The Fluvial Sedimentology of Pennsylvanian Sandstones in the Illinois Basin

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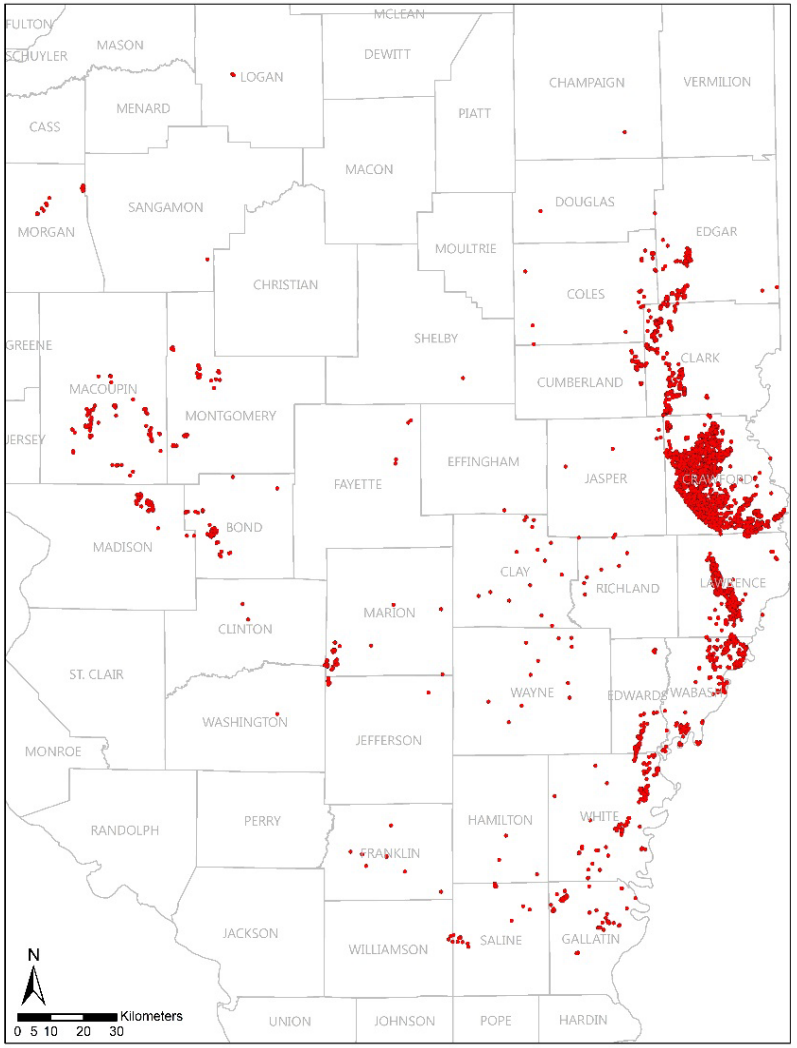
Outline

- Background
  - Pennsylvanian oil production
  - Stratigraphy & geologic setting
  - Study area
- Methods
  - Using geophysical logs & core
- Results
  - Comparing three channel deposits
- Implications

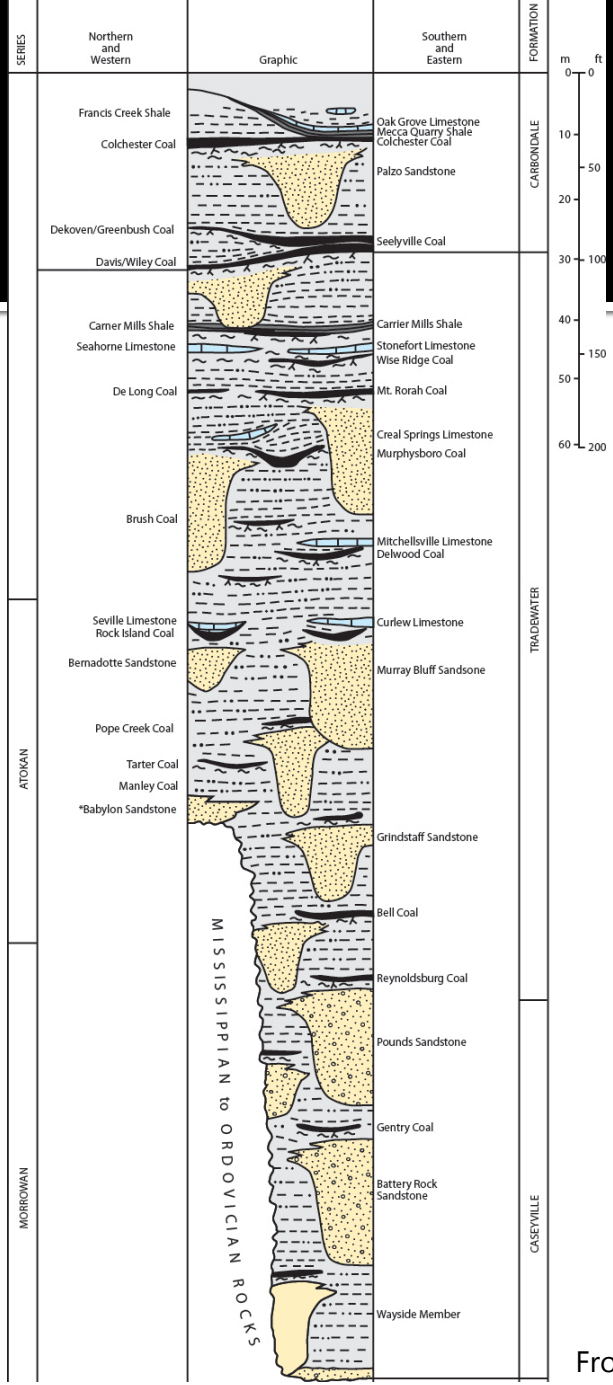
Pennsylvanian oil production

- Southeastern Illinois
  - Early development
  - Continued production
  - CO_2 EOR and storage possibilities
  - Abundant data
    - Well logs
    - Core



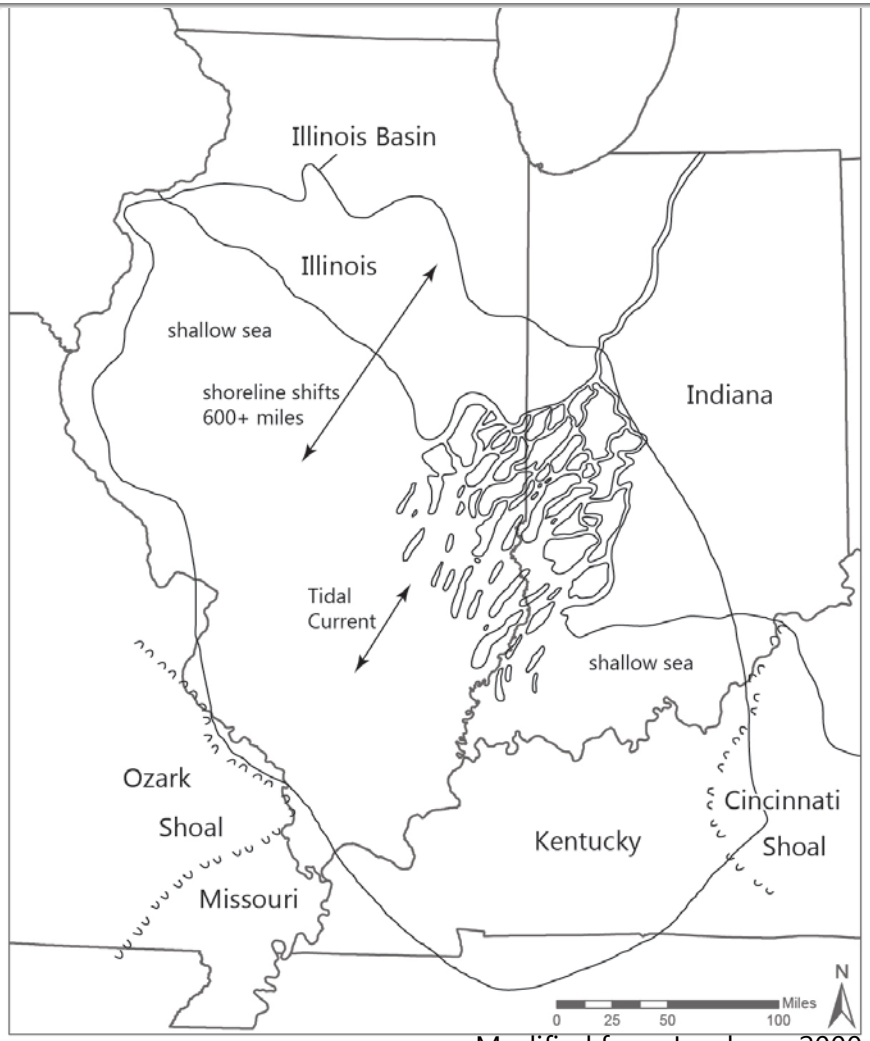
Stratigraphy

- Lower Pennsylvanian
  - Caseyville Fm.
  - Tradewater Fm.
- Largely sandstones and shales
- Sub-Pennsylvanian unconformity

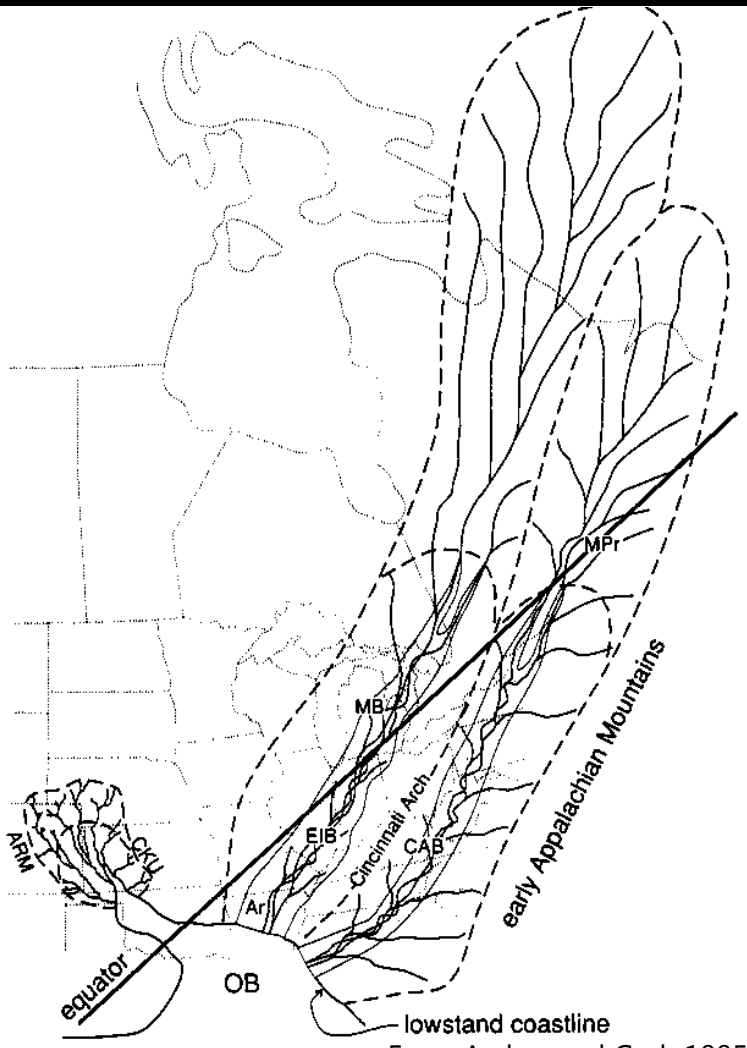


From Nelson et al., 2011

Geologic setting



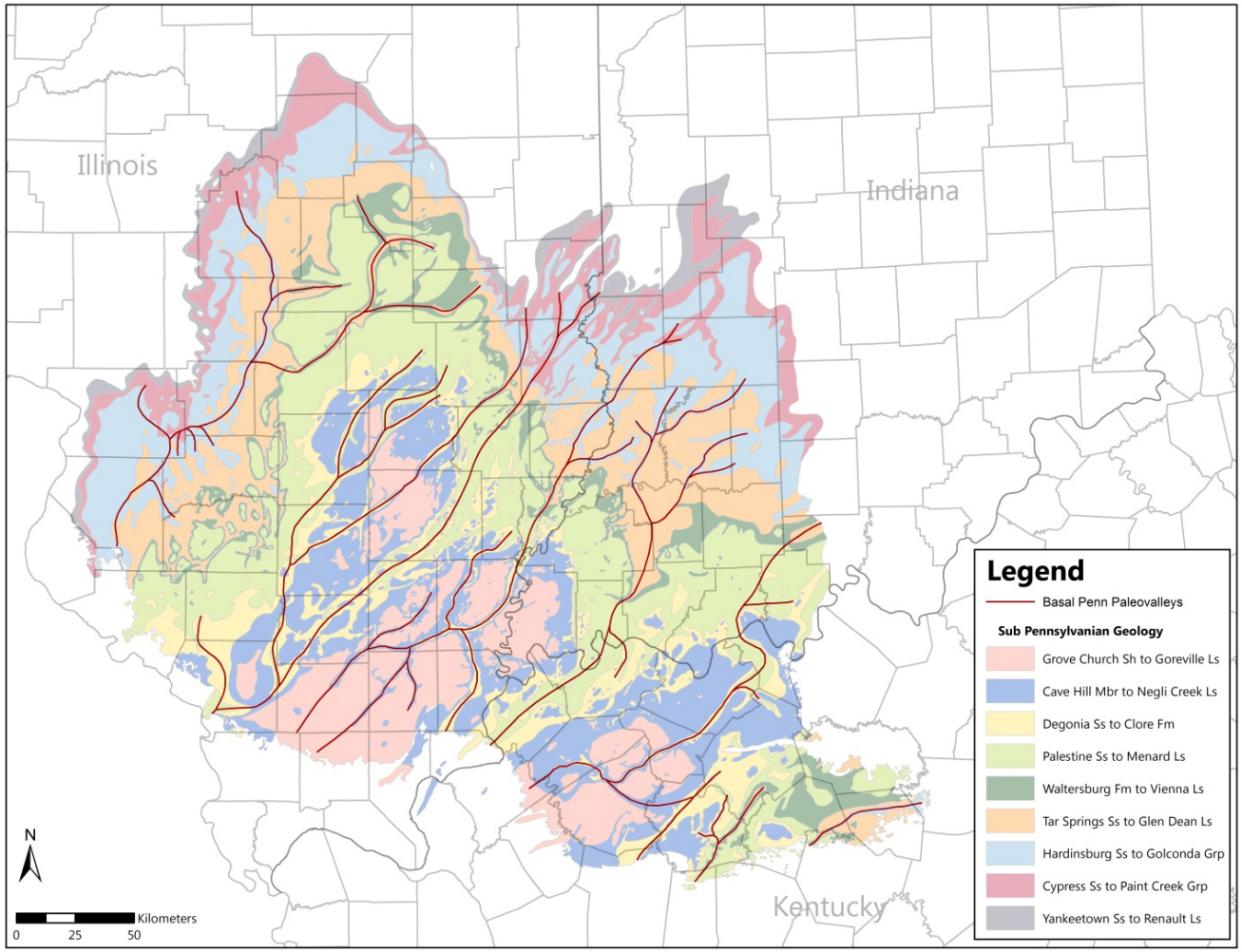
Modified from Jacobson 2000



From Archer and Greb 1995

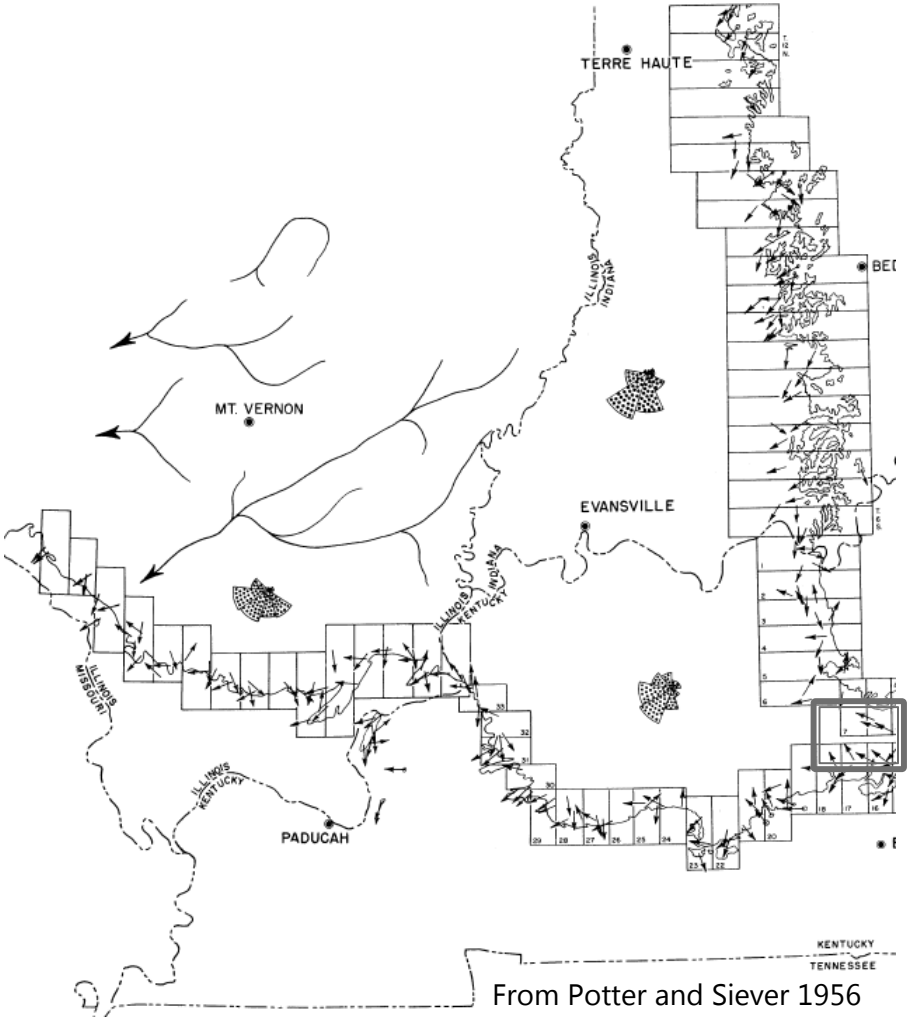
Sub-Pennsylvanian Unconformity

- Chesterian subcrop
- SW trending paleovalleys
- 134 m of relief
- Overprinted on structural features

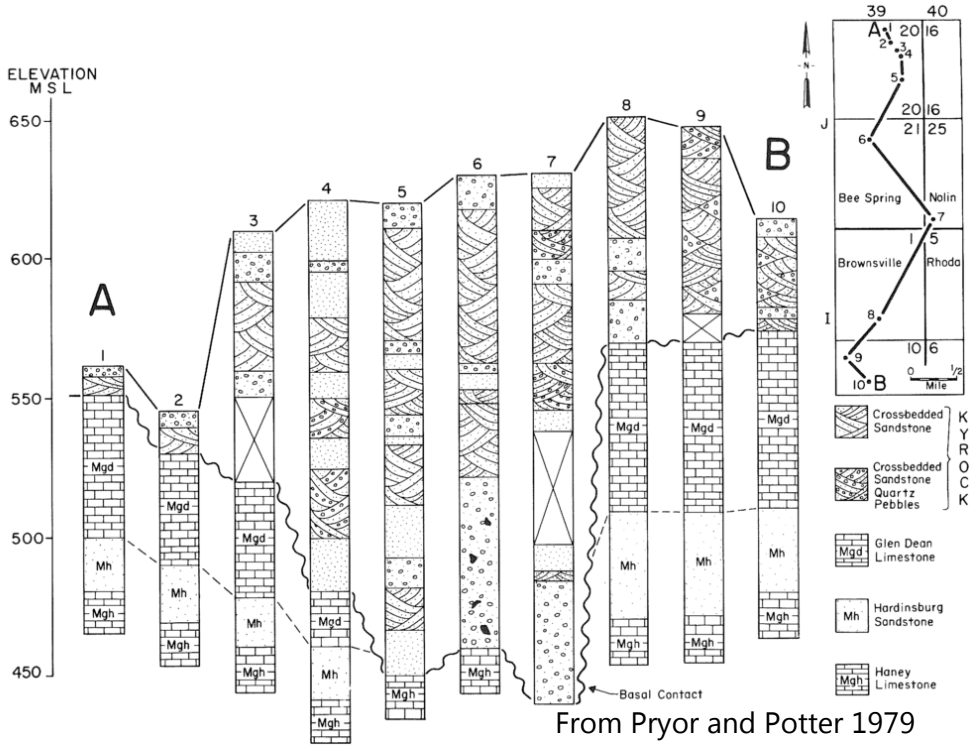


From Bristol & Howard 1971

Channel fill sediments

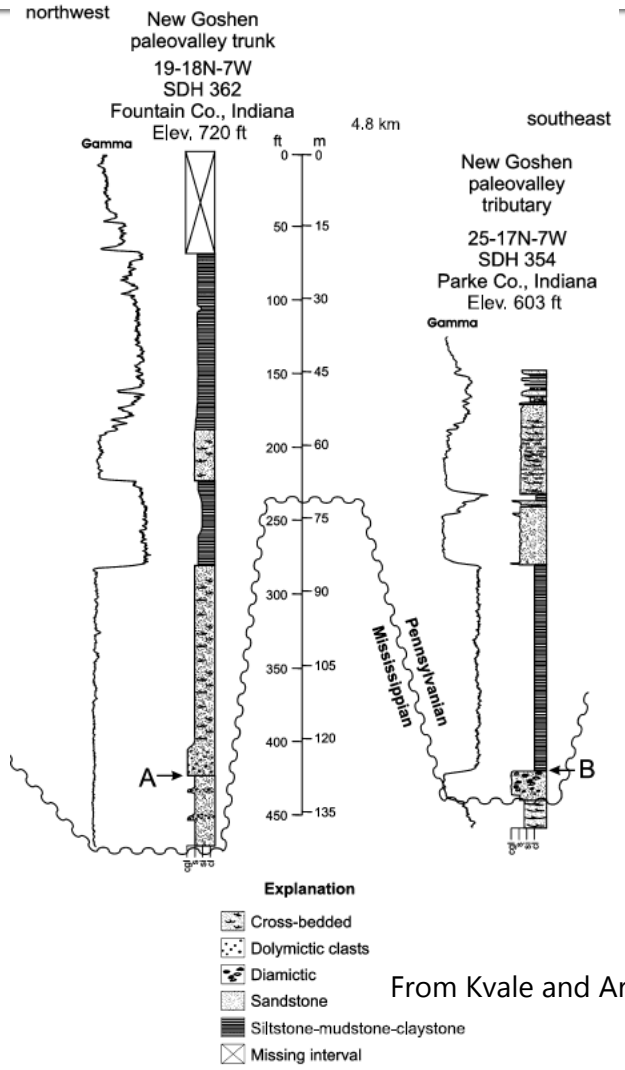


From Potter and Siever 1956

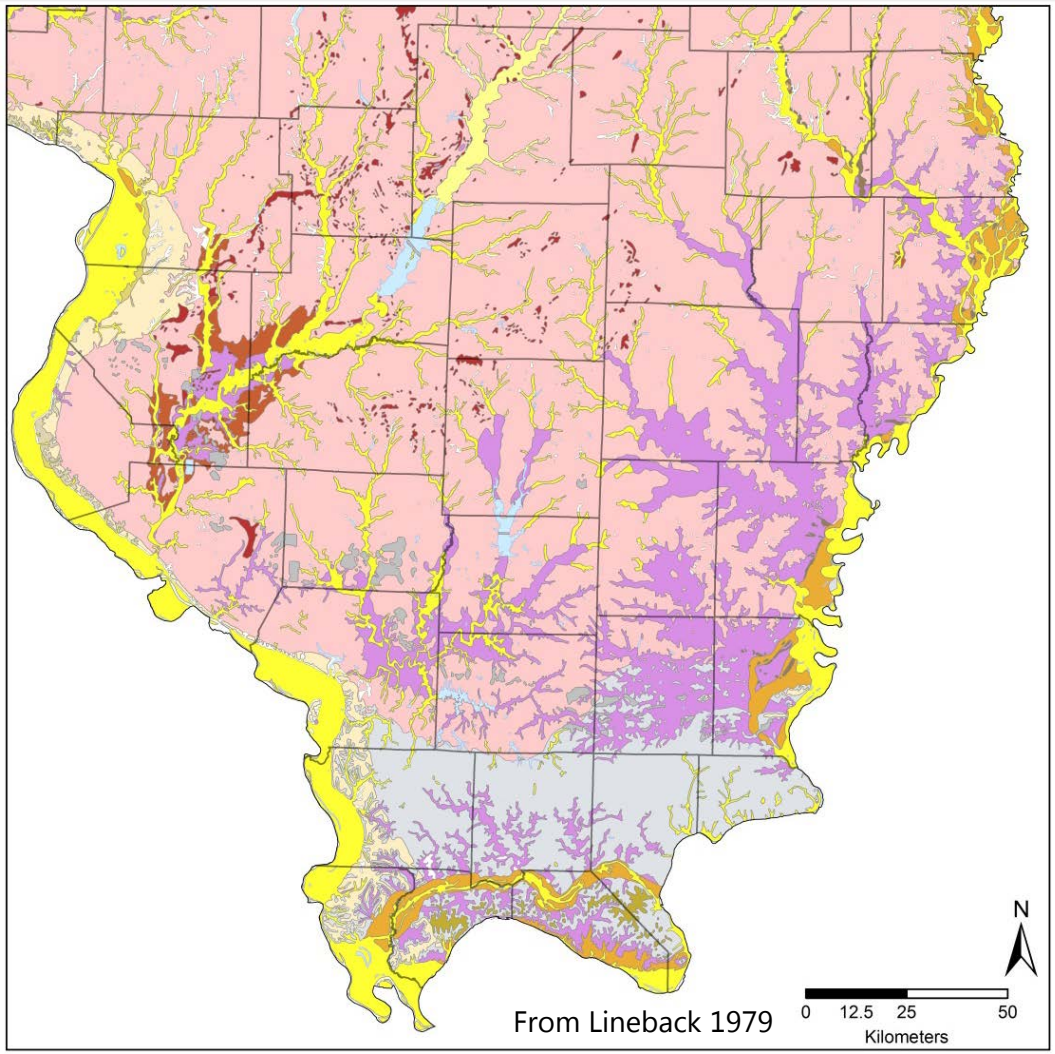


From Pryor and Potter 1979

Channel fill sediments



From Kvale and Archer 2007



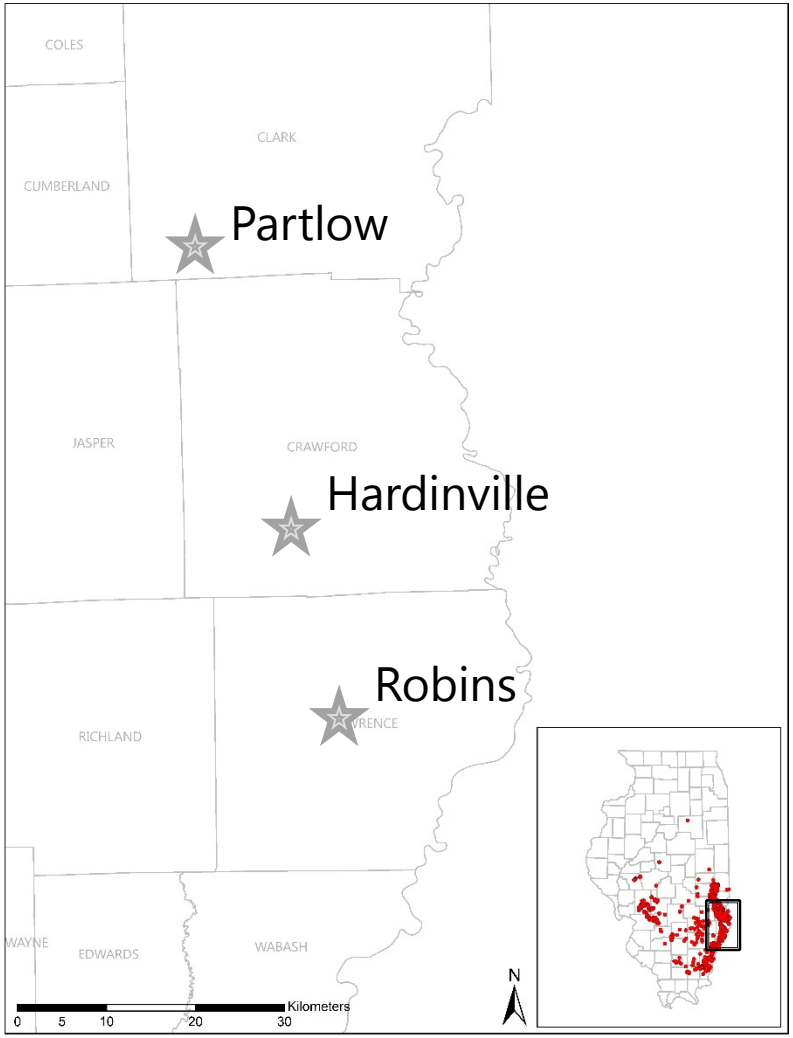
From Lineback 1979

Objectives of this talk

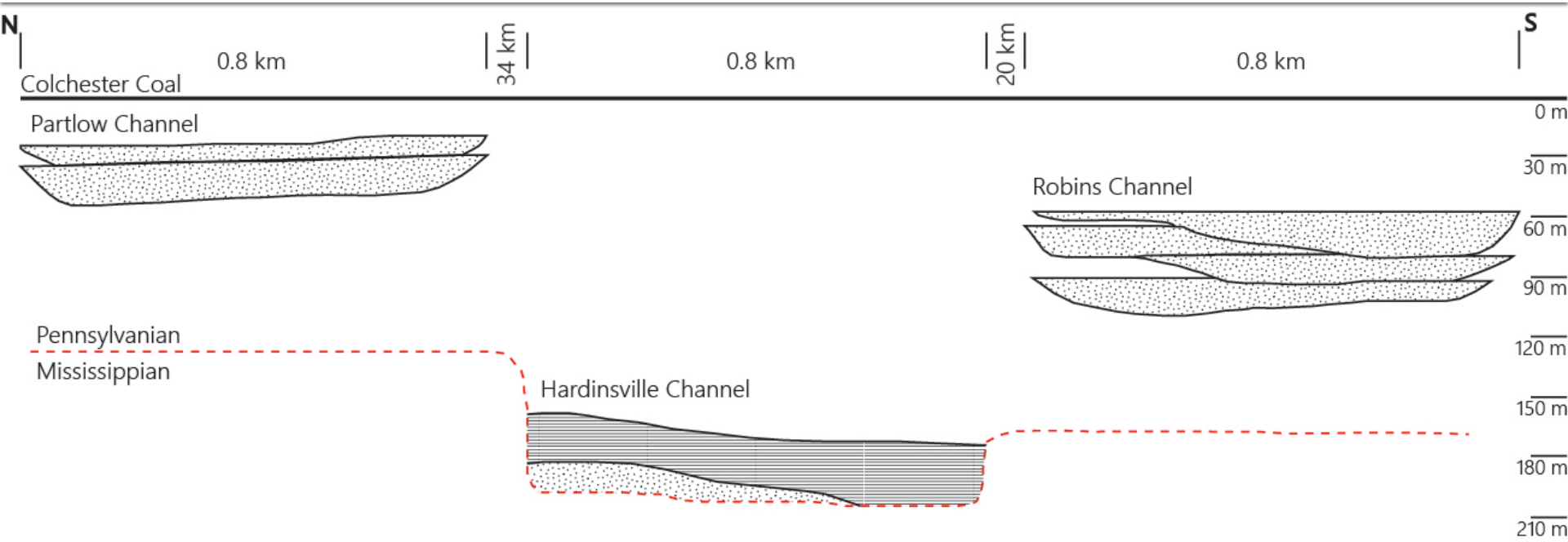
- Three subsurface examples
- Caseyville and Tradewater Formations
- Comparison of observed facies
- Implications for basin sedimentation and oil reservoirs

Study area

- Three subsurface examples
- Areas with dense log and core control
- Each sandstone is an oil reservoir



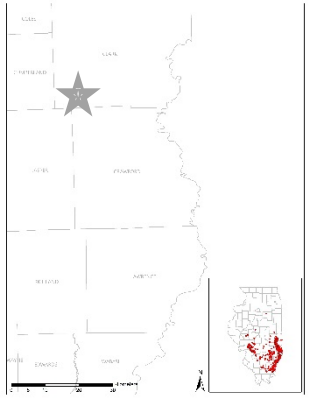
Cross section

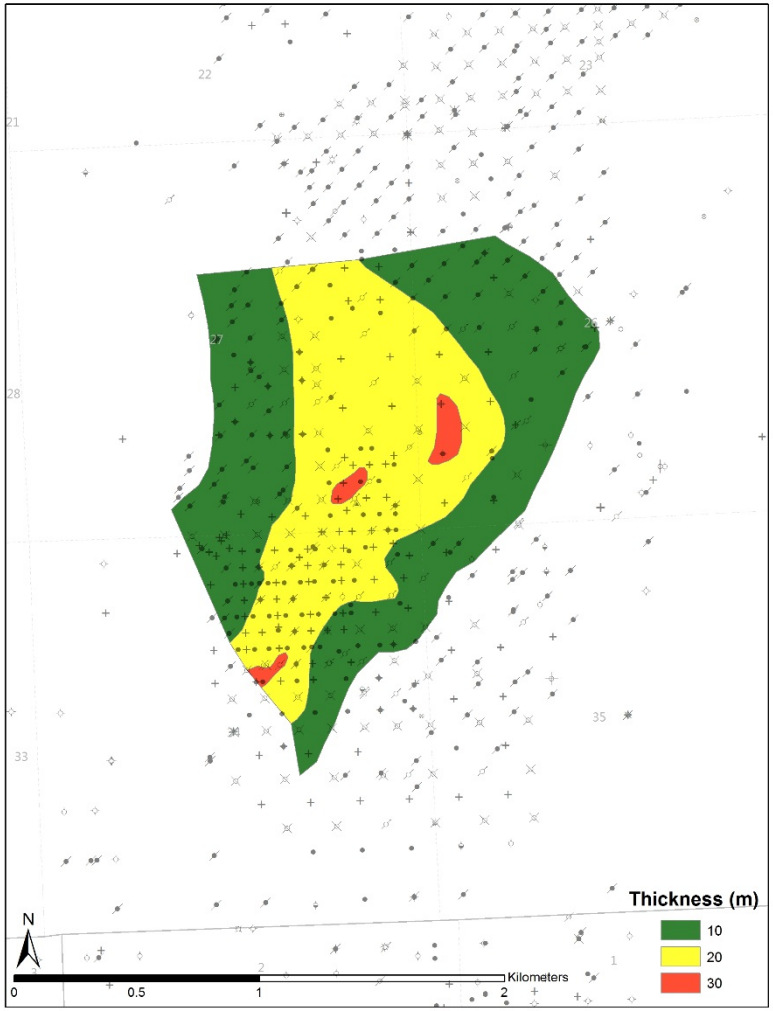


- Diagrammatic N-S Cross section showing stratigraphic position of three channels
- Core was examined from each channel

Partlow channel

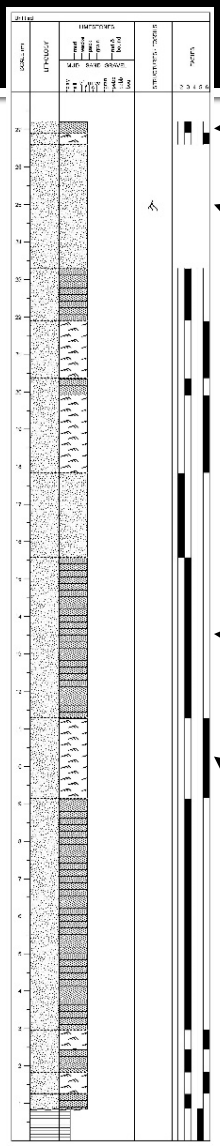
- Tradewater Formation
- Dimensions
  - 2.5+ km long
  - 1 km wide
  - 1.5-30 m thick
  - W/T = 33
- NE-SW trend
- 8 Cores





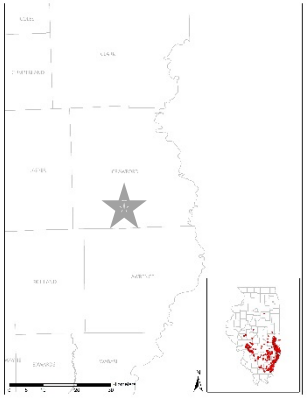
Partlow channel - facies

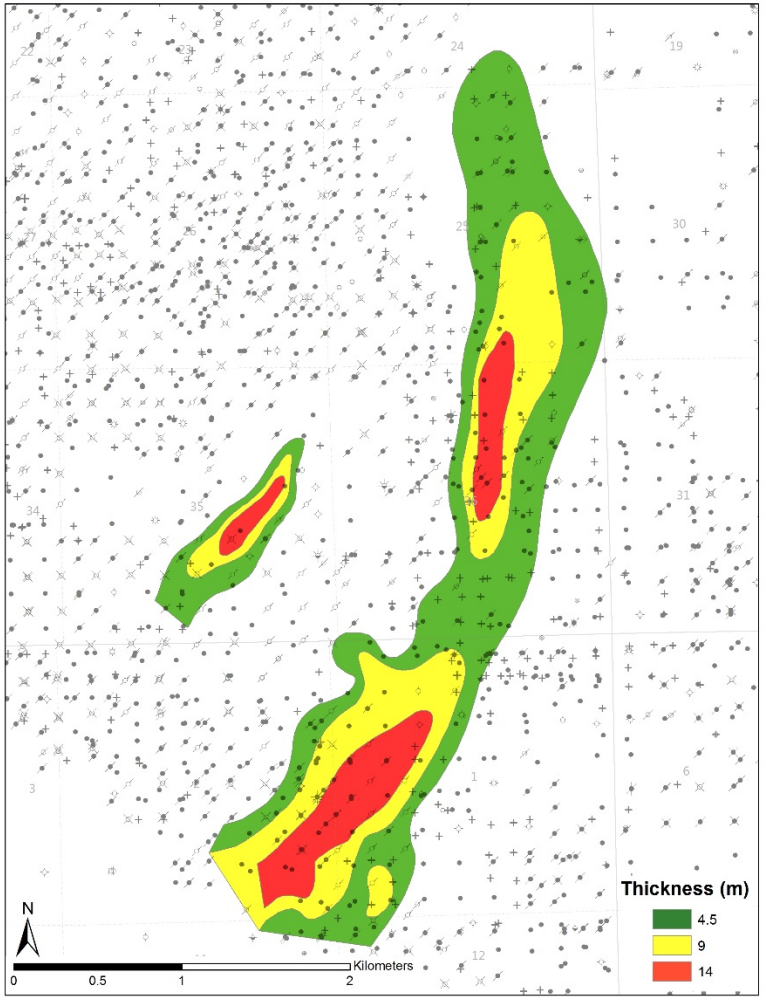
Facies	Description	Interpretation
Fl	Silty shale with occasional beds of very-fine sandstone; ripple bedded; laminated	Overbank
Fsc	Fine laminated shale	Floodplain or estuarine mud
PS	Fine to medium grained sandstone; weak pedogenic features; rootlets; disturbed bedding; carbonaceous fragments	Paleosol
Sp	Fine to medium grained sandstone with planar crossbeds; common soft sediment deformation; siderite clasts along bed set surfaces	2D-3D Dunes
Sr	Fine to medium grained sandstone with rippled bedding	Ripples
Sm	Medium to coarse grained sandstone with massive bedding; can be calcareous	Mass flow (?)



Hardinville channel

- Caseyville Formation
- Dimensions
  - 5 km long
  - 0.8 km wide
  - 1.5-14 m thick
  - W/T = 18
- NE-SW trend
- 3 Cores



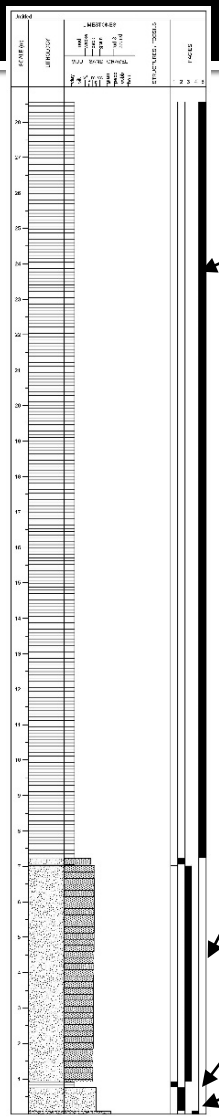


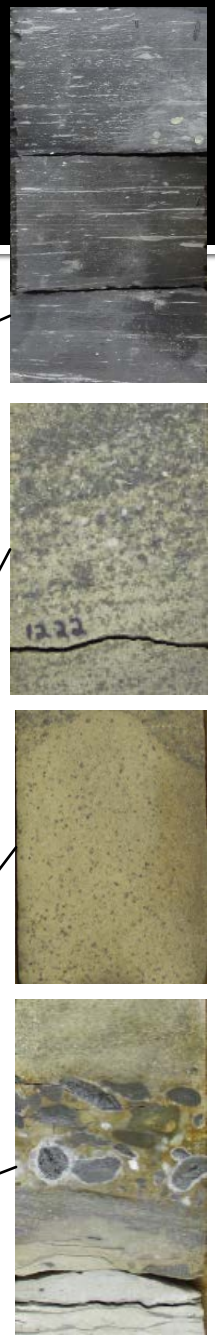
Modified from Howard & Whitaker 1988

Hardinville channel - facies

Facies	Description	Interpretation
Fsc*	Fine laminated shale; thin silt and sand lenses; bioturbated	Estuarine mud
Fl	Interbedded shale and silty very-fine grained sandstone; ripple bedded	Overbank
Sm	Fine to medium grained sandstone with massive to weakly subhorizontal bedding	Mass flow (?)
Sp	Medium to coarse grained sandstone with planar crossbeds; common quartz granules; siderite clasts along bed set surfaces	2D-3D Dunes
Gm	Crudely bedded gravel or gravelly sandstone; contains coal, shale, siderite, and lithic clasts; siderite or calcite cemented matrix	Lag

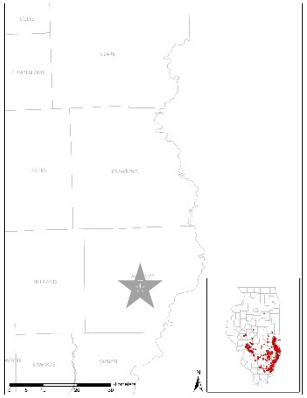
*inferred from logs and analogous channels

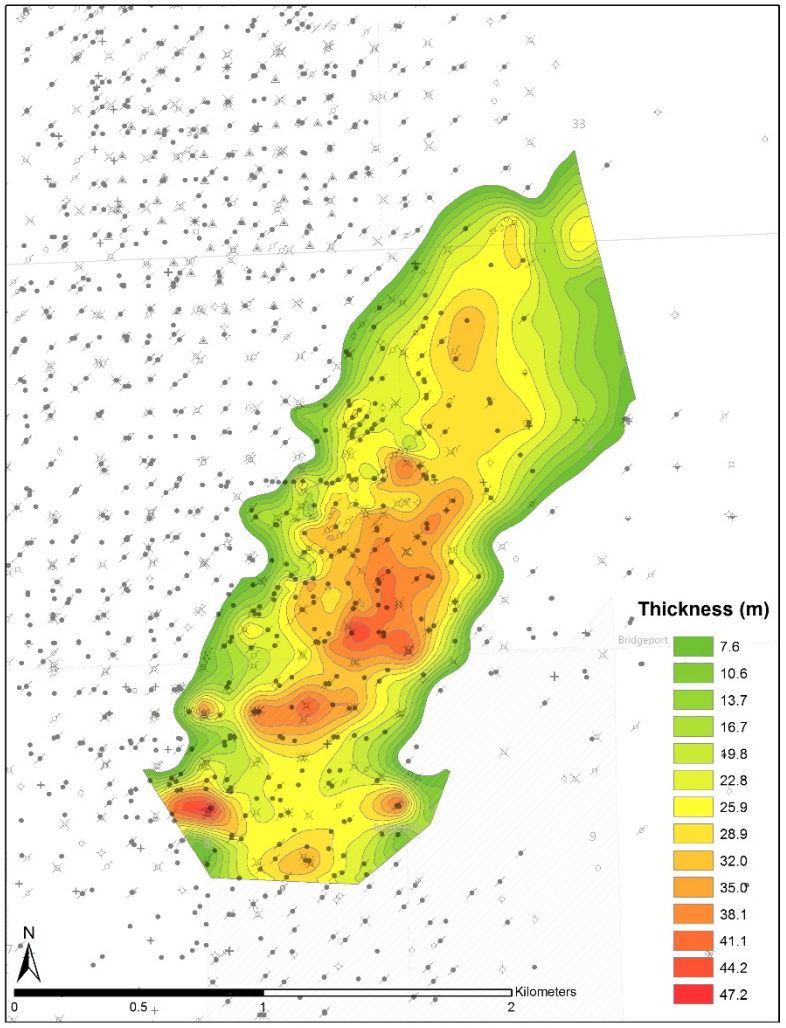




Robins channel

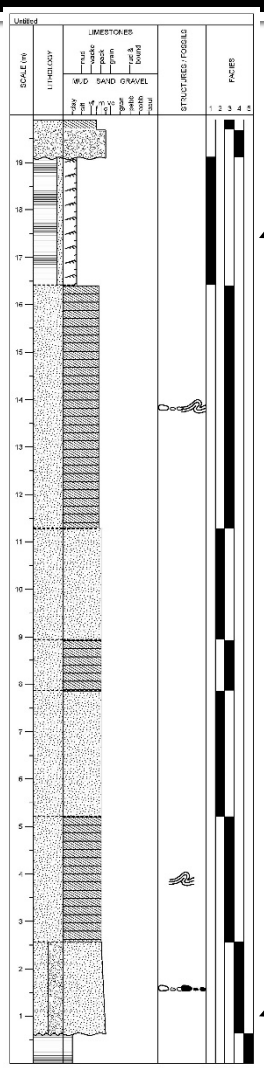
- Tradewater Formation
- Dimensions
  - 3+ km long
  - 1.1 km wide
  - 5-50 m thick
  - W/T = 22
- NE-SW trend
- 18 Cores



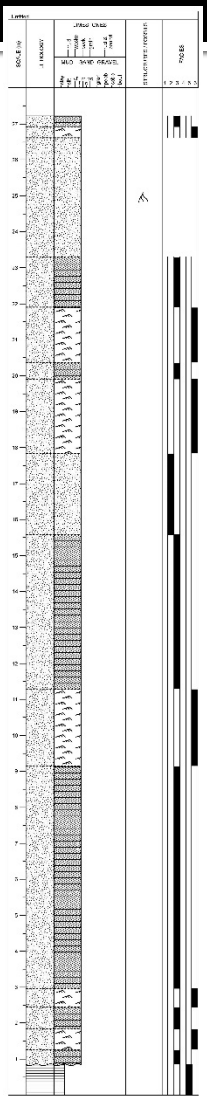


Robins channel - facies

Facies	Description	Interpretation
Fl	Interbedded shale and silty very-fine grained sandstone; ripple bedded; rhythmic; few bidirectional ripples; weakly bioturbated; sideritized bands	Tidally influenced overbank or estuarine muds
Fsc	Fine laminated shale	Floodplain or estuarine mud
Sm	Medium grained sandstone with massive bedding	Mass flow (?)
Sp	Medium to coarse grained sandstone with planar crossbeds; common soft sediment deformation; siderite clasts along bed set surfaces	2D-3D Dunes
Gm	Crudely bedded gravel or gravelly sandstone; contains coal, shale, siderite, and lithic clasts; siderite or calcite cemented matrix	Lag

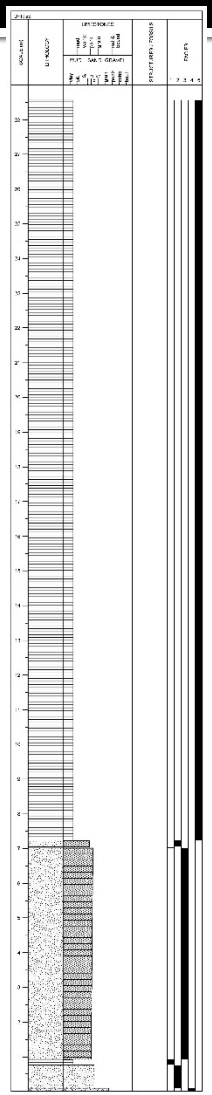


Channel comparison



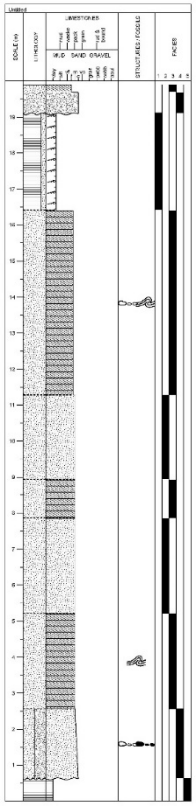
Partlow

- Active channel
- Predominately ripples and dunes
- Weak paleosol in upper part



Hardinsville

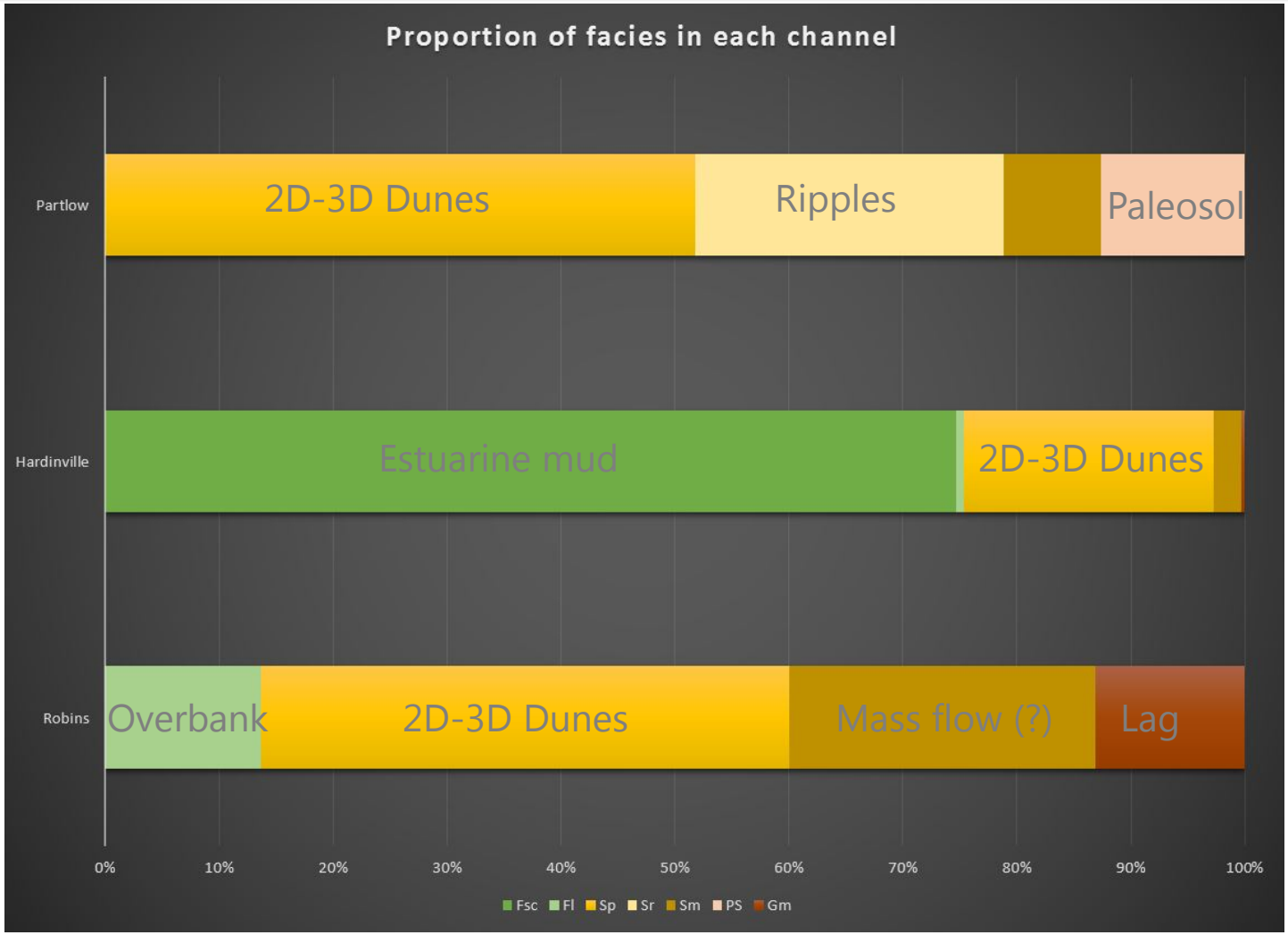
- Active channel became estuarine
- Predominately dunes
- Most of valley is filled with estuarine mud



Robins

- Active Channel
- Predominately dunes and mass flow
- Common gravelly zones along bed set surfaces and no overall grain size trends

Channel comparison

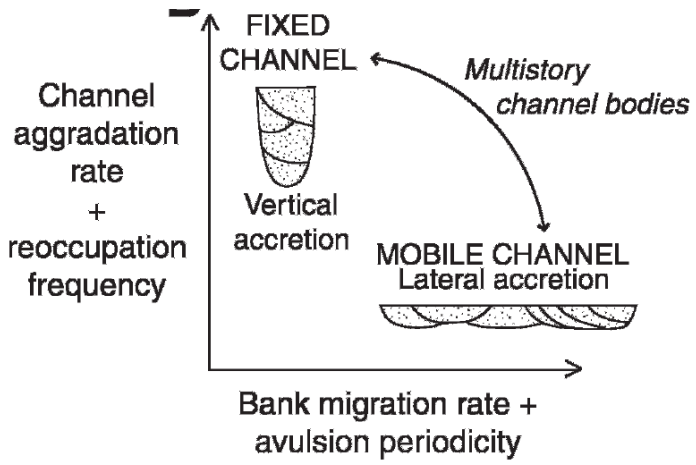


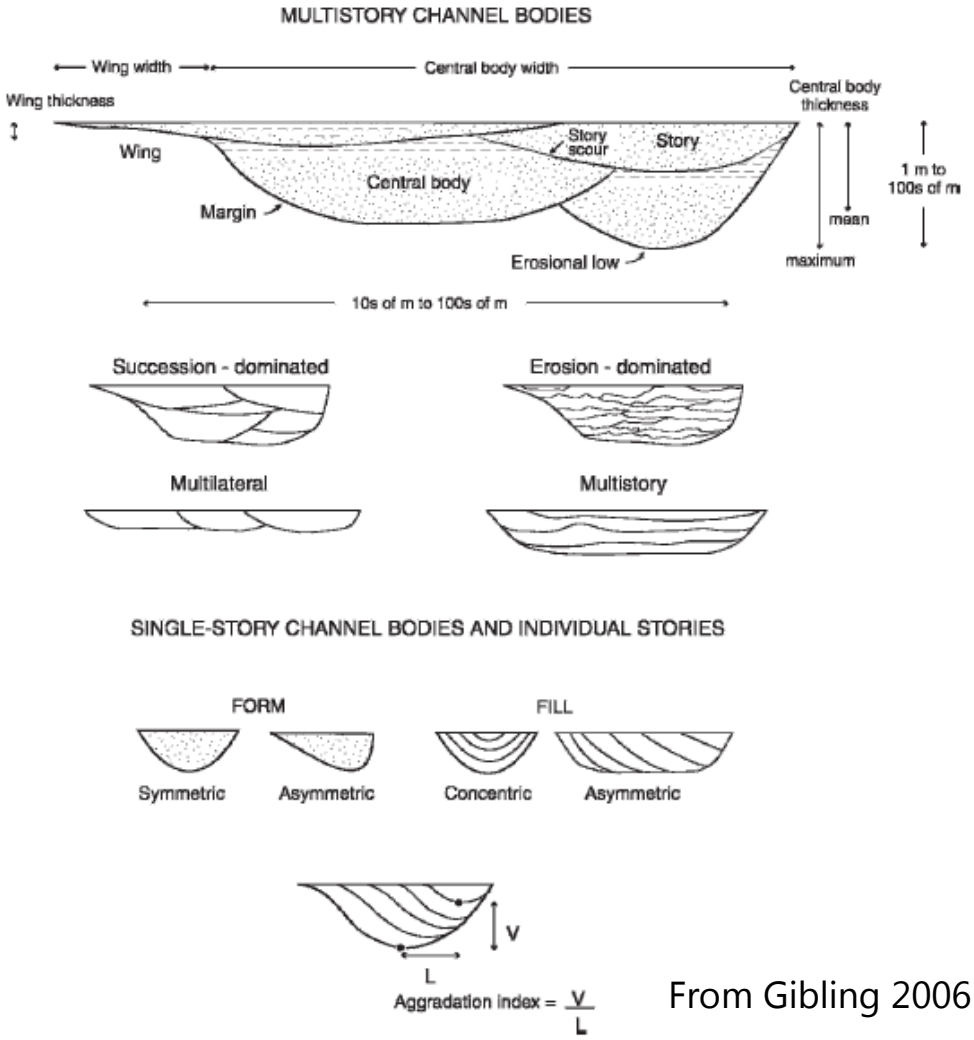
Channel interpretations

- Regional three dimensional changes
  - Tidal influence wanes stratigraphically higher and updip
  - General fining upward trend across channels
- Narrow sheets
  - Becoming slightly broader through time – less confined to bedrock valleys
- Possibly formed through multiple episodes of deposition

Implications

- Channel dimensions
- Arrangement of architectural elements

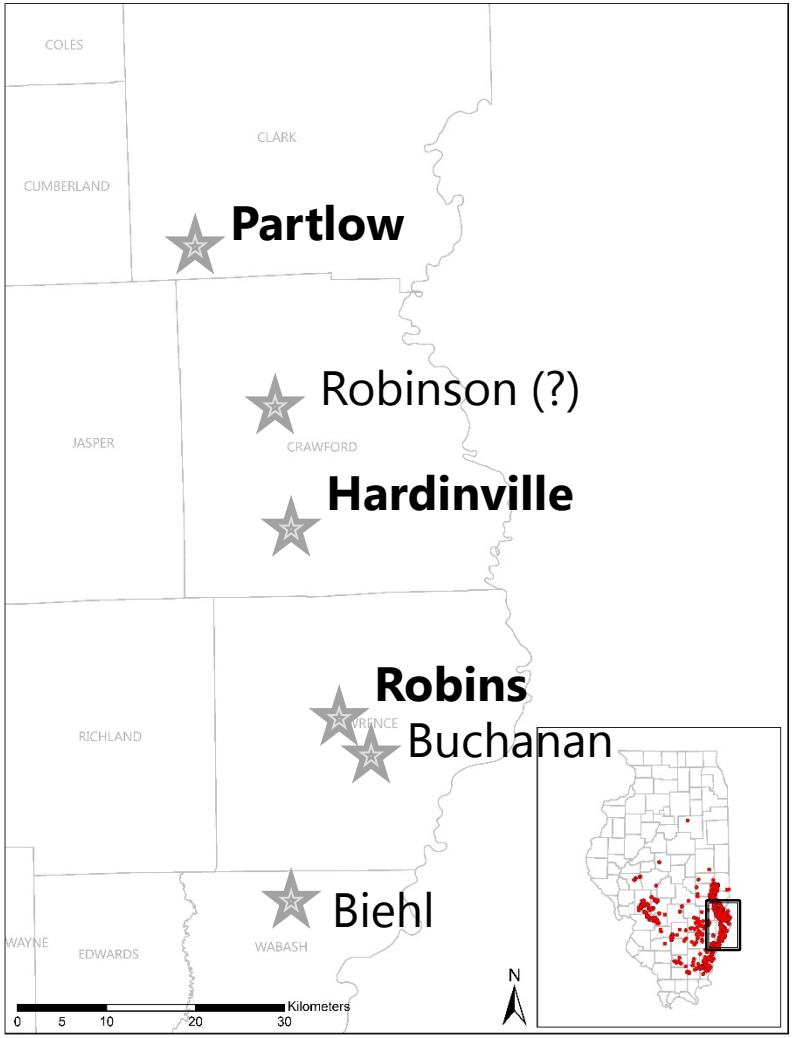




From Gibling 2006

Implications

- Potential for additional studies of known and unknown channels in the area



Summary

- Pennsylvanian channels are common in southeastern Illinois and are a resource
- Changes in channel fill and morphology through time give clues as to how the basin filled
- Carboniferous basins with similar deposits exist all over the world

Garden of the Gods, Southern Illinois

Brimham Rocks, North Yorkshire, England

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