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The Spearfish Formation in the Williston Basin of western North Dakota

Wallace G. Dow
University of North Dakota

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THE SPEARFISH FORMATION IN THE
WILLISTON BASIN OF WESTERN
NORTH DAKOTA

by

Wallace G. Dow

B.A. in Geology, Rutgers University, New Brunswick, 1959

A Thesis
Submitted to the Faculty
of the
Graduate School
of the
University of North Dakota
in partial fulfillment of the requirements
for the Degree of
Master of Science

Grand Forks, North Dakota
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1964
This thesis submitted by Wallace G. Dow in partial fulfillment of the requirements for the Degree of Master of Science in the University of North Dakota, is hereby approved by the Committee under whom the work has been done.

Walter R. Moore
Chairman

John R. Reid

Dean of the Graduate School
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THE SPEARFISH FORMATION IN THE
WILLISTON BASIN OF WESTERN
NORTH DAKOTA

Wallace G. Dow

INTRODUCTION

General

The Spearfish Formation was named by Darton (1899, p. 387) who later described it (1901, p. 516) as a conspicuous series of gypsiferous red beds cropping out in the vicinity of the Black Hills, South Dakota. The Spearfish Formation, as originally defined, included all rocks between the Minnekahta Limestone of Permian age and the Sundance Formation of Jurassic age. In the absence of fossil evidence, Darton (1901, p. 519) tentatively assigned a Triassic age to the Spearfish although he believed the lower portion may be Permian in age.

More recently, a unit of gypsum interbedded with maroon and gray shales originally included at the top of Darton's Spearfish have been redesignated as the Gypsum Spring Formation of Middle Jurassic age (Imlay, 1947, p. 237). Maple and Bergendahl (1956, p. 84) supported this correlation and placed an unconformity, representing
most of Lower Jurassic time, between the Spearfish and the Gypsum Spring Formations. The Spearfish Formation of the Black Hills, as restricted, contains red beds and gypsiums of Permian and Triassic age.

The Spearfish Formation crops out in a red valley of variable width that encircles the Black Hills. It also crops out along the Belle Fourche River in the vicinity of Devil's Tower, Wyoming (Plate 14). Thicknesses of the formation in the Black Hills vary from 400 to 700 feet. Darton (1909, p. 28-30) gave several measured sections of the limited exposures present.

Figure 1 shows the upper part of the Spearfish Formation on the west flank of the Black Hills near Four Corners, Weston County, Wyoming. In this area, the Spearfish is capped by 30 feet of white gypsum of the Gypsum Spring Formation. In the vicinity of Devil's Tower, Crook County, Wyoming, the Gypsum Spring Formation is only about 10 feet thick. Detail of the upper part of the Spearfish in this area is provided by Rea and Paape (1958, p. 305). This section, shown in figure 2, consists in general of a predominance of orange-red siltstone with maroon shale and fine sandstone interbeds.

The discovery of oil in the Williston Basin of North Dakota in 1951 spurred an extensive drilling program which revealed a series of red siltstones and shales with thick salt interbeds in the subsurface of western North Dakota and eastern Montana. The stratigraphic position of these beds suggested that they might be equivalent to the Spearfish Formation of the Black Hills. Poor well control between the central part of the basin and the outcrop sections, however, precluded definite correlation with the type Spearfish and the term "Spearfish" was used
Figure 1 — Upper part of the Spearfish Formation capped by 30 feet of Gypsum Spring Formation. Red Butte, 5 miles south of Four Corners, Weston County, Wyoming.

Figure 2 — Upper part of the Spearfish Formation, the Gypsum Spring Formation, and the Stockade Beaver Member of the Sundance Formation. East side of Devil's Tower, Crook County, Wyoming.
with some reservation. Subsequently numerous and varied correlations appeared, all of which were based on limited well control. Due to a considerable expansion of available data in recent years, a new look at these strata seemed justified. The main purpose of this study is to produce a detailed discussion of these rocks in the western part of North Dakota and to establish, if possible, a correlation with the type Spearfish north of the Black Hills.

Methods of Study

The combined use of mechanical and sample logs provided the data on which this report is based. Mechanical logs of 288 wells in western North Dakota were chosen so as to provide the best coverage possible. In areas where wells are closely spaced, approximately one well per township was used while in other areas, all available well control was employed. Detailed mapping of the Spearfish Formation was restricted to North Dakota west of 101° longitude (Figure 3). In addition, two cross sections were prepared to trace the Spearfish Formation from the subsurface of the Williston Basin to a bore hole six miles north of the outcrop area near the South Dakota - Wyoming border. Plates 1 and 14 show the well control used in the preparation of this report.

Gamma ray and lateroresistivity curves were used whenever possible because they are the most abundant and provide the best definition of the strata involved. Tops were taken from gamma ray logs, when they were available, to provide uniformity in correlation. Microlatereo, section gage, and neutron curves proved useful in
Figure 3 — Index map showing approximate limits of the Spearfish Formation and equivalents in the Williston Basin. Modified slightly after Ziegler, 1955, p.171.
distinguishing salt from anhydrite. Lithologic descriptions were taken from sample logs in the form of North Dakota Geological Survey Circulars. In addition, some detailed sample logging was done by the writer.

The isopachous maps included in this report are actually isochore maps because thicknesses have not been corrected for dip or well deviation. However, since dips in the basin generally do not exceed one degree, differences in real and apparent thickness is so small that they can, for all practical purposes, be ignored.

Acknowledgments

The writer wishes to express his appreciation to Dr. Walter L. Moore, Associate Professor of Geology at the University of North Dakota for suggesting the problem and for his interest and advice during the course of study.

The writer is indebted to Dr. Wilson M. Laird, State Geologist of North Dakota, for affording summer employment and the use of the facilities of the North Dakota Geological Survey. Thanks are expressed to Sidney E. Anderson, Clarence G. Carlson, Dan E. Hansen, and other members of the North Dakota Geological Survey who offered assistance.

The manuscript benefited from critical review and suggestions by Dr. John R. Reid and Alan M. Cvancara of the University of North Dakota.
STRATIGRAPHY

Units underlying the Spearfish Formation

Throughout much of western North Dakota and South Dakota, in the area between the southern end of the Nesson Anticline and the Black Hills, the Spearfish Formation rests on and is conformable with the Minnekahta Limestone of Permian (possibly Leonard) age. To the north and east of the Minnekahta Limestone (Plate 8), the Spearfish Formation rests with angular discordance on rocks of progressively older Paleozoic age. In the area covered by this study the oldest rocks encountered, underlying the Spearfish Formation, are the Frobisher-Alida interval of the Madison Group (Mississippian). The pre-Spearfish unconformity truncates the Minnekahta and extends about 10 miles inside the latter's present limit. Plate 8 shows the subcrop pattern of the units underlying the Spearfish Formation in western North Dakota.

In some areas where the Spearfish Formation rests directly on redbeds of the Opeche Formation and the Big Snowy Group (Heath and Otter Formations), its lower boundary is difficult to determine. In these areas erosional lows are commonly developed in the underlying shales and the lower beds of the Spearfish vary in thickness in response to this relief. As a result, an added section of Spearfish is generally found above underlying shale units which cannot be traced to areas where the Spearfish rests on resistant strata.
Consequently a margin of error in selecting the base of the Spearfish of a few feet or even a few tens of feet can be expected in these areas.

Spearfish Formation

GENERAL

In the subsurface of the Williston Basin in western North Dakota, the Spearfish Formation can be divided into three lithologic units, which, in ascending order are: (1) a lower red siltstone and gray shale unit, (2) a middle salt unit, and (3) an upper red siltstone, shale, and fine-grained sandstone unit. These units correspond, respectively, to the Spearfish Formation (restricted), Pine Salt, and the Saude Formation of Zieglar (1955) and are herein redesignated the Belfield Member, Pine Member, and Saude Member of the Spearfish Formation. Typical radiation and electric logs of these units are shown in figure 4.

In North Dakota, the Spearfish Formation reaches a thickness of 715 feet just north of the Cedar Creek Anticline in the extreme southwestern corner of the state. From this point, it thins gradually northward to an average thickness of 300 feet along the Canadian border. Figure 3 shows the approximate lateral extent of the Spearfish Formation and equivalents in the Williston Basin and adjoining areas. Plate 3 shows its areal extent and thickness trends in western North Dakota.

It has been 9 years since Zieglar introduced the terms Pine and Saude. Although these terms were never established in accordance
Figure 4 - Typical radiation and electric logs showing the members of the Spearfish Formation and the Poe Member of the Piper Formation.
Figure 5 — Electric and radiation logs of the type section, Belfield Member, Spearfish Formation.
7310 - 30 Missing

7330 - 40 Shale, gray, N3, fissile, some reddish orange siltstone, 10R 6/6, trace of white anhydrite, considerable salt from collapse.

7340 - 50 Siltstone, reddish orange, shale, gray, N3.

7350 - 60 Missing

7360 - 70 Shale, gray, N3 and siltstone, light brown, 5YR 5/6, trace of anhydrite.

7370 - 90 Shale, gray, trace of light brown siltstone, trace of anhydrite.

7390 - 00 Shale, gray, trace of light brown siltstone, trace of pyrite.

7400 - 10 Shale, as above, trace of dolomite, finely crystalline, grayish pink, 5R 8/2.

7410 - 20 Shale as above, trace of selenite?, trace of dolomite as above.

7420 - 31 Shale, as above, trace of anhydrite, moderate pink and white.

The Belfield Member varies in thickness from an erosional edge to 232 feet in northwestern Dunn County, North Dakota. Its distribution and thickness in North Dakota are shown on plate 7.

Lithologically, this unit consists of fissile gray shale interbedded with reddish orange siltstone and mudstone, especially in the upper portion. Thin beds of whitish and pinkish anhydrite are present locally. Traces of pyrite and grayish pink dolomite are present in some areas.

The Belfield Member is conformable with the underlying Minnekahta Limestone except along a narrow belt just inside the limits of the Minnekahta where it rests on an erosional surface. The Belfield does not extend beyond the Minnekahta limit and is itself terminated along
an erosional belt 10 - 30 miles in width. Except along this erosional belt, the Belfield is conformably overlain by either the Pine Salt Member or the Saude Member of the Spearfish Formation.

**PINE SALT MEMBER**

Overlying the Belfield Member throughout much of western North Dakota is the Pine Salt Member which ranges in thickness from 215 feet in Bowman County to a feather edge along the margins of its basin of deposition. This unit thickens somewhat south of the Cedar Creek Anticline, reaching a maximum thickness of about 300 feet 35 miles north of the Spearfish outcrop area in the Black Hills.

The Pine was named by Ziegler (1955) who included a persistent sandy siltstone unit and an equally persistent anhydrite and salt unit in its upper part. The anhydrite and salt unit is referred to in this report as the G marker bed. The top of the Pine is herein revised to exclude these two units. In his original description of the Pine, Ziegler suggested that additional well control might warrant such a revision. The thickness and areal extent of the Pine Salt Member are shown in plate 6.

The type section of the Pine Member is herein designated as the interval between 5237 and 5432 feet, mechanical log depth, in the Carter Oil Co., L. L. Johnson No. 1 well, NW, SW, Sec. 9, T. 129 N., R. 106 W., Bowman County, North Dakota. The well was spudded on October 27, 1957 and completed on January 6, 1958 having reached a total depth of 8980 feet. The mechanical log depths were measured from the rotary drill bushing which was 15 feet higher than the ground
level of 2938 feet above sea level. The name Pine is considered to have become established through popular use.

The type log of the Pine Salt Member is shown on figure 6. The following lithologic description is based on samples on file at the North Dakota Geological Survey. Sample depths have been adjusted to mechanical log depths.

Samples:

5237 - 70 Salt, some moderate reddish orange siltstone, minor dark gray shale.

5270 - 00 Salt

5300 - 20 Salt, some medium dark gray shale and minor reddish orange siltstone.

5320 - 70 Salt

5370 - 32 Salt, minor dark gray shale and moderate reddish orange siltstone.

The Pine Salt Member consists of clear halite with thin interbeds of reddish orange siltstone and white anhydrite. Anhydrite occurs frequently in the lower part of the unit and is especially common in northern Billings County. In this area the base of the Pine is difficult to determine accurately due to the apparent gradational character of these basal anhydrite beds with the red siltstones of the underlying Belfield Member. Descriptions of two cores taken from this unit in Amerada's Dena Svor well, Sec. 9, T. 156N., R. 95 W., Williams County, North Dakota are given by Anderson and Hansen (1957). These cores reveal that the Pine in this area consists of large crystals of halite interbedded with hard red shale containing variable amounts of salt inclusions.
Figure 6 — Electric and radiation logs of the type section, Pine Salt Member, Spearfish Formation.
The Pine Salt Member is conformable with the underlying Belfield Member except along a narrow belt where it rests on eroded Belfield shale. The Pine extends somewhat beyond the Belfield in northwestern North Dakota where it rests with angular discordance on rocks as old as Mississippian. The Pine thickens in areas where it rests on the soft shales of the Opeche Formation and the Big Snowy Group, suggesting erosional lows which were filled with salt. There is also a commensurate thinning over the Amsden Formation which is more resistant and which, therefore, probably formed an erosional high on the pre-Pine surface.

The Pine represents a period of restricted marine conditions. Since the Pine Salt rests on the pre-Spearfish unconformity to the east and north of its basin of deposition, the barrier doubtlessly lay to the west or south. Perhaps the Belt Island and Sheridan Arch which restricted the Jurassic seas of the Williston Basin (Peterson, 1957, p. 406) played a part in the formation of these late Permian evaporites. Very little sedimentation occurred on the eastern and northern margins of the Pine basin because nowhere in North Dakota is the Pine seen to grade laterally into shales. In the area north of the Black Hills, however, a red siltstone and gypsum section of limited thickness is probably correlative with the Pine Salt of the deeper part of the basin. The Pine Salt Member is conformably overlain by the red mudstones of the Saude Member of the Spearfish Formation.

SAUDE MEMBER

The upper red mudstone unit of the Spearfish Formation, termed the Saude Formation by Ziegler (1955) is herein reduced to
member status and placed in the Spearfish Formation. The base of the Saude is extended to include a persistent anhydrite and salt unit and an equally persistent sandy siltstone unit formerly included by Ziegler in the underlying Pine Salt.

The Saude Member ranges in thickness from a feather edge along its periphery to over 350 feet in western North Dakota and to nearly 500 feet in South Dakota just north of the Black Hills. Its distribution and thickness in western North Dakota are shown on plate 4.

The type section of the Saude Member is herein designated as the interval between 6290 and 6610 feet, mechanical log depth, in the Amerada Petroleum Corporation, Pederson, Cater No. 1 well, NE, SW, Sec. 21, T. 158 N., R. 95 W., Williams County, North Dakota. The well was spudded on February 16, 1959 and completed on April 6, 1959 having reached a total depth of 10,441 feet. The mechanical log depths were measured from the rotary drill bushing which was 14 feet higher than the ground level of 2458 feet above sea level. The name Saude is derived through popular usage.

The following lithologic description is based on samples on file at the North Dakota Geological Survey. Sample depths are adjusted to mechanical log depths. The type log is shown on figure 7.

Samples:

6290 - 50 Shale, moderate reddish brown, 10 R 4/6, to pale reddish brown, 10 R 5/4, lumpy, slightly calcareous, silty, some white anhydrite.

6350 - 30 Siltstone, moderate reddish orange, very slightly calcareous, sandy in part, with very fine to fine, rounded, frosted quartz grains, a little white anhydrite.
**Figure 7**—Electric and radiation logs of the type section, Saude Member.
Siltstone, as above, traces of colorless anhydrite, traces of sandstone, moderate reddish orange, very fine to medium grained, silty, slightly calcareous.

The Saude Member is predominantly made up of reddish orange siltstone and fine-grained sandstone with frequent anhydrite interbeds. Reddish brown and gray siltstone and shale lenses occur locally. In some areas, frosted sand grains occur scattered through the siltstone.

Near the base of the Saude Member in the southwestern corner of North Dakota is a persistent anhydrite bed which locally contains salt. Where salt is present the unit thickens, reaching as much as 50 feet in southwestern Billings County. An isopachous map of this unit, herein referred to informally as the G marker bed, is shown on plate 5. The G marker bed is generally separated from the underlying rocks by a persistent sandy siltstone unit but east of the edge of the Pine Salt Member it rests directly on the shales of the Belfield Member.

The Saude Member extends well beyond the limits of the Pine Salt and rests unconformably on progressively older Paleozoic rocks to the east and north. The character and distribution of the Saude suggest that it is an onlapping transgressive sand and siltstone unit that was deposited in a growing basin. Lithofacies studies by Goldsmith (1959, p. 11) based on sand-silt ratios indicate a source area lying generally to the west and north.

Comparison of the pre-Spearfish subcrop map (plate 8) and the Saude isopachous map (plate 4) reveals a marked thinning over resistant rocks such as the Amsden Formation and the Kibbey Formation and a thickening over erosional lows underlain by the Opechee Formation.
and the Heath and Otter Formations of the Big Snowy Group. The relative relief of the pre-Spearfish surface at the time of basal Saude deposition had a great effect on controlling the thickness and lithology of the lower part of the unit. In areas where topographic lows were present the Saude thickens and in areas underlain by topographic highs, thinning is observed. This feature is well developed in Divide and Williams Counties, North Dakota.

In some areas, especially in Bottineau County, North Dakota, and southern Saskatchewan and Manitoba, the Saude contains a basal sand unit. In Bottineau County, the sand varies from 10 to 40 feet in thickness and consists of a very fine grained quartzose sandstone with some interbedded reddish and greenish siltstone and shaly sandstone (Harrison and Larson, 1958, p. 29). The topographic relief on the pre-Spearfish surface at the time of deposition had the greatest effect on the distribution and thickness of the basal sand, causing it to be concentrated in the low areas. However, minor structural activity appears to have played a part as well, since the sand is seen to overlap onto resistant strata at some points.

In Canada a basal sandstone unit is distinctive and is called the frosted-grain unit of the Watrous Formation. This unit is made up of sandstone, conglomerate, and locally contains fragments of chert and limestone derived from the pre-Spearfish surface. In southern Saskatchewan, the basal Watrous contains an orange-red frosted grain unit of possible aeolian origin (Milner and Thomas, 1954, p. 256). Well rounded, frosted sand grains occur scattered through the silty beds of the Saude in North Dakota (Ziegler, 1956, p. 196).
Smith (1956, p. 105) believed these to be windblown deposits and that these and the thin anhydrite beds of the Saude were associated with playa lakes. Goldsmith (1959, p. 11) suggested that a large alluvial plain may have existed in the basin during much of Saude time. Lithofacies studies based on sand-silt ratios indicate the apices of sandstone tongues to be in northwestern North Dakota and southeastern Saskatchewan, thereby indicating source areas near these localities. These data, together with the irregularity of bedding in the Saude and the apparent absence of strand line deposits, imply that much of the Saude is continental in origin. Regularity of bedding south of the Cedar Creek Anticline and in the lower portions of the Saude in southwestern North Dakota, however, suggests that these beds may be marine.

The Saude is overlain by a lower evaporite member of the Piper Formation. The contact is probably conformable throughout much of northwestern North Dakota and Canada. To the west and south, however, a considerable portion of the Saude has been removed by erosion and the lower boundary of the Piper is marked by a distinct angular unconformity.

Units Overlying The Spearfish Formation

Throughout western North Dakota, the Spearfish Formation is overlain by a series of anhydrite and salt beds designated as the Poe Member of the Nesson Formation by Nordquist (1955, p. 104). Geologists at the North Dakota Geological Survey, however, believe the term Nesson Formation should be abandoned and the term Piper
Formation used in its place. Since the term Poe Member is useful in describing the lower evaporite unit it will be referred to as the Poe Member of the Piper Formation in this report. This usage is not formally proposed and is employed solely for the sake of continuity. The cross sections in North Dakota (plates 9-12) have as a datum a persistent anhydrite bed near the top of the Poe Member which probably closely approximates a time line. The Poe Member, as defined by Nordquist, locally includes an additional evaporite bed which occurs above this datum plane.

The Poe Member consists of white to pink anhydrite, interbedded with dark red shale and a little limestone near the top (Nordquist, 1955, p. 104). Included also in the lower part of the type Poe is a basal salt unit which lies almost entirely within the boundaries of North Dakota. This unit was named the Dunham Salt by Ziegler (1955) who regarded it as part of the Spearfish Formation. The Dunham is considered to be a facies of the Poe by most other workers (Goldsmith, 1959, Nordquist, 1955) and the present writer. The Dunham locally attains a thickness of 130 feet and is found only in the central part of the basin (plate 2). The Dunham is believed to be conformable with the underlying Saude Member of the Spearfish Formation although some small local unconformities may exist.

The Poe Member is reasonably uniform in thickness where it overlies the Saude, but exhibits considerable variation to the east of the Saude limit where it rests on the pre-Spearfish erosional surface (Nordquist, 1955, p. 104-105). This uniformity in thickness over the Saude suggests the lack of an erosional surface.
Several divergent opinions as to the proper stratigraphic position of the post-Minnekahta, pre-Piper red beds of the Williston Basin have appeared since these beds were first observed in the subsurface. Figure 8 shows the best known correlations.

The term Spearfish, when first extended into the Williston Basin of western North Dakota, was applied to rocks between the Minnekahta Limestone of Permian age and the Piper Formation of Jurassic age. The term "Spearfish" was used because of its lithologic resemblance and similar stratigraphic position to the Spearfish Formation of the Black Hills. These red beds were considered to be essentially Triassic in age and the term "Spearfish" was applied with some reservation by most geologists.

In 1955, Ziegler subdivided these red beds into four units which, in ascending order, were: (1) Spearfish Formation (restricted), (2) Pine Salt, (3) Saude Formation, and (4) Dunham Salt. Ziegler (1956, p. 176) postulated a major unconformity at the base of the Pine Salt which "can be mapped with varying degrees of certainty across North Dakota and with a little imagination across northwestern South Dakota back to the Black Hills." Ziegler correlated this unconformity with the regional erosion surface at the base of the Jurassic in central Montana. Thus, the Pine, Saude, and Dunham were, according to him, Jurassic in age. Although he believed the Spearfish
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Figure 8 — Previous and present stratigraphic nomenclature of the post-Minnkota, pre-Piper rocks of the Williston Basin.
in the Black Hills to be in part Triassic, it was beveled northward so that no Triassic sediments were present in the Williston Basin.

In contrast to Ziegler's ideas, Hadley and Lewis (1957, p. 1434-1486) assigned most of the red bed sequence, except for the lower portion of Ziegler's Spearfish (restricted), to the Triassic system. They believed that the Saude conformably underlies and overlies adjacent rock units in the central and northern part of the basin but lies with marked unconformity along the margins on rocks as old as Mississippian. They believed this to be the only major unconformity associated with the Spearfish Formation in the Williston Basin.

Francis (1957, p. 376) referred to the "Spearfish" only as the Jura-Triassic red beds and dispensed with any further classification as implying more than is known.

Goldsmith (1959, p. 11) correlated the lower shale unit (Spearfish (restricted) of Ziegler) with a red and green shale unit of inferred Permian age in the Black Hills. Likewise, the Pine salt was believed to be a lateral equivalent of interbedded red mudstone and gypsum units of Permian age in the Spearfish surface sections. The Saude Formation was tentatively considered by Goldsmith to be of Lower Triassic age and correlative with Lower Triassic units in the Black Hills. Goldsmith also maintained that a major unconformity representing much of Middle and Late Triassic and Early Jurassic time separates the Saude from overlying formations. A basal conglomerate in the overlying Poe evaporite Member of the Piper Formation (Nesson Formation of Nordquist) locally marks the unconformity.
The stratigraphic relationships and correlations set forth in this paper are essentially a modification and extension of Goldsmith's conclusions. The lower shale unit (Zeilfield Member) of the Spearfish Formation is considered to be Permian in age for the following reasons: (1) its conformable relationship with the underlying Minnekahta Limestone of Permian age, (2) its concordant limits with the Minnekahta indicate deposition in a basin of similar configuration, and (3) its correlation with the lower portion of the type Spearfish of inferred Permian age north of the Black Hills. The relatively large amount of gray (marine?) shale suggests environmental conditions not unlike those that probably existed in Minnekahta time.

The Pine Salt Member is considered Permian in age because of its correlation with Permian gypsoms and shales in the Black Hills surface sections. As stated by Goldsmith (1959, p. 11) "evaporites are more common in the Permian than in the Triassic System." The Pine Salt may also be correlative with the Evay tongue of the Phosphoria Formation of central Wyoming because of its similar stratigraphic position.

The oldest rocks of the Saude Member consist of red siltstones which overlie the Pine Salt in extreme southwestern North Dakota. They are probably marine in origin because of their conformable relationship with the underlying salt beds. Following deposition of these beds, the seas again were restricted and a thin bed of anhydrite was deposited. This bed is herein informally called the G marker bed and is correlated with the top of the Goose Egg Formation of eastern Wyoming and Montana (Figure 9; Plate 15). Since the base of the Triassic System is placed
Figure 9 — Cross section showing correlation of the G marker bed with the top of the Goose Egg Formation. Tops in the Gulf No. 1 Boyle are as picked by the Nomenclature Committee, Wyoming Geological Association, in Wyoming Stratigraphy, Part I, 1956.
slightly below the top of the Goose Egg Formation by Wyoming geologists, and is separated from the G marker bed by a thin siltstone unit, the top of the Pine Salt is at about the same stratigraphic position and therefore marks the top of the Permian System. The combined thinness and wide areal extent of the G marker bed suggests that it is probably marine in origin. Its greater thickness and localized salt content in southwestern North Dakota is probably due to basin subsidence and restriction of this part of the basin by the Cedar Creek Anticline.

Beds of the Saude Member above the G marker bed can be separated into two areas by a line extending from southeastern Montana to northwestern South Dakota, just south of and roughly parallel to the Cedar Creek Anticline. South of this line, individual beds in the Saude can be traced for some distance indicating uniformity of deposition and probable marine conditions. Such uniformity of bedding is also present in the Red Peak Member of the Chugwater Formation of central Wyoming which is a lateral equivalent of the Saude.

The Saude in this area has an angular relationship with the overlying Poe Member of the Piper Formation which can be traced across most of the area between the North Dakota - South Dakota border and the Black Hills, and into eastern Montana and Wyoming (Plates 15 & 16, Figure 9). Evidence of angular discordance is lost about 30 miles north of the outcrop area and it appears questionable whether the angular unconformity extends as far south as the surface sections. The Saude thins markedly over the Cedar Creek Anticline but thickens again in the main part of the basin. The unconformity cannot be traced with any degree of accuracy north of the anticline and its
extent in North Dakota is not known. Goldsmith (1959, p. 11) extended this erosional surface about 50 miles into North Dakota and cited indirect evidence such as the presence of a local conglomerate at the base of the overlying Poe evaporite Member (Nordquist, 1955, p. 104) for its presence in the southwestern part of North Dakota.

The Saude Member is stratigraphically equivalent to the Watrous Formation in Saskatchewan (Zieglar, 1956, p. 175). The Watrous Formation is divided into three units, a basal frosted grain unit, a middle shale unit, and an upper evaporite unit. The lower two units are equivalent to the Saude Member in North Dakota while the evaporite unit is correlative with the Poe Member of the Piper Formation. A Jurassic age is commonly assigned to the Watrous although its basal portion may be Triassic (Cumming, 1956, p. 169). No unconformity is recognized within the Watrous Formation in Saskatchewan.

It is apparent, then, that the Saude is conformable with overlying Jurassic strata in Canada and separated from the Jurassic in South Dakota and southeastern Montana by a sharp unconformity. The following hypothesis is submitted to account for this apparent discrepancy. The depositional history of the Saude in North Dakota and Canada was probably somewhat different than in areas to the south. In the main part of the Williston Basin, north of the Cedar Creek Anticline, the Saude is considered to be an onlapping transgressive unit, becoming younger to the east and north. It is probable that the Triassic - Jurassic time boundary lies within the upper part of the Saude. Geologic time is a very difficult factor to deal with in an unfossiliferous sequence of beds and location of time boundaries
must depend on other criteria. Recognizable unconformities serve this purpose best where they are present but in their absence, the position of time boundaries can only be estimated. The relationship of the Saude in North Dakota with its laterally equivalent rocks indicates that it is probably Triassic in age, becoming younger to the east and north along the margins of its basin of deposition. The upper part of the Saude in extreme northwestern North Dakota and southern Saskatchewan may be Jurassic in age. The major unconformity on top of the Saude south of the Cedar Creek Anticline limits its age in this area to the Triassic, probably Lower and Middle Triassic. This is in agreement with the supposed Lower Triassic age of the Red Peak Member of the Chugwater Formation in Wyoming which is a lateral equivalent of the Saude in that area. Figure 10 shows the laterally equivalent rocks of the Saude and other members of the Spearfish Formation in Canada, South Dakota, and Wyoming.

The Piper Formation as defined in this report is equivalent to the Gypsum Spring Formation of the Black Hills (Francis, 1957, p. 375). Plates 15 and 16 show this correlation. The Poe Member of the Piper Formation is correlative with the upper unit of the Watrous Formation of Saskatchewan (Milner and Thomas, 1954, p. 257).
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Figure 10 — Correlation of the Spearfish Formation of western North Dakota with laterally equivalent rocks in Canada, South Dakota, and Wyoming.
STRUCTURAL ELEMENTS

General

The western part of North Dakota lies entirely within the Williston Basin. The Williston Basin can be described as a stable shield basin, formed by a broad gentle downwarp on the cratonic platform and characterized by relatively slow undisturbed sedimentation. Several positive and negative structural elements which affected deposition of the Spearfish Formation are present in western North Dakota. The major positive elements are the Nesson and Cedar Creek Anticlines. In addition to these, several minor structures are defined by thickness variations on the isopachous maps (Figure 11).

Nesson Anticline

Although the Nesson Anticline is a major structural feature in the Williston Basin, it was apparently relatively inactive during Spearfish time. A marked thickening of the Belfield Member on the southwestern end of the anticline is balanced by a thinning of the overlying Pine Member in the same area. These thickness trends are interpreted as being due to differential erosion of the Belfield before deposition of the Pine Salt rather than to structural activity. The isopachous map of the total Spearfish shows little variation in thickness over the Nesson Anticline.

Activity of the Nesson Anticline was apparently renewed during Late Jurassic time. The Dunham salt beds of the Piper Formation are
Figure 11 — Location map showing positive and negative structural elements that affected Spearfish sedimentation in western North Dakota.
absent along the axis of the anticline (plate 2) and a thickening of the "Morrison" over these areas indicates solution during Late Jurassic time. Apparently a gentle uplift fractured the overlying rocks allowing percolating water to reach the Dunham salt 800 feet below the surface. An unusual system of "solution channels" in the Dunham (Figure 12) is interpreted as being due to solution along fractures or faults of minor displacement. These channels are very narrow and elongated normal to the anticlinal axis. Such an orientation suggests that they may be cross faults of the type commonly found on anticlinal structures. The presence of faulting in this area is further suggested by progressively higher oil-water contacts in pools from south to north along the axis of the Nesson Anticline (C. B. Folsom, North Dakota Geological Survey, oral communication, May, 1964).

Cedar Creek Anticline

The Cedar Creek Anticline (Figure 11) had a somewhat greater effect on Spearfish sedimentation than did the Nesson Anticline. During deposition of the Minnekahta Limestone and the Belfield Member, however, the anticline was inactive as these units continue over it with little change in thickness. During Pine time the anticline became active. This activity is reflected by a marked thinning of the Pine Salt over the anticlinal axis in South Dakota (Plate 15). The relatively high position of the anticline during this period may have contributed to the development of restricted conditions in the North Dakota part of the basin. The presence of salt in the G marker bed in the southwestern part of North Dakota and its sudden change to
Figure 12 — Isopachous map of the Dunham beds showing solution channels in the northwestern part of the Charlton Field, McKenzie County, North Dakota.
a thin anhydrite over the Cedar Creek Anticline indicates restriction by this structure.

Near the end of Saude deposition (Late Triassic?) the Cedar Creek Anticline rose considerably causing the Saude to be eroded and forming the angular unconformity which separates the Spearfish from younger rocks in the area. The uniformity in thickness of the overlying Piper Formation indicates development of near peneplain conditions prior to Piper time.

Bowman Low

The Spearfish Formation reaches its greatest thickness in North Dakota in a small area in extreme southwestern Bowman County. This low takes the form of a narrow trough, the axis of which is just north of and parallel to the Cedar Creek Anticline (Fig. 11). Apparently the crest of the anticline was farther south during Spearfish time as areas of thick Spearfish accumulation are penetrated by wells lying on and producing from that structure as it is known today. The tectonics of the Bowman Low are vague but its position suggests that it is probably intimately connected with the activity of the adjacent Cedar Creek Anticline.

The continuity of the Bowman Low is interrupted by what appears to be a northern extension or high axis off of the Cedar Creek Anticline (Figure 11). The structure is defined by a marked thinning of all three members of the Spearfish Formation. However, since the presence of this high is defined by a single well, future drilling is necessary before its precise relationship with the Cedar Creek Anticline can be established.
Golden Valley Low

About 50 miles north of the Bowman Low in an area centering in the southwestern corner of Golden Valley County is a broad structural depression that marks the depocenter of the Spearfish Formation in the Williston Basin. All the units of the Spearfish thicken toward this area where a maximum of 670 feet is reached. Although this is 45 feet less than the total Spearfish preserved in the Bowman Low, the Golden Valley Low is considered the depocenter due to its larger size and persistence throughout Spearfish time.

Stark High

The Stark High is located a few miles northwest of Dickinson in the western portion of Stark County, North Dakota. It is defined by an abrupt thinning of the Belfield and Saude Members of the Spearfish Formation but no effect on the intermediate Pine Salt has been observed. Although the Stark High is very limited in size, its significance is enhanced by the presence of two producing oil wells associated with it.

Mercer High

A positive area of unknown size is defined by the presence of a "fenster" in the Minnekahta Limestone in western Mercer County, North Dakota (plate 8). Here, a single well shows the Belfield Member resting on the Minnelusa Formation. Since the Belfield is considered to be conformable with the Minnekahta and the latter is present in wells completely surrounding the area, the apparent anomaly can be
explained in either of two ways. First, it is possible that the structure was high in Permain time and the Opechee and Minnekahta Formations were never deposited in the area, and second that the structure became active immediately prior to Spearfish time, subjecting the Opechee and Minnekahta Formations to erosion. Inadequate well control in the area at the present time makes a choice difficult, although the writer favors the first because of the time necessary for the erosion of post-Minnelusa, pre-Spearfish strata. The structure was inactive during Spearfish time as neither the Belfield nor the Saude were affected by it.
Known Oil Fields

The Saude Member of the Spearfish Formation produces oil in the Newburg and South Westhope Fields, Bottineau County, North Dakota. The Spearfish pay section is a very fine grained, quartzose sandstone interbedded with red and green siltstone and shale. It varies in thickness from 0 to 40 feet and occurs at the base of the Saude where it lies directly on the pre-Spearfish unconformity. The sands are considered to be an onlapping transgressive unit that were deposited in a topographic low. They wedge out up dip and laterally, forming a stratigraphic trap. The oil apparently migrated from the underlying Madison, across the unconformity, and into the porous basal sands of the Saude. Detailed consideration of these fields was given by Folsom, Hansen, and Anderson (1958) and by Harrison and Larson (1958).

Petroleum Possibilities

Unfavorable porosities in much of the Spearfish Formation make it an unlikely prospect as a source rock for petroleum. Oil bearing sand lenses of limited extent such as those that occur in the Newburg and South Westhope Fields may be discovered by future drilling, but their location is difficult or impossible to predict. Since close proximity to a source rock appears to be a necessary prerequisite, new drilling in areas where the Spearfish overlies such petrolierous rocks as the Madison Limestone may reveal new pools in Spearfish sands.
The most important role of the Spearfish in the development of petroleum traps is where it forms a seal over porous strata. This condition is met at numerous localities but rocks at none of these have produced oil to date. Some possibilities include areas where the Saude Member overlies the Tyler Sand, Kibbey Sand, or the sands of the Minnelusa Formation.

Stratigraphic traps may occur where Paleozoic formations pinch out against the Stark or Mercer Highs. Two wells are currently producing from stratigraphic traps in Typer sands on the flanks of the Stark High. A closer look at the Mercer High may reveal similar traps.

Another possibility for the formation of petroleum traps occurs in areas where the Pine or Dunham salts have been removed by solution. Porous beds on the down dip side of collapse structures might become sealed by lowering of overlying impervious strata. Solution of the Dunham on the crest of the southern half of the Nesson Anticline and of the Pine in eastern Slope and western Stark Counties has been observed. Oil bearing horizons, if present, would be located in Jurassic rocks and since the Jurassic is productive in parts of Montana, the possibility should not be overlooked in North Dakota. Careful drill stem testing of porous Jurassic strata in the above mentioned areas might prove fruitful.

Salt

The Dunham beds of the Piper Formation and the Pine Salt Member of the Spearfish Formation are potential sources of halite in North Dakota. Due to their depth, however, the only economic way in which
they could be used would be to employ a solution mining method. Fresh water could be introduced into the formation to dissolve the salt, and the resulting brine would be pumped to the surface and evaporated. Cost could be reduced by employing abandoned exploratory wells. The resulting cavities could then be used for the storage of liquid petroleum products. This procedure is currently being used by the Dakota Salt and Chemical Company in four wells a few miles east of Williston, Williams County, North Dakota. In this area Mississippian salts are being mined. Texaco Inc. has developed one well in Devonian salts for L.P.G. storage in Burke County but the salt produced in the formation of the cavity was pumped back into the Dakota Sandstone rather than being used for commercial purposes.

Groundwater and Gypsum

The Spearfish Formation yields limited amounts of groundwater from shallow wells near the outcrop area in Wyoming and South Dakota. A high content of calcium sulfate in the water, however, generally makes it unacceptable as drinking water and its use is limited to agricultural and industrial purposes (Whitcomb et al., 1958, p. 254). Due to unfavorable porosities and depths in North Dakota, the production of groundwater from the Spearfish Formation is nonexistent.

The gypsum of the lower Spearfish in the outcrop area could conceivably become of local importance if a favorable market is developed. The general impurity and limited extent of these deposits, however, render large scale development improbable.
The Spearfish Formation of the Black Hills has been traced into the Williston Basin of western North Dakota. In the basin, the formation can be divided into three members. In ascending order these are: (1) a lower gray shale and red siltstone unit herein named the Belfield Member, (2) a middle salt unit, the Pine Salt Member, and (3) an upper red siltstone and fine grained sandstone unit, the Saude Member. Type sections for all three members are herein established. Isopachous maps and stratigraphic cross sections have been prepared to delineate the thickness and distribution of each of the units in western North Dakota.

The Belfield Member and the Pine Salt Member are considered to be Permian in age and are correlated with the Permian part of the type Spearfish Formation in the outcrop sections north of the Black Hills. The Saude Member is predominantly Triassic in age although its upper part in extreme northern North Dakota and Canada may contain the Triassic-Jurassic boundary. The Saude in North Dakota is probably non-marine in origin and was deposited in a different depositional environment than its equivalent south of the Cedar Creek Anticline. South of the anticline the upper part of the Saude has been removed by erosion and a sharp angular unconformity separates the Saude from overlying Jurassic sediments. A persistent anhydrite bed in the lower part of the Saude in southwestern North Dakota is correlated with the top of the Goose Egg Formation in eastern Wyoming and Montana.
BIBLIOGRAPHY


APPENDIX

Well locations and formation tops the North Dakota wells used in this study are listed by counties and then by North Dakota Geological Survey well numbers as shown on the location map (Plate 1). The wells outside of North Dakota are listed by state, county, and then by cross section number as shown on the index map (Plate 14). Formation tops are given as the depth in feet from the Kelly bushing (K.B.). The top of the lowermost formation listed is also the depth to the pre-Spearfish surface (Plate 8).

Billings County

291. Amerada Petrol. Corp. - H. May # 1
NE NE 9 - 139 - 100
K.B. 2774

Piper Fm.
Poc Mbr.
Dunkan beds
Spearfish Fm.
Sauve Mbr.
G marker top
G marker base
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.

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SE SE 17 - 1½3 - 100
K.B. 2815

Piper Fm.
  Poe Mbr.
    Dunham beds
  Spearfish Fm.
    Saude Mbr.
    Pine Mbr.
    Belfield Mbr.
    Minnekahta Fm.

840. Stanolind Oil & Gas Co. - Schwartz # 1
SE SE 3¼ - 138 - 100
K.B. 2828

Piper Fm.
  Poe Mbr.
  Spearfish Fm.
    Saude Mbr.
      G marker top
      G marker base
    Pine Mbr.
    Belfield Mbr.

859. Texaco - Gov't.-M. S. Pace # 1
SW NE 31 - 1¼ - 100
K.B. 2463

Piper Fm.
  Poe Mbr.
    Dunham beds
  Spearfish Fm.
    Saude Mbr.
    Pine Mbr.
    Belfield Mbr.
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SE SE 4 - 140 - 100
K.B. 2736

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Mimiskahta Fm.

6910
6956
7091
7280
7409

2788. Hunt Oil Co. - A. T. Thompson # 1
NE NE 33 - 141/4 - 99
K.B. 2716

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Mimiskahta Fm.

6974
7008
7130
7290
7430
7649

2798. Lamar Hunt - N. P. # 1
SW NW 9 - 141/4 - 100
K.B. 2592

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Mimiskahta Fm.

6992
7038
7194
7320
7533

2853. Shell Oil Co. - Gov't. # 14X - 5 - 1
NE NE 5 - 143 - 100
K.B. 2572

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Mimiskahta Fm.

6662
6702
6807
7020
7146
7350
3211. H. L. Hunt - N. P. # 1
NE SE 1 - 141 - 100
K.B. 2741

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saupe Mbr.
Pine Mbr.
Belfield Mbr.
Minnakahta Fm. 6993

Bottineau County

38. The California Co. - B. Thompson # 1
SW SE 31 - 160 - 81
K.B. 1526

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saupe Mbr.
Madison Grp.
Ratcliffe Interval 3852

200. Ward-Williston Oil Co. - Gorder # 1
C NW 35 - 164 - 80
K.B. 1503

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saupe Mbr.
Madison Grp.
Ratcliffe Interval 3239

201. Ward-Williston Drlg. Co. - Klackstead # 3
NE NW 36 - 164 - 79
K.B. 1525

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saupe Mbr.
Madison Grp.
Ratcliffe Interval 3083
206. Zach Prooks Drlg. Co. - Berenson # 1
SW SE 21 - 163 - 80
K.B. 1503

Piper Fm.
Poe Mbr. 3130
Spearfish Fm.
Saude Mbr. 3177
Madison Grp.
Ratcliffe Interval 3346

NW SW 1b - 163 - 82
K.B. 1530

Piper Fm.
Poe Mbr. 3300
Spearfish Fm.
Saude Mbr. 3434
Madison Grp.
Probisher-Alida Interval 3573

524. Dakota Drlg. - O. Anderson # 1
SE NW 19 - 161 - 81
K.B. 1522

Piper Fm.
Poe Mbr. 3475
Spearfish Fm.
Saude Mbr. 3600
Madison Grp.
Ratcliffe Interval 3855

893. Amerada Petrol. Corp. - Beauchamp # 1
SE SW 21 - 161 - 79
K.B. 1473

Piper Fm.
Poe Mbr. 3131
Spearfish Fm.
Saude Mbr. 3220
Madison Grp.
Ratcliffe Interval 3440
911. H. M. Cox - Foland-State # 1
NE NE 31 - 163 - 82
K.B. 1565

Piper Fm.
Poe Mbr. 3458
Spearfish Fm.
Seade Mbr. 3590
Madison Grp.
Ratcliffe Interval 3728

949. Cardinal Drlg. - A. J. Gunning # 1
NE NE 15 - 159 - 82
K.B. 1563

Piper Fm.
Poe Mbr. 3665
Spearfish Fm.
Seade Mbr. 3770
Madison Grp.
Poplar Interval 4017

962. Amerada Petrol. Corp. - Luddington # 1
SW NE 5 - 160 - 80
K.B. 1503

Piper Fm.
Poe Mbr. 3290
Spearfish Fm.
Seade Mbr. 3408
Madison Grp.
Ratcliffe Interval 3632

1159. Monsanto Oil Co. - Halvorson # 1
NW SE 2 - 162 - 79
K.B. 1499

Piper Fm.
Poe Mbr. 2930
Spearfish Fm.
Seade Mbr. 3028
Madison Grp.
Ratcliffe Interval 3160
1206. Anschutz Drilling Co. - Heath # 1
SE NE 31 - 159 - 83
K.B. 1661

    Piper Fm.
    Poe Mbr.  4100
    Spearfish Fm.
    Saude Mbr.  4186
    Madison Grp.
    Poplar Interval  4450

1324. Leach Oil Corp. - R. R. Smith # 1
SW SW 1/4 - 162 - 80
K.B. 1507

    Piper Fm.
    Poe Mbr.  3150
    Spearfish Fm.
    Saude Mbr.  3250
    Madison Grp.
    Ratcliffe Interval  3450

G. Fossom # 1
NE NE 31 - 162 - 81
K.B. 1523

    Piper Fm.
    Poe Mbr.  3404
    Spearfish Fm.
    Saude Mbr.  3500
    Madison Grp.
    Ratcliffe Interval  3728

1427. Carter Oil Co. & Phillips Petroleum Co.
G. Blowers # 1
SE SW 20 - 160 - 83
K.B. 1624

    Piper Fm.
    Poe Mbr.  3928
    Spearfish Fm.
    Saude Mbr.  4022
    Madison Grp.
    Poplar Interval  4251
3017. Simcox Oil Co. - J. E. Reed # 1
SE SE 13 - 161 - 83
K.B. 1566

Piper Fm.
Poe Mbr.
Spearfish Fm.
Sauede Mbr.
Madison Grp.
Ratcliffe Interval

3250. Amerada Petrol. Corp. - T. Peland # 1
SE SW 31 - 163 - 81
K.B. 1522

Piper Fm.
Poe Mbr.
Spearfish Fm.
Sauede Mbr.
Madison Grp.
Ratcliffe Interval

Bowman County

485. Hunt & Brooks - State # 1
NW NW 16 - 129 - 104
K.B. 3212

Piper Fm.
Poe Mbr.
Spearfish Fm.
Sauede Mbr.
G marker top
G marker base
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.
516. Western Natural Gas Co. - Traut-Trager # 1 FEB
   N.W SW 13 - 132 - 102
   K.B. 3074

   Piper Fm.
   Poe Mbr. 6226
   Spearfish Fm.
   Saude Mbr.
   G marker top 6228
   G marker base 6365
   Pine Mbr.
   Belfield Mbr.
   Minnekahta Fm.
   6685

1446. J. H. Snowden - M. A. Morrison # 1
   SE SW 34 - 130 - 103
   K.B. 3028

   Piper Fm.
   Poe Mbr. 5588
   Spearfish Fm.
   Saude Mbr.
   G marker top 5650
   G marker base 5900
   Pine Mbr.
   Belfield Mbr.
   Minnekahta Fm.
   6191

1575. Carter Oil Co. - L. L. Johnson # 1
   N.W SW 9 - 129 - 106
   K.B. 2953

   Piper Fm.
   Poe Mbr. 4810
   Spearfish Fm.
   Saude Mbr.
   G marker top 4890
   G marker base 5179
   Pine Mbr.
   Belfield Mbr.
   Minnekahta Fm.
   5181

   5237
   5232
   6505
### 2942. Shell Oil Co. - # 32X - 3A - 7
**Location:** SW NE 3 - 130 - 107  
**K.B.:** 3000

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### 3338. Shell Oil Co. - # 41 - 24A - 36
**Location:** NE NE 2h - 130 - 107  
**K.B.:** 2970

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### Burke County

### 836. Carter Oil Co. - Morrissey # 1
**Location:** SE SE 6 - 161 - 92  
**K.B.:** 2153

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### 898. Texota Oil Co. - Ely # 1
**Location:** SE SE 32 - 163 - 93  
**K.B.:** 1936

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1006. Calvert Drlg. Inc. - A. C. Lovejoy # 1  
NE NE 30 - 161 - 90  
K.B. 1872

Piper Fm.  
Poe Mbr.  
4,745
Spearfish Fm.  
Saude Mbr.  
4,833
Kibby Mbr.  
5163
Poplar Interval

1082. Calvert Drlg. Inc. - Jepson # 1  
NE NE 30 - 161 - 90  
K.B. 2075

Piper Fm.  
Poe Mbr.  
5430
Spearfish Fm.  
Saude Mbr.  
5550
Kibbey Fm.  
5880

1153. Northwest Drlg. Co. - Durick # 1  
SW SE 31 - 164 - 93  
K.B. 1911

Piper Fm.  
Poe Mbr.  
5080
Spearfish Fm.  
Saude Mbr.  
5192
Kibbey Fm.  
5550

1368. Calvert-Williamson - R. Bryant # 1  
NW NW 29 - 159 - 90  
K.B. 2367

Piper Fm.  
Poe Mbr.  
6606
Spearfish Fm.  
Saude Mbr.  
6130
Heath-Otter Fms.  
6470
1428. Calvert Drig., Inc. - Davis # 1
NE SE 15 - 163 - 89
K.B. 1895

Piper Fm.
  Poe Mbr.  4640
Spearfish Fm.
  Saude Mbr.  4749
Madison Grp.
  Poplar Interval  5028

1430. Hunt Oil Co. - F. H. Cooksley # 1
NE SE 22 - 161 - 94
K.B. 2419

Piper Fm.
  Poe Mbr.  6061
Spearfish Fm.
  Saude Mbr.  6174
Heath-Otter Fms.  6525

1490. Northern Pump Co. - Bauer # 1
SE SE 31 - 163 - 88
K.B. 1895

Piper Fm.
  Poe Mbr.  4750
Spearfish Fm.
  Saude Mbr.  4830
Madison Grp.
  Poplar Interval  5139

1493. Petroleum Corp. of America - B. Wilson # 1
NE SE 32 - 164 - 90
K.B. 1920

Piper Fm.
  Poe Mbr.  4770
Spearfish Fm.
  Saude Mbr.  4890
Madison Grp.
  Poplar Interval  5170
1531. Northwestern Oil Drilling Co. – T. Olson # 1
NW NE 18 - 162 - 90
K.B. 1945

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Madison Grp.
Poplar Interval

1540. Arrowhead Exploration Co. – Probst # 1
SE SE 17 - 163 - 92
K.B. 1930

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

1766. Pan American Petroleum Corp. – R. Owings # 1
SE SW 13 - 161 - 92
K.B. 2171

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

1807. Northern Pump Co. – Jacobsen # 1
NE NW 21 - 161 - 89
K.B. 1961

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

1966. Hunt Oil Co. – E. K. Olson # 1
SW SW 18 - 160 - 94
K.B. 2346

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.
2132. Lion Oil Co. - Ely # 1
NE NW 36 - 163 - 92
K.B. 1947

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

2304. Stewart Patrol. Co. - Huff # 1
SW SW 31 - 161 - 93
K.B. 2477

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

2323. Calvert Drlg., Inc., Sun Oil Co. -
J. Naruskie # 1
NE NE 23 - 160 - 94
K.B. 2447

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

2406. Carter Oil Co. - State-Moberg # 2
SW SW 17 - 159 - 94
K.B. 2231

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

2430. Ohio Oil Co. - J. Rolie # 1
NW SW 4 - 162 - 94
K.B. 1948

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.
2829. Great Plains Royalty et. al. -
    H. K. & M. B. Fetherston # 1
SE SE 18 - 160 - 92
K.B. 2348

Piper Fm.
    Poe Mbr.
    Spearfish Fm.
    Saude Mbr.
    Heath-Otter Fms.

3290. Mar-Min Dauel. Co. - A. Peterson # 1
SE SW 28 - 162 - 94
K.B. 2302

Piper Fm.
    Poe Mbr.
    Spearfish Fm.
    Saude Mbr.
    Heath-Otter Fms.

Divide County

321. Argyle Royalte Co. - Baukol-Noonan # 1
SW NE 11 - 162 - 95
K.B. 2031

Piper Fm.
    Poe Mbr.
    Spearfish Fm.
    Saude Mbr.
    Kibbey Fm.

548. Pure Oil Co. - C. Gunderson # 1
SW NW 11 - 160 - 98
K.B. 2242

Piper Fm.
    Poe Mbr.
    Spearfish Fm.
    Saude Mbr.
    Amsden Fm.
1024. Phillips Petrol. Co. - Braathen # 1
NE NW 29 - 162 - 95
K.B. 2233

Piper Fm.                  5697
Poe Mbr.       
Spearfish Fm.                  5791
Sauve Mbr.  
Heath-Otter Fm.      6128

1286. Skelly Oil Co. - O. H. Olsen # 1
SE NE 33 - 162 - 100
K.B. 2275

Piper Fm.                  5993
Poe Mbr.       
Spearfish Fm.                  6070
Sauve Mbr.       6130
Kibbey Fm.  

1443. Dakamont Explor. Corp. - H. E. Jacobson # 1
SW NE 6 - 162 - 96
K.B. 1945

Piper Fm.                  5446
Poe Mbr.       
Spearfish Fm.                  5564
Sauve Mbr.       5900
Kibbey Fm.  

1532. Spartan Drig. Co. - K. J. Ecklund # 1
SW NW 9 - 162 - 95
K.B. 2016

Piper Fm.                  5491
Poe Mbr.       
Spearfish Fm.                  5606
Sauve Mbr.       5940
Kibbey Fm.  

1546. Kerr-McGee Oil Industries Inc. - Johnson # 1
NE NW 3h - 162 - 101
K.B. 2261

Piper Fm.                  6000
Poe Mbr.       
Spearfish Fm.                  6090
Sauve Mbr.       6440
Kibbey Fm.  


1900. Signal Drdg. Inc. - K. Unhjem # 1
NW SW 5 - 162 - 98
K.B. 2121

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

5936
5930
6270

2010. Carter Oil Co. - D. Moore # 1
NW NE 7 - 163 - 102
K.B. 2206

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

5522
5607
5941

2121. Pan American Petrol. Corp. - M. Bakken # 1
NE SE 29 - 161 - 95
K.B. 2327

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Ansden Fm.

5880
5980
6226

2143. Kerr Mcgee Oil Industries Inc. - Wifstad # 1
SW NW 13 - 163 - 95
K.B. 1912

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

5206
5304
5644

2688. Signal Drdg. Inc. - Hagen # 1A
NE NW 10 - 163 - 98
K.B. 1966

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

5400
5510
5830
2702. Signal Drlg. et. al. - State-Brady # 1
SW SE 8 - 163 - 96
K.B. 1924

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

2714. Signal Drlg. Inc. - Elmar # 1
SE SE 11 - 162 - 96
K.B. 2037

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

2720. Signal Drlg. Inc. - Carlson # 1
NW NW 27 - 163 - 100
K.B. 2170

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

2721. Signal Drlg. Co. - Lund # 1
SW SW 15 - 161 - 100
K.B. 22k2.

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Heath-Otter Fms.

2722. Signal Drlg. Co. - Joyce # 1
SE SW 13 - 161 - 98
K.B. 2060

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Heath-Otter Fms.
2716. L. Hunt - J. Drodal # 1
SE SW 11 - 161 - 95
K.B. 2396

Piper Fm.
Poe Mbr. 5995
Spearfish Fm.
Saude Mbr. 6095
Keath-Otter Mros. 6356

2759. Signal Drlg. & Exploration Co. - Sullivan # 1
SE NW 23 - 160 - 96
K.B. 2320

Piper Fm.
Poe Mbr. 5992
Spearfish Fm.
Saude Mbr. 6090
Amsden Fm. 6405

2970. Mar-Min Devel. Co. - J. Rasm # 1
NE NE 20 - 162 - 101
K.B. 2244

Piper Fm.
Poe Mbr. 5921
Spearfish Fm.
Saude Mbr. 6010
Kibbey Fm. 6366

2996. Hunt Petrol. Corp. - C. Roestel # 1
SE SW 25 - 161 - 96
K.B. 2364

Piper Fm.
Poe Mbr. 5980
Spearfish Fm.
Saude Mbr. 6073
Amsden Fm. 6315

3098. Amerada Petrol. Corp. - S. Grout # 1
NE SE 11 - 160 - 97
K.B. 2273

Piper Fm.
Poe Mbr. 6137
Spearfish Fm.
Saude Mbr. 6227
Amsden Fm. 6273
3177. Hunt Petrol. Corp. - L. Rosten # 1 - E  
NW SE 30 - 160 - 97  
K.B. 2315

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sande Mbr.  
Amsden Fm.  

3196. Hunt Petrol. Corp. - E. Salveson et al. # 1  
NW SE 25 - 160 - 98  
K.B. 2309

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sande Mbr.  
Amsden Fm.  

3260. Amerada Petrol. Corp. & Sun Oil Co. -  
G. Anderson # 1  
NW SW 30 - 161 - 102  
K.B. 2104

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sande Mbr.  
Kibbey Fm.  

3374. Hunt Petrol Corp. - I. Olson # 1  
SE SW 32 - 160 - 101  
K.B. 2257

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sande Mbr.  
Amsden Fm.  

3456. Cardinal Petrol. Co. - Nat'l. Bulk Carriers -  
Kittelson # 1  
SW SW 35 - 163 - 103  
K.B. 2118

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sande Mbr.  
Kibbey Fm.  

5553  
5633  
5980
Dunn County

505. Socory Vacuum - Dvorak F - 32 - 62
SE NE 6 - 141 - 94
K.B. 2296

Piper Fm.
Poe Mor.
Dunham beds
Spearfish Fm.
Sauke Mor.
Belfield Mor.
Minnekahta Fm.

607. Mobile Producing Co. - Kennedy 7 - 32 - 24p
SW NE 21 - 149 - 93
K.B. 2145

Piper Fm.
Poe Mor.
Dunham beds
Spearfish Fm.
Sauke Mor.
Pine Mor.
Minnekahta Fm.

734. Cities Service Oil Co. - Clarke #1
NE NW 17 - 145 - 91
K.B. 2235

Piper Fm.
Poe Mor.
Dunham beds
Spearfish Fm.
Sauke Mor.
Minnekahta Fm.

793. Mobil Producing Co. - S. Birdbear et. al. #1
SE NW 22 - 149 - 91
K.B. 2092

Piper Fm.
Poe Mor.
Spearfish Fm.
Sauke Mor.
Minnekahta Fm.
824. Northwest Oil Drll. Co. - W. Hamann # 1
     SE SE 8 - 141 - 91
     K.B. 2113

     Piper Fm.
     Poe Mbr. 5780
     Spearfish Fm.
     Saude Mbr. 5818
     Belfield Mbr. 5912
     Minnekahta Fm. 6073

826. Stanolind Oil & Gas Co. - H. Creek # 1
     NW SW 11 - 146 - 91
     K.B. 2291

     Piper Fm.
     Poe Mbr. 6120
     Dunham beds 6232
     Spearfish Fm.
     Saude Mbr. 6330
     Minnekahta Fm. 6540

892. Argo Oil Co. - Larsen # 1
     NE NW 19 - 144 - 94
     K.B. 2410

     Piper Fm.
     Poe Mbr. 6549
     Dunham beds 6600
     Spearfish Fm.
     Saude Mbr. 6678
     Pine Mbr. 6831
     Belfield Mbr. 6943
     Minnekahta Fm. 7020

897. W. H. Hunt - T. W. Darwin # 1
     SW SW 35 - 145 - 96
     K.B. 2519

     Piper Fm.
     Poe Mbr. 6823
     Dunham beds 6866
     Spearfish Fm.
     Saude Mbr. 6975
     Pine Mbr. 7136
     Belfield Mbr. 7180
     Minnekahta Fm. 7402
1219. Kayfair Minerals Inc. - E. Lockwood Jr. # 1
SW NW 5 - 147 - 93
K.B. 2172

Piper Fm.
Poe Mbr.
Dunham beds
6220
Spearfish Fm.
Saude Mbr.
6390
Pine Mbr.
6600
Belfield Mbr.
6689
Minnekahta Fm.
6753

1408. The Calif. Co. - C. Danielson & Bank of
N. D. # 1
NW SW 20 - 148 - 97
K.B. 2162

Piper Fm.
Poe Mbr.
Dunham beds
6584
Spearfish Fm.
Saude Mbr.
6628
Pine Mbr.
6737
Belfield Mbr.
6950
Minnekahta Fm.
6992

1787. Sinclair Oil & Gas Co. - B. Heidecker # 1
NW NE 23 - 143 - 93
K.B. 2248

Piper Fm.
Poe Mbr.
Dunham beds
6211
Spearfish Fm.
Saude Mbr.
6248
Belfield Mbr.
6305
Minnekahta Fm.
6450

2230. Continental Oil Co. - State # 1
SW SW 36 - 147 - 96
K.B. 2647

Piper Fm.
Poe Mbr.
7082
Spearfish Fm.
Saude Mbr.
7153
Pine Mbr.
7320
Belfield Mbr.
7387
Minnekahta Fm.
7546
2352. Amerada Petrol. Corp. - U.S.A. Reed
Tract 1, #1
SE NW 15 - 148 - 95
K.B. 2441

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2615. Stewart Petrol. Corp. - J. Dvirnak #1
NE NE 20 - 146 - 96
K.B. 3039

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2618. Pan American Petrol. Corp. - J. Huber #1
SW SE 15 - 145 - 91
K.B. 2212

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2618. Lyda Hunt - Herbert Trusts' et. al.
H.B. Gun #1
Sw SE 8 - 147 - 93
K.B. 2297

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3044. Amerada Petrol. Corp. - M. Selle Tract 1 # 1  
NE NE 27 - 143 - 92  
K.B. 2200

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Saude Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

6158
6219
6354
6410

3199. Amerada Petrol. Corp. - J. Steffen # 1  
NW NE 16 - 144 - 92  
K.B. 2198

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Saude Mbr.  
Minnekahta Fm.  

6121
6170
6324

Golden Valley County

410. Gulf Oil Corp. - N. Borough - Federal # 1  
NE SW 24 - 143 - 108  
K.B. 2515

Piper Fm.  
Poe Mbr.  
Dunham beds  
Spearfish Fm.  
Saude Mbr.  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

6695
6755
6780
6820
7084
7280
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2894. Shell Oil Co. - N. Brown et al. - 41-24-1
NE NE 24 - 142 - 103
K.B. 2688

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Grant County

232. Youngblood & Youngblood - Kelstrom # 1
SW SW 26 - 133 - 83
K.B. 1997

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Hettinger County

511. Socony Vacuum Co. - F - 14 - 24P Jacobs # 1
SW SW 24 - 134 - 96
K.B. 2616

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1926. Amerada Petrol. Corp. - R. Grosz # 1  
NW NE 35 - 135 - 93  
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McHenry County

1622. Triton Oil Co. - Switzer # 1  
SW SW 2h - 158 - 80  
K.B. 1503

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1632. Triton Oil Co. - Fredrickson # 1  
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K.B. 1509

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1651. Hunt Oil Co. - E. Rosenau # 1  
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K.B. 1473

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2670. Cardinal Petrol. Co. - Hordt-Bank of N. D. # 1
NE SE 6 - 158 - 80
K.B. 1505

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Madison Corp.
Poplar Interval

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.

McKenzie County

33. Mallard Petrol. Ltd. & C. W. Jones -
B. Pissar # 1
SW SE 12 - 149 - 96
K.B. 2434

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.

78. Amerada Petrol. Corp. - N. D. # "D" - 1
NE NW 16 - 153 - 95
K.B. 2474

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.
147. Amerada Petrol. Corp. - G. Wollon # 1
NW NW 15 - 152 - 96
K.B. 2430

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Pine Mbr.
- Belfield Mbr.
- Minnekahta Fm.

277. Amerada Petrol. Corp. - N. D. "B"
Tract 2, # 1
NE NE 16 - 149 - 95
K.B. 2364

- Piper Fm.
- Poe Mbr.
  - Dunham beds
- Spearfish Fm.
- Saude Mbr.
- Pine Mbr.
- Belfield Mbr.
- Minnekahta Fm.

303. Amerada Petrol. Corp. - N. D. "B"
Tract 3, # 1
SW SW 16 - 150 - 95
K.B. 2263

- Piper Fm.
- Poe Mbr.
  - Dunham beds
- Spearfish Fm.
- Saude Mbr.
- Pine Mbr.
- Belfield Mbr.
- Minnekahta Fm.
306. Amerada Petrol. Corp. - E. H. Pittsley # 1  
SE SE 15 - 151 - 96  
K.B. 2395

Piper Fm.  
Poe Mbr.  
  Dunham beds  
Spearfish Fm.  
Saude Mbr.  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

341. Stanolind Oil & Gas Co. - W Starr # 1  
SW SE 21 - 152 - 94  
K.B. 2140

Piper Fm.  
Poe Mbr.  
  Dunham beds  
Spearfish Fm.  
Saude Mbr.  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

527. The Calif. Co. - Rough Creek # 1  
NW NE 13 - 148 - 96  
K.B. 2472

Piper Fm.  
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Spearfish Fm.  
  Saude Mbr.  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

545. Phillips Petrol. Co. - Hoehn "A" # 1  
NE SE 13 - 152 - 102  
K.B. 2278

Piper Fm.  
Poe Mbr.  
  Dunham beds  
Spearfish Fm.  
Saude Mbr.  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

6334  
6380  
6445  
6656  
6790  
6950  
6197  
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6300  
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<td>Pine Mbr.</td>
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<td>Belfield Mbr.</td>
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1451. Juniper Oil & Mining - A. Elton # 1
N.W. 1/4 2 - 151 - 95
K.B. 2312

Piper Fm.
  Poe Mbr.
  Dunham beds.
Spearfish Fm.
  Saude Mbr.
  Pine Mbr.
  Belfield Mbr.
  Minnekahta Fm.
  6245
  6300
  6350
  6600
  6710
  6802

1469. Amerada Petrol. Corp. - Bear Den # 1
NE 25 - 149 - 96
K.B. 2408

Piper Fm.
  Poe Mbr.
  Dunham beds.
Spearfish Fm.
  Saude Mbr.
  Pine Mbr.
  Belfield Mbr.
  Minnekahta Fm.
  6559
  6600
  6725
  6981
  7154

Tract 1, # 1
NE SW 35 - 150 - 97
K.B. 2334

Piper Fm.
  Poe Mbr.
  Spearfish Fm.
  Saude Mbr.
  Pine Mbr.
  Belfield Mbr.
  Minnekahta Fm.
  6710
  6760
  6760
  6982
  7060
  7132
1619. Amerada Petrol. Corp. - A. Kennedy #1
NW NE 29 - 151 - 96
K.B. 2270

Piper Fm.
Poe Mbr.
Durham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minniekahta Fm.

1624. Investors Oil Inc. - I. & E. Shaide #1
SW NE 8 - 151 - 103
K.B. 2200

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minniekahta Fm.

1679. Amerada Petrol. Corp. - C. C. Hogen
Tract 1, #1
SW SE 10 - 153 - 96
K.B. 2017

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minniekahta Fm.
1740. Amerada Petrol. Corp. - J. Ijaadal
Tract 1, #1
NE NW 29 - 150 - 96
K.B. 2243

Piper Fm. 6490
Poe Mbr. 6490
Spearfish Fm. 6520
Saude Mbr. 6772
Pine Mbr. 6772
Belfield Mbr. 6798
Minnekahta Fm. 6930

1816. Calvert, King, Stevenson, et. al. -
M. Signalness # 1
SW NW 2 - 150 - 96
K.B. 2382

Piper Fm. 6390
Poe Mbr. 6390
Dunham beds 6390
Spearfish Fm. 6500
Saude Mbr. 6754
Pine Mbr. 6805
Belfield Mbr. 6984
Minnekahta Fm. 6984

2226. Amerada Petrol. Corp. - U.S.A. Thomas #1
SW NW 18 - 153 - 94
K.B. 2134

Piper Fm. 6130
Poe Mbr. 6130
Dunham beds 6186
Spearfish Fm. 6278
Saude Mbr. 6560
Pine Mbr. 6683
Belfield Mbr. 6733
Minnekahta Fm. 6733
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<td>SW MB 15 - 145 - 101</td>
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<td>Carter Oil Co.</td>
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<td>SW NW 14 - 146 - 101</td>
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2707. Shell Oil Co. - N. P. R. R. -14-35-1
S.W. SW 35 - 145 - 101
K.B. 2218

Piper Fm. 6550
Poe Mbr.
Spearfish Fm. 6603
Saude Mbr.
Pine Mbr. 6770
Belfield Mbr. 6920
Minnekahta Fm. 7122

2746. W. H. Hunt - A. M. Holt # 1
NE SE 8 - 153 - 97
K.B. 2110

Piper Fm. 6850
Poe Mbr.
Spearfish Fm. 6900
Saude Mbr.
Pine Mbr. 7151
Belfield Mbr. 7210
Minnekahta Fm. 7295

2786. W. H. Hunt - U.S.A. "A" # 1
NW SW 15 - 148 - 102
K.B. 2383

Piper Fm. 6973
Poe Mbr. 7010
Dunham beds
Spearfish Fm. 7059
Saude Mbr.
Pine Mbr. 7226
Belfield Mbr. 7359
Minnekahta Fm. 7550

2821. W. H. Hunt - E. Glovatsky # 1
NW NE 3 - 145 - 99
K.B. 2681

Piper Fm. 7162
Poe Mbr. 7201
Dunham beds
Spearfish Fm. 7220
Saude Mbr.
Pine Mbr. 7416
Belfield Mbr. 7525
Minnekahta Fm. 7724
2019. L. H. Hunt-Herbert Trusts', et. al. -
H. C. Nystand # 1
NE SW 31 - 152 - 99
K.B. 2316

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.

3020. Sinclair Oil & Gas Co. - Federal - 7009 -
McKenzie # 1
NE NW 33 - 146 - 104
K.B. 2516

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.

3064. Sinclair Oil & Gas Co. - Federal - 7020 -
McKenzie # 1
NW SE 11 - 147 - 103
K.B. 2345

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnekahta Fm.
3157. Caroline Hunt Trust Estate - M. Nelson # 1-A
NW SE 11 - 149 - 90
K.B. 2232

Piper Fm.
    Poe Mbr.
        Dunham beds
Spearfish Fm.
    Saude Mbr.
Spearfish Mbr.
Belfield Mbr.
Minnekahta Fm.

McLean County

49. Stanolind Oil Co. - McLean County # 1
SW SW 8 - 150 - 30
K.B. 2100

Piper Fm.
    Poe Mbr.
Spearfish Fm.
    Saude Mbr.
    Heath-Otter Fms.

432. H. Hanson Oil Syndicate - N. E. Hanson # 1
SW SE 2 - 146 - 31
K.B. 1957

Piper Fm.
    Poe Mbr.
Spearfish Fm.
    Saude Mbr.
Amsden Fm.

1194. Calvert Drlg. Co. - G. Wolf # 1
NW NE 5 - 149 - 90
K.B. 1989

Piper Fm.
    Poe Mbr.
        Dunham beds
Spearfish Fm.
    Saude Mbr.
Speeche Fm.

K.B. 2232

K.B. 2100

K.B. 1957

K.B. 1989
1516. H. Hanson Oil Syndicate - Samuelson #1
SE SW 32 - 146 - 82
K.B. 2022

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Minnelusa Fm.

Piper Fm. 4674
Poe Mbr. 4703
Spearfish Fm. 4800

Mercer County

21. F. F. Kelly - F. Leutz #1
NW NE 28 - 142 - 89
K.B. 2284

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Belfield Mbr.
- Minnekahta Fm.

Piper Fm. 5239
Poe Mbr. 5918
Spearfish Fm. 5960
Saude Mbr. 6014
Belfield Mbr. 6040
Minnekahta Fm.

377. Williston Oil & Gas Co. - Boeckel et. al. #1
SW SW 10 - 144 - 88
K.B. 2059

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Belfield Mbr.
- Minnekahta Fm.

Piper Fm. 5536
Poe Mbr. 5580
Spearfish Fm. 5575
Saude Mbr. 5722

2826. Sinclair Oil & Gas Co. - A. Hauck #1
SE SW 31 - 143 - 90
K.B. 2200

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Belfield Mbr.
- Opeche Fm.

Piper Fm. 6041
Poe Mbr. 6096
Spearfish Fm. 6234
Saude Mbr. 6290
Belfield Mbr.
Opeche Fm.
Horton County

133. Deep Rock Oil Co. - H. Johnson "A" # 1
S NW 30 - 139 - 86
K.B. 2204

Piper Fm.
Poe Mbr.
Opechee Fm.

464. Deep Rock Corp. - Gangl # A-1
NW NW 11 - 135 - 82
K.B. 2134

Piper Fm.
Poe Mbr.
Minnelusa Fm.

1620. Pan American Petrol. Corp. - R. Vetter # 1
NE SW 27 - 139 - 90
K.B. 2426

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saupe Mbr.
G marker top
G marker base
Belfield Mbr.
Minnakhta Fm.

2185. Fletcher Oil & Gas Co. & Singal Drlg. Co. -
Boehm # 1
SW NE 11 - 139 - 82
K.B. 1861

Piper Fm.
Poe Mbr.
Minnelusa Fm.
237. Amerada Petrol. Corp. - C. Rice # 1  
NE NW 23 - 158 - 94  
K.B. 2425

- Piper Fm. 
  Poe Mbr.  6250
  Dunham beds  6326
- Spearfish Fm. 
  Saude Mbr.  6380
  Pine Mbr.  6705
  Opeche Fm.  6758

355. Amerada Petrol. Corp. - C. Hanson # 3  
SW NW 18 - 158 - 94  
K.B. 2339

- Piper Fm. 
  Poe Mbr.  6075
- Spearfish Fm. 
  Saude Mbr.  6170
  Pine Mbr.  6178
  Opeche Fm.  6508

416. C.W.R. Oil co. & Whitson Inc. -  
N. Johnsberg # 1  
SW NW 15 - 158 - 93  
K.B. 2413

- Piper Fm. 
  Poe Mbr.  6102
- Spearfish Fm. 
  Saude Mbr.  6198
  Pine Mbr.  6808
  Opeche Fm.  6890

474. W.H. Hunt - W. D. Dunham # 1  
NW NW 24 - 155 - 90  
K.B. 2161

- Piper Fm. 
  Poe Mbr.  5800
  Dunham beds  5878
- Spearfish Fm. 
  Saude Mbr.  6016
  Pine Mbr.  6310
  Amsden Fm.  6348
528. W. H. Hunt – Anderson # 1
NW NW 25 – 157 – 89
K.B. 2271

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Heath-Otter Mns.

534. Amerada Petrol. Corp. – B. Lokken # 1
NE SW 2 – 157 – 94
K.B. 2399

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Opeche Fm.

592. W. H. Hunt – E. G. Horne # 1
SE NW 14 – 156 – 92
K.B. 2322

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Opeche Fm.

1223. Texata Oil Co. – W. F. Bauer # 1
SW SE 27 – 156 – 99
K.B. 2180

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Heath-Otter Mns.
1307. L. H. Cron - M. C. Jorstad # 6
S: SE 9 - 157 - 94
K.B. 2319

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Apache Fm.

1315. Calvert Drlg. Inc. - Bratlien # 1
NE NE 9 - 158 - 92
K.B. 2288

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

1406. Calvert Drlg. Co. & L. J. Williamson Inc. -
Salo # 1
NE SW 19 - 157 - 90
K.B. 2384

Piper Fm.
Poe Mbr.
Dunkam beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Amsden Fm.

1813. Anschutz Drlg. Co. & Sun Oil Co. - State # 1
NE NE 16 - 157 - 88
K.B. 2301

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Heath-Otter Fms.
1844. Anschutz Drig. Co. - A. Lehman # 1
SW SW 10 - 158 - 91
K.B. 2402

Piper Fm.
Poe Mbr. 6162
Spearfish Fm.
Saude Mbr. 6217
Pine Mbr. 6590
Amsden Fm. 6610

2273. Stewart Petrol. Co. - Gvancava # 1
NW SW 15 - 155 - 93
K.B. 2360

Piper Fm.
Poe Mbr. 6638
Spearfish Fm.
Saude Mbr. 6720
Pine Mbr. 7006
Opeche Fm. 7050

2695. Hunt Petrol. Co. - J. Dancing Bull # 1
NE NW 9 - 150 - 92
K.B. 2115

Piper Fm.
Poe Mbr. 6232
Dunham beds 6277
Spearfish Fm.
Saude Mbr. 6390
Pine Mbr. 6625
Minnekahta Fm. 6714

2779. N. W. Edmund - W. A. Spletstroser # 1
SW NW 19 - 152 - 88
K.B. 2086

Piper Fm.
Poe Mbr. 5786
Spearfish Fm.
Saude Mbr. 5830
Opeche Fm. 6100
2816. Davis Oil Co. - L. Carkuff # 1
SW SE 12 - 154 - 92
K.B. 2389

Piper Fm.
   Poe Mbr. 6510
   Dunham beds 6606
Spearfish Fm.
   Saude Mbr. 6647
   Pine Mbr. 6930
   Opeche Fm. 6953

3005. I. J. Wilhite - Krueger # 1
SW SW 9 - 158 - 89
K.B. 2342

Piper Fm.
   Poe Mbr. 5814
   Spearfish Fm.
   Saude Mbr. 5938
   Heath-Otter Fms. 6280

3134. Shell Oil Co. - Prochaska # 12 - 8 - 1
SW NW 8 - 155 - 93
K.B. 2297

Piper Fm.
   Poe Mbr. 6017
   Dunham beds 6510
Spearfish Fm.
   Saude Mbr. 6568
   Pine Mbr. 6862
   Opeche Fm. 6904

3227. Amerada Petrol. Corp. - N. D. - "M" # 1
SE SE 16 - 155 - 94
K.B. 2030

Piper Fm.
   Poe Mbr. 6066
   Dunham beds 6129
Spearfish Fm.
   Saude Mbr. 6208
   Pine Mbr. 6500
   Belfield Mbr. 6516
   Minnekahta Fm. 6567
3228. Calif. Oil Co. - L Elefson & Federal Land
 Bank # 1
 NE NE 6 - 157 - 91
 K.B. 2429

 Piper Fm.
 Poe Mbr. 6288
 Dunham beds 6378
 Spearfish Fm.
 Saude Mbr. 6390
 Amsden Fm. 6711

3317. Jack Gryenberg - Johnsonberg # 1
 NE NE 25 - 153 - 92
 K.B. 2308

 Piper Fm.
 Poe Mbr. 6550
 Spearfish Fm.
 Saude Mbr. 6616
 Pine Mbr. 6872
 Belfield Mbr. 6915
 Minnekahta Fm. 6945

3353. Monsanto Chem. Co. - Jackson # 1
 NW NW 28 - 158 - 91
 K.B. 2344

 Piper Fm.
 Poe Mbr. 6150
 Dunham beds 6237
 Spearfish Fm.
 Saude Mbr. 6256
 Amsden Fm. 6576

 Oliver County

95. Youngblood & Youngblood - Wachter # 1
 SE SW 3 - 141 - 81
 K.B. 1924

 Piper Fm.
 Poe Mbr. 4178
 Minnelusa Fm. 4210
2183. Fletcher Oil & Gas Co. & Signal Brg. Co. -
Bucligen #1
NW NW 34 - 141 - 85
K.B. 2173

Piper Fm.
Poe Mbr.
Opechee Fm.

3277. Sunray Dx. Oil Co. - Henke #1
NE SE 14 - 142 - 85
K.B. 2193

Piper Fm.
Poe Mbr.
Opechee Fm.

Renville County

369. Sohio Petrol. Co. - J. Nelson #1
SE SW 34 - 158 - 81
K.B. 1541

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Madison Grp.
Poplar Interval

3814. Sohio Petrol Co. - Marcil #1
NW NW 13 - 163 - 84
K.B. 1623

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Madison Grp.
Ratcliffe Interval
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<td>SW SW 9 - 163 - 87</td>
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1602. Petrol. Corp. of America - L. Krueger # 1
NW NE 26 - 161 - 87
K.B. 1858

Piper Fm.
Poe Mbr. 4678
Spearfish Fm.
Saunder Mbr. 4774
Madison Grp.
Poplar Interval 5110

1726. Gulf Oil Corp. - Rusch # 1
SE NW 3 - 163 - 85
K.B. 1677

Piper Fm.
Poe Mbr. 3830
Spearfish Fm.
Saunder Mbr. 3927
Madison Grp.
Ratcliffe Interval 4089

1727. Gulf Oil Co. & Signal Drlg. Co. - R. Hoke # 1
SE SW 32 - 161 - 84
K.B. 1705

Piper Fm.
Poe Mbr. 4190
Spearfish Fm.
Saunder Mbr. 4276
Madison Grp.
Poplar Interval 4518

1815. Davis Oil Co. - Jensen # 1
NW NW 21 - 162 - 87
K.B. 1856

Piper Fm.
Poe Mbr. 4630
Spearfish Fm.
Saunder Mbr. 4723
Madison Grp.
Poplar Interval 5022
1822. T. Jordan et. al. - J. Routledge # 1
NE NW 29 - 163 - 86
K.B. 1802

Piper Fm. 4307
Poe Mbr.
Spearfish Fm. 4406
Saude Mbr.
Madison Grp.
Poplar Interval 4606

3280. Texata Oil Co. - RaaF # 1
SE SE 15 - 162 - 84
K.B. 1624

Piper Fm. 3856
Poe Mbr.
Spearfish Fm. 3970
Saude Mbr.
Madison Grp.
Ratcliffe Interval 4193

3335. C. W. Jones, Shell Oil Co., Sun Oil Co. -
Larson # 1
NW SE 31 - 160 - 85
K.B. 1782

Piper Fm. 4534
Poe Mbr.
Spearfish Fm. 4641
Saude Mbr.
Madison Grp.
Poplar Interval 4960

3368. Cardinal Petrol. et. al. - M. Ness # 1
NW NW 6 - 161 - 85
K.B. 1770

Piper Fm. 4348
Poe Mbr.
Spearfish Fm. 4440
Saude Mbr.
Madison Grp.
Poplar Interval 4724
3422. Farmers Union Inc. - Rhoads # 1
NE SW 16 - 158 - 82
K.B. 1599

Piper Fm.
Poe Mbr.  2
Spearfish Fm.
Saude Mbr.  3954
Madison Grp.
Poplar Interval  4186

Slope County

91. Stanolind Oil & Gas Co. - J. Brusich # 1
SE SE 8 - 135 - 98
K.B. 2803

Piper Fm.
Poe Mbr.  6304
Spearfish Fm.
Saude Mbr.  6361
G marker top  6116
G marker base  6430
Pine Mbr.  6117
Belfield Mbr.  6660
Minnekahta Fm.  6864

378. D.D. Feldman Oil & Gas Co. - J. Benz # 1
SW NE 20 - 135 - 98
K.B. 2974

Piper Fm.
Poe Mbr.  6690
Spearfish Fm.
Saude Mbr.  6748
G marker top  6801
G marker base  6805
Belfield Mbr.  6864
Minnekahta Fm.  7022
1464. Skelly Oil Co. - Bismarck "A" # 1
SW SE 16 - 135 - 100
K.B. 2807

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<td>Saude Mbr.</td>
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<td>6783</td>
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<td>Minnekahta Fm.</td>
<td>6989</td>
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2895. N. American Royalties et. al. - Hamann
Estate # 1
SE SE 9 - 135 - 101
K.B. 2795

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<td>Minnekahta Fm.</td>
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3383. Pan Am. Petrol. Corp. - L. Foreman # 1
SW SE 23 - 133 - 106
K.B. 2787

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<td>Saude Mbr.</td>
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<td>Pine Mbr.</td>
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<td>Belfield Mbr.</td>
<td>5979</td>
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<td>Minnekahta Fm.</td>
<td>6156</td>
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Stark County

344. Plymouth Oil Co. - F. Fischer # 1
SW NE 11 - 137 - 98
K.B. 278h:

Piper Fm.
  Poe Mbr.  6709
Spearfish Fm.
  Saude Mbr.
    G marker top  6763
    G marker base  6826
  Pine Mbr.
  Belfield Mbr.
  Minnekahta Fm.

539. W. H. Hunt - V. H. Kudrna # 1
SW NW 20 - 139 - 97.
K.B. 2590

Piper Fm.
  Poe Mbr.  6462
Spearfish Fm.
  Saude Mbr.
    G marker top  6520
    G marker base  6590
  Pine Mbr.
  Belfield Mbr.
  Minnekahta Fm.

613. Amerada Petrol. Corp. - R. E. Newton # 1
NW SW 31 - 140 - 99
K.B. 2627

Piper Fm.
  Poe Mbr.
    Dunham beds  6685
  Spearfish Fm.
    Saude Mbr.
      G marker top  6869
      G marker base  6972
    Pine Mbr.
    Belfield Mbr.
    Minnekahta Fm.

657. Sun Oil Co. - Beaudoin # 1  
NW SW 9 - 138 - 99  
K.B. 2640

Piper Fm.  
Pee Mbr.  
Spearfish Fm.  
Saupe Mbr.  
G marker top  
G marker base  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Mbr.  

6694

810. Southern Prod. Co. & Texata Oil Co. -  
F. J. Wamer # 1  
NW NW 9 - 137 - 97  
K.B. 2690

Piper Fm.  
Pee Mbr.  
Spearfish Fm.  
Saupe Mbr.  
G marker top  
G marker base  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Mbr.  

6556

850. W. K. Hunt - A. A. Privatsky # 1  
NW NW 15 - 138 - 98  
K.B. 2652

Piper Fm.  
Pee Mbr.  
Spearfish Fm.  
Saupe Mbr.  
G marker top  
G marker base  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Mbr.  

6624

6627

6677

6751

6760

6810

7010

7200
1466. Leach Oil Corp. - W. Kalanek # 1
SE NW 32 - 140 - 96
K.B. 2516

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
G marker top
G marker base
Pine Mbr.
Belfield Mbr.
Minnakahta Fm.

1536. Skelly Oil Co. - Weigum # 1
SE NW 25 - 138 - 99
K.B. 2614

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
G marker top
G marker base
Pine Mbr.
Belfield Mbr.
Minnakahta Fm.

1641. Texata Oil Co. - J. Kubishta # 1
SE SE 6 - 138 - 95
K.B. 2511

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
G marker top
G marker base
Belfield Mbr.
Minnakahta Fm.
1574. Northern Pump Co. - C. Braun # 1
NW NW 15 - 137 - 99
K.B. 2733

Piper Fm.
Poe Mbr. 6680
Spearfish Fm.
Saude Mbr. 6730
G marker top 6811
G marker base 6831
Pine Mbr. 6900
Belfield Mbr. 7014
Minnekahta Fm. 7261

1646. Atlantic Refining Co. - J. J. Kadmas, Jr. # 1
NE SE 31 - 140 - 96
K.B. 2498

Piper Fm.
Poe Mbr. 6716
Spearfish
Saude Mbr. 6766
G marker top 6905
G marker base 6913
Pine Mbr. 6931
Belfield Mbr. 6983
Minnekahta Fm. 7070

1935. Sinclair Oil Co. - J. Mueck # 1
SE NE 29 - 140 - 94
K.B. 2427

Piper Fm.
Poe Mbr. 6473
Spearfish Fm.
Saude Mbr. 6528
Belfield Mbr. 6600
Minnekahta Fm. 6731
2004. Skelly Oil Co. - P. Stiegl # 1
NW SW 9 - 138 - 92
K.B. 2416

Piper Fm.
Poe Mbr. 5786
Spearfish Fm.
Saude Mbr.
G marker top 5841
G marker base 5869
Belfield Mbr. 5878
Mirnekahta Fm. 5878

2075. Skelly Oil Co. - S. Merrill # 1
SE NW 33 - 140 - 98
K.B. 2526

Piper Fm.
Poe Mbr. 6697
Spearfish Fm.
Saude Mbr. 6714
G marker top 6892
G marker base 6901
Pine Mbr. 6970
Belfield Mbr. 7126
Mirnekahta Fm. 7296

2117. Tenn. Gas Transmission Co. -
Casimer-Duletski # 1
NW NW 16 - 139 - 99
K.B. 2644

Piper Fm.
Poe Mbr. 6690
Dunham beds 6732
Spearfish Fm.
Saude Mbr. 6784
G marker top 6863
G marker base 6897
Pine Mbr. 6955
Belfield Mbr. 7120
Mirnekahta Fm. 7311
2496. Atlantic Refining Co. - A. Eberts #1
SE SW 18 - 138 - 97  
K.B. 2726

- Piper Fm.  
  Poe Mbr. 6882  
  Spearfish Fm.  
    Saude Mbr. 6934  
    G marker top 6954  
    G marker base 7004  
  Belfield Mbr. 7050  
  Minnekahta Fm. 7238

3160. Amerada Petroleum Corp. - L. Koppinger #1
SE NW 20 - 137 - 95  
K.B. 2695

- Piper Fm.  
  Poe Mbr. 6447  
  Spearfish Fm.  
    Saude Mbr. 6495  
    G marker top 6555  
    G marker base 6558  
  Belfield Mbr. 6584  
  Minnekahta Fm. 6737

Ward County

47. H. Hunt Trust - Wald #1
SE SW 23 - 155 - 81  
K.B. 1595

- Piper Fm.  
  Poe Mbr. 3815  
  Spearfish Fm.  
    Saude Mbr. 3887  
    Madison Grp.  
    Poplar Interval 4185
52. Manete Oil Co. - N. O. Lee # 1
NE NE 2½ - 156 - 85
K.B. 1839

Piper Fm.
Poe Mbr. 4612
Spearfish Fm.
Saude Mbr. 4708
Kibbey Fm. 5000

105. Stanolind Oil & Gas Co. - W. Waswick # 1
SW NE 2 - 153 - 85
K.B. 2175

Piper Fm.
Poe Mbr. 5150
Dunham beds 5212
Spearfish Fm.
Saude Mbr. 5240
Pine Mbr. 5186
Heath-Otter Fms. 5517

126. Quintana Prod. Co. - C. W. Linnertz # 1
SW SE 33 - 156 - 83
K.B. 1772

Piper Fm.
Poe Mbr. 4384
Spearfish Fm.
Saude Mbr. 4467
Madison Grp.
Poplar Interval 4755

392. Sam G. Harrison - J. E. Anderson # 1
SW SW 21 - 157 - 85
K.B. 1875

Piper Fm.
Poe Mbr. 4790
Spearfish Fm.
Saude Mbr. 4891
Kibbey Fm. 5186
538. W. H. Hunt - F. C. Neumann # 1
SW SE 33 - 152 - 82
K.B. 2087

Piper Fm.
Poe Mbr. 4734
Spearfish Fm.
Saude Mbr. 4787
Kibbey Fm. 5069

656. W. H. Hunt - G. Almy # 1
NW NE 13 - 155 - 82
K.B. 1632

Piper Fm.
Poe Mbr. 3985
Spearfish Fm.
Saude Mbr. 4066
Kibbey Fm. 4348

1061. Calvert Drlg. Inc. - G. Jacobson # 1
SW SW 30 - 153 - 84
K.B. 2112

Piper Fm.
Poe Mbr. 5170
Spearfish Fm.
Saude Mbr. 5267
Pine Mbr. 5497
Heath-Otter Fms. 5525

1138. H. Mack. Cox - Kotosek # 1
NW SW 19 - 156 - 82
K.B. 1636

Piper Fm.
Poe Mbr. 4136
Spearfish Fm.
Saude Mbr. 4214
Madison Grp.
Poplar Interval 4504
1438. L. J. Williamson Inc. - Pederson # 1
NW SW 6 - 156 - 86
K.B. 2104

Piper Fm.  
Poe Mbr.  5370
Spearfish Fm.  
Saude Mbr.  5104
Kibbey Fm.  5759

1801. Anschutz Drilg. Co. & Sun Oil Co. -
O. Nielson # 1
SW NE 21 - 159 - 87
K.B. 1952

Piper Fm.  
Poe Mbr.  5047
Spearfish Fm.  
Saude Mbr.  5143
Kibbey Fm.  5460

1808. Northern Pump Co. - Schoemer # 1
NW NE 11 - 160 - 89
K.B. 1956

Piper Fm.  
Poe Mbr.  5070
Spearfish Fm.  
Saude Mbr.  5176
Kibbey Fm.  5515

State # 1
NW NW 32 - 159 - 88
K.B. 2141

Piper Fm.  
Poe Mbr.  5507
Spearfish Fm.  
Saude Mbr.  5608
Kibbey Fm.  5953
1876. Exploration Drilling Co. - K. Grider # 1  
SE NE 22 - 150 - 87  
K.B. 2006

  Piper Fm.  
  Poe Mbr.  
  Spearfish Fm.  
  Saude Mbr.  
  Kibbey Fm.  

1885. Juniper Oil & Mining - Huber # 1  
SW NW 18 - 160 - 87  
K.B. 1919

  Piper Fm.  
  Poe Mbr.  
  Spearfish Fm.  
  Saude Mbr.  
  Madison Grp.  
  Poplar Interval  

2017. British American Oil Co. - Anderson "C" # 1  
NW NW 2 - 157 - 82  
K.B. 1598

  Piper Fm.  
  Poe Mbr.  
  Spearfish Fm.  
  Saude Mbr.  
  Madison Grp.  
  Poplar Interval  

2051. Davis Oil Co. - A. Peterson # 1  
SE NE 28 - 153 - 86  
K.B. 2117

  Piper Fm.  
  Poe Mbr.  
  Spearfish Fm.  
  Saude Mbr.  
  Amsden Fm.  

5217  
5312  
5627  
4961  
5070  
5392  
3880  
3960  
4208  
5446  
5530  
5760
213h. The Texas Co. - R. T. James # 1
NE NW 3 - 159 - 07
K.B. 1921

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Madison Grp.
Poplar Interval

2930. I. J. Wilhite, & C. W. Jones -
A. W. Benno # 1
NW NW 8 - 151 - 83
K.B. 1845

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

2931. I. J. Wilhite & C. W. Jones -
SE SE 32 - 155 - 85
K.B. 2170

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Heath-Otter Fms.

3039. I. J. Wilhite - R. D. Becker # 1
NW NW 11 - 155 - 85
K.B. 1924

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Kibbey Fm.

5390
4,582
4,977
4,973
5,267
3080. Cardinal Petrol. Co., & Nat'l Bulk Carriers -
E. Mathis # 1
SE SE 13 - 152 - 83
K.B. 2110

- Piper Fm. 430
- Poe Mbr. 4886
- Spearfish Fm. 5178
- Saude Mbr.
- Kibbey Fm.

3124. Signal et. al. - Halseth # 1
NW SW 3 - 156 - 81
K.B. 1566

- Piper Fm. 3732
- Poe Mbr. 3823
- Spearfish Fm. 4138
- Saude Mbr.
- Madison Grp.
- Poplar Interval

3125. Calvert et. al. - Troxel # 1
SW NE 11 - 156 - 86
K.B. 1990

- Piper Fm. 5008
- Poe Mbr. 5100
- Spearfish Fm. 5390
- Saude Mbr.
- Kibbey Fm.

3314. I. J. Wilhite - Pietsch # 1
SW SE 7 - 153 - 83
K.B. 2067

- Piper Fm. 4924
- Poe Mbr. 5020
- Spearfish Fm. 5290
- Saude Mbr.
- Kibbey Fm.
Williams County

32. Amerada Petrol. Corp. - H. O. Bakken #1
SW NW 12 - 156 - 95
K.B. 2458

Piper Fm.
  Poe Mbr.  6110
  Spearfish Mbr.
    Saude Mbr.  6230
    Pine Mbr.  6520
  Speche Fm.  6550

128. Amerada Petrol. Corp. - N. D. "E" #1
NW NW 16 - 154 - 95
K.B. 2305

Piper Fm.
  Poe Mbr.  5928
    Dunham beds  5980
  Spearfish Fm.
    Saude Mbr.  6034
    Pine Mbr.  6318
    Belfield Mbr.  6380
  Minnekahta Fm.  6453

313. Kenneth A. Ellison - Ellison N. D. #1
NE NE 16 - 159 - 96
K.B. 2266

Piper Fm.
  Poe Mbr.  6164
    Dunham beds  6210
  Spearfish Fm.
    Saude Mbr.  6276
    Speche Fm.  6605

547. W. H. Hunt - B. H. Wypeuck #1
NE NW 27 - 156 - 97
K.B. 2272

Piper Fm.
  Poe Mbr.  6450
  Spearfish Fm.
    Saude Mbr.  6524
    Pine Mbr.  6820
    Belfield Mbr.  6870
  Minnekahta Fm.  6945
984. Pure Oil Co. - Esterby # 1
SW SW 11 - 159 - 100
K.B. 2056

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

999. Texaco Inc. - J. Donalme # 1
SW NE 23 - 154 - 100
K.B. 2253

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnakhta Fm.

NE NE 35 - 157 - 95
K.B. 2250

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Opeche Fm.

1231. Amerada Petrol. Corp. - Iverson-Nelson # 1
SW NE 2 - 155 - 96
K.B. 2316

Piper Fm.
Poe Mbr.
Dunham beds
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Minnakhta Fm.
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<td>NE NJ 36 - 155 - 96</td>
<td>2038</td>
<td>Piper Fm. 5668, Poe Mbr. 5735, Spearfish Fm. 6010, Saude Mbr. 6013, Pine Mbr. 6098, Belfield Mbr. 6098, Minnekahta Fm. 6098</td>
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<td>NE NE 28 - 154 - 95</td>
<td>1903</td>
<td>Piper Fm. 5460, Poe Mbr. 5536, Spearfish Fm. 5615, Saude Mbr. 5890, Pine Mbr. 5960, Belfield Mbr. 5960, Minnekahta Fm. 5960</td>
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<td>NE NE 9 - 154 - 96</td>
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<td>Piper Fm. 5502, Poe Mbr. 5502, Spearfish Fm. 5521, Saude Mbr. 5546, Pine Mbr. 5546, Belfield Mbr. 5910, Minnekahta Fm. 5972</td>
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<td>NE NE 9 - 157 - 95</td>
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<td>Piper Fm. 6140, Poe Mbr. 6221, Spearfish Fm. 6532, Saude Mbr. 6568</td>
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1745. Hunt Oil Co. - W. Odegaard # 1
C NW 21 - 157 - 95
K.B. 2361

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Cpeche Fm.

2122. Calvert Drilg. Inc. & N. Am. Royalties -
H. Hermanson # 1
NW NE 18 - 159 - 95
K.B. 2313

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Amsden Fm.

2182. Amerada Petrol. Corp. - Pederson-Cater # 1
NE SW 21 - 156 - 95
K.B. 2473

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Cpeche Fm.

2501. Hunt Oil Co. & Amerada Petrol Corp. -
H. Iverson # 1
SE SW 30 - 156 - 95
K.B. 2392

Piper Fm.
Poe Mbr.
Spearfish Fm.
Saude Mbr.
Pine Mbr.
Belfield Mbr.
Mimekahta Fm.
2824. Hunt Oil Co. - C. Price # 1
SW NW 29 - 159 - 103
K.B. 2042

Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

2828. Texaco Inc. - L.J. Hovde # 1
NW NW 16 - 154 - 96
K.B. 2233

Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Pine Mbr.
- Belfield Mbr.
- Minnekahta Fm.

2846. Hunt Oil Co. & Skelly Oil Co. - State of N.
Dak. # 1
NW NE 16 - 158 - 103
K.B. 2165

Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

2861. Dakota Salt & Chemical Co. - Fee # 1
SE SW 17 - 154 - 100
K.B. 1883

Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Pine Mbr.
- Belfield Mbr.
- Minnekahta Fm.
2933. Hunt Petrol. Corp. & Skelly Oil Co. -
H. A. Garaas # 1
NW SW 33 - 159 - 102
K.B. 2209

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

2959. W. H. Hunt - A. Strand # 1
SE SE 22 - 157 - 103
K.B. 2461

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

3043. James S. Wise - G. Emerson # 1
SE SE 27 - 159 - 102
K.B. 2777

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

3106. Hunt Petrol. Co. - Larson Estate # 1
SW SE 20 - 159 - 102
K.B. 2224

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.

3230. Hunt, Texaco & Skelly Oil Cos. - E. Beaver # 1
SW SE 10 - 159 - 102
K.B. 2272

- Piper Fm.
- Poe Mbr.
- Spearfish Fm.
- Saude Mbr.
- Amsden Fm.
3235. Sun Oil Co. - State # 1
NW NW 16 - 156 - 101
K.B. 2168

  Piper Fm.  6822
  Poe Mbr. 
  Spearfish Fm.  6885
  Saude Mbr. 
  Pine Mbr.  7212
  Speche Fm.  7308

3252. Hunt Oil Co. - A. S. Hoover et. al. # 1
NE NW 3 - 156 - 99
K.B. 2150

  Piper Fm.  6375
  Poe Mbr. 
  Spearfish Fm.  6451
  Saude Mbr. 
  Amsden Fm.  6766

3274. H. L. Hunt - G. T. Solem # 1
NW SE 2 - 159 - 98
K.B. 2306

  Piper Fm.  6320
  Poe Mbr. 
  Spearfish Fm.  6419
  Saude Mbr. 
  Amsden Fm.  6696

3363. Texaco Inc. - C. Pederson # 1
NW SE 19 - 157 - 96
K.B. 2332

  Piper Fm.  6346
  Poe Mbr. 
  Spearfish Fm.  6427
  Saude Mbr. 
  Pine Mbr.  6750
  Minnekahta Fm.  6762

3373. Hunt Petrol. Co. - Larson-Sabine et. al. # 1
SW SW 4 - 159 - 102
K.B. 2218

  Piper Fm.  6186
  Poe Mbr. 
  Spearfish Fm.  6259
  Saude Mbr. 
  Amsden Fm.  6407
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<td>Union Oil of Calif. - Gov't - Newton #1</td>
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Butte County, South Dakota

D-2. Shell Oil Co. - W. Johnson # 23 - 23
NE SW 23 - 10N - 2E
K.B. 3293

Spearfish Fm. 1963
G marker top 2397
Minnekahta Fm. 2633

D-3. Superior Oil Co. - Indian Creek # 1 - 33
SE SW 33 - 13N - 2E
K.B. 3239

Spearfish Fm.
Saude Mbr. 3708
G marker top 3995
Pine Mbr. 4053
Belfield Mbr. 4363
Minnekahta Fm. 4478

D-4. Amerada Petrol. Corp. - State # 1
NW NW 4 - 14N - 4E
K.B. 3028

Spearfish Fm.
Saude Mbr. 1278
G marker top 1458
Pine Mbr. 1503
Belfield Mbr. 1836
Minnekahta Fm. 1956

Harding County, South Dakota

D-5. Richfield Oil Corp. - State # A - 1
SE NW 16 - 17N - 4E
K.B. 3141

Piper Fm.
Poe Mbr. 4707
Spearfish Fm.
Saude Mbr. 4833
G marker top 4939
Pine Mbr. 4996
Belfield Mbr. 5209
Minnekahta Fm. 5408
D-6. Shell Oil Co. - Gov't. # 32 - 27  
SW NE 27 - 20W - 5E  
K.B. 2996

Piper Fm.  
Poe Mbr.  
Spearfish Fm.  
Sauve Mbr.  
G marker top  
Pine Mbr.  
Belfield Mbr.  
Minnekahta Fm.  

5367  
5226  
5497  
5531  
5576  
5763

Crook County, Wyoming

DE-1. Mobile Producing Co. - P. Helmer  
# F - 13 - 21  
NW SW 21 - 54N - 60W  
K.B. 3575

Spearfish Fm.  
G marker top  
Minnekahta Fm.  

536  
966  
1209

E-2. Hunt Oil Co. - Gov't. - Miller # 1  
NE NW 1/4 - 50N - 61W  
K.B. 3387

Spearfish Fm.  
G marker top  
Minnekahta Fm.  

1087  
1553  
1772
LEGEND

○ CONTROL WELL
400 THICKNESS IN FEET

CONTOUR INTERVAL — 100 FEET

ISOPACHOUS MAP
OF THE
SPEARFISH FORMATION

PLATE 3
LEGEND

○ CONTROL WELL
200 THICKNESS IN FEET
CONTOUR INTERVAL - 50 FEET

ISOPACHOUS MAP
OF THE
SAUDE MEMBER, SPEARFISH FORMATION

PLATE 4
LEGEND

○ CONTROL WELL
255 THICKNESS IN FEET

CONTOUR INTERVAL — 50 FEET

ISOPACHOUS MAP
OF THE
PINE SALT MEMBER, SPEARFISH FORMATION

PLATE 6
LEGEND

CONTROL WELL
ITS THICKNESS IN FEET

CONTOUR INTERVAL - 50 FEET

ISOPACHOUS MAP
OF THE
BELFIELD MEMBER, SPEARFISH FORMATION

PLATE 7
SOUTHERN HALF OF THE
NORTH-SOUTH CROSS SECTION
OF THE SPEARFISH FORMATION
IN WESTERN NORTH DAKOTA

PLATE 9
Wilson M. Laird, State Geologist

NORTHERN HALF OF THE NORTH-SOUTH CROSS SECTION OF THE SPEARFISH FORMATION IN WESTERN NORTH DAKOTA

PLATE 10
Wilson M. Laird, State Geologist

INVESTORS
SHAIDE NO. I
McKENZIE CO.
G.R.
L.L.

23 MILES
SPEARFISH FORMATION
NORTHERN EAST-WEST CROSS SECTION
OF THE SPEARFISH FORMATION
IN WESTERN NORTH DAKOTA
PLATE II

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SOUMHERI EAST-WEST CROSS SECTION
OF THE SPEARFISH FORMATION
IN WESTERN NORTH DAKOTA
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SPEARFISH FORMATION

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PLATE 14
Wilson M. Laird, State Geologist

NORTH DAKOTA GEOLOGICAL SURVEY

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BLACK HILLS—NORTH DAKOTA
CROSS SECTION OF THE
SPEARFISH FORMATION
THROUGH WYOMING & MONTANA
PLATE 16
PLATE 17—CROSS SECTION SHOWING EFFECT OF DUNHAM SALT SOLUTION ON OVERLYING ROCKS. FOR LOCATION SEE FIGURE 10.