Potash deposits in the Devonian Prairie Evaporite, southwestern Manitoba

salt distribution

potash + salt distributio

eastern limit of the

Prairie Evaporite

Prairie Evaporite

0 10 20 30 40

wells that penetrate the

Russell-McAuley

potash area

Daly-Sinclair potash area

Figure 3: Map of southwestern Manitoba showing the

distribution of the salt and potash + salt, oil fields and wells

potash occurrence are shown, as are the northern (Russell

Russell-McAuley area. The salt distribution edge is equivalent

The known area of potash occurrence in Manitoba

can be subdivided into three subareas that are separated

1) the Russell-McAuley area, covering townships

2) the Daly-Sinclair area, covering townships 5 to

3) the Pierson area, occurring in township 1,

The only area that has been actively explored for

potash is the Russell-McAuley area, where the Esterhazy

Member is of sufficient thickness and grade to sustain

potentially economic underground potash mining.

to the eastern limit of the salt and potash + salt distribution

deposit) and southern (St. Lazare deposit) blocks of the

4. Potash occurrences

from each other by broad areas with no potash

occurrence in the Prairie Evaporite (Figure 3):

14 to 21, ranges 27 to 29W1;

11, ranges 27 to 29W1; and

range 28W1.

areas. (from Nicolas, 2015)

that penetrate the Prairie Evaporite. The three mains areas of

M.P.B. Nicolas

Manitoba Geological Survey, Winnipeg, Manitoba, Canada

Manitoba 5,50

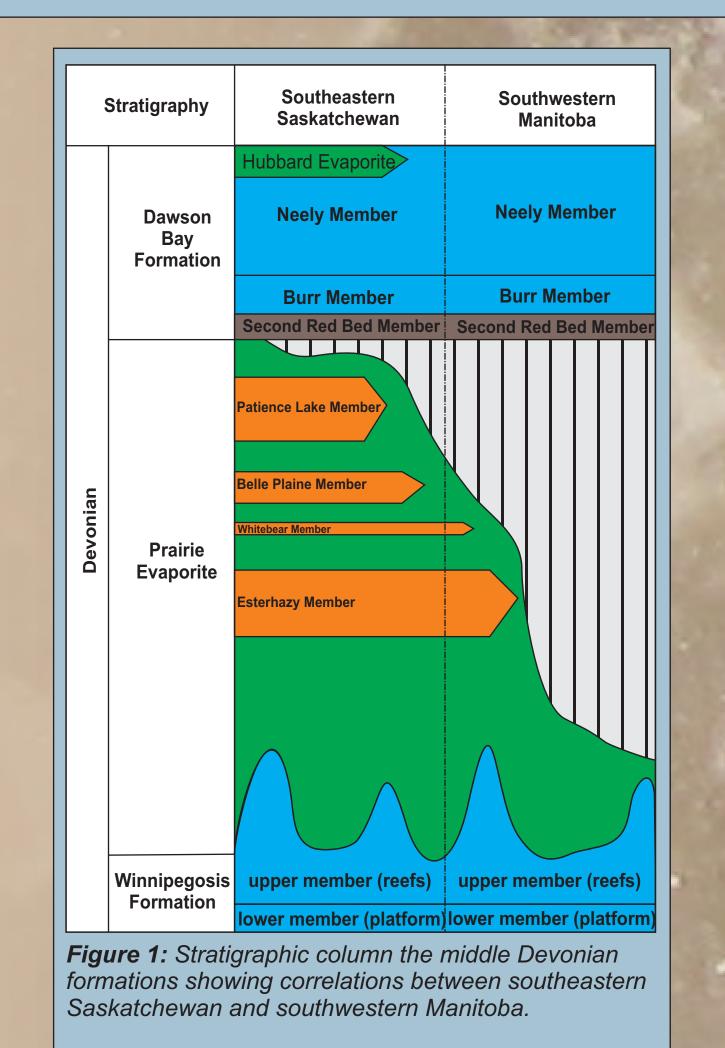
Potash Geology

1. Introduction

The Prairie Evaporite is a thick Denonian-aged evaporitic sequence dominantly consisting of halite and anhydrite. It includes four potash-bearing members, from oldest to youngest they are: the Esterhazy, White Bear, Belle Plain and Patience Lake members. Of these four members, only the Esterhazy and White Bear extend into Manitoba (Figure 1). The Esterhazy Member is the only potash bed in Manitoba with sufficient thickness and grade to sustain potentially economic underground potash mining. The ore grade and tonnages measured in Manitoba's Esterhazy Member are comparable to nearby, active, long-lived potash mines in Saskatchewan. Nearby mines include Potash Corporation of Saskatchewan's (PCS) Rocanville mine and The Mosaic Company's Esterhazy K1 and K2 mines (Figure 2).

The known area of potash occurrence in Manitoba can be subdivided into three subareas that are separated from the others by broad areas with no potash occurrence in the Prairie Evaporite (**Figure 3**). These areas total approximately 2,247 km² of known, potentially mineable, potash occurrences.

Exploration for potash in Manitoba has been intermittent for many decades since potash exploration targeting the eastern extension of the prolific Saskatchewan deposits started in 1959. Drillhole and coring programs, supported by 2-D and 3-D seismic surveys, indicate that Manitoba has potentially economically mineable, sizable potash deposits with geological conditions similar to those in Saskatchewan.



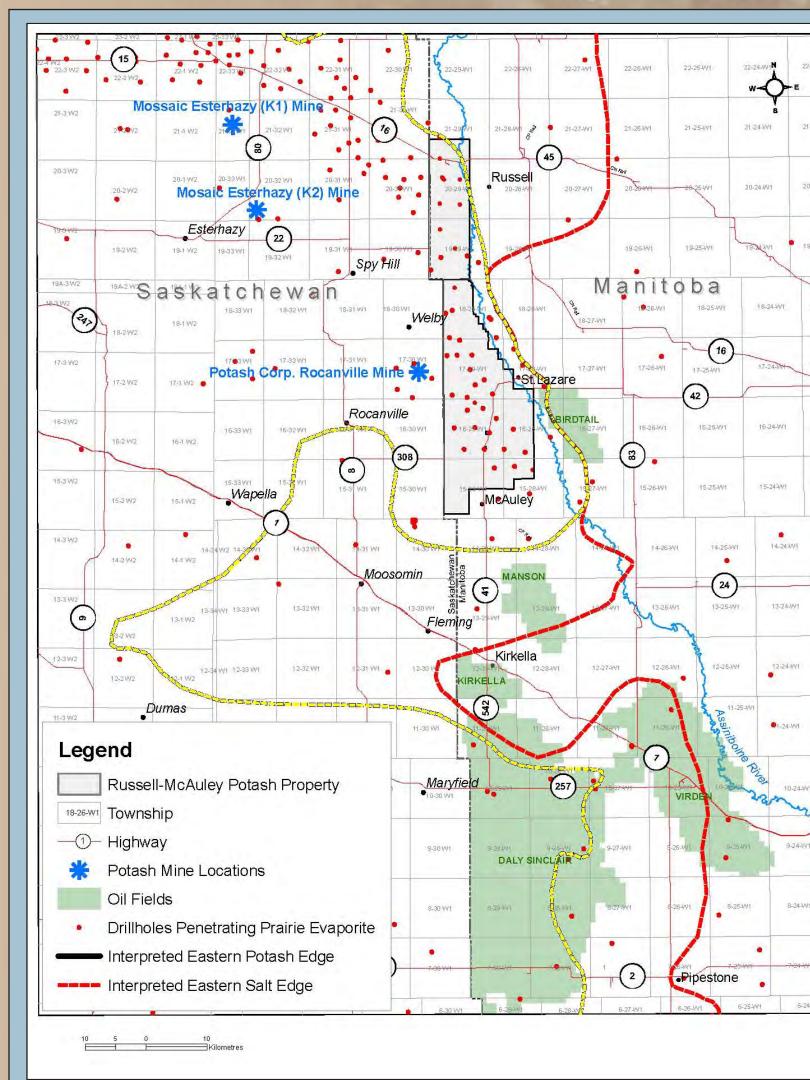


Figure 2: Geological map showing the eastern edge of the Prairie Evaporite salt dissolution front (red), and the eastern edge of the known potash area (yellow), drillholes that penetrate the Prairie Evaporite, and location of nearby potash mines in southeastern Saskatchewan.

2. Regional and Local Geology

In Manitoba, the Paleozoic-, Mesozoic- and Cenozoic-age strata form a basinward-thickening, southwesterly-sloping wedge, with the strata reaching a total thickness of 2.3 km in the extreme southestern corner of Manitoba (Figure 4). The potash-bearing Devonian-age Prairie Evaporite was deposited within the Elk Point Basin (Figure 5). The Prairie Evaporite consists mainly of thick halite beds, with minor anhydrite and four localized potash beds. Within the basin, the formation can exceed 210 m in thickness, and lies at depths of 200 to 2,700 m below surface.

The overlying Second Red Bed Member of the Dawson Bay Formation consists of grey, brown and red shales and argillaceous mudstones, which are overlain by limestone, dolomite and some interbedded anhydrite. The underlying Winnipegosis Formation consists of interbedded dolomite, dolomitic limestone and anhydrite. Reef structures within the Winnipegosis Formation have been identified by seismic surveys. These project up into the overlying Prairie Evaporite in a number of locations and are shown schematically in Figure 4 and 6.

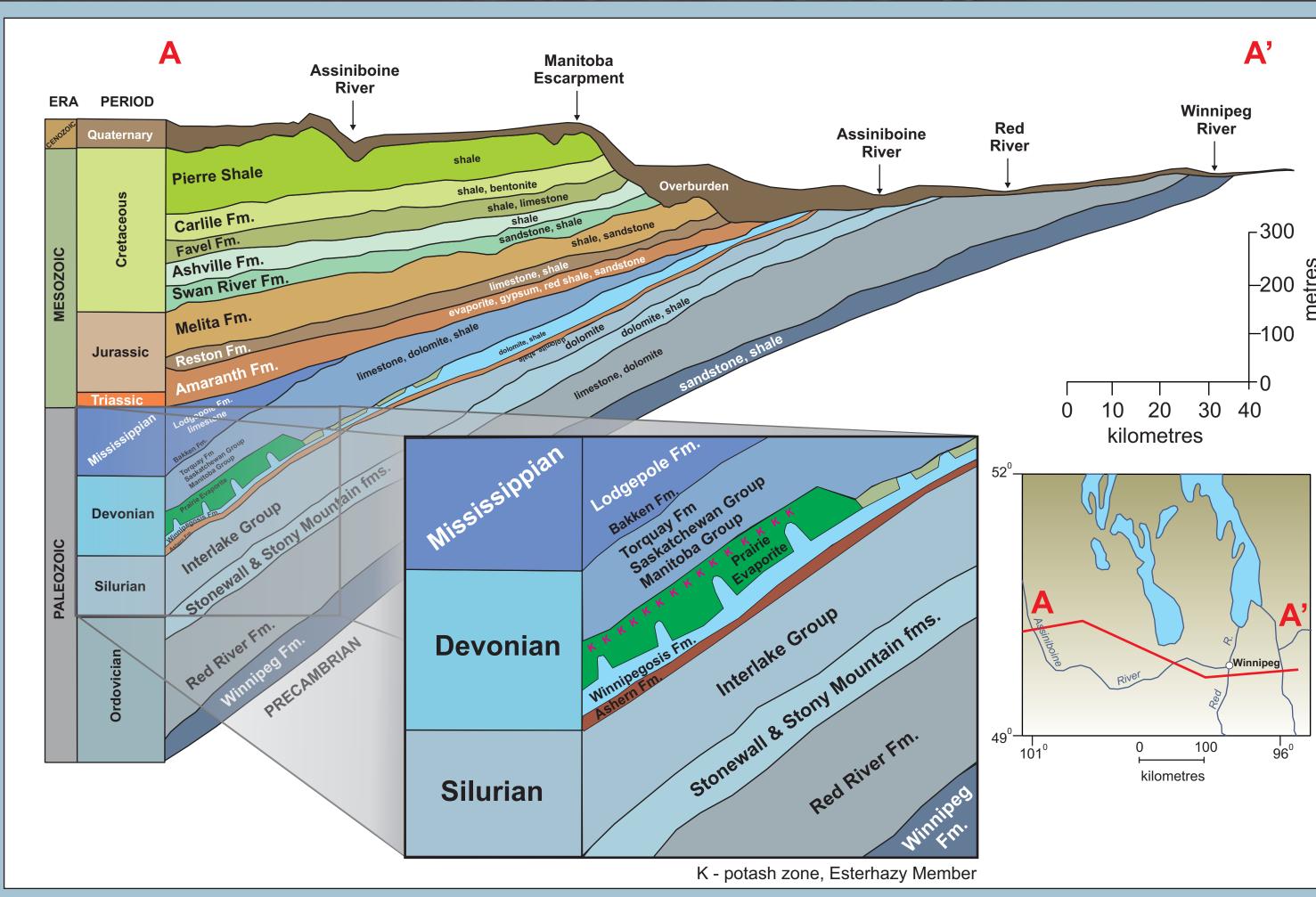


Figure 4: Vertically-exaggerated and simplified cross-section of Paleozoic to Cenozoic formations in southern Manitoba, showing the stratigraphy of the potash-bearing Prairie Evaporite, and underlying Winnipegosis and Ashern Formations. (Modified from Bamburak and Nicolas, 2009)

0 100 200 300

Potash distribution area Calgary

Figure 5: Distribution and isopach of the Prairie Evaporite in the Elk

0 Limit of Prairie Evaporite

822.12 m

indicates section with missing core.

Point Basin. (Nicolas, 2015)

SCALE

100 0 km 100 200 300

100 0 miles 100 200

830.28 m

Figure 7: Composite core photo from 3-29-20-29W1 of the upper portion of the Prairie Evaporite showing the White Bear and Esterhazy members (outlined in red boxes); depths from 818.62 to 846.92 m; box with 'X'

3. Esterhazy Member

The Esterhazy Member is the most economic potash beds. It consists of euhedral to subhedal halite crystals with large anhedral sylvite crystals and minor interstitial carnolite and clays (Figure 7 and 8).

The Esterhazy Member is intermittently present in a narrow, elongate strip in southwestern Manitoba, from Township 5 to 21, Ranges 27 to 29 W1 (Figure 2). The Prairie Evaporite salt dissolution edge runs roughly northsouth from Township 1 to 29, through Range 27 W1, and represents the maximum eastern extent of salt (and therefore potash) occurrence (Figure 9). Over the area of known potash occurrence in Manitoba, the thickness of the Esterhazy Member averages 5.6 m.

The Esterhazy Member in Manitoba compares favourably in grade, size and mining conditions to deposits supporting producing mines in southeastern Saskatchewan in the operations of PotashCorp at Rocanville and at Mosaic's operations at Esterhazy, just west of the MPC land holdings. It is the only potash bed of potentially economic significance in Manitoba.

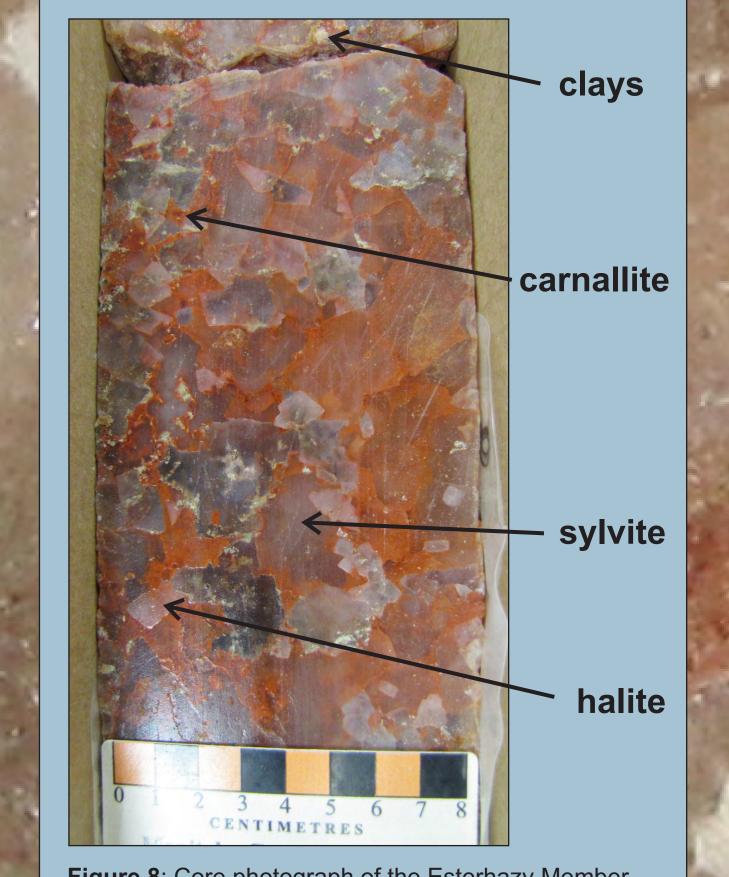


Figure 8: Core photograph of the Esterhazy Member, Prairie Evaporite, showing the potash ore zone of the St. Lazare deposit in 8-28-17-29W1; approximate depths are 915.3 to 916.03 m.

5. Russell-McAuley Area

Saskatchewan Manitoba

E, WB, BP, PL Esterhazy, White Bear, Belle Plaine and Patience Lake members, respectively

Figure 6: Idealized east-west section through the Prairie Evaporite

and adjacent rock units. (Nicolas, 2015)

Canamax Harrowby Prov. P.T.H.

The potash deposits in the Russell-McAuley area are located between townships 14 and 21, ranges 27 and 29W1 (Figure 9), and are the most explored area for potash in the province. The isopach of the formation varies due to proximity to the dissolution edge but can measure up to 139 m thick (Figure 9).

The deposits in the Russell-McAuley area are the only potash deposits in Manitoba potentially amenable to conventional underground mining methods. From a potash-resource perspective, the Russell-McAuley area can be subdivided into two blocks: a northern block, referred to as the Russell deposit; and a southern block, referred to as the St. Lazare deposit (Figure 10). Both

deposits are continuous into one another, the distinction between the two blocks simply reflects the extent of two long-standing potash dispositions held by competing

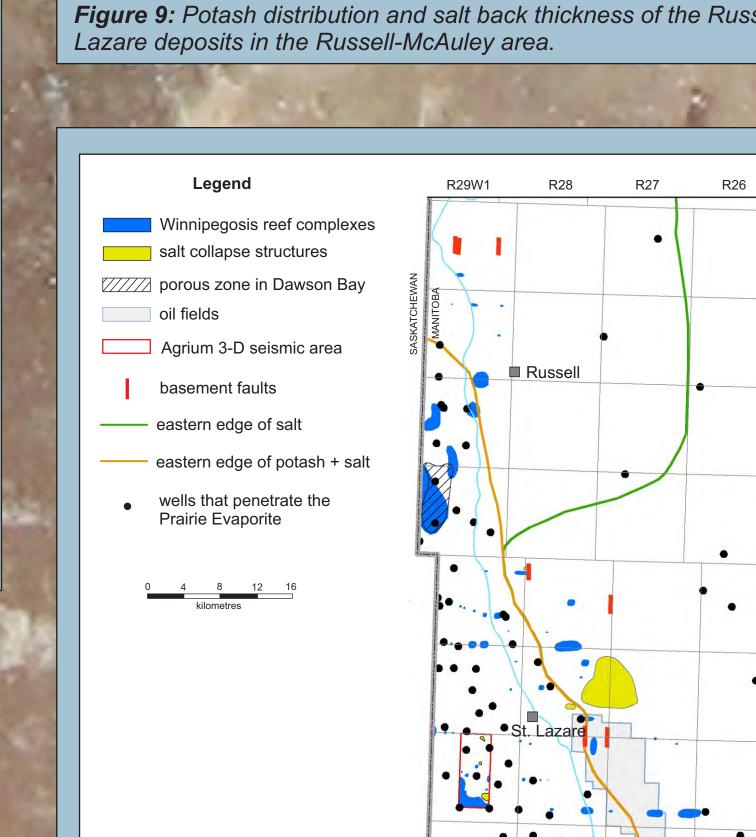


Figure 10: Compilation map of showing the location and size of Winnipegosis reefs and collapse structures and basement faults, as identified by 2-D and 3-D seismic surveys. Information compiled from assessment file

Potash Exploration

6. Potash Resource

Formal mineral resource estimates have been prepared for the Russell deposit, most recently in 2009. A historical resource estimate for the St. Lazare deposit was prepared in 1983. Table 1 summarizes the estimated resources for both the Russell and St. Lazare deposits. The Russell-McAuley area has a robust resource potential for a long term, minimum 20 year, secure supply, at a rate of 2 Mt/y KCI, or higher.

Table 1: Mineral resource estimates for the Russell and McAuley areas in southwestern Manitoba.

Area	Million tonnes ³	Average grade (% K₂O)
Russell deposit ¹	392	22.5
St. Lazare deposit²	650	20.9

¹BHP Billiton reports from ADM Consulting Ltd. and AMEC Americas Ltd. (2009) ²Bannatyne (1983), 16% cut off grade

³ Neither of the resource estimates has been reported using the definition standards of the Canadian Institute of Mining, Metallurgy and Petroleum and, therefore, do not meet the reporting requirements of Canadian National Instrument 43-101.

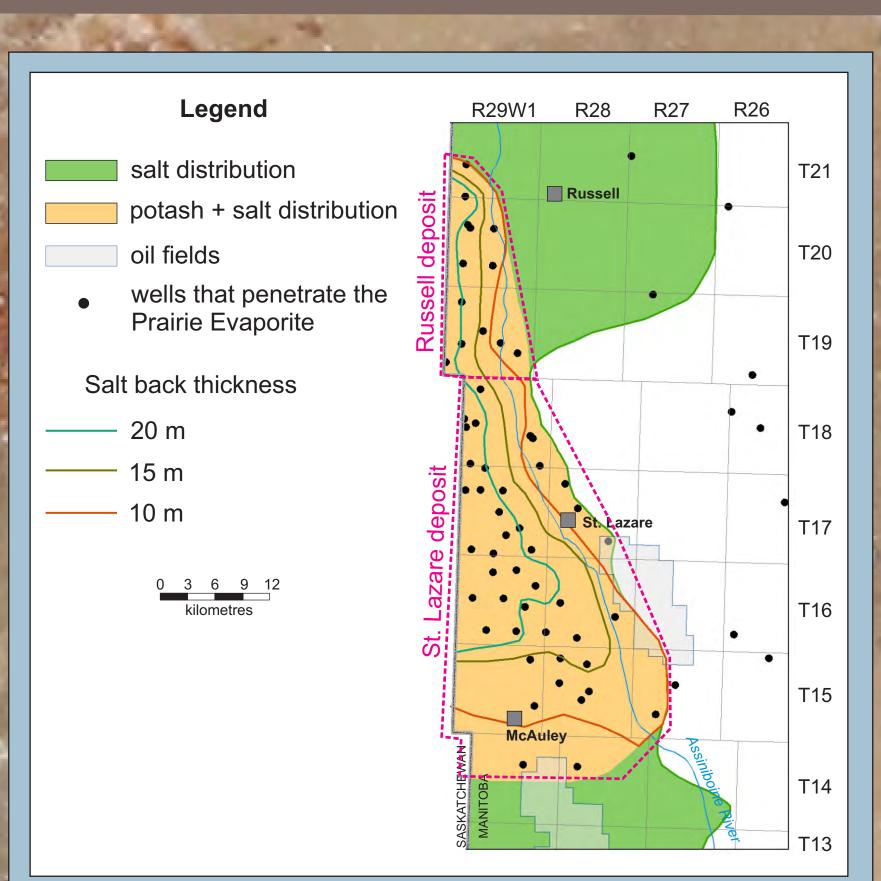
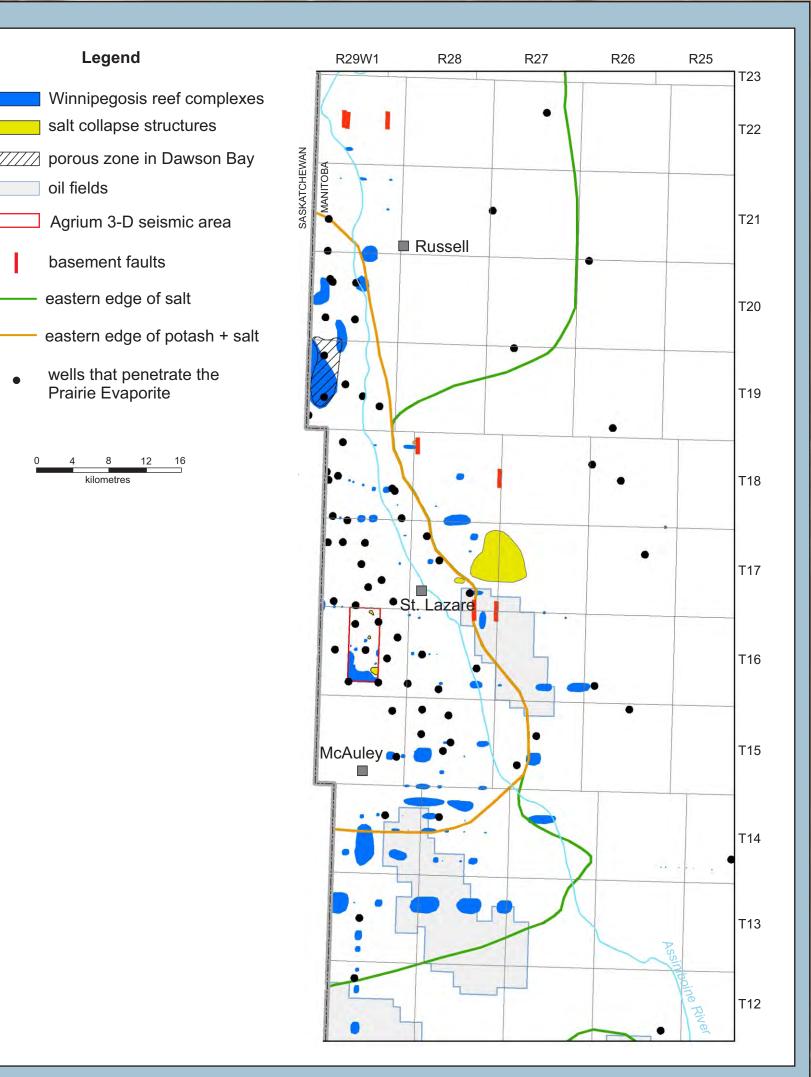


Figure 9: Potash distribution and salt back thickness of the Russell and St.



74426 and Gendzwill (unpublished report, 1986).

7. Exploration History

The discovery of potash in Manitoba was in an oil well drilled in 1951 at 15-18-10-27W1. This discovery led to exploration programs by several companies. Table 2 has a detailed chronology of potash exploration in Manitoba.

In 2013, the crown potash area was amalgamated and is currently held by Manitoba Potash Corporation (MPC) (Figure 11). The MPC property has a combined exploration database for 40 holes that penetrate the Prairie Evaporite Formation, with additional data available for a number of other holes, both within and outside the property. There is also 2-D and 3-D seismic data available for certain areas in and around the Property.

In January 2015, MPC, assisted and advised by Micon International Limited and Manitoba Mineral Resources, initiated the divestiture process to sell MPC and its assets in the Russell-McAuley area. The phased divestiture process for MPC is ongoing.

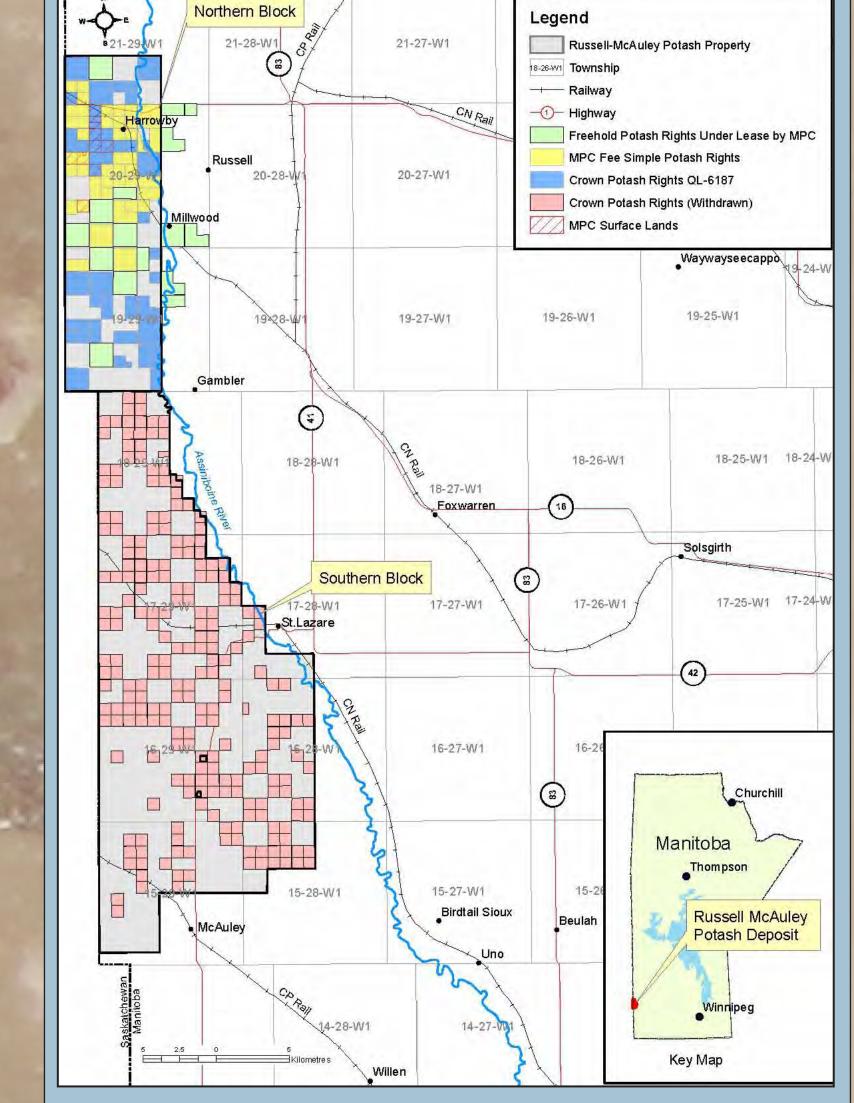


Figure 11: MPC property in the Russell-McAuley area, southwestern

Table 2: Detailed chronology of potash exploration in Manitoba.

Year	Deposit	Company	Details
1951	-	Imperial Oil	Discovery of potash at 15-18-10-27W1 near Virden.
1956-1966	St. Lazare	Sylvite of Canada S.A.M. Explorations Ltd. Francana Oil & Gas Ltd. Tombill Mines Ltd.	Sylvite and its predecessor companies Francana, S.A.M. and Tombill, drilled 10 exploration holes between Twp 17-19, Rge 29W1.
1964-1966	St. Lazare	Prairie Potash Mines Ltd.	South of the Sylvite area, Prairie Potash (owned by Canadian Nickel Co. Ltd. and Consolidated Faraday) drilled 15 holes. They conducted feasibility studies but the lease was allowed to lapse in 1977.
1968	St. Lazare	Sylvite of Canada	Sylvite let the exploration permit lapse in Manitoba to develop Saskatchewan mine (at Rocanville).
1980-1982	St. Lazare	IMC Ltd.	International Minerals & Chemical Corporation (Canada) Ltd. (IMC), predecessor to Mosaic, explored for potash south of the Sylvite program area. IMC dropped the program in 1982.
1980-1985	Russell	Amax Minerals Ltd. Canamax Resources Inc.	Amax was issued a 5-year permit in the Russell deposit (i.e. northern block), predecessor to Canamax; 8 exploration holes were drilled by the end of 1983.
1985	Russell	Canamax Resources Inc.	Canamax has Kilborn Ltd. undertake a preliminary engineering and economic evaluation of the Russell area deposit.
1986	Russell	Canamax Recources Inc. MPC	Canamax and the Government of Manitoba established Manitoba Potash Corporation (MPC); owed 51% by Canamax and 49% by Government of Manitoba. Kilborn prepared a technical feasibility study on the Russell deposit and completed it in October 1987.
1989	Russell	EMC Potamine Potash Mining Company of Canada Inc.	Entreprise Minière et Chimique (EMC) bought the Canamax interest in MPC. EMC established Potamine for its interest in MPC.
1995	Russell	Potamine	Potamine (though Gemmes and MDPA Ingénierie) carried out a critical review of the Kilborn feasibility study and ran a 3-D seismic study of the area.
1997	Russell	EMC	EMC in unwilling to proceed with the Russell project due to flooding in its Clover Hill potash mine in New Brunswick.
2006	Russell	Potamine BHP Billiton MPC	Potamine's interest in MPC is acquired by BHP Billiton. North Rim Exploration Ltd. prepared a mineral resource estimate for the Russell deposit (northern block). AMEC America's Limited prepares a high level conceptual development study on the Russell project.
2005-2010	St. Lazare	Agrium Inc.	Agrium Inc. gets a 5-year 45,000 hectare potash exploration permit (QP-154) in the St. Lazare area. Agrium cancels their Manitoba permit in favour of other projects.
2009	Russell	ADM Consulting Inc.	ADM Consulting Inc. completes a resource estimate for the Russell deposit.
2007-2009	St. Lazare	Western Potash	Western Potash Corp. held three potash exploration permits adjacent to the eastern and southern boundaries of the northern and southern blocks (referred to as their Russell-Miniota property). They drilled 9 exploration holes. Western Potash cancels their permits to focus on its Milestone potash solution mining project in Saskatchewan.
2012	Russell	BHP Billiton MPC	BHP Billiton relinquished its interest in MPC to the MPC, to focus on large-scale Jansen project in Saskatchewan.
2013	St.Lazare & Russell	MPC	MPC acquires the southern block crown land (previous Agrium permit area). MPC now controls all the crown potash lands in the north and south block (Russell and St. Lazare deposits).
2015	St.Lazare &	MPC	MPC begins divestiture process to sells the company and its assets.

References

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