

Potash deposits in the Devonian Prairie Evaporite, southwestern Manitoba



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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 Nutrien's (formerly Potash Corporation of Saskatchewan, 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.

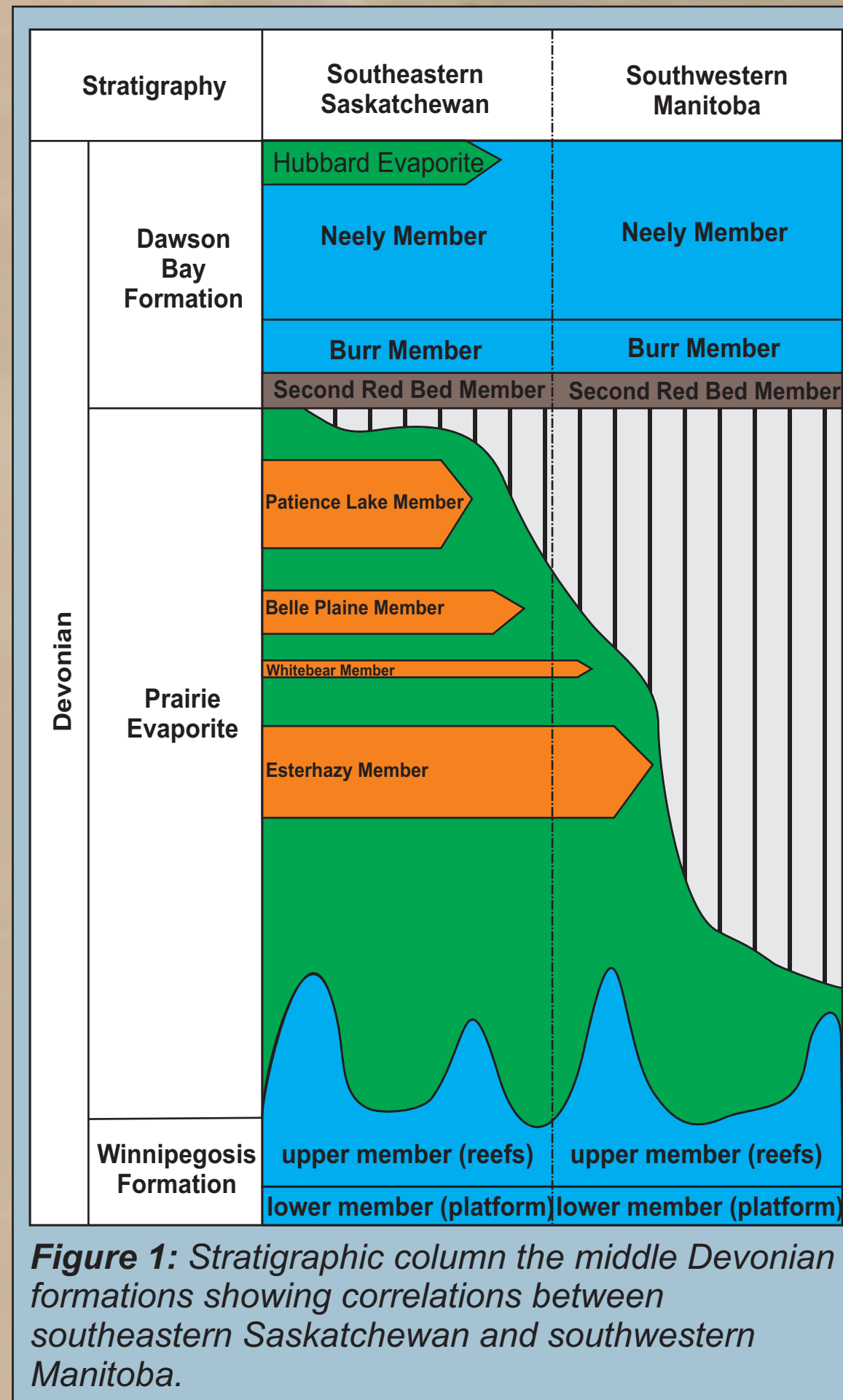


Figure 1: Stratigraphic column of the middle Devonian formations showing correlations between southeastern Saskatchewan and southwestern Manitoba.

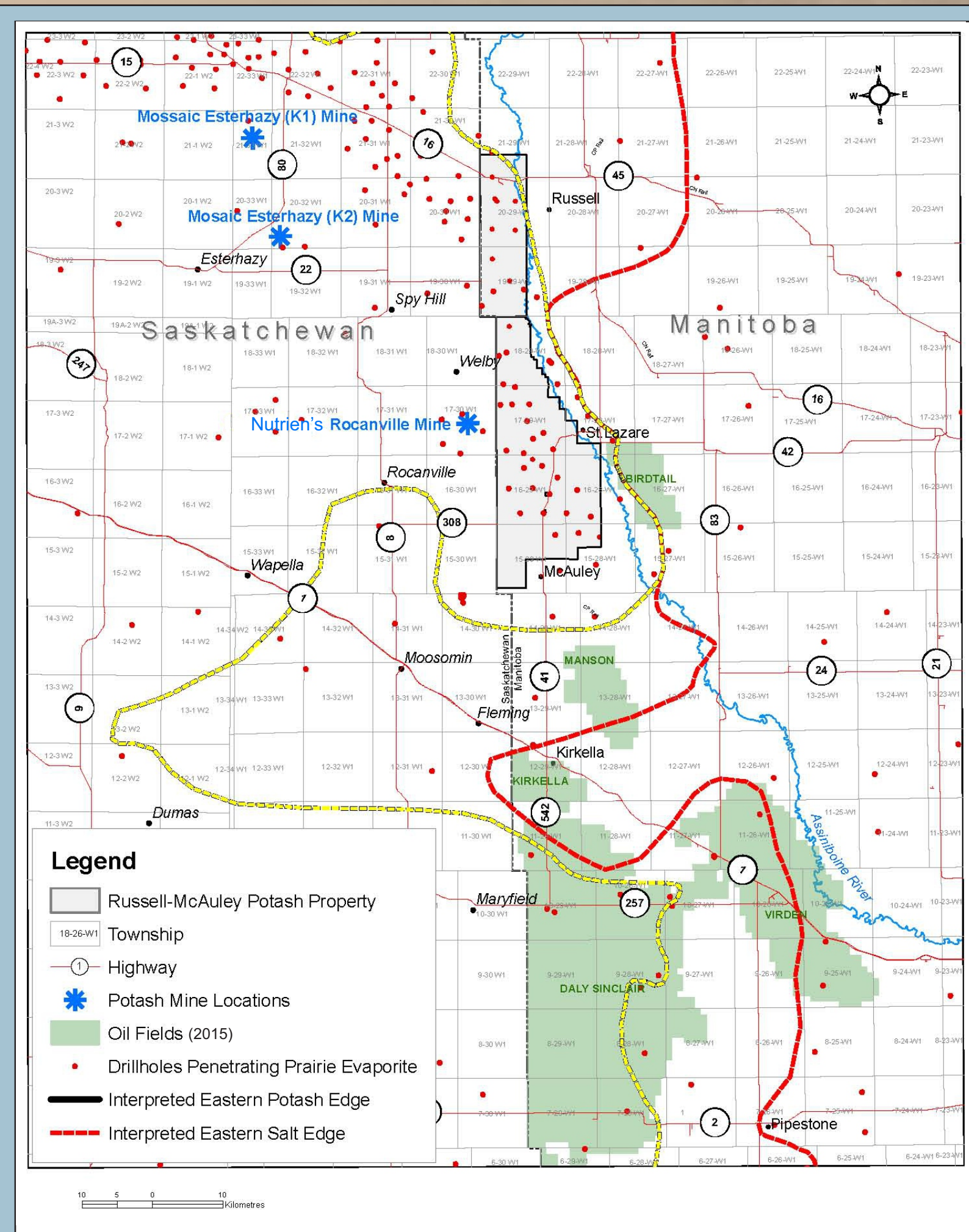


Figure 2: Geological map showing the eastern edge of the Prairie Evaporite salt dissolution front (red), and the eastern edge of the known potash area (yellow), drillholes that penetrate the Prairie Evaporite, and location of nearby potash mines in southeastern Saskatchewan.

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 southeastern 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 (Figure 10). These project up into the overlying Prairie Evaporite in a number of locations and are shown schematically in Figure 4 and 6.

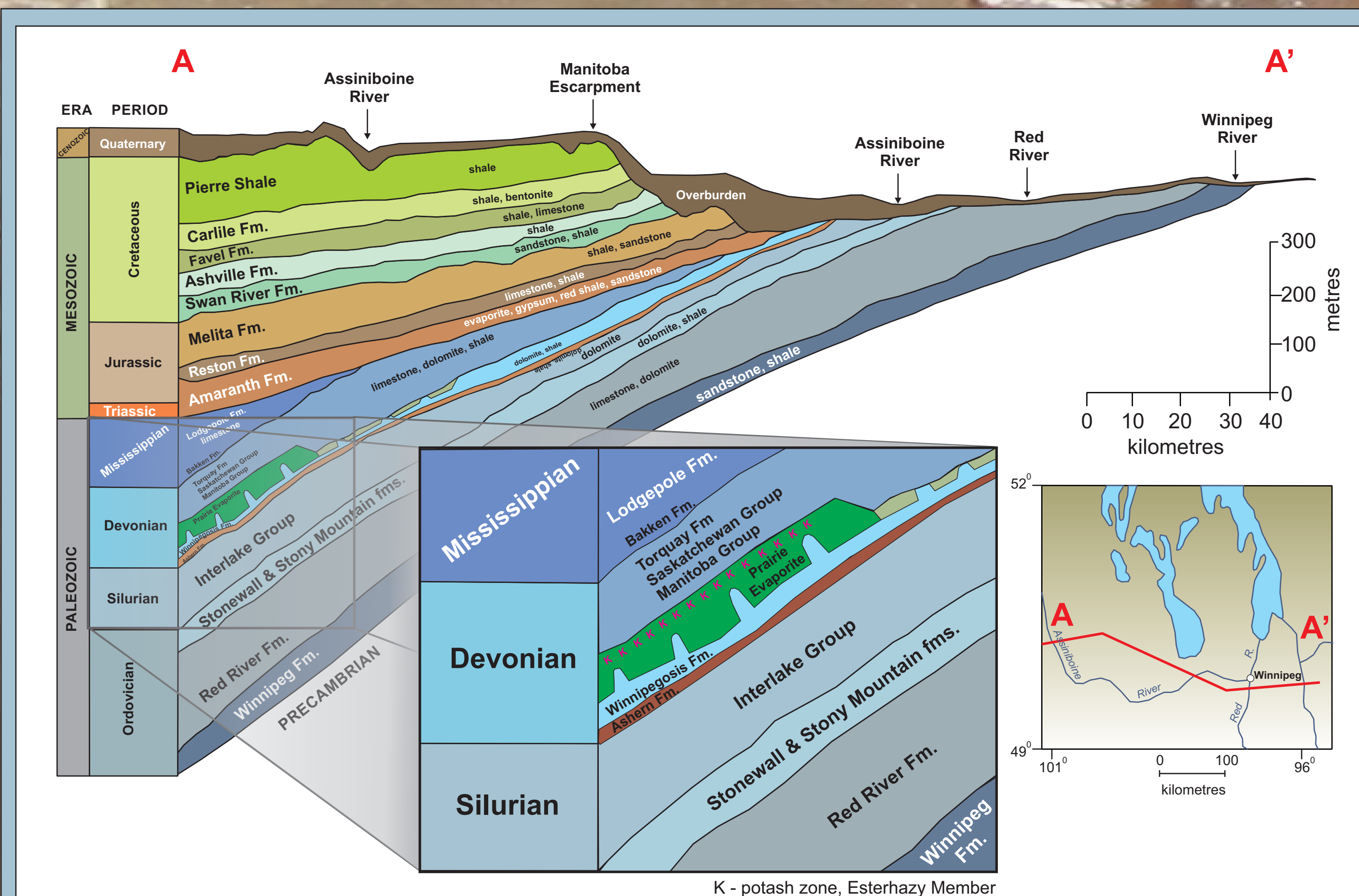


Figure 4: Vertically-exaggerated and simplified cross-section of Paleozoic to Cenozoic formations in southern Manitoba, showing the stratigraphy of the potash-bearing Prairie Evaporite, and underlying Winnipegosis and Assiniboine Formations. (Modified from Bamurak and Nicolas, 2009)

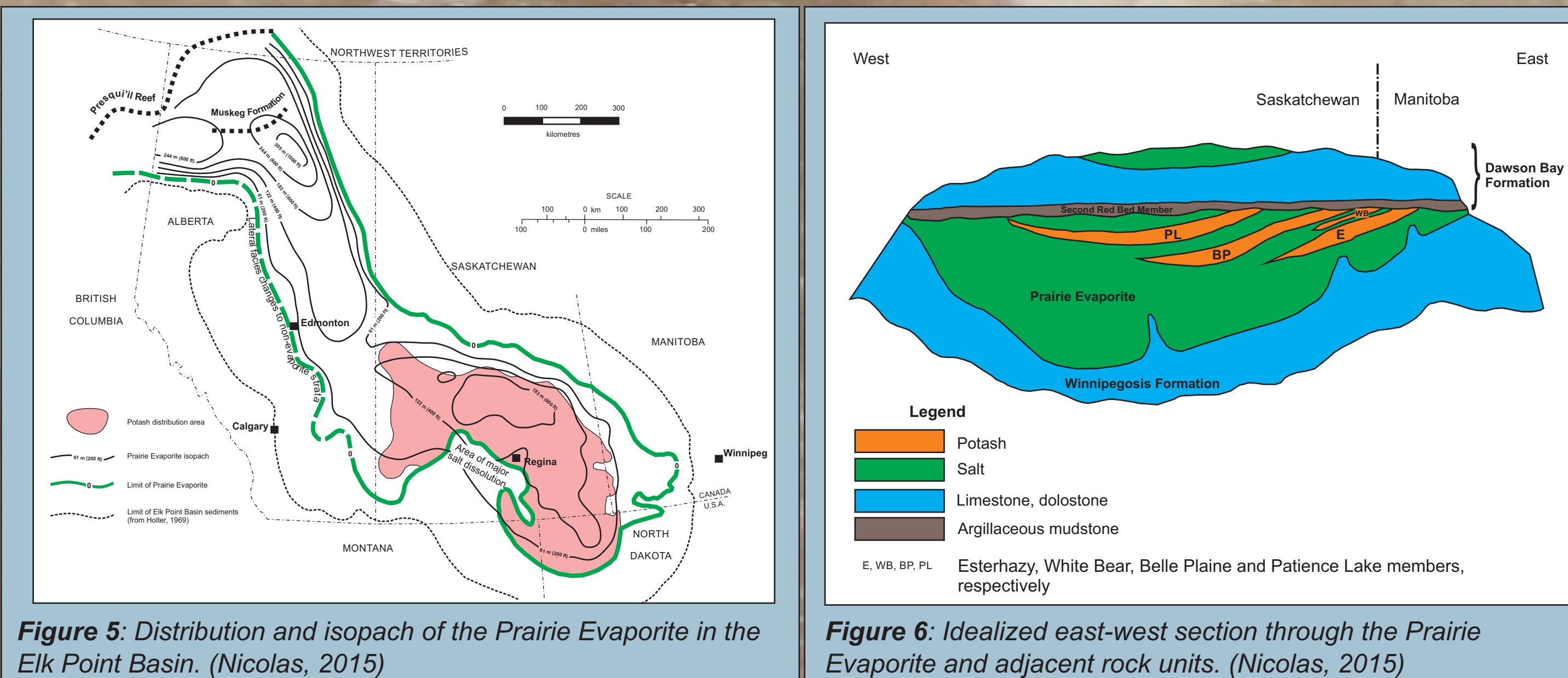


Figure 5: Distribution and isopach of the Prairie Evaporite in the Elk Point Basin. (Nicolas, 2015)

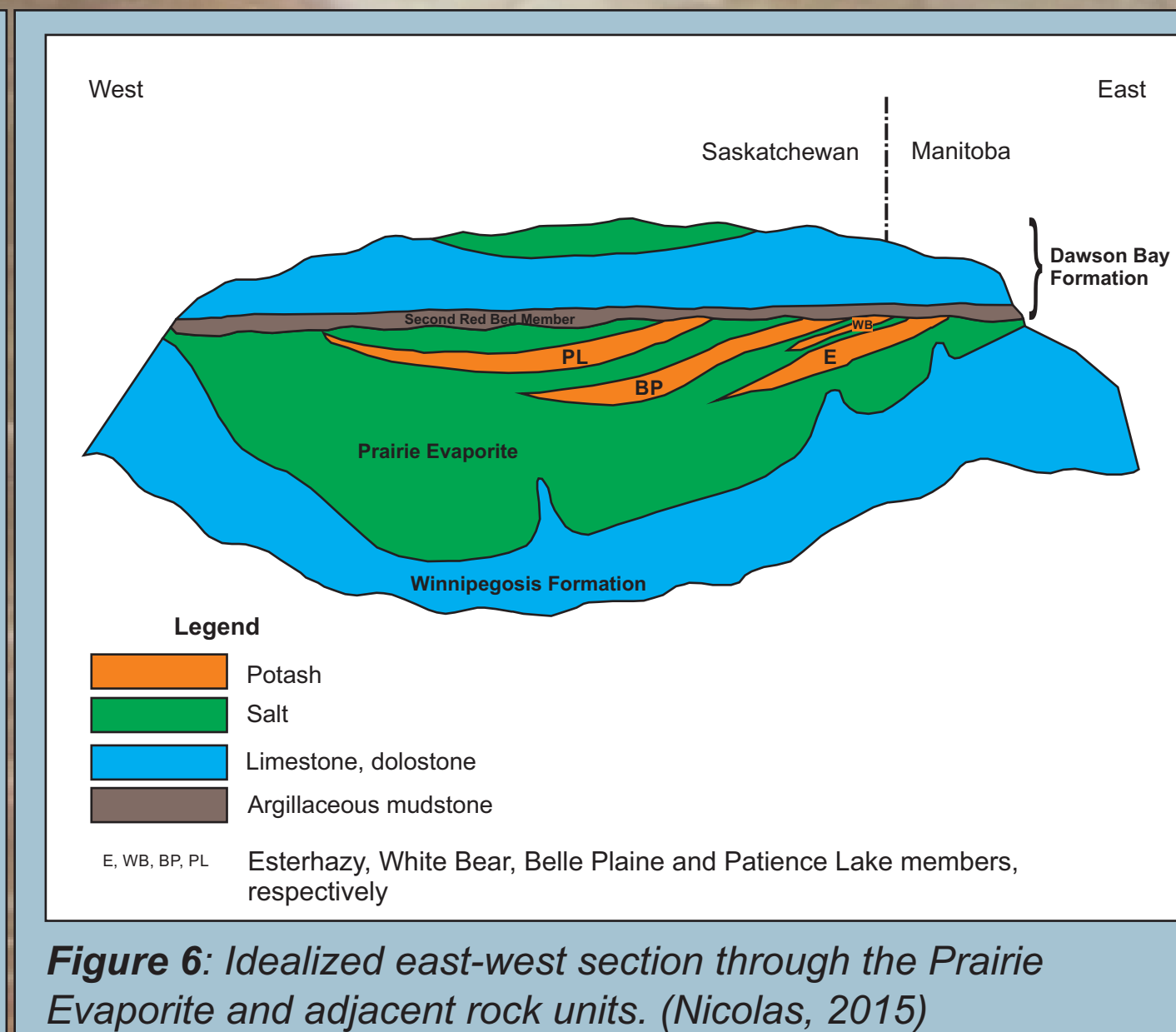


Figure 6: Idealized east-west section through the Prairie Evaporite and adjacent rock units. (Nicolas, 2015)

3. Esterhazy Member

The Esterhazy Member is the most economic potash beds. It consists of euhedral to subhedral 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 north-south 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 Nutrien's at Rocanville and at Mosaic's operations at Esterhazy, just west of the MPC land holdings. It is the only potash bed of known economic significance in Manitoba.

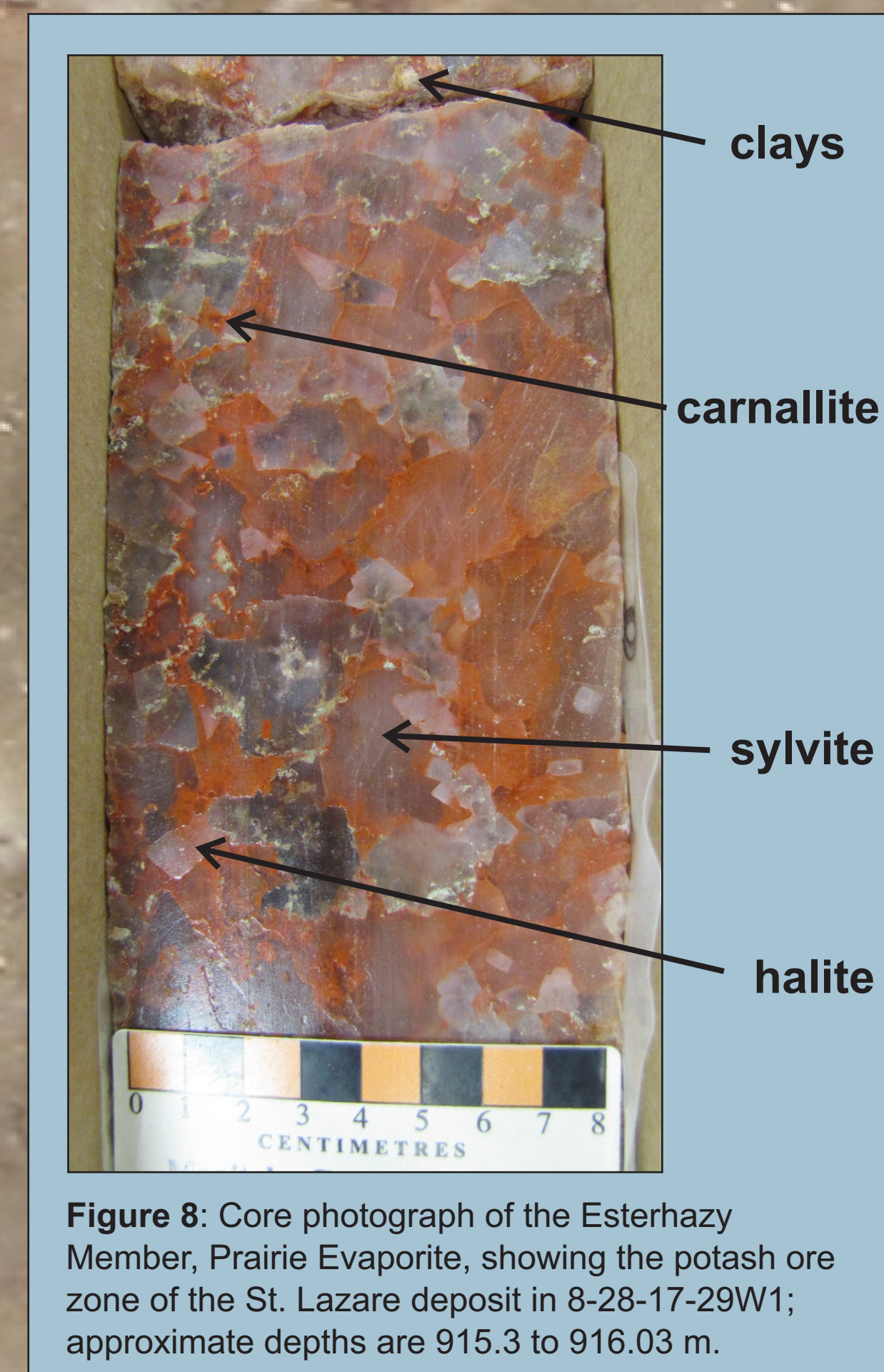


Figure 8: Core photograph of the Esterhazy Member, Prairie Evaporite, showing the potash ore zone of the St. Lazare deposit in 8-28-17-29W1; approximate depths are 915.3 to 916.03 m.

5. Russell-McAuley Area

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, however are also excellent candidates for solution mining. This potash resource has been historically 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 & 11). 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 companies.

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 assuming conventional underground mining operations. 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 KCl, or higher.

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

Area	Million tonnes ¹	Average grade (% K ₂ O)
Russell deposit ¹	392	22.5
St. Lazare deposit ²	650	20.9

¹ BHP Billiton reports from ADM Consulting Ltd. and AMEC Americas Ltd. (2009)
² Bannatyne (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.

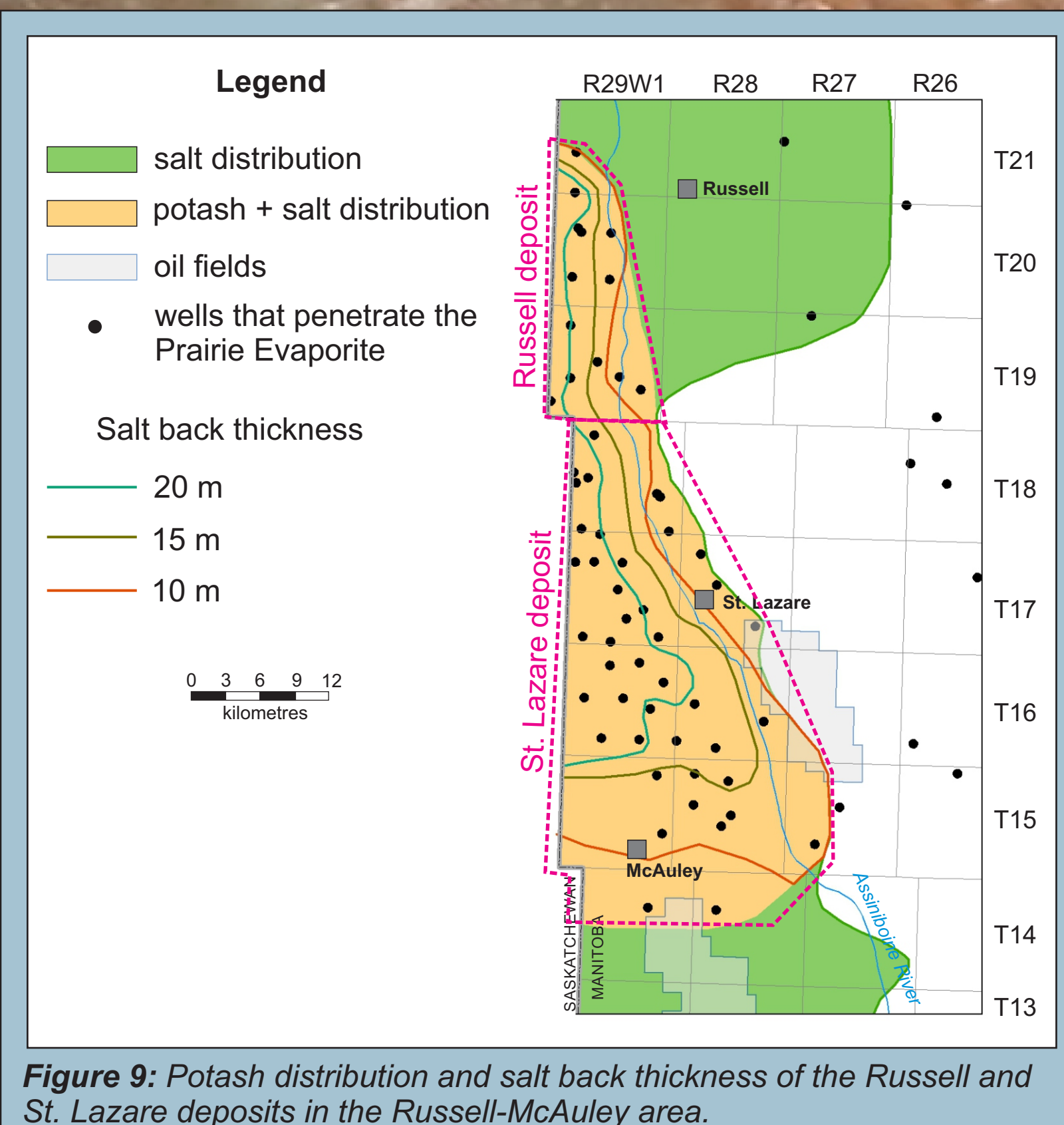


Figure 9: Potash distribution and salt back thickness of the Russell and St. Lazare deposits in the Russell-McAuley area.

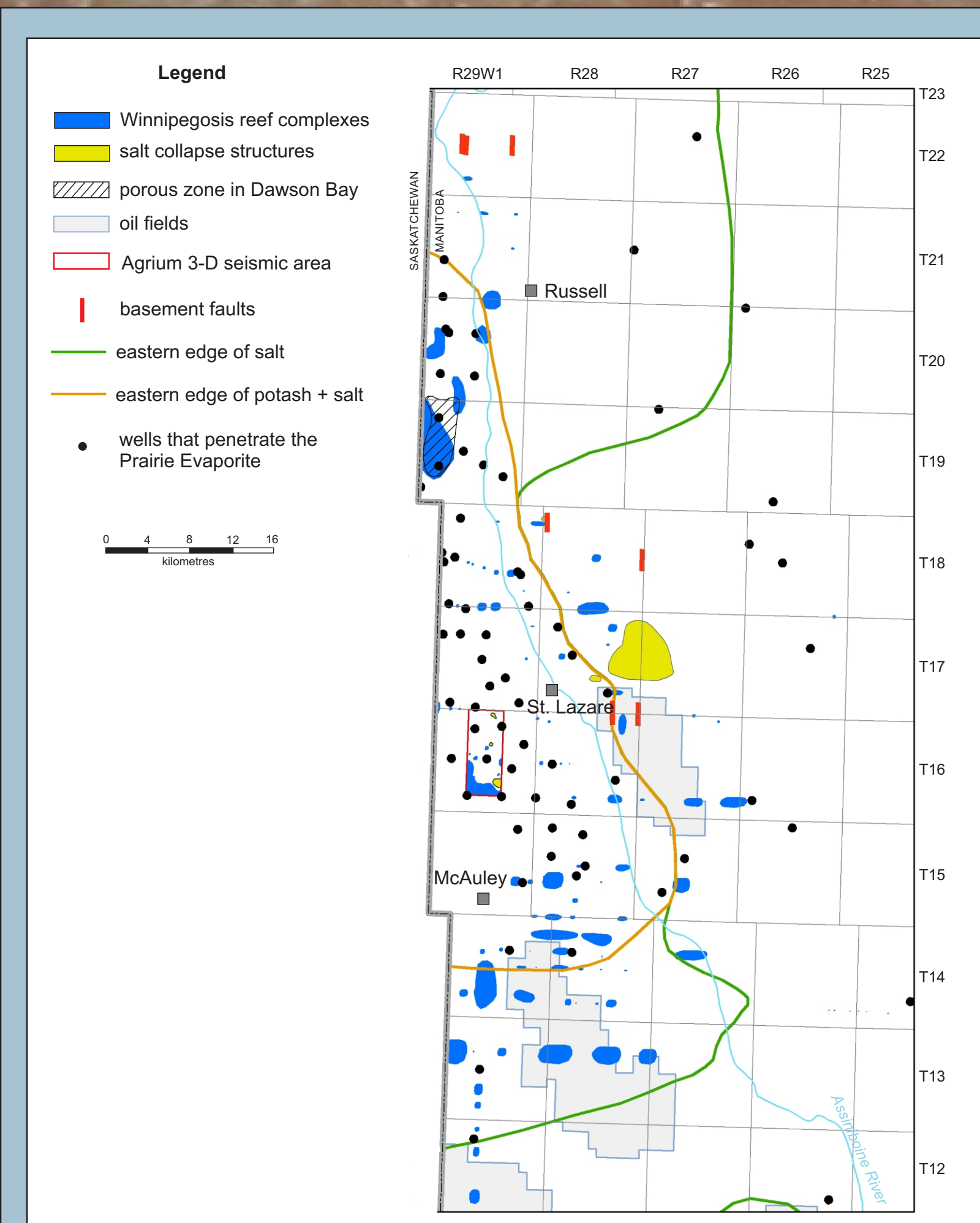


Figure 10: Compilation map of showing the location and size of Winnipegosis reefs and collapse structures and basement faults, as identified by 2-D and 3-D seismic surveys. Information compiled from assessment file 74426 and Gendzwil (unpublished report, 1986).

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), and consists of both the Russell and St. Lazare deposits (Figure 11). The MPC property area 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 (Figure 10). There is also 2-D and 3-D seismic data available for certain areas in and around the Property.

Manitoba is looking to embrace new technologies and flexibility for future potash development. A new plan targeted to encourage potash development in Manitoba will be announced at a later date.

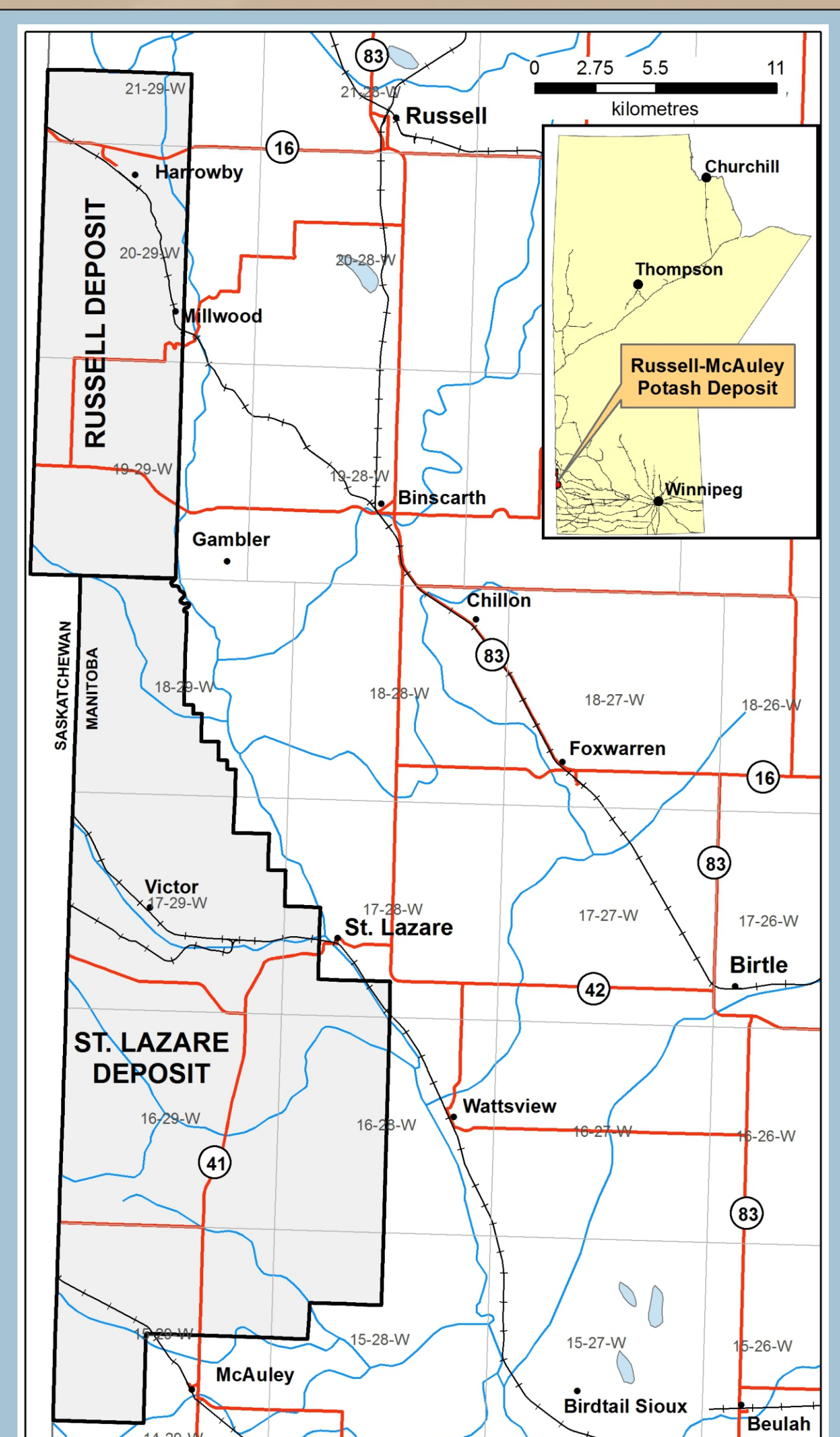


Figure 11: Location of the two historical potash deposits in the Russell-McAuley area, southwestern Manitoba.

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. Francan Oil & Gas Ltd. Tomhill Mines Ltd.	Sylvite and its predecessor companies Francan, S.A.M. and Tomhill, 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	Amex Minerals Ltd. Canamax Resources Inc.	Amex 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 Resources 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-Minota 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).
2018	St. Lazare & Russell	To be determined	Manitoba looks to embrace new technologies and flexibility for future potash development.

References

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