Tide-influenced Deltas

Introduction

- Rivers drain toward large bodies of water such as the ocean. Sediment carried by the river will accumulate at the mouth of the river to form a delta. Tidal currents from the ocean create a redistribution of sediment as well as a change in geometry.
- Fresh water from snow packs and other inland drainage flows towards the mouth of the delta while sea water is mixed from the ocean tide.
- Tide-influenced deltas are one of three examples of types of deltas that commonly exist around the world. Other two include river-dominated and wave-dominated
- There is an oscillation between flow direction within the environment due to the influence of both tidal currents and river flow.
- [Figure 1] (Left) Satellite Imagery from of Google Earth of Ganges Delta located within the Indian states Bangladesh and West Bengal.

- [Figure 2] (Right) Sketch of Ganges Delta with estimated facies. Facies include; older surface facies, delta plain facies, tidal plain facies, and tidal sand bar facies.

**Sediment Transport Process**

- Sediment is transported by the flow of water in rivers towards the sea, as sediment approaches the delta, there is a large influence by tidal currents. The delta is not to be confused with tide-dominated, there is an exchange of flow direction between the river and tidal currents within these locations when the tide retreats. This is also not to be confused with wave dominated deltas whereas oscillation is more frequent.
- The ocean's tide oscillates at a given location (our tide-influenced delta) which directly affects the flow direction within the delta. When a tide moves towards the coast, the flow direction is dominated to flow towards inland. As the tide retreats back into the ocean, the flow direction changes ~180 degrees to flow away from the river, allowing the river output to dominate the flow direction for the moment. This oscillation pattern is continuous over time in tide-influenced deltas, creating unique sedimentary structures, such as herringbone cross stratification and reactivation surfaces.
The flow speed within this environment depends on the size of the river, size of the delta, and intensity of tidal influence. Sediment is carried from rivers towards the delta; the amount of sediment and grain size range depends on the flow speed of the river. The grain size range of sediment found in tide-influenced deltas include silt to medium-sand size grains.

Sedimentary structures in these environments include parallel laminations to the flow direction, herringbone cross stratification, reactivation surfaces, mud drapes and also include signs of bioturbation within delta plains where the activity of water is minimal. Many of these structures represent the ongoing direction of flow and change in speed of overall flow.

Characteristics of Deposited Sediment

- The grain size ranges between mud size grains up to medium-sand sized grains. It is uncommon to find sediment grains larger than sand-size grains but is still possible when large natural influences interfere the steady flow of a tide-influenced delta. This could include a high tide, large river flow from inland flooding, or storm.
- Within the sedimentary structures found in these environments, there is a range of grain sizes that associate with specific settings. Mud drapes as an example is mostly consistent of mud-sized grains. Herringbone cross stratification can host grains larger than sand size grains, depending on the flow speed that influenced the shape of stratification. Weak flows will provide smaller grains like mud-size grains while faster flows may carry sand, gravel, and even pebble sized grains.
- In fine sediments like mud, there is often times bioturbation within areas like the delta plains. Bioturbation can include burrowing of small animals or traces of roots scattered within the area. Much of the conserved bioturbation is located on land within the delta plains where activity does not disturb the development of these traces.
- In reference to Walther's Law, our lateral depositional environment is also represented within a vertical sequence of the tide-influenced delta. Under the surface, there is a vertical progression of the depositional layers stacked. These facies include the delta plain facies, tidal flat facies, and tidal sand bar facies.

Typical Vertical Sequence of Facies Representing Tide-Influenced Delta
It is complicated to capture all of the different types of vertical stratigraphy columns due to the high variability of conditions that can alter the depositional settings of the environment.

The vertical sequence provided is an example of the Ganges-Brahmaputra tide-influenced delta mentioned from above.

Within the stratigraphy column, there is noted sequence between mud-size grains and sand-size grains, there is no signs of larger grain sizes present within the environment. The amount of sediment and sediment size range depends mostly on the rivers output from seasons of normal flows, deficient flows, and flooded flows.

Within the finer sediments such as the laminated mud and mottled mud there are signs of bioturbation such as burrowing, roots, and shells.

[Figure 5] Example Stratigraphy Column of Ganges Delta by Steven Goodbred and Yoshiki Saito

Summary

- Tide-influenced deltas are one three different types of common deltas that exist around the world.
- Sediment transportation relies heavily on the strength and size of river, tide level influences the direction of sediment flow.
- Grain sizes range between mud-sized grains up to medium-sized grains, larger grain sizes are uncommon.
- Herringbone cross stratification, reactivation surfaces, mud drapes, and bioturbation are examples of sedimentary structures found within the depositional environments.

Key Words

- Tide  
- Herringbone Cross Stratification  
- Reactivation Surfaces  
- Mud Drapes  
- Bioturbation  
- Walther's Law

References

- [Figure 1] Map showing location of Ganges Delta located within the Indian states Bangladesh and West Bengal.
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Sketches (Figures 2 and 3) were drawn by me.