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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References


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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

Distal alluvial plain

Base Level

Isolated, high-sinuosity fluvial channels

Tidally influenced fluvial deposits

Amalgamated fluvial channels

Valley incision

Low-sinuosity high-gradient rivers

(Wright and Marriott 1993)

(Shanley and McCabe 1994)
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

*(Holbrook, 2006)*
Cycles and packages in the Triassic Wolfville Fm: the Fundy Basin (Nova Scotia)

Active syn-sedimentary faulting
Fluvial evolution through basin history:

- 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)

(Leleu & Hartley, 2010)
Minas sub-basin
### Lower Wolfville Fm

<table>
<thead>
<tr>
<th>Period</th>
<th>Age (Ma)</th>
<th>Layer</th>
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<tbody>
<tr>
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<td></td>
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</tr>
<tr>
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<td>Wolfville Fm</td>
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<td>North Mountain Basalt</td>
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<tr>
<td><strong>Early Jurassic</strong></td>
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<tr>
<td>Blomidon Fm</td>
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<tr>
<td><strong>North Mountain Basalt</strong></td>
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<td></td>
</tr>
</tbody>
</table>

![Lower Wolfville Fm geological section](image-url)
- 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
Middle Wolfville Fm

<table>
<thead>
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<th>Age (Ma)</th>
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<td>Anisian</td>
<td>245.9</td>
</tr>
</tbody>
</table>

North Mountain Basalt
Blomidon Fm
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

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

- Lower resolution packages:
  - Bedload grainsize changes forming sequences

- Lowest resolution:
  - Basin architecture changes
Control on the alluvial architecture

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

- Avulsion (autocyclic)

Hajek et al., Geology, in press
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