

BACKGROUND

The Kootenai Formation in western Montana has traditionally been considered to be fully non-marine (e.g., Walker, 1974; Mudge and Rice, 1982; Berkshire 1985). In particular, the quartz-rich Third Kootenai member (Sunburst Sandstone) was originally interpreted to be of fluvial and lacustrine origin (Walker, 1974). However, more recent work by Burden (1984), Hopkins (1985), Vuke (1987) and Farshori and Hopkins (1989) indicate a marine to brackish setting.

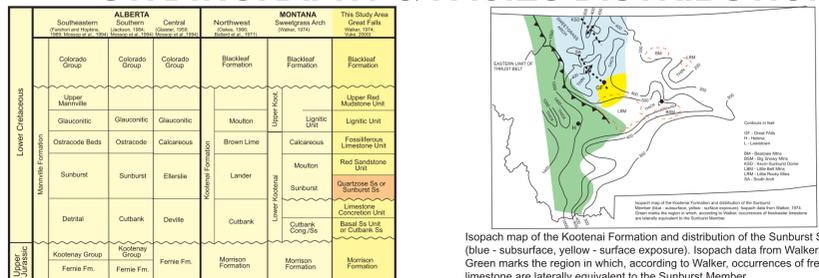
PURPOSE OF THE LONGTERM STUDY

- 1) Provide detailed facies information for the Sunburst Sandstone and correlative strata in the Great Falls area.
- 2) Establish sequence stratigraphy relationships.
- 3) Provide a link between surface and subsurface physical properties.

PURPOSE OF THE POSTER

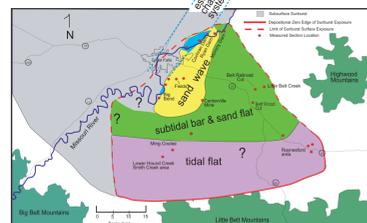
- To demonstrate that:
1. At least 4 major tide-dominated facies make up the Sunburst Sandstone and equivalent strata.
 - Sand Wave (estuary shoal-and-channel complex)
 - Estuary Tidal Channel
 - Subtidal Sand Bar and Flat
 - Tidal Flat
 - 2) The southern terminus of earliest marine transgression (Barremian) into the Cretaceous foreland was located just south of the Great Falls area. And, that the Sunburst represents southward transgressive-to-highstand systems development in a N-S-striking basin-scale "embayment".

STRATIGRAPHY & FACIES DISTRIBUTION

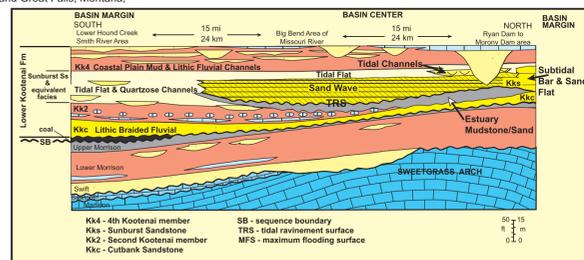


Isopach map of the Kootenai Formation and distribution of the Sunburst Sandstone (blue - subsurface, yellow - surface exposure). Isopach data from Walker, 1974. Green marks the region in which, according to Walker, occurrences of freshwater limestone are laterally equivalent to the Sunburst Member.

Correlation of nomenclature for Upper Jurassic and Lower Cretaceous rocks of west-central Montana and surrounding region. Correlation between Alberta subsurface and Great Falls, Montana, outcrops by Farshori and Hopkins (1989).

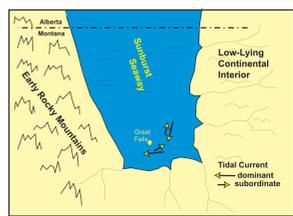


Study area and preliminary map of facies distribution.



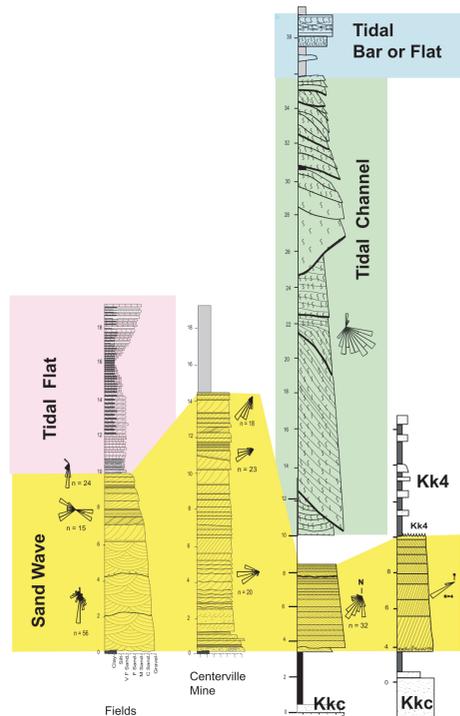
Schematic cross-section of lower Kootenai facies distribution across the Sweetgrass Arch. Modified from Walker, 1974.

EXTENT OF "SUNBURST SEA" INTO MONTANA

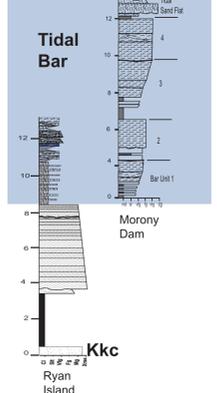


MEASURED SECTIONS OF FACIES TYPES

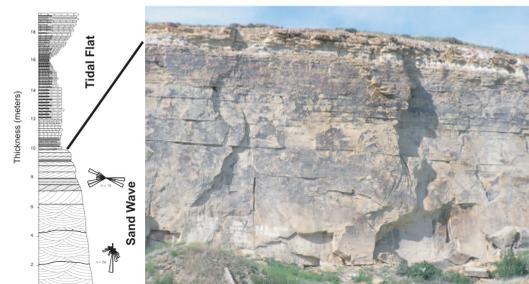
(geophysical log-profile indicators)



Sand Wave transition into Estuary Mud



SAND WAVE FACIES



Upward-fining facies sequence at Fields, MT. Here the tidal body erosionally overlies estuary mudstone.



Sand wave body in disconformable contact with Kootenai fluvial sandstone, opposite Ryan Island.



Sand wave body in erosional contact with organic-rich mudstone, Ryan Island. Trough cross-stratification in the flow-transverse view appear as stacked tabular (two-dimensional) cross-stratified sets in the longitudinal view.

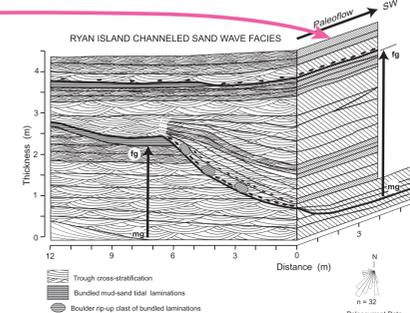


Diagram of outcrop at left illustrating the composite nature of the lithofacies and the three-dimensional aspects of individual facies units and internal structures. The front panel of the diagram represents the back-left side of the outcrop (not shown in photo); corresponding views are indicated by pink lines.



Sand wave body in erosional contact with estuarine mudstone and flaser (tidal creek?) bedding, Ryan Island.



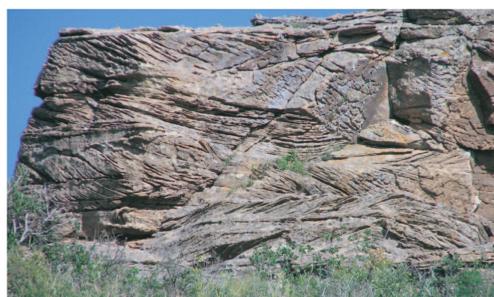
Sand wave facies in erosional contact with nonmarine mudstone and fluvial channel sandstone of the 2nd Kootenai member, Belt RR cut.



Channel-shaped base of sand wave body in erosional contact with estuary mudstone, south of Great Falls.



"Rusty Bed" appearance of Sunburst sandstone.



Stacked tabular sets of large-scale trough cross-stratification.



Longitudinal view of cross-stratification sets. Foreset units resting upon sloping surfaces reflect bedform migration along slopes mantling the extant composite sand wave.



Large-scale two-dimensional cross-stratification in the lower part of the facies, south side of Cochran Dam.



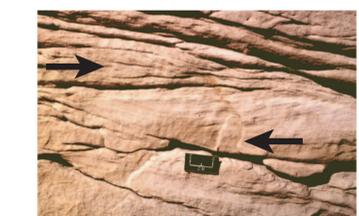
Reactivation surface.



TRANVERSE VIEW
Orthogonal views of inversely graded sand-avalanche tongues within two-dimensional cross-stratification set.



LONGITUDINAL VIEW



Bipolar paleoflow evidenced by small-scale ripple bundle and overlying smaller scale ripple bedding.

PROPERTIES OF SAND WAVE FACIES (TIDAL SHOAL BAR-AND CHANNEL)

- OVERALL**
- A relatively extensive, 5 to 14 m-thick, NE-SW elongate (?), upward-fining quartz sandstone body.
 - Pinches out to east and south toward basin margin; extends N& W into subsurface.
 - **Disconformable lower contact** above: (1) Sunburst estuary mudstone & tidal bedding, (2) non-marine Kk2 coastal plain facies, and (3) fluvial lower Kootenai sandstone.
 - Overlain by tidal flat, subtidal/estuary mud, and tidal channel facies depending upon location.
- INTERNAL PROPERTIES**
- A composite of southwestward-elongate bodies having a channel-shaped base and horizontal to slightly convex upper surface.
 - Vertical structural sequence: upward thinning, tabular to broadly wedge-shaped, cross-stratified beds ranging from about 2.5 m to 5 cm in thickness. Large- to medium-scale two-dimensional ("tabular") and three-dimensional (trough) cross-stratification typical.
 - Multiple internal erosion surfaces.
 - Lithic content typically high along the erosional (ravinement) base of the unit with concentrations of mudstone rip-up clasts.
 - Plesiosaur bone fragments and ammonites extremely rare.
 - Trace fossils include *Ophiomorpha* and *Diplocraterion*.
- Other sedimentary structures:**
- Lateral ripple-bundle sequences with rare and poorly developed reactivation surfaces.
 - Rare small-scale reversed ripple foresets with larger ripple bundles.
 - Mud drapes very rare.
 - Avalanche sand-tongue structures within tabular-planar foreset beds.
 - Bundled mud-sand tidal laminations rare in between channel bodies.
 - Cross-stratification unimodal to multimodal with bipolar components in the SW-NE and NW-SE directions.
 - Stacked sets of medium- and small-scale cross-stratification with intervening erosional surfaces reflecting composite dune development as in modern tidal systems.