Sediment Dispersal Across Late Cretaceous Shelf, Western Interior Seaway, Northern Utah and Colorado, USA*

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Abstract

Two large (200-300 km), near-continuous outcrops transect and extensive well-log data (c. 2800 wells) allow quantitative analysis of sediment dispersal and associated high-resolution (c. 0.1-0.5 Ma) stratigraphic architecture across a large area (c. 60,000 km^2) of the latest-Santonian-to-middle-Campanian coastal plain, shoreline and offshore shelf environments along the western margin of the Western Interior Seaway in northeastern Utah and northwestern Colorado, USA.

In the lower part of the studied interval, sediment was dispersed via wave-dominated deltaic systems with a "compound clinoform" geomorphology in which an inner, wave-dominated shoreface clinoform was separated by a muddy subaqueous topset from an outer clinoform containing sand-poor, gravity-flow deposits. These strata are characterised by relatively steep, net-regressive shoreline trajectories (>0.1°) with concave-landward geometries, narrow nearshore belts of storm-reworked sandstones (2-22 km), wide offshore mudstone belts (>250 km) and relatively high sediment accumulation rates (c. 0.27 mm/yr).

The middle and upper parts of the studied interval also contain wave-dominated shorefaces, but coeval offshore mudstones enclose abundant "isolated" tide-influenced sandstones that were transported sub-parallel to the regional paleoshoreline by basinal hydrodynamic (tidal?) circulation. These strata are characterised by relatively shallow, net-regressive shoreline trajectories (<0.1°) with straight to concave-seaward geometries, wide nearshore belts of storm-reworked sandstones (19-70 km), offshore mudstone belts of variable width (130 to >190 km) and relatively low sediment accumulation rates (c. ≤0.11 mm/yr).

The change in shelfal sediment dispersal and stratigraphic architecture, from (1) "compound clinoform" deltas characterised by across-shelf sediment transport to (2) wave-dominated shorelines with "isolated" tide-influenced sandbodies characterised by along-shelf sediment transport, is interpreted to reflect increased interaction with the hydrodynamic regime in the seaway as successive

shelfal depositional systems advanced out of a sheltered embayment ("Utah Bight"). This advance was driven by decreasing tectonic subsidence rate, which also suppressed autogenic controls on stratigraphic architecture.

References

DeCelles, P.G. and J.C. Coogan, 2006, Regional structure and kinematic history of the Sevier fold-and-thrust belt, central Utah: GSA Bulletin, v. 118/7-8, p. 841-864, doi: 10.1130/B25759.1.

Krystinik, L.F. and B.B. DeJarnett, 1995, Lateral variability of sequence stratigraphic framework in the Campanian and lower Maastrichtian of the Western Interior Seaway *in* J.C. Van Wagoner and G.T. Bertram (editors), AAPG Sequence Stratigraphy of Foreland Basin Deposits: Outcrop and Subsurface Examples from the Cretaceous of North America: AAPG Memoir 64, p. 11-25.

Obradovich, J.D.,1993, A Cretaceous time scale: *in* Evolution of the Western Interior Basin: Geological Association of Canada, Special Paper, p. 379-396.

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Aims

Analysis of a large, well constrained dataset from ancient shelf strata:

- to demonstrate the range of processes that dispersed sediment over the shelf

- to investigate how these various processes have contributed to shelf morphology and construction

- to elucidate the relative role of various forcing mechanisms in controlling shelf stratigraphy

Talk Outline

Dataset and geological context

- Cretaceous Western Interior Seaway

Shelf deposits and depositional system(s)

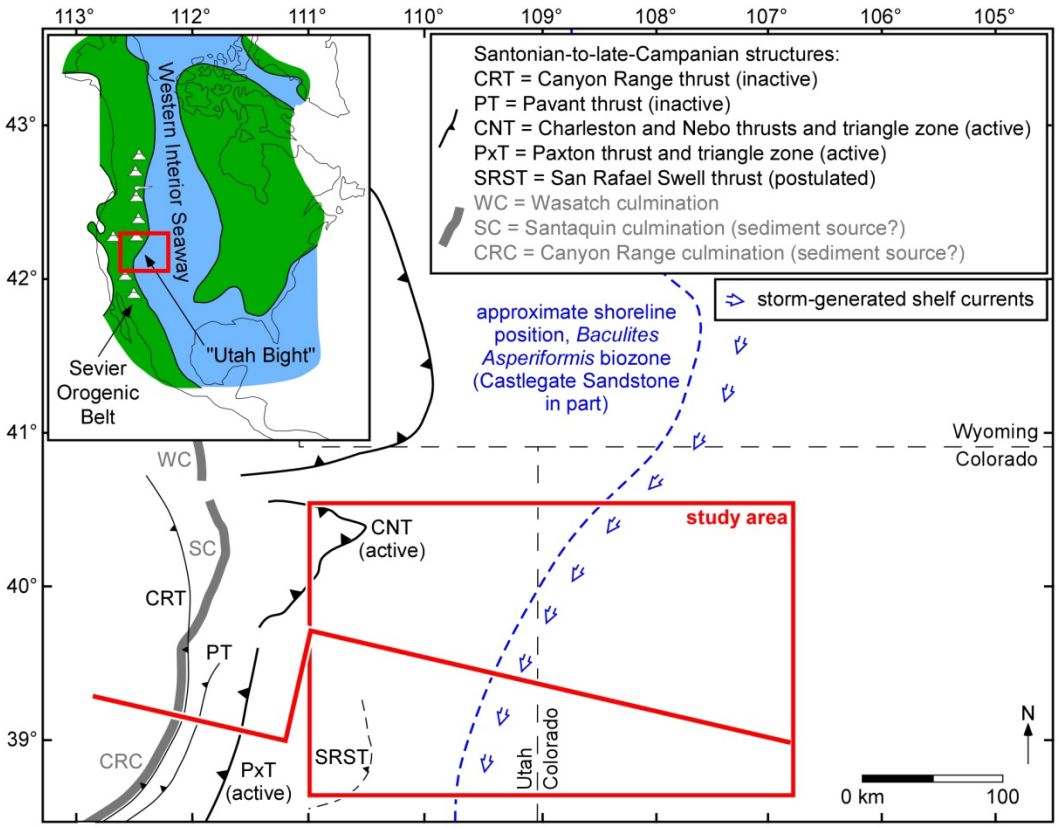
- range of sediment dispersal processes active on shelf
- styles of stratigraphic architecture
- shelf palaeogeomorphology

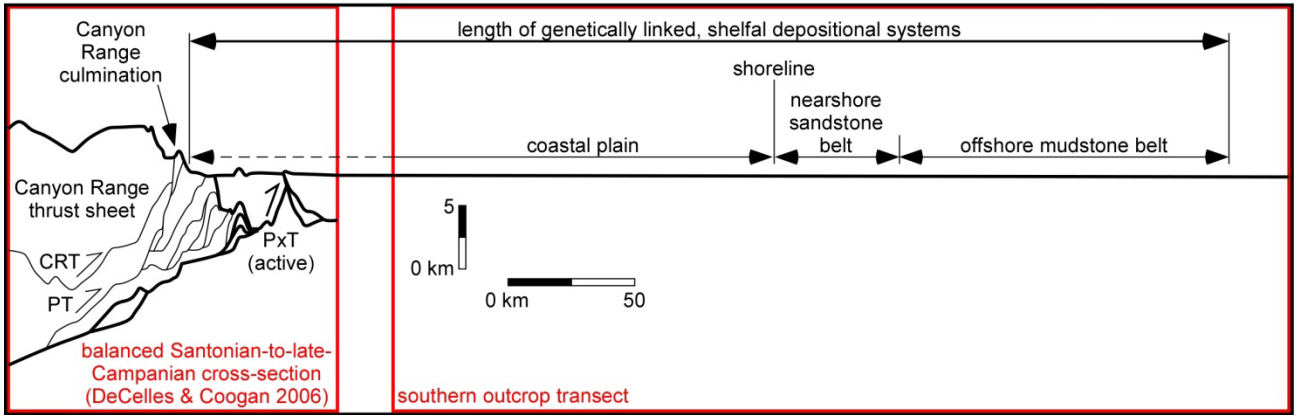
Quantitative measures of stratigraphic architecture

- sediment volumes and sediment accumulation rates
- shoreline trajectory

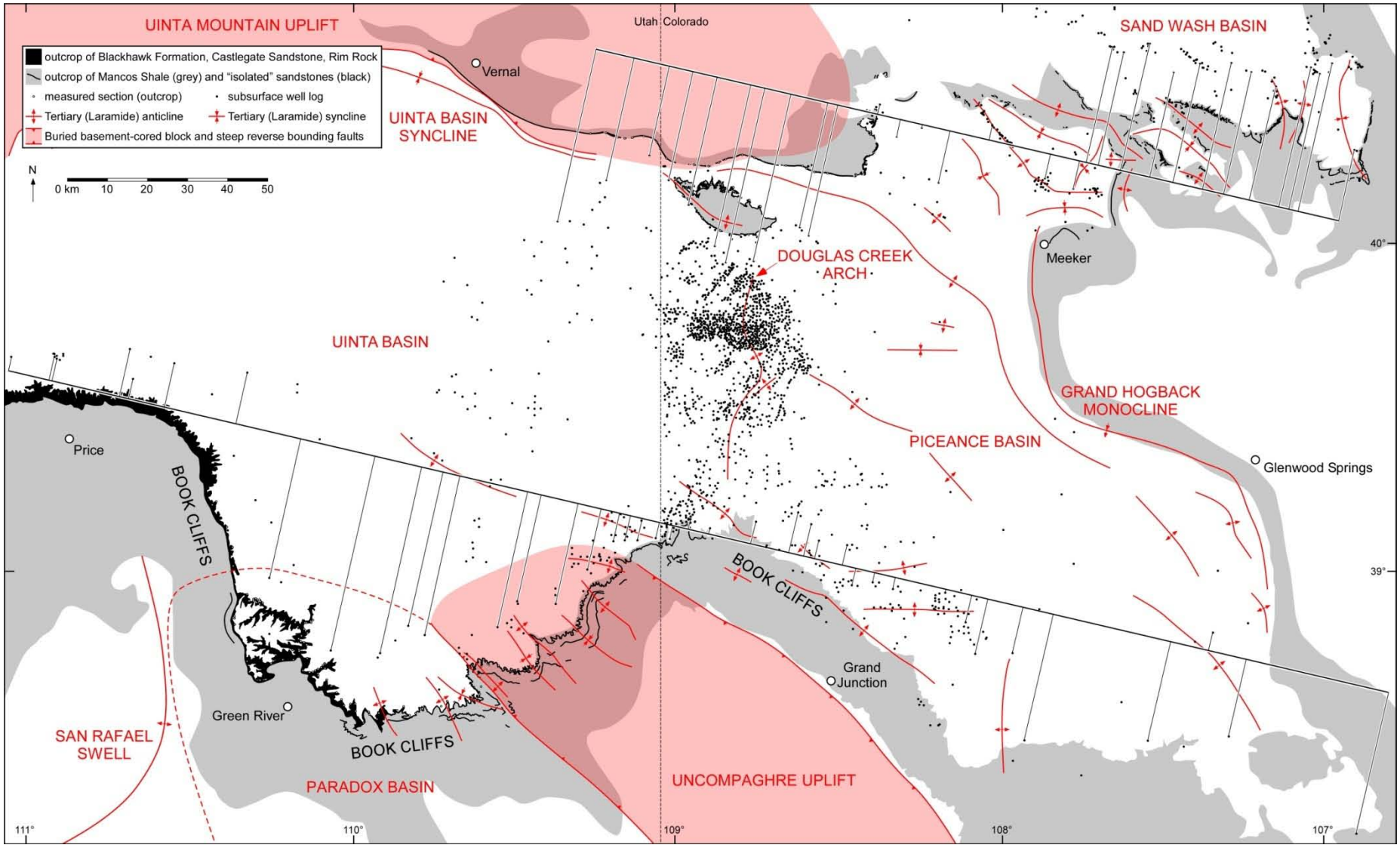
Conclusions

Geological setting and dataset



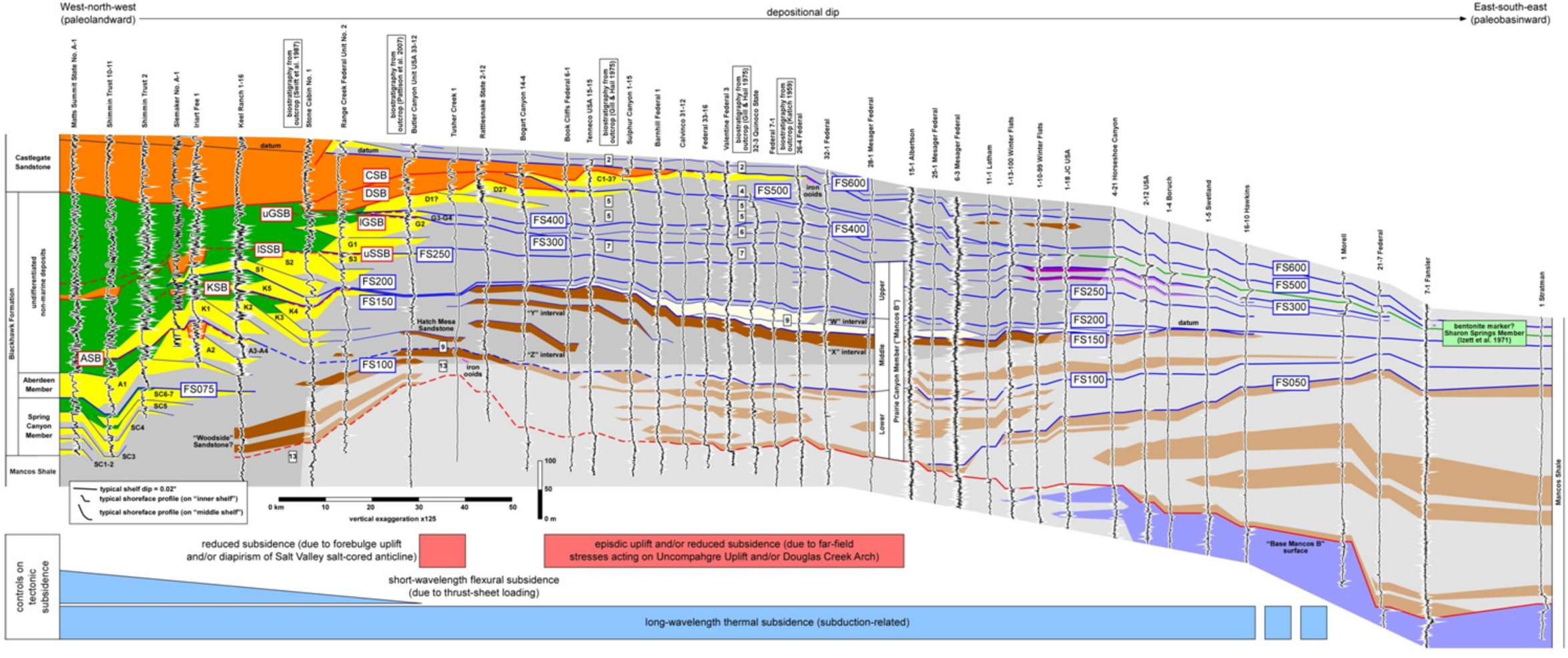


Geological setting and dataset

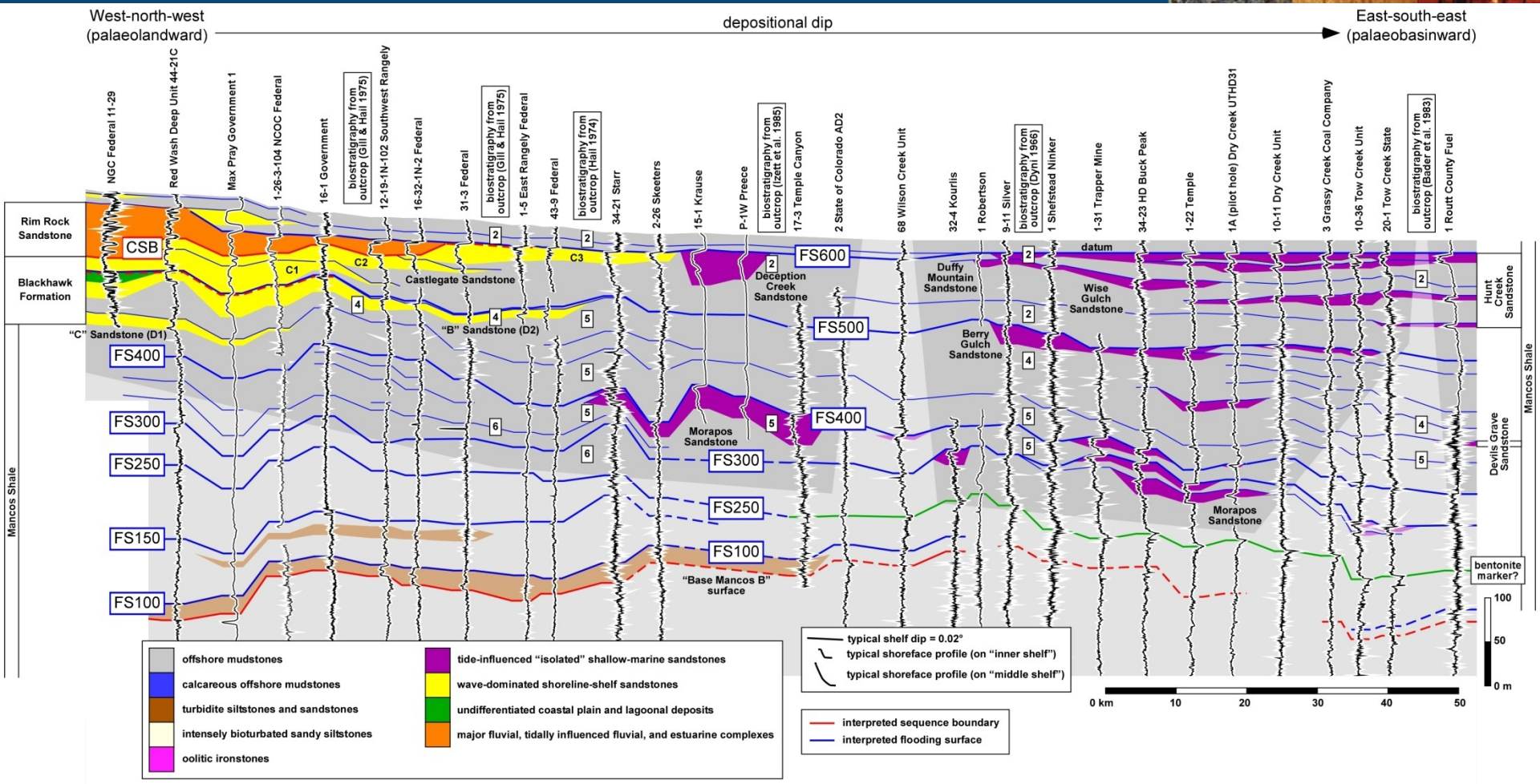


- continuous exposure along two dip-oriented shelf transects
- extensive subsurface well-log dataset (c. 2800 wells)

Southern shelf transect (Book cliffs)

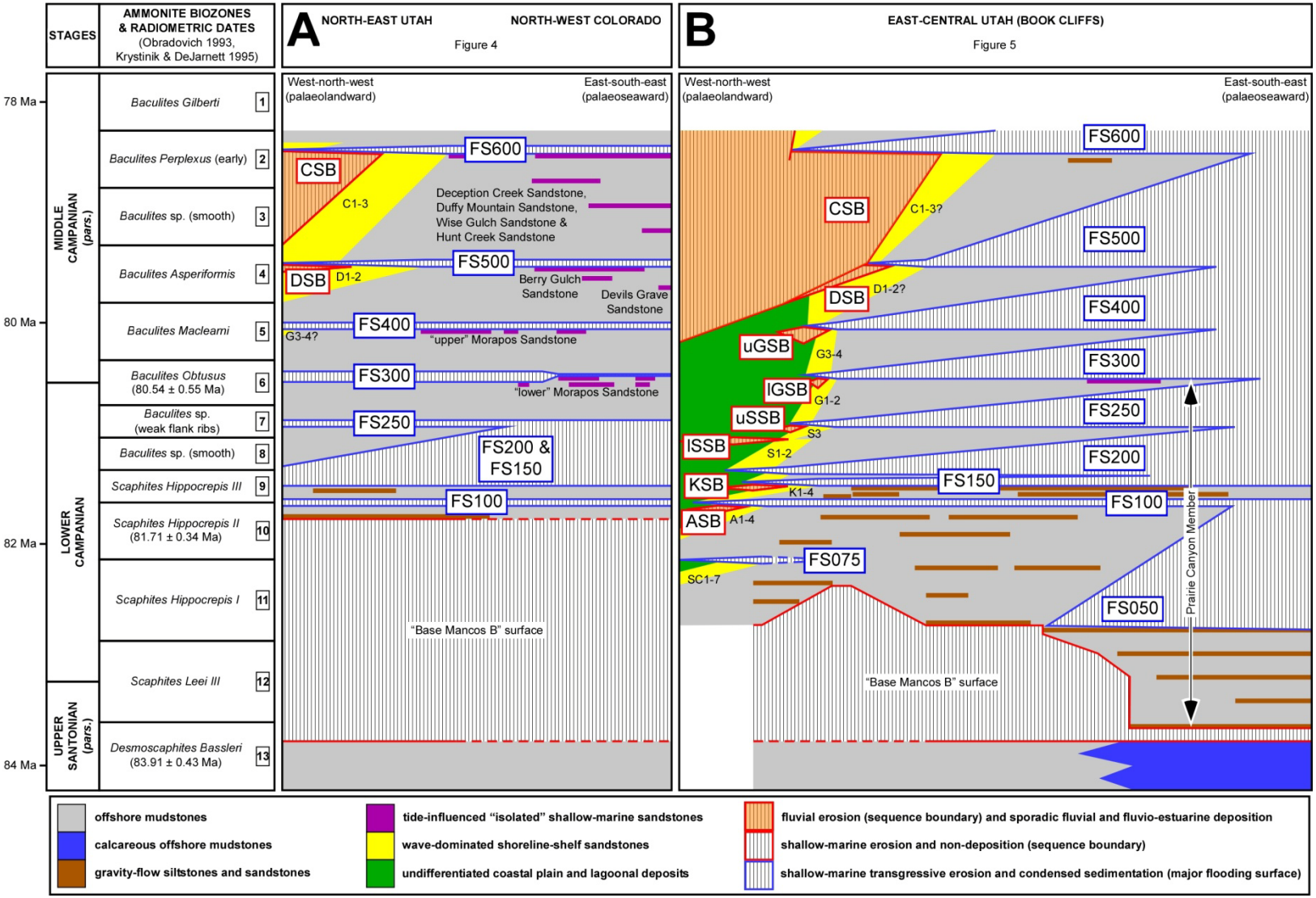


Northern shelf transect



- Transects combine outcrop and subsurface well-log data
- Major flooding surfaces and sequence boundaries correlated through dataset
- Isopach and palaeogeographic maps constructed for key intervals

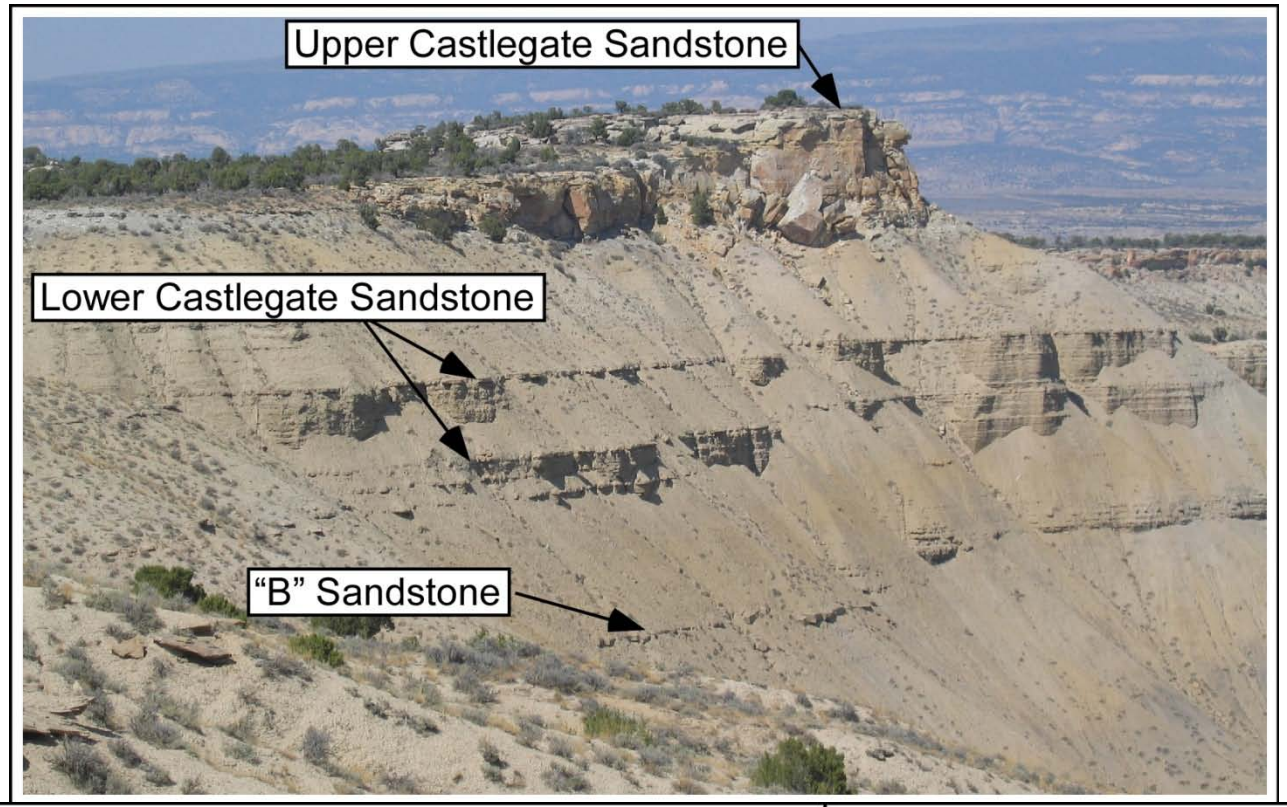
Chronostratigraphic framework



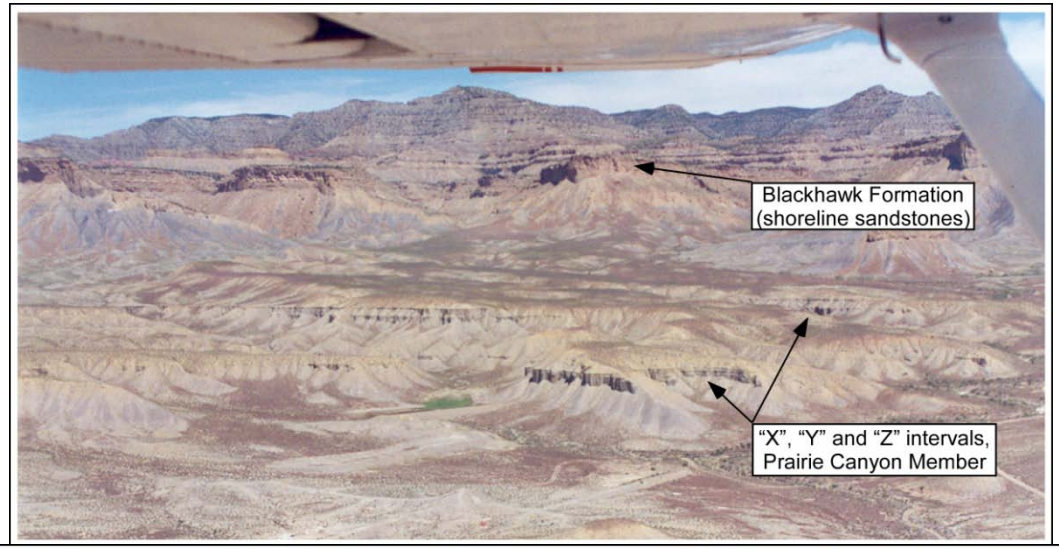
Sequence stratigraphic framework tied into ammonite biostratigraphy

- c. 0.5 Ma time resolution

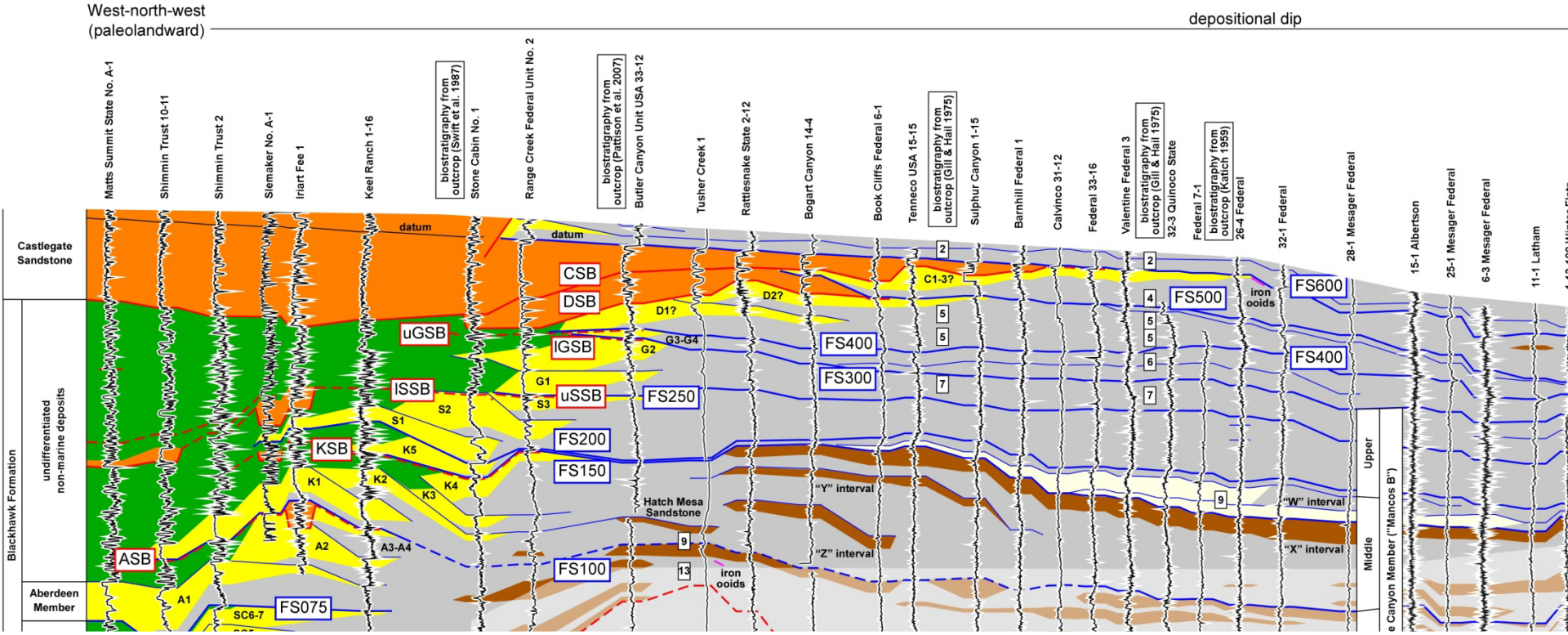
Wave-dominated deltaic shorelines

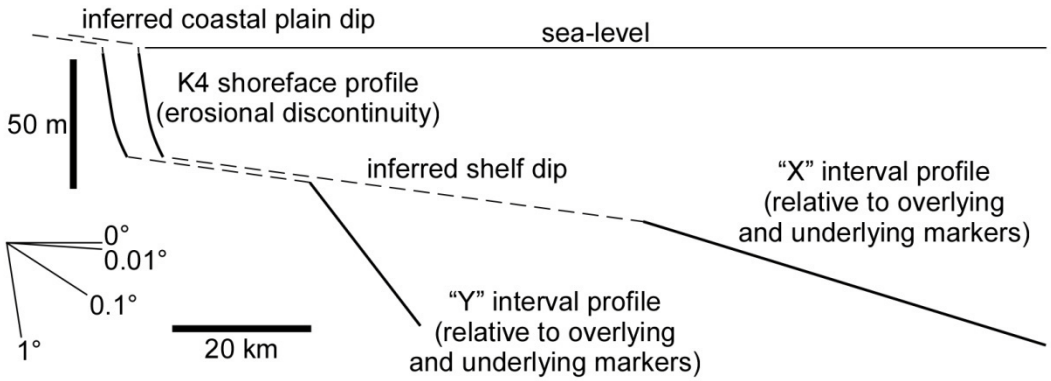


Gravity flows on shelf

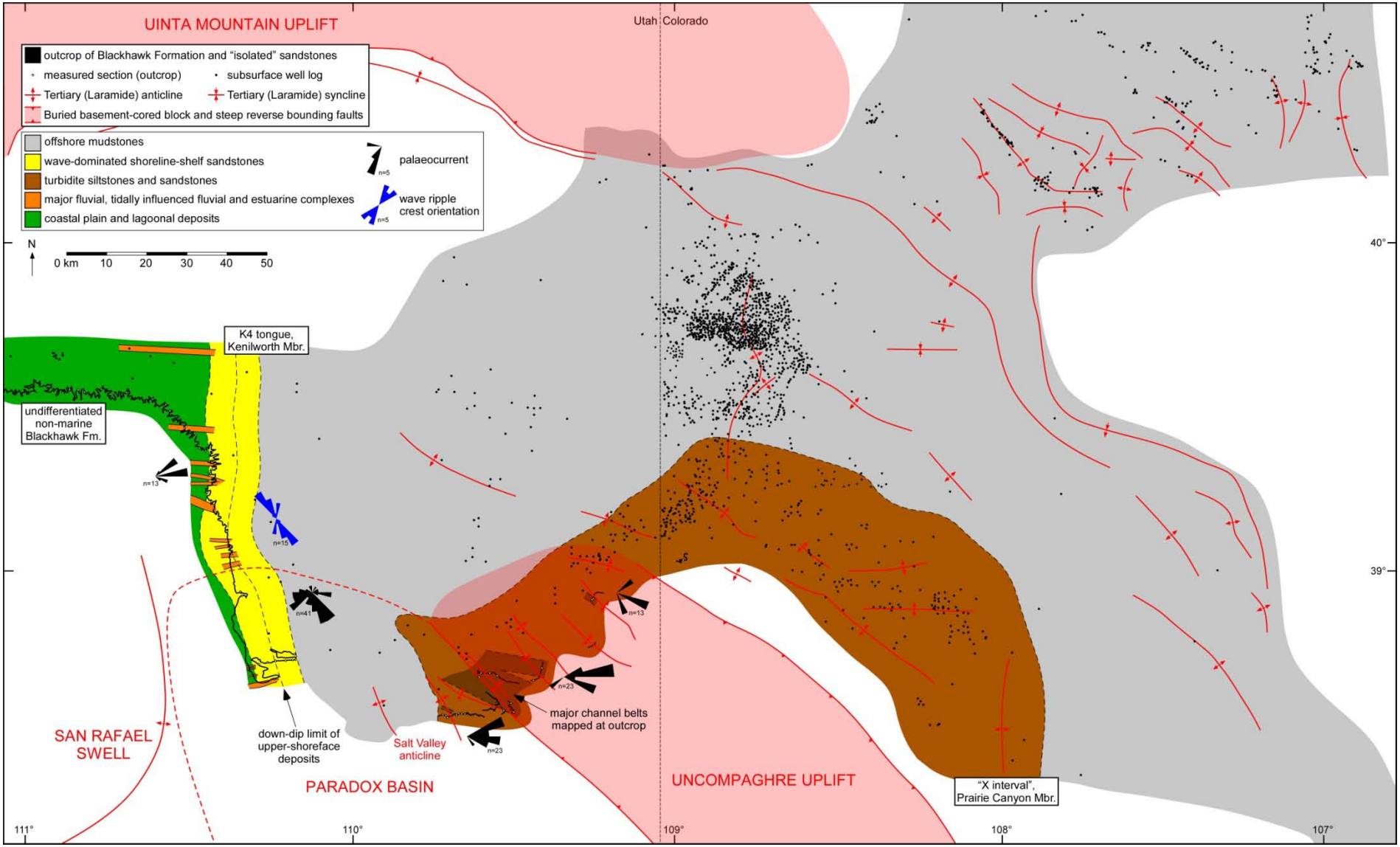


Wave-dominated delta morphology

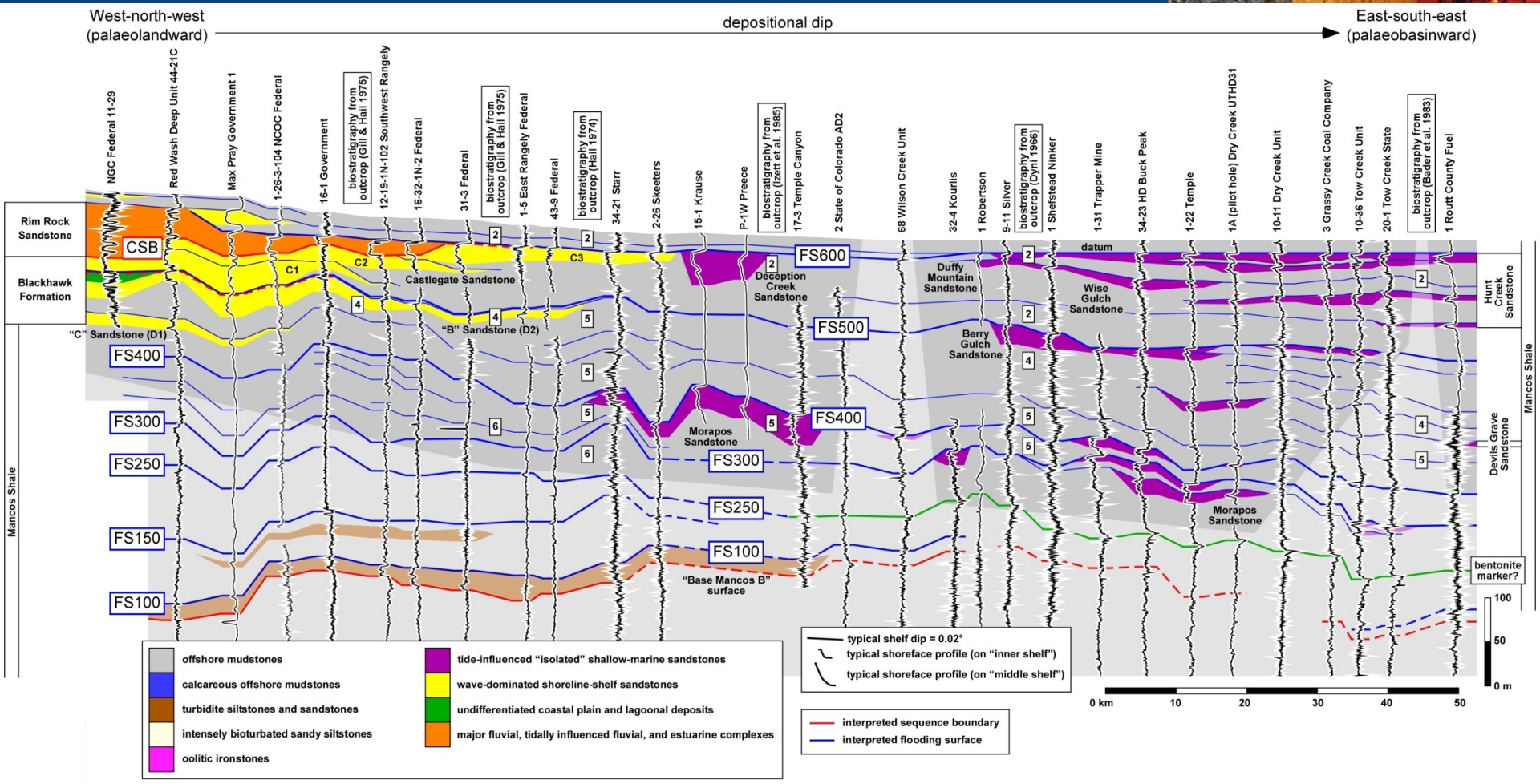




Palaeogeography: sub-FS150



Northern shelf transect



- Transects combine outcrop and subsurface well-log data
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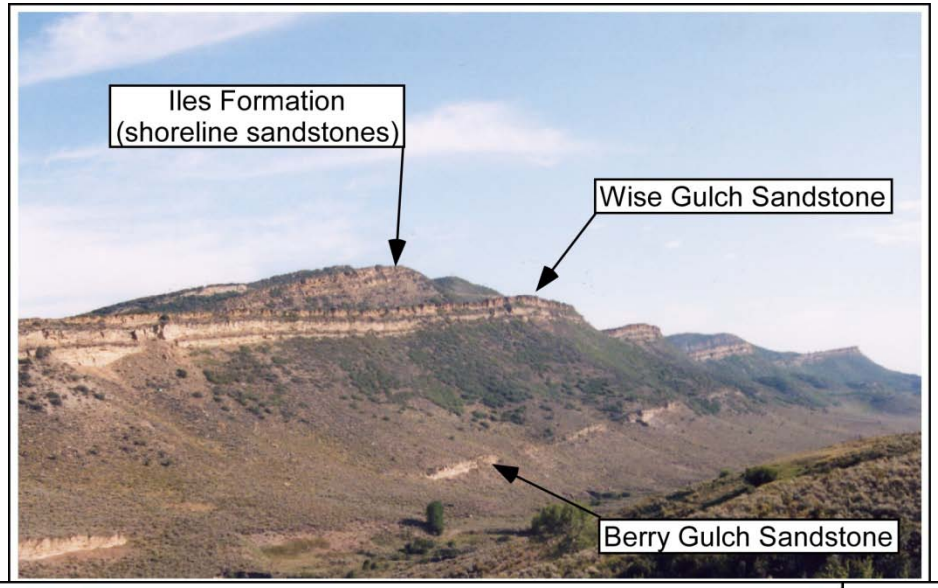
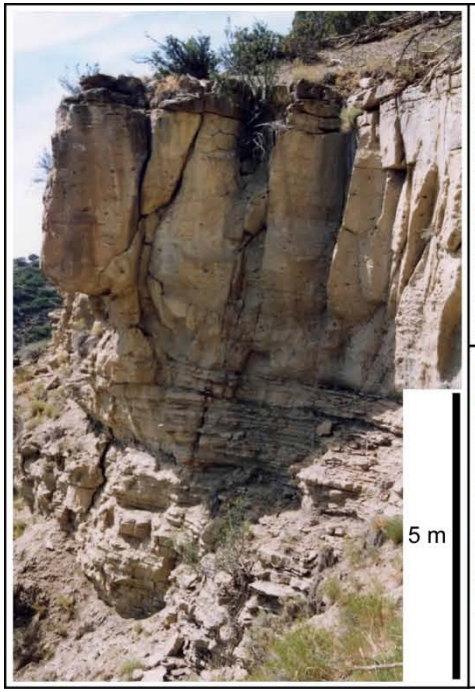
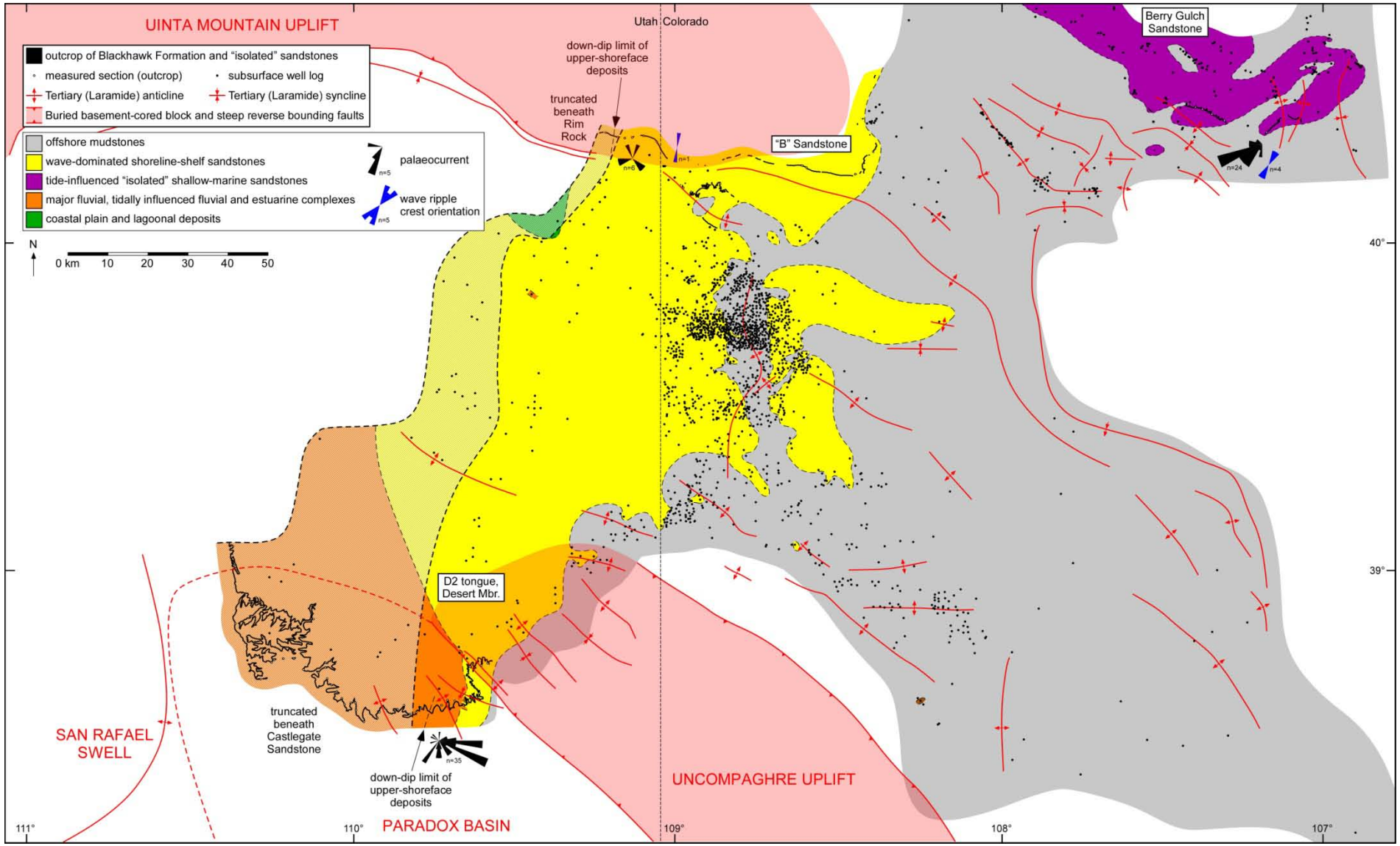
Tidally influenced deltaic shorelines(?)

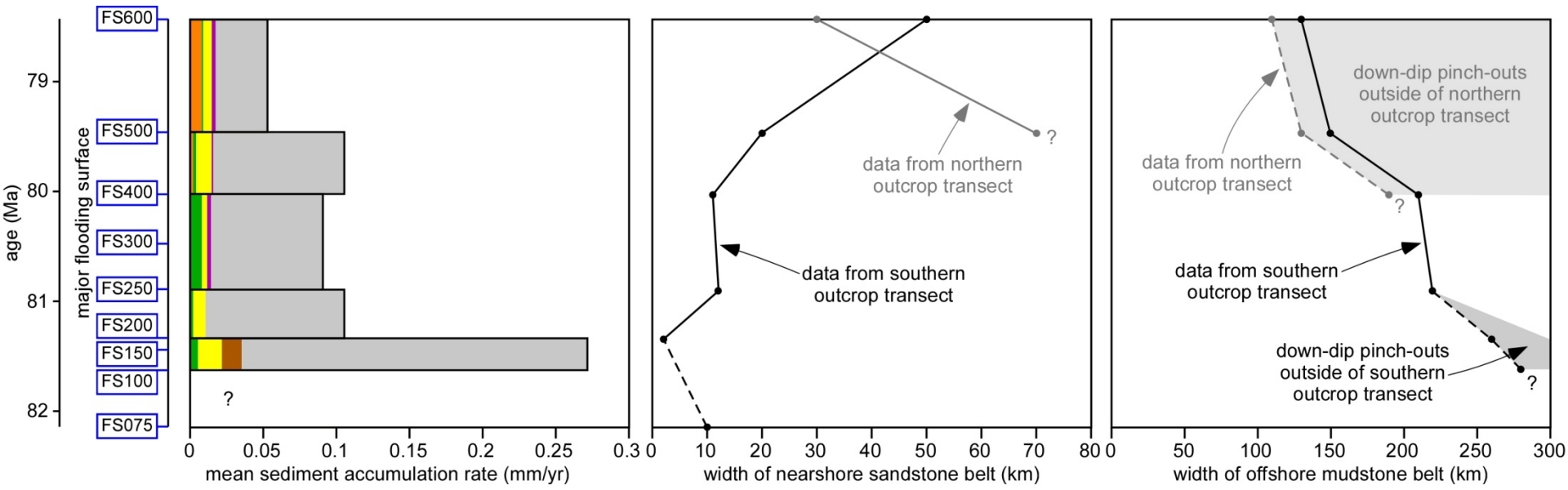




Palaeogeography: sub-FS500



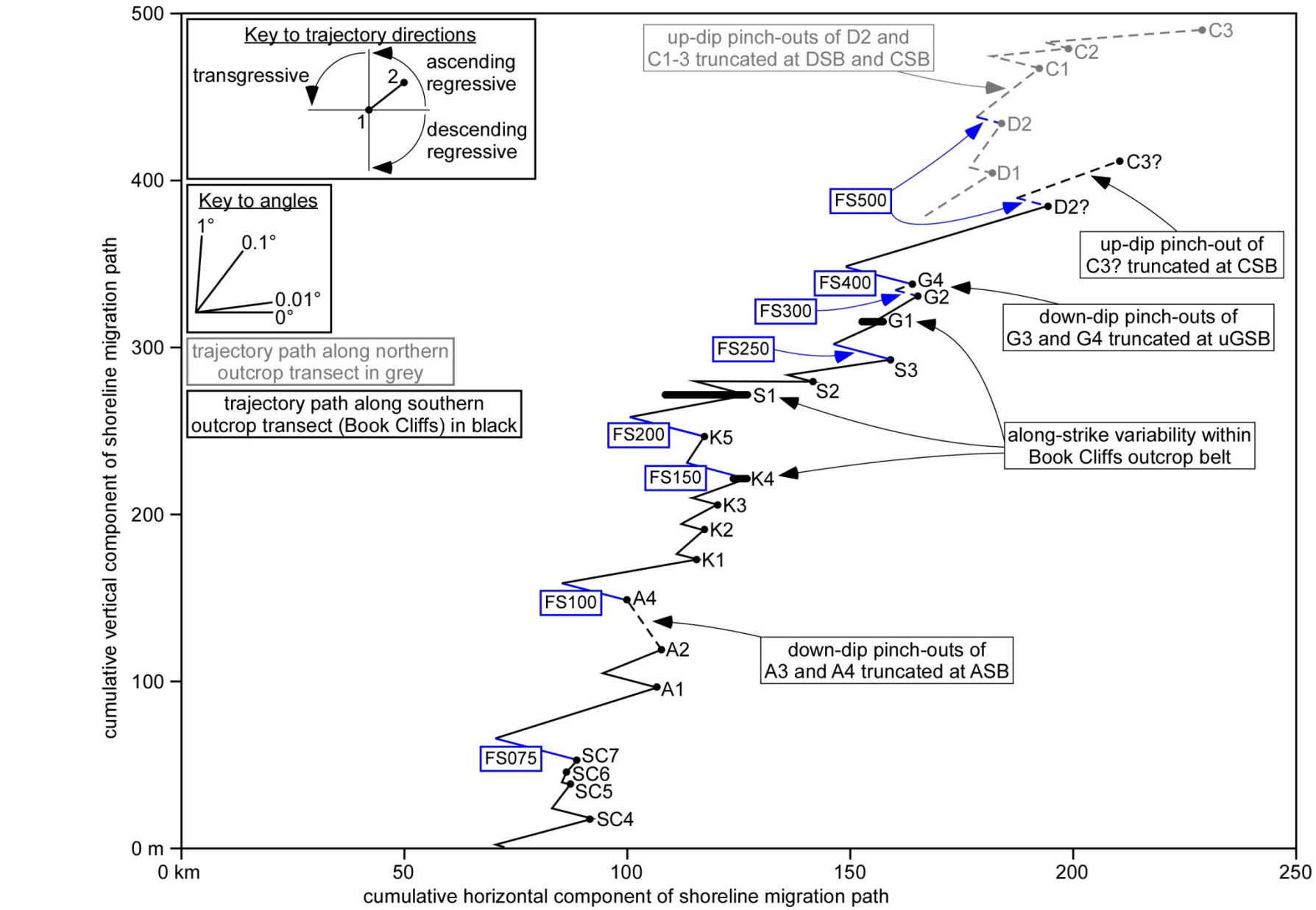
Genetically linked shoreline-shelf systems



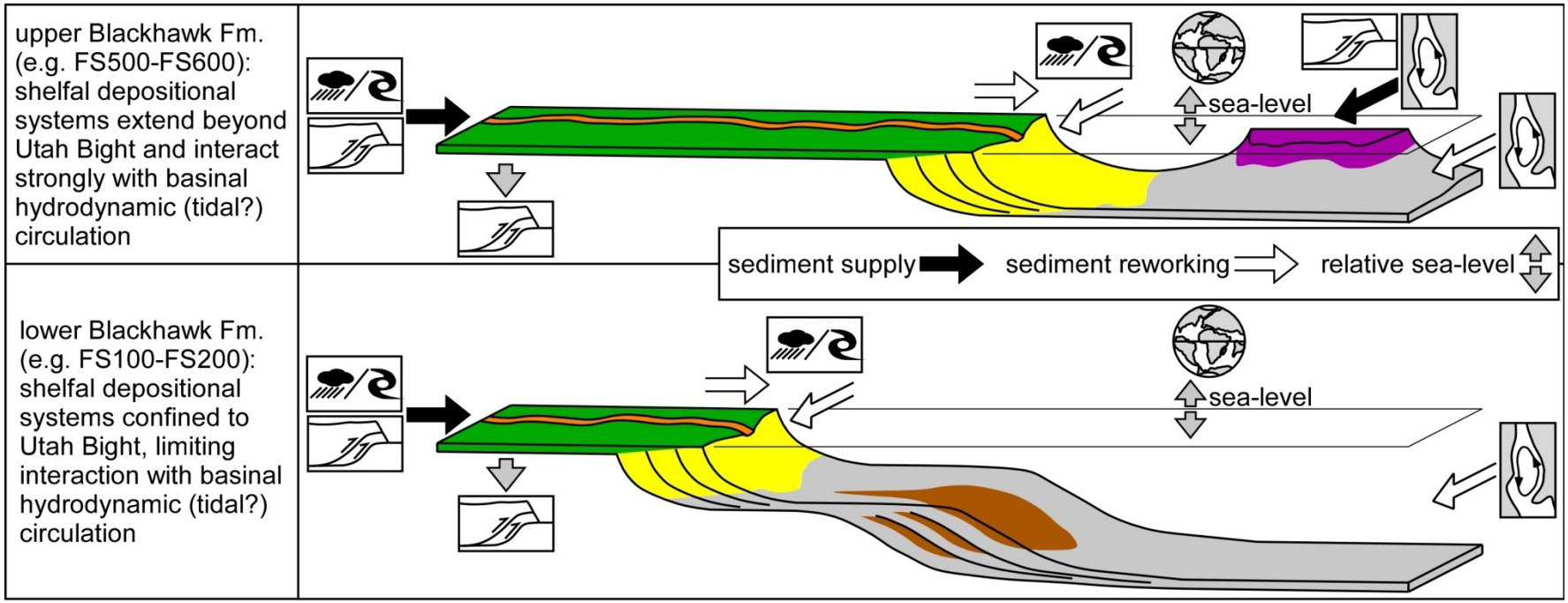
- Wave-dominated delta with “compound clinoform” geomorphology:
  - narrow nearshore belts of storm-reworked sandstones (2-22 km)
  - wide offshore mudstone belts containing gravity flows (>250 km)
  - relatively high sediment accumulation rates (c. 0.27 mm/yr)

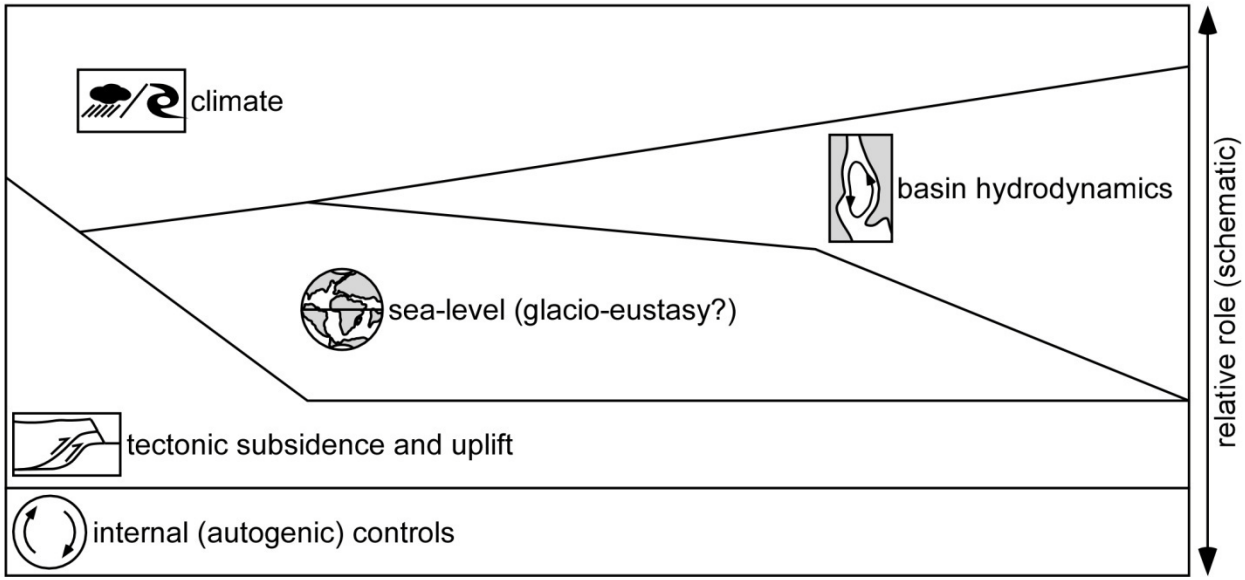
- Wave-dominated delta with coeval “isolated” tide-influenced sandstones:
  - wide nearshore belts of storm-reworked sandstones (19-70 km)
  - offshore mudstone belts of variable width (130 to >190 km)
  - relatively low sediment accumulation rates (c. ≤0.11 mm/yr)

Shoreline trajectory



Genetically linked shoreline-shelf systems





Conclusions

- Wave-dominated delta with “compound clinoform” geomorphology:
  - narrow nearshore belts of storm-reworked sandstones (2-22 km)
  - wide offshore mudstone belts containing gravity flows (>250 km)
  - relatively high sediment accumulation rates (c. 0.27 mm/yr)
  - dominantly across-shelf sediment transport
  - relatively steep, net-regressive shoreline trajectories (>0.1)

- Wave-dominated delta with coeval “isolated” tide-influenced sandstones:
  - wide nearshore belts of storm-reworked sandstones (19-70 km)
  - offshore mudstone belts of variable width (130 to >190 km)
  - relatively low sediment accumulation rates (c. ≤0.11 mm/yr)
  - dominantly along-shelf sediment transport
  - relatively shallow, net-regressive shoreline trajectories (<0.1)

- Change in shelfal sediment dispersal and stratigraphic architecture due to:
  - increased interaction with hydrodynamic regime in the seaway
  - driven by decreasing tectonic subsidence rate, which forced progradation