North Dakota Geological Survey
Geological Investigation No 280 - Sheet 3 of 5

K_2O Grades of the Belle Plaine Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

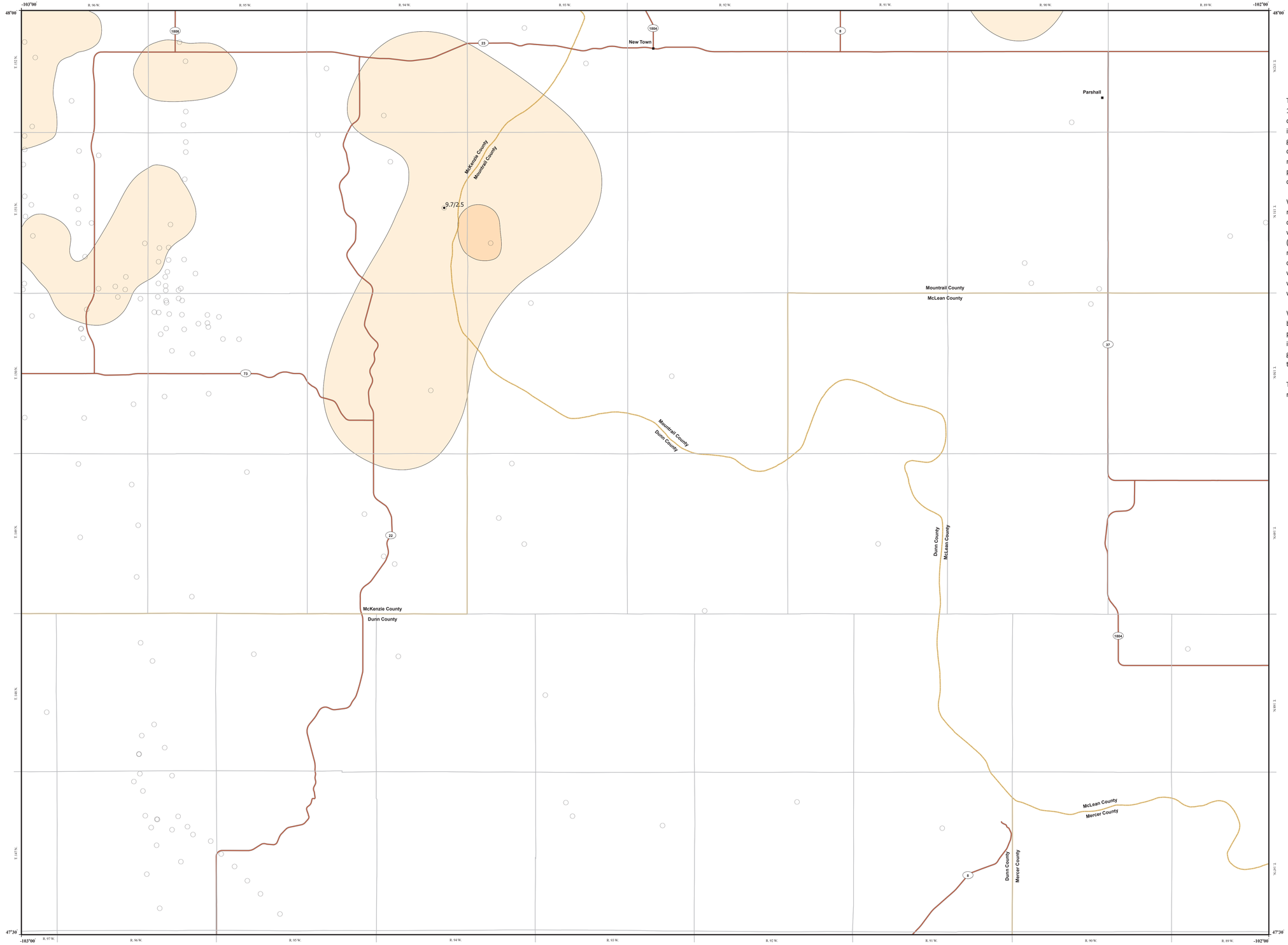
Parshall Quadrangle, North Dakota

Adjoining 100K Maps

Williston	Stanley	Minot
Watford City		Garrison
Grassy Butte	Killdeer	Hazen

7°19'
2017 Magnetic North
Declination at Center of Sheet

North Dakota Geological Survey
Edward C. Murphy, State Geologist



Ned W. Kruger

2024

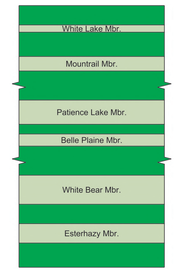
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Belle Plaine Member was identified on the geophysical logs of 22 wells. Isopach contours were generated via PETRA (ver. 3.13.5) geological software. The contour lines were computer-generated based on well-control data, with minimal adjustments made by the author. Areas with a geological anomaly may not be accurately portrayed. The potash member thickness for each well, and the isopach contours generated from them, were modified from Kruger (2014).

Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide (K_2O) concentrations. Average K_2O concentrations and potash member thicknesses were obtained using the grade-thickness method described in Nelson (2007), where bed thickness is equal to the distance between the elevations at which the gamma-ray response declines to one-half its maximum value.

When a potash member displayed multiple gamma-ray log peaks separated by troughs representing salt or insolubles such as clay or anhydrite, thin potash intervals at the upper or lower boundaries of the member were not included in thickness or average-potash-grade calculations if the corrected gamma-ray measurements were less than 100 API or separated by more than four feet from main body of the potash member.

The total volume of potash-containing salt within the Belle Plaine Member as represented on this sheet is approximately 46,000 acre-feet.

Thickness (ft)
- 0
- 1-3
- 4-6



Symbols

- Well Control
- 9.7/2.5 Avg K_2O % / Thickness (feet)

Other Features

- Section Line
- City
- 2 Federal Highway
- 50 State Highway

N W E S

Scale 1:100,000

0 1 2 3 4 Miles

0 1 2 3 4 Kilometers

Mercator Projection
Standard Parallel 47°30'0"N

North American 1983 Datum
Central Meridian 102°30'0"W

References:

Crain, E. R., 2014, Crain's petrophysical handbook; URL<<LINK>http://spec2000.net/17-specpotash.htm</LINK>>, accessed 14 January 2014.

Crain, E.R., and Anderson, W.B., 1966, Quantitative log evaluation of the Prairie Evaporite formation in Saskatchewan: Journal of Canadian Petroleum Technology, vol. 5, p. 145-152.

Kruger, N.W., 2014, The Potash Members of the Prairie Formation in North Dakota: North Dakota Geological Survey, Report of Investigation no. 113, 39 p.

Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.

Cartographic Compilation: Navin Thapa

North Dakota Geological Survey
Geological Investigation No 280 - Sheet 5 of 5

K_2O Grades of the Esterhazy Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

North Dakota Geological Survey
Edward C. Murphy, State Geologist

Ned W. Kruger

2024

This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Esterhazy Member was identified on the geophysical logs of 44 wells. Isopach contours were generated via PETRA (ver. 3.13.5) geological software. The contour lines were computer-generated based on well-control data, with minimal adjustments made by the author. Areas with a geological anomaly may not be accurately portrayed. The potash member thickness for each well, and the isopach contours generated from them, were modified from Kruger (2014).

Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide (K_2O) concentrations. Average K_2O concentrations and potash member thicknesses were obtained using the grade-thickness method described in Nelson (2007), where bed thickness is equal to the distance between the elevations at which the gamma-ray response declines to one-half its maximum value.

When a potash member displayed multiple gamma-ray log peaks separated by troughs representing salt or insolubles such as clay or anhydrite, thin potash intervals at the upper or lower boundaries of the member were not included in thickness or average-potash-grade calculations if the corrected gamma-ray measurements were less than 100 API or separated by more than four feet from main body of the potash member

The total volume of potash-containing salt within the Esterhazy Member as represented on this sheet is approximately 2,300,000 acre-feet.

Thickness (ft)
- 0
- 1-3
- 4-6
- 7-9
- 10-12

- White Lake Mbr.
- Mountrail Mbr.
- Patience Lake Mbr.
- Belle Plaine Mbr.
- White Bear Mbr.
- Esterhazy Mbr.

Symbols

- Well Control
- 18.8/7.0 Avg K_2O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway

Scale 1:100,000

Miles: 0 1 2 3 4

Kilometers: 0 1 2 3 4

Mercator Projection
Standard Parallel 47°30'0"N

North American 1983 Datum
Central Meridian 102°30'0"W

References:

Crain, E. R., 2014, Crain's petrophysical handbook; URL<<LINK>http://spec2000.net/17-specpotash.htm</LINK>>, accessed 14 January 2014.

Crain, E.R., and Anderson, W.B., 1966, Quantitative log evaluation of the Prairie Evaporite formation in Saskatchewan: Journal of Canadian Petroleum Technology, vol. 5, p. 145-152.

Kruger, N.W., 2014, The Potash Members of the Prairie Formation in North Dakota: North Dakota Geological Survey, Report of Investigation no. 113, 39 p.

Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.

Cartographic Compilation: Navin Thapa

North Dakota Geological Survey
Geological Investigation No 280 - Sheet 1 of 5

K_2O Grades of the Mountrail Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Parshall Quadrangle, North Dakota

Williston	Stanley	Minot
Watford City		Garrison
Grassy Butte	Killdeer	Hazen

Adjoining 100K Maps

2017 Magnetic North Declination at Center of Sheet

North Dakota Geological Survey
Edward C. Murphy, State Geologist

Ned W. Kruger

2024

This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Mountrail Member was identified on the geophysical logs of 62 wells. Isopach contours were generated via PETRA (ver. 3.13.5) geological software. The contour lines were computer-generated based on well-control data, with minimal adjustments made by the author. Areas with a geological anomaly may not be accurately portrayed. The potash member thickness for each well, and the isopach contours generated from them, were modified from Kruger (2014).

Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide K_2O concentrations. Average K_2O oncentrations and potash member thicknesses were obtained using the grade-thickness method described in Nelson (2007), where bed thickness is equal to the distance between the elevations at which the gamma-ray response declines to one-half its maximum value.

When a potash member displayed multiple gamma-ray log peaks separated by troughs representing salt or insolubles such as clay or anhydrite, thin potash intervals at the upper or lower boundaries of the member were not included in thickness or average-potash-grade calculations if the corrected gamma-ray measurements were less than 100 API or separated by more than four feet from main body of the potash member.

The total volume of potash-containing salt within the Mountrail Member as represented on this sheet is approximately 1,200,000 acre-feet.

Thickness (ft)

- 0
- 1-3
- 4-6
- 7-9

- White Lake Mbr.
- Mountrail Mbr.
- Patience Lake Mbr.
- Belle Plaine Mbr.
- White Bear Mbr.
- Esterhazy Mbr.

Symbols

- Well Control
- 11.4/3.0 Avg K_2O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway

Scale 1:100,000

Miles: 0 1 2 3 4

Kilometers: 0 1 2 3 4

Mercator Projection
Standard Parallel 47°30'0"N

North American 1983 Datum
Central Meridian 102°30'0"W

References:

Crain, E. R., 2014, Crain's petrophysical handbook; URL<<LINK>http://spec2000.net/17-specpotash.htm</LINK>>, accessed 14 January 2014.

Crain, E.R., and Anderson, W.B., 1966, Quantitative log evaluation of the Prairie Evaporite formation in Saskatchewan: Journal of Canadian Petroleum Technology, vol. 5, p. 145-152.

Kruger, N.W., 2014, The Potash Members of the Prairie Formation in North Dakota: North Dakota Geological Survey, Report of Investigation no. 113, 39 p.

Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.

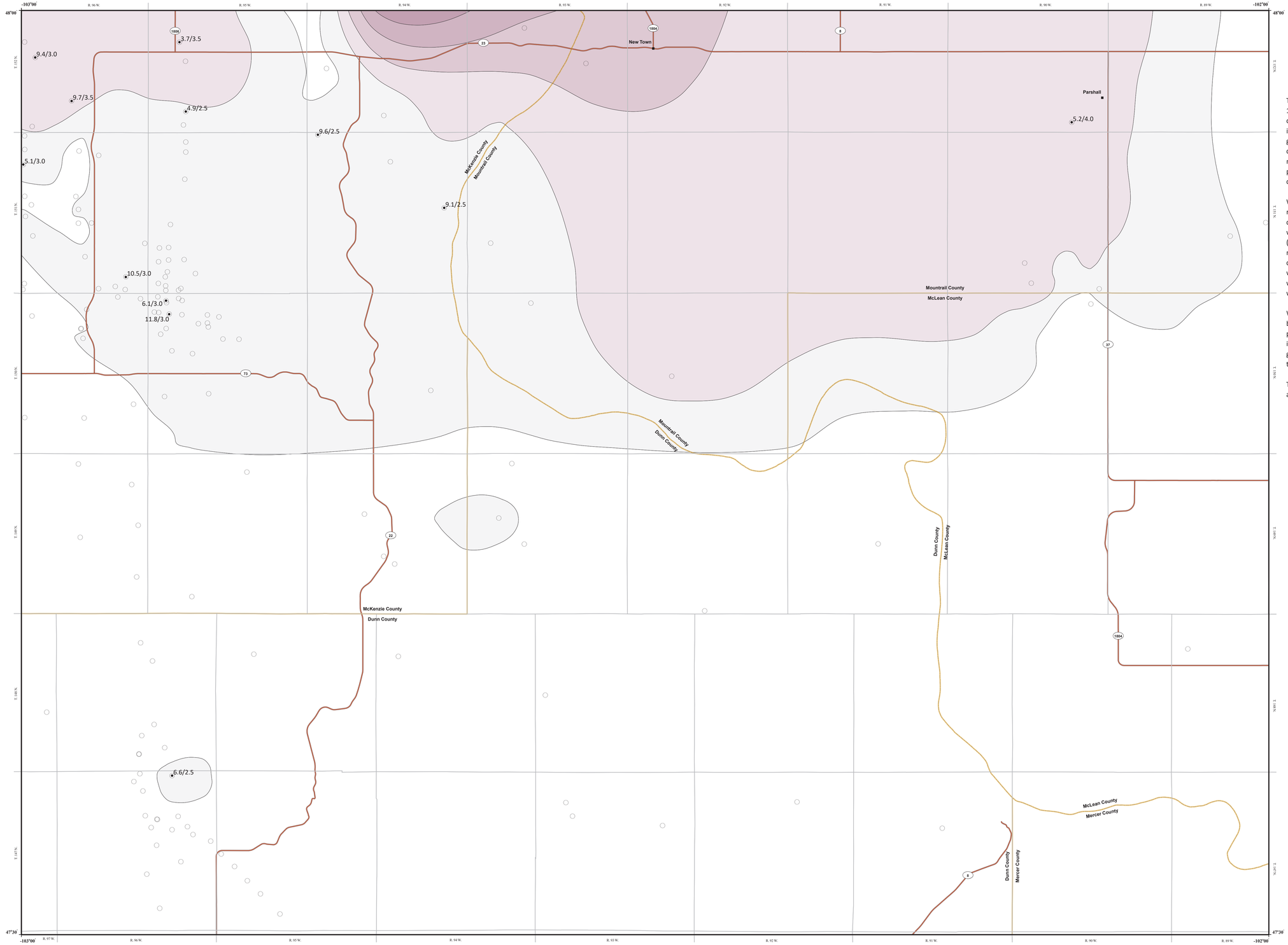
Cartographic Compilation: Navin Thapa

North Dakota Geological Survey
Geological Investigation No 280 - Sheet 2 of 5

K_2O Grades of the Patience Lake Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

North Dakota Geological Survey
Edward C. Murphy, State Geologist



Ned W. Kruger

2024

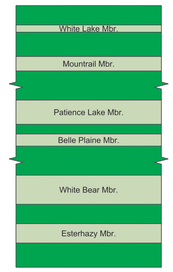
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Patience Lake Member was identified on the geophysical logs of 73 wells. Isopach contours were generated via PETRA (ver. 3.13.5) geological software. The contour lines were computer-generated based on well-control data, with minimal adjustments made by the author. Areas with a geological anomaly may not be accurately portrayed. The potash member thickness for each well, and the isopach contours generated from them, were modified from Kruger (2014).

Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide (K_2O) concentrations. Average K_2O concentrations and potash member thicknesses were obtained using the grade-thickness method described in Nelson (2007), where bed thickness is equal to the distance between the elevations at which the gamma-ray response declines to one-half its maximum value.

When a potash member displayed multiple gamma-ray log peaks separated by troughs representing salt or insolubles such as clay or anhydrite, thin potash intervals at the upper or lower boundaries of the member were not included in thickness or average-potash-grade calculations if the corrected gamma-ray measurements were less than 100 API or separated by more than four feet from main body of the potash member.

The total volume of potash-containing salt within the Patience Lake Member as represented on this sheet is approximately 1,300,000 acre-feet.

Thickness (ft)
- 0
- 1-3
- 4-6
- 7-9
- 10-12
- 13-15
- 16-18



Symbols

- Well Control
- 11.8/3.0 Avg K_2O % / Thickness (feet)

Other Features

- Section Line
- City
- 2 Federal Highway
- 50 State Highway

Scale 1:100,000

0 1 2 3 4 Miles

0 1 2 3 4 Kilometers

Mercator Projection
Standard Parallel 47°30'0"N

North American 1983 Datum
Central Meridian 102°30'0"W

References:

Crain, E. R., 2014, Crain's petrophysical handbook; URL<<LINK>http://spec2000.net/17-specpotash.htm</LINK>>, accessed 14 January 2014.

Crain, E.R., and Anderson, W.B., 1966, Quantitative log evaluation of the Prairie Evaporite formation in Saskatchewan: Journal of Canadian Petroleum Technology, vol. 5, p. 145-152.

Kruger, N.W., 2014, The Potash Members of the Prairie Formation in North Dakota: North Dakota Geological Survey, Report of Investigation no. 113, 39 p.

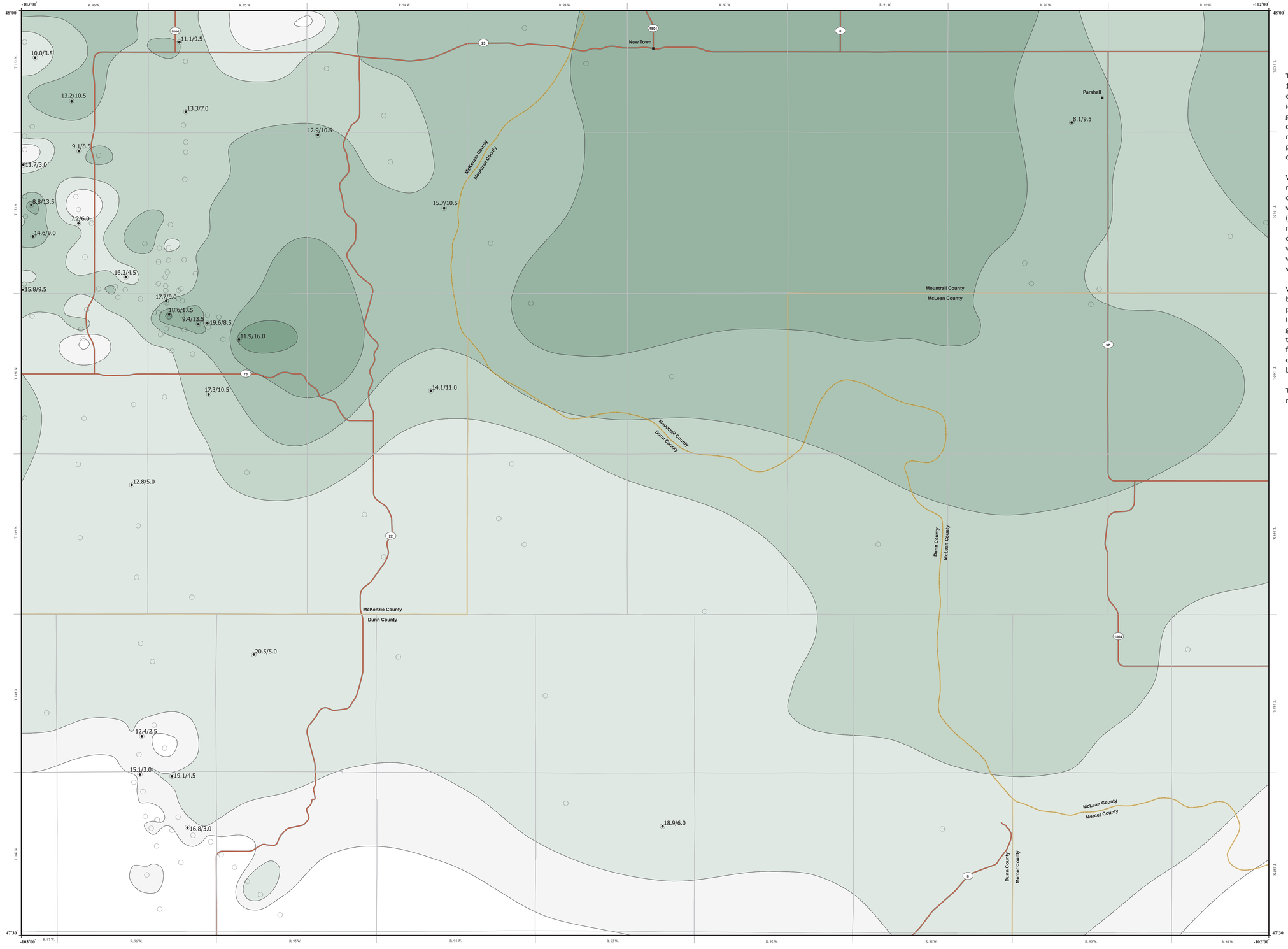
Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.

Cartographic Compilation: Navin Thapa

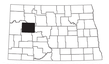
North Dakota Geological Survey
Geological Investigation No 280 - Sheet 4 of 5

K_2O Grades of the Belle Plaine Member of the Prairie Formation

Parshall 100K Sheet, North Dakota



Adjoining 100K Maps



North Dakota Geological Survey
Edward C. Murphy, State Geologist

Ned W. Kruger

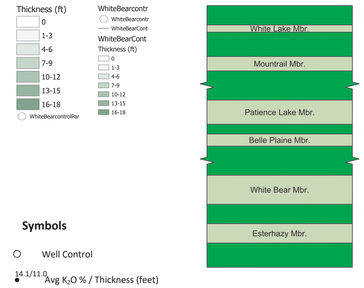
2024

This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The White Bear Member was identified on the geophysical logs of 129 wells. Isopach contours were generated via PETRA (ver. 3.13.5) geological software. The contour lines were computer-generated based on well-control data, with minimal adjustments made by the author. Areas with a geological anomaly may not be accurately portrayed. The potash member thickness for each well, and the isopach contours generated from them, were modified from Kruger (2014).

Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide (K_2O) concentrations. Average K_2O concentrations and potash member thicknesses were obtained using the grade-thickness method described in Nelson (2007), where bed thickness is equal to the distance between the elevations at which the gamma-ray response declines to one-half its maximum value.

When a potash member displayed multiple gamma-ray log peaks separated by troughs representing salt or insolubles such as clay or anhydrite, thin potash intervals at the upper or lower boundaries of the member were not included in thickness or average-potash-grade calculations if the corrected gamma-ray measurements were less than 100 API or separated by more than four feet from main body of the potash member. This occurred most frequently in deposits of the White Bear Member, which may appear as one or two potash-rich beds underlying a thin potash-containing zone separated by an interbed of halite.

The total volume of potash-containing salt within the White Bear Member as represented on this sheet is approximately 7,540,000 acre-feet.



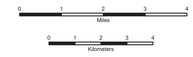
Symbols

- Well Control
- 14.1/11.0 Avg K_2O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway

Scale 1:100,000



Mercator Projection
Standard Parallel 47°30'0"N

North American 1983 Datum
Central Meridian 102°30'0"W

References:

Crain, E. R., 2014, Crain's petrophysical handbook; URL<<LINK>http://spec2000.net/17-specpotash.htm</LINK>>, accessed 14 January 2014.

Crain, E.R., and Anderson, W.B., 1966, Quantitative log evaluation of the Prairie Evaporite formation in Saskatchewan: Journal of Canadian Petroleum Technology, vol. 5, p. 145-152.

Kruger, N.W., 2014, The Potash Members of the Prairie Formation in North Dakota: North Dakota Geological Survey, Report of Investigation no. 113, 39 p.

Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.

Cartographic Compilation: Navin Thapa