Exploring the Oxbow Lake Facies Model at LeFleur's Bluff State Park, Jackson, Mississippi

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ABSTRACT

The classic facies model representing oxbow lake formation and evolution suggests a meandering river erodes its cutbacks at the neck of a meander and those two banks erode to provide the river a shorter course of flow. As the new foreshortened river course develops, the abandoned channel neck fills with a mud plug and subsequently disconnects the main channel from the newly established oxbow lake. In this traditional model, the sediment filling the oxbow lake are muds, representing the lower energy environment of the stagnant lake. Our study explores this traditional facies model by sampling the sediment near an oxbow lake within the Pearl River floodplain. Sediment from two hand-augured holes near Mayes Lake were sampled to analyze the texture, organic carbon, and soil color. The first site sampled was aligned with the middle of the channel of the current oxbow lake, but just above the standing water within the lake. The second site sampled was on the bank of the current Pearl River channel and oxbow lake. The percent sand content within the first site showed an overall trend of coarsening upward, while the second site showed the classic fining upward trend expected within a meandering fluvial system. Compared with samples from nearby Crane Lake oxbow, Mayes Lake oxbow textures contain much more sand. Using width/depth ratios to calculate average depths of the Pearl River channel, it is possible our sampling did not reach the classic mud plug.

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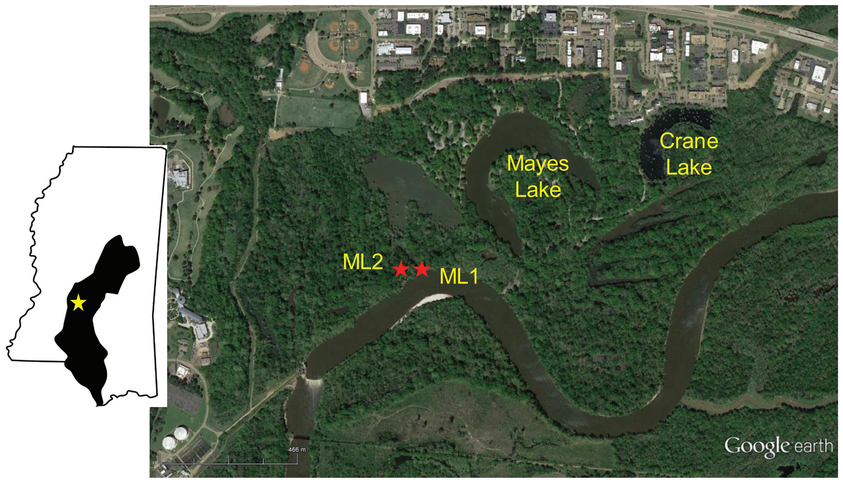
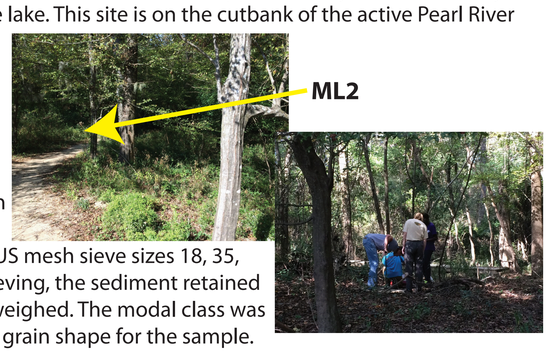
Introduction:
The classic facies model representing oxbow lake formation and evolution suggests a meandering river erodes its cutbanks at the neck of a meander and those two banks erode to provide the river a shorter course of flow. As the new foreshortened river course develops, the abandoned channel neck fills with a mud plug and subsequently disconnects the main channel from the newly established oxbow lake. In this traditional model, the sediment filling the oxbow lake are muds, representing the lower energy environment of the stagnant lake. Our study explores this traditional facies model by sampling the sediment near an oxbow lake within the Pearl River floodplain.



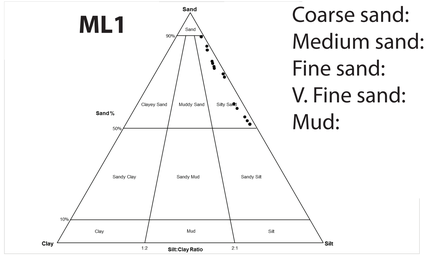
Study Area:
The Pearl River has its headwaters in Neshoba County in central MS and flows for 715 km to its mouth in the MS sound. It is a meandering coastal plain river with a drainage area of ~22,700 km^2. The floodplain consists of bottomland hardwood and cypress swamps. The study area in Jackson averages around 135 cm of rainfall annually. Mayes Lake day use area within Lefleur's Bluff State Park consists of three adjacent oxbows each with standing stagnant water.

Methods:
Our field methods consisted of hand augering two holes to collect sediment. We collected samples every 20 cm until we encountered the water table. At ML1, we reached a depth of 280 cm and in ML2 we reached a depth of 420 cm. Munsell color was determined in the field.

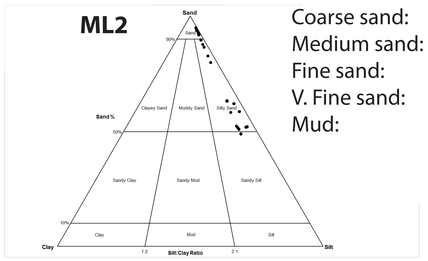
ML1 was located in the middle of the oxbow channel approximately 3 m horizontally from the stagnant water in the lake. This site is on the cutbank of the active Pearl River channel. As you can see in the picture ML1 was located just off the natural levee ~6 m above the water level on that day in the Pearl River. Each sample was air dried for a week before sieving them with a Ro-tap. Using ~100 g, sieving was completed using US mesh sieve sizes 18, 35, 60, 120, 230, and 325. After sieving, the sediment retained on each individual sieve was weighed. The modal class was used to determine an average grain shape for the sample.



Results:

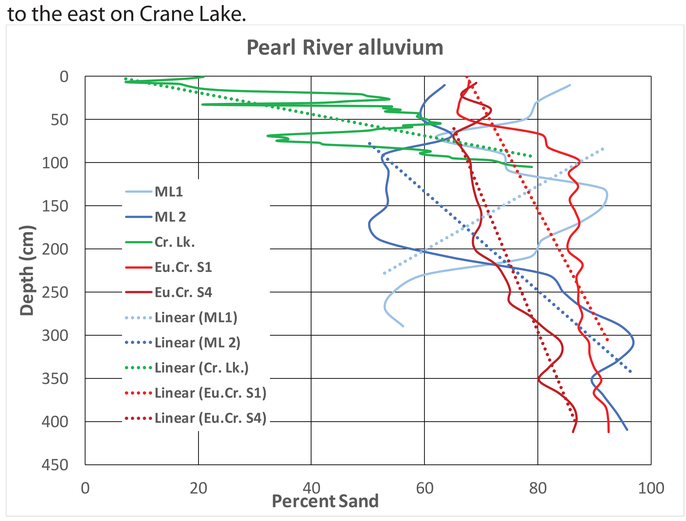


Coarse sand:	6.9%
Medium sand:	8.5%
Fine sand:	39.6%
V. Fine sand:	18.8%
Mud:	26.2%



Coarse sand:	4.1%
Medium sand:	19.5%
Fine sand:	34.8%
V. Fine sand:	14.9%
Mud:	26.6%

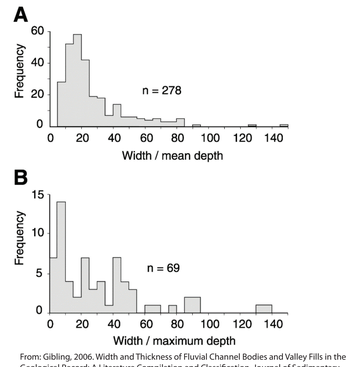
Other studies completed near Mayes Lake that we used to compare our texture results too included a study to the west on Eubanks Creek and a study to the east on Crane Lake.



GRADISTAT software was used to calculate statistics on the sieved data.
ML1 ranged from a low of 53 to high of 91% sand.
ML2 ranged from a low of 50 to high of 97% sand.
The percent sand curve shows a near inverse relationship of increasing and decreasing sand content at the two sites.
The coarsening upward sequence of ML1 may be the result of sediment from the modern Pearl River channel filling in over the older lacustrine material from the original oxbow lake. This is possible because the meandering streams in the Coastal Plain have extremely low relief and are subject to repeated episodes of overbank flooding. During these periods of overbank flood events, the loss of competence on the floodplain and specifically within lower elevation areas of the floodplain would lead to coarser sand sized material being deposited, while on the higher elevations of the floodplain finer material will be deposited. As deeper overbank waters deposit coarser sands in the Mayes Lake oxbow, finer sands will be deposited at the slightly elevated location of ML2.

Conclusions:
Texture characteristics of our Mayes Lake samples are similar to other Pearl River alluvium studies completed in the immediate area. What is different about our targeted site of ML1; the site where we expected to find the mud plug, is that it shows a coarsening upward trend.
The question becomes, what may explain this coarsening upward trend? A possible explanation could be that perhaps coarser overbank deposits are depositing within the lower elevation of the oxbow channel and creating the coarsening upward trend. Alternatively, we questioned whether our sample collecting reached deep enough to find a potential mud plug?

To address the depth question we used published width/depth ratios from Gibling, 2006. Width/depth measurements for modern channels are shown. In A), the Width/mean depth ratio for 278 surveyed reaches from two publications (in Church and Rood (1983) and Hey and Thorne (1986)), are shown representing datasets from 16 publications. The mean of those 278 reaches is 27. In B) the Width/maximum depth for 69 reaches is shown from Schumm (1960). The mean of those 69 reaches is 42.2.



From: Gibling, 2006. Width and Thickness of Fluvial Channel Bodies and Valley Fills in the Geological Record: A Literature Compilation and Classification. Journal of Sedimentary Research. 2006;76(5):731-770.

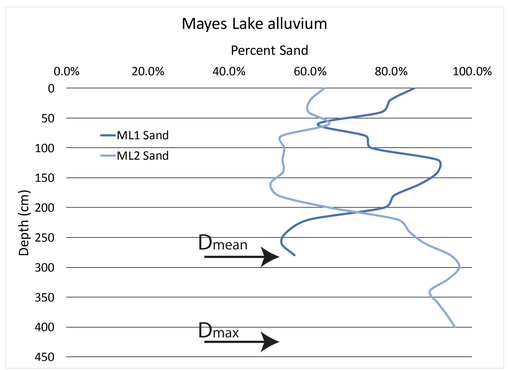
To determine depths for Mayes Lake oxbow we used an average of width measurements made at ten different straight reaches along the modern Pearl River channel between Mayes Lake State Park and the Ross Barnett Reservoir. The average of those ten banktop-to-banktop width measurements was 100 m.

If avg. W on Pearl is 100 m than: $100m/D_{mean} = 27$ $D_{mean} = 2.7$ m $100m/D_{max} = 42.2$ $D_{max} = 4.22$ m

The same studies mentioned above provided a ratio of Maximum to Mean Depth for the same reaches. The mean depth study revealed a maximum/mean depth ratio of 1.58. Using this 1.58 ratio and our calculated mean depth of 2.7 m we computed a max depth of 4.27 m.
Mean depth: 1.58 = x/2.7 m x = 4.27 m max depth

The maximum depth study revealed a maximum/mean depth ratio of 1.5. Using this 1.5 ratio and our calculated maximum depth of 4.22 m we computed a mean depth of 2.81 m.
Max depth: 1.5 = 4.22 m/x x = 2.81 m mean depth

In our two sampling holes, ML1 reached 280 cm, and ML2 reached 420 cm.
Our methods of computing mean and maximum channel depths based on Width/Depth ratios suggests that Mayes Lake oxbow should have a mean depth of 281 cm and a maximum depth of 427 cm.
It is plausible that our augured depths did not reach deep enough to find the mud plug formed when Mayes Lake oxbow was created.



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