REGIONAL GEOLOGICAL SYNTHESIS

SE Saskatchewan Paleoenvironments

and a 3D geological framework

Walpole / Wawota to Wolseley / Indian Head
Formation architecture, depositional settings and conditional hydrocarbon targets

20	4,074	31,794	10
mapped intervals	regional well records	selected formation picks	interpretive / model figures

Prepared for Jory Young
26 October 2026

A regional screening interpretation based on published core studies, government maps and public formation picks. The model is a reconstruction from contours, not the original provincial grid or a demonstrated inventory of oil accumulations.

Reading guide

The corridor is worth testing as several stacked, discontinuous play fairways. Current evidence does not establish one continuous shoreline, reef ridge or oil-filled reservoir belt.

Evidence level	How to read it	What it does not establish
Published local observation	An identified core, thin section, log panel or described interval in the corridor. Well names, depths and original page references are retained.	Connected reservoir beyond the sampled well, a closed trap, mobile oil or commercial flow.
Regional interpretation	A depositional model supported across a study area, with local transfer qualified. Competing models are retained where material.	A precisely mapped local shoreline or a universal environmental interpretation.
Conditional exploration hypothesis	A location or subenvironment worth testing if reservoir, seal, charge, timing and preservation coincide.	A discovery, resource estimate, lease recommendation or drillable prospect.
Numerical framework	Top and gross-thickness contours reconstructed on a 2 km mesh, with public original formation picks shown separately.	Net pay, current well status, high-resolution structural closure or an independent validation of the source maps.

Detailed coverage of all 20 previously mapped intervals, plus their important local subdivisions and a supplementary regional stratigraphic inventory. The 3D geometry contains only the 20 supported mapped intervals; no local Red Jacket, Dina, Cummings or net-pay surfaces were fabricated.

The 50 profiles cover all 20 modeled intervals, their important subdivisions and additional regional context. The supplementary formations are not asserted to occur at every point along the town corridor. The full data package retains source URLs, mapping conventions and reproducible calculations.

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Navigation: major chapters and each formation have PDF bookmarks. Numbered references link to original sources; the digital evidence register contains the complete URLs and detailed anchor information.

What the evidence says about the belt

The proposed Walpole-Wawota-Indian Head/Wolseley belt is geologically worth testing as several superposed, discontinuous play fairways. The evidence does not yet establish one continuous shoreline, reef ridge or oil-filled reservoir belt. This study separates published rock observations, regional environmental interpretations and conditional exploration hypotheses.

Western carbonate anchor

Lower Red River around Tyvan, Chapleau Lake and Montmartre is supported by a recent core, log and petrographic study. Porous lower-cycle dolomite beneath Lake Alma/C anhydrite is a better-defined test than a hypothetical continuous reef. The Montmartre Birdbear thin section provides a separate local environmental observation, not a connected oil accumulation. [1, 5]

Mississippian preservation matters

An updip failure can reflect removal of the useful upper reservoir rather than a wholly unfavourable original environment. The Souris Valley preservation hypothesis and variable Parkman caprock make the relationship between retained reservoir, the unconformity and Watrous cover an important local test. The proposed extension remains a hypothesis. [13, 15, 26]

Jurassic sand bodies are member-specific

The Wapella-Moosomin study supports estuarine, brackish coastal and tidal-channel environments in separate Red Jacket subdivisions. Reconstructing an A1 valley does not locate a younger A2 barrier or B channel without correlation. The barrier proposed south or west of the A2 setting is poorly controlled. [28]

Broadview and Wapella provide a direct contrast

Published Cummings core at Broadview contains permeable sand with pyrobitumen, while the cited Wapella Cummings interval is mostly mud. This supports local sand-versus-mud heterogeneity and evidence for past charge. Pyrobitumen does not demonstrate present mobile oil. [29, 30]

Bakken and Torquay require bed-scale tests

Whole-formation thickness hides the facies, cement and source-contact relationships that control these plays. A time-specific Bakken regional direction can inform a local reconstruction; it cannot be extended to all members or all formations. The Torquay saline-lake interpretation remains one model among published alternatives. [11, 8, 7]

Why a line of small pools could emerge

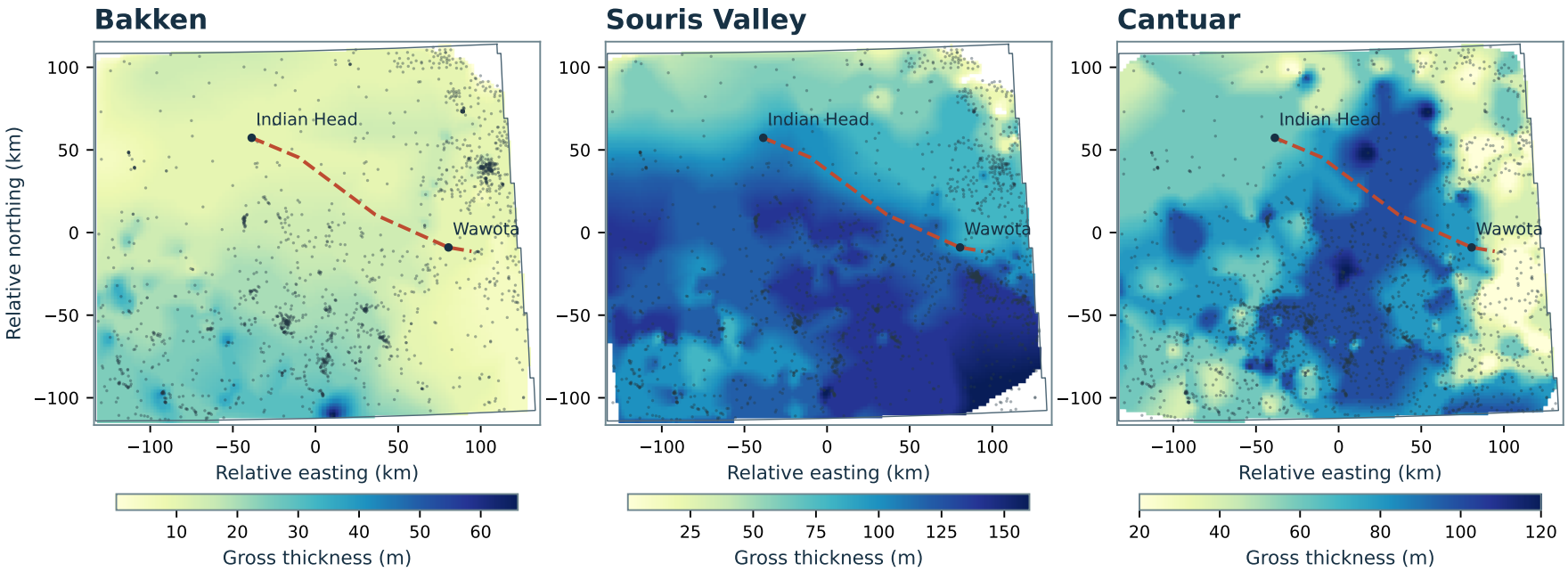
Several mechanisms could produce a discontinuous geographic trend: preservation along an erosional subcrop; repeated shoal or tidal-channel bodies; local secondary porosity; structural relief inherited from basement or salt dissolution; and migration toward updip traps. These processes occurred at different times. Their geographic coincidence must be demonstrated independently for each reservoir horizon. [40, 2, 15, 28]

The most useful next map is therefore a cycle- or member-scale facies and net-reservoir map tied to wet, dry and productive wells. Total formation thickness is a starting framework, not the final exploration variable.

Model geography and selected thicknesses

Where the 3D framework is supported

Regional well-top control and source-based formation thickness • discussion line is geographic context only



Dots: original framework well picks. Colour: interpolation of published gross-thickness contours, masked by source edges and support.

Blank areas are unmodeled, not necessarily absent. Each panel has its own thickness scale. EPSG:2957; grid north up.

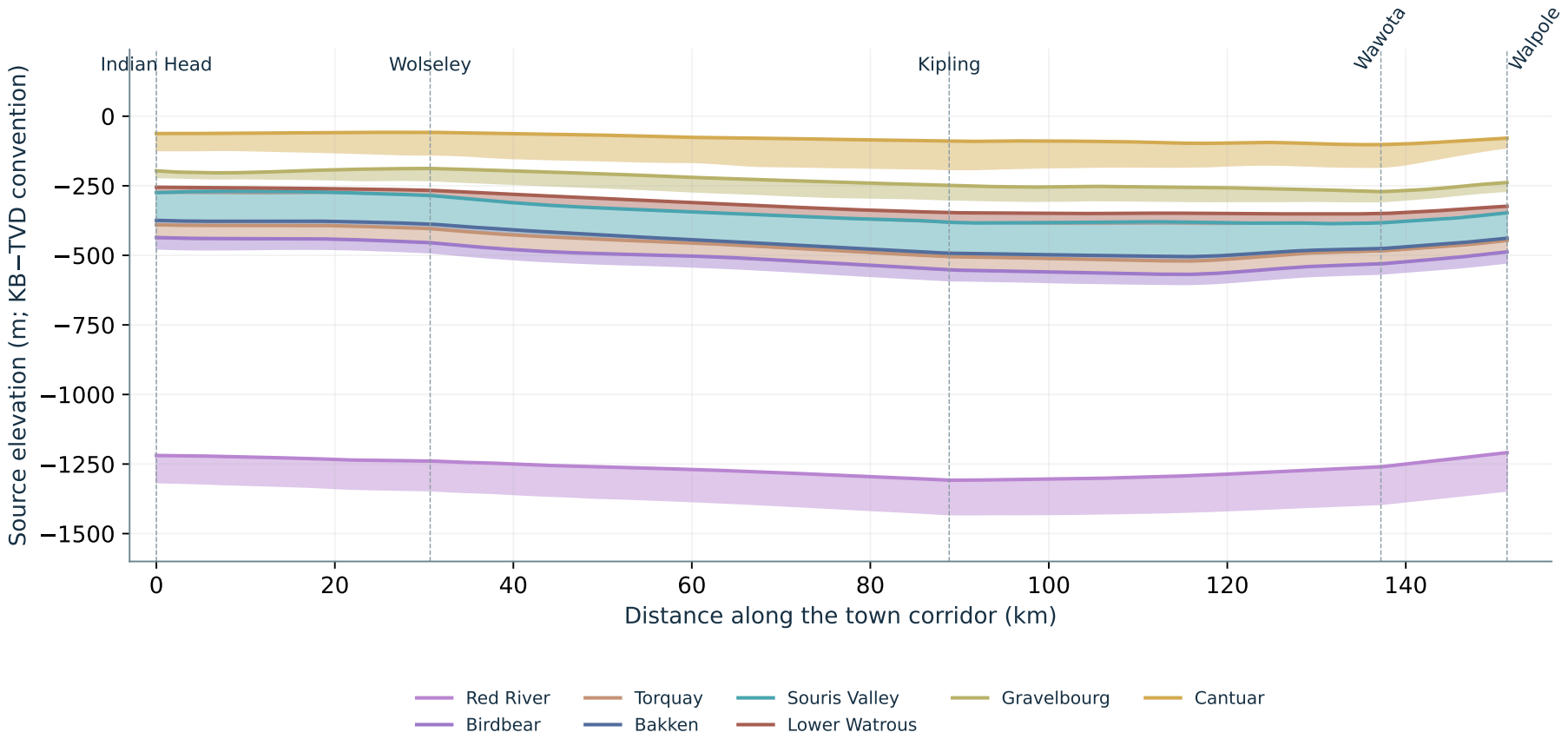
Sources: Saskatchewan public SPFPS TVD dataset and 2014 structure/isopach/zero-edge services. Derived figure; not an official SGS product.

Data-derived regional examples. Colour scales are individual to each formation; points are original public formation-top controls. The town line is a discussion corridor, not a geological boundary. Gaps may reflect limits of contour support or the presence mask and do not by themselves prove absence. [41-43]

A section along the discussion corridor

A regional section along the discussion corridor

Computed from reconstructed contour surfaces • 2 km mesh • present-day geometry, not restored paleotopography



Filled band = mapped gross interval beneath its top. Unshown intervals and white space are not proof of absence.

Sources: SPFPS 2014 structure/isopach services; reconstruction and datum checks described in the report. Vertical scale is highly exaggerated.

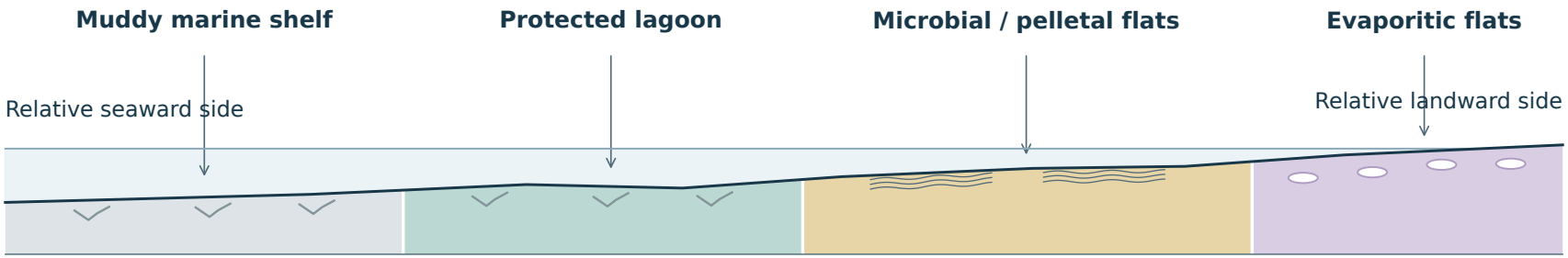
Data-derived present-structure section sampled from the reconstructed 2 km mesh. Coloured bands represent selected gross intervals, including potentially overlapping composites. This is not a restored depositional section, a ground-surface profile, or proof of seal continuity. [41-43]

Older carbonate seas

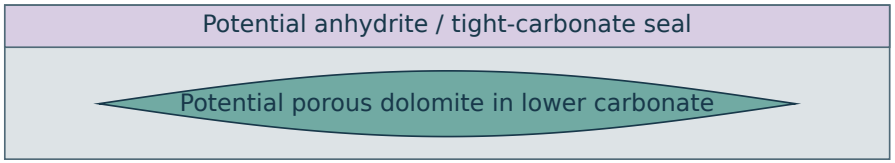
Carbonate settings, seals and later pore changes

Red River and Birdbear: related processes at different geological times, not one continuous facies belt.

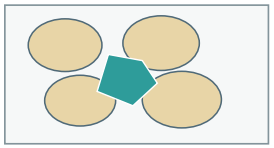
Deposition: low-relief carbonate environments



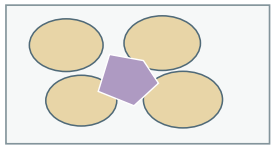
After burial: a reservoir still needs a seal



Later alteration can help or harm



Dissolution opens pores



Cement can fill pores

Montmartre Birdbear: 9-14-13-11W2, 4464 ft — microbial / pelletal fabric; not a pay claim.

Montmartre Red River: 8-21-13-11W2, 2166 m — dolomitized burrows and a partly filled fracture.

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Thomas & Qing (2025), Figs. 8E / 11 / 12B / 15, pp. 13 / 17 / 18 / 21; Nichols (1970), pp. 21–23.
Local Birdbear anchor: Nichols (1970), Appendix D p. 53; Plate 13 Fig. 1, caption / image pp. 80–81.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [1, 2, 4, 12, 5]

Ordovician and Devonian carbonate seas

The older carbonates need their own environmental and petroleum-system models. The strongest direct western-corridor evidence is lower Red River in the Tyvan-Chapleau Lake-Montmartre area, plus Birdbear petrography at Montmartre. Neither observation establishes an uninterrupted reef ridge or an oil-filled belt.

Red River strata - whole mapped interval

Mapped gross interval

Environment. Upper Ordovician warm, shallow, low-gradient epeiric carbonate sea, with three broad carbonate-to-evaporite cycles. In formal SE Saskatchewan nomenclature these comprise Yeoman plus Herald formations; the lowest cycle is Yeoman + Lake Alma, the middle is Coronach, and the upper is Redvers. The mapped total thickness includes rocks deposited at different times and in different environments.

Published evidence. Direct corridor: Thomas & Qing (2025) integrate 143 wireline logs, 63 cored intervals and50 thin sections over T8-16, R5-15W2, including Tyvan, Chapleau Lake and Montmartre. Their detailed facies analysis focuses on Lake Alma/C anhydrite and strata below, not the whole mapped Red River interval.

Additional observation. Direct log: 131/16-14-014-12W2/00; 98J089, Figure 4p6, shows the three cycles and the lower productive interval.

Conditional reservoir setting. Lowest cycle > local porous dolomitized facies below Lake Alma/C anhydrite > connected intercrystalline or dissolution pores and fractures.

Additional candidate. Within lower cycle > isolated palaeohigh/shoal or microbial-patch margins > only where net porosity and permeability survive cementation.

Additional candidate. Younger cycles > any independently demonstrated porous laminated dolostone > separate exploration hypothesis. Coronach success in North Dakota is not evidence for an equivalent productive Saskatchewan corridor belt.

Preservation / test. Dolomitization, dissolution and fracturing can create or preserve pores; dolomite overgrowth, calcite, anhydrite and silica can remove them. Modern geometry also includes burial compaction, basement reactivation and salt-related deformation.

Further constraint. Red River oil-source correlations with organic-rich Yeoman kukersites are established at basin level (Lillis (2013)); this does not prove source maturity or a migration route into every mapped local high.

Further constraint. Formal Yeoman/Herald boundary picks can be subjective in core and logs. Do not equate the entire mapped Red River interval with a single shoreline or reservoir.

Where to look relative to the environment. No single compass shoreline is justified for the whole interval. Present regional dip and total zero edge are not palaeoshorelines.

Corridor relevance. The strongest direct older-Paleozoic evidence in the western half of the proposed belt is lower Red River around Tyvan-Chapleau Lake-Montmartre. A total-thickness map provides regional presence and architecture; it cannot show which of the lower-cycle facies are porous.

References [1, 2, 4, 12].

Birdbear Formation

Mapped gross interval

Environment. Late Devonian shallow carbonate shelf/lagoon, predominantly muddy. Lower carbonate beds record partly restricted conditions with intervals of more open-marine influence and scattered coral/stromatoporoid growth. The upper carbonate-anhydrite interval records stronger restriction, microbial/pelletal flats and repeated carbonate-evaporite deposition. A true continuous reef barrier is not demonstrated by the reviewed southeast-Saskatchewan core evidence.

Published evidence. Direct corridor petrography: BA Montmartre Paul9-14-13-11W2, sample BB102 at 4464 ft (original published depth), Nichols (1970) Appendix D printed p. 53/PDF 75. Plate 13Fig1 caption printed p. 80/PDF 96 and image p. 81/PDF 97 show algal-stromatolitic dolomite overlain by pelletal dolomite. Both sample-depth table and image were visually checked. This is a local rock-fabric observation, not proof of oil pay.

Additional observation. Regional core synthesis: Nichols (1970) printed pp. 21-23 emphasizes poorly sorted bioclasts in micrite, scattered growth-position organisms and weakly agitated muddy environments. It explicitly warns against fore-reef/back-reef interpretation where a reef has not been established.

Conditional reservoir setting. Muddy shallow shelf > upper part of lower carbonate unit > porous dolomite/dolomitic limestone below an effective anhydrite-rich cap.

Additional candidate. Local skeletal/pelletal accumulation or incipient biological patch > grainier or dissolution-prone fabric > only where connected porosity survives.

Additional candidate. Restricted upper flats > microbial/pelletal dolostone > locally porous secondary target, with much less basis for assuming widespread oil pay.

Preservation / test. Dolomitization, intergranular pore preservation, dissolution, vugs and rare biomolds can improve flow; cementation and anhydrite fill can destroy it. Nichols found that dolomite content is not a simple porosity proxy. Salt dissolution beneath the formation and later differential compaction can create structure after deposition; modern highs need not have been original shallow-water patches.

Further constraint. Birdbear charge should not automatically be assigned to Bakken. Lillis (2013), p. 13 regarded a distinct internally sourced Birdbear system as plausible but still lacking a definitive oil-source correlation in the reviewed record. Local oils/source extracts and maturity must be checked before choosing a charge path.

Further constraint. The most detailed retrieved local primary study is from1970; its original observations remain useful, while its basin-wide petroleum prospect rankings are historical and are not adopted here.

Where to look relative to the environment. Use relative open shelf > restricted muddy lagoon/flat > evaporitic flat. Compass placement is low confidence locally. Do not align a Birdbear reef to the regional zero edge.

Corridor relevance. The Montmartre thin section establishes that restricted microbial/pelletal Birdbear facies occur within the western corridor. It does not connect that locality to a continuous reservoir or oil belt. Test local lower-carbonate quality and cap preservation around independently demonstrated structures and known Birdbear occurrences.

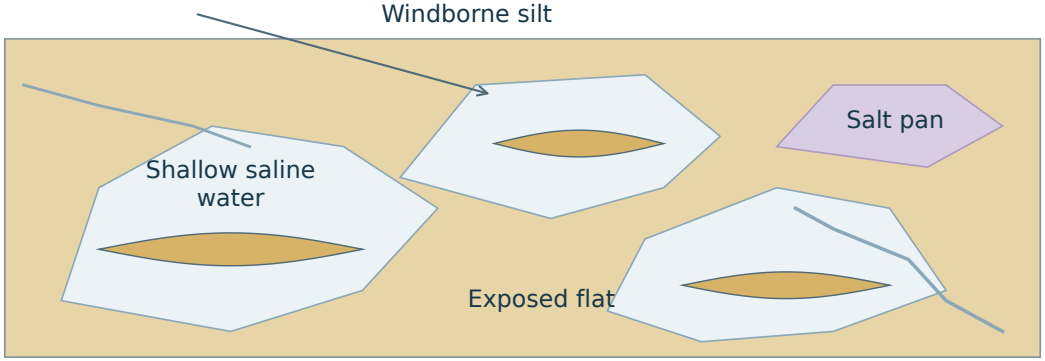
References [5, 12].

Torquay: competing restricted-basin models

Torquay: proposed saline-lake mosaic and reservoir facies

Facies observations are firmer than one universal environmental model; no lake margin is mapped here.

Proposed mosaic — Yang (2020)



Alternative interpretation

Marine / tidal-flat settings appear in earlier studies.

Test fauna, exposure surfaces, salinity indicators and stratigraphic connections.

Red beds or absent fossils alone do not prove a lake.

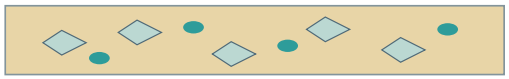
Nested target: cleaner facies + preserved connected pores

F1 Muddy dolomicrite



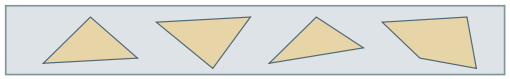
Often tight / weak fluorescence

F2 Cleaner silty dolostone



Preferred where pores survive

F4 Brecciated sediment



Breccia does not guarantee flow

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Yang (2020), Fig. 6 p. 7, Figs. 13–15 pp. 15, 21–22; alternative models discussed pp. 18–20.
Charge / unit preservation are separate tests: Yang (2018), Figs. 25–29 pp. 20–24. F1–F7 ≠ Units 1–6.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [6, 7, 12]

Torquay: a restricted mixed-sediment system

A proposed saline-lake/playa model explains much of the published Torquay evidence, but older marine and tidal-flat interpretations remain relevant alternatives. Distinguish the numbered stratigraphic units from numbered lithofacies: Unit 4 and facies F4 are different classification systems.

Torquay Formation

Mapped gross interval

Environment. Late Devonian mixed fine-grained dolomite, silt/sand, clay and evaporite succession. Yang (2020) interprets much of southeastern Saskatchewan as ephemeral saline lakes/salt pans with windblown silt and storm/ephemeral-stream reworking. Earlier published models include tidal flats and mixed marine-lacustrine settings. The facies observations are stronger than any claim that the entire corridor was a lake.

Published evidence. Regional study: Yang (2020) uses >2000 logs, 18 cores, 30 thin sections from9 wells and11 XRD analyses from2 wells over T1-15, R30W1-30W2. Detailed photographed examples are mostly south/east of the core corridor.

Additional observation. Regional direct photo contrast: 141/16-34-001-15W2; 13J076, Fig 6p7. F2 silty dolostone at 2304.14 m fluoresces strongly; F1 argillaceous dolomicrite at 2306.36 m is weak/nonfluorescent; F3 at 2315.39 m is weak; F4 breccia at 2319.92 m shows none. Visually verified. Fluorescence is evidence of hydrocarbon-bearing pores, not flow rate.

Conditional reservoir setting. Upper stratigraphic package, Units4-6 > comparatively low-clay F2 silty/fine sandy dolostone > preserved intercrystalline/intergranular pores; this is the main facies target in Yang (2020).

Additional candidate. F3 laminated alternations > cleaner silty dolostone laminae and locally connected fractures > limited vertical communication where muddy layers intervene.

Additional candidate. Lower package, Units1-3 > more oxidized, anhydritic, salt-pan facies > generally poorer reservoir candidates; evaporites may instead seal.

Preservation / test. Coarser low-clay F2 permits greater early dolomite recrystallization and pore development than muddy F1. Later clean dolomite rims, quartz overgrowth, pyrite and anhydrite plug pores. Dissolution can open secondary pores; fractures may help only if open and connected. Brecciation is not by itself evidence for reservoir quality.

Further constraint. Cap/lateral containment, charge timing and present oil saturation must be verified for each prospect; a saline-lake environment does not establish a self-sourcing oil system.

Further constraint. Yang (2020) saline-lake interpretation is a model. Lack of fauna, red beds and evaporites are not uniquely lacustrine; key cited isotopic support includes U.S. analogues rather than a new local Saskatchewan isotopic transect.

Where to look relative to the environment. Low for the precise corridor. A broad western marine connection and inland saline-lake system can be illustrated only as Yang (2020) proposed regional model. Use a non-georeferenced inset.

Corridor relevance. Provides a plausible set of tight-dolostone and subcrop targets where the required units and source/seal configuration survive. Present evidence is weaker for drawing a continuous Wawota-to-Wolseley Torquay reservoir corridor than for the specific southern/eastern producing analogues.

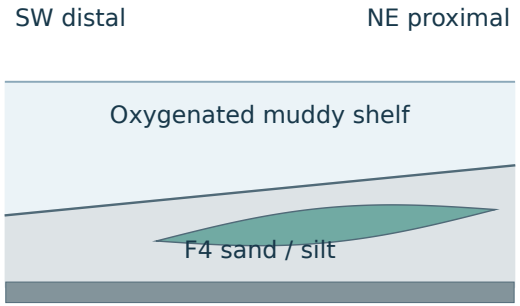
References [6, 7, 12].

Bakken: shifting marine and embayment settings

Bakken: marine → embayment → renewed marine flooding

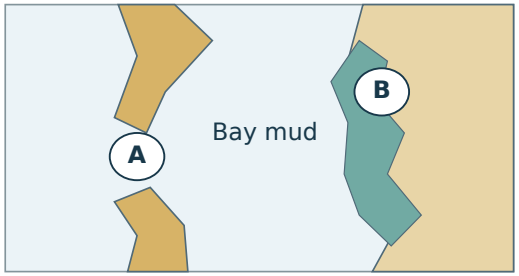
Three time slices from the regional model; the geometry of any corridor sand body still needs well control.

1 Marine shelf / ramp



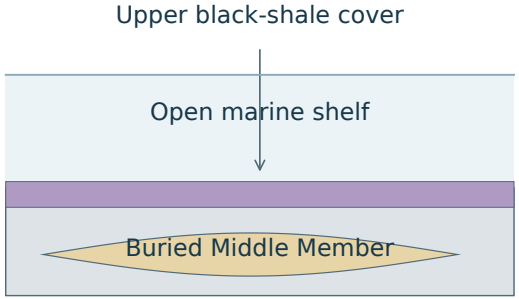
Lower black shale: shelf source interval

2 Brackish embayment



Localized sand bodies and mud baffles

3 Marine flooding



Source / seal role depends on burial

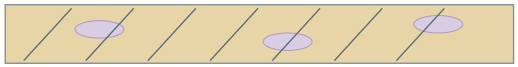
Nested reservoir-prone facies — all require preserved, connected pores

Marine: F4 offshore transition



Marine trend: regional and time-specific

A F6 bay-mouth sand



Clean sand can be cemented tight

B F7 / F8C tidal-flat sand



Mud drapes can reduce connectivity

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Angulo & Buatois (2012), Fig. 11 p. 1033, Figs. 9–10 pp. 1030–1032; (2011), Table 2 p. 4.
Cement / pore example: Kohlruss & Nickel (2009), Rocanville core and thin section, Figs. 11–12 p. 10.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [8, 9, 10, 11, 12]

Bakken: marine shelf, embayment, marine flooding

The Middle Bakken contains more than one reservoir geometry. Its early open-marine facies can be regionally extensive; later bay-mouth and tidal-flat facies are patchier. A regional northeast-proximal/southwest-offshore trend is supported for particular intervals. It does not locate a fixed shoreline through the modern towns.

Bakken Formation

Mapped gross interval

Environment. Late Devonian-early Carboniferous shallow epicontinental sea. Lower and Upper black shales accumulated mainly under oxygen-poor shelf water. The Middle Member records marine lower-offshore to offshore-transition/lower-shoreface deposition, followed by a more localized brackish embayment and then renewed open-marine flooding. Angulo & Buatois (2012) favor this model after comparing competing sequence interpretations.

Published evidence. Direct corridor inclusion: Angulo & Buatois (2011) Table 1p3 lists TRICENT ET AL MUTRIE11-36-13-11W2,101/11-36-013-11W2/00; 80J106, core1259.4-1271.3 m in its facies-calibrated dataset. This establishes analyzed local core, not a published per-well facies log or proof of pay for that interval.

Additional observation. Near-corridor eastern analogue: Rocanville08-05-16-31W1, UnitB core695.5 m and thin section694m (Kohlruss & Nickel (2009), Figs11-12p10). Calcite occurs as isolated blebs rather than pervasive cement, leaving porous sandstone. Both images were visually inspected.

Conditional reservoir setting. Open-marine Middle Member > offshore-transition F4 very-fine sandstone/siltstone > relatively widespread preserved porous intervals; grain size alone does not determine flow.

Additional candidate. Brackish embayment > bay-mouth/barrier F6 fine sandstone > locally excellent where calcite/dolomite cement is incomplete, as the Rocanville example demonstrates.

Additional candidate. Embayment margins > wave-dominated tidal-flat F7 and muddy-draped tidal-flat F8C > sand-rich connected laminae; mud drapes produce baffles and anisotropy.

Preservation / test. Calcite and dolomite cement can fill even the cleanest and coarsest sandstone. Finer F4/F7/F8C can retain better reservoir properties than strongly cemented F6. Compaction, bioturbation and mud drapes alter connectivity; dissolution is not the demonstrated explanation for every porous interval. Rocanville calcite-bleb edges support incomplete cement emplacement in the cited study, with the detailed fluid-flow explanation still speculative.

Further constraint. Lillis (2013) documents migration into immature Canadian reservoirs and a NE Torquay-Rocanville migration trend including cited Jurassic Red Jacket and Cretaceous Wapella examples. That charge trend is not the same as the user's WNW pool-belt hypothesis and is not a depositional shoreline.

Further constraint. Sequence interpretation differs: Kohlruss & Nickel (2009) emphasize falling-stage/lowstand UnitB; Angulo & Buatois (2012) interpret a transgressive brackish embayment after a sea-level fall. Do not merge both into an apparently unique established timeline.

Where to look relative to the environment. Moderate at regional sequence scale: lower marine facies belts trend NW-SE with deeper/distal towardSW and inferred shorelineNE; progradationSW followed by transgressive embayment migrationNE in AB12. Low for precise placement of subenvironments in the user corridor.

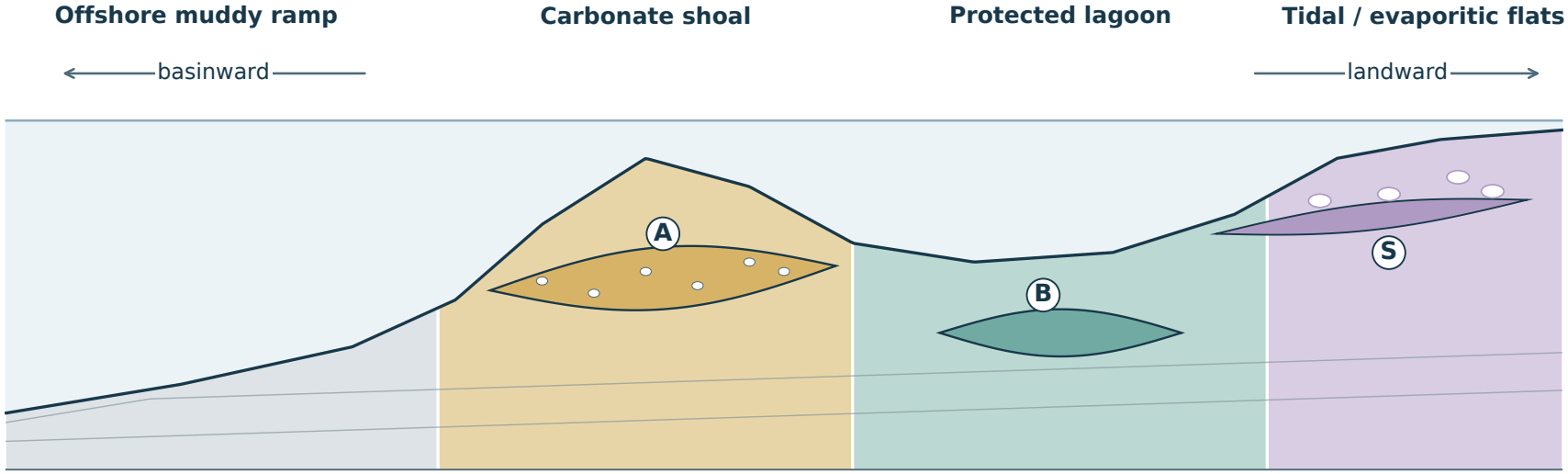
Corridor relevance. Published Mutrie core gives a local western-corridor anchor; Rocanville gives a nearby eastern counterexample to the idea that UnitB is always tight. The attractive small-pool hypothesis is patchy reservoir-quality sand preserved within a complex bay/flat succession, requiring bed-scale correlation and cement/charge tests.

References [8, 9, 10, 11, 12].

Lower Mississippian carbonate ramp

Carbonate ramp: subenvironments and reservoir filters

Regional facies concepts from southern Saskatchewan analogues; local axes require correlated wells.



A Grain-rich shoal / flank
Sand pores may survive, or be closed by calcite and anhydrite.

B Dolomitized lagoon
Muddy precursors can become reservoirs if pores connect.

S Tight mud / evaporite
Potential seals must be continuous and survive later alteration.

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Rott & Qing (2005), Figs. 4, 9, pp. 4, 8; Ji & Salad Hersi (2016), Fig. 5, p. 11.

Confidence: regional processes well supported; exact facies boundaries and corridor orientation unresolved.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [13, 14, 15, 26, 16, 17, 18, 19]

Souris Valley, Tilston, Alida and Kisbey

Carbonate bank growth, muddy basinward deposits, shoals and localized quartz-sand influx built a varied succession. Subsequent erosion changed which parts remain near the northern margin. Test whether an attractive thickness trend is original deposition, preserved erosional relief, or later deformation.

Souris Valley Beds / Lodgepole Formation

Mapped gross interval

Environment. Early Mississippian transgression over the Bakken followed by shelf-margin carbonate growth: cleaner carbonate bank, muddy basinward clinoforms and localized Waulsortian-type mud mounds. A mound is not automatically a framework reef.

Published evidence. Basal glauconitic wackestone, bioturbated transition and argillaceous limestone are illustrated at successive levels. 16-30-9-30W1; 1007.0, 1002.0 and 997.0 m. [14; Plate 4, caption printed 50/PDF 63, photographs PDF 64]

Additional observation. Bryozoan fabrics, abundant early calcite spar and locally leached, bitumen-bearing material demonstrate both original biological fabrics and later pore modification. 5-7-9-30W1; 929.8 and 927.5 m. [14; Plate 8, caption printed 70/PDF 83, photographs PDF 84]

Conditional reservoir setting. Preserved upper crinoidal/ooidal shoal packages where dissolution or dolomitization left connected pores.

Additional candidate. Localized mound flank/top or clinoform-to-bank terminations, only where core establishes reservoir quality and sealing facies.

Preservation / test. Separate primary facies from early spar, burial compaction, dissolution and sub-Mesozoic alteration. A preserved porous body needs lateral/top containment and an independently demonstrated migration/charge history. Thin muddy clinoforms can be barriers but do not establish a sealed accumulation by themselves.

Further constraint. Reject the hypothesis if: correlated cores show the purported upper reservoir never developed rather than having been eroded.

Where to look relative to the environment. Basinward southward progradation is supported regionally; individual shoal/mound axes and northern shoreline positions are not fixed by the official thickness or zero-edge maps. Confidence: Moderate for basinward direction; low for local axes.

Corridor relevance. The thesis samples the southeastern margin, including northern townships near the broader Parkman corridor. Lake 2023 specifically treats Parkman as an exception to disappointing subcrop results and points to Northgate T2 R2W2-South Fillmore T9 R11W2, approximately 60 km downdip, as an exploration hypothesis. Daly examples are Manitoba analogues, not Wawota control. No demonstrated continuous shoal was traced to Indian Head.

References [13, 14, 15, 26].

Tilston Beds

Mapped gross interval

Environment. Shallow carbonate platform/ramp with mobile skeletal, peloidal and locally ooidal grain bodies, adjoining quieter muddy carbonate and peritidal facies. This is a carbonate sand-shoal model; framework reef growth requires additional evidence.

Published evidence. Published thin section identifies peloidal grainstone with interparticle pores. 101/01-11-006-33W1; licence 86J054; 1158.5 m. [16; Figure 5A, p.11]

Additional observation. Oil-stained dolomitized packstone with biomoldic pores and dolomitized crinoidal packstone are illustrated from the northern part of the thesis study. 15-29-9-31W1; 943.4 and 950.8 m. [14; Plate 7A-B, caption printed 66/PDF 79, photographs PDF 80]

Conditional reservoir setting. Clean skeletal/peloidal shoal packages with connected interparticle or secondary pores.

Additional candidate. Dolomitized packstone with preserved molds/vugs where plug data demonstrate permeability.

Additional candidate. Preserved subcrop remnants with intact top seal and demonstrable lateral closure.

Preservation / test. Original grain richness alone is insufficient: pressure solution, calcite/anhydrite cement and recrystallization modify connectivity. Northern subcrop trapping requires preservation and a competent alteration/Watrous seal; Parkman seal failure is locally documented, so continuity cannot be assumed.

Further constraint. Reject the hypothesis if: a mapped remnant disappears after original picks are audited.

Where to look relative to the environment. Regional landward-to-basinward facies changes are plausible; no single measured shoal orientation is established for the Walpole-Wolseley corridor by these studies. Confidence: Moderate setting; low corridor-scale geometry.

Corridor relevance. The 15-29-9-31W1 observation is closer to the northern producing trend than the Ji-Hersi southern study. It is a local sample, not evidence that the whole Tilston preservation edge carries the same facies. Any Candiac remnant shown on official regional maps requires independent picks and core confirmation.

References [16, 14, 26].

Alida Beds

Mapped gross interval

Environment. Inner shelf to wave-agitated carbonate bank/shoal and foreslope; facies include crinoidal mud/wackestone, echinoderm and ooid grain/packstone, peloidal facies and quartz-bearing intervals.

Published evidence. Cross-bedded echinoderm grainstone is illustrated, supporting current/wave reworking of skeletal sand. 10-12-8-4W2; 1202.60 m. [17; Figure 4, p.4]

Additional observation. A SW-NE structural section through Arcola-Buffalo Head illustrates strong facies changes; its southwest mound component is explicitly inferred. It is not a restored paleotopographic section. Section approximately 13-20-7-4W2 to 8-2-9-3W2; . [17; Figure 9, p.8]

Conditional reservoir setting. Clean crinoid/echinoderm or ooid shoal crests and flanks where cement is incomplete.

Additional candidate. Dolomitized or selectively dissolved grain-rich facies with measured connectivity.

Additional candidate. Local facies terminations against tight mud-rich carbonate, combined with preserved top seal.

Preservation / test. Anhydrite, calcite and compaction may destroy original sand pores; dissolution can reopen them. Distinguish depositional facies from the crosscutting diagenetic caprock. A local structural or facies trap still needs charge and spill-point evaluation.

Further constraint. Reject the hypothesis if: clean-bank interpretation is replaced by muddy carbonate in adjacent cores.

Where to look relative to the environment. A documented SW-NE section tests local facies relations; its direction does not establish a regional coastline or a corridor-parallel bank. Confidence: High local facies descriptions; low extrapolated azimuth.

Corridor relevance. Best direct examples are Arcola, Buffalo Head and Rosebank, south of much of the town corridor. Transfer the facies model only where the Alida is independently shown to be preserved.

References [17, 18].

Kisbey Interval / Kisbey Sandstone

Mapped gross interval

Environment. Mixed quartz sand and carbonate along a shallow marine carbonate-siliciclastic interface. Published models include lowstand sand influx followed by marine reworking/transgression, with localized channels, dunes or sabkha; neither an all-fluvial-valley nor an all-shoreface label is justified.

Published evidence. Gamma-ray/photoelectric logs and a detailed published core column show quartz-rich beds alternating with carbonate, cross-bedding, dolomicritic clasts and marine trace fossils. Provident Hastings E 131/6-2-4-33W1/00; Cored interval 1173.5-1191.8 m. [19; Figure 2a-b, p.4]

Additional observation. The author documents contrasting sand/carbonate successions in wells within about 800 m and questions treating every thick sand as erosional valley fill. His Kisbey interval definition is broader than traditional sandstone picks. 6-28-3-31W1 and 9-29-3-31W1; . [19; Figures 8-9 pp.10-11 and discussion]

Conditional reservoir setting. Clean, connected marine-reworked sand lenses or genuine channel fills bounded by tight carbonate/mud.

Additional candidate. Carbonate-sand transitions where dolomitization or carbonate dissolution enhances connectivity.

Additional candidate. Local lowstand sand accumulation preserved beneath a subsequent transgressive seal.

Preservation / test. Carbonate matrix and anhydrite cement can dominate quality. Gross thickness and quartz content are not net pay. Correlation must distinguish sequence position, erosional relief and diagenetic overprint before inferring connectivity or charge pathways.

Further constraint. Reject the hypothesis if: a proposed incised channel lacks basal erosion/truncation or preserves continuous underlying markers.

Where to look relative to the environment. Local channel or elongate sand-body axes need closely spaced correlations. No reliable universal current direction or corridor-aligned shoreline is supplied by the regional isopach. Confidence: High mixed marine sedimentary evidence; low specific corridor geometry.

Corridor relevance. Published reference sections are predominantly southern Saskatchewan. This facies model applies to the northern corridor only where the same stratigraphic interval survives and its picks are consistent with the study definition.

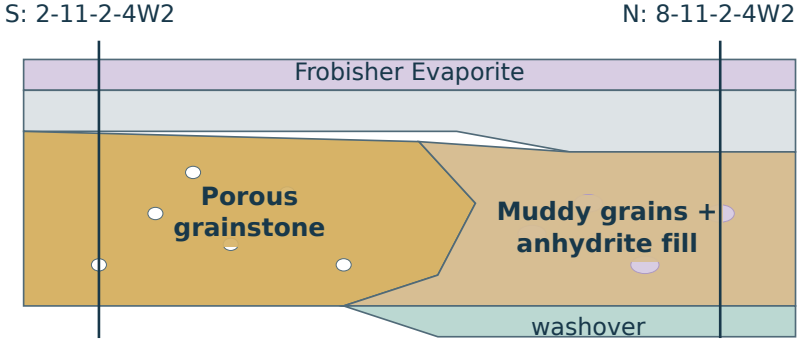
References [19, 16].

Frobisher, Midale and Ratcliffe

Local facies traps and evaporite-cycle distinctions

Pinto illustrates lateral reservoir loss; evaporite names require both stratigraphic and environmental context.

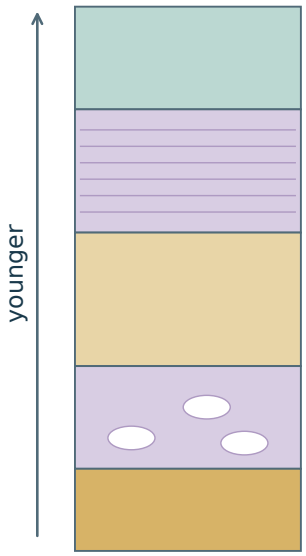
A Frobisher grain bank, Pinto



A small bank can lose reservoir quality laterally before the formation ends.

Published facies evidence; geometry simplified.
No thickness scale is implied.

B Two evaporites, different context



* Lower Frobisher Evaporite can belong to an upper Frobisher genetic cycle. Lithostratigraphic and genetic cycle boundaries need not coincide.

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Nimegeers & Marsh (2006), Figs. 1–2, p. 2; Marsh & Qing (2002), pp. 39, 43. Liu & Qing (2009), pp. 2–4, Fig. 5, p. 8; Lake & Kent (2007), Fig. 5, p. 7.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [20, 21, 16, 22, 27, 23, 24, 25]

Frobisher, Midale and Ratcliffe: shoals, lagoons and evaporites

Reservoir-prone bodies include coated-grain shoals, locally dolomitized muddy carbonates and tidal channels, beside tight muds and evaporites. Evaporite names are not simple time lines: Frobisher Evaporite lithostratigraphy and genetic-cycle boundaries differ; Midale Evaporite is commonly associated with basal Ratcliffe deposition and lateral Ratcliffe carbonate equivalents.

Frobisher Beds

Mapped gross interval

Environment. Repeated shallow-water carbonate-evaporite cycles: coated-grain shoals, muddy back-barrier/lagoonal facies, washover, algal/peritidal muds and evaporitic exposure. Steelman core work recognizes four progradational cycles; the lithostratigraphic boundaries do not coincide everywhere with genetic cycle boundaries.

Published evidence. Pinto photos and a south-north two-well stratigraphic section show porous ooid shoal rock changing into poorly sorted muddy, anhydrite-cemented back-barrier facies and intraclast washover. 2-11-2-4W2 and 8-11-2-4W2; 5196 ft; 5204 ft; 5219 ft. [21; Figures 1-2, PDF p.2/printed 635]

Additional observation. Steelman nodular anhydrite overlies an exposed argillaceous dolomudstone; the upper genetic cycle boundary is placed at a flooding surface within the lower Frobisher Evaporite. 1-29-4-4W2; 1379.7 m. [20; Figure 10 printed 43/PDF 7; cycle discussion printed 39/PDF 3]

Conditional reservoir setting. Clean ooid/peloid shoal crest and margins, enclosed laterally by mud-rich or cemented facies.

Additional candidate. Dolomitized protected-lagoon/peritidal carbonate where pore throats remain connected.

Additional candidate. Repeated reservoir lenses at distinct cycle levels rather than one undifferentiated Frobisher body.

Preservation / test. The same depositional belt can alternate porous and anhydrite-plugged rock over short distances. Fault/inherited relief may influence accommodation locally, but must be established independently with multi-horizon structure and stratigraphy. A productive shoal analogue does not establish charge in an untested lens.

Further constraint. Reject the hypothesis if: adjacent wells fail to show predicted clean-to-muddy transition at the same cycle level.

Where to look relative to the environment. Pinto locally demonstrates a south-north cross-facies transition; Steelman authors also discuss local NE-SW structural/depositional trends. These are not a single regional shore-parallel azimuth. Confidence: High local transition; low corridor-scale projection.

Corridor relevance. Pinto and Steelman are southern analogues. Their reservoir geometry is useful for nested facies mapping, but younger Frobisher preservation must be established before applying it to Walpole-Indian Head.

References [20, 21, 16].

Frobisher Evaporite

Mapped gross interval

Environment. Evaporitic tidal-flat/sabkha and restricted-basin transition with nodular or mosaic anhydrite, dolomitic mud and exposure indicators. Common lithostratigraphy places it at the base of the Midale Beds; genetic-cycle work places part of its lower interval with the upper Frobisher cycle.

Published evidence. Nodular anhydrite and dolomitic stringers are photographed. 01/01-03-05-06W2; 1412.5 m. [22; Figure 5D, p.8]

Additional observation. Lower evaporite overlies an exposure surface; a higher example contains nodular/chicken-wire anhydrite interbedded with red lateritic mud. 1-29-4-4W2; 1379.7 and 1374.2 m. [20; Figures 10-11, printed 43/PDF 7]

Conditional reservoir setting. Adjacent or interfingering porous carbonate at an evaporite margin, if reservoir facies is present.

Additional candidate. Thin dolomitic intervals only where core/permeability demonstrate connected pores; massive anhydrite is primarily a seal.

Preservation / test. Continuous anhydrite can provide top/lateral seal and brines can alter adjacent carbonate. Dissolution, fractures or discontinuous facies can compromise containment. Evaporite thickness alone predicts neither reservoir nor charge.

Further constraint. Reject the hypothesis if: supposed carbonate-margin reservoir is absent or fully anhydritized.

Where to look relative to the environment. Restricted landward evaporitic facies versus basinward carbonate is defensible as a conceptual relation; exact margin location and time equivalence require cycle-by-cycle correlations. Confidence: High lithofacies; moderate genetic interpretation; low corridor margin location.

Corridor relevance. Direct samples are Steelman. The official zero edge represents present preservation and cannot be plotted as the ancient evaporite shoreline. Distinguish basal-Midale lithostratigraphic usage from Marsh-Qing genetic-cycle assignment.

References [22, 20].

Midale Beds (carbonate interval)

Mapped gross interval; overlaps named subdivisions

Environment. Shallow carbonate shoals and protected lagoonal/peritidal environments; lower Vuggy facies include skeletal/oncoid/ooid/peloid carbonates, while upper Marly commonly includes dolomitized muddy, bioturbated facies. These labels combine lithology and reservoir convention, not a uniform two-layer depositional sheet.

Published evidence. Ooid/peloid grainstone-packstone contacts a peloidal/algal wackestone in photographed core. 01/07-26-03-06W2; 1536.5 m. [22; Figure 3B, p.6]

Additional observation. A bioturbated dolomudstone with molds is shown separately from patterned dolomitic mud; porous texture is not restricted to high-energy grainstones. 01/01-03-05-06W2; 1402.3 and 1401.5 m. [22; Figure 5A-B, p.8]

Additional observation. Mapping convention: The mapped gross Midale interval includes basal Frobisher Evaporite. The carbonate facies below are discussed separately from that evaporite; their two mapped thicknesses must not be added.

Conditional reservoir setting. Preserved grain-rich Vuggy shoals with limited anhydrite plugging.

Additional candidate. Dolomitized Marly lagoon/pond facies with connected intercrystalline pores.

Additional candidate. Onlap pinch-outs and carbonate-to-evaporite/tight-mud changes around demonstrable paleorelief.

Preservation / test. Dolomitization can improve muddy facies; anhydrite can plug shoals, molds or fractures. Separate depositional onlap, diagenetic porosity and later structural closure. Top/lateral seals and migration access need to be demonstrated for each proposed lens.

Further constraint. Reject the hypothesis if: a proposed Marly depositional thick is a diagenetic/log-pick effect.

Where to look relative to the environment. Facies position is locally controlled by inherited relief and accommodation; do not assign a single Midale shoreline from modern formation edges. Confidence: High southern facies inventory; moderate local onlap; low northern extrapolation.

Corridor relevance. Steelman, Benson, Midale and Weyburn work provides southern reservoir analogues. It does not establish Midale presence or specific shoals along the full northern town corridor.

References [22, 27].

Midale Evaporite

Mapped gross interval

Environment. Commonly treated as basal Ratcliffe evaporitic strata, laterally related to basinward Ratcliffe carbonates. It includes tidal-flat muds, standing-water evaporites and exposure intervals; it must not be represented solely as a dry sabkha or simply as the upper Midale reservoir facies.

Published evidence. Laminated anhydrite is interbedded with patterned dolostone. 41/08-05-05-06W2; 1416.5 m. [22; Figure 5C, p.8]

Additional observation. A pictured approximately metre-scale cycle contains laminated mud and rooted/burrowed intervals; the caption explicitly says laminated anhydrite is absent in this particular cycle. 7-5-5-4W2, Steelman; No depth supplied in caption. [23; Figure 5, PDF p.7]

Conditional reservoir setting. Porous basinward carbonate equivalents beside the restricted evaporite basin.

Additional candidate. Dolomitized carbonate interbeds only if pore connectivity and containment are verified.

Additional candidate. Underlying Midale reservoirs where evaporite continuity provides an effective seal.

Preservation / test. The main direct petroleum role is sealing and influencing adjacent carbonate alteration. Stacked standing-water/tidal-flat cycles can be heterogeneous; dissolution/fracturing requires separate seal assessment. The source model's climate, prevailing-wind and basement-barrier explanations remain hypotheses.

Further constraint. Reject the hypothesis if: cored interval lacks evidence of standing-water precipitation where that process is proposed.

Where to look relative to the environment. Landward restricted hypersaline basin, separating barrier and basinward carbonate is an interpretive cross-section; no precise local shoreline azimuth follows from the isopach. Confidence: High observed textures; moderate broad process model; low corridor reconstruction.

Corridor relevance. Steelman/Weyburn examples are southern analogues. A published model describes metre-scale deepening cycles and terminal exposure, whereas some broader stratigraphic schemes

emphasize regression; preserve this model dependence.

References [22, 23, 24].

Ratcliffe Beds

Mapped gross interval; overlaps named subdivisions

Environment. Carbonate-evaporite system with open-marine carbonate, high-energy coated-grain barriers, restricted lagoons and hypersaline evaporitic interiors. Lake's two-barrier interpretation is a useful model; broader Ratcliffe includes multiple cycles and cannot be reduced to one barrier at one instant.

Published evidence. Photographs/thin sections show sparry ooid/peloid limestone and algal-coated grains; extensive calcite cement is also present. HB Miami Hummingbird 3-26B-2-19W2; 6161,6141 and 6235.5 ft. [25; Plate VIII A-C, caption printed 56/PDF 58, photos printed 57/PDF 59]

Additional observation. A conceptual south-to-north section separates an outer oncoid barrier, restricted lagoon, inner barrier and hypersaline Midale-Evaporite lagoon. [24; Figure 1, p.1 and discussion]

Additional observation. Mapping convention: The mapped gross Ratcliffe interval includes Midale Evaporite. This evaporite is also a lateral restricted equivalent of basinward Ratcliffe carbonate; their mapped thicknesses must not be added.

Conditional reservoir setting. Coated-grain barrier/shoal bodies where cement has not eliminated connected pores.

Additional candidate. Dolomitized restricted-lagoon carbonate near reflux pathways.

Additional candidate. Localized tidal-inlet/grainstone lenses and carbonate-evaporite facies terminations.

Preservation / test. Dolomite texture and cement history are decisive: microcrystalline mud-rich rock may remain tight, while some coarser dolomite has intercrystalline/vug pores. Internal evaporites and tight muds can isolate lenses; charge, spill points and postdepositional deformation remain separate tests.

Further constraint. Reject the hypothesis if: no lateral carbonate-evaporite facies equivalence at the selected cycle.

Where to look relative to the environment. Lake depicts basinward south versus landward north, but this is conceptual, not a measured local barrier azimuth. Fuzesy shows that preserved subcrop facies vary around the basin; the subcrop is not a universal ancient shoreline. Confidence: Moderate regional process; low exact northern-corridor geometry.

Corridor relevance. Fuzesy's cores are chiefly south-central Saskatchewan, well west/south of the original Wawota corridor. They corroborate facies possibilities, not local presence. Lake's model applies to southern late Mississippian strata and must not be projected into Souris Valley or Tilston time.

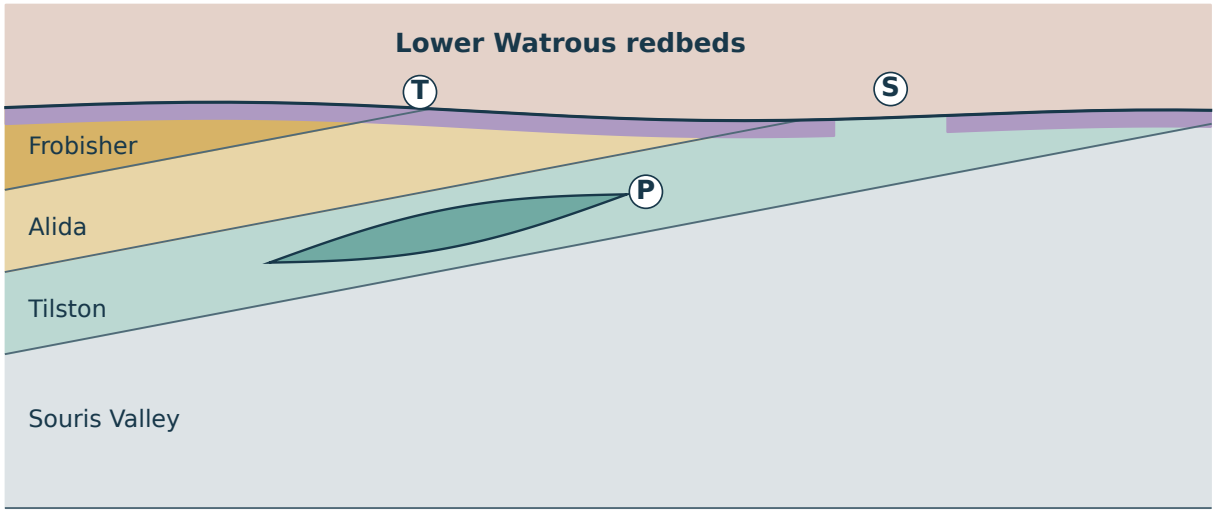
References [24, 25].

Erosion and Watrous cover

Later erosion: preservation is not a depositional shoreline

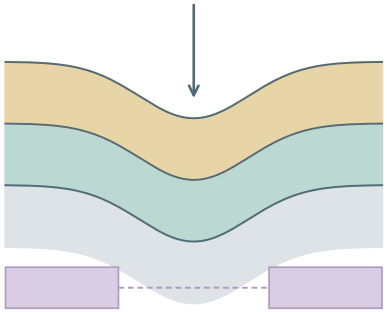
A preserved formation edge, a reservoir facies pinch-out and a failed seal are different geological observations.

A Truncation beneath Lower Watrous



B Conditional salt relief

Only if independently shown



Possible salt loss

Test with salt maps, multiple horizons and timing evidence. A single isopach is insufficient.

T Erosion cuts across beds of different ages.

P A depositional facies lens ends inside a preserved bed.

S Altered caprock may be discontinuous or later dissolved.

Conceptual • not to scale • not a mapped paleoshoreline

Sources: Bates & Kendall (2008), Fig. 2, p. 3; Nickel & Kent (2008), p. 1; Lake (2023), pp. 1–2.

Seal variability is documented at Parkman; salt-related relief is an optional regional hypothesis, not a local finding.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [13, 26, 20, 16, 28, 31, 33]

Erosion, preservation and the Watrous cover

Present-day subcrop belts record what survived. A porous bed may be removed updip, preserved just downdip, or altered into a sealing caprock. The Watrous succession helps explain containment, but fractures, dissolution and local erosion can change its effectiveness. Total Mississippian and total Watrous are composite intervals, not additional beds to add to their constituents.

Total Mississippian (composite interval)

Mapped gross interval; overlaps named subdivisions

Environment. A time-integrated stack, not one paleoenvironment: basal marine flooding/shelf-margin carbonates, successive shallow carbonate platforms and shoals, localized quartz-sand influx, restricted lagoons, tidal flats and evaporites, later truncated and altered.

Published evidence. Parkman comparison panels distinguish a typical altered caprock from a site with anhydrite dissolution and upward hydrocarbon migration. This is evidence of local seal variability, not a facies map. MUS Parkman 4-34-8-33W1; MOC Parkman 12-16-9-33W1; . [26; Figure 2, PDF p.3/printed 811]

Additional observation. The regional Souris Valley is progressively truncated northward; younger units and subcrop facies are consequently preserved differently. [13; PDF p.1]

Additional observation. Mapping convention: The mapped total Mississippian interval includes Souris Valley through the younger preserved beds and excludes the separately mapped Bakken interval. It overlaps its named Mississippian subdivisions.

Conditional reservoir setting. Formation-specific porous facies intersecting a competent trap and charge pathway.

Additional candidate. Stacked but separately evaluated reservoir lenses; never sum gross thicknesses as prospective pay.

Preservation / test. Use an event sequence: deposition > early diagenesis > burial/deformation and exposure/erosion > further cementation/dissolution > migration, entrapment and possible leakage. Relative timing may overlap and must be tested. Neither later caprock geometry nor present structural dip restores original bathymetry by itself.

Further constraint. Reject the hypothesis if: an apparent depositional thickness trend disappears after separating erosion, compaction or structural effects.

Where to look relative to the environment. Broad northern basin-margin versus southern basinward setting is useful; each interval has its own facies migration, preservation and deformation history. Confidence: High need for time separation; low single-map paleoenvironment.

Corridor relevance. The total-thickness map is a preservation/accommodation screen across the study area. Around the northern town corridor, a regional thick may be mostly nonreservoir lower strata, while a thinner remnant may retain a locally favorable bed. Named pools need their own correlated cores and tests.

References [13, 26, 20, 16].

Lower Watrous Member

Mapped gross interval

Environment. Oxidizing low-relief mudflat/playa and continental to marginal-marine settings, with evaporative exposure and a possible eolian component.

Published evidence. Red fine-grained matrix, anhydrite and pitted/frosted quartz; scarce fossils give limited age control.

Conditional reservoir setting. Localized basal or other quartz sands rather than the redbed blanket as a whole.

Preservation / test. Reject or revise the candidate if: core/logs show homogeneous impermeable redbeds or cemented sand; oil charge is absent despite adequate reservoir.

Further constraint. Historic Jurassic oil occurrences outside the mapped lower-Watrous limit suggested a seal/migration effect, but Kreis explicitly cautioned that poor southern well control made it inconclusive.

Where to look relative to the environment. No defensible fixed Wawota-Indian Head shoreline azimuth from these data. Confidence: Moderate for broad environment; low for local sand-body geometry.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 33, 42; ATLAS16; MB16 pp. 181-186

References [28, 31, 33].

Upper Watrous Member

Interpretive subdivision; no separate modeled surface

Environment. Restricted shallow marine carbonate-evaporite basin with persistent evaporation; less continental than lower Watrous.

Published evidence. Anhydrite/dolomite interbeds and marine plus terrestrial palynomorphs.

Additional observation. At Central Del Rio Red Jacket 6-19-13-32W1, oil staining and bitumen-coated fractures in dolostone coexist with gypsum-sealed fractures.

Conditional reservoir setting. Fractured or brecciated dolostone if fractures remain connected and unfilled.

Preservation / test. Reject or revise the candidate if: gypsum/anhydrite fills fracture porosity; evaporite dissolution permits leakage or water influx.

Further constraint. The Manitoba exposed-gypsum analogue does not directly measure the buried Wapella anhydrite reservoir or its permeability.

Where to look relative to the environment. Upper Watrous thickens southeastward at the expense of lower-Gravelbourg unit A, implying longer-lived southeastern evaporitism during western carbonate deposition. Confidence: Moderate local stratigraphic evidence.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 33, 42; MB16 pp. 181-186 (analogue)

References [28, 33].

Watrous Formation

Mapped gross interval; overlaps named subdivisions

Environment. Composite of oxidized continental to marginal-marine redbeds below and restricted marine evaporite/carbonate deposits above.

Published evidence. Lower member: red mudstone/siltstone, scattered frosted quartz, anhydrite and episodic exposure.

Additional observation. Upper member: interbedded anhydrite, dolomite and dolomitic mudstone.

Conditional reservoir setting. Local basal or intraformational sands where genuinely porous; fracture/breccia porosity is a separate possibility.

Preservation / test. Reject or revise the candidate if: mud/evaporite replaces proposed sand; cement destroys pores; a migration barrier prevents charge; fractures leak instead of retain oil.

Further constraint. Do not treat total Watrous thickness as sandstone thickness.

Where to look relative to the environment. Upper member locally oversteps the lower member northeastward near Wapella; present mapped edges combine onlap and later erosion. Confidence: Moderate for local correlation; low for a continuous regional palaeoshoreline.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 33, 42; ATLAS16; MB16 pp. 181-186

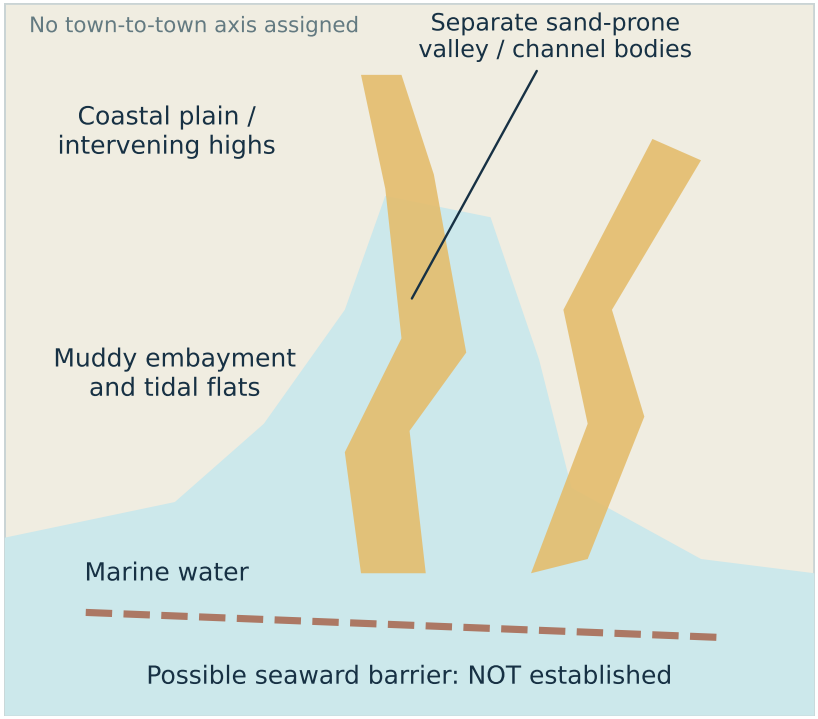
References [28, 31, 33].

Jurassic valleys and coastal systems

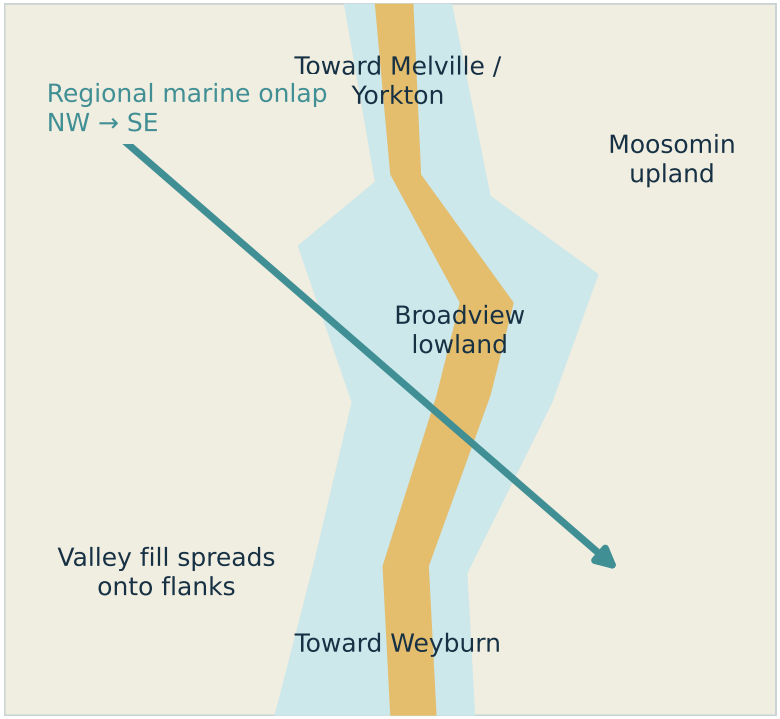
Two valley systems, separated in time

Conceptual plan views • not to scale • boundaries below are explanatory, not mapped shorelines

MIDDLE JURASSIC | Red Jacket / Moosomin



EARLY CRETACEOUS | pre-Cantuar relief



Reservoir targets sit inside each system: clean channel sand, reworked sand sheets and local mouth bars.

Do not connect a Jurassic Moosomin valley to the younger Assiniboia valley as one channel network.

Sources: Kreis (1991), Report 217, pp. 36–39, 43; Christopher (2003), Report 223, pp. 45–53, Fig. 27.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [28, 30, 32]

Jurassic: coastal carbonates, valleys and tidal channels

Gravelbourg and the locally named Red Jacket succession preserve distinct coastal and shallow-marine episodes. Kreis's Wapella-Moosomin study documents erosive sand bases, opposing cross-beds, mud drapes and oil-stained sands. A south/west seaward barrier is a published possibility for one Moosomin interval; the original author explicitly regarded its existence and position as unresolved.

Gravelbourg Formation

Mapped gross interval

Environment. Marine transgression from restricted carbonate settings toward shallow coastal marine carbonate/mud environments; upper member has stronger low-salinity coastal influence.

Published evidence. Oolitic/peloidal and skeletal limestone, glauconite, microforaminifera, calcareous mudstone and local quartz sand.

Additional observation. Sandy bioclastic bodies can contain graded beds, cross-bedding and truncation surfaces.

Conditional reservoir setting. Locally weakly cemented quartz sands and high-energy sandy skeletal/oolitic bars.

Preservation / test. Reject or revise the candidate if: the expected shoal is tight calcite-cemented rock; a sandy log response lacks effective permeability; no charge or closure.

Further constraint. Formation isopach is not net reservoir. The historic unsuccessful Moosomin example shows that presence of the unit is insufficient.

Where to look relative to the environment. Lower unit B oversteps unit A northeastward; detailed bar geometry around Red Jacket is not resolved by sparse control. Confidence: Moderate for overstep and shallow-marine interpretation; low for exact bar axes.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 33-35, 42; photo 3, p. 64

References [28].

Lower Gravelbourg Member

Interpretive subdivision; no separate modeled surface

Environment. Unit A restricted shallow-marine dolomitic carbonate; unit B more open but locally low-salinity nearshore carbonate and mud, including energetic bars.

Published evidence. Tricent et al. Moosomin 4-28-14-31W1 at 654.0 m: skeletal/oolitic/peloidal limestone with inclined cross-beds, graded bedding and a reactivation surface.

Additional observation. Fresh/brackish indicators could represent local reduced salinity or transported fauna; the report retains both alternatives.

Conditional reservoir setting. Weakly calcite-cemented sand; porous sandy bioclastic limestone.

Preservation / test. Reject or revise the candidate if: core proves pervasive calcite cement; historic Moosomin 4-28-14-31W1 was abandoned after attempted production because of poor reservoir quality.

Further constraint. Production statements are observations reported in 1991, not current operating status.

Where to look relative to the environment. Northeastward overstep is supported; a continuous bar belt is not. Confidence: High for photographed bedding, moderate for bar interpretation, low for extrapolated geometry.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 33-34, 42, 64 (photo 3)

References [28].

Upper Gravelbourg Member

Interpretive subdivision; no separate modeled surface

Environment. Coastal marine setting of reduced salinity backed by extensive swamp/coastal-plain environments.

Published evidence. Terrestrial palynomorphs coexist with marine species and low-salinity ostracode/foraminiferal assemblages in the regional comparison.

Conditional reservoir setting. Local sand lenses if present and uncemented; mud-rich intervals are potential seals.

Preservation / test. Reject or revise the candidate if: no porous sand exists at the proposed horizon; facies/correlation is incorrectly projected from another district.

Where to look relative to the environment. Rocanville A at Wapella is interpreted as a more landward counterpart than upper Gravelbourg to the southwest; exact correlation boundaries require care. Confidence: Moderate regional facies relation, limited local palynological sample density.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 18-20, 34

References [28].

Red Jacket Formation, Wapella-Moosomin local framework

Interpretive subdivision; no separate modeled surface

Environment. Rocanville coastal/shelf deposits, Moosomin incised-valley/estuarine and tidal-flat deposits, then Burrows marine flooding and tidal progradation.

Published evidence. Multiple actual cored facies and oil-stained sands establish a local Jurassic petroleum system; they do not prove an uninterrupted regional sand belt.

Conditional reservoir setting. Rocanville B sheets/channels; Moosomin A1 valley sands; A2 sand lenses; B tidal-channel sand.

Preservation / test. Reject or revise the candidate if: thickened section is muddy or cemented; suspected collapse structure is absent; no charge; erosion removes the target.

Further constraint. No separate regional Red Jacket surface exists in the inspected SPFPS Mesozoic service.

Where to look relative to the environment. Some historic pool/thickness trends are north-northeast to south-southwest and associated with salt-collapse interpretation, but channel and shoreline geometry differs by member. Confidence: Moderate local geological hypothesis; low for extension toward Indian Head without correlation.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 34-39, 43

References [28].

Rocanville Member (A, B, C)

Interpretive subdivision; no separate modeled surface

Environment. A: reduced coastal plain/swamp to nearshore; lower B: shallow-marine sheet sands and local channels; upper B: restricted to supratidal flats; C: renewed open-marine transgression.

Published evidence. Rocanville A at Tidewater Wapella No. 6-33-14-1W2 has freshwater ostracodes at 760.4-760.5 m and terrestrial palynomorphs at 760.2 m, but only one palynological sample.

Additional observation. Pondex Pat Parkman 5-22-10-1W2 at 965.5-967.0 m has erosive, cross-bedded basal B channel sand (photo 5).

Conditional reservoir setting. Lower-B sheet sand and erosive channels; local porous sand below a carbonate-cemented cap.

Preservation / test. Reject or revise the candidate if: upper-B muddy/supratidal facies replaces reservoir; carbonate cement eliminates pores; the possible channel is only a misleading blocky log signature.

Further constraint. Source argues that lack of marine fossils in one A sample cannot exclude nearshore marine deposition.

Where to look relative to the environment. Basal B thickens north/east, tentatively suggesting sand sources in those directions; this is not a measured palaeocurrent azimuth. Confidence: Moderate source-direction inference; high for individual core structures.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 24, 34-36, 43, 65 (photo 5)

References [28].

Moosomin A1

Interpretive subdivision; no separate modeled surface

Environment. Erosive valley/lowland fill subsequently drowned into reducing, brackish tidal estuaries or coastal embayments; minor fluvial/splay influence is possible.

Published evidence. CNW Wapella 6-2-15-1W2: basal oil-saturated sand and Rocanville clasts near 743.9 m; opposed cross-beds at 739.3-743.6 m; carbonaceous/micaceous material at 731.2 m.

Additional observation. Pyrite, siderite, low-diversity trace fossils and mixed terrestrial/marine evidence support the estuarine interpretation.

Conditional reservoir setting. Clean, weakly cemented valley-axis or tidal-channel sand bodies within a heterolithic fill.

Preservation / test. Reject or revise the candidate if: valley fill is mostly mud; sands tight or water-bearing; proposed continuation absent in control wells; later erosion breaches the trap.

Further constraint. The published 45 km Red Jacket valley reconstruction is an interpretation, not a measured edge usable as an exact 3D boundary.

Where to look relative to the environment. Wapella-North Wapella and Red Jacket-Rocanville are separate local reconstructed valleys. Their end positions are poorly controlled; proposed Red Jacket A1 fill had no core in the study. Confidence: High for Wapella core observations; moderate for estuarine interpretation; low for remote valley boundaries.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 36-37, 43; photos 17-20 pp. 69-70; Appendix C.4 p. 87

References [28].

Moosomin A2

Interpretive subdivision; no separate modeled surface

Environment. Low-energy brackish coastal marine/possible lagoonal conditions with tidal reworking, overstepping A1 valleys and intervening highs.

Published evidence. Aberford Wapella 12A-34-14-1W2 at about 712.3 m: wave/current ripples and heterolithic bedding.

Additional observation. Arco South Wapella 11-23-14-1W2 at about 737.6 m: climbing ripples and pyrite nodule.

Additional observation. Marine palynomorphs/foraminifera, fine sand/silt, pyrite and variable stacking support intermittent marine influence.

Conditional reservoir setting. Discontinuous stacked fine-sand lenses with low clay and limited carbonate cement.

Preservation / test. Reject or revise the candidate if: no clean sand, pervasive cement, or an open-connected aquifer; alleged continuous barrier has no supporting wells.

Further constraint. Do not render a continuous south/west barrier as observed geology.

Where to look relative to the environment. Kreis proposes a possible seaward barrier-island complex south/west of the study area, but explicitly says existing well control cannot prove or disprove it. Confidence: High for pictured sedimentary structures; moderate for restricted marine interpretation; low for barrier existence or position.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 37, 43; photos 21-22 p. 71

References [28].

Moosomin B

Interpretive subdivision; no separate modeled surface

Environment. Tidal-channel and subtidal to intertidal-flat succession, often with fining-up channel sand below an upper muddy tidal-flat interval.

Published evidence. Saskoil North Wapella 16A-14-15-1W2 at about 676.6 and 678.6 m: truncating cross-beds and mud drapes.

Additional observation. Tricent et al. Red Jacket 2-4-14-32W1 at about 669.8 m: mud-clast lag at the base of an oil-saturated sand.

Additional observation. Flaser/wavy/lenticular bedding, burrows and mixed fresh/brackish/marine indicators are observed locally.

Conditional reservoir setting. Tidally reworked channel/point-bar sand, locally beneath muddy flat deposits.

Preservation / test. Reject or revise the candidate if: channel compartments are isolated by mud; fine-grained flats dominate; sand is cemented or water-bearing and uncharged.

Further constraint. Historical production attribution in the report is not a statement about present rates or reserves.

Where to look relative to the environment. Channel orientation cannot be transferred from total-Moosomin thickness alone. Some historic reservoir trends are NNE-SSW, but individual channel axes need well correlation. Confidence: High for tidal evidence; moderate for local channel reconstruction; low for regional extension.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 pp. 38-39, 43; photos 31-33 pp. 74-75; photos 39-41 pp. 78-79

References [28].

Burrows Member (A and B)

Interpretive subdivision; no separate modeled surface

Environment. A: widespread shallow marine flooding mud; B: renewed tidal/intertidal progradation with heterolithic sand and mud.

Published evidence. A is locally a 2.5-3.2 m grey mudstone/claystone marker with marine foraminifera and dinoflagellates.

Additional observation. B contains bioturbated sand/silt/mud and fresh/brackish indicators.

Conditional reservoir setting. Local B sand lenses; A is more plausibly a cap than a blanket reservoir.

Preservation / test. Reject or revise the candidate if: mud-rich or cemented facies; inconsistent correlation; erosion at overlying Rierdon or later Cretaceous surface.

Further constraint. The basal shell-rich Rierdon sand is geologically Rierdon but was included with top Burrows B for practical log picking in the report; geological and operational boundaries differ.

Where to look relative to the environment. Local transgression followed by progradation; a single continuous shoreline direction is not established. Confidence: Moderate from local correlations and palaeontology.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 p. 39

References [28].

Rierdon Formation

Interpretive subdivision; no separate modeled surface

Environment. Marine transgression: an erosive shell-rich basal sand/lag passes into calcareous marine mudstone.

Published evidence. Basal Gryphaea-rich sand is locally under 1.5 m thick; the overlying mudstone provides a distinctive marine interval.

Conditional reservoir setting. Any basal sand requires separate permeability and thickness confirmation; marine mudstone is principally seal/framework in this appraisal.

Preservation / test. Reject or revise the candidate if: thin or absent reservoir, pervasive carbonate cement, or erosional removal.

Further constraint. No separate Rierdon geometry was added to this 20-interval model.

Where to look relative to the environment. Preservation is strongly modified by sub-Cretaceous erosion; no preserved edge should be read directly as the original shoreline. Confidence: High for marine facies; variable local preservation.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. K91 p. 39; C03A pp. A-7-A-10

References [28, 30].

Jurassic composite interval

Mapped gross interval; overlaps named subdivisions

Environment. A time-transgressive stack of evaporitic, marine carbonate, coastal-plain, estuarine, tidal-flat and offshore-mud environments with intervening unconformities.

Published evidence. Wapella Red Jacket records several distinct depositional phases; Rierdon contains marine mudstone above an erosive shell-rich basal lag.

Additional observation. Regional Jurassic strata are progressively truncated toward the northern basin margin.

Additional observation. Mapping convention: The mapped total Jurassic interval includes Upper Watrous, so it partially overlaps total Watrous as well as including Gravelbourg and other Jurassic strata. These gross thicknesses must not be added.

Conditional reservoir setting. Individual named porous members and lenses; total thickness cannot assign reservoir facies.

Preservation / test. Reject or revise the candidate if: target member removed at unconformity even where another Jurassic unit survives; thick composite consists largely of seal/nonreservoir.

Further constraint. Composite interval must not be added to the thickness of its constituent units in a 3D stack.

Where to look relative to the environment. Modern Jurassic zero edge is mainly a preservation/subcrop boundary, not a single Jurassic shoreline. Confidence: High for the distinction; exact original northern extent is uncertain.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

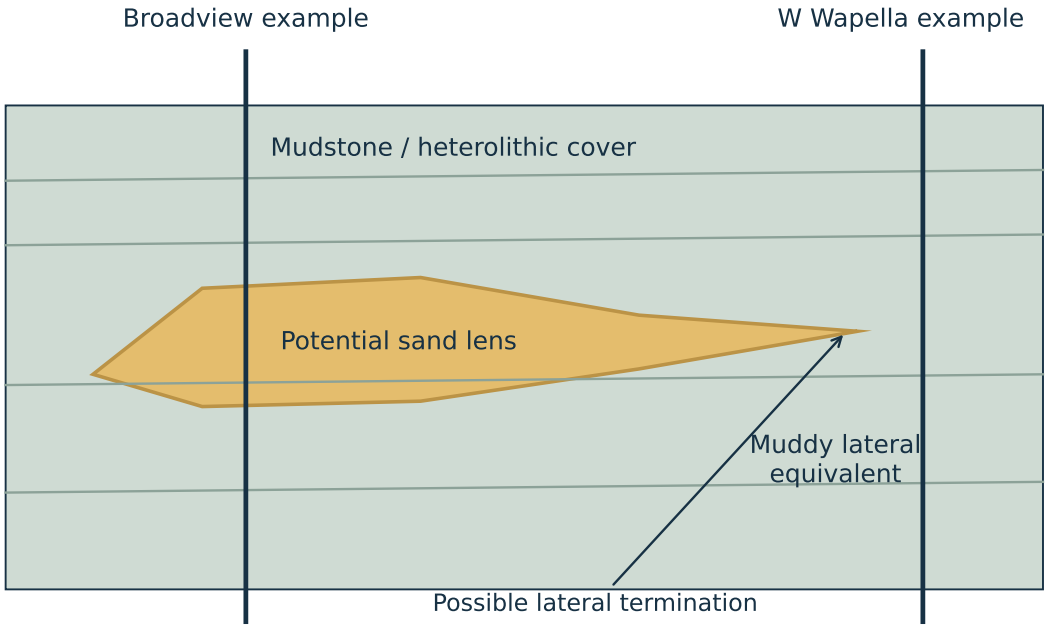
Source anchors. K91 pp. 33-39, 42-43; ATLAS18

References [28, 32].

Cantuar and Mannville valley systems

A formation can contain sand in one well and mud in the next

Published local core contrast + conceptual reservoir geometry • core depths are not a correlated TVD datum



CUMMINGS CORE CONTRAST

Broadview 14-17-15-4W2
707.7–710.2 m
Permeable sand described; pyrobitumen in pores.

W Wapella 16-33-14-2W2
676.7–684.7 m
Largely mud/shale with thin very fine sand.

Interpretation: investigate member-scale sand continuity and cementation before drawing a reservoir belt.

The lens geometry above is a testable hypothesis; it is not a measured section between these two wells.

Pyrobitumen records past charge. Mobile oil, connected pore space and a retaining trap still require testing.

Source: Christopher (2003), Report 223, Appendix A, pp. A-7–A-10; regional interpretation pp. 52–53.

Conceptual reconstruction; not to scale and not a mapped ancient shoreline. [29, 30]

Cantuar and Mannville: a younger valley system

The pre-Cantuar Assiniboia drainage and its fill are younger than the Jurassic Moosomin valleys. The regional reconstruction links the Weyburn area with a Broadview low and northward drainage, followed by marine flooding broadly from northwest toward southeast. Local Dina/Cummings sand distribution must be mapped separately from the total formation isopach.

Dina Member

Interpretive subdivision; no separate modeled surface

Environment. Lower valley-fill to estuarine sand, passing into transgressive marine/shoreface or deeper embayment deposits according to location.

Published evidence. TW Sohio W Wapella 16-33-14-2W2, KB 613.3 m: interpreted Dina core from 684.7-704.1 m contains fine to medium sand, heterolithic mud/sand, carbonaceous debris and marine bioturbation/glauconite.

Additional observation. Imperial TW Broadview 14-17-15-4W2, KB 617.5 m: adjusted Dina picks; porous weakly cemented sands alternate with calcite-cemented and shale intervals; a long core gap prevents a continuous description.

Additional observation. Sohio St Hubert 14-1-15-3W2 at 698-707.1 m is a useful muddy/silty counterexample.

Conditional reservoir setting. Clean, weakly cemented valley/channel sand; locally reworked estuarine or shoreface sand.

Preservation / test. Reject or revise the candidate if: the candidate sand correlates to older Jurassic rock; clay/kaolinite/calcite occludes pores; the interval is an open aquifer or charge is degraded.

Further constraint. Appendix depths are reported core depths, not a surveyed TVDSS dataset; KB alone does not validate conversion.

Where to look relative to the environment. Regional NW-derived marine flooding reworked older valley fill. Southeast Shield/country-rock sources contributed detritus; no exact local palaeoflow vector is measured here. Confidence: High for described core lithology; moderate for member correlation and regional process.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. C03 pp. 46-52; C03A pp. A-7-A-10

References [29, 30].

Cummings Member

Interpretive subdivision; no separate modeled surface

Environment. Shallow marine/coastal sand-mud cycles following Dina transgression, with locally regressive coarsening-up sand and adjacent marsh/lignite environments.

Published evidence. TW Sohio W Wapella 16-33-14-2W2: 676.7-684.7 m is largely mud/shale with plant carbon, sideritic material and thin very fine sand.

Additional observation. Imperial TW Broadview 14-17-15-4W2: 707.7-710.2 m is described as well sorted, weakly cemented and very permeable, with pyrobitumen filling pores.

Conditional reservoir setting. Clean reworked fine-sand lenses/sheets and local mouth-bar or shoreface sand, where present.

Preservation / test. Reject or revise the candidate if: nearby equivalent is predominantly mud, sand is cemented, or pyrobitumen represents degraded/immobile residue without recoverable oil.

Further constraint. Broadview pyrobitumen is evidence of past charge, not a flow test or proof of mobile oil/pay.

Where to look relative to the environment. Regional coastal belts shift during repeated onlap/regression. Lloydminster-area barrier examples in the report are not direct proof of a Wapella barrier complex. Confidence: High for exact core contrast; moderate for local coastal interpretation.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. C03 pp. 52-53; C03A pp. A-7, A-10

References [29, 30].

Cantuar Formation

Mapped gross interval

Environment. Multiple valley-fill, estuarine, coastal, tidal and shallow marine cycles, with strong inherited topographic control.

Published evidence. In southeastern Saskatchewan the pre-Cantuar Assiniboia drainage links the Weyburn region to a broad Broadview basin west of the Moosomin upland and continues north toward Melville/Yorkton.

Additional observation. Dina/Cummings cores near Wapella and Broadview show marked sand/mud and cementation differences over short distances.

Conditional reservoir setting. Dina basal/fluvial-estuarine sands and reworked marine sands; Cummings fine sand/mouth-bar or shoreline sheets; other members require separate evidence.

Preservation / test. Reject or revise the candidate if: sub-Pense erosion removed the target; valley thick is muddy; carbonate cement/biodegradation blocks flow; only water is present.

Further constraint. Total Cantuar isopach cannot be displayed as Dina/Cummings net sand.

Where to look relative to the environment. Marine flooding broadly NW > SE; onlap also moves outward from valley axes onto flanks. The Assiniboia valley is younger than the Jurassic Moosomin valleys. Confidence: Moderate regional reconstruction; local axes require better control.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. C03 pp. 45-53, 77; Fig. 27; C03A pp. A-7-A-10

References [29, 30].

Pense Formation

Interpretive subdivision; no separate modeled surface

Environment. Widespread marine transgression and repeated generally upward-coarsening marine sand-mud cycles above a sub-Pense planation surface.

Published evidence. Christopher describes more laterally consistent bedding/thickness than Cantuar members; capping sand can be strongly calcite cemented.

Additional observation. The type core at Sohio Canadian Devonian Pense No. 1, 14-6-17-22W2, is 809.9-840.6 m below KB, outside the local Wapella corridor.

Conditional reservoir setting. Locally porous parts of marine sand cycles if cementation permits.

Preservation / test. Reject or revise the candidate if: calcite cement destroys pores; a thin marine sheet lacks closure or contains water.

Further constraint. Included to explain the Mannville hierarchy; not a newly mapped prospect in this task.

Where to look relative to the environment. Regional marine flooding across an eroded Cantuar landscape; do not assign local Wapella shoreline geometry from a distant type section. Confidence: High for regional marine succession; low for corridor-specific sand distribution.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. C03 pp. 77-79

References [29].

Mannville Group (restricted use in Christopher 2003)

Mapped gross interval; overlaps named subdivisions

Environment. Cantuar fills and onlaps an inherited eroded landscape with fluvial-to-estuarine and marine cycles; Pense records more extensive marine flooding after another erosional surface.

Published evidence. Christopher defines restricted Mannville as Cantuar plus Pense, separated from the older Success Formation.

Additional observation. Regional variations reflect valleys, uplands, marine incursions, local regression and subsequent erosion.

Conditional reservoir setting. Individual channel, mouth-bar, shoreface and other sand bodies within named members.

Preservation / test. Reject or revise the candidate if: thick group consists of mud; the target member is absent or cemented; a connected sand carries water without oil.

Further constraint. Nested interval: do not add Mannville thickness to Cantuar/Pense or sum Cantuar with its Dina/Cummings members.

Where to look relative to the environment. Regional early marine onlap came from the northwest toward the southeast; local channels and coastal strands have their own orientations. Confidence: Moderate to high at regional scale, low for unresolved local shorelines.

Corridor relevance. Local evidence and regional extension must be evaluated separately.

Source anchors. C03 pp. 1-3, 45-53, 77-79

References [29].

Other formations in the regional stack

These supplementary units prevent the 20 mapped intervals from being mistaken for a complete stratigraphic column. They provide regional environmental context only. Presence, names and boundaries must be checked in each local well; no unsupported new surfaces have been invented.

These are regional context profiles, not additional model surfaces or a verified local well column. Local penetration, preservation, reservoir quality and charge remain separate questions.

Deadwood Formation

Environment. Cambrian-earliest Ordovician marine siliciclastic platform deposits, dominated by shale/siltstone with sandy and minor carbonate intervals.

Conditional reservoir setting. Sandy beds warrant reservoir-quality tests; muddy beds can restrict flow, but hydrocarbon charge is a separate unproved element locally.

Preservation / test. Erosion and basement relief cause thinning or absence, particularly eastward; verify penetration and correlation at each corridor location.

References [35, 36].

Winnipeg Formation

Environment. Ordovician marine transgression deposited basal quartz sand and overlying shale.

Conditional reservoir setting. Sand is a possible reservoir and shale a possible seal; neither establishes a charged local trap.

Preservation / test. Onlap, erosion and basement structure affect preservation; it can overstep absent Deadwood and must be mapped independently.

References [36].

Stony Mountain Formation

Environment. Marine flooding produced lower argillaceous carbonates/shales, followed by shallower carbonate-evaporite deposition.

Conditional reservoir setting. Gunn mud-rich beds can restrict fluid flow; cleaner dolomitized beds are conditional reservoir candidates.

Preservation / test. Member boundaries and evaporite extent change laterally; regional occurrence does not establish a continuous corridor seal or reservoir.

References [36].

Stonewall Formation

Environment. Latest Ordovician-early Silurian carbonate cycles include argillaceous markers and locally evaporitic caps.

Conditional reservoir setting. Porous dolomite is a possible reservoir; dense carbonate/anhydrite may seal.

Preservation / test. Evaporites diminish away from basin centre; later erosion affects preserved thickness and forbids blanket corridor-presence assumptions.

References [36].

Interlake Group

Environment. Silurian carbonate platform; upper beds locally preserve exposure breccias, fenestrae and desiccation features.

Conditional reservoir setting. Dolomitization/exposure may create pores, but cement can fill them; seals and charge require separate verification.

Preservation / test. Sub-Devonian erosion truncates the group; upper subdivisions are difficult to correlate without core.

References [36].

Ashern Formation

Environment. Basal Middle Devonian nearshore clastics/redbeds and sandy or shaly dolostone onlap a pre-Devonian erosional surface.

Conditional reservoir setting. Mud-rich intervals may form baffles or cover; reservoir claims require clean, connected porous beds.

Preservation / test. Onlap and local relief make preservation variable; not demonstrated at every corridor site.

References [37].

Winnipegosis Formation

Environment. Middle Devonian shallow-marine carbonate platform with local reef/mound growth and inter-mound deposits.

Conditional reservoir setting. Porous buildups are legitimate regional targets; Tableland is a southeastern Saskatchewan analogue.

Preservation / test. A local mound and its seal must be demonstrated; missing overlying salt can reflect dissolution or mound geometry.

References [37].

Prairie Evaporite Formation

Environment. Restricted Middle Devonian evaporitic basin deposited halite, potash salts and anhydrite.

Conditional reservoir setting. Intact evaporites seal; dissolution can deform overlying reservoirs or breach compartment boundaries.

Preservation / test. Salt loss must be separated from original depositional absence; neither remaining salt nor collapse alone predicts corridor oil.

References [37, 40].

Dawson Bay Formation

Environment. Middle Devonian flooding after exposure/dissolution progressed from basal red mud through restricted Burr to more marine Neely carbonates, then renewed restriction/evaporites.

Conditional reservoir setting. Porous carbonate beds are possible reservoirs; muddy/evaporitic caps are possible seals.

Preservation / test. Local dissolution, facies changes and cap preservation need well control; no specific corridor pool is implied.

References [37, 38].

Souris River Formation

Environment. Middle-Late Devonian shallow shelf built repeated shallowing-upward carbonate-evaporite cycles with redbed/muddy breaks.

Conditional reservoir setting. Carbonate shoals or dolomitized beds may be reservoirs; evaporite and muddy interbeds can compartmentalize them.

Preservation / test. The regional shelf model is supported, but individual cycle quality, preservation and charge in the corridor remain unverified.

References [38].

Duperow Formation

Environment. Late Devonian shelf succession of cyclic carbonate, evaporite and fine clastic deposits; some later shelf stages were more shale-rich.

Conditional reservoir setting. Porous dolomitized/grainier beds are possible reservoirs, with tight carbonate, shale or anhydrite interbeds as barriers.

Preservation / test. Do not transplant Alberta Leduc reef geometry into Saskatchewan; local member correlations, diagenesis and charge must be demonstrated.

References [39].

Big Valley and other locally preserved upper Devonian intervals

Environment. Keep any independently picked carbonate interval between Torquay and Bakken in its own stratigraphic position. Its preservation can separate potential Torquay reservoirs from Bakken source or seal units.

Published evidence. Torquay correlation studies document changing contacts beneath the Bakken unconformity.

Conditional reservoir setting. Porous carbonate or contact-controlled targets need a separate facies and charge test.

Preservation / test. No new Big Valley thickness surface was built here; do not force direct Torquay-Bakken contact everywhere.

References [6].

Other Charles/Mississippian intervals, including Poplar where preserved

Environment. Repeated shallow carbonate-restricted evaporitic deposition followed by variable truncation.

Published evidence. Frobisher work uses overlying Ratcliffe-Poplar preservation patterns as structural context.

Conditional reservoir setting. Independently porous carbonate cycles with seal and charge.

Preservation / test. Younger beds preserved farther basinward cannot be extended automatically beneath the northern corridor.

References [21].

Shaunavon, Vanguard and Success: regional context

Environment. Shaunavon represents carbonate and siliciclastic shallow-marine facies; Vanguard includes marine mud and sand. Success preserves older, commonly quartz-rich fluvial to locally marine deposits beneath later erosion.

Published evidence. Regional names and their lateral equivalents change across southern Saskatchewan and Manitoba.

Conditional reservoir setting. Local porous sands or carbonate grain bodies; muddy intervals can contain or separate them.

Preservation / test. Red Jacket, Shaunavon and Gravelbourg correlations are partly lateral. Success is excluded from Christopher's restricted Mannville. Do not stack lateral equivalents as separate local units.

References [32, 29].

Joli Fou and Colorado succession: regional context

Environment. Marine shale, silt and subordinate sand deposited in the Cretaceous interior seaway; deeper-water mud accumulation alternated with shoreline progradation and erosion. Local nomenclature includes such intervals as Westgate, Belle Fourche, Second White Specks, Carlile and equivalents.

Published evidence. Regional Atlas framework; these are not newly interpreted corridor reservoirs.

Conditional reservoir setting. Any preserved, connected sand body or separately evaluated unconventional interval; marine muds commonly serve as seals and burial cover.

Preservation / test. Do not project western Saskatchewan Viking/Cardium producing analogues into the eastern corridor without direct correlation and local reservoir evidence.

References [44].

Milk River/Lea Park, Belly River and younger cover where preserved

Environment. Marine to shoreline and continental sedimentation followed by repeated regression, transgression and erosion. Younger southern Saskatchewan packages include Bearpaw, Eastend, Whitemud, Battle, Frenchman and Paleocene Ravenscrag in their respective preserved areas.

Published evidence. Regional Atlas distributions; present preservation varies greatly.

Conditional reservoir setting. Local coastal/fluvial sands, and separate coal/biogenic-gas systems if supported by local data.

Preservation / test. This is not a claim that every named unit exists at Indian Head or Wawota. Upper cover matters for burial and erosion history; it does not establish a shallow oil belt.

References [45].

Quaternary cover

Environment. Glacial till, meltwater sand/gravel and lake deposits reshape the modern landscape.

Published evidence. Modern terrain and drainage postdate the Paleozoic and Mesozoic depositional systems by tens to hundreds of millions of years.

Conditional reservoir setting. No deep oil play is inferred from modern valleys alone.

Preservation / test. Modern topography is not a restored ancient coastline; the 3D zero-elevation plane is also not terrain.

References [46].

Conditional follow-up areas

These five areas organize the next geological tests. Their order is not a quantified chance-of-success ranking. A plausible depositional environment must still have present reservoir quality, a retained seal, charge and mobile hydrocarbons.

1. Wawota-Walpole-Parkman and adjacent preserved Mississippian margin

Strong follow-up for preservation and local reservoir quality

Hypothesis. Souris Valley shoal/mound or bank-margin remnants, or a younger bed only where it is demonstrably preserved, sealed beneath Watrous/altered caprock.

Existing evidence. Regional truncation, nearby core analogues and published Parkman seal variability.

Most useful test. Map top and base of the same reservoir cycle across producing, wet and dry control wells. Test whether the reservoir is removed or merely changes facies updip.

Reject or revise if: Reservoir interval eroded; surviving rock tight; top seal breached; oil stain without movable saturation.

2. Wapella-Moosomin-Red Jacket-Rocanville

Strongest direct local Jurassic facies case

Hypothesis. Separate valley-axis sands, tidal-channel lenses and sheet-sand remnants in specific Red Jacket members.

Existing evidence. Published local core structures and historical oil-bearing sand examples; not a new production inventory.

Most useful test. Separate A1, A2 and B; flatten on member-scale flooding surfaces; correlate clean sand to lateral muddy/cemented equivalents.

Reject or revise if: A proposed single channel joins different ages; mud fills the thick; an alleged barrier has no well support.

3. Broadview-Wapella and the younger Assiniboia drainage region

Strong local sand-versus-mud test

Hypothesis. Dina/Cummings reservoir lenses within a broader Cantuar valley/estuary succession.

Existing evidence. Contrasting local core descriptions, including pyrobitumen in Broadview Cummings.

Most useful test. Resolve core/log depth shifts; distinguish Jurassic from Cantuar basal sand; map net porous sand, cap continuity, oil properties and pressure.

Reject or revise if: Only immobile residue remains; sand is an open water-bearing body; cement destroys permeability.

4. Tyvan-Chapleau Lake-Montmartre and westward toward Wolseley/Indian Head

Strong lower Red River anchor; extension remains conditional

Hypothesis. Porous lower-cycle dolomite under Lake Alma/C anhydrite, locally draped over independently demonstrated relief; Birdbear is a separate secondary evaluation.

Existing evidence. 2025 Red River core/log study overlaps the western corridor; local Montmartre Birdbear petrography.

Most useful test. Separate lower-cycle facies from gross Red River thickness, map net porosity and structure at close spacing, verify oil family/charge.

Reject or revise if: No connected pores or no closure/seal; migration pathway fails; extension rests only on a town-to-town line.

5. Bakken/Torquay across the wider region

Bed-scale facies and contact screen

Hypothesis. Middle Bakken embayment/flat or offshore-transition sands and selected Torquay silty dolostones preserved with effective source/seal contact.

Existing evidence. Regional core-based facies studies, local Mutrie sampling and eastern Rocanville reservoir-quality contrast.

Most useful test. Map individual facies/cycles and cement distribution, not whole-formation thickness; reconcile competing sequence models and maturity/charge.

Reject or revise if: Porous-looking sand is cemented; source is immature with no demonstrated migration; required unit/contact absent.

From a pool to an environmental reconstruction

1. Establish the exact stratigraphic level

Audit KB/ground elevation, MD versus TVD, deviation, casing depth, core shifts and formation/member picks.

Required result. A common datum and a bed-scale correlation, including dry and water-bearing wells.

2. Read the rock fabric

Grain support, sorting, ooids/peloids, fossils, mud drapes, cross-beds, ripples, burrows, rooting, desiccation and evaporite textures.

Required result. Competing environmental interpretations with positive and negative diagnostic evidence.

3. Calibrate logs to core

Use GR, resistivity, density-neutron, sonic and PE with actual core and cuttings. Correct environmental and borehole effects.

Required result. Facies and net-reservoir maps at the scale justified by well spacing; gamma shape alone is not a unique environment.

4. Separate deposition from later changes

Flatten on multiple time-stratigraphic surfaces; compare isopach patterns above/below suspected relief, salt removal and erosional contacts.

Required result. A dated event model: depositional relief, compaction, faulting, dissolution and erosion tested separately.

5. Establish reservoir and containment

Core porosity/permeability, pore throat distribution, capillary entry pressure, connected fracture evidence, lateral facies/seal changes and local structure.

Required result. A geometrically contained reservoir with realistic continuity, rather than a gross-thickness anomaly.

6. Test charge and present fluids

Oil shows, DST/RFT/pressure, water salinity, oil gravity/viscosity, biomarkers, source maturity and degradation.

Required result. Evidence for mobile retained hydrocarbons and charge timing. Pyrobitumen, fluorescence and stain are not equivalent to current productive saturation.

A direction is earned by correlation

If core at a pool records a protected, marginal-marine environment, first determine the age and the indicators of salinity and energy. Then correlate outward on the same time surface. A transition into coarser, better-sorted, wave- or tide-worked sediment could support a nearby sand bar, shoal or shoreface; a transition into skeletal carbonate may support a more open marine setting. Neither trend fixes a compass direction without neighboring wells. A mound or reef requires evidence of constructional relief and biological fabric, not merely a porous carbonate interval.

Use separate maps for each hypothesis: reservoir-facies distribution, net connected porosity, structure at a common datum, local seal facies, erosion/preservation and charge evidence. Where the maps disagree, retain the uncertainty rather than forcing one belt through them.

Twenty modeled intervals: numerical inventory

Ranges refer to valid cells in this regional reconstruction, not the entire geological unit or a specific prospect. Top values use the source subsea convention (mSS*); the precise vertical datum was not identified. H is mapped gross thickness. Comparison residuals use original picks from the source mapping compilation.

Interval	Top range (mSS*)	Gross H range (m)	Matched picks	Median |residual| (m)
Red River	-2,550.0 to -525.7	70.0 to 160.0	385	2.7
Birdbear	-1,800.0 to 50.0	0.9 to 45.0	1326	3.5
Torquay	-1,700.0 to 75.2	19.3 to 71.4	1561	3.1
Bakken	-1,650.0 to 73.0	0.1 to 66.1	1605	3.2
Souris Valley	-1,550.0 to 100.0	0.1 to 160.0	1735	4.2
Tilston	-1,500.0 to -350.0	0.1 to 120.0	1535	4.5
Alida	-1,439.1 to -500.0	0.0 to 105.4	1506	5.7
Kisbey	-1,400.0 to -531.0	0.0 to 30.1	1184	5.3
Frobisher	-1,389.2 to -550.0	0.0 to 90.0	1863	4.3
Frobisher Evaporite	-1,250.0 to -650.0	0.0 to 9.9	722	4.1
Midale	-1,350.0 to -600.0	0.1 to 35.0	1444	3.7
Midale Evaporite	-1,300.0 to -702.3	0.0 to 14.0	941	3.7
Ratcliffe	-1,300.0 to -550.0	0.1 to 60.0	1164	3.9
Total Mississippian	-1,150.0 to 100.0	0.1 to 575.0	3511	3.8
Total Watrous	-1,000.0 to -31.8	0.0 to 160.0	1760	2.5
Lower Watrous	-1,050.0 to -79.3	0.0 to 140.0	1708	2.1
Gravelbourg	-950.0 to 100.0	0.1 to 80.0	1842	3.2
Total Jurassic	-700.0 to 100.0	0.1 to 380.0	1876	5.9
Cantuar	-644.7 to 122.9	20.0 to 120.0	1918	3.7
Mannville	-600.0 to 150.0	25.0 to 150.0	1950	3.3

Top minus H gives the displayed base. The total-interval and evaporite overlaps on the next page must be respected. A small same-source residual tests consistency of sign, units and interpolation; it is not independent geological accuracy. [41-43]

Interval hierarchy: avoid double-counting rock

A displayed interval is a mapping convention. Some gross intervals contain others; total Jurassic partially overlaps total Watrous. The viewer retains each source interval rather than silently changing its definition.

Mapped interval	Relationship in this model	Practical reading
Midale	Includes the Frobisher Evaporite.	Discuss carbonate facies and evaporite separately, but do not add their gross thicknesses.
Ratcliffe	Includes the Midale Evaporite; the evaporite also passes laterally into basinward Ratcliffe carbonate.	Lithostratigraphic and genetic-cycle boundaries are not interchangeable.
Total Mississippian	Contains Souris Valley and younger retained beds; excludes the separately mapped Bakken interval in this data convention.	Total Mississippian is an architecture / preservation interval, not one depositional environment.
Total Watrous	Contains Lower Watrous and Upper Watrous.	The lower and total Watrous surfaces are useful different views of the same stack.
Total Jurassic	Includes Upper Watrous as well as Gravelbourg and other Jurassic strata.	Partially overlaps total Watrous; do not sum both total intervals.
Mannville	Includes Cantuar and Pense.	Cantuar is not an additional thickness to add beneath total Mannville.

Audit basis: derived bases were compared to adjacent mapped tops across common model cells and checked against published stratigraphic nomenclature. Typical median differences at the relevant contacts are near zero; the report retains genuine interpolation mismatches. This geometric consistency supports the interval interpretation but does not resolve every member boundary. The data package includes the complete hierarchy audit.

The Frobisher Evaporite is commonly placed at basal Midale lithostratigraphically, while part belongs to the upper Frobisher genetic cycle. The flooding surface can lie within the evaporite. Preserve that distinction when drawing a depositional history. [20, 22, 23, 24]

How the model was compiled

The 3D geometry is an independently assembled visualization of public provincial mapping products. It is not an official Saskatchewan Geological Survey model. The 2019 provincial framework paper describes a larger model of 71 mapped intervals and 85 surfaces; this deliverable contains the 20 intervals supported by the present map compilation. [43]

The source structure contours have 50 m spacing. They and gross-thickness maps were reconstructed on a 2 km mesh, with no attempt to manufacture small-pool closures or bed-scale reservoir geometry between the source constraints.

Horizontal frame. EPSG:2957 (NAD83(CSRS) / UTM zone 13N), with a 135 x 116 mesh at 2,000 m spacing. The 49-51 degrees N, 105-101.2 degrees W working extent is clipped to Saskatchewan. The geographic boundary is densified before projection.

Contour interpolation. Structure contours and ordinary isopachs are sampled at approximately 1 km along-line spacing and linearly interpolated to the mesh. Actual zero-thickness edges constrain H = 0. Categorical edge codes are excluded from physical thickness and elevation values.

Presence and gaps. Zero-edge lines partition the province-clipped region; only areas with supporting positive-thickness contours are retained. The mask uses 25 m noding and up to 100 m border endpoint reconciliation. No extrapolation beyond the contour-sample convex hull is performed. Small isolated compartments may be unmodeled.

Well controls. The public query retrieved 4,205 records in a padded search extent; 4,074 usable regional records are included. Of 37,505 accepted picks including two unconformity fields, 31,794 refer to the 20 selected intervals. Original formation depths, KB and identifiers are retained separately from interpolated surfaces.

Depth and datum. Source formation depths are treated as TVD according to the public dataset metadata. Top elevation = source KB elevation - formation TVD. Zero and missing fields are not interpreted as absence; picks more than 5 m deeper than recorded total depth are excluded. Exact geodetic vertical-datum realization remains unresolved.

Consistency check. Median absolute interpolated-top residuals against source picks range from about 2.1 to 5.9 m by interval. The picks were used in the mapping compilation and are not an independent validation sample. The 50 m contour spacing and map age are more consequential than this residual for small-pool interpretation.

Derived bases and overlap. Base elevation equals mapped top minus mapped gross vertical thickness. Independently mapped intervals can disagree or cross; surfaces were not silently shifted to produce a watertight stack. The hierarchy table identifies overlapping totals and evaporite members. None of these thicknesses is net pay.

Meaning of the display. Formation edges can reflect erosion, deposition, later dissolution or mapping limits; they are not automatically ancient shorelines. The reference plane is source zero elevation, not terrain. Vertical exaggeration changes apparent slope and thickness. Present structure is not restored paleotopography.

Public source lineage [41, 42, 43, 34]. The full source URLs for each structure, isopach and zero-edge layer are stored in model.json.

Using the 3D / VR deliverables

Browser viewer

Open the interactive viewer
se-sask-geology-3d.chasergeo.chatgpt.site

The viewer provides a layer list for all 20 intervals, solo and grouped views, formation or thickness colouring, top / base / gross-interval display, opacity, wireframe, vertical exaggeration and cutaway planes. Towns, original well picks and a reference elevation plane can be switched on. Click a surface for its interpolated top and thickness, and use the study and sources tabs for geological context.

Suggested first inspection

1. Orient. Start with the overview, fit the region, show towns and identify the discussion corridor. Rotate the stack to see how present structure differs from map extent.

2. Isolate. Solo Souris Valley, Bakken or Cantuar. Change colour to gross thickness and inspect the mapped edge and nearby data controls.

3. Inspect a section. Use a north-south or east-west cutaway. Compare top and derived base; check the displayed vertical exaggeration before judging dip or relief.

4. Check the source definition. Read the selected interval note. Inspect Midale versus Frobisher Evaporite or Jurassic versus Watrous only with their overlap in mind.

5. Return to evidence. Use original picks and the study profiles to identify where bed-scale core/log work could resolve a promising geometry. A smooth 3D surface alone does not provide that evidence.

VR and portable models

The site includes an immersive WebXR tabletop mode for a compatible headset browser on HTTPS. The VR interface provides layer selection, solo / overview, geometry and vertical-exaggeration controls; controller rays can interrogate a surface. Physical headset tracking and controller behavior have not been tested on the user's device.

Two GLB files provide portable scene geometry at 1x and 25x vertical exaggeration. The 1x file preserves true proportions, not survey-sized real-world metre coordinates: horizontal 100 km is represented by one scene metre. Metadata stores the EPSG:2957 origin, vertical convention, scale and unit source URLs. Each file contains overview, detailed and all-interval scenes; the all-interval scene intentionally includes overlapping composites.

Without WebGL, the viewer uses a labelled software fallback with a coarser visual mesh; picking retains the 2 km data. Use a WebGL-capable browser for the full display geometry.

Material limits

No complete new interpretation of all original LAS logs, DSTs, seismic or physical core was performed. Published core photographs, sections and descriptions were reviewed alongside public formation picks.

A mapped edge can be erosional, depositional, diagenetic or affected by later dissolution. It is not automatically a shoreline.

Model cells are 2 km and structure contours are 50 m apart; this framework cannot resolve the closure or reservoir continuity of a typical small pool.

The model is derived from contour lines, not the original official kriging grids. Well comparison is a same-source consistency check, not independent validation.

Absence of a pick, a contour or a modeled surface does not by itself demonstrate formation absence.

Present structure is not depositional paleotopography. The precise geodetic vertical datum was unspecified in the retrieved source metadata.

Gross interval thickness is not net pay. Mapped Midale includes Frobisher Evaporite; mapped Ratcliffe includes Midale Evaporite. Total Jurassic includes Upper Watrous and partly overlaps total Watrous. Total Mississippian excludes the separately mapped Bakken. Composite thicknesses must not be summed with their constituents.

No discovery probabilities, recoverable resources, land values or drilling locations are assigned.

References and source access

Source IDs used in the digital evidence register are shown alongside the numbered citations. Links lead to publisher, government, university or author-hosted originals. Historical descriptions retain their original well names and depth units; page anchors distinguish printed and PDF numbering where necessary.

[1] RR25 Thomas, A.D. & Qing, H. (2025). Lithofacies Analysis and Petroleum Reservoir Characteristics of the Ordovician Red River Formation, Williston Basin, Southeastern Saskatchewan. SGS GR2025-9. Open source (publications.saskatchewan.ca)

[2] KK00 Kreis, L.K. & Kent, D.M. (2000). Basement Controls on Red River Sedimentation and Hydrocarbon Production in Southeastern Saskatchewan. SGS Misc.Rep.2000-4.1. Open source (pubsaskdev.blob.core.windows.net)

[3] PH08 Pratt, B.R. & Haidl, F.M. (2008). Microbial Patch Reefs in Upper Ordovician Red River Strata, Williston Basin, Saskatchewan: Signal of Heating in a Deteriorating Epeiric Sea. GAC Special Paper48,303-340. Open source (www.researchgate.net)

[4] UQ07 Urban, M. & Qing, H. (2007). Preliminary Core Description and Lithofacies Analysis of the Ordovician Coronach Member, Herald Formation, Southeastern Saskatchewan. SGS PaperA-3,13 pp. Open source (pubsaskdev.blob.core.windows.net)

[5] N70 Nichols, R.A.H. (1970). The Petrology and Economic Geology of the Upper Devonian Birdbear Formation, Southeastern Saskatchewan. Saskatchewan Department of Mineral Resources, Report 125. Open source (publications.saskatchewan.ca)

[6] Y18 Yang, C. (2018). Tight Oil Plays of the Upper Devonian Torquay Formation in Southeastern Saskatchewan: I. Stratigraphic Framework and Its Control on Oil Production. SGS Misc.Rep.2018-4.1, PaperA-3,26 pp. Open source (publications.saskatchewan.ca)

[7] Y20 Yang, C. (2020). Tight Oil Plays of the Upper Devonian Torquay Formation in Southeastern Saskatchewan: II. Storm-influenced Saline Lake Deposits. SGS Misc.Rep.2020-4.1, PaperA-3,27 pp. Open source (publications.saskatchewan.ca)

[8] KN09 Kohlruss, D. & Nickel, E.H. (2009). Facies Analysis of the Upper Devonian-Lower Mississippian Bakken Formation, Southeastern Saskatchewan. SGS Misc.Rep.2009-4.1, PaperA-6,11 pp. Open source (pubsaskdev.blob.core.windows.net)

[9] AB10 Angulo, S. & Buatois, L. (2010). Sedimentary Facies Distribution of the Upper Devonian-Lower Mississippian Bakken Formation, Williston Basin, Southeastern Saskatchewan: Implications for Understanding Reservoir Geometry, Paleogeography, and Depositional History. SGS PaperA-4,18 pp. Open source (pubsaskdev.blob.core.windows.net)

[10] AB11 Angulo, S. & Buatois, L. (2011). Petrophysical Characterization of Sedimentary Facies from the Upper Devonian-Lower Mississippian Bakken Formation in the Williston Basin, Southeastern Saskatchewan. SGS PaperA-6,16 pp. Open source (publications.saskatchewan.ca)

[11] AB12 Angulo, S. & Buatois, L.A. (2012). Integrating Depositional Models, Ichnology, and Sequence Stratigraphy in Reservoir Characterization: The Middle Member of the Devonian-Carboniferous Bakken Formation of Subsurface Southeastern Saskatchewan Revisited. AAPG Bulletin96(6),1017-1043. Open source (doi.org)

[12] L13 Lillis, P.G. (2013). Review of Oil Families and Their Petroleum Systems of the Williston Basin. The Mountain Geologist50(1),5-31. Open source (pubs.usgs.gov)

[13] nickel_kent2008 Facies Relationships and Hydrocarbon Potential in the Souris Valley Beds (Lodgepole Fm.) in Southeast Saskatchewan PDF p.1, printed p.928 Open source (geoconvention.com)

[14] sereda1990 Aspects of the Sedimentology, Stratigraphy and Diagenesis of Lower Mississippian Shelf Margin Carbonates: Souris Valley-Lodgepole Interval of the Williston Basin University of Saskatchewan thesis; Plates 4, 7, 8; PDF pp.63-64, 79-80, 83-84; Figure 16 PDF pp.136-137 Open source (harvest.usask.ca)

[15] lake2023 Upside Potential of the Basal Mississippian Souris Valley Beds/Lodgepole Formation in Southeast Saskatchewan: An Alternate Model Using Evidence from Drill Core SGS core-talk notice/abstract, PDF pp.1-2; not a complete core atlas Open source (www.apegs.ca)

[16] ji_hersi2016 Diagenesis and Petrographic Reservoir Characterization of the Mission Canyon Formation, Southeastern Saskatchewan SGS MR 2016-4.1, Paper A-5; Tables 1-2, Figures 3, 5-6; especially p.11 Open source (pubsaskdev.blob.core.windows.net)

[17] rott_qing2005_sedimentology Sedimentology and Facies Description of Mississippian Alida Beds, Williston Basin, Southeastern Saskatchewan SGS MR 2005-4.1, Paper A-12; Figures 3-9, pp.3-8 Open source (pubsaskdev.blob.core.windows.net)

[18] rott_qing2005_diagenesis Diagenesis of Mississippian Alida Beds, Williston Basin, Southeastern Saskatchewan - Evidence from Petrographic and Fluid-Inclusion Data SGS MR 2005-4.1, Paper A-11; petrographic/paragenetic synthesis Open source (pubsaskdev.blob.core.windows.net)

[19] kent2007_kisbey An Enigmatic Interval Rich in Sand-size Quartz Particles in the Mississippian of Southeastern Saskatchewan: A Possible Solution to Its Origin Based on Sequence Stratigraphic Principles SGS MR 2007-4.1, Paper A-5; Figure 2 p.4, Figures 7-10 pp.9-14 Open source (pubsaskdev.blob.core.windows.net)

[20] marsh_cycles Transgressive-Regressive Cycles of the Mississippian Frobisher Carbonate-Evaporite Succession in the Steelman Area, Southeastern Saskatchewan SGS MR 2002-4.1 pp. 37-46; PDF p.3 = printed 39; Figures 9-11 printed42-43 Open source (pubsaskdev.blob.core.windows.net)

[21] nimegeers2006_frobisher Hydrocarbon Potential in Coated-Grain Banks of the Mississippian Frobisher Beds, Southeastern Saskatchewan Convention extended abstract; Figures 1-2 PDF p.2, printed 635 Open source (geoconvention.com)

[22] midale2009 A Preliminary Investigation of Diagenesis of the Mississippian Midale Beds, Steelman Midale Pool, Southeastern Saskatchewan SGS MR 2009-4.1, Paper A-7; nomenclature pp.2-4, core photos Figures 3-5 pp.6-8 Open source (pubsaskdev.blob.core.windows.net)

[23] lake_kent2007_evaporite Highstand Stacked Tidal Flat / Standing Water Evaporite Cycles of the Midale Evaporite in Southeast Saskatchewan (Mississippian Williston Basin) Convention core-display abstract; Figure 4 PDF p.6; Steelman core Figure 5 PDF p.7 Open source (geoconvention.com)

[24] lake2007_ratcliffe Multiple Barriers within the Mississippian Ratcliffe Beds of the Williston Basin, Southeastern Saskatchewan SGS MR 2007-4.1, Paper A-6; Figure 1 and four-page discussion Open source (pubsaskdev.blob.core.windows.net)

[25] fuzesy1973_ratcliffe The Geology of the Mississippian Ratcliffe Beds in South-Central Saskatchewan SGS Report 163; printed pp. 26-33; Plate VIII caption/photo printed 56-57 (PDF 58-59); Plate X printed60-61 (PDF 62-63) Open source (pubsaskdev.blob.core.windows.net)

[26] bates_kendall2008 Understanding the Origin of the Sub-Unconformity Diagenetic Caprock, in the Mississippian of the Williston Basin, Southeast Saskatchewan Convention extended abstract; Figure 2 PDF p.3, printed 811 Open source (geoconvention.com)

[27] lake2001_midale_onlap Onlap within the Mississippian Midale Beds of Southeastern Saskatchewan SGS MR 2001-4.1; five-page report and Benson onlap interpretation Open source (pubsaskdev.blob.core.windows.net)

[28] K91 Kreis, L.K. (1991), Stratigraphy of the Jurassic System in the Wapella-Moosomin Area, Southeastern Saskatchewan, Saskatchewan Energy and Mines Report 217. Printed page n is physical PDF page n+10 in the recovered main PDF. Pocket figures are separate PDFs. Open source (publications.saskatchewan.ca)

[29] C03 Christopher, J.E. (2003), Jura-Cretaceous Success Formation and Lower Cretaceous Mannville Group of Saskatchewan, Saskatchewan Industry and Resources Report 223. Printed page n is physical PDF page n+10 in the main text; appendices have their own printed numbering. Open source (pubsaskdev.blob.core.windows.net)

[30] C03A Christopher (2003), Report 223, Appendix A: core descriptions. Printed A-n corresponds to physical PDF page n in this separate Appendix A file. Open source (pubsaskdev.blob.core.windows.net)

[31] ATLAS16 Geological Atlas of the Western Canada Sedimentary Basin, Chapter 16: Triassic Strata, Alberta Geological Survey. Open source (ags.aer.ca)

[32] ATLAS18 Geological Atlas of the Western Canada Sedimentary Basin, Chapter 18: Jurassic and Lowermost Cretaceous Strata, Alberta Geological Survey. Open source (ags.aer.ca)

[33] MB16 Lapenskie and Bamburak (2016), Manitoba Geological Survey Report of Activities, GS-18, pp. 181-186. Open source (www.gov.mb.ca)

[34] SPFPS Marsh and Love (2014), Saskatchewan Phanerozoic Fluids and Petroleum Systems Project, Open File 2014-1; Saskatchewan GeoAtlas Mesozoic service. Open source (gis.saskatchewan.ca)

[35] A8 WCSB Atlas (1994), Chapter 8: Middle Cambrian to Lower Ordovician Strata Descriptions of Formations - Deadwood; Facies Belts; Post-Lower Ordovician Influences; Figs8.6,8.18,8.20 Open source (ags.aer.ca)

[36] A9 WCSB Atlas (1994), Chapter 9: Middle Ordovician to Lower Devonian Strata Williston Basin; Reference Well; Williston Basin Cross Sections; Figs9.13-9.18,9.23-9.26 Open source (ags.aer.ca)

[37] A10 Meijer Drees, N.C.(1994), WCSB Atlas Chapter 10: Devonian Elk Point Group Depositional History; Cross SectionN-N'; Figs10.6-10.8,10.17-10.18 Open source (ags.aer.ca)

[38] A11 WCSB Atlas (1994), Chapter 11: Devonian Beaverhill Lake Group Southern Bank/Souris River Shelf; Figs11.6e, 11.8b, 11.12-11.16 Open source (ags.aer.ca)

[39] A12 WCSB Atlas (1994), Chapter 12: Devonian Woodbend-Winterburn Strata Eastern Basin; Lower/Middle/Upper Leduc correlations to Duperow; Figs12.15,12.22 Open source (ags.aer.ca)

[40] A27 Kent, D.M.&Christopher, J.E.(1994), WCSB Atlas Chapter 27: Geological History of the Williston Basin and Sweetgrass Arch Introduction; Local Basement Structures; Salt Solution Tectonics Open source (ags.aer.ca)

[41] MODEL1 SPFPS public TVD well picks Open source (services3.arcgis.com)

[42] MODEL2 Open File 2014-1 maps Open source (publications.saskatchewan.ca)

[43] MODEL3 Provincial 3D framework methods (Marsh & Music, 2019) Open source (ags.aer.ca)

[44] A20 WCSB Atlas, Chapter 20: Cretaceous Colorado/Alberta Group Open source (ags.aer.ca)

[45] A24 WCSB Atlas, Chapter 24: Uppermost Cretaceous and Tertiary Strata Open source (ags.aer.ca)

[46] A26 WCSB Atlas, Chapter 26: Quaternary Geology of the Western Plains Open source (ags.aer.ca)

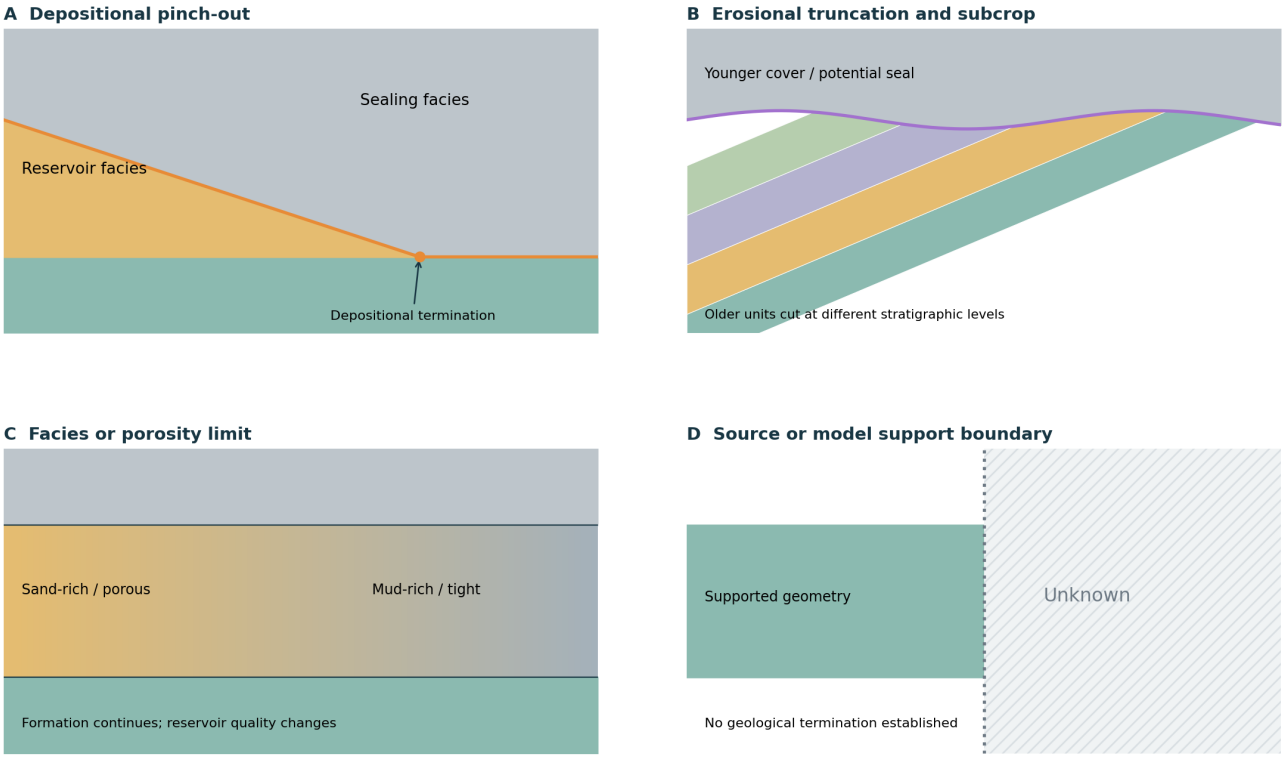
SASKATCHEWAN + MANITOBA / INTERPRETATION GUIDE

Formation edges and erosional surfaces

How to read zero edges, pinch-outs, thinning contours and model limits

A shared guide for the regional map atlases and 3D / VR models. The purpose is to preserve the distinction between published geometry, a proposed geological mechanism and the limits of available control.

Four edges that must remain different in maps and 3D



CONCEPTUAL - NOT TO SCALE. A published zero edge identifies a limit of preserved occurrence; its origin requires additional evidence.
Only A is a depositional pinch-out. B records removal. C is a reservoir-property change. D records an evidence limit.

Original conceptual cross-sections. They explain classification, not mapped positions or local closure. A zero-thickness line does not alone identify its cause.

Read the evidence class before interpreting a line

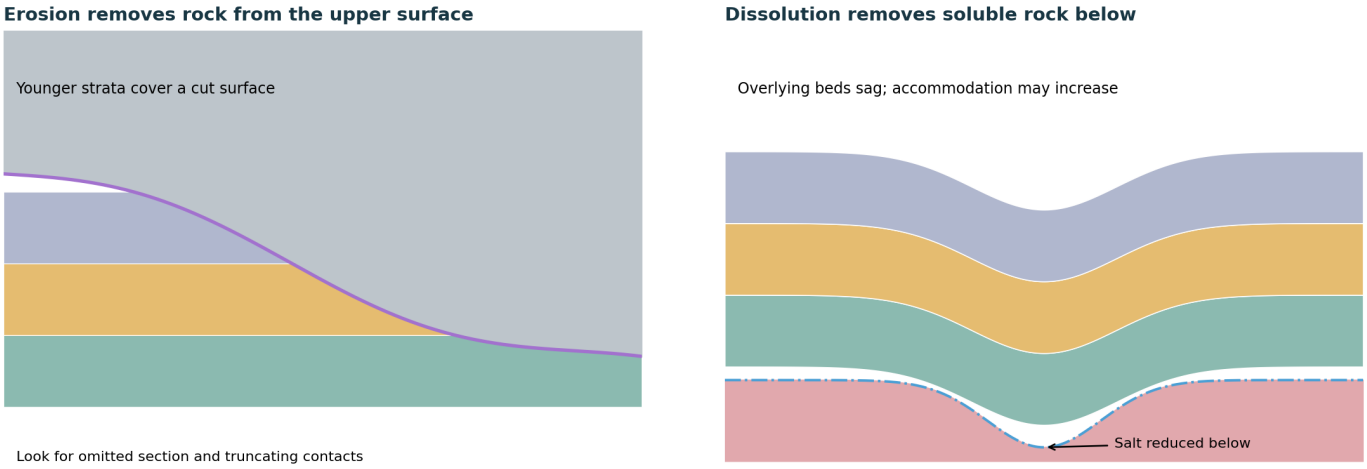
Class	What it establishes	What it does not establish
Published formation zero edge	The source maps a limit at which the named preserved interval is absent or approaches zero.	Depositional origin, exact subcrop position, a reservoir seal or a fluid contact.
Depositional pinch-out	The bed or facies body terminates through its original accumulation pattern, supported by correlation/facies evidence.	That the enclosing formation disappears, or that hydrocarbons are present.
Erosional truncation / subcrop	A younger surface removes older strata; the affected older unit meets that surface.	Original shoreline direction or preserved reservoir quality.
Reservoir facies / porosity limit	Connected sand, dolomite porosity or another effective reservoir property changes laterally.	A zero edge of the entire formation.
Model-derived thin interval	A positive low-thickness contour from the specified supported top/base interval.	Zero thickness or proof of either deposition or erosion.
Support limit / map clipping	The available model, data or project domain ends.	Geological absence. It is retained as an uncertainty boundary.
Salt-dissolution front	Evidence suggests removal of soluble strata and associated modification of the overburden.	An erosional land surface or a reliably sealed petroleum trap.

A zero edge identifies where a preserved interval reaches its mapped limit. Classifying its origin requires additional evidence. A named stratigraphic contact or administrative polygon boundary is not automatically a zero edge. Published mapping may contain both erosional and depositional segments; preserve that uncertainty instead of assigning one cause to the entire line.

Three spatial relationships to reconstruct

- Formation preservation: where the complete named interval remains and where it is omitted or removed.
- Reservoir distribution: where connected sand, carbonate fabric or secondary pores occur inside that preserved interval.
- Trap and seal: where structure, juxtaposition and fluid history could retain hydrocarbons. Neither of the first two maps supplies this automatically.

A missing interval can have more than one geological cause



CONCEPTUAL - NOT TO SCALE. Both processes can modify thickness, structure and seals; they can also act at different times in the same area.
Compare multiple horizons, core fabrics, evaporite residues and the timing of overlying thickening before assigning a mechanism.
A fracture or collapse trend may enhance flow, compartmentalize it or breach a seal; it is not automatically a trap.

Original conceptual comparison. Manitoba examples include pre-Mesozoic truncation and the documented local Manson dissolution/structural interpretation. Sources R01-R03 and R17 in the main study.

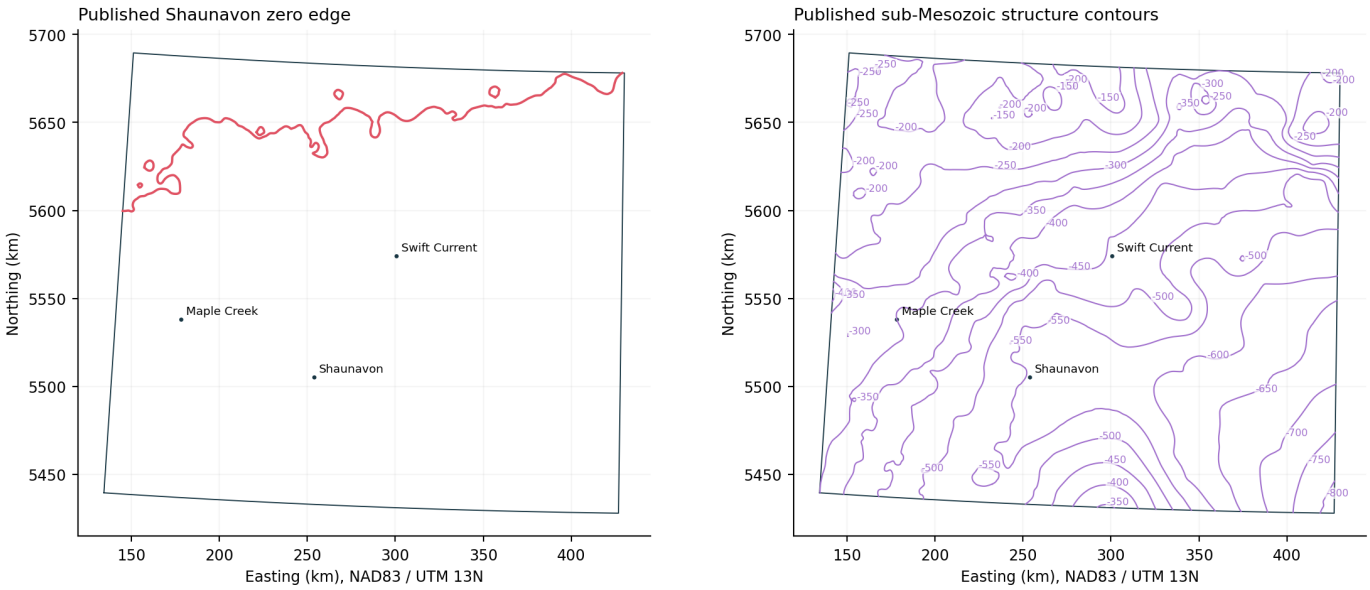
Evaluate the alternative explanation

An apparent thickness low may reflect nondeposition, erosion, dissolution, a composite interval, a miscorrelated pick or model support. Test contrasting explanations with correlated wells, sample fabrics and several bounding horizons. A more detailed line drawing is not a substitute for these observations.

Saskatchewan: independently published edges

Saskatchewan: source-mapped zero edges and erosional-surface contours

The two line classes answer different questions; their attributes must not be interchanged.



Actual provincial GIS geometry, clipped to southwest study. Zero-edge cause remains unclassified. Structure values are source elevations in metres.
The regional framework was prepared on modified 2 km grids; detailed vector vertices do not establish pool-scale accuracy.
Source: Marsh and Love (2014), SGS Open File 2014-1; Saskatchewan Mesozoic map services. No new fault or prospect boundary inferred.

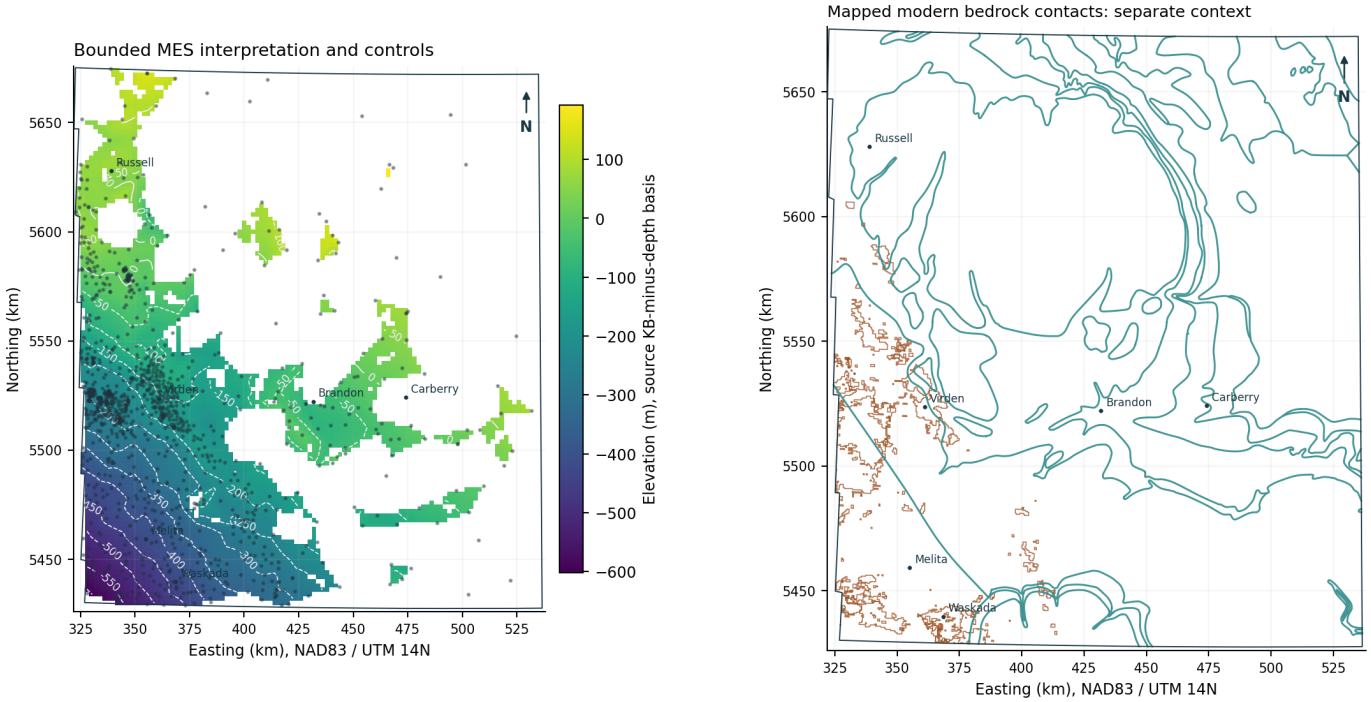
Actual government GIS lines. The Shaunavon zero-edge layer supplies occurrence-limit geometry, not genetic classification or elevation. The unconformity contour layer supplies mapped structural elevations. Source: SGS Open File 2014-1 and Mesozoic GIS.

The provincial geological map layers provide independently mapped zero edges. Their source class is retained; unspecified genetic origin remains unspecified. Arbitrary CAD ZLEVEL values on a zero-edge layer must not be treated as elevation. Only a structure-contour layer with a documented elevation attribute supplies a structural contour value.

Manitoba: subcrop interpretation and a picked surface

Two different surfaces: buried sub-Mesozoic and modern bedrock

Do not interpret a modern contact as a deep subcrop or an original depositional shoreline.



MES: 1,173 accepted vertical-classified records; 1,163 unique locations; 4,202 supported 2 km nodes. 50 m contours.
No extrapolation: within control hull, 7.5 km of a control, maximum 20 km triangle edge. Five-fold holdout MAE 5.965 m; RMSE 10.002 m.
38 conflicting display nodes masked; source picks retained. Holdout is not independent pick validation; full surveys/datum conversion unverified.
Sources: MGS TGI historical MES records; Manitoba mapped bedrock contacts; existing pool inventory. Erosional relief is not a mapped trap.

MES: 1,173 accepted vertical-classified records; 1,163 unique locations; 4,202 supported 2 km nodes. 50 m contours. No extrapolation: within control hull, 7.5 km of a control, maximum 20 km triangle edge. Five-fold holdout MAE 5.965 m; RMSE 10.002 m. 38 conflicting display nodes masked; source picks retained. Holdout is not independent pick validation; full surveys/datum conversion unverified. Sources: MGS TGI historical MES records; Manitoba mapped bedrock contacts; existing pool inventory. Erosional relief is not a mapped trap.

Published subcrop maps and the bounded historical-pick surface answer complementary questions: which older unit is exposed beneath cover, and the elevation of the picked unconformity. A model-support outline and a small positive isopach are separate, lower-order evidence layers. They must not be presented as measured geological zero edges.

Custom contours in 3D and VR

- Select the formation and choose structure or gross interval thickness. Structure contours describe an elevation surface; thickness contours describe a top/base difference, not an elevation. A thickness isoline displayed on a formation plane is still an attribute contour.
- Set a positive contour interval in metres. The offset selects the reference level for that sequence. For example, 50 m with zero offset gives ..., -100, -50, 0, 50, 100 ... for elevations; a 10 m thickness interval gives 0, 10, 20 ... only where supported values actually cross those levels.
- Contours are calculated from the same supported grid triangles used for the display. Null or unsupported triangles must not be bridged. A small interval produces more lines; it does not add well control, improve the 2 km source resolution or establish a smaller feature.
- Compare top and base structure, where a valid base is available, with gross thickness. Parallel structure and nearly constant thickness are different from converging top/base surfaces. Neither pattern alone determines geological cause.
- Use the classified-edge layer and source inspector separately from custom contours. A chosen 5 m contour is a thinning indicator, not an official zero edge. The absence of a 0 m contour does not prove the unit never terminates; the mapped values may end at a source-support limit.
- In VR, keep vertical exaggeration visible. Exaggeration alters the visual steepness of structures and apparent spacing in elevation. It does not change source metres, the chosen contour values or the horizontal position of the classified edge.
- The portable GLB downloads contain fixed 50 m structure contours. Adjustable intervals and offsets are controls in the live browser / VR viewer. Edge segments without supported formation elevation remain separately named reference context at 0 m in the portable package; that reference height is not a geological depth.

A defensible local extension test

Question	Supporting observation	Contrary or unresolved evidence
Is the target present?	Correlated top/base or a documented reservoir bed in penetrating wells.	No penetration, absent or uncertain picks, ambiguous correlation.
Is the edge geological?	Source-classified edge or local stratigraphic evidence of termination.	Mesh boundary, clipping line, sparse data or arbitrary positive isopach.
What caused it?	Truncation, onlap/facies relations, dissolution fabrics and event sequence.	Several mechanisms explain the same geometry.
Is there connected reservoir?	Core-calibrated properties and continuity at the target interval.	Cemented pores, muddy fill, isolated vugs or disconnected bodies.
Can oil or gas be retained?	Charge evidence plus effective seal/trap and compatible fluid data.	Water-bearing test, breached seal, immature source without migration evidence.

These tests organize geological investigation; they do not calculate reserves, recommend a drilling location or assign a discovery probability.

Primary references

Saskatchewan Mesozoic mapping service

https://gis.saskatchewan.ca/egis/rest/services/Economy/Mesozoic/FeatureServer

Manitoba Williston Basin TGI maps

https://www.manitoba.ca/iem/geo/willistontgi/maps.html

Manitoba TGI 3D model and historical databases

https://www.manitoba.ca/iem/geo/willistontgi/3dmodel.html

Nicolas and Barchyn (2008), Paleozoic synthesis, GP2008-2

https://www.manitoba.ca/iem/info/libmin/GP2008-2.pdf

Nicolas (2009), Mesozoic synthesis, GP2009-1

https://www.manitoba.ca/iem/info/libmin/GP2009-1.zip

Nicolas (2012), Three Forks stratigraphy, GR2012-3

https://www.manitoba.ca/iem/info/libmin/GR2012-3.pdf

Fulton-Regula (2024), Manson reservoir observations

https://www.gov.mb.ca/iem/geo/field/roa24pdfs/GS2024-23.pdf

Manitoba M-2: Mississippian erosion and subcrop map

https://www.gov.mb.ca/iem/geo/stratmaps/pdfs/m-2.pdf

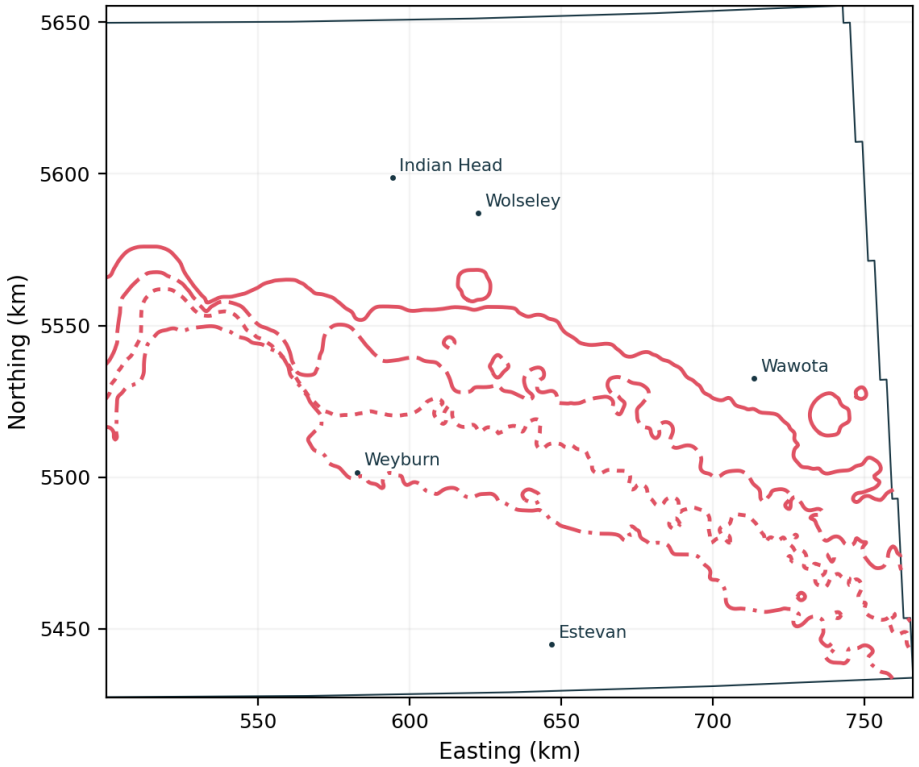
Manitoba P-1: Paleozoic erosion map

https://www.gov.mb.ca/iem/geo/stratmaps/pdfs/p-1.pdf

Southeast Saskatchewan: formation edges and erosion

Release coverage: 292 zero-edge feature records and 243 unconformity-contour records.
The plate selects a few units; the data package retains all five added unconformity-contour families.

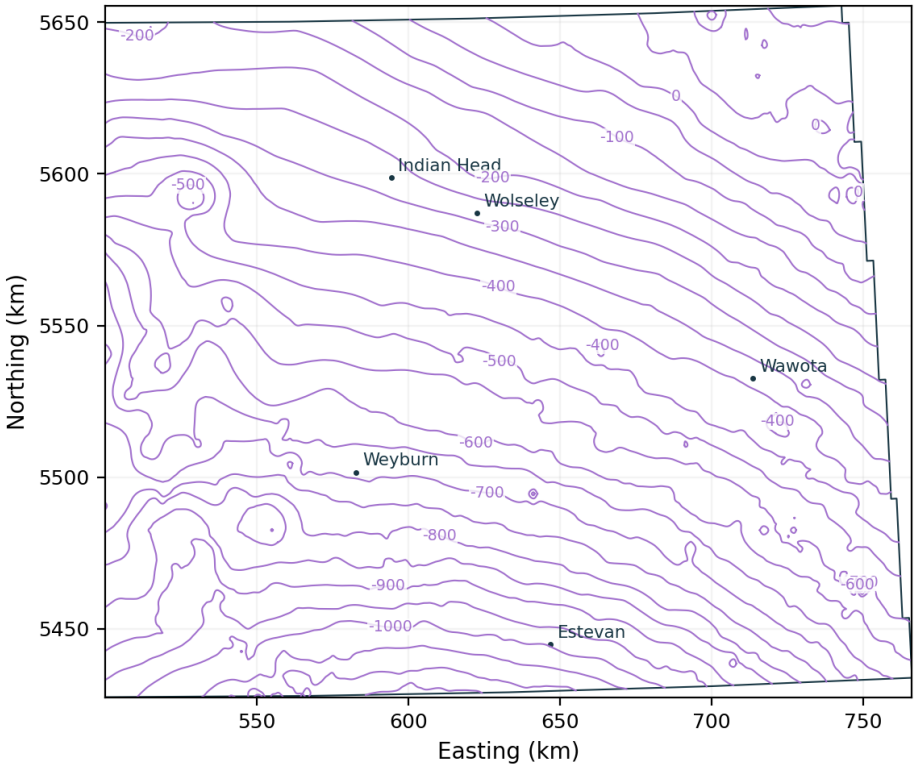
Selected published formation zero edges



Red: published zero-edge class; style identifies the unit

Tilston
Frobisher
Alida
Midale

Published sub-Mesozoic structure contours



Purple: erosional-surface elevation contours (m)
Contour values use the released source datum.

Modern map coordinates: NAD83(CSRS) / UTM 13N, EPSG:2957. Source: Marsh and Love (2014), SGS Open File 2014-1; provincial GIS.
Zero-edge origin remains unspecified. A structural contour is not the perimeter of an unconformity, a shoreline or a fluid contact.
Source framework uses modified 2 km grids; detailed vertices do not establish pool-scale precision. No prospect boundary is assigned.