Evidence of a Sandy Suspended-Load Dominated River from the Mississippian Cypress Formation, Illinois, USA

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Agenda

1. Aims

2. Study Areas and Project Workflow

3. Results

4. Discussion

Aims

- What is the dominant paleoenvironment of thick Cypress sandstones?

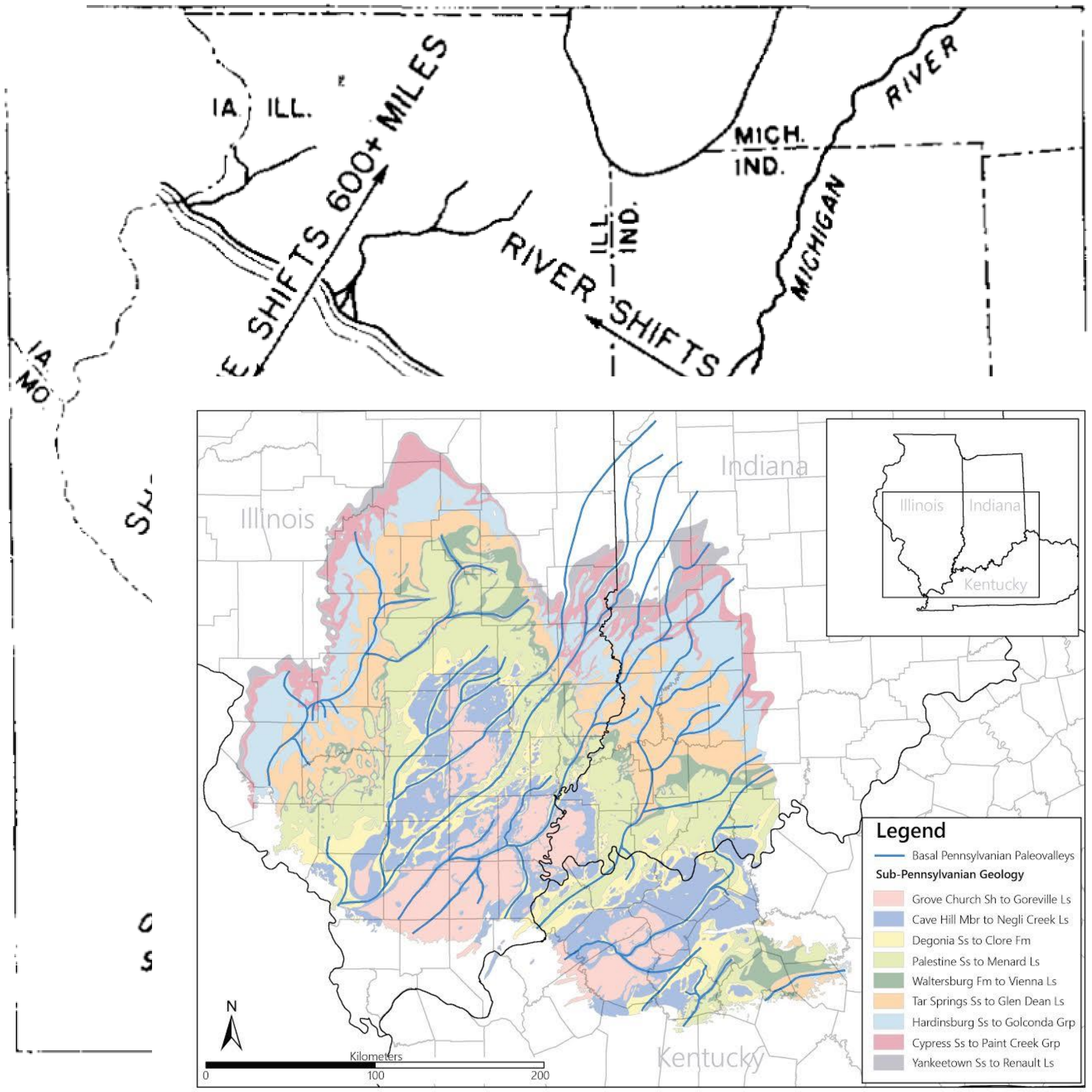
- What is the dominant mode of sediment transport in thick Cypress sandstones?

- How is this mode of transport manifested in the resultant sedimentology and does it influence bedform scaling relationships?

Geologic Context

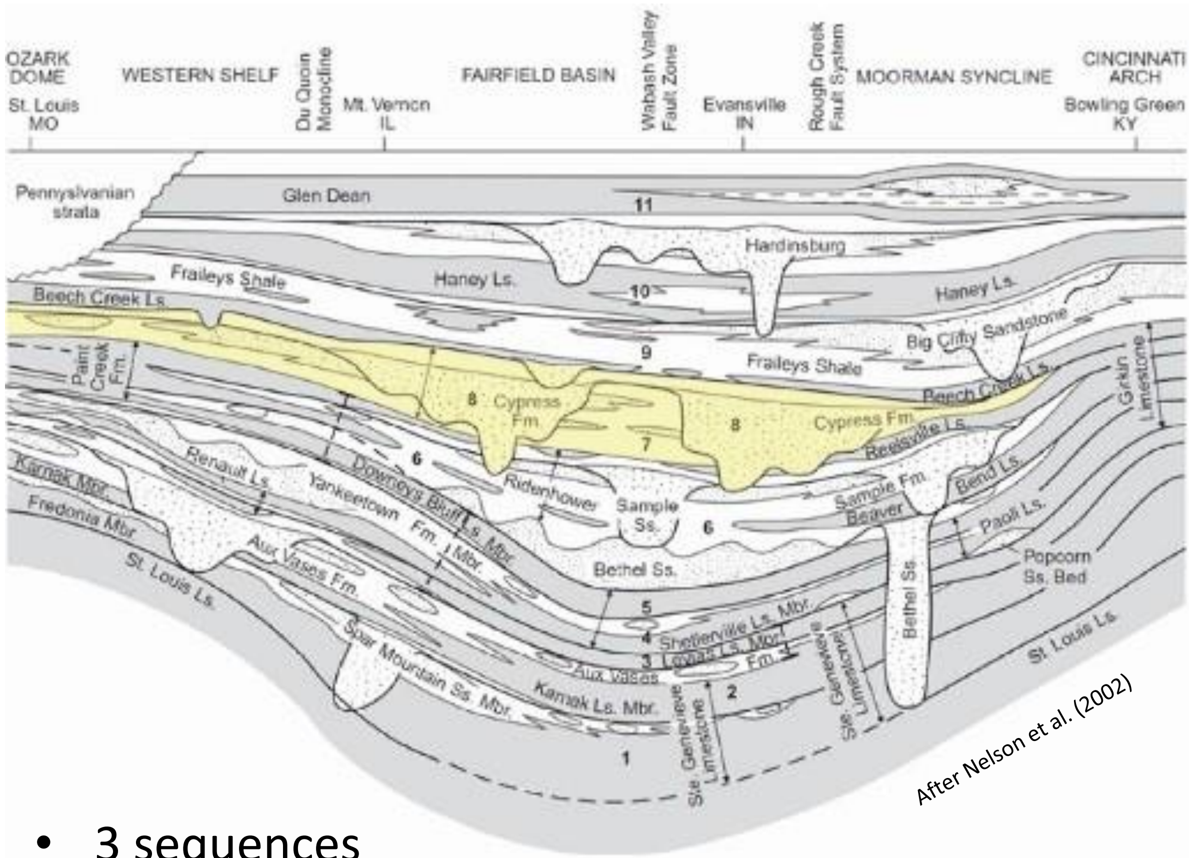
- Upper Mississippian sandstones are consistently very fine- to fine-grained
- Interpreted low-channel slopes and low accomodation
- Tropical, semi-arid climate near the equator
- Glacioeustatic fluctuations drove sequence formation
    - Forced progradations of deltas
- Evidence of southwestward sediment transport throughout the Carboniferous

Midcontinent USA – Illinois, Indiana, Kentucky

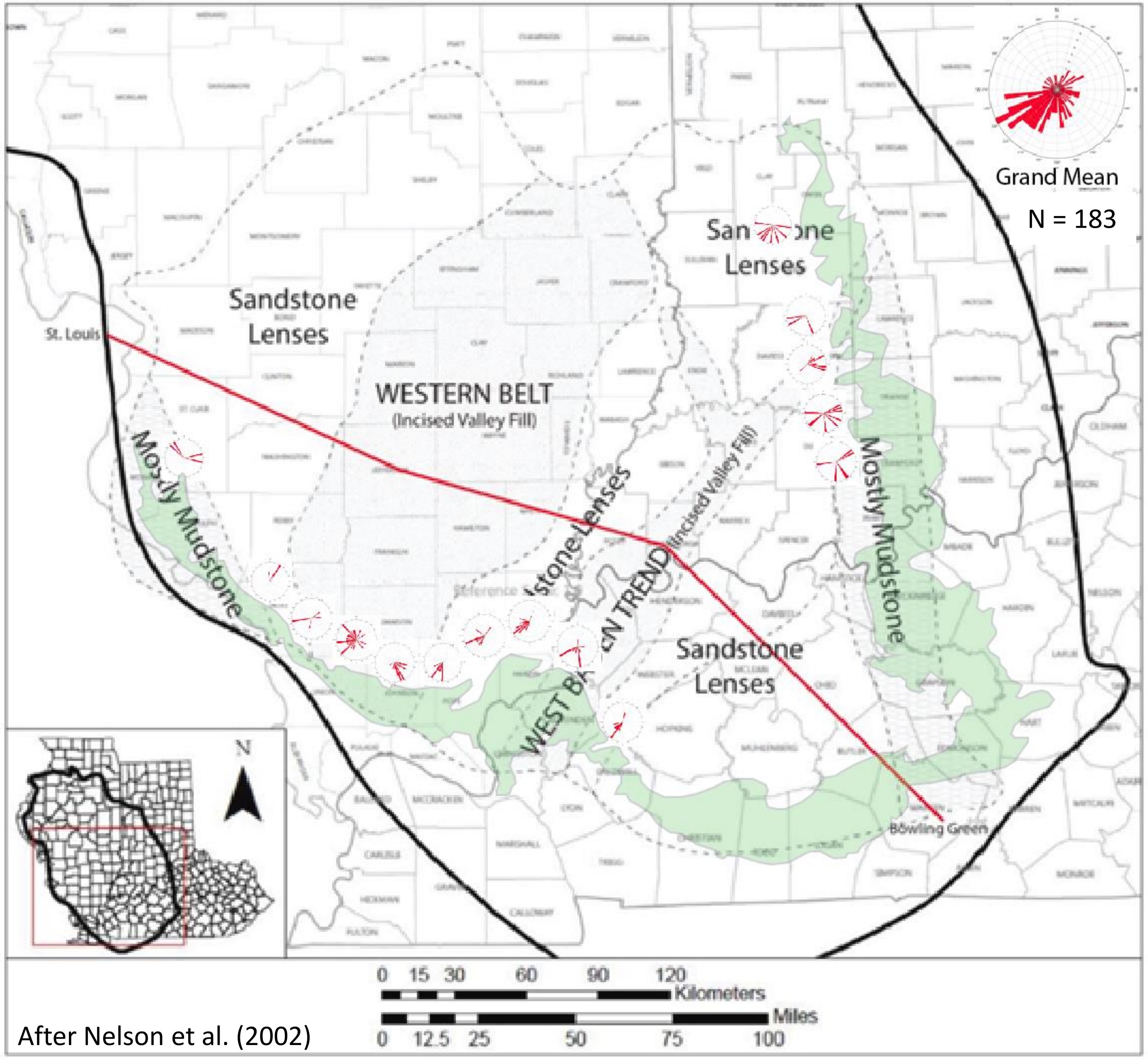


After Bristol and Howard (1971)

The Upper Mississippian Cypress Formation



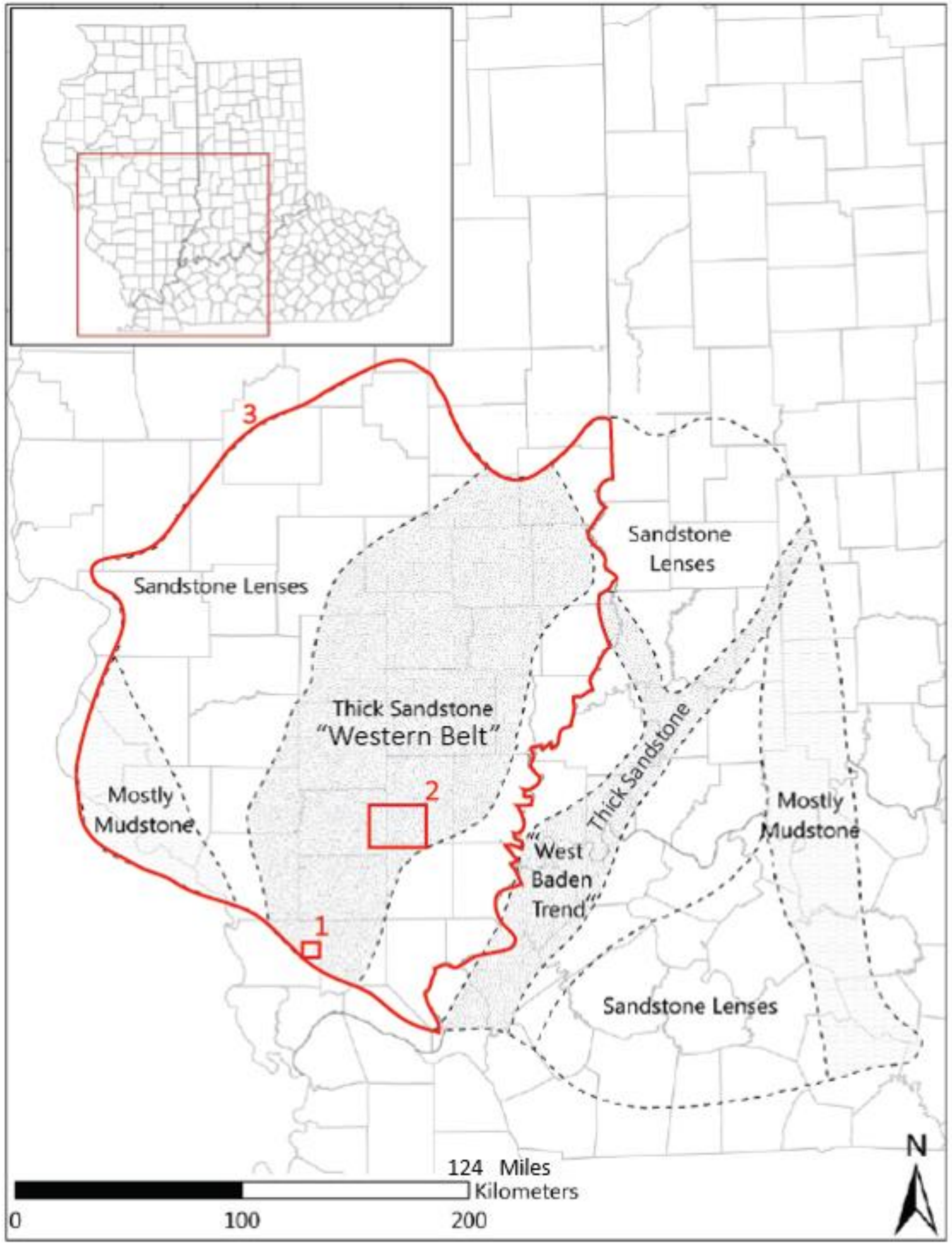
- 3 sequences
- Can be mostly mudstone, sandstone lenses, or thick sand (up to 60 m)
- Capped by regional limestone marker bed
- **Western Belt believed to be dominantly marine reworked braided river deposits**



Current measurements compiled from this study and notes of Potter et al. (1958)

STUDY AREAS
AND
PROJECT WORKFLOW

Study Areas



Modified from Nelson et al. (2002)

1. Outcrop Scale Study – Cypress Creek (type locality)

No detailed sedimentological work thus far

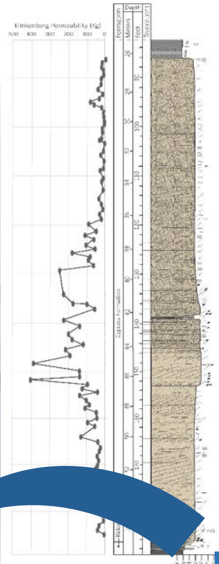
2. Oil Field Scale Study – Dale Oil Field

3. Regional Scale Study

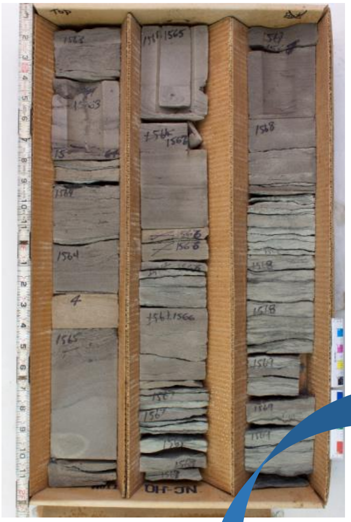
Project Workflow

- Study outcrop to understand outcrop-scale variation and context for facies observed in core
- Relate outcrop findings to core and well logs in oilfield-scale study in the basin interior
- Incorporate findings into regional context

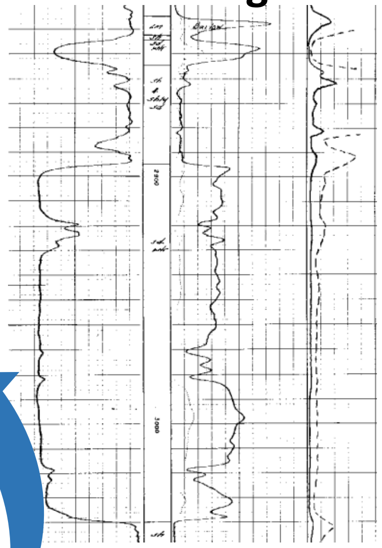
Permeability



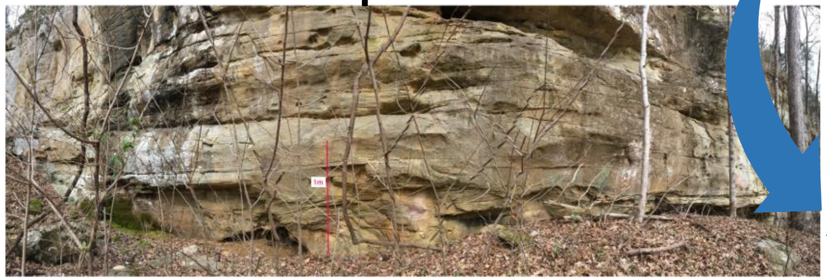
Core



Well logs

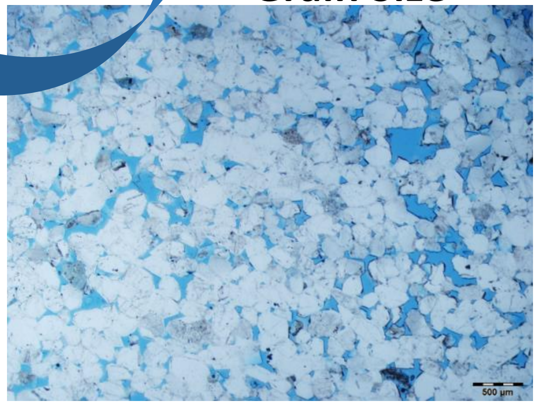


Outcrop



DATA INTEGRATION

Grain Size



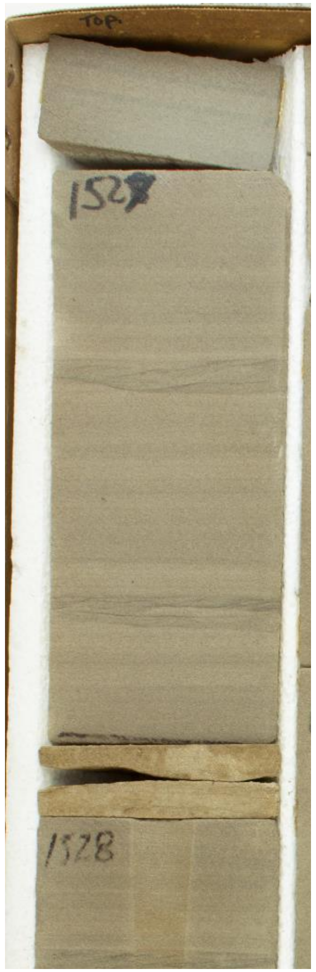
Scaling Relationships & Mode of Transport ← **Paleoenvironments**

RESULTS

Principal Cypress Sedimentary Facies

- Ripple-bedded

- Planar-bedded



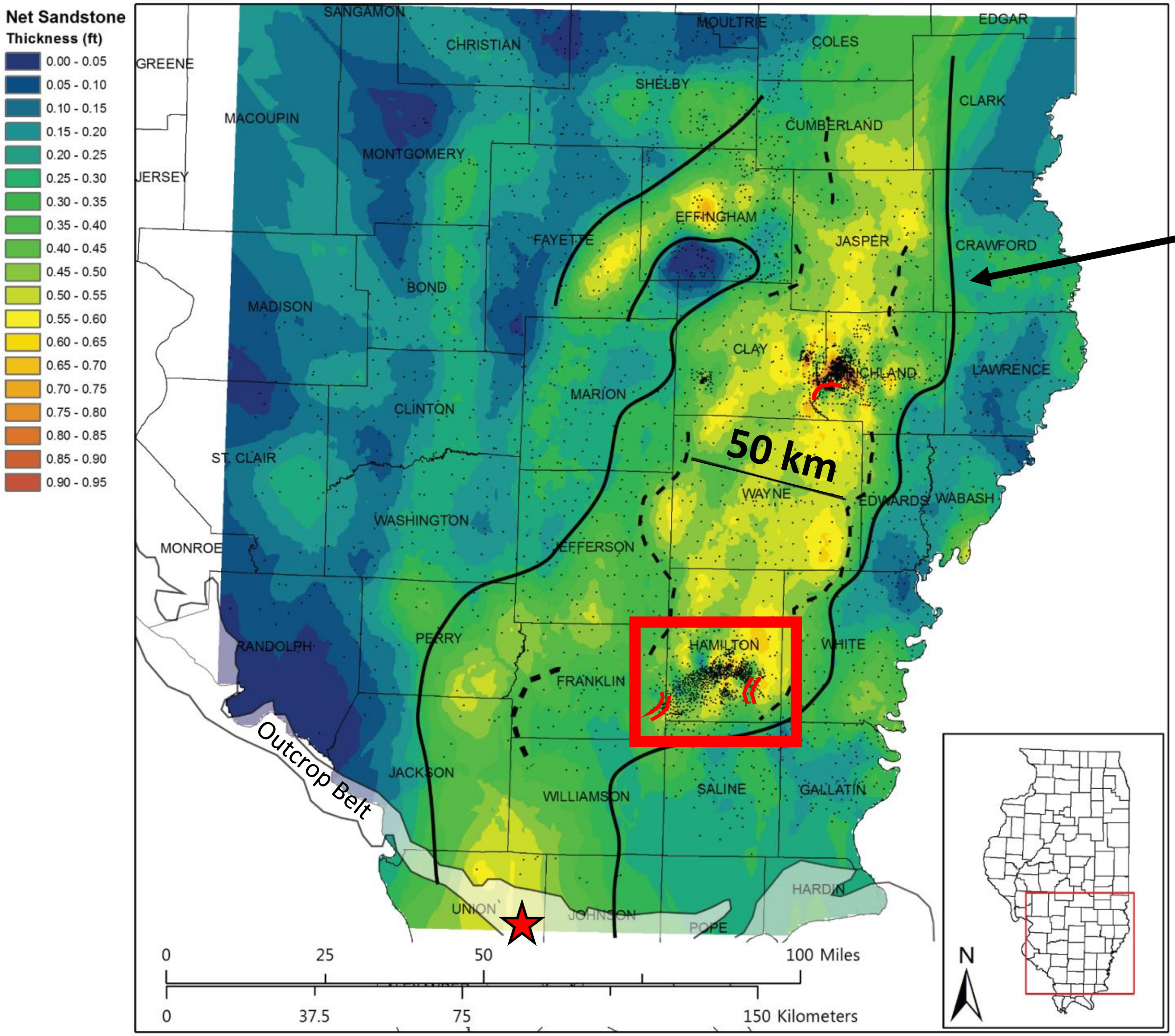
- Cross-bedded

- Conglomeratic

- How are these facies manifested in outcrop?

3. Regional Picture

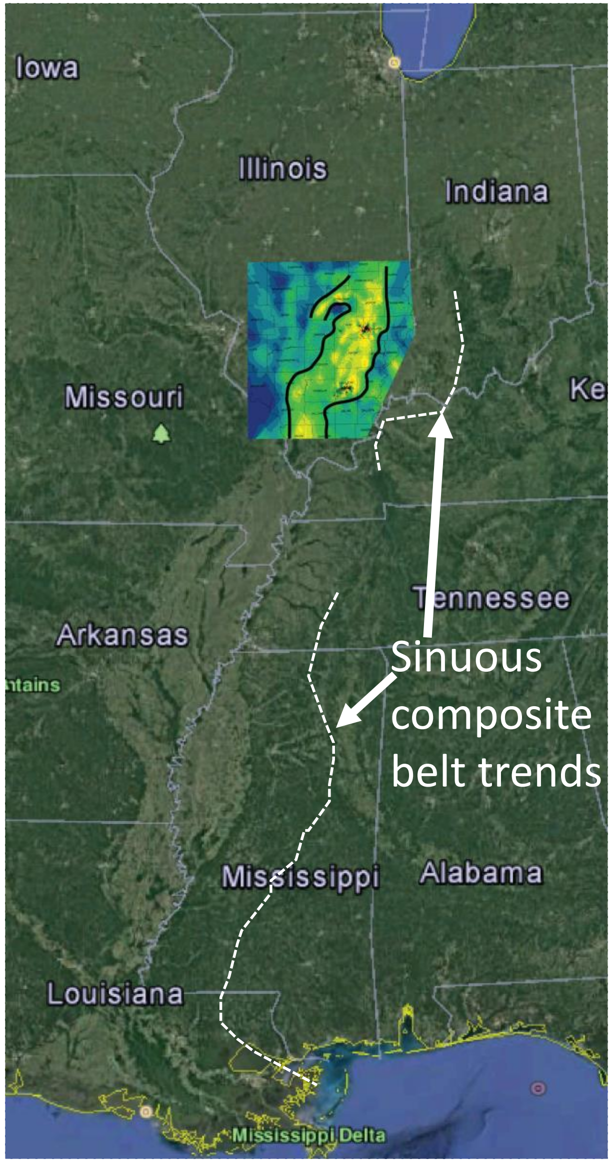
Regional Net Sandstone Isopach



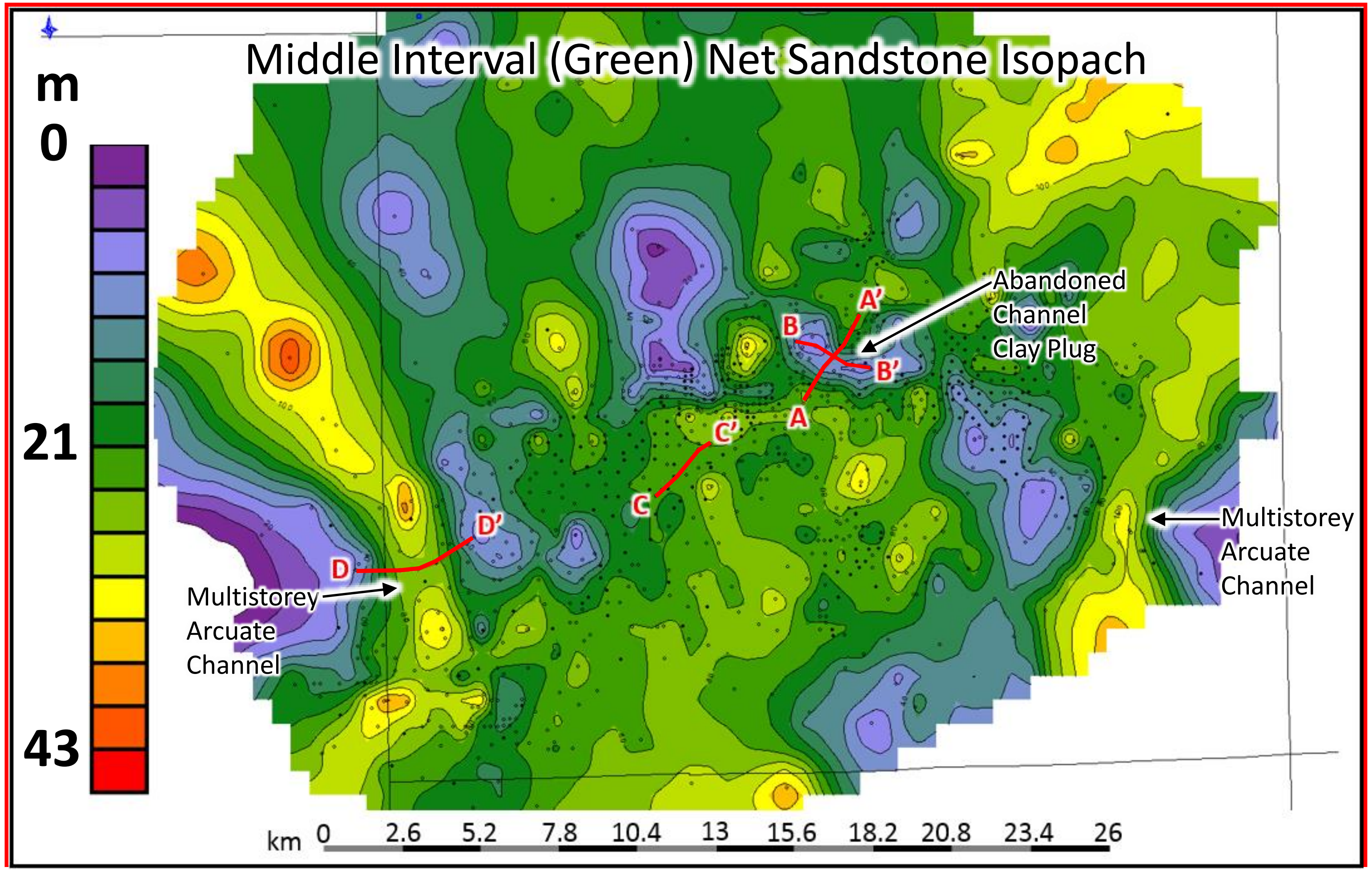
Data compiled from Kalin Howell, Zohreh Askari, Nathan Webb, and Seyler et al. (2002)

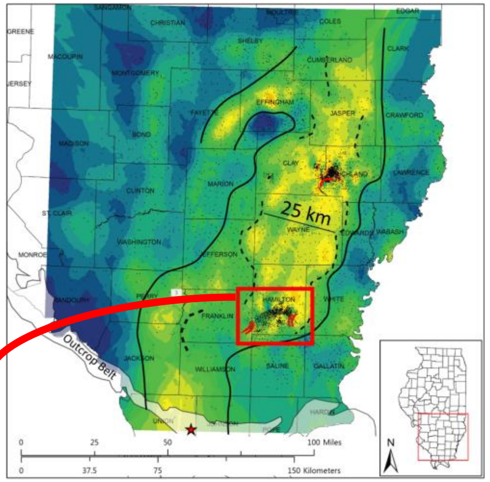
- Meandering or anastomosing **composite fluvial belt** deposited during sea-level lowstand?
- Subsidiary trends present
- "Zoned" belt: locus of fluvial deposition in central axis of overall belt
- Sinuous composite river belt?

For scale....

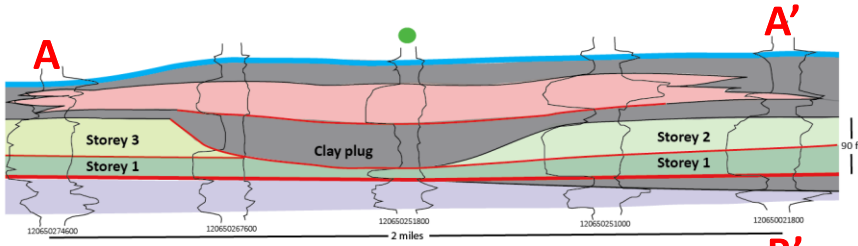


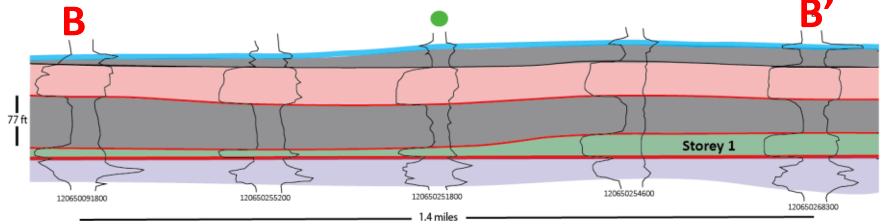
2. Oilfield-Scale Picture

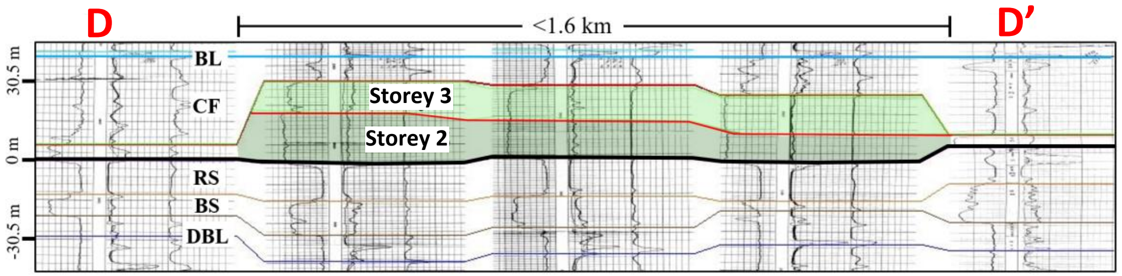




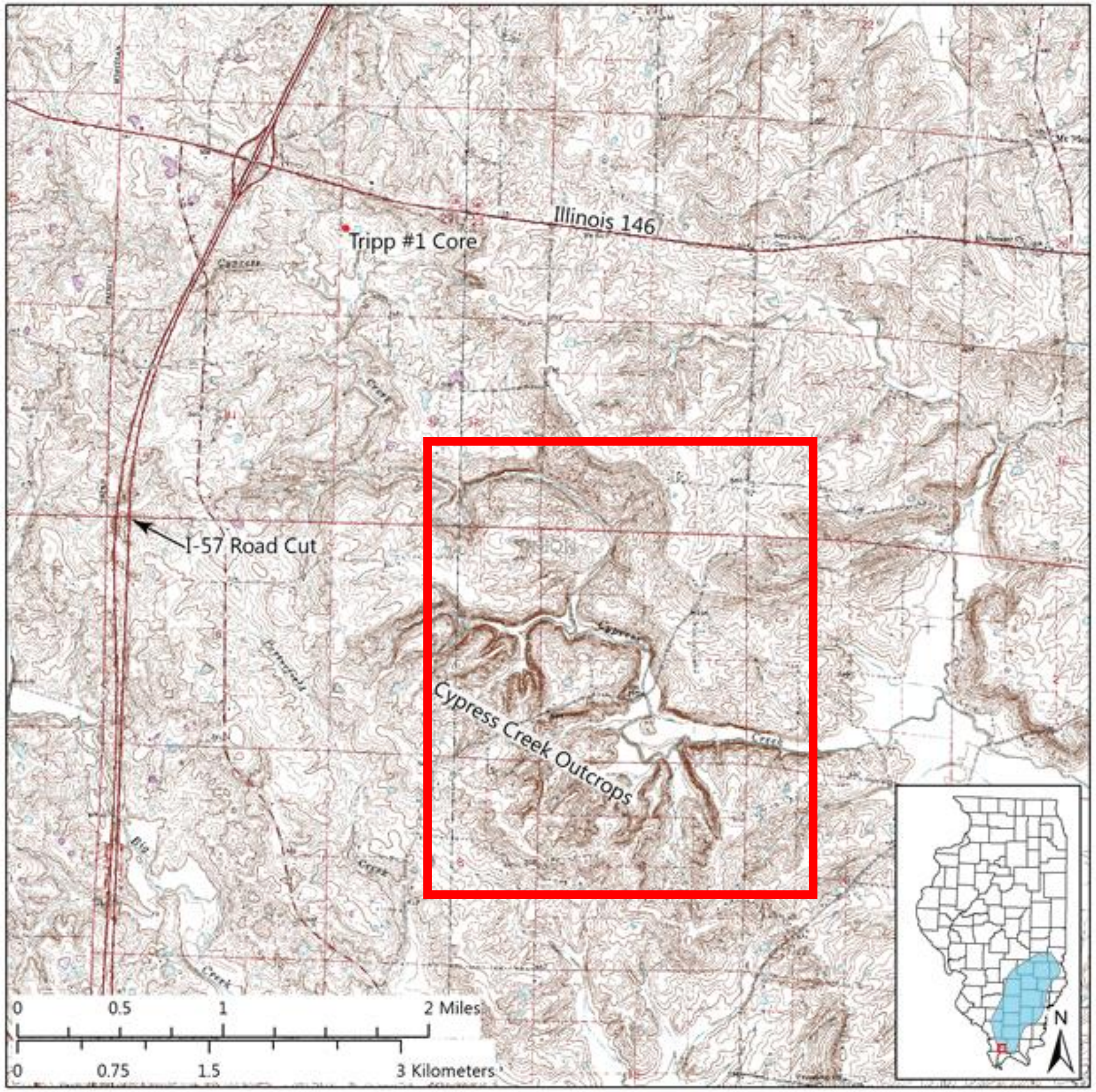
- Multistorey arcuate channel trends
- Abandoned channel clay plugs
- Multistorey sheet-like bodies

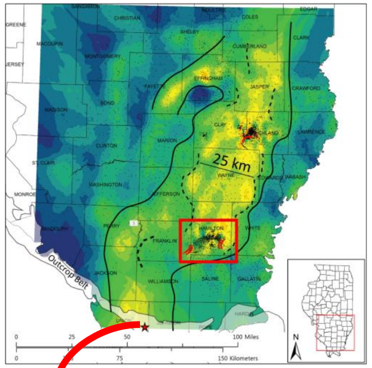


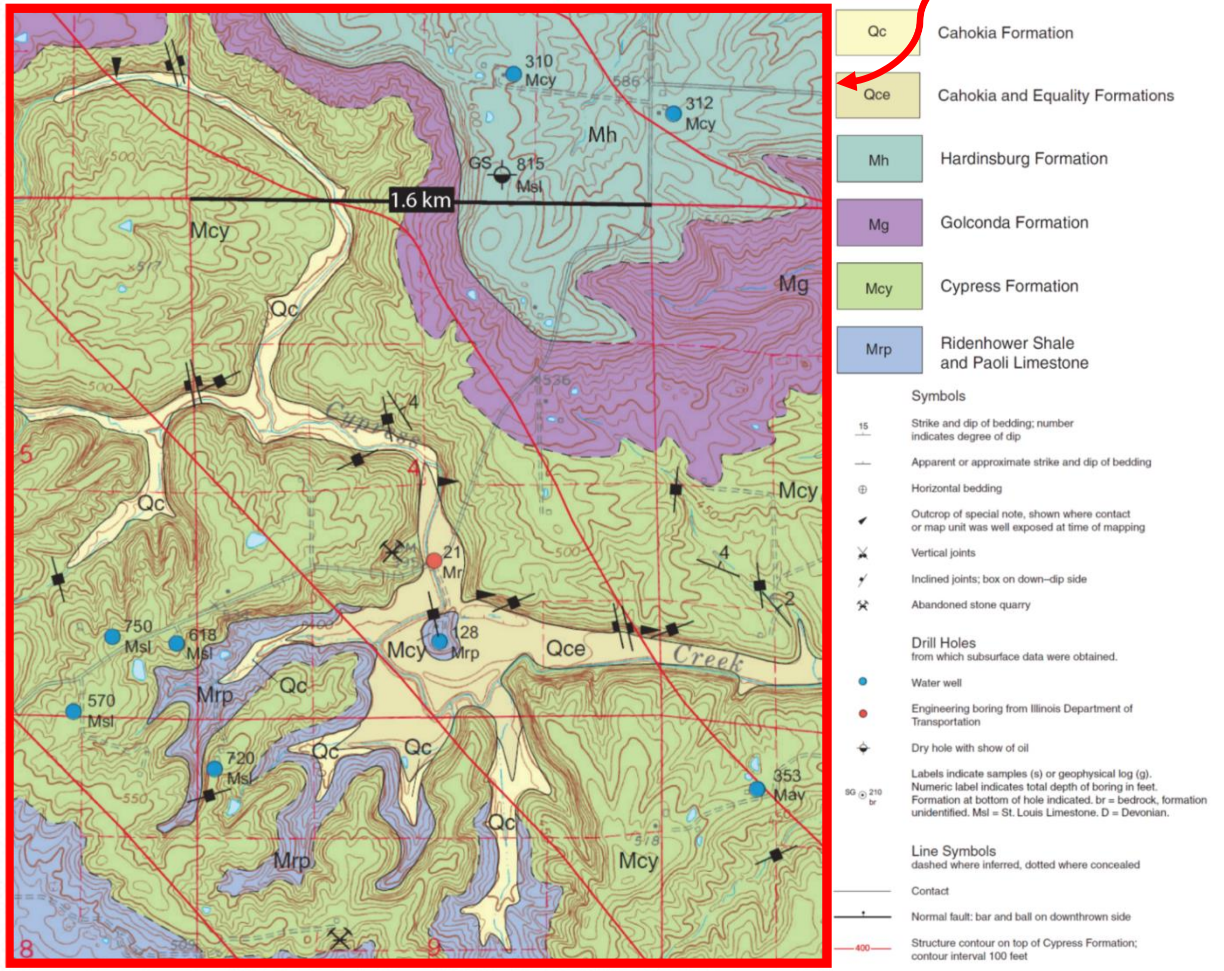




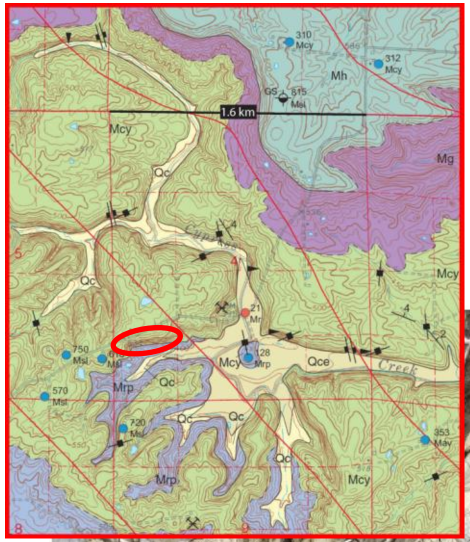
1. Cypress Creek Outcrops



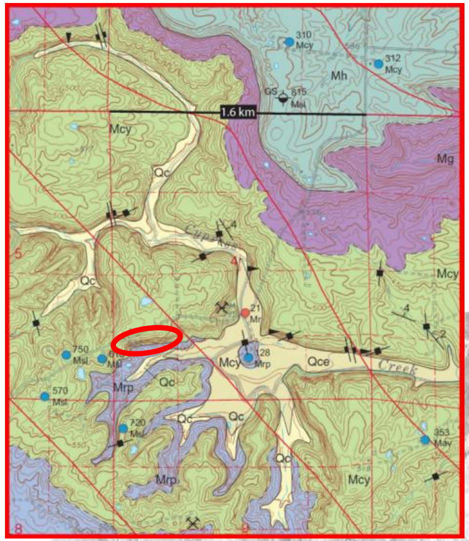


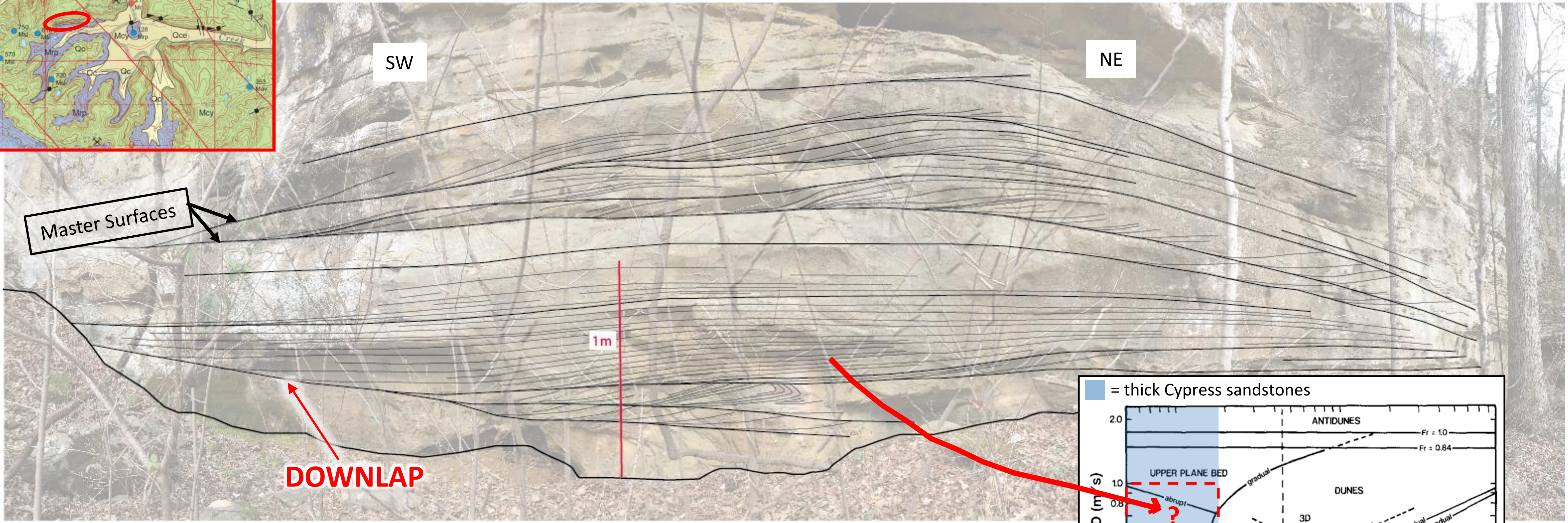


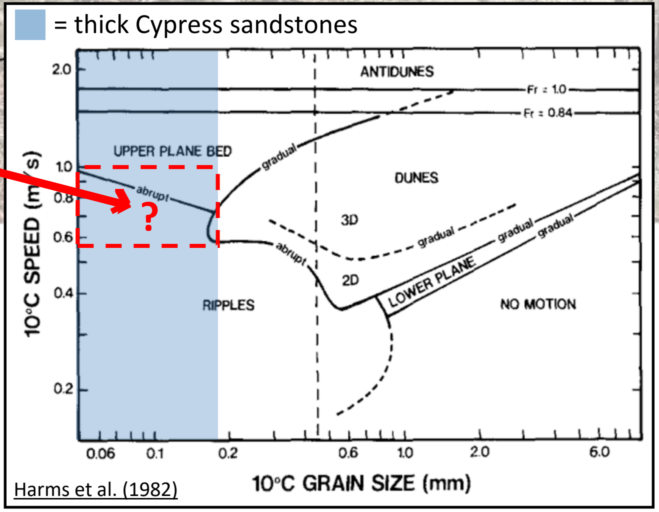
Cypress Creek Outcrops



Cypress Creek Outcrops

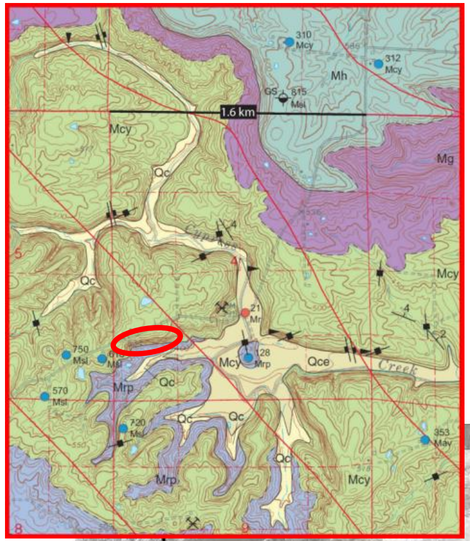




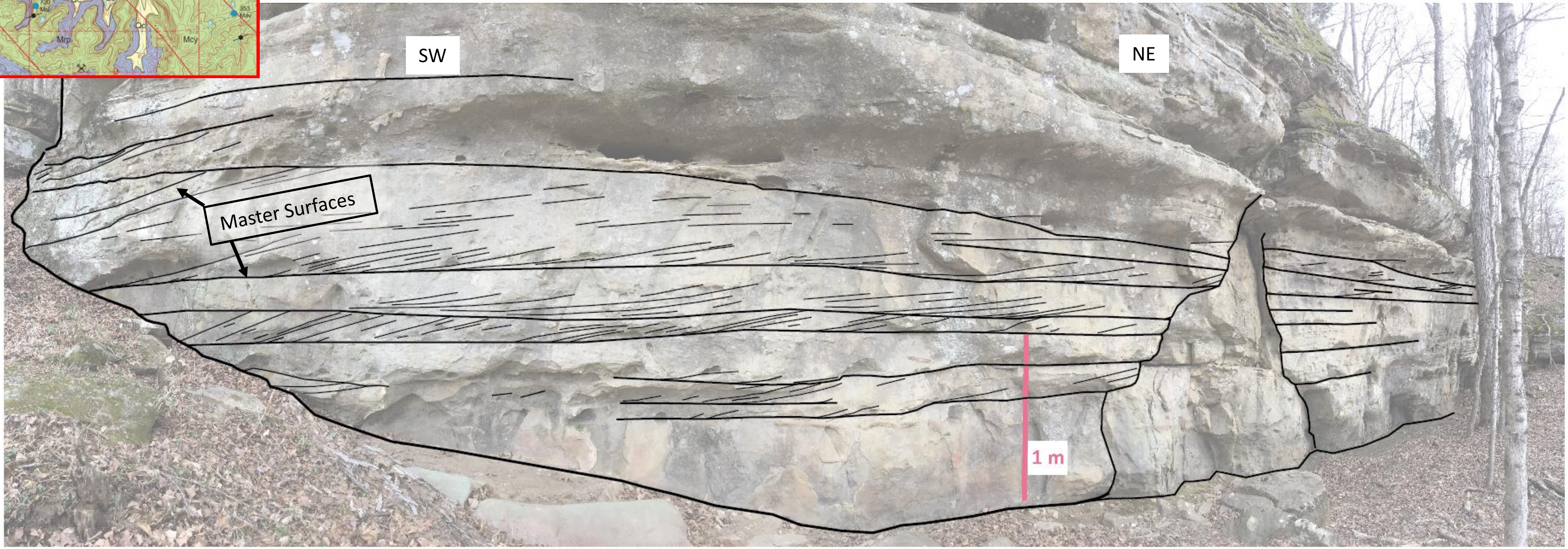


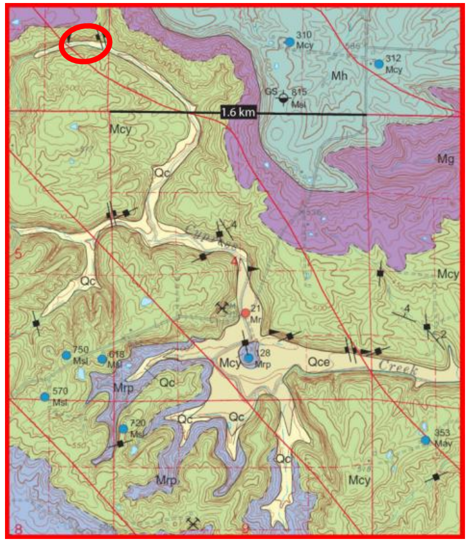
- **All low-angle and planar beds in thick Cypress deposited by flow velocities greater than ripples and lower than upper-stage plane beds**
- Common low-amplitude, long wavelength master surfaces with low angle cross-sets often superimposed

Cypress Creek Outcrops



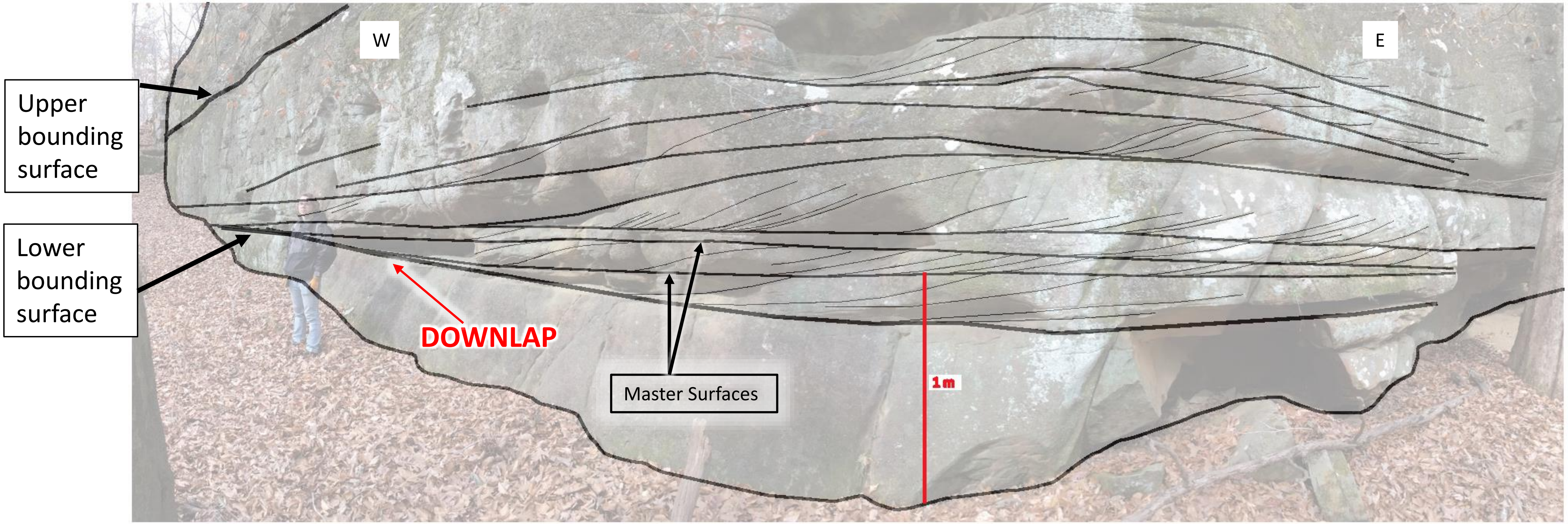
- **Small cross-sets**: mean thickness = 0.27 m
- **Low angle cross-sets common:** < 15°
- **Convex-up & sigmoidal foresets and tangential toesets common**
- **All beds dip uniformly to the W-SW**



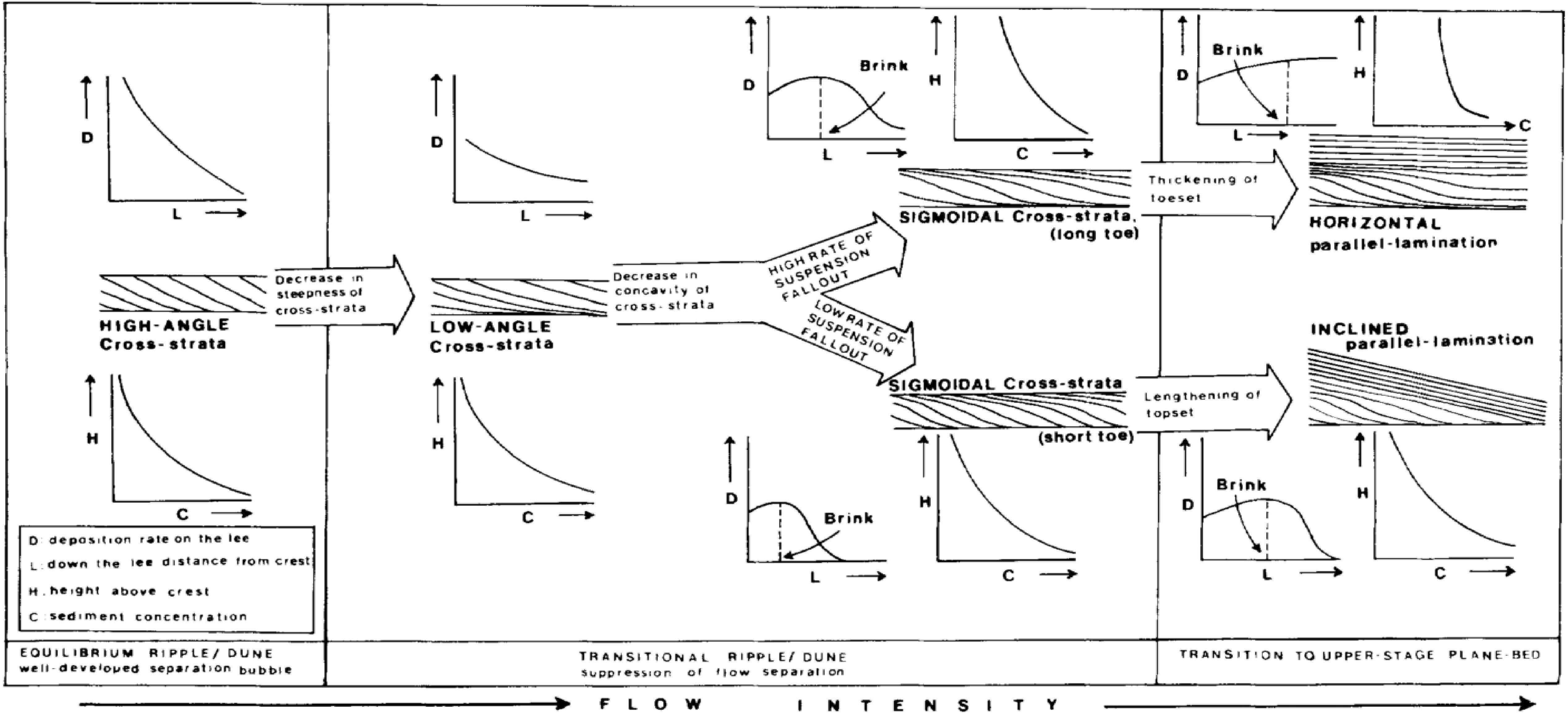


Cypress Creek Outcrops

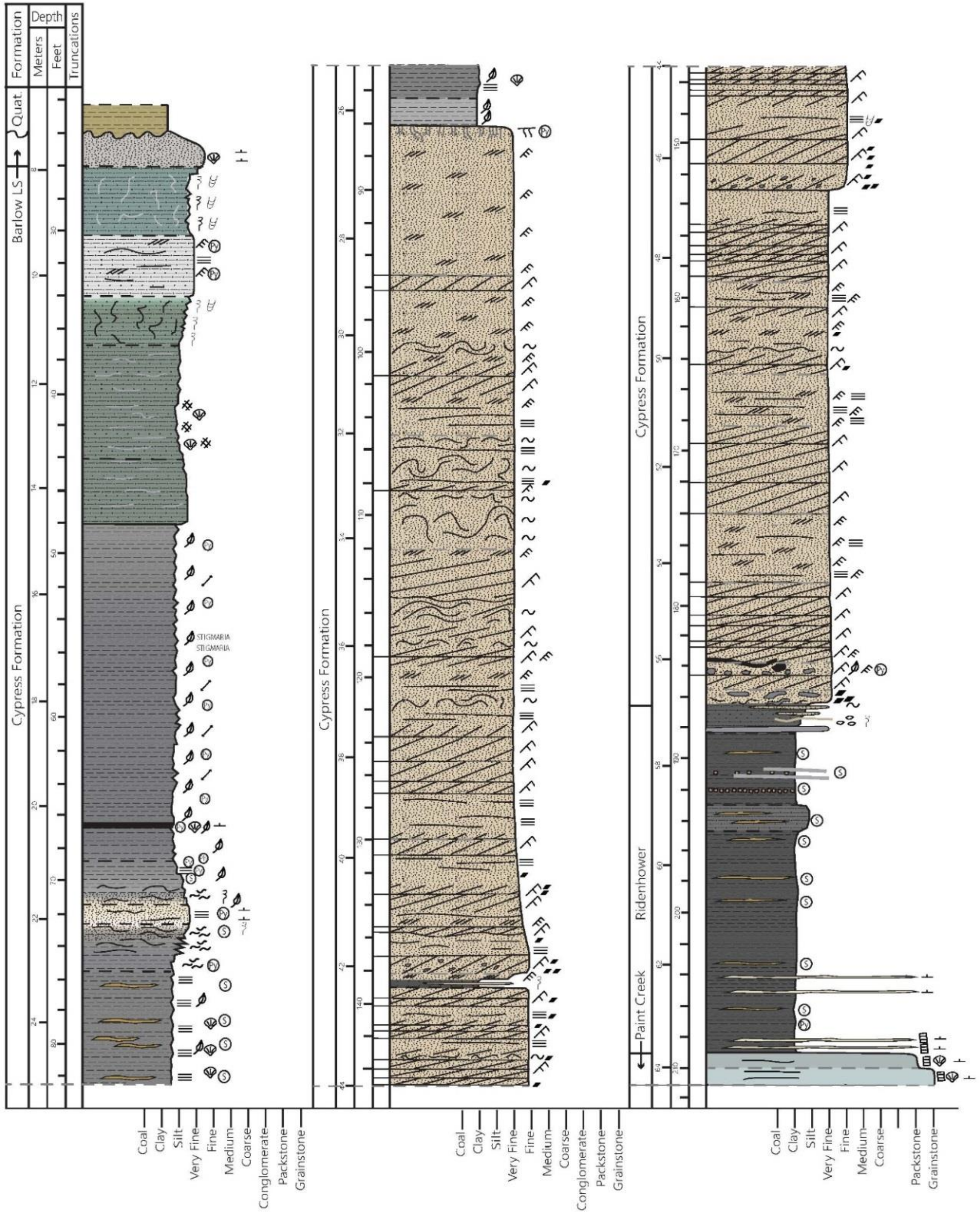
- Low-angle master surfaces dip gently westward and truncate at upper bounding surfaces and downlap onto lower bounding surfaces
- **Low-amplitude, long wavelength dunes? Or unit-bars?**
- **Convex-up & sigmoidal foresets and tangential toesets common**

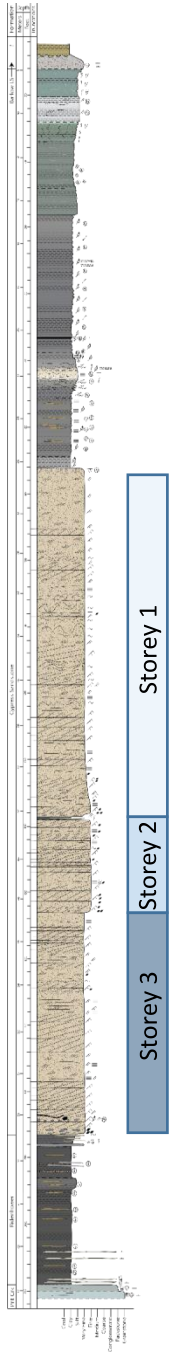


Dune to USPB Transition



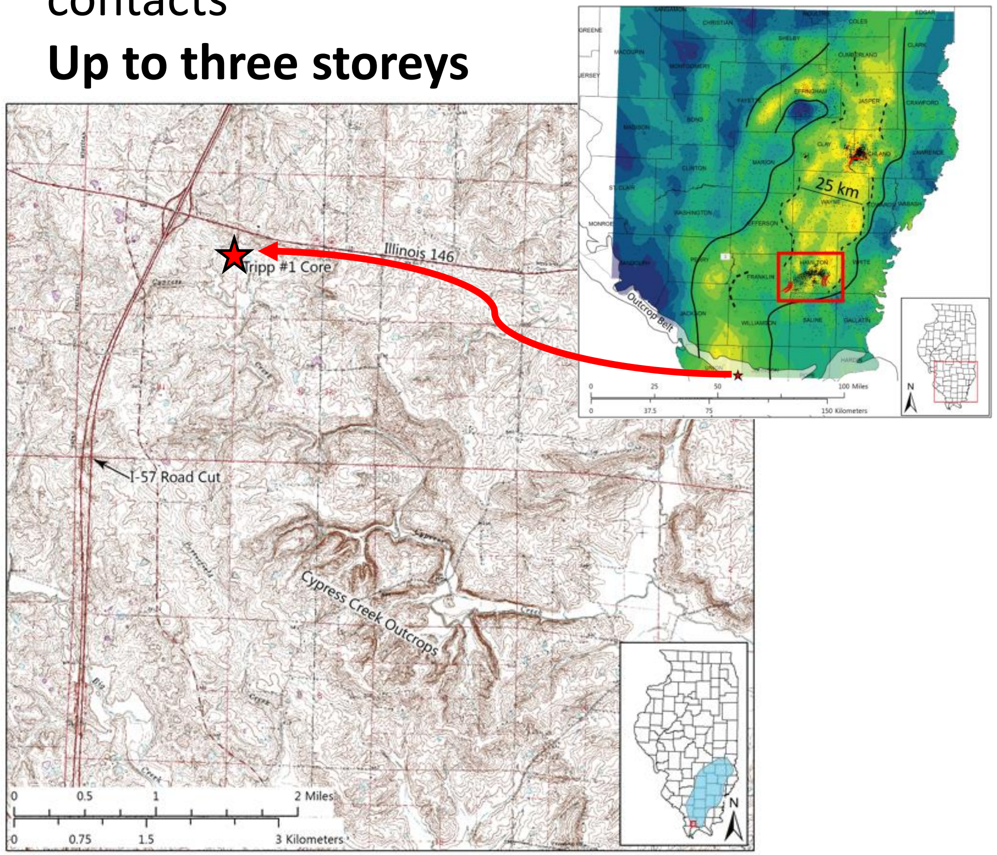
Chakraborty & Bose, 1992

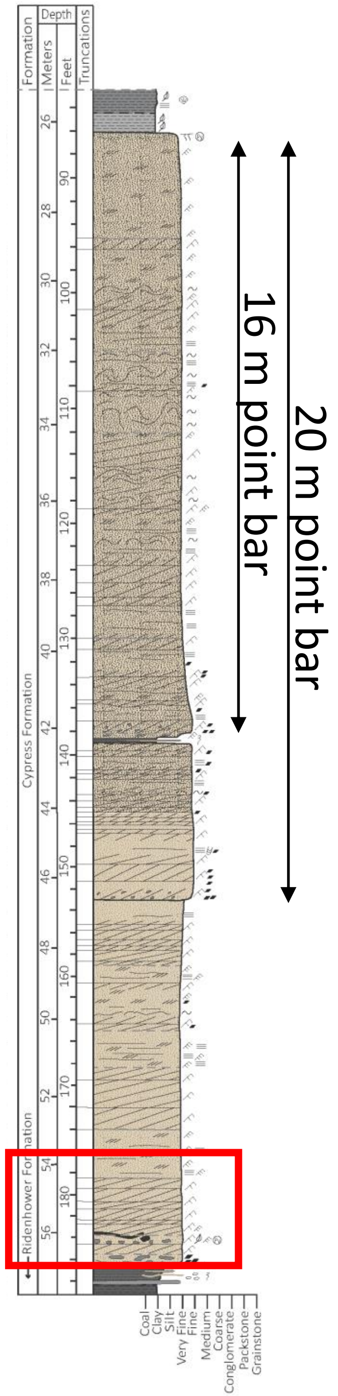




Tripp-1 Well

- 3.5 km from Cypress Creek outcrops
- Cored 31 m of thick Cypress sand
- 99% recovery in sand
- Core through entire Cypress, including upper and lower formation contacts
- **Up to three storeys**

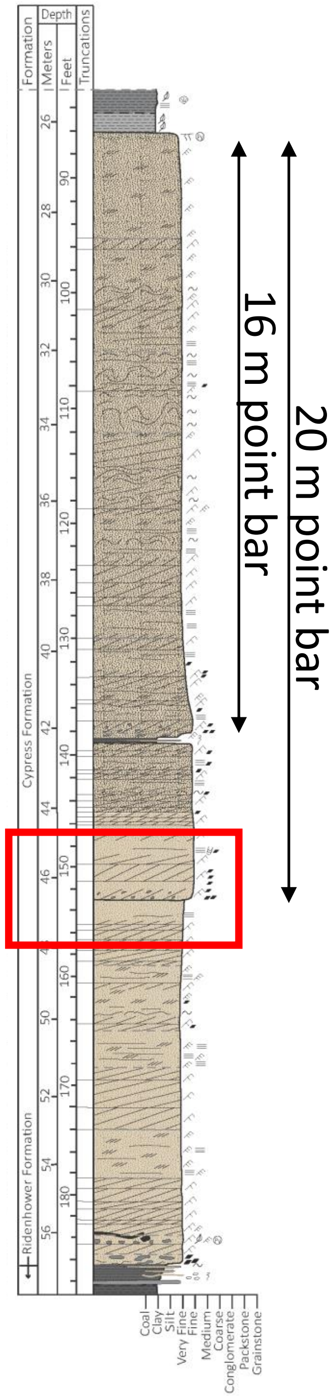




Tripp-1 Well

- Mean x-set thickness = 0.29 m
- Evidence for point bars 16-20 m thick?
  - Subtle basal lags, abrupt grain size increase
  - Fining-up
  - Decrease in bedform size upwards
  - Rooted top and gleyed paleosol

Tripp-1 Well



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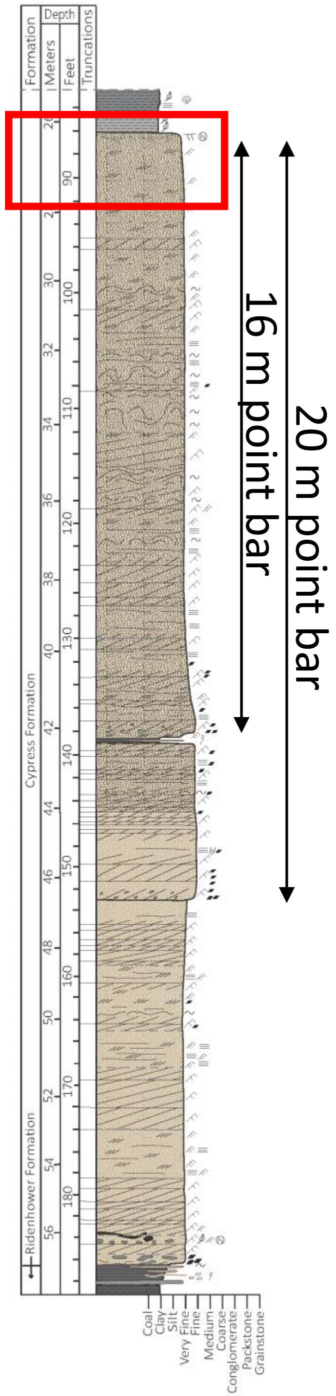

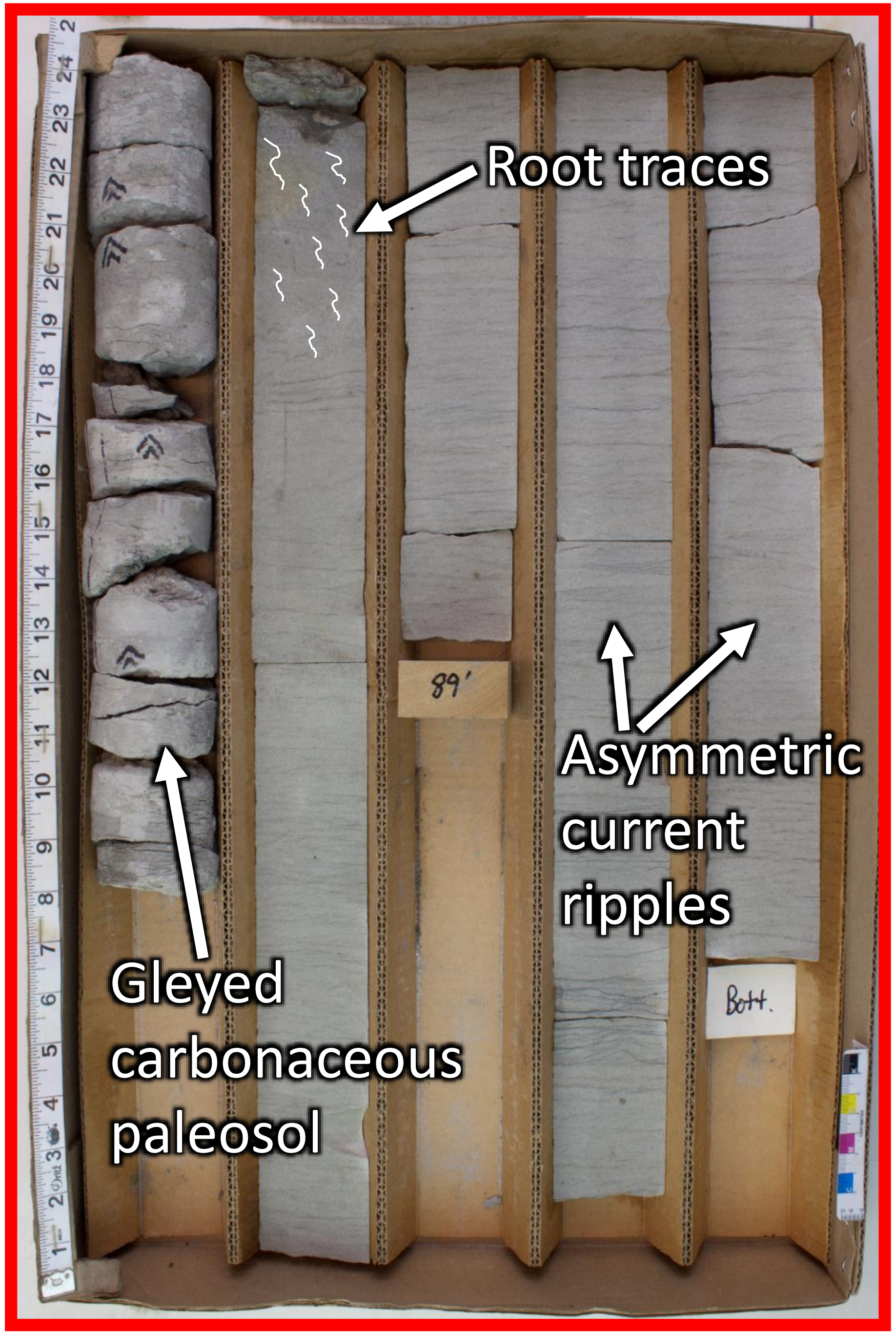

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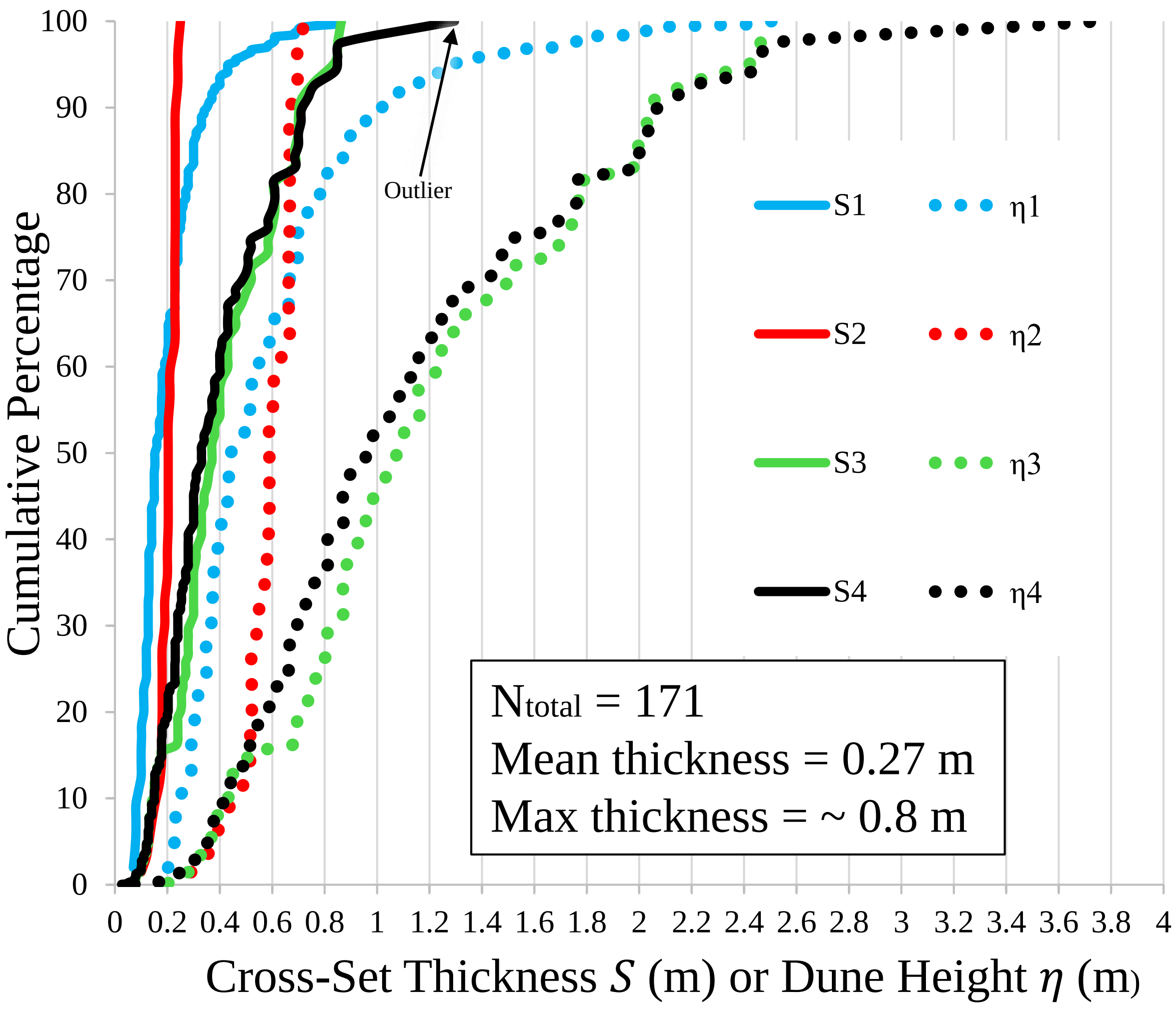
Summary of Interpretations

- D_{50} = ~132 µm (from thin section grain measurements)
- Multistorey sandstones within a ~ 50 km wide composite fluvial belt
    - Arcuate channel trends
    - Abandoned channel clay plugs
    - Sheet-like bodies
- **Channel storeys from 16 – 20 m thick**
- **Small simple cross-sets: mean thickness = ~0.3 m**
- **Unidirectional, low-angle foresets abundant (<15°)**
- **Sigmoidal & convex-up foresets and tangential toesets abundant**

DISCUSSION

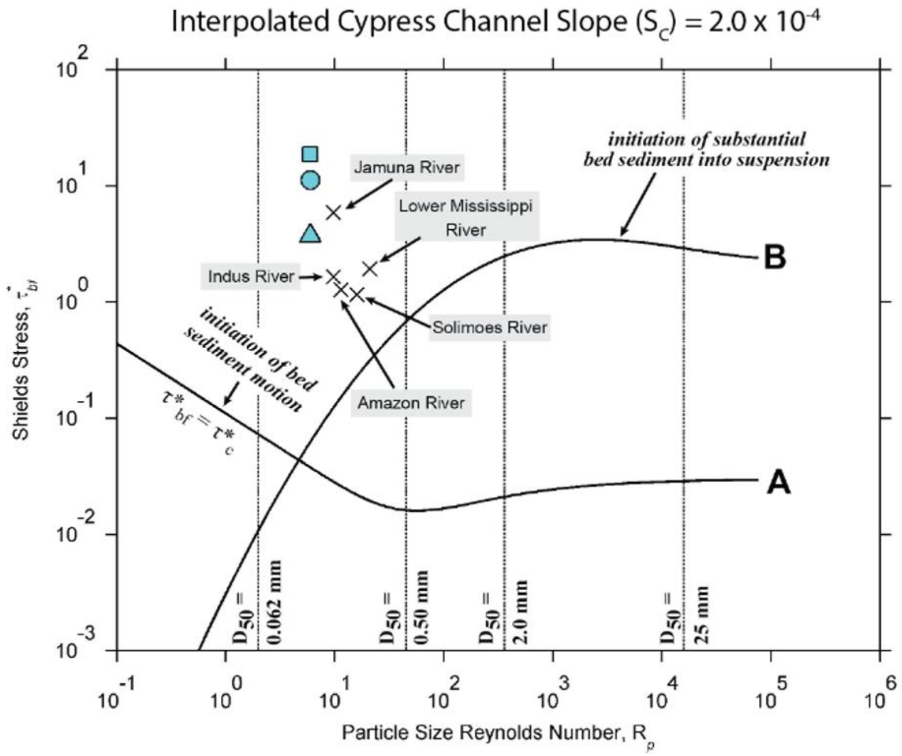
Scaling Relationships

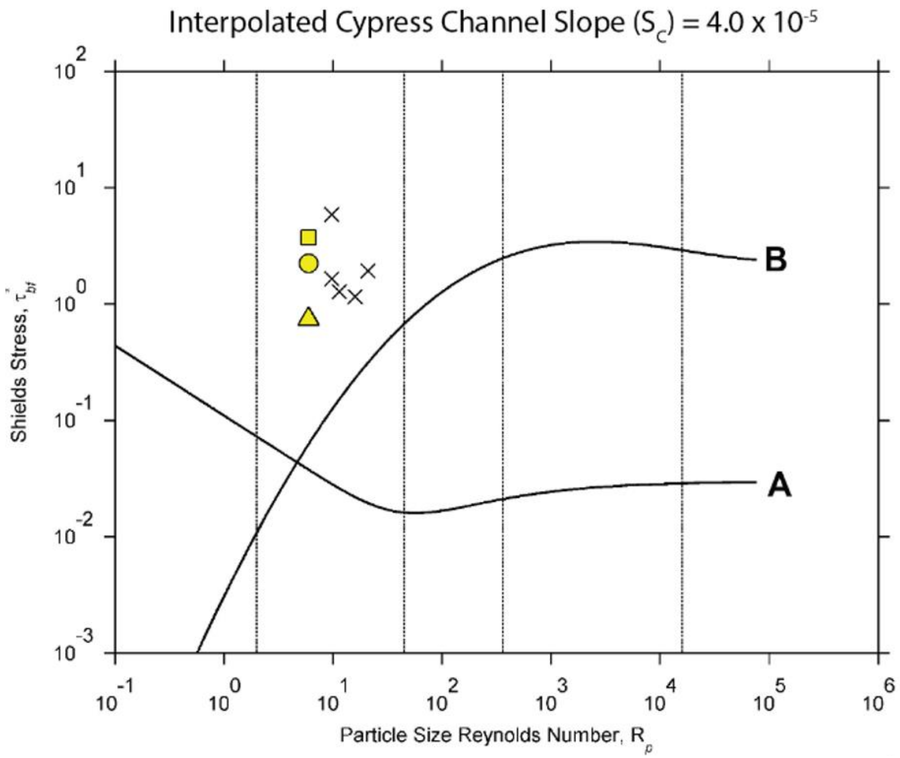


- ***Cross-set derived*** **bankfull depths**
  - Mean bankfull depth ~4 m
  - Maximum bankfull depth ~12 m
- ***Channel-fill derived*** **bankfull depths**
  - Mean bankfull depth ~10 m
- Bankfull depths from maximum thickness cross-sets are closer to mean bankfull depth derived from channel fills
  - **Mean cross-set thickness significantly underestimates actual mean bankful depth**

Affinity for Suspended Load Transport

	Blue			Yellow		
Channel bed slope S_c	2.0×10^{-4}			4.0×10^{-5}		
Bankfull depth H_{bf}	△ = 4 m	○ = 12 m	□ = 20 m	△ = 4 m	○ = 12 m	□ = 20 m





- Consistently fine grain size (D_{50} = ~132 μm)
- Low angle surfaces (<15°)
- Sigmoidal and convex-up foresets & tangential toesets
- Small simple cross-sets (0.29 m)

- Big fine-grained rivers are more suspension dominated
  - Low angle surfaces dominate
- Ancient Cypress river also suspension dominated
  - **Most cross-sets do not scale ideally to flow depths**
  - **Maximum cross-set thickness best for estimating paleodepths?**

Thanks to…

Julia Cisneros	John Nelson
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Beverly Seyler	Michael Lewsader
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QUESTIONS?