Abstract

The Wahweap Formation (Fm) is a ~400 m thick package of fluvial/estuarine channel sandstones and floodbasin mudstones deposited adjacent to the Western Interior Seaway (WIS) during the Late Cretaceous. It contains four informal members: the lower, middle, upper and capping sandstone members. This study aims to test existing tectono-eustatic basin models and reconstruct the sedimentary and tectonic history of the southern Cordilleran foreland basin during this important interval.

A radiometric date of 80.1 Ma has been obtained from the lower part of the middle member, indicating that the middle and upper members were deposited during the Claggett transgression, a eustatic rise in the WIS that occurred at ~79.6 Ma. Sedimentological analysis and sand:mud ratios suggest that the lower member, which contains two laterally extensive sandstone bodies with internal erosive surfaces and intraformational rip-up clasts, was deposited in a low accommodation space setting.

The middle member is dominated by grey mudrocks with minor carbonaceous shale and fine-grained sandstone. It represents the fastest sediment accumulation rate in the Wahweap Fm and records a shift to a high accommodation space setting at the same time as the initiation of the Claggett transgression in the WIS. The upper member consists of several thick sandstone bodies interbedded with mudrocks. Tidally influenced inclined heterolithic strata and the brakish water trace fossil Teredolities are present suggesting, along with its appropriate age, that the upper member corresponds to the sea level highstand in the WIS during the Claggett transgression. Sedimentological evidence and new age data therefore suggest that stratigraphic changes in the Wahweap Fm are eustatically rather than tectonically driven, and support previous placement of a sequence boundary at the upper/capping sandstone contact.
Sequence Stratigraphic Control on Alluvial Architecture in an Upper Cretaceous Fluvial System – Wahweap Formation, Southern Utah, U.S.A.

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Wahweap fossils

Cimolodon electus

Cimolodon similis

Cimexomys sp. cf. C. antiquus

Eaton, 2002
Facies (Kaiparowits Plateau)
Facies (Kaiparowits Plateau)
Lower Member

- Mud dominated with two extensive amalgamated sandstone bodies
- Carbonaceous shale (subaqueous floodplain), splay and levee deposits
- Pedogenic carbonate associated with amalgamated sandstone bodies

Rapid sedimentation in a seasonal environment
Facies (Kaiparowits Plateau)
Facies (Kaiparowits Plateau)
KAIPAROWITS FORMATION

CAMPANIAN

middle

WAHWEAP FORMATION

upper member

lower member

SANTONIAN

CONJACIAN

Strait Cliffs Formation

Drip Tank Member

John Henry Member

Smoky Hollow Member

upper member

middle member

bentonite layer

Drip Tank Sandstone

(Straight Cliffs Formation)
Age information provided by $^{40}\text{Ar}/^{39}\text{Ar}$ dating of 5 sanidine crystals

- Radiometric dates from a volcanic ash
- Detrital zircon ages from the capping sandstone (Larsen, 2007)
- Previous radiometric dates from the overlying Kaiparowits Formation
Middle Member

- Mud dominated
- Carbonaceous shale (subaqueous) with minor pedogenesis towards top of horizons
- Channel elements contain wackes or siltstones

High accommodation space, rapid sedimentation
Facies (Kaiparowits Plateau)
Facies (Kaiparowits Plateau)
Upper Member

- Sandstone dominated
- IHS occurs in lower part
- Multistorey channel sandstones, numerous levee and splay deposits

Slow reduction in accommodation space, tidal influence
Facies
(Kaiparowits Plateau)
Capping Sandstone

- Major shift in depositional environment: meandering to braided
- Large bars, numerous internal erosive surfaces, incision up to 2 m
- Sandstone dominated; minor palaeosol horizons with pedogenic carbonate

Low accommodation space, extensive reworking of deposits
Western Interior Seaway: Late Cretaceous cyclothsems

- Bearpaw (~74.0 Ma)
- Claggett (79.6 Ma)
- Niobrara
- Greenhorn

Kauffman, 1977
Non-marine sequence stratigraphy

• Changes in base level affect deposition in continental environments:
  – Stream type
  – Accommodation space (aggradation vs. amalgamation)

• Transgressions can be eustatic (global) or localised (due to tectonic subsidence).

• Were changes in base level during Wahweap deposition eustatic or tectonic?
Teredolites: Brackish water trace fossil

Heterolithic strata: Tidal couplets

Alluvial architecture at maximum transgression
Are stratigraphic changes in the Wahweap Formation controlled by eustasy or tectonic events?

- Tectonic events generate changes that are localised and vary proximally/distally.
- Eustatic events generate changes that are extensive and noticeable in proximal and distal parts of a basin.
# Age of the Claggett

<table>
<thead>
<tr>
<th>Age (Ma)</th>
<th>Stage</th>
<th>Western Interior Ammonite Zones</th>
<th>HAWA</th>
<th>Big Bend N.P. Texas</th>
<th>San Juan Plateau</th>
<th>Kaiparowits Plateau</th>
<th>Henry Basin</th>
<th>Book Cliffs</th>
<th>Rock Springs Uplift</th>
<th>Bighorn Basin</th>
<th>Red Bird Wyoming</th>
<th>Northwest Montana</th>
<th>Central Montana</th>
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<tbody>
<tr>
<td>74-75</td>
<td>upper</td>
<td>D. cheyennense</td>
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<td>E. jenney</td>
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<td>76-77</td>
<td>middle</td>
<td>D. stevensoni</td>
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<td>D. obtusus (80.54 Ma)</td>
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<td>B. sp (weak flank</td>
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<td>79-80</td>
<td>lower</td>
<td>B. sp (smooth)</td>
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<td>S. hippocrepis III</td>
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<td>B. sp (smooth)</td>
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Conclusions – Alluvial Architecture

• Wahweap deposition occurred in a wet, seasonal climate.

• Sand:mud ratios and alluvial architecture suggest high accommodation space in the lower and middle members, with low accommodation space in the top of the upper and capping sandstone.

• Alluvial architecture and correlation with other sequences support the placement of a sequence boundary at the upper-capping sandstone contact.
Conclusions – Tectonic and Eustatic Influences

• Eustasy (the Claggett transgression) controls major changes in stacking patterns, depositional environment and the position of sequence boundaries.

• Smaller-scale changes in alluvial architecture and sand:mud ratios may be tectonically or climatically driven.
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References


