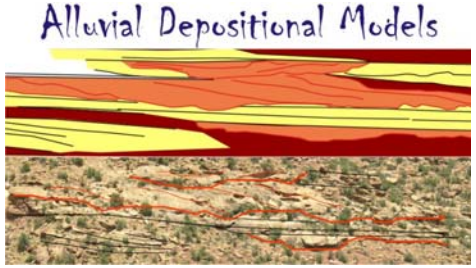
COLORADOSCHOOLOFMINES
EARTH ENERGY ENVIRONMENT



Record of intensified continental floods in a Super-Greenhouse Fluvial System

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&
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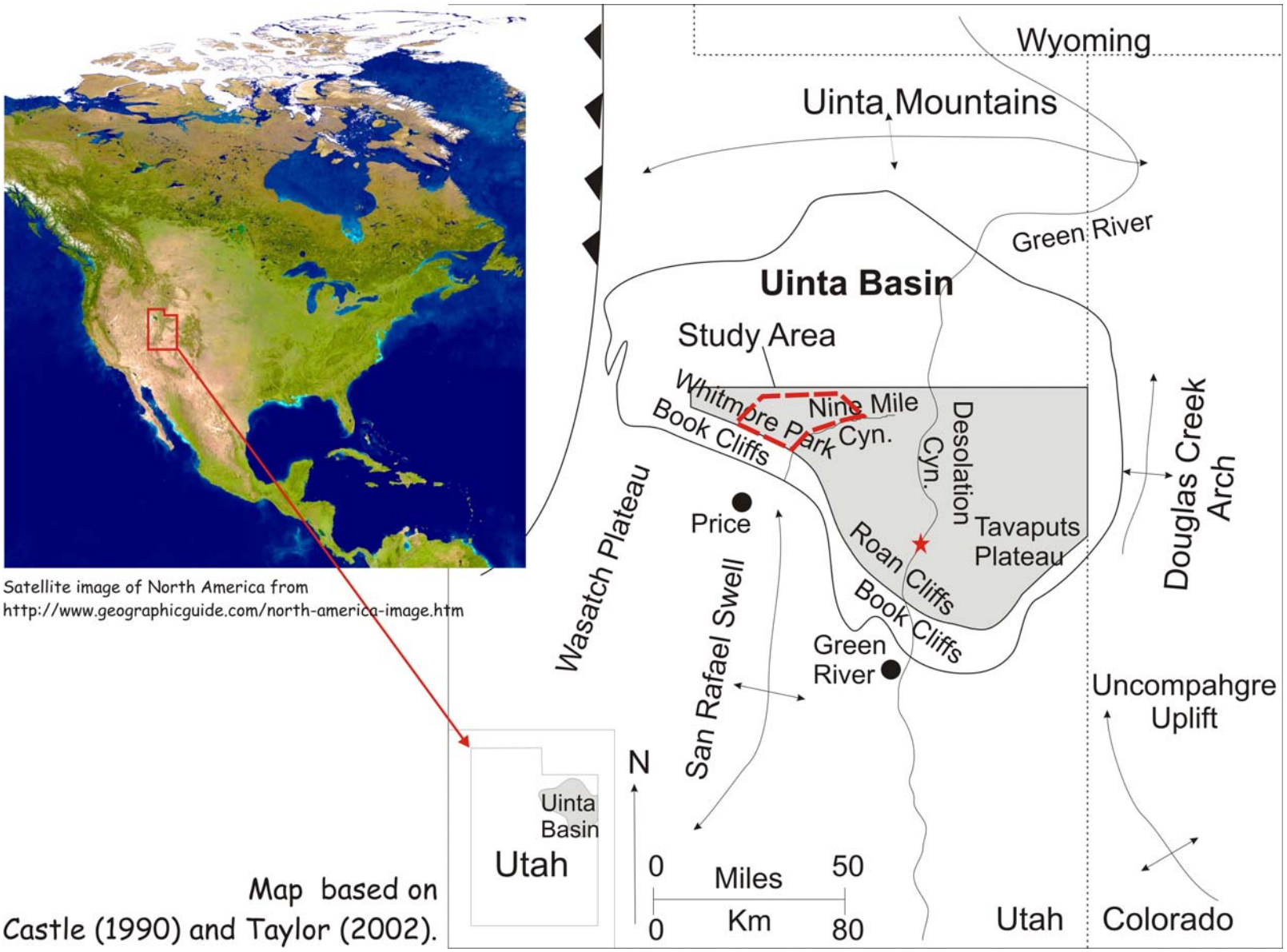
Plink-Bjorklund et al., 2011. AGU Chapman Conference on S2S, Jan. 24-27, 2011

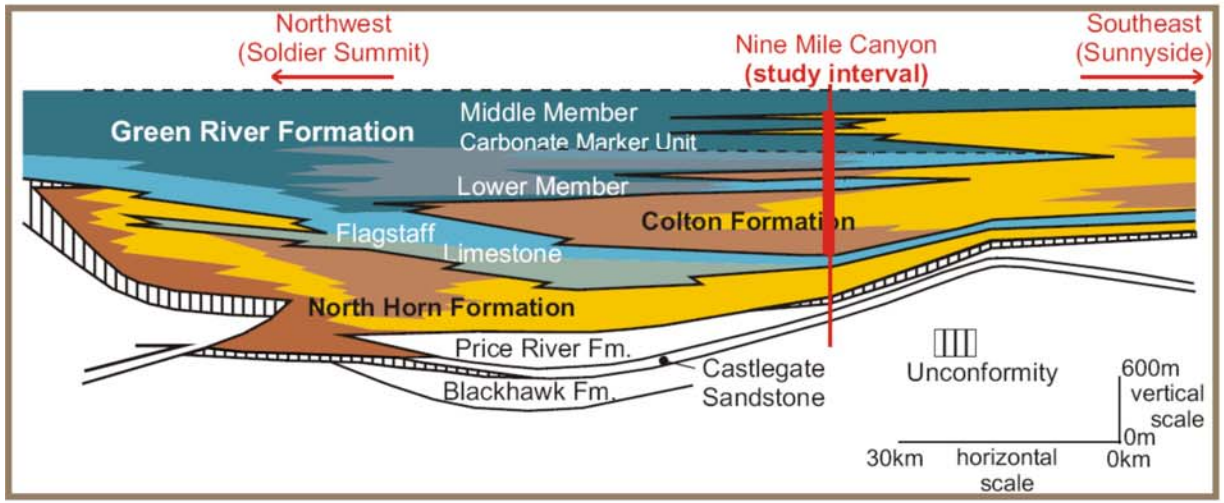
KEY POINTS:

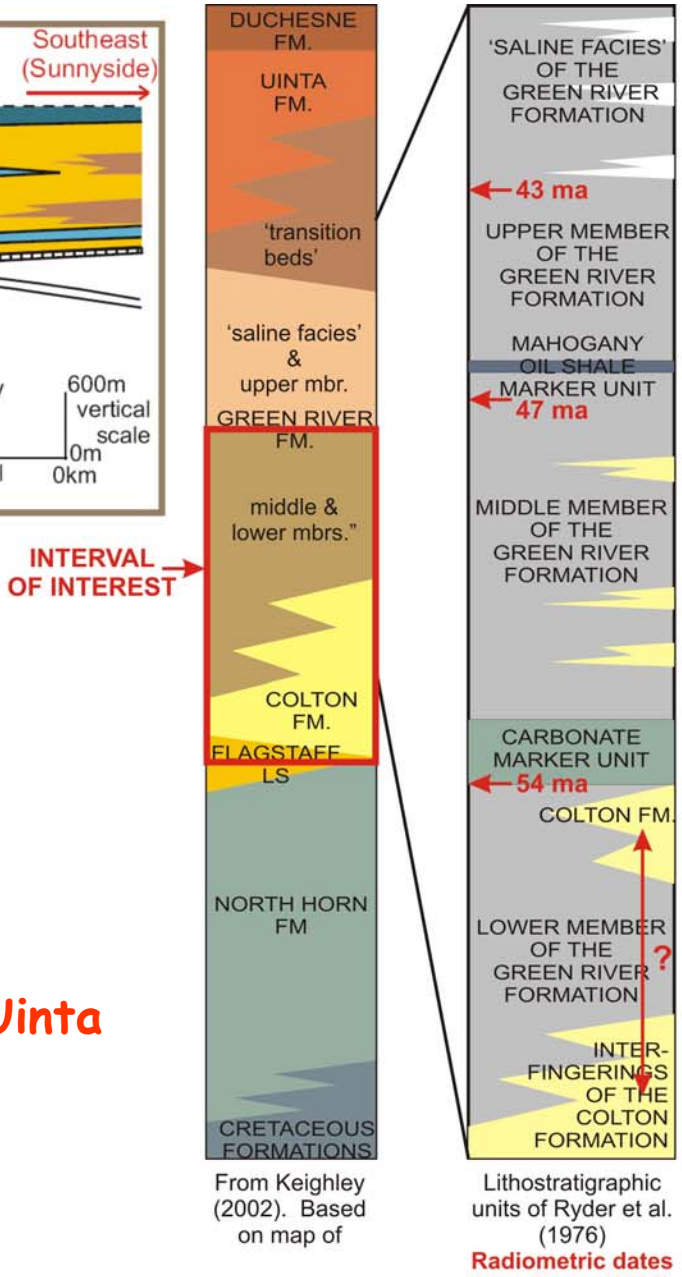
- Effects of climate warming on ancient river systems, especially
  - sediment production, transport and deposition rates
  - avulsion, and thus catastrophic flooding frequency
- New methodology for extracting such information from the ancient record
- Implications for future river-behavior predictions??

DATASET:
FLUVIAL-LACUSTRINE FILL,UINTA BASIN, UTAH



DATASET: Wasatch and Green River Fm





From Keighley (2002). Based on map of

Lithostratigraphic units of Ryder et al. (1976)

Radiometric dates from Remy (1992)

AGE:

-Early Eocene

TECTONICS:

-Continued subsidence on the Uinta basin

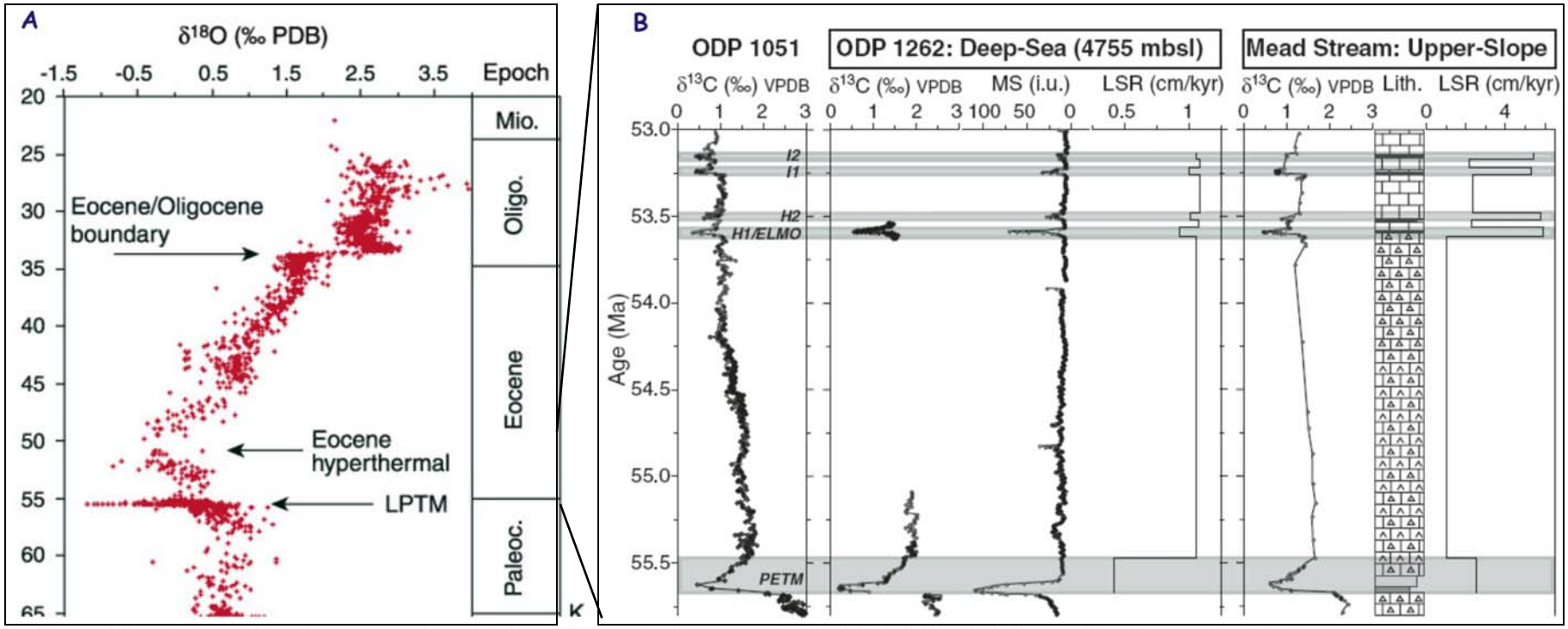
-Laramide uplifts provided the source

-In contrast to North Horn Fm below, and Uinta Fm above

DATASET:
"SUPER-GREENHOUSE" EARLY EOCENE

Paleocene/Eocene Thermal Maximum (PETM) - ca 55.3-55.7 Ma
(Lourens et al., 2005)

Hyperthermals H1, H2, I1, I2 - ca 53.6, 53.5 & 53.3-53.2 Ma
(Cramer et al., 2003; Lourens et al., 2005)



(A) modified from Bralower, et al., 2002, after Zachos et al., 1993, 2001, (B) from Nicolo et al., 2007

DATASET

- Measured sections, lateral mapping, walk-out of stratigraphic intervals, photomosaics, GPS dataset, etc.
- Combined paleosol & continental trace fossil analyses
- Bulk organic carbon isotope ($\delta^{13}C_{org}$) & C_{org}/N_{tot}

DOMINANT CHANNEL-FILL TYPE

Sedimentary structures:

- dominantly gradational plane-parallel-laminated sandstones
- +convex-up low-angle bedforms
- +climbing ripples
- +structureless sandstones
- +soft-clast conglomerates
- +minor cross-stratification (5-10% of observed volume)

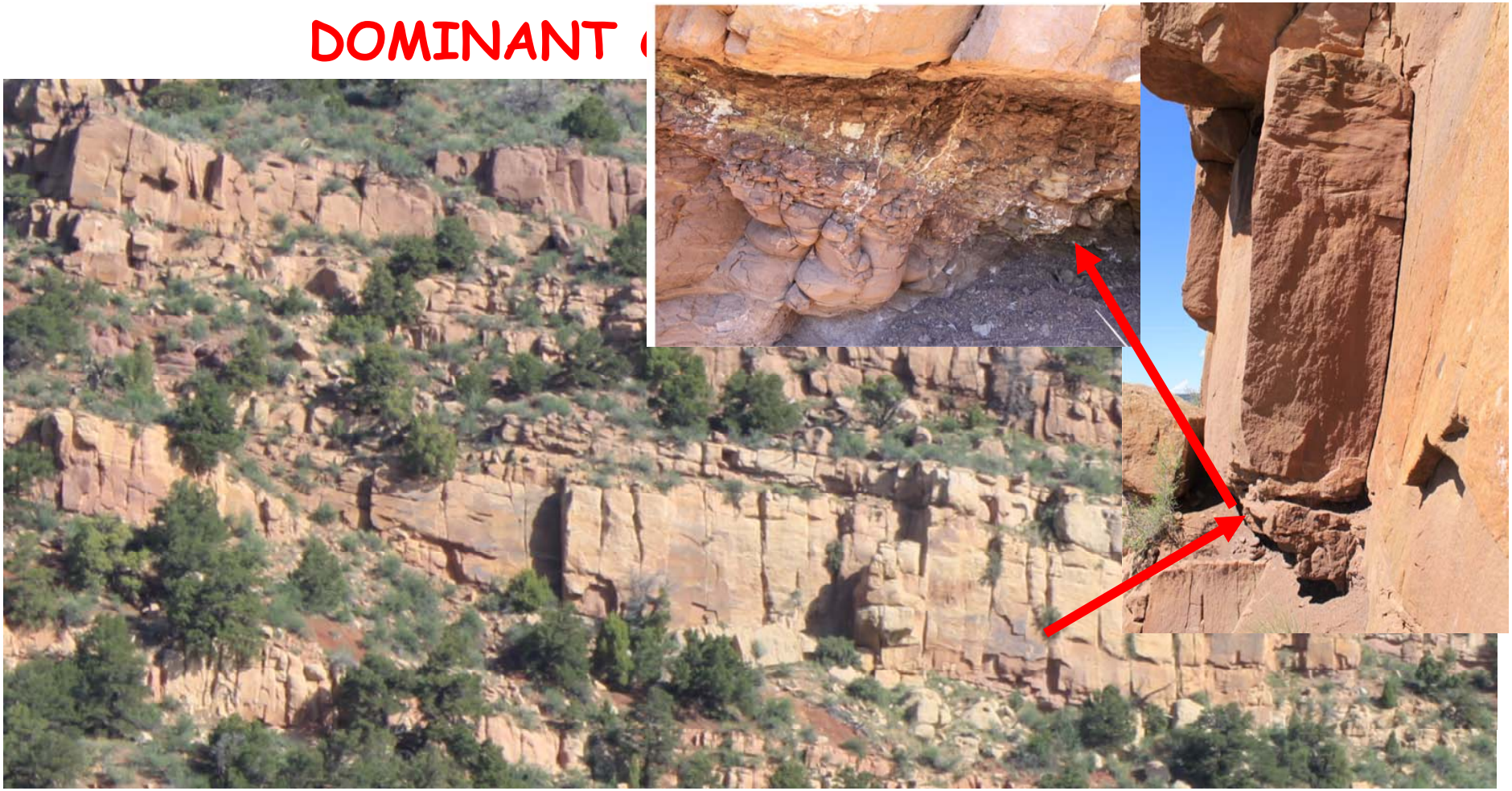
Geometry:

- multiple internal erosion surfaces
- simple, convex-up low-angle barforms with, thick, dominantly downstream accretion sets

High deposition rates

More comparable to the deposition rates in mouth bars or turbidites than in rivers

DOMINANT (



Paleosols & bioturbation

- in places bioturbation & paleosols at accretion set boundaries
- overbank soils poorly developed, indicate dry conditions
- trace fossil assemblages indicate wet conditions

Highly episodic deposition with sustained dry periods + intermittent wet periods with very high rates of deposition – intense monsoon

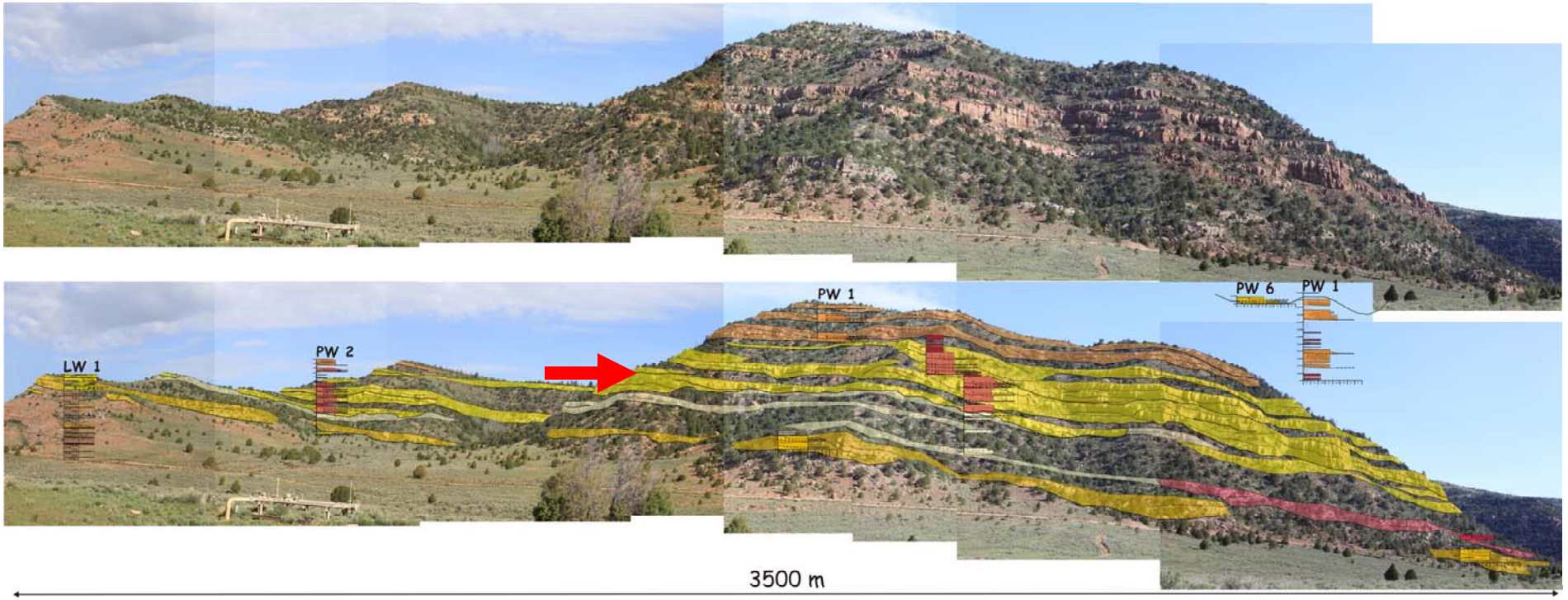
DOMINANT CHANNEL-FILL TYPE

Erosion:

- Up to 20-30 m of erosion at channel bases
- High degree of vertical channel amalgamation
- Large channels

High deposition rates &
High erosion rates;
High water discharge

Lateral amalgamation + thick bar accretion sets – high avulsion rates



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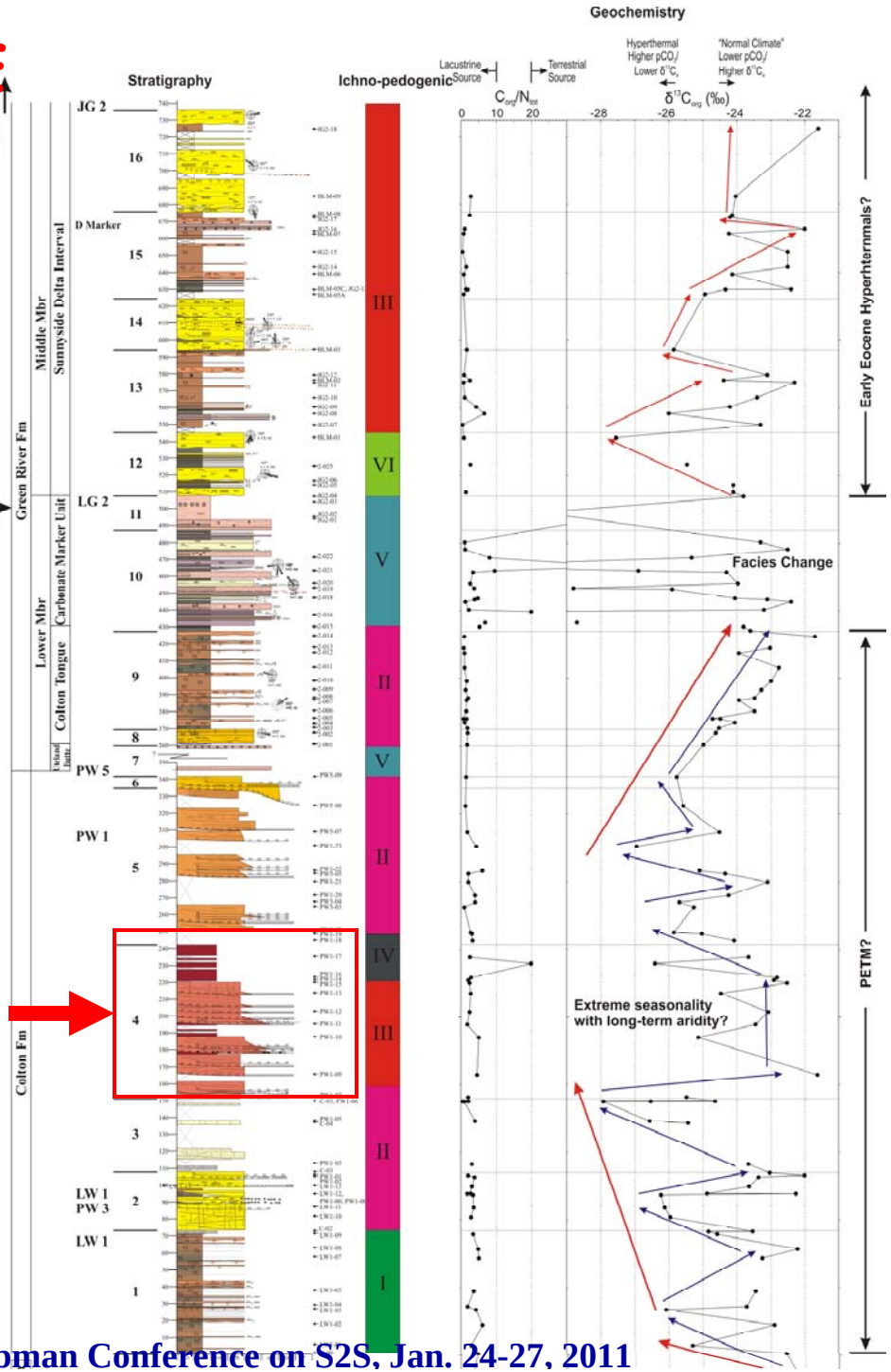
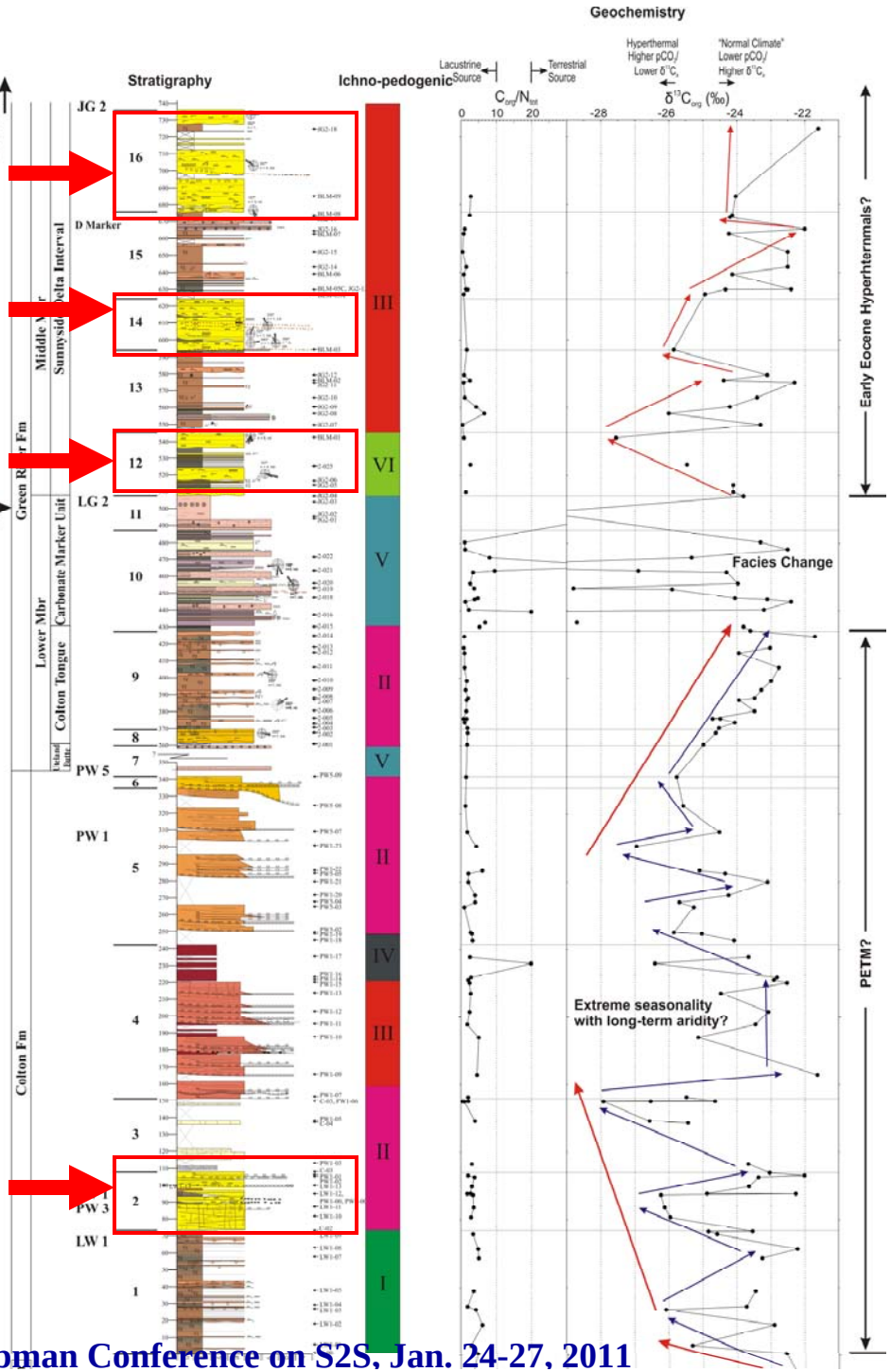
HIGH-DEPOSITION-RATE CHANNEL FILLS 1

- Largest channels, 10-s of m erosion at bases = very high water discharge
- Thickest accretion sets (up to 20 m) = very high sand supply, very high deposition rates
- Bioturbation & paleosol formation common on accretion set boundaries = very episodic with long periods of non-deposition = long dry periods with intense wet periods; paleosols=dry; ichnofossols=wet
- Channels laterally & vertically extremely amalgamated = very high avulsion rates
- This package has deepest erosion surfaces & highest aggradation rates
- **Fluvial megafan**



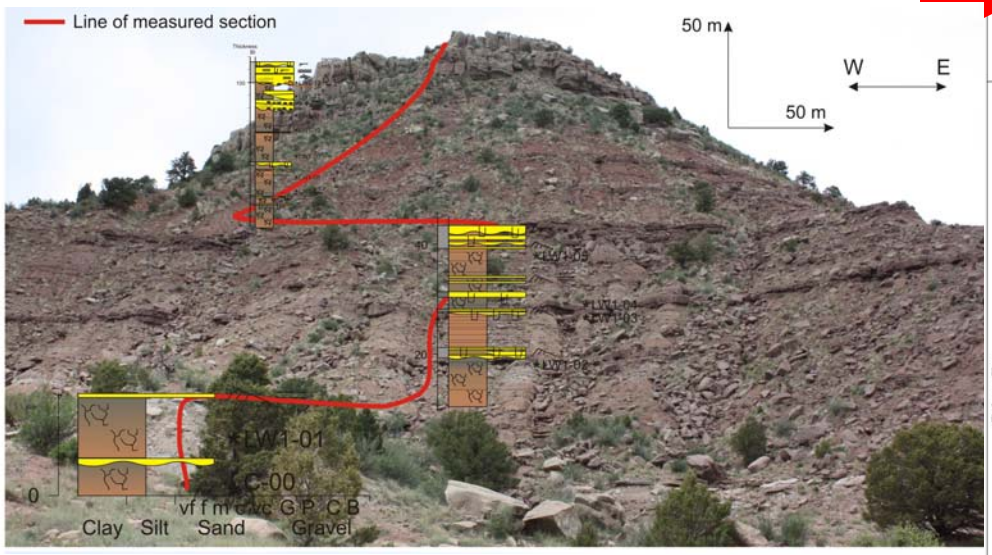
HIGH-DEPOSITION-RATE CHANNEL FILLS 2

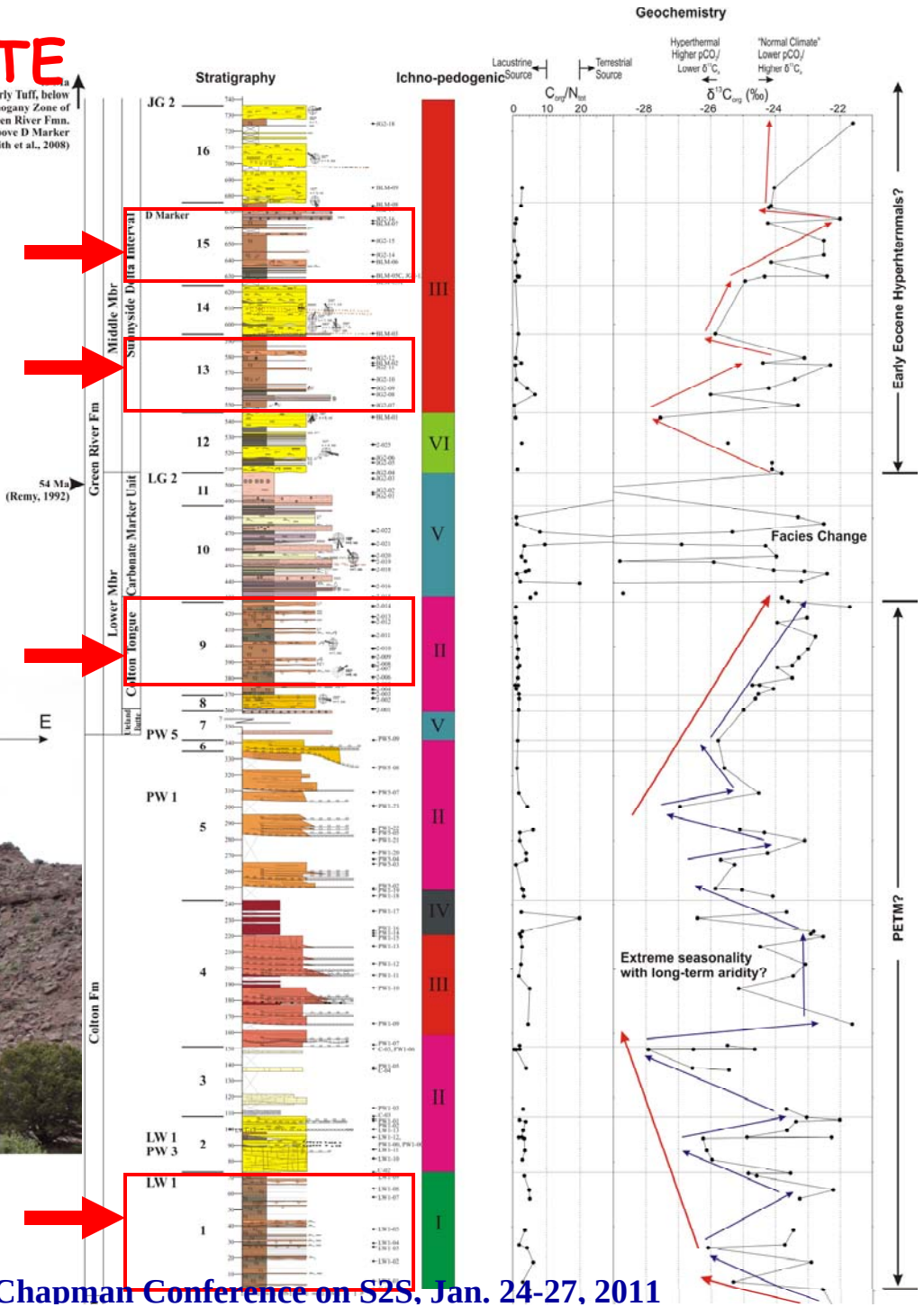
- Large channels, erosional bases = high water discharge
- Thick accretion sets = high sand supply
- Bioturbation on accretion set boundaries = episodic
- Channels laterally amalgamated = high avulsion rates
- Paleosols: oxisols, but bioturbation indicates wet consitions - monsoonal climate with distinct dry & wet periods;
- Somewhat less deep erosion, thinner accretion packages



HIGH-DEPOSITION-RATE CHANNEL FILLS 3

- Small channels = <u>low water discharge</u>
- Encased in thick floodplain fines = high fine-grained sediment storage
- Poorly developed soils, dry soils, wet trace assemblages; long dry periods with short wet -intense monsoon, high deposition rates





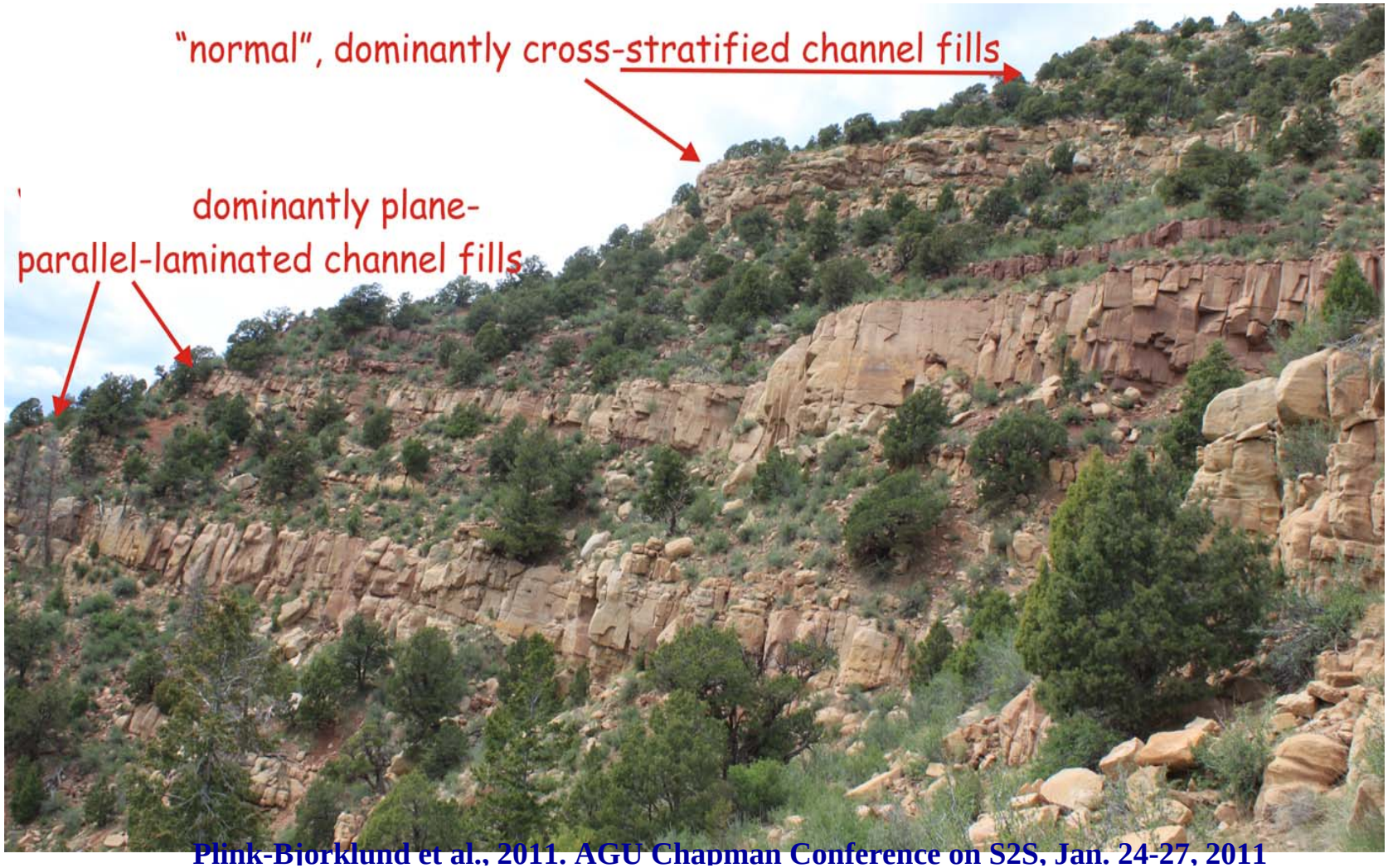
"NORMAL" CHANNEL FILLS

Sedimentary structures:

- dominatly cross-stratified sandstones
- +plane-parallel-laminated sandstone
- +ripple-laminated sandstones

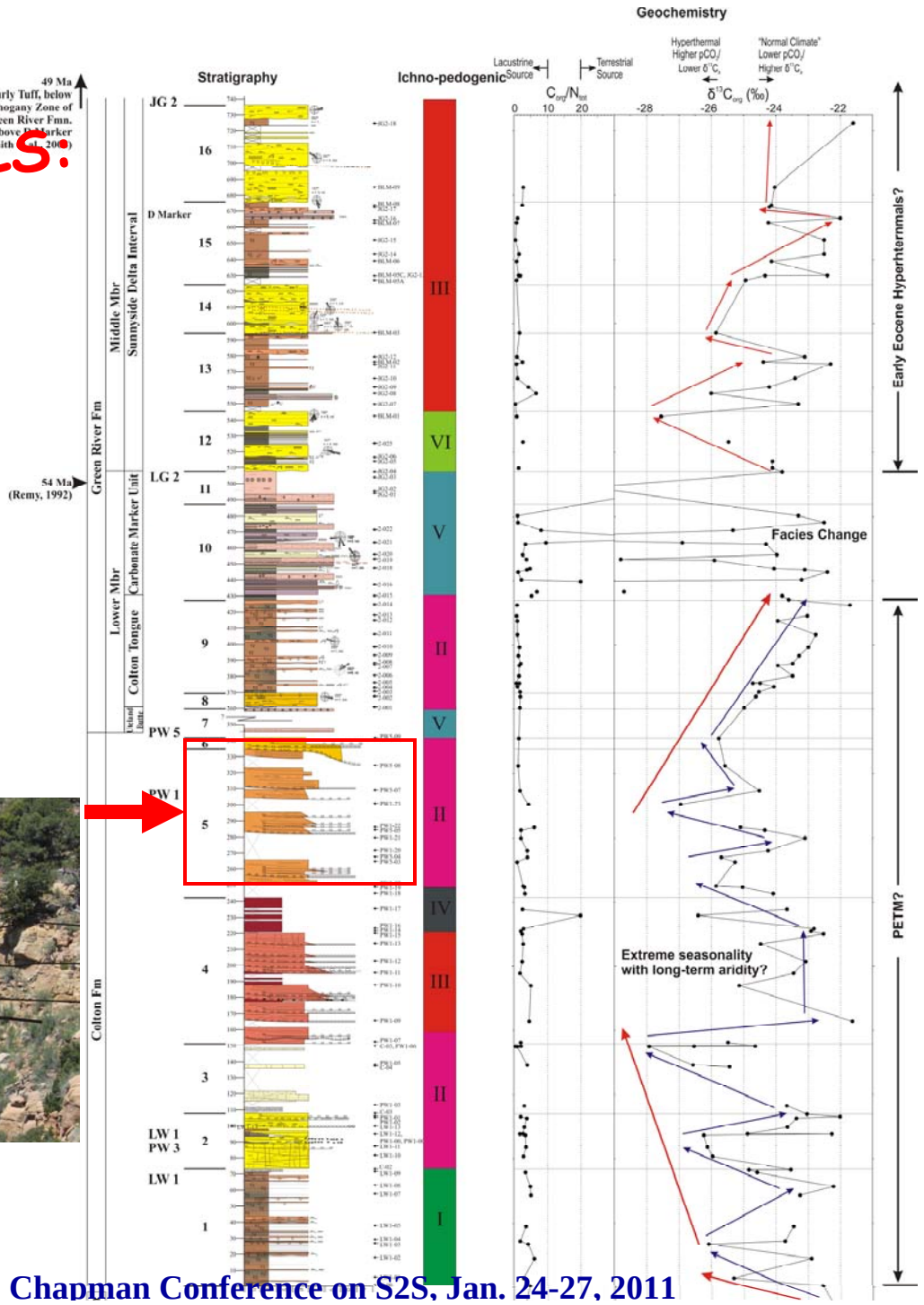
Geometry:

multiple internal erosion surfaces complex, thin, lateral, downstream and upstream accretion sets



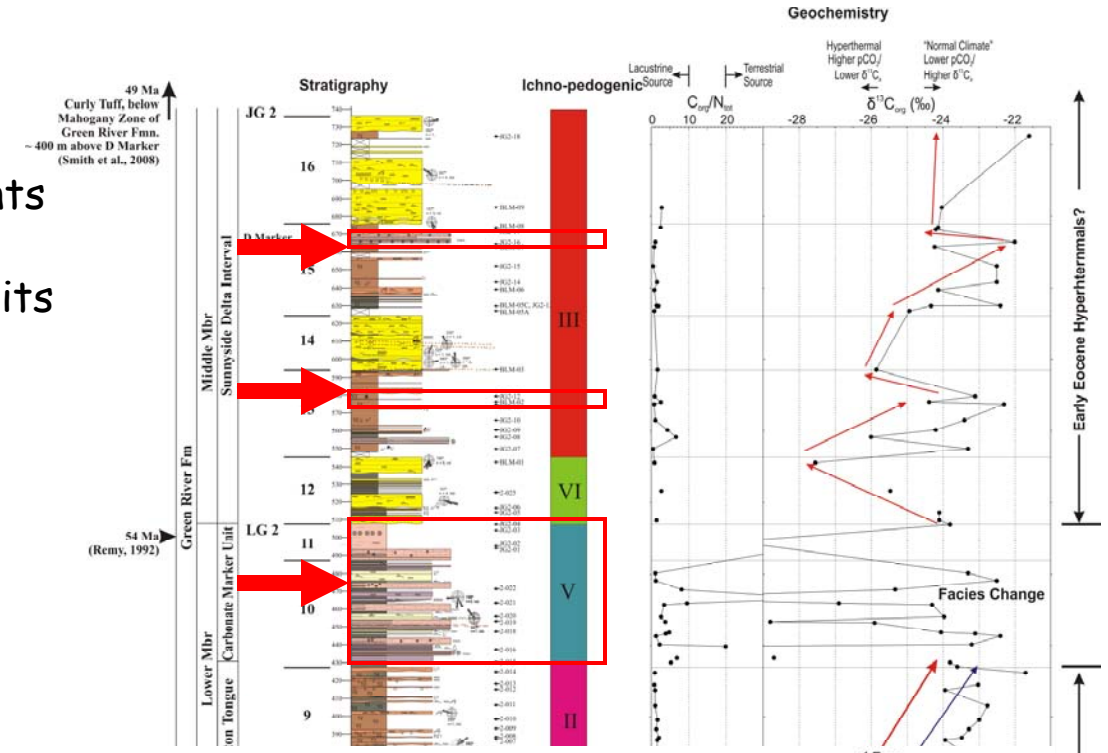
"NORMAL" CHANNEL FILLS:

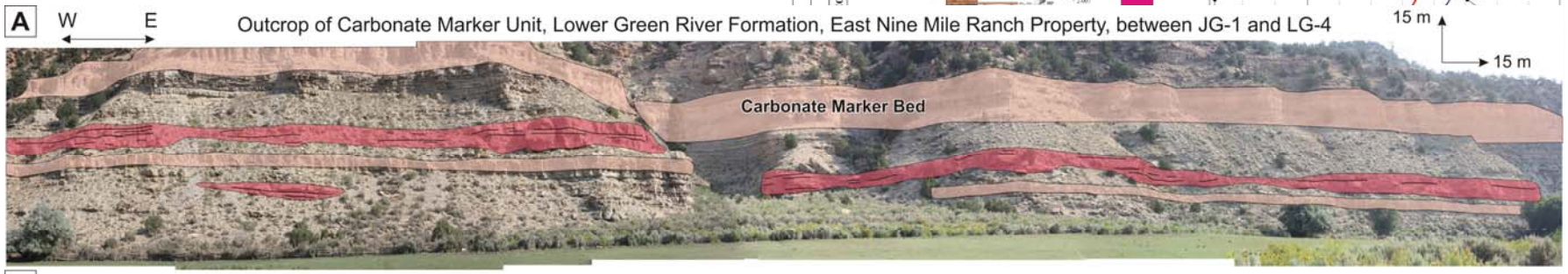
- Lower deposition rates
- Stable water and sediment discharge
- Better developed soils,
- Dry soils, wet trace assemblages; wet and dry monsoon, lower intensity

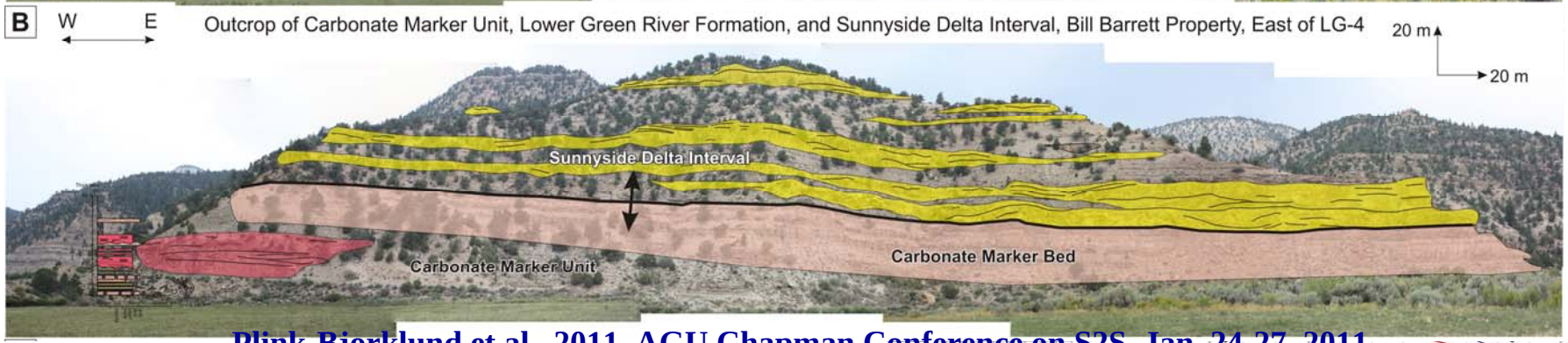


LAKE BEDS

- dominatly carbonate lake sediments
- +siliciclastic mouth bars
- +some fine siliciclastic lake deposits
- = low siliciclastic sediment supply
- Soils & bioturbation: lake







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Multiple pulses of intensified erosion, deposition rates and seasonality

Lake:
very low siliciclastic sediment production

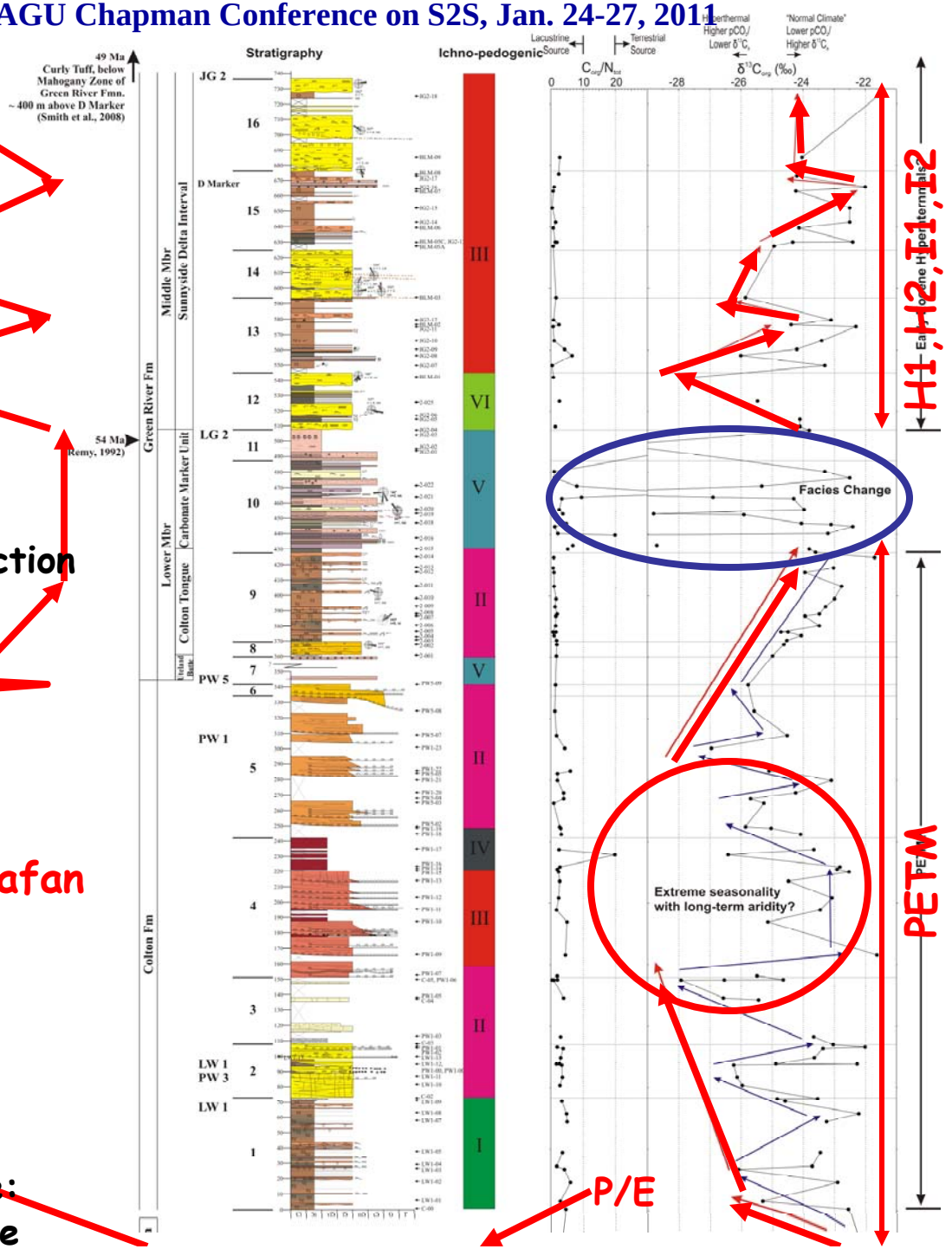
Stabilization with episodes of high seasonality

Extreme seasonality with long-term aridity

Fluvial megafan

Intensified seasonality: high discharge, episodic deposition, high deposition rates

Onset to seasonal climate: high deposition rates low discharge



LESSONS LEARNED:

1. Main effects of hyperthermals:
   - increased monsoon intensity,
   - increased sediment production rate,
   - increased erosion & deposition rate,
   - increased avulsion & catastrophic flooding frequency and intensity

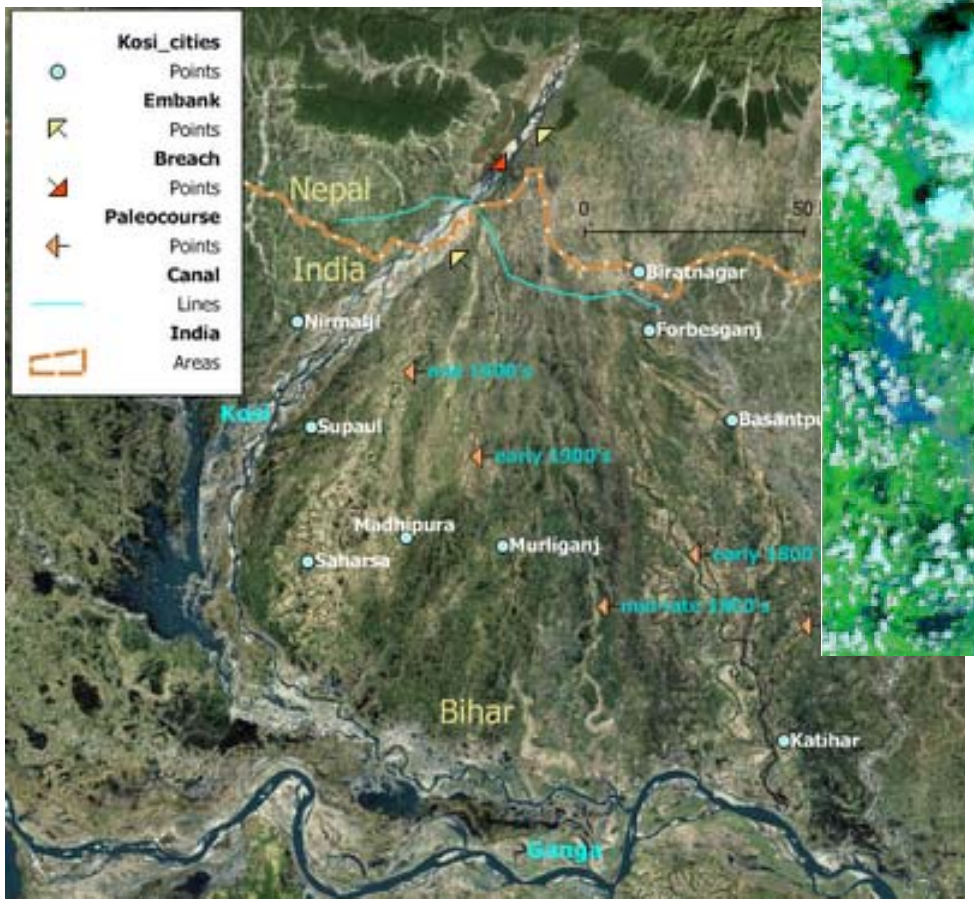
2. Complex response of rivers to hyperthermals
   – function of buffering or non-linear river response?
   -complex changes during hyperthermals?

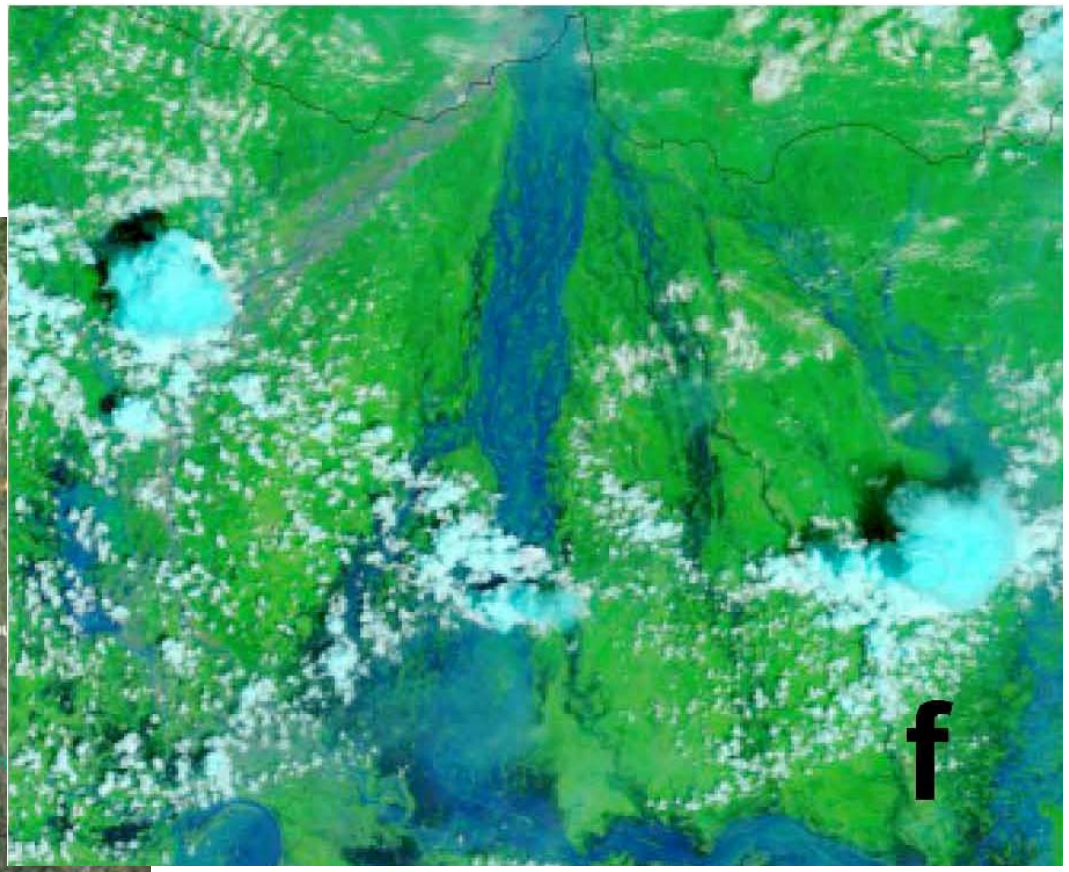
3. Most intensive erosion episodes were accompanied by highest deposition & avulsion rates – characteristic for climate-controlled cyclicity?

4. The combination of stratigraphy-sedimentology with isotope analyses and ichno-pedogenic analyses – a successful method for documenting climate control in continental settings.

5. Implications for future predictions?

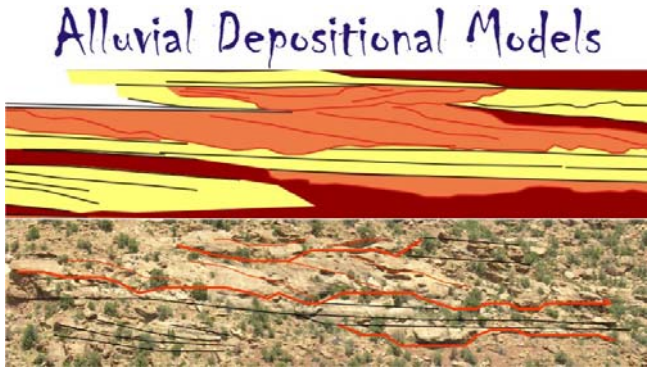
Higher temperatures will cause sustained droughts and frequent catastrophic flooding events in systems with monsoonal climate and high sediment supply??





A satellite image of the Kosi fan avulsion in India during the 2008 flood: NASA Earth Observatory

Kosi megafan; uvratk.blogspot.com/2008/08/kosi-breaches



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