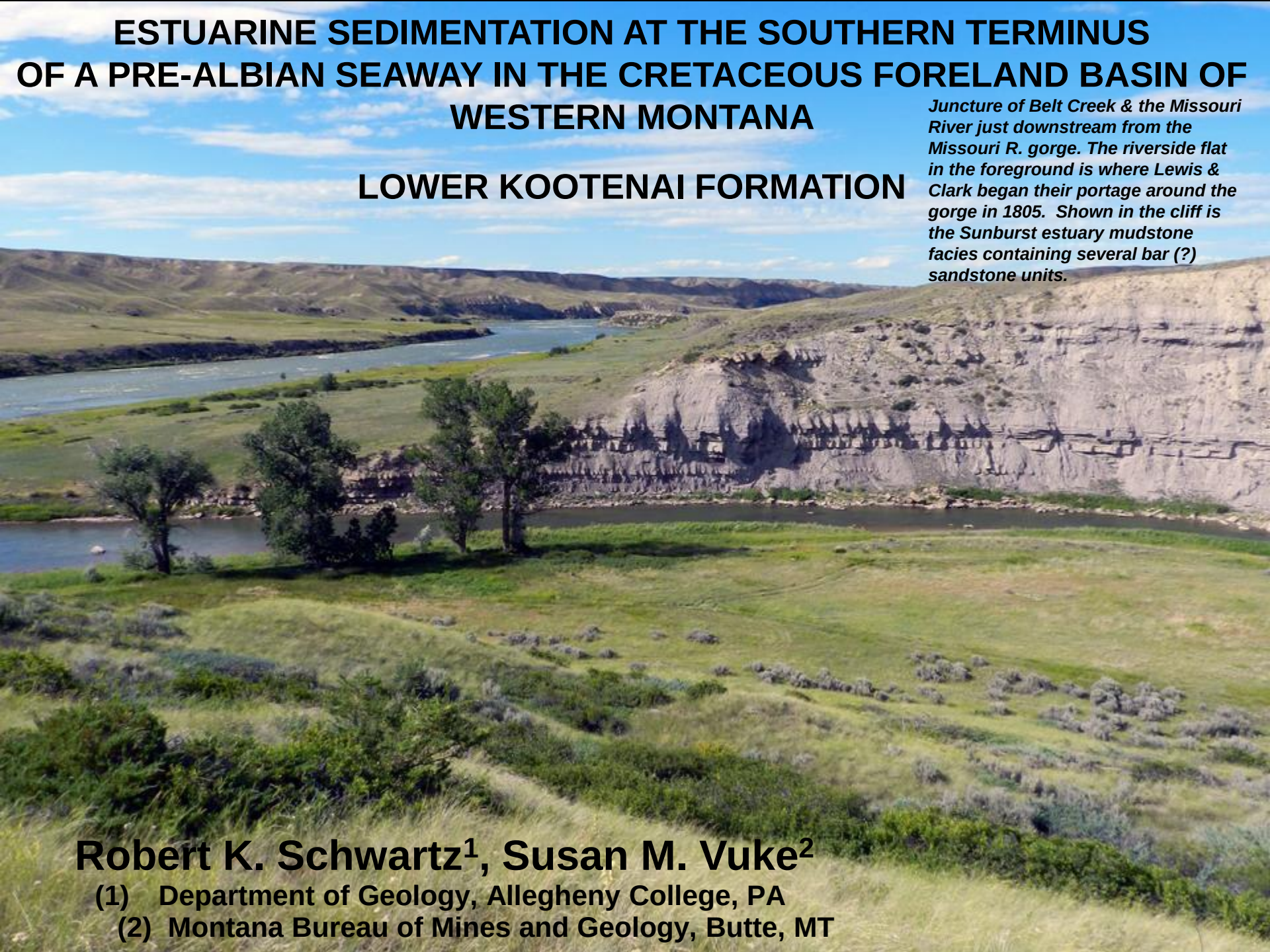
ESTUARINE SEDIMENTATION AT THE SOUTHERN TERMINUS OF A PRE-ALBIAN SEAWAY IN THE CRETACEOUS FORELAND BASIN OF WESTERN MONTANA

LOWER KOOTENAI FORMATION



Juncture of Belt Creek & the Missouri River just downstream from the Missouri R. gorge. The riverside flat in the foreground is where Lewis & Clark began their portage around the gorge in 1805. Shown in the cliff is the Sunburst estuary mudstone facies containing several bar (?) sandstone units.

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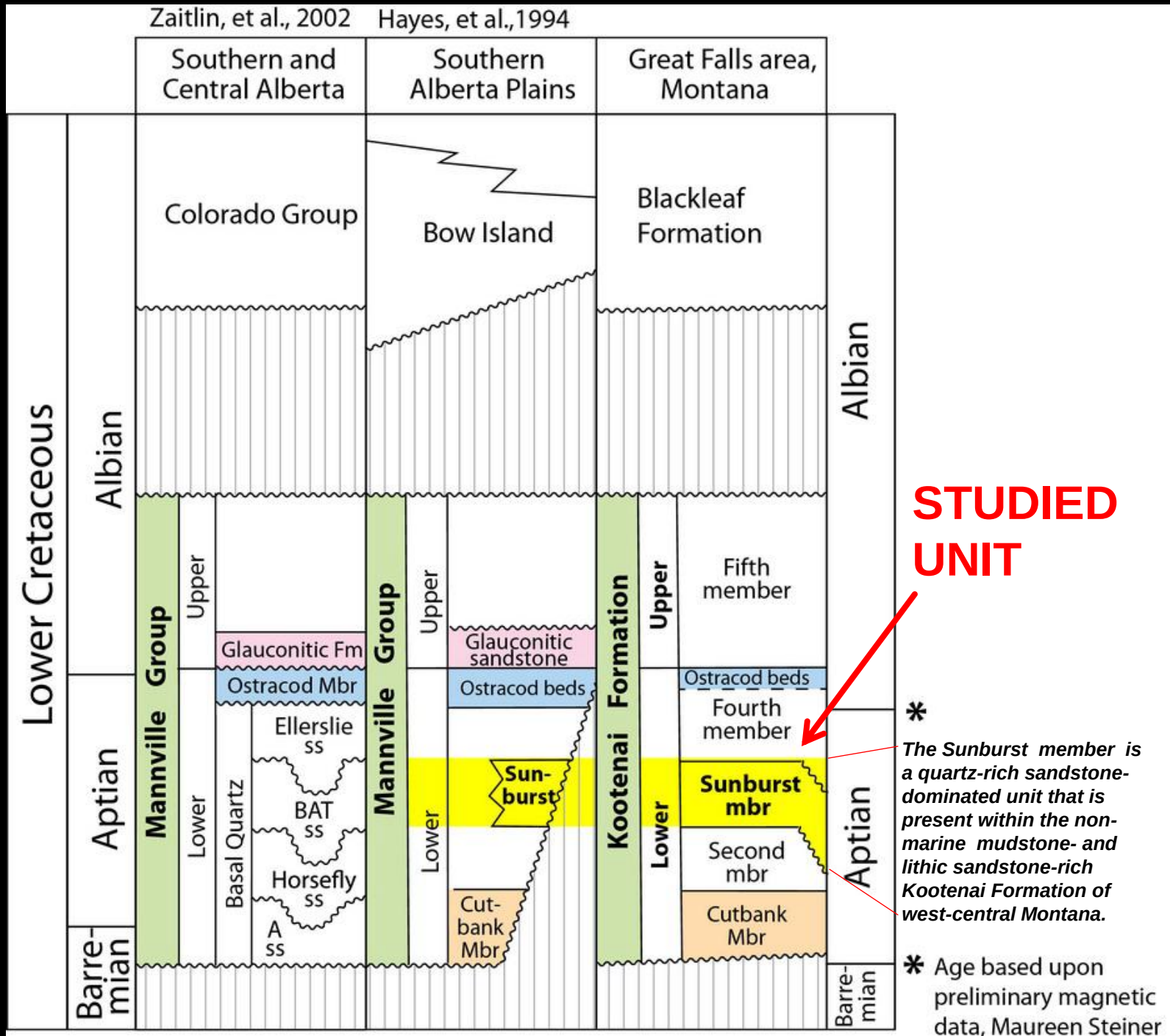
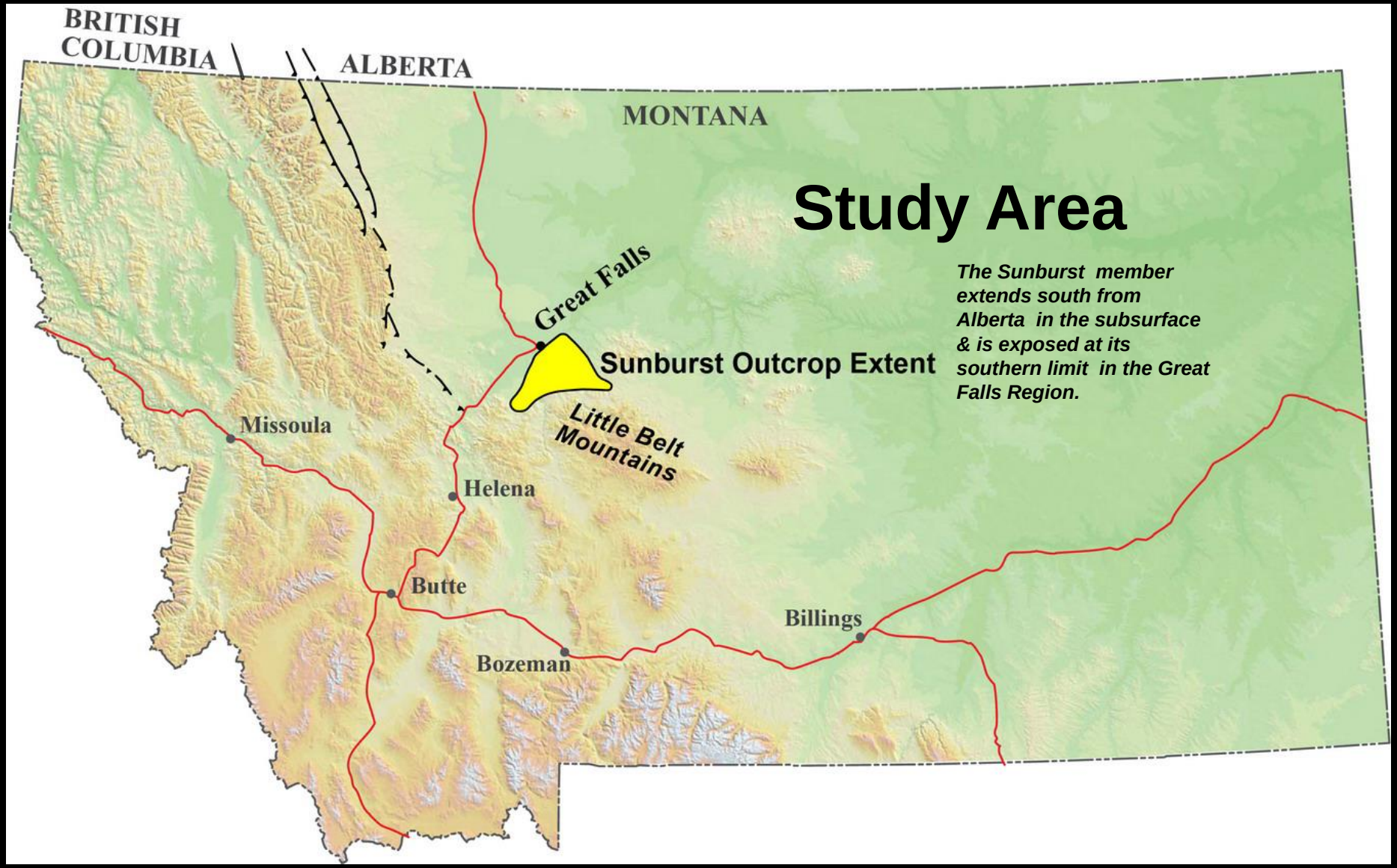
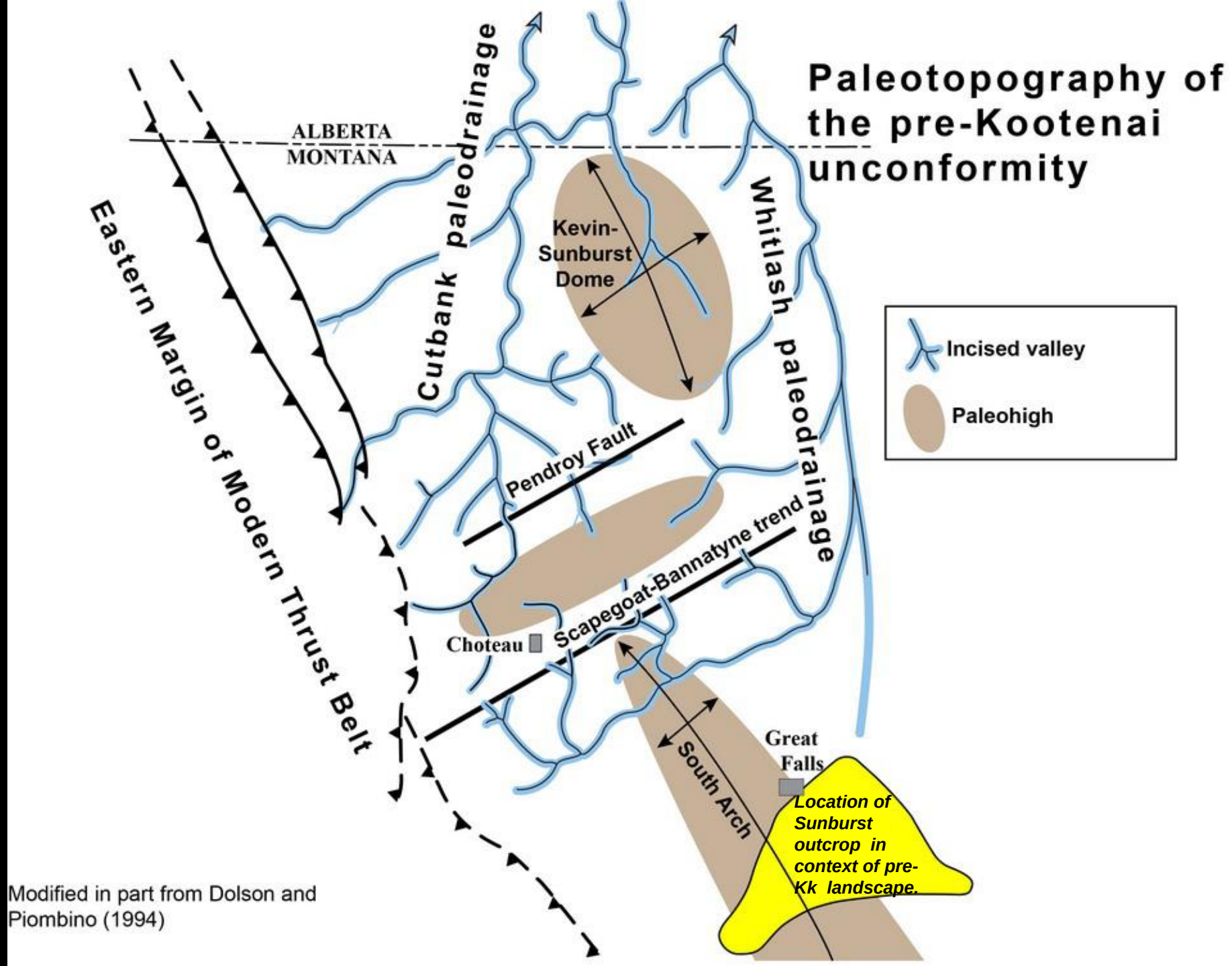
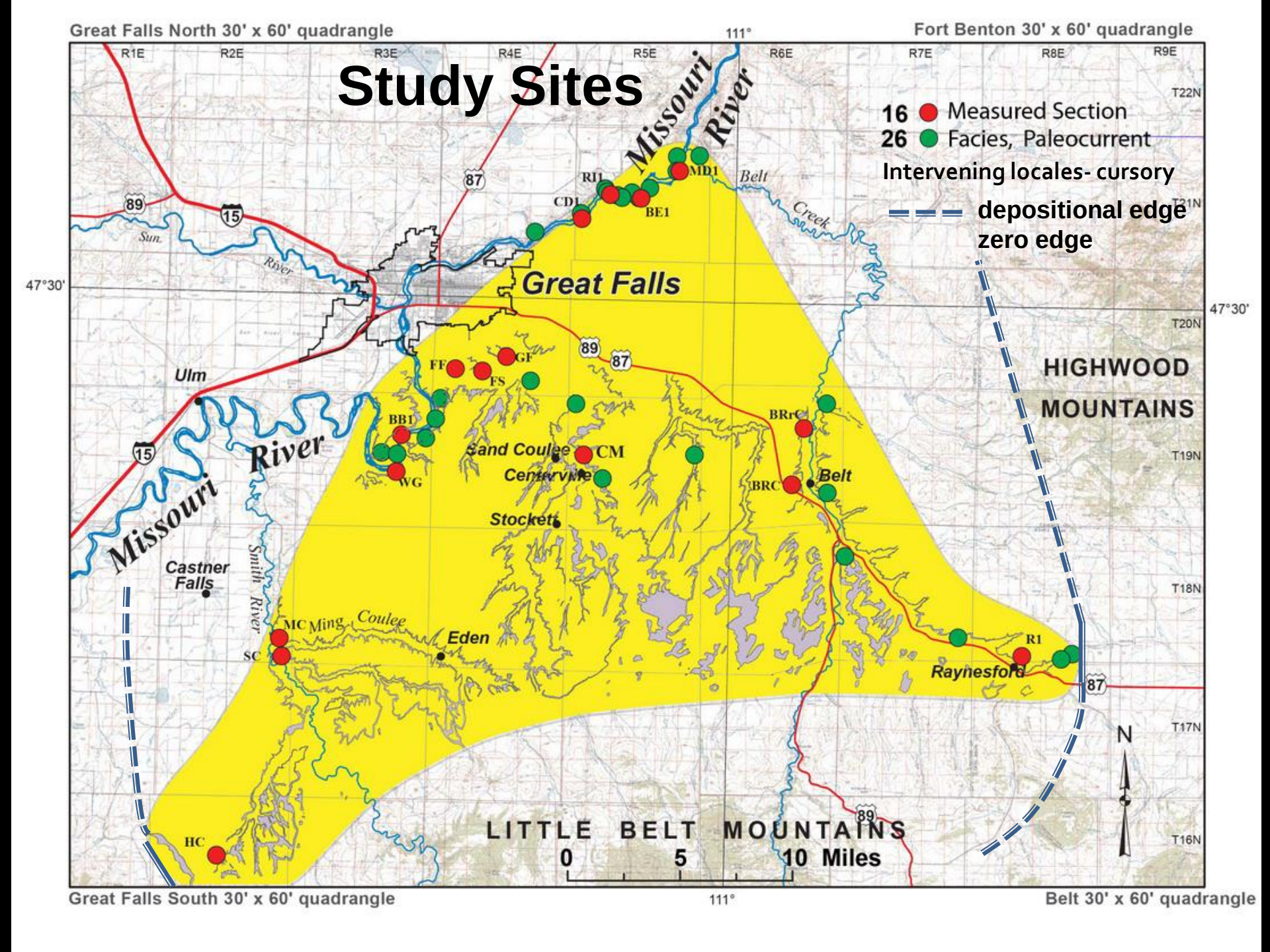
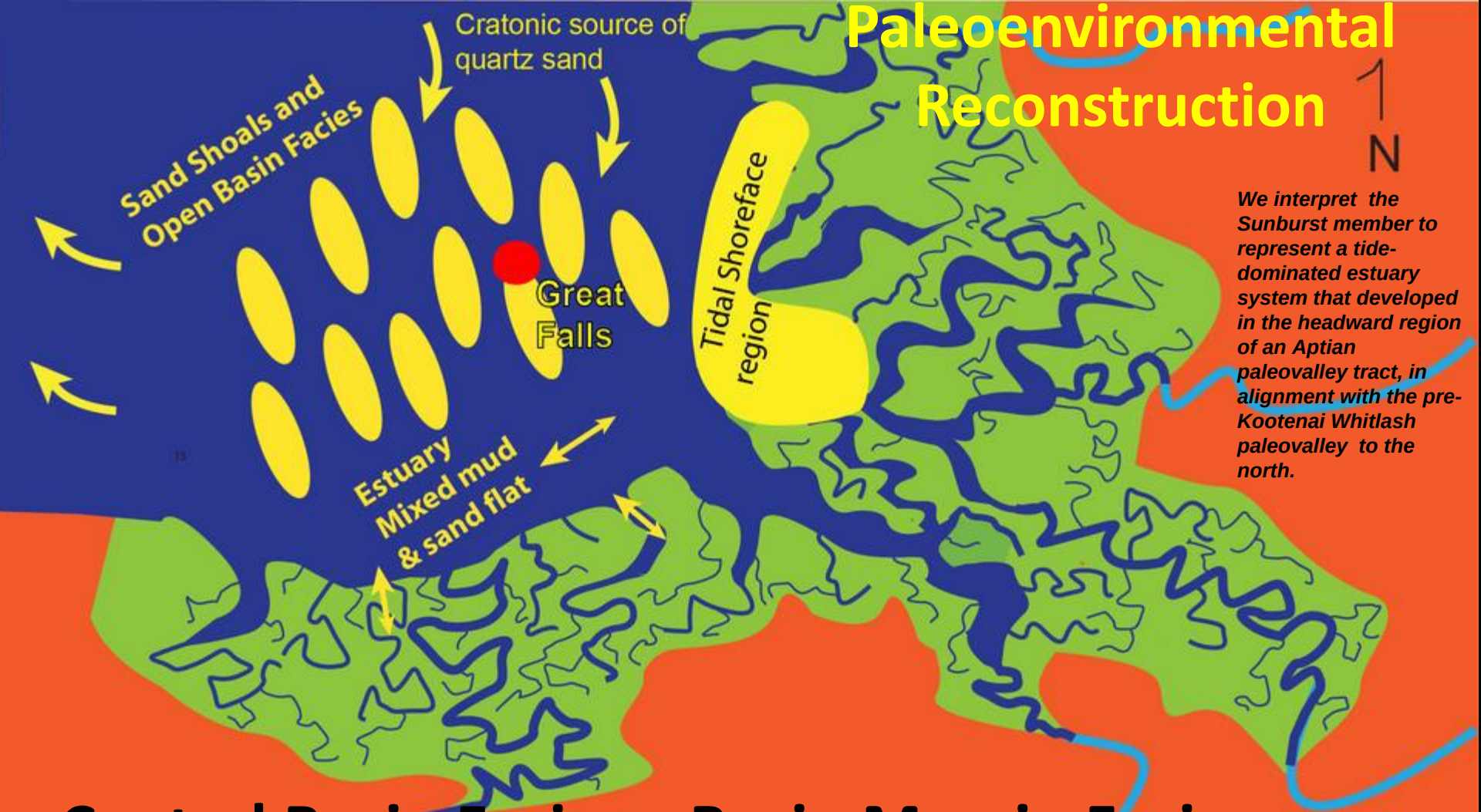

Zaitlin, et al., 2002
Hayes, et al.,1994
Southern and Central Alberta
Southern Alberta Plains
Great Falls area, Montana
Lower Cretaceous
Albian
Aptian
Barre-mian
Colorado Group
Bow Island
Blackleaf Formation
Mannville Group
Upper
Lower
Glauconitic Fm
Ostracod Mbr
Basal Quartz
Ellerslie ss
BAT ss
Horsefly ss
A ss
Glauconitic sandstone
Ostracod beds
Sun-burst
Cut-bank Mbr
Kootenai Formation
Fifth member
Ostracod beds
Fourth member
Sunburst mbr
Second mbr
Cutbank Mbr
STUDIED UNIT
* The Sunburst member is a quartz-rich sandstone-dominated unit that is present within the non-marine mudstone- and lithic sandstone-rich Kootenai Formation of west-central Montana.
* Age based upon preliminary magnetic data, Maureen Steiner


BRITISH COLUMBIA
ALBERTA
MONTANA
Study Area
The Sunburst member extends south from Alberta in the subsurface & is exposed at its southern limit in the Great Falls Region.
Great Falls
Sunburst Outcrop Extent
Little Belt Mountains
Missoula
Helena
Butte
Billings
Bozeman


Paleotopography of the pre-Kootenai unconformity
ALBERTA
MONTANA
Eastern Margin of Modern Thrust Belt
Cutbank paleodrainage
Whitlash paleodrainage
Kevin-Sunburst Dome
Pendroy Fault
Scapegoat-Bannatyne trend
Choteau
Great Falls
South Arch
Location of Sunburst outcrop in context of pre-Kk landscape.
Incised valley
Paleohigh
Modified in part from Dolson and Piombino (1994)


Great Falls North 30' x 60' quadrangle
Fort Benton 30' x 60' quadrangle
Great Falls South 30' x 60' quadrangle
Belt 30' x 60' quadrangle
Study Sites
16 Measured Section
26 Facies, Paleocurrent
Intervening locales- cursory
depositional edge
zero edge
Great Falls
Missouri River
Ulm
Sand Coulee
Centerville
Stockett
Belt
Raynesford
Castner Falls
Eden
Ming Coulee
Smith River
Belt Creek
Sun River
HIGHWOOD MOUNTAINS
LITTLE BELT MOUNTAINS
0 5 10 Miles
RI1
MD1
CD1
BE1
FF
GF
FS
BB1
WG
CM
BRrC
BRC
MC
SC
HC
R1
R1E
R2E
R3E
R4E
R5E
R6E
R7E
R8E
R9E
T22N
T21N
T20N
T19N
T18N
T17N
T16N
47°30'
111°
89
87
15
N

Paleoenvironmental Reconstruction

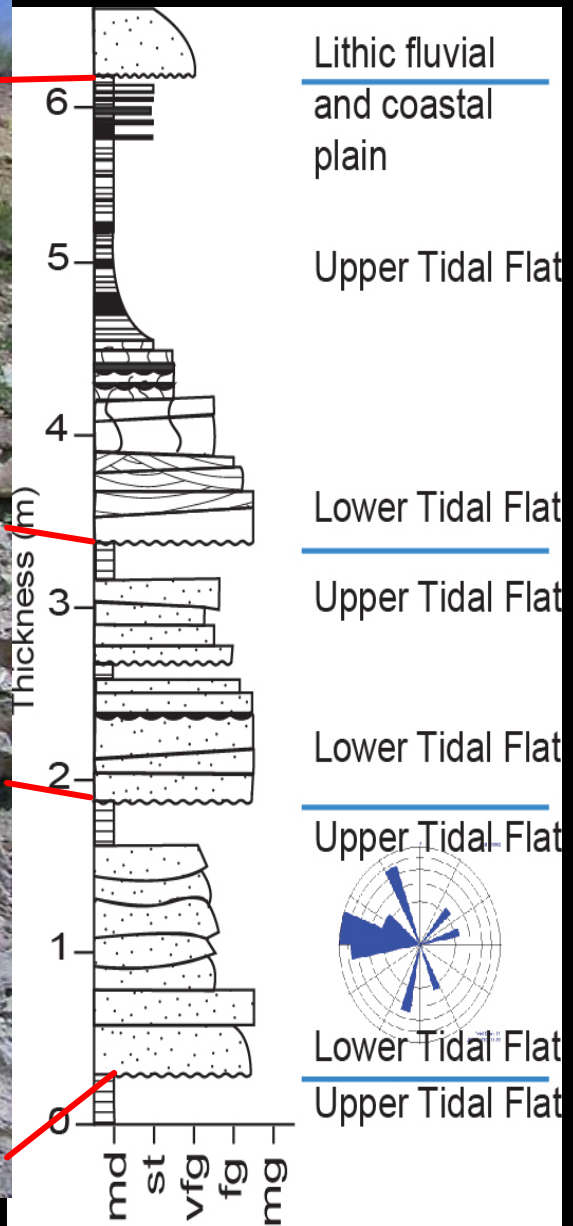


We interpret the Sunburst member to represent a tide-dominated estuary system that developed in the headward region of an Aptian paleovalley tract, in alignment with the pre-Kootenai Whitlash paleovalley to the north.

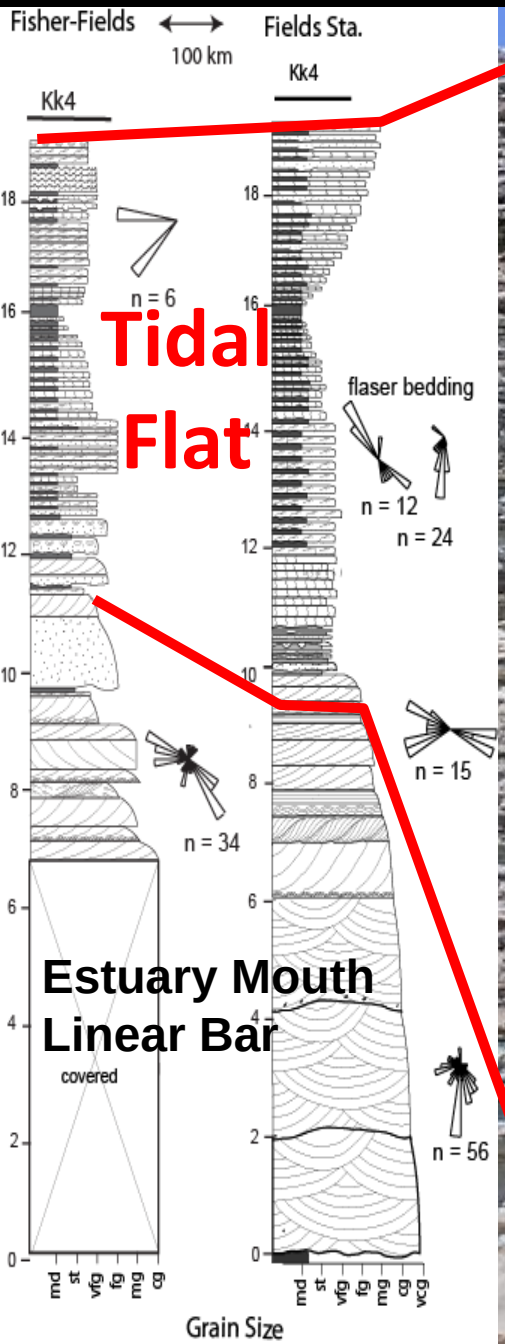
Central Basin Facies
tidal flat
estuary-channel
estuary-mouth bar
estuary mudstone

Basin Margin Facies
tidal flat-and-channel
tide-dominated shoreface

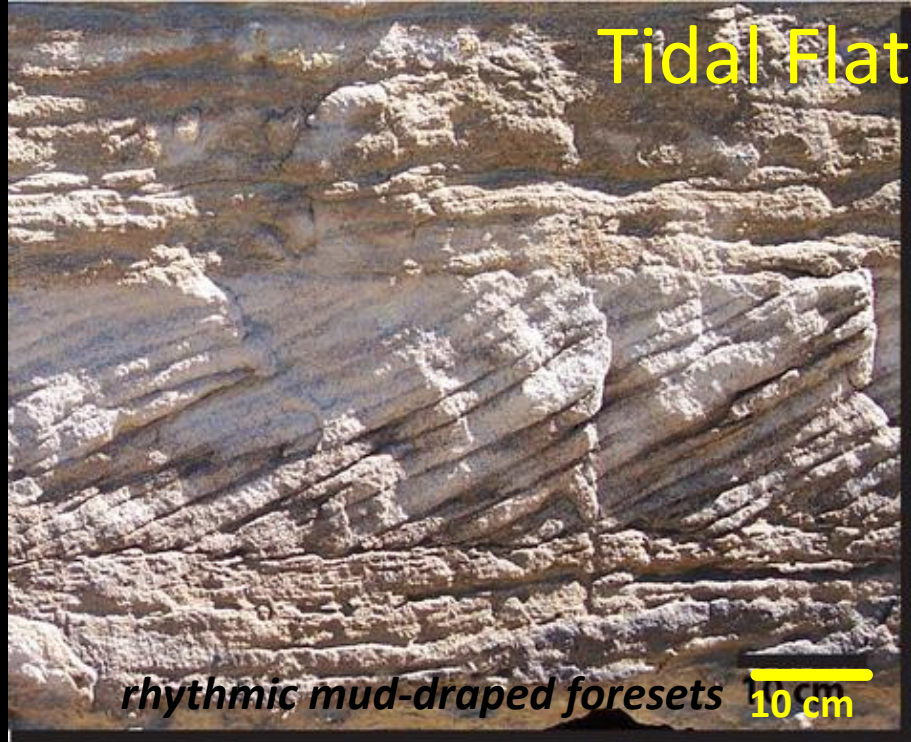
Basin Margin - Tidal Flat Facies



Basin Ctr - Tidal Flat Facies Above Estuary Mouth Bar



Tidal Flat Structures



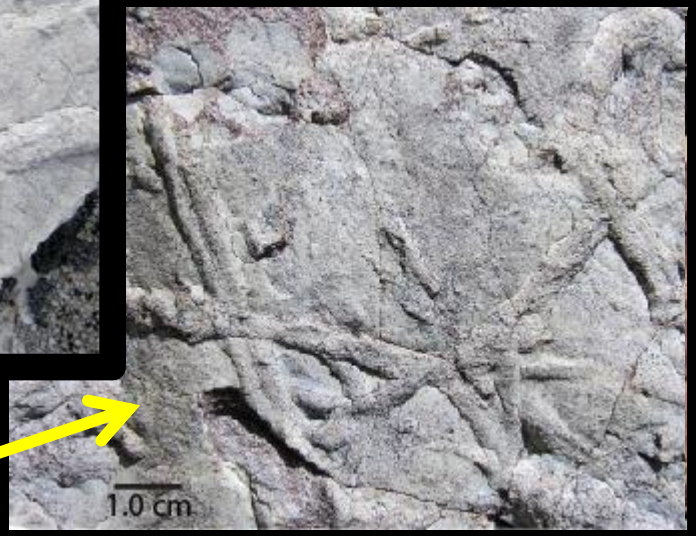
Tidal Flat Trace Fossils

Possibly *Planolites* & small *Taenidium*

Cylindrichnus

Arthropod trace

← *Skolithos, Planolites &*
Scoyenia-or *Psammichnites*-like

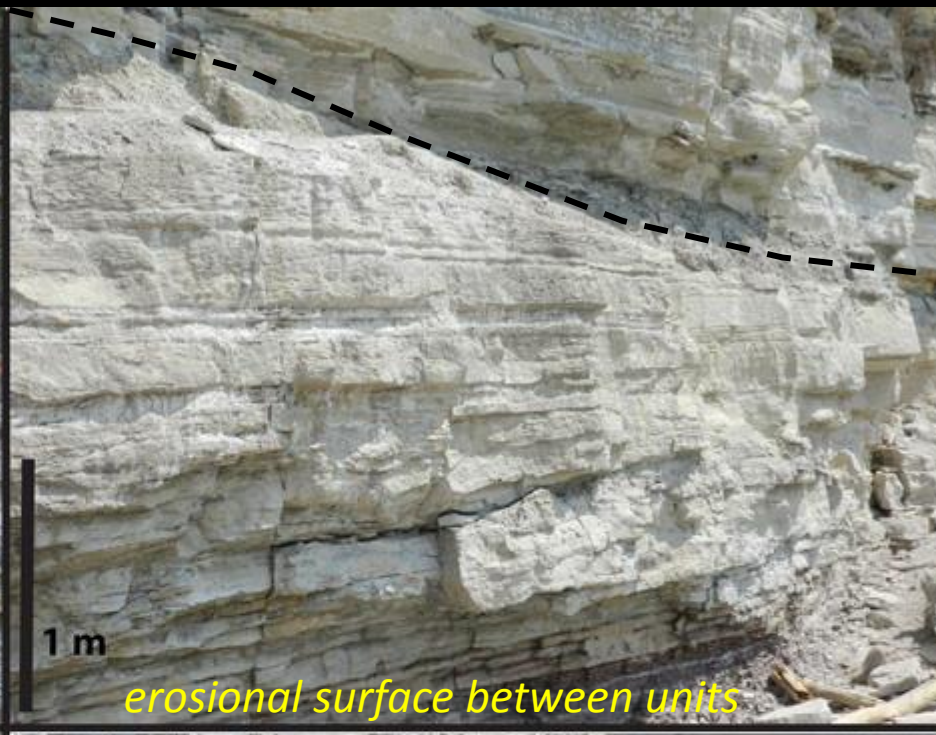


Psammichnites

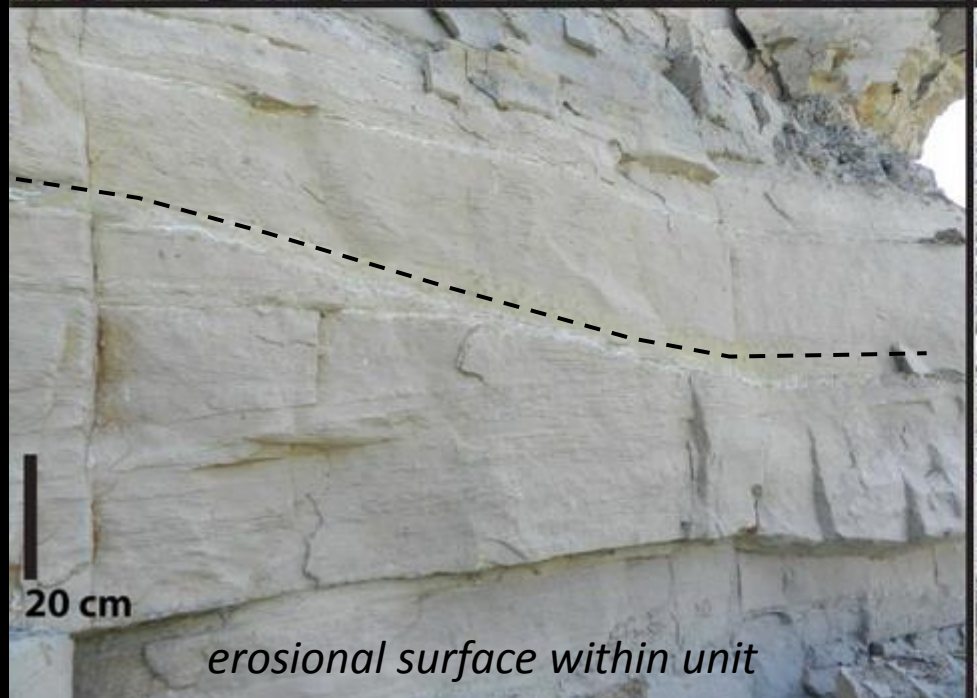
Horseshoe crab crawling-to-resting

Basin Margin - Tide-dominated shoreface succession

ripple-bedded upward-coarsening unit



erosional surface between units



erosional surface within unit

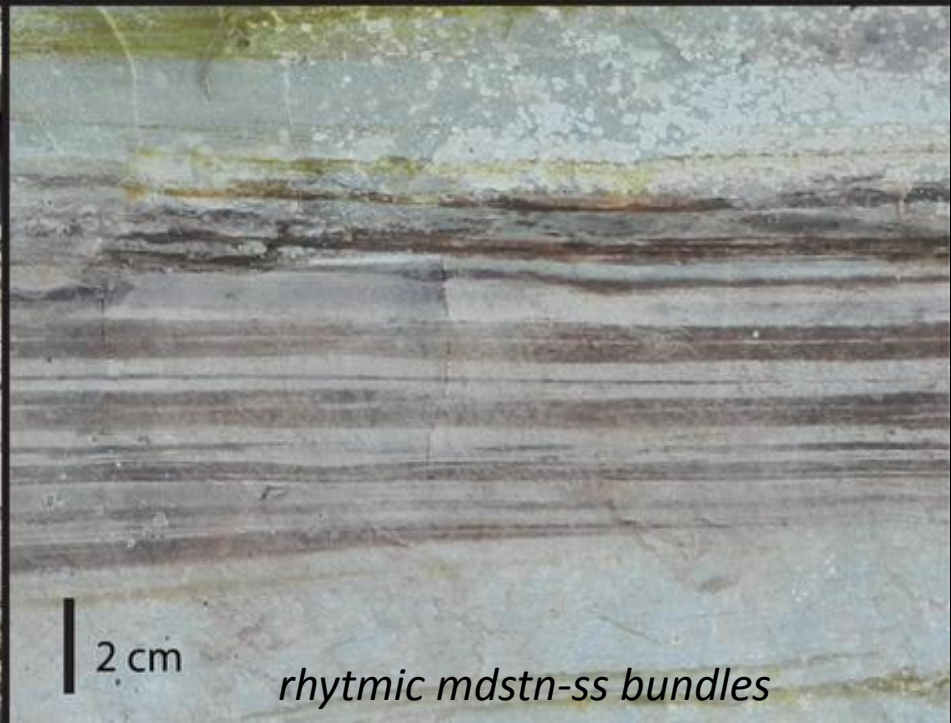
trough cross-stratification restricted to above channel-shaped erosional surface

Shoreface Tidal Structures

flaser bdg

flaser bdg; reversed foresets

flaser bdg; transverse view

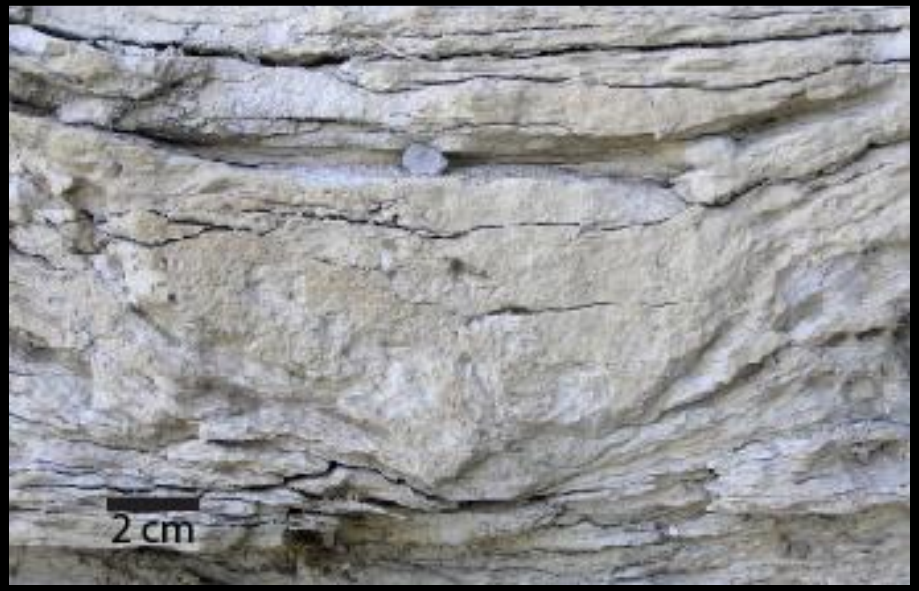


rhytmic mdstn-ss bundles

Tidal Shoreface Trace Fossils

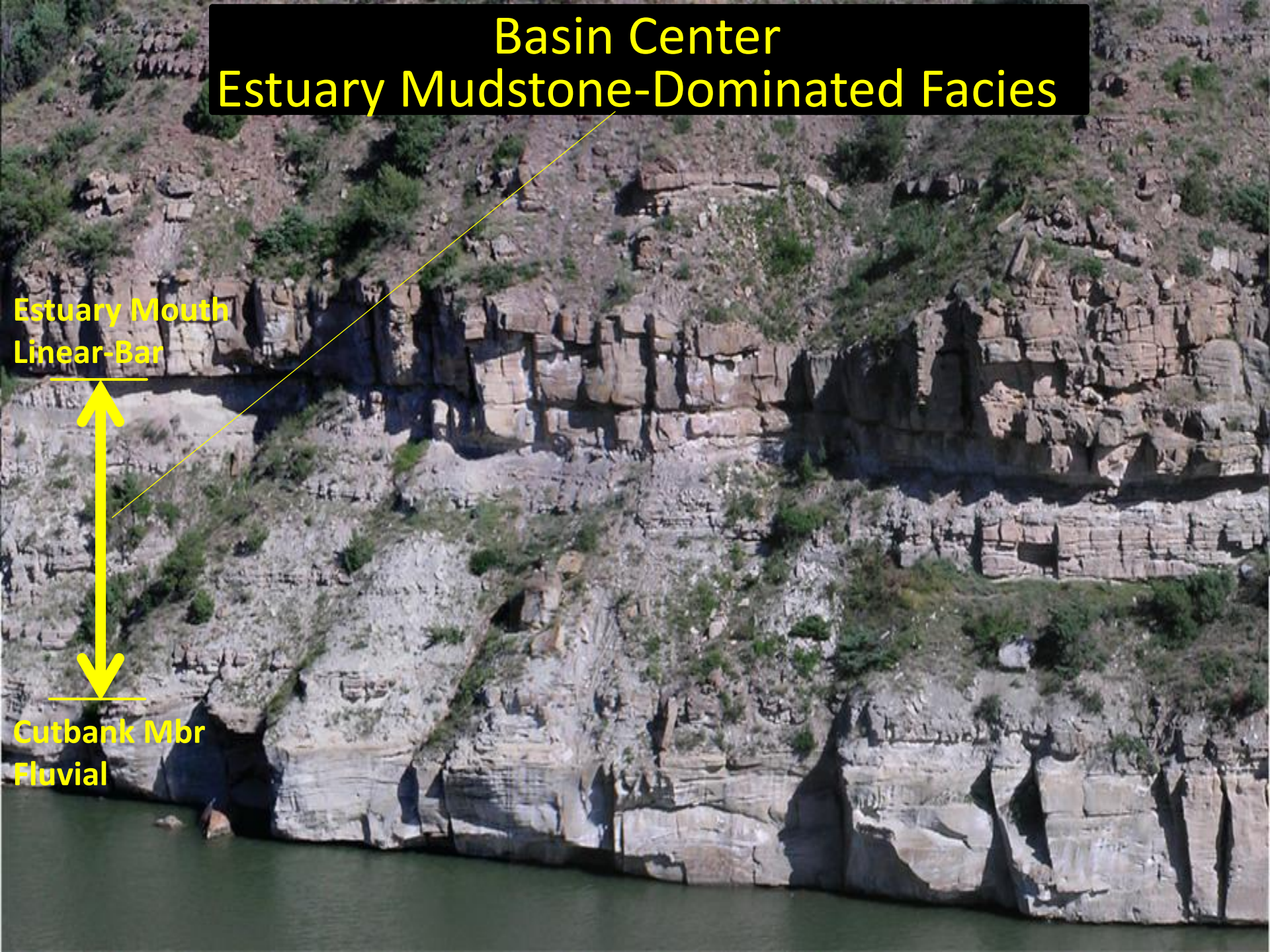
Arenicolites

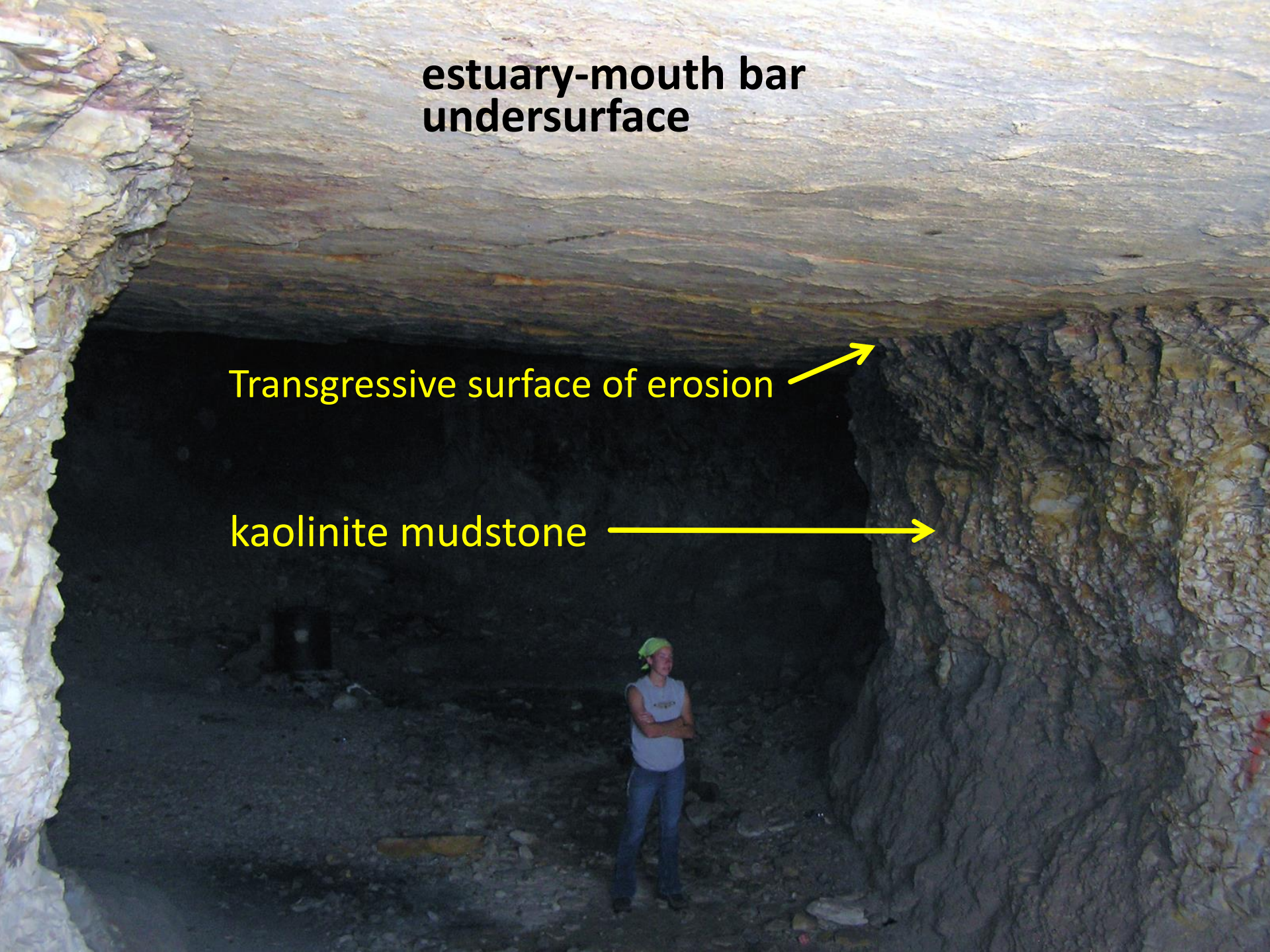
Hematized *Ophiomorpha*



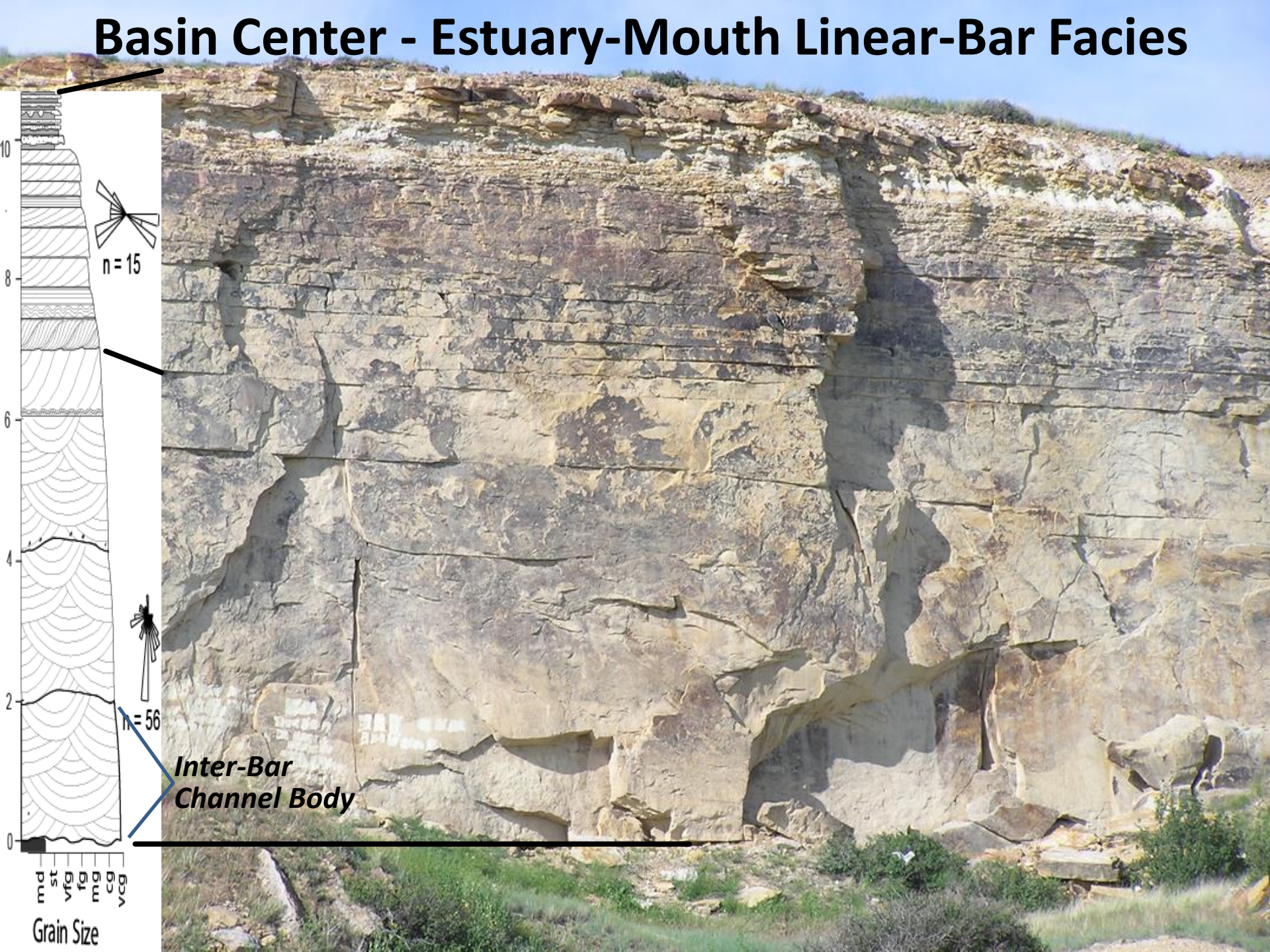
Pisichnus, ray feeding structure

Bivalve crawling trace

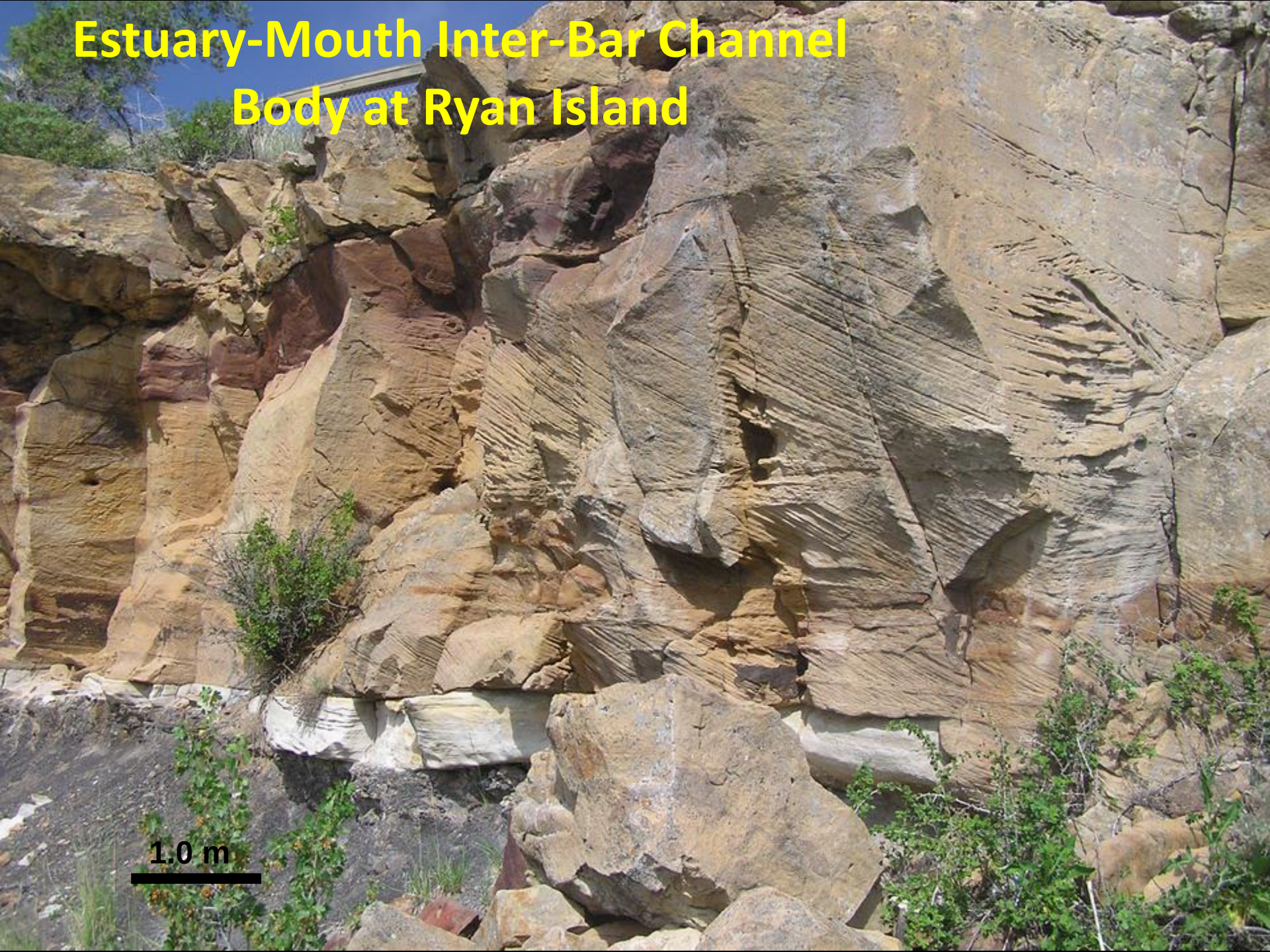

Basin Center
Estuary Mudstone-Dominated Facies
Estuary Mouth
Linear-Bar
Cutbank Mbr
Fluvial


estuary-mouth bar undersurface
Transgressive surface of erosion
kaolinite mudstone

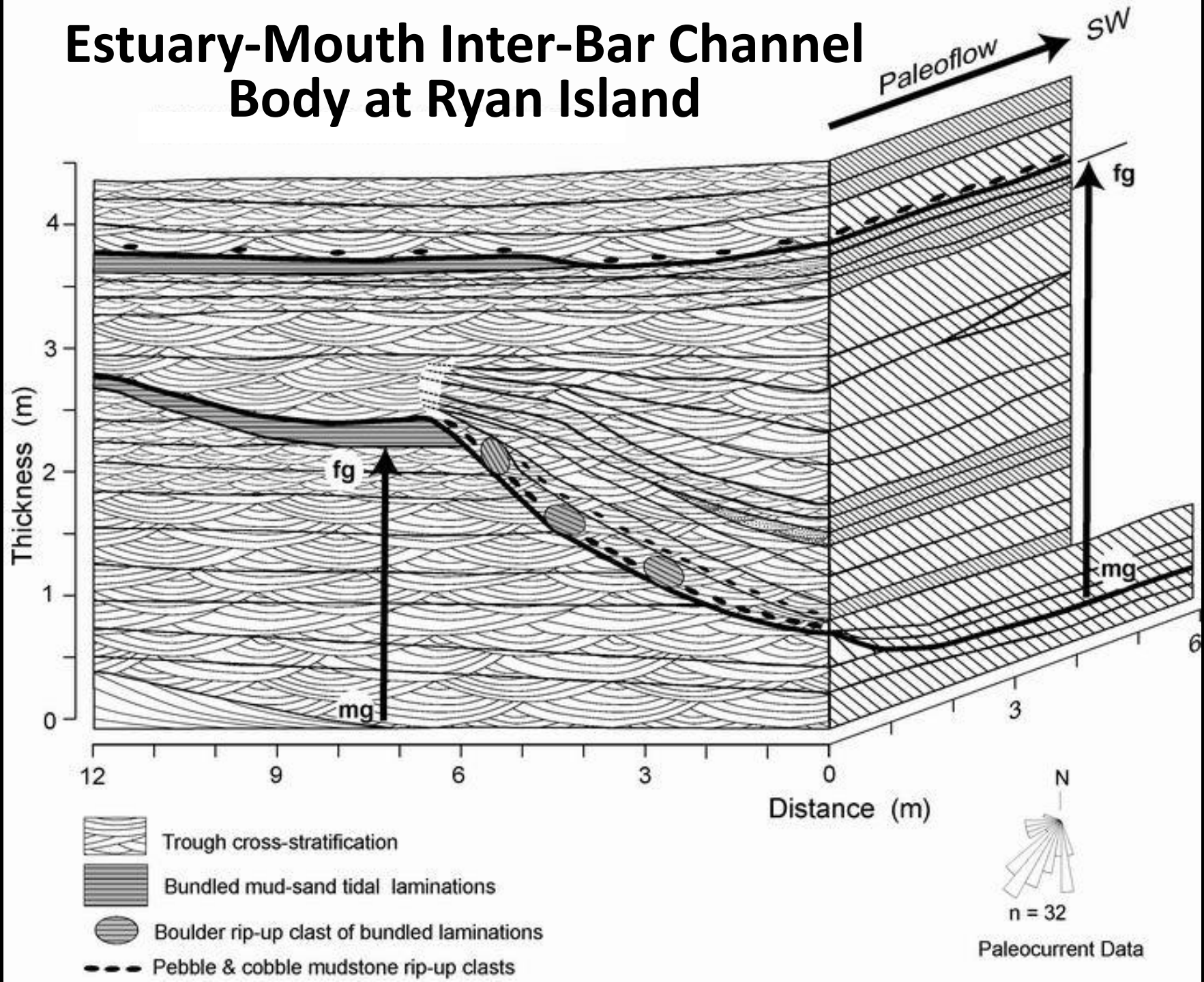
Basin Center - Estuary-Mouth Linear-Bar Facies




Estuary-Mouth
Linear-Bar
Facies
Central Basin Mudstone-Dom. Facies

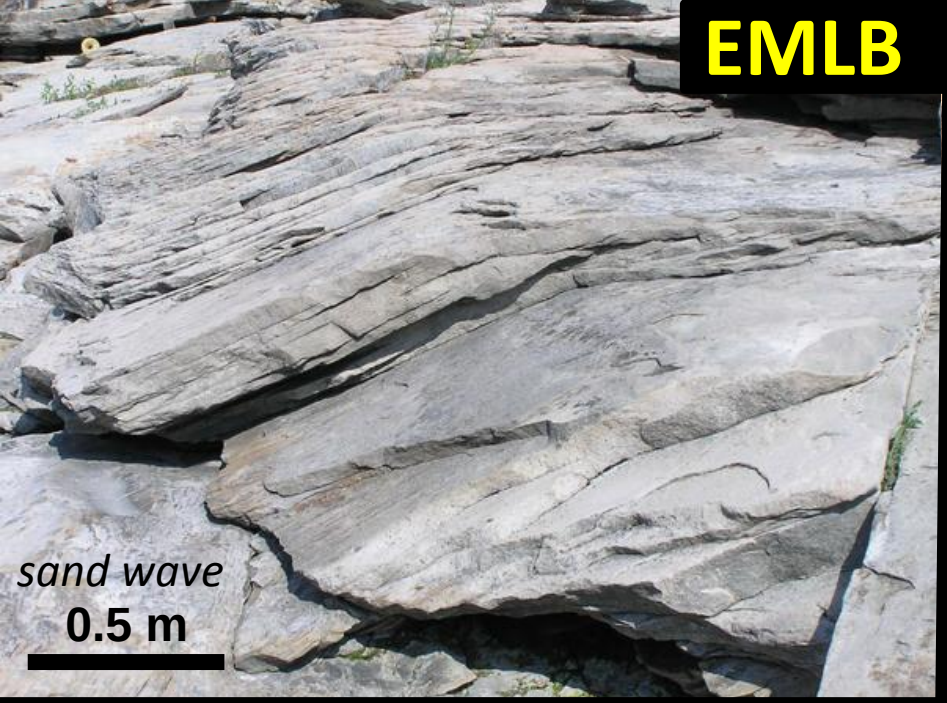

Estuary-Mouth Inter-Bar Channel
Body at Ryan Island
1.0 m

Estuary-Mouth Inter-Bar Channel Body at Ryan Island



Estuary-Mouth Inter-Bar Channel Fill

EMLB Structures



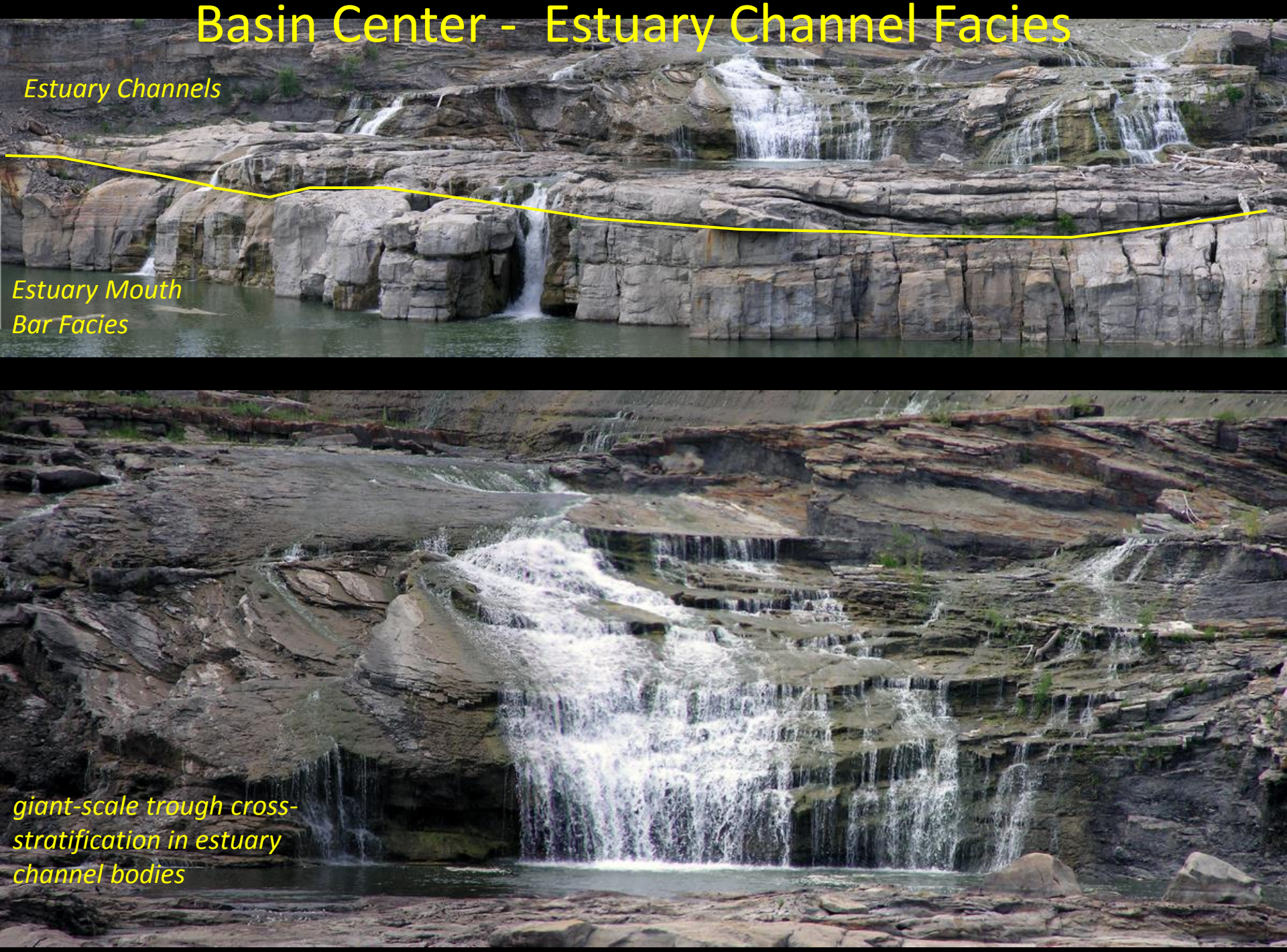
Estuary-Mouth Linear-Bar Trace Fossils

Ophiomorpha

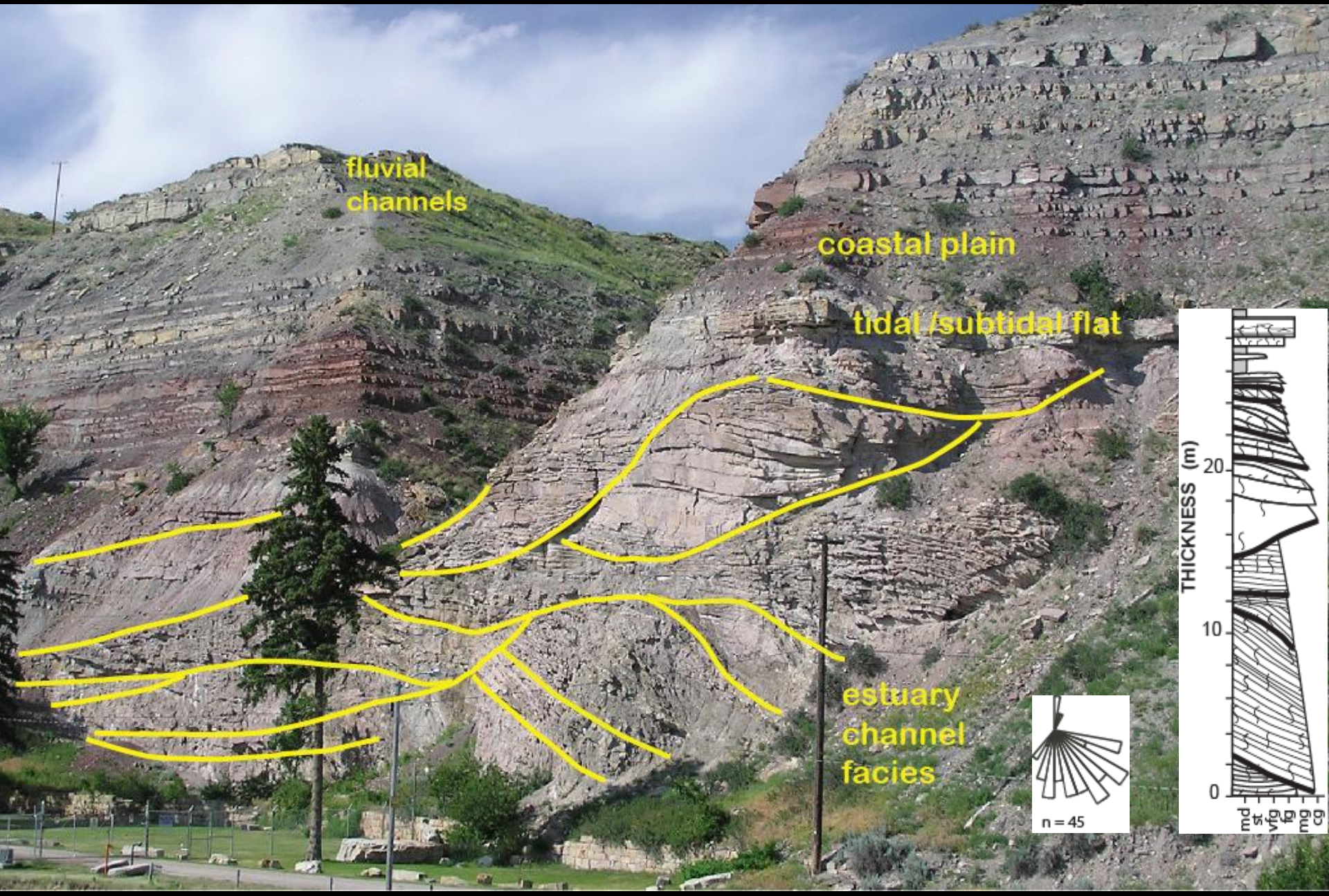
Diplocraterion

Unidentified

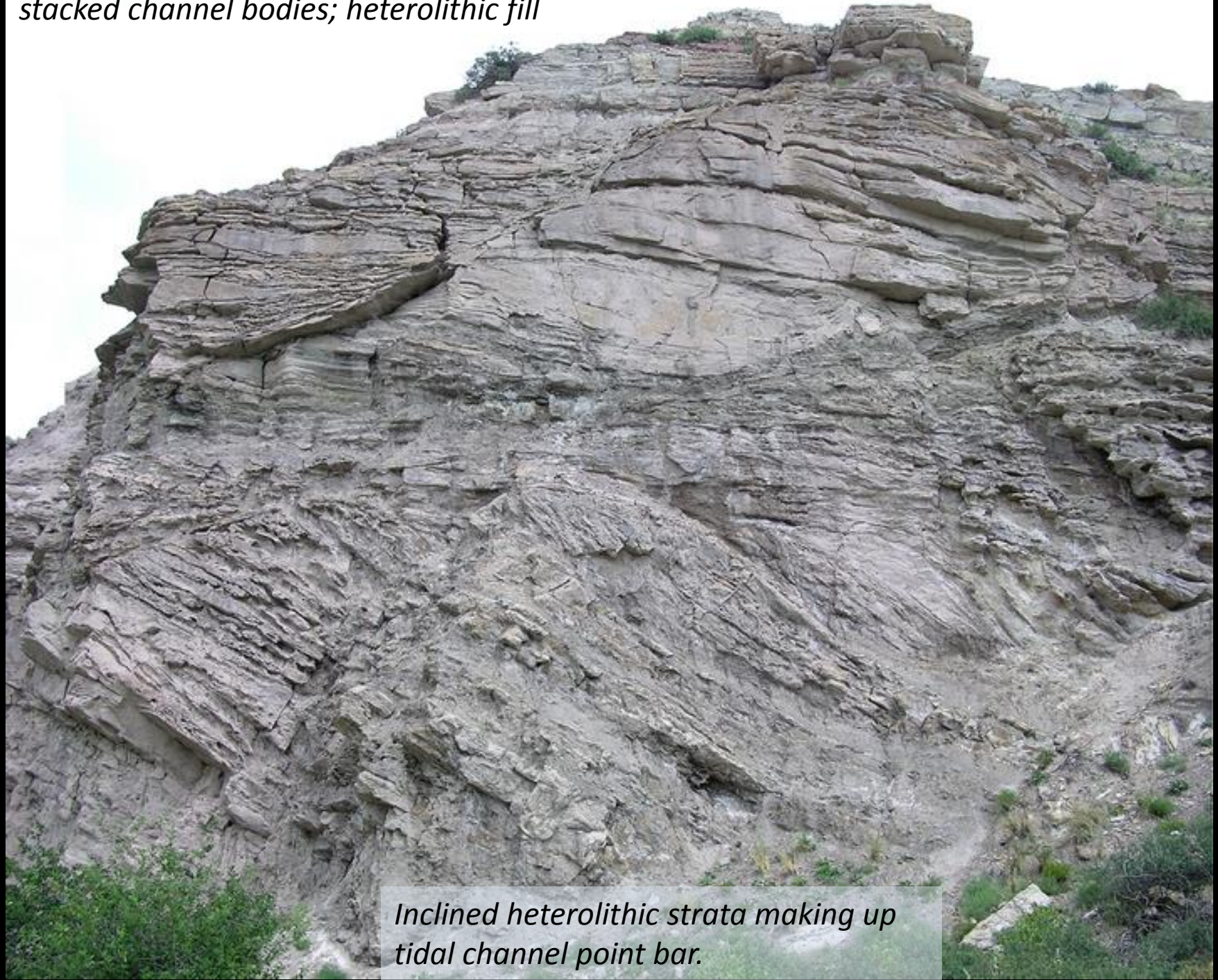
Basin Center - Estuary Channel Facies



Basin Center - Estuary Channel Facies

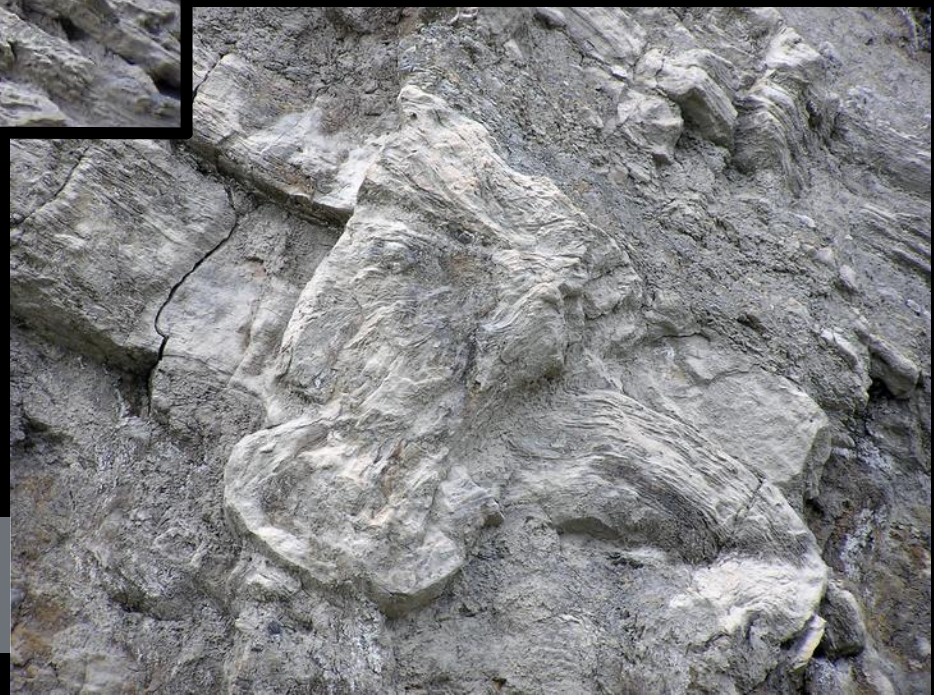


stacked channel bodies; heterolithic fill

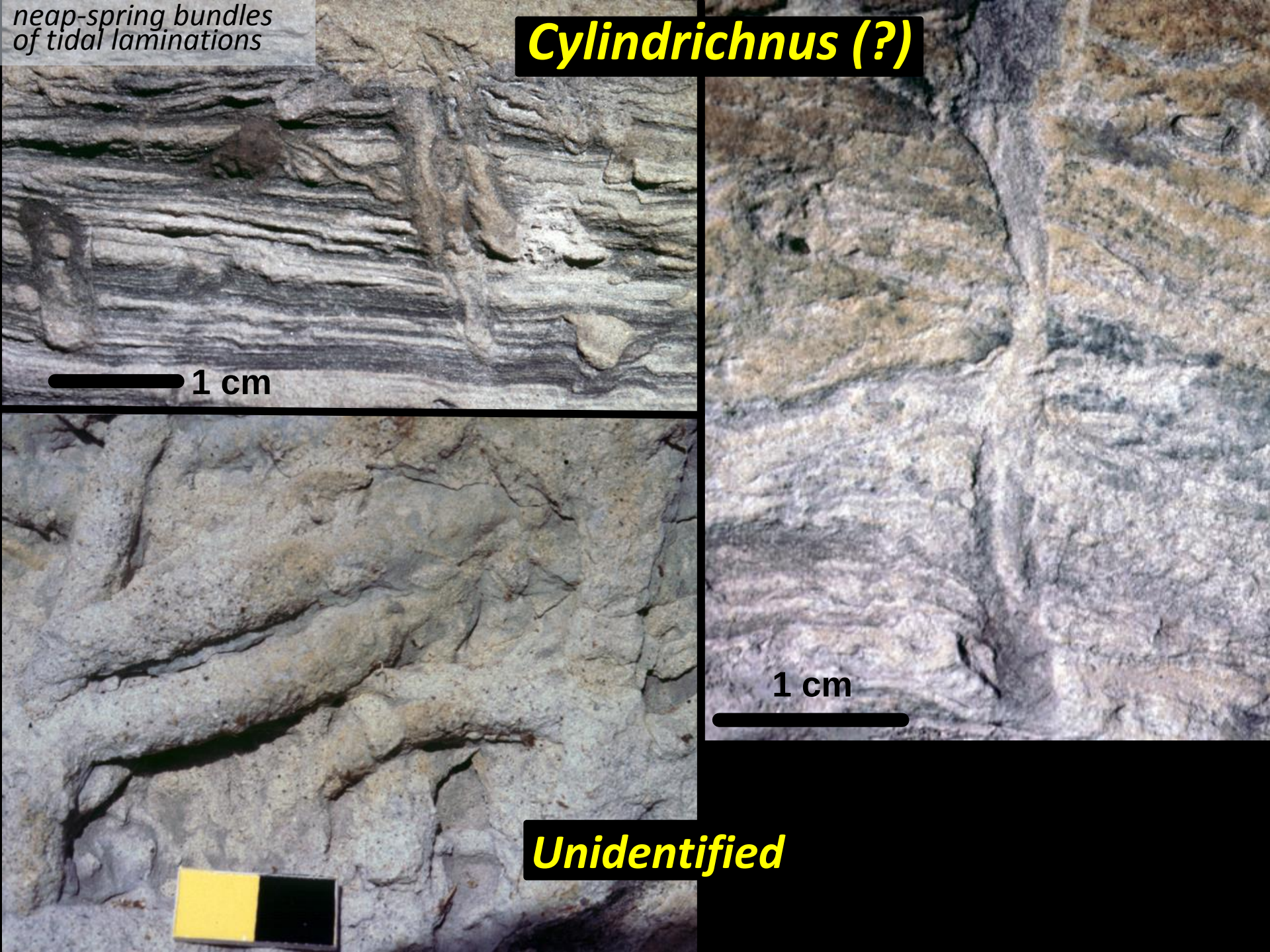


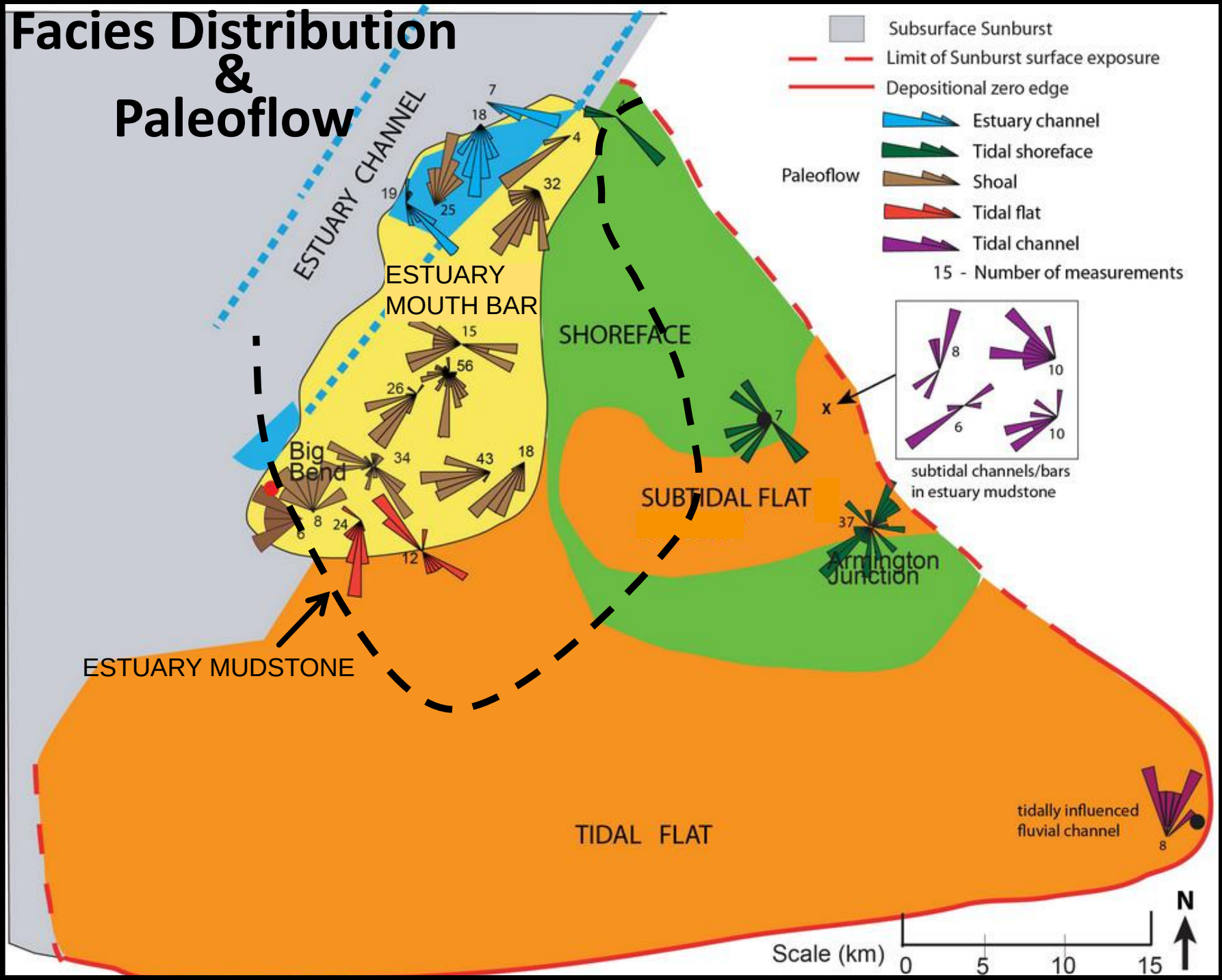
Inclined heterolithic strata making up tidal channel point bar.

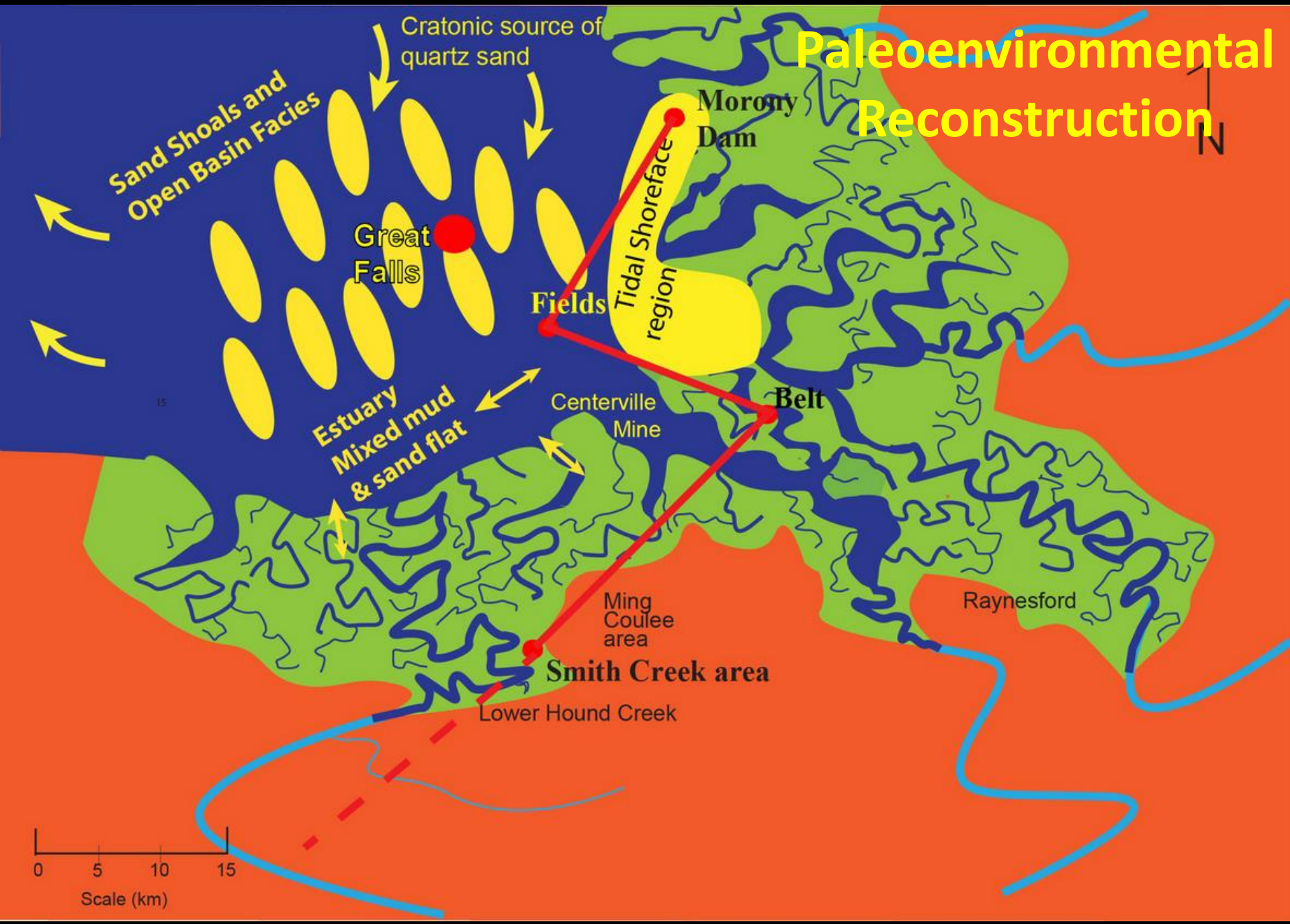
heavily bioturbated & deformed inclined heterolithic strata; bipolar foresets



compressional deformation at base of oversteepend IHS


neap-spring bundles
of tidal laminations
1 cm
Cylindrichnus (?)
1 cm
Unidentified


Facies Distribution
&
Paleoflow
Subsurface Sunburst
Limit of Sunburst surface exposure
Depositional zero edge
Paleoflow
Estuary channel
Tidal shoreface
Shoal
Tidal flat
Tidal channel
15 - Number of measurements
ESTUARY CHANNEL
ESTUARY
MOUTH BAR
SHOREFACE
SUBTIDAL FLAT
Big
Bend
Farmington
Junction
subtidal channels/bars
in estuary mudstone
ESTUARY MUDSTONE
TIDAL FLAT
tidally influenced
fluvial channel
Scale (km)
0
5
10
15
N


Paleoenvironmental Reconstruction
Cratonic source of quartz sand
Sand Shoals and Open Basin Facies
Great Falls
Fields
Tidal Shoreface region
Morony Dam
Centerville Mine
Belt
Estuary
Mixed mud & sand flat
Ming Coulee area
Smith Creek area
Lower Hound Creek
Raynesford
N
0 5 10 15
Scale (km)

Stratigraphic Summary