Temporal Evolution of Fluvial Style within a Compound Incised Valley, Ferron Notom Delta, Henry Mountains Region, Utah*

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Search and Discovery Article #50198 (2009)
Posted September 30, 2009

*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Denver, Colorado, June 7-10, 2009

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Abstract

Nonmarine sequence stratigraphic models hypothesize systematic changes in fluvial architecture and style within individual sequences and across sequence boundaries. These models, however, are largely assumed rather than documented.

Major fluvial bodies are well exposed along depositional strike near the top of the Ferron Notom Delta in the Henry Mountains region, Utah. Field correlation and mapping show that these fluvial facies are contained within a wide compound incised valley. The valley is partitioned into two unconformity-bounded sequences, each of which comprises a multistory fill that reaches a maximum thickness of about 30 m. The two major erosional surfaces extend laterally for several kilometers and shows erosional relief up to 10 m. Each erosion surface shows a marked basinward shift in faces.

Detailed bedding architectural analysis establishes the fluvial style within each valley fill. Within the younger valley, there is a systematic evolution of fluvial style from braided, to braided with meandering reaches, and finally to a low sinuosity river systems with channels occupied by dune fields. In contrast, formative rivers within the older valley are always meandering. A major change in valley sedimentology is recognized as shown by the changes in regional flow direction, over all grain size, channel geometry, and fluvial style. Paleocurrent data shows that there is a 30° eastward shift in main flow as the compound incised valley evolves from the older to the younger system. A clear change in fluvial style from meandering into braided streams across the basal erosional surface of the younger valley is documented. The river deposits also show a distinct increase in overall grain size and greater preserved dune height across the boundary. Paleohydraulics calculations suggest an increase in river dimension and discharge across the boundary.

Changes in fluvial style within the younger valley are interpreted as the result of loss of slope and/or discharge during the gradual filling of the valley. The change in fluvial style across the sequence boundary is interpreted, however, as the result of a possible high-frequency climate change driven by Milankovitch cycles, even though short-term and low-amplitude eustasy is also the driving force for the development of the incised valleys.

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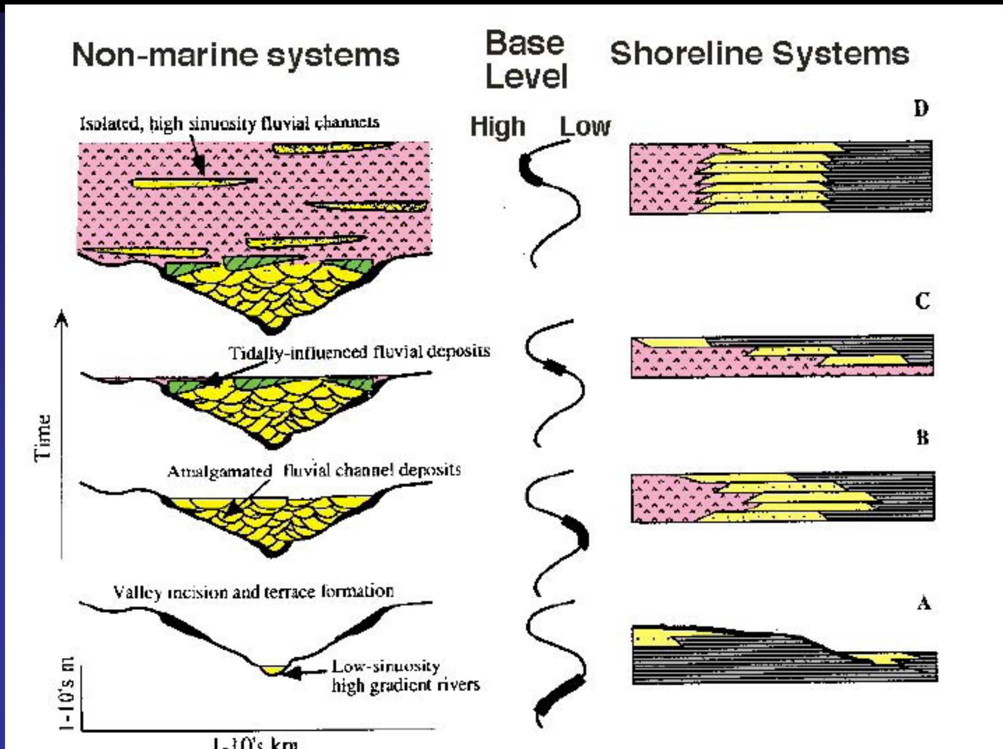
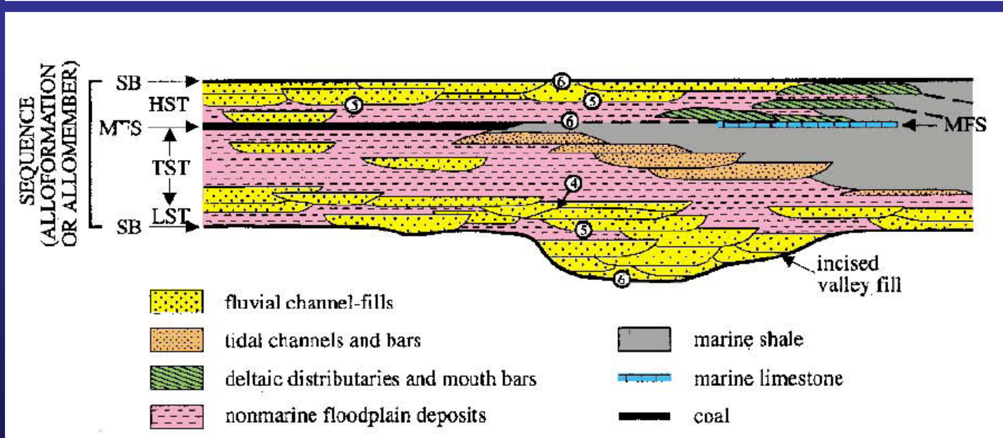


Shanley and McCabe, 1994

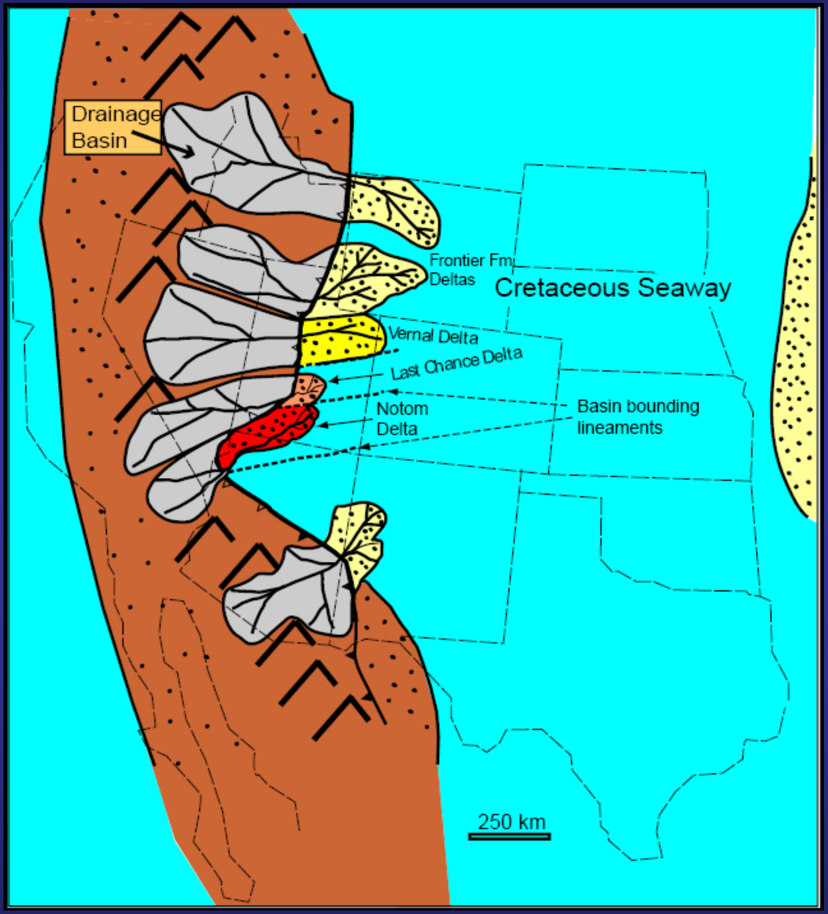


Miall, 1997

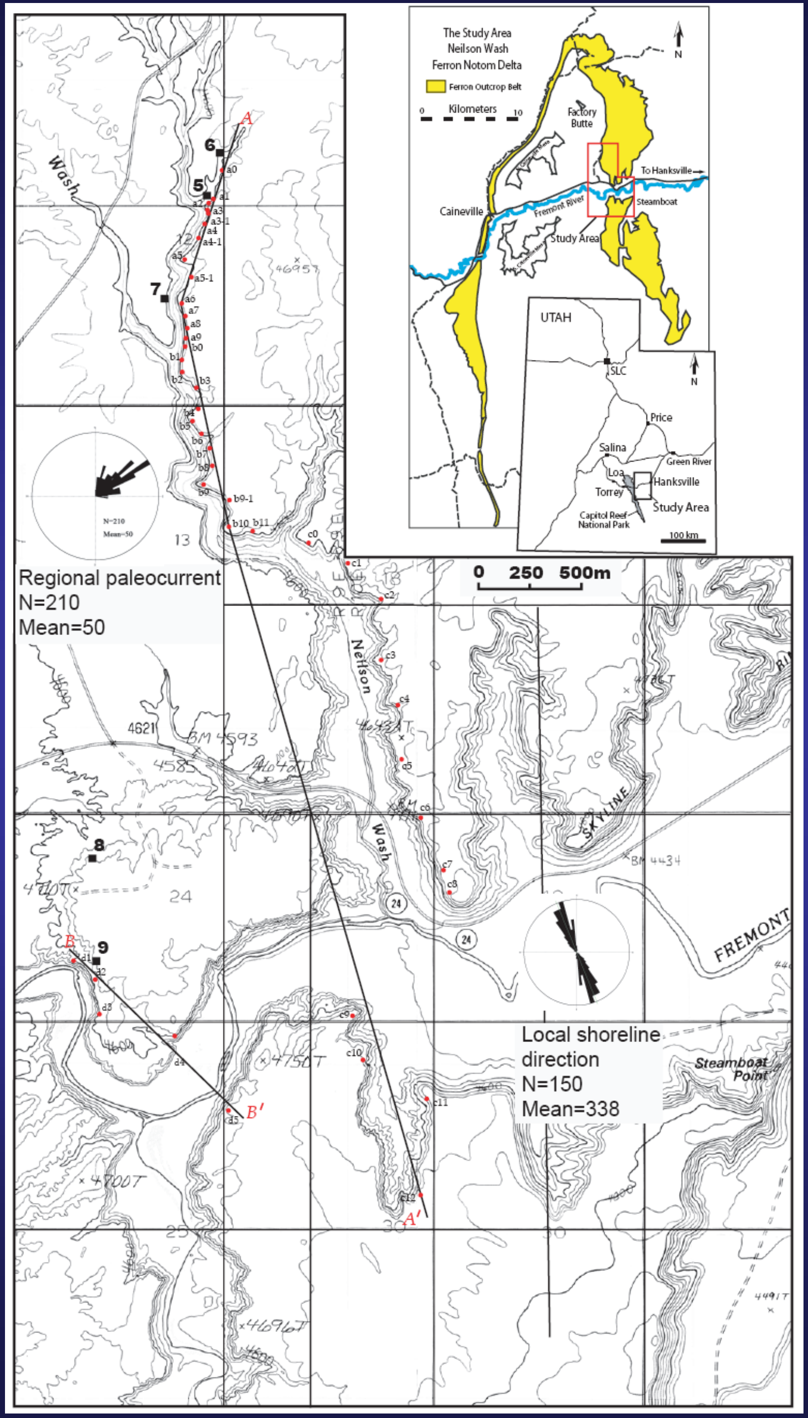
MOTIVATION

1. The existing nonmarine stratigraphic models are largely assumed, rather than documented, and their validity needs to be further tested.
2. What's the possible fluvial architecture with nonmarine sequences?
3. How about fluvial style?
4. Import for understanding fluvial architecture and reservoir geometry when the subsurface is sparsely sampled.

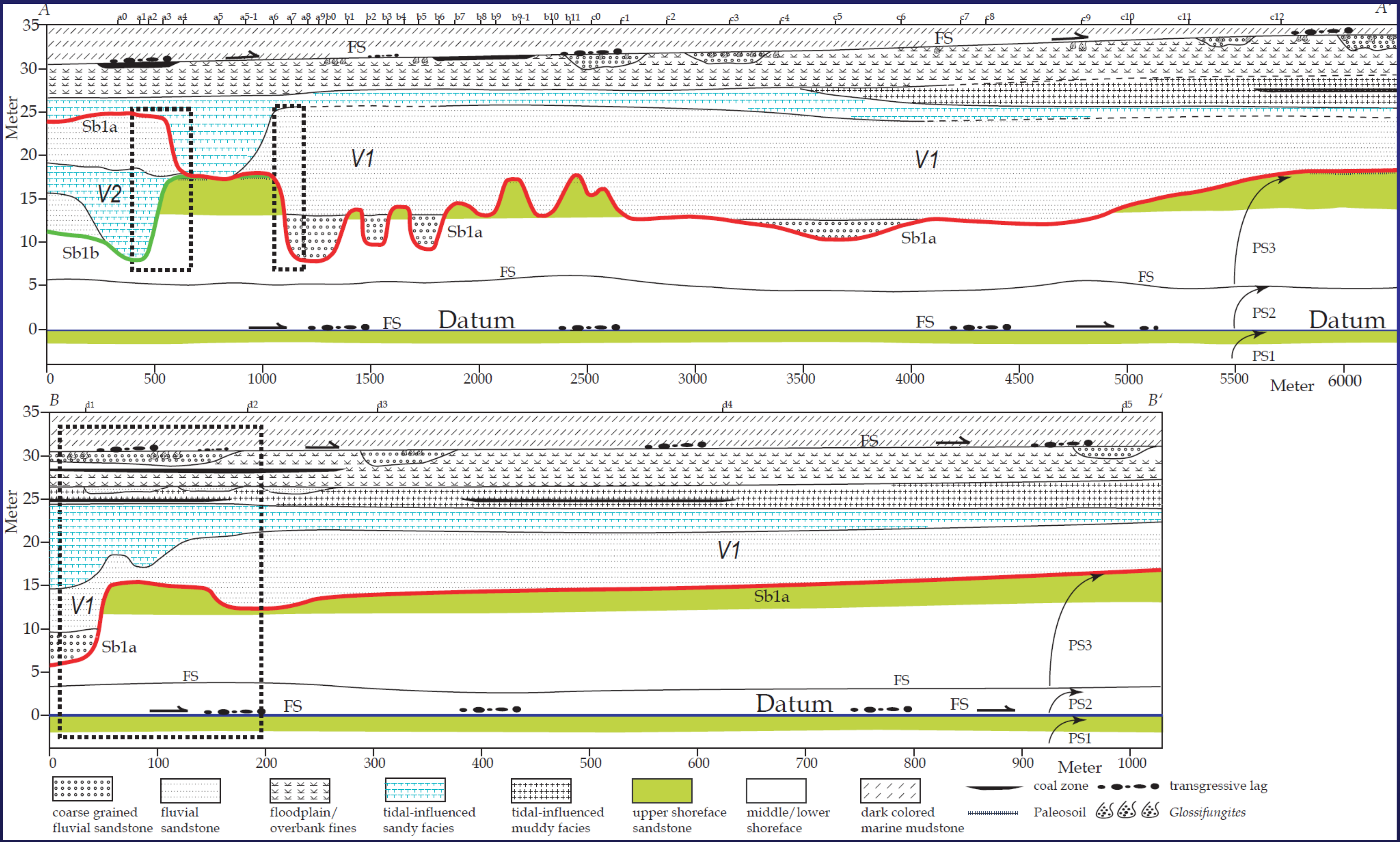
Regional geology and data set



Turonian paleogeography of North America showing the location of the Ferron clastic wedges (*Bhattacharya and Tye, 2004*).

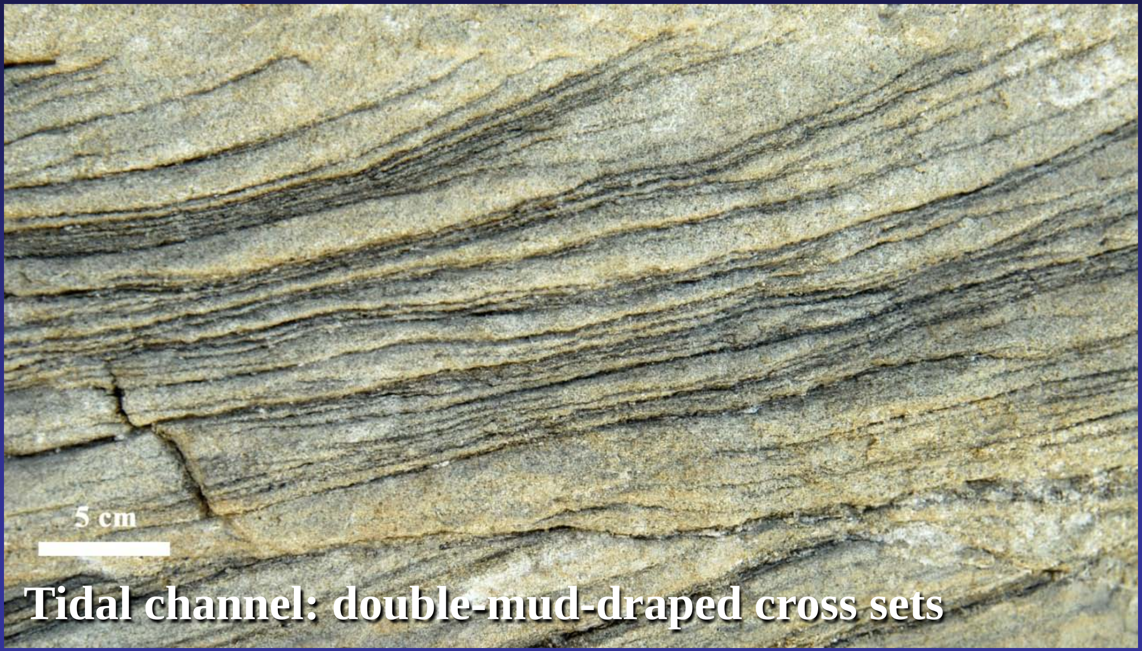


Stratal and facies organization within the compound incised valley

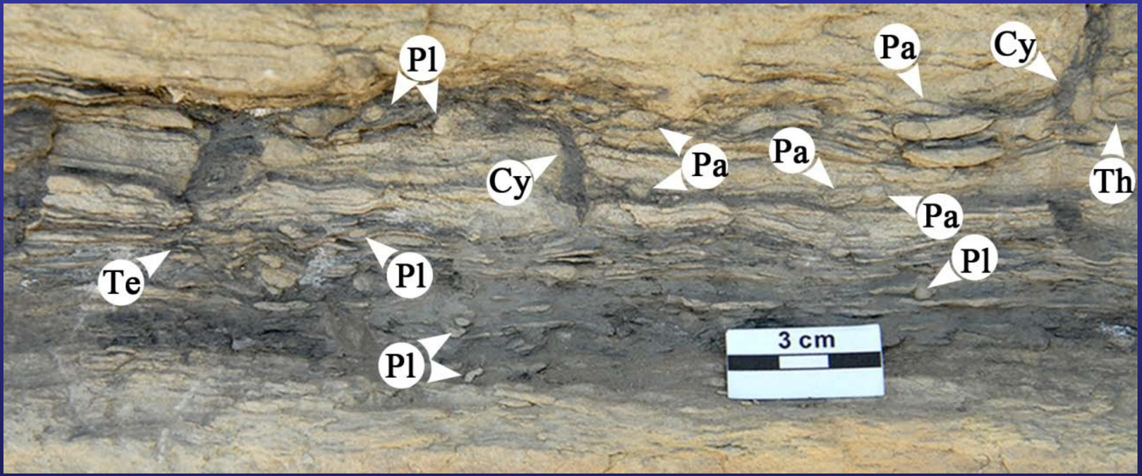


Deformed fluvial sandstone overlain by heterolithic tidal facies

Tidal facies



Tidal channel: double-mud-draped cross sets

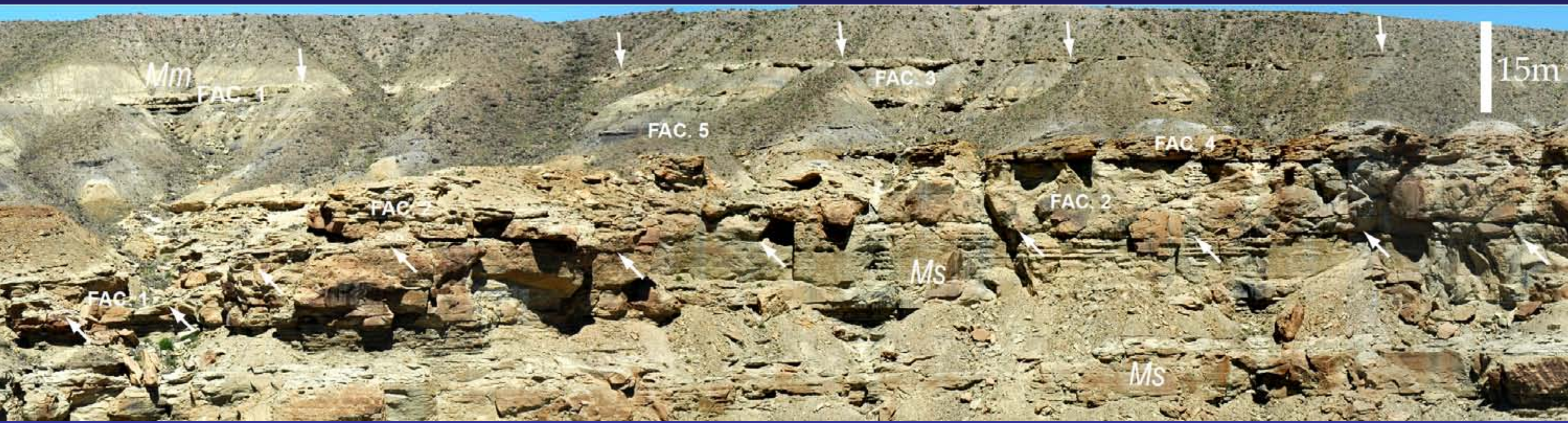


Teichichnus (Te), *Planolites* (Pl),

Palaeophycus (Pa), *Cylindrichnus* (Cy)

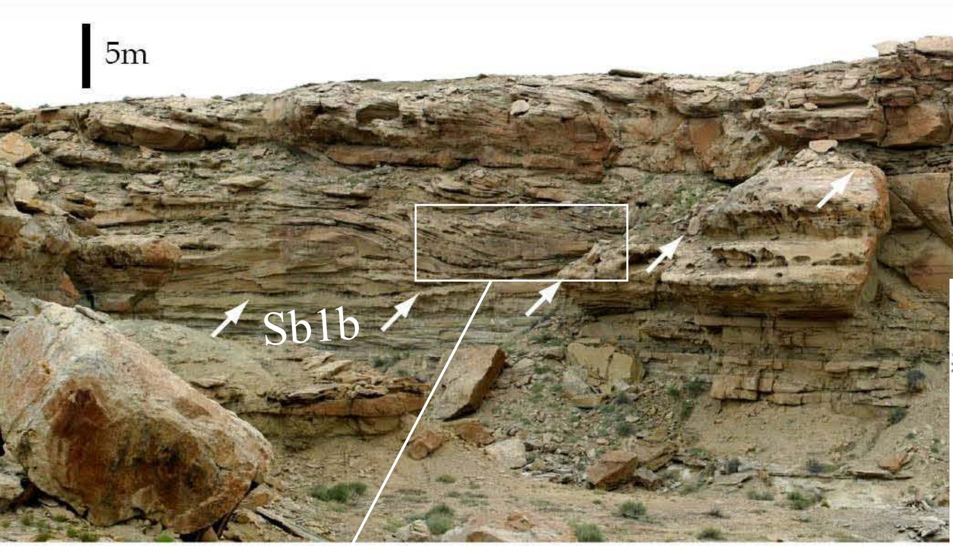
Flaser within tidal-fluvial channel

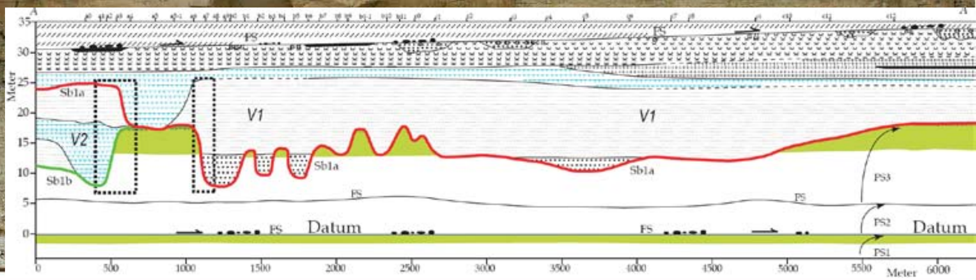
Internal facies organization within each valley episode



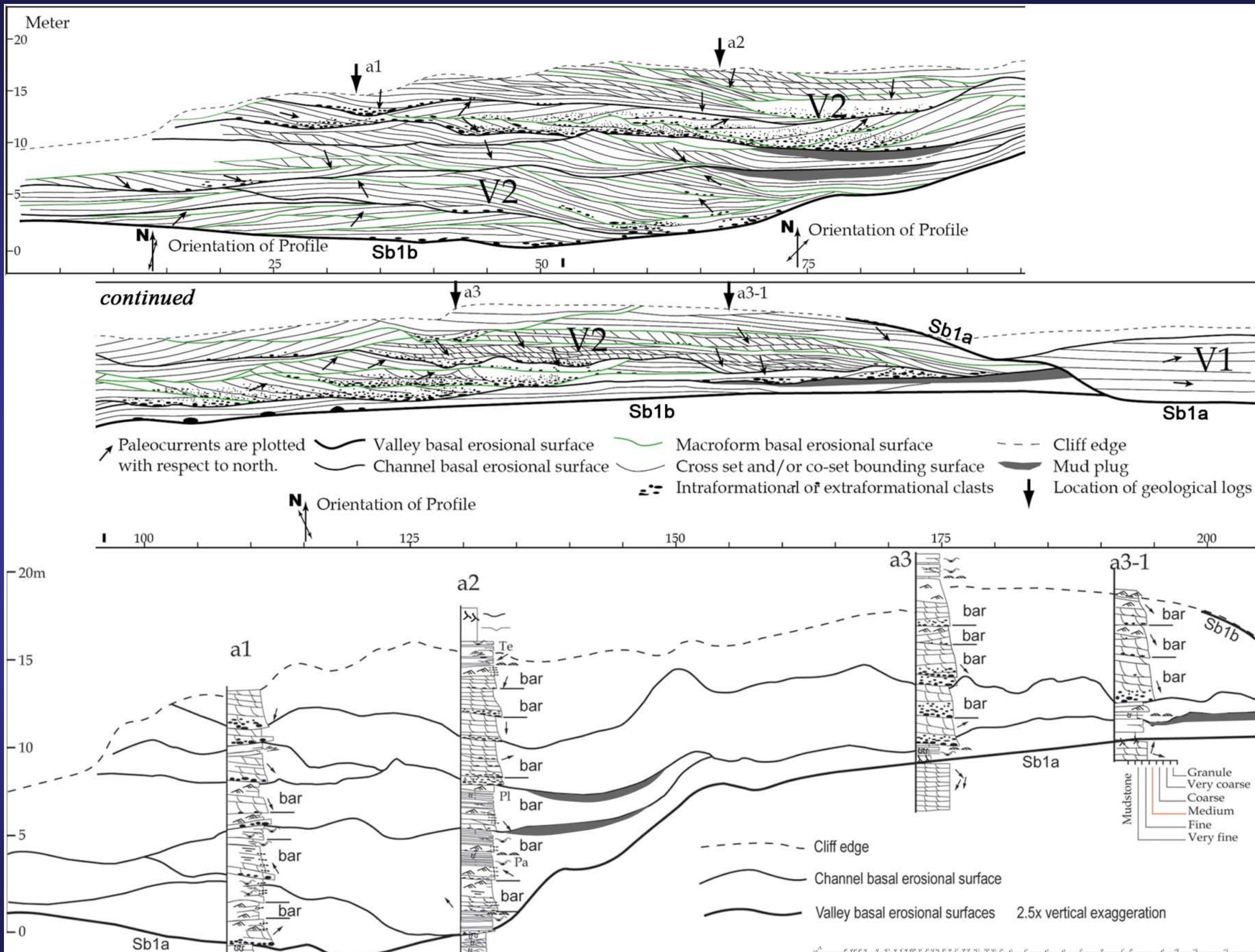
- **Ms: marine shoreface sandstone**
- **FAC1: coarse-grained fluvial sandstone**
- **FAC2: fluvial sandstone**
- **FAC3: fluvial overbank fines**
- **FAC4: sandy tidal deposits**
- **FAC5: muddy tidal deposits**

Unidirectionally dipping bed/bed sets



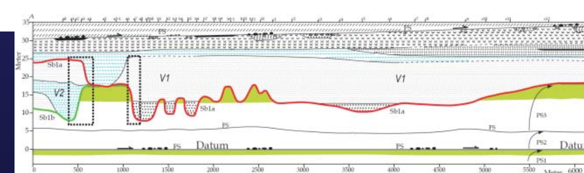


Bedding architecture of the meandering TST/HST deposits in V2

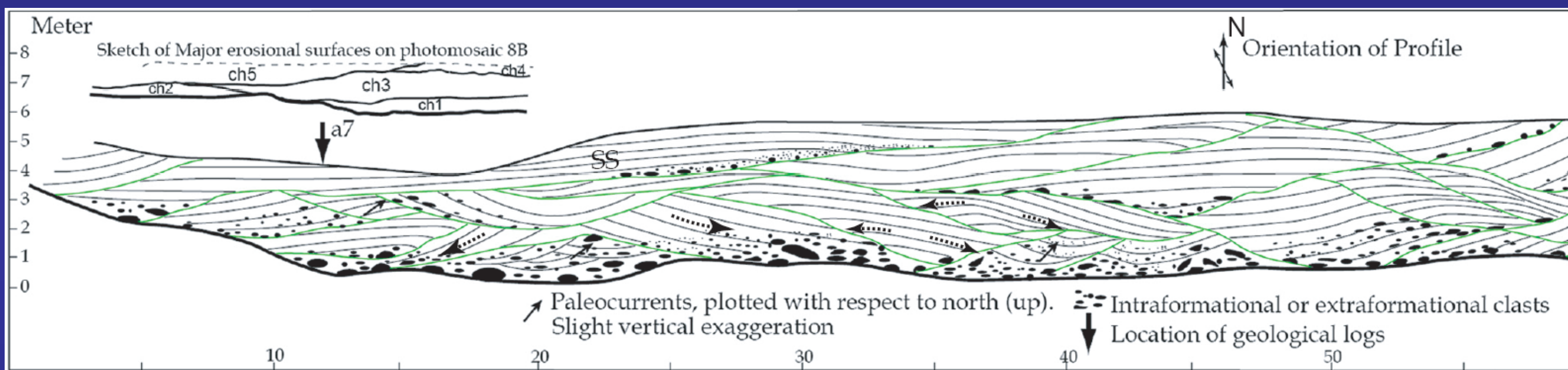


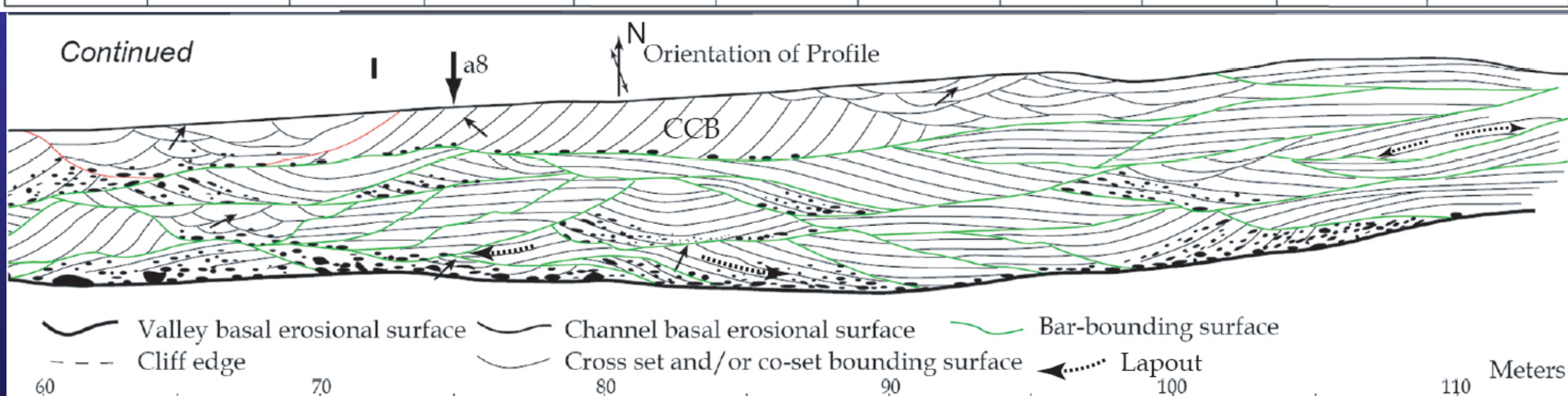
Single-thread meandering channel deposits.

Each bar is geometrically disconcordant with respect to its adjacent bars, representing adjustments of bar geometry during successive major floods.



Bedding architecture of the braided channel Ch1 in V1

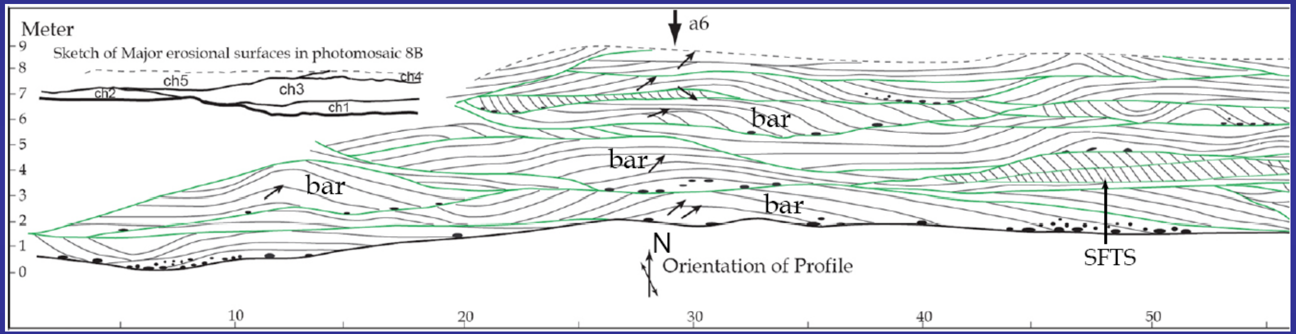


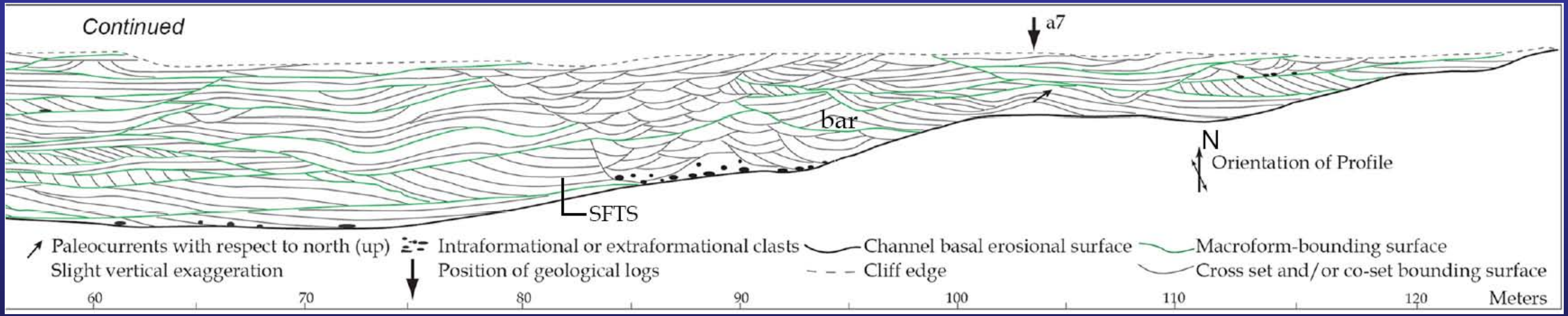


Cross channel bars (CCB), sand sheet (SS), and sand flats.

The common occurrence of chutes and fills most probably indicates variable discharge.

Bedding architecture of the braided channel Ch5 in V1





- Common occurrence of slipface bounded tabular sets (SFTS);
- Less common chutes and fills;
- Overall smaller macroforms (generally less than 1 m thick and 35 m wide);
- Clearly different architecture from that in Ch1.

Typical macroforms within the braided channel Ch5

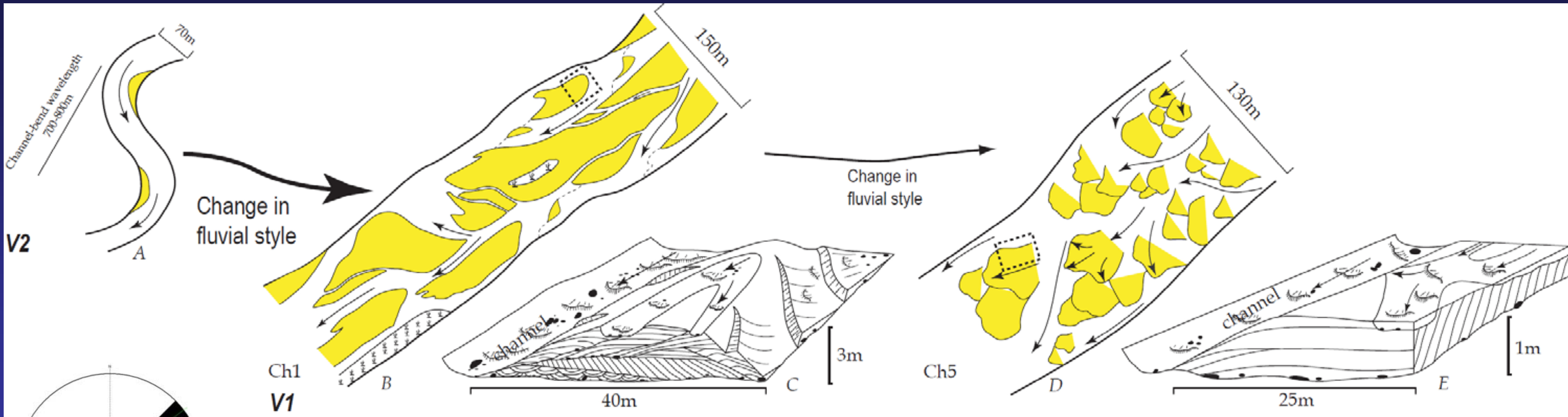
braided bars

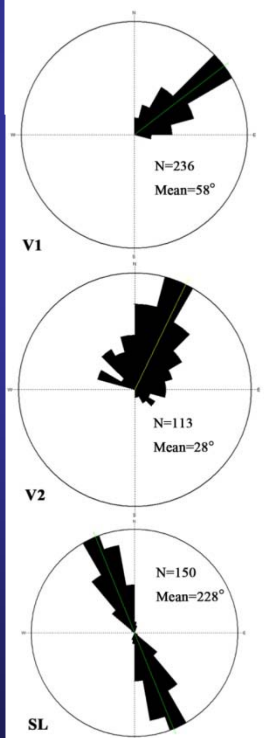
transverse/linguoid bars

Unidirectional dipping meandering tidal channel deposits

Low-sinuous river system occupied primarily by dunes

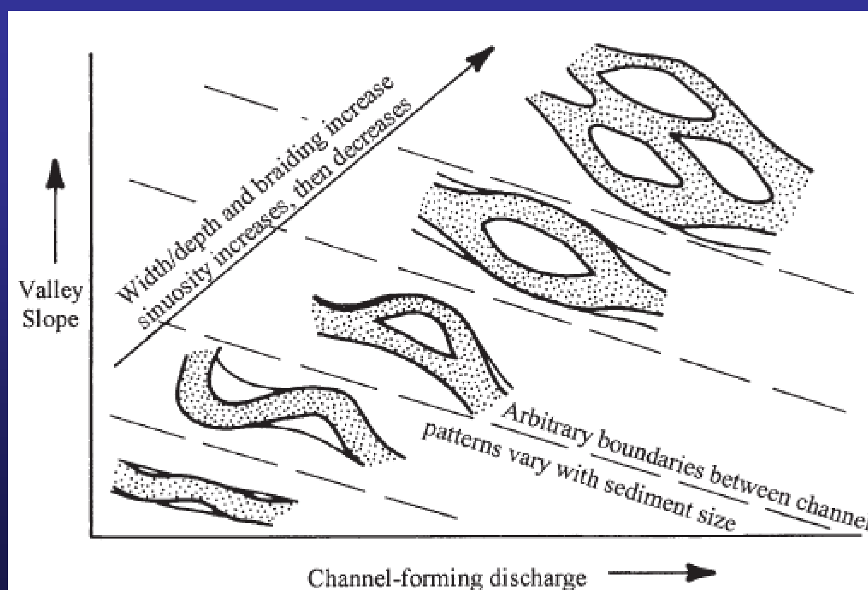
Paleogeography





paleoflow and the approximate shore line direction.

What controls the change in fluvial style across the sequence boundary?



- Increase in grain size? Yes
- Increase in slope? possible
- Increase in discharge?

(Bridge, 2006)

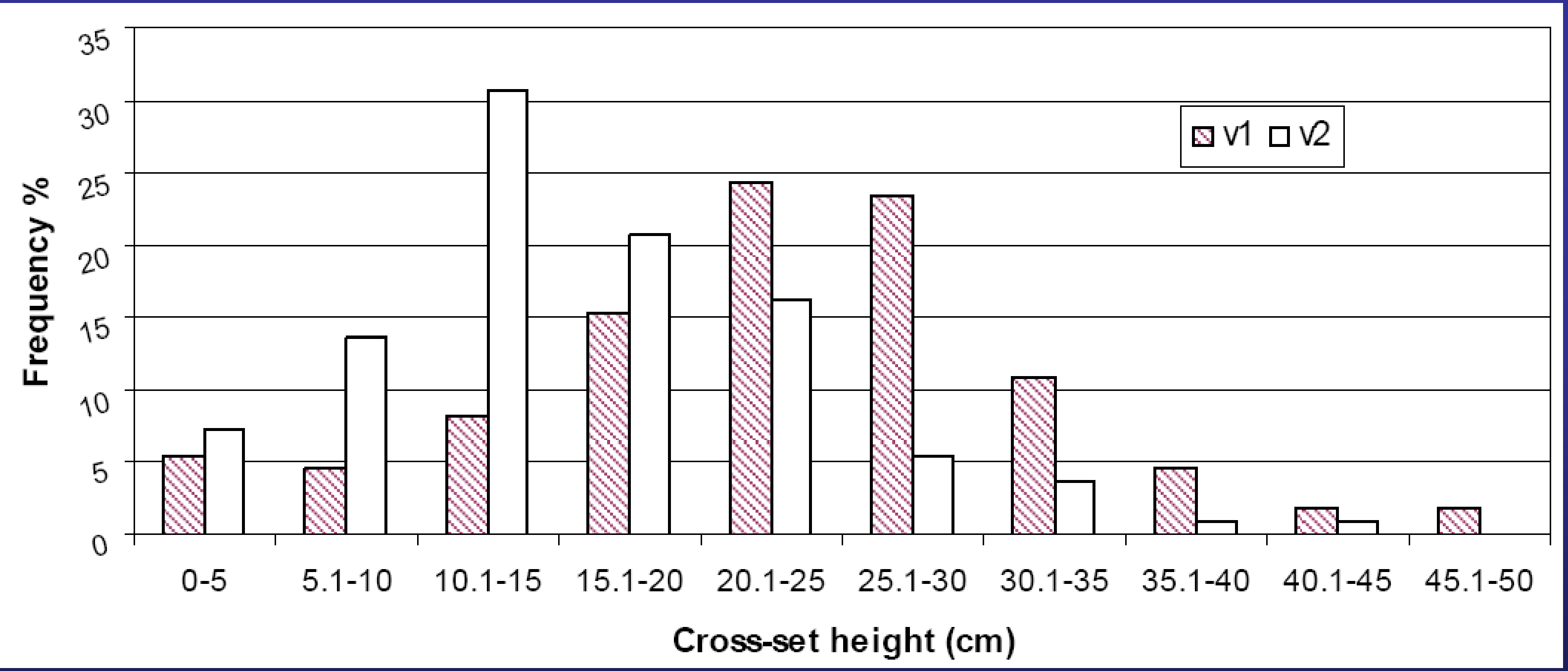
Increase in discharge from V2 to V1 (possible climate change)

Bridge and Tye (2000) Bhattacharya and Tye (2004)

	Average cross-set thickness (cm)	Average dune height (cm)	Estimated water depth (m)	Maximum channel/bar thickness from field data (m)	Flow velocity (cm/sec)	Average channel width (m)	Channel discharge (m^3/sec)
V1	24	71	4.3-7.1	8.4/7.3	100-160	168	420-1290
V2	16	47	3.0-5.0	5.5/4.8	80-125	80	110-310

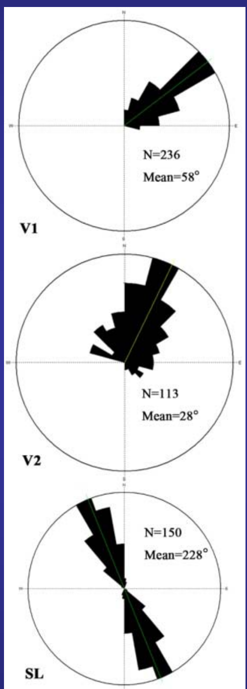
Techniques from Bridge and Tye (2000), Bhattacharya and Tye (2004), Bhattacharya and MacEachern (in press).

Analysis of dune height, flow depth, paleodischarge for the formative rivers within V1 and V2.



Histogram of cross-strata thickness of fluvial sandstones within V1 and V2. Cross-strata thickness within V1 is larger than that within V2.

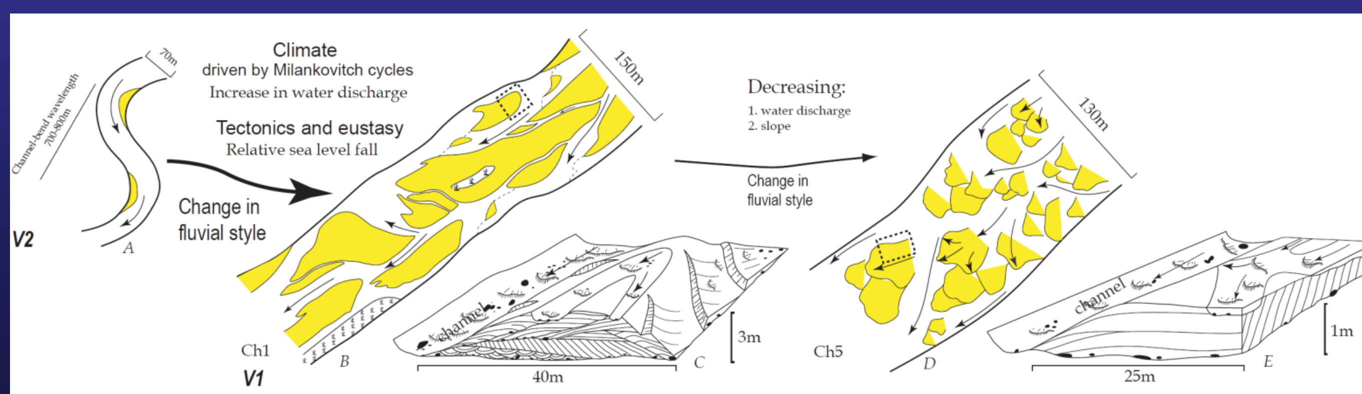
Summary and conclusions



1) There is a systematic vertical change in facies from sheet fluvial sandstone, into heterolithic tidal facies, and finally back into fluvial facies within each of the valleys, similar to that predicted by the nonmarine sequence stratigraphic models.

2) A change in fluvial sedimentology occurred from V2 to V1, as evidenced by the increase river discharge and changes paleocurrent directions and fluvial style. This is interpreted partially as the result of a climate change.

3) Within V1, formative rivers change temporally from braided, to meandering tidal channels, and finally to a low sinuous river system dominated by dunes. In contrary, formative rivers within V2 seems always meandering. **Predicting fluvial architecture is more effective than fluvial style.**



Acknowledgements

UNIVERSITY of HOUSTON

Anadarko Petroleum Corporation

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Thanks for your attention

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