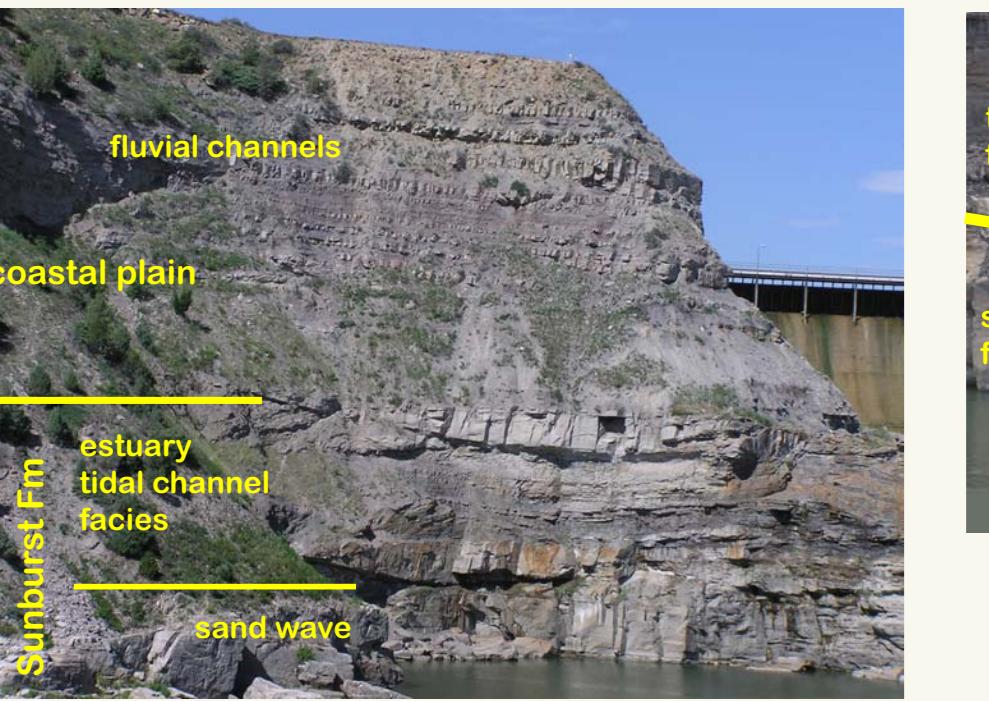
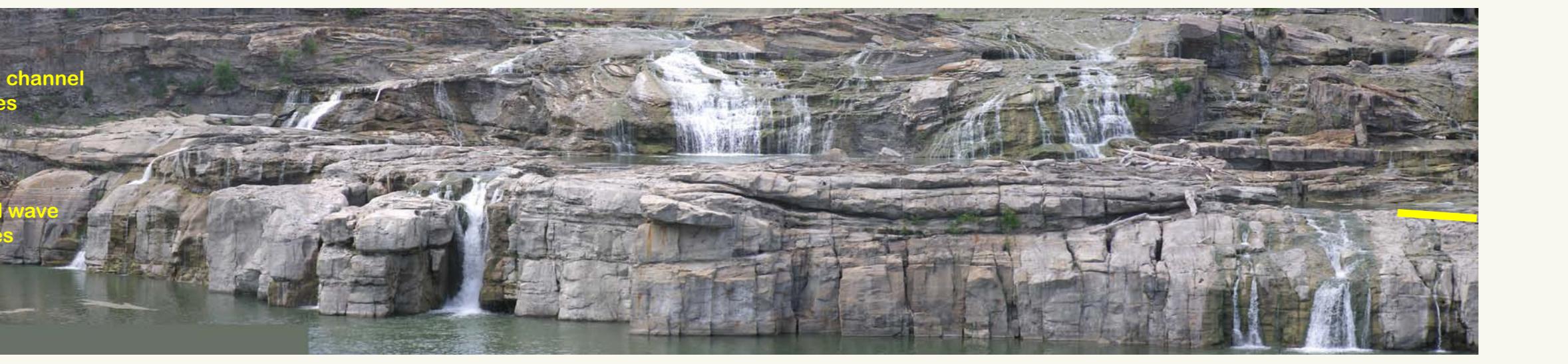


## TIDAL CHANNEL LITHOFACIES



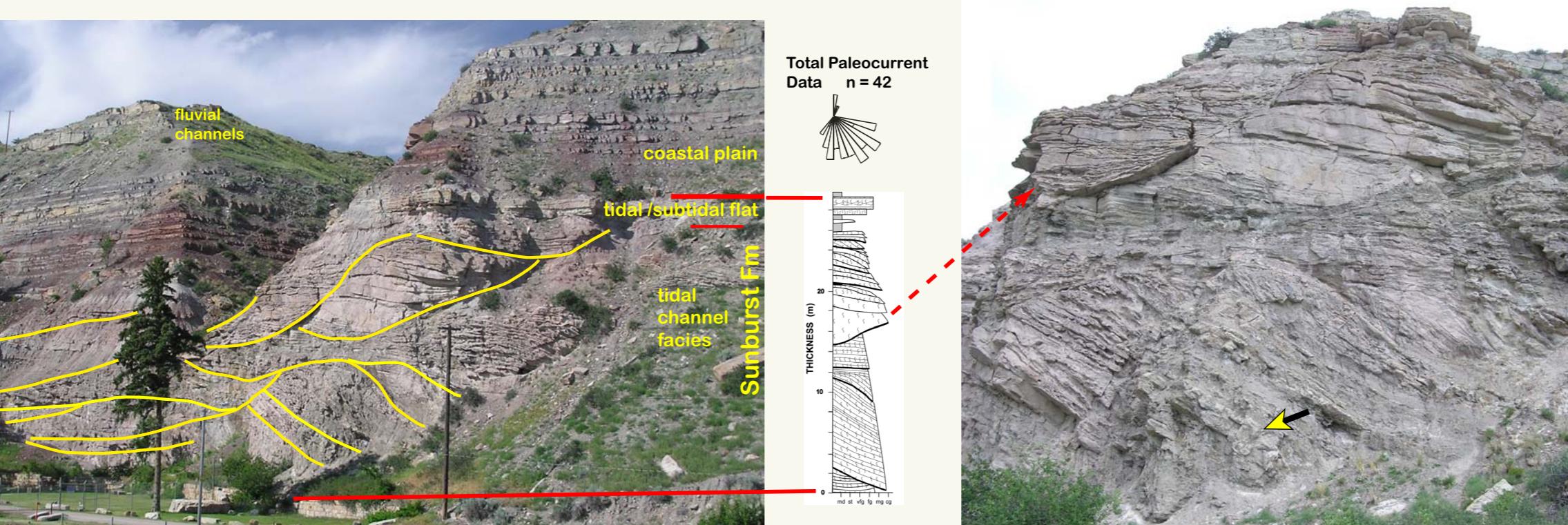
Tidal channel facies in erosional contact with underlying sand wave facies, Ryan Dam spillway. Nonmarine coastal plain and fluvial facies conformably overlie the Sunburst Fm.



Tidal channel facies in erosional contact with the underlying sand wave facies, Ryan Dam spillway.



Close-up of upper right photo showing giant-scale trough cross-stratification within a channel body.



Overview of the tidal channel complex overlain by widespread tabular tidal flat (Sunburst) and maroon coastal plain facies (Kk4 member), Ryan Dam. Yellow lines mark the erosional base of major channel bodies in the exposure.

Close up of laterally and vertically stacked channel bodies. Over-steepened beds and compressional fold (arrow; see photo below) occur within slumped channel-margin unit at lower left.



Bioturbated bundles of neap-spring tidal-laminations within channel body.



Soft-sediment fold due to compression at the base of a channel-margin slump block.



Bioturbated heterolithic channel fill consisting of fine sand and organic-rich very fine sand.

### PROPERTIES OF TIDAL CHANNEL FACIES

#### Overall

- Exposures occur along the Missouri River gorge between Cochran Dam and Ryan Dam.
- A complex of laterally and vertically stacked, clayey to clean quartz arenite, channel bodies up to 40 m thick and >5 km wide.
- Erosionally overlies sand-wave facies; overlain by tidal bar-to-tidal flat and nonmarine Kk4 facies.

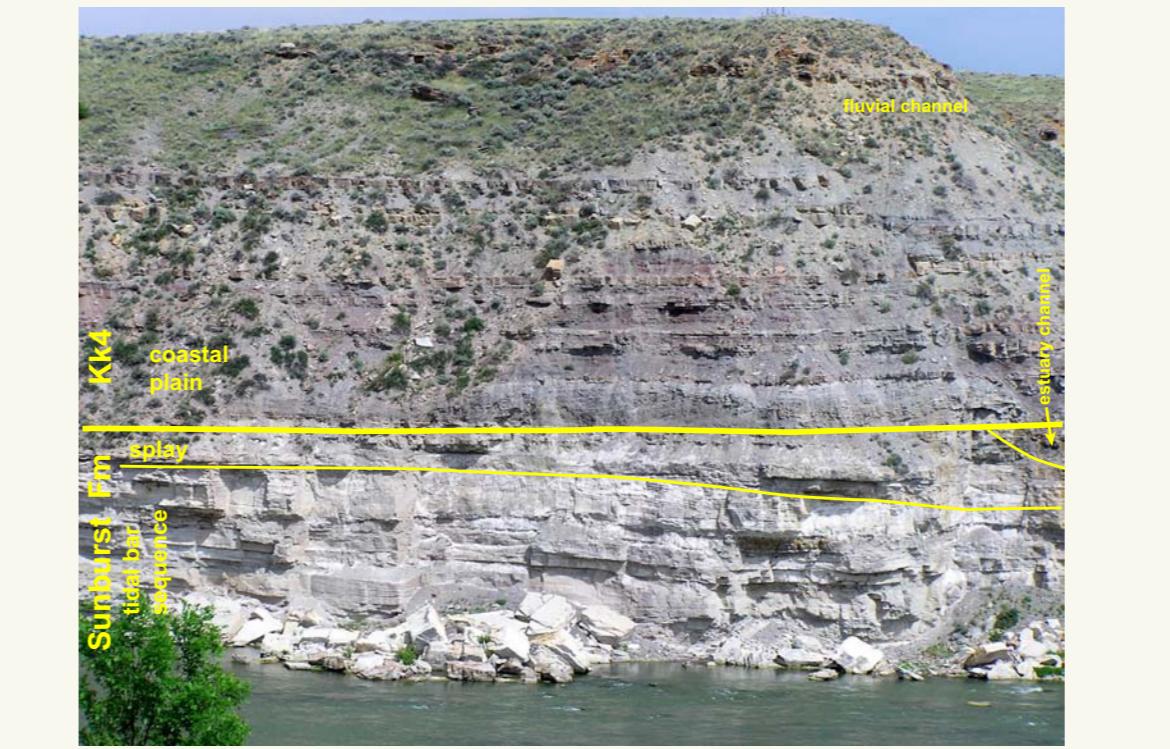
#### Channel Body Properties

- Upward-fining sandstone and heterolithic fill.
- Channel-body orientations approximately NE-SW.
- Individual channel widths: several to > 20-m; channel thicknesses: meter to 10-m scale.
- Bedding: subhorizontal to concave and ECS-like; over-steepened beds within slump blocks.

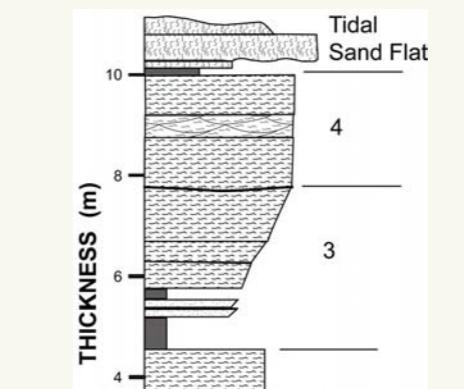
#### Sedimentary structures:

- Medium- to large-scale trough cross-stratification & small-scale ripple bedding.
- Bank accretion bedding.
- Mud drapes
- Wave ripples
- Vertically accreted spring-neap bundles of parallel lamination.
- Stump blocks.
- Trace fossils locally abundant; bioturbation fabric common, ranging up to 100%.
- Paleoflow usually unimodal between SSW-SSE; rarely bimodal-bipolar with 2nd mode to north.

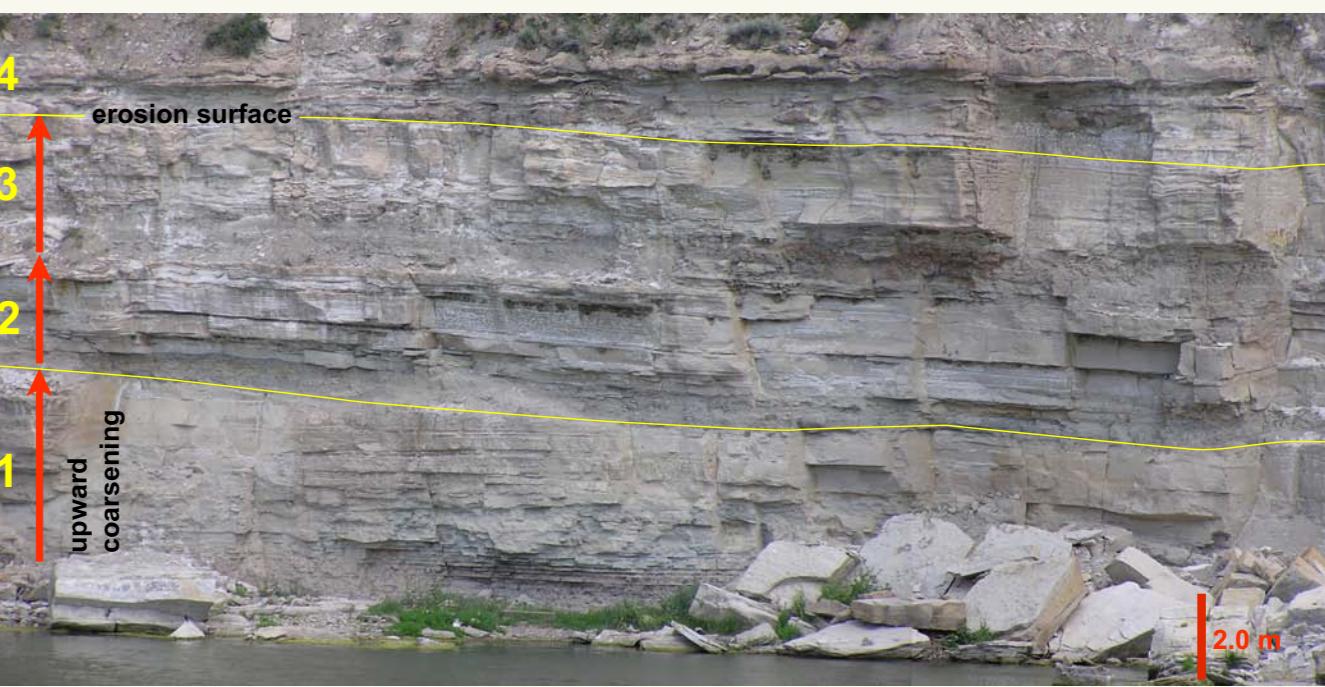
## SUBTIDAL SAND BAR/FLAT LITHOFACIES



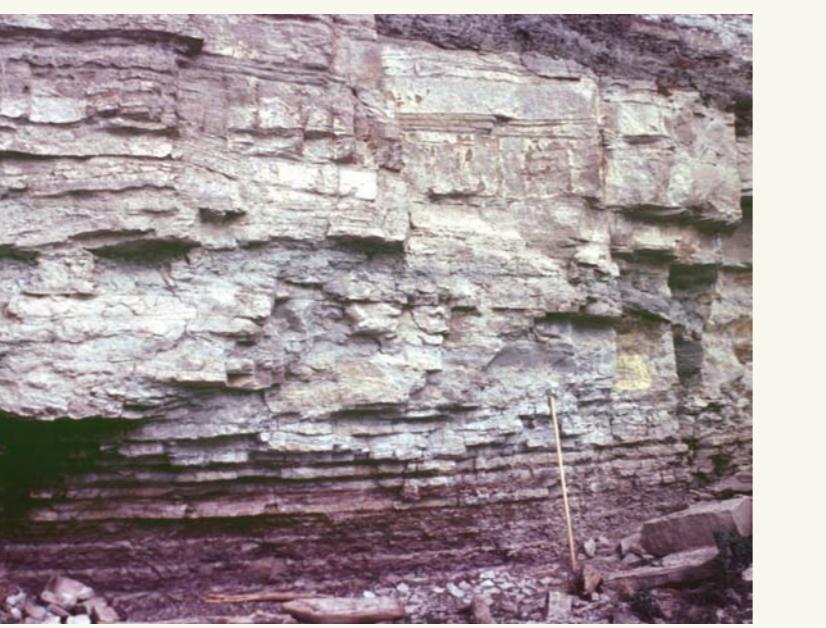
Overview of Sunburst subtidal bar/flat succession near Morony Dam. A splay and estuary(?) channel facies vertically and laterally truncate (unshown at right) the bar succession at this locale.



Representative stratigraphic section of stacked subtidal bar/flat units and overlying tidal flat facies at Morony Dam site.



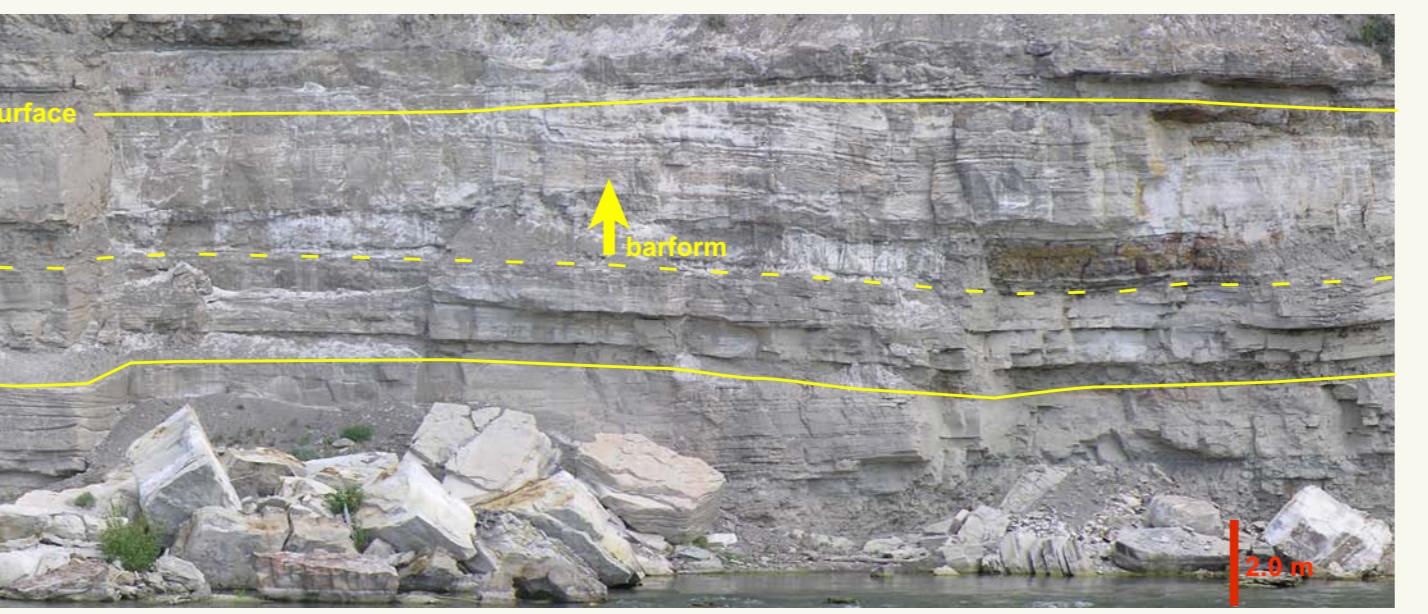
Close up of three to possibly four upward-coarsening subtidal bar/flat units. The upper parts of the 1st and 3rd units are truncated by a discordant to slightly discordant erosional surface (yellow lines); unclear for the 2nd unit. Laterally, coarser sandstone of different units can become amalgamated resulting in loss of unit identity.



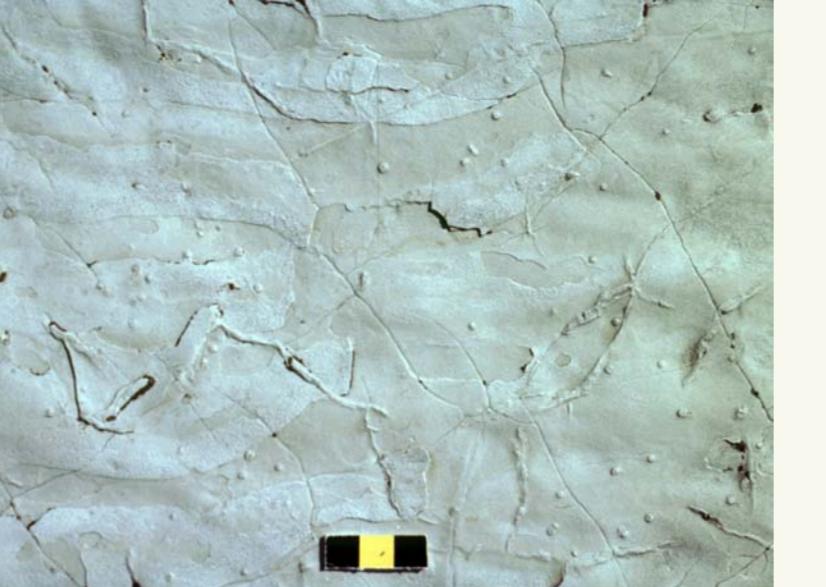
Upward coarsening and sandstone-bed thickening within bar/flat unit 1.



Close up of stacked tabular upward-coarsening bar/flat units.



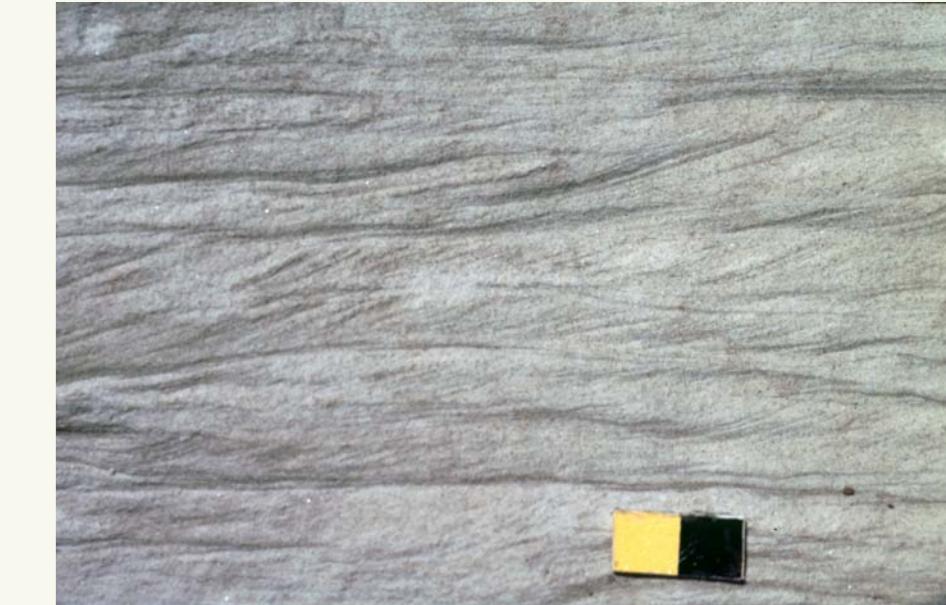
Truncated convex bedding (yellow arrow) in unit 3 indicating a bar-form morphology prior to erosion. This view of the outcrop is lateral to the photo in the upper right. Solid yellow lines designate well defined erosion surfaces, dashed line designates a speculative erosional surface.



Paired upper tubes of U-shaped burrows on a wave-ripped bed surface.



Ripple bedding within large-scale trough sets. Localized trough sets within the subhorizontally bedded tabular units indicate localized current scour-and-fill across bar deposits.



Unidirectional small-scale ripple cross-stratification with mud drapes indicating repetitive tractive tidal current flow in one direction alternating with slack-water conditions. Curvilinear scour surfaces in between or truncating the ripple sets may have resulted from erosion in front of superimposed ripple forms and/or stronger tidal current events.

### PROPERTIES OF SUBTIDAL BAR/FLAT FACIES

#### Overall

- At Morony Dam: An 11-15 m thick composite of up to five, vertically stacked, generally 2-4 m thick, upward-coarsening, mud (or heterolithic)-to-sand tabular units occurs directly above the basal Kootenai (Cutbank) fluvial sandstone. At Ryan Island: A relatively thin bar sequence (~5m) occurs above the sand wave facies.
- The facies is directly overlain by tidal flat and coastal plain facies, or locally truncated and overlain by estuary channel deposits.
- Subhorizontal, low-angle, and convex-to-concave bedding indicates accretion upon wide, low relief, bar forms and adjacent subhorizontal surfaces.
- Widespread, subhorizontal-to-slightly undulatory erosional surfaces truncate and occur within the Sunburst bar units. Sand-unit stacking and intervening erosion is consistent with episodic bar growth, abandonment (sand starvation), and tidal current breaching as occurs in modern estuary settings.

#### Other sedimentary structures

- Localized low-relief, channel-shaped scours (m-scale width) with symmetrical fill.
- Scattered wide (~5 m), low-amplitude (0.5-1.0 m) sets of trough cross-stratification.
- Flaser bedding.
- Mud drapes.
- Rhythmic amalgamated sets of small-scale ripple cross-stratification and parallel lamination.
- Ripple cross-stratification usually unimodal to rarely bimodal-bipolar.
- Bioturbation fabric common; trace fossils present but ichnospecies diversity low.