STATE OF SOUTH DAKOTA
George T. Mickelson, Governor

STATE GEOLOGICAL SURVEY
E. P. Rothrock, State Geologist

REPORT OF INVESTIGATIONS
No. 57

DEEP BORINGS OF WESTERN SOUTH DAKOTA

by

C. L. Baker

University of South Dakota
Vermillion, South Dakota
August, 1947
## ERRATA

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**PLATE 2**

FORMATION THICKNESS IN BORINGS
DEEP BORINGS OF WESTERN SOUTH DAKOTA

by

C. L. Baker

INTRODUCTION

During the last fifteen years about two dozen borings made in the State of South Dakota have reached into or penetrated Paleozoic rocks yielding much new information concerning sedimentary rocks not formerly known beneath the Dakota Basin and extending the knowledge of rock structure, particularly in the rocks beneath the Upper Cretaceous. With one exception—namely, the earliest drilled of these tests, the Gypsy Oil Company Hunter No. 1 in southeastern Pennington County—the holes drilled are in three rather circumscribed areas situated in central South Dakota and on the northern and southern ends of the Black Hills uplift in western South Dakota. The major and deeper part of the Dakota Basin in the northwestern one-fourth of the state has not yet been tested by any drilling.

Cuttings and cores from the tests have been studied and described under the binocular microscope supplemented in some cases by resistivity logs. Since nearly all formations penetrated above the Spearfish red beds cave greatly in the hole during drilling, results cannot be expected to be more than reasonably accurate, being subject necessarily to a considerable amount of individual interpretation.

SUMMARY OF RESULTS

One of the greater Paleozoic depositional basins of North America extended across South Dakota in a northwest-southeast direction. Its eastern margin was the southwestern end of the pre-Cambrian shield with rocks of that age outcropping in the eastern part of the state at present altitudes ranging from 1000 to 1500 feet above sea level. The southwestern margin of the Dakota Paleozoic basin was the northeast end of the Colorado land mass extending from the north end of the present Black Hills uplift south-southeastward to the Chadron or Cambridge arch some
60 to 100 miles east of the southwest corner of South Dakota; on the latter in southwest Shannon County, South Dakota, Pennsylvanian rocks rest directly upon pre-Cambrian and in a distance of 250 miles south-southeastward from the deep borings in Harding County more than 2000 feet of strata ranging from the base of the Middle Ordovician to the top of Mississippian, wedge out against the Colorado land mass. In central South Dakota (Stanley County) on the north flank of a prominent structural ridge plunging northwest, in the 10 miles distance between the Phillips Dakota No. 1 and Lang No. 1 borings, Paleozoic strata thin from 1565 to 200 feet, Ordovician and probably Upper Cambrian strata wedging out, the top of the pre-Cambrian ascending 1600 feet. Similarly from the Carter Dakota No. 1 in western Potter County southward 35 miles to Pierre the Paleozoic decreases from 1430 to probably about 150 feet, the pre-Cambrian ascending 1000 feet. In the southeast corner of South Dakota 372 feet of Middle and Lower Ordovician and Upper Cambrian and 263 feet of overlying Paleozoic, considered Devonian or partly Devonian and Silurian, are present between the pre-Cambrian and the base of the Cretaceous. No boring yet has penetrated the full succession of Paleozoic strata anywhere in the middle of the Dakota depositional basin of Paleozoic time.

The Dakota Paleozoic depositional basin is now the Dakota structural basin in which both Mesozoic and Paleozoic rocks have been downwarped. The greatest known structural relief in the state is two miles (10,500 feet) between outcropping St. Peter sandstone at 5,000 feet altitude in the northern Black Hills and its projection to beneath the trough of the structural basin halfway between the northwest corner of the state and Missouri River where it is estimated to descend to 5500 feet beneath sea level, on the assumption that there is no thickening of the Paleozoic section between western Harding County and the synclinal trough, a supposition which may not be correct. Northeastward down the flank of the Chadron arch from southwestern Shannon County (Amerada Red Eagle No. 1) 125 miles to southeastern Pennington County (Gypsy Hunter No. 1) the base of the Pennsylvanian Minnelusa formation descends 1865 feet, the top of the Dakota sandstone descending about 2000 feet in this distance. A west-northwest plunging arch extending from Chamberlain on Missouri River to northern Haakon County is shown by a lowering of the Dakota sandstone 800 feet between the two places; the crest of this arch dips only 100 feet in a distance of 75 miles between central Lyman and central Stanley counties. The general strike of the rocks from southeastern Pennington County to Campbell County on the Missouri River is northeast. Northward plunging synclines probably flank both sides of the north end of the Chadron arch.
Several unconformities exist in the sedimentary rock successions. There is one between lower Eocene Cenozoic and underlying strata. Another, marked by widespread overlap of the basal Cretaceous on older Mesozoic and Paleozoic, especially on the east flank of the Dakota Basin, lies at the base of the Dakota-Lakota series. The marine Sundance (basal Upper Jurassic) overlaps the underlying red beds on the east basin flank and extends to central South Dakota. The Pennsylvanian Minnelusa formation overlaps wedging out older Paleozoic on both east and west basin flanks. The lower Mississippian Madison (Pahasapa) limestone rests upon varying strata of Ordovician, upper Cambrian and pre-Cambrian age. There is evidence in the central part of the state that the Sioux quartzite area was uplifted at the close of Lower Ordovician (Beekmantown) time and was the source of the widespread St. Peter sandstone at the base of the Middle Ordovician which extends from central South Dakota to the Bighorn Mountains of Wyoming but is absent in the southern half of the Black Hills and to the south of them.

FORMATIONS ENCOUNTERED IN THE DEEP BORINGS

Approximate formation thicknesses in the various borings are shown in the accompanying table.

PRE-CAMBRIAN South of the Black Hills the top of the pre-Cambrian is granitoid or schistose rocks and in central South Dakota it is granite, diorite and quartz monzonite or granodiorite but higher up on the slope of the pre-Cambrian shield in southeastern South Dakota it is Sioux quartzite and argillite.

CAMBRIAN In the three borings farther down the slope of the pre-Cambrian shield in the center of the state is a member of green shale 100 to 125 feet thick, somewhat sandy, and in one hole based by a thin sandstone which may be Upper Cambrian. The Cambrian is absent in borings south of the Black Hills; its horizon is not reached elsewhere.

ORDOVICIAN The typical upper Mississippi Valley Beekmantown section of Oneota, Shakopee and New Richmond occurs in boring lower down the slope in central South Dakota, being overlapped farther up the slope by St. Peter sandstone. The St. Peter is present in all these borings except the Phillips Lang No. 1, the overlying total Paleozoic being there only 150 feet thick. The St. Peter is present in three borings in Harding County north of the Black Hills, in neither of which its full thickness was penetrated. It is there overlain by higher Ordovician, thickening northward 650 feet in Northern Ordinance Government No. 1 to 890 feet in State Royalty No. 1. The basal part of this higher section is

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green shale with small black phosphate nodules, in part sandy, 80 to 25 feet thick, of Decorah-Platteville (Black River) age, succeeded by dolomite and limestone containing a few higher Ordovician brachiopods. Part of this upper succession in the two northern wells may be Trenton, the upper part being likely Richmond. It is possible that part or all strata in the thin Whitewood outcropping in the Black Hills is Trenton, there being apparently conformable gradation upward from the Decorah-Platteville. Near Galena in the Black Hills the Whitewood rests directly upon St. Peter, the green shale being absent.

MISSISSIPPIAN The lower Mississippian Madison (Pahasapa) limestone wedges out on the Chadron uplift and eastward up the flanks of the west-northwest plunging arch of the pre-Cambrian shield in central South Dakota. It is thickest (500 to 650 feet) in the three Harding-County borings in the northwest, where it thickens northward. It is cavernous south of the Black Hills as it is on outcrop. In the western half of the Dakota Basin there is strong probability that the later Mississippian Big Snowy group is present, especially beneath Harding County. In the central basin (Gypsy Hunter No. 1) and in central South Dakota a second laterite or red bed may separate Minnelusa above from Big Snowy beneath, the line of division being at the top of 450 feet of strata in the Gypsy Hunter, leaving an upper 320 feet only as Minnelusa, while in the Phillips Dakota No. 1 boring in northern Stanley County 150 feet below the red bed might be considered to be Big Snowy and 435 feet above it to be Minnelusa.

For the present it appears best to assume that the presence of Big Snowy is doubtful except beneath northwestern South Dakota. In the state's central area Paleozoic rocks above mid-Ordovician are highly variable, probably having gaps and overlaps; only the two northern borings in Stanley County are known to penetrate anhydrite, either of the Minnelusa, Big Snowy or of some other formation.

PENNSYLVANIAN All Black Hills outcrop sections of Minnelusa are misleading since most of the carbonates and virtually all calcium sulphate have been dissolved, leading to very extensive solution collapse and thinning of 200 feet or more, leaving a residue mainly sandstone except for some thin limestones and dolomites in the basal third. A few miles east of outcrops, in the Rapid City Airport borings, most of the upper half of the Minnelusa appears to be anhydrite and the lower half carbonates with actually less sandstone than is present in nearest outcrops. Forty-five miles farther east, in Gypsy Hunter No. 1 boring, there would appear to be considerably more shale and siltstone, relative to carbonate rocks, in the lower half but the record is better than that of
the Rapid City Airport holes, because the lower Minnelusa section
was drilled with cable tools after caving Mesozoic was cased off.
There remains the possibility that this lower part may be Big
Snowy although bituminous and other shales are present in the
succession south of the Black Hills, both in outcrop and under-
ground, and underground in central South Dakota. Thickness of
so called Minnelusa is only 75 feet more in the Gypsy Hunter than
in the Rapid City Airport holes.

The thickest Minnelusa is on the southwest and south sides
of the Black Hills, nearer to source of sediments. In Provo
Ordnance No. 1 it amounts to 1035 feet, decreasing to 750 feet in
Amerada State Agricultural College No. 1. However, a plausible
interpretation of the succession in Amerada Red Eagle No. 1,
southwest Shannon County, is that the overlying Opeche red beds
have there increased to four times their usual thickness, leaving
only 570 feet of underlying Minnelusa, mainly carbonates and
anhydrite. In the Lance Creek oil field, Wyoming, these strata
are called Hartville and considered to be equivalent to Ten
Sleep and Amsden. It is possible that the red part of the Ams-
den is the basal laterite of the Minnelusa. This laterite occurs
at the base of the Minnelusa at all but one of the sections of
Black Hills outcrops made by the writer and appears likewise in
all the borings herein considered; it is the insoluble residue
from solution of underlying Madison limestone, produced under
warm, moist seasonal rainfall weathering. It contains Mesolobus
mesolobus and Chaetetes milleporaceous, diagnostic fossils of low
Pennsylvanian. Near the top of the Minnelusa in northern Black
Hills outcrops, vicinity of Beulah, Wyoming, associated with some
outcropping thin gypsum beds, is a nondescript brachiopod fauna
of either Pennsylvanian or Permian age.

RED BEDS Between the Minnelusa and lower Upper (Oxfordian)
Jurassic marine Sundance formation intervenes a succession of red
siltstone, sandstones, anhydrite and one limestone (Minnekahta)
the age or ages of which are unknown, geologic work for 75 years
having failed to yield diagnostic fossils. The lower division or
Opeche is generally about 100 feet thick and contains at least
one bed of calcium sulphate in southwestern Black Hills outcrops.
It is succeeded by thin Minnekahta limestone, generally between
30 to 50 feet thick, finely laminated or varied, light pinkish or
lavendar, in places magnesian, with Paleoniscid fishes and Esthe-
ria or Estheria--like brine shrimps, undoubtedly lacustral or
lagoonal, grading upwards into calcium sulphate in southwest
Black Hills outcrops and an excellent stratigraphic and struc-
tural datum plane for strata above the basal Minnelusa uncon-
formity; however, it does not extend as far east as central
South Dakota.
Overlying it is another red bed, the Spearfish, containing one or more anhydrite members. Gypsum outcrops in exposures of the red beds on the Black Hills flanks, probably because they are much less permeable than the sandstones and carbonates of the Minnelusa.

**MID-MESOZOIC** The Sundance is present at least as far east as the State's center, overlapping the lensing out red beds to the east. It is dominantly marine, characterized by glauconite pellets; it is bentonitic and contains one or more sandstone aquifers. At its top, south and southeast of the Black Hills, is a local sandstone, the Unkapa. Overlying is the Morrison formation, largely varicolored, sombre-hued bentonitic clays and bentonites but in places sandy, overlapped towards the center of the state by the Cretaceous.

**CRETACEOUS** The Cretaceous formations outcrop over most the Dakota Basin. All Lower and Middle Cretaceous with exception of uppermost Cenomanian appear to be absent. The Lakota, Fuson, Dakota (Fall River) and overlying Thermopolis (Skull Creek) shale are now referred to upper Cenomanian, the base of true upper Cretaceous being taken as the Muddy or Newcastle sandstone. The Dakota and Lakota are mainly sandstones, the Lakota being the coarser and locally containing fine pebbles. The Fuson is largely bentonitic clays and shales with some coal and sandstones. The Thermopolis or Skull Creek is a dark brownish to bluish shale, the coloring matter of which appears to be largely ferrous carbonate. The Minnewaste lens or wedge of chemically precipitated dolomite immediately above the Lakota in southeast Black Hills exposures becomes in descending order limestone, anhydrite and dolomite in the Amerada State Agricultural College boring in northeastern Fall River County. At the top of the Fuson, widespread underground, is an horizon of rhodochrosite or mangano-siderite pellets, medium sand grain in size. Flanking and overlapping upon the pre-Cambrian shield in central South Dakota are various sandstones of the Dakota-Lakota group and some higher ones. True shales in the Upper Cretaceous are confined to the succession below the top of the Sharon Springs basal member of the Pierre.

The bulkiest ingredient of Upper Cretaceous strata is bentonite, sodium bentonite in rocks of Benton and Niobrara age (Colorado group) and calcium bentonite in Pierre, Fox Hills and Lance. The bentonite occurs both in thin pure beds and as admixtures in all the other strata; hence nearly all strata above the red beds cave in drill holes. The Greenhorn is a thin impure limestone, changing to marl north and northeast of the Black Hills, characterized by numerous prismatic *Inoceramus* shell fragments and *Globigerina*, above which Carlile, Niobrara and basal Pierre (Sharon Springs) shales and marls are markedly bituminous though mainly impermeable. The facies or tongue of
pure Niobrara chalk, outcropping in Missouri River Valley up-
stream to Fort Thompson, changes underground to north and west
into marl with numerous minute chalky pellets. The clays of the
Lance are mainly bentonite.

Copper sulphides and carbonates occur sporadically in sedi-
mentary rocks of the Dakota Basin, oxidation zone carbonates
both in Pierre and basal Minnelusa laterite, sulphides more
widely distributed. The bronze-colored manganese sulphide (hauere-
ite) is found in the lower half of the Pierre.

PERMEABLE HORIZONS IN WHICH OIL OR GAS SHOWINGS ARE FOUND

Many permeable sandstones, limestones and dolomites occur in
the Paleozoic succession; the most widespread aquifers in which
are the St. Peter sandstone and the Madison limestone, likely
the two greatest aquifers underlying the Dakota Basin. The Sun-
dance has one sandstone or more intercalated in a marine section.
More widely known for 65 years are the Dakota-Lakota group of
sandstones. Higher up are the Newcastle or Muddy sandstones and
a few other thin ones, perhaps localized, in higher Benton,
Niobrara, Pierre and Fox Hills.

Good oil showings have been found in South Dakota in St.
Peter sandstone, Madison limestone, Minnelusa, Sundance, Unkpapa,
the Dakota-Lakota series, the Newcastle or Muddy sandstone and
the Niobrara.
DESCRIPTIONS OF WELL CUTTINGS

A. Central South Dakota

1. PIERRE AIRPORT 1, 2130' SNL, 190' WEL. NE.\(\frac{1}{4}\), Sec. 35, T. 111 N., R. 79 W., Hughes County. Ground altitude 1708.18', cutting measurements from 1718' altitude.

0- 100' Pierre clay, bentonitic, micaceous, gypsiiferous, green grey. Haploporella abundant 10'-30', 70'-80', milliols 70'-80', some manganese oxide coated nodules and nodular tawny clay ironstone

100- 110 Sand, medium to coarse

110- 375 Clay and mudstone, grey, considerable manganese oxide 160'-70', Haploporella, Textularia, "Cristellaria," 200'-20', mudstone, more compact, light grey, begins at 230', white bentonite at 270'.

Globigerina abundant, Textularia and abundant biotite flakes at 320'-30'. Tan clay ironstone, 330'-50'. First shell fragments and hard brown bentonite at 350'-60'. Dark grey dense, fine texture fossiliferous concretionary limestone, containing silt and bentonite, 360'-75'. Much octahedral and red brown to bronzy hauerite (?) and Inoceramus prisms 370'-75'.

375- 380 Chalk, light grey, impure silty, shale, soft, very dark blue grey to black, bituminous, much iron carbonate

380- 410 Mainly grey bentonitic clay, considerable chalk.

Small oval brown pellets of clay ironstone

410- 430 Clay, a little darker grey

430- 550 Mostly cavings (?) of black soft manganese-bearing, partly laminated clay, white bentonite, 490'-500'

550- 570 Niobrara chalk, impure, silty, light grey, spotted

570- 690 Chalk, marly, spotted grey and white, bituminous, fish remains, chalk pellets flattened along laminae. Purer chalk, 650'-60' and 680'-30' (full of Textularia, Globigerina and "Cristellaria"). The chalk has flakes of biotite and white mica

630- 740 Carlile mudstone, dark grey, compact

740- 770 Limestone, magnesian, dark grey, dirty, fine-grained with shell fragments

770-1010 Shale, dark and light grey. Foraminifera at 830' and from 960' downwards. Particles of cuprite-red hauerite (?) at 880'-30'

1010-1060 Greenhorn limestone, grey, spotted, chalky, impure sandstone, light grey, fine-grained, with Inoceramus prisms, some shale, dark blue grey

1060-1120 Graneros with light grey sandstone in cuttings, grey fine grained. Impure, limy cement, micaceous, a little serpentine, angular grains, some dark chert and lignite fragments, fish remains
| 1120-1165 | Shale, dark grey |
| 1165-1180 | Sandstone, light grey, fine grained, with sparse serpentine |
| 1180-1205 | Shale, dark green grey |
| 1205-1230 | Sandstone, fine to medium grained, biotite flakes |
| 1230-1280 | Shale, as above |
| 1320-1410 | Shale, nearly black, compact, fissile (Thermopolis phase), some light brown siltstone |
| 1410-1510 | Dakota sandstone, light brown, fine to medium grained some arkosic and angular below 1440' |
| 1510-1520 | Manganosiderite pellets, small |
| 1520-1530 | Lakota grit, quartzose, poorly cemented, subrounded to subangular |
| 1540-1560 | Sundance sandstone, fine grained, glauconitic, at 1600'-30' sandstone is cream colored, changing to light brown, 1630'-40', both are fine grained |
| 1670-1720 | Siltstone, carmine and brown |
| 1720-1730 | Clay, light green, bentonitic |
| 1770-1800 | Sandstone, glauconitic, fine grained |
| 1800-1810 | Sandstone, dark grey, fine grained, pyritic and glauconitic |
| 1810-1820 | Sandstone, light grey, fine grained |
| 1830-1840 | Sandstone, coarse, subangular to subrounded. Water flowed 1100 gal. per minute, temperature 109° F., shut-in pressure 350 lbs. per sq. in. |
| 1850-1860 | Sandstone, grey, fine grained, lignite fragments |
| 1865-1875 | Sandstone, coarse, bentonitic |
| 1875-1885 | Claystone, green drab, bentonitic, pyrite-cemented sandstone, some lignite and alabaster. Quartzite and granite pebbles reported, 1865'-1900' and 1935'-40' |
| 1895-1915 | Sandstone, brown, fine grained, porous, cemented with pyrite, 1895'-1905' |
| 1925-1935 | Sandstone, fine to coarse, angular |
| 1935-1945 | Siltstone and mudstone, maroon, purple, lavender and pink, some chert pebbles |
| 1945-2015 | Bentonite, hard, light brown grey, mottled with purple, mudstone and siltstone, bentonitic, purple, stained tan and yellow. Particle of native copper |
| 2015-2025 | Bentonite, sandy |
| 2025-2035 | Bentonite, varicolored, with plagioclase and bentonite |
| 2035-2055 | Basal Sundance, with small pebbles of chert and quartz |
| 2055-2065 | Minnelusa (?) sandstone and mudstone, maroon, sandstone is brown, fine, densely cemented, angular to rounded |
| 2065-2075 | Sandstone, brown, dolomite and pyrite cement |
| 2075-2095 | Sandstone, brown, medium to coarse, angular |
| 2095-2115 | Bentonite |
| 2115-2125 | Grit, coarse, to conglomerate, fine, quartz and chert pebbles. The Minnelusa (?) sandstones are water-bearing
Limestone, very dark grey, fine texture, grades down into black and grey shale

Limestone, dark blue grey, finely crystalline, and brown-grey, lithographic

Limestone, brown, fossiliferous, some bentonite, butternut brown

Grit to fine conglomerate, quartzose

Laterite, Indian red, mottled with grey

Pahasapa (Madison) limestone, cream, finely crystalline, imperfect colites. Top probably at 2252'. Combined flow of water from sands between 1865' and 2252', most of which came from the lower sand, was about 2200 gal. per minute, shut-in pressure 290 lbs. per sq. in., temperature 117° F.

Limestone, yellow brown, finely crystalline

Limestone, cream, porous, sandy at base

Age unknown, sandstone, coarse, angular, shale, lavender and terra cotta

Limestone, cream to dove, lithographic

Dolomite (Lower Ordovician (?)), light brown grey, sugary, porous, with quartz grains, becomes sandier downwards. Vein calcite 2355'-2365'

Sandstone, grey, silty, some shale, red pebbles of chert and a few of granite, one of which was at least three-fourths inch across.

Water encountered between 2338' and 2370' flowed 200 gals. per minute, bottom hole pressure 1350 lbs. per sq. in., shut-in pressure, 345 lbs. per sq. in., temperature 102° F.

Noteworthy in the above are the unusual number of sandstones in the Upper Cretaceous, the probable wedging out of Fuson and Morrison, the occurrence of marine Sundance so far east with a great amount of sandstone, the presence of only 200' of Minnelusa (?) and of only 55' of Pahasapa and the very thin possible Ordovician. The facts may possibly be interpreted as caused by secular upwarplings of the southwest part of the pre-Cambrian nucleus at various times from early Paleozoic to mid-Cretaceous.

It is possible that the sandstone from 1170' to 1320' depth is the type Dakota and perhaps equivalent to the Muddy or Newcastle.
2. PHILLIPS PETROLEUM CO. LANG 1, Center NE, ¼ SE, ¼ Sec. 26, T. 5 N., R. 28 E., Stanley County. Altitude 1982'.

0- 220' No cuttings
220- 250 Pierre clay, bentonitic, grey to green grey, a little white chalk, details as below:
250- 280 Foraminifera
340- 360 Hauerite (?), a little red clay
400- 430 A little white clay
610- 820 Sharon Springs shale (?), very dark blue grey, bituminous, Textularia, 730'-820'

820- 850 Niobrara marl, chalky, grey, foraminifera
850- 880 Chalk, impure
880- 910 Chalk, impure, and chalky marl
910- 970 No cuttings
970-1000 Carlile limestone, dark grey, sand, fine
1150-1180 Textularia in blue grey shale
1300 Greenhorn limestone, grey, sandy, with many Inoceramus prisms
1330 Graneros clay, dark blue grey
1450 Sandstone, grey, fine grained
1430 Clay, bentonite, light grey
1510 Minute chunks of asphalt in dark blue grey shale, more abundant, 1540'-70'

1600-1630 Dakota sandstone, light grey, fine grained, micaceous, siltstone, dark grey, dolomitic cement
1630 Shale, very dark blue grey
1680-1695 Sandstone, grey
1695-1725 Shale, dark blue grey
1725-1740 Sandstone, buff, fine grained, micaceous
1740 Manganeseiferous pellet horizon
1750-1770 Sandstone, light brown, fine grained--Lakota
1770-1815 Sandstone, cream, well sorted
1830-1845 Sandstone, light brown grey, medium grained, angular to subrounded, poorly sorted, larger grains in silty matrix

1905-1920 Clay, bentonitic, light blue grey--Morrison
1920-1935 Bentonite, light grey, with biotite, some clay, brown
1935-1950 Clay, red brown
1950-1980 Clay, green grey
1980-1995 Siltstone, dark brown red, carmine-specked
1995-2010 Shale, dark blue grey
2010-2025 Siltstone, dark grey, limy
2025-2040 Sundance sandstone, dark grey, very fine, glauconitic
2040 Sandstone, medium grained, glauconite, in part stained with heavy black oil

2040-2085 Shale, black, very bituminous
2085-2100 Sandstone, grey, medium grained, and shale, black, bituminous
2100-2115 Gypsum, white satin spar, clay, light green grey, bentonitic
2115-2130 Clay, as just above
2130-2145 Sandstone, coarse to gritty, pyrite cement, sub-
round, etched grains
2145-2160 Sandstone, fine, cemented with chalcopyrite, black
manganese oxide
2165 Siltstone, light grey, bentonitic
2175-2190 Siltstone, light grey, bentonitic, some clay and
sand
2190-2205 Shale, dark grey
2205-2220 Sandstone, medium grained
2220-2235 Conglomerate of quartz and abundant quartzite,
lignite and selenite
2235-2250 *Minnelusa* limestone, magnesian, cream buff, very
fine grained, dolomite crystals in calcite matrix,
chert, light grey white, milky
2250-2260 Shale, black
2260-2275 Limestone, dolomitic, grey, silty, fine sugary
2275-2280 Limestone, light brown, calcite veined
2280-2285 Limestone, cream, fine texture, dull lustre
2285-2290 Shale, black, and sandstone, fine (cavings?)
2295-2310 Limestone, as last above, silty below
2315-2320 Siltstone, cream
2325-2330 Bentonite, light grey and terra cotta
2330-2335 Limestone, light brown grey and pink, lithographic,
bentonite, light green
2335-2340 Limestone, light brown grey and pink, lithographic,
bentonite, white
2340-2345 Clay, red brown (terra cotta), bentonitic
2345-2350 Limestone, cream and pink, lithographic, mudstone,
dark terra cotta
2350-2355 Mudstone, terra cotta, tawny, grey and brick red,
shale, brick red
2355-2375 Clay, bentonitic, mottled salmon and grey, tawny
and brown at base, alabaster
2375-2380 Limestone, light brown, very fine, nodular
2380-2385 *Sioux* quartzite, pink, coarsely crystalline, iron
oxide, blue black. Large grains sand with quartzite
matrix
2385-2390 Argillite, black, sericitic
2390-2403 Quartzite, pink
2403-2408 Quartzite, lavender
2408-2435 Quartzite, lavender and pink
<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-755'</td>
<td>No cuttings, Pierre clay</td>
</tr>
<tr>
<td>755-845</td>
<td>Niobrara marl, spotted chalky, laminated, flattened light grey chalk discs in darker grey marl, bituminous</td>
</tr>
<tr>
<td>845-905</td>
<td>Marl, less chalky</td>
</tr>
<tr>
<td>905-935</td>
<td>Marl, with chalky fragments</td>
</tr>
<tr>
<td>935-965</td>
<td>Carlisle shale, dark blue grey, bentonitic</td>
</tr>
<tr>
<td>965-995</td>
<td>Shale, medium grey, sandstone, fine grained, biotitic</td>
</tr>
<tr>
<td>995-1055</td>
<td>Shale, medium grey</td>
</tr>
<tr>
<td>1055-1085</td>
<td>Shale, medium grey, foraminifera</td>
</tr>
<tr>
<td>1085-1130</td>
<td>Shale, darker grey</td>
</tr>
<tr>
<td>1130-1250</td>
<td>Shale, darker grey, foraminifera</td>
</tr>
<tr>
<td>1130-1290</td>
<td>Shale, black, bituminous</td>
</tr>
<tr>
<td>1190-1250</td>
<td>Greenhorn limestone, made up of Inoceramus prisms and Globigerina, sandy</td>
</tr>
<tr>
<td>1260-1320</td>
<td>Graneros shale, black and dark grey, bituminous, some with chalky spots</td>
</tr>
<tr>
<td>1320-1350</td>
<td>Siltstone, light grey</td>
</tr>
<tr>
<td>1350-1440</td>
<td>Some sandstone, grey, fine grained</td>
</tr>
<tr>
<td>1530-1560</td>
<td>Some bentonite, light brown</td>
</tr>
<tr>
<td>1590-1620</td>
<td>Bentonite</td>
</tr>
<tr>
<td>1640-1650</td>
<td>Bentonite, also at various depths down to 1740</td>
</tr>
<tr>
<td>1640-1660</td>
<td>Dakota sandstone, red brown, angular, fine grained, ferruginous, mostly well cemented</td>
</tr>
<tr>
<td>1660-1670</td>
<td>Sand, fine, angular</td>
</tr>
<tr>
<td>1680-1690</td>
<td>Manganese (or rhodochrosite) pellets, sometimes cement small quartz grains</td>
</tr>
<tr>
<td>1690-1700</td>
<td>Sandstone, very light grey, very fine, lignite fragments</td>
</tr>
<tr>
<td>1750-1760</td>
<td>Sandstone, grey, fine grained, much bentonite</td>
</tr>
<tr>
<td>1760-1770</td>
<td>Sand, fine with some large grains, angular to sub-angular, a little glauconite, copper sulphides</td>
</tr>
<tr>
<td>1780-1790</td>
<td>Sandstone, brown and grey, fine and medium grained interbedded, selenite</td>
</tr>
<tr>
<td>1790-1810</td>
<td>Morrison clay, light green grey, bentonitic</td>
</tr>
<tr>
<td>1810-1830</td>
<td>Shale, blue grey, selenite</td>
</tr>
<tr>
<td>1830-1840</td>
<td>Bentonite, white</td>
</tr>
<tr>
<td>1840-1850</td>
<td>Shale, light and dark grey, also blue grey, silty</td>
</tr>
<tr>
<td>1850-1860</td>
<td>Sundance sandstone, grey, fine grained, biotite and white mica, glauconitic</td>
</tr>
<tr>
<td>1870-1890</td>
<td>Clay, light green grey and red brown, silty</td>
</tr>
<tr>
<td>1920-1940</td>
<td>Sundance, with large glauconite nodules</td>
</tr>
<tr>
<td>1930-1950</td>
<td>Clay, drab, bentonitic</td>
</tr>
<tr>
<td>1950-1970</td>
<td>Sandstone, dark grey, fine grained, clayey and siltstone, some glauconite, some of which is yellow brown</td>
</tr>
</tbody>
</table>
1970-1980  Sandstone, medium grained, angular, glauconitic
1980-2000  Mudstone, grey, brown grey, salmon and terra cotta, bentonite
2000-2010  Concretions, maroon, ferruginous
2010-2040  Sandstone, marcasite cemented
2040-2080  Sandstone, light grey, fine grained, with much pyrite cement
2080-2120  Bentonite, varicolored
2120-2140  Bentonite, brick red and tan
2140-2150  Bentonite, light grey, compact, flaky
2150-2160  Sand grains, all sizes, satin spar
2160-2165  Bentonite, green grey, translucent, compact, satin spar
2165-2185  Sand, all size grains from grit to fine, subrounded to subangular
2175-2200  Siltstone, sandy, salmon, mottled with grey, some white kaolin or bauxite, some fibrous to splintery, unctuous to dull lustre
2205-2225  Minnelusa dolomite and magnesian limestone, dove and light grey, very fine texture
2225-2230  Dolomite, darker grey, vuggy, fine crystals
2230-2235  Limestone, dolomitic, medium grey, fine rhombic, calcite veins, chert, brown grey
2235-2240  Sandstone, light grey, fine grained, limy cement
2240-2245  Chert, light grey
2245-2255  Dolomite, light dove grey, texture fine powdery, some calcite, probably sandy
2255-2280  Sandstone, light grey, fine grained, angular to subrounded, probably in part dolomite cemented
2280-2285  Chert, dark blue grey
2285-2295  Limestone, magnesian, grey, fine sugary
2295-2305  Limestone, magnesian, lighter grey
2305-2315  Dolomite, black to dark blue grey, flaky, clayey
2315-2320  Bentonite, light grey
2320-2325  Bentonite, light sea green, silty
2325-2330  Dolomite, dove, with coarsely crystalline rhombohedral and scalarohedral calcite
2330-2355  Dolomite, brown cream, fine sugary, calcite veins
2355-2385  Sandstone, cream, very fine, dolomite cement, much clay, bentonitic
2385-2405  Dolomite, light brown, fine grained, silty, much clay, bentonitic, salmon, grey and green
2405-2425  Clay (?), varicolored, mostly light green and grey
2425-2435  Shale and clay, red, bentonite, lavender, sandy, red, purple, tawny, brown and green bentonite continues down to 2490'
2435-2440  Limestone, grey, fine texture, fossils, small dolomite rhombs
2440-2460  Mostly varicolored clay
2460-2470  Dolomite, cream and light pink, fine texture
2480-2495  Shale, red and maroon

-14-
2495-2505 Sandstone, cream, with about one-half limestone, coarse to medium quartz grains scattered through limestone, some grit size, some limestone, lithographic
2505-2515 Limestone, dark blue grey, very fine grained, clayey
2515-2520 Limestone, dove, lithographic
2520-2525 Limestone, dove, fine sugary, fossils
2525-2530 Shale, black
2540-2555 Limestone, dove, lithographic
2555-2565 Shale, black
2565-2588 St. Peter grit, largely pink-coated grains, some smaller grains, subround to subangular, some grains one-fourth inch across, fragments of coarse Sioux quartzite
2588-2595 Sand, St. Peter
2595-2600 Shale, yellow and brown yellow, some grey mottling, bentonitic
2600-2605 Sand, fine grained, angular to subangular, dark brown red bentonite matrix, sand grains coated brown red, poorly sorted, some red shale
2605-2610 Sandstone, light red brown, fine grained, poorly sorted, angular to subangular
2610-2620 Limestone, dolomitic, light brown grey, fine sugary
2620-2625 Kaolin, impure white, dolomite, light brown grey, vuggy, very small rhombs
2625-2535 Conglomerate, grit and sandstone
2635-2767 Sioux quartzite
4. PHILLIPS PETROLEUM CO. DAKOTA 1, Center NW.\(\frac{1}{4}\) NW.\(\frac{1}{4}\), Sec. 16, T. 6 N., R. 27 E. Altitude 2177', cuttings measured from 2186'. 4000' casing run.

0-307' No cuttings, Pierre, surface casing to 307'
307-315 Pierre clay, grey, bentonitic, considerable chalk, light grey
315-325 Some bentonite, white, biotitic
325-330 "Cristellaria," Ammodiscus
330-335 A little alabaster, foraminifera
355-360 Bentonite, white, biotitic
435 Rhodochrosite or manganosiderite pellets, light brown
450-475 Clay, brownish, very bentonitic, clay ironstone concretions
455 Globigerina
490-520 Concretions, tan and brown, very dense texture, manganiferous
520 Clay, grey, limy, biotite flakes
545 Ammodiscus
565 Inoceramus prisms
605-640 Bentonite in large quantity
645-735 Clay, lighter grey, bentonitic. Abundant bentonite to 850'. Inoceramus prisms
735-780 Bentonite, light brown grey, some sandy and ashy beds
795 First shell fragments other than Inoceramus
790-850 Gumbo, very sticky
855-885 Concretions, grey septarian, calcium carbonate
885-985 Shale, very dark blue grey, bituminous, many fish fragments
985-1040 Marl, chalky, spotted two shades of grey, bituminous
1040-1075 Shale, grey, becoming darker at 1055', shell fragments, Textularia
1075 Bentonite, grey, with small cinnabar--crimson dots of magnetic iron oxide
1100 Clay, light tawny, silty, with dots as above
1115-1120 Some marl, dark grey, chalky
1135-1270 Niobrara marl, chalky grey, with black shale, laminated. Chalk is bituminous, both shale and chalk have a glossy partial film darker and more bituminous, softer than above, 1220'-70', less chalk below 1265'
1235 Bentonite
1310 Chalcopyrite
1315-1340 Some sandstone, grey, fine grain, fish remains and glauconite
1380 Siltstone, light green grey
1430 Mudstone, light grey
1585-1625 Greenhorn limestone, packed with Inoceramus prisms, light, has numerous fine sand grains 1610'-25'
1625 Bentonite, white, top Graneros shale
1640 Shale, dark blue grey, bituminous, sandstone, light grey, fine, limy
1670 Sandstone, light grey, fine, fish scales
1685 Shale, black, with alum
1695 Shale, grey, with small chalky spots
1700-1710 Bentonite, bluish
1725 Shale, lighter grey, with Inoceramus prisms and thin interlaminae of fine light grey sandstone, Globo-
bigerauna
1760-1765 Shale, black, bituminous
1785-1790 Bentonite, light grey
1825-1830 Bentonite, light grey
1835-1840 Bentonite, tan
1870 Shale, dark blue grey
1910-1915 Dakota sandstone, grey, fine. Resistivity log indi-
cates sandstones at 1912', 1965'-85', 2000'-2110'
(interbedded with shale), 2170'-85' and 2235'-45';
cuttings are very poor, mainly cavings
1915-1920 Sandstone, light grey, medium grain, angular, dark chert grains
1920-1925 Clay, bentonitic, light green grey
1935-1940 Ironstone, brown
1955-1960 Clay, light green grey, bentonitic
1970-1975 Shale, dark brown grey
1975-1980 Sandstone, light brown grey, coarse to fine
1985-1990 Bentonite, light blue grey
2005-2015 Siltstone, light brown
2015-2025 Sandstone, light brown, fine grained, very silty
2050-2065 Shale becomes very dark blue grey, possibly some fine sandstone
2065-2070 Siltstone, dark maroon, rhodochrosite pellet horizon
2070-2075 Sandstone, fine angular, light grey (base Dakota)
2075 Fuson bentonite, drab
2095-2115 Shale, black and dark blue grey
2115-2125 Shale, grey, silty, clay ironstone, brown
2125-2130 Siltstone, light yellow brown, micaceous
2130 Shale, grey, ash, micaceous and bentonitic
2140-2145 Sandstone, light grey, cone-in-cone
2145-2150 Sandstone, light grey, medium grained, angular
2160-2165 Mudstone, purplish, bentonite, drab
2165 Siltstone, light yellow brown, shale, grey, silty, sandstone, light brown, medium grained, angular, ferruginous
2175-2180 Clay ironstone, brown
2180-2185 Lakota sand, loose, coarse, subrounded to subangular, partly pitted
2195-2190 Sandstone, brown grey, fine to medium, angular
2190-2195 Sandstone, lighter grey
2195-2200 Bentonite, light grey and blue grey
2200-2215 Sandstone, light brown grey, fine to coarse, angular, micaceous, carbonaceous, poorly sorted, much brown sandy clay ironstone 2205'-10'
2215-2225  Shale, dark blue grey
2235-2240  Concretions and sandstone as above, grit size, black and dark brown, rounded chert, base Lakota
2240-2275  Shale, dark blue grey
2275-2280  Shale, black
2280-2290  Shale, brown red (terra cotta) and drab, bentonite
2415  Sandstone, grey, fine, angular, poorly sorted
2410-2435  Glauconite Sundance clay
2435-2445  Bentonite, drab and light grey fine sandstone, 2435'–40'
2460-2465  Sandstone, light grey, very fine grained, micaceous
2474  Sandstone, pyrite-cemented, coarse, angular
2565  Mudstone, drab, soft, micaceous
2585-2590  Limestone, cream, sandstone, grey, fine, mudstone, bright red, bentonite, very light grey
2595-2605  Shale, grey
2605-2610  Sandstone, light grey, fine, angular
2610-2625  Sandstone, light grey, fine, angular, and clay, green grey, bentonitic
2625-2655  (Minnelusa) limestone, magnesian, light pink and cream, fine sugary sandstone, coarse, considerable glauconite nodules in cavings, also some large quartz grains in white limy matrix
2665-2670  Bentonite, green grey
2670  Limestone, magnesian, buff and cream
2680-2690  Sandstone, cream, fine to medium, interbedded with limestone, cream, fossiliferous, vuggy, with small dolomite crystals
2690-2695  Shale, black, bituminous
2698  Sandstone, coarse, subangular, glauconitic, limestone, magnesian, buff, vuggy
2720  Limestone, magnesian, cream, very fine sugary
2725  Much chert, light grey milky, in limestone as just above
2735-2750  Anhydrite, white and grey, in dolomite, light brown, dull, very fine texture
2750-2770  Dolomite, brown grey, very silty, sugary
2770-2775  Much chalcedony, white to blue, milky, and much calcite
2775-2785  Sandstone, grey, fine grained, very vuggy, limy cement
2780-2800  Anhydrite, white, light blue and light brown grey, silty, dolomite, fine sugary, with chert, blue grey, 2795'–2800'
2800-2805  Dolomite, grey and brown, finely crystalline, very cavernous
2805-2810  Anhydrite, light grey to white, in dolomite, light brown
2810-2820  Limestone, magnesian, light cream grey, cavernous, fine grained, with spots of dolomite
2820-2825  Anhydrite, white, light grey and blue, chert, light grey, milky
2825-2830 Limestone, dolomitic, light brown grey, small rhombs in finer limestone matrix
2830-2835 Shale, brick red, bentonitic
2835-2840 Anhydrite and limestone, dolomitic, light brown
2845-2850 Limestone, dolomitic, grey, fine texture
2850-2855 Limestone, light brown, very sandy, fine quartz grains
2855-2860 Anhydrite, white
2860-2865 Limestone, dolomitic, light brown, some sandy, rest very fine and dense
2865-2880 Anhydrite and limestone, dolomitic, fine, dense powdery texture, not sandy
2880-2910 Shale, purple and maroon, tawny yellow and brown, bentonitic, some shale, sandy and siltstone
2910-2960 Clay, salmon, mottled with grey, and sea green, sandy and silty, bentonitic, ostracods and gastrapods in lower part
2960-2980 Grit size fragmentary quartz, chert, jasper and limestone
2980-3000 Bentonite, tan, pink and lavender
3000-3005 Clay, salmon (or light brick red), mottled with brown grey
3005-3010 Pebbles, mostly of grey limestone
3010-3015 Small Spirifer
3015-3020 Limestone, cream, fine sugary to lithographic varicolored, quite pebbly
3020-3060 Clay, varicolored, quite pebbly
3060-3065 Limestone, cream, finely crystalline, fossils, secondary calcite
3075-3085 Limestone, grey, finely crystalline, Nummulostegina and ostracods
3085-3095 Limestone, darker grey, fossils
3095-3100 Limestone, dark blue grey, with some black shale
3100-3105 Limestone, dove, fine powdery texture
3105-3115 Limestone, cream grey, fine powdery texture
3115-3120 Shale, black, bituminous, hard, fissile
3120-3130 Limestone, spotted with two shades of grey, fine grained
3130-3140 Shale, black, bituminous, finely fissile
3140-3145 Sandstone, buff, fine grained, poorly sorted, subangular to subrounded
3145-3150 Shale, black, bituminous, hard, finely fissile
3150-3155 Limestone, black, bituminous, clayey
3160-3165 Claystone, salmon, and sandstone, coarse, light grey, angular, pyrite cement, with plant fragments replaced by covellite and chalcopyrite
3165-3182 Claystone, salmon, limy, bentonitic matrix, and clay, brown drab
3185-3190 Clay, yellow brown and lavender, bentonitic, partly laminated, limestone, cream and pink, fine texture
3190-3195 Limestone, cream and pink, fine powdery texture, Productus
Clay, light green grey, bentonitic, sandy and silty
Pahasapa (Madison) limestone, cream to light brown, fine granular
Limestone, creamy white to light blue grey, fine sugary, grey above, flaky
Limestone, creamy white, fine sugary, imperfect oolites, flaky
Limestone, pink, dull, porous, small rhombs, flaky
Limestone, light cream to pinkish and dove, fine sugary powdery texture
Limestone, pink, distinct small crystals
Limestone, light dove, powdery to fine crystalline, vuggy
Limestone, magnesian, light brown grey, honeycombed
Limestone, light brown to cream, lithographic to fine crystalline
Limestone, magnesian, grey, fine crystalline
Limestone, dolomitic, grey, porous, with small dolomite rhombs
Limestone, cream, oolitic
Limestone, cream, oolitic, with scattered dolomite rhombs
Limestone, dolomitic, grey, porous, small dolomite rhombs
Limestone, cream, oolitic
Limestone, dolomitic, grey and cream, small rhombs
Limestone, cream and grey, oolitic, passing down into grey dolomite
Dolomite, grey, rhombic
Limestone, cream, imperfectly oolitic, partly lithographic, partly with dolomite rhombs
Dolomite, cream, vuggy, limy, fossils, rhombic
Dolomite, cream, with milky white chert
Dolomite, cream, chert, opaque white with fine dots
St. Peter grit, with finer sand matrix, etched, subround grains, some silt
Dolomite, grey, very porous, medium to coarse rhombs
Grit
Shakopee dolomite, light grey
Dolomite, grey and light green grey, finely crystalline
New Richmond sand, coarse
Grit, subround, etched grains, some glauconite
Oneota dolomite, cream and dove, finely crystalline
Dolomite, light grey brown, porous fine to medium rhombs
Dolomite, light grey brown, porous fine to medium rhombs, sandy
Dolomite with bluish white milky chert
Dolomite; with some large quartz grains
Sandstone, grey, coarse, abundant matrix of dolomite
| 4065-4075 | Shale, green, chloritic and bentonitic |
| 4075-4080 | Conglomerate, quartzose |
| 4080-4125 | Shale, green, chloritic and bentonitic, with interbeds of coarse grey sandstone |
| 4125-4160 | Shale, pistachio green, epidotic |
| 4160-4165 | Conglomerate |
| 4165-4180 | Shale, as last above, sandy |
| 4180-4206 | Pre-Cambrian granite, quartz, pink potash feldspar, muscovite, biotite |
Sand, various sizes, coarse to fine, angular to subangular, some frosted grains, rose quartz, dark flint, calcite crystals. Some quartz grains polished and partly rounded. Some milky white, most transparent and colorless. Some bentonite, green and light grey, selenite flakes and schist fragments. Pierre clay below 65'.

Pierre clay, bentonitic, green grey, mudstone, somewhat compact, bentonitic, biotite flakes, clay ironstone, yellow to brown, Inoceramus and ammonite, all above 150'. Haploporaella common, 150' to -60', some chalk, light grey, 200' -10', siltstone with clay ironstone cement, 250' -70', Globigerina at 270', Haploporaella and considerable white biotitic bentonite, 300' -20', Lituoella, Haploporaella and other poorly preserved foraminifera at 320' -50', round disks possibly plants, 250' -320', Dorothea, very small "Cristellaria" and Haploporaella common at 360' -70', "Cristellaria", Vidalina and Glomospira at 390' -400', clay ironstone, 400' -10', Dentalium, "Cristellaria" and chalky particles, 410' -30', Vidalina, 430' -40', darker brown grey than above and below, with fish remains, bituminous and laminated, 510' -40', Pulvinulinella, 560' -70', white bentonite, 530' -70', small round pyritized organic balls and Vidalina at 570' -80', pyrites Haploporites, 620', considerable white bentonite, 630' -40', marl, grey, with white chalk particles, 640' -50', chalk, spotted marl and "Cristellaria", 670' -80', Haploporites, 730' -40', marl, dark blue grey with very small chalk particles, bituminous, transitional to Niobrara, 740' -65'.

Niobrara marl, chalk spotted, bituminous, flattened chalk particles, fish remains, less chalky in lower part, Robulus and Pullenia

Bentonite, rather firm, grey white

Carlile clay, blue grey, Robulus, Globorotalia, Polyphragma

Clay ironstone concretions

Clay becoming darker

Valvulina (?)

Sandstone, light grey, fine

Mudstone, medium green grey, very bentonitic, numerous biotite flakes, dwarfed foraminifera

Haploporites

Hyperammonoides

Considerable light grey bentonite
1125-1230  Greenhorn limestone, light grey, translucent, crystalline, full of Inoceramus prisms and fish remains, some grey ashy marl, Globigerina, some glass shards and bentonite flakes, mudstone, dark blue grey, bentonitic, with Textularia and nonionid at base
1230-1300  Graneros mudstone, dark blue grey, bentonitic
1300-1310  Bentonite, grey white
1310-1320  Ammodiscoides, Haploporites
1320-1330  Chalk with small dark specks, Glomospira, miliolid
1340-1350  Bentonite, grey white, Globigerina, Orbulina
1360-1370  Cribrobulimina
1380-1400  Globigerina, Elphidium, Orbulina, light grey, fine grained sandstone, limy cement
1400-1410  Limestone, sandy, oolitic, glauconitic
1440-1560  Lower Graneros shale, dark and bituminous
1560-1570  Sandstone, light grey, fine, glauconitic
1570-1590  Dakota sandstone, grey, coarse, angular, felspathic and with other minerals from crystalline rocks, some recrystallized quartz, lignite fragments and mica flakes, limy cement, porous, rolled detrital pyrite, top Dakota probably at 1556'
1600-1610  Bentonite, white
1660-1670  Fuson bituminous coal, coking, bright shiny lustre with woody fusain structure
1670-1700  Shale, dark blue grey
1700-1720  Sandstone, brown, micaceous and lignitic, Inoceramus prisms, bentonite, light grey green
1720-1730  Sandstone, brown grey, coarse, porous, micaceous, angular, lignite, carbonaceous shale, silicified wood
1730-1740  Clay ironstone, brown, concretionary
1740-1770  Siltstone, very light grey, hard, micaceous, clay ironstone (?), dark purple, some small jasper and quartz pebbles
1780-1790  Clay, green grey, bentonitic, sandstone, yellow brown, coarse
1830-1840  Considerable sandstone, base Lakota, 1845'
1850-1860  Morrison bentonite, light grey blue
1860-1890  Dolomite, light brown, finely crystalline
1890-1910  Mudstone, light blue grey
1910-1940  Some sandstone, white, very fine grained
1940-1960  Sundance sandstone, grey, with specks of glauconite
1960-1980  Mudstone, grey
1980-2020  Abundant glauconite nodules
2020-2040  Limestone, light grey, fine grained
2040-2080  Sandstone, light grey, fine grained, limy cement
2080-2120  Sandstone, light grey, medium grained, some polished sub-angular grains of grit size, mica, "black sand," lignite fragments
2120-2130  Some red brown concretionary aggregates
2130-2150 Siltstone, dark cherry red, conglomerate with iron oxide cement, some pebbles of brownish wine color, matrix of small silty pellets and quartz grains, vesicular material partly filled with concentric mineral

2145-2170 Minnelusa sandstone, brown, fine grained, insoluble cement

2170-2180 Possibly siltstone, crimson, sandy

2180-2190 Sandstone, grey, medium grained, angular to subround, porous

2190-2240 Siltstone, sandy, to sandstone, fine silty, salmon

2240-2250 Sandstone, light grey to light salmon pink, medium grained, angular to subround, poorly sorted, some large grains, grains pitted, little or no cement

2250-2260 Sandstone, fine grained in part

2260-2270 Sandstone, with some coarse rounded dolomite grains, claystone, terra cotta

2270-2280 Sandstone, pink, fine grained, poorly sorted, some large grains, limy cement

2280-2290 Limestone, pink to white, sandy in part, very finely crystalline

2290-2300 Limestone, cream, cavernous, some stained red and pink, finely crystalline, with a little chert and some quartz crystals

2300-2320 Dolomitic limestone, cream, fine grained, opaque, a little chert, 2310'-20'

2310-2330 Sandstone, light grey, angular, fine grained, poorly sorted

2330-2350 Limestone, magnesian, cream, very fine texture, milky chert and milky vein quartz

2350-2370 Siltstone, brown grey, very limy, micaceous, some sand grains

2370-2380 Limestone, magnesian, grey, with white spots, perhaps altered oolitic, cavernous, silty, a mixture of limestone and dolomite

2380-2400 Anhydrite, white and light grey

2400-2410 Anhydrite, white and blue grey, with mixed limestone and dolomite, with some quartz sand below

2410-2430 Limestone, dolomitic, cavernous, light brown grey, sponge spicules, anhydrite fillings

2430-2445 Shale, black, very bituminous

2445-2450 Limestone, magnesian, light blue grey, very fine sugary, some dark grey chert

2450-2480 Anhydrite, blue grey and white, with dolomite, cream, porcellaneous, light milky chert and bi-pyramidal quartz, 2460'-80'

2480-2490 Dolomite, limy, light grey, finely crystalline, with translucent chert

2490-2500 Sandstone, grey, coarse, subangular to subround, some citrine and brown, white, and grey chert grains, poorly sorted, some frosted grains, really a fine grit
2500-2510  Pleurotoma, albite, almandite and bipyramidal quartz
2510-2540  Dolomite, light brown grey, fine sugary, limy, dolomite crystals in limestone
2540-2550  Clay, bentonitic, light green grey, tawny yellow and pink, silty
2550-2560  Dolomite, light to medium grey, medium-sized crystals, apparently partly sandy
2560-2570  Mudstone, bentonitic, salmon pink to terra cotta and tawny yellow, glauconitic, gastropods and ostracods, limestone, light grey, crystalline
2570-2580  Bentonite, varicolored
2580-2610  Bentonite, predominantly pink
2610-2625  Limestone, cream, lithographic, capulid gastropod
2625-2640  Clay, bentonitic, tawny yellow and dark brown red, lavender, purple and bright green
2640-2645  Limestone, medium grey, fossiliferous, nodular
2645-2670  Shale, black and dark grey, bituminous, limy, chalcopyrite
2670-2680  Limestone, dove to medium grey, very fine texture
2680-2690  Shale, dark blue grey and black, bituminous, ostracods
2690-2700  Limestone, medium grey, fine, small specks pyrite, fossiliferous
2700-2708  Shale, black, shiny, hard and tough, bituminous, much chalcopyrite
2708-2720  Sandstone, light grey, fairly coarse, pyrite cement, angular to subround, poorly sorted
2720-2730  Limestone, dark blue grey, fine texture, sandy and clayey
2730-2735  Sandstone, coarse to medium, recrystallized quartz common
2735-2760  Pahasapa (Madison) limestone, magnesian, cream, very fine sugary, some small vugs, light grey chert
2760-2770  Limestone, cream, coarser than above
2770-2780  Limestone, cream, lithographic, fossiliferous
2780-2790  Limestone, dove grey, fine sugary
2790-2800  Limestone, light brown grey, porcellaneous or lithographic
2800-2810  Limestone, light grey, fine sugary
2810-2830  Limestone, dove (light brown grey), dense, finely crystalline
2830-2840  Limestone, dove (light brown grey), a little more porous and coarser crystalline
2840-2860  Limestone, light brown, quite porous, crystalline
2860-2880  Limestone, light brown, fine sugary, fossiliferous
2880-2890  Limestone, grey and light brown, full of small round cavities
2890-2910  Limestone, brown, dense with local calcite crystals, fossiliferous, imperfect oolites
2910-2940  Limestone, interbedded brown, oolitic, and grey, sugary, full of holes

-25-
<table>
<thead>
<tr>
<th>Interval</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2940-2970</td>
<td>Limestone, grey, dolomite crystals in fine ground-mass</td>
</tr>
<tr>
<td>2970-3030</td>
<td>Limestone, dolomitic, grey, fine sugary, porous, oolites at base</td>
</tr>
<tr>
<td>3030-3160</td>
<td>Limestone, light brown, fine, dense, oolitic in part. At 3058' texture becomes fine sugary. Stylolites and fossils. At 3110' becomes largely oolitic with pores. Below 3120' it is again dense to fine sugary and fossiliferous. Dolomite rhombs in calcite</td>
</tr>
<tr>
<td>3160-3260</td>
<td>Limestone, dolomitic, medium brown, sugary, porous and vuggy, dolomite rhombs, fossils. Bituminous at 3210'</td>
</tr>
<tr>
<td>3260-3300</td>
<td>St. Peter sandstone, light grey, coarse, with grains of all sizes, subangular to round, some frosted grains. Coarse grains scattered through white finer matrix. Pink sand grains fairly common (likely derived from Sioux quartzite), very small glauconite spots</td>
</tr>
<tr>
<td>3300-3340</td>
<td>Shakopee dolomite, light brown, perfect rhombs with open spaces between, some vugs filled with anhydrite, lower 10' slightly bituminous</td>
</tr>
<tr>
<td>3340-3350</td>
<td>Sandstone, grey, fine to coarse, unsorted, small specks glauconite</td>
</tr>
<tr>
<td>3350-3400</td>
<td>Dolomite, brown cream, rhombs with vugs partly filled with anhydrite, compound dogtooth spar crystals. Bituminous, 3380'-3400', where texture is fine sugary</td>
</tr>
<tr>
<td>3400-3430</td>
<td>New Richmond sandstone, coarse, gritty, angular to subround, frosted, glauconitic, some jasper and rose quartz grains, some recrystallized</td>
</tr>
<tr>
<td>3430-3440</td>
<td>Oneota dolomite, brown grey, sugary</td>
</tr>
<tr>
<td>3440-3450</td>
<td>Limestone and dolomite mixed, grey, medium sized crystals</td>
</tr>
<tr>
<td>3450-3460</td>
<td>Dolomite, finely crystalline, dense, interbedded with sandstone, coarse, subround to angular</td>
</tr>
<tr>
<td>3460-3500</td>
<td>Dolomite, light brown, fine sugary</td>
</tr>
<tr>
<td>3500-3530</td>
<td>Dolomite, dove, a little larger size crystals, vuggy, with some dry hydrocarbon stylolites</td>
</tr>
<tr>
<td>3530-3620</td>
<td>Dolomite in limestone matrix, light brown, some fine sand grains</td>
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<tr>
<td>3620-3640</td>
<td>Limestone, light brown and grey, rough crystalline texture, white chert, secondary calcite</td>
</tr>
<tr>
<td>3540-3660</td>
<td>Sandstone, light brown grey, fine apparently interbedded with cherty limestone</td>
</tr>
<tr>
<td>3660-3700</td>
<td>Abundant chert, light blue grey, limestone, light grey, silty, fossiliferous</td>
</tr>
<tr>
<td>3700-3780</td>
<td>Limestone, light brown, fine texture, chert less abundant, fossils common including small orthid brachiopods, small black chert or phosphate pebbles, considerable sand, 3740'-380'</td>
</tr>
<tr>
<td>3780-3880</td>
<td>Shale, upper 20' light green, rest dark green, sandy and silty above, chloritic and bentonitic</td>
</tr>
<tr>
<td>3880</td>
<td>Pre-Cambrian diorite, plagioclase, hornblende, biotite, hornblende in part chloritized</td>
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</tbody>
</table>
6. CARTER OIL CO. STRATIGRAPHIC TEST 1, Center NE.¹⁄₄ NW.¹⁄₄, Sec. 34, T. 118 N., R. 78 W., Potter County. Altitude 1865'.

0-10'
Pierre clay, bentonitic, green-grey, white satin spar gypsum

10-790
Pierre clay, bentonitic, with details as follows: much selenite, 60'-70', satin spar and some fine sand 80'-90', quartz, jasper, chert, hornblende, rose quartz, grossularite or andradite, almandite, biotite, chlorite, serpentine, potash and plagioclase feldspar and fragments of holocrystalline igneous at 90'-100' may be cavings from the surface. _Inoceramus_ prisms, 90'-100' and 140'-50', some sandstone, 140'-50', shell fragments, 180', chalk, light grey, with _Haploporella_ and _Ammodiscus_, 265'-70', mudstone, blue grey, 310'-420', greenish bentonite, 420'-50', small oval tan concretions, 580'-90', light tan brown limestone concretions and hauerite (?), 590'-700', Sharon Springs shale, very dark blue grey, bituminous, 710'-90'

790-910
Niobrara, marl, grey, chalk-specked, bituminous, brownish, more compact and chalkier, 830'-40'

910-1240
Carlife shale, dark grey, with silty grey limestone, 980'-90', chalk, light cream-grey, small black dots, 1030'-40', sandstone, grey, fine, biotitic, 1040', brown iron carbonate, 1170', shale nearly black, 1200'-40'

1240-1250
Greenhorn limestone, grey, sandy, porous, crystalline, packed with _Inoceramus_ prisms and fish remains

1250-1260
Bentonite, light green grey, _Cribrobulimina_

1260-1330
Limestone, light and dark grey, coarsely crystalline, bituminous, with flattened pyrite pebbles, _Globigerina_, _Inoceramus_ prisms, fish remains

1330-1380
Graneros marl, chalky, dark grey, spotted, bituminous

1380-1390
Bentonite, light grey

1400-1510
Sandstone, light grey, fine grained, biotite and a little glauconite, limy cement, fish remains

1510-1590
Shale, dark blue grey, bituminous

1590-1730
Dakota sandstone, medium grained, subrounded to subangular, little cement, apparently nearly all sandstone, 1640'-1730'

1730-1760
_Fuson_ shale, dark blue grey, bituminous

1760-1770
Manganosiderite (or rhodochrosite) pellets in loose sand

1810-1850
_Lakota_ (?), mostly sandstone with considerable mudstone, light green grey, bentonitic, some interbeds of white bentonite with small quartz and biotite fragments

1850-1900
Sandstone, brown grey, arkosic, fine grained

1900-1910
_Sundance_ sandstone, light grey, glauconitic, mudstone with _Haploporella_
Some bentonite, light green, sandy
Sandstone, light brown and grey, fine grained, micaceous
Limestone, rich brown
Sandstone, mostly, medium grained, brown siltstone cemented with iron carbonate
Sandstone, grey, fine grained, part with much glauconite
Clay ironstone, dark brown grey, fine texture, nodular
Sandstone, dark grey, fine grained, glauconitic, micaceous, partly quartzite, 2030'-40'
Clay ironstone, dark brown, fine sugary texture, probably some bentonite, brown, 2050'-70'
Sandstone, brown to grey, medium to coarse well-polished grains, subangular to subround, limy cement, also pyrite cement, high porosity, abundant lignite fragments
Sandstone, grey and brown, coarse
Residual soil of cream to light brown kaolin or bauxite with maroon to crimson mottlings, silty to sandy, some small pebbles. Lowest 10' is partly pink and lavender, bentonite, orange, tan and yellow, 2160'-40'. Probably top of Paleozoic (Minnelusa (?) ) or basal Sundance.
Minnelusa sandstone, cream, poorly sorted, medium grained, subangular to subround, limy cement to porous
Sandstone, as above, but with some jasper grains, stained with yellow ochre
Clay, brown red, bentonitic
Considerable milky chert, weathered selenite, siltstone, pink
Siltstone, dove, magnesium-calcium carbonate cement, with some shale, dark blue grey, bituminous
Siltstone and fine sandstone, light grey, recrystallized quartz
Shale, black, very bituminous
Limestone, magnesian, light brown grey, sugary, porous
Dolomite, light brown grey, fine sugary
Limestone, magnesian, cream to light dove, fine sugary
Sandstone, white, fine grained, limy cement
Mudstone and siltstone, maroon
Cavings but perhaps in light grey limestone
Bentonite, light grey, green grey, pink and yellow, small nautiloid
Limestone, cream, lithographic, calcite fillings of vugs
Bentonite, pink yellow, brown, light green and light grey
Limestone, light grey and cream streaked, lithographic, much secondary calcite
Limestone, dark blue grey, bituminous, fine powdery texture
Shale, black, bituminous, limy
Limestone, cream, lithographic to powdery texture, chalcopyrite
Limestone, finely crystalline and vuggy, magnesian in lower beds
Limestone, cream, obscurely oolitic, porous, finely crystalline, possible unconformity
Pahasapa (Madison) (?) limestone, magnesian, light brown; crystalline, very porous and vuggy, dolomite rhombs in calcite matrix. Some conglomerate, dark brown bituminous streaks and stains, porosity decreases downwards
Limestone, light dove, very dense, minute dolomite rhombs
Dolomite, grey, very vuggy, crystalline
Limestone, light brown and grey, obscurely oolitic, very fine, ostracods
Limestone, cream, oolitic
Limestone, dark grey, fine, porous and vuggy
Limestone, light brown grey, large oolites with pores between, secondary calcite, alabaster, 2665'
Limestone, grey, coarse, abundant sand grains
Dolomite, dark grey, fine sugary, calcite matrix
Dolomite, grey, crystalline, considerable fine sand and silt
Limestone, cream, oolitic in part, porous, lithographic to crystalline, looks like Madison
Limestone, cream, medium sized crystals, porous and vuggy
Limestone, light brown, crystals in fine powdery matrix
Siltstone, salmon, some claystone, brick red
Sand, loose, coarse, unsorted, subrounded to subangular, St. Peter (base of mid-Ordovician)
Shakopee (Lower Ordovician) dolomite, dark brown, coarsely crystalline, very porous
Dolomite, white and light green grey, fine sugary, with scattered large sand grains
Dolomite, light green grey, fine sugary
Dolomite, brown, fine sugary, vuggy
Dolomite, grey, fine sugary, with scattered small and larger quartz grains
New Richmond sandstone, grey and green grey, grains fine to coarse
Oneota dolomite, light brown grey, sugary, vuggy, secondary quartz crystals
Dolomite, darker brown, secondary quartz crystals
<table>
<thead>
<tr>
<th>Interval</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3270-3320</td>
<td>Dolomite, light brown, milky white chert, secondary quartz crystals</td>
</tr>
<tr>
<td>3320-3380</td>
<td>Dolomite rhombs in calcite crystals, light blue chert, some siltstone</td>
</tr>
<tr>
<td>3380-3440</td>
<td>Limestone, cream, fine texture, white matrix of abraded calcite crystals</td>
</tr>
<tr>
<td>3440-3460</td>
<td>Limestone, cream, with fine detritus</td>
</tr>
<tr>
<td>3460-3490</td>
<td>Shale, light dull green, bentonitic, some fine sandstone in upper and numerous small quartz grains below</td>
</tr>
<tr>
<td>3490-3560</td>
<td>Shale, dull green, unctuous, bentonitic, flaky, hard, probably chloritic</td>
</tr>
<tr>
<td>3560-3580</td>
<td>Sandstone, grey, porous, poorly sorted, varying size grains, finer above</td>
</tr>
<tr>
<td>3580-3611</td>
<td>Pre-Cambrian granodiorite or quartz-monzonite, extensively chloritized, contains quartz, biotite, plagioclase, some orthoclase, hornblende; feldspars are kaolinized</td>
</tr>
</tbody>
</table>
B. Central Western South Dakota


0- 243' No cuttings. Fox Hills formation
243- 560 No cuttings. Pierre bentonitic clay
560-2050 Pierre clay, bentonitic, grey green, with some white chalky layers, selenite, fine mica flakes, small serpentine particles, shell fragments, including Inoceramus

640& 710 Robulus navarroensis, Dorothea (?) at 640'
750- 760 Abundant shell fragments, hauerite (?)
760- 770 Chalcopyrite, Robulus, abundant Inoceramus prisms
810 Robulus
830 Robulus, Globigerina, many shell fragments
840- 850 Part with very small quartz grains, noted also higher up, fine greywacke sand, chalcopyrite, many shell fragments

850- 860 A little milky chert
900- 910 Dorothea, Globigerina, Robulus
920 Dorothea, and considerable calcite
360- 370 Robulus
930 Robulus, Globigerina
920 Dorothea
1020 Some light grey limestone
1040 Some greywacke sandstone with andesite fragments, brown siltstone
1090 Haplophragmoides
1140 Robulus
1170 Globigerina, Textularia, Haplophragmoides, some brown limestone concretions
1180 Dorothea, Dentalina
1200 Brown septarian concretion
1210 Haplophragmoides, Dorothea, Globigerina
1280 Nodogenerina
1280 Considerable brown clay ironstone
1380 Dorothea
1340 Somewhat limier, Globigerina
1360 Robulus, echinoid spine, Haplophragmoides, Globigerina, Dorothea
1410 Haplophragmoides
1420 Textularia, Globigerina
1450 Robulus, Haplophragmoides, Textularia, Globigerina, Dorothea and Miloloid, sandstone, grey, medium grain with black particles
1450 Haplophragmoides, Dorothea, Globigerina, small pearl and Chara seeds, limestone, light grey, very dense, some with cone-in-cone structure

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1480 Dorothea
1490 Cribrostomoides
1500 Dorothea, cone sparsesiderite, some hauerite (?)
1520 Globigerina
1530 Globigerina, Robulus, Textularia, Dorothea
1550 Globigerina, Robulus, Textularia
1560 Chalk, light brown
1584–1590 Ammodiscus
1590 Textularia
1602–1604 Core of mudstone, dark grey, very fine, compact
1610 Haplophragmoides
1630 Haplophragmoides, Dorothea
1660 Top of Sharon Springs shale, dark grey, bituminous, serpentine pellets common, Dorothea, abundant Chara seed
1670 Dorothea, Globigerina, some sandstone and light grey limestone.
1680 Robulus, Globigerina
1690 Haplophragmoides, brown clay ironstone, very dark grey marl
1700 Ammodiscus, Dorothea, Textularia, nonionid, some fine grit, black elliptical pebbles, fish remains, bituminous grey marl
1730 Nonionid ("Cristellaria"), Textularia, Dorothea
1740 Nonionid ("Cristellaria"), Ammodiscus, Globigerina
1750 Some small flattened chalk pellets, serpentine or glauconite pellets common
1760 Robulus, Textularia, Globigerina, Vidalina, Polyphragma, flaky, fissile shale of two tones of dark blue-grey. Considerable biotite occurs in the Sharon Springs
1790 Dentalina, a little light grey, fine grained, limy sandstone
1820 Some limestone, fine texture, light grey
1830 Limestone more abundant
1860 Dorothea
1900–1910 Chalk-spotted marl
1300 Dorothea
1320 Textularia, miliolid
1330 Robulus
1340 Textularia
1350 "Cristellaria," Robulus, Globigerina, Dorothea
1380 Vidalina, Globigerina
2010 Vidalina, Globigerina, Robulus
2040 Many small concretionary nodules of serpentinous clays, as usual, there is much caving material in the Pierre cuttings
2050–2090 Niobrara marl, dark grey, chalk-spotted, Robulus, Globigerina
2030–2110 About half chalk, rest is marl
2110 Permanganate—appearing substance
2130-2160 Some particles nearly pure chalk
2160-2170 Less impure but solid chalk, *Globigerina*
2170-2250 Carlile marl, dark blue grey, somewhat flaky, bituminous, fish remains and *Inoceramus*
2250-2260 *Robulus*, *Dorothea*, some sandstone, light grey, micaceous
2260 *Dorothea*
2270 *Globigerina*, some sandstone, light grey, fine, limy
2290 Shale very dark, nearly black, fine mica flakes, considerable limy sandstone, light-grey, fine to medium, micaceous, biotite, hornblende, greywacke, foraminifera
2330 Shale is dark blue-grey
2410 Sandstone as at 2230'
2460 Shale is dark blue-grey
2500-2520 Greenhorn shale, almost black, with some flattened chalk pellets and fish remains
2520-2563 Same but chalk particles very fine
2563-2575 Limestone, light grey, chalky and clayey, crystalline, spotted two shades grey, partly oolitic, *(Globigerina)*
2575-2610 *Graneros* mudstone, bentonitic, flaky but not laminated
2610 Color lighter
2620 *Vidalina*, *Globigerina*, *Dorothea*
2630 Shale again dark with small chalk spots
2770 Some coarsely crystalline limestone with phlogopite
2810 Shale very dark blue grey, Thermopolis (Skull Creek) facies
2820 Some brown clay ironstone
2950 Some siltstone, light grey
2980-3010 *Dakota* sandstone, light grey, very fine, silty
3010-3060 Increase in amount of sandstone
3060 Shale dark blue grey, sparse manganosiderite pellets. Reported base *Dakota* at 3082'
3100-3160 Sandstone, creamy white, medium grained, porous, subangular
3160-3170 Limestone brown, with sponge spicules, siderite
3170-3230 *Fuson* shale, dark blue grey. Casing run to 3209'
3180-3240 Bentonite, dark green, pellets in dark blue grey mudstone
3240-3280 Sandstone, fine grained with green bentonite matrix
3280-3330 Shale, dark blue grey
3330-3390 *Lakota* sandstone, light buff, medium grained, micaceous, angular, porous
3390-3410 Shale, dark blue grey
3410-3420 Sandstone, grey-white, medium grained, angular, porous, white ashy matrix, micaceous. Some recrystallized quartz, some large quartz grains partly rounded and frosted, a few pieces hornblende. Base coarser sandstone, more prevalently recrystallized
3420-3440  Morrison mudstone, light grey green, bentonic, micaceous, and silty
3440-3450  Mostly bentonite, dull light green with spots and streaks of dark green
3450-3460  Some siltstone, terra cotta, with sand grains, more abundant sandstone, fine grained and unsorted, light green, some drab bentonite with numerous quartz grains
3460-3470  Sandstone, buff, fine grained, angular
3470-3480  Sandstone, large quartz grains, angular, some mudstone light green grey bentonite
3480-3540  Sandstone, non- limy, buff to light grey, poorly sorted, angular, some recrystallized, becomes finer below
3540-3550  Bentonite, light green, compact, conchoidal fracture
3550-3570  Bentonite, as just above but some light grey, full of quartz grains
3570-3580  Mudstone, bentonic, 3 shades of light green, some sandstone, bentonic, some large subround etched grains, matrix partly limy, a little limestone
3580-3600  Sundance sandstone, light grey, medium grained, angular, porous, glauconitic
3600-3780  Siltstone, light grey, glauconitic
3750-3767  Sandstone, buff, fine grained, glauconitic, grey below
3767-3836  Spearfish sandstone, salmon, fine silty, angular. Color very light red brown
3836-3850  Sandstone, light grey
3850-3950  Anhydrite, white, and siltstone, dull brown red
3950-3980  Minnekahta limestone, dense, buff, somewhat magnesian, cavernous limestone—anhydrite mixture, some finely pisolitic
3980-4000  Opeeche siltstone, dark red brown
4000-4010  Limestone—anhydrite, light grey
4010-4082  Siltstone, red brown, anhydrite at base
4082-4120  Minnelusa limestone, cream to light pink, magnesian, lithographic, becoming silty at base
4120-4130  Limestone, bentonic, lavender, fine grained
4130-4140  Some anhydrite, mostly light pinkish brown fine grained limestone, silty, with small crystals of anhydrite
4140-4150  Anhydrite, white to pinkish
4150-4170  Limestone, dolomitic, brown buff, fine texture anhydrite, some pink, and sandstone
4170-4190  Limestone, dolomitic, cream, porcelain texture
4190-4200  Limestone, magnesian, light brown grey, fine texture, anhydrite, grey and white
4200-4220  Sandstone, salmon, fine grained, angular, white anhydrite
4220-4280  Perhaps all anhydrite, light grey and white, perhaps, at 4250'-60' some sandstone, salmon fine
4280-4300 Sandstone, light grey and pink, medium grained, angular, poorly sorted, larger grains rounded and etched, and dolomite, dark pink
4300-4330 Dolomite, pink, fine texture, anhydrite, white and grey
4330-4360 Siltstone, brown red or dark salmon, somewhat limy
4360-4380 Siltstone, dark red-vermillion, finer, shale, red, with light green-grey splotches
4380-4400 Shale, red, green-splotched, interbedded with sandstone, red, silty, micaceous, angular
4400-4420 Shale, lavender
4420-4430 Sandstone, brown, fine grained, silty, poorly sorted, limy, some white
4430-4450 Limestone, dolomitic, fine texture, brown pink, and anhydrite, white
4450-4470 Sandstone, cream, medium grained
4470-4480 Sandstone, grey, medium grained, poorly sorted, angular, somewhat limy
4480-4490 Anhydrite, grey and white, dolomite, grey-brown, fine sugary
4490-4500 Sandstone, light grey, fine, poorly sorted with some large rounded frosted grains
4500-4520 Shale, black, extremely bituminous, very small mica flakes
4520-4530 Limestone, magnesian, brown grey, fine sugary, siltstone, grey
4530-4575 Limestone, magnesian, grey, fine granular
4575-4591 Limestone, dolomitic, dove grey, fine granular
4591-4605 Limestone, grading down into darker color, then to siltstone and at base to shale, shiny black, very bituminous
4605+4611 Sandstone, light grey and white, fine, limy, recrystallized, chert, dark brown and grey
4611-4622 Sandstone, light grey, fine, angular, limy
4622-4630 Limestone, magnesian, very light grey, fine texture, with a little shale, light green. The limestone is an intermixture of dolomite and calcite crystals
4630-4641 Sandstone, light grey, very fine grained, limy
4641-4652 Shale, grey, light green and lavender, bentonitic, underlain by limestone, magnesian, very light grey, fine texture
4652-4661 Dolomite, cream to light grey, finely crystalline
4661-4671 Mudstone and siltstone, dark dull purple-red, blotched, light grey green
4671-4683 Mudstone, red, green and grey
4683-4693 Siltstone, light green grey, limy
4693-4710 Anhydrite, white
4710-4722 Limestone, magnesian, light grey, fine texture to amorphous, shale, light green, bentonitic
4722-4729 Mudstone, butternut brown with grey laminae
Limestone, very dark blue grey, clayey
Limestone, medium grey, fine granular, glauconitic, some shale, black and dark grey, bentonitic
Limestone, light dove grey, lithographic
Some bentonite, dark dull lavender
Shale, black
Bentonite, dark grey, and limestone, grey
Limestone, dove grey, lithographic to fine granular, calcite veins
Sandstone, lavender, with light grey bands, some grit size
Laterite, dark Indian red, bentonitic, and sandy
Sandstone, white, medium grained, non-sorted, some large frosted subround grains
Pahasapa (Madison) limestone, light dove grey, lithographic to fine granular
Limestone, as above, but with considerable light milky chert
Limestone, with a little chert, calcite veins
Limestone, some light brown with small dolomite crystals
Limestone, magnesian, light brown, with small dolomite crystals, some pink, probably rest is cream or buff
Limestone, with some larger dolomite rhombs
Limestone, dolomitic, brown, finely crystalline, porous, with small dolomite crystals

Fresh water rose 1400' in one hour from Dakota sandstone at 3041' depth. Fresh water rose 2300' in one hour from Lakota sandstone at 3325' depth. Fresh water rose 3000' in 15 minutes from Morrison sandstone at 3461' depth. One-half bailer of water per hour from Minnelusa limestone at 4520'-4580' depth. Fresh water rose 3850' from top of Madison Pahasapa limestone of 4855'-72' depth. Fresh water rose 4000' from Madison magnesian limestone at 4934' depth.
C. Eastern Flank, Black Hills

8. RAPID CITY AIRPORT 2, 1480' EWL, 2438.8' SNL, Sec. 13, T. 2 N., R. 8 E., Pennington County, Altitude 3210.4'.


0– 290' No cuttings

230– 350 Pierre bentonitic clay, medium blue-grey, bentonitic and muscovitic, with thin streaks and nodules of limestone with hauerite (manganese sulphide?). Fish remains, white bentonite with phlogopite, 340'–50', considerable dark grey limestone, 300'–10', cone-in-cone concretions, Inoceramus prisms and shell fragments. Much organic matter replaced by pyrite and marcasite. Shark's teeth. Chalcopyrite

350– 360 Limestone, dark blue-grey, earthy. Shot-like pyrite

360– 370 Hauerite (?), chalcopyrite

370– 420 Clay, blue grey

420– 430 Limestone, very muddy, dark grey

430– 530 Mudstone, dark-grey, more compact than higher up talium and Globigerina at 450'. Hauerite (?) in balls, pipe concretions and replacing Inoceramus prisms at 470'–80', Cristellaria at 480'–90', much manganosiderite at 500'–20', Globigerina and Dentalium at 510'–20', chalcopyrite at 520'–30'

530– 570 Marl, grey, spotted with white chalk pellets

570– 630 Chalcopyrite rather abundant. Sulphides replacing hydroids and bryozoa at 610'. Rest of interval blue-grey clay

630– 700 Niobrara marl, spotted with chalk pellets, bituminous

700– 840 Niobrara marl, spotted chalky, bituminous, dark grey, bentonitic with biotite flakes. The chalk pellets, as usual in the borings, are flattened parallel to the lamination. Infant ammonites (goniatite stage) at 820'–30'. At the base is limestone, hard, medium grey, dense, finely crystalline and bentonitic

840– 860 Carlile mudstone, bentonitic, micaceous, with a little chalk, medium grey worn Globorotalia, Robulus and Globigerina, with some fine sand, 850'–60'

860– 870 Sandstone, greywacke, biotitic, medium grained, light grey

870– 900 Marl, sandy and chalky, grey

900– 910 Mostly grey bentonite

910–1000 Some sandstone, medium grained, light grey, with biotite and glauconite, lime cement, angular grains, some black chert grains. Probably the interval is largely dark grey shale
<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000-1050</td>
<td>Cement from casing obscures cuttings</td>
</tr>
<tr>
<td>1050-1160</td>
<td>Siltstone, dark blue-grey, with small white chalk pellets. Some laminae limy</td>
</tr>
<tr>
<td>1160-1170</td>
<td>Siltstone with Globigerina and Inoceramus prisms</td>
</tr>
<tr>
<td>1170-1190</td>
<td>Siltstone with some fine-grained medium grey sandstone</td>
</tr>
<tr>
<td>1190-1270</td>
<td>Greenhorn marl, speckled with chalk pellets, Inoceramus prisms</td>
</tr>
<tr>
<td>1270-1280</td>
<td>Some sandstone with large quartz grains. Numerous Globigerina, a little chalcopyrite</td>
</tr>
<tr>
<td>1280-1330</td>
<td>Marl, bentonitic, chalk-specked, dark grey. Many Globorotalia and Globigerina. The Greenhorn contains some light grey limestone and glauconite, also hauerite (?) and chalcopyrite or bornite. At 1250' light grey sandy limestone has interbeds of finely laminated black bituminous bentonitic shale and rare malachite. 'Probably mainly dark blue grey shale below 1300' and may more properly be uppermost Graneros.</td>
</tr>
<tr>
<td>1330-1530</td>
<td>Graneros shale, bentonitic, limy, dark blue-grey. Some black shale at 1450'</td>
</tr>
<tr>
<td>1530-1700</td>
<td>Shale, mostly dark brown grey but some dark blue grey, with varying amounts of bentonite</td>
</tr>
<tr>
<td>1700-1750</td>
<td>Shale, silty, becoming darker progressively downwards than that above</td>
</tr>
<tr>
<td>1750-1780</td>
<td>Shale, mostly dark brown grey</td>
</tr>
<tr>
<td>1780-1800</td>
<td>Mudstone, bentonitic, medium grey</td>
</tr>
<tr>
<td>1800-1830</td>
<td>Mudstone, dark brown grey, flaky</td>
</tr>
<tr>
<td>1830-1850</td>
<td>Sandstone, light grey, extremely fine (Newcastle)</td>
</tr>
<tr>
<td>1870-1890</td>
<td>No cuttings</td>
</tr>
<tr>
<td>1890-2120</td>
<td>Shale, dark blue grey (Thermopolis or Skull Creek)</td>
</tr>
<tr>
<td>2120-2200</td>
<td>Dakota (Fall River) sandstone, grey, fine</td>
</tr>
<tr>
<td>2200-2257</td>
<td>Fuson shale and bentonite, dark grey</td>
</tr>
<tr>
<td>2257-2301</td>
<td>Lakota water-bearing sandstone, orange, coarse, sub-angular at 2281', light grey bentonite, 2295'</td>
</tr>
<tr>
<td>2301-2320</td>
<td>Morrison siltstone, dark grey, and sandstone, light brown grey, medium</td>
</tr>
<tr>
<td>2320</td>
<td>Some sandstone</td>
</tr>
<tr>
<td>2400-2410</td>
<td>Clay, green</td>
</tr>
<tr>
<td>2410-2420</td>
<td>Sandstone, grey, medium grain</td>
</tr>
<tr>
<td>2430-2440</td>
<td>Sandstone, grey, fine</td>
</tr>
<tr>
<td>2450</td>
<td>Sundance sandstone, light grey and bentonite, light grey-green</td>
</tr>
<tr>
<td>2470-2500</td>
<td>Sandstone, light grey, and bentonite, light grey. Much light grey bentonite, 2480'</td>
</tr>
<tr>
<td>2670</td>
<td>Some glauconitic sandstone and lavender bentonitic clay. Ostracods at 2680'</td>
</tr>
<tr>
<td>2710</td>
<td>Limestone, oolitic, glauconitic, light grey</td>
</tr>
<tr>
<td>2730-2750</td>
<td>Sandstone, glauconitic, light grey, fine grained</td>
</tr>
<tr>
<td>2820</td>
<td>Sandstone, fine</td>
</tr>
<tr>
<td>2900</td>
<td>Siltstone, lavender</td>
</tr>
</tbody>
</table>

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Sandstone, glauconitic, light grey, with siltstone interlaminæ, Morrison and Sundance, except as noted above, are difficulty determinable because of caving. There is considerable of the usual Sundance grey-green bentonitic clay

Increase in amount of silty fine salmon sandstone

Siltstone, salmon

Anhydrite

Siltstone, salmon

Minnekahta limestone, light grey, pink-tinted, lithographic

Opeche siltstone, dark brown red

Some anhydrite

Siltstone, red

Sandstone, dark brown red, fine grained, a little lighter than just above, some white and grey anhydrite

Siltstone, dark brown red

Basal Opeche sandstone, unsorted, coarse to fine grains, rounded to angular, large grains rounded and frosted

Minnelusa anhydrite, finely crystalline, light grey and white

Sandstone, cream white, limy, medium to fine, poorly sorted

Sandstone, cream, coarse, angular grains

Limestone, brown grey, fine texture, and anhydrite, fine, grey

Anhydrite, cream white, finely grained, some faintly pink

Cavings

Siltstone and claystone, dark brown red

Anhydrite, cream and grey, granular to fine crystalline, some yellow and pinkish, some dolomite and coarse green sandstone. At 3700' some pink and orange medium grained sandstone. At 3740' and below some white sandstone

Anhydrite, white to light grey and pink, finely crystalline, some limestone

Some sandstone, coarse, white, limy or dolomitic cement, subrounded grains

Considerable dark brown red siltstone (cavings?)

Anhydrite, grey, irregularly stained pink

Mostly sandstone, coarse white

Anhydrite, grey, stained brick red

Sandstone, medium grained

Sandstone, grey

Anhydrite, grey, and siltstone, bright brick red

Anhydrite, cream, dense to fine crystalline

Anhydrite, cream, and sandstone, fine, pink,
| 3910-3320 | Anhydrite, cream, and siltstone, bright brick red |
| 3920-3950 | Probably mostly cavings, possibly largely anhydrite |
| 3950-3980 | Shale, dark dull maroon, sandstone, pink to grey, medium to fine grained, some coarse, dolomite, dark pink, finely crystalline, some cavernous |
| 3980-4000 | Some limestone, cream, porcellaneous, with milky chert |
| 4000-4010 | Limestone, light grey, fine, dense, perhaps some sandstone |
| 4010-4050 | Limestone, light brown grey, dense, with some Paris green bentonitic shale |
| 4050-4060 | Limestone, magnesian, medium grey, dense |
| 4060-4070 | Some sandstone |
| 4070-4080 | Limestone, as last above |
| 4080-4090 | Limestone, cream, lithographic |
| 4090-4100 | Sandstone, cream, medium grained, angular to rounded |
| 4100-4140 | Dolomite, light creamy brown grey, dense, a little white chert |
| 4140-4150 | Dolomite, light brown, sandy |
| 4150-4160 | Some shale, maroon and bright green, large dolomite rhombs |
| 4160-4185 | Dolomite, cream to pink, porous to lithographic, some large rhombs |
| 4185-4190 | Top of laterite zone, Kaolin or bauxite, white, liny. Leached zone |
| 4190-4195 | Grit, quartzose, angular and rounded, chert fragments and dark red sandy clay |
| 4195-4205 | Laterite, largely siltstone, maroon, with white and light grey spots. Some is Indian red (turgite). Some chert and large quartz fragments |
| 4205-4215 | Pahasapa (Madison) limestone, cream, lithographic, light milky chert |
| 4215-4250 | Limestone, cream, showing crystals |
| 4250-4310 | Limestone, cream, with milky chert |
| 4310-4350 | Limestone, light brown grey, some pinkish, dense fine texture, calcite veined. Some magnesian and dolomitic, small secondary dolomite rhombs |
| 4350-4425 | Limestone, dolomitic, light pink to grey, small rhombs with open spaces between; matrix is calcite |

Static level of Madison water 4100' above sea level, temperature 121° F. Rapid City Airport 1 boring penetrated 400' of Madison limestone.
3. RAPID CITY AIRPORT 3, Pennington County

0- 80' No cuttings
80-100 Terrace gravel and pebbles of quartz, chert, schists, sandstone, limestone, concretionary iron oxide and quartzite
100-130 Pierre bentonitic clay, green grey, very small mica flakes, small limy nodules, Inoceramus prisms and foraminifera, some silt
130-140 Some fine light grey sandstone and small serpentine particles
140-150 Some chlorite and biotite flakes in the marl
150-440 Marl, as above. Shell fragments at 200'-220'. Very limy with bornite replacing shell matter at 240'-70'. Bentonitic siltstone at 270'. First pure light grey bentonite with broken fish bones at 290'. Foraminifera at 310'. A little brown grey limestone at 330'. Copper sulphide and fish scales at 370'. Some fine sand and silt at 420'. Light brown ironstone concretions at 435'-45'
440-450 A little spotted chalky marl. Chalcopyrite. Remainder of interval bentonitic marl
620-630 Marl, spotted chalky, chalk pellets rather sparse in bituminous Sharon Springs shale
710-760 Sharon Springs dark blue grey bituminous shale
790-300 Niobrara marl, flattened chalk pellets in bentonitic bituminous clay
300-340 Carlile shale, dark blue grey
340-350 Bornite fairly common as a cement. Some grey limestone, Belemnitella
360-370 Considerable silt and fine sand
370-380 Shark tooth in shale
380-1010 Shales, dark grey, fine sandy with biotite and epidote, chert and muscovite. Sandstone in whitish spots (tuffaceous)
1010-1060 No cuttings
1060-1150 Mostly cavings. Perhaps some sandstone, 1100'-1150'
1150-1160 Some very dark blue grey shale, probably continues to 1130'
1130-1220 Greenhorn (at least in part) shale, limy to chalky, dense, laminated, very dark grey, sandy and with some sandstone
1220-1260 Apparently typical Greenhorn. Packed Inoceramus prisms. Globigerina especially in thin light grey bituminous limestone films
1260-1270 More limestone than just above
1270-1280 Inoceramus fragments common
1290-1310 Some sandstone, glauconitic, limy, light grey, biotite, also Globigerina and Inoceramus prisms, limestone. Belemnitella

-41-
1310-1330  Graneros shale, dark blue-grey, bentonitic
1330-1400  Shale, dark grey, with minute chalk particles, fish scales
1400-1450  Shale, dark grey, with fish remains
1450-1460  Numerous Globigerina
1460-1470  Bentonite, whitish grey
1470-1490  Shale, as above, but more fissile from here downwards
1490-1510  Considerable light grey impure limestone with fish remains
1510-1520  Sandstone, limy cement, light grey, Globigerina
1530-1540  Shale, dark blue grey, with much broken fish remains
1540-1550  Some limestone, largely of broken Inoceramus prisms
1550-1660  Shale, dark blue grey, broken fish skeletal-fragments, very fine mica flakes, some coarse flaky brown grey bentonite layers
1660-1840  Shale apparently more bentonitic, not so dense and fissile as above. Globigerina and fish remains
1840-1890  Shale, dark blue-grey, apparently more alkaline than usual
1890-1920  Newcastle (Muddy) sandstone, light buff, fine, porous, angular to subround, micaceous and carbonaceous
1920-2220  Thermopolis (Skull Creek) shale, dark blue grey and light brown, bentonitic
2220-2250  Dakota sandstone, fine and bentonite, purple
2250-2260  Sandstone, fine brown red
2260-2360  Fuson shale, dark blue grey
2360-2380  Lakota sandstone, coarse, angular, drab bentonite
2410-2440  Sandstone, dark grey, fine to coarse, angular to subangular, partly recrystallized
2440-2510  Shale, Morrison (?), dark blue grey, flaky, considerable drab bentonite, Ostracods at 2460'-80'
D. North of Black Hills

10. NORTHERN ORDANANCE GOVERNMENT 1, 660' NSL, 660' WEL, SE. 1/4, Sec. 32, T. 15 N., R. 2 E., Harding County. Altitude of ground 3322', derrick floor 3326'.

<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4800</td>
<td>No cuttings</td>
</tr>
<tr>
<td>4800-4860</td>
<td>Opeche siltstone, brown red, some anhydrite, white</td>
</tr>
<tr>
<td>4860-4890</td>
<td>Minnelusa cream and pink dolomite, fine granular, and sandstone, secondary anhydrite</td>
</tr>
<tr>
<td>4890-4900</td>
<td>Mudstone, brown red, green splotted, sandstone, pink, fine to medium, angular to subround, coarse</td>
</tr>
<tr>
<td>4900-4910</td>
<td>white and salmon grit</td>
</tr>
<tr>
<td>4910-4920</td>
<td>Minnelusa limestone, dolomitic, cream, powdery texture, porous, dull lustre</td>
</tr>
<tr>
<td>4920-4940</td>
<td>Dolomite, pink, cream and lavender, finely crystalline, sandstone, white and pink, fine grained</td>
</tr>
<tr>
<td>4940-4950</td>
<td>Dolomite and anhydrite, light buff and white, pink tinted, lithographic texture</td>
</tr>
<tr>
<td>4950-4980</td>
<td>Dolomite, anhydrite and milky chert</td>
</tr>
<tr>
<td>4980-5020</td>
<td>Dolomite, buff, fine granular, pink tinted, secondary anhydrite</td>
</tr>
<tr>
<td>5020-5040</td>
<td>Dolomite, buff, anhydrite, with some siltstone, lavender, dolomitic, bentonitic, flaky, green</td>
</tr>
<tr>
<td>5040-5060</td>
<td>mottled</td>
</tr>
<tr>
<td>5060-5070</td>
<td>Sandstone, cream, fine to medium grained, porous, some coarser etched grains</td>
</tr>
<tr>
<td>5070-5090</td>
<td>Sandstone, light red brown, (salmon), fine to medium grained, porous, subangular, with coarser</td>
</tr>
<tr>
<td>5090-5100</td>
<td>etched grains</td>
</tr>
<tr>
<td>5100-5130</td>
<td>Dolomite, light grey, lavender tinted, fine powdery sugary</td>
</tr>
<tr>
<td>5130-5150</td>
<td>Dolomite, light grey, and pink, fine powdery sugary, sandy, sandstone, white</td>
</tr>
<tr>
<td>5150-5160</td>
<td>Dolomite, cream and partly pink, fine powdery granular texture, some sandstone, light pink,</td>
</tr>
<tr>
<td>5160-5180</td>
<td>Dolomite, cream and light brown, splotted with pink</td>
</tr>
<tr>
<td>5180-5220</td>
<td>Sandstone, light pinkish grey, fine grained, dolomite cement</td>
</tr>
<tr>
<td>5220-5230</td>
<td>Dolomite, light grey, pink tinted, fine granular, some sandy</td>
</tr>
<tr>
<td>5230-5240</td>
<td>Dolomite, lavender tinted, fine granular, some sandy, and fine grey sandstone</td>
</tr>
<tr>
<td>5240-5260</td>
<td>Dolomite, pink, fine granular and pink, some bipyramidal quartz crystals</td>
</tr>
<tr>
<td>5260-5270</td>
<td>Dolomite, cream, splotched with pink, fine sandstone</td>
</tr>
<tr>
<td>5270-5280</td>
<td>Sandstone, dark pink, fine grained, color caused by bright red bentonite</td>
</tr>
</tbody>
</table>
Shale, bright brick red, purple, yellow brown and lavender, bentonite, light grey and green grey, splintery, increasing amount of sandy siltstone downwards

Bentonite, lavender and grey

Anhydrite, grey and pink

Anhydrite, cream and shale

Anhydrite, pinkish cream, crystalline, vuggy

Anhydrite, pinkish cream, dense fine grained

Dolomite, cream, pink stained, dense fine grained

Dolomite, light grey

Anhydrite, light grey

Mainly anhydrite, cream and light grey, and dolomite

Dolomite, cream

Mainly anhydrite, light brown grey, vuggy

Dolomite, cream and light dove, pink tinted, fine sugary

Dolomite, cream and light dove, coarsely crystalline

Dolomite, light dove

Anhydrite, lavender and light grey, shale, carmine and purple

Dolomite, cream, light grey, shale, some pinkish stained, bottom of abundant red shale cavings, 5550'

Dolomite, cream and pink, lithographic, and anhydrite

Anhydrite, light grey, pink and cream, very fine grained

Anhydrite, cream and light blue grey

Dolomite, light grey, fine crystalline

Limestone, partly magnesian, brown cream, vuggy, finely crystalline, dolomite rhombs in calcite, fossils, anhydrite veined

Dolomite, rather dark brown, rhombic, very cavernous

Possibly Pahasapa (Madison) limestone, altered oolitic, very cavernous

Dolomite, light brown, rhombic, cavernous, secondary white anhydrite replacements

Limestone, light grey and brown, oolitic

Dolomite, light brown, cavernous, rhombic, small cream spots, oolites replaced partly by dolomite, which cements them, some anhydrite filled cavities, mostly oolitic limestone below 5670'

Limestone, magnesian, dove, finely crystalline, vuggy, common white spots anhydrite, small dolomite rhombs

Dolomite, brown, vuggy, crystalline

Limestone, cream to light dove, fine sugary texture, partly oolitic; fossils

Dolomite, brown, some white and brown spotted, oolitic, rhombic, vuggy, stylolites

Dolomite, dove, some secondary white anhydrite fillings, some recemented breccia
Anhydrite, white and light grey, fine powdery texture
Anhydrite, light buff, some pink stained, lithographic texture
Dolomite, buff, sugary, very cavernous, altered oolites, some dark brown red shale (cavings?)
Limestone, light brown, shale, red
Anhydrite, light dove and white spotted, lithographic
Dolomite, buff, cavernous, fine sugary
Madison (Pahasapa) (?) limestone, brown, rhombs in finer limestone matrix, fine sugary, oolitic in part, fossils
Limestone, dolomitic, brown grey, fine textured rhombs, with small creamy spots of calcite, cavernous, altered oolitic, perhaps some shale, magenta, 5910'-60'
Limestone, magnesian, cream buff, spotted, many small dolomite rhombs connecting oolites, fossils, oolites more dissolved and more spotted, 5950'-60'
Dolomite, medium grey, very small crystals, a little secondary anhydrite, 5990'-6000'
Limestone, light dove, somewhat fragmental, fragments cemented by coarser calcite, otherwise fine lithographic texture
Dolomite, as at 5960'-6010', with a little purplish stain
Dolomite, light grey, greenish shade, quite silty
Dolomite, light grey, fossiliferous, secondary dogtooth spar and rhombs, some oolites spotted white and grey, dolomite rhombs
Dolomite, light brown, sugary rhombic, with small cavities
Dolomite, light grey brown, more cavernous, medium sized rhombs, vitreous lustre, partly finer sugary crystals, likely recrystallized
Same but a lighter grey brown and with smaller rhombs
Dolomite, as at 6070'-6110'
Dolomite, light brown, medium sized rhombs, quite vuggy
No cuttings
Dolomite, as above, with small amount of chert, light grey, milky
Siltstone and claystone, light green grey and dark blue grey, dolomitic and bentonitic
Dolomite, light grey, very finely crystalline
Dolomite, light green, very finely crystalline
Sandstone, light grey, fine to medium, subangular to subround, some etched grains, chert grains various shades of grey, very poorly sorted, dolomitic cement
Later Ordovician (?) dolomite, light and dark grey, fine amorphous, grading down into light dove lithographic, shale, very dark blue grey, hard, silty

Dolomite, light dove, amorphous, lithographic
Dolomite, medium grey, claystone, medium grey
Limestone, magnesian, medium grey, quite fine texture, somewhat clayey

Dolomite, medium grained, fine sugary, some secondary anhydrite, 6470'-80'
Dolomite, light dove grey, pink splotched, finely crystalline
Dolomite, brown grey (dark dove), large rhombs, probably recrystallized, vuggy
Dolomite, cream, dove near top, coarse rhombs, vuggy

Dolomite above grades down into finer grained, with fine porcellaneous texture, stylolites
Dolomite, dark dove (light brown grey) rather small rhombs, some vugs, a little lighter dove below 6620'
Dolomite, buff and light dove, finely crystalline, some spots of large crystals, stylolites. May be Bighorn (upper Ordovician) which possibly may begin at 6360' though the 6360'-6650' interval may be Niagaran or Devonian

Mostly dolomite, dull greenish, impure, passing down into magnesian limestone, some shale, dolomitic
Siltstone to fine sandstone, grey green, limy and dolomitic cement

Decorah-Platteville (Black River) shale, dull Lincoln green, fissile, bentonitic, chloritic, black phosphate nodules from 6460' down, up to one-half inch size, some siltstone, green, at base very dark grey, purple, lavender and brown shale

St. Peter sandstone, grey, some greenish, fine grained

Sandstone, white, medium grained, porous, subangular, partly recrystallized, grains originally etched, recrystallized. Top may be at 7017'
11. NORTHERN ORDNANCE CORP. HARDING SCHOOL LAND 1, Center SW.
1/4 SW. 1/4, Sec. 1, T. 17 N., R. 1 E., Harding County.
Altitude 3430'.

0- 75' White River Oligocene sand, medium, angular, mica-
ceous, with dark chert, green garnet and vermiculite
particles

75-100 Hell Creek sand, fine grained, and clay, bentonitic,
grey green, carbonaceous, biotitic

100-130 Clay, green grey, bentonitic

130-140 Clay, dark grey, bentonitic, lignitiferous

140-170 Clay, dark grey, bentonitic, with light green small
serpentine nodules, some silt and fine sandstone

170-180 One fossil shell

170-220 Same with more serpentine pellets, fossils, very
bentonitic 75' - 220'

220-230 Clay, as above

260-280 Foraminifera, rather abundant at 280' - 90'

280-310 Shell fragments

310-320 Cone-in-cone concretions, foraminifera and abundant
serpentine nodules

320-340 Clay, very bentonitic

340-350 Inoceramus prisms, biotite flakes, fine sand

350-360 Pyritized plant spores

380-390 Sand, fine

390-400 Many Inoceramus prisms, much fine sand

400-410 Aragonite

410-420 Fox Hills sand, fine, many biotite flakes

420-430 Sand, fine grained, angular, numerous light green
glaucite nodules

430-450 Same with foraminifera

470-480 Clay, with foraminifera

480-510 Sand, fine, angular, foraminifera, biotite

490-510 Sand, fine, angular, glauconite

510-520 Clay, grey, bentonitic

520-560 Grit to fine sand grains, subrounded, etched, some
chert grains, light green glauconite

560-580 Clay, grey, foraminifera and shell fragments

580-590 Sand, medium with some coarse grained

590-620 Conglomerate and grit, pieces up to one-half
inch, some of chert and ironstone, mostly of
quartz, more or less angular, some pebbles well
rounded and polished, a few pebbles of sandstone
and limestone

620-630 Pierre sand, fine, angular

630-650 Clay, green grey, very bentonitic, foraminifera

650 Beginning of pure bentonite beds, casing run at 715'

830 Clay, as in succession above, shell fragments and
Inoceramus prisms

960-970 Sand, fine to medium, with black chert, biotite and
a little glauconite
Foraminifera, small olivine particles

Sand, fine

White mica flakes commoner from here down

Bentonite; light grey

Shale, dark grey

Concretions, dark, limy

Cereal 6 inches of clay ironstone, light brown concretionary, following considerable fine angular sand, biotite, vermiculite, serpentine, a little olivine, milky chert, some bentonitic clay, cemented by iron oxide

Sandstone, limy cement, fine grained, with quartz, serpentine, white chert and a few olivine particles

Foraminifera

Considerable fine sand, angular, with olivine and light green glauconite

Concretion, brown grey

Limestone, light grey

Sandstone, fine grained, arkosic

Usual clay with pure bentonite and concretions down to 2050', with following details

Limestone concretions, light and brown grey, some sandstone, grey, with subangular serpentine particles, some septarian aragonite

Concretions, tan and dark brown, with vein aragonite and calcite

A little azurite (hydrous copper carbonate)

Foraminifera

Copper sulphide, either bornite, covellite or oxidized chalcopryite, bronze color, tarnishing to covellite and chalcopyrite. Fills fossil shell

Robulus

Sandstone, greywacke, with some chlorite

Olivine and chlorite

Sandstone, light grey, greywacke, fine grained, serpentine, biotite

Some vermiculite

Dorothea (also occurs much higher)

Sand, fine, with biotite and serpentine

Chalk, light grey, soft

Bentonite, light milky grey with biotite flakes, a few foraminifera

Fish remains commoner than higher up

Dorothea

Niobrara, Beaver Creek chalky member, shale, dark grey, speckled with soft chalk in minute flattened blebs, really a shaly marl, bituminous

Malachite (hydrous copper carbonate)

Sandstone, grey, fine, angular, many biotite flakes

Chalk marl with foraminifera

Chalk marl with Globigerina, base Niobrara (?)
2490  Bornite
2510  Sandstone, fine
2520-2610  Azurite and bornite, chalky marl with shale, dark grey
2580  Textularia
2608-2623  Core of silty greywacke sandstone with thin inter-films of dark grey shale, considerabe biotite and
vermiculite, plant fragments, mostly clay near bottom
2623-2630  Marl, chalky, foraminiferal
2650  Bentonite, pure, brown and yellow
2750  Sandstone, with serpentine and small black chert particles
2800-2810  A little white chalky material
2810-2870  Sandstone, angular, fine grained, interbedded with
shale, dark blue grey, bituminous, malachite at
2830'-40', chalcopyrite 2860'-70'
2870-2940  Shale, dark blue grey, and limestone, light grey,
fragmental, sandy, packed with Globigerina and
broken Inoceramus prisms. Azurite 2920'-30'
2940-3080  Shale, dark blue grey, with some chalk and pure
bentonite, Globigerina common, thin sand laminae,
some limy films containing sand grains and Ino-
ceramus prisms. The Greenhorn may be from 2960'
to 3050' where the impure limestone appears to be
more abundant. Azurite at 3020'-30'
3080-3500  Much bentonite, some pure, fish remains
3080  Bentonite, light brown grey, biotite and vermicu-
lite, Globigerina common
3110  Azurite
3150-3180  Shale, blue grey
3180  Azurite, brown iron carbonate nodules, in shale,
flaky, slaking, very bentonitic
3220  Azurite
3240  Shale, dark blue grey, with silty laminae, fissile,
miccaceous, azurite, bornite
3280-3290  Sandstone, grey, fine grained, interbedded with
dark grey chalky and bentonitic shale, Globigerina
3290-3300  Sandstone, grey, fine grained, with some limestone
and much biotite
3330-3340  Azurite, fish scales, some creamy chalk
3340-3380  Bornite, interbedded laminated sandstone and shale,
biotite flakes common, Textularia at 3370'
3380-3420  Shale, dark blue grey, flaky, fish scales
3420-3440  Limestone, grey, sandy, fossiliferous
3480-3500  Bentonite, milky, brown, sandstone and shale inter-
bedded
3600-3630  Muddy (?) sandstone, cream-buff, fine to medium
grained, angular to subangular, soft, porous. This
is possibly the Dakota sandstone.
3630-3740  Some beds of bentonite, milky, yellow
3630-3640  Sandstone, medium grained, angular
3650-3680  Shale, dark grey, very small chalk spots, foramini-
fera

-43-
3680-3700 Clay ironstone, light brown, considerable brown
grey bentonite, fish scales
3710 Azurite
3710-3710 Shale, dark blue grey, quite flaky and bentonitic,
fish scales, bones and spines
3910-3917 Core of mudstone, compact, dense, very dark blue
grey, "ripple"-laminated, very fine mica flakes
3929-3948 Core: upper 5½', mudstone with bentonite specks
  3', siltstone, grey, lenticular, with
  laminated darker grey muddier
  sediment
  lower 4½', mudstone, dark blue grey, finely
  laminated
3941½-3948 Core: Dakota, upper 4' 10", siltstone to fine
  sandstone, light grey
  in thin lenses, inter-
  laminated with finer,
  darker grey
  lower 1' 2", sandstone, light grey,
  fine grained, mica-
  ceous, bentonitic, chlo-
  ritic, angular, porous
3948-3966 Core, sandstone, light grey,
  fragments, fine grained
  with lignitic plant
3966-3970 Bentonite, green drab
3970-4050 Sandstone and shale, as overlying, biotite, white
  mica and chlorite flakes
4050-4075 Shale, dark blue grey, biotite
4075-4078 Core, mudstone, dark grey
4078-4079 Lakota sandstone, light grey to white, medium grained,
  angular, much lignitiferous material, bentonitic
4073-4085 Sandstone, light grey, coarser
4085-4150 Sandstone, light to dark grey, fine to coarse, some
  chert and biotite, lignitic, recrystallized
4150-4180 Morrison lignitic shale and sand, clay, light grey,
  bentonitic
4180-4220 Shale, dark blue grey and bentonite
4220-4235 Sundance bentonite, lavender, terra cotta, grey and
  green, sandstone, grey, fine grained, glauconitic,
  angular, Pachyteuthis (Belemnites) found in cavings
  lower down
4240-4250 Azurite and bornite rather common, bentonite, vari-
  colored
4250-4270 Bentonite, grey, lavender, terra cotta
4270-4310 Bentonite, varicolored
4310-4330 Bentonite, green, grey, etc.
4330-4470 Bentonite, grey and brown, abundant
4330-4340 Limestone, cream, finely crystalline, in part sandy
4340-4400 Some strata of glauconitic sandstone, bentonite
  green, sandy, at 4380'-30'
4400-4430 Sandstone, light grey, fine grained, glauconitic,
  angular grains, limy
4450-4460 Gryphaea
4460-4510 Bentonite, pure, brown, grey and lavender
4510-4530 Sandstone, light grey, fine grained, glauconitic, siltstone, dark grey
4530-4540 Sandstone, light grey, fine grained, bentonite, white, Pachyteuthis
4540-4550 Sandstone, light grey, fine grained
4550-4590 Sandstone, as above, shale, green grey, bentonitic
4590 Sandstone, below to 4750' pure bentonite in the cuttings
4750 Siltstone, terra cotta, shale, green grey, and sandstone, grey, fine grained
4786-4810 Limestone, cream, lithographic, shale, light green, flaky, bentonitic
4810-4840 Spearfish (?) siltstone, red brown
4840-4860 Anhydrite, white, magnesian limestone, light brown, lithographic
4860-4865 Limestone, light brown with anhydrite, very fine lithographic, mudstone, red brown bentonite, sandstone, glauconitic, light green grey
4865-4870 Sandstone, coarse, ferruginous
4870 Pachyteuthis in cavings
4910 Sandstone, grey, unusually large glauconite pellets, limestone, magnesian, white, soft powdery, siltstone, light green grey, bentonite, lavender, some medium sized well polished grains and white and black mica in sandstone
4980-5345 Spearfish siltstone, salmon, with sand grains. Top of Spearfish may be at 4810', cavings obscuring formation below
5345-5350 Minnekahta limestone, dolomitic, cream, fine sugary, anhydrite white, alabaster
5380 Same but limestone cream, grey, pink and light brown
5330-5470 Probably Opeche red beds, mostly cavings
5470-5500 Minnelusa dolomite, buff, very fine sugary, porous, some light pink, sandstone, coarse, grey, mostly cavings
5500 Bentonite, pink, hard, flaky, mostly cavings
5520-5530 Dolomite and sandstone, red, coarse, mostly cavings
5530-5580 Dolomite, pink and grey, fine sugary, sandstone, pink and grey, coarse to medium, limestone, sandy, mostly cavings
5580-5605 Dolomite, cream, fine sugary, some full of sand grains
5605-5620 Sandstone, grey and pink, fine to medium grained
5620-5660 Dolomite, pink and grey, fine powdery
5660-5670 Sandstone, white, fine, subround
5670-5710 Sandstone, cream and pink, fine grained and dolomite, cream and pink
5720-5730 Dolomite, cream, grey, with sandstone
5730-5760 Sandstone, cream, fine grained, some quite limy, dolomite, cream and pink

-51-
5760-5790  Dolomite, cream and pink, some light brown grey, fine texture
5790-5860  Dolomite, cream, buff and pink, fine powdery, vein calcite
5860-5910  Siltstone, bright red, grading to tan, mostly dull brown red in lower half. Some sandstone and grit
5910-5920  Big Snowy (?) limestone, cream and light grey, lithographic
5920-5970  Limestone, grey, pink stained and streaked, lithographic, calcite-veined, largely cavings
5970-6000  Large calcite rhombs in finer matrix
6000-6020  Siltstone, red, limestone, pink, dolomite, light grey
6020-6070  Anhydrite and dolomite mixed, fine sugary, minute dolomite rhombs, calcite, some sand grains, crystallized quartz crystals at 6040'-50', mostly cavings
6070-6080  Limestone with dolomite rhombs, porous, dull, powdery
6080-6150  Limestone, as above fossiliferous, some larger rhombs, anhydrite zone with carbonate interbeds and mixtures, 6000'-6220'
6150-6200  Some oolites, limestone, cream buff, coarser than above, fossils
6200-6220  Anhydrite, white and brown grey, light blue grey, dull, dolomite, light brown, lithographic
6220-6240  Anhydrite, light brown grey, chert, blue
6240-6270  Madison (?) dolomite, spotted grey, coarsely crystalline calcite
6270-6280  Limestone, more oolitic downwards, more coarsely crystalline, quite porous, stylolitic
6280-6290  Limestone, oolitic
6290-6400  Small dolomite rhombs in calcite matrix, fossiliferous
6400-6465  No cuttings
6465-6485  Cavings
6485-6520  Dolomite, white to dove
6520-6525  Limestone, buff, porous, dolomite rhombs in calcite matrix with anhydrite, light blue grey, wholly crystalline, oolites and imperfect oolites with pore spaces between
6525-6600  Limestone, cream, lithographic, anhydrite, some oolitic, also finely crystalline, rhombic, fossils
6600-6760  Limestone, light brown grey, finely crystalline, vuggy, dolomitic rhombs in white fine limestone matrix, limestone, white, chalky
6760-6790  Limestone, light brown grey with dolomite rhombs
6790-6815  Limestone, light brown grey, fine sugary
6815-6900  Pahasapa (Madison) limestone, cream buff, crystalline, imperfectly oolitic, fossils
6900-6930  Limestone, buff, recrystallized with vestigial oolites, a little sandstone, fine grained, pink, fossils, malachite, some chert, some limestone, porcellaneous
6930-7045 Limestone, some magnesian, fossils
7045-7085 Dolomite, white, chalky, limestone, magnesian, cream to dove, finely crystalline, chert, milky white
7085-7110 Limestone, pink
7110-7125 Limestone, pink, with small specks of green clay
7125-7175 Dolomite, mostly, conglomerate, pink, ferruginous, coarse sand grains, limestone pink partly pinkish dolomite
7175-7220 Limestone, cream, finely crystalline, flaky
7220-7250 Limestone, cream, and pink
7250-7275 Limestone, magnesian, cream and lavender, lithographic
7275-7295 Dolomite, cream, porcellaneous, stylolitic
7295-7430 Limestone and dolomite, very fine grained, light blue grey and brown, conglomerate at 7375' may be base of Madison.
7430-7495 Limestone, becomes light grey brown, some cream, very fine dense, mostly dolomite
7495-7500 Limestone, dolomitic, light brown, rhombic
7500-7540 Limestone, dolomitic, buff to light brown, very little milky chert
7540-7545 Limestone, cream
7545-7560 Limestone, cream, dull, fine powdery texture, dense, lithographic
7560-7630 Dolomite, light brown (dove) and cream, a little coarser than just above, contains anhydrite
7630-7750 Dolomite, dove, more coarsely crystalline, rhombic, stylolitic, limestone, soft white chalky
7750-7755 A little milky chert
7755-7760 Dolomite, pink, fine rhombic
7760-7830 Dolomite, dove, spotted, pink, fine rhombic
7830-7835 Brachiopod
7835-7905 Shale, dark Lincoln green, unctuous, flaky and splintery, with some quartz and black phosphate grains (Decorah ?)
7905-7980 Shale, green and purple, some very bentonitic and green, cores from 7913'-62' are shale, dark green, chloritic, dense compact, conodont (Belodus compressus); cores from 7962'-66' shale, dark grey, siltstone, green grey, with thin shale lenses, black phosphate and sand grains at 7965'-66' is medium grey bentonite
7980-8000 St. Peter sandstone, pure white, medium to coarse grained, subrounded, calcite cement, etched grains in part recrystallized
12. STATE ROYALTY PETROLEUM CO. 1, 100' NW. of center, SW. ¼ NE. ¼, Sec. 35, T. 13 N., R. 1 E., Harding County. Altitude 3267.5'


0- 160' Lance
   160- 380 Fox Hills
   380- 540 Pierre bentonitic clay
   540- 760 Pierre bentonitic clay, light green grey, *Inoceramus prisms*, clay ironstone concretions, very small mica flakes, shell fragments, hauerite (bronzy "pyrite"), some fine sand, more forams below 720'
   760- 800 With some fine angular grains of sand and small dark brown grains, perhaps of volcanic rock
   800- 900 Clay, bentonitic, light green grey, small flakes biotite, muscovite, chlorite or vermiculite, small serpentine nodules, occasional fragment of olivine, fine angular quartz grains, fish and shell fragments and *Inoceramus prisms*
   900-1020 Clay, bentonitic, green grey, biotite and chlorite, clay ironstone concretions, fine quartz silt, shell fragments and *Inoceramus prisms*
   1020-1100 Less sticky clay from here down, but forams very rare
   1100-1150 Fish remains more common and clay in part darker.
   1150-1260 First pure, bentonite, 1110'
   1260-1270 No cuttings
   1270-1280 As last above
   1270-1280 Sandstone, grey, fine grained serpentinous greywacke. Resistivity log indicates sandy zone 1315'-1365'
   1280-1420 Clay as above, clay ironstone concretions
   1420-1440 Sand, fine grained
   1440-1620 Usual clay, clay ironstone concretions
   1620-1680 Clay has considerable vein calcite
   1680-1700 Considerable sand
   1700-1720 Some limestone, light grey, impure
   1720-1730 Tan clay ironstone
   1730-1740 Bentonite, grey
   1740-1750 Bentonite, light yellowish or greenish grey, flaky
   1780-1810 Bentonite and concretions, shell fragments
   1810-1840 Some serpentinous greywacke
   1840-1865 Considerable fine sandy
   1860-1890 Clay, as usual
   1890-1900 Fine sandy
   1900-2070 Fish and shell fragments, ironstone concretions, a small portion with small chalky particles
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2070-2080</td>
<td>Core of clay, light green grey, laminated, very bentonitic, small chalky particles</td>
</tr>
<tr>
<td>2080-2160</td>
<td>Clay, as usual, with some purer bentonite</td>
</tr>
<tr>
<td>2160-2300</td>
<td>Niobrara darker chalky marl, with small flattened chalky particles</td>
</tr>
<tr>
<td>2300-2390</td>
<td>Carlile shale, light green grey</td>
</tr>
<tr>
<td>2390-2400</td>
<td>Some fine sand with abundant biotite flakes</td>
</tr>
<tr>
<td>2400-2410</td>
<td>Chalcopyrite</td>
</tr>
<tr>
<td>2430-2480</td>
<td>Sandstone, light grey, fine grained, greywacke, calcite cement, considerably biotite, more prevalently sandstone 2450'-2470'</td>
</tr>
<tr>
<td>2480-2540</td>
<td>Shale, blue grey, chalcopyrite</td>
</tr>
<tr>
<td>2540-2550</td>
<td>Large amount of dogtooth spar</td>
</tr>
<tr>
<td>2570-2580</td>
<td>More limy, much secondary calcite, <em>Inoceramus</em> prisms</td>
</tr>
<tr>
<td>2610-2620</td>
<td>Malachite</td>
</tr>
<tr>
<td>2630-2640</td>
<td>Pyritized <em>Inoceramus</em> prisms</td>
</tr>
<tr>
<td>2650-2660</td>
<td>Calcitized aggregates of <em>Inoceramus</em> prisms--Greenhorn (?)</td>
</tr>
<tr>
<td>2660</td>
<td>Black bituminous shale begins and increases downwards</td>
</tr>
<tr>
<td>2710</td>
<td>Sand, fine, biotitic, interlaminated with black shale</td>
</tr>
<tr>
<td>2730-2740</td>
<td><em>Globigerina</em> common</td>
</tr>
<tr>
<td>2740-2760</td>
<td>Greenhorn abundant broken <em>Inoceramus</em> prisms, probably a sandy crystalline limestone, some serpentine fragments and <em>Globigerina</em></td>
</tr>
<tr>
<td>2760-2800</td>
<td>Shale, dark grey, bituminous</td>
</tr>
<tr>
<td>2800-2810</td>
<td>Bornite</td>
</tr>
<tr>
<td>2810-2840</td>
<td>Limestone, light grey, impure, <em>Globigerina</em>, broken <em>Inoceramus</em> prisms, some serpentine fragments. Chalcopyrite at 2820'-30', base Greenhorn (?)</td>
</tr>
<tr>
<td>2840-2850</td>
<td>Chalcopyrite, less limestone, fish remains</td>
</tr>
<tr>
<td>2850-2870</td>
<td>Some limestone</td>
</tr>
<tr>
<td>2870-2940</td>
<td>Graneros shale, dark grey, some limestone</td>
</tr>
<tr>
<td>2940-2970</td>
<td>Shale, black, bituminous, fissile, compact</td>
</tr>
<tr>
<td>2970-2980</td>
<td>Chalcopyrite, shell fragments</td>
</tr>
<tr>
<td>3000-3010</td>
<td>Chalcopyrite</td>
</tr>
<tr>
<td>3020-3080</td>
<td>Chalcopyrite, black shale</td>
</tr>
<tr>
<td>3080-4650</td>
<td>No cuttings, but resistivity log and geologist's record indicate that Graneros black and dark grey shale continues to 3415' depth, Muddy or Newcastle sandstone with shale interbeds occurs at 3415'-55', then black (Thermopolis) shale to 3785', Dakota sandstone, white, fine grained, 3785'-3860', Fuson shale, black, and interbedded grey and tan fine grained sandstone, from 3860'-3965', Lakota sandstone, white, fine grained, 3965'-4000', Morrison clay from 4000'-4125' and upper Sundance clay and sandstone, 4125'-4650'</td>
</tr>
<tr>
<td>4650-4660</td>
<td>Sundance limestone, dove, lithographic, in part originally oolitic, cavings of light green fine grained glauconitic sandstone, light green, yellow green and brown bentonitic clay</td>
</tr>
</tbody>
</table>
4660-4670 Much grey and a little lavender bentonite
4670-4700 Considerable clay, greenish yellow, drab and lavender, silty and bentonic, some varicolored and spotted, a little terra cotta silt
4700-4710 Limestone, clayey and silty, soft amorphous, chalky, with some dolomite and secondary anhydrite
4710-4720 Mudstone, lavender, limy, bentonitic
4720-4730 Limestone, brownish dove, lithographic
4730-4810 Spearfish siltstone, dark brown red, splotched with light grey, secondary anhydrite
4810-4820 Sandstone, dark brown red, very silty, fine to coarse grained, secondary anhydrite
4820-4904 Siltstone, dark brown red, some anhydrite. Sandstone, 4825'-40' below which siltstone is either sandy or contains sandstone interbeds
4904-4914 Core. Siltstone, dark brown red, with small mica flakes
4914-5110 Siltstone, dark brown red, partly sandy, fine grained sand
5110-5188 Siltstone, salmon, full of small sand grains
5188-5230 Minnekahta thin white anhydrite at top. Remainder limestone, light grey and pink, fine texture, dull lustre, soft. Finely crystalline and more compact 5200'-30', deep pink color, 5210'-20', lower 15' silty and light brown
5230-5320 Opeeche siltstone, dark brick red, some fine sand and secondary anhydrite. Some coarse sand grains 5310'-20'
5320-5340 Sandstone, white and light grey, pink stained, fine and medium grained, angular, recrystallized
5340-5410 Siltstone, brick red, possibly cavities
5410-5425 Minnelusa dolomite, dove grey, lavender splotched, lithographic
5425-5435 Core of sandstone, pink and light grey, angular, medium grained
5435-5440 Dolomite, dove, lithographic, partly sandy
5440-5445 Dolomite, lavender, grey spotted, fine granular
5445-5450 Dolomite, grey, lavender tinted, fine granular, secondary anhydrite
5450-5460 Sandstone, cream, coarse to medium, etched, sub-round, insoluble cement
5460-5470 Sandstone as above, with dolomite, light brown, lavender
5470-5480 Dolomite, dove, fine crystalline, with larger secondary rhombs
5480-5500 Sandstone, cream, lavender tinted, coarse to medium, etched, sub-round, dolomite cement, some bipyramidal quartz
5500-5505 Dolomite, cream, lavender tinted, fine granular to lithographic
5505-5510 Dolomite, lavender, fine granular
5510-5515 Dolomite, cream, lithographic, milky chert
5515-5520 Sandstone, cream, lavender tinted, fine grained, dolomite cement
5520-5530 Dolomite, cream, sandy, lavender stained, some sandstone as overlying
5530-5535 Sandstone, fine grained, cream, lavender tinted, dolomite cement
5535-5545 Dolomite, dove, lavender stained, fine dense, mostly lithographic, white chert and anhydrite
5545-5550 Sandstone, cream, fine grained, angular
5550-5567 Core: Dolomite, dove, lavender stained, fine, dense, and shale, purple
5567-5576 Dolomite, cream, some lavender tinted, porcelainous, dull, milky chert
5576-5578½ Core: Mostly white anhydrite but some dolomite, pink and dove, dense, with calcite veinlets
5586-5593 Core: Dolomite, light pink grey, lithographic to fine granular, cuttings of fine rhombic dolomite
5593-5600 Core: Dolomite, light lavender and cream, fine rhombic, some very light green bentonite
5600-5605 Core: dolomite, pink, cemented breccia and light grey lithographic, anhydrite, white
5605-5610 Core: dolomite, purplish, earthy, and light grey, also mudstone, purple, dolomitic, cuttings largely bentonite, light lavender and light green, shaly
5610-5627 Dolomite, pink and cream, dense lithographic to fine granular, some secondary anhydrite, stylolites, also noted higher up
5627-5630 Same as last except some is pink and coarse rhombic
5630-5635 Core: anhydrite, white and grey, coarsely crystalline
5635-5645 Core: dolomite, dark lavender, fine grained to coarse rhombic
5645-5652 Core: mudstone, dull cochineal red, some grey dolomite, crystalline, top of laterite zone
5652-5662 Core: bentonite, sandy, yellow brown, pink, grey and lavender
5662-5684 Sandstone, cream, medium to coarse grained, etched, subangular, some is lavender and light green, some fine grained but mostly coarse, some bentonite, light sea green, splotched with lavender
5684-5694 Sandstone, white and red brown, cross bedded, coarse, angular, with some black chert grains, the matrix is laterite
5694-5704 Core: siltstone, dull brown red, sandy, mottled with a lighter shade
5704-5709 Core: siltstone, salmon, with bleached spots of buff, mostly continuous cores from 5709'-'7511'
5709-5714 Mudstone, lavender, purplish and and bright brick red, anhydrite, pinkish, grey, yellow, sandy bentonitic clay. Some red siltstone and sandy mudstone, grey bentonite, red sandstone with bentonitic matrix

-57-
5714-5724  Sandstone, cream to buff, medium to coarse angular, limy cement, grains partly recrystallized, also core of coarse to medium white sandstone, also buff sandstone, including some bentonite and brick red fine siltstone

5724-5734  Core same sandstone and some lavender siltstone, also grit, brick red and buff, with secondary anhydrite, bentonitic red, lavender and yellow mudstone

5734-5740  Core mudball conglomerate, green in purple matrix of silt and fine sandstone, also lavender siltstone and pink-stained grey sandstone with un assorted grains of all sizes.

5740-5750  Limestone, light grey, pink and lavender-stained, very fine texture, a little anhydrite (overlapping samples 5740'-62')

5740-5747  Core purplish, lavender and green bentonitic mudstone, purple-stained light grey dolomite, bipyr amidal quartz crystals

5750-5760  Limestone as at 5740'-50' with a little intermixed anhydrite

5747-5757  Core, same as cuttings, with some light greenish anhydrite fillings

5757-5762  Core of same dove limestone with secondary anhydrite and green and purple shale interbeds, coarse subangular sand in green bentonite

5762-5770  Same as last

5770-5780  Same with some light grey sandy dolomite, some oolitic, also medium-sized dolomite rhombs in white powdery limestone matrix

5780-5790  Same (core) with purple and magenta hard siltstone concretion, cuttings of anhydrite and silty and sandy dolomite

5790-5807  Core streaked lavender, purple and green light fine grained limestone, with a little anhydrite, some coarse and fine grey and pink limestone and pink siltstone in cuttings

5807-5812  Core pink and green-grey mottled mudstone and anhydrite, fine, white, pink-tinged

5812-17-22  Core anhydrite, light greenish, pinkish and white

5822-5840  Core anhydrite, white

5840-50-60-70  Cuttings and cores of limestone, medium grey, finely crystallized with small dolomite rhombs in core fragments of white anhydrite and pink and cream spotted soft powdery dull dolomite, anhydrite and dolomite with interbedded pink-stained anhydrite

5870-5878  Intermixtion of anhydrite and dolomite, small rhombs dolomite in anhydrite ground mass, buff, core has also dove and purple-splotched dolomite and some secondary anhydrite.

5878-5884  Same as just above

5884-5891  Core light buff limestone with coarser dolomite rhombs
Limestone, light buff
Limestone, buff, porous, altered oolitic and altered fossils, cavernous, also same as just above
Limestone, buff, fine, dull, stylolitic, oolitic, some with dolomite rhombs
Limestone, light brown-grey, porous, many dolomite rhombs
Limestone, rhombs of dolomite in white finer matrix
Limestone dove, fine rhombs in white matrix
Dolomite, dove, fine rhombic
Limestone, dove, coarsely crystalline
Limestone finely crystalline with much secondary calcite
Limestone with light grey anhydrite
Anhydrite and dolomite, white, dove, brown, grey, pink, lavender, lavender-brown, light and dark blue-grey, varicolored, some limestone 6005'–16'. Some spotted dolomite may have been originally oolitic. It has larger crystals in a finer matrix. Lower anhydrite is darker grey.
Limestone, oolitic, vuggy, dove, Madison (?)
Limestone, finer, vuggy, dove, porous
Limestone, dove, dolomite rhombs in calcite matrix 6134'–44', oolitic and vuggy
Limestone dove, oolitic
dolomite, fine rhombic, vuggy, dove or buff
Limestone, oolitic, buff
Limestone and dolomite, buff
Limestone, buff, finely crystalline, stylolitic
Dolomite, dove, finely crystalline with light grey anhydrite
Anhydrite, light grey, light bluish grey and dove, a little dolomite
Dolomite, dove, finely crystalline, very vuggy
Dolomite, dove, finely crystalline, limy
Dolomite, oolitic, buff
Dolomite, light brown, fine crystals
Dolomite rhombs in cream powdery calcite
Dolomite, oolitic, cream-buff
Limestone, oolitic, Schuchertella, and white coarse anhydrite
Dolomite, dove, finely crystalline, porous, with anhydrite
Dolomite, brown-grey, fine rhombic, stylolites with anhydrite
Dolomite, light grey, finer
Dolomite, light grey, finer, with light grey coarser limestone
Dolomite, light brown, sugary, with light grey coarser limestone
6495-6501  Limestone, spotted cream and light brown, altered oolites, porous
6501-6511  Limestone, light and medium grey, stylolitic
6511-6521  Limestone, light and medium grey, dolomite, light grey fine, anhydrite, grey-white
6521-6530  Limestone grey, magnesian, lavender stained
6530-6560  Dolomite, light grey to purple, finely crystalline and grey stylolitic limestone 6540'-60'
6560-6580  Limestone, grey, medium crystals and dolomite, grey and purple with large anhydrite-filled cavities
6580-6583  Both limestone and dolomite as above, limestone fossiliferous, light grey, stylolitic
6583-6593  Limestone, grey, stylolitic, medium crystals, also cream, oolitic, very porous
6585-6595  CORRECTED DEPTH—Limestone, grey, stylolitic, fine sugary dolomite, lavender-tinged light grey
6535-6605  Limestone, light grey, medium crystals, in part lavender-stained
6605-6615  Limestone, light grey, purple-stained, fine, some fairly coarse, grey, purple-specked, some pink-stained stylolitic
6615-6625  Limestone and dolomite, cream and light grey, lavender-stained, also limestone, coarsely crystalline altered oolitic
6630-6638  Limestone and dolomite, light brown, fine, porous
6638-6643  Dolomite, light brown, fine, sugary and limestone, cream to light brown
6643-6648  Limestone, light dove, finely crystalline
6648-6652  Dolomite, purple-tinged grey, fine sugary, stylolitic
6652-6664  Limestone, dolomitic, fine sugary, light grey, Productus
6664-6669  Limestone, light brown-grey, fine
6669-6672  Limestone, buff, fine
6672-6676  Limestone, cream-buff and dolomite, white, powdery, very porous
6676-6686  Limestone, light dove, sugary, light grey chert
6686-6636  Limestone and dolomite, light dove, sugary
6636-6701  Limestone light dove, sugary and dolomite, fine, grey, stylolitic
6701-6708  Limestone, and dolomite, light grey, sugary
6708-6710  Limestone, light brown-grey, medium crystals and dolomite, cream
6710  Limestone, light grey, fine and dolomite, light brown very porous, sugary
6713-6723  Dolomite and limestone, light dove and cream, very porous, chert, white, porous
6723-6733  Dolomite dull brown-grey, vuggy
6733-6740  Dolomite and limestone, light dove, porous, limestone is oolitic
6740-6749  Limestone, magnesian, limy, dove, sugary
6749-6756  Dolomite, limy, dove, sugary, also cream colored, chert, fine, opaque, porous

-60-
6757-6761  Dolomite and limestone, light grey and brown, sugary
6767-6801  Dolomite, grey-brown and cream, medium rhombic porous with white anhydrite fillings
6801-6815  Dolomite, light brown-grey, fine, with white anhy-
           drite fillings, white porous chert, thin shelled brachiopods
6815-6820  Dolomite, light and medium grey, fine sugary
6820-6828  Dolomite, darker grey, sugary, white decomposed chert
6828-6832  Dolomite, light brown, fine sugary
6832½-6837  Dolomite, medium grey, fine sugary, anhydrite fillings
6837-6841  Dolomite, light brown, fossils, white decomposed chert, sponge spicules
6841-6846  Dolomite, light grey, anhydrite fillings, sponge spicules
6846-6852  Dolomite, light grey, cream amorphous chert, sponge spicules
6852-6855  Limestone, light grey and cream
6855-6858  Dolomite, light grey stylolites, large amount anhy-
           drite, cream and light grey
6858-6861½  Anhydrite, very fine, stylolites, light brown-grey, perhaps mixture of dolomite and anhydrite
6861½-6874½  Dolomite, brown-grey, sugary and white anhydrite with cream amorphous chert below 6865'
6874½-6876½  Dolomite, grey sugary and cream amorphous chert
6876½-6884½  Dolomite, grey sugary and cream amorphous chert
           with sponge spicules and secondary anhydrite
6884½-6887  Limestone, grey, fine, stylolitic
6887-6889  Limestone, grey, fine with cream amorphous dull chert
6889-6914  Dolomite, pink-stained light grey, medium crystals, glauconite specks 6889'–34'
6914-6933½  Dolomite, grey and purple, fine, some pink and vuggy, glauconite specks 6914'–19', with mudstone, purplish, sericitic, partly silty
6933½-6934½  Dolomite, pink, with white anhydrite cavity fillings
6934½-6940  Dolomite, light pink to lavender with large to small etched sand grains and small pebbles, possibly basal Englewood
6940-6945  Dolomite, buff and cream, fine sugary, vuggy
6945-6949  Dolomite, buff and cream, light greenish and grey, dark green and purple fine mudstone and siltstone, some fairly light green, chloritic
6949-6961  Dolomite, light brown-grey, vuggy sugary with larger secondary crystals
6961-6965  Dolomite, grey and cream, fine sugary to powdery, dull
6965-6966  Dolomite, pinkish, but mostly dolomitic green and lavender silty hard mudstone
6966-7002  Dolomite grey, cream and lavender, fine, lower 5' green and purple specked

-61-
Dolomite, light grey sugary with white anhydrite fillings

Cream sugary, porous, fine secondary anhydrite

Bighorn dolomite, cream, vuggy, stylolites, with *Zygospira modesta*, diagnostic for Richmond Upper Ordovician

Dolomite, fine, cream and light grey

Dolomite, fine, cream and light grey, partly oolitic, with light green "meta"-bentonite

Dolomite, fine, cream and light grey and large chunk anhydrite, very fine dense cream

Dolomite, some purple and pink stained, cream, dense

Mudstone, light green, light grey, green-grey, purple, lavender, grey, dark grey, cream, probably mixed with dolomite, stylolites, purple and green anhydritic shale, 7101'-12'

Dolomite, buff, greenish, lavender, light brown, dark grey, dense, fine, fossils, 7136'-45'

Dolomite, medium grey, dense, fine, some secondary anhydrite

Dolomite, lavender and light grey green, dense, fine, some coarser and crystalline

Claystone, dolomitic, lavender, purple and green, anhydrite cement

Claystone, dolomitic, same, white anhydrite cavity fillings

Dolomite, light grey-green, lavender-stained, lower 7' cream-brown and light pink with fine cream-buff dolomite. A little light green unctuous bentonite 7247'-53'

Dolomite, large rhombs, some anhydrite, cavernous, light lavender, brown and grey

Limestone, fine light brown, *Zygospira*, mudstone, finely laminated, grey, purple stained

Limestone, magnesian, cream, fine and mudstone, dolomite, light grey and purple, fossils

Limestone, magnesian, light grey, with a little anhydrite

Dolomite, light cream, faintly laminated, vuggy, lower half with minute veinlets

Dolomite, light cream and light brown-grey, sugary with some light brown-grey limestone 7337'-55', wavy laminae 7347'-55', considerable secondary anhydrite 7361'-63'

Limestone, cream, medium crystals, small rhombs dolomite

Dolomite, light brown and grey some pink-stained, stylolitic, porous to sugary and dense, some secondary anhydrite, some rhombic, also light brown-grey limestone, fine dense, 7456'-64'
7485-7488 Limestone, cream, fine matrix with smaller dolomite rhombs and larger calcite crystals
7488-7501 Dolomite, limy, light brown-grey, fine sugary
7501-7514 Limestone, light dove to brown-grey, fine sugary, fossils, stylolitic. Strophomena at 7508'-11' Mainly cuttings 7514'-7908' T.D.
7514-7625 Limestone, cream to dove, finely crystalline, partly pink-stained
7625-7640 Limestone, pink, fine rhombs
7640-7689 Limestone, less uniformly pink
7689-7710 Limestone, light and medium grey, finely crystalline
7710-7720 Limestone, darker grey, silty, finely crystalline
7720-7730 Middle Ordovician dark grey limestone, very fine to medium crystalline. Contains oldest known fish scales and Mid-Ordovician graptolites
7730-7740 Decorah-Platteville shale, dark blue-grey grading down into green chloritic. Basal limestone may contain small brown chert pebbles and fine sand grains
7740-7745 Shale, chloritic, bentonitic, green, with scattered small quartz grains and black phosphate grains, apparently a little fine light grey sandstone at upper contact
7745-7777 Decorah-Platteville shale, Lincoln green, bentonitic, chloritic, fine sandy and black phosphate grains, some rolled and rounded and fine pebble size
7781-7783 Some green siltstone
7781-7785 Green shale has some sandstone, white, fine to medium, subround to subangular
7785-7820 Green shale, darker green grey, some sandstone, white, coarse, angular
7820-7903 St. Peter (Lower Ordovician) sandstone, cream, poorly cemented, porous, grains medium to coarse, angular to subround, partly recrystallized. Saturated with light yellow oil at 7820'. Angular pink feldspar fragments from 7876' downwards
7903-7908 Sandstone, arkosic, with abundant fresh pink potash feldspar, muscovite, some bornite. Sand grains angular to subangular, coarse to fine. Some grit, quartzose, T.D.
E. South of Black Hills

13. BELL OIL CO. BELL (CLEVELAND STONE QUARRY) 1, NW. corner
Sec. 8, T. 8 S., R. 3 E., Fall River County. Drilled with
cable tools.

0- 30' Gravel, pebbles and Lakota sandstone, buff, coarse
to fine, angular
30- 40 Sandstone, fine grained, angular, with light green
bentonitic matrix
40- 50 Sand, cream, coarse to fine, etched, recrystallized,
angular to sugangular
50- 60 Morrison sand, fine, with bentonitic matrix, lavender,
light grey and light green
60- 70 Sandstone, light green to cream buff, white ashy
matrix, fine to silt size grains, angular, bentonitic
matrix
70- 80 Sandstone, light grey, shale, dark brown grey, bi-
tuminous, bentonitic, some silty, hard and tough
80- 90 Shale, as just above, with interlaminae of siltstone,
lighter grey
90- 100 Shale, brown, bentonitic, bituminous, with sandstone,
fine to medium, angular grains
100- 140 Sand, grey, medium to fine, angular to subrounded, ben-	onite, medium grey, silt grey, considerable sand
recrystallized
140- 165 Siltstone, grey and brown, very bentonitic, grades
down into sandstone and grey bentonite
165- 185 Sandstone, grey, medium to fine, subangular to sub-
round, some recrystallized, some etched, some vein
selenite
185- 190 Bentonite, light green grey and medium grey
190- 200 Shale, dark brown grey, bituminous, sandstone,
grey, fine
200- 220 Sandstone, cream, fine, siltstone, dark grey, shaly
220- 230 Bentonite, light blue grey
230- 240 Sandstone, light grey, fine, shale, black, bituminous
240- 260 Bentonite, light blue grey, chalcopyrite and some
shale, grey, 250'-60'
260- 270 Limestone, light dove grey, fine powdery texture,
bentonite, cream, Chara seeds
270- 280 Bentonite, light dove, limy. Ostracods and Chara
fruits
280- 290 Bentonite, light blue grey, silty and sandy, sand
size particles of chert, grey and brown, limestone
and quartz
290- 310 Bentonite, cream, grey, light green grey, dense,
limy, Ostracods
310- 320 Bentonite, same colors, but sandy
320- 330 Mudstone, bentonitic, dove and light green grey,
limy, limestone, bentonitic, light dove
330- 350 Mudstone, and siltstone, light grey green, bentonitic
350- 370 Sandstone, cream grey, fine, poorly sorted, white
limy cement, angular to subrounded, some etched
370-380  Sundance siltstone, light green and lavender, mica-
aceous, glauconitic
380-440  Bentonite, light grey, biotitic, glauconite in small
subround particles
440-450  Siltstone, grey, glauconitic, with shaly bentonite
450-480  Sandstone, grey, fine, angular, glauconitic, Pachy-
teuthis (Belemnites), shaly bentonite increasing in
amount downwards
480-585  No cuttings
585-615  Sandstone, light grey, fine, angular milky chert,
brown ironstone, selenite, authigenic quartz
618-630  As just above but glauconitic
630-640  Sandstone, light grey, very fine, limy cement, ben-
tonite, light grey
640-650  Siltstone, light grey, glauconitic
650-700  Mudstone, green grey, bentonitic
700-710  Siltstone to fine sandstone, brown grey, limy cement
710-725  Limestone, grey, sandy and ashy, bentonite, grey
green, platy
725-735(?) Sandstone, cream, with some coarse etched grains
735-775  Spearfish siltstone, claystone and sandstone, brown
red, some green
775-785  Anhydrite
785-840  Mudstone, salmon, some sandstone, white, some an-
ydrite and gypsum
840-940  Anhydrite in large amount in red siltstone
940-1125  No cuttings
1125-1170 Minnekahta limestone, buff, very fine texture, some
anhydrite and gypsum
1170-1180 Same with a little translucent chert
1180-1200 Limestone, cream, pink and lavender, fine powdery
texture
1200-1210 Opeche siltstone, dull red brown, limy
1210-1220 Siltstone, bright brick red, some sandstone and
cream anhydrite
1220-1280 No cuttings
1280-1330 Siltstone, sandstone and mudstone, bright brick red,
a little anhydrite, etched sand grains
1330-1390 Top Minnelusa (Converse) sandstone, brown buff,
fine, angular to subround, gypsiferous
1390-1400 Anhydrite, brown grey
1400-1440 No cuttings
1440  Sandstone, brown red, fine, angular, siltstone, brown red
1460  Same with anhydrite, brown grey
1480-1500 Anhydrite, brown grey and white, some fossiliferous
limestone with milky chert, sand
1510-1520 Sand, fine, subangular, some anhydrite
1520-1540 Anhydrite, grey, cream, brown, silty
1540-1550 Sandstone, buff, fine grained
1550-1560 Sandstone, buff, fine grained with anhydrite
1560-1570  Anhydrite, pinkish and cream
1570-1580  Anhydrite, with red sandy clay
1580-1615  No cuttings
1615-1630  Sandstone, brown red, siltstone and anhydrite, some large clear quartz fragments, milky chert
1630-1674  Sandstone, brown red to buff, fine to medium, angular to subround, etched, poorly sorted
1675-1690  Anhydrite, buff, stained with pink
1690-1700  Sandstone, fine, anhydrite, siltstone, brown red
1700-1715  Anhydrite, cream and grey, very fine
1715-1725  Anhydrite, cream, well crystallized
1725-1737  No cuttings
1737-1748  Sandstone, light grey, poorly sorted fine to medium, limy cement, anhydrite, claystone, grey, bentonitic, shale, black, bituminous, selenite and satin spar
1748-1752  Siltstone, chlocolate to yellow brown, lavender and grey, micaceous
1752-1755  Clay, chocolate, clay ironstone, yellow brown and red brown, anhydrite, grey chert, shale, brown grey and butternut brown, fissile, considerable bornite
1755-1759  As above with shale, dark grey, very fissile
1759-1764  As above with considerable shale, black, bituminous, siltstone, grey
1764-1766  Bentonite, dark purple and medium blue grey, siltstone, brown and red, shale, butternut brown and black, bituminous, anhydrite, white and blue grey
1766-1787(?)  Same but more brown grey anhydrite
1787-1798  About as above with some quartz and milky chert
1798-1807  Mostly shale, grey, chocolate brown and black, bituminous
1812-1818  Some chert, milky
1818-1856  Anhydrite, grey, white and blue grey
1856-1866  Anhydrite, dove and cream
1866-1896  "Leo" sandstone, cream, fine grained, etched, angular to subround, poorly sorted
1896-1900  Anhydrite, grey and blue grey
1900-1910  Shale, black, micaceous, very bituminous
1910-1920  Sandstone, fine angular to subround, partly etched
1920-1937  Anhydrite, light grey, bituminous shale 1731'-37'
1937-1945  Sandstone, grey, fine, anhydrite cement
1945-1949  Anhydrite, grey, bituminous shale, black
1949-1953  Sandstone, light grey, fine, interbedded with shale, medium grey
1953-1958  Same but shale is black bituminous
1958-1970  Anhydrite, grey
1970-1998  Anhydrite, grey, black bituminous shale and grey sandstone
1998-2005  Sandstone, cream, fine grained
2005-2011  Anhydrite, dove
<table>
<thead>
<tr>
<th>Time Period</th>
<th>geological description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011-2018</td>
<td>Anhydrite, grey, with chert, dark blue grey</td>
</tr>
<tr>
<td>2018-2028</td>
<td>Sandstone, cream, fine grained</td>
</tr>
<tr>
<td>2028-2038</td>
<td>Anhydrite, grey and white, sandstone, translucent chert</td>
</tr>
<tr>
<td>2038-2045</td>
<td>Sandstone, grey, fine grained</td>
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<tr>
<td>2045-2084</td>
<td>Anhydrite, grey to 2068', cream, 2068'–84', sandy 2076'–84'</td>
</tr>
<tr>
<td>2084-2120</td>
<td>Anhydrite, cream, recrystallized in part, with etched sand, grades down into dolomite, fine sandy and silty</td>
</tr>
<tr>
<td>2120-2132</td>
<td>Siltstone, cream buff, clay, green, brown red</td>
</tr>
<tr>
<td>2132-2142</td>
<td>Dolomite, buff, translucent and milky pinkish chert abundant</td>
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<tr>
<td>2142-2158</td>
<td>Same with clay, light salmon and green grey, bentonitic</td>
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<tr>
<td>2158-2170</td>
<td>Claystone and siltstone, purple and green grey, bentonitic</td>
</tr>
<tr>
<td>2170-2181</td>
<td>Claystone and siltstone, purple, green, grey, brown red</td>
</tr>
<tr>
<td>2181-2204</td>
<td>Same with some small fragments of cream crinoidal limestone, sand grains, 2195'–2204'</td>
</tr>
</tbody>
</table>
14. BURLINGTON RAILROAD WELL, Edgemont, Fall River County

530- 600' Lakota sandstone, grey, medium grained, angular to subround
600- 620 Sandstone, darker grey, medium grained, angular to subround
640- 642 Sandstone, grey, medium grained, angular to subround, bentonite, grey, white and lavender, chalcopyrite and chalcocite
970-1000 Morrison sandstone, fine grained, with clayey matrix, terra cotta and light grey mixed
1020-1040 Sundance sandstone, fine grains, some citrine quartz and brown chert grains in light grey bentonitic matrix, mudstone, light grey green
1160-1174 Sandstone, light grey to buff, fine grained, angular
1174-1190 Siltstone, light grey to buff
1228-1230 Spearfish mudstone, salmon and deeper red
1237-1250 Mudstone, salmon
1250-1270 Mudstone, salmon
1410-1430 Anhydrite and red beds
1450-1490 Siltstone, salmon
1720-1850 Mudstone, salmon, silty
2303-2325 Minnelusa anhydrite, white and grey, limestone, grey, a little chert, sandstone, grey, medium grained, angular, a little black shale, chalcopyrite
2325-2352 Anhydrite and limestone, grey, some chert, small sand grains, chalcopyrite
2352-2400 Same as last, chalcopyrite
2400-2440 Sandstone, fine grained, anhydrite, limestone, chalcopyrite
2440-2465 Chalcopyrite, shale, black, sandstone, very fine grained, anhydrite intercrystallized with limestone
2465-2490 Considerable milky white chert, fine quartzose sandstone, brown grey limestone, sandstone, medium to coarse, rounded grains, mostly light grey brown cherty limestone
2516-2537 Sandstone, red brown, fine angular grains
2537-2572 Sandstone, brown
2572-2535 Sandstone, buff, fine angular grains
2641-2648 Mudstone, purplish, sandstone, medium subround to subangular grains, limestone, grey, fine textures
2730-2764 Mudstone, purplish, (laterite), sandstone, fine grained, a little white bentonite, chalcopyrite. This well obtained its water in the upper Pahasapa limestone at 2980' depth. The railroad well at Minnekahta penetrated anhydrite-bearing Minnelusa from 330'-1342'.

-68-
15. CONTINENTAL OIL CO. STATE 1, 2310' SNL, 2273' EWL, Sec. 36, T. 8 S., R. 3 E., Fall River County. Altitude 4046'.

0- 30'  Dakota sandstone, cream, medium sized angular grains
30- 70'  No cuttings
70- 30'  Sandstone, as at 0'-30'
30-100' Siltstone, dark grey, sandy
100-130' Sandstone, buff and cream, fine grained, selenite veins
130-250' Sandstone, as above with some pink potash feldspar grains, brown or grey, poorly sorted, some siltstone, Lakota
250-280' Morrison siltstone, dark and lighter grey, laminated
280-330' Siltstone with interbedded sandstone, light grey, fine grained, bentonite, light grey and green
330-380' Siltstone, grey
380-430' Siltstone, grey, some sandy, limy cement, bentonite, light grey
320-330' Sundance limestone, light grey, fine texture, dense
330-350' Siltstone, green grey, glauconitic, grades to fine sandstone, chalcopyrite with pyrite
350-370' Sandstone, light grey, medium grained, subangular to subround
370-380' Siltstone and mudstone, medium grey
380-430' Chalcopyrite, diminutive Porocystis-like organism (Cymopelia?) marcasitized, a little blue chert, organisms, 420'-30'
430-440' Sandstone, light grey, glauconitic, fine grained
440-480' Sandstone, light grey, glauconitic, fine grained, same fossils as above, 470'-80'
480-510' Siltstone, terra cotta, chalcopyrite, same fossils as above
510-530' Bentonite, grey and green, sandstone, salmon, medium grained
530-540' Bentonite with phlogopite, algal fruits
540-600' Sandstone, very light grey, fine grained, bentonite, white, sandy, 550'-60', sandstone, glauconitic and micaceous
600-650' Sandstone, as above, chalcopyrite
650-700' Sandstone, as above
700-730' Spearfish sandstone, salmon, grading to siltstone downward
730-810' Siltstone, salmon, gypsiferous, sandstone, light grey, medium grained
810-930' Siltstone, salmon, anhydrite
930-1060' Anhydrite, white, fairly coarsely crystalline, pink stained, 1030'-60'
1060-1120' Siltstone and mudstone, salmon, some anhydrite, especially at 1070'-80'
1120-1170' Minnekahta limestone, light grey, white and pink, fine dense, some anhydrite
1170-1200' Opeche mudstone, dark brown red, darker red than the Spearfish

-69-
1200-1250 Same with anhydrite, white, fine, dense, some grey spots, some sandstone
1250-1325 Sandstone, dark brown red but lighter than siltstone above, some siltstone
1325-1360 Sandstone, red brown, fine to medium grained, siltstone, dark brown red
1360-1380 Minnelusa sandstone, red and light grey, some white anhydrite
1380-1460 Anhydrite, white, grey, pink, crystalline with dolomite and magnesian limestone, some of the latter light grey and dense
1460-1480 Limestone, light grey, very finely crystalline
1480-1540 Limestone, dolomitic, light grey, with chert, light grey and milky, chalcopyrite, anhydrite, foraminifera, 1500'-10'
1540-1620 Anhydrite, white and pink
1620-1650 Sandstone, brown, medium grained, limestone, glauconitic, grey and pink, anhydrite
1650-1690 Limestone, brown and pink, fine texture, anhydrite, white
1690-1760 Sandstone, mostly
1760-1770 Limestone, dark grey, a little anhydrite
1770-1780 Sandstone, limestone, dark grey, earthy, a little anhydrite
1780-1790 Anhydrite, dark brown grey, chert
1790-1820 Sandstone, much limestone, dark grey, earthy, shale, very dark grey
1850-1880 Shale, very dark grey, anhydrite, brown grey
1880-1890 Sandstone, some recrystallized, anhydrite, dark grey, chalcopyrite
1890-1910 Shale, dark grey, anhydrite, dark brown grey
1930-1930 Sandstone and anhydrite
1930-1940 Chalcopyrite, mostly siltstone, light grey, considerable chert, bipyramidal quartz crystals
1940-1960 Sandstone, fine grained
1960-1980 Anhydrite, dark grey, limestone, light grey, considerable chert, dark blue grey, shale, black
1980-2000 Limestone, light grey, fine granular
2000-2010 Sandstone, grey, fine grained
2010-2030 Sandstone, light grey, fine grained, much limy cement, quartzitic, abundant milky chert
2030-2070 Sandstone, with limestone, dark brown grey and chert, white
2070-2090 Sandstone, light grey, very fine grained, some dark brown red
2110-2140 Sandstone, buff, fine-grained, with limestone, 2130'-40', lavender, light grey, pink, fine texture
2140-2150 Sandstone, grey, limestone, white, very fine texture
2150-2170 Laterite, mudstone and siltstone, sandy, green grey, dark grey, brown, yellow, purple, some sandstone, buff, and limestone, white
2170-2220 Siltstone and mudstone, sandy, purple, becomes quite limy at 2180', bentonitic, light green and grey spots
2220-2238 Pahasapa (Madison) limestone, buff, light grey, white, lithographic texture, lost circulation which led to abandonment
16. **BLACK HILLS ORDNANCE DEPOT, PROVO, U.S. WAR DEPT. 1, 1060.7' NSL, 304.7' WED, SE. 4, Sec. 3, T. 10 S., R. 2 E., Fall River County. Altitude, concrete base, ground, 3655.1', top of rotary table 3663.6', top of Kelly bushings, 3664.5'. Formation depths measured from 3664.5' altitude.

0-10' Carlile shale, weathered, dark olive green or drab, bentonic, large amount of eolian angular flaky quartz sand, fine, some grains coarse, frosted, sub-angular

24-34 Shale, dark blue grey, bentonic, gypsiferous and limy

44-50 Shale with calcite veinlets

50-70 Shale with sandstone, medium grey, biotitic, chloritic, fine angular, lime cement, fish scales

70-100 Shale, dark grey, bentonic, compact

200-280 Greenhorn marl, dark grey, very minutely laminated, much speckled with chalky and translucent limestone, hard, some very fine quartz sand, fish remains. Greenhorn limestone reported down to 380', alternating with dark shale

380-700 Graneros (Belle Pourche) shale, dark grey, limy and silty streaks and bentonite, white, 680'-90'

700-850 Mowry shale, dark brown grey, fish scales

850-870 Neafsky shale, limy, bentonite

870-830 Newcastle sand, light grey, very fine grained, water-bearing

830-1088 Thermopolis (Skull Creek) shale, very dark grey, with bentonite, phlogopite, silt and sand

1088-1115 Dakota (Fall River) sandstone, light grey, fine to medium grained, micaceous, marcasite

1115-1175 Sandstone, light grey, fine to medium, hard, angular, shale, dark grey, bentonite, sandstone at 1140'-58'

1175-1250 Sandstone, light grey and white, fine to medium hard, bentonite, white, shale, dark grey, sandy, bentonite

1250-1350 Clay, dull purple and dark grey, very bentonitic, sandstone, coarse

1350-1370 Lakota sandstone, light grey, porous, limy cement, poorly sorted coarse to fine grains, subrounded to subangular

1370-1390 Sandstone with clay, purple, sandy

1390-1450 Sandstone, white, coarse

1450-1470 Morrison clay, light grey, brown and lavender, silty

1470-1500 Clay, grey, silty

1500-1560 Bentonite, light grey, green and brown, some sandstone, light grey, fine, clay, grey

1560-1590 Clay, dark grey, and bentonite, hard, light grey and light green
1590-1600 Clay, dark grey
1600-1640 Sundance sandstone, light grey, fine to medium, limy glauconitic, shale, dark grey
1640-1685 Shale, dark blue grey
1685-1735 Sandstone, light grey, fine, glauconitic, micaceous, limy, milky white chert
1735-1810 Sandstone, light grey, fine, mainly clay, terra cotta, purple, dark grey, bentonitic, light green bentonite
1810-1860 Sandstone, light grey, fine grained, limy glauconitic
1860-1880 Clay, terra cotta, sandstone, light grey
1880-1890 Shale, dark blue grey, some nearly black, silty and sandy
1950-2000 Sandstone, light grey, fine grained, glauconitic
2000-2037 Sandstone, cream, medium to coarse grained, porous, large grains rounded and etched, limy cement, glauconitic, vein calcite, some milky chert
2037-2160 Spearfish siltstone, sandy salmon, micaceous
2160-2374 Zone of anhydrite, white and light grey, interbedded with siltstone and mudstone, brown red and sandstone, mostly fine grained and silty
2374-2428 Minnekahta limestone, magnesian and dolomite, light grey and brown, fine, dense, with some anhydrite, some stained pink. Base Minnekahta may be at 2408'
2428-2480 Opeche sandstone, red-coated, fine grained
2480-2560 Siltstone, dark dull brown red, some sandy
2560-2570 Anhydrite, grey, sandstone, dark red, mostly fine grained, mudstone, red
2570-2600 Sandstone and mudstone, red, some anhydrite
2600-2620 Minnelusa sandstone, pink and light grey, medium grained, subangular
2620-2654 Anhydrite, white and pink, a little sandstone, white
2654-2670 Mostly sandstone, pink and white, angular, medium grained, chalcopyrite, nodule of chalccotite, considerable limestone, magnesian, brown grey
2670-2690 Limestone, brown grey, specked with dark grey, finely crystalline
2690-2720 Sandstone, white and buff, limestone and dolomite, as above, increased pink sandstone, 2710'–20'
2720-2730 Limestone, probably magnesian, cream, very finely crystalline to porous
2730-2770 Apparently only cavings
2770-2840 Sandstone, limestone, white and anhydrite grey, pink and dull lavender
2840-2850 Some shale, maroon, otherwise as overlying
2850-2880 Anhydrite, pink, purple and grey, shale, maroon, sandstone, pink and grey
2880-2920 Same, with limestone, predominantly magnesian
2325-2335 Red marker, shale, dull purple to maroon, flaky
2335-2960 Like from 2880'–2920' but more limestone, grey, sandstone, medium grained, less anhydrite

-73-
2960-3030 Sandstone, light grey, fine to medium, shale, very dark grey, hard, fissile, limestone, earthy, brown grey, fine grained, a little white anhydrite, limestone predominates, with considerable pink staining, some chalcopyrite in sandstone, some calcite, dark brown grey

3030-3040 Shale, nearly black, fissile, hard, mostly limestone, light grey dense

3040-3060 "Leo" sandstone, white, medium coarse, subangular, show of oil and gas

3060-3070 Shale, dark brown black, chalcopyrite

3070-3090 Chalcopyrite, milky chert, limestone mostly

3090-3110 Bipyramidal quartz, mostly limestone

3110-3150 Limestone with a little milky white chert, abundant at 3130'-40', sandstone, limy, siltstone

3150-3170 Sandstone, light grey, medium grained, subangular to subrounded, limy cement, limestone, light brown grey, finely crystalline, anhydrite, white

3170-3175 Limestone, medium brown grey, some oolitic, some with quartz grains, a little white anhydrite, some white chert, most limestone porous, some very fine textured

3175-3180 Mostly sandstone

3180-3200 Limestone, as above, some silty, a little white chert

3200-3210 Sandstone, with limestone and anhydrite

3210-3220 Limestone

3220-3240 Sandstone, some grey and white chert

3240-3250 Sandstone, white, medium grained, porous

3250-3260 Limestone, sandstone, chert, milky

3260-3295 Sandstone, white, fine grained, limy cement, porous

3295-3330 Limestone, silty and sandy, sandstone, limy, fine grained, a little anhydrite

3330-3340 Sandstone, white, fine, limestone, light grey, dense

3340-3370 Sandstone, cream, very fine grained, limy cement, siltstone, dark purple and lavender, 3350'-70'

3370-3390 Limestone, light grey, very fine, dense, some sandstone and lavender siltstone

3390-3420 Chalcopyrite mixed with pyrite, mostly sandstone, buff and grey, very fine, limestone, light grey, with considerable chert

3420-3470 Some chert, grey and white, much siltstone, lavender, sandstone, limestone, echinoid spines

3470-3500 Increase in chert, siltstone, lavender, splotteded with light green grey to white

3500-3510 Same, mudstone, purple and lavender, some silty, limestone, light grey, lithographic, chert, white translucent

3510-3560 About half limestone and chert, small brown chert pebbles in sandstone, echinoid spines, chalcopyrite, some limestone finely crystalline, mudstone with limy spots, organic

3560-3570 Considerable limestone stained pink to purplish, mostly very dense fine granular
| 3570-3590 | Mudstone, dull purple, flaggy to finely laminated, sandstone, red, subrounded grains, horn coral |
| 3590-3630 | Mudstone, yellow, with abundant ostracods |
| 3630-3640 | Grit or conglomerate of brown grey chert, malachite and azurite |
| 3640-3660 | Pahasapa (Madison) limestone, white and pink, with large calcite rhombs |
| 3660-3675 | Limestone, white to pink, recrystallized, large rhombic crystals in finer matrix |
| 3675-3685 | Limestone, white to pink, as just above, with sandstone, white, rather coarse, limy matrix, some translucent chert, malachite, 3680'-85' |
| 3685-3740 | Same limestone, white, dense, chalcopyrite, otherwise as overlying |
| 3740-3750 | Same limestone marbleized, mostly pink, some vein quartz |
| 3750-3780 | Part of limestone has finer crystals than from 3640'-3750' |
| 3780-3800 | Limestone, light cream, fine grained, cavernous |
| 3800-3880 | Mixture of dolomite and limestone, light grey, fine textured, drusy, some silt size quartz fragments, 3830'-35' |
| 3880-3930 | Limestone, light grey and (mostly) very pink, medium grained, a little sandstone, white, coarse |
| 3930-3999 | Sandstone, coarse, angular to subangular, some grains corroded, some nearly perfect crystals, singly and in cluster, disintegrated from underlying granite |
| 3999-3999 | Sandstone as overlying, with particles of brown phyllite or mica schist, shale, green |
| 3999-3999 | Pre-Cambrian biotite granite |

Water from Dakota sandstone, 1085'-1158', rose 660' in 15 minutes, bottom hole pressure, 360 lbs. (?)
Water from upper Dakota sandstone, 1271'-1345', rose 660' in 12 minutes, bottom hole pressure 360 lbs. (?)
Water from red Sundance sandstone, 1728'-1775', rose 1215' in 18 minutes, bottom hole pressure, 700 lbs. (?)

**Flowing**

Water from upper part basal Sundance 1964'-2010', rose 1680' in 3 minutes, bottom hole pressure, 1000 lbs.

**Flowing**

Water from basal Sundance sandstone, 1964'-2033', rose 2027' in 23 minutes, bottom hole pressure, 375 lbs.
Water from sandy zone Minnelusa sandstone, 2603'-2654', rose 270' in 15 minutes, bottom hole pressure, 160 lbs.

**Flowing**

Water from upper Madison, 3652'-3696', rose 3300' in 25 minutes, bottom hole pressure, 1900 lbs.

**Flowing**

Water from lower Madison, 3781'-3825', rose 3785' in 34 minutes, bottom hole pressure, 1975 lbs.

**Artesian Flow**

Water from Madison, 3628'-3828' was 120 gals. per minute, temperature, 133° F.
17. AMERADA PETROLEUM CORP., SOUTH DAKOTA AGRICULTURAL COLLEGE
S, R. 7 E., Fall River County. Altitude 3386'.

0- 775' No cuttings, Pierre clay
775- 800 Marl, chalk speckled, medium grey, Globigerina,
Inoceramus, fish remains
800- 830 Shale, dark blue grey, bituminous, chalk pellets,
Sharon Springs
830- 840 Shale, black
840- 900 Niobrara marl, grey, much chalk, Globigerina and
fish remains
900- 350 Carlile shale, dark blue grey, a few chalk pellets,
bituminous, biotite, fish remains
350-1020 Shale, black, bituminous, small chalk spots, pure
bentonite beds
1020-1050 Shale, blue grey, chalk spotted, concretions and
bentonite beds
1050-1060 "Cristellaria"
1060-1070 Shale, black, bituminous
1070-1080 Copper sulphide and hauerite (?) in a pyritic zone
1080-1100 Sandstone, grey, fine grained
1120-1150 Sandstone, grey, fine grained, limy cement, biotite,
carbonaceous, fish fossils
1150-1180 Shale, grey, dark
1180-1190 Sandstone, with dark chert and medium grained sand
particles
1190-1240 Shale, dark blue grey, iron carbonate concretions,
fish fossils
1240-1290 Shale, black
1290-1300 Shale, black, bituminous, Globigerina
1340-1375 Greenhorn limestone, grey, packed with Inoceramus
prisms, interbedded with chalky marl, Globigerina
1375-1410 Graneros shale, dark blue grey, small flattened
chalk pellets
1410-1600 Shale, black, slightly bituminous, small flattened
chalk pellets, fish fossils, bentonite, 1580'-30'
1600-1630 Shale, dark blue grey to black, bentonite, Globi-
gerina, fish fossils
1630-1700 Sandstone, grey, fine grained
1790-1830 Shale, dark blue grey, clay ironstone
1890-1920 Muddy or Newcastle sandstone, grey, fine grained,
angular, limy cement
1970-2000 Sandstone, red stained and shale, purple, "rusty" beds
2110 Sandstone, grey, fine grained, impermeable, dirty,
some with glauconite and selenite
2150-2200 Dakota sandstone, light grey, fine to medium grained,
porous, subangular to subrounded, carbonaceous, mica-
ceous, some large quartz grains, lignite, 2180'-85'
2200-2210 Manganosiderite or rhodochrosite pellets
2210-2229 Sandstone, light green, fine grained
2223-2233  Sandstone, light grey, fine to medium grained, porous, angular to subrounded, carbonaceous, partly recrystallized, some siltstone, red

2233-2265  Cement and cavings, some sandstone

2265-2270  Fuson shale, sandy shale and siltstone, dark grey

2270-2285  Sandstone, light grey, fine grained

2285-2300  Shale, grey, bentonitic

2300-2310  Sandstone, light grey, fine to medium, subangular to subrounded, partly recrystallized, porous

2310-2315  Shell fragments

2325-2350  Shale, various shades grey, bentonitic, some sandy, coal

2350-2370  Shale, various shades grey and lavender, bentonite, coal

2370-2375  Sandstone, medium to coarse, porous, limy cement, subangular to subrounded

2385-2390  Brown platy magnetic iron oxide, shales as above

2390-2420  Sandstone, as at 2370' - 75', partly recrystallized, etched grains, some blue grey chert particles

2420-2430  Conglomerate, unusual quantity of bluish and milky chert fragments, grit

2430-2435  Sandstone, fine to medium, spotted light grey, very light grey cement, bentonite, angular to subrounded, good permeability

2435-2440  Minnewaste limestone, light grey and cream

2440-2445  Limestone, cream grey, oolitic

2445-2450  Chert, bluish and milky, much bentonite, grey

2450-2455  Limestone, light and dark grey mixed, also cream, finely crystalline

2455-2485  Anhydrite, bluish white, some impure, clay, dark grey, bentonitic and silty

2485-2495  Dolomite, light dove, dense, very fine grained, silt particles with anhydrite fillings

2495-2510  Sandstone, light grey, fine grained, limy cement

2510-2520  Shale, dark grey

2520-2530  Limestone, medium grey, very fine grain

2530-2555  Mudstone, green grey and drab, bentonitic

2555-2560  Mudstone, brown drab and dark grey, carbonaceous, bentonitic

2560-2635  Lakota sandstone, light grey, fine to medium, mostly recrystallized, some shale, grey, sand grains angular to subangular, porous, some carbonaceous material

2635-2700  Perhaps mostly shale, dark chert particles and large quartz grains

2700-2720  Morrison mudstone, dark and medium grey, green grey, brown grey, bentonitic

2720-2725  Siltstone, light red brown, perhaps some lignite

2725-2730  Siltstone or fine sandstone, brown red, brown, yellow, quartzitic

2730-2740  Clay, dove and light green grey, bentonitic

2740-2770  Sandstone, light grey, buff and cream, fine grained, partly recrystallized, nonrounded, porous, some finer micaceous laminae
2770-2805  Sandstone, partly quartzitic, light brown and very light grey, cement is chert or chalcedony
2805-2810  Mudstone, light yellow and leek green, very small dark spots, bentonitic
2810-2815  Sandstone, as at 2740'-70'
2815-2820  Perhaps mainly mudstone
2820-2830  Sandstone, light brown grey, quite fine grained
2830-2835  Bentonite, green grey, sandy
2835-2845  Clay or mudstone
2845-2850  Grit, quartzose
2850-2865  Sand, light salmon, clayey
2865-2870  Sand, poorly sorted, fine, partly rounded, in matrix of salmon clay
2870-2875  Clay (?)
2875-2900  Sandstone, buff, grey, pinkish, fine grained, partly rounded, Unkpapa
2900-2930  Clay, light green grey, sandy, some with silt laminae
2930-3005  Sundance bentonite, oily green, hardened, siltstone, greenish, glauconitic
3005-3010  Sandstone, grey, fine, glauconitic
3010-3025  Cavings
3025-3030  Small globular marcasitized "golf ball" organisms
3030-3050  Sandstone, glauconitic, limy, fine to medium, finer below
3055-3065  Sandstone, light grey, glauconitic, fine grained, porous
3065-3070  Clay (?)
3070-3080  Sandstone, as last above, siltstone, light green grey, limestone, grey, silty
3080-3145  Mudstone, mostly light green grey, bentonitic, siltstone, 3125'-30'
3145-3150  Mudstone, chocolate, bentonitic, sandy
3150-3155  Caliche
3155-3165  Sandstone, light salmon, fine to medium grained
3165-3170  Sandstone, light grey, glauconitic
3170-3195  Sandstone, cream, fine grained, sparsely glauconitic
3195-3200  Spearfish mudstone, brown red
3200-3215  Sandstone, cream, fine grained, bentonite, brown and drab
3215-3225  Sandstone, light salmon, fine grained, mudstone, brown red
3225-3250  Sandstone, light salmon, pink, mudstone and siltstone, salmon
3250-3275  Anhydrite
3275-3280  Mudstone, red
3280-3335  Siltstone, dark salmon
3335-3350  Anhydrite, cream, stained pink
3350-3360  Siltstone, salmon
3360-3370  Sandstone, salmon, fine grained with larger frosted subround grains, unsorted
3370-3380  Anhydrite, cream, some pink stained

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<table>
<thead>
<tr>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3405-3415</td>
<td>Anhydrite, light grey</td>
</tr>
<tr>
<td>3425-3430</td>
<td>Limestone, buff, lavender-stained, fine powdery texture</td>
</tr>
<tr>
<td>3430-3450</td>
<td>Siltstone, dark brown red</td>
</tr>
<tr>
<td>3450-3455</td>
<td>Sandstone, dark brown red, unsorted coarse to fine, siltstone</td>
</tr>
<tr>
<td>3460-3465</td>
<td>Mudstone, dark brown red</td>
</tr>
<tr>
<td>3465-3500</td>
<td>Siltstone, etc., salmon, with light grey to white spots</td>
</tr>
<tr>
<td>3500-3505</td>
<td>Minnekahta limestone, buff, fine powdery texture</td>
</tr>
<tr>
<td>3505-3520</td>
<td>Limestone, pink-stained cream, fine granular</td>
</tr>
<tr>
<td>3520-3529</td>
<td>Limestone, light pink brown, fine granular</td>
</tr>
<tr>
<td>3545-3555</td>
<td>Limestone, purplish, fine granular</td>
</tr>
<tr>
<td>3555-3565</td>
<td>Opeeche siltstone and fine sandstone, light brown</td>
</tr>
<tr>
<td>3565-3575</td>
<td>Siltstone, brown red (?)</td>
</tr>
<tr>
<td>3575-3580</td>
<td>Possibly limestone, buff, fine texture</td>
</tr>
<tr>
<td>3580-3585</td>
<td>Dolomite, brown cream, fine texture</td>
</tr>
<tr>
<td>3585-3620</td>
<td>Limestone, pink cream, fine texture</td>
</tr>
<tr>
<td>3620-3630</td>
<td>Shale, brown and dark purple</td>
</tr>
<tr>
<td>3630-3645</td>
<td>Sandstone, light salmon, fine to medium, poorly sorted, limy cement, anhydrite above</td>
</tr>
<tr>
<td>3645-3660</td>
<td>Cavings</td>
</tr>
<tr>
<td>3660-3670</td>
<td>Siltstone, salmon</td>
</tr>
<tr>
<td>3670-3685</td>
<td>Minnelusa sandstone, light salmon, fine grained</td>
</tr>
<tr>
<td>3695-3705</td>
<td>Sandstone, cream buff, medium grained, limy cement, angular to subround</td>
</tr>
<tr>
<td>3705-3735</td>
<td>Anhydrite, light grey, brown mottled</td>
</tr>
<tr>
<td>3735-3755</td>
<td>Sandstone, light salmon and grey, fine to medium, poorly sorted, dolomitic cement</td>
</tr>
<tr>
<td>3755-3800</td>
<td>Dolomite, brown grey, fossiliferous, brachiopods, medium sized crystals, porous</td>
</tr>
<tr>
<td>3800-3815</td>
<td>Anhydrite, light and medium grey</td>
</tr>
<tr>
<td>3815-3830</td>
<td>Sandstone, cream and buff, fine to medium, dolomite cement</td>
</tr>
<tr>
<td>3830-3850</td>
<td>Dolomite, grey, fine powdery texture, grading downward into limestone</td>
</tr>
<tr>
<td>3850-3855</td>
<td>Limestone and anhydrite</td>
</tr>
<tr>
<td>3855-3860</td>
<td>Sandstone, light pink brown, fine to medium texture, dolomitic limestone cement</td>
</tr>
<tr>
<td>3860-3870</td>
<td>Dolomite, light brown grey, fine powdery texture</td>
</tr>
<tr>
<td>3870-3910</td>
<td>Anhydrite, pinkish above, grey below</td>
</tr>
<tr>
<td>3895-3910</td>
<td>Sandstone, cream, and light pink, medium and coarse, poor sorting, dolomitic cement</td>
</tr>
<tr>
<td>3910-3930</td>
<td>Anhydrite, cream and grey</td>
</tr>
<tr>
<td>3930-3935</td>
<td>Dolomite, brown grey, fine powdery, mixed with anhydrite</td>
</tr>
<tr>
<td>3938</td>
<td>Lost circulation</td>
</tr>
<tr>
<td>3940-3945</td>
<td>Dolomite, anhydrite, purple mudstone</td>
</tr>
<tr>
<td>3945-3950</td>
<td>Possibly sandstone, cream and pink</td>
</tr>
<tr>
<td>3950-3965</td>
<td>Limestone, dark grey, splotched with lighter grey, fine powdery, passing downwards to dolomite</td>
</tr>
</tbody>
</table>
3965-3970  Dolomite, dark grey, splotched with lighter grey, fine powdery, passing downwards to anhydrite
3970-3980  Anhydrite, grey and brown grey, and dolomite
3980-4010  Dolomite, medium and dark grey, fine powdery texture, larger secondary crystals
4010-4040  Sandstone, light grey, fine to medium grained, etched, subangular to subround, dolomite cement, glauconite (?)
4040-4045  Dolomite, brown grey, fine powdery texture, larger secondary crystals
4045-4060  Sandstone, light grey, medium grained, etched, subangular to subround, dolomite cement
4060-4065  Shale, black, very bituminous
4065-4070  Anhydrite and dolomite mixed
4070-4075  Possibly black shale
4075-4085  Dolomite, dark grey, fine sugary
4085-4090  Sandstone, medium grey, fine grained, dolomite cement
4090-4095  Core of dolomite
4095-4100  Shale, dark blue grey limy, possibly hydraulic limestone
4100-4115  Dolomite, dove grey, fine powdery, brittle, flaky
4115-4130  Same with intermixed anhydrite and bluish and smoky translucent chert
4130-4135  Dolomite and anhydrite mixed
4135-4150  Sandstone, cream, fine grained, cement probably mostly siliceous, some quartzite
4150-4155  Dolomite, medium grey, intermixed with anhydrite, in part sandy
4155-4170  Sandstone, light bluish grey, fine to medium grained, poorly sorted, etched, nonround, dolomite cement
4170-4175  Shale, black, bituminous
4175-4180  Sandstone, as at 4155'-70', quartzitic, chert fragments
4180-4185  Dolomite, brown dove, lithographic
4185-4200  Limestone, dolomitic, brown grey, very fine powdery texture, dense, flaky, a little chert
4200-4215  Dolomite, grey, fine powdery texture
4215-4220  Shale, black, bituminous
4220-4240  Dolomite, light grey, fine powdery texture
4240-4250  Dolomite, light grey, fine sugary
4250-4255  Anhydrite, light grey
4255-4280  Dolomite, light grey
4280-4295  Dolomite, light brown grey, vuggy, a little coarser, some rhombic
4295-4305  Dolomite, brown, rhombic, with a little chert
4305-4320  Dolomite, cream grey, with fine sand, vuggy, rhombic, tinged with pink
4320-4325  Sandstone, cream and pink, angular, fine to medium grains, dolomitic, milky chert
4325-4340  Dolomite, deep pink or rose, fine rhombic to powdery, vuggy, sandy and less pink below
4340-4350  Sandstone, light pink, fine grained, dolomitic cement
<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4350-4355</td>
<td>Grit size grains of quartz, carnelian and feldspar, some chert, subangular to subround, many chatter marks</td>
</tr>
<tr>
<td>4355-4360</td>
<td>Sandstone, cream, fine grained</td>
</tr>
<tr>
<td>4360-4365</td>
<td>Bentonite or bauxite, greenish white</td>
</tr>
<tr>
<td>4365-4375</td>
<td>Lateritic clay, brown red, mottled with grey</td>
</tr>
<tr>
<td>4375-4415</td>
<td>Laterite, sandy, maroon to purplish, also clay, spotted grey and light green, some bentonite or bauxite, some bright green is either hydrous iron or nickel silicate, some clay like pipestone, hard, red, lustrous, also lavender</td>
</tr>
<tr>
<td>4415-4420</td>
<td>Some cream chert, much cream fine sandstone</td>
</tr>
<tr>
<td>4420-4454</td>
<td>Laterite, more sandy, some tan and brown</td>
</tr>
<tr>
<td>4454-4465</td>
<td>Pahasapa (Madison) limestone, cream, flaky, brittle, extremely fine powdery texture, small secondary calcite crystals</td>
</tr>
<tr>
<td>4465-4475</td>
<td>Same with vugs and geodes, pink stained, secondary rhombic dolomite crystals</td>
</tr>
<tr>
<td>4475-4482</td>
<td>Same with altered oolites</td>
</tr>
<tr>
<td>4482-4502</td>
<td>Core of dolomite</td>
</tr>
<tr>
<td>4495-4520</td>
<td>Limestone, cream, partly altered oolites and part very fine texture</td>
</tr>
<tr>
<td>4520-4543</td>
<td>Dolomite, pink stained, rhombic, vuggy, cavernous, part coarsely crystalline</td>
</tr>
<tr>
<td>4543-4548</td>
<td>Cored dolomite, lost circulation and hole</td>
</tr>
</tbody>
</table>
18. AMERADA PETROLEUM CORP. PERRY MOODY 1, center NE. ¼ NW. ¼
NE. ¼, Sec. 8, T. 12 S., R. 6 E., Fall River County, 1651'
W. and 330' S. of NE. corner Sec. 8. Altitude 3650'.

0-340' No cuttings
340-360 Pierre clay, green grey, bentonitic, fine mica flakes,
some biotite, silty, foraminifera, Inoceramus prisms,
in part limy, brown ironstone concretions
360-370 Clay, lime cemented
410-420 Considerable biotite flakes, brown ironstone concre-
tions
460-480 Clay micaceous and silty
500-510 Clay partly lime cemented
510-520 Inoceramus and concretions
520-580 Clay silty and carbonaceous, to fine sandy
630 More silty than above
670-680 Shell fragments, much bentonite to 630'
680-700 Some sandstone, grey, fine grained, bentonitic
700-720 Some of the clay is darker grey
720-730 Limestone, grey, clayey
730-740 Clay with hauserite (?) and selenite
740-750 Clay ironstone
800-820 Limestone, dark grey, fine texture, clayey
820-830 Saracenaria
830 Some concretionary ironstone
870-890 Brown ironstone, shell fragments
930 Semi-shale, darker grey than above, limy, with con-
cretions
920-350 Darker and bituminous clay
350 Clay, chocolate, bentonitic, concretions, dark brick
red
1020-1030 Sharon Springs shale, dark blue grey to black, bitu-
minous, fish remains
1030-1190 Niobrara marl, chalk speckled, bituminous, chalk
particles flattened along laminae, more marl than chalk
1190-1250 Carlile shale, dark blue grey and black, bituminous,
some chalk spotted marl
1250-1260 Increase in chalk speckled marl
1260-1280 Mostly chalk speckled marl, grey, fish remains
1280-1290 Even more chalky
1290-1310 Less chalky
1310-1320 More chalky, first Globigerina, here abundant
1320-1350 Less chalky
1350-1360 Shale, black and dark blue grey, some chalky marl
1360-1380 Fine sand and much biotite, some coarse angular sand,
Globigerina
1380-1400 Considerable sandy light grey chalk with many Globi-
gerina, a little volcanic ash, light green, blue grey
chert fragments
1400-1440 Shale, blue grey, a little gypsum
1450-1460 Limestone, clayey and silty, fine texture
1460-1480 Sand, fine, and silt, light grey, Globigerina
1500-1510 Sandstone, coarse, angular, with dark grey chert particles
1510-1520 Shale, blue grey, some ironstone, brown
1520-1630 Shale, very dark blue grey, with light grey siltstone laminae, bituminous, some fine sandstone, small particles either glauconite or green volcanic ash, fish fragments
1630-1710 Shale, dark blue grey, with small amount of disseminated chalk, Globigerina
1710-1740 Greenhorn limestone, light grey, many Inoceramus prisms, foraminifera, purer cream limestone, 1720'-40', fine powdery texture
1740-1760 Graneros shale, dark blue grey, some small chalk spots, foraminifera
1760-1810 Marl, chalky
1810-1840 Bentonite, brown grey, impure, shale with small amount of chalk, Globigerina
1840-2130 Shale, dark blue grey, minute chalk particles, bentonite, cream, 1860'-70', mudstone, purplish brown (perhaps ironstone), 1870'-80'
2130-2140 Sandstone, grey, fine grained
2160-2180 Muddy or Newcastle sandstone, light grey, fine grained, porous, carbonaceous, poorly sorted angular to sub-angular
2190-2200 Sandstone, some reddish, cemented with chalcopyrite
2210-2220 Shale, brown red and blue grey, Inoceramus
2240-2250 Limestone, light brown, impure
2250-2260 Shale with fish scales, bentonitic, brown, lavender, purple
2280-2300 Some sandstone, grey
2300-2310 Sandstone, light grey, fine grained, below which is shale, blue grey and purple
2460-2461 A very little sandstone
2461-2462 Shale more purplish than usual, selenite and satin spar
2466-2467 Bentonite, light blue
2490-2499 Shale, black, Inoceramus prisms, some purplish and blue grey, partially black below
2513-2514 Shale, terra cotta and brown, bentonitic
2514-2570 Occasional siltstone in the shale
2570-2585 A little fine grey sandstone
2585-2605 Dakota sandstone, grey and brown, fine, partly recrystallized, porous, angular to subangular
2605-2650 Considerable shale, blue grey and brown grey
2650-2684 Some grey sandstone
2684-2686 Lignite, impure
2692-2702 Lakota sandstone, grey, fine grained
2710 Sandstone
2756-2775 Sandstone, cream, coarser, medium to coarse grained, partly recrystallized, angular to subrounded, porous
Sandstone, cream, finer, partly recrystallized

Morrison clay, white, brown, grey, green grey, bentonitic at base, a few small chert pebbles

Sandstone, cream, fine grained, porous

Mudstone, brown, purple and yellow

Sandstone, cream, limy cement

Shale, dark blue grey, with sandstones, light grey or cream, fine grained, some clay, light green grey, silty, bentonitic, also brown, red and purple clay, some bentonite, green and grey, with scattered quartz grains. As usual in this sequence, extensive cavings make exact determinations difficult

Sandstone, cream, fine grained, subrounded, poorly sorted, Unkpapa

Sundance limestone, light and darker grey, small specks glauconite

Siltstone, grey, with considerable glauconite

Sandstone, cream, glauconitic

Mudstone, dull green, bentonitic

Sandstone, cream, fine grained, sparse glauconite

Clay, terra cotta

Siltstone, terra cotta and red brown

Siltstone and fine sandstone, light red brown and cream

Clay and siltstone, light green grey, bentonitic

Sandstone, cream, fine grained

Shale, green grey, dark grey and black

Spearfish siltstone, salmon

Anhydrite, white

Anhydrite, white, cream and buff

Mudstone, dark salmon

Anhydrite

Siltstone, red, and anhydrite

Minnekahta dolomite, cream tobuff, finely crystalline, becomes pinkish limestone near base, some anhydrite

Opeche anhydrite, pink and buff, siltstone, lavender and purple

Siltstone, purple and red brown

Sandstone, cream, fine grained, siltstone, salmon

Siltstone, salmon

Sandstone, cream, fine grained

Minnelusa limestone, cream, finely crystalline

Sandstone, cream, fine grained, angular to subrounded, poorly sorted, some large grains, porous

Shale, dark blue grey to black; may be cavings

Sandstone, buff and salmon

Siltstone, dark salmon

A little chalcedony

Anhydrite, light grey, partly pink

Sandstone, cream, fine grained, non- limy cement

Anhydrite, grey
4055-4065 Anhydrite, light grey, spotted, with large insoluble residue of sulphate
4065-4078 Probably fine silica rock, with sponge spicules, some grey chert, anhydrite, light grey
4078-4085 Anhydrite, white
4085-4100 Anhydrite, white, faintly pink, fine sandstone and siltstone
4100-4135 Anhydrite, grey, pink and salmon
4135-4150 Sandstone, medium to fine grained, anhydrite cement
4150-4165 Sandstone and siltstone, salmon, buff and cream, coarser below
4165-4180 Anhydrite, cream and grey, in part sandy
4180-4205 Anhydrite, grey, sandstone, cream and salmon
4205-4210 Anhydrite, grey
4210-4215 Anhydrite, brown grey
4215-4220 Dolomite, light brown grey, sponge spicules
4220-4225 Dolomite, light brown grey, very fine powdery or amorphous
4225-4230 Sandstone, light grey to pink, fine grained, poorly sorted
4230-4240 Dolomite, light brown grey, fine texture
4240-4255 Sandstone, pink-spotted cream, cement dolomitic
4255-4260 Anhydrite, white
4260-4275 Dolomite, medium grey, anhydritic, dirty, fine grained, vuggy
4275-4285 Anhydrite, sandstone, siltstone and dolomite
4285-4290 Dolomite, medium to light grey, spotted
4290-4315 Siltstone to fine sandstone, light grey
4315-4340 Mostly anhydrite, perhaps partly grey dolomite
4340-4345 Sandstone, light grey, fine grained
4345-4350 Shale, black, shiny, bituminous, finely fissile, compact
4350-4360 Dolomite, dark grey, sugary, with larger secondary crystals, some oil saturation, vuggy, fossil casts
4360-4365 Dolomite, light and medium grey, sugary, quite vuggy, sandy and silty
4365-4375 Dolomite, creamy buff, medium sized rhombs, fine powdery matrix of limestone, stylolitic, limestone, dove, finely crystalline
4375-4395 Limestone, dove, lithographic, with calcite veins
4395-4405 Dolomite, dove, fine powdery texture
4405-4415 Anhydrite, light grey, spotted
4415-4425 Sandstone, light grey, fine grained
4425-4430 Anhydrite, light grey
4430-4435 Anhydrite, light grey, and dolomite, light grey, vuggy
4435-4440 Dolomite, anhydrite and sandstone, light grey
4440-4450 Sandstone, light grey, fine grained, poorly sorted, angular to subrounded
4450-4455 Shale, black, bituminous
4455-4500 Dolomite, grey, brown grey, dove and dark, brown, fine powdery texture, chert, light blue, 4465'
4500-4515 Limestone, light grey and dark brown grey, fine texture, dolomite, calcite veins
4515-4520 Shale, black, if not cavings
4520-4530 Sandstone and siltstone, light grey, show of oil
4530-4535 Anhydrite, spotted white and light grey
4535-4540 Dolomite, light dove, fine sugary, vuggy, sponge spicles
4540-4550 Limestone, cream dove, lithographic, flaky
4550-4555 Sandstone, grey, porous, fine grained, subangular
4555-4566 Limestone, light dove grey, altered oolitic
4571-4575 Dolomite, finely crystalline, very vuggy
4575-4578 Sandstone, cream buff, fine grained, vuggy, porous
4578-4580 Limestone, light dove, lithographic, flaky
4580-4585 Dolomite, brown grey, partly limy, fine grained, with translucent chert
4585-4595 Dolomite, anhydritic, brown grey, with translucent chert
4595-4605 Limestone, cream, fine texture, silty and sandy below
4605-4615 Limestone, cream, silty, fine grained
4615-4625 Dolomite, cream, fine rhombic
4625-4630 Dolomite, pyritic (very small cubes), sandstone, pyritic, bentonite, light green and grey, siltstone, red, numerous large etched sand grains
4630-4652 Siltstone to fine sandstone, cream, subangular, poorly sorted, limy cement, pinkish below 46451', bentonite, bright green, flaky
4652-4655 Siltstone, mudstone and sandstone, lavender, brick red, brown
4655-4668 Same, some bentonitic laterite, some also purple, somewhat sandy
4668-4680 Sandstone, purple and maroon, clayey, bentonite, light green, sandy, limy cement, sand poorly sorted, subangular to subrounded, some etched, some large grains, a few carnelian grains
4680-4693 Clay, purplish, bentonitic, sandy, sandstone cream-splotched and purple, azurite
4693-4713 Some sponge spicles in purple clay, 4700'-10', small turgite nodules, largely clay, bentonitic, sandy, purple, small quartz and carnelian pebbles, malachite
4713-4735 Large amount of cream sandstone in purple clay, some yellow and brick red clay
4736-4760 Sand, cream and red, coarser, subangular, partly recrystallized
4760-4770 Chert, pebbles (?), light yellowish cream, translucent Cavings
4780-4790 Cavings
4790-4795 Sandstone, mostly pink, some cream
4795-4810 Chert, milky, sandstone, pink all sizes, non-round grains, etched, some recrystallized, chert pebbles, some apparently decomposed
4810-4865 Pahasesapa (Madison) limestone, cream, lithographic, secondary calcite in vugs
4865-4875 Much pink-splotched secondary cavern filling of dolomite and calcite. Lost returns.
4875-4875 Lost returns
4875-4880 Pre-Cambrian granite, cored
0-325' No cuttings. Niobrara and Carlile
325-330 Marl, dark blue grey, spotted with rather sparse chalk pellets, greywacke, bentonite, with biotite, phlogopite and a small amount of basic green mineral
330-360 Shale, dark blue grey, small flattened chalk particles, seams of lighter siltstone, chlorite, brown mica, fish remains
360-375 Same but less chalk
385-400 Globigerina, Inoceramus prisms, Textularia, shale, fine flaky, limy, bentonitic and silty
400-405 Shale, more chalky, bituminous, fish remains
405-415 Sandstone, medium size grains, abundant small chalk pellets and Globigerina, impure limestone, fish and Inoceramus prisms, top Greenhorn
415-440 Greenhorn limestone, light grey, impure, fine crystalline, many Globigerina and Inoceramus prisms, fish remains, white bentonite, 435'-40'
440-445 Foraminifera extraordinarily abundant, especially Globigerina
445-460 Graneros shale, dark blue grey, chalk spotted, Globigerina
460-465 Globigerina abundant, Inoceramus
465-470 Limestone, grey, fine texture
510-530 Less chalk spots in shale
530-555 Fish scales and Globigerina common, chalk spots more scattered
555-570 Some laminae of limy silt, many Globigerina, still chalky
570-580 Still less chalk
580-600 Very small chalk dots, shale, flaky, bentonitic, Globigerina, Inoceramus, fish remains
600-615 Limestone, light grey, fairly large crystals, some quite clayey, Inoceramus and fish
615-620 Sandstone, grey, dirty, fine grained, glauconitic, fish
620-655 Bentonite, white, probably layers of Inoceramus and fish fragment limestone interbedded with bentonitic shales carrying many small Inoceramus fragments
655-630 Inoceramus fragments scarcer, fish, shale, darker, quite bentonitic
630-750 Foraminifera scarce or lacking, dark grey shale, much bentonitic mud, no chalk
750-755 Sandstone, medium grained, grey, subangular, poorly sorted, pyrite and chalcopyrite cement
755-765 Sandstone, light brown grey, micaceous, ligniferous, part limy cement, medium grained
765-785  Shale, dark blue grey, light brown iron carbonate concretion, 770'–75'
785-790  Sandstone, light grey, fine grained
790-800  Shale, dark blue grey, brown clay ironstone concretions, bentonic
805-810  Iron carbonate, bentonic, fine grained, light butternut brown
810-820  Sandstone, medium grained, subangular, pyrite cemented, chalcopyrite and bornite
820-840  Shale, dark blue grey
840-845  Siltstone, brown iron carbonate cement
845-860  Shale, blue grey
860-865  Lignite, very bituminous, coking
865-880  Shale, perhaps with sandstone interbeds
880-885  Sandstone, light brown grey, fine grained, bentonic
885-890  Siltstone, light grey, sandy
890-900  Shale, sandy, blue grey
900-920  Sandstone, grey, dark chert and biotite particles, probably mostly shale
920-930  Shale with buff soft limestone
930-940  Sandstone, light grey (Mowry ?), bentonic, soft
940-1000  Sandstone, light grey, fine grained, micaceous, carbonaceous
1015-1020  Concretions
1020-1025  Siltstone, red brown
1025-1035  Sandstone, light grey, quite fine grained, carbonaceous, some unsorted and partly rounded, medium sized grains, 1030'–35'
1035-1050  Bentonite, light grey drab, hardened
1050-1055  Sandstone, coarse, subangular, lignite
1055-1075  Shale, somewhat lighter grey than usual
1075-1080  Red brown "rusty" beds, fish scales
1080-1145  Clay ironstone concretions
1145-1165  Shale, dark blue grey
1165-1270  Shale, dark blue grey, silty, Globigerina
1270-1300  Some shale, red brown
1300-1345  Dakota sandstone, light grey, fine grained, micaceous, poorly sorted, subangular to subrounded
1345-1350  Shale, dark blue grey
1350-1365  Siltstone, brown and brown red
1365-1400  Some sandstone
1400-1440  Cavings
1440-1450  Sandstone, medium grey, carbonaceous, micaceous, limy cement, fine grained
1450-1465  Manganosiderite or rhodochrosite pellets in grey siltstone or very fine sandstone, somewhat bentonic, brown red mottled, bentonite, drab
1465-1480  Fuson siltstone, purple and maroon, bentonite, drab, mottled, brown, red and yellow
1480-1500  Siltstone and fine sandstone, grey and brown, bentonic matrix
1505-1510 Sandstone, light grey, fine grained, porous, sub-angular, poorly sorted, partly recrystallized
1510-1515 Shale, dark blue grey, fissile
1515-1525 Sandstone, like at 1505'-10'
1525-1545 Some sandstone, light brown
1545-1560 Shale and bentonite, lignitiferous
1560-1605 Bentonite beds, grey drab
1605-1610 Sandstone, light grey, medium grained, subangular to subround, porous, pyrite cement
1610-1613 Lakota sandstone, large grains, some grit size, some rose quartz, etched, angular to subround, some recrystallized
1613 Lost circulation
1613-1625 Limestone, light yellow buff, amorphous, looks like caliche
1625-1660 Sandstone, grey, fine to medium grains, etched, subangular to subround, porous, marcasite, some large grains, non-sorted, many grains recrystallized, becomes coarser downwards, considerable pyrite cement, 1642'
1660-1632 Grit, partly subround, etched, some rose and citrine quartz grains, pyrite between grains
1692-1698 Bentonite, light leek green, silty
1698-1705 Cavings, some bentonite, drab, lavender, mottled with red brown
1705-1744 Sandstone, cream, fine to medium grained, permeable, some dolomitic cement, poorly sorted, subangular, some grey chert grains, grades down into claystone, light grey
1744 Morrison siltstone, mottled brown red, yellow brown, purple, lavender, bentonitic
1745-1750 Bentonite, dove grey, silty
1750-1755 Siltstone, light brown grey
1755-1765 Bentonite, dove grey
1765-1770 Bentonite, dove grey, lavender and light green
1770-1775 Siltstone, light grey, bentonitic, light grey, fine texture
1775-1780 Bentonite, light green grey and lilac
1780-1800 Bentonite, lavender, silty, with fine sand below
1800-1830 Sandstone, cream, fine grained, subangular, porous, chert cement in part, denser below
1830-1835 Limestone, brown grey, sandy
1835-1845 Sandstone, orange mottled, fine grained
1845-1850 Sandstone, yellow, fine grained
1850-1855 Sundance bentonite, dull green, sandstone, glauconitic, fine grained
1855-1860 Limestone, cream, amorphous
1860-1865 Cavings
1865-1870 Bentonite, splintery, dull green, grey and brown, some limestone, brown, very fine and dense
1870-1880 Cavings

-83-
1880-1895 Sandstone, grey spotted, fine grained, some glauconite, minute pellets dull greasy dull green hydrous iron silicate
1895-1900 Bentonite, dark dull green
1900-1905 Bentonite, grey, silty
1905-1910 Clay, light green grey, bentonitic, silty
1910-1925 Bentonite, grey drab
1925-1930 Siltstone, light green grey, bentonitic, dove bentonite
1930-1935 Sandstone, light grey, fine grained, porous
1935-1940 Bentonite, lavender
1940-1945 No cuttings
1945-1950 Siltstone, light red brown, bipyramidal quartz
1950-1954 Sandstone, cream, fine grained, porous
1954-1975 Sandstone and siltstone, light red brown, porous, fine grained
2000-2065 Sandstone and siltstone, light green grey, small amount glauconite, bentonitic, a little coarser and less sorted in lower part
2065-2080 Siltstone, red brown
2080-2105 Sandstone, light grey, fine to coarse rounded and etched grains
2105-2140 Spearfish siltstone, dark brown red, micaceous, calcite crystals
2140-2150 Limestone, light brown grey, with larger calcite crystals and dogtooth spar, vuggy, coarse to fine texture
2150-2160 Siltstone, dull brown red
2160-2175 Siltstone with scattered etched rounded quartz grains, brown red
2175-2180 Siltstone, brown red
2180-2190 Limestone, cream to light brown grey, vuggy, much dogtooth spar, sandstone, fine, red brown
2190-2220 Limestone, light brown grey, vuggy, much dogtooth spar, crystalline
2220-2235 Anhydrite, white to blue
2235-2255 Limestone, grey (?), and red beds
2255-2260 Siltstone, red brown
2260-2270 Anhydrite, cream, pink-tinged
2270-2275 Siltstone, bright brown red
2275-2280 Anhydrite, cream brown
2280-2290 Sandstone, light grey green, some pink, silty
2290-2300 Anhydrite and brown red siltstone
2300-2310 Anhydrite, pink-splotched
2310-2340 Siltstone, bright salmon
2340-2345 Anhydrite
2345-2355 *Minnekahta dolomite, pink buff, fine sugary*
2355-2365 Limestone, pinkish buff, fine sugary, some yellow below 2360
2365-2375 Dolomite, buff and yellow, pink stained, fine sugary
2375-2380 Limestone, light grey brown, small crystals, calcite veined

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Opechee siltstone, brown, hard, dolomitic
Siltstone and sandstone, brown red, splotched green grey
Anhydrite, cream, with siltstone, light salmon, dolomite
Anhydrite, cream, and blue, pink tinged
Siltstone, dark salmon, calcite crystals
Sandstone, dark salmon, medium grained, subround
Siltstone, dark salmon
Siltstone, maroon, micaceous, considerable medium grain, etched, subround sand
Sandstone, cream
Siltstone, sandy
Sandstone, cream, fine to medium grained, subround, porous
Sandstone, light pink, fine grained, porous, limy cement
Siltstone, salmon, micaceous
Sandstone and siltstone, salmon, fine grained, subangular to subround
Siltstone, dark salmon
Sandstone, buff, subangular grains, fine grained
Sandstone and siltstone, salmon
Sandstone, salmon, subround to subangular
Sandstone and siltstone, salmon
Siltstone and claystone, salmon
Sandstone, salmon, fine grained
Siltstone, dark salmon
Sandstone, salmon, fine grained
Sandstone, cream, fine grained
Sandstone, salmon, fine grained
Anhydrite, light brown grey
Sandstone, pink, fine grained
Siltstone, salmon
Anhydrite, white and blue grey
Dolomite, grey, fine sugary vuggy, shale, black, bituminous
Dolomite, mixed with anhydrite, grey with small dark spots, porous
Sandstone, medium grey, pink mottled, nonsorted, insoluble cement
Quartzite, pink, fine to medium grained
Anhydrite, light brown grey, fairly coarsely crystalline
Dolomite, grey, fine sugary, vuggy
Dolomite, grey, with anhydrite, cream and light grey, fairly coarsely crystalline, fossils
Limestone, grey, sugary, small rhombs, vuggy, fossiliferous
Anhydrite, limestone, dolomite, quartzite, red
Sandstone, pink cream, medium grained, subangular to subround, etched, quartzite cement
2830-2835  Anhydrite, dolomitic, pink stained dove, fine texture
2835-2840  Anhydrite, cream
2840-2845  Siltstone, salmon, with light grey spots
2845-2850  Anhydrite, cream to light grey
2850-2855  Anhydrite, cream and light brown grey, well crystallized
2855-2860  Dolomite, dark grey, dirty, sugary, with secondary anhydrite, shale, black, bituminous
2860-2865  Anhydrite, cream and dove, sandstone, light grey, fine grained
2865-2870  Dolomite, dark grey, fine sugary
2870-2875  Anhydrite, cream and light dove
2875-2880  Limestone, dolomitic, cream, vuggy, altered oolites
2880-2885  Limestone, dolomitic, pink brown, fine texture
2885-2890  Limestone, dolomitic, light grey, fine texture
2890-2895  Limestone, dove grey, lithographic
2895-2900  Dolomite, brown grey, sugary
2900-2905  Anhydrite, cream grey
2905-2910  Limestone, grey and red brown, fine texture
2910-2915  Dolomite, light grey, pink tinged, sugary
2915-2920  Dolomite, light brown, small rhombic crystals
2920-2925  Dolomite, cream buff, medium sized rhombs
2925-2930  Dolomite, cream, buff, fine sugary, partly altered oolites, vuggy
2930-2935  Dolomite, light blue grey, fine powdery texture
2935-2940  Limestone, dove, lithographic, lavender tinged below 3030!
3030-3035  Limestone, dolomitic, cream, fine powdery texture
3035-3040  Dolomite, light grey, fine powdery texture
3040-3045  Dolomite, light grey, stained faintly pink, small rhombs, vuggy
3045-3050  Limestone, pink, medium sized crystals
3050-3055  Limestone, magnesian, cream, small rhombs and fine powdery, faint pink tinge, less magnesian in lower part
3055-3060  Limestone, light pink, sugary rhombic
3060-3065  Limestone, light pink, sugary rhombic, dolomitic
3065-3070  Dolomite, light pink, sugary rhombic
3070-3075  Limestone, cream, pink tinged, sugary rhombic
3075-3080  Limestone, light grey cream, fine powdery to fine rhombic
3080-3085  Limestone, medium grey, light green grey and lavender, bright green glauconite, small dolomite rhombs and quartzose silt
3085-3090  Limestone, cream, lithographic to fine crystalline
3090-3095  Dolomite, cream, fine rhombic
3095-3100  Limestone, cream, fossiliferous, altered oolites
3100-3105  Limestone, cream, fine powdery texture
3105-3110  Dolomite, cream, fine powdery texture, faint greenish tinge, some red laterite
3235-3230 Limestone, cream and brown grey, fine powdery, clay, sandy, red
3230-3235 Limestone, cream grey, sandy, fine powdery texture
3285-3305 Laterite, maroon and purple, with fine sand grains, some coarse rounded and etched sand, light green splotches, bentonite, sandy, bright light green
3305-3315 Sandstone, yellow and light grey
3315-3325 Sand, coated dark brown red grains, fine to medium to coarse grains, angular to subrounded, larger grains in matrix of vermillion clay
3325-3340 Sandstone, light buff, fine grained, dolomitic cement
3340-3345 Laterite, maroon, sandy
3345-3353 Dolomite, light yellow and grey, cavernous, fine sugary
3353-3358 Small nodules of dark grey and red hematite cementing sand grains, arkosic fragments of orthoclase, biotite and quartz
3358-3367 Pre-Cambrian granite, feldspar largely kaolinized, some albite, abundant biotite, some orthoclase and phlogopite, stained with turgite (hydrous hematite)
20. AMERADA PETROLEUM CORP. MILDRED VORHEES 1, SE. 1/4 NE. 1/4 SW. 1/4,
Sec. 25, T. 10 S., R. 8 E., Fall River County. Altitude 3332'.

0- 40' No cuttings
40- 75* Chadron (lower White River) conglomerate, caliche-
cemented, angular milky chert and quartz, black obsi-
dian, silicified wood, selenite, satin spar, iron
oxide nodules, red silts at base

75- 330 Pierre bentonitic clay, blue grey with greenish tinge,
small biotite and muscovite flakes, pyritized ammo-
nites, locally silty and limy. Hauerite cements
Inoceramus prisms at 150'-65'. Aragonite and cubical
nodules of hauerite, 165'-80'. Pseudotetrahedral
(sphenoideal) chalcopyrite in coxcomb marcassite and
bentonite, 180'-35'. Tan clay ironstone below 225'.
Shell fragments, 240'-60'. Clay ironstone, tan,
280'-300', with aragonite cone-in-cone there and
lower down.

330- 460 Sharon Springs shale, dark blue grey, bituminous,
faintly chalky, fish remains

460- 500 Niobrara marl, grey, with numerous small flattened
chalk pellets, more chalk in lower part

500- 520 Shale, very dark blue grey, bituminous, with small
amount chalk pellets

520- 630 Marl, grey, chalky, some oil staining, 580'-630'

630- 660 Carlile shale, blue grey, small percentage minute
chalk pellets

660- 700 Globigerina marl, with chalk pellets and shell
fragments, light grey

700- 730 Shale, dark blue grey, considerable chalcopyrite,
720'-730'

730- 740 Some limestone, light grey, very finely crystalline

750- 730 Considerable claystone, yellow and crimson

730- 830 Calcite, honey yellow and colorless, limestone,
light blue grey, fine texture, probably septarian
concretion zone

810- 850 Considerable octahedral, nonworn magnetite, pyritized
fossils

850 Some small almandine garnets, dodecagonal, excep-
tional abundance pyrite, dark grey scoraceous, amorph-
ous substance, bornite, considerable chalcopyrite,
Cristallaria

860 Large fragment chalcedony, light blue white, cement-
ing fine sands, grey fine silty limestone

890 Some sandstone, grey, fine grained

300- 310 Some blue grey chert or chalcedony, pyritized glo-
bular organisms, single and also in aggregates of
much smaller spheres, Cristallaria, fish remains,
red and yellow iron oxide fragments, vesicular slag,
shell fragments, some pyritized, grey medium and
angular grained sandstone with biotite and ser-
pentine fragments, small Globigerina, Belemnitella
340-350 Shale, very dark blue grey
360-380 Bornite and chalcopyrite, shale as just above
390-1000 Shale, largely silty and chalky, blue grey
1000-1040 Shale with small flakes of chalk, very dark blue grey
1040-1050 Large piece of bornite, shale, dark blue grey, missing intervals above due to extensive caving
1070-1100 Greenhorn limestone, light grey, impure, fish remains, Globigerina and Inoceramus prisms, cement in part pyrite and chalcopyrite, limestone has coarse to fine crystals with calcite veins, numberless loose Globigerina 1030'-1100'
1100-1200 Graneros shale, dark blue grey, cavings suggest fine grained sandstone at base of Greenhorn. Some shale has interbedded sand laminae with a little serpentine and a few blebs of chalk
1200-1220 Shale, very dark blue grey, Globigerina
1220-1240 Shale, dark blue grey, very small chalk particles
1240-1260 Shale, grey, with a silvery sheen, bornite, chalcopyrite
1260-1270 Bornite and black shale
1270-1290 Perhaps a little grey fine grained sandstone, chalcopyrite
1290-1330 Shale, black, some grey scoriaceous material, concretions and fish remains
1330-1400 Clay ironstone, dark brown grey, medium crystals, magnetite
1400-1420 Some magnetite
1420-1440 Concretions more abundant
1440-1480 Some sandstone, grey, coarse, angular, pyrite and chalcopyrite cements, abundant Inoceramus prisms
1480-1520 Sandstone, light grey, fine grained, muscovitic, some bornite cemented. Coarse angular sandstone with rounded chert particles, pyrite cemented, large percentage of sulphides, including chalcopyrite, as cement of sand and Inoceramus prisms
1520-1550 Sandstone, very light grey, fine, angular grains, limy cement, muscovitic, coarser downwards, possibly black felsitic diabase, magnetic and fine grained, garnet rock, also magnetite. Some dark brown siderite cementing silt
1550-1620 Shale, dark blue grey
1620-1635 Muddy (Newcastle) sandstone, light grey, muscovitic, fine grained, angular, fine white powdery matrix, fish and small chert fragments. Resistivity log indicates probable sandstone from 1475'-1510' and 1530'-85'.
1645 Some shale, silty, purplish
1655-1680 Some sandstone, light grey, medium grained, shale, dark blue grey
1680-1700 Shale, bentonitic, some lighter blue grey
1700-1730 Some sand with garnet fragments
1730-1740  Some ironstone concretions
1740-1325  Shale, dark blue grey, flaky, concretions. Casing
          run to 1336'
1325-1360  Dakota sandstone, brown to grey, fine grained,
          angular to subangular; some medium sized grains and
          dark chert fragments, limy cement, some carbonaceous
          material. Sandstone abundant after circulating
          at 1351'
1360-1370  Sandstone, light grey, medium grained, angular
          grains, muscovitic, less cement than next above
1370-1395  Dark brown red magnetic iron oxide stone, some mag-
          netite cemented sandstone, some jet (wood) fragments
1395-2000  Manganosiderite or rhodochrosite pellets, magnetic,
          crimson and brown, in varicolored bentonite matrix
2000-2020  Fuson clay and siltstone, terra cotta, varicolored
          bentonitic clay
2020-2025  Abundant lignite, some pyritized
2025-2040  Clay and shale, bentonitic, various shades of gray
2040-2045  Sandstone, light grey, medium grained, porous,
          angular grains, carbonaceous and muscovitic
2045-2065  Sandstone, partly cemented by pyrite and chalco-
          pyrite
2065-2070  Mainly shale, dark blue grey, fissile
2070-2080  Lakota sandstone, light grey, largely fine grained
2080-2090  Sandstone, some pink and cherry red, ferruginous
          cement
2090-2100  Considerable lighter grey and green grey shale
2100-2105  Sandstone, light grey, very fine grained, micaceous
2105-2110  Bentonite, yellow and tan, some mottled red and
          crimson
2110-2150  Cavings: sandstone, shale, bentonite, some large
          etched sand grains
2150-2180  Grit size sandstone, etched angular grains, some
          citrine and rose, some recrystallized. Below
          2165' increase in porosity, mostly loose grains,
          some rounded
2180-2190  Practically all grit. Base Lakota
2190-2195  Morrison, increase in bentonite
2195-2200  Limestone, cream, lithographic, and sandstone,
          cream, fine grained, limy cement, bentonite, light
          green and drab, iron and copper sulphide crystals,
          sand grains partly rounded, striated prism chalco-
          cite cementing sandstone
2200-2215  Bentonite light green, drab, light olive yellow,
          some fine sand grains
2215-2220  Limestone, cream, lithographic, containing sparse
          sand grains
2220-2250  Bentonite, somewhat darker than above, sparse sand
          grains, chalcopyrite
2250-2265  Limestone, light grey, lithographic, carbonized reeds
2265-2270  Clay, bentonitic, terra cotta, brown and drab, light
          green
2270-2275 Sandstone and lithographic limestone, light grey, bentonitic. Sandstone is fine grained with limy cement.

2275-2280 Limestone, cream grey to drab, lithographic
2280-2285 Clay, terra cotta and lavender, bentonitic and sandy

2285-2290 Apparently most limestone as above but less pure. Some sandstone and bentonitic clay

2290-2305 Sandstone with limy or bentonitic matrix, fine grains scattered

2305-2310 Quartzite, cream to light pink, milky white opal cement. Angular medium sized quartz grains, some chlorite aggregates. Some porous loosely cemented sandstone. Matrix before silicification may have been bentonite. Many sand grains recrystallized

2310-2320 Sandstone, less cemented, grains recrystallized, coarse angular sandstone at base with some chalcopyrite, rose quartz grains, some quartzitic cement, some grains grit size

2320-2345 Cavings, miscellaneous shale, clay, bentonite, sandstone, coal, limestone, fissile shale containing sand grains, some light grey bentonitic clays

2345-2370 Sandstone and siltstone, light grey, very fine grained, limy cement, very small light mica flakes, chalcopyrite, 2360'-65' in prevalent siltstone

2370-2375 Limestone, lithographic, light brown grey, and bentonite and siltstone, lavender to brown, sandy, bornite

2375-2380 Sandstone, light grey, fine grained, small octahedral magnetite, locally quartzite

2380-2385 More matrix than sand grains

2385-2390 Shale, dark blue grey, some silty

2390-2395 Sandstone, light grey, fine grained

2395-2405 Limestone, light grey, finely crystalline to powdery, sandy and some sandstone

2405-2410 Limestone, magnesian, light dove grey, with scattered small round and angular sand grains

2410-2415 Unkkapa sandstone, pink, angular, fine grained, some limy cement

2415-2420 Sandstone, both medium grey and pink, dolomitic cement, carbonaceous, partly recrystallized, apparently partly permeable, some light sea green sandy bentonite (caving?)

2420-2435 Sandstone, salmon, fine grained, angular and subangular, some larger grains, dolomite cement, fairly porous, matrix of red clay

2435-2495 Sandstone, salmon, with some cream, much mauve-colored and sea green sandy caving bentonite, etched sand grains, some pink sandstone; colors other than salmon in thin bands and streaks; coarser and less sorted in lower part
Sandstone, crimson splotched clay cementing the grains
Sundance limestone, light grey and white spotted, breccia of broken shell fragments cemented with finely crystalline white calcite, small elliptical to spherical concretionary brown calcite pellets, some bright green glauconite pellets in fine grained sandstone in lower part

Siltstone, light grey, small white mica flakes
Clay, silty and bentonitic, flaky, medium grey, with white mica flakes and diminutive "goof ball" pyritized, probably plant fruit, fossils
Sandstone, grey, fine grained, and siltstone, glauconitic, shale, grey, bentonitic; mostly sandstone, with more glauconite than higher up
Sandstone, light grey, fine grained, abundantly glauconitic, limy cement, angular grains, dark chert fragments, plant fragments, partly permeable, white mica flakes
Sandstone more abundant and permeable, less glauconite and finer below, thin darker grey silt laminae near base
Sandstone, fine grained; and siltstone, light salmon, small white mica flakes, silt a little darker and in fine laminae
Sandstone, cream, fine grained, porous, coarser than next above, some rose quartz
Siltstone, brown drab, limy cement
Sandstone, light grey, silty, very fine grained, limy cement, sparse glauconite, some dark green grey bentonite films increasing downwards
Mostly grey clay cavings of Morrison
Sandstone, lavender, medium grained, angular, porous, poorly sorted, many small and some large grains, etched, poorly rounded, limy cement. Downwards color becomes bright salmon, almost crimson. Recrystallized sand grains
Perhaps clay, light green, bentonitic, and siltstone in both, but much sandstone
Bentonite, brown drab, yellow, light green, clay with fine glauconitic sand laminae, possibly some light grey fine fossiliferous sandstone. Nearly all cavings, 2700-2790
Spearfish siltstone, dark brown red (dark salmon), mainly siltstone, striated twinned chalocite in light drab caving bentonite at 2805-2810
Higher percent mudstone, dark salmon, with white leached spots, anhydrite veinlets
Anhydrite, fine crystalline, cream in part, mostly pink or red stained
Siltstone, as higher, white mica flakes
Sandstone, cream, coarse grained, rounded, etched, insoluble cement

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<table>
<thead>
<tr>
<th>Page Range</th>
<th>Description</th>
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<tbody>
<tr>
<td>2885-2300</td>
<td>Siltstone, bright brick red, light grey spots</td>
</tr>
<tr>
<td>2300-2385</td>
<td>Largely cavings but perhaps in red siltstone interbedded with anhydrite</td>
</tr>
<tr>
<td>2385-2390</td>
<td>Siltstone, red</td>
</tr>
<tr>
<td>2390-2935</td>
<td>Perhaps mostly anhydrite</td>
</tr>
<tr>
<td>2935-3015</td>
<td>Siltstone, bright brick red, with vein anhydrite or perhaps interbedded anhydrite. Splashes of anhydrite increase downwards and some of the siltstone has rounded and etched, partly large size, quartz grains</td>
</tr>
<tr>
<td>3015-3035</td>
<td>Increase in anhydrite apparently mixed with or interbedded with bright red siltstone, some fine sandstone with larger etched rounded grains</td>
</tr>
<tr>
<td>3035-3070</td>
<td>Siltstone and fine sandstone, dark salmon</td>
</tr>
<tr>
<td>3070-3075</td>
<td>Sandstone, cream, very fine grained</td>
</tr>
<tr>
<td>3075-3110</td>
<td>Minnekahta limestone, cream to pink, lithographic to fine crystalline, some bright green stain, anhydrite zone at top. Minute bornite crystals in limestone in upper 10'. Stained purple maroon at base where limestone is more coarsely crystalline</td>
</tr>
<tr>
<td>3110-3115</td>
<td>Opechee siltstone, dull maroon, compact, slightly dolomitic</td>
</tr>
<tr>
<td>3115-3120</td>
<td>Dolomite, dull maroon to grey, veined and splotched with anhydrite</td>
</tr>
<tr>
<td>3120-3130</td>
<td>Siltstone, lavender to light purple, dolomitic</td>
</tr>
<tr>
<td>3130-3145</td>
<td>Siltstone, purple, with anhydrite, small segregations of colorless and milky chert and red to deep orange jasper in anhydrite, some bright green either of a secondary copper, nickel or hydrous iron silicate mineral</td>
</tr>
<tr>
<td>3145-3161</td>
<td>Mostly cavings, but perhaps siltstone and fine sandstone, dull dark red</td>
</tr>
<tr>
<td>3160-3170</td>
<td>Anhydrite, white, and siltstone, dark salmon</td>
</tr>
<tr>
<td>3170-3210</td>
<td>Siltstone, dull dark red, with anhydrite containing dark salmon dots</td>
</tr>
<tr>
<td>3210-3225</td>
<td>Same with fine grained angular sandstone</td>
</tr>
<tr>
<td>3225-3255</td>
<td>Sandstone, cream, fine grained angular to subround</td>
</tr>
<tr>
<td>3235-3245</td>
<td>Siltstone, dark red and light brown</td>
</tr>
<tr>
<td>3245-3255</td>
<td>Minnelusa sandstone, cream to orange, poorly sorted, some etched grains fine to coarse, angular to subround, porous, feldspathic</td>
</tr>
<tr>
<td>3255-3265</td>
<td>Sandstone, cream, fine grained</td>
</tr>
<tr>
<td>3265-3300</td>
<td>Probably mainly siltstone, somewhat sandy, dull dark maroon red, perhaps with interbeds of buff to orange fine grained sandstone</td>
</tr>
<tr>
<td>3300-3305</td>
<td>Perhaps increase in sandstone</td>
</tr>
<tr>
<td>3305-3315</td>
<td>Sandstone, buff to orange, fine grained, permeable, angular</td>
</tr>
<tr>
<td>3315-3345</td>
<td>Siltstone, usual red color, white mica flakes some claystone, possibly a little dove lithographic limestone; mostly cavings</td>
</tr>
<tr>
<td>3345-3350</td>
<td>Sandstone, buff to reddish, fine, angular, porous, partly recrystallized grains</td>
</tr>
<tr>
<td>Number</td>
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</tr>
<tr>
<td>3350-3365</td>
<td>Siltstone, dark brown red, micaceous, scattered angular quartz grains at top</td>
</tr>
<tr>
<td>3365-3380</td>
<td>Sandstone, dull pink fine grained, somewhat silty, porous, partly recrystallized, lower part in part buff</td>
</tr>
<tr>
<td>3380-3395</td>
<td>Siltstone, dark brick red, with a little vein anhydrite</td>
</tr>
<tr>
<td>3395-3425</td>
<td>Sandstone, buff and pink, fine grained, a little coarser and all dull pink and micaceous below 3405, silty below 3420, a small amount of anhydrite</td>
</tr>
<tr>
<td>3425-3440</td>
<td>Siltstone, dark brick red, some fine pink sandstone, 3430-3435</td>
</tr>
<tr>
<td>3440-3450</td>
<td>Anhydrite, cream, finely crystalline, with considerable alabaster</td>
</tr>
<tr>
<td>3450-3485</td>
<td>Anhydrite, light to dark brown grey, with milky chert and alabaster</td>
</tr>
<tr>
<td>3485-3495</td>
<td>Dolomite, grey, fine granular, intermixed with clayey anhydrite</td>
</tr>
<tr>
<td>3495-3505</td>
<td>Anhydrite and alabaster</td>
</tr>
<tr>
<td>3505-3520</td>
<td>Sandstone, pink and white, some large rounded etched grains in finer angular ones, dolomitic cement, considerable porosity, based by dove lithographic limestone</td>
</tr>
<tr>
<td>3520-3525</td>
<td>Anhydrite, grey, clayey</td>
</tr>
<tr>
<td>3525-3535</td>
<td>Dolomite, grey, earthy, sugary and vuggy, partly with larger crystals, giving a &quot;porphyritic&quot; texture</td>
</tr>
<tr>
<td>3535-3540</td>
<td>Dolomite, cream, semi-lithographic</td>
</tr>
<tr>
<td>3540-3550</td>
<td>Anhydrite, white and light pink, finely crystalline, with alabaster</td>
</tr>
<tr>
<td>3550-3570</td>
<td>Sandstone, lavender to white, mottled, quite fine and silty, micaceous, dolomite cement; the white is coarser and angular grained. In lower part mostly cream sandstone, with the mottled apparently at the top. Large grains rounded, poorly sorted, partly porous</td>
</tr>
<tr>
<td>3570-3585</td>
<td>Limestone, dolomitic, brown grey, sugary, vugs partly refilled, likely originally fossiliferous; becomes buff below; contains rare chalcopyrite and a little milky chert</td>
</tr>
<tr>
<td>3585-3590</td>
<td>Probably sandstone, cream, coarse to medium grained, poorly sorted, subround to subangular, porous, largely recrystallized grains</td>
</tr>
<tr>
<td>3590-3595</td>
<td>Sandstone, fine grained, light salmon, permeable, poorly sorted, subround to angular, spotted with cream</td>
</tr>
<tr>
<td>3595-3615</td>
<td>Dolomite, buff to pink, lithographic, anhydrite, pink, grey, white</td>
</tr>
<tr>
<td>3615-3630</td>
<td>Anhydrite, white and light grey</td>
</tr>
<tr>
<td>3630-3640</td>
<td>Sandstone, salmon, mostly medium grained, partly rounded, insoluble cement, poor sorting, some large size grains</td>
</tr>
<tr>
<td>3640-3665</td>
<td>Anhydrite, grey and white</td>
</tr>
</tbody>
</table>
3665-3670  Dolomite, dark grey, deposited simultaneously with anhydrite particles
3670-3680  Sandstone, pink to red brown, poorly sorted, various size grains, dolomitic cement
3680-3700  Dolomite, dove, fine powdery texture, some pink staining, silty near base
3700-3710  Anhydrite, mostly white
3710-3725  Dolomite, cream to light grey, finely crystalline, dense, flaky, scattered larger crystals, originally fossiliferous
3725-3745  Dolomite, light pink, fine texture to lithographic
3745-3762  Dolomite, lavender, fine texture, with cream bands, powdery texture
3762-3775  Red marker, clay, magenta, finely colloidal and floculent, laminated, shaly, with very fine white mica flakes, probably a cacerite
3775-3780  Sandstone, cream to buff with faint green tinge, very fine grained, dolomitic cement
3780-3785  Shale, glossy black, very bituminous, compact
3785-3800  Dolomite, brown, fine sugary, some anhydrite splotches, slightly bituminous, considerable clayey matter, sponge spicules, white at base
3800-3805  Shale, black, very bituminous, grading at top to dolomite
3805-3810  Limestone, dolomitic, clayey and grey dolomitic siltstone, small dolomite rhombs in calcite matrix
3810-3815  Sandstone, light grey, very fine grained
3815-3820  Limestone, light grey brown, fine sugary
3820-3832  Limestone, dove, lithographic, flaky, dolomite, light cream grey, pink stained, fine sugary texture
3832-3840  Dolomite, light brownish grey, finely rhombic, somewhat vuggy
3840-3845  Sandstone, light grey, small scattered grains in dolomite matrix, possibly some red siltstone
3845-3850  Dolomite, light grey, fine powdery texture
3850-3860  Sandstone, light grey, fine and angular grains, dolomitic cement, coarser and less sorted below. Large increase in magenta shale at 3855-3860 which may be caving, anhydrite at base
3860-3870  Sandstone, light grey and white
3870-3874  Siltstone, light grey, limy cement, very thinly laminated, resembles a natural cement rock
3874-3885  Sandstone, light cream grey, dolomitic cement, poorly sorted, fine to medium grained, subrounded and etched to angular grains
3885-3890  Shale, black, very bituminous
3890-3895  Sandstone, as at 3874-3885 with some chalcopryite as cement
3895-3905  Dolomite, grey, very fine powdered sugar texture, clayey, vuggy, a little milky chert
3905-3920  Dolomite, dark blue grey, very clayey, fine texture, becomes lighter and purer below after passing through zone of sooty dolomite
3920-3945    Dolomite, buff, fine powdered sugar texture, with some limy dark blue grey shale, 3925-3930, vugs increasing in lower part
3945-3950    Dolomite, pink, fine grained vuggy, with large amount of dogtooth spar and some bipyramidal quartz in vugs, color produced by fine red clay
3950-3955    Sandstone, pink, fine grained, angular grains, porous
3955-3975    Dolomite, light grey, vuggy, fine grained to lithographic
3975-3980    Dolomite, pink, lavender and light grey, lighgraphic cavernous, with rhombic crystals coating vugs
3980-3985    Sandstone, light pink, small quartz grains scattered through dolomite matrix, vuggy
3984-3990    Dolomite, cream, with pink spots, fine texture with some coarser rhombs, vuggy
3990-4000    Dolomite, pink, fair sized rhombs with open spaces between
4000-4010    Dolomite, cream, fine powdery, full of solution holes
4010-4015    Dolomite, grey, fine rhombic to lithographic, vuggy, lighter grey below
4015-4025    Dolomite, cream, secondary calcite, containing some large etched subangular quartz grains
4025-4045    Sandstone and grit, white, grains angular, unassorted, limy cement, much recrystallized quartz or small quartz crystals
4045-4055    Same with brick red to lavender lateritic clay matrix
4055-4070    Sandstone, cream, medium and fine grained, limy cement, mostly angular grains, larger ones etched, glassy orthoclase (sanidine) fragments
4070-4075    Sandstone, conglomeratic, fragments of hydrated sericite schist, rose and citrine quartz, grains
4075-4100    Laterite, sandy, and sandstone with laterite matrix, lavender, salmon and maroon, mottled light green grey and salmon sandy clay, feldspar and quartz fragments
4100-4110    Chert, light yellowish
4110-4120    Dolomite, cream, fine rhombic, very cavernous
4120-4125    Siltstone, cream and pink-lavender, dolomitic cement
4132-4142    Pre-Cambrian biotite-muscovite schist cut by graphic granite, at top with kaolinized feldspar and epidotized ferromagnesian minerals albite in perthite, large muscovite flakes, graphic granite contains light greenish yellow, either vanadium or uranium, mica
21. WOODWARD OIL COMPANY, GERTRUDE SCHMITT 5, Sec. 4, T. 12S, R. 4E., Fall River County.

0- 60 Sand and fine gravel, weathered brownish tan Niobrara marl with chalk pellets, fragments of quartz, chert and selenite.

60- 30 Niobrara marl, grey, with flattened chalk pellets, Cristellaria, Globigerina.

90- 100 Somewhat purer chalk.

100- 120 Marl, blue grey, numerous flakes of phlogopite mica, many Globigerina, large amount of bentonitized volcanic ash, fish fragments. Transition between Niobrara and Carlile

120- 220 Carlile claystone, dark blue grey, micaceous and bentonitic, with small chalk pellets, notably at 140' to 150', somewhat silty, Globigerina and a few Inoceramus prisms. Chalcopyrite 210'-220'

220- 260 Sandstone, light grey, fine grained, angular, micaceous (phlogopite); very small amount glauconite, some dark grey chert grains, coarser at base

260- 310 Claystone, medium grey, silty, finely laminated layers of clay and silt

310- 320 Sandstone, grey, fine grained, interlaminated with siltstone

320- 440 Claystone and siltstone interlaminated, phlogopite, small specks of glauconite, Globigerina and a few Inoceramus prisms

440- 485 Shale, dark blue grey, with small chalky spots, interlaminated siltstone, Inoceramus prisms and Globigerina. Grades down into Greenhorn

485- 500 Greenhorn limestone, grey, composed of Globigerina and Inoceramus prisms

500- 530 Largely chalk-spotted dark grey marl, chalk decreasing downwards, some blue grey bentonite, numerous Inoceramus prisms and Globigerina

530- 540 Graneros shale, dark blue grey, darker and more compact than Carlile. Bentonitic, somewhat chalky, flakes easily, Chalcopyrite 580'-590'. Fish remains, somewhat bituminous, small flakes of white mica. Large admixture of bentonite below 650', also with interlaminae of quartzose silt. Below 800' the shale is dark blue grey and non-limy with very fine white mica flakes. Anomia at 840'-850'. Lighter blue grey below 850'.

340- 350 A little fine sandstone

350-1040 Shale, medium blue grey, finely micaceous

1040-1120 Muddy or Newcastle sandstone, light grey, fine grained, lignite fragments. Large flakes muscovite mica, some coarse angular grains of quartz and chert, fish remains, gas-producing, sandy bentonite with coarse sand grains at 1060'-70' with fine sand grains, 1085'-90'. Sandstone from 1090 to 1120', medium to coarse angular grains, very lignitic.

-105-
1120-1210 **Thermopolis (Skull Creek)** shale, blue grey and brown drab, bentonitic

1210-1220 Some sandstone, fine grained, muddy, dark grey, with small amount glauconite

1220-1310 Shale, dark blue grey, bentonitic

1310-1330 **Dakota (Fall River)** sandstone, light grey, medium grained, angular, considerable pyrite cement, a few larger, rounder grains

1330-1350 Shale (?) dark blue grey, silty, with sandstone as just above

1350-1360 Fuson manganosiderite or rhodochrosite pellet horizon (occurs in hole No. 4 at 1360'-1365')

1360-1420 Shale, dark blue grey, fissile

1420-1440 Sandstone, light grey, fine grained, some carbonaceous siltstone. Matrix of white bentonite, 1430'-1440'

1440-1450 Shale, as above

1450-1470 Loose sand, light grey, subrounded, etched, medium to coarse, some ashy bentonite

1470-1520 Shale as above, some dark bentonite

1520-1530 Minnewasté limestone, cream, very fine powdery texture, containing fine sand

1530-1560 Probably top Lakota sandstone, light grey, fine grained, angular. Chalcopyrite; cuttings mainly shale (probably caving)

1560-1600 Sand, loose, medium to large grains, subround and etched, chalcopyrite rather abundant at top

1600-1610 Sandy bentonite, light grey

1610-1650 Sandstone, light grey, fine grained, angular

1650-1660 Probably base Lakota sand, loose, medium to coarse, angular to subround, etched. Considerable chalcopyrite. Some sand recrystallized

1660-1680 Cavings

1680-1690 Probably Morrison, cavings and lavender to brown yellow bentonite

1700-1710 Some drab bentonitic shale

1710-1740 Sandstone, Unkpapa (?), cream, fine grained, recrystallized. Likely the oil horizon in hole No. 4. Becoming coarser below, poorly sorted, permeable, some larger and more rounded etched grains

1740-1750 Sundance sandstone, grey, fine, glauconitic, light green bentonite

1750-1770 Siltstone, dark grey

1770-1736 Sandstone, light grey, fine grained, with small glauconite particles, bentonite, light lavender

1796-1802 Sandstone, medium grey, fine grained, quite glauconitic, a little dove fine textured limestone. *Camptonectes* and *Pachyteuthis*

1823-1826 Sandstone, medium grey, fine, glauconitic, *Pachyteuthis*

1826-1832 Shale, blue grey, bentonitic, "golf ball" fossil, small black organic fragments
The section is continued downwards in cuttings from SCHMITT NO.4, 660' W. of E. line, 660' N. of S. line, Sec. 4, T. 12S, R. 4E.

1832-1870  Cavings of shale, a little loose sand and bentonite
1870-1880  Bentonite, light drab, with small sand grains in it, some light grey muscovitic siltstone and light green bentonite
1880-1920  Sundance sandstone, light grey, fine to medium grained, with light grey siltstone with minute particles of bright green glauconite, matrix is drab bentonite, also bentonite, light drab and green
1920-1980  Sandstone, light grey, small glauconite pellets, medium to fine grained, subangular, some light drab bentonite in the sandstone
1980-2050  Same, with grey and drab siltstone, bentonitic, small pyritized "golf ball" organisms, lavender and green pentinite, micaceous grey siltstone, Pachyteuthis (Belemnites) fragments at 2050'
2050-2060  Detrital (water-worn) bornite in fine sandstone
2060-2100  Sandstone, purple pink, fine, some dark maroon brown iron oxide stone, chalcopyrite, hauerite (?), glauconite more prevalent than higher up, molluscan fragments
2100-2110  Shale, drab, bentonitic
2110-2130  Sandstone, light grey and light green, small amount glauconite, cavings mostly dark brown grey bentonitic shale, also lavender, light grey and light green grey bentonite
2130-2160  Mostly as just above, some sandstone, 2130'-2140'
2160-2180  Sandstone, brown red, Pachyteuthis, also sandstone, light grey, interlaminated with dull brown red, some lavender, fine to medium grained, some dark brown fine chert particles, some small light green bentonite balls in the glauconite sandstone
2180-2190  Some siltstone, dark grey, with larger darker green glauconite nodules, sandstone as just above, light grey bentonite full of biotite flakes
2190-2230  Spearfish mainly siltstone, salmon, sandstone, dark brown red, locally leached white, a little anhydrite, white
2230-2320  Almost all cavings
2320-2340  Anhydrite, white and light pink, much cavings
2340-2390  Siltstone, dark salmon, some red fine sandstone, locally bleached white
2390-2440  Minnekahta limestone, white, light grey and light pink, very fine powdery texture, top likely at 2395'
2440-2460  Opeeche siltstone, lavender and purplish
2460-2490  Siltstone, salmon, some grey medium grained sandstone
2490-2500  Probably Minnelusa sandstone, silty, pink to lavender and medium red, fine grained with some larger, poorly sorted, siltstone, clayey, red
2500-2510 Some sandstone, light grey, coarse, angular
2510-2520 Sandstone, pink, unsorted, fine to coarse, angular
to subangular, porous, also grit in a red clay matrix,
brown drilling mud
2520-2550 Cavings
2550-2560 Perhaps some very fine light grey dolomite
2560-2600 Sandstone, light grey poorly sorted, considerable
coarse angular grains
2600-2670 Besides usual cavings of Fuson and Sundance there
is coarse light grey sandstone, and very fine grained
carbonate rock, the coarse grained angular light grey
sandstone contains dark brownish chert particles,
large frosted grains in bluish white matrix
2670-2690 Some anhydrite, white
2690-2730 Dolomite, light grey, mainly anhydrite, white
2730-2760 Anhydrite and sandstone, light grey, medium grained,
porous
2760-2770 Limestone, dolomitic, and dolomite, light grey,
finely crystalline, vuggy, some milky chert
2770-2820 Anhydrite, white, finely crystalline
2820-2850 Dolomite, light brown grey cream, fine grained, per-
haps some anhydrite
2850-2860 Anhydrite, white, and sandstone, light grey, medium
to coarse, subrounded to subangular, some frosted
grains
2860-2880 Sandstone, light grey and salmon, medium to fine, an-
ydrite, white and probably siltstone, salmon
2880-2910 Anhydrite, white
2915-2920 Dolomite, light brown finely crystalline, spotted
with white anhydrite
2915-2920 Dolomite, light brown, fine rhombic
2924 Dolomite, light brown, perhaps some buff fine grained
sandstone
2325-2350 Sandstone, cream, medium grained, porous
2350-2360 Dolomite, light brown grey, fine sugary
2360-2370 Anhydrite
2370-2380 Dolomite, medium grey, finely crystalline, secondary
veins, small vugs
2380-2390 Increase in anhydrite, with stylolitic dolomite
2390-3015 Dolomite, as above, mixed with considerable anhydrite
3015-3025 Siltstone, sandy, dark purplish red
3025-3030 Limestone, light grey, fine powdery texture, some
very vuggy, secondary calcite
3030-3035 Considerable dog tooth spar crystals, beginning at
3025'
3035-3055 Dolomite, very spongy and cavernous, light grey
travertine-like, many dog tooth spar crystals,
small to fairly large, some clustered, some per-
fact scalenohedrons, some attached to very black,
very fissile manganiferous shale and to salmon and
scarlet residual clay. The solution zone perhaps
extends from 3025' to 3080'.
3055-3080 Dolomite, medium and light grey, fine powdery, vuggy, dog tooth spar
3080-3085 Anhydrite and dolomite
3085-3090 Anhydrite more prevalent
3090-3095 Anhydrite and brown grey fine textured dolomite
3095-3100 Shale, black, bituminous
3100-3105 Sandstone, light pink, medium to coarse grained, porous, subangular to subround, limy cement
3105-3115 Cavings mostly, possibly salmon siltstone
3115-3135 Dolomite, light grey, very fine powdery texture, some milky chert, sandstone, purple, brown, yellow, dolomite grades down into limestone, light brown grey
3135-3145 Dolomite, dark grey, finely crystalline
3145-3155 Dolomite, grey, very fine texture, silty, lighter grey beneath, secondary vein anhydrite
3155-3170 Possibly sandstone and siltstone, grey, purplish and lavender, unsorted, poorly cemented sandstone
3170-3175 Considerable coarse sand, bipyramidal quartz crystals, considerable secondary calcite but mostly cavings which may be cavernfill since here circulation and hole were lost. There is some chalcopyrite

There is exceptionally large amount of sandstone in all the Cretaceous formations.
(cuttings are very poor, owing to large amount of cavings)

0-60  Graneros shale, drab and blue grey. Mowry facies, hard, fish scales
60-80  Shale, blue grey, soft slaking bentonitic
80-110 Sandstone, light grey, fine grained, insoluble cement, marnose nodules, flakes of muscovite, plant fragments, chlorite and numerous heavy mineral grains, pyritized "golf ball" fossils (plant fruit?)
110-140 Shale, blue grey, with grey and white bentonite
140-170 Shale, bentonitic, considerable sandstone, not cemented, somewhat coarser than above but still fine grained, fish, plant and shell fragments
170-190 Large sized quartz and flint sand size grains in silty matrix
190-220 Some tan clay ironstone concretions, brown and grey sandstone, angular, unsorted grains, clayey
220-230 Sandstone, light grey, medium grained, angular, porous larger grains subrounded and etched, hardened bentonite, grey, lavender, light green
230-250 Considerable clay ironstone
250-280 Quartzite, grey, and sandstone, brown
280-300 Limestone, light grey, fine textured, sandy
300-350 Interlaminated fine sandstone and shale, grey, bentonite, slaking, chalcopyrite and Inoceramus prisms
350-360 Shale, dark blue grey, mostly bentonite, slaking rapidly in water, some sandy and sandstone at top with a little glauconite
360-430 Some chalcopyrite and Inoceramus prisms
440-470 Fall River (Dakota) sandstone, grey, fine grained, some pyrite cemented, angular, carbonaceous
470-480 Fusian siltstone, dark reddish brown, abundant brown rhodochroite or manganosiderite pellets about size of medium sand grains and soluble in concentrated hydrochloric acid; their matrix is mainly brown and grey somewhat silty bentonite
500-510 Bentonite, grey drab
510-520 Lignite, dirty, with much marcasite replacing wood
520-540 Sandstone, light grey, fine grained, angular, some larger partly rounded etched grains, laminated and carbonaceous
540-560 Sandstone, clayey, fine to coarse, poorly sorted, partly recrystallized
560-570 Bentonite, hard, brittle, containing small angular sand grains, light green grey and light cream
575-580 Sandstone, cream, fine grained, angular, with some coarse round grains, matrix of white bentonite
| 580-600 | Mostly bentonite, light grey |
| 600-630 | Mostly bentonite, light grey and lavender, sandy, partly rounded sand grains |
| 630-650 | Increase in sand |
| 650-660 | Bentonite, grey and lavender |
| 660-680 | Mostly sand, some coarse, etched, partly rounded |
| 680-690 | Increase in sand |
| 690-730 | Lakota (?) sandstone, light grey, fine grained, angular, perhaps contains small particles of chlorite (at least some clear green mineral grains) |
| 730-740 | Clay, grey, bentonitic, with some light grey sandstone |
| 740-760 | Bentonite, grey, full of small sand grains |
| 760-770 | Sandstone, light grey, fine to medium grained, angular |
| 770-790 | Minnewaste (?) limestone, light grey, finely crystalline, sandy |
| 790-800 | Sandstone, light grey, very fine grained |
| 800-840(?) | Bentonite, light drab, silty and sandy, with numerous dark grey and drab ostracods |
| 840-860 | Unkpapa (?) sandstone, light grey, fine grained, micaceous |
| 860-870 | Shale, dark grey, very thinly laminated, some brown bituminous, fish remains, chalcopyrite or borinite |
| 870-920 | Sandstone, light grey, fine grained, angular, carbonaceous |
| 920-930 | Bentonite, whitish, sandy |
| 930-940 | Siltstone, grey |
| 940-990 | Unkpapa (?) sandstone, white to buff, permeable, fine grained, angular, partly recrystallized |
| 990-1000 | Limestone, light grey, dull, amorphous |
| 1000-1010 | Bentonite, light grey, sandy |
| 1010-1040 | Limestone, light grey, containing many coarse rounded and etched sand grains |
| 1040-1080 | Sandstone, light grey, fine grained, and siltstone, light grey, bentonitic |
| 1080-1100 | Sundance siltstone, light grey, glauconitic |
| 1100 | Chalcopyrite |
| 1110-1160 | Pachyteuthis |
| 1160-1215 | Sandstone, grey, fine grained, glauconitic, porous |
| 1215-1220 | Sandstone, cream, fine grained |
| 1220-1250 | Siltstone, red brown, sandy |
| 1250-1270 | Bentonite, green, grey and lavender (cavings?) |
| 1270 | Pachyteuthis and "golf ball" fossil (much caving 1270-1310) |
| 1310-1350 | Sandstone, cream, fine grained, glauconitic, some greyish with more glauconite |
| 1350-1410 | Sandstone, light grey, fine grained, glauconitic, limy cement |
| 1410-1440 | Limestone, medium grey, finely crystalline |
| 1440-1490 | Sandstone, light brown grey, fine grained, limy and silty |
1430-1520  Siltstone, brown, bentonitic  
1520-1550  Sandstone, cream, fine grained, angular, porous, some etched and medium rounded grains  
1550-1580  Spearfish siltstone, dark salmon, sandy  
1580-1590  Anhydrite, cream, some faint pink  
1590-1610  Siltstone, dark salmon, sandy  
1610-1630  Anhydrite  
1630-1680  Siltstone, dark salmon, with small spots of anhydrite, sandy  
1680-1715  Anhydrite, pink stained, with some very fine and dense dolomite in lower part  
1715-1770  Siltstone, dark salmon, small sparse sand grains  
1770-1785  Largely sandstone, light salmon, fine grained  
1785-1790  Minnekahta limestone, buff, magnesian, very fine sugary  
1790-1830  Limestone, light grey, lavender stained, fine sugary, may contain some anhydrite, darker lavender in lower part  
1830-1850  Opeche siltstone, dull lavender, and some purple claystone  
1850-1860  Some milky chert and anhydrite, rather coarsely crystalline  
1860-1880  Siltstone, maroon  
1880-1890  Mudstone, dark salmon, containing a few sand grains, some sandstone and siltstone  
1890-1895  Anhydrite and sandstone, light brownish red, fine grained  
1895-1910  Sandstone, light brown red, mostly angular, fine grained  
1910-1920  Sandstone, pinkish buff, mostly angular, fine grained  
1920-1930  Siltstone, dark salmon, with some fine orange sandstone  
1930-1980  Sandstone, light salmon, fine grained  
1980-2000  Claystone and fine grained sandstone, dark salmon  
2000-2030  Minnelusa sandstone, light brown red, poorly sorted, subround grains, a little coarser than that above  
2030-2040  Limestone (?) fine grained, light grey, sandy, some oolitic  
2040-2070  Anhydrite  
2070-2090  Dolomite, light brown grey, fine sugary  
2090-2100  Sandstone, cream, fine to medium grained, poorly sorted, partly subrounded  
2100-2110  Limestone, magnesian, light brown grey, sugary and vuggy  
2110-2120  Dolomite, light grey, dense, with numerous white sponge spicules  
2120-2140  Limestone, magnesian, light brown grey, sugary and vuggy  
2140-2150  Sandstone, cream, fine to medium grained, poorly sorted, some subround grains  

-110-
<table>
<thead>
<tr>
<th>Page Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2150-2160</td>
<td>Limestone, magnesian, light grey, fine grained</td>
</tr>
<tr>
<td>2160-2220</td>
<td>Anhydrite</td>
</tr>
<tr>
<td>2220-2230</td>
<td>Sandstone, light grey, fine to medium grained, poorly sorted</td>
</tr>
<tr>
<td>2230-2250</td>
<td>Limestone, light grey, fine texture</td>
</tr>
<tr>
<td>2250-2260</td>
<td>Anhydrite</td>
</tr>
<tr>
<td>2260-2290</td>
<td>Dolomite and magnesian limestone, light brown grey, sugary and vuggy</td>
</tr>
<tr>
<td>2290-2300</td>
<td>Sandstone, grey, fine to medium, partly rounded and etched</td>
</tr>
<tr>
<td>2300-2330</td>
<td>Cavings</td>
</tr>
<tr>
<td>2330-2350</td>
<td>Apparently dolomite, brown grey, probably some anhydrite and sandstone, obscured by cavings</td>
</tr>
<tr>
<td>2350-2410</td>
<td>A little light grey translucent chert in dolomite (?)</td>
</tr>
<tr>
<td>2410-2420</td>
<td>Probably anhydrite</td>
</tr>
<tr>
<td>2420-2440</td>
<td>Dolomite, grey, fine sugary, some apparently sandy</td>
</tr>
<tr>
<td>2440-2450</td>
<td>Shale, black, bituminous, with very fine mica flakes</td>
</tr>
<tr>
<td>2450-2460</td>
<td>Sandstone, grey, fine angular grained</td>
</tr>
<tr>
<td>2460-2500</td>
<td>Dolomite, grey, fine sugary, dense, flaky</td>
</tr>
<tr>
<td>2500-2520</td>
<td>Limestone, dolomitic, light brown grey, fine dense, with vein anhydrite</td>
</tr>
<tr>
<td>2520-2530</td>
<td>Same, with milky chert</td>
</tr>
<tr>
<td>2550-2550</td>
<td>Anhydrite, grey</td>
</tr>
<tr>
<td>2550-2580</td>
<td>Limestone, dolomitic, medium grey, fine sugary, sandy at base</td>
</tr>
<tr>
<td>2580-2600</td>
<td>Anhydrite and sandstone, light grey</td>
</tr>
<tr>
<td>2600-2610</td>
<td>Limestone, dolomitic, grey, sandy</td>
</tr>
<tr>
<td>2610-2620</td>
<td>Sandstone, light grey, fine grained</td>
</tr>
<tr>
<td>2620-2650</td>
<td>Anhydrite, sandstone, white, dolomite, light grey, fine grained, dense</td>
</tr>
<tr>
<td>2650-2690</td>
<td>Sandstone, light grey to buff, fine grained, permeable, limy cement</td>
</tr>
<tr>
<td>2690-2700</td>
<td>Anhydrite and dolomite</td>
</tr>
<tr>
<td>2700-2710</td>
<td>Limestone, light grey, fine texture</td>
</tr>
<tr>
<td>2710-2730</td>
<td>Anhydrite and dolomite</td>
</tr>
<tr>
<td>2730-2800</td>
<td>Laterite, lavender and purple, clayey and sandy, some tan and brown, some with light grey spots. Some red and yellow jasper pebbles at 2760-2770, considerable anhydrite, pink and grey, at 2790-2800, brachiopods</td>
</tr>
<tr>
<td>2800-2810</td>
<td>Sandstone, cream, medium grained, recrystallized grains fairly well rounded and polished to subangular</td>
</tr>
<tr>
<td>2810-2820</td>
<td>Large amount of coarse, subrounded etched sand grains, red coated, together with finer angular grains in a friable sandstone</td>
</tr>
<tr>
<td>2820-2870</td>
<td>Madison (Pahasapa) limestone, white, fine powdered sugar texture, stained pinkish by weathering, oolitic. Becomes coarser crystalline in lower part</td>
</tr>
<tr>
<td>2870-2880</td>
<td>Limestone, light creamy white, dense, dull porcellaneous</td>
</tr>
<tr>
<td>2880-2890</td>
<td>Limestone, pink, fine grained</td>
</tr>
</tbody>
</table>
2830-3000 Limestone, light creamy white, dense, dull porcellaneous. Stylolites with turgite residues, flaky fracture, locally with larger crystals, altered oolites and dogtooth spar in vugs. Some milky chert at 2920.
3004 Total depth.