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A mechanical well log study of the popular interval of the Mississippian Madison Formation in North Dakota

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A MECHANICAL WELL LOG STUDY OF THE POPLAR INTERVAL OF THE MISSISSIPPIAN MADISON FORMATION IN NORTH DAKOTA

by
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This Thesis submitted by C. W. Cook in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

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ABSTRACT

The Poplar interval of interbedded evaporites and carbonates forms the uppermost part of the Mississippian Madison Formation in western North Dakota. A detailed mechanical well log study of the Poplar interval in North Dakota was conducted to interpret the Poplar's regional geology and to attempt to locate areas with potential for petroleum production. Limestone, dolomite, anhydrite and salt were differentiated using mechanical well logs.

The complex facies of the Madison are subdivided into para-time rock units (the Poplar interval is one) on the basis of extensive thin anhydrite beds which are considered time-parallel.

The base of the Poplar interval is a wide-spread anhydrite unit. The top of the Poplar on the basin flanks is a thin anhydrite, whereas in the basin interior a thick massive salt overlying the thin anhydrite is considered to be the top. Salt deposits formed during periodic increases in the rate of basin subsidence account for most of the increase in thickness (176 feet on the basin flanks, to 687 feet in the central basin area) of the Poplar interval.

The anhydrites and salts of the Poplar interval were deposited in a saline environment caused by the restriction of a regressing sea. Periodic transgressions caused near normal marine conditions that resulted

in the deposition of carbonates. Some anhydrites that may have been deposited in sabkhas resulted in linear down dip trends of thicks and thins in gross anhydrite in the basin and a general increase in anhydrite from the basin center to the basin margins.

Except where influenced by the Nesson Anticline and other structures in Divide and Billings Counties the Poplar interval generally conforms to the Williston Basin. The Nesson Anticline and a small anticline named Divide High in Divide County were actively positive, although subdued in Poplar time. An anticline in Billings County appears to represent a post-Poplar event. Pre-Mesozoic erosion had little effect on the present day topography of the Poplar.

Poplar exploration should be carried out primarily as a search for anticlines similar to that in the East Poplar Field in Montana that produces oil from the Poplar interval. Stratigraphic traps should also be considered.

CHAPTER I

Introduction

Purpose

Since the discovery of petroleum in North Dakota in 1951, the most prolific producing formations have proven to be those within the Mississippian Madison Group. Carlson and Anderson (1965, p. 1841), in discussing Madison production, pointed out that the majority of this production is in northwestern North Dakota, primarily from structural traps along the Nesson Anticline and secondly from stratigraphic traps in the form of porosity pinch-outs caused by updip facies changes and abutment against the pre-Mesozoic unconformity.

The interbedded carbonates and anhydrites of the Popular interval of the Madison produce oil in the East Poplar Field in Montana and have long been considered to have good potential for petroleum reserves in North Dakota.

On the recommendation of Dr. Walter L. Moore, Professor of Geology at the University of North Dakota, I undertook a mechanical well log study of the Poplar interval in North Dakota. The result is a regional study of the Poplar in which the stratigraphy, structure and lithology along with the effects of erosional truncation have been

interpreted in an attempt to locate potential petroleum traps. A limited interpretation of the environments of deposition and its affect on petroleum accumulation has been made.

Location and Extent of Study Area

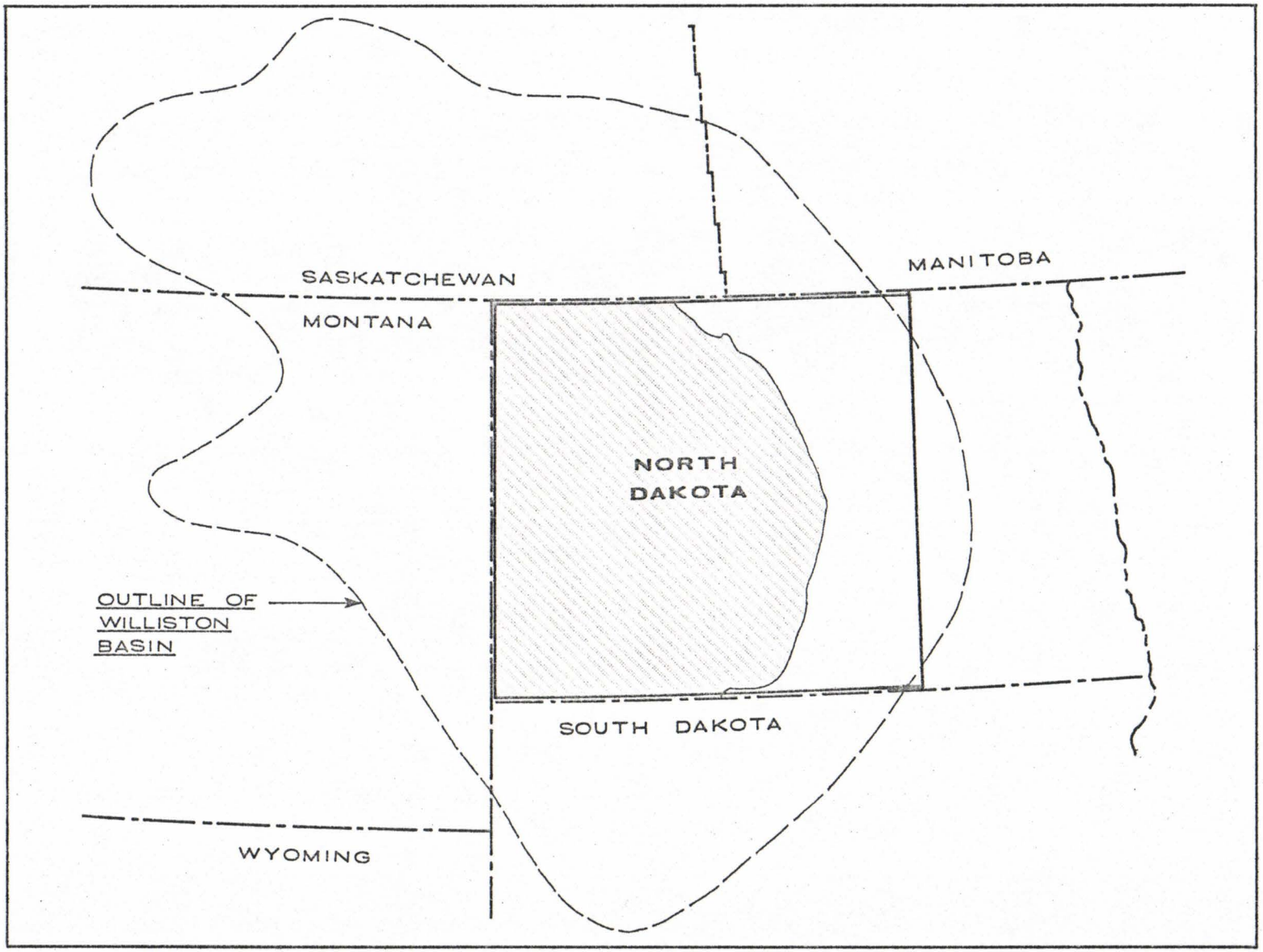
The Poplar interval within North Dakota is restricted to the Williston Basin, and the study area, which is approximately 210 miles long and 195 miles wide, is delineated by the Canadian border to the north, the Montana boundary to the west, the South Dakota boundary to the south, and the Ratcliffe interval subcrop to the east (Figure 1). The Ratcliffe interval lies conformably below the Poplar interval. The eastern edges of the Poplar and the Ratcliffe subcrops were controlled by pre-Jurassic erosional truncation. The Poplar subcrop below the unconformity occurs in Renville, McHenry, Sheridan, Wells, Kidder, Burleigh, Emmons and Sioux Counties (Plate 1).

Methods of Study

Mechanical logs of 281 wells penetrating the Poplar interval were examined and the resultant data are found in the Appendix.

When available, electric, gamma ray, and sonic logs were used supplemented by self potential, micro, caliper, neutron and formation density logs. Good log control permitted differentiation between limestone, dolomite, anhydrite and salt. This interpretation of lithologies is made without the benefit of core or drill samples. It is based on the physical properties of the rocks, recorded in the

Fig. 1. Map showing location of study area and occurrence of the Poplar interval in North Dakota. (Modified after Carlson and Anderson, 1965, p. 1834.)


SASKATCHEWAN
MANITOBA
MONTANA
NORTH
DAKOTA
OUTLINE OF
WILLISTON
BASIN
SOUTH DAKOTA
WYOMING

mechanical logs which were run in the wells.

Through discussions with Sidney B. Anderson, head of the subsurface division of the North Dakota Geological Survey, I established mechanical well log parameters for differentiating the salts, anhydrites, limestones and dolomites previously established from the literature as being the primary phases in the interval. Dolomites could not be differentiated from silts and shales. Dolomites as interpreted from the logs were considered to range from very organic-rich dolomites to very argillaceous, silty dolomites.

Figure 2 shows a gamma ray log, sonic log (interval transit time), spontaneous potential log, and induction electrical log (resistivity - conductivity) along with the lithology of the Poplar interval which was interpreted from them. Any phase with a resistivity greater than 75 ohms-m^2/m, an interval transit time less than 52 microseconds per foot and a gamma radiation of 16 API units or less was considered to be anhydrite. Phases with a gamma radiation in excess of 32 API units, which corresponded to a transit time of 61 microseconds per foot or greater and a resistivity of 8 ohms-m^2/m were considered to be dolomites. Phases with properties intermediate to those of anhydrite and dolomite as indicated by the logs were considered to be limestone.

Porous and clean limestone was interpreted from low resistivity, low gamma ray, and slow transit time readings on the logs, whereas argillaceous and dense limestone was interpreted from high gamma ray

Fig. 2. Diagram showing typical well logs of the Poplar interval, and the lithology which has been interpreted from them.

NDGS 3540

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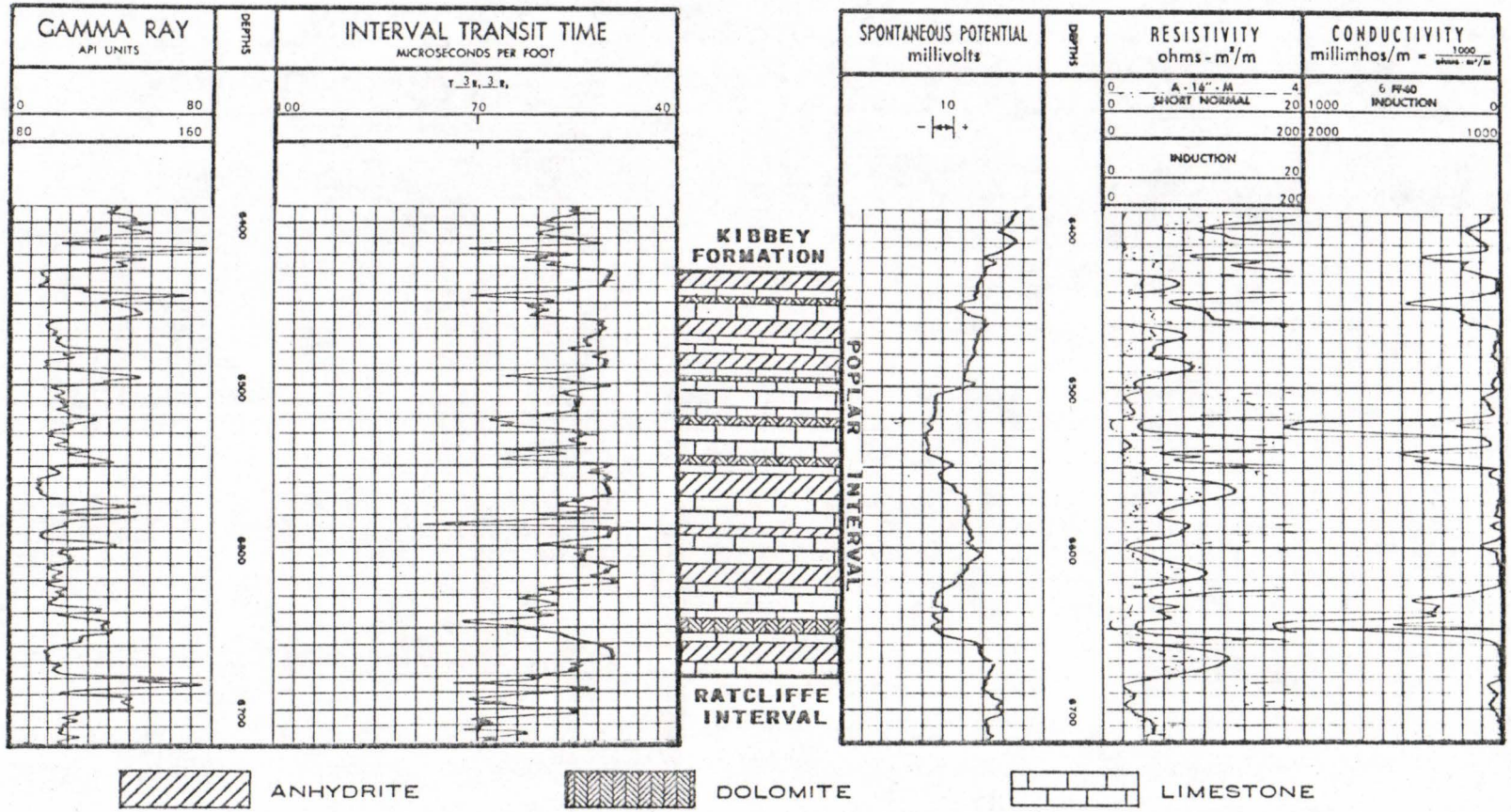
KB 2259



and fast transit time readings. Salt is not represented in Figure 5 but where present it was easily recognized because salt has slow transit times (approximately 70 microseconds per foot) and the caliper log indicated washed-out intervals.

Five cross sections (Plates 5-9) using the top of the Poplar interval as datum were constructed to show the stratigraphy of the unit throughout the basin.

A structure contour map (Plate 1) was constructed on the top of the Poplar interval to determine the strike and dip and general form of the interval within the basin. This map was also used to locate any anomalous features that may be potential structural traps for hydrocarbons. Two isochore maps were made, one of the total Poplar interval (Plate 2) and one of the total salt in the interval (Plate 3). These maps were used to determine if there are any anomalously thick or thin parts of the interval which may suggest carbonate buildups, stratigraphic pinch-outs, or erosional truncations, which could result in hydrocarbon reservoirs. A map showing the ratio of anhydrite to carbonate in the interval (Plate 4) was made to show concentrations of anhydrite and carbonate. Because the carbonate is potentially porous and the anhydrite nonporous, this map shows where areas of potentially high porosity are most likely to pinch-out in the zones of low porosity.

Previous Work

The upper Mississippian intervals have received considerable attention in the past but most of it has been applied to the more prolific producing zones such as Midale and Frobisher limestones.

Fuller (1956a, p. 32), in discussing the Charles facies, described the gross stratigraphy and lithology of the Poplar beds in Saskatchewan. Beekly (1956, p. 61-65) discussed the stratigraphy, structure, lithology and type of porosity in the reservoir beds in the East Poplar Field in Montana. Anderson (1958) discussed the lithology and stratigraphy of the Charles Formation in northwestern North Dakota, and on several geologic cross sections of the Mississippian section in northwestern North Dakota, demonstrated the facies relationships and the stratigraphy of the Poplar interval. The Special Studies Committee of the Billings Geological Society (1964, p. 105-108) has described lithology and depositional environments of the Charles Formation in northeastern Montana. Moore (1964, p. 263-265) discussed the limestone, dolomite and anhydrite phases of the Mission Canyon facies and how they can be differentiated on mechanical well logs.

CHAPTER II

Stratigraphy

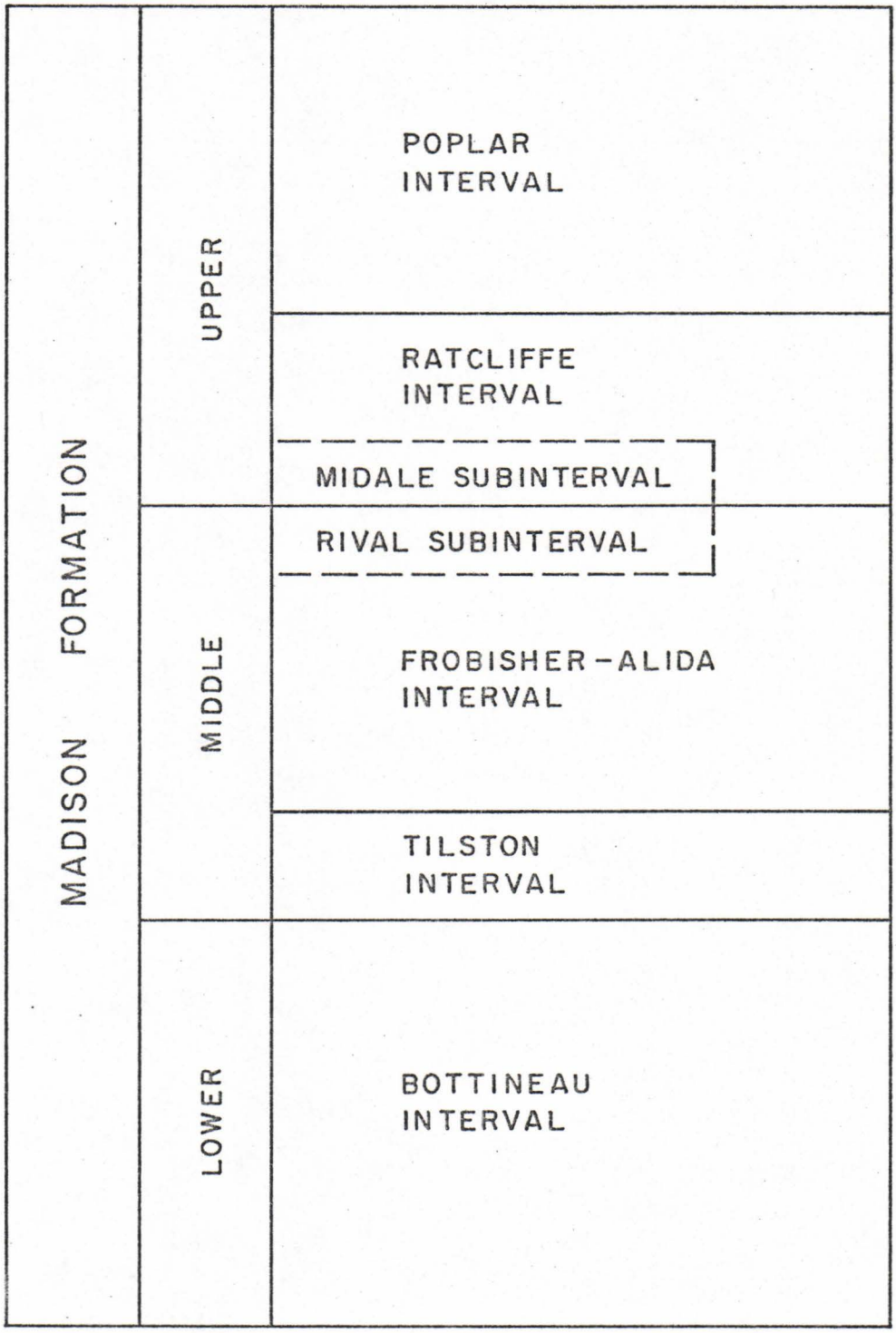
General Stratigraphic Correlations

In North Dakota the Poplar interval is considered to be the series of interbedded salts, anhydrites, carbonates and occasional thin clastic tongues which make up the upper part of the Madison Formation (Carlson and Anderson, 1965, p. 1840-1841) (Figure 3).

The terminology for Mississippian rocks used in the Williston Basin today is a combination of the original terminology applied to exposed strata in Montana and the terminology which has evolved as more and more information from the subsurface has been gathered from the numerous wells drilled in Williston Basin.

Peale (1893, p. 33) applied the term "Madison limestone" to a series of Lower Carboniferous limestones exposed near Three Forks Montana. The Madison was later elevated to the rank of group when it was subdivided by Collier and Cathcart (1922, p. 173) into two formations, the Lodgepole and Mission Canyon. The lower of the two, the Lodgepole, was named for 800 feet of thin-bedded limestone in Lodgepole Canyon. The upper formation consisted of 500 feet of thick-bedded limestone, and was named for the Mission Canyon where it was

Fig. 3. Chart showing subdivision of the Madison Formation into units, intervals and subintervals. (Modified after Carlson and Anderson 1966, p. 5).


MADISON FORMATION
UPPER
MIDDLE
LOWER
POPLAR INTERVAL
RATCLIFFE INTERVAL
MIDALE SUBINTERVAL
RIVAL SUBINTERVAL
FROBISHER-ALIDA INTERVAL
TILSTON INTERVAL
BOTTINEAU INTERVAL

described. Both of these type sections are located in the Little Rocky Mountains of Montana.

Subsurface terminology was first introduced by Seager (1942, p. 864) when he applied the term "Charles Formation" to some evaporites he logged in the California Company Charles No. 4 well in eastern Montana. Seager was uncertain whether the Charles should be included in the Madison Group below or the Big Snowy Group above. Ultimately he included it as the basal formation of the Big Snowy Group. This nomenclature was accepted until 1951 when the Charles was transferred to the Madison Group. The increased amount of subsurface information, combined with studies of exposures of the Madison in southwestern Montana, indicated that the Charles Formation was genetically related to the Madison (Sloss and Moritz, 1951, p. 2157).

With the added information from increased drilling throughout the Williston Basin, geologists became aware of the complex facies relationships of the Madison. Porter (1955, p. 128) recognized that the Charles, Mission Canyon and Lodgepole interfingered and exhibited both lateral and vertical facies relationships. In trying to correlate these subsurface facies geologists found that the terminology as applied at the surface was inadequate.

Fuller (1956a, p. 32), in discussing the Mississippian rocks in southeastern Saskatchewan, pointed out that the Charles Formation could be defined to include all the evaporite beds intertonguing with the Madison limestone along the margin of the basin as well as the

beds overlying the continuous limestone within the central basin area, but he felt the result would lack utility. Fuller presented a second alternative which could be to pick some well defined, basin wide, bed as the base or lower limit of the formation, but felt that this would leave the undesirable situation of massive evaporites on the basin flank within a sequence clearly defined as Madison or Mission Canyon limestone. Fuller (1956b, p. 26) overcame these problems by using mechanical log markers for subdividing the horizons of the Madison. He believed that the thin anhydrite beds which were uniform over large areas were time parallel units, and consequently divided the Madison into para-time rock units (Figure 4).

This concept was accepted by both the Saskatchewan Geological Society and the North Dakota Geological Survey. Since the marker horizons used in Saskatchewan were not suitable for basin wide correlations in North Dakota a new definition of Madison stratigraphy was established by the North Dakota Geological Survey. Smith (1960, p. 959), who chaired the committee to redefine the Saskatchewan terminology, used two good basin wide marker horizons to subdivide the Madison in North Dakota. Of the changes Smith made, one was to redefine the Poplar, Ratcliffe and Frobisher-Alida Units. As the Stratigraphic Code does not recognize para-time rock units, a second change by the committee was to refer to the units as intervals (Figure 5).

Carlson and Anderson (1965, p. 1840) pointed out that although the terms Charles, Mission Canyon and Lodgepole are within the limits

Fig. 4. Diagram illustrating the relationship between para-time rock units and facies units of the Madison Formation. (Modified after Carlson and Anderson, 1965, p. 1842.)

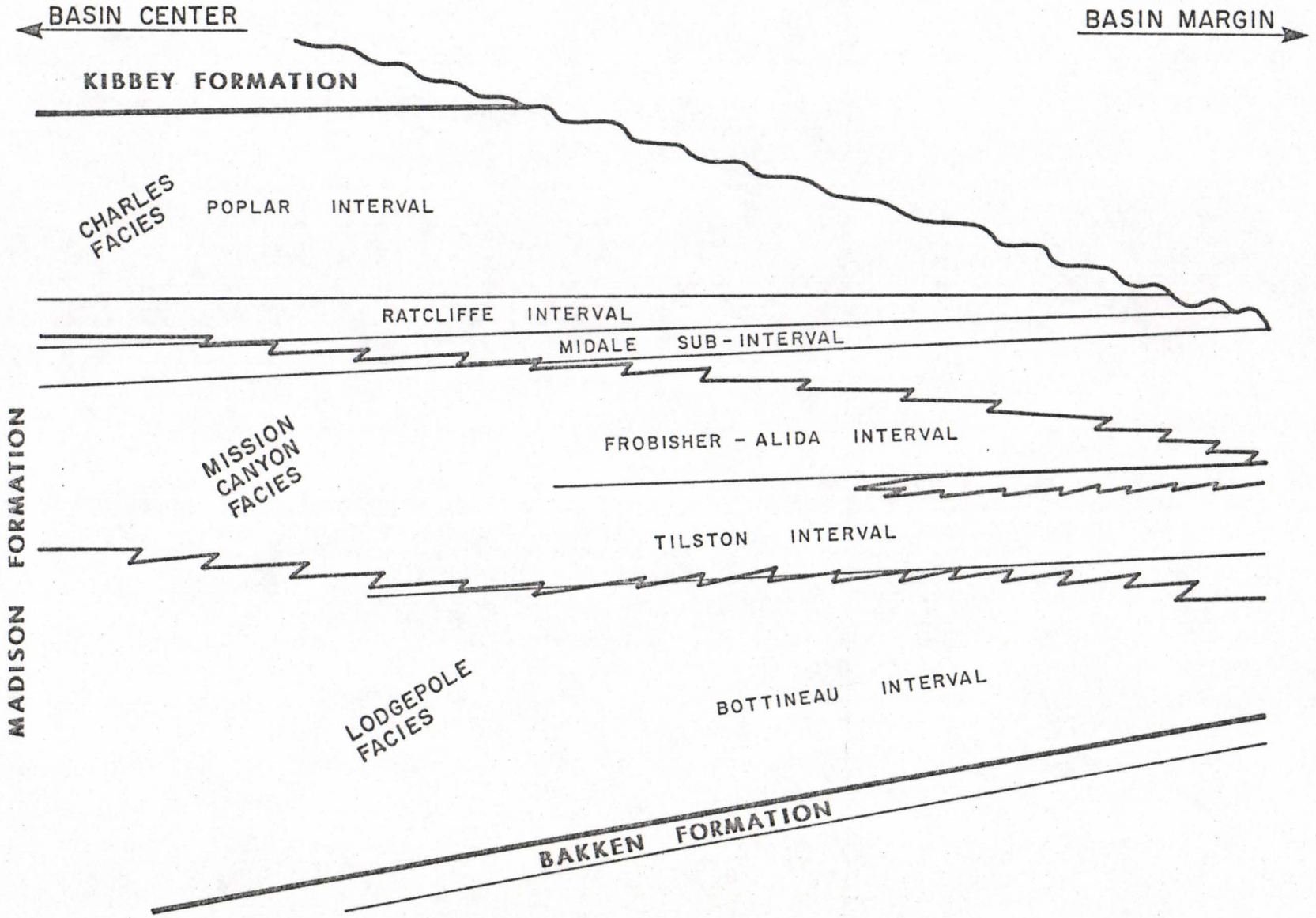
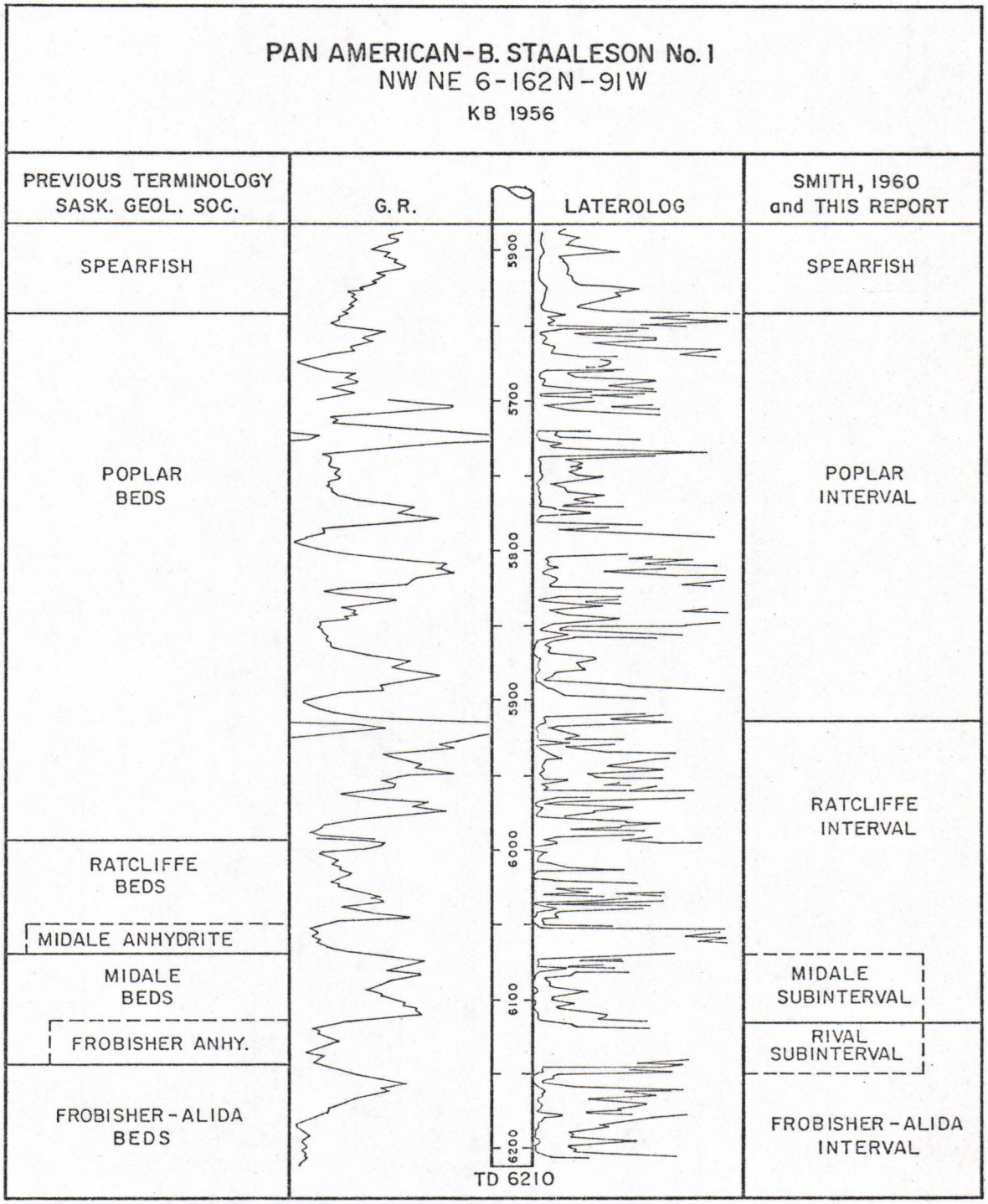

BASIN CENTER
BASIN MARGIN
KIBBEY FORMATION
CHARLES FACIES
POPLAR INTERVAL
RATCLIFFE INTERVAL
MIDALE SUB-INTERVAL
MISSION CANYON FACIES
FROBISHER - ALIDA INTERVAL
TILSTON INTERVAL
MADISON FORMATION
LODGEPOLE FACIES
BOTTINEAU INTERVAL
BAKKEN FORMATION

Fig. 5. A well log showing the log characteristics of the two good marker horizons (base of the Poplar interval and base of the Ratcliffe interval) used for the subdivision of the Madison Formation in North Dakota as well as a comparison of the redefined intervals with the previously used Saskatchewan terminology. (With permission from Anderson and others, 1960, p. 4.)

STRATIGRAPHIC SECTION



of the definition of formations, it is more convenient to refer to them as facies within the Madison, and that the Madison should be considered a formation. In ascending order the intervals of the Madison Formation are Bottineau, Tilston, Frobisher-Alida, Ratcliffe, and Poplar.

The North Dakota Geological Survey now recognizes the Poplar interval as the sequence of rocks lying conformably between the Ratcliffe interval beneath and the Kibbey Formation above except where the Poplar has been truncated by Mississippian and pre-Jurassic erosion. The Poplar subcrop is overlain by Mississippian Heath and Otter Formations from the southwest half of Sheridan County to the South Dakota border, whereas from the northeast half of Sheridan County north to the Canadian border the Poplar subcrop is overlain by the Juro-Triassic Spearfish Formation (Anderson and Mendoza, 1960).

The Ratcliffe is an interval of interbedded carbonates and evaporites, similar to the Poplar interval except that there is little salt in the Ratcliffe.

The Kibbey, Otter, Heath and Spearfish Formations for the most part consist of clastics that are predominately shale with minor fractions of silts and sands.

Detailed Stratigraphy

Excluding the structurally anomalous thick in south-central McKenzie County, and the thin, eroded subcrop area, the Poplar interval is thinnest (176 feet) in northeast McLean County (Plate 2) and thickens

toward the basin center where it reaches 687 feet.

The stratigraphic sections (Plates 5 through 9) show a varied and complex stratigraphy within the interval, but close examination of the sections reveals some consistency and rhythm in the strata.

A striking feature of the interval is the extensiveness of some of the anhydrites which can be correlated great distances across the basin. There are two types of anhydrites, marginal anhydrites which occur in the basin flanks and wedge out toward the center of the basin, and basin anhydrites which may but do not always extend across most or all of the entire study area. This distribution suggests that the former may have been deposited in sabkhas, whereas the latter probably were submarine deposits. The genesis of the two types will be elaborated on under Depositional Environments.

Two of the basin anhydrites which occur throughout the study area are labeled A-1 and A-2 on the cross sections. A-1, the lowermost anhydrite is used to pick the base of the Poplar interval, because it is easily recognized on logs throughout the basin. However, a thin limestone sometimes separates it from the Ratcliffe interval below.

A-2, a thicker anhydrite unit, generally divides the Poplar interval in half, except in the central basin area where the upper Poplar is much thicker due to the presence of thick salt at the top of the interval. A thick limestone unit overlies each of the anhydrites and each limestone is overlain in turn, by an apparently randomly inter-

bedded sequence of limestones anhydrites and in the central basin area salts.

The beds of primary dolomite, scattered throughout the interval, are highly organic and argillaceous and in some cases may be predominantly silty shales. Unfortunately, it was not possible to differentiate between organic-rich dolomites and shales with mechanical logs.

The thin dolomites commonly overlie anhydrite beds but this cannot be considered a rule. They occur with no obvious pattern throughout the limestone phase, and consequently are not differentiated from the limestone beds in the description of the stratigraphy which follows.

The lower sequence of limestones, anhydrites and salts between A-1 and A-2 gradually thickens from an average of 90 feet on the basin margin to approximately 150 feet in the basin center. The first 50 feet of this unit is limestone, with the exception of the southwest part of the basin where the limestone is interbedded with thin, marginal anhydrites. As a rule this limestone increases in porosity and to some extent shaliness from the central basin to the margins. The porosity tends to increase from the bottom of the bed upwards.

The second, 50 to 100 feet of the unit consists of interbedded limestone, anhydrite and salt, including two basin anhydrites. The first is limited to the central and northern portion of the basin and consequently is seen only on sections AA' and BB' (Plates 5 and 6). The second anhydrite was the last anhydrite deposited before A-2. It

is more extensive, occurring throughout most of the study area with the exception of the extreme west-central area along the Montana border (Section BB', Plate 6).

Several marginal anhydrites occur in the 50 feet below A-2. On cross sections paralleling strike such as CC' and the south portion of DD' (Plates 7 and 8 respectively) marginal anhydrites commonly appear as individual lobes with little lateral extent. For example, marginal anhydrites in wells 1807 and 4400 have little lateral extent in cross section CC' (parallel to strike) yet extend for up to 10 miles down dip in cross section BB'.

Two salt beds occur in the sequence below A-2. The first lies within the limestone between the two anhydrites and is only 10 to 15 feet thick. It is restricted to the very central portion of the basin and consequently appears only on section BB' (Plate 6). The second salt, immediately above the second anhydrite (Section BB', Plate 6), reaches a maximum thickness of approximately 30 feet in the central basin area. This salt extends much farther than the other to the north, south and east, but as with the anhydrite it overlies, it does not extend very far to the west (Sections AA', BB' and EE', Plates 5, 6 and 9).

Directly above A-2 another extensive unit consists of a thick limestone bed and a salt bed which are separated in places by a discontinuous anhydrite bed. The limestone gradually thins from approximately 75 feet in the central basin to approximately 60 feet on the

north and northeast margins and roughly 45 feet on the south and southeast margins. This limestone is similar to the one discussed in the sequence below A-2 in that porosity and shaliness appear to increase towards the margins with some pronounced exceptions as in well 2892 (Section BB') in which the limestone appears quite tight. A few marginal anhydrites in this limestone can be seen on Sections CC' and DD'.

The overlying salt in the sequence immediately above A-2 is the most extensive salt in the Poplar interval. Its lateral extent can be seen as the 0-foot line on the Total Salt Isochore Map (Plate 3). It has a maximum thickness of approximately 60 feet in the central basin and thins gradually to 0 feet in the marginal area (Sections BB' and EE', Plates 6 and 9). Where the extensive salt bed thins to zero feet the underlying limestone merges with the limestones and anhydrites above and the unit can no longer be distinguished (for example, see Section BB', Plate 6).

In the central basin area, immediately above the extensive salt bed a 135-foot sequence of thinly interbedded limestones, anhydrites and salts occurs (Sections AA', BB' and EE'). It is also evident from these three sections that the top of this sequence correlates with the top of the Poplar on the basin flanks.

On the basin flanks the extensive salt bed described earlier is overlain by a limestone unit which thins from a maximum of 60 feet at the edge of central basin to roughly 40 feet on the eastern margin

(Section BB') and down to 10 feet on the southeast and southern margins (Sections EE' and DD'). This limestone is overlain by a 10-foot anhydrite bed which is the top of the Poplar interval on the basin flanks.

Near the edge of the central basin the upper limestone and anhydrite cap changes facies into the previously discussed, thinly-bedded sequence of limestone, anhydrite and salt (Sections BB' and EE'). Where the facies change occurs, the dip of all the beds discussed in the Poplar interval so far increases into the basin center (Sections AA', BB' and EE'). The dip seen on the cross sections is apparent. The structure contour map (Plate 1) shows that the top of the Poplar actually has a substantial dip into the basin center and hence the dip of the beds is actually greater than is apparent in the cross sections. The hinge line where the thinly-bedded sequence increases in dip into the basin center coincides with the zero edge of an overlying massive salt bed which thickens to over 170 feet in the central basin area. This salt is capped in places by a minor limestone bed (Sections AA' and BB'). Although this salt is the uppermost unit of the Poplar interval in the central area it is younger than the anhydrite at the top of the Poplar interval on the basin flanks, because it overlies the anhydrite's equivalent in the basin center.

It is noteworthy that the change in dip of the beds corresponds to an abrupt increase in total Poplar thickness towards the center of the basin (Plate 2).

This change also corresponds to an abrupt increase in salt thickness (Plate 3) towards the basin center. On the basin flank the beds below the extensive salt have an increased dip to accomodate the salt as it thickens towards the basin (Section BB, Plate 6). The same is true of the beds beneath the salts in the sequence below A-2.

All the salt beds thicken towards the basin center whereas there is little variation in the total carbonate and anhydrite thickness throughout the basin. This is born out by the two isochore maps (Plates 2 and 3). On Plate 2 the Poplar interval can be seen to thicken gradually from roughly 200 feet at the subcrop to approximately 275 feet where the first salt occurs, and then it thickens abruptly to 687 feet in the basin center, an increase of 412 feet. On the Total Salt Isochore (Plate 3) the salt increases from 0 feet to 367 feet in the same distance. The salt was responsible for all but 45 feet of the total increase.

Apparently the central basin periodically subsided more rapidly than the basin flanks and when it did salt was deposited. Generally the deposition of salt kept pace with subsidence as the tops of the salt beds in each case are flat relative to their bases. This is most evident with the last thick salt where the top of the salt is level with the top anhydrite bed on the basin flank.

CHAPTER III

Lithology

General Lithology

In order to interpret lithologies from mechanical logs some prior knowledge must be gained of the range of lithologies to be expected. A search of the literature produced no descriptions specifically of the Poplar, probably because the Poplar does not outcrop and very few cores have been cut during drilling operations. However, a number of authors described the general lithology of Mississippian rocks of the Williston Basin, and the Charles facies, which generally includes the Poplar interval, has been described in general. Descriptions of the Charles facies can be applied with discretion to the Poplar.

Fuller (1956a, p. 32) described the Charles Formation of southern Saskatchewan as consisting of iron oxide-rich silty anhydritic mudstones, dolomitized limestones, argillaceous and organic dolomites, and massive anhydrite. He thought the mudstones were equivalents of the massive salts in North Dakota and Montana, suggesting the salts had been removed by ground-water solution.

Beekly (1956, p. 62) described the Charles Formation in the East

Poplar Field of Montana as consisting of 41 per cent limestone, 27 per cent anhydrite, 27 per cent dolomite, 3 per cent salt, and 2 per cent shale. He indicated that the low percentage of salt was a local anomalous condition unique to the East Poplar Field. In the general area of the field normally over 100 feet of salt and occasionally up to 280 feet are present.

The Special Studies Committee of the Billings Geological Society (1964, p. 105-107) discussed the Charles rocks in eastern Montana in more detail, discriminating between argillaceous limestones deposited in deep water which may be dolomitized, and reefoid limestones deposited in patch reefs in shallow water. The Committee indicated that the upper Charles facies were deposited in a more restricted environment and described the limestones of this type as dense and argillaceous with few fossils. The dolomites are of two types, primary dolomites which are argillaceous and in part silty, and secondary dolomites which result from the dolomitization of limestone. The anhydrites range from pure to very argillaceous. The Commitee described the formation as having salt deposits which may be interbedded with shales and siltstones.

Moore (1964, p. 263-264) described limestone, dolomite and anhydrite phases of the Ratcliffe and Frobisher-Alida intervals. Although the strata he described are below the Poplar interval the general sequence of interbedded carbonates and anhydrites is similar to that on the margins of the Poplar interval. The environments of deposition

of the Ratcliffe were probably similar to those of the Poplar at times, and consequently similar lithologies probably exist in both intervals.

Moore (1964) described the limestones as being highly variable, highly indurated, fossilized, and at times secondarily dolomitized. The dolomite phase he described as consisting of subhedral grains of dolomite in a finer-grained dolomite matrix. It is generally weakly indurated, soft and friable. Significantly, he described it as having minor amounts of organic material as opposed to the higly organic dolomite described by Fuller (1956a) in Saskatchewan.

Moore described a bimodal anhydrite phase. One mode is a mixture of fine anhydrite and dolomite grains and the other a contorted, interlaminated sequence of thin, fine-grained dolomite stringers and relatively coarser-grained anhydrite stringers.

For the purpose of interpreting lithologies from the mechanical logs it is assumed, on the basis of the above references, that the Poplar interval consists primarily of limestone, dolomite, anhydrite, and salt. The criteria for differentiating these lithologies using the mechanical logs is discussed under Methods of Study.

Lithologic Variations

The ratio of total anhydrite to total carbonate in the Poplar interval was determined for all wells in which the Poplar lithology was interpreted, and an anhydrite/carbonate ratio map (Plate 4) was constructed. The map shows linear trends of anhydrite-rich areas and

anhydrite-poor areas. The areas of high anhydrite/carbonate ratios generally correspond to the presence of marginal anhydrites. This variation in lithology will be further discussed in the following chapter on depositional environments.

Salt is the dominant lithology in the central basin area but is minor in the basin flanks and absent in the basin margins.

There is a general increase in anhydrite from the central basin area towards the basin margins that corresponds to a decrease in carbonates towards the margins.

CHAPTER IV

Depositional Environments

To fully understand the depositional environments one should have a detailed knowledge of the lithology and paleontology of the area he is dealing with. As my understanding of the Poplar lithology is gathered from a gross application of general rock types to mechanical well logs, my interpretation of environments must be grossly generalized. As the Poplar interval consists of interbedded carbonates and anhydrites capped with a thick salt in the central basin area it is assumed to have been deposited in a sea which was generally regressing. The cyclical deposits of carbonate and evaporites indicate that regression was interrupted with many transgressive surges.

The Poplar interval is the final stage of a normal marine carbonate and evaporite cycle deposited in the Williston basin during Madison time.

Sandberg (1964, p. 38) suggested that the Williston basin of Mississippian time was flooded from the west by a sea that transgressed from the Cordilleran Geosyncline eastward through a trough in the position of the eroded Central Montana Uplift. According to the

Special Studies Committee (1964, p. 105) the first shallow waters of the transgression deposited argillaceous and sparsely fossiliferous limestone of the Lodgepole facies, which was followed by a deeper, normal marine sea that deposited the fossiliferous limestones of the Mission Canyon facies.

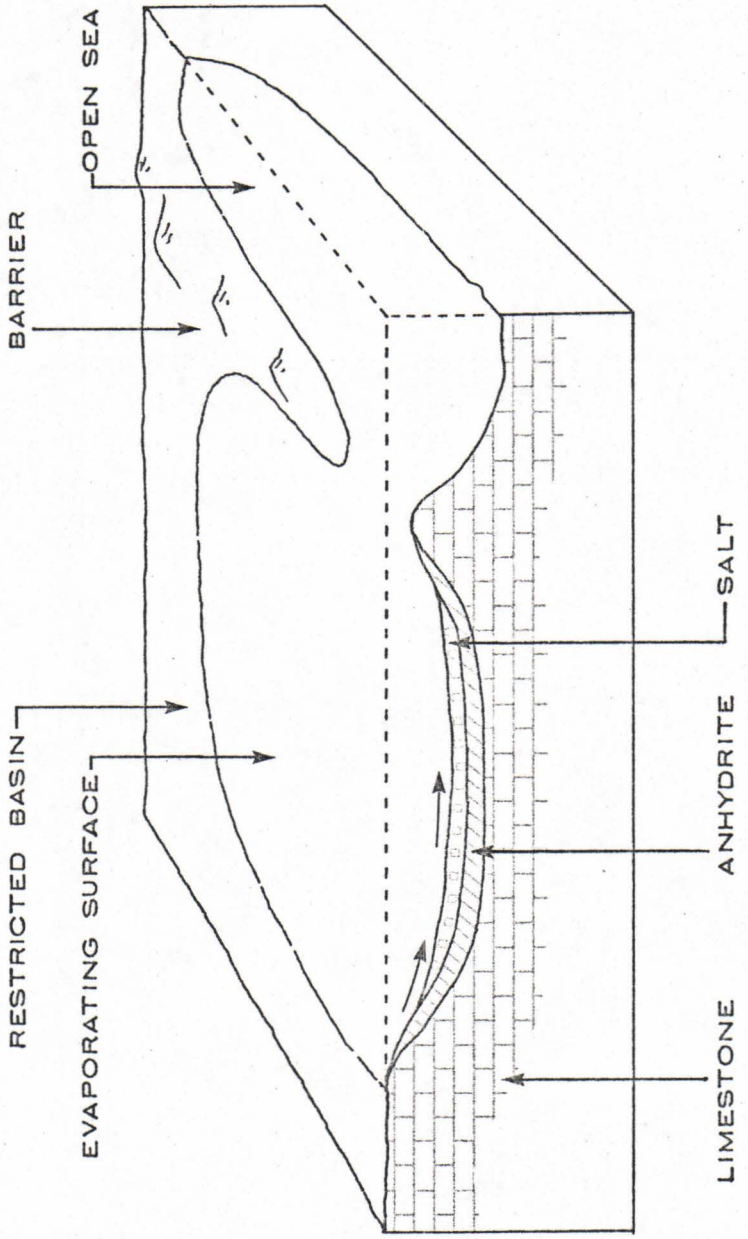
The Committee stated that a progressive restriction of the sea over wide areas during Charles time was caused by shallow tectonic and/or organic topography such as reefs. The organic deposits of the initial Charles facies were interrupted by saline cycles that the Committee believed were created by distant sills.

The saline cycles resulted in the deposition of the anhydrite and salts of the Poplar interval. The carbonates of the Poplar were deposited during interruptions of the saline cycles by marine transgressions that resulted in nearly normal marine environments.

The basin anhydrites described in the section on stratigraphy are no doubt evaporites that resulted from restrictive conditions imposed by barriers. Because these anhydrites are so widespread and uniform, the Special Studies Committee believed the restrictive barriers were remote from a local area. The Committee also referred to some localized evaporites that were thought to have developed on the sill area. These are the marginal anhydrites, discussed under stratigraphy, which I suspect were deposited in sabkhas.

Sloss (1966, p. 30) used the Briggs model (Figure 6) as one explanation for the deposition of thick basin evaporites. In that

Fig. 6. Diagram showing a restricted basin that could precipitate thick evaporite sequences. (Modified after Sloss, 1966, p. 30.)


OPEN SEA
BARRIER
RESTRICTED BASIN
EVAPORATING SURFACE
SALT
ANHYDRITE
LIMESTONE

model, normal sea water fed into a shallow basin isolated from the open sea by a sill or bar, undergoes intense evaporation. The concentrated brines that result around the basin margins become more dense and sink to the basin floor. If the concentration reaches 3 1/3 times normal sea water gypsum will precipitate. The gypsum will invert to anhydrite when buried to a depth of 500 feet or 2000-3000 feet depending on whether water can escape. The important feature of this model is that the dense concentrated brine solution liberated of gypsum flows back to the open sea either by refluxing through the barrier or through stratified flow across the barrier (dense brine flows out below normal sea water flowing in). By removing the gypsum-depleted brine more normal marine water is allowed into the basin and a current is set up that allows continuous deposition of anhydrite on the basin floor. If the brine solution cannot flow or reflux back to the open sea the brine concentration increases and salt is precipitated.

Sloss (1966, p. 24) also related the deposition of different facies to the rate of subsidence of the basin; and he believed that salt is deposited during a high rate of subsidence but did not indicate why. As noted in the discussion on stratigraphy, this idea appears to comply with the deposition of the Poplar salts. Perhaps periodic, rapid subsidence in the basin center in Poplar time elevated the barrier to the point that concentrated brines could no longer flow back to the open sea. However, if the barrier was still in the same position relative to the open sea, normal sea water could still flow

into the basin to replace water losses resulting from constant evaporation. The process, if prolonged, would result in thick salt deposits.

Sloss (1966, p. 31) differentiated between basin interior anhydrites (dark and micro- to crypto-crystalline) and basin margin anhydrites, light colored, dolomitic, nodular, and granular or bladed. He pointed out that marginal anhydrites can originate in a sabkha.

In this study sabkhas represent wide, flat, coastal areas, such as those along the Persian Gulf described by Illing (1966, p. 11-17), where high evaporation rates can result in the precipitation of evaporites. When referring to the genesis of anhydrites, I refer to those deposited in sabkhas as sabkha anhydrites. Those deposited in submarine conditions, I refer to as basin anhydrites.

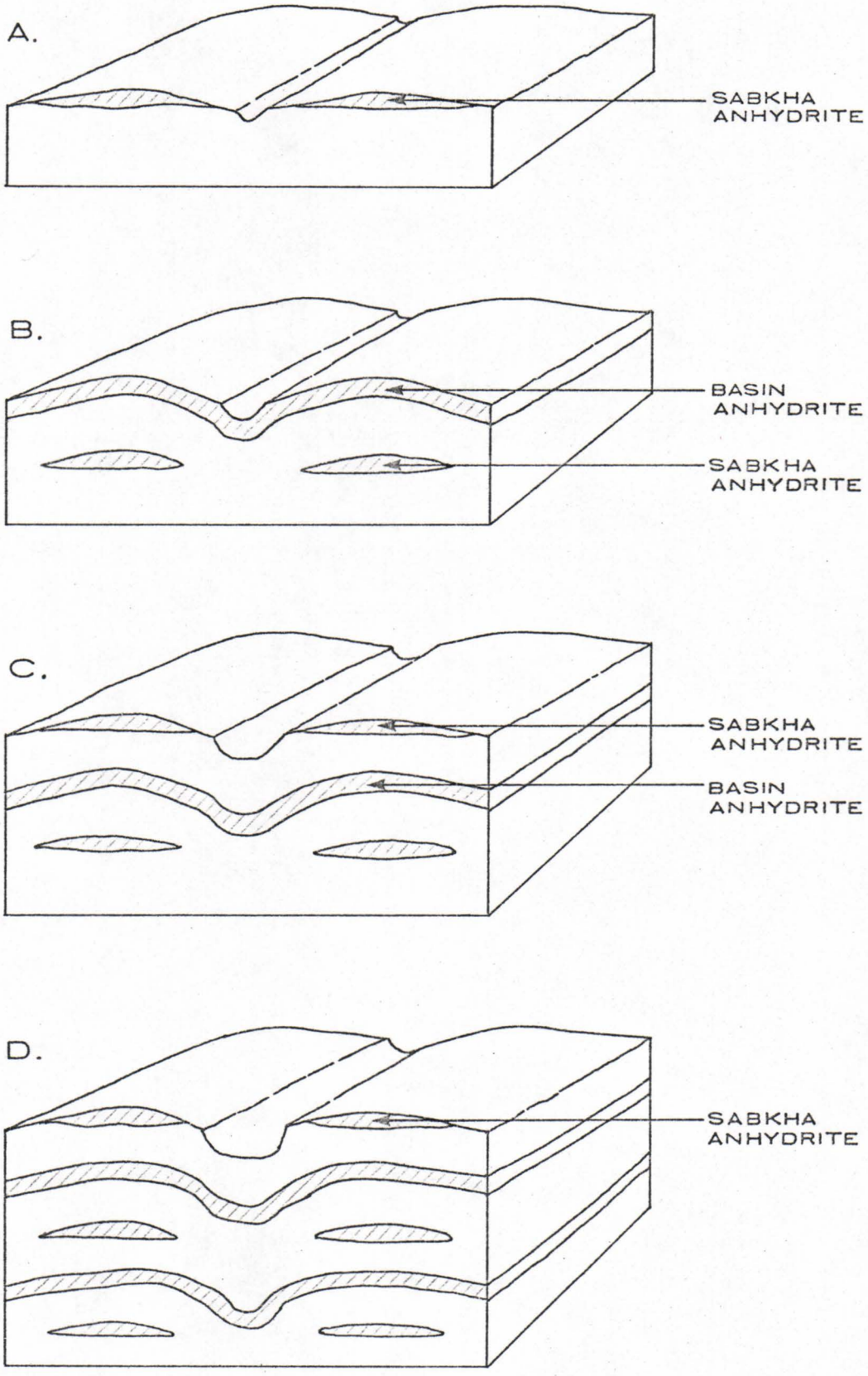
As noted in the discussion on stratigraphy, marginal anhydrites are extensive down dip (Plates 5, 6 and 9) but discontinuous along strike (Plates 7 and 8). This results in linear, down-dip trends of thicks and thins in gross anhydrite in the interval, which are shown on the Anhydrite/Carbonate Ratio Map (Plate 4). Assuming the marginal anhydrites were deposited in sabhkas, it is possible to explain the variations in the anhydrite/carbonate ratio in the Poplar interval.

Assuming there were minor topographic highs and lows on the supratidal flats of the basin margins and conditions were right for the development of sabkhas, anhydrites would have been precipitated on the highs, in the capillary zone above the water-table (Illing, 1966). Drainage present, either from storm waves or continental drainage, would

have followed the lows (Figure 7A).

A drainage pattern would have been established that would have maintained the low areas. When the area was flooded by marine transgression and limestones and basin anhydrites were deposited, they would have draped over the highs and sagged into the lows preserving the previously established topography (Figure 7B). When the sea regressed and conditions were reestablished which were favorable for the development of sabkhas, deposition and drainage would have been on and in the preserved highs and lows (Figure 7C). In this way the sabkha anhydrites were successively deposited in the same geographic locations causing anhydrite-rich and anhydrite-poor areas (Figure 7D and Plate 4).

Fig. 7. Diagrams illustrating anhydrite deposition which would lead to the variations in the ratio of anhydrite to carbonates in the Poplar interval.


A.
SABKHA ANHYDRITE
B.
BASIN ANHYDRITE
SABKHA ANHYDRITE
C.
SABKHA ANHYDRITE
BASIN ANHYDRITE
D.
SABKHA ANHYDRITE

CHAPTER V

Structure

Configuration of the Top of the Poplar Interval

The structure of the Poplar interval in North Dakota generally reflects the shape of the Williston Basin except where it has been influenced by the Nesson Anticline and lesser anticlines (Plate 1).

The center of the Poplar basin is in central McKenzie County. Excluding a down-faulted block about 12 miles west of the basin axis, the lowest recorded Poplar top in the study area is 6589 feet below sea level (well 2849, T 152 N, R 99 W, Plate 1). This general area apparently was the basin center during Poplar time, as the Poplar reaches its maximum thickness there (687 feet in well 2828, T 154 N, R 98 W, Plate 2), if a structurally anomalous thickness in T 148 N, R 101 W is excluded.

The highest recorded Poplar in the North Dakota portion of the basin, excluding the subcrop area, is 2411 feet below sea level in northeast McLean County (well 3076, T 150 N, R 79 W, Plate 1). The maximum relief in the study area, discounting the structurally anomalous well 4062, is 4178 feet.

The north-south trending axis of the basin extends from north-

central Divide County southward to the eastern part of Bowman County (Plate 1).

The northern, eastern, and southern flanks of the Poplar basin occur largely within the study area, whereas the western flank lies essentially beyond the study area. The flanks studied dip fairly uniformly toward the basin center. The dip that is 40 feet per mile on the south flank changes gradually to 47 feet per mile on the east flank, and to 56 feet per mile on the northeast. The north flank, which is interrupted by the Nesson Anticline, dips about 47 feet per mile. In all cases the dip flattens fairly aburptly to about 13 feet per mile in the central part of the basin. The change to flatter dips occurs between the elevation of -6000 feet and -7000 feet.

Influence of Individual Structures

Nesson Anticline

The Nesson Anticline, the dominant structure in the basin, is a north-south trending feature approximately 90 miles long by 25 miles wide that plunges an average of 22 feet per mile from the southeast corner of Divide County southward into west-central Dunn County. Relief on the structure is a maximum of 900 feet near the border between Williams and McKenzie Counties, and decreases uniformly north and south from that area.

The Poplar interval thins slightly across the axis of the anticline. On Plate 2 the axis of the anticline is superimposed on the isochore map, and the Poplar can be seen to be thicker on either side

of the anticline than it is along the axis. An example is seen in the three wells 1765, 3843 and 2969 in T 151 N, R 97 W, R 96 W and R 95 W.

In well 1765 the Poplar is 592 feet thick. It thins to 562 feet in well 3843 and thickens again to 583 feet in well 2969. Because the Poplar thins over the Nesson Anticline the structure was actively positive during the deposition of the Poplar interval. However, considering that the structure's effect on the thickness of the Poplar was limited to a decrease of 10 to 30 feet, in striking contrast to the present relief of 900 feet, the anticline clearly was a more subtle feature during Poplar deposition than it is at present. Most of the relief on the structure today must be a result of post-Madison activity.

Surprisingly, although the anticline was positive during deposition of the Poplar interval, it has not affected the pattern of deposition of the Poplar, as there are no significant facies changes related to the anticline. This supports the suggestion that relief was low during deposition of the Poplar interval.

Billings High

A structural high almost wholly within Billings County (Plate 1) is referred to in this paper as the Billings High. The high is approximately 60 miles long by 12 miles wide, strikes north-south and plunges gently north at 15 feet per mile. It extends from northern

Slope County to southern McKenzie County. Relief across the structure is interpreted to be 50 to 100 feet on the west flank. The east flank dips into the basin center, and therefore, most of the relief on that flank, up to 300 feet, is a regional effect. Because there is no evidence of this structure in the Poplar isochore map (Plate 2), it must represent a post-Poplar event.

Divide High

In the northwest corner of the study area, a structural high plunges out of Saskatchewan into Divide County and is referred to here as the Divide High. The North Dakota portion of this high is approximately 21 miles long by 10 miles wide, strikes northwest-southeast and plunges to the southeast at 50 feet per mile. The structural relief across the Divide High is greater than 100 feet and locally greater than 200 feet. A slight thin on the isochore map (Plate 2) corresponds to the high, suggesting that the Divide High was present and active during the deposition of the Poplar interval.

Cedar Creek Anticline

The Cedar Creek Anticline lies to the south, outside of the study area. It trends northwest-southeast and intersects the South Dakota-Montana boundary just south of the southwest corner of North Dakota. The effect of the Cedar Creek Anticline on the Poplar structure in North Dakota can be seen as a slightly steeper northeast dip (Plate 1) in the southwest corner of Bowman County. There is no evidence

that the anticline influenced the Poplar's thickness in North Dakota (Plate 2). Because it lies outside of the study area, no conclusions are drawn as to its effect on the Poplar interval in general.

Normal Faults

An anomaly in southwest McKenzie County (T 148 N, R 101 W and R 102 W) is interpreted to be a result of normal faulting. The top of the Poplar in well 2786 is close to regional depth and thickness (Plates 1 and 2), whereas in well 4062 it is approximately 500 feet higher than regional depth and 267 feet thicker than the regional thickness. In striking contrast, the adjacent well 4385 has the top of the Poplar 600 feet lower than regional depth and about 60 feet thinner than regional thickness. Apparently the location of well 4062 was on a down-dropped block (greater stratigraphic thickness) whereas the location of the adjacent well 4385 was on an upthrown block (thinner stratigraphic thickness) during the depositon of the Poplar. The faults have affected the thickness of individual units within the Poplar, and it can be concluded that both faults were more or less continuously active during deposition of the Poplar. Surprisingly, during some later post-Poplar event, movement of the two fault blocks was reversed and they assumed their present position.

Effects of Pre-Mesozoic Erosional Truncation

Pre-Mesozoic erosional truncation had little effect on the structure of the Poplar. A subtle change in slope from that on the eroded surface

of the Poplar to that on the uneroded top of the Poplar can be detected on Plate 1. The break in slope is most apparent in the northeast where it steepens from approximately 41 feet per mile southwest on the subcrop to approximately 56 feet per mile southwest on the basin flank. In the southeast where the dip of the Poplar is less steep, the break in slope is more difficult to detect. There, it changes from about 35 feet per mile on the subcrop to about 40 feet per mile on the basin flank.

CHAPTER VI

Economic Geology

Present

To date the only economic production from the Poplar interval has been the oil produced from the East Poplar Field in Montana, midway between the Bowdoin Dome and the Nesson Anticline. Production is from what Beekly (1956, p. 61-65) referred to as the "A," "B" and "C" zones. I believe the "A" and "B" zones correlate respectively with the limestones immediately overlying the A-2 and A-1 anhydrites discussed in this study. The "C" zone appears to lie within the Ratcliffe interval. According to Beekly, the average porosity in the limestones is 11 per cent and consists of fractures, intercrystalline porosity and occasionally larger vugs.

The East Poplar Field oil is in a structural trap, an anticline 10 miles long by 6 miles wide. With an average net pay of 35 feet, an average porosity of 11 per cent and a productive area of approximately 17,000 acres, Beekly estimated in 1956 that the recoverable reserves for the field were greater than 60 million barrels of oil.

Future

Perhaps the first step in the exploration for other petroleum

reservoirs in the Poplar interval should be to determine anomalous conditions associated with the East Poplar Field which are directly responsible for entrapment of hydrocarbons. Similar conditions should then be looked for throughout the basin. As previously noted, the East Poplar Field oil occurs in an anticline and porosity is intercrystalline, fracture, and in part vuggy. One anomalous situation in the East Poplar Field that does not appear directly related to entrapment is the lack of thick salt directly over the anticline. The Special Studies Committee (1964, p. 107) pointed out that the carbonate rocks often have a salt matrix, and if this salt is removed by secondary processes porosity is enhanced. Perhaps the lack of salt and the intercrystalline porosity in the East Poplar Field is a result of ground-water solution.

Plate 1 shows structure contours drawn on the top of the thick salt present in the central part of the Poplar basin. Across two prominent structures, the Divide High and the Nesson Anticline, the total salt interval (Plate 3) thins, and it can be concluded that the structural relief on subsalt stratigraphic units is even greater than that shown on the top of the interval. The Billings High, on the other hand, corresponds more or less with an area of thicker salt and subsalt structural relief there will be subdued relative to that on the top of the interval. The structure contour map, used in conjunction with the salt isochore map, is thus a good indicator of structures to be expected at deeper levels. Nonetheless some structures

at depth could be masked by the thick salt deposits and for a full understanding of any specific interval a separate structure map should be constructed.

Structure maps made on the A-1 and A-2 anhydrites would be more suitable for showing the structure of limestones above them. Similarily the Total Salt Isopach map (Plate 3) does not show the variation in thickness of the individual salt beds, and isochores made on the salts immediately overlying the limestones would be more likely to show any anomalous thins within the salts.

In general, the area bounded by the Nesson Anticline on the east, the Billings High to the south and the Canadian border to the north, has been the most unstable during and since Madison time, and is, therefore, the most logical area to explore for structures. Mechanical logs indicate that the Poplar limestones generally are tighter towards the central basin area, but they are also cleaner, and porosity could be enhanced by fracturing and/or by salt solution, as in the East Poplar Field.

Fuller (1956, p. 48) pointed out that as the late Madison sea gradually regressed, each marine limestone facies which resulted from periodic retransgressions was deposited farther basinward. This is reflected in the positions of oil pools in stratigraphically lower reservoirs towards the edge of the basin and higher horizons towards the basin center.

In North Dakota production in the northeast part of the basin is

established from horizons stratigraphically below the Poplar. For example, the Midale subinterval is productive in the northeast half of Burke County. Consequently production from the Poplar might be expected in the northeast and southeast of Williams and Divide Counties.

Fuller indicated oil pools that are similar to these in southeastern Saskatchewan are structural stratigraphic traps in which the escape of oil is prevented in part by the impermeable rock at the pre-Mesozoic erosion surface that forms a continuation of overlying bedded anhydrites. In addition, there is a loss of permeability due to metasomatic replacement of reservoir limestone by anhydrite.

If similar conditions prevail in the Poplar interval the Anhydrite/Carbonate Ratio map (Plate 4) can be used to locate areas of low anhydrite concentrations that trend into areas of high anhydrite concentration. In the areas of higher anhydrite percentages there is a greater possibility of limestone replacement by anhydrite. One such area is in Mountrail County where the ratio of anhydrite to carbonate is 0.2 in central Mountrail County and 0.7 updip in northeast Mountrail Country. A stratigraphic trap resulting from loss of porosity and permeability due to replacement of limestone by anhydrite could exist in this area assuming the necessary overlying anhydrite bed is present to act as a cap rock.

Although mechanical log interpretations indicate that porosity increases towards the margins, the increase in porosity is often

accompanied by an increase in shaliness which reduces the effectiveness of the porosity. In spite of the increased shaliness the subcrop has potential for petroleum entrapment, because any porosity in limestones sloping up to the eroded subcrop area should be effectively sealed above and below by anhydrites, and should be capped on the up dip eroded surface through induration of the erosion surface and by silts and shales of the Spearfish Formation. Examples of this type of trap are seen in Bottineau County in the Starbuck and Kuroki fields in which the truncated Midale subinterval is sealed by the overlying Spearfish Formation.

CHAPTER VII

Summary and Conclusions

The Poplar interval is a para-time rock unit of interbedded salts, anhydrites and carbonates that form the uppermost part of the Mississippian Madison Formation. It was deposited in that part of western North Dakota covered by the Williston Basin. The interval varies in thickness from 176 feet on the margins to 687 feet in the central basin area. Salt is present in the central basin area and absent on the basin margins. There is a slight increase in the ratio of anhydrite to carbonate from the central basin area to the basin margins.

The Madison Formation consists of the Lodgepole, Mission Canyon and Charles facies. These three facies have a highly complex lateral and vertical relationship and consequently have been subdivided into para-time rock units on the basis of thin anhydrite beds that are uniform over wide areas and easily picked on mechanical logs. The complex facies are a result of repeated minor transgressive and regressive surges during the onlap and offlap of the Madison sea.

The Poplar interval contains two types of anhydrite, basin anhydrites probably deposited in a submarine environment and marginal anhydrites confined to the basin flanks, which may have been deposited in a sabkha

environment.

Successive deposition of marginal anhydrites in the same geographic locations resulted in linear down dip trends of thicks and thins in gross anhydrite in the interval.

A striking feature of the complex stratigraphy of the Poplar interval is the extensiveness of some of the basin anhydrites, two of which occur throughout the study area. The lower of the two is the marker horizon used to pick the base of the Poplar interval. On the basin flanks the top of the Poplar is a 10-foot anhydrite bed, which when traced toward the basin center dips beneath a salt bed that thickens rapidly from the flanks to the basin center. At the 0 edge of the uppermost salt there is a hinge line where the bedded sequence below the salt increases in dip basinward. Most of the increase in Poplar thickness from the hingeline to the basin center can be accounted for by salt deposition which probably corresponds to periodic increases in the rate of basin subsidence.

With the knowledge that the Poplar interval consists primarily of limestone, dolomite, anhydrite and salt, the lithology of the Poplar interval can be interpreted from the physical properties of the rocks recorded in mechanical logs which were run in the wells drilled through the Poplar.

The progressive restriction of the regressing sea during deposition of the Charles facies produced a saline environment in which the salts and anhydrites of the Poplar were deposited. The limestones of the

Poplar were deposited in near normal marine environments that occurred during periodic marine transgressions.

The structure of the Poplar interval generally conforms to the shape of the Williston Basin except where it has been influenced by the Nesson Anticline and two lesser anticlines, one in Divide County and one in Billings County. The Nesson Anticline and the structure in Divide County appear to have been actively positive during deposition of the Poplar whereas the structure in Billings County appears to represent a post-Poplar event. Pre-Mesozoic erosion created little topography on the Poplar.

The Poplar interval produces oil from an anticline in the East Poplar Field in Montana. Exploration for further Poplar reservoirs should consist of a search for similar structures. There is also some potential for stratigraphic traps caused by up dip permeability barriers that resulted from the replacement of the reservoir limestone by anhydrite. There is also potential in the subcrop area where eroded limestones are overlain by silts and shales of Spearfish Formation.

APPENDIX

Mechanical Well Log Data

The wells are listed in numerical order within each county and the counties are arranged in alphabetical order.

The Poplar and Ratcliffe tops are given as depth in feet below the Kelly bushing elevation (K.B.), and as subsea elevations.

The apparent thickness of the Poplar is recorded in feet.

For those wells from which sufficient data were collected, the total salt, total carbonate, and total anhydrite in the Poplar interval is recorded in feet. The anhydrite--carbonate ratio (A/C) is recorded for these wells also.

BILLINGS COUNTY

N.D.G.S. Well Number 555
Standard Oil & Gas Company
N.W. 1 (N.P.) #1
SE SE Sec. 17 T 143 N, R 100 W
K.B. 2815

Tops: Poplar interval	8969	-6154
Ratcliffe interval	9434	-6619
Isochore	465	

N.D.G.S. Well Number 2357
The California Company
Government #1 Bullion Butte
NE NW Sec. 20 T 137 N, R 102 W
K.B. 2718

Tops: Poplar interval	8463	-5745
Ratcliffe interval	8703	-5985
Isochore	240	
Total Salt	38	
Total Carbonate	143	
Total Anhydrite	59	
A/C	.41	

N.D.G.S. Well Number 2745
Hunt Oil Company
Wm. Palanuk #1
NE SW Sec. 15 T 144 N, R 99 W
K.B. 2727

Tops: Poplar interval	9100	-6373
Ratcliffe interval	9554	-6827
Isochore	454	

N.D.G.S. Well Number 2798
Lamar Hunt
Northern Pacific Ry Co. #1
SW NW Sec. 9 T 144 N, R 100 W
K.B. 2592

Tops: Poplar interval	8890	-6298
Ratcliffe interval	9362	-6770
Isochore	472	

N.D.G.S. Well Number 3746
Davis Oil Company
Kevin-Federal #1
SW SW Sec. 10 T 138 N, R 100 W
K.B. 2814

Tops: Poplar interval	8658	-5844
Ratcliffe interval	8936	-6122
Isochore	278	

N.D.G.S. Well Number 4035
Tom Jordan
State No. 1
SE SE Sec. 36 T 144 N, R 100 W
K.B. 2597

Tops: Poplar interval	8912	-6315
Ratcliffe interval	9368	-6771
Isochore	456	
Total Salt	209	
Total Carbonate	163	
Total Anhydrite	84	
A/C	.55	

N.D.G.S. Well Number 4091
Sunray D-X Oil Company
North Dakota Federal A #1
SE NE Sec. 10 T 138 N, R 102 W
K.B. 2528

Tops: Poplar interval	8360	-5832
Ratcliffe interval	8668	-6140
Isochore	308	
Total Salt	79	
Total Carbonate	160	
Total Anhydrite	69	
A/C	.43	

N.D.G.S. Well Number 4176
Fundamental Oil Corporation
Tracy Gov't #2 - 24
SE NW Sec. 24 T 138 N, R 101 W
K.B. 2732

Tops: Poplar interval	8547	-5815
Ratcliffe interval	8841	-6109
Isochore	294	
Total Salt	71	
Total Carbonate	124	
Total Anhydrite	99	
A/C	.80	

N.D.G.S. Well Number 4419
Shell Oil Company
Shell - N.P. Gov't #44 - 14
SE SE Sec. 14 T 144 N, R 102 W
K.B. 2341

Tops: Poplar interval	8550	-6209
Ratcliffe interval	9047	-6706
Isochore	497	
Total Salt	239	
Total Carbonate	178	
Total Anhydrite	80	
A/C	.45	

N.D.G.S. Well Number 4455
Shell Oil Company
Gov't #41x - 18
NE NE Sec. 18 T 143 N, R 101 W
K.B. 2468

Tops: Poplar interval	8580	-6112
Ratcliffe interval	9065	-6597
Isochore	485	
Total Salt	220	
Total Carbonate	185	
Total Anhydrite	80	
A/C	.43	

N.D.G.S. Well Number 4642
Amerada Petroleum Corporation
U.S.A. Melvin Tract 1 #1
SW NW Sec. 30 T 140 N, R 102 W
K.B. 2585

Tops: Poplar interval	8532	-5947
Ratcliffe interval	8795	-6210
Isochore	263	
Total Salt	47	
Total Carbonate	119	
Total Anhydrite	97	
A/C	.82	

N.D.G.S. Well Number 4833
Mesa Petroleum Company
Mesa #1-34 Federal-F.U.C.E.
NE NW Sec. 34 T 141 N, R 100 W
K.B. 2593

Tops: Poplar interval	8590	-5997
Ratcliffe interval	9015	-6422
Isochore	425	
Total Salt	120	
Total Carbonate	227	
Total Anhydrite	78	
A/C	.34	

BOTTINEAU COUNTY

N.D.G.S. Well Number 2596
Phillips Petroleum Company
Brandt #1
SE NW Sec. 19 T 160 N, R 80 W
K.B. 1511

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 3539
Arex Corporation
Johnson No. 1
SE SE Sec. 4 T 159 N, R 82 W
K.B. 1574

Tops: Poplar interval	4046	-2472
Ratcliffe interval	4140	-2566
Isochore	94	

N.D.G.S. Well Number 3887
Clyde W. Jones
Undlin #1
SE NE Sec. 24 T 159 N, R 83 W
K.B. 1595

Tops: Poplar interval	4192	-2597
Ratcliffe interval	4255	-2660
Isochore	63	

N.D.G.S. Well Number 3960
Amerada Petroleum Corporation
Glinz #1
NE NW Sec. 12 T 159 N, R 82 W
K.B. 1538

Tops: Poplar interval	3950	-2412
Ratcliffe interval	3962	-2424
Isochore	12	

BOWMAN COUNTY

N.D.G.S. Well Number 516
Western Natural Gas Co.
Traux Trear #1
NW SW Sec. 13 T 132 N, R 102 W
K.B. 3074

Tops:	Poplar interval	7852	-4778
	Ratcliffe interval	8040	-4966
Isochore		188	

N.D.G.S. Well Number 1446
J. H. Snowden
M. A. Morrison #1
SE SW Sec. 34 T 130 N, R 103 W
K.B. 3028

Tops:	Poplar interval	7100	-4072
	Ratcliffe interval	7289	-4261
Isochore		189	

N.D.G.S. Well Number 2509
Shell Oil Co.
Unit #41-23A
NE NE Sec. 23 T 130 N, R 107 W
K.B. 2979

Tops:	Poplar interval	6368	-3389
	Ratcliffe interval	6551	-3572
Isochore		183	

N.D.G.S. Well Number 3059
Shell Oil Co.
Unit #33X-34B-15
NW SE Sec. 34 T 131 N, R 107 W
K.B. 3007

Tops: Poplar interval	6398	-3391
Ratcliffe interval	6579	-3572
Isochore	181	
Total Salt	0	
Total Carbonate	110	
Total Anhydrite	71	
A/C	65	

N.D.G.S. Well Number 3261
Continental Oil Company
Federal 15 #1
NW NE Sec. 15 T 129 N, R 106
K.B. 2924

Tops: Poplar interval	6412	-3488
Ratcliffe interval	6598	-3674
Isochore	186	
Total Salt	0	
Total Carbonate	111	
Total Anhydrite	75	
A/C	.68	

N.D.G.S. Well Number 3798
Shell Oil Co.
Gov't #13-32
NW SW Sec. 32 T 131 N, R 106 W
K.B. 3037

Tops: Poplar interval	6719	-3682
Ratcliffe interval	6909	-3872
Isochore	190	
Total Salt	0	
Total Carbonate	128	
Total Anyhdrite	62	
A/C	.48	

N.D.G.S. Well Number 4143
A. J. Hodges Ind.
Hestekin #1
NE NE Sec. 15 T 130 N, R 104 W
K.B. 3179

Tops: Poplar interval	7328	-4149
Ratcliffe interval	7516	-4337
Isochore	188	

N.D.G.S. Well Number 4545
Pel-Tex Petroleum Company Inc.
Kennedy #1
NW NW Sec. 17 T 130 N, R 100 W
K.B. 2867

Tops: Poplar interval	7258	-4391
Ratcliffe interval	7451	-4584
Isochore	193	
Total Salt	0	
Total Carbonate	107	
Total Anhydrite	86	
A/C	.80	

N.D.G.S. Well Number 4577
Golden Eagle Refining Company-Mutex
Holecek #1
NE NE Sec. 17 T 129 N, R 104 W
K.B. 3211

Tops: Poplar interval	7090	-3879
Ratcliffe interval	7272	-4061
Isochore	182	
Total Salt	0	
Total Carbonate	109	
Total Anhydrite	73	
A/C	.67	

N.D.G.S. Well Number 4669
International Nuclear Corporation
Miller et al., #1-62
SW NE Sec. 21 T 131 N, R 104 W
K.B. 3158

Tops: Poplar interval	7410	-4252
Ratcliffe interval	7596	-4438
Isochore	186	
Total Salt	0	
Total Carbonate	110	
Total Anhydrite	76	
A/C	.69	

BURKE COUNTY

N.D.G.S. Well Number 1006
Calvert Drilling Incorporated
A. C. Lawson #1
NE NW Sec. 36 T 162 N, R 88 W
K.B. 1872

Tops:	Poplar interval	5165	-3293
	Ratcliffe interval	5373	-3501
Isochore		208	
Total Salt		0	
Total Carbonate		130	
Total Anhydrite		78	
A/C		.60	

N.D.G.S. Well Number 1082
Calvert Drilling Incorporated
Jepsen #1
C. NE NE Sec. 30 T 161 N, R 90 W
K.B. 2075

Tops:	Poplar interval	6090	-4015
	Ratcliffe interval	6355	-4280
Isochore		265	

N.D.G.S. Well Number 1724
Sunray-Mid Continent Oil Co.
M. E. Peterson #2
NE SW Sec. 8 T 159 N, R 94 W
K.B. 2340

Tops:	Poplar interval	7220	-4880
	Ratcliffe interval	7677	-5337
Isochore		457	

N.D.G.S. Well Number 1807
Northern Pump Co.
Jacobsen #1
NE NW Sec. 21 T 161 N, R 89 W
K.B. 1984

Tops: Poplar interval	5724	-3740
Ratcliffe interval	5965	-3981
Isochore	241	
Total Salt	0	
Total Carbonate	149	
Total Anhydrite	92	
A/C	.62	

N.D.G.S. Well Number 2304
Stewart Petroleum Company
Huff #1
SW SW Sec. 31 T 161 N, R 93 W
K.B. 2477

Tops: Poplar interval	7153	-4676
Ratcliffe interval	7488	-5011
Isochore	335	
Total Salt	57	
Total Carbonate	206	
Total Anhydrite	72	
A/C	.35	

N.D.G.S. Well Number 2323
Calvert Drilling Inc. Sun Oil Co.
J. Maruskie #1
NE NW Sec. 23 T 160 N, R 94 W
K.B. 2417

Tops: Poplar interval	7151	-4734
Ratcliffe interval	7578	-5161
Isochore	427	

N.D.G.S. Well Number 2436
Kerr-McGee Oil Industries
V. C. Berger #1
C. SW NW Sec. 33 T 160 N, R 94 W
K.B. 2425.8

Tops: Poplar interval	7235	-4809
Ratcliffe interval	7710	-5284
Isochore	475	
Total Salt	184	
Total Carbonate	218	
Total Anhydrite	73	
A/C	.33	

N.D.G.S. Well Number 2549
W. E. Bakke
Thelma Hanson #1
NW NW Sec. 6 T 162 N, R 91 W
K.B. 1965

Tops: Poplar interval	5700	-3735
Ratcliffe interval	5944	-4029
Isochore	244	
Total Salt	0	
Total Carbonate	190	
Total Anhydrite	54	
A/C	.28	

N.D.G.S. Well Number 2790
Wilhite-Skelly
Setterlund #1
NE SW Sec. 34 T 34 N, R 94 W
K.B. 2410

Tops: Poplar interval	7494	-5084
Ratcliffe interval	7990	-5580
Isochore	496	
Total Salt	232	
Total Carbonate	172	
Total Anhydrite	92	
A/C	.53	

N.D.G.S. Well Number 2800
Amerada Petroleum Corp.
Gagnum 1 #1
SW NW Sec. 13 T 163 N, R 89 W
K.B. 1887

Tops: Poplar interval	4996	-3108
Ratcliffe interval	5100	-3213
Isochore	105	
Total Salt	0	
Total Carbonate	82	
Total Anhydrite	22	
A/C	.27	

N.D.G.S. Well Number 2829
Great Plains Royalty et al.
M. K. & M. B. Fetherston #1
C. SE SE Sec. 18 T 160 N, R 92 W
K.B. 2348

Tops: Poplar interval	6925	-4577
Ratcliffe interval	7274	-4926
Isochore	349	
Total Salt	53	
Total Carbonate	209	
Total Anhydrite	87	
A/C	.42	

N.D.G.S. Well Number 2892
Monsanto Chemical-Lion Oil Division
C. SW SW Sec. 10 T 160 N, R 91 W
K.B. 2327

Tops: Poplar interval	6586	-4259
Ratcliffe interval	6865	-4538
Isochore	279	
Total Salt	20	
Total Carbonate	176	
Total Anhydrite	83	
A/C	.47	

N.D.G.S. Well Number 3586
North American Royalties Inc.
Rudolf Skalicky #1-A
Belco Pet. Corp.
NW SE Sec. 24 T 160 N, R 93 W
K.B. 2364

Tops: Poplar interval	7012	-4648
Ratcliffe interval	7352	-4988
Isochore	340	
Total Salt	49	
Total Carbonate	236	
Total Anhydrite	55	
A/C	.23	

N.D.G.S. Well Number 3591
Pan American Petroleum Corporation
Clarence Holter #1
SW NW Sec. 160 T 161 N, R 93 W
K.B. 2154

Tops: Poplar interval	6350	-4196
Ratcliffe interval	6634	-4480
Isochore	284	
Total Salt	30	
Total Carbonate	191	
Total Anhydrite	63	
A/C	.33	

N.D.G.S. Well Number 3870
Farmers Union Central Exchange
Iverson-Bank of North Dakota Unit No. 1
NW SE Sec. 26 T 163 N, R 94 W
K.B. 1930

Tops: Poplar interval	5916	-3986
Ratcliffe interval	6216	-4286
Isochore	300	
Total Salt	36	
Total Carbonate	187	
Total Anhydrite	77	
A/C	.41	

N.D.G.S. Well Number 3915
Clandler & Associated
Radenz-Sorum No. 1
C NE NE Sec. 31 T 163 N, R 89 W
K.B. 1923

Tops:	Poplar interval	5235	-3312
	Ratcliffe interval	5366	-3443
Isochore		131	
Total Salt		0	
Total Carbonate		88	
Total Anhydrite		43	
A/C		.49	

N.D.G.S. Well Number 4036
Midwest Oil Corporation
Casteel No. 1
SE NE Sec. 17 T 163 N, R 93 W
K.B. 1928

Tops:	Poplar interval	5698	-3770
	Ratcliffe interval	5980	-4052
Isochore		282	

N.D.G.S. Well Number 4139
Whitehall Western Oils Ltd.
State of North Dakota
SE NE Sec. 16 T 161 N, R 92 W
K.B. 2365

Tops:	Poplar interval	6611	-4246
	Ratcliffe interval	6916	-4551
Isochore		305	
Total Salt		42	
Total Carbonate		187	
Total Anhydrite		76	
A/C		.41	

N.D.G.S. Well Number 4509
J. B. Hawley Trust
Rykken #2
SW NE Sec. 1 T 161 N, R 91 W
K.B. 1968

Tops: Poplar interval	5840	-3872
Ratcliffe interval	6076	-4108
Isochore	236	
Total Salt	0	
Total Carbonate	175	
Total Anhydrite	61	
A/C	.21	

BURLEIGH COUNTY

N.D.G.S. Well Number 145
Continental Oil Company
McCay #1
NW NW Sec. 32 T 137 N, R 76 W
K.B. 1869

Tops:	Poplar interval	3512	-1643
	Ratcliffe interval	3542	-1673
Isochore		30	

N.D.G.S. Well Number 151
Hunt Oil Company
Emma Klevan #1
SW SW Sec. 18 T 140 N, R 80 W
K.B. 1910

Tops:	Poplar interval	4550	-2640
	Ratcliffe interval	4691	-2781
Isochore		141	

N.D.G.S. Well Number 155
Continental Oil Company
Dronen #1
NE NE Sec. 9 T 140 N, R 75 W
K.B. 1912

Tops:	Poplar interval	3430	-1518
	Ratcliffe interval	3510	-1598
Isochore		80	

N.D.G.S. Well Number 174
The Continental Oil Company
Duemeland #1
NW NW Sec. 3 T 140 N, R 77 W
K.B. 1981

Tops:	Poplar interval	3850	-1869
	Ratcliffe interval	3925	-1944
Isochore		75	

N.D.G.S. Well Number 701
Caroline Hunt Trust Estate
University Land #1
NE NE Sec. 36 T 144 N, R 75 W
K.B. 2023

Tops:	Poplar interval	3568	-1545
	Ratcliffe interval	3650	-1627
Isochore		82	

N.D.G.S. Well Number 723
Caroline Hunt Trust Estate
Schlaback #1
NE NE Sec. 36 T 139 N, R 76 W
K.B. 1880

Tops:	Poplar interval	3475	-1595
	Ratcliffe interval	3510	-3510
Isochore		35	

N.D.G.S. Well Number 756
Caroline Hunt Trust Estate
Rob't Nicholson #1
SE SE Sec. 32 T 137 N, R 77 W
K.B. 1891

Tops:	Poplar interval	3620	-1729
	Ratcliffe interval	3747	-1856
Isochore		127	

N.D.G.S. Well Number 763
Caroline Hunt Trust Estate
Anton Novy #1
SE SE Sec. 14 T 144 N, R 77 W
K.B. 1947

Tops:	Poplar interval	3880	-1933
	Ratcliffe interval	4007	-2060
Isochore		127	

N.D.G.S. Well Number 772
Caroline Hunt Trust Estate
#1 Paul Ryberg
NW NW Sec. 23 T 140 N, R 79 W
K.B. 2007

Tops:	Poplar interval	4271	-2261
	Ratcliffe interval	4348	-2341
Isochore		77	

N.D.G.S. Well Number 1371
Continental and Pure Oil Companies
J. F. Miller #1
SE SW Sec. 30 T 143 N, R 75 W
K.B. 2051

Tops:	Poplar interval	3722	-1671
	Ratcliffe interval	3810	-1759
Isochore		88	

N.D.G.S. Well Number 4199
Chevron Oil Company
Koskl #1
NE SE Sec. 11 T 141 N, R 76 W
K.B. 2004

Tops:	Poplar interval	3700	-1696
	Ratcliffe interval	3790	-1786
Isochore		90	

N.D.G.S. Well Number 4249
Chevron Oil Company
Deckert #1
NE SW Sec. 27 T 142 N, R 75 W
K.B. 1878

Tops:	Poplar interval	3483	-1605
	Ratcliffe interval	3565	-1687
Isochore		82	

N.D.G.S. Well Number 4389
Tom Vessels & Perry Bass
Helen Bourgois #1
SW NE Sec. 33 T 141 N, R 80 W
K.B. 2126

Tops:	Poplar interval	4770	-2644
	Ratcliffe interval	4920	-2794
Isochore		150	

DIVIDE COUNTY

N.D.G.S. Well Number 1900
Signal Drilling & Exploration, Inc.
Knute Unhjem #1
NW SW Sec. 5 T 162 N, R 98 W
K.B. 2221

Tops:	Poplar interval	6596	-4375
	Ratcliffe interval	6896	-4675
Isochore		300	
Total Salt		34	
Total Carbonate		194	
Total Anhydrite		72	
A/C			

N.D.G.S. Well Number 2714
Signal Drilling & Exploration, Inc.
Elmar #1
C SE SE Sec. 11 T 162 N, R 96 N
K.B. 2037

Tops:	Poplar interval	6225	-4188
	Ratcliffe interval	6545	-4508
Isochore		320	
Total Salt		60	
Total Carbonate		179	
Total Anhydrite		81	
A/C		.45	

N.D.G.S. Well Number 2720
Signal Drilling & Exploration
#1 Carlson
NW NW Sec. 27 T 163 N, R 100 W
K.B. 2170

Tops:	Poplar interval	6271	-4101
	Ratcliffe interval	6628	-4458
Isochore		357	

N.D.G.S. Well Number 2721
Signal Drilling & Exploration
Lund #1
SW SW Sec. 15 T 161 N, R 100 W
K.B. 2242

Tops:	Poplar interval	6892	-4650
	Ratcliffe interval	7285	-5043
Isochore		393	
Total Salt		128	
Total Carbonate		208	
Total Anhydrite		57	
A/C		.27	

N.D.G.S. Well Number 2722
Signal Drilling & Exploration
Joyce #1
SE SW Sec. 13 T 161 N, R 98 W
K.B. 2060

Tops:	Poplar interval	6746	-4686
	Ratcliffe interval	7160	-5100
Isochore		414	
Total Salt		132	
Total Carbonate		203	
Total Anhydrite		79	
A/C		.38	

N.D.G.S. Well Number 2736
Lamar Hunt
Jens Brodal #1
NW SW Sec. 11 T 161 N, R 95 W
K.B. 2396

Tops:	Poplar interval	6915	-4519
	Ratcliffe interval	7264	-4868
Isochore		349	

N.D.G.S. Well Number 2970
Mar-Win Development Company
Joseph Raaum #1
NE NE Sec. 20 T 162 N, R 101 W
K.B. 2244

Tops:	Poplar interval	6522	-4278
	Ratcliffe interval	6909	-4665
Isochore		387	

N.D.G.S. Well Number 3098
Amerada Petroleum Corporation
#1 Susie Grout
Sec. 11 T 160 N, R 97 W NE SE
K.B. 2273

Tops:	Poplar interval	7262	-4989
	Ratcliffe interval	7682	-5409
Isochore		420	
Total Salt		119	
Total Carbonate		191	
Total Anhydrite		110	
A/C		.62	

N.D.G.S. Well Number 3276
Central Leduc Oils
NW NE Sec. 25 T 162 N, R 95 W
K.B. 2239

Tops:	Poplar interval	6574	-4335
	Ratcliffe interval	6890	-4551
Isochore		316	
Total Salt		42	
Total Carbonate		201	
Total Anhydrite		73	
A/C		.36	

N.D.G.S. Well Number 3374
Hunt Petroleum Corporation
Ivan Olson #1
SE SW Sec. 32 T 160 N, R 101 W
K.B. 2257

Tops:	Poplar interval	7280	-5023
	Ratcliffe interval	7733	
Isochore		453	
Total Salt		137	
Total Carbonate		232	
Total Anhydrite		84	
A/C		.36	

N.D.G.S. Well Number 3441
Cardinal Petroleum & National Bulk Carriers
#1 Thon
SE SE Sec. 3 T 162 N, R 102 W
K.B. 2244

Tops:	Poplar interval	6363	-4119
	Ratcliffe interval	6752	-4508
Isochore		389	
Total Salt		63	
Total Carbonate		224	
Total Anhydrite		102	
A/C		.46	

N.D.G.S. Well Number 3625
Brandywine Oil Company
Brady #1
C SW SW Sec. 21 T 163 N, R 96 W
K.B. 1926

Tops:	Poplar interval	5978	-4052
	Ratcliffe interval	6292	-4366
Isochore		314	
Total Salt		36	
Total Carbonate		222	
Total Anhydrite		56	
A/C		.25	

N.D.G.S. Well Number 3638
Tom Jordan et al.
Bublitz #1
NE SE Sec. 17 T 162 N, R 100 W
K.B. 2276

Tops:	Poplar interval	6586	-4310
	Ratcliffe interval	6950	-4674
Isochore		364	
Total Salt		64	
Total Carbonate		233	
Total Anhydrite		67	
A/C		.29	

N.D.G.S. Well Number 4154
Calvert Drilling & Producing Company Kelsch & Donlin
Windfaldet #1
NE NE Sec. 25 T 163 N, R 99 W
K.B. 2206

Tops:	Poplar interval	6450	-4244
	Ratcliffe interval	6740	-4534
Isochore		290	
Total Salt		37	
Total Carbonate		161	
Total Anhydrite		.57	

N.D.G.S. Well Number 4193
United States Smelting Refining & Mining Company
Kenneth Nelson #1
NE NW Sec. 8 T 163 N, R 102 W
K.B. 2218

Tops:	Poplar interval	6090	-3872
	Ratcliffe interval	6427	-4209
Isochore		337	
Total Salt		59	
Total Carbonate		189	
Total Anhydrite		89	
A/C		.47	

N.D.G.S. Well Number 4428
Signal Exploration Phillips Petroleum-
A. J. Hickerson-States Oil Company
Harold Johansen #1
C.N.W. Sec. 2 T 161 N, R 103 W
K.B. 2092

Tops:	Poplar interval	6377	-4285
	Ratcliffe interval	6811	-4719
Isochore		434	

N.D.G.S. Well Number 4459
States Oil Company-Pan American Pet. Corp. et al.
Douglas Graupe #1
NE SE Sec. 27 T 161 N, R 102 W
K.B. 2091

Tops:	Poplar interval	6706	-4615
	Ratcliffe interval	7168	-5077
Isochore		462	
Total Salt		132	
Total Carbonate		248	
Total Anhydrite		82	
A/C		.33	

N.D.G.S. Well Number 4507
Petroleum Inc. No. Hellen
NE NE Sec. 21 T 163 N, R 101 W
K.B. 2214

Tops:	Poplar interval	6307	-4093
	Ratcliffe interval	6630	-4416
Isochore		323	
Total Salt		50	
Total Carbonate		168	
Total Anhydrite		105	
A/C		.63	

N.D.G.S. Well Number
Mule Creek Oil Company, Inc.
Lien #1-3417
SW SE Sec. 17 T 163 N, R 95 W
K.B. 1914

Tops: Poplar interval	5838	-3924
Ratcliffe interval	6140	-4226
Isochore	302	
Total Salt	27	
Total Carbonate	218	
Total Anhydrite	57	
A/C	.26	

N.D.G.S. Well Number 4777
Texakota, Inc.
Friday #1
NW SE Sec. 32 T 161 N, R 95 W
K.B. 2320

Tops: Poplar interval	6930	-4610
Ratcliffe interval	7302	-4982
Isochore	372	
Total Salt	67	
Total Carbonate	231	
Total Anhydrite	73	
A/C	.32	

N.D.G.S. Well Number 4837
Miami Oil Producers, Inc. et al.
Roy Hagen #1
SW NE Sec. 12 T 160 N, R 100 W
K.B. 2112

Tops: Poplar interval	6982	-4870
Ratcliffe interval	7411	-5299
Isochore	429	
Total Salt	142	
Total Carbonate	192	
Total Anhydrite	95	
A/C	.50	

DUNN COUNTY

N.D.G.S. Well Number 505
Socony Vacuum F 32 6P
Dvorak
SE NE Sec. 6 T 141 N, R 94 W
K.B. 2296

Tops:	Poplar interval	8239	-5943
	Ratcliffe interval	8518	-6222
Isochore		279	

N.D.G.S. Well Number 607
Mobil Producing Company
Kennedy F32-24P
SW NE Sec. 24 T 149 N, R 93 W
K.B. 2147

Tops:	Poplar interval	8318	-6171
	Ratcliffe interval	8807	-6660
Isochore		489	

N.D.G.S. Well Number 793
Mobil Producing Company
Solomon Birdbear
SE NW Sec. 22 T 149 N, R 91 W
K.B. 2092

Tops:	Poplar interval	7975	-5883
	Ratcliffe interval	8343	-6251
Isochore		368	

N.D.G.S. Well Number 824
Northwest Oil Drilling Company
Walter Hamann #1
SE SE Sec. 8 T 141 N, R 91 W
K.B. 2113

Tops:	Poplar interval	7443	-5330
	Ratcliffe interval	7690	-5577
Isochore		247	

N.D.G.S. Well Number 892
ARGO Oil Corporation
Larson #1
NE NW Sec. 19 T 144 N, R 94 W
K.B. 2410

Tops:	Poplar interval	8666	-6256
	Ratcliffe interval	8994	-6584
Isochore		328	

N.D.G.S. Well Number 897
W. H. Hunt
T. W. Darwin #1
SW SW Sec. 35 T 145 N, R 96 W
K.B. 2519

Tops:	Poplar interval	8974	-6455
	Ratcliffe interval	9350	-6831
Isochore		376	
Total Salt		124	
Total Carbonate		195	
Total Anhydrite		57	
A/C		.29	

N.D.G.W. Well Number 1787
Sinclair Oil & Gas Company
Bill P. Heidecker #1
NW NE Sec. 23 T 143 N, R 93 W
K.B. 2248

Tops:	Poplar interval	8108	-5860
	Ratcliffe interval	8450	-6202
Isochore		342	

N.D.G.S. Well Number 2230
Continental Oil Company
State #1
SW SW Sec. 36 T 147 N, R 96 W
K.B. 2614

Tops:	Poplar interval	9090	-6476
	Ratcliffe interval	9591	-6977
Isochore		501	

N.D.G.S. Well Number 2615
Stewart Petroleum Corporation
Jack Dvirnak #1
NE NE Sec. 20 T 146 N, R 96 W
K.B. 3039

Tops:	Poplar interval	9554	-6515
	Ratcliffe interval	10020	-6981
Isochore		466	
Total Salt		192	
Total Carbonate		190	
Total Anhydrite		84	
A/C		.44	

N.D.G.S. Well Number 2618
Pan American Petroleum Corporation
Jacob Huber #1
SW SE Sec. 15 T 145 N, R 91 W
K.B. 2212

Tops:	Poplar interval	7840	-5628
	Ratcliffe interval	8160	-5948
Isochore		320	
Total Salt		79	
Total Carbonate		161	
Total Anhydrite		74	
A/C		.46	

N.D.G.S. Well Number 2724
Amerada Petroleum Corporation
Signalness Unit "A" #1
NW SE Sec. 15 T 148 N, R 96 W
K.B. 2383

Tops:	Poplar interval	8660	-6277
	Ratcliffe interval	9197	-6814
Isochore		537	

N.D.G.S. Well Number 2848
Lyda Hunt-Herbert Trust's et al.
Henry Bad Gun #1
SW SE Sec. 8 T 147 N, R 93 W
K.B. 2297

Tops:	Poplar interval	8418	-6121
	Ratcliffe interval	8879	-6582
Isochore		461	
Total Salt		176	
Total Carbonate		227	
Total Anhydrite		58	
A/C		.26	

N.D.G.S. Well Number 3044
Amerada Petroleum Corporation
Marieselle
NE NE Sec. 27 T 143 N, R 92 W
K.B. 2200

Tops:	Poplar interval	7775	-5575
	Ratcliffe interval	8088	-5888
Isochore		313	
Total Salt		70	
Total Carbonate		168	
Total Anhydrite		75	
A/C		.45	

N.D.G.S. Well Number 3178
United Producing Company, Inc.
Clarence Danielson #1
NW NW Sec. 20 T 148 N, R 97 W
K.B. 2443

Tops:	Poplar interval	8930	-6487
	Ratcliffe interval	9492	-7049
Isochore		562	
Total Salt		222	
Total Carbonate		282	
Total Anhydrite		58	
A/C		.21	

N.D.G.S. Well Number 3199
Amerada Petroleum Corporation
John Steffen #1
NW NE Sec. 16 T 144 N, R 92 W
K.B. 2198

Tops: Poplar interval	7959	-5761
Ratcliffe interval	8289	-6091
Isochore	330	

N.D.G.S. Well Number 4220
Sinclair Oil & Gas Company
#1 Knudsvig
1980 N 1980 E Sec. 13 T 145 N, R 94 W
K.B. 2210

Tops: Poplar interval	8298	-6088
Ratcliffe interval	8710	-6500
Isochore	412	
Total Salt	119	
Total Carbonate	234	
Total Anhydrite	59	
A/C	.25	

N.D.G.S. Well Number 4468
Phillips Petroleum Company
Bren #A-1
656 FWL - 1980 FNL Sec. 19 T 141 N, R 96 W
K.B. 2545

Tops: Poplar interval	8705	-6160
Ratcliffe interval	8972	-6427
Isochore	267	
Total Salt	66	
Total Carbonate	121	
Total Anhydrite	80	
A/C	.66	

EMMONS COUNTY

N.D.G.S. Well Number 16
Northern Ordnance Corps
Franklin Investment 1
NW SW Sec. 35 T 133 N, R 75 W

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 23
Roeser & Pendleton Inc.
#1 J. J. Weber
NE SE Sec. 35 T 133 N, R 76 W
K.B. 2012

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 43
Peak Drilling Company
#1 Olhauser
NE SE Sec. 8 T 132 N, R 78 W
K.B. 1820

Tops: Poplar interval	3372	-1552
Ratcliffe interval	3392	-1572
Isochore	20	

N.D.G.S. Well Number 742
Mobil Producing Company
Kruse F22-30P
SE NW Sec. 30 T 134 N, R 75 W
K.B. 2044

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 4212
Chevron Oil Company
Engleman #2-1
SE SE Sec. 17 T 136 N, R 76 W
K.B. 1890

Tops:	Poplar interval	3400	-1510
	Ratcliffe interval	3440	-1550
Isochore		40	

GOLDEN VALLEY COUNTY

N.D.G.S. Well Number 2894
Shell Oil Company
Shell-N.P. Brown et al., 41-241
C NE NE Sec. 24 T 142 N, R 103 W
K.B. 2688

Tops:	Poplar interval	8722	-6034
	Ratcliffe interval	9164	-6476
Isochore		442	
Total Salt		206	
Total Carbonate		162	
Total Anhydrite		74	
A/C		.46	

N.D.G.S. Well Number 4130
Amerada Petroleum Corporation
Ramona Waldron #1
SW NW Sec. 9 T 138 N, R 105 W
K.B. 2867

Tops:	Poplar interval	8316	-5449
	Ratcliffe interval	8532	-5665
Isochore		216	
Total Salt		24	
Total Carbonate		94	
Total Anhydrite		98	
A/C		1.04	

N.D.G.S. Well Number 4308
Skelly Oil Company
Arthur Reinholz #1
SE NW Sec. 23 T 139 N, R 104 W
K.B. 2766

Tops:	Poplar interval	8516	-5750
	Ratcliffe interval	8767	-6001
Isochore		251	
Total Salt		48	
Total Carbonate		97	
Total Anhydrite		106	
A/C		.92	

N.D.G.S. Well Number 4466
Lamar Hunt
Emmet Daily #1
SE SE Sec. 33 T 142 N, R 104 W
K.B. 2295

Tops: Poplar interval	8582	-5987
Ratcliffe interval	8998	-6405
Isochore	416	
Total Salt	141	
Total Carbonate	205	
Total Anhydrite	70	
A/C	.34	

N.D.G.S. Well Number 4467
Lamar Hunt
Knute Farstveet #1
SW NW Sec. 21 T 140 N, R 105 W
K.B. 2765

Tops: Poplar interval	8500	-5735
Ratcliffe interval	8808	-6043
Isochore	308	

N.D.G.S. Well Number 4490
Lamar Hunt
USA #1
SE SW Sec. 29 T 138 N, R 103 W
K.B. 2765

Tops: Poplar interval	8338	-5573
Ratcliffe interval	8566	-5801
Isochore	228	
Total Salt	29	
Total Carbonate	96	
Total Anhydrite	103	
A/C	1.07	

N.D.G.S. Well Number 4498
Pubco-Empire
Federal #14-16
SE SE Sec. 14 T 139 N, R 103 W
K.B. 2718

Tops:	Poplar interval	8569	-5851
	Ratcliffe interval	8820	-6102
Isochore		251	

N.D.G.S. Well Number 4791
Woods Petroleum Corporation
Slocomb #1
C NW Sec. 29 T 141 N, R 104 W
K.B. 2895

Tops:	Poplar interval	8740	-5845
	Ratcliffe interval	9090	-6195
Isochore		350	

GRANT COUNTY

N.D.G.S. Well Number 232
Youngblood and Youngblood
Kelstrom
SW SW Sec. 26 T 133 N, R 83 W
K.B. 1997

Tops:	Poplar interval	4372	-2375
	Ratcliffe interval	4528	-2531
Isochore		156	
Total Anhydrite		48	
A/C		69	

N.D.G.S. Well Number 3636
Cardinal Petroleum-Lone Star Producing Bulk Carriers
Bierwagen #1
SW NE Sec. 1 T 133 N, R 90 W
K.B. 2350

Tops:	Poplar interval	6083	-3733
	Ratcliffe interval	6275	-3925
Isochore		192	
Total Carbonate		123	
Total Anhydrite		69	
A/C		.56	

N.D.G.S. Well Number 4100
Union Oil Company of California
NPRR #1
NW NW Sec. 23 T 131 N, R 85 W
K.B. 2014

Tops:	Poplar interval	4572	-2558
	Ratcliffe interval	4698	-2684
Isochore		126	

N.D.G.S. W11 Number 4111
Union Oil of California
NPRR #1-15
SE SE Sec. 15 T 132 N, R 84 W
K.B. 1960

Tops:	Poplar interval	4477	-2517
	Ratcliffe interval	4559	-2599
Isochore		82	

HETTINGER COUNTY

N.D.G.S. Well Number 511
Socony Vacuum Company Pegasus Division
F-14-24P Jacobx #1
SW SW Sec. 24 T 134 N, R 96 W
K.B. 2616

Tops: Poplar interval	7339	-4723
Ratcliffe interval	7540	-4924
Isochore	201	
Total Carbonate	107	
Total Anhydrite	94	
A/C	.88	

N.D.G.S. Well Number 1926
Amerada Petroleum Corporation
#1 R Grosz
NW NE Sec. 35 T 136 N, R 93 W
K.B. 2549

Tops: Poplar interval	7204	-4655
Ratcliffe interval	7411	-4862
Isochore	207	
Total Carbonate	139	
Total Anhydrite	68	
A/C	.49	

KIDDER COUNTY

N.D.G.S. Well Number 230
The Carter Oil Company
State #1
NE SE Sec. 16 T 143 N, R 71 W
K.B. 1889

Tops: Poplar interval	not present
Isochore	0

LOGAN COUNTY

N.D.G.S. Well Number 590
Caroline Hunt Trust Est.
F. M. Fuller #1
SW SE Sec. 6 T 136 N, R 73 W
K.B. 2011

Tops: Poplar interval	not present
Isochore	0

MCHENRY COUNTY

N.D.G.S. Well Number 1632
Triton Oil Company
Fredrickson #1
SW NE Sec. 24 T 157 N, R 80 W
K.B. 1509

Tops:	Poplar interval	3796	-2287
	Ratcliffe interval	3914	-2405
Isochore		118	

N.D.G.S. Well Number 1668
Triton Oil Company
Freeman #1
SW NE Sec. 8 T 155 N, R 78 W
K.B. 1521

Tops:	Poplar interval	3636	-2115
	Ratcliffe interval	3684	-2163
Isochore		48	

N.D.G.S. Well Number 1697
Triton Oil Company
Gange #1
SE SW Sec. 4 T 153 N, R 76 W
K.B. 1551

Tops:	Poplar interval	3330	-1779
	Ratcliffe interval	3334	-1783
Isochore		4	

N.D.G.S. Well Number 1720
Hunt Oil Company
Frank Boehm #1
NE NE Sec. 30 T 154 N, R 77 W
K.B. 1557

Tops:	Poplar interval	3524	-1967
	Ratcliffe interval	3570	-2013
Isochore		46	

N.D.G.S. Well Number 2504
Cardinal Petroleum Haciendo Oil
Olaf Nelson et al., #1
NW NW Sec. 31 T 155 N, R 76 W
K.B. 1517

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 3201
Cardinal Petroleum Company
Rothgarn #1
SE SE Sec. 22 T 157 N, R 79 W
K.B. 1498

Tops: Poplar interval	3636	-2138
Ratcliffe interval	3688	-2190
Isochore	52	

N.D.G.S. Well Number 3670
Geochemical Surveys
Johnson-Bank of North Dakota #1
NW SW Sec. 6 T 156 N, R 79 W
K.B. 1509

Tops: Poplar interval	3725	-2216
Ratcliffe interval	3790	-2281
Isochore	65	

N.D.G.S. Well Number 4112
Kewanee Oil Company
Torg #1
NW SW Sec. 8 T 156 N, R 80 W
K.B. 1526

Tops: Poplar interval	3984	-2422
Ratcliffe interval	4103	-2577
Isochore	155	

N.D.G.S. Well Number 4148
Peltex-Continental Oil Company
U.S.A. Schimelfenig #1
SE SE Sec. 11 T 156 N, R 79 W
K.B. 1493

Tops:	Poplar interval	3610	-2117
	Ratcliffe interval	3660	-2167
Isochore		50	

MCKENZIE COUNTY

N.D.G.S. Well Number 545
Phillips Skelly, Gulf
Hoehn A-1
NE SE Sec. 13 T 152 N, R 102 W
K.B. 2278

Tops:	Poplar interval	8700	-6422
	Ratcliffe interval	9262	-6984
Isochore		562	

N.D.G.S. Well Number 956
Gulf Oil Corporation & Sun Oil Company
Bennie-Pierre-Federal #1
NW SW Sec. 28 T 148 N, R 104 W
K.B. 2339

Tops:	Poplar interval	8560	-6221
	Ratcliffe interval	9100	-6761
Isochore		540	
Total Salt		238	
Total Carbonate		252	
Total Anhydrite		50	
A/C		.20	

N.D.G.S. Well Number 1267
Amerada Petroleum Corporation
Halvor Rolfsrud
SE NE Sec. 17 T 152 N, R 96 W
K.B. 2457

Tops:	Poplar interval	8250	-5793
	Ratcliffe interval	8830	-6373
Isochore		580	

N.D.G.S. Well Number 1765
The Texas Company
R. Koeser (NCT-1) #1
NW NW Sec. 35 T 151 N, R 97 W
K.B. 2431

Tops:	Poplar interval	8620	-6189
	Ratcliffe interval	9212	-6781
Isochore		592	

N.D.G.S. Well Number 1971
Amerada Petroleum Corporation
Bear Den Unit #2
NE NE Sec. 25 T 149 N, R 96 W
K.B. 2514

Tops:	Poplar interval	8771	-6257
	Ratcliffe interval	9327	-6813
Isochore		556	
Total Salt		183	
Total Carbonate		333	
Total Anhydrite		40	
A/C		.12	

N.D.G.S. Well Number 2382
Gulf Oil Corporation
Lawrence Bird's Bill #1
NW NE Sec. 30 T 150 N, R 94 W
K.B. 2167

Tops:	Poplar interval	8370	-6203
	Ratcliffe interval	8985	-6818
Isochore		615	

N.D.G.S. Well Number 2452
Amerada Petroleum Corporation
Lillibridge #2
SW SE Sec. 20 T 150 N, R 96 W
K.B. 2304

Tops:	Poplar interval	8510	-6206
	Ratcliffe interval	9063	-6759
Isochore		553	

N.D.G.S. Well Number 2645
Amerada Petroleum Corporation
U.S.A. Forest #1
NE SW Sec. 21 T 153 N, R 94 W
K.B. 2199

Tops: Poplar interval	8507	-6308
Ratcliffe interval	9110	-8911
Isochore	603	

N.D.G.S. Well Number 2667
Texaco, Inc.
Gov't Mary Paae #1
SW NW Sec. 14 T 146 N, R 101 W
K.B. 2392

Tops: Poplar interval	8742	-6350
Ratcliffe interval	9261	-6869
Isochore	519	
Total Salt	239	
Total Carbonate	204	
Total Anhydrite	76	
A/C	.37	

N.D.G.S. Well Number 2786
H. L. Hunt
U.S.A. "A" #1
NW SW Sec. 15 T 148 N, R 102 W
K.B. 2383

Tops: Poplar interval	8774	-6391
Ratcliffe interval	9325	-6942
Isochore	551	
Total Salt	222	
Total Carbonate	289	
Total Anhydrite	40	
A/C	.14	

N.D.G.S. Well Number 2849
Lyda Hunt-Herbert Trust's, et al.
Henry C. Hystad #1
NE SW Sec. 31 T 152 N, R 99 W
K.B. 2316

Tops: Poplar interval	8905	-6589
Ratcliffe interval	9546	-7230
Isochore	641	
Total Salt	273	
Total Carbonate	301	
Total Anhydrite	67	
A/C	.22	

N.D.G.S. Well Number 2969
Texaco, Inc.
Gov't Dorough "E" (NCT-2) #9
NW SE Sec. 21 T 151 N, R 95 W
K.B. 2608

Tops: Poplar interval	8605	-5997
Ratcliffe interval	9188	-6580
Isochore	583	

N.D.G.S. Well Number 2987
H. L. Hunt
USA "B" #1
C. NE Sec. 22 T 145 N, R 101 W
K.B. 2381

Tops: Poplar interval	8638	-6257
Ratcliffe interval	9130	-6749
Isochore	492	
Total Salt	205	
Total Carbonate	207	
Total Anhydrite	80	
A/C	.39	

N.D.G.S. Well Number 3157
Caroline Hunt Trust Estate
Martin Nelson #1-A
NW SE Sec. 11 T 149 N, R 98 W
K.B. 2232

Tops: Poplar interval	8815	-6583
Ratcliffe interval	9432	-7200
Isochore	617	
Total Salt	314	
Total Carbonate	237	
Total Anhydrite	66	
A/C	.28	

N.D.G.S. Well Number 3537
Calvert Drilling & Producing Company
Belquist #1
NW NW Sec. 15 T 15 N, R 95 W
K.B. 2250

Tops: Poplar interval	8292	-6042
Ratcliffe interval	8863	-6613
Isochore	571	
Total Salt	249	
Total Carbonate	259	
Total Anhydrite	63	
A/C	.24	

N.D.G.S. Well Number 3843
Calvert Drilling & Producing Company et al.
Muirhead-Helseth Unit #1
NE NE Sec. 27 T 151 N, R 96 W
K.B. 2385

Tops: Poplar interval	8420	-6035
Ratcliffe interval	8982	-6597
Isochore	562	
Total Salt	268	
Total Carbonate	242	
Total Anhydrite	52	
A/C	.22	

N.D.G.S. Well Number 3975
Tom Jordan
Heart Heirs #1
SW SW Sec. 17 T 151 N, R 94 W
K.B. 2070

Tops:	Poplar interval	8188	-6118
	Ratcliffe interval	8760	-6690
Isochore		572	
Total Salt		285	
Total Carbonate		201	
Total Anhydrite		86	
A/C		.43	

N.D.G.S. Well Number 4050
Amerada Petroleum Corporation
Skjelvik Unit #1
SE SW Sec. 26 T 150 N, R 97 W
K.B. 2237

Tops:	Poplar interval	8528	-6291
	Ratcliffe interval	9090	-6853
Isochore		562	
Total Salt		266	
Total Carbonate		213	
Total Anhydrite		83	
A/C		.39	

N.D.G.S. Well Number 4061
Mobil Oil Corporation
Grady Heirs F-11-16-1
NW NW Sec. 16 T 152 N, R 93 W
K.B. 2020

Tops:	Poplar interval	8170	-6150
	Ratcliffe interval	8716	-6696
Isochore		546	
Total Salt		282	
Total Carbonate		199	
Total Anhydrite		65	
A/C		.33	

N.D.G.S. Well Number 4062
Shell Oil Company
22X-28-1
SE NW Sec. 28 T 148 N, R 101 W
K.B. 2214

Tops: Poplar interval	8168	-5954
Ratcliffe interval	9010	-6796
Isochore	842	
Total Salt	379	
Total Carbonate	324	
Total Anhydrite	139	
A/C	.43	

N.D.G.S. Well Number 4304
Helmerich & Payne, Inc.
Federal McKenzie #1 (OWDO-AFE-7607)
NE NW Sec. 33 T 146 N, R 104 W
K.B. 2515

Tops: Poplar interval	8624	-6109
Ratcliffe interval	9128	-6613
Isochore	504	
Total Salt	216	
Total Carbonate	208	
Total Anhydrite	80	
A/C	.38	

N.D.G.S. Well Number 4361
Calvert Drilling & Producing Company
Quale #1-Bank of North Dakota
SE NW Sec. 31 T 153 N, R 95 W
K.B. 2298

Tops: Poplar interval	7905	-5605
Ratcliffe interval	8532	-6234
Isochore	627	
Total Salt	269	
Total Carbonate	280	
Total Anhydrite	78	
A/C	.29	

N.D.G.S. Well Number 4395
Shell Oil Company
Turnquist #13X-15
NW SW Sec. 15 T 148 N, R 101 W
K.B. 2246

Tops:	Poplar interval	9293	-7047
	Ratcliffe interval	9780	-7534
Isochore		487	
Total Salt		221	
Total Carbonate		212	
Total Anhydrite		54	
A/C		.25	

N.D.G.S. Well Number 4439
J. H. Moore-R. E. Massengill et al.
Olson #1
NE SE Sec. 18 T 151 N, R 103 W
K.B. 2200

Tops:	Poplar interval	8540	-6340
	Ratcliffe interval	9102	-6902
Isochore		562	
Total Salt		253	
Total Carbonate		246	
Total Anhydrite		63	
A/C		.26	

N.D.G.S. Well Number 4617
King Resources
Anton Zurn Estate
NW NE Sec. 1 T 145 N, R 99 W
K.B. 2652

Tops:	Poplar interval	9212	-6560
	Ratcliffe interval	9628	-6976
Isochore		416	
Total Salt		143	
Total Carbonate		209	
Total Anhydrite		64	
A/C		.31	

N.D.G.S. Well Number 4807
Consolidated Oil & Gas
Federal Land Bank #24-1
NW¼ Sec. 24 T 151 N, R 101 W
K.B. 2130

Tops: Poplar interval	8618	-6488
Ratcliffe interval	9196	-7066
Isochore	578	
Total Salt	319	
Total Carbonate	210	
Total Anhydrite	49	
A/C	.23	

MCLEAN COUNTY

N.D.G.S. Well Number 432
Herman Hanson Oil Syndicate
NE Hanson #1
SW SE Sec. 2 T 146 N, R 81 W
K.B. 1957

Tops: Poplar interval	4980	-3023
Ratcliffe interval	5150	-3193
Isochore	170	
Total Carbonate	87	
Total Anhydrite	83	
A/C	.96	

N.D.G.S. Well Number 1194
Calvert Drilling, Inc.
George S. Wolf #1
NW NE Sec. 5 T 149 N, R 90 W
K.B. 1989

Tops: Poplar interval	7658	-5669
Ratcliffe interval	8005	-6016
Isochore	347	

N.D.G.S. Well Number 1516
Herman Hanson Oil Sundicate
Samuelson #1
SE SW Sec. 32 T 146 N, R 82 W
K.B. 2022

Tops: Poplar interval	5444	-3422
Ratcliffe interval	5626	-3605
Isochore	182	
Total Carbonate	109	
Total Anhydrite	73	
A/C	.67	

N.D.G.S. Well Number 3076
I. J. Wilhite
Arnold Tarasenko #1
SE NW Sec. 14 T 150 N, R 79 W
K.B. 2089

Tops: Poplar interval	4500	-2411
Ratcliffe interval	4676	-2587
Isochore	176	
Total Carbonate	15	
Total Anhydrite	95	
A/C	1.17	

N.D.G.S. Well Number 3089
Cardinal Petroleum Company-
National Bulk Carriers
Carl Ecklund #1
NW NW Sec. 14 T 150 N, R 80 W
K.B. 2006

Tops: Poplar interval	4680	-2674
Ratcliffe interval	4885	-2879
Isochore	205	
Total Carbonate	96	
Total Anhydrite	109	
A/C	1.14	

N.D.G.S. Well Number 4375
Empire State Oil Company
Young Bear-Sanderson #1
NW NE Sec. 1 T 148 N, R 90 W
K.B. 2064

Tops: Poplar interval	7462	-5398
Ratcliffe interval	7774	-5710
Isochore	312	
Total Salt	89	
Total Carbonate	149	
Total Anhydrite	74	
A/C	.50	

MERCER COUNTY

N.D.G.S. Well Number 21
F. F. Kelly
#1 F. Leutz
NW NE Sec. 28 T 142 N, R 89 W
K.B. 2286

Tops:	Poplar interval	7270	-4984
	Ratcliffe interval	7515	-5229
Isochore		245	

N.D.G.S. Well Number 377
Williston Oil & Gas Company
Boeckel et al., #1
SW SW Sec. 10 T 144 N, R 88 W
K.B. 2059

Tops:	Poplar interval	6960	-4901
	Ratcliffe interval	7210	-5151
Isochore		250	

N.D.G.S. Well Number 2826
Sinclair Oil & Gas Company
August Hauck #1
SE SE Sec. 1 T 143 N, R 90 W
K.B. 2200

Tops:	Poplar interval	7474	-5274
	Ratcliffe interval	7737	-5537
Isochore		263	
Total Salt		54	
Total Carbonate		134	
Total Anhydrite		75	
A/C		.56	

N.D.G.S. Well Number 4177
Pel-Tex Oil Company, Inc.
Herrmann #1
NE SW Sec. 17 T 145 N, R 88 W
K.B. 2203

Tops: Poplar interval	7348	-5145
Ratcliffe interval	7597	-5394
Isochore	249	
Total Salt	35	
Total Carbonate	146	
Total Anhydrite	68	
A/C	.47	

MORTON COUNTY

N.D.G.S. Well Number 133
Deep Rock Oil Company
Hilda Johnson
SW SW Sec. 30 T 139 N, R 86 W
K.B. 2204

Tops: Poplar interval	6152	-3948
Ratcliffe interval	6345	-4141
Isochore	193	
Total Carbonate	141	
Total Anhydrite	52	
A/C	.37	

N.D.G.S. Well Number 491
National Buld Carriers
Miller #1
NW NE Sec. 20 T 136 N, R 81 W
K.B. 1925

Tops: Poplar interval	4355	-2430
Ratcliffe interval	4495	-2570
Isochore	140	

N.D.G.S. Well Number 1620
Pan American Petroleum Corporation
Raymond Vetter #1
NE SW Sec. 27 T 139 N, R 90 W
K.B. 2426

Tops: Poplar interval	7054	-4628
Ratcliffe interval	7254	-4828
Isochore	200	
Total Salt	0	
Total Carbonate	135	
Total Anhydrite	65	
A/C	.48	

N.D.G.S. Well Number 2185
Fletcher Oil & Gas Company & Signal
Drilling & EPl. Company
Boehm #1
SW NE Sec. 11 T 139 N, R 82 W
K.B. 1861

Tops:	Poplar interval	4769	-2908
	Ratcliffe interval	4914	-3058
Isochore		150	

N.D.G.S. Well Number 3859
Amerada Petroleum Corporation
James Meyer #1
SE NE Sec. 34 T 135 N, R 83 W
K.B. 2125

Tops:	Poplar interval	4736	-2611
	Ratcliffe interval	4890	-2765
Isochore		154	

N.D.G.S. Well Number 3978
Austral Oil Company, Inc.
John J. Leingang Unit 6524 #1
SE NW Sec. 34 T 137 N, R 83 W
K.B. 2281

Tops:	Poplar interval	5115	-2834
	Ratcliffe interval	5328	-3047
Isochore		213	

N.D.G.S. Well Number 416
O.W.R. Oil Company
Nels Johnsberg #1
C. SW NW Sec. 15 T 158 N, R 93 W
K.B. 2413

Tops:	Poplar interval	7710	-5297
	Ratcliffe interval	8040	-5627
Isochore		330	

N.D.G.S. Well Number 474
W. H. Hunt
#1 W. & D. Dunham
C. NW NW Sec. 24 T 155 N, R 90 W
K.B. 2161

Tops:	Poplar interval	7100	-4939
	Ratcliffe interval	7390	-5229
Isochore		290	

N.D.G.S. Well Number 592
William Herbert Hunt
Erwin G. Horne #1
SE NW Sec. 14 T 156 N, R 92 W
K.B. 2322

Tops:	Poplar interval	7685	-5362
	Ratcliffe interval	8037	-5715
Isochore		352	

N.D.G.S. Well Number 1012
Amerada Petroleum Corporation
Maryon Sather
C. NE NE Sec. 3 T 157 N, R 94
K.B. 2389

Tops:	Poplar interval	7630	-5241
	Ratcliffe interval	8120	-5731
Isochore		490	
Total Salt		198	
Total Carbonate		111	
Total Anhydrite		103	
A/C		.55	

N.D.G.S. Well Number 1844
Anschutz Drilling Company, Inc.
Arthur Lehman #1
C. SW SW Sec. 10 T 158 N, R 91 W
K.B. 2402

Tops:	Poplar interval	7198	-4796
	Ratcliffe interval	7480	-5078
Isochore		282	
Total Salt		34	
Total Carbonate		164	
Total Anhydrite		38	
A/C		.18	

N.D.G.S. Well Number 2273
Stewart Petroleum Company
Cvancara #1
C. NW SW Sec. 15 T 155 N, R 93 W
K.B. 2360

Tops:	Poplar interval	8214	-5854
	Ratcliffe interval	8743	-6383
Isochore		529	

N.D.G.S. Well Number 2779
NW Edmund
W. A. Spletstroser #1
SW NW Sec. 19 T 152 N, R 88 W
K.B. 2086

Tops:	Poplar interval	6966	-4880
	Ratcliffe interval	7249	-5163
Isochore		283	
Total Salt		34	
Total Carbonate		191	
Total Anhydrite		58	
A/C		.30	

N.D.G.S. Well Number 2816
Davis Oil Company
Len Carkuff #1
C. SW SE Sec. 12 T 154 N, R 92 W
K.B. 2389

Tops: Poplar interval	8040	-5651
Ratcliffe interval	8450	-6061
Isochore	410	
Total Salt	144	
Total Carbonate	217	
Total Anhydrite	49	
A/C	.23	

N.D.G.S. Well Number 3005
I. J. Wilhite
Kreuger #1
C. SW SW Sec. 9 T 158 N, R 89 W
K.B. 2342

Tops: Poplar interval	6650	-4308
Ratcliffe interval	6930	-4588
Isochore	280	
Total Salt	29	
Total Carbonate	182	
Total Anhydrite	69	
A/C	.38	

N.D.G.S. Well Number 3227
Amerada Petroleum
N.D. "N" #1
SE SE Sec. 16 T 155 N, R 94 W
K.B. 2030

Tops: Poplar interval	7860	-5830
Ratcliffe interval	8447	-6417
Isochore	587	

N.D.G.S. Well Number 3317
Jack Grynberg
Johnsonberg #1
NW NE Sec. 25 T 153 N, R 92 W
K.B. 2308

Tops: Poplar interval	8126	-5815
Ratcliffe interval	8548	-6240
Isochore	422	
Total Salt	152	
Total Carbonate	191	
Total Anhydrite	79	
A/C	.41	

N.D.G.S. Well Number 3540
Pan American Petroleum Corporation
Gradon Quigley
SE SE Sec. 30 T 158 N, R 88 W
K.B. 2259

Tops: Poplar interval	6428	-4169
Ratcliffe interval	6680	-4421
Isochore	252	
Total Salt	0	
Total Carbonate	181	
Total Anhydrite	71	
A/C	.39	

N.D.G.S. Well Number 3581
Pan American Petroleum Corporation
K. Jellberg #1
NW NW Sec. 5 T 156 N, R 88 W
K.B. 2268

Tops: Poplar interval	6570	-4302
Ratcliffe interval	6814	-4546
Isochore	244	
Total Salt	0	
Total Carbonate	160	
Total Anhydrite	84	
A/C	.53	

N.D.G.S. Well Number 4113
Texaco, Inc.-Skelly Oil Company
Fort Berthold-Allottees #1-A
SE NW Sec. 4 T 150 N, R 93 W
K.B. 2198

Tops: Poplar interval	8434	-6240
Ratcliffe interval	8938	-6740
Isochore	500	
Total Salt	216	
Total Carbonate	220	
Total Anhydrite	64	
A/C	.29	

N.D.G.S. Well Number 4194
Rex Baker
Amdal No. 1420
SW SW Sec. 20 T 157 N, R 89 W
K.B. 2222

Tops: Poplar interval	6754	-4532
Ratcliffe interval	7040	-4818
Isochore	286	
Total Salt	24	
Total Carbonate	151	
Total Anhydrite	111	
A/C	.74	

N.D.G.S. Well Number 4386
Empire State Oil Company et al.
Vorwerk #1
SE SE Sec. 28 T 151 N, R 90 W
K.B. 2216

Tops: Poplar interval	7738	-5522
Ratcliffe interval	8048	-5832
Isochore	310	
Total Salt	80	
Total Carbonate	172	
Total Anhydrite	58	
A/C	.34	

N.D.G.S. Well Number 4682
Union Oil Company of California
Edwin Johnson #1
SE SE Sec. 4 T 157 N, R 91 W
K.B. 2372

Tops: Poplar interval	7341	-4969
Ratcliffe interval	7635	-5263
Isochore	294	
Total Salt	54	
Total Carbonate	158	
Total Anhydrite	82	
A/C	.52	

OLIVER COUNTY

N.D.G.S. Well Number 283
Fletcher Oil & Gas Company & Signal
Drilling & Exploration Company
Rueligen #1
NW NW Sec. 34 T 141 N, R 85 W
K.B. 2173

Tops:	Poplar interval	6030	-3857
	Ratcliffe interval	6213	-4040
Isochore		183	

N.D.G.S. Well Number 3277
Sunray DX Oil Company
#1 Henke
NE SE Sec. 14 T 142 N, R 85 W
K.B. 2193

Tops:	Poplar interval	6051	-3858
	Ratcliffe interval	6239	-4046
Isochore		188	
Total Salt		0	
Total Carbonate		128	
Total Anhydrite		60	
A/C		.47	

PIERCE COUNTY

N.D.G.S. Well Number 2209
Cardinal-Great American
Bessel #1
SE NE Sec. 33 T 152 N, R 72 W
K.B. 1624

Tops: Poplar interval	not present
Isochore	0

N.D.G.S. Well Number 3877
The Oil Capitol Corporation
Hager F. L. B. #1
SE NW Sec. 15 T 151 N, R 74 W
K.B. 1577

Tops: Poplar interval	not present
Isochore	0

N.D.G.S. Well Number 3879
The Oil Capitol Corporation
Schneider #1
SW SE Sec. 11 T 153 N, R 74 W
K.B. 1560

Tops: Poplar interval	not present
Isochore	0

RENVILLE COUNTY

N.D.G.S. Well Number 1178
Sohio Petroleum Company
Hanson #1
SW SW Sec. 9 T 163 N, R 87 W
K.B. 1814

Tops:	Poplar interval	4691	-2877
	Ratcliffe interval	4739	-2935
Isochore		48	

N.D.G.S. Well Number 1602
Petroleum Corporation of America
Lillian Krueger #1
NW NE Sec. 26 T 161 N, R 87 W
K.B. 1858

Tops:	Poplar interval	5110	-3252
	Ratcliffe interval	5262	-3403
Isochore		152	

N.D.G.S. Well Number 1815
Davis Oil Company
Jensen #1
NW NW Sec. 21 T 162 N, R 87 W
K.B. 1856

Tops:	Poplar interval	5030	-3174
	Ratcliffe interval	5148	-3292
Isochore		118	

N.D.G.S. Well Number 1822
Tom Jordan F. M. Ricks Signal Drilling
J. K. Routledge
NE NW Sec. 29 T 163 N, R 86 W
K.B. 1802

Tops:	Poplar interval	not present
Isochore		0

N.D.G.S. Well Number 2679
Western Natural Gas Company
Weber #1
NE SW Sec. 1 T 158 N, R 82 W
K.B. 1550

Tops:	Poplar interval	4090	-2540
	Ratcliffe interval	4245	-2795
Isochore		155	

N.D.G.S. Well Number 2697
Cardinal Petroleum Company
SW SW Sec. 36 T 160 N, R 84 W
K.B. 1633

Tops:	Poplar interval	4365	-2732
	Ratcliffe interval	4415	-2782
Isochore		50	

N.D.G.S. Well Number 3335
Clyde W. Jones-Shell Oil-Sun Oil
#1 Larson
NE SW Sec. 31 T 160 N, R 85 W
K.B. 1782

Tops:	Poplar interval	4974	-3192
	Ratcliffe interval	5100	-3318
Isochore		126	

N.D.G.S. Well Number 3359
Cardinal
Engebretson #1
NE NE Sec. 28 T 161 N, R 85 W
K.B. 1764

Tops:	Poplar interval	4740	-2976
	Ratcliffe interval	4760	-2994

N.D.G.S. Well Number 3534
Fred Goodstein
Ralph Fuchs #1
NW NW Sec. 29 T 159 N, R 84 W
K.B. 1714

Tops:	Poplar interval	4702	-2988
	Ratcliffe interval	4824	-3110
Isochore		122	

N.D.G.S. Well Number 3953
Chandler and Associates
McCarroll No. 1
SW NE Sec. 4 T 162 N, R 86 W
K.B.

Tops:	Poplar interval	not present
Isochore		0

N.D.G.S. Well Number 4238
The Anshutz Corporation, Inc.
Sandberg #1
NW NE Sec. 28 T 158 N, R 86 W
K.B. 1890

Tops:	Poplar interval	5454	-3564
	Ratcliffe interval	5690	-3800
Isochore		236	
Total Salt		0	
Total Carbonate		118	
Total Anhydrite		74	
A/C		.46	

N.D.G.S. Well Number 4277
Tiger Oil Company
Bloms #1
SW NW Sec. 10 T 148 N, R 84 W
K.B. 1721

Tops:	Poplar interval	4710	-2989
	Ratcliffe interval	4855	-3134
Isochore		145	

N.D.G.S. Well Number 4470
Northwestern Refining Company-
North Star Petroleum Company
Annie Einerson #1
NW NW Sec. 22 T 158 N, R 85 W
K.B. 1819

Tops:	Poplar interval	5080	-3261
	Ratcliffe interval	5288	-3469
Isochore		208	

N.D.G.S. Well Number 4709
Stratigraphic Oil Company
Rikka Ness #1
NE NW Sec. 1 T 161 N, R 86 W
K.B. 1769

Tops:	Poplar interval	4745	-2976
	Ratcliffe interval	4758	-2989
Isochore		13	

SHERIDAN COUNTY

N.D.G.S. Well Number 693
Caroline Hunt Trust Estate
#1 Walter E. Bauer
SW SW Sec. 19 T 146 N, R 76 W
K.B. 1984

Tops:	Poplar interval	4024	-2040
	Ratcliffe interval	4123	-2137
Isochore		99	

N.D.G.S. Well Number 735
Caroline Hunt Trust Estate
C. A. Pfieffer #1
SW SW Sec. 16 T 146 N, R 74 W
K.B. 1994

Tops:	Poplar interval	3470	-1476
	Ratcliffe interval	3613	-1619
Isochore		143	

N.D.G.S. Well Number 1392
Continental & Pure Oil Companies
Albrecht #1
NE NE Sec. 27 T 146 N, R 77 W
K.B. 1954

Tops:	Poplar interval	4010	-2056
	Ratcliffe interval	4150	-2196
Isochore		140	

N.D.G.S. Well Number 1605
General Crude Oil Company
McElvain #1
NE NW Sec. 18 T 145 N
K.B. 2011

Tops:	Poplar interval	3814	-1803
	Ratcliffe interval	3883	-1872
Isochore		69	

SIOUX COUNTY

N.D.G.S. Well Number 631
The Ohio Oil Company
#1 Standing Rock Sioux Tribal
NE SE Sec. 29 T 131 N, R 80 W
K.B. 1732

Tops:	Poplar interval	3502	-1770
	Ratcliffe interval	3578	-1855
Isochore		76	

SLOPE COUNTY

N.D.G.S. Well Number 2805
North American Royalties et al.
Hamann Estate #1
SE SE Sec. 9 T 135 N, R 101 W
K.B. 2795

Tops: Poplar interval	8140	-5345
Ratcliffe interval	8340	-5545
Isochore	200	
Total Salt	0	
Total Carbonate	113	
Total Anhydrite	87	
A/C	.77	

N.D.G.S. Well Number 3383
Pan American Petroleum Corporation
Lydia Foreman #1
SW SE Sec. 23 T 133 N, R 106 W
K.B. 2798

Tops: Poplar interval	7012	-4214
Ratcliffe interval	7208	-4410
Isochore	196	

N.D.G.S. Well Number 3588
Sun Oil Company
Greer-Federal #1
SE SE Sec. 21 T 134 N, R 105 W
K.B. 2895

Tops: Poplar interval	7601	-4706
Ratcliffe interval	7800	-4905
Isochore	199	
Total Salt	0	
Total Carbonate	124	
Total Anhydrite	75	
A/C	.60	

N.D.G.S. Well Number 4119
H. L. Hunt
U.S.A. -8 #1
SE NW Sec. 8 T 136 N, R 101 W
K.B. 2725

Tops: Poplar interval	8240	-5515
Ratcliffe interval	8470	-5745
Isochore	230	
Total Salt	19	
Total Carbonate	112	
Total Anhydrite	99	
A/C	.82	

N.D.G.S. Well Number 4280
Amerada Petroleum Corporation
Ivan Mitchell #1
NE NW Sec. 18 T 135 N, R 103 W
K.B. 2971

Tops: Poplar interval	8198	-5227
Ratcliffe interval	8392	-5421
Isochore	194	
Total Salt	0	
Total Carbonate	124	
Total Anhydrite	70	
A/C	.56	

STARK COUNTY

N.D.G.S. Well Number 613
Amerada Petroleum Corporation
R. E. Newton #1
NW SW Sec. 31 T 140 N, R 99 W
K.B. 2697

Tops:	Poplar interval	8798	-6101
	Ratcliffe interval	9129	-6432
Isochore		331	

N.D.G.S. Well Number 810
Southern Production Company, Inc. &
Texaco Oil Company
Frank J. Wamner #1
NW NW Sec. 9 T 137 N, R 97 W
K.B. 2690

Tops:	Poplar interval	8290	-5600
	Ratcliffe interval	8510	-5820
Isochore		220	

N.D.G.S. Well Number 1536
Skelly Oil Company
Weigum #1
SE NW Sec. 25 T 138 N, R 99 W
K.B. 2644

Tops:	Poplar interval	8446	-5802
	Ratcliffe interval	8702	-6058
Isochore		256	
Total Salt		36	
Total Carbonate		114	
Total Anhydrite		106	
A/C		.93	

N.D.G.S. Well Number 1574
Northern Pump Company
C. Braun #1
NW NW Sec. 15 T 137 N, R 99 W
K.B. 2733

Tops:	Poplar interval	8450	-5715
	Ratcliffe interval	8700	-5967
Isochore		250	

N.D.G.S. Well Number 1935
Sinclair Oil and Gas Company
#1 Joe Muecke
SE NE Sec. 29 T 140 N, R 94 W
K.B. 2427

Tops:	Poplar interval	8022	-5595
	Ratcliffe interval	8270	-5843
Isochore		248	
Total Salt		39	
Total Carbonate		140	
Total Anhydrite		69	
A/C		.49	

N.D.G.S. Well Number 2004
Skelly Oil Company
#1 Paul Stieg
NW SW Sec. 9 T 138 N, R 92 W
K.B. 2416

Tops:	Poplar interval	7345	-4929
	Ratcliffe interval	7557	-5141
Isochore		212	
Total Carbonate		155	
Total Anhydrite		57	
A/C		.37	

N.D.G.S. Well Number 2075
Skelly Oil Company
S. Merrill #1
SE NW Sec. 33 T 140 N, R 98 W
K.B. 2526

Tops: Poplar interval	8620	-6094
Ratcliffe interval	8880	-6354
Isochore	260	
Total Salt	44	
Total Carbonate	140	
Total Anhydrite	76	
A/C	.54	

N.D.G.S. Well Number 2117
Tennessee Gas
#1 Casimec Duletski
NW NW Sec. 16 T 139 N, R 99 W
K.B. 2644

Tops: Poplar interval	8678	-6034
Ratcliffe interval	9002	-6358
Isochore	324	
Total Salt	41	
Total Carbonate	181	
Total Anhydrite	77	
A/C	.43	

N.D.G.S. Well Number 2496
Atlantic Refining Company
Anton Eberts #1
SE SE Sec. 18 T 138 N, R 97 W
K.B. 2726

Tops: Poplar interval	8464	-5738
Ratcliffe interval	8707	-5981
Isochore	243	
Total Salt	26	
Total Carbonate	122	
Total Anhydrite	95	
A/C	.78	

N.D.G.S. Well Number 3515
Continental Oil Company
Stoxen #1
NW NW Sec. 9 T 140 N, R 93 W
K.B. 2292

Tops: Poplar interval	7665	-5373
Ratcliffe interval	7962	-5670
Isochore	297	
Total Salt	63	
Total Carbonate	171	
Total Anhydrite	63	
A/C	.38	

N.D.G.S. Well Number 4134
Texaco, Inc.
Schank (NCT-1) #1
NW SE Sec. 15 T 137 N, R 92 W
K.B. 2341

Tops: Poplar interval	6990	-4649
Ratcliffe interval	7194	-4853
Isochore	204	
Total Carbonate	128	
Total Anhydrite	75	
A/C	.59	

N.D.G.S. Well Number 4198
Pel-Tex Petroleum Company, Inc.
Biel Dreis #1
SE NW Sec. 29 T 137 N, R 95 W
K.B. 2813

Tops: Poplar interval	8092	-5279
Ratcliffe interval	8298	-5485
Isochore	206	
Total Carbonate	111	
Total Anhydrite	95	
A/C	.86	

N.D.G.S. Well Number 4250
Wolf Exploration Company
Dvorak #1
SE NW Sec. 17 T 139 N, R 97 W
K.B. 2486

Tops: Poplar interval	8350	-5864
Ratcliffe interval	8598	-6112
Isochore	248	
Total Salt	30	
Total Carbonate	132	
Total Anhydrite	86	
A/C	.65	

N.D.G.S. Well Number 4446
Union Oil Company of California
R. P. Pflepsen #1
NW NW Sec. 11 T 139 N, R 93 W
K.B. 2456

Tops: Poplar interval	7662	-5206
Ratcliffe interval	7896	-5440
Isochore	234	
Total Salt	22	
Total Carbonate	141	
Total Anhydrite	71	
A/C	.50	

WARD COUNTY

N.D.G.S. Well Number 588
W. H. Hunt
F. C. Newman #1
SW SE Sec. 33 T 152 N, R 82 W
K.B. 2087

Tops:	Poplar interval	5214	-3127
	Ratcliffe interval	5450	-3363
Isochore		236	

N.D.G.S. Well Number 995
Calvert Drilling, Inc.
H. Sinclair #1
C. SW SE Sec. 23 T 160 N, R 89 W
K.B. 1998

Tops:	Poplar interval	5782	-3784
	Ratcliffe interval	6022	-5024
Isochore		240	
Total Carbonate		100	
Total Anhydrite		79	
A/C		.49	

N.D.G.S. Well Number 1061
Calvert Drilling, Inc.
Gilbert Jacobson
C. SW SW Sec. 20 T 153 N, R 84 W
K.B. 2112

Tops:	Poplar interval	6110	-3998
	Ratcliffe interval	6367	-4255
Isochore		257	

N.D.G.S. Well Number 1801
Anschutz Drilling Company &
Sun Oil Company
O. Nielson #1
C. SW NE Sec. 21 T 159 N, R 87 W
K.B. 1954

Tops:	Poplar interval	6504	-3650
	Ratcliffe interval	5864	-3892
Isochore		242	
Total Salt		0	
Total Carbonate		182	
Total Anhydrite		60	
A/C		.32	

N.D.G.S. Well Number 1843
Anschutz Drilling Company, Inc.-
M. B. Rudman
Harriet Sinclair
NW NW Sec. 32 T 159 N, R 88 W
K.B. 2141

Tops:	Poplar interval	6133	-3992
	Ratcliffe interval	6380	-4239
Isochore		247	
Total Salt		0	
Total Carbonate		199	
Total Anhydrite		48	
A/C		.24	

N.D.G.S. Well Number 2051
Davils Oil Company
Allen Peterson #1
SE NE Sec. 28 T 153 N, R 86 W
K.B. 2117

Tops:	Poplar interval	6318	-4201
	Ratcliffe interval	6570	-4453
Isochore		252	
Total Salt		12	
Total Anhydrite		88	
Total Carbonate		152	
A/C		.58	

N.D.G.S. Well Number 2929
I. J. Wilhite-Clyde W. Jones
Novak-North American Royalties #1
SE NW Sec. 6 T 155 N, R 82 W
K.B. 1631

Tops:	Poplar interval	4566	-2935
	Ratcliffe interval	4800	-3169
Isochore		234	
Total Salt		0	
Total Carbonate		128	
Total Anhydrite		106	
A/C		.83	

N.D.G.S. Well Number 2930
I. J. Wilhite-Clyde W. Jones
Arthur W. Benno
K.B. 1845
NW NW Sec. 8 T 154 N, R 83 W

Tops:	Poplar interval	5084	-3239
	Ratcliffe interval	5318	-3473
Isochore		234	
Total Salt		0	
Total Carbonate		128	
Total Anhydrite		16	
A/C		.83	

N.D.G.S. Well Number 3080
Cardinal Petr.
Ed Mathis #1
SE SE Sec. 13 T 153 N, R 83 W
K.B. 2110

Tops:	Poplar interval	5341	-3231
	Ratcliffe interval	5590	-3480
Isochore		249	
Total Salt		0	
Total Carbonate		146	
Total Anhydrite		103	
A/C		.71	

N.D.G.S. Well Number 3166
Simcox Oil Company
Clarence Chilson
NW SW Sec. 16 T 157 N, R 81 W
K.B. 1584

Tops: Poplar interval	4136	-2552
Ratcliffe interval	4285	-2701
Isochore	149	

N.D.G.S. Well Number 3237
I. J. Wilhite
Vern Waldref #1
NE NW Sec. 19 T 154 N, R 81 W
K.B. 1566

Tops: Poplar interval	4500	-2934
Ratcliffe interval	4730	-3164
Isochore	230	
Total Salt	0	
Total Carbonate	134	
Total Anhydrite	96	
A/C	.72	

N.D.G.S. Well Number 3314
I. J. Wilhite
#1 Pietsch
SW SE Sec. 7 T 153 N, R 83 W
K.B. 2067

Tops: Poplar interval	5410	-3343
Ratcliffe interval	5688	-3621
Isochore	278	
Total Salt	0	
Total Carbonate	145	
Total Anhydrite	120	
A/C	.85	

N.D.G.S. Well Number 3445
Mule Creek Oil Company, Inc.
Harold Gowin #1-241
C. SE SW Sec. 1 T 157 N, R 82 W
K.B. 1567

Tops:	Poplar interval	4210	-2643
	Ratcliffe interval	4372	-2805
Isochore		162	

N.D.G.S. Well Number 3501
Calvert Drilling & Producing Company
Simon Fuchs No. 1
SE NW Sec. 23 T 156 N, R 81 W
K.B. 1562

Tops:	Poplar interval	4124	-2562
	Ratcliffe interval	4330	-2768
Isochore		206	

N.D.G.S. Well Number 3552
Anschutz Oil Company, Inc., Kewanee Oil Company
Stoa No. 1
C. SE NE Sec. 23 T 157 N, R 86 W
K.B. 1968

Tops:	Poplar interval	5594	-3626
	Ratcliffe interval	5835	-3867
Isochore		241	
Total Salt		0	
Total Carbonate		136	
Total Anhydrite		104	
A/C		.76	

N.D.G.S. Well Number 3557
Vaughn Petroleum, Inc.
State of North Dakota No. 19-1
SW SW Sec. 19 T 156 N, R 91 W
K.B. 1606

Tops:	Poplar interval	4318	-2712
	Ratcliffe interval	4574	-2969
Isochore		257	

N.D.G.S. Well Number 4097
Cardinal-Baker
21-36 Schwartz
NE NW Sec. 36 T 160 N, R 88 W
K.B. 1952

Tops:	Poplar interval	5540	-3588
	Ratcliffe interval	5818	-3866
Isochore		278	

N.D.G.S. Well Number 4153
Chandler & Associates, Inc.
No. 1 Wickman
Sec. 29 T 154 N, R 84 W
K.B. 2115

Tops:	Poplar interval	5624	-3509
	Ratcliffe interval	5857	-3742
Isochore		233	
Total Salt		0	
Total Carbonate		145	
Total Anhydrite		132	
A/C		91	

N.D.G.S. Well Number 4155
Pel-Tex Conoco
Davy #1
NW SE Sec. 10 T 155 N, R 84 W
K.B. 1818

Tops:	Poplar interval	5061	-3243
	Ratcliffe interval	5297	-3479
Isochore		236	

N.D.G.S. Well Number 4159
Pel-Tex-Conoco
Stevick
SE NE Sec. 22 T 155 N, R 85 W
K.B. 1996

Tops: Poplar interval	5574	-3578
Ratcliffe interval	5810	-3814
Isochore	236	
Total Salt	0	
Total Carbonate	147	
Total Anhydrite	89	
A/C	.61	

N.D.G.S. Well Number 4216
Pel-Tex-Conoco
Johnson #1
NE NE Sec. 36 T 156 N, R 87 W
K.B. 2263

Tops: Poplar interval	6190	-3927
Ratcliffe interval	6440	-4177
Isochore	250	
Total Salt	0	
Total Carbonate	164	
Total Anhydrite	86	
A/C	.52	

N.D.G.S. Well Number 4400
Harrington #1
Earl Schartz et al.
NW SE Sec. 10 T 156 N, R 84 W
K.B. 1730

Tops: Poplar interval	4818	-3088
Ratcliffe interval	5058	-4328
Isochore	240	
Total Salt	0	
Total Carbonate	171	
Total Anhydrite	69	
A/C	.65	

N.D.G.S. Well Number 4768
Wheless Drilling Company
Flammang #1
NE NW Sec. 23 T 155 N, R 86 W
K.B. 2255

Tops: Poplar interval	6078	-3823
Ratcliffe interval	6320	-4065
Isochore	242	
Total Salt	0	
Total Carbonate	168	
Total Anhydrite	74	
A/C	.44	

N.D.G.S. Well Number 4794
Cardinal & Burton
Schwede #1
NW SE Sec. 22 T 157 N, R 87 W
K.B. 2227

Tops: Poplar interval	6215	-3988
Ratcliffe interval	6456	-4229
Isochore	241	
Total Salt	0	
Total Carbonate	164	
Total Anhydrite	77	
A/C	.47	

N.D.G.S. Well Number 4805
Echo Oil Corporation
Livingston #1 1-22
NW NE Sec. 22 T 156 N, R 83 W
K.B. 1678

Tops: Poplar interval	4600	-2922
Ratcliffe interval	4825	-3147
Isochore	225	

N.D.G.S. Well Number 4891
Koch Exploration Company
Herigstad #1
SW SE Sec. 31 T 154 N, R 82 W
K.B. 1797

Tops: Poplar interval	4930	-3133
Ratcliffe interval	5165	-3368
Isochore	235	
Total Salt	0	
Total Carbonate	129	
Total Anhydrite	106	
A/C	.82	

WELLS COUNTY

N.D.G.S. Well Number 425
Wilson Germany
Dickenson #1
SE SE Sec. 32 T 145 N, R 72 W
K.B. 2060

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 1384
Continental & Pure Oil Companies
Board of Univ. & School Land #1
SW SW Sec. 16 T 147 N, R 73 W

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 3296
Cardinal Petroleum Company
A. Patzer #1
NW NE Sec. 22 T 149 N, R 73 W
K.B. 1622

Tops: Poplar interval	not present	
Isochore	0	

N.D.G.S. Well Number 4252
Chevron Oil Company
Grimm #1
SW NE Sec. 28 T 145 N, R 73 W
K.B. 1998

Tops: Poplar interval	3326	-1328
Ratcliffe interval	3410	-1412
Isochore	84	

WILLIAMS COUNTY

N.D.G.S. Well Number 313
Kenneth A. Ellison
Ellison North Dakota #1
NE NE Sec. 16 T 159 N, R 96 W
K.B. 2266

Tops:	Poplar interval	7380	-5114
	Ratcliffe interval	7893	-5627
Isochore		513	

N.D.G.S. Well Number 984
Pure Oil Company
Esterby #1
SW SW Sec. 11 T 159 N, R 100 W
K.B. 2056

Tops:	Poplar interval	7218	-5162
	Ratcliffe interval	7718	-5662
Isochore		500	
Total Salt		209	
Total Carbonate		221	
Total Anhydrite		56	
A/C		.25	

N.D.G.S. Well Number 1745
Hunt Oil Company
Willard Odegard Unit #1
C. NW Sec. 21 T 157 N, R 95 W
K.B. 2361

Tops:	Poplar interval	7520	-5159
	Ratcliffe interval	8060	-5699
Isochore		540	

N.D.G.S. Well Number 2091
Amerada Petroleum Corporation
Davidson Walla Unit #1
C. SW¼ Sec. 26 T 156 N, R 96 W
K.B. 2343

Tops:	Poplar interval	7611	-5268
	Ratcliffe interval	8203	-5860
Isochore		592	

N.D.G.S. Well Number 2476
Dakota Salt Chemical Company
Dakota Salt #1
NE NW Sec. 20 T 154 N, R 100 W
K.B. 1881

Tops:	Poplar interval	8310	-6429
	Ratcliffe interval	not penetrated	

N.D.G.S. Well Number 2515
Amerada Petroleum Corporation
Boe-Ferguson Unit #1
SW¼ Sec. 14 T 155 N, R 96 W
K.B. 2189

Tops:	Poplar interval	7456	-5267
	Ratcliffe interval	8056	-5867
Isochore		600	

N.D.G.S. Well Number 2828
Texaco, Inc.
L. J. Hovde #1
NW NW Sec. 15 T 154 N, R 98 W
K.B. 2233

Tops:	Poplar interval	8730	-6497
	Ratcliffe interval	9417	-7184
Isochore		687	
Total Salt		367	
Total Carbonate		197	
Total Anhydrite		122	
A/C		.62	

N.D.G.S. Well Number 2846
Hunt Oil Company & Skelly Oil Company
State of North Dakota #1
NW NE Sec. 16 T 158 N, R 103 W
K.B. 2165

Tops: Poplar interval	7451	-5286
Ratcliffe interval	7963	-5798
Isochore	512	

N.D.G.S. Well Number 3106
Hunt Petroleum Corporation
Larson Estate #1
SW SE Sec. 20 T 159 N, R 102 W
K.B. 2224

Tops: Poplar interval	7378	-5154
Ratcliffe interval	7878	-5654
Isochore	500	
Total Salt	174	
Total Carbonate	270	
Total Anhydrite	56	
A/C	.21	

N.D.G.S. Well Number 3235
Sun Oil Company
State #1
NW NW Sec. 16 T 156 N, R 101 W
K.B. 2168

Tops: Poplar interval	8248	-6080
Ratcliffe interval	8822	-6654
Isochore	574	
Total Salt	317	
Total Carbonate	211	
Total Anhydrite	46	
A/C	.22	

N.D.G.S. Well Number 3252
Hunt Oil Company
Annie S. Hoover et al., #1
NE NW Sec. 3 T 158 N, R 99 W
K.B. 2150

Tops: Poplar interval	7654	-5504
Ratcliffe interval	8160	-6010
Isochore	506	
Total Salt	207	
Total Carbonate	201	
Total Anhydrite	98	
A/C	.49	

N.D.G.S. Well Number 3274
H. L. Hunt
Carl T. Solem #1
C. NW SE Sec. 2 T 159 N, R 98 W
K.B. 2306

Tops: Poplar interval	7530	-5224
Ratcliffe interval	8038	-5732
Isochore	508	
Total Salt	208	
Total Carbonate	209	
Total Anhydrite	91	
A/C	.44	

N.D.G.S. Well Number 3363
Texaco, Inc.
Clarence Pederson #1
NW SE Sec. 19 T 157 N, R 96 W
K.B. 2332

Tops: Poplar interval	7995	-5663
Ratcliffe interval	8595	-6263
Isochore	600	
Total Salt	307	
Total Carbonate	210	
Total Anhydrite	83	
A/C	.40	

N.D.G.S. Well Number 3385
Continental Oil Company
Bakken State 2 #1
NE SW Sec. 2 T 156 N, R 95 W
K.B. 2249

Tops: Poplar interval	7533	-5284
Ratcliffe interval	8092	-5843
Isochore	559	
Total Salt	288	
Total Carbonate	222	
Total Anhydrite	49	
A/C	.22	

N.D.G.S. Well Number 3406
Hunt Petroleum Corporation
Emeila Erickson et al., #1
NE NE Sec. 10 T 156 N, R 99 W
K.B. 2281

Tops: Poplar interval	8446	-6165
Ratcliffe Interval	9071	-6790
Isochore	625	
Total Salt	325	
Total Carbonate	228	
Total Anhydrite	72	
A/C	.32	

N.D.G.S. Well Number 3439
Hunt Petroleum Corporation
Martin-Johnson #1
NE NW Sec. 4 T 158 N, R 100 W
K.B. 2011

Tops: Poplar interval	7454	-5443
Ratcliffe interval	7946	-5935
Isochore	492	
Total Salt	232	
Total Carbonate	201	
Total Anhydrite	59	
A/C	.29	

N.D.G.S. Well Number 3449
Hunt Petroleum Corporation
Chester J. Hamers #1
NW/4 Sec. 20 T 157 N, R 98 W
K.B. 2213

Tops: Poplar interval	8216	-6003
Ratcliffe interval	8814	-6601
Isochore	598	

N.D.G.S. Well Number 3471
H. L. Hunt
Richard Larsen #1
SW NW Sec. 15 T 157 N, R 103 W
K.B. 2474

Tops: Poplar interval	8065	-5591
Ratcliffe interval	8606	-6132
Isochore	541	
Total Salt	258	
Total Carbonate	193	
Total Anhydrite	90	
A/C	.47	

N.D.G.S. Well Number 3979
Sun Oil Company
Heier #1
NE SE Sec. 25 T 159 N, R 95 W
K.B. 2284

Tops: Poplar interval	7228	-4944
Ratcliffe interval	7729	-5545
Isochore	501	
Total Salt	183	
Total Carbonate	244	
Total Anhydrite	74	
A/C	.30	

N.D.G.S. Well Number 4340
Pan American Petroleum Corporation
Clifford Marmon #1
360' N/S - 660 E/W Sec. 2 T 154 N, R 95 W
K.B. 1972

Tops:	Poplar interval	7640	-5668
	Ratcliffe interval	8250	-6278
Isochore		610	
Total Salt		330	
Total Carbonate		218	
Total Anhydrite		62	
A/C		.28	

N.D.G.S. Well Number 4597
Lamar Hunt
Donald Voll #1
SW NE Sec. 5 T 154 N, R 103 W
K.B. 2338

Tops:	Poplar interval	8430	-6092
	Ratcliffe interval	9008	-6670
Isochore		578	
Total Salt		275	
Total Carbonate		225	
Total Anhydrite		78	
A/C		.35	

N.D.G.S. Well Number 4618
Amerada Petroleum Corporation
Trogstad #1
NE NW Sec. 17 T 156 N, R 103 W
K.B. 2413

Tops:	Poplar interval	8189	-5776
	Ratcliffe interval	8753	-6340
Isochore		564	

N.D.G.S. Well Number 4903
Monsanto Company
Twin State #16-1
SW NE Sec. 16 T 159 N, R 103 W
K.B. 2034

Tops:	Poplar interval	6991	-4957
	Ratcliffe interval	7510	-5476
Isochore		519	

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NORTH DAKOTA

PLATE # 1

STRUCTURE CONTOUR MAP
TOP OF POPLAR INTERVAL
SHOWING POPLAR SUBCROP

CONTOUR INTERVAL = 100 FEET

SCALE 0 6 12 18 24 30 MILES

C.W. COOK 1974

LEGEND

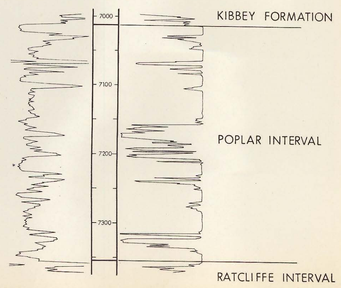
-4648 — SUBSEA ELEVATION. (R.S. — RATCLIFFE SUBCROP.)

○ — CONTROL WELL.

3586 — N.D.G.S. NUMBER.

POPLAR SUBCROP.
(PRE-MESOZOIC TRUNCATION)

NDGS 3586
NW-SE-24-160-93
KB 2364



NORTH DAKOTA

PLATE # 2

ISOCHORE MAP

POPLAR INTERVAL

SHOWING POPLAR SUBCROP

CONTOUR INTERVAL = 25 FEET

SCALE 0 6 12 18 24 30 MILES

C.W. COOK 1974

LEGEND

340 — APPARENT THICKNESS.

O — CONTROL WELL.

3586 — N.D.G.S. NUMBER.

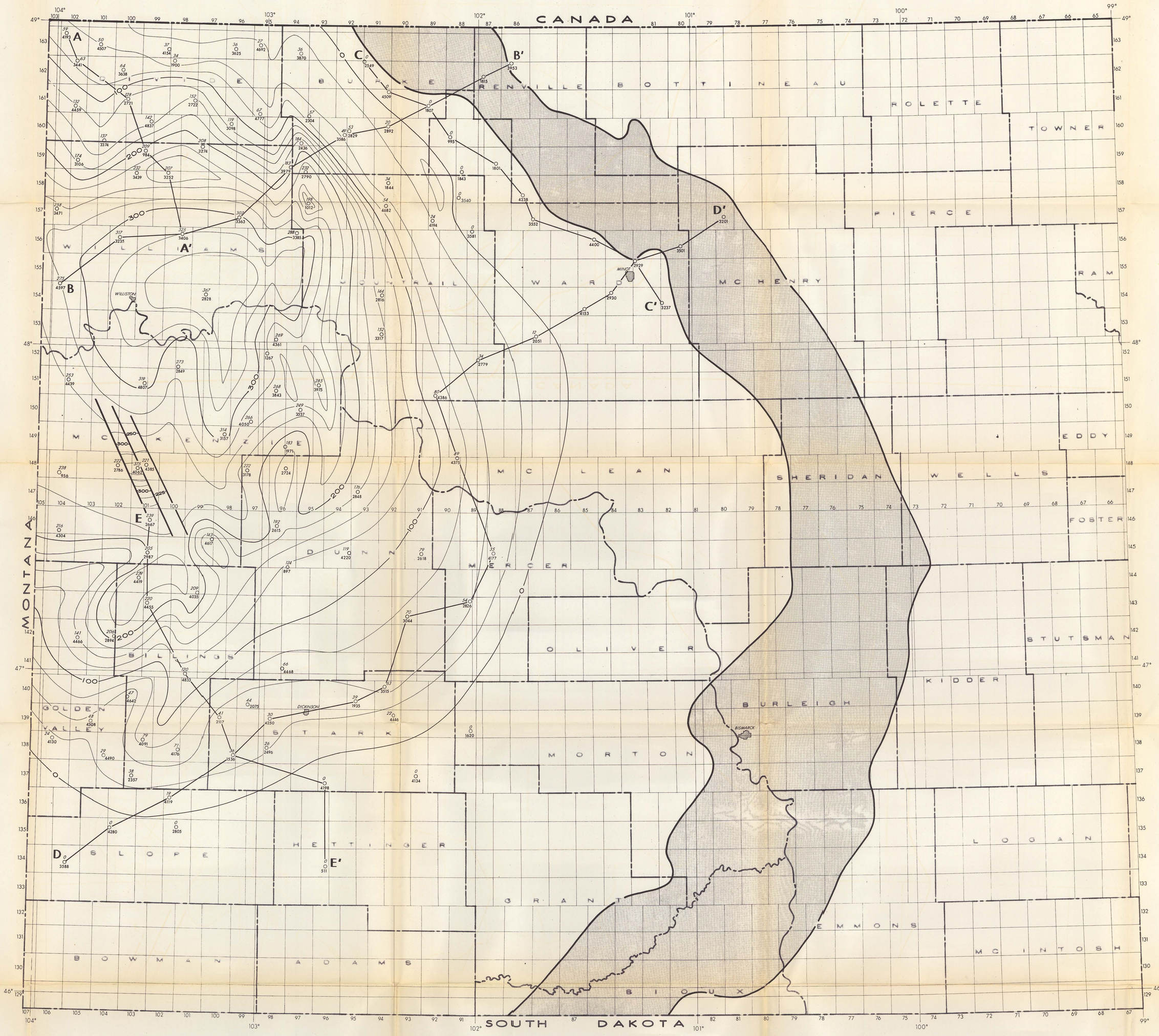
POPLAR SUBCROP. (PRE MESOZOIC TRUNCATION.)

NDGS 3586
NW-SE-24-160-93
KB 2364

KIBBEY FORMATION

POPLAR INTERVAL

RATCLIFFE INTERVAL



LEGEND

49 ---- APPARENT THICKNESS.

○ ---- CONTROL WELL.

3586 ---- N.D.G.S. NUMBER.

POPLAR SUBCROP.
(PRE-MESOZOIC TRUNCATION)

NORTH DAKOTA

PLATE # 3

TOTAL SALT ISOCHORE
POPLAR INTERVAL
SHOWING POPLAR SUBCROP

CONTOUR INTERVAL = 25 FEET

SCALE 0 6 12 18 24 30 MILES

C.W. COOK 1974

LEGEND

.28 ○ 3586 — ANHYDRITE / CARBONATE RATIO. CONTROL WELL. N.D.G.S. NUMBER.

POPLAR SUBCROP. (PRE-MESOZOIC TRUNCATION)

NORTH DAKOTA

PLATE #4

ANHYDRITE / CARBONATE RATIO MAP

POPLAR INTERVAL

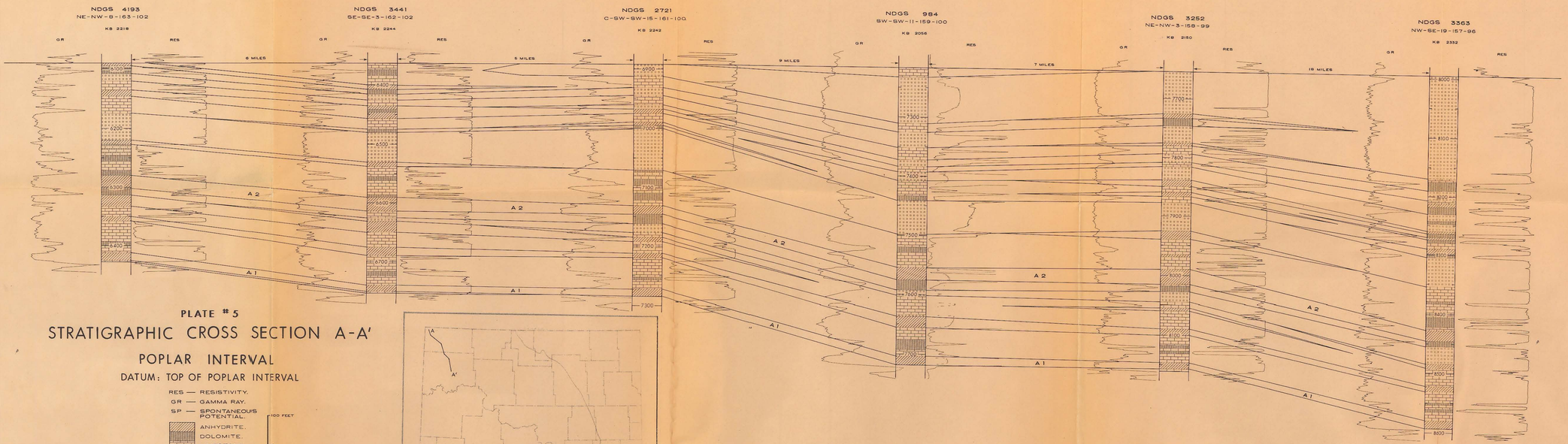
SHOWING POPLAR SUBCROP

CONTOUR INTERVAL = 0.10 FT. ANHYDRITE TO 1.00 FT. CARBONATE

SCALE 0 6 12 18 24 30 MILES

C.W. COOK 1974

A



A'

PLATE # 5

STRATIGRAPHIC CROSS SECTION A-A'

POPLAR INTERVAL

DATUM: TOP OF POPLAR INTERVAL

RES — RESISTIVITY.
GR — GAMMA RAY.
SP — SPONTANEOUS POTENTIAL.

ANHYDRITE.
DOLOMITE.
LIMESTONE.
SALT.

100 FEET
50
0
AS NOTED

C. V. Cook
1974

B

B′

NDGS 4597
SW-NE-E-154-103
KB 2338

NDGS 3235
NW-NW-16-156-101
KB 2188

NDGS 3406
C-NE-NE-10-155-99
KB 2281

NDGS 3363
SW-SE-19-157-95
KB 2332

NDGS 3979
NE-SE-25-159-95
KB 2284

NDGS 3586
NW-SE-24-160-93
KB 2384

NDGS 2892
SW-SW-10-160-9
KB 2327

NDGS 1807
NE-NW-21-161-89
KB 1894

NDGS 1815
NW-NW-21-162-97
KB 1854

GR RES SP

18 MILES 14 MILES 15 MILES 15 MILES 15 MILES 10 MILES 10 MILES 15 MILES 6 MILES

DPO

A2 A1

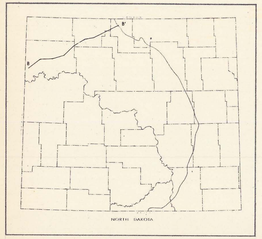


PLATE # 6

STRATIGRAPHIC CROSS SECTION B-B′

POPLAR INTERVAL

DATUM: TOP OF POPLAR INTERVAL

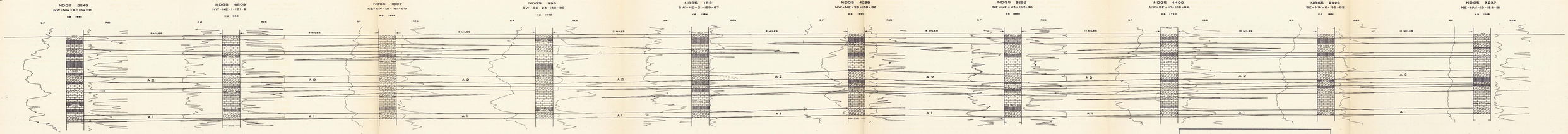
RES — RESISTIVITY.
GR — GAMMA RAY.
SP — SPONTANEOUS POTENTIAL.

ANHYDRITE.
DOLOMITE.
LIMESTONE.
SALT.

100 FEET
50
0
AS NOTED

C. W. COOK 1974

C



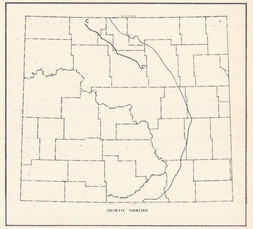


PLATE # 7

STRATIGRAPHIC CROSS SECTION C-C'

POPLAR INTERVAL

DATUM: TOP OF POPLAR INTERVAL

RES — RESISTIVITY.
GR — GAMMA RAY.
SP — SPONTANEOUS POTENTIAL.

ANHYDRITE.
DOLOMITE.
LIMESTONE.
SALT.

100 FEET
50
0
AS NOTED

C.W. COOK 1974

C'

D

→ D″

NDGS 3566
SE-SE-21-154-105
K.B. 2895

NDGS 4280
NE-SW-18-155-103
K.B. 2871

NDGS 419
NE-SW-9-156-101
K.B. 2721

NDGS 1536
SE-NW-25-158-99
K.B. 2854

NDGS 4250
SE-NW-17-159-97
K.B. 2688

NDGS 1935
SE-NE-29-160-94
K.B. 2437

NDGS 3515
NW-NW-9-160-93
K.B. 2292

NDGS 3044
NE-NE-27-161-92
K.B. 2200

NDGS 2826
SE-SW-1-161-90
K.B. 2200

NDGS 4177
NE-SW-17-161-88
K.B. 2205

D ←

D″

NDGS 4177
NE-SW-17-161-88
K.B. 2205

NDGS 4375
NW-NE-1-160-90
K.B. 2084

NDGS 4366
SE-SE-28-157-90
K.B. 2315

NDGS 2779
SW-NW-9-152-88
K.B. 2098

NDGS 2051
SE-NE-28-153-86
K.B. 2117

NDGS 4153
NE-NE-23-154-84
K.B. 2115

NDGS 2930
NW-NW-8-154-83
K.B. 1845

NDGS 2929
SE-NW-6-155-82
K.B. 1831

NDGS 3501
SE-NW-23-156-81
K.B. 1962

NDGS 3201
SE-SE-22-157-79
K.B. 1989

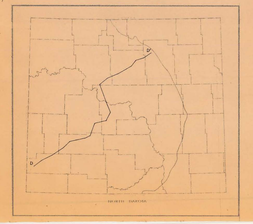


PLATE #8

STRATIGRAPHIC CROSS SECTION D-D′

POPLAR INTERVAL

DATUM: TOP OF POPLAR INTERVAL

RES — RESISTIVITY.
GR — GAMMA RAY.
SP — SPONTANEOUS POTENTIAL.

ANHYDRITE.
DOLOMITE.
LIMESTONE.
SALT.

100 FEET

AS NOTED

C.W. COOK 1974

E

NDGS 2667
SW-NW-14-146-101
KB 2392

NDGS 2987
C-NE-22-146-101
KB 2361

NDGS 4485
NE-NE-18-143-101
KB 2480

NDGS 4833
NE-NW-34-141-101
KB 2693

NDGS 2117
NW-NW-16-139-99
KB 2844

NDGS 1536
SE-NW-25-138-99
KB 2644

NDGS 4198
SE-NW-29-137-95
KB 2913

NDGS 511
SW-SW-24-134-96
KB 2614

E'

GR RES SP

8 MILES 11 MILES 17 MILES 12 MILES 9 MILES 21 MILES 19 MILES

A2 A1

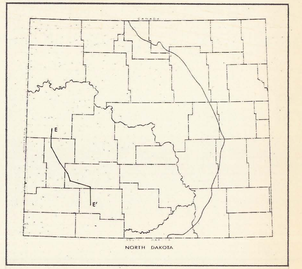


PLATE #9

STRATIGRAPHIC CROSS SECTION E-E'

POPLAR INTERVAL

DATUM: TOP OF POPLAR INTERVAL

RES — RESISTIVITY.
GR — GAMMA RAY.
SP — SPONTANEOUS POTENTIAL.

ANHYDRITE.
DOLOMITE.
LIMESTONE.
SALT.

100 FEET
50
0
AS NOTED

C.W. COOK 1974