

PS Sequence Stratigraphy and Resulting Reservoir and Non-Reservoir Facies Distribution, Upper Devonian Winterburn Group, Nikanassin Range Outcrops, Alberta Canada*

John Weissenberger¹, Pak Wong², and Murray Gilhooly¹

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¹Husky Energy Ltd., Calgary, Alberta (john.weissenberger@huskyenergy.com)

²Consultant, Victoria, British Columbia

Abstract

Upper Devonian (Frasnian) Winterburn Group carbonates, adjacent argillaceous carbonates and shales are exposed in the Front Ranges of the Canadian Rockies along the McConnell thrust fault southwest of the town of Cadomin, Alberta. The outcrops span a transition from shallow water platform carbonates to basin-filling shale and carbonates along the flanks of the Jasper Basin, a significant Frasnian/Famennian-aged basinal embayment within the western portion of the Western Canadian Sedimentary Basin. Over six kilometres of continuous outcrop, on the vertical to sub-vertical walls of three adjoining cirques, allow an understanding of the stratigraphic relationships and facies patterns within and between 3rd order depositional sequences of the late Frasnian Winterburn Group. Detailed section description and tracing of bedding relationships on photomontages define the overall basin-fill pattern in these sequences, with each sequence defined by geometries, stratal stacking and facies patterns.

The studied interval is represented by a succession of 3rd and constituent 4th order sequences recording systematic changes in stratal stacking pattern and resultant depositional styles. From the oldest to the youngest 4th order sequence, the following changes are noted: a) sequence 1 (upper part exposed): progradation, b) sequence 2: aggradation-progradation-downstepping, c) sequence 3: progradation-downstepping-lowstand, d) sequence 4: progradation-lowstand and e) sequence 5: aggradation-progradation-lowstand (?).

Sequences 1 to 4 depict a pattern of decreasing accommodation in the late Frasnian. This is manifested by decreasing aggradation and increasing progradation. The youngest sequences are characterized by no aggradation, limited progradation and well developed lowstand deposits and erosional truncation of foresets. Sequence 5 depicts a turnaround to increasing accommodation as evidenced by an aggradational lower section characterized by patch reef inception. At the Nikanassin Range, a high-resolution sequence stratigraphic framework can be constructed from the excellent exposure, leading to a better understanding of accommodation change in the late Frasnian.

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Pak Wong - Consultant, Victoria, British Columbia;
John Weissenberger and Murray Gilhooly - Husky Energy Ltd., Calgary, Alberta



Abstract

Upper Devonian (Frasnian) Winterburn Group carbonates, adjacent argillaceous carbonates and shales are exposed in the Front Ranges of the Canadian Rockies along the Nikanassin thrust fault southwest of the town of Cadomin, Alberta. The outcrops span a transition from shallow water platform carbonates to basin-filling shale and carbonates along the flanks of the Jasper Basin, a significant Frasnian/Famennian-aged basinal embayment within the western portion of the Western Canadian Sedimentary Basin. Over six kilometres of continuous outcrop, on the vertical to sub-vertical walls of three adjoining cirques, allows an understanding of the stratigraphic stacking relationships and facies patterns within and between 3rd order depositional sequences. This documents the systematic change in accommodation approaching a 2nd order sequence boundary within the latest Frasnian Winterburn Group.

Detailed section description and tracing of bedding relationships with photomontages define the overall basin-fill pattern in these sequences, with each sequence defined by geometries, stratal stacking and facies patterns.

The studied interval is represented by a succession of 3rd and constituent 4th order sequences recording systematic changes in strata stacking pattern and resultant depositional styles. From the oldest to the youngest 3rd order sequence, the following changes are noted: a) WD3 (upper part, basinal environment, exposed along the adjoining cirque walls); progradation, b) W11: lowstand-aggradation-progradation, c) W12: lowstand-progradation-aggradation-downstepping d) W13: lowstand-aggradation-progradation. Sequences WD3 to W13 depict a pattern of decreasing accommodation in the late Frasnian. This is manifested by decreasing aggradation and increasing progradation. The late highstand of the W12 sequence is characterized by an absence of topset deposition and pronounced foreset truncation, culminating in the 2nd order sequence boundary above.

At the Nikanassin Range, a high resolution sequence stratigraphic framework can be constructed from the excellent exposure, leading to a better understanding of accommodation change in the late Frasnian.

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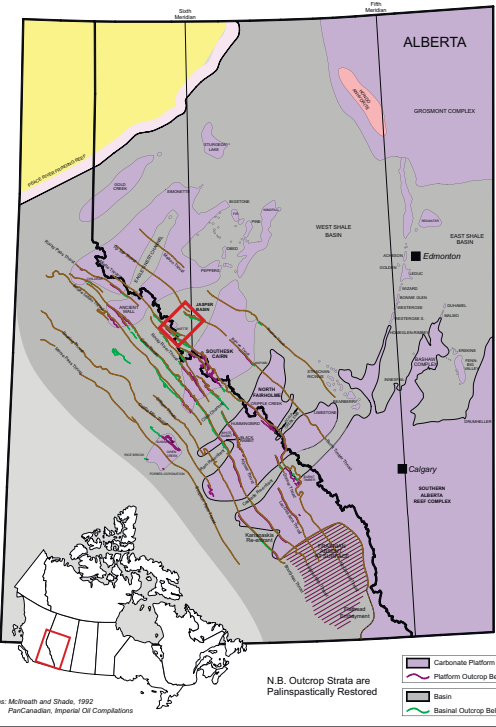
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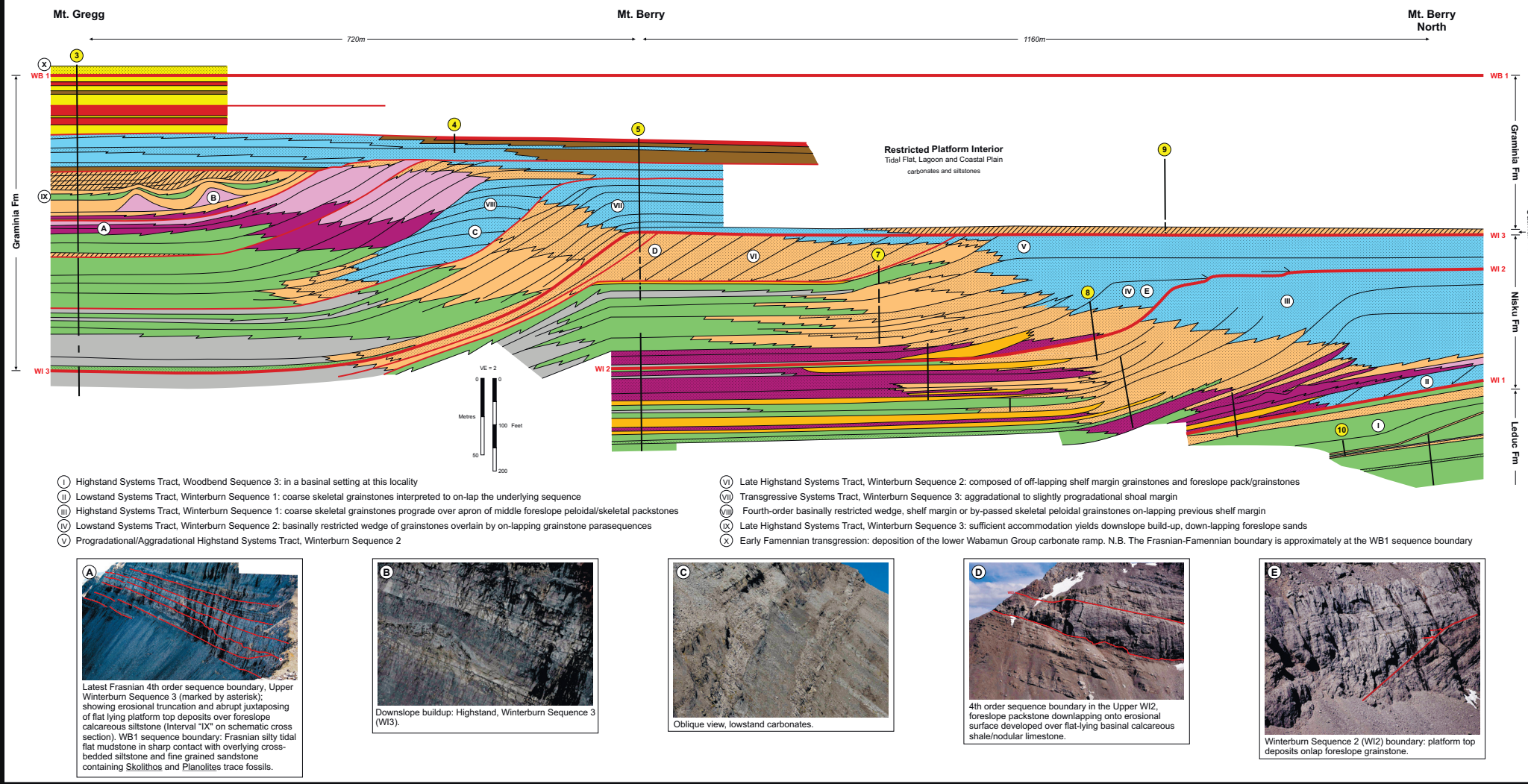
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Woodbend Group Shale/Reef Paleogeography, Alberta



Late Frasnian Sequence Stratigraphy, Jasper Basin, West-Central Alberta Rocky Mountains



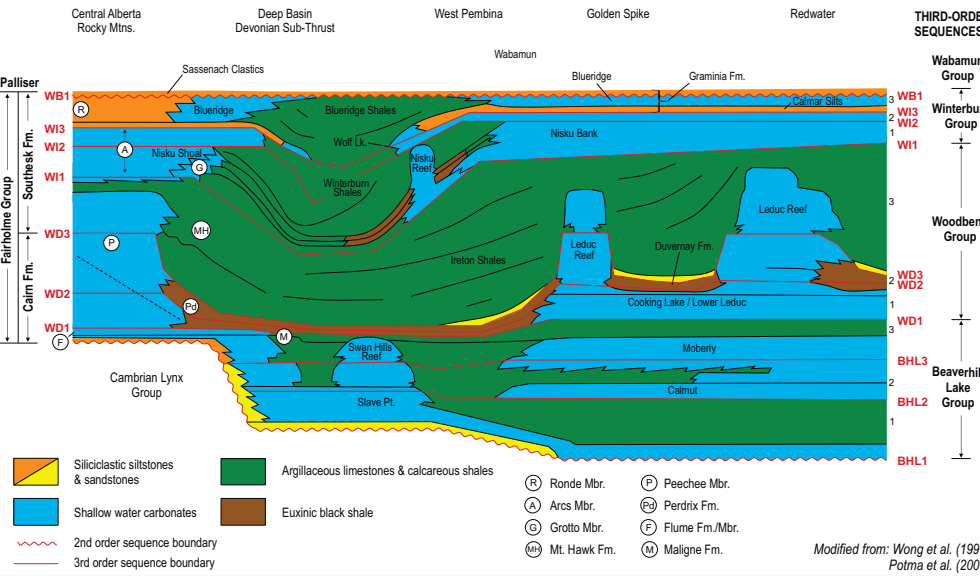
Depositional Environment: Facies

1	1C	Siliciclastic Lagoon: Silty dolomud to packstone (1) Dolomitic siltstone to sandstone (1C)
1A		Restricted Lagoon: Silty, burrowed dolopackstone and dolomudstone
2		Tidal Flat: Dolomud-packstone, fenestral to cryptalgal
3		Semi-Restricted Lagoon: Burrowed dolomud-packstone, common <i>Amphipora</i>
4		Open Lagoon: Bulbous stromatoporeid/ <i>Amphipora</i> dolowackestone to packstone. Rare corals
5	5A	Upper Foreslope (Reef Margin Reef Flat): Thick tabular to hemispherical stromatoporeid doloboundstone and dolograins (5) Skeletal dolograins (5A)
6	6A 6B	Foreslope Sands: Dolopackstone (6) Dolograins to dolopackstone (6A) Burrowed calcareous siltstone (6B)
7	7A	Middle Foreslope: Tabular and branching stromatoporeid and branching coral doloboundstone and dolopackstone to dolowackestone (7) Oncoïd and crinoid dolopackstone to dolowackestone (7A)
8	8A	Lower Foreslope: Wafer stromatoporeid and branching coral doloboundstone to dolowackestone, with crinoids & rugose corals (8) Medium to thin bedded limemudstone to wackestone (8A)
9	9A	Basin: Grey nodular to nodular bedded wackestone and limemudstone (9) Green argillaceous nodular to nodular bedded wackestone and limemudstone (9A)
10		Shale and calcareous shale
11		Intraclast rudstone / packstone

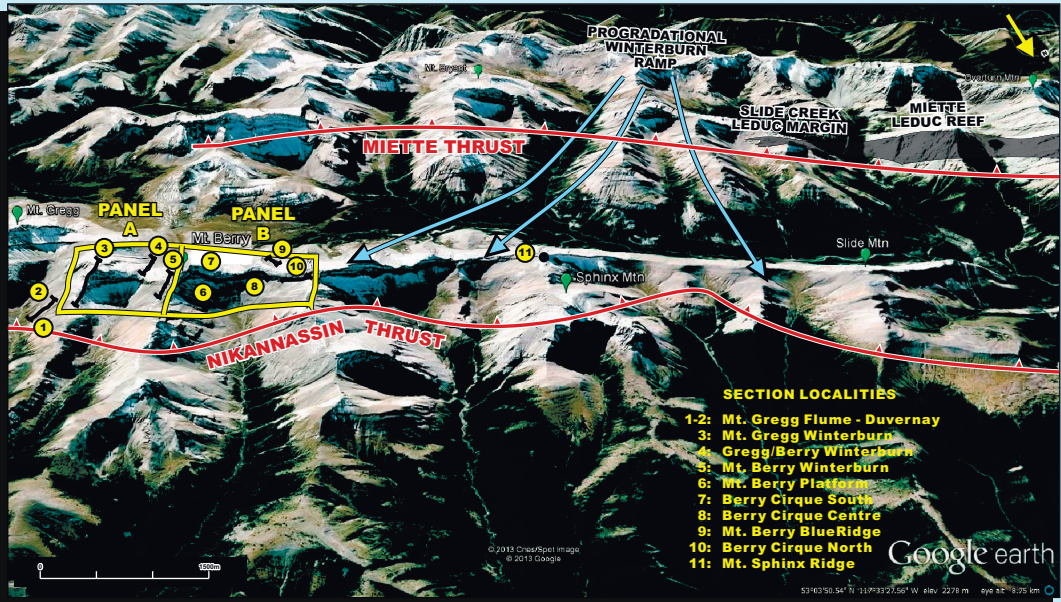
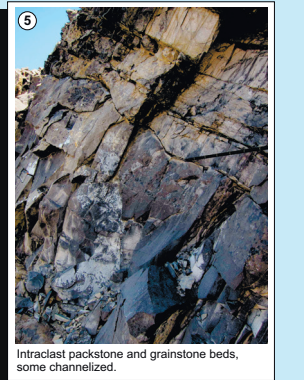
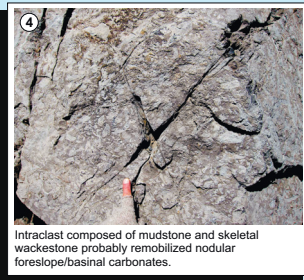
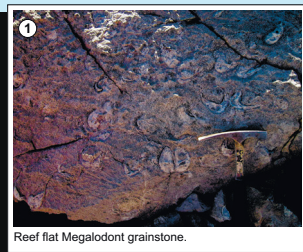
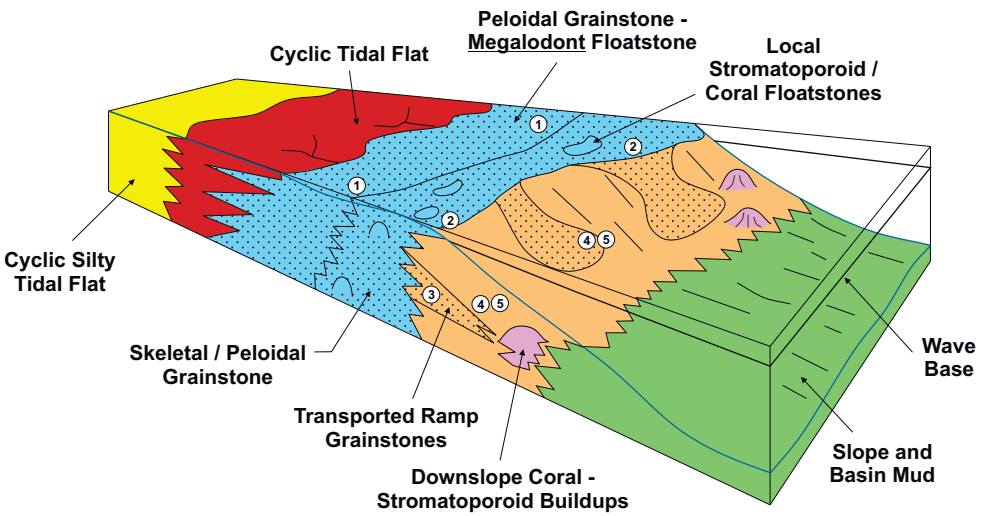
— 4th Order Sequence Boundary
— 3rd Order Sequence Boundary

— Fault
— Section Measured

Schematic Sequence Stratigraphy, Upper Devonian, Central Alberta



Winterburn Environment of Deposition Model



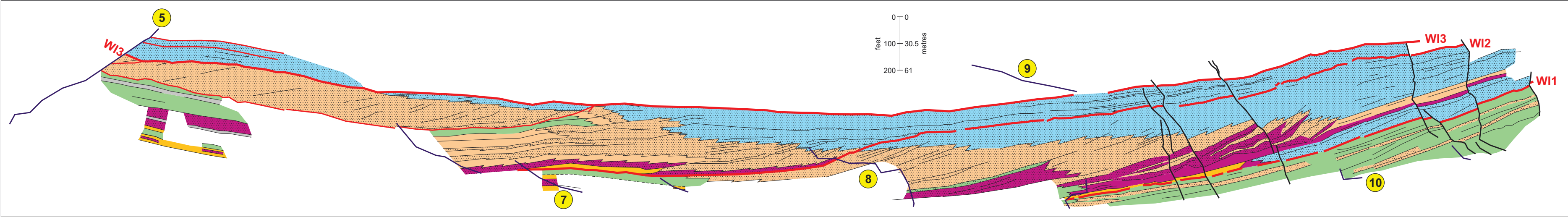
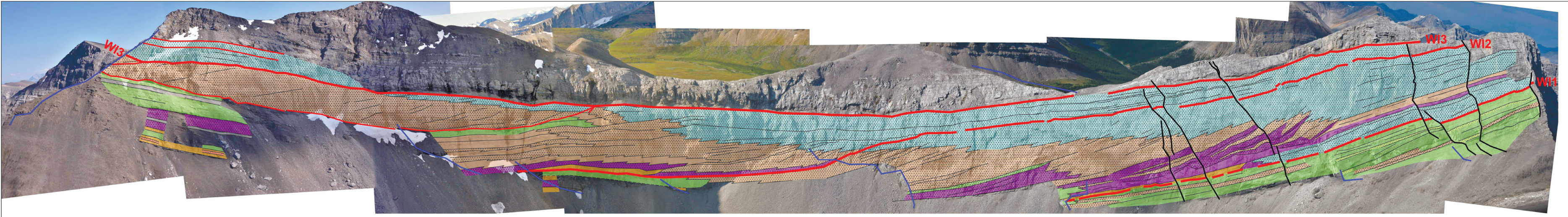
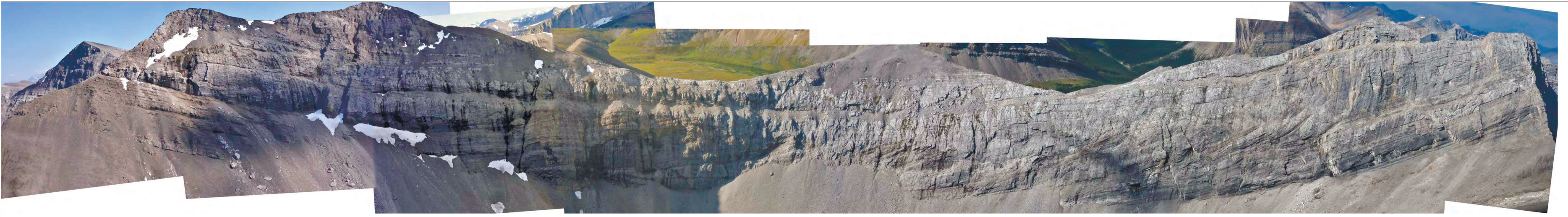
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Mt. Berry

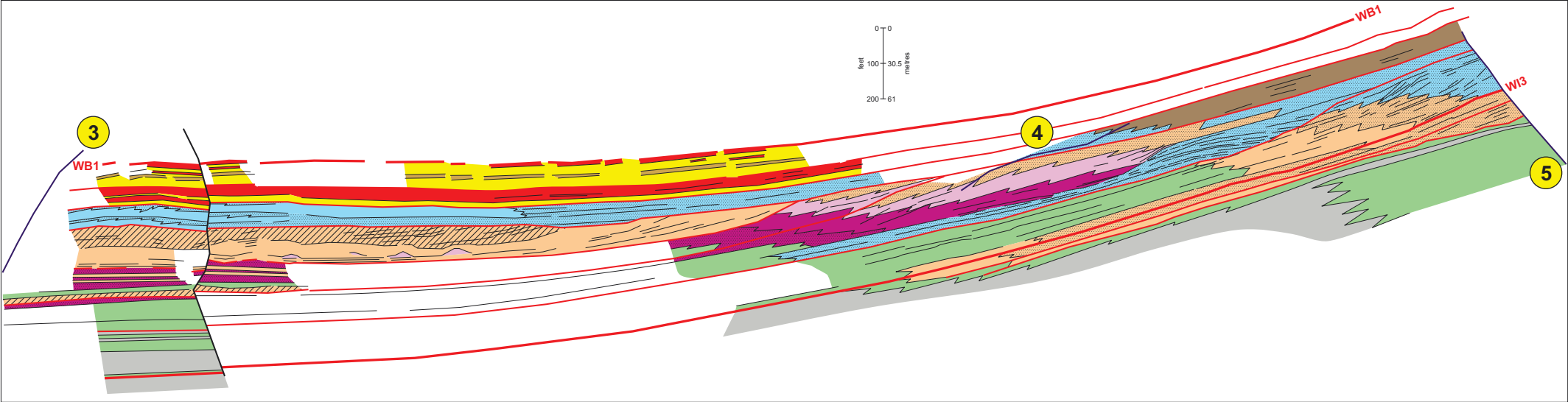
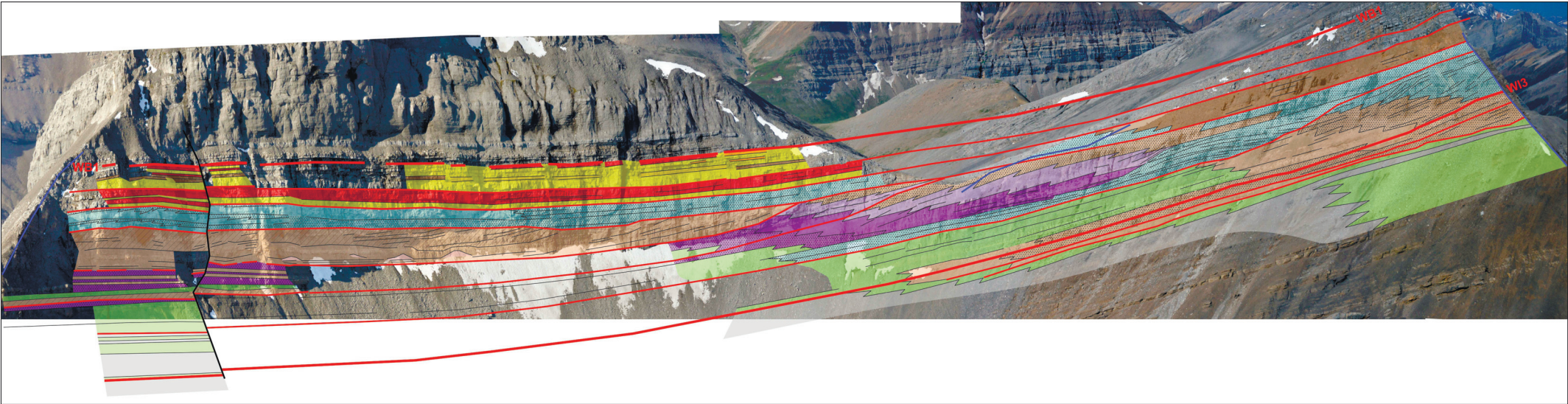
Panel B



Depositional Environment: Facies	
1	Siliciclastic Lagoon: Silty dolomud to packstone (1) Dolomitic siltstone to sandstone (1C)
1A	Restricted Lagoon: Silty, burrowed dolopackstone and dolomudstone
2	Tidal Flat: Dolomud-packstone, fenestral to cryptalgal
3	Semi-Restricted Lagoon: Burrowed dolomud-packstone, common <i>Amphipora</i>
4	Open Lagoon: Bulbous stromatoporoid/ <i>Amphipora</i> dolowackestone to packstone. Rare corals
5	Upper Foreslope (Reef Margin Reef Flat): Thick tabular to hemispherical stromatoporoid doloboundstone and dolograins (5) Skeletal dolograins (5A)
6	Foreslope Sands: Dolopackstone (6) Dolograins to dolopackstone (6A) Burrowed calcareous siltstone (6B)
7	Middle Foreslope: Tabular and branching stromatoporoid and branching coral doloboundstone and dolopackstone to dolowackestone (7) Oncoïd and crinoid dolopackstone to dolowackestone (7A)
8	Lower Foreslope: Wafer stromatoporoid and branching coral doloboundstone to dolowackestone, with crinoids & rugose corals (8) Medium to thin bedded limemudstone to wackestone (8A)
9	Basin: Grey nodular to nodular bedded wackestone and limemudstone (9) Green argillaceous nodular to nodular bedded wackestone and limemudstone (9A)
10	Shale and calcareous shale
11	Intraclast rudstone / packstone
<div><div></div>4th Order Sequence Boundary</div> <div><div></div>3rd Order Sequence Boundary</div> <div><div></div>Fault</div> <div><div></div>Section Measured</div>	

Panel A


Mt. Berry




Depositional Environment: Facies

- | | | |
|----|-------|--|
| 1 | 1C | Siliciclastic Lagoon:
Silty dolomud to packstone (1)
Dolomitic siltstone to sandstone (1C) |
| 1A | | Restricted Lagoon:
Silty, burrowed dolopackstone and dolomudstone |
| 2 | | Tidal Flat:
Dolomud-packstone, fenestral to cryptalgal |
| 3 | | Semi-Restricted Lagoon:
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Skeletal dolograinstone (5A) |
| 6 | 6A 6B | Foreslope Sands:
Dolopackstone (6)
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Wafer stromatoporoid and branching coral doloboundstone to dolowackestone, with crinoids & rugose corals (8)
Medium to thin bedded limemudstone to wackestone (8A) |
| 9 | 9A | Basin:
Grey nodular to nodular bedded wackestone and limemudstone (9)
Green argillaceous nodular to nodular bedded wackestone and limemudstone (9A) |
| 10 | | Shale and calcareous shale |
| 11 | | Intraclast rudstone / packstone |
- 4th Order Sequence Boundary

— 3rd Order Sequence Boundary

 Fault

 Section Measured