[PS]Accommodation Fluvial Reservoir Analog for the High-Accommodation Mungaroo Formation: Role of Propagating "Tie" Channels in Lake-Filling Processes in High-Accommodation Fluvial Systems, Grajalva River, Tabasco State, Mexico*

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Abstract

High-accommodation fluvial systems are subject to much modeling and substantial rock drilling and imagining, but limited modern field observation. The Grijalva River system of Tabasco State, Mexico, offers the opportunity to study these systems. Here, subsidence rates of up to 9mm/year result in high-accommodation conditions for the river as it approaches the Gulf Coast in southern Mexico. Lakes and small propagating channels, similar to what are commonly called "tie" channels, dominate the flood basin between major channel belts. Understanding of the co-evolution of lakes and tie channels is key to understanding the overall high-accommodation system.

Tie channels connect the floodplain lakes to the main river channel and allow for the exchange of water and sediment into and out of the lakes. Tie channels also are instrumental in the filling/death of the lake. Tie channels propagate across lakes as deltas. The process of tie-channel propagation is still poorly understood. Nonetheless, once the tie channel reaches the other side of the lake, the lake is now bisected by the narrow alluvial ridge emplaced by tie-channel propagation, and the lake is separated in two with respect to water and sediment, except during the rainy season. Asymmetry in sediment input now leads to fill of compartments within the lake formed by tie-channel bisection, rather than overall aggradation of the lake as a whole.

This is best exemplified by the Pantanos de Centla. Here a tie channel propagated across this floodbasin lake in an orientation parallel to the main Grijalva River approximately 20 years ago. After the lake was compartmentalized by the tie channel, splay sediments from the adjacent Grijalva could only reach the new northern compartment. This northern compartment is now filled and has evolved to a vegetated glade, while the southern compartment remains as a lake. Filling of the northern compartment now permits bypass of sediment from the Grijalva into the southern compartment which has begun filling with splay delta sediment. Close examination of high-accommodation flood basin systems in the Grijalva reveal that deposition in flood basins is characterized by local rapid aggradation of sites and compartments rather than a uniform aggradation across the floodbasin. The co-evolution of tie channels and flood basin lakes are key elements of this aggradational process.

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High-Accommodation Fluvial Reservoir Analog for the High-Accommodation Mungaroo Formation

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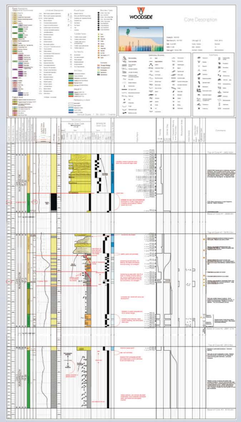
Introduction

This research asserts that high-accommodation systems, like the Mungaroo, that are characterized by floodplain lakes may have a built-in mechanism which fosters connectivity between channel belts through the backswamp deposits and thus offers previously unrecognized production potential for high-accommodation strata. This mechanism is the tendency of splay deltas sourcing from one channel to propagate linearly until they encounter another channel. Splay deltas are traditionally modeled with lobate geometry within ancient rocks (Fielding, 1984; Guion, 1984; Glover and O'Beirne, 1994) based on analogy with marine delta lobes (e.g., Saucier, 1994) and some well studied lobate deltas within freshwater lakes (e.g., Smith et al., 1989). More commonly, splays advancing into standing water within floodplain lakes form linear channels that propagate across the lake, forming a linear ribbon of splay delta deposits dissected by a central channel (Stoner and Holbrook, 2008). These "propagating channels" or "tie channels" appear to continue to propagate until they intersect another channel whereby they can rejoin the active river flow (Figure 2). This tendency for splay deltas to manifest as ribbon-form propagating channels rather than lobes has been suggested by a few authors working in the rock record (Jorgensen and Fielding, 1996; Avenell and Lang, 1998).

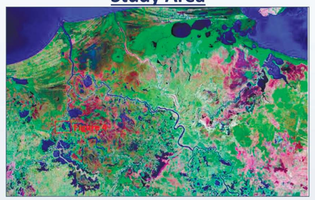
This tendency of splay deltas to form ribbons rather than lobes has important implications for production. First, splay deltas commonly encountered within cores of lake-prone high-accommodation sections should probably be modeled as ribbon rather than lobe geometry. Second, if these propagating channel systems generate sufficient sand, the resulting ribbons would tend to link more reservoir-quality channel belts. Rather than channel belts forming discrete reservoirs, they could be likened unto veins joined by capillary propagating channels. This linkage between reservoirs would mean that production from one quality reservoir could potentially drain adjacent reservoirs through these capillary links, and result in recoverable gas volumes sufficient to warrant completion in high-accommodation intervals previously dismissed.

At present, these channel/splay ribbons are not well studied in the modern and this question cannot be easily answered. This project will examine how lakes in high accommodation systems fill and how modern propagating channel ribbon form to see if the lithologic and geometric characteristics of these are sufficient to connect larger belts. In addition, this study will examine and constrain the geometry and volume of the channel belts they connect. The fundamental question remains as to which factors cause splay deltas to default to ribbon instead of lobate forms (e.g., hyperpycnal flow, fluctuation of water levels, vegetation, etc.). We offer a "gun barrel" hypothesis as a first round explanation of this phenomenon (Hull and Holbrook, 2012).



A typical core description form the Triassic High-accommodation Mungaroo Formation off the Northwest shelf of Australia.

Study Area



Overview of the Grijalva wave-dominated delta and the high-accommodation fluvial system abruptly up depositional dip. Lake fill study area is outlined in the red

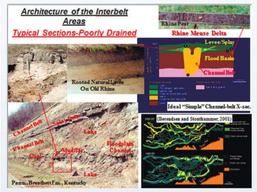
Lake fill study area. The sediment filled western compartment and the current lake (eastern) compartment are visible. The old tie-channel dissecting the lake is identified as is a young tie-channel still propagating across the lake. The Grijalva River is located west of the lake and one of the splays coming from the river is labeled.

Methods

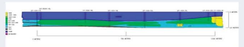
Propagating channel ribbons and channel belts of the Grijalva are examined using the Dutch hand-coring system and hand-operated suction cores. Splay ribbons and channel belts identified from aerial photography are examined through cross sections and longitudinal sections of closely spaced cores. These cores are used to compare modern environments with resultant core facies to develop a bank of core analogs for deposits of various backswamp environments that can be used to better interpret Triassic Mungaroo borehole and seismic data. The collection of cores will be used to assess geometry of sand bodies, lateral interrelation of sandy and muddy facies, and estimates of total net to gross of the broader delta environment.

Architecture of the Interbelt Areas
Poorly Drained Flood Basins

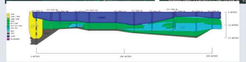
Architecture of the Interbelt Areas
Typical Sections-Poorly Drained



Results

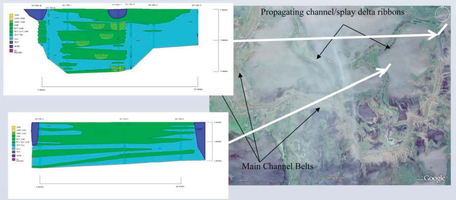


Lake cross-section N-S.



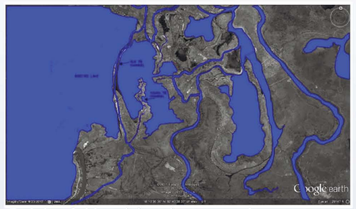
Lake cross-section E-W, transecting an old tie channel, splays of the adjacent Grijalva, and the delta front of the tie channel.

Tie Channels

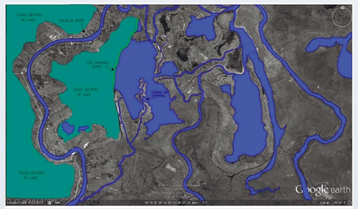


Co--evolution of Lake and Channel Systems

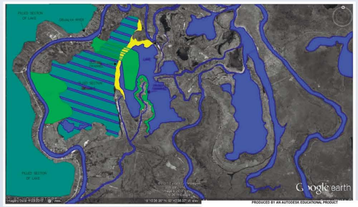
Evolution of a lake and channel system stage 1.



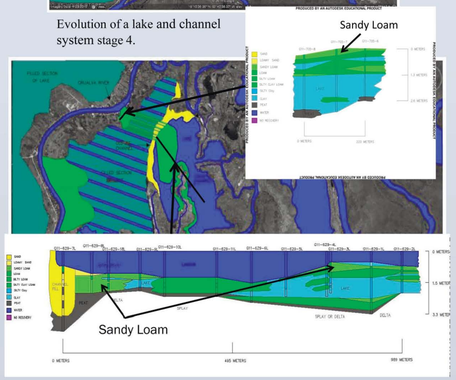
Evolution of a lake and channel system stage 2.



Evolution of a lake and channel system stage 3.



Evolution of a lake and channel system stage 4.



Conclusions

Tie-channels also are instrumental in the filling/death of floodplain lakes. Tie-channels propagate across lakes as deltas. Once the tie-channel reaches the other side of the lake, the lake is now bisected by the narrow alluvial ridge emplaced by tie-channel propagation, and the lake is separated in two compartments with respect to water and sediment, except during the rainy season when tie-channel levees may be topped. Asymmetry in sediment input now leads to filling of compartments within the lake formed by tie-channel bisection, rather than overall aggradation of the lake as a whole.

This is best exemplified in the Pantanos de Centla. Here a tie-channel propagated across this flood basin lake in an orientation parallel to the main Grijalva River (south to north). After the lake was compartmentalized by the tie-channel, splay sediments from the adjacent Grijalva could only reach the new western compartment. This western compartment has filled over the past 20 years and has evolved into a vegetated glade, while the eastern compartment remains as a lake. Filling of the western compartment now permits bypass of sediment from the Grijalva into the eastern compartment which has begun filling with splay delta sediment from the Grijalva. Close examination of high-accommodation flood basin systems in the Grijalva reveal that deposition in flood basins is characterized by local rapid aggradation of sites and compartments rather than a uniform aggradation across the flood basin. The co-evolution of tie-channels and flood basin lakes are a key element of this aggradational process.

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