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POTASH
IN NORTH DAKOTA

by

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POTASH IN NORTH DAKOTA

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ABSTRACT

Potash deposits are believed present in the Devonian Prairie Formation in northwestern North Dakota. This is based on gamma ray logs of the Prairie of North Dakota which correlate closely with gamma ray logs of the Prairie of adjacent areas in Saskatchewan and Manitoba where potash is known to be present. Depths to North Dakota potash range from about 5,800 to 12,500 feet, with the shallowest near the Bottineau-Renville County line in north-central North Dakota and the deepest in Dunn and McKenzie Counties in western North Dakota. Exploitation of potash at these depths is contingent on solution mining techniques. The potash occurs in several beds within a thick section of halite. Individual beds range in thickness from a few feet to as much as 20 feet.

INTRODUCTION

At the present time there is no potash mining in North Dakota. However, potash deposits are currently being developed in southeastern Saskatchewan by both conventional and solution mining methods.

The conventional mines are being developed in areas where the potash deposits are present at depths of 3,000 to 3,500 feet. A solution mining project is operating near Belle Plaine, Saskatchewan where the potash beds are present at a depth greater than 5,000 feet. Potash deposits are also known to be present in Manitoba at depths of about 3,000 feet thus making conventional mining methods also possible there.

About sixty wells in northwestern North Dakota have penetrated evaporite beds which are believed to contain potash deposits. This belief is based on comparisons of the gamma ray log characteristics of these wells with logs of wells penetrating known potash sections in Saskatchewan and Manitoba.

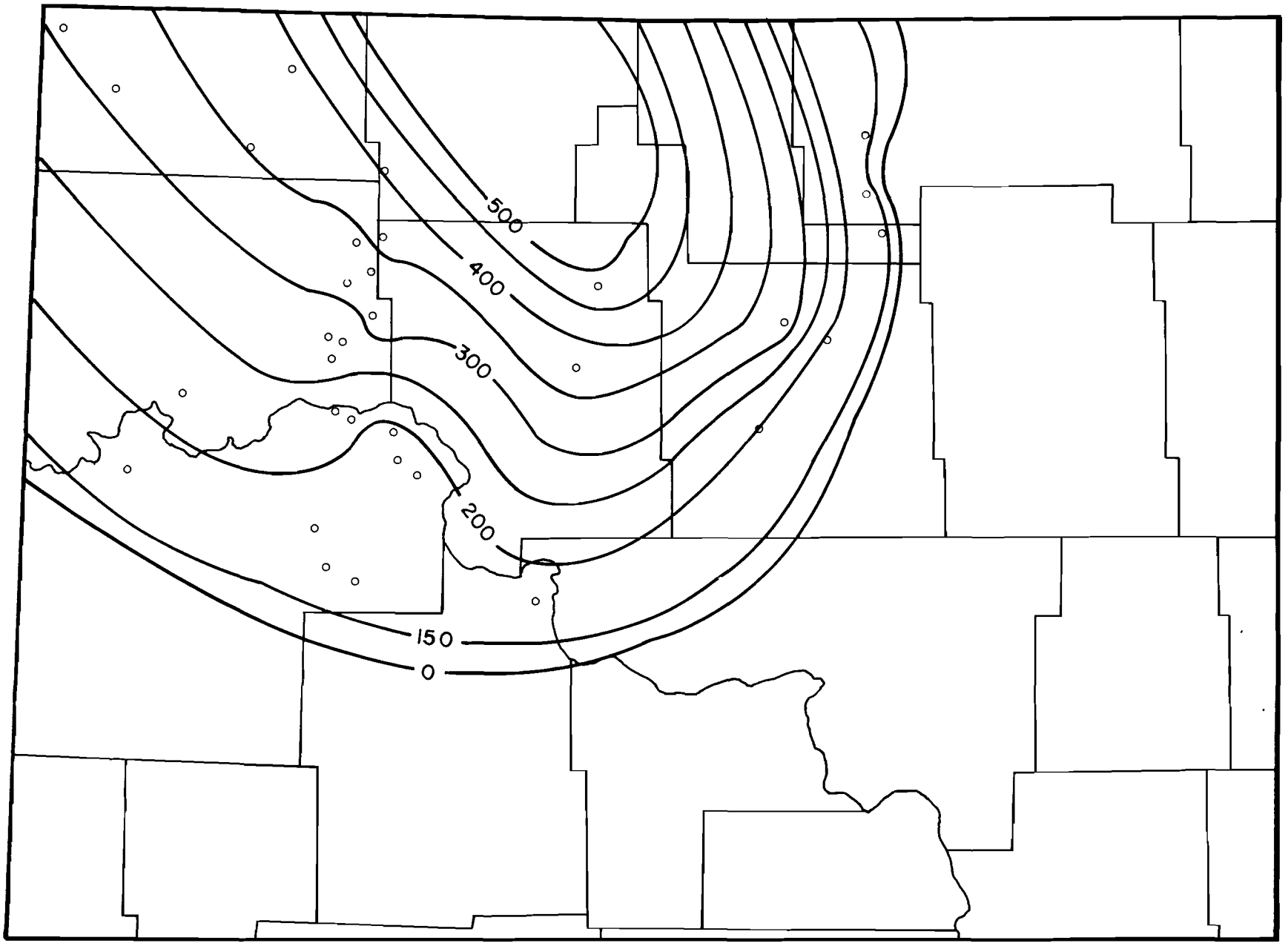


FIGURE 1 — ISOPACH MAP OF PRAIRIE FORMATION

The purpose of the present study is to show the similarities of the stratigraphic sections of the Prairie Formation in Manitoba, Saskatchewan and North Dakota and to provide information necessary to promote serious investigation of the potash potential of North Dakota. Such an investigation should recognize that we cannot expect to find potash deposits at depths favorable for conventional mining methods, so production will have to depend on solution mining techniques.

STRATIGRAPHY

The Prairie Formation, of Middle Devonian age, is present in northwestern North Dakota (fig. 1), where it ranges in thickness from zero to more than 500 feet, thickening northwestward into Saskatchewan. The Prairie conformably overlies the Winnipegosis Formation (Middle Devonian) and is conformably overlain by the Dawson Bay Formation (Middle Devonian).

A typical section of the Prairie is shown by the log (fig 2.) of the Carter Oil Company - Dallas Moore No. 1 well, located in NW NE Sec. 7, T. 163 N., R. 102 W., Divide County, North Dakota. In this well the Prairie is about 315 feet thick and there appear to be two potash beds; one at a depth of 9,230 to 9,245 feet and one at a depth of 9,295 to 9,302 feet. Cuttings of the Prairie from this well were logged as salt; no potash cuttings were recognized. Similar descriptions are also available for other wells which have penetrated the Prairie Formation and used salt base muds. The lack of recognition of potash in the cuttings may be due to the greater solubility of potash relative to halite, but potash may have been overlooked because of its physical similarities to halite. One stratigraphic test hole, the TXL - gas storage well, located in SE NW Sec. 7, T. 162 W., Burke County, cored the Prairie Formation, probably including the supposed potash section, but this core and any information regarding chemical analyses of that core have not been released by Texaco, the present operator.

In Manitoba, Bannatyne (1960, p. 10) has shown a comparison of a gamma ray log of a cored section of the Prairie Formation with the chemical analyses of the core (fig. 3). The increasing intensities of the gamma ray log with the higher grade potassium oxide analyses are clearly shown. Similarly (Potash in Saskatchewan, 1965, fig. 1) a close correlation between increasing potassium oxide values and increasing gamma ray intensity is shown by a gamma ray log of a cored section in Saskatchewan. Therefore, although we have not examined cuttings or cores of potash from the Prairie Formation of North Dakota, we feel confident that when future cores are cut through more radioactive beds of the Prairie Formation in North Dakota, relatively high grade potash deposits will be found.

CARTER OIL COMPANY — D. MOORE NO. 1
NW NE 7-163-102
DIVIDE COUNTY

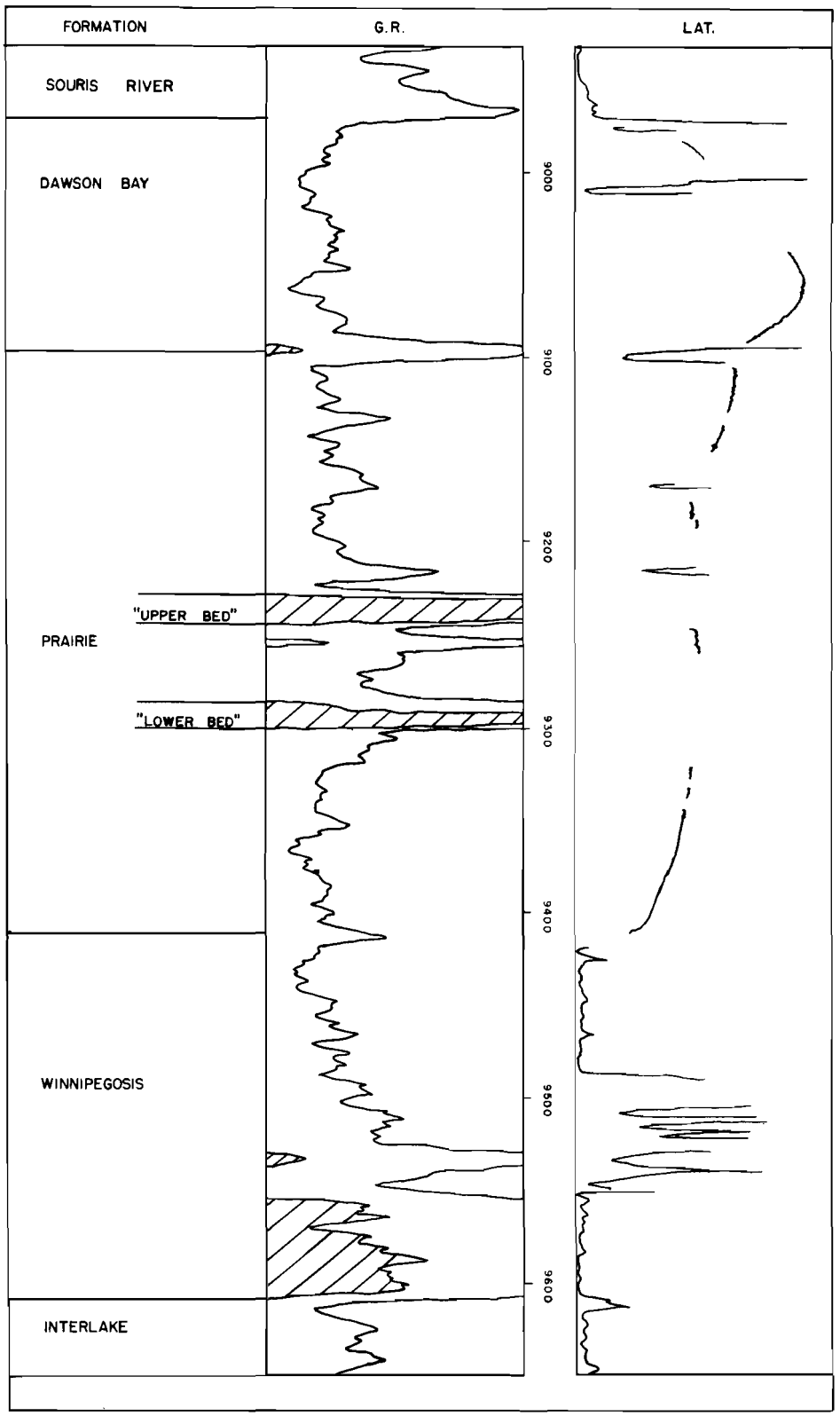


FIGURE 2 – TYPICAL GAMMA RAY LOG OF DAWSON BAY, PRAIRIE AND WINNIPEGOSIS FORMATIONS IN NORTHWESTERN NORTH DAKOTA

Examination of the logs of all wells penetrating the Prairie Formation indicate that there is considerable variation in gamma ray characteristics within the Prairie Formation in North Dakota. Most of the wells show two distinct "potash beds" based on the gamma ray characteristics; however, some wells have only one bed, others have three or four beds, and the TXL well has six fairly distinct beds. Until cores have been cut and chemcial analyses obtained it cannot be determined if one bed is of much higher quality than another. The general thickness and number of "potash beds" is shown on the isopach map (fig. 4), which shows that the greatest cumulative thickness is found in two wells in Burke County. The depth-to-potash map (fig. 5) is based on the depth to the main bed where only one bed is present, and to the "upper bed" where two or more beds are present. It may be noted from this map that in North Dakota the persistent "potash beds" have been penetrated at shallowest depths in western Bottineau and eastern Renville Counties, where these beds are present at depths of slightly more than 6,000 feet in two wells near the eastern limit of the Prairie Formation. The gamma ray intensities seem to indicate that relatively high grade potash deposits will be found wherever more than 100 feet of Prairie Formation is penetrated.

POTENTIAL ROLE OF NORTH DAKOTA IN WORLD POTASH MARKET

The United States currently leads the world in potash production, with 90 per cent of domestic production coming from Carlsbad, New Mexico (Minerals Yearbook, 1963, p. 922). The other major producers are West and East Germany, France, Russia, and Canada. The major market for potash is the fertilizer industry; with a large part of this market located in the midwestern United States. Thus, potash deposits of North Dakota, which are almost certainly present over a wide area of the northwestern part of the State, are favorably located geographically for the major domestic potash markets. As the Saskatchewan mines are developed and the Carlsbad reserves are depleted, Saskatchewan will very likely capture a large portion of this midwestern market if North Dakota deposits are not developed. Canada will then replace the United States as the leader in world potash production.

Canadian potash deposits generally range in grade from about 25 to 35 percent K_2O equivalent content, and are the highest grade known potash deposits in the world. Potash deposits currently being mined average about 19 per cent K_2O equivalent in New Mexico and about 15 per cent in West Germany (Minerals Yearbook, 1963, p. 913). It may be anticipated that North Dakota potash deposits will be similar in grade to the Canadian deposits.

Potash deposits of North Dakota are at depths that will require development of solution mining techniques before they can be utilized. These deposits

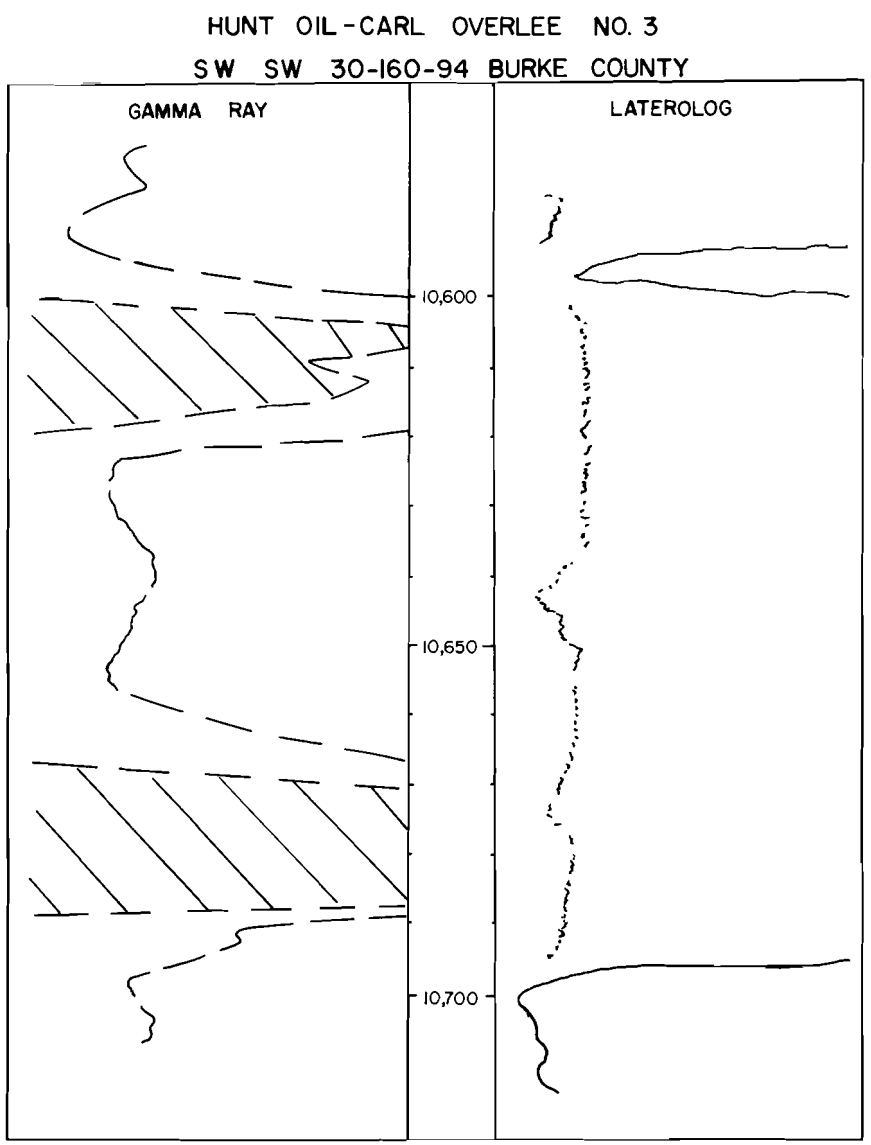


FIGURE 3-BANNATYNE, 1960, P. 10.

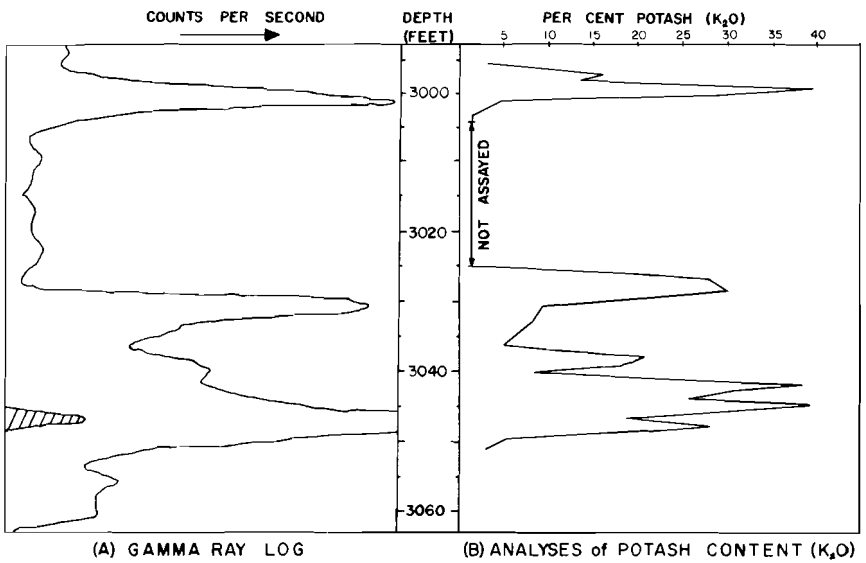


FIGURE 3 – COMPARISON OF A TYPICAL NORTH DAKOTA GAMMA RAY LOG OF THE PRAIRIE FORMATION WITH A LOG AND CHEMICAL ANALYSIS FROM MANITOBA

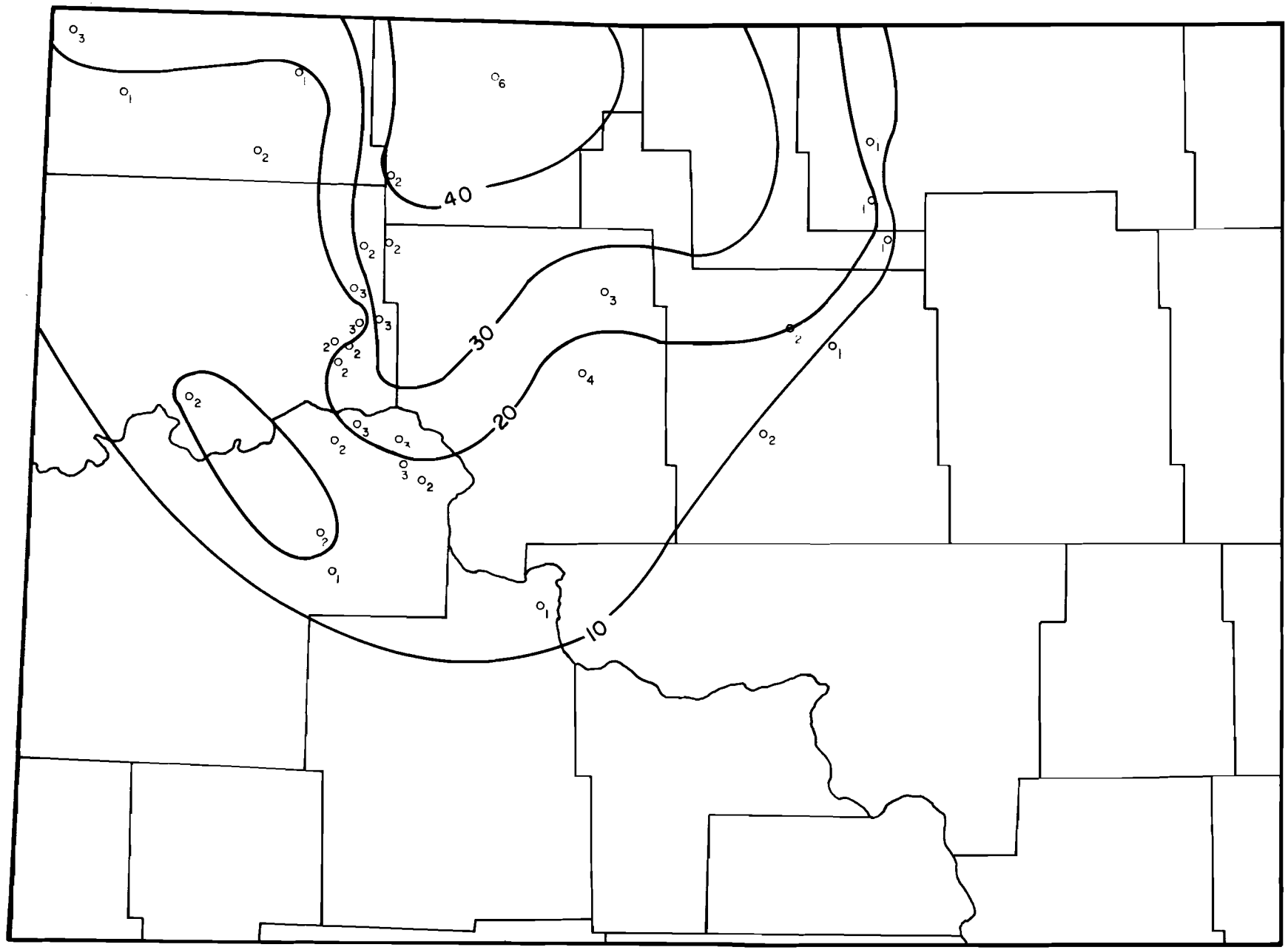
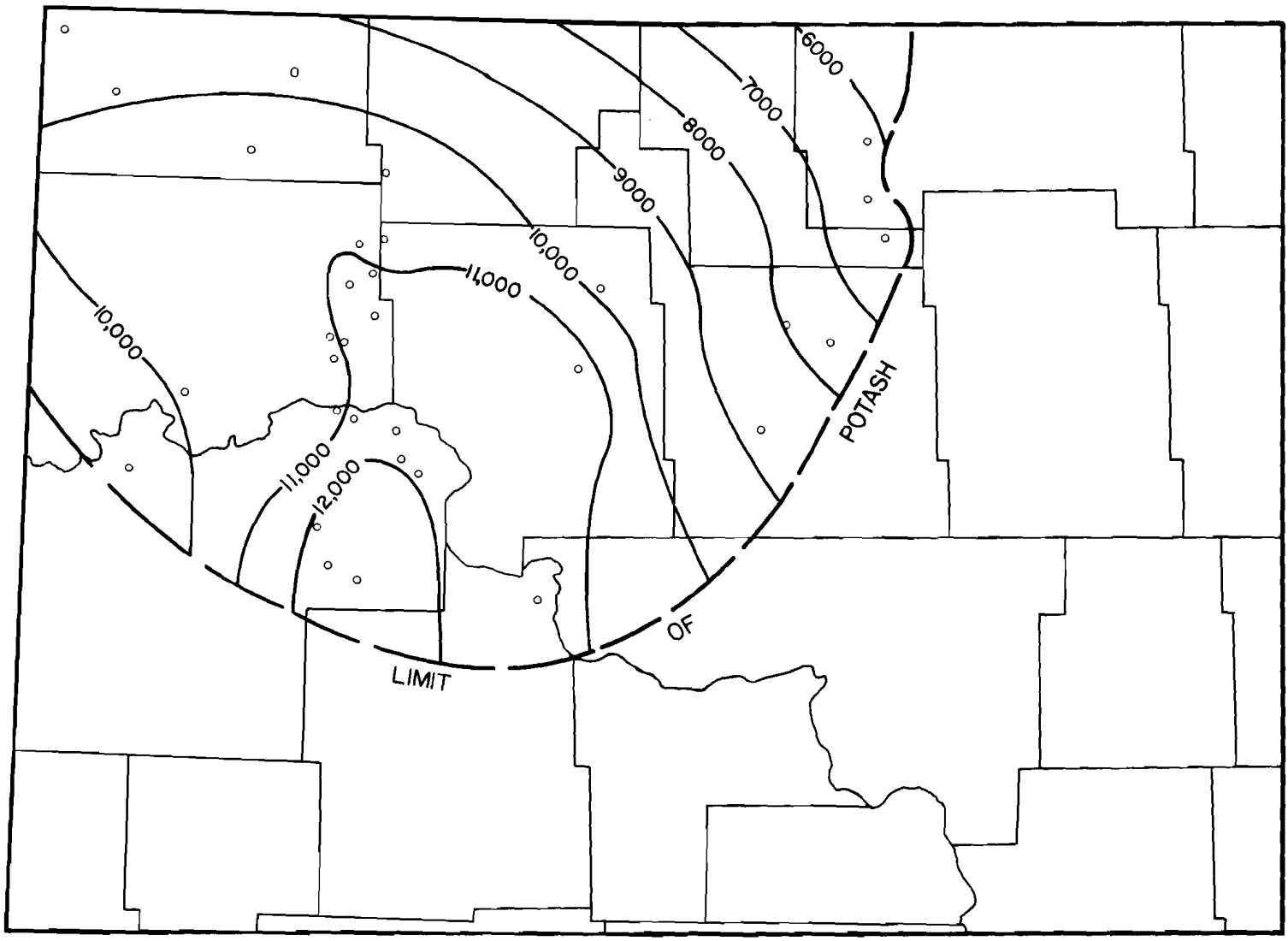


FIGURE 4 – ISOPACH MAP OF POTASH BEDS OF PRAIRIE FORMATION



CONTROL WELL ○

CONTOUR INTERVAL 1000 FEET

AREA OF STUDY

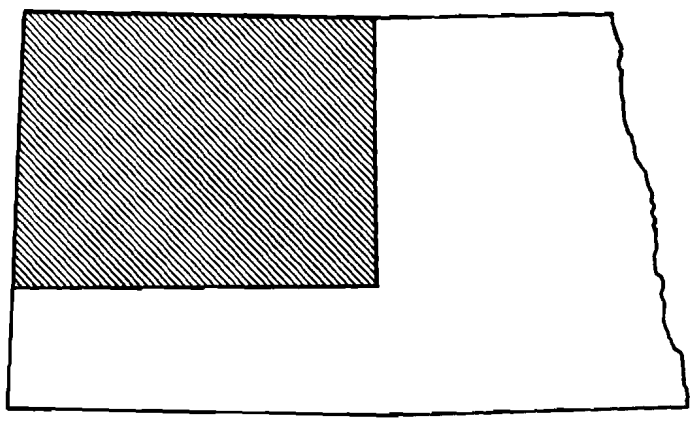


FIGURE 5 – DEPTH TO POTASH

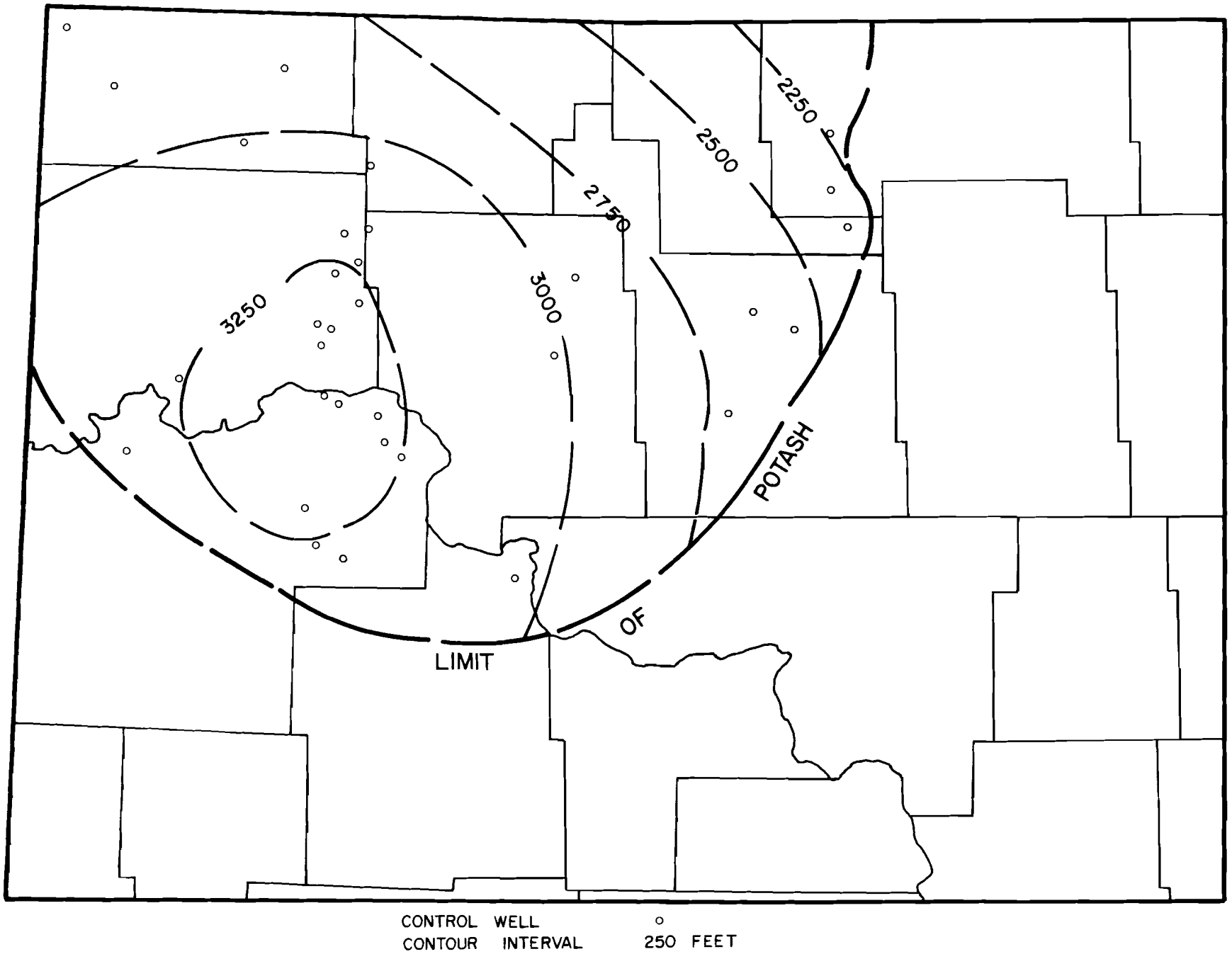


FIGURE 6 – ISOPACH MAP OF PALEOZOIC CARBONATES

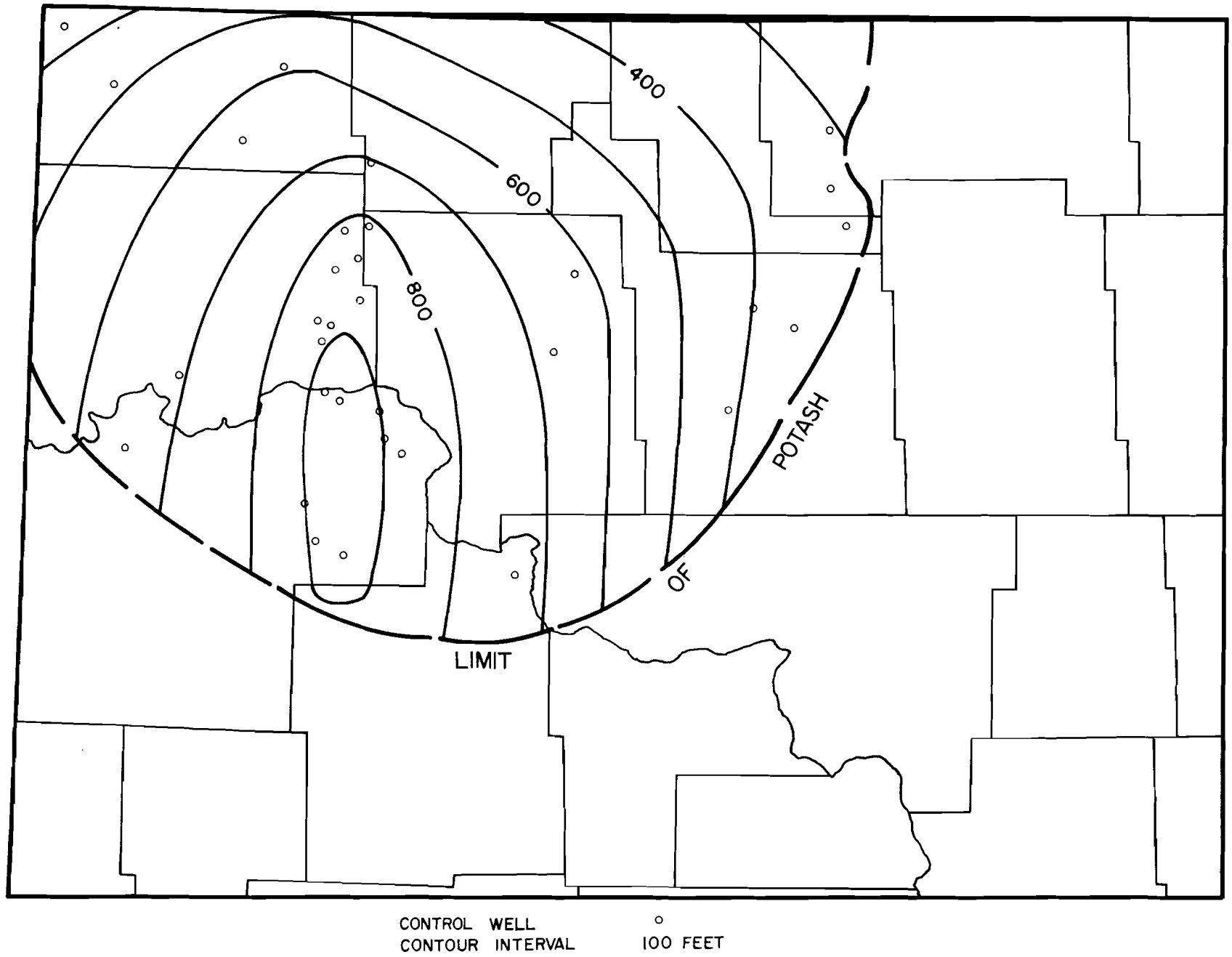


FIGURE 7 – ISOPACH MAP OF "SILICEOUS BEDS" OF BOTTINEAU INTERVAL – MADISON FORMATION

are interbedded with relatively thick and soluble halite beds, a complicating factor in solution mining. However, if Kalium Chemicals Ltd. can solve these problems at its solution mining operations near Belle Plaine, Saskatchewan, then a similar technique should be feasible in North Dakota.

Since North Dakota potash deposits are slightly deeper than those in Saskatchewan, it is anticipated that drilling costs will be somewhat higher. However, the increased spread in relative solubilities of halite and potash salts due to increased temperatures and pressures at these depths may prove advantageous for differential solution. In Burke County, where potash is at a depth of about 9,000 feet, the bottom hole temperature was recorded as 170° F. at 9,114 feet in the TXL - gas storage well. The location of the North Dakota deposits in relation to the major markets will be an advantage over the Canadian operations and may partially offset the disadvantage of greater drilling costs.

In general, it is relatively inexpensive to drill the shales and sandstones of the Mesozoic and Cenozoic section. Higher costs are involved in drilling the carbonates and evaporites of the Paleozoic section, particularly the siliceous limestone portion of the Bottineau interval (Lodgepole) of the Mississippian Madison Formation. The isopachs of the Paleozoic carbonates (fig. 6) and the Bottineau interval (fig. 7) show that both of these units are thinnest where potash is shallowest.

Potash deposits will be present at shallowest depths in northeastern Renville or western Bottineau County (fig. 5). In this area, the potash beds will be penetrated at depths of 5,800 to 6,200 feet of which 3,600 to 3,800 feet will be Cenozoic and Mesozoic shale and sandstone. There is little information on the Prairie Formation in this area, but it is known that the present eastern margin of the Prairie Formation is probably a solution margin rather than a depositional margin. Inasmuch as this edge is likely to be very irregular, care must be taken in choosing a location near it.

In the Burke County area there is probably a thicker potash section present, but it will be deeper than in the Renville - Bottineau area. The greater depth will also include a thicker Bottineau interval, as well as a greater thickness of Paleozoic carbonates. Therefore, development of a solution mining project in this area will involve greater drilling costs than the Renville - Bottineau County area.

The Divide County area is similar to the Burke County area for depth-to-potash and drilling costs. It is also somewhat farther from the major markets than the other potential producing areas.

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