

ARCHITECTURE OF A TIDE-DOMINATED SHOREFACE SYSTEM IN THE LOWER CRETACEOUS KOOTENAI FORMATION, WEST-CENTRAL MONTANA

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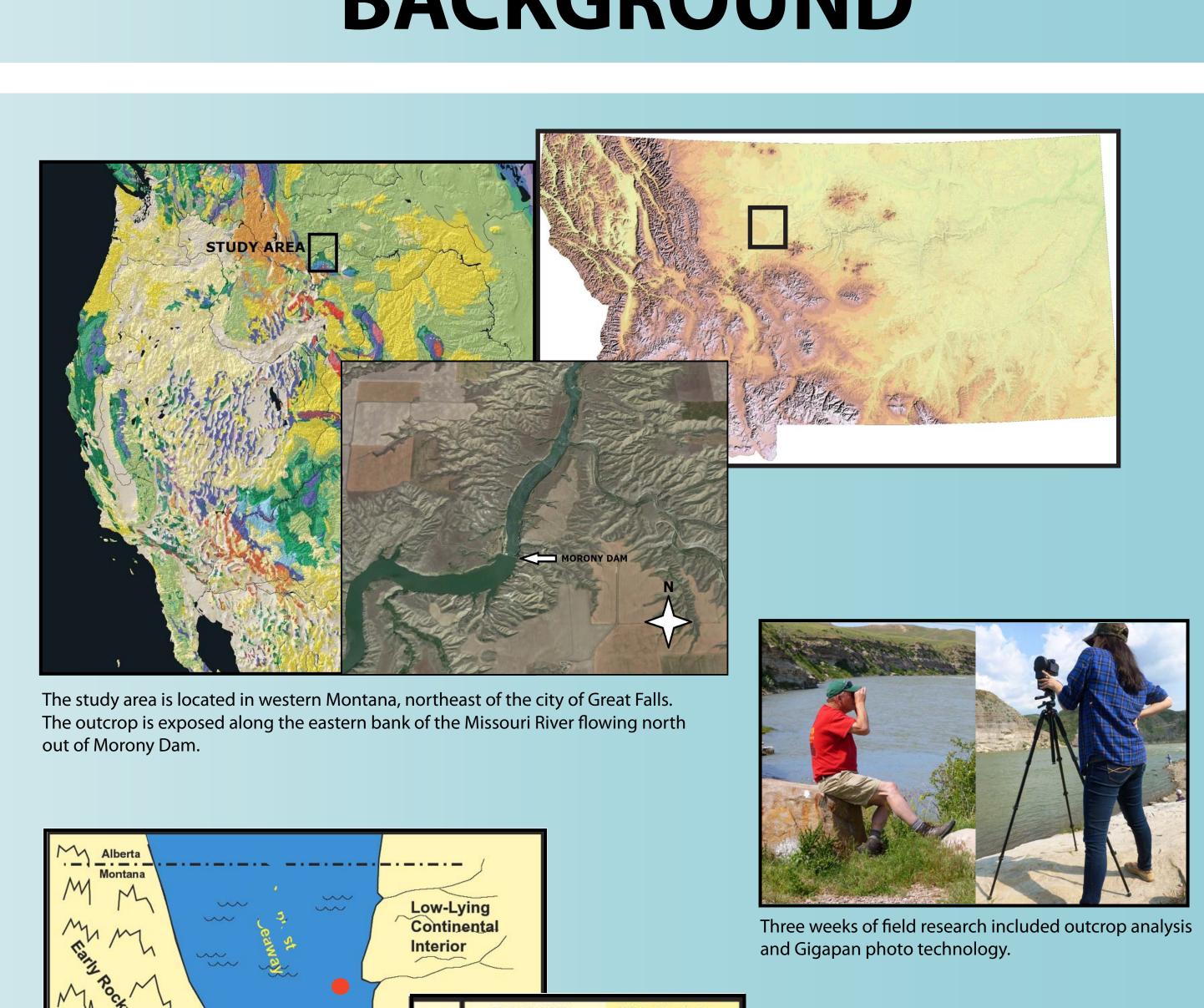
ABSTRACT

Integrated long-distance, high-resolution photography and detailed outcrop analysis were used to document the architecture of a tide-dominated, low wave-energy, shoreface lithosome along the Missouri River Gorge near Great Falls, Montana.

The lithosome (~18 m thick) consists of five vertically stacked, widespread, tabular units and scattered channel bodies. Internally, the tabular units (~2-4 m thick) coarsen upwards and the architecture of a representative unit includes a thin basal mudstone or heterolithic interval changing upward to a thicker bedded, amalgamated, fine- to rarely medium-grained sandstone. However, the full vertical succession of five units are stacked in a net upward-coarsening succession in which the basal unit is mudstone dominated and successive units contain less mud. Sand fractions are quartzose, very well rounded, and very well sorted. Rhythmic bedding is characteristic and ranges from horizontal to convex on the tidal bar scale (dm wavelength). Scattered medium-scale trough cross-stratification and thin channel-shaped lenses (~1-15 m wide) indicate episodic current activity. Widespread erosional surfaces separate the units, as well as occur internally, causing localized discordances between units or the amalgamation of sandstone-dominated units. The channel bodies are relatively large (50-100's m wide, 5-10 m thick), contain heterolithic fill similar in composition to the tabular units, and transect one or more of the tabular units, documenting the coexistence of cross-shore channels.

Diagnostic structures of tidal origin include mud couplets, neap-spring lamination sets, flaserto-lenticular bedding, amalgamated ripple beds separated by reactivation surfaces, rhythmically alternating ripple beds and parallel-laminations, mm-scale clay drapes, and lateral sets of small-scale ripple bundles. Small-scale wave-ripples (~ 4 cm spacing) are present on some surfaces and hummocky cross-stratification is exceptionally rare. Trace fossils include Arenicolites, Ophiomorpha (very rare), Macaronichnus, Planolites, Piscichnus, horseshoe crab-like resting traces, and bivalve crawling traces indicating marine to slightly brackish conditions. Bioturbation index typically ranges between 3 and 6. A Glossifungites ichnofacies caps the succession.

BACKGROUND



Cutbank Cong./Ss

Morrison Formation

Correlative stratigraphic column showing location

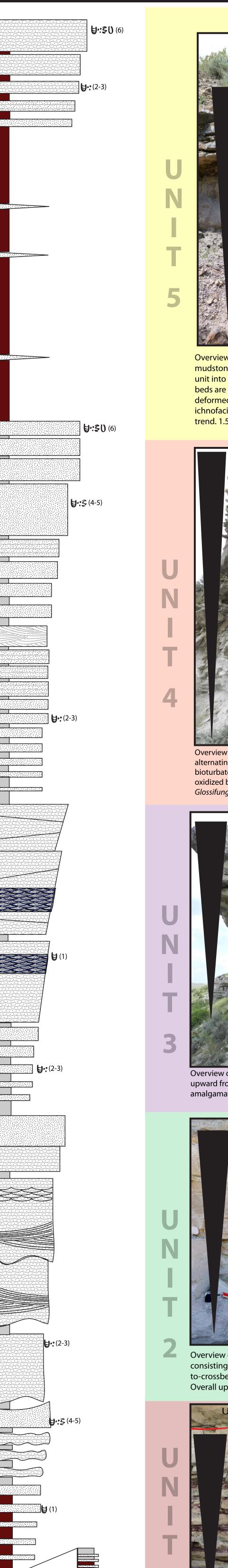
tidal-shoreface outcrop along Missouri River.

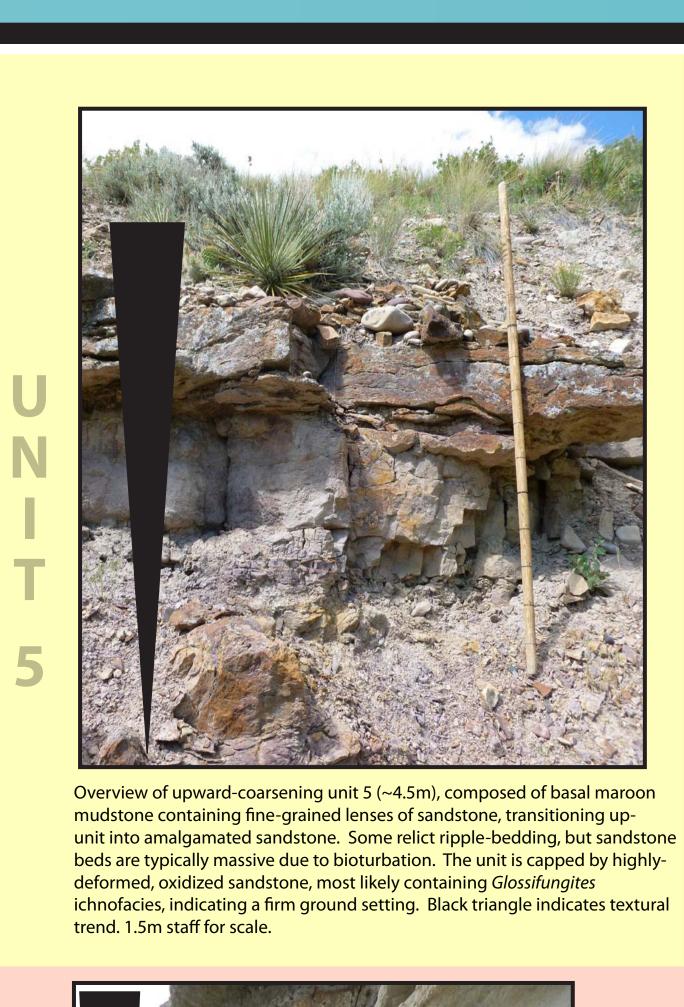
Basal Ss Unit or Cutbank Ss

SOME BIOTURBATION

Stratigraphic column detailing grain size, thickness (m), and

sedimentary structures of five units studied at Morony Dam.





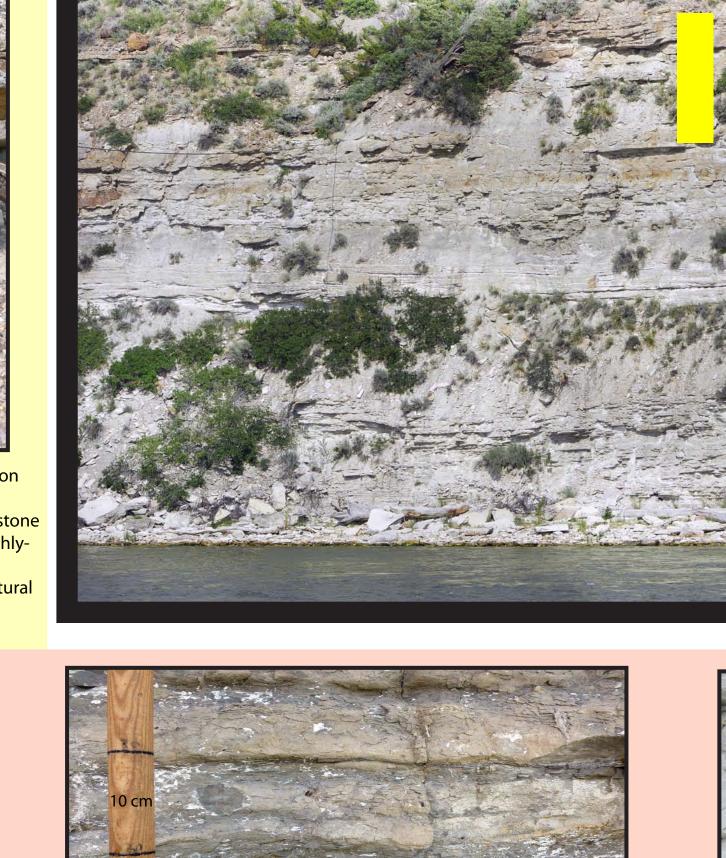
upward into sand-dominant, wavy bedding. Mudstone grades from maroon in color, due to

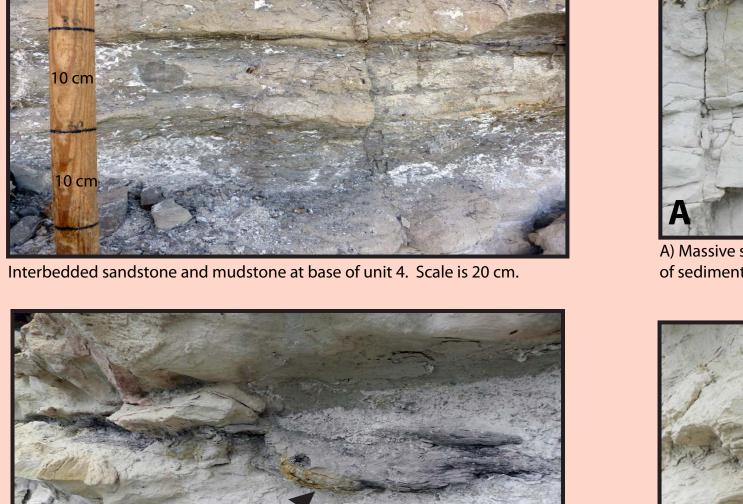
reworking of underlying Kk2, to gray in upper part of the unit. An erosional scour surface

separates unit 1 from overlying unit 2. 1.5m staff for scale.







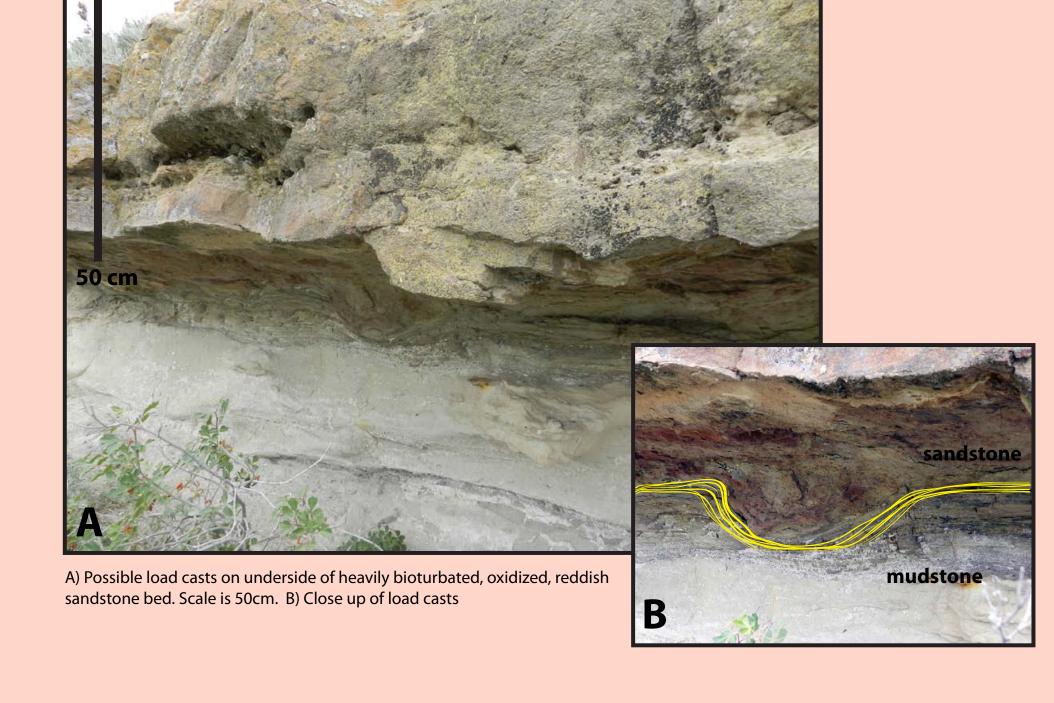


during periods of higher energy. Scale is 5cm.

Close up of maroon tidal bundles. Mudstone layers deposited during periods of

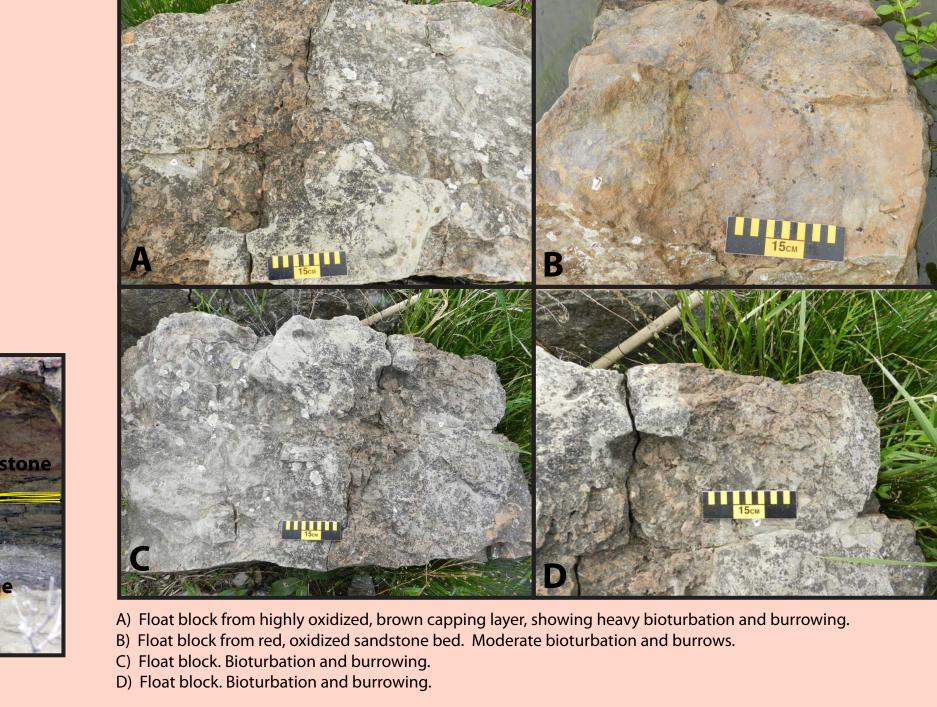
reduced tidal current energy, while fine-grained sandstone beds deposited



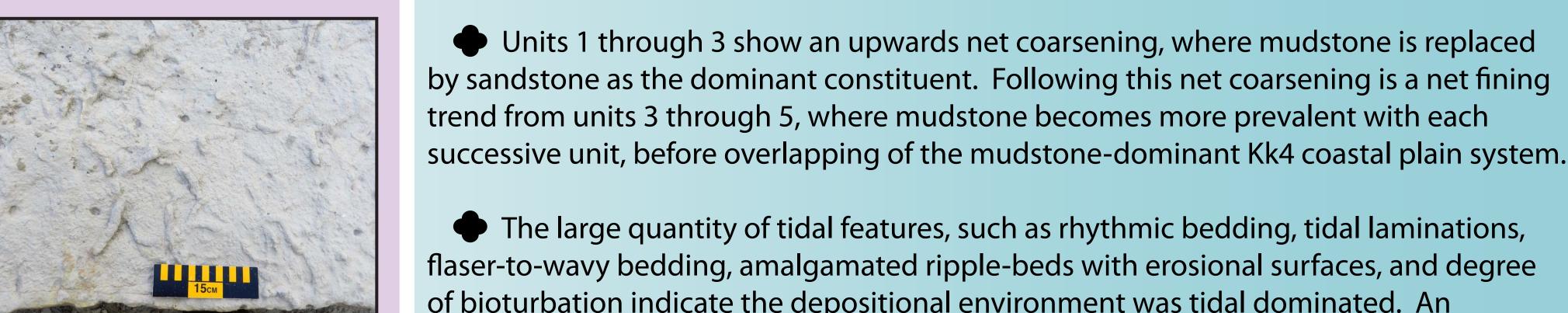


A) Flaser bedding. Small-scale troughs are mantled by mm-scale mud-d Scale is 15cm. B) Close up of flaser bedding.

Gigapan image of tidal shoreface succession in the Sunburst Member near Morony Dam.







bedded sandstone beds.

Morony Dam (unit 5).

mudstone within the capping Sunburst unit at

The large quantity of tidal features, such as rhythmic bedding, tidal laminations, flaser-to-wavy bedding, amalgamated ripple-beds with erosional surfaces, and degree of bioturbation indicate the depositional environment was tidal dominated. An absence of features associated with wave-dominated shorefaces, such as wave-ripple cross-lamination, hummocky cross-stratificationand surf-zone related trough cross-stratification further supports this hypothesis.

CONCLUSIONS

The five upward coarsening units represent shoreface tidal parasequences.

The typical vertical succession of a shoreface parasequence consists of a mudstone

dominant base, coarsening upwards into thicker, sometimes amalgamated ripple-

The maroon mudstone within unit 1 is due to ravinement and reworking of the

(red mudstone coastal plain facies) could have contributed to the abundance of maroon

underlying maroon estuarine mudstone facies of Kk2 (Kootenai Formation). Similarly,

reworking of the adjacent coastal plain mud, such as occurs in the overlying Kk4 unit

The limited diversity of the abundant trace fossils found within the units indicates a shallow water, brackish-marine setting.

ACKNOWLEDGEMENTS

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REFERENCES

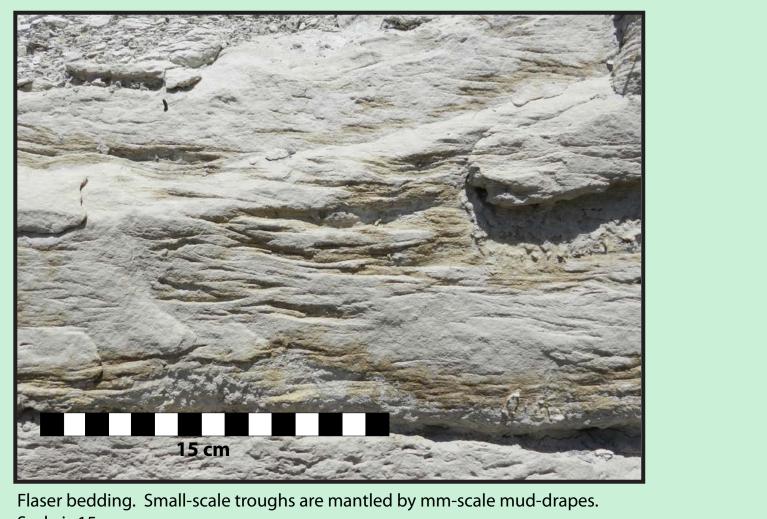
Schwartz, R. K., Vuke, S. M., 2007, Tide-Dominated Facies Complex at Southern Terminus of Sunburst Sea, Cretaceous Kootenai Formation, Great Falls, Montana: http://www.searchanddiscovery.com/documents/2007/07036schwartz (accessed July 2014).

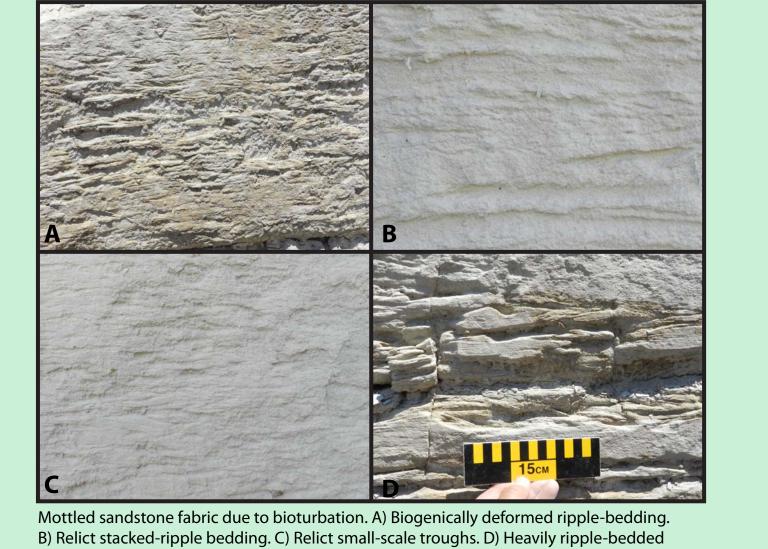




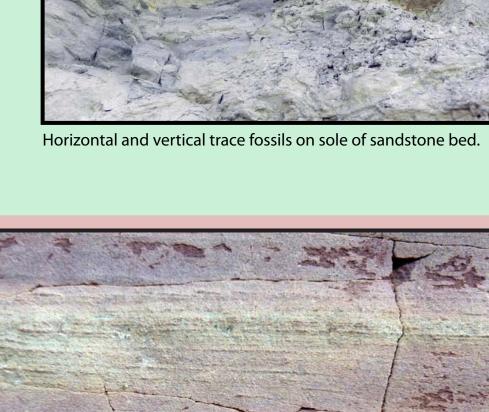
Close up of rhythmic mud-sand couplets, indicative of

alternating suspension fallout-tractive flow conditions.









Close up of sandstone beds displaying small-scale foresets, demonstrating kinematics

of tidal current event (see arrow) Upper flow regime parallel laminations are followed

by lower flow regime ripple bedding and muddy sand suspension fall out. Scale is 3cm.





Beds transition from tabular to increasingly wavy-bedding up-unit. Scale is 15cm.

