Cycles and Packages in Fluvial Deposits: What Do We Know? Examples from the Triassic Wolfville Fm (Nova Scotia)*

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Abstract

Fluvial successions are often described in term of hierarchical packages that form distinct patterns developed at different orders of magnitude. Patterns are repetitive and often considered cyclic. Usually the fluvial architecture is defined by (1) a channel body as smallest element, (2) channel complexes formed by stacked channel bodies, and (3) packages of channel complexes and abandonment facies forming repetitive units. Channel complexes are commonly interpreted to be largely autogenic in origin (i.e. migration/ avulsion). In contrast, the controls that drive the repetition of stacked channel complexes and abandonment facies, representing the migration/ avulsion of a channel belts are debated.

We discuss the controls on Late Triassic fluvial architecture in the Wolfville Fm (Fundy, Nova Scotia) in which different orders of cycles have been recognized in both gravelly- and sandy-bedload fluvial successions. We show that an additional type of stacking pattern can be recognized. In the gravelly fluvial succession, thirteen cycles have been mapped across 23 km of braid-plain. Each cycle displays a decrease in pebble content and an evolution in bedform architecture. In the sandy fluvial succession, the classic three order packages have been recognized together with an additional larger order package (4) identified using in-channel grain size variations. We interpret the grain-size trend to record progressive changes in runoff and fluvial transport capacity indicative of a climatically-driven signal.

Determining autogenic vs. allogenic controls in fluvial succession is challenging and interpretations depends on simplistic (unrealistic?) depositional models. Difficulties in interpretations also depend on recognition of architectural elements and bounding surface orders that can be misinterpreted where amalgamation is significant. We suggest that recognition of gradual grain size variations allows determination of climatic controls. The repetition of channel complexes and abandonment units, showing higher frequency than grain-size cycles, could be interpreted to reflect autocyclic switching of channel belts.

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Cycles and Packages in Fluvial Deposits: What Do We Know?

Examples from the Triassic Wolfville Fm (Nova Scotia)

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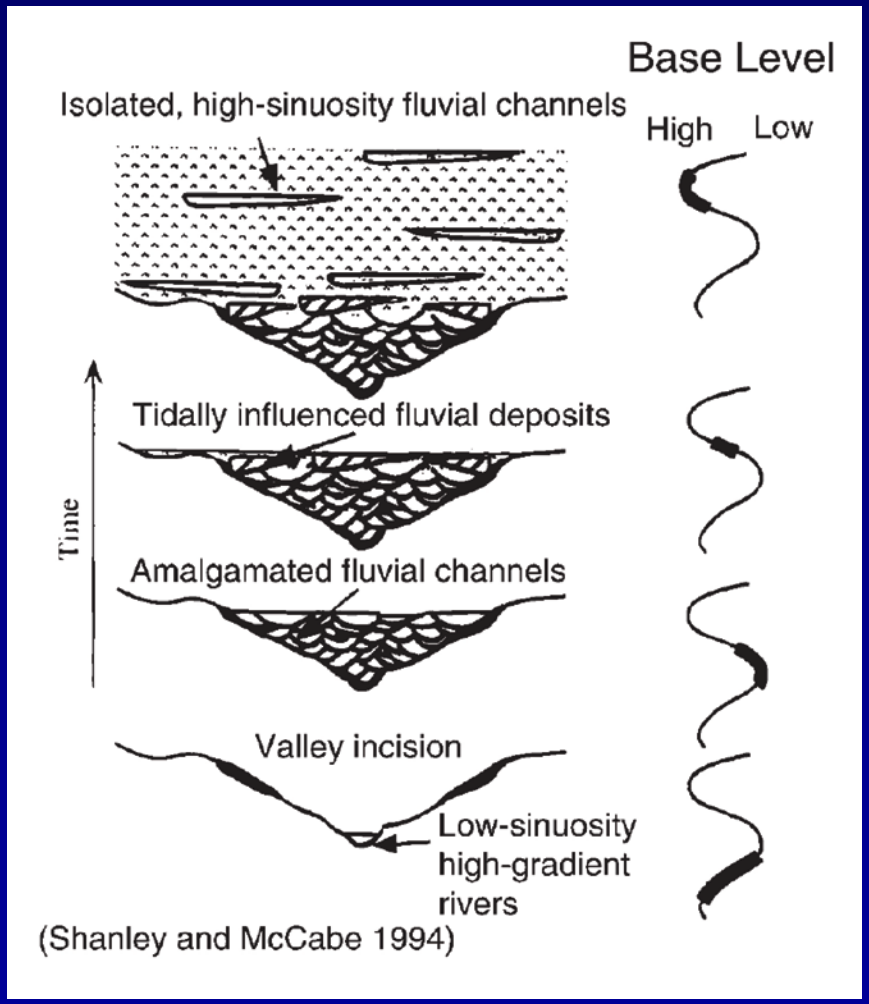
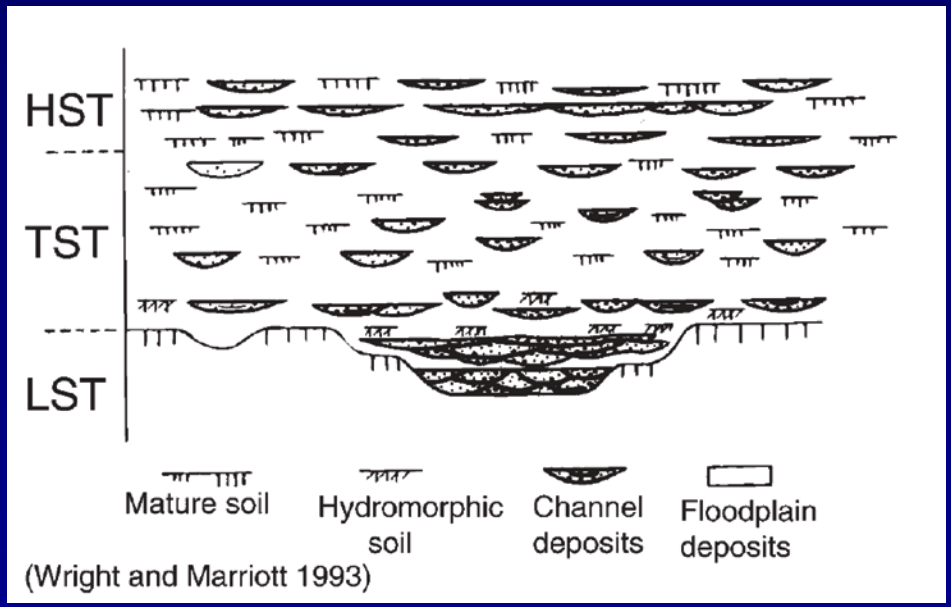
Outline

- Existing models of the controls on large-scale alluvial architecture
- Examples of alluvial architecture from Triassic of Fundy Basin
- Discussion of architectural hierarchy and controls
- Conclusions

Controls on alluvial architecture



(Shanley and McCabe 1994)



(Wright and Marriott 1993)

Distal alluvial plain

Control on the alluvial architecture

LAB model (70's): Architecture controlled by variation of accommodation space/ sediment supply

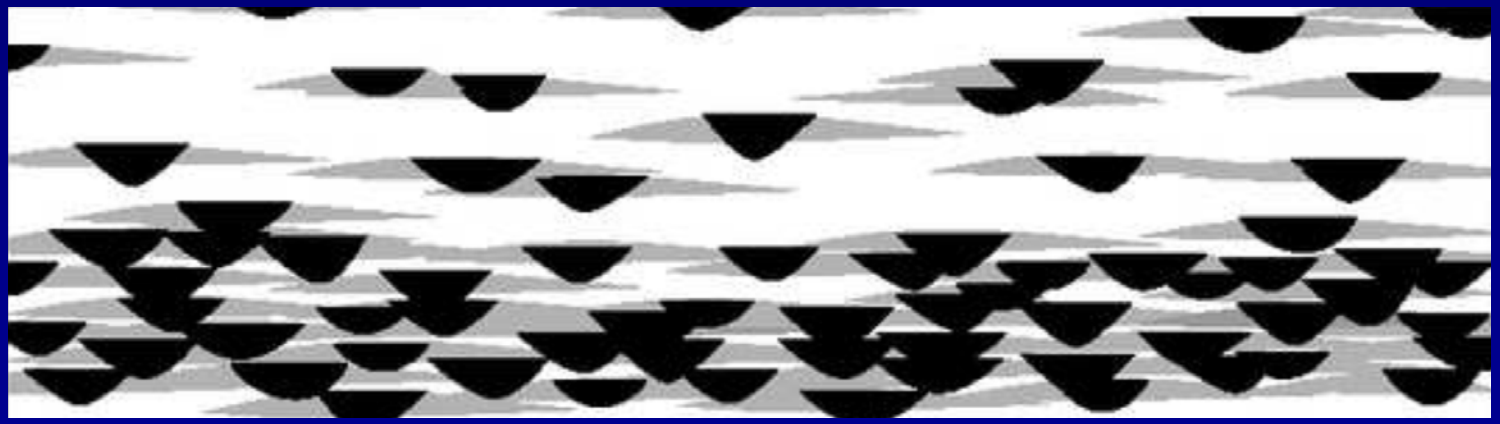
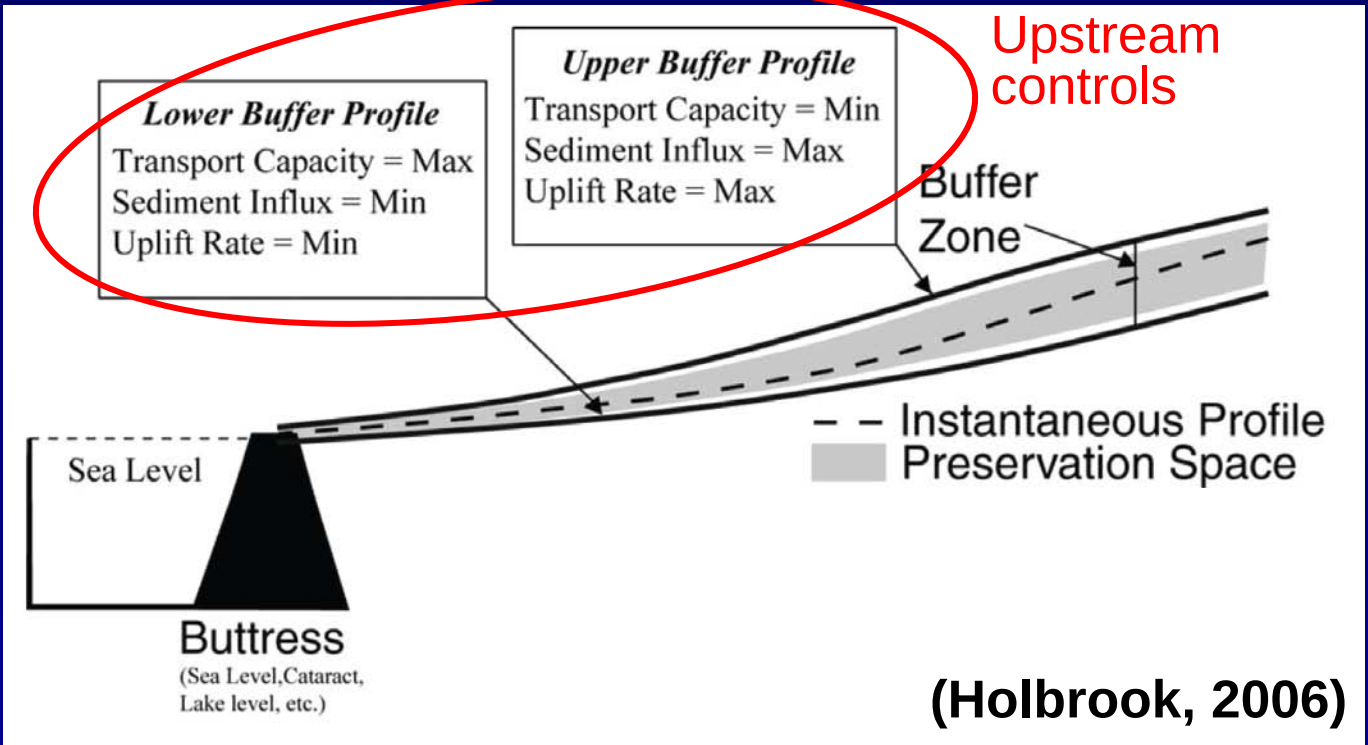


Figure from Hajek et al., Geology, in press

Controls on alluvial architecture

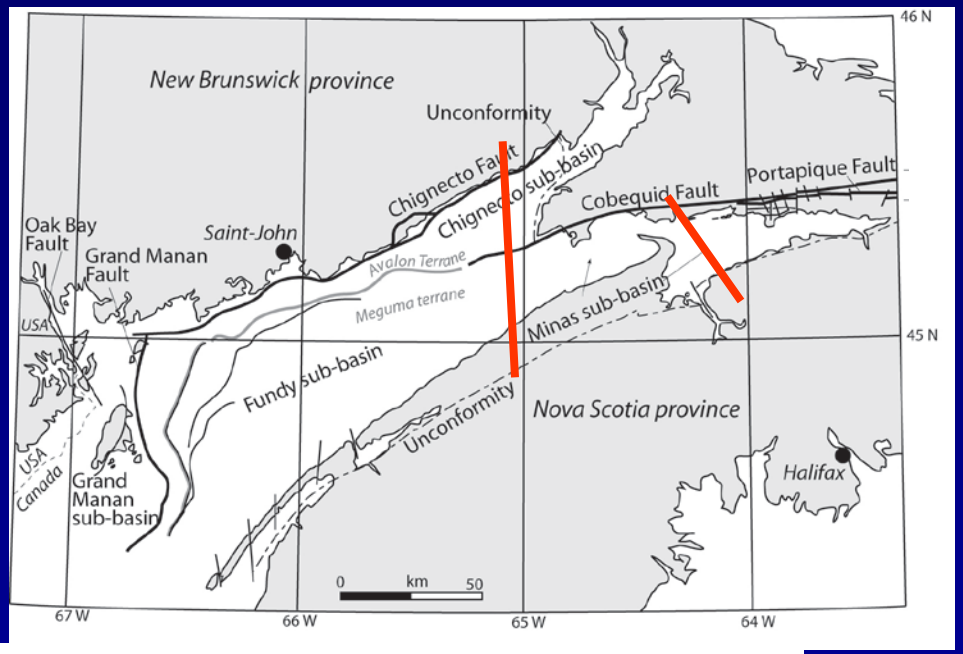


- Base level
- **Upstream controls**
  - Vertical movement
  - Sediment supply
  - Water discharge

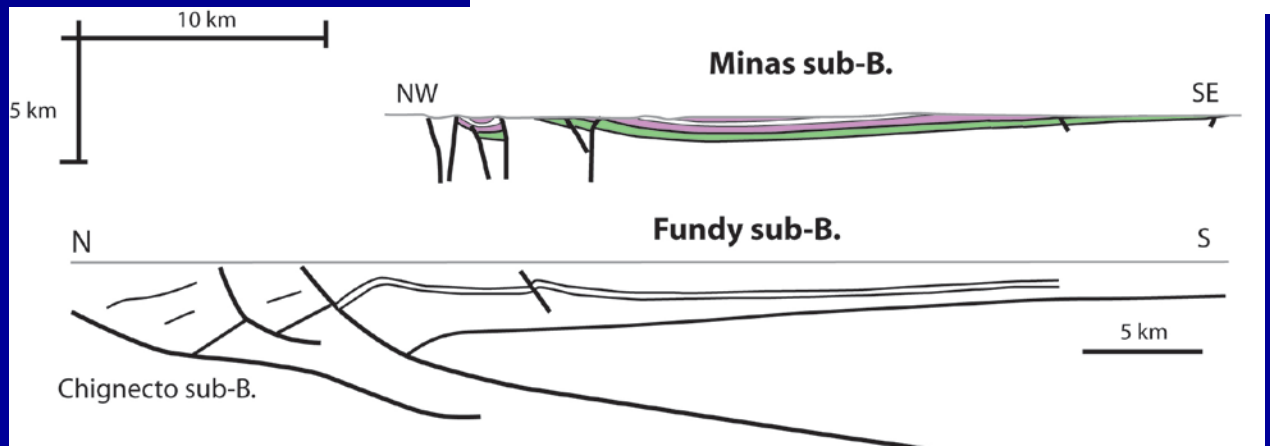
Catchment area

Cycles and packages in the Triassic Wolfville Fm:

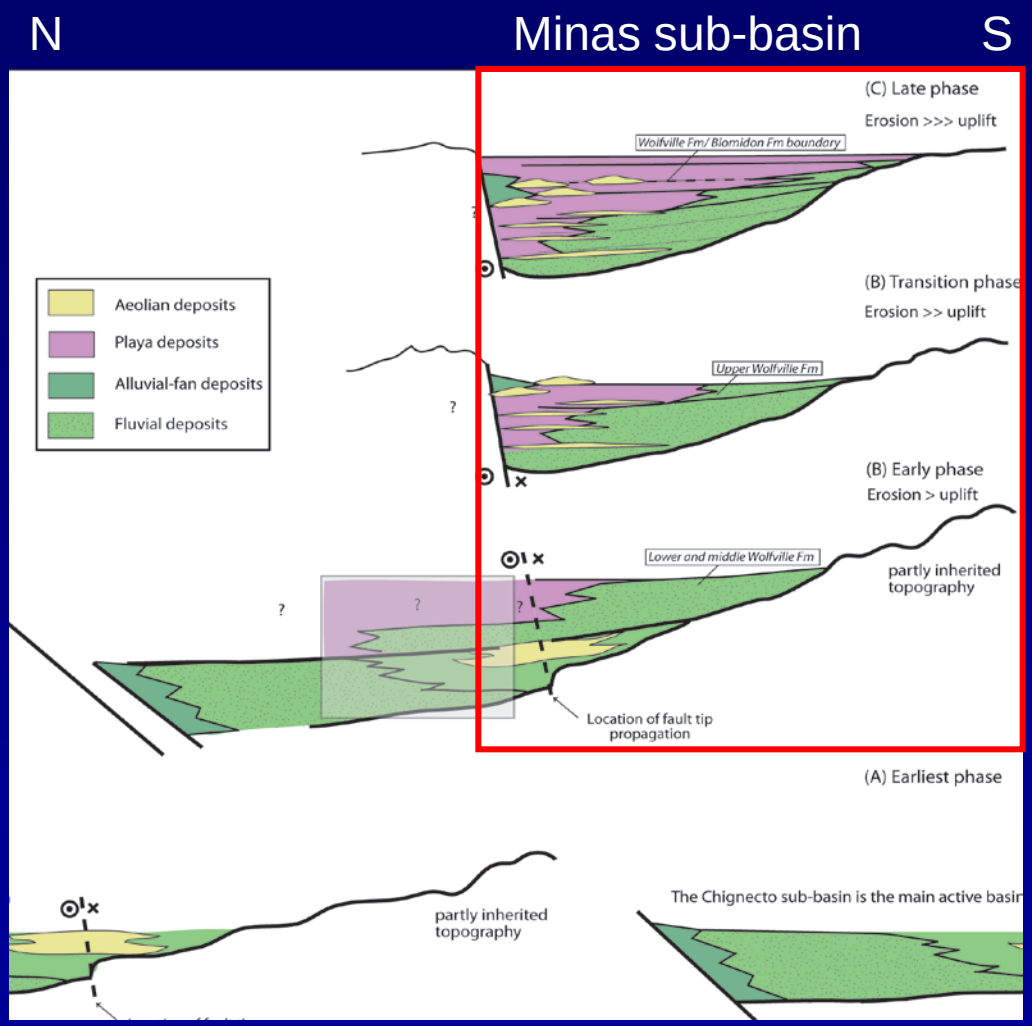
the Fundy Basin (Nova Scotia)



Active syn-sedimentary faulting



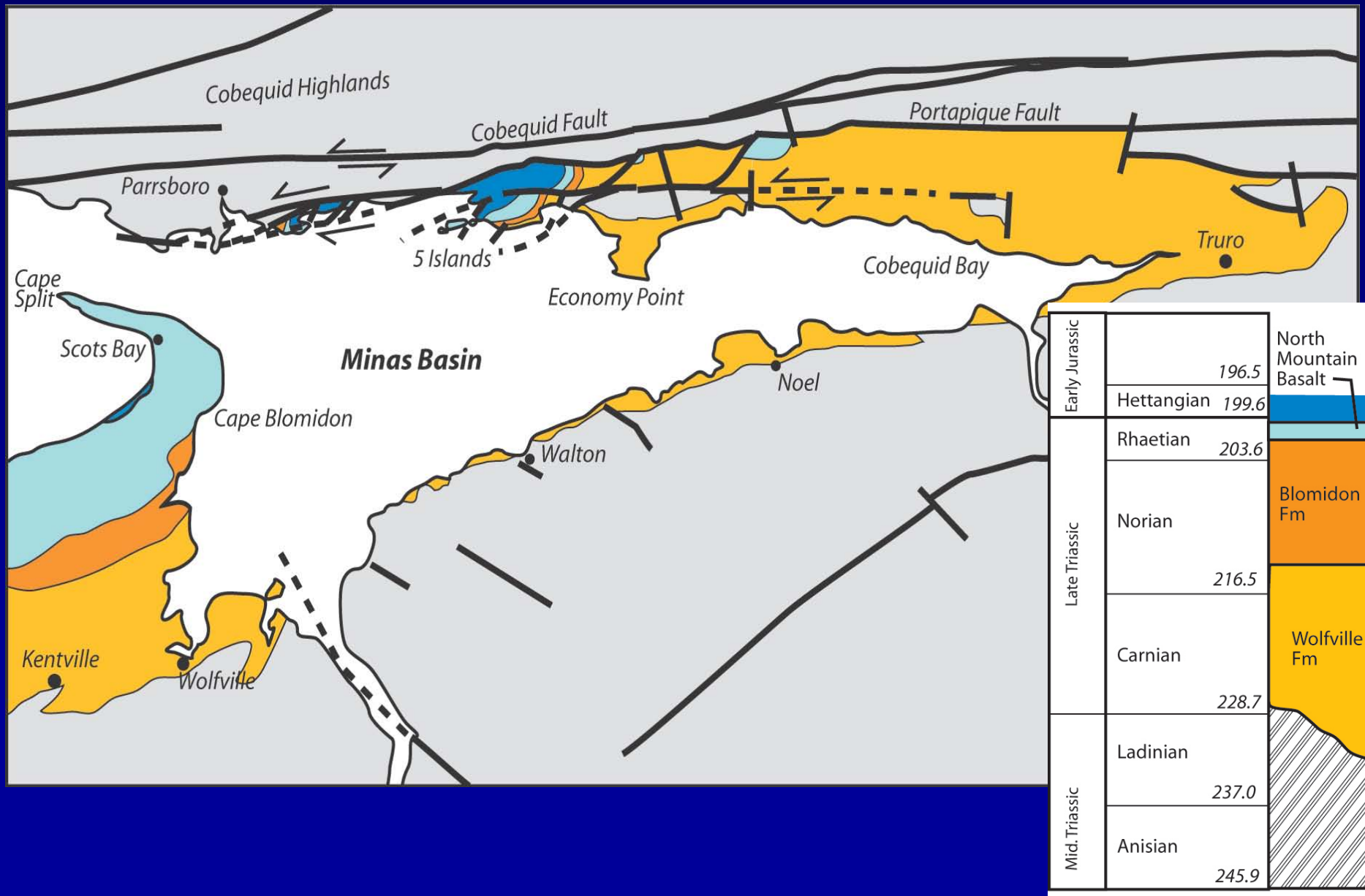
Fluvial evolution through basin history:



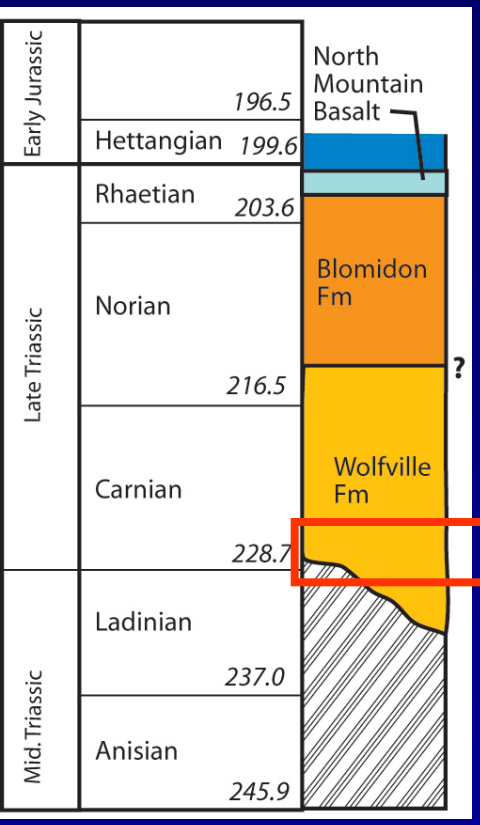
(Leleu & Hartley, 2010)

- Back-stepping of fluvial system towards the paleo-drainage area
- No rejuvenation of paleo-relief (no uplift in paleo-drainage area)
- Global decrease of sediment supply and water discharge
- High-resolution lacustrine cycles controlled by monsoon (Olsen, 1986)
- High-resolution cycles in fluvial architecture

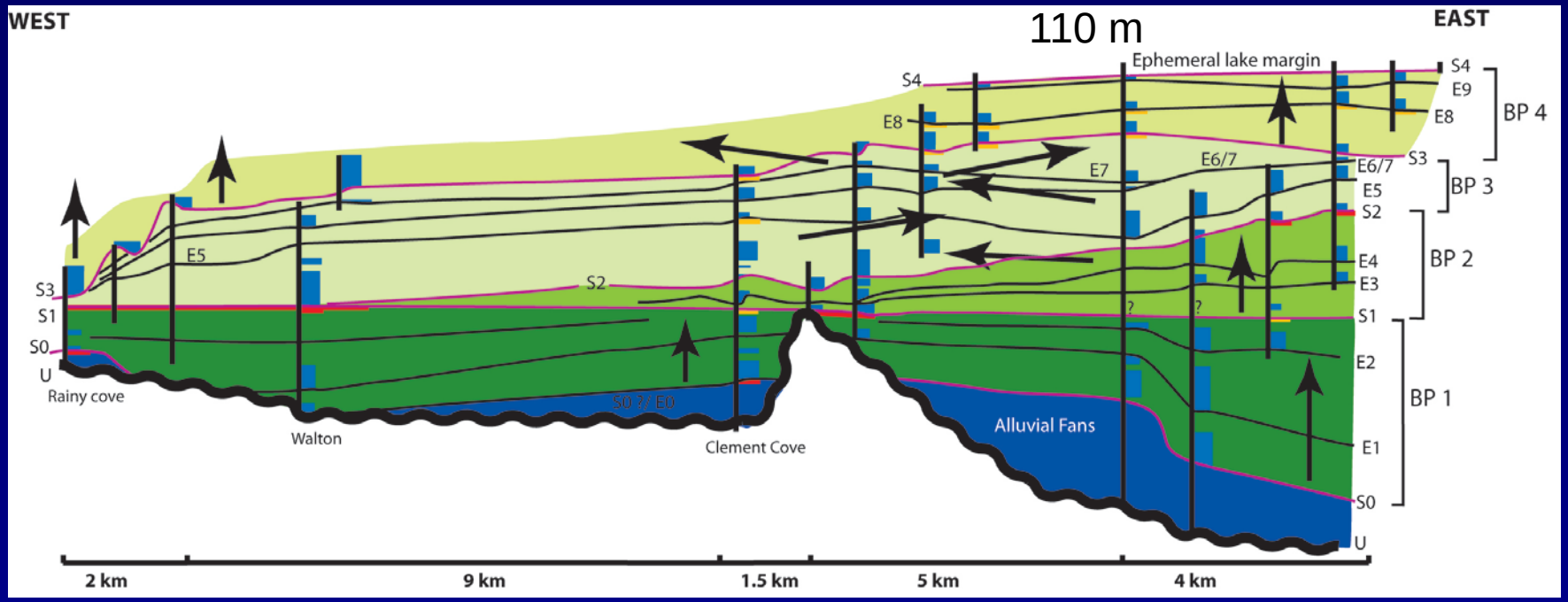
Minas sub-basin



Lower Wolfville Fm



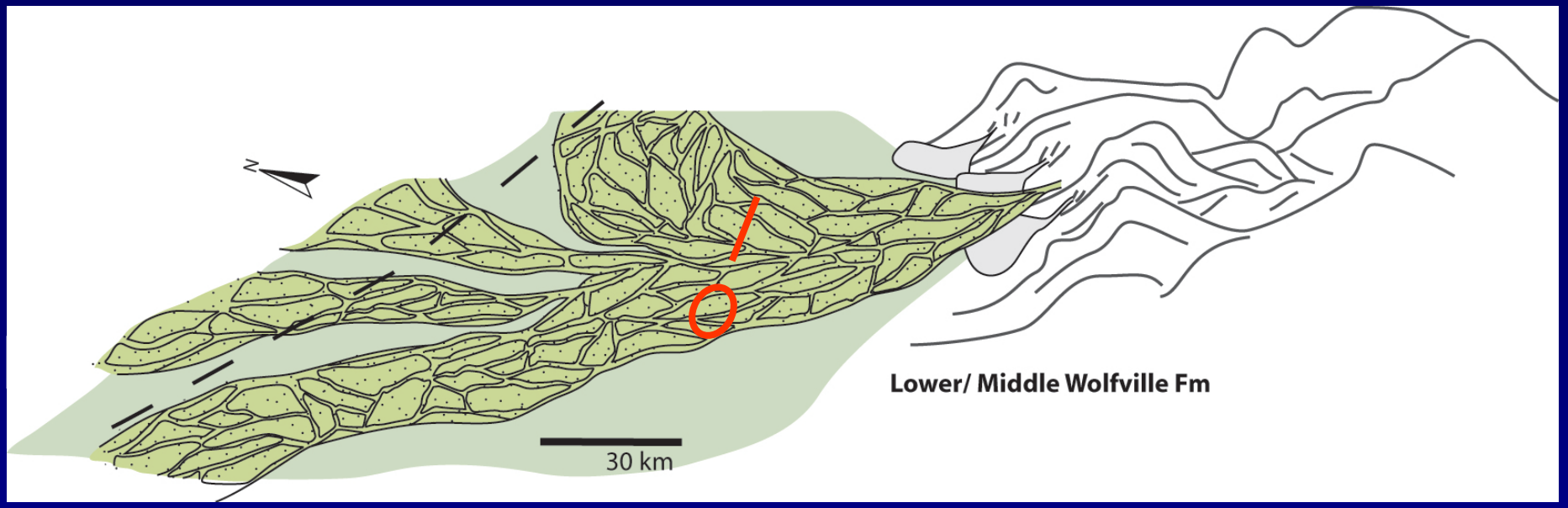
Lower Wolfville Fm

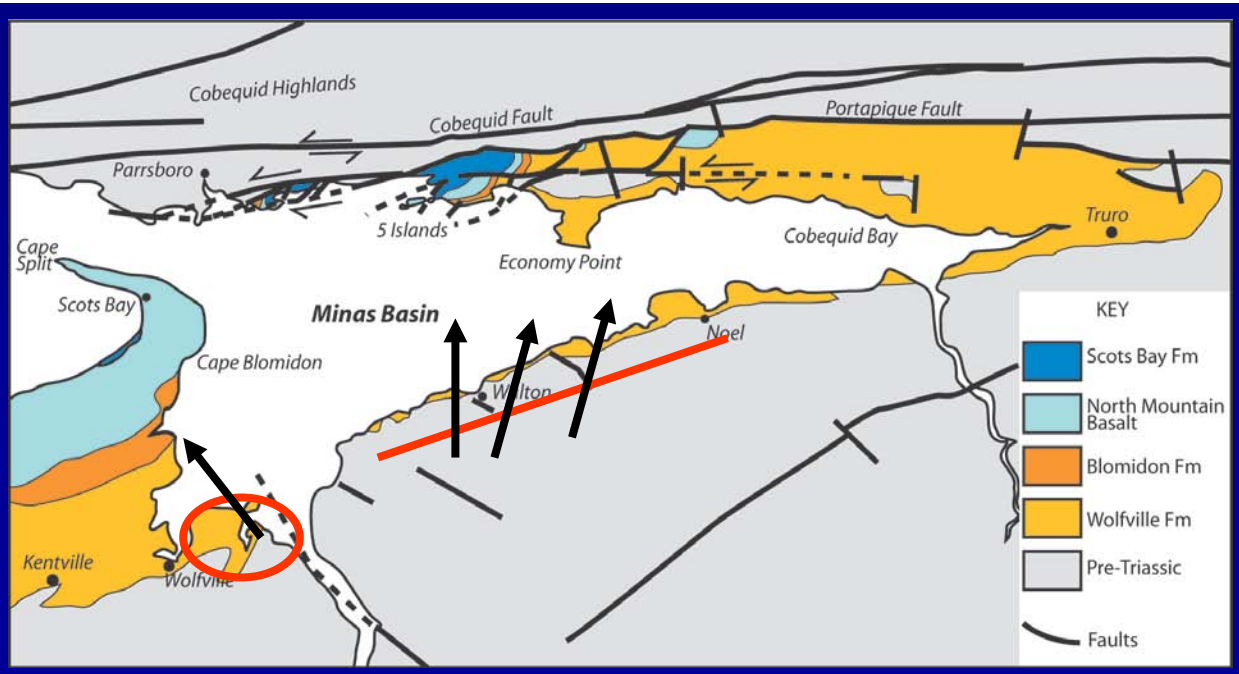


(Leleu et al., 2009, JSR)

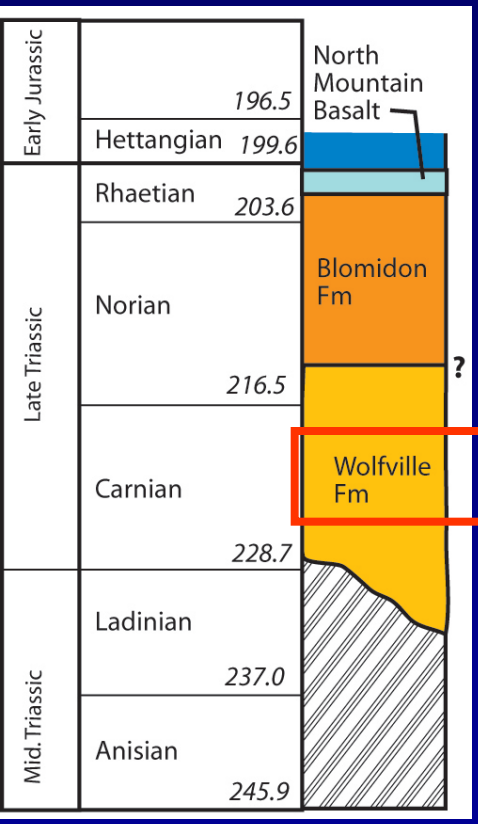
- 13 fining-upwards sequences at basin-scale
- Mega fluvial system
with either synchronous active channels or high frequency avulsion/ migration:
Width of active braid-plain > 10 km
- Sediment supply at basin-scale controlled by water discharge
[climatic signal in catchment area?]
- 4 Mega-sequences (BP1-4): migration of mega alluvial system within the basin

Lower Wolfville Fm

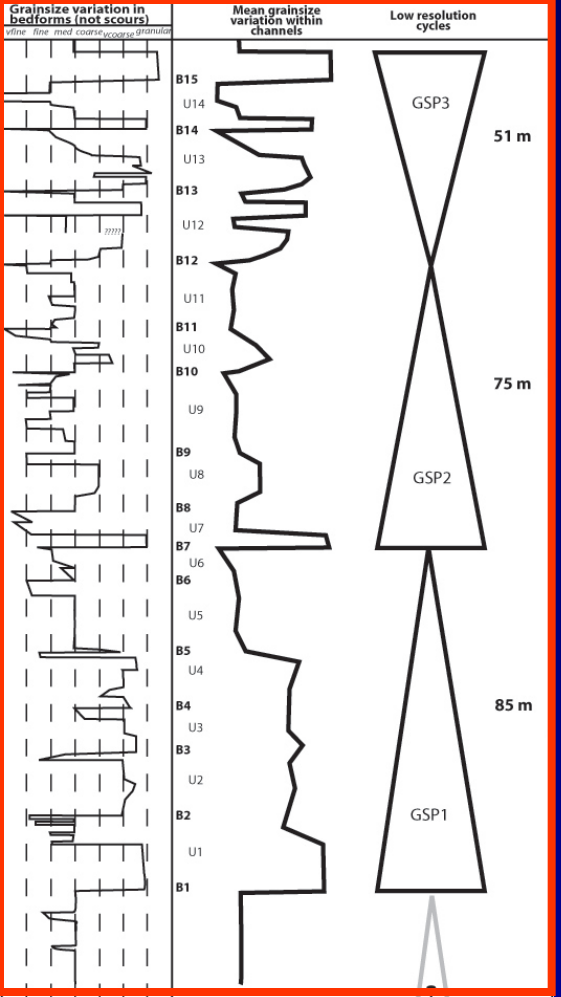




Middle Wolfville Fm



Middle Wolfville Fm



- 15 sequences of channel belt abandonment
- 3 mega sequences (bedload variations):
  - Climatic signal in catchment area
  - Capture in catchment area
  - Variations in uplift rate

(Leleu et al., in press, JSR)

Hierarchy in architecture of alluvial system

- High resolution packages:
  - Channel body is the smallest element
  - Channel complexes (belts) formed by stacked channel bodies

  Autocyclic

- Medium resolution packages:
  - Packages of channel complexes and abandonment facies forming repetitive units

  Autocyclic **on a DFS**

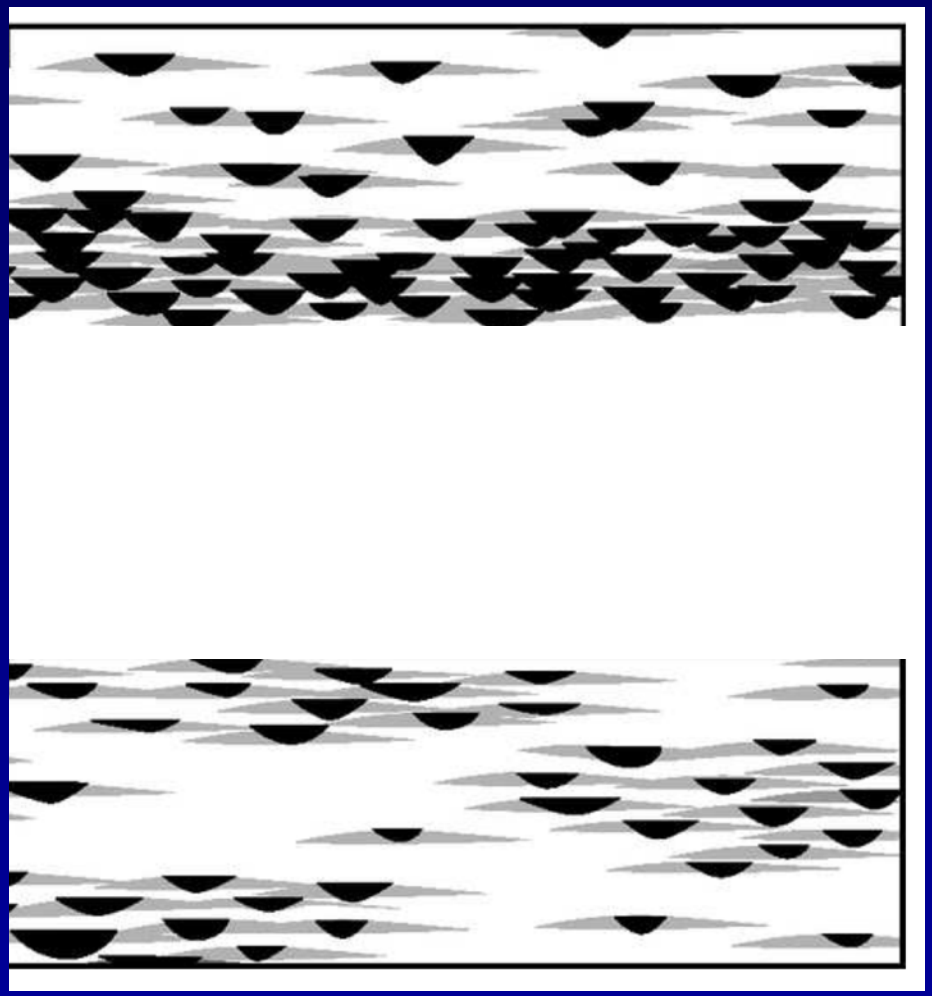
- Lower resolution packages:
  - Bedload grainsize changes forming sequences

  Allocyclic: climatic if repetitive

- Lowest resolution:
  - Basin architecture changes

  Allocyclic

Control on the alluvial architecture



Hajek et al., Geology, in press

- **LAB model (70's): Architecture controlled by variation of accommodation space/ sediment supply**

- **Avulsion (autocyclic)**

Control on the alluvial architecture

Adequate sedimentary models

- Distributive (*vs* tributive)
- Facies belt and architecture very different at basin-scale
- Deciphering controls depend on the sedimentary model

Conclusions

Cycles and Packages in Fluvial Deposits: What Do We Know?

- Upstream parameters are the main controls on alluvial architecture
- Upstream parameters are catchment-related.
- Adequate sedimentary models are necessary at regional scale before deciphering controls…
- Superimposition of cycles at different scales
  - High resolution: Migration/ avulsion of channels: autocyclic processes
  - Medium resolution: stacked channel complexes: autocyclic processes (channel belt avulsion) or/ and allocyclic (catchment-related or basin-related)
  - Low resolution: Bedload changes: water discharge variations [climatic trends when basin-wide and repetitive]
  - Lowest resolution (basin fill): allocyclic (catchment-related or basin-related)
- Regional knowledge is needed and better constrains on catchment
  - Climatic controls can be determined

Thanks for your attention