Abstract

Due to the logistical challenges and the dynamic nature of fluvial systems, studying modern point bar deposits over formative time periods is difficult. Seasonal and annual changes in precipitation can greatly influence the rate at which deposition is recorded. The lack of accurate sediment packages during studies is different to compare sedimentation rates to actual chronostratigraphic events such as floods. This study combines photogrammetry, mapped surface migration, a survey of sediment elevation change, and aerial, and water discharge rates to develop a more complete understanding of how point bars form. The study area is along the Powder River between Moorhead, Montana, USA, and Broadus, Montana, USA. The Powder River is a northward flowing, meandering river that is sourced from the Bighorn Mountains in northeast Wyoming, USA and is a tributary to the Yellowstone River. Point bar PR141A, the focus of this study, is the result of the neap tide stream off of point bar PR141 during a 50 year flood in 1978. The sediment elevation survey is conducted annually, with a few exceptions, at centimeter scale to determine sediment elevation change and the building and erosions of the point bar. The survey is applied to the architectural analysis of the sediment packages within the point bar to compare time with sediment deposition. This study reconstructs the growth of point bar PR141A, its discrete accretionary architecture at the scale of years, and determine the interrelationship between annual flooding events and bar accretion. The sediment survey timeline shows that on average the river builds one accretionary body per yearly flood cycle. On occasion, the river builds multiple bodies during the same flooding event. The graphs below depict what type of bedforms will form under different flow volumes and velocities. The trenches were interpreted and individual sediment packages delineated and compared to the USGS survey and stream gauge data. The trenches will be interpreted and individual sediment packages delineated and compared to the USGS survey and stream gauge data. The trenches will be interpreted and individual sediment packages delineated and compared to the USGS survey and stream gauge data. Methods

• A trench was dug along the axis of point bar PR141A (Fig 3a). The trench dimensions are 80m long, 1m deep, and a 1/2m wide. The limiting factor in depth was the water table. The location of the trench was 1m downstream of the Moosely and Meade survey line. The slightly downstream location was chosen to minimize the influence of the surface features used by the survey.

• To create a 3D model we took thousands of photos with roughly 60% overlap in the horizontal and vertical directions. We used Agisoft Photoscaner 3D software to stitch the photographs together. The software uses photogrammetry to determine depth and connectivity of images to render a 3D model of the trench face.

• We field mapped the current surface features, to include ridges and swells, scours, and point bars. Aerial LIDAR data was used to create a digital elevation model (DEM) of PR141A. Aerial and satellite photos were collected to map the migration of point bar PR141A as a whole, and to track the evolution of the surface features of the point bar.

• A trench was dug along the axis of point bar PR141A (Fig 3a). The trench dimensions are 80m long, 1m deep, and a 1/2m wide. The limiting factor in depth was the water table. The location of the trench was 1m downstream of the Moosely and Meade survey line. The slightly downstream location was chosen to minimize the influence of the surface features used by the survey.

• To create a 3D model we took thousands of photos with roughly 60% overlap in the horizontal and vertical directions. We used Agisoft Photoscaner 3D software to stitch the photographs together. The software uses photogrammetry to determine depth and connectivity of images to render a 3D model of the trench face.

• We field mapped the current surface features, to include ridges and swells, scours, and point bars. Aerial LIDAR data was used to create a digital elevation model (DEM) of PR141A. Aerial and satellite photos were collected to map the migration of point bar PR141A as a whole, and to track the evolution of the surface features of the point bar.

Introduction

Although the internal architecture of a point bar has been studied, relationships between specific discharge events and specific bar architectures is not established. The purpose is to reconstitute the growth of the point bar and discrete accretionary architecture at the scale of years in order to determine the relationship between annual flooding events and bar accretion processes. The timing of events such as high precipitation months, floods, and effects of more than one event to the sediment deposition and internal geometry of the point bars will be compared. The history of the bar surface depositional features will be analyzed to produce and interpret the processes by which they were formed and modified. Relationships between bar-surface migration, accretionary bodies, accretionary crevices, and changes in river discharge rates are expected.

Results

• On average, one accretionary body is formed per yearly flood cycle.

• Fractured bars are caused from pole deviation of accretion sets caused by randomized composite constructional surfaces formed by selective and local stacking of multiple units.

• Surveys that do not match third order surfaces are the result of accretionary sets developing in either less than one year or more than one year per event.

Future

• Hydraulic equivalence will be determined comparing the mass of different grain types such as gravel, sand, or coal fragments. This relationship can help determine the type of sediment based on the flow, helping predict sediment volumes from different rainfall floods.

Architectures

Figures 4a through 6d are examples of architectures or geometries that are found in the studied point bar and are as follows:

Fig 4: Seasonal changes showing the result of incision - Fig 5: studying sign - Fig 6: phase curve building, and phase trend - Fig 7a trough cross-building.

The graphs below depict what type of bedforms will form under different flow volumes and velocities. The graphs below depict what type of bedforms will form under different flow volumes and velocities.

References


Hydraulic equivalence will be determined comparing the mass of different grain types such as gravel, sand, or coal fragments. This relationship can help determine the type of sediment based on the flow, helping predict sediment volumes from different rainfall floods.

Architectural and Chronostratigraphic Analysis of a Modern Point Bar: Powder River, Montana, USA

B. M. Warwick¹, J. M. Holbrook¹, and J. A. Moody²

¹ School of Geology, Energy, and the Environment, Texas Christian University, Texas, USA
² U.S. Geological Survey, Colorado, USA