Oil Potential of the Birdbear Formation in Saskatchewan

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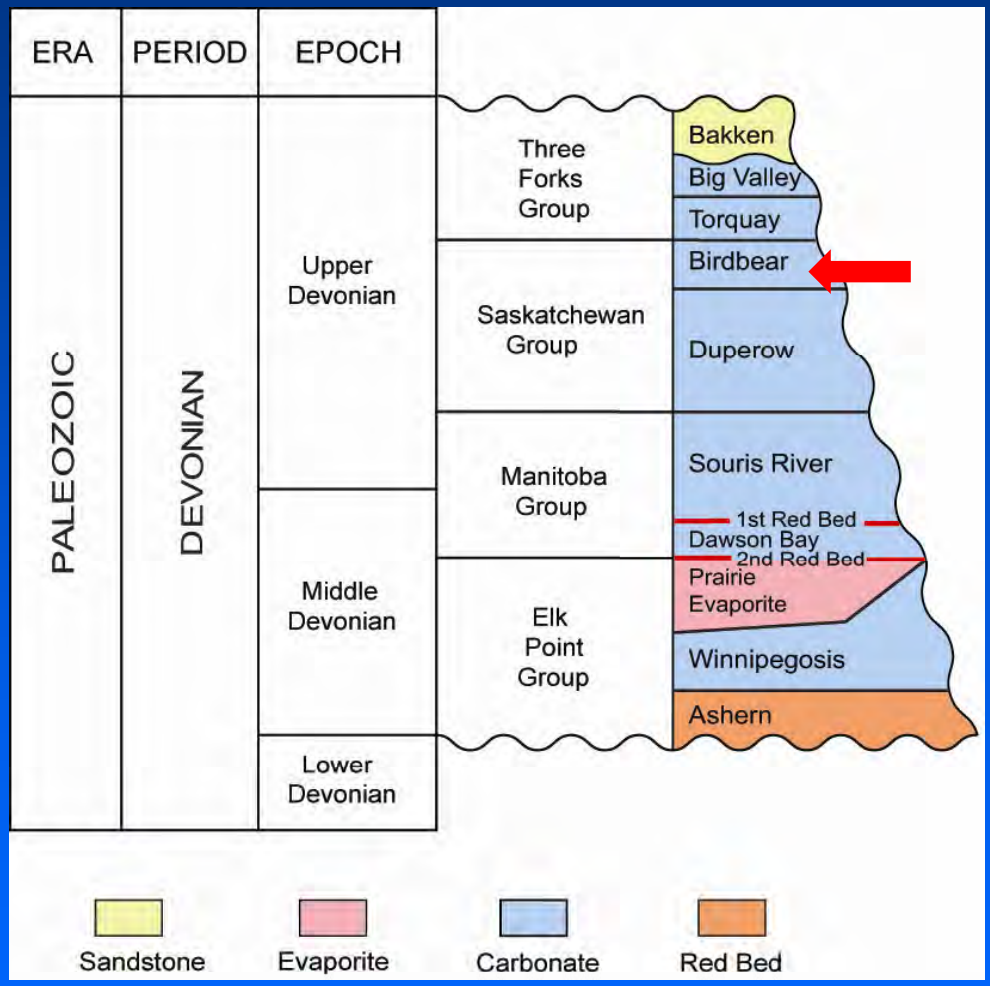
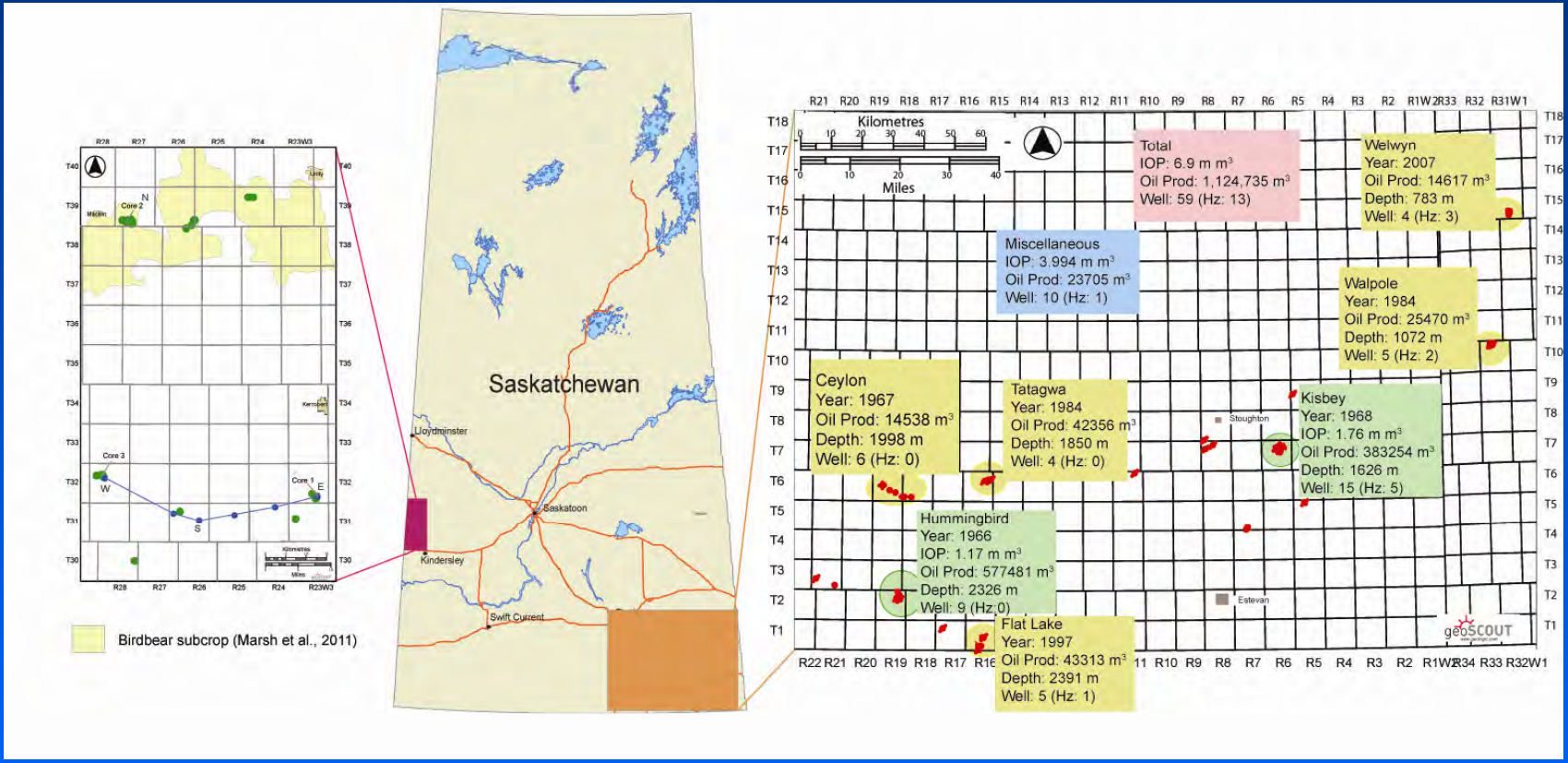
Devonian Stratigraphy of Saskatchewan



Birdbear Formation

- Saskatchewan Gr. in Upper Devonian
- Conformable with the underlying Duperow and overlying Torquay Fms
- North margin was truncated by the sub-Mesozoic unconformity and overlain by the Lower Cretaceous Mannville Group
- Upper portion of the Birdbear correlates with the Nisku Fm. of the Alberta Basin

Birdbear Oil Production Areas in Saskatchewan



Two petroleum systems of Birdbear oil plays in Saskatchewan:

- **Williston Basin petroleum system in southeastern Saskatchewan**
- **Alberta Basin petroleum system in west-central Saskatchewan**

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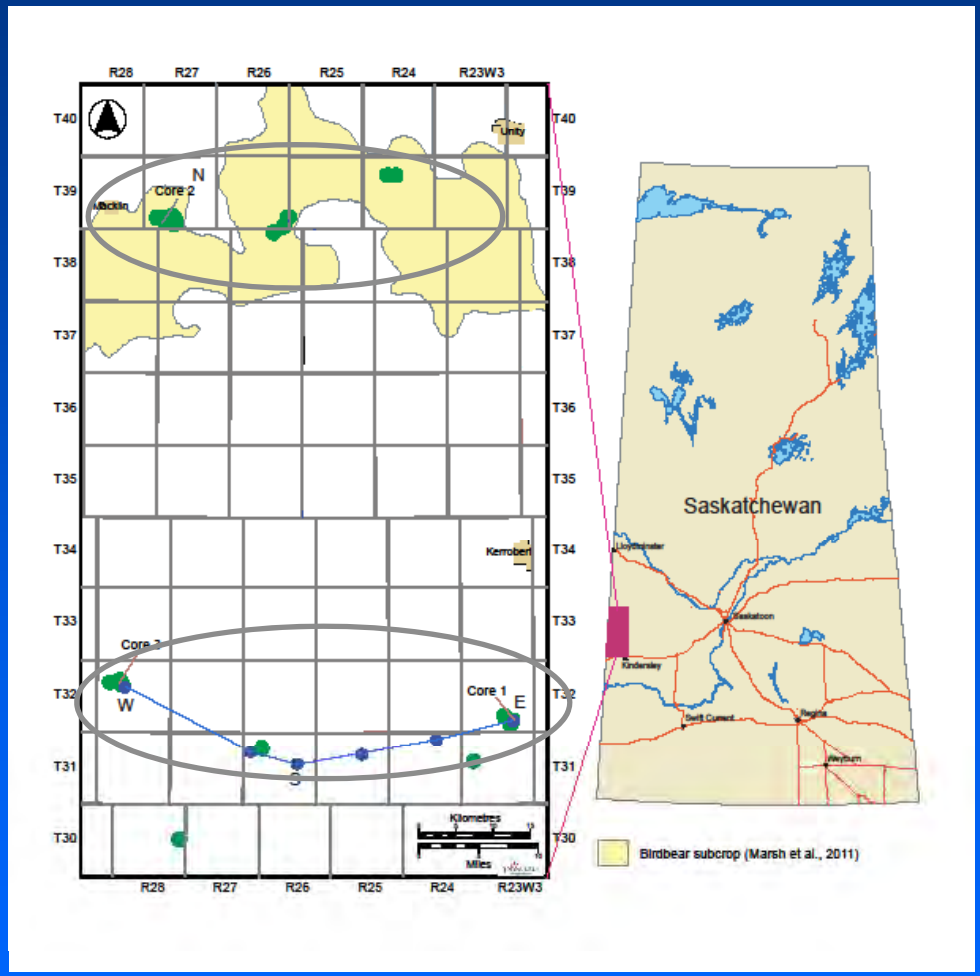
Birdbear Oil Production in West-central Saskatchewan



Depth of Birdbear Production:

- 750m along the subcrop of the Birdbear Fm.
- 960m in northwest of Kindersley (Tp. 30 to 32, Rge. 23W3 to 28W3)

Average density of the oil: 990 kg/m^3 (API ~ 11)

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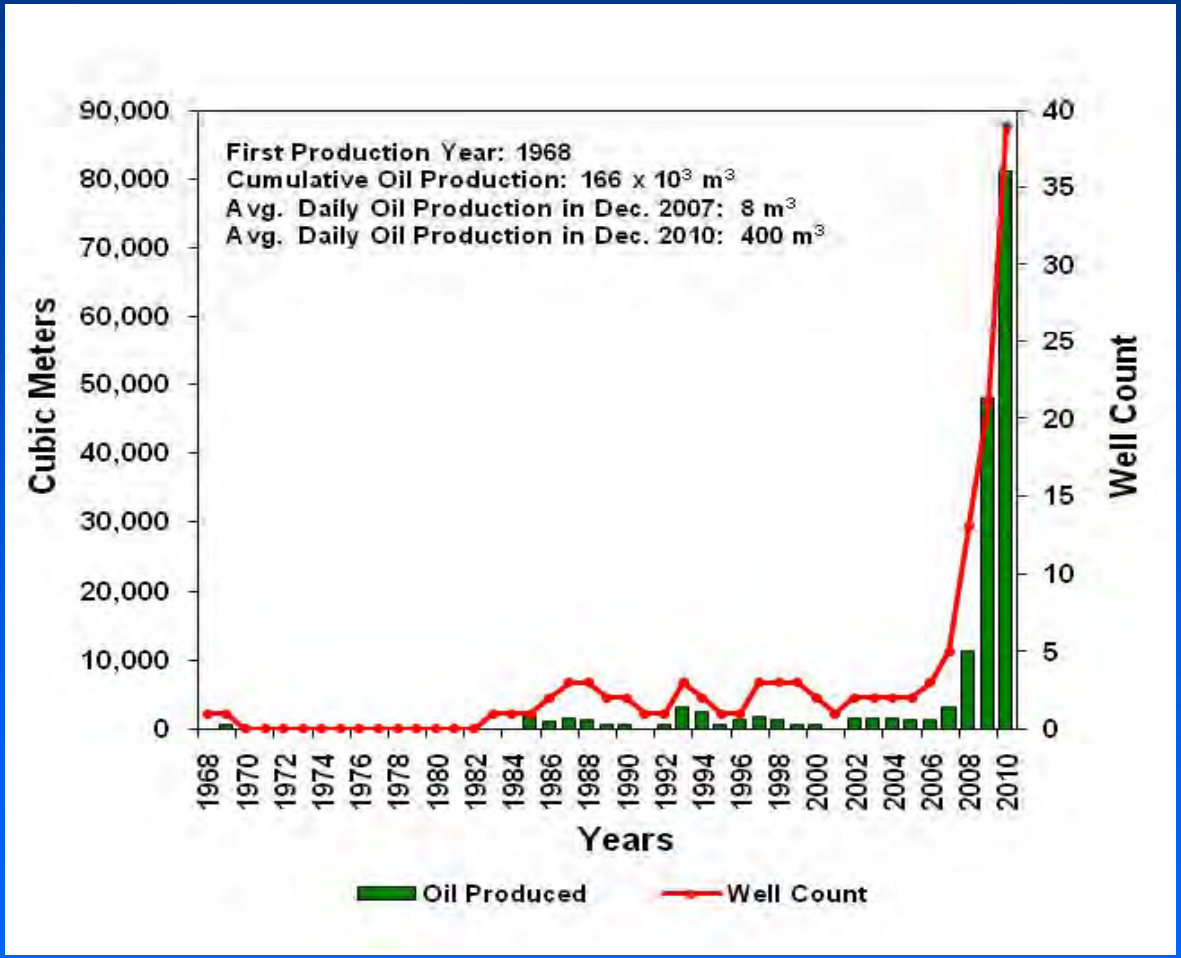
Birdbear Oil Production in West-central Saskatchewan



- 14 vertical production wells in the end of 2007
- 38 horizontal wells drilled since 2008, 35 of them are producing
- Discovered IOP: 2.816 mm^3 (SMER 2008)
- Cum production up to 2010: 0.166 mm^3
- Recovery factor: <6%
- Potential to improve recovery rate by applying advanced technologies and to discover new resources

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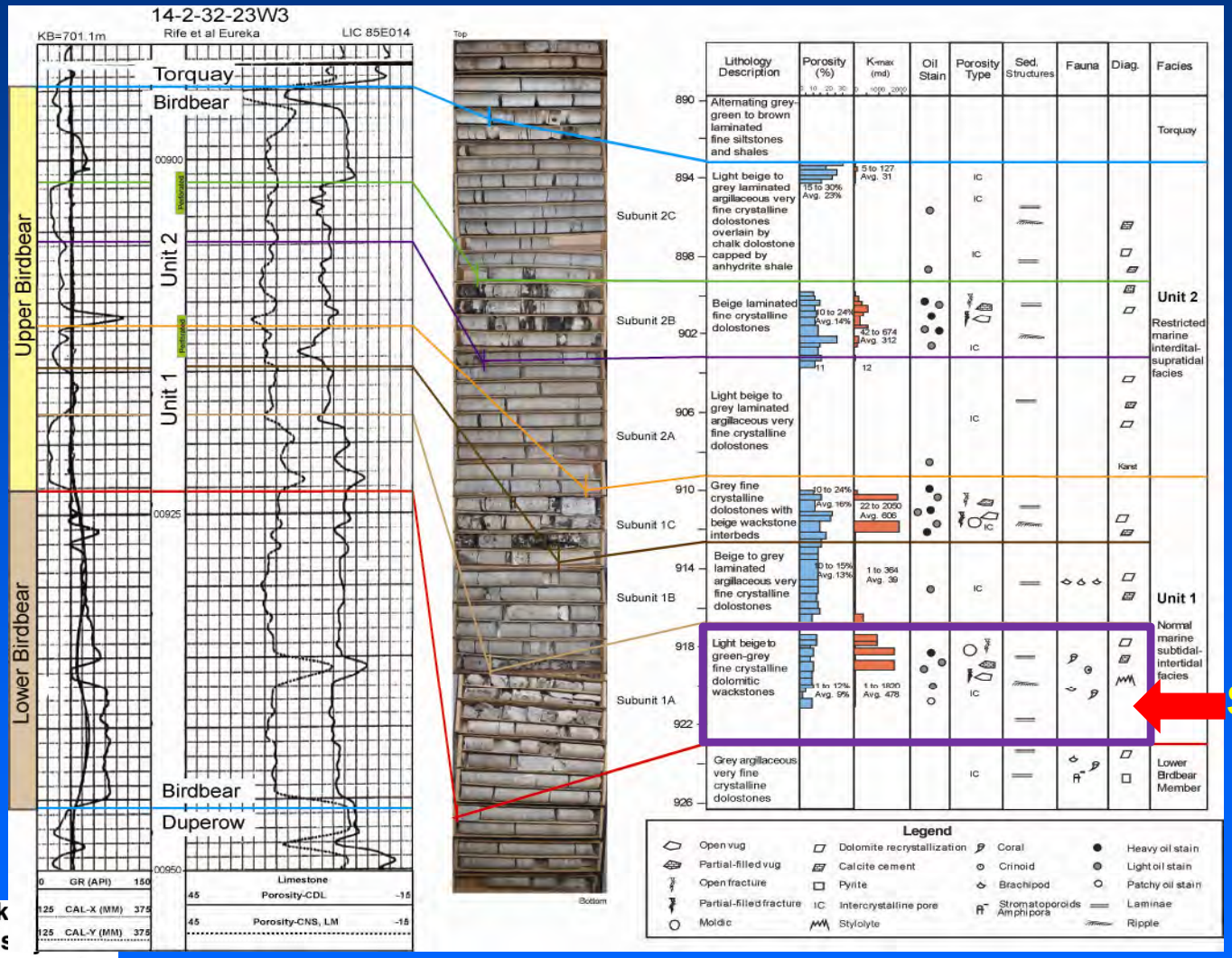
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 1A

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Birdbear Stratigraphy- Subunit 1A

Location **14-02-032-23W3** Depth **923 m**

Location 14-02-032-23W3 Depth 921.1m

Location 14-02-032-23W3 Depth 919 m

- **Porosity: 10%,**
- **Variable max permeability: 1 to 2000 md**
- **Scattered oil stain**

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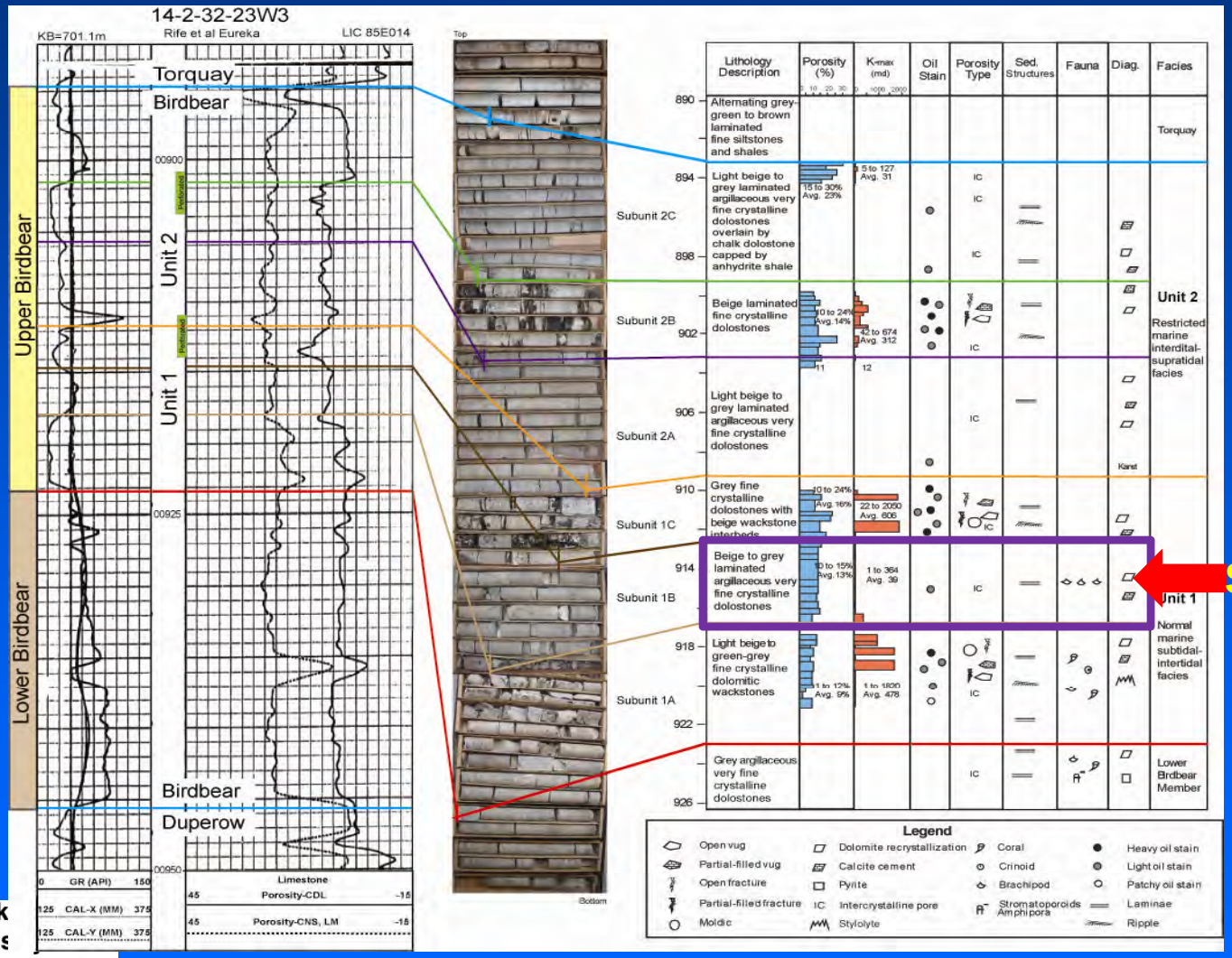
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 1B

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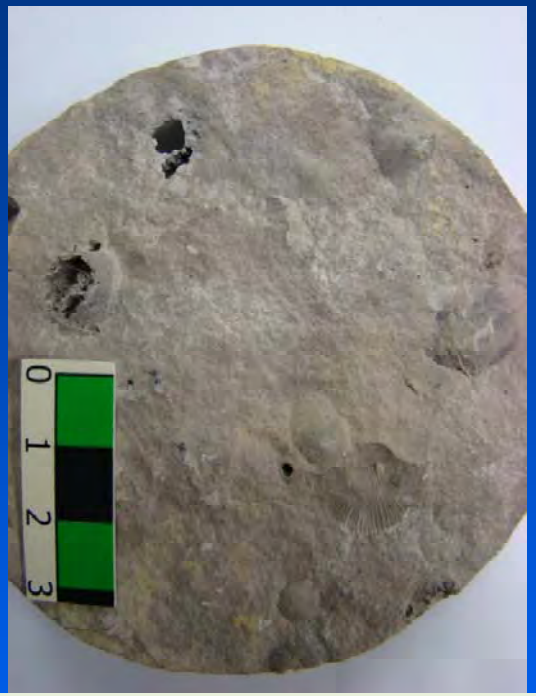
Birdbear Stratigraphy- Subunit 1B

Location **14-02-032-23W3** Depth **912.7m**



Location **14-02-032-23W3** Depth **914.8m**

- **Porosity: 10-15%,**
- **K-max: 1 to 364 md**
- **Little oil stain**

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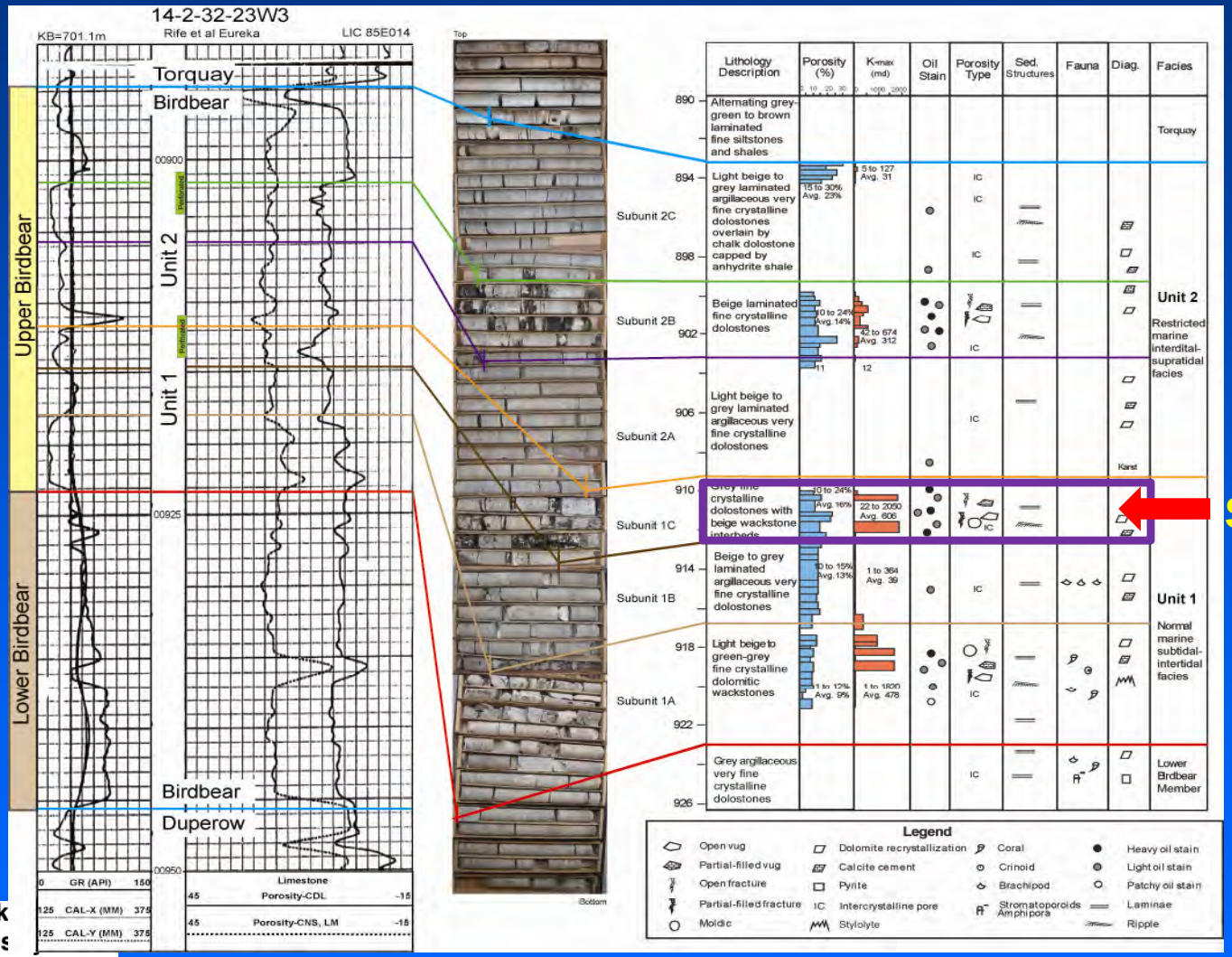
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 1C

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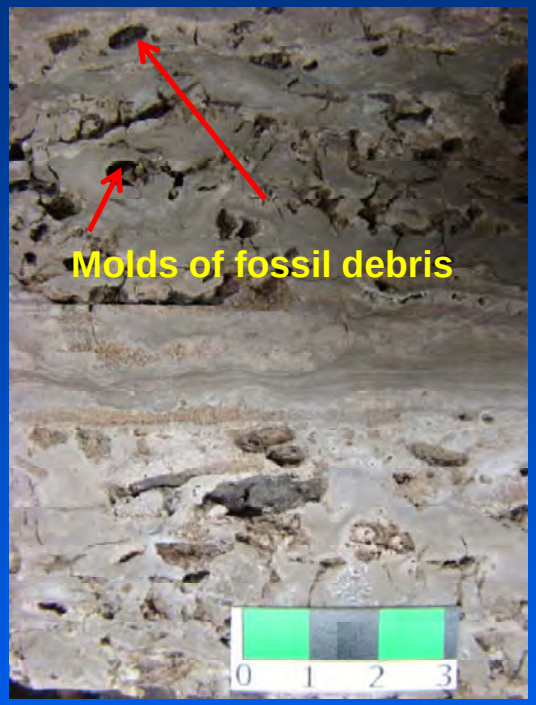
Birdbear Stratigraphy- Subunit 1C



Location 14-02-032-23W3 Depth 910 m

Location 14-02-032-23W3 Depth 911.5m

Location 14-02-032-23W3 Depth 917.8 m

- Fine crystalline dolomitized wackstone interbedded with fine crystalline dolostone
- Porosity type: intercrystalline pore, moldic, dissolution vugs and fractures
- Porosity: 10-24%, avg. 16%
- Variable max permeability: 22 to 2050 md , avg. 606 md
- Intensive heavy oil stain

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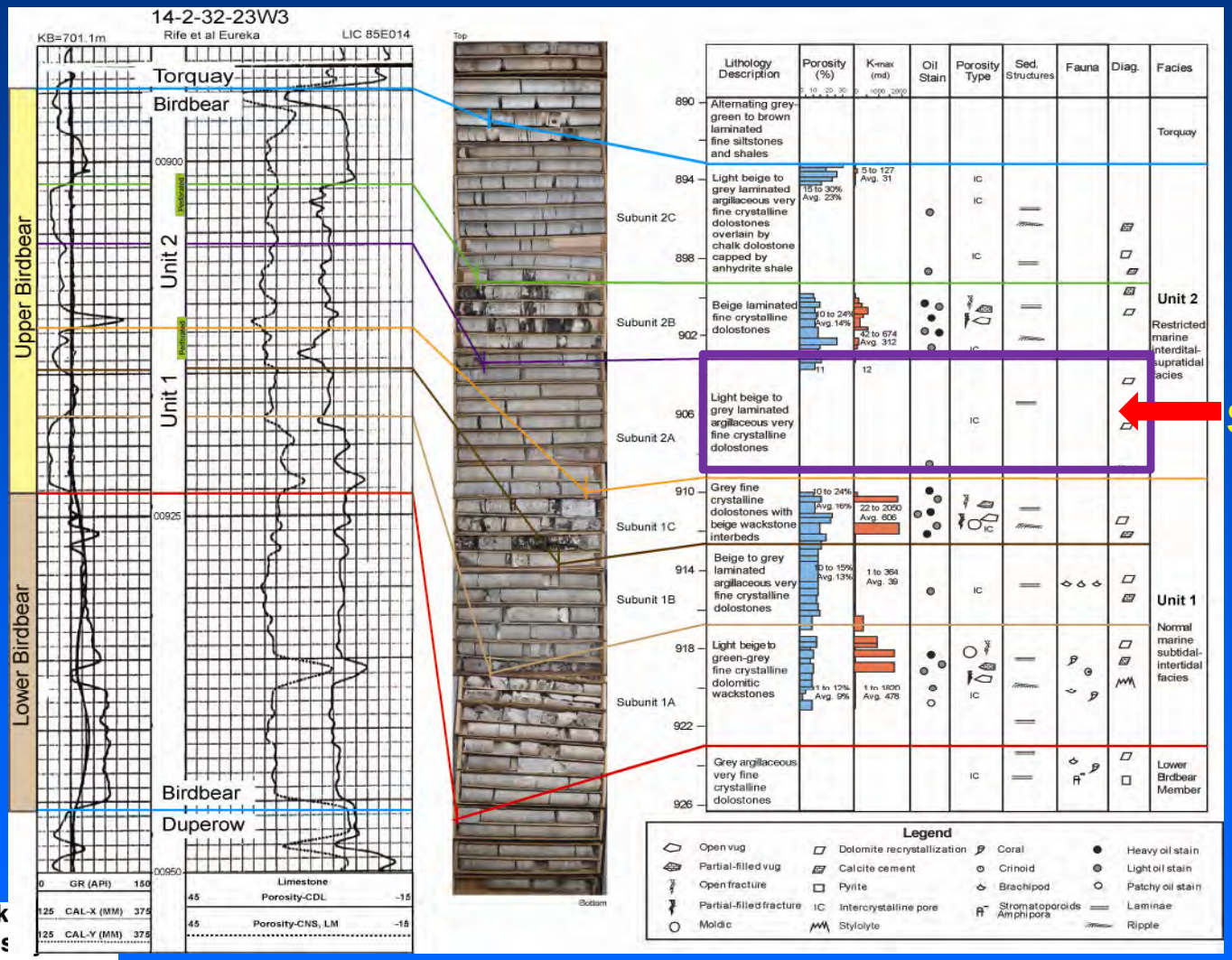
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 2A

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Birdbear Stratigraphy- Subunit 2A

Location 14-02-032-23W3 Depth 903.5 m

Location 14-02-032-23W3 Depth 903.6m

- Porosity: low
- Permeability: low
- No oil stain
- Seal of Subunit 1C

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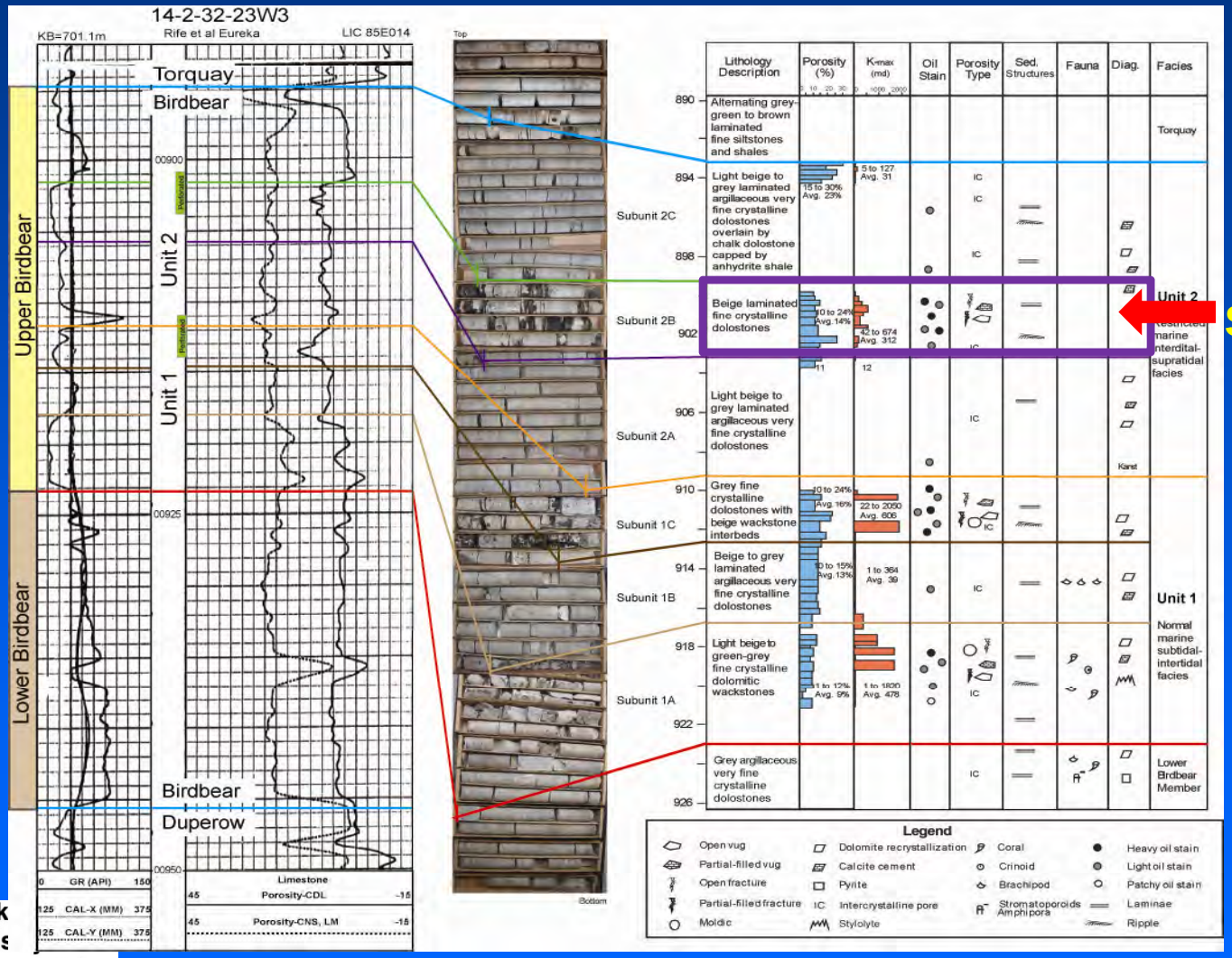
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 2B

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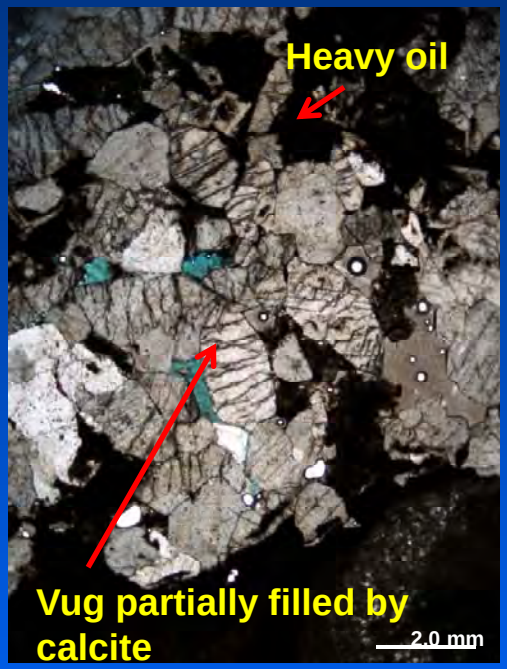
Birdbear Stratigraphy- Subunit 2B

Location 14-02-032-23W3 Depth 900.8 m

Location 14-02-032-23W3 Depth 901.1m



Location 14-02-032-23W3 Depth 902.8 m

- Laminated fine crystalline dolostones
- Porosity type: intercrystalline pores, vugs and fractures
- Porosity: 10-24, avg. 14%
- Variable max permeability: 42 to 674 md, avg. 312 md
- Intensive heavy oil stain

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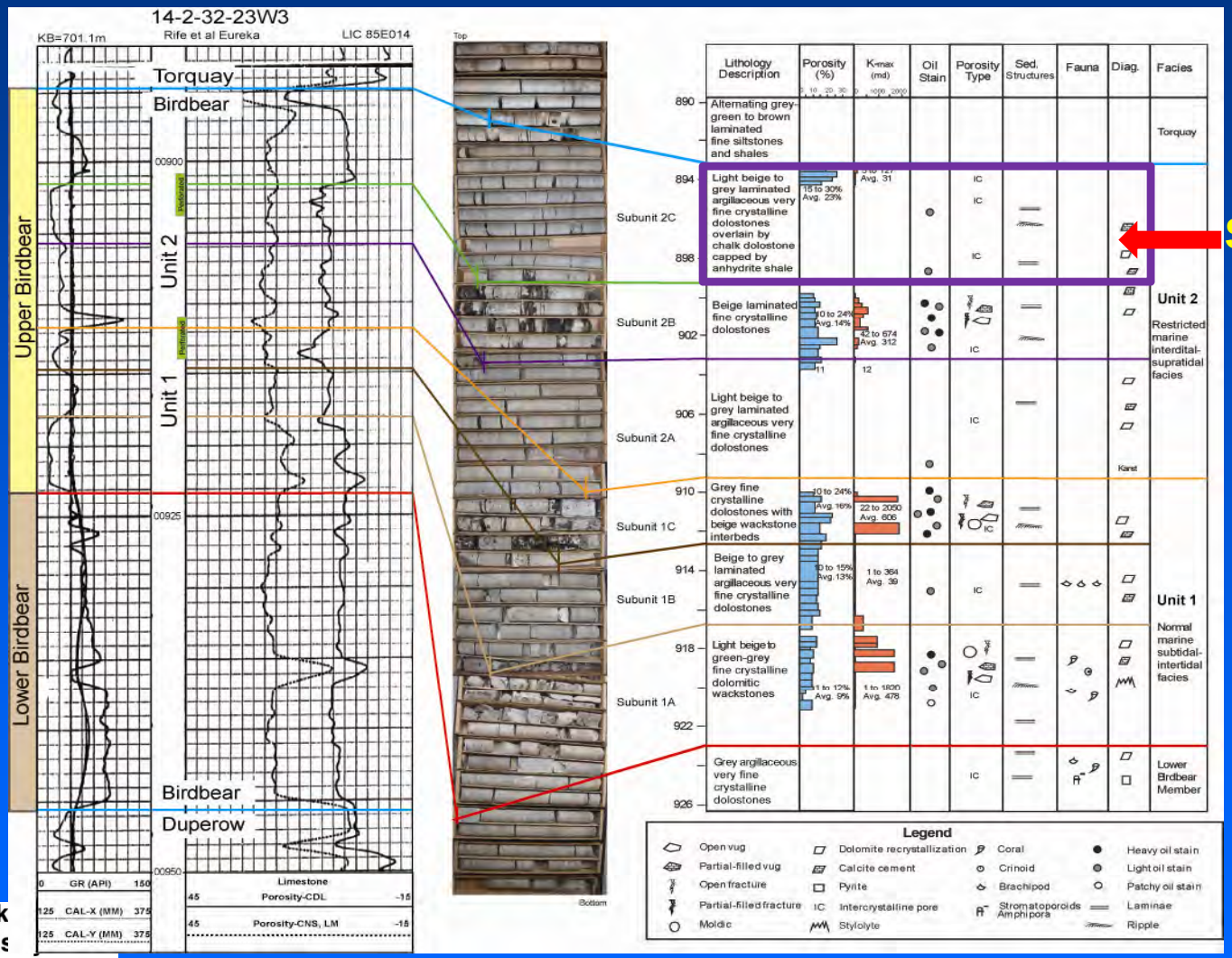
Birdbear Stratigraphy, Lithology and Facies in West-central Saskatchewan



Subunit 2C

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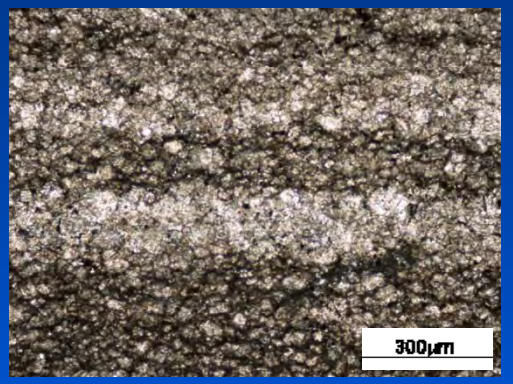
Birdbear Stratigraphy- Subunit 2C

Location 14-02-032-23W3 Depth 896.8 m

Location 14-02-032-23W3 Depth 897.2m



Location 14-02-032-23W3 Depth 898.8 m

- Porosity: low
- Permeability: low
- No oil stain
- Seal of Subunit 2B

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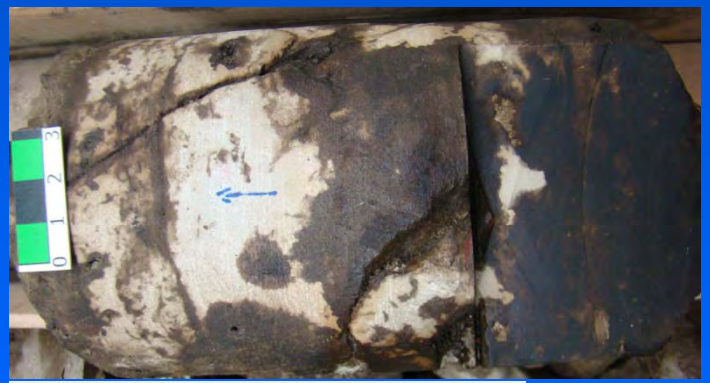
Birdbear Reservoir Characteristics along Subcrop Area in West Central Saskatchewan

Location 12-04-039-27W3 Depth 750.3 m



Location 12-04-039-27W3 Depth 751.6 m

- Burial depth: 750m
- Lithology: fine crystalline dolostone with uniform crystal size, subhedral to euhedral dolomite crystals
- Minerals: 92% dolomite, 3% calcite, 3% clay, 2% quartz
- Porosity type: intercrystalline pores with solution-enhanced vugs and fractures
- Dissolution vugs partially filled by late stage dolomite and calcite
- Good porosity: 15-24%, variable permeability: up to 400md

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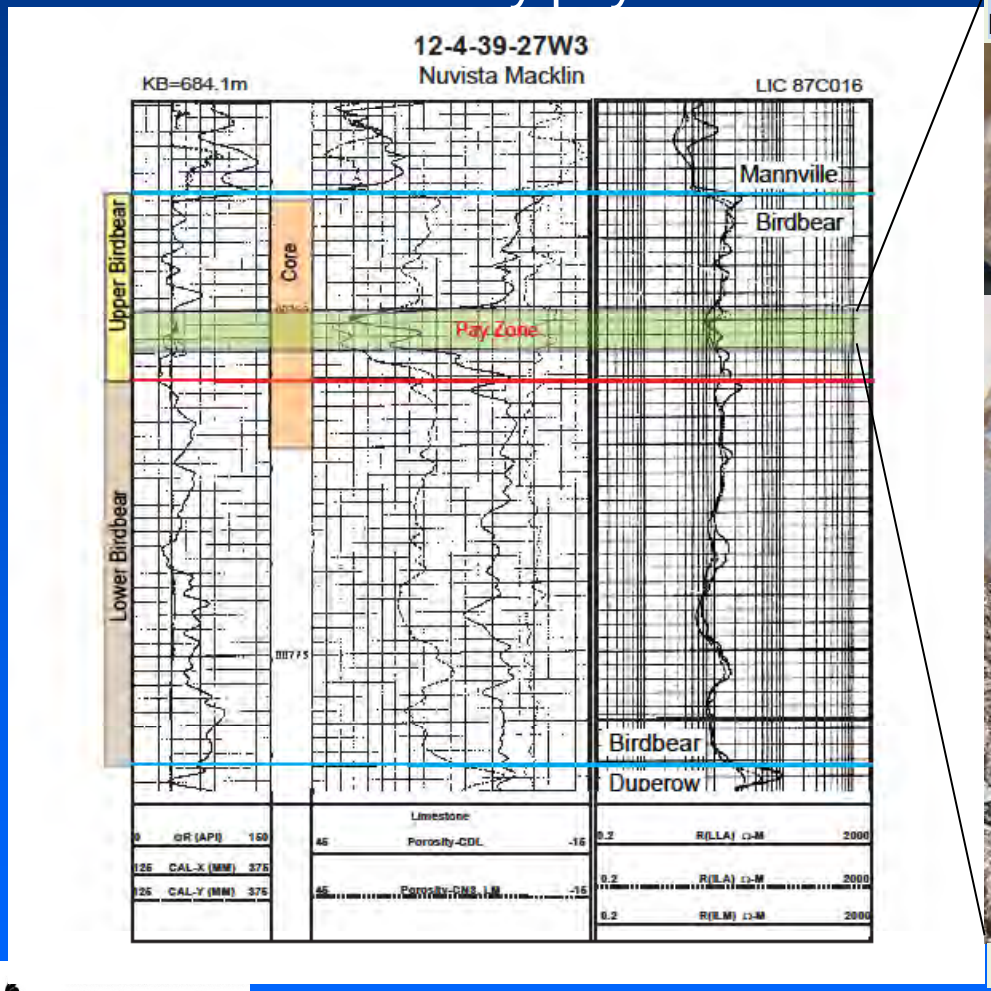
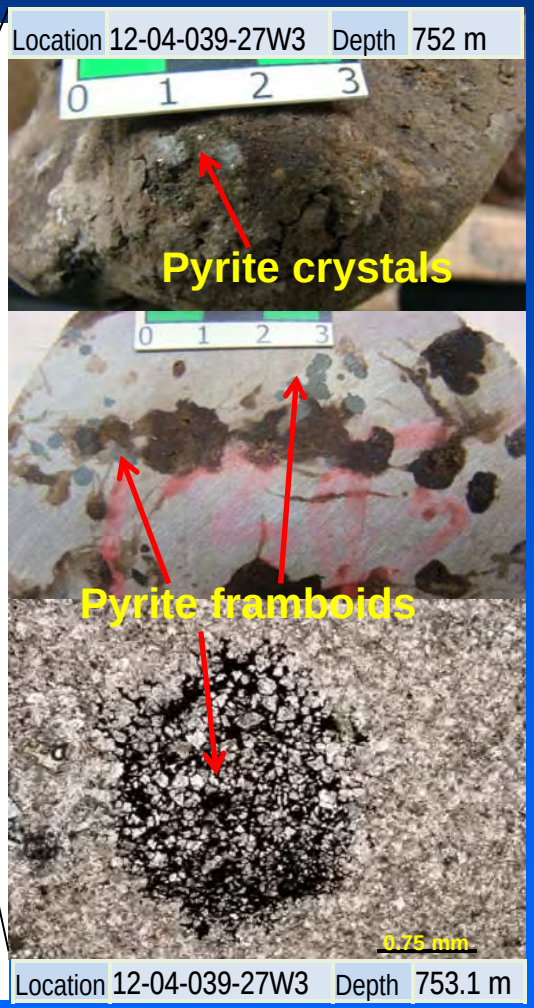
Birdbear Reservoir Characteristics along Subcrop Area in West-central Saskatchewan

Low resistivity pay zone





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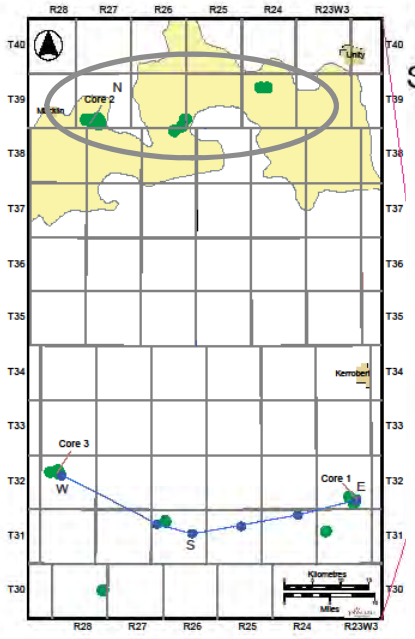
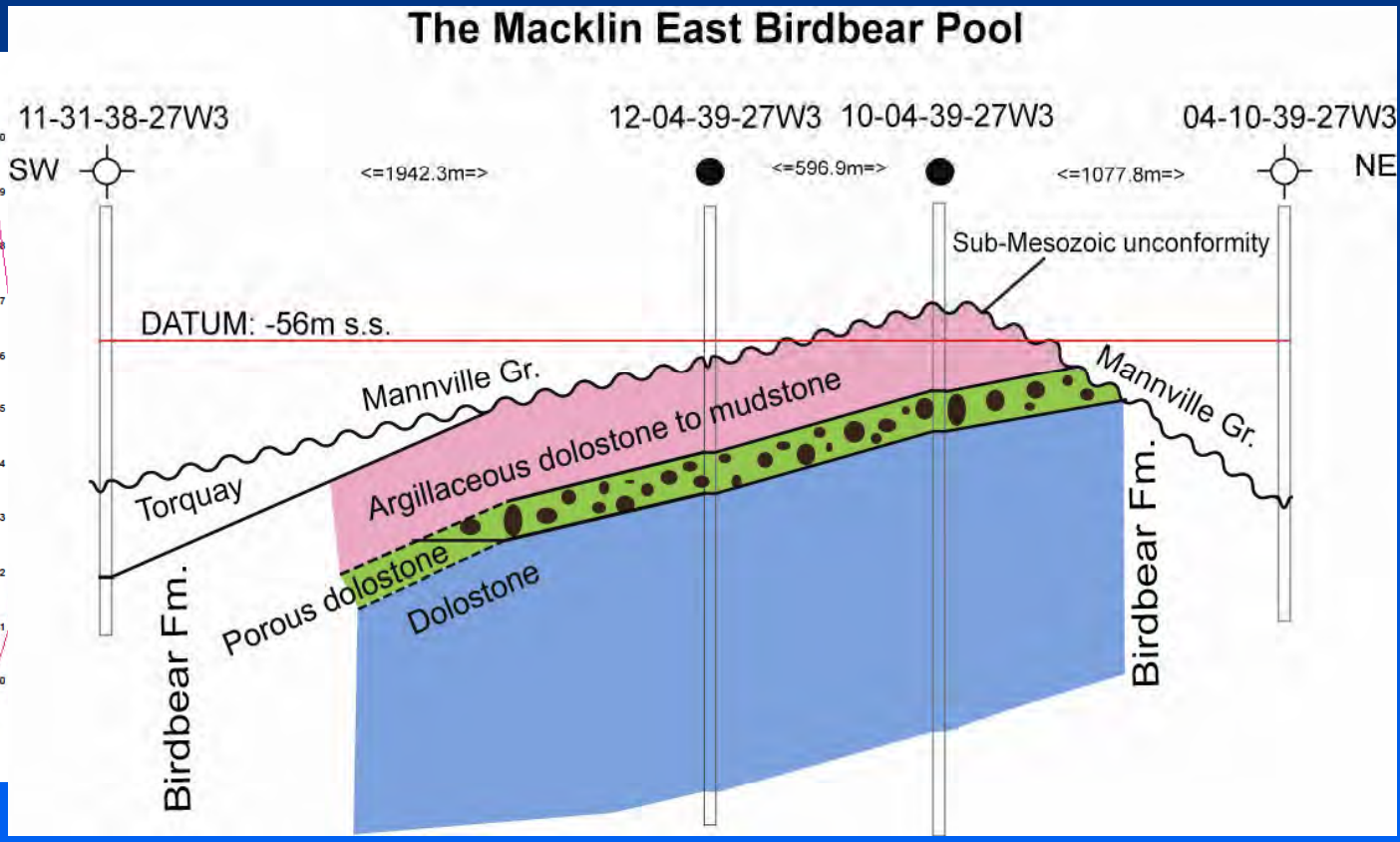
Summary of diagenesis events and their effect on reservoir quality

Major Diagenetic Event	Timing	Effect on Porosity and Permeability
Dolomitization	Shortly after burial	Increase porosity due to formation of intercrystalline pore
Compaction	During burial	Reduce porosity
Dissolution	Pre-Cretaceous uplift and erosion	Increase porosity and permeability due to formation of vugs, fractures, cavities
Dolomite re-crystallization	Re-burial	Decrease porosity and permeability by reducing pore space and blocking throat
Calcite cementation	Re-burial	Decrease porosity and permeability by reducing pore space and blocking throat

Birdbear Trapping Mechanism in West Central Saskatchewan





- Trap at updip escarpment edges formed by pre-Cretaceous erosion
- Reservoir quality enhanced by dissolution during uplift and erosion related to the sub Mesozoic unconformity.

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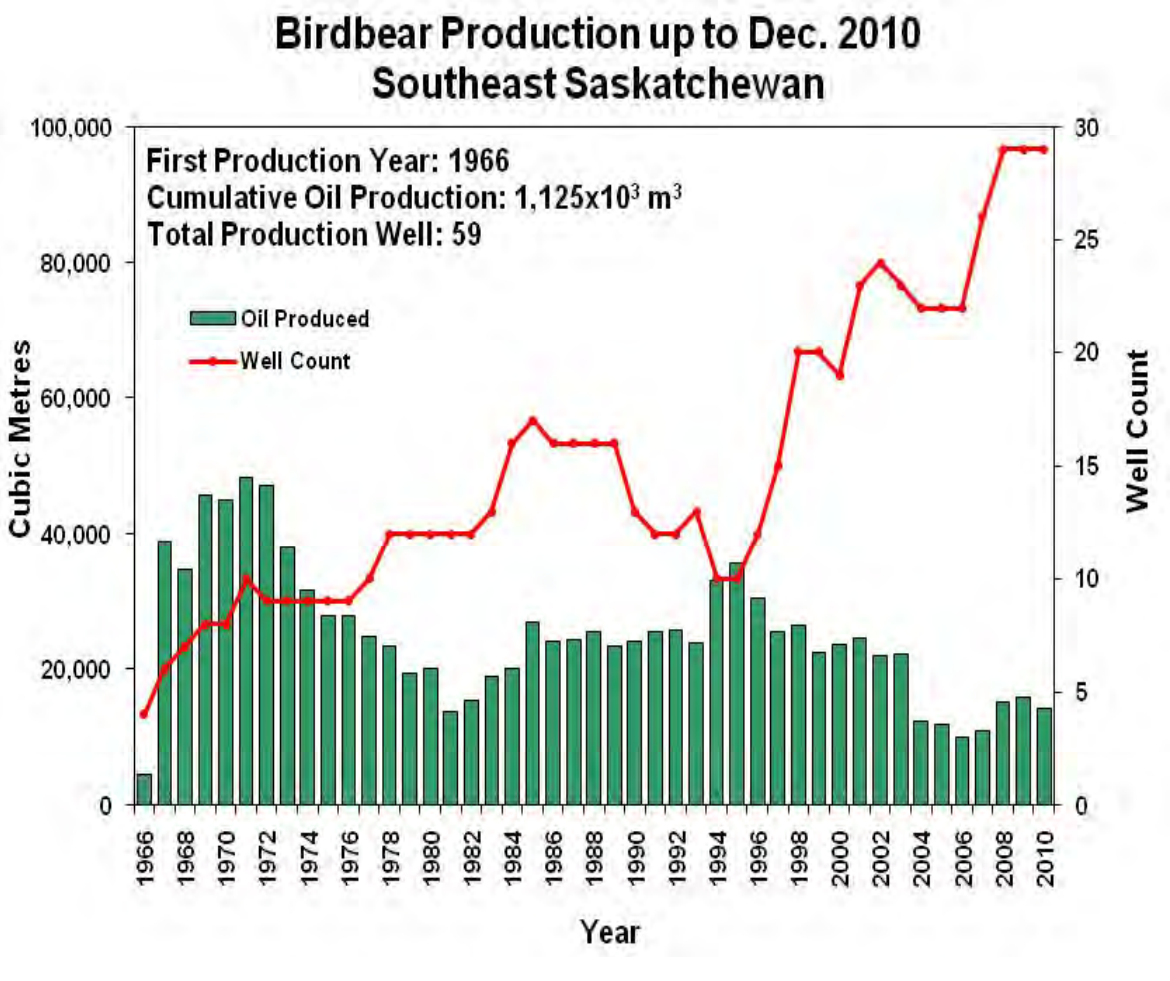
Birdbear Production up to Dec. 2010, Southeastern Saskatchewan



IOP (10^6m^3) (From SMER 2008)	6.921
Cum oil produced up to Dec 2010 (10^6m^3)	1.125
Recovery rate	16%
Well drilled into Birdbear	1789
Well drilled through Birdbear	1445
Well perforated	155
Well produced	59
Success rate	38%
Horizobtal well	13

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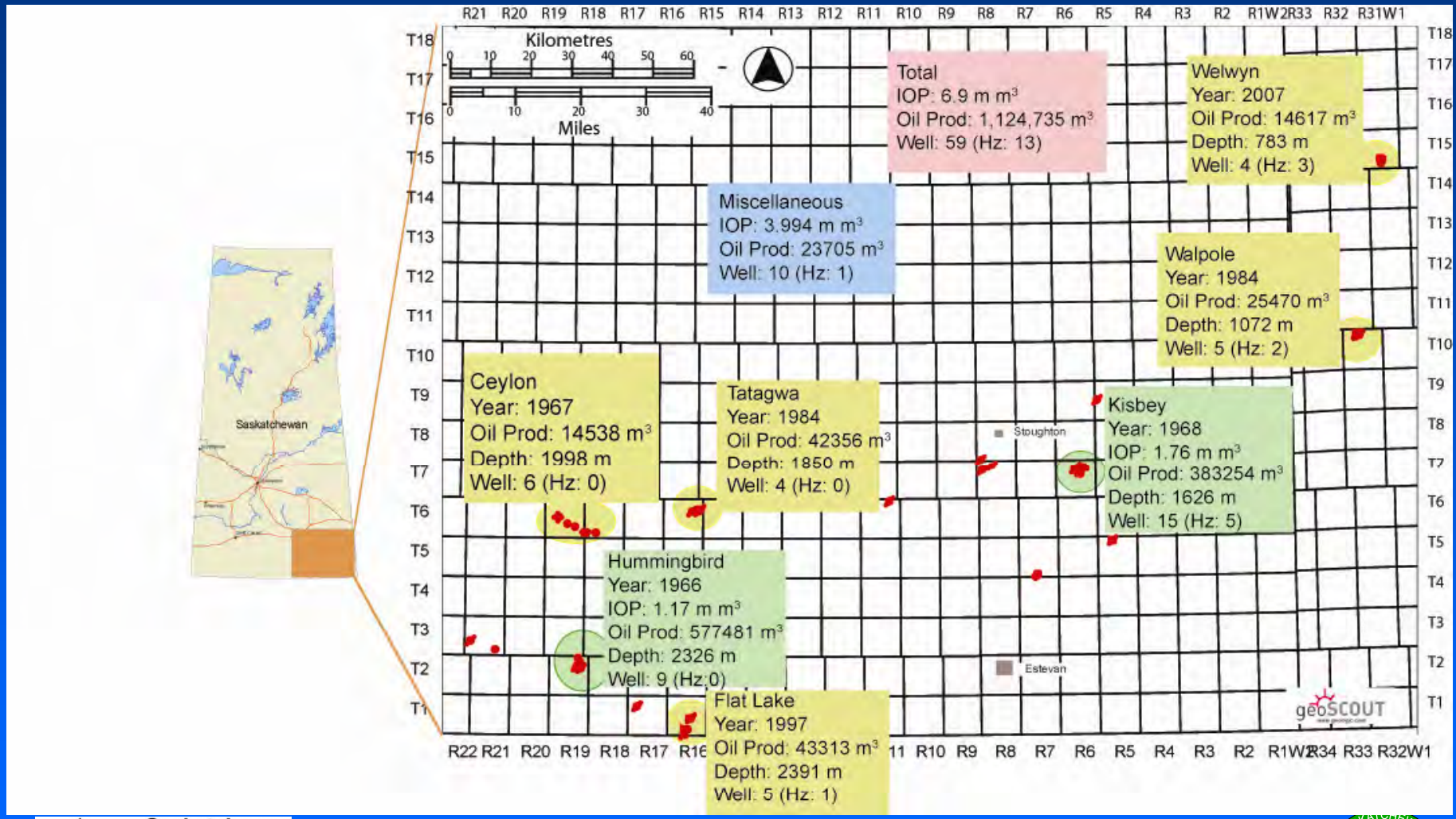
Birdbear Oil Pools in Southeast Saskatchewan



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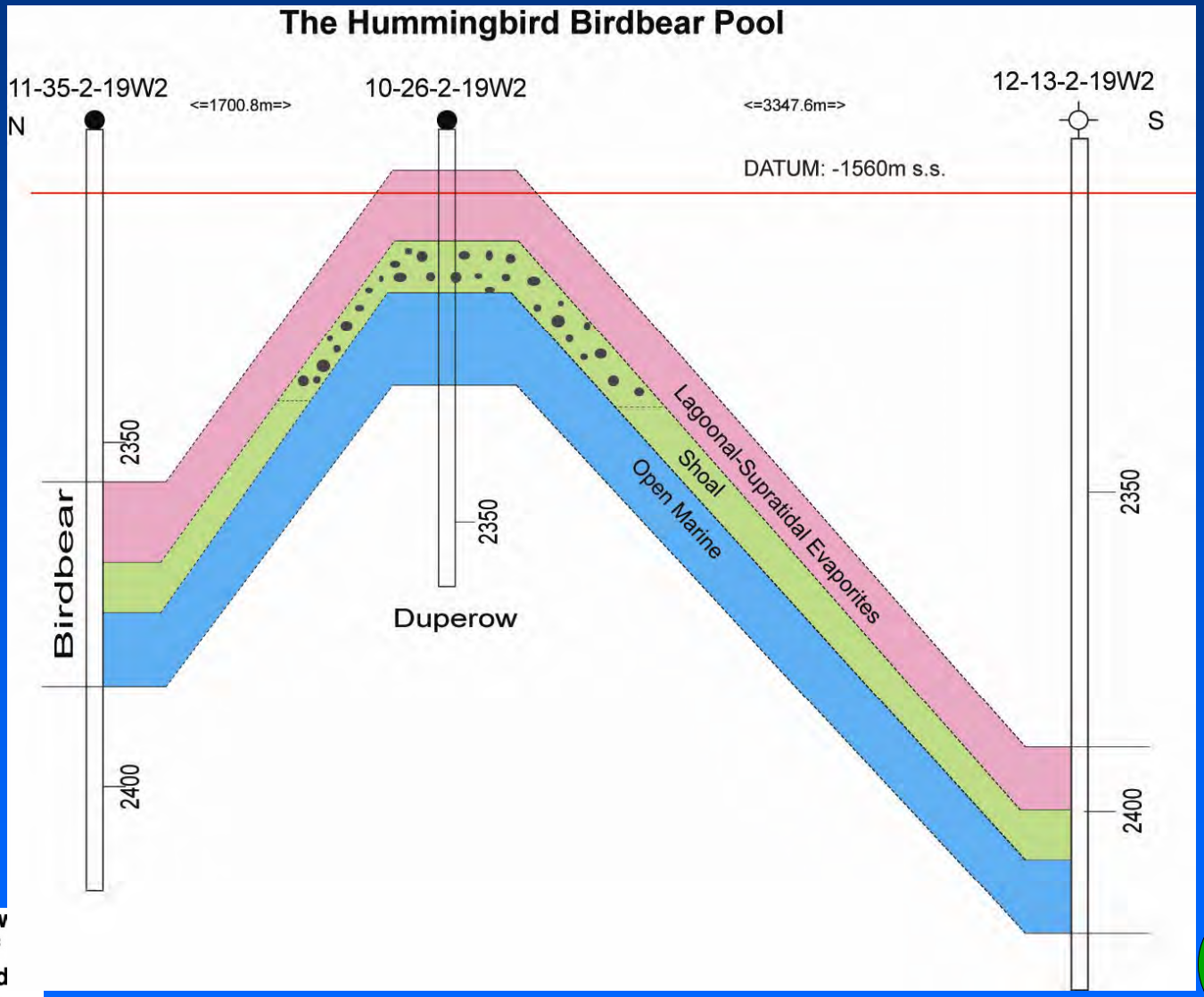
Birdbear Trapping Mechanism in Southeast Saskatchewan



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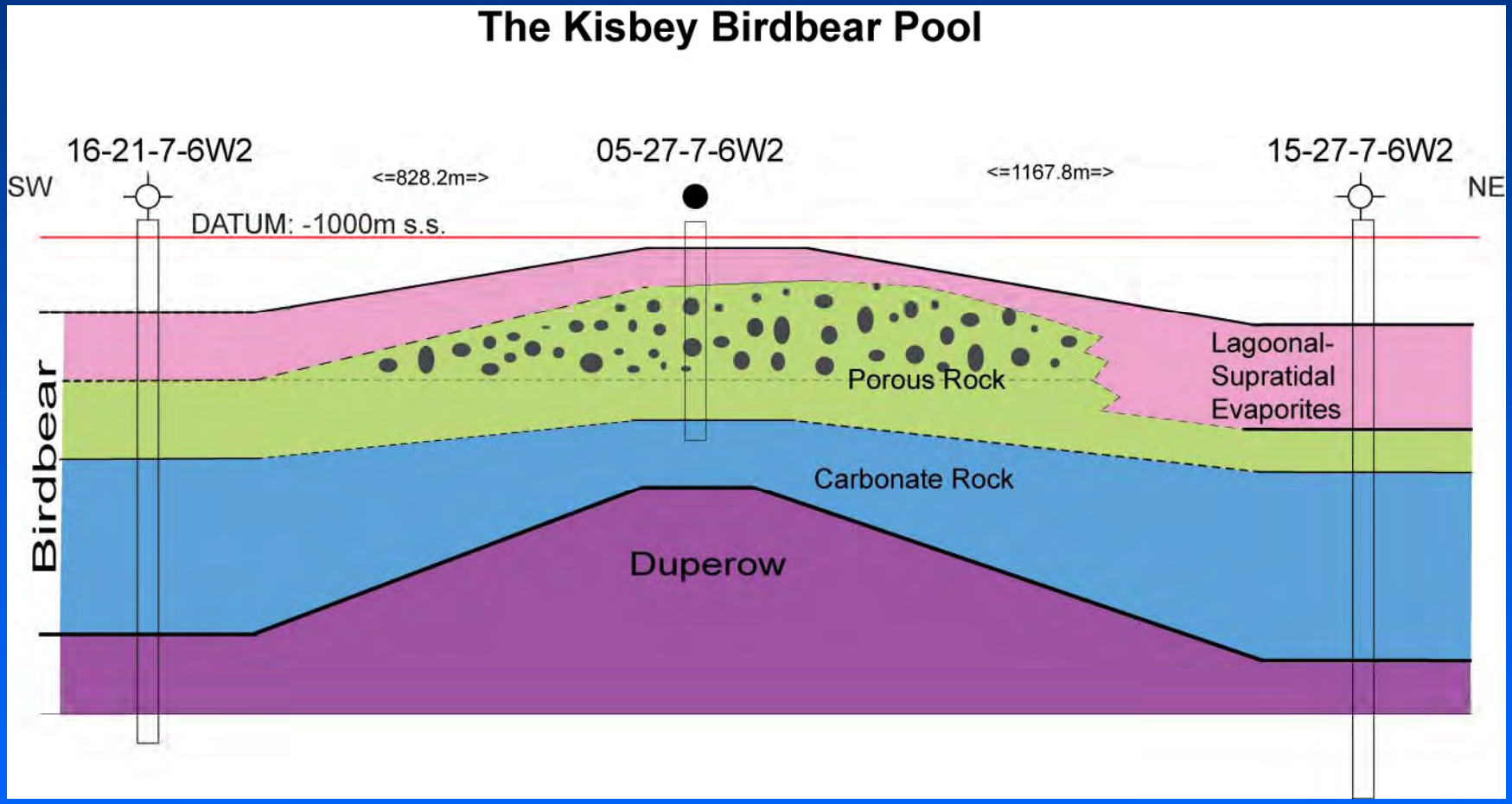
Birdbear Trapping Mechanism in Southeast Saskatchewan



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Summary of the Birdbear Plays in Saskatchewan

	West-Central Saskatchewan	Southeast Saskatchewan
Petroleum system	Eastern edge of Alberta Basin	Williston Basin
Oil quality	Heavy: >980 kg/m^3	Light to medium: <900 kg/m^3
Oil source	Unclear, possible Winterburn Group source rocks in central to southern Alberta	Winnipegosis and partly self-sourced (Fowler et al., 2001)
Traps	Structural highs along the subcrop formed by updip escarpment edges	Structural traps associated with collapse structure, up-dipping closures of non-permeable rock
Reservoir rock	Dolostones with solution enhanced porosity	Limestone to dolostones
Seal	Argillaceous dolostone/mudstone	Anhydrite
Production depth	750 m to 960 m	780 m to 2390 m
Prod/Perf well	53/138: success rate of 38%	59/155: success rate of 38%
Hz well	40	13

Summary: Birdbear Potential in Saskatchewan

Why Birdbear?

- Lower drilling density (horizontal well)
- Lower drilling and completion cost
- Small price gap between heavy and non-heavy oil

Exploration target:

- Stratigraphic trap in Kindersley area and southeast of Saskatchewan
- Structure high along subcrop zone

For more information or questions pertaining to this presentation please contact:

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Detail information are also available from:

Summary of Investigations 2010 at http://www.ir.gov.sk.ca/soi

or

Prospect Saskatchewan at SMER booth

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