

# **Alternating Currents: When Braided Channels Go Snaky\***

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## **Abstract**

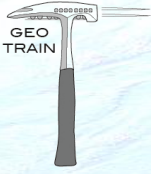
Numerous articles have been published on the characteristics of braided and meandering channels. Sections exposed in Dinosaur Provincial Park and at Sandy Point, both provincial parks within Alberta, show the transition from the braided channels of the underlying Oldman Formation into the meandering channels of the overlying Dinosaur Park Formation, both Campanian in age. Detailed fieldwork at those localities, comprising numerous logged sections, have been used to build up a three dimensional picture of what happens at this transition. Several striking geological features can be directly tied to events across this boundary. The succession begins with the Comrey Sandstone, made up of several laterally extensive braided river sand bodies. Overlying this is a succession of floodplain mudstone beds, capped by a striking orange sandstone with common unionid fugichnia and extraformational clasts, in contrast to the rest of the Oldman Formation. This is overlain by further orange coloured, dipping siltstones and mudstones interpreted as lateral accretion surfaces (LAS). The contact to the overlying Dinosaur Park Formation is marked by a change to bentonitic flood plain sediments, common palaeosols and cream coloured fine-grained sandstone beds representing meandering channels. This contact lies a further metre above the orange LAS, showing that the transition from braided to meandering deposits is initiated some way below the Formation boundary. Lateral changes in the character of this transition will be discussed, as well as the orientation of the orange LAS (point bar) deposits. A model will be presented that explains all of the sedimentological data over this interval.

Additional analytical work has been undertaken on the modern day Bow and Missouri rivers. These are considered representative of rivers in temperate North America. The Bow River (and downstream the South Saskatchewan River) is considered as a type example of a braided river, yet both rivers are clearly hybrid, with characteristics of both meandering and braided rivers, often within the same reach. In the Calgary area, the downtown area and several suburbs adjacent to the river inhabit point bars, while the river exhibits many braid bars as it flows through the city. The Missouri River, examined in the area around Great Falls, Montana, is similarly a “hybrid” river. The implications of these observations for the transition described above will also be discussed.

### **References Cited**

Eberth, D.A., and A.P. Hamblin, 1993, Tectonic, stratigraphic, and sedimentologic significance of a regional discontinuity in the upper Judith River Group (Belly River wedge) of southern Alberta, Saskatchewan, and northern Montana: Canadian Journal of Earth Sciences, v. 30, p. 174-200.

Hartley, Adrian J., Amanda Owen, Alistair Swan, Gary S. Weissmann, Barbara I. Holzweber, John Howell, Gary Nichols, and Louis Scuderi, 2015, Recognition and importance of amalgamated sandy meander belts in the continental rock record: Geology, v. 43/8, p. 679-682.



# Alternating currents: when braided channels go snaky



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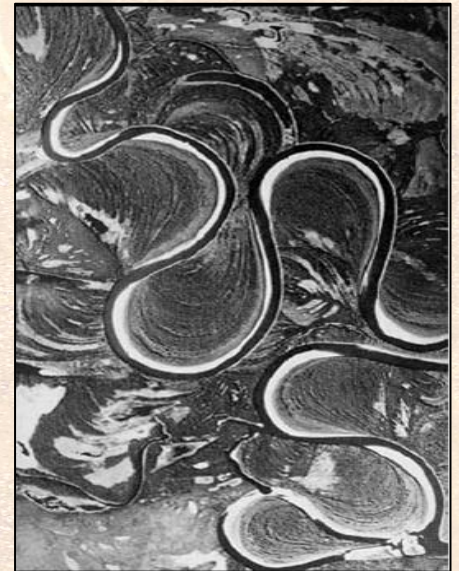






# Introduction

- Today's presentation is all about braided versus meandering channels.
- Study area is Dinosaur Provincial Park:
  - Older Oldman Fm. dominated by "braided" river deposits.
  - Younger Dinosaur Park Fm. is considered meandering.
- We will examine their sedimentology.
- What happens at the transition from one to the other?
- How can we explain this?
  - Relative sequence stratigraphy
  - Tectonic and climatic overprint
- What do we observe in the modern? Discussion
  - End members in extreme settings
  - More common hybrids: Bow River; Missouri River, etc.
- What does this tell us about the studied succession?

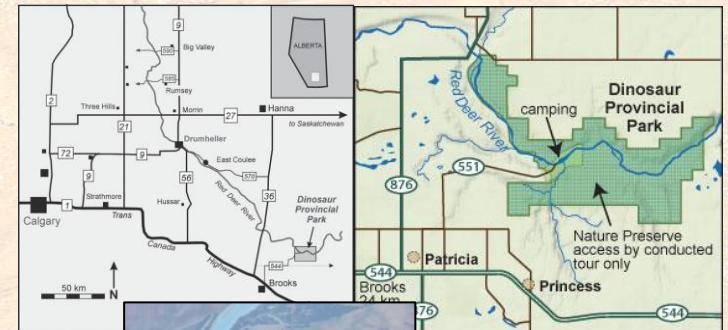






# Study area: Dinosaur Provincial Park

- Located 150 km east of Calgary.
- Established in 1955 as Provincial Park.
- UNESCO World Heritage Site in 1979.
- Badlands cover more than 73 km<sup>2</sup>
- Exposed due to erosion by rivers, fed by glacial meltwaters.
- Incredibly rich fossil fauna with more than 40 dinosaur species and many other vertebrates and invertebrates (>500 species).
- Excellent exposures allow detailed fieldwork, with older rocks exposed in core area of Park.



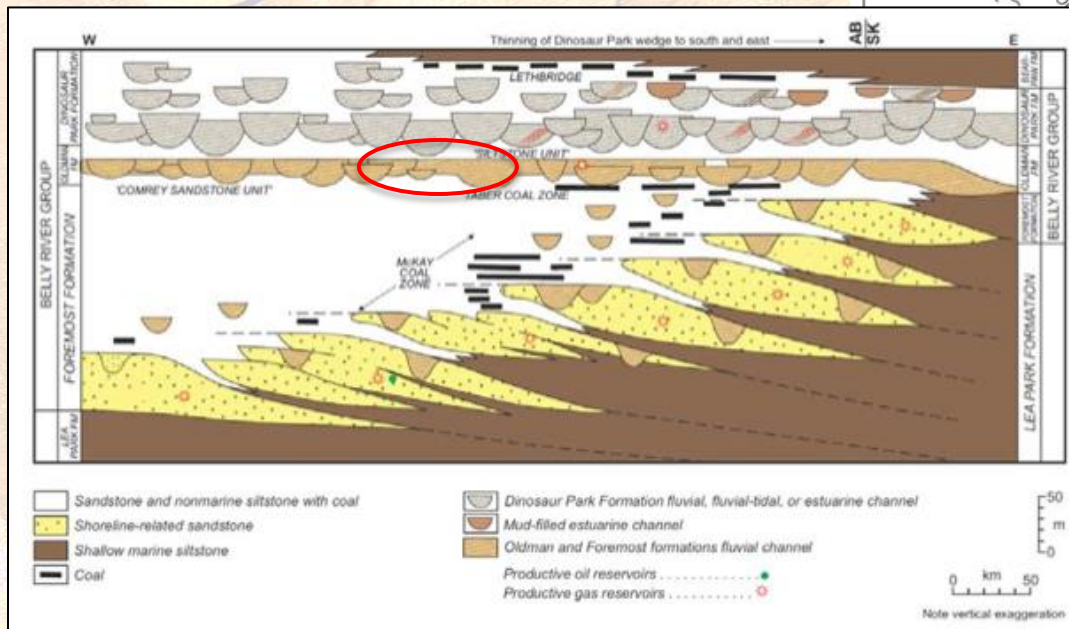
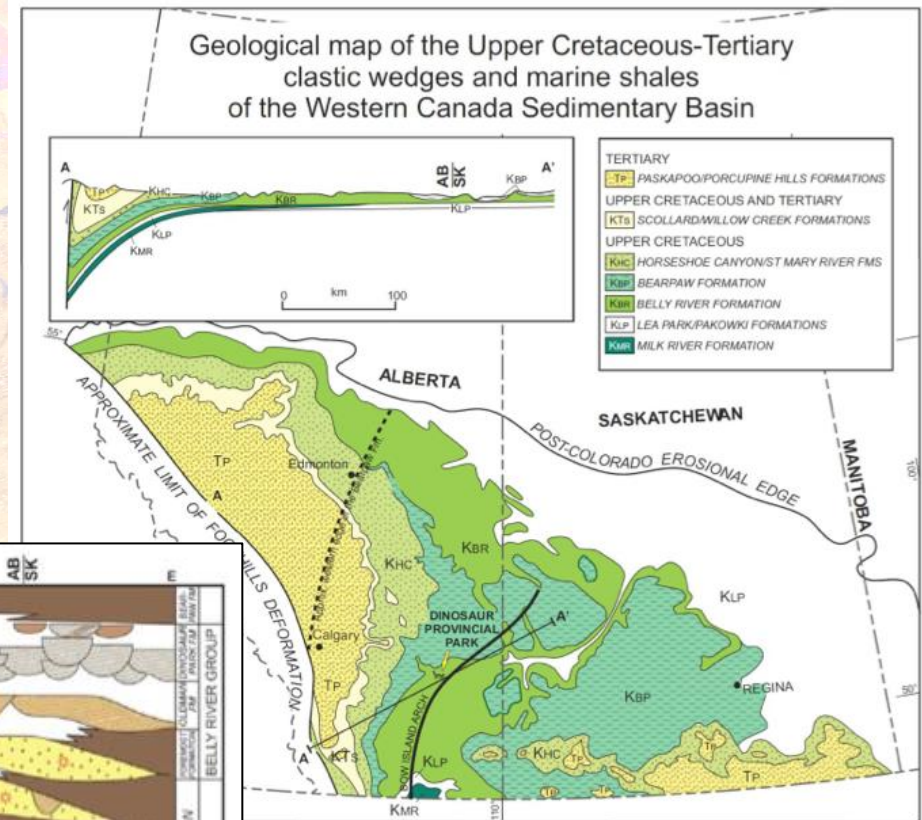
4 km  
loop  
road





# Regional setting

- Series of clastic wedges prograding into the Western Epicontinental Seaway to East.
- Looking at the Campanian: 76 MYO. Dated using bentonite ash beds.
- Note the varied stacking patterns through the Formations.



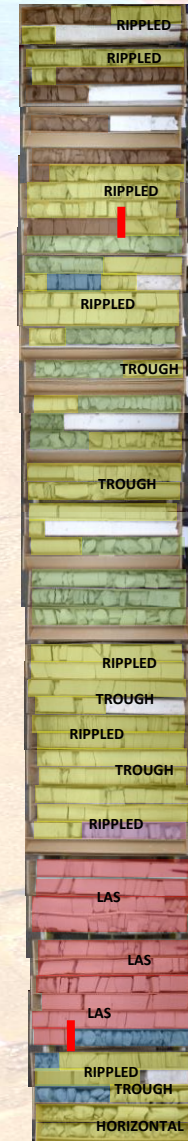
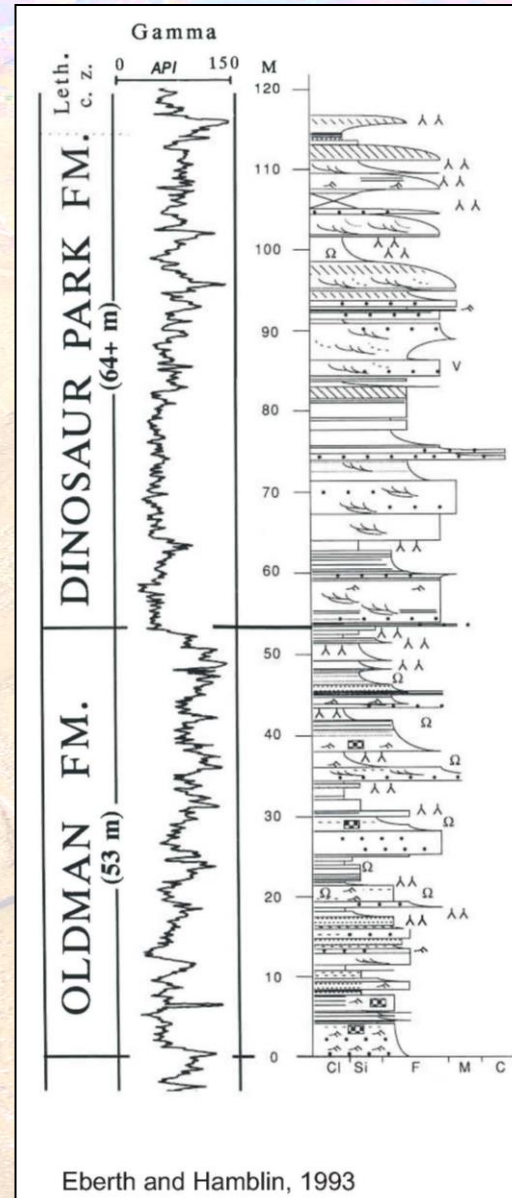




# Geology of the Park

- Older Oldman Fm. overlain by Dinosaur Park Fm.
- Very different character, demonstrated on GR log.
- Differing:
  - Provenance.
  - Depositional character.
  - Grain size.
  - Presence of extraformational clasts.

Paleocene	Paskapoo		
	Unconformity		
Maastrichtian	Scollard		
	Wapiti		
	Battle		
	Horseshoe Canyon		
	Bearpaw		
Campanian	Belly River	Judith River	Dinosaur Provincial Park
			Oldman
			Foremost
	Lea Park		
U. Santonian	Colorado Group		



DINOSAUR PARK

OLDMAN

Brown Siltstone	Channel
Paleosol	Point bar
Grey mudstone	Siltstone







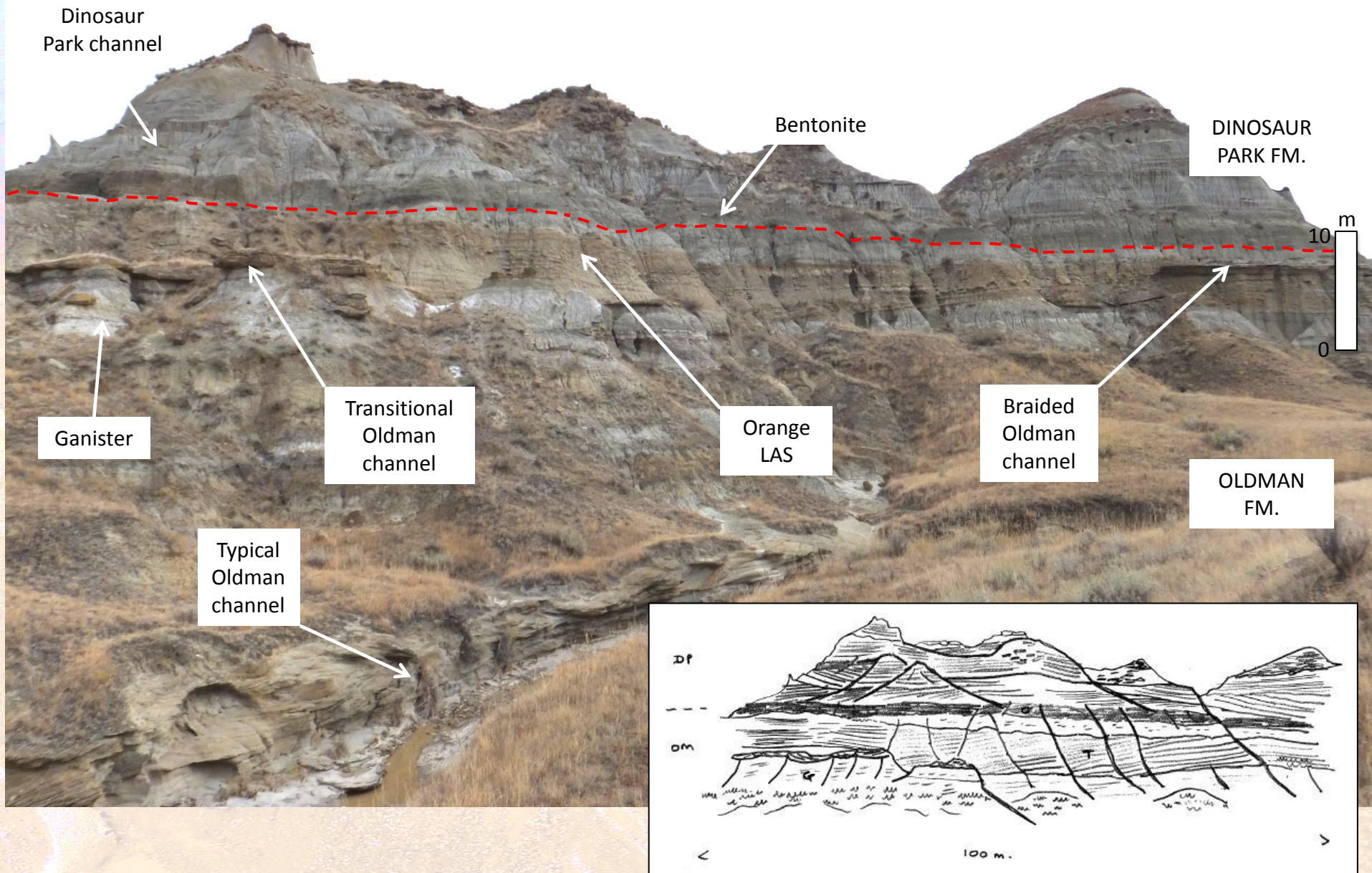
## Transitional succession







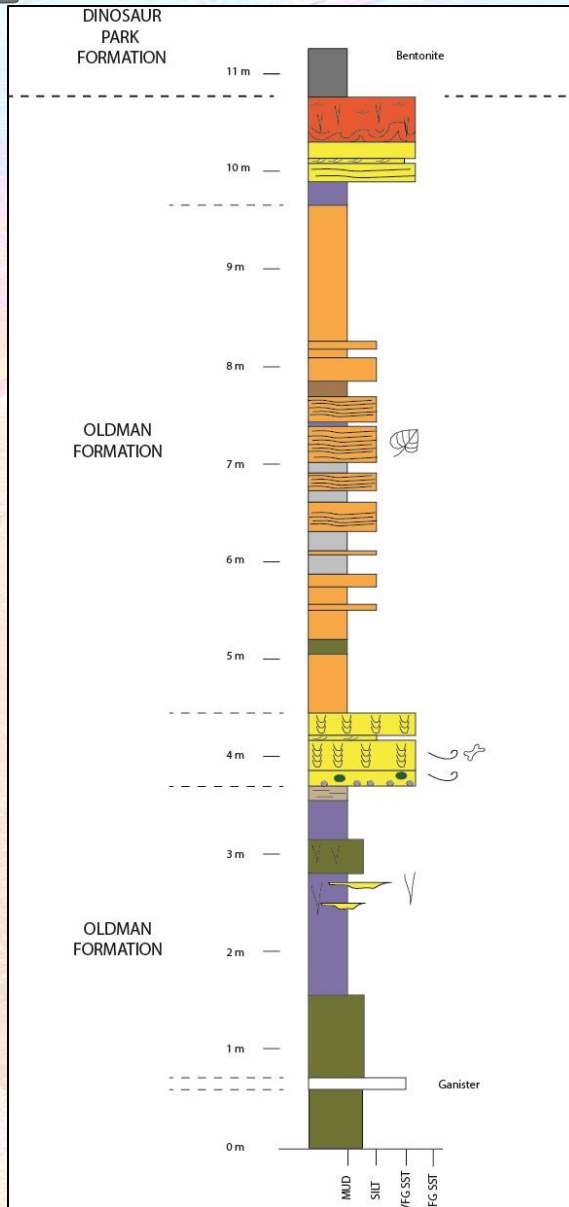
# Overview of transitional stratigraphy







# Transitional stratigraphy



DP bentonite

OM braided channels  
and overbanks

Orange LAS

Unionid channel

Overbanks

Ganister

- Logged 23 sections in Dinosaur Provincial Park.
- Photo on previous page shows the type section.
- Further section measured at Sandy Point in eastern AB, 101 km to East.
- Composite log from Park shown here – 11 m in thickness.
- Impressive variety of sedimentary environments.
- Will describe and interpret them, then add context.



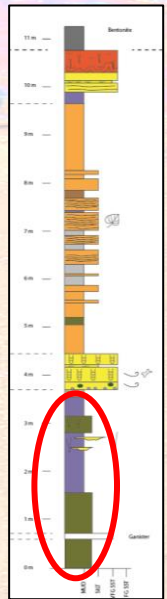
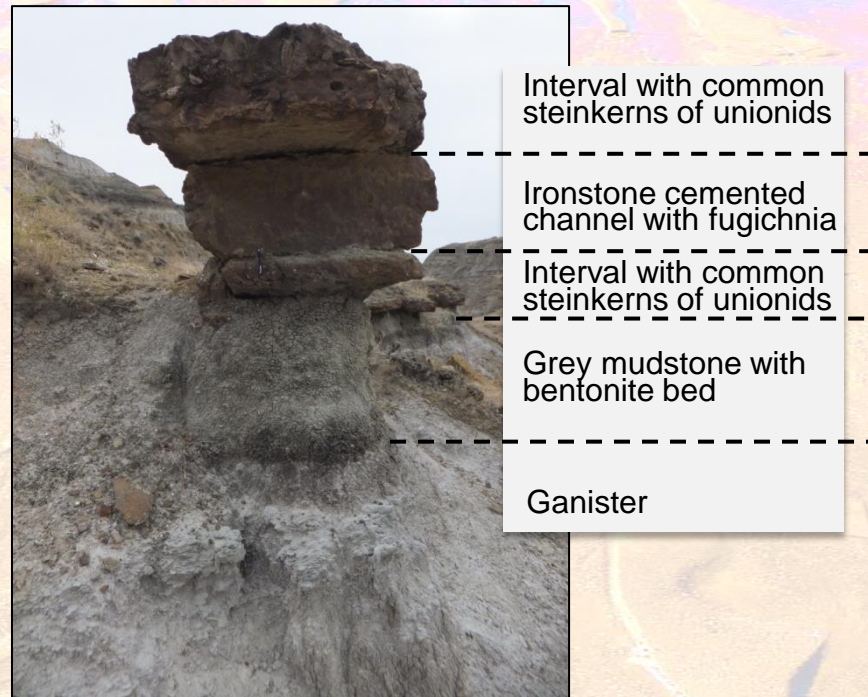
4 km  
loop  
road





# Ganister and overbank fines

- Ganister ranges from a few cm to more than 50 cm in thickness.
- Interpreted as a siliceous palaeosol, typically heavily cemented.
- Form in cooler environments with standing water; equivalent to caliches further south (more arid).
- Can be correlated into Montana – shows regional climatic control.
- Overbanks range from carbonaceous to grey, often organic rich and sometimes rooted.
- There are also bentonites (volcanic clays).

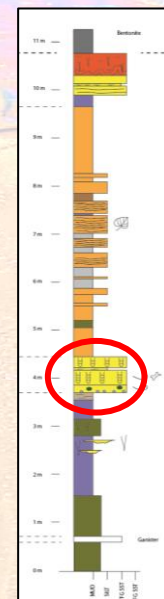
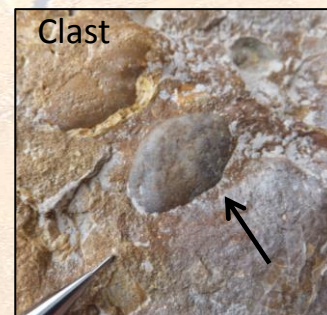
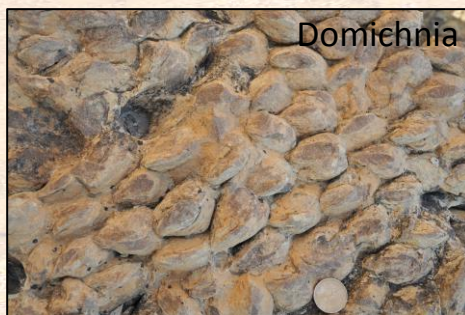






# The unionid channel

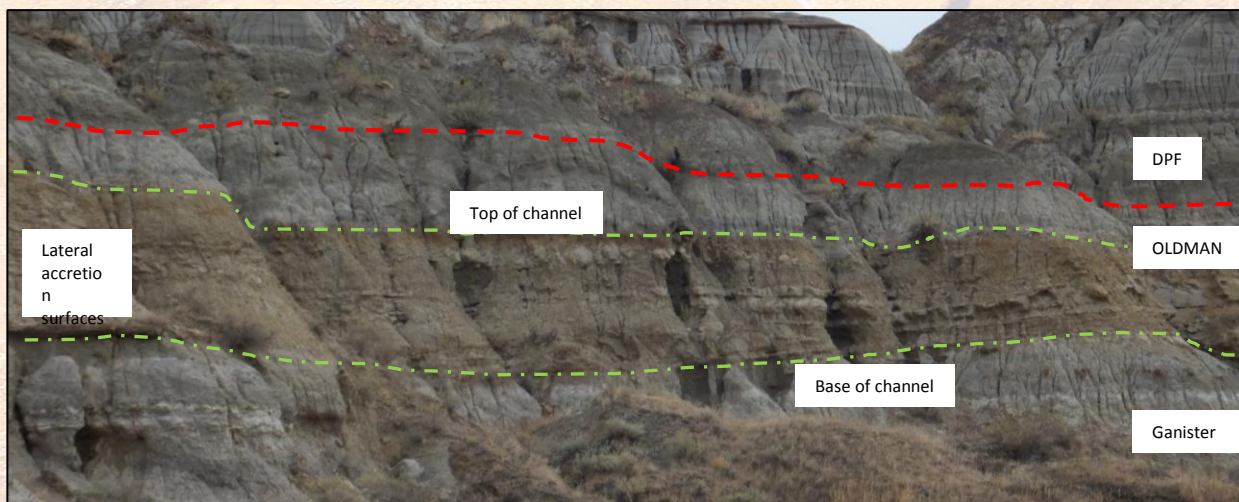
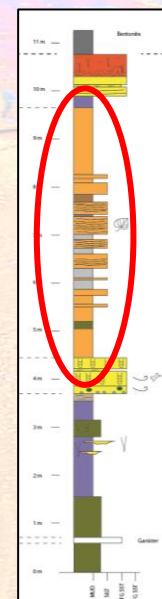
- A gripping and tragic story!
- Channel cuts into overbank fines.
- Populated by unionids.
- Flood accompanied by sedimentation leads to fugichnia.
- Later fall in water levels leaves unionids high and dry.
- Channel contains only extraformational clasts in Oldman Fm.
- Unionids - low energy and gradient. Why the change?
- Unique bivalve concentration.
- Clasts suggest different provenance.





# Orange LAS

- Interbedded orange organic rich siltstone and orange or grey mudstone beds.
- Dip consistently at each outcrop.
- Variable thickness.
- Interpreted as LAS packages.
- Bed can be traced for > 100 km – suggests climatic control, not tectonics alone.
- Commonly incised into by overlying channels.
- Orange may be due to reworked iron on floodplain.





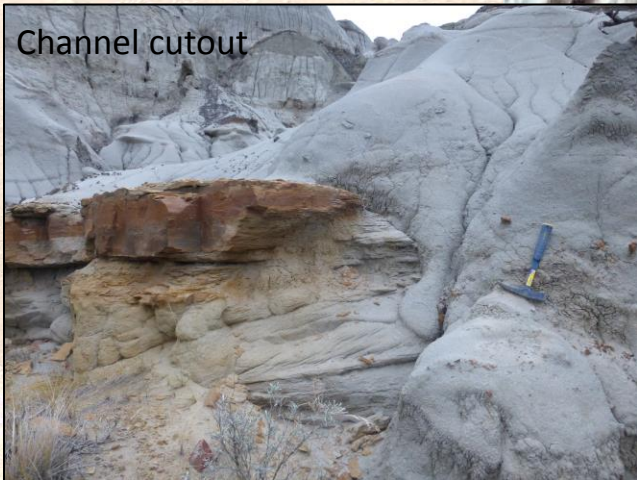


# Distribution of orange LAS

- Orange LAS occurs in every section except where cut out by erosion by overlying channels.
- Thickness varies, probably also due to erosion.
- Orientation of LAS indicates multiple small point bars.



Channel cutout

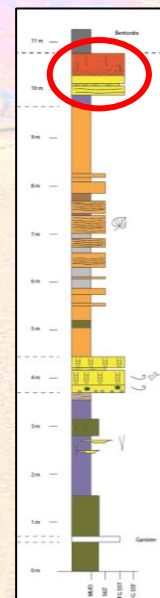
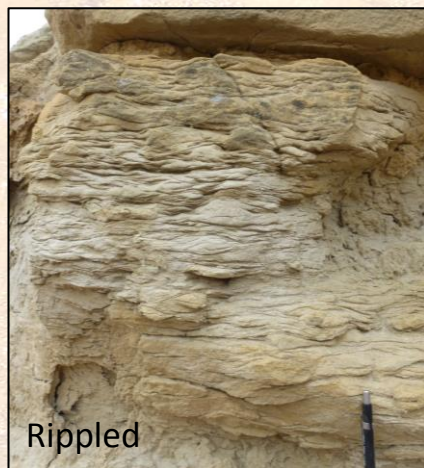






# Upper Oldman channels

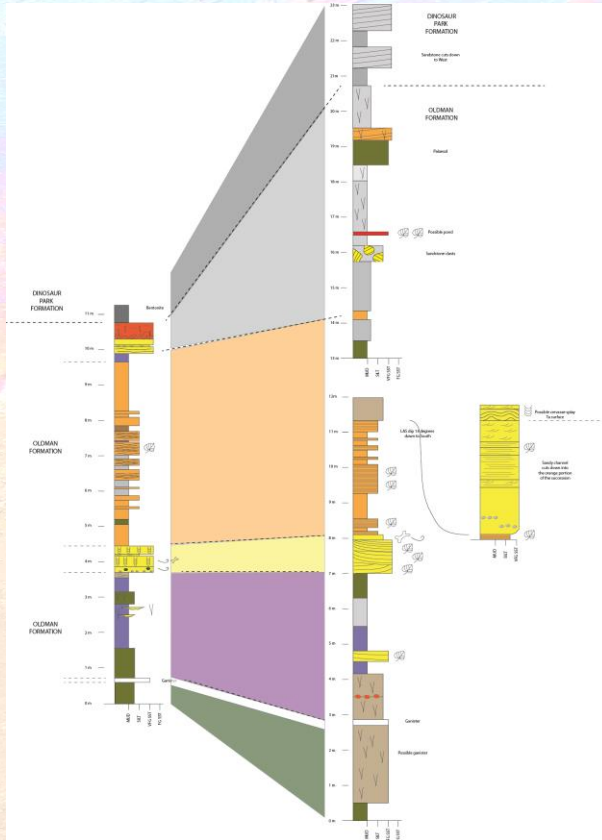
- Trough xbs and ripples.
- Sometimes beds of climbing ripples.
- Often dewatered.
- Usually cemented.
- Interpreted as small braided channels and crevasse splays.
- Fairly rapid deposition.
- Possible dinoturbation.
- Overlain by Dinosaur Park Fm. bentonites or sandstone beds.



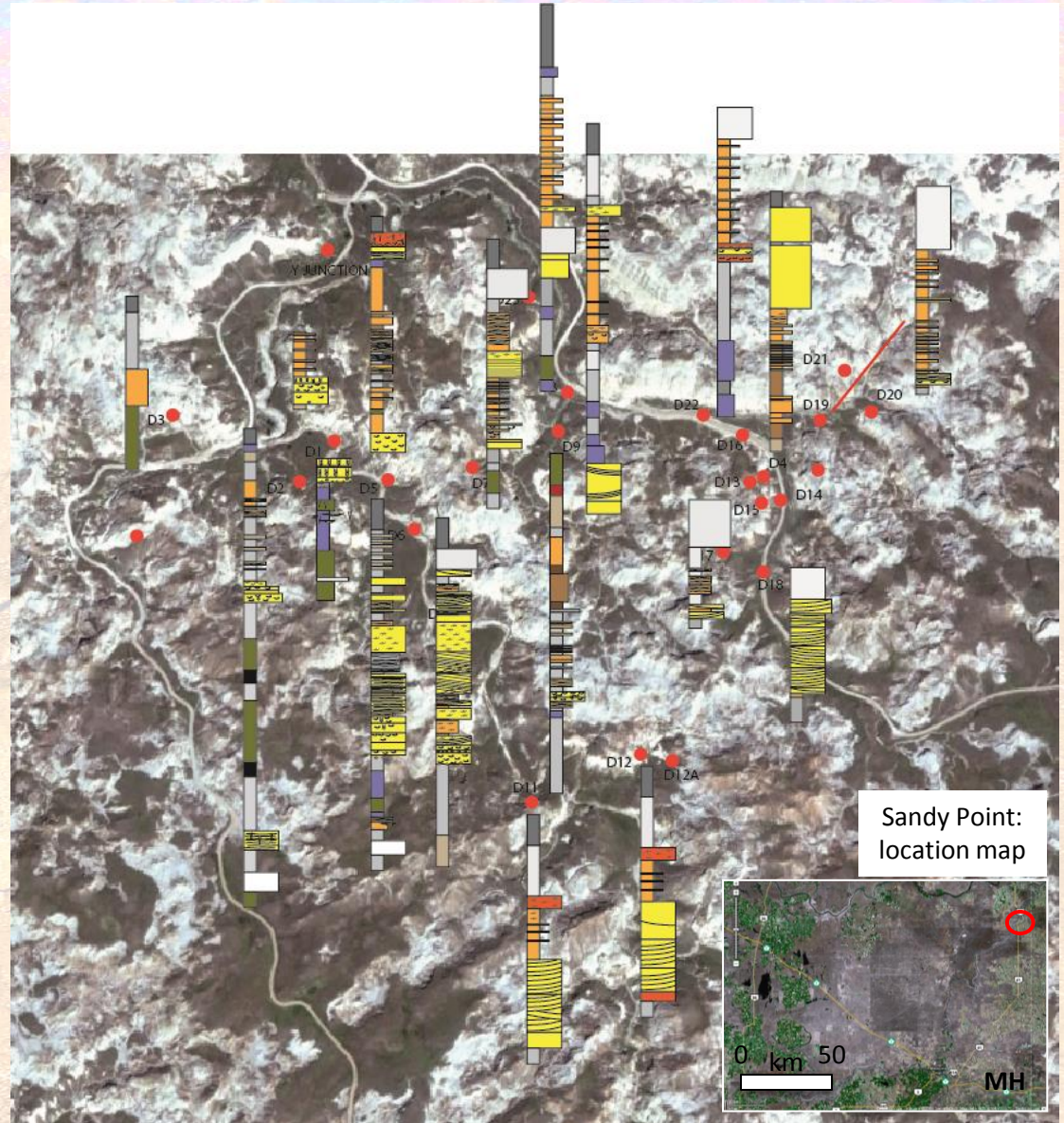




# Overview of logged sections in Park and Sandy Point



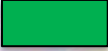




- Succession thickens to East, towards the sea.
- Otherwise very similar (over 100 km).

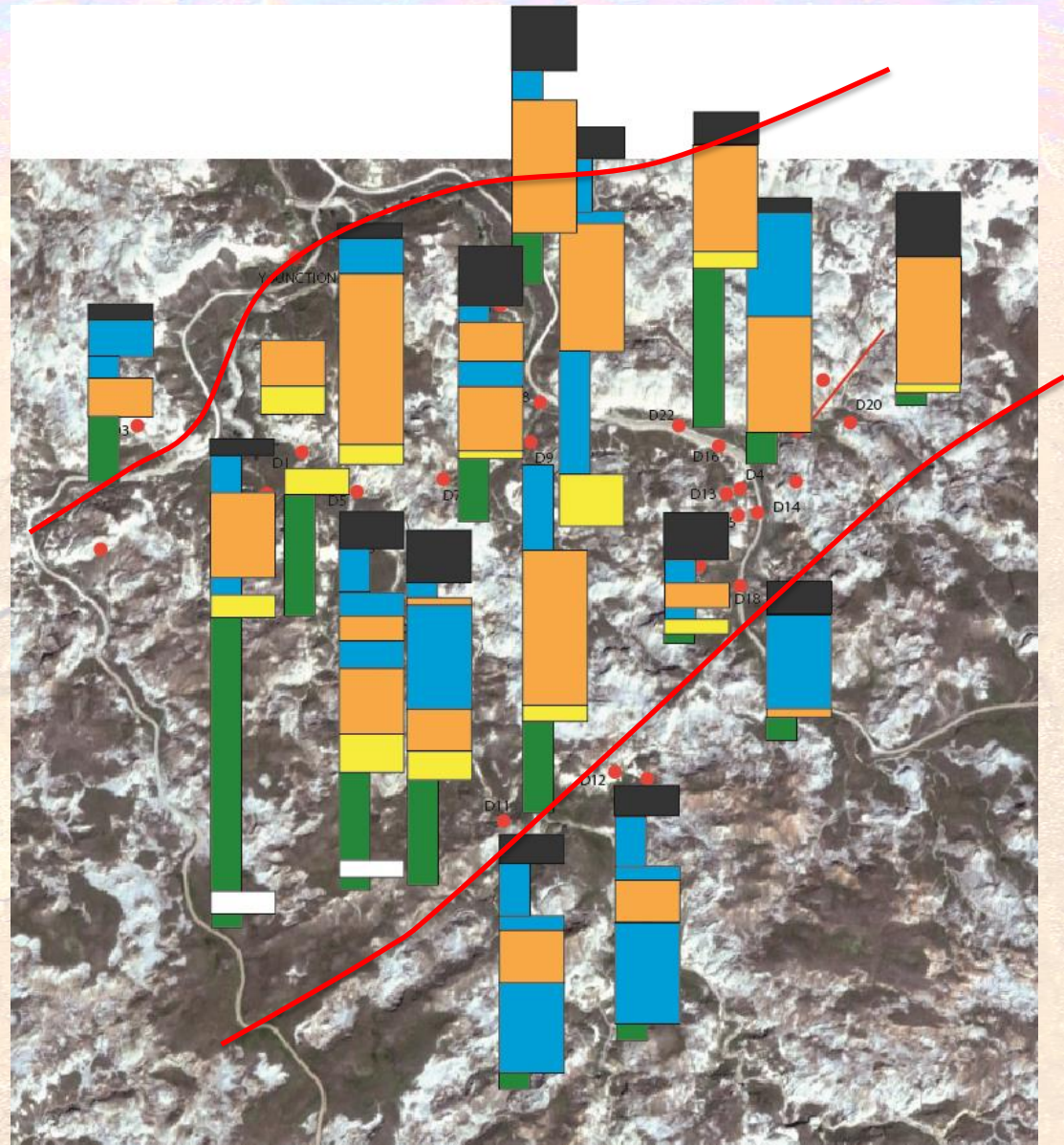






# Summary of transitional sections

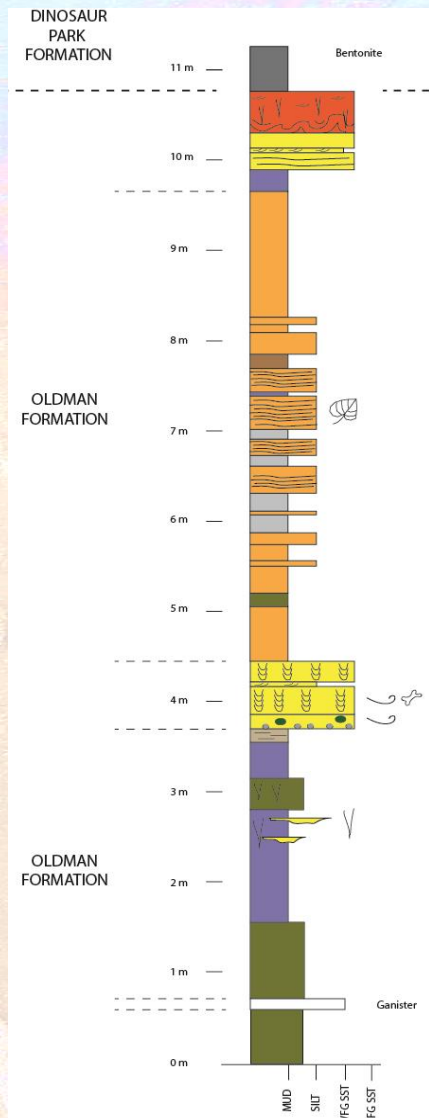
- Overbanks at base. 
- Red lines delineate zone with unionid channel present.
- Unionid channel eroded into to South. 
- Orange LAS are ubiquitous in the Park and beyond. 
- Most sections show “Oldman style” channels at or near top of Oldman succession. 
- Overlain by DP Fm. 







# Interpreted succession



Low

High



Gradual rise in relative sea level through meandering to fully marine.

Upper Oldman channels are braided, showing a fall in relative sea level.

Orange LAS shows a fully meandering system (the “little one before the big one”). Relatively high sea level.

Unionids show lower gradient, slower currents, still braided.

Overbanks preserved, showing some accommodation space.

Ganister: standing water, higher relative sea level.

Comrey Sandstone, stacked channels, low accommodation space

## POSSIBLE DRIVER

Eustasy  
(transgression)

Pause in  
Tectonic  
downwarp?

Tectonic  
downwarp?  
and Climate

Tectonic  
downwarp?  
and Climate

Climate and  
Eustasy

Eustasy  
(stillstand)



## Hybrids and Conclusions

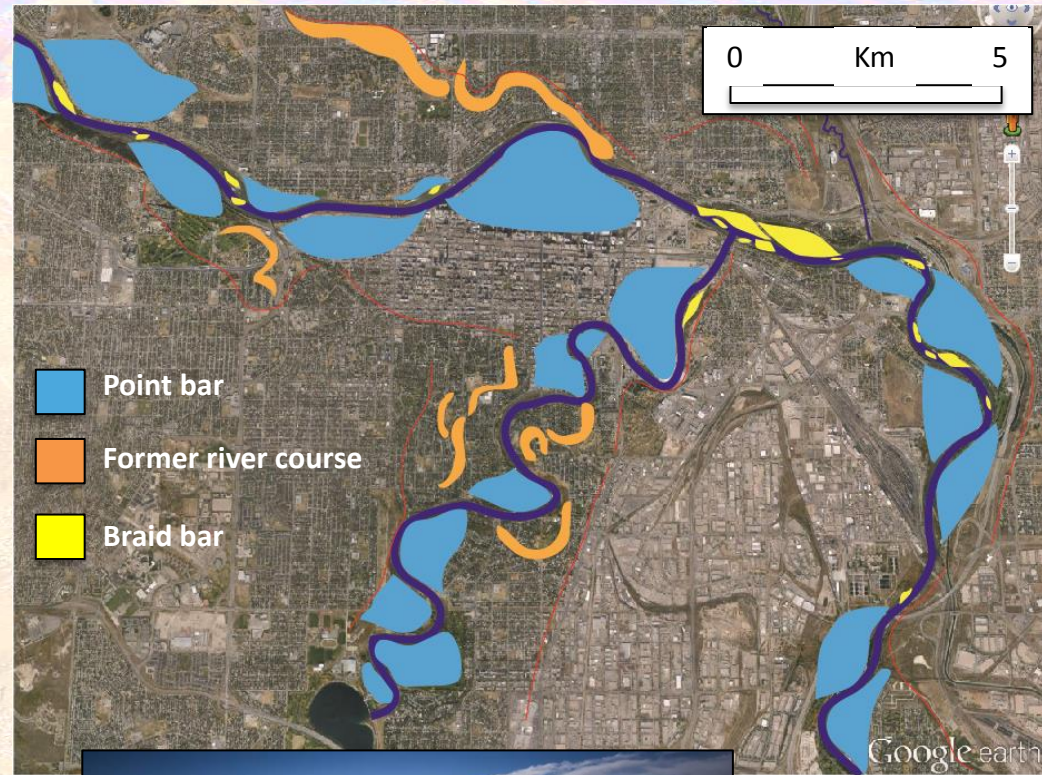






# Bow River

- Most modern rivers are hybrids or meandering.
- Even the Bow, which is the type section for braided rivers (South Saskatchewan River).
- Examples are rare of “pure” braided (Hartley et al 2015).
- What does this say for the Oldman deposits?
- Probably not braided, just straight channels. So less of a change to meandering.
- Orange LAS may represent a climatic change. Need to explain meanders AND provenance change AND colour. Downwarp and wetter conditions.

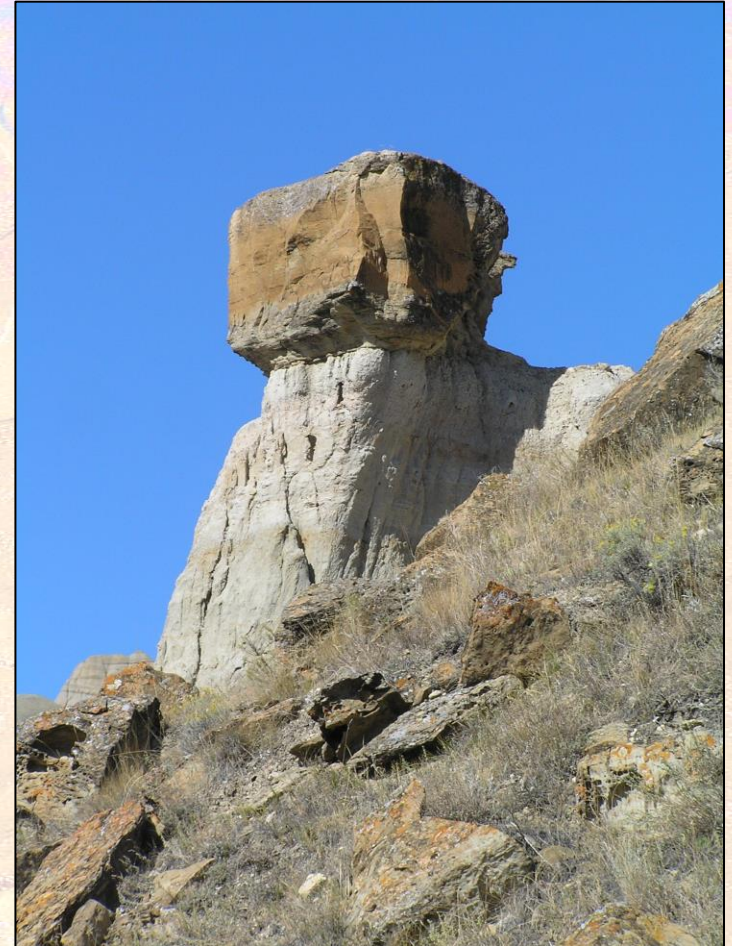






# Conclusions

- We can apply a relative sea level curve to the 12 m thick transitional zone.
- The fluvial succession can be closely correlated over more than 100 km.
- The channel rich in unionids is clearly indicating a change in fluvial style, probably to a lower gradient.
- There is a “little one before the big one” in terms of an earlier meandering channel within the Oldman Formation, before the dominantly meandering Dinosaur Park Fm.
- There is clearly a change in provenance. However the LAS suggests that this may not be due to uplift, but instead may be due to subsidence in Oldman source area.
- There is clearly a (regional) climatic component to the depositional changes within this relatively thin succession.







**Thank you**

