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Influence of the Atchafalaya River on recent evolution of the chenier-plain inner continental shelf, northern Gulf of Mexico

A.E. Draut[a,*], G.C. Kineke[b], D.W. Velasco[c], M.A. Allison[d], R.J. Prime[b]

[a]*University of California, Santa Cruz/US Geological Survey, 400 Natural Bridges Drive, Santa Cruz, CA 95060, USA*
[b]*Department of Geology & Geophysics, Boston College, Chestnut Hill, MA 02467, USA*
[c]*Sontek/YSI Inc., 6837 Nancy Ridge Drive, San Diego, CA 92121, USA*
[d]*Department of Earth & Environmental Sciences, Tulane University, New Orleans, LA 70118, USA*

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Abstract

This study examines the influence of the Atchafalaya River, a major distributary of the Mississippi River, on stratigraphic evolution of the inner continental shelf in the northern Gulf of Mexico. Sedimentary, geochemical, and shallow acoustic data are used to identify the western limit of the distal Atchafalaya subaqueous delta, and to estimate the proportion of the Atchafalaya River's sediment load that accumulates on the inner shelf seaward of Louisiana's chenier-plain coast. The results demonstrate a link between sedimentary facies distribution on the inner shelf and patterns of shoreline accretion and retreat on the chenier plain. Mudflat progradation on the eastern chenier-plain coast corresponds to the location of deltaic mud accumulation on the inner shelf. On the central chenier-plain shelf, west of the subaqueous delta, relict sediment is exposed that was originally deposited between ~1200 and 600 years BP during activity of the Lafourche lobe of the Mississippi Delta complex. Mass-balance calculations indicate that the eastern chenier-plain inner shelf and coastal zone form a sink for $7 \pm 2\%$ of the sediment load carried by the Atchafalaya River.

Keywords: Mississippi Delta; Chenier plain; Continental shelf stratigraphy; Coastal sediment; USA; Gulf of Mexico; Louisiana

1. Introduction and objectives

Understanding the processes and pathways of sediment dispersal from a fluvial source in a shallow marine environment is a first-order research concern in modern and ancient sedimentary systems. The goal of this study is to improve constraints on the factors that govern fine-grained sedimentation and geomorphic evolution on the chenier plain of western Louisiana, a classic area for the study of mud-dominated sedimentary systems. To better define nascent stratigraphic development within the young Atchafalaya sedimentary system,

*Corresponding author.
E-mail address: adraut@usgs.gov (A.E. Draut).

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this study has examined temporal and spatial evolution of deltaic sedimentary facies on the inner continental shelf. The results link inner-shelf facies distribution to coastal geomorphic variability, and allow estimation of a sediment budget for Atchafalaya River deposits on the shelf.

1.1. The Mississippi–Atchafalaya River system

Quaternary development of the Mississippi Delta complex was affected by continental glaciation and the corresponding decrease in eustatic sea level, which reached a minimum at ~18 kyr (~120 m below present; Fairbanks, 1989). During this sea-level lowstand, Mississippi sediment was delivered to the outer edge of the continental shelf while fluvial channels incised the shelf and older deltaic deposits. After 18 kyr, as Holocene sea level rose, fluvial sediment filled alluvial valleys (~18–9 kyr) and then, after ~9 kyr, began to construct the modern delta plain (e.g., Coleman, 1988; Tye and Coleman, 1989; Saucier, 1994). Since the last glacial maximum, the Mississippi River has built six major delta lobes onto the continental shelf of the northern Gulf of Mexico (Fig. 1, Table 1). Each delta lobe was at one time the primary locus of river deposition (Frazier, 1967; Coleman, 1988). Four of the six lobes are relict features that no longer receive sediment but are subsiding and being reworked by waves. The fifth, the Balize Delta lobe, has been the active Mississippi depocenter for the past 800–1000 years (Coleman, 1988; Saucier, 1994; Roberts, 1997). The sixth, at the mouth of the Atchafalaya River, represents a new lobe being built at the western edge of the delta complex as the Mississippi has begun to abandon the Balize course in favor of the Atchafalaya route.

Diversion of Mississippi flow to the Atchafalaya had occurred by the 16th century, as a meander bend of the Mississippi intersected the Red River, whose course below the capture site was known as the Atchafalaya. In 1963, the US Army Corps of Engineers completed a control structure that maintains the proportion of Mississippi discharge carried by the Atchafalaya at no more than 30%. As Atchafalaya discharge increased naturally prior to construction of the control structure, the intrabasin lakes and swamps filled with sediment (e.g., Tye and Coleman, 1989). By the 1950s these were largely full, and a subaqueous delta had begun to form in shallow Atchafalaya Bay (Rouse et al., 1978; Van Heerden and Roberts, 1980, 1988; Roberts et al., 1997). Subaerial exposure of the

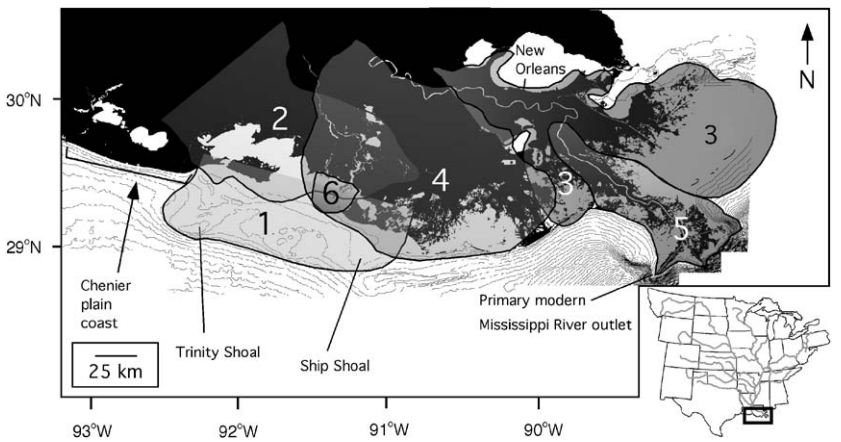

Fig. 1. Six major depocenters of the Mississippi Delta complex that have developed since 9 kyr. In order from oldest to youngest, these are the Maringouin (1), Teche (2), St. Bernard (3), Lafourche (4), modern (Plaquemines–Balize, 5) and Atchafalaya (6) lobes. Figure modified from Penland et al. (1990), based on radiocarbon dating work of Frazier (1967). Within each major lobe there are between three and six smaller sub-lobes (not shown). Bathymetric contour interval is 2 m. Inset map shows drainage basin of the Mississippi River, with box indicating enlarged area of the Mississippi Delta.