture, volatile matter, and fixed carbon are resolved into carbon, hydrogen, oxygen, and nitrogen by the ultimate analysis.

Coal samples from six mines (Baker, Johnson, Keller, Martin, Miller, and Teazen) were analyzed as received, meaning the samples represent the coal as mined. The average proximate analysis for the six mines is as follows: moisture, 27.4 percent; volatile matter, 40.93 per cent; fixed carbon, 25.84 per cent; ash, 5.82 per cent; sulphur, 0.42 per cent; and, heating value (B. t. u.), 7,880. Coal from the Miller Mine analyzed 8,265 B.t.u. This coal contains little ash and sulphur. Economically,-the coal, when burned, leaves a light, fluffy ash which does not clinker and has no deleterious corrosive action on boiler pipes.

An ultimate analysis (as received) of a sample from the Johnson Mine revealed the following: hydrogen, 5.24 per cent; carbon 58.98 per cent;-nitrogen, 1.24 per cent; oxygen, 27.12 per cent; sulphur, 0.46 per cent; and, ash, 6.96 per cent.

Samples of coal from this area have been air dried, and the heating values were raised to an average of 9,238 B. t. u. for nine samples. Therefore, an increase in the heating value will result if the coal is allowed to air dry prior to domestic and industrial consumption.

The coal in this area has been called lignite. However, comparative chemical and physical characteristics of lignite and subbituminous coal indicate this coal may be classified subbituminous C rank.

Character of overburden. The character of the overburden is not a detriment to strip mining. The overburden, which is the upper Hell Creek, is composed chiefly of lenticular bentonitic clays, silts, sands, and soft, partly-indurated siltstones and sandstones. Dragline buckets and bulldozers easily remove the overburden. Average thicknesses of overburden are removed at the following mines; Miller Mine, 11½ feet; Baker Mine, 24½ feet; Johnson Mine, 32 feet; Teazen Mine, 37½ feet; and, Keller Mine, 38 feet.

Estimated Coal Reserves. The total estimated coal tonnage for the Isabel quadrangle is approximately 166,332,425 tons. Tonnage is computed on the basis of a minimum thickness of 2½ feet, a specific gravity of 1.25, and 1,700 tons per acre foot. The tonnage is further resolved into three categories; measured (coal reserves located within 0.5 miles from outcrops, strip mines, or drill holes), 62,324,825 tons; indicated (coal reserves located between 0.5 and 1.5 miles from outcrops, strip mines, or drill holes), 67,820,550 tons; and, inferred (coal reserves located more than 1.5 miles from outcrops, strip mines, or drill holes), 36,187,050 tons.

Potential Mining Areas. Favorable mining areas exist between the mines in the Firesteel area in Sec. 7,8,16,17,18,19,20,21, T. 17 N., R 23 E., and northeast of Isabel in the vicinity of several abandoned mines in Secs. 15,22,27, T. 17 N., R. 22 E.

Data from 20 Survey drill holes indicate two potential stripping areas. Four feet of coal underlies only 14 feet of overburden in Sec. 1, T. 17 N.,R. 21 E., Ziebach County, and five feet of coal underlies 30 feet of overburden in Sec. 6, T. 17 N., R. 22 E., Dewey County. Systematic detailed drilling is necessary in determining the exact quantities of coal and overburden in these areas.

SAND AND GRAVEL

Sand and gravel deposits occur as terraces along Firesteel Creek, Red Earth Creek, and near Isabel Lake. These deposits contain a large percentage of limonite which breaks fairly easily, but these materials are adequate for road metal. Terraces along Firesteel Creek are the largest in the quadrangle, with thicknesses ranging from zero to 12 feet, and offer the best possibilities for large-scale exploitation.

The estimated volumes of sand and gravel are as follows: Sec. 25, 26,34,35, T. 18 N., R. 22 E., Corson County, average thickness five feet, 205 acres, 1,653,666 cubic yards; Secs. 25,30,31,36, T. 18 N., R.22-23 E., Corson County, average thickness three feet, 64 acres, 309,760 cubic yards; Secs. 27,34, T. 18 N., R. 22 E., Corson County, average thickness three feet, 34 acres, 164,560 cubic yards; Sec. 33, T. 18 N., R. 22 E., Corson County, average thickness three feet, 26 acres, 125,840 cubic yards; Secs. 29,32,33, T. 18 N., R. 22 E., Corson County average thickness three feet, 23 acres,111,320 cubic yards; Sec. 19, T. 16 N., R. 21 E., Dewey County, average thickness two feet, 26 acres, 83,893 cubic yards; Sec. 13, T. 16 N., R. 21 E., Ziebach County, average thickness two feet, 22 acres, 70,987 cubic yards; Sec. 11, T. 15 N., R. 22 E., Dewey County, average thickness two feet, 20 acres, 64,533 cubic yards; Secs. 35,36, T. 18 N., R. 21 E., Corson County (two terraces), average thickness three feet, 12 acres, 58,080 cubic yards; Sec. 15, T. 17 N., R. 22 E., Dewey County, average thickness three feet, 12 acres, 58,080 cubic feet; and, several other small terraces averages less than 50,000 cubic yards.

SANDSTONE

The silica-cemented sandstone, which caps the Fox Hills buttes, is an excellent source of block or building stone as the sandstone possesses good structural strength.

CLAY

The Elk Butte member and many clayey horizons in the Hell Creek formation can be used to seal leaking stock dams, thus conserving water. The Elk Butte bentonitic clay has commercial possibilities for the manufacture of light-weight aggregate.