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

LOWER KOOTENAI FORMATION

Robert K. Schwartz¹, Susan M. Vuke²
(1) Department of Geology, Allegheny College, PA
(2) Montana Bureau of Mines and Geology, Butte, MT

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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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.
The Sunburst member extends south from Alberta in the subsurface & is exposed at its southern limit in the Great Falls Region.
Location of Sunburst outcrop in context of pre-Kk landscape.
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.
Basin Margin - Tidal Flat Facies
Tidal Flat Structures

- Rhythmic mud-draped foresets
- Flaser bedding
- Wavy bedding
- Bioturbated ripple bedding
Tidal Flat Trace Fossils

Possibly *Planolites* & small *Taenidium*

*Cylindrichnus*

⇐ *Skolithos, Planolites* & *Scyenia*-or *Psammichnites*-like

Arthropod trace

*Psammichnites*

Horseshoe crab crawling-to-resting
Basin Margin - Tide-dominated shoreface succession
ripple-bedded upward-coarsening unit

erosional surface between units

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

erosional surface within unit
Tidal Shoreface Trace Fossils

*Arenicollites*

*Hematized Ophiomorpha*

*Pisichnus*, ray feeding structure

*Bivalve crawling trace*
Basin Center
Estuary Mudstone-Dominated Facies

Estuary Mouth
Linear-Bar

Cutbank Mbr
Fluvial
kaolinite mudstone

estuary-mouth bar
undersurface

Transgressive surface of erosion

kaolinite mudstone
Basin Center - Estuary-Mouth Linear-Bar Facies

Inter-Bar Channel Body
Central Basin Mudstone-Dom. Facies

Estuary-Mouth
Linear-Bar
Facies
Estuary-Mouth Inter-Bar Channel Body at Ryan Island
Estuary-Mouth Inter-Bar Channel Body at Ryan Island
Northern Basin and Range

0.5 m EMLB Structures

reactivation surface

sand wave 0.5 m
two-part ss foresets with mud drapes; possible spring-neap trend

inclined erosional surfaces overlain by neap-spring tidal bundles; overlies bar form
Estuary-Mouth Linear-Bar Trace Fossils

Ophiomorpha

Diplocraterion

Unidentified
Basin Center - Estuary Channel Facies

Estuary Channels

Estuary Mouth Bar Facies

giant-scale trough cross-stratification in estuary channel bodies
Basin Center - Estuary Channel Facies

- Fluvial channels
- Coastal plain
- Tidal/subtidal flat
- Estuary channel facies
heavily bioturbated & deformed inclined heterolithic strata; bipolar foresets

compressional deformation at base of oversteepened IHS
Cylindrichnus (?)

Unidentified neap-spring bundles of tidal laminations
Paleoenvironmental Reconstruction

- Sand Shoals and Open Basin Facies
- Cratonic source of quartz sand
- Great Falls
- Estuary Mixed mud & sand flat
- Fields
- Tidal Shoreface region
- Smith Creek area
- Lower Hound Creek
- Ming Coulee area
- Centerville Mine
- Morony Dam
- Raynesford

Scale (km)
Stratigraphic Summary

- **Estuary Mouth Bar**
- **TRS** - transgressive surface
- **Ts** - transgressive system tract
- **TS** - transgressive surface
- **LST** - lowstand system tract
- **HST** - highstand system tract
- **TST** - transgressive system tract
- **Kk4** - Coastal Plain Fluvial & Paleosol
- **SUNBURST**
- **Kk2** - Paleosols & Siliciclastic Lacustrine
- **Lithic Fluvial**
- **Paleosols & Siliciclastic Lacustrine**
- **Tidal Flat**
- **Estuary Channel**
- **Incised Valley Fill**
- **TST-HST LST**
- **CUTBANK MBR.**
- **JURASSIC MORRISON FM.**
- **20 m**