Mangrove Channels: Morphoplogy, Magnitude and Migration

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Summary

Little research has been undertaken into mangrove channels, although these can be considered as potentially excellent reservoir facies, typically encased in source rock facies. Channel morphology and magnitudes are impacted by climatic and tidal factors, although it is considered that antecedent drainage patterns have the greatest influence. These factors also affect the quantity and character of vegetation and wildlife, which may also significantly affect channel evolution.

Introduction

The development of mangrove drainage systems has received little attention in the published literature. This is despite their potential as both reservoirs, and as conduits for hydrocarbons migrating into shallow marine reservoirs from ancient mangal muds. In addition mangrove channels provide a livelihood for many inhabitants of areas such as South East Asia and other equatorial regions, and access to rainforest hinterlands.

Ongoing research on both modern and ancient mangrove channel depositional systems has led to a series of original observations on such systems, and has facilitated the development of a classification system of such channels, including insights into width:thickness ratios. The importance of antecedent drainage patterns, developed on primary mudflats in coastal areas (often at a micro scale), has been identified as providing a palimpsest which governs the overall drainage patterns in mangrove areas. This typically takes place prior to colonisation by mangrove plants.

However the morphology of the small, secondary channels is strongly influenced by the later rootedness of the soil through which the channels are incised. This in turn is affected by climate, meaning that different climatic regimes lead to mangrove channels with different characteristics.

Climate also has a strong control on runoff, and hence on overall channel dimensions. The degree of tidal influence also plays a part in determining channel morpnhology, and the interplay between these factors will also be examined.

These controls also influence channel migration, but a much more significant factor is the impact of animals (and man) on such systems. For example African mangrove channels typically migrate due to hippopotami, crocodiles and speedboats. Models will be presented quantifying the impact of the various factors introduced above on the overall development of mangrove channels systems.

Methodology

The data drawn together to develop the ideas presented here are manifold, and can be subdivided into several categories:

- Ancient data collected from ancient mangrove localities identified in Malaysian Borneo, Spain and other outcrops

- Modern data gleaned from Google Earth and aerial photos, supplemented by photographs taken by the author while on commercial flights in Borneo, Oman
- Modern data collected primarily by observations made by kayak and on foot, focusing on the detail scale, and featuring locations primarily in Florida, Borneo, Vietnam

In addition to geological fieldwork, considerable time has gone into observations on the impact of man and other wildlife on such mangrove channel systems. It is hereby postulated that the main driver of channel migration and avulsion in mangrove settings is wildlife activity. This may be supplemented, or indeed completely replaced (as is eastern Borneo, where much of the local wildlife has been hunted) by the activities of man.

Discussion

As demonstrated in an earlier CSPG presentation (Noad 2009), mangrove systems can be subdivided into two main categories: humid, clastic-dominated mangrove systems; and arid, carbonate-dominated mangrove systems. The climatic control is clear, but also impacts other factors that affect mangrove channel morphology:

- Freshwater runoff will obviously affect the size of individual channels in a mangrove channel system. The lack of runoff will lead to smaller channels.
- Vegetation can provide a strong control on channel morphology, as thick rooting will lead to channels with steep banks, and an inability to migrate. Hence in more humid, fertile, settings the vegetation will have a greater control on channel dimensions.
- As mentioned above, the wildlife (and human activity) in and around the mangroves can lead to dramatic channel avulsion. The types of wildlife extant in such settings are closely related to climatic factors. In addition the more fertile the setting, the more likely it is that humans will have colonized and be busy exploiting any particular region.

Another factor that will influence channel density, size and shape is the degree of tidal influence, and whether it is greater than seaward channel flow.

Conclusions

The initial, overall drainage pattern in mangrove settings is believed to relate to antecedent drainage patterns developed on coastal mudflats, prior to colonization by plants. However the morphology of the individual channels is subsequently influenced by climate in terms of: sediment type (clastic versus carbonate); runoff (high versus low seaward flow rates); vegetation (and how much the roots constrain channel migration); wildlife and human activity (and their impact upon channel avulsion); and also by tidal factors.

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References

Noad, J., 2009, The Sedimentology of Ancient Mangroves: Swamped with Hydrocarbon Potential. CSPG Technical Luncheon presentation: abstract, June 2009.