Mud-dominant point bars are common features showing deposition by either tidal influence, bar tails, or counter point bars. Less understood are mud-dominant point bars that lack these depositional characteristics. These “muddy-normal” point bars are common in hydrocarbon reservoirs. Better understanding a muddy-normal point bar’s impact on reservoir quality and how they form will assist in establishing predictive relationships that will aid in production and exploration. Upper Cretaceous fluvial strata of the Dinosaur Park Formation in the Steveville badlands of Dinosaur Provincial Park, Alberta, are targeted to address this issue. The goal of this study was to determine processes by which normal-muddy point bars form from LIDAR renderings to develop a 3D model of the bar volume. Strikes and dips, paleocurrents, and stratigraphic columns were collected to determine accretion trajectories and lithologic trends. Surfaces were also mapped according to the rules of architectural-element analysis in 3D form. This point bar had altering layers of sand and mud, mud comprising over 50%. Mud layers within this point bar have current ripples, suggesting that the mud layers were deposited by active accretion events. This point bar also consists of accretion packages with differing orientations. The sand and mud packages are present throughout the point bar and do not appear to reflect location within the bar. These data suggest that the muddy deposits of the muddy-normal point bar reflect changes in trajectory of the bar and sudden and temporary adoption of accretion orientations not conducive to sand deposition, and do not record either late stages of growth in the overall bar formation process, deviations from fully fluvial drivers, or counter point bar patterns.
Abstract

Mud-dominant point bars are common features showing deposition by either tidal influence, bar tails, or counter point bars. Less understood are mud-dominant point bars that lack these depositional characteristics. These “muddy-normal” point bars are common in hydrocarbon reservoirs. Better understanding a muddy-normal point bar’s impact on reservoir quality and how they form will assist in establishing predictive relationships that will aid in production and exploration. Upper Cretaceous fluvial strata of the Dinosaur Park Formation in the Steevie badlands of Dinosaur Provincial Park, Alberta, are targeted to address this issue. The goal of this study was to determine processes by which normal-muddy point bars form from LIDAR renderings to develop a 3D model of the bar volume. Strikes and dips, paleocurrents, and stratigraphic columns were collected to determine accretion trajectories and lithologic trends. Surfaces were also mapped according to the rules of architectural-element analysis in 3D form. This point bar had altering layers of sand and mud, mud comprising over 50%. Mud layers within this point bar have current ripples, suggesting that the mud layers were deposited by active accretion events. This point bar also consists of accretion packages with differing orientations. The sand and mud packages are present throughout the point bar and do not appear to reflect location within the bar. These data suggest that the muddy deposits of the muddy-normal point bar reflect changes in trajectory of the bar and sudden and temporary adoption of accretion orientations not conducive to sand deposition, and do not record either late stages of growth in the overall bar formation process, deviations from fully fluvial drivers, or counter point bar patterns.

Introduction

This study examined the internal architecture of a heterolithic point bar deposit within the Cretaceous Belly River Group of Dinosaur Provincial Park, Canada, more specifically the Steevie Area, that lacked evidence of tidal or counter-point-bar features. (Modified from Smith’s reconstructed paleo-meander belt)

The heterolithic point bar in this study differs from typical heterolithic point bars because it was neither formed, nor influenced by counter or tidal processes, yet it shares similar features to a typical heterolithic point bar. This study’s point bar has thicker mud deposits, like that of a counter point bar, and alternating beds of sand and mud, as in IHS, but it is neither. (Modified from Smith et al. (2009))

Here we see images from across this study’s point bar. As seen from these images, the point bar looks like a “normal” point bar, except for the fact that it is about 50% mud instead of predominantly sand. We know this “muddy-normal” bar was neither the result of tidal influences nor counter point bar processes, it is something entirely new. We do not see such things as mud clast breccias at the base, thick clay layers in the uppermost portion, or completely diminishing and filling of sand interbeds. The goal of this study was to determine the process though which mud-dominant point bars form.
Controlling Factors and Mechanisms in the Formation of a Muddy-Normal Point Bar: A 3D Architectural Element Analysis of a Heterolithic Point Bar in Dinosaur Provincial Park, Alberta, Canada

Methods

Results

Interpretations of the photographs taken from the field revealed four main facies types - mud (blue), sand (yellow), floodplain (gray), and channel fill (red). This detailed stratigraphic column shows the complete point bar - from floodplain deposit to floodplain - illustrating the progression of facies types and their transitions. The Faro Focus3Dx 130 (Faro) was used to collect spatial data points for a 3D model. This model was taken at the location of Section 1. The Faro provided photo-realistic 3D topographic data based on spatial data points. A total of 28 scans were collected at a ratio of 1:2 and a quality of 4x. Data points collected through this process were given to Echo3D to generate a 3D model.

We applied the process and principles laid out by Miall (1985, 1986, 1996) and Holbrook (2010) to an architectural analysis of the photographs. The facies types identified in the field were mudstone, sandstone, and channel fill. This detailed stratigraphic column shows the complete point bar - from floodplain deposit to floodplain - illustrating the progression of facies types and their transitions. The Faro Focus3Dx 130 (Faro) was used to collect spatial data points for a 3D model. This model was taken at the location of Section 1. The Faro provided photo-realistic 3D topographic data based on spatial data points. A total of 28 scans were collected at a ratio of 1:2 and a quality of 4x. Data points collected through this process were given to Echo3D to generate a 3D model.
Using the interpreted photographs and stratigraphic columns, we identified the percentage of mud and sand. For these tables, each section was divided into units and then each unit was further divided into mud and sand layers, as designated by the appropriate interpreted photographs. We also distinguished what layers were 50% mud and 50% sand (50/50) as seen in red. These tables allowed us to quantitatively see how much mud is actually contained within this study’s point bar. Out of 152 layers, 60 are mud, 42 are sand, 46 are 50/50, and 4 were uncounted due to lithification. These tables further support this that this is a muddy point bar. Also noted in these tables is the type of lapping relation of each unit – as divided by major accretion surfaces. We were looking to see if there was any pattern between lapping surface type and the type of sediment deposited. As can be seen from these tables, there was no notable correlation between the two.

Here we graphed mud percentages against units for each section - mud percentage on the y-axis and unit number is on the x-axis. We used these graphs to see if there was a trend associated with the formation of muddy-normal point bars. From these graphs we determined that there was no trend.

We plotted strikes and dips of major accretion surfaces using Rick Allmendinger’s Stereonet 9. We then transferred the stereograms manually to Illustrator to distinguish surfaces between mud (blue), sand (yellow), and 50/50 (red). We were looking to see if there was a correlation between orientation and what was deposited. Through this process we found a fairly strong correlation with orientation and sand deposits and a slight correlation with orientation and mud deposits. In this stereonet we have not corrected for position in the point bar, but are currently working on a new stereonet that will account for position. We believe, that once position is accounted for, both mud and sand deposits will show a correlation with orientation.