Fluvial systems

Distinctive features

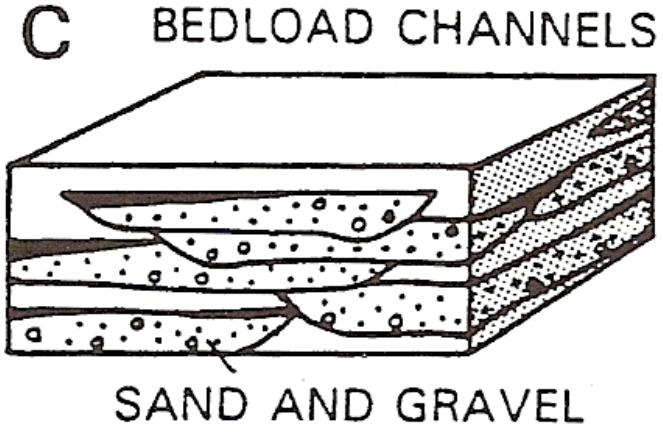
- Size and geometry of channels
  - Their sinuosity
  - Their ability to migrate
  - Associated bars
  - Occurence of ± extended
    - overbank deposits
    - Natural levees

Channel form

- Sinuosity (ratio channel length and valley length)
- Single-channel (*meandering*)
- Multiple-channel (*braided*)
- Channel subdivision by
  - large bedforms (bars)
  - accreting islands around which channel reaches diverge and converge (braiding)
  - Stationary and smaller channels (*anastomosing*)

Braided – bedload channels

- Multiple channels separated by bars and islands
- Steep gradients
- High width/depth ratios (> 40)
  - Wide, shallow stream bed (e.g. Brahmaputra = 50:1 – 500:1)
- Low sinuosity (1.2 – 1.2)
- Tend to migrate laterally
- Channel fills are coarse-grained
  - Little suspended load material

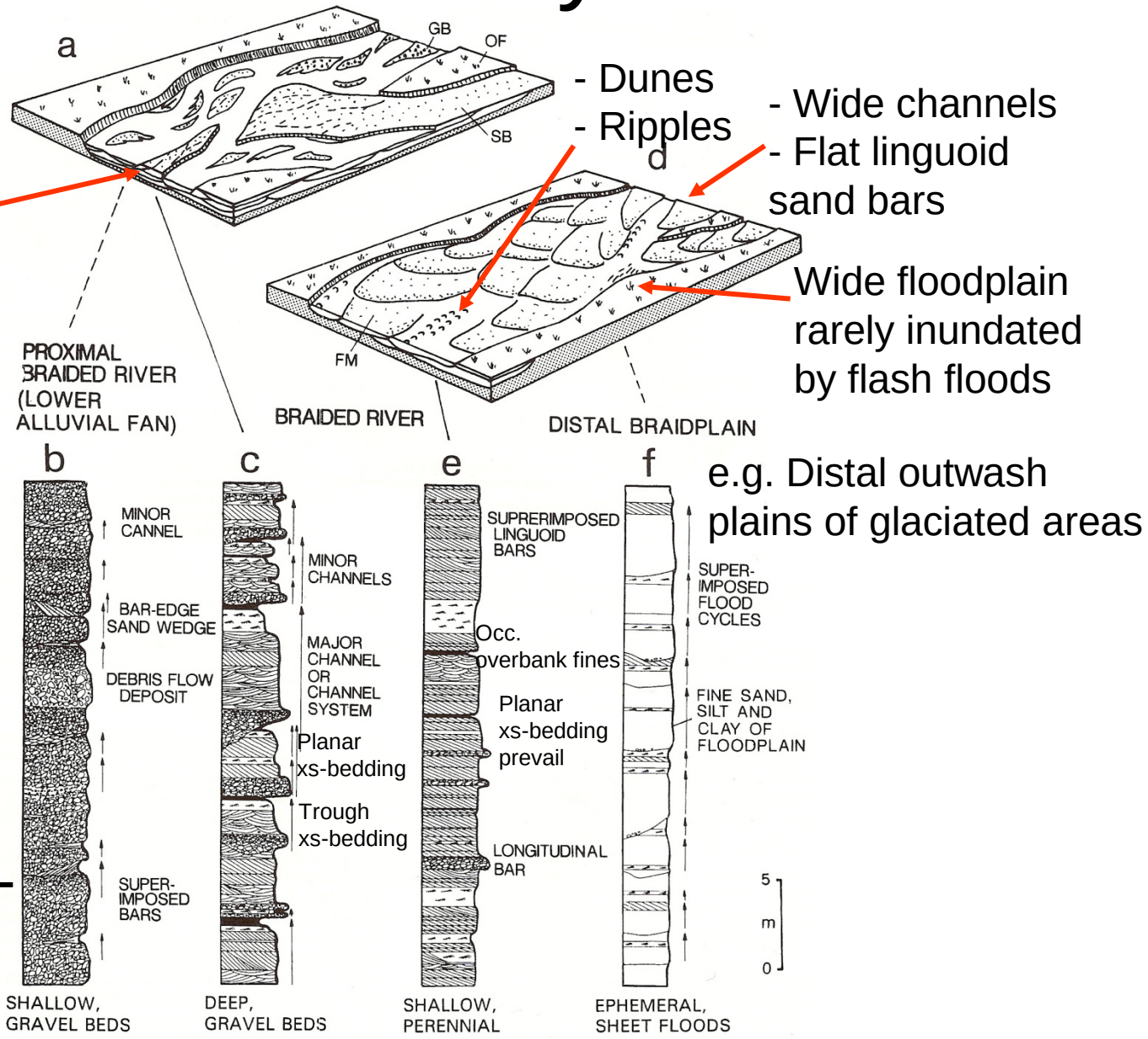


Causes of braiding

- Grain size is proportional to channel slope
  - Also affects channel roughness
- The degree of braiding ↑ with discharge or slope
- Tend to form in env. of large sed. supply and rel. steep gradients (high-relief)
  - Braiding occurs at lower discharge or slopes as bed material size ↓

Example

Braided river systems



Longitudinal gravel bars

- Dunes
- Ripples

- Wide channels
- Flat linguoid sand bars

Wide floodplain rarely inundated by flash floods

e.g. Distal outwash plains of glaciated areas

Lateral migration of bars leads to tabular sheets of gravel

Braided systems

Alaska, USA

Outwash plain

Iceland

Outburst floods - geohazard

Iceland

Large outwash plains - meltwater

Iceland

Large outwash plain

Iceland

Outburst flood monitoring

‘Recently’ abandoned channels

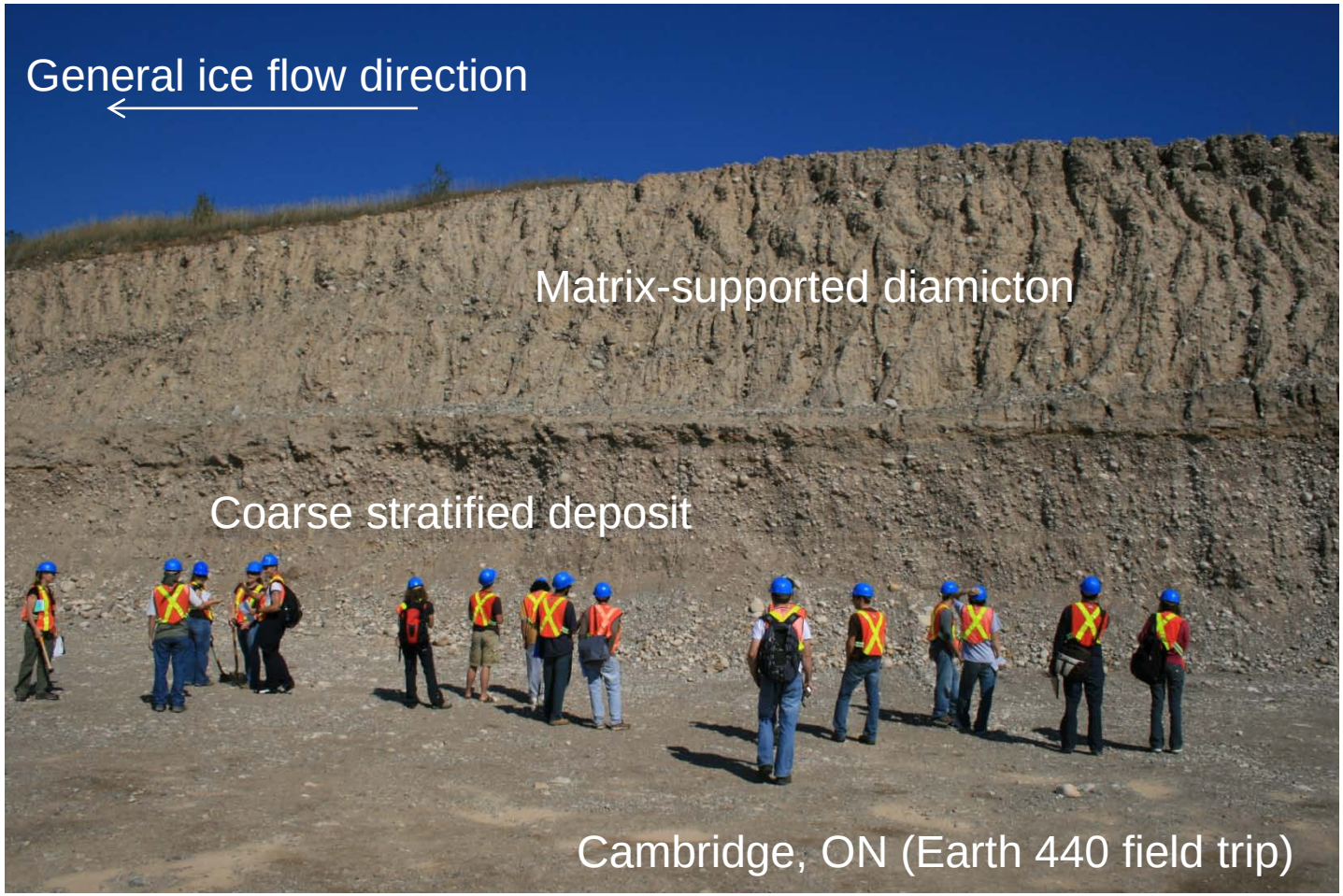
Braided river deposits

Peru

Downstream facies change

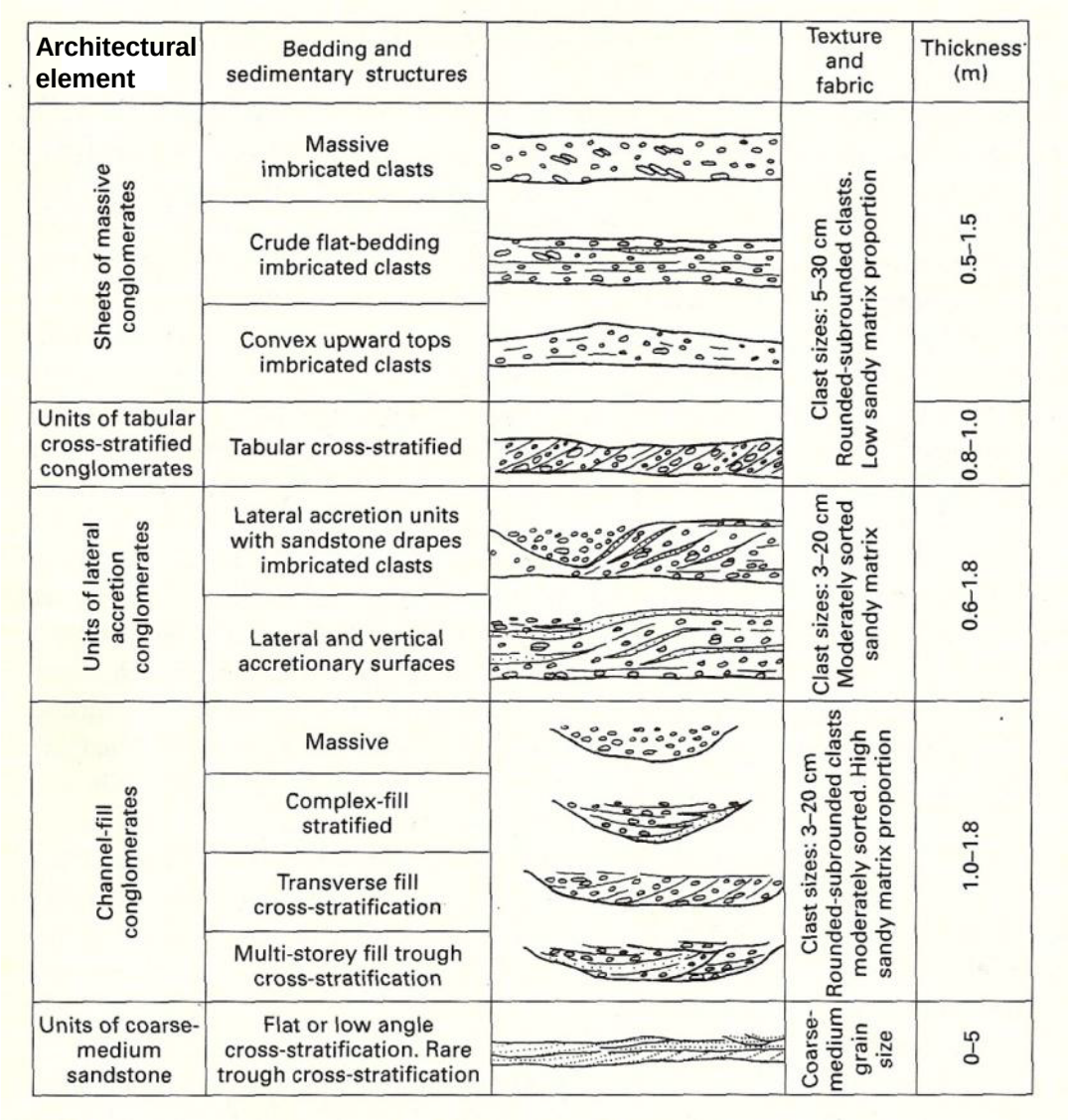
Peru

Quaternary example



Extensive tabular unit

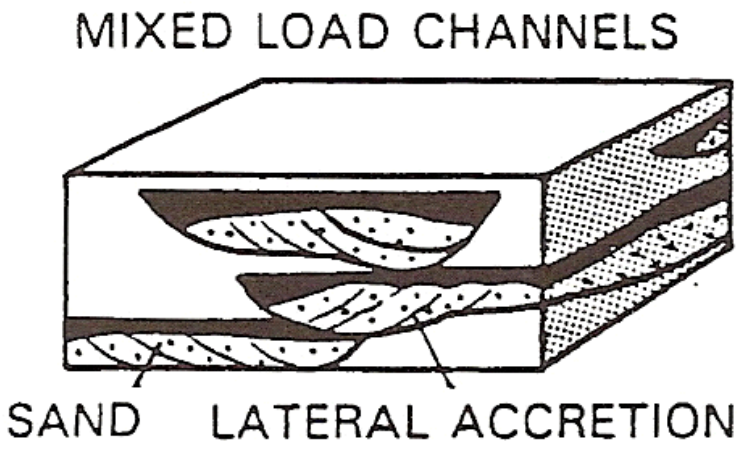
Conglomeratic alluvial facies



Architectural element	Bedding and sedimentary structures		Texture and fabric	Thickness (m)
Sheets of massive conglomerates	Massive imbricated clasts		Clast sizes: 5–30 cm Rounded-subrounded clasts. Low sandy matrix proportion	0.5–1.5
	Crude flat-bedding imbricated clasts			
	Convex upward tops imbricated clasts			
Units of tabular cross-stratified conglomerates	Tabular cross-stratified			0.8–1.0
Units of lateral accretion conglomerates	Lateral accretion units with sandstone drapes imbricated clasts		Clast sizes: 3–20 cm Moderately sorted sandy matrix	0.6–1.8
	Lateral and vertical accretionary surfaces			
Channel-fill conglomerates	Massive		Clast sizes: 3–20 cm Rounded-subrounded clasts moderately sorted. High sandy matrix proportion	1.0–1.8
	Complex-fill stratified			
	Transverse fill cross-stratification			
	Multi-storey fill trough cross-stratification			
Units of coarse-medium sandstone	Flat or low angle cross-stratification. Rare trough cross-stratification		Coarse-medium grain size	0–5

Meander –mixed-load systems

- Sinuosity (> 1.5)
- More floodplain deposits
- Channels are more stable
  - Lower width/depth ratio
  - Filled with sand and minor proportion of silt/clay
    - Flanked by levee sands and silts and crevasse-splay sands



Causes of sinuosity

- Low-powered, single-channel streams
  - Sinuosity ↑ with width/depth ratio
  - Sinuosity ↑ with ↓ bed material size
- Opposite relationship for multiple-channel rivers

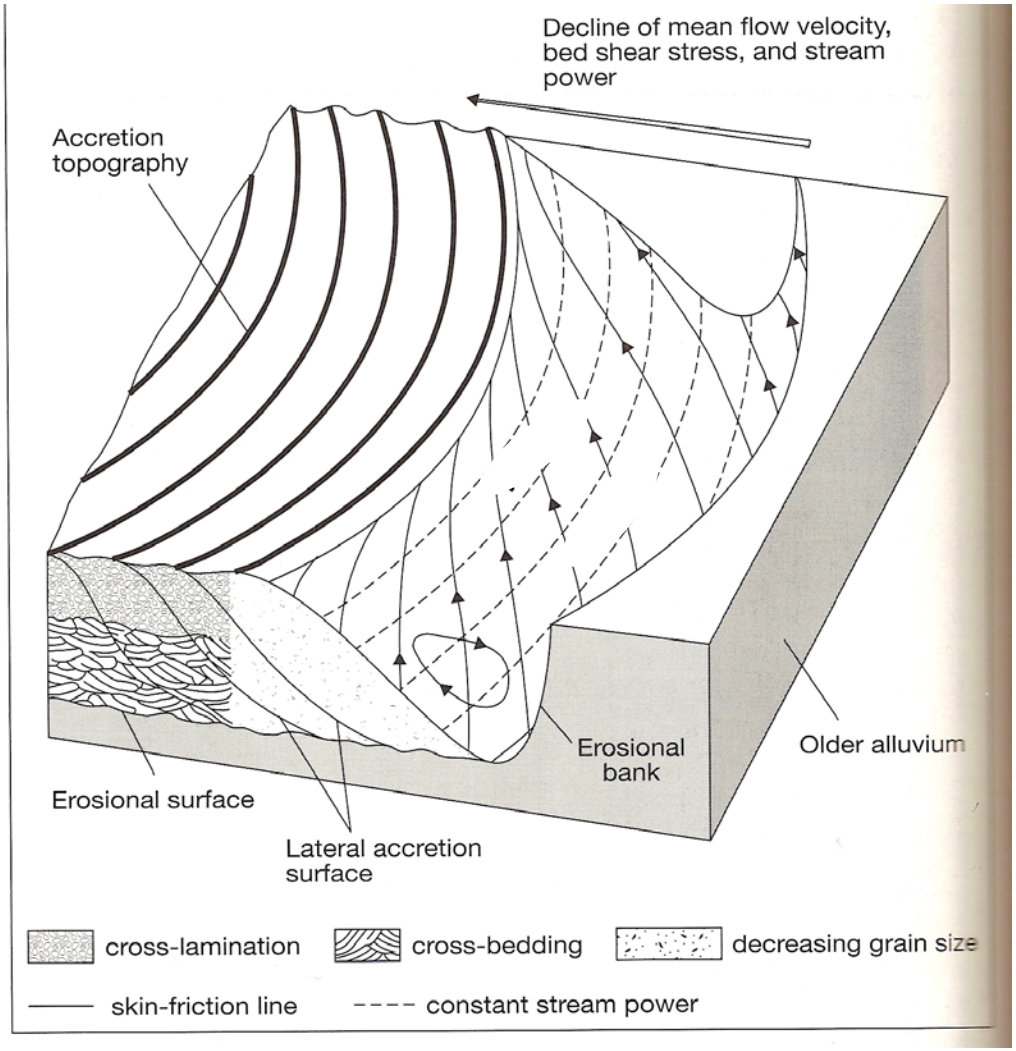
Earth as Art:
LiDAR Interpretations of Illinois Landscapes

Pecatonica River - eastern Winnebago County LiDAR 3 meter DEM

Channel floor

- Sediment lags
  - Coarsest material transported by the river
    - Peak flow
  - May contain mud clasts or blocks eroded from the banks
  - Flat, elongate bars
    - Imbricated gravel
    - Crudely laminated and planar xs-bedded gravelly sand

Channel transport

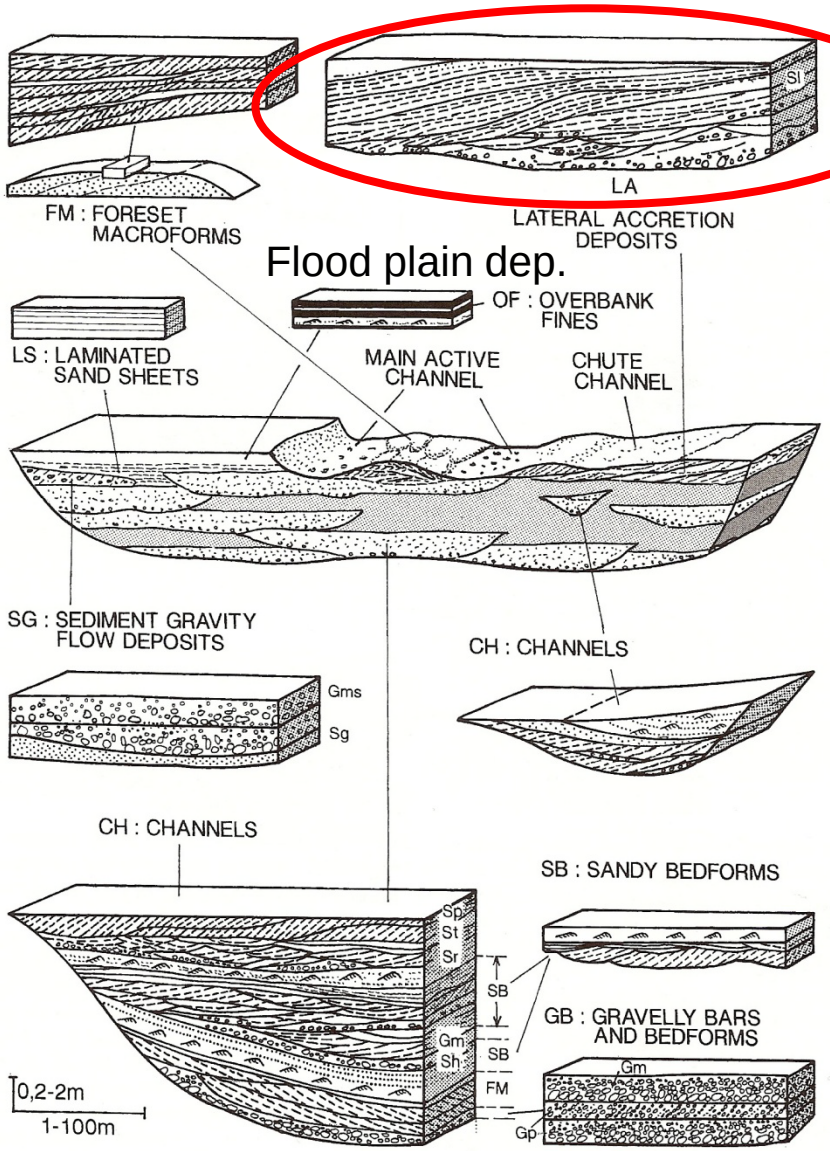


Architectural elements

Point bar deposits

Flash floods

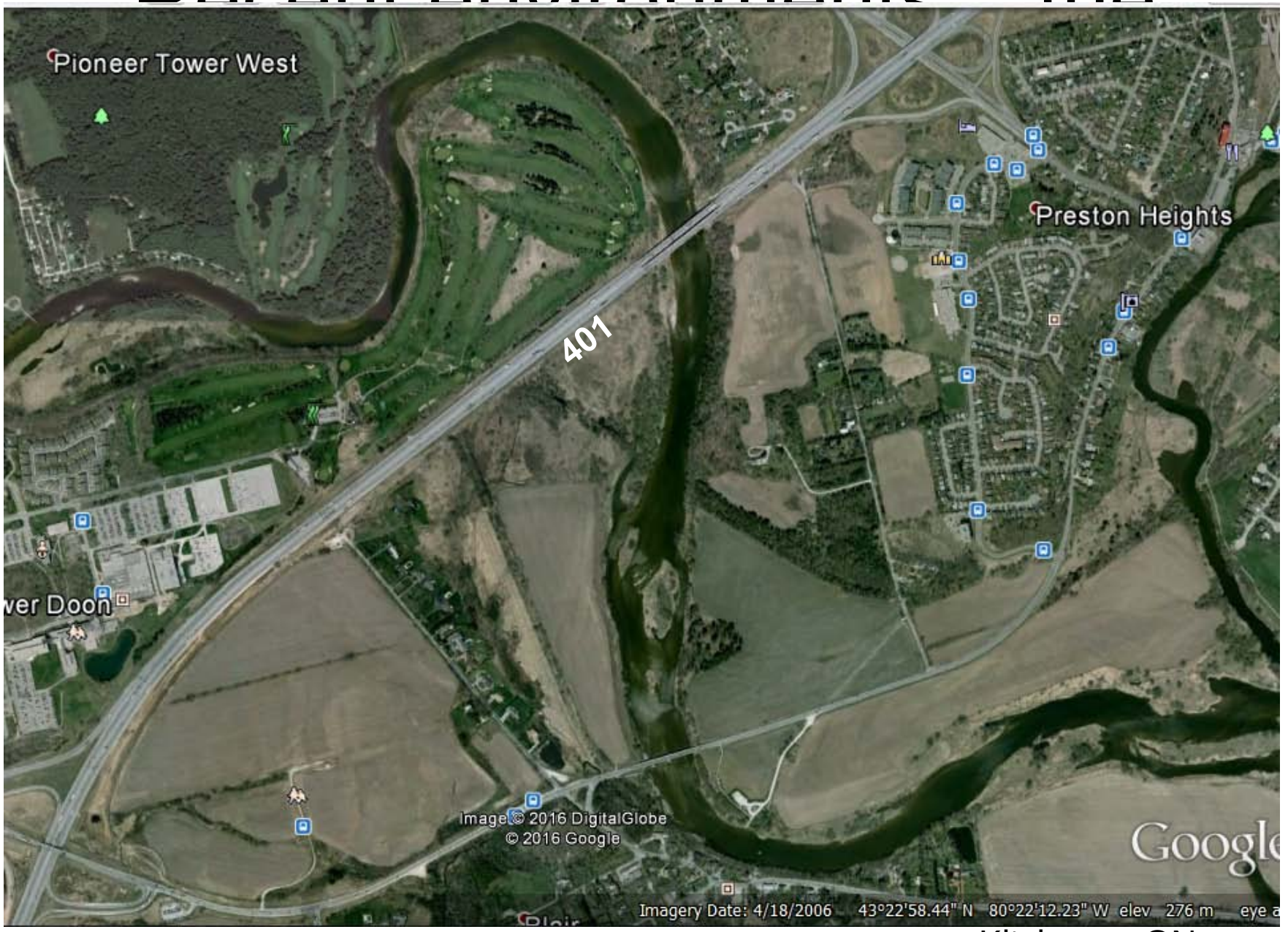
Flood plain dep.



Point bars

- Deposition in areas of lower velocity turbulence
- Sediment moves up and out of the channel onto the bar
  - Fining-upward sequences
    - Sand on top of channel lags
  - Internal structures
    - From horizontal bedding (upper flow regime)
    - To trough xs-bedding (lower flow regime)
  - Lateral accretion complexes
    - “epsilon” xs-bedding
    - Ridge-and-swale topography

Recent environments – the



Kitchener, ON

Point bar

George River (northern QC)

Lateral accretion units

Lateral accretion units

Another example…

Chute bars

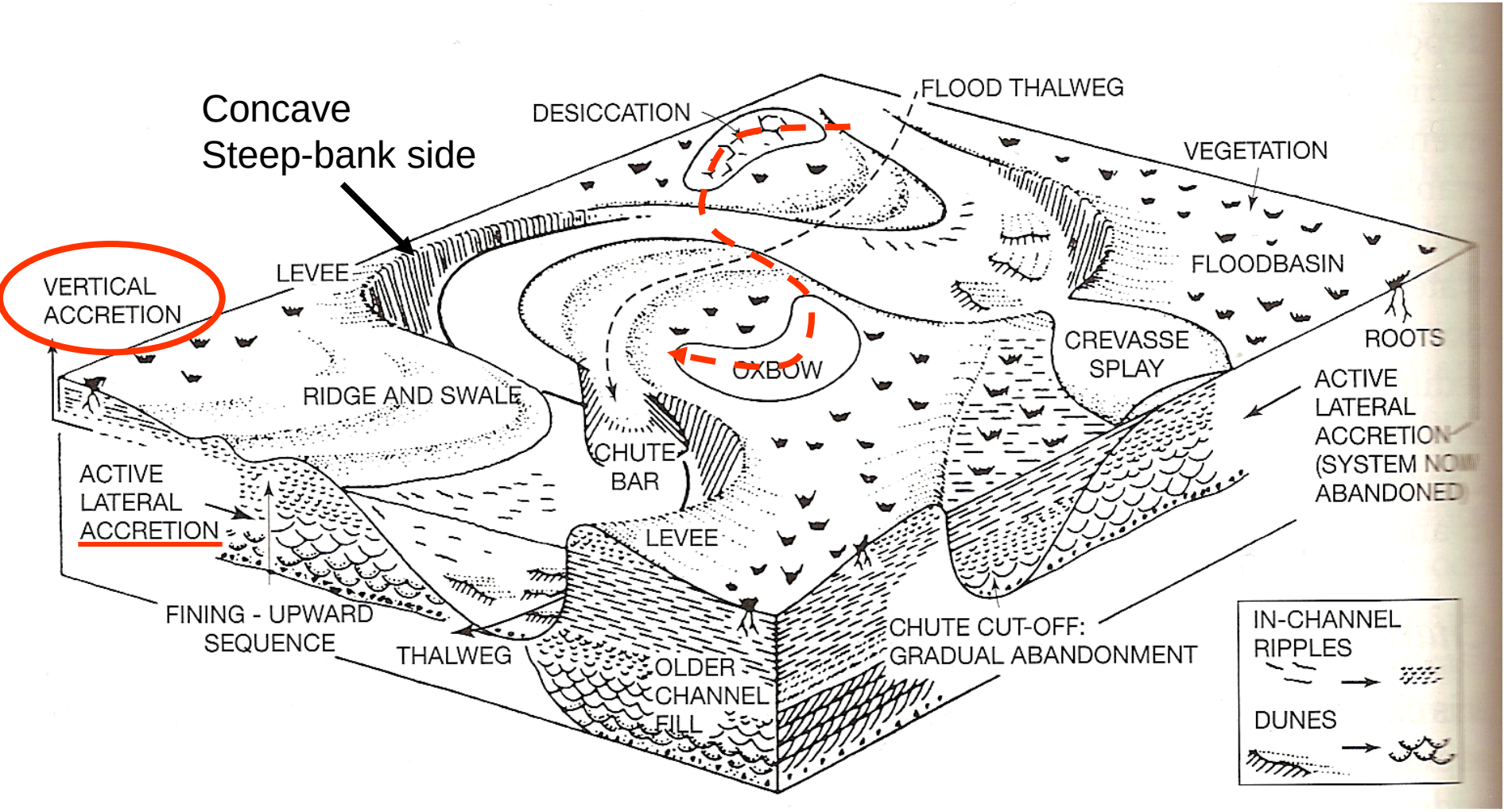
- Generated during flood stage
- Coarse-grained bedload material

Floodplain deposition

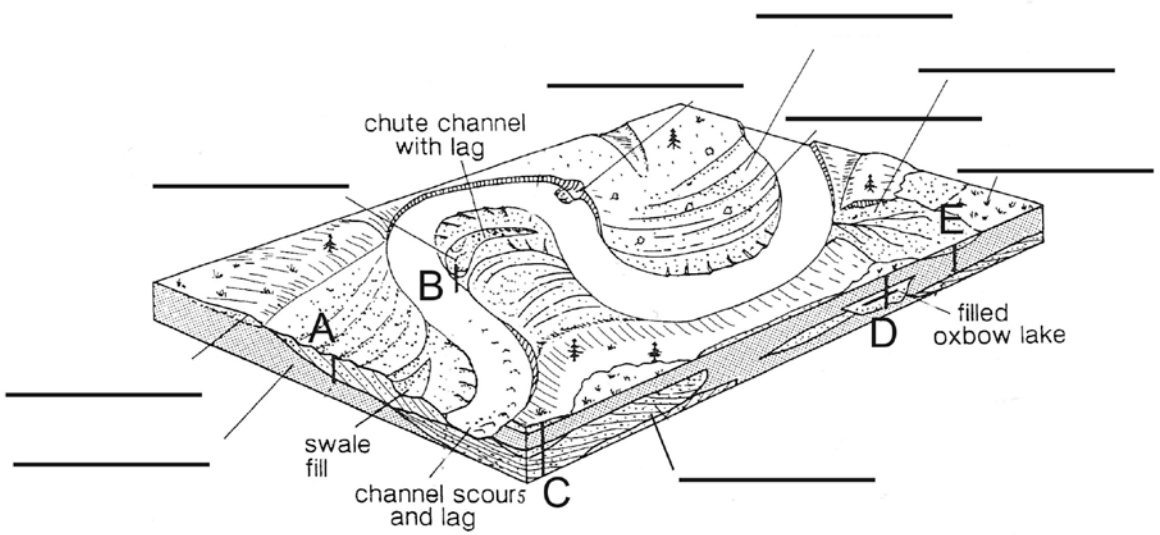
- Natural levee deposits
  - Build up during moderate floods
  - Horizontally stratified fine sands overlain by laminated silt/mud
- Floodplain deposits
  - Fine-grained sediments (through settling)
  - Laminated beds (few millimeters)
  - Plant debris
  - Bioturbation (land-dwelling organisms or plant roots)
  - Soil forming processes
  - Backswamps and lakes when the wt is at the surface (humid climates)
- Crevasse-splay deposits
  - Rapid sedimentation from traction/suspension
    - May resemble a Bouma sequence
  - Grade into the fined-grained floodplain deposits

Natural levee and crevasse splay

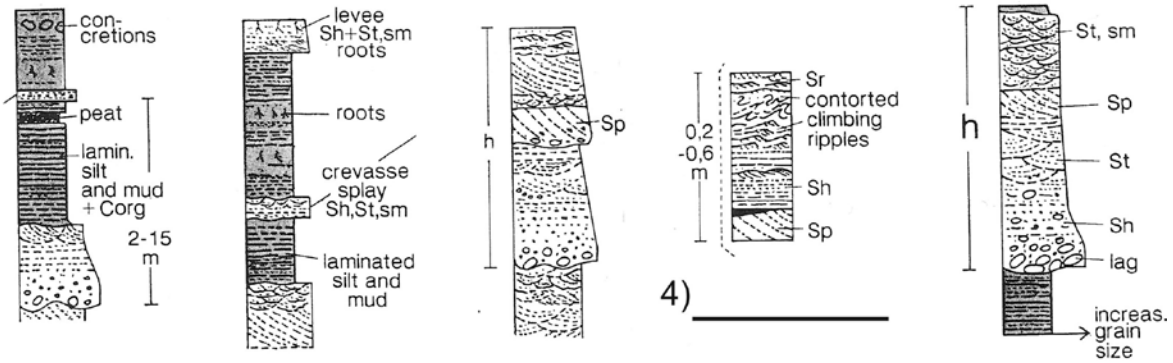
Meandering river system



Exercise/ problem



1) _____ 2) _____ 3) _____ 5) _____



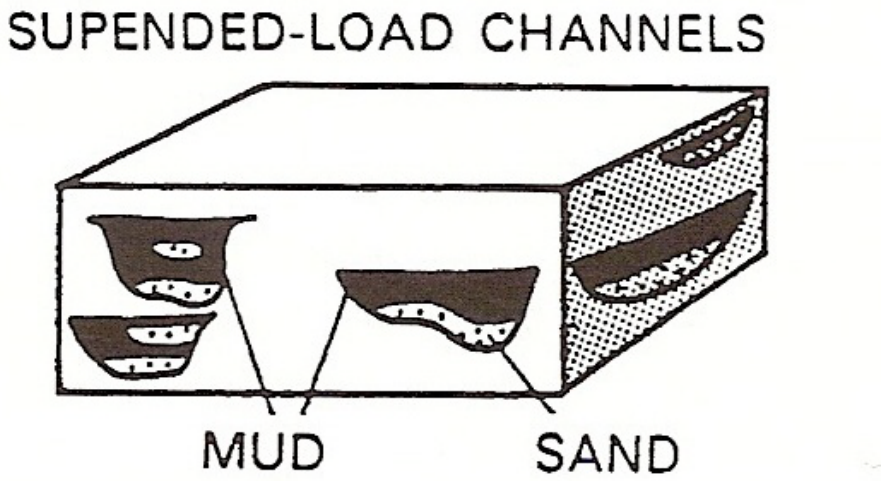
Sp: sand; planar cross beds (sand bars)
St: sand; trough cross beds (dunes)
Sr: sand; ripple cross lamination (lower flow regime)
Sh: sand; horizontal lamination (upper flow regime)

Natural levee	Ridge and swale
Chute bars	Older lateral accretion complex
Erosion bank	Backswamp
Point bar	Crevasse splay
Floodplain deposits	

Compare your answers with:
Einsele G. Sedimentary Basins…
p. 45 (course reserve)

Suspended-load systems

- High sinuosity single channels
- Great stability
- Low width/depth ratio (< 10)
- Gradient and stream power are usually low
- Channel fills
  - High proportion of silts/muds
- Silty levee deposits are well developed

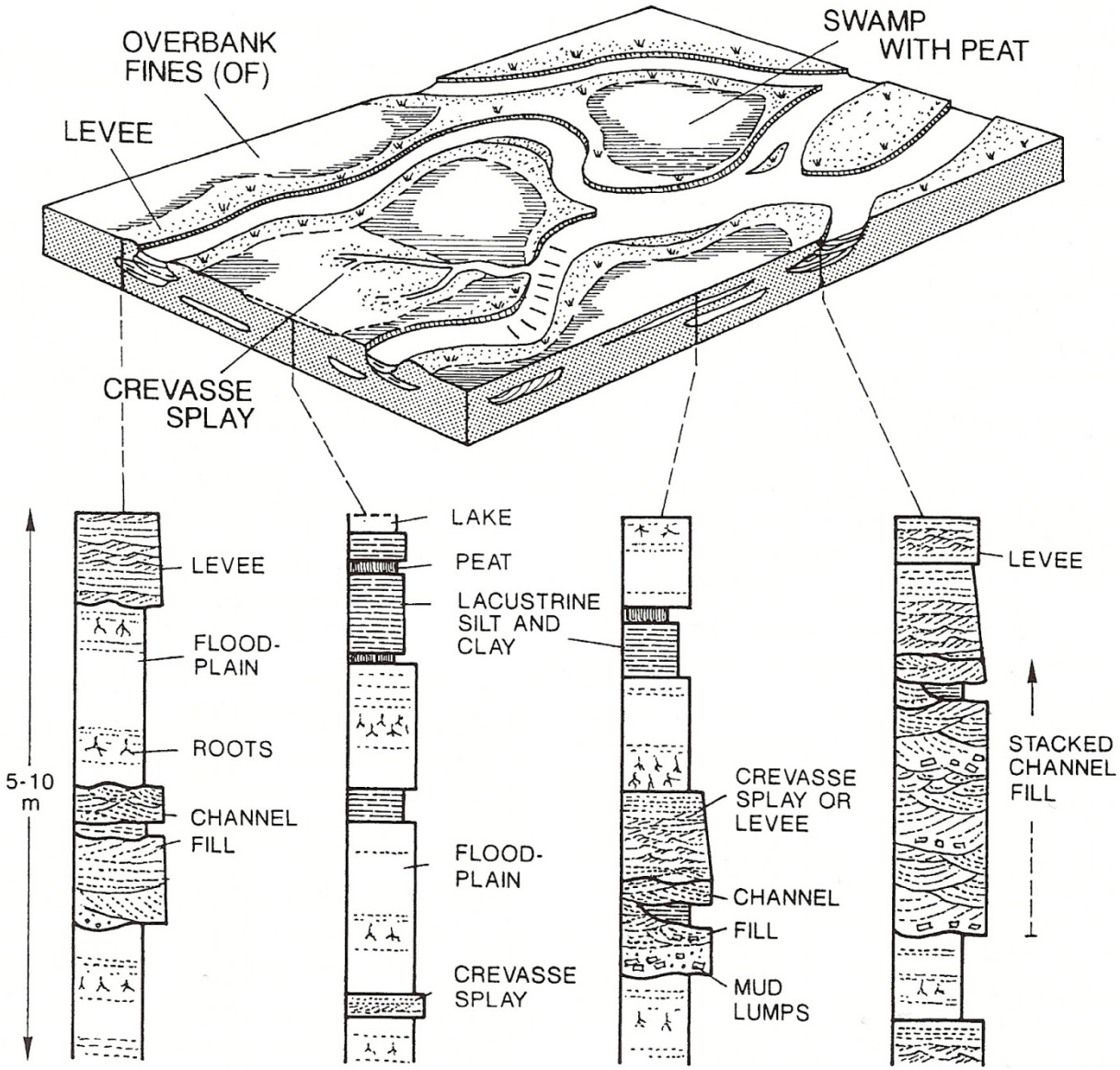


Anastomosed rivers

Columbia River

http://www.geo.uu.nl/fg/palaeogeography/results/fluvialstyle

Anastomosted rivers

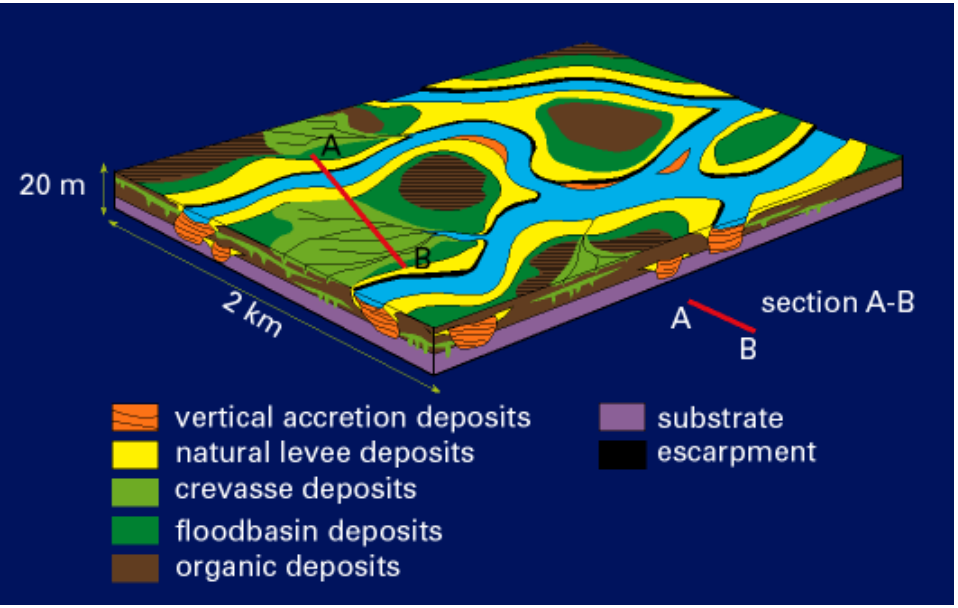


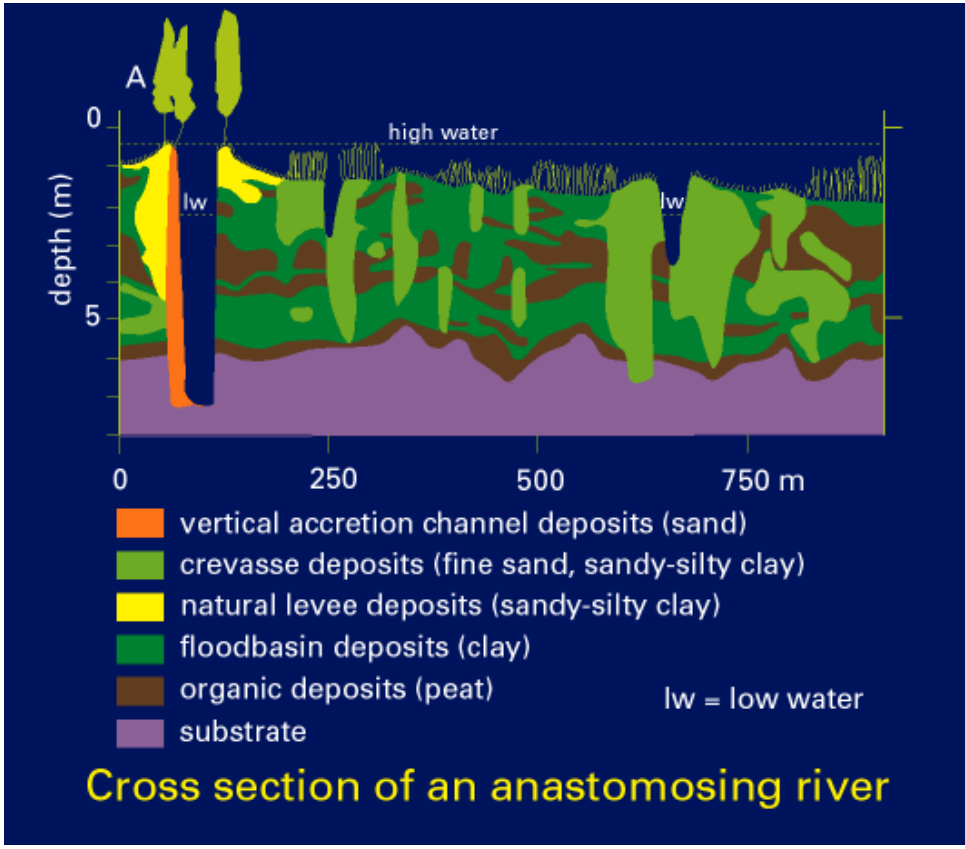
Mud-rich sed. source
V. low river gradient
Seasonal water budget

V. low gradient in a subsiding basin maintained for a long time

e.g. Foreland basin settings

Rhine-Meuse system in the Netherlands

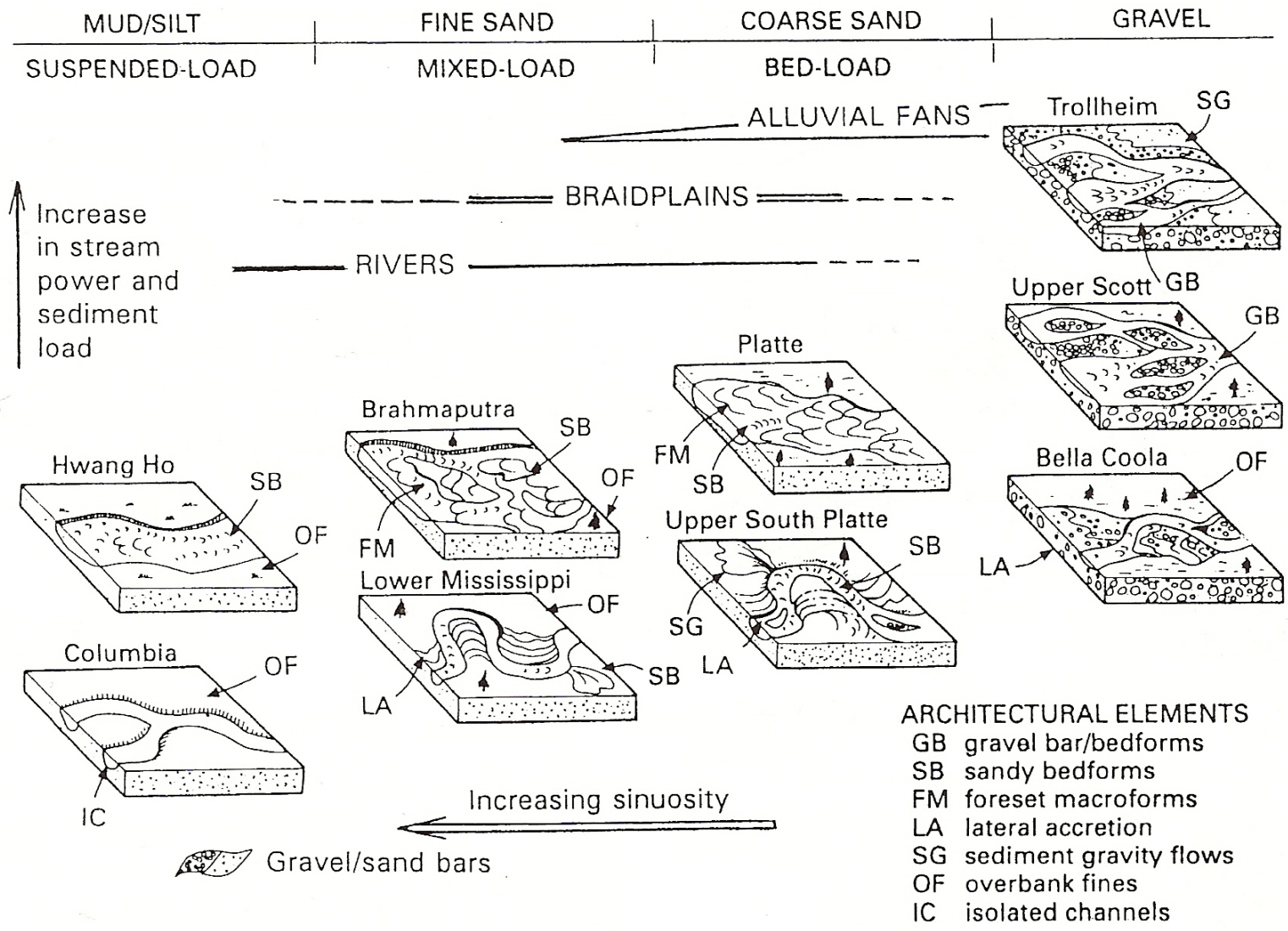




http://www.geo.uu.nl/fg/palaeogeography/results/fluvialstyle

Weerts, H.J.T. (1996), Complex confining layers. Architecture and hydraulic properties of Holocene and Late Weichselian deposits in the fluvial Rhine-Meuse delta, The Netherlands. Netherlands Geographical Studies 213, 189 pp.

Channel types, gradients, sed. load



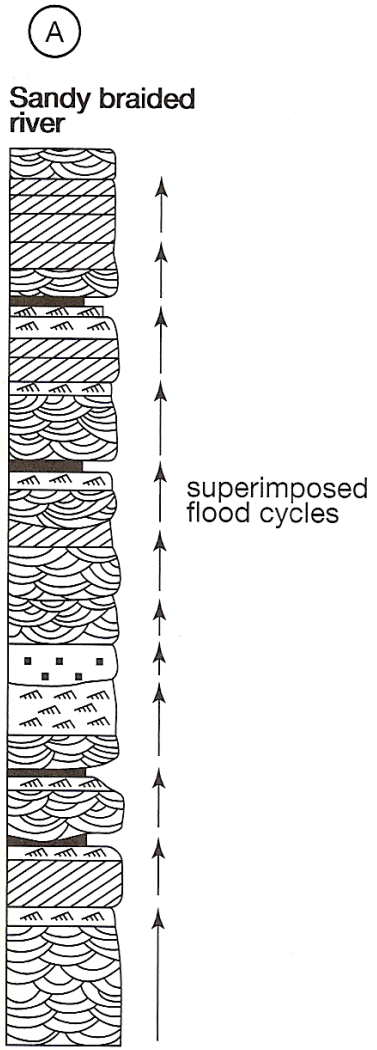
Fluvial deposits - summary

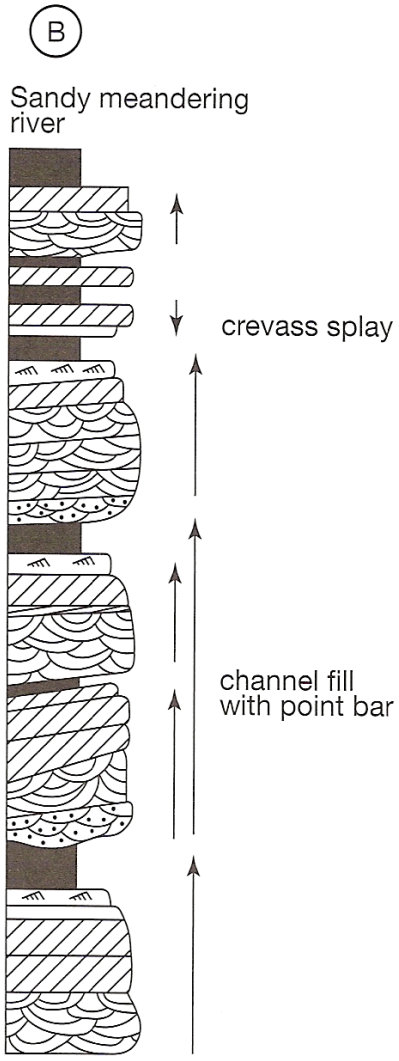
- Subenvironments
  - Point bars and lateral accretion complexes
  - Chute bars
  - Channels and their fills
  - Braid bars of braided rivers
  - Natural levees and crevasse splay deposits
  - Floodplain deposits
  - Oxbow lakes

Sediment characteristics

- Sand, gravel and mud (floodplains)
- Moderately- to poorly-sorted
- Point bars and braid bars
  - Fining-upward
- Migration of channels
  - Fining-upward succession
    - Channel lags are overlain by
      - Point bar deposits
      - Floodplain deposits
  - Multiple episodes of migration = stacking of such successions
- Multiple episodes of channel shifting and bar migration (braided rivers)
  - Vertical stacking of bar deposits (cyclic sequences)

Vertical profiles

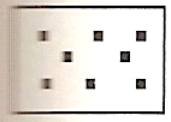


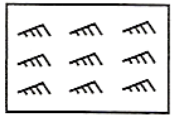


Traction structures


Trough cross-bedded sand


Planar cross-bedded sand

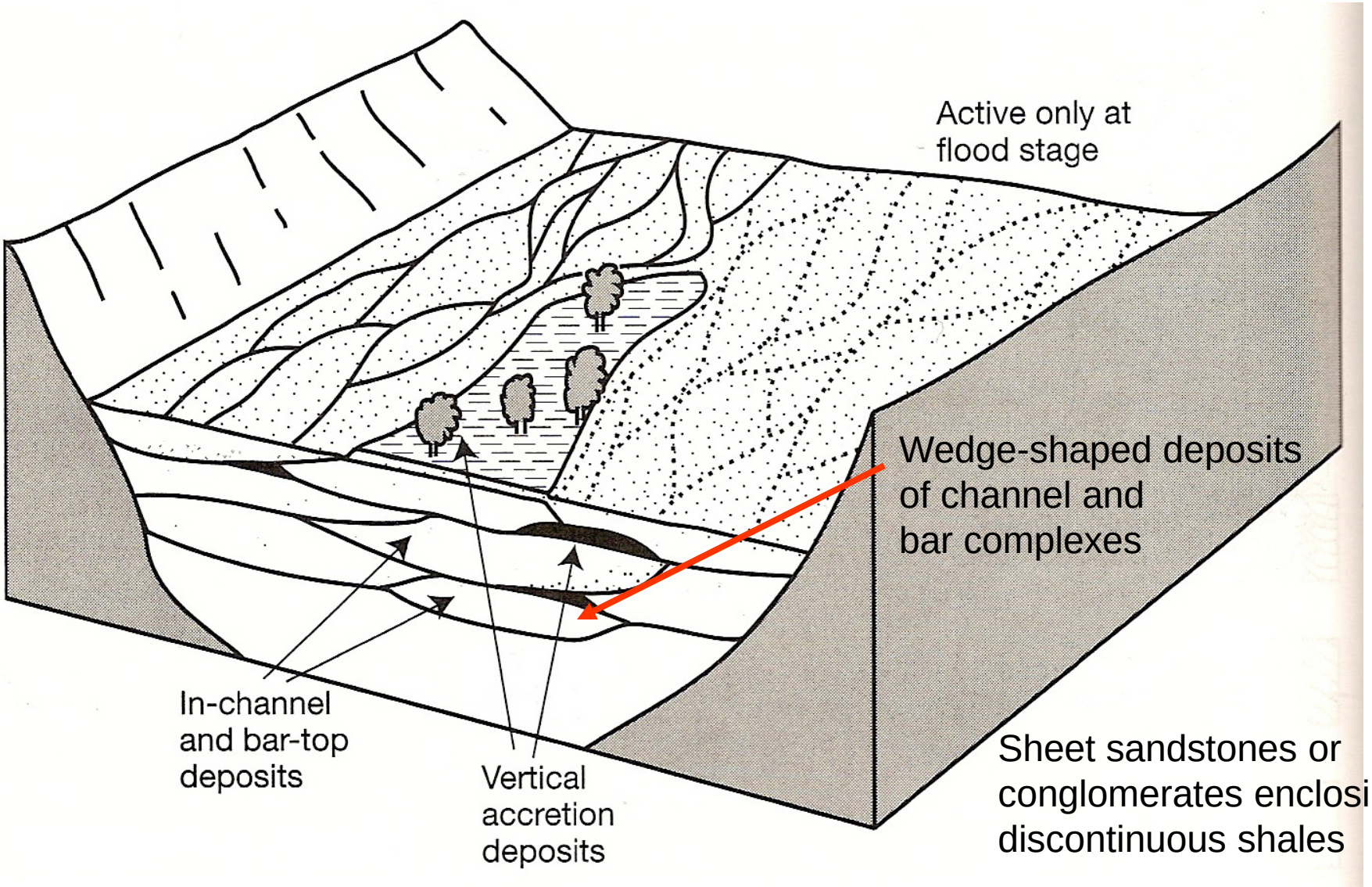

Planar laminated sand


Ripple-marked sand

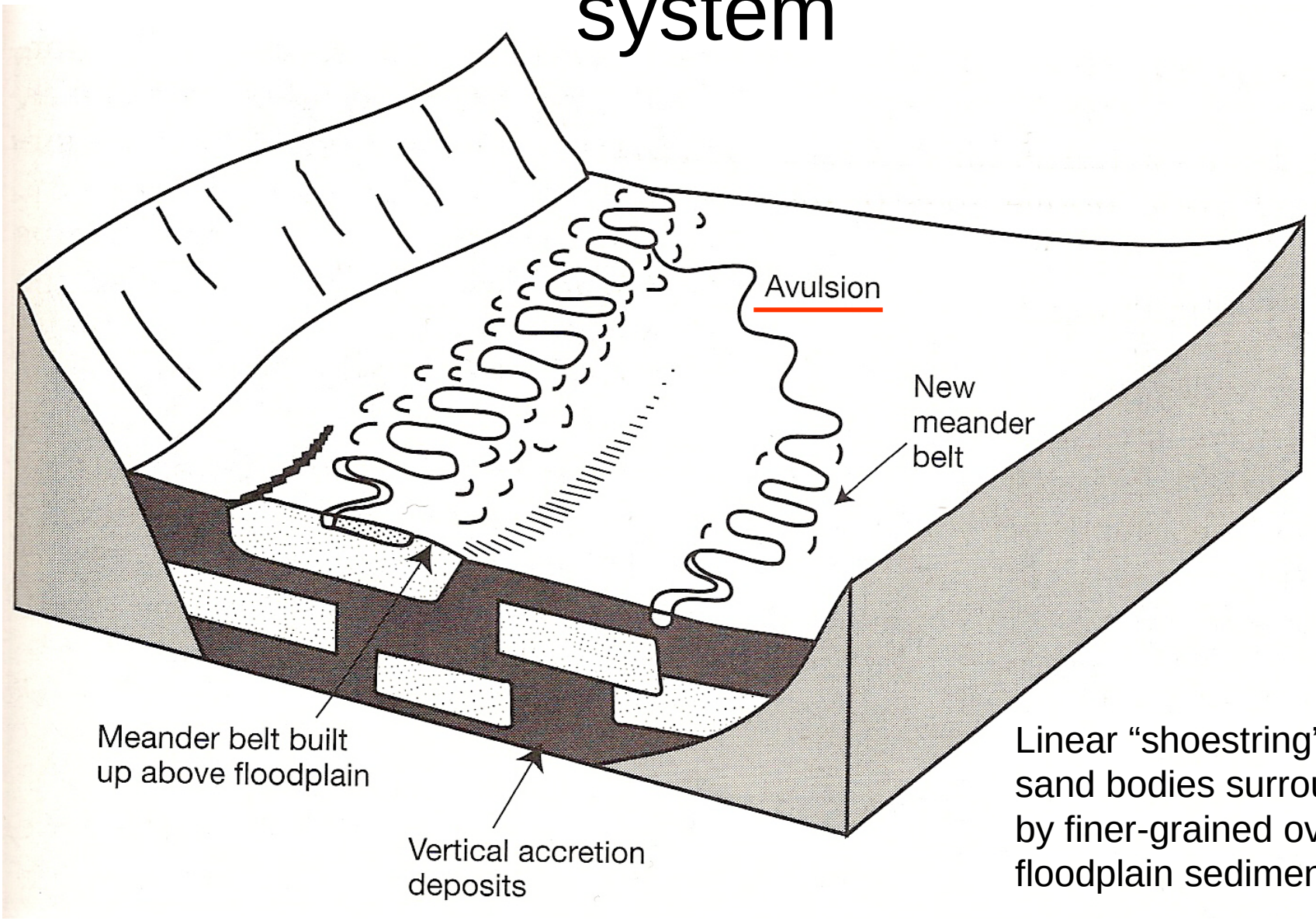

Mud

Fossils: fish and terrestrial animals
Trace fossils
Plant remains

Fluvial architecture – braided system

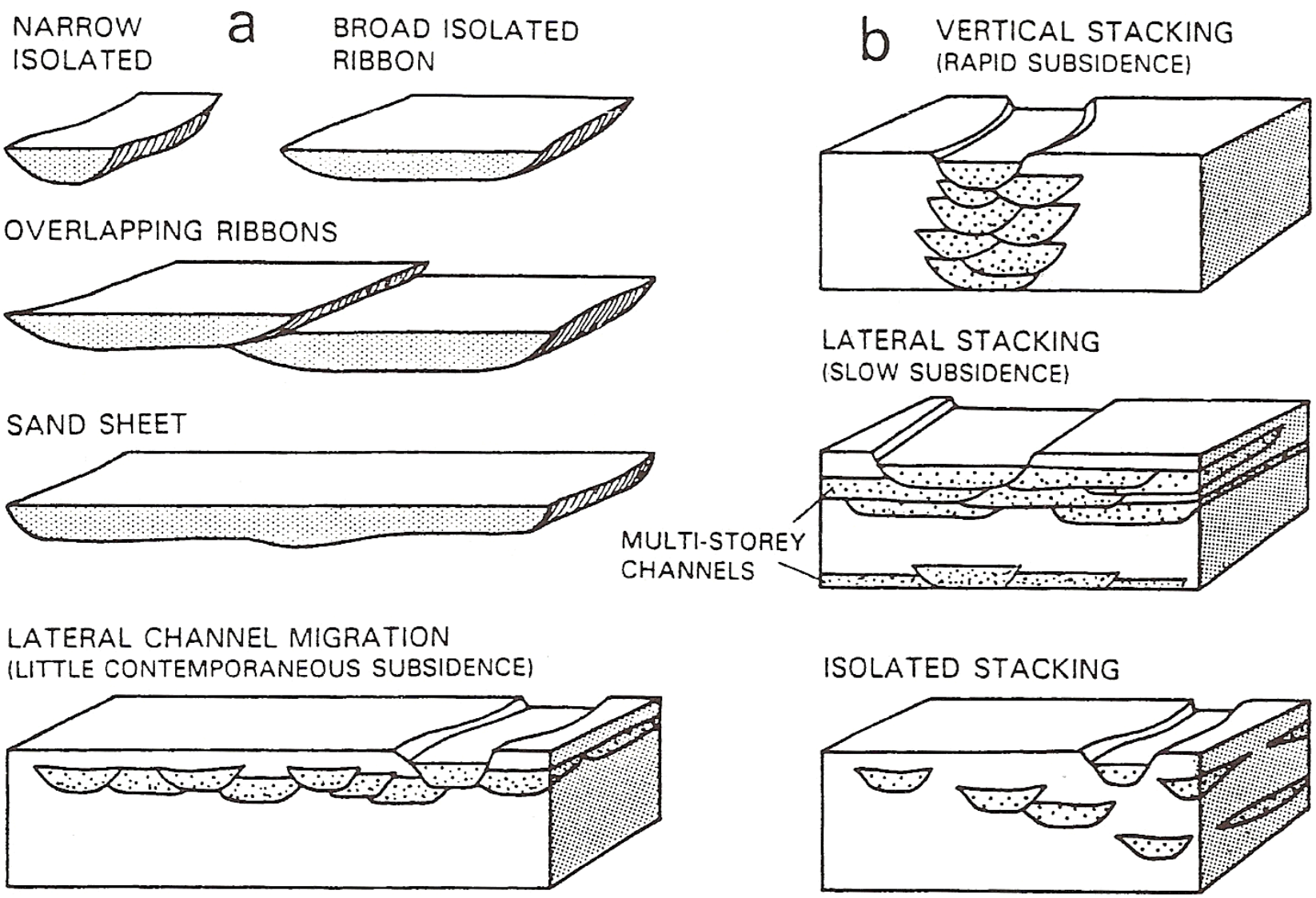


Fluvial architecture – meandering system

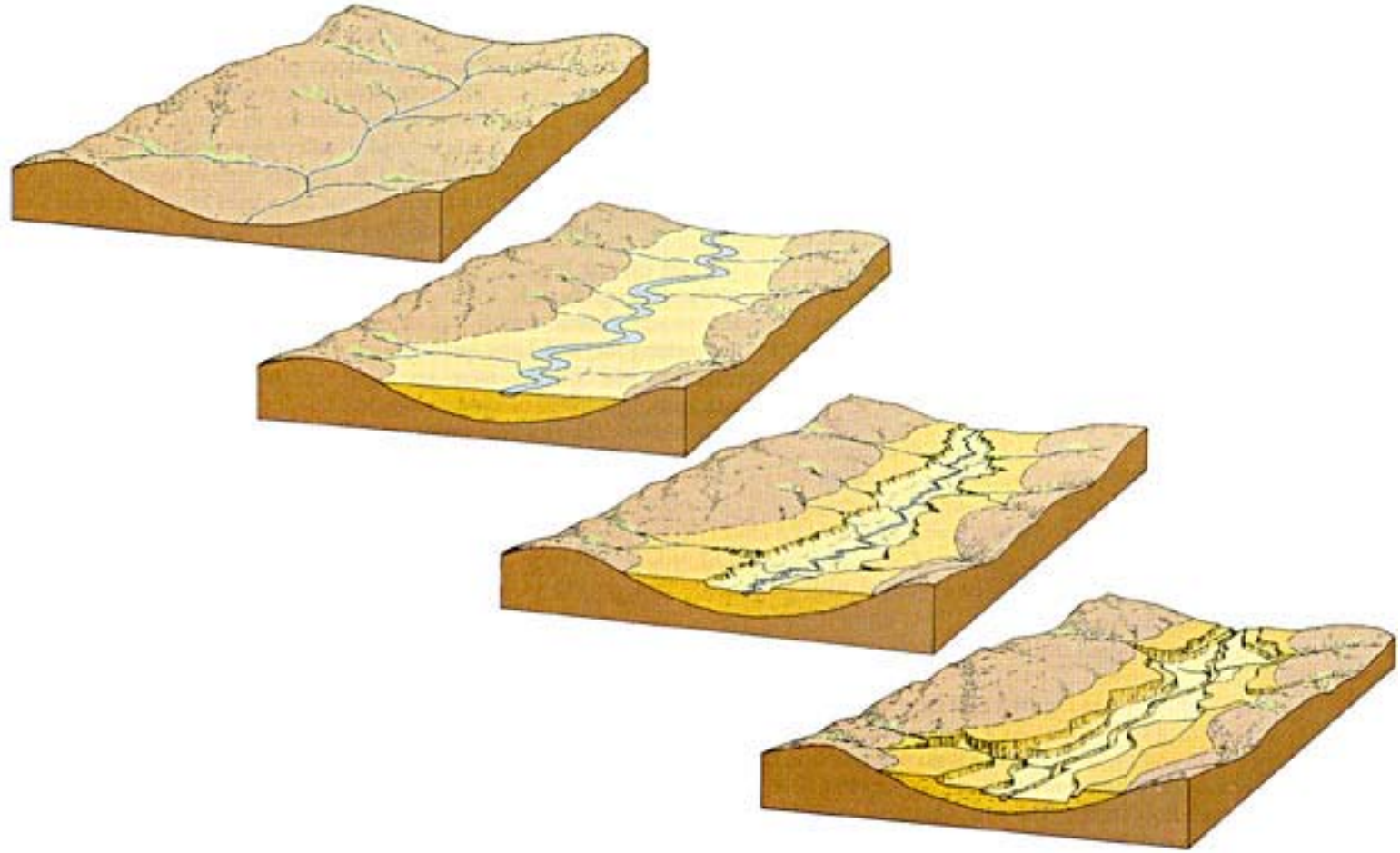


Linear “shoestring” sand bodies surrounded by finer-grained overbank floodplain sediments

Role of subsidence



Role of uplift



Terrace

Peru

Close-up view of terrace

Peru