

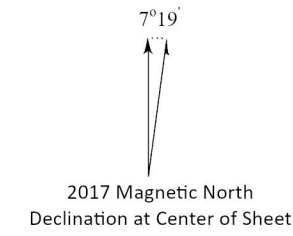


K₂O Grades of the Mountrail Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Willow	Steady	Moist
Wet	City	Cartoon
Green	Blue	Black

Adjoining 100K Maps



Ned W. Kruger

2024

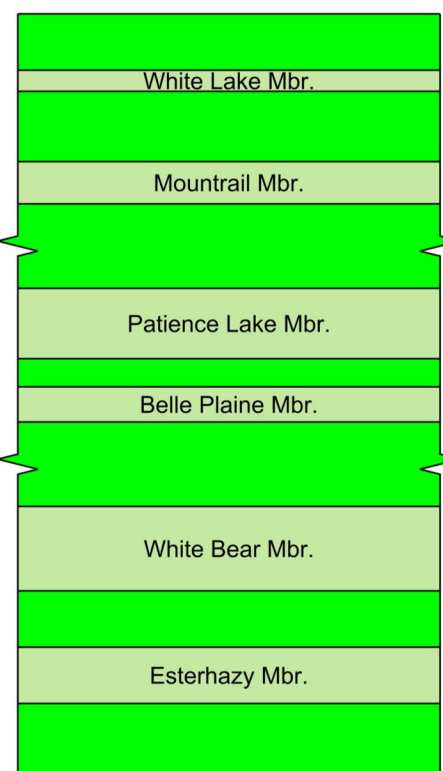
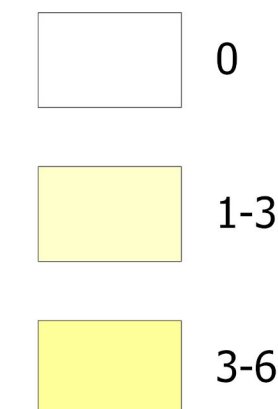
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Mountrail Member was identified on the geophysical logs of 62 wells. Isopach contours were generated via 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 K₂O concentrations. Average K₂O 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)



Symbols

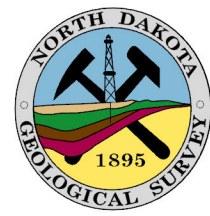
- Well Control
- Avg K₂O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway

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.

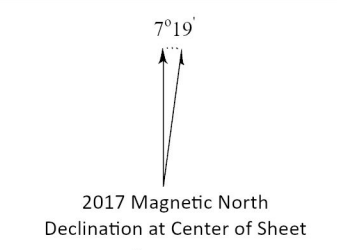


K₂O Grades of the Patience Lake Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Willbore	Steady	Meat
Waters	City	Cartoon
Garry	Belt	Killdeer
		Black

Adjoining 100K Maps



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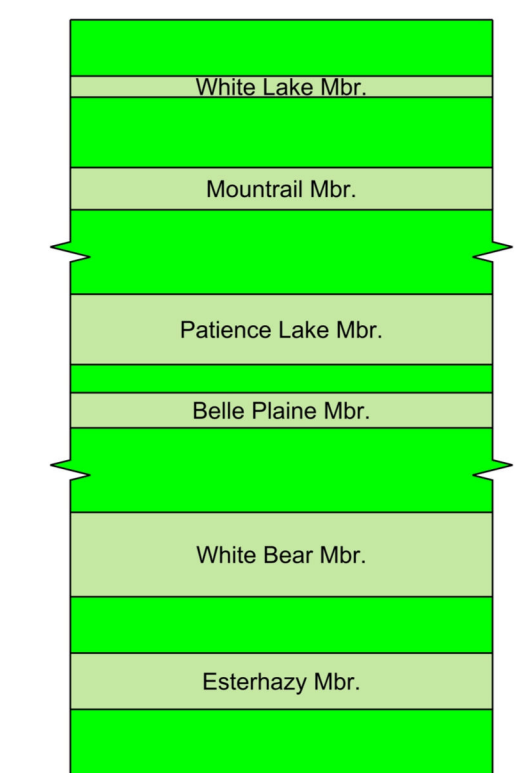
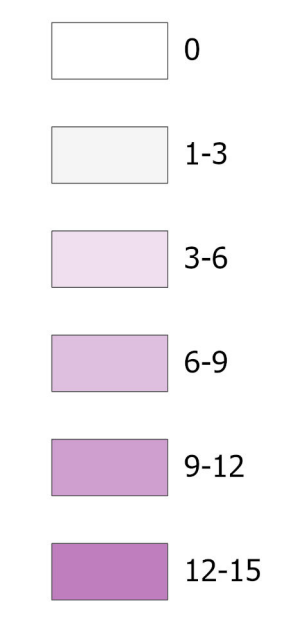
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Patience Lake Member was identified on the geophysical logs of 73 wells. Isopach contours were generated 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 (K₂O) concentrations. Average K₂O 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)

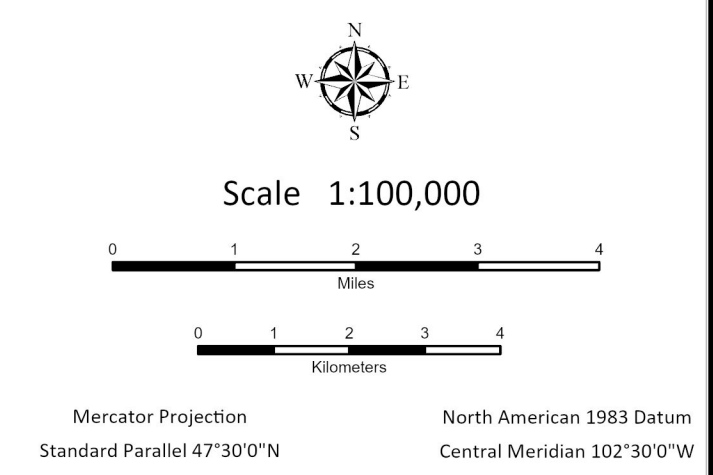


Symbols

- Well Control
- 11.8/3.0 Avg K₂O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway



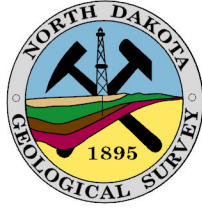
References:

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.

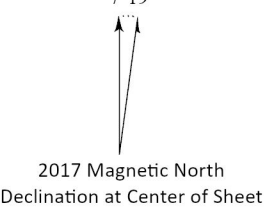
Nelson, P.H., 2007, Evaluation of potash grade with gamma-ray logs: U.S. Geological Survey, Open File Report 2007-1292, 14 p.



K₂O Grades of the Belle Plaine Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Williston	Steady	Maat
Williston	City	Cartoon
Green	Bar	Black
Adjoining 100K Maps		



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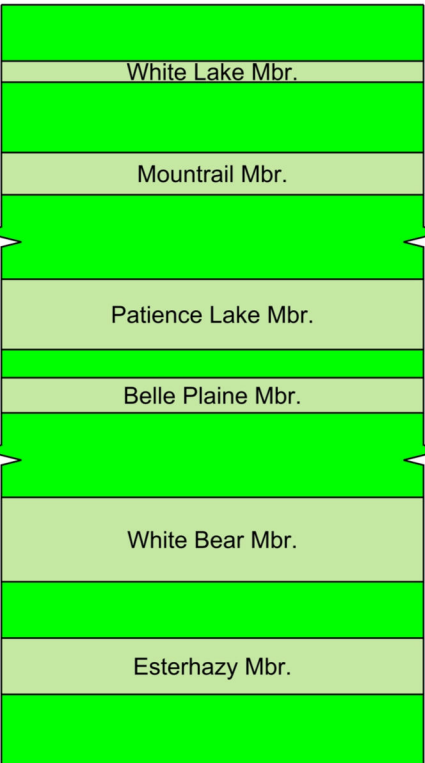
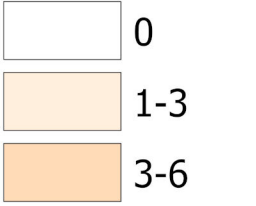
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Belle Plaine Member was identified on the geophysical logs of 22 wells. Isopach contours were generated 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 (K₂O) concentrations. Average K₂O 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)



Symbols

- Well Control
- Avg K₂O % / 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

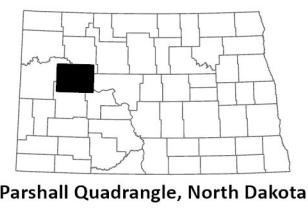
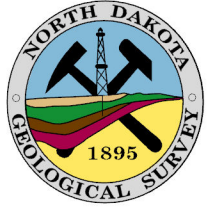
References:

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.



K₂O Grades of the White Bear Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Willow	Steady	Most
Wetland	City	Cartoon
Grass	Bar	Kilobit
Bar	Bar	Bar

Adjoining 100K Maps

2017 Magnetic North
Declination at Center of Sheet

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).

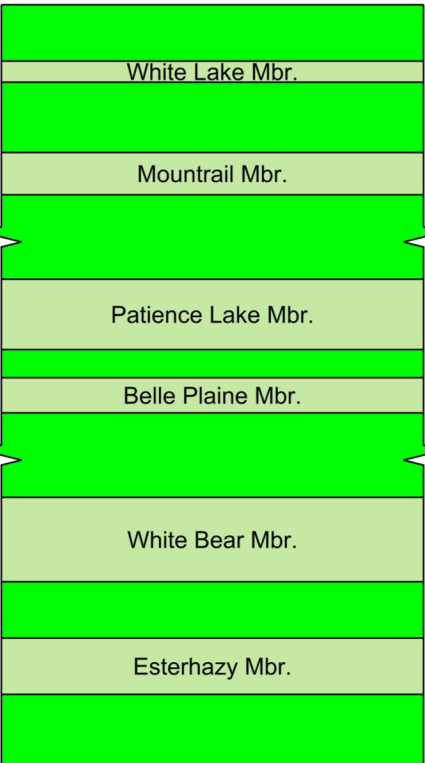
Where present, all calculations were based on gamma-ray log measurements recorded in API units taken at six-inch increments throughout the potash-containing portion of the log. Corrections for borehole size and drilling mud weight as well as removal of the baseline gamma-ray signal were made (Crain, 2014; Crain and Anderson, 1966). The corrected gamma-ray measurements were converted into apparent potassium oxide (K₂O) concentrations. Average K₂O 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.

Thickness (ft)

- 0
- 1-3
- 3-6
- 6-9
- 9-12
- 12-15
- 15-18



Symbols

- Well Control
- Avg K₂O % / Thickness (feet)

Other Features

- Section Line
- City
- Federal Highway
- State Highway



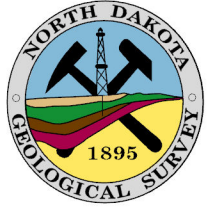
Scale 1:100,000



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.

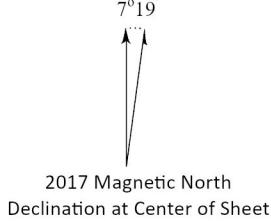


K₂O Grades of the Esterhazy Member of the Prairie Formation

Parshall 100K Sheet, North Dakota

Willow	Hardy	Maat
Willow	City	Cartoon
Green	Bar	Kilobit
Bar		Bar

Adjoining 100K Maps



Ned W. Kruger

2024

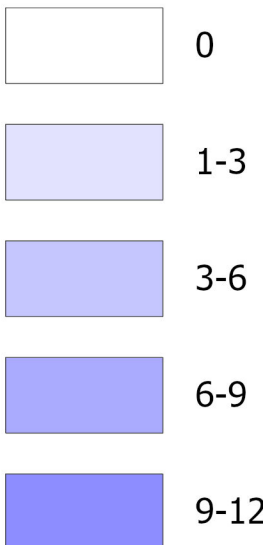
This series of maps of the Parshall 100K Sheet was based on public data from 151 wells gathered by the North Dakota Industrial Commission – Department of Mineral Resources, Oil and Gas Division. The Esterhazy Member was identified on the geophysical logs of 44 wells. Isopach contours were generated via 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 (K₂O) concentrations. Average K₂O 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)



Symbols

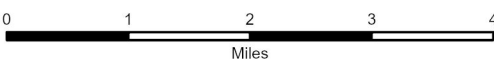
- Well Control
- 18.8/7.0 Avg K₂O % / Thickness (feet)

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.